CURRICULUM VITAE

Arnaud Mercier

European Commission

Arnaud Mercier is working for the Joint Research Centre of the European Commission Institute for Energy in the Energy Systems Evaluation Unit. In this unit, he is leading the group on Energy Systems Modelling. Since 2007, Arnaud Mercier has been involved in the preparation and implementation of the European Strategic Energy Technology Plan (SET-Plan) with a strong contribution to the development of a European Technology Mapping exercise – a brief and comprehensive analysis of the prospects and impacts on EU Energy Policy goals of key low carbon technologies. This activity is now an integral part of the newly-established Information System of the SET-Plan, with a mission to provide reliable and up-to-date information on energy technology to support policy decision making.

Hrvoje Petrić

European Commission
Joint Research Centre
Institute for Energy
Address: P.O. Box 2,
NL-1755 ZG Petten
Tel: +31-224-56 50 23
Fax: +31-224-56 56 23
E-mail: Hrvoje.petric@ec.europa.eu
Website: http://ie.jrc.cec.eu.int/

Hrvoje Petric is working as Scientific Officer with the European Commission – Joint Research Centre, as part of the Team responsible for evaluation and modelling of the EU energy system. He started his career as Assistant Lecturer at the University of Zagreb, Faculty of Mechanical Engineering. Before he joined the European Commission, he has been working for the Energy Institute Hrvoje Pozar in Croatia as Deputy Head of Department for Energy Generation and Transformation. He was also a national representative and a Member of the Board of Directors in the COGEN Europe. Hrvoje is an Executive MBA Alumnus from the IEDC - Bled School of Management and holds a M.Sc. Degree in Mechanical Engineering from the University of Zagreb. He has been involved and led various projects within the energy sector, as well as policy support for the same, for the past twelve years, with a special focus on techno-economic assessment of energy systems and power plants, cogeneration and energy efficiency.

Arnaud MERCIER
Hrvoje PETRIC
Estathios PETEVES
European Commission Joint Research Centre Institute for Energy
Netherlands

TOWARDS A EUROPEAN ENERGY TECHNOLOGY POLICY – THE EUROPEAN STRATEGIC ENERGY TECHNOLOGY PLAN (SET-PLAN)

Abstract

The transition to a low carbon economy will take decades and affect the entire economy. There is a timely opportunity for investment in energy infrastructure. However, decisions to invest in technologies that are fully aligned with policy and society priorities do not necessarily come naturally, although it will profoundly affect the level of sustainability of the European energy system for decades to come. Technology development needs to be accelerated and prioritized at the highest level of the European policy agenda. This is the essence of the European Strategic Energy Technology Plan (SET-Plan).

The SET-Plan makes concrete proposals for action to establish an energy technology policy for Europe, with a new mind-set for planning and working together and to foster science for transforming energy technologies to achieve EU energy and climate change goals for 2020, and to contribute to the worldwide transition to a low carbon economy by 2050.

This paper gives an overview of the SET-Plan initiative and highlights its latest developments. It emphasises the importance of information in support of decision-making for investing in the development of low carbon technologies and shows the first results of the technology mapping undertaken by the newly established Information System of the SET-Plan (SETIS).

PREMA POLITICI ENERGETSKE TEHNOLOGIJE ZA EUROPU – EUROPSKI STRATEŠKI ENERGETSKO TEHNOLOŠKI PLAN (SET PLAN)

Sažetak

Prijelaz na niskougljičnu ekonomiju trajat će desetljećima i utjecat će na cjelokupno gospodarstvo. Postoji pravovremena prilika za ulaganje u energetsku infrastrukturu. Međutim, odluke o ulaganjima u tehnologije koje su u potpunosti usklađene s političkim i društvenim prioritetima ne donose se lako, iako će duboko utjecati na razinu održivosti europskog energetskog sustava u desetljećima koja su pred nama. Tehnološki razvoj treba ubrzati i učiniti prioritetom na najvišoj razini. Ovo je bit Europskog strateškog energetsko-tehnološkog plana (SET Plan).

SET Plan daje konkretne prijedloge za djelovanje na uspostavi politike u energetskim

tehnologijama za Europu s novim referentnim okvirom planiranja i suradnje. Osim toga, daje i prijedloge za jačanje znanosti tehnologija energetskih transformacija kako bi se postigli energetski ciljevi i ciljevi borbe protiv klimatskih promjena do 2020 u Europskoj uniji te za doprinos globalnoj tranziciji k niskougljičnoj ekonomiji do 2050. godine.

Ovaj rad daje pregled inicijativa SET Plana s posebnim osvrtom na to što se u okviru Plana događa u najnovijem periodu. Rad naglašava važnost informacija u podršci procesu odlučivanja o ulaganjima u razvoj niskougljičnih tehnologija i pokazuje rezultate preslikavanja tehnologija poduzetog u okviru novog Informacijskog sustava SET Plana (SETIS).

1. INTRODUCTION

The European Union needs affordable, secure and sustainable flows of energy. In the last decades, the European energy system has shown growing signs of unsustainability. Time is of the essence. Europe is constantly increasing its imports of fossil fuels from different regions of the world, while in the same time, energy prices are drastically rising. Energy consumption continues to increase whilst the energy sector is still the first contributor to greenhouse gases emissions. Globally, if annual emissions continue at today's levels, greenhouse gas levels would eventually lead to a rise by 2 – 5ºC of global mean temperature with damaging effects on human societies. Altogether, these trends pose significant threats and difficulties to EU citizens and the competitiveness of the EU industry.

With current trends and technologies, the EU and the world will not achieve its climate change objectives at a cost that is economically sustainable [1]. Reversing the trend of carbon-intensive energy production and consumption is challenging and requires an urgent, long-lasting and drastic shift towards low-carbon energy technologies. Research and innovation in energy technologies are therefore vital in meeting the EU's climate and energy policy goals. But the current European innovation system is not currently geared to deliver this technology change. A novel approach has to be developed based on reinforced and focused cooperation at the European level [2].

2. A LEVEL PLAYING FIELD FOR LOW CARBON TECHNOLOGIES

A striking feature of the current European energy system, shared with other part of the world, is that despite formidable technology advances and the provision of high quality and reliable services, the current energy supply and consumption pattern will have to be changed if Europe wants to continue to rely on energy as a key enabler of economic growth and enjoyable lifestyle.

In a snapshot, in a business as usual scenario[1], the final energy demand for the EU-27 is forecasted to steadily increase in all the different end-use sectors. Compared to 2005, in 2030, Europe will consume about 20% more final energy. Transport remains the fastest growing sector with an average annual increase of 1%, and no clear sign of stabilization before 2030. Europe is also steadily relying more and more on import of primary energy resources to fuel its energy demand. This is not a prescribed feature at such. However,

[1] EU Energy and Transport Trends up date 2007 (business as usual scenario)

considering the recent increase in energy price and the possibilities of disruption of energy supply, this situation poses a risk for Europe economy and citizens. Overall, Europe is slowing shifting from a current 50% dependency ratio to approximately 70% by 2030. This trend is mainly caused by the declining of domestic European production capacity of fossil fuels, combined with a quasi-monopoly of fossil fuel in the EU energy balance, where 78% of the energy comes from fossil fuels. This ratio is predicted to remain about the same up to 2030, in a context where in two years time, the price of a barrel of crude oil has more than doubled. On the Greenhouse emission front, despite a commitment and burden sharing agreement to reduce European emissions by 8%, these emissions are still growing with an expected average annual increase of 0.3%. Transport is the second largest contributor to CO_2 emissions after the power sector. [3]

The response to these challenges is far-reaching, and triggered a comprehensive approach from the European Union encompassing binding targets for 2020 to reduce greenhouse gas emissions by 20% and ensure 20% of renewable energy sources in the EU energy mix; a plan to reduce EU global primary energy use by 20% by 2020; carbon pricing through the Emissions Trading Scheme and energy taxation; a competitive Internal Energy Market; an international energy policy as proposed and adopted by the European Union in its energy package in 2008 [4].

However, this is only one part of the solution. There is more and more certainty that the new frame of development of energy policies driven by the sustainability imperative requires a drastic change of the energy technology mix. Incremental technological improvements are not sufficient. As an example, the way carbon-based energies are transformed and consumed through an open to air cycle can no longer be sustained and, hence, calls for revising engineering concepts of energy conversion and production. New processes need to be developed and deployed rapidly.

A fundamental question for policy decision is related to the timing and focus of these up-coming investments in new infrastructures. A recent study performed by the European Commission Joint Research Centre (JRC) [5] revealed that about 60% of coal and oil-fired power plants and 17% of gas-fired plants are older than 25 years, as shown in Figure 1. Less than 10% of the current power plant fleet will be operating by 2030. This situation is a great opportunity to reformulate the technology paradigm of the future EU energy system. This is all the more important since the conventional energy infrastructure lasts on average for about 30 years and even more.

Source: [5]

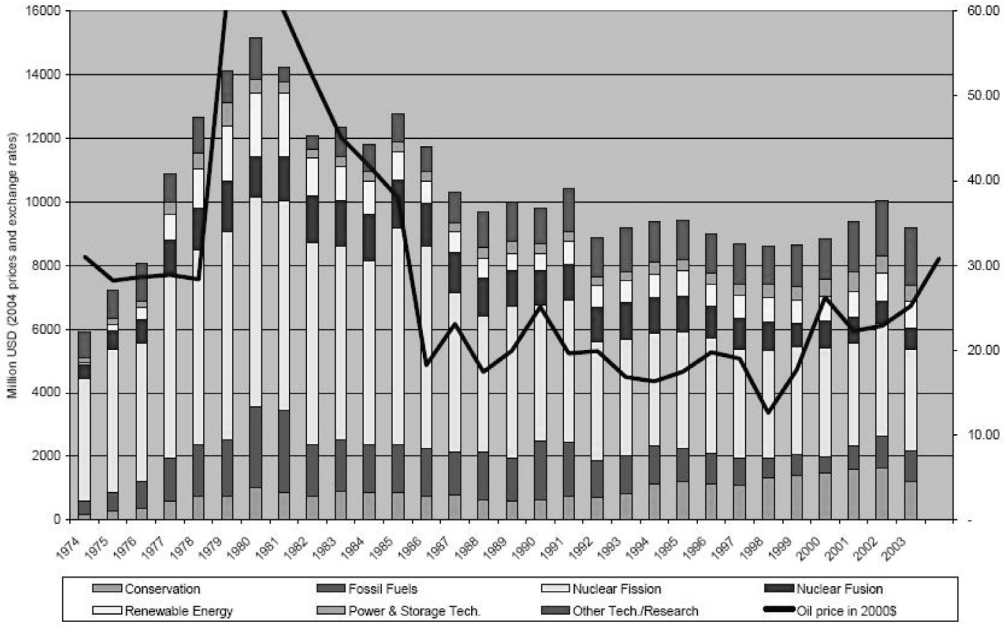
Figure 1: Age distribution of the operational fossil fuel electricity generation capacity

Nevertheless, having to make such investments does not necessarily guarantee the move towards the establishment of a sustainable energy system. From a pure market principle, there is not a natural market attraction for such low carbon energy technologies as new technologies are normally more expensive and deliver the same service as conventional ones. Furthermore, significant societal spill-over are embedded in these technologies which are not easy captured in a liberalised environment. In addition, new technologies require substantial investment and long development periods, and the change from well understood and mastered centralised energy infrastructures. A clear indicator of these difficulties is that the level of investment and deployment in low carbon technology options seems to lag behind the necessity, although the portfolio of technologies that will have an impact on the EU energy system is quite well known.

Public energy research budgets in the EU Member States have generally declined substantially since the second oil shock. Quite a good correlation of research and development (R&D) investment with oil prices was recorded in the past and seemed to be an effective driver for mobilizing the necessary volume of investment. As shown in Figure 2 presenting the R&D expenditure over the last decades in all OCDE countries, this model continues to predominate. However, the main driver is no longer solely the economics of energy production. Carbon-constraints play an equivalent role as a market signal to direct investment on low carbon technologies.

Most of the new technologies that will play a fundamental role in the new energy infrastructure have yet to be developed and/or are in a transition to mass market deployment. An idea of the required intensity of investment can be drawn up from the past: the relative intensity of public investments dedicated to energy research in 1981 was 4 times higher than the corresponding level in 2005. In other words, considering 2005 level of public R&D investment, with an equivalent intensity as in 1981 for energy issues, the amount of investment would increase from the current 2.1 b€ to 8.4 b€ [6]. It is noted that this indicator shall not be considered as absolute as it depends on the overall economy structure with a current shift towards knowledge-based R&D intensity activities and it is stressed that the effect of the carbon constraint is not factored in. It is believed that private investment shows a similar pattern of under-investment as public expenditure, although the availability of data renders more difficult such analysis.

Irrespective of the absolute research and development and demonstration (R&D, D) investment amount, all indicators converge to the conclusion that the level of R&D investment in low carbon technologies does not match the scope and magnitude of the challenge.



Source: [7]

Figure 2: R&D expenditure in IEA countries

Furthermore, the current European innovation system seems not to be geared to deliver the technology at the right pace to meet the short and medium goals recently adopted by the European Council. Although Member States research and industry is ranking among the top players at the global level, Member States do not have the necessary critical mass of R&D, D infrastructure to allow the European industry to compete in global markets in the future. The EU innovation system is fragmented into loosely aligned research strategies and sub-critical capacities, at a time when the main global players, the United States and Japan, but also emerging economies such as China, India and Brazil, are facing the same challenges and are multiplying their efforts to develop and commercialize new energy technologies.

3. TOWARDS A EUROPEAN ENERGY TECHNOLOGY POLICY

The transition to a low carbon economy will take decades and affect the entire economy. There is a timely opportunity for investment in energy infrastructure without major destruction of values. However, decisions to invest in technologies that are fully aligned with policy and society priorities does not necessary come naturally, although the lifetime of these technologies will create a lock-in effect for decades to come. Technology development needs to be accelerated and prioritized at the highest level of the European policy agenda to ensure their cost-effective and timely deployment and obtain the relevant impact on our policy goals in parallel to ensuring a conducive environment for investment in these technologies. This is the essence of the European Strategic Energy technology Plan (SET-

Plan), adopted on 28 February 2008 by the Council of the European Union [2].

The SET-Plan makes concrete proposals for action to establish an energy technology policy for Europe, with a new mind-set for planning and working together, with the ambition to accelerate knowledge development, technology transfer and up-take, to maintain EU industrial leadership on low carbon energy technologies, and to foster science for transforming energy technologies to achieve EU energy and climate change goals for 2020, and to contribute to the worldwide transition to a low carbon economy by 2050.

The SET-Plan is under-pinned by grand technology challenges to be met in the next 10 years to bring about the technology shift required to develop a sustainable energy system. The main elements are shown in Figure 3 and Figure 4 respectively for 2020 and 2050. This vision recognizes the necessity to address deployment and diffusion barriers for those technologies that are deemed to deliver by 2020, mostly available today or in the final stages of development, while calling for immediate actions to prepare for resolving and developing the major breakthroughs for the new generation of technologies that will have mostly an impact by 2050.

– Make second generation biofuels competitive alternatives to fossil fuels, while respecting the sustainability of their production;

– Enable commercial use of technologies for CO_2 capture, transport and storage through demonstration at industrial scale, including whole system efficiency and advanced research;

– Double the power generation capacity of the largest wind turbines, with off-shore wind as the lead application;

– Demonstrate commercial readiness of large-scale Photovoltaic (PV) and Concentrated Solar Power;

– Enable a single, smart European electricity grid able to accommodate the massive integration of renewable and decentralised energy sources;

– Bring to mass market more efficient energy conversion and end-use devices and systems, in buildings, transport and industry, such as poly-generation and fuel cells;

– Maintain competitiveness in fission technologies, together with long-term waste management solutions;

Source: [2]

Figure 3: Key EU technology challenges for the next 10 years to meet the 2020 targets

– Bring the next generation of renewable energy technologies to market competitiveness;

– Achieve a breakthrough in the cost-efficiency of energy storage technologies;

– Develop the technologies and create the conditions to enable industry to commercialise hydrogen fuel cell vehicles;

– Complete the preparations for the demonstration of a new generation (Gen-IV) of fission reactors for increased sustainability;

– Complete the construction of the ITER fusion facility and ensure early industry participation in the preparation of demonstration actions;

– Elaborate alternative visions and transition strategies towards the development of the Trans-European energy networks and other systems necessary to support the low carbon economy of the future;

– Achieve breakthroughs in enabling research for energy efficiency: e.g. materials, nano-science, information and communication technologies, bio-science and computation

Source: [2]

Figure 4: : Key EU technology challenges for the next 10 years to meet the 2050 vision [2]

The SET-Plan is above all an Action plan for a new research and innovation approach at the European level. This new approach aims at increasing synergies at Community level to improve the leverage effect of European programmes in working on more targeted technology development while pursuing a broad portfolio management, raising de-facto the strategic visibility of investments, avoiding duplication of efforts, and hence securing increased and sustained funding.

This new model for research and innovation calls upon integration of development, demonstration and deployment (3D) as a vehicle for meeting the mid-term EU policy targets and fertilising the science for the long-term challenges. Science and deployment are joint driving forces to push forward technology delivery. New knowledge supports the development of close to market technologies and the needs for changing and adapting existing infrastructure in the mid term, while it is a major force to open up new avenues of technology options that are not yet in a market perspective, but are required to perform the deep decarbonization of the EU energy system in the long term.

This 3D research and innovation model constitutes the essence of the SET-Plan structure. It is materialized by joint endeavours between academia, research and industry, such as the Research Alliance to improve the cost effectiveness of collaborative research at European level, pooling and making better use of a critical mass of resources, and the proposal of several European Industrial initiatives (EII) to strengthen industrial energy research and innovation on technologies for which working at Community level will add most value. These EIIs will contribute to focus and align the efforts of the Community, Member States and industry to achieve common goals, creating a critical mass of activities and actors.

In its Communication [2], the Commission proposed to launch six priority initiatives, starting in 2008.

- European Wind Initiative: focus on large turbines and large systems validation and demonstration (relevant to on and off-shore applications).
- Solar Europe Initiative: focus on large-scale demonstration for photovoltaics and concentrated solar power.
- Bio-energy Europe Initiative: focus on 'next generation' biofuels within the context of an overall bio-energy use strategy.
- European CO_2 capture, transport and storage initiative: focus on the whole system requirements, including efficiency, safety and public acceptance, to prove the viability of zero emission fossil fuel power plants at industrial scale.
- European electricity grid initiative: focus on the development of the smart electricity system, including storage, and on the creation of a European Centre to implement a research programme for the European transmission network.
- Sustainable nuclear fission initiative: focus on the development of Generation-IV technologies.

This ambition for a new research and innovation model is also reflected in the governance structure of the SET-Plan with a clear integration of information management and decision making and monitoring in a single, coherent framework. A Steering group, populated by the Member States and the Commission is established to provide a high level discussion platform and a flexible framework for strategic planning and implementation. The decision-making is supported by an open-access knowledge and information management system on energy technologies. This information system of the SET-Plan, called SETIS, is operated by the European Commission Joint Research Centre.

Furthermore, this innovation model is open to international cooperation as technology development implies both economic growth and a levy to ensure a global sustainable pattern of development. Measures that are envisaged within the SET-Plan encompass cooperation on research or standards, but also technology transfer to developing countries.

4. TECHNOLOGY MAPPING FOR DECISION MAKING

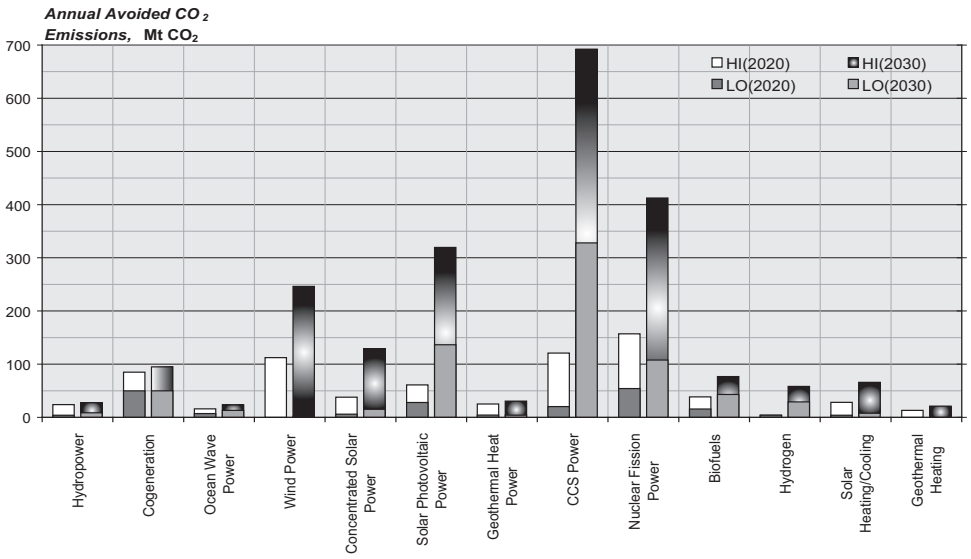
Understanding the prospects of low carbon technologies, the economics and timing of their contribution to Europe's policy goals are critical questions to be answered to support policy actions to foster European innovation and to meet the goals of establishing a European sustainable energy system by the middle of the century.

An integral part of the activity of SETIS is the so-called technology and capacity mapping. These exercises aim at providing brief and comprehensive information of the current and future prospects of key low carbon technologies as well as of financing and human resources capacities to pursue R&D,D developments in Europe.

The first energy Technology Map has been produced to support the selection of proposals for European Industrial Initiatives in the context of the preparation of the European Strategic Energy Technology Plan in 2007 [8]. This Technology Map focused mainly on energy supply technologies and alternative transport fuels. Fourteen technologies were analyzed,

including renewable sources (wind, solar, bio-energy, hydropower, ocean, geothermal), nuclear (fission and fusion), fossil fuels (cogeneration of heat and power, zero emission fossil fuel power generation), Hydrogen and Fuel Cells and the Transition planning of energy infrastructure (smart-grids). An impact assessment of the contribution of different technologies on EU policy goals has been carried out following a common assessment framework. The basic principle of this assessment framework is the evaluation of the effect of the penetration of each technology individually into an established business-as-usual baseline scenario. The evaluation is based on a number of key indicators, namely CO_2 avoided, carbon mitigation cost, fossil fuels saved, and changes in the overall production cost of the energy carrier that the technology produces (electricity, heat, or transport fuel). The time horizon considered for the assessment is 2030.

The main finding of the Technology Map is that a broad portfolio of technologies needs to be developed strategically and inclusively to meet the EU policy goals. Supply-side technologies such as wind, solar, hydropower, biofuels, cogeneration and zero emission fossil fuel power plants have the potential to contribute in meeting the European goals in the short and medium term. New generation nuclear fission reactors, hydrogen fuel cells and ocean energy, but also nuclear fusion in a longer term, are examples of advanced technologies that should be pursued now so they can contribute to the long term vision of a European sustainable energy system. These will complement energy efficiency measures as well as initiatives that will modernise and make more robust existing energy infrastructure. The contribution of the portfolio of low carbon power technologies with regards to CO_2 emission reduction is shown in Figure 5.



Source: [8]

Figure 5: CO_2 savings in the Power sector – SET-Plan Effect [8]

The Technology Map provided also some insights on the challenges of implementation and the timing when a specific technology or set of technologies could be considered as “established” to become a “relevant” option for the energy sector. This time frame is

considered along with the potential of low-carbon energy technologies against the EU policy goals over the next fifty years horizon as summarized in Figure 6 below.

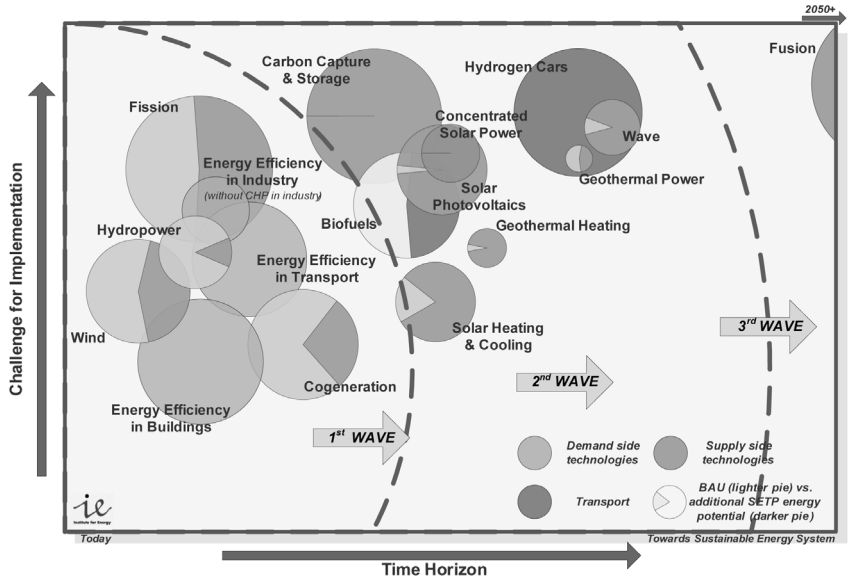


Figure 6: Assessment of the contribution of key low carbon energy technologies towards EU Energy Policy goals

For each technology considered, the maximum energy potential, on a final energy basis, is indicated by the size of a circle. The colour shading differentiates between the maximum potential expected to be exploited in the baseline (light coloured pie), and the remaining potential that could be exploited providing sufficient support, R&D, D efforts, etc. are made. The level of exploitation of the additional potential of each technology, as well as its timing, could be assumed as the SET Plan leverage effect.

The relative position of each technology on the Time Horizon axis indicates an approximate time period when a specific/set of technologies are expected to be established as a "relevant" option for the energy sector. Challenge for Implementation indicates in relative terms how demanding is the development and deployment of a given technology with respect to other technologies within a similar time period.

Technology options that become available for the energy sector are dynamically indicated by "waves" overtime. It can be shown from the graph, that several "waves" of technology deployment can be expected until 2050, offering, each, new opportunities to build a low carbon and sustainable energy system. A first wave, with a short-to-medium time horizon, is mainly composed of today's well established and/or high penetrating technologies. A second wave, ranging from medium-to-long term, includes advanced technologies such as solar, biofuels, carbon capture and storage technologies, but also at later stage hydrogen fuel cells in the transport sector and the next generation of renewable technologies such as ocean technologies. This will be complemented by fusion technologies around 2050 and onwards.

As part SETIS activities, the JRC will revisit and periodically update this Technology Map.

5. CONCLUSION

Development of new, low carbon technologies needs to be accelerated and prioritised to ensure their cost-effectiveness and timely deployment. The European Strategic Energy Technology Plan makes concrete proposals for action to accelerate the development and deployment of low carbon energy technologies to support policy actions to foster innovation and to meet EU goals of establishing a European sustainable energy system by the middle of the century.

Through the SET-Plan, a new innovation model is being implemented for building a sustainable energy system based on

- Joint Programming and Implementation
- Strategic governance supported by a Knowledge & Information Management System

Six European Industrial Initiatives on key low carbon technologies have been proposed and are being defined and prepared with a possible launch in the next one to three years.

In the meantime, the European Commission is working on a proposal to stimulate and facilitate the financing of these low carbon technologies. A communication is to be released in 2009.

A European knowledge management and information system on energy technologies (SETIS) has been established in 2008 with the objective to establish a robust open-access information system on energy technologies and their innovation aspects, geared to supporting an effective strategic planning, monitoring and assessment of the European Strategic Energy Technology Plan. An integral part of SETIS is the technology and capacity mapping, which provides brief and comprehensive information of the prospects of major low carbon technologies, as well as of financing and human resources capacities to pursue R&D, D developments in Europe. The main findings of the first technology Map are that a broad portfolio of technologies needs to be developed strategically and inclusively to meet EU policy goals. Technology options can be expected to become available for the energy sector in several “waves” overtime, each wave synergistically contributing to the creation of a low carbon and sustainable energy system.

Above and all, the participation and engagement of European Stakeholders is critical and imperative for the success of the SET-Plan.

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