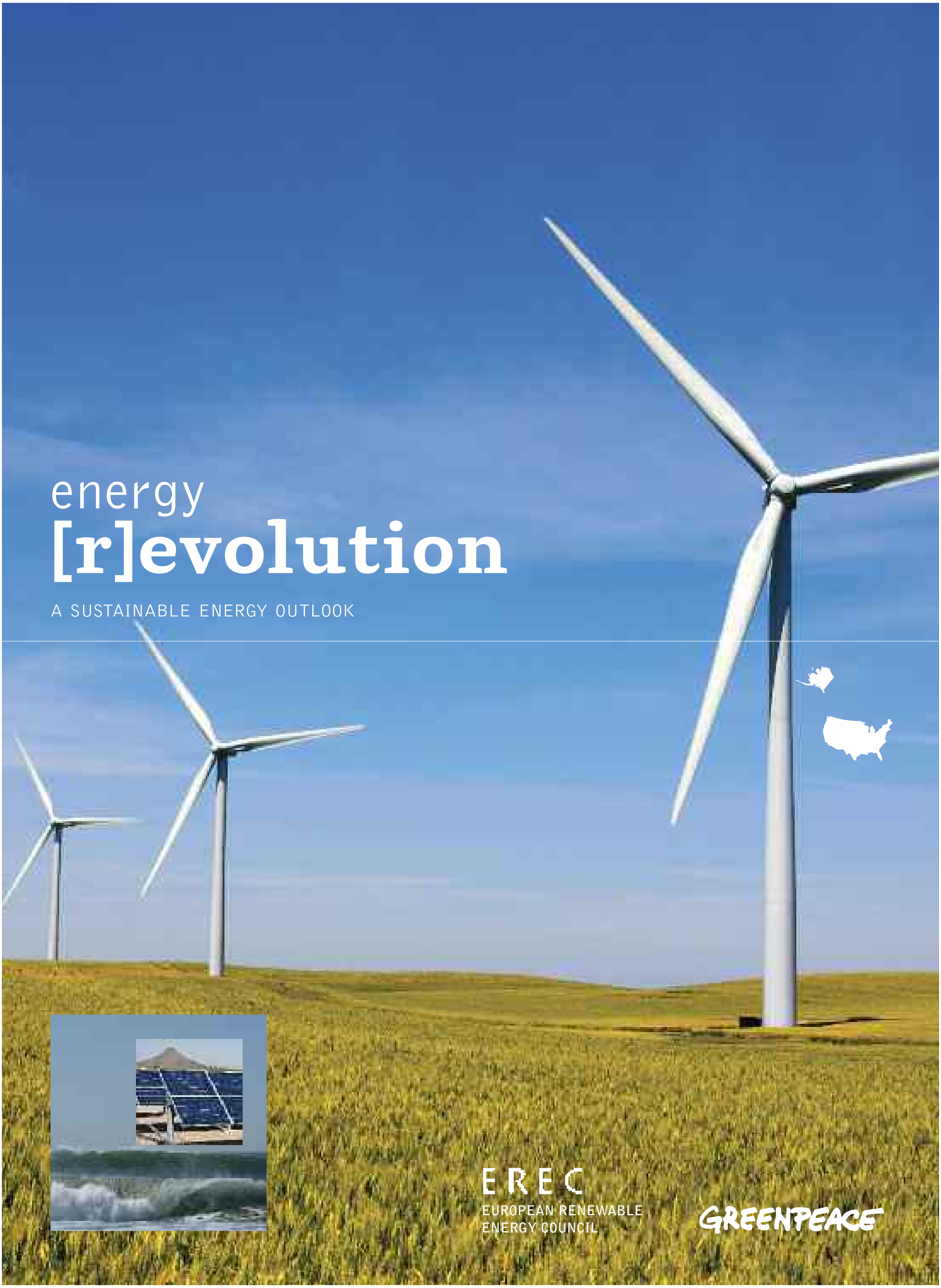
energy
[r]evolution

A SUSTAINABLE ENERGY OUTLOOK



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report 2010 usa energy scenario introduction & executive summary

partners

Greenpeace International, European Renewable Energy Council (EREC)

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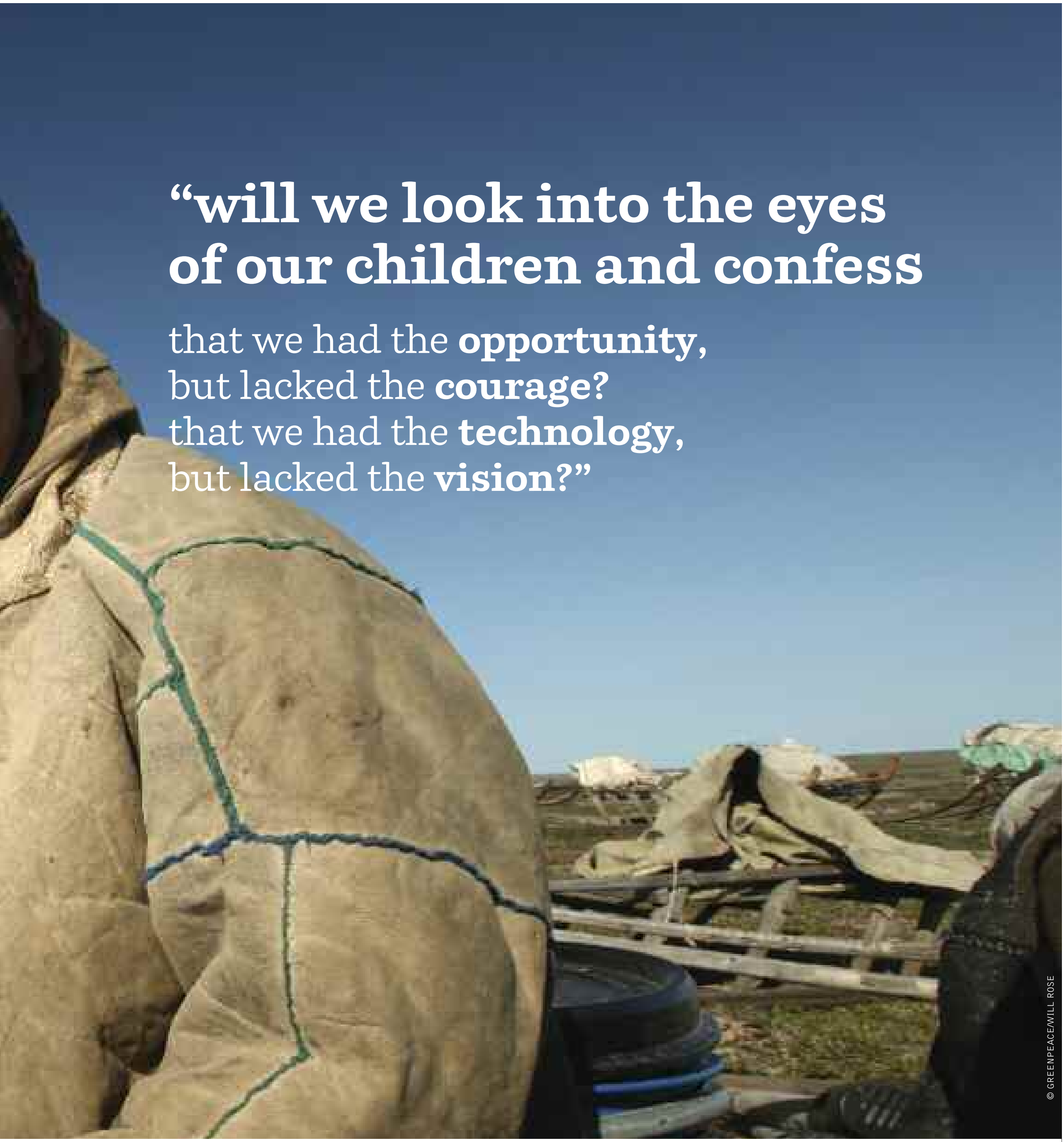
image THE INDIGENOUS NENETS PEOPLE MOVE EVERY 3 OR 4 DAYS SO THAT THEIR REINDEER DO NOT OVER GRAZE THE GROUND AND THEY DO NOT OVER FISH THE LAKES. THE YAMAL PENINSULA IS UNDER HEAVY THREAT FROM GLOBAL WARMING AS TEMPERATURES INCREASE AND RUSSIA'S ANCIENT PERMAFROST MELTS.



"will we look into the eyes of our children and confess

that we had the **opportunity**,
but lacked the **courage**?
that we had the **technology**,
but lacked the **vision**?"

Concepts, Stuttgart, Germany: Dr. Stephan Schmid Ecofys BV, Utrecht, The Netherlands: Wina Graus, Eliane Blomen. Greenhouse Development Rights (Chapter 2.3) EcoEquity, Paul Baer, Assistant Professor, School of Public Policy, Georgia Institute of Technology, Atlanta, USA

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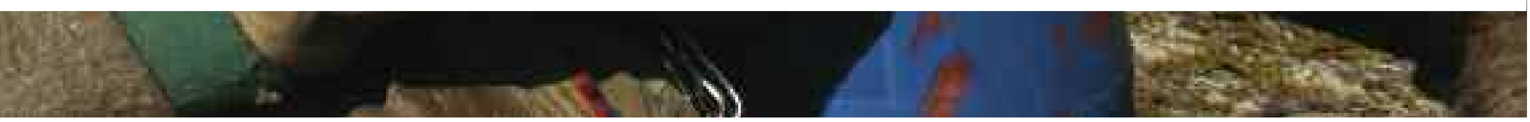

For further information about the global, regional and national scenarios please visit the energy [r]evolution website: **www.energyblueprint.info/**
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foreword

As I write, oil from a deepwater BP well is washing up on the sandy beaches and marshes of the Gulf Coast. At the same time, families in West Virginia are mourning the loved ones they lost in an explosion at a Massey Energy mine that claimed 29 lives—the worst mining disaster in the US in a generation. Sadly, these inestimable tragedies are only the recent headline-getters.

Every day, millions of people whose stories you won't hear are suffering the direct effects of our addiction to fossil fuels. Asthma, cancer, mutilated ecosystems, devastated communities—these are the hidden costs of our backward energy system, and we're paying those costs right now, whether we know it or not. Unfortunately, the worst is yet to come. According to the Nobel-prize winning Intergovernmental Panel on Climate Change, we must peak global warming pollution by 2015 and nearly eliminate it by mid-century.

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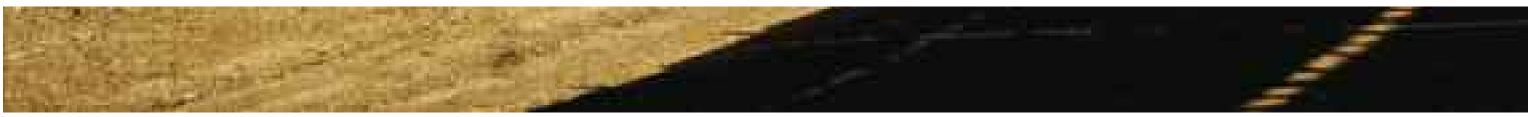

ANDASOL 1 SOLAR POWER STATION SUPPLIES UP TO 200,000 PEOPLE WITH CLIMATE-FRIENDLY ELECTRICITY AND SAVES ABOUT 149,000 TONNES OF CARBON DIOXIDE PER YEAR COMPARED WITH A MODERN COAL POWER PLANT.

If we fail to do so, we risk crossing tipping points in the climate system that could bring about devastating droughts, floods, sea level rise, storms, and wildfires. We are altering the fundamental systems that make our planet habitable. We can't politick our way out of this reality. Rhetoric won't keep our cities from flooding or ecosystems from collapsing. We must decide that enough is enough, and we must take real, bold, immediate action.

We are lucky, in the face of these grim realities, that we have the ability to save ourselves and preserve a livable planet for our children and grandchildren. Using technologies that already exist today—from wind turbines to super-efficient appliances to electric cars--we can continue to grow our economies while reversing the deep damage that fossil fuels have done. By taking simple steps like retrofitting our buildings to make them efficient, we can create millions of jobs and save millions of dollars. By investing in massive renewable energy and efficiency projects we can provide ourselves with energy security and ensure our leadership role in a new global economy. We can continue to thrive, without risking disasters like the Gulf oil spill or the catastrophe promised by unchecked climate change. This Energy [R]evolution is our roadmap.

Industry lobbyists and their PR people would have us believe that these things aren't possible. They've spent millions in campaign contributions and advertising to spin the idea that fossil fuels and nuclear power are a necessary part of our economic success. But you must ignore the politicians that parrot their talking points and the attractive ads, because it is a lie. When our leaders in government find the courage to force polluters to account for the true cost of fossil fuels, and find the wisdom to invest in solutions like renewables and efficiency, that lie will be exposed.

We cannot survive without an energy revolution. The keys to our future have been in the wrong hands for too long, and it will take all our strength to take them back. I hope you will join us.

Phil Radford
EXECUTIVE DIRECTOR
GREENPEACE USA
JUNE 2010

introduction

"FOR THE SAKE OF A SOUND ENVIRONMENT, POLITICAL STABILITY AND THRIVING ECONOMIES, NOW IS THE TIME TO COMMIT TO A TRULY SECURE AND SUSTAINABLE ENERGY FUTURE."

image A WORKER ENTERS A TURBINE TOWER FOR MAINTENANCE AT DABANCHENG WIND FARM. CHINA'S BEST WIND RESOURCES ARE MADE POSSIBLE BY THE NATURAL BREACH IN TIANSHAN (TIAN MOUNTAIN).

Energy policy has a dramatic impact across the social, political and economic spectrum. Governments and businesses must focus on the fact that energy is the lifeblood of the economy. For scientists, the crucial matter is the threat of climate change brought about by burning fossil fuels. NGO's concentrate on the environmental and social impacts, and economists on the potential of a shift in the way our energy is produced. For engineers, the task is developing new technologies to supply and consume energy in a smarter way. But at the end of the day, we are all consumers and we all must deal with the full reality of our energy system—from volatile prices to oil spills. Access to sufficient energy is vital to making our economies work but at the same time, our demand for energy has become the main source of the greenhouse gas emissions that put our climate at risk. Something needs to change.

While the last climate change summit in Copenhagen failed to produce an agreement, international negotiations to address the issue remain high on the political agenda. At the same time, highly volatile fossil fuel prices are creating more and more uncertainty for the global economy, creatingan indirect incentive for investing in renewable energy technologies, which are now booming. Against this backdrop, the third edition of the Energy [R]evolution analysis takes a deep plunge into what's possible in terms of energy supply strategies for the future and how to develop a sustainable energy and climate policy.

Access to energy is of strategic importance for every country in the world. Over the past few years oil prices have gone up and down like a rollercoaster, jumping to a record high in July 2008 of $147.27 and then falling back again to $33.87 in December. Even so, over the whole of 2009 the average oil price was still between $60 and $80 per barrel. At the same time, with gas prices in Europe rising in line with the price of oil, the impact on both the heating and power sectors has been huge.

Security of energy supply is not only influenced by the cost of fuels, however, but by their long term physical availability. Countries without their own fossil fuel supplies have increasingly shown interest in renewable energy sources, not only because of the price stability this brings but because they are indigenous and locally produced.

Renewable energy technologies produce little or no greenhouse gases and rely on virtually inexhaustible natural elements for their 'fuel'. Some of these technologies are already competitive. The wind power industry, for example, has continued its explosive growth in the face of a global recession and a financial crisis and is a testament to the inherent attractiveness of renewable technology. In 2009 the total level of annual investment in clean energy was $145 billion, only a 6.5% drop from the record previous year, while the global wind power market grew by an annual 41.5%. In the US

image NORTH HOYLE WIND FARM, UK'S FIRST WIND FARM IN THE IRISH SEA WHICH WILL SUPPLY 50,000 HOMES WITH POWER.

alone, the wind industry grew by nearly 40%. The renewable energy industry now employs around two million people worldwide and has become a major feature of national industrial development plans. In the US, wind already employs more people than coal. Meanwhile, the economics of renewables are expected to further improve as they develop technically, and as the price of fossil fuels continues to rise and as their saving of carbon dioxide emissions is given a monetary value. These cost comparisons, already favorable to renewables, don't even account for the massive externalized costs of fossil fuels such as the oil spill in the Gulf of Mexico.

Despite the small drop in fossil fuel emissions in the industrialized world as a result of the economic crisis, globally the level of energy related carbon dioxide continues to grow. This means that a recovered economy will result in increasing CO_2 emissions once again, further contributing to the greenhouse gases which threaten our planet. A shift in energy policy is needed so that a growing economy and reduced CO_2 emissions can go hand in hand. The Energy [R]evolution analysis shows how this is possible.

Although the Copenhagen climate change conference at the end of 2009 was a huge disappointment, it should not lead to a feeling that nothing can happen. A change in energy policy has to be connected to a change of climate policy. The United Nations (UNFCCC) climate talks therefore still remain central to the survival of our planet and a global regime for CO_2 reduction. Placing a price on carbon, as well as a long term agreement on CO_2 reduction, are both of vital importance for the uptake of renewables and energy efficiency. The achievement of a new 'fair, ambitious and legally binding' (FAB) deal relies fundamentally on legally binding emissions reduction obligations, on common guidelines for accounting rules, on a compliance regime and on agreed carbon trading mechanisms.

energy [r]evolution 2010

This is the third edition of the global Energy [R]evolution scenario since the first one was published in January 2007, each analysis deeper than the last. In the second edition we introduced specific research for the transport sector and an investigation of the pathway to future investment in renewable energies. Since then we have published country-specific scenarios for over 30 countries and regions, added a study of the employment implications of the scenarios and a detailed examination of how the grid network needs to be improved and adapted.

This new edition has broken fresh ground again. The 2010 Energy [R]evolution not only includes the financial analysis and employment calculations in parallel with the basic projections, we have also added a second, more ambitious Energy [R]evolution scenario. This was considered vital because rapid improvements in climate science made it clear during 2009 that a global 50% reduction in energy related CO_2 emissions by 2050 might not be enough to keep the global mean temperature rise below +2°C. An even greater reduction may be needed if runaway climate change is to be avoided.

The advanced Energy [R]evolution scenario has changed five parameters compared to the basic version. These mean that the economic lifetime of coal power stations has been reduced from 40 to 20 years, the growth rate of renewables has taken the advanced projections of the renewable industry into account, the use of electric drives in the transport sector will take off ten years earlier, the expansion of smart grids will happen quicker, and last but not least, the expansion of fossil fuel based energy will stop after 2015.

A drastic reduction in CO_2 levels and a share of over 80% renewables in the world energy supply are both possible goals by 2050. Of course this will be a technical challenge, but the main obstacle is political. We need to kick start the Energy [R]evolution with long lasting reliable policy decisions within the next few years. It took more than a decade to make politicians aware of the climate crisis; we do not have another decade to agree on the changes needed in the energy sector. Greenpeace and the renewables industry present the Energy [R]evolution scenario as a practical but ambitious blueprint. For the sake of a sound environment, political stability and thriving economies, now is the time to commit to a truly secure and sustainable energy future – a future built on energy efficiency and renewable energy, economic development and the creation of millions of new jobs for the next generation.

Christine Lins
SECRETARY GENERAL
EUROPEAN RENEWABLE
ENERGY COUNCIL (EREC)
JUNE 2010

Sven Teske
CLIMATE & ENERGY UNIT
GREENPEACE INTERNATIONAL

executive summary

"AT THE CORE OF THE ENERGY [R]EVOLUTION WILL BE A CHANGE IN THE WAY THAT ENERGY IS PRODUCED, DISTRIBUTED AND CONSUMED."

image THE PS10 CONCENTRATING SOLAR THERMAL POWER PLANT IN SEVILLA, SPAIN. THE 11 MEGAWATT SOLAR POWER TOWER PRODUCES ELECTRICITY WITH 624 LARGE MOVABLE MIRRORS CALLED HELIOSTATS. THE SOLAR RADIATION, MIRROR DESIGN PLANT IS CAPABLE OF PRODUCING 23 GWH OF ELECTRICITY WHICH IS ENOUGH TO SUPPLY POWER TO A POPULATION OF 10,000.

The threat of climate change, caused by rising global temperatures, is the most significant environmental challenge facing the world at the beginning of the 21st century. It has major implications for the world's social and economic stability, its natural resources and in particular, the way we produce our energy. The Copenhagen Accord, a political declaration agreed by many key countries at the climate change summit in December 2009, has the stated aim of keeping the increase in global temperatures to below 2°C, and then considering a 1.5°C limit by 2015. However, the national emissions reduction pledges submitted by various countries to the United Nations coordinating body, the UNFCCC, in the first half of 2010 are likely to lead to a world with global emissions of between 47.9 and 53.6 gigatons of carbon dioxide equivalents per year by 2020. This is about 10–20% higher than today's levels. In the worst case, the Copenhagen Accord pledges could even permit emission allowances to exceed a 'business as usual' projection.[1] In order to avoid the most catastrophic impacts of climate change, the global temperature increase must be kept as far below 2°C as possible. This is still possible, but time is running out. To stay within this limit, global greenhouse gas emissions will need to peak by 2015 and decline rapidly after that, reaching as close to zero as possible by the middle of the 21st century.

a safe level of warming?

Keeping the global temperature increase to 2°C is often referred to as a 'safe level' of warming, but this does not reflect the reality of the latest science. This shows that a warming of 2°C above pre-industrial levels would pose unacceptable risks to many of the world's key natural and human systems.[2] Even with a 1.5°C warming, increases in drought, heat waves and floods, along with other adverse impacts such as increased water stress for up to 1.7 billion people, wildfire frequency and flood risks, are projected in many regions. Neither does staying below 2°C rule out large scale disasters such as melting ice sheets. Partial de-glaciation of the Greenland ice sheet, and possibly the West Antarctic ice sheet, could even occur from additional warming within a range of 0.8 – 3.8°C above current levels.[3] If rising temperatures are to be kept within acceptable 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.

references
1 COPENHAGEN ACCORD PLEDGES ARE PALTRY-JOERI ROGELJ, MALTE MEINSHAUSEN, APRIL 2010.
2 W. L. HARE. A SAFE LANDING FOR THE CLIMATE. STATE OF THE WORLD. WORLDWATCH INSTITUTE. 2009.

image WELDER WORKING AT VESTAS WIND TURBINE FACTORY, CAMPBELLTOWN, SCOTLAND.

climate change and security of supply

Spurred by recent rapidly fluctuating oil prices, the issue of security of supply – both in terms of access to supplies and financial stability - is now at the top of the energy policy agenda. One reason for these price fluctuations is the fact that supplies of all proven resources of fossil fuels – oil, gas and coal – are becoming scarcer and more expensive to produce. So-called 'non-conventional' resources such as shale oil have even in some cases become economic, with devastating consequences for the local environment. What is certain is that the days of 'cheap oil' are coming to an end. 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 power than the world currently consumes - forever.

Renewable energy technologies vary widely in their technical and economic maturity, but there are a range of sources which offer increasingly attractive options. These include wind, biomass, photovoltaics, solar thermal, geothermal, ocean and hydroelectric power. Their common feature is that they produce little or no greenhouse gases, and rely on virtually inexhaustible natural elements for their 'fuel'. Some of these technologies are already competitive. The wind power industry, for example, continued its explosive growth in the face of a global recession and a financial crisis in 2008 and 2009 and is a testament to the inherent attractiveness of renewable technology.

Last year (2009) Bloomberg New Energy Finance reported the total level of annual investment in clean energy as $145 billion, only a 6.5% drop from the record previous year. The global wind industry defied the economic downturn and saw its annual market grow by 41.5% over 2008, and total global wind power capacity increase by 31.7% to 158 GW at the end of 2009.[4] More grid-connected solar PV capacity was added worldwide than in the boom year of 2008. And the economics of renewables 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.

At the same time there is enormous potential for reducing our consumption of energy, and still continuing to provide the same level of energy services. This study details a series of energy efficiency measures which together can substantially reduce demand across industry, homes, business and services.

In contrast to the explosive growth and promise of renewables and efficiency, nuclear energy is a relatively minor industry with major problems. The average age of operating commercial nuclear reactors is 23 years, so more power stations are being shut down than started. In 2008, world nuclear production fell by 2 % compared to 2006, and the number of operating reactors as of January 2010 was 436, eight less than at the historical peak of 2002. Although nuclear power produces little carbon dioxide, there are multiple threats to people and the environment from its operations. 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. As a result, nuclear power is discounted in this analysis.

the energy [r]evolution

The threat of climate change demands nothing short of an Energy Revolution--a transformation that has already started, as renewable energy markets exhibit huge and steady growth. In the first global edition of the Energy [R]evolution, published in January 2007, we projected a global installed renewable capacity of 156 GW by 2010. At the end of 2009, 158 GW has been installed. More needs to be done, however. At the core of this revolution will be a change in the way that energy is produced, distributed and consumed. The five key principles behind this shift will be to:

the five key principles behind this shift will be to:

- Implement renewable solutions, especially through decentralized energy systems
- Respect the natural limits of the environment
- Phase out dirty, unsustainable energy sources
- Create greater equity in the use of resources
- Decouple economic growth from the consumption of fossil fuels

Decentralized energy systems, where power and heat are produced close to the point of final use, will avoid the current waste of energy during conversion and distribution. Investments in 'climate infrastructure' such as smart interactive grids, as well as super grids to transport large quantities of offshore wind and concentrating solar power, are essential. Building up clusters of renewable micro grids, especially for people living in remote areas, will be a central tool in providing sustainable electricity to the almost two billion people around the world for whom access to electricity is presently denied.

greenhouse development rights

Although the Energy Revolution envisages a clear technological pathway, it is only likely to be turned into reality if its corresponding investment costs are shared fairly under some kind of global climate regime. To demonstrate one such possibility, we have utilized the Greenhouse Development Rights framework, designed by EcoEquity and the Stockholm Environment Institute, as a way of evening up the inherently unequal abilities of countries to respond to the climate crisis in their energy polices.

The Greenhouse Development Rights (GDR) framework calculates national shares of global greenhouse gas obligations based on a combination of responsibility (contribution to climate change) and capacity (ability to pay). Crucially, GDRs take inequality within countries into account and calculate national obligations on the basis of the estimated capacity and responsibility of individuals. Individuals

references

3 JOEL B. SMITH, STEPHEN H. SCHNEIDER, MICHAEL OPPENHEIMER, GARY W. YOHE, WILLIAM HARE, MICHAEL D. MASTRANDREA, ANAND PATWARDHAN, IAN BURTON, JAN CORFEE-MORLOT, CHRIS H. D. MAGADZA, HANS-MARTIN FÜSSEL, A. BARRIE PITTOCK, ATIQ RAHMAN, AVELINO SUAREZ, AND JEAN-PASCAL VAN YPERSELE: ASSESSING DANGEROUS CLIMATE CHANGE THROUGH AN UPDATE OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC) "REASONS FOR CONCERN". PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES. PUBLISHED ONLINE BEFORE PRINT FEBRUARY 26, 2009, DOI: 10.1073/PNAS.0812355106. THE ARTICLE IS FREELY AVAILABLE AT: HTTP://WWW.PNAS.ORG/CONTENT/EARLY/2009/02/25/0812355106.FULL.PDF A COPY OF THE GRAPH CAN BE FOUND ON APPENDIX 1.

4 GLOBAL WIND 2009 REPORT, GWEC, MARCH 2010, S. SAWYER, A. ZERVOS.

"The long term scenario has been developed further towards a complete phasing out of fossil fuels in the second half of this century."

with incomes below a 'development threshold' – specified in the default case as $7,500 per capita annual income, PPP adjusted – are exempted from climate-related obligations. Individuals with incomes above that level are expected to contribute to the costs of global climate policy in proportion to their capacity (amount of income over the threshold) and responsibility (cumulative CO_2 emissions).

The result, of these calculations is that rich countries like the United States, which is also responsible for a large proportion of global greenhouse gas emissions, will contribute much more towards the costs of implementing global climate policies (such as increasing the proportion of renewables) than a country like India. Based on a 'Responsibility and Capacity Indicator', the US, accounting for 36.8% of the world's responsibility for climate change, will in turn be responsible for funding 36.3% of the required global emissions reductions.

The GDR framework therefore represents a good mechanism for helping developing countries to leapfrog over fossil fuel dependence and into a sustainable energy supply, with the help of industrialized countries--while maintaining economic growth and the need to satisfy their growing energy needs. Greenpeace has taken this concept on board as a means of achieving equity within the climate debate and as a practical solution to kick-starting the renewable energy market in developing countries.

methodology and assumptions

Three global scenarios up to the year 2050 are outlined in this report: a Reference scenario, an Energy [R]evolution scenario with a target to reduce energy related CO_2 emissions by 50%, from their 1990 levels, and an advanced Energy [R]evolution version which envisages a fall of 82% in CO_2 by 2050.

The Reference Scenario is based on the reference scenario in the International Energy Agency's 2009 World Energy Outlook (WEO 2009) analysis, extrapolated forward from 2030. Compared to the previous (2007) IEA projections, WEO 2009 assumes a slightly lower average annual growth rate of world Gross Domestic Product (GDP) of 3.1%, instead of 3.6%, over the period 2007-2030. At the same time, it expects final energy consumption in 2030 to be 6%% lower than in the 2007 report. China and India are expected to grow faster than other regions, followed by the Other Developing Asia group of countries, Africa and the Transition Economies (mainly the former Soviet Union). The OECD share of global purchasing power parity (PPP) adjusted GDP will decrease from 55% in 2007 to 29% by 2050.

The Energy [R]evolution Scenario has a key target for the reduction of worldwide carbon dioxide emissions down to a level of around 10 Gigatons per year by 2050. A second objective is the global phasing out of nuclear energy. To achieve these goals the scenario is characterized by significant efforts to fully exploit the large potential for energy efficiency. At the same time, all cost-effective renewable energy sources are used for heat and electricity generation, as well as the production of bio fuels. The general framework parameters for population and GDP growth remain unchanged from the Reference scenario.

The Advanced Energy [R]evolution Scenario takes a much more radical approach to the climate crisis facing the world. In order to pull the emergency brake on global emissions it therefore assumes much shorter technical lifetimes for coal-fired power plants - 20 years instead of 40 years. This reduces global CO_2 emissions even faster and takes the latest evidence of greater climate sensitivity into account. To fill the resulting gap, the annual growth rates of renewable energy sources, especially solar photovoltaics, wind and concentrating solar power plants, have therefore been increased.

Apart from that, the advanced scenario takes on board all the general framework parameters of population and economic growth from the basic version, as well as most of the energy efficiency roadmap. In the transport sector, however, there is 56% lower final energy demand due to a combination of simply less driving and instead increase use of public transport and a faster uptake of efficient combustion vehicles and – after 2025 – a larger share of electric vehicles.

Within the heating sector there is a faster expansion of CHP in the industry sector, more electricity for process heat and a faster growth of solar and geothermal heating systems. Combined with a larger share of electric drives in the transport sector, this results in a higher overall demand for power. Even so, the overall global electricity demand in the advanced Energy [R]evolution scenario is still lower than in the Reference scenario.

In the advanced scenario the latest market development projections of the renewable industry[5] have been calculated for all sectors (see Chapter 5, Table 5.13: Annual growth rates of renewable energy technologies). The speedier uptake of electric vehicles, combined with the faster implementation of smart grids and expanding super grids (about ten years ahead of the basic version) allows a higher share of fluctuating renewable power generation (photovoltaic and wind). The threshold of a 40% proportion of renewables in global primary energy supply is therefore passed just after 2030 (also ten years ahead). By contrast, the quantity of biomass and large hydro power remain the same in both Energy [R]evolution scenarios, for sustainability reasons.

towards a renewable future

Today, renewable energy sources account for 5.4% of the USA´s primary energy demand. Biomass, which is mostly used in the heat sector, is the main source. The share of renewable energies for electricity generation is 8.6%, while their contribution to heat supply is around 11.6% (to a large extent accounted for by traditional uses such as collected firewood). About 80% of the primary energy supply today still comes from fossil fuels. Both Energy [R]evolution Scenarios describe development pathways which turn the present situation into a sustainable energy supply, with the advanced version achieving the urgently needed CO_2 reduction target more than a decade earlier than the basic scenario.

The following summary shows the results of the advanced Energy [R]evolution scenario, which will be achieved through the following measures:

- Exploitation of existing large energy efficiency potentials will ensure that final energy demand decreases significantly - from the current 66,935 PJ/a (2007) to 46,897 PJ/a in 2050, compared to 72,483 PJ/a in the Reference scenario. This dramatic reduction is a crucial prerequisite for achieving a significant

references
5 SEE EREC, RE-THINKING 2050, GWEC, EPIA *ET AL.*

image THOUSANDS OF FISH DIE AT THE DRY RIVER BED OF MANAQUIRI LAKE, 150 KILOMETERS FROM AMAZONAS STATE CAPITOL MANAUS, BRAZIL.

share of renewable energy sources in the overall energy supply system, compensating for the phasing out of nuclear energy and reducing the consumption of fossil fuels.

- More electric drives are used in the transport sector and hydrogen produced by electrolysis from excess renewable electricity plays a much bigger role in the advanced than in the basic scenario. After 2020, the final energy share of electric vehicles on the road increases to 8.6% and by 2050 to over 91%. More public transport systems also use electricity, as well as there being a greater shift in transporting freight from road to rail.
- The increased use 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, the 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 utilization. By 2050, around 98% of electricity will be produced from renewable sources. A capacity of 2,533 GW will produce 6,446 TWh/a renewable electricity in 2050. A significant share of the fluctuating power generation from wind and solar photovoltaic will be used to supply electricity to vehicle batteries and produce hydrogen as a secondary fuel in transport and industry. By using load management strategies, excess electricity generation will be reduced and more balancing power made available.
- In the heat supply sector, the contribution of renewables will increase to 98% by 2050. Fossil fuels will be increasingly replaced by more efficient modern technologies, in particular biomass, solar collectors and geothermal. Geothermal heat pumps and, in the world's sunbelt regions, concentrating solar power, will play a growing part in industrial heat production.
- In the transport sector the existing large efficiency potentials will be exploited by a modal shift from road to rail and by using much lighter and smaller vehicles. As biomass is mainly committed to stationary applications, the production of bio fuels is limited by the availability of sustainable raw materials. Electric vehicles, powered by renewable energy sources, will play an increasingly important role from 2020 onwards.
- By 2050, 87.4% of primary energy demand will be covered by renewable energy sources.

To achieve an economically attractive growth of renewable energy sources, a balanced and timely mobilisation of all technologies is of great importance. Such mobilisation depends on technical potentials, actual costs, cost reduction potentials and technical maturity. Climate infrastructure such as district heating systems, smart- and supergrids for renewable power generation as well as more R&D in storage technologies for electricity are from great importance to turn this scenario into reality. The successful implementation of smart grids is vital for the advanced Energy [R]evolution from 2020 onwards.

It is also important to highlight that in the advanced Energy [R]evolution scenario the majority of remaining coal power plants – which will be replaced 20 years before the end of their technical lifetime – are in China and India. This means that in practice all coal power plants built between 2005 and 2020 will be replaced by renewable energy sources from 2040 onwards. To support the building of capacity in developing countries significant new public financing, especially from industrialized countries, will be needed. It is vital that specific funding mechanisms such as the "Greenhouse Development Rights" (GDR) and "Feed-in tariff" schemes (see chapter 2) are developed under the international climate negotiations that can assist the transfer of financial support to climate change mitigation, including technology transfer.

future costs

Renewable energy will initially cost more to implement than existing fuels. The slightly higher electricity generation costs under the advanced Energy [R]evolution scenario will be compensated for, however, by reduced demand for fuels in other sectors such as heating and transport. Assuming average costs of 3 cents/kWh for implementing energy efficiency measures, the additional cost for electricity supply under the advanced Energy [R]evolution scenario will amount to a maximum of $42 billion/a in 2030. These additional costs, which represent society's investment in an environmentally benign, safe and economic energy supply, continue to decrease after 2030. By 2050 the annual costs of electricity supply will be $183 billion/a below those in the Reference scenario. It is assumed that average crude oil prices will increase from $97 per barrel in 2008 to $130 per barrel in 2020, and continue to rise to $150 per barrel in 2050. Natural gas import prices are expected to increase by a factor of four between 2008 and 2050, while coal prices will continue to rise, reaching $172 per tonne in 2050. A CO_2 'price adder' is applied, which rises from $20 per ton of CO_2 in 2020 to $50 per ton in 2050.

future investment

It would require until 2030 $5.1 trillion in investment for the advanced Energy [R]evolution scenario to become reality - approximately 160% higher than in the Reference scenario ($2.0 trillion). Until 2050 investments sum up to $8.4 trillion in the advanced scenario compared to $3.2 trillion in the reference case. Under the advanced scenario, however, the world shifts about 80% of investment towards renewables and cogeneration; by 2050 the fossil fuel share of power sector investment would be focused mainly on combined heat and power and efficient gas-fired power plants. The average annual investment in the power sector under the advanced Energy [R]evolution scenario between 2007 and 2050 would be approximately $196 billion.

Because renewable energy has no fuel costs (except biomass), however, the fuel cost savings in the advanced Energy [R]evolution scenario reach a total of $1.3 trillion, or $55 billion per year until 2030 and a total of $6.3 trillion, or $146 billion per year until 2050.

This means that under the Reference scenario the additional costs for fossil fuels from 2007 until the year 2050 are as high as $6.3 trillion, which is significantly higher than the entire additional investment in renewable and cogeneration capacity required to implement the advanced scenario. These renewable energy sources would then go on to produce electricity without any further fuel costs beyond 2050, while the costs for coal and gas will continue to be a burden on national economies. Part of this money could be used to cover stranded investments in fossil-fuelled power stations in developing countries.

“Worldwide we would see more direct jobs created in the energy sector if we shift to either of the Energy [R]evolution scenarios than if we continue business as usual.”

future global employment

Worldwide, we would see more direct jobs created in the energy sector if we shifted to either of the Energy [R]evolutions. The Energy [R]evolution scenarios lead to more energy sector jobs in USA at every stage of the projection.

- There are 1.1 million energy sector jobs in the Energy [R]evolution scenario and 1.4 in the advanced version by 2015, compared to 0.47 million in the Reference scenario.
- By 2020 job numbers reach 1.17 million in the Energy [R]evolution scenario (1.34 million in the advanced version), twice as much as in the Reference scenario.
- By 2030 job numbers in the renewable energy sector reach 834,000 in the Energy [R]evolution scenario, 1.1 million in the advanced version) and reach only 231,000 in the Reference scenario.

development of CO_2 emissions

While US emissions of CO_2 will decrease by 4% under the Reference scenario, under the Energy [R]evolution scenario they will decrease from 5,742 million tons in 2007 to 728 million tons in 2050, 86% below 1990 levels. Annual per capita emissions will drop from 18.6 tons/capita to 1.8 tons/capita. In spite of the phasing out of nuclear energy and a growing electricity demand, CO_2 emissions will decrease enormously in the electricity sector. In the long run efficiency gains and the increased use of renewable electric vehicles, as well as a sharp expansion in public transport, will even reduce CO_2 emissions in the transport sector. With a share of 48% of total emissions in 2050, the transport sector will reduce significantly but remain the largest source of CO_2 emissions - followed by industry and power generation.

The advanced Energy [R]evolution scenario reduces energy related CO2 emissions over a period ten to 15 years faster than the basic scenario, leading to 5.9 t per capita by 2030 and 0.3 t by 2050.

policy changes

To make the Energy [R]evolution real and to avoid dangerous climate change, Greenpeace and EREC demand that the following policies and actions are implemented in the energy sector:

1. Phase out all subsidies for fossil fuels and nuclear energy.
2. Internalize the external (social and environmental) costs of energy production through emissions trading and regulation.
3. Mandate strict efficiency standards for all energy consuming appliances, buildings and vehicles.
4. Establish legally binding targets for renewable energy and combined heat and power generation.
5. Reform the electricity markets by guaranteeing priority access to the grid for renewable power generators.
6. Provide defined and stable returns for investors, with programs like feed-in tariffs.
7. Implement better labelling and disclosure mechanisms to provide more environmental product information.
8. Increase research and development budgets for renewable energy and energy efficiency.

figure 0.1: development of primary energy consumption under the three scenarios

('EFFICIENCY' = REDUCTION COMPARED TO THE REFERENCE SCENARIO)

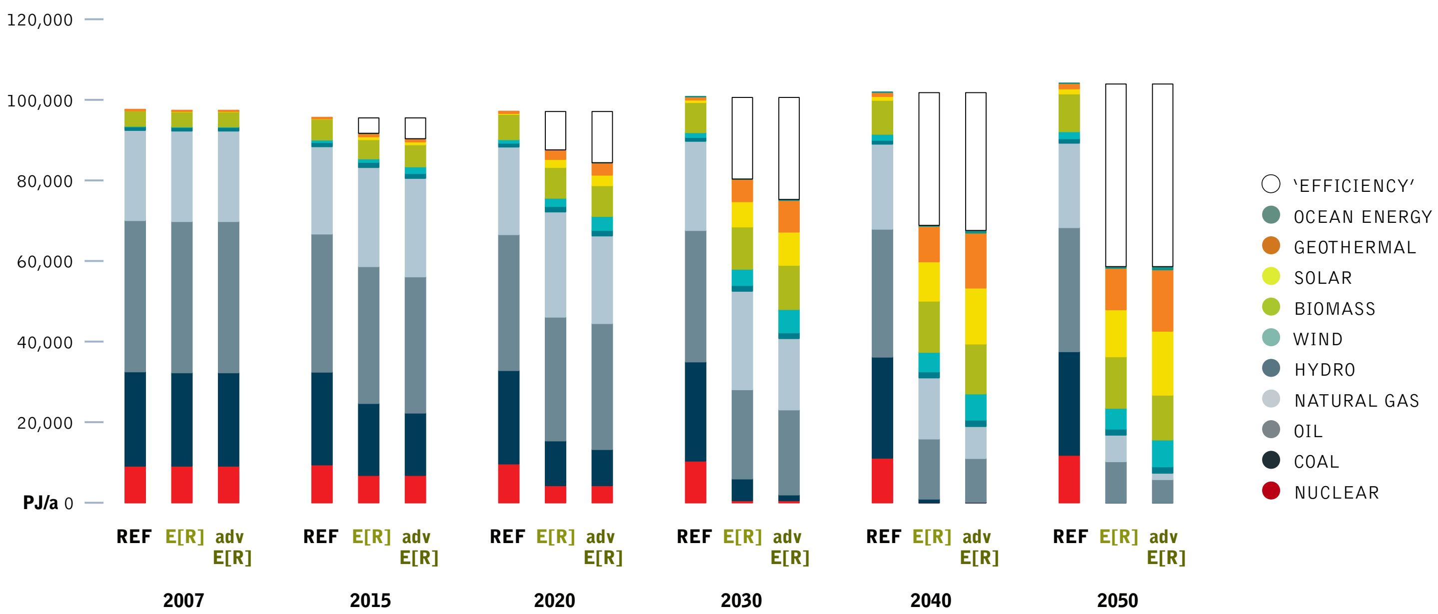

image CONSTRUCTION OF THE OFFSHORE WINDFARM AT MIDDELGRUNDEN NEAR COPENHAGEN, DENMARK.

table 0.1: energy [r]evolution: summary for policy makers

	POLICY	WHO	2010	2015	2020	2025	2030	2035	2040	2045	2050
	Climate										
targets	• Peak global temperature rise well below 2°C	UNFCCC									
targets	• Reduce ghg emissions by 40% by 2020 (as compared to 1990) in developed countries	UNFCCC									
targets	• Reduce ghg emissions by 15 to 30% of projected growth by 2020 in developing countries	UNFCCC									
targets	• Achieve zero deforestation globally by 2020	UNFCCC									
targets	• Agree a legally binding global climate deal as soon as possible	UNFCCC									
	Energy										
targets	• USA: binding target of at least 20% renewable energy in primary energy consumption by 2020	USA									
targets	• G8: min 20% renewable energy by 2020	G8									
targets	• No new construction permits for new coal power plants in Annex 1 countries by 2012	G8									
targets	• Priority access to the grid for renewables	G8									
targets	• Establish efficiency targets and strict standards for electric applications	National Governments									
targets	• Strict efficiency target for vehicles: 80g CO_2/km by 2020	National Governments									
targets	• Build regulations with mandatory renewable energy shares (e.g. solar collectors)	National Governments									
targets	• Co-generation law for industry and district heating support program	National Governments									
	Finance										
mechanisms	• Phase-out subsidies for fossil and nuclear fuels	G20									
mechanisms	• Put in place a Climate Fund under the auspices of the UNFCCC	UNFCCC									
mechanisms	• Provide at least 140 billion USD/year to the Climate Fund by 2020	UNFCCC									
mechanisms	• Ensure priority access to the fund for vulnerable countries and communities	UNFCCC									
mechanisms	• Establish feed-in law for renewable power generation in Annex 1 countries	National Governments									
mechanisms	• Establish feed-in law with funding from Annex 1 countries for dev. countries	G8 + G77									
	ENERGY [R]EVOLUTION RESULTS										
	Renewables & Supply										
power	Global Renewable Power Generation										
power	• Shares (max = adv. ER - Min = ER): **30%** / **50%** / **75%** / over **90%**	Utilities & RE Industry									
power	• Implementation of Smart Grids (**Policy**/**Planning**/**Construction**)	National Governments									
power	• Smart Grids interconnection to Super Grids (**Policy**/**Planning**/**Construction**)	Gov & Grid Operator									
power	• Renewables cost competive (max = worst case - min = best case)	RE - Industry									
power	• Phase out of coal power plants in OECD countries	Utilities									
power	• Phase out of nuclear power plants in OECD countries	Utilities									
heating	Global Renewable Heat supply shares										
heating	• Shares (max = adv. ER - Min = ER): **30%** / **50%** / **75%** / over **90%**	RE Industry									
heating	• Implementation of district heating (**Policy**/**Planning**/**Construction**)	National Governments									
heating	• Renewables cost competive (max = worst case - min = best case)	RE Industry									
final energy	Global Renewable Final Energy shares										
final energy	• Shares (max = adv. ER - Min = ER): **30%** / **50%** / **75%** / over **90%**										
final energy	• Consumer and business (Other Sectors)										
final energy	• Industry										
final energy	• Transport										
final energy	• Total Final Energy										
	Efficiency & Demand										
consumer	Global Statonary Energy Use										
consumer	• Efficiency standards reduce OECD household demand to 550 kWh/a per person	Cusumer Product Dev.									
consumer	• Power demand for IT equipment stablized and start to decrease	IT Industry									
consumer	• National energy intensity drops to 3 MJ/$GDP (Japan's level today)	Industry + Gov.									
transport	Global Transport Development										
transport	• Shift fright from road to rail and where possible from aviation to ships	Gov. + Logistic Industry									
transport	• Shift towards more public transport	Regional Governments									
transport	• Efficient cars become mainstream	Car-Industry									
emissions	**Energy Related CO_2 Emissions**										
emissions	• Global CO_2 reductions (min = adv. ER - Max = ER): **Emission peak** / **-30%** / **-50%** / **-80%**										
emissions	• Annex 1 CO_2 reductions (min = adv. ER - Max = ER): **Emission peak** / **-30%** / **-50%** / **-80%**										
emissions	• Non Annex 1 CO_2 reductions (min = adv. ER - Max = ER): **Emission peak** / **-30%** / **-50%** / **-80%**										

climate protection and energy policy

1

image THE LOCAL ALASKAN TELEVISION STATION BROADCASTS A WARNING FOR HIGH TIDES AND EROSION ALONG THE SEASIDE DURING A 2006 OCTOBER STORM WHICH IMPACTS ON THE VILLAGE OF SHISHMAREF. © GP/ROBERT KNOTH

“never before has humanity been forced to grapple with such an immense environmental crisis.”

GREENPEACE INTERNATIONAL
CLIMATE CAMPAIGN

image WANG WAN YI, AGE 76, ADJUSTS THE SUNLIGHT POINT ON A SOLAR DEVICE USED TO BOIL HIS KETTLE. HE LIVES WITH HIS WIFE IN ONE ROOM CARVED OUT OF THE SANDSTONE, A TYPICAL DWELLING FOR LOCAL PEOPLE IN THE REGION. DROUGHT IS ONE OF THE MOST HARMFUL NATURAL HAZARDS IN NORTHWEST CHINA. CLIMATE CHANGE HAS A SIGNIFICANT IMPACT ON CHINA'S ENVIRONMENT AND ECONOMY.

The greenhouse effect is the process by which the atmosphere traps some of the sun's energy, warming the earth and moderating our climate. A human-driven increase in 'greenhouse gases' has enhanced this effect artificially, raising global temperatures and disrupting our climate. These greenhouse gases include carbon dioxide, produced by burning fossil fuels and through deforestation, methane, released from agriculture, animals and landfill sites, and nitrous oxide, resulting from agricultural production, plus a variety of industrial chemicals.

Every day we damage our climate by using fossil fuels (oil, coal and gas) for energy and transport. As a result, climate change is already impacting on our lives, and is expected to destroy the livelihoods of many people in the developing world, as well as ecosystems and species, in the coming decades. We therefore need to significantly reduce our greenhouse gas emissions. This makes both environmental and economic sense.

According to the Intergovernmental Panel on Climate Change, the United Nations forum for established scientific opinionon climate change, the world's temperature could potentially increase over the next hundred years by up to 6.4° Celsius. This is much faster than anything experienced so far in human history. The goal of climate policy should be to avoid dangerous climate change, which is being translated in limiting global mean temperature rise, as compared to pre-industrial levels, well below 2°C above, or even below 1.5°C. Above these tresholds, we will reach dangerous tipping points and damage to ecosystems and disruption to the climate system increases dramatically. We have very little time within which we can change our energy system to meet these targets. This means that global emissions will have to peak and start to decline by 2015.

Climate change is already harming people and ecosystems. Its reality can be seen in disintegrating polar ice, thawing permafrost, dying coral reefs, rising sea levels and fatal heat waves. It is not only scientists that are witnessing these changes. From the Inuit in the far north to islanders near the Equator, people are already struggling with the impacts of climate change. An average global warming of 1.5°C threatens millions of people with an increased risk of hunger, malaria, flooding and water shortages. Never before has humanity been forced to grapple with such an immense environmental crisis. If we do not take urgent and immediate action to stop global warming, the damage could become irreversible. This can only happen through a rapid reduction in the emission of greenhouse gases into the atmosphere.

This is a summary of some likely effects if we allow current trends to continue:

Likely effects of small to moderate warming

- Sea level rise due to melting glaciers and the thermal expansion of the oceans as global temperature increases. Massive releases of greenhouse gases from melting permafrost and dying forests.
- A greater risk of more extreme weather events such as heatwaves, droughts and floods. Already, the global incidence of drought has doubled over the past 30 years.
- Severe regional impacts. In Europe, river flooding will increase, as well as coastal flooding, erosion and wetland loss. Flooding will also severely affect low-lying areas in developing countries such as Bangladesh and South China.
- Natural systems, including glaciers, coral reefs, mangroves, alpine ecosystems, boreal forests, tropical forests, prairie wetlands and native grasslands will be severely threatened.
- Increased risk of species extinction and biodiversity loss.

The greatest impacts will be on poorer countries in sub-Saharan Africa, South Asia, Southeast Asia and Andean South America as well as small islands least able to protect themselves from increasing droughts, rising sea levels, the spread of disease and decline in agricultural production.

longer term catastrophic effects Warming from emissions may trigger the irreversible meltdown of the Greenland ice sheet, adding up to seven metres of sea level rise over several centuries. New evidence shows that the rate of ice discharge from parts of the Antarctic mean it is also at risk of meltdown. Slowing, shifting or shutting down of the Atlantic Gulf Stream current will have dramatic effects in Europe, and disrupt the global ocean circulation system. Large releases of methane from melting permafrost and from the oceans will lead to rapid increases of the gas in the atmosphere, and consequent warming.

"climate change has moved from being a predominantly physical phenomenon to being a social one" (hulme, 2009)."

the kyoto protocol

Recognising these threats, the signatories to the 1992 UN Framework Convention on Climate Change (UNFCCC) agreed the Kyoto Protocol in 1997. The Protocol finally entered into force in early 2005 and its 190 member countries meet annually to negotiate further refinement and development of the agreement. Only one major industrialised nation, the United States, has not ratified Kyoto.

The Kyoto Protocol commits the signatories from developed countries to reduce their greenhouse gas emissions by 5.2% from their 1990 level by the target period of 2008-2012. This has in turn resulted in the adoption of a series of regional and national reduction targets. In the European Union, for instance, the commitment is to an overall reduction of 8%. In order to help reach this target, the EU has also agreed a target to increase its proportion of renewable energy from 6% to 12% by 2010.

At present, the 193 members of the UNFCCC are negotiating a new climate change agreement that should enable all countries to continue contributing to ambitious and fair emission reductions. Unfortunately the ambition to reach such an agreement in Copenhagen failed and governments will continue negotiating in 2010 and possibly beyond to reach a new fair, ambitous and legally binding deal. Such a deal will need to ensure industrialized countries reduce their emissions on average by at least 40% by 2020, as compared to 1990 emissions. They will further need to provide at least $US 140 billion a year to developing countries to enable them to adapt to climate change, to protect their forests and to achieve the energy revolution. Developing countries should reduce their greenhouse gas emissions by 15 to 30% as compared to the projected growth of their emissions by 2020.

This new FAB deal will need to incoporate the Kyoto Protocol's architecture. This relies fundamentally on legally binding emissions reduction obligations. To achieve these targets, carbon is turned into a commodity which can be traded. The aim is to encourage the most economically efficient emissions reductions, in turn leveraging the necessary investment in clean technology from the private sector to drive a revolution in energy supply.

After Copenhagen, governments need to increase their ambitions to reduce emissions and need to even more invest in making the energy revolution happening. Greenpeace believes that it is feasible to reach a FAB deal in Cancun at the end of this year, if their would be sufficient political will to conclude such an agreement. That political will seems to be absent at the moment, but even if a FAB deal could not be finalised in COP16, due to lack of ambition and commitment of some countries, major parts of the deal must be put in place in Cancun, specifically those related to long term finance commitments, forest protection and overall ambition of emission reductions, so that by the Environment and Development Summit in Brazil in 2012 we can celebrate a deal that keeps the world well below 2 degrees warming with good certainty.

international energy policy

At present, renewable energy generators have to compete with old nuclear and fossil fuel power stations which produce electricity at marginal costs because consumers and taxpayers have already paid the interest and depreciation on the original investments. Political action is needed to overcome these distortions and create a level playing field for renewable energy technologies to compete.

At a time when governments around the world are in the process of liberalising their electricity markets, the increasing competitiveness of renewable energy should lead to higher demand. Without political support, however, renewable energy remains at a disadvantage, marginalised by distortions in the world's electricity markets created by decades of massive financial, political and structural support to conventional technologies. Developing renewables will therefore require strong political and economic efforts, especially through laws that guarantee stable tariffs over a period of up to 20 years. Renewable energy will also contribute to sustainable economic growth, high quality jobs, technology development, global competitiveness and industrial and research leadership.

renewable energy targets

In recent years, in order to reduce greenhouse gas emissions as well as increase energy security, a growing number of countries have established targets for renewable energy. These are either expressed in terms of installed capacity or as a percentage of energy consumption. These targets have served as important catalysts for increasing the share of renewable energy throughout the world.

A time period of just a few years is not long enough in the electricity sector, however, where the investment horizon can be up to 40 years. Renewable energy targets therefore need to have short, medium and long term steps and must be legally binding in order to be effective. They should also be supported by mechanisms such as feed-in tariffs for renewable electricity generation. In order for the proportion of renewable energy to increase significantly, targets must be set in accordance with the local potential for each technology (wind, solar, biomass etc) and be complemented by policies that develop the skills and manufacturing bases to deliver the agreed quantity of renewable energy.

In recent years the wind and solar power industries have shown that it is possible to maintain a growth rate of 30 to 35% in the renewables sector. In conjunction with the European Photovoltaic Industry Association[6], the European Solar Thermal Power Industry Association[7] and the Global Wind Energy Council[8], the European Renewable Energy Council and Greenpeace have documented the development of those industries from 1990 onwards and outlined a prognosis for growth up to 2020 and 2040.

references

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8 'GLOBAL WIND ENERGY OUTLOOK 2008', OCTOBER 2008.

image A PRAWN SEED FARM ON MAINLAND INDIA'S SUNDARBANS COAST LIES FLOODED AFTER CYCLONE AILA. INUNDATING AND DESTROYING NEARBY ROADS AND HOUSES WITH SALT WATER.

demands for the energy sector

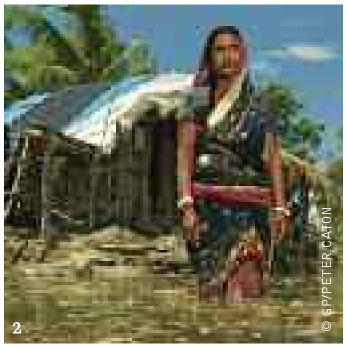
Greenpeace and the renewables industry have a clear agenda for the policy changes which need to be made to encourage a shift to renewable sources.

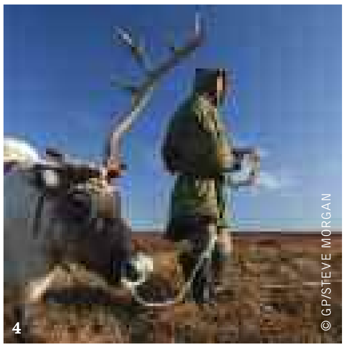
The main demands are:

1. Phase out all subsidies for fossil fuels and nuclear energy.
2. Internalise external (social and environmental) costs through 'cap and trade' emissions trading.
3. Mandate strict efficiency standards for all energy consuming appliances, buildings and vehicles.
4. Establish legally binding targets for renewable energy and combined heat and power generation.
5. Reform the electricity markets by guaranteeing priority access to the grid for renewable power generators.
6. Provide defined and stable returns for investors, for example through feed-in tariff payments.
7. Implement better labelling and disclosure mechanisms to provide more environmental product information.
8. Increase research and development budgets for renewable energy and energy efficiency

Conventional energy sources receive an estimated $250-300 billion[9] in subsidies per year worldwide, resulting in heavily distorted markets. Subsidies artificially reduce the price of power, keep renewable energy out of the market place and prop up non-competitive technologies and fuels. Eliminating direct and indirect subsidies to fossil fuels and nuclear power would help move us towards a level playing field across the energy sector. Renewable energy would not need special provisions if markets factored in the cost of climate damage from greenhouse gas pollution. Subsidies to polluting technologies are perverse in that they are economically as well as environmentally detrimental. Removing subsidies from conventional electricity would not only save taxpayers' money. It would also dramatically reduce the need for renewable energy support.

> "If we do not take urgent and immediate action to protect the climate the damage could become irreversible."





images 1. AN AERIAL VIEW OF PERMAFROST TUNDRA IN THE YAMAL PENINSULA. THE ENTIRE REGION IS UNDER HEAVY THREAT FROM GLOBAL WARMING AS TEMPERATURES INCREASE AND RUSSIA'S ANCIENT PERMAFROST MELTS. **2.** SOVARANI KOYAL LIVES IN SATJELLIA ISLAND AND IS ONE OF THE MANY PEOPLE AFFECTED BY SEA LEVEL RISE: "NOWADAYS, HEAVY FLOODS ARE GOING ON HERE. THE WATER LEVEL IS INCREASING AND THE TEMPERATURE TOO. WE CANNOT LIVE HERE, THE HEAT IS BECOMING UNBEARABLE. WE HAVE RECEIVED A PLASTIC SHEET AND HAVE COVERED OUR HOME WITH IT. DURING THE COMING MONSOON WE SHALL WRAP OUR BODIES IN THE PLASTIC TO STAY DRY. WE HAVE ONLY A FEW GOATS BUT WE DO NOT KNOW WHERE THEY ARE. WE ALSO HAVE TWO CHILDREN AND WE CANNOT MANAGE TO FEED THEM." **3.** WANG WAN YI, AGE 76, SITS INSIDE HIS HOME WHERE HE LIVES WITH HIS WIFE IN ONE ROOM CARVED OUT OF THE SANDSTONE, A TYPICAL DWELLING FOR LOCAL PEOPLE IN THE REGION. DROUGHT IS ONE OF THE MOST HARMFUL NATURAL HAZARDS IN NORTHWEST CHINA. CLIMATE CHANGE HAS A SIGNIFICANT IMPACT ON CHINA'S ENVIRONMENT AND ECONOMY. **4.** INDIGENOUS NENETS PEOPLE WITH THEIR REINDEER. THE NENETS PEOPLE MOVE EVERY 3 OR 4 DAYS SO THAT THEIR HERDS DO NOT OVER GRAZE THE GROUND. THE ENTIRE REGION AND ITS INHABITANTS ARE UNDER HEAVY THREAT FROM GLOBAL WARMING AS TEMPERATURES INCREASE AND RUSSIA'S ANCIENT PERMAFROST MELTS. **5.** A BOY HOLDS HIS MOTHER'S HANDS WHILST IN A QUEUE FOR EMERGENCY RELIEF SUPPLY. SCIENTISTS ESTIMATE THAT OVER 70,000 PEOPLE, LIVING EFFECTIVELY ON THE FRONT LINE OF CLIMATE CHANGE, WILL BE DISPLACED FROM THE SUNDARBANS DUE TO SEA LEVEL RISE BY THE YEAR 2030.

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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, Africa, 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]
Created in April 2000, the European Renewable Energy Council (EREC) is the umbrella organisation of the European renewable energy industry, trade and research associations active in the sectors of bioenergy, geothermal, ocean, small hydro power, solar electricity, solar thermal and wind energy. EREC thus represents the European renewable energy industry with an annual turnover of €70 billion and employing 550,000 people.

EREC is composed of the following non-profit associations and federations: AEBIOM (European Biomass Association); EGEC (European Geothermal Energy Council); EPIA (European Photovoltaic Industry Association); ESHA (European Small Hydro power 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); EREF (European Renewable Energies Federation); EU-OEA (European Ocean Energy Association); ESTELA (European Solar Thermal Electricity Association).

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image ICE MELTING ON A BERG ON THE GREENLANDIC COAST. GREENPEACE AND AN INDEPENDENT NASA-FUNDED SCIENTIST COMPLETED MEASUREMENTS OF MELT LAKES ON THE GREENLAND ICE SHEET THAT SHOW ITS VULNERABILITY TO WARMING TEMPERATURES. **front cover images** WIND TURBINE FARM IN CALIFORNIA. © PHOTOQUEST/DREAMSTIME. © IMDAN/DREAMSTIME. © PHOTOQUEST/DREAMSTIME.