Sub-theme

5. Government role in Triple Helix interactions

5.2. Good practice, bad practice: learning from evaluations of government-funded innovation programs in support of innovation, technology transfer and entrepreneurship

Title

Triple Helix Sector Roadmaps: the case of the European Technology Roadmap-processes in Energy Technologies

Lykke Margot Ricard, DTU Management Engineering, Technical University of Denmark, lmri@man.dtu.dk

About the author

Lykke Margot Ricard is a PhD student at Department of Management Engineering, Technical University of Denmark (DTU), where she is working on strategic management in science technology and innovation with special attention to sustainable energy systems.

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Abstract

This paper is concerned with a new innovation policy instrument in the European Union, named the European Technology Platforms (ETPs). Today, after just a few years, 36 industry-led ETPs have emerged. This paper presents a narrative case study investigating the platforms in the specific technology sectors of wind power and carbon, capture and storage. The purpose is to bring European R&D closer to the market and direct European R&D via framework programs working for economic change and fulfilling social requirements. By introducing a new policy tool such as the ETPs, the EU Commission shows that the boundaries of strategy and priority-setting processes have changed from previously being constrained by a technocratic tradition that uses technological experts, towards engaging stakeholders representing not only science but also industry. They are characterized by membership on a volunteer basis and through highly consensual research agendas that create a shared middle- and long-term vision related to emergent issues such as shaping and directing the current energy system towards a low-carbon economy. This is an institutional change that is co-evolving with the emergence of a new tool that engages key stakeholders from industry to mobilize a higher rate of technical change though R&D investment.

1. Introduction

Although the European Union evolved out of the European Coal and Steel Community, which was founded already in 1951 and has legislated ever since in energy policy, an overall European energy policy does not yet exist. In 2008, the European Union dependency rate for crude oil was 84.2 % and for natural gas 62.3 %, which makes the current energy system vulnerable [1]. Energy systems around the world are facing grand societal challenges caused by scarce oil and gas resources, insecure energy supply, and climate change. This is the emergent issue related to in the context of this paper. Europe needs a sustainable growth plan involving a transition to a low-carbon economy, where job creation and affordable energy prices are part of the regime. This was recently formulated the European Commission, DG Energy [2] as a strategy for competitive, sustainable and secure energy. Estimates are that over the next decade investments up to one trillion euro are needed in order to transform the current energy systems in Europe, replacing equipment and changing resources. With this estimate, EU is facing; insufficient energy research budgets in EU; structural weakness in technology innovation, and; international competitors that are accelerating their efforts to challenge Europe’s leading position in renewable energies [3] [4]. But what is the right way to move from identification of these challenges to action? Setting targets alone has proved to be an insufficient means for government to structure change. One thing is sure, the longer we wait, and the more expensive the structural change will be [5].

Today, the European Union consists of 27 member states. The largest expansion was in 2004 and included 10 new countries. Clearly, they did not all face the same problems – or to phrase it more theoretically: clearly, they did not have the same innovation systems. The important analysis from the European Union has tried to answer the question: What are common European problems, and what problems have to be dealt with at the national level? Furthermore, looking at US and Japanese research policies, which use a differentiation rather than imitation approach [6], could inspire Europe to select a few areas in which it has promising technological capabilities.

<u>Changes in EU governance</u>

The original Lisbon strategy of the European Commission from 2000, which had a time span of ten years, was the agenda for making the EU *“the most competitive and dynamic knowledge-based economy in the world by 2010, capable of sustainable economic growth with more and better jobs and greater social cohesion and respect for the environment”* [7,8]. The strategy highlighted the concept of the knowledge triangle to ensure better interaction between three key drivers of a knowledge society – the interactions between research, education and innovation. However, in 2005, the mid-evaluation of the Lisbon strategy was made, which included a wide range of consultancies with experts and the public. The result was harsh. It showed a Europe that was falling behind its competitors and R&D that was leaving Europe. The mid-evaluation of the Lisbon strategy was also a critique of a strategy evolving into a complex setting of goals and with confusion in division of responsibilities between EU and its member states, as well as internal coordination within EU institutions [9]. The result was to re-launch the Lisbon Strategy, reducing goals yet keeping the goal of dedicating the three percentages of GDP to investment in R&D [6], as well as a new role for the European Commission – from a largely administrative role towards a political role [7].

Since the EU Commission supported setting up of the first European Technology Platform in 2001, which was in aeronautics, the emergence of European Technology Platforms has risen today to 36 industry-driven platforms. The largest increase was within energy technologies, around the same time as the mid-evaluation of the Lisbon strategy. In the European Research Advisory Board's report from 2004, recommendation was made to establish European Technology Platforms – while aware that a few existed already. The main argument for establishing the platforms was to ensure that European R&D responded to the economic change and social requirements of Europe:

> *"All too often in the past, European R&D, which could solve many of our economic, technical and social challenges, has failed to deliver. Issues related to regulation, finance, education, and markets created barriers in the innovation process"* (Report 2004) [10].

In setting up the platforms, the focus was to be on redirecting resources in time to respond to changes, and thereby to: 1) deliver benefits to European citizens; 2) create competitiveness for European companies; and 3) end the situation in which high EU R&D investments often produce fewer than expected benefits. The recommendations went on to the question of who should participate, and emphasized that it should not only be R&D communities but also key actors from industrial communities, companies, regulators, and consumer groups. As a result, the platforms should bring together key actors from the entire innovation process, thus ensuring both a vertical and horizontal coupling; and so it was stated that

> "*The Platform leaders - will be those engaged in bringing the technology successfully into the market. This emphasizes the companies commercializing the technology and other non-technical groups such as regulators and users. And it will be essential to get the right players – especially from industry" (Report 2004).* [10]

There are nine Energy Platforms and seven of these (2011) are pointed out as key technologies in the European Commission's Strategic Energy Technology plan (SET-Plan), set to "*achieve a certain policy goal or increase competitiveness in a certain sector"* [5]. The seven key technologies have delivered their roadmaps focusing on R&D priorities, demonstration, and deployment up to 2020. The Zero Emissions Platform (ZEP) was formed in October 2005, and the Wind Energy Platform (the TPWind) was formed in September 2006. At that time, they were an innovation policy tool meant to engage industry stakeholders in the European Framework Programs, since they according to EU leading civil servant, had been missing [5].

The two platforms, which are the subjects of the case studies in this paper, are centered on the two technologies; Wind power and carbon capturing and storage (CCS). Both technologies are seen by the IPCC panel, IEA and the EU Commission as technological solutions to the climate change challenges. Wind is projected to play a huge role in contributing to achievement of the EU targets for renewable energy of 20 percent in 2020; while CCS is part of the transition solution towards a sustainable energy system, since both IPCC and IEA projections forecast that renewable energy alone will not ensure an 80-90 percent emission reduction of the 1991 level by the year 2050. Both platforms are proving to be powerful players in making the framework programs better suited to meet the needs of industry, as well as to gather knowledge via the participatory process about redirecting European R&D towards a low-carbon economy.

A description of the institutional setting that this paper relates to is followed by a review of theoretical contributions to the emergence of an innovation policy perspective that opens to new governance instruments and tools, This sets the scene for discussing why a deepening study of these new policy tools is providing evidence of their characteristics, values and pitfalls, as well as new areas for further research. The case study is positioned within innovation policy with a special focus on the roles of the actors.

2. State-of-the-art

This paper investigates characteristics of the European Technology Platforms in Wind and CCS from an innovation policy perspective. It concludes that it is a somewhat new innovation policy tool and in that context creates new roles in the alliance between industry-university and government relations, thus the triple helix [11,12] roadmap processes. The structure of the information that flows from the platforms and to the framework programs and the strategic energy technology plan's (SET-plan's) information system is the framework for a technology roadmap, recently positioned in the literature as a foresight vehicle [13,14]. The emergence of a new policy tool, and thus a new institutional context, seems to follow the path from government to governance [15,16], and is also a paradigm shift from a science and technology policy towards an innovation policy that is broader in its perspective of focusing on the overall innovative performance of the economy. The broader scope of instruments includes a broader inclusion of actors – in this case, the industrial business communities – because they are seen as powerful players in a knowledge economy.

There are only a few case studies on sector roadmaps, and none of them examine the roadmap processes of the European Technology Platforms in energy; however, the sparse case studies in sector roadmaps all point out weakness in creating ownership of the roadmap at sector level [17]. Therefore, this case study is furthermore an investigation into how the actors in the European Technology Platforms and the European Commission work to create ownership as well as to offer implementation systems into which the stakeholders can feed the roadmaps.

Many scholars have focused on why changes should be made in the current energy system, and what changes should be made in order to build a sustainable future. One thing that scholars can agree on is that the transition to a sustainable energy system means changes in more than one system and requires governments to navigate across complex networks of actors, artifacts and institutions [18,19]. As Freeman already pointed out in 1963, technical change relates to many interrelated factors: education, training, design, engineering, production etc. Systemic thinking and innovation policy seem to bring the actors from the industrial business communities into play again, since they seem to have been left out of policy discussions; they may also have closed themselves in, so as not to risk leaking superior technology to their competitors. However, customer-driven innovation, open innovation, corporate social responsibility, and last but not least, globalization and economic crisis, which caused cutbacks in core business during the 1990s, with out-sourcing possibilities and new markets, have left the companies focusing on a smaller core but a larger partner network in every function of the company, from supplier network to innovation network.

The analytical framework of this paper is set within an innovation policy context related to theories of innovation systems (Freeman's version) and technology foresight, which have proved to be in co-evolution with policy perspectives, from a science and technology policy towards a focus on innovation policy. This section therefore presents a brief theoretical discussion of the constitution of the perspectives of science, technology and innovation policy, innovation system (IS) and evolutionary growth theory. This provides insight into the theoretical perspective on innovation policy and how the current literature characterizes its instruments.

Innovation policy and innovation system

Within the last decade, EU policy has changed in political instruments and perspective – from science to technology policy and lately to innovation policy [20] [21]. These policy perspectives open up almost like Chinese boxes, where innovation policy is the largest box. The difference between a traditional science policy and a technology policy is characterized by a more instrumental focus on national prestige and economic objectives, but with the same elements, such as universities, research institutions, technological institutes and R&D laboratories. From focusing on the production of scientific knowledge, technology policy has a wider focus on the advancement and commercialization of sectorial technical knowledge, e.g. the universities' link with industry. Thus, commercialization of technologies is a step towards an innovation policy perspective. The difference lies in a broader focus – from a focus on the universities and technology sectors to a focus on overall innovative performance [21] , which includes the business communities.

Setting R&D priorities is still a very important factor and is widely recognized as an important instrument for structuring change. Yet, it is not the only one. Technical change does not only depend on R&D, as Christopher Freeman [22] pointed out already in 1963, but on many related factors such as education, training, production engineering, design, quality control etc. Freeman was one of the architects behind the "Frascati Manuel" (OECD, 1963), which provided OECD and political institutions with methods to measure R&D and compare across countries. Freeman (1995) [23] states that the authors of "Frascati Manuel" already then pointed out a critique of the methods that endorsed the linier innovation model and overlooked the feedback mechanism from the market and production into the R&D system:

”*The simple fact that the R&D measures were the only ones that were available reinforced these tendencies...”* [23] Freeman 1995, p.6).

Moreover, he stated, with empirical evidence in contrast to endorsing the linear innovation model:

“*Numerous case studies of innovation [9] brought out the importance of flows of information and knowledge between firms as well as within firms. Moreover, the results of the empirical research pointed to the importance both of flows to and from sources of scientific and technical knowledge and of flows to and from users of products and processes*” [24] Freeman p.30 1996).

Innovation policy and innovation systems seem to have a mutual historical development with an explicit shift in perspective from systems of production towards systems of innovation. In 1987, Freeman used the expression: “The national system of innovation”, which he defined as:

”... the network of institutions in the public and private sector whose activities and interactions initiate, import and diffuse new technologies” [25](Freeman 1987).

The term national Innovation system was developed for twenty years, in parallel, by Christopher Freeman at SPRU, Sussex University, UK, and the IKE group at Aalborg University, Denmark, as a way of perceiving innovations in contrast to the economic policy perception of international competiveness as static measurements of e.g. national nominal wages of labor and nominal value of currency, where innovation and learning were important focus of the processes[20] .

The evolutionary economic concept plays a significant role in the innovation system perspective. Behind the innovation system perspective lies the economic concept of a selection mechanism that stands in opposition to neoclassic economic theories. According to Nelson (1995) Neoclassic growth theory has been constrained by its basis on mechanical concepts of equilibrium [26]. Neoclassical theory assumes full information and independent utility functions, whereas an evolutionary economic theory builds on uncertainties, expectations and also some sort of ‘systematic selection mechanism’ that opens for a broader understanding of what is actually happening at the micro level, in order to understand the various levels of aggregate; moreover, it builds on technological developments as an endogenous growth factor [27] [20]. Innovation system is a theoretical concept within evolutionary economics. It allows us to see the variations among firms and in the technologies:

“Within this model more productive and profitable techniques tend to replace less productive ones, through two mechanisms. Firms using more profitable technologies grow. And more profitable technologies tend to be imitated and adopted by firms who had been using less profitable ones” (p.71 Nelson, 1995 [26].

In the last chapter in Handbook of Innovation, Lundvall & Borrás (2006, p. 615) [21] argue that an innovation system perspective is an interactive process focusing on competencies between suppliers, users, knowledge institutions and policymakers. It provides heterogeneous perspectives on the role of innovations, dynamics and transformations, and therefore also naturally develops insights of why best practice cannot be transferred from one context to another. Since, the national innovations system was introduced; scholars have introduced regional innovation systems, sectorial systems of innovation and technological innovation systems. A technological innovation system was first defined by Carlsson and Stankiewicz (1991) [28]. It is an approach that looks for seven functions [29] and focuses on the structural elements necessary for a well-performing system. This approach has received much criticism from the innovation system research community [30] on the grounds that its perspective is much too functionalistic and leaves out the social shaping of the actors and not just by the actors [31]; therefore, it also lacks dynamics. This is not the case in the research presented here, since the actors, with their competing visions, expectations, and also networks, capabilities and resources, are close to what Freeman, in his article on “The greening of technologies and models”, called mobilizing human capital combined with R&D investments in order to create change towards growth and the greening of technologies.

The point of mentioning the various innovation systems perspectives is that these perspectives can been seen as a set of lenses focusing on the central viewpoint: a technology or a sector linked to a technological domain. It is at the same time blind to these other aspects. Each perspective focuses on different aspects of innovation systems – a model giving meaning to what we see and experience. The choice depends on the question being asked, but perhaps in this case - where we are dealing with EU’s multi-level policy as well as a Europe R&D system consisting of many systems. The investigation could be to study if any new models are emerging from the European Commission assuming this more active political role?

3. Methodology

The framing for the roadmap processes was found in the literature on a changing institutional context, where government becomes the host of governance bodies. This seems to be the case with the policymakers of the European Commission, who act more in a political role than formerly solely as administrators. The innovation policy perspective, where innovation and competitiveness are in focus, includes the industrial and business communities as stakeholders. The paradigm for understanding the action plans of the ETPs lies in the social shaping of technology (SST). It is clear that when gathering different stakeholders, including business competitors, it must form some sort of empowerment, since roles and interests of heart are at stake in which actors may have conflicting interests. The approach to finding structure and defining the role and targets in a process that has been negotiated is not an easy task, since the process lies in the minds of the key stakeholders, those who are leading the platform. The methodology is therefore not a strictly evidence-based approach, but a narrative approach, which seeks to tell the story behind the roadmap processes, in order to form the body of roles and powers that define the technology path that is now laid out in the specific European roadmaps in Wind and in CCS.

The narrative approach

The analytical framework for reconstruction is inspired by Callon's *Some elements of a sociology of translation: domestication of the scallops and the fishermen of St Brieuc Bay* (1986) [32], the structure follows the four elements of an approach translating a study of power: *problematization, interessment, enrollment and mobilization*. The four elements comprise the structure chosen for presenting the stories, for two important reasons: First, when focusing on a proposed problem of a technology or barriers to bringing R&D to the market, a relevant question may be whom it concerns; and secondly, it may be important to ask who is proposing the relevance? [33]

Data and methods

The narrative is constructed from interviews and key presentations, as well as from observations made while participating in the General Assemblies, selecting among those who were visible by making presentations at the platforms.

<u>Exploratory interviews</u>

Exploratory interviews were carried out in the early phase of the research in order to gain understanding of the technical and organizational context in which the case object, the ETP in wind and CCS, operates. The key stakeholders in Denmark were the first to be interviewed. Through an exploratory interview with the head of the wind department at Risoe DTU, Technical University of Denmark, who was pointed out as a key player, it was possible to identify the UpWind project as the partnership first forming the TPWind platform. This interview was made in 2009. A key player in CCS was the CEO and Chief Geologist from Vattenfall, who gave a key presentation at the DTU workshop preceding the climate change meeting in Copenhagen in 2009. He was not only a member of the Advisory Council, but also one of the founding members of the ZEP in 2005, when he was working for GEUS, a Danish sector research institute with expertise in geological studies. These interviews were helpful in preparing to participate in the ETP General Assemblies.

<u>Observation of ETPs in the General Assemblies (GA)</u>

The GA gathers all the members of the specific platform – approximately 200 in the ZEP and 100 in the TPWind. The GA's are usually held once a year, but in the initial stage of making the roadmaps, GAs were held twice a year. As observer, I registered all barriers mentioned to be of importance to the sectors, and who mentioned them, in order to identify any conflicts that might lie in the barriers mentioned.

<u>Semi-structured interviews</u>

Interviews were conducted at a later stage using an interview guide for semi-structured interviews [2]. The questionnaire was structured in accordance with the key outcomes from the extensive interviews with the Chief Geologist from Vattenfall. Each interview was meant to take 30-45 minutes. The stakeholders that were interviewed here were all participating in the TPWind GA – The leading EU civil servant that were with the head of DG Energy and participated in both TPWind and ZEP. Two leading researchers in wind were with the two industrial players most in the forefront in wind: Siemens Wind Power and Vestas. Interviewees were asked to name the most important barriers, if any, to bringing the sector forward. They were then asked to rank the barriers according to degree of success, and whether an issue was within the sector's capability to arrive at a solution. Interviewees were also asked about their self-interest in participating in the ETP.

4. The story of the roadmaps of the TPWind and ZEP

The EU Parliament, and particularly the European Council, plays a significant role in setting overall priorities, such as the overall budgets for EU's framework programs, the grant types of the framework programs, and overall priorities among major areas of science and technology. Member countries, universities, industry, and NGOs still have interests in influencing these overall priorities; however, there seem to be strong indicators that point to the fact that influence might be more efficiently pursued on the level of strategic research agendas and thereby on the sector level of each ETP.

The story behind the European wind roadmap

TPWind was launched in 2006. The platform webpage says:

> *"It is unique: the only body with sufficient representation or 'critical mass' of wind-specific knowledge and experience to be able to fully understand and map realistic and prioritised pathways for policy and technology R&D, taking into account the full range of sector needs"* [34].

The members comprise stakeholders from wind industry-universities-government relations, and R&D institutions, finance organizations, and the wider power sector, as well as new representatives from the oil and gas companies participating as observers (just as I am).

A lot has happened in the wind industry within the last 20 years. As the story goes, wind power started out with small entrepreneurs and rebel researchers with roots in the hippie environment and a driving vision for making a better world. Originally, these researchers set out to experiment with nuclear power at Risoe, the Danish National Laboratory, when funding of nuclear power in the early 1970s became like a glass ceiling – just waiting to fall down. The researchers then started looking at alternative power sources and started by producing a wind atlas from the data collected from the wind mast placed in Roskilde, Denmark, to measure wind conditions in the case of a nuclear power release. But now, for example at the TPWind general assembly on March 3, 2011, everybody is wearing a dark suit, white shirt and tie, which is a strong signal that wind power, has become a large industry. The entrepreneurs have been replaced by managers and professionals in governmental affairs, and some of the pioneers are also wearing the uniform worn by those in a powerful industry.

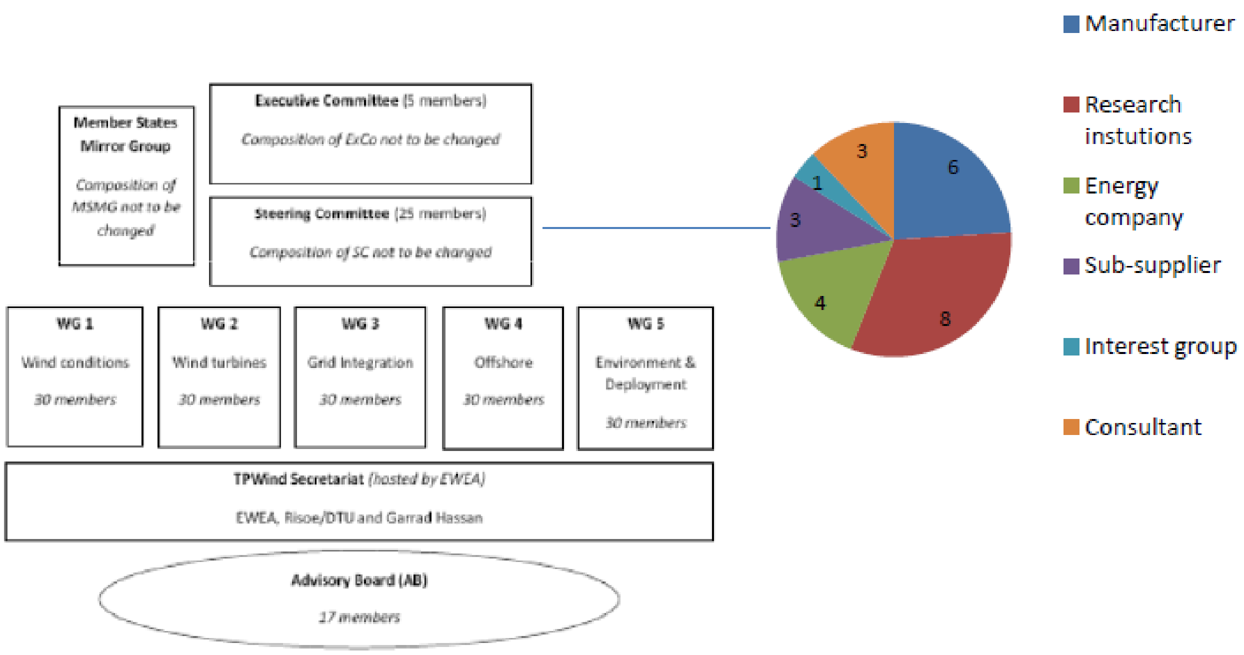
Problematizing: A Response to Major European Challenges?

At the beginning of the 1970s, research and breakthrough discoveries were the business of research institutions and small entrepreneurs; today, the wind firms have their own R&D departments. As the wind industry has become big business, it has also opened new markets for existing industries by placing demands on manufacturing, installation, maintenance, and electronic control systems. And lately, offshore wind farms are opening up new markets for oil and gas industries. To put it another way, the wind industry is setting the agenda for business opportunities in existing industries, and it may be seen as a driver for generating new knowledge in other industries. But the wind industry is dependent for its development on technology transferred from other industry sectors, such as aeronautics, shipping, steel and composites. Furthermore, globalization, with strong international competition from China and internationalization of R&D, is putting the benefits of a strong European wind industry at stake, thus creating the issue of maintaining Europe's leading position as a wind competence centre.

Enrolment and mobilization: key-stakeholders of TPWind

The preparatory step for developing the network was the integrated EU project UPWind funded with 50 percent under the 6th EU FP. The project included 43 partners from industry and research communities within Europe [35]. The same partners agreed to the common vision: Wind energy should cover 12-14 percent of the EU's electricity consumption by 2020, with a total installed capacity of 180 GW. By 2030, this should increase to 300 GW of installed capacity. Stakeholders defined a Strategic Research Agenda with the expectation of implementation in the European Framework Program (FP7) and collaboration in Joint Undertakings between partners. The platform's stakeholders are responsible of mobilizing the significant human and financial resources necessary to fulfill this vision. From being a project partnership, the platform has taken the form of an institutional body.

Figure 4.1. TP WIND structure and leadership, distributed on key stakeholders

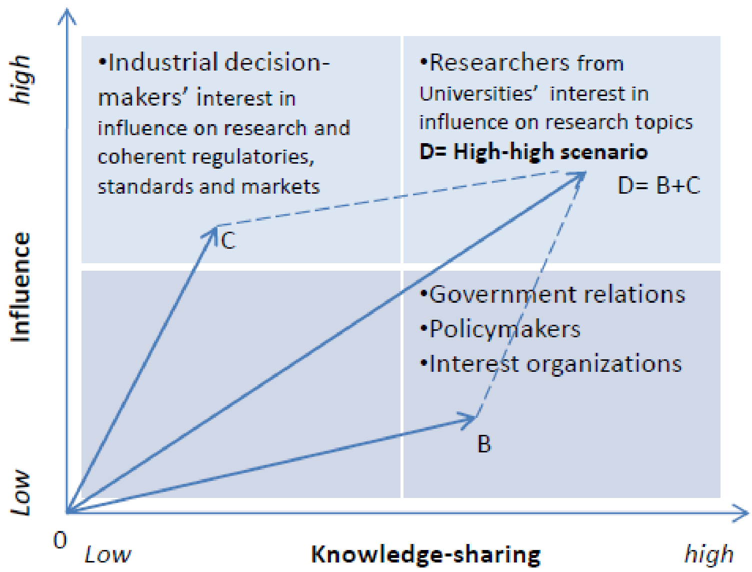


In TPWind, it is the Steering Committee that represents the leadership of the platform. The figure shows the type of organization in which the TPWind leadership is distributed and is made on the basis of data collected from each member of the Steering Committee (which is in accordance with sponsorship structure). TP Wind's key stakeholders are divided into the category that the member represents. The figure shows multiple stakeholders from the business community and science community, yet the picture is dominated by very competitive wind turbine manufacturers such as Vestas, Siemens Wind Power, Gemesa, GE Wind Energy, Iberdrola, and Alstom Ecotéchnia. These are the key-stakeholders representing the leadership of the platform, which should be industry-led. A dominating group in the leadership however is the representatives from research centers and universities.

Interessement: Interest at stake

By gathering multiple stakeholders, different interests and expectations are present and also at stake. The roadmap process includes a negotiation process: What are the most important barriers that are critical for success? Who has access to these? In TP Wind, the manufacturers are the largest group represented, which consists of multinational companies. The wind industry has developed rapidly in Denmark. It was the research centers and small entrepreneurs who started the wind industry some 40 years ago, transforming their production from rural machines to wind turbines. As the wind turbine manufacturers have grown large, so has their knowledge. Today, a wind turbine consists of 1500 components. In continuation of this steady growth, as the global targets for renewable energy pull production, the manufacturers are developing in-house competencies and followed by IPR protection. Due to their size, the large manufacturers and suppliers are able to develop the technology and components needed in-house. For a large manufacturer like Vestas, the core IPR-protected technology is the wind turbine. But why risk leaking knowledge about what is seen as part of the firm's core competitive advantage, when it can be done in-house? Some of this knowledge needs to be shared with the strong research centers and universities if there is to be a competence centre in Europe; therefore, collaboration and knowledge-sharing are at stake in this sector.

Figure 4.2. TP Wind interest matrix



The two-times-two matrix in figure 4.2 supports the conflict with regard to knowledge-sharing. To be positive, the author inserted the power of conflict into a vector addition interpreted geometrically by the parallelogram law. The effect of the powers, and thus interest, would be a consensus leading to the high-high scenario of high influence on the roadmap combined with high knowledge-sharing.

Figure 4.3. Barriers and capabilities in the wind sector

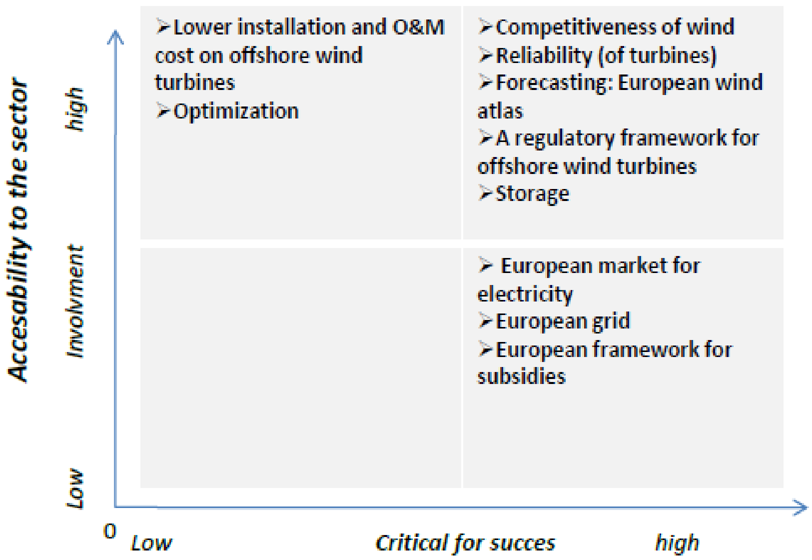


Figure 4.3 is a graphic representation of the ranking of the most important barriers identified in the interviews with stakeholders. Interviewees were asked to name the most important future barriers for developing the European wind sector. The interviewees were then asked to rank the barriers on a scale from 1-5, 5 being highest. Off-shore wind turbines were ranked as 1-2, while a regulatory framework for off-shore turbines was ranked as 3. A European Grid and a joint market for distribution of electricity were ranked 5 (the highest, and in 5 out of 6 interviews, one ranked it 4). A European framework for subsidies was ranked 4. The results were plotted in after the ranking in the interview and rated according to whether the key stakeholders would have accessibility or control over it in the network

The result strikingly shows that the expectations of a co-evolution of a sector's developing at a higher innovation level in Europe, only happens if new challenges are laid out of higher capacity. The TP Wind roadmap is now the European Industrial Initiative (EII). Yet, the roadmap is perceived to be less important than the vision of the leading industrial stakeholders (Siemens and Vestas). Vice-Presidents from Vestas' R&D Technologies said:"The vision is now a driver for the sector". To a high degree, the TP Wind roadmap outlines and focuses on off-shore wind turbines; however, when asked to name the barriers to developing wind technology further and also ranking them, ownership of the vision, as well as the vision itself, are perceived as strong.

The story behind the CCS roadmap

The Zero Emission Fossil Fuel Power Plant Platform, which recently changed its name to Zero Emissions and is also known as ZEP, deals with the technology Carbon Capture and Storage (CCS). The platform was funded in 2005, based on an idea of the advisory committee to the European Committee on clean coal back in 2003.

Problematizing: A response to a major European challenge?

The focus of the ZEP is on deployment of CCS, and therefore, the vision is also commercial: CCS is to be commercially available before 2020. CCS is a new emerging technology at the beginning of creating its path; however, the carbon capture technology has its origin in the gas industry (power stations), and the storage part has its origin in the oil industry. The main objective is to reduce the cost of the techniques in order for the technology to be commercially ready before 2020. This can only be done by large-scale demonstration plants, meaning testing the CCS techniques in current coal-fired power plants in close relationship with R&D studies. The other important issue is public acceptance of storage of CO_2 underground. This is called the NUMBY challenges (not under my backyard)[36]. Since the establishment of ZEP, there has been visible political backing regarding the barriers and potential of the technologies for enabling CCS. In 2007, the European Council endorsed the Commission's intention to stimulate the establishment of up to 12 CCS demonstration projects by 2015. Such an initiative is the first of its kind in which the European Commission and industry join in the effort to advance large-scale deployment in order to demonstrate the feasibility of CCS in power generation and lower the current cost of electricity produced with CCS by the year 2020. Furthermore, the European Union committed itself in 2008 to reduce carbon dioxide emissions by 50 percent by the year of 2050, and recognized the role of "*technologies enabling capture, transport and storage of* CO_2" [37]

According to Vattenfall's CEO, there is a huge amount of research in the R&D phase and none in the demonstration and deployment phase, which is a solid bottleneck in the innovative phase for making CCS commercially ready before 2020. In his perspective, the industry has an important role in the strategic debate between EU and the key stakeholders, since a vast technological domain, like the coal power plants, cannot be driven alone by R&D. So far, the issues in the debate leading up to the European roadmap on CCS have been: How many demonstration plants are necessary to prove that CCS can be commercially ready by 2020? The demonstration plants should then be established in 2015. Now, what is really happening is a few demonstration plants with the risk of excess research in the R&D phase. Pilot tests can be carried out by this research, but when the technology has to be taken to full scale, demonstration and research can no longer carry the process, he explains. Before we actually get to build a power plant with CCS or apply CCS in an existing power plant, there will be no new data and no new knowledge to push the process. There are no technological barriers, but we consider market barriers such as public acceptance and political barriers as one issue: Is this an acceptable technology? First, we need from the politicians to hear if we can take it to a commercial stage. The other issue is: how do we make a business model out of CCS? Meaning how to finance the development, because: *"...if there is no roadmap of how to reach the vision in 2020 – it is rather impossible to mobilize resources and invest in this technology",* he says.

Enrolment and mobilization: Key stakeholders in ZEP?

The common vision was the first task and consensus among members took some time, accordingly three months [36]. Finalizing the strategic research agenda and the strategic deployment document at the end of 2006 was an eye-opener that required restructuring the taskforces. The main challenges were now commercial viability, public acceptance and liability of storage. A focus shift from development to implementation was required. The working groups were transformed from being divided into different technologies to becoming a technology group, a demonstration and implementation group, Policy and Regulation, and Public Communication, all working groups that called for qualified applicants. The Steering Committee then made a public call for applicants via its website and invitations through the network. The co-ordination group selected the applicants. As applications came in, the taskforce of Policy and Regulation had an overrepresentation of researchers among the 46 applicants. So, the group decided instead to invite stakeholders from the business communities of the Eastern European countries.

The organizational structure of ZEP started as a network-like structure with five members that comprised an Advisory Council. Later, this quickly developed into more of a governance structure like that of a Steering Committee, Coordination Group, and Government Group (formerly Mirror Group). The activities are carried out by taskforces. The platform is supported by a Secretariat that receives partial financial support from the European Commission under FP6/FP7; the other part of the financing comes from industry sponsors, which are identical with key-stakeholders.

Figure 4.4. The structure of ZEP and leadership distribution on stakeholders

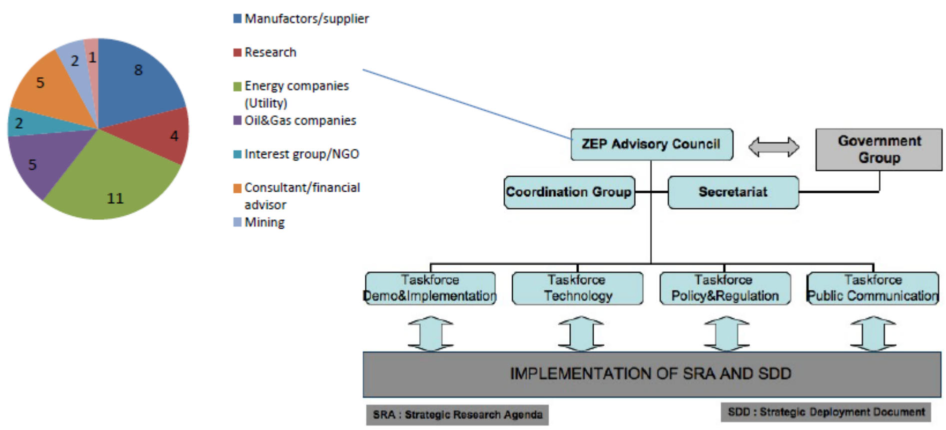
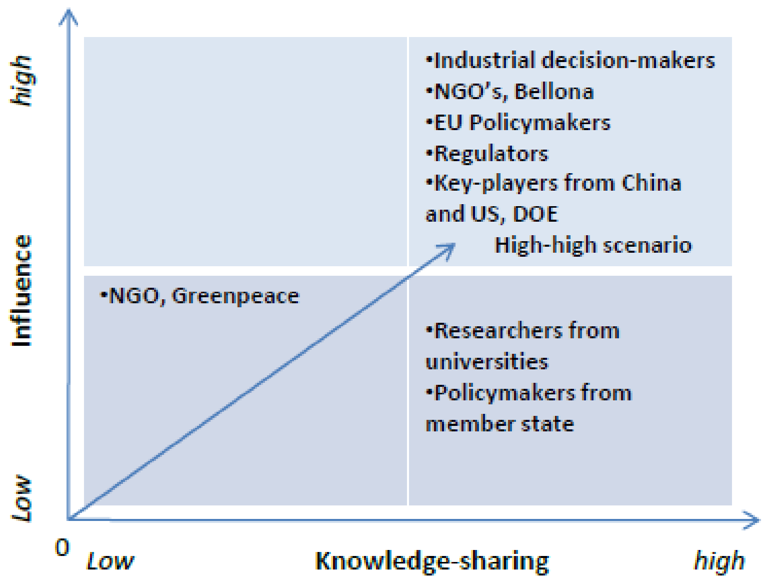


Figure 4.4 shows the structure of the ZEP, where the Advisory Council forms the leadership of the platform. The figure then shows the organizational types represented in the Advisory Council and thus the distribution of leadership among stakeholders, which, according to the recommendations of the European Research Advisory Board's report from 2004, form the key stakeholders and should be industry-led. The main representatives are the electricity companies that own the utilities, and second largest, the oil and gas industry. The figure gives a picture of a multiple set of stakeholders involved in the key decision-making in the ZEP, ranging from business community to science community. The figure also shows the power balance in the platform, with the largest representation from industry, and within industry, the largest representation is from the utility companies, then the equipment supplier, and third, representatives from the oil and gas industry.

4.5. ZEP interest matrix

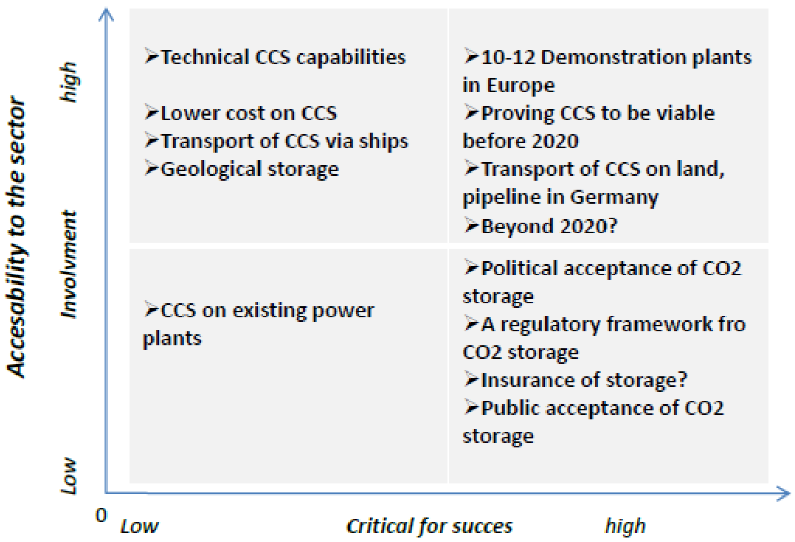


An Energy company like Vattenfall, which is selling electric power and heating, is interested in an open knowledge process that includes all sub-suppliers, as this may lower prices on components and contributes to a cheaper total solution than just going along with one sub-supplier. The equipment suppliers/manufacturers, however, would be interested in closing the innovation process, so as not to leak any of their knowledge on components for commercially viable CCS power plants – such knowledge is superior technology and protected by Intellectual Property Rights (IPR)). The oil and gas industries have a different approach, as they already have the techniques, knowledge and technologies for CCS: combustion techniques from the gas industry and transport and storage from the oil industry – like "enhanced oil recovery" (EOR). The point to be made is that they already have the techniques, and CCS will open new business opportunities. There seems to be a certain consensus in the research institutions that are stuck with the current techniques, since a public policy is lacking [38]. This may explain the table 4.5 where actors come very close to the high-high scenario. Greenpeace was invited in the forming of the platform, but as the story goes, they change strategy from a low carbon towards a no carbon at all. The NGO organization Bellona's CEO was in 2007 appointed to vice-chair of the ZEP Advisory Council. On their webpage it says:

> *"The appointment of the Bellona staff means the Oslo-based organisation's work will play a key role in forming the entire culture surrounding the development and implementation of emissions-free, climate friendly industry and technology across Europe, and eventually - via the platform's example - the world". (15/3/2007)*[39]

Figure 4.5 shows barriers and capabilities critical to successful commercialization, ranked in relation to accessibility to the sector and involvement. Data and scores are extracted from interviews and presentations at the ZEP general assembly in 2009 and 2010.

Figure 4.5 Barriers and capabilities in Carbon, capture and storage



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CCS application in existing or new power plants involves high-risk investment, since CCS is not yet proven on a large scale, and the future of the technology is uncertain. It still lacks public as well as political acceptance on national levels. Until now, the EU incentives for a knowledge-sharing process have been:[1]

€1 billion from the EU Recovery Plan, due to the financial crisis (that is 1/5 of the total budget for energy).[2]
150-300 million emission allowances – auctioning revenues from The New Entrants Reserve (NER) under the EU Emissions Trading Scheme (equals €1.8-3.7 billion at current carbon prices, but the EU Commission calculates they could be worth €6 billion).[3]
The Seventh Framework Program (€425 m).[4]

[1] www.corporateeurope.org/system/files/files/article/**Public_Money_ZEP**.pdf

[2] http://www.europarl.europa.eu/sides/getDoc.do?language=EN&type=IM-PRESS&reference=20090505IPR55117

[3] http://www.euractiv.com/en/energy/eu-clears-extra-funds-carbon-storage-offshore-wind/article-188185

[4] http://cordis.europa.eu/fp7/energy/open-topics_en.html#carbon-capture-storage

An efficient tool for dealing with multiple stakes and business interests has been to come up with a knowledge-sharing plan, also referred to as the knowledge-sharing document, which was a clear structure on what information that could be shared and how. In the Technology taskforce, the discussion has been heavily on how to share knowledge. Because of the main discussion about what are the projects and who will finance them, the stakeholders started cost-estimating a highly efficient coal-fired power plant with applied CCS. They identified not only technical issues (who has the best project?) but also political issues: *You can have the CCS demonstration projects in the northern countries, but there also has to be one in e.g. Poland, as they would need to be spread geographically* (Interview, CEO, Vattenfall, [36]).

When reflecting on the strategic process, he fears that there is a massive focus on getting the 10-12 demonstration projects, but no focus on the day after tomorrow – after the demonstration plants, the real innovative step is when CCS is applied in a full-scale power plant. A vacuum is created by blindly following the Koyoto-agreement and focusing on the 10-12 demonstration plants. We have an artificial time horizon, whereas USA has a more natural time horizon. When can we apply CCS in full scale?

5. Findings and interpretation

Observations revealed a clear command in the division of roles. Both chairmen are highly respected industrial players in leading positions. In ZEP, the chairman is the leading executive vice-president of Royal Dutch Shell's CO_2 department, and a co-vice-chairman is from Bellona, a Norwegian NGO. In TPWind, the chairman is Head of Government Affairs at Siemens Wind Power A/S. The findings were by large in accordance with the recommendations laid out by the European Research Advisory Board's report from 2004 on the ETPs. Mobilization of allies seems strong as otherwise; it should close [10]. Who speak for whom? Valued statements gathered from interviews point to the fact that the ETPs are simply a strong voice of the industry, as long as nobody is fooled with anything else, this is a valuable communication tool as to letting the information flow via more channels, this one from markets.

Following the processes in the two platforms, the author developed a model (figure 5.I) illustrating the coordination processes between the multi-levels: micro, sector, and macro. The focus is on the roadmapping process, on the creation of ownership and legitimacy of vision and roadmap. After the first prototype of the model, it was tested in interviews with stakeholders from TPWind (industry and researchers) and EU's leading civil servant from DG Energy and finally fitted.

Figure 5.1 Coordination model

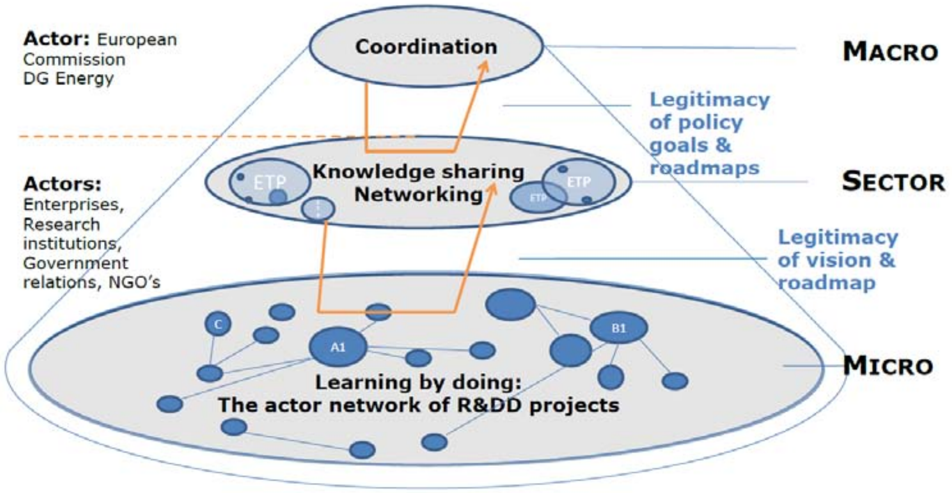

Figure 5.1 illustrates the bottom-up foresight process that creates ownership of visions and roadmapping processes:

1. Micro level related to learning by doing in the joint projects
2. Sector level related to face-to-face knowledge-sharing, influence, information's-flows and networking in the platforms at General Assemblies, at Steering Committee meetings etc. as to establish relations.
3. Macro level related to coordination at the supra-national level

The model illustrates the coordination process of the roadmaps. At micro level, we have the actor network of R&D and demonstration that have been and are being carried out. The ETPs are placed at the sector level dimension – as there are seven platforms within energy and all these deliver a roadmap – legitimacy of the common vision, including the roadmap, in wind and CCS is established via negotiations processes, where the outcome and participants are visible (See exhibits I and II for the European wind roadmap and the CCS roadmap). ETP actors participate only at the sector level.

At the macro level, it is DG Research in energy and transport of the EU Commission that manages the process by integrating these in a portfolio of energy technology roadmaps. This portfolio is then managed through common assessment frameworks such as the EU SET-Plan, ERA Strategy (Energy 2020), EU Framework Program, the amount of investment and support. After the negotiation process on estimates of investments needed at certain stages, the roadmap then serves as the European Industrial Initiative in Wind and in CSS.

The roadmaps serve as both a strategy and a communication tool at many levels:

First, the roadmaps serve as tools to communicate market information to the SET-plan's information system. Second, the roadmaps serve as strategies for the European Industrial Initiatives. And third, they provide a transparent process that efficiently focuses only on the technology layers in the roadmap and a few milestones in order to align funding schemes. The combination of the roadmapping tool and processes and transparency in stakeholder participation make it a visible process. Anyone can google ZEP or TPWind and see who is participating. In addition, the roadmap shows that

> *"… these are the ones that participate plus we invest this amount of money and for that they promised these deliveries within 2020. It becomes a visible process".* [5]

The basic value of the strategic effort is that it increases the effectiveness of public support and enhances the coordination of available funding schemes - both EU and national funds can view actions and priorities identified in the Roadmaps. As a result, the added value of the roadmapping processes is that Technology Platforms also helps clarify the long-term development trajectory of low carbon technologies and contribute to create certainty for investors.

6. Conclusions

Industry-university-government relations changed into a more institutionalized context as new policy tools were introduced following EU governance's shift to an innovation policy, a policy that is broader in scope and instrumentation than the prior science and technology policy had been. It is investigated how the strategic aspect of the sector roadmap processes of the European Technology Platforms in Energy changes and introduces a new form of active governance that engages stakeholders that especially includes the industrial business community. The processes introduce roadmapping, a tool that since its introduction into corporate settings in the late 1970s is becoming more popular at the sector level.

Today, these platforms amount to 36 industry-driven platforms divided into technology-specific sectors. By introducing a new policy tool like the ETPs, the EU Commission shows that the boundaries of strategy and priority-setting processes are changing from previously being constrained by a technocratic tradition using technological experts towards moving outside traditional institutions. It reflects the fact that governments cannot be seen as the sole authority for making decisions; instead, government becomes the host of mechanisms involving non-governmental actors. Thus, policymakers themselves become stakeholders. That the strategic processes create a vision through highly consensual research agendas is evidence of the powerful effect of engaging stakeholders that can mobilize changes in the form of existing technical capabilities and future investments in demand and supply technologies. One can say that it is a change from a solely evidence-based policy towards a more narrative policy, building on expectations, uncertainties and visions to mobilize human capital. In the context of the case, it provides evidence for a new knowledge model showing how EU government, via an innovation policy tool, engages stakeholders from business and research communities. The structure of the relationship between stakeholders, vertically and horizontally, becomes the roadmap framework that serves as a medium for communication between many levels, thus a carrier of the vision.

7. Policy implications and directions for further research

Formal alliances between members from science, industry R&D, and industrial production have proven very efficient in development and deployment of technology. Inclusion of public authorities in the alliance will enable an efficient flow of information.

A R&D and demonstration alliance is becoming more essential as joint research is encouraged by the European Commission and implemented in the future framework programs and thus in integrated R&D projects. A R&D and demonstration alliance gives companies the opportunity for a relatively low investment to buy an option in technology research that in time could have market potential. Moreover, the incentive is that previous efforts to make technology ready for the market have been the task of the industry alone. Nowadays, the idea is that by bringing stakeholders together from the whole process of technology development, from research to market – by joining forces – we can reduce “time-to-market” for specific technologies. Clear goals and incentives for science and industry to actively take part in “joint programming” activities should be set. It is envisaged that this could be implemented in an international context where a group of countries with a particular interest and capacity in a strategic research topic join a R&D and demonstration program. Developing shared visions and mutual acknowledged strategic research agendas are important tasks for such alliances. Strong evidence for this is the European Technology Platforms, which already exist at the European level. The platforms provide a meeting place for the most innovative industrial companies and R&D communities to identify together, in the specific sector, the most important technological research and development necessary in order to reach future goals in technology sectors. An important key issue is of course the allocation of resources for new R&D as well as utilizing existing capabilities.

The roadmap processes of the ETPs in wind and CCS show that the European Union is supporting a new mechanism that allows the flow of information between central actors in sectoral innovation processes. It is developing some sort of foresight in the actors, or what Teece [40-42] has called dynamic capabilities – that is, sensing and seizing social and economic issues that need redirection of resources at the right time. This is not referred to as trend extrapolation, but more what Freeman referred to: "What would happen if these trends continued unchecked” ([24] p.33). It is a new governance mechanism, evolving along new more dynamic capabilities, which is built-in via the more active and political role of the European Commission in changing the existing science and technology systems.

Freeman, in his 1996 paper, "The Greening of Technologies and Models" [24], once argued that a new model of innovation would need to be evolved for a greening of technologies. This would require a science and policy system that is highly responsive to social and economic change. Is what we are seeing evidence of a new institutional change co-evolving with the emergence of a technical change?

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Exhibit I: European Wind roadmap – from the TPWind

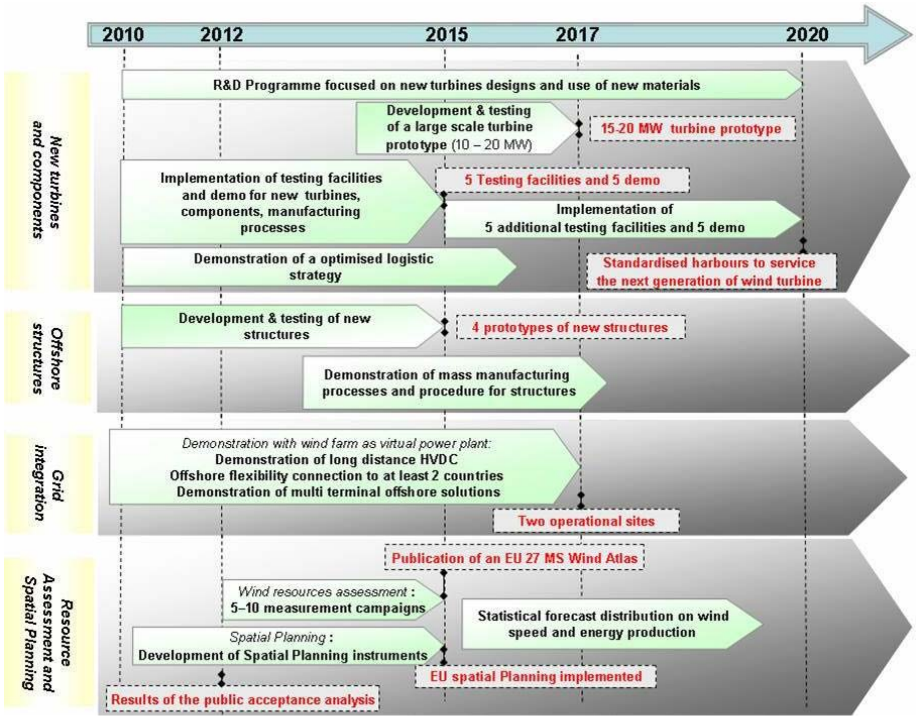

Exhibit II: European CCS roadmap – from ZEP