Renewable Energy Report

Ed 5 2010

Hydro Power
Wind Power
Solar Photovoltaic
Solar Thermal Heat
Solar Thermal Cooling
Solar Thermal Power Generation
Biomass
Geothermal Power Generation
Geotherrmal Heat
Marine Energy
Hybrids
Fuel Cells
Hydrogen

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Introduction

The ABS Renewable Energy Report Ed 5 2010 is a 370 page overview of all renewable energy sources and technologies, outlining their current stages of development, their relative contributions and their advantages and disadvantages, together with their potential contributions.
Renewable energy has become a high profile issue and is a significant resource with many diverse applications. It accounts for 13% of the world's primary energy supply and it is at the energy mainstay of large swathes of the developing world.
Renewable energy is seen by many as a sustainable, environmentally friendly energy for a polluted industrialised world, with rapidly developing new technologies. It is a partial answer to the depletion of fossil fuel reserves. However, renewable energy is not without problems and limitations and the report discusses these as well as its benefits.

- Hydro Power – Large Hydropower (LHP), Small Hydropower (SHP)
- Wind Power
- Geothermal High Temperature Electricity Generation and Low Temperature Heat
- Marine Energy – Tidal Barrage, Wave, Wave or Marine Current, Ocean Thermal Energy Conversion (OTEC), Salinity Gradient
- Solar Photovoltaic
- Solar Thermal - CSP Electricity and Heat Collectors and Pumps, Solar Thermal Cooling
- Hybrids
- Fuel Cells
- Hydrogen
- Biomass - Bioheat, Biofuel (Ethanol, Biodiesel), Biogas (Anaerobic Digestion or Fermentation of Municipal Solid Waste (MSW), Mure/Sewage Sludge, Landfill Gas (LFG),Biodegradable waste), Biopower
- Distributed Generation

The report identifies fundamental issues with the development of these technologies.

- Cost
- Environmental compliance
- Competitive position versus clean coal technology and other
- Resources and feedstocks

Report Scope

- This report pulls the various resources into a coherent picture
- The report is divided into 13 sections, covering each resource in detail
- The contribution and characteristics of each resource are examined
- The status of industrial development is described for each resource
- The mainstream technologies are indentified
- The technologies are explained and new developments outlined
- The technologies cover a spectrum from mature to pioneering status
- The manufacturing industry for each technology is outlined
- Markets are evaluated and those in commercial development are sized
- Historical development is charted and commercialisation is described
- Accessibility of renewable energy sources is explored
- How far off is large scale usage and of which resources?
- The structure of renewable energy markets and industries
- The size of the markets
- The commercialisation of each technology
- Which forms of renewable energy can provide base load power?
- The costs of this energy
- The environmentally friendly renewable energies

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1. OVERVIEW OF RENEWABLE ENERGY

Renewable energy in world primary energy supply

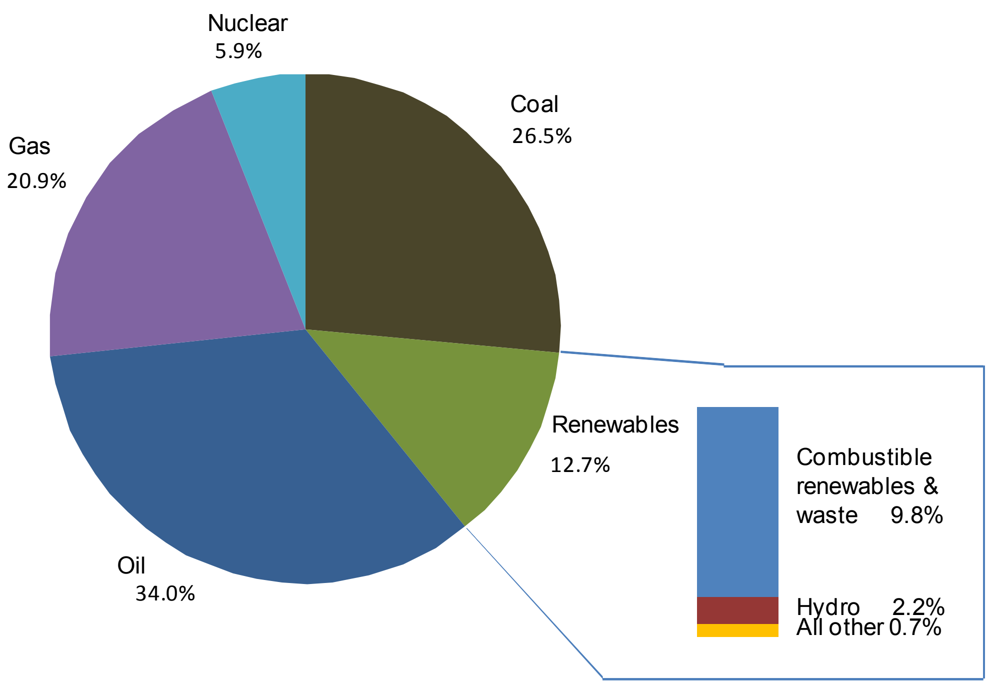
Most energy sources can be consumed in two ways, directly and indirectly when converted to another form of energy. For example, wood can be burned directly as a primary energy source to heat space, or it can be burned to produce heat to generate electricity, a secondary energy source. Likewise, geothermal energy can be used directly as heat for industrial process or bathing, and indirectly to generate electricity. This report examines both uses but focuses mostly on indirect use for generating electricity and to a lesser extent liquid or gas fuels. Some energy sources, such as hydro or wind power are mostly used to generate electricity but they can be used directly, as both sources have been used to raise water for irrigation.

It is important to bear these distinctions in mind because the profiles of primary and secondary use of renewable energy are quite different. For example, renewables account for 14% of global energy supply, after fossil fuels, and biomass and combustible waste account for nearly 80% of primary renewable energy. Most consumption of primary renewable energy is of traditional fuels in developing countries, such as wood or animal dung. However, the generation of electricity, a secondary energy source, presents quite a different picture. Renewables account for 19% of total electricity generation. Hydro power accounts for 90% of renewables' share of electricity production and biomass for only 5%.

TPES – Total Primary Energy Supply

In 2007, renewable energy sources accounted for 12.7% of the 12,029 Mtoe of World Total Primary Energy Supply (TPES). As a primary energy source biomass is a significant resource. CRW (combustible renewables and waste), represents 77% of the total supply of renewable energy, followed by hydro power with a 17% share. Geothermal, wind power and solar photovoltaic energy are small in the overall total but are growing rapidly.

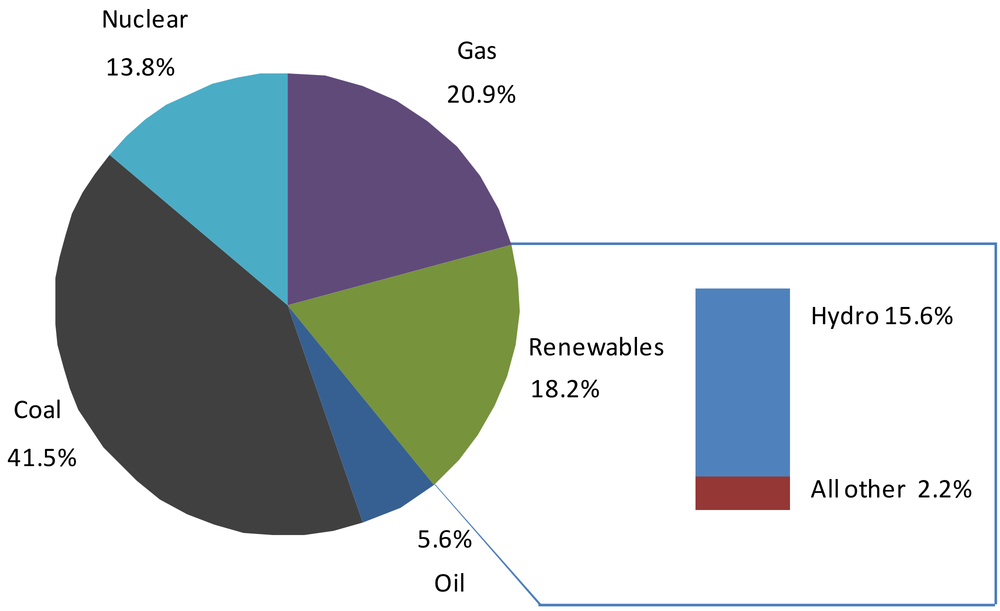
Figure 1.1: Total global primary energy supply 2007



Source: IEA Data

The IEA forecasts that renewable energy supply will grow at 1.3% a year for the next thirty years, slower than the rate of growth of conventional energy and that the share of renewable energy in TPES will decline from 13.4% in 2005 to 12.5% in 2030.

Figure 1.6: Renewables in electricity production 2007



Source: IEA

Types of renewable energy

The traditional forms of renewable energy, such as non-commercial biomass, geothermal heat and water power, have been with mankind since life started. Conversion into secondary energy is relatively new and is escalating now, driven by concern about the depletion of fossil fuel resources and environmental concerns about pollution, climate change and global warming. The different renewable energy sources are in varying stages of development.

Renewables constitute 12.8% of global primary energy supply and hydro is the second largest renewable contributor, accounting for 2.2% of primary energy supply. Biomass is the most significant renewable primary energy source, accounting for 10.0% of the total, with hydro power second but considerably smaller at 2.2%.

Hydro power

Hydro power is a mature generating technology. Although not the largest renewable primary source, which is biomass, hydropower is the largest renewable source of electricity. At 15.6% hydro power currently has a slightly larger share than nuclear power which has 13.8%. Hydro power is the most important renewable energy source for the generation of electricity.

The installed hydro power generating capacity of the world has increased from under 50 GW in 1950 to an estimated 929 GW in 2008. However, the actual measure of what is available, net summer capacity, is predicted at 89% of this, 827 GW.

The theoretical size of worldwide hydropower is about 3,000 GW, four times greater than what has already been exploited. The actual amount of electricity which will ever be generated by hydropower will probably be much lower than the theoretical potential, because of environmental concerns and economic constraints. Hydropower has reached its potential capacity limit in most OECD countries and much of the remaining hydro potential in the world exists in the developing countries of Africa and Asia, and it is considerable in these regions. . In North America 72% of potential has been exploited and in OECD Europe 63%. The highest level of exploitation after that is in Asia, with 45%. The Pacific and non-OECD Europe follow with 25% and 21% respectively. But in the developing countries exploitation ranges from 6-12%, indicating a huge theoretical potential for hydropower development.

Hydro power is commonly divided into three size categories, small-, mid- and large-scale (LHP). The definitions are not fixed but by convention, small-scale usually refers to plants up to 25 MW in capacity. Within the small hydro power (SHP) category are two sub-divisions; mini is usually defined as <500kW and micro < 100 kW.

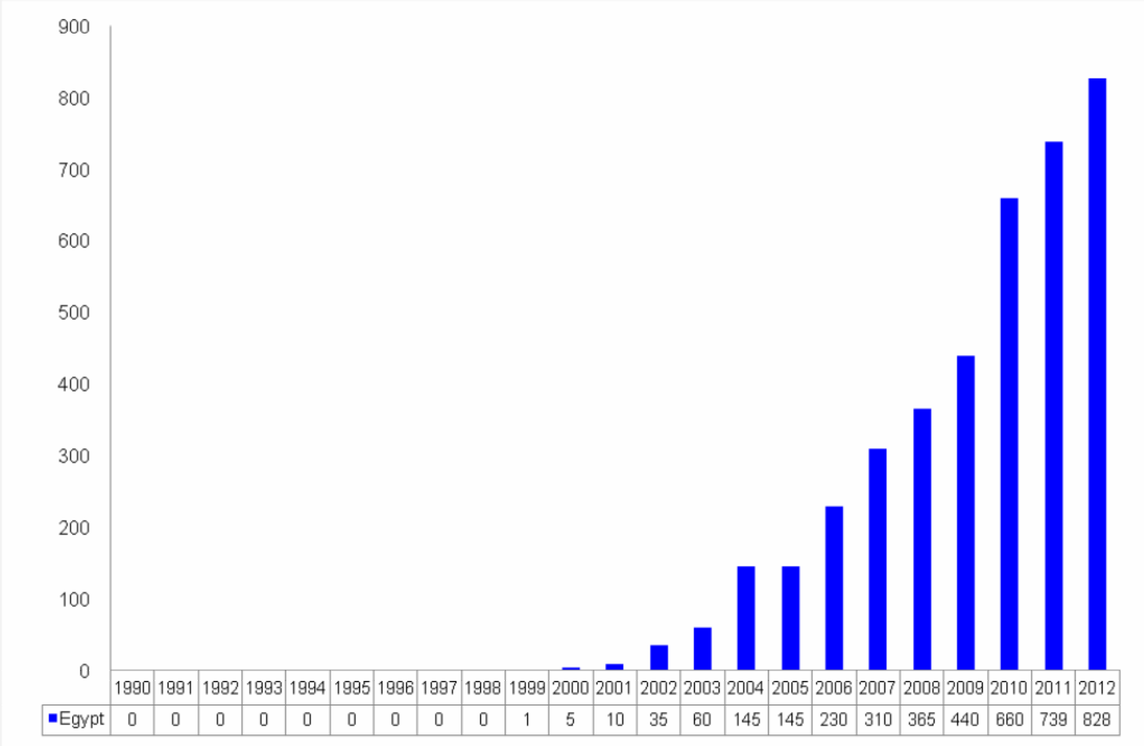
National wind power markets and support plans Intermediate countries – Africa

Egypt

2008 Ranking by cumulative installed capacity: 23rd

Installed capacity in Egypt has reached 365 MW in 2008. Reuters reported in August 2009 that capacity had reached 430 MW, so 2009 forecasts are on target. Strong growth is expected to 2012.

Figure 3.33: Installed wind power capacity in Egypt, MW, 1990-2012



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Egypt	0	0	0	0	0	0	0	0	0	1	5	10	35	60	145	145	230	310	365	440	660	739	828

Source: GWEC

Hurghada 5.2 MW was the first commercial wind farm with 42 turbines of different technologies (2 blades, 3 blades, tubular & rigid towers) and it has been operational since 1993, when it was first connected to the local grid. About 40% of the Hurghada wind farm components were locally manufactured.

The first major wind development is the Zafarana project, located by the Red Sea. The farm has been constructed and operated in stages since 2001, in cooperation with Denmark, Germany and Spain. A partnership with Japn in 2008 added 55 MW, and an additional 75 MW begins operation in 2009. Ultimately Zafarina will have an installed capacity of 545 MW and will be the largest wind farm in Africa and the Middle East.

In 2008 work began on the Gulf of El Zyat wind farm, funded in part by the EU. Completion is scheduled for 2013, when it should be contributing 200 MW to installed capacity.

Government support

In August 2009 the Electricity Ministry announced the allocation of 1.5 million feddans (663,000 hectares) of government land in Upper Egypt for wind farm development. The land is in the provinces of Beni Suef, Minya and Assiut.

Morocco

2008 Ranking by cumulative installed capacity: 28th

In 2008, Morocco nearly doubled its installed wind capacity with 102 MW of new installations, bringing the total to 226 MW.

There are two principal technologies:

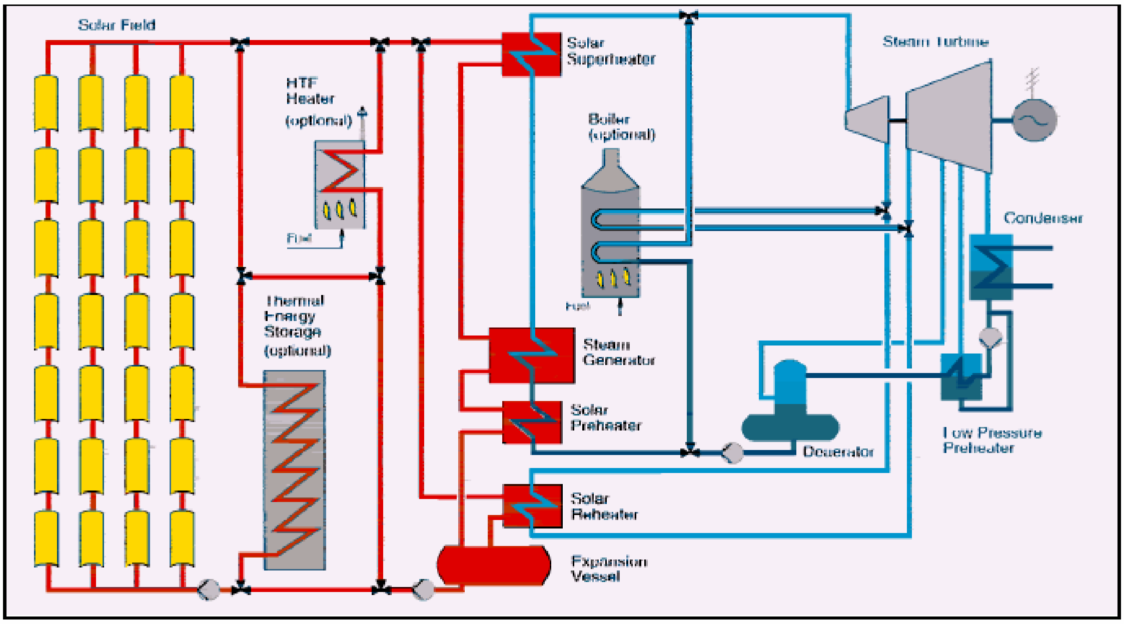
- SEGS (Standard Energy Generating System), Rankine-Cycle STPP
- ISCCS (Integrated Solar Combined-Cycle System) and other hybrid systems.

Originally, all SEGS STPPs were Rankine-cycle systems. Rankine-cycle plants are a mature technology that offers a high solar contribution. Recently, integrating the solar collector system with a gas-fired combined-cycle system has been proposed as a lower cost alternative for generating solar-powered electricity.

Rankine-Cycle Systems

The Rankine-cycle STPP is a steam-based power plant with solar energy as the heat source. The hot collector heat transfer fluid transfers its heat in the heat exchanger to the water/steam. The steam drives the turbine to produce electricity and the spent steam is condensed into water in the condenser. The water is reheated in the heat exchanger and the cycle repeats. Because of the seasonal and daily variation in solar radiation, a Rankine-cycle system can only be expected to operate at full load for approximately 2400 hours annually (25% capacity factor) without the use of thermal storage. In most cases, it makes sense to add a fossil-fuel heater so that the system can operate at full load for more hours. SEGS are usually designed so that the plant can operate at full load on fossil fuel alone. Back-up fuels can be coal, oil, naphtha and natural gas. The number of hours a plant operates will depend on local conditions. In most cases, however, it makes sense to operate this type of plant to meet the daily periods of high demand for electricity (10 to 12 hours per day). Rankine-cycle systems suffer from relatively low efficiencies (whether solar or fossil-fuel powered) and the conversion of heat to electricity has an efficiency of about 40%. If the conversion efficiency from fossil fuel to heat is included, the plant efficiency drops to approximately 35%.

Figure 7.7: Rankine-Cycle STPP



Source: Pilkington Solar International

ISCCS, Integrated Solar Combined Cycle Systems

Conventional combined cycle (CC) power plants are a very attractive configuration where a suitable fossil fuel such as natural gas or fuel oil is available, due to excellent performance, cost and emission characteristics. The CC plant consists of a combustion (gas) turbine (GT), heat recovery steam generator (HRSG) and steam turbine (ST). Fuel is combusted in the gas turbine in the normal way, and the hot exhaust gases pass through the HRSG. Here the energy from the gases generates and superheats steam to be used in the ST bottoming cycle. Hence, the energy in the gas, or other fossil fuel, is used much more efficiently than in a GT alone. Modern cycles can achieve overall thermal-to-electric efficiencies of up to 55%.

Solar energy can be integrated into the second stage of this process. These systems are referred to as Integrated Solar Combined Cycle Systems (ISCCS). ISCCS differ from the Rankine-cycle systems in that the solar components are an add-on to a conventional power plant, sometimes referred to as a

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