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Policy issues: Energy and environment

Summary of the energy programme of UNEP and summary on the present status of, major trends in and future prospects for renewable energy

Note by the Executive Director

Summary

The annexes to the present note provide additional information on issues of relevance to energy and environment, as referred to in document UNEP/GCSS.IX/9/Add.1. Annex I provides a summary of the energy programme of the United Nations Environment Programme and annex II provides a summary on the present status of, major trends in and future prospects for renewable energy.

The annexes are being submitted without formal editing.

* UNEP/GCSS.IX/1.

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Annex I

A Summary of the Energy Programme of UNEP

Overall Objective and Context

UNEP helps decisionmakers to consider environmental and social factors when making energy-related decisions. The ultimate objective of the Programme is to help bring about a global shift to energy systems that are less disruptive to the environment, do not harm human health, and that support sustainable development in its broadest sense. Energy is required for development and more sustainable approaches to producing and consuming energy are a prerequisite for sustainable development. UNEP helps governments and the private sector to:

- improve the overall planning and management of energy systems
- deploy and use renewable and low- / non-carbon energy technologies
- direct financing to energy efficiency and renewable energy investments
- increase the efficiency with which energy is transformed and used
- develop alternatives to and shift consumer preferences away from energy intensive products and services.

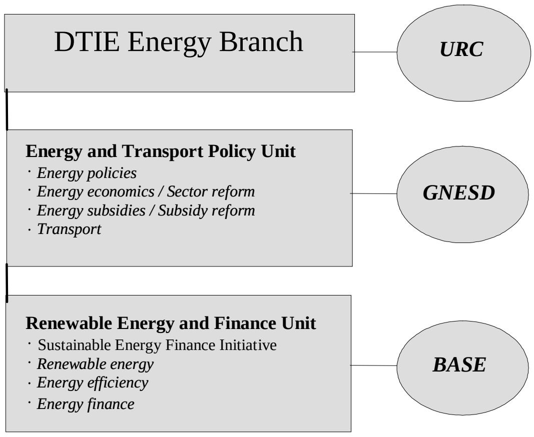
The Energy Programme works in the context of the internationally agreed goals of the United Nations Millennium Declaration (2002), doing so from the perspective that energy is a critical input to almost all development activities. The Programme supports the WSSD Plan of Implementation and the Bali Strategic Plan on Technology Support and Capacity-building.

UNEP's approach is technology neutral in that it doesn't favour or disfavour particular energy technologies. Rather, it focuses on promoting robust technical and economic analysis of different technology options so that decision-makers can make better informed policy and investment decisions. Projects and activities take into consideration the country-specific characteristics of problems or issues and the capabilities of partners. Most energy programme activities have a strong demonstration value in that they show – through example – how new approaches and partnerships can bring results.

Including the UNEP Risø Centre on Energy, Climate and Sustainable Development and the Basel Agency for Sustainable Energy (BASE), UNEP's energy programme is one of the largest in the UN system, both in number of staff and in the amount of resources available for non-investment areas such as capacity building and policy support. Staff have educational and professional expertise in energy and environment planning, energy management, economics, finance, business development, climate change mitigation analysis, development planning, and public policy. The nucleus of UNEP's energy work is the Energy Branch in the Division of Technology, Industry and Economics, but coordinated activities are also undertaken by other UNEP Divisions and UNEP Regional Offices.

Energy Branch Structure and Main Areas of Activity

The Energy Branch is divided into two units, one promoting policies that place energy and transport within a broader sustainable development context and one steering project developers and the investment community toward greater support of renewable energy and energy efficiency projects.



Energy and Transport Policy Unit

The shift to a global energy system that supports the objectives of sustainable development depends on sound analysis of options, good decision-making by public and private sector policymakers, and the balanced consideration of social, economic, and environmental factors. UNEP activities enable decision makers to understand better the link between the energy choices they face and broader sustainable development issues. The emphasis is on building human capabilities and increasing opportunities for development while reducing the harmful effects of energy production and use, with a focus on developing countries.

UNEP has, particularly through the UNEP Risø Centre, a strong position regarding policy analysis and capacity development, with a current focus on the nexus between energy, climate change and sustainable development. The Kyoto Mechanisms, in particular the Clean Development Mechanism, have a strong potential to contribute to financing energy activities that have both development and climate benefits. In parallel, UNEP helps mainstream climate and other environmental concerns into the energy development agenda. Current multi-country projects such as the *Capacity Development for the CDM* and *Climate Change and Development* and *Carbon Finance for Sustainable Energy in Africa* – both bilaterally funded – give UNEP the means to influence climate change and development policies simultaneously.

The Global Network on Energy for Sustainable Development (GNESD) is the main effort through which UNEP seeks to influence energy sector decisions in developing countries by strengthening capabilities for sound policy analysis. The Network provides an umbrella for joint activities involving 20 Centres of excellence in developing and developed countries. These activities expand the global knowledge base about the environmentally sound provision of energy services, leading to better policy decisions. Network members collaborate on information exchange; learning, analysis and study; policy support; and capacity building, with a focus on issues of concern to developing countries. Because UNEP's role is a facilitator of the GNESD, the Network is linked to the Energy and Transport Policy Unit while maintaining its own identity.

The International Conference for Renewable Energies held in Bonn, Germany in June 2004 concluded with a call to create a Renewable Energies Global Policy Network, a senior level body that would help maintain the momentum of the Conference by delivering a convincing justification for renewable energy scale-up to mainly political audiences. REN21 draws on the results of other initiatives, such as the GNESD, and gives a political impetus to their work that is lacking at present. UNEP will co-manage the REN21 technical secretariat with the German technical assistance agency GTZ, an effort that is linked to the International Energy Agency's technology programme.

Areas of increased focus – 2006-2007

The UN Commission on Sustainable Development will in its 2006 and 2007 sessions focus on energy issues. Through its analytical work on energy sector policy reform, energy regulation, and energy access, UNEP will contribute to a better understanding of why some efforts to expand energy supplies in developing countries have been successful in reaching poorer populations while others have failed, and the environmental consequences of different approaches.

UNEP is putting additional attention on the area of energy economics and determining energy futures or scenarios. A pilot effort with the International Energy Agency to improve the developing country coverage in the *World Energy Outlook,* undertaken in 2004, is being expanded. The new approach will lead to better projections of future total energy supply and demand, costs, investments, and GHG emissions in a way that influences today's energy policies. UNEP's contribution to this joint effort is determining the energy, environmental, and social policies and measures being undertaken or planned in major developing countries that act to influence future energy demand and supply.

There is growing global interest in the role of hydrogen as a clean energy carrier. Through a link to the International Partnership on a Hydrogen Economy and in particular its education and outreach efforts, UNEP is helping developing countries better understand the technical and economic issues involved and their associated policy implications.

Finally, most energy projections show that fossil fuels will continue to be the main primary energy supply for most countries, at least through the next planning and investment cycle. Many developing countries, China, India and South Africa in particular, have large coal reserves and will continue to use these, particularly for power generation. UNEP will put increased emphasis on promoting the use of clean fossil fuel technologies and in particular the transfer of improved technologies to developing countries. Participation in the Expert Group on Technology Transfer established under the UN Framework Convention on Climate Change gives UNEP an opportunity to influence international action in the area of clean fossil fuel technologies. Similarly the Dams and Development project gives the organization a means of bringing a greater degree of consensus on the manner in which the hydropower potential in many developing countries may be realized without unacceptable environmental and social consequences.

Finally, reducing the environmental impacts of transport requires coordinated action from different stakeholders to:

- integrate land use and transport infrastructure planning
- change transport consumption patterns, including through better traffic management, more diverse modal mixes including public and non-motorised transport options, and avoidance of unnecessary travel
- improve drive systems and diversify fuel choices, and
- improve the quality of conventional fuels.

The creation of a dedicated transport post in the Energy Branch is allowing UNEP to put more emphasis on transport issues. High priorities in the coming years are working with developing countries to develop tools, indicators and operational parameters for assessing the performance of sustainable transport systems, assisting developing country cities in developing better transport plans, expanding work with the private sector through the Mobility Forum and the Partnership for Clean Fuels and Vehicles, particularly on biofuels.

Renewable Energy and Finance Unit

Effective markets for clean energy depend on mature technologies, good information that is widely shared, and full internalization of environmental and social costs – conditions that generally do not exist at present. Project development and initial transaction costs are often prohibitive, which leads commercial developers and financiers to shun otherwise good business opportunities. Inherent caution is compounded by a lack of information, experience, and tools needed to quantify, mitigate and hedge project and financial product risks. Without a concerted push to reduce project development costs and increase finance flows, investment in clean and 'carbon-light' sustainable energy options will be insufficient to make a real difference in the overall energy mix.

Through projects supported by the UN Foundation, bilateral donors, and the GEF, UNEP has developed a reputation within the sustainable energy community of demonstrating new ways of stimulating clean energy financing through well structured partnerships. Our approach is to use donor support to bring about commercial investment in the clean energy sector, either by sharing front-end costs or the specific risks of financing sustainable energy investments.

UNEP has a number of projects underway that target two specific gaps in clean energy finance. The Rural Energy Enterprise Development (REED) efforts in parts of Africa, Brazil and China provide the early stage risk capital that entrepreneurs need to develop and commercialize new clean energy products and services. For sectors that are already commercialized – but where growth is constrained by a lack of end-user finance – UNEP has been implementing credit enhancement programmes that help local banks build new consumer loan portfolios. Examples include credit programmes in India for solar home systems and in Tunisia for domestic solar water heating systems, and a leasing programme for hotel solar water heating systems in Morocco. Similar programmes are being developed for other countries.

For larger grid-connected projects, our efforts focus on issues such as lowering deal origination and transaction costs and adapting risk management (insurance) and export credit instruments to the sector.

UNEP has also been supporting initiatives aimed at improving energy efficiency in industry through National Cleaner Production Centres, exploiting links between energy and sustainable production and consumption.

The common elements of these various programmes are: demonstrating some new approach to sustainable energy market development; working in partnership with first movers; achieving results on the ground; and doing so in ways that foster long term market sustainability.

Although having innovative projects and partnerships is important, catalyzing broad support within the finance community requires an overall approach to enhance knowledge transfer and replication. Part of our strategy is to support growth of a nascent sustainable energy finance community through an initiative developed by UNEP Energy, the UNEP Finance Initiative, and our BASE collaborating centre. The Sustainable Energy Finance Initiative, or SEFI, brings together financiers, engages them to do jointly what they may have been reluctant to do individually, and persuades them to enter into public-private alliances in the sustainable energy finance area. These alliances share costs and lower barriers to investment. When fully developed SEFI will provide financiers with the information and tools, give them advisory support regarding potential investments, provide a means of sharing best practice, and create the means for launching new sustainable energy finance instruments.

Areas of increased focus – 2006-2007

During the coming years UNEP anticipates expanding joint efforts with financial institutions and other partners. This will involve building longer term partnerships that take on a more strategic orientation. With Italian Government support, a broad programme for finance sector engagement on renewable energy is underway in North Africa, with good possibilities of expansion. UNEP is also working more closely with the World Bank, most recently on the joint *Carbon Finance for Sustainable Energy Services in Africa* project.

Annex II

Renewable Energy: A Summary of Present Status, Major Trends and Future Prospects

This Annex summarizes recent technological and market developments for various renewable energy technologies. It is largely drawn from two recent reports prepared for the Renewable Energy Policy Network for the 21st Century – REN21 – a global policy network that provides a forum for international leadership on renewable energy. REN21's goal is to foster the rapid expansion of renewable energies in developing and industrial countries by bolstering policy development and decision making on the sub-national, national, and international levels. The establishment of a global policy network was embraced in the Political Declaration of the International Conference for Renewable Energies, held in Bonn, Germany in 2004.

The first report, titled *Renewables 2005 – Global Status Report*, provides comprehensive information about renewable energy markets, investments, and policies. It is the outcome of an extensive research and review process involving over 100 researchers and contributors and represents a 'status quo' look at the situation of renewable energy today. *Renewable Energy and Climate Change*, the second study, provides a forward look at renewable energy from a climate change perspective. Focusing largely on developed economies, it throws light on the contribution that renewable energy technologies might play in reducing emissions of greenhouse gases.

Both reports have contributed toward a better understanding of renewable energy. Regular updates of the data and analyses contained in these and other publications are envisaged as an integral part of the REN21 agenda: building the ability of the renewable energy community to influence national legislation and international processes.

This Annex offers UNEP's interpretation of the key facts and conclusions about renewable energies contained in the two reports. It is a contribution to the REN21 aim of creating "an environment in which ideas and information are shared and cooperation and action are encouraged to promote renewable energy worldwide."

Introduction

By most accounts, the production and use of renewable energy has grown steadily over the last 25 years. Led by solar photovoltaic and wind sources, these "new" renewables currently account for 20–25 percent of the US $110–150 billion invested annually in power generation worldwide.

The heightened role of renewables reflects a significant scaling up of investments traceable back to the late 1970s. The decade 1995 to 2004 witnessed a further acceleration with annual investments in renewable energy growing from about US $6 billion to nearly US $30 billion.

Despite this growth, however, the contribution of renewables to global energy consumption remains relatively low. In 2004, renewables contributed about 4 % to total global power sector capacity. Correspondingly, renewables share of total investments –US $30 billion – is modest compared with total energy investments of US$ 150 in 2004.

On the one hand, policy-makers in developed and developing economies recognize that renewables can play a substantial role in meeting growing demands for energy while protecting the environment and improving energy security. On the other hand, in most cases renewables are still not competitive and account for only a small portion of the energy mix in all countries today.

Global Status of Renewable Energy

Markets

The *Global Status Report* estimates that renewable energy currently makes up 17 percent of the world's total primary energy. The bulk of this share is taken up by 'traditional' biomass (9 percent) and large hydropower (6 percent). Though having the smallest percentage share (2 percent), new renewables have the largest future potential amongst the three forms of renewable energy. For example, grid-connected solar photovoltaic (PV) is the fastest growing energy technology in the world today. Installed solar capacity grew by 60 percent per year from 2000–2004 notably in Japan, Germany, and the United States.

As displayed in Tables 1a – 1d,[1] renewables are advancing in the power generation, hot water and space heating, transport fuels and rural (off-grid) energy markets. However, with the possible exception of rural (off-grid) energy, much of the growth in these markets is restricted to developed economies.

Investments

In 2004, annual investment in renewable energy capacity and installations reached US $34 – 35 billion. The solar PV manufacturing industry contributed between 11 – 14 percent of this investment, and several hundred million dollars was invested by the ethanol industry in new production plants. Much of the investment in renewables comes from a variety of public and private sources in OECD countries where a large buoyant market for investment in large-scale energy projects has emerged. Major commercial banks and other large investors are starting to "mainstream" renewable energy investments in their lending portfolios.

In non-OECD countries modest but promising signs of increased investment are emerging, albeit mainly from public sources. About US $500 million goes to developing countries each year as development assistance for renewable energy projects, training, and market support. The German Development Finance Group (KfW), the World Bank Group, and the Global Environment Facility provide the majority of these funds.

[1] Adapted from *Renewables 2005 – Global Status Report*

Table 1a: Status of Renewables Technologies – Characteristics and Costs: Power Generation Markets

Technology	Typical Features	Typical Energy Costs (cents/kWh)	Existing capacity (2004)	Cost Trends and Potential for Cost Reduction
Large hydro	Plant size: 10 – 18000 MW	3-4	720 GW	Stable
Small hydro	Plant size: 1 – 10 MW	4-7	62 GW	Stable
On-shore wind	Turbine size: 1-3 MW Blade diameter: 60 – 100 meters	4-6	48 GW	Costs have declined by 12 – 18% with each doubling of global capacity. Costs are now 50% those of 1990. Future reductions from site optimization, improved blade/generator design, and electronics.
Off-shore wind	Turbine size: 1.5-5 MW Blade diameter: 70 – 125 meters	6-10		Markets still small. Future cost reductions due to market maturity and technology improvement.
Biomass power	Plant size: 1-20 MW	5-12	39 GW	Stable
Geothermal power	Plant size: 1-100 MW Type: binary, single-flash, double-flash, or natural steam	3-6	8.9 GW	Costs have declined since the 1970s. Costs for exploiting currently economic resources could decline with improved exploration technology, cheaper drilling techniques, and better heat extraction.
Solar PV (module)	Cell type and efficiency: single-crystal: 17% polycrystalline: 15% thin film: 10-12%	---	4 GW	Costs have declined by 20% for each doubling of installed capacity, or by about 5% per year. Costs rose in 2004 due to market factors. Future cost reductions due to materials, design, process, efficiency, and scale.
Roof-top solar PV	Peak capacity: 2-5 kWp	20 – 40		Continuing declines due to lower solar PV module costs and improvements in inverters and balance-of-system components.
Solar thermal power (CSP)	Plant size: 1-100 MW Type: tower, dish, or trough	12 – 18	0.4 GW	Costs have fallen from about 44 cents/kWh for the first plants in 1980s. Future reductions due to scale and technology.

Table 1b: Status of Renewables Technologies – Characteristics and Costs: Hot Water/Heating

Technology	Typical Features	Typical Energy Costs (cents/kWh)	Existing capacity (2004)	Cost Trends and Potential for Cost Reduction
Biomass heat	Plant size: 1-20 MW	1-6	220 GWth	Stable
Solar hot water/heating	Size: 2-5 m^2 Type: Evacuated	2-25	77 GWth	Costs stable or moderately lower due to economies of scale, new materials, larger collectors, and quality improvements.
Geothermal	Plant capacity:	0.5 - 5	13 GWth	See geothermal power above

heat	1-100 <u>Type</u>: binary, single-and double-flash, natural steam, heat pumps		(direct heating) 15 GWth (heat pumps)	

Table 1c: Status of Renewables Technologies – Characteristics and Costs: Biofuels

Technology	Typical Features	Typical Energy Costs (cents/kWh)	Existing capacity (2004)	Cost Trends and Potential for Cost Reduction
Ethanol	<u>Feedstock</u>: sugar cane, sugar beets, corn, or wheat (and cellulose in the future)	25 – 30 cents/liter gasoline equivalent	31 billion liters/yr	Declining costs in Brazil due to production efficiencies, now 25-30 cents/equivalent-liter (sugar), but stable in the United States at 40-50 cents (corn). Other feedstocks higher up to 90 cents. Cost reductions for ethanol from cellulose are projected, from 53 cents today to 27 cents post-2010; modest drops for other feedstocks.
Biodiesel	<u>Feedstocks</u>: Soy, rapeseed, mustard seed, or waste vegetable oils	40 – 80 cents/liter diesel equivalent	2.2 billion liters/yr	Costs could decline to 35 – 70 cents/liter diesel equivalent post-2010 for rapeseed and soy, and remain about 25 cents (currently) for biodiesel from waste oil.

Table 1d: Status of Renewables Technologies – Characteristics and Costs: Rural (off-grid) Energy

Technology	Typical Features	Typical Energy Costs (cents/kWh)	Existing capacity (2004)	Cost Trends and Potential for Cost Reduction
Mini-hydro	<u>Plant capacity</u>: 100 – 1000 kW	5-10	---	Stable.
Micro-hydro	<u>Plant capacity</u>: 1 – 100 kW	7-20	---	Stable to moderately declining with efficiency improvements.
Pico-hydro	<u>Plant capacity</u>: 0.1 – 1 kW	30 – 50	---	
Biogas digester	<u>Digester size</u>: 6 – 8 m^3	n/a	16 million	Stable to moderately declining with economies of construction and service infrastructure.
Biomass gasifier	<u>Size</u>: 20 – 5000 kW	10 – 12	n/a	Excellent potential for cost reduction with further technology development.
Small wind turbine	<u>Turbine size</u>: 3 – 100 kW	15 – 20	---	Moderately declining with technology advances.
Household wind turbine	<u>Turbine size</u>: 0.1 – 1 kW	20 – 40	---	
Village-scale mini-grid	<u>System size</u>: 10 – 1000 kW <u>Options</u>: Battery back-up or diesel	25 – 100	---	Declining with reductions in solar and wind component costs.

Solar home system	System size: 20 – 100 Wp	40 – 60	2 million	Declining with reductions in solar component costs

Industry Structure

The *Global Status Report* demonstrates that that renewable energy has become "big business:" There are currently 60 publicly traded renewable energy companies or renewable energy divisions of major companies worldwide, each with market capitalizations greater than US$ 40 million; the estimated total market capitalization of these companies and divisions exceeds $25 billion, and "the next largest 100 renewable energy companies or divisions would add several billion dollars more of market capitalization to this figure."

The **wind power** industry produced more than 6,000 wind turbines in 2004, at an average size of 1.25 MW each. The **PV** industry displays the highest rate of growth. Cumulative production, which was 1 gigawatt five years ago, reached 4 gigawatts by the end of 2004. Expansion plans by major manufacturers are expected to raise production capacity to 400 MW by the end of 2005. Increases totaling several hundred megawatts further capacity are expected in the 2006–2008 period.

The **biomass power and heat** and **small hydro** industries are "much more mature, localized, and diverse than those for wind and solar PV." Biomass heat and power investments are for the most part undertaken by companies that generate large quantities of waste biomass, such as timber and paper companies and sugar mills. European industry continues to lead the field of small hydropower manufacturing, with most companies engaged in upgrading and refurbishing existing plants. Small hydro technology improvements are focused on exploiting low heads (less than 15 meters) and small capacities (less than 250 kW).

The United States and Brazil have emerged as major centers of the global ethanol industry. More than 300 sugar mills/distilleries were producing ethanol in Brazil in 2004, and 39 new distillers were licensed in early 2005. Brazil's ethanol industry accounted for about 50% of all international shipments of ethanol during 2004. In the United States, construction of 12 new ethanol plants was completed in 2004, bringing the total to more than 80. Also in 2004, construction of 16 new plants was started. By the end of 2005, several large ethanol plants are expected to have begun production in Germany and the United States.

Policies

Policies have had a major impact on the speed and extend of renewable energy development. There is considerable scope for further enhancing their effectiveness if design and implementation problems, especially in developing countries, can be addressed.

A major lesson from previous policy initiatives is that significant growth in the renewable energy market "has always resulted from combinations of policies, rather than single policies, that longevity and predictability of policy support is important, that local and state/provincial authority and involvement are important, and that individual policy mechanisms are evolving as countries gain more experience" (*Status Report*, p.21).

At least 48 countries worldwide currently have some type of renewable energy promotion policy, including 14 developing countries. The main types include: feed-in policies, renewable portfolio standards, direct capital investment subsidies, grants, or rebates, tax incentives and credits for renewable energy. In each case, the *Status Report* cites several examples with brief explanations of the main actors involved in their design and implementation.

Rural Applications

The most common applications of renewable energy for rural (off-grid) energy services are cooking, lighting and other small electric needs, process motive power, water pumping, and heating and cooling.

An estimated 360 million households worldwide still lack access to central electric power networks. The main electrification options include power grid extension, diesel generators connected in mini-grids, renewable energy connected in mini-grids (solar, wind, and/or biomass gasification, sometimes combined with diesel), and household scale renewable energy (solar home systems and small wind turbines). Often the cost of traditional grid extension is prohibitive.

Prospects for Renewable Energy

Renewable Energy and Climate Change concludes from an extensive survey of alternative scenarios that climate change mitigation policies will continue to be a major driver of renewable energy as an alternative to fossil fuels. Renewable energy systems already in place have reduced GHG emissions from the energy sector. Renewable energy can play a key role in stabilizing atmospheric CO_2 concentration at between 450 to 550 ppm, especially when combined with energy efficiency improvements and cleaner fossil fuels. Other options such as carbon sequestration or a dramatic scale-up in the use of nuclear power, though technically possible, are less attractive on economic and political grounds.

The focus of policies should be on addressing the market distortions and institutional, financial, and economic barriers to increased deployment of renewable energy solutions. Overcoming these barriers and accelerating the transition to renewable energy require designing and implementing a mix of context-sensitive policies and targets.

Policy targets for renewable energy provide perhaps the strongest indications that policy makers worldwide are making concerted efforts in this regard. At least 43 countries currently have a national target for renewable energy supply, including all 25 EU countries. Ten of these are developing countries, namely: Brazil, China, the Dominican Republic, Egypt, India, Malaysia, Mali, the Philippines, South Africa, and Thailand.

In addition to these 43 countries, 18 U.S. states (and the District of Columbia) and three Canadian provinces have targets based on renewables portfolio standards (although neither the United States nor Canada have national targets).

Investors are responding to these favorable developments in renewable energy policy. The International Energy Agency, in its most recent World Energy Investment Outlook, estimates that fully one-third of new power generation investment in OECD countries over the next thirty years will be renewable energy.

Ultimately, renewable energy’s role in climate change and development is no longer a question whether or not to expand it, but how fast it should be expanded. Indeed, “the next 10 to 20 years are the decisive window of opportunity for transforming energy systems. If this transformation is initiated later, disproportionately high costs must be expected” (German Advisory Council on Global Change).