futu[r]e investment

A SUSTAINABLE INVESTMENT PLAN FOR THE POWER SECTOR TO SAVE THE CLIMATE

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Greenpeace International, European Renewable Energy Council (EREC)

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"Futu[r]e Investment" is based on the Global Energy Scenario report "Energy [R]evolution", published in January 2007. "Futu[r]e Investment" takes a step further by looking at the changes needed in investment by the power sector into renewable energy to fully realise the outcomes of the "Energy [R]evolution". For further information about the "Energy [R]evolution" please see the full report at www.energyblueprint.info.

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cover image SOLAR AND WIND ENERGY GENERATION.
image WIND TURBINE.

foreword

2007 has seen unprecedented momentum on the issue of climate change, from an unequivocal conclusion by scientists that it is underway to the sobering impacts and the cautiously optimistic economics of what it might cost to curb climbing temperatures. A big part of the economics—of the transition to a low carbon global GDP—will be technology including energy generation systems allied to the enormous energy efficiency gains possible in homes, workplaces, power plants and in the transportation sector.

Renewable energies, from wind and solar to biomass and geothermal will have an important role to play in switching the globe's economies onto a more climate-friendly trajectory if intelligent market instruments continue to be deployed and expanded. Meanwhile increased investment in research and development could see other kinds of renewables like perhaps ocean thermal energy conversion, tidal and wave power becoming commercial and widespread over the decades to come.

The scale and pace of investments in commercial forms of renewables has certainly be rising and in recent years at an exceptional speed. Indeed so exceptional, that wind, solar and biomass are now, and in some areas independent of the vagaries of the oil price for perhaps the first time ever. Around 18 per cent of global investment or about $100 billion in power generation in 2006 was in renewables by some estimates. While much of this remains in developed countries, there is emerging interest in developing countries in particular China and India where new renewable corporations are emerging as global players.

The growth is also spawning a new generation in high-tech industries and jobs with some experts estimating that by 2020 more people in Germany, for example, will be employed in environmental industries like renewables than in the automotive industry.

There are many factors driving this surging interest including energy security concerns. But above all it is the issue of climate change and the need to address greenhouse gas emissions which is at the heart of the renewable investment rush. The United Nations, via the Kyoto Protocol emission reductions treaty and its flexible mechanisms, can take some credit for establishing innovative markets that are accelerating deployment of renewables in developed and developing countries. Indeed the Clean Development Mechanism is set to deliver financial flows in part to renewable energy schemes of some $100 billion, perhaps more over the coming years.

The attraction of renewables goes beyond their simplicity and their greenhouse gas emission reduction potential. In many rural areas of developing countries they offer a rapid chance for poorer communities to gain access to electricity without waiting for a grid.

The potential can be big as well as small scale. A United Nations Environment Programme report on the world's deserts noted that there is enough solar power in an 800 by 800 km area of a desert, such as the Sahara to generate all the world's electricity needs and more. Part of this could be used to generate electricity directly or to produce hydrogen—a promising alterative fuel. Over the coming few months we will gain an insight into whether the political world is ready to back the deep emission reductions urgently needed post 2012 which will stimulate renewable energy investments even further.

The European Union has set a 20 per cent emission reduction for 2020 and positive signals are emerging from other quarters including Japan and the United States. Some countries, from Costa Rica and New Zealand to Norway have pledged to go carbon neutral by mid century. The speed at which the transition to a low, perhaps even de-carbonized economy will occur will depend on serious and sustained political will if we are to achieve the ultimately goal of an up to 80 per cent cut in greenhouse gases. It will also depend on creative thinking and a dispassionate assessment of all the options available.

This new report is just the kind of publication that will strike a thoughtful chord with the expert and the novice in the field of renewable energy. I am sure it will spark even greater interest and action towards a more sustainable, climate friendly, energy mix and allow renewables to achieve their full and very exciting potential.

Achim Steiner
UNEP
JUNE 2007

introduction

THIS REPORT SHOWS THAT INVESTMENT IN RENEWABLES PAYS OFF QUITE QUICKLY DUE TO MASSIVE SAVINGS IN FUEL COSTS. IN FACT, A 'BUSINESS AS USUAL' MIX IN THE WORLD GLOBAL POWER GENERATION SECTOR WOULD RESULT IN 10 TIMES HIGHER FUEL COSTS, WHEN COMPARED TO THE ADDITIONAL INVESTMENT NEEDED TO IMPLEMENT THE ENERGY [R]EVOLUTION PATHWAY.

image HARNESSING NATURE'S SUSTAINABLE ELEMENTS.

Since "*Energy [R]evolution*" was first published at the end of January 2007, Greenpeace and EREC have received an overwhelming wave of support. The *Energy [R]evolution Scenario* is a real alternative to the IEA´s world energy outlook – and the only practical blueprint for how to cut global energy related CO_2 emission by 50% by 2050 to avoid dangerous climate change, while maintaining global economic growth.

The *Energy [R]evolution* report shows that renewable energy is not a dream for the future – it is real, mature and can be deployed on a large scale. Decades of technological progress have seen renewable energy technologies such as wind turbines, solar photovoltaic panels, biomass power plants, geothermal power and solar thermal collectors move steadily into the mainstream. The global market for renewable energy is growing dramatically; in 2005 its turnover was US$38 billion, 26% more than the previous year.

The time window for making the shift from fossil fuels to renewable energy is very short. Within the next decade many of the existing power plants in the OECD countries will come to the end of their technical lifetime and will need to be replaced. But a decision taken to construct a coal power plant today will result in the production of CO_2 emissions until 2050.

Energy policy options and future pathways are naturally influenced to a huge extent by political decision makers. Decisions need to be made now. Plans made by power utilities over the next few years will define the energy supply of the next generation. We strongly believe that this should be the "solar generation". The current energy supply structure can clearly not be maintained in a sustainable way. The economic, social and environmental costs would be unacceptable to humanity.

Over the coming two decades we will witness the largest turnover in electricity generating technology the world has ever seen. Existing plant needs to be retired, and in addition, new plant will have to be built to satisfy the increasing global demand for power - not least from India and China. We must use this opportunity to change our energy supply structure to include a much larger share of indigenous, renewable resources, so we can develop our economies on the basis of known and predictable cost of electricity.

During the last few months, as we have presented the *Energy [R]evolution Scenario* at press conferences, energy conferences and one-to-one interviews with politicians, financial experts and utilities, it has become clear that detailed investment figures for our scenario are of great interest. Therefore, this report takes a close look at the investment pathways of the power sector. We concentrate on the power sector, because comparative figures were more easily available.

image UTTARADIT, THAILAND, 26 MAY 2006. DESTRUCTION ENGULFS THE DISTRICT OF LABLAE IN UTTARADIT PROVINCE AFTER A MUDSLIDE SWEPT THROUGH THE DISTRICT AND DESTROYED EVERYTHING ON ITS PATH. MORE THAN A HUNDRED ARE FEARED DEAD AND MISSING AS THE PROVINCE OF UTTARADIT AND OTHER NORTHERN THAI PROVINCES WERE SUBMERGED IN THE AREA'S WORST FLOODS IN RECENT HISTORY. SCIENTISTS WARN THAT EXTREME WEATHER EVENTS DUE TO CLIMATE CHANGE WILL HIT HARD AND MORE OFTEN IN THE COUNTRY, ALONG WITH OTHER PARTS OF ASIA.

First positive developments

Wind provides an example of what is possible if technological development accompanies favourable political development. Wind energy had a record year in 2006. Global demand for wind power capacity grew by 32%, following an increase in the market of more than 40% in 2005. The value of wind turbines sold last year was €18 billion. In Europe, for the seventh consecutive year, wind power was second only to gas in terms of new capacity. New wind power installations in 2006 amounted to 7588 MW, seriously challenging gas (approximately 8500 MW in 2006) as the preferred European choice in electricity generating capacity. A similar pattern is emerging in the US, where wind was second only to gas in terms of new installations in 2005, according to the US Energy Information Administration. The same is expected for 2006. A similar success story could be told for other technologies such as solar PV which has shown average growth rates above 30% during the last few years. Between 2001 and 2005, 35% of all new capacity installed in the EU was based on renewables.

For the majority of countries experiencing high and increasing energy imports, the coming years will be a balancing act between reducing import dependence and exposure to fluctuating and unpredictable fuel import prices on the one hand, while simultaneously working to curb emissions of greenhouse gases and other pollutants from electricity generation on the other. We have a 10-year window to avoid irreversible damage to the world as a result of man-made climate change. Deploying indigenous wind energy and building new gas plant while securing gas supplies is certainly not the worst response importing countries can make when trying to navigate through the increasingly challenging climate and energy situation.

As mentioned, the global market for wind turbines was worth some €18 billion in 2006. The amount comes very close to the increase in the EU's gas bill every time the price of oil increases by US$20. The European Commission has calculated that for every US$20 increase in the price of oil, the price of Europe's gas imports rises by €15 billion annually, given the unfortunate link between gas and oil prices. For comparison, the cost of wind turbines installed in Europe in 2007 was approximately €9 billion. A tripling of oil prices from US$20 to US$60, as we have experienced in the past few years, thus adds €30 billion annually to the Europe's gas importation bill and constitutes a transfer of wealth from Europe to gas-exporting countries. Europe is not an isolated case. Very few countries are net exporters of fuel, and even fewer will be in the future. Due to the concentration of the remaining reserves, most countries will be transferring an ever-increasing share of their wealth abroad if imports continue to grow and prices continue to rise. And there is only one long-term direction for oil and gas prices: up!

The dependence on few fossil fuel sources is of particularly concern in many developing countries. Some developing countries spend nearly all their development aid on coping with increasing - and volatile - oil prices. Europe, as well as North America, Japan, India, China and many other importing countries will have to accept a transfer of wealth to fuel exporters in the medium term. But the impact on their economies and the global environment can be limited, in the short, medium and long term, through much-needed energy efficiency measures and the deployment of renewables.

The battle for energy in this century will not be won by following the strategy that proved to be the winning one in the 20th century, i.e. of either producing fuel or of controlling fuel supplies. It will be won by those regions of the world that have the foresight to act now to protect their economies and the global climate. It will be won by the regions that excel in developing, deploying and exporting renewable energy technologies to a world that cannot afford to do without them. A well-known consultancy has just produced a report saying that by 2020 in Germany, environmental technologies will be the major industry, ahead of the automobile and steel industries for which Germany is famous.

Long term energy policy will attract investors

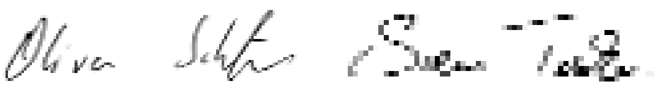
In order to build up a large scale renewable industry – big enough to satisfy the growing demand for power supply globally – long term energy policies are needed. Short term thinking – aimed at 'the next election' - will have dire consequences for future generations. Those countries with long term policies for renewable power generation such as Germany, Spain and Denmark have been able to build up strong renewable industries. The weaker the policy, the smaller the renewable industry and the higher the prices for power generation equipment.

We have shown two best practice examples for renewable power policy: The German Feed-in law and the Texas Renewable Portfolio Standard – just two out of numerous good examples around the world. The money is available, so it's just a matter of lowering the risk for RE investors and making RE investments commercially viable through a defined and stable return that can only be provided by appropriate government policies. The bottleneck therefore is not because there is no money for renewables but because there is a either a total absence of policy to encourage major investment in renewable energy, or weak policies that result in smaller scale investments, hence the impression that renewables can only work on a much smaller scale.

This report shows that investment in renewables pays off quite quickly due to massive savings in fuel costs. In fact, a 'business as usual' mix in the world global power generation sector would result in 10 times higher fuel costs, when compared to the additional investment needed to implement the *Energy [R]evolution* pathway.

Today's politicians can change the energy supply for the next generation – a good argument for the next election! As more and more people will say:

"I love renewable energy – and I vote!!"



Oliver Schäfer
EUROPEAN RENEWABLE ENERGY COUNCIL (EREC)
JANUARY 2007

Sven Teske
CLIMATE & ENERGY UNIT
GREENPEACE INTERNATIONAL

executive summary

THE AVERAGE ANNUAL FUEL COST SAVING OF THE ENERGY [R]EVOLUTION SCENARIO ARE 10 TIMES HIGHER THAN THE ADDITIONAK INVESTEMNET COST OF THIS SCENARIO.

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image 30TH OCTOBER 2006 - NONTHABURI, THAILAND - VILLAGERS PADDLE A BOAT AT A VILLAGE IN KOH KRED ISLAND WHICH WAS ENGULFED BY RECENT FLOODING. KOH KRED IS A TINY ISLAND IN THE CHAO PHRAYA RIVER, LOCATED IN NONTHABURI PROVINCE OUTSKIRT OF BANGKOK. EARLIER IN THE YEAR, SCIENTISTS WARNED THAT THAILAND WOULD EXPERIENCE MORE FREQUENT EXTREME WEATHER EVENTS DUE TO THE IMPACTS OF CLIMATE CHANGE.

climate threats and solutions

Global climate change, caused by the relentless build-up of greenhouse gases in the earth's atmosphere, is already disrupting ecosystems and is already causing about 150,000 additional deaths per year. An average global warming of 2°C threatens millions of people with an increased risk of hunger, malaria, flooding and water shortages.

If rising temperatures are to be kept within tolerable limits then we need to significantly reduce our greenhouse gas emissions. This makes both environmental and economic sense. The main greenhouse gas is carbon dioxide (CO_2) produced by using fossil fuels for energy and transport.

Recent large increases in the price of oil and gas; the 'weaponisation' of energy supplies for political purposes (i.e., Russia/Ukraine, Russia/EU, Venezuela/US, Argentina/Chile, etc.); and the dependence of many economies on sources of supply in some of the most unstable regions of the world, have brought the issue of security of supply to the top of the energy policy agenda.

One reason for the price increases is that supplies of all fossil fuels - especially oil and gas - are becoming scarcer and more expensive to produce. The days of "cheap oil and gas" are coming to an end. This opens the door for the use of unconventional sources like oil shale or tar sands with huge environmental impacts. Coal also faces rising prices. China, a former coal exporting country will soon import increasing amounts of coal to satisfy its booming economy. In addition, the outlook for capturing and storing CO_2 after 2020 (irrespective of whether this is realistic or just wishful thinking) is encouraging industrialized countries to built new coal power plants in the coming years.

Uranium, the fuel for nuclear power, is also a finite resource.

By contrast, the reserves of renewable energy that are technically accessible globally are large enough to provide about six times more energy than the world currently consumes - forever.[1]

Renewable energy technologies vary widely in their technical and economic maturity, but there are a range of sources which offer increasingly attractive options. These sources include wind, biomass, photovoltaic, solar thermal, geothermal, ocean and hydroelectric power. Their common feature is that they produce little or no greenhouse

references
1 ISES / DR. STRADMANN / DR. NITSCH

image GEOTHERMAL ACTIVITY.

gases, and rely on virtually inexhaustible natural sources for their "fuel". Some of these technologies are already competitive. Their economics will further improve as they develop technically, as the price of fossil fuels continues to rise and as their saving of carbon dioxide emissions is given a monetary value globally.

At the same time there is enormous potential for reducing our consumption of energy, while providing the same level of energy 'services'.

Although nuclear power plants produce little carbon dioxide, there are multiple threats to people and the environment from their operation. These include the risks and environmental damage from uranium mining, processing and transport; the risk of nuclear weapons proliferation; the unsolved problem of nuclear waste; and the potential hazard of a serious accident. The nuclear option is therefore discounted in this analysis. The solution to our future energy needs lies instead in greater use of renewable energy sources for both heat and power.

Carbon dioxide capture and storage (CCS) is a technology still under development. Although the number of pilot projects under development is increasing, no project including a coal power plant with CO_2 storage has so far been realised. CCS will not begin in earliest before 2020 and will probably not become commercially viable as a possible effective mitigation option until 2030. CCS is expensive and increases the costs of power generation between 40% and 80% compared with conventional power plants, depending on the location of the plant, the storage site, and the transport and capture technology used. CCS also further reduces the efficiency of power plants and thus requires more resources. In addition, all CCS technologies require that between 11 and 40% more fossil fuel resources are used to generate the same amount of electricity[2], also incurring proportional additional environmental damage from air and water pollution associated with extraction of that extra fuel. CCS produces additional long-term costs. Monitoring and verification over the years is necessary to guarantee the retention of the stored carbon dioxide. Even then, opportunities to intervene in order to prevent or control unexpected leakage are likely to be limited. The CCS option is therefore discounted in this analysis.

the energy [r]evolution of the power sector

Two scenarios up to the year 2050 are outlined in this report. The *Reference Scenario* is based on the Reference Scenario published by the International Energy Agency in World Energy Outlook 2004, extrapolated forward from 2030. Compared to the 2004 IEA projections, the new World Energy Outlook 2006 assumes a slightly higher average annual growth rate of world GDP of 3.4%, instead of 3.2%, for the 2004-2030 time horizon. At the same time, WEO 2006 expects final energy consumption in 2030 to be 4% higher than in WEO 2004. A sensitivity analysis on the impact of economic growth on energy demand under the Energy [R]evolution Scenario shows that an increase of average world GDP of 0.1% (over the time period 2003-2050) leads to an increase in final energy demand of about 0.2%.

The *Energy [R]evolution Scenario* sets a target for the reduction of worldwide emissions by the power sector of 60% below current levels by 2050. A second objective is the global phasing out of nuclear energy. To achieve these targets, the scenario is characterised by significant efforts to fully exploit the large potential for energy efficiency. At the same time, all cost-effective renewable energy sources are accessed for electricity generation, and cogeneration from both fossil fuels and renewable energy sources (such as geothermal and bio energy) is expanded.

Today, renewable energy sources account for 18% of the world's electricity demand. Large hydro power plants are currently the largest renewable source, but wind energy is rapidly picking up. The share of new renewable energy (e.g. solar energy, biomass, and geothermal) in electricity generation is currently well under 1%, but with double digit growth rates in the past decade. The Energy [R]evolution Scenario describes a development pathway which transforms the present situation into a sustainable energy supply:

- Exploitation of the large energy efficiency potential will slow down the rapidly growing electricity demand from the current 13,675 TWh/a (billion kWh per year) to 26,000 TWh/a by 2050. Under the Reference Scenario there would be an increase to 39,000 TWh/a. Commitment to a successful efficiency strategy within the power sector is a crucial prerequisite for achieving a significant share of renewable energy sources, compensating for the phasing out of nuclear energy and reducing the consumption of fossil fuels.
- The increased used of combined heat and power generation (CHP) also improves the supply system's energy conversion efficiency, increasingly using natural gas and biomass. In the long term, decreasing demand for heat and the large potential for producing heat directly from renewable energy sources limits the further expansion of CHP.
- The electricity sector will be the pioneer of renewable energy utilisation. By 2050, around 70% of electricity will be produced from renewable energy sources, including large hydro. An installed capacity of 7,100 GW will produce 21,400 Terawatt hours per year (TWh/a) of electricity in 2050.
- By 2050, 16% of electricity generation will be covered by combined heat and power plants - roughly half of those plants will run on biomass, and more than 40% will use gas as a fuel.

To achieve an economically attractive growth of renewable energy sources, a balanced and timely mobilisation of all renewable technologies is of great importance. This depends on technical potentials, actual costs, cost reduction potentials and technological maturity.

references
2 IPCC SR ON CCS TECHNICAL SUMMARY TABLE TS.3

development of CO_2 emissions by the power sector

Worldwide CO_2 emissions by the power sector will almost double under the Reference Scenario by 2050 - far removed from a sustainable development path. But under the Energy [R]evolution Scenario, power sector emissions will decrease from 10,200 million tonnes in 2003 to 4,200 m/t in 2050. In spite of the phase-out of nuclear energy, and increasing electricity demand, CO_2 emissions in the electricity sector will decrease enormously due to the use of renewable energy and energy efficiency. With a share of 36% of total CO_2 emissions in 2050, the power sector will fall behind the transport sector as the largest source of emissions.

generation costs

Due to the growing demand for power, we are facing a significant increase in society's expenditure on electricity supply. Under the Reference Scenario, the undiminished growth in demand, the increase in fossil fuel prices and the costs of CO_2 emissions all result in electricity supply costs rising from today's US$1,130 billion per year to more than US$4,300 bn per year in 2050.

The Energy [R]evolution Scenario not only complies with global CO_2 reduction targets, but also helps to stabilise energy costs and thus relieves the economic pressure on society. Increasing energy efficiency and shifting energy supply to renewable energy resources leads to long term costs for electricity supply that are one third lower than in the Reference Scenario. Following stringent environmental targets in the energy sector pays off in economic terms.

investment in power plants

The global market for new power generation equipment is - after years of stagnation - booming. While most existing power plants are ageing and need to be replaced (= "repowering"), developing countries such as China and India are building up new infrastructures for rapidly increasing electricity demand.

There is a huge opportunity to use the window of the next 5 to 15 years to invest in new sustainable and climate- friendly power generation. Every decision about new power plants today will influence the energy mix of the next 30 to 40 years.

Renewable energy sources - with the exception of bioenergy power plants - do not need any fuel, which makes operation costs independent of fluctuating world market fossil fuel prices, and generation costs predictable over a period of 20 years and longer.

In the Reference Scenario there will be almost 10,000 new fossil fuel power plants[3] by 2030. Roughly half of those power plants will be run on gas, the other half on coal. Lignite power plants remain a niche market. New renewable energy capacity may be in the same range as new coal. However 70% of the new installed power plants in the Reference Scenario would be based on fossil fuel, 25% renewable and 5% nuclear. As new nuclear capacity would replace mainly old existing power plants, nuclear will remain marginal on the global scale.

figure 1: development of global electricity generation under the energy [r]evolution scenario

'EFFICIENCY' = REDUCTION COMPARED TO THE REFERENCE SCENARIO

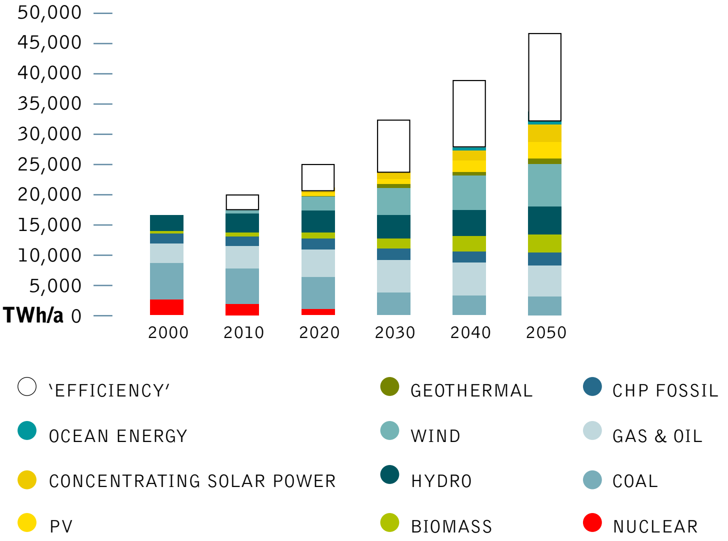
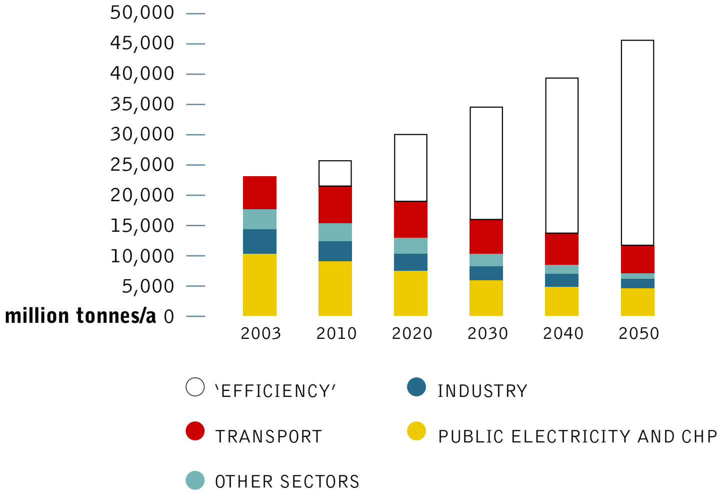


figure 2: development of global co₂ emissions by sector under the energy [r]evolution scenario

'EFFICIENCY' = REDUCTION COMPARED TO THE REFERENCE SCENARIO



references

3 ASSUMING THAT THE AVERAGE SIZE IS 500 MW PER POWER PLANT

image SOLAR AND WIND-FACILITY NEAR ROSTOCK.

In the Energy [R]evolution Scenario, however, there will be just 4,000 new fossil fuel power plants by 2030. A large percentage of those power plants are currently under construction or have gone online between 2004 and January 2007. Gas power plants - especially cogeneration - play an important role. More than half of the new power plants run on gas, the remainder on coal. Lignite power plants will not be built under the Energy [R]evolution Scenario. However, two thirds of new installed power capacity in the Energy [R]evolution Scenario would be based on renewable energy sources, leaving one third to fossil fuels - around half of these power plants will be efficient combined heat and power plants (CHP). Nuclear capacity would cease by 2030 when old existing power plants will be replaced by renewable power plants.

future energy prices and power plant investment costs

The recent dramatic increase in global oil and gas prices has resulted in much higher forward price projections. Under the 2004 'high oil and gas price' scenario by the European Commission (2004), for example, an oil price of just US$34/bbl in 2030 was assumed, and under a 'soaring oil and gas prices' scenario the oil price reached US$50/bbl in 2030. Only two years later, the IEA-WEO expects the oil price to be at US$52/bbl in 2030 (IEA 2006a), and in the 'high' projections of the US Department of Energy's Annual Energy Outlook the oil price reaches US$90/bbl in 2030 ($54 in the reference case) (US DoE 2006). Considering the IEA's continuous underestimation of oil prices in the past and the growing global oil and gas demand, which goes along with the expected passing of the global oil mid depletion point, we assume a price development path in which the price of oil reaches US$85/bbl by 2030 and US$100/bbl in 2050 (Table 1). Gas prices are assumed to increase to US$9-10/GJ by 2050.

Compared to fossil fuels, biomass prices are highly variable, ranging from no or low costs for residues or traditional biomass in Africa or Asia to comparatively high costs for biofuels from energy crops. Despite this variability, this paper assumes an aggregated price for biomass in Europe. The increasing biomass prices reflect the link between biofuel and fossil fuel prices and a rising share of energy crops. For other regions prices are assumed to be lower, considering the large amount of traditional biomass use in developing countries and the high potential of as yet unused residues in North America and the Transition Economies.

Projections of CO_2 emission costs are even more uncertain than energy prices. IEA (2006b) assumes a CO_2 reduction incentive of 25 US$/t$CO_2$ in 2050. A study commissioned by the German Advisory Council on Global Change (WBGU 2003) suggest that under a 450 ppm CO_2 stabilisation scenario the price for global CO_2 emission allowances will rise to around 50 US$/t$CO_2$ in 2030, and - depending on the scenario - to more than 100 US$/t$CO_2$ in 2050. We assume that CO_2 costs rise linearly from 10 US$/t$CO_2$ in 2010 to 50 US$/t$CO_2$ in 2050, which is twice as high as the IEA's projection, but still conservative compared with other studies. We assume that CO_2 emission costs will be accounted for in Non-Annex B countries only after 2020.

Besides the conventional fossil based technologies, which still show a significant potential for cost reduction and improvement of efficiencies, there is a broad range of renewable energy technologies available today, which differ in terms of their technical maturity, costs, and development potentials. Most of the renewable technologies employed today are at an early stage of market development. Accordingly, their costs are generally higher than for competing conventional systems - particularly also because it is still virtually free to destroy the environment by emitting greenhouse gases (GHG). If a polluter-pays principle were to be in operation, and CO_2 already had a price according to the damages it causes, the competitiveness of renewables would be greatly strengthened.

Stimulating market introduction would drive these technologies through their learning curves, thus exploiting the large potential for cost reduction. Table 2 shows the expected development of specific investment costs for key electricity generation technologies. The prerequisite for this cost development is the further dynamic market uptake of renewable energy technologies to facilitate technical learning.

fuel costs versus investment costs

The total costs for fossil fuels in the Reference Scenario between 2004 and 2030 add up to a total of US$18,6 trillion - compared to US$13,1 trillion in the Energy [R]evolution Scenario. This means fuel costs in the Energy [R]evolution Scenario are already 30% lower in the year 2030 (in 2050, the fuel costs are more than 70% lower). The "gas bill" remains roughly at the same level - in the Energy [R]evolution Scenario it is 10% below the Reference Scenario. Equally importantly, the money spent on the alternative scenario for oil and coal to generate electricity is also 50% below the Reference Scenario.

The total fuel cost savings in the Energy [R]evolution Scenario are as high as US$5.4 trillion or US$202 billion dollar per year.

table 1: total global fuel cost savings in the energy [r]evolution scenario compared to the reference scenario

	CUMMULATIVE COST IN BILLION $2000				AVERAGE ANNUAL SAVINGS FOR FUEL IN BILLION $2000
FOSSIL FUELS	2003 - 2010	2011 - 2020	2021 - 2030	**2004 - 2030**	**2004 - 2030**
Hard coal Mill t	134	780	1,753	**2,667**	**99**
Natural gas in E+9m3	19	148	663	**831**	**31**
Crude oil in Mill barrel	127	700	1,135	**1,962**	**73**
Total	281	1,628	3,551	**5,459**	**202**

table 2: Investment Costs Energy [R]evolution versus Reference

ENERGY [R]EVOLUTION VERSUS REFERENCE	BILLION $				AVERAGE PER YEAR BILLION $
INVESTMENT	2003 - 2010	2011 - 2020	2021 - 2030	**2004 - 2030**	**2004 - 2030**
Nuclear power plant	-222	-190	-168	**-581**	**-22**
Fossil fuels	-325	-628	-762	**-1,714**	**-63**
Renewables	113	1,105	1,672	**2,890**	**107**
Total	-434	287	742	**595**	**22**

The comparison between the extra fuel costs in the Reference Scenario and the extra investment costs of the Energy [R]evolution Scenario shows that the average annual additional fuel costs of the Reference Scenario are about 10 times higher than the additional investment requirement of the Energy [R]evolution Scenario.

In fact the additional costs for coal from today till the year 2030 are as high as US$100 billion, which would cover 92.5% of the total annual investments needed in renewable power generation required to implement the Energy [R]evolution Scenario.

But these renewable energy sources will produce electricity without any further fuel costs beyond 2030, while the fuel costs for coal and gas will continue to be a burden on national economies.

reform of global finance institutions

Demand for energy, particularly electricity, is increasing worldwide. This is especially the case in developing countries, which rely heavily on export credit agencies (ECAs) and multi-lateral development banks to provide financing for energy and other industrial projects.

To be consistent with the emerging international regime for limiting greenhouse gas emissions, ECAs and other international financial institutions which support or underwrite projects around the world must have policies consistent with the need for limiting greenhouse gas emissions and climate protection. At the same time there needs to be a transition plan and flexible timeframes to avoid imposing undue adversity on developing countries' economies that are overly reliant on conventional energy sources and exports. There also needs to be recognition that meeting the development goals of the world's poorest will require significant support for the foreseeable future.

Policies to address these issues must include:

- A defined and increasing percentage of overall energy sector lending directed towards renewable energy and energy efficiency projects.
- A rapid phase out of explicit and implicit subsidies for conventional, polluting energy projects.

to implement the energy [r]evolution in the power sector and to avoid dangerous climate change, Greenpeace and EREC demands the following for the power sector:

- Phase out of all subsidies for fossil fuels and nuclear energy and the internalisation of external costs
- Set legally binding targets for renewable energy
- Provide defined and stable returns for investors
- Guaranteed priority access to the grid for renewable generators - and clear and simple administrative procedures
- Strict efficiency standards for all electricity consuming appliances

installed capacity by technology

THERE IS A HUGE OPPORTUNITY TO USE THE WINDOW OF THE NEXT 5 TO 15 YEARS TO INVEST IN NEW SUSTAINABLE AND CLIMATE- FRIENDLY POWER GENERATION

image MAN USING METAL GRINDER ON PART OF A WIND TURBINE MAST IN THE VESTAS FACTORY, CAMBELTOWN, SCOTLAND, GREAT BRITAIN. WIND TURBINES ARE NOT ONLY A SOURCE OF RENEWABLE ENERGY BUT ALSO A SOURCE OF EMPLOYMENT.

The global market for new power generation equipment is - after years of stagnation - booming. While most existing power plants are ageing and need to be replaced (= "repowering"), developing countries such as China and India are building up new infrastructures for rapidly increasing electricity demand.

There is a huge opportunity to use the window of the next 5 to 15 years to invest in new sustainable and climate- friendly power generation. Every decision about new power plants today will influence the energy mix of the next 30 to 40 years.

Renewable energy sources - with the exception of bioenergy power plants - do not need any fuel, which makes operation costs independent of fluctuating world market fossil fuel prices, and generation costs predictable over a period of 20 years and longer.

new installed capacity (global)

reference scenario

In the Reference Scenario there will be almost 10,000 new fossil fuel power plants[4] by 2030. Roughly half of those power plants will be run on gas, the other half on coal. Lignite power plants remain a niche market. New renewable energy capacity may be in the same range as new coal. However 70% of the new installed power plants in the Reference Scenario would be based on fossil fuel, 25% renewable and 5% nuclear. As new nuclear capacity would mainly replace old existing power plants, nuclear will remain marginal on the global scale.

energy [r]evolution

In the Energy [R]evolution Scenario, however, there will be just 4,000 new fossil fuel power plants by 2030. A large percentage of those power plants are currently under construction or have gone online between 2004 and January 2007. Gas power plants - especially cogeneration - play an important role. More than half of the new power plants run on gas, the remainder on coal. Lignite power plants will not be built under the Energy [R]evolution Scenario. However, two thirds of new installed power capacity in the Energy [R]evolution Scenario would be based on renewable energy sources, leaving one third to fossil fuels - around half of these power plants will be efficient combined heat and power plants (CHP). Nuclear capacity would cease by 2030 when old existing power plants will be replaced by renewable power plants.

references
4 ASSUMING THAT THE AVERAGE SIZE IS 500 MW PER POWER PLANT

figure 3: **new capacity in GW - REF Scenario**

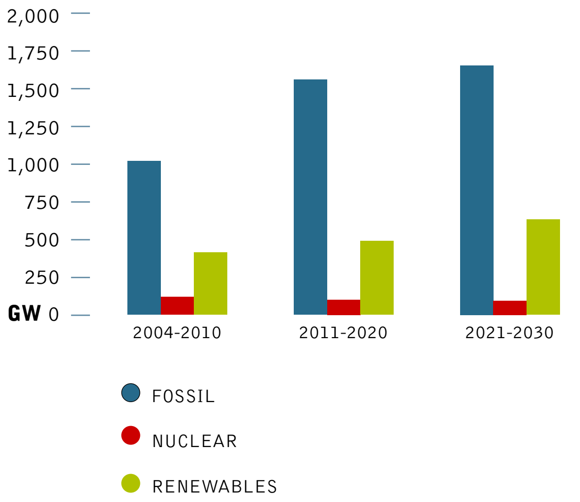


figure 4: **new capacity in GW - energy [r]evolution scenario**

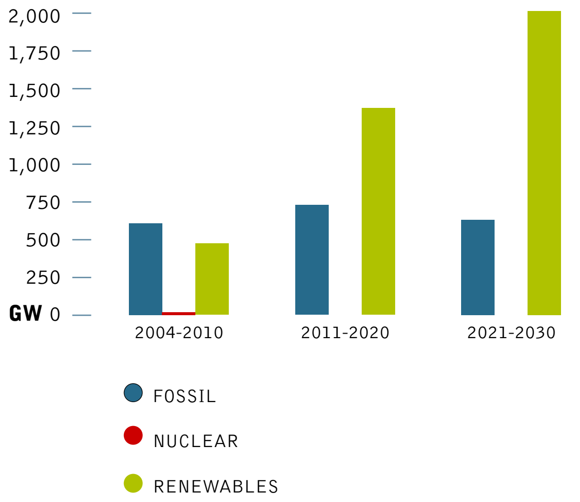


table 3: **total new installed capacity till 2030 by technology - REF**

TECHNOLOGY	GW	2004 - 2010	2011 - 2020	2021 - 2030	**2004 - 2030**
Fossil	GW	1,027	1,568	1,669	**4,264**
- Lignite	GW	24	27	29	**80**
- Coal	GW	399	619	679	**1,697**
- Oil	GW	172	202	195	**568**
- Gas	GW	432	720	766	**1,918**
Nuclear	GW	126	107	94	**327**
Renewables	GW	415	489	633	**1,536**
- PV power	GW	6	16	38	**61**
- Solar thermal	GW	1	1	3	**5**
- Wind power	GW	89	126	249	**464**
- Biomass and waste	GW	16	18	28	**61**
- Geothermal	GW	11	8	17	**36**
- Hydro power	GW	291	319	296	**906**
- Ocean energy	GW	0	1	1	**3**
Total	GW	1,568	2,163	2,396	**6,127**

table 4: **total new installed capacity till 2030 by technology - E[R]**

TECHNOLOGY	GW	2004 - 2010	2010 - 2020	2021 - 2030	**2004 - 2030**
Fossil	GW	608	720	623	**1,950**
- Lignite	GW	0	0	1	**7**
- Coal	GW	196	163	62	**420**
- Oil	GW	39	41	50	**130**
- Gas	GW	367	516	511	**1.394**
Nuclear	GW	17	0	0	**17**
Renewables	GW	477	1,371	2,023	**3,872**
- PV power	GW	22	176	551	**750**
- Solar thermal	GW	2	27	109	**138**
- Wind power	GW	138	809	1,026	**1,972**
- Biomass and waste	GW	12	21	27	**60**
- Geothermal	GW	10	11	20	**41**
- Hydro power	GW	289	316	274	**879**
- Ocean energy	GW	2	11	16	**30**
Total	GW	1,101	2,101	2,647	**5,849**

development of power plants: investment costs

WITH RENEWABLE ENERGY TECHNOLOGIES LARGE COST REDUCTIONS CAN BE ACHIEVED DUE TO TECHNICAL LEARNING, MANUFACTURING IMPROVEMENTS AND LARGE-SCALE PRODUCTION, UNLIKE CONVENTIONAL TECHNOLOGIES.

2

image TEST WINDMILL N90 2500, BUILT BY THE GERMAN COMPANY NORDEX, IN THE HARBOUR OF ROSTOCK. THIS WINDMILL PRODUCES 2,5 MEGA WATT AND IS TESTED UNDER OFFSHORE CONDITIONS. AT LEAST 10 FACILITIES OF THIS TYPE WILL BE ERECTED 20 KM OFF THE ISLAND DARSS IN THE BALTIC SEA BY 2007. TWO TECHNICIANS WORKING INSIDE THE TURBINE.

fossil fuel technologies and carbon capture and storage (CCS)

While the fossil fuel power technologies employed today for the utilization of coal, gas, lignite and oil are established and at a very late stage of market development, further cost reduction potentials are assumed. However the overall potential for cost reductions is rather limited and will be achieved mainly via an increase in efficiency, which will bring down specific investment costs.[5]

There is much speculation about the potential of carbon capture and storage (CCS) technology as a solution to mitigate climate change even though the technology is still under development.

CCS is a means of trapping CO_2 from fossil fuels, either before or after they are burned, and "storing" (effectively disposing of) it in the sea or beneath the surface of the earth. There are currently three different methods of capturing CO_2: 'pre-combustion', 'post-combustion', and 'oxyfuel combustion'. However, development is in a very early stage and CCS will not be implemented - in the best case - before 2020 and will probably not become commercially viable as a possible effective mitigation option until 2030.

The power company, Siemens, estimates that CO_2 capture costs for oxyfuel coal combustion is US$20-50 per tonne of CO_2. The IEA estimates capture costs between US$30-60 per tonne of CO_2 not emitted into the atmosphere. The costs include CO_2 compression but do not include the costs of CO_2 transport and storage. If CO_2 is transported 300 km from a single power plant, and is stored in an onshore reservoir that does not produce economic revenue, the additional cost may be around US$8 per tonne of stored CO_2. If CO_2 is transported a greater distance or stored in a distant offshore reservoir, the additional costs may be higher, up to US$20 per tonne of stored CO_2. As long as the price per tonne of CO_2 is below US$25-30, CCS might never take off - except with heavy subsidies and incentives, distorting competition for the best available technology including renewables: increase of end-use efficiency, gas-fired electricity generation and wind are already commercially available and have lower costs than future coal-fired electricity generation with CCS. In plants with CCS, about 10-15% of the CO_2 would still be emitted into the atmosphere. In addition, all of the power generation technologies emit some CO_2 and other pollutants indirectly, during fuel production and transportation and power plant production. Life-Cycle Assessments (LCA) covers such indirect emissions.

For the above reasons, CCS power plants are not included in our financial analysis.

reference
5 GREENPEACE INTERNATIONAL BRIEFING: CARBON CAPTURE AND STORAGE, DR. GOERNE, 2007

table 5: development of efficiency and investment costs for selected power plant technologies

		2010	2030	2050
Coal-fired condensing power plant	Efficiency (%)	41	45	**48**
	Investment costs ($/kW)	980	930	**880**
	Electricity generation costs including CO_2 emission costs ($ cents/kWh)	6.0	7.5	**8.7**
	CO_2 emissions [a)] (g/kWh)	837	728	**697**
Oil fired condensing power plant	Efficiency (%)	39	41	**41**
	Investment costs ($/kW)	670	620	**570**
	Electricity generation costs including CO_2 emission costs ($ cents/kWh)	22.5	31.0	**46.1**
	CO_2 emissions [a)] (g/kWh)	1,024	929	**888**
Natural gas combined cycle	Efficiency (%)	55	60	**62**
	Investment costs ($/kW)	530	490	**440**
	Electricity generation costs including CO_2 emission costs ($ cents/kWh)	6.7	8.6	**10.6**
	CO_2 emissions [a)] (g/kWh)	348	336	**325**

source DLR, 2006 [a)] REFERS TO DIRECT EMISSIONS ONLY, LIFE-CYCLE EMISSIONS ARE NOT CONSIDERED HERE.

investment cost projections for renewable energy technologies

Many of the technologies employed today for the utilization of renewable energy sources are at a relatively early stage of market development. Accordingly, the costs of electricity, heat and fuel production are as a rule higher today than the costs of competing conventional systems - a reminder that external costs of conventional power production are not calculated within the prices. It is expected, however, that compared with conventional technologies large cost reductions can be achieved due to technical learning, manufacturing improvements and large-scale production. Especially when developing long-term scenarios spanning periods of several decades, the dynamic trend of cost developments over time plays a crucial role in identifying economically sensible expansion strategies.

The correlation between specific investment costs and cumulative production volume of a technology that is empirically observed for many products can be represented in the form of so-called learning curves. The cost reduction that can be achieved by doubling cumulative production is known as the progress ratio (or learning factor; a progress ratio f = 0.9 means that costs fall by 10% if cumulative production doubles; this corresponds to a learning rate of 0.1). Technology-specific progress ratios are derived from a literature review.

No learning curves for technologies for the use of renewables have been as closely investigated as those for the photovoltaic (PV) sector, and there is scarcely any other technology for which one can find such agreement in the literature on the findings: the learning factor for PV modules, taken as the mean of the figures for various module types, is fairly constant over a period of 30 years at around 0.80, which is relatively high. This optimistic estimate is supported by the fact that it is still possible to achieve ongoing increases in the efficiency of PV modules both in the laboratory and under real conditions. In the long run, however, it must be assumed that the photovoltaic sector too will see a decline in the opportunities for cost reductions through technical learning, and that the learning rate will fall.

In the last 20 years the development of wind energy markets has taken very different courses in different regions. Accordingly, various studies have observed relatively large regional differences in the individual learning factors. In England, for example, a country where expansion of wind energy has been very hesitant to date, the learning factor is still around 0.75, which points to a sharp downward trend in costs. In Germany, by contrast, a learning factor of 0.94 was determined for wind energy systems built between 1990 and 2000. The low learning rate of 0.06 can be explained by the high level of advance investment by the manufacturers, who kept on putting new performance classes on the market at very short intervals. Although expectations are that the existing cost reduction potential is not yet exhausted, the low learning rate found for onshore systems in Germany is adopted here and taken as constant for the period under consideration. Owing to the relative lack of experience in the offshore sector, however, a greater cost reduction potential is expected here and it is assumed that the learning rate will be correspondingly higher.

Owing to the small number of concentrated solar power plants built to date, it is particularly difficult to arrive at reliable learning factors for this sector. Here it is assumed that the learning factor of 0.88 derived from the data for parabolic trough reflectors built in California will change to 0.95 in the course of market introduction up to 2050.

For geothermal power generation systems there are no learning curves in the literature despite a worldwide installed capacity of around 10,000 MWel. Since a large proportion of the costs in the geothermal field is due to deep drilling, the figures for the oil production sector can be used for drawing analogies here. Scenarios drawn up by the IPCC work on the basis that geothermal power generation costs will fall by nearly 50 percent by 2050.

A learning factor of 0.986 was determined for hydropower plants built in the OECD countries between 1975 and 1993. Recent experience however shows that as a result of compensating measures for nature conservation, which can amount to as much as 30 percent of the investment volume, the specific costs for hydropower plants will tend to rise. We thus assume a progress ratio of 1.1, leading to an increase of specific investment costs.

table 6: investment cost projections for renewable energy technologies

		2003	2010	2020	2030	2040	2050
Photovoltaic							
capacity	GW	0.56	22.9	202	511	735	894
cumulated capacity	GW	2.88	25.4	214	604	1,032	1,485
progress ratio			0.8	0.8	0.85	0.9	0,92
investment costs	€/kWp	5,750	2,853	1,436	1,126	1,038	994
Generation costs (min/max)	ct/kWh	0.37-0.76	0.21-0.45	0.11-0.22	0.07-0.14	0.06-0.11	0.05-0.1
Concentrating solar thermal							
capacity	GW	0.354	4.6	72	273	459	628
cumulated capacity	GW	0.354	4.7	74	311	634	1,032
progress ratio			0.88	0.88	0.93	0.95	0.95
investment costs	€/kWp	2,300	1,426	858	738	701	676
Generation costs (min/max)	ct/kWh	0.18-0,20	0.08-0.12	0.06-0.09	0.06-0.09	0.06-0.09	0.05-0.09
Wind							
capacity	GW	41	256	1,024	1,509	1,884	2225
cumulated capacity	GW	41	270	1,166	2,163	3,293	4,576
progress ratio			0.94	0.94	0.94	0.94	0.94
investment costs	€/kWp	1,350	1,141	1,001	948	913	886
Generation costs (min/max)	ct/kWh	0.08-0.1	0.07-0.08	0.06-0.07	0.05-0.06	0.05-0.06	0.05-0.06
Biomass (no CHP applications)							
capacity	GW	28	85	177	261	352	433
cumulated capacity	GW	28	95	229	402	623	880
progress ratio			0.85	0.86	0.87	0.9	0.92
investment costs	€/kWp	3,850	2,893	2,387	2,132	1,995	1,914
Generation costs (min/max)	ct/kWh	0.06-0.10	0.06-0.11	0.06-0.11	0.06-0.12	0.07-0.12	0.07-0.12
Geothermal							
capacity	GW	10	17	26	39	54	69
cumulated capacity	GW	10	21	38	64	99	141
progress ratio			0.8	0.8	0.85	0.9	0.9
investment costs	€/kWp	8,000	6,349	5,205	4,606	4,314	4,087
Generation costs (min/max)	ct/kWh	0.12-0.23	0.11-0.19	0.10-0.15	0.08-0.12	0.07-0.10	0.07-0.10
Hydro							
capacity	GW	800	938	1,089	1,193	1,285	1,358
cumulated capacity	GW	800	1,218	1,838	2,487	3,175	3,891
progress ratio			1.1	1.1	1.1	1.1	1.1
investment costs	€/kWp	2,200	2,331	2,467	2,571	2,659	2,734
Generation costs (min/max)	ct/kWh	0.03-0.07	0.04-0.09	0.05-0.10	0.05-0.10	0.06-0.10	0.06-0.11
Ocean energy							
capacity	GW	0.24	3.4	13	36	70	104
cumulated capacity	GW	0.24	3.5	15	44	96	165
progress ratio			0.85	0.85	0.87	0.9	0.92
investment costs	€/kWp	6,000	3,204	2,276	1,830	1,626	1,524
Generation costs (min/max)	ct/kWh	0.49-0.55	0.11-0.36	0.07-0.19	0.06-0.17	0.05-0.13	0.04-0.10

figure 5: maximum and minimum electricity generating costs of renewable and non renewable energy sources. PV vs Oil/Diesel including peak power and residential power prices

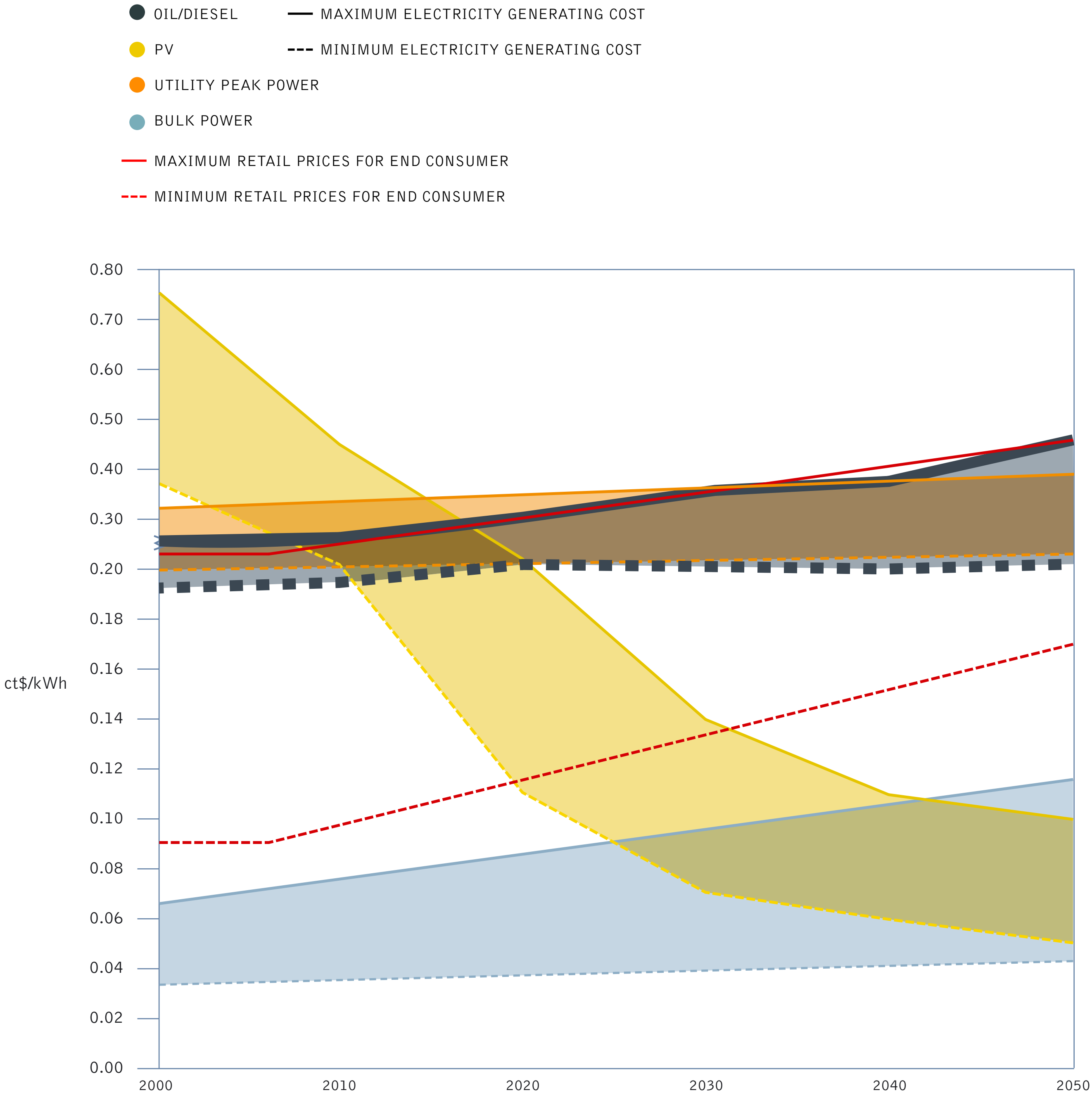


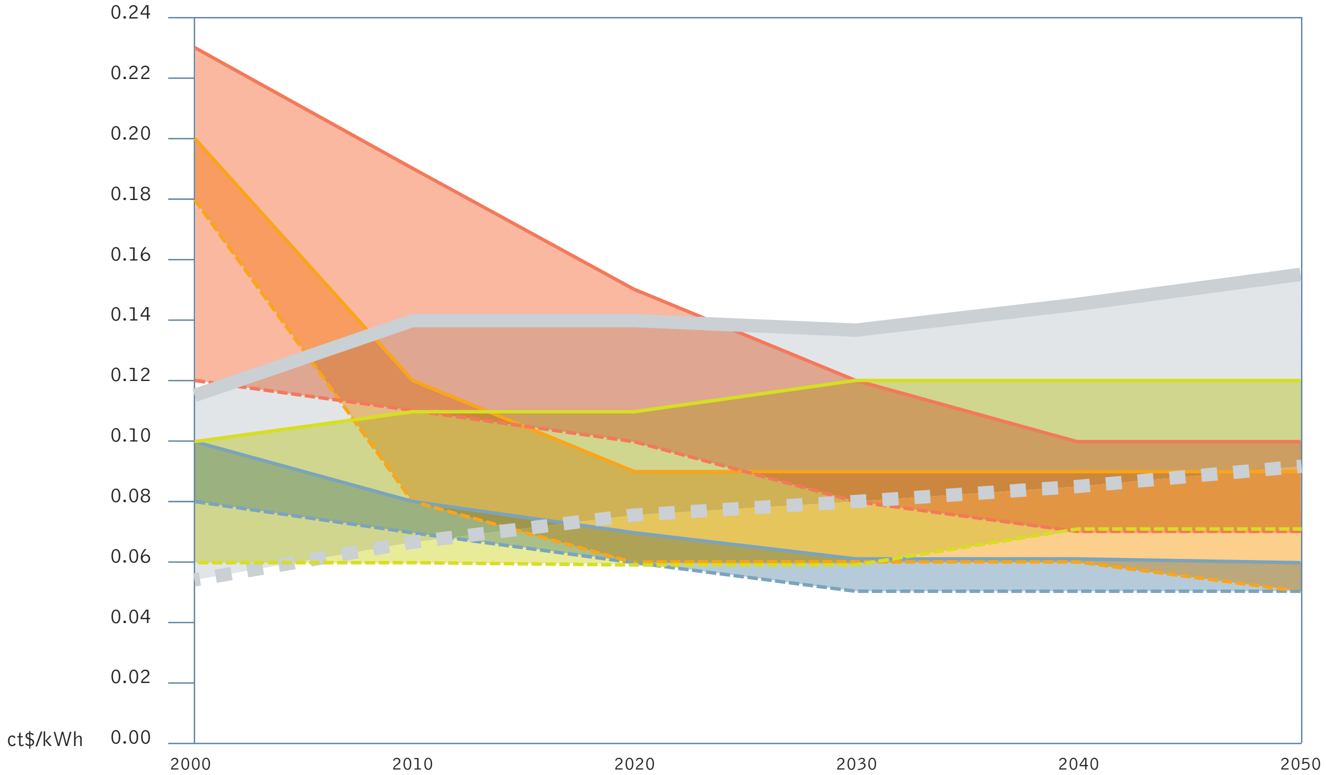
figure 6 & 7: maximum and minimum electricity generating costs of renewable and non renewable energy sources

— MAXIMUM ELECTRICITY GENERATING COST

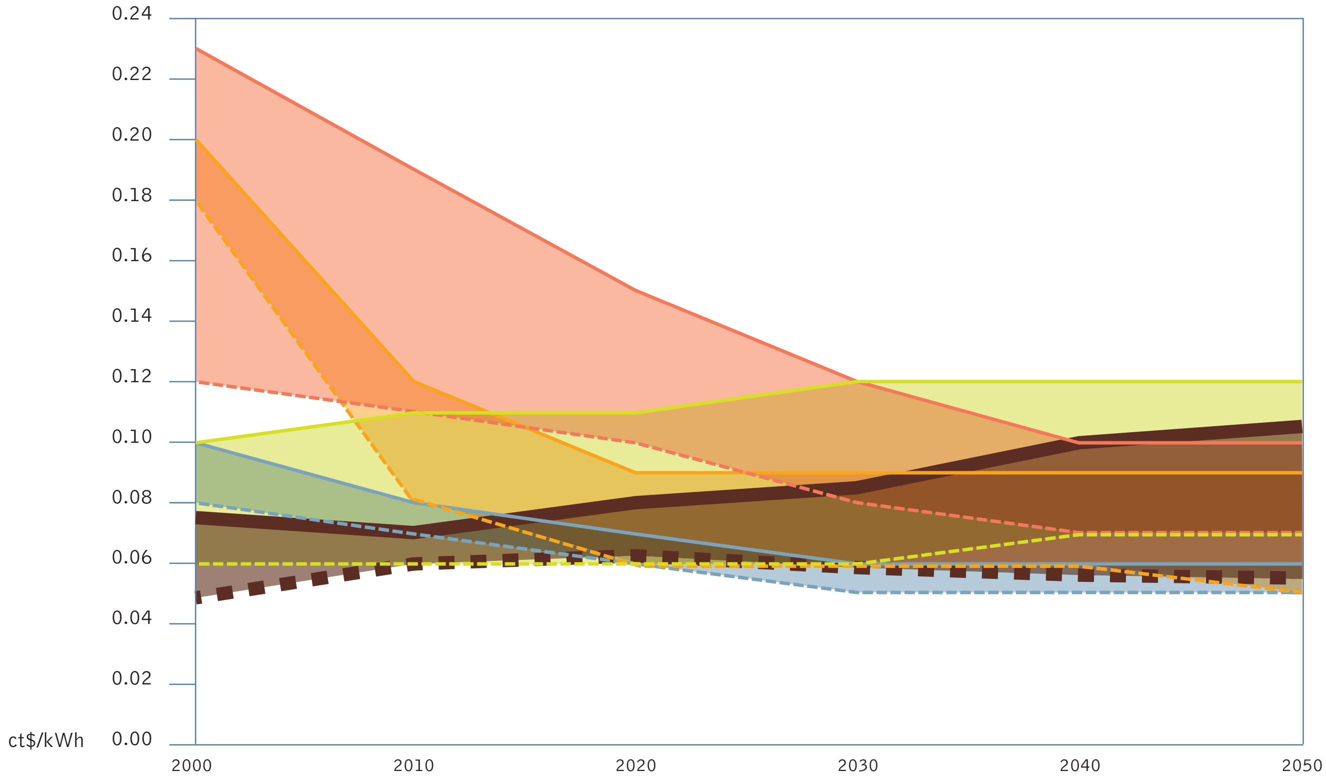
--- MINIMUM ELECTRICITY GENERATING COST

- NATURAL GAS CC
- COAL
- WIND
- GEOTHERMAL CHP
- BIOMASS (NO CHP APPLICATIONS)
- CONCENTRATING SOLAR THERMAL

gas vs concentrating solar thermal, wind, biomass and geothermal



coal vs concentrating solar thermal, wind, biomass and geothermal



fuel costs

THE RECENT DRAMATIC INCREASE IN GLOBAL OIL PRICES HAS RESULTED IN MUCH HIGHER FORWARD PRICE PROJECTIONS.

3

image FLARE STACK AT AN OIL REFINERY IN IMMINGHAM, UK.

fossil fuel price projections

The recent dramatic increase in global oil prices has resulted in much higher forward price projections. Under the 2004 'high oil and gas price' scenario by the European Commission, for example, an oil price of just US$34/bbl was assumed in 2030. Ongoing modelling funded by the Commission (CASCADE-MINTS 2006), on the other hand, assumes an oil price of US$94/bbl in 2050, a gas price of US$15/GJ and an international coal price of US$95/t.

Current projections of oil prices in 2030 range from the IEA's US$52/bbl up to over US$100. As the supply of natural gas is limited by the availability of pipeline infrastructure, there is no world market price for natural gas. In most regions of the world the gas price is directly tied to the price of oil. Current projections of gas prices in 2030 range from the US Department of Energy's US$4.5/GJ up to the highest figure of US$6.9/GJ. Taking into account the recent development of energy prices, these projections might be considered too conservative. Considering the growing global demand for oil and gas we have assumed a price development path for fossil fuels in which the price of oil reaches US$85/bbl by 2030 and US$100/bbl in 2050. Gas prices are assumed to increase to US$9-$10/GJ by 2050.

image A COW INFRONT OF A BIOREACTOR IN THE BIOENERGY VILLAGE OF JUEHNDE. IT IS THE FIRST COMMUNITY IN GERMANY THAT PRODUCES ALL OF ITS ENERGY NEEDED FOR HEATING AND ELECTRICITY, WITH CO_2 NEUTRAL BIOMASS.

table 7: assumptions on fossil fuel price development

FOSSIL FUELS	2003	2010	2020	2030	2040	2050
Crude oil in $2000/bbl	28.0	62.0	75.0	85.0	93.0	**100.0**
Natural gas in $2000/GJ						
- America	3.1	4.4	5.6	6.7	8.0	**9.2**
- Europe	3.5	4.9	6.2	7.5	8.8	**10.1**
- Asia	5.3	7.4	7.8	8.0	9.2	**10.5**
Hard coal $2000/t	42.3	59.4	66.2	72.9	79.7	**86.4**

table 8: assumptions on biomass price development

$2000/GJ

BIOMASS	2003	2010	2020	2030	2040	2050
Biomass in $2000/GJ						
- Europe	4.8	5.8	6.4	7.0	7.3	**7.6**
- other Regions	1.4	1.8	2.3	2.7	3.0	**3.2**

table 9: assumptions on CO_2 price development

($/T$CO_2$)

COUNTRIES	2010	2020	2030	2040	2050
Kyoto Annex B countries	10	20	30	40	**50**
Non-Annex B countries		20	30	40	**50**

biomass price projections

Compared to fossil fuels, biomass prices are highly variable, ranging from no or low costs for residues or traditional biomass in Africa or Asia to comparatively high costs for biofuels from energy crops. Despite this variability, this paper assumes an aggregated price for biomass in Europe. The increasing biomass prices reflect the link between biofuel and fossil fuel prices and a rising share of energy crops. For other regions prices are assumed to be lower, considering the large amount of traditional biomass use in developing countries and the high potential of as yet unused residues in North America and the Transition Economies.

cost of CO_2 emissions

Projections of CO_2 emission costs are even more uncertain than energy prices. IEA (2006b) assumes a CO_2 reduction incentive of 25 US$/t$CO_2$ in 2050. A study commissioned by the German Advisory Council on Global Change (WBGU 2003) suggests that under a 450 ppm CO_2 stabilisation scenario the price for global CO_2 emission allowances will rise to around 50 US$/t$CO_2$ in 2030, and - depending on the scenario - to more than 100 US$/t$CO_2$ in 2050. We assume that CO_2 costs rise linearly from 10 US$/t$CO_2$ in 2010 to 50 US$/t$CO_2$ in 2050, which is twice as high as the IEA's projection, but still conservative compared with other studies. We assume that CO_2 emission costs will be accounted for in Non-Annex B countries only after 2020.

Assigning a price to CO_2 emissions we implicitly assume the introduction of a global CO_2 tax, which further increases the economic competitiveness of renewable energies compared to fossil fuels.

renewable energy investments - status quo

RENEWABLE ENERGY MARKETS GREW ROBUSTLY IN 2005.
source ERIC MARTINOT / REN21

4

image A MAINTENANCE ENGINEER INSPECTS A WIND TURBINE AT THE DAN NAN WIND FARM IN NAN'AO, GUANGDONG PROVINCE WHICH HAS ONE OF THE BEST WIND RESOURCES IN CHINA AND IS ALREADY HOME TO SEVERAL INDUSTRIAL SCALE WIND FARMS. CHINA HAS INVESTED IN WIND POWER TO HELP OVERCOME ITS RELIANCE ON CLIMATE DESTROYING FOSSIL FUEL POWER AND SOLVE ITS ENERGY SUPPLY PROBLEM.

a global market overview

Renewable energy markets grew robustly in 2005. Large hydropower increased by an estimated 12-14 Gigawatts (GW) in 2005, led by China (7 GW added), Brazil (2.4 GW added), and India (over 1.3 GW added). Small hydro increased by 5 GW to total 66 GW worldwide, with 38.5 GW existing in China alone as the boom in small hydro investment there continued.

Wind power was second in power capacity added, with 11.5 GW added and existing capacity growing by 24 percent to reach 59 GW. More than half of global wind power additions were in three countries: the United States (2.4 GW), Germany (1.8 GW), and Spain (1.8 GW). India jumped ahead of Denmark into fourth place in terms of total installed capacity, adding 1.4 GW in 2005. Strong growth took place in China, with 0.5 GW added to the previous existing 0.8 GW. Offshore wind installations grew by at least 180 mega¬watts (MW).

Biomass power generation and heat supply continued to increase at both large and small scales, with an estimated 2-3 GW power capacity added in 2005, bringing existing biomass power capacity to about 44 GW. Annual increases of 50-100 percent or more in biomass power production were registered for 2004 (most recent data) in several OECD countries, including Germany, Hungary, the Netherlands, Poland, and Spain. Other increases of 10-30 percent were registered in Australia, Austria, Belgium, Denmark, Italy, South Korea, New Zealand, and Sweden. There is an increasing proliferation of small projects in developing countries, such as Thailand's "small power producers" program, which resulted by 2005 in 50 biomass power projects totalling 1 GW and several small-scale biogas power projects. Bagasse power plants are under development by the sugar industry in several countries, such as the Philippines and Brazil. Geothermal power saw continued growth as well, with contracts for an additional 0.5 GW in the United States and plants under construction in 11 countries.

Grid-connected solar photovoltaic (PV) continued to be the fastest growing power generation technology, with a 55 percent increase in cumulative installed capacity to 3.1 GW, up from 2.0 GW in 2004. More than half of the annual global increase occurred in Germany, which saw over 600 MW of PV installed in one year. Grid-connected solar PV increased by about 300 MW in Japan and 70 MW in the United States. Several milestones occurred in 2005, such as the commissioning of the world's largest solar PV power plant, 10 MW

image CONCENTRATING SOLAR POWER (CSP) AT A SOLAR FARM IN DAGGETT, CALIFORNIA, USA.

total, in Germany, and many large commercial installations of tens and hundreds of kilowatts (kW) each. German cumulative PV capacity exceeded Japan's for the first time. Including off-grid applications, total PV existing worldwide increased to 5.4 GW, up from 4.0 GW in 2004.[3]

Overall, renewable power capacity expanded to 182 GW, up from 160 GW in 2004, excluding large hydropower. The top six countries were China (42 GW), Germany (23 GW), the United States (23 GW), Spain (12 GW), India (7 GW), and Japan (6 GW). India's renewable power capacity exceeded Japan's for the first time. The capacity in developing countries grew from 70 GW to 80 GW, with China (small hydro) and India (wind) leading the increase. The developing-country share thus remained constant compared to 2004, at 44 percent. Including large hydropower, renewable power capacity reached 930 GW in 2005.

investment flows

An estimated US$38 billion was invested in new renewable energy capacity worldwide in 2005, up from US$30 billion in 2004. Almost all the increase was due to increased investment in solar PV and wind power. Technology shares of the US$38 billion annual investment were wind power (37 percent), solar PV (26 percent), solar hot water (11 percent), small hydropower (11 percent), biomass power and heat (7 percent), and geothermal power and heat (7 percent). So the overall investment in renewables within the power sector in 2006 was approximately US$33 billion. An additional US$15-20 billion was invested in large hydropower.

The largest country shares of annual investment were by Germany, China, the United States, Spain, Japan, and India. Investment in Germany and China increased from US$6 billion each in 2004 to US$7 billion each in 2005, mostly for wind and solar PV in Germany and for small hydro and solar hot water in China. The United States was number three, with about US$3.5 billion, followed by Spain and Japan, with more than US$2 billion each, and then India. (These figures do not include large hydropower; investment in large hydropower in China was an additional US$10 billion in 2005, with 7 GW of new capacity installed. Thus, counting large hydropower, China's investment was about US$17 billion.)

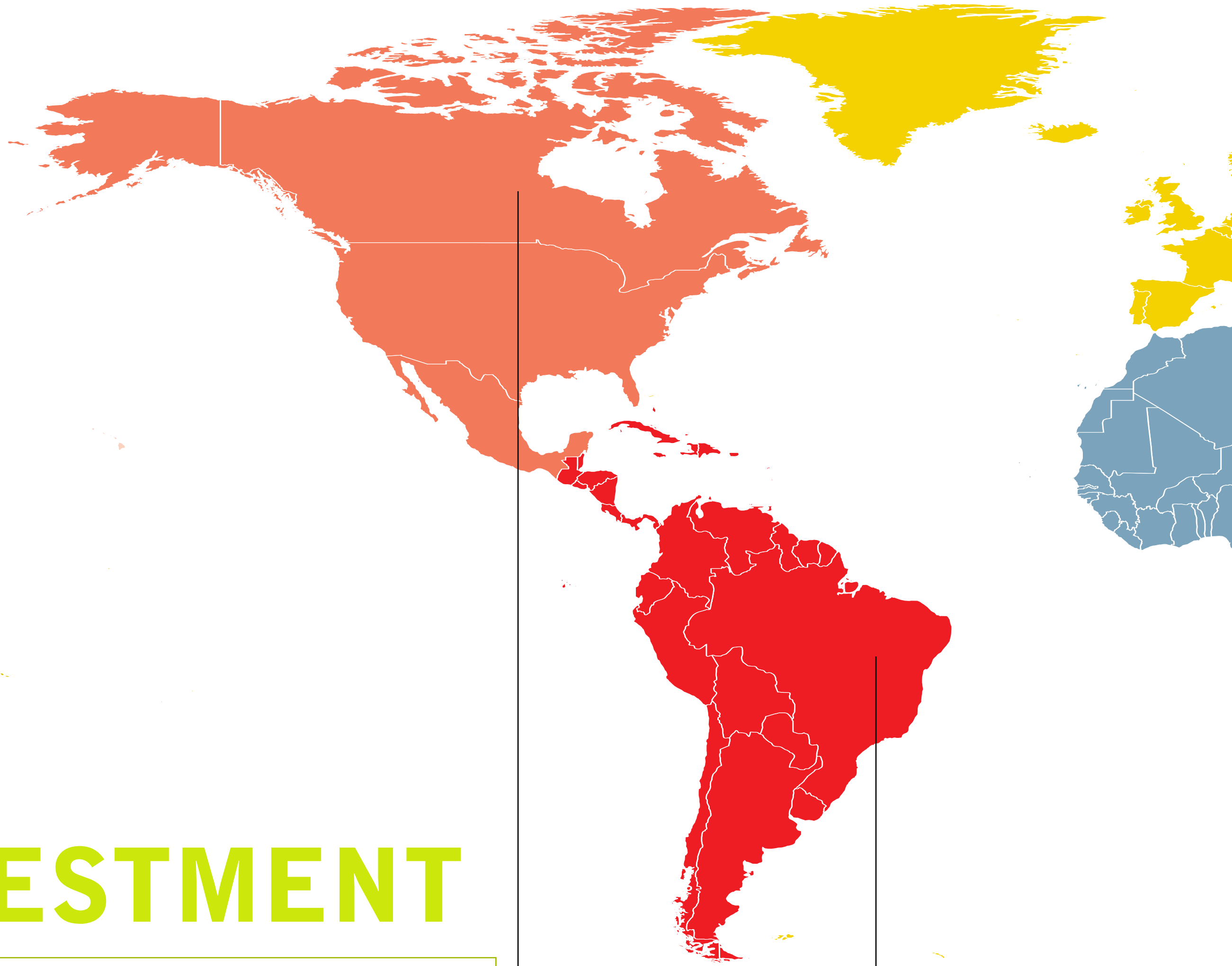
In addition to renewable energy capacity investment, the solar PV industries made substantial capital investments in new manufacturing plants and equipment in 2005. Investment by the solar PV industry in 2005 was an estimated US$6 billion and was expected to reach US$8-9 billion in 2006. Development assistance for renewables investments in developing countries continued at a slightly faster pace in 2005, as increased commitments and special funds came into play. KfW committed 137 million (US$170 million) to renewables in developing countries in 2005. The World Bank Group committed US$150 million to renewables (excluding GEF funds and carbon finance) plus US$420 million for large hydropower, both increases from 2004. The Global Environment Facility continued as in 2004, with US$100 million committed, about half of that for World Bank projects and the rest for other agencies. In addition, the "Special Facility for Renewable Energies and Energy Efficiency" announced at the "Renewables 2004" conference by the German government was launched in 2005 with funding of 500 million (US$625 million). Established by KfW, this facility will provide concessional loans to public agencies through 2009 for investments in countries that form part of Germany's program of development cooperation. In 2005, the German government made financing commitments of 170 million (US$210 million) under this facility.

table 10: selected indicators

	2004	2005
Investment in new renewable capacity (annual)	$30	$38 billion
Renewables power capacity (existing, excl. large hydro)	160	182 GW
Renewables power capacity (existing, incl. large hydro)	895	930 GW
Wind power capacity (existing)	48	59 GW
Grid-connected solar PV capacity (existing)	2.0	3.1 GW
Solar PV production (annual)	1,150	1,700 MW
Solar hot water capacity (existing)	77	88 GWth
Ethanol production (annual)	30.5	33 bill. litrs
Biodiesel production (annual)	2.1	3.9 bill. litrs
Countries with policy targets	45	49
States/provinces/countries with feed-in policies	37	41
States/provinces/countries with RPS policies	38	38
States/provinces/countries with biofuels mandates	22	38

map 1: investment in energy sources under the reference and the energy [r]evolution scenarios

WORLDWIDE SCENARIO



SCENARIO
INVESTMENT

LEGEND

> -30   > -20   > -10

> 0   > 10   > 20

> 30   > 40   > 50

> 60   > 70

% INCREASE OR DECREASE IN INVESTMENT NEEDED UNDER THE E[R] SCENARIO WHEN COMPARED TO REFERENCE SCENARIO 2004-2030. GLOBAL CHANGE IN INVESTMENT IS 9.4%

0   1000 KM

REF REFERENCE SCENARIO

E[R] ALTERNATIVE SCENARIO

DIF DIFFERENCE BETWEEN SCENARIOS

INVESTMENT IN NUCLEAR POWER PLANTS BILLION $

INVESTMENT IN FOSSIL FUEL POWER PLANTS BILLION $

INVESTMENT IN RENEWABLE POWER PLANTS BILLION $

OECD NORTH AMERICA

		REF	E[R]	DIF
	2004-2010	61.0	0.0	-61
	2011-2020	61.2	0.0	-61
	2021-2030	41.9	0.0	-42
	2004-2030	164.1	0.0	-164
	2004-2010	199.3	53.0	-146
	2011-2020	218.0	44.2	-174
	2021-2030	202.8	38.8	-164
	2004-2030	620.1	136	-484
	2004-2010	164.6	214.1	50
	2011-2020	160.9	430.6	270
	2021-2030	220.9	506.8	286
	2004-2030	546.4	1151.4	606
	2004-2010	424.9	267.1	-158
TOTAL	2011-2020	440.0	474.8	35
	2021-2030	465.6	545.6	80
	2004-2030	1330.5	1287.4	-43

LATIN AMERICA

		REF	E[R]	DIF
	2004-2010	1.6	0.0	-2
	2011-2020	3.3	0.0	-3
	2021-2030	1.5	0.0	-2
	2004-2030	6.4	0.0	-6
	2004-2010	37.6	22.2	-15
	2011-2020	57.7	2.2	-55
	2021-2030	84.7	6.0	-79
	2004-2030	180	30.4	-150
	2004-2010	133.7	92.4	-41
	2011-2020	155.0	189.2	34
	2021-2030	163.6	219.4	56
	2004-2030	452.3	501.1	49
	2004-2010	172.9	114.6	-58
TOTAL	2011-2020	215.9	191.4	-25
	2021-2030	249.8	225.4	-24
	2004-2030	638.7	531.5	-107

OECD EUROPE

		REF	E[R]	DIF
	2004-2010	52.9	0.0	-53
	2011-2020	18.6	0.0	-19
	2021-2030	33.1	0.0	-33
	2004-2030	104.6	0.0	-105
	2004-2010	74.7	42.9	-32
	2011-2020	103.3	43.8	-59
	2021-2030	85.9	38.8	-47
	2004-2030	263.8	125.5	-138
	2004-2010	154.4	206.2	52
	2011-2020	190.0	343.6	154
	2021-2030	220.0	365.7	146
	2004-2030	564.4	915.5	351
	2004-2010	282.0	249.1	-33
TOTAL	2011-2020	311.9	387.4	76
	2021-2030	339.0	404.5	65
	2004-2030	932.9	1,041.0	108

MIDDLE EAST

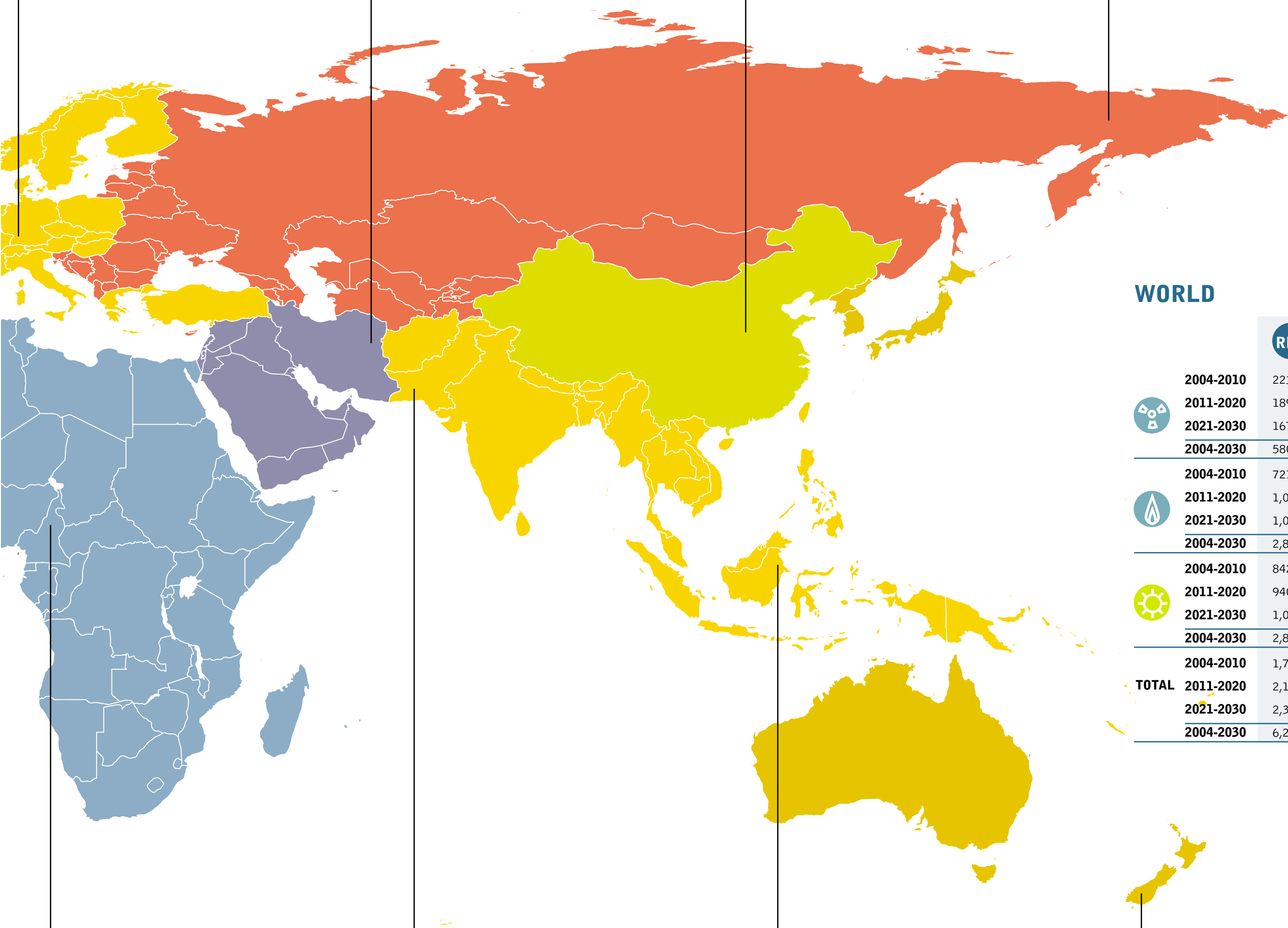
		REF	E[R]	DIF
	2004-2010	1.5	0.0	-1
	2011-2020	0.0	0.0	0
	2021-2030	0.0	0.0	0
	2004-2030	1.5	0.0	-1
	2004-2010	37.1	21.6	-15
	2011-2020	61.8	31.2	-31
	2021-2030	63.2	13.6	-50
	2004-2030	162.0	66.4	-96
	2004-2010	17.6	25.4	8
	2011-2020	10.1	64.7	55
	2021-2030	13.3	178.3	165
	2004-2030	40.9	268.3	227
	2004-2010	56.1	47.0	-9
TOTAL	2011-2020	71.9	95.8	24
	2021-2030	76.4	191.9	115
	2004-2030	204.4	334.8	130

CHINA

		REF	E[R]	DIF
	2004-2010	10.7	1.5	-9
	2011-2020	24.6	0.0	-25
	2021-2030	26.2	0.0	-26
	2004-2030	61.5	1.5	-62
	2004-2010	141.6	119.2	-22
	2011-2020	234.9	146.6	-88
	2021-2030	239.1	96.1	-143
	2004-2030	615.6	361.9	-254
	2004-2010	102.7	130.6	28
	2011-2020	178.6	353.7	175
	2021-2030	170.6	546.1	376
	2004-2030	451.9	1,030.4	579
	2004-2010	255.0	251.4	-4
TOTAL	2011-2020	438.1	500.3	62
	2021-2030	435.9	642.2	206
	2004-2030	1,129.0	1,392.4	263

TRANSITION ECONOMIES

		REF	E[R]	DIF
	2004-2010	17.0	0.0	-17
	2011-2020	26.9	0.0	-27
	2021-2030	15.3	0.0	-15
	2004-2030	59.2	0.0	-59
	2004-2010	19.9	.6	-10
	2011-2020	33.8	14.6	-19
	2021-2030	37.4	3.9	-33
	2004-2030	91.0	28.2	-63
	2004-2010	79.2	50.6	-29
	2011-2020	66.1	84.7	19
	2021-2030	73.6	201.6	128
	2004-2030	218.8	336.9	118
	2004-2010	116.1	60.2	-56
TOTAL	2011-2020	126.7	99.3	-27
	2021-2030	126.2	205.5	79
	2004-2030	369.1	365.1	-4



WORLD

		REF	E[R]	DIF
	2004-2010	223.7	1.5	-222
	2011-2020	189.6	0.0	-190
	2021-2030	167.6	0.0	-168
	2004-2030	580.9	1.5	-580
	2004-2010	721.7	397.2	-325
	2011-2020	1,044.0	416.4	-628
	2021-2030	1,078.3	316.0	-762
	2004-2030	2,844.1	1,129.6	-1,715
	2004-2010	842.4	955.0	113
	2011-2020	940.2	2,044.9	1,105
	2021-2030	1,089.3	2,761.5	1,672
	2004-2030	2,871.1	5761.3	2,890
	2004-2010	1,787.8	1,353.7	-434
TOTAL	2011-2020	2,173.8	2,461.3	287
	2021-2030	2,335.2	3,077.6	742
	2004-2030	6,296.1	6891.0	595

AFRICA

		REF	E[R]	DIF
	2004-2010	0.9	0.0	-1
	2011-2020	0.9	0.0	-1
	2021-2030	0.9	0.0	-1
	2004-2030	2.7	0.0	-3
	2004-2010	39.4	20.4	-19
	2011-2020	59.9	21.6	-38
	2021-2030	75.6	12.8	-63
	2004-2030	174.9	54.7	-120
	2004-2010	13.6	22.0	8
	2011-2020	14.5	85.6	71
	2021-2030	41.8	199.2	157
	2004-2030	69.1	306.7	238
	2004-2010	54.0	42.3	-12
TOTAL	2011-2020	75.3	107.2	32
	2021-2030	118.3	212.0	94
	2004-2030	246.7	361.4	115

SOUTH ASIA

		REF	E[R]	DIF
	2004-2010	10.1	0.0	-10
	2011-2020	8.1	0.0	-8
	2021-2030	12.5	0.0	-12
	2004-2030	30.7	0.0	-31
	2004-2010	45.2	18.3	-27
	2011-2020	84.6	31.8	-53
	2021-2030	107.4	29.9	-77
	2004-2030	237.1	80.0	-157
	2004-2010	57.1	77.3	20
	2011-2020	57.1	143.3	86
	2021-2030	53.5	195.1	142
	2004-2030	167.7	415.7	248
	2004-2010	112.3	95.6	-17
TOTAL	2011-2020	149.8	175.1	25
	2021-2030	173.3	225.0	52
	2004-2030	435.4	495.7	60

EAST ASIA

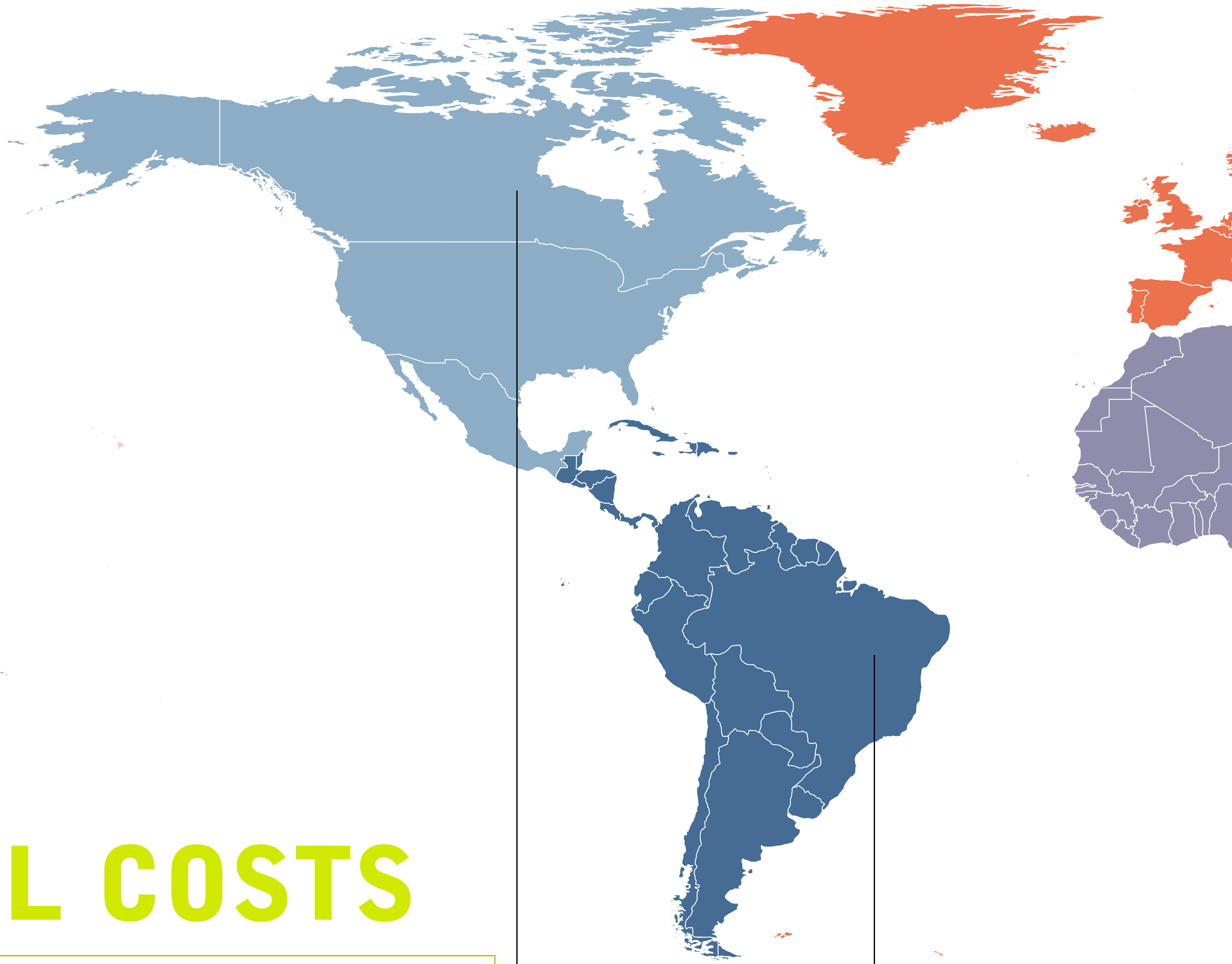
		REF	E[R]	DIF
	2004-2010	6.5	0.0	-6
	2011-2020	4.6	0.0	-5
	2021-2030	4.6	0.0	-5
	2004-2030	15.7	0.0	-16
	2004-2010	54.3	28.6	-26
	2011-2020	96.4	31.6	-65
	2021-2030	100.1	20.2	-80
	2004-2030	250.9	80.4	-170
	2004-2010	73.5	81.1	8
	2011-2020	49.8	158.5	109
	2021-2030	60.9	191.8	131
	2004-2030	184.2	431.4	247
	2004-2010	134.3	109.7	-25
TOTAL	2011-2020	150.9	190.1	39
	2021-2030	165.6	212.0	46
	2004-2030	450.8	511.8	61

OECD PACIFIC

		REF	E[R]	DIF
	2004-2010	61.5	0.0	-61
	2011-2020	41.4	0.0	-41
	2021-2030	31.6	0.0	-32
	2004-2030	134.4	0.0	-134
	2004-2010	72.8	61.3	-11
	2011-2020	93.6	48.8	-45
	2021-2030	82.1	55.9	-26
	2004-2030	248.5	166	-82
	2004-2010	46.1	55.3	9
	2011-2020	58.2	191.0	133
	2021-2030	71.3	157.5	86
	2004-2030	175.6	403.8	228
	2004-2010	180.3	116.6	-64
TOTAL	2011-2020	193.2	239.8	47
	2021-2030	185.1	213.5	28
	2004-2030	558.6	569.8	11

map 1: fuel costs in the reference and the energy [r]evolution scenario

WORLDWIDE SCENARIO



SCENARIO

FUEL COSTS

LEGEND

> 0 · > 5 · > 10 · > 15 · > 20 · > 25 · > 30 · > 35 · > 40 · > 45 · > 50

% FUEL COST SAVING IN THE ALTERNATIVE SCENARIO COMPARED TO THE REFERENCE SCENARIO 2004-20030. GLOBAL FUEL SAVING IS 29.38%

REF REFERENCE SCENARIO
E[R] ALTERNATIVE SCENARIO
DIF DIFFERENCE BETWEEN SCENARIOS

0 1000 KM

COST OF COAL BILLION $
COST OF GAS BILLION $
COST OF OIL BILLION $

OECD NORTH AMERICA

		REF	E[R]	DIF
Coal	2004-2010	409	351	58
	2011-2020	639	353	286
	2021-2030	723	197	525
	2004-2030	1,771	901	870
Gas	2004-2010	327	304	23
	2011-2020	578	464	114
	2021-2030	776	552	224
	2004-2030	1,680	1,320	361
Oil	2004-2010	128	103	26
	2011-2020	235	98	137
	2021-2030	240	53	187
	2004-2030	604	254	350
TOTAL ALL FUELS	2004-2010	865	758	107
	2011-2020	1,452	915	537
	2021-2030	1,738	802	936
	2004-2030	4,055	2,475	1,580

OECD LATIN AMERICA

		REF	E[R]	DIF
Coal	2004-2010	6	4	2
	2011-2020	13	4	9
	2021-2030	20	4	16
	2004-2030	39	11	28
Gas	2004-2010	52	50	1
	2011-2020	163	105	58
	2021-2030	336	106	230
	2004-2030	551	261	289
Oil	2004-2010	53	40	13
	2011-2020	93	35	58
	2021-2030	84	16	69
	2004-2030	231	91	140
TOTAL ALL FUELS	2004-2010	111	94	17
	2011-2020	268	143	125
	2021-2030	441	126	315
	2004-2030	820	363	457

OECD EUROPE

		REF	E[R]	DIF
	2004-2010	132	114	18
	2011-2020	237	143	94
	2021-2030	308	115	193
	2004-2030	677	372	305
	2004-2010	192	204	-12
	2011-2020	363	399	-36
	2021-2030	528	581	-53
	2004-2030	1,083	1,183	-100
	2004-2010	92	87	5
	2011-2020	117	87	30
	2021-2030	86	40	47
	2004-2030	295	214	81
TOTAL ALL FUELS	2004-2010	416	405	11
	2011-2020	718	629	89
	2021-2030	922	735	187
	2004-2030	2,056	1,769	287

MIDDLE EAST

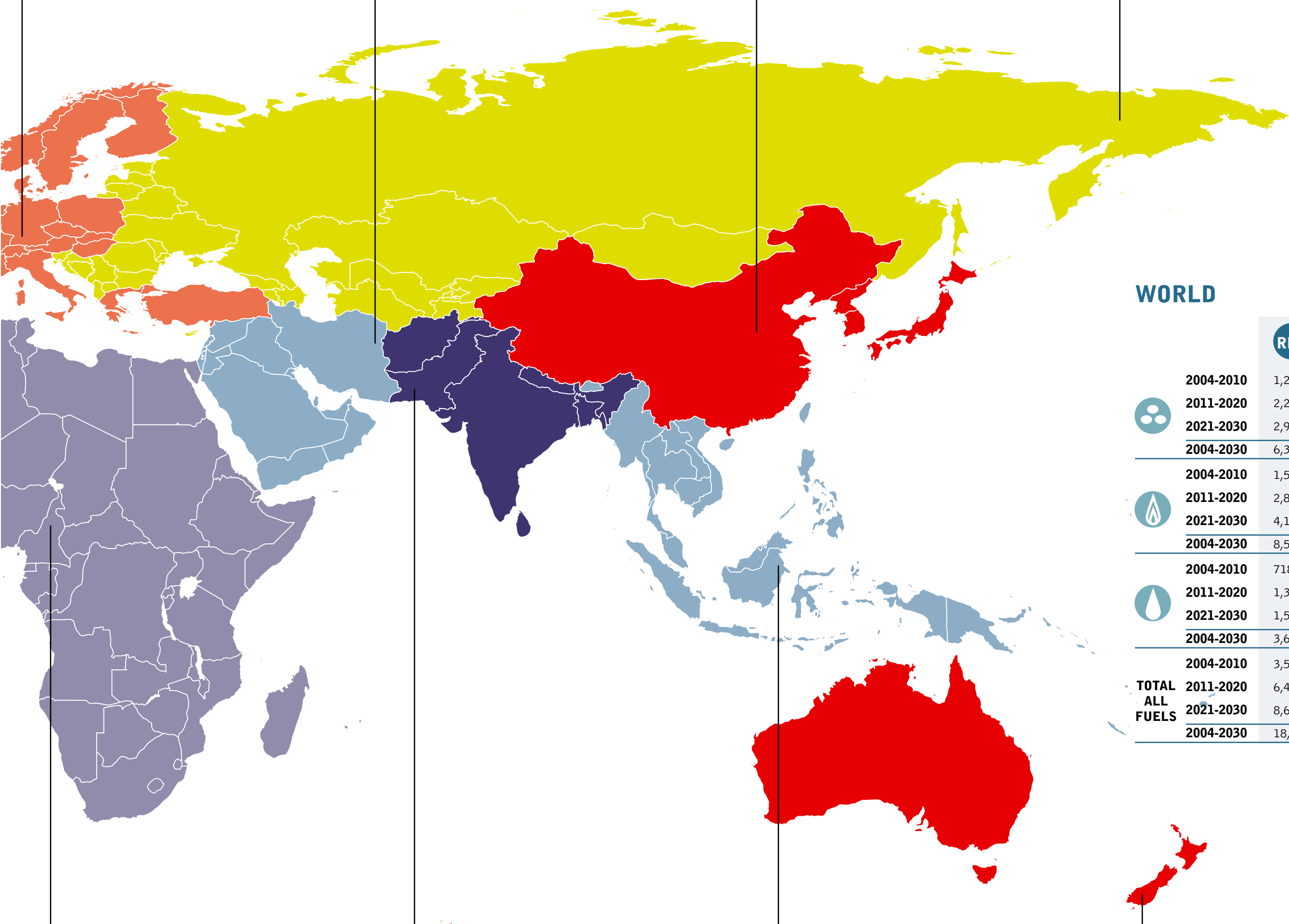
		REF	E[R]	DIF
	2004-2010	6	5	1
	2011-2020	12	7	4
	2021-2030	16	8	7
	2004-2030	33	21	12
	2004-2010	124	120	4
	2011-2020	260	232	28
	2021-2030	397	287	110
	2004-2030	780	638	141
	2004-2010	128	108	20
	2011-2020	275	132	143
	2021-2030	383	73	310
	2004-2030	786	313	473
TOTAL ALL FUELS	2004-2010	258	233	25
	2011-2020	546	371	175
	2021-2030	796	368	427
	2004-2030	1,599	972	627

CHINA

		REF	E[R]	DIF
	2004-2010	322	304	18
	2011-2020	639	494	145
	2021-2030	937	516	421
	2004-2030	1,898	1,315	584
	2004-2010	19	43	-24
	2011-2020	84	219	-135
	2021-2030	166	460	-295
	2004-2030	269	722	-453
	2004-2010	36	33	3
	2011-2020	69	53	17
	2021-2030	71	43	28
	2004-2030	177	159	48
TOTAL ALL FUELS	2004-2010	377	379	-3
	2011-2020	793	767	26
	2021-2030	1,174	1,020	154
	2004-2030	2,344	2,166	178

TRANSITION ECONOMIES

		REF	E[R]	DIF
	2004-2010	99	86	13
	2011-2020	137	94	44
	2021-2030	126	72	54
	2004-2030	362	251	110
	2004-2010	378	376	2
	2011-2020	532	466	66
	2021-2030	646	402	244
	2004-2030	1,556	1,245	311
	2004-2010	48	37	11
	2011-2020	81	33	48
	2021-2030	79	14	65
	2004-2030	208	84	124
TOTAL ALL FUELS	2004-2010	525	499	26
	2011-2020	751	593	158
	2021-2030	851	488	362
	2004-2030	2,126	1,580	546



WORLD

		REF	E[R]	DIF
	2004-2010	1,248	1,114	134
	2011-2020	2,213	1,433	780
	2021-2030	2,929	1,176	1,753
	2004-2030	6,389	3,723	2,667
	2004-2010	1,538	1,519	19
	2011-2020	2,883	2,735	148
	2021-2030	4,154	3,491	663
	2004-2030	8,576	7,745	831
	2004-2010	718	590	127
	2011-2020	1,373	673	700
	2021-2030	1,525	390	1,135
	2004-2030	3,616	1,654	1,962
TOTAL ALL FUELS	2004-2010	3,504	3,223	281
	2011-2020	6,469	4,842	1,628
	2021-2030	8,608	5,057	3,551
	2004-2030	18,581	13,122	5,459

AFRICA

		REF	E[R]	DIF
	2004-2010	44	43	1
	2011-2020	83	65	18
	2021-2030	114	59	56
	2004-2030	242	167	75
	2004-2010	54	47	7
	2011-2020	157	107	50
	2021-2030	331	169	191
	2004-2030	542	323	218
	2004-2010	43	28	15
	2011-2020	114	31	83
	2021-2030	167	14	152
	2004-2030	324	73	251
TOTAL ALL FUELS	2004-2010	141	118	24
	2011-2020	355	203	151
	2021-2030	612	242	369
	2004-2030	1,108	564	544

SOUTH ASIA

		REF	E[R]	DIF
	2004-2010	99	86	14
	2011-2020	192	107	85
	2021-2030	297	81	216
	2004-2030	588	273	315
	2004-2010	65	38	26
	2011-2020	159	156	2
	2021-2030	256	262	-6
	2004-2030	480	457	23
	2004-2010	36	23	13
	2011-2020	94	22	72
	2021-2030	129	8	121
	2004-2030	259	53	205
TOTAL ALL FUELS	2004-2010	199	147	53
	2011-2020	445	285	159
	2021-2030	682	351	331
	2004-2030	1,326	783	543

EAST ASIA

		REF	E[R]	DIF
	2004-2010	39	38	0
	2011-2020	92	56	36
	2021-2030	185	48	137
	2004-2030	316	142	174
	2004-2010	137	132	4
	2011-2020	262	228	34
	2021-2030	329	259	69
	2004-2030	727	619	108
	2004-2010	67	47	20
	2011-2020	165	68	97
	2021-2030	185	51	134
	2004-2030	418	166	251
TOTAL ALL FUELS	2004-2010	243	218	25
	2011-2020	518	351	167
	2021-2030	699	359	341
	2004-2030	1,460	928	532

OECD PACIFIC

		REF	E[R]	DIF
	2004-2010	92	83	9
	2011-2020	169	110	59
	2021-2030	202	75	127
	2004-2030	464	269	195
	2004-2010	191	204	-13
	2011-2020	326	359	-33
	2021-2030	391	412	-21
	2004-2030	908	975	-67
	2004-2010	86	85	1
	2011-2020	129	115	14
	2021-2030	100	78	23
	2004-2030	315	278	38
TOTAL ALL FUELS	2004-2010	370	373	-3
	2011-2020	624	584	40
	2021-2030	693	565	128
	2004-2030	1,687	1,522	165

GREENPEACE
DESIGN WWW.ONEHEMISPHERE.SE CONCEPT SVEN TESKE/GREENPEACE INTERNATIONAL.

table 11: top five contries with regards to renewable energy capacity[6]

TOP FIVE COUNTRIES	#1	#2	#3	#4	#5
Annual amounts or capacity addition in 2005					
Annual investment	Germany/China (equal)		United States	Japan	Spain
Wind power	United States	Germany	Spain	India	China
Solar PV (grid connected)	Germany	Japan	United States	Spain	France
Solar hot water	China	Turkey	Germany	India	Austria/Greece/ Japan/Australia
Ethanol production	Brazil/United States (equal)		China	Spain/India (equal)	
Biodiesel produciton	Germany	France	Italy	United States	Czech Republic
Existing capacity as of 2005					
Renewables power capacity (excl. large hydro)	China	Germany	United States	Spain	India
Large hydro	United States	China	Brazil	Canada	Japan/Russia
Small hydro	China	Japan	United States	Italy	Brazil
Wind power	Germany	Spain	United States	India	Denmark
Biomass power	United States	Brazil	Phillippines	Germany/Sweden/Finland (equal)	
Geothermal power	United States	Phillippines	Mexico	Indonesia/Italy (equal)	
Solar PV (grid connected)	Germany	Japan	United States	Spain	Netherlands
Solar hot water	China	Turkey	Japan	Germany	Israel

source ERIC MARTINOT, REN21

figure 8: renewable power capacities for developing countries, EU, and top 6 individual countries, 2005.[7]
EXCLUDES LARGE HYDROPOWER

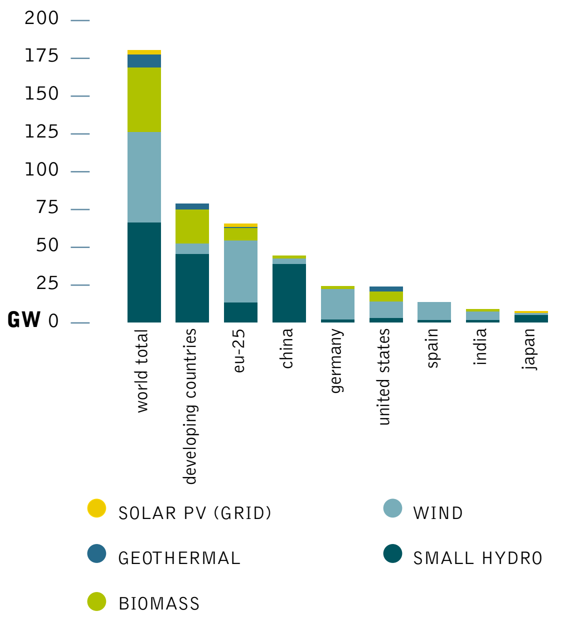
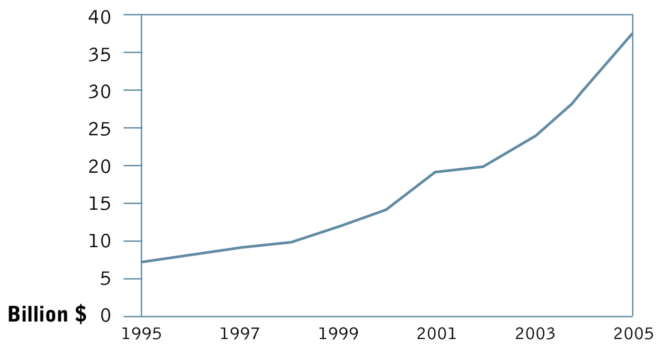


figure 9: annual investment in renewable energy 1995-2005.[8]



references
6 ERIC MARTINOT, REN21
7 ERIC MARTINOT, REN21
8 ERIC MARTINOT, REN21

investment in new power plants

THE AVERAGE ANNUAL INVESTMENTS IN THE POWER SECTOR IN THE ENERGY [R]EVOLUTION SCENARIO BETWEEN 2004 AND 2030 IS APPROX. €280 BILLION (= US$300-350 BILLION) - WHICH IS EQUAL TO THE CURRENT AMOUNT OF SUBSIDIES FOR FOSSIL FUELS GLOBALLY.

5

image BIOMASS ENERGY PLANT NEAR VARNAMO, SWEDEN.

The overall global market volume for new power plants until 2030 will be in the region of US$7 trillion.

The main driver for investment in new power generation in OECD countries will be the ageing power plant fleet.

Utilities will make their technology choices within the next 5 to 10 years based on national energy policies - especially liberalisation, renewable energy and CO_2 reduction targets.

Within Europe, the emission trading scheme may have a large impact on whether the majority of investment will go towards conventional fossil fuel power plants or co-generation.

International finance institutes will not play a role in the investment decisions of OECD based utilities, as they will finance the new projects themselves. However, in developing countries, international financial institutes will play a major role in future technology choices.

The investment volume in the Energy [R]evolution Scenario is US$7.5 trillion, approx 9% higher than in the Reference Scenario, which will require US$6.9 trillion.

While the overall investment in renewable energy and fossil fuels is almost equal in the Reference Scenario, with approx. US$3.1 trillion each until 2030, the Energy [R]evolution Scenario shifts more than 80% of the investment towards renewable energy. The fossil fuels share within the power sector focuses mainly on combined heat and power and efficient gas power plants.

The average annual investments in the power sector in the Energy [R]evolution Scenario between 2004 and 2030 is approx. €280 billion (= US$300-350 billion) - which is equal to the current amount of subsidies for fossil fuels globally.

figure 10: global investment in new power plants

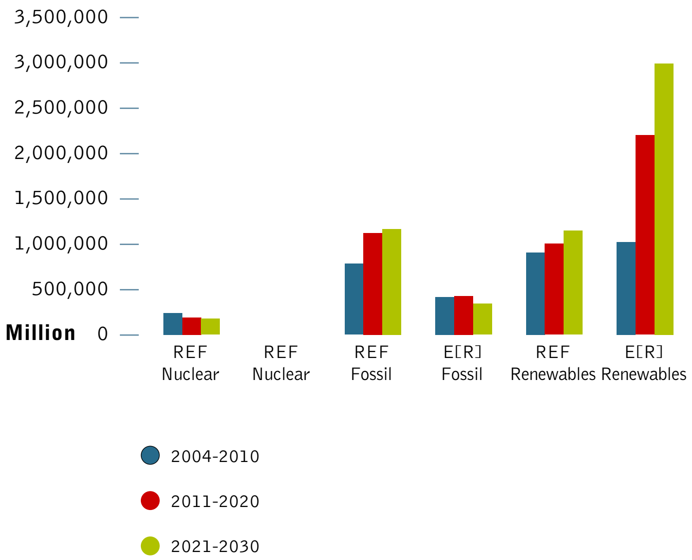


figure 11: change in cumulative power plant investment in the energy [r]evolution scenario

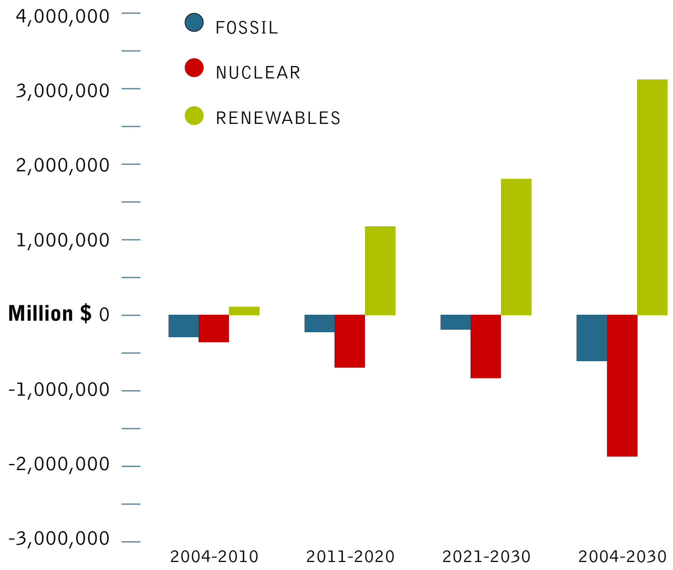


table 12: global investment in new power plants - REF

ENERGY INVESMENT	2003 - 2010 billion $2000	2011 - 2020 billion $2001	2021 - 2030 billion $2002	**2004 - 2030** billion $2004	**2004 - 2030** billion $2005
- Nuclear power plant	224	190	168	**581**	**22**
- Fossil fuels	722	1,044	1,078	**2,844**	**105**
- Renewables	842	940	1,089	**2,871**	**106**
Total	1,788	2,174	2,335	**6,296**	**233**

table 13: global investment in new power plants - E[R]

ENERGY INVESMENT	2003 - 2010 billion $2000	2011 - 2020 billion $2001	2021 - 2030 billion $2002	**2004 - 2030** billion $2004	**2004 - 2030** billion $2005
- Nuclear power plant	2	0	0	**0**	**0**
- Fossil fuels	397	415	316	**1,130**	**42**
- Renewables	955	2,045	2,762	**5,761**	**213**
Total	1,354	2,461	3,078	**6,891**	**255**

figure 12: investment shares - REF versus E[R]

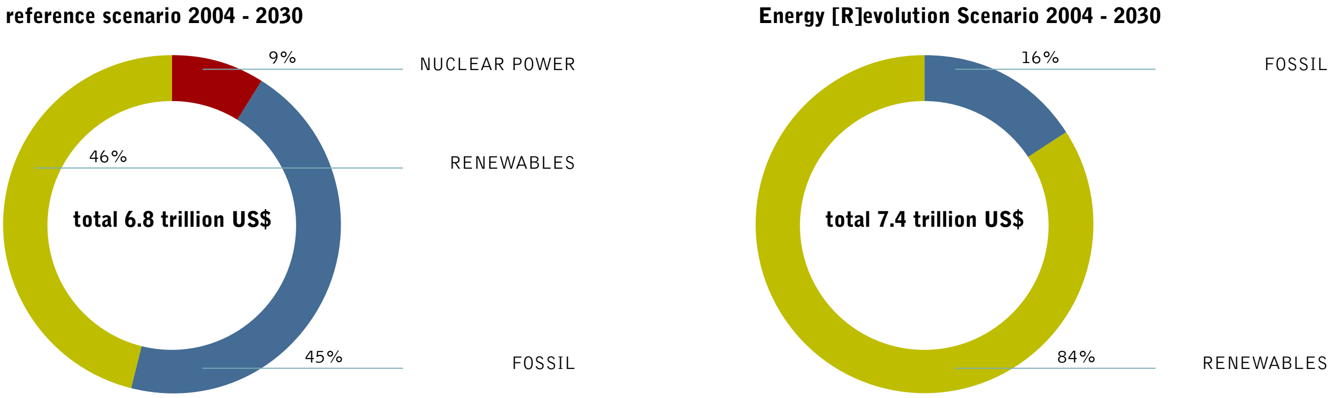
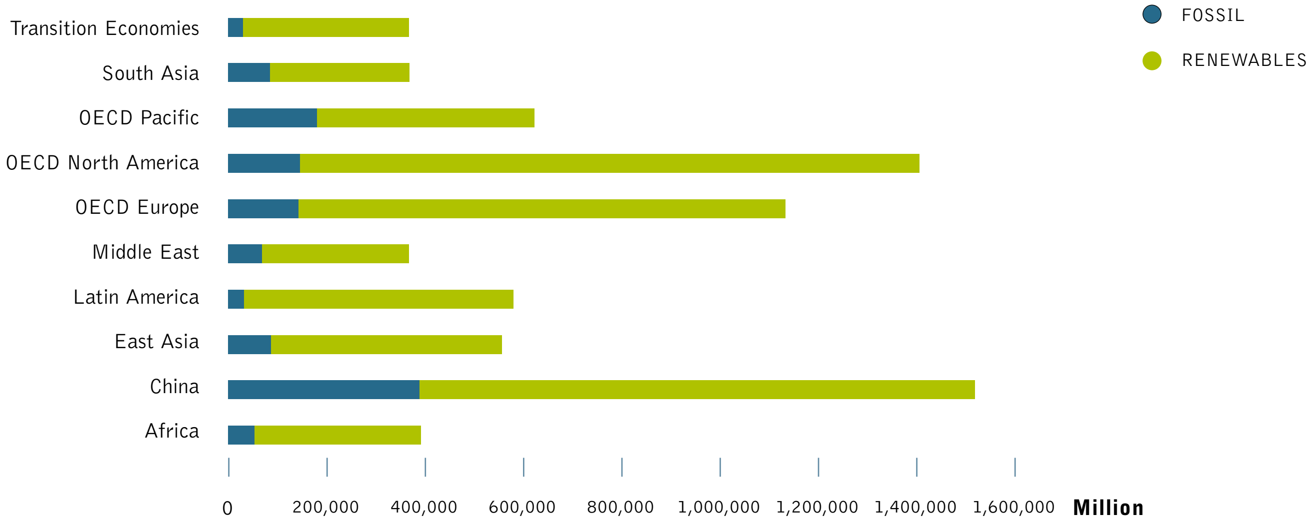


table 14: investment shares - REF versus E[R]

ENERGY [R]EVOLUTION VERSUS REFERENCE	BILLION $				AVERAGE PER YEAR BILLION $
INVESTMENT	2003 - 2010	2011 - 2020	2021 - 2030	**2004 - 2030**	**2004 - 2030**
- Nuclear power plant	-222	-190	-168	**-581**	**-22**
- Fossil fuels	-325	-628	-762	**-1,714**	**-63**
- Renewables	113	1,105	1,672	**2,890**	**107**
Total	-434	287	742	**595**	**22**

figure 13: cumulative power plant investments by region 2004-2030



The main investments in new power generation will take place in China, followed by North America and Europe. South Asia - namely India - and countries of the East Asia region - such as Indonesia, Thailand and the Philippines are "hot spots" of new power generation investments.

investment by technology

renewable power generation investment

In the Reference Scenario the investment volume for renewable electricity generation is in a range of US$2.8 trillion - compared to US$5.7 trillion in the Energy [R]evolution Scenario - however the regional distribution in the Reference Scenario and the Energy [R]evolution Scenario is almost equal.

table 15: total new investment till 2030 by technology - REF

NEW INVESTMENT	2004 - 2010 billion $2000	2011 - 2020 billion $2001	2021 - 2030 billion $2002	**2004 - 2030** billion $2004
Renewables	842	940	1,091	**2,874**
- PV power plant	23	31	45	**98**
- Solar thermal power plant	2	4	10	**16**
- Wind power	102	123	222	**447**
- Biomass power plant	30	32	49	**111**
- Geothermal power plant	77	42	75	**194**
- Hydro power	607	705	688	**2,001**
- Ocean energy power plant	1	4	2	**8**

table 16: total new investment till 2030 by technology - E[R]

NEW INVESTMENT	2004 - 2010 billion $2000	2011 - 2020 billion $2001	2021 - 2030 billion $2002	**2004 - 2030** billion $2004
Renewables	945	2,016	2,732	**5,693**
- PV power plant	84	337	641	**1,062**
- Solar thermal power plant	6	93	403	**502**
- Wind power	157	792	916	**1,865**
- Biomass power plant	24	38	47	**109**
- Geothermal power plant	71	57	89	**217**
- Hydro power	603	700	636	**1,939**
- Ocean energy power plant	10	30	32	**72**

The investment volume within the different renewable power generation technologies depends on the status of technical development. Technologies like wind power - which is in some regions with good wind resources already cost competitive - will have a larger investment volume and a bigger market share within the overall renewable investments. However the market volume by technology and region also depends on the local resources and the policy framework. Figure 15, 17a and table 22 provide an overview about the investments by technology and region.

For solar photovoltaic, the main market will remain for some years in Europe and the US, but will soon expand across China and India. Due to the fact, that solar PV is a highly modular and decentralized technology, which can be used almost everywhere, the market will be distributed across the entire world.

Concentrated solar power systems (CSP) can only be operated within the sunbelt of the world. Therefore, the main investments in this technology will take place in North Africa, the Middle East, parts of the USA and Mexico, as well as south-west China, India and Australia. Due to the lack of direct sunlight, the market volume for Europe will be very limited.

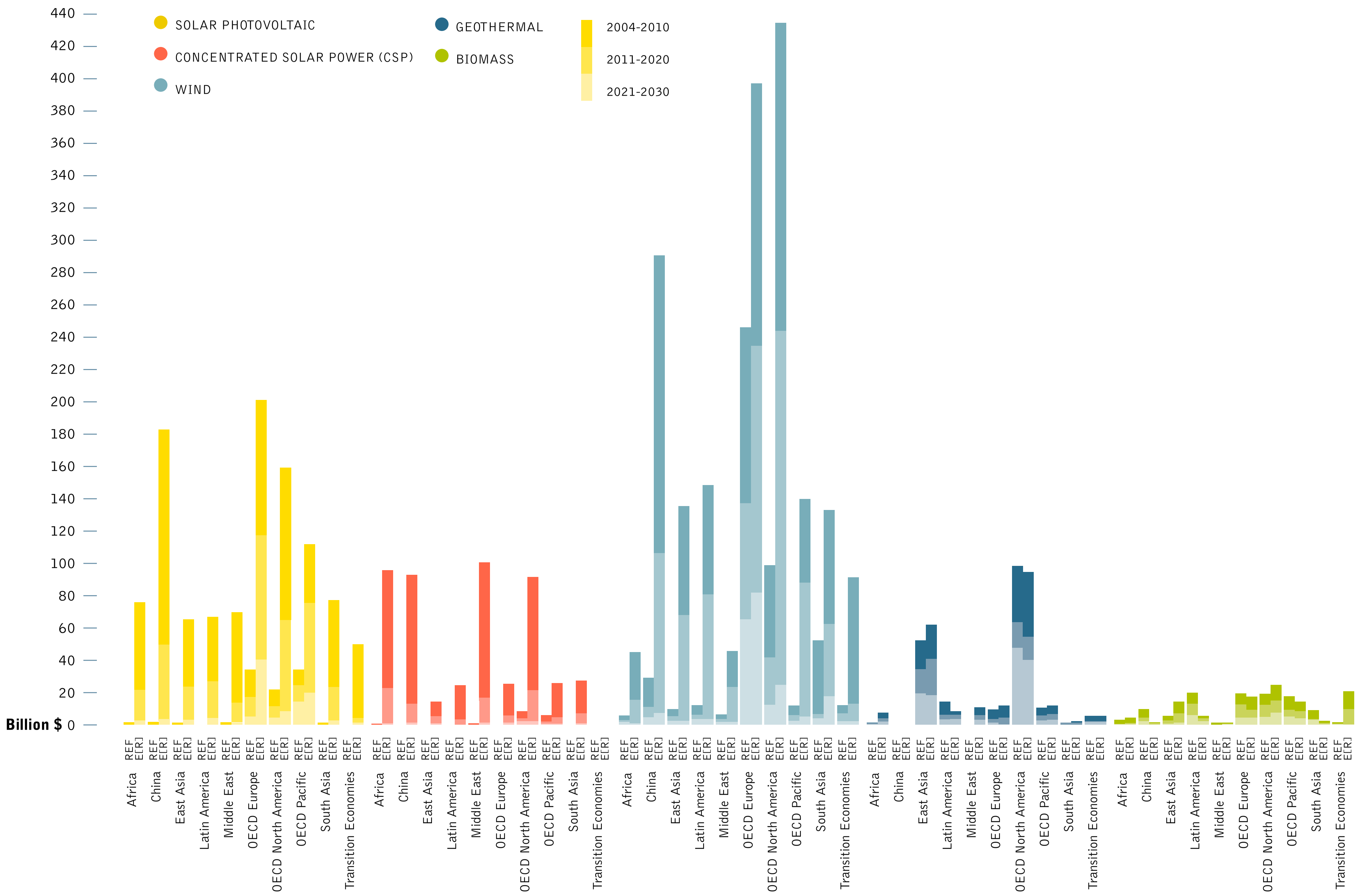
The main development of the wind industry will take place in Europe, North America and China. Offshore wind technology will have a larger share from approx 2015 onwards. The main offshore wind development will take place in North Europe and North America.

The market for geothermal power plants is mainly North America and East Asia. The USA, Indonesia and the Philippines and some countries of central and southern Africa have the highest potential for the next 20 years. After 2030, geothermal power generation will expand to other parts of the world like Europe and India.

Bioenergy power plants are distributed over the whole world as there is potential almost everywhere for biomass and/or biogas (cogeneration) power plants.

figure 14: investment in renewable energy sources by region

"This is only one way how a sustainable pathway could look like. Within the renewable energy sector some technologies could develop even more dynamic as particular industries, such as PV or biomass, expect. Further technological breakthroughs and rapid cost reduction could lead into much higher deployment rates."



fossil fuel power plant investment

Under the Reference Scenario, the main market expansion for new fossil fuel power plants is in China, followed by North America - which would have a volume equal to India and Europe together.

In the Energy [R]evolution Scenario the overall volume for fossil fuel power stations until 2030 is with 1,200 billion (REF 3,100 billion) significantly lower.

investment in new coal power plants

China is by far the biggest investor in coal power plants in both scenarios. While in the Reference Scenario the growth trend of the decade (2000-2010) continues towards 2030, the Energy [R]evolution Scenario assumes that in the second and third decade (2011-2030) growth slows down significantly. In the Reference Scenario the massive coal expansion is due to China, followed by the USA, India, East Asia and Europe.

figure 15: investment in coal power plants

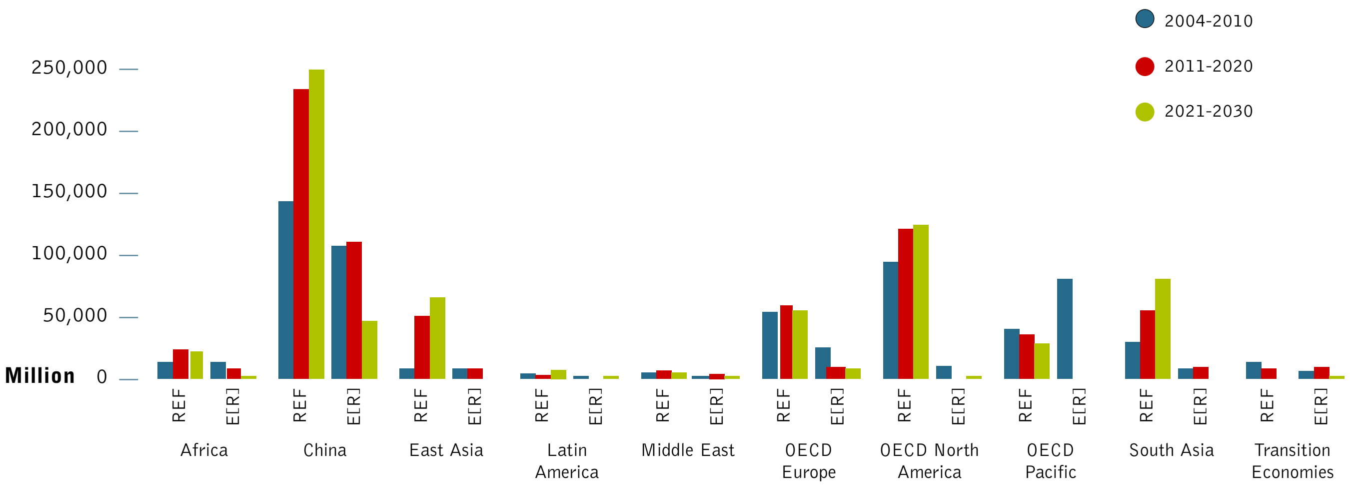


table 17: investment in coal power plants

		2004-2010	2011-2020	2021-2030	2004-2030
Africa	Reference	14,495	24,078	23,659	62,232
	Energy [R]evolution	12,720	7,891	759	21,370
China	Reference	143,439	233,350	248,941	625,731
	Energy [R]evolution	107,813	110,109	47,524	265,446
East Asia	Reference	9,106	51,094	66,974	127,174
	Energy [R]evolution	8,443	8,036	0	16,479
Latin America	Reference	4,313	2,206	5,793	12,312
	Energy [R]evolution	488	0	1,563	2,051
Middle East	Reference	1,794	4,172	2,690	8,656
	Energy [R]evolution	147	2,223	178	2,584
OECD Europe	Reference	55,372	58,711	55,720	169,803
	Energy [R]evolution	24,306	9,158	7,090	40,555
OECD North America	Reference	95,422	121,815	124,574	341,812
	Energy [R]evolution	9,658	0	296	9,954
OECD Pacific	Reference	38,708	36,334	28,617	103,659
	Energy [R]evolution	21,980	0	0	21,980
South Asia	Reference	28,970	56,028	79,806	164,803
	Energy [R]evolution	7,109	9,365	0	16,475
Transition Economies	Reference	12,505	8,643	0	21,147
	Energy [R]evolution	6,248	10,049	319	16,616
Global Total	**Reference**	**404,124**	**596,431**	**636,774**	**1,637,328**
	Energy [R]evolution	**198,913**	**156,831**	**57,729**	**413,473**

(more) costs for fossil fuels

THE MONEY SPENT IN THE ALTERNATIVE SCENARIO FOR OIL AND COAL TO GENERATE ELECTRICITY IS 50% BELOW THE REFERENCE SCENARIO.

image PLATFORM/OIL RIG DUNLIN A IN THE NORTH SEA SHOWING OIL POLLUTION.

The total costs for fossil fuels in the Reference Scenario between 2004 and 2030 add up to a total of US$18,6 trillion - compared to US$13,1 trillion in the Energy [R]evolution Scenario. So fuel costs in the Energy [R]evolution Scenario are already 30% lower in the year 2030 (in 2050, the fuel costs are more than 70% lower). The "gas bill" remains roughly on the same level - in the Energy [R]evolution Scenario it is 10% below the Reference Scenario. The money spent in the alternative scenario for oil and coal to generate electricity is 50% below the Reference Scenario.

table 18: cummulative fossil fuel costs - global Reference scenario (power generation)

FOSSIL FUEL	CUMMULATIVE COST IN BILLION $2000 2003-2010	2011-2020	2021-2030	**2004-2030**
Hard coal in Mill t	1,248	2,213	2,929	**6,389**
Natural gas in E+9m³	1,538	2,883	4,154	**8,576**
Crude oil in Mill barrel	718	1,373	1,525	**3,616**
Total	3,504	6,469	8,608	**18,581**

(DLR: EURO1 = US$2000 0.92)

table 19: cummulative fossil fuel costs - energy [r]evolution scenario (power generation)

FOSSIL FUEL	CUMMULATIVE COST IN BILLION $2000 2003-2010	2011-2020	2021-2030	**2004-2030**
Hard coal in Mill t	1,114	1,433	1,176	**3,723**
Natural gas in E+9m³	1,519	2,735	3,491	**7,745**
Crude oil in Mill barrel	590	673	390	**1,654**
Total	3,223	4,842	5,057	**13,122**

(DLR: EURO 1 = US$2000 0.92)

table 20: fuel costs versus renewable energy sources without fuel

THE TOTAL FUEL COST SAVINGS IN THE ENERGY [R]EVOLUTION SCENARIO ARE AS HIGH AS US$5.4 TRILLION OR US$202 BILLION PER YEAR.

	CUMMULATIVE COST IN BILLION $2000				AVERAGE ANNUAL SAVINGS FOR FUEL IN BILLION $2000
FOSSIL FUEL	2003 - 2010	2011 - 2020	2021 - 2030	**2004 - 2030**	**2004 - 2030**
Hard coal Mill t	134	780	1,753	**2,667**	**99**
Natural gas in E+9m3	19	148	663	**831**	**31**
Crude oil in Mill barrel	127	700	1,135	**1,962**	**73**
Total	281	1,628	3,551	**5,459**	**202**

table 21: Investment Costs Energy [R]evolution versus Reference

ENERGY [R]EVOLUTION VERSUS REFERENCE	BILLION $				AVERAGE PER YEAR BILLION $
INVESTMENT	2003 - 2010	2011 - 2020	2021 - 2030	**2004 - 2030**	**2004 - 2030**
Nuclear power plant	-222	-190	-168	**-581**	**-22**
Fossil fuels	-325	-628	-762	**-1,714**	**-63**
Renewables	113	1,105	1,672	**2,890**	**107**
Total	-434	287	742	**595**	**22**

The average annual additional fuel costs of the reference scenario are about 10 time higher than the additional investment requirments of the energy [r]evolution scenario.

The comparison between the extra fuel costs in the Reference Scenario and the extra investment costs of the Energy [R]evolution Scenario shows that the average annual additional fuel costs of the Reference Scenario are about 10 times higher than the additional investment requirements of the Energy [R]evolution Scenario.

In fact, the additional costs for coal from today until the year 2030 are as high as US$100 billion: this would cover 92.5% of the total annual investments in renewable power generation, required to implement the Energy [R]evolution Scenario.

But these renewable energy sources will produce electricity without any further fuel costs beyond 2030, while the fuel costs for coal and gas will continue to be a burden on national economies.

policy recommendations

HOW DO WE PUT A PRICE ON LOST HOMES ON PACIFIC ISLANDS AS A RESULT OF MELTING ICECAPS OR ON DETERIORATING HEALTH AND HUMAN LIVES?

7

image WALRUS ON AN ICEFLOW IN THE CHUCKCHI SEA, ARCTIC.

internalisation of the social and environmental costs of polluting energy

The real cost of energy production by conventional energy includes expenses absorbed by society, such as health impacts and local and regional environmental degradation - from mercury pollution to acid rain - as well as the global negative impacts from climate change.

Hidden costs include the waiving of nuclear accident insurance that is too expensive to be covered by the nuclear power plant operators, and is hence paid by tax-payers. The Price-Anderson Act, for instance, limits the liability of US nuclear power plants in the case of an accident to an amount of up to US$98 million per plant, and only US$15 million per year per plant, with the rest being drawn from an industry fund for up to US$10 billion - and after that taxpayer pays.

Environmental damage should, as a priority, be rectified at source. Translated into energy generation this would mean that, ideally, production of energy should not pollute and that it is the energy producers' responsibility to prevent pollution. If they do pollute they should pay an amount equal to the damage the production causes to society as a whole. The environmental impacts of electricity generation can be difficult to quantify, however. How do we put a price on lost homes on Pacific Islands as a result of melting icecaps or on deteriorating health and human lives?

An ambitious project, funded by the European Commission - ExternE - has tried to quantify the true costs, including the environmental costs, of electricity generation. It estimates that the cost of producing electricity from coal or oil would double and that from gas would increase by 30% if external costs, in the form of damage to the environment and health, were taken into account. Other, more recent studies come to even higher numbers of external costs.

If those environmental costs were levied on electricity generation according to their impact, many renewable energy sources would not need any support. If, at the same time, direct and indirect subsidies to fossil fuels and nuclear power were removed, the need to support renewable electricity generation would seriously diminish or cease to exist.

the definition of external costs

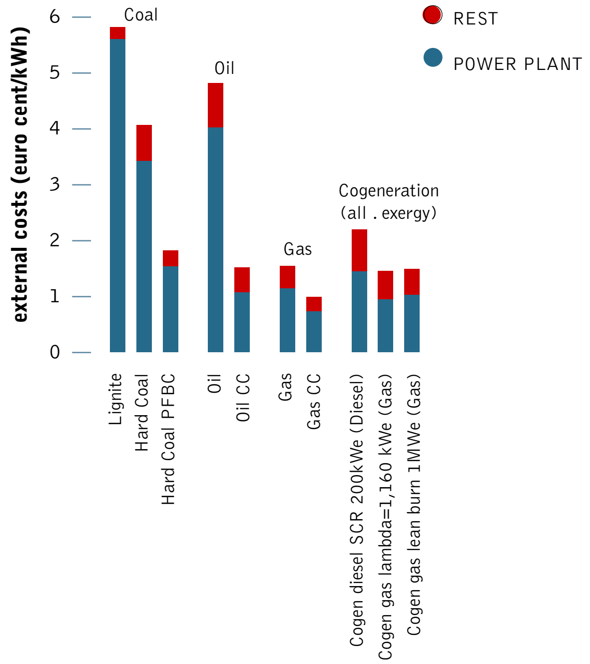
The scope of the ExternE Project is to value the external costs, i.e. the major impacts, of economic activities, referred to both production and consumption. Up to now, valuations of external costs have mainly been applied to energy-related activities such as fuel cycles, and activities related to transport of persons and freight, but the focus is being broadened and the methodology extended to activities such as different industrial processes.

An external cost, also known as an externality, arises when the social or economic activities of one group of persons have an impact on another group and when that impact is not fully accounted, or compensated for, by the first group. Thus, a power station that generates emissions of SO2, causing damage to building materials or human health, imposes an external cost. This is because the impact on the owners of the buildings or on those who suffer damage to their health is not taken into account by the generator of the electricity when deciding on the activities causing the damage. In this example, the environmental costs are "external" because, although they are real costs to these members of society, the owner of the power station is not taking them into account when making decisions. Note that external costs are unintended and result from there being no property rights or markets for these environmental effects. The potential value of the ExternE project therefore lies in valuing external costs in order for those values to be included in the design of policy to correct for the present lack of such property rights and markets.

There are several ways of taking account of the cost to the environment and health, i.e. for 'internalising' external costs. One possibility would be via eco-taxes, i.e. by taxing damaging fuels and technologies according to the external costs caused. For example, if the external cost of producing electricity from coal were to be factored into electricity bills, between 2 and 7 cents per kWh would have to be added to the current price of electricity in the majority of EU Member States. Another solution would be to encourage or subsidise cleaner technologies thus avoiding socio-environmental costs. The Community guidelines on state aid for environmental protection explicitly foresee that EU member states may grant operating aid, calculated on the basis of the external costs avoided, to new plants producing renewable energy. Besides that, in many other widely accepted evaluation methods such as green accounting, life-cycle analysis and technology comparison, the quantitative results of external costs are an important contribution to the overall results.

source EXTERNE (WWW.EXTERNE.INFO)

figure 16: external costs of current and advanced electricity systems, associated with emissions from the operation of power plants and with the rest of the energy chain – fossil fuels



source FINAL REPORT EXTERNE-POL, VERSION 2, AUGUST 2005, PAGE 35

"The Extern-E study is used here as an example, because it is one of very few studies which went a long way. Still there are many shortcomings in Extern-E in our point of view. It for example does not take into account nuclear liabilities at all and therefore gives a wrong impression of the true costs of nuclear. Also other significant external cost factors for conventional sources were not taken into account. A more detailed study would most likely result in substantially higher external cost calculations for nuclear and fossil fuels."

image ENERGY PLANT NEAR REYKJAVIK, ENERGY IS PRODUCED FROM THE GEOTHERMAL ACTIVITY. NORTH WEST OF ICELAND.

financing sustainable development

reform of export credit agencies (ECAs), multi-lateral development banks (MDBs) and international Finance institutions (IFIs)

Demand for energy, particularly electricity, is increasing worldwide. This is especially the case in developing countries, which rely heavily on export credit agencies and multi-lateral development banks to provide financing for energy and other industrial projects.

To be consistent with the emerging international regime for limiting greenhouse gas emissions, ECAs and other international financial institutions which support or underwrite projects around the world must have policies consistent with the need for limiting greenhouse gas emissions and for climate change protection. At the same time there needs to be a transition plan and flexible timeframes to avoid undue hardships on developing country economies that are overly reliant upon conventional energy sources and exports. It should also be recognised that meeting development goals for the world's poorest will require subsidies for the foreseeable future.

Policies to address these issues must include:

- A defined and increasing percentage of overall energy sector lending directed to renewable energy projects.
- A rapid phase out of support for conventional, polluting energy projects.

export credit agencies

Export Credit Agencies are the world's largest public financial institutions. They are mainly based in OECD countries and represent by far the single largest source of public financial flows from North to South. They are the least examined, the least transparent, the least accountable, and, perhaps in some ways, the most harmful. They include the US Export Import Bank (USEXIM), the Japan Bank for International Cooperation (JBIC), Germany's Hermesbürgschaft (Hermes Guarantee), France's COFACE, the British Export Credit and Guarantee Department (ECGD), Belgium's Office National du Ducroire, Canada's Export Development Corporation, Italy's SACE and various Scandinavian ECAs. In addition, there are lesser-known ECAs from China, India, Korea, Thailand, Malaysia and Sri Lanka. The World Bank's Multilateral Investment Guarantee Agency (MIGA) acts as the World Bank's ECA70.

It is essential to note that ECAs are *public* financial institutions and use taxpayers' money with national governments determining their policies and the projects that they support.

The purpose of ECAs is to support the sales of goods and services from companies in the home country of the ECA to buyers, mainly in southern countries, and to provide political risk insurance as companies seek security for their projects against nationalization and expropriation, currency instability, war and civil disturbance. The host country, through the use of military and paramilitary forces, often provides security. ECAs help attract commercial banks, equipment suppliers and contractors.

how ECAs work When a company needs loans from commercial banks for a large project that could have political and/or economic risks, it first attempts to obtain ECA support, in the form of a direct loan, an investment guarantee or political risk insurance.

In many cases, the ECA in turn may require a sovereign guarantee from the host country where the project will be implemented so that if the project were to fail for economic or political reasons that would trigger ECA liability, the host country is liable for the replacement of funds paid out by the ECA. Hence the system converts the corporate risks inherent in dubious and purely private sector transactions into public debt (i.e. the government and people) of a developing country. Even without such host country guarantees, in practice political pressure is applied in order to bail out failed projects.

Sometimes multilateral development banks provide joint financing of projects supported by ECAs. Such partnerships open a country for foreign investment but with 'structural adjustment policies' as part of the criteria; such policies could include deregulation, privatization, and liberalization of the national economy. For example, JBIC partnered with the World Bank to provide US$530 million for a coal sector rehabilitation package for 24 open cast coalmines in India. The World Bank loan was tied to a structural adjustment agenda aimed at liberalizing coal imports, deregulating coal prices and reducing the workforce leading to 20,000 people losing their jobs.

ECAs have supplied funding of over US$20 billion for fossil fuel plants in Bangladesh, Cambodia, China, Hong Kong, India, Indonesia, Laos, Malaysia, New Zealand, Pakistan, Philippines, and Thailand. The power sector - nuclear, big dam hydropower, fossil fuels and attendant infrastructure - represents by far the highest value sector for projects for which total finance data is available. Only a very small portion of current ECA business supports renewable energy projects. For example, between 2000 and 2003, support to renewable energy projects was less than 1% of total support by most ECAs. Of the US$28 billion Ex-Im Bank (US ECA) provided in loans and guarantees for energy-related projects from 1990 to 2001, 93% was used to finance fossil fuel projects and 3% was for renewable energy projects.

Not surprisingly, the most important destinations of ECA export credits and project financing for energy-intensive activities include developing countries with some of the largest greenhouse gas emissions (Brazil, China, India, Indonesia and Mexico). The seven leading industrialized economies (Canada, France, Germany, Italy, Japan, the United Kingdom and the United States) provided most of the ECA financing for energy-intensive exports or projects73.

Apart from providing financial support to polluting energy sources, another key problem of ECAs is their lack of transparency. The denial of public access to information by ECAs makes it difficult to really identify those that are supporting the expansion of coal power throughout Asia. It also leads to a lack of accountability for the environmental consequences of their financing. Over three-quarters of ECA-supported fossil-fuelled energy and power project financing in East and South Asia went to just five countries: China (US$6.2 billion), Indonesia (US$5 billion), Pakistan (US$3.6 billion), the Philippines (US$3.6 billion), and India (US$3.3 billion).

JBIC - the largest public financier of coal power plants in asia The Japan Bank for International Cooperation is the largest public financial institution in the world and provides a good example of the massive support provided for home corporations like the Mitsubishi group companies as well as coal and power companies from other countries.

JBIC was established in 1999 when two Japanese financial institutions - the Japan Export-Import Bank (JEXIM) and the Overseas Economic Cooperation Fund (OECF) - merged into one bank. OECF was mainly responsible for giving loans to governments in developing countries as Official Development Assistance (ODA), the role of which, according to the Japanese government, is to promote the economic development and welfare of developing countries.

JEXIM, on the other hand, gave export or import loans, investment and untied loans to both governments and private companies in support of Japanese companies' exports and investments. Hence JBIC now lends to governments and to both Japanese and foreign companies. According to the JBIC annual report 2003, the bank has US$192.3 billion worth of outstanding loans and lends US$17.7 billion annually to 40 countries; most (80%) are in Asia. By comparison, the World Bank has outstanding loans of US$223.1 billion and an annual lending of US$18.5 billion.

Japanese ODA (part of JBIC) in the energy sector greatly favours fossil fuel projects and, as a result, Japan is one of the world's largest CO_2 emission contributors amongst the developing countries. In 1993, Japanese ODA financing of fossil fuel related projects was about four times that spent on energy conservation-related projects. By 2002, this had grown to seven to one. The sum of the budget allocated for energy ODA between 1992 and 2001 reached US$19.7 billion. It is clear that the focus for Japan's foreign aid and investment through JBIC is on energy sector development in Asian countries, as among the top ten recipients, eight countries are located in Asia with China and India the two largest. Among fossil fuel-based projects, fossil fuel power generation projects are dominant. Between 1993 and 2002, approximately US$7.6 billion was loaned for a total of 53 fossil fuel power generation projects, with most of the loans (32 projects or 63.1%) for coal projects.

Over 70% of the lending to China has been to support coal-fired power plants. The key Japanese industries that have benefited from these projects are companies such as the Mitsubishi group (Mitsubishi Heavy Industries, Ltd. and Mitsubishi Corp) and China Light and Power (CLP) based in Hong Kong.

Loans to India from JBIC were provided for construction of five coal-fired thermal power plants, one natural gas-based power plant, one oil/gas combined cycle plant, five transmission line and distribution system projects, and two power efficiency projects. The total financing for fossil fuel projects for the past decade accounts for up to 77.8% excluding transmission and distribution projects. Between 1993 and 2002, only 6 renewable energy projects have received support and these were in 3 countries - the Philippines (two geothermal and one wind project), Indonesia (two small hydro projects), and Brazil (one wind project). The total expenditures for renewables projects for the years 1993-2002 accounted for 3.3% of the total energy and infrastructure expenditures.

multilateral development banks (MDBs)

Unlike the ECAs, the mandate of the MDBs includes development. In other words, the projects they fund should be targeted at poverty alleviation. MDBs are the largest source of development finance in the world, typically lending between US$30-40 billion to low and middle-income countries in any given year. Their financing comes coupled with policies that govern the direction and type of 'development'.

Despite their mission to reduce poverty and encourage economic development, MDB loans have been responsible for causing widespread environmental and social damage from ill-conceived programmes that have adversely affected millions of people in developing countries.

The MDBs include: the Asian Development Bank; the African Development Bank; the European Bank for Reconstruction and Development; the Inter-American Development Bank and the World Bank Group which is sub-divided into: the World Bank (including the International Bank for Reconstruction and Development, the International Development Association, the International Finance Corporation and the Multilateral Investment Guarantee Agency). In Asia, the two key MDBs are the Asian Development Bank and the World Bank Group.

the asian development bank (ADB) The ADB, established in 1966, is comprised of shareholders from 63 member countries (45 from Asia and Pacific and 18 from other parts of the globe) the largest being Japan and the United States. Each member country has a representative serving on the Board of Governors. The stated mission of the ADB is to reduce poverty in the Asia Pacific region.

Although the ADB claims to operate in the interest of Asia's poorest citizens, civil society groups have long been concerned about the ADB's failure to promote sustainable and equitable growth in the region. ADB-

image SOLAR PANELS ON REFRIGERATION PLANT (FOR KEEPING FISH FRESH). LIKIEP ATOLL, MARSHALL ISLANDS.

funded operations have been responsible for causing widespread environmental and social damage, adversely affecting some of the region's poorest and most vulnerable communities.

Though publicly financed by taxpayers, ADB activities (and those of other Multilateral Development Banks) are often carried out without the informed participation of the taxpayers themselves, affected people, non-governmental organisations (NGOs), or, in many cases, the elected officials in the borrowing countries. This, despite the recognition that sustainable development and poverty alleviation are impossible without informed public participation in the decision making process.

Between 1970 and 2003, the ADB co-financed projects to the tune of US$40.6 billion, 41% of which was to the energy sector. The stated goal of the ADB's new energy policy (2000) is that they will actively promote the development of renewable energy resources and support the uptake of cost-effective renewable energy technologies and assist countries in formulating renewable energy projects for remote areas. However, only one out of the eight energy sector projects receiving ADB funding of US$756.7 million in 2003 was for a form of clean energy development. In the Philippines, a long-time member country of the ADB and just one among the many examples of the Bank's disgraceful energy lending practices, ADB financing for renewable energy amounts to only 0.09 percent of the ADB's entire funding support for the country. Much of the ADB's financing was channelled in support of coal-fired power initiatives.

The ADB has recently announced programs that it says will help combat climate change. These are the Energy Efficiency Initiative (which has been renamed the Clean Energy Initiative [CEI] to include renewable energy), the Carbon Market Initiative (CMI), and the creation of Regional Energy Hubs. The announcements are welcome but also deserve further scrutiny.

the world bank group The mission of the original World Bank, founded together with the International Monetary Fund (IMF) at the 1944 Bretton Woods conference, was largely to provide reconstruction financing for post-World War II Europe.

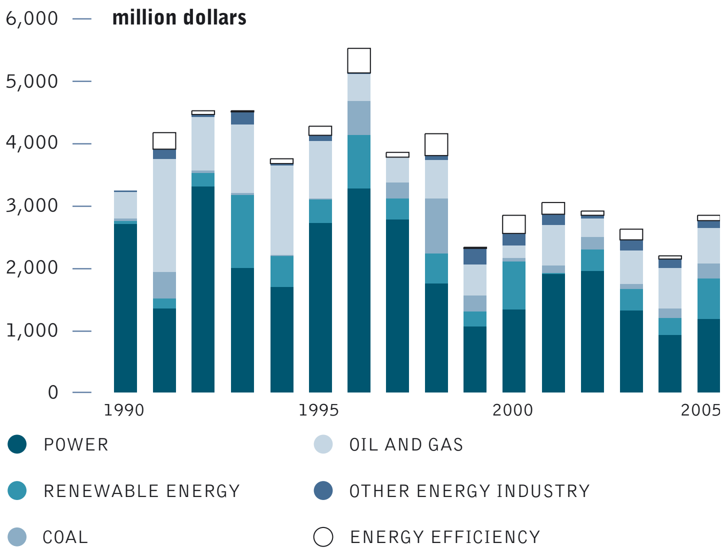
However, after only four reconstruction loans, the Bank shifted its attention to less developed countries. In 1948, Chile became the Bank's first developing country client. Since then, the World Bank has lent over US$500 billion to low and medium income countries.

As the single largest source of development finance in the world, the World Bank has an enormous impact on the lives and livelihoods of millions of people in developing and transition countries. Given its lending resources, policy prescriptions, and political backing, the World Bank plays a pivotal role in shaping the development priorities of countries around the world.

Although the World Bank's stated mission is to "to promote sustainable private sector investment in developing countries, helping to reduce poverty and improve people's lives", this does not happen in practice. For instance, in 2002-2003 the Bank's energy financing for big fossil fuel projects beat renewable and energy efficiency projects by a 17 to 1 ratio.

The MIGA is the political risk insurance arm of the World Bank Group - the World Bank's ECA. It provides non-commercial risk insurance for private enterprises investing in developing countries and provides developing country members with technical assistance on investment promotion. Like the ECAs, MIGA guarantees to protect investors against loss resulting from expropriation, breach of contract, war, and civil disturbance including insurrection, coups d'état, revolution, sabotage, and terrorism. In addition to offering insurance to private companies, MIGA mobilises additional guarantees for investors and assists host governments with legal services and strategic advice regarding investment. As of June 2003, MIGA had issued guarantees worth over US$12 billion since its inception.

figure 17: World Bank investment in energy by recipient, 1990-2005



source IEA

financing sustainable development: the ADB as an example

An energy revolution is both required and desirable. It is economically and technologically viable but it can only succeed if Export Credit Agencies, Multi-lateral Development Banks and International Finance Institutions join and help to lead it.

The responsibility of a major development institution such as ADB is not to finance fossil fuel development, particularly coal-related projects which already enjoy massive support from the private sector. The crucial role that the ADB should play is to ensure that its member countries are able to fully exploit their efficiency and renewables potential sustainably and equitably, both in on-grid and off-grid applications.

What should a development bank such as the ADB do?

quit coal Programs such as the CEI and CMI will be rendered meaningless unless and until the ADB stops supporting coal projects. The ADB must recognize that every dollar that it spends on perpetuating the illusion of "clean coal" is a dollar diverted away from efficiency and renewables – the real energy solutions. Getting out of coal will also force the ADB to develop the energy efficiency and renewables market to its full promise.

reverse over-reliance on carbon market Based on its emphasis on the CMI, the ADB appears to be relying too much on carbon market instruments.

The carbon market is not a bad thing per se but, the fact is, it will also not drive fundamental realignments in investment in the energy sector, especially in the near-term. It needs to be complemented by other policies. The market that the ADB intends to tap is based on the Clean Development Mechanism (CDM) of the Kyoto Protocol, and right now investment flows in the CDM are overwhelmingly going to non-CO_2 gases such as HFC23 (used in refrigeration) and methane which have no impact on developing countries' energy sectors and their development. These types of projects are cheap and easy, which is what the market wants.

Initiatives such as the CMI can't just leave the development of sustainable energy options to the market. Institutions such as the ADB need to shift resources towards actual renewables and efficiency projects and at the same time put in place policies that can stimulate the development of real energy solutions, such as what feed-in tariffs have done for wind development in India. Other policy measures include getting developing member countries to govern their energy choices through Integrated Resource Planning (IRP). Implementing the IRP ensures that a country's available renewable and efficiency potentials are evaluated first for full utilization before new capacity is even considered.

increase US$1 billion per year to CEI, keep it coal-free: The ADB has committed to provide a minimum of US$1 billion per year to fund the CEI. This is welcome. However, in order for the ADB to play a leading role in developing the renewables and efficiency market in Asia, the ADB must also:

- Set a target period of at least 10 years for the implementation of its clean energy facility.
- Increase the US$1 Billion Clean Energy Pipeline by 10 percent annually. It is a fact that the expected cost reduction in renewables is essentially not a function of time, but of cumulative capacity, which means dynamic market development is required. The yearly 10 percent growth in the facility furthers such development.
- Keep coal out of the US$1 billion pipeline. The ADB must secure the environmental integrity of its clean energy facility and ensure that it is used exclusively for new, renewable energy and energy efficiency projects and programs, preferably based on a combination of new, large on-grid projects and grid adjustments that will facilitate the rapid development of the renewable energy market, using the decentralized energy approach where applicable, for instance in the Pacific and in countries where rural electrification is key such as Laos and Bangladesh.

ensure energy hubs are relevant While such information sharing initiatives are important in terms of capacity building and developing country expertise, it is crucial that the ADB plays a more active role in demonstrating the kind of policy environment that will allow renewables to flourish. For instance, it needs to demonstrate to member countries successful frameworks used in effective renewables legislation across Asia.

policy recommendations

There are five key issues driving the need for a massive expansion of renewable energy technologies:

- Protection of the global climate
- The need for secure energy supplies that do not suffer dramatic and sudden swings in prices which largely create macroeconomic instability
- The need for poverty alleviation
- Protection of local human health, social welfare and the environment
- The need for a large number of distributed sources of generation, which are inherently more stable, and less prone to catastrophic accidents or failure, and much less vulnerable to attack from hostile forces

These demand an urgent change in the way governments plan for and support the development of energy sources.

All governments need to rapidly accelerate the development of renewable energy markets to cut CO_2 emissions and drastically reduce costs making sustainable energy sources accessible to developing countries.

The international finance system must stop actively encouraging the expansion of energy- and carbon intensive production capacities and infrastructure. Governments must establish a coherent policy framework across all financial actors - public, national, international and private - and demonstrate a true willingness to stop climate change and encourage the expansion of renewable energy technologies and energy efficiency programmes.

Only through a fundamental shift in the policies of governments (north and south) and of public and private financial institutions, can political and fiscal barriers be removed so as to provide the necessary spur for the massive global uptake of renewable energy technologies and energy efficiency programmes.

reference

THE US$1 BILLION CLEAN ENERGY FUND INITIATIVE OF THE ADB IS NOT ACTUALLY A NEW IDEA. IT WAS ACTUALLY PROPOSED 11 YEARS AGO BY THE NGO WORKING GROUP ON THE ADB. SEE THE NGO-PO CAMPAIGN MANUAL ON THE ADB, ED. ELIZABETH PUA-VILLAMOR AND MELINDA MAE BUAN OCAMPO, NGO WORKING GROUP ON THE ASIAN DEVELOPMENT BANK, OCTOBER 1996.

good practice / case studies

GERMANY HAS DEVELOPED THE MOST DYNAMIC RENEWABLE ELECTRICITY MARKET AND RENEWABLE INDUSTRY WORLD WIDE.

8

image image PHOTOVOLTAICS FACILITY AT 'WISSENSCHAFTS UND TECHNOLOGIEZENTRUM ADLERSHOF' NEAR BERLIN, GERMANY. SHEEP BETWEEN THE 'MOVERS' KEEPING THE GRASS SHORT.

the renewable energy act of germany

Worldwide, people are surprised by the fact that Germany has developed the most dynamic renewable electricity market and renewable industry world-wide. How could this happen? Many different kind of programmes in many countries have been started in the past in order to accelerate the markets for renewable energies, but none has been as successful over such a short period of time as the feed-in tariff in Germany. The idea of the feed-in tariff has been adapted in several countries and of course each country adjusted it to its specific needs. The basic idea behind it is very simple:

feed-in tariff: the driver of the success story in germany

It is evident that without the support of suitable instruments the expansion of renewable electricity markets worldwide will not happen at sufficient speed. In order to accelerate the reconstruction of our electricity supply it is necessary to implement powerful and efficient tools supporting the use of renewable electricity. The premium feed-in tariff has proved its power and efficiency during the previous years. Producers of renewable electricity:

- Have the right to feed renewable electricity into the public grid
- Receive a premium tariff per generated kWh reflecting the benefits of renewable electricity compared to electricity generated from fossil fuels or nuclear power
- Receive the premium tariff over a fixed period of time

All three aspects are simple but it took significant effort to establish them. For many years the utilities did not allow the feeding of renewable electricity into their grid (and this is still the case in many countries even today). The right to feed electricity into the public grid cannot be taken for granted and in most countries the utilities fight this idea very strongly once it comes up.

feed-in tariff: who pays for it?

In the past many programmes intended to push renewable electricity were financed through the budget of a ministry. This implies the disadvantage that lack of state money could lead to the programme being stopped. Therefore the feed-in tariff model takes a completely different approach.

In Germany in 2006 the utilities pay a fixed premium tariff for renewable electricity - the tariff varies with the size and the technology of the installation. Therefore the utilities, as a first step, have higher costs due to the premium tariff. The utilities are authorised to charge this extra cost, spread equally to all electricity consumers via their usual electricity bill. With this system the programme works independently of the financial situation of the state and is not in permanent danger of being stopped due to the financial situation at the state level. At the same time, the extra cost that each electricity consumer has to pay in order to increase the share of renewable energy in the national electricity portfolio is very small. In Germany the monthly extra costs per household due to the feed-in tariff for renewable electricity was less than €1 per month - or €12 per year. So every electricity consumer contributes to the restructuring of the national electricity supply structure from a fossil-based one towards a sustainable and independent electricity supply structure.

feed-in tariff: the driver of cost reduction

The costs for renewable electricity have been reduced constantly since the technology was introduced to the markets. But it is evident that today in most cases renewable electricity cannot yet compete with grid electricity generated from fossil fuels. While it is expected that prices for electricity generated from fossil fuels will keep rising constantly, at the same time it is very important to keep a high pace in bringing the cost of renewable electricity down. For this reason the feed-in tariff in Germany is reduced each year by 5%, but only for newly installed systems. Once a system is connected to the grid the feed-in tariff remains constant over the complete period of 20 years. The reduction by 5% each year places pressure on the industry to bring the costs for renewable electricity down by 5% each year in order to keep the market alive. This planning security is an essential element of the success story of the feed-in tariff.

feed -in tariff: the driver of high quality renewable electricity systems

With the investment subsidy approach there is little incentive to maintain the system properly over its whole lifetime. Maintenance is linked to a moderate degree of investment, but if the customer received the complete financial incentive up-front, there is no incentive to operate the system at the highest possible level.

feed-in tariff: the driver of easier financing

The up-front costs of renewable electricity systems are a clear barrier to a wider market penetration. A feed-in tariff guaranteed by law over a sufficient period of time serves as an excellent security for the customer's bank in order to finance the system.

the feed-in tariff needs a strong co-driver: simple and quick administration as well as guaranteed grid access for renewable electricity

The feed-in tariff needs a strong partner in order to be able to unfold its full power and this is a simple and quick approval process from the administration. Even if an excellent feed-in tariff is in place, but procedures for the approval of the installation of a system and for its connection to the grid takes many months, the number of potential customers will remain limited.

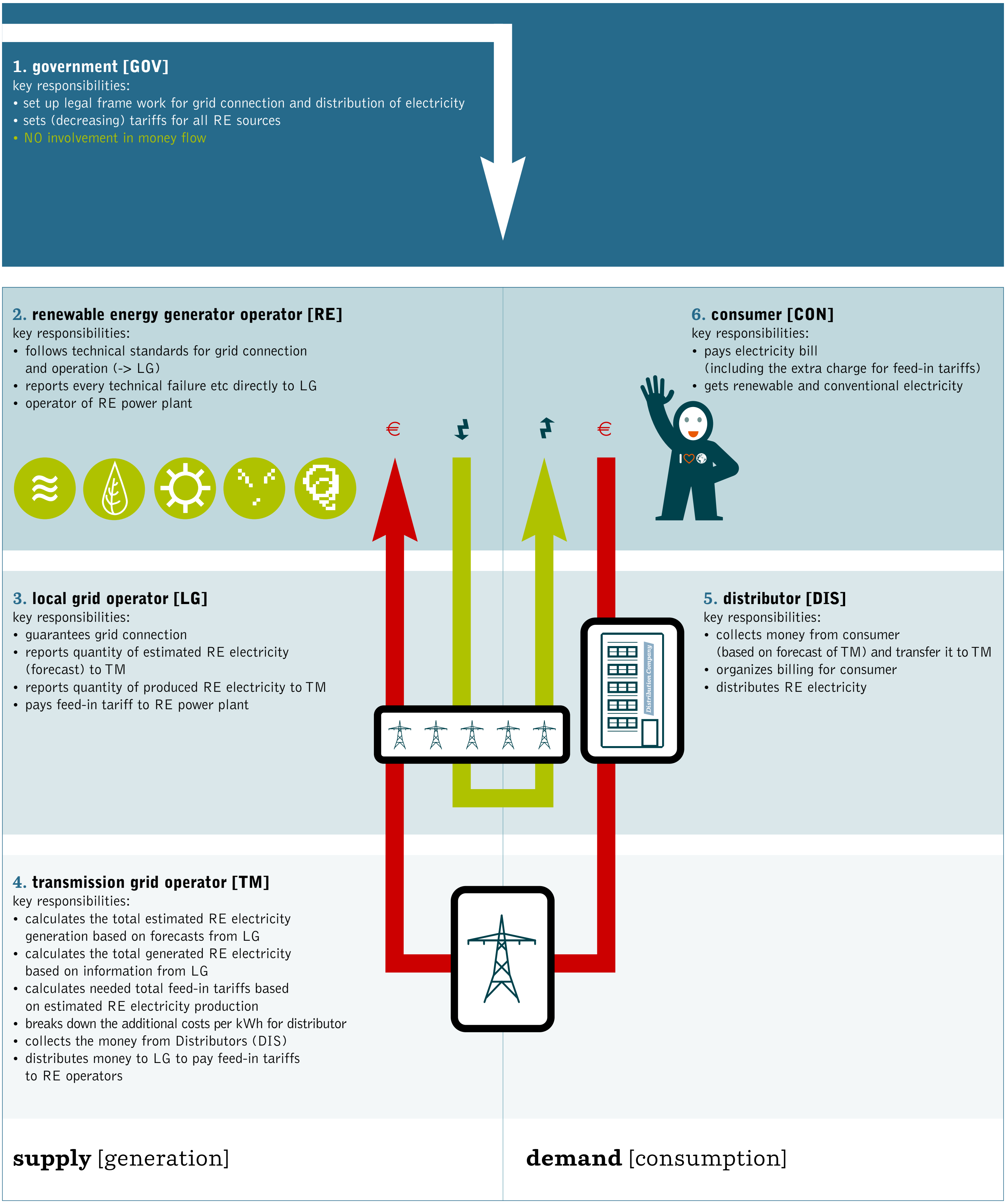
table 22: **key data on renewable energies in germany 2005/2006**

	2005[1]	2006[1]	CHANGES
Share RE in total primary energy consumption	4.7%	5.3%	+12.8%
Share RE in total final energy consumption	6.6%	7.4%	+12.2%
Share RE electricity in total gross electricity consumption	10.4%	11.8%	+13.4%
Share RE heating in total heat consumption	5.3%	5.9%	+11.3%
Share RE in total fuel consumption of road traffic	3.8%	4.7%	+23.7%
CO_2 emissions avoided through RE[2]	ca. 86m t	ca.97m t	+12.7%
- of which through EEG	ca. 37m t	ca. 44m t	+18.9%
Total turnover from RE of which:	ca. 18.1bn	ca. 21.6bn	+19.3%
- turnover from constructing plants	ca. 10.3bn	ca. 11.3bn	+9.7%
- turnover from operating plants	ca. 7.8bn	ca. 10.3bn	+32.1%
Employees in RE sector	ca. 157,000 (2004)	ca. 214,000	+ca. 36% compared with 2004

RE=RENEWABLE ENERGIES
1 PROVISIONAL DATA
2 CALCULATED ACCORDING TO SUBSTITUTION OF OTHER ENERGY FORMS

source BMU-2007

figure 18: **how does it work? the german feed-in tariff law for renewable energies (EEG)**



renewable portfolio standards - texas

In 1999 George Bush signed the Texas RPS into law as governor. Today, Texas generates more electricity from wind than any other state, and wind development is booming. Texas accounted for nearly a third of the new wind power installed in 2006 in the United States, and three of the five largest wind farms in the nation are located in Texas. This year the American Wind Energy Association (AWEA) believes as much as 2,000 MW of new wind power could be installed in Texas, potentially a full two-thirds of wind development in the United States. This would bring the total wind power in Texas to over 5,000 MW effectively reaching the state RPS goal set for 2015 only two years ago.

The original state RPS was passed in 1999 under then Governor Bush, the policy was so successful that it was increased in 2005 to 5,880 MW by 2015 (roughly 5 percent of electricity demand). It also includes a requirement that at least 500 MW of non-wind renewable energy be developed. The RPS includes strong penalties for failure to meet the RPS mandate ($50 per MWh or double the average cost of credits).

The common view of the success of the wind industry in Texas is that the RPS jumpstarted the market, but now wind competes well on the open market with fossil fuels. Also, the industry development has continued in part because of the creation of a proactive planning process to drive investment in necessary power line upgrades and extensions. The wind industry recently announced that it would invest $10 billion in wind projects if the necessary infrastructure investments were made.

The Texas RPS requires a renewable energy capacity on the following schedule:

- 2,280 MW by 1/1/2007
- 3,272 MW by 1/1/2009
- 4,264 MW by 1/1/2011
- 5,256 MW by 1/1/2013
- 5,880 MW by 1/1/2015

Qualifying renewable energy sources include solar, wind, geothermal, hydroelectric, wave or tidal energy, or biomass or biomass-based waste products, including landfill gas. Qualifying systems are those installed after September 1999. The RPS applies to all retail energy providers including municipal and cooperative utilities.

The state established a renewable energy credit (REC-trading program) that began in July 2001 and will continue through 2019. Under PUCT rules, one REC represents one megawatt-hour (MWh) of qualified renewable energy that is generated and metered in Texas. A Capacity Conversion Factor (CCF) is used to convert MW goals into MWh requirements for each retailer in the competitive market. The CCF is administratively set and equal to 35% for the first two compliance years, thereafter based on the actual performance of the resources in the REC-trading program.

Each retailer in Texas is allocated a share of the mandate based on that retailer's pro rata share of statewide retail energy sales. The program administrator will maintain a REC account for program participants to track the production, sale, transfer, purchase, and retirement of RECs. Credits can be banked for 3 years, and all renewable additions have a minimum of 10 years of credits to recover over-market costs. A penalty system has been established for providers that do not meet the RPS requirements. The penalty is the lesser of $50 per MWh or 200% of the average cost of credits traded during the year.

image STORM STUDIED AND FILMED BY THE CENTER OF SEVERE WEATHER RESEACH (CSWR) WITH DOPPLER ON WHEELS, NEAR BEATRICE, NEBRASKA, USA.

appendix

table 23: investment in renewable energies in billion $2000

PHOTOVOLTAIC		AFRICA	CHINA	EAST ASIA	LATIN AMERICA	MIDDLE EAST	OECD EUROPE	OECD NORTH AMERICA	OECD PACIFIC	SOUTH ASIA	TRANS. ECONS.
2004-2010	REF	0.0	0.0	0.0	0.0	0.	5.0	4.0	14.0	0.0	0.0
	E[R]	2.4	2.9	2.9	3.5	1.1	40.4	8.2	19.9	2.7	0.4
2011-2020	REF	0.0	0.0	0.0	0.0	0.0	12.7	7.5	10.6	0.0	0.0
	E[R]	19.0	47.0	20.5	24.1	12.0	76.8	56.2	57.0	20.7	3.4
2021-2030	REF	1.7	1.8	0.9	0.0	1.3	17.8	10.3	10.0	0.8	0.0
	E[R]	54.9	132.5	41.2	39.3	57.4	84.3	94.9	35.7	53.9	46.9
CONCENTRATED SOLAR POWER											
2004-2010	REF	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.6	0.0	0.0
	E[R]	0.4	0.8	0.4	0.0	1.1	0.7	1.6	0.7	0.8	0.0
2011-2020	REF	0.0	0.0	0.0	0.0	0.0	0.0	1.7	1.8	0.0	0.0
	E[R]	21.8	12.1	5.2	2.6	16.0	4.3	20.0	4.2	5.5	0.0
2021-2030	REF	0.5	0.0	0.0	0.0	0.5	0.0	5.5	3.9	0.0	0.0
	E[R]	74.2	80.1	11.8	22.2	83.3	19.1	69.9	21.3	21.1	0.0
WIND POWER											
2004-2010	REF	1.3	5.1	2.6	3.4	1.6	65.6	13.5	2.4	4.2	2.1
	E[R]	0.8	7.7	2.6	3.4	1.6	81.6	34.5	5.0	17.6	2.1
2011-2020	REF	0.8	6.6	2.6	2.6	1.1	71.4	27.7	3.4	2.5	4.6
	E[R]	15.6	109.1	65.7	76.9	22.2	153.0	209.3	83.4	44.5	11.0
2021-2030	REF	4.0	16.9	4.6	6.7	2.7	108.9	57.5	8.9	6.5	5.3
	E[R]	27.7	174.0	67.7	67.4	22.0	162.7	191.8	51.5	70.6	78.6
GEOTHERMAL											
2004-2010	REF	0.3	0.0	19.5	3.5	0.0	1.0	47.9	2.8	0.0	1.8
	E[R]	1.6	0.0	18.2	3.5	2.6	0.1	40.0	3.2	0.0	1.8
2011-2020	REF	0.4	0.0	16.3	2.9	0.0	1.9	15.5	3.1	1.1	0.7
	E[R]	2.5	0.0	2.6	2.9	3.2	4.1	15.8	3.9	1.1	0.7
2021-2030	REF	0.4	0.0	17.1	8.5	0.0	5.8	35.0	5.4	0.0	2.9
	E[R]	3.3	0.0	21.3	2.2	5.0	8.7	39.2	5.2	0.9	2.9
BIOMASS											
2004-2010	REF	0.8	2.2	0.8	6.6	0.0	5.1	5.4	5.7	3.1	0.4
	E[R]	0.5	0.4	1.7	2.7	0.4	5.2	8.1	4.2	0.4	0.4
2011-2020	REF	0.0	2.7	2.3	6.5	0.0	8.0	7.6	4.2	0.7	0.1
	E[R]	0.7	1.0	5.9	2.4	0.3	4.7	7.6	4.9	1.0	9.8
2021-2030	REF	2.1	5.1	3.0	8.7	1.4	6.5	6.4	8.3	5.8	1.2
	E[R]	2.8	0.5	7.1	1.5	1.1	7.9	8.6	5.7	1.2	10.2

image PHOTOVOLTAIC.

GREENPEACE

Greenpeace is a global organisation that uses non-violent direct action to tackle the most crucial threats to our planet's biodiversity and environment. Greenpeace is a non-profit organisation, present in 40 countries across Europe, the Americas, Asia and the Pacific. It speaks for 2.8 million supporters worldwide, and inspires many millions more to take action every day. To maintain its independence, Greenpeace does not accept donations from governments or corporations but relies on contributions from individual supporters and foundation grants.

Greenpeace has been campaigning against environmental degradation since 1971 when a small boat of volunteers and journalists sailed into Amchitka, an area west of Alaska, where the US Government was conducting underground nuclear tests. This tradition of 'bearing witness' in a non-violent manner continues today, and ships are an important part of all its campaign work.

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EREC

european renewable energy council - [EREC]
EREC is an umbrella organisation of the leading European renewable energy industry, trade and research associations active in the sectors of photovoltaic, wind energy, small hydropower, biomass, geothermal energy and solar thermal:

AEBIOM (European Biomass Association)
EGEC (European Geothermal Energy Council)
EPIA (European Photovoltaic Industry Association)
ESHA (European Small Hydropower Association)
ESTIF (European Solar Thermal Industry Federation)
EUBIA (European Biomass Industry Association)
EWEA (European Wind Energy Association)
EUREC Agency (European Association of Renewable Energy Research Centers)

EREC represents the European renewable energy industry which has an annual €20 billion turnover. It provides jobs to around 300.000 people!

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image WIND TURBINES AT SUNSET.