# The Greenpeace Climate Vision

## Background Note No.1

# The Energy Sector

### A. Projected business as usual emissions for 2050

Figures for the BAU greenhouse gas emissions for the energy sector are based on projections from the figures developed by the IEA in its World Energy Outlook 2007[1], and as reported in the EREC/Greenpeace Energy [R]evolution scenario[2].

This gives the following numbers, in million tonnes $CO_2$ a year:

| Subsector | 2005 | 2010 | 2020 | 2030 | 2040 | 2050 |
|---|---|---|---|---|---|---|
| **Industry** | 4,292 | 4,863 | 5,618 | 6,199 | 6,684 | 7,138 |
| **Other sectors** | 3,405 | 3,645 | 4,065 | 4,423 | 4,630 | 4,802 |
| **Transport** | 5,800 | 6,411 | 7,718 | 9,020 | 10,521 | 12,283 |
| **Electricity and Steam Generation** | 10,293 | 12,442 | 15,605 | 18,579 | 20,793 | 23,106 |
| **District Heating** | 561 | 571 | 535 | 496 | 467 | 443 |
| **Totals** | **24,351** | **27,932** | **33,541** | **38,716** | **43,095** | **47,773** |

### B. The Greenpeace Climate Vision's Zero Emissions Pathway

The Greenpeace Climate Vision's Zero Emissions Pathway for the energy sector builds further upon the 2008 EREC/Greenpeace Energy [R]evolution scenario, with two additional sets of measures[3]:

- the advanced phase-out of coal-fired power plants and their replacement by increasing the capacity and the faster deployment of wind, solar and geothermal energy;
- the advanced integration of two less-developed technologies: ocean power and battery electric vehicles.

[1] IEA. 2007: World Energy Outlook 2007. International Energy Agency. November 2007.

[2] EREC/Greenpeace. 2008: Energy [R]evolution. A sustainable global energy outlook. European Renewable Energy Council/Greenpeace. October 2008. (www.energyblueprint.info)

[3] We have also identified additional potential for energy demand reduction on top of the Energy [R]evolution scenario. This is described in *The Greenpeace Climate Vision: Background Note No. 8*

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## The EREC/Greenpeace Energy [R]evolution scenario

The EREC/Greenpeace Energy [R]evolution scenario provides a detailed description of how, within the social and economic parameters of the IEA's World Energy Outlook, an ambitious deployment of energy efficiency and renewable energy can strongly reduce $CO_2$ emissions from the energy sector.

The Energy [R]evolution scenario has a target for worldwide $CO_2$ emissions to be reduced to 50% below 1990 levels by 2050. A second objective is the global phase-out of nuclear energy.

To achieve these targets, the scenario is characterised by significant efforts to fully exploit the large potential for energy efficiency. At the same time, all cost-effective renewable energy sources are accessed for heat and electricity generation, as well as the production of sustainable biofuels.

Today, renewable energy sources account for 13% of the world's primary energy demand. Biomass, which is mostly used in the heat sector, is the main renewable energy source. The share of renewable energies for electricity generation is 18%. The contribution of renewable energy to heat supply is around 24%, accounted for - to a large extent - by traditional uses such as collected firewood. About 80% of the primary energy supply today still comes from fossil fuels.

The Energy [R]evolution scenario describes a development pathway that turns the present situation into a sustainable energy supply through the following measures:

- exploitation of existing large energy efficiency potentials will ensure that primary energy demand increases only slightly – from the current 474,900 PJ a year (2005) to 480,860 PJ a year in 2050, compared to 867,700 PJ a year in the 'business-as-usual' (BAU) scenario. This dramatic reduction is a crucial prerequisite for achieving a significant share of renewable energy sources in the overall energy supply system, for compensating the phase-out of nuclear energy, and for reducing the consumption of fossil fuels;

- increased use of combined heat and power generation (CHP), which improves the supply system's energy conversion efficiency, increasingly using natural gas and biomass. In the long-term, the decreasing demand for heat and the large potential for producing heat directly from renewable energy sources limits the further expansion of CHP;

- the electricity sector will be the pioneer of renewable energy utilisation. By 2050, around 77% of all electricity will be produced from renewable energy sources. A capacity of 9,100 GW will produce 28,600 TWh a year renewable electricity in 2050;

- in the heat supply sector, the contribution of renewable energy will increase to 70% by 2050. Fossil fuels will be increasingly replaced by more-efficient modern technologies, in particular biomass, solar collectors and geothermal energy;

- before sustainable biofuels are introduced in the transport sector, the existing potential for improving vehicle efficiency has to be exploited. As biomass is mainly committed to stationary applications, the production of biofuels is limited by the availability of sustainable raw materials. Electric vehicles powered by renewable energy sources will play an increasing role from 2020 onwards;

- by 2050, 56% of primary energy demand will be covered by renewable energy sources.

The slightly higher electricity generation costs (compared to conventional fuels) under the Energy [R]evolution scenario are to a large extent compensated for by reduced demand for electricity. Assuming average costs of 3 cents/kWh for implementing energy efficiency measures, the additional cost for electricity supply under the Energy [R]evolution scenario will amount to a maximum of USD 10 billion a year in 2010. These additional costs, which represent society's investment in an environmentally-benign, safe and economic energy supply, continue to decrease after 2010. By 2050 the annual costs of electricity supply will be USD 2,900 billion a year below those in the BAU scenario.

**While $CO_2$ emissions worldwide will double under the BAU scenario up to 2050, and are thus far removed from a sustainable development path, under the Energy [R]evolution scenario they will decrease from 24,350 $MtCO_2$ in 2003 to 10,590 $MtCO_2$ in 2050.**
In spite of the phasing out of nuclear energy and a growing electricity demand, $CO_2$ emissions will decrease enormously in the electricity sector. With a share of 35% of total emissions in 2050, the power sector, although reducing its contribution significantly, will remain the largest source of $CO_2$ emissions, followed by transport and industry.

## The Advanced Energy [R]evolution scenario

The Advanced Energy [R]evolution scenario takes a much more radical approach to the climate crisis facing the world. In order to pull the emergency brake on global emissions it therefore assumes much shorter technical lifetimes for coal-fired power plants – 20 years instead of 40 years. This reduces global $CO_2$ emissions even faster and takes the latest evidence of greater climate sensitivity into account.

In order to fill the resulting gap, the annual growth rates of renewable energy sources, especially solar photovoltaics, wind and concentrated solar power plants have been increased. Their growth rates increase from 2020 onwards to 2050. These expanded growth rates are in line with the current projections of the wind and solar industry[4]. Therefore, in the Advanced Energy [R]evolution scenario, the capacities for solar and wind power generation appear 10 to 15 years earlier than projected in the Energy [R]evolution scenario. The expansion of geothermal co-generation has also been moved 20 years ahead of its expected take-off.

All other results remain the same as in the Energy [R]evolution scenario, with the changes only affecting the power sector.

The main change for the power sector in the Advanced Energy [R]evolution scenario is that all conventional coal-fired power plants are phased out by 2050. Between 2020 and 2050 a total of approximately 1,200 GW of capacity will be replaced by solar photovoltaics, on and offshore wind and concentrated solar power plants. By 2050, 86% of electricity will be produced from renewable energy sources. The remaining fossil fuel-based power production is from gas. In contrast to the basic Energy [R]evolution scenario the expected capacity of renewable energy will emerge 15 years ahead of schedule.

**In comparison with the basic Energy [R]evolution scenario, the Advanced Energy [R]evolution scenario will reduce greenhouse gas emissions by a further 2,100 $MtCO_2$ a year by 2050 and will thus reduce $CO_2$ emissions from the energy sector to 8,416 $MtCO_2$ a year by 2050.**

## The advanced integration of less-developed technologies

In addition to the Advanced Energy [R]evolution scenario, our zero emissions pathway envisages a much sooner and faster integration of two less-developed technologies: ocean power and battery electric vehicles.

Based on reports on the theoretical, technical and market potential of these technologies we envisage an additional reduction of 873 $MtCO_2$ a year by 2050. This can be achieved through a combination of:

- **Ocean power**
  The REN21 report on Renewable Energy Potential[5] estimates the technical potential of ocean energy at 50,000 PJ a year. Due to the fact that this technology is still in an experimental phase, with the first commercial plants only recently being installed, the EREC/Greenpeace Energy [R]evolution scenario foresees only 2,437 PJ a year coming from ocean power in 2050. Based on the Ecofys background study[6] for the REN21 report, however, we can identify the economic potential (at a cost below 10 cents/kWh) for ocean energy to be 8,635 PJ a year by 2050.

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[4] See GWEC/Greenpeace. 2008: Global Wind Energy Outlook 2008. Global Wind Energy Council/Greenpeace. October 2008 (www.gwec.net/fileadmin/documents/Publications/GWEO_2008_final.pdf); and: EPIA/Greenpeace. 2008: Solar Generation V – 2008. European Photovoltaic Industry Association/Greenpeace. September 2008. (www.epia.org/fileadmin/EPIA_docs/documents/EPIA_SG_V_ENGLISH_FULL_Sept2008.pdf)

[5] REN21. 2008: Renewable Energy Potential. August 2008. (www.ren21.net/news/news30.asp)

[6] Hoogwijk M. and Graus W. 2008: Global potential of renewable energy sources: A literature assessment. Ecofys, March 2008. (www.ren21.net/news/news30.asp)

**This is 6,198 PJ a year more than in the EREC/Greenpeace scenario.** This additional electricity can be used to power an increase in the use of battery electric cars;

- **Battery electric vehicles**
  Of all the conversion and storage technologies currently being developed, the expansion of battery electric vehicles seems to be the most promising. Battery electric vehicles offer the opportunity to drive vehicles based on renewable energy on a very large scale. Battery electric vehicles are much more efficient than combustion engines and are also twice as efficient as other alternative engines such as fuel cell, hydrogen and compressed air engines.[7] Battery electric cars also provide an excellent opportunity to provide massive storage capacities when renewable electricity production surpasses demand. As such they are an important element of future smart grids and can play a role in the better balancing of supply and demand.

  While the Energy [R]evolution scenario provides for approximately 30-40% of all vehicles to be battery electric in 2050, the IEA Energy Technology Perspective Blueprint scenario[8] has a version that provides for 90% of new vehicles to be connected to the grid in 2050. Based on this IEA scenario our zero emissions pathway envisages increasing the use of battery electric vehicles beyond the Energy [R]evolution scenario, using the full additional capacity of ocean power as identified above. Assuming a double efficiency of battery electric vehicles, we can envisage an equal demand reduction.

  **This would reduce fossil fuel use in the transport sector in the Energy [R]evolution by 25% and would equally reduce $CO_2$ emissions by 25%, or 873 $MtCO_2$ a year by 2050.**

## C. Reduction potential for the energy sector

The total mitigation potential of the Energy [R]evolution scenario would result in an emissions reduction of 40,230 $MtCO_2$ a year by 2050, as compared to the BAU scenario. This means that emissions from the energy sector can be reduced to 7,543 $MtCO_2$ a year by 2050.

This is a reduction of 84% compared to the projected 2050 BAU emissions and a reduction of 65% compared to the emissions from the energy sector in 1990. In the zero emissions pathway, the energy sector can provide a reduction of 37% compared to total global greenhouse gas emissions in 1990.

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7 Mazza P. and Hammerschlag R. Wind-to-wheel energy assessment. (www.efcf.com/reports/E18.pdf)

8 IEA. 2008: Energy Technology Perspectives 2008. Scenarios and strategies to 2050.