GreenFacts
Facts on Health and the Environment

Scientific Facts on

Energy Technologies

Scenarios to 2050

Source document:
IEA (2008)

Summary & Details:
GreenFacts

Context - The growing use of energy that underlies current economic growth puts unsustainable pressure on natural resources and on the environment.

What options do we have for switching to a cleaner and more efficient energy future? How much will it cost? And what policies could achieve this?

This Digest is a faithful summary of the leading scientific consensus report produced in 2008 by the International Energy Agency (IEA):
"Energy Technology Perspectives 2008 : Scenarios and strategies to 2050. Executive Summary."

The full Digest is available at: https://www.greenfacts.org/en/energy-technologies/

This PDF Document is the Level 1 of a GreenFacts Digest. GreenFacts Digests are published in several languages as questions and answers, in a copyrighted user-friendly Three-Level Structure of increasing detail:

- Each question is answered in Level 1 with a short summary.
- These answers are developed in more detail in Level 2.
- Level 3 consists of the Source document, the internationally recognised scientific consensus report which is faithfully summarised in Level 2 and further in Level 1.

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1. Introduction: What challenges is the energy sector facing?


Oil demand continues to increase steadily

The projected substantial growth in the global economy between 2008 and 2050 implies an increase in energy needs. Unsustainable pressures on the environment and on natural resources are inevitable if energy demand remains closely coupled with economic growth and if fossil fuel demand is not reduced.

Over the last two years, global carbon dioxide CO_2 emissions and oil demand have continued to increase steadily. "Business-as-usual" projections foresee a 70% increase in oil demand and a 130% rise in CO_2 emissions by 2050. Such an increase in CO_2 emissions could raise global average temperatures by 6°C or more, resulting in significant impacts on all aspects of life and irreversible changes in the natural environment.

A dramatic shift is needed in government energy policies, ensuring longer-term planning on which industries can rely. International cooperation among all major economies will also be crucial, bearing in mind that a large proportion of future CO_2 emissions are likely to come from the developing world.

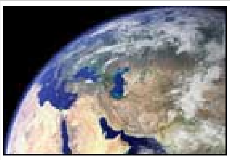
2. What are the different action scenarios considered?


Reducing CO_2 emissions to 2005 levels is not enough to limit global warming to 2 - 2.4 °C.

Two sets of scenarios assess the efforts needed to either stabilize CO_2 emissions at the level they were in 2005, or reduce them to 50% of that level by 2050.

2.1 The **ACT scenarios** aim to bring back CO_2 emissions to 2005 levels by 2050. This difficult and costly goal implies the adoption of a wide range of existing clean technologies, plus the deployment of some newer technologies, such as CO_2 capture and storage [see https://www.greenfacts.org/en/co2-capture-storage/index.htm] (CCS). Additional investments in the energy sector of roughly 0.4% of global gross domestic product each year between now and 2050 would be needed.

2.2 Reducing CO_2 emissions to 2005 levels is not enough to limit global warming to 2 - 2.4 °C, a level that would prevent the most severe consequences. The **BLUE scenarios** aim to prevent global warming from exceeding this temperature range by bringing emission levels down, by 2050, to a level that is half what they were in 2005. This even more difficult and costly goal requires urgent implementation of unprecedented new energy policies, the widespread deployment of technologies still under development, and additional investments in the energy sector that could reach 1.1% of global GDP each year between now and 2050.


See also our Digest on Climate Change [see https://www.greenfacts.org/en/climate-change-ar4/index.htm]

2.3 These required additional investments do not represent net costs, because technology investments in energy efficiency, in many renewable energy sources and in nuclear power all reduce fossil fuel requirements. In fact, in both ACT and BLUE scenarios, the estimated total undiscounted fuel cost savings for coal, oil and gas consumers over the period to 2050 are greater than the additional investment required.

2.4 In addition to their environmental benefits, the scenarios also show a more balanced outlook for oil markets.

3. What must be done in different sectors to substantially reduce CO_2 emissions?

See also our Digest on CO_2 Capture & Storage [see https://www.greenfacts.org/en/co2-capture-storage/index.htm]

Energy efficiency improvements in buildings, appliances, transport, industry and power generation represent the largest and least costly area for reducing CO_2 emissions. Next are the measures to produce energy through renewable sources, nuclear power, and CO_2 capture and storage [see https://www.greenfacts.org/en/co2-capture-storage/index.htm] (CCS) technologies. Action in all these areas is urgent and necessary.

3.1 Substantially lowering the energy consumption of **buildings** – with building insulation, heat pumps, solar heating and highly-efficient appliances and lighting among others – is essential in both ACT and BLUE scenarios. While the ACT scenarios can use technologies that are widely available today, the BLUE scenarios call for new and emerging technologies.

3.2 For **power generation** and industry, the deployment of CCS [see https://www.greenfacts.org/en/co2-capture-storage/index.htm] is the single most important new technology for avoidance of CO_2 emissions in both ACT and BLUE scenarios, before renewable sources and nuclear power. A massive switch to renewable sources of energy such as wind, solar and biomass is needed, and nuclear power also needs to play an increasingly important role. Given the broad range of possible energy mixes, countries have various options for reducing CO_2 emissions from the power sector.

Major improvements in the efficiency of conventional vehicles are needed.

3.3 The **transport sector** represents, by far, the largest area of additional investment in both ACT and BLUE scenarios. Major improvements in the efficiency of conventional vehicles are needed, with biofuels, hybrid and hydrogen technologies also playing a role.

3.4 **Industries** account for more than one-third of global energy use and CO_2 emissions. They have a good record of energy efficiency gains in recent years, driven by the need to manage energy costs, but great potential exists for further efficiency gains. However, very large CO_2 emission reductions from this sector are hard to achieve and need significant investments to upgrade industrial plants and deploy CCS [see https://www.greenfacts.org/en/co2-capture-storage/index.htm] technology.

4. How much effort is needed in research, development and demonstration?

The Esbjerg Power Station, a CO_2 capture site in Denmark
Source: *DONG Energy*

Some of the technologies needed to reach the targets set in the most ambitious scenarios are not yet available, and many others require further refinement and cost reductions. A huge effort of research, development, and demonstration (RD&D) is therefore urgently needed, both in the public and the private sector. It is estimated that the public sector needs to increase research and development investments by as much as ten times the current amounts.

The large-scale demonstration of the technical and economical feasibility of new technologies, such as CO_2 capture and storage [see https://www.greenfacts.org/en/co2-capture-storage/index.htm] in coal plants, also urgently requires significant public sector support.

In addition, the basic sciences of physics, chemistry and geology also need to be enhanced because they are fundamental to technology in which important breakthroughs are possible.

5. How can technologies be efficiently deployed?


Governments must enhance deployment programmes, for technologies such as solar energy
Source: Johan Bolhuis

Most new technologies have higher costs than established ones, but it is only through their deployment that costs can be reduced and the product adapted to the market. Governments must enhance deployment programmes, especially for technologies with the greatest potential such as biofuels and solar energy.

5.1 To overcome barriers to technology deployment, strict efficiency **regulations** for buildings, appliances and vehicles are essential in all scenarios. Public acceptance of the standards that are necessary to achieve very low-energy and zero-energy buildings and a four-fold reduction in the CO_2 emissions of vehicles will be critical.

5.2 Private-sector investment is – and will remain – the primary facilitator of technology deployment and diffusion. There is an urgent need to design and implement a range of policy measures that will create clear, predictable, long-term economic **incentives** for CO_2 reduction in the market. Only on this basis will business be able to take the steps needed and confidently undertake the huge investment programmes required.

5.3 Governments will need to lead **public opinion** by making the connection between the widely recognized urgent need to address climate change and the specific projects required which could face public opposition.

6. How essential is international collaboration?

International collaboration is essential to accelerate the development and global deployment of sustainable energy technologies in the most efficient way. Networks in which numerous technology experts from around the world co-ordinate their energy technology programmes already exist. These networks need strong international leadership from policy makers at the highest level.

In order to reach the global targets set into the ACT and BLUE scenarios, the International Energy Agency (IEA) has identified seventeen key technologies for energy efficiency, power generation and transport and, for each, has drawn a roadmap that describes the actions required to deliver their potential. These roadmaps are developed in the full “Energy Technology Perspectives 2008” report.

Examples of possible technology options (key roadmaps)

Supply side	Demand side
• **Fossil-fuel power plants** which capture and store the CO_2 they generate (**CCS [see https://www.greenfacts.org/en/co2-capture-storage/index.htm]**) • **Nuclear power plants** • **Wind turbines** located both onshore and offshore • **Biomass** burnt in **power** using integrated gasification combined cycle (IGCC) technology, alone or in combination with other fuels (co-combustion) • **Solar power** generated by **photovoltaic panels** (PV) that convert the sun's light directly into electricity • **Solar power** generated by **concentrators** that convert the sun's heat into electricity • Coal power plants using integrated gasification combined cycle (IGCC) technology • New coal power plants using ultra-supercritical technology • Second-generation liquid biofuels	• Energy efficiency in buildings and appliances • Heat pumps used for heating and cooling • Solar space and water heating • Energy efficiency in transport • Electric and plug-in vehicles • Hydrogen fuel cell vehicles • CO_2 capture and storage (CCS) applied to various processes such as hydrogen production and fuel transformation • Energy efficiency of motor systems used in industry

Partner for this publication

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