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.

This third edition of the Energy [R]evolution is even more ambitious and visionary than the previous two editions. The report demonstrates how the world can get from where we are now, to where we need to be in terms of phasing out fossil fuels, cutting CO_2 while ensuring energy security. This phase-out of fossil fuels offers substantial benefits such as independence from world market fossil fuel prices as well as the creation of millions of new green jobs. It also means providing energy to the two billion people currently without power. Our future and the future of the planet is rooted in the investment in people and local communities in terms of installing and maintaining renewable energy sources, rather than further subsidising the dirty fossil fuels which are inherently finite. The following executive summary outlines in brief a practical blueprint of how to make this a reality.

environmental challenge:

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, agreed 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 gigatonnes 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

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.

drought, heatwaves 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.

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 and gas' 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.

Against these positive attractions, 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. The nuclear option is therefore discounted in this analysis.

the energy [r]evolution

The climate change imperative demands nothing short of an energy revolution, a transformation that has already started as renewable energy markets continue to grow. 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:

- Implement renewable solutions, especially through decentralised 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

Decentralised 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

But although the Energy [R]evolution 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 utilised the Greenhouse Development Rights framework, designed by EcoEquity and the Stockholm Environment Institute, as a way of evening up the unequal ability of different countries to respond to the climate crisis in their energy polices.

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."

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 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 of America, which are 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 USA, 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 into a sustainable energy supply, with the help of industrialised 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 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 more than 80% 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 WEO 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 Gigatonnes per year by 2050. A second objective is the global phasing out of nuclear energy. To achieve these goals 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 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 15 to 20% lower final energy demand until 2050 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 and hydrogen 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 13% of the world'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 18%, while their contribution to heat supply is around 24%, 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 increases only slightly - from the current 305,095 PJ/a (2007) to 340,933 PJ/a in 2050, compared to 531,485 PJ/a in the Reference scenario.

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.

This dramatic reduction is a crucial prerequisite for achieving a significant 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 4% and by 2050 to over 50%. 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 utilisation. By 2050, around 95% of electricity will be produced from renewable sources. A capacity of 14,045 GW will produce 43,922 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 91% 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, 80% 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 grids and supergrids for renewable power generation, as well as more R&D into storage technologies for electricity, are all vital if this scenario is to be turned 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 industrialised 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 $31 billion/a in 2020. These additional costs, which represent society's investment in an environmentally benign, safe and economic energy supply, continue to decrease after 2020. By 2050 the annual costs of electricity supply will be $2,700 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 tonne of CO_2 in 2020 to $50 per tonne in 2050.

future investment

It would require until 2030 $17.9 trillion in global investment for the advanced Energy [R]evolution scenario to become reality - approximately 60% higher than in the Reference scenario ($11.2 trillion). Under the Reference version, the levels of investment in renewable energy and fossil fuels are almost equal - about $5 trillion each - up to 2030. Under the advanced scenario, however, the world shifts about 80% of investment towards renewables; by 2030 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 2030 would be approximately $782 billion.

Because renewable energy has no fuel costs, however, the fuel cost savings in the advanced Energy [R]evolution scenario reach a total of $6.5 trillion, or $282 billion per year until 2030 and a total of $41.5 trillion, or an average of $964 billion per year until 2050.

"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]evolution scenarios.

- By 2015 global power supply sector jobs in the Energy [R]evolution scenario are estimated to reach about 11.1 million, 3.1 million more than in the Reference scenario. The advanced version will lead to 12.5 million jobs by 2015.
- By 2020 over 6.5 million jobs in the renewables sector would be created due a much faster uptake of renewables, three-times more than today. The advanced version will lead to about one million jobs more than the basic Energy [R]evolution, due a much faster uptake of renewables.
- By 2030 the Energy [R]evolution scenario achieves about 10.6 million jobs, about two million more than the Reference scenario. Approximately 2 million new jobs are created between 2020 and 2030, twice as much as in the Reference case. The advanced scenario will lead to 12 million jobs, that is 8.5 million in the renewables sector alone. Without this fast growth in the renewable sector global power jobs will be a mere 2.4 million. Thus by implementing the E[R] there will be 3.2 million or over 33% more jobs by 2030 in the global power supply sector.

development of CO_2 emissions

While CO_2 emissions worldwide will increase by more than 60% under the Reference scenario up to 2050, and are thus far removed from a sustainable development path, under the advanced Energy [R]evolution scenario they will decrease from 28,400 million tonnes in 2007 (including international bunkers) to 3,700 in 2050, 82% below 1990 levels. Annual per capita emissions will drop from 4.1 tonnes/capita to 0.4 t/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 42% 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.

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. Internalise the external (social and environmental) costs of energy production 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 by feed-in tariff programmes.
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: global: development of primary energy consumption under the three scenarios

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

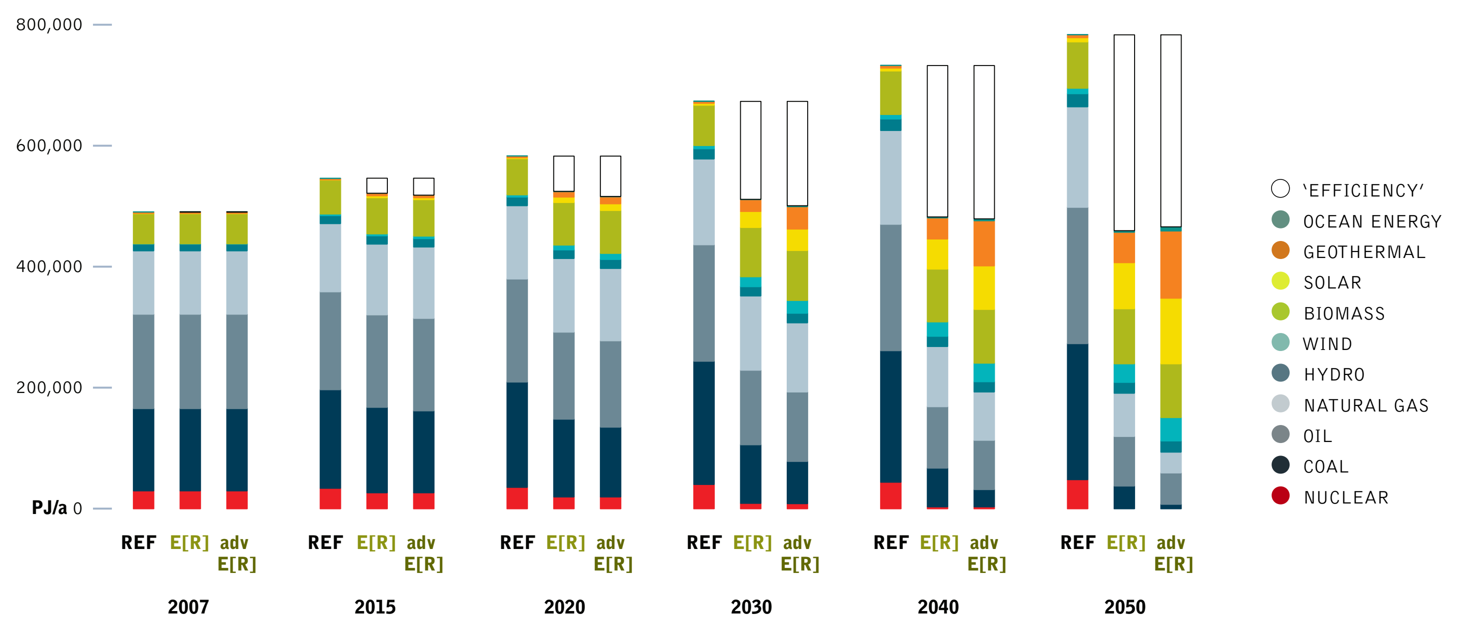

image CONSTRUCTION OF THE OFFSHORE WINDFARM AT MIDDELGRUNDEN NEAR COPENHAGEN, DENMARK.

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	• EU27: binding target of at least 20% renewable energy in primary energy consumption by 2020	EU									
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 acces 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%**										