Transforming Innovation into Realistic Market Implementation Programmes

Workshop Summary

27-28 April 2010
IEA Experts Group on R&D Priority Setting and Evaluation

International Energy Agency

International Energy Agency

iea Energy Technology Network

International Energy Agency

The International Energy Agency (IEA) is the energy forum for 28 advanced economies. IEA member governments are committed to taking joint measures to meet oil supply emergencies. They also have agreed to share energy information, to co-ordinate their energy policies and to co-operate in the development of rational energy programmes that ensure energy security, encourage economic growth and protect the environment. These provisions are embodied in the Agreement on an International Energy Programme, the treaty pursuant to which the Agency was established in 1974.

The IEA carries out a comprehensive programme of energy cooperation among 28 Member countries. The founding objectives of the IEA are to:

- Maintain and improve systems for coping with oil supply disruptions.
- Promote rational energy policies in a global context through co-operative relations with non-member countries, industry, and international organisations.
- Operate a permanent information system on the international oil market.
- Improve the world's energy supply and demand structure by developing alternative energy sources and increasing the efficiency of energy use.
- Promote international collaboration on energy technology.
- Assist in the integration of environmental and energy policies.

The IEA member countries are Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, Germany, Hungary, Ireland, Italy, Japan, Republic of Korea, Luxembourg, Netherland, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom, and United States. The European Commission also participates in the work of the IEA.

IEA Experts' Group on R&D Priority Setting and Evaluation

Research, development and deployment (RD&D) of innovative technologies is crucial to meeting future energy challenges. The capacity of countries to apply sound tools in developing effective national R&D strategies and programmes is becoming increasingly important. The IEA Experts' Group on R&D Priority Setting and Evaluation (EGRD) was established by the IEA Committee on Energy Research and Technology (CERT) to promote development and refinement of analytical approaches to energy technology analysis; R&D priority setting; and assessment of benefits from R&D activities.

Senior experts engaged in national and international R&D efforts collaborate on topical issues through international workshops, information exchange, networking, and outreach. Nineteen countries and the European Commission participate in the current programme of work. The results and recommendations support the CERT, feed into analysis of the IEA Secretariat, assist the G-8 and Major Economies Forum (MEF), and provide a global perspective on national R&D efforts.

For information on further activities of the EGRD, see www.iea.org/about/experts.asp.

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Executive Summary

Transferring technologies from the laboratory to the marketplace is a multi-faceted challenge. Financial, regulatory, structural, and market barriers exist at all points of research, development, demonstration, and deployment (RDD&D) process. Policies and programmes aimed at reducing cost and risk, implementing codes and standards, designing public outreach programmes or implementing tax and financial incentives have been successful in overcoming these barriers. This challenge is not new, but has recently gained renewed interest following discussions at high-level meetings.

- At Aquila, Italy in July 2009, G8 leaders emphasised the paramount importance of technology development and diffusion on a global scale in meeting the challenges of climate change and moving towards a low-carbon society while accelerating economic recovery.
- At their July 2009 assembly, leaders of the Major Economies Forum on Energy and Climate Change (MEF) stated that that the need for and deployment of transformational clean energy technologies at lowest possible cost is urgent.
- At the IEA Ministerial meeting October 2009, Ministers committed to undertake more efforts to accelerate public investments in research, development, and demonstration (RD&D) with a view to doubling cost-effective R&D investment in low-carbon technologies by 2015 to accelerate the spread of low-carbon energy technologies.

Evidently, funding research of new and enhanced energy technologies is vital. Equally important will be the policies and programmes to facilitate deployment of those technologies, whether in IEA Member countries or non-Member countries.

Creating Business from Ideas

Creating commercial products from innovative technologies, let alone identifying the most promising ideas to commercialise, is a highly complicated affair with numerous barriers. Creativity, intelligence, courage, and risk taking are required to explore roads and cross valleys to create feasible and prosperous businesses from ideas.

As new businesses are founded on entrepreneurship and the necessary financing to realize the ideas, one approach to commercialisation is to pursue any available avenue in order to secure financing and support. Another venture capital approach is to carefully select the best suitable investment opportunities and at the same time acquire the right personnel who exemplify the strong leadership in execution necessary for developing innovative, technology-based businesses.

A national structured network of specialized research units—a favoured mechanism to address R&D challenges, create significant interest, and become an attractive partner for industry and international cooperation—allows for specialization in a variety of disciplines, close interaction between basic and applied research, and needs-driven R&D activities. Several national entities exist to impel innovations in laboratories, universities, and research institutions with processes for identifying and translating these ideas into commercial products. The Carnot Institutes in France exemplify this ethos with 33 public research entities in a wide variety of fields. With 13,000 employees, their resources are as impressive as the versatility. The overarching organization and coordination allows for targeted development of identified promising technologies with industry partnership, because many issues, such as intellectual property rights (IPR), are addressed early in the process. The Fraunhofer Institute in Germany also operates as a distributed network of research entities with varied specialties. Like the Carnot Institutes, the Fraunhofer Institute focuses on IPR management, offers R&D business services for industry, and creates spin-off companies. The European Space Agency (ESA) has developed technology transfer programs specifically designed to identify technologies developed for the space programmes that have high potential for non-space related applications. Crucial to carrying technology across the divide from validation and demonstration to completion and operation is business incubation which takes place at the ESA's four Business Incubation Centres (BICs). As evidenced by these network organisations, partnerships frequently require negotiations on intellectual property rights (IPR), which are not always straightforward.

International cooperation is increasingly important to the creation of new businesses from promising ideas. Companies operate in the global market and collaborate with the research institutions that maintain an international profile, engage in international research alliances and networks, and in some cases have locations globally. However, effective ways of implementing international public-private collaboration are a constant challenge and need to be explored in depth. Since 2003, The IEA has had private companies participating in the Implementing Agreements (IAs). Today around 50 companies are deeply involved in various IAs and at the project level, this number is much higher. In the post-COP15 processes to address climate change, industry views are even more important than ever before. This is reflected in the IEA outreach to industry.

Early Stage Market Entry

Early stage market entry is characterised by a product with narrow application in the market, possibly limited by barriers to wider market adoption. This crucial stage in the market penetration of a new technology requires support from both the government and private sector firms. Though these two elements are necessary for effective promotion of a new energy technology, the mix of resources and patterns of investment varies significantly by technology and by country.

The complex need for government involvement and private sector engagement in technology commercialisation efforts does not have a "winning formula." However, there are a number of parallel and interrelated pathways for accelerating energy technology commercialisation that include research, development and demonstration (RD&D), incentives, market mechanisms, regulatory frameworks, information campaigns and other programmes. Such policies and programmes must be tailored to the specifics of the technology and must be shaped within the boundary of national or regional circumstances. Austria found that early stage market entry for sustainable buildings technologies and innovations should focus on the market, and not on the technology. The government must put forward a clear and concise mission and message for the supported goals and the foundation of a long-term regulatory framework is important for key market players. Japan's stationary fuel cell programmes found that significant support for demonstrations and funding for installations not only brought the costs of the new technology down, but also improved consumer awareness of early market entry, and codes and standards that ensured safety and reliability were crucial in continuing deployment. Korea similarly experienced significant early adoption of efficient technologies by implementing some mandatory energy standards, while also providing energy labels that informed consumers and helped create demand for the higher efficiency products.

Creating both incentive to invest in R&D and early market demand for innovative technologies is difficult, but several techniques have been developed and implemented. The World Future Council researched feed-in tariffs in their various forms and found that they often helped reduce the risks of early development, spurring even small and medium actors to innovate and develop supported technologies. Risø DTU, the Danish National Laboratory for Sustainable Energy, similarly engenders industry input with a need-driven approach to innovation; by directly addressing an identified industry need, the funding and subsequent commercialisation of an innovative technology is closely tied to industry players. Indeed, the need for cooperation and coordination among government and industry was also exemplified in the research on the market deployment of electric vehicles (EVs) and hybrid electric vehicles (HEVs) performed under the IEA's IA on Hybrid and Electric Vehicles.

Government RD&D policies and programmes play a crucial role in the inception and realisation of an innovative technology and would benefit from adopting best practices in design and implementation. This may include designing strategic programs to fit national policy priorities and resource availability; rigorous monitoring and evaluation of results and adjusting support if needed; and increasing linkages between government and industry and between the basic science and applied energy research communities to accelerate innovation.

Addressing early stage market entry requires a focus on enabling advancement from developing infrastructure and planning for the technology through R&D financing and capital cost support for large-scale demonstration projects. The next step will introduce stable, technology-specific incentives such as feed-in tariffs, tax credits, and loan guarantees. This progression will usher the technology through a phase in which there is a high cost gap between the new technology and similar technologies and/or substitutes in the market. This approach makes use of the “push” of RD&D activities from the technology development and demonstration stage and the “pull” of market deployment into niche markets for further refinement and development until the technology can shrink the cost gap and achieve competitiveness in the market place.

Full-Scale Implementation: Shaping Market Behaviour

The key aspects of an approach for market entry will likely include conditioning, shaping behavioural norms, and informing and influencing consumer choices. Achieving market competitiveness is a step forward on the path towards a mature technology. Along the way, technology-neutral policies will be elemental, albeit at a declining level of support compared to the earlier stages in market deployment. In order to reach mass markets, policy support will need to accelerate adoption of the technology by addressing specific market barriers which may include establishing building codes and standards, efficiency standards (MEPS), and campaigns to raise industry and public awareness and support.

The high level of uncertainty surrounding market demands and consumer behaviour complicates energy technology deployment, regardless of its cost-effectiveness and environmental benefits. Policy options that can help an energy technology reach full market adoption are numerous and varied in scope and mechanism (see **Figure 1**). However, these policies are not all guaranteed to be successful, given the complex nature of energy technology markets and the public-goods nature of the energy technologies themselves, and must be accompanied by equally impactful regulations to shape the market so as to minimise market failures. This requires both government and industry involvement to ensure the optimal mix of resources and strategic policy options are implemented.

Warm Up New Zealand: Heat Smart, a program to install heating insulation particularly in poor households, used a combination of significant funding to pay for much of the installation costs and partnership with the private businesses that performed the installations. The government was thereby able to achieve significant awareness with the public while also monitoring and maintaining the quality of the installations.

Italy implemented smart meters for electricity by setting deadlines for replacing old metering systems and setting minimal functional requirements without mandating the technology or system architecture. By not dictating the technological advancements, Italian utilities were largely able to meet the deadlines and the minimum standards, and where issues arose, communication with all stakeholders was used to find solutions.

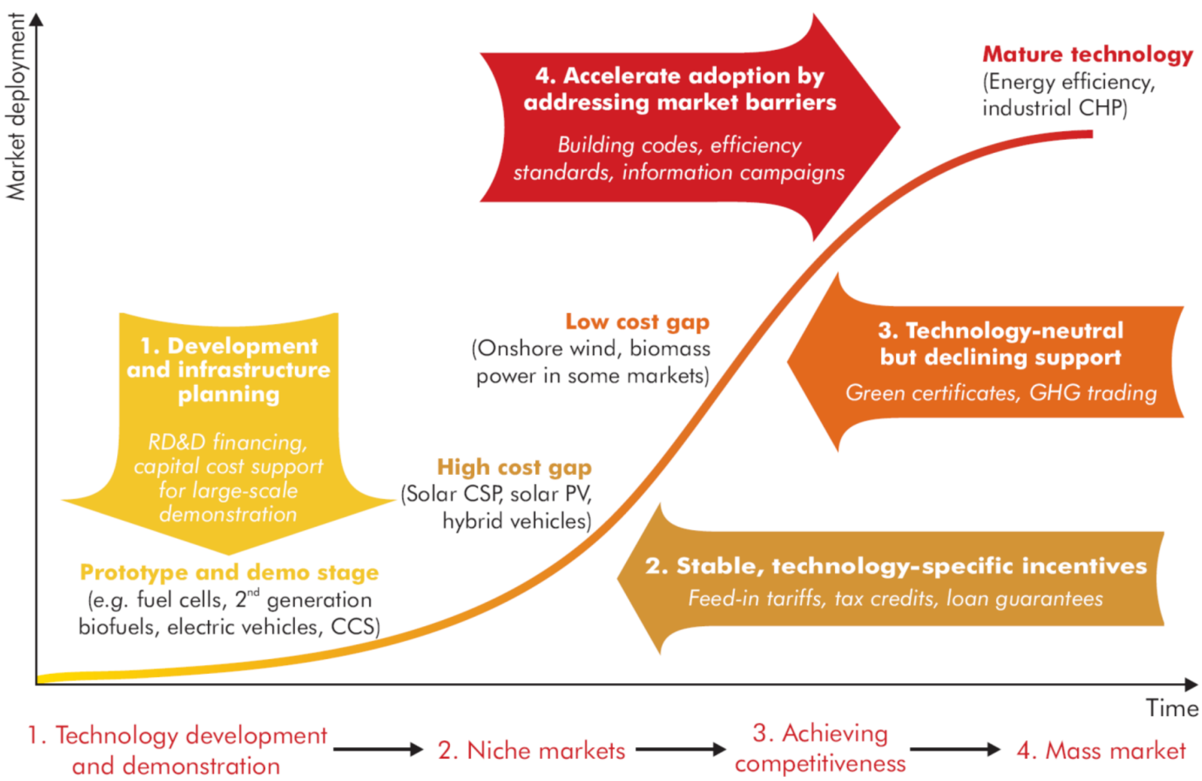


Figure 1: Policies for supporting low-carbon technologies.

The United States implemented its Energy Star labelling programme with great success in driving consumer awareness of energy efficiency. Coupled with sales tax and other tax incentives or credits, the programme has driven sales of efficient products and provided impetus to manufacturers to compete on efficiency, engendering further innovation.

The Dutch facilitate their transition to a green economy by supporting frontrunner technologies. Of particular importance are the transportation advancements and development of energy neutral buildings. Both technologies are likely to achieve greater market penetration through government support in the form of targeted financial incentives and through comprehensive action plans implemented by a coalition of stakeholders.

The United Kingdom's Carbon Disclosure Project (CDP) encourages significant energy conservation and greenhouse gas emissions reduction in commercial activities by focusing on the supply chain linkages. The CDP supports these reductions by aggregating the data to show the cost savings that could be and have been realised from avoided emissions.

Conclusions

The workshop covered three stages of the deployment continuum: deployment and diffusion and bringing science together with entrepreneurs; how to get products to the market; and tools and techniques for shaping consumer behaviour in markets at large. Conclusions of the workshop included that subsidies are still a clear need in areas where public benefits are compelling but costs are not within reach. To bring together ideas and business, ways must be identified to cut through bureaucracy and bring innovators together with financiers or to stimulate alternative paths to the research goal. The intellectual capacity and breadth of expertise—and budget—of the French Carnot Institutes was impressive. The Institutes' organization admirably manages this abundance to shepherd innovative technologies into the marketplace. And while a unique best organisational structure may not exists, as science knows no boundaries, more capacity can accelerate results.

Barriers are not always technical or financial. They can be cultural—for example how people think about their environment; therefore, social science should be taken more seriously and be included more in technology discussions. There is a need to re-introduce surveys as an embedded part of deployment programmes, and consumer behaviours and cultural barriers in general require further examination.

Overall, this workshop demonstrated that developing innovative technologies in order to address energy security and climate change issues is a primary concern across the globe. The range of policies and programs, many of which are innovative in their own right, that support the identification of promising technologies and ideas as well as their continued development is impressive. While some policies target short-term goals and others aim to achieve long-term aspirations, cooperation among these international efforts as well as further organisation will be necessary to implement innovative solutions worldwide.

Background

Low-carbon energy technologies are central to addressing energy security, climate change, and air pollution challenges while maintaining a strong global economy and meeting industrialised and developing countries' energy and other development needs. Energy technology development plays a central role in realising synergies between these challenges and meeting them simultaneously.

Research and development (R&D) policy has long been regarded as the main pillar of science and technology policies and innovation. Government support for R&D is usually provided either directly, by funding public research projects, or through the funding of other public and private institutions that perform research activities. More investment in low-carbon energy technology research, development, and demonstration (RD&D) is needed at all stages of technology development. After years of stagnation, government spending on low-carbon energy technologies has risen. But current levels still fall well short of what is needed. Recent analysis by the International Energy Agency (IEA)[1] suggests that public sector low-carbon energy RD&D spending will need to increase by two to five times current levels to deliver significant greenhouse gas (GHG) emissions reductions in the long term.

Developing new technologies is not enough. The public-goods nature of energy technologies requires that governments play multiple roles in the innovation process, not only funding basic research, technology development, and demonstration, but also supporting the creation of a market environment that is more conducive to innovation and stimulating market demand for low-carbon technologies. Private sector firms are the other major supporters of RD&D activities; however, the patterns of investments vary tremendously by country and by technology.

[1] IEA (2010), Energy Technology Perspectives, IEA/OECD, Paris (forthcoming).

Introduction

With this workshop, the IEA Experts' Group on R&D Priority Setting and Evaluation (EGRD) examined the techniques and programmes in place across the world. Recognising that new technologies naturally must progress from conception of an idea, to prototyping and development, to early demonstration, and finally to more mature market deployment and commercialisation, the workshop is organised by these stages. Since numerous programmes exist to develop technology and fundamental research into transformational, commercialised projects, the goal of the workshop was primarily to identify these programmes and what makes them successful as well as the barriers they faced and how those barriers were addressed.

While government support of fundamental research into innovative processes is essential, most new technologies will require, at some stage, both the "push" of R&D and the "pull" of market deployment. This means that governments and industry also need to accelerate energy technology commercialisation through a number of parallel and interrelated pathways, including R&D incentives, market mechanisms, regulatory frameworks, information campaigns, and other programmes. These policies and programmes must be tailored to the specifics of the technology, as well as to the national or regional circumstances.

Post-R&D stages must be addressed by innovation policies to accelerate the entry of new low-carbon energy technologies in the marketplace. Governments have introduced many initiatives to address the gap between R&D and commercialisation and help bring new technologies to the market. Hence, this workshop focused not only on supporting commercialisation, but also on the early stages of identifying and developing technologies that are most promising for future energy and efficiency goals.

Adopting good practices in design and implementation will improve current government R&D policies and programmes. This includes the design of strategic programmes to fit national policy priorities and resource availability; the rigorous monitoring and evaluation of results and adjusting support if needed; and the increase of linkages between government and industry, and between the basic science and applied energy research communities to accelerate innovation.

IEA: Energy Technology Perspectives

Peter Taylor, Head, Energy Technology Policy, IEA

- Link to presentation slides: http://www.iea.org/work/2010/transform/taylor.pdf

To facilitate a global energy technology revolution that will solve climate change and energy security challenges, the IEA collects and analyzes data from across the globe. To date, there are some early signs of progress, but much more remains to be accomplished. The primary tasks will by identifying the relevant technologies and evaluating the costs and benefits and the policies that will drive those technologies.

While a wide range of technologies will be necessary to substantially reduce energy-related CO_2 emissions, several key technologies will be prominent. End-use fuel and electricity efficiency may be the most beneficial, providing 38% of the reduction by 2050 in IEA's BLUE Map scenario. Carbon capture and storage (CCS) and renewable sources of energy are expected to provide an additional 19% and 17% of the reduction respectively. In terms of total primary energy demand, the IEA analysis under the BLUE Map scenario anticipates that by 2050, demand for coal, oil, and natural gas will be lower than today. Similarly, nuclear, biomass, and renewable energy use will increase significantly, requiring a substantial increase over present investment levels in a range of technologies from CCS to off-shore wind power.

The range of technologies and efficiency improvements will have to be distributed globally as primary energy demand increases. In the OECD countries, primary energy demand is expected to slowly increase through 2050 in the baseline scenario; however, in non-OECD countries, it is projected to more than double. Similarly, non-OECD countries are predicted to have the greatest energy-related CO_2 emissions, and thus provide the greatest opportunity for emissions abatement. As a result, most of the additional investment in low-carbon technologies will be needed in non-OECD countries through the year 2050.

Many low-carbon technologies will not be cost competitive in the next decade, even with a price on carbon. Electricity efficiency savings may prove most achievable in the near term, but the technologies with the greatest potential for reducing CO_2 emissions from power generation like CCS, wind, biomass, solar, and marine energy come with a high marginal abatement cost. To encourage development of these technologies, government support policies must be appropriately tailored to the stage(s) of technological development. In early and preliminary stages, R&D financing and other cost support is needed for development and infrastructure planning. As market deployment begins to increase, feed-in tariffs, tax credits, and loan guarantees help encourage further growth. Once technologies begin to achieve competitiveness, technology-neutral policies like green certificates and GHG trading ensure continued growth. Finally, in order to achieve mass market penetration, implemented policies must accelerate adoption by addressing market barriers such as building codes, efficiency standards, and public misinformation.

In general, carbon pricing is important, but should be complemented by other policies. These policies must be tailored to the technology's stage of development, reflect good design principles, and implement best practices. According to IEA analysis (IEA, forthcoming 2010)[2], public R&D spending must at least double in order to achieve CO_2 reduction targets. A number of enabling actions are also needed, including private sector leadership; expanded human capacity; greater government outreach and planning on infrastructure needs; and expanded, more effective international collaboration.

United States Strategies for Commercialisation and Deployment of Technologies and Practices

Robert Marlay, Deputy Director, Climate Change Policy and Technology, U.S. Department of Energy

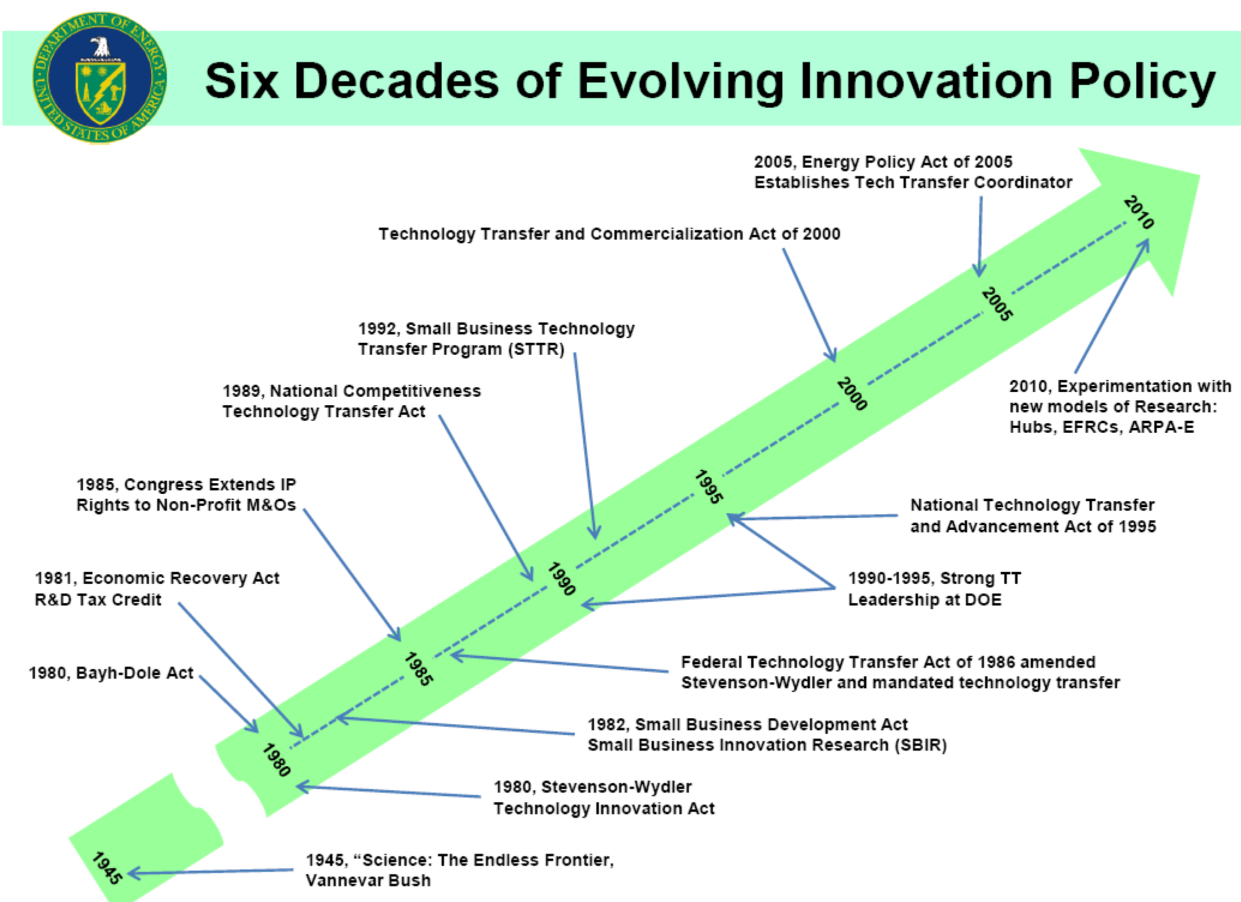
- Link to presentation slides: http://www.iea.org/work/2010/transform/marlay.pdf

The U.S. government has a long history of evolving innovation policy meant to support R&D and the transfer of its outcomes to business and the marketplace. Over the past six decades, federal policies,

[2] IEA (2010), Energy Technology Perspectives, IEA/OECD, Paris (forthcoming).

including the government's own investments and broader forms of legislation, have been used to spur innovation as a key factor in technological change, economic growth, and the realisation of important public benefits. Beginning in 1945 with a well-argued assertion by Vannevar Bush (*Science: The Endless Frontier*) that basic research is vital to a strong economy, government policies have aimed to grow and strengthen the research enterprise of the United States – in businesses important to national goals, universities, and national laboratories. These policies continue today. In 1980, the Bayh-Dole Act "changed the world" with its reform of intellectual property (IP) rights relating to federally funded research and codified "rules of engagement" for ownership of inventions. This Act essentially endowed the research performer, rather than the research funder, with the rights to IP. Although initially restricted to universities and small businesses, coverage has since been progressively expanded. More recently, both the Energy Policy Act of 2005, which established a Technology Transfer Coordinator, and the U.S. Department of Energy's (DOE) experimentation with new models of research, like innovation hubs, Energy Frontier Research Centers (EFRCs), and Advanced Research Projects Agency–Energy (ARPA–E), have continued the evolution and expansion of policies and programmes supporting innovation.

Figure 2: Policies and legislation supporting innovation in the U.S.



Too often business entrepreneurs, financing specialists, and lab scientists work entirely within their own expertise, unable to leverage the assets of the others. By developing integrated partnering systems, governments can facilitate the flow of ideas across boundaries and help stimulate innovation and entrepreneurship. Traditional methods to encourage partnership and collaboration include sharing of information on IP, Co-operative Research and Development Agreements (CRADA), licensing, technical consulting, working for non-federal sponsors, and personnel exchanges exposing employees to each partners' facilities and operations. Newer avenues for partnership have been developed and are discussed further below. Traditional or innovative, these modalities for bringing partners together generally fall into four categories of policies: economic, research, innovation, and personnel. Each has its strengths and weaknesses, but all have the potential to drive progress through multi-partner engagements. Through the traditional programmes, DOE Labs have consistently generated around one-third of the technology transfer transactions of all federal labs, which have led to significant technical enterprise.

Experimentation with new models of research and innovation has taken many different forms with various structural organisations (see **Error! Reference source not found.**). Science parks and regional development authorities implement economic policies to further innovation. New innovation hubs, ARPA–E, EFRCs, and prize-based incentives focus on encouraging research in targeted areas. Open source software, innovation systems, and internet-based connectivity for problem solving all represent innovative polices that allow for previously unheard-of collaboration. And researcher exchanges, entrepreneur sabbaticals, and "entrepreneurs-in-readiness" (venture capitalists, not co-located but affiliated with innovation sites) programmes support the talented individuals who have an aptitude for growing innovative businesses. Each of these new models may receive different amounts of funding and focus on a certain range of the research, development, commercialisation, and deployment progression, which every successful technology must endure. For example, the energy innovation hubs are topic-specific, ambitious concentrations of multidisciplinary talent under one-roof. The hubs are intended to emulate the idea-generating collaborations of the old Bell Labs and Manhattan Project and facilitate the purposeful drive from fundamental research through to commercialisation. The EFRCs, which are also topic-specific, tend to be university based and are more focused on fundamental research needed to address the most significant barriers to technical progress in clean energy. Finally, ARPA–E focuses on projects that have a high risk of failure, but whose success would have significant near-term impacts; organises projects around relatively few, yet important, technical themes; and assembles teams that are experienced in bringing new ideas to commercialised products.

Significant prize-based incentives, such as the H-Prize for hydrogen technology and the L-Prize for lighting advancements, generate interest in the targeted areas of research as well as the general public. These prize-based incentives have already led to significant new inventions that will reduce energy consumption and emissions. Science and technology parks at Oak Ridge, Tennessee; Sandia, New Mexico; and Ames, Iowa, provide the land and facilities adjunct to or nearby the national laboratories. This close proximity has proven helpful for the start-up of new, innovative businesses. Several open innovation models eschew the centralised resources and achieve widespread collaboration by breaking down the barriers to information sharing. Open-source resources like "data.gov" and software like the

Multiphase Flow with Interphase eXchange (MFIX) take advantage of the simple distribution capabilities offered by the internet. Finally, programmes like entrepreneurs-in-readiness recognise that talented personnel who specialise in the development and financing of disruptive start-ups are as key to successful businesses as the new technologies they implement.

Addressing the non-technical barriers to commercialisation and deployment (C&D) will also be necessary for future development. In general, technologies suitable for C&D are those with validated or operational systems prepared for market entry and expansion. By examining detailed barriers related to cost effectiveness, fiscal issues, regulatory conditions, statutory conditions, IP rights, and others, DOE has been able to identify and inventory the programmes and policies that push C&D. These barriers have been identified, catalogued, and prioritised for 15 specific technologies in the following categories: end-use efficiency and infrastructure, energy supply, carbon capture and sequestration, and non-CO_2 GHGs. With this information, analysts have examined both the strengths and the potential gaps in policies for each of the technology areas and may suggest key incentives, credits, or other motivations for future policy development.

Overall, these strategies for C&D of new technologies and practices have led to several recent examples of success stories. The Ames Laboratory in Iowa developed energy-efficient magnetic refrigeration using a permanent magnet and certain rare-earth elements. The U.S. Army has incorporated lightweight, flexible photovoltaic (PV) power systems for use in the field, leading to the formation of Powerfilms Inc., which produces and develops the PV systems for civilian and military purposes. The National Energy Technology Laboratory developed the open-source MFIX software package and has worked with Southern Company and Kellogg Brown & Root to improve the designs of advanced transport gasification systems. Two technologies that have been successfully implemented by spin-off companies include the lead-free solder technology developed by The Ames Laboratory and the millimetre wavelength body scanner developed by the Pacific Northwest National Laboratory. By developing technologies and supporting C&D activities, DOE has amassed a significant IP portfolio that continues to generate income for supporting future endeavours.

Creating Business from Ideas

This session focused on innovations in laboratories, universities, and research institutions as well as the processes for identifying and translating these ideas into commercial products. Creating the business, let alone identifying the most promising ideas, is a highly complicated affair with numerous barriers to overcome. Creativity, intelligence, courage, and risk taking are required to explore roads and cross valleys to create feasible and prosperous businesses from ideas.

A favoured mechanism to address R&D challenges, create significant interest, and become an attractive partner for industry and international co-operation is a national structured network organisation of specialised research units. This network organisation allows for multi-disciplinary specialisation, close interaction between basic and applied research, and needs-driven R&D activities, all of which are highly appreciated by industry.

Rapid and targeted knowledge creation and diffusion demands close co-operation between research institutes and industry, which also attracts finance from public and private investors. One such example is the Fraunhofer Institute, which received approximately 40% of its financing from industry. Partnerships also include requests for intellectual property rights (IPR), which are not always straightforward. Two conflicting perspectives arise. On the one hand, patents with exclusivity are transformed into commercial products and can also be a starting point for research projects, so IPR is a necessary and legitimate means of protecting an institution's property and businesses. On the other hand, the patent landscape seems to be overcrowded and may restrict the freedom of operation for businesses in a rapidly developing knowledge economy.

New businesses are founded on entrepreneurship and the necessary financing to realise the ideas. One approach is to pursue any available avenue in order to secure financing and support. Another venture capital approach is to carefully select the best suitable investment opportunities and at the same time acquire personnel who exemplify the strong leadership and execution skills necessary for developing innovative, technology-based businesses.

International outlook and co-operation is an increasing aspect of creating businesses from ideas. Companies operate on global markets and co-operate with the research institutions that best suit their needs. Attractive research institutes have a highly international profile, engage in international research alliances and networks, and in some cases have locations globally. However, effective ways of implementing international public-private collaboration are a constant challenge and need to be explored in depth. Since 2003, the IEA has had private companies participating in the Implementing Agreements (IAs). Today, around 50 companies are deeply involved in various IAs; at the project level, this number is much higher. In the post-COP15 processes to address climate change, industry views are even more important than ever before. This is reflected in the IEA outreach to industry.

France: Carnot Institutes

Joachim Rams, Président, Association of Instituts Carnot

- Link to presentation slides: http://www.iea.org/work/2010/transform/rams.pdf

Made up of a network of 13,000 researchers at 33 public research entities, the Carnot Institutes is a multidisciplinary research network dedicated to technology transfers and industrials partnerships that brings together federally funded R&D and industry to improve technology and further innovation. Their researchers represent 12% of the French public research staff, and their activities represent 45% of the research funded by companies and performed by French public laboratories. Primarily, the Carnot Institutes network offers easier access to research expertise in a wide range of areas, quality co-operation and collaboration, and professionalised management of partnership research.

The Carnot Institutes built their areas of expertise around the goal of improving society with better transport and mobility, renewable energy, personal health care, homeland security, information and communication technologies (ICT), and civil safety. Therefore, they have developed seven main areas of expertise in:

- ICT—Micro & Nano Technologies
- Materials, Mechanics, and Processes
- Environment and Energy, Propulsion, Chemistry
- Earth Sciences and Natural Resources
- Life Sciences & Health Technologies
- Building, Civil Engineering, and Land Use Planning
- Social Sciences

In order to further organise the research and take advantage of common capabilities, the "Association des instituts Carnot" or "AiCarnot" acts as coordinator and network developer among the various independent entities and as a kind of federal level of control for the institutes. Moreover, the AiCarnot garners specific financial public support for each institute and helps define medium term objectives. One key component of the AiCarnot's support is the defining and management of intellectual property rights policies. That is, this central authority "promot[es] the identification, protection, management and transfer of any element of IP which is of industrial, economic and social interest, and implement[s] the necessary tools for tracking research results."[3] Furthermore, their management of technology transfers allows them to apply the leverage of widespread capabilities to distribute technology as widely as possible. Therein lies one of the Carnot Institutes greatest strengths. As a well managed, but exceptionally broad-focused organisation, the Carnot Institutes are able to coordinate resources from a

[3] Carnot institutes, The Carnot institutes' code of best practices for Intellectual Property and Knowledge & Technology Transfers

variety of fields to address specific innovations while also relying on the central governing body for solutions to universal barriers like IP management.

Germany: Fraunhofer Institute for Solar Energy Systems

Tilmann Kuhn, Head of Group Solar Facades, Fraunhofer Institute for Solar Energy Systems

- Link to presentation slides: http://www.iea.org/work/2010/transform/kuhn.pdf

The Fraunhofer-Gesellschaft is one of the leading organisations for applied research in Europe with 17,000 employees, the majority of whom are qualified scientists and engineers. Since 2003, the number of PhD and diploma students either directly employed or contracted through universities has more than doubled. With an annual budget of more than 1.6 billion euros, the organisation is made up of 59 research institutes throughout Germany and many more worldwide. International co-operation is supported through affiliate institutes in Europe, USA, Asia, and the Middle East. Two-thirds of their research contracts are from industry and public funds. Fraunhofer engages in a range of activities: research into materials, modelling, and methods to advance technology; development of components, prototypes, systems, and procedures; and provision of consulting services, testing, monitoring, and quality assurance.

The Fraunhofer Institute for Solar Energy Systems (ISE) was established in 1981 and generated 55 million euros in 2009 according to preliminary accounting, 40% of which came from industry and 30% from federal government projects. The primary areas of business for Fraunhofer ISE include:

- Energy Efficient Buildings and Technical Building Components
- Applied Optics and Functional Surfaces
- Solar Thermal Technology
- Silicon Photovoltaics
- Alternative Photovoltaic Technologies
- Renewable Power Supply
- Hydrogen Technology

In order to create business from ideas, Fraunhofer ISE focuses on three different, but interrelated paths: R&D business services for industry, spin-off companies, and IPR management (see **Figure 3**). One example in their portfolio of the importance of IPR management is the development of venetian blinds with “genius slats.” These blinds, which offer enhanced solar control glazing for internal daylighting, were developed in partnership with industry and the IPR are jointly held with the industry partner. Another example of Fraunhofer ISE’s support of an idea into a full business is their coordination of the European Union (EU) Project “Cost-Effective,” which aims to develop

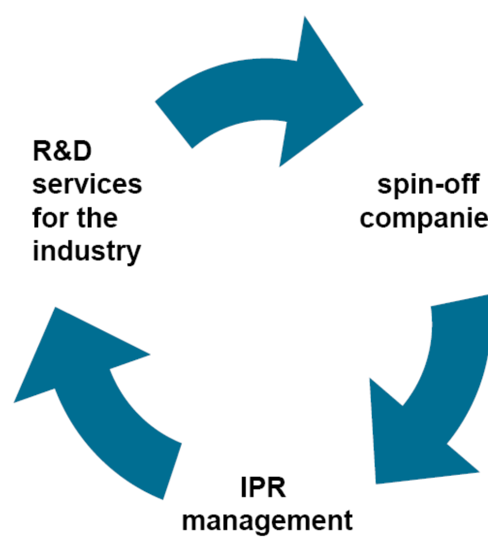


Figure 3: Primary Paths to Innovation at the Fraunhofer Institute.

transparent solar thermal facades. The technology collects solar thermal energy to improve the energy efficiency of high-rise buildings while also offering lighting and glare control. Fraunhofer patents were the starting point for the research projects supported by the Cost-Effective partnership. Another example that began with Fraunhofer patents is the multifunctional Building Integrated Photovoltaics (BIPV) glazing. These windows have integrated PV to deliver solar electricity while allowing an appreciable amount of light through the pane. Finally, Concentrix solar is a spin-off company that has found success in its own right with Fraunhofer as a shareholder and grantor of an exclusive licence for their technology. Fraunhofer aided their success by first building the pilot production plants and then leasing the facilities to the new company. Consequentially, Concentrix has grown steadily since partnering with Abengoa Solar on concentrating solar power (CSP) and achieving its first 100 kilowatt (kW) installation in Spain in 2008. Continuing these successes, Fraunhofer ISE continues to innovate itself and further develop solar technologies by setting a world record for solar cell efficiency in January 2009.

European Space Agency Experience with Technology Transfer

Callum Norrie, European Space Agency Technology Transfer Office

- Link to presentation slides: http://www.iea.org/work/2010/transform/norrie.pdf

The Technology Transfer Programme Office within the European Space Agency (ESA) has extensive experience supporting the development and commercialisation of space-related technologies. Their model emphasises supporting the innovation chain throughout the development cycle. Awareness programmes utilise the internet, human networks, and events to support the generation and formulation of basic concepts. The Transfer Demonstrator Programme provides support for R&D that leads to validation and demonstration of the initial concept. Business incubation with the ESA's four Business Incubation Centres (BICs) is crucial to carrying technology across the divide between validation and demonstration to completion and operation. Finally, funding through investment forums like the Open Sky Technology Fund offers support to reach complete, operational businesses. Through this model and continuous support, the programme has demonstrated numerous success stories of bringing space-based technologies to bear in non-space sectors, including the following:

- Concentrating Photovoltaics with Triple Junction GaAs Solar Cells
- Space Systems Improving Efficiency of Solar Power
- Saving Fuel with Smart Vehicles and Smart Driving
- Tracking your Carbon Footprint
- Micro Electro Mechanical Systems (MEMS) Sensors to Protect Oil Rigs from Dangerous Gases

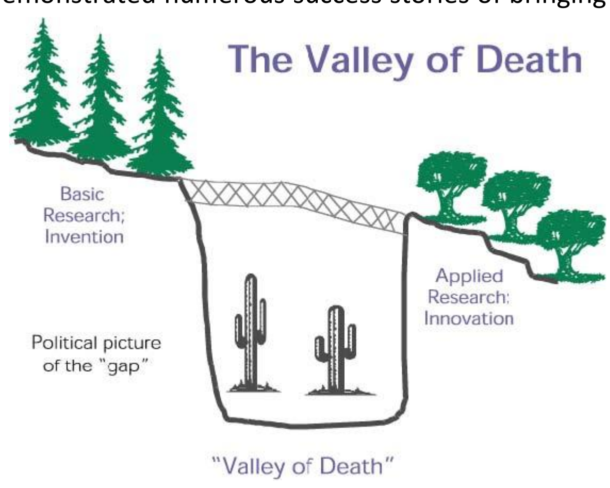


Figure 4: Innovative technologies require significant support beyond basic research to develop useful applications.

- Space Sensors Reduce Emissions from Heating Systems
- Monitoring of Offshore Oil and Gas Fields
- Detection of Natural Resources using Gradiometers
- Monitoring of Heavy Mining Machines
- Optimisation of Windmill Efficiency

Given the difficulty of spanning the "valley of death," (see **Figure 4**) the BICs have played a particularly important role in scientific business development in Europe and in expanding space industry technologies into non-space sectors. The BICs are also linked to the EU's European Space Incubators Network (ESINET), an established network with similar aims. The longest established of the four operational BICs is located at the European Space Research and Technology Centre (ESTEC). As of late 2008, 49 companies "graduated," thanks to the technical and engineering support and the financial assistance available at ESTEC.

While the BICs provide immersive assistance, many companies require only the guidance and funding offered by investment funds and venture capital. The Open Sky Technology Fund operated by the Triangle Venture Capital Group targets companies using space-related technologies or satellite applications in non-space applications. The ESA Investment Forum 2010 provided the opportunity for space-related companies to pitch their business plans for investment to a targeted, receptive, and knowledgeable audience.

In general, as a public entity, the ESA recognises that the greatest value it can provide is perhaps not innovation itself, but rather the environment and conditions necessary for innovation. Because innovation often happens through collaboration, it is at heart a people business. However, technology advancement will include spin-offs and positive externalities with innovation in areas that are beneficial to society—though often unforeseen.

Funding Mechanisms for Technology Transfer

Bernd Geiger, Managing General Partner, Triangle Venture Capital Group Management

- Link to presentation slides: http://www.iea.org/work/2010/transform/geiger.pdf

Various ways have been identified to accomplish technology transfer and commercialisation. The first means is licensing, which generally allows for an expeditious transaction, but too often provides little return on investment, little or no influence on the use of the technology, and may require significant acquisition time. The second popular means is a spin-off, which may take a long time to initiate and may carry a greater risk of failure, but often this transfer mechanism guarantees a willingness to maximise the commercial potential of the technology.

Even with a transfer mechanism in place, developing and growing a new business around that technology can proceed through a number of avenues. The entrepreneurial approach is to always take advantage of any and all available assistance or funding in order to reach the goals of the new company. The self-funded approach is more autonomous, but generally leads to an insecure outcome as the founder is detached from resources for experience and guidance. The public funding approach is frequently insufficient to cover the whole company development cycle. Moreover, the fundamental goals of the company founders and the public benefactors may not be aligned closely enough to ensure commercial viability. Similar to the self-funded approach, the bank funding approach generally leaves the founder detached from resources for experience and guidance. An additional obstacle of the bank-funded approach is that banks are typically motivated to fund investment opportunities rather than R&D projects. Finally, the business-angel funding approach, like public funding, does not cover the whole development cycle and is often more a hobbyist approach than a well-developed business solution. Venture capitalists, on the other hand, are interested in creating a successful business by investing selectively and by utilising their own experience and connections to support that investment.

While having a vision and connecting with potential customers on the development of a prototype is essential to turning a technology into a successful product, understanding market dynamics and best practices for R&D processes are equally important. In other words, cohesive project and product manager functions are crucial. Additionally, having dedicated and energetic people is necessary in the start-up phase.

Specific to Triangle Venture Capital Group, the Open Sky Technologies Fund targets space-related technologies and satellite applications for non-space applications. This 100 million-euro fund supports companies with first-round investments plus follow-on investments and aims to help them become profitable growing businesses within 3–6 years. In general, the venture capital fund seeks to develop business from technologies that are developed at the best research facilities and championed by people with a strong vision for how the product will affect and change the way in which people live and work.

Early Stage Market Entry

Early stage market entry is characterised by a product that exists and is available in the market but has a narrow window of application. It may be limited by a number of barriers to wider market adoption. This stage in the market penetration of a new technology is crucial and requires support from both the government and private sector firms. Though these two elements are key ingredients for effective promotion of a new energy technology, the mix of resources and patterns of investment vary significantly by technology and by country.

The need for government involvement and private sector engagement in technology commercialisation efforts is complex and does not have a "winning formula." However, there are a number of parallel and interrelated pathways for accelerating energy technology commercialisation that include RD&D, incentives, market mechanisms, regulatory frameworks, information campaigns, and other programmes. Such policies and programmes must be tailored to the specifics of the technology and must be shaped within the boundary of national or regional circumstances.

The current government RD&D policies and programmes play a crucial role in the inception and realisation of an innovative technology and would benefit from improvements by adopting best practices in design and implementation. This may include the design of strategic programmes to fit national policy priorities and resource availability; rigorous monitoring and evaluation of results and adjusting support if needed; and the increase of linkages between government and industry, and between the basic science and applied energy research communities to accelerate innovation. Similarly, the post-RD&D stages in the market deployment process are especially important to accelerating the entry of new low-carbon energy technologies in the marketplace and merit strong consideration in developing innovation policies.

Addressing early stage market entry will require a focus on enabling advancement from developing infrastructure and planning for the technology through RD&D financing and capital cost support for large-scale demonstration projects. The next step will progress towards a phase which introduces stable, technology-specific incentives such as feed-in tariffs, tax credits, and loan guarantees. This progression will usher the technology through a phase in which there is a high cost gap between the new technology and similar technologies and/or substitutes in the market. This approach makes use of the "push" of RD&D activities from the technology development and demonstration stage and the "pull" of market deployment into niche markets for further refinement and development until the technology can shrink the cost gap and achieve competitiveness in the marketplace.

Below are a number of case studies from nations around the world that focus on successful strategies for moving technologies to market from the early stages of technology development. Case studies will focus on effective policies and processes in the areas of building technologies (Austria), fuel cell technologies (Japan), energy labels and standards (Korea), feed-in tariffs (Germany), models for innovation (Denmark), and electric vehicles (EV) and hybrid electric vehicles (HEV) (multi-national experience).

Austria: Energy Efficiency in Buildings

Herbert Greisberger, Director, Austrian Society for Environment & Technology

- Link to presentation slides: http://www.iea.org/work/2010/transform/greisberger.pdf

The Austrian energy strategy prioritises energy efficiency and has a special focus on buildings in particular. A number of barriers to energy efficiency in buildings have been identified and include public awareness, high investment costs, and limited acceptance of new technologies in the industrial and consumer markets. Despite these existing barriers, substantial improvements have been made in the energy efficiency of buildings over recent decades. However, the fragmented buildings industry, mostly comprised of small- and medium-sized enterprises (SMEs), as well as their limited exposure to international competition may contribute to a lack of innovation in energy efficiency in the industry. Furthermore, energy demand is not a main driver in buildings R&D which likely contributes to the depressed levels of innovation. Currently, there are few countries in the international arena that run R&D programmes for building technologies—ongoing R&D focuses on incremental improvements. This paucity of programmes may be due to the limited energy savings from efficiency gains which have not resulted in reducing energy demand for heating and hot water.

The "Building of Tomorrow" programme, run by the Ministry for Transport, Innovation and Technology, is an RD&D programme aimed at increasing the number of sustainable buildings in Austria. This programme involves applied research and demonstration projects as a competitive mechanism to ensure a high standard for R&D. Over 750 projects were submitted, one-third of which were supported with more than 25 million euros of public funding. By the end of the programme, 25 demonstration sites and a standard for sustainable buildings were developed along with the necessary technologies and technical capacity required within the research community. The klima:aktiv Buildings programme is another component of the general strategy for expanding the presence of energy-efficient buildings. This programme is dependent on the success and outcomes of the Building of Tomorrow efforts to refine the definition of sustainable buildings and further the development of niche markets for passive houses (defined as using less than 15 kWh/m^2)[4]. This programme will rely on a number of instruments to achieve its goal: adaptation of subsidies, financial instruments, engagement of the construction industry, and training activities.

The "Building of Tomorrow" programme focuses on RD&D, relies on high levels of public funding, seeks out demonstration sites targeting niche markets, aims to promote competitive concepts, and targets the research community. In comparison, the klima:aktiv Buildings programme focuses on information dissemination through brochures, websites, and exhibitions; training programmes for craftsmen and pre-fabricated house salesmen; and financial assistance with federal subsidies and special loans from private banks. The klima:aktiv programme relies on standard funding schemes and aims to usher technologies from niche markets towards main markets and promotes the klima:aktiv standard and scoring system while targeting customers, industry, and relevant stakeholders. Together, they

[4] Passive house end-use energy consumption must be less than 15 kWh/m^2 per year for each of heating and cooling demand or must have a peak heat load of 10W/m^2. Total primary energy consumption (including source energy for electricity, heating, hot water, etc.) must be less than 120 kWh/m^2 per year.

encompass the conceptualisation and R&D stages and the transition from niche market towards main markets as the target group shifts from the research community to consumers, industry, and stakeholders. The website (www.klimaaktivhaus.at) provides a forum for identifying buildings (over 1,000 have been declared thus far) and allows for the communication of innovative ideas and concepts, in part, by promoting their standard and scoring system which grades structures on energy efficiency, construction materials, indoor air quality, and other factors. Stricter regulations are being implemented in some federal states that govern the use of renewables (Styria and Upper Austria) and the Passive House standards for social housing (Vorarlberg), embodying the programme's goal of pushing efficient building technologies from niche markets to the level of development of standards and regulation. Together, the "Building of Tomorrow" programme and klima:aktiv programme encompass the conceptualisation and R&D stages as well as the transition from niche market towards main markets as the target group shifts from the research community to consumers, industry, and stakeholders.

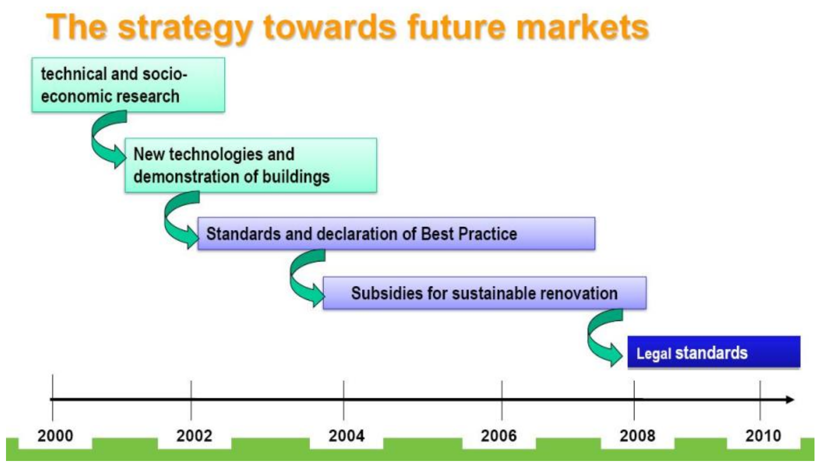


Figure 5: The schedule of progression from laboratory research to market implementation.

The Austrian experience has found that focus should be on the market (see **Figure 5**), and not on the technology. A clear and concise mission and message including the definition of "sustainable buildings" and the foundation for potential long-term regulatory framework is important to communicate to key market players. Among the lessons learned, the Austrian Society for Environment and Technology (ÖGUT) found that subsidies played an important role in accelerating adoption of technologies by markets. Furthermore, due to the complexity of the necessary adjustments during construction phases, they found renovating buildings to install the Passive House features to be more effective than including these features at the outset. Based on the European experience, other similar European programmes, such as Eracobuild, have found that such efforts helped provide major steps forward with regard to energy efficiency and reduction of CO_2 emissions for all climates and construction types. However, continued investment in R&D programmes and building technologies is needed, specifically public support, as these programmes are the basis for sustainable markets in the building sector.

Future research needs include rethinking the energy system based on the concept of sustainable buildings, energy-producing new buildings relying on renewable energy, and renovating existing buildings based on "factor 10 concepts"[5] and technologies. The "Building of Tomorrow PLUS" concept, begun in 2008 and lasting until 2012, builds on the Zero-Energy-Buildings concept and aims to develop PLUS-Energy-Buildings. This programme is expected to yield buildings as generators of energy, strengthen technological leadership, transition from single to series manufacturing, and elevate the level of networking and education in the area of sustainable buildings. Looking forward, building technology policy may play an important role in shaping sustainable building markets. To continue development in the buildings sector, target-oriented R&D activities must be intensified to spur the development of novel building concepts and investigate the impacts of the programme through socio-economic research, especially in the area of renovation. Highly efficient building technologies must be adapted to climates and local resources, international co-operation in R&D needs to be intensified, and various instruments are needed in order to overcome barriers to innovation in the construction industry.

Japan: Stationary Fuel Cell Programme

Makoto Akai, National Institute for Advanced Industrial Science and Technologies

- Link to presentation slides: http://www.iea.org/work/2010/transform/akai.pdf

In Japan, a number of policies have been enacted that contain measures pertaining to mitigating climate change and reducing energy use. One example is the Hatoyama Initiative, introduced in September of 2009, in which Japan aims to reduce its emissions by 25% by 2020 compared to 1990 emissions levels. This and other strategic plans and initiatives promote the use of new, innovative technologies that improve efficiency or are low-carbon technologies targeting the power, transport, industrial, residential and building sectors in part by developing and promoting fuel cells and hydrogen technology.

The Cool Earth policy implemented in 2008 focuses efforts on 21 key innovative energy technologies in energy efficiency and lowering carbon emissions. Supply-side policies for low-carbon technologies focus on renewable energy (biomass, solar, wind) and other low-carbon technologies (nuclear, superconducting power transmission). Demand-side policies focus on the transportation, industrial, and building sectors. A number of technologies are applicable across sectors as well, including power storage; power electronics; hydrogen production, storage, and transport; and CCS technology.

The Japanese model provides a useful perspective for successful R&D investment. The Japanese Hydrogen & Fuel Cell Promotion Office within the Ministry of Economy, Trade, and Industry (METI)—in collaboration with other ministries—funds the New Energy and Industrial Technology Development Organisation (NEDO) to execute its programme activities that include materials programmes and demonstration projects for hydrogen and fuel cells. NEDO then provides funding and operations and management support to universities, private companies, and national labs. NEDO is also developing codes and standards as well as demonstrative research projects.

[5] Factor 10 states that over the next 30–50 years (one generation), a decrease in energy use and material flows by a factor of 10 and an increase in resource productivity/efficiency by a factor of 10 is required to achieve dematerialization.

A primary example project is the extensive demonstration project to implement polymer electrolyte fuel cells (PEFC) in residential applications. The Residential PEFC project started in 2002 with the commercial launch in 2009, the same year in which a government subsidy was sanctioned for installation. Upon full commercialisation, the cost per unit is expected to reach an R&D target set by NEDO and the growth in the market will be self-sustained. This project involved the development and installation of a stationary PEFC cogeneration system for residential use, collection of data and identifying and solving technological problems with the system. The PEFC extensive demonstration project reduced costs, improved durability and reliability, and heightened public recognition to expedite the commercialisation of the residential PEFC system and establish early entry market.

The subsidies for PEFC installation that supported the project declined from 6 million yen in 2005 to 2.2 million yen in 2008 as the costs came down. Analytical and evaluative support from the New Energy Foundation (NEF) and the Subcommittee of Performance Evaluation who work with manufacturers and test operators to evaluate system performance and recommend improvements provided support to ensure quality installation and operation. In order to increase reliability and further reduce system cost, a number of performance targets have been set for the mid- and long-term to help guide improvements and testing such as target prices, unit production levels per year, and durability estimates.

Codes and standards were also implemented following certification tests and evaluation techniques to ensure system safety. Additionally, in 2008 seven Japanese Industrial Standards (JIS) were newly established for small size PEFC systems addressing terminology, safety, testing methodology, and other similar issues after the PEFC system certification was authorised in 2007. Expected savings of approximately 1,000 mega-joules (MJ) of primary energy and 100 kg of CO_2 emissions reductions per month per site validated the use of the residential PFEC cogeneration system. Since 2005, the average cost of units has fallen roughly 57% from 7.7 million yen for FY2005 model to 3.3 million yen in FY2008 model.

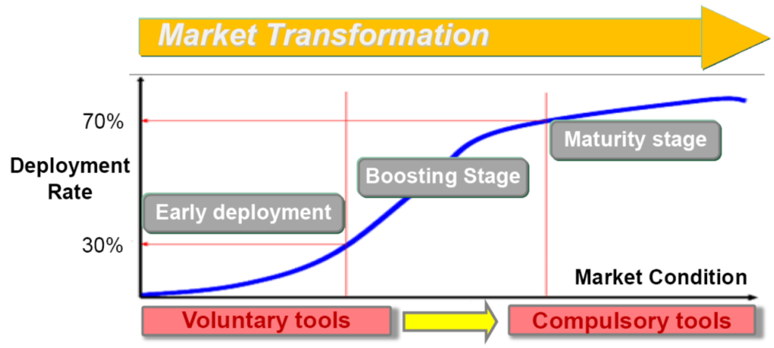
Officially commercialised in 2009, three manufacturers began selling the PEFC systems with the support of a subsidisation programme implemented by the Fuel Cell Association (FCA) that reimbursed half of the users' costs up to 1.4 million yen. The FCA also helped install 1,500 units as of September 2009 in addition to the 3,307 installed through the demonstration project from 2004–2008. Further cost reductions are expected with mass production of the units and continuous improvements. In addition to the testing phases and process improvements, there have been public exhibitions of the system at the Fuel Cell Exposition and on the internet to increase awareness of the benefits. In 2008, the Toyako Summit also served as a good opportunity to raise international awareness for the PEFC system.

Korea: Energy Labels & Standards

Ki-Hyun Lee, Asst. Manager, Energy Labels & Standards, Korea Energy Management Corporation

- Link to presentation slides: http://www.iea.org/work/2010/transform/hyun.pdf

Korea has a number of policies that promote energy efficient technologies, including three energy labelling and standards programmes: Energy Efficiency Labels and Standards Program, High-Efficiency Equipment Certification Program, and e-Standby Program. These programmes lay out mandatory, voluntary, and voluntary-to-mandatory standards, respectively, to accelerate market acceptance and adoption of targeted technologies (see **Figure** 6). In total, these labelling programmes cover 84 products that range from household items (e.g., refrigerators and TVs) to industrial equipment (e.g., pumps) or power transmission equipment (e.g., transformers).



Each programme employs a different strategy with a distinct goal. Established in 1992, the mandatory Energy Efficiency Labels and Standards Program uses an Efficiency Grade Label to indicate how efficient each product is, targeting energy-intensive products with widespread use. The voluntary High-Efficiency Equipment Certification Program established in 1996 focuses on early stage markets for high-efficiency industrial products with significant energy conservation potential that exhibit low deployment rates. Products bear a label and receive a High-Efficiency Equipment Certificate. The promotion policy for this programme includes financial incentives such as rebates. Implemented in 1999, the e-Standby program supports the Standby Korea 2010 initiative that aims to reduce standby power of all products below one watt (W) by 2010. This voluntary-to-mandatory programme targets products with significant standby power and uses an attached label to differentiate its products from other products. All three programmes employ promotion policies that include mandatory use in public and specified buildings and availability through the central and local government's Public Procurement Service (PPS).

Korea's strategy for these programmes incorporates a mix of policy tools that are similar in nature but vary in approach to facilitate market entry. The selection process for intervention tools drew from market research on the current market and future prospects, R&D projects for enhancing efficiency, and case studies on other countries' best practices. Voluntary tools like certification, rebates, and tax deductions were identified as appropriate in the early deployment and early growth stages. Compulsory tools such as minimum energy performance standards (MEPS) and mandatory use policies, on the other hand, can be effective in the mature

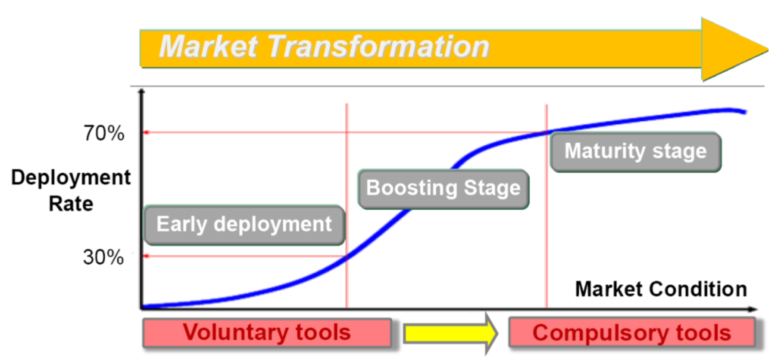


Figure 6: Korea's designed progression from voluntary tools to the compulsory tools to support market growth.

stage for phasing out less efficient equipment. Phasing out low efficiency products through standards implementation has proved effective in fluorescent lamp markets (deploying 32W lamps instead of 40W lamps) and among television producers (increased sales of energy saving TVs that meet standards). In general, more promotion tools are needed in the early deployment stages compared with later stages in order to realise a successful market intervention.

Following the intervention in the markets, the Korean Energy Management Corporation (KEMCO) performed market research, sales data analysis and evaluation, and implemented a monitoring programme to track the effect of the intervention tools on the markets and ensure product quality is maintained at a high level. This element of performance measurement and evaluation helped improve the labels over time. The Efficiency Grade Labels for the Energy Efficiency Label and Standard programme incorporated an emission factor (over the past five years) and CO_2 emissions and serve as a measure to establish a sustainable culture of production and consumption by providing the most practical and useful information for consumer education (see

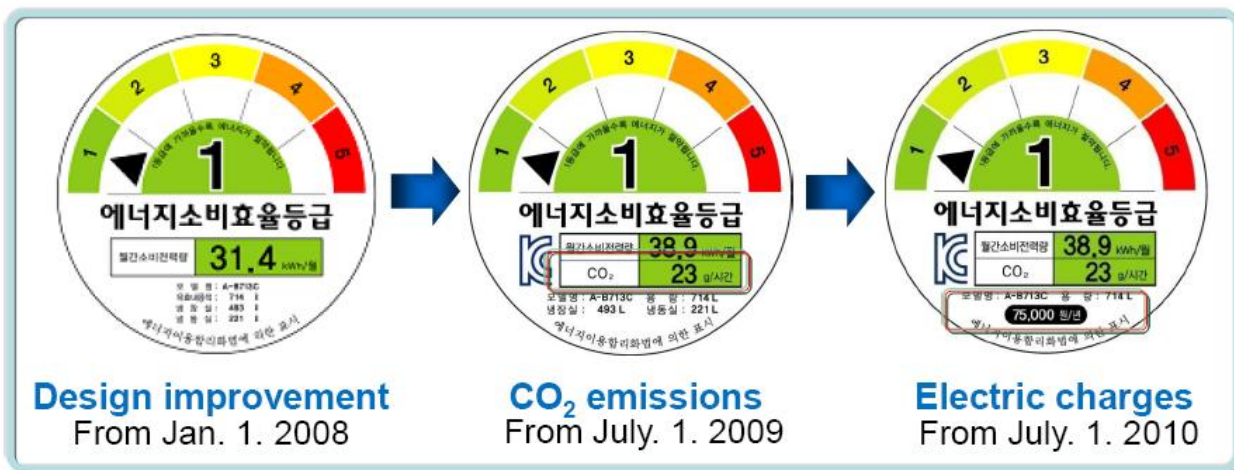


Figure 7). Korea became the first nation to implement CO_2 labels for the operational stage of various electronics, first targeting automobiles and recently expanding to electrical goods. This policy now covers nearly 128 million models of 19 products.

Speaking to the successful nature of such standards and labelling programmes, the market share of supported products grew for the seven target products of the Standby Power Warning Label. Voluntary-

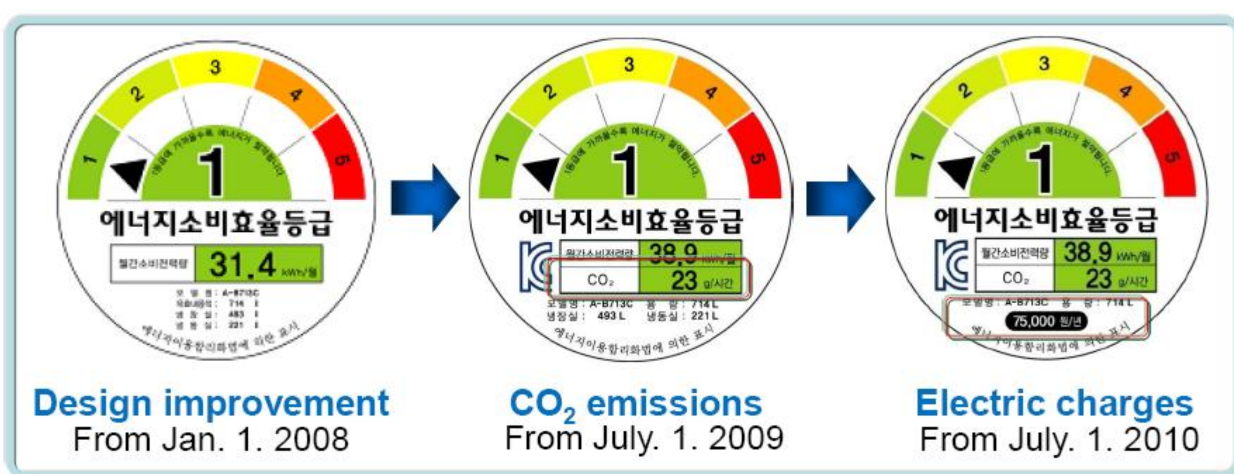


Figure 7: The evolution of efficiency labels to include more relevant information.

to-mandatory programmes such as the e-Standby program exhibit a unique shift in strategy, beginning with the voluntary label for compliant products and later introducing a mandatory warning label for non-compliant products. From the product's early market stages, the minimum efficiency "push" method such as implementing the MEPS, essentially prohibits the production and sale of inefficient products. Later in the market penetration process, efficiency improvements in energy intensive products strengthened the efficiency "pull" of the markets to induce rapid product evolution and market transformation. However, in the Labels and Standards Program where efforts have a limited effect on actual efficiency and consumption, sales-weighted average energy efficiency targets were introduced to companies to bolster the efficiency "pull." The shift in strategies from minimum "push" to maximum "pull" reflects the evolution of the product in the markets and serves as a useful approach to early market introduction.

Creating Markets for Renewable—Best Practice Design of Feed-in Tariffs

David Jacobs, World Future Council

- Link to presentation slides: http://www.iea.org/work/2010/transform/jacobs.pdf

The majority of EU nations implement feed-in tariffs (FITs), quotas, or tax incentives and investment grants to support market penetration by green technology. Worldwide, these types of policy tools have also been adopted in Africa, North and South America, Asia, and Australia. Given the widespread adoption of these practices, the World Future Council (WFC) conducts research and evaluation of the best practices in this field and executes an informational campaign that includes publishing books and brochures for policy makers, presenting at international conferences and parliamentary hearings, hosting workshops, and creating networks and feasibility studies.

Basic FIT design options include a financing mechanism, targets and progress reports. More specifically, these components include a purchase obligation that is independent of the electricity demand from the utility, a guaranteed tariff payment (fixed and pre-defined; based on generation costs), and payment over a long period of time, reflecting the average lifetime of power plants. These tariffs are based on technology-specific generation costs and "reasonable" rates of return. Other cost factors include investment costs (material and capital costs), grid-related and administrative costs, operation and maintenance costs, fuel costs, and decommissioning costs (where applicable). Additional options for tariff differentiation and adjustment may be based on technology, size and location; tariff degression; and inflation indexation. In the past, the tariff payment duration was short based on the conventions of the electricity sector, but contemporary FITs have long payment durations that usually match the lifetime of the power plant (approximately 20 years). This shift was a result of increasingly complex investment structures.

FITs are useful in that they reduce price risk, and therefore costs, so that even small and medium sized actors can afford cheap loans while the reduced risk also allows for reduced costs for the end-use consumer. The advent of FITs has also replaced longer negotiations between OPET RES-e[6] producers and

[6] The Organization for the Promotion of Energy Technologies (OPET) RES-e is a European technology network that promotes energy technologies for the generation of electricity from renewable energy sources (RES-e).

utilities/monopolists due to the short track for power purchase agreements (PPAs) and the accelerated growth of the renewable energy sector in a "protected" market. The FITs' financial incentive and performance-based method of market introduction brings together innovators and utilities, whether public or private-owned, in a combined effort in which both parties share the risk of the investment and realise the benefits with additional cost savings passed along to end-users.

Overall, the WFC concluded that FITs managed to encourage investment in renewable energy sources at an early stage of market development. This method has proven successful for a number of technologies though experts question whether FITs can help incorporate an increasing share of renewable energy. A number of design options exist for achieving effective market integration. Alternative sales options such as market sales, premium FITs, and self-generation/consumption particularly in the case of solar PV could prove useful. Tariff payments for improved system integration are another design option. These improvements might include auxiliary grid services like reactive power and response to voltage dips, demand-oriented services, and steady electricity supply service. Regulations for controlling power output also implement a forecast obligation and may incorporate remote-controlled power output. With increasing share of RES-e, the outlook for the future must turn from designing support mechanisms to designing electricity markets. This raises questions about fixing tariffs or market sales instead, selectivity about who should generate power, coping with the merit-order effect[7], and establishing capacity markets.

Rationales, Results and Recommendations from Risø Innovation Activities

Adam Hillestrøm, Senior Business Developer, DTU Innovation Group, Risø National Laboratory

- Link to presentation slides: http://www.iea.org/work/2010/transform/hillestrom.pdf

Risø DTU contributes to research, development, and international exploitation of sustainable energy technologies while strengthening economic development in Denmark. As one of Europe's leading research labs in sustainable energy, Risø is also a significant player in nuclear technologies. Innovation, which is an independent goal at Risø, can be seen as need-driven or technology-driven. Whichever the principal driver, network-based innovation which involves a problem, its solution, the key agents, and necessary funding and/or resources as the four pillars that support the core of a business opportunity, boosts the innovative process' chance of success.

Risø is organised by areas of research which range from plasma physics and radiation research to solar, wind, and biosystems to materials research and systems analysis. Cross-organisational coordination groups support and help guide innovation and subsequent business development. In Risø, the innovation activities take place in a flat organisation (i.e., one management level) in which all business developers—representing the spectrum of business and science, start-ups and large industrial corporations—are accountable for their own projects.

[7] The merit-order effect is a result of the average cost of electricity production decreasing due to a FIT tariff (or price) that is lower than the price from the most expensive conventional plant.

Risø Innovation Activities (RIA) include commercial tasks, technology driven innovation, and needs driven and network based innovation. In commercial tasks, Risø works with companies to improve their ability to innovate. Technology-driven innovation projects involve the commercialisation of patents (i.e., technology transfer), while need-driven and network-based innovation processes are developed through a proactive dialogue with industry by organising matchmaking events, networks, and one-on-one meetings to establish co-operation projects. The business model for Risø's activities is funded through external project funding and commercial revenues. External project funding comes from region-specific sources and mechanisms such as the Copenhagen Cleantech Cluster while commercial revenues come from Risø's support of patenting activities, research applications, and supporting other DTU institutes.

The technology-driven innovation model supports the commercialisation of inventions and technologies, acting as part of a commercialisation team by first identifying inventions and technologies with commercial potential. Bridging the "Valley of Death" between basic and applied research, this model involves supporting the patent process and supporting research applications to finance the development of a concept or technology to commercialisation or at least to the point that it attracts sufficient external funds to finish development. The advantages of the technology-driven innovation model are RIA's ability to ensure commercialisation and optimise the result while maintaining close ties with researchers and ceding control of patents to the inventors in order to maintain momentum. The multi-faceted services that RIA provides include funding support, consulting and technical expertise, and hands-on capabilities and experience. The technology driven model, however, can be time consuming and more complex than simply selling a patent yet still leave RIA unable to fully control the commercialisation process. Indeed, not all inventions are equally suited to this approach.

The need-driven, network-based method takes an outside-in approach to innovation by identifying industry needs where RIA can make a contribution. A portfolio of tools has been developed over time that highlights matchmaking between research and industry and networking activities about specific clean-tech topics while involving a diverse group of people. By capturing industry needs, this model provides feedback to RIA to maximise the innovation potential and allow for optimal use of RIA competencies while also incorporating industry knowledge into the research process. By nature, need-driven innovation is closer to the market and hence may create the most direct effect in the market. This approach also allows for the identification of new business opportunities where RIA technology can be applied. Contrastingly, there exists an inherent difficulty in presenting researchers with the "right" challenges; sometimes researchers need to be more involved, perhaps in events which are not part of their individual interests. Synchronisation between research field and industry is also hard to achieve, as is measuring the results of need-driven innovation. In this model, RIA does not follow projects all the way to commercialisation.

Market Deployment of EVs and HEVs: "Lessons Learned"

Tom Turrentine, Director, Plug-In Hybrid Electric Vehicle Research Center, University of California at Davis

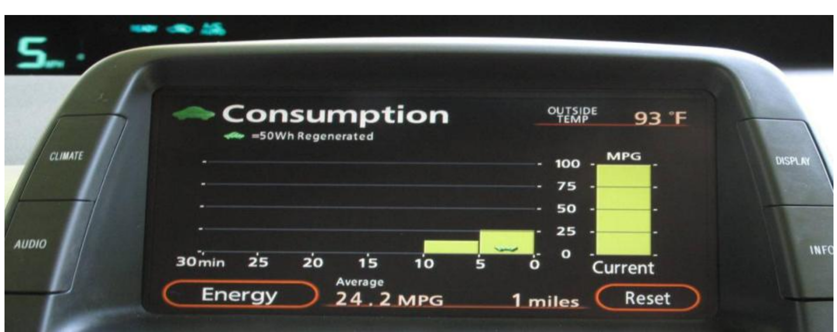
- Link to presentation slides: http://www.iea.org/work/2010/transform/turrentine.pdf

This presentation highlights successes and mistakes in battery electric vehicle (BEV) and hybrid electric vehicle (HEV) deployments in Europe, USA, and Japan in the 1990s. The study period for these technologies lasted from October 2007 to June 2010 during which new workshops with "new deployment efforts" and interviews with experts were conducted across the globe. Part of the exercise was comparing deployment efforts from different nations. A number of cases were investigated including cases in Switzerland, France, Japan, California, Sweden, and New England. Overall, these efforts showcased examples of small markets promoting clean electricity while working with original equipment manufacturers (OEMs) (Switzerland), clean air regulations affecting practical household infrastructure (California, USA), procurement programmes (Sweden), and a small EV company overcoming cold weather issues (New England, USA).

Participants in these projects included utilities, OEMs, government offices, universities, project veterans (Mendrisio and La Rochelle), and IEA representatives. This multi-disciplinary team investigated the projects and programmes to evaluate what worked and what did not work. The group assessed a variety of incentive programmes like tax breaks, high-occupancy vehicle (HOV) lanes, free parking, others; deployment approaches such as mandates and procurement programmes; retail practices including market planning, fleets, and dealerships; infrastructure and utility lessons on slow vs. fast charging and billing challenges; market research practices in modelling and providing demonstrations; and commercial approaches like pay-as-you-go batteries and leasing options. A number of lessons were highlighted by the OEMs that participated, and involving a diverse set of actors also helped gain perspective on the merits and disadvantages of a programme (e.g., zero-emissions vehicle [ZEV] programme, viewed as a cost by a U.S. OEM and as a threat by a Japanese OEM). Toyota, for example, has explored several technical options but still found no business case for BEVs, citing the current "car culture" as in need of reform. This is an example of consumer-driven innovation—development and R&D focusing on the needs of the consumer rather than on the technology demonstrating good results.

EV deployments have shown that a level of education is required among consumers and industry for such technologies to take hold in markets since management support of sales was deemed inadequate. Infrastructure and regulations also proved to be limiting factors in the case of neighbourhood EV (NEV) and city EV (CEV) markets because they were small markets and these vehicles were not allowed on many roads. The market environment was such that all small EV firms failed or were bought and there was a lack of support for electronics (or batteries) in OEMs.

On the regulatory side of the issues, the California Air Resource Board (CARB) found it was hard to justify forcing technologies to market that need long-term R&D, do not have near-term benefits and do not impact consumers. However, taking chances can be good—the ZEV mandate resulted in



much cleaner vehicles across California's fleet. This mandate also resulted in R&D investments—particularly in batteries—and prepared the market and CARB for GHG control, even though NEVs were found to be of little value for complying with emissions regulations and findings indicated that U.S. fleet mandates were not applied well. Defining a class of vehicles as Advance Technology Partial ZEVs (ATPZEVs) and allowing them special privileges like access to HOV lanes proved to be instrumental in keeping technology development moving, despite the need to maintain "technology neutral" regulations. One must also note that OEMs cannot be forced to do what is contrary to their desires at the whole power train level. However, success with BEVs paved the way for the HEV market and the recent development of plug-in hybrid electric vehicle (PHEV) technology as consumers were better prepared and educated.

Utilities have been learning about getting consumers plugged in and have installed public "fast" charging infrastructure, despite being expensive, over-subsidised and under-used in most locations, exemplifying the problems and expenses associated with these much-needed infrastructures. Findings also suggested that HEV energy displays influenced driver behaviours and changed their understanding of fuel economy. Gaining familiarity with the HEV and the information that is provided on the in-dash screen instruments increases the owners' understanding and perceived "value" of the vehicle (see **Figure 8**). This instrument also helps inform the HEV owner of how fuel economy varies over speed, terrain, and weather.

Figure 8: Descriptive dashboards provide instant feedback to drivers in order to effect better driving habits.

In conclusion, a systematic co-operation between OEMs, government, and the power industry is needed to build the necessary relationships and cooperative structure needed for successful deployment. A number of government intervention solutions were proposed that included regulatory constraints, focus on electricity prices, a structural shift to smaller, more limited range vehicle infrastructure (e.g., roads, parking, charging), and the development of lifestyle markets (e.g., resorts, city environments). Careful timing of the rollout of vehicles, infrastructure, incentives, taxes and tax rate are also sensitive factors to be considered along with the chasm between early and mass markets. The early markets are characterised by innovators that are motivated by difference and are willing to pay extra for a new technology, while the main market consists of consumers that have different, more risk-averse behaviour in that they are motivated by sameness and the low prices of goods. Overall, an effective approach for developing the appropriate market may require a systematic preparation of the market through energy education, vehicle instrumentation, and social energy accounting. Finally, a number of policy instruments and support from government and industry will likely need to be provided simultaneously to nurture the various aspects of the young market, phasing in certain programmes and phasing out others over time as the market grows.

Full-Scale Implementation: Shaping Market Behaviour

The key aspects of an approach for market entry will likely include conditioning, shaping behavioural norms, and informing and influencing consumer choices. Achieving market competitiveness is a step forward on the path towards a mature technology. Along the way, technology neutral policies will be elemental, albeit at a declining level of support compared to the earlier stages in market deployment. In order to reach mass markets, policy support will be needed to accelerate adoption of the technology by addressing specific market barriers which may include options such as establishing building codes and standards, efficiency standards (MEPS), and information campaigns to raise industry and public awareness and support.

The high level of uncertainty surrounding human demands and consumer behaviour complicates energy technology deployment, regardless of its cost-effectiveness and environmental benefits. The policy options that can help an energy technology reach full market adoption are numerous and varied in scope and mechanism and must be accompanied by equally impactful regulations to shape the market so as to minimise market failures. However, these policies are not all guaranteed to be successful, given the complex nature of energy technology markets and the public-goods nature of the energy technologies themselves. This requires both government and industry involvement to ensure the optimal mix of resources and strategic policy options are implemented.

Warm Up New Zealand: Heat Smart

Sea Rotmann, Principal Scientist, Energy Efficiency and Conservation Authority

- Link to presentation slides: http://www.iea.org/work/2010/transform/rotmann.pdf

By providing information to all New Zealand homes, businesses and local and central governments, the entity established by the Energy Efficiency & Conservation Act (EECA) aims to improve the standard of living of NZ residents with efficient housing/building technologies. Currently, New Zealand has an issue with substandard housing that does little to conserve heat and provide adequate shelter. This situation leads to both housing conditions that contribute to health care costs nationwide and wasted energy from inefficient technologies and fuels. Therefore, with the Warm Up New Zealand: Heat Smart programme, New Zealand has the opportunity to improve energy savings, reduce energy demand and related GHG emissions, provide construction jobs performing retrofits, and improve population health and productivity.

Specifically, Warm Up New Zealand: Heat Smart is a Government programme providing house owners and tenants with grants for insulation and clean heat. Funding is available for approximately 180,000 houses over 4 years, worth more than 150m euros. All homeowners can get 33% off the cost of installing ceiling and underfloor insulation, and other insulating measures up to NZ$1,300 (approximately 740 euros). A low income household can get 60% off the total cost of insulation, not including third party funding. In some regions, local organisations, including district health boards, contribute additional third party funding for low income groups.

However, a number of barriers exist to uptake of the improved insulation including cultural issues, alternative priorities, financial hurdles, implementation difficulties, insufficient knowledge, insufficient or contradictory regulations, and compliance problems. In response, the Government of New Zealand made the programme its flagship social effort and focused on improving uptake by the public, ensuring effective delivery, increasing third-party funding, changing behaviour on energy use, improving health benefits, and stimulating demand for further home improvements. These changes were achieved by expanding the programme to include stakeholders such as landlords and making the grants available for any house constructed before 2000, regardless of resident income. While upper-income households have not utilised the programme as much as lower-income residents, research suggests that the expanded reach of grants has increased awareness of household energy efficiency. The improved awareness begins with the focus on insulation, but widening the attention to overall home heating and then to home lighting and to other aspects of living quarters leads to the eventual inclusion of energy conscious decision-making in day-to-day activities.

Because the programme was designed to partner with private businesses, the private sector has financed a large share of the costs of improvements. The government has been able to ensure both a range of options for efficiency upgrades and quality by contracting with service providers and by setting quality standards. Increased awareness and uptake has been achieved through widespread marketing on TV, internet and radio; encouraging service providers to inform their customers of efficiency options; and making the programme available to a large portion of the population. The government standards address requirements for insulation products and installation techniques through strengthened building codes. Indeed, the improved standards have led to the formation of the industry body the Insulation Association of New Zealand (IAoNZ) which develops and maintains the installer training scheme. Finally, continual research and monitoring and evaluating the programme's key performance indicators will ensure continued success.

The EECA-derived programme was developed to address the inadequacies of previous programmes that had little impact over the previous decades. By covering the entire market from manufactures of insulation to consumers, the New Zealand Government has been successful in increasing demand, creating a market and improving service provider quality and choice. The uptake of better insulation had sufficient barriers to warrant this broad level of government intervention, but improving home quality through improved insulation will lead to permanent changes in the culture around home energy use. With these changes in perception, building codes will increase the minimum insulation standards ensuring still wider adoption of these important practices.

Italy: The Case of Smart Meters

Ferruccio Valli, Head, Electricity Quality of Supply, National Authority for Electricity and Gas

- Link to presentation slides: http://www.iea.org/work/2010/transform/villa.pdf

As of mid-2009, 30 million electricity smart-meters have been installed in Italy which represents 90% market penetration; in Europe, only Sweden has a greater percentage market penetration. The scale of the market indicates that 35 million low voltage (LV) meters have been deployed and that these meters currently measure 137 TWh. While Italy has substantial experience and expertise with electricity smart metering, they are only just beginning their development of both demand response tools and natural gas smart metering. Beginning in January 2008, small and large power users are required to start installation of smart meters. All large power users (greater than 55kW) were required to have installations by the end of 2008, while increasing portions of smaller users must install meters until at least 95% of electricity withdrawal points are covered by the end of 2011.

The regulatory environment that has created this uptake began with the liberalisation of the electricity sector starting in July 2007. Because the advanced meter management (AMM) systems were not initially required, differentiation among the Distribution System Operators (DSOs) came about as some utilised the AMM systems while others used electromechanical methods to measure real-time consumption. Finally, Italy's electric authority had received guidance to characterise AMM systems from the functional and performance points of view. In all, these policies aim to help ensure competitiveness in the supply of electricity to residential and non-residential customers, establish the functional and technological conditions to make it possible to extend hourly metering to LV withdrawal points, and to improve the quality of the electricity metering, supply and distribution services, ensuring the same functional and performance levels for all LV consumers, both in the free market and those with government provided service.

Italy set minimum requirements to ensure consistency for the consumers and interoperability and standardisation for the technologies, such as the functional requirements for single-phase and three-phase and mono-directional and bi-directional meters. These minimum requirements were also intended to ensure they are system-oriented and do not impede or limit technological innovation or reject new solutions and architectures. Performance requirements such as the annual percentage of successful remote transactions (e.g., activation/deactivation) and the annual number of meters registering a failure reported to the control centre were also created. A metering tariff was established in order to separate the charge from the distribution tariff in place. The "extra charge" experienced from 2004 to 2007 was less than 2 euros per year, but going forward the metering tariff will be adjusted annually. Other mechanisms will be established to account for the high costs incurred by smaller Distributed Network Operators (DNOs).

Demand response for retail markets (i.e., LV customers) involves responding to power and energy use. For power, the household capacity is generally limited to 3 kW which is accomplished with a breaker on the meter. Energy limits are being gradually stepped up with stricter metering requirements implemented over time. Time-of-Use (TOU) tariffs which charge different rates based on the time of use (i.e., peak, mid-level, and off-peak) are being implemented for LV consumers in order to shift consumption to lower demand times.

Because electricity is not used for thermal energy, gas metering is also being investigated in order to improve recording and accounting for natural gas consumption. Italy has performed a cost-benefit analysis to determine the net present value at year 15 of different annual consumption bands measured in Euros per meter. Additionally, minimal functional requirements have been established for different types of gas meters. Eventually, the adoption of these meters will be integrated with the electricity meters already widely adopted. First generation regulation and standards will ensure both electricity and gas smart meter use while second generation development envisions interoperability and communication.

The roll-out of the electricity smart meters was successful because the Italian government set deadlines for replacement of old metering systems and set minimal functional requirements, but did not mandate the technology or system architecture. They did, however, use financial penalties for missed replacements. Also of note is an equalisation mechanism that accounted for higher costs to smaller DNOs, enabling wider use of the technology. The primary challenge of implementing the new system was finding the balance between customer needs and rights, the systems needs, and the technical limitations of the smart metering systems. This challenge was addressed, if not fully overcome, by engaging in dialogue with all stakeholders involved. Yet, a number of difficulties remain such as the proprietary nature of the communication protocols and the long lag time for software updates to the millions of meters. Overall, the Italian experience has shown that smart metering is feasible and adds minimal cost to the consumers while accelerating the competition among energy suppliers.

United States: Energy Star Program

Craig Zamuda, Senior Advisor, Climate Change, Policy and Technology, Department of Energy

- Link to presentation slides: http://www.iea.org/work/2010/transform/zamuda.pdf

Energy Star is a voluntary, government-backed program aimed at helping consumers protect the environment through superior energy efficiency. Products that earn the Energy Star label meet strict energy performance criteria set by DOE and the U.S. Environmental Protection Agency (EPA) without sacrificing performance or product features. The EPA and DOE established energy-efficiency criteria following key "guiding principles" and utilising an open process with input from manufacturers. Interested manufacturers, retailers, and energy efficiency programme sponsors can join the programme—and gain access to the symbol—by signing a Partnership Agreement.

Since being introduced in 1998, the Energy Star label can now be found on nearly 35% of clothes washers increasing market share from less than 1% to over 35% through 2005. Similar success has been experienced in the case of CFLs, windows, and residential water heaters. Energy Star has also turned its focus to new and existing homes, with more than 28,000 homeowners saving energy annually as a result of the state and local-sponsored initiative Home Performance with Energy Star with 27 sponsors around the country. In 2009 alone, more than 100,000 Energy Star new homes

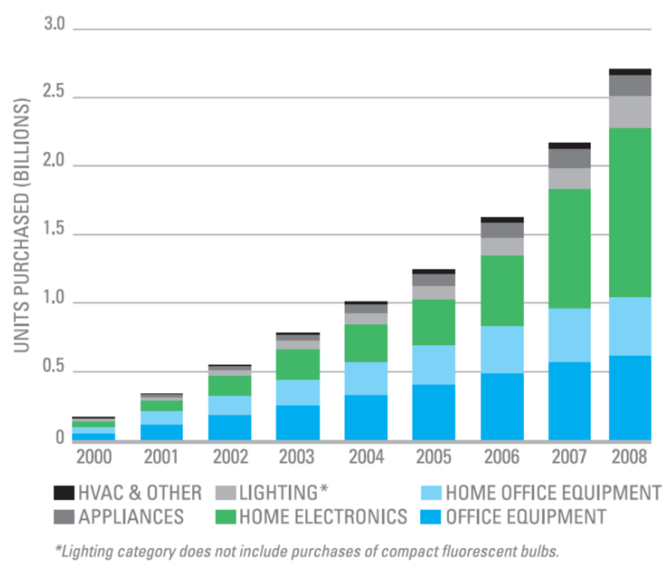


Figure 9: Energy Star products sold from 2000-2008. Energy Star products are sold across more than 40,000 models of consumer and commercial devices.

were constructed, raising the total to more than 1 million. The Energy Star program includes on-line assessment tools, installation guidelines, and information for commercial and public consumers.

Over 60 product categories are covered by the Energy Star program in the U.S. including appliances and equipment for residential and commercial markets ranging from heat pumps and boilers to computers and monitors to home audio and refrigerators (see **Figure 9**). The share of home electronics in the Energy Star product market has increased to the point where today it accounts for the majority of Energy Star products on the market. About 3 billion such products were sold in 2009 alone in more than 60 product categories, across more than 40,000 models. In 2009 alone, Americans saved roughly $17 billion in energy bills with Energy Star products, saved over 190 billion kWh of electricity or approximately 5% of U.S. electricity demand, and saved approximately 45 MMT Carbon equivalent (equal to the annual emissions of 30 million cars). Even more important is the rising consumer awareness about Energy Star products which has risen from 40% in 2001 to 76% in 2008. This has likely contributed to the rising sales of Energy Star qualified products from below 4 million units in 1998 to over 15 million units in 2006.

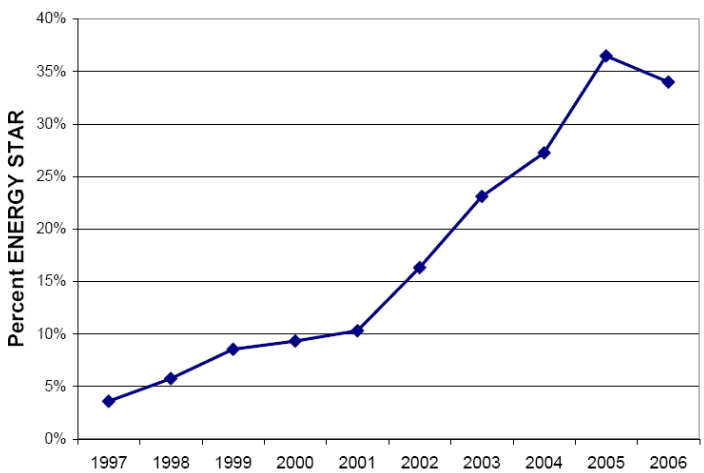


Figure 10: Percent of clothes washers ENERGY STAR qualified. Every clothes washer sold today is more efficient than the best clothes washer available at the beginning of 1997.

This type of labelling programme serves as an effective market-building tool because of the promotional designation for product marketing in ads and collateral materials. Moreover, the programme provides a basis for utility program eligibility for rebates and financing for Energy Star qualified products while also simplifying procurement specification for large organisations. Sales tax and other tax incentives (credits) often reference Energy Star as well. These tools, coupled with the recognition of the Energy Star label help promote use and awareness of energy saving devices and appliances by focusing on consumers as the ultimate beneficiary of the product development. The voluntary nature of the program provides impetus for manufacturers to meet Energy Star requirements to remain competitive in their target markets, spurring continued development of energy-efficient consumer products (see

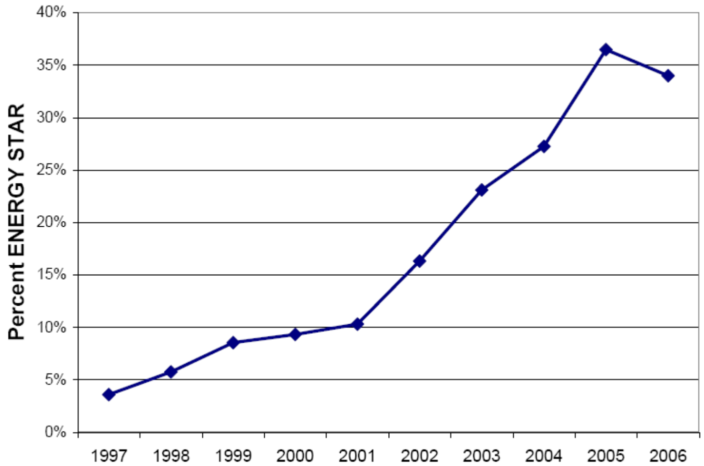


Figure 10).

Since 2001, an increasing number of commercial and industrial facilities have been Energy Star-rated and labelled. Through 2009, benchmarking efforts were undertaken and more than 80,000 buildings representing more than 11 billion square feet were covered in that exercise. The Energy Star Challenge is challenging organisations across multiple sectors to improve the performance of their entire portfolio by 10% or more while partnering with 17 manufacturing sectors including steel, petrochemicals, cement, glass, and automobiles as well as hundreds of industrial companies. The energy-water nexus, specifically wastewater facilities and energy use at those facilities will be the focus of future Energy Star efforts.

The “SUPER STAR” Program is another improvement in the Energy Star portfolio of activities in which the U.S. EPA will set performance levels for super efficient products. This “Super Star” program is intended to reflect higher tier products; the name and look of this higher tier label will be developed and rolled-out in fall of 2010. Generally, products in the top 25% in terms of efficiency will qualify as Energy Star products and the top 5% will qualify as SUPER STAR products.

However, one challenge facing the Energy Star Program is the over-reliance on industry for support and success of the programme. A March 2010 Government Accountability Report revealed that covert testing showed that certification processes are subject to fraud and abuse, indicating that bogus products could qualify for the programme. The programme will bolster verification and testing efforts by requiring manufacturers to submit complete laboratory testing reports and results from an approved, accredited laboratory and the DOE will conduct off-the-shelf product testing at third-party, independent test laboratories.

The U.S. government has made arrangements with agencies in other countries regarding Energy Star for office equipment. This series of agreements and co-operative partnerships are an example of international harmonisation in the markets of these energy efficient products. Policy makers and manufacturers both benefit from leveraging their limited resources and sharing valuable knowledge to each other's benefit. Co-operation in this form may lead to uniform internationally-recognised test procedures and potentially uniform specification guidelines for globally-traded products. This level of government coordination can help facilitate the development of standardised specification levels based on a global data set. These factors will help minimise manufacturers' cost of participation and compliance while ensuring the comparability of efficiency claims worldwide.

Energy Transition: The Dutch Approach

Hugo Brouwer, Director, Energy Transitions, Ministry of Economic Affairs

- Link to presentation slides: http://www.iea.org/work/2010/transform/brouwer.pdf

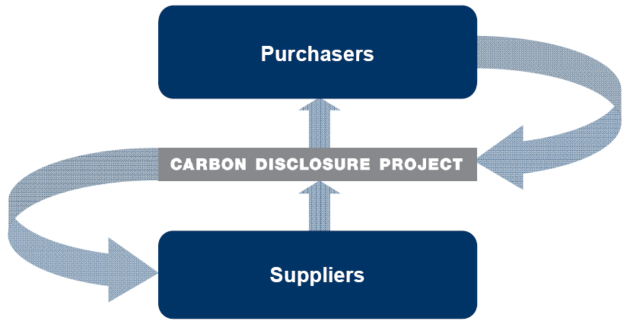
The Netherlands has established energy and emissions targets for 2020 that include a 30% reduction in CO_2 emissions compared to 1990 levels, a 20% share of renewable energy use, and a 2% annual energy efficiency increase. The strategy to achieve these targets consists of three "policy waves" that involved taking large steps in terms of policy, preparing meters, and continuing with long-term innovation. In order to execute a successful energy transition, the Dutch are taking a multi-pronged approach that includes long-term visions such as transition paths; aligned climate policy and industrial policy; development of stakeholder platforms for public-private co-operation; focus on frontrunners and superstar technologies; innovation beyond the conventional technology and financing innovations; and interdepartmental collaboration.

Frontrunner technologies are the focus of the Dutch strategy and are expected to deliver 90% of the future solutions and act as a key component in an energy transition. In addition to nurturing the frontrunners, accelerating innovation through a strategic agenda is essential to achieving market acceptance and pushing a technology from demonstration stages to holding a significant portion of market share and avoiding the valley of death. Approximately 30 programmes will receive funding from a total of 438 million euros from 2008 to 2012. These programmes will focus in the areas of green raw materials, new gas, renewable energy, sustainable mobility, chain-efficiency, built environment, and a greenhouse as a power plant. From 2004 to 2008 a total of 384 projects in these areas were supported with funding totalling 0.3 billion euros and investments totalling 2 billion euros.

However, in addition to researching and developing an innovative concept, it is crucial to identify and exploit transition paths in order to implement an effective market penetration strategy. Such pathways exist for technologies to exploit infrastructures in the areas of natural gas, biogas, hydrogen fuels, biofuels, electric transportation, and intelligent mobility. By the year 2020, the transport sector is anticipated to make public transport busses more than 20% more efficient, reduce emissions standards for personal automobiles down to 80 mg per km, raise efficiency standards for new cars by a factor of 30, and establish infrastructure filling stations for natural gas, biogas, and electricity. A variety of policy instruments may be used to effect a successful policy initiative that include green leases, green fiscal incentives, biogas filling station infrastructure, DutchHy: H2-coalition Amsterdam—Rotterdam, and an Action Plan for Electric Transport.

Another component of the overall Dutch energy transition strategy is geared towards goals of achieving energy neutral new buildings and retrofitting existing buildings to be 30% more efficient, targeting 2.4

million dwellings. The strategy involves innovation programmes in experimental areas, and developing and executing an action plan by a coalition of stakeholders. Regional partnerships such as the Rotterdam Climate Initiative will also play an important role in an effective energy transition strategy. The goal of this initiative is to reduce CO_2 emissions by 50% from 1990 levels by 2025. This initiative aims to achieve these reductions through carbon capture and sequestration (CCS), exploiting CO_2 in horticulture, installing LED streetlights, maximising the deployment and use of energy efficient public transport, and increasing the deployment of industrial energy efficiency.



The Dutch approach focuses on the frontrunners to play a key role in this strategy, but the utility of public-private and regional partnerships is very powerful and not to be underestimated. This model will help connect different communities of innovative people to realise an environment of vital activity to spark innovative developments. Such collaborations may also help focus efforts on societal innovation, instead of purely focusing on technological innovation. Additional benefits from coordinated public-private efforts may result in combined focus of climate change policy and business opportunities that could be beneficial to both efforts. These activities will need to focus on being pragmatic, taking advantages of opportunities, no matter how small, and start on a smaller scale and gradually enlarge the focus and effort with time. Finally, it is imperative to communicate the impacts and achievements of innovations with concrete results either through demonstrations to the public or through informational or outreach campaigns to communicate progress to gain public support.

United Kingdom: Carbon Disclosure Project

Frances Way, Head of Supply Chain, Carbon Disclosure Project

- Link to presentation slides: http://www.iea.org/work/2010/transform/way.pdf

The Carbon Disclosure Project (CDP) is an international framework where organisations can measure and disclose GHG emissions and climate change strategies for setting targets and improving environmental performance. The data is made available to a broad audience that includes investors, policy makers, and the general public. The CDP currently has 534 institutional signatory investors and $64 trillion in assets being managed by CDP's signatory investors. A total of 56 companies are engaging their suppliers through CDP while 2,300 suppliers requested to disclose and over 2,500 companies have responded to CDP in 2009.

Figure 11: The CDP positions itself to communicate with suppliers and purchasers in order to collect the relevant data.

The CDP's effectiveness hinges on leveraging authority between the purchasers and suppliers within the supply chain (see **Figure 11**). By working closely with both parties and engaging both, the CDP can maximise the effectiveness of the supply chain linkage and relationship between purchaser and supplier. This authority is an imperative part of the strategy for achieving a significant impact, given the number of large corporations that are current members of the CDP supply chain that include PepsiCo, Wal-Mart, Vodafone, Nestle, IBM, DELL, and many others.

CDP plays an important role in Public Procurement practices, working with several government agencies to ensure that data on emissions and supply chain risk is of high quality. This can help ensure that public procurement efforts are well-informed in making purchasing decisions on behalf of taxpayers. In one example, the U.S. General Services Administration (GSA) has assessed the feasibility of working with Federal vendors and contractors to provide information to assist Federal agencies in tracking and reducing (scope 3[8]) GHG emissions related to the supply of products and services to the U.S. government. Beyond this, it was recommended that vendors and contractors register with a voluntary registry or organisation for reporting GHG emissions.

Benchmarking efforts may serve as a form of motivation in such a project. By surveying all organisations, whether members of the CDP supply chain or all members, this can provide useful information on the utility that organisations see in such an effort. These organisational surveys track information about participation and performance by assessing suppliers against each other and the member average. A number of metrics are measured and reported to gauge these two areas that include the number of suppliers requested to participate, the participation rate, strategic awareness, carbon reduction ambition, reporting capabilities, and implementation practice.

In order to ensure compliance with the carbon management criteria, requirements for participation in the programme are set to increase. Data will be gathered concerning the member willingness to deselect Suppliers for failing to meet these criteria as a method of gauging the perceived importance of meeting these requirements. The CDP also tracks annual data on the number of suppliers and members who have adopted GHG emissions and/or energy reduction plan and their level of emissions reporting.

A case study on DELL shows that in order to meet corporate expectations, Tier-1 suppliers[9] must demonstrate publicly disclosed annual GHG emissions data by participating in the CDP, an established public goal for reducing operational GHG impacts, and must set expectations for Tier-2 suppliers to manage and publicly disclose emissions per GHG Protocol. Failure to comply with these requirements can negatively affect the suppliers ranking and potentially diminish future ability to compete for DELL's business. Wal-Mart has selected CDPs standardised reporting system for its suppliers to measure their GHG emissions and reduction targets. The companies' scores from the Supplier Sustainability Assessment will be used to identify supplier leadership, determine strategies for business success in a sustainable manner, and measure overall supplier performance against goals. Wal-Mart has its own corporate goal of eliminating 20 MMT of GHG emissions from their global supply chain by the end of 2015. Another case study found that office-based organisations saved 95% of their energy consumption by consolidating computer terminals after discovering that computers were responsible for the vast

[8] Scope 3 emissions include indirect emissions from sources not owned or controlled by the institution such as indirect electricity-related emissions (transmission and distribution losses), commuting, outsourced activities, waste disposal, etc.

[9] Tier-1 suppliers are larger companies typically found at the top of the supply chain. Tier-2 and tier-3 suppliers are smaller companies that supply parts and components to the upper-tier suppliers who employ them.

majority of emissions. This action saved $500,000 annually. Of note is that this was not considered a business issue before measuring their emissions.

The risks and opportunities of climate change serve as strong motivators for investors and companies to gather the relevant information. This is exemplified by the increasing number of global corporations that are increasingly making carbon management a requirement for doing business. In order to better estimate the impacts of sustainable actions, Return on Investment (ROI) estimates for clean technology could factor in the risk of the company losing business in order to provide a more comprehensive measure of the impact of such investment.

Discussion and Conclusions

The structure of the workshop covered three stages of the deployment continuum, emphasising deployment and diffusion and bringing science together with entrepreneurs. The next stage looked at how to get products to the market. Lastly, tools and techniques for shaping consumer behaviour in markets at large were presented. The various presentations demonstrated a significant amount of knowledge, know-how, and success stories. While the premise of the Secretariat study 'energy technology transitions' that there is lack of understanding of best tools and approaches overlooks some of the programs presented, a need to bring together opportunities, particularly for policy makers and for investment, still exists.

Regarding ways to bring together ideas and business—cutting through bureaucracy and bringing innovators together with financiers can be difficult, but such relationships have been built effectively by many programs, some even stimulating alternative paths to the research goal, such as in the United States. The intellectual capacity and breadth of expertise of the French Carnot Institutes—as well as their budget—was impressive. The Institutes' organisation admirably manages this abundance to shepherd innovative technologies into the marketplace. And while a unique best organisational structure may not exists, as science knows no boundaries, more capacity can accelerate results.

However, there are still some areas where public benefits are compelling but costs are not within reach so subsidies are often needed. In general, projects must attract sufficient financing from the private sector on their own merit, but where a technology development or demonstration project cannot, subsidies are needed to start the process. In the long-term, though, these subsides may not be good for continued organic growth of the technology. As for government support more generally, regulations and policies must be harmonised with the norms and standards used to foster consistency and stability for early growth of innovative technologies in the market.

In the session on behavioural science and how can we shape consumer response, signals such as sticks or carrots have been used with significant success. Barriers are not always technical or financial. They can be cultural for example how people think about their environment; therefore, social science should be taken more seriously and be included more in technology discussions. There is a need to re-introduce surveys as an embedded part of deployment programmes, and consumer behaviours and cultural barriers in general require further examination.

Appendix A: List of Acronyms

AMM	advanced meter management
ARPA–E	Advanced Research Projects Agency–Energy
ATPZEV	Advance Technology Partial Zero-Emissions Vehicle
BEV	battery electric vehicle
BICS	Business Incubation Centres
BIPV	Building Integrated Photovoltaics
C&D	commercialisation and deployment
CARB	California Air Resource Board
CCS	carbon capture and storage
CDP	Carbon Disclosure Project
CERT	Committee on Energy Renewable Technology
CRADA	Co-operative Research and Development Agreement
CSP	concentrating solar power
DOE	U.S. Department of Energy
DSO	Distribution System Operator
EECA	Energy Efficiency & Conservation Act
EFRC	Energy Frontier Research Centre
EGRD	Experts' Group on R&D Priority Setting and Evaluation
ESA	European Space Agency
ESINET	European Space Incubators Network
ESTEC	European Space Research and Technology Centre
EU	European Union
EV	electric vehicles
FCA	Fuel Cell Association
FIT	feed-in tariff
GHG	greenhouse gas
HEV	hybrid electric vehicle
HOV	high-occupancy vehicle
IAs	Implementing Agreements
IAoNZ	Insulation Association of New Zealand
ICT	information and communication technologies

IEA	International Energy Agency
IP	intellectual property
IPR	intellectual property rights
ISE	Institute of Solar Energy Systems
JIS	Japanese Industrial Standards
KEMCO	Korean Energy Management Corporation
LV	low voltage
MEF	Major Economies Forum
MEMS	Micro Electro Mechanical Systems
MEPS	minimum energy performance standards
METI	Ministry of Economy, Trade, and Industry (Japan)
MFIX	Multiphase Flow with Interphase eXchange
MJ	mega-joules
NEF	New Energy Foundation
NEDO	New Energy and Industrial Technology Development Organisation
OECD	Organisation of Economic Co-operation and Development
OEMs	original equipment manufacturers
ÖGUT	Austrian Society for Environment and Technology
OPET	Organization for the Promotion of Energy Technologies
PEFC	polymer electrolyte fuel cells
PHEV	plug-in hybrid electric vehicle
PPS	Public Procurement Service
PV	photovoltaic
R&D	research and development
RD&D	research, development, and demonstration
RDD&D	research, development, demonstration, and deployment
RES-e	generation of electricity from renewable energy sources
RIA	Risø Innovation Activities
SMEs	small- and medium-sized enterprises
W	watt
WFC	World Future Council
ZEV	zero-emissions vehicle

Appendix B: Agenda

IEA Committee on Energy Research and Technology
EXPERTS' GROUP ON R&D PRIORITY SETTING AND EVALUATION

TRANSFORMING INNOVATION INTO REALISTIC MARKET IMPLEMENTATION PROGRAMMES

27-28 April 2010

International Energy Agency
9, rue de la Fédération
Paris 75015

AGENDA
Day 1

9:00		Opening Remarks	*Nobuo Tanaka, Executive Director International Energy Agency*
9:15	1	Energy Technology Perspectives	*Peter Taylor, Head, Energy Technology Policy International Energy Agency*
9:45	2	Strategies for Commercialisation and Deployment of Technologies and Practices	*Robert Marlay, Director, Climate Change Policy and Technology, Department of Energy*
10:15		Break	
		CREATING BUSINESS FROM IDEAS	
		Moderator: Birte Holst Jorgensen (Riso National Laboratory, Denmark)	
10:45	3	France: Instituts Carnot	*Joachim Rams, Président, Association of Instituts Carnot*
11:15	4	Germany: Fraunhofer Institute for Solar Energy Systems	*Tilmann Kuhn, Head of Group Solar Facades, Fraunhofer Institute for Solar Energy Systems*
11:45	5	European Space Agency Experience with Technology Transfer	*Callum Norrie, European Space Agency Technology Transfer Office*
12:15	6	Funding Mechanisms for Technology Transfer	*Bernd Geiger, Managing General Partner, Triangle Venture Capital Group Management*
12:45		Lunch	
		EARLY STAGE MARKET ENTRY	
		Moderator: Michel Gioria (ADEME, France)	
14:15	7	Austria: Energy efficiency in buildings	*Herbert Greisberger, Director, Austrian Society for Environment & Technology*
14:45	8	Japan: Stationary fuel cell programme	*Makoto Akai, National Institute for Advanced Industrial Science and Technologies*
15:15	9	Korea: Energy Efficiency Label and Standard Program	*Ki-Hyun Lee, Asst. Manager, Energy Labels & Standards, Korea Energy Management Corporation*
15:45		Break	
16:15	10	Creating Markets for Renewables: Best Practice Design of Feed-in Tariffs	*David Jacobs, World Future Council*
16:45	11	Rationales, Results and Recommendations of Energy Technology Innovation	*Adam Hillestrom, Senior Business Developer, DTU Innovation Group, Riso National Laboratory*
17:15	12	Electric and Hybrid Vehicles: Strategies, Incentives, Successes and Failures	*Tom Turrentine, Director, Plug-In Hybrid Electric Vehicle Research Center, University of California at Davis*
17:45		Close day 1	

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AGENDA
Day 2

FULL-SCALE IMPLEMENTATION: SHAPING MARKET BEHAVIOUR			
Moderator: Frank Witte (NL Agency, Netherlands)			
9:00	13	Italy: The Case of Smart Meters	*Ferruccio Valli, Head, Electricity Quality of Supply, National Authority for Electricity and Gas*
9:30	14	New Zealand: Shaping Consumer Choices	*Sea Rotmann, Principal Scientist, Energy Efficiency and Conservation Authority*
10:00	15	United States: EnergyStar	*Craig Zamuda, Senior Advisor, Climate Change, Policy and Technology, Department of Energy*
10:30		Break	
11:00	16	Netherlands: Interministerial Programme for Energy Transitions	*Hugo Brouwer, Director, Energy Transitions, Ministry of Economic Affairs*
11:30	17	United Kingdom: Carbon Disclosure Project	*Frances Way, Head of Supply Chain, Carbon Disclosure Project*
12:00		Lunch	
DISCUSSION AND CONCLUSIONS			
Moderator: Peter Cunz, Chair, Committee on Energy Research and Technology			
13:30	18	Reflection, Discussion and Next Steps	*Robert Marlay, Director , Climate Change Policy and Technology, Department of Energy*
14:00	19	Open Discussion	*Moderator*
Which policies, programmes or measures: ➢ *provided the greatest insight for participants?* ➢ *are found to be the most effective and why?* ➢ *are found to be the least effective and why?* ➢ *are better suited to a particular sector or technologies?* ➢ *have the greatest potential for reducing CO2 emissions?* ➢ *have the greatest potential for cost reduction?* ➢ *are able to overcome financial barriers?* ➢ *sidestepped regulatory barriers?* ➢ *was the most efficiently implemented?*			
16:00	20	Session wrap-up and summary	*Moderator*
17:00	21	Workshop Conclusion	*Rob Kool, Manager, International Sustainable Development, NL Agency*
17:30		Close	

All presentations may be consulted at www.iea.org/work/workshopdetail.asp?WS_ID=448.