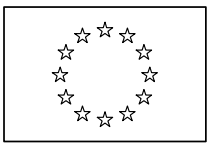

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COMMUNICATION FROM THE COMMISSION TO THE COUNCIL, THE EUROPEAN PARLIAMENT, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

Towards a European Strategic Energy Technology Plan

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Towards a European Strategic Energy Technology Plan

(Text with EEA relevance)

1. INTRODUCTION – THE EUROPEAN ENERGY CHALLENGE

Europe has entered a new energy era, as presented in the Energy Green Paper '*A European Strategy for a Sustainable, Competitive, and Secure Energy*'[1]. Global demand for energy is increasing within a framework of high and unstable energy prices. Emissions of greenhouse gases are rising. Reserves of oil and gas are concentrated in a few countries. Against this backdrop, it is clear that the European Union and the rest of the world have not reacted quickly enough to increase the use of low-carbon energy technologies or to improve energy efficiency. As a consequence, climate change has become a real threat and security of energy supply is worsening. EU greenhouse gas emissions will exceed the 1990 level by 2% in 2010 and by 5% in 2030[2]. EU dependence on imported energy will increase from the current 50% to 65% by 2030.

Given the severity of the threats for the European Union, the Commission in its Communication "*An Energy Policy for Europe*"[3] proposes a strategic energy policy objective: by 2020, the EU will reduce its greenhouse gas emissions by at least 20% compared to 1990 levels in a manner compatible with its competitiveness objectives. In addition, according to the Commission Communication "*Limiting Climate Change to 2°C - Policy Options for the EU and the World for 2020 and Beyond*"[4], by 2050 global greenhouse gas emissions must be reduced by 50% compared to 1990 levels, implying reductions in industrialised countries of 60 to 80%.

2. A VISION OF EUROPE'S ENERGY FUTURE

To turn towards security and sustainability, Europe's energy system must rapidly progress on four main fronts:

– The efficient conversion and use of energy in all sectors of the economy, coupled with decreasing energy intensity;

– The diversification of the energy mix in favour of renewables and low-carbon conversion technologies for electricity, heating and cooling;

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1 COM(2006) 105, 8.3.2006.

2 According to the PRIMES model baseline scenario which takes into account approved policy and a business as usual scenario

3 COM(2007) 1, 10.1.2007.

4 COM(2007) 2, 10.1.2007.

– The decarbonisation of the transport system through switching to alternative fuels;

– Full liberalisation and interconnection of energy systems, incorporating 'smart' information and communication technologies to provide a resilient and interactive (customers/ operators) service network.

The Annex to this Communication presents an independent overview[5] of the energy technologies that can contribute to achieving these goals, as well as the vision statements of the European Technology Platforms in the energy field. Together, they enable a tentative picture to be built up of how the energy technology landscape could evolve:

– By 2020 technology advances will enable the 20% renewable market penetration target to be met. We will see a sharp increase in the share of lower cost renewables (including the roll-out of off-shore wind and 2nd generation biofuels) and clean coal technologies in the energy system. Energy efficiency will be taken onto a new level, with the 20% reduction potential achieved, and efficient hybrid vehicles will be widespread;

– In the 2030 time horizon electricity and heat production should be well down the road to decarbonisation, with fully competitive renewable energy technologies, including mass-market large-scale offshore wind, and extensive near-zero emission fossil fuel power plants. We should also see widespread fuel diversification in the transport sector, with mass markets for 2nd generation biofuels and the penetration of hydrogen fuel cells;

– For 2050 and beyond, a paradigm shift in the way we produce, distribute and use energy should be completed, with an overall energy mix largely comprising renewables, sustainable coal and gas, sustainable hydrogen, Generation IV fission power and fusion energy.

This is a vision of a European Union with a thriving and sustainable economy, with world leadership in a diverse portfolio of clean, efficient and low-carbon energy technologies as a motor for prosperity and a key contributor to growth and jobs. A European Union that has grasped the opportunities lying behind the threats of climate change and globalisation and that it is ready to contribute to the global energy challenge, including increasing access to modern energy services in the developing world.

3. THE VITAL ROLE OF ENERGY TECHNOLOGY

Innovation in energy technology shapes society. The steam engine triggered the industrial revolution. The internal combustion engine made mass transport possible. Gas turbines in aviation have shrunk the world. But the explosion in demand brought about by the success of energy technology has a price. Energy underpins the social and economic fabric of society, rendering it vulnerable to disruptions in supply. It is also damaging the planet. Climate change, driven by energy-related greenhouse gas emissions, is widely regarded as "the greatest and widest-ranging market failure ever seen"[6] and a major threat to the global economy.

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5 From the Sixth framework programme's Advisory Group on Energy (AGE).

6 Stern Review on the Economics of Climate Change – UK HM Treasury: http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/sternreview_index.cfm

In the 21st century technology has a vital role to play in breaking once and for all the link between economic development and environmental degradation, by ensuring sufficient clean, secure and affordable energy. Strong policies to enhance energy efficiency and incentives for the introduction of low-carbon technologies, combined with a stable market for carbon emissions, can set the direction, but it is technology, allied to behavioural changes, that will have to deliver.

Technological progress can create new opportunities to harness the vast but largely untapped renewable energy sources. It will increase energy efficiency throughout the energy system, from source to user, progressively decarbonise transport and the conversion of fossil fuels and deliver advanced options for nuclear energy. Information and communication technologies will contribute to demand reduction and allow the smart interconnection of European energy networks.

Investing more and better in new energy technologies must be a strategic priority for the European Union. The global nature of the energy challenge and the massive investments required world-wide represent an opportunity in terms of growth and jobs. The International Energy Agency estimates that 16 trillion Euros will have to be invested in energy-supply infrastructure worldwide in the period up to 2030[7]. Most of this represents export potential for European businesses. The European Union must be in the vanguard of this global effort.

4. WHAT HAS BEEN ACHIEVED TO DATE

Energy research has been carried out at EU level since the 1960s, initially under the European Coal and Steel Community and Euratom treaties and continuing under successive research Framework Programmes. These Community actions have a proven European added value in terms of building critical mass, strengthening excellence and exercising a catalytic effect on national activities. In combination with national programmes, working at European level with an adequate combination of innovation and regulatory measures has produced substantial results, for instance in the fields of clean and efficient coal, renewables, energy efficiency, cogeneration and nuclear energy. This can be illustrated through some examples:

– Wind energy[8]: technological progress has enabled a 100-fold increase in the power of wind turbines, from 50 kW to 5 MW units, in 20 years and reduced costs by more than 50%. In consequence, the installed capacity has increased 24 times in the last ten years to reach 40 GW in Europe, which represents 75% of global capacity.

– Photovoltaics[9]: in 2005, the world production of photovoltaic modules was 1760 MW compared to 90 MW in 1996. Over the same period, the average module price has decreased from about €5/W to about €3/W. In Europe, the installed capacity has increased 35-fold in 10 years to reach 1800MW in 2005 and the average annual growth rate of about 35% in the past decade makes photovoltaics one of the fastest growing energy industries.

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7 IEA World Energy Investment Outlook 2003.

8 European Wind Energy Technology Platform (http://www.windplatform.eu/).

9 European Photovoltaic Technology Platform http://ec.europa.eu/research/energy/nn/nn_rt/nn_rt_pv/article_1933_en.htm)

– Clean coal[10]: coal-fired power stations have already benefited from a one-third improvement in efficiency over the last 30 years. Modern installations are now capable of running at 40-45% efficiency, yet there is still plenty of scope for further development in this area. A broad reduction in "classic" emissions (SO_2, NO_x and dust) has already been completely implemented in many EU Member States.

– The European fusion research programme through its cutting-edge project, ITER, provides an exemplary model for large-scale international cooperation in research and development involving seven partner countries representing more than half of the world's population.

The EU Research Framework Programmes will continue to form a key piece of the energy technology development jigsaw. The Seventh Framework Programmes will support both technological research and demonstration, not only within the Energy theme and Euratom programme, but also as a cross-thematic element that is supported by most of the other themes, in particular information and communication technologies, biotechnologies, materials and transport. The programmes will also fund socio-economic and policy research on the necessary changes at systemic level that are required for a transition to a 'low carbon economy and society' in the European Union and beyond, while the Joint Research Centre provides scientific and technical support to energy policy making. The Competitiveness and Innovation Programme, and specifically its Intelligent Energy-Europe pillar, will complement this activity by addressing non-technological barriers and providing support to accelerate investment and stimulate the market uptake of innovative technologies across the Community.

In recent years, the European technology platforms (ETPs) established in the energy field (see annex) have demonstrated the readiness of the research community and industry, together with other important stakeholders, such as civil society organisations, to develop a common vision and establish specific roadmaps to achieve it. These technology platforms are already having an influence on European and national programmes, but this in itself does not overcome the problem of fragmentation and overlapping activities. The platforms themselves are calling for action at European level and a framework for the elaboration of large-scale integrated initiatives needs to be developed for this to happen. A clear strategy for energy technology would help these platforms work together more closely, rather than competing for scarce investment resources.

5. THE INSUFFICIENT SCALE OF THE CURRENT EFFORT

'Business as usual' is not an option. The current trends and their projections into the future demonstrate that we are simply not doing enough. To put the European Union and global energy systems onto a sustainable path, to benefit from the consequent market opportunities and to achieve the ambitious vision outlined above, will require a sea-change in European energy technology innovation, from basic research right through to market take-up.

The energy technology innovation process demonstrates structural weaknesses that can only be overcome by concerted action, simultaneously on many different fronts. The complexity of the innovation process is characterised by long lead times to mass market (often decades) due to the inertia inherent in existing energy systems, locked-in infrastructure investments,

[10] Euracoal (http://euracoal.be/newsite/overview.php)

dominant, often natural monopoly, actors, diverse market incentives and network connection challenges.

This is compounded by the disappointing progress towards a European Research and Innovation Area and historically declining research budgets in the energy sector. For reasons mainly related to the specificities of the sector, energy research budgets (public and private) in OECD countries have halved in real terms since the 1980s[11] and it is paramount that this trend be decisively reversed, certainly in the European Union. Given the uncertainties and risks inherent in low-carbon technology innovation, increased public investment and a stable, predictable policy framework will play a vital role in leveraging increased private investment, which should be the main driver of change.

The increased budgets of the Seventh Framework Programmes of the European Union, as well as the Intelligent Energy-Europe Programme, are a step in the right direction. In the former, the average annual budget dedicated to energy research (EC and Euratom) will be €886m, as compared to the €574m of the previous programme. Nevertheless, the contrast with the planned sharp increases in the centrally managed research programmes of global competitors is still stark. For example, the 2005 US Energy Bill proposes in the Federal budget $4.4 billion for energy research in 2007, $5.3 billion in 2008 and $5.3 in 2009, sharply up from the $3.6 billion dedicated in 2005.

In order to be able to compete in global markets, the European Union and its Member States have both to increase their investment, public and private, and to mobilise all these resources much more effectively to address the mismatch between the sheer magnitude of the challenge and the underlying research and innovation effort. All Member States have their own research programmes on energy, mostly with similar objectives and targeting the same technologies. In addition, public and private research centres, universities and dedicated agencies complete a picture of scattered, fragmented and sub-critical capacities. Working together will benefit all, exploiting the federating role that the European Union can play in the field of energy.

The potential of enhanced international cooperation must also be harnessed in a more effective way. Energy security and climate change are global issues with solutions that can be deployed globally, giving rise to huge markets but also to severe competition. Finding the right balance between cooperation and competition is vital. ITER and fusion have provided a model for large-scale international cooperation in research to meet global challenges and such an approach may have potential in other areas. The European Union and many of its Member States also participate in multi-lateral co-operation initiatives, such as the International Partnership for the Hydrogen Economy (IPHE), the Carbon Sequestration Leadership Forum (CSLF) and the Generation IV International Forum (GIF), whose potential has still to be fully realised. Synergies in the development of efficient and low carbon technologies should be further enhanced by closer and result-oriented cooperation with international partners, e.g. the United States.

[11] OECD Round Table on Sustainable Development, 30 June 2006.

6. TRANSFORMING ENERGY TECHNOLOGY INNOVATION: A EUROPEAN STRATEGIC ENERGY TECHNOLOGY PLAN (SET-PLAN)

The European Union must act jointly and urgently. It will take decades to progressively transform the energy system, but we must start now. It is a process that requires strategic action at European level, pro-active planning and a comprehensive policy framework. To meet the challenge, we must develop a world-class portfolio of affordable, competitive, clean, efficient and low-carbon technologies and create stable and predictable conditions for industry, particularly SMEs, to ensure their widespread deployment in all sectors of the economy.

The broad technology portfolio approach spreads risk and avoids locking-in to technologies that may not provide the best solution in the long run. The portfolio includes existing technologies that can be deployed immediately, technologies where incremental improvements are needed, technologies where breakthroughs are required, transition technologies and technologies which necessitate major changes to existing infrastructures and supply chains. All of these technologies face different challenges and barriers and are likely to be brought to commercialisation within different time horizons.

Creating the framework conditions and incentives for the development and take-up of energy technologies is a matter of public policy. A whole range of instruments is available at European and national level to help accelerate technology development (technology push) and the market introduction process (demand pull). The following is a non-exhaustive inventory of such instruments:

– ***Technology push instruments:*** EU Research Framework Programme and associated initiatives (e.g. European Research Area Networks scheme, Risk Sharing Finance Facility of the European Investment Bank, Infrastructures for research, Joint Technology Initiatives and other possibilities under Articles 168, 169 and 171 of the EC Treaty and Title II of the Euratom Treaty), European Coal and Steel Research Fund, national research and innovation programmes, venture capital and innovative financing mechanisms[12], European Investment Bank, Structural Funds for innovation, COST, EUREKA, European Technology Platforms.

– ***Demand pull instruments:*** EU directives setting targets and minimum requirements, performance regulations, pricing policies (Emissions Trading Scheme and fiscal instruments such as energy taxation), energy labelling, standards policy, voluntary agreements of industry, feed-in tariffs, quotas, obligations, green and white certificates, planning/building regulations, grants for early adopters, fiscal incentives, competition policy, public procurement policies, trade agreements.

– ***Integrated innovation instruments:*** The proposed new European Institute of Technology (EIT) will play an important role in enhancing the relations and synergies between innovation, research and education. The creation of an energy-related Knowledge and Innovation Community may be envisaged by its autonomous Governing Board. The Community Competitiveness and Innovation Programme (in particular the Intelligent Energy-Europe programme) seeks to remove non-technological barriers that prevent market take-up. In addition, the lead market approach announced in the recent innovation

[12] For example, the EU Global Energy Efficiency and Renewable Energy Fund (GEEREF).

strategy[13] could lend itself well to the launching of large-scale strategic actions aimed at facilitating the creation of new knowledge-intensive energy markets.

The essence of the European Strategic Energy Technology Plan (SET-Plan) will be to match the most appropriate set of policy instruments to the needs of different technologies at different stages of the development and deployment cycle. The SET-Plan must therefore embrace all aspects of technological innovation, as well as the policy framework required to encourage business and the financial community to deliver and support the efficient and low-carbon technologies that will shape our common future. In coherence with the Communication "*An Energy Policy for Europe*"[14], the SET-Plan will address different time horizons and important milestones that have to be met to put our energy system on a sustainable path. The socio-economic dimension, including behavioural changes and social attitudes with an impact on energy use will also be taken into account.

The SET-Plan must stem from a shared and inclusive European vision, involving all relevant actors: industry, the research community, the financial community, public bodies, users, civil society, citizens, unions. It must be ambitious in setting targets, but realistic and pragmatic regarding resources. While avoiding being perceived as a European level 'picking winners' approach, the SET-Plan will have to be selective – 'different horses for different courses' – ensuring that the right portfolio of technologies is brought forward to enable Member States to pick and choose the appropriate combination for their preferred energy mix, indigenous resource base and exploitation potential.

The strategic element of the plan will be to identify those technologies for which it is essential that the European Union as a whole finds a more powerful way of mobilising resources in ambitious result-oriented actions to accelerate development and deployment. Technologies on which we should work in strong coalitions or partnerships, identifying precise and measurable objectives and then pursuing these in a focused and coordinated manner, sharing risks and leveraging sufficient resources from a wide variety of sources. Possible examples of such large-scale initiatives, which are beyond the capacity of any single country, could be biorefineries, sustainable coal and gas technologies, fuel cells and hydrogen and Generation IV nuclear fission.

The SET-Plan will not be an isolated initiative, but will build on and complement existing initiatives, such as national energy strategies and reviews, as well as the Environmental Technologies Action Plan (ETAP) and the planned flagship initiative on Information and Communication Technologies for Sustainable Growth, where there is potential to optimise synergies.

7. PROCESS TO ARRIVE AT THE SET-PLAN

The Commission intends to put forward a first European Strategic Energy Technology Plan for endorsement by the 2008 Spring Council.

To arrive at a shared European vision on the role that technology can play in the context of a European energy policy and produce a credible and widely supported SET-Plan requires widespread consultation and the active involvement of all relevant stakeholders. It must be a

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13 COM(2006) 502, 13.9.2006.

14 COM(2007) 1.

broad, participative, consensus-building initiative, based on a thorough analysis of the strengths and weaknesses of the current innovation system and an objective assessment of the realistic potential of technologies to contribute to energy policy goals.

A two-stage approach is envisaged. In an initial phase, up to May 2007, the Commission will consult with established advisory and stakeholder groups, such as the High Level Group on Competitiveness, Energy and Environment, the FP7 Advisory Groups, relevant European Technology Platforms and Member State groups. A series of expert workshops will be convened and, possibly, a high-level European conference organised in the first half of 2007.

In a second phase, around July 2007, a public consultation on a preliminary draft SET-Plan will be conducted. The input from the consultation will then be incorporated into the plan and a final round of validation with experts and advisory groups carried out to ensure its robustness.

The delivery of the first SET-Plan by the end of 2007 will not be a one-off exercise, but the start of a dynamic process that will be regularly reviewed and adjusted to changing needs and priorities. To this end, the plan will also propose a monitoring and evaluation scheme, including technology watch and assessment and an extension of the 'EU Industrial R&D Investment Scoreboard'[15] to include energy research.

8. CONCLUSIONS

(1) The world has entered a new energy era. The European Union should lead the way towards a paradigm shift in the way energy is produced, distributed and used.

(2) Energy technology has a vital role to play in breaking once and for all the link between economic development and environmental degradation.

(3) In combination with national activities, working at European level with an adequate combination of innovation and regulatory measures has produced substantial results.

(4) However, the continuation of 'business as usual' is no longer an option. The current trends and their projections into the future demonstrate that we are simply not doing enough to respond to the energy challenge.

(5) The Commission's view is that the increased budgets of the Seventh Framework Programmes (50%, from €574M/year to €886M/year), as well as the Intelligent Energy-Europe Programme (100%, from €50M/year to €100M/year), are a step in the right direction that Member States and industry should at least match.

(6) The European Union must act jointly and urgently, agreeing and implementing a European Strategic Energy Technology Plan (SET-Plan) in 2007 embracing the whole innovation process, from basic research to market take-up and facilitating research and development cooperation with international partners.

(7) The SET-Plan must stem from a shared and inclusive European vision, involving all relevant actors. It must be ambitious in setting targets, but realistic and pragmatic

[15] Published annually by the European Commission: http://iri.jrc.es/do/home/portal/inicio

regarding resources. The strategic element of the SET-Plan will be to identify those technologies for which it is essential that the European Union as a whole finds a more powerful way of mobilising resources in ambitious result-oriented actions to accelerate their pathway to the market.

ANNEX

Overview of key low-carbon technologies at different stages of innovation and their prospects for market penetration

1. The analysis of the FP6 Advisory Group on Energy

The report *'Transition to a sustainable energy system for Europe: The R&D perspective'* (2006, EUR 22394) by the FP6 Advisory Group on Energy identifies key future technology options. Their analysis, which provides a useful reference point, is summarised below.

Time to widespread deployment	Transport technology	Electricity/heat conversion technology
Immediate/Short-term	Reduction in demand (e.g. smaller engines)	Low/medium temperature solar thermal applications for hot water, heating, cooling, industrial processes
┃	Advanced high-efficiency ICEs	Combined Cycle Gas Turbine (CCGT)
┃	Improved hybrid electric designs with petrol, diesel, biodiesel	Nuclear fission (Gen III/III+)
┃		Wind energy (including offshore/deep offshore)
┃	Bio-diesel; bio-ethanol	System integration (grid issues)
┃		Solid biomass
┃	Co-processing of biomass with fossil fuels	Fuel cells (SOFC, MCFC)
┃		Geothermal energy (including deep geothermal – HDR/HFR)
┃	Synthetic fuels from gas/coal-Fischer-Tropsch	Carbon capture and storage (CCS)
┃		Cleaner use of coal (steam/gas turbine, combined cycle) with CCS
┃	Biofuels from ligno-cellulosic feedstocks	Advanced fossil fuel plants (super/ultra-supercritical steam; Integrated Gasification CC (IGCC), with CCS
┃	Electric vehicles (EVs) with advanced battery electricity storage	Solar photovoltaic (PV)
┃		Solar thermal power plants
┃	Hydrogen with fuel cells	Ocean energy (wave, sea current)
┃		Nuclear fission – Generation IV
Longer term	Air transport: hydrogen/gas turbine	Nuclear fusion

End-use energy efficiency technologies are also analysed in the report, but the range is so extensive that a concise summary, as above, is not possible. The full report can be downloaded from: http://ec.europa.eu/research/energy/gp/gp_pu/article_1100_en.htm

2. Prospects for market penetration – the vision statements of European technology platforms in the energy field

According to the *zero emission fossil fuel power plants ETP*[16], by 2020, fossil fuel power plants will either be capable of capturing almost all their CO_2 emissions in an economically viable manner, or will be able to include CO_2 capture systems ("capture-ready"). Between now and 2050, this would equate to a progressive diminution of 60% in CO_2 emissions from power generation and demonstrate the importance of zero-emission fossil fuel energy.

The *biofuels ETP*[17] considers that up to one quarter of EU road transport fuel needs can be met by clean and CO_2 efficient biofuels by 2030.

The *photovoltaic ETP*[18] confirms that the 3 GW target for 2010 can be achieved. Furthermore, by 2030 the cost of photovoltaic generation will be competitive in most parts of the electricity market. The installed capacity may increase to 200 GW in the EU and 1000 GW worldwide, giving access to electricity to more than 100 million families, particularly in rural areas.

The *wind energy ETP*[19] projections for 2030 suggest that 23% of European electricity could be provided by wind farms, with 300 GW installed capacity (supplying 965 TWh, up from 83 TWh in 2005).

The *hydrogen and fuel cell ETP*[20] foresees in its 2020 snap-shot that fuel cells for portable devices and portable power generation will be established markets. Regarding stationary combined heat and power applications, the installed capacity could be up to 16 GW, and in the road transport sector, again by 2020, the start of a mass-market roll-out of hydrogen powered vehicles could represent annual sales of up to 1.8 million vehicles.

The *solar thermal ETP*[21] considers that this technology will cover up to 50% of all heating applications requiring temperatures up to 250°C by 2030. The total installed capacity could reach 200 GW(thermal).

The *smartgrids ETP*[22] looks at the future electricity networks needed to enable the energy system to meet the needs of Europe's future. Taking advantage of advanced ICT, networks must become flexible, accessible, reliable and economic, embracing the latest technologies to ensure success, whilst retaining the flexibility to adapt to changing needs.

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16 http://www.zero-emissionplatform.eu/website/

17 http://ec.europa.eu/research/energy/pdf/draft_vision_report_en.pdf

18 http://ec.europa.eu/research/energy/nn/nn_rt/nn_rt_pv/article_1933_en.htm

19 http://www.windplatform.eu/

20 https://www.hfpeurope.org/

21 http://www.esttp.org/cms/front_content.php

22 http://www.smartgrids.eu