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**L'OFFICE PARLEMENTAIRE D'ÉVALUATION
DES CHOIX SCIENTIFIQUES ET TECHNOLOGIQUES**

on

INNOVATION AND CLIMATE CHANGE: THE ROLE OF SCIENTIFIC AND TECHNOLOGICAL ASSESSMENT

Transcript of the Public Hearing of September 24th 2015 and considerations resulting from these debates, to be transmitted to the negotiators of the COP21

BY

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PREAMBLE

The European Parliamentary Technology Assessment (EPTA) has been bringing together, for over twenty-five years, sixteen structures dedicated to scientific and technological evaluation for European parliaments. The rotating presidency organizes two annual regular meetings to share material. In 2015, the OPECST had the honour of assuming this presidency and was fortunate to have the full support of its EPTA counterparts to prepare the public hearing of September 24th 2015. It was designed to assess the role of innovation in the fight against climate change, with a goal of supporting the development of technological systems, which inherently release less greenhouse gaz.

This public hearing was awarded the COP21 label, as recognition of an initiative to ensure the success of the Conference of the Parties to the United Nations Framework Convention on Climate Change, to be held in Paris from November 30th to December 11th, 2015.

With the support of the EPTA and scientific services of foreign embassies in France, the hearing met the scale of a real European parliamentary conference: twenty-seven national elected officials from all European countries, including thirteen chairs of standing committees, were delegated by their Parliament.

The meeting's symbolic significance was twofold: firstly, to illustrate, during the preparation of a major international event like the COP21, the contribution of technology assessment to the steering of public policies; secondly, to celebrate the thirtieth anniversary of the first OPECST report. It had analysed, back in 1985, the phenomenon known as "acid rain".

This document covers all three parts of the participants' contributions to this event of a European scale.

It opens with "considerations", drawn from experience shared during the debates and their preparation. These "considerations" mark the collective wish of the EPTA organisations to attract the attention of COP21 negotiators on the role of innovation in the fight against climate change and in the policies required to adapt to this change. These considerations were discussed on September 23rd 2015 at the annual EPTA meeting, and were presented in outline at the conclusion of the public hearing on September 24th 2015. They were then modified to take into account what was added during the debates, and finally were adopted by the EPTA.

The second part of the document contains the proceedings of the actual public hearing, in which nearly a hundred speakers intervened.

The third part consists of the "Green Paper" developed collaboratively by the EPTA organisations to take stock of technology assessments conducted in their respective countries on the subject of public policies to fight climate change.

All these texts constitute the contribution of the EPTA, fully supported by the OPECST, to the preparation of the COP21.

Jean-Yves LE DÉAUT
Member of Parliament
President of OPECST
President of EPTA for 2015

CONSIDERATIONS RESULTING FROM THE DEBATE FOR A TRANSMISSION TO THE COP21 NEGOTIATORS

On the basis of a previous collaborative work, the delegates attending this conference, after a broad consultation, came to conclusions on the issue of innovation and climate change, with particular attention on energy consumption.

They suggest to take the following points into consideration.

General policy options

1. Support for innovation must be at the core of climate change strategies for reducing society's greenhouse gas emissions. This requires a systematic coupling of binding measures to limit the use of some technologies (such as driving prohibition for certain types of vehicles), with incentives to develop alternative solutions.

2. Promote measures in favour of transition management as a way of dealing with climate change.

3. Allocate sufficient means to researches regarding adaptation policies.

4. Maintain a wide range of research on techniques to reduce CO_2 emissions to explore all possible technological ways and thus increase the probability for new solutions to emerge.

5. Encourage Parliaments to evaluate new technological opportunities taking into account whole lifecycle so as to concentrate financial resources on the most efficient solutions.

6. Ensure that public financial support to develop technologies allowing a reduction of CO_2 emissions includes some subsidies, allocated to studies about users' involvement.

7. Sustain policies focused on results and not on means, and give priority to methods measuring "on the spot" both energy consumption and CO_2 emissions.

8. Establish and promote international co-operation and partnership on research and forecasting of climate change and environmental conditions.

General technical options

9. Look through past efforts to tackle air pollution (acid rain, gases destroying the ozone layer) in order to draw new lessons for the fight against CO_2 emissions.

10. Prioritise the development of cost effective solutions for massive inter-seasonal energy storage.

11. Develop public research programs investigating on CO_2 conversion techniques (such as methanation and other technologies of CO_2 processing).

Technical options by sector

In the building sector:

To achieve concrete results in the reduction of CO_2 emissions related to buildings:

12. Apply option 7, and especially …

13. Focus thermal building regulations on results rather than means.

14. Extend to all carbon neutral building projects, regardless of their design, financial support dependant on duly verified performance, so as to include Passivhaus or Minergie projects on a fair basis for example.

To speed up the renovation of old buildings:

15. Establish a plan of incentives for old buildings renovation based on allocation to whole renovation projects, after a global analysis of flaws to be corrected, financed by limiting aids to products installed without any previous global analysis.

16. Introduce renovation funding mechanisms enabling that loan reimbursement occurs at the time of property transfer or succession, the debt being mortgaged on the increase in asset value as a result of better energy efficiency

17. Support the installation of active energy management systems, with smart meters, thus allowing users to take control of their building's energy performance.

To speed up the dissemination of innovation:

18. Facilitate the testing of new technical solutions by establishing specific mechanisms to insure the first implementation of innovations.

19. Ensure, with the opening of technical bodies and new controls at the European level, maximum transparency on technical evaluation procedures for products, and on standards development.

In the agriculture sector:

20. Expand both research effort and lifecycle assessments in the field of second and third generation biofuels, so as to best target progress made in this field.

21. Retain control on the conditions in which agricultural land can be allocated, in a balanced way, to energy crops and to food.

22. Organise a legal framework for data recovery at the European level to supply Big Data systems, essential for precision agriculture.

23. Promote measures to develop the necessary skills and advisory mechanisms for farmers in the future.

24. Encourage both maintenance of traditional and innovative farming, in order to maintain the possibility for "frugal" innovations to emerge.

25. Preserve and try to expand the ability of forests and oceans to store CO_2.

26. Establish international partnerships to make further progress, on recovery, treatment and desalination of water.

In the transport sector:

27. Give priority to support research and innovation in order to quickly reach the goal of cars producing less than 2l/100km.

28. Regularly set more stringent obligations on consumption and CO_2 or particles emissions, while supporting efforts to develop more efficient technologies in this regard (innovation in engines, fuels or batteries).

29. Establish at the European level the terms of a regular and transparent monitoring of current vehicles' performance regarding consumption and CO_2 and particles emissions.

30. Set up the necessary infrastructures to charge electric vehicles and to distribute hydrogen, compressed air and natural gas.

31. Encourage the creation of multimodal platforms to ensure complementarity between means of transport.

32. Reduce the need for travel through virtual access, making use of new technologies.

33. Provide benefits for environmentally friendly vehicles on public roads, highways, and parking lots (cost reduction, priority access …).

34. Strengthen the legal basis for new uses of vehicles, where passengers get into touch via Internet websites (carsharing, carpooling or more intense use of corporate fleets).

35. Prepare the legal framework, in particular regarding liability, necessary for the development of driverless vehicles.

In the area of citizens' involvement:

36. Support experiments aiming at nudging the use of these new technologies.

37. Support means for raising citizen's awareness and for involving them in the decision making process prior to the introduction of innovation.

38. Promote a public discussion at European, national, regional and local levels on the extent of the necessary financial means, geared especially towards innovation, to achieve tangible results by the middle of the century, in terms of reduction in CO_2 emissions.

All of the above mentioned options deserve assessment of the technologies involved. Thus, climate change action (prevention, mitigation, adaptation) may be balanced with the needs and expectations of society and lead to better political decision-making.

OPENING CEREMONY

Mr Jean-Yves Le Déaut, MP, President of OPECST, President of EPTA for 2015. Dear colleagues and friends, let me thank you for attending this meeting hosted by the Office for Scientific and Technological Assessment (OPECST). The European Parliamentary Technology Assessment (EPTA) network was established some 25 years ago following an initiative of Lord Kennet, chair at the time of the UK Parliamentary Office of Science and Technology (POST), who made sure to tour all the different European capitals to create a body of European parliamentary members focused on scientific and technological matters.

This meeting is taking place to coincide with the French presidency of EPTA in 2015 – Austria will take over next year – and today we have decided to tackle the hugely important topic of innovation and climate change, a subject that will be introduce by Mr Jean Jouzel. Mr Claude Bartolone, President of the National Assembly, has apologised for not being with us this morning; he will, however, be at the lunch celebrating the thirtieth anniversary of OPECST.

Our first report was issued in 1985; headed up by our late colleague, Mr Georges Le Baill, this report focused on the topic of acid rain. Today we are very happy to host 27 Members of Parliament from 16 European countries, as well as a number of experts on technology evaluation from some 30 countries including the United States, Korea and Russia. We thank them for being here with us today.

Indeed, we have actually broadened our original vision for this meeting. EPTA has some 20 member countries but we have opened it to all members of the European Economic Area in order to encourage European parliaments who have not yet established a Technology Assessment office to take the plunge and to join our club. We invite these countries to join EPTA and to participate in this European initiative. On that note, let me just thank Paul Rübig, the Chairman of Science and Technology Options Assessment (STOA) on behalf of the European Parliament, who is here with us today.

I think our exchanges will be all the more interesting because our speakers represent the entire scientific community, all with interests in promotion, distribution and innovation in the area of climate change. Of course, innovation is not the only solution in the fight against climate change, but sometimes we focus too much on matters of tax or regulations without actually seeing that science and research can be a way forward in a positive direction. That is not to say that it cannot lead us in a bad direction as well, but today we are going to focus on forward strides in innovation in the fight against climate change and global warming.

This conference has the support and sponsorship of COP21, the twenty-first Conference of Parties on climate change, which is being held in Paris in two months' time.

The four workshop topics were selected by our EPTA colleagues during our meeting at the end of April. The topic of agriculture was introduced at that time and confirmed during a meeting of our Scientific Council on 9th June. This topic seeks to focus on the types of innovation that aim to ensure better management of energy demands in terms of basic human behaviour: eating, housing and transportation. We are trying to get individual citizens involved in terms of their daily activities to reduce greenhouses gases. We want to focus on actions that can be taken around energy demand on the supply side, opening up the topic to one that is common to all countries and allowing for broad and open exchange of our different experiences.

Adaptions of energy supply also have a strategic dimension in terms of the geography and history of each country, as well as the fundamental policy choices that have been made. The problems the countries of the South have to solve are not the same that the ones the countries of the North have to solve.

This conference does not seek to discuss nuclear energy or hydrocarbons and their role in generating electricity, even though these are of course very important issues. This is particularly true in France where the recent law on energy transition aims to reduce the nuclear share in the electricity mix down to 50% by 2025 while maintaining research efforts for the fourth generation of nuclear reactors.

Claude Birraux, Christian Bataille and Bruno Sido looked into nuclear power following the Fukushima accident in 2011, and recommendations from their work have been followed in the energy transition law. The progressive decrease in the production of nuclear power to reach 30-40% by the end of the century should be based on a minimum production of stable energy from a nuclear source; most people rely on gas and goal for this but France has maintained its choice that it took in the early 1970s to abandon coal. Given that renewable energies are often a combination of local efforts to reduce greenhouse gas emissions, these discussions will very much be part of our conference.

Each topic will be the focus of a 90-minute workshop which will be introduced by framing comments followed by a fully open discussion. Based on the rules of OPECST and the European Council, each speaker outside of the initial introductory remarks will have only two minutes to make their point but can have a second speaking turn if possible.

Throughout the day we will be discussing technological advances and we will be hearing feedback about experiences already implemented across different countries. Nonetheless, we felt that certain areas of research have a specific strategic character and they should be taken up during the course of the day on the

matter of innovation and climate change; these will take the form of special presentations on the ‘new frontiers’ of research that will come at the end of each workshop. Topics will include research areas that we have been following for a number of years such as solar power and CO_2 conversion. In March I visited a research institute in New Mexico and, although it is still at an experimental stage, there is a carbon dioxide experimental reactor which uses a solar-based process for the production of methanol.

We will also be considering future forms of mobility and transportation, looking at some of the successful experiments involving citizens. As we all know, we cannot win the fight against climate change without fully involving our fellow citizens.

Let me just wrap up by saying that we are celebrating the thirtieth anniversary of OPECST in 2015. We will be celebrating it this afternoon and two presentations should enable us to find out a little bit more about the first topic we studied, acid rain. This will be all the more interesting because, looking back, acid rain seems like a much smaller version of the type of problems that we face on the planet today.

EPTA’s Green Paper contains 16 presentations that will form the point of departure for our discussions. We will be putting together general recommendations to send to the COP21 organisers to become part of the documents taken into consideration by the negotiators. So this conference does have a specific role: we do not want innovation to be forgotten and we want to tell negotiators that the fight against climate change also has to go through our parliaments. Without parliament there would be no forward strides, and I think we all know that, so I am really counting on you to send out strong signals from today’s discussions.

Thank you for being here and thank you for the quality of the exchanges that I am sure we will be having today.

Mr Bruno Sido, Senator, First Vice-President of OPECST. Thank you, Mr President. I just wanted to send my greetings and welcome all the Members of Parliament, scientists and others who are with us today.

We have heard about the high points in the life of the EPTA from President Jean-Yves Le Déaut, but my role is now to call your attention to another event that justifies the holding of this gathering. That is the thirtieth anniversary of OPECST, or rather the publication of its first report on acid rain, as our President just said, in 1985.

The Office was born in 1983 from a heady ambition: to put our finger on those scientific and technological topics that raised complex problems and to popularise knowledge about them for Members of Parliament before they enacted laws on these important topics. This was clear and praiseworthy goal, but there was always a risk of not actually fulfilling our objectives. Thirty years later,

however, I can say with certainty that the Office has played its role; through the magic of the methodology that we have used for our studies, we have been able to see the participation of very involved Members of Parliament.

In terms of the composition of OPECST, there are 18 Members of Parliament at each assembly, all of whom are volunteers, and we have a Scientific Committee of 24 members. At a very high level we have interviews and visits which keep the Office in touch with university researchers and the corporate world.

We are very attentive to the types of science and technology topics that we should discuss, selecting subjects that are already up for discussion or potentially up for discussion in Parliament. The Office holds public hearings and also receives advice at regular intervals from a group of specialists set up by the 'rapporteurs' for specific studies. We have a twofold secretariat made up of people from Parliament in charge of proceedings with summaries and draft studies.

In his quasi-political essays, Paul Valéry wondered what the response of the greatest scientist of the day would be in the eighteenth century if, somewhere deep in the depths of hell, a messenger from earth showed them a dynamo. He felt that Archimedes, Newton, Galileo and Descartes, who had never heard of electricity or induction, would have found this object very mysterious indeed. Similarly, today the Office hears from Volta, Ampere, Faraday and others who enlighten the readers of its reports.

So, in spite of the Office's methodological precautions, all of this might have been a failure from the very first report onwards. It looked at a topic that was actually a bit of a taboo and divided scientific opinion at the time, i.e. the long-term atmospheric pollution known as acid rain which led to the deterioration of forests in the east of France and the west of Germany.

Let me just pay tribute to those who were involved in that study, in addition to the late Georges Le Baill, and implemented the working methods that have been those of the Office from the start. They concluded that the phenomenon of acid rain added to the influence of numerous pollutants, including automobile emissions, and the effects on soil; this knowledge is now commonplace and accepted as common sense. We have had studies involving 800 pages and summaries of public hearings; this is an impressive corpus of knowledge and I think it has become somewhat of a reference point within the scientific community.

The EPTA meeting will be focused on innovation in the fight against climate change. It is my pleasure to draw your attention to the fact that the method I have described has worked very well. In 2002, Senator Marcel Deneux suggested that the Office should deal with climate change in the year 2100; this work led to the first parliamentary report on climate change and to some one hundred recommendations which can be found in the lobby area. Unfortunately, not all of

his recommendations have been implemented, and what was urgent 12 years ago has now become an even more pressing priority.

I will also mention something specific about the Office's methodology; it gives specific attention to the choice of words used in its studies. Indeed, the title of the 2002 report did not use the term "global warming", which we felt was too vague and did not directly mention the climate. We also chose not to use the term 'climate change' in the singular; this made it appear that there would only be one simple climate change and it that it was much easier to see than the actual very complex reality that we have to deal with.

The Office decided to use the term 'climate changes,' in plural, to specifically mention the climate, not to speak specifically of warming (because cooling is also involved) and to also mention the multiplicity of changes that we have to expect and even fear. More recently, in my latest report on corporate digital security with Mrs Anne-Yvonne Le Dain, we also decided to choose very clear French terms which are easy to understand, all the while mentioning their English equivalents and also providing clear explanations of the more technical terms.

To conclude, first of all let me wish you a very fruitful day of work here in Paris. I would also like to ask you to remain informed, both today and into the future, about the original methodologies that our different parliaments have used and that have helped us here at the Office improve our own. You will have an opportunity to take a look at these during the course of today's discussions.

Mr Jean-Yves Le Déaut. Thank you very much, Bruno. Let me now give the floor to Jean Jouzel, a member of the IPCC, CNRS gold medal recipient and who, on behalf of the IPCC, received the 2007 Nobel Prize.

Mr Jean Jouzel, Member of the IPCC. Thank you, Mr Chairman, I am delighted to be here today. First of all I would like to congratulate the Office on its thirtieth anniversary. I am a researcher myself and I think it is a very good thing that there should be Parliamentarians in France who take a keen interest in innovation.

When we talk about global warming, it is not possible to limit it to 2°C just like that (and I will try to explain why we have to work towards that target in a moment); it is something that we will not be able to achieve in the absence of research, including basic research, and innovation. It is a true change of development we have to implement in all areas; technology will change so we have to look to these innovations in the fight against climate change. These are all topics that we will be broaching today.

I shall also be referring to timescales. You mentioned acid rain, which of course is very interesting, and you also mentioned the ozone problem. Now, there are some similarities between the two; the ozone was largely resolved through

innovation and there are similarities with climate change or global warming, but that is far more complex.

Let me tell you where we stand in terms of global warming. Why must we remain below a 2°C increase, why is that essential and how does it involve innovation? Well, the situation today is that if nothing were done against global warming, by the end of the century there would be in increase in temperature of 4-5°C and it would rise to over 6-7°C by the end of next century. Consequences would be mainly negative in all areas: acidification of oceans, for example, and extreme weather events like tornadoes and heat waves. The latter will not necessarily be more numerous, but will become much stronger; in France, for instance, by the end of the century heat waves could be 7-8°C higher. The summer of 2003 was only 3°C above average and that was definitely a very bad memory for us.

Equally, if nothing is done against global warming then population-related issues would increase, such as migration due to lack of access to water, issues with food security, loss of biodiversity, health and natural ecosystems. There are also irreversible aspects such as the rise in sea levels, some 20cm, and the melting of permafrost which nobody can stop: it is going to continue. If we do nothing to fight global warming then the situation could become quite dire; we really have to remain below the 2°C mark, and that is at the heart of the Paris climate conference.

Clearly what we will need is a different type of development. If you look at the composition of greenhouse gases, fossil fuels make up about two thirds, possibly three quarters of the increase in greenhouse gases every year. There is agriculture; agricultural practices, which will be discussed today, account for about 20%, and then there is deforestation at 10%.

Central to this, especially in terms of long-term stabilisation of the climate, is the accumulated level of CO_2 that is produced. If we want to stay below 2°C only 800 billion tons of CO_2 can be emitted; if we look at our reserves of fossil fuels which are easy to tap, both financially and technologically, we have 5,000 billion tons. So, if we want to remain below 2°C, we have to leave 80% of the easily accessible fossil fuels where they are.

We cannot go on with ‘business as usual’ for the next twenty years and then do nothing after that; obviously we will need a total change in our development. Innovation has to work for new uses. There are a lot of obstacles – town planning, energy storage, *etc*. – so you need basic research and innovation in these areas. I am quite certain that innovation will be the key to success in the fight against global warming and the 2°C limit.

I referred to the fact that the ozone was a problem that was resolved through innovations. Chemists were able to produce new chemical compounds which resolved the ozone layer issue, but these chemicals were greenhouse gases;

at the time, people realised that if they stopped using CFCs, the ozone situation would return to what it was before the industrial era. It is quite similar, but in this case innovation covers all areas of everyday life; the innovations that are needed for agricultural practices, transport and so on.

Then there is another problem, and it is something that should be a concern for each and every one of us, as is the case in France; many emissions are due to the way we move about, transport that is, and the way in which we live in our homes and heat them and use energy. We can all have an impact on the emissions of our countries.

So, every individual is implicated. There has to be an ambitious agreement at the Paris conference, but local authorities, NGOs, the educational system, the media all have to come on board as well. I am very glad to see that you Parliamentarians are fully mobilised for the COP21 event. I truly believe that innovation is the key if we are to limit global warming to 2°C.

Mr Jean-Yves Le Déaut. Thank you very much, Jean, for these introductory remarks. I would now like to give the floor to Mrs Patricia Lips, Chairwoman of the Committee on Education, Research and Technology Assessment at the German Bundestag. She has hosted us several times at the Bundestag and I would like to thank her for being here today.

Mrs Patricia Lips, Chairwoman of the Committee on Education, Research and Technology Assessment at the German Bundestag. Mr President, Mr Le Déaut, Senator Sido, fellow Parliamentarians and Senators, scientists and expert members of the EPTA community, we are meeting here for at least three reasons and I am not quite sure which of these I should address first in my speech. Should it be the annual EPTA meeting, Mr Le Déaut, which this year is taking place here in Paris under your presidency? Or should it be the topic of innovation and climate change which you have chosen as the key theme of the conference?

These subjects are important, highly topical and forward-looking, but permit me, if you will, to start instead with something else: OPECST is celebrating its thirtieth birthday today, and I would like to extend my warmest congratulations to you, to Mr Le Déaut, to Mr Sido, to all the Parliamentary Members, Senators, to those who initiated the Office and developed it, and to those who worked in it and continue to do so.

I would also like to pass on the good wishes of my colleagues in the German Bundestag and our Committee on Education, Research and Technology Assessment. They ask for your understanding that because of the very full first week of sittings in Berlin, many of them are unable to be with us today.

As we heard, in 1983 the National Assembly decided to establish OPECST for the purposes of advising Parliament on questions relating to scientific and technological developments. In 1985 you presented the first report

on long-range forms of air pollution. At the time, the German Bundestag had already been debating for over ten years whether it needed technology assessment to provide policymaking advice in the area of science and technology for its works. While there was agreement between the parties and parliamentary groups that we did need it, there was no agreement on what form it should take or how it should be organised. It was not until four years later in 1989 that our Parliament voted to establish this kind of office: we call it TAB.

Now that your Office, the somewhat older sister to our TAB, has come of age, there are no longer any doubts in the respective Parliaments about the existence and the need for them. This brings me to the second reason for our meeting here in Paris; the international TA family and its cooperation in EPTA.

Ladies and gentlemen, international cooperation in the field of TA has developed enormously in recent years. The EPTA community has expanded from six members in 1990 to 13 full members today, and some more associated members. The first informal annual EPTA gatherings have developed into full-blown working meetings. This spring, the four-year European PACITA Project, funded under the Seventh Framework Programme (FP7) for research, drew to a close in Berlin, and I have every hope that more countries will decide to establish TA or even parliamentary TA.

France, with its international engagement, has always been the engine driving international cooperation in the field of TA. I would like to recall the final declaration of the meeting of European Parliamentary Committees and Offices for Scientific and Technological Assessment almost exactly seven years ago in September 2008 in Paris. It stressed the role of parliaments in fostering the debate between experts, parliamentarians and citizens on scientific and technological advances. It encouraged national parliaments to step up their cooperation in the field of TA, to exchange expertise more efficiently, to share best practice, to use these results and, in particular, to consolidate the parliamentary dimension of EPTA.

Mr Le Déaut, Mr Sido, the French presidency of EPTA in 2015 will further strengthen the networking and cooperation of TA partners, but it will also raise the profile of the work of parliamentary TA beyond the circle of the informed. EPTA is to publish the results of today's expert hearing on the very ambitious topic of innovation and climate change in a Green Paper and will send out a signal beyond EPTA. I fully support the intention to feed the contributions of EPTA partners and the findings of today's hearing into the debates in this year's UN climate change conference in Paris in December.

To meet its target of reducing greenhouse gases by 40% by 2020, Germany is focusing in particular on expanding renewable energies and improving energy efficiency. Innovation and climate change is also a priority area of our TA in the German Bundestag.

I would like to mention briefly a few studies commissioned by our office which relate to the topics discussed today; these reports are also subject to discussion in parliament, and most of the studies relate to subject areas two and three here. These reports include: *Prospects for low-carbon and low-emission transportation*; *Fuel cell technology*; *Electro-mobility concepts and their importance for commerce, society and the environment*; *Carbon capture and storage in power stations*; *Energy storage systems*; *Management of the carbon cycle*; *Climate engineering*; *Precision agriculture*; *Opportunities and challenges of new energy growth*.

So far we have only commissioned three studies on the subject of energy efficiency of buildings, and innovation and public involvement in this area: *New materials for energy saving and energy conversion*; *Use of renewable raw materials in the construction sector*; and, on the subject of public involvement, *Possibilities for action with respect to communication and involvement in the expansion of the electricity grid*. We will, however, consider devoting more attention to these subjects in our TA in the future.

As I end my remarks, I would like to wish today's event every success. I would also like to take this opportunity to tell you that we are also celebrating an anniversary in December this year, when TA in the Bundestag and our TAB will be 25 years old. We will celebrate this birthday on 2nd December in the German Bundestag and I extend a very warm invitation to you to attend this celebration. The main theme of this event will be Human-Machine Interaction, and we will be looking at the technological developments contributing to the phenomenon of the dissolution of boundaries between humans and machines. I hope we find some answers! Thank you very much. As I said, my best wishes for a successful day.

Mr Jean-Yves Le Déaut. Thank you very much, we will be more than happy to take up this invitation; indeed, we will actually be having our own hearing on Robots and Policymaking very soon. As we have finished all the opening speeches, we are now going to hear from Mr Patrick Criqui, Director of Research at the French National Centre for Scientific Research (CNRS), who will be talking about worldwide assessment of the role of innovation to reduce CO_2 emissions.

FORECAST INTRODUCTION

WORLDWIDE ASSESSMENT OF THE ROLE OF INNOVATION TO REDUCE CO_2 EMISSIONS

Mr Patrick Criqui, Director of Research, CNRS. Thank you, Mr President, Mr Vice-President, ladies and gentlemen. Thank you very much for your invitation, I am more than happy to be here today and give you an overview of how important technology is against a backdrop of low-carbon economies.

I am going talk about the main findings of the studies that are the fruits of two international research programmes. The first is the Deep Decarbonisation Pathways Project (DDPP) which was launched in 2013 by Jeffrey Sachs, Special Advisor to UN Secretary-General Ban Ki-moon, and Laurence Tubiana. This project aimed at stimulating the production of low-carbon scenarios, i.e. scenarios that tie in with the 2°C threshold that Jean Jouzel mentioned earlier. There are 15 teams from different countries devoted to this task of designing low carbon scenarios.

The second project, which built on the work of the DDPP, is an effort made by ANCRE, a French institute set up in 2009. This programme fosters exchange between researchers from large public institutions, be it universities or the French Institute for Oil, the CNRS etc. The idea that we had in our workgroup was to build on the scenarios that come from this report to try and understand how useful technology and innovation can be to drive down greenhouse gas emissions in the long run.

This brings me to talk about climate stabilisation wedges. If we do nothing, greenhouse gas emissions will increase; as such, what we want to do is use different levers – or different wedges – to drive down greenhouse gas emissions. In 2012 Dr Jim Williams, an advisor on low-carbon transformation pathways, stated that there were three building blocks for the decarbonisation of a system; energy efficiency, decarbonisation of electric systems and development of low-carbon energy vectors. As we all know, transport is the sector that depends the most on fossil fuels, particularly oil, but we need to decarbonise the electric system before moving to a system that is more geared to electricity.

These three building blocks are absolutely crucial and they guide all the scenarios that can be found in the deep decarbonisation project that we worked on at ANCRE. In our work we have tried to identify 17 technologies or decarbonisation wedges. We consider that there are a number of levers in terms of energy efficiency and, on the other hand, there are decarbonisation levers such as substituting electricity for fuel.

Then of course there are the biogas and natural gas networks, and we have identified a number of areas for capturing carbon as well as substituting coal for gas (we could talk about this at length, but we know that gas is as effective as coal and releases half as much CO_2; in fact, this is the option that the United States opted for many years ago.) Then there is onshore and offshore wind energy, solar energy biomass and other applications such as geothermal energy.

These are the 17 options that we have tried to identify and quantify in order to understand how important they are in these different deep decarbonisation scenarios. I do not plan to go into the detail of the results at this meeting, but the four graphs that we have here – which show developed and developing countries and low and high-carbon countries – demonstrate how we can start to build an analysis based on prospective results.

The results are also a good way to show how we can measure the impact of the main 17 technologies in driving down greenhouse gas emissions and it also shows how the contexts are different from one country to another. For example, in emerging countries that release very little CO_2, decarbonisation is not an important lever because in these countries energy consumption is quite low so there is little room to manoeuvre. However, these countries must not start consuming a lot of energy; unfortunately this is what is forecast in the different scenarios.

Demand vectors are also crucial, in fact they are as important as the supply vectors. The innovations that need to be implemented to achieve decarbonisation are as important in our study as the supply side of things, in other words the development of low-carbon energy production. This of course has many implications, but I think the main one is that on the demand side we need to innovate from a technical, social and behavioural point of view, and we have talked a lot about how important local regions are going to be in the rolling out of the low-carbon or decarbonisation programmes and projects.

The second key point that we can derive from this kind of analysis is the importance of solar and wind energy in many countries and many regions. I think we need to rethink the architecture of the main energy system, especially for electricity, and I think that in the future we should have super-grids to strike the right balance between supply and demand, and also smart-grids, maybe at a more local level, to be more flexible in meeting the demands of users. We will also need to consider energy storing techniques. These are the main innovations that we need to be able to achieve.

In our workgroup, or rather in the ten workgroups that we have set up, we have focused on areas such as nuclear power, solar power, the transport industry, and we have asked all of the experts at ANCRE to explain the main barriers that need to be lifted. It is interesting to see that these experts all highlighted the importance of increasing the R&D effort and pushing the technology aspect; they also highlighted the importance of having demand ‘pull’ policies by sending the right economic messages and also by having relevant and appropriate regulations.

This brings me to my conclusion. With these decarbonisation scenarios, the larger emission countries can now roll out longer term strategies than they are able to with the Intended Nationally Determined Contributions (INDCs) at COP21. This is why we need to have a diversified technology portfolio: there is no silver bullet and there is no 'one-size-fits-all' solution. Each country and each region must strike the right balance and come up with the most relevant technology portfolio as possible.

In addition, public policies must combine the technology push, through R&D policies, as well as demand policies through carbon pricing, quotas and emission standards. Barack Obama's Clean Power Plan (CCP) is an emission standard system which could be replicated and work as well as tax or quota systems.

I think it is important to highlight that research should focus on developing technologies to improve solar panels and to improve positive-energy buildings, but also focus on the systemic side of innovations that need to be implemented through smart-grids, through energy storage, through smart communities and at a grassroots level. Research must take all of these different aspects into account and I think it is a very important part of the solution. Thank you very much.

Mr Jean-Yves Le Déaut. Thank you very much, Mr Criqui. We are now going to move on to the first workshop, which will focus on innovation for energy efficiency of buildings. I will call upon Mrs Ana Isabel Mariño Ortega and Mrs Anne-Yvonne Le Dain to chair this workshop.

FIRST WORKSHOP:
INNOVATION FOR ENERGY EFFICIENCY OF BUILDING

Chaired by Mr Christian Bataille, MP, Vice-president of OPECST, and Mrs Ana Isabel Mariño Ortega, Senator, Chair of the Spanish Environmental & Climate Change Committee

Mrs Ana Isabel Mariño Ortega. I have recently been appointed as Chair of the Environmental and Climate Change Committee in Spain and this is the first time that I have represented my country at such an important meeting. We are here today to listen to the debate and to try to see if the objectives that we set ourselves are relevant in Spain vis-à-vis climate change. I would now like to give the floor to Anne-Yvonne Le Dain.

Mrs Anne-Yvonne Le Dain, MP, Doctor in Earth Sciences. [On behalf of Mr Bataille] Thank you very much. Members of Parliament, ladies and gentlemen, this first workshop will focus on innovation and on a very important area of energy consumption: buildings. Buildings are responsible for 40% of energy consumption in the European Union and, depending of the carbon mix of countries, they account for 15-25% of CO_2 emissions, both when they are being built and when they are being used. There is great potential to drive these figures down.

As the Homes Project reminded us, in Europe we have over 230 million buildings. These buildings could be very useful in developing local renewable energies, be it through geothermic energy or how they are positioned towards the sun and prevailing winds. Innovation is therefore extremely important against this backdrop and, as you know, we always need to find cheaper technical solutions. These solutions must be as cheap as possible, easy to implement and adaptable; sometimes, for example, it is necessary to make do with poorer performance to drive down CO_2 emissions for many older buildings in Europe. We need to be more effective of our use of heating in the winter and cooling in the summer.

I would like to thank OPECST for their 2009 Report headed by Claude Birraux. The idea of results is very important in this report, but it is also very important to follow up on these implementations and not just focus on means. Indeed, in 2018 a CO_2 cap will be implemented in France and I hope that the participants in this meeting will also be following this very pragmatic approach.

INTRODUCTORY SPEECHES

HOW DOES INNOVATION HELP ENERGY EFFICIENT REFURBISHMENT?

Mr Jean-Yves Le Déaut. I am going to take on my new role and begin the introductory speeches in this workshop. Alongside Senator Marcel Deneux, I am the co-author of the OPECST Report, *Regulatory obstacles to innovation in the sector of energy efficient buildings*. Researching this report provided an opportunity for us to go to Sweden, Austria, Germany, Finland and the United States to look at the hindrances to thermal refurbishment.

As we have heard, a very large percentage of CO_2 emissions are released by buildings. In terms of construction it is always very difficult to change mind-sets and techniques, and innovations are much more complicated to implement as they have to go through all the different layers from architect to craftsman to estate agent etc. Innovations tend to focus more on building, i.e. the different elements of construction, rather than on refurbishing. I believe we can only win the battle for refurbishment if we champion innovation, yet there are many barriers in our way.

In nearly all countries, apart from Sweden, we measure the theoretical performance of buildings and not the actual performance, and yet it is results that are important. In Germany you were honest enough to say that you had fallen short of your projections; we have not done this in France and so we need to move towards real performance assessment. Equally, all of our systems are based on products and not on architectural projects; we should not put products at the heart of this system because they benefit constructors and they will change the price of these products depending on how many subsidies they can get from the state.

So, there are a few issues to address. First of all, the price; in France we estimate the refurbishment of buildings to cost €1,000 billion, and it is similar in Germany. It is a very large market and so we need to find a cheap, large-scale, effective solution; we can only do so by innovating.

There is yet another barrier to innovation, and I will conclude here: this barrier is regulations and standards. Standards are crucial but they also protect a number of companies that sell certain products. I think that the regulation and standard system that is headed by a number of national or European organisations must be swifter without, of course, forgetting health and safety.

HOW TO BETTER PROMOTE ECO-FRIENDLY CONSTRUCTION TECHNIQUES?

Mr Lucien Figuier, Institutional relations Director, Saint-Gobain. When we assess the impact of building solutions on the environment it is essential to have an overall and complete approach to this assessment. Complete, that is, in the sense that we are looking to assess the overall environmental impact; this means including CO_2, but also including other types of impact such as water

consumption during the manufacturing process and the efficient use of natural resources. The approach should also be one that looks at the different lifecycles of the product, from extraction of raw materials right to the end of its life, including, of course, the manufacturing process.

This complete approach has two advantages. Firstly, it helps us to avoid moving a source of pollution from one phase to another in the lifecycle of a product, or to trade one source of pollution for another. Secondly, there is an operational advantage in that it enables us to identify the different components of a product and look at the manufacturing process as a whole in order to reduce the environmental impact of the overall technical solution.

The overall approach should be combined with other features such as performance, cost and the use of new technologies by the different involved parties. The technical aspect should not be mixed with environmental performance assessment; you have to make a choice between these when you are examining the environmental impact of a given solution. Cost is another important component to measure the usefulness of a solution in relation to existing solutions and to assess the capacity of this innovation to actually become a serious contender in a given market. Another variable, which I think is often ignored, is the different pillars of ability to actually implement the solutions that come onto the market to guarantee the successful rolling out of these building techniques.

Within this overall approach, or 'eco-innovation' approach, where you have to consider environmental and technical performance, cost and implementation, it is necessary to make constant arbitrations in order to get environmentally respectful and technically solid solutions onto the market.

WHAT IS THE REAL IMPACT OF ENERGY-EFFICIENT BUILDINGS IN THE FIGHT AGAINST CLIMATE CHANGE?

Mr Jean-Loup Bertez, Administrator of *La Maison Passive*. Ladies and gentlemen, with only three minutes I will be leaving aside the topic of the 'grey energy' that a building has over a 50-year lifecycle. The question I have been asked is about the impact of energy-efficient buildings, and this is actually quite an overwhelming topic. The obligation to produce results means that you have to anticipate, calculate, design and measure; it requires discipline and precision. It is such an overwhelming task, in fact, that regulations from 2012 actually provided some incentive to avoid focusing on these results.

It is necessary to base our goals on objective, measurable and verifiable factors, otherwise it is just an empty promise. As such, we need to have a contractual approach to measure results; we need independent third parties to guarantee the reliability of the processes. We have to be able to use measurable orders of magnitude and we have to be able to use stable and reliable units of measure, otherwise it serves no purpose.

We also have to eliminate low quality, which is a source of waste and environmental damage. Very high efficiency in building is technically incompatible with low quality, and we cannot actually achieve this goal without eliminating this waste. Unfortunately our dominate culture allows for this waste, but the culture of true energy efficiency does not allow for such an approach. The extra cost is really just the extra cost of the inefficiency of existing buildings, and many are actually very fearful of the obligation to produce results.

We therefore need to design based on the results that we need to achieve; results that can be tested, verified and that are up to the task of climate change. The building also has to be inhabitable and it has to be renewable; it has to meet a number of objectives.

The laws of physics are ruthless: air quality deteriorates if it is subjected to over 10 W/m^2, one third of the power of the candle that I have just shown. We no longer speak of heating, only of simple temperature maintenance. This performance, the true high-performance for climate and energy, therefore excludes the presence of technical facilities dedicated to heating, and precisely those which cause emissions to the atmosphere.

The needs of the planet are the same as those of human beings, and these can only be achieved through quality design and implementation that has to be controlled, precise and rigorous, and it is the fruit of strong and functional optimisation work on the building. I think this is actually a very realistic and operative goal; it can already be seen in around fifty countries, including France, on tens of thousands buildings of all kinds, involving several million square metres. Thanks to Professor Wolfgang Feist and his German-Swedish scientific team, this innovative development is known as ‘passive buildings.’

This leads me to my conclusion. To be properly designed and produced, a building does not need to be active, it can be passive: devoid of conventional equipment dedicated to heating and air conditioning, its own constructive qualities are all it needs.

THE USE OF REGULATION MECHANISMS TO INSURE OPTIMAL COMFORT WITH MINIMAL ENERGY CONSUMPTION – CASE STUDY OF BUILDING 22-26

Mr Dietmar Eberle, Austrian Architect. Thank you very much. 22-26 is something very simple; on one side, it is a building, on the other side, it is a way of thinking. The radical approach of this way of thinking is that this building has no heating, no cooling and no ventilation. Instead, when we start to use the surroundings of every site in relation to each building, we find that we do not need the technology that we have been focusing in recent years anymore.

22-26 focuses primarily on three questions. Firstly, it focuses on comfort; the relationship of the user of the building in relation to their building. This comfort level is something that we have understood up until now very much only

as a question of numbers, but I think this kind of understanding is more a question of the behaviour of the people in relation to their specific circumstances.

Secondly, and I think this is very important, is focusing on cost; not only in terms of investment cost, but at the same time also on maintenance cost. Maintenance costs are a big issue in development and important in terms of results for our future generations; reducing maintenance costs is incredibly important.

Finally, 22-26 focuses on dramatically reducing the energy demand. We made this building more than two years ago and, since then, it has become one of the most measured buildings in Europe. We measure every room, every day, 24-hours a day, on four different levels: temperature, carbon dioxide, humidity and microbiological air quality. There will be a lot of new issues that we will talk about in the future, not only in terms of energy demand but also in terms of combining this efficiency with quality. Quality for living conditions focuses on carbon dioxide, humidity and the microbiological circumstances of the air.

To conclude, I think that we need to build up more knowledge on the questions that I have raised and we need to start to understand that a lot of models that we use to calculate energy efficiency in buildings do not really focus on what actually happens in the buildings afterwards. The main contributions to the buildings of the future will not be the technical surroundings but the people who use the building. Thank you very much.

HOW DO ASSESSMENT TECHNIQUES HELP US CHOOSE BETWEEN RENOVATION AND REBUILDING?

Mr Linas Balsys, Member of the Environment Commission of the Lithuanian Parliament. Thank you very much. Mr President, Mr Vice-President, thank you very much for organising this great event and for the opportunity to exchange opinions before the Paris summit.

In Lithuania we are quite lucky from a political point of view because we are already using 23% renewable energy in our energy mix. This is more than our target for 2020. This is good news because this figure is based largely on the usage of biomass in the heating sector. The bad news, however, is that half the population in Lithuania live in individual houses and the other half live in ‘block buildings’ or multi-residential condominiums.

The majority of these condominiums are more than 40 years old and obviously they need some renovation or to be demolished. Looking purely scientifically, you could do the building audit, the energy audit, you could take into account the client resources and expectations, and in many cases you would decide that the best course of action was to demolish. This is rarely what we do. We do not demolish because, on the political side, the majority of these flats, apartments and condominiums are privatised; they are the private property of a lot of people, many of whom are not well-off.

So, if we make a decision to demolish, we simply do not know what to do with the people who live in these buildings. As such, in many cases we decide to retrofit instead of demolish, but this leads to the question of how the retrofit should be done, and this is where we politicians have to step in with our 'smart' laws. To my mind, the major component of this smart approach is to be very flexible in terms of policies and to let people choose the methods of retrofit and renovation which would have the quickest results, the greatest effects, the lowest cost and the fastest payback time.

These elements might not seem particularly simple and easy to combine, but we already have some experimental models that work very well. One method is to simply renovate the heating point in the house and change the windows, which could save up to 30% of energy.

Finally, we have to be very flexible as politicians and decision-makers and be very innovative in applying the newest available technologies. Luckily these technologies exist and luckily we have enough developers to start using them. In countries like Lithuania where we have very many old buildings which we cannot demolish, we have to keep them in order to allow people to live in them.

OPEN PERSPECTIVES FOR CONSTRUCTION TECHNIQUES BASED ON THE PHYSICAL QUALITIES OF MATERIALS

Mr Marcel van de Voorde, Professor at Delft University of Technology, Netherlands, Member of the OPECST scientific Council. Thank you. The global construction industry accounts for a significant proportion of the world's energy consumption and carbon emissions, as does the operation of domestic, commercial and industrial buildings. The modification of the chemical reactions and material structure at the nano-scale has enormous potential for redefining the future portfolio of construction materials.

Today, nanotechnology is most probably the only technology available to realise breakthroughs with drastic reductions in energy consumption and CO_2 production in the building industry. Other revolutionary technologies have still to be invented and present available technologies can only make small evolutionary improvements.

Nanotechnology will be used in the fabrication of materials, in the construction of materials and in the equipment for energy production and storage in buildings. Nanotechnology is the technology of the future. The house of the future will become a nano-house.

To give a few examples, nano-cement and concrete are much easier and quicker to fabricate with lower production costs and less energy consumption. Construction materials can be ten to a hundred times stronger than the best materials on the market, with much lower installed weight and flexible in its

construction. These are fantastic materials for withstanding earthquakes and heavy storms.

Nanotechnology provides environmental stability against all types of chemical and environmental attacks; painting and outside cleaning of houses will belong to the past. Nano-materials have self-cleaning capacities whereby dust and organic deposits will degrade under the action of the sun and rainwater will remove surface dirt.

Nanotechnology offers reduced energy consumption, with less energy required to heat buildings in cold weather or cool them in hot weather, dramatically reducing carbon emissions. Nano-active coatings can be used to control thermal transmissivity through windows, for example, for optimal control of building thermal regulation. Thermal insulation on the basis of nanotechnology and extremely porous nano-materials present excellent thermal insulation properties.

The antibacterial functionality of nano-coatings and surface treatments will help in filters in home appliances. Photocatalytic nano-coatings purify the air and maintain optimal indoor air quality.

Smart or intelligent materials will integrate new functionalities, such as nano-sensors, into materials. Objects will become communicators, able to adapt to their external environment: automatic control of electricity, gas and water consumption with the smart grid, detection of CO and CO_2, quality control of air, energetics management, and cracks in buildings will be detected and self-repaired. There will also be flexible solar materials with nano-layered dye-sensitised cells which can produce electricity inside a building.

Beyond the technical performance that nanotechnology will offer is a promise for the future at a low cost. All the technologies which we are applying at the moment are just simple, small improvements to what already exists; to make a marked improvement over the next five years we will need breakthroughs, we will need solar cells and CO_2 conversion. These should not be in the background; they should be our main focus.

Finally, basic research is not available in construction and our architects and construction engineers do not have appropriate courses at university to inform them about nanotechnology in the building industry.

OPEN DEBATE

Mr Christian Bataille. Thank you. Before we move on to the question and answer session, I would like to thank Anne-Yvonne Le Dain who was able to step in for me to chair the start of this workshop. I will also note that I have worked on this particular subject of building renovation and drafted a report together with Claude Birraux back in 2009; the recent energy transition legislation

came in the wake of all this preliminary work. I will now open the floor for questions.

Mr Paul Rübig, Member of the Scientific and Technological Options Assessment Committee (STOA), European Parliament. A question for Dietmar Eberle: what can you tell us about the storage of energy in a building? How do you measure it and how can we cope with this problem?

Mr Dietmar Eberle. We currently have some algorithms and we have developed our own methods of calculation; there is not a high level of knowledge on this kind of storage because it is very complex. At the moment I know we calculate and we follow all the temperature of the building and the surfaces of the building 24 hours a day to see what happens.

I also want to note that I support the demand for more nano-technological materials; I think this will be the big breakthrough, even if it takes some time. At the moment we have to ask ourselves what we do now and what will we do in 20 years, and I think there will be a lot of difference.

Mrs Mathilda Ernkrans, Chair of the Committee of Environment and Culture of the Swedish Parliament. Thank you for your contributions, it was very interesting to listen to them all. I would like to emphasise how important it is in Sweden to create and build passive houses; it is something that is highly necessary for Sweden to have more energy efficiency in houses.

Nano-techniques have lots of possibilities – we know that and it was described very well by Marcel van de Voorde – but, as we also know, the health and environmental effects of nano-techniques are still unknown and more research needs to be done. It would be interesting to hear you elaborate a little bit more on the downside of nano-techniques. Thank you.

Mr Marcel van de Voorde. If you look at nanotechnology and the materials used in buildings, we need to consider the production of the materials and the equipment which is used for storage of solar cells etc. The nanotechnologies in materials – such as bricks – are chemically so strongly bonded that they cannot escape, so there is principally no problem, not even for the insulating materials; it is not like asbestos. In terms of equipment, nano-electronics were already nano-electronics and so this does not play an important role.

I am a member of international, American and European health and safety committees. We do not have to worry about the safety of nano. Indeed, at a university in China they have defined rules about nanotechnology in buildings; nanotechnology is a safe technology and can solve many problems very simply. There should be a collaboration scheme between architects and some of the institutes which we have in Europe on the modern building of a house and large buildings in Europe. Nanotechnology does not pose any critical problems from a safety point of view.

Mr Huw Irranca-Davies, MP, Chair of the Environmental Audit Select Committee of the British Parliament. I have a question for the two or three colleagues who presented on the building and architectural side. Very close to my constituency in South Wales, Cardiff University has been involved in a ground-breaking project on what they call and 'energy-positive' buildings.

The project had certain criteria for these buildings; they should use existent technologies, they should be affordable and should use local suppliers and local materials. This was about making an energy-positive home liveable, warm, comfortable, with storage, with existent technologies, but under £100,000. The idea was that if they could do that and it could be replicated in concert with the building industry, then we had a game plan of how to do things.

I also want to make an observation to my colleague who talked about nanotechnology. Bill Gates was recently at Parliament and a question was asked of him and the Bill Gates Foundation, 'Where do we see the answers to tackling climate change?' And he said, 'We haven't even begun to explore the answers yet. The technologies that we want, they aren't even there yet.' So perhaps nano is an example of that.

What role does that issue of affordability, as well as good design and good architecture, have in order to break the back of this building problem? And, on the question of regulation, Mr President, my question to you is what role, when you have the policies lined up and the innovation and technology in place, what role does consistency of regulatory practice have as opposed to chopping and changing, both for research investment, but also for investment from industry to take these things forward?

Mr Christophe Morel, Co-Director, Technical Department, CSTB. I work at CSTB and I would like to tell you about our analysis as a technical centre on these issues in relation to climate change. I will be supporting what has already been said during the debate.

CSTB (*Centre Scientifique et Technique du Bâtiment*) is the French national organisation providing research and innovation in the construction industry. We report to the minister in charge of building. Our centre is looking into the sustainable building of the future which is light on resources and economically acceptable. In France we have 33 million homes, half of which were built before 1975, a time when thermal performance did not exist. The main challenge is therefore renovation, reducing heat and energy use for these buildings drastically, and we are only at the very beginnings of this effort.

Regarding new buildings, we have come a little further; with regulations as they are now in Europe following the European directive, I think we have probably done most of the work, but we should be able to move from a conventional approach, as worked out at the design stage, to an approach where real consumption is measured on the building.

Now, of course it is all about fighting climate change. As Mrs Le Dain said, the building sector represents about 40% of energy consumption in France and a very large share of CO_2 emissions. The regulatory framework today focuses on energy consumption and will have to move to a new dimension in order to take on board climate change. We will have to move from low-consumption buildings to low-consumption, carbon-lean and low-environmental impact buildings. This is in keeping with the energy transition law voted by our Parliament. Thank you.

Mrs Mady Delvaux, Member of the European Parliament, STOA Board of Directors. I am a Member of the European Parliament and I am here with Mr Paul Rübig. I would like to thank you for organising this event; it is a truly interesting. I have a question for the politicians. We are all well aware of the need to invest in construction in order to reduce energy consumption; research seems to be making progress. We have heard that that skills are necessary in order to implement that change, so I would like to know whether there are any strategies with a view to training professionals. In construction there are a lot small businesses involved and I was wondering how they could be motivated, enticed and made aware of these issues and how to introduce them to these new technologies.

Mr Jean-Yves Le Déaut. I would like to start by answering our colleague, Mr Irranca-Davies, who asked us how policymakers can set up consistent standards in order for industry to be able to avail itself of these possibilities. This is indeed a question which came up in my report drafted together with my colleague the Senator.

First of all, things have to be clear at the European level; you cannot have rules which vary from country to country, so we will have to discuss these regulations and standards. If at all possible, this should also be discussed at global level, but that would be a lot more complicated. We must also ensure at all times that there are no obstacles to innovation; many people have mentioned that new technologies bring about new issues, there are obstacles to innovation and I think that the role of parliaments is paramount.

As Mr Morel from the CSTB stated, in France we have given our Parliamentary Office more weight in order to be in constant discussion with the organisations which are in charge of monitoring and control. They cannot work as a standalone: they have to hear what businesses large and small have to say, what citizens have to say, and take this all on board. So that is one of the solutions that we have included in our recent legislation; Parliament is involved in control, especially with the independent authority in charge of standardisation.

Mr Lucien Figuier. You stress the importance of in-house training to lead innovative environmental projects and you also talked about different innovative and research projects to mitigate the effect of greenhouse gas on the environment. The other dimension that I believe to be very important, especially when designing a product, is the launch of the product on the market.

I believe that this is something that must be addressed in-house, and different stakeholders must be trained so as to guarantee that scientific innovation is effectively and swiftly implemented in construction. In other words, it is a back and forth between the designer of the technical solution, the capacity of the actor to implement it, and the feedback from the person on the ground to the person who has designed it. It is a whole virtual circle that we need to kick off that will benefit everybody. Thank you.

Mr Olivier Cottet, Technology and Strategy, Schneider Electric. Today I would like to talk about the Homes Project, the outcomes of this project that we mentioned earlier, and how it has had an impact. The whole idea of this project was for all buildings in Europe to be as effective as possible by deploying innovation and new technologies.

The Homes Project stated that the use of energy was an opportunity to drive down greenhouse gas emissions by 20-30%. As we said earlier, there are 230 million buildings in Europe, and therefore there is a great potential to do better. We must also improve the level of services that we provide the people who live in these buildings; people must feel comfortable in these buildings and the buildings must also be efficient.

At a local level, we need to think about local authorities and local policy design, and the surplus of energy produced by these buildings must serve the fight against climate change. From an environmental point of view we must increase the production of renewable energies with smart-grid-ready buildings; all of this ties in, of course, with a low-carbon economy. The models that we need to implement must be sustainable.

To conclude, I would like to say that if we do not measure the performance of buildings then it is pointless. It is like having a car without a meter. We need to intervene everywhere; in homes, in schools and in offices, and we must go over and beyond what we have been doing for the last few years. There are a number of sensors that we can set up in offices and homes to improve the efficiency of buildings, and we must also be able to change the behaviours of individuals.

Finally, I would like to say that efficiency and flexibility are innovations in and of themselves that will enable the deployment of smart-grids. Thank you very much for your attention.

Mr Jean-Loup Bertez. I would just like to stress that the buildings we are erecting or renovating will still be standing in 2050. We only have one opportunity to do things the right way and we must seize it immediately and aim for the very best, even if we cannot generalise very high standards on a very large scale.

My second point is on passive buildings. Let us not forget that the production and consumption of energy both leave a mark, so we need to bear in mind that we need to drive down our consumption as much as possible so that we

produce as little as possible. This clearly means that it is impossible to build a positive-energy building if we do not have energy passive buildings first. Earlier we saw a diagram with four passive buildings that are currently standing with results that have been empirically verified; these buildings are excellent and the feedback of the people living in these buildings is also quite unbelievable. They say that they will never go back to a traditional house after having lived in these passive buildings.

Mr Mikko Alatalo, Member of the Finnish Parliament, Member of the Committee for the Future. I would like to ask about the integration of wood construction in passive houses. In northern countries we have a lot wood and, like in Sweden, we also have a lot of passive houses nowadays; do you think we still need nanotechnology? If so, how do you combine it with wood construction?

Mr Marcel van de Voorde. I think nanotechnology could also play a very important role in wood construction. For example, it could upgrade quality in the fabrication of the wood or you could add a number of detective sensors to make all type of controls. Nanotechnology could improve the bacterial aspects, or so-called 'mechanical properties,' of the wood, and wood treated with coated materials could also offer many opportunities. In that respect, wood is similar to other construction materials, so there is a big future for nanotechnology in wood. I can send you reports and chapters from books with have been written with specialists in the field if you are interested in this material. Thank you.

Mr Pierre-René Bauquis, former Director Strategy and Planning, Total. Thank you, Mr President, for giving me the floor. I am going to start by asking a very politically incorrect question: I would like to better understand the link between decarbonisation issues and political decisions. Now, allow me to shed some light on this; I am not going to talk about the recent energy transition law, even if I believe it is more an antinuclear than a pro-carbon law, but I would like to talk about a law that was enacted under the previous majority.

The decisions that were made for buildings and construction (the most famous one being the 50kW/m^2/year regulation) has had a very antinuclear effect and it has cost us an increase of the carbonisation of new buildings. In other words, priority was given to gas and that was detrimental to electricity in a country where 85% of electricity is carbon-based. So could you please tell us about the gap between the discourse and what is actually enacted by both majorities in the past and today?

Mr Jean-Yves Le Déaut. I said that we did not want to raise this issue this morning, so I apologise, but nevertheless you have raised this question and the Office has looked into it. Our position is to drive down the share of nuclear energy because an accident such as Fukushima has dramatic and serious consequences.

The Office believes that the energy transition was maybe too ambitious and that we needed to take a bit more time to make this energy transition fully successful. We also said that we need more innovation and more technology, and this is what we are talking about this morning, to succeed in our energy transition. We talked about the Grenelle law that was enacted under the previous majority and, even if we have not adopted the same stance as our German colleagues, we have decided to drive down the share of nuclear energy in the energy mix in France. Nevertheless, the Office states quite clearly that we are not going to go as fast as the Government has planned in terms of energy transition.

However, this does not really tie in with what we wanted to say this morning; it is a very French issue and we are here as members of different European countries, so that is why it was not on the agenda for this morning. We have different stances in Europe but nevertheless we share the same core idea whereby decarbonisation and energy efficiency are a means to end; in other words, a way to find a solution to a problem that we all are all confronted with on an international level.

Mr Christian Bataille. I would like to go back to what Mr Le Déaut said; thousands of pages have been written about this topic of nuclear energy in France, but let's just say that sometimes discourse is a way to avoid action. That is something that I have noticed for quite a long time now.

Mr Hugues Vérité, Advisor, Gimelec. Gimelec is a group of industry stakeholders who champion energy efficiency and energy pooling. What I wanted to say this morning is about how we can move from innovation to market. There are a few solutions that I wanted to share with you against this European backdrop. There is a European directive to assess energy efficiency and it paves the way to a new Europe. I wanted to talk about what we believe in our organisation and how we should fight against climate changes.

First of all, why would we not streamline the number of directives in that field? Why do we need a directive on the energy efficiency of buildings and another one of the energy efficiency of something else on the other hand? We believe that the approach must be a systemic one and streamlining European directives could be a way to achieve this.

Another question is the energy package that you are probably going to look into and maybe even takes decisions on. I think that we need to increase transparency here. It is a problem in energy; there is not enough transparency and regulation authorities must be more stringent. I know that is close to your heart here at OPECST. Regarding European directives, I think it is important for the European energy system to be as flexible as possible to mainstream renewable energies and to digitalise the European economy so that we can multiply our competitiveness.

Mrs Patricia Lips, Chairwoman of the Committee on Education, Research and Technology Assessment at the German Bundestag. I have listened very carefully and I would like to say a few words. First of all, it is very interesting to hear about the technology in this area. Some of it we already use, such passive houses, but maybe there will be more technology in ten or 20 years that we have not even thought about yet.

However, there is one element which has been missing in the discussion so far: what about the citizen? We cannot change anything without the citizen. They must be convinced; they must do it in the end and they have to be able to do it, not just financially but willingly. Maybe this is not the right platform for it but it is important for me to think about it. In Germany we have been able to make big steps but only because many of our citizens were already convinced. You can make standards, you can even make common standards, but you cannot say 'You have to do it now!' You have to convince. This is very important to me; people need to have the will to do it. This is very important.

Mr Jean-Yves Le Déaut. Thank you very much for your contribution; this afternoon we will have two hours devoted to this topic.

Mr Pascal Laude, Head of Partnerships and Synergies "Grand Est", EDF. I will not be talking about nuclear issues! We have spoken a lot about new buildings today, but what I wanted to bring to the table is that there are many standards that have been enacted to manage industrial buildings, especially ISO 50 001. Energy efficiency, as the President stated earlier, has a very economic dimension.

This ISO 50 001standard is a way to use data to design indicators and also targets to improve energy efficiency. We set these objectives and we make sure that we meet them. The idea is that everything that comes into energy consumption, the structure, the building etc. must take on board and must take into account all stakeholders in the construction industry. This has not been developed to a great extent in France and I think the strictures should be used for existing assets.

We have talked a little bit about new buildings but in the tertiary sector there is a whole sector of buildings that have to be renovated. To lower consumption means lower costs but also means a reduction in greenhouse gases. Thank you.

Mr Reinhard Grünwald, Office of Technology Assessment of the German Bundestag. I have another question for the gentleman who talked about nano-materials. I would like you to expound a little bit on the timescales; when do you think that all the nano-materials will actually make an impact in the real world and on the real market on a mass scale?

The background of my question is twofold. Firstly, the Karlsruhe Institute of Technology has developed a substitute for concrete as a building material; it has nice properties but they found it extremely difficult to find a company who wanted to put this product to the market. Established practices are just the way they are and you do not use a material where you do not know that it can actually survive 50 or 100 years, the usual timeframe that a building will live. So that was really a problem.

My other experience dates back to my own biography. Twenty years ago, when I was a PhD student working on nano-sensitised solar cells, everybody thought that these solar cells would be available on the mass market in five or so years. Obviously this was a long time ago, but I still cannot see many of those on rooftop; there have been some technical problems that have been underestimated and these kinds of barriers pop up on many different occasions when it comes to putting scientific knowledge to innovations in the real world. That is the background to my question. Thank you.

Mrs Nicola Blackwood, Chairwoman of the Office for Science and Technology of the British Parliament. I would like to thank the President and OPECST for this very important debate. Energy efficiency must be the most important carbon reduction measure; the cheapest energy is the energy we that we do not use. A number of speakers have pointed out that human behaviour will define success in this area; I know there is going to be a session later but I am afraid I will not be able to be here for that.

The United Kingdom is rolling out universal installation of smart meters between 2015 and 2020. It is an industry-led programme and some pilots are already up and running. It is a bit early to analyse the data from this, but so far it does seem that the problems with this are not going to be interoperability or costs, but it is actually going to be that people are not using them effectively. One relevant statistic comes from SSE who found that a third of users had switched off their smart meters within a year of installation.

So, my question to those in the room who know about this is: what good practice can speakers share on how culture change in energy consumption can be stimulated by innovation?

Mr Marcel van de Voorde. You probably know that a number of construction materials are used in Germany. Coated materials are often used to clean buildings and windows, for example, and they are already on the market in large quantities. The only problem is that in order to get a nano-material, a new invention to the market, the engineers and the architects must actually know what to do with it. I think that is the biggest problem that we have.

In terms of the equipment that is used in buildings, nano-electronics also play a very important role already today. So, principally, in a number of sectors the materials and the market are already there, particularly in terms intelligent

materials, and the market is not bad; there are many small and medium-sized enterprises in the business.

It will still take some time, however, before nanotechnology will get a breakthrough, and this is down to the points that were made by both the German representative and the Swedish representative. Society must be behind it and society has to want these materials; many of the materials are there, companies are there, in others they will come very soon, and if people see the big advantage of the nanotechnology in these products there will be a breakthrough in this technology in all sectors.

Mrs Melanie Peters, Director of the Rathenau Instituut, Netherlands. I know that consumer organisations in the Netherlands have been working on smart meters together with the electricity companies and the green movement, but at some point they did not want to anymore because of the privacy issues. This is why most consumers turn their meter off. At the Rathenau Instituut we are looking into privacy by design; you could design these meters so they register what you are using but they do not take data that you do not want others to have.

Another issue with smart meters is that electricity companies use it to price the electricity; they know exactly when the peak price should be and so you pay peak rate for peak usage times throughout the day. In that way people feel fooled; they are trying to save energy but the energy they use becomes more expensive. There is some reciprocity in that; the energy companies would have to reward saving energy and not use the data from the smart meters to charge higher prices. So there is a collective issue, not just a consumer issue, but we are currently looking into this at the Rathenau Instituut.

NEW FRONTIERS

WHAT ARE THE PROSPECTS OFFERED BY NEW PHOTOVOLTAIC TECHNOLOGIES?

Mr Daniel Lincot, Director of Research, CNRS, École nationale supérieure de chimie. Thank you for you invitation to speak at this gathering; I am very happy to be here. The first point in terms of understanding changes in the area of photovoltaic technologies in relation to climate change is to compare the share of this technology in electricity production today. What we see is that there has been significant growth in just a few years; almost 1% of world energy production is now photovoltaic and, in some pioneering countries – such as Germany, Italy and Greece – it is even greater.

If this growth continues, photovoltaic power will increasingly be seen as an answer to the needs of the fight against climate change. The projection for 2020 is 500 GW and, according to the International Energy Agency, 16% by 2050 and 4.5 TW. This is the outlook, but first and foremost we should look to the quick growth of production. Photovoltaic power is entering the terawatt sphere; this has

happened for technical reasons and for cost reasons, and I will be getting into this is the second part of my presentation.

This slide shows how quickly this production capacity has been installed and the following slide shows that one of the main underlying reasons for this change is the drop in the cost of photovoltaic energy production in just a few years. It used to be 60 cents/kWh but now we are in the area of 10 cents/kWh or even lower depending on the region; projections for 2050 are talking about 4 cents/kWh. The underlying reason for this progress is that there are scale effects but also technological effects and, in particular, solar cell technology where the average yield has risen to 15% and the record yield is 25.6%.

New technologies are being rolled out, including silicon and layered technology, and this has led to a big increase in yields in Germany. We are seeing two major trends: on the one hand very high yield and at the same time new applications using flexible and thin layers. This progress will continue and we are trying to move towards standard modules; if you look at the technological changes, today we have the technical means to go beyond 30% yield with modules on the condition of using multi-junction technology.

Multi-junction solar cells are solar cells with multiple junctions made of different semiconductor materials; each material's junction will produce electric current in response to different wavelengths of light. The use of multiple semiconducting materials allows the absorbance of a broader range of wavelengths, improving the cell's sunlight to electrical energy conversion efficiency. With these so-called 'tandems' we can have a maximum yield of some 40%. You can imagine how, in a few years, the roadmap is to go towards higher than 30% with these tandem cells. We will then be going even further towards innovation in the area of materials.

You may have heard about photovoltaic and different types of cells like organic cells; a lot of research has been done today on reducing costs to use new materials, to have further breakthroughs for photovoltaic power production to go beyond 50%. This is possible in theory using these different materials. What I just wanted show was how quickly this new technology has emerged. It is still a non-mature technology but, nonetheless, perovskites have gone from a 3% yield in 2009 to a 20.1% yield in 2015.

Perovskite technology has used research on other materials; progress does not come from an isolated initiative but rather of the pooling of knowhow and research. I think this is really important. We have to be vigilant, we have to ensure that we can work towards a day where our children are using solar power with extremely high generation yields.

So there is tremendous potential in the area of technology; there are also new ideas, plastic cells, perovskite cells, and this could lead to numerous usages. Photovoltaics incorporated directly into buildings, for example, and also

photovoltaics that can be rolled out in agriculture. All these new uses can be used by our co-citizens and will stimulate research and uses in a whole range of areas to implement this technology.

I think one interesting new usage is photovoltaic coupling and storage, and there is a lot of research being done around storing the energy generated in this way. As Mr Jouzel was saying, we have to focus on the importance of fundamental research, but also the importance of speeding up transfers into industry to benefit society as a whole over the coming years to find new technological pathways. I think this is going to be very important.

We are going to need better cooperation and better coordination between research institutes in France, in Europe and the world over, to speed up links to industry. Government policy is also a key factor; none of this would have happened if public policy decisions had not been taken to develop this, especially in Germany, Japan and France, with the Grenelle Environment Roundtable. Finally, of course, we need citizen support for this all to work.

THE FUTURE OF ENERGY STORAGE

Mr Paul Lucchese, CEA, President of the European Research Association on Hydrogen. Thank you for you invitation, Mr Chairman. Energy storage is not a new issue, but what we are focusing on today is energy storage based on variable renewable energies. This has increased quite strongly over the past ten years and there are a number of reports, both internationally at a national level, which show there is strong interest in energy storage and developments in this area.

Why? First and foremost this is due to the increasing share of variable intermittent renewable energies in the energy mix; the discrepancy between supply and demand will call for solutions to be able to cater for this. Then there is another dimension and this is something that is something which is not very often mentioned, it is not crystal clear, but it is there in the energy transition legislation. There is the devolution to the more regional and local authorities of energy management. This will also call for storage and the setting up of local value chains, an energy system in which there will be a large share of renewables. There is also the development of transport networks, including at European level, smart grids at local level and digital technologies.

What I find interesting in the energy transition law passed in August is that is recognises the importance of storage and it calls for the integration of storage operators in the various arrangements; there is a notion of interaction between electricity, gas and heat grids. There is also a specific role given to hydrogen energy storage and it has been requested that a plan be put forward with a focus on economic models.

This piece of legislation leads me to share a few messages which I believe are important; first of all, R&D is essential in basic research and incremental research. To use the example of cells and batteries, a lot still has to be done to bring down costs and to bring down the amount of raw materials. In the manufacturing, the new batteries and fuel cells also need to be improved; there is a Chinese manufacturer who is going to work on this large scale and will bring down costs, and Deutsche Bank says it could go down from 14 cents/kWh to 2 cents/kWh by 2020. That of course changes the whole picture of the energy systems, because if you add the cost of storage to the tune of two cents, it does indeed have an impact on distribution and transport grids. So, R&D is essential.

The second message is that proof has to be shown; energy systems are becoming increasingly complex and, for urban grids and anything that has to do with cities, we are still lacking demonstrations. What we also have in our legislation and in all the reports is that there is a severe lack of economic models for storage in order to be able to provide a stable market. Now, there are two possibilities, there is power to power, that is cells and other systems where electricity it stored and then fed back into the grid. For hydrogen storage there is a much greater span of possibilities because hydrogen can do a lot more than just what it can do for electricity, but we do not yet have any economic models in this respect.

Finally, we need to adapt our regulatory framework, our tariff arrangements and a number of societal aspects. This has to be done at European level and it is a question for the industry. I was talking about these ‘mega plants’ in China, for instance, but what is Europe doing? Should there be a Franco-German alliance, perhaps? This is all food for thought. Thank you very much.

Mr Jean-Yves Le Déaut. Thank you. We are now coming to the end of the first workshop. I would like to thank Ana Isabel Mariño Ortega from the Spanish Senate; this was a first for her and we are very glad to see her here in Paris. I would also like to thank Christian Bataille; Christian is one of the pillars of OPECST, he has been active here since 1998 and has worked on many different energy-related issues.

SECOND WORKSHOP:
INNOVATION TO FEED HUMANITY WHILST REDUCING GREENHOUSE GAS EMISSIONS

Chaired by Mr Bruno Sido, Senator, First Vice-president of OPECST, and Mr Paul Rübig, MEP, Chairman of STOA (Science and Technology Options Assessment), European Parliament

Mr Jean-Yves Le Déaut, MP, President of OPECST, President of EPTA for 2015. We have gigatons of carbon in the biosphere, mainly in the oceans but also in soil, forests, in biomass, so this roundtable will be looking that the question of whether we can regulate the biomass where carbon can be stored.

Mr Paul Rübig. For this meeting in Paris, it is very important for us to see that we are at the forefront of cutting edge technologies and that we should look at how we should get better solutions for the future, and therefore it is very clear that how to feed the world will play a very important role.

STOA is the Science and Technology Options Assessment of the European Parliament and is made up of 25 members of European Parliament from different disciplines. One of our main activities is to see how we can create mobility for our next generation; we might be talking about building up the 5G system or about self-driving cars that can go up to 500 km/hr, but our main focus is decreasing CO_2 consumption by more than 20%.

Using different kinds of technologies will play a very important role in this, and so number two on the agenda is very clearly the question of sustainable resources. What can we do about the production of food? How much water do we need to produce the food? How does this compete with renewable energy? As you know, biofuels and bioliquids are fighting for forests and feed which is normally for our animals; there has been quite a strong public debate about whether we should we use it for the plate to eat or for the tank to move about. It is very clear that these questions play a crucial role in the public perception.

Our third priority is information and communication technology: how can we keep our networks stable against cyber-attacks and cyber war? It is clear that ICT is merging with energy infrastructure, so what can be done in terms of the distribution of energy? On one hand we need to look at storage capacity and, on the other, we need to look at production.

The production of energy is a national issue; a European level can look at best practice or benchmarking, but the decision is purely on a national level. Storage, of course, is internal market; it is an area where the European Union has to do a certain kind of objective checking and look at how we can organise storage

from a little tiny battery out of the nano industry to a huge battery of water storage to produce electricity.

It is also very clear that we are moving into an era of virtual reality; all the products which exist in reality can now be built in virtual reality. This allows for a new algorithm and a totally new way of communication and behaviour. We also need to look at the positive and negative side of CO_2, looking at the future impacts in this area; today we have heard an architect saying they measure the CO_2 in rooms to see how it develops over different periods, and our farmers are now using CO_2 in some areas to grow flowers in much quicker ways and it is done on other areas.

We need to create a resource-efficient Europe but we also need to look at these issues on a global level, as we will be discussing at COP21. Thank you very much for organising this conference.

Mr Bruno Sido. The question for this second workshop is quite simple: is it possible to feed humankind, numbers being on the increase, limiting greenhouse gases in order to produce the food? This, however, does not describe the whole problem; if we were to give priority to food production, leaving to one side greenhouse gas emissions, those emissions would be endangering food production itself.

Agriculture is responsible for 10-20% of greenhouse gas emissions. I am a farmer myself and I know that it is an area where you can adapt through innovation; however, agricultural production so far has been based on the increase of fertilisers and now we have to produce more and more, but at the same time reduce outside products being used.

Let me give you an example: the extension of rice fields. This could be a very important part of future agricultural production but these fields emit methane which, as you know, is a powerful greenhouse gas. Methane is far more emissive than carbon dioxide which everybody is focussing on, so this would be bad news in terms of greenhouse gases and, at the end of the day, water resources would also suffer.

I am very sorry that the role of the oceans and their contribution to feeding humanity is not very prominent here in this workshop because the fisheries resources are very important, but it may be discussed at some later stage. There is overfishing and that is clear from the report drafted in 2008 by our former colleague, Senator Pierre-Marcel Cléach, on research and the evaluation of fish resources. These resources should not bring any disruption to the ocean's balance through pollution, as was mentioned Mr Courteau's report in 2011 on the Mediterranean.

All these issues were recently examined by the Office through public hearings on environmental research back in July 2014, regarding seeds in 2015 and also big data in July this year. The Office is very interested in these matters

and there were already some very useful analyses about ten years ago in Pierre Laffitte and Claude Saunier's report in 2006 on the contribution of science and technology to sustainable development, Senator Gérard Miquel on the quality of water and sanitation in 2003 and Marcel Deneux in 2002 regarding the magnitude of climate changes by 2025, 2050 and 2100.

Perhaps, Mr Chairman, we could now give the floor to Mrs Le Dain who will be giving the first introductory speech.

INTRODUCTORY SPEECHES

INNOVATION TO MASSIVELY STORE CARBON IN THE GROUNDS (ON THE COUNTRYSIDE) AND ON WALLS AND ROOFS (IN CITIES)

Mrs Anne-Yvonne Le Dain, MP, Doctor in Earth Sciences. This is a rather provocative title: how to innovate massively by storing carbon in soil and in walls and roofs in cities. There has been a deep concern about this since the end of the 1980s; a wave of ambitions were expressed with the Kyoto Protocol 1997, but today the general feeling is that it is complicated. There is worldwide ambition, there is great awareness, but institutions and countries and even citizens seem to feel that they cannot take ownership of these issues. As such, we have a collective form of shame which is administrative, political and scientific.

Innovation is at the core of this, but innovation cannot be global; it is local, with a few people researching and then money is needed to invest. Regarding carbon, we only just found out with the Volkswagen scandal that nitrogen dioxide is the priority in the US and is not here, so it is something that is both delicate and complicated. It is an essential issue and everyone is the culprit. You have the megalopolises and then you have the deserts; usually there is oil there, that is almost a geological given, and then there is the agricultural world.

Improving agricultural practices could improve the CO_2 situation by 20%, but should forests really become vast biodiversity museums, carbon storage places that are not be used at all without any destruction?

These are economic, social and financial situations regarding carbon which are crucial; can this conundrum be solved at an international level? Worms bury carbon and the total mass of these creatures is greater in weight than any other form of animal population, but instead of opting for this, these worms indeed do store carbon but they also make holes in the soil so they contribute to the emissions. So everybody is extremely worried; you hear one thing and then you hear the opposite, within a couple of months or even a couple of weeks, so it is something which is truly essential because it has a strong local aspect.

You have the local and global, and central to all of this is the carbon issue; worldwide, especially in the south, there is the question using the walls of buildings to grow plants, store carbon and even feed people.

SCIENCE AND TECHNOLOGY SERVING THE ADAPTATION TO CLIMATE CHANGE

Mrs Valérie Masson-Delmotte, Paleoclimatologist, member of the OPECST Scientific Council. I am going to read a speech drafted by Mr Alexandre Magnan, Research Fellow at IDDRI, and I am going to talk about an issue that has been overlooked so far, about adaptation to climate change. The whole idea of adaptation is to help people around the world to be less vulnerable to climate change, to be more resistant to drought, to floods, but also to longer trends such as acidification and different changes in weather.

Developed countries must be sufficiently flexible to adapt to climate change and to integrate new knowledge, but must also be sufficiently robust to have a long term vision. The whole point of adaptation is to be coherent over time whilst evolving with the changing circumstances. As you can see on the screen: adaptation = resilience + anticipation. How can people resist and adapt to extreme weather conditions?

Adaptation is all about anticipating what will come ahead and all of this really ties in with resilience and anticipation. Mr Magnan also stresses how important adaptation is on the ground and should be in policymaking. There are many other dimensions that come into play; the efficiency of local governance, for example, as well as the relative importance of this issue compared to others.

I would like to highlight the importance of scientific expertise against a backdrop of adaptation, and a better understanding of science is crucial to calibrate our strategy in terms of adaptation; we must take into account local constraints as well as local opportunities. Recent developments in terms of modernisation have now provided us with ‘pictures from the future,’ if you will; they are not perfect, of course, they are not completely reliable but, nevertheless, I think that they go to show that science can and does shed some light on policymaking.

Science is also crucial to mitigate risks. If you look, for example, at vulnerability trajectories where you can see the current level of vulnerability and look at future levels of vulnerability of the same population in decades to come. A very good example is the development of coast areas; urbanisation in coast cities has increased a lot in France, as well as in the United States, and these populations are very vulnerable to violent climate change effects and weather events. So here once again we can, with science, go beyond the uncertainty of climate change; we can predict these patterns and trends.

It is too easy to say, ‘I can’t decide anything now because I don’t know what the future will hold.’ This is made redundant by science. Adaptation is crucial, as I said earlier, because the future is more and more certain and technology is a key to designing a number of solutions to climate change. For example, in terms of alert systems, technology is crucial.

So, to conclude, I would like to raise two points: adaptation is crucial, it is an essential strategy. We try when adapting to think about the unthinkable, but we cannot do this without science and technology. Thank you very much.

WHICH INNOVATIVE AGRONOMIC TECHNIQUES CAN HELP TACKLE CHALLENGES LINKED WITH CLIMATE CHANGE AND POPULATION GROWTH?

Mr Michel Griffon, Former Scientific Director at CIRAD, President of AEI (The International Association for Ecologically-Intensive Agriculture). Good morning. What agricultural techniques can we implement to help tackle challenges linked with climate change and population growth? We need to be able to feed in years to come some nine billion people by 2050, and ten to 11 billion at the end of this century.

The equation is simple: we must produce more without increasing the number of fields so as to avoid deforestation. So we need to increase yields per acre, which are unfortunately stagnating right now. We must turn away from some chemical products that we are using now, we must improve the irrigation of crops and increase their diversity, and we must do all of this with very few resources.

In terms of the climate issue for agriculture, we need to find a way to resist droughts, high temperatures and heavy rain. The conundrum is the following: we need to increase crops yields, we need to adapt productive ecosystems to save as much water as possible, we need to increase the diversity of crops while driving down greenhouse gas emissions, we must turn away from fossil fuels, and we must also curtail the release of gas from cattle.

In this regard I think that agroecology is the most promising pathway; in other words, the intensive environmental agricultural model or the sustainable intensification as it is also known. These systems draw on the natural assets of the environment, we use intensively ecosystems but not chemical inputs that often cause problems, and we also use conventional techniques when appropriate.

The techniques that are inappropriate right now are, for example, associated crops that have synergic effects, crops that constantly use the same land without crop rotation, and then there are also some crops that release more greenhouse gas than others. We must also turn away from traditional agricultural techniques and we must also use the enemies of the enemies of the crops in our fight and diversify our crops as much as possible to fight against climate change.

We must also come up with new molecules that are ‘bio-inspired,’ in other words imitating nature which is easier to use in productive ecosystems as they are very close to natural molecules, rather than producing synthetic molecules.

Regarding the production of energy, once again we need to come up with new molecules, not molecules that come from the oil industry, we must also use the landscape in an environmentally friendly way and we must also go back to

longstanding agricultural techniques that we have unfortunately given up. Thank you very much.

WHAT ARE THE CONDITIONS FOR FRUGAL INNOVATION TO BE SUCCESSFUL?

Mr Jean-Marc Bournigal, President of IRSTEA, Vice-President of AllEnvi. Thank you very much. Frugal innovation is, for example, solar energy for remote houses in India. The same could be said for other countries as well and there are many other examples in the desert and other areas; there is also payment with mobile phones without a bank credit card in Nigeria, for example. All of these are examples of frugal innovation.

Frugal innovation is about innovating, yes, but innovating in a cheap way with very few resources and many constraints, so it is doing more and better with less, and that is what southern countries have been doing for many years now. Frugal innovation is now coming to our countries because of the economic crisis and its success is fostered by consumers whose means have dropped because of the economic crisis.

Everybody is championing frugal innovation in the south and also in the north, and many say that developing countries are more innovative, especially for climate change, because they are the first ones to bear the brunt of it. It is true that we have seen a new value creation model in the south, a very innovative one, which is demand-based but always takes into account the environment and also society at large.

This new innovation strategy is based on five major trends. First of all, the collaborative economy that is growing, the circular economy that is also growing, the makers' economy, the DIY economy, and then the sustainable economy and also the digital economy. Frugal innovation is based on creativity and on imagination, but also characterised by networks. It is a network that is very far removed from the current linear model that we have, the linear model that we have had so far has been broadly unsuccessful and quite disappointing at times.

Frugal innovation also calls for flexibility for the creation of new economic models, for the use of new technologies, and sometimes innovation does not have to be more complicated; sometimes innovation is just plumping for the simpler but the more effective option. So we need to work in networks; we must go over and beyond the traditional partnerships that we have and we must also look into the potential of other industries that are currently being overlooked and we must raise awareness of this over and beyond traditional partnerships and traditional platforms.

We need to go further and everybody needs to understand that they can create and they can design tools. For research institutions, frugal innovation is crucial and it also reflects a deep change in our society and of course for

researchers as well. Frugal innovations from the south are changing the landscape of innovation throughout the world and we in the north find this all to be very inspiring and draw on what has been done in countries in the south. Thank you very much.

THE CONTRIBUTION OF THE EUROPEAN SPACE POLICY TO THE FIGHT AGAINST CLIMATE CHANGE

Mr Jean-Yves Le Gall, Chairman of CNES, Co-Chairman of ESA Council. Thank you, Mr Chairman. We are currently preparing for COP21, as you know, and I would like to seize this opportunity to tell you where we stand as regards the COP21 and the meeting that we had last week in Mexico. We came together with 24 heads of space agencies from all around the world and unanimously adopted a declaration on the potential impact of satellites to better understand climate change and climate events. This paper was then disseminated to all the countries that took part in the meeting in Mexico.

During this meeting we stressed three points that highlight how much space can be important and interesting for climate change. First of all, for all the variables involved in climate change – as defined by the Global Climate Observing System (GCOS) – 26 of them can only be seen at a global level from space, and therefore satellites against this backdrop are crucial to monitor the national and international commitments that are made. With satellites we can observe different criteria and come up with different trends and monitor many variables.

The third point is that satellites can also manage climate events by giving to countries priority access to data coming from satellites belonging to different countries, and in the future I am sure that with satellites we will be able to predict tsunamis and earthquakes. The European and French satellite programmes are quite exceptional in that regard; we have two – and soon we will have three – and they are the ones that monitored the rise in sea levels of 3mm last year. We also have the Merlin programme, another programme for carbon dioxide that will hold national governments accountable.

The people who took part in the meeting in Mexico stated how impressed they were by the tools that were used for the COP21 to succeed, as well as all the programmes and projects that have been designed for the COP21 to be successful.

HOW COULD SPATIAL DATA AND MODELING CONTRIBUTE TO THE MANAGEMENT OF CLIMATE CHANGE?

Mr Pascal Lecomte, Head of the ESA Climate Office. The ability of our society to adapt to climate change depends on our ability to monitor, understand and predict the impact of human activities on environmental changes. The impact on climate, water, food and energy resources have often been studied separately

when it comes to risk management; in fact they respect different facets of very much linked matters for our society.

We therefore have to develop a new type of thought that incorporates these risks in an interdependent fashion and in a common system of risk management. The earth data are essential for this, especially earth observation satellites which play an essential role to give us an overall vision, whether a local vision or a global vision, in a uniform fashion that are comparable and that are repetitive with frequent data gathering to assess the different variables for assessing and evaluating risk.

As Mr Le Gall said, greenhouse gas, sea levels and ocean temperatures were looked at by the GCOS which was initiated by the UN to create a global climate monitoring system and to examine the physical and chemical properties of the sea and the different layers of the atmosphere. With the new generation of satellites now in operation, including the European Commission's Copernicus Programme, there has been huge progress in observation techniques but also with climate modelling of the atmosphere and earth surface.

There has also been a great evolution of computer systems; climatologists can now predict with tremendous precision – which is actually getting more precise with each day – and over years and decades they use simulations to develop a long-term forecast. As such, satellite observations have become indispensable to verify these projections and we have higher and higher resolution images from these satellites. We get a collection of data that can be used by different experts; this transformation into information needs to combine the satellite data with models, with different local knowledge, and other techniques and mechanisms. These are all indispensable when it comes to climate adaptation and mitigation.

OPEN DEBATE

Mr Jean-François Minster, Scientific Director, Total. Good morning. I would like to come back to the whole matter of biomass resources and biomass related to broader energy challenges. There is a huge gap in terms of availability of biomass; we cannot continue to have such uncertain forecasts when it comes to availability of biomass and their use. People are working on potential resources (i.e. what existing surface areas allow us to produce) with an optimistic take on yields, without fully understanding what land has to be kept for food production and biodiversity.

At Total we call these 'technically accessible resources' that are in relation to farming practices, land ownership, the food needs of local populations and other dimensions. From one country to the next, the technically accessible resources are two times less than actually accessible resources.

When it comes to the question of use for energy, there could be need for heat for energy or biofuel, so when you assess this you have to do this with local stakeholders and not just using satellites; you have to have teams on the ground and we do this country by country. We have academic teams on the ground and today we have a forecast that we have made available for all; we published it because we feel that what we need are pooled estimations that are respectful of people's needs so that we can all use these resources together.

Pr Lord Julian Hunt of Chesterton, Member of the House of Lords, UK. I thought that the last presentation about the role of satellites and space was very important. I have done some collaborated work on networks in the equator, and I just wanted to note that there are many features of the climate and the processes there which are very different to those at higher latitudes.

Most of the computer models that we use for climate – I know about this as I used to be Head of the Met Office – are very much focused on higher latitude science. So, for example, the way in which precipitation is changing in much more dramatic ways and the long periods of cloud cover are causing concern about the ability to use solar PV in the equatorial regions.

I think we must have more involvement between the scientists and the scientific groups involved in the equatorial countries and those leading the international sciences. I think other speakers have commented on this, but that does need to be emphasised.

Mrs Mathilda Ernkrans, Chair of the Committee on Environment and Agriculture of the Swedish Parliament. I could talk a little bit about how Sweden works and is very engaged in producing biofuel and biogas from manure; it is very interesting because you can reduce fossil usage and use fewer of chemical fertilisers and so you get better agriculture and also use less fossil fuels.

That is very interesting, but I think I will just make the comment that I agree agroecology is promising and, overall, I think we need to have more focus on technology assessments and innovations on a more sustainable agriculture, both economically, ecologically and socially, because we will not be able to feed people in a world effected by climate change without equitable distribution.

This perspective is something that I did not hear in the introductions. I think technology assessments and innovations on equitable distribution are vital because that is a key role in innovations to feed humanity while reducing greenhouse gas emissions. Thank you.

Dr Chris Tyler, Head of the UK Parliamentary Office of Science and Technology (POST). This is one of those debates where there are many important technological and political issues which Europe in particular finds difficult to air. From a technological perspective, genetic modification is one of those technologies that we have not invested in for various political and public reasons, and this is certainly a forum in which that would be a useful debate.

Secondly, investment in technologies like precision agriculture and novel food production has been historically quite low in Europe, which again is an area which could yield important development both for increasing production while not increasing carbon dioxide.

A third element is much more for the political realm than the technological realm, but of course there are technological and economic concerns that could inform it. This element is difficult agricultural form issues, including things that people do not talk about like bigger farms and fewer farmers,; these are extremely important issues and if we do not talk about them in a forum like this I think we miss an opportunity.

Mr Ola Elvestuen, Chair of the Environment and Energy Committee of the Norwegian Parliament. On this issue I would like to bring attention to our 'blue forests' and their potential both for storing carbon and also for food production. If you look at our blue forests – that is the mangrove, salt marshes, seagrass meadows and also kelp forests – they have huge potential for storing carbon. A mangrove forest can store five times what is in a rainforest.

In tropical areas, 50% of all carbon storage and ocean sediments are stored in mangroves, salt marshes and seagrass meadows, even though they only cover 0.5% of the seabed. These areas have huge potential and positive aspects when it comes to food production and maintaining biodiversity, and also of course when it comes to adaptation and the rising sea levels.

However, many of these areas are in a dire situation, so this is an issue that should definitely be crucial in our preparation for COP21 In Norway some of our scientific institutes have created what they call the Norwegian Blue Forest Network in order to bring attention to this issue and also to look at where we can work most efficiently, both nationally with our kelp forests but also internationally, especially when we look at mangroves.

It is interesting to see how we can bring this into the United Nations Programme on Reducing Emissions from Deforestation and Forest Degradation (or UN-REDD Programme), for instance, when it comes to the UN actions there and also when it comes to the COP21. I think this is an area that has been paid far too little attention; the potential to store carbon is enormous and the benefits beyond that with biodiversity, food production and also adaptation for the climate change that we are seeing are immense. Thank you.

Mr Jean-Yves Le Gall. Thank you, Mr President. Let me just compliment the presenters on the question of satellites. I would just like to focus on one point; the changes we have seen in relation to technological advances. Satellites have given us an overall global view of climate change and it was sea levels that also showed the average rise in the temperature of the earth.

Thanks to technological advances, satellites will enable us to see regional emissions of carbon dioxide and methane. The consequence of this is that countries that commit to reduce their emissions, it means that we can verify compliance in their industry and their systems do indeed reduce emissions. It will also enable us on an international scale to ensure that the commitments made at international gatherings, for example at COP21, are met.

There is a new era that we are entering when it comes to satellite observation when it comes to climate change. I wanted to highlight these changes because we will finally have a measurement instrument that is international and reliable and that will enable us to see what happens also on a local level, which we were not able to do in the past. Thank you very much.

Mr Bruno Revellin-Falcoz, Academy of Technologies, member of OPECST Scientific Council. I would just like to continue with what Jean-François Minster was saying about the wide range of assessments that exist. Given that there are a number of us here who are familiar with these questions, what is the body, what are the organisations that really see these questions and are able to reduce the gaps in assessments? Because unfortunately we do not have reliable assessments and this skews the debate. We need an international organisation that gives specific thought to this whole matter on innovation and climate change.

Mrs Mady Delvaux, MEP, STOA Board of Directors. In terms of all the data that is gathered – and, as far as I have understood, there are tremendous discrepancies in assessment – which is the body or the organisation that can gather together these assessments and settle potential conflicts and eliminate these discrepancies? What type of international cooperation do we have and which countries, which continents are involved in this?

Mr Michel Griffon. I think we can answer in the following way: there is no actual coordination between the different initiatives. There are different models such as the Food and Agriculture Organization of the United Nations (FAO) model; this is based on agriculture questions, but not biomass. Then there is the International Food Policy Research Institute (IFPRI) model which is focused on food production, but not so much on biomass.

For a specifically economic approach to these questions, ESA looks at satellite data and perhaps comes closest to the reality of the situation. In France, there is the joint initiative of the French National Institute for Agricultural Research (INRA) and CIRAD, and I think there are some other university-based initiatives all over the world.

However, as Jean-François Minster was saying, there is no actual mechanism that would allow us to have satisfactory modelling and an assessment of the situation that is rather closer to the reality on the ground. Thank you.

Mrs Anne-Yvonne Le Dain. I would just like to comment on what Mr Griffon and Mr Minster have both said. We should be able to take decisions and to decide on protocols that are not so ambitious that we cannot meet them; we need answers and solutions that are locally performing and relevant technologically speaking, but also in terms of effectiveness in relation to local communities and their realities. Thank you.

Mrs Lieve Van Woensel, Member of the European Parliament and of STOA. For the past three years we have conducted a very intensive series of studies on food and agriculture and how to feed the world in 2050, and in this study two or three years ago there was a clear lack on information on precision agriculture.

The situation is now changing very quickly and therefore two of the European Parliamentary committees asked the STOA Panel to carry out a new study. We will be starting a new foresight study looking to precision agriculture in Europe and also in a global context, but also on the impact of precision agriculture for food production and farming in Europe. This is for your information to let you know that this is a hot topic at the moment.

Mr Jean-Marc Bournigal. There is also the Global Agricultural Monitoring Initiative (GEOGLAM) project following a decision on the part of G20 and the UN to monitor food production across the world in order to counter the volatility phenomenon that had been noted.

Mr Pascal Lecomte. Thank you, Chairman. I wanted to reply to the question. At least in terms of space there is a Committee on Earth Observation Satellites (CEOS); along with many other agencies, CNES works together with CEOS to coordinate our efforts. Between ESA and NASA, for instance, we have worked on the assessment of ice melt in the Arctic and Arctic regions. I chair the working group on climate. So what I wanted to say is that there is coordination, at least regarding space agencies, and there are some 50 space agencies and 150 satellites up there.

Mr Lars Klüver, Director, Danish Board of Technology Assessment. I just wanted to say that I think it is interesting to hear about the technological side of innovation here, but it seems to me that political innovation and diffusion of political innovation is an issue of particular importance.

In 2009, the Danish Ministry of Agriculture issued a report of 15 measures to decrease the CO_2 release from Danish farmland; four of these measures, covering 75% of the CO_2 reduction, related to manure being used for biogas, production of willow woodchips on marginal or poor soils, straw for combined heat and power, and closing agriculture production on wet farmlands. These are quite simple measures that make 75% of the CO_2 reduction.

For me, this means that maybe we should focus more on innovating in policies to make this happen. For example, we are talking about incentives for farmers to actually go in this direction, we are talking about making good local and national markets for biomass, and we are also talking about land use reforms and maybe even changing ownership and distributing land between farmers in different ways. My point is that we need to focus not only on technological innovation but also political innovation. Thank you.

Mr Bruno Sido. Let me reassure you, the French Parliament is highly creative and, at the Grenelle Environment Roundtable, we adopted a number of measures which coincide with what you are talking about.

Mr Huw Irranca-Davies. Further to the point that has just been made, back in 2008/09 the then UK Parliament commissioned a piece of work by the Foresight Futures organisation looking at those very issues of land use. This work tried to drive the agenda behind the data and the evidence that we currently had to get into these arguments about changes in land use, trade-offs between food production, carbon, housing etc.

This was a very innovative piece of work, but the gentlemen who proceeded me is absolutely right: the challenge of it politically is to take people with you with some areas that are highly contentious in the way that you use your land. Where is the trade-off between carbon and biodiversity, farming and food production and food security, biomass production and so on? I do agree, however, that in the successive five or six years our evidence base has moved on significantly.

I think it is timely that, at a European level, we look at this again in order to see where we need to make some challenging decisions based on the evidence that is in front of us to challenge our thinking about what we do with land, what we use for carbon storage, what we use for biodiversity and what we use for economic development as well. I suspect this is most challenging not for scientists but for policymakers and politicians.

Mr Pascal Lecomte. Thank you, Chairman; I would like to react to what was said just now. A few years ago, together with the World Meteorological Organisation (WMO) and the Coordination Group for Meteorological Satellites (CGMS), we were asked to draft a document describing a climate architecture. When you say the word ‘meteorology’ today, it goes from satellites observation all the way to forecasts for people who want to go out on a picnic next weekend, but we find it hard to pass on the climate change message to society.

We have the data, we have the essential climatic variables, but then the data has to be transformed into information which society can take on board. Then there is another pillar which is the decision-making, the choices that have to be made. These two first pillars are properly covered; we can collect data, there is never enough, and we will always need more and more satellites and models.

We have something there, the data can be transformed into essential climatic data so we can look at CO_2 and greenhouse gases, but then to say the least we feel far more uncomfortable beyond that because that is basic information which we find very difficult to transform into something which is palatable for society.

Mr Jean-Yves Le Déaut. Thank you for that. If there are no further comments I will hand over to Anne-Yvonne Le Dain, but first I would like to respond to a comment made by Mr Klüver.

We do not only have technological innovation: we have parliaments and citizens. Our parliaments, as I was saying earlier, need to mobilise because we represent the citizens of our respective countries, and what our citizens want has to be reflected in parliament. Very often political innovation seems to find its expression in tax and regulatory innovation, many regulatory taxes being added onto the existing taxes, and we are probably not doing enough for social innovation and possibly not enough for technical innovation to support political innovation.

I was elected a long time ago – far too long ago, probably – and before that I taught at a university. When I came to this parliament is was a bit of a jolt because when they found out that I used to teach science at university all my colleagues thought I had all of the knowledge; every time there was something related to technology or science they all turned to me, and when I said that I could not always help, they found that most surprising.

Furthermore, our colleagues did feel that technology was important, but since they were not well acquainted with it they did not look at all of the technological fields available to solve a given political issue. I should like to thank Jean-Yves Le Gall and Jean-Marc Bournigal who are in charge of the European or French bodies. There are others who are going to join us; we could have invited other European organisations, maybe we are not acquainted with each other well enough yet, but it is through contacts between parliamentarians such as today which will allow us to solidify and strengthen these links.

Mrs Anne-Yvonne Le Dain. What more can I say? You said it so eloquently! I would also like to thank the gentleman who very kindly said that two pillars are well taken care of, but there are two others and scientists cannot take over the whole burden of this for the world; we have to ensure that politically and administratively there are not too many obstacles and that possibilities can come to fruition. And let me say this: the local level is an infinite space for innovation, as well as the global level.

Mr Jean-Yves Le Gall. You thanked the people in charge of research institutions, and in my turn I would like to thank the politicians and especially those of the Office because without them we could not achieve anything. What I found absolutely amazing is this kind of alchemy which we are witnessing in the

run-up to COP21 in terms of this interest in climate; in that respect it is already the beginnings of a success and I think we should pay tribute to the Office's work. I wanted to thank you for that.

NEW FRONTIERS

Mr Jean-Yves Le Déaut. We shall not move onto the New Frontiers section of this workshop and hopefully we will find some answers to the question of CO_2 conversion. Some people think there are alternatives to CO_2 storage in forests or other parts of the biosphere which would be an artificial carbon cycle, it would then be a very useful advantage because CO_2 would be transformed into raw material and then in the artificial cycle it could become part of our market and the emitters would then be able to sell the CO_2.

The Americans are very much looking into this. I went to the Sandia laboratory in New Mexico last February where researchers are working on the Sunshine-to-Petrol project, a reactor which is continuously fed by CO_2 with concentrated solar energy and is able to produce methanol. We have asked Mrs Christine Mansilla from I-tésé to present the available information on life cycles of these solutions, and then Mr Vincent César from CNRS will say more.

CAN CARBON BE STORED BY THE MEANS OF CO2 CONVERSION?

Mrs Christine Mansilla, CEA, I-tésé. I am very pleased to speak today at this conference about CO_2 valorisation and the potential and key issues. CO_2 valorisation, meaning capturing CO_2 from diffuse or concentrated sources, and reusing it with or without transformation, is one of the levers to mitigate greenhouse gas emissions. There is high potential here because today only 0.5% of emissions are valorised.

CO_2 valorisation pathways are very varied and have very diverse potentials in terms of CO_2 consumption, because this consumption ranges from a few dozen million tons to a few billion tons per year at the global level, depending on the pathway. That is to say, up to several percent of the global emissions. The potentials are also very diverse in terms of duration of CO_2 sequestration in the cycle, because CO_2 depending on the pathway would be re-emitted when burning energy products, whereas it would be stored longer when producing chemicals and of course even longer for mineralisation processes.

Nevertheless, complete environmental footprints remain to be assessed. The issues involve the energy consumption because some pathways require very significant amounts of low carbon electricity, for instance, and the end product to which it would be substituted, as well as other impacts besides CO_2 balance. The pathways, finally, are more or less mature. Among the most promising ones we can mention are thermochemical processes such as those evoked by Mr Le Déaut

before, the process that would be developed, for instance, by the Sunshine to Petrol team at Sandia is one example.

Also, in the medium term, CO_2 hydrogenation appears very promising because no major technological bottleneck is identified. However, the process economics still need to be consolidated and in this respect CO_2 price is a major question in relation to policy and regulation issues. Thank you for your attention.

CO2 CONVERSION BY CHEMICAL MEANS: PROGRESS

Mr Jean-Yves Le Déaut. I would like to introduce Vincent César who is part of a 'parliamentarian-scientist-researcher' triangle, an Academy of Sciences initiative which has been doing well for several years now. Mr César has worked with Parliament and he can tell us a little about the chemical conversion of CO_2.

Mr Vincent César, Researcher, CNRS. Good morning. Thank you for the introduction and for having invited us. My colleague summed up the economic aspects and the political issues at stake; I would now like to talk about the more technical side of things.

I shall provide a few figures first to illustrate what I am saying; currently emissions in the atmosphere are about 30 gigatons per annum and are rising. Fossil fuels such as oil, coal and gas are becoming rarer and they are the main sources of current chemical products. As such, transforming CO_2 is very meaningful because it is stable, nontoxic and does not cost much (although this is debatable), and could at the end of the day replace hydrocarbons through chemical synthesis.

Right now there are very few industrial processes which use CO_2. Let me just mention one process which represents more than 98% of the industrial use of CO_2, that is urea synthesis through the Bosch–Meiser process using CO_2 and ammonia. Urea is used 95% of fertilisers, so less than 1% of CO_2 emissions are used by these industrial methods, and what has to be noted here is CO_2 is functionalised without any formal reduction of the carbon atom.

This leads me to this crucial issue of CO_2 conversion. In the carbon cycle, CO_2 is the ultimate state of carbon; it is the final product of combustion and oxidation of organic matters, so it is the most oxidised state of carbon. Therefore recycling has to go through a reduction process and there are two very important challenges here in energy terms. First of all, carbon is very stable and therefore energy has to be used to convert it, and usually this goes through high energy products, therefore you need catalysts in order to obtain the chemical reaction.

This is a very important point so, for those who are not chemists, but maybe I could explain it differently; everybody understands that if you want to go from A to B it is much easier to go through three 200 metre mountain passes than one which is 5,000 metres. So this is something which nature can do through

photosynthesis, transforming CO_2 and water through solar energy into organic matter such as sugars.

The challenge for chemists today is to find the conditions and catalytic systems which will make it possible to bring about these reactions, temperature and pressure conditions in order to make it economically viable, and what is important is to understand the mechanisms that are put into play. So far it has been mainly products through direct CO_2 reduction: formic acid, carbon monoxide, formaldehyde, methanol and methane. These are chemical processes for alternate fuels.

As I said, you have to select the desired product, there is the environmental impact which you have to consider and also the economic interests of the process. It is very important to consider what the primary source of energy is and therefore hydrogenation reactions are a different case because dihydrogen can now be obtained durably through water electrolysis and with its reaction with CO_2 it gives water as a by-product. There is also Carbon Recycling International and the George Olah Plant (named after the winner of the 1994 Nobel Chemistry prize in 1994) where geothermal energy is used as a primary source to transform CO_2.

There are other systems which are also efficient for selective production of formic acid, methanol and even methane, and finally electro-catalysis is also a mature technique now to generate carbon monoxide. Photo-catalysis should make it possible to reduce CO_2 directly through light radiation, but this is still something for the future. This is something which we have been looking into very much over the past decade and all research efforts, be they chemical or industrial, are making headway. There are still, however, a number of scientific hurdles to overcome, for instance the range of products which are directly accessible through CO_2 and the carbon-carbon links.

Mr Mikko Alatalo, Member of the Finish Parliament, Member of the Committee for the Future. In terms of innovation in transportation in Finland, we are currently producing biodiesel from waste and residues; Neste Oil makes biodiesel from fats and oils, for example, and also the pulp companies are developing biofuels waste and solid biomass. Also, as Mr Klüver from Denmark mentioned, I think we need political decisions about reducing emissions in agriculture, for example converting animal and vegetable waste into biogas. This is one of the ways to turn this policy into business.

Mr Jean-Yves Le Déaut. Before we break for lunch, I would like to thank each and every one of you for being here this morning; there are more than 200 people here in this room representing more than 30 countries. I would also like to thank Bruno Sido, Senator and First Vice-President of OPECST, and all the staff of the Office. Finally, I would like to thank Claudie Haigneré, former astronaut and Minister for Research for the French Government, for all her input.

30TH ANNIVERSARY OF FIRST OPECST REPORT: WHAT ABOUT ACIDIFICATION PROBLEMS, THIRTY YEARS AFTERWARDS?

Mr Jean-Yves Le Déaut, MP, President of OPECST, president of EPTA for 2015. Dear colleagues, this afternoon we are going to start by celebrating the thirtieth anniversary of the Parliamentary Office. It is also the twenty-sixth birthday of the EPTA as it was founded in 1991; so 25 years of existence for EPTA and 30 for the Office. As you have seen we have had many of the former presidents with us over lunch, including Claude Birraux, but I would also like to pay tribute to the former presidents that have passed away, such as Jacques Valade and Henri Revol.

It is a belated birthday because the legal foundation of the organisation was on 8th July 1983, so we are in fact celebrating the first report that was submitted in 1985. This first report was devoted to acid rain, a topic that very much grabbed the headlines at the time.

The Office had a very rigorous and accurate methodology and they title of the publication was a very scientific one; the report was led by Mr Georges Le Baill, a Deputy in the Hauts-de-Seine who was an engineer by trade and served two mandates in parliament. We would have been very happy to see him here among us today but unfortunately he passed away some nine years ago. We would like to pay tribute to him today.

This report was the first one to highlight the importance of having to fight against climate change and it is also a way to celebrate the scientific breakthroughs that have happened, and the conclusion of the report was very relevant regarding the problem of forest depletion because of acid rain. The rapporteur highlighted that a lot of scientific uncertainty could have many explanations, hence the need to do research and development to drive down the release of pollutant substances as quickly as possible.

I am going to call upon Christer Ågren from Sweden who represents an NGO called AirClim, and we are going to ask him to tell us about what has been done in the field for the last thirty years on acid rain. I would like to thank Mr Christer Ågren for being here today, you have the floor.

Mr Christer Ågren, Director, Air Pollution & Climate Secretariat, AirClim (NGO), Sweden. Thirty years of acid rain in five minutes – I will challenge that and give you 150 years of acid rain in six minutes! On my first slide you can see the development of the acidifying pollutants from 1880 up to the early 2000s and, as you can see, the emissions of acidifying air pollutants peaked in the 1980s. The primary acidifying pollutant was sulphur dioxide, but also nitrogen

oxides and ammonia contributes; in some areas of Europe the nitrogen pollutants are nearly as important as the sulphur ones.

Why did the pollution come down? Well, mainly as a result of the environmental debate, the impact on nature and ecosystems; forests in Central Europe, lakes and rivers in Scandinavia, for instance. The reduction in emissions was also a result of the energy changes in the 1980s and 90s that followed the oil crisis in the 1970s. So it was a combination of environmental policy and energy policy.

Here you can see the development for European Union countries over the last 30 years up to 2013, the most recent data from the European Environmental Agency, and you can see tremendous reduction in sulphur emissions, more than 90% since the peak in 1980. Nitrogen oxide emissions, which come primarily from the transport sector, are not quite as good but have still more than halved over the past 30 years, while a third of acidifying pollutant ammonia is clearly lagging behind with a modest 27% reduction.

So what has this done to deposition, the impact on nature? We can clearly see that less emissions results in less deposition. That was challenged in a heated debate in the 1980s, but now we can see the results; if you reduce emissions you also reduce concentrations and you reduce deposition. This figure illustrates the area of ecosystems in Europe where the deposition exceeds the tolerance of nature: how much pollution nature can withstand, and that varies in different areas of Europe. You can see a significant improvement when it comes to acidification and a slight improvement when it comes to eutrophication. Eutrophication is another word for over-fertilisation by nitrogen pollution and has a great impact on biodiversity.

This slide shows you from left to right, 1980 up to what we expect it to be in 2020; the area with acid overload has come down from nearly half of the ecosystem area in 1980 to only one tenth in 2010. For eutrophication there is also some improvement but this is not as significant.

Sweden and Norway were the two countries initiating the debate about transboundary air pollution as a result of the acidification problems we suffered in our freshwater environment. This was discovered in the 1960s but was brought onto the agenda in the 1970s and 80s. We can see also a significant change in deposition in Sweden; the top graph shows you the situation for southwest Sweden where we have the highest deposition and the highest impact because that area is closest to the continent, to the sources of the pollution. About 90% of the sulphur pollution that falls over Sweden is imported from other countries and from international shipping in the sea areas around Scandinavia.

While the deposition has come down and the area with excess deposition has come down, we do not see a similar improvement in the environment. What we have learnt is that is takes time for ecosystems to recover, and that is a lesson

that is important to remember when it comes to other environmental issues as well; even if we reduce the pollution load, some of the damage that has been caused takes a very long time to recover, and some of the damage might even be irreversible.

In the next slide we can see some statistics. Excess deposition has come down from nearly 60% at the worst time in 1980 to 17% today. The number of acidified lakes has not come down as much, but it has nearly halved which is a great improvement; we started with nearly 20,000 acidified lakes in the 1980s and we are now down to about 10,000 lakes. We regularly lime several thousand of these lakes; we put lime in the water to neutralise both the rivers and the lakes, and similar activities are going on in Norway. We are spending tens of millions of euros to maintain the biological life in these areas.

The important lesson from this is that it is easy to pollute, but it takes work and money and time to reduce pollution. We can reduce the emissions but even if we manage to reduce emissions, some of the damage takes a very, very long time to recover and some of the damage might even be irreversible.

Some 30 or 40 years ago the focus was on nature and ecosystem protection. Over the past couple of decades, the focus when it comes to the air pollution debate has changed from ecosystems to humans; we focus much, much more now on human health. We are more concerned about ourselves than our environment today that we were previously.

The most important European Union legislation to control transboundary air pollution is the 2001 National Emission Ceilings Directive. Late in 2013, the Commission proposed to update that directive with new emission targets for 2020 and 2030, although these are not very ambitious targets from the environmental movement's point of view. You can see that the estimated cost for this legislation for all 28 member countries would be about €2.2 billion per year in 2030. It sounds like a tremendous amount of money, but if you split that between the EU populations, you are talking about €4 per person, per year. What did you pay for your last cup of coffee?

We will not die from this level of ambition, but still it is very hotly debated, both in parliament and in the council, and some member countries claim very fiercely that this legislation is too ambitious. This is far from too ambitious; we have close to half a million people dying annually in the European Union as a result of air pollution, the same air pollution that has been acidifying and eutrophicating our environment.

I think it is also important to note that there are very important connections between climate policy and air pollution policy. Strong air pollution policy helps climate in the sense that stricter standards on power stations, for example, means that they are closing down the old and inefficient ones and replacing them with new and more efficient ones or, even better, by efficiency renewables. The less

fossil fuel you burn, the less air pollutants will be emitted, so these go hand in hand.

There are some source sectors which are more important than others now for the next steps of emission control. I mention four of the most contentious ones here. Firstly, domestic heating; this is politically a very hot issue because you go in and try to regulate people's everyday lives. Secondly, diesel engines; it might be enough to say the word 'Volkswagen' and then you know what it is all about.

Thirdly, international shipping, a sector which is still 30 years behind in legislation; it is getting a little better in northern Europe because we have sulphur emission control areas in the North Sea and the Baltic Sea, but southern Europe is still clearly lagging behind. Finally, agriculture; we have been talking about this today in terms of climate, but ammonia is getting relatively more and more important because SOx and NOx emissions are coming down, ammonia is more or less stable and is not coming down at all to the same extent as the other pollutants or as much as is needed to protect health and the environment. Thank you.

Mr Jean-Yves Le Déaut. Thank you very much, Mr Ågren, for this presentation. I would like to thank Pierre Laffitte, one of the former Presidents and also a Senator who is among us today and who will be concluding today's meeting with a speech at the very end.

Now we will move onto the next workshop, and I will call upon Jean-Paul Chanteguet, Chairman of the Committee of the National Assembly on Sustainable Development and Territorial Planning. Unfortunately not able to call upon Mr Rainer Vakra, Chairman of the Committee on Environment of the Estonian Parliament, he is in Estonia.

THIRD WORKSHOP:
INNOVATION FOR TRANSPORTATION AND SUSTAINABLE MOBILITY

Chaired by Mr Jean-Paul Chanteguet, MP, Chairman of the Committee of the National Assembly on sustainable Development and territorial Planning

Mr Jean-Paul Chanteguet. Thank you very much, Mr Chairman. Ladies and gentlemen, good afternoon. I am delighted to be here this afternoon and to preside over this roundtable. I will be wearing my cap of Chairman of the Committee of the National Assembly on Sustainable Development and Territorial Planning this afternoon. Before I hand the floor to the different people here in the room, I would like to introduce my colleague who is a deputy and also a Member of the French Parliament, Denis Baupin.

Very quickly, transport is probably the sector in which there is the most to do and where innovation can be the most effective. Think about cars, for example, that very soon will only be consuming two litres of oil to run 100 km. Some of these innovations are progressive, such as hybrid cars, for example, that either run on fuel or electricity who release less CO_2 but also have a bigger range than 100% electric vehicles.

Other innovations are going to come as maybe a slight surprise, arriving at maturity right now; there are new engines, there are also new fuels in the pipeline, so we do not know how the car in the future will be propelled. There are many options that are going to come to the fore in years to come.

Nonetheless, pollution due to transport is going to have to be driven down; we are going to have to continue to fight against fine particles and to drive down CO_2 emissions as we know how bad both of these are for public health. Some efforts have been made but we need to do more; regulations are becoming more stringent but with the recent Volkswagen scandal I think we can all agree that more can be done.

So let’s have a look at the societal issues and impact of transport on pollution. A lot of the innovations that we need are going to have an impact on the way we go from one place to another – carpooling, for example, because a lot of young people are never going to own their own car – so all of this is going to change, and we will be addressing all of this during this roundtable.

I will be giving the floor to a great variety of people. Mr Denis Baupin who drafted a report entitled *New, smooth and sustainable mobility: the conception of ecological vehicles*. But we will also have members of academia and speakers from the automobile industry from different countries. In the New Frontiers section we will be giving the floor to the sociologist Georges Amar who

will be telling us about his vision of mobility and we will also be welcoming Michael Nentwich from the Austrian Institute of Technology Assessment who will be talking about socioeconomic aspects of sustainable mobility.

Those are the few words that I wanted to say by way of introduction. I will now give the floor to Mr Denis Baupin.

INTRODUCTORY SPEECHES

WHICH INNOVATIONS ARE NECESSARY TO PROMOTE NEW MOBILITIES?

Mr Denis Baupin, MP, co-author, with Senator Fabienne Keller, of the OPECST report *New, smooth and sustainable mobility: the conception of ecological vehicles*. Mobility is confronted to two main challenges. Firstly, there is the environmental issue. As the recent Volkswagen scandal showed, everybody needs to comply with the new standards and the new constraints, and no one should ever try to circumvent these standards.

The second challenge has to do with how we are going to change the way in which we go from one place to another, and we are going to be talking about BlaBlaCar, Uber and all these topics that are at the heart of the debate. I am here only talking about individual vehicles; mobility is a much larger landscape than that and, as you know, there are many stakeholders.

I am a member of the Green Party. I know that that might be a bit contentious right now in France but, nevertheless, a lot of people know that I was the anti-car speaker in Paris for many years and I have been working on solutions to turn away from individual vehicle ownership. Do couples with no children need to have a car with four seats in it? Do we need to have cars that go as fast as 180 km/hr, even when the speed limit is 130 km/hr on motorways? All these questions are questions that I have been raising for quite some time. Then there is also fuel efficiency; because of this constructors have to downsize, so they make the same car but they try to downsize and to drive down the consumption of cars.

The idea was to see whether we could come up with new concepts to try and find an optimal solution and design the best possible vehicle. We met all of the car manufacturers in Europe and we asked then three questions. First of all, are you able to manufacture these new vehicles? They all answered, yes, they could and they had concept cars that proved it. Second question: why don't you do it? And they said, 'We don't think there is a market for these vehicles and, because we need to put €1 billion upfront to produce on a large scale we are not sure whether it is a good idea.'

The third question we asked was what if the public authorities were to send a signal from the top and if we gave a number of financial incentives and tolls, for example, on motorways, would you be interested in that? Car manufacturers all answered yes. So this is why we are trying to translate this into

law at a national and local level to send this signal from the top so that car manufacturers finally manufacture and design cars that are relevant in our time.

WHICH ENERGIES FOR WHICH MOTOR AND ENGINE TECHNOLOGIES?

Mr Pierre-René Bauquis, former Director Strategy and Planning, Total. In the face of the climate challenge, the key question is what type of energy will be used in our vehicles; the type of engine is really somewhat subordinate to this. This raises two economic questions, one in a traditional economic sense and another in terms of the cost of CO_2 emissions in particular.

Until 1990, the answer to the question, 'What type of energy and what type of engine?' was straightforward: it was oil and combustion engines. However, since we have realised that we have to penalise noxious emissions, the whole equation has changed. The priority today is reducing CO_2 emissions and other pollutants such as nitrous oxide. There are two stages; one was downsizing – and this has enabled us to lower emissions by 50% – and then if you want to go further we have to go towards substitution with non-carbon engines. For this, there are really only two candidates; non-carbon generated electricity and hydrogen.

What really strikes me is to see the survival of the myth about hydrogen which has been coming and going over the last hundred years. BMW and Mercedes had hydrogen pressure vehicles and, more recently, the technological star of the industry has been Toyota, which has just brought out the Mirai. You can buy one for €75,000; the cost to Toyota is about twice this price.

In 1997, Toyota started a new era of the automobile with the Prius, a hybrid which could go from one engine type to another, it could store electricity on board and it is really the ancestor of what is going to end up becoming the solution. I will not list the other types of vehicle which are similar, the Kangoo and so forth, but what is really striking is this myth of the hydrogen vehicle that driven by major companies.

Why do I think this is the wrong solution? There are various factors: it is very expensive to produce; it is very expensive to transport at ten times the cost of liquid gas; it is very expensive to store in vehicles (maximum 5% of weight, 95% is the packaging) and none of this can be compensated by other yield-type advantages. Equally, from a safety point of view, hydrogen atom are not just atoms that can be sent anywhere; these cars are bombs waiting to blow up and I do not think it is common sense to go down this route.

When it comes to the question of electricity, there are two types of solutions and they are complementary to one another; pure electric for urban and suburban areas (Bolloré has taken this path in France) and the rechargeable hybrid. I think this is a large scale solution for the future. It should cover 80% of the car fleets in developed countries in 20 or 30 years; because they are duel-fuel, electricity from the grid and hydrocarbon fuel, they present a number of solutions.

I have gone over my time but, if anybody is interested, I have a more in-depth written presentation on this very topic. Thank you.

HOW TO ASSESS THE ENVIRONMENTAL IMPACT AND ENERGY EFFICIENCY OF DIFFERENT FUEL TYPES?

Mr Linas Balsys, MP, Member of the Environmental Commission of the Lithuanian Parliament. Thank you, Mr President. That is a very difficult question, colleagues, how to assess the environmental impact and energy efficiency of different fuel types. The short answer is: I don't know. That is it. The question is so complex and involving a lot of different various other factors than just the fuel type itself.

The short answer would also be that the best fuel is the one which is never used. I really mean it, because if we are diminishing the usage of fossil fuel, then only we can say that it is really energy efficient. We cannot speak about energy efficiency whilst speaking about the fuels. So the more efficient we are in using any type of fuel is the best.

Of course, if we take the traditional fossil fuels like coal, petrol and gas, it is more or less clear; all of this fuel is really bad because there is no compromise between the environmental benefits and the efficiency of energy itself. But of course we are the petroleum civilisation nowadays and this means that even if we are on our way to refusing the fossil fuel, we still use it.

So the coal is worst, petrol is second worst, and then especially the aviation fuel, and I am very glad that we have the regulation by the European Commission stating very clearly on how to measure, how to report and what it all means. In this respect I would suggest we politicians have to think twice before flying to the United Nations Climate Change Conference; it is better not to go there at all and to talk on the phone instead.

Then, if we take gas, gas is recognised as the least damaging type of fossil fuel because it is more or less clean, but it is not really clean because the natural gas itself is a powerful greenhouse gas. In this respect, if we take the new source of fuel like shale gas etc. then we are in very big danger of methane leakage and all the other problems related to this type of fuel, and then we have to say that this is also not acceptable.

We could say that nuclear is quite CO_2 friendly but it is not friendly in all the other meanings, and all the catastrophes show that it is really not the way to go because it is very difficult to find an investor to invest on its own into the new nuclear power station. It is not even possible to find an insurance company which will agree to insure your new nuclear power station, so it all goes on the shoulders of tax payers and in this respect we cannot say this is really very friendly type of fuel.

So, what is left? Renewables. I think everybody agrees that renewables is the right way to go, except maybe for biofuel. Biofuel is something that we have to think twice about before going into this business because it has related side effects, like the changing the land usage and depriving the land from producing food and producing biofuel. Maybe we will have another generation of biofuels which really will be more or less acceptable.

I believe that really need a more united approach on the European Union level, because if we take member states from nation to nation we have different regulations, we have different situations with the types of fuel, the different legislation, but we are all in the European Union at least or the European Economic Area. We all are in the same single market, and if we do not have the universal rules and regulations then it is very difficult to achieve the European-wide harmonised development of the new ecologically and climate-friendly types of energy and types of fuel.

In this respect it would be really very good to have more active cooperation between the national parliaments and the European Parliament; the format that we are in now is really very suitable for that, and I am really very glad that we can discuss these issues.

Finally, everybody is talking about electric cars, but there is one important thing; if you produce an electric car which is produced using the nuclear or coal energy, this is not a green. We have to produce electric cars using renewable energy. Thank you.

Mr Jean-Paul Chanteguet. Thank you very much for those remarks. I would like to give the floor to Jean-Pierre Orfeuil who is an Urbanist from the City on the Move Institute (*Institut pour la ville en mouvement*). He is answering the question of how to evaluate current social trends in transportation.

HOW TO EVALUATE CURRENT SOCIAL TRENDS IN TRANSPORTATION?

Mr Jean-Pierre Orfeuil, Urbanist, *Institut pour la ville en mouvement.* Thank you. The City on the Move Institute was guided by the same concerns that have brought us together here today. It is difficult to talk about mobility or transportation without talking about lifestyle, territory and transportation for all. Through four illustrations I would like to illustrate this belief.

The first point is that when it comes to the energy transition I am of a certain age, I am familiar with a time where energy transition and transportation meant more taxes and more road tolls, and this raises a problem for disadvantaged and precarious sectors of the population. One of our first focuses for action was to create mechanisms which have a lot to do with what was discussed this morning: frugal innovation. Let me just say that it is through dealing with the problems of at-risk groups that we were able to develop systems of pooling and car sharing well before the systems that were created for the broader population as such.

Secondly we have the whole question of new expectations and new values that are emerging and which may provide an underpinning for carrying out the energy transition. The first topic that we looked into in 2006, we actually had quite a lot of difficulty finding speakers, and this has to do with sharing: vehicle sharing, journey sharing and so forth. Since then, the situation has changed quite a bit: Vélolib and Autolib now exist, as well as BlaBlaCar etc. On this topic what we should be mindful of is what we were not ready for, even in the 1990s, that is to make the question of vehicles not just personal question. People were reticent on this score in the past but younger generations are much more open to this idea that it is not just a matter of having one's own private vehicle.

Then when it comes to societal values, it is the whole value of 'lightness' and mobility which people have analysed by looking at smartphones and mobile technology. The whole problem of transportation in urban settings is, as Denis Baupin was saying, to move away from four-seat vehicles with only one person in the car, or to focus on high-speed vehicle; what we are talking about is the use of small, safe, clean vehicles for urban settings. On this point countries like Germany or the Netherlands are ahead of us in relation to one type of vehicle, and that is electric bicycles.

The Baupin/Keller report talks about cooperation with local authorities on a European level because you are not just going to build one of these small vehicles for one country, for France let alone for Luxembourg or Belgian. So, yes, we should be looking at smaller vehicles, but it would be even better if they had networks that they could be used on in a safe and independent way. Unfortunately we have very heavy networks for extremely high speeds which can become real obstacles and which divides the city up into different areas. We have a programme called Passages which seeks to reduce the effects of these obstacles or barriers.

Let me just say based on small scale initiatives we have actually been quite surprised that with competitions in Latin America, North America and of course in Europe, in has been interesting to see how interested urbanists and other are in the invention of a twenty-first century vehicle, but also the networks on which these vehicles can be used.

Let me just wrap up by saying that the whole question, when it comes to energy transition, concerns countries but it also concerns cities, and without the cities we will not be able to take this whole project forward.

ECO-EFFICIENT TRANSPORT AS A MEANS TO REDUCE DEPENDENCE ON PETROLEUM IMPORTS AND SEARCH FOR SOLUTIONS TO CLIMATE CHANGE

Mr Theodoros Karapiperis, Head of Unit, Scientific Foresight Unit (STOA), European Parliamentary Research Service (EPRS), European Parliament. Thank you, Chairman and organisers, for giving me the opportunity to make this short presentation where I will try to speak very briefly about what is

being done at the level of the European Union and from the point of view in STOA, in particular in the area of sustainable transport and mobility.

At the level of European legislation one basic instrument from 2010 is a directive ITS which actually is at the basis of the coordinated deployment of intelligent transport systems across Europe. The implementation of this directive has been quite successful at many levels, in fact also in terms of the adoption of the different implementing measures, but there have also been challenges.

These challenges have been particularly important in the area of the adoption of the necessary technical organisational and service provisions, especially in areas where there are no European decisions taken (i.e. real-time traffic information services or the multi-model information service). Now, all this is done in a framework where we are realising the increasing scarcity of fossil fuels and also the alarming impact of greenhouse gas emissions, which makes it clear that it is crucial now to consider alternatives for technology and fuels used in transport.

In this context, STOA has its own priority area on eco-efficient transport and mobility; within this area, STOA is trying to identify policy actions and options for policy initiatives to achieve eco-efficient transport and for reducing dependence of member states on oil imports, and for helping Europe to address the climate change issue.

I will try to refer very briefly to a few studies. The 2013 study on eco-efficient transport comes to the conclusion that economic growth can actually benefit from transport becoming more efficient and respectful of the environment. It proposes a broader approach and systemic approach which will take into account the technical factors (fuel, information technology and so on), the nontechnical factors (technologic costs, infrastructure, lack of coordination), and it also takes end-user concerns, preferences and habits into account.

A 2012 study on technology options for urban transport came to the conclusion that transport systems can change a lot through technologies. It proposed that a strategy which should go via reducing carbon use, cleaner fuels and propulsion technologies, but also optimised transport flows, encouraging users to use modes of transport which are more friendly to the environment, and also reducing the need to travel through virtual accessibility, making use of technology such as video conferencing.

Although we all agree about the need to decarbonise the transport system, the relative performance of different alternative technologies still remains to be assessed, and this was done in a study that was published in 2014 on using methanol as a possible fuel in the future. This study came to the conclusion that the development of efficient processes for capturing CO_2 and converting to methanol was one of the most challenging points in this area, and actually they

also recommended we should avoid to the extent possible hydrogenation processes which may consume a lot of energy.

Last but not least there was a smaller scale study on future metal demand from photovoltaic cells and wind turbines, which looked into another aspects of this kind of approach where the need to ensure that there will be enough supply of rare raw materials that are needed, especially in this case for solar panels and wind turbines.

Looking to the future, STOA is now working towards launching a study on resources and instruments for financing new transport infrastructure projects. We will certainly address issues of the sustainability in the context of that project and we will report back to you.

NORWEGIAN EXPERIENCES IN THE TRANSPORT SECTOR: ZERO EMISSIONS AND NEW SOLUTIONS FOR THE MARITIME SECTOR

Mr Ola Elvestuen, MP, Chairman of the Standing Committee on Energy and the Environment of the Norwegian Parliament. When it comes to transportation, I think the most important thing is to have our priorities right, that is special planning, city planning, you have to make walkable cities, walkable societies, you have to prioritise bicycling, you have to build up a good public transportation system, a good national railway system, but still even though we do that, individual travel by cars will still be there and it is here to stay.

When it comes to cars, they have to become zero emission, and I am a strong believer also for hydrogen and fuel cell cars. I have a claim that the technology is already here; not yet for everyone, but it is increasingly practical for more people more often, with electric cars. The challenge is to create a market for them. I think in Norway we are that early market.

For the first six months this year, zero-emission cars made up 18.4% of all new cars sold in Norway. This is done with a good incentive system; there are no taxes for them, there is no VAT, they have free access to toll roads, they can park for free, they have access to bus lanes.

If you look at Norway’s goals for reducing greenhouse gas emissions, it is by 40% until 2030, and we are the country that does not have any coal plants running, 90% of our power is hydropower, a lot of that reduction has to be from the transportation sector. So if we look at the car sales, they have to be almost 100% zero-emission by 2025 to reach that goal.

This creates other challenges; it is a challenge for the grid system if there are so many electric cars, but it also creates possibilities. What benefits can we get from electric cars that we do not have for a regular car? How can we use it when it is standing still, how can we balance the electrical system with it, and how can we

also make money for having a car when you do not use it? There are a lot of possibilities and challenges in that.

When it comes to biofuels it is common to think about the moving of heavy goods and trucking; that is where you need biodiesel and that is where you need biogas. You also need biogas electric solutions for public transportation. I would like to say a little bit about what is happening within the maritime sector; natural gas is already an alternative within the shipping industry, but in Norway we now have the first car ferries that are fully electric and running in regular traffic.

We are also looking at the possibilities in the future; hopefully within three or four years we will have the first high-speed passenger ferry that is run on hydrogen fuel cells. Within five or six years it will also be possible to see the first coastal freight ships to have hydrogen-powered fuel cells.

When they look at the price of electricity there is a surplus of renewable electricity in Norway and so the price is low. You look at that price and you look at hydrogen produced from water electrolysis, within the scope of three or four years it can be competitive to the price of natural gas. If we can switch that and make that competitive it will mean that it gives some real possibilities for the future and we can make the first dents into the emissions that come from international shipping, which I think today is about 8% of the total emissions in the world. Thank you.

Mr Jean-Paul Chanteguet. Thank you very much. To talk about vehicles that consume two litres per 100 kilometres, or 250 miles to the gallon, let us hear Mr Didier Houssin.

2L/100 KM CAR FOR EVERYBODY

Mr Didier Houssin, Chairman, *IFP Energies nouvelles*. Thank you very much. *IFP Energies nouvelles*, the French oil institute, is working on a vehicle which uses less than 2 litres/100 km; it also contributes to reducing CO_2 emissions because there is a lot of demand for mobility in emerging countries. Even with the 2° scenario, internal combustion engines will still be dominant in 2050 and the best way to reduce CO_2 emissions is to improve the energy efficiency of vehicles.

Now, the objective of the programme is to design a car for all at an affordable price; it is not a concept car for the rich. In order to do this together with our partners we are developing a number of technologies which can be used on all ranges of vehicles, individual vehicles, and trucks.

Now, there is the optimising of diesel and petrol engines and we feel that a 40-50% gain on vehicles consumption is possible compared to today's baseline, especially if thermal losses are mainly recycled from exhaust fumes. Then there is the electrifying of vehicles through hybrid vehicles with optimised functions

according to the routes and a compromise between purchase cost and usage cost, and optimised energy also on board the vehicle. We have worked on a delivery vehicle in the Lyons region with an optimisation of the battery and thermal engine for transport, so the vehicle should reduce its consumption as much as possible throughout its use and with limited sound emissions as well in urban areas.

The fourth possibility is improving the use of a vehicle. Having several people in a car can make a big difference as well and we have driving aids now which make it possible to reduce consumption. Then there is the automobile industry, downsizing is possible there, and there is also the environmental impact, the use of green fuels such as second generation biofuels, which do not compete with food crop production. We are very close to having competitive technologies here; the programme is a collaboration between the various players in the sector and therefore we can speed up innovation because there is a certain measure of urgency regarding the improvement of engine technologies.

IFP carries the Carnot label for our transport energy sector and we find that there are many initiatives in small and medium-sized companies on these subjects. We take part in this and we are also present on various platforms and initiatives in Europe. Once again, it is very important in terms of competition within the European industry and also efficiency regarding the CO_2 emissions in the transport sector. Thank you.

OPEN DEBATE

Mr Joseph Beretta, President, AVERE-FRANCE (The European Association for Battery, Hybrid and Fuel Cell Electric Vehicles). Electric mobility is not just a battery-run vehicle, it is also a hybrid rechargeable vehicle and also fuels cells. We feel that energy and engine is a very important couple, so you have to find the right solution.

An electric vehicle is the most relevant on short distances, and I am not just saying urban or semi-urban areas, I think it is also relevant in rural areas, so it is very important to adopt a position there. Hybrid vehicles are there to improve the efficiency of an internal combustion energy and the rechargeable vehicles, they say it is the best possible compromise, but it isn’t, it is just a choice according to use because if you want a lot of autonomy you need a lot of battery.

Now, fuel cells, when I say this I am talking about the ultimate electric car, so electric mobility is there to bring about the energy transition in transport whilst guaranteeing a low level of pollution because you can’t fiddle and electric car because it will never emit any pollutants.

Now, before I come to my conclusion, I should like to correct a few mistakes. When you say ‘a hydrogen car is a bomb’ it is not true; if such a vehicle catches fire it burns up just like a petrol engine vehicle. It does not explode, I have seen this with my own eyes. When I hear that hybrid rechargeable vehicle will

save the grid it is not true because a hybrid vehicle with storage can also serve that purpose. What I am saying is that you have to find the right association between technology and engine according to the use.

Mr Henri Revol, Honorary Senator, Former President of OPECST. One answer to Mr Bauquis' question on whether we have enough control in terms of safety for future hydrogen cars: given that in France unfortunately the statistics are draconian, there are tens of thousands of cars that are burned by delinquents, unfortunately, and that includes hybrid cars.

Mr Marc Teyssier d'Orfeuil, Club of Ecological Vehicles. I have been listening to you and the conclusion is that there is no silver bullet; it is for the consumer to decide whether they want methanol or hybrid solutions. There are many parliamentarians here from European countries and my comment is regarding the involvement of local communities with positive discrimination in terms of parking for electric cars. This is a very strong lever encouraging people to acquire electric cars. We also have bonuses on motorways for these environmentally friendly cars, and if we can use all these positive discrimination measures people will turn to electric cars.

So I was saying to parliamentarians in other countries, turn to local authorities, they have a responsibility and a potential lever with parking alone. If you decide to give a 50% rebate to small vehicles it really makes a difference, so local authorities have a very important part to play in this and it is part of the dynamic we need to see at European level.

Innovation is important and there are innovations which may fail, but let us avoid saying that one solution is better than the others; it is energy mix and consumers are ready to try things. What I am sure of is that the energy mix in more sustainable vehicles is something we all have to push.

Mr Denis Baupin. To add to what Marc Teyssier d'Orfeuil was saying, listening to the various speakers, what springs to mind is that we should open up vistas rather than pre-empt options. That is at least what we said in our regard regarding technologies, especially regarding vehicle; our idea is that we should leave everything open because there are possibilities to produce renewable electricity, gas and others, so there are quite a few technological options. As to the vehicle itself, well of course we are not against the idea of new models; if you can combine that with more traditional options then you can come to something even more interesting in terms of reducing consumption and pollution.

Then there is another point that has not really been mentioned much, it is the digital revolution. Will this bring about any changes regarding the way mobility is organised? There again, you have to remain open-minded and yet be extremely careful regarding data; who will be aggregating mobility? Will it be Google? Will it be Renault? Will it be Volkswagen? Or will it be some transport utility in a given country?

So those are also questions we parliamentarians must be aware of and in industrial terms obviously I think that sooner or later there will be a manufacturer who comes back with a mobility iPhone, if I may put it that way; a vehicle which is both attractive, fun, and which uses very little space and fuel. Whoever goes along that road will probably be a big winner on the market. So it is probable that the car industry will come up with this.

Mr Ola Elvestuen. I would like to say that I strongly agree that local communities, and in particular cities, are very important. I used to be Vice-Mayor for Transportation and Environment in Oslo, and Oslo has definitely driven this process with electric vehicles in Norway. We started offering free parking to electric vehicles and also put out 200 public charging points which are also free to use.

The most important incentive was when we agreed that electric cars and zero-emission cars could use the bus lanes. That is actually so attractive now that there are too many electric cars and now they have to be taken out again, but that is because you have to handle the success. It is really an incentive that worked because a lot of driver commute and this is the way to get to work. This is when you reach not the environmentalists but you reach everyone else that sees that it is practical for them.

So local communities and cities are very important, also when you look at the new ideas that have to be developed in the new sharing economy that we are seeing developing in more and more cities, you have it with bikes, cars and now other areas. I think this is the way to go. When we drive, we look at texting or mobile phones as a distraction, but when you look at young people coming up today, it is not the being online that is the distraction, it is the driving that is the distraction. It is becoming a totally new way to look at the car and also look at transportation.

Mr Lars Klüver, Director, Danish Board of Technology. I would just like to tell you about a project we finished in 2012 in which we invited all the big players in the Danish transport sector to do a project together with us trying to see how we could imagine a transport system for Denmark 2050 that would be 100% sustainable. What we did was we basically let them negotiate solutions, and we calculated on those solutions in an energy model that combined the energy system with the transport system so that we optimised on both the transport system and the energy system at the same time.

Out of that came some quite interesting results. One of them was that we simply needed to get everything that could be run on electricity to get that onto electricity, and that was because the electrical motor is so effective. So we got much more out of the energy if we could get it over on electricity. A part of that was that we saw a very big opportunity in electric two-wheelers; because it is not a bicycle, it is a bicycle with a help motor, but you can expand them into

motorcycles and many other head of vehicles in the future so that you can imagine a much greater use of two-wheelers in the future run on electricity.

There was nearly no hydrogen in that system, and the reason was that it was so expensive in energy terms to get from water to wheels, and so we lost too much energy in the energy system of making the hydrogen, so it was simply too ineffective to fit into the energy system. Biomass could not be used as biofuels for personal transportation basically; all the biomass we could produce in Denmark and transform would be used for air traffic, for ships and for long-distance transport. So basically no biofuels for personal transportation, that was also necessary.

The last thing I would say is that we could only get to 80% sustainability through technical means, the last 20% we had to find through new ways of working and new ways of placing work.

Mrs Amélie Séguret, BlaBlaCar. I represent the company BlaBlaCar, a community of car poolers where people share the same car to go from one city to the next, they pay for petrol and for tolls, but the driver makes no profit at all. We started operating in France in 2006 and we are now operating in 19 countries with millions of travellers every month. With BlaBlaCar we can optimise the use of cars and we are able to offer up many free seats in cars that would normally be empty. I think that we need to divide the number of empty seats in cars by four; right now with BlaBlaCar we have an average of 2.8 people in our cars, whereas the average in Europe is 1.7 people per car, per trip.

We are working to innovate BlaBlaCar from a technological point of view, with new features that make a communication between passengers and drivers easier, but also new features to build trust between drivers and passengers. We are investing tools to enable passengers to choose who they are going to be travelling with, who will be at the wheel, and they base all of this on the feedback left by the community at large. To conclude, I would like to stress that we are coming up with a new affordable mobility solution that meets the increasing demand for mobility whilst also protecting the environment.

Mr Laurent Taupin, Head of Eolab project, Research Department, Renault. I am a Project Leader for Renault and am currently working on EOLAB, a research project that came about a year ago during the Salon de Paris. We came up with a car that consumes five times less fuel than the traditional Renault Clio. The aerodynamics of the car have been optimised to make it 30% more effective than other standard cars, and the engine is also a new generation electric engine. All of this is part of our 2l/100km plan and is one of many innovations that we will be rolling out in years to come, but in fact EOLAB is not new at all; we have been able to design low-carbon vehicles for quite some time. The whole point of EOLAB is to prove that such a vehicle can be designed, but also to prove that these vehicles are economically viable and that profits can be made on the mass market.

The novelty of EOLAB is to design low-carbon cars for all. We have to juggle a number of constraints, of course. First of all, the car must be attractive otherwise it will not find its market; it is not always easy to design a pretty car when the aerodynamics are pushed to the very limits. Equally, the weight has to be brought down to a minimum (which also imposes a number of constraints), it must not be a niche product and it must also be environmentally friendly. The whole process was based around technique and economic issues, and involved many stakeholders in the French automobile industry. EOLAB currently could not really exist in a factory; we are still far away from factories and so we need to continue to move forward. Nevertheless, we have drawn up a first road map that leads to the mass production of low carbon affordable cars.

Mr Marcel Van de Voorde. I was in charge of research at the European Commission and I know that quite a lot of research studies are being carried out at the moment on exhaust gas and CO_2 released by cars. They are looking at how this gas could be transformed into methanol or other liquid substances, or even into fuel that could be 'recycled' so as to go full circle and no longer release CO_2. BMW have carried out a number of experiments in that regard to find a solution to the CO_2 emitted by cars and already uses CO_2 to make fuel. There is also quite a lot of research that has been carried out in Japan and the United States that points to the same conclusions.

However, the problem we have is that of efficiency; we need to be efficient on a very large scale and, once again, technology is going to be very important against this particular backdrop, as are materials and catalysers. We need to identify which opportunities we can seize, and I am convinced that French car manufacturers are also very interested in this solution. We basically need to have a car that is like a small chemical plant; this might be complicated in a car, but I am sure that we already have the means to fit such chemical plants on a lorry as an initial experiment.

Mr Maxime Pasquier, Engineer, Ademe. I am in charge of energy efficiency at Ademe and I would like to talk about the electric vehicle, both in France and in Germany. I am going to be talking about the lifecycle results and talking about the three main points of the lifecycle of cars. Analysis show that electric vehicles provide an answer to many global problems (they are very positive in the fight against climate change and global warming, of course), but it all depends on how the electricity is produced.

Electric vehicles also address the problem of resource depletion and answer the problem of diversification of energy sources in transport; the impact of this is positive both in France and, even more so, in Germany. Equally, if you look at air quality indicators such as the potential of photochemical areas, traditional vehicles create a lot of ozone that is toxic for humans and electric vehicles are a lot less toxic that other cars in that regard. What we can say is that in France and Germany the source of electricity has a big impact on greenhouse gas emissions.

Sometimes the production of the car requires more energy than the actual use of the car. So all this is still very important and you must bear it in mind.

We have a number of recommendations. Of course we must look at how the electricity is produced by using renewable energies in a smarter manner (and I would like to remind you of what Mr Beretta said earlier in that regard), but it is also important to have public policies and incentives to improve the quality of the air so that we can make the most of electric vehicles. In order to drive down the impact of producing and manufacturing electric vehicles we need to continue our efforts in R&D in batteries and on recycling batteries of electric cars. That is another avenue that seems to be interesting. Then there is the intense use of electric vehicles that is also very beneficial; I am talking here about fleets of corporate cars or, if we are talking about individual car, there again a lot can be done.

So here we are talking about very specific use; in our culture we are used to conserving a car as a universal vehicle that can be used in many different ways, and I think it is important to talk about the digital revolution that we mentioned earlier so that we can adapt the use of vehicles to our actual needs. The environmental issues with which we are confronted today are so important that we need to be as relevant as possible in our use of vehicles.

Mr Sébastien Grellier, Director of Communication and Public Affairs, Toyota. I would like to go back to what was said earlier about the Baupin/Keller report, which we have not spoken a lot about today, especially the issue pertaining to the lifecycle of vehicles. We have been talking about different engines and different energy sources; all of this is very interesting but, if you really want to drive down the impact of vehicles on the environment, you need to take into account the whole lifecycle of vehicles from production to recycling.

This is something that we have been doing at Toyota for quite some time (through the design of the factories etc.) to preserve resources and to recycle as many parts of a vehicle as we possibly can. This is a quantitative assessment system which is part of this cycle that we call 'Eco-VAS,' or ecological vehicle assessment system. This takes into account the quantitative data throughout the lifecycle of a vehicle. Now, everyone here knows our company, but I would just like to give you two specific figures. Firstly, we have sold 8 million hybrid vehicles since 2007. We talked about the price earlier, and I think that this is a very interesting case in point; it took us ten years to sell one million vehicles, but to reach the second million it only took us ten months.

To conclude, I would like to echo Mr Beretta's earlier comment; we have been working for the last 20 years to find a solution, but the problem in France is that we often get different technologies to compete with one another rather than trying to strike the right balance between them. Let us not forget that consumers will vote with their feet, or rather their wallets, and they are the ones who are going to decide, and the VW scandal is very important in that regard. We must use

electric vehicles, especially in urban areas, and the hybrid car is the easiest one to sell on the mass market; remember, a hybrid Toyota some ten years ago cost €30,000 and now this price has been halved. My final comment is on safety and hydrogen: if we can sell a new hydrogen car in the next 15 years it might cost €30,000 – which be a bomb, but a good one!

Mr Claude Couderc, Public Affairs Department, PSA. I wanted to talk about our experience at PSA that we have been carrying out over the last four years in Berlin. We have a carpooling system where people in Berlin have 350 cars at their disposal in what we call a 'free-floating system' so users can simply use a card take a car anywhere in Berlin. Berlin is, in that regard, a pilot city; there are some areas where you can take a car, others where you can drop it off, the whole idea is to use a car as much or as little as you want and just leave it somewhere that is convenient.

So we are trying to come up with mobility solutions but they need to be rolled out on the ground to see if they will work. The last four years in Berlin have enabled us to understand what worked and what did not work, and what consumers wanted and what their behaviour would be, and we cannot do anything without knowing what users do. This experiment is an investment; it is not profitable at all for the moment, but it is interesting to see that users find pleasure in using this new solution and they must do, otherwise they would not turn to it.

Mr Pierre-René Bauquis. I knew that the rather provocative comments that I made earlier would get some people's backs up! The representative from Toyota and the representative of the French electrical vehicles association says that they are not bombs. I am actually a great admirer of Toyota; in 2005 they invited me to speak on the future of automobiles, so these are people for whom I have the greatest respect.

There are two ways to look at the hydrogen in vehicles. It is either a liquid at −253°C (BMW have spent a decade trying to develop them) but then there is no problem if some nut sets your vehicle on fire. With LNG it is the same thing, except that such vehicles cannot be left in carparks because, by definition, there is a boil-off otherwise you are not at −253°C. So now people are looking at 700 bar of pressure in the Mirai, but when you look at the tank of the Mirai – and if we are talking about a proper terrorist here – if you heat up these vehicles past 700 bar then the whole building is history. If you can prove to the contrary I am interested in hearing what you have to say.

I have heard some troubling things that hydrogen pack vehicles in Norway; that 99% of non-petrol cars are electric. I have not heard of this hydrogen pack vehicle before, but I might be wrong – you live there, you know what you are talking about – but something we have never looked at is the cost for Norwegian communities. You buy these high-level American electric vehicles, Tesla for example, and if you calculate the cost of the CO_2 tons avoided, it is a few hundred dollars; it is not nothing but it is negligible. But then you say they benefit for

several hundred euros per ton that is not such a bad thing. The Head of AVERE-FRANCE said, if I understood him correctly, that he did not see any difference between a rechargeable hybrid and an all-electrical car when it comes to regulation on the network; can you actually explain what you mean by this please?

Mr Ola Elvestuen. Zero emission cars today are 99% of electric cars. We are an early market for electric cars, but the same system applies for the fuel cell hydrogen-powered cars. So we expect to be an early market also for them when they come along, but it takes a little longer. That is the idea and that is also why it is a long-term policy also to introduce hydrogen. I think where it is even more interesting is in the maritime sector, and there it is liquefied hydrogen.

Mr Claude Birraux, former MP, former President of OPECST. I see that hydrogen is a topic of great interest. Governor Schwarzenegger launched the Hydrogen Highway project. Is anyone here able to tell me where California has got to on this Hydrogen Highway?

Mr Laurent Gouzenes, Scientific Director, Pacte Novation, Member of the OPECST scientific Council. I am a science director. The first point when it comes to measuring pollution is that it is more upstream; it is not the same thing if you die at two years old or 99 years old, so when you are counting the number of deaths I would like some other figures, not just number of deaths. That is just a detail. Secondly, the consumption profile; there is personal consumption for vehicles but there is also transportation of merchandise, of goods, which is actually the same order of magnitude as passengers. There is tremendous progress to be made there. Trains are very inefficient; they are connected to locomotives and they can only go on rails, you have to be able to put together a train and put them on the tracks. It is a very slow and not a very flexible system, and the same thing goes for boats and barges. This is also a problem when it comes to transportation of goods.

As for personal transportation, it is hard to find a happy medium between the subway and a luxury 4X4 vehicle with leather seats. The question about personal transportation is that you need to make many short trips and you do not necessarily need the highest level of comfort, and BlaBlaCar is kind of speaking to this. We have to better share the transportation infrastructure; not just the infrastructure that does not move, but also public transport and small vehicles. If they can actually stay on the roads for a longer time and not spend most of their time parked somewhere that would also be much more efficient use of resources and infrastructure. It is better to have them actually running and being driven on our roads, and this would also reduce production costs for all these vehicles that are just sitting around parked for most of the time. So when we are talking about new transportation systems for the future I think we have to give these questions some serious thought.

Mr Jean-Yves Le Déaut. We have now come to the end of this roundtable on transportation. I was worried that it would run into the following

topic, which focuses on the involvement of citizens. Thanks to the Chair we are able to keep the discussion going and we are able to show that you cannot disassociate technological innovation from social innovation and, for that matter, from political innovation: it is all tied together.

Now we are going to hear from two people, Georges Amar and Michael Nentwich, who are going to talk about the new patterns of sustainable mobility. In terms of global warming and air pollution, we need a new a more integrated approach on a European level and we need technological assessment; we need all these techniques and we need to hear about the efficiency and the effectiveness of these techniques.

Denis Baupin said something that I thought was very important, and Laurent Gouzenes mentioned it as well; we will have more information technology in vehicles so we will need a digital component to these policies. What concerns us is that digital has got inside automobiles. We have had a number of hearings organised by the French parliament, one on data collection and data transmission (I believe Denis Baupin talked about this) and in the area of agriculture we talked about this, but I think it is valid for all areas when it comes to data transmission. We also had a meeting on robotics and law, we are having this on 15 December, and there will be robotics in cars, especially as we are moving towards driverless vehicles

Of course, digital questions are therefore important, particularly if data is forged, but there is also the question personal data and confidentiality. This whole question should bring us to create software systems that gather data while dealing with these questions of personal information, confidentiality and so forth.

NEW FRONTIERS

HOW TO PROMOTE NEW PATTERNS OF SUSTAINABLE MOBILITY?

Mr Georges Amar, Futurist, Mobility Consultant. I would like to give you a peek into the future. We are developing new forms of transportation and mobility which are not sustainable and which therefore call for a lot of innovation, and even breakthrough innovation, so it is a paradox to have a futuristic approach towards technology breakthroughs.

We are not seeking to predict the future but rather we are trying to pinpoint paradigm changes. This is two-sided: to detect which paradigms are becoming obsolescent and simultaneously to try to find and develop emerging paradigms, so I suggest we do this when it comes to transportation. Please excuse me that this is rather complex, but I am basically boiling it down to four stages. The first stage might not be the easiest to implement but, if you have a bit of imagination, it will be easy to imagine; the other extreme is to think of innovations that are practically unfathomable but are new transportation paradigms, and that really requires imagination.

The first stage, which may be a bit of a caricature at times, is the constant concept. Let me give you two examples: the automatic subway and the electric vehicle, or the hybrid car. These are constant concepts. It is a bit mean-spirited to say this, but if you think about the automatic subway, Line 1 of the Paris Métro system that goes from Vincennes to La Défense, it has been totally automatic for the past three years. Are you bothered by this? Does this prevent you from using Line 1? No, and yet this is a huge technological change with a very high level of performance. Does this change the Métro as such? No, not really. You could say the same thing for electric cars, hybrid cars and all the rest. That is the first state; I am not saying that these technological innovations based on this constant concept are bad or unimportant, but the concept does not change. I think we can all agree on that.

The second stage is what I call conceptual innovation, and what is interesting here is that very often reality outstrips fiction. We have innovations that are real and already function, but we cannot grapple with the huge step forward that these present. So there is already a change of paradigm there; we cannot quite put a name on them and yet they have policy impacts.

Let me give you an example which is the most straightforward one; we have seen innovations for a number of years now like Vélib', Autolib and BlaBlaCar, where the underpinning concept is really forward looking and is very significant. I tried to work on this and play around to try to come up with a name. I came up with a name that was not very pretty, but it is interesting because it is rather paradoxical: I called it IPT, or individual public transport. It is not pretty, but the concept is interesting; car sharing and bike sharing are public systems but they are also individual at the same time. It is neither one nor the other, but they are both one and the other. IPT makes us see through this paradox that individual transportation and public transportation are two different things, and logically they should be counterpoised.

So IPTs are a contradiction in terms, or an oxymoron; they do not exist expect conceptually, and yet we are seeing it increasingly. In fact we can agree – at least I agree – that IPTs are a project that takes us into the future. If you believe it is a concept for the future, this has a consequence both intellectually and practically speaking. Both individual transportation and private transportation are concepts that both belong to the past. I am trying to provoke some discussion but I also believe this, public transportation will actually be increasingly individual as far as users are concerned.

From the point of view of the users, individual transportation will be more and more public, and we also know this, and so when I hear political proposals saying that we are going to develop public transportation, I am former employee of the Paris public transport system, the RATP, I am very happy when I hear about this, except that public transportation is a concept of the past. Public transportation, same service, same access for everyone, this concept is no longer

current, this is not the future, you can have wonderful public transportation or wonderful individual transportation, but this is not a system for the future.

With the third stage you can see a big change in meaning here, deep going change in significance linked to what is called mobile lifestyle; transportation is just one hour per day but mobile life is actually 24 hours a day, and throughout one's life. Everything in life is done or can be done in a mobile fashion. To avoid misunderstanding, mobile lifestyle does not mean that you are constantly moving and jittering from left to right, rather mobile lifestyles mean domesticating or civilising mobility, and I think as such we are just at the beginning of a civilisation of mobility, where mobility is actually calmness within a framework of mobility, we are just entering a life of mobility which will be a civilisation of mobility.

Let me give you three examples of this; it is actually quite entertaining to see that part of the meeting here is called New Frontiers, it is amusing because *Nouvelles Frontières* is actually a travel agency in France. Just a few years ago, *Nouvelles Frontières* carried out an advertising campaign which I thought was very interesting, it had added to it name new encounters. When I saw this it was a poster on one of their stores but I fully grasped what they were getting at. It means that genuine trips, genuine journeys, implicitly, it is not travelling hundreds of miles away but rather to meet new people and to make new encounters. I think this change in meaning is interesting, it is not a paradigm of distance and speed, whereas new encounters is the value of this new mobility.

There are many examples that you could think of to illustrate this change in meaning. Take the car, for example, once it becomes automatic – and it is going to be automatic, everything is going to be automated – so when cars are automated people will realise that the car is in fact a place, a mobile place, a location, locations will be mobile and they are mobile. So it will be a place to meet people, to chat – 'bla bla bla' as in BlaBlaCar! This new mobility paradigm is not a domination of mobility as such, the new paradigm is that the distinction between mobile and immobile becomes very fuzzy. Mobility is becoming so natural that you are mobile just as you breathe, in and out, so vehicles are going to become places, that is the paradigm, and therefore life becomes a mobility system.

One very last point, the fourth stage, the prospective and most paradoxically stage. Here I am referring to total transmutation of mobility, and we will come to a level of mobility aesthetics, mobility is going to become beautiful and significant. So restriction may well become a value. It is an artistic principle and once we have reached the stage of aesthetics, the significance of mobility will be completely changed.

SOCIOECONOMIC ASPECTS OF SUSTAINABLE MOBILITY

Mr Michael Nentwich, Austrian Institute of Technology Assessment. I have a very short presentation. I want to tell you something about some work that has been done at the Austrian Academy of Sciences where there is a

commission called Sustainable Mobility, which is our topic today. It has five working groups and I am the chair of the fifth one, so in a sense what Lars Kluver said just before there is 80% technology and maybe 20% or even more which is about the social aspects, economic aspects and legal aspects. Only a couple of weeks ago we issued this first report, it is about 40 pages, and unfortunately it is in German but if you read German it might be interesting to you. I will just summarise what we have done in this report.

The main results are the following (this focused on Austria but I think that it is relevant for most other European countries as well): there is a slight trend towards sustainable mobility in Austria and beyond, but the sustainable mobility future will not be either/or (we have heard this already today) it will be a mix of various transport means. Our car traffic is not bad at all, but it depends on the circumstances, on the uses, another result was that e-mobility in all kinds of forms, from the e-car to e-motos will play a role, as well as alternative mobility concepts. We have heard of them before like car sharing etc. And also information and communication technologies will play an important role. BlaBlaCar, for instance, is one example, but also organising work and conferences in a different way.

Another interesting result was that the full potential of public transport is not yet exploited, at least not in Austria, and even less so in riding the bicycle and walking distance. The idea of these experts in the commission said that there will be a mix of bicycling, walking, public transport, and only 10% of cars, at least in towns.

We focus then in the commission on the main barriers, and I will just name a few of them. Something that has been mentioned already today is land use regulation, which is obviously favouring urban sprawls so there is more decentral housing, which means that the daily needs of transport get longer and longer. Then there is no cost transparency and no mechanisms to internalise the external costs of the conventional transport system, therefore there is bad competition between the new modes of sustainable transport and the traditional ones. There is not much awareness of the opportunities, of the differences of the options, and there might be awareness raising as an answer to this. The other main result was that traffic regulations do not favour these alternative means of transport. It is more legal issues about cars and how they work together and less about other means like walking and bicycles etc.

I will finish with the last slide which is the preliminary recommendations. This commission has not finished yet, but we have come up with specific awareness raising for alternative forms is very important and we do not know enough about how sustainable mobility develops so the proposal is to have a clearing house for data in this respect just to be able to acknowledge the advantages and disadvantages in this respect.

Another recommendation is to have all the traffic and transport planning in a more participatory way; maybe this will be discussed in the next session. There is a lot of interdisciplinary research needed and, as I said before, land use reform and regulation reform is something which might be interesting for you as politicians here around the table. And, last but not least, tax laws or external costs are somehow to be internalised in the way we treat mobility. Thank you for your attention.

FOURTH WORKSHOP:
CITIZENS' INVOLVEMENT IN THE USE OF SMART TECHNOLOGIES

Chaired by Mrs Dominique Gillot, Senator, Member of OPECST, and Mrs Mathilda Ernkrans, Chair of the Committee on Environment and Agriculture of the Swedish Parliament.

Mrs Dominique Gillot. We are now going to start the fourth workshop which is going to look into climate change from a different perspective. Usually the issue is approached through technological solutions as we saw throughout these discussions; energy savings, renewables and conditions for their implementation, in particular financial conditions.

This time we would like to look at climate change in the light of individual behaviours which must be brought to contribute to technological solutions and innovations. The idea is to analyse the behaviours and analyse them in a cross-cutting fashion. I have just heard was someone talking about 'interdisciplinarity' and I think that that is a word which fits in beautifully. There are the psychological principles, because for each area we know that acceptance and understanding on the part of the users are essential if we are to meet the medium and long-term objectives in a sustainable way.

Building professionals know about the rebound effect that is using a more energy efficient environment to take a step back or lower energy costs which make people turn up the heating. Public policy has traditional means to weigh in on behaviour (like regulatory obligations and tax incentives) but information, education and participation are ways to obtain spontaneous involvement of individuals. It may be less certain, but it also costs a lot less for the administration while being a lot more difficult to quantify.

The speakers will be looking at the known systems to involve people or will be signalling others, each time giving objective elements for analysis because we are no longer at the stage when we exchange intuitions or beliefs. Given what is at stake in terms of climate change, the time has come to find out exactly what works, encourage it and encourage a further progress with the citizens because they can help leverage efforts to stand up to the effects of climate change. Thank you.

Mrs Mathilda Ernkrans. I am co-chair of this the fourth roundtable discussion I just want to add a little bit to what the chair said because it is now time to talk about the citizens' involvement in the use of smart technologies. In the first workshop we mentioned a need to have this perspective on the citizen, on the people, on the human beings who are expected to have a functioning everyday life

living, working and transporting themselves in a world affected by climate change and in a world with less climate emissions.

I am sure there would be good examples within the conference and we will start off as the Chair said with listening to interesting introductions to this roundtable discussions. Just to add one point that I thought about during the third workshop when we talked about cars and transportation systems; I think we need to adapt the equality agenda and knowledge on these issues. We know, for example, that fossil fuel cars were designed and often used by men with quite a lot of money; I hope that our future cars and mobility systems will involve women and also people with different incomes.

If we do not do this, citizens will not follow what we need to do to live in a world with climate change and fewer climate emissions. Hopefully this workshop will take us a little bit further in the discussion on to involve citizens in this using smarter technologies.

INTRODUCTORY SPEECHES

CAN INFORMATION, TRAINING AND EDUCATION IMPROVE PEOPLE'S HABITS?

Mr Didier Mulnet, Blaise Pascal University of Clermont-Ferrand, Laboratoire Acté. There are scientific concepts behind my answers and they might seem a little provoking, if not a bit of a caricature. While I do not want to deny how important knowledge is, I would like to draw your attention to the fact that knowledge is only a small part of a whole: to inform does not change behaviours, or only very rarely, look at smoking for instance.

Why? Well, knowledge is only part of it all; giving knowledge is a little bit like putting a snowball on top of an iceberg but everything is happening under the water line. The implicit social representations are right at the top but the superficial part does not achieve much; you have the climate sceptics and you have various living habits which need to be approached differently.

Now, when you raise awareness does this change behaviour? Usually this basically only concerns the two first stages; generally speaking it does not go any further and people are not ready to commit. If you want to go from preparation to action you must mobilise other methods, engagement theories, manipulation and this means adopting things like the model frames which stem from the dependency models. You deal with addiction in the same way. We have to be clear the most difficult thing is the two last boxes here, because if you are to maintain behaviours and stabilise behaviour it means that you are in fact grounding this in society, therefore the person will change status and strategy. Here lies the danger of behaviourism: you do not want to get things wrong.

Now, education: what is education? Educating means adopting a systemic vision; it is not just about energy, production and consumption, there is grey energy, there are relationships and you need a prospective vision taking on board changes in speed, collective vision, collective and individual responsibility and ethics. Where you are with whatever means are at your disposal, there is the identification of the difference of change and this leads to the question of sudden change and chosen change: are you adapting or are you mitigating? It is not the same thing.

To conclude, it is an evolutionary spiral; it takes some time but not too much time. It means you have to bring in all types of knowledge and you can say two things: first of all, what is education? It is opening up questions and reformulating them. Society in many ways goes faster than education; there is a major constraint in that the older tools will need to adapt to what is needed.

ARE REGULATION AND FISCAL POLICIES THE ONLY MEANS TO FIGHT AGAINST CLIMATE CHANGE?

Mr Bernard Tardieu, President of the Committee on Energy and Climate Change at the French Academy of Technologies. Well, these are not the only tools, the only weapons, and they are slightly unwieldy because they lack an overall explicit vision with objectives which are stated in terms of greenhouse gas emissions. At European level, at least, there is very little anticipation, so our citizens do not really understand.

If we take energy efficiency, we all understand that it is about the same service provided with fewer emissions, so this is all about laws and bonuses and engineers are delighted to be able to do things so well. But look at BlaBlaCar, a phenomenon which is radically increasing the number of people in cars, and lives are changing; our children and grandchildren will live totally differently from the way we live.

Energy is a very complex system which is difficult to understand and to share, so the question arises how we will be able to identify and encourage this change in behaviour and how we will be able to tell this story and share it among the citizens of the world. Let me come back to renewable energies; let’s look to the longer term, to a world with no more fossil fuels and 100% renewables. Territories are unequal in terms of sun, wind or water, of course, and there will be other intermittent energies. For communication and research it is clear that you need storage and that you need to manage demand, especially in terms of what is needed in other forms of energy to back them up.

So you need an energy base with an overall vision and this means renewable stored energy. There will be biomass, hydrogen, methane, electrolysis and all the rest, but you will have to store energy, it will have to be available, it will have to be transportable and the system’s vulnerability will have to be reduced. This is something which is not really dealt with in France or Europe nor

taken on board in guaranteed feedback prices. One takeaway from this is how happy engineers are to try and circumvent and overcome constraints, so thank you very much for this!

HOW CAN CITIZENS TAKE PART IN ACTIVE ENERGY MANAGEMENT AND NEW MEANS OF TRANSPORTATION?

Mr Étienne Klein, Head of the Scientific Research on Matter Laboratory, CEA, Member of the OPECST Scientific Council. Thank you very much. I am neither a sociologist nor a politician, I would like to make a few comments on the debate that has been going on today.

It seems to me that we are developing many intellectual systems to try and avoid understand what we already know. For example, today a philosopher wrote in *Le Figaro* that the COP21 will not amount to anything; they put forward a series of arguments that you can read for yourselves. Some people are happy to emulate this kind of very negative attitude but it is not the case for everybody; we will talk about this later on, but there is this feeling in society at large that everybody has sufficient knowledge to understand a certain number of issues and a lot of it has to do with common sense.

The English philosopher Bernard Williams points out that our modern or post-modern societies are animated by two currents of thought. The first is the thirst for truth whereby citizens do not want to be fooled and, when a discourse becomes too widely accepted, they start to question if this desire, this thirst for truth is a very healthy one. It is the only way to really understand what goes on over and beyond images and simple appearance. The same philosopher said that we challenge the truth quite a lot as well, so as soon as something is considered as being true then we ask if it has to do with culture, history or with the current climate.

This quest for truth is sometimes very complicated and kicks off a critical atmosphere throughout all of society, and a lot of the debate on climate change has been unfortunately polluted by such an atmosphere. Some say scientists all speak in the same way and have the same discourse; some are calling for a complete renovation. Unfortunately we do not have time to talk about this, but I am all for a complete overhaul and right now the fundamental concepts are very difficult to understand and grapple with.

Maybe the answer to your question is that we need to change the way in which we talk about energy because right now the discourse about energy does not really enable anyone to understand what energy really is. We need to talk about energy consumption. For the physicist all this has no meaning whatsoever. No one has ever produced energy and no one has consumed energy; energy is defined by the very fact that can be kept and stored. If the energy at the end of the system is the same as at the beginning of the system that is what we believe, so there is no production and no consumption.

To consume a unit of energy – electricity, for example – is to convert it into another unit of energy in another form; it is an organised energy system. Take hot water, for example, that you can heat with electricity so we are not producing energy. In the same way you cannot produce energy because it would mean that starting from scratch you could make energy, produce energy and that is not true; the only thing you can do is take energy and transfer it to another system or change its shape. If our discourse goes against the laws of physics then we must be lying.

Maybe one way in which you could improve the whole situation would be to use a solution that came to the fore a few years ago; the concept of the energy slave. The human body, for example, consumes 100 Watts through our consumption of food and, for a whole day, this represents 2.4 kW/hour. That is what we consume every day; 0.54 at breakfast, 0.54 at lunch and 0.54 at dinner and this is also what we need to climb all the way up to the top of Mont Blanc.

It is interesting to calculate your own energy consumption every evening, how much we consume to move from one point to another, to eat, to heat ourselves etc. and to divide this by the consumption of a human body for one day. This is where the energy slave concept comes in because there are some machines that have worked to provide you with energy; in Europe, on average, we need 200 slaves, so to speak, and in the United States, 400. If you leave a 40 Watt lamp on all day long it becomes a slave and a car that needs 8 litres to run a hundred kilometres would then become seventeen energy slaves etc. So it is a concept that gives you a more comprehensive picture of what energy actually is.

HOW DOES TAKING PART IN THE DECISION PROCESS INFLUENCE PERSONAL, DAY-TO-DAY INVOLVEMENT?

Mr Thierry Touchais, General Manager, Good Planet Foundation. Good afternoon. The fight against climate change is not only and cannot be only linked to the designing of new innovations through hard science because we also believe that behavioural and social sciences are crucial to fight against climate change. It is true that we need to have citizens on board for all these solutions to work, they need to have sufficient amount of skills and knowledge to do so. As an NGO, as a foundation, we need to disseminate this knowledge even though, as we know, knowledge is not enough; we have talked about this earlier.

Regarding decision-making processes, unless there is a regulatory constraint, citizens decide to act or not act at their own individual level. I think a good case in point is a collaborative economy; the cloud, the web etc. This new economy where people share and pool resources; we talked about BlaBlaCar, for example.

So, behaviours are more important than technology in the push when it comes to driving down greenhouse gas emissions, but the law is slightly lagging behind in many regards and citizens need to embrace new technologies to make up

for it. At my organisation we are convinced that a good foundation is the tenant to any ownership of citizens and is the key to go forward.

This is why the foundation has decided to organise a grass-root conference that will be hammering out a new charter on food and how health, pleasure and climate can be reconciled, because the food industry represents 27% of CO_2 emissions in France, which is more than any other sector.

So the answer to your question is yes, we believe that we can change the behaviours of all stakeholders in different industries as well as in national institutions in terms of agriculture and food to make sure that people are more responsible and accountable.

THE CONTRIBUTION OF CREATIVE ECONOMY

Mr Mikko Alatalo, Member of the Finish Parliament, Member of the Committee for the Future. At first when we consider citizens' involvement it is very important to think about intelligent systems to monitor and manage energy use in Finland. The Committee for the Future has advocated introducing net metering, with net metering distributing small-scale renewable power production. This would be compensated better for citizens and it would make it more attractive to move to zero and even plus-energy houses.

I said earlier that the key focus on reducing the carbon footprint of construction has been increasing. The years of the wood national programme have been promoting wood construction, standards have been developed by wood elements and I think citizens are ready for that.

Secondly, I am going to tell you about this report of the Committee for the Future about the creative economy. When you produce music, literature or movies or games it does not cause gas emissions in the large scale. Of course, cars could be entertainment places when they are automatic, but the branch of creative economy is growing. It is interesting when we think about artists nowadays; they have to be entrepreneurs in the future and of course support has to be given to the technology industry because the contents are going to be most important in business.

We also need smart technologies in culture. Of course when people are in the online world the need for travelling is getting smaller; people are doing creative work at home and the concept of work is changing. As it has been said, when the robots are doing the work and everything is turning more automatic then it gives time and space for people to do creative work from games to design from art to entertainment. And maybe the consumer is there in BlaBlaCar. The school system has been very creative in Finland but in the future we need also more entrepreneurial thinking. To conclude, I would say that the creative sector produces a lot of wellbeing for the people and also online and in the cloud.

CITIZENS' INVOLVEMENT

Pr Lord Julian Hunt of Chesterton, House of Lords, UK. Thank you very much, Chairman. I began my career in local politics with an environmental question of how we could remove cars from the pedestrian area of Cambridge. This was 1971 and it was a very revolutionary experiment in local government, but we had a vote and we got almost 99% approval. This was before smart technology.

What I wanted to speak about in fact was the way in which smart technology is, as we have heard, being used in many European countries. Perhaps one of the most revolutionary, which the British Government even approved of, was the Cucumber Project, an extraordinary programme of popular involvement of the environmental information.

I just wanted to speak very briefly about the role of the citizen in reducing climate change hazard impacts in Asian urban areas, where of course the population is rapidly growing and these are the parts of the world with the greatest sensitivity to climate change. In places like Manilla, where I have been collaborating, predictions about extreme natural hazards in the atmosphere, oceans and floods can also provide estimates of the likely physical and social impacts, for example the collapse of buildings the effects of sickness and mortality.

Improvements in computations and with satellites are improving the accuracy of warnings about the both short-term and long-term hazards associated with climate change, particularly extreme rainfall, heat waves and forest fires, but a new development is the use of real-time information provided by citizens. They are doing this in Italy, as I said, this is the question in Asia and by using this real-time information this can help the citizens reduce their impacts.

In Manilla, special smartphones are provided to people in the vulnerable areas and these smartphones will transmit the water level in real-time: blue if the water is at your ankle, yellow if it is at your knee, red if it is at your chest, and this information goes back to the hazard control centre. Using this data as well as weather radar and satellite then they can do calculations in real time of how the floods are moving, quite randomly through these areas; this provides real-time advice back on the smartphone to the people in the communities and then tells them that the water level is going down or it is rising, in which case they must move away.

This is a very advanced system using all the information and it is now saving many lives; it was interesting that it was able to be introduced in these communities and they could understand it quite well because of the smart technology. New approaches for minimising impacts of natural hazards are being discussed in Asian seminars through an NGO which I am involved with, www.ancst.org and this is following the United Nations meeting March 2015.

I agree with our Deputy Chairman, Mrs Mathilda Ernkrans that we have to be very consultative and help women's role and impacts in these areas because sometimes the systems are designed by men and that is not always the best thing to do, so that is a very important point. Finally I would like to make the comment to Mr Touchais that I agree that people's behaviour can change to help deal with climate.

CITIZEN DELIBERATIONS: PROMISES AND RISKS

Mr Gérald Bronner, Professor of Sociology at Paris-Diderot University, Member of the OPECST Scientific Council and Member of the French Academy of Technologies. The question of citizen involvement is really essential because it deals with a common good that can be used or can be served through individual initiative. Very often individuals who want to work in favour of the common good often benefit from the common but do not make any specific individual effort or contribution and this creates a negative effect.

You can eliminate these negative effects in a number of ways. One of them, which has been explored by contemporary political thought, is the new democratic processes involving direct citizen participation. Whether you call this participatory democracy or neighbourhood participation, whatever term you give, this has given rise to a number of hopes but also fears because there is something ideological.

I think the issues are sufficiently important that this should be approached through a type of social engineering that keeps in mind existing scientific literature and there is an abundant literature on this topic. One of the topics that has to be clarified before just giving in to these processes is the whole question of representativeness of involved citizens. How do you select citizens who are involved in these initiatives, should that be based on voluntary involvement, that is get the most motivated citizens to express their view and represent the population or should we get these volunteers among NGOs as often NGOs themselves want or, rather, should we just draw by lots? What should be the size of these deliberating bodies?

This is important because if one person out of 200 speaks it is no longer a deliberative body; perhaps there may be an optimal size to ensure that the floor is given to at least 50% of people and not one percent of people. If there is no such optimal size, how do you avoid social effects given the different levels of cultural capital among different participants, cultural differences that can be expressed through people's different ability to express arguments powerfully which may shift the centre of gravity of discussions and exchanges. How do you avoid polarisations that are covered in their literature where you find there is a difference between the overall viewpoint and the individual views expressed? And will a group reach reasonable conclusions and not sub-optimal ones?

There is another question. Of course I have to deal with these questions with broad brush strokes, unfortunately. The problems that are submitted to deliberation, all the people involved do not have the same cognitive underpinnings. In some situations we do not see an equal share of individual participations but you are drifting toward the rational decision-making norm.

None of these defects that I mentioned cannot be overcome, especially in relation to the overall benefit to be had from such collective deliberations, but there would have to be a specific discussion and debate and lengthy work on this question.

ROLE OF NGOs IN THE PREPARATION OF COP21

Mrs Alissa Scholl, Lawyer and Member of the NGO Islands First. Thank you, first of all, for giving me the floor today. I am involved with Islands First and was involved at the Bonn meeting in June. Ours is a New York-based NGO that helps islands deal with the problem of climate change.

One of the major challenges for COP21 is citizen involvement, because in relation to the inertia of decision-makers there is an urgent need for mobilisation and there is an urgent need for a citizen's movement to push the UN negotiations forward. We have seen the Climate 21 coalition of NGOs which has created a real a veritable activist network, and there was the People's Climate March which took place in September 2014 providing concrete solutions based on work being done on the ground, and there is also the sixty solutions presented in the book that has been mentioned here.

In order to mobilise people, citizens have to be informed; there are educational campaigns, WWF, Greenpeace and others involved in this, and although these initiatives are reaching greater and greater numbers of people, Usually the people are informed already; it is harder to involve less committed and less knowledgeable segments of the population, and so civil society has to ask itself how can it ensure that climate change questions really penetrate into the hearts and minds of the global citizenry.

There are is a need for campaigns, for NGO posters in public places and in public transportation to show that this is a problem of daily life and that, even though climate change may seem far away, when you look at what is happening in small Africans islands and developing nations, the problems are here and now. We need to go in a new direction and so mobilisation is essential.

When you look at the negotiations, you wonder whether the negotiators are in a position to find the appropriate answers to climate change because the negotiations are very difficult and often involve very dense technical jargon. I am not saying that climate change is not a technical topic, of course it is technical as well, but there is also just a question of finding funding and often the struggle to find the right terms and right words is more important than the structure to deal

with climate change. It is possible that we will come out of the COP21 with a text that is incomprehensible and that is not even adopted, and so NGOs are trying to work in the direction of finding solutions.

There are reasons for optimism in terms of improving energy efficiency; COP has begun to understand had now has a workstream which seeks to deepen post 2020 commitments in terms of using technology with a high greenhouse gas reduction potential. So this is a real forum discussion and to find concrete solutions; it is an opportunity for civil society and for the private sector to participate more actively in the negotiations. You can make submissions to the makes secretariat participate in the experts' group. Last June we dealt with all these questions, transportation, building construction which we have talked about here today.

Just to wrap up, innovation and technology have their place but we should not go down the wrong path; we have to ensure that these are genuinely green technologies and I think that there has to be a genuine exchange with those NGOs which have different points of view. Thank you.

INVOLVEMENT OF THE PUBLIC IN SCIENCE

Mrs Melanie Peters, Director of the Rathenau Instituut, Netherlands. Thank you for the invitation. I want to point out that engaging citizens creates better decisions and this is what I believe. Then what we need is not discussions about knowledge because citizens cannot compete in knowledge or in scientific thinking; what we need is discussions that we have together on our assumptions, fears, and hopes for the future and in this we are all equal.

As technology assessment institutes we reformulate questions that appear to be scientific but actually they are not only about science, they are about us. I am a toxicologist by training and in the 1990s we toxicologists had to admit that we would never be able to protect the public as much as we wanted. We need more discussion with the public to see where it is possible to reduce risks, what substances we really need and which ones could be banned. But we also need a discussion on what risk we can never avoid; which risk we do have to accept for our own wellbeing.

Then we also need politicians to take decisions where collective action is needed; where to ban substances or protect workers or consumers or say where we definitely cannot live without accepting risks. At the Rathenau Instituut a recent study showed us again; we looked at shale gas and there the government refused to involve the public. Of course, this only caused distrust and the case was lost; the people did not want it. We looked at discussions on nuclear waste and where to store it; of course it is very difficult to talk about long term effects, to talk about generations that you will never meet, but people want it and they are very aware that not all of the discussion is something they are knowledgeable about. They

therefore call for scientists to come into the debate but they also do want to be consulted if it about their own backyard.

I get hope from my students who I have worked with over the last years. We worked on a big project that was called Rights to a Green Future and we asked ourselves whether future generations have rights and whether we can now decide about these future generations. Our professors on Kantian ethics thought that this was not possible; why should I do something for you if I do not live in the same century? You can never return the favour to me.

However, the students did not understand the problem. They said, 'Why should I not save the environment; I got it from my parents so why not give it to tomorrow's children?' This is what we need; we need this type of generational thinking. Maybe this is what scientists do not understand but the public can teach us, all of us, who are often very much involved in science and thinking that the answer should be there.

Again, our task as technology assessment institutes is to bridge the gap between science, the public and politicians, and reformulate the questions that come to us on climate change and on the future. We need citizens, of course, to design this future, our common future. Again, I think there is no way out; we do need to involve citizens and it does make decisions better. Thank you.

ROLE OF THE RESEARCHERS AND OF THE SOCIETY. FROM THE CITIZENS TO THE PLAYERS

Mr Patrick Monfort, General Secretary of the National Trade Union of Scientific Researchers (SNCS-FSU). Thank you. I work at CNRS on human pathogens. Our linear economy, which extracts, consumes and puts to waste, has brought about global environmental issues. This is the Anthropocene, where humans have changed the earth system.

With knowledge, researchers can contribute to technological innovation but also other types of innovation; social, economic, ecological etc. They have expertise on environmental issues which can weigh on political or industrial decisions; shale gas, for example, or continents exploiting new earth emerging from the Arctic. Society can be seen either as a positive factor or as a hindrance. The contribution of researchers to the resolution of the current crisis is important but research in most countries does not really allow for workers, scientists and citizens to take part in decision-making regarding global sustainability and usually what is brought to the fore are not the factors related to world sustainability.

The economic model has to be challenged and the development model has to be challenged, otherwise we will be facing the same consequences as we have been. Research must benefit from major public programmes given what is at stake and researchers must be given all freedom to work together in full international

cooperation with citizens' organisations, unions and industry and public authorities.

Research is there to answer specific questions but it must also be left a free hand in researching other areas which might bring up answers to other issues. So freedom means freedom of initiative and there also has to be freedom as to the consequences of innovations which could be a problem regarding human health or the environments. It is a matter of credibility and acceptability of the innovations.

As scientists we must also interact with the unions, the workers, with citizens, with the authorities, with the state, in order to define policies which are sustainable regarding climate. We need scientific basis and there should be a choice of scientific priorities within a democratic framework. So there has to be scientific democracy with collaboration between researchers and citizens with intellectual freedom for research and the scientific guarantee of knowledge in public policy.

THE STATUS OF RESEARCH ON CITIZEN INVOLVEMENT

Mr Alain Fuchs, President of CNRS, President of Alliance Athena. Thank you. The movement which seeks to involve citizens with science and technology has become more prominent with citizens conferences and public debates. As was mentioned just now, all these things have to do with public and ethical responsibility and this is also encouraged by the European Commission amongst others.

Now, the scientific community does have a certain number of assets which need to be mobilised and this is not always done or, at least, not sufficiently. Interdisciplinarity, for example: the possibility to mobilise researchers in social sciences to look at the stakes and consequences of political involvement of citizens beyond the slightly dusty concept of acceptability.

All interdisciplinary actions which we are seeing emerge today, the human and social sciences issues are no longer only at the conclusion of the work on knowledge when you start thinking about its consequences, but it is throughout, from the very beginning, that there are societal challenges that need to be met. For instance, when there is a call for projects on energy, nature, resources, society, this involves human social sciences researchers.

Interdisciplinarity brings about more sustainable solutions and human social sciences are not just there just 'to educate the public at large.' For instance, in new styles of consumption that is not entirely efficient because there is a great wealth of acquired and future knowledge which would bring about a new practice of modern scientific research which is very useful to our countries and technological innovation as we hope it will come about.

Social changes cannot be seen as separate from society. That is what we put forward in Athena; sharing of knowledge, participation, the mobilisation of new players and new behaviours.

REFLEXIONS OF THE NATIONAL CONSULTATIVE ETHICS COMMITTEE

Mr Jean-Claude Ameisen, President of the National Consultative Ethics Committee. Thank you very much. My first point is that for the past seventy years, the Nuremberg Code has meant that biomedical and ethical choices have been based on free and informed choice, i.e. the individual's choice. Paternalistically, some seventy years ago it was called 'free and informed consent,' but what was granted was not the right to say yes but rather the right to say no, so it could be informed refusal. Well why, would one have said then, would one presume somebody was going to refuse or to consent?

Today it is not about consent, it is a choice which can be built freely and in an informed manner. It is participation in the creation of these choices and society brought about the choices in knowledge of the complexity of issues and in presenting a number of options. I think that, individually and collectively, this free and informed choice process is at the heart of democracies and democratic life. Notwithstanding the weaknesses and insufficiencies that were mentioned, now there is the 2011 Act and we were asked to organise citizens' conferences when the law was to be changed.

That is a very interesting thing, because the principle of the National Ethics Committees and all such committees throughout the world is the fact that they bring together several perspectives. So I say that any form of debate which allows these multiple perspectives is the most likely to come up with the most original and potentially useful solutions. Then there is another advantage which is to reduce the risk of forgetting those whose marginalisation may have made them invisible. So bringing in all these perspectives together is very important in order for people to take ownership of the choices.

Now just a couple of words on climate; public and ethical thinking must take a step back. The threat is great but climate change is only a symptom of the harm we are doing to our world. If we take greenhouse gas emissions, for instance, the use of fossil fuels, even independently from greenhouse gases is something which kills eight million people every year throughout the world at exorbitant cost. So should we deal with the matter medically when there is a possibility to deal with the symptoms one by one or should we see climate change as a problem per se and then take the causes of environmental degradation one by one?

In a way it is a lever to transform the consequences of the harm we have done to the environment and I would say that health, which of course individually and collectively is of great importance, is something which could move people beyond the usual vision they have of things such as deforestation and so on and so

forth. Thinking about the indicators for measuring energy transition, take the medical indicators; there can be a positive or negative effect to such and such a measure in health, so beyond a specific objective individually and collectively people are involved this way and it brings people into the debate and therefore society makes itself better heard. Thank you.

Mrs Dominique Gillot. Thank you, Professor. If I may, I would like to include what you said in our objectives because we moved from free and informed consent to helping society to set up its choices in an enlightened way, and I think that now we must allow citizens to act in full knowledge of the situation, taking on board all these parameters related to climate change, and thereby decide what is best for our society.

REFLEXIONS OF THE ANALYTICAL DEPARTMENT OF THE FEDERATION COUNCIL, RUSSIA

Mr Timur Semenov, Analytical Department of the Federation Council, Russia. Thank you for the invitation and the opportunity to take part in such a perfectly organised conference. We support the proposed conclusion of the conference and in this document we have several pieces about the promoting of public debates and the involvement of citizens in various forms of public debate. Certainly everybody supports such an approach.

The Analytical Department of the Federation Council of Russia always tries to pay attention not only to forthcoming smart technologies but to promote events in regions in the Russian Federation (not only in the capital) and to attract sophisticated systems of expert assessment. We also try to attract the general public and to attract to participation, for example, in the Nevsky Ecological Congress which we regularly organise in St Petersburg.

Many of the speakers here at the conference have also paid attention to the imperative of sharing of knowledge, of dissemination of the balanced and objective information about smart technology. I would say that only on a certain level of competence do public debates become really effective, and the problem of climate change is very good example here. The public knowledge should be balanced and here we see the big role of parliaments, because parliament according to its nature is a place where we can balance different points of view and so we can find the balanced opinion and decision.

Parliament can perform the mission of sharing the knowledge and information about smart technology, including citizen involvement, with only one or two words about the different possibilities of involving citizens. We would encourage everybody to pay a bit more attention to direct involvement, not only in social media etc. but involvement in different events personally; in exhibitions, in new museum technologies, even in outdoor activities. Thank you very much for your attention.

OPEN DEBATE

Mrs Brigitte Vu, engineering Consultant. I wanted to talk about smart management of buildings, as well as management in general, because this goes for everyday life, for work, for industry, for tertiary buildings and for housing.

Everybody knows what is at stake, but what can be noted, based on studies in Europe and North America, energy consumption gains between 15-20% if the counting system provides direct information. That is, if there is a display on a module, for example, or if there is indirect information through bills rated at 0-10%, a household which has an electric communicating meter will be consuming less than a household with a traditional bill.

Magazines such as National Geographic and Globe Scan have surveyed 17,000 consumers in 17 countries and a large percentage of those consumers reduce their bills for financial reasons, so smart meters with information in euros have a great impact in housing, special social housing where the impact is greatest.

So, depending on how the tools are set up and measuring is necessary in order to generate energy consumption savings and to increase the comfort of the people within the dwelling. This notion of players today is essential and we need to set up an application which allows the man in the street to save in Kilowatt/Euros in Europe and worldwide.

Mr Patrice Noailles, Forum for Innovation Policies. Initially a lot was said – and Jean Jouzel stressed this – about the need to continue efforts in innovation. It would be advisable to open up new doors within society in order for innovation to be given the right to flourish and not simply be tolerated. The current system is such, apart from some specific cases, so there were discussions about a year ago on innovation; things have not changed very much since then.

So, would this not be an opportunity to say, alongside everything that needs to be done, what we are aware of in terms of education and so on and so forth? Is this not a time to say that we should be looking for a change that will allow innovators to express themselves here and throughout the world? Because all countries here are concerned there will not be 80% gains on fossil fuels, on oil, through simple political efforts.

Mr Francois Moisan, Executive Director at Ademe. It is a pity that the previous speaker left; she mentioned international studies which make it possible to assess how consumers can be involved in the limiting of their own consumption. Now we have come a lot further now in France with experiments carried out with investment for the future projects and therefore we have the smart grids and on the one hand we integrate renewables and on the other side we involve consumers and see how consumers can limit their consumption especially at peak times.

Now, the current results available focus on consumer behaviour; over fifteen thousand households are currently involved and findings so far tend to show that a consumer on average can reduce by 0.821 kilowatt. So what we can hope is to benefit from this which will reduce demand especially during peak hours. This is part and parcel of our study and citizen involvement is very important.

Mrs Françoise Lavarde, general Secretary of the National Commission for Public Debate. The participants in this roundtable have showed how important it is to get citizens to come on board; we also highlighted how difficult it was from a methodological point of view. Thank you very much for giving me the floor. I would like to share with you an experiment that we carried out and to talk about the outcome of a global citizenship debate that we organised with the United Nations and also with the Mission Republic organisation.

Our objective was to get ten thousand citizens from around the world to take part in the same project for one day. People from very different backgrounds, men, women, in different countries and we organised ninety seven debates that were held in seventy six countries. What did they debate about? They talked about the five main priority areas that are enshrined in the COP21 that will be debated in December.

What is very interesting is that they were able to take part in these debates thanks to moderators to have their own opinion. They received beforehand a number of documents, paper and audio and video and the outcome of the debate shows that there are no preconceived ideas. You can find all the results of this experiment on Worldwide Youth, our website as well as on the CNDP website. I believe that this methodology is very important and very interesting and I think it is the key to improve citizenship participation.

Mr Laurent Gouzenes, Scientific Director, Pacte Novation, Member of the OPECST scientific Council. I am going to be very brief. I have a lot of experience in citizenship and grass roots debate; I took part in many citizenship debates and it was quite an undertaking, believe me. First of all we had three different demographics; you had the layman, then you had the scientists from the research community, and then members of different industries.

We also added NGOs on top of this. The NGOs were not there to debate but to push their own anti-research, anti-government and anti-everything agenda. As we had opened the door it was difficult to push them out and close the door behind them or to switch their microphone off. So we were never really able to conduct a real debate. We would try to hold debates on nanotechnologies, on quite complicated issues, and then there were also people who were taking intellectual shortcuts for example.

Let me share an example with you, someone accused a nanotechnology company owner of polluting the planet and this was really not going in the right direction. Equally, I do not think people in the automobile industry are making cars to pollute as much as possible; I hope that they are doing the opposite. Scientific debate is very complicated because scientific discourse is very complicated; for example, you can say that as life expectancy increases so does CO_2 emissions. Thank you.

NEW FRONTIERS

ASSESSMENT OF ASSOCIATIVE, REGIONAL OR NATIONAL EXPERIENCES ON CITIZENS' INVOLVEMENT REGARDING INNOVATION IN BUILDING, TRANSPORTATION AND AGRICULTURE

Mr Lars Klüver, Director of the Danish Board of Assessment. Thank you very much for the opportunity to speak now. I think there is a general consensus that the whole transition of the energy system, energy savings, energy conservation and the changes of behaviour that are needed in this whole transition will not succeed without citizens. The citizens have to back it up and they have to get the solutions they need.

What I will focus on in this short presentation is how we can do that and what we can achieve by it. I speak from thirty years of experience in citizen engagement, that is my background, but I will simply talking about which roles the citizen play and do whether we have the methods for that. One important role is that they can give us information of the needs that they have. If they are going to change behaviour then we have to deliver technologies that work for them so they can change behaviour.

So, exploring the needs they have and exploring the barrier that they need, and then find innovative solutions so that they do not need those barriers anymore. It is an extremely important point in this transition; we need the citizens' knowledge to do that and we can involve them to get it.

User-centric design is also very important; the solutions we bring need to work and we can involve citizens as users in the innovation process with user-centric design principles and the solutions we will get out of that will be better. A specific case of user-centric design is passive participatory planning. If you want our cities, for example, to be sustainable in the long run then they have to be designed for that and those who have to live in them are the citizens and they know how they will use that design. So user-centric design in city planning, which is called participatory planning, is an extremely important thing if we want to have sustainable cities.

There is also the perspective of citizens being the affected persons in this; and just think of one example which is the noise from wind turbines. Involving citizens proactively to find solutions of how we place wind turbines on land, how

they should be compensated if they find that the noise is too bad and things like that. Finding solutions together with citizens can avoid a lot of conflicts with regard to situations where citizens are affected by our policies. Then there is the whole area of acceptance. Very important; there is acceptance of technologies of course.

We heard earlier today about the story of smart meters which were not privacy enhanced so people did not want those smart meters because they were afraid of losing privacy in the process. That can be avoided; these kind of things can be avoided if we talk with the citizens in advance. The same with policies, policies which might not work if the citizens don't like them can proactively be made better and more robust by engaging the citizens.

Let me take one example. The policies in Denmark about placing photovoltaics on the roofs of private houses that has stopped now because the incentive we give citizens are not good enough and because, in the battle between who should produce the energy the citizens or the big energy companies, the big energy companies won. That is not the way we get citizens to invest in photovoltaics and help us find the money to make this transition. So that is an example of a policy that has stopped activity because the citizens reacted to a bad policy.

I can come up with many more examples but I have forty six seconds left, so what I would like to say is that we have heard examples of citizen participation that did not go well. My experience through many, many years in this field is that citizen participation can be made to go well. We know a lot about public-centred activity, we know a lot about how to get those who do not normally get involved, how to get them into the room and work with us.

They are enormous amounts of methods that can be used in this field, they are well tested, they are well documented, they have been exported all over the world and they even work in very many cultures. So we have really, really big knowledge about methods and we have the methods for nearly any kind of participation process.

Finally, I just want to say that we have the method, yes, but we do not necessarily have the needed investment for those methods. If we want to have the good things from participation then we need to have the participation and that demands time and money. And I think it is very important that we consider if we really want to have these goods from participation and we want to have the citizens back up all the policies if we want that then I think we cannot avoid using some money on it. I think that is a very important thing for policy making in the future. So also accept the need for participation and accept that it won't come for free.

THE MOBIDIX EXPERIMENT: FEEDBACK ON THE EFFECTIVENESS OF DIFFERENT METHODS OF CITIZEN INVOLVEMENT

Mr Alain Rallet, Economist, University of Paris-Sud. Good evening. I would like to talk about an experiment that we carried out in Saclay on the behavioural changes in mobility. Very quickly, this area can be found thirty kilometres south of Paris as a high-tech area with a lot of congestion problems. Because the public transport system solutions are not effective at all and yet five thousand people already work there and thousands will flock to this area in years to come to work and dwell.

Citizens are increasingly angry with the situation and I think that this calls for an innovative solution. So what we experimented in this area is a collective solution to improve mobility and to do away with congestion, and all this is based on individual actions and the whole idea is for each individual action to spill over and have a positive effect on the community. Currently when we talk about smarter cities, the city is considered as being a system made up of different flows that need to be streamlined and managed as effectively as possible and sensors and detectors are placed everywhere in cities to track flows of citizens, nearly like '1984'.

However, this can cause many problems; we need to discipline this with regulation and tax incentives. I suggest we shift to another vision that of 'smart citizens'. In other words, to empower citizens to interact and to coordinate with one another to improve the quality of mobility. Currently we have digital platforms that can help us to achieve this but there is a problem of getting people collectively to act. It is true that at an individual level people want to improve the system and they want to do away with congestion, but they do not know what to do so they individually give up, and they become passive actors which in fact they are not.

So we need to go over and beyond this and this is what our whole experiment was based around. We had a smart phone and also a computer app so that everybody could take part and we asked one hundred and fifty people to use it for a whole month and to tell us through the application what they did, the kind of individual action that they were taking at their level, so car-pooling to go to work for example or taking public transport or we also asked them to tell us how happy they were with their transport choice that they could rate with a smiley face going from one to five and so we were able to quantify how happy they were with these individual initiatives.

We also assessed the impact of the aggregate of these individual initiatives, because if you take them as a stand-alone initiative they don't really matter but they do matter when you zoom out and look at the collective spill-over. So it is interesting to look at the feedback and send that feedback to users as an incentive, it is what we called 'quantified comments'. And it has proved to be very effective; we have in fact designed a CO_2 indicator for each individual and another

indicator for the quality of transport. These individual indicators were very effective also individual incentives, for example, you could win points by pointing to what initiative you took on any particular day.

We also introduced a bit of competition and a ranking system and if people thought that they were too far down the table they sort of gave up and we also congratulated people who were in a group that was doing particularly well. Then we also introduced financial incentives, people at the top were awarded one hundred and fifty Euros and others fifty and this didn't work at all people gave up once again and that was expected because, when you come up with a cash handout as incentives, then people do not come on board. It is the same for people who give blood; it is an experiment that had already proven this in the past.

So the whole idea was to aggregate these individual initiatives and to see how positive they were for the community. And in fact community is crucial in building trust and that's what start-ups don't understand because they immediately go out there to reach out to as many people as possible, to the whole world in fact, but by doing so they dilute trust on a far too big a scale and this is why start-ups fail one after the other. Thank you very much.

CONCLUSION AND PRESENTATION OF EPTA'S GREEN PAPER

CONCLUDING REMARKS ON THE ROLE OF OPECST

Mr Pierre Laffitte, Former Senator and Former Vice-President of OPECST. I think that today we can see signs of maturity and I believe this has to do with the role played by all the members of the Office since its creation, thanks to the existence of the Office and thanks to the devotion of the members of the Office that were sent from the National Assembly and the Senate. This has allowed us to build something that is really quite unique within the French system. It is something that is unique and actually atypical, but also at the same time anarchistic in the etymological sense of the term because our common project is innovation and its impact on society and its effects are not necessarily seen as positive.

The best demonstration of this is that innovation does not exist in corporate and territorial assessment. It is seen as something that will actually reduce profitability and since innovation is directly to short term profitability, which I actually think is a catastrophe for the world economy, this way in which short term finance has taken power is no doubt one of the major causes of the difficulties that we face today. It was the central source of the financial crisis in 2008 with the sub-primes but now it is also the cause of this huge schism between people and political life.

Only 10% of young people age of eighteen to twenty four will vote in the coming regional elections in France. This is a huge reversal for democracy in France and the Parliamentary Office for Science and Technology Assessment can play a role in righting this sorry state of affairs. It is not a party political body it knows what innovation means and it knows the dangers that also exist.

How do we remedy these dangers? How do we deal with innovation in the legal realm? We can carry out studies; why not study the possibility of cable cars in the Latin Quarter? They use cable cars in the favelas of South America, in Medellin in Colombia, and this cable car has tremendously reduced the dependence on drug traffickers. In another major capital city we have seen this put in place in Rio de Janeiro where the favelas have a much better system of mobility now and connectedness to the rest of the city. So we need a group of prominent persons such as those in the Science and Technology Assessment Office.

There is also a very dangerous problem with ISIS, and we could tackle the questions of cyber-crime because everything related to electric and electronic networks is extremely vulnerable to cyber-attacks and cyber-crime has no reached very worrying levels in France and Germany. There is now a joint initiative between France and Germany in relation to electric and electronic companies who

want to carry out research on this matter and we have to involve scientific stakeholders, those involved in technology and, as we've seen in a white paper published in the Electricity and Electronics Review which provides extensive detail on the subject and this is such a complex topic that we really have to get a series of starter companies involved and perhaps the Parliamentary Office for Science and Technology Assessment could also get involved.

EPTA'S CONTRIBUTION FOR THE COP 21 AGENDA OF SOLUTIONS

Mr Jean-Yves Le Déaut, MP, President of OPECST, President of EPTA for 2015. Thank you very much, Pierre. With a number of Chairs it may seem that we are running this meeting in a rather authoritarian way and in any case it was not an easy matter to organise this gathering; we are combining the anniversary of the Office with the participation of our colleagues from the EPTA. Had there not been the combination of the Office and EPTA we would not have had such quality exchanges today and I think the network that has been established is a network of quality.

I would like to thank PACITA and Lars who is here and whom I thank on behalf of the different European Office Directors. We also invited European countries who never came to our network meetings but who are there today; Romania, Bulgaria, Estonia, Lithuania and all these countries were in attendance and so today we had we were up against a major challenge but I think we were able to meet the twofold challenge.

We have limited resources, we only use the resources of the parliament and with these resources we organise this meeting and thanks to all of you we held a meeting of very high calibre. Two hundred and thirty five people participated and were in attendance and ninety seven took the floor. Ninety seven spoke which I think is a good measure of the level of participation. We did somewhat better when we were focussed on Higher Education, but they were much better at keeping to their time limits. In any case ninety seven people did speak and that is a lot of people.

I would like to thank all participants and, in particular, the presidents of the various commissions. As I said in my introductory remarks, this conference should lead to the production of proposals which we will send to the COP21 negotiators in the form of a document. This document will be broken down into three parts and this is why I wanted you to be here for the third part. The first part will be the EPTA green paper which has already been produced with sixteen contributions – and if a seventeenth one comes along we will include it. These contributions come from a range of countries and are available in the lobby outside the hall.

Of course, no one here believes that innovation and technology can solve every problem, but nonetheless there is social innovation and political innovation to be had as well. We should be wary, however, of certain trends in the political

realm which do not deal adequately with subjects with which they are not very familiar. This applies to the question of technology and the role of the Office of Technology Assessment is to say that certain technologies can be used effectively.

Jean Jouzel was saying that CO_2 is a phenomenon of a long term constant and we have to reduce CO_2 emissions in the very functioning of our basic technical infrastructures. We have to change our technological environment and replace it with an environment that is a lower emitter of carbon dioxide. It is essential that the entire effort against greenhouse gasses is not based only on control policies or otherwise there will be severe reversals just as we have seen when it comes to energy consumption in the building sector. Of course there are major differences between the north and the south; you do not apply the same solutions in all the countries and regions of the world.

So I think our first recommendation is to make a priority of innovation in the fight against climate change and not just an adjustment variable. The example of acid rain that we looked at is a good demonstration of this and of course, even though we are not dealing with this anymore, we are dealing with problems of much higher gravity. Rising awareness allowed for an effective fight against acid rain, and this applies for climate change today.

I will come back to the details that are found in the green paper and in the summary of our work today. A couple of words, we are not going to use the term recommendation we are going to use the word option to not sound too imperative and we also felt that these considerations are fruit of our deliberations to not give a wrong impression colleagues did not have a mandate and so there can be three categories which I will spell out quickly. General policy options, general technical options and technical options. In the area of general policy our wish, and I think this was said very clearly today, we wish to place support for innovation within the strategy of the fight against climate change simultaneously with other forms of innovation of course to make society's technical infrastructure less emitting of CO_2 often with binding measures for example banning traffic or with incentives to develop substitute solutions.

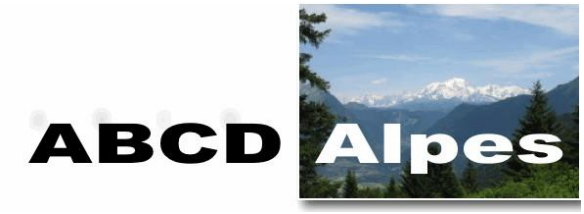
The second point comes from our EPTA colleagues to promote policies to change certain management practices to fight against climate change. The third point is to maintain a wide range of research pathways and others. We had a good attendance from heads of various French and European bodies here who talked about this. We have to be able to progress in the fight against CO_2 emissions and we should look at all possibilities and increase the possibilities, and I say probability not possibility of their emerging solutions.

Fourth, to encourage parliaments. Parliaments are important in this fight. It hasn't been said enough in the preparations for the COP21, parliaments must explore technological solutions keeping in mind CO_2 emissions in all parts of the life cycle. And to use allotted resources in the most efficient way. Fifthly: to ensure through conditions of government support that technologies seeking to

reduce CO_2 should be immediately connected to the better use by consumers. To allocate resources for adaptation, this was said by Sweden and others today and it was said yesterday as well on the topic of adaptation. To make a priority to the development and so during two round tables developing methods to measure performance for energy consumption and for CO_2 emissions and in the fight against air pollution.

There are other general technical options that you will find in document that was made available to you in English and French. This document is not the final document; there will be some back and forth with you aiming to enrich these documents and come up with a final document. Technical options in different sectors, in the construction sector, in agriculture, in transportation and in the area of citizen engagement. This document will, broadly speaking, reproduce what was said today. So I ask you to adopt this approach. To wrap up this conference, thank you to all of your participation.

APPENDIX:
CONTRIBUTION OF MR JEAN-LOUP BERTEZ, PRESIDENT OF ALLIANCE POUR LA BIODIVERSITÉ, LE CLIMAT ET LA DURABILITÉ DANS LES ALPES



September 24th 2015

Jean-Loup BERTEZ (contact@abcd-alpes.com)

Innovation & changement climatique :
l'apport de l'évaluation scientifique & technologique

Mobilities and proximity, the Personal Rapid Transit option

If it needs to be "on its own site" to establish itself successfully as an effective alternative to the private car, the "shared public transportation" does not necessarily need to be "collective".

If conventional solutions for undifferentiated collective passengers picking up (metro, tram, bus) compete successfully with the private car in many territorial configurations, in some cases they leave gaping "empty offers"... no solution can claim to universality.

Little known in France, while imagined in the country (it is a distant heir of Aramis Matra, who developed it in the years 60-80), the Personal Rapid Transit (PRT) is a choice response to these two issues.

This is a shared public transport solution running on its own site, through the approach known as "Transport on Demand" (that is its originality and its major contribution): PRT is technically based on the implementation of lightweight, small size, automatic & guided electric vehicles. Worldwide, one count only half a dozen achievements ... this is a market in phase of emergence, on which there is still no dominant or important industrial player: the few actors of the trade are SMEs (Sweden, UK, Netherlands, South Korea, Austria).

Institutionally, the only somewhat active country is Sweden: at the moment, there are several networks projected in the country, including a 470 km network in the Stockholm area.

Metro, tram, bus: the undifferentiated collective passengers picking up offers are timed by the operator ... conversely, as all "Transport on Demand" offers, PRT is timed by the user.

This originality makes it viable where more conventional solutions are not: the territories where travel demand is not enough continuous & high in time to justify heavy means constantly circulating.

The PRT privileged land is a promising market, still rather few investigated: the medium-sized urban areas, the sparsely populated or discontinuous suburbs, the complex territories (cramped, rough, *etc*.), or even the secondary railway lines, threatened abandonment, due to the cost of heavy equipment used too little ... the PRT ideally complements the conventional solutions.

With respect to this promising opportunity, France has strengths and skills to assert, including, without claim to completeness:

- To develop this innovative solution for sustainable mobility, we have the "Future Investments;

- Program (AIP)" (PIA/Programme d'Investissements d'Avenir), with its component "City of Tomorrow" a substantial amount of €, still largely unused, dedicated to "sustainable mobility";

- For the network electronic & computing intelligence, we have a world technology leader, Thalès, with its CBTC technology, being deployed on the oldest PRT in the world (1975);

- For batteries and vehicles, we have Bolloré and Ligier ... and the second developed his VIPA ("Autonomous Vehicle Individual Public") in favor of the abovementioned PIA;

- To create the network infrastructure, skills to mobilize (civil engineering and structural steel) are standard: network infrastructure can be achieved with local employment;

- To design and drive the projects, it lacks a networker, following the example of Pomagalski for cable ... why not SNCF, whose president has just claimed his interest in "light metro systems" and that has many secondary lines seeking future?

We even have a test area, the complex area of Lake Annecy, for which a pre-study with an encouraging functional simulation is available (a 65 km network).

Can we afford not to explore this promising opportunity?

EPTA'S GREEN PAPER

THE PARLIAMENTARY OFFICE FOR SCIENTIFIC AND TECHNOLOGICAL ASSESSMENT

Innovation and Climate Change:

The Role of Scientific and Technological Assessment

Green Paper presented by

Mr. Jean-Yves Le Déaut

Member of the French Parliament for Meurthe et Moselle

OPECST President

EPTA President for the year 2015

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Contents

Introduction

This report was jointly written by the member organizations of EPTA (European Parliamentary Technology Assessment), the European structure regrouping different bodies in charge of the scientific and technological assessment for their respective Parliaments and by STOA (Science and Technology Options Assessments), the equivalent body of the European Parliament. Russian and American EPTA observing members also contributed to this report.

With the French Presidency of EPTA for the year 2015, OPECST was in charge of coordinating this report, which gathers sixteen monographs written by these different bodies.

It focuses on this year chosen theme: assessing technological contributions to tackling climate change. EPTA chose to work on this subject as it is closely related to the 21st United Nations Climate Change Conference (also known as COP21), which will be held in Paris, at Le Bourget site, from November 30 to December 11, 2015.

The aim, on the one hand, is to gather assessments regarding the three largest greenhouse gas emitting sectors: buildings, transportation and agriculture. On the other hand, in a more original approach, an overview is made on ways to induce citizens to contribute individually to climate policies, in particular when it comes to changing their habits.

Thus, this report reviews different studies carried out for several years in the relevant sectors of the EPTA organizations. Based on observations from previous evolutions, it summarizes the difficulties that have yet to be overcome. Possible and feasible solutions are presented, as well as accepted and acceptable solutions in each country, often revealed through a comparative approach.

These referenced studies aim at providing to Parliaments' members new and rigorous insight on these challenging and far-reaching questions, generally not presented by medias in proper ways for political decisions.

Therefore, it is the very purpose of the EPTA organizations to identify clearly these challenges and to be able to render their complexity through an instructive and comprehensive analysis in order to provide the necessary details for a complete understanding. Their task precisely consists of making recommendations to their Parliaments out of experts' technical analyses. These can either be compiled in publications and reports or expressed during public or private hearings.

The organizations, and consequently the cultures of the different EPTA members are very diverse, be they University departments, Parliamentary services, or even independent bodies. Even if their working methods are quite different, whether they favour written or oral procedures, they all meet the same goal: providing, with the utmost rigour, operational recommendations to members of their Parliament.

The two annual EPTA meetings are an opportunity to exchange profitable knowledge and experience. The Norwegian Presidency in 2014 took the excellent initiative of publishing a summary document to keep track of these meetings. From this inspiration, we decided to gather the contributions of our colleagues on the 2015 common theme in this report, in order to highlight the richness resulting from this coordinated work, based on different national background.

Conclusions of this collaborative work will be presented at the European Parliamentary conference, accredited by the COP21, held on the same subject by OPECT and EPTA at the French National Assembly on September 24th, 2015. This report, the conference proceedings, as well as the proposals resulting from debates will be sent to the COP21 committee.

Jean-Yves Le Déaut

Member of the Parliament for Meurthe et Moselle

OPECST President

EPTA President for the year 2015

France

Innovation and Energy Efficiency of Buildings

OPECST has studied this topic at least four times, in four different reports: a report from Mr. Birraux and Mr. Le Déaut from 2001 concerning the technological propect of renewable energies, which already included elements related to bioclimatic architecture; a report from Mr. Birraux and Mr. Bataille from 2009 on thermal regulation modulation, which advised to add a cap on CO_2 emissions within construction regulations, thus complementing the requirement of an energy consumption standard; a report by Mr. Le Déaut and Mr. Sido from September 2013 on energy transition, which analyzed the costs of building renovations; and finally, a report from Mr. Le Déaut and Mr. Deneux from July 2014 on regulatory obstacles to innovation in the sector of energy efficient buildings, which proposed reforms to foster innovation, most of which have subsequently been put into law through the new July 2015 law on energy transition.

These reports analyze the situation and propose solutions.

1. On what analyses are based these reports?

Innovation within the building sector is key to the fight against CO_2 emissions, given that buildings use on average 40% of primary energy in Europe. Improved conception, building structures but also heating and air conditioning are appealing to construction as much as renovation. The goal is to minimize energy consumption, whilst retrieving as much calories as possible contained within the building's materials or in the ground, in used waters, or simply by relying on natural temperature discrepancy to allow air circulation.

In Northern Europe, where technological innovations have made the construction of so-called "passive" buildings possible, which use less than 15 kWh of heat per square meter per year, and less than 120 kWh in total per meter square per year, the primary goal is resisting against the winter's cold. But these improvements must also be geared, in the South, towards resisting against the summer's heat.

Generally, local assets must be used to profit from the use of renewable energies and have as little as possible recourse to energy produced by centrally and then distributed through national networks, which for the most part in Europe (a little under 50% on average) still stems from fossil fuels: coal, gas and petrol. On average, carbon free electricity is produced for a little under 25% from nuclear energy, for 15% by hydroelectricity and for a little over 15% by renewable energies.

2. What does OPECST propose?

Looking towards 2020, directive 2010/31/EC of May 19th 2010 sets the target of almost entirely energy efficient building, that is, a building which minimizes energy losses, and uses to its maximum potential local renewable energy sources.

For construction, innovations relating to phase-change materials, which strengthen the building's thermal inertia, and thus help reduce inside the effect of outside temperature changes over a longer period of time. These innovations can also cover assembling methods out of prefabricated elements, which will reduce coordination problems between the different workmen, often responsible for damage or underperformance caused by tightness issues. Indeed, when walls are drilled to make up for a preliminary mistake, the building' thermal inertia is compromised by a potential leak thus created.

For renovation, innovations cover new methods of product application which are efficient and easy to perform. Concerning insulation, reference can be made to thin multi-layer insulation, which is capable of adding tightness to the structure by its flexibility and its adaptability to imperfect volumes. Reference can also be made to an outdoors product (Parex-IT) currently being tested at the INES (located at Bourget du Lac), which is composed of an aerogel, can be applied by gun nuzzle and which achieves external thermal protection greater than polystyrene.

Innovation can also cover ventilation and air conditioning systems. For example, the University of Phoenix in Arizona, inspired by Indians customs, has come up with systems, which after digital simulation, have been perfected to function with little energy and are perfectly suited for big commercial buildings in dry desertic climates.

Innovation, transports and mobility

In 2011 and 2012, Mr. Denis Baupin, MP, and Mrs. Fabienne Keller, Senator, wrote a report on behalf of OPECST concerning means of smooth and sustainable mobility and the conception of ecological vehicles.

This report mainly deals with questions relating to transportation and new types of vehicles and leads to a little over a hundred propositions.

1. On what analyses are based these reports?

For both rapporteurs, priority must be given to mobility itself rather than the mode of transportation, to the different uses of vehicles rather than their motorization. There is a diversity of potential technological evolutions for motors and fuels which must be recognized. The real needs of users of private and public transport must be born in mind. These differ not only according to traditional criteria (sex, age, profession) but also according to workplace and home location, and furthermore, according to individuals' behavior regarding exclusive car use only.

Growth of carpooling and car sharing requires rethinking transportation and forces public authorities, as well as car manufacturers, to contemplate the future of road use and parking. Electric vehicles, or vehicles which run on hydrogen or compressed air, also require planning new networks to charge up their batteries or new networks to insure adequate energy supply.

The rise in carbon emissions due to vehicles and transport is no longer an inevitable fate. Fine-particle emissions from diesel vehicles can be considerably reduced, thanks to technological improvements. This reduction of emissions is highly desirable but requires regular control of diesel vehicles, as well as incentives to renew the oldest vehicles, which don't have the necessary catalytic converters to respect current emissions criteria.

2. What does OPECST propose?

The report looks at ways to enable sustainable mobility, which reduce greenhouse gas emissions. Nine topics are covered: planning a more energy efficient, interactive, intermodal and smooth transportation; the transition of the car model to more efficiency, pleasure, modernity, friendliness, modularity and imagination; contracting with manufacturers to renew the automobile model and secure jobs; benefits given to pioneers regarding parking, fiscal policy and bonus, and influence on users to adopt more efficient, less polluting and small sized vehicles; measures to encourage car sharing; setting up partnership governance, as part of strategic State action; setting up a watch on technological and social innovations relating to mobility; promoting a European politic in favor of sober transportation.

These propositions were presented during the parliamentary debate on the latest energy transition law adopted the 22nd of July 2015. Some have been accepted. Indeed, this law gives a definition of low carbon vehicles, sets a mandatory percentage of such vehicles within the public fleet, and puts into place preferential toll prices for such vehicles. The law also plans an ID system for vehicles authorized to drive in congestion zones starting as early as 2016 and envisages a report on the possibility of reserving a highway lane to public transport, taxis and very low carbon vehicles.

Furthermore, the energy transition law sets forth a strategy for sustainable development and a 2030 objective of 7 million public and private electric recharge stations. The law also creates a cash bonus for converting from old pollutant vehicles to new or second hand low carbon vehicles. The law provides for a national strategy to reduce atmospheric pollutant emissions by 30th of June 2016, and strengthens the technical control of atmospheric pollutants and fine particles emissions.

Some of the proposals of the report were taken into account in this law. Others require prolonged action with multiple contributors. Regional entities will play a crucial role in this area. Many of them are currently starting initiatives to limit city pollution, but also to rationalize car use. Common transportation entities are now in charge of planning intermodal connections between transportation methods. This can be greatly facilitated by remodeling transport stations or building new ones which integrate from the very start the need for multimodal hubs.

Other proposals must be enacted by manufacturers. But remarkably, manufacturers themselves are gradually taking note of changes in transport users' behaviors and consequently are offering new vehicles with one, two, three or four wheels. Their range of products extends to incorporate smaller, lighter vehicles, which take up less space on public roads and parking areas. With the rapid proliferation of electronic and communication equipment within vehicles, new perspectives are now offered, among which the emergence of driverless cars, which will require public authorities to establish new sets of recommendations in the coming years.

The OPECST report, which was written on the basis of numerous hearings, was without a doubt a forerunner.

Innovation to feed the world with minimal greenhouse gas emissions

OPECST has recently studied these topics through multiple public hearings: on environmental research in July 2014, on the seed sector in January 2015 and on Big Data in agriculture in July 2015. Past reports have also covered these issues. This was the case of the report by Mr. Pierre Laffitte and Mr. Claude Saunier from 2006 on scientific and technological contributions to sustainable development, the report by Mr. Gérard Miquel on water quality and sanitation, and especially of Mr. Marcel Deneux's founding report from February 2002 on the assessment of the scale of climates changes by 2025, 2050 and 2100. M. Jean-Yves Le Déaut, Member of the French Parliament, current OPECST President, has, meanwhile, chaired in 2006 a fact-finding mission for the French National Assembly, on the theme « Climate change : the major challenge », for which Mrs. Nathalie Kosciusko-Morizet, later Secretary of State and then French Minister of State for Ecology, was rapporteur.

1. On what analyses are based these reports?

Agricultural production techniques are subject to a global « scissors effect » between the huge demographic growth generated by the overall post-war improvement of life conditions, which further increases the number of mouths to feed for several decades, and the growing demand to produce with less greenhouse gas emissions.

Until the 1980s, increased agricultural production was based on increased farm inputs, which led whether directly or indirectly to an increase in greenhouse gas emissions. Today, agriculture must continue to increase production whilst decreasing external inputs of industrial origin. This tension will only be overcome by a number of innovations, probably groundbreaking innovations, for it is the very concept of agriculture as a production process that must be revolutionized to multiply its capacity.

This technological leap will be all the more demanding as three major transformations are now in play and will further increase the tension between food production and demand:

- rising standard of living in developed countries will lead to a demand for a better quality of diet. This will directly translate into increased consumption of meat and dairy, which require more agricultural resources;
- economic and demographic development will mechanically reduce the land available for agriculture;
- climate change will itself reduce production potential due to sea level rise and increased number of extreme weather events.

2. What does OPECST propose?

To solve this growing gap between food production and demand, three new approaches seem necessary:

- favoring plants, which naturally require less farm inputs, such as fertilizer or pesticides. This means that progress must be made in genetic selection and research, but also that innovations are required to improve planting combinations. Agricultural equipment will need to be adapted to new land configurations ;
- soil improvement techniques, whether by depollution or desert conquest, in order to counterbalance losses due to increased urbanization. This will inevitably happen through better water recovery and treatment, especially through desalinization techniques ;
- big Data will emerge as a key way to continuously optimize production conditions, through very precise monitoring, both temporal and spatial. This will become essential, in particular to use farm inputs in the most efficient way.

This scissor effect on agricultural production will not hit all continents the same way. Indeed, demographic pressure is unlikely to weigh heavily on western countries, whereas the Indian sub-continent will have to deal with extreme population densities, more than 500 habitants per square kilometer, by 2050. If population density doubles in Africa, huge land surfaces would still be available through desert conquest. In Egypt for example, desert makes up 96% of the country's land. Rebalancing between these different situations will occur through international transactions, which will provide leverage to adaptation requirements.

Europe will trade its surplus in production for a while, but will not indefinitely profit from this global war against hunger and global warming. Indeed, Europe is responsible, through its ecological footprint per capita, of a much greater drain on natural soil resources and water than the global average (4.9 "global" hectares for an average of 1.8). It is therefore in Europe's own interest to take an active role in this new revolution towards intensive and sober agriculture.

A distinction must then be drawn between on the one hand, technological solutions that could mature in developed countries, and then be typically broadcast around the world, and on the other, "frugal" innovations born through engineering required by the specific circumstances of developing countries, and which then go on to win the developed world.

Citizens' involvement in the use of smart technologies

Citizens's involvement was an essential dimension in many topics, long-standing subject for OPECST, delt in its first report on managing nuclear waste by Mr. Christian Bataille, MP in 1990, or on bioethics by Mr. Frank Serusclat, Senator in 1992. More recently, in 2012, it was an important part of the report by Mrs. Geneviève Fioraso's, MP, on challenges of synthetic biology, or in 2014, of the report by Mrs. Maud Olivier, MP, and Mr. Jean-Pierre Leleux, Senator, on the dissemination of scientific, technical and industrial culture.

Nevertheless, the necessary involvement as part of the fight against the greenhouse effect must not only be an acceptation in principle, but also a personal and tangible mobilisation.

1. How can we analyze citizen involvement in relation to innovation in favor of climate change?

The control of CO2 emissions related to energy demand depends crucially on the behaviors of economic agents. The latter must appropriate innovations in energy consumption, and must favor energy savings and the use of renewable energies.

Such appropriation requires coming up with new ways of mobilizing people, besides fiscal policy and regulation.

In this regard, it appears that all big economic agents, that is, public administration, companies and households, have very different behaviors.

In fact, administrations can only modulate according to hierarchical instructions, on the condition that they are given the financial means to do so in the first place. Companies comply more easily, and some even become proactive, as they seek to adapt their image and communication technique to today's trends. In any case, they have a direct interest in investing in energy savings.

Behavior of households is oftentimes most problematic.

There is no doubt people have taken note of the reality of climate change, in France as in all other developed countries, but actions translating this reality will only follow as long as they are free and occasional. Following recycling guidelines, using one's bike or walking by foot when the weather is nice is a form of progress. But there is a large gap with a behavior where one chooses to systematically change one's investments and consumptions bearing in mind the goal of sustainable development.

Even the wealthiest households, that is, those that have the means to be role models to individual behavior change, still react essentially according to traditional criteria. Typically, buyers of high power cars continue to value an image of power and prestige associated with their purchase, and the vehicle's technological improvements are only a bonus in that decision process. It would be better to be able to count on these wealthy customers to put their purchasing power at the service of deployment, without subsidies, of new eco-friendly engines.

2. What could OPECST propose?

To the extent that the trending effects and imitation of the upper classes will have little of a role to play, the middle classes too will only change their consumption and investments in the fight against greenhouse effect, if they are encouraged financially or forced to do so. Thus, it is not surprising that part of the French national debate on energy transition in 2013 focused on the one hand, on the relative merits of increasing grants, and the on other, on establishing new duties.

In fact, in terms of economic flows, both devices appear quite similar. Indeed, it must be considered that all forms of aid are financed by levies. On the one hand, a system of obligations forces households to allocate part of their income to an expenditure that is not in their priorities; on the other, a system of aid confiscates the same amount through taxation, to then restore it to households when they act as desired. In both cases, the result for households is forced allocation of resources.

Yet, any forced allocation functions to the detriment of other sectors of the economy because it drains purchasing power. With these politics based on aid or duties, it is feared that too violent a drain, that is to say, very strong in too short a time, may have counterproductive effects.

In this regard, the report by Mr.Jean-Yves Le Déaut and Mr. Bruno Sido of September 2013 on energy transition recalled the extents of financial masses to mobilize in France to reduce CO2 emissions by a factor 4 by 2050: nearly one trillion euros over three or four decades. These are significant amounts, perfectly in line with those announced in Germany for the success of the *Energiewende*.

It therefore seems reasonable to dedicate aids for the less advantaged households, and also to spread the effort required of middle-class households by relaxing the schedule, so that the latter extends to the second half of the century.

Furthermore, it is essential to improve the field of incitement by adherence: "understand to act", and thus limit forced allocation of resources. This requires education and some form of participation to the decision process. The problem is that all activities are not suitable for this approach due to the complexity of the subject and scattering of those most concerned.

For example, how can we make the general population adhere to building renovation? The field is complex. For example, just looking at thermal regulation, these are not based on directly measurable consumption (heating, hot water, ventilation, air conditioning, lighting) through bills, but on conventional consumptions, melted in the mass of real consumptions and therefore difficult to grasp.

As for the participation in the decision process, this becomes difficult due to centralization of policy drafting. Hence, how can one feel personally and directly concerned if participation is limited to the involvement of representatives of associations in the decision making process? Real participation requires extreme decentralization, reaching every citizen.

Austria

Innovation for energy efficiency of buildings

Austria certainly is one of the leading countries in Europe regarding the development of energy efficient buildings. There are large research and dissemination programmes, funding schemes to support energy efficient technologies, active industry networks, a wide range of competent technology providers, as well as a high level of acceptance for energy efficiency in the population. In the last 15 years sustainable innovation in the Austrian building sector has taken place in an astonishing comprehensive and effective way.

Early experiences with energy efficient building technologies date back to the 1970s when privately organized groups started to develop alternative co-housing projects (Rohracher and Ornetzeder 2002). In the 1980s active and passive solar technologies became more popular and a first Passive House was constructed in 1996. Since then the market for ultra low energy buildings has rapidly increased. Statistics show that there were more than 10,000 buildings meeting passive house standard at the end of 2010 (Lang 2010, 33). Per capita, this was more than in any other country of the world. Most of these buildings are newly constructed private single-family houses. Although the passive house standard has mainly been adopted in this sector, other types of buildings such as large residential and office buildings, schools, kindergartens and other public buildings as well as even large industrial buildings have been realised in the last decade (innovative gebäude 2015). Based on these developments, ultra-low energy standards are even met in renovation projects today.

In 1999 the Austrian Ministry of Transport, Innovation and Technology (BMVIT) launched a new research and demonstration programme called “Building of Tomorrow” (www.hausderzukunft.at). This programme soon became the main innovation driver within the Austrian building sector. It substantially supported the improvement of already known architectural concepts (i.e. the active solar low-energy approach and the Passive House standard) and allowed the development of a broad range of novel building technologies, including facade integrated solar systems, super-insulated windows, ecological building insulation materials, energy efficient ventilation systems or solar cooling systems. Until today, more than 60 demonstration buildings have been supported and evaluated within the framework of “Building of Tomorrow” (BMVITa 2012). In addition to technology-oriented research, the programme also supported the development of social and organizational solutions (e.g. planning procedures and guidelines, business models for energy efficient solutions, models to better integrate users in innovation) and funded social research projects (e.g. post-occupancy research as well as STS and TA studies).

NB: For precise references, please, contact ITA.

In 2004 the Ministry of the Environment launched the Austrian Climate Initiative (klimaaktiv), which also put much emphasis on energy efficiency and the use of renewable energy sources in the building sector (www.klimaaktiv.at). Finally, with the establishment of the Climate and Energy Fund in 2007, the conditions for the development and dissemination of energy efficient building technology were once more improved significantly (www.kimafonds.at).

Monitoring research shows, that demonstration buildings in the residential sector in most cases are able to meet the projected low energy standards and post-occupancy research report on a high level of user satisfaction (Lechner et al. 2015; Suschek-Berger et al. 2014). To a certain extent the technological achievements in the building sector are reflected in statistical data, too. Final energy consumption for space heating of private households decreased by 21.7 per cent per square meter in the period from 1995 to 2012. Similar reductions could be achieved in office buildings as well as in the public sector (BMWFW 2014, 90ff).

User participation is of major importance in large renovation projects. Several studies have addressed this topic and came up with a number of recommendations to improve the participation of occupants in practice (Tappeiner et al. 2005; Hüttler et al. 2006; Suschek-Berger and Ornetzeder 2006). Empirical research shows that large housing associations in Austria call on many years of experiences regarding renovation projects including well-established forms of communication and participation (Suschek-Berger and Ornetzeder 2010). Basic rights to be involved are even guaranteed by law. However, research also revealed that there is a need to improve and expand existing practices when low-energy standards have to be achieved successfully in the future.

Developments in the last years show that the innovation focus in the building sector has shifted from the building level to the district or settlement level. An indication of this shift is the increasing importance of smart city concepts. Today, large research as well as implementation programmes and projects usually focus on sustainable urban developments (BMVITa 2012). As larger urban developments basically are of political nature, models of citizen participation will play an even more important role in the future.

Innovation for transportation and mobility

Austria is an important location of the automotive supply industry. Manufacturers are concentrated in three regions (Graz, Vienna, Upper Austria) and employ a total of more than 170,000 employees. Main industrial consumer for Austrian products and services is the German automotive industry. Due to a highly skilled workforce the Austrian automotive industry specializes in research and development, including engine and powertrain development, advanced combustion systems, e-drives, hybrid solutions, fuel cells, hydrogen production, etc. In addition, some companies focus also on simulation and testing of new engines and powertrains (Austrian Business Agency 2008).

To better support innovation in the area of advanced propulsion systems and energy carriers the Austrian Federal Ministry for Transport, Innovation and Technology (BMVIT) founded the Austrian Association for Advanced Propulsion Systems (A3PS) in 2006 (www.a3ps.at). The same Ministry funds the development of sustainable vehicle technologies (with a focus on alternative propulsion systems, alternative fuels, advanced electronics systems, and lightweight construction) within the framework of a large national mobility research programme (BMVITb 2012). In addition, the Austrian Climate and Energy Fund supports the introduction of e-mobility. Currently, there are seven model regions for e-mobility covering about 1,500 electric vehicles and more than 1,000 charging stations (Klima- und Energiefonds 2015).

However, vehicles with alternative propulsion systems (fuel cell, hybrid or fully electrical vehicles) are still very rare in Austria. Market shares of such vehicles amounted to 1.2% in 2013 respectively to 1.5% in 2014 of newly registered cars (Statistik Austria 2014). However, the domestic market for e-bicycles and e-mopeds is booming. With about 40,000 imported e-bikes in 2012 and high growth rates in the last years is Austria among the most dynamic markets in Europe (Eurostat). Car sharing is quite popular in larger cities. According to data from 2009 Austria is among the leading countries in Europe (Bundesverband Carsharing). It remains to be seen whether these offers actually reduce traffic and car ownership or whether car sharers have additional private cars or have been using public transport before.

The Austrian Academy of Sciences has a special commission on sustainable mobility, which recently issued a discussion paper on the socio-economic aspects of the transition to sustainable mobility systems (Chaloupka et al. 2015). The paper points to a number of barriers that make changes to more sustainable mobility behaviours difficult. Among them the paper highlights inadequate land use regulation that favours urban sprawl and prolongs daily routes; lacking cost transparency and mechanisms to internalise external costs of conventional transport systems; discrimination of bicycles, pedestrians, and public transport in road traffic regulations; etc. To influence mobility behaviour effectively the expert group recommends strategies like target specific awareness raising activities via public relations or mobility counselling. In addition an index for sustainable mobility development and a clearinghouse for mobility data management, participatory planning procedures, and interdisciplinary research to promote social innovations is needed.

The Academy paper argues that also in a sustainable mobility future there will be a mix of various transport means, including public and semi-public transport, individual motor car traffic, non-motorised vehicles, car-sharing in various forms, pedestrians, etc. From a sustainability perspective, motorcar traffic is not per se bad; it all depends on the circumstances, the technologies, and usage modes. While an urban area may need only 10-20 % car traffic (e.g. for ambulances, taxis) and go along with other forms of transportation, this is much different in rural areas, where a share of 55 % seems to be the optimum (currently it is of 90 % in the countryside). Therefore, it is argued that a future optimal transportation mix is a difficult construct. E-mobility will play a role, as well as alternative mobility concepts (car-sharing, etc.), and modern ICT will part of the solution.

Although Austria is among the leading countries regarding the use of public transport (Eurostat 2015), experts say that the full potential has not been reached so far; and this is even more true for riding bicycle and walking. In cities like Vienna a mix of 20 % bicycling, 30 % walking, 40 % public transport, and 10 % cars may be desirable as well as feasible in the future (Magistrat der Stadt Wien 2009).

Innovation to feed the world with minimal greenhouse gas emissions

Austria is well known for its leading role in organic farming. While in Europe on average only 2.5 per cent of the farmland is organic with a share of nearly 20 per cent Austria is on second place behind Liechtenstein (Willer and Lernoud 2015, 23). This development is a consequence of early pioneering work of individual farmers, highly committed supermarket chains that started with organic product lines already in the 1990, and an ambitious organic action programme of the responsible Ministry, which promotes the greening of the small-scale farming in Austria since 2001 (Eder 2006).

However, a high share of organic farming does not mean lower greenhouse gas emissions in any case but according to a recently published meta-analysis organic farming practices have positive impacts on the environment in general (Tuomisto et al. 2012). In addition, recent research suggests that organic farming even could play an important role in saving world hunger (Ponisio et al. 2014). According to this study organic production may easily reach conventional productivity levels by using certain diversification methods (i.e. multi-cropping and crop rotations).

Drawing on this kind of knowledge and expertise most research activities in Austria focus on the potential of organic farming to combat hunger and climate change. One of the main players in this field is the Centre for Development Research (CDR) at the University for Natural Resources and Life Sciences (BOKU) in Vienna. Research at CDR typically is carried out within international networks; aiming at scientific and practical outcomes at the same time. Current projects at CDR include topics like carbon storage and soil biodiversity, food security and climate adaptation through soil and water conservation, resilient and profitable rural livelihood systems in Africa or adaptive small scale farming systems in in Bangladesh, India and Nepal. Participation of local people in target countries is a constitutive part in almost all of these research activities.

Innovation regarding food chain efficiency is another important topic in this area. Based on a report for STOA, the ITA recently issued a policy brief discussing options for reducing food waste in Austria (Gudowsky and Torgersen 2015) – which would be a contribution to reduce production and hence related greenhouse gas emissions. Roughly one third of all food produced for human consumption is wasted within the Austrian food chain. Farmers, manufacturers, retailers, and food service operators (e.g. hotels, restaurants, hospitals) all contribute to the extent of waste in Austria: more than 260 kg per capita and year. At least half of this waste could be avoided. Avoidable causes include overproduction, improper packaging and storage, or misleading expiry date labelling. In Europe, each ton of wasted

food generates almost two tons of greenhouse gas emissions. Here, there are several promising options for social, regulatory and technological innovations that would reduce food waste, save resources and therefore lower agricultural greenhouse gas emissions.

Reviewing current food safety regulations could identify provisions that are not mandatory with regard to protecting human health, but would otherwise cause a lot of waste. Another measure is to amend marketing standards focussing on external appearance towards consumption quality: taste, natural purity, nutritional value, and growing conditions. Furthermore, facilitating alternative marketing channels for fruit and vegetables not meeting marketing standards would reduce waste as well as shorten transport distances, e.g. farmers' markets, producer co-operatives, solidarity purchasing groups or community-supported agriculture. Also, improving food date labelling could help to reduce confusion between 'best before' and 'use by'. 'Best before' should reflect the true shelf life of products. Abolishing expiration dates for stable products is another option.

On the technological side, measures are mostly aimed at increasing efficiency, e.g. intelligent ordering systems or RFID technology, which is used to, amongst other things, collect temperature data during transport. Other 'intelligent' technologies promise to reduce food waste at different levels of the food chain, i.e. packaging labels, refrigerators, supermarket trolleys, or waste bins. Nevertheless, they are currently only being developed. It is uncertain as to how much they can contribute to solving the problem and whether they cause any side or rebound effects.

Citizens' involvement in the use of smart technologies

Involvement of citizens in research and demonstration projects on smart technologies became quite popular in recent years. A status-report form 2010 on smart grid research in Austria listed eleven projects that explicitly aimed to involve end-users in their research activities (Schauer 2010). While in those early projects users usually had been involved in a selected way using classical forms of participation (i.e. focus groups, interviews, workshops) more recently citizens play an even more important role. Examples are large smart meter field trials (Seebauer et al. 2013) or integrated smart grid model villages (Salzburg AG 2013).

In one of the smart meter field trials it was investigated to what extent, and by which measures, smart meters would allow for a cut in electricity consumption in private households. 250 Austrian households were able to gain experience with smart meters in a year-long field trial. On average, these households reduced their electricity consumption by around five per cent. Consequently, the results are similar to comparable international field trials, which identified savings between 3 and 10 per cent. Smart metering, however, only led to a reduction in energy consumption when combined with comprehensive information and visualization (Ornetzeder 2014).

In the small village of Köstendorf the local energy provider (Salzburg AG) runs a demonstration project to learn more about the interplay of PV systems, electric cars and

household consumption dynamics and how to control the low-voltage grid under real world conditions. PV systems on 40 building and 36 electric vehicles are involved in this field test (Salzburg AG 2013). A similar project has been launched in Upper Austria, involving 37 privately owned PV systems (Abart 2012). However, results from these projects are not available yet.

Another line of research focuses on smart devices as means of participation in collective awareness raising and behaviour change initiatives to fight climate change. As stated in a recent national report, the problem pressure and need for action in Austria is especially high: "The achievement of the 2050 targets only appears likely with a paradigm shift in the prevailing consumption and behaviour patterns and in the traditional short-term oriented policies and decision-making processes (…)." (APCC 2014, 53). The international research project "*e2democracy*" studied a set of seven largely identically organised (e-)participation processes at local level in Austria, Germany and Spain (Aichholzer et al. 2013). Unique features were the long-term monitoring of a combination of several intervention approaches (informational, collaborative, learning- and community-based) and the coverage of direct as well as indirect emissions at individual and collective level. Citizen panels were collaborating with local governments over up to two years (in the period 2010 to 2012) aiming to reduce CO_2 emissions by at least 2 % per year. Participants used a CO_2 calculator for bi-monthly individual consumption monitoring and feedback of CO_2 footprints with free choice of participation mode, via traditional means or via e-participation. The study showed that local community based participation approaches in combination with individual eco-feedback can foster sustainable behaviour and local climate protection. The majority of participants reduced their CO_2 emissions by at least 2% per year. However, to provide appropriate choice options at individual level, it is crucial to create framework conditions that enable and facilitate alternative courses of action in various areas of life – from climate-friendly transport options to pro-climate choices in energy supply and nutrition. The e-participation option clearly increases participation readiness (around two thirds of the participants are "onliners"). Hence, the most important effect of the e-participation opportunity is to extend the participation rate. E-participation is not a panacea as on-liners do not differ from off-liners in terms of the effects achieved. However, in view of the high problem pressure and need for action to reduce greenhouse gas emissions in Austria integrated approaches building on the support of smart technologies are indispensable.

Catalonia

Introduction: Catalan climate policy

Catalonia is aware that the Mediterranean area is one of the regions of the European Union where the most significant impacts of climate change are expected. The 2012-2020 Plan for Energy and Climate Change is the roadmap that the Government of Catalonia has designed to respond to these challenges and to meet the EU objectives on energy and climate change. The aim is to achieve an economy and society of low energy intensity and low carbon emissions that is innovative, competitive and sustainable in the medium and long term. This is the first time that Catalonia has addressed energy and climate policies together and in a coordinated fashion. The plan establishes the lines of work and the priorities for reducing energy consumption by 20%, increasing the proportion of renewable energy to 20% and reducing CO2 emissions of the energy cycle by 25%, in line with the EU's 20-20-20 target.

Innovation for energy efficiency of buildings

Buildings are points of intensive energy consumption through their use of heating, air conditioning and lighting. In Catalonia, only 7% of the building stock was built after the entry into force of the sectoral regulations on energy saving and efficiency and over 60% was built before 1980. Taken together, these factors indicate that building construction is a field with great potential for energy saving and efficiency, and that much of the effort should focus on energy rehabilitation of existing buildings.

New buildings must include energy optimization criteria in the design and choice of materials. In the rehabilitation of existing buildings, on the other hand, improvements in energy efficiency can be achieved by introducing integrated management systems through new information technologies, by working on the building envelope to improve its thermal behaviour, or by using soft measures such as replacement. The Government of Catalonia offers a line of grants for rehabilitating and controlling buildings: grants for rehabilitating empty buildings, Technical Inspection of Buildings (ITE) to obtain the Certificate of Building Fitness, grants for rehabilitating residential buildings, grants for renovation work inside dwellings for senior citizens, and grants for improving accessibility in public housing neighborhoods.

Renewable energies will be an essential element for increasing self-production of electricity by consumers towards the so-called "net balance": users generate the electricity they consume and use the network as a warehouse for storing surplus power and retrieving it when they need it, until they reach a balance at the end of a long period. In fact, estimates suggest that in a few years the price of generating one's own energy will be the same as the price of energy from the grid (a point known as "grid parity").

This scenario requires the widespread installation of small renewable energy systems in the home (mainly photovoltaic panels but also small wind turbines, etc.). The Government of Catalonia has already begun work towards the establishment of a legal framework in the Spanish State to regulate this electricity supply model, because under current regulations self-consumption is not compatible with supplying the grid. In addition to the net balance, there are other ways of bringing renewable energy to the domestic sphere. Biomass is a renewable and independent source of heating and hot water with a payback period of less than five years if a fuel oil or gas boiler is replaced after 10 years. Solar thermal energy is another renewable source of hot water and heating but it usually requires the support of a conventional boiler. Though all these technologies have applications for both single- and multi-family dwellings, the payback period is shorter in the latter because of the scale of the installations. The goal is for the buildings in Catalonia to move towards energy self-sufficiency in the long term, with the electricity and gas grids as a fall-back system

The Construction Technology Institute of Catalonia (ITeC), which forms part of the European Organisation for Technical Assessment in the area of construction products (EOTA), is an agency of the Government of Catalonia authorized to evaluate products without standards and innovative products as a Technical Assessment Body in the framework of EU Regulation 305/2011.

Innovation for transportation and mobility

The transport sector is the main end consumer of energy in Catalonia because it absorbs nearly 40% of the total. In addition, 97% of the energy consumed by this sector comes from oil or its derivatives, involving a high level of polluting emissions. It is therefore a priority area for implementing savings and efficiency measures.

There are several lines of energy saving in the transport sector. One of them is to diversify the energy used by promoting the transition from conventional internal combustion engines to more efficient vehicles, such as electric ones, and by promoting more efficient or renewable fuels such as LPG and biofuel.

Progress must also be made in rationalizing the demand for mobility and transport: making as few journeys as possible, using the most appropriate means, and exploiting intermodality between different modes of transport. Another area with a wide margin for improvement is the efficiency of the current fleet of vehicles. Fleet management systems can be used to optimize routes, and efficient driving techniques can save up to 20% of fuel.

Biofuels are the main way to introduce renewable energy in the transport sector. In addition to the biofuels that are currently used, the Energy Plan mentions the need for research into second generation biofuels, i.e. those made from non-food raw materials. These new biofuels would avoid undesired effects such as environmental sustainability issues, competition with food uses and higher food prices. The aim is that these biofuels will be used by 2020. In

Catalonia, the Catalan Institute for Energy Research (IREC) has a group undertaking research in this field at its laboratory in Tarragona.

Innovation to feed the world with minimal greenhouse gas emissions

The productivity of the crops cultivated in the Mediterranean is limited by the environmental conditions. However, it is improved by agronomic methods and systems based on genetic and ecophysiological knowledge of the species cultivated and the places where they grow (soil, climate, social structure, etc.). Climate change and an annual increase in the variability of the agricultural sector will lead to an increase in problems and risks. It is interesting to note that the sector contributed 8.1% of the total emission of greenhouse gases in Catalonia, a similar percentage to that of industry.

The following measures have been proposed to adapt crops to the current phase of climate change and allow them to act as carbon sinks: (a) adapting plant material to the intended destination and use, taking into account its ecophysiological characteristics (resistance to drought, extreme temperatures, salinity, pollution, relations with other organisms, etc.); (b) increasing agricultural biodiversity; (c) improving water storage and soil fertility; (d) increasing the efficiency of water use through methods and systems that integrate our needs as users with the availability of plant material and water, such as sensors to aid agronomic decision making (precision agriculture) and the use of reclaimed water; (e) valuing agricultural practices as a component of the landscape, and therefore accepting that all actions taken from inside and outside affect trophic networks positively or negatively; (f) considering that agricultural demands will be at the regional level, but they will be greatly affected by globalization and increasing population. These problems must be solved politically, through the development of social norms (insurance, subsidies, guaranteed prices for production, water and energy, etc.) and the rational regulation of the prices and ownership of land and water. Incentives must be provided for the management of crops as major water regulators and carbon sinks.

In June 2015 the Parliament of Catalonia approved a resolution urging the Government of Catalonia to “Promote and fund organic farming to reduce the growing emissions from the agricultural sector and have a positive impact to mitigate them”.

Citizens’ involvement in the use of smart technologies

Catalonia is drafting a law on climate change and has called on public participation through an online survey.

In addition to this experience, civil society shows a high level of involvement in relation to climate change. Catalonia has many municipalities that form part of the European Covenant

of Mayors and more than 180 Catalan municipalities (7% of the European total) are already carrying out energy efficiency plans.

The Catalan Office for Climate Change promotes and supports the establishment of voluntary agreements with Catalan organizations, entities and groups for the reduction of greenhouse gas emissions. More than 60 organizations have joined the voluntary agreements programme in just over a year and a half. Most of the measures undertaken by these organizations involve the reduction of energy consumption. They include a wide range of activities such as improving lighting, heating and air conditioning, replacing cars with more efficient ones, purchasing hybrid vehicles (which in some cases now account for 17% of the fleet), organizing efficient driving courses, car sharing among employees, and innovative measures for reducing mobility by implementing telework and rationalizing working hours. The participating organizations are clear evidence that a good standard of living is compatible with reducing energy consumption.

Finally, it should also be noted that in June 2015 the Parliament of Catalonia approved a resolution urging the Government of Catalonia to "Continue implementing education on climate change in schools and among the public and to implement an effective information campaign on climate change, its causes and consequences, the scientific basis and measures to be taken to mitigate it".

Conclusion

Saving and energy efficiency policies will be key to ensuring the achievement of a sustainable energy system.

Renewable energies are a strategic option for the present and future.

It is possible to decouple GDP from energy consumption, as long as energy is used intelligently and sensibly.

The R&D effort in new energy technologies must be increased.

The energy sector must be strengthened as an opportunity to grow economically and create skilled labour. Electric mobility and construction are two of the main areas that can lead to the creation of new business initiatives.

It is necessary to involve civil society in the construction of the new energy model of Catalonia through training, participation and the inclusion of economically disadvantaged social sectors.

Denmark

Before the first energy crisis in the 1970'es Denmark had a very inefficient energy system, and innovation - in buildings, transportation, food production or in anything connected to energy production and consumption for that matter - did not at all focus on the energy dimension. The two energy crises in the 1970's changed that dramatically. For Denmark the first crisis was a real shock. Denmark was nearly totally dependent upon import of energy, not the least for heating in the wintertime as a temperate climate zone country. The population, industry and commerce were therefore hard struck by the restrictions during the crisis. This ended up in strong policymaking in order to avoid the repetition of the shock.

The policies in the years after the crisis touched upon all elements covered by this green book, plus some extra important features of which the following were very important:

- Denmark invested in a gas infrastructure over time covering all towns in Denmark. The infrastructure includes 19.000 km gas distribution tubes[1]
- The gas came from the North Sea, and Denmark became a net exporter of gas and oil
- The energy production was changed into gas fired combined power and heat production, including small scale combined installations for small communities
- A distribution system for district heat was established covering all major cities
- Incentives for insulating houses were made resulting in a huge wave of energy renovation to increased standards
- Voluntary agreements were made with producers and resellers of household appliances resulting in a labelling system for energy efficiency
- Green taxation of gasoline, cars and other consumer goods with large energy footprints was increased/introduced, resulting in high price levels as compared to other European countries
- Incentives for innovation in the energy system were made, including subsidies for wind power

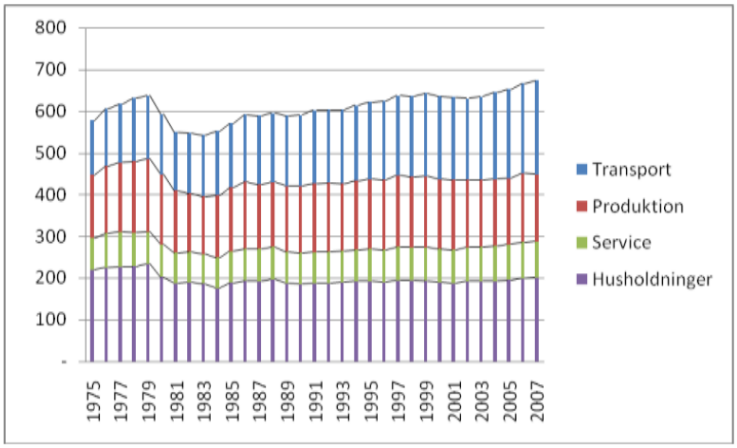
These policies resulted in Denmark "un-coupling" the relation between economic growth and energy consumption growth. The energy consumption became stabile even under times of large economic growth. This has resulted in an estimated net income from the energy policy of 50 billion DKK/year – 1.300 Euro/capita/year – or, as Henrik Lund, energy economist at Aalborg University has put it "this has paid for the Danish education system".

The figure above[2] shows the final energy consumption (that is, excluding losses in the energy production industry) from 1975 to 2007. It shows a stable consumption in all sectors except

[1] http://www.naturgasfakta.dk/copy_of_miljoekrav-til-energianlaeg/naturgasnettet-i-danmark

for the transport sector in which there was some growth in the consumption. The reduction in 1979 is due to political decisions after the second oil crisis 1979. Despite a doubling of the GNP in the shown period the energy consumption has largely been stable.

Figur 2.2: Endeligt energiforbrug fordelt på sektorer i DK.(PJ)



Kilde: /6/

The energy policy in Denmark has steadily followed up upon the policies established after the first and second energy crisis. Denmark has a 35% sustainable energy target for 2020 and a 50% target for wind power alone and these will be reached. The CO2 target for 2020 is a 40% reduction, and a 100% reduction for 2050. If these targets will be fully fulfilled is being intensely debated these years, though.

The fossil energy production in the North Sea has peaked and the income of gas/oil export is decreasing. Danish energy policy is therefore focussed on avoiding net import of energy, lowering the carbon-footprint and continuing the Danish industrial success in the energy sector and in energy efficiency in other industrial sectors.

Innovation for energy efficiency of buildings

As part of the un-coupling policies Denmark has made several very important steps towards energy efficiency in buildings. Incentives were made in the 70'es for energy renovation, which resulted in a large wave of activity, resulting in a generally high standard of energy efficiency in Danish buildings. These policies also helped innovation in the sector. These were the times when companies like Velux (flexible, highly insulated roof-top windows), Rockwool (stone-based insulation materials), Grundfoss (high-tech energy efficient pumps) and Danfoss (house heating control solutions) had their highest growth and established themselves as important global companies, based on highly innovative solutions.

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[2] EA Energianalyse A/S, Evaluering af samtlige danske energispareaktiviteter, December 2008

Although Danish buildings had a very good standard when looking a decade back the standard is not good enough when we look thirty years ahead, at which time we are to reach a 100% CO2 reduction target. Energy efficiency of buildings is therefore still an important policy aim.

New buildings are being built with the needed standards. The concepts for making "zero energy houses" are in place and the total economy of such investments is positive. The development in this area in Denmark is much comparable to the ones described in the chapter from Austria, though the incentives have been weaker and later than in Austria. There is a positive development in the amount of new zero-energy buildings being built. But new buildings only represent a minor part of the mass of buildings, so in the long term this is a needed development but with a 20-30 years view this will not make the needed change in the total energy standard of Danish buildings.

The challenge is, thus, to increase the efficiency in the old buildings. And this challenge is huge. Calculations have been made showing that large parts of the Danish building mass will lose value, so that they will be un-sellable if they are not energy renovated. This represents a problem for the house owners, but not only, since the Danish financing of houses are based on a bond-emission system, which means that the Danish economy can be drawn down by large losses of value in the building sector.

The means to reach a higher standard in the old buildings are manifold and of very different character. All involve innovation – but mostly social and political innovation – not so much technical innovation.

For very old buildings, many of them protected by conservation acts, it is not possible to make use of energy renovation, since that would reduce the historic value of the buildings, which would not be allowed. These buildings will be more and more expensive to heat up, which will reduce the attractiveness for buyers, and they will become an increasingly large problem for the energy conservation policies. The energy labelling of such houses reflects this problem and innovations that could be made are much about increasing the energy labelling without making change to the physical house. Solutions may be found in connecting local/private investments in sustainable energy production to the registration number of the house, so that the net energy consumption of the number is being reduced. In other words, owners of such houses could voluntarily attach a duty to privately fund a certain amount of sustainable energy production to the house number, which compares to the energy consumption of the house, resulting in a net zero energy consumption from the total investment in the house. This would demand new legislation in Denmark, which would favour private energy production against the large scale commercial energy production, since the privately consumed energy under this regime would not be taxed (because it would need to get status as energy conservation rather than energy production). This is probably the reason that such an innovation has not been implemented yet.

For individual buildings 30-50 years old – that is, buildings made during or after the energy crises – the problem often is that they have a much too low energy insulation standard, but it often costs more to make the needed energy renovation than to tear down the house and build

a new one – except for a fraction of these houses, which have a high architectonical value. This represents a problem in many ways. One of the biggest may be that houses, which lose value, are being bought by people with low income, resulting in very large areas – and sometimes whole suburbs or towns – lose social status and to some extend develops into ghettoes. Being proactive and avoid the loss of status is therefore very important, and that has something to do with energy/building policies, but not only.

One case of such a development has been the town near Copenhagen, Stenlille. Stenlille was expanded heavily during the 70-80'es and the standard of the houses energy-wise, but also in architectonical terms, do not live up to the demands of today. Stenlille lost social status and social life was suffering, youth gangs were beginning to be formed, and the resourceful inhabitants to move away. The municipality therefore in 2012 initiated a process to increase the value of Stenlille, which included investments in public participation activities, social life, refurbishing the elderly care services and a general remake of the public space in the town. The results were positive, since Stenlille now is becoming more attractive, meaning that resourceful people move in, who have the economy to energy renovate the houses or build new houses. Stenlille is an example of the problems that many municipalities are struggling with, which demand mainly social/political innovation, but have a very large impact on the future energy consumption.

For the very large mass of buildings in the larger towns/cities in Denmark classical energy renovation is possible and often can be made so that it increases the visual and usability qualities of the houses. Such renovation often includes a new highly insulated roof, new windows, exterior insulation of the walls and updating the heating system equipment. For most houses this can increase the standards to what will be needed long-term. The problems to be faced in that process are connected to a) economic incentives, which is a political problem, and b) to the re-education of engineers, architects, building workers and investors and house owners. In technical terms it is recognised that the techniques to make effective energy renovation are at hand. Not to say that they cannot be improved, but the need for other measures is much higher.

In 2008 Teknologirådet, The Danish Board of Technology, gathered actors in the building sector to evaluate the Danish policies and suggest actions to improve the energy-efficiency of buildings[3]. The report states that a yearly replacement of 1% of the buildings with new buildings, total energy renovation of 2% of the buildings and moderate renovation of 1% in total would result in 80% reduction of the energy consumption from buildings after 25 years. This would give a net energy saving of 50 billion DKK/year (~8.000 DKK/capita ~1.000 euro/capita/year) and 10 million ton CO2 (or, yet another "pay for the Danish education system"). But even more important it would keep or increase the value of the buildings. The sector pointed at incentives, education, high standards in the building directives, and the public buildings being in the front of the development as the main needed initiatives.

[3] http://www.tekno.dk/wp-content/uploads/2015/01/nummer255.pdf (in Danish only)

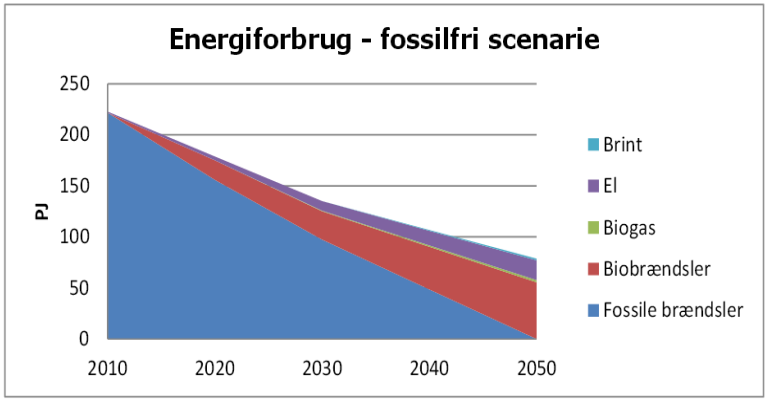
Innovation for transportation and mobility

Although Denmark has a relatively large industrial B2B production of parts and components for the automobile industry this chapter will focus on the innovation areas in which Denmark has a leading position and a clear industrial role to play (expecting that the automobile industry will be covered by the car-producing countries).

There is no doubt that the transport sector will be important – and probably even the most important – sector to make innovation in if the national and global targets for CO2 reduction are to be met. The reason is that the technologies for turning most other sectors into sustainable electricity consumption instead of fossil fuel consumption are available. That is not yet true for most of the transport sector.

The main possibility for Denmark to contribute to and make industrial development on top of innovation is in the development of biofuel producing technology[4]. Danish industrial production of enzymes is at the front edge technically and Danish research in this field is in the absolute global elite.

In 2012 The Danish Board of Technology published a report on scenarios for transformation of the transport system into zero-emission of CO2[5]. The study clearly showed that biofuels will be important because they must be regarded as the primary non-fossil fuel for air, ship and long distance lorry transportation. All other forms of transportation must be expected to use electric drive 25 years ahead, which can be accommodated by the development into a 100% sustainable energy production system.



Figur 27 Transportdrivmidler 2010-2050, Fossilfrit scenarie

The availability of biomass is the limiting factor, though. It is generally accepted among experts that Danish harvest of biomass could be doubled to 200 PJ over the next 20 years. If the need for biomass in the transport sector is to be covered (air, ships, lorries only) this would take up roughly 75 PJ, which leaves only little biomass for other energy purposes left, since the rest is used by the agricultural sector itself. Therefore, innovation for effective

[4] Analysis of the potential for commerce of green transition of the transport sector (in Danish) : Analyse af erhvervsmæssige potentialer ved grøn omstilling af transportsektoren; udarbejdet for Energistyrelsen, DAMVAD 2014.

[5] Danish transport without coal and oil (in Danish), Teknologirådet 2012. http://www.tekno.dk/wp-content/uploads/2014/12/p12_Dansk_transport_uden_kul_og_olie_hvordan.pdf

production and transformation of biomass will be crucial. The figure, from the report, to the left shows the composition of energy sources in a 100% sustainable energy transport system. Although most of the transport will be using electricity (purple) the effectiveness of electric motors results in relatively low energy consumption from this part of the transport. Biofuels (red), on the contrary, are rather ineffective fuels because of the loss in the transformation of biomass to biofuels and because of the ineffective combustion motor. Biofuels must, accordingly, be seen as a highly important innovation field in order to increase the effectivity "from yield to wheel".

Danish biomass for biofuel production is for now only consisting of straw from cereal production. This is not optimal because the availability is dictated by the factors determining the production of cereals, and because cereals have a short growth season. One major step forward is regarded to be a shift from straw to a combination of grass and nitrogen-capturing plants[6]. These are plants that grow all year round, so-called "green fields", can be harvested multiple time per year, can create their own main ferilizers and can be used for multiple industrial purposes before they end in the biofuel refinery – and even after.

A report by the Danish Board of Technology, made for the Ministry of Commerce in 2009 on biofuel production in Denmark[7], showed that the economy of biofuels would be dependent upon the business cases for high-value side productions, such as valuable fibres, enzymes, chemicals and nutrients, because the production price of the biofuel alone could not be expected to be able to compete with electricity or, on a free market, fossil fuels. The future will, thus, not bring us biofuel refineries, but rather multi-purpose biorefineries, which must be said to fit well into the visions of a future bioeconomy.

Some other areas which have been pointed out as innovation fields in which Denmark plays and could play an important role in increasing the energy efficiency of the transport sector are[8]:

- Friction reducing paint for ships: Denmark has a strong actor in Hempel ship painting.
- Logistics: Danish shipping industry is among the worlds' largest and highly innovative.
- Friction reducing asphalt: Denmark has been in front in this area
- Smart traffic systems: Highly innovative ICT sector and relatively strong traffic research.

Other innovation areas, mentioned in the DBT report are:

- Avoiding traffic work by innovation in ICT collaboration systems and video-conferencing

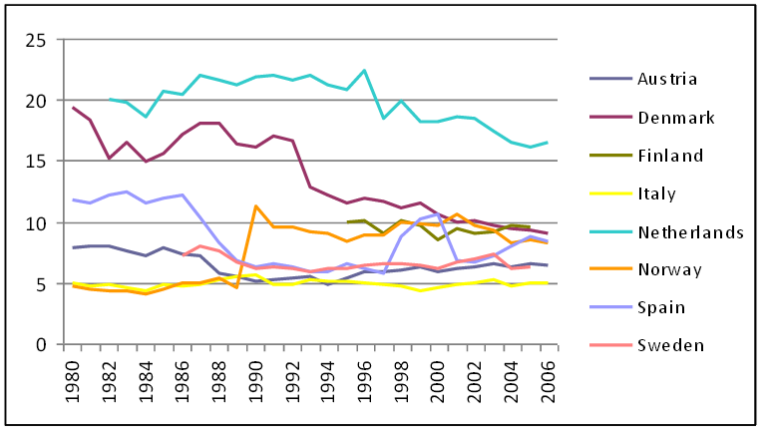
[6] Prof. Lene Lange, Aalborg University. Personal communication.
[7] White book on perspectives fo biofuels in Denmark (in Danish): Hvidbog om perspektiver for biobrændstoffer i Danmark, Teknologirådet 2009.
[8] Reference 4

- Smart town planning to make mobility streams “move in both directions” at peak hours, thereby making better use of public transportation capacity
- Increased innovation in 2- and 3-wheeled electric vehicles to reduce the use of heavier vehicles

Innovation to feed the world with minimal greenhouse gas emissions

Danish agriculture is highly intensive, based on strong agricultural research, but also very energy consuming. So, Denmark can hardly lead the way for other countries with regard to low CO2 emission from agriculture. The following figure shows the development in energy intensity in agriculture of eight European countries 1980 to 2006. Except for Netherland, which has much greenhouse production, Denmark is the highest energy consumer per euro produced in agriculture[9].

Figur 3.22: Energiintensitet, landbrug, (MJ/euro, 2000-priser).



This, on the other hand, leaves a lot to do on improvement. The Danish Ministry for Climate, Environment and Foods in 2009 published a report on 15 measures for reduction of CO2 from agricultural production[10]. The four most effective measures, which covered 75% of the effect from the total of the measures, were:

- Manure being used for biogas
- Production of wood chips of willow on marginal/poor soils
- Straw for combined heat and power
- Closing agriculture production on wet farmland

[9] Reference 2
[10] Agriculture and Climate (In Danish) : Landbrug og klima, 2009 : http://mfvm.dk/foedevarer/indsatsomraader/klima/rapport-om-landbrug-og-klima/

Many of the 15 measures could be subjects to innovation. Biogas is not yet a perfect technology; Yields of energy crops are not overwhelming; Straw for combined heat and power is a very low-value use of a material, which may be used for high-value biorefinery production before it ends in the boiler; and invention of low-impact production systems on wetlands could help not only Danish farmers but farmers in many parts of the world.

The report on a 100% sustainable transport system also touched upon the energy consumption in agricultural machines. Around 10% of the total Danish energy for transport is used by agriculture and the potential for innovation in energy efficiency of the machines and for less mechanical treatment of the soil is big.

Organic agriculture has traditionally been seen as having smaller environmental footprint than industrial agriculture. This picture is not necessarily true when it comes to greenhouse gas production because of the dependency on animals for fertiliser production. Methane from animals has a large greenhouse effect, whereas industrial fertilizers in principle can be produced from sustainable energy sources. The innovation potential in organic agriculture is still large and one of the obvious areas for innovation, as seen from a carbon footprint point of view, is sustainable fertilizer production.

The Danish landscape is under pressure from many sides. There are many policies for land-use in Denmark, and put together they use the Danish square-kilometres 140%[11]. Main sources of this over-expectation of what Danish land can be used for are the plans of establishing forest; climate adaptation strategies; loss of land because of climate change; and the continuous expansion of the cities. This development has called for new and innovative ways of using land, including agroforestry, city-farms, and moving animal farms into industrial areas – all fields of practice, which are being researched and innovated on in all corners of the world. Danish agricultural research has not yet taken this challenge up but could probably play an important role if it did so.

Citizens' involvement in the use of smart technologies

The Danish tradition for citizen involvement in innovation is quite strong. Since the upcoming development of the internet a huge multitude of ICT development projects have used different technologies and methods for evaluation of consumer reactions, usability, user behaviour etc. It seems however, that this tradition has not really been rooted in the development and implementation of the energy transition.

It is a well-known fact among energy specialists in Denmark that the needed energy transition is possible with the technologies we have today and the development rates we see in them – transportation maybe being the exception from the rule. The challenge for innovation and

[11] Analysis of existing policies for Danish land-use : http://www.tekno.dk/article/baggrund-og-forloeb-i-danmarks-areal-i-fremtiden/

implementation is therefore not to be found in the lack of technologies, but rather in the uptake of the technologies.

The important questions for research and innovation seem therefore to be of the kind like:

- What can make consumers buy the energy-effective consumer goods?
- How can consumers be nudged to eat less meat?
- Which incentives can make private house-owners invest in decentral sustainable energy production?
- How can a large part of the population be brought to a high competence level with regard to energy consumption behaviour, energy conservation investments, etc?

The answers to this kind of questions are 'smart' in another sense of the word than 'technologically smart'. They can only be made through deep involvement of the citizens, so that policy-makers can be sure of the positive effects if the solutions will be implemented.

The case of Stenlille described above is another example of the importance of involving the citizens in the process of transformation of the built environment towards better energy standards. Many towns in Europe are struggling with depression resulting in little investments in the houses and their energy performance. Local empowerment and education seems to be central means – if not the only means – for solving such questions. The social innovations needed to make that happen in large scale have not really been made yet or experimented with in large scale, but would certainly have a large impact if they were.

In the transport sector we witness another problem, which only can be met by deep interaction with the citizens. We all know that increasing the private transport instead of the public transport will result in increased CO2 emissions, but that does not change our behaviour – neither as consumers, voters nor as decision-makers. The innovations that could truly make a difference in the transport sector are probably social/political innovations, which will make it easy and comfortable to change behaviour. One example of such innovations could be a common payment system for private car taxes and public transportation, so that the extra price of using public transportation when you already have paid for your car is reduced. However, without knowing quite surely how the citizens will react on such measures, decision-makers will hardly take steps towards implementing them. Public participation is certainly a way forward for getting knowledge about how different policy measures will be received.

In general there is another consensus among energy specialists, that the participation of citizens in the energy transition is not enough to meet the challenges – but the challenges cannot be met without the participation of the citizens.

Finland

Innovation for energy efficiency of buildings

There are various policies to increase energy efficiency in buildings in Finland. They include the building code for both new and existing buildings; energy labelling; financial support for housing companies and households; R&D&D; information and training; and energy taxes. The measures also facilitate innovation through increasing demand; e.g. tightening the building code has forced construction companies to find commercially attractive ways to build passive houses.

There have been various R&D&D programmes on low-carbon buildings. Examples from recent years include

- FInZEB: building a national consensus with stakeholders on near zero energy houses to implement the EPBD in the Finnish context (finzeb.fi) ;
- GUGLE: increasing the energy performance of an aging neighbourhood near the city centre in Tampere (eu-gugle.eu/fi/pilot-cities-4/tampere) ;
- SubUrbanLab: engaging with residents to cut energy use in rental apartment buildings (suburbanlab.eu/living-labs) ;
- Renzero: piloting the energy renovation of an old single-family house (renzero.fi)
- MECOREN: developing methods and concepts for sustainable renovation (vtt.fi/sites/mecoren/en) ;
- FRAME: ensuring moisture control in energy efficient construction (tut.fi/en/about-tut/departments/civil-engineering/research/structural-engineering/building-physics/frame/index.htm) ;

The most prominent forum for showcasing innovation has been the annual housing fair (asuntomessut.fi/en/english-home) drawing thousands of visitors and getting widespread media attention. Innovative solutions demonstrated at fairs have included

- zero energy houses ;
- block houses constructed of wood ;
- waste heat recovery from wood stoves ;
- recycled construction materials ;
- automated waste collection systems ;
- heat recovery from lake bed sediments ;
- CHP from biogas with fuel cells ;

- intelligent systems to monitor and manage energy use.

The Committee for the Future has advocated introducing net metering. With net metering distributed small-scale renewable power production would be compensated better which would make it more attractive to move to zero and even plus energy houses.

A key focus on reducing the carbon footprint of construction has been on increasing the use of wood. A national programme has promoted wood construction and a standard has been developed for wood elements (RunkoPES). Some Finnish examples of wood construction can be found at woodarchitecture.fi.

Rudus (rudus.fi) has developed green concrete that the company claims can cut carbon footprint by 20–50%. An interesting innovation is a robot for sorting construction waste by Zen Robotics (zenrobotics.com).

There is of course a of innovation activity in related fields, especially energy. For example, an Aalto University research group has made the world record in the efficiency of black silicon solar cells.

Innovation for transportation and mobilities

As Finland has never been a major car industry hub, innovation has focused on areas other than engine technology. Strengths include e.g. advanced biofuels and intelligent transport systems (ITS).

Finland is home to the world's largest producer of biodiesel from waste and residues, majority state-owned Neste (neste.com). Company's NEXBTL is advanced drop-in biodiesel that can be used up to 100% in normal diesel cars without modifications. Neste also produces renewable aviation fuel that has been demonstrated on commercial passenger flights.

For its biofuels Neste uses various feedstocks, including waste fats and oils. There has been considerable controversy on the use of palm oil and related by-products which contribute to tropical forest loss through indirect land use change (ILUC). Neste is exploring new feedstocks such as algae and microbes, but these remain at pre-commercial phases.

Various Finnish companies are involved in developing biofuels out of waste, industry by-products or solid biomass. For example, UPM (upmbiofuels.com) produces biodiesel out of crude tall oil, a by-product of the pulp industry. St1 (st1biofuels.com) uses various waste streams, including bakery waste and saw dust, to produce bioethanol.

There have been numerous R&D programmes on low-carbon transport, biofuels and ITS, including:

- Transeco: developing, demonstrating and commercialising technology for improved energy efficiency and reduced emissions in road transport (transeco.fi/en)
- Liikennelabra: "Transport Lab", demonstrating ITS solutions (liikennelabra.fi)

- EVE: creating an EV community and developing test environments (tekes.fi/en/programmes-and-services/tekes-programmes/eve)

The ITS field is convened by ITS Finland (its-finland.fi/index.php/en). The Committee has suggested setting up regional ITS test platforms and using taxation to support ITS solutions.

The most internationally renowned pilot is KutsuPlus (kutsuplus.fi/home), a hybrid between public transport and taxis. Registered users can hail a KutsuPlus mini bus online paying a fee of 3.5€ per trip + 0.45€ per kilometre. The bus picks passengers from any of the designated stops and delivers them to any of the same stops using algorithms to combine the routes of different passengers.

A third field of activity revolves around electric vehicles. Keliber (keliber.fi/lang/en) is planning to open the largest lithium mine in Europe and European Batteries (europeanbatteries.com), if it can recover from filing for bankruptcy, manufacture lithium batteries. Various companies are involved in building smart charging systems (see e.g. Ensto, ensto.com, and Liikennevirta, virta.fi). The committee has called using tax reductions to speed up the introduction of EVs.

The role of different fuels in low-carbon pathways has been addressed by e.g. a Ministry working group on alternative propulsion and the Government Foresight Report on Long-Term Climate and Energy Policy (bit.ly/1NGMuvs). One take-home lesson from the latter is that deep decarbonisation pathways are likely to require the electrification of the car fleet. Technically cars could be powered by biofuels, but as sustainable biomass resources are limited, they need to be reserved for uses where no viable alternatives exist – in particular air traffic, shipping and heavy road transport.

Some weak signals suggest that Finland, too, may be reaching peak car, i.e. a peak in the use of private cars. However, there is insufficient data to substantiate claims. Furthermore possible underlying trends are clouded by the deep and long recession in the Finnish economy.

Innovation to feed the world with minimal greenhouse gas emissions

Various studies suggest that reducing emissions in agriculture can prove challenging and possibly costly. Most promising and cost-effective measures include preserving organic soils; converting animal and vegetable waste into biogas; improving manure management; plant breeding; reducing the use of nitrogen fertilisers; increasing energy efficiency; replacing fossil fuels with renewables; cutting food waste; and moving to more vegetable-based diets. The climate programme for agriculture, co-ordinated by the Ministry of Agriculture, lists 76 measures to mitigate climate change or adapt to it.

There is a lot of R&D work going on developing commercially viable ways to produce fertilisers out of manure in a relatively sparsely inhabited country like Finland. For example,

Palopuro Agroecological Symbiosis project (blogs.helsinki.fi/palopuronsymbioosi/english), aims at energy and nutrient self-sufficient production. Sybimar (sybimar.fi/en) uses industrial ecology to combine aquaculture, greenhouse, biofuels and wind power, achieving closed loops. The Committee has called for the government to set a target to make Finland the leading country in recycling nutrients.

There is some work going on in developing new ways to increase the carbon content of agricultural soils. Humuspehtoori (humuspehtoori.fi) sells a product containing wood fibre from paper industry. There are also trials of using wood carbon in agricultural soils, for example at the Knehtilä farm.

As the low-hanging fruits are unlikely to suffice to reach low-carbon pathways in the medium- and long-term, more innovative and radical solutions need to be explored. These may include exploring alternative food sources, structural changes such as replacing animal products with vegetable-based options in production and consumption as well as modifying plants and animals.

There is both academic and industrial research going on searching for ways to substitute soy in animal feed with locally produced proteins. The use of blue lupin and faba bean are studied at the University of Helsinki. A Finnish dairy product company Valio (valio.com) is developing a process for producing protein-rich liquid feed from silage.

Several companies are working on locally produced vegetable-based alternatives to meat and dairy products. For example, Bioferme (bioferme.fi/en) uses oats to produce alternatives to dairy products (e.g. yoghurt) and Raisio (raisio.com/en/en) manufactures oats-based drinks. Oy Soya Ab (jalotofu.fi) uses hemp to substitute soy in tofu, Verso Food (versofood.fi/en) produces protein-rich products based on faba beans and Palkuainen (tempe.fi) is developing tempeh made from peas and lupin. Entocube (entocube.com) is working on commercialising crickets as a low-carbon protein source.

There is a relatively long research tradition in Finland looking at carbon footprints of food, led by what is now called Natural Resources Institute Finland (luke.fi/en). Projects have included research on the carbon footprint of different foodstuffs and lunch options as well as carbon footprint labelling. The aforementioned Raisio has introduce carbon footprint labels on some of its products.

Social innovations on reducing food waste like inviting senior citizens to eat what is left from school lunches for a marginal price are spreading from one municipality to several others (sitra.fi/en/blog/industrial-symbiosis/sidestreams-food-money). Also social media tools are being used for sharing food.

Specifically on the issue of converting excess renewable power to fuels, a sizeable research programme is looking at the feasibility of turning electricity into methane (neocarbonenergy.fi).

Citizens' involvement in the use of smart technologies

In most cases the role of information and education in changing people's behaviour is likely to be limited and temporary. This is all the more so if other factors run counter to the goals. For example, it is of limited use to run a campaign to get people to shift from private cars to public transport if public transport services are limited, of poor quality or expensive.

"Soft" measures can be more effective if they are combined with other measures and designed carefully. Demos Helsinki (demoshelsinki.fi/en), a Finnish think tank, has worked on the gatekeepers of low-carbon solutions, i.e. key people that can influence whether consumers choose low-carbon options. Addressing these gatekeepers – e.g. appliance sales people regarding energy efficiency – can be more effective than campaigns directed at the general public.

Based on research we know that communication by peers and role models tends to have a significantly larger impact. Information can also play a larger role if it involves a social element. For instance, being the first one in a neighbourhood to install a solar panel can have a multiplication factor as other people can see the solution with their own eyes.

Some of the work providing information on low-carbon choices is publicly funded. Motiva (motiva.fi/en), a state-owned company, serves as a national information clearinghouse. Regional energy offices provide information and training locally in some regions, with different focuses. However, funding tends to be scarce and project-based, reducing the efficiency and long-term impact of activities.

There are various ways to involve communities and citizens in low-carbon solutions. Lumituuli (lumituuli.fi) is the first citizen-owned wind power company in Finland. Joukon Voima (joukonvoima.fi) explores using crowdfunding to finance renewables projects. Also new business models can make low-carbon change easier, e.g. financing that allows the customer to pay for the investment incrementally from the savings generated.

The previous Committee for the Future worked on two general tools that can be applied also to addressing climate change. The Committee commissioned a report (www.eduskunta.fi/FI/tietoaeduskunnasta/julkaisut/Documents/tuvj_1+2012.pdf) and carried out a pilot project on crowdsourcing. The lessons were mostly promising, suggesting that crowdsourcing can work in involving citizens and provide multiple benefits. The Committee advocates setting clear and enabling rules to make crowdfunding attractive.

The Committee also commissioned a report (https://www.eduskunta.fi/FI/tietoaeduskunnasta/julkaisut/Documents/tuvj_10+2014.pdf) on what is called "kokeiluyhteiskunta" in Finnish. The term, sometimes translated as "enabling" or "experimenting" state means a society open to and actively promoting pilot and demonstration projects as a way to test ideas and learn from them quickly.

Both crowdsourcing and greater use of piloting can play a role engaging citizens in addressing climate change in general and promoting low-carbon innovation in particular. For example, crowdsourcing can be used to provide input to and increase the acceptability of certain

climate policy measures. Likewise, piloting can be a tool to test new low-carbon technologies or climate policies and gain experience for developing them before scaling them up.

Germany

Innovation and Energy Efficiency of Buildings

The improvement of the energy efficiency of buildings is one of the key pillars of Germany's strategy to achieve a sustainable energy consumption. Almost 40 % of the primary energy consumption in Germany is in the building sector. The official goal is to reduce the demand for heat by 20 % in 2020 and the non-renewable primary energy consumption by 80 % in 2050 (both relative to 2008 levels) (BMWi 2010, p. 22). This implies that the building stock has to become almost climate-neutral by 2050!

On the one hand there are huge potentials for energy savings in buildings, many of them are even profitable in economic terms. But on the other hand there are numerous obstacles to activate these potentials. To name just two important ones: the pay-back times for energy efficiency measures are typically rather long and there is the well-known investor-user dilemma meaning that the investment requirements on the one hand and the benefits generated by the investments in terms of lower energy costs on the other hand do not coincide with the same actor.

A number of measures have been implemented already by the German government to achieve the stated goals. To name just two of them: the efficiency standards for new and existing buildings have been raised continuously (e.g. via the latest amendment of the Energy Savings Directive (EnEV) in 2013), and the government-owned development bank KfW (Kreditanstalt für Wiederaufbau) runs a programme to finance building refurbishments with a financial volume of 1,8 Mrd. Euro each year.

However the assessment of the expert commission which evaluates the progress of the "Energiewende" (energy transition) is somewhat sobering. In order to achieve the goals, there is an urgent need for additional measures. Action has to be taken soon, taking the long capital lockup into account: "First, the German government must decide soon on the design of financial support measures for building modernisation, ensuring they are compatible with the targets and second, a stricter Energy Savings Ordinance is required – also for new buildings. At the same time, it should be examined whether the efficiency requirements for existing buildings have to be increased as well" (Löschel et al. 2014, S. 11).

Research and innovation play a key role in achieving the goals, therefore Germany has implemented a comprehensive research programme "Buildings of the Future", which aims at developing energy optimized buildings ranging from small incremental improvements e.g. by providing quality assurance for windows and glazing to innovative concepts like "energy-plus

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NB: For precise references, please, contact TAB.

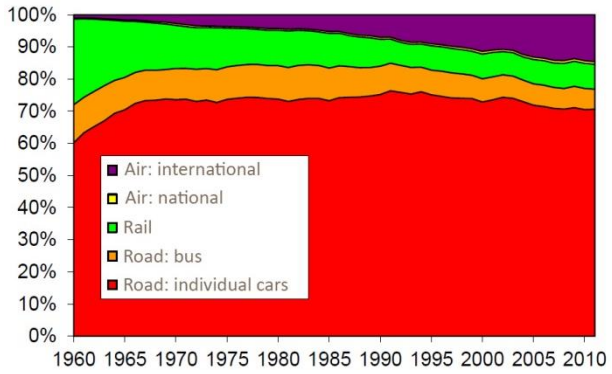
buildings" that have a positive annual energy balance i.e. they produce more energy than is consumed.

From a TA perspective the building sector is a somewhat neglected area. There are much less TA studies available for this area than for example for the electricity sector. The last TAB-project that touched this area dates back to 1999 and dealt with the use of renewable raw materials in the construction of buildings (TAB 1999). Here is certainly room for improvement.

Innovation for Transportation and Mobility

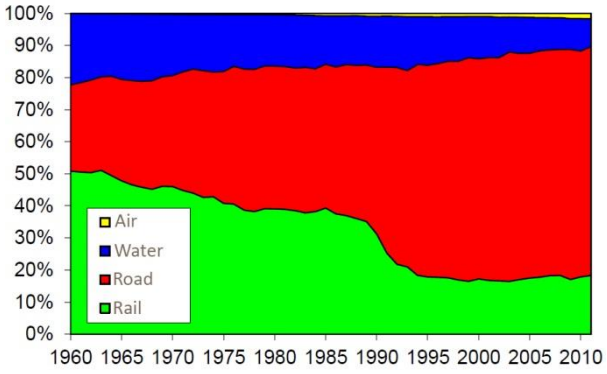
The transportation sector is one of the major sources of CO_2. Its importance has even increased over the recent years, its share of Germanys CO_2-emissions increased from 11 % in 1990 to around 17 % today. After a steep increase of CO_2-emissions caused by the transportation sector (taking account also of the emissions from the production of the fuels) from around 1960 till 2000 the emissions have flattened out and just recently begun to decrease - however slowly - by about 2 % in the last decade. This is in contrast to most other sectors (households, industry, energy industry) where CO_2-reduction amounts to 20-35% compared to 1990 levels. The main reason for the recent decrease of CO_2-emissions in the transportation sector was the introduction of biofuels. In a "trend scenario", which takes into account the official forecast of transportation volume and expected trends and political decisions taken, these emissions will stay rather constant till 2030.

Fig. 1a: Traffic volume passenger transport



(IFEU 2012, p.16)

Fig. 1b: Traffic volume cargo transport



(IFEU 2012, p.17)

On the other hand the official goal is to reduce the endenergy consumption in the mobility sector by 40 % till 2050 (from 2005 levels), which would at the same time reduce the greenhouse gas emissions substantially. To achieve this goal the government has published in 2013 a comprehensive "Mobility and Fuels Strategy", which highlights that: "The key prerequisites for achieving the targets are the diversification of the energy sources for transport through alternative fuels, in conjunction with innovative drive technologies, further improvements in the energy efficiency of combustion engines and the optimisation of transport processes" (BMVBS 2013, p.6).

There are huge challenges ahead in order to implement this. Here is just one example: There is a wide agreement, that reductions of CO_2-emissions can very effectively be initiated by a change in modal split towards more environment friendly means of transportation (eg. public transportation for passengers and rail for cargo). However the current trends point in the opposite direction both for passenger and for cargo transport. In the case of passengers, air transport is expanding substantially (see Fig. 1a) and in the case of cargo, road transportation has gained immensely at the expense of both rail and waterway transport (see Fig. 1b).

In terms of technological innovation in road transport, electric vehicles draw a lot of attention in the recent years. TAB has published a comprehensive report on this issue in 2012: "Electric mobility concepts and their significance for the economy, society and the environment" (TAB 2012a).

The official objective set in agreement with industry is to have at least 1 million electric vehicles in Germany by 2020 and over 5 million by 2030 (Federal Government 2009). The term »electric vehicle« here refers to four-wheeled vehicles with a battery which can be charged externally by connecting it to the mains. These are purely battery-electric vehicles (BEV) and hybrid vehicles with a mains connection, so called plug-in hybrids (PHEV). Environmental concerns on the one hand and on the other hand keeping Germany's automobile industry competitive in the future are both important factors for supporting the development and diffusion of electric vehicles.

There is still a long way to go in order to reach these targets: As of January 2014 there were 21.324 BEV, 1.374 PHEV and 161 Fuel-Cell Vehicles on the road in Germany.

From an industry point of view, the battery has the biggest share of the value added in electric vehicles. This market is currently dominated by Asian companies, Germany hardly plays any role here internationally. Therefore, it seems much more promising to invest in the next generations of batteries than in the lithium-ion technology used today. Only second to the battery, power electronics systems are of a great importance. This technology is important not only for electric vehicles, but also for other future technologies, e.g. in the fields of energy efficiency and renewable energies as well as for the control of electricity grids. It is essential to safeguard the strong competitive position Germany holds in this area today.

Electric vehicles can play an important role in changing mobility patterns, therefore the use of electric vehicles in car sharing, commercial car fleets and multimodal mobility services is highly attractive. In this way, electric mobility can be a cornerstone of a sustainable transport system.

Transportation and mobility was an important thematic focus of TABs work in recent years: already ten years before the already mentioned report on electric mobility (TAB 2012a), we published a report which developed a set of political instruments and measures to steer the energy supply in the mobility sector towards more sustainability (TAB 2002). In 2006 another extensive technology assessment report was published, which gives an overview of technological innovations in powertrain technologies and systems and their potential to reduce energy consumption and emissions. All of this was analysed in a comprehensive "well-to-wheel" perspective (TAB 2006).

Innovation for Agriculture, Food and Environment

Agriculture is one of the major causes of man-made greenhouse gas emissions worldwide. Apart from CO_2 also large emissions of methane (CH_4) and nitrous oxide (N_2O) are produced through agriculture. In Germany, agriculture is responsible for about 7 % of all greenhouse gas emissions. Because of the very different causes and diverse sources of the emissions, it is rather difficult to tackle these emissions. At the same time, there are numerous additional obstacles and challenges to overcome in order to reduce them. For example, it is not at all easy to convince farmers to give up on traditional agricultural practices, which are sometimes proven for centuries, only because other practices promise to have a lower greenhouse gas footprint.

Also there are a number of conflicts regarding land-use: if, for example, a less greenhouse gas intensive agriculture produces lower yields, a greater area needs to be used to produce the same amount as before. Arable farm land however is a scarce resource and there are a lot of conflicting uses of land area (housing, infrastructure, nature reserves, leisure and recreation…). The biomass that is produced on a given area is also subject to use conflicts: food and feed, energy/fuels, industrial raw materials (wood, raw materials for chemical and pharmaceutical processes etc.).

On the issue of use conflicts there were three TAB reports published recently: the first (TAB 2005a) critically appraises a number of instruments and measures that had the intention of reducing land use in Germany. The second report (TAB 2010) provided a systematic analysis of "Opportunities and challenges facing new energy crops". It covered an overview on the technical and agricultural potentials of energy crops and dealt in detail with possible problems of competition for acreage on a national and a global level, with options for improving the environment-friendly production, and with the prospects of sustainability certification measures. Taking into consideration the many interdependencies between research, economics and policy, four different fundamental directions of political action on growth targets and funding policy with regard to energy crop utilization were formulated. The third report addressed quite a concrete question: is the available land better used in terms of Germanys targets for sustainable development if it is converted to organic farming or if energy crops are grown on it? Various strategic options are discussed in this report (TAB 2012b).

In this very complex field, easy answers are hard to find. Over the years TAB has undertaken a number of relevant projects: in 2005 the report on "*Precision Agriculture" was published (TAB 2005b).* Precision agriculture is an innovative (digital) information controlled management concept of crop production, based upon on various new or advanced technologies. These include in particular satellite-supported positioning systems, sensor technologies for data collection and geo-information systems. This promises to enhance the productivity of the land and at the same time reduce the environmental burden, especially since pesticides and fertilisers can be applied more precisely tailored to the specific need of the individual plants. All in all precision agriculture holds promise for a more sustainable agriculture in the future.

And finally a TAB-report from 2011 concludes that research definitely has a word to say when it comes to combat undernourishment and malnutrition that prevail on a global scale. Especially participatory user-oriented research strategies promise a potential to overcome the hurdle of transferring positive research results into the daily land management practices.

Technological options to reduce atmospheric CO_2 by active management of the CO_2-cycle connected to land use practices have been assessed in two recent TAB reports (TAB 2012c, TAB 2014b). The cultivation of microalgae to produce energy carriers as well as chemical feedstock for the food, feed and pharmaceutical industry seems to have good prospects for large-scale application in the medium term (after 2020). Another interesting option is to convert biomass into coal-like substances ("biochar" e.g. with a process called hydrothermal carbonization). This material can either used as a source of energy, or it can be pulverized and utilized as a soil conditioner. Under favourable conditions this can both fix atmospheric CO_2 and improve the harvest yield of poor soils.

Innovation and Citizens' Involvement

The high hopes that information and education can quickly and thoroughly change peoples' behaviour towards a more sustainable life-style that were prominent in the 1970s and 1980s are pretty much shattered. Many more factors play a role in peoples' behavior than just their knowledge about certain issues.

One example from the electricity sector is: if you provide people with "smart meters" that measure their electricity consumption and display that information in an easily accessible fashion (displays, on their smart phones …) they will change their consumption pattern and use less electricity. However this change is large initially and tends to decrease again over time when the old routines start kicking in again. The amount of energy that can be saved this way is around 5 % of the households electricity consumption (TAB 2015). This display of information can be called a "nudge" that softly pushes people towards a more sustainable consumption without taking away their autonomy to decide for themselves. This concept has gained a lot of attendance recently and some researchers believe that this could be a means to achieve a positive change beyond legislation and regulation (Thaler/Sunstein 2009).

On the other hand it is clear that people in Germany and other western democracies want to participate in the decision making process about issues that have impacts on their daily lives and are not willing to simply accept decisions taken by authorities. Infrastructure projects decided at the German federal level, which have to be implemented at the local level (rural districts and municipalities), therefore very often give rise to partly very committed or emotional debates and various conflicting interests. Particularly local elected political representatives are confronted with this situation. Currently, this is especially virulent for the expansion of electricity grids that is planned because of Gemanys plans to switch electricity generation to renewable energies ("Energiewende"). There are indications, that well-designed public participation processes can increase acceptance of the planning process and can lead to

better overall solutions. But there are no easy recipies, a productive discussion culture and trust can only be earned after hard debates. This was the topic of a recent TAB report (2015).

A recent trend in Germany with a profound impact on the energy landscape is the abundant spawning of energy cooperatives. This is a very hands-on approach of citizens' participation. Citizens join together to build and operate power plants, mostly based on PV- or windpower, to produce their own electricity. Commonly this type of engagement is seized by people who want to contribute actively to an energy system that is decentralized, environmental friendly and based on renewable sources.

Greece

Innovation for energy efficiency of buildings

1. "Energy saving at home" program

This program provides financial incentives for the implementation of energy-saving interventions in the residential building sector. The program covers old, authorized buildings, which were not built under the Thermal Insulation Regulation, are located in areas with a specific zone price and are used as primary or secondary residence. Moreover, the owners must meet certain income criteria.

2. "Exoikonomo (Save)" program

The purpose of this program is the implementation of actions and proven best practices in order to reduce energy consumption in the urban environment giving emphasis on the building sector (municipal buildings) and the upgrade of public spaces, on one hand, and in the area of municipal and private transport and energy intensive municipal facilities, on the other, through the implementation of technical interventions and actions to raise awareness and mobilize citizens, the local government, businesses and bodies.

3. "Exoikonomo II (Save II)" program

This measure constitutes the continuation of "Exoikonomo" program and foresees the upgrade of municipal buildings and infrastructure and installation of electronic and "intelligent" metering of electricity. This measure aims at the utilization of electronic metering in order to measure on an hourly basis the electricity consumption giving the opportunity to collect effectively all the necessary information regarding the consumption of industrial, commercial and residential consumers and to facilitate the promotion of financial or other incentives to promote rational organization of consumption behavior.

Innovation for transportation and mobilities

Reducing the energy footprint of the demand sector can be achieved by focusing on the transport sector. Examples include promoting use of LNG on sea going vessels, trains and trucks, utilizing the geographically strategic position of the existing LNG terminal at the island of Revithoussa. Strategic initiatives of the EU such as the Blue Corridor would contribute in promoting the above initiatives of Greece. We also support the effective promotion of electric and gas-powered cars and buses, the electrification of the railway and public transport network, the use of smart meters and the implementation of "smart grids".

The replacement of old passenger vehicles aims at the replacement of EURO III passenger vehicles with new EURO V vehicles through the partial or complete exemption from the special registration passenger vehicles tax.

The extension of the Athens Metro and the development of the Thessaloniki metro has as an objective the increased utilization of fixed rail transport in the city of Thessaloniki, which will lead to the significant reduction of private car use and will result in the achievement of energy savings.

Innovation to feed the world with minimal greenhouse gas emissions

The attracting of well-established international companies can ensure the safe exploration and extraction of hydrocarbons in conjunction with the close cooperation with Greek companies and will maximize the benefits from the exploitation of domestic natural resources. The most effective way to achieve this – in the fierce competition currently prevailing in the international hydrocarbon market – is to establish a stable and favorable regulatory framework that would minimize the risk of doing business in Greece. Furthermore, it requires organizing a well-targeted and dynamic informational campaign for international companies, as well as a parallel initiative informing the Greek society with regards to a realistic timetable and the real possibilities of our country in this field.

Citizens' involvement in the use of smart technologies

The participation of citizens in the decisions of the Administration concerning the protection of the environment finds legitimizing basis to: (a) effectively achieved the content of Democracy (b) the existence of the social rights of the individual, the environment and therefore for protection and (c) is a growing conscious need for a balanced sharing of the arrangement and to address the social needs between public power and civil society as a whole dynamic with buffering capacity and (d) article 24 , paragraphs 1 and 2 and article 25 paragraph 1 in the 1975 Constitution. However, up to the moment, no particular measures concerning citizens' involvement have been taken.

Conclusion

Greece needs a modern regulatory framework for the operation of Energy Service Companies (ESCOs) and development of energy saving and energy efficiency projects. Targeted regulatory interventions can immediately tackle hurdles such as: the absence of a framework for heat trading and active management of renewable energy sources; the lack of incentives for the energy upgrades of facilities in the private sector and the absence of a load balancing

market in gas and electricity. The issuing of financial tools such as green bonds by the local authorities (based on the American PACE model) could be very helpful in this respect as well as the provision of guarantees from European bodies.

This objective ought to be considered as one of Greece's highest priorities. At present, Greece's energy market ails from a significant amount of state intervention and distinctly lacks the necessary conditions conducive to the development of a competitive environment. The Hellenic government can promote structural reforms in the national energy market. As an example, we refer to the widening in scope of the term "choosing customer" for natural gas, the amending of terms for calls for tenders for natural gas undertaken by the Hellenic National Gas Company (DEPA), establishing rules to allow for the possibility of commercially trading LNG quantities in tanks, the liberalization of bilateral contracts for the supply of electricity, third party access to lignite deposits, and the ability to use trade optimization infrastructure for renewable energy sources.

The Hellenic regulatory framework for renewables should be harmonized in line with EU 2030 targets, and specifically make use of the cooperation mechanisms outlined in directive 2009/29/EU for the promotion of the use of renewable energy sources and cross border energy trade. In particular, the Government can promote a new competitive model based on market mechanisms driven by carefully set targets based on technology and geographic location. The Direkt Vermarktung (direct marketing) model which is being applied in Germany could serve as an indication. Such a model would drastically reduce the associated financial burdens on our national economy.

The Netherlands

Introduction

Climate change generates chances for innovation and opens windows for new business. Entrepreneurs are looking for new techniques to live, to consume and to transport people in a way that is less detrimental to climate than the conventional ways. Innovations can contribute to either mitigate or to adapt the consequences of climate change. Innovations focusing on mitigation reduces the magnitude of climate change itself (such as geoengineering or measures to directly reduce carbon dioxide emissions). Innovations focusing on adaptation limits society's vulnerability to climate change impacts and makes society robust against climate change (such as sustainable living and protection against floods).

Policy initiatives and societal trends

Sustainable energy evidently is one of the domains in which innovations related to climate change take place. Those innovations mostly lead to mitigation, as these aim to less carbon dioxide emissions. Figures generated by the so-called top sector Energy, one of the sectors in which the Netherlands excels globally and which receive high government priority, show that the largest part of the sector's available financial resources was invested in biobased economy (ECN, 2014). Next to that, the number of patents in sustainable energy related technologies, has been significantly increased, especially patents for solar energy, biomass and wind energy. Public expenditures for innovation in energy-related technologies in general has nonetheless been reduced since 2010.

Water, agri-food and logistics are examples of other domains in which innovations take place with regard to adaptation and mitigation of the climate change consequences. Innovation in water management, for instance, mostly leads to adaptation. The Dutch Delta program is one of the most globally known examples; it aims to protect against floods and to secure fresh water supplies. Together with the program Knowledge for Climate, which is established to foster co-creation between universities, research institutes and government in making the Netherlands more robust to climate change, it works to a 'climate proof' country (Kennis voor Klimaat, 2014)[12].

[12] In 2013, the Rathenau Instituut published a report (http://www.rathenau.nl/publicaties/publicatie/kenniscoproductie-voor-de-grote-maatschappelijke-vraagstukken.html) about co-creation of knowledge of societal challenges.The program Knowledge for Climate is regarded as a good example of co-creation, in which both society and science work together to define future research agendas (Boon and Horlings,2013).

Challenges

In 2013, the Dutch Ministry of Infrastructure and the Environment published its climate agenda (Ministry of Infrastructure and the Environment, 2013), which sketches an approach that combines climate adaptation and climate mitigation. The climate agenda emphasizes the importance to further stimulate the innovation chances by creating necessary conditions for innovation and by eliminating non-financial obstacles.

Challenges for the Dutch government with regard to adaptation and mitigation are: realizing robust vital sectors (such as nature, energy, ict, transportation and public health); broadening the measures to realize mitigation (such as strengthening the European emission trade system and carbon dioxide norms); facilitating renewable energy and energy saving (such as transportation and storage of energy); stimulating sustainable mobility (such as expanding the introduction of carbon neutral cars); further developing of a circular economy and of a sustainable use of raw materials); and, stimulating sustainable agri-innovations (Ministry of Infrastructure and Environment, 2013).

Current TA projects

The Rathenau Instituut conducts research on the societal and political effects of new technologies. Concerning technologies that contribute to the adaptation or mitigation of climate change consequences, the Rathenau Instituut currently conducts the following projects:

1. Innovation for energy efficiency of buildings

Building houses efficiently, by sustainable use of resources or by building houses in a way that living requires less energy, is an example of innovation that contributes to a lower demand of energy. Smart grids, for instance, enables smart energy supply to houses and enhances sustainable living. An example of such an initiative in the Netherlands is the project Stroomversnelling, an initiative of Platform 31 (a platform for spatial and urban planning). The project Stroomversnelling aims to build in total 111.000 carbon neutral houses, while the housing expenditures of its occupants stay unaffected. Four construction agencies and six housing corporations have agreed to build the first 11.000 houses during the next few years.

Next to constructing energy efficient houses and buildings, the use of sustainable materials and the recycling of household waste also contribute to a sustainable way of living. Stimulating and facilitating a circular economy and the use of sustainable materials (not only at consumption level, but merely at geopolitical and national level), are topics that are addressed in the Rathenau report Resource Hunger (http://www.rathenau.nl/publicaties/publicatie/sustainable-alleviation-of-resource-hunger-management-summary.html) (Krom & Van Waes, 2014). The Rathenau Instituut analyzed what (geopolitical) strategies are open to the Netherlands and the European Union for securing critical resources in a sustainable way. A transition to the circular economy can play

an important role in this, provided that the recycling of critical materials is made economically viable, and that resources that will still need to be imported as input for the circular economy at least meet minimum sustainability requirements (Krom & Van Waes, 2014).

2. Innovation for transportation and mobilities

In September 2013, more than 40 organizations, such as governments (both national and regional), employers, labor unions, ngo's and financial organizations, committed themselves to the national Energy Agreement for Sustainable Growth ('Energieakkoord') (SER, 2013). Essence of this agreement is that the concerning actions have to lead to a sustainable and affordable energy supply, to employment and to innovation in sustainability related technologies. Smart mobility and smart transportation is one of the focus points.

One project of the Rathenau Instituut in 2015 focused on smart mobility and autonomous cars (http://www.rathenau.nl/publicaties/publicatie/converging-roads.html) (Timmer et al. 2015). Self-driving cars are considered by the Dutch government as an important way to reduce congestion and improve traffic flow, to reduce fuel consumption and improve road safety. The Netherlands wants to be actively involved in the development of autonomous cars (Parliamentary Documents II, 2013/14, 31305, No. 210), for example by allowing tests and experimenting with more flexible regulations. Dutch companies play an important role as suppliers of systems and components for the automotive industry, and the country is also strong in communication technology and intelligent traffic management systems. Besides reducing environmental and congestion costs, developing self-driving cars can give an important economic boost to the mobility industry in both the Netherlands and the European Union.

The Dutch focus has been on improving communication between cars and between cars and

road infrastructure. The ultimate goal is a self-driving car that smoothly connects to a platoon of cars on the motorway and that responds to warnings transmitted by smart infrastructure, for example about icy conditions, mist, or unexpected obstacles. This approach depends heavily on public-private cooperation and investments.

But now self-driving cars are also being developed in Silicon Valley. These innovative vehicles have sparked interest in the Netherlands as well. But the Rathenau project found that their rapid advance is threatening to interfere with the Dutch approach. These autonomous robot cars have onboard sensors that enable it to guide itself safely. But the cars do not communicate with other cars or with the road infrastructure, and are therefore not equipped for platooning. And precisely platooning brings the most benefits for efficient driving, i.e. saving energy and reducing congestion.

The robot cars are interesting for the automotive industry because it can function independently of other cars and a particular road infrastructure. There is a risk that private parties will focus on the development of the autonomous robot car at the expense of cooperative systems such as those being developed by the Netherlands.

In the view of the Rathenau Instituut, efficient development of the self-driving car requires convergence of the two approaches – autonomous and cooperative. In order to benefit from the technical advantages from both approaches, and to achieve public goals as regards road safety, traffic flow and the environment, it is important that the robot car is compatible with cooperative systems. This means that it must be able to connect to other cars and to traffic management systems. The Dutch government can play a role in this by imposing requirements for vehicle communication and by influencing international standards.

Another current project of the Rathenau Instituut focuses on the governance of smart cities. Not only mobility and transportation, but also digital platforms, smart ict solutions, robots and the internet of things pose challenges for the governance of cities.

One of the new projects of the Rathenau Instituut (2015-2016) will focus on the governance of smart cities. Worldwide citizens and companies are involved in setting-up digital platforms for sharing goods and services. Well-known examples are Airbnb (housing) and Ueber (mobility). These platforms have a huge potential for changing the way in which the use of goods and the delivery of services are *organized*, involving a new dynamic between policy-makers, citizens and companies In a similar vein cities worldwide have formulated ambitions to become 'smart' cities, wanting to harvest the full potential of the Internet of things, in which everything is connected to everything and everyone. Potential applications include both the organization of the government itself as well as employing smart technology to govern the city and for the *organization* of delivering public services. Here too, the use of smart ICT applications have the potential to radically change the way that our institutions are organized. This raises the question, for instance, whether (local) governments are willing and able to let citizens and companies take over parts of what previously was considered a government task.

Central to this new project of the Rathenau Instituut will be to examine - through case studies[13] - the societal meaning and significance of developments towards making cities 'smart'. Particular attention will be devoted to (a) mapping who is (not) involved in specific initiatives, (b) the extent to which these initiatives (could) change the relation between policy-makers, cities and companies, and (c) what governance structures are needed to safeguard central societal values such democratic decision-making, transparency, inclusiveness, sustainability, well-being, and the livability of cities.

Recognizing that smart city initiatives are often initiated by local governments (faced with important societal challenges) and companies (developing technical options to meet these challenges), the Rathenau Instituut will specifically map *the way in which* citizens are involved and can be involved in concrete smart city initiatives. This way the project aims at including the input of citizens in such a way to support that smart cities will also be livable cities, i.e. places in which citizens are able to lead a good life, enjoy a high level of well-being, and will remain to have an important say in the governance of the city.

[13] Case studies will focus on energy, mobility, security, resources/ circular economy, the sharing economy, and the delivery of public services.

3. Innovation to feed the world with minimal greenhouse gas emissions

In order to feed the still rapidly growing world population in an environmentally sustainable, animal friendly and economically feasible way, present-day agriculture is increasingly using all kind of smart technologies. Present-day farms more and more become part of the 'Internet of things'. By making use of drones, smart cameras, wearables, innovative fertilizing and feeding systems and sophisticated computer models, conditions for both crop production as well as animal husbandry can be monitored, analyzed and optimized. By supporting or even replacing human observation by electronic monitoring and analysis, agricultural production can become more productive, environmentally sustainable and animal friendly. At least, these are the promises of Smart Farming.

In an explorative study on Smart Farming, the Rathenau Instituut has explored to what extent present-day farmers in the Netherlands incorporate smart technologies in their daily practices (Bos, 2015). Although the concept of Smart Farming is appealing, the practice of Smart Farming appears to be multiform. The way in which smart technologies are implemented in agricultural practices, strongly depends on the precise purposes and context. Nevertheless, the following issues can be depicted as deserving further attention and research: to what extent is it feasible to replace human observation by electronic monitoring and analysis (e.g. with regard to the handling of animals and related animal welfare issues); to what extent a broad implementation of smart technologies would further a large-scale, industry-like type of agriculture; to what extent a broad implementation of smart technologies would turn farmers into data managers, losing all connotations to agriculture as a 'natural' practice?

Rathenau Instituut will continue its research on smart farming during the next few years.

4. Citizen's involvement in the use of smart technologies

In the period ahead the mobility system and our mobility behavior are expected to change drastically. The more vehicles and roads are equipped with smart technology, the greater will be the stream of data that they exchange. That data can be used for new applications and new revenue models, but it also raises questions regarding privacy, ownership, and reuse. What should car manufacturers be permitted to do with that data? What about insurance companies? And should the authorities be allowed to use this data in investigations?

Although cautious public discussion is beginning about what uses the digital data generated by smart cars may be put to, the Rathenau Instituut concluded in the project on 'smart cars' (http://www.rathenau.nl/publicaties/publicatie/converging-roads.html) that civil-society organizations and the public currently hardly play any significant role in the development of smart and self-driving vehicles (whether that means the cooperative or the robot car). Indeed, they are conspicuously absent. Users are not seen as inevitably involved in the social embedding of the self-driving car. The closed nature of the innovation process derives partly from conflict avoidance. Controversial issues, such as variable road pricing and privacy, are often avoided, even though the associated functionalities arise almost of their own accord. The process of strategy development in the current Dutch policy program (Better Informed on the Road) was deliberately not set up too broadly because building trust between market and

government was seen as a critical task. But the rate of current developments demands the input and involvement of users, the public, and civil-society organizations. The input of all these parties is necessary, specifically now that self-driving cars are leaving the confines of the test circuit and start driving on public roads. Only by involving citizens it will be possible to reach policy goals such as saving energy, reducing congestion and increasing road safety.

Part of the new project of the Rathenau Instituut 'smart cities' (mentioned above), is to explore how smart technologies, such as sensors, smartphones and apps, might empower users to participate in measuring energy savings, carbon emissions, and how such data will be used by citizens, companies and governments to make changes in their policies / living areas or (driving) behaviors. Insurance companies are now starting to experiment with smart measuring devices for cars, that give users real-time feedback on their driving style, and may either receive discounts for a 'sustainable' and 'safe' driving style.

Conclusion

The Rathenau Instituut continuously monitors developments regarding innovations and emerging technologies that foster sustainability and that diminish the disastrous effects of climate change. One of the major themes is the way in which ICT related technologies can play a role in the transition towards a more sustainable society. The development of smart cities, smart cars and smart farming are key in the projects we currently conduct. Herein, the involvement of citizens in the design of those technologies and in measuring trends and collecting data seems to be essential.

Norway

Background: The Norwegian Climate Agreement

Oil and gas are Norway's most important export and driver of the economy. It is also this sector that emits the most climate gasses. The Norwegian government has therefore given priority to a green transition to further both economic and environmental sustainability.

The Norwegian climate policy is based on a broad political agreement made in 2012. In addition to the overarching objectives on emission reductions, the agreement describes a series of measures that will be implemented in Norway. These include:

- phasing out fossil heating oil ;
- stricter energy requirements for the building sector ;
- contributing to developing biogas in Norway ;
- the car taxes shall be used to contribute to getting a more environmentally and climate-friendly vehicle fleet ;
- strengthening the role of the railway in the transport system.[14]

Innovation for energy efficiency of buildings

Energy use in private households stabilised at around 44-46 Twh in the mid-1990s, following a period of 2% annual increase from the 1970s.[15] However, policy makers see a reduction in this sector of 1,4-3 Twh as realistic.[16]

Norwegian homes are to a large extent heated by the use of electricity, which accounts for about 70% of energy spent. It should be noted, however, that because the electricity in the Norwegian power grid is mainly hydropower, the amount of greenhouse gases emitted is relatively low.

In 2012 the Norwegian Government put forth three goals for sustainable energy use in buildings:

- Use of energy should be considerably reduced by 2020.
- Regulations should ensure that new buildings are constructed as to require energy below allowed regulated levels.

[14] https://www.regjeringen.no/en/topics/climate-and-environment/climate/innsiktsartikler-klima/agreement-on-climate-policy/id2076645/
[15] Norwegian Water Resources and Energy Directorate (2011).
[16] Meld. St. 28 (2011–2012) Gode bygg for eit betre samfunn, white paper on buildings for a better future, p 76.

- Support schemes and information should help make existing buildings more energy efficient.[17]

1. A public enterprise for green energy

Enova is a public enterprise owned by the Ministry of Petroleum and Energy, established in 2001 in order to drive forward the changeover to more environmentally friendly consumption and generation of energy in Norway. In order to achieve this, Enova works closely with public and private enterprises in order to reduce energy consumption and simultaneously increase power generation from renewable sources.

In 2014 Enova according to their annual report joined 1400 new projects in the private and public sectors, and supported 4500 new energy measures in residential buildings. This was the first year it granted more support for innovation and technology development than spread of familiar technology in the markets, which is an interesting shift in light of the energy and climate challenges we are facing. These challenges cannot be solved without innovation and technology development.

Enova provides funding for projects that lead to more sustainable energy consumption. One example of a project supported by Enova is Statkraft Varme's installation of a district heating line between two neighbourhoods in Trondheim municipality. During the period 2009-2014 the project received support of 19,1 mill NOK. Renewable heating is one of the markets ENOVA is engaged in, as it holds the potential for being a more reliable and sustainable form of energy for the future.[18]

2. Passive houses and zero emissions

In both 2015 and 2020 the Norwegian regulations on energy use in buildings will become stricter. The regulations of 2015 are at passive house levels, while regulations in 2020 will approach zero emissions.[19] The relevant actors in the construction sector have been notified of the changes a few years in advance in order to give the construction industry enough time to adjust and be encouraged to innovate before the regulations take effect.

Furthermore, the political agreement on climate policy says that fossil oil heating in households is to be prohibited by 2020. In addition to reducing greenhouse gases, local pollution will be reduced and the risk of leakages will be eliminated. As an alternative to fossil oil, bio oil will remain available.

In July 2010, new regulations that include demands on energy efficiency in buildings (Tek 10) were introduced in Norway.[20] It sets the minimal requirements buildings must satisfy in terms of materials used and alternatives for heating. For instance Tek 10 says that buildings of more

[17] Meld. St. 28 (2011–2012) Gode bygg for eit betre samfunn, white paper on buildings for a better future, p 73.
[18] ENOVA (2015), pp. 60–73.
[19] Meld. St. 28 (2011–2012) Gode bygg for eit betre samfunn, white paper on buildings for a better future, p 10.
[20] http://www.innovabygg.no/energi-og-varme/tek-10

than 500 m^2 must attain more than 60% of its heating from other sources than direct acting electricity or fossil fuels. For smaller buildings the limit is set at 40%.

Innovation for transportation and mobility

Over the past 15 years, the Norwegian Board of Technology (NBT) has conducted several projects that are either directly or indirectly related to cleaner and greener road traffic. Both hydrogen fuel and biofuel have been discussed. Even though these have interesting potentials, the NBT in 2009 stated that electric vehicles and hybrid cars were the most promising technologies and should be made widely available. This was suggested as a part of a scheme to reduce Norway's combined CO_2-emissions by 2020.[21]

1. Norway as an early market for electric vehicles

As a part of reaching the goal of reducing CO_2-emissions in the transport sector, the government has implemented extensive tax cuts and benefits to encourage consumers to choose electric vehicles (EVs) instead of their fossil fuelled counterparts. In addition to putting a CO_2-component to car VATs this makes it cheaper to buy cars that produce low emissions. The NBT suggested this solution as early as in 2006.[22] Additional fiscal and non-fiscal measures directed specifically at EVs have been implemented:

- zero VAT policy on buying EVs ;
- heavily reduced annual car tax (435 NOK annually as opposed to normal rates of 3060 – 3565 NOK)[23] ;
- no fees on toll roads ;
- free public parking ;
- free use of ferries ;
- free charging at public charging stations ;
- access to bus lanes.

The favourable conditions for EVs have made Norway one of the biggest markets for EVs globally, second only to California, and Norway is now in a favourable position to test and develop new technologies and solutions for greener driving.

So far the incentives have had a large impact in leading Norwegians to buy EVs, and might even fall victim to their own success. The measures were set to last either through 2017 or up to 50.000 EVs in total sold. During the first few months of 2015 EVs stood for 19% of all new cars sold, and the sales goal of 50.000 was met in April 2015. This has led to public

[21] Norwegian Board of Technology (2009).
[22] Norwegian Board of Technology (2006).
[23] Meld. St. (2014–2015): p. 78–79.

debate on the EV incentives. For instance the high number of EVs in the area surrounding Oslo has congested the bus lanes during rush hour, and on some ferries as much as 20–25% of cars are EVs riding for free. Still the program has been extended through 2017.[24]

2. "Cities of the future": Towards zero emissions

In 2012, the Norwegian government stated that the growth in passenger transport in major urban areas should be absorbed by public transportation, bicycling and walking.[25] This has been dubbed the "zero growth goal", and frames the debate on innovation in this sector.

To achieve this, an increasing number of urban area buses are running on non-fossil fuels. Ruter, the administration company for public transport in Oslo and its suburbs, is operating busses running on hydrogen, bio fuels and bioethanol. The aim is to use exclusively renewable sources by 2020. So far, bio fuels have been favoured, as it significantly reduces emissions and can be used by adjusted diesel engines.

The "Cities for the future" programme is collaboration between the state and 13 major Norwegian cities. The programme facilitates the option of walking or biking, as an alternative to other forms of transportation. Some of the measures are:

- reward schemes for increased public transport and reduced car traffic ;
- increased number of charging stations for EVs ;
- improved facilities for biking.

The program includes an option for the state and individual cities to committing to holistic city environment deals. These deals are to contain concrete goals towards reducing car use and fostering environmentally friendly transport.[26]

Food and Environment

1. Tracing the carbon footprint

In 2008 the NBT published a report on food and climate[27], which pinpointed the two-fold challenge of creating a stable food supply while climate gas emissions must be reduced.

The NBT suggested introducing "carbon footprinting" as a common methodology for calculating and documenting the impact at different stages. Furthermore it pointed to the need for a common international method that can provide the carbon footprint for the entire life cycle of a product.[28]

[24] Meld. St. (2014–2015): p. 92. http://www.statsbudsjettet.no/upload/Revidert_2015/dokumenter/pdf/stm2_2015.pdf
[25] Meld. ST. 21 (2011-2012): pp. 9–10.
[26] https://www.regjeringen.no/no/tema/kommuner-og-regioner/by--og-stedsutvikling/framtidensbyer/test-artikkel/id547993/
[27] Norwegian Board of Technology (2008a).
[28] Norwegian Board of Technology (2008b).

If implemented, a carbon label directed at consumers can facilitate three functions:

- giving authorities tools to map emissions over time ;
- providing the food sector with a guide to cut costs ;
- informing consumers about the carbon emissions from the products they buy.

A standard for carbon footprinting for sea food was launched by the standardization body Standards Norway in 2013. As more and more market actors, as well as costumers, demand documentation of carbon footprint, this standard gives an advantage to climate friendly products.[29]

2. A national strategy for the bioeconomy

The Norwegian government is currently initiating a task force developing a national bioeconomy strategy which should be presented by the end of 2015. The aim of the new strategy is to facilitate a "green turn" which makes Norway less dependent on the production and consumption of fossil fuels, as well as making greener business avenues more innovative.[30]

The bioeconomy is a circular economy meaning that the by-product(s) from one value circle is a valuable raw material for another value circle. This economy is based on the potential of turning biomass into, among other things, food, fuels, chemicals and materials.

The Research Council of Norway initiated a research program in 2012, BIONÆR, which is focusing on the further development of the bioeconomy in Norway. This is the most dedicated program for the development of the Norwegian bioeconomy, and has provided support for more than 330 projects. Among these is "Sustainable path creation for innovative value chains for organic waste products", an interdisciplinary research program on the transition to the bioeconomy.[31]

Moreover, a new Norwegian Institute of Bioeconomy Research (NIBIO) was established in August 2015.[32] NIBIO will be a ministerial agency with separate powers and independent leadership. With more than 650 full-time employees, this is now one of the largest research institutions in Norway.

3. The potential of the oceans

Salt water covers 70 % of earth's surface. 50 % of the biological production takes place in salt water, but without any cultivation taking place as in agriculture. However, only 2 % of the global human food intake comes from the oceans, whose most productive parts are the shallow coast and fjord areas.

[29] Standards Norway (2014):*Årsrapport 2013*.
[30] https://www.regjeringen.no/no/aktuelt/nasjonal-biookonomistrategi/id2402513/
[31] https://www.forskningsradet.no/prosjektbanken/#!/project/244249/no
[32] https://www.regjeringen.no/en/aktuelt/Norwegian-Institute-of-Bioeconomy-Research-has-been-established/id2426068/

Norway was the first country to start fish farming in salt water and, after about 45 years of growth, has a leading position globally. The growth potential for Norway as well as other nations is very high and this will be one of the future low emission production systems for food. However, to be able to obtain that higher amount of raw materials, fjords and coastal areas should be utilized.

One example of a Norwegian company that focuses on finding innovative ways of producing bio mass and bio energy sustainably along the Norwegian coast is Ocean forest. Partly founded by the environmental organization Bellona, combatting climate change is a key focus. As such, one of their goals is to find production methods which eliminate more CO_2 than they emit. The idea is to use algae, salt water and CO_2 to produce products such as food and fuels. The company aims at commercializing their solutions within five years after start-up.[33]

[33] http://bellona.no/prosjekter/ocean-forest

Poland

General issues

Poland's CO_2 emission in 2013 were estimated at 320 million tonnes. The main emission source was fuel combustion that contributed 92% of total CO_2 emission (in that category energy industries contributed 52%, manufacturing and construction 9%, transport 14%). Polish per capita emissions (8,3 tonnes of CO_2/year) are about the average for the EU.

Poland is one of the more energy intensive countries of the European Union. The emissions level in Poland is relatively high because of the energy sector reliance on coal. Almost 90% of Polish electricity and heat generation is derived from coal. Coal industry constitutes an important part of the Polish economy and the state owns considerable shares in power plants. Both factors contribute to the fact that there is limited political interest in diminishing the role of coal as an energy source. Domestic deposits of coal are also perceived as an important asset from the point of view of energy security. Energy security reasons disfavour switching to cleaner natural gas which would have to be imported.

Poland is often perceived as a country that strongly opposes the EU climate policy. However it is worth noting that Poland has managed to substantially reduce its GHG emissions during its economic transformation. As a result of the structural shift towards less energy-intensive sectors, the country's overall GHG emissions fell by around 30% between 1988 (Polish base year under the UNFCCC) and 2013. Since the early 2000s, annual GHG emissions have remained broadly stable, despite the significant growth of GDP in that period. This reflects efforts to include more renewable energy in the energy mix and investments in more energy-efficient technologies. However energy efficiency of Polish economy, although improving, still remains well below EU averages.

Poland does not have specific climate change policy (beyond the commitments adopted under international treaties and EU legislation). The climate issues are dealt within the framework of other sectoral policies, most notably energy policy. *Energy Policy of Poland until 2030* (adopted in 2009) is mostly focused on improving energy security, efficiency and competitiveness. The *Energy Policy 2030* is now being revised aiming at more robust diversification of energy mix towards gas, nuclear power and renewables. At the same time, Poland is in the process of formulating a national plan for reducing GHG emissions, the *National Programme for a Low-Emission Economy Development* (the document is currently entering the final stage of ministerial approval). So far Poland's main instrument of climate policy is the EU Emission Trading Scheme (EU ETS), that covers around half of the country's GHG emissions. Emissions in sectors not covered by the EU ETS (primarily the residential, transport and agriculture sectors) are set to rise 14% above the 2005 level by 2020.

Energy Efficiency of Buildings

The *Energy Policy 2030* strategy lists a number of measures addressing energy demand, some of them are relevant for building sector. These include for instance (i) setting energy efficiency national objectives and introducing systemic support mechanisms; (ii) using mandatory energy performance certificates for buildings and apartments upon their marketing or renting; (iii) determining energy intensity of devices and power-consuming products, introducing minimum standards for power-consuming products; (iv) committing the public sector to serve as a role model of efficient energy usage; (v) supporting investments in energy saving through preferential loans and grants from domestic and European funds.

Improving Energy efficiency has been declared a priority of Poland's energy policy. Many activities in that area follow the EU legislation. Implementing the provisions of Directive 2006/32/EC on energy end-use efficiency and energy services, in April 2011 Poland issued its *Act on Energy Efficiency*. Following the obligations established by the Directive 2010/31/EC on the energy performance of buildings, the Polish government prepared National Energy Efficiency Action Plan (EEAP) which covers among others buildings sector. The EEAP adopted in 2011 established an energy savings target of 11% by 2016 compared to 2001-2005 average. Under new EU legislation (2012/27/EU) Poland's 2014 EEAP set an indicative target for 2020 of stabilising primary energy consumption at the 2010 level. This will require strengthening energy efficiency in all sectors. According to many studies there is significant potential to improve energy efficiency in housing and public buildings, but also in district heating systems.

Public support for thermal improvement investment in existing buildings is available through Thermo-modernization Fund, overseen by the Ministry of Infrastructure and Development and managed by the state owned bank (Bank Gospodarstwa Krajowego). It provides subsidised loans mainly to local governments and building owners to renovate apartment buildings. The fund targets "best practice" renovations focusing on projects that would not be attractive under normal lending conditions. Besides, the programme has helped to develop energy audit services.

Transport

Poland's transport sector has experienced very high rates of emission growth in recent two decades - it has grown by almost 75% since the beginning of economic transition. In 2013 transport sector contributed 14% of the country's total GHG emission. Moreover, Poland still has relatively low rates of motorization, what suggest that the growth of road transport will continue. This problem is exacerbated by a high share of ageing vehicles, which tend to be more fuel inefficient and polluting. As in other transition economies, Poland has been investing heavily in roads, which have accounted for 90% of transport infrastructure investments in recent years. Despite significant investments, the density of motorways remains among the lowest in the EU and the rail network is substantially underinvested. In the

case of both the passenger and cargo transport, the most conspicuous change is the growing importance of road transport: it accounts for 95% of total inland passenger transport and 75% of freight . In the road transport, the fuel consumption grew and the number of cars increased The only positive trend was a decrease in the energy intensity indices of the means of transport.

Until recently, little progress has been made in addressing the environmental impact of transport. The *Transport Development Strategy* was adopted by the Council of Ministers in 2013. The main goal of the Strategy is "to enhance territorial accessibility and to improve the safety of traffic participants and the efficiency of the transport sector by creating a consistent, sustainable and user-friendly transport system at the local, national and European level". One of the detailed objectives is to "limit the adverse impact of transport on the environment". However there is little direct reference to climate or GHG emission reductions needs. One of the proposed measures is to gradually increase the share of bio-components in transport fuels. In addition, the obligation to consider emissions-related factors and energy consumption of all vehicles purchased in the public procurement procedure has been introduced.

Agriculture

Polish agriculture is characterised by ample land resources, with a simultaneous large share of poor and acidified soils, a substantial fragmentation of farms and persisting traditional production methods. The total area of farms in Poland in 2012 was about 18 million ha, representing about 58% of the total national territory. Since 2000 the agricultural land area has decreased significantly while other land uses, including for housing, services and infrastructure, have increased.

So far Poland has not adopted policies and measures that aim directly at reducing GHG emissions in agriculture. However, in the framework of the EU climate 2020 package Poland is obliged to limit the rise in GHG emissions in sectors not covered by the EU ETS to max. 14% above the 2005 level. So far this goal has not been supported by specific policy measures.

Promotion of eco-innovation

Between 2007 and 2013 Poland's gross domestic expenditure on R&D rose from 0,57% of GDP to 0,9% driven by significant increases in the national research budget and EU funding. Despite this effort, Poland's innovation performance is one of the poorest in the EU, where the average R&D capacity stands at 2,4% of GDP. Polish firms spend very little on R&D and innovation, as the business spending is mostly allocated to technology absorption. To address this challenge the government reformed the system of cooperation between economy and science and research sector. The reform included creation of agency for applied research and introduction of more competitive funding schemes. In 2013 the Council of Ministers adopted

the *Strategy for Innovative and Efficient Economy* which includes measures to support business innovation and sets priorities for granting EU funds. Eco-innovation mirror's Poland's general innovation trends. Despite relatively poor performance some positive initiatives may by highlighted, most notably the GreenEvo program oriented towards supporting exports of green technology and the GEKON programme, jointly implemented by the National Environmental Fund and the National Centre for Research and Development that stimulates co-operation between science and industry on environmental technology. EU funds have helped establish eco-innovation oriented clusters such as the Silesian Environmental Technology Cluster, the Baltic Eco-Energy Cluster, the Clean Energy Cluster of Southern Poland. The Climate-KIC (Knowledge and Innovation Community) located in Wroclaw is the largest public-private innovation partnership in the country which focuses on climate change and consists of private companies, academic institutions, and representatives from the public sector. There is a clear focus on research and development in the area of renewable energies, biofuels and clean coal technologies. Research in the field of energy-efficient buildings (including zero-emission standard) are carried out by the Cracow University of Technology and by the Building Research Institute in Warsaw.

Russia

Innovation for transportation and mobility

The project of the Integrated Eurasian Transport System aims to ensure a transcontinental transport mobility through an optimal balance of energy consumption and environmental safety

The idea of building a transcontinental transport route Eurasia – North America dates back to the beginning of the XX century, ever since remaining in focus of interest by scientists and politicians.

Back in the 90's much deliberation at major international conferences was held over a project of overland link between the continents of Asia and North America.

Lately developed an upgraded megaproject known as "Integrated Eurasian Transport System" (IETS) or "Trans-Eurasian Belt RAZVITIE" (TEPR) involves construction on the Russian territory of the transport network link between Western Europe and the Far East, the North America and the South-East Asia. The project concept was developed by the Center of research and implementation of the megaproject *IETS* in the Institute of Social and Political Studies (ISPS) of the Russian Academy of Sciences (the corresponding report was published by Dr. V. Yakunin and Academicians G. Osipov and V. Sadovnichy)[34]. The project implies the establishment of integral infrastructure system providing flexible unity of the transport (rail and road routes), energy and telecommunication systems.

Main ideas of the project have been several times brought to the discussion at the Council of the Federation, as well as at the Baikal Economic Forum. On November 30, 2011 the Council of the Federation held parliamentary hearings "International transport corridor Europe – Russia – Asia-Pacific region as a space for innovation"[35] to review the *IETS* draft submitted by the ISPS Director, Academician Gennady Osipov.

The recommendations of the parliamentary hearings have stressed, in particular, the necessity "to consider under the EU-Russia Summit and Russia – APEC the feasibility of establishing and developing international transport corridors North America – Russia – Southeast Asia (Alaska – the Bering Strait – Yakutia – Siberia – China)".

In March 2014 the project "Integrated Eurasian transport system" was presented by Dr. V. Yakunin (former President of the JSC "Russian Railways") and approved by the Presidium of the Russian Academy of Sciences.

[34] Yakunin V.I., Osipov G.V., Sadovnichy V.A. *The Uniform Eurasian Infrastructure System*. – M.: ISPS of RAS, 2013.
[35] "International transport corridor Europe – Russia – Asia-Pacific region as a space for innovation" / Analytical News Bulletin of the Council of the Federation № 2, Moscow, 2012.

The elements of the integrated infrastructure shall include: construction of 47 thousand Km of railways, 120 thousand Km of main roads, laying of 23 thousand Km of fiber-optical cable[36]. Therewith, traffic volumes would interact with the energy flow, knowledge and technology capacities. Thus, creating innovation environment in the region to forming a center for scientific developments and the production center based on advanced technologies provided by many countries involved.

According to the developers' evaluation, the implementation of the megaproject can reduce the delivery time of goods between the Western Europe, and the Far East, the South-East Asia and the North America to 5-6 times and reduce delivery costs to two or three times[37]. The developers of the project are convinced that the functional role of the railways in the world will increase. First of all, it is environmentally friendly compared to other transport systems and its development is more efficient in terms of minimizing CO_2 emissions. Secondly, most railways are safe, and finally, more comfortable for the individual.

The project potentiality enables optimization of traffic flows on the global level and the balance of the interests between major economic regions of the world, serving as an important tool of global geopolitical security. It is to no exemption that the implementation of the Russian IETS project may take place in cooperation with plans of the construction of China's Silk Road Economic Belt and the Maritime Silk Road of the XXI century (the development strategy initiative known as "One Belt, One Road").

Construction of these transport systems will allow Russia to substantially increase its transit capacities, to combine the efforts with a number of countries having a strong potential for economic growth.

Innovation for Agriculture, Food and Environment

1. On counteraction to global climate change: new technologies for utilization of greenhouse gases

The Climate Doctrine of the Russian Federation[38] states that "climate change is one of the most crucial world problems of the XXI century, which goes beyond the scope of scientific problems and constitutes a complex of interdisciplinary problems, encompassing environmental, economic and social aspects of sustainable development of the Russian Federation". The Council of the Federation of the Federal Assembly of the Russian Federation has consistently advocated for intensification of joint efforts of the international

[36] http://www.council.gov.ru/media/files/41d56050809b3f319188.pdf
[37] *Op. cit.*
[38] Approved by Order of the President of the Russian Federation on December 17, 2009, #861-rp.

community to combat global climate change, limiting the harmful effects on the environment[39].

Since 2008, the Council of the Federation in collaboration with the Interparliamentary Assembly of the Commonwealth of Independent States has been holding Nevsky International Ecological Congress[40] – the largest environmental forum in Russia.

VII Nevsky Congress, which took place in May 2015, focused on the strategy of ecological safety. Particular attention was given to the terms of support and implementation of advanced scientific research that would contribute to reduction of industrial impact on the environment. In particular, the final document of the Congress refers to the project *Synthesis* on production of hydrocarbons by utilizing greenhouse gases[41].

Earlier the Council of the Federation has sponsored discussion on the Project in various format: at the meeting of the Scientific Expert Council headed by the Chairperson of the Council of the Federation (April 2012), at the Nevsky Congress, and at the Baikal International Economic Forum (2012).

2. Production of hydrocarbons by utilizing greenhouse gases (project *Synthesis*)

Today the concentration of carbon dioxide (CO_2) in the atmosphere is two times higher than at the beginning of the Industrial revolution. Currently, the world is in search of different means to achieve reduction of greenhouse gases emission, including carbon dioxide capture and its burial underground in deep porous layers, brined, or depleted oil and gas fields. However, in general it requires very expensive technical methods that do not guarantee prevention of the carbon dioxide release from the Earth's surface burials.

Scientists of the Russian Academy of Sciences have developed the technology of recycling of the industrial emissions of carbon dioxide into organic synthesis products (project *Synthesis*) that produces the carbon turnover, similar to the natural one. Carbon dioxide serves as raw material for production of synthetic liquid energy carrier with improved environmental effects (motor fuel, dimethyl ether, high-octane gasoline, high-octane fuel oil, etc.).

Technology in general is unique and is introduced for the first time, patented by the Russian Federation on methods to produce synthesis-gas and organic synthesis products from carbon dioxide and water. Practical technology includes the following main stages:

- Extraction and concentration of carbon dioxide from diluted gaseous industrial emissions (from 7% to 97% CO_2 content) using the renewable amine based absorbents.

[39] Russian senators have been addressing these issues at the PACE Sessions in September 2009 and January 2014, at the 22nd Session of the Asia-Pacific Parliamentary Forum (APPF) in January 2014, at the Second Summit of Global Legislators Organization for a Balanced Environment (GLOBE) in June 2014 and in number of other parliamentary meetings.
[40] http://ecocongress.info
[41] Project *Synthesis* has been introduced by the Scientific Council of the Program for Fundamental Research at the Presidium of the Russian Academy of Sciences.

- Reduction of carbon dioxide and water to produce hydrogen and carbon monoxide, i.e. synthesis-gas in parallel processes of electrolysis of water, chemical and catalytic reduction of carbon dioxide by using hydrogen electrolysis. Thus resulting electrolysis oxygen is utilized in a parallel process of partial oxidation of methane, which produces additional synthesis-gas and the excess (trade) hydrogen.
- Final stage of technology includes organic synthesis processes based on the conversion of synthesis-gas into methanol and oxygen-containing products or based on Fischer-Tropsch synthesis conversion into liquid hydrocarbons and synthetic fuels.

Perspective technology development will be set forward to achieve extraction of carbon dioxide also directly from the earth's atmosphere using a gas-selective membranes.

Currently provided preliminary project of a pilot plant of the carbon dioxide processing[42] with the capacity up to 5,000 tons per year of liquid hydrocarbons and up to 20,000 tons per year of organic synthesis products (intermediates) for further developing the production of clean gasoline and Diesel premium fuel of "Euro-3", "Euro-4" or higher standard, as well as of hydrogen fuel.

[42] Project *Synthesis*. Pre-draft project of creation of experimental-industrial complex of the carbon dioxide processing with the capacity of 5,000 tons of hydrocarbons per year. – M.: ISPS of RAS, 2015. 124 p.

Sweden

Innovation for energy efficiency of buildings

Buildings and the residential sector account for 40 percent of Sweden's energy consumption. Sweden has set the target that all new buildings will be nearly zero-energy buildings in 2020 and an action plan to reach the goal has been developed[43]. Energy efficiency will be needed in the whole sector both in new constructions and renovation as well as the daily operation of buildings. Priorities will not only be given to make buildings more energy-efficient but also to learn more about consumer choices, decisions and lifestyles that affect energy use. One of the biggest challenges identified concerns the existing building stock and to make it more energy efficient. The Swedish Energy Agency highlights the construction and building sector as a strategic priority area for research and innovation in the coming years and allocates 20 million SEK for a new research and innovation program. Additional funds for a larger collaboration program with the industry in the field will also be a priority. A Government assigned evaluation of existing and new low energy buildings showed that even if low energy buildings use less energy in the operational phase, greater investments in climate shells and installations can be difficult to get back in terms of reduced heating costs during the life of the building. However, from an environmental perspective, it is beneficial to build with a higher ambition in terms of energy. In terms of the building's entire life cycle, including operation stage, the climate benefits of building energy-efficient is clear[44].

1. Energy-efficient refurbishment

A large part of the Swedish apartment blocks are built in the years 1965 – 1975. A successful energy-efficient refurbishment of this stock would result in a significant reduction in the total energy consumption of the residential sector. This is a priority for the government who allocates money to property owners to be invested in refurbishment of these buildings to make them more energy efficient and to stimulate innovation. The Government also intends to strengthen the consumer's role for improving energy efficiency through municipal energy and climate advice. A national strategy for energy-efficiency renovation of buildings has been outlined and the strategy include instruments that stimulate cost-effective renovations of buildings. The strategy also identifies barriers to energy efficiency.

2. A smart and energy-efficient city – the development of the Royal Seaport

A new area of Stockholm is developing with smart electricity grids. It will enable an increasing use of energy from solar and wind power and the electricity demand will be

[43] Miljö- och energidepartementet 2012 Vägen till nära-nollenergibyggnader, Skr. 2011/12:131
[44] Report 2015 by the National Board of Housing, Building and Planning and the Swedish Energy Agency *Utvärdering av lågenergibyggnader - en fallstudie*. Ett gemensamt regeringsuppdrag för Boverket och Energimyndigheten, rapport 2015:25

managed in a smarter way. The area will also contribute to knowledge building; Residents will be able to see what kind of energy they're using, how it affects the environment and how much it costs. And, perhaps most important of all, if they will make active green choices, with the help of a smart communication system and smart plugs, thermostats and appliances.

3. Incentives to increase energy efficiency in buildings

An initiative to reduce energy use in buildings was introduced in 2006 through a law requiring building owners to declare energy use and indoor environment for their houses, so called energy declarations[45]. The energy declaration includes, amongst others, information on the heated area of the house, energy use for heating, comfort cooling, domestic hot water and proposals for actions to reduce energy consumption. The energy declaration provides recommendations about cost-effective measures to improve the energy performance of the houses.

Green Leases are established with the purpose of reducing the environmental impact from commercial premises. The leases describe what actions tenant and landlord have agreed on to reduce the environmental impact, energy and indoor environment, materials and waste. The green leases can offer a common incentive to implement energy efficiency measures but case studies show that it can be difficult to change the existing lease structures as changes are associated with transaction costs and agreements involving different parties can split incentives regarding energy efficiency. Furthermore, a short lease length weakens the incentive to conduct major energy investments. In conclusion, separation of ownership and usage may not be optimal from an energy efficiency point of view[46].

4. Large research program in the field of energy-efficient building and living

E2B2 is the largest research programme in Sweden to date in the field of energy-efficient building and living. The aim is to contribute to enhanced energy efficiency in the built environment through research, development, innovation and demonstration. It is a broad programme that includes research on buildings across their entire life cycle – from planning, production, renovation and redevelopment to deconstruction and demolition. Research on how human habits, choices and lifestyles can impact energy use is also included in the programme[47].

Innovation for transportation and mobility

About 40% of Sweden's greenhouse gas emissions comes from transportation (aviation included). After a peak in emissions around 2005, emissions have decreased slightly. Road

[45] Ministry of Sustainable Development 2006 Energy declarations of buildings, Government Bill 2005/06:145
[46] Bonde M, 2012. Difficulties in changing existing leases – one explanation of the "energy paradox"? Journal of Corporate Real Estate
[47] http://www.e2b2.se/english#sthash.XfhcpgQT.dpuf

transportation accounts for the greatest share of the transport sector's greenhouse gas emissions. Emissions increased from 1990 to 2005 before stagnating, and have since then been decreasing somewhat as a result of an increased share of renewable fuels, higher energy efficiency and reduced fuel consumption in combination with the economic downturn in 2008-2009.

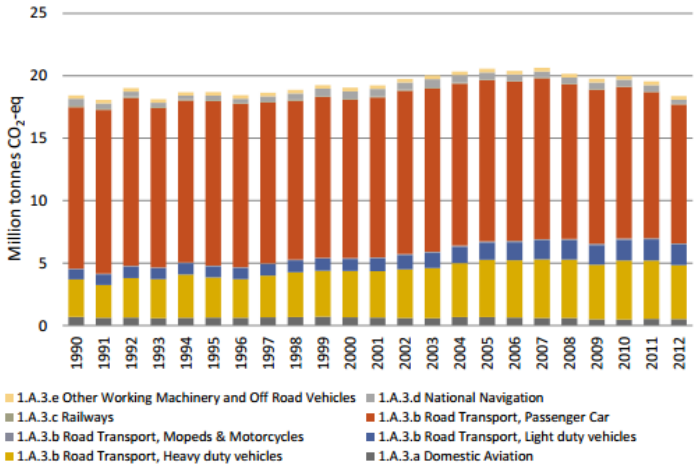


Figure 2.16. Emissions of CO2 eq. from the transport sector, total and per subsector

1. Government's initiatives to reduce the environmental impact of transport sector

The carbon tax has since the early 1990s been central to reduce carbon emissions in Sweden. Other instruments, such as technology procurement, information, differentiated vehicle taxes and investment grants, has also contributed to reduced greenhouse gas emissions. The current Swedish climate strategy puts emphasis on general financial instruments such as carbon tax and emissions trading. In the transport sector, the regulation of carbon dioxide emissions from new cars has contributed to decreasing carbon dioxide emissions in Sweden[48]. The present Government has appointed a researcher to submit a proposal for a so-called bonus-malus system for new light vehicles where environmentally friendly vehicles with relatively low carbon emissions could be rewarded with a bonus when purchased and vehicles with relatively high emissions of carbon dioxide obtain higher taxes[49].

2. Strategic innovation programs in the transport sector

Infrasweden2030 is a new strategic innovation program with the aim to create new ideas and innovations but also a plan how these will be implemented in society. It is not just about the technical aspects, but also social and institutional. A holistic approach will be applied on how different technologies interact and how people use the technology. It will bring together the latest technology from material sciences, automotive technology, information and communication with road and rail technology, standardization, business and game simulation for creating a strategy for innovation. **Automated Transport Systems**, is a strategic program

[48] Miljödepartementet 2014 Sveriges sjätte nationalrapport om klimatförändringar, Ds 2014:11
[49] Finansdepartementet 2015 Ett bonus–malus-system för lätta fordon, Dir. 2015:59

with the aim to investigate the driver's role in the transport system and how the driver can be assisted or replaced by advanced ICT systems that will operate in both the vehicle movements, and the entire infrastructure[50].

Innovation to feed the world with minimal greenhouse gas emissions

Agriculture's greenhouse gas emissions (GHGE) in Sweden are equivalent to approximately 10 million tonnes of carbon dioxide every year. The major part of emissions consists of carbon dioxide from plant cultivation and animal husbandry, and is primarily nitrous oxide from fertilizers and manure and methane from enteric fermentation and manure management. These emissions have fallen by 16 percent since 1990. Swedish agricultural production also indirectly causes GHGE in other countries through the use of imported mineral fertilizer and imported fodder. The Swedish Board of Agriculture has mapped how climate may affect agriculture within a 25 year period. The climate-change scenarios indicate an increasing production potential at northern latitudes, with positive opportunities for Swedish agricultural production, but also indicate increasing risks for, e.g., new plant and animal pests and diseases, and extreme weather events such as heat waves, flooding, and draught.

1. Future agriculture – an interdisciplinary research initiative

Future Agriculture - Livestock, Crops and Land Use is a multidisciplinary research platform initiated by SLU (Swedish University of Agricultural Sciences) researchers together with industry, interest groups and government agencies. The work focuses on Sweden and the Nordic countries, but has also a global perspective. Within the programme, researchers together with the agricultural sector, governmental agencies, and nongovernmental organisations develop research on sustainable use of natural resources, with an emphasis on agricultural production and land use. Six overarching challenges for agricultural research emerging from five future scenarios have been identified: Reduction of the environmental impact of agriculture and mitigation of climate change; Responses to societal values and contribution to policies; Adaptation of agriculture to a changing climate; Management of present and potential risks; Agriculture and rural development; Resolution of conflicting goals of agriculture and land use.

2. Improved efficiency and recycling of nutrients – crucial aspects

When it comes to reduction of the environmental impact of agriculture, improved efficiency is a key tool. High-productivity systems involving minimal waste of energy and materials will be needed. The recycling of nutrients and other materials within the farm, as well as between urban and rural areas, is also a central issue. An important question concerns the degree to

[50] VINNOVA, Sweden's innovation agency

which efficiency can be improved and impacts mitigated by integrated production systems (e.g. crops and livestock, or crops and trees) at farm, landscape or regional level, taking transport needs into account. The potentials and limitations of using new technology should be explored and evaluated for whole production systems. This requires an advanced understanding of agriculture as an ecological system, and an appreciation of the way technology can be used to reinforce ecological processes[51].

Citizens' involvement in the use of smart technologies

1. Smart sustainable cities – ICT solutions need to be carefully investigated

Several studies have highlighted how ICT can be used to achieve cities' climate targets by lowering energy use and greenhouse gas (GHG) emissions from different sectors such as power, transportation, agriculture, building, manufacturing and consumer and services. A recent study focusing on a consumption-based lifecycle perspective, concluded that "hotspots" where household functions with a high energy use and opportunities for ICT solutions overlap, are the areas with greatest potential for energy reductions. ICT solutions are enabling technologies integrated in large socio-technical systems where factors other than merely technical potentials play a role. This means that without careful implementation in combination with other measures, ICT solutions might result in increased energy use instead of a reduction, either directly or in other parts of the energy system or society, often called the rebound effects. A Swedish study shows that a mismatch between a city's climate targets and the opportunities presented by ICT solutions can be found. The climate targets of the City of Stockholm only cover 50 to 60% of the total energy use, according to consumption-based calculations. Such a target not only implies that there is no monitoring of a large proportion of energy use, but also risks resulting in a whole range of measures being overlooked. In order to turn the potentials into real savings, cities need to explore the opportunities thoroughly and investigate how they can best support the implementation of different ICT solutions[52].

2. Together with residents – new innovative solutions are developed

An example of citizens' involvement in the use of smart technology can be found in the West Harbour of Malmö in Sweden. Seven smartly designed rental apartments, owned and managed by the energy company E.ON, are used to demonstrate new ways to generate and use energy through interaction with its customers in the houses. This part of the city is powered by solar energy, wind, water and organic waste. The residents produce their own energy, control energy use and test the energy solutions that are most effective, without

[51] Bengtsson et al., 2010 Future Agriculture– Livestock, Crops and Land Use, A Strategic Programme for Research, Swedish University of Agricultural Sciences (SLU)

[52] Kramer et al. 2014 Smart sustainable cities - Exploring ICT solutions for reduced energy use in cities. *Environmental Modelling & Software*

sacrificing comfort. In addition, most of the tenants have access to electricity or biogas, so that solutions for sustainable transportation can be evaluated. The plan is to implement smart solutions to other areas based on the experience from these houses. However, both organisational and legislative barriers have been identified after an evaluation with the energy company, residents and other institutions involved. The organisational barriers are related to the complexity of the business model and the limitations of some companies to cooperate in a holistic energy system model. Legislative barriers are related to the limitations to make a business of selling locally produced renewable energy to the grid[53].

[53] City of Malmö 2013 e-harbours WP 3.7 Application of Smart Energy Networks Organisational and Legislative Analysis Summary results of showcase at City of Malmö

Switzerland

Swiss climate policy

Switzerland pursues an active policy on reducing greenhouse gases and is contributing to the international goal of limiting global warming to two degrees. The CO_2 Act, the heart of the Swiss climate policy, intends to reduce Switzerland's domestic emissions by at least 20% in comparison to their 1990 level by 2020. The Act primarily concerns fossil thermal and motor fuels, but also includes other important greenhouse gases in addition to CO_2. It also assigns to the federal government the role of coordinating climate change adaptation activities (Federal Office for the Environment FOEN, 2015a).

In 2013, the greenhouse gases released into the atmosphere within Switzerland amounted to 52.6 million tons of CO_2 equivalent, this results in a per capita release of 6.5 t (FOEN, 2015b). With 31%, the transport sector accounts for the larges proportion of Swiss greenhouse gases emissions. They have risen by 10% since 1990 and road traffic is the largest source with 99% of transport emissions (FOEN, 2015c). Given the large contribution from this sector, this paper focuses on the domain of transportation and mobility. It describes two TA-SWISS studies examining the potential and challenges of 2nd generation biofuel technology and electric mobility.

Innovation for transportation and mobility: 2nd generation biofuels

Biofuels made from renewable resources have come under heavy criticism. Energy crops stand in direct competition with food production or biodiversity conservation, and the environmental impacts of biofuels production are often greater than those of fossil fuels. New hope is being placed on the 2nd generation of biofuel technology, where not only oils, sugar and starch but also ligno-cellulosic compounds are transformed into fuels. This leads to a higher conversion efficiency and facilitates the use of alternative feedstocks like wood, grass or biowaste, which serve as more sustainable feedstocks.

The TA-SWISS study shows on the value chain level that the sustainability of 2nd generation biofuels depends mainly on the choice of feedstock. The use of waste feedstocks like manure, biowaste or residual wood usually results in a high sustainability potential and large greenhouse gas savings. However, if a 2nd generation feedstock has to be cultivated by agriculture or forestry, as it is the case for grassland or short-rotation wood, land consumption will be substantial for relevant volumes of fuel. This increases land use pressure on natural areas, while biodiversity is generally threatened.

Although sustainable production of biofuels is generally possible, the large-scale production of 2nd generation biofuels is restricted either by limited land availability, limited waste feedstocks or – in the case of fuels from algae – high costs and energy consumption.

As all biofuel and electric mobility pathways considered are not yet economically competitive, policy regulations will have a major influence on the success of 2nd generation biofuels. Of primary importance is the increase of the tank-to-wheel efficiency of internal-combustion engines. A reduction in average fleet consumption from currently 7.9 l/100km to 4l/100km in the year 2030 would double the potential of sustainable bio-based mobility in Switzerland to 15%, while sustainability would also be increased.

In summary, 2nd generation biofuels allow a more sustainable mobility than both fossil and 1st generation biofuels based on agriculture. Due to the limited availability of both waste feedstocks and cultivation area, however, sustainable bioenergy-based mobility is restricted to clearly less than 8% of individual mobility in Switzerland, if constant mobility and fleet efficiency is assumed. Nevertheless, 2nd generation biofuels may play a relevant complementary part in supplying our future mobility, in particular for long distance transport and aviation where electric mobility is less suitable.

Five proposals for exploiting the potential of biofuels[2] :

- Improvements in vehicle efficiency and the sustainable use of first generation biofuels should be promoted in parallel – likewise the use of second generation biofuels combined with electrical mobility
- Initiatives must be launched to integrate all of the relevant actors into sustainable resource management at national and international level.
- The main focus must be the supply of sustainable raw materials, and therefore to promote the use of waste material and wood, as well as the cultivation of crops on areas of land that were previously of relatively little interest to the farming industry.
- Broadly supported and accepted methods must be developed to record and prevent undesirable and indirect side effects of biofuels.
- The perspective for the assessment of biofuels must move away from one-sided emphasis on the CO_2 balance and increasingly include social and ecological aspects as well.

Innovation for transportation and mobility: Electric mobility[3]

Electric cars are seen as the great hope for a sustainable or at least less polluting mode of transport. Generally speaking, electric cars increase the energy efficiency of travel and reduce dependency on conventional fuels such as petrol and diesel. Thanks to its energy mix, of which a large part comes from hydroelectric power, Switzerland has the right conditions to generate environmentally friendly energy for electric vehicles. Furthermore, the planned

major expansion of renewable energy production may be supported by electric vehicles as a form of local energy storage.

However, in order to reap the ecological benefits of alternative fuels, many conditions need to be met. The benchmark against which electric cars are measured is becoming even more rigorous as conventional combustion engine vehicles are continually technically refined to make them more efficient and ensure lower CO2 emissions. By 2035, a compact car which today uses on average 7.5 l/100km could be using only 4.8 l/100km; this corresponds to a reduction of more than one third. The same compact car which runs on electricity could cut its energy use from 24 kWh to 16 kWh per 100 kilometres by 2035 through improvements in auxiliary systems such as heating and battery conditioning. This corresponds to a reduction of around 30% in CO2 emissions.

Due to environmental pollution during the manufacture of the car, the life cycle assessment of electric cars is not substantially better than that of conventional vehicles: If the entire life cycle is taken into consideration, 90% of greenhouse gas emissions from battery-powered vehicles are produced during manufacture. This compares with 25% for mid-sized cars with combustion engines today, increasing to 40% over the longer term.

During operation, environmental pollution depends on how much fuel the vehicle consumes, or in the case of electric cars, the electricity mix. In comparison with other countries, Switzerland has one of the lowest CO2 producing electricity mixes, based on hydroelectric and nuclear power. Operating an electric car powered by Swiss electricity therefore produces 70% fewer greenhouse gas emissions than a comparable combustion engine vehicle. By contrast, if the electric car is charged using the average EU electricity mix, of which 52% comes from fossil fuels, the CO2 reduction in comparison with a conventional car is reduced to 20%.

The authors estimate that in 2025, on average one in ten new cars will run on electricity, and in 2035 every second new car will be an electric car. According to this, the greenhouse gas emissions from transport are expected to decrease by 10% until 2020 compared with today, despite a calculated 24% increase in mobility. For 2035, 20-30% reduction in greenhouse gases is predicted.

The more actively energy policy measures promote energy efficiency for new cars, the more likely it is that electric mobility will increase. Electric cars have high energy efficiency and small and mid-sized cars in particular are well suited to running on electricity – thanks to advances in battery technology, which will mean increasingly fewer compromises in future. Accordingly, targeted drive-specific support for electric cars does not seem to be necessary.

In future, the energy efficiency of road vehicles will improve more rapidly than the rate of total mobility. This will mean not only a reduction in CO2 emissions, but also in income from fuel taxes. Electricity for electric cars is not taxed any higher than «normal» electricity. The higher the rate of electric mobility, the greater the pressure to switch to a taxation system based on kilometres travelled will become. The TA-SWISS study recommends also basing this kind of distance travelled-based taxation models on primary energy efficiency; this would avoid the risk of such a system change slowing the market penetration of electric cars. In

order to prevent negative feedback effects, an increase in the general cost of mobility is needed to ensure that more environmentally friendly and less expensive vehicles do not result in an increase in the general traffic.

The most important recommendations for a sustainable use of electric mobility[4] :

- Introducing mobility pricing models in order to offset the dwindling income from fuel duties.
- Duties relating to driving performance should be structured in such a way that they foster efficient vehicles and the combined usage of public and private modes of transport.
- Efficient vehicles should also be given preferential treatment when granting approval for passenger cars. This should take into account not only the vehicle's energy consumption during its operational lifetime, but should also assess its environmental impact over its lifecycle as a whole.
- In order to prevent negative feedback effects, an increase in the general cost of mobility is needed to ensure that more environmentally friendly and less expensive vehicles do not result in an increase in general traffic.
- Design and recycling guidelines need to be drawn up so that the materials used can be recycled and the dependency on primary raw materials can be reduced.

Conclusion

The two TA-SWISS studies show that both biofuels and electric mobility could help to limit harmful CO2 emissions and to reduce Switzerland's dependency on fossil fuels. For both technologies, however, the respective energy source has to be taken into account: Biofuel is only sustainable if it is produced from waste materials; while electric mobility can only be considered environmentally friendly if the batteries are charged with electricity from renewable or low CO2 energy sources.

Electric mobility overall seems to have a higher potential than 2nd generation biofuels. Nevertheless, 2nd generation biofuels may play an subsidiary role, in particular for long distance transport and aviation. Therefore, the two technologies should be regarded as complementary and ways must be found to promote them both simultaneously, together with improved vehicle efficiency.

United Kingdom

Innovation for energy efficiency of buildings

In 2012, energy usage in UK buildings accounted for approximately 37% of UK carbon emissions, 24% from residential buildings and 13% from non-residential buildings.[54] A series of UK public sector organisations estimate that energy efficiency innovations have the potential to reduce cumulative emissions by up to 29 million tonnes of CO_2 ($MtCO_2$) by 2020 and up to 159 $MtCO_2$ by 2050[55,56] and help the UK to achieve its EU Energy Efficiency Directive target of a 20% reduction on projected energy consumption by 2020.[57] Current UK innovations in building energy efficiency can be split into three main areas: construction, refurbishment and development of new materials and components.

1. Construction

Improved methods for constructing new buildings can lead to better energy efficiency than that achieved by previous approaches.

Innovations for new builds aim to lower carbon emissions from the build process and reduce the cost of constructing low carbon buildings. Such innovations include:

- The production and use of more sustainable materials for use in building frames, such as lightweight timber[58] or composite materials partly made up of crop materials (e.g. straw and hemp) which have negative embodied carbon.[59]
- The development of transportable factories for the production of whole structures, such as walls and beams. These factories allow the structures to be built close to the construction site, reducing the carbon footprint of transporting them. They also reduce the carbon emissions of construction projects by increasing the speed of completion by up to 30%[60] and could enable the use of robotics in construction, further improving efficiency.[61]

[54] Committee on Climate Change, 2013. *Meeting Carbon Budgets: 2013 Progress Report to Parliament - Chapter 3: Progress reducing emissions from buildings*
[55] Technology Innovation Needs Assessment, 2012 *Domestic Buildings Summary Report*
[56] Technology Innovation Needs Assessment, 2012 *Non-domestic Buildings Summary Report*
[57] European Parliament, 2012. *Council Directive 2012/27/EU of 25/10/2012 on energy efficiency.*
[58] Innovate UK, *Innovative thinking to help deliver low carbon buildings* [Online] Available: https://interact.innovateuk.org/zh/press-release-display-page/-/asset_publisher/u5igfmj8gOAf/content/innovative-thinking-to-help-deliver-low-carbon-buildings [Accessed 25 August 2015]
[59] University of Bath Department of Architecture and Civil Engineering. *Low-carbon materials* [Online] Available: http://www.bath.ac.uk/ace/research/cicm/low-carbon-materials/ [Accessed 3 September 2015]
[60] Skanska, 2013. *Skanska secures government grant to trial new construction method* [Online] Available: http://www.skanska.co.uk/news--press/display-news/?nid=zvBcN758 [Accessed 3 September 2015]
[61] Skanska, 2015. *Skanska wins grant to develop construction robots* [Online] Available: http://www.skanska.co.uk/news--press/display-news/?nid=1x1pU3JM [Accessed 3 September 2015]

2. Refurbishment

The energy efficiency of buildings can be improved through refurbishments. Innovate refurbishment techniques developed in the UK include:

- The use of laser technology to measure rooms and fit internal wall insulation. This minimises waste in materials cut, ensures rooms are fully insulated and speeds up refurbishment projects, all of which ultimately reduce GHG emissions.[62, 63]
- Two new energy efficient ventilation and temperature regulations systems. The first enables cool air to circulate around a building without a need for a fan, by incorporating air pipes and water coils into beams.[64] The second also allows heated fluids to pass through small tubes in a building's structure to allow both heating and cooling.[65]

3. Materials and components

New materials and components can enable buildings to be more energy efficient. Technologies being trialled include:

- New heat storage materials, known as phase change materials. These store heat from a warm room as they undergo a change of state, generally from solid to liquid and can release heat when a room cools.
- Development of materials that improve the absorption of solar heat. For example, Tata Steel are developing a micro-perforated, ridged steel that is treated to absorb high levels of solar radiation. This steel is attached to buildings, and creates a layer of warm air between the steel and the building wall. This warm air is then either pumped directly into the building.[66]
- Recovery systems to re-use water (and heat from water).[67]

Innovation for transportation and mobilities

In 2013, transport was responsible for the emission of the equivalent of 116.8 million tonnes of CO_2 in the UK, over 20% of the country's total emissions.[68] To meet its greenhouse gas emission (GHG) reduction targets, UK Government and industry are exploring a number of

[62] Technology Strategy Board, 2013 *Retrofit Revealed: The Retrofit for the Future projects – data analysis reports*
[63] Sustainable Homes, 2014. *Oxford whole house retrofit reduces CO2 by over 80%* [Online] Available; http://www.sustainablehomes.co.uk/blog/bid/206447/Oxford-whole-house-retrofit-reduces-CO2-by-over-80 [Accessed 3 September 2015]
[64] ECA Energy Technology list, 2015. *Active chilled beams*
[65] University of Reading School of Construction management and Engineering. Radiant heating and cooling system using capillary tubes. [Online] Available: http://www.reading.ac.uk/CME/research/cme-Radiant-heatingand-cooling-system-using-capillary-tubes.aspx [Accessed 3 September 2015]
[66] TATA Steel, *Sustainable Building Envelope Centre* [Online] Available: http://www.sbec.eu.com/ [Accessed 26 August 2015]
[67] Buildings Research Establishment, *BRE Innovation Parks* [Online] Available: http://ipark.bre.co.uk/index.jsp [Accessed 25 August 2015]
[68] Department of Energy and Climate Change, 2015. *2013 UK Greenhouse Gas Emissions, Final Figures*. London: Department of Energy and Climate Change

innovation options. These include alternative fuels, new car usage models, improved cycle safety, better transport planning, single ticketing and new lightweight transport materials.

1. Alternative fuels

There has been some innovation and increased uptake of potentially lower carbon fuel alternatives, including electricity, hydrogen and natural gas**.**

Electrification of transport is increasing. A UK Government grant of up to £5,000[69] has been credited with accelerating the increase in purchases of private electric and electric-hybrid road vehicles, with a total of 35,705 eligible vehicles registered since the grant's introduction in 2011.[70] Currently around 40% of the UK rail network is electrified and there are plans to expand across key routes.[71] Electric bus numbers are also increasing. For example, in London numbers of diesel-electric hybrid buses are planned to rise from 800 in 2014 to 1,700 (20% of the fleet) by 2016.[72] Finally, new wireless charging technology has been deployed in Milton Keynes for a fleet of electric buses, allowing buses to recharge at stops.[73]

Hydrogen vehicle uptake has been slow. Zero emission hydrogen buses are in operation in London (8 buses) and Aberdeen (10 buses)[74] and innovative hydrogen production and bus refuelling stations have been jointly developed by UK gas production and power distribution companies.[75,76]

Natural gas use has been trialled in around 200 heavy goods vehicles (which are unsuited to electrification).[77] The vehicles tend to refuel at the companies' private fuelling stations, as public infrastructure for natural gas vehicles is limited. Using natural gas produces up to 28% lower GHG emissions (up to 65% in the case of bio methane) compared to diesel.[78]

2. Car usage models

In the UK, there has been a rise of business models that use web and app platforms to enable car sharing.[79] This could reduce emissions by encouraging people to combine car rental with

[69] GOV.UK *Plug-in car and van grants*. [Online]. Available: https://www.gov.uk/plug-in-car-van-grants/overview. [Accessed 24 August 2015]
[70] 102 EV Registrations 2010-2015, SMMT http://www.smmt.co.uk/category/news-registration-evs-afvs/
[71] Network Rail, 2013. *Technical Strategy*.
[72] Network rail, *Electrification* [Online]. Available: http://www.networkrail.co.uk/aspx/12273.aspx. [Accessed 20 August 2015]
[73] Transport for London, 2014 *New hybrid bus charging technology trial announced* [Online]. Available: https://tfl.gov.uk/info-for/media/press-releases/2014/august/new-hybrid-bus-charging-technology-trial-announced. [Accessed 20 August 2015]
[74] IEET and ITS-UK, 2014. *Local Authority Guide to Emerging Transport Technology*
[75] Aberdeen Invest Live Visit *Hydrogen Bus Project* [Online]. Available: http://aberdeeninvestlivevisit.co.uk/Invest/Aberdeens-Economy/City-Projects/H2-Aberdeen/Hydrogen-Bus/Hydrogen-Bus-Project.aspx [Accessed 27 August 2015].
[76] Air Products, 2014. *Bringing Hydrogen to London's Streets*
[77] Aberdeen Invest Live Visit *H2 Aberdeen: Who is involved?* [Online]. Available: http://aberdeeninvestlivevisit.co.uk/Invest/Aberdeens-Economy/City-Projects/H2-Aberdeen/Hydrogen-Bus/Hydrogen-Bus-Who-is-involved.aspx [Accessed 02 September 2015]
[78] C. L. Fevre, 2014. *The Prospects for Natural Gas as a Transport Fuel in Europe*. The Oxford Institute for Energy Studies
[79] C. Kluyver, 2014 *Foot on the gas?* National Grid [Online]. Available: http://www.nationalgridconnecting.com/foot-on-the-gas/. [Accessed 20 August 2015].

public transport.[80] Other schemes, such as the E-Car Club, encourage electric car use by taking the up-front cost away from the individual.[81]

3. Cycle Safety

To incentivise cycling in London, cycle safety innovations are being trialled. For example, large vehicles are being fitted with systems to electronically detect cyclists in blind spots.[82]

4. Planning and data

The UK is improving transport planning by collecting larger amounts of data and using more advanced data analytics. Data on aviation is being used to improve air traffic management and integration with other transport services. For public transport data streams such as social media can be used to 'map sentiment' to establish real time needs of transport users and enable dynamic timetabling.[83] These complement the existing use of large volumes of data about road and rail journeys that are used by transport authorities to increase travel efficiency.

5. Single ticketing

Examples include London's Oyster card and acceptance of contactless debit/credit cards, which can be used across different forms of public transport. These are increasingly widespread across the UK. They can encourage use of public transport and also reduce idle times of buses, making journeys more efficient and lowering emissions.[84]

6. Lightweight materials

The UK is aiming to develop expertise in designing and researching lightweight materials that increase vehicle fuel efficiency. Funding has been awarded to a variety of projects, including research into the use of lightweight aluminium matrix composites to reinforce automotive components.[85]

[80] Prakash, A. and Kar-Gupta, S., 2014 *Rise of the car-sharing apps poses threat to auto sector* Reuters [Online] Available: http://uk.reuters.com/article/2014/12/18/uk-autos-apps-idUKKBN0JW1TJ20141218). [Accessed 18 August 2015]

[81] POSTnote 496 Trends in Transport

[82] GOV.UK, 2015 *Crowdfunding investors celebrate successful exit from E-Car Club* [Online]. Available: https://www.gov.uk/government/news/crowdfunding-investors-celebrate-successful-exit-from-e-car-club. [Accessed 20 August 2015]

[83] Transport Research Laboratory, *Cycle Detection using Intelligent Transport Systems* [Online] http://www.trl.co.uk/solutions/sustainability/cycling/safer-cycling-innovations/cycle-detection-using-intelligent-transport-systems/ [Accessed 27 August 2015]

[84] Transport Systems Catapult, 2013. *Transport Systems Catapult: Five-Year Delivery Plan to March 2018 (abridged)*

[85] School of Engineering - University of Portsmouth, 2009 *How Oyster Cards reduce the environmental impact of the London bus nework* [Online]. Available: http://mosaic.cnfolio.com/B101CW2008B180. [Accessed 24 August 2015].

Innovation to feed the world with minimal greenhouse gas emissions

Agriculture contributes 9% of the UK's greenhouse-gas (GHG) emissions burden and 10-12% globally. Although there is a long-term declining trend from UK agriculture, the sector in England has a carbon budget reduction objective of 3 million tonnes of carbon dioxide equivalent ($MtCO_2e$) per annum set for the period 2018-2022 in line with the requirements of the Climate Change Act, an 11% reduction on 2008 emissions levels. Similar reductions are required for Scotland (1.3), Wales (0.6) and Northern Ireland (0.276). Nitrous oxide contributes more to global warming than any other gas emitted from agriculture (UK emissions - 30.3 $MtCO_2e$) with soils are the main source of emissions (90%). It arises from microbial activity following application of man-made nitrogen fertilisers, farmyard manures and slurries and re-deposition of airborne nitrogen pollution to land. The main sources of agricultural CO_2 emissions are on-farm energy use and crop storage (UK emissions - 6.6 $MtCO_2e$). The majority of methane emitted is from fermentation by livestock digestive systems and the anaerobic break-down of stored manures and slurries (UK emissions - 22.3 $MtCO_2e$).[86]

However, along with any mitigation requirements agricultural systems will also need to adapt radically to meet the rising global demand for food,[87] decreasing water availability[88] and increasing pest resistance to available agrochemicals, such as herbicides.[89] The UK Agri-Tech Strategy was launched in 2013 to encourage innovation in agriculture to address these challenges. Combining UK research strengths in areas such as soil and crop science, robotics, and ICT could lead to products and services for export. Emerging key approaches to address GHG emissions include precision farming techniques, controlled-environment farming, alternative animal feeds and edible insects:

- Precision farming uses technology, agricultural engineering and data to help farmers apply treatments efficiently through the 4Rs: "right intervention, right time, right place, and right amount". For example, farmers can target fertiliser where it is most needed, rather apply a uniform rate to the whole field, potentially reducing costs and overall use. In 2012, 22% of English farms used Global Positioning Systems and 20% used soil mapping to optimise treatments. More efficient use of inputs can contribute to sustainable intensification of food production – optimising yields while reducing environmental impacts, including GHG emissions. However, high initial capital costs are likely to limit adaption to larger farms.[90]

[86] Innovate UK, 2012 *Competition winners announced for £56 million investment into low carbon vehicles* [Online] Available: https://connect.innovateuk.org/web/energy-efficiency/article-view/-/blogs/competition-winners-announced-for-%C2%A356million-investment-into-low-carbon-vehicles?_33_redirect=https%3A%2F%2Fconnect.innovateuk.org%2Fweb%2Fenergy-efficiency%2Farticle-view%3Fp_p_id%3D33%26p_p_lifecycle%3D0%26p_p_state%3Dnormal%26p_p_mode%3Dview%26p_p_col_id%3Dcolumn-1%26p_p_col_count%3D1%26p_r_p_564233524_tag%3Dlightweight%2Bsustainable%2Bbodyshells [Accessed 26 August 2015]
[87] POSTnote 486, Emissions from Crops
[88] POSTnote 499, Novel Food Production
[89] POSTnote 385, Water in Production and Products
[90] POSTnote 501 Herbicide Resistance

- Technological advances in lighting, hydroponics and climate control are enabling farming to move into controlled indoor environments. Controlled environment farming is an extension of greenhouse-based horticulture, which allows total control of the growth environment, with crops grown all year round and protected from extreme weather events, such as storms, and from pest attacks. Controlled-environment farming can increase the yield of some crops and decrease resource use, but is not suited to staple crops like maize and wheat.[91]

- Sustainable sources of animal feed such as insects could reduce the dependence on feed soy from tropical rain forest areas. Insect meal is rich in protein and nutrients, and industrial rearing of some species in factories could be raised on manure and organic food waste; although manure cannot legally be used as feed under current EU regulations.[92] The UK Food and Environment Research Agency (FERA) is co-ordinating an international research project – ProteINSECT – investigating insect rearing for feed production, with large-scale production being commercialised by companies such as Entomotech in Spain.[93]

- Vegetable protein from nuts, soy, pea, chickpea and lupin could provide an alternative to livestock protein,[94] but more novel protein sources may also be needed. At least 1,900 insect species are known to be safe to eat for humans,[95] and although the nutritional content varies between species, the protein and nutrient profile of insects broadly resembles that of meat.**Erreur ! Signet non défini.** Insect rearing produces less greenhouse gas and ammonia emissions per kg of protein when compared to pig and cattle production, but there are likely to be issues around public acceptance.[96]

Citizens' involvement in the use of smart technologies

Smart technologies enable accurate, detailed and real time information to be relayed to a user. This can help to facilitate changes in behavior that lead to lower greenhouse gas emissions.[97] Key smart technologies that have been introduced to the UK include smart meters of energy and water and those designed to facilitate more efficient travel.

1. Smart Metering

Smart metering improves the recording of energy and water usage and communication of this information to consumers and suppliers. Better communication to consumers can help them

[91] POSTnote 505 Precision Farming
[92] POSTnote 499 Novel Food Production
[93] European Union, 2009. Regulation (EC) No 1069/2009 of the European Parliament and of the Council. *Official Journal of the European Union*, L 300: 1-33.
[94] POSTnote 499 Novel Food Production
[95] Day, L, 2013. *Trends in Food Science and Technology* 32: 25-42.
[96] Van Huis, A, 2013. *Annual review of Entomology*, 58:563-83.
[97] POSTnote 499 Novel Food Production

identify and reduce wasteful usage, as well as prompt the purchase of more efficient devices.[98]

Following the 2008 and 2011 Energy Acts, UK energy suppliers are obliged to take all reasonable steps to install electricity and gas smart meters and in home displays (IHDs) in all domestic and small non-domestic properties by 2020. The aim is to achieve close to 100% coverage, with an estimated 53 million smart meters to be installed, ensuring the UK is compliant with the 2012 EU Energy Efficiency Directive. In addition to financial savings to consumers, suppliers and operators, UK trials of smart meters suggest that they may reduce electricity and gas consumption by between 3-19% and 3-5% respectively.[99] The smart meter roll-out is also expected to provide an estimated nationwide benefit of £1.3 billion from reduced CO_2 emissions and improved air quality.[100]

Reduction in water usage contributes to energy savings (and thus reduced GHG emissions) by reducing the amount of energy used to distribute, treat and heat water. Research suggests that smart water meters with IHDs can reduce water usage by 3-4% over 18 months. However, most UK households are charged at a fixed annual rate for water and are not fitted with a meter. Water meters will be fitted to a property if customers request it, if the property is new or if the property is in an area the water company designates as 'water stressed'. A nationwide roll-out is unlikely due to technical and logistical obstacles, for example water meters are often outdoors and underground, so it would be difficult to transmit information from them in to a house.[101]

Smart technologies can also be used on larger non-domestic properties (such as offices) to energy savings by other means. For example, apps can encourage users to reduce their energy use through a points system with prizes for energy saving behaviour. The ability to compare data with other building users and forums for discussion with building users and maintenance staff. In one project these methods facilitated a 20% saving in gas use when trialled and was launched publically in 2012.[102]

2. Smart transport internet applications

These applications gather real-time data on transport timetables, congestion, delays and the location of the application user to allow users to plan the quickest (or another preferred) route to their destination. Informing individual transport decisions enables improved balance between transport supply and demand, reducing the need for new infrastructure, services or vehicles,[103] which in turn reduces GHG emissions from transport. One such app, CityMapper was developed and launched in London in 2012. Estimates suggest that CityMapper is

[98] POSTnote 417 Energy Use and Behaviour Change
[99] POSTnote 417 Smart Metering of Energy and Water
[100] POSTnote 417 Smart Metering of Energy and Water
[101] National Audit Office, 2014. *Update on preparations for Smart Metering*
[102] POSTnote 417 Smart Metering of Energy and Water
[103] The University of Warwick, EMPOWER: Empowering empathic energy efficiency design [Online] http://www2.warwick.ac.uk/fac/sci/wmg/research/experiential_engineering/projects/pastprojects/empower/ [Accessed 26 August 2015]

installed on approximately half the iPhones in London[104] and the app has been rolled out in a further 28 cities worldwide so far.[105]

[104] Catapult: Future Cities, 2014. *How can the UK innovate for the world's cities?*
[105] CityMapper, 2015. *CityMapper* [Online]. Available: www.citymapper.com. [Accessed 25 August 2015]

United States

Innovation for energy efficiency of buildings

In 2014, U.S. buildings consumed 41 percent of the nation's energy and emitted about 39 percent of its carbon dioxide. Green building practices can create more resource-efficient buildings, lower operating costs, reduce pollution, and improve indoor air quality. Although there is no generally accepted definition for green building, analysis of various standards, such as the widely-used Leadership in Energy and Environmental Design (LEED) rating system, shows that a green building incorporates one or more of the following six generally recognized elements: (1) *energy conservation or efficiency measures:* to reduce energy consumption in a building or use renewable sources of energy; (2) *indoor environmental quality measures:* to enhance indoor environmental quality through ventilation and use of low pollution-emitting materials; (3) *water conservation or efficiency measures:* to reduce water consumption inside and outside the building; (4) *integrated design principles:* to plan and design using a project team with variety of stakeholders, such as architects, builders, and building engineers; (5) *sustainable siting or location measures:* to locate building so as to minimize impact on the nearby ecosystem; and (6) *measures to reduce the environmental impact of materials:* to reduce the environmental impact of materials, such as using sustainably grown materials and products with high recycled content, among other things.

U.S. federal laws have directed government agencies to foster green building practices in the "nonfederal sector." This accounts for most of the nation's buildings and includes state and local government as well as private sector buildings. There are a large number of federal initiatives across multiple U.S. government agencies designed to promote green building practices in the nonfederal sector. The U.S. government is also taking steps to implement energy efficient building requirements in federal buildings, often by using energy savings performance contracts (ESPC), where private contractors finance the up-front costs of energy improvements. Agencies then repay contractors from the savings, such as those resulting from lower utility bills. Cost and energy savings that contractors reported to agencies for most ESPCs have met or exceeded expectations, but some of these savings may be overstated.

Use of renewable energy is another way for buildings to help ameliorate the effects of greenhouse gases on climate change. State policies requiring the use of renewable energy in electricity production, as well as U.S government funding and tax credits for renewable energy producers, were major factors that resulted in a 30-fold increase in production and a 19-fold increase in consumption of electricity from wind and solar energy in the United States during the years from 2000 to 2013. In particular, solar energy can be used to heat, cool, and power homes and businesses with a variety of technologies that convert sunlight into usable energy. Examples of solar energy technologies include photovoltaics, concentrated solar power, and solar hot water. Solar energy technology advancement activities are financed through both public and private investment. Majority of the initiatives funded by six U.S.

agencies have supported photovoltaic technologies. These government initiatives included multiple technology advancement activities ranging from basic research to commercialization by providing funding to various types of recipients including universities, industry, and federal laboratories and researchers, primarily through grants and contracts.

Additionally, since power plants are the largest major source of greenhouse gas emissions in the United States, President Obama and the Environmental Protection Agency have recently established the Clean Power Plan, which sets standards for existing power plants to reduce carbon dioxide emissions by 32 percent from 2005 levels by 2030. If successful, this plan would lead to 30 percent more renewable energy generation in the United States.

Innovation for transportation and mobilities

Transportation accounts for 71% of U.S. petroleum use and 33% of the nation's carbon emissions, and predicted surges in population growth will trigger ever greater demand for fuel to power vehicles. Energy-efficient transportation strategies could reduce both oil consumption and greenhouse gas emissions. Using less motorized mobility, increasing vehicle efficiency, and using fuels that are less intensive in petroleum and carbon can reduce GHGs and petroleum use while still meeting transportation needs. In the United States, two key regulations—the fuel economy and greenhouse gas vehicle emission standards, as well as the Renewable Fuel Standard—have contributed to declining petroleum-based fuel consumption.

Another law requires that, by 2022, U.S. transportation fuels contain 36 billion gallons of renewable fuels, of which 15 billion gallons of renewable fuel may come from corn ethanol but the remainder must come from advanced biofuels, such as ethanol made from cellulosic sources like switchgrass, and forest and agricultural residues such as sawdust and sugarcane. There are several key challenges in meeting these requirements, including the lack of sufficient cellulosic biofuel commercially available to meet the mandate. Nevertheless, biofuels from sustainably-harvested biomass could supply significant shares of the markets for jet fuel, gasoline, and diesel if the U.S. government's biofuels technology goals are met, these markets are mature, and projected market conditions exist. The U.S. government also supports the development and use of alternative jet fuels from non-petroleum feedstocks, including renewable biomass (such as crop and tree residues, algae, or separated municipal solid waste). Achieving price competitiveness for alternative jet fuels is the overarching challenge to developing a viable market. As such, no alternative jet fuels are currently commercially available at prices competitive with conventional jet fuels.

An option for lowering greenhouse gas emissions from transportation is the adoption of electricity- and hydrogen-powered vehicles. However increased adoption of such vehicles depends on simultaneous and widespread development of infrastructure for hydrogen production, distribution, and fueling, as well as for electric vehicle charging. While developing this retail fueling infrastructure would be costlier than maintaining current infrastructure, infrastructure costs are only a small portion of total fuel costs. Strong policies and incentives may be needed to overcome consumer cost and range concerns, address

automaker production and deployment issues, and encourage energy suppliers to rapidly build infrastructure. Recognizing that uncertain consumer acceptance and fueling infrastructure development may create significant investor risks, the full transition from conventional vehicles could easily take 35-50 years.

Innovation to feed the world with minimal greenhouse gas emissions

The agricultural sector is a major part of the U.S. economy and it emits about 6 percent of total U.S. greenhouse gas emissions, but U.S. lands (mostly forestlands) sequester enough carbon to offset 12 percent of total greenhouse gas emissions. Sources of these emissions include fuel consumption, fertilizer that can emit nitrous oxide, and methane emissions from livestock. Farmers can take certain mitigation actions to reduce greenhouse gas emissions and sequester carbon. For example, farmers can use energy-efficient buildings, vehicles, or farm equipment that runs on renewable energy, rather than fossil fuels. In addition, farmers can implement mitigation measures, such as no-till farming and precision agriculture. Adoption of precision agriculture can reduce environmental harm from the overapplication of inputs such as fertilizers and pesticides, which can reduce nitrous oxide emissions. Through the digestive process, livestock emit a considerable amount of methane, a greenhouse gas; reducing these emissions is another mitigation strategy. Work is being done to alter the diet of cattle and to improve manure management practices in an effort to reduce methane emissions.

Agriculture in the United States has been and will continue to be affected by climate change, which will likely cause an increase in temperature, rainfall intensity, and extreme events in some areas, and extreme climate conditions, such as sustained droughts and heat waves. Table 1 summarizes the potential impact of climate change on agriculture in the United States.

Category	Projected Changes	Examples of impacts on agriculture
Temperature	Increase in average U.S. temperatures of between 1.6°C and 5.5°C by end of the century.	Crop yield losses; Longer growing season; Increased irrigation needs in some areas; Increase in animal stress
Carbon dioxide	Increased levels of atmospheric carbon dioxide.	Increase in plant growth for some species
Water	Change in the timing, intensity, and amount of rain/snow mix; Increase in heavy rain as well as drought conditions.	Increase in water use due to higher temperatures; Less growth and lower yields; Challenges in getting water to crops at the right time; Increase in flooding events and erosion
Extreme conditions	Increase in droughts and more extreme precipitation events.	Increase in soil erosion; Altered water availability; Loss of organic matter in soil

Weeds, insects, and disease	Increase in weeds, insect population levels, and disease; Change in the geographic distribution of pests.	Change in yields and quality of crops. Potentially increased herbicide and pesticide use

Table 1: Projected Impacts of Climate Change on Agriculture in the United States

The U.S. government's climate change priorities for agriculture include, among other things, providing better information to farmers on future climate conditions. These priorities generally align with national priorities, which include promoting actions that reduce greenhouse gas emissions, advancing climate science, developing tools for decision makers, and developing better projections of future climate conditions. The government is engaged in research efforts aimed at better understanding climate change's impacts on agriculture and providing technical assistance to farmers. Through the use of existing conservation and energy programs, the aim is to reduce greenhouse gas emissions and sequester carbon so it is not released, or is actively withdrawn, from the atmosphere.

Citizens' involvement in the use of smart technologies

National surveys of U.S. public opinion have found broad public support for a variety of measures to increase energy efficiency and diversify the energy supply. Based on surveys, about three-quarters of the U.S. public strongly or somewhat support developing more fuel-efficient cars, power plants, and other such technologies; encouraging businesses to reduce their carbon dioxide emissions; and relying more on wind and solar power. About 65 percent of the public strongly or somewhat supports actions to encourage people to reduce carbon dioxide emissions–for example, by driving less or renovating their homes. About 45 percent strongly or somewhat support relying more on nuclear power because it reduces greenhouse gas emissions.

Research shows that citizens are more inclined to take action to combat climate change if they see their actions bringing benefits to themselves and the society; and if they have emotional feelings such as fear and anger at the present reality and future dangers. Their judgments and emotions depend on whether they give priority to moral outcomes. Because of this, messages about the consequences of climate change should be framed in the context of the values that are central to particular audiences. Simply providing information to citizens about the dangers of climate change is not likely, in itself, to stimulate effective action. Before information leads to action, citizens have to recognize personal responsibility for the problem and they must have information about specific actions that they can take to counter climate change.

The U.S. government disseminates such actionable information to citizens through agency websites. For example, one website points out how driving a car, using electricity to light and heat your home, and throwing away garbage all lead to greenhouse gas emissions and how citizens can reduce emissions through simple actions such as changing old appliances and light bulbs with ENERGY STAR products, powering down electronics, using less water, and

recycling. Such energy efficiency measures in homes and buildings could help counter effects of climate change because a large portion of total U.S. energy consumption occurs in homes and buildings. However, people tend to undervalue energy savings because of misperceived energy prices, imperfect information about energy efficiency, and biased reasoning about energy savings. Some options that could counter people's misperceptions would be to reflect the social costs of energy use in the price of energy, provide financial incentives for reduced energy use, improve energy-efficiency standards, and provide better information about energy efficiency. Many of these options are in use nowadays in the United States.

European Union

Taking into account the specific character of STOA, which, unlike other EPTA members, advises the European Parliament (EP) and is not bound to a particular country, this contribution will address issues at a European level. The aim is twofold:

- to describe succinctly at the legislative level of the European Union (EU) the state of play and main challenges in the four headings proposed by the conference organisers, and
- to present the outcomes (identified and assessed policy options) of selected studies, relevant to the various headings, that STOA has recently carried out.

Innovation for energy efficiency of buildings

1. EU legislation: the state of play

Buildings are considered to be one of the main sources of energy consumption at EU level and are, in fact, responsible for a major part of CO_2 emissions in the EU. They would therefore have to be taken duly into account by any European strategy to increase energy efficiency and fight climate change. The EU has adopted a wide range of energy-specific measures, but has also integrated energy efficiency clauses into existing instruments (e.g. applying procurement criteria that take energy efficiency into account). Besides these legislative initiatives, a series of financial instruments have also been adopted at EU level in order to boost the practical implementation of the measures in financial and social terms.

According to the Energy Efficiency Directive (2012/27/EU)[106], EU Member States should:

- proceed with considerable energy-efficient renovation of central government buildings,
- purchase buildings only if their energy efficiency has been ensured, and
- develop long-term strategies for building renovation at national level.

Since 2010, the indicative target of a 20% improvement in energy efficiency[107] is expected to be achieved also through the implementation of the Energy Performance of Buildings Directive (2010/31/EU)[108]. The Directive imposes requirements concerning the need for issuing energy performance certificates when selling or renting buildings in the EU and

[106] Directive 2012/27/EU of the EP and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC *OJ L 315, 14.11.2012, p. 1–56*

[107] Communication from the EC, Europe 2020: A Strategy for Smart, Sustainable and Inclusive Growth *COM(2010)2020*: http://ec.europa.eu/archives/growthandjobs_2009/pdf/complet_en.pdf

[108] Directive 2010/31/EU of the EP and of the Council of 19 May 2010 on the energy performance of buildings *OJ L 153, 18.6.2010, p. 13–35*

introduces inspection schemes or equivalent measures for heating and air conditioning systems. For the first time, an EU legal instrument of this kind sets a specific deadline by which all new buildings should be of nearly zero-energy character (by 31 December 2020, for public buildings by 31 December 2018). The Directive also introduces minimum energy performance requirements for new buildings, major building renovation or replacement of building components. The Member States are asked to introduce financial measures at national level, in order to enhance the energy efficiency of buildings. The European Commission (EC) has recently increased the target for improvement in energy efficiency by 7% by 2030 (so, in total 27%) through the 2014 Energy Efficiency Communication[109].

Although some Member States, among which France and Germany, provide special preferential loans and fiscal reduction of up to 30% of the cost for energy efficiency renovations, so as to achieve the targets of the Directive, the overall implementation of the directive has been deficient. A European Commission progress report from 2013 found that Member States had to make a lot more efforts in favour of nearly zero-energy buildings. According to the same report, the overall rate of increase in building energy efficiency has been limited to 1.4% annually, with 64% of space heaters still being inefficient and 44% of windows still being single-glazed[110].

As main problems are identified a slow transposition process, the financial crisis that has minimised the capacity of certain Member States and parts of the society to benefit from investment in energy efficiency measures and lack of incentives that could strengthen the consumers' capacity to improve the energy performance of building elements and revamp the building renovation process. Among the measures that could strengthen the implementation of the Directive is the introduction of a binding target to boost public building renovation and of criteria in public spending favouring energy efficiency, as well as the deployment of Energy Service Companies (ESCOs) as catalysts for renovation.

Innovation for transportation and mobility

1. EU legislation: the state of play

The Intelligent Transport Systems (ITS) Directive (2010/40/EU)[111] set the basis for the coordinated deployment and use of ITS across Europe through six priority actions:

- the provision of EU-wide multimodal travel information services and (b) real-time traffic information services;

[109] Communication from the EC to the EP and the Council, Energy Efficiency and its contribution to energy security and the 2030 Framework for climate and energy policy *COM(2014) 520 & SWD(2014) 255*
[110] Report from the EC to the EP and the Council, Progress by Member States towards Nearly Zero-Energy Buildings *COM(2013)483*
[111] Directive 2010/40/EU of the European Parliament and of the Council of 7 July 2010 on the framework for the deployment of intelligent transport systems in the field of road transport and for interfaces with other modes of transport *OJ L 207, 6.8.2010, p. 1-13*

- data and procedure for the provision, where possible, of road-safety-related minimum universal traffic information free of charge for users;
- the harmonised provision of an interoperable EU-wide eCall;
- the provision of information and (f) reservation services for safe truck parking places.

The implementation and specification (mostly through implementing acts) of the ITS Directive has proven to be a success in general, especially given the recent adoption of Regulation 2015/758[112] concerning type-approval requirements for the deployment of the eCall in-vehicle system based on the 112 service. Nevertheless, the rapid deployment of new transport-related technologies has pointed to the need for introducing new priorities, beyond what is currently referred to in Annex I of the Directive.

The main challenge has been the adoption of necessary specifications – including functional, technical, organisational or service provisions – to ensure that ITS are deployed and operated in a compatible and continuous manner for those priority areas (real-time traffic and multimodal travel information services), where no EU legislative action has been taken.

2. Relevant STOA studies

With the increasing scarcity of fossil fuels and the more and more alarming impact of greenhouse gas emissions, it is becoming crucial to consider alternatives for the technology and the fuels employed in transport. In addition to making transport more efficient and friendly to the environment, consumer awareness and readiness to change behaviour are imperative in order to move towards a sustainable transport future.

Transport issues are covered by the STOA priority area *'Eco-efficient transport and mobility*'. In recent years, STOA has carried out a number of studies examining the options available for policy action to achieve eco-efficient transport, thus reducing the dependence of Member States on oil imports and helping Europe address climate change.

The main conclusions drawn by the above-mentioned STOA studies are listed below:

- Economic growth will benefit from transport becoming more efficient and respectful of the environment. The STOA study '*Eco-efficient transport futures for Europe*' (2013)[113] (options brief / full study) established that, to optimise eco-efficiency, one has to adopt a broader approach and a systemic perspective. Policy options comprise improvements on the fuel and information technology side, tackling non-technical factors (technology costs, infrastructure issues, lack of policy coordination) and paying attention to end-user concerns, preferences and habits.

[112] Regulation (EU) 2015/758 of the EP and of the Council of 29 April 2015 concerning type-approval requirements for the deployment of the eCall in-vehicle system based on the 112 service and amending Directive 2007/46/EC *OJ L 123, 19.5.2015, p. 77–89*

[113] '*Eco-efficient transport futures for Europe*', EP 2013 (IP/A/STOA/FWC/2008-096/LOT2/C1/SC1/SC9); authors: J. Schippl, M. Edelman, M. Puhe, M. Reichenbach (Institute for Technology Assessment and Systems Analysis (ITAS), Karlsruhe Institute of Technology (KIT))

- Transport systems could change dramatically through the use of new technologies. Realising that an increase in urban transport can have a disastrous impact on the health and the quality of life of the urban population and on the quality of the urban environment, the 2012 study '*Technology options in urban transport*'[114] (options brief / full study) proposed a strategy for facilitating the development and deployment of more efficient transport systems based on: (i) reducing carbon use (clean fuels and propulsion technologies, optimised transport flows); (ii) encouraging users to shift towards more environmentally friendly modes of transport; and (iii) reducing the need to travel through virtual accessibility, making use of technology (e.g. video-conferencing).
- There are various decarbonised alternatives to the present European transport system and, although there is a consensus about the need to move in this direction, the relative performance of the alternatives has to be assessed. In this context, STOA published, in 2014, a study entitled '*Methanol: A future transport fuel based on hydrogen and carbon dioxide?*'[115] (options brief / full study). The study identified as the main challenge to the use of methanol as a fuel the development of efficient processes for capturing CO_2 and converting it to methanol, while preferably avoiding the addition of hydrogen via hydrogenation, as this would result in additional energy consumption.
- Renewable energy systems will increasingly replace fossil fuels in the energy mix of EU Member States. The 2011 STOA study *'Future metal demand from photovoltaic cells and wind turbines'*[116] (study) looked into one kind of potential difficulties that the deployment of renewable energy systems might encounter: the need to ensure an adequate supply of raw materials used in solar panels and wind turbines in the face of an ever increasing demand. It is imperative to prevent bottlenecks in the supply of raw materials, which may delay the transition to a low-carbon economy as part of climate change policy.

Innovation to feed the world with minimal greenhouse gas emissions

1. EU legislation: the state of play

The social and environmental sustainability of biofuels has become a major issue of attention concerning the relationship between food production and climate change. The increasing

[114] '*Technology options in urban transport: Changing paradigms and promising innovation pathways*', EP 2012 (IP/A/STOA/FWC/2008-096/LOT2/C1/SC8); authors: J. Schippl, M. Puhe (ITAS, KIT)
[115] '*Methanol: A future transport fuel based on hydrogen and carbon dioxide?*', EP 2014 (IP/A/STOA/FWC/2008-096/Lot1/C1/SC3); authors: S. Faberi, L. Paolucci ((Institute of Studies for the Integration of Systems (ISIS)) D. Velte, I. Jiménez (Tecnalia)
[116] *'Future metal demand from photovoltaic cells and wind turbines: Investigating the potential risk of disabling a shift to renewable energy systems', EP* 2011 (internal study); author: I. Öhrlund (STOA)

worldwide demand for biofuels and bioliquids, and the incentives for their use provided for by EU law have led the EU to introduce sustainability criteria for biofuels and bioliquids. A pan-European certification system of sustainable biofuels is, however, lacking; instead, EU legislation on biofuels pursues compliance via national or voluntary schemes.

The production of biofuels relates directly to land use change, as the former can displace food production to previously non-agricultural land, such as forests, resulting effectively in an increase in net greenhouse gases. To combat indirect land use change, the amendment of the current EU biofuels legislation (primarily the Renewable Energy Directive[117] and the Fuel Quality Directive[118]) has been proposed, but without success.

Moreover, the Europe 2020 Strategy - A resource-efficient Europe[119] calls for an increase in resource efficiency, to: "… find new ways to reduce inputs, minimise waste, improve management of resource stocks, change consumption patterns, optimise production processes, management and business methods, and improve logistics", without, however, specifying the means or setting binding targets for the achievement of the these objectives.

The Roadmap to a Resource-Efficient Europe[120] follows up on this and emphasises the erosion of Europe's natural resources though increasing global demand, especially in the food sector. The Roadmap calls for "incentives to healthier and more sustainable production and consumption" and for halving food waste in the EU by 2020. At the same time, the Commission undertook to look into ways of limiting food waste through the full supply chain and reducing the impact of food production and consumption on the environment.

The EP 2011/2175(INI) report[121] on "how to avoid food wastage: strategies for a more efficient food chain in the EU" also strongly supports action in this area, calling upon the Commission "to take practical measures towards halving food waste by 2025 and at the same time preventing the generation of bio-waste".

2. Relevant STOA studies

'Technology options for feeding 10 billion people' (2013)

Ideas about the future of the global food system are remarkably diverse. Increasing agricultural productivity will not suffice by itself to tackle the challenges lying ahead. EU Member States can draw upon a productive agriculture and food system, relatively robust

[117] Directive 2009/28/EC of the EP and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC *OJ L 140, 5.6.2009, p. 16–62*

[118] Directive 2009/30/EC of the EP and of the Council of 23 April 2009 amending Directive 98/70/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending Council Directive 1999/32/EC as regards the specification of fuel used by inland waterway vessels and repealing Directive 93/12/EEC *OJ L 140, 5.6.2009, p. 88–113*

[119] Communication from the EC to the EP, the Council, the European Economic and Social Committee and the Committee of the Regions, A resource-efficient Europe – Flagship initiative under the Europe 2020 Strategy *COM(2011)021*

[120] Communication from the EC to the EP, the Council, the European Economic and Social Committee and the Committee of the Regions, Roadmap to a Resource Efficient Europe *COM(2011)571*

[121] EP resolution of 19 January 2012 on how to avoid food wastage: strategies for a more efficient food chain in the EU (2011/2175(INI))

soils, a variety of efficient farming systems, good infrastructure and support services, a highly skilled workforce, an adequate investment capacity and first-class research institutions. This comprehensive STOA project, comprising five studies and a synthesis report, identified some key challenges that will confront Europe in a highly competitive global agri-food system and provided a set of policy options to address them. Two of these challenges – climate change and biodiversity losses – were the subject of one of the studies.

According to this study[122], 'sustainable intensification' is key for increasing the productivity of agricultural land in the face of a changing climate. Changes in consumption patterns (particularly a decrease in meat consumption) and a greater effort over time to reduce food wastage are also necessary. The options identified by the study include: (i) incentivising farming practices that are resilient to climate change and respect biodiversity; (ii) implementing policies and regulations for constraining unsustainable practices; (iii) innovation for a productive climate-resilient agriculture that benefits biodiversity, whilst ensuring environmental safeguards for new technologies; (iv) funding to stimulate research; and (v) reducing adverse external impacts of agricultural practices and imported biofuels.

'Sustainable management of natural resources with a focus on water and agriculture' (2013)

Over 40% of Europe's total area is under agricultural use. Therefore, land management is critically important for maintaining natural resources, including water. Water resources are essential for all sectors of the European economy, but particularly for agriculture. Both water quality and quantity are important for sustainable water use and efficiency. Climate change is expected to exacerbate existing pressures on water, such as more frequent and more severe droughts and floods, affecting agricultural soils and requiring adaptation by water users, farms, regions and the EU Member States.

According to this study[123] (options brief), a major change is needed in approaches to water use and water efficiency in all sectors, and in approaches to sustainable soil and water management in agriculture, to meet EU targets for a good water conservation status. Key areas for improvement include: (i) effective implementation and enforcement of relevant legislation to protect Europe's waters; (ii) better integration and implementation of EU-level water priorities at sectoral, national and regional level; (iii) reducing water losses, and increasing water savings and efficiency; (iv) encouraging, also at national and regional levels, sustainable farming practices, promoted by the CAP[124], to prevent soil erosion and loss of organic matter, capture soil carbon and improve water retention; (v) ensuring effective and

[122] *'Interactions between climate change & agriculture and between biodiversity & agriculture'*, EP 2013 (IP/A/STOA/FWC/2008-096/Lot3/C1/SC5-SC9); authors: E. Underwood, J. Poláková, B. Kretschmer, A. J. McConville, G. M. Tucker (Institute for European Environmental Policy (IEEP)), E. Dooley, A. Frelih-Larsen, S. Naumann (Ecologic Institute), S. Berman, M. Sarteel, C. Tostivint (BIO Intelligence Service), N. M. van der Grijp (Institute for Environmental Studies (IVM)), VU University), N. Maxted (School of Biosciences, University of Birmingham)

[123] *'Sustainable management of natural resources with a focus on water and agriculture'*, EP 2013 (IP/A/STOA/FWC/2008-096/LOT3/C1/SC7); authors: J. Poláková, A. Farmer (IEEP), S. Berman (BIO Intelligence Service), S. Naumann, A. Frelih-Larsen, J. von Toggenburg (Ecologic Institute)

[124] Common Agricultural Policy: http://ec.europa.eu/agriculture/cap-overview/2012_en.pdf; http://ec.europa.eu/agriculture/cap-post-2013/

efficient use of EU funds for water management; and (vi) improved provision of information and tools for better decision-making in water and soil management.

Citizens' involvement in the use of smart technologies

1. EU legislation: the state of play

The use of smart technologies as a means for the empowerment of citizens has recently become an issue of legal attention through various initiatives taken at the EU level. In the field of energy consumption, this empowerment becomes evident through the possibility, via smart grids and smart metering systems, of providing information on real-time consumption that allows consumers to manage their energy consumption actively.

The EC 2015 Energy Union Communication describes a vision, "where citizens ... benefit from new technologies to reduce their energy bills, participate actively in the market, and where vulnerable consumers are protected"[125]. It further stresses the need to reform energy markets and reinforce the power of consumers, who should have permanent access to comprehensive and accurate information, allowing them to make educated choices.

The strategic plan of the EU to replace at least 80% of electricity meters with smart meters by 2020[126] does not come without challenges, especially the need to protect consumers' privacy and personal data, as well as to address the digital divide within the EU.

2. Relevant STOA study

The deployment of smart grids raises a variety of challenges directly relevant for policy-makers and stakeholders. The 2012 STOA study *'Smart grids/Energy grids'*[127] (study / options brief), addressed issues raised by the large-scale deployment of smart electricity grids in Europe for policy-makers, industry, operators, regulators and society at large.

Among other things, the study found that, despite an increasing electricity demand, an increase in the cost of distributed generation may contribute to giving off-grid options a competitive advantage. It also discusses privacy and security issues, concerns about possible health effects, and the concomitant need for utilities to actively involve and empower end-users. The study argues that radical changes in operators' business models are necessary, based on a fair distribution of benefits among actors. It finally calls for a new regulatory framework to stimulate investment, while ensuring a level playing field in the sector.

Some of the study findings are explained in more detail below:

[125] Communication from the EC to the EP, the Council, the European Economic and Social Committee, the Committee of the Regions and the European Investment Bank, A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy *COM(2015)080*

[126] EC Report, Benchmarking smart metering deployment in the EU-27 with a focus on electricity *COM(2014)356*

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Technology and Innovation

Smart Grids rely on a variety of technological advances, many of which have already proven their technical value. More innovation is needed and expected (notably in energy storage), but the real key to a successful deployment of smart grids will be the capability to integrate individual technologies and devices into a multi-layer, multi-actor service framework. Although technological changes are well on their way in all three layers of smart grid systems (energy technologies, market applications, information and communication), the most decisive progress is expected in information and communication technologies, which will play a fundamental role in ensuring the necessary integration.

Regulation

The smartening of electricity grids is driven by a combination of economic interests and technical feasibility. The deployment of smart grids requires a stable, predictable policy framework to guarantee that the necessary resources, including investments, are mobilised. Current regulation models primarily aim at achieving cost-efficiency and are not designed to promote innovative investments, high R&D levels or ambitious targets. These models are likely to lead grid companies to keep to traditional approaches and postpone investments in technologies necessary for smart grid deployment. Regulatory models must therefore provide incentives for utilities to invest in smart grid technologies and applications.

Citizens' involvement

Customers are at the centre of the transition towards smart grids, which will only take place if users shift from the traditional passive mode to an actively participative role. For this to happen several basic conditions must be met, including notably: (i) credible monetary savings (at least 10%); (ii) ease of use of home automation systems and other enabling technologies; and (iii) retaining control over one's own consumption. In order for smart grids to actually deliver benefits to the customer, utilities must drastically change their communication behaviour and engage in reciprocal actions.

Conclusions and proposals

Many considerations emerge from reading all these contributions.

First, we note that innovation has already, in each country, a relatively significant position in political decisions regarding greenhouse gas emission reduction. This shows that, at governments' level, the pursued strategy of modifying technical infrastructures in order to gain better control of these emissions, while maintaining standards of living, prevails over drastic approaches consisting in a compelled return to nature. It is a way to take into account the need to work through a sustainable change, regarding technical infrastructures, rather than applying restrictions, always subject to reversibility.

The technological solutions considered are quite diverse among EPTA members. Even if some options seem genuinely prominent, such as energy storing, the idea that one invention will, by itself, radically resolve the problem of greenhouse gas emissions tends to pragmatically fade away behind an all-out strategy, which aims to achieve a cumulative set of relatively accessible gains. The explored range is widely shared. According to its natural or geographical advantages, in terms of biomass, for example, a particular country put special emphasis on one or the other technology.

Technological solutions have mostly been subject to evaluations by our counterparts from EPTA, which helped to give them proper weight in national strategies, reflecting the strategy defined by the European Union for its Member States. These assessments highlight the importance of life-cycle analyses, which sometimes lead to questioning the relevance of some options, and at least have resulted in a relative reframing of public support, as it was the case for first-generation biofuels, and photovoltaic solar power.

User behaviour is considered in all countries as an integral part of innovative technical processes. By being more or less suitable to these innovations, users can ensure the full effectiveness of the process, or otherwise reduce its scope, up to jeopardize the economic balance of innovation. Users' taste for comfort threatens all efforts made in building energy savings with a "rebound" effect. Car sharing innovative methods depend on the trust that users give to online services regarding the management of their private data, whereas agricultural innovations must take into account consumers' visceral fear of poison.

Besides these general observations, confirming the need to devote explicit funding to innovation from climate change policies allocations, in particular to enable parallel pursuits of promising new technological opportunities, conducting life-cycle assessments and developing user involvement mechanisms, **some elements directly related to the four areas covered by the different monographs stand out.**

In the housing sector, responsible for an average of 20% of greenhouse gas emissions, it is clear that it will be easier to achieve quick tangible results for new constructions, and that a longer term effort must be made to renovate older buildings, even if they were built recently.

In many countries, the so-called "passive" and "neutral" houses, energetically speaking, appear as a realistic goal. The technical solutions seem ready, but economic and financial barriers have yet to be overcome. In order to know if the investments being made are appropriate, tangible energy efficiency measurements have to be standardized. Occupants' involvement is essential to the success of thermal renovation efforts, since it implies the adoption of new energy consumption behaviours. The use of non-carbon energy sources for electricity generation, the development of smart grids tracking buildings energy production, the widespread use of smart meters and active energy management systems, are considered to be the main targets to rapidly achieve.

In the transport sector, responsible for 20% of greenhouse gas emissions, the emphasis is being made on the need to reduce gasoline consumption per 100 kilometres and manage, as a first stage, to manufacture vehicles consuming only 2 litres per 100 kilometres. Rapid development of electric cars is considered, even if it still remains quite slow, in particular due to the lack of charging infrastructures, and to the insufficient autonomy of nowadays batteries used in these vehicles. Research and innovation are still needed to improve batteries, as well as designing new engines and producing cleaner fuels (such as biofuels of second or third generation, compressed air, hydrogen, or natural gas). The focus is finally put on the need to think in terms of mobility and intermodal means of transport. Adaptation to new forms of mobilité (carsharing, change of attitude regarding possession) is absolutely necessary.

In the field of agriculture, responsible for 10% of greenhouse gas emissions, it appears that new techniques can be used to reduce farming carbon footprint, in particular regarding livestock. Several studies show the benefits of the transition towards precision farming, based on large-scale computer processing of vast amount of available data (Big Data), while mentioning the difficulties to generalize this approach. Research studies appear promising for specific crops with high protein content.

In all these areas, citizens' involvement is crucial. But this cannot be decreed. Providing better information to citizens is certainly necessary but it is not a panacea. Increasingly, citizens want to be genuinely involved in decisions and no longer accept policies developed in technocratic ways and imposed from above. Democratic debate methods must be improved, and shared decision-making process must be put in place. But it is not only a matter of raising collective commitment; it must also lead to a change in everyday behaviour. Social innovation is now essential, but it is still in its early stages.

Innovation, which served as a frame to this report's reflexions, appears as a fundamental dimension of climate change policies. It overcomes Malthusian approaches and their reversible effects, by providing sustainable solutions, integrated into basic technical infrastructures of society, in ways maintaining the standards of living in developed countries, and improving the quality of life in developing countries.

It must be ensured, however, that innovation does not raise new fears. Therefore its cultural acceptance as well as its ergonomics must be of primary concern.

Innovation cannot be an adjustment variable of climate change policies. It must be at the very core of their priorities.

Appendix: Contributors to this report

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