



WWF

REPORT

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BUSTING THE MYTHS

Debunking myths about renewable energy



FOREWORD



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Renewable energy and energy efficiency are essential if we are to realize an energy transition to a sustainable future for all. The current way we produce and use energy is untenable. Our carbon-intensive energy system – based on oil, coal, gas and inefficient use of traditional bioenergy in developing countries – is the main contributor to climate change as well as air, soil and water pollution. It is responsible for almost three quarters of global greenhouse gas emissions and an estimated four million premature deaths due to air pollution.

Energy derived from the sun, the wind, the sea, and the Earth's heat, water and biomass has the potential to meet the world's energy demand in a sustainable way. Harvesting our energy from renewable sources can raise social and environmental prosperity significantly by securing affordable, reliable and clean energy for everyone. Unfortunately, despite its multiple benefits, renewable energy is still subject to common misconceptions that distort the real value of renewables, including the economic and the environmental implications of both small- and large-scale deployment. Usually these are based on public misinformation, prejudices, old data, weak science, ignorance, or propaganda promoted by vested interests. As renewables are produced by relatively new technologies, mistrust or scepticism explains the core substance behind many of the myths around renewables. Most of the time, arguments used to dismiss renewables are simply examples of knowledge gaps, misinterpretation of facts or magnification of uncertainties.

This report presents evidence and facts that demystify some of the most popular myths about renewable energy relative to its economic viability, sustainability and technological reliability.

To achieve the optimal decarbonisation path, misconceptions need to be debunked and large societal support for boosting clean renewable energy needs to take place. Demystifying myths about renewable energy is therefore a crucial step on our way to a 100% renewable energy future by 2050 – one precondition to help the world limit global warming to no more than 1.5°C above pre-industrial temperatures.

CONTENTS

Glossary	4
Renewable Energy in Numbers	7
Introduction	12
10 Myths about Renewable Energy in Short	17
Myths on Economic Feasibility	18
Myth 1: Renewables Are Too Expensive	20
Myth 2: Renewable Energy Do Not Need Economic Incentives to Develop	23
Myths on Energy Sustainability	26
Myth 3: Renewables-Based Electricity Is Equally Harmful to the Environment as Conventional Electricity.	28
Myth 4: Producing Renewables Consumes More Energy Than It Delivers	31
Myth 5: Renewables Require too Much Land to Produce Electricity	33
Myth 6: Hydropower Is Mostly Bad for Nature and People	34
Myth 7: Production of Bioenergy has Negative Effects on Nature, Climate and Food Security	36
Myths on Technological Reliability	40
Myth 8: Renewables Do Not Deliver Reliable Energy On Demand.	42
Myth 9: Renewables Cannot Replace Fossil Fuels in the Transport and Built Environment Sectors	46
Myth 10: Renewable Energy is Infinite	48
Upholding Facts on Renewable Energy	50
Conclusions	52
Miscellaneous Myths about Renewables	53
10 Facts about Renewable Energy in Short	55
References	56

GLOSSARY

Anthropogenic: related to the influence of human activities on natural and other ecosystems e.g. anthropogenic climate change is that caused by human activities and not by natural phenomena.

Baseload: the minimum amount of power that needs to be made available to meet minimum demands, based on reasonable expectations of electricity demand.

Bioenergy: refers to all forms of biomass burnt for energy use and includes forest, timber and agricultural products, residues, animal dung and all organic waste.

Climate change: is the scientifically observed and statistically significant change in climate (i.e. regional temperature, precipitation, extreme weather, etc.) over long-lasting periods (decades to millions of years). The climate change we are currently experiencing is caused, to a large extent, by human-made (i.e. anthropogenic) alterations of the natural world, particularly through the increase of greenhouse gas emissions to the atmosphere and the consequential strengthening of the greenhouse effect, also known as global warming. Natural climate change has happened in the past and is still happening due to changes in natural factors such as oceanic circulation, variation of solar radiation, volcanic eruptions, etc. Nonetheless,

scientists overwhelmingly concur that these factors are not the prime drivers of the currently observed temperature increases that are happening at an unprecedented speed, and can only be explained by the similarly fast growth in atmospheric GHG concentrations released since the 19th century.

CO₂eq: refers to the emissions or emissions concentration of greenhouse gases controlled by the Kyoto Protocol and the United Nations Framework Convention on Climate Change (UNFCCC) – carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), fluorinated gases (F-gases) and sulphur hexafluoride (SF₆) – based on the equivalent warming that would be caused by carbon dioxide only. By definition and over a 100-year time scale one kg of carbon dioxide has the warming impact of “1”, while that of the other greenhouse gases with same the weight have a much higher warming impact.

Concentrated Solar Power (CSP): a renewable energy technology that converts sunlight concentrated by mirrors or lenses into heat, by heating up a liquid such as water or oil, and, subsequently, to electrical power by driving a conventional steam turbine.

Distributed generation: also called decentralized generation, this refers to the way electricity or heat is generated

from on-site energy sources such as solar panels, mini hydro, small wind turbines or independent-to-the-grid heat and power facilities. Commonly, but not exclusively, it is used for describing photovoltaics (PV) used in building for own electricity generation.

EJ: in the international system of units (SI), the joule (J) is the unit used to measure energy. EJ, or exajoule, is equivalent to 1×10^{18} (1 billion times 1 billion) joules or 1.055 quadrillion BTU (in the English system of units). For instance, USA and China have an energy consumption of about 100 EJ each year.

Emissions life cycle: in the context of this report, it refers to the inventory of the greenhouse gas releases associated with all upstream and downstream steps of energy generation, particularly power generation, beginning with resource extraction and continuing through processing and end use.

Energy Payback Time (EPT): is the operational time an energy technology needs in order to recover the energy consumed for the manufacture, operation and decommissioning of electricity generation. In other words, the energy needed to produce a wind or gas turbine, a solar panel or a nuclear plant.

Energy return on energy invested (EROI): measures the balance between the energy output in terms of electricity generated (considering the expected lifetime of a given technology) and the primary energy expended in electricity production (including energy-conversion technology, manufacturing, operation and decommissioning).

First generation biofuels: refers to liquid bioenergy produced from starch, sugar or vegetable oils. These fuels dominate the current landscape of liquid biofuels. Sugarcane and corn are the main feedstocks used to produce bioethanol (blended or used instead of

petrol), while soy, coconut, palm oil, rapeseed and used cooking oil are used to produce biodiesel.

Fossil fuels: all hydrocarbons in long-time geological reservoirs, such as oil, coal and gas.

Greenhouse gases (GHG): those gases that contribute to the greenhouse effect by trapping heat in the atmosphere, e.g. water vapour (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), and ozone (O_3). Although GHGs occur naturally in the atmosphere, their increasing presence is caused by fossil fuel burning, industrial processes and applications, and the land-use change from increased agricultural activity and clearing of forests. GHGs are prime contributors to anthropogenic climate change. Besides CO_2 , N_2O and CH_4 , the Kyoto Protocol includes as GHGs sulphur hexafluoride (SAF_6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs). Also present in the atmosphere, and entirely human made, are halocarbons as well as other chlorine- and bromine-containing substances, as specified in the Montreal Protocol.

GW: in the international system of units (SI), the watt (W) is the unit used to measure electric power capacity. GW, or gigawatt, is equivalent to 1×10^9 (1 billion) watts. For instance, USA and China have a total installed capacity of power plants of about 1000 GW and 700 GW respectively.

kWh: in the international system of units (SI), the watt-hour (Wh) is the unit used to measure electric power load. kWh, or kilowatt-hour, is equivalent to 1×10^3 (1 thousand) watts per hour. For instance, USA and China have an annual total power generation of about 4 trillion kWh each.

Learning technologies: refer to PV and wind power generation technologies.

Levelised cost of electricity (LCOE): the cost per unit of energy over the average lifetime of a specific technology, including costs for initial investments, fuels, maintenance and operations, and decommissioning. It is used to describe the average kWh production cost, comparing for instance wind and gas or nuclear and solar power.

Capacity factor: the annual ratio of the actual power output of a plant over the net maximum power output if it were possible to operate at full capacity indefinitely. For instance, weather-dependent power plants, such as solar and wind, have a lower capacity factor than coal or nuclear, that can run in baseload.

Renewable energy: the energy that comes from natural resources, namely renewables, such as sunlight, wind, water streams, waves and tides and geothermal heat and biomass, and that is replenished over short timeframes.

Reserves: only those fossil fuel and mineral occurrences that are presently economically and technologically viable for extraction.

Resources: all those fossil fuel and mineral occurrences that have been identified geologically, including those that are presently not economically and technologically viable for extraction. As a result of technological progress and mankind's search for non-renewable fuels, many resources have been turning into reserves in the last decades.

Second generation biofuels: generally produced through the conversion of various lignocellulosic

feedstock (grasses, wood, waste and residues) using thermo-chemical or biochemical routes. There are only a few commercial projects presently; most facilities are pilot projects. Second generation biofuels in general are perceived to be less risky, however the environmental performance of these fuels will largely depend on how, which and where the feedstocks are produced.

Solar photovoltaics (PV): a renewable energy technology that generates electrical power by converting solar radiation into direct current electricity using solar panels.

Technical renewable energy potential: the one that can be exploited based on presently available technologies given system performance constraints. The technical potential is always much larger than the economic or the realisable potential. The former describes all presently cost-effective renewables and the latter only those that are "realistically" deployable because of non-financial impediments and bottlenecks.

Traditional biomass: refers to agricultural by-products, wood and dung harvested and/or used for cooking and heating purposes.

Water consumption intensity of electricity generation: amount of water used (including evaporated or polluted water) during electricity-generation processes.

RENEWABLE ENERGY IN NUMBERS

The world has abundant renewable energy resources: global potential endowments of renewable resources are quite vast. It is estimated that *total technical renewable energy potential can exceed 100 times present global energy consumption.*¹ By source, around 95% of this potential comes from solar technologies, namely solar photovoltaics (PV) and concentrated solar power (CSP), and some 2% from wind energy. Geographically, this potential is mostly available in Africa (47%), Asia & Pacific (23%) and Middle East (12%).² The economic potential, though lower than the technical potential, is also assumed, with continued cost declines of renewable energy technologies and enhanced concerns on whether conventional fuels (nuclear and fossil) can provide an energy supply a few orders of magnitude higher than present energy demand.

The world is increasing its energy demand: to a large extent, economic growth has driven the rise in global energy consumption in recent years. This is particularly due to growth in emerging economies, while growth in countries belonging to the Organisation for Economic Co-operation and Development (OECD) is flattening albeit on a high consumption level. In 2012, global energy demand was 522 EJ, which represented a 1.8% consumption growth compared to 2011 (broadly in line with the historical average).³ Following this trend, *it is projected that under a Business-As-Usual scenario, by 2020 global energy consumption will rise by ca. 20%, i.e. to 625 EJ.*⁴

The world is far from using its technological and economic renewable energy potential: in 2012, despite the great availability of global resources, about 9% of total energy demand was covered by renewables, excluding traditional biomass use. *Fossil fuels and nuclear energy contributed to 87% and 4% of the total energy consumption respectively.*⁵

Renewable energy reduces CO₂ emissions: in 2012, fossil fuel combustion was responsible for emitting almost 32 billion tons of global carbon dioxide (CO₂) – an increase of 1.4% on 2011 and the highest emission level ever.⁶ The International Energy Agency (IEA, 2012) projects annual emissions to exceed 37 Gt CO₂ per year by 2035 based on present pathways. *It is foreseen that quadrupling current renewable energy consumption by 2035 (from ~17 EJ to ~70 EJ) could avoid up to 3.5 Gt of CO₂ emissions per year – 23% of the CO₂ emissions abatement needed in order to be on track with the 2°C target by 2035.*⁷

1 IPCC, *Special Report on Renewable Energy Sources and Climate Change Mitigation*.

2 Krewitt et al., *Role and Potential of Renewable Energy and Energy Efficiency for Global Energy Supply*.

3 BP *Statistical Review of World Energy*.

4 OECD/IEA, *World Energy Outlook 2012*.

5 BP *Statistical Review of World Energy*.

6 OECD/IEA, *Redrawing the Energy-Climate Map: World Energy Outlook Special Report*.

7 OECD/IEA, *World Energy Outlook 2012*.

Energy efficiency could be a game-changer for renewable energy: energy efficiency is a key requisite to meeting global future energy needs from sustainable renewable sources. *Implementation of strong energy efficiency measures as proposed by the International Energy Agency (e.g. end-use efficiency, energy conservation, electricity savings and power plant efficiency) could result in annual improvements in energy intensity of 1.9% over 2011-2035, compared to 1.0% per year achieved over 1980-2010. This would result in at least 74% (75 EJ) of the efforts to reduce projected future energy use by 2035.*⁸ Reducing energy demand by improving energy efficiency and reducing wasteful use of energy – and coupling these measures with grids that can cope with the increasing demand for renewable electricity – coincides with a fast renewable energy supply growth that will ultimately result in an energy system that can be 100% sustainably sourced.⁹

Renewable energy creates jobs: *over 5.7 million people worldwide work directly or indirectly in the renewable energy industry.* Solar PV and wind power account for ca. 40% of the total work force in the renewable energy sector. The largest job markets in the sector are located in China (1.7 million), the European Union (1.2 million), Brazil (0.8 million) and the United States (0.6 million).¹⁰ Compared to fossil fuels, renewables create between 1.5 and 7.9 times more jobs per year per unit of electricity generated (i.e. GWh),¹¹ and between 1.9 and 3.2 times more jobs per million of \$US invested.¹² For comparison, 20 of the largest oil and gas companies, providing up to five times more energy, employ 2.1 million people.¹³

Renewable power generation is becoming increasingly competitive: a limiting factor for renewables is their comparably high up-front costs, which encourage small and cash-constrained investors to prefer non-renewable options. Nonetheless, different to conventional technologies, the levelized cost of electricity generation (LCOE) of learning technologies such as wind, solar PV, CSP and some biomass technologies has fallen considerably due to enhanced economies of scale, increased technology efficiency and better capacity factors. *For instance, depending on technology and markets, prices for PV modules have fallen over 60% in the last two years. Similarly, wind turbine costs have declined by around 25% since 2009.* Other technologies such as hydropower and geothermal electricity are, under favourable resource conditions, often the lowest cost option to generate electricity. In fact, at current prices for conventional technologies, renewables are the most cost-effective option for off-grid electrification, and for centralized grid supply in particular locations.¹⁴ Although there are significant differences in installed capital costs between particular technologies and regions, the expectation is the same: capital costs for modern renewables will keep falling.

Investments in renewable power generation may increase rapidly: global investments in renewable energy projects grew at an annual rate of ca. 26% during the period 2004-2011, from \$54 billion to \$302 billion.¹⁵ After a decline in 2012 (-16%), investments are expected not only to recover back to 2011 levels but to exceed them around 2015. Depending on policies and incentives, it is *estimated that global*

8 Ibid.

9 Deng, Blok, and van der Leun, "Transition to a Fully Sustainable Global Energy System."

10 REN21, *Renewables 2013-Global Status Report*.

11 Wei, Patadia, and Kammen, "Putting Renewables and Energy Efficiency to Work: How Many Jobs Can the Clean Energy Industry Generate in the US?"

12 Pollin, Heintz, and Garret-Peltier, *The Economic Benefits of Investing in Clean Energy*.

13 "Top 20 Largest Oil & Gas Employers."

14 IRENA Secretariat, *Renewable Power Generation Costs in 2012: An Overview*.

15 Bloomberg New Energy Finance, "Global Trends in Clean Energy Investment."



The Walney Offshore Windfarm consists of Walney 1 and Walney 2 each with 51 turbines have a total capacity of 367.2 MW, enough to power 320,000 homes.

investments in renewable energy projects may rise to between \$US 470 billion and \$US 880 billion by 2030.¹⁶

Under current trends, renewables are expected to account for ca. 50% of the total power generation capacity by 2030: based on current trends, renewables are expected to scale from a 28% share in 2012 to 48% of global installed capacity by 2030. *This would allow renewables to generate up to 37% of the total global electricity supply, the majority by hydropower, with wind and solar contributing 12% and 6% respectively.¹⁷* Though these trends are promising, showing as they do a continued growth in renewables, this will not be enough to put the world on a 100% renewable energy pathway by 2050.

The world is building a clean-energy policy landscape: though the speed of renewable energy and energy efficiency implementation is not sufficient, policy instruments and packages to support renewable energy are nevertheless increasing. *By 2012, at least 138 countries adopted targets for renewable energy. Additionally, at least 127 countries had some type of renewable electricity policy by 2013, namely feed-in-tariffs or renewable portfolio standards. Renewable energy policy initiatives have taken place both at national and state/provincial level.¹⁸ Other renewable-energy friendly policy schemes, such as the carbon-pricing scheme, have been adopted or are under consideration in at least 11 additional countries.¹⁹*

¹⁶ Guy Turner, "Global Renewable Energy Market Outlook: Fact Pack."

¹⁷ Ibid.

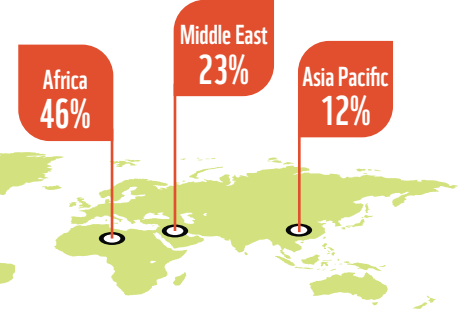
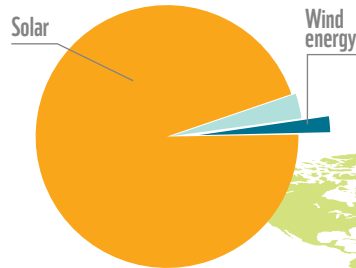
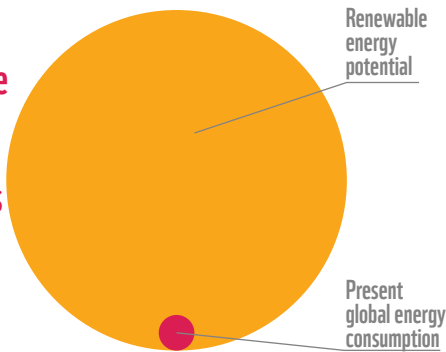
¹⁸ REN21, *Renewables 2013-Global Status Report*.

¹⁹ GLOBE Intl., *The GLOBE Climate Legislation Study*.

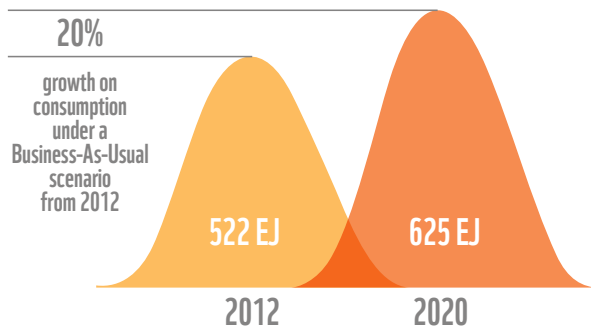
Renewable energy in numbers

The world has abundant renewable energy resources

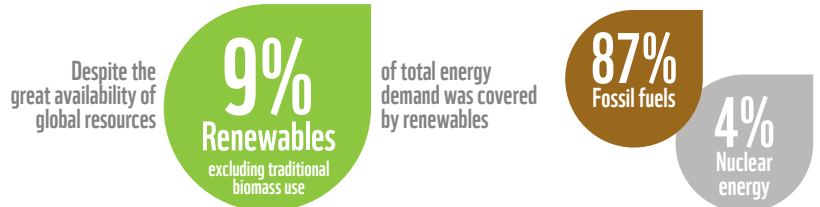
Estimated total technical renewable energy potential can exceed **100 times** present global energy consumption



The world is increasing its energy demand

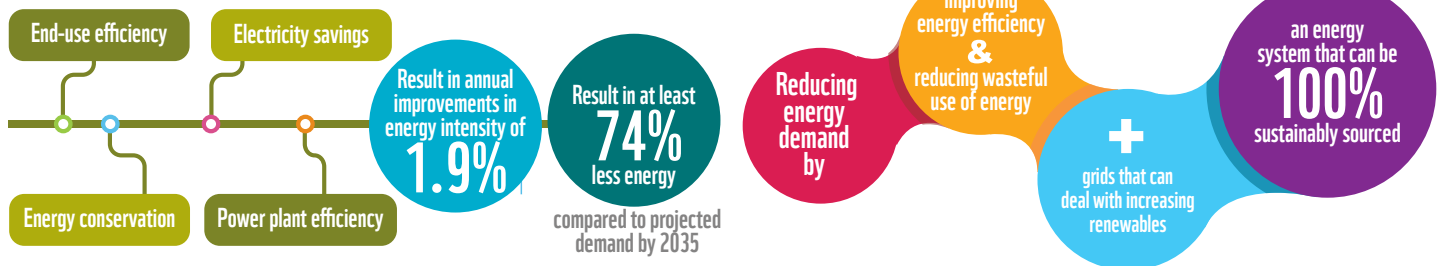


The world is far from using its technological and economic renewable energy potential



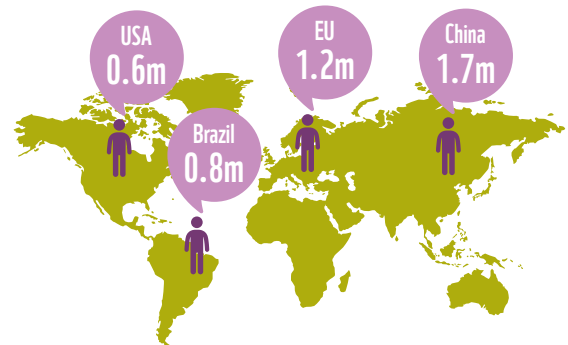
Energy efficiency is key requisite

to meeting global future energy needs from sustainable renewable sources

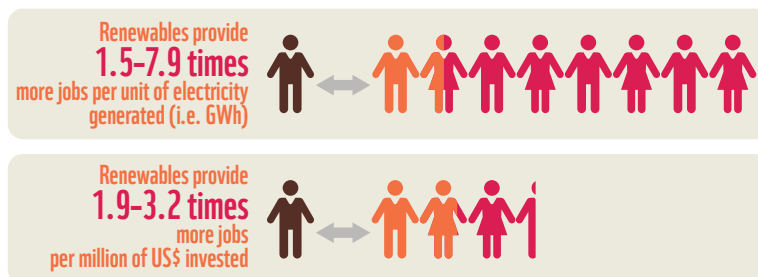


Renewable energy creates jobs

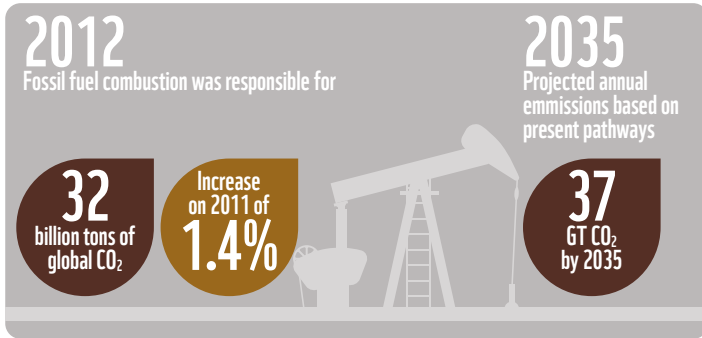
5,7 million people worldwide work directly or indirectly in the renewable energy industry



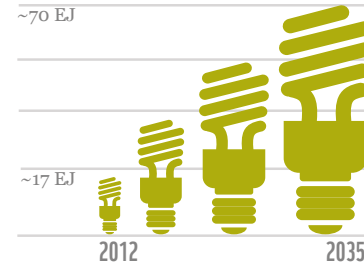
Renewable energy (compared to fossil fuels) creates more jobs per year



Renewable energy reduces CO₂ emissions



Quadrupling current renewable energy consumption

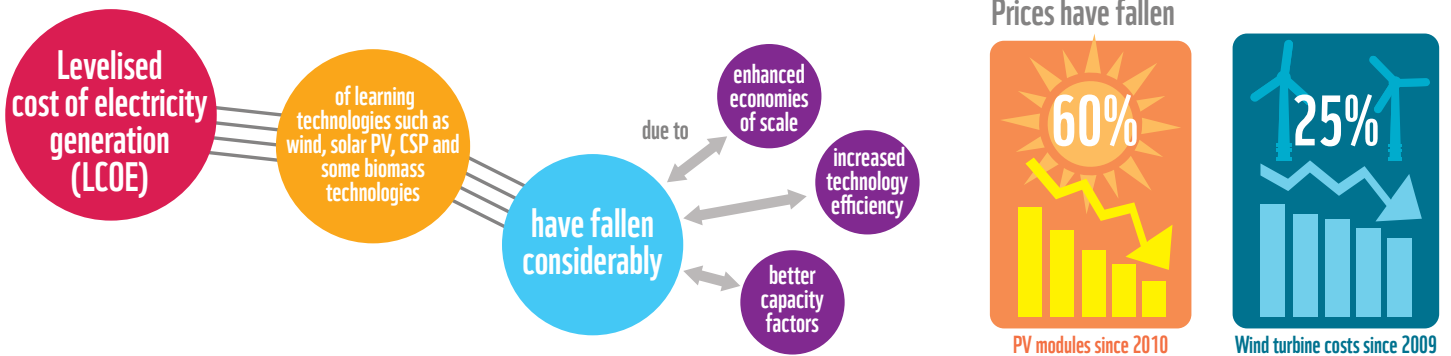


could avoid **3.5** Gt CO₂ emissions per year

23% of CO₂ emissions abatement

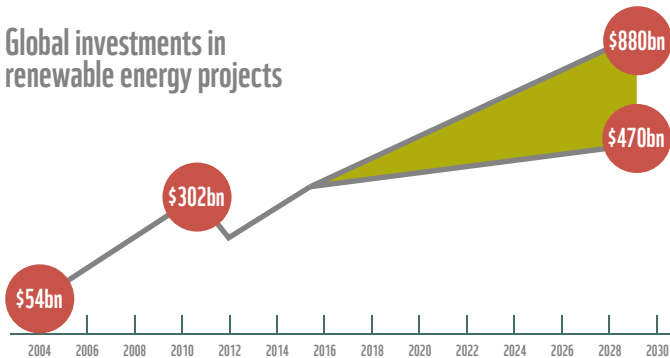
to be on track with the 2°C target by 2035

Renewable power generation is becoming increasingly competitive

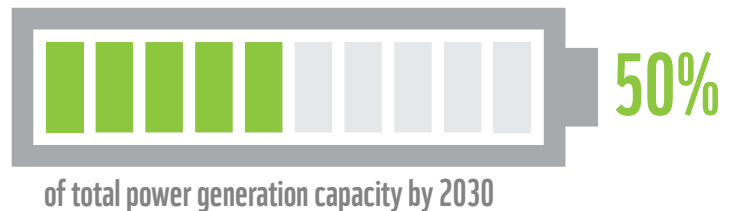


Investments in renewable power generation may increase rapidly

Global investments in renewable energy projects

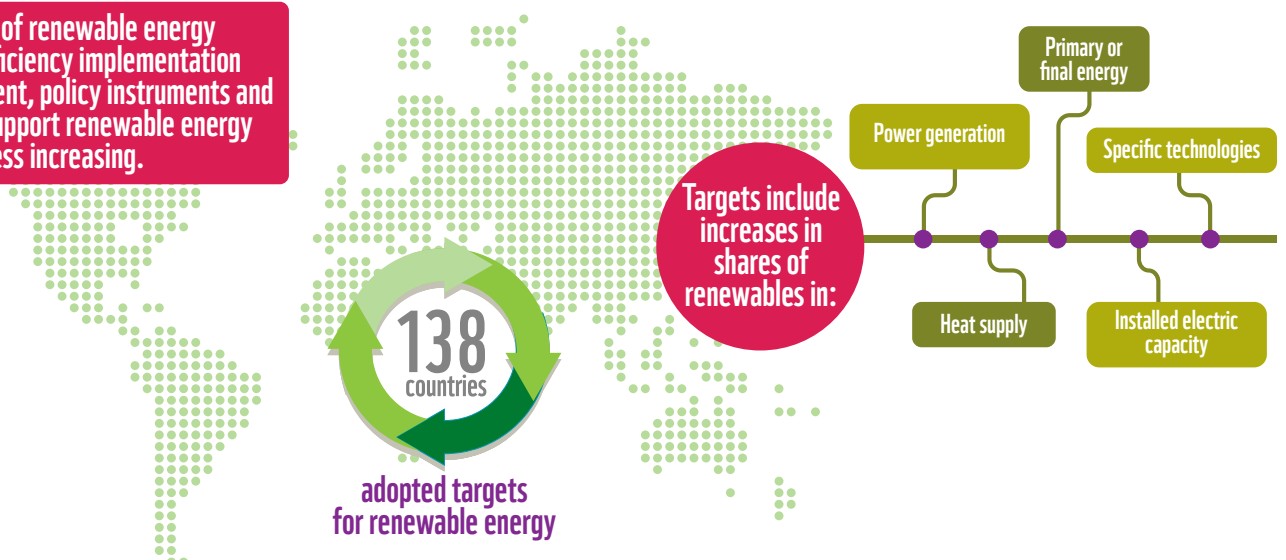


Renewables are expected to account for

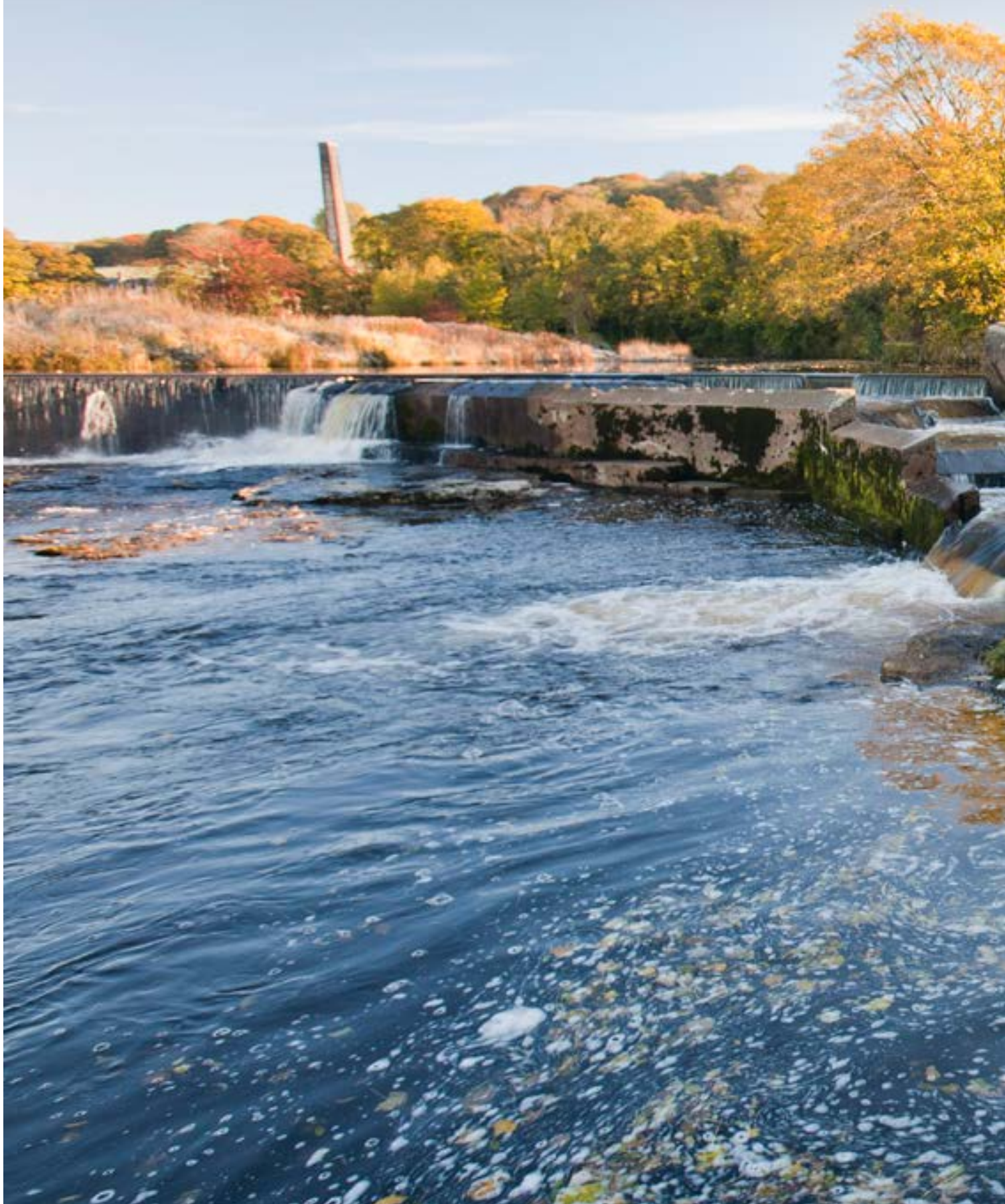


The world is building a clean energy policy landscape

Though speed of renewable energy and energy efficiency implementation are not sufficient, policy instruments and packages to support renewable energy are nevertheless increasing.



INTRODUCTION





INTRODUCTION

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A solar electric panel and wind turbine being used to power a neon road sign.

Given their multiple benefits, renewables have grown rapidly in recent years, particularly solar and wind. It is estimated that renewables (namely hydro, modern biomass for heat and electricity, wind, solar, geothermal, and liquid biofuels) supply almost 10% of all global energy, and more than 20% of world electricity.²⁰ Excluding large hydro, investments in renewables between 2010 and 2012 averaged \$US 245 billion annually – almost fourfold the yearly average invested during 2004 and 2006.²¹ At the same time, the manufacturing costs for renewables have declined substantially. For instance, depending on technology and markets, prices for PV modules have fallen over 60% compared to 2009; wind turbine costs by around 25%.²² Simultaneously, the load factor (electricity produced by a given technology and size), particularly for wind power, has increased substantially and thus enhanced technology reliability.

Today, China, the USA and Germany lead the renewable energy race; together, (excluding large hydro) they account for 46% of total global investments in renewable energy and 55% of global renewable energy generating capacity.²³ In Europe, investments in solar and wind power capacity installations outpaced others, reaching 70% of the total in 2011 and 2012.²⁴ Since 2011, global investments in renewables in developing countries were higher than those in OECD.

Investments significantly increased in countries such as the Philippines, India, South Africa, Mexico, UK, Italy, Brazil, Canada, Australia and Japan, to name a few. South Africa for instance invested in 2012 almost 1% of its GDP into renewables, positioning itself as a world champion in renewable energy investments in that year.²⁵ This promising global investment trend in renewable energy is expected to continue. For example, Saudi Arabia, the biggest oil supplier in the world, announced in early 2013 its intentions to produce 55 GW of renewable power by 2035.²⁶

That said, the global energy market is still not a level playing field and renewables are far from attracting the majority of global energy investments. In 2012, worldwide upstream oil and gas investments alone achieved a new historical record of \$US 619 billion – \$US 350 billion more than what was invested in renewables in the same

20 REN21, *Renewables 2013- Global Status Report*.

21 The Pew Charitable Trust, *Who's Winning the Clean Energy Race?*.

22 IRENA Secretariat, *Renewable Power Generation Costs in 2012: An Overview*.

23 The Pew Charitable Trust, *Who's Winning the Clean Energy Race?*.

24 EWEA, "Statistics", 2013.

25 The Pew Charitable Trust, *Who's Winning the Clean Energy Race?*.

26 US Energy Information Administration, "Saudi Arabia."



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Employees of the Walney Offshore Windfarm project.

year.²⁷ Furthermore, it is estimated that subsidies to fossil fuels amount to at least \$1.9 trillion every year.²⁸

Currently, about 80% of global energy consumption comes from conventional technologies, mostly fossil fuel based technologies. Fossil fuel combustion is the main contributor to the increase in atmospheric CO₂ concentrations since the industrial revolution, and is the primary cause of anthropogenic climate change. Emissions from fuel combustion exceeded 30 Gt CO₂ in 2010, 40% higher than 1990 levels.²⁹ Today the world faces a record 400 ppm of atmospheric CO₂ concentration – unprecedented in human history.³⁰ If this trend continues the world’s future is threatened by a likely increase in global mean temperature of much more than 2° C, with disastrous economic, social and environmental consequences³¹ (see Box 1).

Renewable energy has the enormous potential to shift the current global carbon-emitting energy system to a more sustainable one. As sources of clean and reliable energy, renewables are considered key to prevent dangerous climate change while providing secure energy supply and fostering economic growth and social wealth. As WWF’s Energy Report (2011) demonstrates, large-scale deployment of renewables alone would reduce greenhouse-gas emissions from the energy sector by about 80% while keeping global warming well below 2°C by 2050.³²

27 OECD/IEA, *World Energy Outlook 2012*.

28 IMF, *Energy Subsidy Reform: Lessons and Implications*.

29 IEA, *CO₂ Emissions from Fuel Combustion*.

30 Earth System Research Laboratory, Global Monitoring Division, “Recent Monthly Average Mauna Loa CO₂.”

31 PIK, *Turn Down the Heat*.

32 Earth System Research Laboratory, Global Monitoring Division, “Recent Monthly Average Mauna Loa CO₂.”

Embarking on the trajectory towards 100% renewable energy will require doubling the current level of investments in renewables and scaling up current capacity: by 2020, annual investments of up to \$US 510 billion per year in renewable power generation will be needed to avoid exceeding the 2°C target³³, while investments in conventional energy sources will have to decline. By 2030, total renewable energy investments will need to triple to bring about the change needed.

Significantly scaling up renewable energy investments and supply represents huge challenges. The Energy Report shows that a strong long-term renewable energy and energy-efficiency strategy in all societal sectors can deliver 100% renewable energy for the entire world by 2050.³⁴ The WWF energy vision sets out the necessity to fully replace all fossil fuels and nuclear energy supply by mid-century.

In order to avoid a long-term lock-in into a high-carbon infrastructure, and to limit global warming to no more than 1.5°C compared to pre-industrial temperatures, WWF is calling on governments to speed up its efforts and agree to increase the share of global sustainable renewable energy to 25% (excluding traditional and inefficient biomass use), and to at least double the rate of annual improvement in energy productivity (energy use/unit GDP), from presently about 1.2% to 2.4% by 2020.

Box 1 Climate Change: a threat to global economy, society and the natural environment.

Climate change is one of the greatest global threats of this century. The Intergovernmental Panel on Climate Change (IPCC) says an uncontrolled rise in greenhouse-gas emissions will raise global mean temperatures by more than 6°C above the pre-industrial times by the end of the century, resulting in a significant loss in biodiversity and ecosystems.³⁵ If the planet warms more than 3°C, it will fundamentally change the planet we live in.

Man-made climate change is happening much faster than previously observed natural climate changes. Climate change causes speedy alterations in ecosystem and species composition, the rising of sea levels and ocean acidification, among many other problems. It is a hazard for global prosperity, security and social stability.³⁶ Climate change is already causing the death of nearly 400,000 people a year and costing the world more than \$US 1,200 billion (almost 2% of global GDP).³⁷

A very revealing scientific assessment conducted by the Potsdam Institute for Climate Impact Research (PIK, 2012) and commissioned by the World Bank provides further authoritative and substantial information on the impact of global warming.³⁸

33 IPCC, *Special Report on Renewable Energy Sources and Climate Change Mitigation*.

34 WWF Intl., *The Energy Report 100% Renewable Energy by 2050*

35 Warren et al., "Quantifying the Benefit of Early Climate Change Mitigation in Avoiding Biodiversity Loss."

36 The Climate Institute, *Dangerous Degrees*.

37 DARA Internacional, *Climate Vulnerability Monitor: A Guide to the Cold Calculus of A Hot Planet*.

38 PIK, *Turn Down the Heat*.

10 MYTHS ABOUT RENEWABLE ENERGY IN SHORT

Myth: renewables are too expensive.

Myth: renewable energy does not need economic incentives to develop.

Myth: renewables-based electricity is as harmful to the environment as conventional electricity.

Myth: producing renewables consumes more energy than it delivers.

Myth: renewables require too much land to produce electricity.

Myth: hydropower is mostly bad for nature and people.

Myth: production of bioenergy has negative effects on nature, climate and food security.

Myth: renewables do not deliver reliable energy on demand.

Myth: renewables cannot replace fossil fuels in the transport and built environment sectors.

Myth: renewable energy is infinite.

MYTHS ABOUT ECONOMIC FEASIBILITY





MYTH 1: RENEWABLES ARE TOO EXPENSIVE

Renewables are often dismissed due to their high upfront investment costs. Initial capital investments largely influence the economic competitiveness of a given technology, especially when estimating its levelized cost of electricity production (LCOE). Given their upfront capital-intensive nature, renewables, particularly solar technologies, often have higher LCOE values than conventional technologies. This is repeatedly taken as evidence that renewables are more costly.

Using LCOE alone to assess the competitiveness of renewables can be misleading, particularly as the metric does not reflect important costs that otherwise would make conventional technologies more expensive, e.g. environmental externalities or inherent high subsidies (see Box 2). In addition, priority components to LCOEs of conventional technologies are fuel costs of the project. These are subject to price volatility, which in the past has often been underestimated over a multi-decade long project cycle. In comparison, non-biomass renewables have no fuel costs.

Despite LCOE caveats, some renewables are already cost competitive under favourable conditions (e.g. resource availability or adequate policy support), and provide energy services that are competitive with, or cheaper than, those from conventional technologies. Modern combustible biomass for heat, solar thermal energy, distributed solar PV, large-scale hydropower, larger geothermal projects and wind onshore power plants are already competitive with conventional technologies in many places³⁹ (Figure 1).

Renewables can provide a cheaper option for electricity generation, even where fossil fuel-fired generation is the predominant source of electricity. Moreover, some renewables are already the lowest-cost option in regions with good resource availability. This is particularly true on islands, for off-grid options in remote areas and in some regions or countries with particularly favorable conditions. Evidently, as costs decrease, the economic viability of renewables to provide clean and reliable electricity will increase much further. This is true for both industrialized and developing countries.

Although the comparison between renewable and conventional energy-generation costs depends on location and country-specific conditions, LCOEs give an indication that renewables can already provide energy services cost-competitively. In addition, technological advances and further efficiency is expected to improve cost-competitiveness for all renewables relative to conventional technologies; wind and solar, for example, are expected to achieve LCOE declines of 35% (by 2030) and 50% (by 2050) respectively.⁴⁰ So stating that renewables are more costly than conventional technologies is a dubious argument; it is a myth.

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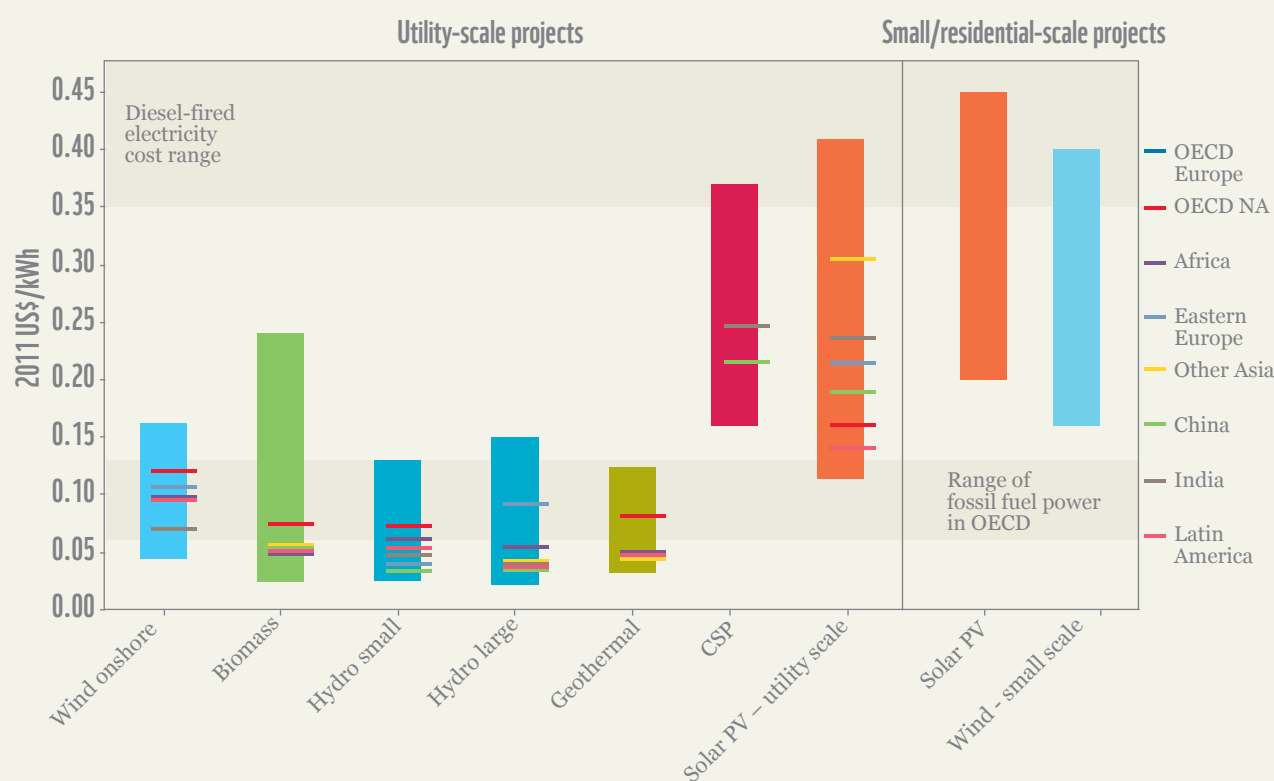


Amrit Singh Thapa, Managing Director of Mirlung Electro-Mech Concern (MEC) looks down on the sprawling city of Kathmandu past his homemade wind turbine, Nepal.

39 IRENA Secretariat, *Renewable Power Generation Costs in 2012: An Overview*.

40 Guy Turner, "Global Renewable Energy Market Outlook: Fact Pack."

Figure 1 Typical LCOE ranges by region for renewable power generation technologies, 2012.



Sources: IRENA (2012).

Note: All LCOE data assume a 10% cost of capital. The large coloured bars represent the typical LCOE range by technology and the coloured horizontal lines the weighted average LCOE by country/region if enough individual project data are available.

Box 2 LCOE: a fair indicator?

LCOE provides a good base for economic comparison among technologies, as it gives an indication of value or economic competitiveness over the full average lifetime. This conventional approach has strong merits, especially in the absence of any other comprehensive economic accounting system. Nonetheless, there are important aspects that a LCOEs analysis does not cover and that often misrepresent conventional energy as much cheaper than renewables.

Overall, LCOEs do not take into consideration other costs except for up-front costs, variable costs (such as for fuel, operations and maintenance), and costs of capital over the lifetime of the project. To illustrate, environmental externalities, decommissioning costs, or any pre-tax or post-tax subsidies and tax credits are excluded by the LCOE analysis. In this respect, some facts about fossil fuel LCOEs are:

- **Fuel and technology subsidies are not considered.** According to the IMF (2013)⁴¹, global fiscal support for fossil fuel consumption amounted to \$1.9 trillion in 2011. Subsidies to renewables amounted to about \$US 88 billion, less than 5% of that for fossil fuel.⁴²

41 IMF, *Energy Subsidy Reform: Lessons and Implications*.

42 OECD/IEA, *World Energy Outlook 2012*.

- **Economic appraisals can underestimate high volatility and uncertainty of fuel prices.** The way in which risks associated with future fossil fuel price volatility and uncertainty are calculated and incorporated into economic comparisons is questionable. For example, it is estimated that, to account for price fluctuations, a hedging premium of 1 to 3 ¢US/kWh should be added to the cost of power generation from natural gas.⁴³
- **Environmental costs are not included.** Although estimates vary, external costs due to fossil electricity production range between 3.3 and above 9.9 ¢US/kWh, depending on the fuel.⁴⁴ In terms of CO₂ emissions, the US Environmental Protection Agency (EPA, 2013) estimates that the economic damages associated with CO₂ emissions could amount to up to \$73 /tCO₂ by 2015.⁴⁵ In the United States⁴⁶ and the European Union⁴⁷ inclusion of external costs for fossil/coal power would make it the most expensive energy source.



© NATIONAL GEOGRAPHIC STOCK / SARAH LEEN / WWF

Man holding solar panel covered with photovoltaic cells at solar park, Leipzig, Germany.

43 REN21, *Renewables Global Futures Report*.

44 IPCC, *Special Report on Renewable Energy Sources and Climate Change Mitigation*.

45 Interagency Working Group on Social Cost of Carbon, *Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis*.

46 Epstein et al., "Full Cost Accounting for the Life Cycle of Coal."

47 ExternE, "External Costs of Energy."

MYTH 2: RENEWABLE ENERGY DOES NOT NEED ECONOMIC INCENTIVES TO DEVELOP

Opponents against policy incentives for renewable energy argue that renewables, namely solar and wind, are already at a competitive advantage due to the increasing support they have been receiving in recent years. Therefore, subsidies to renewable energy should be discontinued. This argument is highly flawed. Indeed, support for renewable energy has increased in the last years, but precisely because renewables often have higher upfront capital needs compared to conventional technologies that in turn benefit from a range of support mechanisms, including counterproductive subsidies (see Box 3).

The World Energy Outlook 2012 of the IEA⁴⁸ states that total global subsidies to renewables jumped to \$US 88 billion in 2011, 24% higher than in 2010, most of these generally paid (directly or indirectly) to electricity producers as support schemes, such as tax credits for production and investment, price premiums, preferential buy-back rates (or feed-in tariffs) and mandates, quotas, or portfolio standards that supported taking up renewables at higher costs to the economy or the consumer. In fact, it should be argued that these “subsidies” are a small attempt to level the playing field in the energy market. For instance, feed-in-tariffs, accounting for almost 50% of all support schemes, cannot really be considered as a “subsidy” – they are usually paid for by consumers to producers and distributors.

Although the energy market is dominated by many perverse incentives supporting the powerful interests of incumbent energy suppliers, renewable energy technologies, particularly solar and wind, have experienced important manufacturing cost reductions in recent years as a result of economies of scale and technology advances. Prices for PV modules have for instance fallen over 60% compared to 2009, whereas wind turbine costs have dropped by around 25%.⁴⁹ However, to foster further deployment, cost-effective grid integration and the establishment of a robust manufacturing sector and long-term investment security, renewables still need policy support, particularly in terms of incentives that help lower capital costs or raise revenues for investors.

According to the IEA (2012)⁵⁰, fiscal support of fossil fuel consumption worldwide amounted to \$US 523 billion in 2011 (all of it outside the OECD), 30% higher than 2010 and six times more than subsidies to renewables⁵¹ (Figure 2). In addition, the OECD (2013)⁵² estimates that fossil fuel subsidies in its 33 member countries had an overall value of about \$US 55-90 billion a year between 2005 and 2011.⁵³ Out of the total, around half was allocated to consumer stimulus, with the remainder allocated to producers or general services that supported producers as a whole in OECD countries.

48 OECD/IEA, *World Energy Outlook 2012*.

49 IRENA Secretariat, *Renewable Power Generation Costs in 2012: An Overview*.

50 OECD/IEA, *World Energy Outlook 2012*.

51 Ibid.

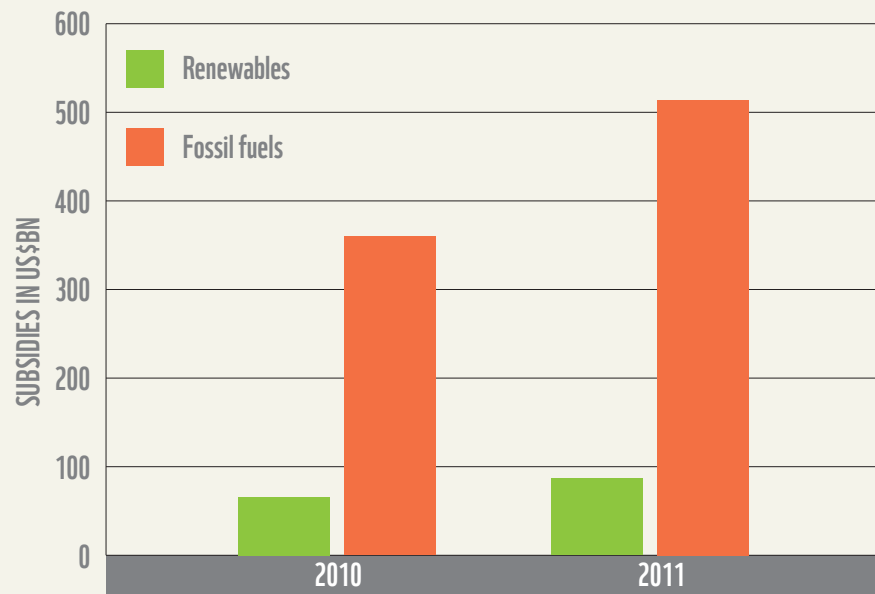
52 IMF, *Energy Subsidy Reform: Lessons and Implications*.

53 *Inventory of Estimated Budgetary Support and Tax Expenditures for Fossil Fuels 2013*.

Most striking however is the recent analysis by the International Monetary Fund (IMF, 2013)⁵⁴ which estimates that global subsidies to fossil fuels would likely exceed \$1.9 trillion a year, amounting to almost 10% of the world's governmental state budgets. The IMF analysis includes consumption subsidies like the International Energy Agency, but also accounts for artificially lower value-added taxes for fossil fuels in many countries compared to other traded commodities, and externalities of \$US 25/ton of CO₂.

Without policy incentives and transforming fossil fuel subsidies into support schemes for renewable energy and energy efficiency, renewables can hardly compete against conventional energy. To ensure sustained deployment of renewables, investors' confidence in the future must be maintained through policy certainty. Additionally, fiscal incentives or direct public financing will enable renewables to compete against generously subsidised conventional technologies. Based on these reasons, stating that renewables no longer need support is a myth.

Figure 2 Subsidies (2010-2011): renewables VS fossil fuels



Source: IEA (2012)

54 IMF, *Energy Subsidy Reform: Lessons and Implications*.



Solar panels, Wuhan City, China

Box 3 Fossil fuel subsidies are cost ineffective

Subsidies to fossil fuels maintain an unsustainable burden on governmental budgets, particularly in poor countries with strong needs for investments in social development. Fossil fuel subsidies benefit neither the poor nor the environment, but rather continue to inflate energy demand at the expense of state revenues; they discourage investments, diminish competitiveness of the private sector over the longer term and create incentives for smuggling.⁵⁵

Transforming fossil fuel subsidies in these countries towards targeted pro-poor development and affordable clean renewable energy access schemes can have a much more positive effect. As renewable energy becomes cheaper due to further advances in technologies and economies of scale, support schemes will decrease and finance ministries will still save money that can be used for education, health, infrastructure, and clean and reliable energy access for the poorest.

55 Ibid.

MYTHS ABOUT ENERGY SUSTAINABILITY





MYTH 3: RENEWABLES ARE AS HARMFUL TO THE ENVIRONMENT AS CONVENTIONAL ELECTRICITY.

Though there is general understanding about the impacts of all power technologies, there is still public perception that renewables create negative environmental effects of similar magnitude or severity during their lifecycles as compared with conventional technologies. This is thought to be true for manufacturing, transporting and assembling renewable-energy conversion technologies that still involve greenhouse gas emissions release, water consumption and land use. Often, these perceptions result from biased information sources.

Lifecycle greenhouse gas emissions of electricity generated from modern renewable resources (excluding land-use change emissions) have been found to be considerably less than from fossil fuel based resources: generally all renewables show emissions between 400 and nearly 1000 g CO₂eq/kWh lower than their fossil fuelled counterparts, i.e. 14 to 134 times lower⁵⁶ (Figure 3). In fact, all solar and wind technologies emit zero GHG while in use. Also, compared to fossil fuels they do not emit any air pollutants such as SO₂, NO_x, heavy metals, dust, ashes or black carbon – the World Health Organization (WHO) estimates that 1.3 million people die every year from urban outdoor air pollution originated by such pollutants.⁵⁷ In Europe alone, health costs associated with air pollution from coal-fired power stations are estimated at almost €43 billion per year.⁵⁸ In addition, unlike nuclear energy, renewables do not generate hazardous waste while in use; worldwide, nuclear energy plants generate over 12,000 tons a year of highly-toxic radioactive waste⁵⁹ (Figure 4).

In terms of water consumption, non-thermal technologies (such as PV or wind), have much lower consumptive use values per unit of electricity generated compared to thermal technologies such as coal, natural gas or nuclear along its full life cycle.⁶⁰ Apart from hydroelectricity in extreme cases, solar thermal electricity and biofuels (especially first generation and those irrigated), fresh water consumption of renewables is minimal. Excluding these, modern renewables consume literally no water. By comparison conventional power-generating technologies are thirsty, consuming in excess of 4 m³/MWh (coal); 3 m³/MWh (nuclear, depending on the cooling system implemented) and 1 m³/MWh (natural gas). Based on the enhanced development of unconventional fuels like shale gas and shale oil, projections indicate a drastic increase in water consumption and pollution in the decades to come⁶¹ (Figure 5).

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The Ormonde Offshore Windfarm, built in the Irish Sea, comprises of 30 RePower 5M wind turbines with the capacity of 150 megawatts and expected to produce around 500 gigawatt hours of electricity every year.

56 IPCC, *Special Report on Renewable Energy Sources and Climate Change Mitigation*.

57 WHO, "Air Quality and Health."

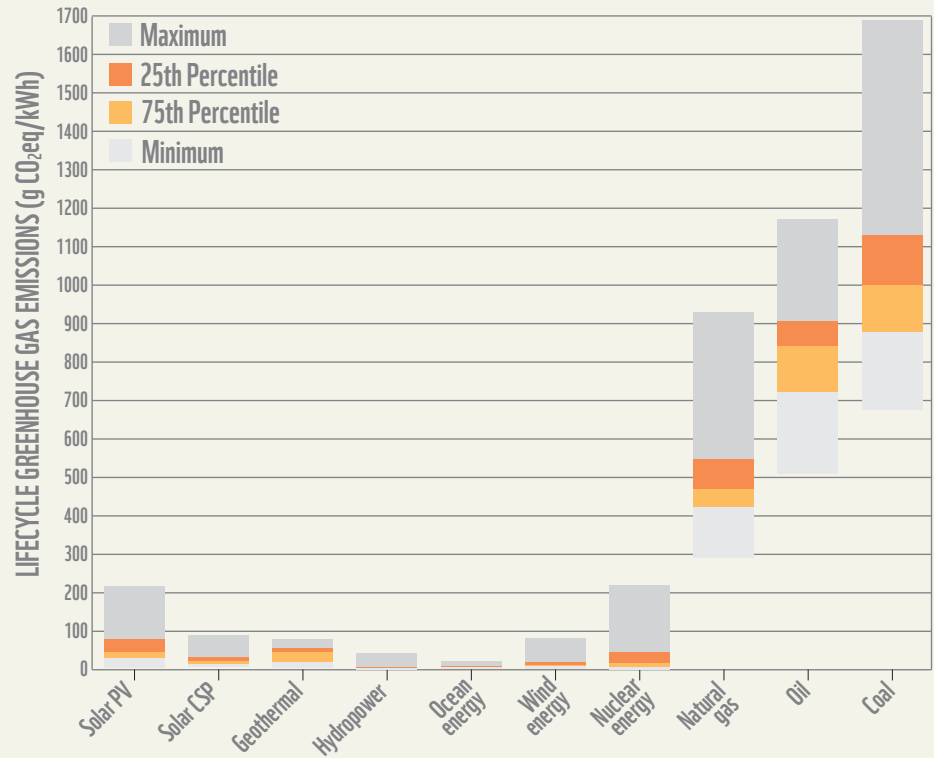
58 HEAL, *The Unpaid Health Bill: How Coal Power Plants Make Us Sick*.

59 Adamantides and Kessides, "Nuclear Power for Sustainable Development: Current Status and Future Prospects."

60 IPCC, *Special Report on Renewable Energy Sources and Climate Change Mitigation*.

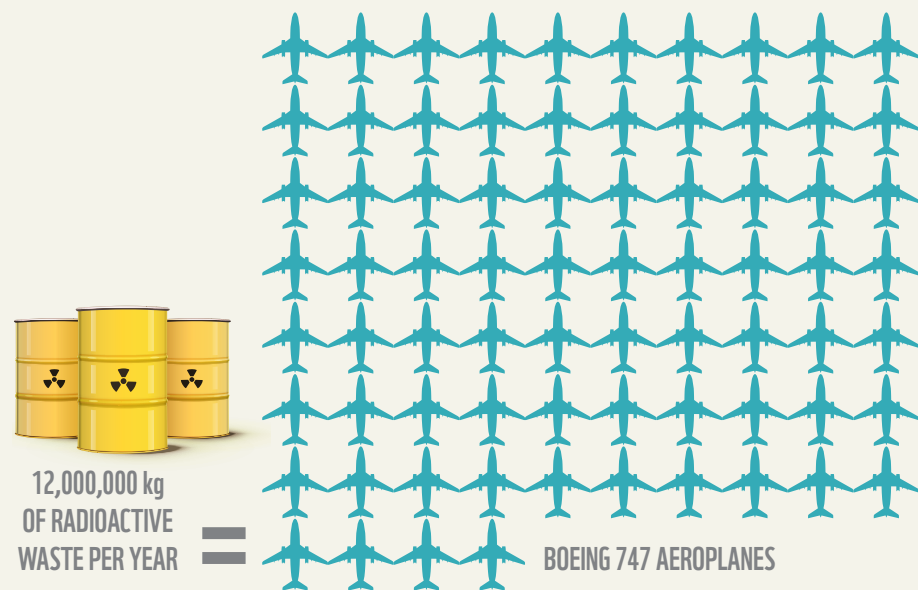
61 OECD/IEA, *World Energy Outlook 2012*.

Figure 3 Estimates of lifecycle GHG emissions for broad categories of electricity generation technologies.



Source: IPCC (2011)

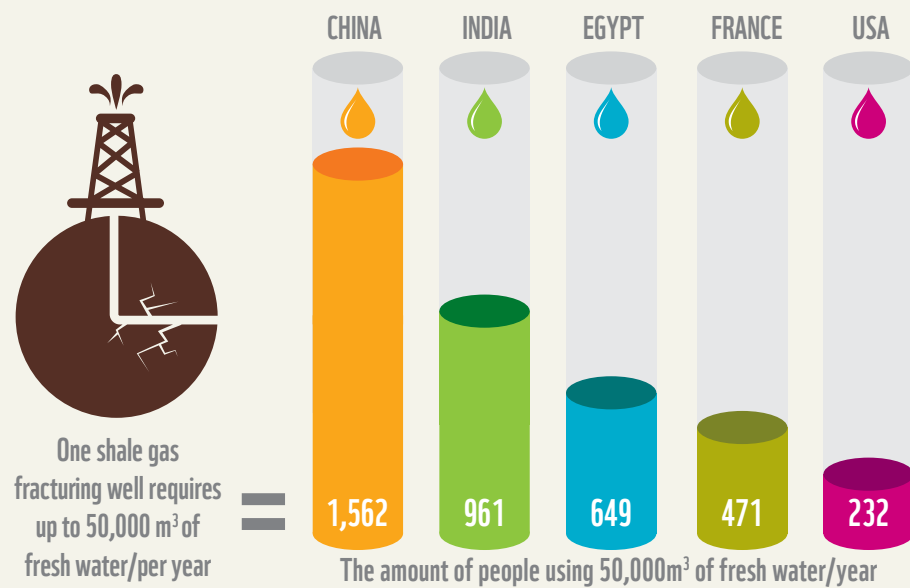
Figure 4 The amount of nuclear waste produced in 1 year. (The hazardous life of nuclear is 240,000 years)



Source: Nuclear waste information – Adamantiades and Kessides (2009).

All human activities, including those related to energy transformation, have an impact on nature and people. However, it is very important not to look into impacts of renewables in isolation but to compare these with the environmental implications of other technologies. Some renewables (such as of biofuels and hydropower) have been shown to have an unacceptable impact on nature, climate and people when not designed, planned or managed sustainably. But this can't be generalised. Renewables have on average a much more beneficial impact on nature than fossil fuels or nuclear. In this respect, maintaining that renewable electricity is as environmentally harmful as conventional electricity is a myth, as practices can be adequately framed and executed to overcome potential harm. The contrary is true for fossil fuels; even under the cleanest circumstances, their use is still unavoidably harmful for the environment and unsustainable for both nature and people.

Figure 5 Comparing the amount of fresh water used in fracking to that used by people (includes both indoor and outdoor use) in a couple of different countries.



Source: WBCD (2005)⁶² and Kharaka et al. (2013)⁶³.

62 World Business Council for Sustainable development, *Facts and Trends Water*.

63 Kharaka et al., "The Energy-water Nexus: Potential Groundwater-quality Degradation Associated with Production of Shale Gas."

MYTH 4: PRODUCING RENEWABLES CONSUMES MORE ENERGY THAN IT DELIVERS

Renewable technologies require energy at different stages of their full life cycle: from extracting raw materials from earth reservoirs to manufacturing their different components (i.e. PV panels or wind turbines) and technology decommissioning. This issue is frequently distorted and magnified to argue that producing renewable technology consumes more energy than it actually delivers.

The idea that the full life cycle energy performance of renewables is lower than that from conventional technologies is often based on the use of the energy payback time (EPT) concept as indicator. In simple terms, the EPT measures how long it takes to generate the same amount of energy it took to produce a given technology. The EPT depends on several factors, including type of technology, system application, energy source availability (e.g. irradiation or wind) and even the energy used in its manufacturing process.

Overall, renewables have lower or comparable EPT's to their conventional counterparts (See Table 1). However, an exception is solar electricity. Both photovoltaic electricity and solar concentrating power tend to have lower EPTs than conventional technologies, as long as they can operate under high-capacity factors. Unfortunately, in some regions where irradiation is limited, these technologies cannot operate at best and usually deliver less energy than other technologies. Consequently, under energy source constraints, EPT's of solar technologies tend to be high. This is often taken as evidence that all renewables cannot pay back their energy input under a reasonable timeframe. However, even comparably high EPTs do not indicate overall economic or environmental ineffectiveness. And in most cases, production and deployment of technologies can be concentrated on regions with low EPT.

Table 1 Energy payback times (EPT) values for different energy conversion technologies

Technology	EPT (years)	
	Range	
Brown coal	0.5	3.7
Natural gas	1.2	3.9
Nuclear	0.8	3
PV	0.2	8
CSP	0.7	7.5
Geothermal	0.6	3.6
Wind	0.1	1.5
Hydroelectricity	0.1	3.5

Source: IPCC (2011)

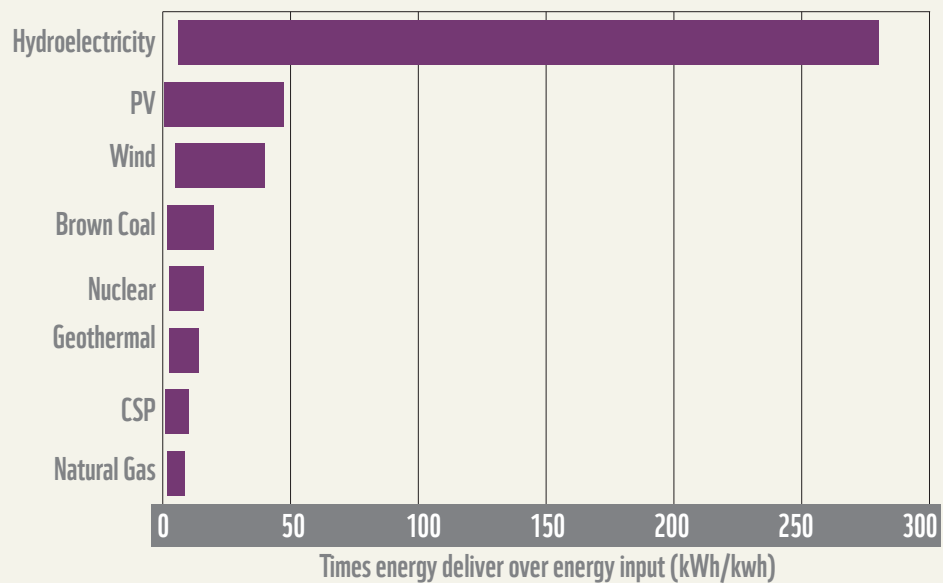
In general, the EPT is a common and adequate parameter to quantify the economic life performance of a technology in terms of energy, however it only accounts for the economic lifetime (the period at the remaining value of the technology) and not the useful lifetime (the remaining physical life of the technology).

Unlike conventional technologies, the useful lifetime of solar technologies is virtually infinite, as no major structural changes need to take place for safety or economic reasons. Additionally, as solar technologies generate power by transforming an inexhaustible source of renewable energy (i.e. solar irradiation) into electricity, they are virtually flow-unlimited. In practice, depending on the materials used for the photovoltaic panels, solar technologies can last for 60 years or more. Instead, the useful life of conventional technologies, without implementing major structural changes, is usually 10 to 20 years lower.

Another indicator that better compares the energy performance full life cycle of renewables against conventional technologies is the energy return on energy invested (EROI). Different to the EPT, the EROI compares energy delivery over energy inputs along the full useful life and not only the economic life of the technology.

When considering EROIs, solar technologies, as well as other renewables, deliver much more energy than what it takes to produce them. In fact, as the IPCC (2011) has shown, modern renewables like solar photovoltaics and wind turbines can deliver over two times the energy conventional technologies can deliver over a full technology useful life cycle. Hydropower, up to 15 times (see Figure 6).⁶⁴

Figure 6 Energy returns on investment (EROI) values for different energy conversion technologies



Source IPCC (2011)

In general, by either using EPT or EROI as reference indicator, it is clear that renewables can deliver much more energy than what they consume compared to conventional technologies, when considering the full life cycle of the technology (both economic and useful life cycle). Depending on the technology, and whether economic or useful life cycle is considered, some renewables can do better than others. However, overall, the conclusion is the same: renewables are “energy-cost” competitive to conventional technologies, and the opposite is just another myth.

64 IPCC, *Special Report on Renewable Energy Sources and Climate Change Mitigation*.

MYTH 5: RENEWABLES REQUIRE TOO MUCH LAND TO PRODUCE ELECTRICITY

Critics of renewable energy often argue that renewables are more land intensive than conventional energy-generation technologies. This may be true when looking statically at land occupation and the development of some renewables, particularly biomass and hydro. Nonetheless, when assessing dynamically the entire lifecycle land requirements of energy conversion technologies, this is not the case, especially for modern renewables.

The lifecycle land use requirements for modern renewables are comparable or lower than those for conventional technologies. Information on lifecycle estimates for land use by energy conversion technologies is limited. However, there is relevant evidence suggesting that, when considering extracting resources, infrastructure needs, generating electricity, disposing the waste, and both direct and indirect land transformation, some renewables have less land requirements than conventional technologies. For example, over a 30-year timeframe, lifecycle land transformation of solar PV is comparable to that of natural gas and lower than most coal fuel technologies⁶⁵. As a matter of fact, in regions such as Indonesia, Madagascar, Mexico, Morocco, South Africa or Turkey, a power sector hypothetically run by 100% PV alone could fully satisfy projected electricity demands using less than one per cent of the region's total land⁶⁶.

The myth that renewables are more land intense than conventional technologies is often used by pro-nuclear advocates who consider renewables as their main business competitors. Many of these advocates argue that solar and wind farms use a great deal more land than nuclear plants and therefore are environmentally unacceptable. However, taking a closer look at the land use of these technologies reveals the opposite. As evidence-based literature findings show, the land required to site and fuel one GW nuclear plant (operating at 90%) will be comparable or far more than the area used by photovoltaic or wind systems with the same annual electricity output (Table 2)⁶⁷.

Table 2 Land use requirements for Nuclear, PV and Wind systems.

Technology	km ² /900 MW electricity generated		Comment
	Min	Max	
Nuclear	≥37	≥38	
Windpower	~1	~13	Min: If in flat open sites.
Photovoltaics	0	≤35	Min: If on existing structure (e.g. roofs)

Source: Lovins (2011).

65 Fthenakis and Kim, "Land Use and Electricity Generation: A Life-cycle Analysis."

66 Denruyter and Mulder, *Solar PV Atlas: Solar Power in Harmony with Nature*.

67 Lovins, "Renewable Energy's 'Footprint' Myth."



Wind turbines on the edge of a wheat field in Saarland, Germany

In general, renewables like solar PV and wind tend to be less land intensive as they are “fuel free”. Once technologies are constructed, they do not require further extraction of resources and therefore require less land than conventional technologies do. Moreover, distributed solar PV can be put on roofs, installed along highways and roads while wind power plants can be located on seas or lands where other activities can still take place e.g. grazing, agriculture, fishing, shading, etc. Oppositely, conventional technologies increase the intensity of their land requirements with time, as they require continuous land transformation in search of fuel. Aside from this, conventional technologies are more likely to produce secondary impact on land use, such as water and soil contamination, and ecosystem degradation that can render land unusable.

Arguing that renewables take up too much land is a myth. As land requirements of energy technologies vary depending on locations and technological conditions, as well as duration and reversibility of the land transformation, it is difficult to accurately compare land requirements between renewable and conventional technologies. Nonetheless, based on a wide set of considerations and including the whole-lifecycle needs of technologies, evidence shows that renewables are less land intensive than conventional technologies, and the opposite is a misconception.

MYTH 6: HYDROPOWER IS MOSTLY BAD FOR NATURE AND PEOPLE

The perception that hydropower is not environmentally and socially friendly is often justified. Hydropower projects can pose a real threat to local environments. But the threat can be minimized or largely mitigated if an integrated and multi-focus project design and development that is sustainable is adhered to.

Hydropower impacts (see Box 4) are highly dependent on the surrounding society and environment. As such, a hydropower installation’s resulting impacts are determined mainly by individual site selection. Each hydropower system, whether small or large, is uniquely created to fit site-specific characteristics; the magnitude of the impact cannot be generalized. By far the most effective way to maximize sustainability is by holistic river-basin planning that at best avoids or minimizes and only then mitigates negative impacts.

Maximizing hydropower sustainability is possible if the right environmental, social and socio-economic aspects are addressed correctly. For instance, the International Energy Agency (2000)⁶⁸, based on one decade of extensive research, more than 200 case studies and 112 experts from 16 countries, has identified 11 factors that require thorough consideration when designing a sustainable hydropower project: hydrological regime, reservoir creation, water quality, sedimentation, biological diversity, barriers to fish migration and navigation, involuntary people displacement, public health, affected people and vulnerable groups, cultural heritage and development benefits.

As the Hydropower Sustainability Assessment Protocol (2013) suggests, ensuring sustainability in hydropower generation involves dealing with three main challenges: 1) adequately understanding ecosystem components and functions, and

68 International Energy Agency, Hydropower and the Environment: Effectiveness of Mitigation Measures

Figure 7 Sustainability criteria for sustainable hydropower. The protocol encompasses all aspects of sustainability



minimizing the impacts on these; 2) ensuring that potential affected individuals and communities benefit from improved living conditions, equitable distribution of benefits and social compensation measures; and, 3) demonstrating sound and equitable distribution of economic benefits at all stages of scheme development and operation of hydropower projects⁶⁹ (Figure 7).

Box 4 Hydropower impacts: positive vs negative

Multi-purpose hydropower can be a sustainable source of energy that helps meet global energy needs. However, along with multiple benefits, several threats can be posed to both livelihoods and ecosystems if hydropower is performed unsustainably. Some of these are:

Positive impacts of hydropower:

- It generates reliable, low-cost and carbon-free electricity.
- It assists flood control.
- It improves freshwater supply, irrigation for agriculture, opportunities for recreation and cleaner ecosystems.
- It creates reliable infrastructure (such as canals, tunnels, dams, reservoirs, access roads, etc.) that remains usable for future generations.
- Its related infrastructure moderates weather-dependent and variable powers (wind and solar) by providing energy storage capacities and grid services.

Negative impacts of hydropower:

- It transforms land-use by submerging large quantities of land to store water for flood control, irrigation and electricity generation.
- It affects water quality.
- It alters river-flow patterns and connectivity, affecting biodiversity and fisheries.
- It affects people downstream by causing involuntary displacement.
- It threatens cultural heritage.

By many means hydropower can be an important and integral part of a reliable and clean energy system. However, it has the potential to be economically, socially and environmentally damaging. Therefore, compliance with sustainable standards is necessary. Arguing that hydropower is always bad for nature and people is a myth, as the argument ignores the multiple benefits of achieving sustainable hydropower; benefits that can be achieved if, and only if, sustainability best practices, which are possible to perform, are thoroughly accounted for.

69 International Hydropower Association, "About Sustainability."

MYTH 7: PRODUCTION OF BIOENERGY HAS NEGATIVE EFFECTS ON NATURE, CLIMATE AND FOOD SECURITY

Bioenergy can provide diverse sustainable alternatives to fossil fuels, additional incomes for rural communities and contribute to development under the right conditions. However, depending on which crops are produced, where and how, bioenergy developments can cause significant negative environmental and social impacts, including deforestation, food insecurity, biodiversity loss, soil erosion, excessive water use and conflicts over land rights and usage.

Critics of the production of bioenergy usually cite two main concerns. Firstly, there is growing fear that bioenergy production, particularly first-generation liquid biofuel production, will displace food crops, raise food prices and aggravate food security (see Box 5). Secondly, there are also concerns about the land requirements for large-scale production of bioenergy crops, particularly virgin land or land with high natural conservation value, and the subsequent impacts on habitats, biodiversity, water and soil quality and GHG emissions (see Box 6). Although concerns are truly legitimate, they often overlook the whole picture.

Box 5 Bioenergy impacts: the rising price of food aspect

At the moment almost all liquid biofuels are produced using crops that are also used for food production e.g. corn, sugarcane, soybean, coconut and palm oil.⁷⁰ Currently, only 3-4% of global agricultural crops are used to produce biofuels.⁷¹ However the rate of increase in use of cereal crops for fuel production is far greater than that for food (or animal feed). Presently, liquid biofuels only provide 3% of global road transport fuels⁷² but further and uncontrolled demand for liquid biofuels could have commodity price effects that seriously aggravate food security, particularly for the poor. It is estimated that 70-75% of the increase in internationally traded food prices during 2002-2008 was caused mostly due to the large increase in biofuel production from cereals in the United States and demand growth in Europe, and the related consequences of lower grain stocks, large land-use shifts, speculative activity and export bans.⁷³ More recent sources conclude that the role biofuels have played in driving up food prices has been smaller than initially estimated, with other factors such as reduced reserves, food waste, speculation, transportation issues, storage costs and problems, and hoarding playing a much larger role.⁷⁴

Bioenergy production can impact on food security. However, a plethora of other factors on the agricultural commodity markets may play a bigger role. For instance, highly volatile fossil fuel prices impact the agricultural system by making production (e.g. fertilizers) and harvesting technologies as well as food transportation more expensive. As a matter of fact, during 2002-2008, the combination of higher energy

70 IEA Bioenergy, *Potential Contribution of Bioenergy to the World's Future Energy Demand*.

71 REN21, *Renewables 2013- Global Status Report*.

72 Ibid.

73 Mitchell, *A Note on Rising Food Prices*.

74 Hamelinck, *Biofuels and Food Security: Risks and Opportunities*.



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Sugarcane can be converted to ethanol biofuel.

prices and related increases in fertilizer prices and transport costs, as well as dollar weakness, caused food prices to rise by about 35-40%⁷⁵. Other identified factors that have contributed majorly to observed price hikes of food crops include speculation by traders and dietary changes such as a higher consumption of dairy and meat products by an increase in population and a growing middle class worldwide.⁷⁶

Box 6 Bioenergy impacts: the land intensity aspect

Various assessments exist on how much land will be required for the bioenergy sector to make a significant contribution to the energy supply. It is estimated that a 10% substitution of liquid transportation fuels globally would require 118 to 508 million ha of new agricultural land (depending on fertilization levels, crop type, productivity, etc.); that is, between 8 to 36% of current global arable land.⁷⁷ WWF's energy report states that we will need approximately 250 million hectares of fast-growing plantations to supply demand; this represents less than 10% of the land area used to produce crops or grazing lands. Still, changing diets and increased meat consumption will continue to be a much bigger driver in the agricultural sector than bioenergy.

Contrary to what is usually thought, sustainable management practices on bioenergy production can reduce impacts on land use, ecological habitats and natural resources. To illustrate, bioenergy crops can work as buffers to the surrounding environment by enriching the soil carbon content, improving the condition of

⁷⁵ Mitchell, *A Note on Rising Food Prices*.

⁷⁶ HLPE, *Biofuels and Food Security. A Report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security*.

⁷⁷ Howarth et al., *Rapid Assessment on Biofuels and Environment: Overview and Key Findings*.

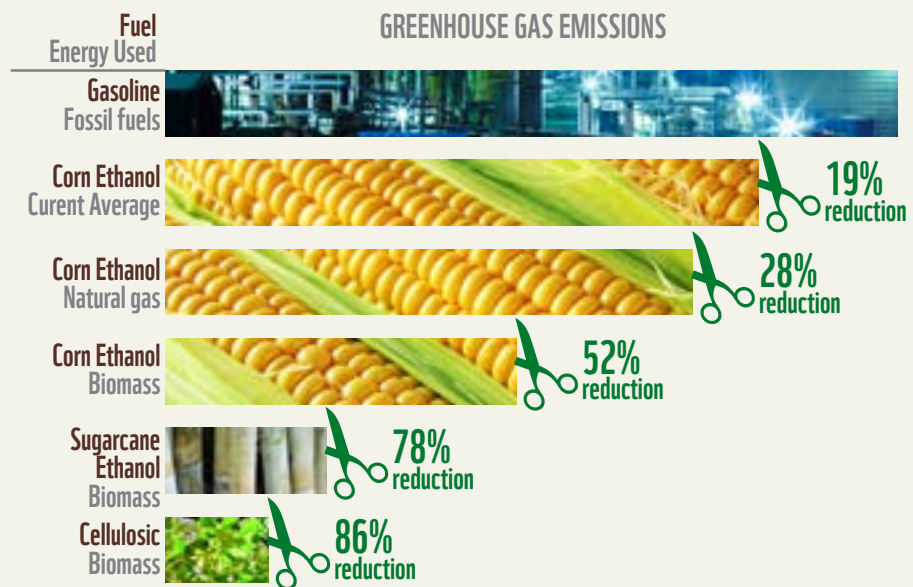
land and reducing desertification. Perennial trees and grasses that are adequate to the regions where they are planted can reduce chemical input needs, ease water requirements and provide habitats for wildlife as compared to annual agricultural crops.⁷⁸

Additionally, well designed modern bioenergy systems may augment local food production. For example, as the Food and Agricultural Organisation (2007) suggests, if first generation nitrogen-fixing biofuel crops are rotated with cereals, overall productivity may be enhanced.⁷⁹

Furthermore, as second-generation biofuel technologies become more available this will reduce possible negative impacts on land and resource competition on food availability, as these are based on non-food-competing feedstock such as woods, grasses or waste materials.

Finally, in terms of greenhouse gas emissions, bioenergy can help to significantly reduce greenhouse gas emissions associated with fossil fuels (Figure 8). For example, if produced in a sustainable manner, ethanol from sugar cane, sugar beet, corn, wheat or lignocellulose can emit less GHG emissions during its full lifecycle than gasoline, petroleum diesel or liquid transportation fuel from coal.⁸⁰ Besides, as natural carbon sinks bioenergy crops can help mitigating climate change by absorbing CO₂ present in the atmosphere. However, this surely depends on the practices followed to produce these fuels (see Box 7).

Figure 8 Well-to-wheels greenhouse gas emission changes by biofuel relative to gasoline.



Source: Wang et al. (2007) and US DOE (2008)

78 UN-Energy, *Sustainable Bioenergy: a Framework for Decision Makers*.

79 Ibid.

80 IPCC, *Special Report on Renewable Energy Sources and Climate Change Mitigation*.

Box 7 Bioenergy impacts: the GHG emissions aspect

Bioenergy should not be considered as 100% carbon neutral. GHG savings and energy balances vary widely and some crops perform far better than others. Crop selection, soil and climate are not the only determining factors. Land use change, agricultural practices, use of by-products, conversion techniques and final energy use all affect the lifecycle GHG balance of bioenergy. For instance, land conversion of carbon-rich vegetation such as primary forests or peat lands cancels out the potential carbon benefits, as production of bioenergy feedstocks results in more emissions than the potential GHG savings.

Bioenergy production is complex and requires practices that take into account ecological and social contexts. Nonetheless, such complexities should not be restrictive. Sustainable production and use of modern bioenergy can be done to achieve maximum environmental and social benefits. Managing demand for bioenergy and prioritizing, where possible, bioenergy use for sectors currently without other renewable alternatives (aviation, shipping, long-haul trucks) should be promoted, along with other sustainable management practices.

Many of the potential problems of bioenergy can be avoided by effective international and governmental policy levers and marketplace co-operation. Different from what the myth states, bioenergy production is not necessarily bad for food security or the environment. In fact, sustainable bioenergy production can be a way to improve both.

MYTHS ABOUT TECHNOLOGICAL RELIABILITY





MYTH 8: RENEWABLES DO NOT DELIVER RELIABLE ENERGY ON DEMAND

Power supply must be available on demand. While all power plants suffer occasional outages, those powered by variable renewables are constrained to a greater degree due to unpredictable seasonal and daily weather changes. Such bottlenecks can be overcome by electricity storage and technical power balancing to meet demand changes.

An optimized mix of renewable power generation and storage technologies can guarantee reliability of electricity supply in terms of fluctuating production and demand. For example, a Delaware University study⁸¹ found that the right mix of wind and solar power and electrochemical storage can power the grid up to 99.9% of the time, at minimal cost. The study showed that the least-cost option yielded three times the electricity needed to meet electrical load, entirely based on renewable electricity. Based on the expected decrease in technology costs by 2030, a renewable electricity system is not more costly than a current conventional system.

Today many countries and regions are successfully integrating increasingly high levels of renewable energy from wind and solar.⁸² Denmark, Germany, Ireland, Spain, south Australia and the US states of Colorado and Texas have relatively high penetrations of renewable energy, proving that variability can be managed if best practices are followed⁸³ (Figure 9).

Germany, which already meets 25% of its electricity demand with renewables⁸⁴, has implemented mechanisms to encourage energy storage, such as grid charges and levy exemptions for energy storage facilities.⁸⁵

With 40% of its electricity demand supplied by renewables⁸⁶, Denmark has also implemented different rules to enable system flexibility, such as providing a larger pool of power sources (e.g. hydropower to accommodate high-wind penetrations), as well as different power market regulations to improve dispatch operations and overall system efficiency.⁸⁷

Other examples of variability management of renewables can be seen in Spain (over 30% renewable electricity supply) and Ireland (around 20% of renewable electricity supply). These countries have adopted measures such as advanced and multiple forecasting in grid operations to predict the amount of energy resources available and reduce uncertainty in generation availability to the system (Spain) or expanding regional integration to avoid vulnerability to weather variability (Ireland).⁸⁸

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A woodchip store for a bio-fuel boiler is seen on the grounds of the Langdale Timeshare in the Lake District, UK. Since the installation of the bio-fuel boiler, which replaced an LPG gas boiler, the company has saved £30,000 a year in running costs. The system will have paid for itself in 4 years and is carbon neutral.

81 Budischak et al., "Cost-minimized Combinations of Wind Power, Solar Power and Electrochemical Storage, Powering the Grid up to 99.9% of the Time."

82 Cochran et al., *Integrating Variable Renewable Energy in Electric Power Markets: Best Practices from International Experience, Summary for Policymakers*.

83 REN21, "Renewables Interactive Map," 2012.

84 Ibid.

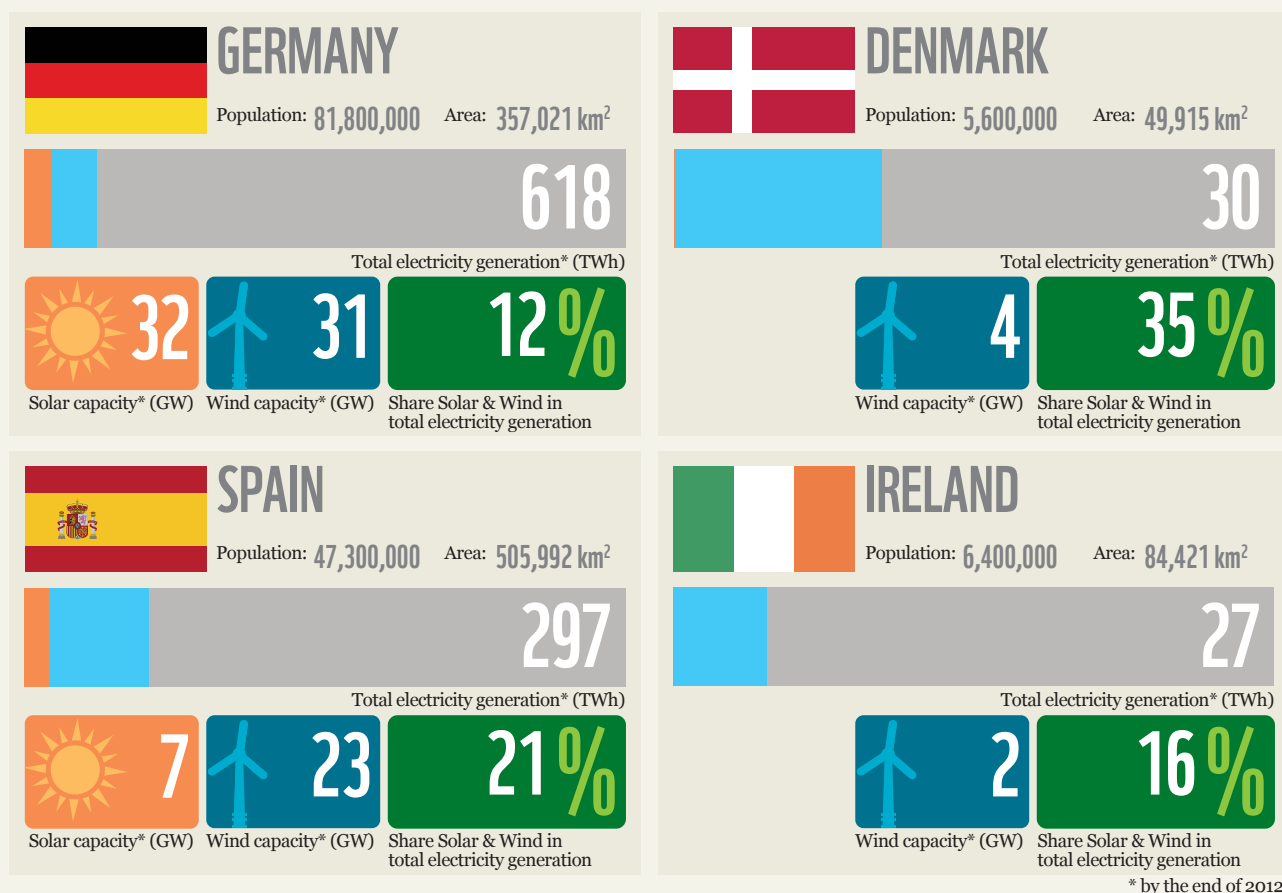
85 Cochran et al., *Integrating Variable Renewable Energy in Electric Power Markets: Best Practices from International Experience, Summary for Policymakers*.

86 REN21, "Renewables Interactive Map," 2012.

87 Cochran et al., *Integrating Variable Renewable Energy in Electric Power Markets: Best Practices from International Experience, Summary for Policymakers*.

88 Ibid.

Figure 9 Renewable energy country profiles: Germany, Spain, Denmark and Ireland.



Sources: IEA (2013), ENERDATA(2013), REN21(2013), IRENA(2013).

Moreover, renewable energy technologies generally account for less ‘down time’ than conventional technologies. Power outages caused by down-time periods in fossil fuel power plants have a bigger impact on conventional large-scale power supply grid systems than outages when individual solar panels or wind turbines are down, as the fraction of electrical production affected is larger in the former than in the latter.

Weather and day-time dependence of wind and solar power govern their availability and create variability over short and long-term periods, fuelling concerns on continued supply reliability. Truly, there are times when single renewable energy installations cannot supply enough power or alternatively, in times of low demand and very favourable weather conditions, ‘overproduce’; countries with high shares of renewables have faced these problems already and produced alternative solutions (see Box 8).



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Box 8 Unreliable renewable energy? A matter of baseload vs dispatchable load

Generally, large shares of variable renewable power cannot be integrated easily into existing grid power systems, unless the design and management of the system changes. Our classical power system works with the concept of ‘baseload’ power: a centralised, all-day power supply from constant sources such as coal or nuclear. A renewable-based system has to work differently to be effective and reliable. This is not only a question of technological but also of policy choices. ‘Dispatchable’ load is increasingly required with a shift to a renewable energy-based system. With the help of smart grids and grid management by the distribution authorities, it is possible to bring the necessary energy services at any time to the customers, who themselves mostly also require variable power on demand (the exception being energy-intensive industrial production plants that manufacture for about 24 hours a day, such as aluminium smelters).

There are several ways in which perceived bottlenecks of system change can be overcome. A study published by the University of California at Davis and Stanford University⁸⁹ showed that there are at least six ways to design and operate reliable renewable-based energy systems:

- by interconnecting among themselves variable energy sources that are geographically dispersed;
- by backing power supply gaps of variable renewables with non-variable energy sources such as hydroelectric or biomass power or geothermal energy;
- by using “smart” power demand-response management that balances loads and renewable power availability;
- by storing electric power in times of over-production;
- by over-sizing the renewable energy system capacity and using the excess power generated to produce fuels such as hydrogen as a back-up opportunity, including non-electricity usages or heat; and,
- by forecasting local weather to manage energy supply needs in a sophisticated way.

Variability issues can also be reduced by upgrading to new intelligent grid systems that can integrate a number of renewable energy sources and generation centres into a reliable supply of power. These enhanced grids, built as a combination of centralized and decentralized systems, can source and combine small-scale as well as large-scale electricity generation centres with locations for demand, as well as provide mutual back-up, export and storage needs. Smart grid enhancement can help compensate for seasonal or daily-low power generation in particular areas (e.g. for wind or solar) by harvesting power in others where resources are more abundant during the same period, thereby minimizing variability issues and continuously reducing the need for back-up power which is always perceived as an impediment.

In view of this, arguing that renewables cannot always deliver energy on demand is a myth.

⁸⁹ Jacobson and Delucchi, “Providing All Global Energy with Wind, Water, and Solar Power, Part I: Technologies, Energy Resources, Quantities and Areas of Infrastructure, and Materials”; Delucchi and Jacobson, “Providing All Global Energy with Wind, Water, and Solar Power, Part II: Reliability, System and Transmission Costs, and Policies.”

MYTH 9: RENEWABLES CANNOT REPLACE FOSSIL FUELS IN THE TRANSPORT AND BUILT ENVIRONMENT SECTORS

It is generally believed that renewable energy cannot substitute the use of fossil fuels across all societal sectors. Given the vast array of services that conventional energy provides (e.g, electricity, heat and mobility), most believe that it is technically impossible to achieve a full replacement of fossil energy. These people maintain that at optimum, renewables are best fit for electricity substitution alone, i.e. provide covering for about one third of all primary energy needs, but not for transport fuels, industrial steam and residential heat demand that are currently supplied with gaseous and liquid fuels. The reality is different. The main obstacles towards a full energy system transformation are not technical – in principle, it is both technologically and economically possible to achieve a fully renewable global energy system. The crucial factors are electrification and energy efficiency.

In the built-environment sector, increasing energy efficiency and conservation would decrease conventional energy consumption. For instance, Ecofys (2012)⁹⁰, suggests that the residential sector provides large opportunities for energy savings, both in new-build and retrofit. The study shows that by applying current market-introduced retrofitting measures in existing buildings (e.g. better insulation systems) and increasing the penetration of new buildings with near-zero energy use in the next decades, drastic reductions of heat demand in the future could be achieved with existing technologies. Similarly, the International Energy Agency (2009) suggests that the renovation of building shells and openings, combined with installation and appropriate operation of heat control and measuring devices, can improve building energy efficiency by up to 60%.⁹¹ Other energy needs can then be fuelled by renewable electricity, for instance with geothermal heat pumps for residual heat requirements in households and dwellings.

In the industrial sector, replacing inefficient technologies and adopting best-available equipment could cut global industrial energy use by almost a third.⁹² Managing energy and optimizing operations can achieve additional large cost-effective energy savings in all industries.⁹³ Finally, holistically transforming production systems, by increasing use of recycled or waste materials and energy, sharing resources among industries and dematerializing industrial processes, can further reduce fossil fuels consumption.⁹⁴

Similarly, the transport sector could reduce future fossil fuel demand by implementing strong energy efficiency standards and, in the case of light-duty vehicle sector, shift to electrically-powered vehicles. Particular to the transport sector, reducing fossil fuel demand cannot be done only with renewable energy electro mobility; other smart measures need to be implemented. For instance, intelligent and attractive public transport systems will reduce overall individual and automotive transport; the same is true with long-distance transport. Highly efficient

90 Deng, Blok, and van der Leun, "Transition to a Fully Sustainable Global Energy System."

91 WWF Intl., *The Energy Report 100% Renewable Energy by 2050*.

92 OECD/IEA, *Spreading the Net: The Multiple Benefits of Energy Efficiency Improvements*.

93 OECD/IEA, *25 Energy Efficiency Policy Recommendations*.

94 OECD/IEA, *World Energy Outlook 2012*.



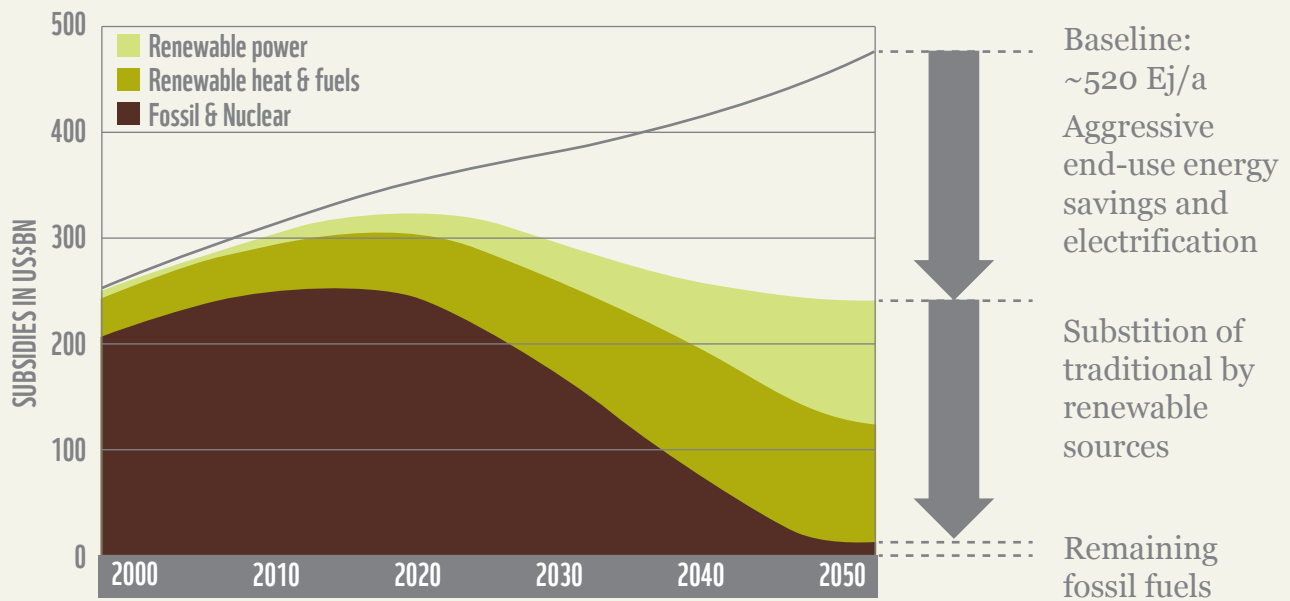
An AlgaeLink Algae growing system that is harvested to make ethanol and biodiesel, UK. Producing oil from algae in this way is much more efficient than from growing traditional plant oil crops like oil seed rape. It also has the benefit that it does not take up space that could be growing food crops.

and fast speed train connections can reduce the need for air travel substantially. However, there are sectors that can't be run on renewable electricity immediately. Aviation and shipping as well as long-haul heavy duty vehicles need to rely on sustainable biofuels and/or hydrogen as an option in the future.

Replacing fossil fuels across all sectors is quite possible once it is understood where and for which service energy is required, and how it can be supplied in a different way. In this respect, reducing energy demand – improving efficiency, advancing system electrification and preparing intelligent grids to integrate an increasing renewable energy supply – would decrease conventional energy consumption across all sectors. The verdict is clear: traditional fossil fuels can be replaced in the next decades with technological progress.

Assuming that renewables cannot replace fuels in transport or in the built environment sector, and therefore that they cannot sustain a fully renewable energy system, is a myth. By tapping technological measures and exploiting energy-saving opportunities, it will be possible to replace fossil fuel energy demand across all sectors (Figure 10).

Figure 10 Evolution path towards 100% renewable energy supply.



Source: Ecofys (2010).

MYTH 10: RENEWABLE ENERGY IS INFINITE

Theoretically, renewable resources are without any limits. Solar, wind, geothermal, hydro, ocean and bioenergy resources can technically exceed 100 times present global energy consumption⁹⁵. However, the hardware of renewable energy conversion technologies (e.g. PV panels, heat pumps, windmills, batteries to store electric power, grids and cables to connect renewables, etc.) employs materials that are either not freely available or require mining practices, water consumption and energy inputs that are often not sustainable.

Renewables-based energy conversion technologies are manufactured using materials that are non-renewable. Rare earths used in wind turbine manufacturing (e.g. neodymium and yttrium), rare metals used in photovoltaics and energy-efficient lighting (e.g. indium and gallium) and other metals used in high density batteries (e.g. cobalt and lithium), motors and infrastructure (e.g. copper) – all these materials might have long-term supply bottlenecks. Although resources of many of these materials are vast, their short-term reserves can be constrained in the future if expansion of renewable energy technologies – as well as other complex technologies (see Box 9) – does not account for materials demand and energy efficiency.

Box 9 Materials bottlenecks: not only a renewable energy problem

It is important to keep in mind that demand for many of “new” materials, such as rare earths, is not limited to new technologies in clean energy production and use. New, sophisticated technologies, particular in the wider information and telecommunication sector but also in household appliance and transport sectors, require a fast growing quantity of these minerals. Therefore general resource efficiency is essential.

Estimating with certainty whether and which materials will be constrained in the near future is hard to assess as it depends upon several factors such as recoverability, demand and global geological distribution. However, research suggests that restrictions might be overcome through reducing, recycling or substituting materials in manufacturing processes.⁹⁶ Moreover, overall strong energy and materials efficiency can also reduce the demand for new supply.

As an example: lithium for batteries can become a bottleneck when resources and reserves of this material shrink while demand keeps rising. Recycling, which becomes more economically attractive as the price for lithium increases, will be a key mitigation for enlarging the availability of supply.

Another example is copper, required for many different applications. Recycling of copper is also possible; moreover, copper can be substituted with other materials such as plastics, glass fiber or aluminum, depending on the application.

Similarly, the availability of rare metals indium and gallium (used in photovoltaic's) may also shrink in the future, but can be substituted with silicon.

95 IPCC, *Special Report on Renewable Energy Sources and Climate Change Mitigation*.

96 Meindersma et al., *Critical Materials for the Transition to a 100% Sustainable Energy Future*.



Rare earth materials – skutterudite, bismuth and molybdenum.



Mechanical processing used to refine lithium spodumene concentrate in western Australia. Lithium is used to produce high density batteries.

Essentially the perception that renewable energy sources are infinitely available and can be used to grow our present energy consumption multiple times is wrong. However, strong additional policies that make economic, social and environmental sense (e.g. an increase in materials efficiency; substitution, recycling and re-use of materials; R&D into new materials and equipment with higher conversion efficiency, and overall energy efficiency in all societal sectors) can help ensure materials availability and abundance so that a 100% renewable energy world by 2050 can be reached easily, without any materials bottlenecks.

UPHOLDING FACTS ABOUT RENEWABLE ENERGY





CONCLUSIONS

Global demand for renewable energy is rising rapidly. In many countries all around the world, renewables already cover a large share of the energy mix. However, even with present annual double-digit growth rates of some renewables, we are far from replacing fossil fuels to the extent required to avert the plentiful risks and shortcomings of these.

Several experts believe that a far higher share of renewables is possible given today's existing technologies and favorable long-term economics across choices⁹⁷. Still, achieving major penetration of renewables is still dependent on a robust policy and business environment. To a large extent, key barrier towards such aspirations are peoples' prejudices. And those are often decisive barriers for policymakers and in the energy sector alike.

Several myths surround renewable energy. In the course of this report, facts and figures have been upheld to debunk 10 of the most common; many more persist. Generally, existing misconceptions undermine the real value of renewables and underestimate their potential to cover global energy needs in a reliable manner. Above all, myths on renewable energy distort people's thinking about the feasibility of moving to a real energy transition and a truly clean energy future.

Realizing transformational changes in the energy system will largely depend on shifts in public choices and positive perceptions towards renewables; not strictly economics nor technologies. A whole shift in the energy paradigm has to take place across sectors, from the energy and transport sectors, to the industrial as well as the built environment sectors. This report shows how many key fundamentals for this whole-system paradigm shift have been indorsed.

Certainly renewable-based energy conversion technologies are not perfect. It is clear that renewable energy alone is not a definitive solution; not without accounting for energy efficiency and conservation. In this report the many challenges have also been acknowledged. But caveats and difficulties must not serve as excuses to withhold the world's ability to create a truly sustainable future⁹⁸. Solutions are at hand; to seize them, we need to catalyze societal support for boosting clean renewable energy. Demystifying myths on renewable energy has been a way to put this action forward.

97 REN21, *Renewables Global Futures Report*.

98 WWF Intl., *The Energy Report 100% Renewable Energy by 2050*.

MISCELLANEOUS MYTHS ABOUT RENEWABLES

The list of myths surrounding renewable energy is long. In this report only those considered the most common have been debunked but there is an extensive number of popular sources that deal with the many other myths. With the aim of busting further existing misconceptions about renewable energy, a selection of additional web-based sources is presented below. The following summary should help expand the reader's arguments in favour of renewables.

- **Source and title: Greenpeace South Africa (2013); Renewable Energy Myths**
Synopsis: six myths about renewable energy blown away! Included: renewable energy is science fiction, renewables cannot supply reliable energy 24/7, South Africa's grid cannot handle renewable energy; renewable energy is bad for the environment.
Link: <http://www.greenpeace.org/africa/en/campaigns/Climate-change/renewable-energy-myths/>
- **Source and title: Vestas (2013); Facts on Wind**
Synopsis: a collection of facts to counter popular wind energy misconceptions in Australia such as wind energy being harmful to human health, wildlife, economy and property value, among many others.
Link: <http://www.actonfacts.org>
- **Source and title: Trillion Fund (2013); Top Ten Renewable Energy Myths – Debunked!**
Synopsis: 10 of the most popular renewable energy myths in the UK completely debunked. Includes the myth about UK “green jobs” going to overseas manufacturers, renewables pushing up utility bills, and the suggestion that the adoption of renewables will make the UK lose competitiveness.
Link: <http://blog.trillionfund.com/2013/04/22/top-ten-renewable-energy-myths-debunked/#.UdxHBzsqbV>
- **Source and title: US Department of Energy (2013); Ethanol Myths and Facts**
Synopsis: five myths concerning ethanol's GHG emissions, inadequacy for modern engines and sustainability are all demystified.
Link: http://www1.eere.energy.gov/bioenergy/printable_versions/ethanol_myths_facts.html
- **Source and title: WWF Germany (2012); Myths and Facts about the Role of Renewable Energy in Germany's “Energy Transition”**
Synopsis: debunks popular myths about renewables in Germany's clean energy transition from an economic (both national and household level) and infrastructure (both power generation and further industrialization) perspective.
Link: <http://www.wwf.de/themen-projekte/klima-energie/energiepolitik/mythen-und-fakten/>
- **Source and title: Friends of the Earth Australia (2012); Renewable Energy Myths**
Synopsis: 10 myths on renewable energy busted, included those around wind farms scaring or killing animals, and being noisy, ugly or reducing property values.

Link: <http://yes2renewables.org/renewables-faq-and-mythbusting/renewable-energy-myths/>

- **Source and title: Oceana (2012); Renewable Energy: Myth vs. Fact**
Synopsis: myths surrounding offshore wind energy are busted, included those that state that environmental organizations and local residents are opposed to offshore wind farms, that these wind farms damage recreational and commercial fishing, and that wind turbines harm the earth's climate by changing/slowing down the planet's wind.
Link: <http://oceana.org/en/our-work/climate-energy/clean-energy/learn-act/renewable-energy-myth-vs-fact>
- **Source and title: Forbes (2012); 3 Myths about America's Clean Energy Future**
Synopsis: separates facts from fiction regarding three popular myths in the USA: funding renewables is a waste of taxpayer's money, the clean energy market is failing, and environmental regulations are destroying the coal industry.
Link: <http://www.forbes.com/sites/manishbapna/2012/11/12/3-myths-about-americas-clean-energy-future/>
- **Source and title: WWF Spain (2011); Let's renew: Myths and Realities of Renewable Energies**
Synopsis: debunks popular myths about renewables in Spain from an environmental, economic and technological perspective.
Link: http://awsassets.wwf.es/downloads/informe_renuevate_ingles_final_ok.pdf
- **Source and title: The Clean Energy Council (2011); Solar Myths and Facts**
Synopsis: 11 myths about distributed solar in Australia, such as solar systems driving the need for expensive grid upgrades, solar being only capable of making small contributions to energy supply, and the limited number of jobs created in the solar sector.
Link: <http://www.cleanenergycouncil.org.au/resourcecentre/Consumer-Info/solar-fact-sheets.html>
- **Source and title: Environmental Leader (2011); Busting Renewable Energy Myths**
Synopsis: myths on the carbon intensity of hydropower and the toxic-gasses release of geothermal energy are busted.
Link: <http://www.environmentalleader.com/2011/06/22/busting-renewable-energy-myths/>
- **Source and title: The Guardian (2008); The 10 big energy myths**
Synopsis: debunks myths commonly used to dismiss investments in renewables, including marine energy is a dead-end, nuclear power is cheaper than other low-carbon sources of electricity, and electric cars are slow and ugly.
Link: <http://www.guardian.co.uk/environment/2008/nov/27/renewableenergy-energy>

10 FACTS ABOUT RENEWABLE ENERGY IN SHORT

- Fact:** renewables can be cost competitive or even cheaper than conventional energy.
- Fact:** phasing out economic incentives to fossil fuels can help develop renewables.
- Fact:** renewables-based electricity is more environmentally friendly than conventional electricity.
- Fact:** renewables do not consume more energy than conventional technologies.
- Fact:** the lifecycle land-use requirements for renewables is comparable or lower than for conventional technologies.
- Fact:** sustainable hydropower can positively benefit nature and people.
- Fact:** sustainable bioenergy can improve food security and the environment.
- Fact:** an optimized mix of renewables and storage technologies can deliver reliable energy all the time.
- Fact:** when combined with greater energy efficiency renewables can replace fossil fuels across all sectors.
- Fact:** renewable energy growth can be constrained by materials employed by energy conversion technologies.

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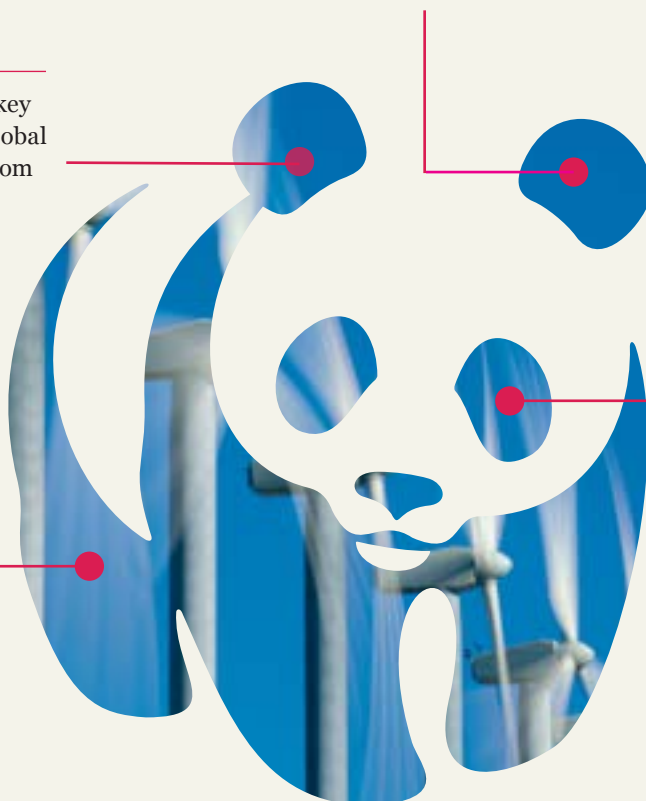


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