



Federal Foreign Office



EXHIBITION

ENERGY IN TRANSITION – POWERING TOMORROW

SOURCES AND REFERENCES



RENEWABLE ENERGIES



MOBILITY

FIND
SOURCES





STATUS

More and more people are consuming more and more energy.	Source
<p>The global population is growing and will reach 10 billion by 2060</p> <p>1990: 5,3 Billion 2020: 7,9 Billion 2060: 10 Billion</p>	<p><i>Statista (2020): Entwicklung der Weltbevölkerungszahl von Christi Geburt bis zum Jahr 2020, [access 2020].</i></p>
<p>More people means a greater demand for energy.</p> <p>1980: 7.324 Billions of kilowatt hours 1918: 22.964 Billions of kilowatt hours</p>	<p><i>Energy Information Administration (2016): Electricity net consumption, [access 2020].</i></p>
<p>Industrialised nations have the highest energy consumption, but emerging economies and developing countries are catching up fast (examples from 2017-2018)</p> <p>Annual rise in electricity consumption (examples from 2017-2018)</p> <p>Nigeria: 8,2% China: 7,7% Kazakhstan: 5,7% India: 5,4% Egypt: 3,6%</p>	<p><i>Enerdata (2019): Global Energy Statistical Yearbook 2019, [access 2020].</i></p>



CHALLENGE

Energy transformation creates: better health!	Source
<p>Lower emissions and cleaner air save lives.</p> <p>Air pollution currently causes around 7 million deaths a year.</p>	<p><i>UN (2019): Press Release: Stressing Air Pollution Kills 7 Million People Annually, Secretary-General Urges Governments to Build Green Economy, in Message for World Environment Day, [access 2020].</i></p>
<p>Many people in sub-Saharan Africa have no access to electricity.</p> <p>The figure was 57 % in 2017. However, there are major differences between individual countries.</p>	<p><i>IEA (2018): Population without access to electricity falls below 1 billion, [access2020].</i></p>
<p>Women are still underrepresented in the energy sector.</p> <p>Women make up just 22 % of the workforce in the conventional energy sector, as against 32 % in renewables.</p>	<p><i>IRENA (2019): A gender perspective, [access 2020].</i></p>
<p>In Nigeria and Tanzania, the NGO Solar Sister is helping women become local energy entrepreneurs.</p> <p>In 2016, Solar Sister changed Nanbet’s life.</p>	<p><i>Solar Sisters: Impact Story - Nanbet, [access 2020].</i></p>
<p>Solar Sister supported around 1,800 female entrepreneurs in 2015. By 2019, this figure had risen to around 4,600.</p>	<p><i>Solar Sisters: What we do – our impact, [access 2020].</i></p>



OUTLOOK

The energy transformation will improve lives across the world.	Source
Renewable energies support the UN Sustainable Development Goals.	<i>UN Sustainable Development Goals: Goal 7, affordable and clean energy, [access 2020].</i>
<p>Cooperatives, energy cooperatives and NGOs are increasingly important.</p> <p>Energy cooperatives</p> <p>Case study: Germany 888 energy cooperatives (as at 2013)</p>	<i>Renewable Energies Agency (2014): Wachstumstrend der Energiegenossenschaften ungebrochen, [access 2020].</i>
<p>Energy cooperatives</p> <p>Case study: Brazil 7 local energy cooperatives installed capacity: 8.5 megawatt peak</p>	<i>GIZ (2019): Cooperativas de geracao compartilhada de energia, [access 2020].</i>
<p>Energy cooperatives</p> <p>Case study: USA Greenpeace partnerships with local education and environmental organisations.</p>	<i>Greenpeace (2020): 100% Renewable Energy for All, [access 2020].</i>



STATUS

The objective of the energy transformation is ambitious.	Source
<p>Achieve huge reductions in global greenhouse gas emissions:</p> <p>down 80% by 2050 (on 1990 levels) 8% Rise in global temperatures < 2°C</p>	<p><i>German Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (2016): Klimaschutzplan 2050, [access 2020].</i></p>
<p>Ever more countries are setting real targets for the expansion of renewables.</p> <p>2019: 18% 2030: 32%</p> <p>*Number of countries with targets for expanding renewables in 2005, 2010, 2015 and 2019.</p>	<p><i>European Union (2018): Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources, [access 2020].</i></p>



CHALLENGE

In developing countries and emerging economies, access to electricity is often a political priority.	Source
<p>About one billion people around the world have no access to electricity. Other fuels are often harmful to the environment.</p>	<p><i>IEA, IRENA, UNSD, WB, WHO (2019): Tracking SDG 7: The Energy Progress Report 2019, [access 2020].</i></p>
<p>State subsidies make investment in renewable energy more attractive.</p> <p>EUR 270,000,000,000 in global subsidies for fossil fuels (2018)</p> <p>EUR 140,000,000,000 in global subsidies for renewable energy (2018)</p>	<p><i>REN21 (2019, p. 34): Renewables 2019 Global Status Report, [access 2020].</i></p>
<p>Example: India</p> <p>India is the world's third largest emerging economy and its fifth largest economy.</p>	<p><i>World Bank (2020): India Overview [access 2020].</i></p>
<p>Polluted air causes a million deaths each year in India.</p>	<p><i>The Lancet Planetary Health (2019): The impact of air pollution on deaths, disease burden, and life expectancy across the states of India: the Global Burden of Disease Study 2017, [access 2020].</i></p>
<p>Since 2009, India has been phasing out subsidies for fossil fuels. In the transport sector, for example, most petrol and diesel subsidies have been scrapped.</p> <p>Political reforms enabled India to reduce subsidies on petroleum products by almost three quarters between 2014 and 2017.</p> <p>Meanwhile, support for renewable energy has increased sixfold.</p>	<p><i>IISD (2017): India's Energy Transition: Mapping subsidies to fossil fuels and clean energy in India, [access 2020].</i></p>
<p>India is just one of the countries around the world that still subsidise coal, oil and gas. Such subsidies amount to more than 6 percent of global GDP.</p>	<p><i>IMF (2019): Global Fossil Fuel Subsidies Remain Large: An Update Based on Country-Level Estimates, [access 2020].</i></p>
<p>For the cost of two years' worth of subsidised kerosene, households can purchase a solar lamp.</p>	<p><i>CCAC (2014): Kerosene Lamps & SLCP's, [access 2020].</i></p>



OUTLOOK

EU GOALS	Source
EU's development cooperation investments in the energy sector focus on renewable energy.	<i>EU (2020): In focus: Renewable energy in Europa [access 2020].</i>
The European Union's Green Deal Objectives: <ul style="list-style-type: none">- 8% complete climate-neutrality by 2050- 8% Decoupling economic growth from the use of resources- 8% Social compensation for regions focused on fossil fuel production	<i>European Commission (2019): Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions – The European Green Deal (COM/2019/640 final), [access 2020].</i>



STATUS

The hunger for energy in today's world knows no bounds.	Source
Global energy consumption is at around 1.6 terajoules per day.	McKinsey (2019): Global Energy Perspective, [access 2020].
1.6 terajoules is roughly 3,000 times the amount of energy produced by a large nuclear power station every day.	BBC (2017): Getting power to people where and when it's needed could rewrite the geopolitical rulebook, [access 2020].
Although we are using energy increasingly efficiently, energy consumption could still rise to 1.8 terajoules a day over the next 30 years.	McKinsey (2019): Global Energy Perspective, [access 2020].
<p>Political pressure Governments around the world are adopting laws requiring companies to reduce their CO2 emissions.</p> <p>The aim is to achieve greenhouse gas neutrality by 2050.</p>	German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2016): Klimaschutzplan 2050, [access 2020].
<p>Economic pressure Fossil fuels are less and less competitive compared to renewable energies. Even in Germany, where sunshine is in short supply, energy from photovoltaic plants already costs as little as 3.7 euro cents per kilowatt hour.</p> <p>In comparison*, energy from lignite costs at least 4.6 euro cents per kilowatt hour.</p> <p>*Examples from Germany, 2018; the prices refer to electricity generation costs.</p>	Fraunhofer ISE (2018, p.2): Stromgestehungskosten Erneuerbare Energien, [access 2020].
Global energy consumption is at around 1.6 terajoules per day.	McKinsey (2019): Global Energy Perspective, [access 2020].



CHANGE

<p>The renewables industry is forging ahead. It is driving innovation and leading the energy sector</p>	<p>Source</p>
<p>The renewables industry is forging ahead. It is driving innovation and leading the energy sector.</p> <p>Rising investment More than double the investments: renewable energies are considerably above coal and gas (2018).</p>	<p><i>UN Environment Programme/ Bloomberg New Energy Finance/ Frankfurt School-UNEP Centre for Climate and Sustainable Energy Finance (2019): Global Trends in Renewable Energy Investment, [access 2020].</i></p>
<p>New jobs 11 million jobs worldwide in the renewables industry (2018).</p>	<p><i>International Renewable Energy Agency (2019): Renewable Energy and Jobs. Annual Review 2019, [access 2020].</i></p>
<p>Innovation 10 years ago, approx. 100,000 patent applications were made every year. 2016 saw more than half a million.</p>	<p><i>IRENA: Renewable Energy Patents Evolution, [access 2020].</i></p>



CHALLENGE

The energy markets not only need to adapt – they need to do so quickly.	Source
<p>New digital business models are catching on fast.</p> <p>Examples: Pay-as-you-go – e.g. in Kenya and Tanzania.</p>	<p><i>IRENA (2020): Pay-as-you-go models. Innovation landscape brief [access 2020].</i></p>
<p>Example Japan: Every year, Japan puts EUR 300 million into subsidising the development of hydrogen filling stations and the purchase of hydrogen cars.</p>	<p><i>European Commission, Directorate-General for Research and Innovation (2018): Case Study Report: Hydrogen Society (Japan), [access 2020].</i></p>
<p>The largest Japanese automotive manufacturer currently has a 76% share of the global hydrogen mobility market.</p>	<p><i>E4tech (2018): The Fuel Cell Industry Review, [access 2020].</i></p>
<p>Example China: Chinese companies are at the forefront of the global photovoltaics market.</p>	<p><i>Institute for Energy Economics and Financial Analysis (2019): Chinese companies take aim at Japan’s growing battery storage market, [access 2020].</i></p>
<p>In 2019, China subsidised the solar industry to the tune of EUR 370 million.</p>	<p><i>Reuters (2019): China to allocate \$435 million subsidies for solar projects in China, [access 2020].</i></p>
<p>Chinese manufacturers currently have a 70% market share. Today, the once leading Japanese and European companies no longer achieve even a combined market share of 10%.</p>	<p><i>Institute for Energy Economics and Financial Analysis (2019): Chinese companies take aim at Japan’s growing battery storage market, [access 2020].</i></p>



OUTLOOK

<p>Environmental technologies are experiencing a boom, with market volumes rising steadily both now and in the future.</p>	<p>Source</p>
<p>Market volumes for environmental technologies and resource efficiency:</p> <p>Increase in trillions of euros</p>	<p><i>BMW (2018): GreenTech made in Germany 2018 Environmental Technology Atlas for Germany. GreenTech made in Germany 2018, [access 2020].</i></p>
<p>Market volumes are rising in all lead markets of the industry:</p> <p>Increase in billions of euros</p> <p>2016</p> <p>2018</p>	<p><i>German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2018, p. 48): GreenTech made in Germany 2018.</i></p>
<p>The global challenges of the energy transformation know no borders. Resources and know-how are being pooled together so practical solutions can be implemented quickly.</p> <p>High energy consumption</p> <p>High number of renewable energy resources</p>	<p><i>Statista (2019): Top 20 countries in primary energy consumption in 2019, [access 2020].</i></p> <p><i>Global Solar Atlas, [access 2020].</i></p> <p><i>Global Wind Atlas, [access 2020].</i></p>



STATUS

Applied research is dynamic and innovative	Source
<p>Most such research is conducted in research institutions and companies outside the universities.</p> <p>Anzahl der Patente im Bereich erneuerbarer Energien: 2 Mio. // jährliche Zuwachsrate: 20%</p>	<p><i>IRENA (2015): 2 million patents & 400 standards for renewable technology now together on INSPIRE, [access 2020].</i></p>



CHANGE

Applied research has meant that renewable energy can be produced at ever lower cost and can be adopted much more rapidly.

The costs of a privately-owned photovoltaic system; 1977: 76\$; price of 1 watt-peak (Allowing for inflation, USD 76 is equivalent to about USD 336 today).

Source

[Bloomberg New Energy \(2015\): Solar PV power cost from 1977 to 2015, \[access 2020\].](#)



CHALLENGE

<p>The more effectively electricity grids can respond to changes in the flow of electricity, the less risk there is of shortages or overloads.</p>	<p>Source</p>
<p>International research projects in this area are particularly promising.</p> <p>Example: Promotion</p> <p>EU 'PROMOTioN' research project: connecting North Sea windparks across Europe.</p>	<p><i>Offshore Wind Energy: PROMOTioN - Progress on Meshed HVDC Offshore Transmission Networks, [access 2020].</i></p>



OUTLOOK

Today, many people around the world have air conditioning	Source
<p>Cooling systems consume around 17% of the world's electricity. Besides air conditioning that also includes cooling systems in supermarkets and data centres.</p> <p>In 2018, cooling systems accounted for around 8% of global CO₂-emissions.</p> <p>By 2050, energy consumption for cooling systems is predicted to increase sixfold. This rise is being driven by new installations in Asian and African countries.</p>	<p><i>IEA (2018): Air conditioning use emerges as one of the key drivers of global electricity-demand growth, [access 2020].</i></p> <p><i>IEA (2018): The Future of Cooling. Opportunities for energy-efficient air conditioning, [access 2020].</i></p>
<p>Radiative cooling could offer a solution for tackling this rapid increase.</p> <p>Cooling panels with the special coating are about the same size as photovoltaic modules and can be integrated with condensers in almost any air conditioning or cooling system. Initial large-scale experiments in California boosted the efficiency of a cooling system under real-life conditions by a full 12%.</p> <p>In future, such specially coated plates in efficient cooling systems could reduce energy consumption by two thirds.</p>	<p><i>Eli A. Goldstein, Aaswath P. Raman, Shanhui Fan (2017): Sub-ambient non evaporate fluid cooling with the sky, in: Nature Energy, [access 2020].</i></p> <p><i>TED (2018): How we can turn the cold of outer space into a renewable resource, [access 2020].</i></p>