Be among the Firsts or Dropped behind – The Renewable Challenge

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Abstract

The article wants to envisage the importance of renewables starting from the climate change issue through the supply security, to the depleting of fossils. The respond of the EU committee and the USA is also highlighted focusing on the renewable policies including both "heat and power" and fuel segments. In the second part, there is an overview of the different renewable technologies and the renewable businesses of some pacesetter companies, including oil supermajors. At the end we tried to project a future technological breakthrough that will be necessary for a sustainable life.

Összefoglalás

Ott a helyünk az elsők között – kihívások a megújuló energiák terén

A cikk célja a megújuló energiág fontosságának bemutatása a klímaváltozás kérdésétől az energiabiztonságon keresztül és a fosszilis energiatartalékok kimerülése által. Bemutatásra kerülnek az USA és az Európai Unió válaszlépései is, mind a hő és áramtermelés, mind pedig az üzemanyagokkal kapcsolatos irányelvek és szabályozások terén. A cikk második felében áttekintjük a különböző energiagfajtákat, azok technológiai hátterét, megvalósíthatóságát, valamint a néhány nagyobb energiavállalat ezirányú tevékenységét. Végül egy jövőbeli technológiai áttörést helyezünk kilátásba, ami a bolygónk hosszú távú fenntarthatóságának elengedhetetlen feltétele lesz.

Introduction

month of the year abundant inventories in One of the hottest issue of the 21st century is the world energy supply. The global energy demand has a significant growth even in the OECD countries, while in the emerging countries the demand growth is proposed to be much bigger. According to the latest International Energy Agency (IEA) outlook, if there will be no new government policies beyond those already adopted by mid-2008, world primary energy demand expands by 45% between 2006 and 2030 – an average rate of growth of 1.6% per year. China and India will account for over half of incremental energy demand to 2030.[1] These countries use coal as a main energy source. The Middle East emerges as a major new demand centre, contributing a further 11% to incremental world demand.

Meanwhile lots of countries have high dependence on foreign energy sources that makes them politically and economically highly exposured. During the recent gas crisis, some countries had serious daily problems after just a couple of days of gas shortage.

In the nowadays structure most of the energy demand is fulfilled by fossil sources, mainly coal and hydrocarbons for energy supply.

The known fossil energy sources are limited. There are year by year new theories about the total amounts to be discovered. For oil there are estimations for resources for 40, 60 or 80 years. Regarding natural gas it can be more then 100 years, or in case of coal even several hundreds. But continuing our existing energy usage all sources will be over in a certain period. We burn all resources in 300 years that accumulated in the past several millions.

Climate change

Burning fossil energy sources produces CO_2 as a by-product. The atmosphere CO_2 content has a significant growth in the last period started at the industrial revolution..

The world energy related CO_2 emission (roughly 2/3 of the total emission) is now slightly below 30 billions of ton per year, projected to increase to 40 billion till 2030. 97% of the projected increase in emissions between now and 2030 comes from non-OECD countries – three-quarters from China, India & the Middle East alone.

Abundant scientific studies and reports disclose sufficient information that rising concentrations of greenhouse gases, especially CO_2, in the atmosphere have direct relation with climate change that we have witnessed in the previous decades. Average temperatures rise, storms are more intense, drought periods longer, glaciers retreat much faster and floods are more commonplace. It is without doubt, that anthropogenic CO_2 is a significant contributor to the increased concentrations of GHGs in the atmosphere.

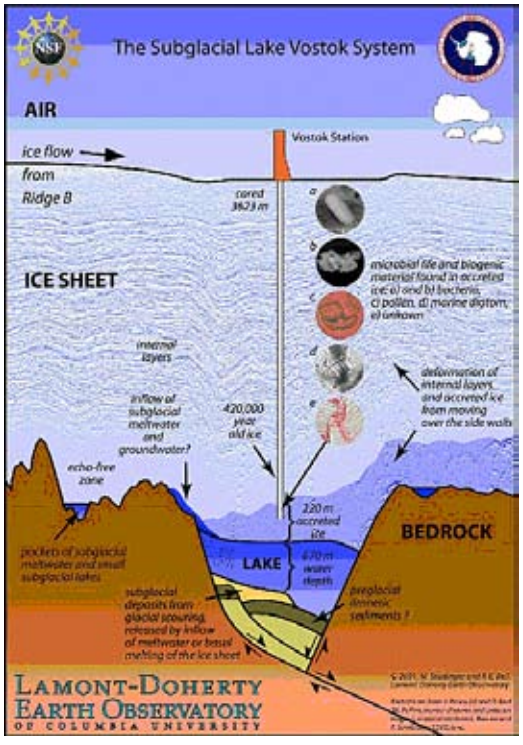
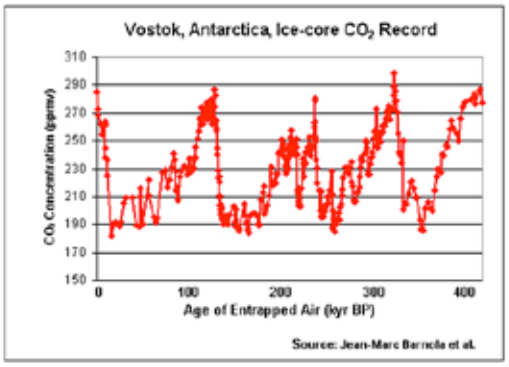


Figure 1. The „VOSTOK" drilling



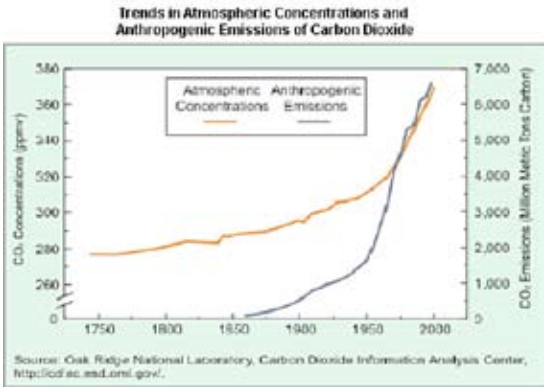


Figure 2. The trends of CO_2 content

In January 1998, the collaborative ice-drilling project of Russia, the United States, and France at the Russian Vostok station in East Antarctic territory yielded the deepest ice core ever recovered, reaching a depth of 3,623m (see figure 1). Ice cores are unique with their entrapped air inclusions enabling direct records of past changes in atmospheric trace-gas composition.

The Vostok project [2] demonstrated that there is a close correlation between Antarctic temperature and atmospheric concentrations of CO_2. The extension of the Vostok CO_2 record shows that the main trends of CO_2 are similar for each glacial cycle.

During glacial-interglacial transitions, the atmospheric concentrations of CO_2 rise from 180 to 280-300 ppm.

The extension of the Vostok CO_2 record shows the present-day levels of CO_2 (375 ppm) are unprecedented during the past 420 000 years. The change is drastic and shocking, anthropo-

genic emissions of CO_2 increased from 315 to 375 ppm in the period of 1970 to 2000. (see Figure 2)

Taking into consideration all the facts of depletion of resources, supply security (both of them increase price growth) and climate change, we can say that we need a switch to locally available energy resources.

Climate change issues have to be treated in global but at least at government level. It seems to be too optimistic to believe that profit-oriented companies will choose the more environmental friendly but more expensive solutions. That's why a number of regulations and financial initiatives are produced to push the move towards renewables. The European Union has a pacemaker role in this area.

Renewable policies in USA

As a pacesetter in the world, on June 1, 2005, California Governor Arnold Schwarzenegger issued Executive Order S-3-05, which established state-wide GHG emission reduction targets of 2000 levels by 2010, 1990 levels by 2020, and 80 percent below 1990 levels by 2050. On September 27, 2006, Governor Schwarzenegger signed the Global Warming Solutions Act, AB 32, which capped the state's GHG emissions at 1990 levels by 2020. This is the first state-wide program in the USA to mandate an economy-wide emissions cap that includes enforceable penalties. [3]

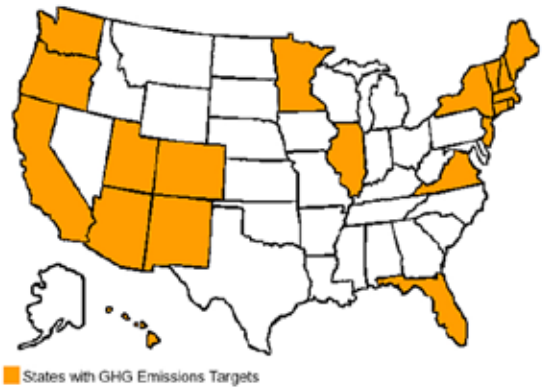


Figure 3. Renewable policies in the USA

Currently 20 states of the USA have individual GHG emission reduction targets (Figure 3).

California also proposed the enforcement of Renewable Portfolio Standard in the power sector ensuring that at least 33% of electricity would be produced in the states from renewables.

Since Barack Obama won the election the USA energy politics started a total change. The "Obama-Biden New Energy for America" plans to have 10% renewables share in power generation in 2012, and 25% in 2050. A challenging "cap and trade" (similar to the European ETS) program planned to be launched with an expected 80% GHG emission decrease by 2050 compared to the 1990 figures. All companies in all industries would have to pay for all of their emissions.

Roughly USD 15 bn/y would be spent on the development of clean energy solutions like utilization of renewables, energy efficiency, low emission coal plants, plug-in hybrid cars, biofuels and a new digital electricity grid. They expect from these investments 5 millions of new "green jobs" in mostly the high skilled manufacturing areas. As a leadership program half of the federal government cars purchase will be plug-in hybrids or all electric ones by 2012. [4]

Setting European pace

Since the Maastricht Treaty one of the main objectives of the European Union is to promote growth while protecting the environment. Sustainable development as another key principle was added by the Amsterdam Treaty. Despite implicit failure of Johannesburg Summit – no specific goals were set to energy sector in contribution for environmental protection – the European Union with more than 80 other pioneer countries set challenging targets and formed the Johannesburg Renewable Energy Coalition (JREC) [5]. Playing key role in assignment of Kyoto Protocol was another clear prove how seriously the EU thinks about this topic. At 2004 the European Conference for Renewable Energy in Berlin defined EU targets for renewable up to 2020 [6]. At the end of 2008, in the middle of the economic crisis, very different movements (from trade unions to some industry represents) formed a last minute coalition, trying to soften these targets without success.

The RES-E Directive provides for a broad definition of renewable energy. It includes hydro power (large and small), biomass (solids, biofuels, landfill gas, sewage treatment plant gas and biogas) wind, solar (PV, heat, thermal electric), geothermal, wave and, tidal energy.

General waste incineration has been excluded but the biodegradable fraction of waste can be considered as renewable. The contentious category biodegradable part of waste incineration 'as long as the waste hierarchy is respected' has been retained. Furthermore, large hydropower (more than10 MW) is also included. It has been tacitly agreed that large hydro will count for meeting the targets but will not be eligible for support measures.

The new Renewable Energy Sources Directive ("Promotion of the use of energy from renewable sources") approved with amendments by the European Parliament in the first reading in December 2008 sets clear target of 20% renewable share in gross final consumption by 2020 in the European Union. Different targets may be assigned to different countries (e.g. Hungary: 13%, Slovakia: 14%) according to their 2005 renewable share and local opportunities. To have a clear view, in the power generation sector the cheapest and most matured technology – relatively easy to realize in larger scales - is the hydro-power, but not all countries has suitable geographic conditions. The transportation sector's accepted 10% renewable share shall be equally shared by all member states. Member states should present their national action plans by June 2010.

There are also strict sustainability criteria for biofuels and bioliquids (for heat and electricity production) GHG emissions saving from their use compared to fossil fuels shall be 35% as the directive enters into force, 50% from 2017, and 60% for new installations from the same time.

Key questions: Future demand and security of supply

Security of energy supply and meeting future demand are the other key drivers for the EU to increase renewable share in the total energy mix. The Second Strategic Energy [7] indicates clear figures for the next decade: *"…Under the new energy policy scenario, the capacity expansion necessary to meet the future power demand and to replace ageing facilities amounts to circa 360 - 390 GW over the period 2005-2020 depending on oil prices…According to the New Energy Policy case, power generation based on gas and renewables would account for about 300 - 315 GW of the required capacity expansion…"*

Translation objectives to practice

The EU promotes cross-border cooperation between states to exchange experience regarding both technological issues as well as successful incentive schemes. Leading countries in the renewable energy sector (Germany, Spain, Denmark) have established the IFIC (International Feed-In Cooperation, 2004) and IRENA (International Renewable Energy Agency, 2007[8]).

Germany at the moment is the worldwide pioneer in expanding its renewables capacities and hence reducing GHG. The strong development has been possible by introducing attractive public support, mainly in the form of feed-in tariffs, starting in 2000. The German Model has been copied by about 50 countries. The German Renewable Energy Law (EEG) defines an annual compensation scheme for newly installed RE capacities. The recent amendment in 2008 (i.e. EEG 2009) was based on targeting 25-30% share of RE in 2020. The compensation is fixed and held constant for 15 years (hydro power < 5 MW), 20 years (wind, biomass, geothermal energy, photovoltaic power) and 30 years (hydro power >5 MW). The base year for calculating the respective compensation is 2004.

Serious commitment is visible in funding renewable research and development. In asset financing for new capacity, Europe leads with investments of USD 38.8bn in 2007[9] of the total finance of USD 84.5 bn of the world. (Figure 4) Among the achievements could be mentioned that PV (photovoltaic) systems efficiency was doubled. On-shore wind farms negative effects raised due to their high impact to landscape and biodiversity [1] were reduced. There is a much clearer picture on the corrosion lifetime of off-shore wind farms and how we could protect these equipments against the corrosion[11]. Expertise exists how the quality of supply affects production of biogas plants and how we can handle these quality issues.

Renewable portfolio in the EU in 2020

Renewable technologies are competing with each other. However the last decades developments turned some of them to mature phase and reasonable investments targets for the energy industry (like biomass and wind-technologies), some of them are close to breakthrough, but their industrial applicability is still a question (PV systems, tide). Due to their 8-15 years payback period time public-private-partnerships could make them more attractive.

The Renewable Energy Roadmap indicates clearly, how the Commission thinks about future renewable portfolio trends [12] (see figure 5).

It is clear from the projections, how the industry should think about its potential investments. There is a room for the Venture Capital to invest in PV development, but it is better for conservative energy industry players to focus on wind and bio-technologies. Despite big share of hydro energy in the energy mix, its growth potential is limited.

Fast integration of Iceland to EU, as a positive side effect of the financial crisis, could strengthen geothermal industry via EU supported technology transfer programs. At February 2009 the European Commission decided to invest €3.5bn of unspent EU funds in a series of "strategic energy projects" as part of Europe's economic recovery plan. The package includes a proposal for a Regulation to grant European Community support to strategic energy projects. A total of Euro 3.5 billion is proposed for 2009-2010 investment in carbon capture and storage (financial envelope: Euro 1,250 million), offshore wind projects (€500m), and gas and electricity interconnection projects (€1,750m). However, it fails to address energy efficiency.

According to EWEA (European Wind Energy Association), the wind industry alone is expected to contribute towards delivering 12-14% of EU electrical demand within 12 years, with more than one-quarter of that coming from offshore wind. By 2030, the contribution of offshore wind alone is expected to reach close to 15% of total EU electrical production.

Standpoint of the member states could be different, how to meet individual commitments and build up internal energy policies.

Competing renewable sources and technologies

Renewable technologies are different, regarding to supply security, applicability, CAPEX need and operation etc. Some of them are mature, some of them before breakthrough. Their synergies with other industries could be different too. Figure 6 shows the the low share of renewables in EU energy consumption.

Hydropower

Hydropower generation is a well-known, widely used, mature technology. Hydroelectric power plants can be divided into run-of-river plants usually having no (or only a small) reservoir (and therefore operating for base load generation) and storage power plants, which are (with their reservoir capacities) predestined for the generation of peak load. Storage power plants might also have

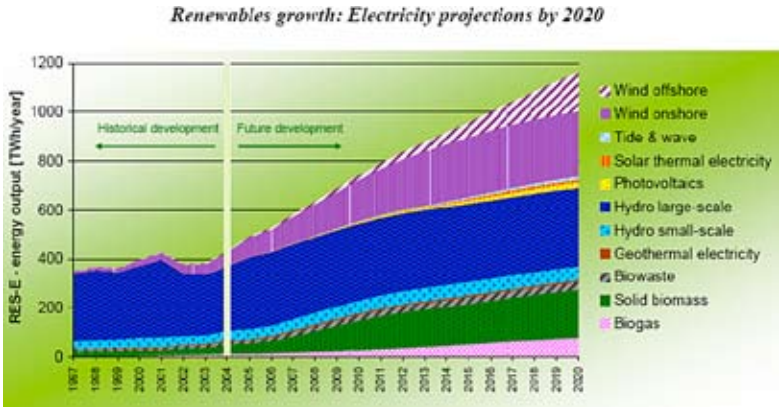


Figure 5. Renewable portfolio trends

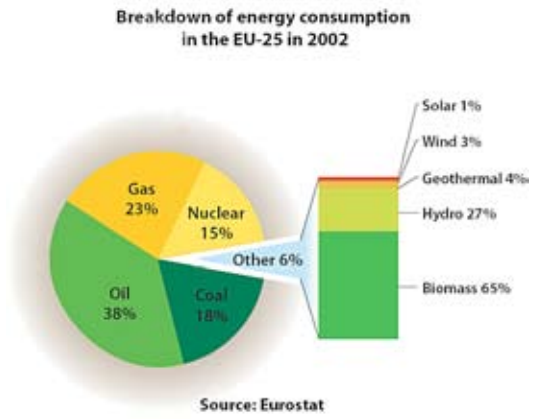


Figure 6. Renewable sources in the EU

pumping facilities producing electricity to supply peak demand by moving water between different reservoir altitudes, i.e. pumping water during day periods when base load prices are rather cheap to higher reservoir levels. However, electricity produced in pumped storage units from water that has previously been pumped uphill should not be considered to be electricity produced from renewable energy sources.

Investments cost are high, however the maintenance cost are the most favourable compared to any other technologies. Hydropower could be a peer-technology of wind power using pumping storage technologies, mentioned above. The technology is CO_2 clean, however its impact to biodiversity is high. Big hydropower plants generate countable risk to human living if geological structure is not stable enough. In the EU there is low potential for hydropower investments.

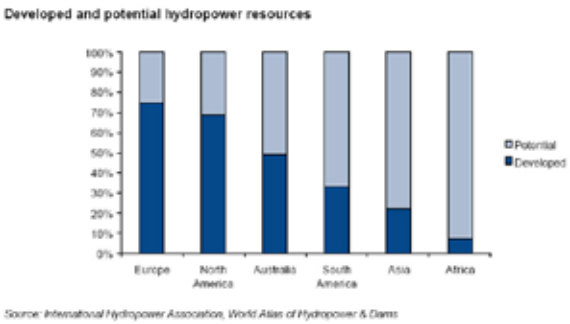


Figure 7. Hydropower potential

Wind power

Wind power industry is the most growing industry compared to other ones. Onshore and offshore platforms generates growing percentage of total EU electricity consumption. From growth point of view, these technologies would generate around one third of EU renewable electricity at 2020. Wind power technology is a mature technology.

Most of the technological problems have been solved in the past decade. CO_2-clean operation is another positive advantage of this technology. From investments point of view, the costs are low-moderate, due to the different geographical locations, development stages of the local wind energy market and the accessibility of the turbines, there is a wide spread between the O&M costs in different areas. For example:

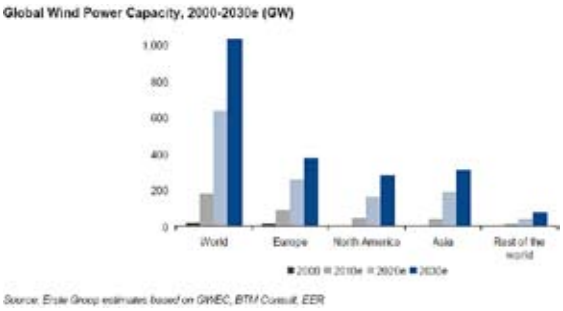


Figure 8. Wind power capacities

one of the world's biggest operators, Iberdrola Renewables(?), estimates that the costs are EUR 25,000/MW in Spain, while in the "young" wind market in the UK, up to 87,000EUR/MW have to be expected. Payback period is about 12 years. The wind farms installed currently have a capacity of 50-200 MW. At this size, operators can benefit from economies of scale in civil engineering and electric connection costs. However, the wind farms require a large area, as turbines typically need 3-5 rotor diameters between them. Disadvantage could be its impact to biodiversity (birds), their impact to the landscape. Noise of equipments is high. Careful setup could handle these issues. The biggest disadvantage comes from supply security side. The electricity market needs continuous supply, however wind-source is not a continuous one. Combining wind power with hydropower (pumping storages) could resolve these problems. Due to geographical limitations of hydropower, wind power limitations also exist.

Geothermal power

Geothermal power is another mature technology. Typically, the use of geothermal potential is divided into two categories: electricity production and direct use. The second category includes all applications other than electricity production, such as heating, supplying baths with thermal water, snow melting, agriculture applications, etc. The main measurement factors for a geothermal well are the temperature of the fluid and the water yield. These factors largely determine the carried energy and the availability of the well for usage. Due to this facts industrial applicability is limited

by geological structures. CAPEX needs are high (mainly drilling costs), however maintenance costs are low. CO_2 emission is low. Impact to biodiversity is low, too.

The European Geothermal Energy Council (EGEC) has worked out a strategic research plan for the period 2008-30 [13]. Their targets for geothermal energy production are:

- For heating & cooling in the EU-27, from the 15 GWt in 2007, capacity should increase to 20 GWt by 2010, 40 GWt by 2020 and 80 GWt by 2030.
- In the EU-27, the present geothermal electricity capacity is 1 GWe, around 10% of world geothermal installation. Other European countries have around 0.5 GWe capacity. For the EU-27, the plan is to reach 1.4 GWe by 2010, 6-10 GWe to be installed by 2020 and 15-30 GWe should be installed by 2030.

Biomass

Until the industrial revolution biomass (for sailing the wind) was the only energy source. Because of high CO_2 emission of coal-plants, nowadays the EU actively supports CO_2-friendly solutions. The main biomass source is wood. Due to its high impact to biodiversity this source is openly criticized by civil movements. However energy forest or grass plantation is less harmful, their negative impact to biodiversity is on the screen.

Primer Biogas production in the EU in Mtoe, 2007

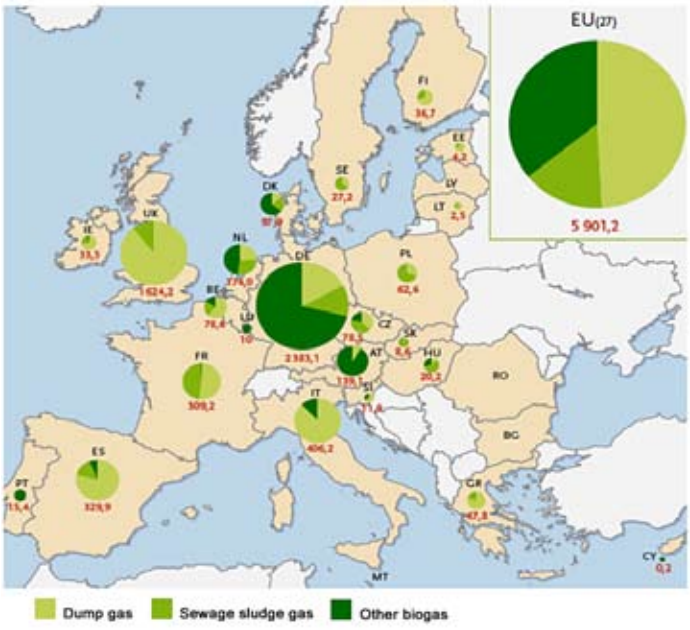


Figure 9. Biomass production areas

Grain and other food sources are efficient in firing but their impact on the food prices is remarkable. Agricultural and animal waste would be one of the biomass sources which doesn't affect negatively the food supply or biodiversity. Maintenance costs are moderate. From supply security point of view these investments have moderate risks. On the other hand, synergies could improve this technology. Biogas plants may emit CH4 into the air, which has more than 20 times higher global warming potential than CO_2. If the farmers could fire/gasify their agricultural waste, then they do not need to pay waste-related fees. Biomass plants create jobs, and revive rural areas.

Methane from waste

Using dump gases, are not renewable sources by definition, however the technology is the same as the biomass-technology. If the hazardous waste could be removed from process, then we could efficiently use this technology to supply small towns, or districts.

Solar power

Solar cells are the technology of the close future. However their efficiency doubled in the past decade (see figure 10) is still not enough to realize positive NPV for solar projects without subsidizing them. CAPEX costs are extremely high. Their energy production highly depends on the geographical location. Industry produces hazardous wastes during PV cells production.

Renewables at some major oil and energy companies

The major oil companies declared full commitment on importance and utilization of renewable energy.

Shell

Shell has a business strategy updated in March 2008 [14]: "More Upstream, Profitable Downstream". In their strategy they also states *"to create a world-leading biofuels business and aim to build a material capability in the capture and storage of CO_2".*

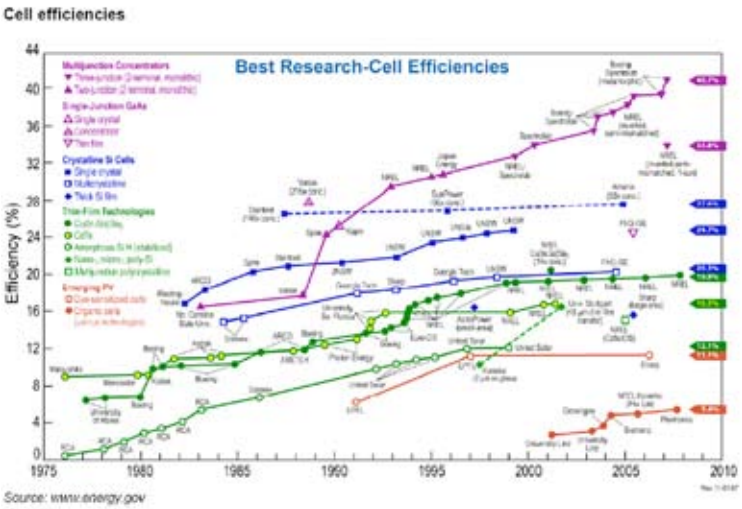


Figure 10. Development of solar cells

Meanwhile Shell runs several projects for research and utilization of alternative energies and emission reduction. The mains of these are wind with a planned commercial capacity of 1,100 MW, and test project in solar power generations. Shell also makes significant effort on the research of the 2nd generation biofuels and hydrogen refuelling.

According to the 2009 strategy update Shell, due to the financial crisis Shell pulled back from wind and solar technologies, but put more focus on biofuels.

Another way to inspire the talents to improve energy efficiency is Shell Eco-marathon, that is a race where the drivers has to uses the least amount of fuel to travel the farthest distance.

British Petroleum

BP is one of the largest commercial users of solar energy in the world – they use BP Solar products at many of own service stations, plants and offices. At BP a separate business, Alternative Energy, handles BP's low-carbon businesses and future growth options outside oil and gas. This includes solar, wind, gas-fired power, hydrogen, biofuels and coal conversion. BP has an increased focus on solar energy.

With over 30 years of experience and installations in over 160 countries, BP Solar is one of the world's largest solar companies, with manufacturing facilities in the United States, Spain, India and China [15]. Their total solar cell power production capacity in the third quarter of 2008 was 277MW, but fell to 213MW in the fourth quarter, due in particular to the fire at Tata BP Solar plant, which disrupted the production [16] .

They have their major manufacturing facilities in the US, Spain, India, China and Australia, and they plan to grow their solar sales acpacity to 800MW in the coming years

To date according to BP calculation, their Solar modules installed worldwide would offset more than 14 million metric tons of CO during their lifetime.

In the US, they won a bid in 2007 to develop 4.3MW of solar energy systems for seven Wal-Mart Stores in California. In Spain with they installed 14MW peak capacity photovoltaic solar power installations.

They also provide systems to low-income families in southern California through our BP Solar Neighbours programme and participate in the Australian Solar Cities initiative which helps residents in social housing save energy and reduce emissions. BP Solar is also bringing solar power to remote areas of developing and emerging economies.

As part of solar research programme, it was announced in 2007 that the US Department of Energy would be contributing to a three-year, $40 million BP programme to reduce the costs of solar cells (50% funded by BP Solar) - part of the Solar America Initiative.

RWE

RWE, one of Europe's five leading electricity and gas companies is also committed to research in renewables. They established a new company called "RWE Innogy Ventures" [17] on February 1, 2008. RWE's activities in the field of renewable energies are pooled in this company. They aim to more than triple RWE Innogy's generation base to 4.5 gigawatts by 2012. They focus on capacity growth in commercially mature renewable technologies, i.e. wind, biomass and hydro, but they also plan demonstration plants to drive the development of emerging technologies, e.g. solarthermal, geothermal, marine energy. RWE also entered in a large-scale - 960MW offshore wind power project in Germany, and launched an algae test plant.

OMV

OMV has a subsidiary called *„OMV future energy fund"*, with 4 FTE involving several other international scientists specialized in energy and climate change [18]. Its task is identifying renewable energy and emissions reduction projects within the OMV group, supports their implementation and provides funding for them. Actual investments by OMV are expected to significantly exceed the Fund's initial budget of EUR 100 million, as in some cases projects will receive support without regard to their profitability.

They run a number of "renewable" projects mainly focusing on Geothermal Energy, 2nd generation biofuels, hydrogen fuel station, refinery development (nanotechnology in effective heat exchangers) CO_2 sequestration (EOR, EGR, not (?) only clear CCS). Interesting try to build a new headquarter with a planned 90% energy saving and 80% less GHG emission.

Future vision

Renewables compared to fossil energy resources are not competitive today, however the drivers mentioned in the first part of the article, force breakthrough in energy production. In the past few years the photo-market completely restructured due to digital processing. Several market leading companies did not recognized potential of digital imaging on time. Polaroid company disappeared, Minolta, with nearly 100 years tradition in photography had to sell its photo-division, while electric companies, like Sony or HP became significant market players. This example clearly shows that the follow-up approach could seriously threaten future of the energy companies, focusing only on fossil resources. The developed countries show increased commitment on the environment protection, so climate change issues. They adjust their regulatory, taxation and subvention system to promote renewables that will accelerate oncoming technological breakthrough. The present economic turmoil offers a good chance to make a green "New deal".The future is clear, we have to decide to be among the firsts, or to be dropped behind.

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