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Eco-Innovation activities in key countries beyond Europe

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Summary

This report investigates public R&D programmes of relevance for eco-innovation and other activities to foster eco-innovation in five key countries outside Europe: the US, Japan, Republic of Korea, China, and India. The report also includes information on market-based policy instruments to support eco-innovation, programmes and activities to mobilise the financing of eco-innovation, environmental regulation and standards, demand-side oriented initiatives to raise awareness with regard to eco-innovation and international initiatives to promote eco-innovation. The aim of the report is to contribute to an ECO-INNOVERA knowledge base, which provides the best possible background for the strategic development of the project as a whole.

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1. Executive Summary

This report investigates public R&D programmes of relevance for eco-innovation and other activities to foster eco-innovation in five key countries outside Europe: the US, Japan, Republic of Korea, China, and India. The report also includes information on market-based policy instruments to support eco-innovation, programmes and activities to mobilise the financing of eco-innovation, environmental regulation and standards, demand-side oriented initiatives to raise awareness with regard to eco-innovation and international initiatives to promote eco-innovation. The aim of the report is to contribute to an ECO-INNOVERA knowledge base, which provides the best possible background for the strategic development of the project as a whole. More detailed information is provided on "Good Practice examples" of programmes for stimulating eco-innovation (annex). The report also includes recommendations that might be of help for designing future measures to promote eco-innovation.

The definition of eco-innovation applied in the ECO-INNOVERA project and in this report is broad and includes technological and non-technological innovations that create business opportunities and benefit the environment.

Summary and conclusions

The investigated countries differ in the degree of innovation capacity and R&D investment. In particular Japan and USA are major players in the field of eco-innovation. Due to Korea's high investments in this area, it is catching up fast. With regard to innovation potential in the area of cleantech start-ups, USA and South Korea rank rather high compared with other countries. China and India have a strong potential for growth in this area, as policy to promote eco-innovation and green growth becomes more and more important. The percentage of Government budget for R&D in environmental issues is particularly high in Korea (around 4 %), while in US and Japan it is around 1%.

Almost all investigated countries include green growth as major pillars in recent strategy documents and stimulus packages with regard to the economic crisis. These strategies stress the importance of R&D for innovation in the environmental area to address both ecologic and economic challenges, particularly in Korea, the US, and Japan, but also in China. The strategies foresee an increase of the share of Gross Expenditure on Research & Development (GERD) for environmental issues to foster green innovation and increased investment to green the economy.

The investigated countries apply a broad range of programmes and activities that on the one hand fund and foster R&D in eco-innovation related areas and on the other promote the commercialisation and dissemination of eco-innovations. In general, most R&D funding programmes of relevance for eco-innovation in the investigated countries

do not explicitly focus on eco-innovation per se. Instead, some R&D programmes listed in this report fund environmental research and environmental technology development without a specific focus on transfer of results and implementation, while other programmes and activities put their focus on promoting implementation and commercialisation of results without a specific environmental focus. However, there are also programmes that combine both.

In the US, a strong focus of public R&D programmes for eco-innovation is on dissemination and commercialisation. The strategy of the US Environmental Protection Agency (EPA) is to anchor innovation in the environmental programmes and to use the limited resources of the EPA as leverage by supporting collaboration with other actors. A number of EPA programmes focus not only on the funding of research and development, but also on demonstration, verification, diffusion and utilisation / commercialisation activities. EPA has been designed as a one-stop-shop to coordinate all programmes in the context of eco-innovation.

The US Small Business and Innovation Research Programme (SBIR) that funds demonstration and commercialisation activities of SMEs can be named as a good practice example. The programme includes a specific EPA-funded programme line for environmental protection. The successful approach of the SBIR programme, which was established in the 1980s, has served as a model for similar programmes in other countries, e.g. the KOSBIR programme of Korea, but also in Japan and a number of European countries. More details on the programme are provided in the annex of this report.

The US "Advanced Research Projects Agency – Energy (ARPA-E)" programme can be named as a good practice example for a programme that promotes high-risk transformative innovations. ARPA-E funds projects at the intersection of fundamental and applied clean energy research and aims to overcome long-term and high-risk technological barriers. The programme's design foresees to sustain for long periods of time those projects whose promise remains real, while phasing out programs that do not prove to be as promising as anticipated.

Public support to R&D is a major instrument to promote eco-innovation in Japan. This is illustrated by the exceptionally high Gross Expenditure on R&D (GERD) and the fact that environmental issues form a priority area within the R&D strategy. Japanese public R&D programmes put a major focus on fostering cooperation between academia and industry to contribute to economic development and competitiveness. A main Japanese R&D programme with regard to eco-innovation is the "Environment Research and Technology Development Fund (ERDF)" that contains a strong orientation towards research that contributes to formulation of policies.

In Korea, recent strategic documents on green growth and on R&D strategy have given priority to the area of environmental research and eco-innovation. However, the linkages between business, university and government research institutes are still weak in Korea and should be improved to support innovation. A specific approach to generate eco-innovations by R&D projects that bring together a critical mass of academia and industry and cover technology development as well as commercialisation was the programme "Eco-Technopia 21 Project". While it did not reach all its goals, it

was successful in increasing the level of technologies in all environmental sectors and in providing business opportunities.

China has seen a big increase in R&D expenditure in recent years. The highly centralised Chinese research system funds R&D projects through a number of different programmes, which usually address several science and technology areas. When it comes to the development of eco-innovation, particularly the "863 R&D programme", which targets cutting edge technologies, and the "National Key Technologies R&D Programme", which has a specific focus on industry needs, should be mentioned. Both programmes cover different areas, among them environmental protection, rational utilisation of resources and sustainable agriculture. With regard to innovation, China's strategy is to evolve into a more innovation-driven society in the coming years.

India has a low but quickly increasing level of general R&D funding. There is a general trend toward fostering innovation in India. The term and concept "eco-innovation" is not that common in India yet; instead the term "environmental and bio-technology" is used in science and economy. Therefore the funding programmes mainly reflect topics of natural and environmental sciences related innovations. In the area of biotechnology, there is the specific programme "SBIRI" to support pre-proof-of-concept research as well as late stage development for SMEs. A particular programme that is described in the annex as a "Good Practice Example" is the Research, Development and Demonstration Programme of the Ministry of New and Renewable Energy. This programme provides good and successful examples for the specific context of Indian rural areas - new technologies that are easy to handle and accepted by rural people.

Concerning priority research fields, it is noteworthy that the US and Japan are very strong supporters for public funding of R&D in energy. Both hold very high patent applications in climate change mitigation technologies. The role of ICT for efficiency improvements in resource use is another priority in Japan. In India, high thematic priorities with relevance for eco-innovation are in the areas of biotechnology, water, food, agriculture, and renewable energy – environmental research is also a priority. Korea's priority fields as defined in the strategy documents are energy sources and efficiency, climate change, and water and waste management. In China the fields of photovoltaic and hydropower, buildings and energy efficiency, agriculture, and water resources should be mentioned. China and India are also heavily involved in waste management.

It can be emphasised that the main instruments of environmental policy and particularly policy to stimulate eco-innovations are almost universally used.

All investigated countries apply *Emission Trading Schemes (ETS)* or are in the process of introducing them. *Environmental technology verification* programmes are in place in the US (since the mid 1990s), Japan (J-ETV, since 2003) and Korea. India and China both expressed interest in developing ETV programmes in the near future. While most countries established laws on *Green Public Procurement* (Japan, Korea, some US states, China), there are also non-mandatory initiatives (e.g. the activities of the Green Purchasing Network in India). The Indian government just introduced a green public

procurement initiative in Nov. 2011. In many of the investigated countries eco-innovations are promoted through *tax incentives* for investments in energy efficiency technology (e.g. US, Korea), fuel efficient, hybrid or electrical vehicles (Japan, US) or renewable energy (e.g. US but also China

Among the applied instruments to mobilise financing for eco-innovation are *tax incentives* for R&D in general (US, China, Japan, India) and the provision of funds for specific loans. These instruments are often targeted to increase private R&D investment in general and are not specifically focused on eco-innovation. In the US there is a specific focus on supporting R&D in SMEs with *loans*. There are also activities that aim at the further promotion of US *venture capital* investment in eco-innovations. Korea is an example where a specific environmental venture fund exists, established by the Ministry of Environment to support venture companies.

All countries apply environmental regulations and performance targets – but specific implementation issues differ. In Japan the Top Runner programme is a specific highlight that defines dynamic targets by setting the most energy-efficient products as a benchmark. The Top Runner Programme is described as a "Good Practice Example" in more detail in the Annex. The Californian Zero Emission Vehicle Program (ZEV) presents a promising and ambitious new approach to reduce vehicle emissions by combining the control of vehicle emissions in a single coordinated package of standards with other measures to increase the number of hybrid and zero-emission vehicles.

India and China face the problem that implementation of environmental regulation lacks effectiveness and efficiency.

In addition, all countries are also involved in international initiatives to foster eco-**innovation.** These range from industry round-tables, R&D cooperation, strategic cooperation, and Clean Development Mechanism projects under the Kyoto frame to specific initiatives to actively promote a country's eco-innovations abroad. It can be observed that the Asian-Pacific space as a frame for cooperation is very important to all the investigated countries.

The investigated countries feature a number of initiatives to raise demand for environmentally friendly products such as *awards* (e.g. for outstanding companies in the area of eco-efficiency in Japan), *eco-labels*, and *education or awareness raising campaigns*.

Recommendations

- In terms of research collaboration, US, Japan and Korea are particular interesting partners in the area of climate change mitigation technologies, energy and resource efficiency.
- In addition, Japan is a particularly interesting partner for research in alternative fuel vehicle technologies.
- India is an interesting research partner particularly in the area of biotechnology, water, renewable energy and agriculture
- China is an interesting research partner particularly in buildings and energy efficiency, agriculture, and water resources
- Programmes that address different stages of the R&D process and include promotion of verification, utilisation, commercialisation and dissemination can be found in the portfolio of the US Environmental Protection Agency and could serve as examples for designing such cross-cutting programmes.
- The US venture capital market for eco-innovation can serve as a model for an active venture capital community.
- The US SBIR programme is a successful good practice example for fostering R&D and innovation in small companies. When adapting the programme, the experiences made by numerous other countries, where it already was adapted, should be taken into account.
- The US APRA-E programme stands out as a unique good practice example for a programme that promotes high-risk transformative innovations. It should be considered when designing a programme along these lines.
- The Japanese Top-Runner programme has proven to be a successful strategy to promote eco-innovation and serves as a good practice example. Initiatives to implement similar programmes in Europe should profit from these experiences.
- The Californian Zero Emission Vehicle Program (ZEV) presents a promising and ambitious new approach to reduce vehicle emissions. It should be considered when designing a programme along these lines.

2. Introduction

This report investigates R&D programmes of relevance for eco-innovation and other activities to promote eco-innovation in five key countries outside Europe: the US, Japan, Republic of Korea, China, and India. It was compiled within the ECO-INNOVERA Task 1.1 „Investigation of eco-innovation activities in key countries beyond Europe". The aim of Task 1.1 and of this report is to contribute to an ECO-INNOVERA knowledge base to provide the best possible background for the strategic development of the project as a whole. The report provides an overview of eco-innovation activities in the named key countries and maps the major public R&D programmes with relevance to eco-innovation. It also presents good practice examples of programmes that stimulate eco-innovation (detailed description in the annex of the report). The report also includes recommendations that might be of help for designing future measures to promote eco-innovation.

The definition of eco-innovation applied in the ECO-INNOVERA project and in this report is broad and includes technological and non-technological innovations that create business opportunities and benefit the environment.

One main focus of this report is put on public R&D programmes of importance for eco-innovation. In addition, the report will also include some information on market-based policy instruments to support eco-innovation and activities to mobilise financing for eco-innovation. Information on environmental regulation and standards, demand-side oriented initiatives to raise awareness with regard to eco-innovation as well as international initiatives to support eco-innovation completes the picture. The information is structured in country profiles and synthesised in the concluding chapter. The amount and the degree of information vary among country profiles and types of activity due to different situations concerning the availability of information as well as the importance that the task attached to the information. More detailed information is provided on "Good Practice examples" for stimulating Eco-innovation. The criterion for identifying good practice examples was that a programme is generally considered as successful in fostering eco-innovation in existing literature or by external experts.

The current report has been compiled by March 2012, based on a draft version, which was delivered in 2011. It is based on desk research carried out by ECO-INNOVERA partners DLR, MST and FORMAS, and on two workshops in December 2010 and February 2012 that brought together ECO-INNOVERA partners and external experts. Information has also been obtained by seeking direct contact with programme managers in the investigated countries and by sending out questionnaires.

Task 1.1 will continue its work and present an update of this report in September 2013.

3. Country Profiles

1.1. USA

The United States has the world's largest economy, with GDP exceeding US$ 14 trillion and GDP per capita of US$ 46.400 in 2009. In 2008 Gross Expenditure on R&D (GERD) increased to 2.8 % and equalled US$ 1.307 per capita. In 2008 two thirds of GERD was financed by industry and 27 % by government. In 2008 the United States recorded 49 patents per million population and almost 20 % of all environmental patents.[1] USA is a major player in eco-innovation and takes up the fifth position on the overall 2012 Global Cleantech Innovation Index[2] as the most innovative country among the larger economies. Eco-innovation investments in environmental innovation are intended to satisfy multiple policy objectives. For example, economic growth and job creation are critical outcomes for all programmes being funded under the American Recovery and Reinvestment Act of 2009 (ARRA, the so-called "Recovery Act").

In 2011 President Obama presented an updated version of the innovation strategy launched in 2009. The new "Strategy for American Innovation" includes initiatives to initiate a clean energy revolution by fostering American leadership in new and improved energy technologies. The strategy also included a special focus on achieving breakthroughs in biotechnology, nanotechnology and advanced manufacturing.

One environmental innovation currently under development in the United States is the Recovery through Retrofit initiative, which is intended to reduce energy costs for middle class families through residential weatherisation and energy efficiency, while creating jobs and reducing greenhouse gases. Integrating the programmes of several US government agencies, the initiative will establish standardised methods of measuring and reporting home energy efficiency, develop financing mechanisms to stimulate demand for weatherisation activities, and standardise workforce and entrepreneurial training to support implementation of the initiative.

With more than USD 100 billion of green investments contained in the Recovery Act, there are many other examples of multi-objective environmental innovations.

At the same time, there remain many gaps in the measurement system that will need to be filled in order to realise economic revitalisation and environmental sustainability. These gaps exist because many organisations investing in environmental innovation were not set up to measure environmental outcomes. Analysis of market demand and penetration, the linking of behavioural change to environmental outcomes, and ex ante/ex post estimation of environmental impacts will all be important investments in support of a robust system of environmental innovation.[3]

[1] OECD (2010), OECD Science, Technology and Industry Outlook 2010.
[2] Cleantech, WWF (2012), The Global Cleantech Index
[3] OECD (2011), Better Policies to Support ECO-innovation; http://www.epa.gov; EPA technology and science entrance: http://www.epa.gov/gateway/science/; EPA programmes: http://www.epa.gov/etop/programs_epasupport.html .

In the following chapter focus will be mainly on federal led initiatives. A number of different programmes cut across the structure of this paper. That is, most often programmes cover more than one element in the R&D continuum going from research to commercialisation, diffusion and utilisation. Consequently, it has proven difficult to distinguish between programmes aiming solely on R&D and programmes with a focus on improving market access or information and dissemination activities. The current distribution is based on a normative evaluation of the main area of focus.

1.2. Main actors of the eco-innovation system

The main public actor with regards to eco-innovation on a federal level is the *Environmental Protection Agency (EPA)* that administers a number of programmes that provide support at various stages on the R&D continuum to develop new environmental technologies.[4]

Further players within the eco-innovation system are:

Department of Energy (DoE): The DoE is an important player and administers several programmes in the field of energy technologies.

Department of Defense (DoD): promotes programmes particularly on energy, vehicle fuels and buildings.

National Science Foundation (NSF): The NSF focuses on basic research and education. It has an environmental research and education division.[5]

The National institute of food and agriculture (NIFA)[6] under U.S Department of Agriculture conducts a number of programmes primarily in partnership with land-grant university scientist and cooperative extension faculty. Programmes vary in outreach but include focus on: Air quality, Ecosystems, Environmental & Resource Economics, Forest, Global Change and Climate, Rangelands and Grasslands, Soils, Sustainable development, water, wildlife and fish.

1.3. Public R&D programmes on eco-innovation

One major public actor with regard to eco-innovation on a federal level is the *Environmental Protection Agency (EPA)*.[7] The objective has been to create a "one-stop-shop" office to assist outside organisations seeking assistance in developing new technologies to ensure that technology support programmes are well integrated and coordinated, and that no resources are duplicated or wasted. Working towards this integration the main institution for coordination of eco-innovation activities is the EPA's Office of Research and Development (ORD).

[4] http://www.epa.gov; EPA technology and science entrance: http://www.epa.gov/gateway/science/; EPA programmes: http://www.epa.gov/etop/programs_epasupport.html .
[5] OECD (2008), „Eco-Innovation Policies in the United States", Environment Directorate, OECD, p. 8.
[6] http://www.nifa.usda.gov/nea/nre/nre.cfm
[7] http://www.epa.gov; EPA technology and science entrance: http://www.epa.gov/gateway/science/; EPA programmes: http://www.epa.gov/etop/programs_epasupport.html .

There are basically three types of programmes EPA's Office of Research and Development (ORD) uses to promote and assist public and private sector interests in developing innovative technologies to address a variety of environmental issues[8]:

1. **Financial support** for small and medium-sized private companies, universities or other not-for-profit organisations to develop new technologies. These include the Small Business Innovation Research (SBIR) programme, which provides assistance to small businesses; the Science to Achieve Results (STAR) competitive grants programme, which provides support to universities and not-for-profit organisations; and the National Environmental Technology Competition (NETC), which recognises and rewards innovative and cost-effective technology solutions developed by private companies in high-priority areas.

2. **Independent testing and performance verification** of privately developed, commercial-ready technologies through the Environmental Technology Verification

   (ETV) programme and, for site remediation technologies, through the Superfund

   Innovative Technology Evaluation (SITE) programme.

3. **In-kind support** working collaboratively with private companies or other government laboratories to share facilities and/or expertise in technology

   development under Cooperative Research and Development Agreements

   (CRADAs).

Besides ORD, activities are also coordinated within other offices in the EPA. The programme portfolio within the EPA provides support at various stages on the R&D continuum to develop new and environmental technologies. The different stages include: Research or proof of concept; Development, Demonstration, Verification, Commercialisation; Diffusion and Utilisation. Some programmes may cover more than one or indeed all the different stages.

Besides the technology development programmes the EPA also carries out a number of partnership programmes and a number of other programmes that are generally informational, or provide encouragement for voluntary actions to use innovative technologies for environmental improvements. In that sense they are stimulating the market for innovative solutions.

[8] Report to Congress; Coordination of programs that foster public and private sector development of environmental technologies. (http://www.epa.gov/environmentaltechnology/pubs/reportCongress.pdf).

An example for a successful EPA programme is the ***Small Business Innovation Research Programme (SBIR)***[9] *(described in more detail as a Good Practice Example in the annex of this report)*. The EPA is one of 11 federal agencies that participate in the SBIR Program established by the Small Business Innovation Development Act of 1982. The purpose of this act was to strengthen the role of small businesses in federally funded R&D and help develop a stronger national base for technical innovation. A SBIR small business is defined as a **for-profit** organization with no more than 500 employees to develop and commercialise new environmental technologies.

Under the programme, "proof-of-concept" activities of proposed technologies can be carried out to investigate the scientific merit and technical feasibility of concepts (first phase). In a second phase, development and commercialization of this technology can be supported. Through this phased approach to SBIR funding, EPA can determine whether the research idea, often on high-risk advanced concepts, is technically feasible, whether the firm can do high-quality research, and whether sufficient progress has been made to justify a larger Phase II effort. EPA's SBIR programme focuses on important areas related to environmental protection including clean air and water, hazardous and solid waste, pollution prevention, remediation, and monitoring. Recent issues addressed include: bio-terrorism, arsenic in drinking water, diesel emissions, and storm water runoff.

Another example of a programme with relevance for eco-innovation, funded by the Department of Energy, is the ***Advanced Research Projects Agency—Energy (ARPA-E) Reference*** *(described in more detail as a Good Practice Example in the annex of this report)*.[10] This represents a new approach to initiate and spur economy-changing innovations by the US Department of Energy (DOE). The underlying business model and approach is based on an approach developed in the Defense Advanced Research Projects Agency (DARPA). It is a high-risk/high-reward approach that has created new industries and yielded massive economy-wide returns on initial investment. Because of these successes, many have advocated for implementing the "DARPA model" at other public R&D institutions. ARPA operates at the intersection of fundamental and applied clean energy research aimed at solving key clean technology challenges.

The Advanced Research Projects Agency – Energy (ARPA-E) has funded the development and deployment of transformational and disruptive energy technologies and systems since 2009. ARPA-E focuses exclusively on high risk, high payoff concepts - technologies promising genuine transformation in the ways energy is generated, stored and utilized. While the DoE invests heavily in conventional energy research, ARPA-E is not intended to augment these efforts.

The mission of ARPA-E is to overcome the long-term and high-risk technological barriers in the development of transformational energy technologies. To achieve this mission, ARPA-E will pursue the following goals: First, ARPA-E aims to enhance the economic security of the United States through the development of energy technologies. Second, ARPA-E aims to ensure that the United States maintains a technological lead in

[9] http://www2.ed.gov/programs/sbir/index.html
[10] http://arpa-e.energy.gov/

developing and deploying advanced energy technologies. The technologies also aim at the reduction of energy related emissions.

1.4. Market-based policy instruments to support eco-innovation

A range of policy instruments will either directly or indirectly support eco-innovation. The ***"Strategy for American Innovation"*** proposed by Obama in 2011 includes several initiatives that although not specifically targeted at eco-innovation may support innovation in general. They include among others: *Making the Research and Experimentation tax credit permanent; Support and protect effective intellectual property rights (optimise patent quality and timeliness; U.S. Intellectual Property Enforcement Coordinator (IPEC); Maintain a U.S. patent database); Promote regional innovation clusters (in particular the: Regional Innovation Ecosystem Development initiative; Rural Regional Innovation Initiative and the Agricultural technology Innovation Partnership Programme (ATIP)).*

EPA programmes with a key element of market facilitation or uptake by funding verification, diffusion, utilisation and technology transfer include programmes on water security, water efficiency market enhancement, the Voluntary Diesel Retrofit Program, the Technology Innovation Program, Technology Testing and Innovation Program, Smartway Transport Partnership, Green Building Program Workgroup, Design for the Environment, Clean Air Technology Center (CATC), and the National Environmental Technology Competition (NETC).[11]

The ***EPA Environmental Technology Verification Program (ETV)***, created in 1995 develops test protocols and verifies the performance of innovative technologies that have the potential to improve protection of human health and the environment. ETV is a voluntary programme that makes objective performance information available to support decision-making. ETV does not endorse, certify, or approve technologies.

ETV operates as a public-private partnership, mainly through cooperative agreements between EPA and private non-profit testing and evaluation organisations. ETV efforts are guided by the expertise of stakeholder groups. These stakeholders represent verification customers for particular technology sectors, including technology purchasers and users, technology developers and vendors, the financial community, state and federal regulators, consulting engineers, environmental organisations, and others.[12]

Green Public Procurement: A 2007 Executive Order integrates and updates prior practices and requirements with the goal of increasing federal purchasing of energy efficient and environmentally preferable products and services. Federal agencies must also ensure that: at least half of renewable energy comes from new renewable sources; water consumption is reduced by 2% annually through 2015; fleet total petroleum consumption is reduced by 2% annually, use of alternative fuels is increased by 10% a

[11] More information on these programmes can be found here: http://www.epa.gov/partners2/programs/index.htm
[12] More information can be found here: http://www.epa.gov/etv/.

year, and plug-in hybrid (PIH) vehicles are used when available at reasonable costs. On a local level, green public procurement plays an important role, too.[13]

In addition, several ***tax incentives*** for investments in energy efficiency, renewable energy and hybrid or clean diesel vehicles as well as tax credits for electricity from renewable sources exist on federal and state level.[14]

With regard to ***Emission Trading Schemes***, the *Regional Greenhouse Gas Initiative (RGGI)* needs to be mentioned, a mandatory cap-and-trade programme to reduce CO2 emissions from the power sector in ten North-eastern and Mid-Atlantic states by 10%. RGGI was established in 2005.

1.5. Other activities and programmes to mobilise financing for eco-innovation

A number of initiatives exist to mobilise financing for innovation, particularly to SMEs. However, they do not necessarily include a specific focus on **eco-**innovation and the environmental dimension.

The Small Business Jobs Act (SBJA, from September 2010) provided an additional US$14 billion more in lending support via the Small Business Administration and more than US$30 billion in capital support for small business lending via the Treasury, as well as US$12 billion in tax relief to small businesses, to help these businesses invest and create jobs. The USDA's Business and Industry Guaranteed Lending Program also provides US$1 billion annually and, on account of the Recovery Act, was able to deliver US$3 billion in FY 2010 to support the financing of rural businesses. All in all, the Obama Administration has sought to facilitate small business development by cutting taxes on small businesses 17 times.

USDA Rural Development's Business and Industry (B&I) Guaranteed Lending Program directly supports the financing of rural businesses, creating sustainable jobs and advancing economic development throughout rural America. The B&I Guaranteed Lending Program improves access to capital for America's rural businesses by providing lending support in partnership with both national and local community banks. The Recovery Act allowed the USDA to provide nearly US$3 billion in lending support that was delivered in FY 2010.

The Innovation Fund will support up to US$1 billion in private-sector financing by matching private capital raised by investment funds that are seeking to deploy capital in early stage innovative small businesses.

In 2008 EPA issued a report on how to promote US *venture capital* investments in environmental technologies. The venture capital market for cleantech is already very strong in the US. In 2010, already US$4 billion of US venture capital went to investment in cleantech. That amounts to almost 25% of all investment in venture capital, and more than in the areas of biotechnology, software and medical equipment.[15]

[13] UN (2008), Sustainable Development Innovation Brief 5.
[14] OECD (2008), „Eco-Innovation Policies in the United States", Environment Directorate, OECD.
[15] http://www.ey.com/US/en/Newsroom/News-releases/US-venture-capital-investment-in-cleantech-grows-to-nearly-4-billion-Dollar-in-2010; OECD (2011), Fostering Innovation for Green Growth, OECD Green Growth Studies, OECD Publishing.

1.6. Environmental regulation and standards

In the US, a large number of regulations and performance targets on federal and state level support eco-innovations. [16]

More recent approaches stimulate the over-performance with regard to regulatory requirements by stimulating higher voluntary action, as the ***National Environmental Performance Track*** **or** ***Climate Leaders*** projects led by EPA. These projects request the fulfilment of higher environmental requirements from their participants and in return acknowledge these as environmental leaders and provide support e.g. in terms of networking or promotion.[17]

Additionally it can be stated that a lot of technology development is connected to the surveillance needs connected to the regulatory requirements.

An example for a recent programme on federal level is California's ***Zero Emission Vehicle (ZEV) Program:***[18] California has a long history of adopting technology-advancing vehicle emission standards to protect public health. The pioneering measures have accelerated the introduction of cleaner cars for a healthier California. On January 27th, 2012, the Air Resources Board (ARB) approved a new emissions-control program for model years 2017 through 2025. The ZEV Program presents a new approach to passenger vehicles – cars and light trucks -- by combining the control of smog-causing pollutants and greenhouse gas emissions into a single coordinated package of standards. The new approach also includes efforts to support and accelerate the numbers of plug-in hybrids and zero-emission vehicles in California.

By 2025, when the rules will be fully implemented it is foreseen that

- New automobiles will emit 34 percent fewer global warming gases and 75 percent fewer smog-forming emissions.
- Environmentally superior cars will be available across the range of models, from compacts, to SUVs, pickups and minivans.
- Consumer savings on fuel costs will average US$6,000 over the life of the car - more than offsetting the average US$1,900 increase in vehicle price for the ultra-clean, high-efficiency technology.

[16] More information on regulations can be found on the EPA website: **Air** regulation (http://www.epa.gov/air/oarregul.html); **Waste** regulation (http://www.epa.gov/lawsregs/topics/waste.html);

Water regulation (http://www.epa.gov/lawsregs/topics/water.html); **Chemicals and Pesticides regulation** (http://www.epa.gov/lawsregs/topics/toxic.html or http://www.epa.gov/lawsregs/topics/pesticides.htm) include: Pollution Prevention Act; Toxic substances Control Act; Federal Food, Drug and Cosmetics Act; Federal Insecticide, Fungicide and Rodenticide Act. Detailed regulation can be consulted here: Chemicals and Hazardous Substances; Formaldehyde ; Nanotechnology ; Polychlorinated ; Biphenyls (PCBs) ; Toxic Release Inventory ; Endangered Species and Pesticides ; Establishments ; Food Quality ; Importing and Exporting ; Labels ; Pesticide Tolerances ; Registration ; Restricted and Canceled Uses ; Storage and Disposal ; Worker Protection

[17] OECD (2008), „Eco-Innovation Policies in the United States", Environment Directorate, OECD, p. 14-15.
[18] http://www.arb.ca.gov/msprog/zevprog/zevprog.htm

1.7. Other initiatives to support eco-innovation

The US is involved in a number of international initiatives that aim at promoting eco-innovation and exporting US products in these areas. Examples are:

Asia-Pacific Partnership on Clean Development and Climate that aims to develop, promote and share cleaner energy technologies (also in the area of energy efficiency).

Renewable Energy and Energy Efficiency Partnership that assists market development of renewable and energy efficiency systems.

Other initiatives are on Hydrogen Economy, Carbon Sequestration, Nuclear Energy, clean energy, ethanol, and biogas.[19]

In the area of R&D with relevance for eco-innovation, several US programmes, particularly the "STAR program", provide possibilities for cooperation.[20]

The USA also participates actively in international cooperation on environmental technology verification: http://www.epa.gov/nrmrl/std/etv/inter-partic.html.

Nearly all the programmes mentioned in this report include a focus on diffusion and utilisation including issues regarding access to information.

1.8. Conclusion on eco-innovation activities in USA

As the worlds largest economy the USA might have a unique opportunity to invest in eco-innovation. In that light it may not be surprising that in 2008 USA recorded almost 20 % of all patents in this area.

In 2003 the Congress directed the Environmental Protection Agency to develop a one-stop shop office (Office of Research and Development - ORD) to coordinate similar programmes which foster private and public sector development of new, cost-effective environmental technologies. Other programmes of relevance for eco-innovation will be managed within other departments such as the Department of Agriculture and the Department of Energy. It must also be assumed that a lot of activities will be conducted at the level of each state – some of them by themselves representing major economic powers.

New, more business-oriented programmes have emerged. One of these is the ARPA which combines new high yield/high-risk concepts with strict rules and obligations for innovative ideas to prove valid.

Programmes within the EPA and ORD cover the whole continuum from research through development to diffusion. The programmes may be divided into three types: Programmes that offer financial support; programmes that offer test and verification of commercial-ready technologies; in-kind support working with private companies or other government laboratories. A programme typically covers several activities within the R & D continuum and almost all include information, diffusion and in that sense market uptake aspects.

[19] OECD (2008), „Eco-Innovation Policies in the United States", Environment Directorate, OECD, p. 23-26.
[20] A number of funding programmes open to EU-based researchers and institutions can be found here: http://www.euussciencetechnology.eu/uploads/docs/Link2US-digital_FinalCatalogue.pdf

The EPA is part of a successful, special funding programme (SBIR) addressing technology development etc. in Small and Medium Sized Enterprises (SMEs) and has a special funding programme (STAR) providing grants to Universities and nonprofits. Both cover a wider range of environmental concerns (water, air, hazardous waste etc.).

Some programmes address specific environmental challenges or concerns such as waste, water, air pollution or chemicals. These can be both informational or with some technology development or research. Some programmes are designed to foster cooperation at the state level and some programmes are designed as partnerships between public and private actors. Other programmes may be generally informational, or provide encouragement for voluntary actions to use innovative technologies for environmental improvements.

1.9. Japan

In Japan, the government's Industrial Science Technology Policy Committee introduced the term "eco-innovation" in 2007 as an overarching concept which provides direction and a vision for the social and technological changes needed to achieve sustainable development. Eco-innovation is increasingly viewed as a field of techno-social innovations that not only can improve environmental conditions but also satisfy subjective values. Eco-innovation covers industry (sustainable manufacturing), infrastructures (e.g. with regard to energy) and consumers and lifestyles.[21]

Japan is the country that files the highest number of patents for environmental technologies. It is a world leader in innovation in air, water and waste pollution abatement or control technologies, climate-related technologies and green information and communication technologies. It also is by far the biggest inventor with regard to alternative fuel vehicle technologies (with 59% of all patent applications). Japan's energy politics have been transformed drastically by the Fukushima nuclear disaster as the government replaced its plan to build more nuclear power stations with a move towards a target for renewables to make up 20% of the country's energy mix by the 2020's.[22]

Japan adopted a "**New Growth Strategy**" in 2009-2010, that identified the environmental as well as the health sector as the key drivers of future growth and in particular aims at promoting "green innovation", e.g. through greening the tax system.[23]

Japan is a world leader in terms of R&D expenditure. R&D spending has been estimated at around 3.1% of GDP in 2004 and above 3.5% in 2005. The **4th Science and Technology Plan** sets the target for R&D investment higher than 4% of the GDP, and the government investment in R&D at ca. 250 billion € during 5 years from FY2011 to FY2015. "Green Innovation" as well as "Life Innovation" and "the Realization of Restoration and Reconstruction from the Disaster" rank as the pillars of Japan's

[21] OECD (2009), Eco-Innovation in industry: enabling green growth.
[22] Cleantech Group LLC / WWF, Coming Clean: The Global Cleantech Innovation Index 2012, 23.

[23] Capozza, I. (2011), "Greening Growth in Japan", OECD Environment Working Papers, No. 28, OECD Publishing, p. 13.

sustainable growth and development.[24]. In 2010 "green innovation" is the most important priority area, receiving 1.9 billion €. It puts specific emphasis on low carbon energy supply, highly efficient and smart use of energy, and greening of social infrastructure. System reform for promoting green innovation, including regulatory and institutional reform, is a further key aspect in the plan.[25]

All in all, government expenditure for R&D in the area of environment has slightly increased, but remains relatively low (1% of overall government R&D budget.)[26]

1.10. Main actors of the eco-innovation system

The research and innovation system in Japan is characterised by a centralised top-down approach, even though it opened up to more diversity in recent years. In R&D policy debates, the need to strengthen basic research is an important issue.

Major players in the innovation and research system with regard to eco-innovation are:

- *Ministry of the Environment (MOE)*: It also hosts the Office of Environmental Research and Technology.
- *Ministry of Economy, Trade and Industry (METI):* METI and its affiliate bodies *NEDO (New Energy and Industrial Technology Development Organisation)* and *AIST (Institute of Advanced Industrial Science and Technology.* METI disburses funds to a range of agencies and supports universities, public research organisations and the non-profit sector for R&D. The main issues for METI are industrial competitive performance and environmental and energy problems. NEDO is a public organisation that coordinates R&D activities of industry, academia and the government and carries out research to develop new energy and energy-conservation.[27]
- *Ministry of Education, Culture, Sports, Science and Technology (MEXT):* MEXT promotes research in important fields such as life science, information technology, nanotechnology and materials, as well as on earth and environmental problems.

Further actors include the *Ministry of Land, Infrastructure, Transport and Tourism (MLIT)*, the *Council for Science and Technology Policy (CSTP)*, the *Japan Science and Technology Agency (JST)*, the *Energy Conservation Centre, Japan (ECCJ),* and the *National Institute for Environmental Studies (NIES)* which conducts multidisciplinary environmental studies in natural, social and human sciences.

Cooperation with industry is an essential trademark of Japan's policies to support eco-innovation. *Nippon Keidanren, Toyota* and *Yogowaka electronics* represent examples of companies that engage in eco-innovation.[28] E.g., in the area of electric cars, close

[24] 19th August 2011 Cabinet Decision „The 4th Science and Technology Basic Plan"
[25] Council for Science and Technology Policy, Japan's Science and Technology Basic Policy Report (December 24, 2010), p. 6-8.
[26] Capozza, I. (2011), "Greening Growth in Japan", OECD Environment Working Papers, No. 28, OECD Publishing, p. 31.
[27] OECD (2009), Eco-Innovation in industry: enabling green growth, p. 83.
[28] OECD (2009), Eco-Innovation in industry: enabling green growth, p. 66, 83.

cooperation of government and industry on R&D and commercialisation development takes place.[29]

1.11. Public R&D programmes on eco-innovation

Environmental R&D efforts in Japan address the grand challenges such as the climate change and energy crisis and focus mainly on the low-carbon society with stable energy supply and demand, highly efficient and smart use of energy, and greening of social infrastructure. Based on the 4th Science and Technology Plan, the government strategically promotes R&D on renewable energy technologies and smart energy network including distributed energy resources, and facilitate the utilization of such technologies to realize a low-carbon society with stable energy supply and demand.

There is no specific R&D programme for eco-innovation in Japan, but several research funding programmes with a focus on environmental issues, which is a priority area in the Japanese R&D strategy. The Ministry of Environment manages the core environmental programme, the ***"Environment Research and Technology Development Fund" (ERTDF)*** which covers a broad area of environmental topics from global system change, pollution, health and risks connected to environmental change, via protection and restoration of eco-systems, waste treatment to sustainable societies and policies. The programme focuses on producing solutions for policy. Themes are based on funding of interdisciplinary projects and the combination of top-down and bottom-up projects. Mainly universities participate in the programme. The budget of the ERTDF-Programme is around US$100 million per year.

Worth mentioning is also the ***Advanced Low Carbon Technology Research and Development Program*** with an emphasis on technologies that promise CO2-reduction.

Besides competitive research programmes such as the ERTDF, public funds for environmental research are also distributed via institutes such as the ***National Institute for Environmental Studies (NIES)***, which collaborates with institutes worldwide in conducting multidisciplinary environmental studies in natural, social and human sciences, or the ***National Institute of Advanced Industrial S&T (AIST)*** which covers different areas. One priority area of AIST is "green innovation".

1.12. Market-based policy instruments to support eco-innovation

There are a number of different market-based policy instruments in Japan that support eco-innovation through emission trading schemes, green public procurement or the promotion specific environmentally friendly product. Nevertheless, a 2011 OECD Working Paper states that Japan could enhance its environmental policy mix by making greater use of such market-based instruments.[30]

[29] OECD (2011), Invention and Transfer of Environmental Technologies, OECD Studies on Environmental Innovation, OECD Publishing, 145. This cooperation includes the coordination of actions of various stakeholders, identification of major technical/market barriers, conducting joint R&D, revising relevant regulations, and laws, developing industry standards, building necessary infrastructure

[30] Capozza, I. (2011), "Greening Growth in Japan", OECD Environment Working Papers, No. 28, OECD Publishing, p. 15.

In April 2009 the Japanese government announced a **financial "stimuli package"** ***("Programme of innovation for Green Economy and Society")*** at ca. 100 billion €. 10% of this package covers green investments and other incentives, including tax incentives for environment-related R&D, the promotion of consumer purchase of energy efficient household appliances and environment-friendly cars (including a tax exemption for electric cars, a tax differentiation of cars, and support for building up an infrastructure for electric cars and for charging stations for these cars). The 10% also cover support for the development of zero energy buildings; support for energy efficient renovation of buildings, the establishment of local green financing funds and the extended reuse of materials through urban mining.[31]

Environment related taxes in Japan consist of revenue from energy use and vehicles. In comparison to other OECD countries, these taxes are relatively low – while the overall energy prices are rather high in Japan. The introduction of a carbon tax has been discussed for several years and may be introduced in 2012. Tax incentives address the areas of energy-efficiency (housing) or investment in environment related R&D. [32]

***Japan – Environmental Technology verification programme (J-ETV)*:** existing since 2003 under the responsibility of the MOE, fully operational since 2008, it promotes and spreads technologies by having their performance verified by independent parties. The budget size in 2011 was ca. 1 million €. In the programme, 8 technological fields (e.g. water treatment technology or energy-saving technology) have been selected for 2011[33]. Voluntary verified technologies can use the J-ETV label. The programme could be further improved by stricter criteria for selecting verification organisations.

Law on Promoting Green Purchasing **(2000):** obligation for all governmental institutions to implement green procurement. The law became mandatory in 2001[34]. More than 90% of products and services procured by government agencies meet the required environmental criteria. This does not apply to the local level, but many local authorities have voluntarily adopted similar measures.[35]

***Voluntary Domestic Emissions Trading Scheme (J-Vets)*:** introduced in 2005 to gain experiences on cost-efficient CO2-emissions reduction and trading. Participating corporations determine their own reduction targets. They can be achieved by reduction efforts or by purchasing allowances – which are sold at a lower price compared to the EU Emission Trading Scheme (ETS). The government subsidises one third of the costs for CO2 reduction activities if the company reaches the voluntary target. Via J-VETS a basic infrastructure for an emission trading scheme was introduced. In 2008, Japan started the pilot phase of a voluntary "Integrated Domestic Market for Emissions Trading", that incorporated elements from J-VETS. In December 2010 plans for the

[31] OECD (2011), Invention and Transfer of Environmental Technologies, OECD Studies on Environmental Innovation, OECD Publishing,106

[32] Capozza, I. (2011), "Greening Growth in Japan", OECD Environment Working Papers, No. 28, OECD Publishing.

[33] www.env.go.jp/policy/etv/en/index.html

[34] http://www.igpn.org/about/index.html. Each ministry or agency is required to design its own procurement policy. The basic policy has 261 items in 19 categories as of February 2012. Some examples of the categories are "paper (7 items)", "Office Automation Machines (19 items)," and "vehicles, etc. (5 items)"

[35] Capozza, I. (2011), "Greening Growth in Japan", OECD Environment Working Papers, No. 28, OECD Publishing, p. 36.

introduction of an ambitious mandatory national ETS were postponed indefinitely in the context of the economic crisis. A regional ETS was introduced in Tokyo in April 2010.[36]

Renewables Portfolio Standard (RPS) – This scheme was introduced in 2003 and requires each electric utility to sale a specific share of energy from renewable sources. The scheme has contributed in recent years to the development of renewable electricity, especially wind, solar and biomass technologies.[37]

Eco-Point Programme, 2009-2010 - encouraged customers to buy energy-efficient household appliances. The customer received "eco-points" which could be used to buy other goods & services.

Carbon Footprint of Products – launched in Japan in 2010; the Japanese government decided on an action plan for achieving a low-carbon society in 2008 and METI started a pilot project; 2011 will be the final year of the pilot project. The project's outcome will be the "Basic Guideline of the Carbon Footprint of Products" and the "Guide of Establishing Product Category Rules"[38].

Feed-in-tariffs in the area of solar power were introduced in November 2009, at a level comparable to Germany. At the same time investment costs for solar panels are subsidised.[39] After the Fukushima disaster, Japan extended its existing feed-in tariff to include solar, wind, hydro, geothermal, and biomass electricity generation.

1.13. Other activities and programmes to mobilise financing for eco-innovation

Japan lacks in cleantech venture capital and cleantech-specific early-stage private finance to help entrepreneurial companies demonstrate and scale their technologies.[40] However, in 2004 the ***Development Bank of Japan (DBJ)*** launched a system to assess the companies' efforts to reduce environmental impact which had a positive effect on the financing terms. The financial sector increasingly offers low-interest loans for environmental investments. At local level some funds for environmental investments, e.g. in Tokyo, have been introduced.[41]

There are also some specific programmes for promoting innovation – not restricted to the area of eco-innovation. This includes the ***Regional Innovation Strategy Support Programme*** that aims at regional innovation and the ***Technology Innovation Program for Small Business Innovation Research (SBIR)*** aiming at SMEs.

There are also ***Eco-town projects:*** joint initiative by METI and MOE to trigger regional initiatives which then target the effective resource circulation of a full range of by–products based on the industrial ecological principles of a zero emissions concept, the

[36] OECD (2008) "Eco-Innovation Policies in Japan"; Environment Directorate, OECD, p.28; International Energy Agency: http://iea.org/textbase/pm/?mode=cc&id=4225&action=detail;
[37] Capozza, I. (2011), "Greening Growth in Japan", OECD Environment Working Papers, No. 28, OECD Publishing, p. 25.
[38] www.cfp-japan.jp/english

[39] Capozza, I. (2011), "Greening Growth in Japan", OECD Environment Working Papers, No. 28, OECD Publishing, p. 26-27
[40] Cleantech Group LLC / WWF, Coming Clean: The Global Cleantech Innovation Index 2012, 23.
[41] Capozza, I. (2011), "Greening Growth in Japan", OECD Environment Working Papers, No. 28, OECD Publishing, p. 30.

principle of 3Rs, and green procurement. In addition, the government launched similar initiatives in 2008: The "Eco-Model City Projects" and the "Biomass Towns".

1.14. Environmental regulation and standards

Generally, targets related to energy efficiency and environmental performance play a crucial role in Japan's policies to support eco-innovation. Industry is considered as a proactive motor of innovation and the system entails a number of industry-led voluntary performance targets. In addition, the government initiates dynamic targets which encourage industries to over-perform the market.

A specific Japanese activity in this area is the ***Top Runner Programme***, introduced in 1999 *(described in more details as a "Good Practice Example" in the annex of this report).* It sets energy efficiency targets at industry-level, based on the value of the most energy-efficient products on the market at the respective time; it takes the current highest energy efficiency rate of products as a benchmark standard in 23 product groups. This new standard must be met by manufacturers in four to eight years; products (ranging from vehicles to household electric appliances) that reach this standard receive the "Top Runner Label"[42], the ones that fail can be "named and shamed" publicly. The Top Runner Programme has been very effective in the promotion of energy efficiency and manufacturers highly support the programme.[43] However, it supports incremental rather than radical innovations.

Legislative Actions on environmental targets include: Packaging Law (1990), Air Pollution Control Law (2006); Energy Conservation Law (amended in 2010); Reinforcement of Energy Saving for plants, buildings & transportation (2005); Law for Enhancing Motivation on Environmental Conservation and promoting of environmental education (2003).

An industry-led initiative on environmental targets is the ***Keidanren Voluntary Action Plan on the Environment.*** The action plan brings together 36 industries and 137 organisations which come not only from manufacturing and energy but from a much wider range of industries. The voluntary participating industries have themselves established quantitative targets for measuring their actions against global warming and waste disposal.[44] Industry as a whole in Japan has made significant efforts for the promotion of recycling.

1.15. Other initiatives to support eco-innovation

International cooperation and technology transfer are an integral part of Japan's initiatives towards eco-innovation. In selected areas, Japan intends to play a leading role in international cooperation, at both G8 and regional level. It uses bilateral economic partnership agreements to foster some of its priorities (e.g. on intellectual property)[45].

[42] www.eecj.or.jp/top_runner/index.html

[43] Capozza, I. (2011), "Greening Growth in Japan", OECD Environment Working Papers, No. 28, OECD Publishing, p. 34.

[44] www.keidanren.or.jp

[45] OECD (2009), "Eco-Innovation policies in Japan", Environment Directorate, OECD.

Japan's international collaborations with implications for eco-innovation are:

- *Collaboration on intellectual property rights (IPR)*
- *Economic and Technical Cooperation (Ecotech) activities in APEC (Asian-Pacific Economic Cooperation)aiming at capacity building and information exchange*
- *Clean Development Mechanism and Bilateral Offset Credit Mechanism (Japanese bilateral direct clean tech investment in developing countries to gain credits for reaching Japanese emission reduction goal)*
- *Asia-Pacific Environmental Innovation Strategy Project (APEIS)*
- *Japanese International Cooperation Agency (JICA), which works with developing countries*
- *East Asia Low Carbon Growth Partnership*
- *Institute for Global Environmental Strategies (IGES)*

At the 2011 UN Climate Change Conference in Durban, Japan announced two initiatives: *"Japan's Vision and Actions toward Low-Carbon Growth and a Climate-Resilient World"* and *"African Green Growth Strategy: Toward Low-Carbon Growth and Climate Resilient Development"*. Both strategies foresee common emission reduction efforts with developed and developing countries.

Among Japanese **initiatives to raise demand** for environmentally friendly products are awards, promotion and information activities.

Eco-Efficiency Awards: sponsored by METI, the Awards were launched in 2005 to simultaneously promote both environment issues and the economy, while also strengthening Japanese businesses using less energy and fewer resources than in other countries; the Award is given in recognition of either corporate activities that contribute to improving socioeconomic conditions while also reducing environmental impact or for products produced as a result of such activities.

There is a range of awareness raising and training initiatives in Japan, with a number of ministries sharing efforts. Examples include:

National Promotion of Eco Driving: the government has taken various actions to promote eco driving by positively affecting drivers´ behaviour. Several ministries have joined to form the "Eco-Driving Promotion Liaison Committee" in 2003[46]. In 2006 the "Action plan to promote eco-driving" was declared and eco driving sessions have been held in close cooperation with the Energy Conservation Centre (ECCJ)[47].

1.16. Conclusion on eco-innovation activities in Japan

Japan has ambitions to become a *Leading Environmental Nation* and a number of key strategic policy documents explicitly refer to that concept. Eco-innovation is adopted by the Japanese government as a broad concept, covering techno-social innovations in industry, infrastructures and the area of consumers and lifestyles.

[46] Ministries involved are METI, MOE, the Ministry of Land, Infrastructure and Transport and the national Police Agency.
[47] www.asiaeec-col.eccj.or.jp/eng/e3105nati_promo.html

Public support to R&D is a major instrument to foster eco-innovation in Japan. This is illustrated by the exceptionally high Gross Expenditure on R&D (GERD) and specific funds for environmental technologies R&D. The focus is on projects that cooperate with industry and contribute to economic development and competitiveness.

In terms of measures to foster eco-innovation, it is notable that performance targets play a crucial role in Japan. The Top Runner Programme is one example for incentives to increase efficiency performances. Another important aspect is the focus on social innovation and programmes and initiatives that target sustainable lifestyles.[48]

There is further potential in the application of economy-wide market-based instruments.[49] The same is the case for environmental venture capital and the stimulation of clean-tech start-ups, which are both at a rather low level in Japan.

1.17. Public of Korea (South-Korea)

Korea is a densely populated country that has experienced a period of rapid development in the last decades. Green Growth and Innovation policies have become increasingly important in recent years. [50]

Environmental industry in Korea has grown from the 1990s onwards and was complemented by a rise in public awareness of environmental issues and governmental efforts toward environmental protection. Development of environmental industry and international cooperation in this area, particularly with China and other Northeast countries was actively promoted by the Ministry of the Environment (MOE). Between 1995 and 2005 the environmental industry in Korea has grown by 13.4 percent annually. In 2005 the green industry was worth more than €13 billion, and is expected to grow to about €18.2 billion by 2015. The Korean industry with regard to environmental technologies mainly consists of small businesses that are essentially focusing on end-of-pipe technologies.[51] Korea has high patent numbers for air pollution abatement and recently a startling growth rate in patents in water pollution abatement and waste technologies, as well as alternative fuelled vehicle technologies.[52]

There is no official definition of ”eco-innovation” in Korea. The *Korean Act on Environmental Technology Development and Support in Korea*[53] defines environmental technology as: “technology necessary for preserving and managing the environment including the enhancement of assimilative capacity, suppressing and removing causes of environmental damages on humans and nature, preventing and reducing environmental pollution, and recovering polluted and destroyed environment”.

[48] OECD (2009), “Eco-Innovation policies in Japan”, Environment Directorate, OECD, p. 22.
[49] Capozza, I. (2011), “Greening Growth in Japan”, OECD Environment Working Papers, No. 28, OECD Publishing, p. 39.
[50] The following study serves as a basis for this chapter: OECD (2008), “Eco-Innovation Policies in the Republic of Korea”, Environment Directorate, OECD.
[51] OECD (2008), “Eco-Innovation Policies in the Republic of Korea”, Environment Directorate, OECD, p. 23.
[52] Cleantech Group LLC / WWF, Coming Clean: The Global Cleantech Innovation Index 2012, 29-30, 94.
[53] “Korea Environmental policy Bulletin”, Issue 2, Volume III, 2005 Ministry of Environment, 2005.

1.18. Main actors of the eco-innovation system

Korea's R&D expenditure currently amounts to 3.5% of the GDP.[54] In 2009, Korea introduced the ***National Strategy for Green Growth*** (2009-50) which foresees to invest 2% of the GDP into green growth areas and puts the focus of Korea's stimulus plan to fight the global recession on green growth ("Green New Deal"). The "Green New Deal" plans to invest €32.5 billion into green growth plans during the next 4 years. Specific objectives are to boost Korea's world market share in green technologies to 8% within 5 years and to support the greening of existing industries, especially SMEs. Among the investigated countries, Korea by far invests the largest share into environmental projects.[55]

Since the 1980s, Korea put emphasis on the planning and conducting of national R&D projects to raise the level of scientific and technological skill. From 2003 onwards, the government placed S&T and innovation at the top of its policy agenda to spur economic growth. At the same time, Korea committed to strengthen its involvement in global issues, such as the preservation of the environment.[56]

The three main sectors for R&D expenditure in Korea are electronics, machinery and communication technologies. 4 % of research expenditure goes to research in environmental, resources and energy issues.[57]

In 2008 the Korean government launched the ***577 Initiative*** as a basic science and technology strategy plan with the objective of making Korea one of the seven most powerful S&T nations.[58] The strategy foresees to expand the gross domestic expenditure on R&D from 3.2% of the GDP in 2006 to 5% by 2012 (US$ 135 billion). A considerable amount of this funding is reserved for basic and fundamental research (50% in 2012). The *577 Initiative* identifies 7 major technology areas among them "global issues-related technologies" to cope with issue of energy, resources, climate change and environment. An expressed goal is to become a leading nation in the green market through doubling R&D investment in green technologies. Another measure of the initiative is to boost support for SMEs' innovation e.g. through the *Korea Small Business Innovation research Program (KOSBIR).* At the same time the efficiency of research management agencies and the R&D management system shall be improved.

The current ***Five-Year-Plan*** (2009-2013) foresees an expansion in investment in R&D for green technologies, with a cumulative amount of €8.5 billion for the whole period. By 2012 20% of the public R&D budget would be reserved for green technologies. All in all the Five-Year-Plan identifies 27 core green technologies in the areas of climate change (e.g. monitoring and adaptation), energy source technologies (e.g. solar energy),

[54] Kooperation international, Länderbericht Südkorea (Band 10/2010), December 2010, http://www.kooperation-international.de/republik-korea-suedkorea/themes/info/detail/data/30257/
[55] Jackson, Tim (2009), Prosperity without Growth. Economics for a Finite Planet.
[56] OECD (2008), "Eco-Innovation Policies in the Republic of Korea", Environment Directorate, OECD, p. 20.
[57] Kooperation international, Länderbericht Südkorea (Band 10/2010), December 2010, http://www.kooperation-international.de/republik-korea-suedkorea/themes/info/detail/data/30257/
[58] Science and Technology Basic Plan of the Lee Myung Bak Administration „Becoming a S&T Power Nation through the 577 Initiative", Ministry of Education, Science and Technology / Korea Institute of S&T Evaluation and Planning, http://www.mest.go.kr/file/577initiative.pdf

efficiency technologies (e.g. green cars, green cities, green processes) and end-of-pipe technologies (e.g. CCS, water management, waste recycling) and virtual reality.[59]

The major governmental bodies and research institutes dealing with research and innovation in Korea are:

- *Ministry of Education, Science and Technology (MEST)* – concerned with basic and fundamental research
- *Ministry of Knowledge Economy (MKE)* – concerned with application-oriented research
- *Ministry of Environment (MOE)*
- *Korea Institute of S&T Evaluation and Planning (KISTEP)* – evaluation of R&D system and planning of research
- *National Science and Technology Council (NSTC)*
- *National Research Foundation of Korea (NRF)* - NRF receives a yearly budget of €1.53 billion and is subordinated directly under MEST.
- *Korea Environmental Industry & Technology Institute (KEITI)* – launched 2009 with the merge of Korea Institute of Environmental Science & Technology (KIEST) and Korea Eco-Products Institute (KOECO)
- *Korea Institute of Energy technology Evaluation and Planning (KETEP)* – government agency under the auspices of MKE that is dedicated to the management of the national energy technology R&D programme with the aim of "Low Carbon, Green Growth"

1.19. Public R&D programmes on eco-innovation

The Ministry of Education, Science and Technology (MEST) administers the *National R&D Program* as an overall research framework programme since 1982. It comprises among others the *21st Century Frontier R&D Program*, the *Creative Research Initiative (CRI)*, the *National Research Laboratory (NRL)*, the *Biotechnology Development Program*, the *Nanotechnology Development Program*, the *Space and Aeronautics Program* and the *R&D Infrastructure Program.*[60] Most programmes do not have a specific focus on environmental research or eco-innovation but cover a broad scope of areas.

The ***21st Century Frontier R&D Program*** focuses on new frontier areas - among them many connected to eco-innovation such as carbon dioxide reduction & sequestration, hydrogen energy (and bioscience, nanotechnology, space technology), and resource recycling. Public support for research infrastructure is provided through the programme ***National Research Laboratory*** that fosters research centres of excellence for „core technologies" - 40 of them are related to environmental research. In addition, there are ***Regional Environmental Technology Development Centres*** that bring together

[59] Jones, R.S. and B. Yoo (2010), „Korea's Green Growth Strategy, Mitigating Climate Change and Developing New Growth Engines", OECD Economics Department Working Papers, No. 798, OECD Publishing, p. 19-21.
60 A description on the National R&D program can be found here: http://english.mest.go.kr/web/1715/site/contents/en/en_0217.jsp

universities, administrative agencies, research institutes, industries and non-governmental organisations to solve unique local environmental problems collectively. Activities of the centres include development of environmental technology, environmental education and technical support to enterprises coping with environmental management problems, dissemination of new environmental technologies, and promotion and education regarding new environmental technologies to local people. [61]

The R&D programmes with regard to energy (energy generation but also energy efficiency) are mostly managed by the ***Korean Institute of Energy Technology Evaluation and Planning (KETEP)***.

SMEs receive specific support through the ***KOSBIR*** programme that foresees that government-financed institutions allocate at least 5% of their R&D budget to support SMEs' technology development and to cover R&D expenses of SMEs capable of separately developing technology.

One particularly interesting Korean programme is the **Eco-Technopia 21 Program**, launched by the Ministry of Environment (MOE) in 2001. The programme is not presented as a good practice example in this report, because an evaluation of Eco-Technopia 21 stated that it failed to reach its ultimate (very ambitious) goals. However, as it still promoted the Korean environmental industries considerably, it is described in a little more detail here. Eco Technopia 21 ran until 2010 with a focus on developing environmental technologies in the fields of air and water quality and waste treatment and the ultimate goal of building world-class core environmental technologies. The programme addressed SMEs in particular, who received competitive governmental research grants (Funding quota: 75% for SMEs, 50% for large industries, overall budget: US$784 million for 10 years). When the outcome of the research leads to a business, the government subsidy should be returned in the form of royalties.

While Eco-Technopia did not reach its ultimate goal of Korea joining the ranks of the world's top five environmental technology developers and led to less-than-average number of patents compared to other environmental R&D programmes, it still led to more-than-average number of business opportunities, lifted the level of technologies in all environmental sectors and achieved profits that were three times larger than investment. Some success factors for this were the link to environmental regulation and the participation of experts from the Ministry of Environment in designing the programme, which facilitated technology adoption and market entry.

1.20. Market-based policy instruments to support eco-innovation

Eco-Innovation in Korea is promoted by numerous market-based policy instruments.

The government provides ***tax incentives*** (certain percentage of the income tax credit, 7% in 2003) for investments in energy efficiency like the installation of energy saving facilities. It also gives out low interest loans form a specific "Fund for the rational use of

[61] OECD (2011), Better Policies to Support Eco-innovation, OECD Studies on Environmental Innovation, OECD Publishing, 55.

energy" to invest into energy efficiency. On the other hand ***environmental taxes*** (e.g. on heavy oil, diesel) account for 9.5% of the total tax revenue which is above the OECD average.

The production of hybrid vehicles was promoted by a Five-Year-Plan that offered ***incentives for the purchase*** of such cars (subsidies, tax breaks, discounted parking fees) and also contains a ***public procurement*** component.

In 2005, the ***Act on the Promotion of the purchase of Environment-friendly Products*** was enforced. Under this law public agencies are asked to purchase environment-friendly products and services.[62] Although green public procurement is still relatively small (roughly 6% of total public procurement in 2003), it has been growing very rapidly.

In 1998 ***a voluntary agreement system*** for the business sector was launched to encourage energy efficiency. Enterprises that participate and agree to voluntary reduction targets qualify for ***low-interest loans*** for energy-saving investments as well as ***tax benefits or technical support.*** This approach will be followed by the new "GHG and Energy Target management System" that also foresee penalties if targets are not met.[63]

Emission Trading Schemes: In 2005 the voluntary "Korea Certified Emissions Reductions (KCER)" market was introduced – certificates are mostly bought by the government due to the lack of reduction obligations. Korea also participates in the Clean Development Mechanism (CDM) established by the Kyoto-Protocol. The Green Growth Strategy announces the gradually introduction of an emissions trading system.

The ***Environmental Technology Verification (ETV) Program*** was set up in 1997 to promote the development of environmental technologies. The programme certifies and verifies environmental technologies that were either developed or improved in Korea. This provides reliable information to technology users and promotes their dissemination. The government also provides benefits for certified technologies, e.g. extra points at public project biddings. Up to 50% of the verification costs are supported by MOE. The certification process either consists of on-site inspections/ verifications and document reviews. It can last up to 12 months.[64]

The Korean Government ***subsidises the purchase and use of micro-combined heat and power (CHP) fuel cell systems*** and covers a certain percentage of the purchasing and installation costs.[65]

1.21. Other activities and programmes to mobilise financing for eco-innovation

To mobilise financing for eco-innovation the following programmes were introduced in the past:

[62] OECD (2008), "Eco-Innovation Policies in the Republic of Korea", Environment Directorate, OECD, p. 15.
[63] Jones, R.S. and B. Yoo (2010), „Korea's Green Growth Strategy, Mitigating Climate Change and Developing New Growth Engines", OECD Economics Department Working Papers, No. 798, OECD Publishing, p. 9.
[64] OECD (2008), "Eco-Innovation Policies in the Republic of Korea", Environment Directorate, OECD, p. 11; http://www.koetv.or.kr/engpage.do?mode=engguid
[65] OECD (2011), Better Policies to Support Eco-innovation, OECD Studies on Environmental Innovation, OECD Publishing, 116

The 577 Initiative foresees as a measure to stimulate private investments in R&D to provide **tax incentives for R&D investment**, deregulation related to corporate research institutes, and the expansion of tax deduction rate for R&D facility investment (from 7% to 10%). In the Green Growth Strategy it is planned to "green" the tax system and to extend **public credit guarantees** to green industry.

The ***Environmental Venture Fund*** was set up by the MOE to support promising venture companies in the area of the environment. All in all venture capital investment in R&D in general is rather below average (0.07% of GDP in 2008).[66] The performance of the fund suffered under uncertainty about the profit rate of environmental industry and a lack of management capacity in this field.[67]

The ***Demonstration & Dissemination Program*** aims at the dissemination of new and renewable energy technologies – installation costs for such power systems are highly subsidised (70% of the costs).

The ***Environmental Technology Business Incubator (ETBI) programme*** selects high-potential environmental ventures and provides comprehensive incubation services to support commercialisation.[68]

The ***Korean Green Industry Complex cluster*** complements support to innovative firms. Its aim is to enhance the global market share of Korea's environmental industry. It supports technology development through technical assistance and information sharing and particularly supports mutual co-operation large firms and SMEs.[69]

1.22. Environmental regulation and standards

In the last 15 years Korea passed a considerable number of environmental legislation.[70]

Important **environmental standards** in Korea with regard to eco-innovation are the *Rational Energy Utilisation Plan*, establishing targets for five year periods, *Building code standards* that address energy efficiency and the initiative *Standby Korea 2010* with the aim of reducing the standby power of all electrical devices below one watt by 2010.

In 2010 the Korean government introduced a pilot project on mandatory negotiated agreement on **energy use targets** which covers firms responsible for 41% of total energy consumption in the industrial sector. It is planned to follow up with a GHG and Energy Target Management System. Companies will be subject to penalties in case of failure to meet the targets.[71]

[66] OECD (2010), Science, Technology and Industry Outlook 2010, p. 198.
[67] OECD (2011), Better Policies to Support Eco-innovation, OECD Studies on Environmental Innovation, OECD Publishing, 60.
[68] OECD (2011), Better Policies to Support Eco-innovation, OECD Studies on Environmental Innovation, OECD Publishing, 60.
[69] Better Policies to Support Eco-innovation, OECD Studies on Environmental Innovation, OECD Publishing, 60.
[70] OECD (2006), Environmental Performance Reviews: Korea, p. 16.
[71] Jones, R.S. and B. Yoo (2010), „Korea's Green Growth Strategy, Mitigating Climate Change and Developing New Growth Engines", OECD Economics Department Working Papers, No. 798, OECD Publishing, p. 10.

1.23. Other initiatives to support eco-innovation

Korea particularly works together with China in initiatives concerning environmental industries e.g. in ***Korea-China Environmental Industry Centers*** and ***Environmental Industry Round-Tables*** that also include Japan and aim at fostering cooperation between the countries in these domains.

Korea participates via the ***Korea Energy Management Corporation (KEMCO)*** in Expert groups of the *Asia-Pacific Economic Cooperation (APEC)* on Energy efficiency and conservation as well as new and renewable energy technologies. KEMCO also works together with other associated organisations of other countries.[72]

The Korean government promotes ***Clean Development Mechanisms (CDM)*** projects under the Kyoto Protocol. As of November 2009, 81 CDM projects were registered. The Korea Energy Management Corporation (KEMCO) offers CDM expert training programmes and organises a council with the government and private sector to assist CDM project development.[73]

Korea Environmental Industry & Technology Institute (KEITI) participates in several international organisations concerned with eco-labelling like the Global Eco-labelling Network (GEN). Korea also participates in the International Green Purchasing Network.[74]

The ***ASEM SMEs Eco-Innovation Center (ASEIC)*** aims to promote Asia-Europe cooperation to create and enhance eco-innovation of small and medium sized enterprises (SMEs) in both regions. The Centre, located in Seoul and funded for the initial phase by the Republic of Korea, was founded in 2012 as an international platform where growing environmental regulations and eco-innovative technologies are shared. SMEs are supported via business incubation and advisory services.

A number of governmental initiatives in Korea are concerned with labelling products with informing users on the environmental impact of products e.g. via eco-labelling. The ***Korea Eco-Label*** is a voluntary certification programme, introduced in 1992. Products that meet certain environmental standards are granted the label, based on lifecycle assessments. In 1992 Korea introduced mandatory energy-efficiency standards that also included eco-labelling to inform consumers. Since 1996, products with a higher energy-efficiency level than is required by law can receive a specific certification. In 1999 the ***Standby electricity reduction programme*** was introduced that grants labels to products that automatically switch to power-saving modes when not used.[75] The ***Environmental Declaration of Products (EDP)*** programme also strives to inform about the environmental impact of products. An ***Environmentally friendly Company Certification*** is awarded to companies that fulfil certain criteria in the area of pollution treatment, environmental management and improvement. These companies are supported in their knowledge exchange on environmental management.

[72] OECD (2008), "Eco-Innovation Policies in the Republic of Korea", Environment Directorate, OECD, p. 19.
[73] http://www.iea.org/Textbase/pm/?mode=pm&id=969&action=detail .
[74] OECD (2008), "Eco-Innovation Policies in the Republic of Korea", Environment Directorate, OECD, p. 18.
[75] Jones, R.S. and B. Yoo (2010), „Korea's Green Growth Strategy, Mitigating Climate Change and Developing New Growth Engines", OECD Economics Department Working Papers, No. 798, OECD Publishing, pp. 10.

With regard to environmental education, Korea launched the the ***Green Home Life Pavilion***, where consumers are shown how to "green" their daily lives through the use of devices for energy saving and greener consumption, and the ***Kids ISO 14000 program*** to foster environmental awareness among children.

A ***National Environmental Technology Information System*** was introduced by the Ministry of Environment (MOE) in 2000. The database provides information on the latest environmental technology available and aims at encouraging creative technology development efforts.

Other awareness raising initiatives include the introduction of energy conservation months & days or the ***Korea Environmental Technology Awards***, which honours persons who have developed or commercialised excellent environmental technologies/products. [76]

1.24. Conclusion on eco-innovation activities in the Republic of Korea

The Republic of Korea attaches great importance to S&T and innovation processes on the one hand and green growth on the other hand as drivers for economic development. This was particularly emphasised in recent years with the introduction of the Green Growth Strategy and the 577 Initiative in research policies. All in all, in terms of patents for innovations in the area of environment, Korea has witnessed high growth rates in the last two decades. The Global Cleantech Innovation Index 2012 states: "The country has strong general innovation inputs and an average entrepreneurial culture. Strong government policies and public R&D funding is countered by weaker access to private finance." [77]

A specific Korean approach to generate eco-innovations by R&D projects that bring together a critical mass and cover technology development as well as commercialisation is the programme "Eco-Technopia 21 Project", that ran up to 2010.

Opportunities for improvement concerning R&D spending in general as well as in the area of eco-innovation concern linkages between business, university and government research institutes that are still weak and should be strengthened to foster the innovation-oriented approach. Further points are a better support to SMEs and a diversification in research areas.[78]

1.25. China

There has been a big increase in China's R&D expenditure in recent years. The annual average growth rate of R&D expenditure was 20.6% in 2000-2002, (the average growth rates in US, Europe and Japan were all less than 3%). Gross domestic expenditure on R&D as a percentage of GDP grew from 0.6% in 1996 to 1.42% in 2006 (compare with 2.3 in OECD countries and 1.8 in EU 25, in 2006). In China's **Medium- and Long-Term S&T Development Plan**, the government's R&D intensity targets are to reach 2.0% in

[76] OECD (2008), "Eco-Innovation Policies in the Republic of Korea", Environment Directorate, OECD, p. 16-18.
[77] Cleantech Group LLC / WWF, Coming Clean: The Global Cleantech Innovation Index 2012, 38, 39.
[78] OECD (2008), "Eco-Innovation Policies in the Republic of Korea", Environment Directorate, OECD, p. 20.

2010 and 2.5% in 2020. During the period 2002-2006 the gross domestic expenditure on R&D (GERD) increased from 37.7 to US$70.6 billion.[79]

The total amount of China R&D expenditure in 2006 was €30,029 million (based on current exchange rates). More than two thirds of R&D funds came from the business sector and one quarter from the government. In terms of R&D expenditure, Chinese business sector also takes the lion's share: 71% of R&D was conducted in business enterprise, while research institutes and universities accounted for 19% and 9% respectively.

In March 2011 China released their ***twelfth five-year plan*** (FYP) for 2011-2016. The plan plays an important role for the fulfilment of the 40–45% carbon intensity reduction target by 2020. The plan calls for energy intensity to decline by a further 16% and it is China's first to include compulsory target for carbon emissions per unit of gross domestic product — to be reduced by 17 % in 2015 relative to 2010.

Seven new strategic industries have been specified in the 12th FYP to stimulate green growth, including advanced materials, renewable and alternative energy, information technology, innovative equipment manufacturing, biotechnology, energy conservation and environmental protection, new energy vehicles (electric, hybrid, etc.),

The Chinese government aims to shift the resources intensive and low value-added economic model towards knowledge-based and high value-added green growth.

In 2009, the Chinese government issued the economic stimulus package of US$ 586 billion to boost economic growth as a response to the global financial crisis; of which a significant part was allocated to infrastructure investment. This has been consolidated in the 12th FYP, which envisions large-scale investments in energy, road bore transport, buildings' infrastructure expansion.[80]

1.26. Main actors of the eco-innovation system

Structure of the research system

China has a highly centralised research system organised and controlled by the central government. The ***National Steering Group for S&T and Education in the State Council*** is the highest ranked organisation in China coordinating all education, research, and innovation related activities. It has nine member ministries or agencies: 1) Ministry of Science and Technology (MOST), 2) Ministry of Education (MOE), 3) Ministry of Finance (MOF), 4) National Natural Science Foundation of China (NSFC), 5) Chinese Academy of

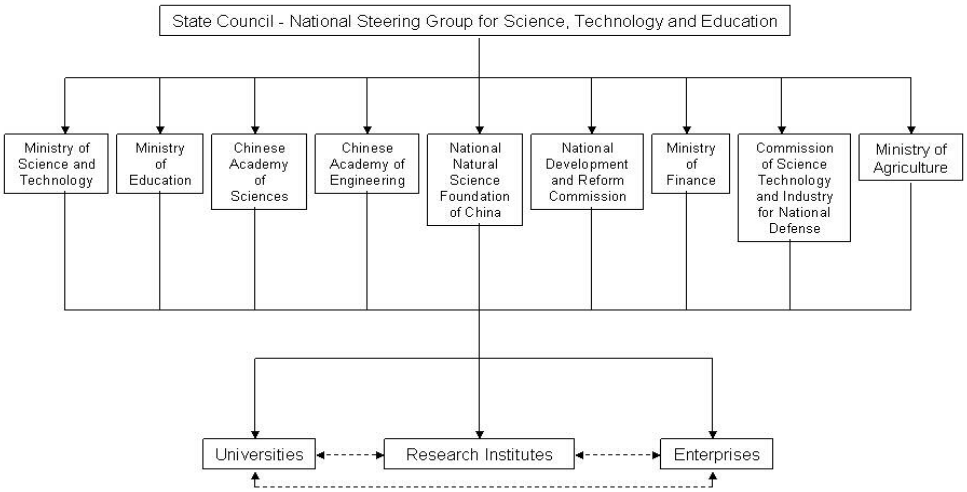
[79] This chapter is primarily based on information from the following sources: OECD (2009), "Eco-Innovation Policies in the People's Republic of China", Environment Directorate, OECD; OECD (2007), OECD Reviews of Innovation Policy, China, Synthesis Report; The Climate Group (2011), Delivering Low Carbon Growth - A Guide to China's 12th Five Year Plan; IVL Swedish Environmental Research Institute (2007), Pontus Cerin, Ulrik Axelsson, Östen Ekengren, "Research, Development and Demonstration Strategies on Environmental Technology";http://www.access4.eu/China/index.php;

http://cordis.europa.eu/erawatch/index.cfm?fuseaction=ri.content&topicID=4&countryCode=CN;
http://www.theclimategroup.org/

[80] Jun Li, XinWang, Energy and climate policy in China's twelfth five-year plan: A paradigm shift.

Sciences (CAS), 6) Chinese Academy of Engineering (CAE), 7) National Development and Reform Commission (NDRC), 8) Commission of Science Technology and Industry for National Defence (CSTIND), and 9) Ministry of Agriculture (MOA).

MOST is the leading ministry and works with other ministries or agencies to coordinate S&T activities. MOST supports several national level science and technology programmes. In particular, MOE plays a role in policies for S&T talent and managing R&D activities in universities; MOF helps to develop fiscal policies to promote R&D activities especially in enterprises; NSFC develops S&T programmes and provides funding for basic and some applied research; CAS is a leading academic institution and comprehensive research and development centre in natural science, technological science and high-tech innovation in China. NDRC develops strategies and policies with a focus on the economic and social aspects of S&T; CSTIND and MOA manage R&D activities related to defence and agriculture respectively[81]



Source: Erawatch research inventory report for China

Key Research policy focus

The ***Medium- and Long-term National Plan for Science and Technology Development*** (2006-2020) outlines ten prioritised fields in research policies. The prioritised fields are: energy (5 topics), water and mineral resources (7 topics), environment (4 topics), agriculture (9 topics), manufacturing technologies (8 topics), transportation (6 topics), information technology (7 topics), population and health (5 topics), urbanisation (5 topics), and public security (6 topics). In addition to these prioritised fields, eight frontier technologies have been selected as priorities for funding: biotechnology (5 topics), information technology (3 topics), new materials and nanotechnology (3 topics),

[81] National profile on China on the ERAWATCH website: http://cordis.europa.eu/erawatch/index.cfm.

advanced manufacturing technologies (3 topics), advanced energy technologies (4 topics), ocean technology (4 topics), laser technology, and aeronautics and astronautics.

Enhancing competitiveness of enterprises and promoting independent innovation are two main aims of Chinese research policy in the next fifteen years.[82] Further aims include: R&D/GDP reaches 2% in 2010 and 2.5% in 2020; the level of reliance on foreign technology drops to 40% in 2010 and 30% in 2020; the share of contribution to economic growth from S&T reaches 45% in 2010 and 60% in 2020; being a "Top 10" country in 2010 in terms of the number of scientific publication citations and a "Top 5" country in 2020; being a "Top 15" country in 2010 in terms of the number of granted invention patents and a "Top 5" country in 2020.

Other goals summarised in the above national S&T guideline documents are as follows:

- Advancing key technologies in manufacturing industry, information technology and agriculture
- Addressing environmental issues by developing energy efficient and clean energy technologies
- Developing human resources as the basis of S&T development in China.
- Enforcing national security through technology development.

Main instruments of research policy

Main instruments of current research policy in China include the following.

- Increasing R&D expenditure, not only by the central government, but also by local government and industry;
- Engaging in international R&D cooperation;
- Encouraging industrial R&D activities by providing fiscal incentives and promoting academic-industry partnership;
- Providing research grants to key research programmes;
- Attracting high quality human resource by setting up funds for excellent researchers;
- Setting up funds to promote the development of universities and research institutes;

Regional responsibilities

Regional policy making in China is led by regional governments and is consistent with national policies. National policies are replicated in each region and customised towards regional needs. For example, after the Five-year National Plan for S&T Development is published, each region is responsible for developing a Five-year Regional Plan for S&T Development. Regional plans generally follow national plans but are allowed to have their own policy measures. While research policies at the national level emphasise

[82] This is specified in two main policy documents: the Medium- and Long-term National Plan for Science and Technology Development 2006-2020 and China's National S&T Development Plan for the 11th Five-year Period 2006-2010.

research investment, research policies at the regional level are more focused on developing research infrastructure, promoting technology commercialisation and attracting high quality human capital.[83]

1.27. Public R&D programmes on eco-innovation

The majority of enterprises' R&D spending (91%) went towards the funding of research in enterprises, especially large and medium-sized enterprises. Research institutes and universities were the main target (85%) of government funds, while around 13% of government funds went to the business sector.

Institutional funds play an important role in China's R&D investment. About forty selected universities receive block funds of millions of Euros directly from national government each year. A large part of the funding goes to academic exchange.

Project-based funding, particularly in the format of research programmes, is the key element of China's R&D investment. According to the released figures from Chinese Ministry of Science and Technology (MOST), special project funds for S&T in 2006 was €7799 million, accounting for about 46% of total government S&T appropriation.

Programmes of the Chinese Ministry of Science and Technology (MoST)

The ***National Basic Research Programme, also called "973 Programme"*****,** is a major Chinese national research that gathers strong expertise with a focus on key basic research projects in the fields of agriculture, energy, information technology, resources and environment, population and health, and materials, among others, in order to develop China's research capacity in key disciplines and interdisciplinary fields, and find comprehensive solutions to major issues in China's development.

Thematic field	*Basic research supported by 973 Programme*
Energy	• Renewable energy in large scale • PV cells with low cost and long life • Developing wind energy and biomass energy • Advanced theory and methodology of energy especially in high energy consumption areas • Materials for efficient energy transport saving,
Water supply and waste water systems	• Water recycling and high efficiency use of water resources in areas with water shortage
Material efficiency	• Circular economy and resource recovery
Mobility and logistics	• Urban transportation, logistics and engineering safety

The ***National High-Tech Research and Development Programme, also called "863 Programme"***, is a major Chinese national research programme with a focus on the application of cutting-edge technologies in certain key areas in the "National Long-term

[83] National profile on China on the ERAWATCH website: http://cordis.europa.eu/erawatch/index.cfm.

Scientific and Technological Development Plan (2006-2020)". It aims to strengthen the independent innovation capacity of China in the high-tech fields and supports pre-commercial high-tech projects especially in IT and biotechnology. Among other fields, it also focuses on energy, resources and environmental technology, marine and agricultural technology, transportation and earth observation.

The ***National Key Technologies R&D Programme*** focuses more directly on industrial needs than the 863 Programme, promotes technical upgrading and restructuring of industries, and tackles major S&T issues in national economic construction and social development. It also deals with key S&T issues that have to be addressed at the national, inter-disciplinary, or inter-regional levels. It includes research on sustainable agricultural development and key technologies for environmental protection and rational utilisation of resources. Enterprises are the major funding beneficiaries.

The 16 ***National S&T Major Projects*** were identified in 2006 and are considered as the most important S&T tasks in the Chinese mid-and-long-term S&T development planning. They address major technologies of strategic importance for the Chinese economy and overall competitiveness by centralising funds and resources. They are being launched one by one on the basis of experts' economic and technological feasibility studies.

Till now, the Chinese government has launched 13 of the 16 National S&T Major Projects. Examples include projects on waste water control and treatment (civil application) or high-resolution earth observation system (military application).

Further programmes of MoST that focus more on policy guidance include the ***Action of Scientific and Technical Service to Cooperations (ASTSC) Programme*** that aims to encourage researchers to join the research and design work of enterprises, especially SMEs facing pressing problems during their developments and the ***National New Products Programme,*** that aims to facilitate the development and industrialisation of high and new technology products that have a high economic competitiveness and promising market potential. The ***International S&T Cooperation Programme*** aims to support Chinese scientists in international research activities (foreign organisations can be eligible partners). It covers international cooperation projects launched under China's multilateral and bilateral S&T agreements with other countries. ISTCP integrates resources for international cooperation under major national S&T programmes such as "863" and "973".

Programmes of the National Natural Science Foundation of China (NSFC):

The ***General Programme*** is a major research programme with the aim to promote the development of natural science disciplines and to stimulate academic innovation. General Programme supports researchers to conduct innovative research on research topics selected freely within the scope of NSFC.

The ***Joint Funds Programme*** includes multiple sub-schemes jointly funded by NSFC and other relevant governmental authorities, regional governments and enterprises. It aims to attract researchers from different sectors of industries, universities and research institutes to support basic research in specific areas.

Another important research programme is the ***Key Programme*** with a focus on global frontier research, innovation resources integration and scientific key breakthrough. Different from the General Programme, the Key Programme mainly concentrates on important scientific issues that require in-depth research and substantial financial support. Topics under the Key Programme are structured according to the Five Year Plans and announced each year.

The ***Major Programme*** focuses on the research of major scientific and technological issues emerging from either science and technology academic research or national economic and social development, which may be studied jointly through interdisciplinary efforts.

In addition to the programmes described above, there are several R&D programmes that focus on fostering international cooperation – without a specific thematic or disciplinary focus. These include *the* ***International (Regional) Cooperation and Exchange Programme*** (NSFC) that promotes the implementation of substantial bilateral and multilateral joint research projects as well as the ***Fellowships for Young International Scientists*** (CAS).

1.28. Market-based policy instruments to support eco-innovation

The Chinese government has, in recent years, increased its commitment to the development of renewable energy, as outlined in the **New and Renewable Energy Development Programme 1996-2010**. This programme aims to improve the efficiency of renewable energy, reduce production costs, and enlarge the share of renewable energy in the overall energy mix. The 1995 Electricity Law also extends support to solar, wind, geothermal and biomass energy for power.

In 2006, to pursue the goal of 20% reduction in energy intensity by 2010, NDRC launched **A Thousand Enterprises Program** in 2006. The programme selected 1008 top firms that together consume one-third of all China‘s primary energy, and instructed them to formulate individual energy efficiency improvement plans in cooperation with local officials. Those enterprises cover nine energy-intensive industrial sectors. Through technology rectification, energy audit and energy consumption metering systems, the firms are expected to save 100 million tons of coal equivalents by 2010. Local governments are also required to develop similar programmes with an additional 100,000 smaller firms in order to achieve the 20% reduction national goal by 2010. It is reported by NDRC that 7.8% of the 1008 enterprises failed to meet their energy saving targets in 2007.

In the “A Thousand Enterprises Program”, government agencies not only perform the conventional regulator‘s role such as monitoring and supervising, but provide enterprises with expertise in choosing the most appropriate conservation measures for them.

Another case in point is the **Ten Key Programs**. In early 2004, ten key energy-saving programmes were identified in the Medium and Long -Term Special Plan for Energy Saving. The ten programmes include technological rectification of boilers, heat-power

combined production, utilisation of waste heat and pressure, oil product replacement, power equipment update, energy saving in buildings, green lighting, energy conservation by government agencies and monitoring of energy saving. The ten programmes, if successful, are expected to save 240 million tons of coal equivalents, accounting for about 40% of the 20% reduction target.

The central government is determined to taking proactive actions to reinforce the energy efficiency and climate friendly urban infrastructure, in particular in the buildings sector. The Ministry of Housing and Urban–Rural Development (MOHURD) requires that local governments complete energy-efficiency retrofits for 35% of existing residential buildings.

Since 2007, there is a ***Green Public Procurement*** rule that asks the central government and provincial governments to give priority to environment-friendly products listed in a "green product inventory". The list includes products ranging from cars to construction materials that have been approved by the China Certification Committee for Environmental Labelling. Products are required to meet the environmental protection and energy saving standards set by the State Environmental Protection Administration in order to obtain the environmental label.[84]

In addition, renewable energy is supported through a number of market based-instruments that include preferential, **government-set prices** and **tax incentives** (reduced VAT) to help these energy sources gain market-share.

The amended **Energy Conservation Law** (2008) emphasis various forms of economic incentives for energy conservation like special funds to support manufacturing energy saving devices, tax benefits and subsidies to producers and users of such devices.[85]

Other activities include a mandatory **labelling scheme** for energy efficiency as well as **subsidies to households who purchase energy saving bulbs**. Since 2008, the MOF and NDRC subsidise households who purchase energy saving bulbs, with a subsidy for up to 50% of the price.

China plans to introduce a Carbon **Emissions Trading Scheme** as a pilot in major cities in 2013 and nationally in 2015.[86]

China has expressed interest to develop an **environmental verification programme** in the near future.

1.29. Other activities and programmes to mobilise financing for eco-innovation

Top-down approaches have traditionally been dominant in China's environmental protection works. Meanwhile, innovative ideas and measures adopted by local government in the pursuit of environmental excellence have surfaced in the past few years. The most outstanding case is the ***eco-city programme.***

[84] UN (2008), Sustainable Development Innovation Brief 5.

[85] OECD (2009), "Eco-Innovation Policies in the People's Republic of China", Environment Directorate, OECD.
[86] http://www.theaustralian.com.au/news/world/polluted-china-plans-carbon-emissions-trading-scheme/story-e6frg6so-1226096969756

By 2008, around 60 cities from 22 provinces have announced various plans to build so-called "eco-city" and the number keeps increasing. Some projects are completely new construction projects (Shijiazhuang, Chengdu), some are urban planning towards ecological friendly approach (Huizhou, Nanchang), some are entertainment parks (Zibo), and some aim to build an entirely new city with an eco label (Chongming Island).

The Chinese government announced in 2011 to increasingly invest public money in **venture capital** funds that focus on cleantech.[87]

1.30. Environmental regulation and standards

The OECD Environmental Performance Review of China (2007) states that China has a set of modern and comprehensive environmental laws, but their implementation lacks effectiveness and efficiency.[88]

Examples for environmental regulation in China are:

In 2005 China passed the ***Renewable Energy Law*** to secure and diversify the country's energy supply (mostly coal and oil) and to better protect the environment, with the aim that by 2020 10% of the nation's energy production must come from renewable sources. In 2007, the NDRC took a further step in the "Mid-to-Long-Term Development Plan for Renewable Energy", which states that renewables must account for 10% of China's overall energy supply by 2010, and 15% by 2020. In addition, a series of regulations, together with the law itself, form the legal framework for renewable energy and a number of policy documents are concerned with the implementation.[89]

The amended ***Energy Conservation Law*** (2008) regulates energy saving in building and transport sectors, improves the management regime and the standards system for energy conservation, and imposes greater penalties for violations than previously were the case.

1.31. Other initiatives to support eco-innovation

International cooperation to build capacity and raise awareness on renewable energy

China's efforts to develop renewable energy have received strong support and financial assistance from the international community. Some countries, including the United States, Australia, and the Netherlands are actively involved in bilateral aid and technical assistance for renewable energy. Some examples of multilateral and bilateral renewable energy projects are summarised below.

The "umbrella" ***Agreement on Cooperation in Science and Technology*** signed by the U.S. and Chinese governments is aimed at maintaining long-term technical cooperation.

[87] http://gigaom.com/cleantech/the-latest-cleantech-vc-china/
[88] OECD (2007), Environmental Performance Reviews – China, p. 18.
[89] OECD (2009), "Eco-Innovation Policies in the People's Republic of China"; Environment Directorate, OECD. The policy documents are: *The Eleventh-Five-Year Plan for the Development of Renewable Energy; Management Methods on Renewable Energy Power Pricing and Costs Sharing for Trial Implementation; Management Rules on Renewable Energy Power Generation*; *Technical Standards on Renewable Energy Power Combined to the Grid; Detailed Methods on Fiscal Subsidy and Preferential Taxation for Renewable Energy*.

Specifically, protocols were established to, 1) help China diversify its energy resources and thereby reduce its future demand for oil; 2) mitigate environmental damage associated with energy consumption through deployment of renewable energy and energy efficiency measures; and 3) enhance U.S. industry competitiveness in China's energy market.

A Protocol for Cooperation in the Field of Fossil Energy Technology Development and Utilisation was established between the U.S. Department of Energy (DOE) and the China's MOST. Moreover, in September 2007, the U.S. DOE and the MOST signed a five-year agreement to promote large-scale deployment of next-generation efficiency vehicle technologies in the U.S. and China, specifically focusing on electric, hybrid-electric, fuel cell, and alternative fuel technologies to implement a Protocol for Cooperation in the Fields of Energy Efficiency and Renewable Energy Technology Development and Utilisation between DOE and MOST. In addition, the US is cooperating with China in clean coal technology, building on the experience in the US Clean Coal Technology Program.

The World Bank has been actively engaged in the energy sector, especially in renewable energy development through loans and carbon financing in China. The **Renewable Energy Scale-up Program** (since 2005) will help enable commercial renewable electricity suppliers to provide energy to the electricity market efficiently, cost-effectively, and on a large scale. It aims to support the implementation of a national policy framework that would require a share of electricity to utilise renewable resources—a mandated market policy.

Further projects of international cooperation include the Sino-Dutch cooperation project *"Promotion of Rural Renewable Energy (RRE) in Western China"* that aims at the integrated development and application of renewable energy resources (biogas, wind, and hydropower) and a *National Solar Water Heating Standards, Testing and Certification Program* supported by UNDP and GEF.

Energy efficiency labelling

The Administrative Measures on Energy Efficiency Labels was fist enforced in 2005. Since then, a mandatory labelling scheme has been phased in, first applied to household appliances including air conditioners, washing machines and refrigerators. The government has issued a series of implementation guidelines on the format of the labels and the testing and inspection methods to determine the appropriate energy efficiency grades.

1.32. Conclusion on eco-innovation activities in China

China's has implemented a strategy to promote more innovation-driven growth and an "innovative society". A major element of its strategy is the building of an enterprise-based innovation system. Though innovation linkages are still weak, there has been considerable progress in raising China's innovative capacities. China has increased the resources for science and technology exceptionally rapidly and is now internationally a

major R&D player. By increasing its investments in science and technology China is also becoming less dependent on foreign technology.

China has been using various means to support and promote environment-related innovation, including public investment in R&D, mobilising financing from multiple sources, government procuring environmentally friendly products, adopting prescriptive measures, adopting market-based instruments, awareness raising and capacity building, and acting globally.

There are a lot of different programmes and activities, both national and regional, promoting eco-innovation in China. Many different organisations and authorities are involved. The R&D budget is steadily increasing, both from central and local government as well as from industry. Many existing R&D programmes are directed to international cooperation. China is also promoting industrial R&D activities by fiscal incentives and promoting collaboration between academia and industry. Project-based funding, particularly in the format of research programmes, is the key element of China's R&D investment. R&D programmes and other measures are characterised by Chinese long-term plans and target large companies rather than SMEs. When it comes to the development of eco-innovation, the "863 R&D programme" that targets cutting edge technologies and the "National Key Technologies R&D Programme" that has a specific focus on industry needs need to be mentioned.

Universities are major players in the S&T system in China and in terms of business participation in public funded R&D, large companies are rather addressed than SMEs. But the ASTSC programme, introduced in 2009, aims at strengthening SME research.

The academic sector in China has strongly picked up the need for eco-innovations but transfer to application must be strengthened. China is today below average in innovation in renewable energies, despite success in photovoltaics and hydropower. China is strong in the building sector and in appliances, with many exports to other emerging economies. Materials are an important area where a focus in trade is to secure resources. Some successful areas for China are hydropower, air condition, appliances, lighting, membranes in sewage treatment and water supply.[90]

1.33. India

India's growing population, along with a shift towards urbanisation and industrialisation, has placed significant pressure on India's natural resources and its infrastructure. Deforestation, soil erosion, water pollution and land degradation continue to worsen and hinder economic development in rural India, while rapid industrialisation and urbanisation in India's booming metropolises are straining the limits of municipal services causing serious air pollution problems[91].

India's economy is growing disproportionately high during the last years. Even through the financial crisis India's economy was stable. India's gross expenditure on R&D (GERD) was 0.8% of GDP in 2007. The government intends to increase this level to 2% over the

[90] Based on presentation of Rainer Walz (Fraunhofer ISI institute) at ECO-INNOVERA workshop in Bonn on 2.12.2010.
[91] Preliminary Report on the Environment Sector of India, ITSMA India.

coming years. Business expenditure on R&D (BERD) was 0.14% of GDP in 2004, also below the BRICS and OECD averages. While both public and private business R&D is low by international standards, growth rates have been strong over recent years.

Particularly, the Indian knowledge base in topics like renewable materials and water are over average and examples for success in technologies like wind energy, water supply, desalination, bio-fuels, renewable resources and sewage treatment support the understanding of sustainability.

The Global Cleantech Innovation Index 2012 states that "India has weak general innovation inputs and no strong entrepreneurial culture." On the other hand it scores high in cleantech-specific innovation drivers, based on the country's attractive infrastructure for renewables and the large amount raised in cleantech funds. The number of environmental patents and reasonable Venture Capital activity in this area is still relatively small. But the country performs much better on commercialised cleantech, with strong revenue from cleantech companies. [92]

The term "eco-innovation" is not that common yet in India. Mostly the term "environmental and bio-technology" is used in science and economy. Therefore most of the research and funding programmes reflect topics of natural and environmental sciences related innovations, funded by India's main actors.

In 2008 India released a first National Action Plan on Climate Change (NAPCC) that foresees measures to enhance solar power and energy efficiency. In 2009, India's Ministry of New and Renewable Energy announced the Jawaharlal Nehru National Solar Mission, a mission to install 20 GW of solar-powered electricity-generation capacity by 2022. The long-term objective of the National Solar Mission is to establish India as a global leader in solar energy. The immediate aim of the mission is to set up an enabling environment for solar technology penetration in the country.[93]

1.34. Main actors of the eco-innovation system

The main actors in the field of eco-innovation are the *Ministry of Science and Technology* with the affiliated departments of *Biotechnology (DBT)*, of *Science and Technology (DST)*, of *Scientific & Industrial Research (DSIR)* and the *Council of Science and Technology (CSIR)*.

The ***Department of Science and Technology (DST)*** was established to support, sponsor and synchronise science and technology activities in the country. The research emphasis of the department is on the emerging areas of alternative energy sources, bio-fuels, development of innovative production, processing and utilisation technologies and resource conservation by valorisation of by-products[94].

A major research funding at university level for all basic and applied sciences and engineering faculty is provided by the ***Council of Scientific and Industrial Research (CSIR)*** which forms a part of the DST. Public R&D programmes and publicly funded R&D organisations generated the highest number of patents registered from India. CSIR also

[92] Cleantech Group LLC / WWF, Coming Clean: The Global Cleantech Innovation Index 2012, 35.
[93] http://en.wikipedia.org/wiki/Jawaharlal_Nehru_National_Solar_Mission
[94] http://india.gov.in

has an ensemble of 37 state-of-the-art research institutes. Out of the 37, 19 are working on issues related to environmental engineering and sciences.

The core competencies of other CSIR laboratories working in the environmental fields are Environmental Impact Assessment, waste water treatment, ecosystems, marine technology, hazardous waste, air pollution and meteorology, coal liquefaction, Climate change, gasification and toxicology.

The ***Ministry of Earth Sciences (MoE)*** develops integrated programmes for forecasting monsoon, weather and predicting climate change, ocean and earth dynamics and resource exploration in Exclusive Economic Zones of Oceans. The key research objectives of the ministry are sustainable ocean and earth development and the use of science and technology for exploration and exploitation of oceanic resources[95].

The ***Ministry of New and Renewable Energy (MNRE)*** was established to develop and deploy new and renewable energy for supplementing energy requirement of the country. MNRE is working for development, application and resource assessment of biomass, wind, solar and other forms of renewable energy.[96]

The ***Ministry of Urban Development*** is in charge of urban development including water supply, sanitation and municipal solid waste management.[97]

The ***Ministry of Water Resources*** undertakes overall development, conservation and monitoring of surface and ground water resources of the country. Different programmes on water quality assessment and management are proposed by the ministry.[98]

The ***Ministry of Environment and Forest (MoEF)*** is the nodal agency in the administrative structure of the Central Government for the planning, promotion, co-ordination and overseeing of the implementation of India's environmental and forestry policies and programmes. The primary concerns of the ministry are implementation of policies and programmes relating to the conservation of the country's natural resources including its lakes and rivers, its biodiversity, forests and wildlife, and the prevention and abatement of pollution.[99]

The ***Industry*** is committed to continual improvement in safety standards and environment pollution control processes[100]. Actors are e.g. the *Green Packaging Industries Pvt Ltd*[101] or *TATA International*. *TATA International* undertakes R&D projects like processes for chrome free leather, process changes study for eco labelling of leather products. It also has one of India's largest solar thermal water heating systems at the leather factory in Dewas[102]. In general, only 21% of the national S&T and R&D efforts fall

[95] http://dod.nic.in
[96] http://www.mnre.gov.in
[97] http://www.urbanindia.nic.in
[98] http://www.wrmin.nic.in
[99] http://moef.nic.in
[100] http://www.sriaindia.com
[101] http://greenpackaging.tradeindia.com
[102] http://www.tatainternational.com

under the private sector and the active fostering of public-private partnerships has therefore been a major policy shift in recent years.[103]

1.35. Public R&D programmes on eco-innovation

As mentioned before, the term "eco-innovation" is not that common in India yet. Therefore most of the public R&D programmes focus on global environmental sciences and biotechnologies. Detailed information e.g. on budgets and duration are only available from personal contact with the responsible employee of the related ministry or department and could not be obtained by desk research.

In general high priority topics in Indian research are biotechnology, food and agriculture, energy and ICT. Other thematic priorities include environment and transport / mobility.[104]

One important R&D programme is the ***New Millennium Indian Technology Leadership Initiative (NMITL)*** run by CSIR. It establishes public-private-partnerships in various areas, among them energy, agriculture, biotechnology. The programme identifies high-risk technology areas for development based on national consultation and invites the best partners from institutions, academia and private sector.

Beside that programme, the Department of Science and Technology (DST) has established the ***Water Technology Initiative (WTI) Programme*** with grants for technologists in academic institutions or grants to cover 50% cost of consumables for Industry-Institution partnership. The aim is to develop low cost domestic purification technologies, options for disposal of scientific waste and initiating application of nano-technology.

Another important programme by the Ministry of New and Renewable Energy (MNRE) supports ***Energy Recovery from Urban Wastes***. Funding will be provided per mega watt (MW) electricity, or for setting up power plants.

Additionally, the role of new and renewable energy has been assuming increasing significance in recent times with the growing concern for the country's energy security. Energy self-sufficiency was identified as the major driver for new and renewable energy in the country in the wake of the two oil shocks of the 1970s. This led to the establishment of the Commission for Additional Sources of Energy in the Department of Science & Technology in 1981. The Commission was charged with the responsibility of formulating policies and their implementation, programmes for development of new and renewable energy apart from coordinating and intensifying R&D in the sector.

1.36. Market-based policy instruments to support eco-innovation

A proposed market-based *mechanism in the form of an* ***emissions trading scheme*** seeks to introduce a system of self-regulation among industrial units by putting a price on emission of pollutants. The first domestic emissions trading scheme will begin in the states Tamil Nadu and Gujarat. Broadly, the state pollution control board will set a limit on the amount of categories of air pollutants that can be emitted on the basis of its

[103] http://cordis.europa.eu/erawatch/index.cfm?fuseaction=ri.content&topicID=4&countryCode=IN
[104] http://cordis.europa.eu/erawatch/index.cfm?fuseaction=ri.content&topicID=4&countryCode=IN

desired concentration in the atmosphere. The state regulator then allocates through permits the "acceptable" level of emissions to industrial units. The industrial units can trade this right to emit, so units which exceed the set level will have to buy permits from those who manage to restrain emissions to that below the cap. This will help in lowering pollution levels at lower overall costs of compliance[105].

The Government offers many ***incentives*** to investors in India with a view to stimulating industrial growth and development. The incentives offered are normally in line with the government's economic philosophy, and are revised regularly to accommodate new areas of emphasis.[106]

The *Ministry of New and Renewable Energy* (MNRE) also encourages industries and organisations for replacing non renewable energy by ***providing subsidies and tax exemption*** on installation and use of renewable energy. This has encouraged the private sector to investigate their potential for utilisation of these forms of energy sources. Tax benefits encouraged many industries for installation of biogas plants, wind turbines and solar water heating systems for heating process & boiler feed water.

India has expressed strong interest towards the USA in developing ***Environmental Technology Verification*** (ETV) programmes.

1.37. Other activities and programmes to mobilise financing for eco-innovation

The Department of Science and Technology (DST) India helped establish the ***National Innovation Foundation*** (NIF) in 2000, with the main goal of providing institutional support in scouting, spawning, sustaining and scaling up grassroots green innovations and helping their transition to self supporting activities. For the last twenty years the ***Honey Bee Network*** *and Society for Research and Initiatives for Sustainable Technologies and Institutions (SRISTI)* have been scouting innovations by farmers, artisans, women, etc. at the grassroots level. ***Grassroots Innovations Augmentation Network (GIAN)*** scales up innovations, from the Honey Bee database of innovations, through value additions in innovations to sustain creativity and ethics of experimentation.[107]

The Ministry of Science and Technology provides tax benefits for research in specific technology areas. The ***Industrial R&D Promotion Programme (IRDPP)*** foresees weighted tax deduction of a sum of equal to one and a half times of any expenditure incurred on scientific research in – among others – biotechnology, chemistry or electronic equipments. A similar programme on *Nanomaterials Science and Technology (NSTI)* also provides tax benefits.[108]

[105] http://cpcb.nic.in/
[106] http://www.embassyindia.es and http://finance.indiamart.com/exports_imports/incentives/general_tax_incentives.html
[107] http://www.nif.org.in/
[108] http://www.dsir.gov.in/tpdup/irdpp/irdpp.htm; http://india.gov.in/sectors/science/research_development.php

1.38. Environmental regulation and standards

In general it can be stated that environmental regulation and standards are in existence in India, but are not effectively enforced.[109]

In India, the *Ministry of Environment and Forests (MoEF)* is the apex administrative body for: (i) regulating and ensuring environmental protection; (ii) formulating the environmental policy framework in the country; (iii) undertaking conservation & survey of flora, fauna, forests and wildlife; and (iv) planning, promotion, co-ordination and overseeing the implementation of environmental and forestry programmes. The responsibility for prevention and control of industrial pollution is primarily executed by the *Central Pollution Control Board (CPCB)* at the Central Level, which is a statutory authority, attached to the MoEF. The State Departments of Environment and State Pollution Control Boards are the designated agencies to perform this function at the State Level[110]. Further actors include the ***Emission controls manufacturers Association (ECMA)***, a non-profit association made up of the world's leading manufacturers of emission control equipment for automobile and non-road engines in India.

The first Indian emission regulations were idle emission limits which became effective in 1989. These idle emission regulations were soon replaced by mass emission limits for both gasoline (1991) and diesel (1992) vehicles, which were gradually tightened during the 1990's. Since the year 2000, India started adopting European emission and fuel regulations for four-wheeled light-duty and for heavy-duty vehicles. Indian's own emission regulations still apply to two- and three-wheeled vehicles[111].

1.39. Other initiatives to support eco-innovation

International activities

Clean technology has become a driver for India-Finland economic and innovation cooperation. Finnish cleantech companies explore various business opportunities in India's booming market while strengthening their cooperation with local companies. Key focus areas are water and energy[112]. Finnish cleantech expertise can strongly contribute to the economic, social and environmental development of India. Finnish cleantech companies are already global leaders in energy efficiency, clean industrial processes and bioenergy. Other key areas are measuring, analysis and automation, renewable energy, waste management as well as water and waste water treatment and air protection[113].

Awareness raising activities

[109] Atiyah Curmally, „Environmental governance and regulation in India", (Environment and Rehabilitation 97), 2002: http://www.archidev.org/IMG/pdf/ENVIRONMENTAL_GOVERNANCE_AND_REGULATION_IN_INDIA.pdf

[110] http://business.gov.in
[111] http://ecmaindia.in
[112] https://www.ecoportal.fi
[113] http://www.cleantechfinland.com

The ***Centre for Science and Environment*** (CSE) is a public interest research and advocacy organisation based in New Delhi. Their aim is to raise concerns, participate in seeking answers and – more importantly – in pushing for answers and transforming these into policy and so practice. They do this through research and by communicating the understanding through publications and educational programmes. Examples are the Environmental education programme (targets schools), The Ecological Footprint project (targets children), and the Anil Agarwal Green College (AAGC) that was established to communicate the science, complexity and politics of environment to build a constituency and cadre of knowledgeable, skilled and committed environmentalists from students, decision-makers, field-level practitioners, civil society groups, journalists, lawyers, and concerned citizens. .AAGC serves as a research, academic and capacity building hub that conducts a number of short and long-term courses and training programmes. Short-term courses range from technical workshops on how to build rainwater harvesting systems and decentralised wastewater treatment structures to policy briefings on ecological poverty and food safety, to hands-on training on environmental communication, information management and advocacy[114].

Other training programmes such as ***Environment Impact Assessment*** (EIA), Managing Urban Growth, and Urban Mobility, seek to actively engage with industry representatives and regulators in the country and across the developing world.

Green Purchasing Network India (GPNI) is an evolving network of professionals interested and active in the general area of sustainable consumption and production - more specifically: in Green Purchasing and Public Procurement[115]. The network organises workshops and provides information and assistance to create awareness amongst Indian industry and other stakeholders about green purchasing and procurement and encourage and facilitate projects in these areas.

1.40. Conclusion on eco-innovation activities in India

The ***Eleventh Five-Year Plan*** to 2012 not only emphasises innovation but also foresees a massive outlay on science, technology and innovation (IST) via a budgetary increase of 220%[116]. There is a general trend in India towards recognising the innovation in both the policy and business sectors. However, it has to be stressed that the overall level of R&D expenditure is still extremely low in India in comparison with the other investigated countries.

Over all, India has got potential for successful eco-innovations but the funding structure and beneficial systems for applicants should be clearer. The term and concept "eco-innovation" is not that common in India yet; instead the term "environmental and bio-technology" is used in science and economy. Therefore the funding programmes reflect topics of natural and environmental sciences related innovations. In this sense, the ministries offer different programmes with relevance for environmental technologies and sensitise companies and institutions especially for eco-innovative products. Indian

[114] http://www.cseindia.org
[115] http://gpnindia.org
[116] Deutsche UNESCO-Kommission e.V., UNESCO Science Report 2010, Bonn 2010.

activities in international networks foster the understanding and enhancements for successful innovations.

India's main focus is on introducing new eco-entrepreneurships in the total field of environmental techniques ranging from waste and energy strategies to irrigation and climate protection systems. That entrepreneurial interest in the environment and clean energy has been catalysed by increasing energy costs, widening energy-deficit and growing awareness about the effects of climate change. These aspects should be stronger included into the current existing knowledge base to strengthen further private and industrial R&D.

Three types of demand drivers have been indicated and are most important. The first is subsidy and mandate-based market growth largely driven by government programmes to position India as a leader in the Go-Green-Movement. The second is fundamental economic value being provided to the customer through eco-innovative products and third is the redeployment of the official and informal sector.

The Indian interest and potential in eco-innovations is huge. To establish a bilateral successful research programme with India it is essential to involve the Indian ministries and partners in strategy, planning and coordination from the beginning.

4. Conclusions

The investigated countries apply a broad range of programmes and activities that on the one hand fund and foster R&D in eco-innovation related areas and on the other promote the commercialisation and dissemination of eco-innovations. The explicit concept of "eco-innovation" is applied differently in the countries: Japan, for example, has adopted the concept and term in its strategy documents and defines it as a broad concept that includes techno-social innovations in industry, infrastructures and the areas of consumers and lifestyles. In other countries, the programmes, activities and strategy documents rather refer to "environmental technologies" or "cleantech" (US).

In particular Japan and USA are major players in the field of eco-innovation. Due to Korea's high investments in this area, it is catching up fast. With regard to innovation potential in the area of cleantech start-ups, USA and South Korea rank rather high compared with other countries. China and India have a strong potential for growth in this area, as policy to promote eco-innovation and green growth becomes more and more important. While Japan is a major player, the innovation potential for clean-tech start-ups ranks not very high compared to other countries, as it seems to lack capacity to commercialise new technology through innovative entrepreneurial start-ups. This could be connected to a rather rigid, formal and risk-averse cultural environment.[117]

Independent of the wording, strategies on growth, innovation, and R&D – as well as stimulus packages in reaction to the economic crisis – stress the importance of R&D for innovation in the environmental area to address both ecologic and economic challenges, particularly in the US, Korea and Japan, but also in China. These strategies therefore foresee an increase of the share of Gross Expenditure on Research & Development (GERD) for environmental issues to foster green innovation. Korea is a particularly striking example with 80% of its Stimulus package reserved for green growth. China has recently adopted ambitious environmental objectives in its 12th Five-Year-Plan that expresses the goal of moving from a resource intensive and low value-added economic model towards knowledge based and high value-added green growth.

R&D funding programmes with relevance for eco-innovation:

The percentage of Government budget for R&D in environmental issues is particularly high in Korea (around 4 %), while in US and Japan it is around 1% (for India and China, no data was available. [118]

In general, most R&D funding programmes of relevance for eco-innovation in the investigated countries do not explicitly focus on eco-innovation per se. Instead, some R&D programmes listed in this report fund environmental research and environmental technology development without a specific focus on transfer of results and

[117] Cleantech Group LLC / WWF, Coming Clean: The Global Cleantech Innovation Index 2012.
[118] Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU), Umweltwirtschaftsbericht 2011, 2011, 26.

implementation, while other programmes and activities put their focus on promoting implementation and commercialisation of results without a specific environmental focus. However, there are also programmes that combine both.

In the **US,** there are multiple actors involved in fostering eco-innovation, like government agencies, industries, academia, non-profit organisations, and states. A strong focus of public programmes for eco-innovation is on dissemination and commercialisation. The strategy of the US Environmental Protection Agency (EPA) is to anchor innovation in the environmental programmes and to use the limited resources of the EPA as leverage by supporting collaboration with other actors. A number of EPA programmes focus not only on the funding of research and development, but also on demonstration, verification, diffusion and utilisation / commercialisation activities. EPA has been designed as a one-stop-shop to coordinate all programmes in the context of eco-innovation. Support is provided in the form of research grants, but also of EPA in-kind services (provision of information, use of facilities).

One of these programmes is the US Small Business and Innovation Research Programme (SBIR) that funds demonstration and commercialisation activities of SMEs. The programme includes a specific EPA-funded programme line for environmental protection. The successful approach of the SBIR programme, which was established in the 1980s, has served as a model for similar programmes in other countries, e.g. the KOSBIR programme of Korea, but also in Japan and a number of European countries. India has launched an SBIR Initiative for the biotechnology sector. The SBIR programme has been identified as a "Good Practice Example". More details on the programme are provided in the annex of this report.

The US "Advanced Research Projects Agency – Energy (ARPA-E)" programme can be named as a good practice example for a programme that promotes high-risk transformative innovations. ARPA-E funds projects at the intersection of fundamental and applied clean energy research and aims to overcome long-term and high-risk technological barriers. The programme's design foresees to sustain for long periods of time those projects whose promise remains real, while phasing out programs that do not prove to be as promising as anticipated. Again, more details on the programme are provided in the annex of this report.

Public support to R&D is a major instrument to promote eco-innovation in **Japan**. This is illustrated by the exceptionally high Gross Expenditure on R&D (GERD) and the fact that environmental issues form a priority area within the R&D strategy. Japanese public R&D programmes put a major focus on fostering cooperation between academia and industry to contribute to economic development and competitiveness. A main Japanese R&D programme with regard to eco-innovation is the "Environment Research and Technology Development Fund (ERDF) that contains a strong orientation towards research that contributes to formulation of policies.

In **Korea**, recent strategic documents on green growth and on R&D strategy have given priority to the area of environmental research and eco-innovation. However, the linkages between business, university and government research institutes are still weak in Korea and should be improved to support innovation. A specific approach to generate eco-innovations by R&D projects that bring together a critical mass of academia and

industry and cover technology development as well as commercialisation was the programme "Eco-Technopia 21 Project". While it did not reach all its goals, it was successful in increasing the level of technologies in all environmental sectors and in providing business opportunities.

The need to strengthen basic research to promote innovation is an issue for both Korea and Japan.

China has seen a big increase in R&D expenditure in recent years. The highly centralised Chinese research system funds R&D projects through a number of different programmes, many of them directed towards international cooperation. The programmes are characterised by Chinese long-term plans and usually address several science and technology areas. When it comes to the development of eco-innovation, particularly the "863 R&D programme", which targets cutting edge technologies, and the "National Key Technologies R&D Programme", which has a specific focus on industry needs, should be mentioned. Both programmes cover different areas, among them environmental protection, rational utilisation of resources and sustainable agriculture. In terms of business participation in public funded R&D, large companies are rather addressed than SMEs. But the ASTSC programme, introduced in 2009, aims at strengthening SME research. It encourages researchers to join the research and design work of SMEs. With regard to innovation, China's strategy is to evolve into a more innovation-driven society in the coming years. Though innovation linkages are still weak, China has made considerable progress in this area. It can be said that the academic sector in China has strongly picked up the need for eco-innovations but transfer to application must be strengthened.

India has seen a massive budgetary increase in general R&D funding and a general trend toward fostering innovation. However, it has to be stressed that the overall level of R&D expenditure is still extremely low in India in comparison with the other investigated countries. The term and concept "eco-innovation" is not that common in India yet; instead the term "environmental and bio-technology" is used in science and economy. Therefore the funding programmes mainly reflect topics of natural and environmental sciences related innovations. In the area of biotechnology, there is the specific programme "SBIRI" to support pre-proof-of-concept research as well as late stage development for SMEs. A particular programme that is described in the annex as a "Good Practice Example" is the Research, Development and Demonstration Programme of the Ministry of New and Renewable Energy. This programme provides good and successful examples for the specific context of Indian rural areas - new technologies that are easy to handle and accepted by rural people. While India has still weak general innovation inputs and no strong entrepreneurial culture, it provides an attractive infrastructure for renewables and there is a large amount of investment raised in cleantech funds with focus on India.

Concerning **priority research fields**, it is noteworthy that the US and Japan are very strong supporters for public funding of R&D in energy. Both hold very high patent applications in climate change mitigation technologies. The role of ICT for efficiency improvements in resource use is another priority in Japan. In India, high thematic priorities with relevance for eco-innovation are in the areas of biotechnology, water,

food, agriculture, and renewable energy – environmental research is also a priority. Korea's priority fields as defined in the strategy documents are energy sources and efficiency, climate change, and water and waste management. In China the fields of photovoltaic and hydropower, buildings and energy efficiency, agriculture, and water resources should be mentioned. China and India are also heavily involved in waste management.

Other activities to foster eco-innovation

The investigated countries apply a number of different **market-based policy instruments** for the promotion of eco-innovation like tax incentives, emission trading schemes, green public procurement or environmental verification (ETV) and eco-labelling. It can be emphasised that these main instruments of environmental policy and particularly policy to stimulate eco-innovations are almost universally used.

Table: Application of different policy instruments to foster eco-innovation

	Environmental taxes	Regulation/ Targets	Green Public Procurement	ETV-Programme	Emission Trading Scheme	Venture investment support
USA	Yes	Yes	Yes	Yes	Yes	Yes
Japan	Yes	Yes	Yes	Yes	Yes	-
Korea	Yes	Yes	Yes	Yes	Yes	Yes
China	Yes	Yes (Implementation problem)	Yes (Implementation problem)	Envisaged	Envisaged	Yes
India	Yes	Yes (Implementation problem)	Yes (start Nov. 2011)	Envisaged	Regional Pilot	-
EU	Yes	Yes	Yes (not all EU countries)	In development	Yes	Yes

All investigated countries apply *Emission Trading Schemes (ETS)*. In the US, these are established on state level – a number of states share a mandatory ETS. In Korea and Japan voluntary ETS exist – plans to implement an ambitious mandatory ETS in Japan have been postponed due to the economic crisis. India and China both have announced to introduce pilot ETS on regional level.

Environmental technology verification programmes are in place in the US (since the mid 1990s), Japan (J-ETV, since 2003) and Korea. India and China both expressed interest in developing ETV programmes in the near future. In the US, which was among the ETV pioneers, a number of programmes which support the development and diffusion of environmental technologies also include verification activities. The introduction of different voluntary or mandatory *eco-labels* to inform users and promote specific environmental-friendly products is common in all investigated countries.

While most countries established laws on *Green Public Procurement* (Japan, Korea, some US states, China), there are also non-mandatory initiatives (e.g. the activities of the Green Purchasing Network in India). The Indian government just introduced a green public procurement initiative in Nov. 2011.

In many of the investigated countries eco-innovations are promoted through *tax incentives* for investments in energy efficiency technology (e.g. US, Korea), fuel efficient, hybrid or electrical vehicles (Japan, US) or renewable energy (e.g. US but also China). One of the elements of Korea's Green Growth Strategy is to "green" the tax system. The contribution of environmental taxes to revenues is also particularly high in Korea.

Among the applied instruments to **mobilise financing** for eco-innovation are *tax incentives* for R&D in general (US, China, Japan, India) and the provision of funds for specific loans. These instruments are often targeted to increase private R&D investment in general and are not specifically focused on eco-innovation. In the US there is a specific focus on supporting R&D in SMEs with *loans*. There are also activities that aim at the further promotion of US *venture capital* investment in eco-innovations. Korea is an example where a specific environmental venture fund exists, established by the Ministry of Environment to support venture companies.

Further activities include funds for promoting industry-academia *networks and clusters* (e.g. Japan) and funds for supporting the establishment of *eco-towns* (Japan, China). In India, the *Innovation foundation* provides institutional support for green innovations on grassroots level.

In the US, a large number of **environmental regulations and performance targets** on federal and state level support eco-innovations. The same can be said for Japan and Korea. Initiatives to foster voluntary over-performance are in place in the US and in Japan. In the US, the Californian Zero Emission Vehicle Program (ZEV) presents a promising and ambitious new approach to reduce vehicle emissions by combining the control of vehicle emissions in a single coordinated package of standards with other measures to increase the number of hybrid and zero-emission vehicles. In Japan the Top Runner programme is a specific highlight that defines dynamic targets by setting the most energy-efficient products as a benchmark. The Top Runner Programme is described as a "Good Practice Example" in more detail in the Annex. The OECD Environmental Performance Review of China (2007) states that although China has a set of modern and comprehensive environmental laws their implementation lacks effectiveness and efficiency. India faces similar problems.

International initiatives in the investigated countries range from industry round-tables with a focus on eco-innovation, collaboration on intellectual property rights (Japan), R&D cooperation, strategic cooperation, Clean Development Mechanism projects under the Kyoto frame to specific initiatives to actively promote a country's eco-innovations abroad. It can be observed that the Asian-Pacific space as a frame for cooperation is very important to all the investigated countries. The US is involved in a number of international initiatives that aim at promoting eco-innovation in different areas (e.g. cleaner energy technologies, energy efficiency, carbon sequestration) and exporting US products. China received strong support from the international community, particularly the US, in the area of renewable energy.

The investigated countries feature a number of **initiatives to raise demand for environmentally friendly products** such as *awards* (e.g. for outstanding companies in the area of eco-efficiency in Japan), *eco-labels*, and *education or awareness raising campaigns*.

Recommendations

- In terms of research collaboration, US, Japan and Korea are particular interesting partners in the area of climate change mitigation technologies, energy and resource efficiency.
- In addition, Japan is a particularly interesting partner for research in alternative fuel vehicle technologies.
- India is an interesting research partner particularly in the area of biotechnology, water, renewable energy and agriculture
- China is an interesting research partner particularly in buildings and energy efficiency, agriculture, and water resources
- Programmes that address different stages of the R&D process and include promotion of verification, utilisation, commercialisation and dissemination can be found in the portfolio of the US Environmental Protection Agency and could serve as examples for designing such cross-cutting programmes.
- The US venture capital market for eco-innovation can serve as a model for an active venture capital community.
- The US SBIR programme is a successful good practice example for fostering R&D and innovation in small companies. When adapting the programme, the experiences made by numerous other countries, where it already was adapted, should be taken into account.
- The US APRA-E programme stands out as a unique good practice example for a programme that promotes high-risk transformative innovations. It should be considered when designing a programme along these lines.
- The Japanese Top-Runner programme has proven to be a successful strategy to promote eco-innovation and serves as a good practice example. Initiatives to implement similar programmes in Europe should profit from these experiences.
- The Californian Zero Emission Vehicle Program (ZEV) presents a promising and ambitious new approach to reduce vehicle emissions. It should be considered when designing a programme along these lines.

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6. ANNEX

Public R&D expenditure for environmental research

Country	Gerd (% GDP in 2008)	Public R&D expenditure for environmental research (% of total public R%D expenditure, 2008)
USA	2.61	1.2%
Japan	3.40	1.0 %
Korea	3.01	4.0%
China	1.54	-
India	0.71 (2006)	-
EU	1.76	3.2% (EU-15)

Source:

Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU), Umweltwirtschaftsbericht 2011, 2011.

Good Practice Examples

Good Practice Example: "Small Business Innovation Research Program (SBIR)" (USA)

1. General information on the programme
Name of the programme:
Small Business Innovation Research Program (SBIR) http://www.epa.gov/ncer/sbir/
Name and type of the managing organisation:
There are 11 federal agencies which participate in this program, including: the Departments of Education (ED), Agriculture (USDA), Commerce (DOC), Defense (DOD), Energy (DOE), Health and Human Services (DHHS), Homeland Security (DHS), and Transportation (DOT); **the Environmental Protection Agency (EPA)**, the National

Aeronautics and Space Administration (NASA), and the National Science Foundation (NSF). The program is administered similarly by each of these departments.
Duration of the programme (start date, end date):
The SBIR Program was established by the Small Business Innovation Development Act of 1982 and is still ongoing.
Geographical extent of the programme (international, national, regional, local)
National (USA)
Type of financing of the programme (public, private, other?)
Public Grants and private contributions.
Overall budget of the programme (€):
For the EPA part of the programme: 2.5 % of the EPA budget reserved for extramural research.
2. Abstract of the programme The Environmental Protection Agency SBIR Program supports small businesses to develop and commercialize new environmental technologies. The programme consists of two phases. Phase I awards are used for "proof of concept" of the proposed technology. Successful Phase I businesses are then eligible to compete for Phase II awards to further develop and commercialize the technology. The purpose of the program is to: stimulate technological innovation; increase small business participation in federal research and development; foster and encourage participation by minority and disadvantaged persons in technological innovation; and increase private sector commercialization of technology derived from federal research and development.
3. Good practice factor The SBIR programme has been positively evaluated in 2008 by the US National Research Council of the National Academies. The program is multi-stakeholder, plural-sector and a good example of public-private cooperation trough many different modalities in the scope of growth creation. The program has proven very successful as an incubator modality to increase private sector commercialization of innovations derived from Federal R/R&D. The program has been adapted and proven successful in a number of other countries (e.g. Japan, Korea and India)
4. Political context The purpose of the Small Business Innovation Development Act that established the programme was to strengthen the role of small businesses in federally funded R&D and help develop a stronger national base for technical innovation, with the ultimate goal of

growth stimulus.

5. Type of programme

The programme focuses on support of research and of application/implementation (including commercialisation and diffusion) of eco-innovation in Small Businesses (supply-oriented).

6. Focus of the programme

The programme focuses on technological innovation in areas related to environmental protection including clean air and water, hazardous and solid waste, pollution prevention, remediation, and monitoring. Recent issues addressed include: bio-terrorism, arsenic in drinking water, diesel emissions, and storm water run-off.

7. Target group of the programme

The programme focuses on Small businesses. In SBIR "small business" is defined as a for-profit organisation with no more than 500 employees to develop and commercialise new environmental technologies. In addition, the small business must be independently owned and operated, at least 51 percent owned by U.S. citizens or lawfully admitted resident aliens, not dominant in the field of operation in which it is proposing, and have its principal place of business in the United States.

Joint ventures and limited partnerships are eligible for SBIR awards, provided the entity created qualifies as a small business.

8. Funding instruments

EPA awards competitive grants to SMEs: Phase I contracts of up to US$80,000 for 6 months. In Phase II, EPA awards contracts of up to US$300,000 for two years. EPA also offers a "Commercialization Option" of up to US$70,000 and one additional year for firms with third party financing for accelerating commercialization. SBIR grants average app. US$295,000.

9. Implementation of the programme

EPA issues annual solicitations for Phase I and Phase II research proposals from science and technology-based firms. The SBIR program is structured in three phases, the first two of which are supported by SBIR funds.

Phase I.

The objective of Phase I is to determine the scientific or technical merit and feasibility of the proposed R/R&D efforts. The Phase I period concentrates on the R/R&D efforts that prove the scientific or technical feasibility of the approach or concept and which are a prerequisite for further support in Phase II. Phase I awards are for periods up to 6 months in amounts as indicated in the Notice Inviting Applications.

Phase II.

The objective of Phase II is to continue the research or R&D effort initiated in Phase I with approaches that appear sufficiently promising as a result of Phase I. Phase II awards are for periods up to 2 years in amounts as indicated in the Notice Inviting Applications.

Phase III.

An objective of the SBIR program is to increase private sector commercialization of innovations derived from Federal R/R&D. During Phase III, the small business concern is to pursue commercialization with non-SBIR funds.

Through the phased approach to SBIR funding, EPA can determine whether the research idea, often on high-risk advanced concepts, is technically feasible, whether the firm can do high-quality research, and whether sufficient progress has been made to justify a larger Phase II effort.

10. Evaluation of the programme

The SBIR programme has been positively evaluated in 2008 by the US National Research Council of the National Academies. The study concluded: "By strengthening the SBIR program, the Committee believes that the capacity of the United States to develop innovative solutions to government needs and promising products for the commercial market will be enhanced."

(*An Assessment of the Small Business Innovation Research Program*, National Research Council, National Academies Press; Charles W. Wessner, *Editor*, Committee on Capitalizing on Science, Technology, and Innovation; 2008)

11. Brief Project example

Please refer to http://www.epa.gov/ncer/sbir/success/ for a multitude of examples from different sectors.

Good Practice Example: "Advanced Research Projects Agency—Energy (ARPA-E)" (USA)

1. General information on the programme
Name of the programme:
Advanced Research Projects Agency—Energy (ARPA-E) http://arpa-e.energy.gov/Home.aspx
Name and type of the managing organisation:
Department of Energy (DOE)
Duration of the programme (start date, end date):
The America Competes Act of 2007 authorized the establishment of ARPA-E within the U.S. Department of Energy. However, ARPA-E did not come into existence until early 2009 when it received $400 million through the American Recovery and Reinvestment Act.

Geographical extent of the programme (international, national, regional, local)
National (USA)
Type of financing of the programme (public, private, other?)
Public
Overall budget of the programme (€):
ARPA-E was appropriated $180 million for Fiscal Year (FY) 2011 (October 1, 2010 through September 30, 2011).

2. Abstract of the programme

The Advanced Research Projects Agency – Energy (ARPA-E) funds the development and deployment of transformational and disruptive energy technologies and systems. It focuses on high-risk concepts with potentially high rewards (reduction of foreign energy imports; cutting of energy-related greenhouse gas emissions; and improvement of efficiency across the energy spectrum). It translates science into breakthrough technologies that promise genuine transformation in the ways energy is generated, stored, and utilized. The mission of ARPA-E is to overcome the long-term and high-risk technological barriers in the development of energy technologies.

It focuses on creative "out-of-the-box" transformational energy research that industry by itself cannot or will not support due to its high risk but where success would provide dramatic benefits for the nation.

3. Good practice factor

The program approach is unique and has proved to be very efficient, based in an organisation that operates at the intersection of fundamental and applied clean energy research aimed at solving key clean technology challenges.

It is based on a high-risk investments approach, and has a unique recruitment and temporary program management structure collaborating with academia and industry.

Its high-risk/high-reward bets has created new industries and yielded economy-wide returns on initial investment.

4. Political context

In December 2010, Congress reauthorized the America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science (America COMPETES) Act, which established the Advanced Research Projects Agency-Energy (ARPA-E) within the Department of Energy (DOE). ARPA-E pursues the following goals: First, ARPA-E aims to enhance the economic security of the United States through the development of energy technologies. Second, ARPA-E aims to ensure that the United States maintains a technological lead in developing and deploying advanced energy technologies.

5. Type of programme

ARPA-E focuses on technological research. It does not commercialize technologies, but through the Technology-to-Market Program, support to increase the probability and

speed of commercialization by the private sector is provided. The programme stimulate eco-innovation supply

6. Focus of the programme

The programme focus on technological innovation mainly in the energy sector e.g.:

Agile Delivery of Electrical Power Technology (ADEPT), Batteries for Electrical Energy Storage in Transportation (BEEST), Building Energy Efficiency Through Innovative Thermodevices (BEETIT), Electrofuels, Grid-Scale Rampable Intermittent Dispatchable Storage (GRIDS), Innovative Materials and Processes for Carbon Capture Technologies (IMPACCT)

7. Target group of the programme

For-profit entities, educational institutions, and nonprofits that are incorporated or otherwise headquartered in the United States are eligible to apply for funding as a standalone Applicant, as the lead organization for a Project Team, or as a member of a Project Team. Federally Funded Research and Development Centers (FFRDCs) are eligible to apply for funding as the lead organization for a Project Team or as a member of a Project Team, but not as a Standalone Applicant. Non-DOE/NNSA Government-Owned Government-Operated laboratories (GOGOs) are eligible to apply for funding as a member of a Project Team, but not as a Standalone Applicant or as the lead organization for a Project Team. State and local government entities are eligible to apply for funding as a member of a Project Team, but not as a Standalone Applicant or as the lead organization for a Project Team.

8. Funding instruments

In its first two years of existence, ARPA-E has awarded amounts ranging from roughly US$400,000 to US$9 million each to 121 projects, with an average award value of US$3 million. The agency supports projects for up to three years. The percentage of cost sharing requirements depends on the nature of applicants (e.g. non-profit or profit) and ranges between minimum 5% and 50% of the budget that the applicants have to provide themselves.

9. Implementation of the programme

ARPA-E publishes calls for proposals. The programme employs a merit review process to select projects based on their potential impact on ARPA-E's mission and their innovative technical approaches and project teams. ARPA-E coordinates closely with other Department of Energy programs, the rest of the federal government, academia, and the private sector to identity "white space" where others are not making investments in innovation but that would be appropriate for ARPA-E's support.

One idea of the programme is to sustain for long periods of time those projects whose promise remains real, while phasing out programs that do not prove to be as promising as anticipated.

10. Brief Project example

Architectural Applications: Innovative Building-Integrated Ventilation Enthalpy Recovery

Architectural Applications and team members will develop a membrane-based enthalpy exchanger that captures the cooling and dehumidifying benefit from building-exhausted air and recycles it to partially condition incoming fresh air. Contrary to conventional

enthalphy recovery systems, this system is located within the depths of the building enclosure and can have a large surface area, with very slow air flow over it, resulting in high efficiency enthalpy recovery with little added fan power. Its integration into the wall will reduce demand on and size of the building air conditioning equipment. It will also work well for existing building renovations. The system promises a coefficient of performance increase of 25 to 40 percent compared to conventional air conditioning systems.

Please refer to http://arpa-e.energy.gov/ for more information.

Good Practice Example: "Top Runner Program" (Japan)

1. General information on the programme
Name of the programme:
Top Runner Program
Name and type of the managing organisation:
Agency for Natural Resources and Energy (Division: Energy efficiency and conservation). The standards are deliberated by "Advisory Committee for Natural Resources and Energy" of the "Ministry of Economy, Trade and Industry". The Committee includes industry representatives, academic experts, government representatives, consumer representatives.
Duration of the programme (start date, end date):
Top Runner Program started in 1999
Geographical extent of the programme (international, national, regional, local)
National (Japan)
Type of financing of the programme (public, private, other?)
Public
Overall budget of the programme (€):
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2. Abstract of the programme The Top Runner Program sets energy efficiency targets for currently 23 product groups (ranging from vehicles to household electric appliances) at industry-level, based on the

value of the most energy-efficient products on the market at the respective time as benchmark. This new standard must be met by manufacturers in four to eight years. Products that reach this standard receive the "Top Runner Label"[119], the ones that fail can be "named and shamed" publicly. In the future, the coverage in terms of the number of product items will be further expanded, and the Top Runner standards will be reviewed.

3. Good practice factor

Literature states that the Top Runner Programme has been very effective in the promotion of energy efficiency and manufacturers highly support the programme (e.g. Capozza, I. (2011), "Greening Growth in Japan", OECD Environment Working Papers, No. 28, OECD Publishing, p. 34.) The energy efficiency improvement gains exceeded initial expectations. However, it induces rather incremental than radical innovations.

4. Political context

The Top Runner Program supports the political goal of reducing energy consumption in the civil sector and transportation sector.

The policy basis is the Energy Conservation Law of 1979 (revision in 1999) with the aim of promoting energy efficiency (background oil crisis in 1970s) and the aims to reduce greenhouse gas emissions (Kyoto protocol and Japanese national goals in this area).

The Top Runner Program interacts with the Japanese energy label programme, established in 2000. The Top Runner standards are also utilised in the Green Purchasing Law and the green automobile tax scheme.

5. Type of programme

The programme focuses on stimulating the supply side of eco-innovation and supports the diffusion of eco-innovation. The obligation of compliance rests with manufacturers and importers, not retailers of product users.

6. Focus of the programme

The programme focuses on technological innovation in energy efficiency of machinery, household devices and vehicles.

7. Target group of the programme

The programme focuses on industries and manufacturers – national companies but also importers.

8. Funding instruments

The instrument of the Top Runner Progamme is to set standards, to label products and to providing an overview of the products on the market.

9. Implementation of the programme

Product groups in the range of the programme are chosen along the following criteria: used in large quantity in Japan; consummation of considerable amounts of energy while in use; requirement of particular efforts to improve their energy consumption efficiency.

[119] www.eecj.or.jp/top_runner/index.html

For the development of standards, Committees with industry, academic, consumer and government representatives come together in different working groups. They measure the energy consumption efficiency of all products currently on the market and determine the most up-to-date maximum efficiency value.

Target years are determined with giving consideration to the degree of how the society demands the equipment energy conservation and efficiency, and manufacturers' product development planning and capacity (mostly three to ten years ahead). Target standard values (Top Runner Standard values) are determined by evaluating potential technical development toward target years, as well as adding the technical development to above maximum efficiency values. The time it takes to enact legislation following the proposal of target differs according to the machinery and equipment, but the process generally takes from a year to two and a half years.

To confirm the achievement of standards, manufacturers are questioned soon after the target fiscal year. The surveys are conducted by the Agency for Natural Resources and Energy that is responsible for enforcing the Energy Conservation Law.

If the results obtained from the energy efficiency surveys mentioned in the previous paragraph appear to be remarkably low compared to judgment standards and a need to make suitable improvements in energy efficiency is recognized at the time, the Minister of Economy, Trade offers recommendations to the manufacturer in question as required. Further, if this advice is not followed, the recommendations are made public and the manufacturer may be ordered to follow the recommendations.

Manufacturers subject to these recommendations and advice should be limited to those whose improvements in manufacturing and imports of equipment are considered to have a substantial impact on energy consumption in Japan. Sanctions can include a cutback in shipping volume according to production and import. Reasons for non-achievement might also be analysed.

The Energy Conservation Law has established a display program for Top Runner target machinery and equipment, so that buyers can obtain information concerning such as the energy consumption efficiency of machinery and equipment at the time of purchase.

Reasons for success are:

- Involvement of primary stakeholders in setting targets which causes high awareness and commitment levels and realistic targets.
- Industrial stakeholders in Japan are used to and at ease with close collaboration with national regulators.
- The instrument is iterative and designed to be flexible, dynamic and adaptive, allowing failures and shortcomings to be addressed and remedied.

- A collection of supportive policy instruments have developed around the Top Runner programme.
- Energy-efficiency in products is usually perceived as a competitive advantage, meaning that no manufacturer has a stake in the opposition of the scheme's objectives.
- The Top Runner approach turns the free-rider effect into an advantage: actors who perform well already at the start of a cycle become free-riders in the sense that they need invest less additional effort during the compliance period that follows.
- Name-and-shame sanctions are effective deterrents in Japan.

10. Evaluation of the programme

There have been some studies with the aim of evaluating the Top Runner Program, which have also served in informing this description:

- Joakim Nordqvist, "Evaluation of Japan's Top Runner Programme within the framework of the AID-EE Project (2006)
- Swedish Environmental Protection Agency, The Top Runner Program in Japan (2005)

The studies show that performance targets are met (however, sometimes too easily, so they might be stricter). Manufacturers are satisfied with the widely accepted programme and state that it encouraged them to strive for more efficient products.

The most common critique directed at Top Runner in Japan is that the approach only encourages incremental technical improvements, while more radical innovations receive no incentives under the scheme.

Good Practice Example: "Research, Development and Demonstration" (India)

1. General information on the programme
Name of the programme:
Research, Development and Demonstration
Name and type of the managing organisation:
Ministry of New and Renewable Energy (MNRE)
Duration of the programme (start date, end date):
Since 2008
Geographical extent of the programme (international, national, regional, local):

international
Type of financing of the programme (public, private, other?):
public
Overall budget of the programme (€):
Over 500 R&D projects, no information on overall budget

2. Abstract of the programme

The thrust areas mainly covers programmes, such as, Rural Energy; Solar Energy; Energy from Urban & Industrial Wastes; Power Generation- Wind, Biomass, Small Hydro; New Technologies- Chemical Sources (fuel cells), Hydrogen, Ocean & Geothermal Energy.

3. Good practice factor

Keeping in view the energy shortage in the country there is a need to tap biomass resources such as cattle dung, kitchen waste, agricultural waste etc for generation of biogas through the involvement of entrepreneurs and industries to set up decentralised biogas based energy infrastructure in the country, at the potential sites where biomass available is plenty. This programme provides good and successful examples in rural areas: new technologies are easy to handle and accepted by rural people (Reference: http://www.mnre.gov.in/schemes/r-d/rd-projects/).

4. Political context

The need to refocus attention on Research, Design & Development (RD&D) has arisen. The underlying purpose of RD&D effort is to make industry competitive. A comprehensive statistic that measures competitiveness is net foreign exchange earning. Accordingly, RD&D effort is to make the country a net foreign exchange earner in the New and Renewable Energy Sector. In addition, the share of indigenously designed, developed and manufactured new and renewable energy systems/ devices has also to increase and consequently monitored for its eventual growth to a dominant position.

5. Type of programme

R&D for technology development should be industry -driven and goal oriented. This programme aims at promoting indigenous R&D for new and emerging technologies and improvement of available technologies.

Some characteristics of the programme are:

- Involvement of industry and scientific establishment.
- Access technological development elsewhere avoiding 'Reinventing the wheel'.
- Time bound specific tasks for identified R&D activities to be assigned to

recognized / identified industry and institutions with clear understanding on the achievement of results.

6. Focus of the programme

RD&D activities shall invariably lead to the manufacture of:

- Solar Thermal (High Temperature) power generation systems.
- Solar Thermal for Urban and Industrial Applications.
- Energy efficient buildings utilizing renewable energy concepts.
- MW scale SPV power generating systems.
- MW scale wind turbine electric generators for low wind regimes.
- Biomass integrated gasification combined cycle systems.
- Simulators for RE grid-interactive power stations.
- Alternate fuels - bio, synthetic and hydrogen systems.
- Hybrid systems.
- Geothermal and Tidal Energy systems.
- Energy intensive storage devices, including those for grid power.

Target group of the programme

RDD&D shall be taken up through the following Partners:

- Solely or jointly by Research and Development Institutions; Academic Institutions, Autonomous Institutions.
- Solely or jointly by Developers and Manufacturers of new and renewable energy technologies, processes, materials, components, sub-systems, products and services; in public and private sector;
- A consortia of Indian and foreign companies, led by an Indian company with more than fifty one percent ownership by Indian citizens including non resident Indians (NRIs).
- Jointly by a consortia of industry and R&D organizations and institutions
- Union Ministries / Departments / Agencies / Public Sector Undertakings (PSUs); States / Union Territories (UTs) Government departments/ agencies and institutions funded by Union/ State/ UT Governments, which have adequate infrastructure for taking up R&D.
- Start-ups having adequate infrastructure

7. Funding instruments

- A specific fluctuation of funding over the duration of the programme is not mentioned.
- Financial assistance for RD&D projects including the technology validation and demonstration projects that involve partnership with industry / civil society organizations should normally be restricted to 50% of the project costs.
- The Ministry may provide up to 100% financial assistant as core support to R&D institutions for setting up specialized Centres of Excellence in the area of renewable energy on the basis of recommendations of Research, Design and Development Sectoral Project Appraisal Committee (RDSPAC) / Research, Design and Development Project Appraisal Committee (RDPAC) as the case may be.

8. Implementation of the programme

To ensure effective and quality implementation of the monitoring process, remuneration will be provided to each expert for each report, subject to a maximum of two in a year, along with Traveling Allowance / Daily Allowance (TA/DA) as per entitlement. The Government/Semi-Government/Autonomous bodies may also be engaged in monitoring work by establishing a special cell in their organizations for this purpose. For all projects under implementation, the monitoring mechanism, if not already in place, would also be introduced as per policy guidelines.

9. Evaluation of the programme

There is no evaluation of the effectiveness of the programme available.

10. Additional information on the programme

R&D projects may be taken up by Universities, research institutions, R&D laboratories and industry, individually or as a consortium. As far as possible, R&D projects should be taken with industry as end-users to ensure that they are involved right from the conception stage of the project. Such projects should clearly quantify outputs, that should be challenging and bench-marked to pre-identified aims.

A profit making industry registered with Department of Scientific & Industrial Research for in-house R&D may submit an R&D project in the prescribed form, to the Ministry for support. The industry is expected to share 50% of the cost of the project and Ministry supports to the extent of remaining 50%.

A consortium of industry, academic institutions, research laboratory and R&D institution etc., may be formed to undertake a R&D project. Clear role and tasks of each member of the consortium will have to be clearly defined. Consortium members will also be required to share at least 50% of the cost of the project. MNRE funds will be released to the implementing institution in the consortium selected by consortium members. Implementing institution will be responsible for the entire expenditure and for other terms and conditions of the project.

An industry may join hands with the Ministry to entrust an R&D project to an R&D institution/research laboratory or an academic institution. Funds in this case will be released to the concerned implementing institution which will also be responsible for the entire expenditure and other terms and conditions MNRE support up to 50% of the cost of the project will be available.

Financial assistance for RD&D projects that involve partnership with industry should normally be restricted to 50% of the project cost. However, any proposal from Universities, Government research institutions etc. Ministry may provide upto100% funding, depending on project priority.

In all the above three models, industry/institution contributing 50/50% of the cost will have the right on commercialization of the technical know-how.

Guidelines for IPR sharing are given in the R&D Policy order.

11. Brief Project example

Under the provisions for technology demonstration of new RDD&D Policy of MNRE, the Ministry took up a new initiative for bottling of biogas to demonstrate an Integrated Technology-package in entrepreneurial mode on medium size (200-1000 cum/day) mixed feed biogas-fertilizer plants (BGFP) for generation, purification/enrichment, bottling and piped distribution of biogas. Installation of such plants aims at meeting stationary and motive power, cooling, refrigeration and electricity needs in addition to cooking and heating requirements. There could be a huge potential of installation of medium size biogas-fertilizer plants in various villages of the country. Under the demonstration phase, the Ministry is providing a central financial assistance of 50 percent of the cost (excluding cost of land) for a limited number of such projects for implementation following an entrepreneurial mode on Built-own-operate (BOO) and reimbursement basis.

List of public R&D programmes in the respective countries

Country	Programme / Initiative & website	Aim / Target	Funding Organisation	Budget / Duration	Major Topics
US	**Science to Achieve Results (STAR) competitive grants programme** http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/recipients.welcome/displayOption/grants	Fund health and environmental research to support Policy	US EPA	Programmes with $1 million to $10 million per year. Grants average about $350,000 per year for three years	Grants (and graduate fellowships) to universities and nonprofits; numerous environmental science and engineering disciplines STAR is focusing on the health effects of particulate matter, drinking water, water quality, global change, ecosystem assessment and restoration, human health risk assessment, endocrine disrupting chemicals, pollution prevention and new technologies, children's health, and socio-economic research.
US	**Small Business Innovation Research Programme (SBIR)** http://www.epa.gov/ncer/sbir/	R&D and Innovation Promotion for SMEs	US. EPA: Office of Research and Development (ORD)	Programmes with $1 million to $10 million per year	Environmental protection including clean air and water, hazardous and solid waste, pollution prevention, remediation, and monitoring. Recent issues addressed include: bio-terrorism, arsenic in drinking water, diesel emissions, and storm water runoff.
US	**Superfund Innovative Technology Evaluation (SITE)** http://www.epa.gov/nrmrl/lrpcd/site/	SITE supports field tests of innovative hazardous waste treatment technologies at sites where few remedial alternatives exist or existing methods are too costly.	US. EPA: Office of Research and Development (ORD)	Programmes with $1 million to $10 million per year	Pilot- and full-scale demonstration and performance reports.; hazardous waste treatment

Country	Programme / Initiative & website	Aim / Target	Funding Organisation	Budget / Duration	Major Topics
US	**Green Engineering Program** http://www.epa.gov/oppt/greenengineering/l	Goal: Stewardship – pollution prevention technology; facilitates the design, commercialisation, and use of processes/ products that are feasible and economical, while minimising the generation of pollution at the source, and the risk to human health and the environment.	US EPA: Office of Prevention, Pesticides, and Toxic Substances	Programmes with $1 million to $10 million per year	Stages on R&D Continuum: Research or Proof of Concept, Development, Diffusion and Utilisation. pollution prevention technology Type of Support Provided: Information and technology transfer, recognition
US	**Federal Technology Transfer Act Activities (FTTA)** http://www.epa.gov/osp/ftta.htm	Research or Proof of Concept, Development, Demonstration, Verification, Diffusion and Utilisation	Office of Research and Development (ORD)	Programmes with $1 million to $10 million per year	Cooperative Research and Development Agreements allow non-federal parties to collaborate on projects with EPA and share in-kind resources.
US	**Water Nonpoint Source Grants Programs** http://www.epa.gov/etop/cont_wnsgp.html	Water	US EPA office of water	Programmes with more than $10 million per year	EPA awards grants to state and tribal agencies to deal with nonpoint sources of water pollution.
US	**Office of Research and Development (ORD) In-House Technology Research** http://www.epa.gov/aboutepa/ord.html	Bench research to full-scale demonstrations and technology transfer	US EPA ORD	Programmes with greater than $10 million per year	Research in environmental technology, including research through technology transfer in monitoring, treatment, prevention, and cleaner technologies. All media.

Country	Programme / Initiative & website	Aim / Target	Funding Organisation	Budget / Duration	Major Topics
US	**Superfund Research Program** http://www.niehs.nih.gov/research/supported/srp/funding/index.cfm	The SRP has applied a multidisciplinary approach to research focused to provide a solid foundation which environmental managers and risk assessors can draw upon to make sound decisions related to Superfund and other hazardous waste sites.	The National Institute on Environmental Health Sciences	_	Strong training component, supporting graduate students and post-doctoral researchers. Funds a variety of outreach efforts to facilitate the translation of the programme's research findings to the communities and organisations most concerned with hazardous substances, with the ultimate goal of improving public health.
US	**Center for Environmental Industry and Technology (CEIT) New England Interstate Regulatory Cooperation Project:** http://www.epa.gov/etop/cont_ceit.html	Regional evaluation programme that provides an opportunity for federal and state environmental agencies to work cooperatively with the private sector in expediting the development and evaluation of promising innovative environmental technologies	Federal/state partnership	_	In the areas of septic system technologies, waste site assessments/clean up technologies, pollution prevention technologies. (Stages on R&D Continuum: Research or Proof of Concept, Development)
US	**Federal Remediation Technologies Roundtable (FRTR):** http://www.epa.gov/publicinvolvement/collaboration/tolsactivities/FederalRemediationTechnologiesRoundtable.htm	To build collaborations among federal agencies involved in hazardous waste site cleanup to share information and discuss future directions of programmes.	Federal Agencies: DoD; DoE; Department of the Interior; EPA; National Aeronautics and Space Administration	_	hazardous waste site cleanup (Stages on R&D Continuum: Research or Proof of Concept, Development, Demonstration, Verification**)**

Country	Programme / Initiative & website	Aim / Target	Funding Organisation	Budget / Duration	Major Topics
US	**Measurement and Monitoring Technologies for the 21st Century:** http://clu-in.org/programs/21m2/	This initiative identifies and deploys promising measurement and monitoring technologies in response to waste management and site cleanup programme needs by matching emerging to existing technologies. The initiative seeks opportunities to showcase promising approaches through further research support, demonstrations, monitored partnership applications, case studies, training, and technical outreach (Stages on R&D Continuum: Research or Proof of Concept, Development, Diffusion and Utilisation).	EPA's Office of Solid Waste and Emergency	_	Promising measurement and monitoring technologies in response to waste management and site cleanup (Stages on R&D Continuum: Research or Proof of Concept, Development, Diffusion and Utilisation).
Japan	**Environment Research and Development Fund (ERTDF)**http://www.env.go.jp/policy/kenkyu/suishin/english/index.html	Fund environmental research to support Policy	Ministry of Environment	Overall budget in FY 2011: US$107 million	Global system changes, pollution, health/ecological risks, environmental protection/ restoration
Japan	**Global Environment Research fund / Programme** http://www.env.go.jp/en/earth/research/gerj/p2.html	The goal is to provide the foundation for the conservation of the global environment in cooperation with similar international efforts. Further goals: To promote multidisciplinary and international research, participation in and coordination with international research programs such as the International Geosphere-Biosphere Program (IGBP) and the World Climate Research Programme (WCRP).	Ministry of Environment	_	Ozone layer, Global warming, Acid precipitation, Marine pollution, deforestation, Loss of biodiversity, Desertification, Human Dimensions of Global Environmental Problems,

Country	Programme / Initiative & website	Aim / Target	Funding Organisation	Budget / Duration	Major Topics
Japan	**National Institute of Advanced Industrial S&T** www.aist.go.jp	The National Institute of Advanced Industrial Science and Technology (AIST) is a public research. The present AIST is a rather new research organization established in 2001.	Ministry of Economy, Trade and Industry (METI)	5-year plan (2010-2014) / Budget goes into annual work plans; each fiscal year, the budget will be decided upon based on the 5-year plan.	AIST has over 40 autonomous research units in various innovative research fields among them biology, green chemistry, materials, energy, engineering, production technology
Japan	**NIES Research Programmes** www.nies.go.jp	NIES collaborates with institutes worldwide in conducting multidisciplinary environmental studies in natural, social and human sciences. NIES is Japan's primary institute for comprehensive research in environmental science.	National Institute for Environmental Studies (NIES)	Budget is allocated based on annual work plans; 5-year plan (2011– 2015)	5 Priority Research ~~P~~rograms and 5 Advanced Research Programs: Climate Change;~~,~~ Sustainable Material Cycle Eco-city Systems; Sustainable Social Systems and Policy; Advanced Environmental Measurement, etc.
Japan	**Cool Earth 50** www.mofa.go.jp	Reduction of global C02 emissions by 50% until 2050	Ministry of foreign affairs	Established in 2008	Three pillars: 1) long-term strategy for global gashouse emission reduction; 2) addressing global warming from 2013 onwards 3) launching a national campaign for achieving the Kyoto protocol target; Identification of 21 key technologies as R&D priority investment areas, road map for each area
Japan	**Advanced Low Carbon Technology Research and Development Program**http://www.jst.go.jp/alca/en/index.html	Promotion of (fundamental) R&D leading to technological innovation development and reduction of Greenhouse Gas emissions	Japan Science and Technology Agency (JST)	Started in April 2010: Budget 2010: 25 million €, 2011: 42 million €, 2013: 48 million €	Energy, eco-technologies, reduction of resource use, system innovation

Country	Programme / Initiative & website	Aim / Target	Funding Organisation	Budget / Duration	Major Topics
Japan	**Regional Innovation Strategy Support Program** http://www.mext.go.jp/english/science_technology/1313333.htm	Establish a support system through the full mobilization of measures by related government bodies which are seamless in function from the university phase to project launch, to effectively support good region-led ideas for regional innovation by 2020 with coordination among academia-industry-government.	Ministry of Education, Culture, Sports, Science and Technology (MEXT), related gov. bodies	Fiscal Year 2011 budget: 11,059 million yen (ca. 100 million €	No specific thematic sector; support for inviting researchers, implementation of human resources programmes, establishment of knowledge networks, sharing of research facilities
Japan	**Technology Innovation Program for Small Business Innovation Research (SBIR)** http://www.chusho.meti.go.jp/sme_english/index.html	Promoting Innovation in Small Businesses; Public R&D Programme /Innovation Promotion	Small and Medium Enterprise Agency	In 2008, expenditures related to the Japanese SBIR program amounted to ca 250 million €; started in 1999	No specific sector
Japan	**Innovation Promotion Program (finished)** www.nedo.go.jp	Promotion of innovation	New Energy and Industrial Technology Development Organisation (NEDO)	2008: 5.27 billion yen; From 2007 – 2009	Industrial Technology, Technological Development, Practical Application of next generation strategic technology, life science, environment, energy, social infrastructure, etc.

Country	Programme / Initiative & website	Aim / Target	Funding Organisation	Budget / Duration	Major Topics
Korea	**Eco-Technopia 21 Project** http://eng.keiti.re.kr/	The **Eco-Technopia 21 Project** aims to develop seven areas of environmental technology to the level of G7-countries; Public R&D Programme/Innovation Promotion	KEITI (MOE)	Total turnover by June 2009 was 1.6 billion US$; 2001-2010; government part: 783 million US$	Environmental technologies in a number of specific areas, including environmental conservation/restoration and precautionary pollution prevention
Korea	**21st Century Frontier R&D Program** http://english.mest.go.kr/web/1715/site/contents/en/en_0217.jsp	To boost national competitiveness in science and technology in new frontier areas.	Ministry of Education, Science and Technology (MEST)	US$ 3.5 Billion over a period of 10 years were planned; 1999 to 2010, last projects finishing in 2013	New frontier areas among them carbon dioxide reduction & sequestration, hydrogen energy (and bioscience, nanotechnology, space technology), resource recycling R&D
Korea	**Creative Research Initiative (CRI)** http://english.mest.go.kr/web/1715/site/contents/en/en_0217.jsp	Creative basic research, developing new fields of scientific research and making technological breakthroughs – „from imitation to innovation“	Ministry of Education, Science and Technology (MEST)	CRI projects receive US$500,000/ year; Since 1997	
Korea	**National Research Laboratory** http://english.mest.go.kr/web/1715/site/contents/en/en_0217.jsp	The programme aims at exploring and fostering research centers of excellence, which will play a pivotal role in improving technological competitiveness.	Ministry of Education, Science and Technology (MEST)	Since 1999; per project appr. US$250.000 for five years. government supports over 444 NRLs across the nation (278 in academia, 114 in research institutes, 52 in industry.)	Exploring and fostering research centres of excellence for „core technologies“ (basis for many industries/products), 40 set up laboratories were related to environment

Country	Programme / Initiative & website	Aim / Target	Funding Organisation	Budget / Duration	Major Topics
Korea	**Global Research Laboratory Programme (GRL)** http://www.nrf.go.kr/html/en/programs/programs_03_01_02.html	The Global Research Laboratory Programme (GRL) aims at promoting international collaborative research between Korean and foreign laboratories, to establish virtual world class laboratories in core technology fields and increase international collaboration.	Ministry of Education, Science and Technology (MEST), administered by National Research Foundation of Korea (NRF)	€12 million (Call2011), projects receive €300.000/year for a duration of 3-9 years; Since 2006	Energy, Environment, Health, Fundamental as well as applied research is funded.
Korea	**KETEP R&D programmes (General)** http://www.ketep.re.kr/	KETEP is a government agency under the auspices of MKE that is dedicated to the management of the national energy technology R&D programme with the aim of "Low Carbon, Green Growth".	Korea Institute of Energy technology Evaluation and Planning (KETEP)	From 2009 onwards	Energy efficiency and resources; energy and resource recycling; new and renewable energy; power generation and electricity delivery; Nuclear Power; Radioactive Waste Management; Human Resources Development; International cooperation
Korea	**KETEP R&D programmes - Specific example: "Renewable energy R&D"** http://www.ketep.re.kr/	Innovation (technical) development and implementation –	Korea Institute of Energy technology Evaluation and Planning (KETEP)	-	Energy, environment, eco-materials: Recycling of carbon dioxide for generating fuels, Smart Water Monitoring
Korea	**KETEP R&D international cooperation programme (sub programme)** http://www.ketep.re.kr/	KETEP's R&D international cooperation programme funds applied research, development and demonstration research between Korean and international partners.	Korea Institute of Energy technology Evaluation and Planning (KETEP)	€10 million (Call 2011), Since 2003	Energy efficiency and resources, new and renewable energy, power generation and electricity delivery

Country	Programme / Initiative & website	Aim / Target	Funding Organisation	Budget / Duration	Major Topics
Korea	**KIAT R&D international collaborative programmes – Strategic Technology** http://www.kiat.or.kr/site/main/index/index002.jsp	Supports the international joint technological development of domestic corporations, universities and research centers.	**Korea Institute for Advancement of Technology (KIAT)**	~ €7 million (2011 Call); Projects funded for max. 5 years	Technology development in areas of high innovativeness, spill-over effect and urgency, which have been designated as strategically important; international cooperation
Korea	**Upgrading Low Rank Coal** http://www.kier.re.kr/eng/index.jsp	Technological Innovation Development / Reduction of Resource Use.	Korea Institute of Energy Research (KIER) –	€1,5 million, 2008-2012	Development of clean coal technology; experimental development, Testing, Prototyping
Korea	**Korea Small Business Innovation Research Program (KOSBIR)** http://www.kosbi.re.kr/	Specifically targets innovation in SMEs - not sector specific.	government or government-financed institutions, supported by KOSBI (Korea Small Business Institute)	In 2007, the budget amounted to 1 billion US $.	(modelled after the US SBIR) foresees that government or government-financed institutions allocate at least 5% of their R&D budget to support SMEs' technology development and to cover R&D expenses of SMEs capable of separately developing technology.
Korea	**KORANET- Korean scientific cooperation network with the European Research Area** www.koranet.eu	Facilitation of research cooperation between Korea and the European Union and at strengthening the communication between the two scientific communities.	Korean Partner: National Research Foundation (NRF)	January 2009-December 2012 (ERA-Net); Call budget: 2 Mio €	Joint Call on Green Technologies in 2012 (• Reduction of carbon footprint • Technologies for a sustainable development • Renewable energies and energy efficiency)

Country	Programme / Initiative & website	Aim / Target	Funding Organisation	Budget / Duration	Major Topics
Korea	**Regional Environmental Technology Development Centres**	Aim is to bring together universities, administrative agencies, research institutes, industries and non-governmental organisations to solve unique local environmental problems collectively.	_	_	Activities of the centres include development of environmental technology, environmental education and technical support to enterprises coping with environmental management problems, dissemination of new environmental technologies, and promotion and education regarding new environmental technologies to local people
China	**973 Programme** http://www.973.gov.cn/English/Index.aspx	The aim is to develop China's research capacity in key disciplines and interdisciplinary fields, and find comprehensive solutions to major issues in China's development.	Chinese Ministry of Science and Technology (MoST)	In 2007, approximately 0.16 billion Euros. 1997-	agriculture, energy, information technology, resources and environment, population and health, and materials
China	**863 Programme** http://program.most.gov.cn/	It aims to strengthen the independent innovation capacity of China in high-tech fields.	the Chinese Ministry of Science and Technology (MoST)	In 2007, approximately 0.55 billion Euros. 1986 -	cutting-edge technologies; pre-commercial high-tech projects especially in IT and biotechnology
China	**National Key Technologies R&D Programme** http://program.most.gov.cn/	Focuses on industrial needs, promotes technical upgrading and restructuring of industries, and tackles major S&T issues in national economic construction and social development	the Chinese Ministry of Science and Technology (MoST)	In 2007, approximately 0.54 billion Euros 1982 -	Key techn. and products for sust.. agric. development; Common key technologies for basic and pillar industries; Techn. support to the "informatisation" of the national economy; Key techn. for environm. protection and rational utilisation of resources; Modernisation of tradit. Chinese medicine (TCM); Major public welfare technologies and technical standardisation

Country	Programme / Initiative & website	Aim / Target	Funding Organisation	Budget / Duration	Major Topics
China	**National S&T Major Projects** http://www.nmp.gov.cn/ (Chinese)	Major Research Programme	the Chinese Ministry of Science and Technology (MoST)	In 2010, approximately 3 billion Euros 2006 -	Major technologies of strategic importance for the Chinese economy
China	**Action of Scientific and Technical Service to Cooperation (ASTSC)** http://program.most.gov.cn/	Policy Guidance Programme solutions to key industrial scientific and technical issues by introducing research institutes and universities to the enterprises	the Chinese Ministry of Science and Technology (MoST)	NA 2009 -	Focuses on technology transfer projects, joint projects and product development projects proposed by SMEs.
China	**National New Products Programme** http://program.most.gov.cn/ http://www.access4.eu/China/274.php	Policy Guidance Programme	the Chinese Ministry of Science and Technology (MoST)	In 2008, approximately 14 million Euros	supported Priority products include those that have independent intellectual property rights and core technologies, products with technology transfer from 863 or Key Technologies R&D Programme, and products jointly developed by enterprises, universities & research institutes;
China	**The International S&T Cooperation Programme** http://www.istcp.org.cn/default.aspx http://www.access4.eu/China/274.php	aims to support Chinese scientists in international research activities	the Chinese Ministry of Science and Technology (MoST)	In 2008, approximately 40 million Euros 2001 -	Special funds programme serves as an umbrella scheme to 863 Programme, 973 Programme and other major national S&T programmes. Same topics called by 863 Programme, 973 Programme and other major national S&T programmes.

Country	Programme / Initiative & website	Aim / Target	Funding Organisation	Budget / Duration	Major Topics
China	**General Programme** http://www.nsfc.gov.cn/Portal0/default166.htm	Major Research Programme	National Natural Science Foundation of China (NSFC)	In 2009, approximately 0.331 billion Euros.	1. Mathematical and Physical Sciences 2. Chemical Sciences 3. Life Sciences 4. Earth Sciences 5. Engineering and Materials Science 6. Information Sciences 7. Management Sciences 8. Medical Science
China	**The Joint Funds Programme** http://www.nsfc.gov.cn/Portal0/default166.htm www.access4.eu/_media/NSFC_3_new.pdf	The Joint Funds Programme aims to attract researchers from different sectors of industries, universities and research institutes to support basic research in specific areas.	National Natural Science Foundation of China (NSFC)	Each Joint Fund has its own budget.	1. NSAF Joint Fund 2. Joint Fund of Astronomy 3. Joint Fund of Research utilising Large-scale Scientific Facilities 4. NSFC-Guangdong Joint Fund 5. NSFC-Yunnan Joint Fund 6. Joint Fund of Civil Aviation Research 7. Joint Fund of Iron and Steel Research Each Joint Fund has its specific research topics published.

Country	Programme / Initiative & website	Aim / Target	Funding Organisation	Budget / Duration	Major Topics
China	**Key Programme** http://www.nsfc.gov.cn/Portal0/default166.htm		National Natural Science Foundation of China (NSFC)	In 2009, approximately 72.41 million Euros,	1. Mathematical and Physical Sciences 2. Chemical Sciences 3. Life Sciences 4. Earth Sciences 5. Engineering and Materials Science 6. Information Sciences 7. Management Sciences 8. Medical Science
China	**Major Programme** http://www.nsfc.gov.cn/Portal0/default166.htm		National Natural Science Foundation of China (NSFC)	In 2010, NSFC published 4 calls for proposals under the Major Programme, with a funding of approx. €1 million each.	Generally, scientists from all natural science and management science disciplines can choose a research topic published by NSFC under the Major Programme.
India	**New Millennium Indian Technology Leadership Initiative (NMITL)** http://www.csir.res.in/external/heads/collaborations/nmitli.htm	seeks to build, capture and retain for India a leadership position by synergising the best competencies of publicly funded R&D institutions, academia and private industry.	Council of Scientific and Industrial Research (CSIR)	. Public partners receive grant-in-aid, private partners receive soft loans.	Funding of high-risk technology areas ; It establishes public-private-partnerships energy, agriculture, biotechnology

Country	Programme / Initiative & website	Aim / Target	Funding Organisation	Budget / Duration	Major Topics
India	**Technology Development and Demonstration Programme (TDDP)** http://dsir.nic.in/tpdup/tddp/tddp.htm	indigenous technologies for new and improved products or processes, absorption and up-gradation of imported technologies	Ministry of Science and Technology, Department of Scientific and Industrial Research (DSIR)	Generally limited to 50% of the eligible project cost	_
India	**Technopreneur Promotion Programme (TePP)** http://www.dsir.gov.in/tpdup/tepp/tepp.htm	Unattached independent innovators like micro and small entrepreneurs working on new designs	Ministry of Science and Technology, Department of Scientific and Industrial Research (DSIR)	Maximum support under this category is between Rs 75,000/- and Rs 45,000,000/- subject to 90% of approved project cost	_
India	**Technology Management Programme (TMP)** http://dsir.nic.in/tpdup/tmp/tmp.htm	enhancing technology management capability in the country	Ministry of Science and Technology, Department of Scientific and Industrial Research (DSIR)	_	_
India	**Water Technology Initiative (WTI) Programme** http://www.dst.gov.in/scientific-programme/t-d-wti.htm	_	Department of Science and Technology (DST)	Up to Rs 1 crore (Rs 10 Mio.) sanctioned in recent projects, grant for technologists in academic institutions / grant to cover 50% cost of consumables for	develop low cost domestic purification technologies, options for disposal of scientific waste, initiating application of nano-technology

				Industry-Institution partnership; since 2007	