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Analiza koncepta energije prihodnosti
Analyzing the concept of future energy

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"You may say I'm a dreamer, but I'm not the only one."

"Imagine", John Lennon, 1971

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Analyzing the concept of future energy

SUMMARY

Societies around the world are faced with many diverse problems today. There is no single solution for these problems. Because of different geographical positions and diverse natural resources, every nation needs its own energy policy. To establish the most effective energy policy, governments need to be familiar with the energy technologies available on the market. Some of them are already commercially available, some are in the process of becoming available, and some have the potential to become available if scientists and developers have more financial resources. The purpose of my thesis is to analyze the factors that influence policies that concern the energy sector and to search for possible solutions.

The first part examines energy technologies that have shaped our past and present, and new technologies that have the potential to influence our energy future. I describe the basic characteristics of conventional technologies, alternative technologies and new technologies that have not been fully developed for commercial use yet but have the potential to become commercially available in the future.

The second part examines public policies and those sections of society that most often affect government action. Those sections include the business, lobbyists, the scientific community, innovators, and the interested public. Some of the mechanisms that governments worldwide use when they are trying to support the development of alternative energy sources are shown.

If governments invested in and financed the research and development of alternative and new energy sources, humanity would obtain access to clean, cheap, decentralized, and safe technologies that would bring a brighter future. To achieve that goal, politicians and those who have influence should become more responsible to people they govern.

Key words: technology, policy, conventional energy, alternative energy, new energy

Analiza koncepta energije prihodnosti

POVZETEK

Družbe po svetu se danes soočajo z množico različnih problemov. Za vse te probleme ne obstaja ena sama rešitev. Zaradi različne geografske lege in raznolikosti naravnih virov potrebuje vsaka država svojo energetsko politiko. Da bi vlade vzpostavile najučinkovitejšo energetsko politiko, morajo biti seznanjene s tehnologijami, ki so dostopne na trgu. Nekatere tehnologije so že komercialno dostopne, druge so v procesu, da postanejo dostopne, tretje pa imajo potencial, da postanejo dostopne, če bi znanstveniki in razvojniki imeli več finančnih sredstev. Namen moje magistrske naloge je analizirati oba sklopa, ki vplivata na politike energetskega sektorja ter iskanje možnih rešitev.

Prvi del naloge raziskuje tehnologije, ki so oblikovale našo preteklost in sedanjost ter nove tehnologije, ki imajo potencial, da vplivajo na našo energetsko prihodnost. Opisala sem osnovne značilnosti konvencionalnih tehnologij, alternativnih tehnologij in novih tehnologij, ki še niso v celoti razvite za komercialno uporabo, vendar imajo potencial, da bi v prihodnosti postale komercialno dostopne.

Drugi del naloge raziskuje javne politike in tiste dele družbe, ki so z vlado najbolj pogosto v interakciji. Ti deli družbe vključujejo poslovneže, lobije, znanost, inovatorje in zainteresirano javnost. Prikazala sem nekatere mehanizme, ki jih uporabljajo vlade po vsem svetu, ko želijo podpreti razvoj alternativnih energetskih virov.

Če bi vlade investirale v raziskovanje in razvoj alternativnih in novih energetskih virov in ju financirale, bi človeštvo dobilo dostop do čistih, poceni, decentraliziranih in varnih tehnologij, ki bi prinesle svetlejšo prihodnost. Da bi dosegli ta cilj, bi morali politiki in vsi tisti, ki imajo vpliv, postati bolj altruistični in moralno odgovorni ljudem, katerim vladajo.

Ključne besede: tehnologija, politike, konvencionalna energija, alternativna energija, nova energija

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LIST OF ABBREVIATIONS AND ACRONYMS

ABS – Independent Energy Market Research Company

ADEME - French Agency for Environment and Energy Management

AFC – alkaline fuel cell

ART – advanced renewable tariff

a-Si – amorphous silicon

a-Si/μc-Si – multi-junction silicon

BWR – boiling water reactor

CAFTA – Central America Free Trade Agreement

CANR – chemically assisted nuclear reactions

CDM – clean development mechanism

CdTe – cadmium telluride

CE – current era

CFCs – chlorofluorocarbons

CH_4 – methane

CHP – combined heat and power

CIGS – copper, indium, gallium, (di)selenide/(di)sulphide

CIS – copper, indium, (di)selenide/(di)sulphide

CMNS – condensed matter nuclear science

CO_2 – carbon dioxide

CPV – concentrator photovoltaics

c-Si – crystalline silicon

CSP – central solar power system

CTE – technical buildings code

D_2O – heavy water

DC – direct current

DMFC – direct methanol fuel cell

DSSC – dye-sensitized solar cells

EEG – German feed-in law

EGS – enhanced geothermal systems

EPR – European pressurized reactor

ERD&D – energy research, development, and demonstration

ETI – energy technology innovation

FAME – fatty acid methyl ester

FBR – fast breeder reactor

FIS – financial incentive schemes

FIT – feed-in tariff

GaAs – gallium arsenide

GCR – gas-cooled reactor

GHG – greenhouse gases

GW – gigawatt

GWP – global warming potential

H_2O – water

HAWT – horizontal axis turbine

HCFC – hydrochlorofluorocarbon

HCl – hydrochloric acid

HFC – hydrofluorocarbon

ICCF – International Conference on Cold Fusion

IGCC – integrated gasification combined-cycle

ITC – investment tax credit

ITER - International Thermonuclear Experimental Reactor

kW – kilowatt

kWh – kilowatt hour

LANR – lattice assisted nuclear reactions

LENR – low energy nuclear reactions

LWGR – light-water graphite reactor

MCFC – molten carbonate fuel cell

mc-Si – mono crystalline

MSP – market incentive program

MTPV – Micron-gap Thermal Photovoltaics

MW – megawatt

N_2O – nitrous oxide

NASA – National Aeronautics and Space Administration

NEPA- National Environmental Policy Act

NF_3 – nitrous trifluoride

NGO – non-governmental organization

NO_x – nitrogen oxides

OECD – Organization for Economic Cooperation and Development

OPEC – Organization of Petroleum Exporting Countries

OPV – organic photovoltaics

OTEC – ocean thermal energy conversion

PAFC – phosphoric acid fuel cell

pc-Si – polycrystalline or multi crystalline

PEMFC – proton electrolyte membrane fuel cell

PFC – perchlorofluorocarbon

PHWR – pressurized heavy-water reactor

PR – public relations

PTC – production tax credits

PURPA – Public Utility Regulatory Policies Act

PV – photovoltaics

PWR – pressurized water reactor

R&D – research and development

REC – renewable energy credit

REP – renewable energy payments

RES – renewable energy sources

RET – renewable energy technology

RME – rapeseed methyl ester

ROC – renewables obligation certificate

RPS – renewable portfolio standard

SBC – system benefits charges

SEG – Searl effect generator

SF_6 – sulfur hexafluoride

SHP – small-scale hydropower

SO_2 – sulfur dioxide

SOFC – solid-oxide fuel cell

TGC – tradable green certificates

TiO_2 - titanium dioxide

TPV – thermo-photovoltaics

TWh – terawatt hour

UNFCCC - United Nations Framework Convention on Climate Change

VAWT – vertical axis turbine

VIVACE – vortex induced vibration for aquatic clean energy

ZPE – zero point energy

μc-Si – micro-crystalline silicon

1 INTRODUCTION

Humanity is facing economic and social crises, poverty, wars, disease and environmental problems. Environmental problems encompass global warming, polluted air, melting glaciers, rising oceans, extreme weather conditions, such as hurricanes, stronger precipitation, floods, longer dry periods without rain and others. All these problems are related to our energy usage. Our conventional energy sources are mostly to blame for greenhouse gases, environmental damage, health problems, and conflicts among countries. Traditional energy interests have disproportionate control over energy and environmental policy making. Where particular energy sources are geographically placed and how countries have access to them are also important.

Environmental issues became the focus of my attention a few years ago. I became aware of the fact that if someone wants to do something positive and supportive for the environment, and consequently for humanity and nature, he or she needs to take a stand and become an active member of society and therefore needs to become familiar with energy issues.

That is why in the first part I introduce a list of the energy sources we use today and their impact on the environment, and the energy sources that could replace them without harmful effect. Because it is unlikely that alternative energy sources will meet expected demand levels (O`Keefe, O`Brien, and Pearsall 2010), I try to show that new energy sources, such as cold fusion and zero-point energy have the potential to solve our problems and can help us to build a sustainable future.

In the second part I try to show current issues and policies around the world, with special emphasis on the US Government policy makers, the interest group system with lobbying, business groups and the interested public. Situations are created where a particular energy technology becomes commercially available and widely used or is being left with no attention, no financial support or even suppressed and kept as a secret as a supposed detriment to the national security. To show what kind of policies and strategies are successful, some policy support mechanisms in different countries around the world are shown. Some future policy considerations that could improve our problems with energy are outlined as well.

2 CLASSIC SOURCES OF ENERGY

Coal, oil, natural gas and nuclear are the fuels we encounter most often. Essentially, 83 percent of the world's energy is produced from fossil fuels and nuclear energy (REN21 2012).

2.1 COAL

Coal is a stratified sedimentary rock composed of organic and inorganic material. The organic material consists of more than 50 percent carbon, and small amounts of hydrogen, nitrogen, and oxygen; the inorganic content includes minerals. Coal may also contain sulfur, arsenic, beryllium, cadmium, mercury, uranium, thorium, and asbestos. Ninety percent of the world's reserves of coal have been formed from peat, which is formed from the deposition of dead organic material. For coal to be formed, peat has to be buried and preserved in an oxygen-poor environment (Ngo and Natowitz 2009). Lignite, subbituminous, bituminous, and anthracite are types of coal, the last of which is the highest-quality coal (Asmus 2009).

2.1.1 Basics of the Technology

The most common ways of removing coal are a continuous mining machine with a large rotating heads that rips into a seam of coal, a machine that cuts out a section of it for blasting, and a rotating shear that cuts it (Image 2.1). Large gathering arms or loaders scoop the coal into shuttle cars or built-in conveyors for the trip to the surface. Surface mining is another popular method. Once extracted, coal is then shipped by rail or barge, or mixed with water and sent through pipelines to power plants. The coal in power plants is then pulverized into a fine powder and blown into the combustion chamber of a boiler, where is burned. This transforms the water in tubes lining the boiler into high-pressure steam, which drives a turbine (Nersesian 2010). More than 90 percent of coal-fired power plants use pulverized coal combustion technology; this method has been in use for more than 60 years. In optimal conditions, up to 41 percent of input energy efficiency can be obtained (Ngo and Natowitz 2009).

Image 2.1: Mining

Source: Sharma.

There are several technologies for using coal. Besides pulverized coal combustion, there are also pressurized fluidized-bed combustion, combined heat and power generation, direct coal liquefaction, coal-to-liquid technologies, and the cleaner technologies listed below.

Pressurized fluidized-bed combustion uses high-ash coal or low-grade coal; the thermal efficiency is 40 percent. In combined heat and power generation, electricity and heat are produced simultaneously. Direct coal liquefaction uses bituminous and subbituminous coal. This process needs hydrogen, which is provided by coal gasification or by steam reforming of natural gas; the resulting products are diesel oil, naphtha and liquefied petroleum gas (Ngo and Natowitz 2009). In coal-to-liquid plants, the coal is first liquefactioned into a solvent and later turned into naphtha, diesel fuel and liquefied petroleum gas (Nersesian 2010).

2.1.1.1 Clean-Coal Technologies

Clean-coal technologies remove 99 percent of the ash, 97 percent of the sulfur oxide emissions, 82 percent of the nitrous oxide emissions, and 50 percent of the mercury. The average OECD efficiency of the thermal plants is 38 percent. Efficiency is essential, because the greater the efficiency, the less coal has to be burned to generate the same amount of electricity (Nersesian 2010).

Cleaner technologies use fluidized-bed combustion at atmospheric pressure, the integrated gasification combined-cycle (IGCC), and indirect coal liquefaction. Fluidized-bed combustion at atmospheric pressure is useful for burning low-grade coal at temperatures up to 950°C, which leads to reduced nitrogen oxides (NO_x) emissions; its thermal efficiency is 30 percent. IGCC is able to produce electricity with high efficiency and lower emissions, and can burn many fuels, including biomass. Indirect coal liquefaction uses the Fischer-Tropsch coal-to-liquid method. It can also use coals such as lignite and biomass and can provide pure diesel fuel (Ngo and Natowitz 2009).

2.1.2 Historical Development

In 1000 BCE, China became the first country to start to using coal instead of wood, and in 1275, Marco Polo, after exploring these, introduced coal to the West.
In the early 1700s, Thomas Savery invented the first steam engine, the use of which caused coal to become the dominant source of energy in Europe. Later, in 1769, James Watt patented a more efficient steam engine, used in the invention of the locomotive, thus creating even more demand for coal (Smith and Taylor 2008). Nevertheless, in 1850, biomass still provided 90 percent of the world's energy, with coal account for the remaining 10 percent.
In the early 1940s, the Second World War compelled Germans to transform coal to petroleum via the Fischer-Tropsch process.
By 2010, 26 percent of the world's energy was produced from coal (Nersesian 2010).

2.1.3 Environmental Impact

The burning of coal can have devastating effects on the environment. Sulfur dioxide (SO_2) and nitrogen oxide (NO_x) cause acid rain and smog, which lead to health problems (Cipiti 2007). Carbon dioxide (CO_2) is released, and there are also mercury, arsenic and selenium emissions (Nersesian 2010). Coal mining is an extremely dangerous activity due to the high risk of explosions, cave-ins and methane (CH_4) leaks (Ngo and Natowitz 2009).

2.1.4 Advantages:

- low and stable price,
- contributes to energy security, because it is domestic fuel in many nations,
- improved mining and technologies could extend nations' reserves,

- gasified coal yields a mixture of hydrogen and carbon monoxide, which can be transformed into higher quality methane, synthetic gasoline or diesel fuel, waxes, and alcohols (Asmus 2009, Nersesian 2010).

2.1.5 Disadvantages:

- it is the dirtiest of all fossil fuels and its combustion causes global warming,
- when coal is burned, mercury, arsenic, selenium are released,
- nitrous oxides, which contribute to smog, and sulfur oxide, droplets of which collect on clouds, which reduces the amount of sunshine reaching the earth, and return to Earth in the form of acid rain,
- coal-to-liquid technology produces large emissions of carbon dioxide,
- pollution control for sulfur dioxide is extremely expensive,
- impacts of mining can damage ecosystems and cause health issues,
- surface mining causes dust and noise,
- valley fills of surface mining can become dams creating contaminated ponds of acid runoff from sulfur-bearing rocks, copper, lead, mercury, and arsenic,
- abandoned underground mines, eventually filled with water, can contain dangerously high concentrations of acids and metallic compounds, which can contaminate drinking water,
- mine workers in some countries that invest relatively little in protecting workers' health, are faced with the loss of hearing, black lung disease, dental and skeletal fluorosis and arsenic poisoning,
- abandoned coal mines can catch fire, burn underground and vent poisonous gases,
- transportation of coal is expensive, and the price increases with the distance between the place of production and the place of use (Asmus 2009, Ngo and Natowitz 2009, Nersesian 2010).

2.2 HYDRO

Moving water contains energy, which can be exploited and used for power generation. Hydropower is a major energy source employed to produce electricity. It produces 20 percent of all the electricity in the world (Ngo and Natowitz 2009).

2.2.1 Basics of the Technology

Today, a standard hydropower system includes a dam, water reservoir, and a penstock (Image 2.2). Water is passed through the turbine, which converts the water's energy into electricity (Craddock 2008). Electricity can also be generated without dams. The run of the river, or diversion system, is the system in which the diverted part of the water, running through the turbine generators, is dependent upon natural river flows. The least common system is the pumped storage system, which pumps water from a lower to an upper reservoir during low electricity demand. During periods of high electricity demand, the water is released back down to the lower reservoir (Asmus 2009).

Image 2.2: Dam

Source: California Energy Commission (1994-2013)

The dam is used to concentrate the water flowing from the river, to raise the level of the river, and to create falling water. Dams can rest on the ground or can be built into the banks of the river. The difference between the upstream part of the dam and the downstream part is called the "head". The head and the flow rate of water are the relevant parameters of a hydropower site. Depending the site and the technology, the yield factor between the reservoir potential energy and the electricity output is up to 80 percent. A high head reservoir with a small flow or a low head with a large flow can have the same output. For high heads (higher than 250–400m) and small flow rate (smaller than $1m^3/s$), impulse turbines are usually used. In impulse turbines, jets of pressurized water impinge on vanes located on the perimeter of a wheel, which operates in the air. For intermediate heads (10–100m) and medium flow rates (1–100m³/s), reaction turbines are mainly used. The reaction turbine is put inside a housing allowing a continuous pressure against the blades. Water enters radially and leaves axially in parallel to the shaft, which rotates the generator. For small heads (smaller than 10m) and high flow rates (larger than 10–100m³/s) axial flow turbines are used. They look similar to boat propellers. A propeller has up to six blades over which water flows. Blades rotate fast even the water velocity is small (Ngo and Natowitz 2009).

2.2.1.1 Turbines

A Pelton turbine (Image 2.3) is a wheel mounted with a set of double cups around its rim. When water forms under a high head's pressure, it hits the edge between every pair of cups as the wheel continues to turn. The water then makes its way past the curved bowls. A remarkably small percentage of the water's original kinetic energy still remains in the water. The Francis turbine (Image 2.4) channels water through a volute, a scroll-shaped tube that diminishes in size while wrapping around itself. The volute forces water to run toward the runner. As water crosses the blades, it is deflected sideways in the direction of the axis, then to the central draft tube, and then to the tail race. The effect of the water being deflected is its force that keeps the rotation going strong. A Kaplan turbine (Image 2.5) is a propeller-type turbine that permits a high rate of rotation, despite low water speeds. The speed of the blades is almost twice as fast as the speed of water (Craddock 2008).

Image 2.3: Pelton Turbine

Source: CINK (2013).

Image 2.4: Francis Turbine

Source: CINK (2013).

Image 2.5: Kaplan Turbine

Source: Electropaedia (2005).

2.2.2 Historical Development

Some believe that the use of water for energy production began 5000 year ago. Our ancestors used water for grinding grain. The Western world started to use water mills 85 BCE. In 1775, the US started to design and construct hundreds of hydroelectric projects. In 1827, a Frenchman, Benoit Fourneyron, created the water turbine, which was the first successful upgrade of water wheels and water mills.

There was a wave of development in the United States. In 1879, the first electricity was generated by water power, lighting 16 lamps. In 1882, the first hydroelectric power plant provided 12.5 kilowatts of power for two paper mills and a home. In 1889, the first hydroelectric power plant generated electricity for use over a long distance. In 1896, the first hydroelectric plant using storage batteries began operating, making it possible to store energy power that would have gone to waste during periods of low demand. In 1898, the first underground hydroelectric plant was built. In 1909, the first dam was built. In 1927, the first hydroelectric plant to use water from a reservoir was built. In 1943, the Hoover Dam produced a million kilowatts of electricity.

More recently, in 1994 China constructed the largest hydroelectric dam (Smith and Taylor 2008).

2.2.3 Environmental Impact

The construction of a water power system can harm the surrounding ecosystem. Construction of a dam causes emissions, dust, noise, accidents, the river habitat is replaced by a lake habitat, people have to be relocated, some fish that cannot travel the river start to decrease and so on (Ngo and Natowitz 2009).

The surface water can become warmer, which lowers its oxygen content and harms some species. Sediment builds up in reservoirs. Leached metals from rocks can pollute reservoirs (Craddock 2008).

The decay of vegetation under water releases high amounts of methane gas (Cipiti 2007).

2.2.4 Advantages:

- no carbon dioxide (CO_2) emissions are produced using hydropower for electricity production,
- dams can last for approximately a century,
- hydropower plants are often the lowest-cost resources,
- there are zero fuel costs,
- there are low maintenance requirements (Asmus 2009, Ngo and Natowitz 2009).

2.2.5 Disadvantages:

- during dam construction, emissions, dust, noise and accidents occur,
- dams cause sediment disturbance, have impact on water quality, the river habitat is replaced by a lake habitat, people have to relocate, the habitat of animals can be destroyed,
- dam construction can destroy archaeological sites and affect archaeological tourism, which plays an important role in economic development and has profound effects on the region's economy (Shoup 2006, Ngo and Natowitz 2009).

2.3 OIL

Ocean plankton, algae, and other forms of plant and animal dead matter sank into oxygen-free waters, which prevented further decay. When buried by new layers of sediment, water is squeezed out and over millions of years the dead matter is transformed into oil. Being lighter than water, oil begins to migrate laterally and vertically through rock layers.

The type of organism, its concentration, depth of burial, and the nature of the surrounding properties define the properties of oil. Commercial crude is a mix of oil from different oil fields with similar properties. The most highly valued crudes are naphthenic, light, sweet crude (Nersesian 2010).

Petroleum is formed from a great number of different types of hydrocarbons. The carbon atoms in hydrocarbon molecules serves as a carrier for hydrogen. During combustion, the same carbon atoms are emitted into the atmosphere.

Crude oil comes in a large number of hues and consistencies: yellow, green, brown and waxy, thick, slight, fluid (Asmus 2009).

2.3.1 Basics of the Technology

Finding hydrocarbons is not easy. Before a well is drilled, explorations start with extensive geophysical surveys (Ngo and Natowitz 2009).

Geologists examine the land and search for three necessary conditions for oil: source rock to generate petroleum, migratory rock through which petroleum moves toward the earth's surface, and reservoir rock where there is an impediment preventing further migration. Once an oil field has been discovered, the development phase begins with the drilling of appraisal wells to measure the extent of an oil field. Drilling onshore or offshore is similar (Image 2.6). If the amount of oil in the reservoir is sufficient, the process starts with preparing a well for casing, which prevents the sides from caving in and protecting freshwater aquifers near the surface. The primary forces that push oil toward the bottom of the well are the pressure differential between the oil within the reservoir rock and the pressure at the bottom of the well. Maintaining reservoir pressure and promoting oil recovery involve injecting water or natural gas. Most wells produce a mixture of oil, saltwater, and natural gas. Once separated, oil is pumped to a staging area and then through collecting pipelines to larger capacity pipelines that connect to refineries or oil export terminals. Tanker trucks complete the movement to wholesalers and retailers.

Refining is the process of transforming oil into different products by separating, altering, and blending various hydrocarbon molecules. Useful products of the refining process, besides gasoline for cars, fuel for heaters, jet fuel, also include plastic objects, such as blood sample vials, gowns for patients and medical personnel, bedding, gloves, plastic packaging, plastic bags, containers, flooring, antifreeze, paints, adhesives, polyester for textiles, upholstery for furniture, polyurethane foams, polyester resins, protective coatings, film, adhesive for plywood, tires, rubber goods, nylon, detergents, fiberglass, herbicides, pesticides and others (Nersesian 2010).

Image 2.6: Oil Platform

Source: Scrape TV (2010).

2.3.2 Nonconventional Oil

A nonconventional source of oil is synthetic crude, or syncrude. It must be processed to produce an acceptable grade of crude oil before it can be fed into conventional refineries. The greatest nonconventional sources of synthetic crude are bitumen deposits. Syncrude can be made from oil sands or oil shale (Nersesian 2010). Oil shale is a fine-graded sedimentary rock containing a large amount of kerogen. Oil sands are a mixture of sand or clay, water, and extremely heavy crude oil (Ngo and Natowitz 2009).

2.3.3 Tar Sands

Tar sands, also called oil sands or bituminous sands, are mixtures of clay, sand, water and bitumen, a heavy black thick oil. The bitumen in tar sands is not pumped from the ground in its natural state, but is mined, usually using strip mining or open pit techniques, or using the application of steam injection. Bitumen must be separated from the clay, sand and water to be refined to oil. Almost two tons of tar sands are required to produce one barrel of oil. The largest deposits of tar sands in the world are found in Alberta, Canada (OSTS PEIS 2012).

The Alberta oil sands are a highly polluting source of oil. Massive amounts of carbon are released from tar sand burning and deforestation. The production of oil from tar sands emits three times the level of greenhouse gases as conventional oil. It requires excessive amounts of energy and fresh water, and destroys huge parts of ancient boreal forest land, severely impacting their indigenous inhabitants (Image 2.7) (Water Conserve 2012).

Image 2.7: Before and After

Source: Water Conserve (2012).

2.3.4 Historical Development

Five thousand years ago, bitumen (also called asphalt), used for construction of roads and for roofing material, was of major importance in the Mesopotamian civilization. In the 5th century BC, Persians used burning oil as a weapon against the Greeks. Later, also in antiquity, petroleum's main use was as a medicine or a liniment (Ngo and Natowitz 2009). In 1859, Edwin Drake struck oil in Pennsylvania, which became the site of the first commercially productive oil well. Oil became used mainly in the form of kerosene, important for lightning. In 1890, the mass production of automobiles increased demand for oil. In 1934, the first international oil pipeline from Iraq to Syria was completed (Smith and Taylor 2008). Today, 31 percent of the world's energy is produced from oil (Nersesian 2010).

2.3.5 Environmental Impact

The use of oil has several impacts on the environment. Carbon dioxide (CO_2), sulfur dioxide (SO_2) and nitrogen oxides (NO_x) are emitted during combustion. Leakage of oil is also an environmental concern. Pollution is frequently a result of a released used engine oil and routine ship maintenance. Oil spills represent 5% of the oil pollution in the oceans (Ngo and Natowitz 2009). As a result of tanker incidents, in last 40 years almost six million tons of oil has been lost in the ocean (ITOPF 2012, 6).

2.3.6 Advantages:

- it is a versatile resource, which can be used for different products with energy and non-energy applications,
- it is distributed throughout the globe,
- it provides revenues to many governments,
- it represents the largest item in the balance of payments and exchanges between nations,
- service and maintenance infrastructure is widespread and mature (Asmus 2009).

2.3.7 Disadvantages:

- wealth and power are concentrated in large multinational firms,
- oil is concentrated in countries with unstable governments,
- combustion of oil products causes global warming,

- gasoline, kerosene and diesel are toxic, flammable and dirty,
- extraction and development can impose severe impacts on local communities and ecosystems,
- nonconventional oil techniques require large amounts of water and energy, which can have an environmental impact on streams, springs and wells,
- crushed rock residue from oil shale present significant disposal problem
- the relentless global pursuit of oil has caused strenghtening of some undemocratic regimes (Campbell and Price 2008, Asmus 2009, Ngo and Natowitz 2009).

2.4 GAS

Natural gas is formed primarily of methane (up to 90 percent), ethane, propane, butane, heavier hydrocarbons, and impurities such as hydrogen sulfide, carbon dioxide, nitrogen, and water (Nersesian 2010).

2.4.1 Basics of the Technology

Natural gas can be transported from the producing wells by pipelines or in liquid form. Pipelines are less expensive for transportation over distances less than 3000 km. As a liquid, natural gas takes up 600 times less volume than at normal temperature and pressure. Specially built tanks are used for transportation, because natural gas becomes liquid below -161°C (Ngo and Natowitz 2009).

Natural gas can be used as a fuel in conventional steam generators, combustion turbines, and combined-cycle plants (Image 2.8). Natural gas burned in a steam generator produces steam that passes through a turbine that drives a generator. Efficiency is up to 40 percent. The remaining energy passes to the environment as the latent heat of vaporization. Combustion turbines are jet engines attached to turbines to generate electricity. They have high operating costs. A combined-cycle plant directs the exhaust gases from a combustion turbine through a steam generator; the steam drives an electricity-generating turbine. Efficiency is up to 50 percent (Nersesian 2010).

Natural gas can also be used in fuel cell technologies that rely upon chemical reactions, whose by-products are water, carbon dioxide (CO_2), and electricity (Asmus 2009).

Image 2.8: Gas Plant

Source: Bates Chemical.

2.4.2 Historical Development

In 1003, the first use of gas was in China, where they drilled natural gas wells and used bamboo pipes to vent the gas (Smith and Taylor 2008). In Europe, some scientists used natural gas for lightning and for inflating hot-air balloons. At the beginning of the 19th century, in the US, gas was used mostly as a fuel for lamps. Later, in 1870 the first gas pipeline was built, first from pine trees, and two years later from metal (Ngo and Natowitz 2009). In 1885, Robert Bunsen developed a burner that mixed air and natural gas, which was used to produce heat for warming buildings and cooking. The development of long-distance pipeline transmission was important in natural gas becoming a commercial energy resource. Today, 22 percent of the world's energy is produced from natural gas (Nersesian 2010).

2.4.3 Environmental Impact

Carbon dioxide (CO_2) and nitrogen oxides (NO_x) are emitted during combustion. Burning natural gas emits as much as 50% less carbon dioxide than coal and as much as 30% less carbon dioxide than oil, but the leakage during transport and utilization of natural gas corresponds to a release of about 25-50 Mt of methane (CH_4) per year into the atmosphere. This fact is very important, because methane (CH_4) is about 25 times more efficient than carbon dioxide as a greenhouse (IPCC 2007b). Emissions of sulfur dioxide (SO_2) and nitrogen oxides are lower than those for coal and oil, but are still significant. Accidents in a drilling well can result in a release of methane and hydrogen sulfide (H_2S). Explosions are also very dangerous, carrying the risk of injury or death for nearby people (Ngo and Natowitz 2009).

2.4.4 Advantages:

- it is the cleanest fossil fuel,
- gas is abundant globally,
- technology offers a good fit for nonstop or peak demand applications,
- it can be installed on-site or in central power station modes,
- power plants do not require fuel storage space,
- power plants do not produce significant amounts of solid waste,
- small combustion turbines do not use significant quantities of water (Asmus 2009).

2.4.5 Disadvantages:

- exploring and drilling for natural gas can damage ecosystem, release toxic substances, and radioactive materials,
- combustion produces emissions of nitrogen oxides, carbon monoxide, methane,
- gas-fired power plants can consume significant quantities of water,
- reserves of natural gas are finite (Asmus 2009).

2.4.6 Hydraulic Fracturing

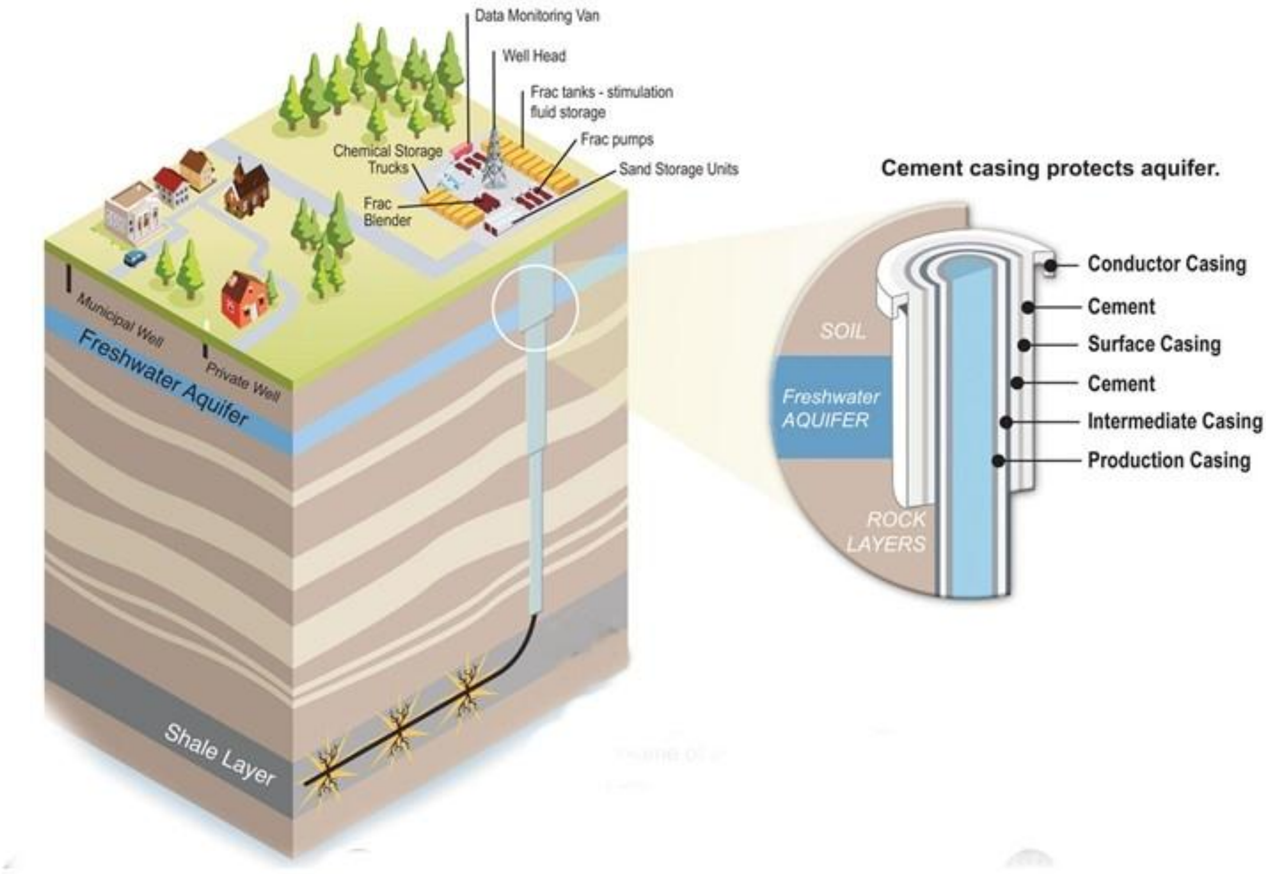
Hydraulic fracturing, called also fracking, is a process used to extract underground resources, such as oil, natural gas, geothermal energy, and even water (EPA 2012). In the United States over 90 percent of the wells drilled use the hydraulic fracturing process to extract natural gas (Groundwork 2011).

2.4.6.1 Basics of the Technology

Fracking can access energy deposits, such as oil and gas, by forcing large quantities of water and sand and chemicals into the wells at extremely high pressure in order to create small cracks, or fractures and release the trapped oil or gas to the surface, where it is captured (NRDC 2012). Each fracturing is custom designed depending on geology, depth, and resources available. The chemicals and products used differ from well to well (TEDX 2007).

The process (Image 2.9) begins with drilling a borehole that is surrounded with protective steel chasing and additional cement casing at ground water levels. The borehole is drilled down to the shale layer to about 2400 meters below the surface. The pipe can be bent and moved horizontally below the ground for another 600 meters (Democracy Now 2010).

Image 2.9: Hydraulic Fracturing



Source: Watershed Council.

The perforating tools are then guided down the borehole carrying conductors, which emit a shock wave and create fractures or fissures into the shale layer. Once the fissures are created, the perforating tools are brought to the surface. Water and sand are then blended with additives and injected into the borehole. The pressure caused by the water and proppant increases size of the fissures. Therefore, the fluids transport the proppant and open the fracture. The most commonly used proppants are silica sands. The largest liquid component (besides water) is hydrochloric acid (HCl) (Spellman 2013).

Most of the water and sand is then removed and stored in the storage reservoir; a small amount of proppant is left behind and holds fissures open. Open fissures allow natural gas to flow towards the surface, where is collected in reservoirs and pumped into container trucks (YouTube 2011b).

2.4.6.2 Historical Development

Since the early-to-mid-19th century until the late 1940s, the oil and gas industry used explosive fracturing to stimulate well production. Explosive fracturing, also called well shooting, consisted of a tin cylinder with liquid nitrogen, which detonated and opened the well to the reservoir. In the 1930s, hydraulic fracturing was a supplemental process used to crack rock formation and increase the effectiveness of the acid. The first well hydraulically fractured was in Kansas in 1947, where 1000 gallons of a gasoline-based napalm gel fracturing fluid were pumped under pressure into the well. During the time, the frac fluid changed. In the 1950s it was gelled oil, while in the 1960s it was linear-gelled water. In the 1970s and early 1980s, the first attempts were being made to access shale gas reserves, using light-sand frac with chemicals. In 1992, in Texas, the first well was drilled horizontally (CAEPLA 2011-2012).

2.4.6.3 Environmental Impact

Hydraulic fracturing is currently taking place without sufficient safeguards, under outdated regulations and inadequate enforcement (NRDC 2012). The majority of chemicals have never been tested at realistic, environmentally relevant, chronic exposure levels. There is not enough data to determine the safety of products that contain unknown chemicals (TEDX 2007). Even though the fracking fluid is composed of 99% sand and water and only 1% of chemical additives (EFD 2012), that 1% is more than 10,000 gallons of chemicals on some fracturing sites that (Lustgarten 2008). In the United States, the 14 leading oil and gas service companies used more than 780 million gallons of fracturing products that contain 750 different chemicals, ranging from harmless and common substances to extremely toxic, listed as hazardous air pollutants and possible human carcinogens (Committee on Energy & Commerce 2011).

In the United States, the hydraulic fracturing is exempt from regulation under the Safe Drinking Water Act, which leaves the American public in ignorance about what the industry is injecting into their land (Democracy Now 2010).

In 2011, France banned hydraulic fracturing after public pressure (Patel 2011). Cantabria became the first region in Spain to ban fracking. People became aware of the dangers of fracking following year-long anti-fracking campaign (Hierro 2013).

2.4.6.4 **Advantages**:

- newly identified gas reserves offer the nation an opportunity to reduce reliance of foreign fuel imports,
- burning gas emits 23 percent less carbon dioxide than burning oil (Lustgarten 2008, YouTube 2011b).

2.4.6.5 **Disadvantages**:

- aquifers can be contaminated by cement channeling and insufficient cement coverage, and leak through casing that starts to corrode over time due to exposure to moisture and chemicals,
- injected fracturing fluids that remain in the ground can be transported by groundwater and therefore can affect water supply of millions,
- the contamination can be also occurred on the surface, where leaky tanks, trucks and waste pits allowed benzene and other chemicals to leach into streams, springs, and water wells,
- the top four health effects are skin and sensory organ, gastrointestinal and liver respiratory, and neurological system damage,
- erosion and runoff from drilling operations can destroy aquatic habitats,
- wastewater that includes fracturing fluids and is misted into the air for evaporation can causes animals stop delivering healthy calves, go sterile, stop going into heat, or have a rash of inexplicable still births,
- some water wells contain so much flammable gas that they could explode,
- in the US many of the products that are being used in hydraulic fracturing are not known to the public, are unstudied and unregulated,
- the chemicals used and the amounts or volumes used can differ from well to well, but there is not enough finances for research for geology and hydrology of the sites,
- fracturing of wells, where a million gallons of fluids are injected underground, can create earthquakes (TEDX 2007, Lustgarten 2008, Democracy Now 2010, GasLand, NRDC 2012, Spellman 2013).

2.5 NUCLEAR ENERGY

Nuclear energy results from the reorganization of the neutrons and protons in a nucleus. As the nuclear forces are much greater than forces between the outer electrons, the energy released in nuclear reactions is about 100 million times greater than in a chemical reaction. This reaction powers the nuclear reactor (O'Keefe, O'Brien, and Pearsall 2010).

2.5.1 Basics of the Technology

A nuclear power station (Image 2.10) works in much the same way as a coal- or gas-fired power station, except it is not fueled by coal or gas but uranium. The nuclear reactor generates heat, which is used to create steam which drives a steam turbine. Nuclear energy can be produced in fission or fusion processes. Fission is the splitting of a heavy nucleus into two or more radioactive nuclei. Fusion is a fusion of two light nuclei into heavier nuclei. Presently, all nuclear reactors use the fission process to generate energy (O'Keefe, O'Brien, and Pearsall 2010).

In a nuclear reactor, controlled fission reactions produce thermal energy, which can be used to supply heat, for industrial or home heating, or to produce electricity (Ngo and Natowitz 2009).

Image 2.10: Nuclear Plant

Source: CBS News (2011).

A nuclear reactor consists of a reactor vessel containing a core in which nuclear reactions take place, a moderator to thermalize the neutrons, and a heat transfer fluid that serves as the coolant, to prevent overheating of the core, and transmits the heat produced in the core to other devices that will use it.

There are different types of nuclear reactors operating in the world: pressurized water reactor (PWR), boiling water reactor (BWR), pressurized heavy-water reactor (PHWR or CANDU), light-water graphite reactor (LWGR), gas-cooled reactor (GCR), and fast breeder reactor (FBR). In PWR and BWR, the coolant is water, which absorbs the thermal energy released in fission reactions and is heated. A PHWR uses heavy water (D_2O) as a moderator. A LWGR is water cooled and uses graphite as a moderator. A GCR is cooled by carbon dioxide gas and moderated by graphite. A FBR is fast neutron reactor, which uses different technologies depending upon the cooling fluid. Nuclear reactors using water as both moderator and coolant dominate the market of electricity production (Ngo and Natowitz 2009).

2.5.1.1 Micro-Nukes

Micro-nukes are small, prefabricated power plants that produce up to few megawatts of electrical power, instead of the 1,000 megawatts of a typical conventional nuclear plant. They are designed to run for 30 years with no care or maintenance. They are fast to build and install, safer, less expensive, and can be located wherever needed. The problem is that they still use standard nuclear technology that produces radioactive waste. Navy ships have used micro-nukes for decades, so the idea is not new (Haven 2011).

2.5.2 Historical Development

In 1936, Leo Szilard discovered the nuclear chain reaction necessary for nuclear fission. In 1942, Enrico Fermi built the first nuclear reactor. In 1946, the first Soviet nuclear reactor began producing 10 watts of power. In 1951, in the US, electric power is obtained from a fast breeder nuclear reactor and a few years later electric power from nuclear energy is sold commercially. In 1956, in England the first power plant produced a substantial amount of electricity. The same year in India, the first Asian nuclear power plant went online. In 1969, India's first nuclear plant for commercial power production produced 420 megawatts of electricity. In 1988, a temperature of 100 million Kelvin was achieved, which was considered the minimum temperature necessary for fusion reaction. In 1994, in the US, the first fusion reactor generated 10 megawatts of power. An improved version of that reactor was built in 1998 in Japan (Smith and Taylor 2008). Today, 2.7 percent of the world's energy is produced from nuclear (REN21 2012).

2.5.3 Environmental Impact

Even though there is no carbon dioxide emission, nuclear plants do have enormous effects on the environment.

The wastes produced by nuclear energy are a major consideration. The amount of waste depends on the back-end fuel cycle used. In the open cycle, the spent fuel from the reactor is treated as waste; in the closed cycle, the spent fuel discharged from the reactor is reprocessed. Therefore, the amount of waste is much larger in the open cycle than in the closed fuel cycle. Such waste is dangerous because of its radioactivity. Waste with short half-lives (less than 30 years) is more radioactive than that with long half-lives (thousands of years) (Ngo and Natowitz 2009). Radioactive waste is unstable configurations of elements that decay, emitting ionizing radiation that can be harmful to human health and the environment. Globally, some 12,000 tons of spent nuclear fuel are produced every year (O'Keefe, O'Brien, and Pearsall 2010).

The second consideration is safety. Defenders of nuclear power argue that safety has improved radically since Chernobyl, but in 2011, in Fukushima, a large nuclear accident happened. There is an assumption that any dose of radiation involves a possible risk to human health. We do know whether some people died directly as a result of radiation from the nuclear accident and people got thyroid cancer as a result of the accident's contamination. Nuclear radiation can harm living tissue. The risk of radiation exposure can cause fetal abnormalities, which can be passed on to progeny, and can cause a cell to grow in an abnormal manner and eventually be manifest as cancer (O'Keefe, O'Brien, and Pearsall 2010).

2.5.4 Advantages:

- nuclear fuels do not emit carbon dioxide during operation,
- nuclear power plants do not directly release sulfur dioxide, nitrogen oxides, carbon monoxide, and mercury,

- nuclear power plants are capable of adding significant power supply from a single, centralized location,
- nuclear power plants can essentially operate around the clock,
- according to some sources, it is a low-cost electricity energy source (Asmus 2009, Ngo and Natowitz 2009, O'Keefe, O'Brien, and Pearsall 2010).

2.5.5 **Disadvantages**:

- nuclear waste is dangerous because of its radioactivity,
- exposure to radiation can cause cancer, gene mutations, premature aging and, in some cases, death,
- countries with nuclear plants have difficulties with siting and developing a geologic repository for spent nuclear fuel and high-level nuclear waste,
- nuclear power plants are vulnerable to terrorism,
- their technology can be used to produce nuclear weapons,
- the risk arising from severe accidents on the scale of the Three Mile Island (1979), the Chernobyl (1986) and the Fukushima accidents (2011),
- the high financial risks of nuclear power, including waste disposal and the costs of repositories,
- nuclear power plants require large quantities of water for cooling purposes,
- the uranium enrichment process depends on huge amounts of electricity, the majority of which is provided by fossil fuel plants releasing pollution emissions,
- the operation of nuclear power plants releases dangerous air emissions in the form of radioactive gases, including carbon-14, iodine-131, krypton-85, and xenon-133,
- uranium mining represents issues of local land and water resources contamination arise, radioactive contamination hazards for mine workers and nearby populations,
- uranium is a finite, nonrenewable resource,
- the insurance problem,
- very expensive (Macfarlane and Ewing 2006, Makhijani 2008, Asmus 2009, Manning and Garbon 2009, Ngo and Natowitz 2009, Linde 2010, O'Keefe, O'Brien, and Pearsall 2010, Stohl et al. 2012, RT Question More 2013b).

2.5.6 After Fukushima:

- a fish found in the vicinity of the crippled Fukushima nuclear plant contained over 2,500 times safe levels of radiation,
- Fukushima debris drifting in the sea hit some areas, and aside the unknown risks, bring invasive species that threat ecosystem and introducing the possibility of consuming contaminated seafood,
- school and parents across Fukushima, according to Japanese education ministry report, restricted the amount of time their children spent outdoors in last two years, which has turned children in Fukushima into the most obese children in Japan,
- catastrophe in Fukushima also affected the local economy; fishing in the southern sea area ground to a halt (McCurry 2012b, The Japan Times 2012, RT Question More 2013a, RT Question More 2013b).

3 ALTERNATIVE SOURCES OF ENERGY

A total of 16.7 percent of the world's energy is produced from renewables (REN21 2012). This figure also includes conventional hydropower.

3.1 SOLAR

The earth intercepts energy from the sun in the form of solar radiation. The amount received annually is more than 10,000 times as much energy as that consumed annually by humankind. This solar energy can be used for heat and electricity (Ngo and Natowitz 2009).

3.1.1 Basics of the Technology

Solar power can be utilized through one of three methods: solar thermal systems, central solar power system, and photovoltaics.

3.1.1.1 Solar Thermal Systems

Solar thermal systems are used in buildings and can capture solar heat in two ways: actively or passively.

The concept of *passive solar heating* is more a matter of architecture. Buildings are designed in a way that captures heat and transmits daylight (Smith and Taylor 2008). According Seifried and Witzel (2010), there are two ways of using solar energy passively.

The first includes special components, such as windows, glass facades and transparent insulation. To obtain as little heat passing out of the building and as much solar energy entering the house in winter, a greater share of insulated south-facing glazing (in the northern hemisphere) has a positive energy payback. The second way includes selecting the proper location and orientation for a building, adapting the shape of the building, using the roof to provide shading, and planting trees to provide shading.

Solar chimneys, Trombe walls, and solar roof ponds are also passive solutions. During the day solar energy heats the solar chimney and the air inside. This creates an airflow that is used to ventilate and cool the building. A Trombe wall is an air channel between sealed insulated glass and a wall, built from stone, concrete, or tank of water. Sunlight passes through the insulated glass, which warms the air in the channel and produces natural ventilation. A solar roof pond consists of a water tank behind an insulating cover that can be opened or closed. For heating, the tank is uncovered during the day and sunlight warms the water in the tank. During the night, the tank is covered and the heat, stored in the tank is used. The house is heated by the radiation from the roof. For the cooling purposes, during the day heat from the building warms the tank, and during the night the heat is radiated away from uncovered tank (Ngo and Natowitz 2009).

Active solar heating typically employs solar collectors (Image 3.1) to absorb the thermal energy from the sun. Solar collectors have black surfaces, made of copper, aluminum or plastic, which result in a high solar absorption. Under these flat plates are heat pipes, which are capable of creating extremely large amounts of heat, because of the pressurized liquid in them. This fluid then flows to the consumer device; typically, to provide heated water (Seifried and Witzel 2010). A collector with a black surface is used for systems where the temperature reaches up to 35°C. A glass pane in front of the black collector produces a greenhouse effect and causes the temperature to rise up to 60°C. If the black paint is replaced by an absorptive material that prevents the reemission of infrared radiation, temperatures can increases up to 90°C. Collectors under vacuum can reach temperatures higher than 100°C (Ngo and Natowitz 2009).

Image 3.1: Solar Collector

Source: Hello Trade.

3.1.1.2 Central Solar Power System (CSP)

A central solar power system is also known as a concentrating system. In CSP systems, the heat from sunlight is used to power a steam turbine which runs a generator. There are three types of CSP systems: parabolic through systems (Image 3.2), tower systems (Image 3.3), and parabolic dishes, or Stirling collector systems (Image 3.4). All of these systems can be used to heat and cool air or water and to generate electricity. Solar troughs are the most commonly commercially used (Cipiti 2007, Smith and Taylor 2008).

Troughs are parabolic-shaped mirrors that focus sunlight onto a tube. The focused solar power heats up a fluid inside this tube up to 400°C. Oil is a typically used liquid in tubes (Cipiti 2007).

Image 3.2: Parabolic Trough Concentrators

Source: Union of Concerned Scientists (2009).

In the *solar tower concept*, mirrors (able to move into two directions) called heliostats track the motion of the sun, reflect sunlight onto a central power (Image 3.3). The concentrated light at the tower heats a molten salt to at high temperatures, around 550°C. Molten salt has proven to be the most successful material, but water and sodium are also used (Cipiti 2007).

Image 3.3: Solar Tower

Source: Ecofriend.

In a *Stirling dish system*, a dish solar collector focuses the sun's power onto a small receiver, where temperatures higher than 1000°C can be reached. The receiver uses the heat to drive a Stirling engine, which generate electricity (Cipiti 2007).

Image 3.4: Stirling Collector System

Source: Erneuerbare Energien und Klimaschutz.

3.1.1.3 Photovoltaics (PV)

Solar cells are the heart of the photovoltaics. They produce both electric current and voltage, and are used to convert sunlight directly into electricity. Cells are connected into panels that are linked together to form an array. The bigger the array, the more electricity it produces. Photovoltaic cells are made from layers of semiconductor material. The most commonly produced PV cells are from monocrystalline silicon or polycrystalline silicon, or can also come in the form of a thin film (Craddock 2008, Seifried and Witzel 2010).

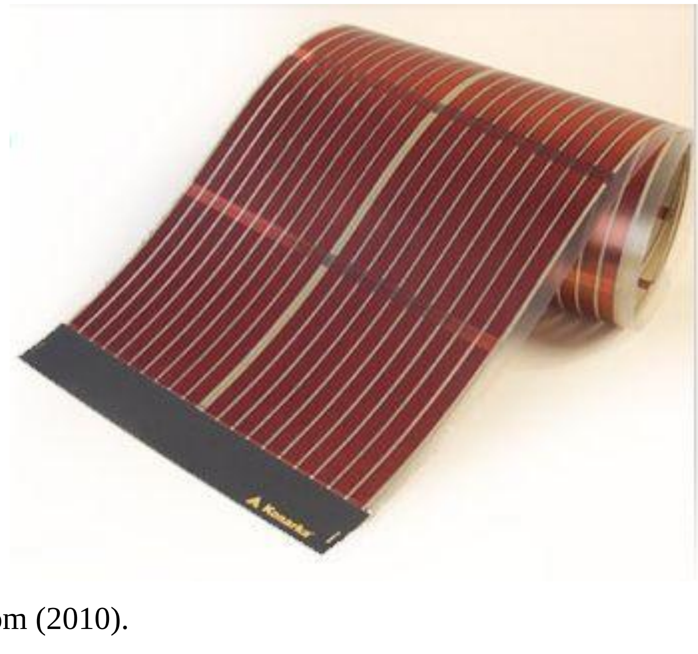
3.1.1.3.1 Photovoltaic Generations

According EPIA (2011), photovoltaic technologies are classified into three generations.
First generation technology includes basic crystalline silicon (c-Si), which are cells made from thin slices, called wafers, cut from a single crystal or a block of silicon. The main types of crystalline cells are mono-crystalline (mc-Si), polycrystalline or multi-crystalline (pc-Si),

and ribbon- and sheet-defined film growth (ribbon/sheet c-Si). Crystalline silicon is the most common and mature technology around the world, representing about 80 percent of the market. Cells turn between 14 and 22 percent of sunlight into electricity.

Second generation technology includes thin film technologies (Image 3.5). Extremely thin layers of photosensitive material are attached to glass, stainless steel or plastic and then laser-cut into multiple thin cells. Types of commercially available thin films are amorphous silicon (a-Si), multi-junction thin silicon film (a-Si/μc-Si), cadmium telluride (CdTe), copper, indium, gallium, (di)selenide/(di)sulphide (CIGS) and copper, indium, (di)selenide/(di)sulphide (CIS). Amorphous silicon can absorb more sunlight than c-Si structures and has efficiencies in the range of 4 to 8 percent. Multi-junction thin silicon film consists of an a-Si cell with additional layers of a-Si and micro-crystalline silicon (μc-Si). The μc-Si layer absorbs more light, which increases efficiency by up to 10%. Cadmium telluride (CdTe) thin films cost less to manufacture, are therefore the most economical thin-film technology currently available, and have a module efficiency of up to 11 percent. CIGS and CIS offer the highest efficiencies of all thin film technologies in the range of 7 to 12 percent, with as much as 20 percent achieved in the laboratory.
Typical thin-film module power ranges from 60 to 350 W depending on the substrate size and efficiency.

Image 3.5: Thin Film



Source: PhysOrg.com (2010).

Third generation technology includes concentrator photovoltaics (CPV), organics, and other technologies that have not yet been commercialized at a large scale.

Concentrator photovoltaics utilize lenses to focus sunlight on to solar cells and are the most efficient in highly sunny areas. Commercial silicon-based module efficiencies range of 20 to 25 percent, gallium arsenide (GaAs) efficiencies range of 25 to 30 percent, even cell efficiencies well above 40 percent have been achieved in the laboratory.

Organic PV cells include both fully organic PV (OPV) solar cells and the hybrid dye-sensitized solar cells (DSSC). Current OPV cell efficiencies are about 6% for very small areas and below 4% for larger areas. DSSC cell efficiencies achieved at the lab across a very small area are in the range of 8 to 12%; commercial applications still have efficiencies below 4%. Third generation technologies that are beginning to reach the market can be classified as advanced inorganic thin films such as spherical CIS and thin-film polycrystalline silicon solar cells, organic solar cells which include both fully organic and hybrid dye-sensitized solar cells, and thermo-photovoltaic (TPV) low band-gap cells, which can be used in combined heat and power (CHP) systems. In addition to the before mentioned emerging third generation PV technologies, a number of technologies that are also under development include active layers that can be created by introducing quantum dots or nanotechnology particles, likely used in concentrator devices, and tailoring the solar spectrum to wavelengths with maximum collection efficiency or increasing the absorption level of the solar cell, applied to all existing solar cell technologies (EPIA 2011).

3.1.1.3.2 Technological Applications for PV

According to EREC (2010) there are different technological applications for PV.

A grid-connected domestic system is the most popular for homes and businesses in developed areas. It is connected to the local electricity network and allows the selling of the excess power to the utility (Image 3.6).

Image 3.6: Solar Panels

Source: Electrician.com.au.

Grid-connected power plants produce large quantities of electricity in a single point (Image 3.7).

Image 3.7: Solar Power Plant

Source: GEOTIMES (2008).

Where no electricity is available, an off-grid system is connected to a battery via a charge controller. A solar system can also be a hybrid system, combined with another source of power, e.g. a biomass, wind or diesel generator. PV cells can be used in watches, calculators, toys, battery chargers, and on the roofs of automobiles (EREC 2010). Some other ideas about solar energy from the sun include space solar panels, space solar power satellites, and lunar solar power systems (Smith and Taylor 2008).

3.1.1.3.3 Micron-Gap Thermal Photovoltaics (MTPV)

MTVP is a new technology that converts heat to electricity using semiconductor chips that can generate electricity using 45 percent less heat than traditional systems. MTPV's initial focus is threefold. First is waste heat conversion that converts waste heat to electricity and reduces the amount and temperature of vented waste heat and emissions from industrial plant processes. Second are solar devices that can enhance the current economics of concentrated solar by increasing efficiency and power output. Third is portable power that looks and works like traditional batteries, but are smaller, lighter and use disposable fuel cartridges to create electricity (MTPV 2009).

3.1.2 Historical Development

One of the first ways of using sun was using a magnifying glass or mirrors to start a fire. Later people used south-facing windows to capture light and warmth from sun (Craddock 2008). In 1767, Horace de Saussure built the first solar collector. In 1774, Antoine Lavosier developed the first solar furnace. In 1839, Alexandre-Edmond Becquerel, a French scientist, discovered that sunlight can be converted into electrical energy when placed in certain cells. In 1860, August Mouchet produced a solar-powered engine. In 1873, Willoughby Smith discovered the photoconductivity of selenium. In 1878, William Adams began construction on the first solar tower. In 1883, Charles Fritts made a solar cell from selenium. In 1885, Charles Tellier invented first solar-powered water pump. In 1891, Clarence Kemp made a solar powered water heater. In 1908, William J. Bailey invented solar collector using copper wires and an insulated box. In 1921, Albert Einstein won the Nobel Prize for theories on the photoelectric effects. In 1941, Russell Ohl replaced selenium in solar cells with silicon, which is more efficient. In 1946, the first commercially sized solar furnace was built in France. In 1954, Bell Laboratories made first solar photovoltaic cell, converting 6 percent of the sunlight hitting the cell into electricity. In 1955, Frank Bridgers designed the first commercial office building to use solar water heating and a passive solar design. In 1960, the first experimental solar thermal power plant, with 1,200 mirrors that concentrated sunlight on a central steam boiler connected to an electric generator, was finished in Turkmenistan. In 1981, Paul MacCready took flight with first solar-powered aircraft. In 1982, photovoltaic production exceeded 9.3 megawatts worldwide. In 1983 worldwide, photovoltaic production jumped beyond 21.3 megawatts. In 1985, the 20% efficiency barrier for silicon solar cells was reached. In 1987, the first thin-film solar cells were developed in Japan, with crystalline silicon replaced by less expensive amorphous silicon. In 1994, in the US 30% efficiency was reached, with a solar cell made of gallium indium phosphide and gallium arsenide. In 1996, the most advanced solar-powered airplane flew over Germany. In 1998, Subhendu Guha invented flexible solar shingles for converting sunlight to electricity on buildings. In 1999, global photovoltaic capacity reached 1 GW (Smith and Taylor 2008). By 2011, solar photovoltaics had increased total global capacity to almost 70GW, concentrating solar thermal power to 1.8 GW, and solar hot water/heat capacity to 232 GW (REN21 2012).

3.1.3 Environmental Impact

Technologies made for solar energy are the most environmental friendly among renewable sources. Even so, some disadvantages do exist.

If a fire breaks out within a photovoltaic module, toxic substances can be released, because some parts contain small amounts of toxic substances, such as cadmium (Craddock 2008). Some emissions are released indirectly during manufacturing and construction (Cipiti 2007). If configured as a central station system, solar energy has a very large environmental footprint (Asmus 2009).

3.1.4 Advantages:

- it is available in inhabited regions everywhere on the earth,
- photovoltaics have no moving parts, thus operation is silent,
- photovoltaic modules can be directly applied to devices and structures that of electricity,
- it has very low greenhouse gas emissions,
- solar power technologies require much less land than hydro, biomass, and coal technologies for the same amount of energy,

- grid applications PV modules can last more than 30 years,
- PV systems can also generate electricity on cloudy days,
- PV creates jobs, energy independence and rural development (Craddock 2008, Smith and Taylor 2008, Ngo and Natowitz 2009**,** EREC 2010).

3.1.5 Disadvantages:

- it is available only during daylight hours,
- the intensity of solar energy depends upon weather and season conditions,
- it requires major effort to store and transport this energy,
- it requires excess land use,
- transformation from solar energy to electricity is very expensive,
- photovoltaics are still expensive,
- PV materials do not respond well to heat – the hotter they get, the more inefficiently they run,
- some modules contain very small amounts of toxic substances,
- silicon cell technology requires a lot of energy,
- in the future, shortages of silicon may influence the development of PV energy (Komor 2004, Craddock 2008, Ngo and Natowitz 2009, Haven 2011).

3.2 WIND

The airflows we know as wind are caused by temperature differences between different locations on the surface of the earth and between different altitudes that create pressure differentials (Ngo and Natowitz 2009).

3.2.1 Basics of the Technology

A steady wind speed, between 18 to 25 km/h, is needed to turn a wind turbine's blades. Blades then capture wind energy and turn the turbine's generator, which generates electricity. When the wind speeds exceed 90km/h, the turbine is shut off to avoid damage to the structure.
Wind conditions, turbine height, and efficiency of the turbine determine the amount of power from wind turbines. The trend is towards larger, taller and more efficient wind turbines (Aswathanarayana, Harikrishnan and Sahini 2010).

According to O'Keefe, O'Brien, and Pearsall (2010), two different types of wind turbines can be defined: the horizontal axis turbine (HAWTs) and vertical axis turbine (VAWTs).

Wind turbines with a horizontal axis can have one, two (Image 3.10), three (Image 3.8) or more (Image 3.9) blades. Single-bladed turbines are the most structurally efficient, two-bladed turbines can operate at higher speed and multi-bladed turbines have high torque in light winds and can work with low frequency mechanical power. For turbines with a horizontal axis, the dominant force is lift and the rotor blades can be in front of (upwind) or behind the tower (downwind). Upwind turbines need a tail or some other mechanism to point them into the wind.

The typical modern wind turbine is a horizontal axis machine with three blades. The blades are made of composite materials, such as fiberglass and polyester or epoxy, or wood and carbon fiber. The blades are connected to a nacelle, which houses a generator and a gearbox. The nacelle and the rotor with blades are positioned on the top of the tower, made from steel. Some rotors are directly connected to the generator, eliminating the need for a gearbox.

Image 3.8: Three Bladed Wind Turbine

Source: Popular Science (2009).

Image 3.9: Multi-bladed Wind Turbine

Source: HubPages.

Image 3.10: Two Bladed Wind Turbine

Source: WordPress.com (2010).

Wind turbines with vertical axes have the advantage that they can be driven by wind from any direction (Images 3.11). However, the disadvantage is that the torque from wind variation during each turn of the blades can produce vibrations. Small wind turbines with vertical axes are more easily installed, produce less noise and are less sensitive to the varying wind (O'Keefe, O'Brien, and Pearsall (2010).

Images 3.11: Different Types of Vertical Wind Turbine

Source: InterNACHI.

Source: Portal of Transformation (2012).

Source: Busytrade.com.

Offshore wind turbines are an emerging alternative. They are sited at depths less than 30m and less than 20km from the coast. At sea, the wind conditions are much better than on the land. However, there are some disadvantages. Offshore wind installations have to be much stronger, because the structure must resist wind, waves and storms at sea. The connection to the electrical grid needs high-voltage transportation systems if the distance is greater than 10,000 m. Therefore, it is more expensive to install wind turbines offshore than onshore (Ngo and Natowitz 2009).

3.2.1.1 Wind Kite Power Plant

There is no working wind kite power plant on the world at the moment. The concept is that wind kites in the no-fly zones, such as a zone above nuclear power plant, could safely and consistently generate electrical power. Utility companies could tether specially designed, giant kites that soar up to an altitude where high winds constantly blow. These giant kites could pull with great force, which would rotate the shaft of the electric generator on the ground (Haven 2011).

3.2.2 Historical Development

For centuries people used wind to power ships' sails. People have used windmills for pumping water and milling grain for over 4000 years. The first documented use of a windmill was in Egypt in 1 CE. In 9 CE in Persia, the first use of vertical windmills occurs. In 1180, the first horizontal axis windmills were built in Europe. Between 1925 and 1957, the Jacob Brothers Company manufactured a large number of wind turbines in the United States. They had output powers in the 2.5–3 kW range. In 1974, in the USA two-bladed wind turbine was developed. The first wind turbine rated over one megawatt was built in 1979 in the USA. In 1983, a Darrieus vertical-axis wind turbine with two blades was built in Canada. At that time, it was the most powerful turbine in the world, with 4 MW of power (Smith and Taylor 2008, Ngo and Natowitz 2009). By 2011, seeing the greatest capacity additions of any renewable technology, wind power capacity increased to approximately 238 GW. China takes the lead in the global market at 44 percent, followed by the United States and India. The largest market in Europe is in Germany (REN21 2012).

3.2.3 Environmental Impact

Wind power is a clean source of energy. During the construction of the wind turbines, a low percentage of carbon emissions are generated (Cipiti 2007). There are some other environmental impacts. The first one is the visual impact. Some people do not like the idea of the local scenery being obstructed by wind turbines. The second one is noise, although design improvements have reduced both aerodynamic noise from the blades and mechanical noise. The third one is connected with the disruption of wild life. Wind farms need large areas for wind turbines (Aswathanarayana, Harikrishnan and Sahini 2010).

3.2.4 Advantages:

- wind velocity at sea is more stable and larger than that on land, more space is available and very few people live close to sea wind turbines, which allows an increase of load factors up to 40%,
- no harmful chemicals are emitted,
- there are no waste or byproducts,
- construction and grid connection can be performed in very little time,

- problems with storing excess energy can be solved with pumping seawater out of the reservoir, like a horseshoe-shaped artificial island, built in Belgium (Craddock 2008, Asmus 2009, Ngo and Natowitz 2009, Strong 2013).

3.2.5 **Disadvantages**:

- winds at any site may be irregular and intermittent,
- winds can destroy wind turbines if they are too strong,
- the air that carries wind energy has a low density,
- wind turbines are usually installed in windy, unpopulated areas. Therefore, it is necessary to extend the existing electrical power transmission grid,
- offshore wind turbine installations are more expensive, because the structure must resist wind and waves, and because of the distance to the electrical grid on the shore,
- some people see wind turbines as intrusive and a form of visual pollution,
- potential interference with radar has emerged as an issue of national security (Komor 2004, Asmus 2009, Ngo and Natowitz 2009).

3.2.6 Disadvantages of Renewables:

- it is difficult to maintain a consistent supply of power to the grid if fluctuating renewable output has to be balanced by input from conventional power stations,
- to keep renewable back-up constantly available requires fossil-fuel power plants to run much of the time, very inefficiently and expensively (Booker 2012).

3.3 BIOMASS

Biomass is living or dead biological material, such as plants (90%), animals and biodegradable wastes, which are a source of carbon. Biomass does not include fossil fuels. Fossil fuels require millions of years to be created, whereas biomass harnessing (which has been planted) is within the timescale of a human life (Ngo and Natowitz 2009).

3.3.1 Basics of the Technology

To process heat, electricity and fuel, *solid biomass, biogas* and *biofuels* are used.
Biomass resources for this purpose can come from forest residue (wood blocks, wood chips), short rotation forestry (willow, poplar, eucalyptus), herbaceous ligno-cellulosic crops

(miscanthus, rapeseed, corn, sugarcane), agricultural by-products and residues (straw, animal manure, husks), industrial residues (from food, used vegetable oils and paper industries, i.e. pulp, black liquor from paper mills), wood wastes (wood processing waste, construction residues, sawdust), organic fraction of municipal solid waste and refuse sewage sludge, algae (EREC 2010).

3.3.1.1 Solid Biomass

The simplest way of using biomass is to burn it (Image 3.12). Wood, in fact, is the largest solid biomass energy resource used for heat production. The more sophisticated fuel, made from wood, is charcoal. Charcoal is the blackish residue consisting of impure carbon obtained by removing water and other constituents. It has a larger density than wood, it is much lighter, and it burns hotter, cleaner and without fumes (Ngo and Natowitz 2009, O'Keefe, O'Brien, and Pearsall 2010).

Image 3.12: Wood Heating Plant

Source: Metso (2013).

3.3.1.2 Biogases

Methane is the most commonly produced biogas (Image 3.13), captured at landfills or by the anaerobic digestion of wastewater, crop residues, sewage, slurry, food processing waste.

Areas are covered with impervious material under which are pipes that remove the gas and trap it for appropriate treatment (Craddock 2008).

Image 3.13: Biogas Power Station

Source: CALNI (2010).

3.3.1.3 Biofuels

The most commonly used biofuels are *biodiesel* and *ethanol*. Sunflowers, rapeseed oil and other plants are grown for their oily seeds, which can be converted into biodiesel. By fermentation, ethanol can be created from sugars. Corn and sugar cane are the most common crops for the production of ethanol. Biodiesel and ethanol can be used in conjunction with diesel (Image 3.14) and petrol (Craddock 2008).

Image 3.14: Diesel Plant

Source: Energy Trends Insider (2010).

Biofuels produced today are called *first-generation biofuels*. There are two different ways of producing biofuels. The first is to use crops that contain high concentrations of vegetable oil (oil palms, soybeans, rapeseed, sunflowers). The second is to use crops that contain a high sugar concentration (sugarcane, sugar beet, sweet sorghum, corn, wheat, barley) from which ethanol is produced.

The concept of *second-generation biofuels* is to use lingo-cellulosic biomass (wood, forestry or farming residues, waste biomass) which is not dedicated to food, so there would not be any competition with food biomass and biofuels. A wide range of biomass is converted into a synthetic gas, from which methanol, or fuel similar to diesel is made. The process is similar to Fischer-Tropsch synthesis (Seifried and Witzel 2010).

Third-generation biofuels include biofuels that could be produced in the sea in the future. Some micro-seaweeds could be used (Ngo and Natowitz 2009). Single-cell algae are capable of producing crude, that is chemically identical to crude oil, but carbon-neutral, non-toxic and sulfur-free (Aswathanarayana, Harikrishnan and Sahini 2010).

3.3.1.4 Thermochemical, Physicochemical and Biologic Transformation Techniques

According Ngo and Natowitz (2009), solid biomass can be converted into energy using thermochemical conversion. Biofuels can be converted into energy using thermochemical conversion, physicochemical conversion or biological conversion. Biogasses can be converted into energy using thermochemical conversion or biological conversion.

3.3.1.4.1 Thermochemical Conversion

According Ngo and Natowitz (2009) thermochemical conversion can be done by direct combustion, by pyrolysis or by gasification.

Most biomass plants used today are based on *direct combustion*. In this technology, solid biomass is burned and used to heat a boiler that supplies steam, which is used in a steam turbine.

Pyrolysis is the thermal decomposition of biomass that occurs in the complete absence of oxygen to prevent combustion. Its products are solid charcoal, liquid bio-oil, and gases. Pyrolysis primary goal is bio-oil production. Bio-oil has a larger density than solid biomass and is easier to store.

Biomass gasification is a process that converts biomass into a gaseous fuel by oxidization of the biomass with air, oxygen, or steam at high temperature. The gas contains hydrogen, carbon monoxide, methane, carbon dioxide, water vapor, some hydrocarbons, and tar residues. The produced gas can be burned directly in boilers to produce steam and electricity. It can be cleaned by removing tars before it is used as a fuel in engines or gas turbines. It can also be used to synthesize other fuels like methanol or hydrogen.

Biomass can also be co-fired in a coal power plant to increase the efficiency of a plant. Up to 5% biomass can be included without any modifications (Ngo and Natowitz 2009).

3.3.1.4.2 Physicochemical Transformations

Physicochemical transformations can be performed via pressing and extraction, or esterification.

With *transesterification*, biofuel such as biodiesel can be produced. The most common derivatives are RME (rapeseed methyl ester) and FAME (fatty acid methyl ester) (Ngo and Natowitz 2009). To create biodiesel, glycerin is separated from animal fats or vegetable oils during esterification (Asmus 2009).

3.3.1.4.3 Biological Conversion

Biological conversion can be done via fermentation and hydrolysis or via anaerobic digestion.

Fermentation is a process that entails the conversion of sugars to ethanol. The process is driven by microorganisms, with yeast being the most commonly used (Craddock 2008).

Anaerobic digestion is a biological process that produces biogas, composed of methane (60%) and carbon dioxide (40%), in which organic materials are decomposed by bacteria in the absence of oxygen. The process is carried out in an airtight digester, where bacteria can be introduced externally if not present in the original biomass. The feedstocks used are agricultural, industrial and household organic waste, sewage sludge, animal by-products and solid municipal waste (Ngo and Natowitz 2009).

3.3.2 Historical Development

Our ancestors burned wood for heating, cooking, and lightning. In 1850, the most popular lamp fuel was biofuel; that year biomass still provided 90 percent of the energy (Nersesian

2010). One result of the Industrial Revolution was that dependency on fossil fuels mostly replaced dependency on biomass. In 1857, the first biogas plant was built to provide methane fuel in India. In 1979, Brazil began to invest in ethanol production from sugarcane. By 2007, in Brazil, over 40 percent of automobiles were powered by ethanol (Smith and Taylor 2008). Today, biomass is estimated to make up to 10 percent of all energy consumed. Biomass power capacity increased to almost 72 GW in 2011. The United States is the leader in the world in biomass-based power generation, followed by some EU countries, Brazil, China, India, and Japan. The primary renewable fuels in the transport sector are ethanol in biodiesel. Annual ethanol production in 2011 was 86.1 billion liters, biodiesel production was 21.4 billion liters (REN21 2012).

3.3.3 Environmental Impact

The great advantage of biomass is that carbon dioxide is captured during biomass growth. That is why removing forests for biomass is detrimental for the environment. It can cause erosion, increase greenhouse gas emissions and release carbon dioxide trapped in the soil. Burning wood and some biofuels causes sulfur emissions, carbon dioxide and emits unhealthy contaminants.

Conventional agricultural crops need fertilizer, which creates pollution of soil and water. Some crops need large amounts of water, which can result in a reduction of water flowing into rivers and can reduce groundwater quality. Improperly converted animal wastes can also pollute watercourses.

In case of waste, their use to produce energy has the positive effect of reducing the amount of end waste. However, many crop wastes left behind are necessary to help with soil quality.

Some crops cannot be grown at the same place every year. They require large areas of valuable farmland (Ngo and Natowitz 2009).

Greenhouse effect is 25 times greater than carbon dioxide (IPCC 2007b). Natural and artificial releases of methane are contributing to global warming. More than a trillion tons of methane are trapped in permafrost and under frozen lakes in the Artic. As the world warms and the Arctic tundra thaws, methane is bubbling out. Methane is also released by farm animals and garbage landfills. One cow emits 0.3 m^3 of methane each day. One ton of municipal waste in a landfill can produce 125 m^3 of methane (Haven 2011).

A white meat diet requires five times more cultivated area than a vegetable diet. A red meat diet requires nine times more cultivated area than a vegetable diet. The problem with some biofuels is that the biomass used to produce them is grown in competition with food production (Ngo and Natowitz 2009, 195—160).

3.3.4 **Advantages**:

- biomass is plentiful; large regions of the earth are covered with forests,
- biomass can be increased by planting trees and grasses,
- biomass is renewable and recyclable energy,
- carbon dioxide is captured during biomass growth,
- ash waste disposal can be used for spreading in the forests and fields to recycle nutrients,
- using wastes to produce energy reduces the amount of end wastes,
- creates jobs in rural areas (Ngo and Natowitz 2009, Nersesian 2010).

3.3.5 **Disadvantages**:

- food biomass can lead to an increase in the price of food,
- burning biomass produces carbon dioxide,
- removing forests can cause erosion,
- burning biomass can have an unpleasant smell,
- some crops cannot be grown at the same place every year,
- growing corn for production of ethanol requires tremendous amounts of fertilizer,
- intensive use of water, fertilizers, pesticides and other chemicals for biomass can result in water pollution and depletion, which can lead to hunger,
- high concentrations of methane gas can result in an explosion (Cipiti 2007, Craddock 2008, Ngo and Natowitz 2009).

3.4 GEOTHERMAL

Heat that comes from within the Earth is used in geothermal processes. That heat comes from decay of radioactive elements within the mantle of the Earth (Craddock 2008). Geothermal steam can be found at depths of up to 3000 meters, or can also lie close to surface (Asmus 2009). By volume, more than 95 percent of our planet is hotter than 1000°C. Heat is flowing from the core to the crust; the amount that reaches the surface is equivalent to 2.5 times our energy consumption. Most of it escapes into space unused (Seifried and Witzel 2010).

3.4.1 Basics of the Technology

Geothermal processes are mostly used for space heating and cooling applications, and production of electricity.

To extract heat, a heat source, a thermal fluid and reservoir of that fluid is needed. The heat source can be the normal conduction of heat through the rocks or a high thermal source such as magma. The fluid is normally water. It can be in liquid or vapor form depending on the temperature and pressure. In some cases, in some reservoirs, water is continuously replenished; in other cases, the water must be pumped down the well, heated and then extracted (O'Keefe, O'Brien, and Pearsall 2010). To generate electricity, power plants need steam (Image 3.15). The steam rotates a turbine that activates a generator (EREC 2010).

Image 3.15: Geothermal Power Plant

Source: Green Diary (2011).

3.4.1.1 Heat Pumps

Half of the geothermal energy currently used comes from heat pumps, which generally run on electricity (Seifried and Witzel 2010). Heat pumps can be used for low-temperature geothermal resources, typically below 20°C. Heat pumps can work in either direction, for heating and cooling. In cold weather, the earth is warmer than the outside air. Heat pumps extract heat from the ground and supply it to the buildings. In hot weather, the earth is cooler than the outside air and the heat pumps can remove heat from the buildings and store it in the earth (Ngo and Natowitz 2009).

A geothermal heat pumps consist of the heat pump unit in the home and a heat exchanger in the ground. The heat exchanger is a long pipe loop through which water circulates. Heat pumps require electricity from the grid (Cipiti 2007).

3.4.1.2 Dry Steam Plants, Flash Steam Plants and Binary Plants

To convert geothermal energy into electricity, three kinds of commercial geothermal plants can be distinguished: dry steam plants, flash steam plants and binary plants. Flash steam plants represent the largest installed capacities (64 percent) (EREC 2010).

Electricity is produced when the temperature of the source is larger than 90°C (Ngo and Natowitz 2009).

Dry steam plants use direct steam resources at temperatures of about 205°C. The steam is extracted from the well and directed through a steam turbine.

Flash steam power plants use hot, pressurized water at temperatures hotter than 175°C. The pressure of the liquid is lowered to flash liquid to steam. The steam is used to run the turbine, and water is injected back into the reservoir. More sophisticated and 20-30 percent more efficient is the dual-flash cycle in which the steam is separated at two different pressures.

Binary plants use geothermal resources at temperatures of about 85°C. The heat in the hot water is exchanged through the use of a fluid that vaporizes at lower temperatures. This vapor drives a turbine (Aswathanarayana, Harikrishnan and Sahini 2010). In this cycle, two fluids are used. The hot water transfers its heat to the hydrocarbon to vaporize it. The vaporized coolant then drives a turbine (Cipiti 2007). A new binary process, known as the Kalina cycle, takes advantage of the low boiling point of the water-ammonia mixture to allow a significant fraction of it to be vaporized by the excess heat available at the turbine exhaust (EREC 2010).

3.4.1.3 Enhanced Geothermal Systems (EGS)

At places where no steam or hot water exists, the goal with EGS is to create a hydrothermal source in an underground location that has hot rocks. Pressurized water can be pumped into these areas to remove heat. EGS depends on the formation of fractures in the ground to increase the flow. The pressurized injection of water forms these fractures, which join other natural fractures. More fractures lead to a greater heating surface area. Drilling for EGS requires depths of at least 3000 m to reach 150°C (Cipiti 2007).

3.4.1.4 Ongoing Research

Some reservoirs exist with temperatures higher than 374°C and pressures greater than 220 bars. In this case, there is no distinction between liquid and vapor. This phase has a much higher heat capacity, which would, if brought to the surface, recover 10 times more energy than with conventional reservoirs (Ngo and Natowitz 2009).

There are three areas of ongoing research and testing. The first is drilling down to *hot dry rock layers,* injecting water, and creating a steady flow of steam returning up the well pipe. These layers are often too deep to reach economically. The second one is drilling into or near heat pools of *magma*. Drilling could trigger a volcanic eruption or an earthquake. Furthermore, the temperatures are so high that the drill pipe could soften and melt. The third one is *low-temperature research* that uses low-temperature fields (Haven 2011).

3.4.2 Historical Development

The earliest usage of geothermal energy was bathing in hot springs and cooking. In 1892, in the US, the first heating system to be heated by geothermal energy was developed. In 1904, in Italy, people started using geothermal energy for electricity production. In 1921, in the US, the first geothermal plant was built, producing 250 kilowatts of electricity. In 1930, in the US, the first commercial greenhouse use of geothermal energy was undertaken. In 1948, J. D. Krocker pioneered first commercial building use of geothermal ground water heat pump. In 1960, in the US, a large-scale geothermal electricity-generating plant began operate, producing 11 megawatts of net power (Smith and Taylor 2008). In 2011, geothermal energy provided 205 TWh, one third in the form of electricity, and other two-thirds in the form of heat. Electrical capacity is estimated at 11.2 GW (REN21 2012).

3.4.3 Environmental Impact

Some greenhouse gases held in ground water can be released when brought into the surface. Deep drilling, construction and access roads can cause water pollution and impact local ecosystems. Very deep drilling and injection of water under pressure can cause minor earthquakes. A high percent of the energy from geothermal systems is rejected to the atmosphere, which produces thermal pollution (Cipiti 2007).

3.4.4 Advantages:

- geothermal energy is accessible everywhere on the earth,
- geothermal plants operate at average efficiencies of 90 percent,
- it is a continuous energy source, available 24 hours a day, throughout the year,
- it is very low in carbon dioxide emissions,
- it occupies less land than other energy resources (Craddock 2008, Ngo and Natowitz 2009).

3.4.5 Disadvantages:

- geothermal resources sufficient for electricity generation are available only in a few countries,
- no preliminary tests can be done in order to test a given location for its potential for geothermal energy stashes,
- it is difficult to say how long a particular resource will last; it can be weeks, months or years,
- drilling into deep rock is expensive and time-consuming,
- in some places, the underground drift velocity of heat might be too slow,
- for enhanced geothermal systems (EGC), water must be pumped down into the reservoir, and is also used for cooling; therefore, EGC does not make sense in areas with limited water resources,
- some argue that geothermal is finite and depletable (Komor 2004, Cipiti 2007, Craddock 2008, Ngo and Natowitz 2009).

3.5 HYDRO - NEW APPROACHES

Approximately 70 percent of the earth's surface is covered with water. Large-scale hydropower projects, such as dams, affect water availability downstream, inundate sites and ecosystems, and have serious socioeconomic impacts because of the need to rehabilitate displaced population (Aswathanarayana, Harikrishnan and Sahini 2010). Some new approaches could bring new technologies that would be more efficient and have less environmental impact.

3.5.1 Basics of the Technology

Today, the new approaches are small hydropower and ocean energy, which involves energy from the tides, the waves, the marine currents, the salinity gradient (osmotic energy) and the ocean thermal gradient.

3.5.1.1 Small-Scale Hydropower Energy (SHP)

Small-scale hydroelectricity facilities (Image 3.16) also include mini-, micro-, and pico-hydroelectricity, depending on the output capacity of the facility (Ngo and Natowitz 2009). The power varies from country to country, but in general small-scale hydro capacity ranges from 1MW to 10MW, mini-scale ranges from 100kW to 1MW, micro-scale ranges from 5kW to 100kW, and pico-scale ranges up to 5kW (Poudel 2010). The SHP plants are multipurpose plants that enable flood prevention and control, irrigation and water supply during dry periods with electricity generation at the same time. Small hydropower is taking advantage of the kinetic energy and pressure of falling water. The rushing water drives a turbine, which converts the water's pressure and motion into electricity. The power of the plant is proportional to the difference between up- and downstream water levels (the head), the quantity of water that goes through the turbines in a given unit of time, and the efficiency of the turbine. Two general types of turbines are used: impulse and reaction turbine. The most commonly used impulse turbine is the Pelton turbine; the most commonly used reaction turbines are Francis and Kaplan (EREC 2010).

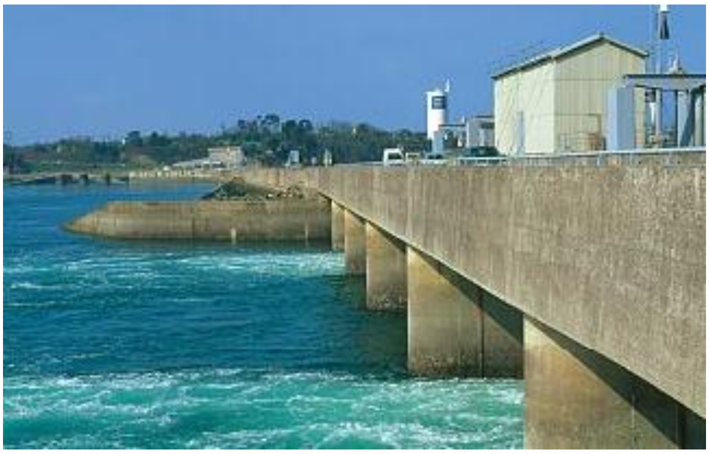
Image 3.16: Small-Scale Hydroelectricity Facility

Source: South Derbyshire District Council.

3.5.1.2 Tide Energy

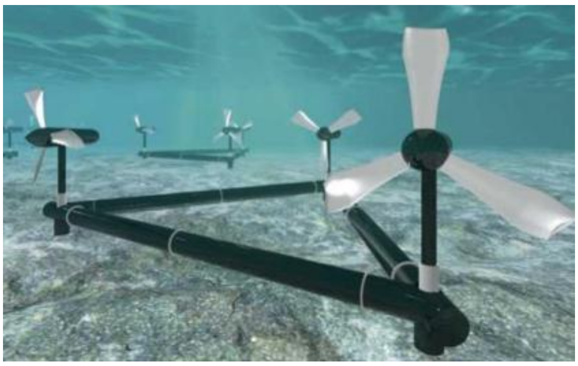
Tides are caused by the gravitational pull of the moon, sun, and Earth. To generate electricity, tidal technologies utilize ocean currents and the difference between low and high tide. Approximately 4 to 5 meters range of tides is required to create electricity. The energy of tides can be harnessed with three main technologies. The first one is *a barrage* or *dam* across an estuary, which forces water to flow through turbines and power a generator (Image 3.17). The second one is *tidal fences*, which look like giant turnstiles. The turnstiles are spun by ocean currents and generate electricity. The third one is *tidal turbines* (Image 3.18, Image 3.19), similar to wind turbines, except they are situated under water (Smith and Taylor 2008).

Image 3.17: Tidal Power Plant



Source: REUK.co.uk. (2007).

Image 3.18: Tidal Turbines



Source: Recharge News (2010).

Image 3.19: Tidal Turbine

Source: The CS Monitor (2011).

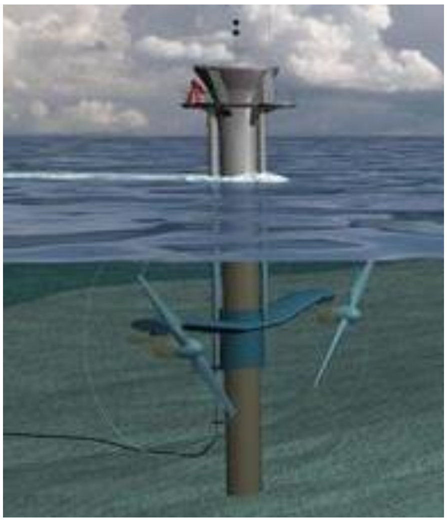
3.5.1.3 Marine Current Energy

Energy from water currents can be harnessed with water turbines (Image 3.20, Image 3.21), which work on the same principle as wind turbines. The kinetic energy of the moving water is transformed into mechanical energy in a turbine and subsequently into electricity. The current velocities of the water are smaller than those of air; thus sea turbines are smaller than wind turbines (Ngo and Natowitz 2009).

Image 3.20: Marine Current Turbine

Source: Gizmondo (2008).

Image 3.21: Marine Current Turbine



Source: REUK.co.uk. (2007).

3.5.1.4 Wave Energy

Wave system converts the mechanical force transmitted by the waves into electricity in both onshore and offshore applications. *Offshore* applications (Image 3.22, Image 3.23) are located in water that is over 30 meters deep. The Salter duck is the best known device. The motion of the waves is used to power pumps or to pressurize water that turns a turbine. Special sea vessels can generate electricity from waves as they travel across the ocean by funneling water inside the craft to turn turbines. *Onshore* applications (Image 3.24) use three technologies to use power of breaking waves on the shore. The first is *the oscillating water column*. Air is compressed and depressurized by water that enters the column. It is then used to spin a turbine and generate electricity. The second is *a tapchan,* or *tapered channel system,* which feeds into a reservoir located on a cliff above sea level. The narrowing of the channel causes the waves to increase in height and spill over into the reservoir. The water from the reservoir then flows back down to the sea through a turbine which produces electricity. The third is *a pendulor device,* i.e. a box open to the sea at one end with flap hinged over it. The flap is moved back and forth by the wave motion, which powers a hydraulic pump and generator (Smith and Taylor 2008).

Image 3.22: Wave Farm

Source: Inhabitat (2008).

Image 3.23: Wave Farm

Source: OffshoreWIND.biz (2012).

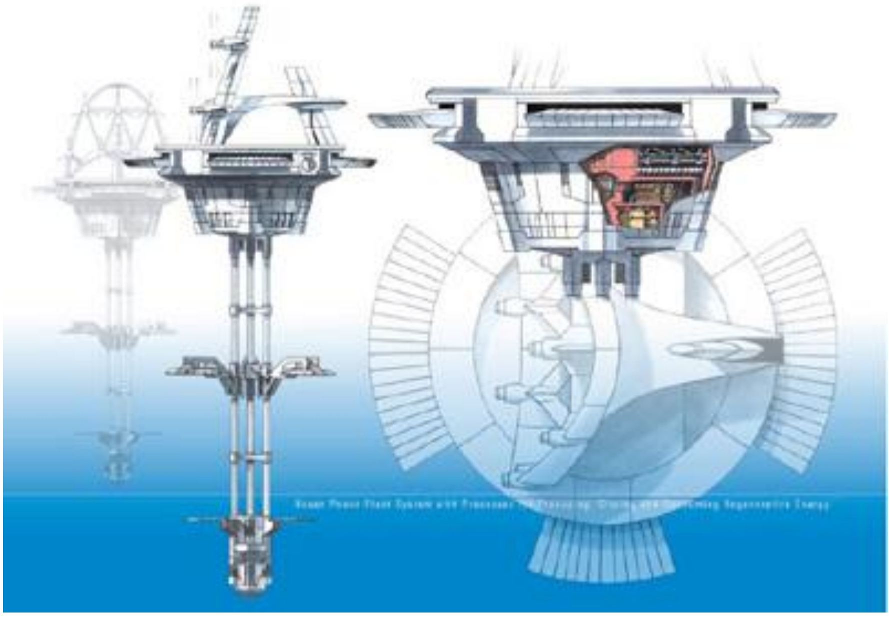
Image 3.24: Wave Power Plant

Source: Daily Kos (2008).

3.5.1.5 Ocean Thermal Energy Conversion (OTEC)

Ocean thermal conversion is caused by temperature differences in the water. The top layer of the water is much warmer than water from the bottom. If the difference is about 20°C, the conditions are proper to generate electricity by specially constructed devices (EREC 2010). There are three OTEC technologies (Image 3.25). The first is *a closed-cycle system*. Low-boiling fluid is vaporized by warm surface water and used to turn the turbine. Cold deep sea water is used to condense the vapor back into liquid where it is returned back to the system. The second is *the open-cycle system*. Warm seawater, placed into a low-pressure container, boils, and the steam is used to turn the turbine. The steam is then turned into fresh water and exported from the system, and new ocean water is used. The third technology is *the hybrid system*. The steam from the open-cycle process is used to vaporize the low-boiling-point fluid used in the closed-cycle system, which is used to turn the turbine (Smith and Taylor 2008).

Image 3.25: Ocean Thermal Energy Conversion Plant



Source: EV World.com (2006).

3.5.1.6 Osmotic Energy

If fresh water mixes with salt water, energy can be harnessed using pressure-retarded osmosis or and electro-dialysis process. Both process uses osmosis with ion-specific membranes. Solutions with higher concentrations of salt have higher osmotic pressure (Aswathanarayana, Harikrishnan and Sahini 2010). The main use of osmotic pressure is in reverse-osmosis applications to produce fresh water from salt water (Image 3.26) (Ngo and Natowitz 2009).

Image 3.26: Osmotic Power Plant

Source: Power Technology.com (2012).

3.5.2 Historical Development

In 1100, a tidal-powered mill was built in England (Smith and Taylor 2008). In 1909, a harbor lightning system in California was powered with a wave energy system (EREC 2010). In the 1930s, a French engineer, Georges Claude, built the first OTEC power plant in Cuba. In 1967, the first commercial tidal electric generator plant was completed in France, capable of producing 240 kW of electricity. In 1995, the first commercial wave-powered electricity generator started to operate. It was also the first plant to commercially power water desalinization plants (Smith and Taylor 2008). The global installed capacity of hydropower in 2011 was nearly 2.7 percent, at approximately 970 GW. In 2011, hydropower generated 3,400 TWh electricity (REN21 2012).

3.5.3 Environmental Impact

Small-scale hydropower has a relatively low impact on the environment because the civil engineering requirements are smaller (Ngo and Natowitz 2009). Ocean energy is responsible for almost no chemical pollution. Some devices might contain very slight amounts of hydraulic oil, but extra precautions are taken to make sure that oil is sealed within the machine. Ocean energy devices are not known for being visually unappealing, and they cause noise pollution (Craddock 2008). There is some danger that fish could become trapped within ocean energy devices, but turbines can be designed to move slowly to allow fish to pass, and cages can be used to prevent damage to larger species (Cipiti 2007). Large wave energy plants could alter coastal sediment transport patterns and affect coastal erosion patterns. The tidal power plant dams could alter estuarine flow patterns, which could lead to a buildup of pollutants in bays and estuaries, and could block fish migrations (Haven 2011). The tidal barriers can destroy the habitat of some birds and sediment, trapped behind the barriers, can accumulate, which can reduce the volume of the reservoir (Ngo and Natowitz 2009).

3.5.4 **Advantages**:

- ocean energy is reliable, inexhaustible and free,
- ocean energy devices have low environmental impacts,
- ocean energy is a viable source for remote areas,
- removing heat, caused by global warming, from oceans is good,
- there are zero fuel costs,
- there is no chemical pollution,
- small hydropower plants have a long lifespan: up to 100 years,
- small hydropower is highly efficient (from 70-90 per cent),
- small hydropower improves grid stability,
- OTEC plants produce electricity 24/7,
- OTEC plants bring valuable, nutrient-rich waters to the surface,
- submerged current plants do not face storm stresses and damage,
- submerged ocean bottom plants do not create visual impacts or disrupt shipping, recreation, or fishing lanes (Craddock 2008, Asmus 2009, EREC 2010, Haven 2011).

3.5.5 **Disadvantages**:

- shore-mounted devices can interfere with shipping and receiving of various imports and exports,
- OTEC plants have the lowest efficiency of any power plant,
- the cost to build OTEC plants is 2 to 4 times that for conventional plants,
- wave energy converters are cost prohibitive,
- waves are unpredictable and intermittent,

- wave energy is widely dispersed, so plants will have to stretch across the ocean, which would require long transmission lines and losses, and be therefore very expensive to build and maintain,
- tidal power plant dams are potentially a hazard to shipping,
- the tidal plants' turbine will be subject to rapid corrosion and marine fouling, thereby increasing maintenance costs,
- large-scale use of ocean currents for power generation could lower average current speed, shift the flow patterns, and affect weather and climate patterns,
- some argue that only wave and tidal energy have significant potential to become commercially viable, but technologies based on temperature and salinity gradients and marine biomass have little chance (Craddock 2008, Aswathanarayana, Harikrishnan and Sahini 2010, Haven 2011).

3.6 ADVANCED HYDROGEN TECHNOLOGIES

Hydrogen is not an energy source but a carrier of energy. It has to be created with either fossil fuel or renewable energy sources. Today, hydrogen is mainly used to make ammonia and methanol, to refine oil, to hydrogenerate food oils, and as a rocket propellant. If it is used with oxygen in a fuel cell mixed, or it is converted into a fuel, it can create electricity and power vehicles (Smith and Taylor 2008).

3.6.1 Basics of the Technology

There are some different methods of producing hydrogen (Image 3.27). Today, 96% of the hydrogen produced and used is derived from fossil fuels. Producing hydrogen from fossil fuels proceeds through the manufacture of syngas. Syngas is a mixture of carbon monoxide and hydrogen. Three most common ways to produce hydrogen are the vaporeforming of natural gas, partial oxidation of oil residues, and gasification of coal. To have a clean source of hydrogen, hydrogen must be produced from water via electrolysis (Ngo and Natowitz 2009).

Image 3.27: Hydrogen and Synthesis Gas Plant

Source: Linde Engineering.

3.6.1.1 Vaporeforming

Vaporeforming consists of using water to produce hydrogen from hydrocarbons. It is used mainly with hydrocarbons such as methane, naphtha, or liquefied petroleum gas. The reaction proceeds at a pressure from 20 to 30 bars at a temperature of about 900°C in the presence of a nickel catalyst. The natural gas must be first desulfurized. The syngas obtained is a mixture of hydrogen, water, and carbon dioxide. With vaporeforming and conversion, 75% of hydrogen and 25% of carbon dioxide can be obtained. It is necessary to separate carbon dioxide from hydrogen and to eliminate the impurities. This can be done with methanation and selective adsorption on molecular sieves (pressure swing adsorption process) (Ngo and Natowitz 2009).

3.6.1.2 Partial Oxidation

Oil residues of hydrocarbons and natural gas can be converted into hydrogen and carbon monoxide. Oxygen is used at temperatures between 1200 and 1500°C and pressures from 20 to 90 bars in the presence of water vapor. If a temperature of about 600°C is used, the catalyst must be present. The produced syngas is then treated by reforming it in the same way as in vaporeforming. The resulting gas must be desulfurized.

The cost of the hydrogen produced by this technique is twice than that in vaporeforming. (Ngo and Natowitz 2009).

3.6.1.3 Autothermal Reforming

Autothermal reforming is at an experimental stage, but can be used in the gas-to-liquid process, in which one synthesizes fuels like natural gas and using the Fischer-Tropsch reaction. This reaction allows the conversion of a mixture of carbon monoxide and hydrogen into synthetic hydrocarbons. The reaction needs a catalyst, such as iron and cobalt (Ngo and Natowitz 2009).

3.6.1.4 Coal Gasification

First, coal is gasified in the presence of water oxygen in order to produce syngas. This is then converted hydrogen and carbon dioxide. Three main technologies are used for that. The first is a fixed-bed technology, in which the gases circulate through coal particles of dimensions from 3 to 30 mm. The temperature is between 800 and 1000°C and the pressure is between 10 and 100 bars. The second one is the fluidized-bed technology, in which the coal particles of 1 to 5 mm are in a suspension in a gas current. The temperature is between 800 and 1000°C. The third is the forced-flow technology, in which particles are of about 0.1 mm. The temperature is between 1500 and 1900°C and the pressure is between 25 and 40 bars (Ngo and Natowitz 2009).

3.6.1.5 Producing Hydrogen In Situ

In a reformer, fuel molecules are broken from ethanol, methanol, gasoline, etc. Using air or water a gas mixture containing hydrogen (of about 30%), carbon monoxide, and carbon dioxide is obtained. Carbon monoxide damages fuel cells, which is why its concentration must be reduced below 10 ppm. For that, a series of chemical reactions at high temperature in the presence of a catalyst must be made (Ngo and Natowitz 2009).

3.6.1.6 Electrolysis of Water

An electrolysis cell is composed of an anode maintained at a positive potential and a cathode at a negative potential, connected to a current generator. The electrodes are in an electrolyte, which is generally an acidic or basic solution, or a polymeric exchange membrane of ions, or a conducting ceramic membrane. In this process, energy is passed through water, transforming it into hydrogen and oxygen (Ngo and Natowitz 2009).

3.6.1.7 Thermochemical Cycles

To decompose water into hydrogen and oxygen, temperatures higher than 3000°C are needed. The iodine-sulfur cycle is a chemical process in which the hydrogen iodide breaks up at lower temperatures and the formed iodine reacts with sulfur dioxide and water to form sulfuric acid and hydrogen iodide (Ngo and Natowitz 2009).

3.6.1.8 Biological Production

In anaerobic and aerobic biotopes, hydrogen can be produced with photosynthetic microorganisms. The principal enzyme is hydrogenase, which catalyzes the decomposition of water. There are three possibilities. The first is the photosynthetic process, in which photosynthetic organisms directly produce hydrogen from solar energy. The second one is anaerobic digestion. The third is photofermentation, in which anaerobic digestion leads to acetates that are transformed into carbon dioxide and hydrogen by photosynthesis (Ngo and Natowitz 2009).

3.6.1.9 Photolysis

Photolysis of water uses sunlight to dissociate water into oxygen and hydrogen. Titanium dioxide (TiO_2) or gallium arsenide (GaAs) are used for this purpose (Ngo and Natowitz 2009).

3.6.1.10 Hydrogen Storage

There are three main hydrogen storage technologies: compressed gas, liquid tanks, and solid metal hydrides. Compressed hydrogen requires one fifth the volume of an equivalent amount of gasoline at the maximum pressure 700 bars. Compressing hydrogen takes energy, which results in a loss of energy. Liquid hydrogen occupies about the same volume as extremely highly compressed gas. To liquefy hydrogen, the temperature must be -259°C. A super insulated tank is required to withstand the pressure. Hydrogen stored in metal hydrides has the same volume as highly compressed hydrogen without the pressure. The most efficient process to distribute hydrogen is to compress it (Cipiti 2007).

Some other possibilities for hydrogen storage exist. Hydrogen can also be stored in carbon nanotubes by chemisorption or physisorption, nanofibers, fullerenes, porous carbon with high surface area, zeolites, glass spheres, and organic compounds (Ngo and Natowitz 2009).

3.6.2 Historical Development

In 1800, William Nicholson and Sir Anthony Carlisle used electrolysis to break water down into hydrogen and oxygen. In 1802, Humphry Davy described the first fuel cell, which would be the basis for generating electricity through electrolysis in future hydrogen energy applications. In 1839, William R. Grove invented the first fuel cell, which was used to convert hydrogen into electricity. In 1959, Harry Karl Ihrig made the first hydrogen fuel cell to power a 20-horsepower vehicle. In 1992, Japan developed first practical, portable fuel cell, capable of producing 250 watts of electricity (Smith and Taylor 2008). Currently, hydrogen is produced from fossil fuels, which is not a clean source of hydrogen (Ngo and Natowitz 2009).

3.6.3 Environmental Impact

Hydrogen, when burned as a fuel, emits only water and heat. However, the use of fossil fuels in the production of hydrogen generates emissions (Cipiti 2007).

3.6.4 Advantages:

- it can be generated from renewable energy sources and fossil fuels,
- it offers very efficient conversion ratio of fuel to energy,
- it has clean on-site power generation (Asmus 2009).

3.6.5 Disadvantages:

- expensive technology,
- it is highly flammable and explosive,
- even compressed hydrogen takes up much more volume than gasoline for the same energy content,
- fuel cell power plants take up lot of space and could disturb habitats,

- no system yet exists to supply and distribute hydrogen,
- the efficiency of the hydrogen economy is low (Cipiti 2007, Asmus 2009, Haven 2011).

3.6.6 Fuel Cell

A fuel cell works much like a battery, but it does not need to be recharged as long as there is fuel (hydrogen or natural gas, for example) and oxygen from the air available. It chemically converts the energy in a fuel into electricity and hot water (Asmus 2009).

3.6.6.1 Basics of the Technology

There are two parts to a fuel cell: a delivery system and the electro-chemical cell. The delivery system is usually a high-pressure gas canister. The second part, the electro-chemical cell, is used to convert fuel into electricity (Haven 2011).
Fuel is put on one side, oxygen on the other side. At the anode, the catalyst splits the fuel into protons, which pass through the electrolyte, a special membrane. The electrons flow out of the fuel cell to the electric appliance before passing to the cathode, where they recombine with the protons and oxygen to form water (Seifried and Witzel 2010).

3.6.6.1.1 Different Types of Fuel Cells

There is a wide variety of different fuel cells. The six primary types are alkaline, proton exchange membrane, phosphoric acid, molten carbonate, solid oxide, and direct methanol fuel cell. Each one produces electricity, but operates at different temperatures, and employs a specific catalyst (Ngo and Natowitz 2009).

3.6.6.1.1.1 Alkaline Fuel Cell (AFC)

An AFC is the oldest type and the least expensive. Such cells were used by NASA in space vehicles, and in portable devices. It functions at temperatures between 80 and 260°C, and pressures up to 4 bars. Their typical useful life spans are 15,000 h (Ngo and Natowitz 2009).

3.6.6.1.1.2 Proton Electrolyte Membrane Fuel Cell (PEMFC)

The key of a PEMFC is an electrolyte membrane, which conducts protons but not electrons. Such cells are used in automobiles, trucks, buses, trains, ships, and submarines, stationary units and portable devices. It functions at temperatures between 80 and 100°C (Ngo and Natowitz 2009).

3.6.6.1.1.3 Phosphoric Acid Fuel Cell (PAFC)

A PAFC allows large power outputs, but has the disadvantage of using a corrosive liquid electrolyte: phosphoric acid. The fuel for this cell can be hydrogen, natural gas, propane, or biogas. It functions at temperatures between 190 and 210°C and is used in stationary units (Ngo and Natowitz 2009).

3.6.6.1.1.4 Molten Carbonate Fuel Cell (MCFC)

An MCFC uses an electrolyte, which is a mixture of molten carbonates. High power outputs can be obtained. It functions at temperatures 650°C and is used in stationary units (Ngo and Natowitz 2009).

3.6.6.1.1.5 Solid-Oxide Fuel Cell (SOFC)

An SOFC uses an electrolyte, such as a ceramic made of solid oxide, usually zirconium dioxide doped with yttrium. It functions at temperatures between 800 and 1000°C, which makes it less sensitive to pollutants or impurities present in the fuel. The fuel can be hydrogen, natural gas, or other molecules containing hydrogen atoms. The SOFC is used in stationary units and transportation (Ngo and Natowitz 2009).

3.6.6.1.1.6 Direct Methanol Fuel Cell (DMFC)

A DMFC is fueled by methanol or ethanol and uses a solid electrolyte. Such cells are used for laptop computers, cellular phones, etc., stationary units and transportation. It functions at temperatures between 50 and 120°C (Ngo and Natowitz 2009).

3.6.6.2 Historical Development

In 1839, English lawyer Sir William Grove invented the fuel cell. In the late 1960s, fuel cells came into practical use and started powering NASA's Gemini and Apollo space capsules (Haven 2011).

3.6.6.3 Advantages:

- fuel cells have high efficiencies and have no moving parts inside the cell, so they are noise- and vibration-free,
- as the fuel source, hydrogen is abundant and readily obtainable,
- the technology is virtually pollution free,
- fuel cells are portable, so there is no need for transmission systems and losses (Ngo and Natowitz 2009, Haven 2011).

3.6.6.4 Disadvantages:

- no system yet exists to supply and distribute hydrogen,
- fuel cells are very expensive,
- fuel cell power plants take up lot of space and could disturb habitats,
- methanol is extremely toxic to humans: its ingestion can cause neurological problems, blindness, and death if the concentration is sufficient (Ngo and Natowitz 2009, Haven 2011).

3.7 SOME OTHER ALTERNATIVE SOURCES OF ENERGY

3.7.1 Hot Fusion

In 2006, the European Union, the United States, China, India, Japan, South Korea, and Russia signed an agreement to build an international fusion project called ITER. It is being built in France, by to 2015. It will be an experimental reactor that will not be used to produce electricity on a large scale but to provide new data to building the first nuclear fusion power plant. Thus far, hot fusion has been unable to provide any energy for human needs (Smith and Taylor 2008).

3.7.1.1 Basics of the Technology

Hot fusion is the combination of light atoms into a heavier atom. It requires a considerable amount of energy to make the light atoms fuse. It is called "hot" because the fusion fuel must be heated to extreme temperatures of over 10 million degrees Celsius. It must also be kept dense enough, and confined for at least one second to trigger the energy release.
Two different experimental approaches are being studied. The first one is fusion energy by magnetic confinement, which uses strong magnetic fields to trap the hot plasma. The second one is fusion by inertial confinement, which involves compressing a hydrogen pellet by smashing it with strong lasers or particle beams (O'Keefe, O'Brien, and Pearsall 2010).

3.7.1.2 Advantages:

- hot fusion is safer than fission because there is no risk of an uncontrolled chain reaction,
- fusion plants produce no pollutants (Postnote 2003, Haven 2011).

3.7.1.3 Disadvantages:

- scientists have not yet been able to produce a controlled hot fusion reaction that could generate cost-effective electricity,
- the problem with hot fusion is in developing a method of heating the fuel to sufficiently high temperatures and confining it long enough,
- the fuel for hot fusion is deuterium and tritium; tritium is radioactive,
- tritium ingested in the human body is a poses a serious long-term threat to health,
- some hot fusion reactor components are radioactive,
- hot fusion plants require a huge nuclear reactor, a plant for electricity and large amounts of water for cooling; thus, it requires large centralized plants, which are too expensive for developing countries (Postnote 2003, O'Keefe, O'Brien, and Pearsall 2010).

3.7.2 Electrical Cogeneration

Coke furnaces, giant boilers, glass furnaces, refinery furnaces, etc. all provide blasts of heat. Much of that heat becomes unwanted waste steam that the plant must dispose of. Cogeneration uses this waste heat. Thus, cogeneration is the production of two useful forms of energy in a single energy conversion process. Cogeneration plants are also called combined heat and power systems (Image 3.28).

Cogeneration systems focus on using waste heat to create a second product. If the plant creates electricity, with cogeneration some nearby facility can use the heat to heat buildings. If the plant is used to create industrial heat, the waste heat can be used to generate electricity.

The greatest innovation in cogeneration is an in-home residential cogeneration unit that runs on natural gas or propane, produces electricity and supplies the house with hot water (Haven 2011).

Image 3.28: Cogeneration Plant

Source: Stanford News (2012).

3.7.2.1 Advantages:

- cogeneration systems increase overall efficiency, release less waste heat into the atmosphere, and reduce pollution (Haven 2011).

3.7.2.2 Disadvantages:

- cogeneration requires a demand for electricity and heat at the same place, on the same cycle,
- cogeneration systems are small and privately owned. Owners often cannot afford the most modern pollution-abating equipment,
- expensive (Haven 2011).

3.7.3 Smart Grid

The term "smart grid" has many definitions. In general, a smart grid involves the development of software and small-scale technology, such as smart meters and new electricity rate structures (TheCapitol.Net 2009). Smart grids involve the delivery of electricity from the suppliers to the consumers through much more efficient, higher-voltage long-distance transmission lines, connected to all generators of electricity, including intermittent sources of energy, like solar and wind. Smart distribution networks are connected by the Internet to smart meters at homes, substations, transformers, and other elements of the transmission and distribution grid. Electric-energy storage units are placed throughout the transmission and distribution networks, and are placed near or in the facilities owned by end users. Distributed intelligence is information-rich two-way communication throughout the grid. A smart-grid distribution system will allow consumers to use time-of-day pricing to reduce their energy costs, and smart meters will help consumers take control of their energy use patterns. Electricity consumers will be able to determine in advance how much they want to pay for their power each month, and make choices about what devices, appliances, lighting will be used in order to meet the price target (Gore 2009).

Within integrated systems, from home to the power plant, the smart grid has two scopes. The first scope is *transmission monitoring and reliability*, which includes real-time monitoring of grid connections, improved automated diagnosis of grid disturbances, better aids for the operators, automated responses to grid failures, the ability to connect new generating plants to the grid, and an enhanced ability to manage large amounts of some renewable energy resources, such as wind and solar. The second scope is *consumer energy management*, which includes the installation of smart meters and other technologies that have the ability to signal homeowners and businesses that power is expensive or in tight supply, that allow the utility to automatically reduce the consumer's electricity consumption when power is expensive or scarce, that automatically detect distribution line failures, identity the specific failed equipment, and help determine the optimal plan for dispatching repair crews to restore service, and that help to install distributed generation and implement an approach that allows operators of generators to sell surplus power to utilities (TheCapitol.Net 2009, 27-28).

3.7.3.1 Advantages:

- the smart grid will be digital, self-monitoring, self-healing,

- the smart grid will eliminate many power outages, minimize others, and assist utilities and informing them where emergency repairs are needed,
- the smart grid is less vulnerable to the threat of digital terrorist acts,
- the smart grid will be more reliable, secure, efficient, less costly to operate, and far less harmful to the environment,
- the smart grid reduces the peak electricity demand,
- the smart grid saves energy, reduces the costs to the consumer, improves reliability and transparency, and therefore offers a better resource management system for the consumers desiring more economical use of energy,
- smart grids combine the principles of decentralization and democratization of energy generation and consumption, improving energy and economic efficiency, better energy and electricity security,
- smart grid investment creates thousands of jobs,
- implementation of the smart grid and related technologies could increase annual gross domestic product (Gore 2009, TheCapitol.Net 2009, Aswathanarayana, Harikrishnan and Sahini 2010).

3.7.3.2 **Disadvantages**:

- the technologies necessary to build a smart grid are still evolving, and there are no operational systems to evaluate,
- smart grid components are expensive, and countries have to invest billions in smart grid technologies (Aswathanarayana, Harikrishnan and Sahini 2010, TheCapitol.Net 2009).

3.7.4 Energy Storage

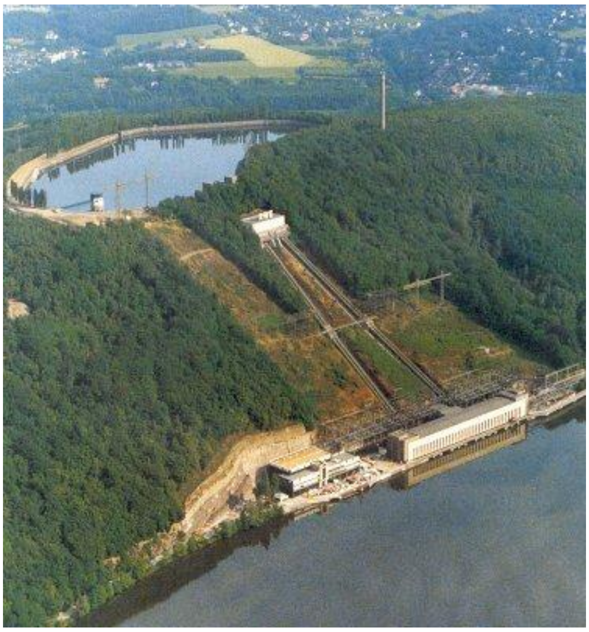
Utility companies depend on power plants to produce energy constantly. Power plants that use fossil fuels or nuclear energy can produce energy day and night. Power plants that use renewables can produce energy only when conditions are good. Electricity producers need to make extra electricity, especially for hours with peak demand. They need to be able to store electrical energy (Haven 2011).

Stored electrical energy can minimize the total amount of installed power that is needed. Power-generating facilities can store electricity during off-peak hours, when it is cheap and the demand is low. Unused electricity at a given time can thus be used later to meet peak demand (Ngo and Natowitz 2009).

3.7.4.1 Pumped Storage System

A pumped storage system (Image 3.29) is based on pumping water up to a higher reservoir during off-peak hours, when demand is low. When the peak demand hours begin, the water is allowed to fall back down to spin turbines that generate electricity, where the surplus electrical energy is transformed into potential energy. Powers of approximately 1GW can be obtained (Ngo and Natowitz 2009).

Image 3.29: Pumped Storage System



Source: FutureLab (2007).

3.7.4.1.1 **Advantages**:

- these technology reduces total pollution, use free energy, and help slow the demand growth on the grid and give other supply technologies more time to develop,
- this technology is well adapted to dealing with fluctuations in demand and to meeting peak demands at certain hours of the day,
- an efficiency of about 70 to 80 percent can be obtained (Haven 2011, Ngo and Natowitz 2009).

3.7.4.1.2 **Disadvantages**:

- this option is not available in areas without lower and higher areas,
- capital costs of pumped storage facilities are large, and long times are needed for their construction,
- reservoirs are like dams, that need to be built because of erosion,
- the problem with storing excess energy from the off shore wind farms can be solved by pumping seawater out of the reservoir; like a horseshoe-shaped artificial island, planned to be built in Belgium (Gore 2009, Ngo and Natowitz 2009, Strong 2013).

3.7.4.2 Compressed Air Energy Storage

Compressed air energy storage system (Image 3.30) involves power pumps that pump compressed air into underground sealed spaces. When needed, the air can be released to blow across turbines and create electricity (Haven 2011).

Image 3.30: Compressed Air Plant

Source: Wired Science (2010).

3.7.4.2.1 **Advantages**:

- this technology uses energy that is otherwise being wasted, reduces total pollution and help slows the demand growth on the grid and give other supply technologies more time to develop (Haven 2011).

3.7.4.2.2 **Disadvantages**:

- its use is limited by the availability of sealed underground spaces,
- in the unloading phase, some heat is required, which is usually solved with natural gas-fired burner, which emits carbon dioxide (Ngo and Natowitz 2009, Haven 2011).

3.7.4.3 Flywheel

A flywheel (Image 3.31) is huge, heavy spinning wheel that stores energy. During low demand times, a power plant shunts excess energy into making a flywheel spin faster. During peak demand periods, the flywheel connects to a turbine that produces electricity (Haven 2011). The flywheel consists of a rotating cylinder and a motor that accelerates a cylinder to a high speed. When the flywheel is allowed to slow down, the rotating energy is converted back into electricity (Ngo and Natowitz 2009).

Image 3.31: Flywheel

Source: Saro`s Corner (2011).

3.7.4.3.1 **Advantages**:

- this technology reduces total pollution, use free energy, and help slow the demand growth on the grid and gives other supply technologies more time to develop,
- flywheels have long lifetimes and require little maintenance (Ngo and Natowitz 2009, Haven 2011).

3.7.4.3.2 **Disadvantages**:

- the size and expense of these units has limited their attractiveness (Gore 2009).

3.7.4.4 Batteries

Batteries do not create energy, but they store it. They are used to power electrical equipment when it is impossible or inconvenient to plug into the grid. Lead acid batteries are still the most commonly used batteries. Newly invented sodium-sulfur batteries use molten sulfur inside. They are fully rechargeable and can store 40% more energy than lead acid batteries. Silver zinc batteries (was originally developed by NASA) have the same efficiency. Currently, the most commonly used batteries in hybrid cars are lithium ion batteries (Haven 2011).

3.7.4.4.1 **Advantages**:

- batteries make intermittent renewable technologies economically feasible and are key to their expanded use (Haven 2011).

3.7.4.4.2 **Disadvantages**:

- electricity from a battery is much more expensive than the same amount of electricity taken directly from the grid,
- the process of manufacturing batteries produces air and water pollution,
- discarded batteries saturate the ground with heavy metals,
- new high-capacity batteries depend on rare metals, such as lanthanum, neodymium, and dysprosium (Haven 2011).

3.7.4.5 Other Storage Systems

According to Gore (2009) and Haven (2011), some innovative and developing storage systems are also worth mentioning: molten salt heat exchanger, footfalls, nanotechnology.

A *molten salt heat exchanger* can be ideal for solar thermal plants, which produce large amounts of heat from the sun to boil water. Excess electricity or heat can heat nitrate salts and turn the salts into a liquid, which retains its heat for weeks. When the liquid is re-solidified back into salts, it releases its stored heat, which can drive a power plant.

Footfalls are ideal for buildings where large numbers of people climb up and down stairs each day. The downward pressure of our foot on the stair can be used to generate electricity. Each person could produce 6 watts per stair.

Some believe that the application of *nanotechnology* to solid-state electrical energy storage devices will lead to a development in solid-state chips. Nanotechnology could be also applied to a nanofabric that would keep our body temperature constant in any weather, so that could eliminate the need for space heating and cooling and therefore reduce residential and commercial electrical demand.

3.7.4.5.1 **Advantages**:

- these technologies reduce total pollution, use free energy, and help slow the demand growth on the grid and give other supply technologies more time to develop (Haven 2011).

3.7.4.5.2 **Disadvantages**:

- these systems are still untested, so some negatives may emerge (Haven 2011).

4 NEW ENERGY

4.1 COLD FUSION

One possible potential energy for a clean future is cold fusion. Cold fusion could be a major scientific discovery that might end the energy crisis. Other names such as low temperature fusion, low energy nuclear reactions (LENR), chemically assisted nuclear reactions (CANR), lattice-assisted nuclear reactions (LANR), condensed matter nuclear science (CMNS) and lattice-enabled nuclear reactions have been put forward for these reactions.

Cold fusion is a nuclear process that releases significantly more energy than nuclear fission. It occurs when ordinary hydrogen and an isotope of hydrogen (deuterium) are being fused. Scientists fuse them at room temperature with metals such as palladium, titanium, nickel and lithium (Krivit and Winocur 2004).

4.1.1 Basics of the Technology

One of the most common methods used to perform cold fusion experiments, (and that used by Fleischmann and Pons) is that of electrolysis (Image 4.1, Image 4.2). Electrolysis is the process of passing an electrical current through a liquid, such as normal water (H_2O), and separating the hydrogen atoms from the oxygen atoms. In the case of heavy water (D_2O), deuterium atoms are separated from the oxygen atoms.

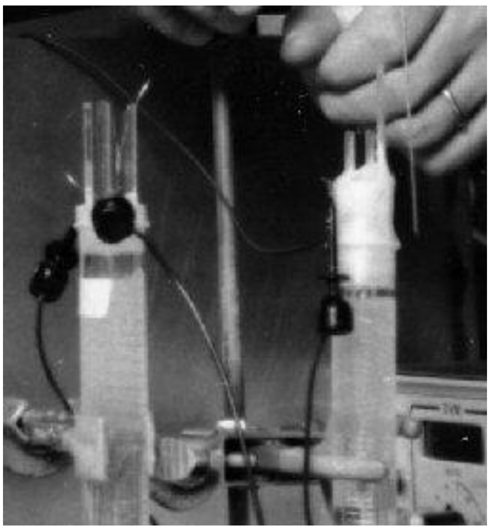
In a classic cold fusion electrolytic cell, platinum is usually connected to the positive terminal, and palladium is usually connected to the negative terminal of the power source.

Because pure water does not conduct electricity, the addition of salts to the liquid allows the electricity to flow through the solution, from one rod to the other. The heavy water solution is separated into its elemental components, deuterium and oxygen, by flow of current (Krivit and Winocur 2004, 5-7).

The electrolysis of heavy water shows a positive rate of excess heat generation that increases markedly with current density. The total specific energy output is 100 to 1000 times larger than the heat generation of reaction of chemical processes (Fleishmann et al. 1990).

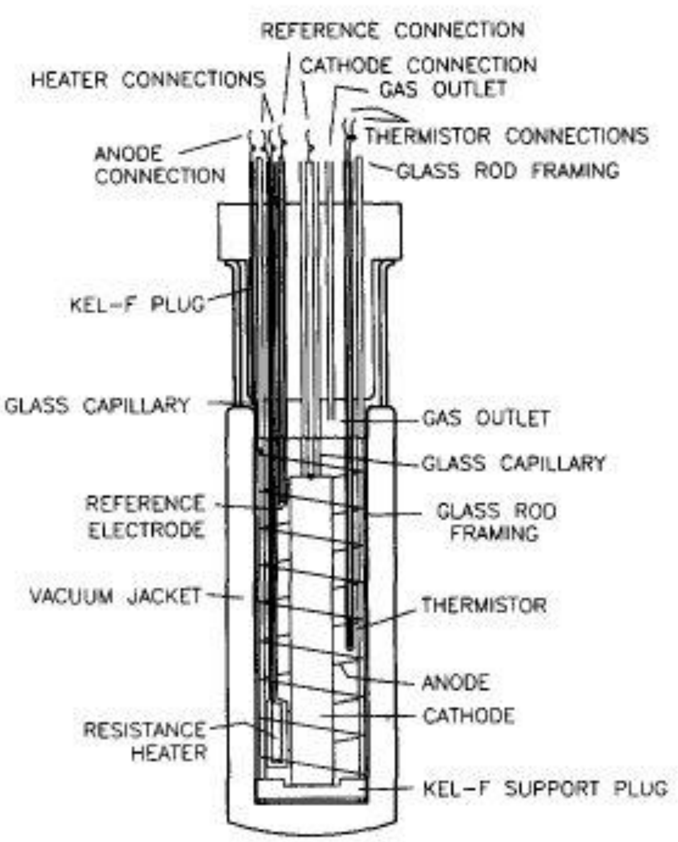
In terms of its physical configuration and mechanical complexity, the apparatus is far less complex than the hot fusion apparatus. However, any cold fusion electrolytic experiment is extremely complex, deceptively so, on a smaller scale. Scientists must contend with a multitude of electrical, chemical, material science, metallurgical and time variables that all occur within the palladium cathode and the cell (Krivit and Winocur 2004, 5-7).

Image 4.1: Fleischmann-Pons cold fusion cells



Source: New Energy Times (2012).

Image 4.2: Schematic Diagram



Source: New Energy Times (2012).

4.1.2 Historical Development

In 1926, Paneth and Peters reported that they had used hydrogen to make helium within palladium and retracted the report the following year as mistaken. In 1984, Martin Fleishman and Stanely Pons, both chemists, began experimenting with electrolytic cells to fuse deuterium inside a palladium lattice. In March 1989, Fleischman and Pons held a press conference about the fusion process. They claimed that they discovered a form of nuclear fusion that works at room temperature. By 1990, many researchers reported evidence of LENRs, so the First Annual Conference on Cold Fusion (ICCF) in Salt Lake City was held that year, with over 200 researchers in attendance (Mizuno 1998, Beaudette 2002).

In January 2011 two scientists, Andrea Rossi and Sergio Focardi, announced that they had developed a cold fusion device capable of producing 12,400 W of heat power with an input of just 400 W. Instead of palladium they used nickel (PhysOrg.com 2011).

By 2012, 17 ICCFs were held in different countries (Italy, Japan, USA, Monaco, Canada, China, France, Russia, India). The last ICCF was held in 2012 in South Korea, with 157 attendees from 19 countries (Nagel 2012). Since February 2012, several first-generation 1 MW ECAT power plants have been running failure-free (Lichtenberg 2012).

4.1.3 Environmental Impact

Cold fusion produces no, or very small amounts of radiation and there are no radioactive byproducts. Some LENR experiments produce some traces of tritium, which is a radioactive form of hydrogen. However, its radiation is so weak that it cannot penetrate human skin and can be shielded against with a piece of paper (Manning and Garbon 2009). LANR have the ability to generate unlimited amounts of energy from water, without any environmentally destructive products, such as greenhouse gases and radioactive waste (JET Energy).

4.1.4 Advantages:

- deuterium can be obtained from the ocean and is inexhaustible,
- LENR-based energy technology is environmentally friendly,
- does not emit greenhouse gases,
- it does not produce radioactive waste,
- LENR may solve global climate and energy issues,
- LENR could power transportation, provide distributed generation for homes, some industrial applications, desalinate water, irrigate deserts,
- LENR could possibly replace petroleum, natural gas, coal, fission nuclear and could be possibly less expensive than renewables,
- cold fusion could shift the balance of political power in the world, because fuel (water) is available to everyone (Krivit and Winocur 2004, Manning and Garbon 2009, Bushnell 2011, Lichtenberg 2012).

4.1.5 Disadvantages:

- the experiments are difficult to reproduce,
- the experimenters who demonstrated cold fusion over the years have been unable to explain the underlying mechanism that drives the reaction,
- currently, we rely exclusively on those mainstream scientists, journalists and pundits who deny the reality of new energy, such as cold fusion (Manning and Garbon 2009, O`Leary 2009, Wolchover 2011).

4.2 FREE ENERGY

Free energy is also known as ether or aether, zero point energy (ZPE), zero point field, vacuum energy, quantum vacuum, quantum gravity, dark matter.

Free energy is alive within spaces smaller than the diameter of a nucleus of an atom (Manning and Garbon 2009). It is a source of potentially unlimited clean energy, which defines the minimum energy that an atom could possess. It is also called zero point energy, because at a temperature of absolute zero the kinetic energy of molecules of a substance retains. So the vacuum is therefore not empty but full of activity. It has pressure, density, and substance. With a minimum of quantum physics, the free energy can be simply regarded scientifically as electromagnetic energy (Valone 2008).

4.2.1 Historical development

In 1891, Nikola Tesla, was the first to recognize the existence and properties of zero point energy (ZPE). In 1912, Max Planck derived the formula that marked the birth of the concept of ZPE. In 1913, Albert Einstein, using Planck's formula as a basis, described the energy fluctuations of thermal radiation and used ZPE term. In 1914, Debye included ZPE and showed its effects on X-rays. In 1948, Casimir predicted forces from ZPE and Sparnaay verified it in 1958. In 1984, Forward described ZPE battery and indicated that ZPE seems to have a definite potential as an energy source. In 1987, Puthoff found that electron-atomic energy state is ZPE and in 1989 claimed that gravity is ZPE. In 1994, Haisch blamed ZPE for inertia. In 1999, Pinto invented a ZPE engine. In 1996, Frank Mead was the first that patented the conversion of ZPE. In 2005, Christian Beck claimed that dark energy had been measured in the lab (Valone 2008, Ch. 2).

The *Casimir effect* evidence shows that random electromagnetic waves remain after all energy is removed. If you put two metal plates close together in a vacuum, they will slowly move towards each other. Outside the plates, all sorts of waves can occur. Quantum pressure is the one that pushes the plates together (YouTube 2011a).

4.2.2 Searl Effect Generator

Free energy covers a spectrum of clean energy technologies. One of which is the Searl Effect Generator (SEG).

The SEG is a device that does not create energy but collects, compresses and converts energy, present everywhere, into usable electricity. The SEG is based on linear induction motor technology on a circular track, riding on a magnetic bearing. The principal is essentially the same as the energy cycle of a hydroelectric power plant that harness water as part of an open system, but the SEG does it at the quantum level with electrons that can absorb and emit kinetic energy, to harness outside energy. To start the system, the SEG uses the abundant reservoir of electrons in rare earth metal neodymium (Morris 2012).

4.2.3 Environmental Impact

Devices such as the SEG generate electrical power by converting natural outside energy regardless of the weather. It does not rely on fossil fuels, so it is a carbon-free alternative (The Searl Solution 2012a). The SEG is a green and clean renewable approach that can provide electrical power to supplement the growing demand for energy with SEG power plants. It is clean, healthy, safe and sustainable alternative (Morris 2012). When the SEG produces useful energy, it creates negative ions to its surrounding environment, causing contaminants to be removed from the air by causing them to drop to the ground (The Searl Solution 2012b).

4.2.4 Advantages:

- the SEG offers the cost effective production of electricity, with low maintenance costs,
- anything that can be run electrically can be driven by an SEG,
- the SEG can be scalable from a small portable unit, to a very large generator,
- SEG technology would eliminate air pollution, solve the energy crisis and support economic growth,
- during operation, the SEG generates unusually high electrical potentials that ionizes the air and kills bacteria and viruses, which can be used to purify the air in hospitals, homes, work places,
- the by-product of the SEG is a cooling effect, which can be utilized for air conditioning or refrigeration purposes,
- the SEG would function well in areas with limited or no access to resources and can be utilized to support local power substations and help the current electrical grid that has problems with losing energy,
- the SEG is more economical than conventional methods in the markets today (The Searl Solution 2012a, The Searl Solution 2012b, Morris 2012).

4.2.5 **Disadvantages**:

- the development and implementation of free energy devices has encountered a great deal of resistance over many years because of the obvious economic repercussions to major oil industries, energy distribution monopolies and stiff ideologies,
- the SEG has not yet researched to be understood by mainstream academia nor by the energy industry (The Searl Solution 2012a, Morris 2012).

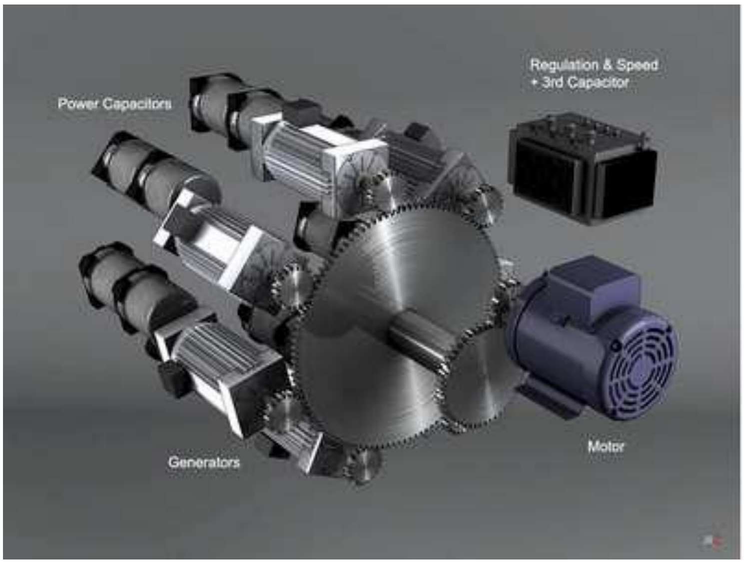
4.3 Motor-Generator Self-Looped with Usable Energy Left Over

A motor turns a larger output generator, and the generator is producing enough energy to keep the motor running, as well as enough left over to power something else; a starter motor initiates its running. It stays going without the help of starter motor until it is turned off. Energy source could have something to do with the phase angle harvesting vacuum energy (PESWiki 2012a).

4.3.1 Karl Palsness' Theory

The theory is based on magnetic flux. Permanent magnets or electromagnets, such as in a generator or a motor, under certain conditions, yield overunity behavior. It is based on the geometry of the system (Image 4.3, Image 4.4) (Sterling 2012).

Image 4.3: Motor-Generator Self-Looped



Source: PESWiki 2012.

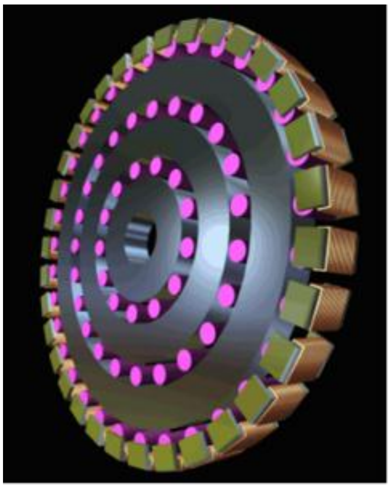
Image 4.4: Motor-Generator Self-Looped

Source: PESWiki 2012.

4.4 Magnet Motor

“A magnetic motor (or magnet motor) is a device which converts power of or relating to or caused by magnetism (e.g. "magnetic forces") into mechanical force and motion, with no other input. It usually provides rotary mechanical motion. The machines that utilizes the properties of a magnet for mechanical energy.” (Image 4.5) (PESWiki d).

Image 4.5: Free Energy Magnetic Motor



Source: Free Energy Blog.com.ar (2010).

4.5 Gravity Motor

Gravity acts at a distance, without a clear energy source. The application of gravity in gravity motors, involves a moving weight that is attached to a wheel in such a way that they are repelled for one half of the wheel's rotation, and attracted for the other half. Weights further from the center apply a greater torque; if such a device worked, the result would be a perpetually rotating wheel. The weights may be hammers on pivoted arms, or rolling balls, or magnets (PESWiki b).

At this time, there are no known functioning gravity motors (PESWiki c).

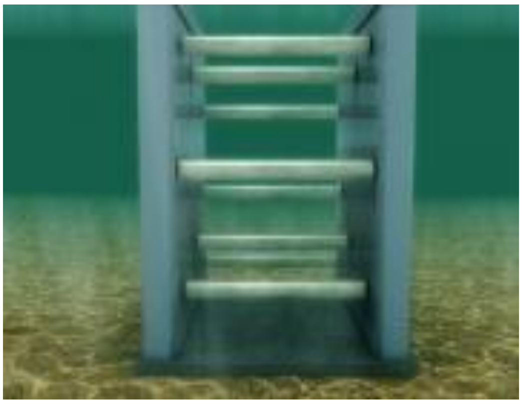
Image 4.6: F. M. Chalkalis Stands in Front of his Gravity Wheel Mechanism.

Source: PESWiki 2010.

4.6 Vortex Technologies

"A vortex is a flow (or any spiral whirling motion) with closed streamlines. The shape of media or mass rotating rapidly around a center forms a vortex. It is a flow involving rotation about an axis (not always oriented vertically, though; sometimes possessing a horizontal axis)." (PESWiki e).

Image 4.7: VIVACE Converter



Source: The Sustainability Laboratories (2009).

The VIVACE Converter (Vortex Hydro Energy) (Image 4.7) harnesses hydrokinetic energy of river and ocean currents. The energy contained in the movement of the cylinders is then converted to electricity (Arnow 2009).

5 CURRENT ISSUES AND POLICIES

Conventional fossil and nuclear fuels are the cause of political corruption, terror threats, pollution, climate change and other externalities. To minimize these effects and bring renewables at the forefront, governments around the world have created different types of policy mechanisms that bring considerable advantages to electricity consumers, electric utilities, politicians, businesses, farmers and society at large.
The following chapters present the policies and strategies that have helped alternative energy sources to expand in many countries around the world.

5.1 CLIMATE CHANGE

Human activities, such as emissions from the use of fossil fuels, clearing of land, and some industrial processes are mostly responsible for elevated levels of greenhouse gases (GHG), which results in warming Earth's climate. The growing global population and economic growth, with dependence on fossil fuels and need for expanding agricultural lands, are expected to raise GHG emissions and induce climate change to levels that could become adverse, especially for people in dry regions that are already vulnerable (Farrugia 2010, Ch. 3).

5.1.1 Current Climate Change Issues

According to Farrugia (2010, Ch. 3) most warming of the Earth's surface has occurred since the Industrial Revolution. Several changes, such as increased precipitation, increased ocean temperatures, altered wind patterns, extreme weather events, melting glaciers and sea ice, and in the timing of seasons, have been observed.

The natural presence of greenhouse gases (GHG), especially water vapor and carbon dioxide, warms the Earth to habitable temperatures; however, according to most scientists, the majority of the Earth's warming is due to GHG emissions from human activities.

5.1.2 Greenhouse Gases (GHG)

Greenhouse gases include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and certain fluorinated compounds, including chlorofluorocarbons (CFC), hydrochlorofluorocarbons (HCFC), hydrofluorocarbons (HFCs), and perchlorofluorocarbons (PFCs), sulfur hexafluoride (SF_6), and nitrous trifluoride (NF_3). These GHG gases remain in the atmosphere for decades to thousands of years, and their warming effects are largely global and persist for decades to millennia. The GHG concentrations increase, if emissions of the long-lived GHG are greater than their removals, such as photosynthesis. Some human activities can balance GHG emissions: carbon removals and sequestration in growing forests, some agricultural soils, and other reservoirs (Farrugia 2010, Ch. 3).

Human activities caused an increase of GHG by 70 percent between 1970 and 2004 (IPCC 2007a, 36). Carbon dioxide has increased mostly due to fossil fuel use in transportation, building heating and cooling, deforestation, decay. Methane has increased mostly due to human activities related to agriculture, natural gas distribution and landfills. Nitrous oxide has increased mostly due to fertilizer use and fossil fuel burning. Halocarbon gas concentration has increased mostly due to refrigeration agents and other industrial processes (IPCC 2007a).

5.1.3 Direct Global Warming Potentials (GWP) Relative To Carbon Dioxide

The table below refers to the warming potential of some particular gases relative to carbon dioxide over 20-, 100-, and 500-year periods, even though some gases will stay in the atmosphere much longer and their total greenhouse effect over time will be greater. A comparison of gases according to their GWP is useful because it takes into account the warming potential of each molecule of a gas and its atmospheric lifetime.

For example: In a 100-year period, 1 mass of atmospheric carbon dioxide has GWP of 1, while a mass of methane has 25, which means that methane is 25 times more powerful a greenhouse gas than carbon dioxide, and stays in the air roughly 12 years. However, the 20-year GWP of methane is 72, which means that the impact of methane is even more powerful in a shorter period (IPCC 2007b, 31-35).

Table 5.1: Warming Potential of Some Gas Relative to Carbon Dioxide

Gas	**Lifetime**	**Global Warming Potential**		
(common name)	**(years)**	**20-years**	**100-years**	**500-years**
carbon dioxide (CO_2)		1	1	1
methane (CH_4)	12	72	25	7.6
nitrous oxide (N_2O)	114	289	298	153
hydrofluorocarbons (HFC-23; CHF_3)	270	12,000	14,800	12,200
perchlorofluorocarbons (PFC-318; c-C_4F_8)	3,200	7,310	10,300	14,700
sulfur hexafluoride (SF_6)	3,200	16,300	22,800	32,600

Source: IPCC (2007b, 33-34).

It important is to take into consideration not only carbon dioxide but also other greenhouse gases; this shows that livestock are responsible for 18 percent of greenhouse gas emissions, which is a bigger share than that of transport. "Only" 9 percent represents carbon dioxide emissions, but 37 percent of methane and even 65 percent of nitrous oxide. Livestock is also responsible for 64 percent of ammonia emissions (Steinfeld et al. 2006). Methane emissions per cow range between 110 and 130 kg per year (FAO 2010). Therefore, the release of 130 kg of methane for each cow is equivalent to about 3250 kg carbon dioxide.

5.1.4 The International Policy Fields

Some legislative actions were accepted to mitigate climate change.
In 1992, 192 countries joined United Nations Framework Convention on Climate Change (UNFCCC) to stabilize greenhouse gases (GHG) concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.
In 1997, 175 countries signed the Kyoto Protocol, where agreed that mandatory GHG reductions are necessary to avoid dangerous anthropogenic interference. Countries agreed to reduce their greenhouse gas emissions by 5% on average for the 2008–2012 period (Farrugia 2010, Ch. 3).

5.1.5 Regulatory and Market Tools to Reduce Greenhouse Gases (GHG)

There are several economically efficient ways to reduce GHG emissions. Governments can do so substantially by putting a price on GHG emissions. This can be done with source-by-source regulations and/or with market mechanisms, such as GHG fees or carbon taxes and cap-and-trade systems (Farrugia 2010, Ch. 3).

5.1.6 Source-by-Source regulations

Emissions reductions can be achieved by setting emission performance standards on each source of pollution, or requiring that sources use a particular type of technology. Regulatory controls have proven to be effective, though there have been some disadvantages. Regulators have had weak information about the costs of technology for each individual source, regulations can be difficult to adjust as circumstances change, and a desired emission reduction target at the least possible cost often cannot be achieved (Farrugia 2010, Ch. 3).

5.1.7 Market Mechanisms

Market mechanisms begin with regulations that can achieve emissions reduction but at lower overall costs. Two principal types of market mechanisms eligible for greenhouse gases (GHG) reduction are GHG fees or carbon taxes, and cap-and-trade systems. Both mechanisms potentially generate revenues.

GHG fees or carbon taxes provide certainty about the prices paid by sources, but uncertainty about how much GHG would be reduced. They are charged to the source of emissions whose managers attempt to reduce its emissions to the level where it is no longer cheaper to make the reductions than to pay the tax.

Cap-and-trade systems provide certainty in how much GHG would be reduced, but uncertainty concerning the prices paid by sources. The regulator sets an overall cap on emissions and allocates responsibility for achieving the cap to individual sources. Emission sources can sell their unneeded emission allowances, or buy them if they emit more than their allowances may comply (Farrugia 2010, Ch. 3).

5.1.8 Market Facilitation Tools

To be more efficient, market mechanisms work with non-regulatory policies that reduce emissions at the lowest costs. Several policy tools exist to make consumers and investors more interested in investing in new technologies.

Two types of policy tools stimulate demand for new technologies. The first is technology-forcing regulations that stimulate demand for better and more cost-effective technologies. Price incentives stimulate technological change and decentralize decision-making to consumers and suppliers. The second is tax incentives that reduce the price to purchasers of certain technologies.

There are also other policy tools that act on the supply of technologies. These are subsidies to research and development (R&D) of new or improved technologies, which are in the form of tax credits for R&D, cost-sharing grants or contracts, direct investments, and loan guarantees; technology awards or prizes offered to innovators that develop advanced technologies; government procurement policies that set standards for performance and guarantee the purchase of technology at a particular price, or by purchasing a technology with lower emissions, even if it is not at the lowest price; federal research with a focused cadre of researchers, with sufficient resources and allowed to pursue high-risk, high-payoff projects that could facilitate technological breakthroughs and radical change in energy systems (Farrugia 2010, 65-66).

5.1.9 Options to Ease the Economic Transition

The global economy has optimized its infrastructure to depend on fossil fuel. To help ease the transition of the current economy to one optimized around low greenhouse gases (GHG) emissions, several policy mechanisms exist: timing the total required GHG reductions to coincide with normal retirements of equipment and infrastructure and when new investment may be made; trading, banking and borrowing of allowances allow sources to manage the timing of their reduction at least cost; information campaigns that help sources anticipate the regulatory regime; investment in appropriate infrastructure that enables deployment of emerging technologies; regulatory and permitting regimes that are adequately prepared for new technologies in new locations (Farrugia 2010, 66-67).

5.2 PUBLIC POLICIES

Governments attempt to enhance the quality of our lives through public policies. Public policies are statements or actions that reflect the decisions, values, or goals of policy makers. There are many different types of public policies. One way to classify them is to distinguish among distributive, redistributive, and regulatory policies. Distributive policies allocate the benefits of resources to more members of society, while redistributive policies shift resources or benefits from advantaged groups to disadvantaged groups, and regulatory policies set guidelines for the actions and practices of private individuals, firms, or businesses (Wilson 2006, 12–15).

5.2.1 The Case for Policy Intervention

The numerous advantages of new energy sources strongly suggest policy interventions. First, a complex web of policies, programs, and subsidies are already in place, thus a compelling public interest to intervene in a free market is required. Second, there are numerous environmental externalities associated with conventional sources exploitation, conversion, and use. In contrast, renewables have significantly lower environmental externalities. Third, private decisions consider only short-term effects and ignore long-term problems. Policy change is needed to ensure that long-term issues so renewables could prevail (Komor 2004).

5.2.2 Policy Goals

Clarifying goals makes selecting specific policies much easier. Policy goals should include reducing environmental harm, meeting a carbon reduction target at the least societal cost, promoting fuel diversity, minimizing the economic harm, and promoting industrial and economic development (Komor 2004, Ch. 1).

5.2.3 Policy Tools for Energy Technology Innovation

Policies that direct and pace energy technology innovation include technology-push and market-pull policies, which attempt to help with the energy-related economic, environmental, and national security challenges. Policies on the technology-push side fund ERD&D (energy research, development, and demonstration) activities, encourage increased participation of the private sector, and increase the quality and the quantity of the ETI (energy technology innovation) workforce. Policies on the market-pull side encourage the early deployment and widespread diffusion of new energy technologies through direct expenditures, tax-related expenditures, financial support, spur ETI by setting technology performance standards, and impose climate regulations to encourage ETI (Gallagher 2009, Ch. 5).

5.2.4 Policy Context

Governments throughout the world have not created one global energy policy. Throughout history, they have ensured that sufficient supplies of fuel have been available. There is a variety of models how to control energy. Establishing the appropriate framework is important. The United Nations Framework Convention on Climate Change (UNFCCC), which came into force in 1994, and The Kyoto Protocol, ratified in 2005, provided a framework for energy policy that has an impact on future of energy (O'Keefe, O'Brien, and Pearsall 2010).

5.2.5 Categorization of 20th Century Subsidies

According to Healey and Pfund (2011, 16), a framework of the different kinds of subsidies that have played a role in shaping today's energy infrastructure and markets are:

a) Tax Policy, which includes special exemptions, allowances, deductions, credits, related to the federal tax code.

b) *Regulation*, which includes incentives that can contribute to public confidence and acceptance of facilities and devices employing a new or potentially hazardous technology; they can also influence the price paid for a particular type of energy.
c) *Research and development*, which includes federal funding for research and development and demonstration programs.
d) *Market Activity*, which includes direct federal involvement in the marketplace.
e) *Government Services* are services traditionally and historically provided by federal governments without direct charge.
f) *Disbursements* involve direct financial subsidies such as grants.

5.3 POLICY MECHANISMS

There are about nine commonly used policy mechanisms that governments around the world accepted to promote renewable energy. These are feed-in tariffs (FITs), renewable portfolio standards and quota systems, tradable certificates and Guarantees of Origin, voluntary green power programs, net metering, public research and development expenditures, system benefits charges, tax credits, and tendering. Hundreds of independent studies and empirical findings support FITs as one of the most effective tools to rapidly increase the share of renewable energy production in use (Mendonca, Jacobs, and Sovacool 2010).

According to Mendonca, Jacobs, and Sovacool (2010, xxiv) the advantages of renewable electricity usage are economic, financial, environmental, social, political, geopolitical, technical and medical; it can engender an energy system where fuel is free, cheap, easy to find, infinitely replenished, supply is reliable and often indigenous, the risk of resource conflicts is minimized as countries use domestically available resources, almost any building, parking lot, field or body of water can be used to generate electricity, the environmental burdens associated with electricity being recede, and where economies become stronger by using more local employment, keeping revenues within the community and promoting competitive manufacturing sector.

5.3.1 Policy Drivers

One of the most powerful job-creating sectors is the renewable energy industry, with its comprehensiveness and coordination of energy policy, providing more jobs per unit of delivered energy than fossil fuel industry.

Policy drivers have been most apparent in renewables, but are spreading in other areas, such as extended producer responsibility, public and private sector green procurement, eco-labeling, recycling and anti-landfill mandates, green building standards, energy efficiency retrofits, sustainable transport, renewable energy and energy efficiency targets, mandates and incentives, solar roof programs, solar thermal ordinances, tax credits, portfolio standards, fuel efficiency standards.

Renewable energy success is dependent on renewable energy resources, and political determination and social awareness. Targets for the deployment of renewables send signals to the market and to those who wish to participate in it. However, this is not possible without the policies that support conditions to reach them and penalties for not doing so (Mendonca, Jacobs, and Sovacool 2010, 8–9).

5.3.2 Public Engagement

Public engagement and acceptance are clearly linked to the nature of investment possibilities. Policies can allow or prevent investment and participation of the general public, which can accelerate or hold back renewable energy deployment.

A growing global population with growing needs and wants, where people distance themselves from the natural environment, cannot bring a smooth transition to a renewables-based energy system. With some policy mechanisms, people could become empowered, interested, active and aware partners in remaking some of the fundamental aspects of society (Mendonca, Jacobs, and Sovacool 2010, Ch. 1).

5.3.3 Barriers to Renewable Energy Deployment

The diffusion of energy technologies has historically been a slow process, taking decades or even centuries. Government intervention can help overcome financial and market impediments, political and regulatory obstacles, cultural and behavioral, and environmental challenges. Government intervention is essential to correct the market failures, political inconsistencies, cultural biases, and misconstrued environmental impact. Robust public policy is needed to create a more just and equitable electricity sector (Mendonca, Jacobs, and Sovacool 2010).

5.3.3.1 Financial and Market Impediments

Financial and market impediments include a lack of information. The production and consumption of information will not occur sufficiently in markets without intervention and education. Those that have information may have strategic reasons to manipulate its value. Consumers can reject what can even be in their interest or the interest of society due to a lack of information.

Financial and market impediments also include improper discount rates and unacceptably high rates of return for other energy investments. Those who could benefit from renewable energy the most often have the least money to invest in it.

Another economic barrier occurs when consumers use technologies selected by others, architects, engineers, builders, who overemphasize up-front costs rather than life-cycle costs.

The last barriers that create predatory and discriminatory practices are practices undertaken by energy firms and electric utilities that attempt to impose fees to connect to the grid, and a desire for businesses and industries to stick to their core mission rather than invest in new forms of energy supply (Mendonca, Jacobs, and Sovacool 2010, Ch. 8).

5.3.3.2 Political and Regulatory Obstacles

Political and regulatory obstacles encompass inconsistent government standards. Entrepreneurs that attempt to invest require consistent conditions. Frequently changing factors, such as tax credits, depreciation schedules, cash flow, insert an extra level of uncertainty into the decision-making process. Another obstacle for renewable energy projects is the large number of authorities that have to be contacted for a large variety of permits, which leads to bureaucratic delays, project delays and adds to the cost of projects.

The biggest impediment concerns government subsidies for fossil fuels and nuclear power technologies over renewables. Such subsidies lower the cost of producing the dirtiest forms of electricity, muddle the market signals that consumers receive, encourage the overconsumption of resources and higher electricity use, and lead to capacity developments and consumer patterns in excess of true needs (Mendonca, Jacobs, and Sovacool 2010, Ch. 8).

5.3.3.3 Cultural and Behavioral Barriers

Cultural and behavioral barriers relate to public misunderstanding about electricity and public expectations about cheap and abundant forms of electricity supply. Most families do not make conscious decisions about electricity consumption and renewable energy at all. People prefer the existing energy system not because it is optimal, but because it is convenient. A strong personal desire among consumers to prioritize comfort, control, freedom, trust, social status, ritual and habit, can shape attitudes for and against renewable energy and sustainability. People tend to remember plausible arguments favoring their own positions and implausible arguments opposing their positions, serving perceived needs for self-justification and not seeking objectives facts (Mendonca, Jacobs, and Sovacool 2010, Ch. 8).

5.3.3.4 Environmental Barriers

Environmental concerns, such as the death of birds resulting from collisions with wind turbine blades, contamination of ecosystems in solar, hydro, geothermal biomass cases, and all other renewables with their own environmental issues, create much less damage to the environment and society than conventional power plants. The existing electricity prices that consumers see on their bills do not reflect the fact that fossil fuel and nuclear plants are the world's largest users of water, produce millions of tons of solid waste, emit mercury, release matter and other noxious pollutants into the atmosphere, and cause widespread social inequity. Consumers do not have to pay for cost of transportation, air pollution, water contamination and land use. If consumers had to pay for all that, the external costs for conventional sources would exceed their current production cost. In contrast, the external costs for renewable energy are much, much smaller (Mendonca, Jacobs, and Sovacool 2010, Ch. 8).

5.3.3.5 Commonly Used Policies around the World

By 2012, many countries around the world had active policies, plans, or targets for renewable energy and climate change mitigation. Policy makers are increasingly aware that renewable energy includes energy security, reduced import dependency, reduction of greenhouse gas emissions, prevention of biodiversity loss, improves health, job creation, rural development, and energy access.

Two of the most commonly used policies in this sector are feed-in tariffs (FITs) and renewable portfolio standards (RPS). At least 65 countries and 27 states used FIT policies and at least 18 countries, 53 other jurisdictions used RPS policies (REN21 2012, 14-15).

5.3.4 FEED-IN TARIFFS (FITs)

A feed-in tariff (FIT) is a policy with different names, such as Renewable Energy Payments (REPs) and Advanced Renewable Tariffs (ARTs).

FITs provide a specified price for purchases of renewable power. Producers are offered a guaranteed price for each unit of electricity fed into the grid, power companies are required to purchase all electricity from eligible producers in their service area over a long period of time, all electric utilities and transmission operators are forced to connect all possible renewable power providers to the grid, and utilities are mandated to pay the interconnection costs or the grid expansion costs, which are then distributed among all electricity consumers.

FITs are independent from governmental spending, which results in them being relatively unaffected by the economic and financial crisis; they provide a stable and successful incentive for new investment and job creation (Mendonca, Jacobs, and Sovacool 2010).

5.3.4.1 Basic FIT Design Options

According to Mendonca, Jacobs, and Sovacool (2010, Ch. 2), the basic idea in designing FITs is to provide a balance between investment security for producers and reduce the additional costs for the final consumers. To accomplish these goals, designing FITs included some important steps.

First, the legislators must decide which renewable energy technologies they want to support. The choice is dependent on the resource that is available.

Second, those who design FITs have to determine which kind of power production plants shall be eligible. The policy maker usually limits tariff payment to the installed capacity of renewable energy plants.

Third, legislators have to establish the appropriate tariff level. If a tariff level is too low, it will not spur any investment in renewables. A tariff that is too high can cause higher costs for final consumers. The most successful countries based their FITs on the real generation costs plus a small premium, and offered sufficient returns on investment. The profitability of renewable energy generation has to be similar or higher than that of fossil or nuclear plants if we want to encourage investment in cleaner energy technologies. After a good frame for tariffs is established, cost factors have to be evaluated. Based on investment cost data, grid-related and administrative costs, operation and maintenance costs, fuel costs, and decommissioning costs, legislators can calculate the nominal electricity production costs for each technology.

Fourth, the policy-makers have to set technology- and size-specific FITs. That is necessary because of the large differences in generation costs among renewable energy technologies. Most FIT schemes set specific tariffs for a particular technology in relation to plant size. Larger plants are generally less expensive.

Fifth, the duration of tariff payment has to be defined. If a legislator desires a short period of guaranteed tariff payment, the tariff level has to be higher. In contrast, for a longer period, the level of remuneration can be reduced. A period of 15–20 years is the most common and successful approach, because a payment of 20 years equals the average lifetime of many renewable plants. When defining the duration of tariff payment, the legislators have three options. They can mandate that the FIT duration period has to be fulfilled or that the renewable electricity producer has the right to leave the FIT but has no right to re-enter, or the producer can switch between the guaranteed remuneration under the FIT.

Sixth, legislators have to create a robust financing mechanism that enables sharing the additional costs equally among all electricity consumers. The governments act only as regulators that determine tariff payment and establish the purchase obligation, but do not finance anything.

Seventh, the purchase obligation is very important investment security, because the grid operator is obliged to purchase and distribute all renewable electricity. This obligation protects renewable electricity producers in monopolistic or oligopolistic markets.

Eighth, priority grid access must be granted. Grid access rules often enable grid operators themselves to prioritize some generation units. Therefore, FITs include provisions that eligible plants must be connected to the grid.

Ninth, cost-sharing for grid connections must be regulated. Grid connection rules impact the overall profitability, and success of renewable energy policies. Due to the high cost of grid connection in relation to the total project cost, the deployment of renewable energy projects can be disturbed.

Tenth, the legislators must create effective administrative procedures that minimize long lead times for project approvals, the number of authorities involved, and the lack of inclusion into spatial planning.

Last, legislators must set renewable energy targets, mention them explicitly in the FIT legislation, and establish a progress report as the scientific basis for future adjustments.

5.3.4.2 Advantages

FITs benefit consumers, politicians, business, farmers, and society. Consumers can receive guaranteed payments, and benefit from additional revenue and the improved reliability of energy supply. Politicians benefit because FITs spur the manufacturing sector, which brings tax revenue and jobs. Business and farmers can install generation equipment and gain extra income. Society benefits from reduced greenhouse gas emissions and greater diversification of the energy sector (Mendonca, Jacobs, and Sovacool 2010).

More specifically, Mendonca, Jacobs, and Sovacool (2010, xxvii) show that economic advantages of FITs are creating green-collar jobs, creating domestic manufacturing and exporting industry, driving economic development, creating a hedge against conventional fuel price volatility, enabling businesses, urban or rural, to developing new revenue streams, helping to establish supply chains for renewable technologies, providing investor security, creating stable conditions for market growth, driving down the production costs of green electricity, developing and expanding export opportunities in the renewable energy sector, and encouraging new start-ups and innovators by transparent policy structure. Further, political advantages can increase the stakeholder base supporting renewable energy policies, demonstrate commitment to renewable energy deployment, create mechanisms for achieving renewable energy and emissions-reduction targets, increase understanding of potential citizen, community and business roles in environmental protection, increase energy security and energy independence, and promote a more decentralized and resilient electricity system. Next are the social advantages that encourage citizen and community engagement in activities protecting the climate and environment, empower citizens and communities, increase resilience of communities, make renewable energy a common part of the landscape and cityscape, and increase public support for renewables through direct stakes and increased exposure to renewables. The last advantages are environmental ones that reduce carbon emissions and other forms of pollution, encourage energy efficiency measures, and reduce dependence on fossil fuels.

5.3.4.3 Disadvantages

According Mendonca, Jacobs, and Sovacool (2010, Ch. 4), some negative experiences of some countries have proven to be counterproductive, when it comes to the rapid uptake of renewable energies.

First, already mentioned above, is a low tariff, which results in few if any investments in renewable energies. Second, high tariffs can undermine efficiency of support instrument, and eventually affect the overall stability of national FIT scheme. Third, a flat-rate tariff that gives the same fixed price for all renewables contradicts a FIT scheme allowing one to establish technology-specific support, and reduce unexpected profits. Fourth, the importance of minimum tariffs significantly reduces transaction costs. This advantage is lost, if a maximum tariff is set, where grid operators and producers have to agree on a tariff payment. Fifth, exemptions from purchase obligation can seriously jeopardize high investment security. Sixth, if governments try to finance FITs through taxes, the general state budget or fund scheme, FITs easily become the subject of political debates when the government changes or the national economy goes through difficult times. Seventh, if FITs are calculated based on electricity prices and avoided costs, the problem with low and high tariffs appear again. Eighth, the problems with capacity caps are the limitation of the total amount of newly installed capacity and consequently hindrance of the creation of mass markets. Usually, shortly before reaching the cap, the market heats up as all producers race to get connected to the grid; when the cap is reached, the market usually collapses as no more capacity can be installed. All this prevents the creation sustainable and predictable market growth, and stable supply chains. Ninth, activists and FIT advocates should fight for FITs to be established by law and not by indefinitely articulated policy.

5.3.5 RENEWABLE PORTFOLIO STANDARDS AND QUOTA SYSTEMS

Renewable portfolio standards (RPS) are sometimes called also Renewable Energy Standards, Sustainable Energy Portfolio Standards, the Mandatory Renewable Energy Target (in Australia), the Renewables Obligation (in the UK), or the Special Measures law (in Japan). RPS set quotas that force suppliers to utilize a certain percentage of their electricity sales, or generating capacity, from renewable energy resources. Quota schemes in Europe are based on trading certificates for target compliance, and are therefore called Tradable Green Certificate schemes (Mendonca, Jacobs, and Sovacool 2010, Ch. 9).

5.3.5.1 Advantages

According Mendonca, Jacobs, and Sovacool (2010, Ch. 9), quota schemes possess at least five advantages.

First, quotas can ensure a given quantity of renewable energy delivered by a given date. Second, quota schemes that are coupled with certificate trading schemes can give utilities and states a great deal of flexibility in meeting targets. Power providers can generate their own renewable energy, the one that is most eligible for them, import it from another state or purchase it on the commercial market. Third, most quota schemes policies are gradually phased in over time and do not require utilities to meet the standard all at once. Fourth, the most successful quota schemes are obligatory and have strict penalties for non-compliance. Fifth, quota schemes have relatively low administrative costs and burdens. A quota costs governments nothing, since its costs are spread among utilities and electricity consumers.

5.3.5.2 Disadvantages

According Mendonca, Jacobs, and Sovacool (2010, Ch. 9), quota schemes have at least six drawbacks.

First, quotas guarantee a certain quantity of renewable energy but prices are set by the existing market and are therefore not predictable and not fixed. Such an impediment may be significant for banks, insurance companies, and investing firms. Furthermore, penalties for non-compliance are often too low, so the utilities rather pay the penalty than invest in more expensive renewables.

Second, implementing agencies, investors and stakeholders must engage with inconsistent RPS goals, such as what counts as renewable energy, when it has to come online, how large it has to be, where it must be delivered, and how it may be traded, which halts investment in the renewable energy market.

Third, quota policies are less flexible in offering target support for specific renewable energy technologies and less effective at ensuring diversification among renewable systems. RPS tends to favor large-scale renewable energy power plants and does not support higher cost renewable energy resources, such as small-scale power plants.

Fourth, to ensure flexibility, many quota schemes rely on tradable certificates, which results in problems associated with tradable credits, which add to the cost of renewable energy

projects. Therefore some areas of the country will soon have a deficit of supply while others will have a surplus.
Fifth, quotas are ineffective at promoting sustained, rapid growth in renewable energy. The uncertainty of prices for renewable electricity encourages suppliers to deal with the risk, so they withdraw capital.
Last, quotas can limit the expansion of renewable energy support. If a quota is based on certificate trade, producers will try not to reach the target in order to keep the certificate price high.

5.3.6 TRADABLE CERTIFICATES AND GUARANTEES OF ORIGIN

Renewable energy credits (RECs) are also called Green Tags, or Tradable Green Certificates (TGCs) in Europe, and Renewables Obligation Certificates (ROCs) in the UK. They confirm that 1MWh of electricity was generated from a renewable resource.
RECs can be bundled, which means that the physical electricity and the certificate were transferred together. RECs that are unbundled refer to the credits that can be traded independently of the actual electricity and traded between utilities and governments to prove compliance with different renewable energy goals and targets.
RECs can also increase flexibility for electric utilities and power providers having to comply with renewable energy regulations and targets.
REC systems allow utilities and providers to generate their own renewable energy, purchase it from others, or buy credits for it (Mendonca, Jacobs, and Sovacool 2010, Ch. 9).

5.3.6.1 Disadvantages

According Mendonca, Jacobs, and Sovacool (2010, Ch. 9) REC systems face at least five challenges.
First, REC systems are expensive and complex. They consume time, and involve transaction costs for producers who certify and sell REC and those who must purchase and verify the authenticity of a REC. The high administrative expenditure excludes small and medium-size enterprises, and can hurt competition in the market. This can force small firms to go through larger utilities for power purchase agreements, which can lead to revelation of all information about projects.

Second, RECs force investors to deal with uncertain price fluctuations, which vary across regions and renewable technologies. This results in unclear price signals to renewable energy investors about the attractiveness of development activity.

Third, unbundling renewable electricity from credits, tradable credit schemes create segregation of electricity markets. Some benefits, such as diversification, cleaner air, better jobs, go to one community, the credit goes to another.

Fourth, RECs tries to increase flexibility and lower costs, which is why they favor least-cost technologies, and not less mature and different renewable energy resources.

Finally, REC schemes tend to support only renewable energy projects that would have nevertheless occurred.

5.3.7 VOLUNTARY GREEN POWER PROGRAMS

Voluntary green programs are also called Green Power Marketing, or Voluntary Green Power markets, or Utility Green Pricing. They enable consumers to voluntarily pay more to receive electricity from renewable resources. Green power programs can include both credits and actual electricity. The customer can join the program offered by a local electric utility or retail marketer to purchase renewable energy or credits (Mendonca, Jacobs, and Sovacool 2010, Ch. 9).

5.3.7.1 Advantages

According Mendonca, Jacobs, and Sovacool (2010, Ch. 9) green power programs have two advantages.

First, they allow customers in places that do not have renewable resources to support the development of renewable technologies elsewhere. Second, those who do not want to pay for the cost of renewable energy do not have to do so.

5.3.7.2 Disadvantages

According Mendonca, Jacobs, and Sovacool (2010, Ch. 9), green power programs have some disadvantages.

First, green power marketing schemes provide no guarantee that additional renewable energy capacity will be built. Managers have little incentive to improve or expand their programs if they are already receiving revenue from customers. Second, green power programs are not mandatory and are therefore used by a very small percentage of customers. Customers can choose conventional electricity at cheaper rates. Third, they try to avoid charging consumers too much, so they tend to promote only the lowest-cost renewable resources. Last, green power programs are more expensive than other policy mechanisms, because they need firms to certify credits, match buyers with sellers, track trades, and ensure that the same credit is not used more than once. These extra costs results in the fact that these programs are the first to be cut during economic crises.

5.3.8 NET METERING

Net metering enables those who connect renewable electricity systems to the grid to receive credit for the electricity they provide to the grid. It allows customers to track the power they consume from the grid and produce to the grid with a single meter. A net metering system enables producers of renewables that produce electricity when it is valued the most to receive higher credit for this more power. It also reduces administration costs for utilities and power providers.

Net metering fail to reflect the full environmental benefits of renewable energy and does nothing to promote large renewable energy power plants (Mendonca, Jacobs, and Sovacool 2010, Ch. 9).

5.3.9 RESEARCH AND DEVELOPMENT EXPENDITURES

Many governments promote renewables by directly paying for research and development (R&D). Many separate programs that are funded are part of major energy activity areas such as energy supply, energy's impact on the environment and health, low-income energy consumer assistance, basic energy science research, energy delivery infrastructure, energy conservation, energy assurance and physical security, and energy market competition and education.

R&D strategies are extremely flexible. Policy makers can support any particular technology, and can control the distribution of research funds. In addition, expenditures create jobs (Mendonca, Jacobs, and Sovacool 2010, Ch. 9).

5.3.10 SYSTEM BENEFITS CHARGES

System benefits charges (SBCs), also called Public Benefit Funds, or System Benefit Funds, or Clean Energy Funds, place a small tax on every kWh of electricity generated, and use the funds collected to pursue socially beneficial energy projects such as assistance to low-income consumers or investments in renewable energy (Mendonca, Jacobs, and Sovacool 2010, Ch. 9).

5.3.10.1 Advantages

According Mendonca, Jacobs, and Sovacool (2010, Ch. 9), SBCs have at least three advantages.

First, they raise significant amounts of money. Second, they distribute the cost of renewable energy among all ratepayers in a given region, forcing everyone to pay for the cleaner energy. Third, SBCs support the policy makers promoting of energy efficiency and other energy projects such as public campaigns about energy, consumer financing for energy efficiency investments, local research and development on new technologies and others.

5.3.10.2 Disadvantages

According Mendonca, Jacobs, and Sovacool (2010, Ch. 9), SBCs have been deployed only in single states or on in-state utilities, and been modestly funded compared to expenditures on electricity. The amount of funding differs from state to state, with only a small amount of money going towards renewables.

5.3.11 TAX CREDITS

Two types of tax credits are included in the promotion of renewable energy: investment tax credits (ITCs) and production tax credits (PTCs).

5.3.11.1 Investment Tax Credits

According Mendonca, Jacobs, and Sovacool (2010, Ch. 9), ITCs provide tax credits to taxpayers who decide to invest in renewable energy projects; ITCs provide a partial tax write-off to investors for a particular renewable energy technology.

ITCs facilitate investment in a specific technology, by shifting the burden of commercialization to companies and investors, and by offering investors a guaranteed and predictable source of tax relief.

Because ITCs give money for investment in a technology, they often spur research on poorly designed systems, and attract less experienced companies into renewable energy industry. They are also expensive, favor commercial installations, centralized and large-scale projects. Finally, many homeowners and manufacturers have no sufficient income to use ITCs efficiently, since they must have the capital up front for investment and can claim the credit when filing their taxes.

5.3.11.2 Production Tax Credits

According Mendonca, Jacobs, and Sovacool (2010, Ch. 9), PTCs provide the investor or owner of a qualifying property with an annual tax credit based on the amount of electricity generated by the facility.

PTCs have provided labor and greater investment in supply-chain capital, including lower risk premiums for manufacturing investment, enhanced private R&D expenditures, promoted cost savings, encouraged transportation savings from increased domestic manufacturing of components, and reduced financing charges and fees. A PTC also distributes the cost of renewable energy projects across all taxpayers. In exchange for the benefits of renewables, the government invests the tax revenue.

However, the PTC does little to help those who are interested in investing the funds, does nothing to raise money before a project starts, when it is most needed, and does not promote diversification of the renewables. PTCs costs governments money in foregone revenue each year; therefore, governments have less revenue available for other programs, so tax rates increase, which eventually creates a greater burden on those in poverty. Most developers needed to create complicated finance structures to raise the capital needed to take advantage of the PTC. The PTC is biased towards wealthy investors and large corporations who can afford to invest in renewables; it excludes individuals and small businesses and discourages community-based projects and investments in small-scale residential systems.

5.3.12 TENDERING

A tendering system, also called a bidding system, is a system in which renewable energy investors, developers and project owners are invited to apply to bid for a renewable energy contract. The bid that gives the lowest price is awarded the contract. Renewable electricity is sold at market prices, while the difference between the sale and purchase price is financed through a tax on all domestic electricity consumption (Mendonca, Jacobs, and Sovacool 2010).

5.3.12.1 Advantages

According Mendonca, Jacobs, and Sovacool (2010, Ch. 9), the tendering system enables a government to directly control the amount of renewable energy generation. With the contracts that are won on the basis of competitive bidding, providers can cut costs to make their bids more attractive, which transfers savings to tax payers and consumers, rather than to corporations or investors.

5.3.12.2 Disadvantages

According Mendonca, Jacobs, and Sovacool (2010, Ch. 9), because of lower purchase prices, the tendering system also has some disadvantages.

First, it hurts providers by persuading them to reduce costs to make their bid attractive, which can damage the investment and can lead to bankruptcy. Second, tendering does not create sustainable renewable energy growth, because it is based on auctions and calls for bids, and because firms often cannot know when the next round would be announced, which complicates investment decisions. Third, the intense price competition does not stimulate the development of a diverse renewable energy market and can worsen anti-competitive practices in electricity markets. That can translate into higher risks and costs. Fourth, since the chance of winning bids is low, many investors and potential power providers decide not to participate.

5.4 POLICY INSTRUMENTS

5.4.1 HYDRO

Governments around the world have supported hydro power with incentives such as federal construction and the operation of dams and transmission facilities, and the net expenditures of the power marketing administrations. Hydropower facilities formed larger project such as flood control, river navigability, regional development, and stimulation of economies. The primary purposes of building dams were irrigation, flood control, and public water supply, and later, electricity. Large hydroelectric facilities are usually government-owned companies, so they do not need to earn private sector rates of return, the price of electricity can be lower, and the risk of loss can be spread among taxpaying public. Government cooperation is also needed for land appropriation to clear the way for the reservoir.

In America, during the Great Depression in the 1930s, Hoover Dam was built to jump-start the US economy.

Norway and Brazil had a national energy policy to become entirely dependent on hydropower for electricity generation at present both are more than 80 percent dependent. In Brazil in 2001, a drought lowered reservoir levels to the point of cutting electricity generation by 20 percent, causing power disruptions and economic confusion. Consequently, Brazil now pursues a policy of energy diversification for electricity generation.

The Indian government is trying to reduce air pollution with hydropower, but faces strong environmental opposition to building dams.

Turkey and Syria have built large-scale dams to irrigate agricultural land, supply water to towns and cities, and generate electricity. Turkish dam projects severely reduced the water flow to Iraq, which destroyed large areas of Iraqi agriculture, forcing Iraq to import fruits, vegetables, and grain, and forcing Kurds and other indigenous people to move away from the reservoir. A water conflict, in which one or more countries have a plan to divert the headwaters of a stream or cut its flow used for irrigation and drinking water, can strain relations between countries or can lead even to war.

Ironically, environmentalists' success in preventing the building of dams, because of preservation and conservation of natural sources, can lead to the building of coal-burning plants that release harmful emissions. (Nersesian 2010, Ch. 8, Healey and Pfund 2011).

5.4.2 COAL

Since the Industrial Revolution, fossil fuels have been used to power the economy. Newcomen's engine led to Watt's steam engine, which spurred technological advances and replaced manual labor. Coal was soon needed as a substitute for wood, partly also because of deforestation. Countries around the world tried to encourage economic development with different energy policies that would encourage the production and consumption of vast quantities of coal. The US government enacted a protective tariff to give domestic producers a major cost advantage by regulating British merchants that had to transported coal to American ports free-of-charge as ballast for ships. In Pennsylvania, state officials exempted coal from taxation, provided incentives for smelters to promote its use, and publicized its advantages within and outside the state. The state also used corporate charters and sponsored a geological survey to encourage new production. Geological surveys identified rich deposits of coal, which lowered the cost of exploration.

Coal became the only source of energy for coal-driven engines, which gave rise to a quickly expanding transporting network. At that time, shipping and railroads were the only source of transportation. With heavy subsidies, by which governments allowed companies to subtract a portion of their income to recover initial capital investments, coal started to dominate for decades in transportation, heating houses and commercial buildings, home cooking, and also in electricity generation.

Countries with large coal reserves passed bills and regulations that promoted coal consumption in order to decrease the need for imported sources (Nersesian 2010, Ch. 4, Healey and Pfund 2011).

5.4.3 NUCLEAR

As fossil fuel prices continue to rise cap-and-trade programs for carbon emissions, or taxes on carbon are enacted, economics favor nuclear power. The higher nuclear power output was also the consequence of the reorganization of the electricity industry from a regulated cost-plus regime to a more liberalized competitive business environment.

Incidents, such as the Three Mile Island, Chernobyl and Fukushima, and the knowledge that terrorists could fly an airliner into a nuclear plant, halted many further orders of nuclear plants, and cancelled many orders for plants not yet started, or caused the conversion of some to fossil fuel plants.

France, as a world leader in nuclear power, did not have the coal and natural gas reserves to rely on for electricity generation after the oil crisis in 1973. The French people did not oppose the government decision to pursue nuclear power because they trusted the government officials, who were also scientists and engineers. Government-owned companies are responsible for all nuclear electricity-generating facilities and plants, and for nuclear waste, which reduces the risk premium that would have to be paid by publicly owned nuclear facilities, and ensures a simpler regulatory regime and the nation's electricity needs.
In the Unites States the Energy Policy Act of 2005 was enacted that provided a substantial tax credit for the first eight years of nuclear plant operation (Nersesian 2010, Ch. 8).

5.4.3.1 After Fukushima

In July 2012, Japanese authorities discovered that subcontractors at the Fukushima nuclear plant underreported the amount of radiation workers were exposed to so they could stay longer on the job. A subcontractor of the plant operator Tokyo Electric Power Company confirmed having nine workers cover their dosimeters with lead plates so that the instruments would indicate a lower level of radiation exposure (The New York Times 2012).

Radioactive contamination can negatively affect a diverse range of living beings. A group of researchers researched spiders, grasshoppers, dragonflies, butterflies, bumblebees, cicadas and birds at almost 1200 sites in Chernobyl and Fukushima, where major nuclear accidents happened. They believe that we should expect more negative effects on animals and including accumulated mutations (Moller et al. 2013).

Another team of researchers has also revealed that after the Fukushima disaster a specific species of local butterfly, the pale grass blue butterfly, which is widespread in Japan, has mutated. They discovered that radionuclides from the Fukushima Nuclear Power Plant caused physiological and genetic damage to this species, which is extremely sensitive to environmental changes. They collected the first batch of butterflies two months after the Fukushima disaster. This batch showed a 12.4 per cent rate of abnormality. They mated these insects far outside the Fukushima-affected area. Their offspring showed an 18.3 percent rate of the same mutations. With the third generation, the mutation rate rose to 33.5 percent, even though only one parent came from a Fukushima-affected population. An important finding was that the certain tendencies can be inherited by next generations (Hiyama et al. 2012).

The research is accompanied by some reports that radiation cover-ups were central parts of the Fukushima plant operations and that workers were not told of the dangers of radiation and encouraged to work in unsafe conditions (Vrba 2012).

After Fukushima, many countries around the world decided to shut down some or all nuclear plants or at least postpone or cancelled number of nuclear reactors under construction. Some global manufacturing giants shifted more of their business to solar and wind energy technologies and formally excited the nuclear energy business.
Germany is an example for other countries. It will close 17 reactors accounting for a quarter of its electricity. The media and the public have to accept a scenario of the inevitable end to the use of nuclear energy in as many places as possible. However, this trend is not taking place in countries such as China, Czech, South Korea and Romania (Yurman 2011).

The safety evaluation of nuclear reactors should be based on the results of both the first and second rounds of stress tests. In Fukushima, thus far none of the utilities attained the standards of a second round reactor stress tests. Therefore, the government should not base a decision on whether to restart reactors on the initial test and say that reactors can withstand the same sort of earthquake and tsunami (as it did in March 2011), especially because the examination of that accident is still incomplete, and the cause remains unclear (Mainichi Japan 2012).

Since the Fukushima disaster, Japan has also been focusing on renewable energy. It is attempting to develop eco-towns focused on developing industrial parks, introducing earth-friendly technologies and promoting environmental methods such as integrated waste management, the three Rs (reduce, reuse and recycle), green consumerism, energy conservation, and combined renewables. The technology and resources are there: it is just a matter of will-power issue and not technology issue. Subsidies to fossil and nuclear are slowing the process, so the shifting subsidies from the polluters to clean energy could solve the problem (Barrett 2012b).

Japan also passed the feed-in tariff bill for renewable energy. The FIT system promotes the growth of renewable energy by requiring utilities to purchase electricity generated by commercially available renewable energy sources for a set price and period. Each power purchase agreement will last as long as 20 years. Electric utilities are allowed to tax a surcharge to cover the purchase costs (The Denki Shimbun 2011, Wang 2011).

5.4.3.2 The World Nuclear Industry Trends after Fukushima

The World Nuclear Industry Status Report 2012 shows that the world nuclear industry is suffering from the cumulative impacts of the world economic crisis, the Fukushima disaster, competition and its own planning and management difficulties (World Nuclear Industry Status Report 2012).

- Only seven new reactors started up, while 19 were shut down in 2011.
- Four countries announced that they will phase out nuclear power within a given time frame.
- At least five countries have decided not to engage or re-engage in nuclear programs.
- Two reactors under construction were abandoned in Bulgaria and Japan.
- Out of the 59 units under construction in the world, at least 18 are experiencing multi-year delays.
- Construction costs are rapidly rising. The European EPR cost estimate has increased by a factor of four (adjusted for inflation) over the past ten years.
- Two thirds of the assessed nuclear companies and utilities were downgraded by credit rating agency Standard and Poor's over the past five years.
- Installed worldwide nuclear capacity decreased again in 2011.
- The European Union nuclear capacity has decreased by 14 GW since 2000.

"The fact that plant life extension seems the most likely survival strategy of the nuclear industry raises serious safety issues. Most critically will be to what extent and for how long nuclear safety authorities will be in a position to withstand growing pressure from nuclear utilities to keep operating increasingly outdated technology", states Mycle Schneider.

5.4.3.3 Nuclear Power Policies

The nuclear power policy makers that started their work in 1950s will see that their monopoly is coming to end. About fifty years ago, engineers, scientists, large companies and states forced the implementation and rapid development of a new energy source that should have exempted humanity from the limitations of fossil fuels.

In 1970s, despite the emergence of the Green movement opposing nuclear power, the oil shock resulted in extensive programs to build new nuclear power plants.

In late 1980s and after the Chernobyl accident, in some countries, such as France and Japan, the Greens had little influence on the decision-making process. In countries such as Germany, Finland and Italy, the Greens blocked the development of any new nuclear power project. In the United States, it was not the Three Mile Island accident or the Greens, but the oil lobby that organized the shutdown of nuclear power development.

In the late 2000s, as fossil fuel prices rose significantly, spurred partly by the appearance of China, India, Brazil and other countries in the Western development model, doubts over reserves, and the requirements limiting CO_2 emissions, which resulted in a widespread resurgence nuclear power. Countries restarted their programs and planned the dozens of new plants. Ironically, the success of policies limiting carbon dioxide emissions called for by the Greens helped the development of nuclear energy. At the same time, America and Japan fully or partially started to privatize their nuclear power networks.

At the beginning of 2011, almost all countries were in agreement about covering the world with nuclear power plants. The process of deregulation in most national electricity markets weakened the regulatory and operational ability of the public bodies required to control safety conditions.

Then the Japanese power plant in Fukushima could not cope with the tsunami and earthquake, even though Japanese plants were believed to be one of the most modern and safest plants in the world. After the Fukushima disaster, a nuclear aware global public opinion emerged. Operators, investors and opponents of nuclear power and policymakers are wondering what trends will prevail in the future and what are the choices available to them.

The world is no longer technologically naive, ideologically divided, highly media supervised, or dominated by developed countries in its technological superiority. The Internet buries any attempt of traditional players to keep the debate on nuclear power within a national framework. Content, ideas, analyses, anticipations on nuclear power can now be exchanged internationally, where new groups, coming from countries that are only now addressing the installation of nuclear facilities, are being integrated.

Large segments of the public are aware that nuclear power's unresolved issues prevent any quick fix. Public opinion with questions via Internet will rapidly make its way to leaders and elite of different countries. They are the makers of nuclear power policy and not the lobbyists. People will demand answers about guaranteed safety, private enterprise's ability to manage nuclear risk, relocation of facilities outside very populated areas, the permanent elimination of nuclear waste, living without nuclear power, the availability of new forms of energy production that will replace nuclear energy, investment in new energy etc. (Excerpt GEAB N° 55 2011).

5.4.4 OIL

5.4.4.1 History

In 1859, oil was discovered in Pennsylvania. A few individuals started to invest in producing wells; those who had the most wells pumping oil as fast as possible had the biggest revenue. The market was soon flooded with unwanted oil. Building railroads had a major effect, because oil could be transported more cheaply. Rockefeller started to shape the oil industry by recognizing the four principals of the oil business: production, transportation, oil refining and marketing. He was the first to successfully control prices; at one point, he controlled 90 percent of the US refinery industry. His idea of an acceptable price was that which would discourage outsiders to build refineries.

In the UK, Winston Churchill agreed that British navy should be switched from coal to oil; he also believed that the Navy should rely on government's own oil fields. The British government owned an oil company but chose not to run it. The Soviet Union was the first government to both own and run its own oil company. During the years prior to and during the First World War, oil was an integral part of national economies, and it became even more so during it. The Second World War only intensified this dependence. Oil became a way of ensuring military success and a commodity of national security importance.

In 1920s, the oil sector was dominated by the British government's half interest in an independently run British Petroleum with a concession in Iran and Iraq, the French government's interest in an independently run Compagnie Francaise de Petroles, with a concession in Iraq, and the Soviet Union controlling its oil resources.

In 1930s, price stability was threatened by another massive oil discovery in east Texas, which created a glut, and oil prices collapsed. The state governments of Texas and Oklahoma declared a law that protected and conserved natural resources, so oil production could be stopped. The Texas Railroad Commission eventually took control and started to regulate the oil industry.

Between the First World War and 1973, the pivotal year in the oil industry, the petroleum industry was run largely through the so-called seven sisters: Exxon, Shell, British Petroleum, Gulf, Texaco, Mobil, and Chevron. They were fully integrated multinational companies that controlled exploring and developing oil fields, refining crude oil and distributing refined products by pipelines, tankers, and tank trucks to gas stations and industrial, commercial, and residential end users. Price and production volumes were set with the oil companies and oil producers. This world collapsed in 1973, when the oil crisis took place. By the late 1950s, Soviet oil was entering the Italy, India, and Japan. The seven sisters had to lower their prices in order to remain competitive in these countries. In 1960, the Organization of Petroleum Exporting Countries (OPEC) was formed by Saudi Arabia, Iran, Iraq, Kuwait, and Venezuela. The purpose was to prevent further reduction in posted prices. Until 1973, nearly all incremental oil demand was coming from the OPEC nations. During 1960 and 1973 OPEC exports were growing faster than world oil demand. In that time, the United States made a transition from the world's largest oil exporter to the world's largest oil importer. In 1973, the US faced embargo because they did not halt their military support to Israel. The prices of a barrel of oil rose sharply, which spurred on the search for alternative sources. Coal was once more an important source, there were many more nuclear power plants, and greater reliance was on natural gas and wood-burning electricity-generating plants. In addition, high prices caused an explosion in non-OPEC crude supplies, especially in the North Slope of Alaska and in the North Sea. Even though the North Slope was an inhospitable place to develop and operate an oil field and required the construction of a more than 1000 kilometers of pipeline, the US this development lessened dependency on other countries. In 1985, Saudi Arabia flooded the market with oil, causing oil prices to collapse. OPEC came to an agreement on production quotas and mechanisms for sharing production cutbacks. OPEC realized that overly high prices enable the development of non-OPEC oil fields that would eventually erode its market share.

The laying of pipelines around the world brings oil companies in contact with governments, where some of them are hostile to one another. That is why selecting the pipeline route and engineering its construction, and also tariff structures, security measures, ways for resolving disputes, and determining a fair share of the benefits of oil exports must be planned very carefully and poses enormous challenges.

In recent times, oil executives have had to deal with environmental groups. In response to environmental lobbying, the World Bank imposed loan agreements that affected the construction of two pipeline projects. The portion of the oil revenues had to be paid directly to indigenous peoples, if the government, oil companies, builders, and operators wanted to obtain bank financing. Even though many environmental groups have been trying to warn for many years how damaging fossil fuels are to the environment, it is the fact that transition from fossil fuels to new energy sources still did not happen to the extent that many wanted, because oil companies are major contributors to government tax revenue. Governments even make far more in revenue than oil companies. Governments support the oil industry by ensuring security of supply, where the cost of oil security falls on the taxpayer as a government expenditure (Nersesian 2010, Ch. 5, Ch. 6).

5.4.4.2 Peak Oil

According Barrett (2012a), four scenarios can show how policy-makers can respond to the peaking of conventional oil production.

The first scenario promotes a long-term, sustainable solution, requiring massive social and economic change. It requires shifting, all over the world, to 100 percent renewable energy sources by a specific date. One problem appears with that scenario: it simply may not be possible to generate all the power we need with renewables based on the existing state of these technologies. As such, we should reduce energy consumption, introduce smart grids, off-peak power storage, invest in the research and development of new energy sources and so on. The fossil fuel and nuclear energy sector will continue to fight these changes through intense lobbying of governments and organized public relations campaigns. Countries going in this direction are Sweden, Denmark, Germany, and California in the US.

The second scenario works with existing institutional structures and tries to gradually shift them to an energy secure future, and solving climate change at the same time. Under this scenario, renewables and nuclear are promoted, but in order to avoid runaway climate change the reduction of dependency on fossil fuels is encouraged. Existing lifestyles, convenience and services are to be maintained, while shifting energy away from fossil fuels, reducing overall energy use and reducing the difference between the developed and the developing world. The problem with this scenario is that it keeps the nuclear option and ignores the risk of nuclear accidents and problems with radioactive waste. Countries going in this direction are Japan, Switzerland, China and India.

The third scenario assumes that it is too late to adapt, and we need emergency measures. It excludes the nuclear and renewable energy options, because they cannot help quickly with the transportation problem, and completely ignores the impact on the environment. It encourages the exploitation of every possible liquid fuel development option, regardless of how destructive they are. It includes enhanced oil recovery from existing oil fields, the conversion of tar sands to liquid fuels and coal-to-liquid and gas-to-liquid operations. Countries going in this direction are the US, the UK and Canada.

The fourth scenario assumes peak oil is not an issue. It is a situation that most countries find themselves in today.

Policy-makers in almost all countries remain silent, inactive, or ignore this issue, hoping it will go away. The peaking of oil production should be a priority issue for every national department of energy, agriculture, environment, transportation, economy, and every ministry of foreign affairs. Waiting until peak production occurs before taking action would result in a liquid fuel deficit and severe economic difficulties. Policymakers all over the world are aware of several reports that were released in the previous decade and argue that there is a significant risk of a peak, and all of them claim it will happen in the very near future - next five years or ten years, before 2015, before 2020 etc. Scientists, researchers, peak oil advocates share part of the blame for not communicating their concerns and the findings of their work effectively to policy-makers and the public. Nevertheless, we need a breakthrough, before we face a breakdown, which has to happen very, very soon (Barrett 2012c).

5.4.4.3 Diversifying Oil Dependent Vehicle Fleet

If any country wants to control its energy future, it will have to develop every domestic source of energy possible. In the US, the Obama Administration has proposed new policy that would reduce the cost of electric vehicles, spur adoption of other fossil oil alternatives in addition to electric vehicles, especially natural gas powered big trucks. Tax credits and other incentives are the mechanisms that can reduce demand for oil, and switch the vehicle fleet to use other fuels than oil (Herron 2012).

5.4.5 NATURAL GAS

The Second World War increased demand for natural gas to fuel factories and armament plants, which stimulated the building of new pipelines. In the US, natural gas and electricity became federally regulated in the 1930s. The Natural Gas Act of 1938 gave the US Federal Power Commission the right to control prices and construction of pipelines. Low prices encouraged consumers to use natural gas over coal, but discouraged investment in developing new gas fields. Proven reserves started to decline. In the 1970s, the deregulation of natural gas production, transmission, and distribution throughout the world solved many problems induced by regulation. Natural gas can be applied from storage or obtained directly from natural gas producers or from other interstate transmissions.

In Europe, governments control and support the companies that dominate a nation's electricity or natural gas business. Prime Minister Thatcher of the United Kingdom was the first to react against high-price energy. She cut subsidies to energy companies, privatized national energy companies, and allowed major consumers to have direct access to energy providers to negotiate electricity and natural gas supplies. In the 1990s, the first EU directives for liberalizing electricity and natural gas established a time frame for specified percentages of natural gas and electricity that had to be satisfied in a competitive marketplace. In 2003, another EU directive accelerated the creation of independent transmission and distribution system operators to separate services provided by integrated transmission and distribution companies. However, natural prices may still remain high if the primary sources of natural gas, such as the North Sea, the Netherlands, Russia, and Algeria, act together against lower prices (Nersesian 2010, Ch. 7).

5.4.6 SOLAR

According to Nersesian (2010, 313–331). The development of solar power started in the United States as a result of PURPA (the Public Utility Regulatory Policies Act) legislation, passed in 1978, which required state regulatory commissions to establish procedures for nonutility companies to sell electricity to utilities generated from renewable energy sources, waste, and cogenerating plants run on natural gas. Today, the largest suppliers of PV cell production are in Japan, Germany, the United States, Norway and Spain. In 2007, significant amounts were spent in the investment and development of solar power by the governments of the United States ($138 million), Germany ($61 million), Japan ($39 million), and South Korea ($18 million). To support the installation of solar energy facilities, many countries offer incentives, for individuals and businesses, that come in various forms, such as a direct grant or rebate paid to the individual or business for installing solar panels, tax benefits, soft loans at below-market interest rates and long payout periods, the right to sell excess production back to the utility at above-market rates (FITs), and sustainable building standards that require installing PV panels.

5.4.6.1 Policy Instruments to Support Solar Thermal

A framework for the long-term success of the solar thermal markets includes regulations that require the use of solar thermal for new buildings and major refurbishments, financial incentives that could accelerate the use of solar thermal in existing buildings, and awareness raising, training of professionals and R&D funding.

In European countries solar, building codes are powerful instruments for promoting the use of renewables in new buildings. They are regulations requiring that a minimum share of the heating demand is covered by solar energy. They allow the gradual preparation of the building stock and create a minimal critical share in the solar market. Germany enacted a renewable heating law, which prescribes a minimal share of 15–50 percent of the total heating consumption of new buildings to be covered by renewable energy sources.

Financial Incentive Schemes (FIS) include public policy financial incentive, such as direct grants (Germany, Austria, Greece), tax reductions (France), loans at reduced rates, or green heat or energy efficiency certificates to those who install or use a solar thermal energy. However, continuity is the most important success factor. FIS have failed with short-term programs or insufficient budgets.

As for administrative barriers, many solar power plants around the world are under review for construction, which can take a long time, because progress in obtaining regulatory approval is impeded over multiple government regulations and jurisdictions. The use of solar systems should be allowed without the need for any special authorization.

Awareness raising, training of professionals and R&D funding are important for the long-term success of the solar markets. In 2006, Austria started a solar campaign, which raised the awareness of solar on the population. Information about solar was brought to many people via brochures, a hotline and a website, and by press.

Germany supports the use of solar thermal energy plants, because they are attempting to improve supply security by reducing dependency upon oil and gas imports, technical improvement, environmental friendliness and protection of the climate. The government gives grant under so-called Market Incentive Program (MSP), in which solar thermal systems are supported through a financial incentive for systems that are used for heating domestic hot water, and central heating, and for enlargements of existing systems and innovative systems.

In Austria, for almost 30 years solar systems have benefited from financial incentives from regional politicians, active solar companies and the regional energy agency. Subsidies have been given for the new house market and for the renovation market, where private home owners, housing associations, installers and solar companies have benefited most. Austria is successful because of the long-term establishment of a continuously growing solar market with stable conditions, constant subsidies, awareness campaigns and training activities for installers.

In France, a tax rebate has significantly contributed to the success of a solar thermal market. The tax reduction or return removes the need to apply for a grant before purchasing a solar thermal system, which reduces the procedure for receiving the FIS and removes the waiting period between the application for a grant and its approval.

Spain has some of the most advanced solar legislation in the world. In 2006, the government approved the new Technical Buildings Code (CTE), that includes the security of the building structure, fire safety, other safety and health issues, sustainability and energy efficiency of the buildings, and an obligation for new buildings and those undergoing a renovation, to cover 30–70 per cent of the domestic hot water demand with solar thermal energy.

Greece is a good example of how a long-term, well-implemented FIS, from 1980s, when market development was boosted by public support in the form of strong awareness-raising campaigns, television advertisements and financial incentives, reached a critical mass, and still continues to grow even though from 2003 there have been no financial incentive schemes and no public support (EREC 2010, Ch. 2, Nersesian 2010, Ch. 9).

5.4.6.2 Policy Instruments to Support Photovoltaics (PV)

Several policies to support PV, such as FITs, investment subsidies, tax credits, bank loans, quota systems, tendering, tradable green certificates, are being put in place.

The German Feed-in Law (EEG) has been the driver for the German PV industry and has also inspired many countries around the world. For PV systems up to 30kW, the producers have the possibility to automatically consume the electricity they produce, so they receive a premium feed-in tariff for the self-consumed PV electricity. The FITs are granted for 20 years.

Spain, like Germany, also initiated FITs for PV, called the Royal Decree. The regulated tariff is calculated according to the existing demand, with a decrease in the remuneration if the quarterly cap is totally covered. Tariffs are granted for 25 years.

Italy offers a well-segmented premium FIT and mixing net-metering. The incentives are granted for 20 years. The PV system owner can set the electricity he produces himself at the same price as the electricity he consumes traditionally from the grid. If there is an excess of electricity fed into the grid, the PV system owner gets a credit for the value of the excess of electricity.

France has faced considerable growth since 2005, when the 50 percent tax credit for the PV market and improved FIT was enacted (EREC 2010, Ch. 6).

5.4.6.3 Policy Instruments to Support Concentrated Solar Power

In Spain, there are two different kinds of incentives that holders of the installations are free to choose. The first is a fixed FIT, the amount of which is the same for all programming periods and depends on the type of installation and the installed power. The second is a premium whereby an additional amount is added to the market price or to the price freely negotiated by the owner of the plant. The amount of the premium varies, depending on the market price (EREC 2010, Ch. 7).

5.4.7 WIND

The US government's involvement in wind energy began after the oil crisis in 1970s. The use of the wind energy has always fluctuated with the price of fossil fuels. Wind farms were (like solar energy) the result of both R&D efforts undertaken by the federal government and financial incentives established by PURPA. The key subsidies that made wind-turbine investments financially attractive were a federal investment credit, federal energy credit, state energy credit, and a high electricity rate mandated by state regulators that had to be paid by utilities for electricity produced from alternative sources.

However, in the 1980s, the government's attitude toward deregulation, an increase in military expenditures, and a period of low oil prices removed the incentives to pursue renewable energy sources and the wind energy business slowed considerably. A decade later, initiatives in some states spurred US wind-energy development. America induced a tax credit, which is a powerful incentive, but the problem was that they normally expire after a short period of time and require frequent legislative renewals, which are not always forthcoming. And when tax credits expire, new units built after the expiration, do not receive the tax incentive.

The American Recovery and Reinvestment Act of 2009 was intended to start the economy by, among other measures, enhancing energy independence. The act provides a 30 percent grant of the installed cost of renewable energy projects is independent of a company's profit and is effective for four years. In the US, to encourage growth in wind energy, many utilities offer customers the option to pay a premium on their electricity rates that will support generation of electricity from renewable energy sources. The utility has to find enough customers and then enter into a contract to buy the output of a renewable power projects at commercial rates that apply to conventional plants. The amount of electricity that carries the premium rate has to cover, but not exceed, the capacity of the renewable energy sources.

The other way that a number of states use is the renewables portfolio standard (RPS) approach, which is essentially a quota system without a price. It creates a competitive environment among renewable energy providers and offers electricity at the lowest possible price by enhancing efficiency and improving technology. Presently, the Obama administration is expected to establish some form of a cap-and-trade program, which will make fossil fuels more expensive and will provide an additional economic incentive for investments in renewables.

The Kyoto Protocol sets up the Clean Development Mechanism (CDM), which permits a company to either reduce its carbon emissions or buy credits via CDMs where carbon emissions can be reduced at less cost than direct investment in carbon-emission controls at the company's facilities.

China and India, even though they do not participate in the Kyoto Protocol, show an example of how CDMs can spur wind-energy development projects. China has also started a construction of wind farms, with an output of 100GW, which will be connected to China's electricity smart grid by a low-loss high-voltage DC transmission system (Nersesian 2010, Ch. 9).

5.4.7.1 Policy Instruments to Support Wind

Many countries have implemented legal frameworks with support mechanisms, such as price-driven mechanisms (feed-in, premium systems), quantity-driven measures (green certificates), tenders, and fiscal incentives. The most common mechanism in Europe is price-based schemes. From the investor's point of view, they are highly favorable as they offer low risk, even if the margin is smaller than with other options. In some countries, instead of a fixed price, the government puts a cap and a floor above and below the electricity price (EREC 2010, Ch. 5).

Germany and Spain, the leaders in wind energy in EU, have various subsidy programs to support the development of renewables. They established a quota that had to be filled by wind power, coupled with an associated electricity rate that would spur its development. In Europe, offshore waters are a very large potential area for development of wind energy (Nersesian 2010, Ch. 9).

5.4.8 GEOTHERMAL

Geothermal energy has received little political attention, in spite of its potential.

5.4.8.1 Policy Instruments to Support Geothermal Heating and Cooling

The main instruments used to achieve the sustainable growth of geothermal energy are financial incentives, regulations, and flanking measures that must be well designed, long-term, carefully managed. Serious efforts are needed to simplify procedures, and establish and implement policies to boost geothermal usage. The legislation and regulation for geothermal energy is highly diverse, which can be a significant barrier to geothermal energy use. Other barriers can also be mining royalties, sewage penalties, groundwater use fees, and environmental taxes. Raising awareness of the public, the understanding of geothermal energy technologies, a well-designed campaign on geothermal technologies, training architects, planners and installers, and R&D in drilling technology, could help develop potential and existing markets and ensure the high quality design and installation of the geothermal systems.

The main uses of geothermal energy in most EU countries are the heating of baths and swimming pools, heating of buildings with district heating networks, heating of greenhouses, fish farming and industrial uses.

In Switzerland, the government partly supported geothermal energy, which was considered a safe and sustainable alternative to a nuclear power-plant project opposed by the Swiss public. Due to growing prices of oil and electricity and increase of energy related taxes, geothermal energy became fully recognized by consumers and decision-makers. The Swedish geothermal heat pump market is the reason Sweden has reduced the use of heating oil by more than 50 percent.

In Germany, the oil crisis in 1970s caused the geothermal market growth. The high price of heating oil and gas provoked interest in substitutes. The market reached a peak in 1981 but dropped in the following years because of the sudden fall of oil prices and a poor perception of the technology. At the beginning of the 1990s, electric utilities and the government initiated the development of ground source heat pump systems and support schemes, the German geothermal association was founded, and energy price increases led to the recovery of the market. Support through the Market Stimulation Program, long winters, further increases of energy prices, media attention to climate change, the removal of the cost of establishing a distribution network in which support is granted through special loans, resulted in growth of sales in the heat pump market during last years.

In France, geothermal district heating receives support from the Ministry of Industry's Heat Pluriannual Programming of Investments, ADEME finances aid for extensions of existing networks according to the number of avoided tons of CO_2, the Regional Council adds aid for district heating, and the government supports 40 percent of CI costs for the extension of existing grid or facilities (EREC 2010, Ch. 4).

5.4.8.2 Policy Instruments to Support Geothermal Electricity

The EU adopted a directive on the promotion of energy from renewables that describes the its strategy and objectives, and requires member states to adopt national plans defining how they intend to reach their own national targets. It also implies that the European geothermal industry should encourage states to implement new geothermal initiatives. New policy initiatives will need to address barriers such as high investment costs, an insufficient database of inventories of geothermal resources, low information and awareness levels, regulations, and R&D and demonstration projects (EREC 2010, Ch. 11).

ABS Energy Research concludes that the market for geothermal energy will continue to grow over the next years and increase by 78% by 2015. The countries driving this growth are the US, the Philippines, and Indonesia. Kenya, Peru and Chile have also begun to pursue the development of its geothermal resources (Baker 2010).

In Japan the Fukushima disaster spur way for new geothermal plants. Under the new feed-in tariff system, utilities are required to pay premium prices for geothermal power. In town called Tsuchiyu, 15 km from Fukushima, a new geothermal plant will be generating 250kW of electricity by 2014. With the feed-in tariff they expect the initial costs will be covered in about seven years. In the long term, Tsuchiyu could become a model for other small towns (McCurry 2012a).

5.4.9 HYDRO - NEW APPROACHES

5.4.9.1 Policy Instruments to Support Small Hydropower (SHP)

The support instruments for small hydropower come in the form of investment and production support, fiscal incentives and grid access. The costs to connect to the grid differ in the EU. The range of approaches includes some countries paying part of the costs for the grid connection, leaving all costs to the investor of SHP, negotiating the costs between the utility and the developer, permitting free use of the grid or basing the connection costs on a fixed price for plants accepted into a support scheme In the case of Sweden, in addition to the fact that using the grid is free, the local grid owner must refund a local producer for any reduction in grid costs resulting from distributor power or a reduced requirement for peak power.

In the case of fiscal incentives, the most widely adopted are feed-in tariffs, which give the SHP generators a guaranteed price for their electricity. Some countries also use green certificates, investment support in the form of a one-time fixed grant that helps to reduce capital costs, a long-term support that stimulate investments and reinvestments in SHP, tax measures, quota systems, loans at preferential conditions, income tax exceptions, and reduced VAT. The RES Directive obliges the member states to define clearer frameworks and consider the share of SHP in their energy mix to meet their mandatory target. In the case of SHP, it is essential to have well-structured and coordinated R&D programs, in order to continue and increase the development of new machines and construction techniques, to develop and boost innovative SHP solutions, and become more environmentally sustainable.

Austria has shown increased efforts to modernize SHP plants and improve their ecological conditions. It established subsidies to support the revitalization of SHP plants and to optimize the ecological energy generation based on hydro power.

Italy ratified the Legge Finanziaria 2008 that simplifies administrative procedures for small plants, strengthens grid connection and introduces development procedures for all renewables.

France accepted feed-in tariffs in 2007, and announced a plan to boost hydro-power to 23 percent by 2020.

The Romanian government's promotion scheme for energy produced by SHP includes feed-in tariffs and green certificates. Renewables can be sold by bilateral contracts at negotiated prices on the Day Ahead Market or to distribution companies at a regulated price. Green certificates can be sold by bilateral contracts or on the centralized green certificates market with a fixed price (EREC 2010, Ch. 9).

5.4.9.2 Policy Instruments to Support Ocean Energy

Governments and private investors have the necessary resources to push ocean energy from the demonstration to the commercial stage in less time that it took for the wind industry. Countries have to start providing their support to solve the non-technological barriers harming the ocean energy sector and to create a favorable climate for it. Support schemes are necessary for ocean energy to develop. Market-driven incentives drive innovation. Incentives, such as investment tax credits, investment and production tax credits, and FITs, created at the early stage of industry development create a market pull and give incentive to early adapters. Because ocean energy is a developing industry, it lacks public awareness. There is also a need for a coordinated approach, simplification of regulation, and sufficient amount of transmission lines.

The Danish government invests more than €3 million per year for pilot projects in wave power technologies, sets a FIT, offers fiscal and investment incentives, and has established a tendering system.

In France, the government's activities for wave energy focused on R&D, established tender system for large projects, tax on polluting activities, and fiscal and investment incentives. In 2005, France modified a FIT for wave and tidal energy. In 2007, they created a grid connection test site to enable initial demonstration of wave energy devices and research on marine and oceanographic applications. Both were supported by public funding.

The Irish government set a framework to support the development of ocean energy. They supported research and development activities, and used the FIT as the main tool for promoting the ocean technologies.

Italy is also investing in wave, current and tidal energy, supporting activities in national research centers. They set quotas, FIT systems, and offer many fiscal and investment incentives and subsidies.

The Portuguese government set up a support scheme similar to FIT, direct subsidy payments and tax incentives, and fiscal and financial incentives for wave energy, established a 320 km^2 pilot zone for testing prototypes and exploitation by pre-commercial and commercial wave farms, and signed a Memorandum of Understanding to establish a framework for signatories' cooperation on the policy, scientific and technical aspects of wave energy generation.

In Spain, in 2007, a new Renewable Act explicitly included ocean energy in the form of wave, tides and currents. A FIT provides support for some offshore renewables for 20 years. The final subsidy for each renewable technology is a combination of the national FIT and the regional support schemes. Some regions have a specific additional set of energy regulation for ocean energy; others are on the frontline of ocean energy initiatives and investment. The Biscay Marine Energy Platform created infrastructure for the research, demonstration and operation of offshore wave devices, to stimulate the growth of a technological and industrial sector in ocean energy.

In 2004, the United Kingdom launched the Marine Renewable Deployment Fund with a budget of 50 million pounds to support the first grid-connected wave and tidal arrays. The support system is based on the Renewable Obligation System and its tradable certificates. The government supported R&D of the marine energy technologies primarily through the technology program, and studied the feasibility of generating electricity from the tidal range. The Scottish government has provided greater support for wave and tidal-stream technologies and provided grants to businesses to support the installation and commissioning/deployment of pre-commercial wave and tidal devices, as well as supporting components of projects requiring testing mooring systems, foundation installation systems that lead to reduced project cost and improved operation and maintenance for the industry. The Welsh government supported projects that developed a Welsh marine renewable energy strategic framework that ensured the sustainable development of the marine renewable energy resource (EREC 2010, Ch. 10).

5.4.10 HYDROGEN

In the 1970s, the oil crisis awakened the public and some countries started to see hydrogen as a motor vehicle fuel. In 1999, Iceland announced a long-term plan to eliminate fossil fuels by 2050. Their motor vehicles and fishing vessels will run on hydrogen produced by electrolysis of water with the electricity generated from hydro and geothermal sources. Building gas stations and roads around city centers expanded the market for automobiles and, which in turn, expanded the market for gas stations and for roads. Knowing that many countries around the world are attempting to ensure an adequate number of refueling stations along highly travelled automobile corridors supports the attraction of hydrogen-fueled vehicles.

The problem with hydrogen technology is that it is very expensive. A hydrogen fuel cell was ten times more costly in 2005 than an internal combustion engine. Hydrogen as a fuel was five times more expensive than gasoline in 2004, but was three times more expensive than gasoline a year later, because oil prices had escalated. In 2008/2009, crude prices fell, and hydrogen became more expensive again. The prices of oil influence whether hydrogen will ever become the fuel of the future (Nersesian 2010, Ch.10).

5.4.11 BIOMASS

In the past, biomass dominated as a fuel source before the Industrial Revolution, when coal entered the picture. Today, approximately one-third of the world's population does not have access to electricity or cannot afford to buy it, so they depend on biomass for their energy needs.

Biomass could be less expensive, if the price of fossil fuels rise or current research and development efforts result in a technological breakthrough that radically changes biomass economics. As fossil fuel prices increase, biomass plays a more active role as a utility fuel, a motor vehicle fuel, and a supplement to natural gas.

Currently, a major problem for the principal population areas of the world is disposing of garbage. There is an alternative to ocean dumping or transforming the countryside into landfills. Besides shipping and dumping fees, an environmental degradation tax would become a part of the cost of dumping garbage in the ocean or in landfills, and make it more expensive. If this were done, a garbage-burning electricity-generation plant that would be without an environmental degradation tax might be economically viable. Moreover, the tax can be dedicated to funding the building of garbage-disposal plants whose output of electricity would reduce the need to burn fossil fuels (Nersesian 2010, Ch.3).

Brazil and the US are the largest ethanol producers in the world. The US produces ethanol from corn, Brazil from sugar.

Brazil has a national energy policy that reduces the consumption of fossil fuels and leads the world in utilizing biomass as a motor vehicle fuel. The United Nations Development Program implemented the UN conventions on biological diversity and climate change. It funds, along with private corporate support, the development of a biomass integrated gasification/gas turbine fueled by wood chips from tree plantations.

The development of the ethanol industry was a result of government support programs that were present for decades. In the 1850s, ethanol was the main fuel for lamps, but an excise tax on alcoholic beverages caused kerosene, whale oil, and methanol to replace ethanol. In 1975, Brazil had two problems: an enormous number of workers in rural regions, and their oil needed to be imported. The government stimulated ethanol production with reduce reliance on imported oil, consequently provided jobs for large numbers of workers, and converted uncultivated land to agricultural use. The government financed low-interest loans for entrepreneurs for construction of ethanol-production plants and the conversion of unused grazing land to sugarcane plantations. The government also required the state oil company to purchase ethanol to blend a vehicle fuel with a minimum of 22 percent ethanol. Gasoline stations had to sell gasoline, gasohol (ethanol-blend), and ethanol. A differential tax was placed on motor vehicle fuel to ensure that ethanol had a 65 percent discount compared with the price of gasoline, and people who purchased automobiles fueled by ethanol received tax incentives. By 1990, half of the motor vehicle fleet was fueled by ethanol.

Brazilian sugarcane growers are free to sell sugar or ethanol, whichever is more profitable, but the state oil company has to buy ethanol to ensure that the minimum content of ethanol in gasoline is satisfied, which creates market for ethanol.

In the mid-1980s, the decline in oil imports and oil prices weakened the government's support to biofuels. The government permitted the free export of sugar to reduce the amount of subsidies to ethanol producers. In 2000, Brazil deregulated the ethanol market and removed all subsidies, but motor vehicle fuels were still required to be blended with 20–25 percent ethanol. Currently, filling stations still have pumps for gasoline, ethanol, and ethanol-blend, and the Brazilian government supports a research program to improve sugarcane varieties and fertilizer applications. However, when oil prices decline, so does the incentive to expand ethanol production. A combination of a low oil prices and high sugar prices is a death for the ethanol producers.

The US supports a program began with the US Energy Tax Act of 1978 that defined gasohol as a blend of gasoline of at least 10 percent ethanol. This exempted ethanol from the gasoline excise tax, providing a direct subsidy for ethanol blended in gasoline. Congress approved several tax benefit packages along with loan and price guarantees to support ethanol producers and blenders, but incentives did not change anything, because oil prices collapsed in 1980s. At that time, the US built biomass electricity-generating facilities, which become financially burdensome. That is why most existing biomass electricity-generating facilities are small, dedicated to meeting the needs of a local industry or community.

The Alternative Motor Fuel Act of 1988 gave credits for automobile manufacturers for building vehicles capable of burning a blend of 85 percent ethanol and 15 percent gasoline, but had little impact as there were remarkably few fuel retailers offering this blend. The Energy Policy Act of 1992 required primarily government-owned automobile fleets to begin purchasing alternative fuels and flex-fuel vehicles capable of burning a blend of ethanol and gasoline. The Energy Policy Act of 2005 contained the Renewable Fuel Standard that guarantees a market for ethanol which has to be infused into the gasoline pool. The Energy Independence and Security Act of 2007 reduces energy demand through greater efficiency, sets the automobile fuel economy average and creates credits for fleet segments that exceed compliance minimums and for dual-fueled automobiles (flex-fuel and biodiesel) that are transferable to other fleet segments. It also defines how to increase energy security through increased production of biofuels.

Ethanol is internationally traded and faces import tariffs and trade restrictions. Some trade agreements, such as the US-Israel Free Trade Agreement, the North American Free Trade Agreement, and the Central America Free Trade Agreement (CAFTA) enable locally made ethanol enters the United States duty-free.

Cellulosic ethanol technology was used during wartime to produce alcohol fuels and chemicals from wood. Interest in this process was increased by the oil crisis in the 1970s and by a DuPont article published in Science Magazine, citing 250 chemical products made from petroleum that had previously been made from ethanol. This spurred university and government laboratories to study this technology. Currently, there are a number of companies active in cellulosic research.

In 2007/2008, food prices rose from higher oil prices for transport fuels and conversion of agricultural output to biofuels in the US and Europe. The world leader in the production and consumption of biodiesel is the EU, especially Germany. The EU has a national policy to encourage the use of diesel engines in automobiles. The German Taxi Association requiring taxis to run on biodiesel was a significant spur in the adoption of biodiesel. In some countries, public buses, tourist boats and yachts run on biodiesel. In the EU, an exemption from a high fuel tax and the Common Agricultural Policy that allowed producers of grains, oilseeds, and protein crops to receive direct payments if they removed a specified percentage of their farmland from production, contributed to the EU becoming a world leader in biodiesel production. German authorities also publicized information and educated the public about biodiesel and make biodiesel available at filling stations with the average distance between filling stations selling biodiesel being about 30 kilometers.

Business with biofuels is not without its risks. Biofuels require various forms of government intervention in the form of subsidies and mandates to keep biofuel companies present on the market. One risk is government cutting expenditure and increasing the nation's export earnings, which can benefit the government at the expense of the ethanol producers. Another risk is the spread between the price of oil and the cost of the feedstock. In Indonesia, in 2008, crude oil prices were at a record high, palm oil was sold at even higher prices, and the government was unwilling to pay a promised subsidy to keep biodiesel producers financially stable; this caused Indonesian biodiesel production to fall by 85 percent. At the same time in the United States, gasoline prices and corn prices were at record highs, which caused some plants to shut down, a few firms declared bankruptcy, and bio-refineries were drastically reduced, which led to the bankruptcy of a leading ethanol producer.

A mandatory requirement is meaningful if the bio-refinery between oil prices and feedstock costs cover the operating and financial costs of a biofuel plant, and the government compensates the difference that keeps biofuel producers whole or mandates a higher price for the biofuel and lets the consumer pay the difference (Nersesian 2010, Ch. 3).

5.4.11.1 Policy Instruments to Support Biomass

In EU, the RES directive promotes biomass for heating and cooling by requesting member states to include it within the national renewable energy targets. Member states are encouraged to integrate biomass technology, such as the use of pellet boilers and stoves. Obligations and fiscal measures are two types of support mechanisms to promote renewable heating and cooling. In Europe, the most commonly used instruments to promote renewables are investment incentives, tax breaks for renewable fuel or investments and low interest loans. Some EU member states policies include CO_2 taxation policies, which penalize polluters and make biomass fuels more competitive. Some reduce rates on wood fuels, and others give subsidies as a part of the high investment cost, which is one of the main barriers to switching from fossil fuels to renewables. Fiscal incentives and regulations can promote or hinder the use of biomass. In Germany, the Federal Building Code and Federal Land Utilization Ordinance, or in Sweden the Permit Procedure are regulations that limit the development of biomass for heat. In contrast, in France, the Wood Fuel program and in Germany the Energy Saving Ordinance have a positive impact on biomass development for heat.

In 2005, France introduced a finance law that regulated the tax credit for sustainable development and rational use of energy, favoring the use of renewables and high biomass efficiency equipment.

The main market incentive program in Germany is the Program to Promote Renewable Energies which supports small-scale biomass heating systems, electricity facilities and biogas plants. The program supports system with grants, long-term and low-interest loans and partial release of debts, which is funded from part of the revenues of the taxation of electricity produced with renewables and the budget from the government. In addition, the systems that meet particularly challenging environmental requirements can obtain an innovation bonus, which can be achieved with lowered administrative burdens.

Sweden is a particularly compelling example where district heating with biomass is a robust solution for reduction of CO_2 emissions; CO_2 emissions in Sweden are 63–87 percent lower than the European average (EREC 2010, Ch. 3).

5.4.11.2 Policy Instruments to Support Bioenergy

EU policy has addressed the biomass sector through setting targets for the promotion of the use of biomass in electricity. The RES directive requires EU countries to develop transmission and distribution grid infrastructure, intelligent networks, storage facilities and the electricity system in order to help develop renewable electricity, including biomass for electricity. The authorization procedures for grid infrastructure must be accelerated, transmission system operators and distributions system operators must guarantee the transmission and distribution of biomass for electricity and ensure that all electricity from renewables has access to the grid, which ensures easier access for biogas and bio-methane to the electricity grids and pipelines. Most EU countries have established FITs for electricity from biomass, while some countries used green certificate schemes or quota obligation system.

Sweden has an integrated waste system that collects, sorts and burns rubbish for making electricity and heat as well as reducing landfill, and cutting CO_2 emissions.

In 1991 in the small city Guessing, Austria, policy-makers decided to gain energy independence mainly based on biomass exploitation. The EU funded projects and built a biomass power plant that produced electricity from organic matter. The city has become energy independent, has overproduction that is being exported, and alleviated its poor economic situation (EREC 2010, Ch. 8).

5.4.11.3 Policy Instruments to Support Bioethanol

Under the EU biofuels directive, member states developed and promoted their own support policies, such as financial incentives (tax breaks or penalties) or obligations that work in markets of differing levels of openness.

The German system successfully transformed itself from pure financial support to obligation. The government set two separate mandatory targets for biodiesel and bioethanol as transport fuels. Fuel suppliers that do not fulfill the targets pay a penalty. The quota can be fulfilled by pure biofuels or blends, which some of them are exempt from the excise duty. Biofuels that are put on top of the quota can apply for tax relief or can count towards the obligation for the following year.

In Sweden, there are no mandatory targets to foster the use of biofuels, but a strong financial incentive is given in the form of full exemption from excise duty, which makes the price for renewable fuels extremely attractive. Furthermore, larger filling stations are obliged to offer a renewable fuel, for ethanol only low import duties have to be paid, and several promoting measures are given such as a CO_2-based vehicle tax, a strict environmental policy for state-owned cars, a clean vehicle premium for private individuals, and exemption from congestion charges.

The French government set indicative targets coupled with a fiscal penalty for blenders, if the volume put into the market is less than the yearly national quota. France has different quota systems for biodiesel and ethanol. In 2006/2007, tenders were published for which biofuels producers could apply. Those who won certain quota can sell biofuel to a fuel distributer, and only quota-related batches are eligible for a tax reduction. Only those biofuels produced as part of the quota are competitive, producers outside this regime cannot find a buyer, in practice. In addition, cars that are not considered environmentally friendly do not qualify for lower road taxes, which impedes the sale of flex-fuel cars. Furthermore, French law permits the tax reduction, which can be adjusted every year (EREC 2010, Ch. 12).

5.4.11.4 Policy Instruments to Support Biodiesel

The EU directive on the promotion of energy from renewables promotes a set of sustainability criteria for the production of biofuels, which will deliver significant greenhouse gas reductions, strict environmental management of plantations, and biodiversity protection. The Energy Taxation Directive 2003 provides the possibility for member states to support the biodiesel sector by applying de-taxation schemes for biofuels production. In 2007, the Commission released a Green Paper that split the tax for energy products into an energy part according to which products would be taxed according to their energy content and an environmental part with CO_2 emission tax.

Germany is by far the biggest biodiesel producer in EU, with almost 2000 public filling stations selling biodiesel. A roadmap for biofuels and a national sustainability scheme are two incentives. The former includes the greenhouse gas calculation methodology for biofuels and outline the idea that biofuels may count as part of the mandatory quota targets when they attain a certain GHG reduction level. The latter includes the feedstock that is supposed to be grown according to criteria that best farming practices exclude certain land. Germany has no production quota, but in the past it invested substantially in new units. In 2006, the Energy Tax Act provided a gradual decrease of tax exemption for biodiesel and vegetable oils.
For more than a decade, the French government encouraged the development of biofuels, via directly blending small amounts into conventional fuels. Their legislation provides for a reduced energy tax for a certain volume of biofuels marketed in France and distributed via a bidding system. Quantities produced in the framework of the quota are the only ones eligible for de-taxation. In 2004, the French parliament adopted a new law that creates a new tax on mineral oil, amends the French customs code and creates a new tax on polluting activities, which covers all fossil fuels for transport. The percentage of the tax will be reduced by the percentage of biofuels in the market (EREC 2010, Ch. 13).

6 INTEREST GROUPS AND THE POWER OF LOBBYISTS IN THE US

Interest groups and lobbying are components of modern democratic politics, whereby organized interests and their representatives attempt to sway policy in their favor. Interest groups have proliferated in part because the government's activities affect almost every aspect of peoples' lives, which gives them plenty of reasons to defend their interests (Kernell and Jacobson 2006).

Lobbying describes paid activity in which individuals that represent their clients' or organizations' interests in attempting to influence government decisions. That happens at every level of government, from local to federal. Lobbyists can also represent issues they are personally interested in on a non-profit basis (Javens 2011).

To potentially do business, lobbyists spend a great deal of time keeping in touch with the government officials who deal with the issues that are also connected with the lobbyists' interests. Much of their work lies in responding to proposals or actions, which is why they regularly read newspapers and more specialized publications and talk to other lobbyists and government officials.

The connection between governments and agents who understand how institutions work brings positive results. Governments welcome lobbying, because they are informed about what people want and therefore can predict how they will react to their incentives. Even officials of non-democratic governments can find life considerably easier if they have the support of the governed.

Decision makers need both political and technical information. For example, The United States Congress cannot legislate clean air or water, without a great deal of technical information on the dangers and risks involved. Government officials want to avoid disastrous and costly mistakes, which is why interest groups provide technical information on why a particular policy could fail, is too expensive, or may produce new disasters.

A successful lobbyist persuades people to do what he or she wants them to do by convincing them that the action serves their own interests. Lobbyists present the action they favor in a way that the action will please politician's supporters and the action they oppose will have the opposite effect. They present information consistent with prevailing public opinion. Politicians know that lobbyists are advocates and trust them when both sides expect to have a continuing relationship. If information turns out to be misleading, its source will never be heeded again (Kernell and Jacobson 2006).

6.1 Lobbying Activities

Lobbying groups are involved in many activities such as: testifying and hearings, contacting government officials directly to present the group`s point of view, engaging in informal contacts with officials – at conventions or over lunch, presenting research results or technical information, sending letters to members of the group to inform them about its activities, entering into coalitions with other groups, attempting to shape the implementation of policies, talking with people from the media, consulting with government officials to plan legislative strategy, helping to draft legislation, inspiring letter-writing or Internet campaigns, shaping the government`s agenda by raising new issues and calling attention to ignored problems, mounting grassroots lobbying efforts, having influential constituents contact their members of Congress, helping to draft regulations, rules, or guidelines, serving on advisory commissions and boards, alerting members of Congress about the effects of a bill on their districts, filing suit or otherwise engaging in litigation, making financial contributions to electoral campaigns, doing favors for officials who need assistance, attempting to influence appointments to public office, publicizing candidates` voting records, engaging in direct-mail fund-raising for the group, running advertisement in the media about the group`s position on issues, contributing work or personnel to electoral campaigns, making public endorsements of candidates for office, and engaging in protest demonstrations (Kernell and Jacobson 2006, 521).

6.2 Financing

Over the past three decades, there has been a proliferation of organizations claiming to represent millions of citizens devoted to some version of the public interest. Concerned citizens, usually put together by enterprising activists supported by charitable foundations, wealthy individuals, or the government itself, give money to groups that pursue some political reform such as environmental protection.

Prominent public interest groups are financed principally by membership dues and small donations, as are many of the large environmental lobbies. Organizations' budgets depend on whether opponents or sympathetic politicians run the government.

Organizations that survive on small contributions have no choice but to focus on the issues that continue to generate contributions. That is why interest group officials spend a good deal of their time just keeping the organization running (Kernell and Jacobson 2006).

There is a so-called 527 type of group in the United States, a type of tax-exempt organization that is created to influence the nomination, election, appointment or defeat of candidates for public office. Major industrial and business lobbies are agricultural, energy, health, insurance, organized labor, software, tobacco and transportation. Major single-issues lobbies are abortion/pro-life, Arab affairs, Armenia, China, Cuba, the environment, federal leadership, foreign/defense policy, gay rights, gun politics, immigration, Israel, retirees, and women's rights (Javens 2011, 12–13).

6.2.1 Lobbying Expenditure

Companies, labor unions, and other organizations spend billions of dollars each year to lobby Congress and federal agencies. A total of $3.30 billion was spent on lobbying in 2012; there were 12,390 active lobbyists (OpenSecrets.org 2013).

Yearly lobbyist expenses in 2012 were $55,882,751.67. Total lobbyist expenses in 2012, for nuclear energy: $69,000; for petroleum energy: $904,466.46, for the environment: $705.770,64, and for lobbying firms: $1,157,562.36 (Public Disclosure Commission 2013).

6.2.1.1 Energy Lobby

The energy lobby represents large oil, gas, coal, and electric utility corporations that attempt to influence governmental policy. Electric and major oil and gas companies are among the ten highest-spending industrial lobbyists. By way of comparison, in the United States, from 2003-2006, the energy lobby contributed $58.3 million to political campaigns, and alternative energy interests contributed around $0.5 million. Around 80% of energy lobby donations went to Republican candidates.

Many of the most influential members of the energy lobby are the top polluters in the United States, and they are criticized for using their influence to block or dilute legislation regarding global climate change. In 2005, the Bush administration consulted one of the biggest oil company regarding its stance on the Kyoto Protocol (Javens 2011, 46–47).

6.2.1.2 Environmental Movement in the United States

The organized environmental movement is represented by non-governmental organizations (NGOs). Large national and smaller local groups with local concerns seek to influence the environmental policy. The largest and the most influential environmental organizations are the so called Group of Ten: Defenders of Wildlife, Environmental Defense Fund, National Audubon Society, National Wildlife Federation, Natural Resources Defense Council, Friends of the Earth, the Izaak Walton League, Sierra Club, the Wilderness Society and the World Wide Fund for Nature. Environmental movements often collaborate with social movements for peace, human rights, animal rights, against nuclear weapons and nuclear power, endemic diseases, poverty, hunger, etc.

As public awareness and the environmental sciences have improved, environmental issues, such as sustainability, ozone depletion, global warming, acid rain, and biogenetic pollution, have emerged. In the 1970's, growing environmental and economic concerns generated extensive legislation, such as the Clean Air Act of 1970, National Environmental Policy Act (NEPA), the Water Pollution Control Act Amendments of 1972, the Endangered Species Act of 1973, the Safe Drinking Water Act (1974), the Resource Conservation and Recovery Act

(1976), the Water Pollution Control Act Amendments of 1977, which became known as the Clean Water Act, and the Superfund Act (1980). These laws regulated toxic substances, pesticides, ocean dumping, protected wildlife, wilderness, and scenic rivers, provided pollution research, standard setting, monitoring, and enforcement.

Some groups are more scientific, have well-defined ethical and political views, backed by hard science. They argue that most environmental studies are relatively new, and we do not know how certain actions may affect the environment, so we should refrain from actions we believe they can cause more harm than good (Javens 2011, 148–156).

6.3 Tactics

To succeed politically, groups often have to form alliances. However, being a part of a coalition can mean the loss of a group's distinctive identity. Groups representing, for example growers of wheat, corn, beef, milk, have been joined by groups concerned with nutrition, food safety, international trade, food processing and distribution, environmental quality, farm credit, and the welfare of rural residents. To survive, an interest group must show that its contribution is unique (Kernell and Jacobson 2006).

Interest groups use the mass media to shape public opinion. It is difficult to ignore a cause for which large numbers of people are demonstrating and are willing to go to jail. Demonstrations strengthen group solidarity and may strengthen the organization. If the news media ignore reports, news conferences, and demonstrations, they fail (Kernell and Jacobson 2006).

6.4 Negative Side of Lobbying

The problem with lobbying is that it creates inequity of access to the decision-making process. Those having more money and better political connections are more influential than others. There are no anti-hunger lobbies or lobbies seeking serious solutions to the problem of poverty. When a powerful coalition battles a less powerful one, the result might be potentially harmful for the entire society.

When lobbyists want to determine issues that are seen as superficial issues, more serious issues such as global warming are neglected, which leads to legislative inertia (Hessenius 2007, Ashbrook 2012).

Operating in sectors such as energy production and distribution, where government policies strongly influence profits, major corporations try to shape public policies to their benefit (Kernell and Jacobson 2006).

6.4.1 Revolving Door

Revolving Door is one of the most criticized aspects of the lobbying. Lobbying firms hire former members of the public office. Experience in government allows former officials to develop a network of friends so they can later exploit on behalf of their clients. The fact is that lobbying salaries are several times higher than public sector salaries. So the people in public sector can try to please prospective employers and put private ahead of public interests (Blandes i Vidal, Draca and Fons-Rosen 2010, 2).

If a congressional committee tried to impose massive cuts in defense and health-care spending, would some federal contractor had a potential advantage, because a number of its lobbyists used to work for members of the committee and would be able to lobby their former employers to limit the effect of any reductions (Eggen 2011).

6.5 Lobbying Regulation

Lobbying in the United State is protected by the First Amendment; this has been upheld by the US Supreme Court (Gelak 2008, 5).

Citizens, acting on their First Amendment rights, can exercise their freedom and act together to pursue their interests through politics (Kernell and Jacobson 2006).

Lobbying can be considered a form of petition, because lobbyists try to persuade government officials either to support or to oppose various policy issues (First Amendment Center).

The United States requires disclosure of lobbying, which allows lobbyists to justify their actions with full compliance of the law. Many of the laws and guidelines that are specified in the Lobbying Disclosure Act of 1995 specify how much lobbyist can spend on specific activities and how to report expenses (Magloff). The Honest Leadership and Open

Government Act of 2007 is a law that amended parts of the Lobbying Disclosure Act of 1995 (Straus 2008).

6.6 BUSINESS AND ENVIRONMENTAL POLICY

One of the key players among interest groups is business. In the United States, more than 75 percent of the groups represent business or professional interests of some kind. Other groups cannot compete with the wealth and other resources of business (Kraft and Kamieniecki 2007, 17—18).

6.6.1 The Influence of Business on Environmental Politics

When governments consider taking actions, such as provisions of tax laws or regulation on environmental protection, whereby businesses can be affected, business groups become exceptionally active and try to help to set the political agenda, formulate environmental policies, and influence decision-making in politics. Although business groups have sought approaches to protecting and enhancing environment quality and many large corporations have developed new technologies and pollution control devices and approaches, nothing fundamentally has changed. Many urban areas still experience air pollution problems, many inland lakes and streams remain polluted, and numerous species of flora and fauna are threatened with extinction. Most environmentalists argue that they just give the impression of greener corporate commitments but often block the enactment and implementation of policies that can protect the environment or weaken them to the point where they become ineffective (Kraft and Kamieniecki 2007).

Environmental and other citizen groups have been successful in overcoming the power of business to some degree, because they received support from the scientific community, public opinion, gained favorable media coverage, and intervened in all of the principal institutional venues. Therefore, several acts that protect the environment have been enacted (Kraft and Kamieniecki 2007).

6.6.2 Public Opinion

Businesses try to influence public opinion, because governments tend to follow the public. People hold opposing ideas, which under varied circumstances might lead them to one decision or another. Consumer choices reflect self-interest, while citizens are motivated by more altruistic concerns when making collective decisions for society at large. Survey researchers determined that more people approve the development of US energy supplies, such as oil, gas, and coal, when they were asked if the country should be less depend on imports of Middle East. The result was reversed when environment impacts were taking into consideration. Environmental concern tends to rank high in the public's consciousness. Business enjoys a privileged position in politics when its interests align with those of the consumer (Kraft and Kamieniecki 2007, Ch. 2).

6.6.3 Access Points in the Policymaking Process

Business and other groups strategically select the stages of the policy process at which they try to promote their interests. They often challenge environmental regulation when the issue is not salient to the public and the media scrutiny is less likely. Such an effort usually begins when bills are first being formally evaluated.

Business groups attempt to delay legislation that could protect the environment by arguing for the need for additional scientific research or attempting to focus on the great costs that such policies could impose on society. Some major corporations, which employ large numbers of people and pay taxes, threaten to move elsewhere if the state or city considers the enactment of laws that will intervene with their business.

If business groups are likely to have success in shaping final rules and determining which rules are initially proposed, it depends on which political party rules at the time. Therefore, they try to influence elections. Elected officials may receive a substantial portion of their campaign contributors from large industries, which may influence their choices regarding laws that influence those particular corporations (Kraft and Kamieniecki 2007, Ch. 12).

6.6.4 Implications for Environmental Policymaking

Business and government leaders become powerful when they join forces and support initiatives that stimulate economic growth. However, competing elites in the media, the scientific community, and environmentalists often highlight the differences between what corporations assert is true and the actual evidence. Media, scientists and environmentalists must make a concerted effort to acquire necessary data and raise awareness of the public. That weakens industry success, where industry leaders try to convince policymakers that current levels of pollution are tolerable, that abundance of natural resources, such as fossil fuels, can be used to support economic development, and that further efforts to enhance environmental protection and natural conservation may have negative impacts on employment and economic growth.

Thus far, environmental groups have been less effective, and the public has consequently failed to take stronger stands on environmental issues and voted for elected officials that have not been able to improve pollution control and conserve natural resources (Kraft and Kamieniecki 2007, Ch. 12).

6.6.5 Implications for Business Management

Businesses must be able to achieve fairly rapid returns on investment without massive capital costs and without waiting for the benefits of the future technological progress.

Three steps for business managers and investors who want to fare well in challenging environments are bringing management to the highest level of strategic planning; recognizing the business opportunities and risks that will come with rising natural resource prices; and being prepared, under any circumstance. The most successful managers will recognize the importance of labor and energy productivity, where energy productivity will be considered as importation as human resources and financial management. A substantial effect will be rising natural resource prices, starting with oil and gas, which will create financial risks, but also provide abundant opportunities for new technologies. The coming transition will affect every kind of business, because no business can function without energy, whether in the form of food, fuel, heating or lighting, or electricity. Survivors will be those who act most quickly to identify and adapt to the inputs (Ayres and Ayres 2010, Ch. 11).

6.6.6 The Green Economy

Our political and social system creates increasingly dangerous environmental and social problems, and our uncritically materialistic way of life threatens the existence of human society, and life on Earth. Greening the economy would create new technologies, industries and jobs, and provide clean, safe environment and improved domestic energy security (Mendonca, Jacobs, and Sovacool 2010).

6.6.6.1 Defining Green Jobs

Green jobs can exist in many different sectors, such as architecture, construction, manufacturing or finance. They directly contribute to preserving or enhancing environmental quality, and set out the principles that define a green economy: equal protection and equal opportunity for all. Therefore, green jobs are related to environmentally friendly products and services, relevant to all education and skill levels, provide a living wage and health benefits, offer career development, and are often locally based (Mendonca, Jacobs, and Sovacool 2010, Ch. 1).

6.6.6.2 Green Jobs in the US

The clean economy in the US employs more workers than the fossil fuel industry. Clean jobs reside in manufacturing and the provision of public services such as wastewater and mass transit, and solar, photovoltaics, wind, fuel cell, smart grid, biofuel, and battery industries. Between 2003 and 2010, the clean economy establishment added half a million jobs and outperformed the nation during the recession. Roughly 26 percent of all clean jobs lie in manufacturing, such as the electric vehicles, green chemical products, and lightning. Biofuels, green chemicals, and electric vehicles are also highly export intensive. Median wages in the clean economy are 13 percent higher than median US wages, yet the workers that are employed have relatively little formal education.

To ensure adequate finances for the clean economy, countries can provide guarantees and participating loans or initial capital for revolving loan funds and reduce the costs and uncertainty of projects, and embrace the incremental growth of energy and environmental research, as well as development and demonstration budgets (Muro et al. 2011).

6.7 INNOVATION

Sustainable development includes the awareness of long term protection of human welfare that starts with responsible use of natural resources so that future generations will be able to meet their own needs (Geenhuizen et al. 2010).

Economic growth and structural and systemic changes in energy systems can be achieved via policies that need to be designed in a way that effectively and efficiently bring the goal nearer, and innovation that includes organizational, infrastructural, and social domains (Geenhuizen et al. 2010).

Sources of energy supply should be sufficiently diverse, robust, and sustainable, should not cause harm to the environment, and should allow economies to continue to grow. Therefore, every technology that could bring structural change comes with issues of security, climate, and cost.

There is no single solution that would meet all society's needs, so the full range of solutions needs to be reconsidered. Transition processes take a long time. It implies technological change, change in consumer habits, law, other aspects of society, and occurs on the local, regional, national, and international levels. Development based on past success defines the existing energy system. Therefore, the transition needs to be pointed toward structural change that considers a more sustainable and desirable direction (Geenhuizen et al. 2010, Ch. 1).

There are three reasons we should focus on new technologies and transition process. The first is the future of security of supply of fossil fuel and its prices. The second is environmental considerations. The scientific community warns of the consequences of global warming that enhances the melting of glaciers, rising sea levels, storms, which could harm ecosystems, animal habitats, and change the timing and magnitude of water supply. The third reason considers the new possibilities that will emerge in connection with research and development in the field of employment and export (Geenhuizen et al. 2010, Ch. 2).

6.7.1 Policies in Cities

Sources of sustainable energy differ from global and local availability, scale and system of production, storage and distribution, fluctuation in production, and payback time and production costs. A move to larger shares of renewable energy is dependent on energy security, energy costs, and energy efficiency. City and local governments can be decision-makers, planning authorities, landowners, developers and building operators, managers of municipal infrastructure, advocates and educators, and providers of role models for citizens and businesses (Geenhuizen et al. 2010, Ch. 2).

According to Geenhuizen et al. (2010, 31–32) the following categories of policies/activities in the cities may be included:

- target setting;
- regulation based on legal responsibilities and jurisdiction of the local government;
- operation of municipal infrastructure;
- voluntary actions, such as in the role of market facilitator, promoter, and role model;
- increased awareness of the general public, stakeholders or groups, and increase support for renewable energy through media campaigns, educational programs, and audits.

The comprehensiveness of city policies depends on geographical resource availability, spatial structure of cities, policies at the provincial and state levels, and local political willingness and organizing capacity.

In recent years, practical experience in the implementation of local renewables has shown several things. First, cities in the range of 100,000 to 500,000 inhabitants tend to be pioneers and most active ones. Second, if large firms actively deal in networks with academics, private and public actors, and if a high level of communication exists, the firms are more willing to contribute to the costs. Third, past and current sustainable energy policies often follow broader sustainability goals, because of increased understanding and policy sophistication. Fourth, pioneering cities can take initiative as role models and other cities may follow. Fifth, local governments respond to national targets for renewable energy, incentive programs, and favorable electricity utility policies. Sixth, awards motivate and create practitioner-communities that can serve in mentoring and obtaining resources for new local groups with similar activities. Finally, the best way for people to become acquainted with new technologies are demonstration centers where people can come, see, touch, and learn about them (Geenhuizen et al. 2010, 32-33).

6.7.2 Environmentally Damaging Government Policies in the Energy Sector

Some government policies that attempt to maintain employment levels lead to negative effects on the natural environment, such as greenhouse gas emissions and air pollution. Subsidies to fossil fuels block the transition to alternative and new energy sources. If public subsidies fail to achieve policy effectiveness, economic efficiency, and environmental implications, they are ineffective. When they are ineffective, it is possible that the positive welfare effects of the expected goals for which the policies were designed are smaller than the negative welfare effects (Geenhuizen et al. 2010, Ch. 3).

Environmentally damaging subsidies are usually large and persistent. OECD countries have given large subsidies to polluting sources. The enhancement of innovation and the improvement of cost competitiveness of cleaner energy sources can be done in the absence of subsidies of fossil fuels. Subsidies to fossil fuels increase their production, consumption, and environmental damages. Removing subsidies from fossil fuels would reduce global carbon dioxide emissions by more than 5 percent (Geenhuizen et al. 2010, 44-46).

A sudden increase in an eco-tax and subsidy removal could lead to decline of profits, which can have unemployment as a consequence. Therefore, such a change has to be gradual (Geenhuizen et al. 2010, Ch. 3).

On the other hand, the European Commission targets reducing greenhouse gas emission by at least 20 percent by 2020, improving energy efficiency by 20 percent by 2020, and raising the share of renewable energy to 20 percent by 2020 (Geenhuizen et al. 2010, 58).

6.7.3 Economic Policy Implications

Large countries, with wider manufacturing industries, have a rather low percentage of renewable energy production. To contribute to higher energy productivity and also economic development, rate of employment, competitiveness of firms, and economic growth, R&D investment has to get its share of attention (Geenhuizen et al. 2010, Ch. 4).

6.7.4 Transitions

Transitions emerge as a consequence of fundamental changes of large technical systems, which include energy infrastructure, and can be augmented with policy, regulation and R&D strategies. Transitioning towards a sustainable energy supply would change the behavior of producers and consumers of energy, the actions of governments in their priorities and policies, and the physical infrastructure. A transition occurs when the structure and content of a system change through system innovation. All actors interact through the economy. Their actions are driven by demand, innovation, resource availability, technological capability and by the rules and regulations set and enforced by government. It is the government that provides policies, taxation, rules and regulations, and must manage transitions in energy systems through the development, implementation, and use of transition assemblages.

In the economy domain, the transition should lead to continuous welfare growth or to limited welfare decrease. In the equity domain, welfare should be distributed more equally than it is now. In the ecology domain, irreversible emissions with global or local environmental impact should be avoided, and the negative biodiversity effects during the transition should be minimized.

Furthermore, by creating public support one can create momentum for change (Geenhuizen et al. 2010, Ch. 10).

6.7.5 Linkages of Firms, Universities, and Research Institutions in Innovation Processes

Companies that do not innovate die. Competitive pressure increases and companies might find that they have no time and no resources to develop the knowledge needed to achieve competitive success through innovations. To acquire knowledge and resources from external sources is a key component of innovations and development in firms. Accordingly, governments have launched numerous initiatives to link universities with industrial innovation (Geenhuizen et al. 2010, Ch. 11).

According to Geenhuizen et al. (2010, 286), governments have a crucial role to play in providing effective support designed to specific needs in innovation practice. They can establish international collaboration in new technology development, introduce scientific inventions and their application to market by R&D organizations and industrial partners, supply resources to enhance academia-industry cooperation including partner search, increase the entrepreneurial spirit and capabilities, increase the level of innovativeness, and design a solid government research policy that leads to higher levels of application of scientific inventions.

6.7.5.1 Industry-Science Interaction and Firm Innovation

Remaining only within the business system does not stimulate innovativeness to the same degree as if the business is connected to the academic world, where more radical innovations can be inspired. In this way, firms can receive access to leading edge technologies, highly trained students, professors, and university facilities.

According Geenhuizen et al. (2010, 218), their main findings between 1986 and 2004 showed:

- University research contributes positively and significantly to R&D intensity of the industry in question;
- About 10% of the new products and processes introduced in the seven industries included in the study could not have been developed in the absence of recent academic research;
- Public research has a considerable effect on industrial innovations. A considerable share of companies has identified product and process innovations that would not have been developed without recent research of public research organizations;
- Firms cooperating with science increase their ability to realize more radical innovations and to introduce products that are new to the market;
- Biotechnology companies with university linkages have lower R&D expenses while having higher levels of innovation output;
- Cooperative research agreements have stimulated industrial patents and company-financed R&D;
- University research as a knowledge source and/or R&D cooperation with universities with a stimulating effect on the level of in-house R&D. Joint R&D with universities has a stimulating effect on product innovation. Process innovations are positively influenced by university knowledge and R&D cooperation with universities;
- R&D cooperation with universities is more focused on radical innovation and the creation of new products.

Even though there are many advantages in cooperation between universities and firms, they still have different purposes, mandates, value and reward systems, cultures, and codes of practice. That is why communication and collaboration can also be problematic. Managers complain that universities have little regard for the urgent deadlines of business. While firms are subject to unexpected mergers, reorganizations, and downsizing, universities usually work in a more stable environment (Geenhuizen et al. 2010, Ch. 11).

The purpose for academia-business collaboration is technology transfer in order to enhance the commercialization of new technology and inventions (Geenhuizen et al. 2010, Ch. 14).

6.7.6 An Integrated Innovation Policy Model for Energy Technology

Energy innovations are likely to be influenced in two directions. They will be pulled into the market by the new economic and policy environment and pushed by the advances in science and technology. They will face intense competition from technologies based on conventional fuel, whose market will still receive powerful political and public support. Policies that encourage such innovation must overcome these obstacles.

There are several energy technologies that have been neglected over the previous two decades. Our innovation policies need to be technology neutral as possible and have to create a field in which technological alternatives could compete in order to produce an optimum mix of future technological options.

Most new energy technologies must compete on price and quality from the beginning with existing technologies that are efficient, cheap, and deeply rooted in economic and political structures. Therefore, their implementation will require some form of government attention to all stages of innovative process, from research to development to prototyping to demonstration to incentives for market entry (Weiss and Bonvillian 2009, Ch. 2).

6.7.6.1 Three Theories of Innovation

How technological innovation takes place in response to market forces, and how this process can be influenced by public policy, can be shown in three concepts.

The first of these is the so-called linear or pipeline model. In this model, research leads to invention, to prototyping, to development, to innovation and widespread commercialization. Government support is needed as a technology enters the market.

The second concept is the market-pull and induced innovation model. A market gives an opportunity first to support and promote an invention, second development and finally research. This idea of demand pulls leads to an induced innovation model, which deals with the process by which new products and technologies arise from the demand side, and innovation.

The third theory deals with the management of innovation and the organizations in which it takes place. New organizational mechanisms will be needed to help bridge the gaps between public and private sectors in developing and implementing new technologies (Weiss and Bonvillian 2009, Ch. 2).

6.7.6.2 The Four-Step Analytic Framework

The design of government programs to stimulate innovation in energy technology requires a sound policy framework that requires a four-step analysis.

The first step draws on the pipeline model, suggesting that support from the government is essential for enhancing a number of promising energy technology options. In this step, these technologies are classified into groups that share the same bottlenecks in their launch paths.

The second step draws on induced innovation theory, and classifies policies for the encouragement of innovation into technology-neutral packages. Policies induce the private sector to take up, modify, and implement the technology advances.

The third and fourth steps draw on the innovation organization theory, which determinates what kinds of innovations do not get government support at critical stages of the innovation process, and what kind of support mechanisms and institutions are needed to fill the gaps in the innovation system (Weiss and Bonvillian 2009, Ch. 2).

6.8 RENEWABLE ENERGY AND THE PUBLIC

6.8.1 A Framework for Understanding Public Engagement with Renewable Energy Projects

Public engagement encompasses public reactions to technology proposals and actions of those actors who are involved in promoting technology development and engaging with public in various ways (Devine-Wright 2011, xxiv).

There are various frameworks that describe public responses to renewable energy. According to Devine-Wright (2011, Ch. 1), one framework that could show how the public interacts with social scientists and technical specialists involved with the deployment of renewable energy has characteristic such as symmetries, expectations, dynamics, and contexts.

Symmetry presumes that there are at least two sides in every case of conflict. On one side are public responses, on the other are others who have an interest in a development of renewable energy technologies. Public actors are both individuals and groups. Renewable energy actors are people in organizations, such as developers, consultants, PR and marketing companies, trade associations, financiers and technology manufacturers that support renewable energy technologies (RET). RET actors and public actors communicate, exchange information and opinions, engage with each other by informal conversations, local media reporting, developers' brochures and exhibitions, public meetings, letters, protest activities and petitions.

Public and RET actors have expectations. Local public actors have expectations, for example, about the form and impact of a proposed RET development, project developer, the process, and a proper and appropriate distribution of benefits. RET actors have expectations of development and decision processes, and how they should operate and engage with the public. The engagement of both sides represents the decisions that are made by public and RET actors. Engagement can be extensive and repeated, or there can be disengagement of local people and some developers, who chose not to actively communicate. The dynamic process of interconnection has several stages that start with awareness of a project that is proposed, its interpretation, evaluation, and response.

How people will react to some projects also depends on how they are attached to the place and landscape where RETs are proposed. The more they feel attached, the more they oppose to particular projects.

High local activity, anticipation of negative impacts, and other interactions do not necessarily lead to rejection of proposed RET projects. Furthermore, disengagement, lack of interaction, or anticipation or positive local outcomes do not necessarily lead to project approval.

6.8.2 Public Engagement in Renewable Energy Decision-making

It is essential to convince people that environmental issues such as global warming are more important than the impact that would renewable energy development bring to the local environment. We need to encourage people to support renewable energy and dramatically increase the proportion of energy generated from renewable sources. One way could be through education, and through changing the timing and number of engagement opportunities available (Devine-Wright 2011, Ch. 2).

6.8.2.1 The Principles of Public Engagement

Government decisions should be discussed with local communities, and should work to protect and serve the public interest. According to Devine-Wright (2011, Ch. 2), there are three reasons public engagement in planning procedures and decision-making about renewable energy should be encouraged.

Firstly, public engagement can be used to increase the likelihood of a successful siting. It could lead to more competent decisions without the opposition of the public. Secondly, people have the right to participate in decisions that affect them. Public engagement can improve governance and rebuild trust in authorities and institutions. Thirdly, local people can be local experts, which can rich and contextualized knowledge of the local area.

6.8.2.2 The Procedures of Public Engagement

There are various methods how to engage the public.

The most frequently used method is to provide information about the need for renewable energy in general or for specific development. This method involves informing people of plans that have been made, with leaflets, advertising, providing exhibitions and displays. This engagement is not particularly effective in encouraging public support and trust, because people have little influence or opportunity to express themselves.

The second method attempts to actively elicit public responses. This method includes a dialogue between the people and the developer and provides the opportunity to discuss with people their reasons for opposing or supporting the particular project. A dialogue allows questions to be asked, and direct responses to be given.

The third method allows the public, not just to discuss any plans, but to be more involved in developing them. Participation is taken much more seriously, and decision-making reflects the views of the people and communities. This approach includes citizens' juries, interactive panels, workshops and conferences (Devine-Wright 2011, Ch. 2).

6.8.2.3 Planning

The planning process would be less about deciding, announcing and defending, local people and decision-makers would work together, and outcomes would be more satisfactory to all, if people engagement should be frequent as possible. However, it is debatable if local people and decision-makers can have the same power positions. People have different levels of access and influence, because of the language, education, social position, ethnicity and gender. The public is also not homogeneous entity, and includes many different interests. Some decisions that could benefit some sections could negatively affect others. Fair engagement processes are exceedingly difficult to implement in practice (Devine-Wright 2011, Ch. 2).

6.8.2.3.1 Public Roles

The existence of multiple public roles can provide understanding of how to approach community projects that could not emerge without householders who are prepared to become renewable energy producers. Devine-Wright (2011, 49) discuss ten roles: captive consumers pay bills to established energy suppliers; active consumers actively choose between suppliers, including green tariffs; service users use energy generated using renewable technologies; financial investors invest in renewable energy projects; local beneficiaries receive benefits in addition to energy services; project protestors actively object to projects through the organization of a local protest group; project supporters actively engage in similar actions to protestors; project participants get involved in community mode of implementation; technology hosts own buildings or land used for hosting technology; energy producers directly own and operate generation technologies of different forms.

6.8.2.4 Five Types of Public Engagement

Devine-Wright (2011, Ch. 7) states that who is engaging whom and how is essential to consider. He distinguishes between five types of engagement.

Engagement through awareness-raising is the positive, potential benefits of energy efficiency and renewable energy. It focuses on a broad range of households and individuals through a website and interactive sections, such as carbon calculators, and tries to raise the visibility of the key messages on household energy and efficiency.

Engagement through advice and information provision is coordinated through a combination of a website and a telephone helpline, through which individuals can access expertise, products and service.

Engagement through producing and consuming services is sought through the provision of an audit, a report of recommended actions and project management functions. These services can be accessed through a website and literature.

Engagement based on subsidy and redistribution engage with those in fuel poverty and social housing. There are efforts to provide energy efficiency products at subsidized rates through a combination of website, telephone and face-to-face interactions.

Engagement at a distance creates a commonly recognized and symbolically visible validation of a set of standards with which rented houses should comply. This engages policy and technical knowledge at a distance from absent landlords.

7 FUTURE ENERGY

7.1 NEW ENERGY

If we stop using fossil fuels and nuclear energy and start using alternative energy sources, such as water, wind, biomass, geothermal, and solar, we will have to deal with problems they cause. Even though there are many advantages, renewables also have their limitations. Therefore, we should reconsider other options for our energy system. The disadvantages could result in an international effort to completely change the sources of energy we use today to ones that are clean, cheap and decentralized. Accordingly, we have to be optimistic and support societies to invest in research for new energies.

Governments and public already have problems accepting and supporting renewable energy technologies. It will be even more difficult to accept and support new energy technologies, such as cold fusion and zero-point energy.

"We shall see that the pervasive use of carbon trading, biofuels, alternative hydrocarbons such as the tar sands of Alberta and oil shale of Utah, carbon sequestration at coal mines, the hydrogen economy, nuclear power, hybrid cars, air cars-even solar and wind-can only distract us from what we really need to do in the long run. We shall see that these 'solutions' are just smoke and mirrors in the well-publicized energy slideshow" (O'Leary 2009, 14).

7.1.1 Myths About New Technologies

O'Leary (2009, Ch. 6) claims that there are some outrageous myths spreading about new technologies:

- new energy is not scientifically valid,
- extraordinary claims require extraordinary evidence,
- if it were real, we'd have it by now,
- we must await the free market to bring us to solutions in its own wise timing,
- we can trust the governments to support clean energy R&D.

7.1.2 The Credibility of Cold Fusion

"Revolutions, even nascent ones in science, always hit hard and they hurt" (Beaudete 2002, xxiv). They do cause losses, but generally create more opportunities than losses (Manning and Garbon 2009). Those who carefully examined results from cold fusion experiments believe that something stupendous is happening in this field. Many reliable sources say several hundred replications have been done. Jed Rothwell, founder of LENR-CANR.org and LENR expert, claims that cold fusion has been reproduced roughly 17,000 times according to an estimate published by the Institute of High Energy Physics, Chinese Academy of Sciences (Sterling 2011).

7.1.3 The Importance of Public Policies in the Process of Putting New Sources of Energy into Force

There is no single solution to the policy issues we face today. Because of massive geographical diversity, each nation needs its own regional energy policies.

The new economy must be governed by responsible government, and the core principles of an altruistic democracy. Politicians will need to become responsible to the people and establish a peaceful, just and sustainable future. They can achieve that by translating what is scientifically and technologically real, and potentially beneficial, into the realm of possibility and action (O'Leary 2009).

The problem is not finding clean technologies that could replace fossil fuels and nuclear fission. The problem is political. The problem is prevalent attitudes (Manning and Garbon 2009).

7.1.4 Public

The public must learn how to respond to the risk of environmental issues; it has to support its rescuing and become active. Future achievements depend on public and political support at a time when policy priorities compete, and the policies that best fit the problem faced are being designed and implemented effectively (Kraft 2011).

Ordinary people are wise to learn basics of science in order to watch where energy technologies are heading. Citizens could pay attention to whether the technologies are in harmony with nature, can benefit everyone, or are chosen for profiteering (Manning and Garbon 2009).

7.1.5 Lobbying

The minority of officials that work in governments, industry, the military and academia know that revolutionary energy inventions exist. However, those who control world finances do not want them, because they could disrupt corporate and geopolitical power structures. Electrical utilities, oil and gas drilling and mining, tax revenues, even radioactive waste, all create personal fortunes, benefit governments, Wall Street and others. The oil-war industry gives vast sums of money for lobbying politicians to keep on taking control. They grab patent rights and claim that a revolutionary advancement is a disruptive technology, a matter of national security and, plainly speaking, a threat to oil-company profits (Manning and Garbon 2009).

King (in Manning and Garbon 2009, 208) lists eight ways of blocking revolutionary energy inventions from the marketplace:

- academic suppression,
- blocking of funding,
- blocking of patents,
- litigation,
- threats to the inventor,
- property destruction,
- framing the inventor with crime,
- assassination.

King claims that problems come from three groups. First, the academic community usually ignores, ridicules, rejects peer reviewers' of papers, shuns and accuses of fraud those who attempt to publish their results. The second community is people from industry and business who do not want change to happen if it means they would no longer maintain their monopoly or would have to retool their factories. The third group is secretive projects. Even presidents of countries sometimes do not know they exist. The military and industry get billions of dollars for those projects, but do not explain how those taxpayers' dollars are spent. O'Leary (2009) adds the group of environmentalists who are scared of the potential misuse of new energy and the media that operate under strict guidelines about what to investigate and what not to investigate.

"Researchers' freedom to study what interests them and what, in their view, may be of potential value to society, is essential for the progress of humanity. If departments of science limit research to the realm of what is known and accepted, no further scientific breakthroughs can occur" (Krivit and Winocur 2004, 229).

7.1.6 Invention Secrecy

"Whenever publication or disclosure by the grant of a patent on an invention in which the Government has a property interest might, in the opinion of the head of the interested Government agency, be detrimental to the national security, the Commissioner upon being so notified shall order that the invention be kept secret and shall withhold the grant of a patent therefor under the conditions set forth hereinafter" (Legal Information Institute).

Under the United States' Invention Secrecy Act of 1951, patent applications on new inventions can be subject to secrecy orders if government agencies believe that disclosure would be detrimental to the national security. There were 5,135 inventions that were under secrecy orders at the end of Fiscal Year 2010, and are not publicly available and have been denied under the Freedom of Information Act (Aftergood 2010).

7.1.7 Market

Neither inventors nor investors know how long it takes to go from the concept to the commercial product. The timeline is especially lengthy when it comes to truly breakthrough energy inventions, because they lack academic and bureaucratic support. For a new energy era to be born, it is necessary to confront politics, inertia, fear and greed. Technological challenges, apathy, antagonism and political opposition barriers new energy technologies that try to succeed in the marketplace.

Business people and investors rarely invest in innovations unless they are fully developed, because they are considered financially too risky. Therefore, the experimenters who passionately explore new technologies typically exhaust their own savings and take out personal loans (Manning and Garbon 2009).

7.1.8 Media

Those who write and create books, articles and advertisements often repeat how dangerous new technologies are. It seems people begin to believe that dirty is actually clean. Often information about new technologies cannot be obtained in science magazines, because a few of them control the market and decide what is going to be published and what not. Fortunately a rapidly increasing number of promising, and often proven, energy inventions surface on the Internet, where many people can access to them (Manning and Garbon 2009).

7.1.9 Open Source

Open source is a movement on the Internet (Open Source Initiative). It helps different researchers and scientists to break out their own ideas about new energy technologies into the public domain without trying to protect intellectual property and patent it, but wanting to share it with people around the world. Other researchers see the information, might adopt it and share their own ideas. The result is that technologies develop faster as usual.

Publicly known inventions will be copied, but the inventor still has the possibility to benefit. The original inventor will be respected all over the world and sought to provide consulting services, which brings profit. He/she could write books or give lectures (Manning and Garbon 2009).

7.2 FUTURE POLICY CONSIDERATIONS

To ensure a stable and clean energy supply, national energy policies have to include reorganized research and development (R&D) activities. R&D is the most valuable part of such policies because it includes funds. If the public and private sector had increased funds for R&D, alternative and especially new energy technologies would have developed much faster and would have the potential to become commercially available in a near future.

Technologies that use fossil fuels are mature technologies that have been used for decades. To mitigate their impact on the environment, the dangerous greenhouse gases that are emitted during combustion could be limited, and the efficiency could be increased.

Technologies that use alternative energy sources are still developing. They can be upgraded and become much more efficient. Their share on global energy market is still relatively small and can be increased. In recent years, investment in technologies that use alternative energy sources has increased considerably (see Appendix A).

Technologies that are classified as new energy are still not developed. They are on the level of basic scientific research. Scientists and inventors try to prove basic principles and create first working prototypes.

The mechanisms introduced in chapter 5.3 are created for alternative sources of energy. The new technologies must first reach the phase where they can become commercially viable. Therefore, governments must divert their attention from conventional energy sources to alternative and especially new energy sources by substantially increasing financial support for R&D. Some financial aid can be gained by diverting subsidies for conventional sources to subsidies for new energy sources, or eco-taxes for GHG emissions, which can be used for R&D funding. Moreover, the stability of policies in alternative sources and new energy source fields should not be just a product of a temporary administration. Obligations should be sustainable and so should be the financing for R&D.

7.2.1 Suggestions and Recommendations for Financing of Research and Development in New Energy Field

It would be wise to perform basic research that would confirm that new sources are possible and, after that, make practical working laboratory prototypes, which would be a beginning for the development of technologies that would be commercialized.

Skarja (2007) suggests four phases, which would need financial support:

- The first phase is a review and study of new sources, selecting the most promising ones.
- The second phase is researching some patents and scientific explanations of their function.
- The third phase would include a plan for manufacturing prototypes of chosen devices, manufacturing of these devices, and experimenting in laboratories.
- In case these tests prove to be effective, the plan for the exploitation of a particular technology and inclusion in the energy system would be accepted.

If researchers have financial support, they can hire a team of helpers, or even an assistant that can assist in accelerating the research and development phase (Manning and Garbon 2009).

7.2.2 Consequences that Could Rise from Investment in R&D in New Energy

Consequences that could rise from investment in R&D in new energy (Greer 2007, New Energy Movement):

- Energy generation becomes decentralized, cheap and easily accessible.
- Toxic pollution from combustion of fossil fuels ends.
- Mitigation of global warming and stabilization of climate patterns.
- Clean air through elimination of air pollution related to energy generation, industry and transportation.
- Great reduction in environmentally-damaging resource extraction.
- Transportation of fossil and nuclear fuels substantially reduced.
- Long lived radioactive wastes are reduced or eliminated.
- Greatly increased recycling of wastes made possible by low cost energy.
- Mitigation and remediation of water and soil pollution made possible by low cost energy.
- No need for expensive, dangerous, landscape-altering power transmission lines.
- Infrastructure investments in centralized power generation and distribution are eliminated.
- Vulnerability of a centralized electrical grid system substantially reduced.
- Cessation of environmentally damaging hydroelectric dam building.
- Restoration and preservation of forests formerly depleted for wood fuel.
- Money now spent on electric power generation, gas, oil, coal and nuclear power would be freed to be spent on more productive and environmentally neutral endeavors.
- A great expansion of the global economy.
- The vast disparity between rich and poor nations is significantly lessened.
- Global standard of living greatly improves.
- Underdeveloped regions would be lifted out of poverty and into a high technology sustainable economies in about a generation
- Education rates improve throughout the developing world.
- Third world birth rates decline as the result of an educated global population and higher living standards.
- A new era of space travel becomes possible with the development of advanced energy and propulsion systems.

- Cessation of military conflicts and geopolitical tensions related to unstable supplies of fossil fuels and other natural resources.
- Greatly enhanced national security, reduced military expenditures, and reduced risk to military personnel and civilians.
- Reduction of the proliferation of potentially destructive nuclear technologies.
- A tremendous wave of human creativity is unleashed as people are freed from toil for basic sustenance, producing unimaginable progress in social and material conditions.
- The practical achievement of an environmentally near-zero impact yet high tech civilization on earth, thus assuring the long-term sustainability of human civilization.
- A global culture of sharing and cooperation.
- The possibility for true and lasting world peace.

Public policies should finance the research and development of new energy, which would bring clean, cheap, renewable, decentralized and benign technologies. The development phase needs to become transparent and public. Policies have to assure public discussions about inclusions of new technologies that would mitigate climate change and pollution. They should offer lectures for public and should make a plan that would help industry and governments to overcome the necessary change to new energy economy (O'Leary 2009).

8 CONCLUSION

Energy is the basic technological foundation of human civilization. For centuries, only human and animal power was available. In 18th century, the Industrial Revolution began to change the main source of energy. It is still in a transition process, because the energy sources we use today are limited and people, are increasingly aware that the usage of conventional sources of energy, such as fossil fuel and nuclear energy, bring negative consequences for the environment and people. The solution to the problem of conventional energy sources is alternative and new energy sources.

During my research, I realized that alternative energy sources are not the final answer to problems we are faced with in using conventional energy sources. Alternative energy sources are a relative answer in a transitional period. New energy sources will have to take their place in the long run.

Energy is deeply entrenched in our civilization. Because the systems producing energy are so complex and so essential, governments have participated from the very beginning, setting policies, standards, financing, locations, international agreements etc.

To understand what is necessary to make effective policy, those making them must have knowledge about technology and about policy. If one does not know which technologies are on the market, which technologies have the potential to become commercially used, and what are the advantages and disadvantages of conventional, alternative and new energy sources, then it is entirely possible that policies that are made or in the process of being made will not be sufficient to solve many problems humanity currently faces.

9 REFERENCES

1. Aftergood, Steven. 2010. Invention Secrecy Still Going Strong. *Secrecy News*, October 31. Retrieved from: http://blogs.fas.org/secrecy/2010/10/invention_secrecy_2010/ (Accessed: May 3, 2013).
2. Arnow, Joshua. 2009. Low Velocity Hydro Power By VIVACE (Vortex Induced Vibrations Aquatic Clean Energy). *The Sustainability Laboratories.* Retrieved from: http://www.sustainabilitylabs.org/news/09-01-02/low-velocity-hydro-power-vivace-vortex-induced-vibrations-aquatic-clean-energy (Accessed: March 20, 2013).
3. Ashbrook, Tom. 2012. Lawrence Lessig on Money, Corruption and Politics. *On Point with Tom Asbrook.* Retrieved from: http://onpoint.wbur.org/2012/01/02/lawrence-lessig-on-money-corruption-and-politics (Accessed: August 17, 2012).
4. Asmus, Peter. 2009. *Introduction to Energy in California.* California, England: University of California Press.
5. Aswathanarayana, U., T. Harikrishnan and K. M. Thayyib Sahini. 2010. *Green Energy*. London: CRC Press.
6. Ayres, Robert U., and Edward H. Ayres. 2010. *Crossing the Energy Divide.* New Jersey: Wharton School Publishing.
7. Baker, Nathanael. 2010. The Geothermal Report: Global Geothermal Capacity Will Grow 78% by 2015. *Energy Boom.* Retrieved from: http://www.energyboom.com/geothermal/geothermal-report-global-geothermal-capacity-will-grow-78-2015 (Accessed: August 13, 2012).
8. Barrett, Brendan. 2012a. Big Picture Policy Responses to Peak Oil. *Our World 2.0.* Retrieved from: http://ourworld.unu.edu/en/big-picture-policy-responses-to-peak-oil/ (Accessed: August 12, 2012).
9. ---2012b. Japan Considers Green Future After Nuclear Disaster. *Aljazeera.* Retrieved from: http://www.aljazeera.com/indepth/opinion/2012/02/201224112019731735.html (Accessed: August 12, 2012).
10. ---2012c. Policy-Makers Slow to Take Peak Oil Action. *Our World 2.0.* Retrieved from: http://ourworld.unu.edu/en/policy-makers-slow-to-take-peak-oil-action/ (Accessed: August 12, 2012).

11. *Bates Chemical.* Natural Gas Plant. Retrieved from: http://bateschemical.com/products/markets-served/natural-gas-plant/ (Accessed: November 1, 2012).

12. Beaudette, Charles G. 2002. *Excess Heat: Why Cold Fusion Research Prevailed.* South Bristol, Maine: Oak Grove Press.

13. Blanes i Vidal, Jordi, Mirko Draca, and Christian Fons-Rosen. 2010. *Revolving Door Lobbyists.* London: Centre for Economic Performance. Retrieved from: http://cep.lse.ac.uk/pubs/download/dp0993.pdf (Accessed: August 17, 2012).

14. Booker, Christoper. 2012. Germany's Wind Power Chaos Should be a Warning to the UK. *The Telegraph,* September 22. Retrieved from: http://www.telegraph.co.uk/comment/9559656/Germanys-wind-power-chaos-should-be-a-warning-to-the-UK.html (Accessed: December 13, 2012).

15. Bushnell, Dennis. 2011. *LENR and NASA.* NASA Langley Research Center. Retrieved from: http://newenergytimes.com/v2/government/NASA/20110922NASA-Bushnell-GRC-LENR-Workshop.pdf (Accessed: December 17, 2012).

16. *Busytrade.com.* 1kw H Type Vertical Wind Turbine. Retrieved from: http://emilyqi547.en.busytrade.com/products/info/1867047/1kw-H-Type-Vertical-Wind-Turbine.html (Accessed: January 16, 2012).

17. CAEPLA. 2011-2012. *A Revolution Underground: The History, Economics & Environmental Impacts of Hydraulic Fracturing.* CAEPLA.

18. *California Energy Commission.* 1994-2013. Hydroelectric Power in California. Retrieved from: http://www.energy.ca.gov/hydroelectric/ (Accessed: April 27, 2013).

19. *CALNI*. 2010. A New Biogas Power Station Showcases How Towns Will be Powered by Locally Produced Energy. By Vern. Retrieved from: http://stopthemoyparkincinerator.com/?p=790 (Accessed: November 1, 2012).

20. Campbell, Kurt M. and Jonathon Price, ed. 2008. *The Global Politics of Energy.* Washington, DC: The Aspen Institute.

21. *CBS News.* 2011. Nuclear Safety Expert: It Could Happen Here. Retrieved from: http://www.cbsnews.com/stories/2011/03/16/eveningnews/main20044005.shtml?tag=cbsnewsTwoColUpperPromoArea (Accessed: November 1, 2012).

22. *CINK.* 2013. Francisova Spiralna Turbina. Retrieved from: http://www.cink-hydro-energy.com/sr/turbina-ossberger?page=francis (Accessed: April 27, 2013).

23. Cipiti, Ben. 2007. *The Energy Construct: Achieving a Clean, Domestic, and Economical Energy Future.* Booksurge Publishing.

24. *Committee on Energy & Commerce.* 2011. Committee Democrats Release New Report Detailing Hydraulic Fracturing Products, April 16. Retrieved from: http://democrats.energycommerce.house.gov/index.php?q=news/committee-democrats-release-new-report-detailing-hydraulic-fracturing-products (Accessed: September 12, 2012).

25. Craddock, David. 2008. *Renewable Energy Made Easy: Free Energy from Solar, Wind, Hydropower, and Other Alternative Energy Sources.* Florida: Atlantic Publishing Group, Inc.

26. *Daily Kos.* 2008. A school of electric fish. 20 new wave power ideas. Retrieved from: http://www.dailykos.com/story/2008/12/05/669590/-A-school-of-electric-fish-20-new-wave-power-ideas (Accessed: February 7, 2012).

27. *Democracy Now.* 2010. World-Renowned Scientist Dr. Theo Colborn on the Health Effects of Water Contamination from Fracking, April 14. Retrieved from: http://www.democracynow.org/2010/4/14/world_renowned_scientist_dr_theo_colborn (Accessed: September 12, 2012).

28. Devine-Wright, Patric. 2011. *Renewable Energy and the Public: From NIMBY to Participation.* Washington, DC, London: Earthscan.

29. *Ecofriend*. What's Next: Harvesting Solar Energy In Deserts. Retrieved from: http://www.ecofriend.com/harvesting-solar-energy-deserts.html (Accessed: January 14, 2012).

30. *EFD.* 2012. How Fracturing Works. Retrieved from: http://www.efdsystems.org/Technologies/HydraulicFracturing/HowItWorks/tabid/1779/Default.aspx (Accessed: December 20, 2012).

31. Eggen, Dan. 2011. Members of Debt Panel Have Ties to Lobbyists. *The Washington Post Politics,* September 6. Retrieved from: http://www.washingtonpost.com/politics/many-members-of-debt-supercommittee-have-ties-to-lobbyists/2011/08/23/gIQANiLr4J_story.html (Accessed: March 3, 2013).

32. *Electrician.com.au.* Solar Panels. Retrieved from: http://www.electrician.com.au/all-day-solar-electrical-pty-ltd/ (Accessed: January 14, 2012).

33. *Electropaedia.* 2005. Hydroelectric Power. Retrieved from: http://www.mpoweruk.com/hydro_power.htm (Accessed: February 6, 2012).

34. *Energy Trends Insider*. 2010. Five Positive Notes on Next-Generation Biofuels.. Retrieved from: http://www.energytrendsinsider.com/2010/06/11/five-positive-notes-on-next-generation-biofuels/ (Accessed: November 1, 2012).

35. *EPA*. 2012. Hydraulic Fracturing Background Information, May 9. Retrieved from: http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/wells_hydrowhat.cfm (Accessed: December 16, 2012).
36. EPIA. 2011. *Solar Generation 6: Solar Photovoltaic Electricity Empowering the World.* Greenpeace. Retrieved from: http://www.greenpeace.org/international/Global/international/publications/climate/2011/Final%20SolarGeneration%20VI%20full%20report%20lr.pdf (Accessed: October 31, 2012).
37. EREC. 2010. *Renewable Energy in Europe: Markets, Trends and Technologies.* Washington, DC, London: Earthscan.
38. *Erneuerbare Energien und Klimaschutz.* Dish/Stirling System Eurodish. Retrieved from: http://www.volker-quaschning.de/fotos/psa/index_e.php (Accessed: January 14, 2012).
39. *EV World.com*. 2006. OTEC Resurfaces. Retrieved from: http://www.evworld.com/article.cfm?storyid=1008 (Accessed: February 7, 2012).
40. *Excerpt GEAB N°55*. 2011. After Fukushima: The Six Essential Features of the Revolution in the Nuclear Power Decision-Making Process for the 2010-2020 Decade. Retrieved from: http://www.leap2020.eu/After-Fukushima-The-six-essential-features-of-the-revolution-in-the-nuclear-power-decision-making-process-for-the-2010_a8032.html (Accessed: August 12, 2012).
41. FAO. 2010. *Greenhouse Gas Emissions From the Diary Sector*. Retrieved from: http://www.fao.org/docrep/012/k7930e/k7930e00.pdf (Accessed: February 28, 2013).
42. Farrugia, Elise M., ed. 2010. *Climate Change: Fundamental Issues and Policy Tools.* New York: Nova Science Publishers, Inc.
43. *First Amendment Center*. Is Lobbying Considered a Form Of Petition? Retrieved from: http://www.firstamendmentcenter.org/faq/frequently-asked-questions-petition (Accessed: March 5, 2012).
44. Fleishmann, Martin, Stanley Pons, Mark W. Anderson, Lian Jun Li, and Marvin Hawkins. 1990. *Calorimetry of the Palladium-Deuterium-Heavy Water System.* USA: Department of Chemistry, University of Utah. Retrieved from: http://www.lenr-canr.org/acrobat/Fleischmancalorimetr.pdf (Accessed: March 5, 2013).
45. *Free Energy Blog.com.ar*. 2010. Save Money With a Free Energy Magnetic Motor. Retrieved from: http://www.freeenergyblog.com.ar/free-energy-magnetic-motor/ (Accessed: March 20, 2013).

46. *FutureLab.* 2007. The Renewable Electron Economy Part VII: Stationary Energy Storage: Key to the Renewable Grid. Retrieved from: http://www.futurelab.net/blogs/marketing-strategy-innovation/2007/10/the_renewable_electron_economy_3.html (Accessed: November 1, 2012).
47. Gallagher, Kelly Sims, ed. 2009. *Acting in Time on Energy Policy*. Washington, D.C.: The Brookings Institution Press.
48. GasLand. *The Sky is Pink: Annotated Documents.* Retrieved from: http://www1.rollingstone.com/extras/theskyispink_annotdoc-gasl4final.pdf (Accessed: September 23, 2012).
49. Gelak, Deanna R. 2008. *Lobbying and Advocacy*. Alexandria: The Capitol.Net, Inc.
50. *GEOTIMES*. 2008. Desert Power: A Solar Renaissance. Retrieved from: http://www.agiweb.org/geotimes/apr08/article.html?id=feature_solar.html (Accessed: January 14, 2012).
51. *Gizmondo*. 2008. World's First Tidal Turbine Power Station Goes Online, Doesn't Blend Seals. Retrieved from: http://gizmodo.com/tidal-turbines/ (Accessed: February 6, 2012).
52. Gore, Al. 2009. *Our Choice: A Plan to Solve the Climate Crisis.* New York: Rodale Inc.
53. *Green Diary*. 2011. Five Biggest Geothermal Power plants in the World. Retrieved from: http://www.greendiary.com/biggest-geothermal-power-plants-world.html (Accessed: April 28, 2013).
54. Greenhuizen, Marina van, William J. Nuttall, David. V. Gibson, and Elin M. Oftedal, ed. 2010. *Energy and Innovation: Structural Change and Policy Implications.* Indiana: Purdue University Press.
55. Greer, Steven M. 2007. *New Energy Solutions and Implications for the National Security and The Environment: A Brief Overview for the US Senate*. Retrieved from: http://www.theorionproject.org/en/newenergy_greer.html (Accessed: May 3, 2013).
56. *Groundwork.* 2011. GWPC and IOGCC Launch www.fracfocus.org. Retrieved from: http://groundwork.iogcc.org/topics-index/hydraulic-fracturing/iogcc-in-action/gwpc-and-iogcc-launch-wwwfracfocusorg (Accessed: September 12, 2012).
57. Haven, Kendall. 2011. *Green Electricity: 25 Green Technologies That Will Electrify Your Future.* California, Colorado, England: ABC-Clio, Inc.

58. Healey, Ben and Nancy Pfund. 2011. *What would Jefferson do?:The Historical Role of Federal Subsidies in Shaping America's Energy Future.* DBL Investors. Retrieved from: http://www.dblinvestors.com/documents/What-Would-Jefferson-Do-Final-Version.pdf (Accessed: July 23, 2012).

59. *Hello Trade*. Sun Ray Solar Products. Retrieved from: http://www.hellotrade.com/sun-ray-solar-products/product.html (Accessed: January 14, 2012).

60. Herron, David. 2012. President Obama Announces Initiatives for Reducing Dependence on Oil. *Torque News*, July 3. Retrieved from: http://www.torquenews.com/1075/president-obama-announces-initiatives-reducing-dependence-oil (Accessed: August 12, 2012).

61. Hessenius, Barry. 2007. *Hardball Lobbying for Nonprofits: Real Advocacy for Nonprofits in the new Century.* New York: Palgrave Macmillan.

62. Hierro, Lola. 2013. Cantabria Becomes First Region in Spain to Ban Fracking. *EL Pais in English*, January 13. Retrieved from: http://elpais.com/elpais/2013/01/30/inenglish/1359554752_960260.html (Accessed: February 4, 2013).

63. Hiyama, Atsuki, Chiyo Nohara, Seira Kinjo, Wataru Taira, Shinichi Gima, Akira Tanahara and Joji M. Otaki. 2012. The Biological Impacts of the Fukushima Nuclear Accident on the Pale Grass Blue Butterfly. *Scientific Reports* 2: 570. Retrieved from: http://www.nature.com/srep/2012/120809/srep00570/pdf/srep00570.pdf (Accessed: August 15, 2012).

64. *Hub Pages.* What is a Horizontal Wind Turbine? By Science Fair Lady. Retrieved from: http://sciencefairlady.hubpages.com/hub/What-is-a-Horizontal-Wind-Turbine (Accessed: January 16, 2012).

65. *Inhabitat*. 2008. The World's First Wave Farm Goes Live in Portugal. Retrieved from: http://inhabitat.com/portugal-wavepower-plant-goes-live/ (Accessed: February 6, 2012).

66. *InterNACHI*. Wind Turbines. Retrieved from: http://www.nachi.org/wind-turbines.htm (Accessed: January 16, 2012).

67. *IPCC.* 2007a. *Climate Change 2007: Synthesis Report*. Retrieved from: http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf (Accessed: February 26, 2013).

68. ---2007b. *Climate Change 2007: The Physical Science Basics*. Retrieved from: http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4_wg1_full_report.pdf (Accessed: February 26, 2013).

69. ITOPF. 2012. *Oil Tanker Spill Statistics 2012.* Retrieved from: http://www.itopf.com/information-services/data-and-statistics/statistics/documents/StatsPack_001.pdf (Accessed: April 20, 2013).

70. Javens, Mack, ed. 2011. *A Reference Guide to Lobbying in the United States: Industrial, Business, and Single-Issues Lobbies.* Webster's Digital Services.

71. *JET Energy*. JET Energy Goal is: Clean Energy Production. Retrieved from: http://world.std.com/~mica/jet.html (Accessed: December 13, 2012).

72. Kernell, Samuel, and Gary C. Jacobson. 2006. *The Logic of American Politics.* Washington, D. C.: CQ Press.

73. Komor, Paul. 2004. *Renewable Energy Policy*. Lincoln: iUniverse, Inc.

74. Kraft, Michael E. 2011. *Environmental Policy and Politics.* Boston: Longman.

75. Kraft, Michael E., and Sheldon Kamieniecki, ed. 2007. *Business and Environmental Policy: Corporate Interests in the American Political System.* Massachusetts, England: The MIT Press.

76. Krivit, Steven B., and Nadine Winocur. 2004. *The Rebirth of Cold Fusion: Real Science, Real Hope, Real Energy.* California: Pacific Oaks Press.

77. *Legal Information Institute.* 35 USC Chapter 17 - Secrecy Of Certain Inventions And Filing Applications In Foreign Country. Retrieved from: http://www.law.cornell.edu/uscode/text/35/181 (Accessed: May 3, 2013).

78. Lichtenberg, Frank. 2012. *ECAT – A Novel and Environmentally Friendly LENR-Based Energy Technology*, December 9. Retrieved from: http://www.novam-research.com/resources/ECAT.pdf (Accessed: Januar 24, 2013).

79. *Linde Engineering*. Hydrogen and Synthesis Gas Plant. Retrieved from: http://www.linde-engineering.com/en/process_plants/hydrogen_and_synthesis_gas_plants/index.html (Accessed: February 7, 2012).

80. *Linde.* 2010. Krypton-85. Retrieved from: http://www.spectragases.com/content/upload/AssetMgmt/PDFs/lighting/PDS-Krypton-85-Rev0.pdf (Accesed: March 1, 2013).

81. Lustgarten, Abrahm. 2008. Buried Secrets: Is Natural Gas Drilling Endangering U.S. Water Supplies? *ProPublica,* November 13. Retrieved from:

http://www.propublica.org/article/buried-secrets-is-natural-gas-drilling-endangering-us-water-supplies-1113 (Accessed: September 23, 2012).

82. Macfarlane, Allison M., and Rodney C. Ewing, ed. 2006. *Uncertainty Underground*: *Yucca Mountain and the Nation`s High-Level Nuclear Waste.* Massachusetts, England: The MIT Press.

83. Magloff, Lisa. Federal Lobbying Guidelines. *Chron*. Retrieved from: http://smallbusiness.chron.com/federal-lobbying-guidelines-14110.html (Accessed: March 5, 2012).

84. *Mainichi Japan.* 2012. Process for Restarting Reactors Preceding New Energy Policy. Retrieved from: http://mdn.mainichi.jp/mdnnews/news/20120308p2g00m0dm056000c.html (Accessed: August 12, 2012).

85. Makhijani, Arjun. 2008. *Carbon-free and Nuclear-free: A Roadmap for U.S. Energy Policy.* Maryland, Michigan: IEER Press and RDR Books.

86. Manning, Jeane, and Joel Garbon. 2009. *Break Through Power: How Quantum-Leap New Energy Inventions Can Transform Our World.* Canada: Amber Bridge Books.

87. McCurry, Justin. 2012a. Fukushima Disaster Paves Way for New Geothermal Plants. *Our World 2.,* August 10. Retrieved from: http://ourworld.unu.edu/en/fukushima-disaster-paves-way-for-new-geothermal-plants/ (Accessed: August 13, 2012).

88. ---2012b. Fukushima Radiation Fears are Linked to Increase in Obesity Among Children. *The Guardian*, December 17. Retrieved from: http://www.guardian.co.uk/environment/2012/dec/27/fukushima-radiation-child-obesity-fears (Accessed: January 21, 2013).

89. Mendonca, Miguel, David Jacobs, and Benjamin Sovacool. 2010. *Powering the Green Economy: The Feed-in Tariff Handbook.* Washington, DC, London: Earthscan.

90. *Metso.* 2013. Heating plants: Heat From Local Wood-Based Feedstocks. Retrieved from: http://www.metso.com/energy/boiler_prod.nsf/WebWID/WTB-090514-22575-A4151?OpenDocument (Accessed: April 28, 2013).

91. Mizuno, Tadahiko. 1998. *Nuclear Transmutation: The Reality of Cold Fusion.* New Hampshire: Infinite Energy Press.

92. Moller, Anders Pape, Isao Nishiumi, Hiroyoshi Suzuki, Keisuke Ueda, and Timothy A. Mousseau. 2013. Differences in Effects of Radiation on Abundance of Animals in Fukushima and Chernobyl. *ScienceDirect.com* 24: 75-85. Retrieved from:

http://www.sciencedirect.com/science/article/pii/S1470160X12002324 (Accessed: August 15, 2012).

93. Morris, Fernando. 2012. Breakthrough Magnetic Waveform Technology. *Searl Magnetics, Inc.* Retrieved from: http://searlmagnetics.com/ (Accessed: February 8, 2013).

94. *MTPV*. 2009. Introducing a New Technology That Converts Heat to Electricity With Breakthrough Performance Using Semiconductor Chips. Retrieved from: http://www.mtpv.com/index.php (Accessed: March 3, 2013).

95. Muro, Mark, Jonathan Rothwell, and Devashree Saha. 2011. Sizing the Clean Economy: A National and Regional Green Jobs Assessment. *Brookings,* July 13. Retrieved from: http://www.brookings.edu/research/reports/2011/07/13-clean-economy (Accessed: March 5, 2013).

96. Nagel, David. J. 2012. Scientific and Commercial Overview of ICCF17. *Infinite energy* 106 (11/12): 18-32,. Retrieved from: http://www.infinite-energy.com/images/pdfs/NagelIE106.pdf (Accessed: December 13, 2012).

97. Nagel, David. J. 2012. Scientific and Commercial Overview of ICCF17. *Infinite energy* 106 (11/12): 18-32,. Retrieved from: http://www.infinite-energy.com/images/pdfs/NagelIE106.pdf (Accessed: December 13, 2012).

98. Nersesian, Roy L. 2010. *Energy for the 21st Century: A Comprehensive Guide to Conventional and Alternative Sources.* New York, England: M. E. Sharpe, Inc.

99. *New Energy Movement*. Energy Innovation Act of 2007. Retrieved from: http://www.newenergymovement.org/EnergyInnovationAct2007.php (Accessed: August 4, 2011).

100. *New Energy Times*. 2012. The Fleischmann-Pons Cold Fusion Method. Retrieved from: http://newenergytimes.com/v2/books/RebirthofColdFusion/FPColdFusionMethod.shtml (Accessed: February 15, 2013).

101. Ngo, Christian, and Joseph B. Natowitz. 2009. *Our Energy Future*: *Resources, Alternatives, and the Environment.* New Jersey: John Wiley and Sons, Inc.

102. *NRDC.* 2012. Protecting Americans from the Risks of Fracking. Retrieved from: http://www.nrdc.org/energy/files/frackingrisks.pdf (Accessed: September 12, 2012).

103. O`Keefe, Phil, Geoff O`Brien, and Nicola Pearsall. 2010. *The Future of Energy Use.* Washington, DC, London: Earthscan.

104. O`Leary, Brian. 2009. *The Energy Solution Revolution.* Hayden: Bridger House Publishers.

105. *OffshoreWIND.biz*. 2012. Wavebob to Invest in Wave Energy Farms. Retrieved from: http://www.offshorewind.biz/2012/01/17/wavebob-plans-to-raise-eur-10-million-uk/wavebob-to-invest-in-wave-energy-farms-uk22/ (Accessed: February 6, 2012).

106. *Open Source Initiative.* Retrieved from: http://opensource.org/ (Accessed: August 4, 2011).

107. *OpenSecrets.org.* 2013. Lobbying Database. Last modified January 28. Retrieved from: http://www.opensecrets.org/lobby/index.php (Accessed: March 20, 2013).

108. *OSTS PEIS.* 2012. About Tar Sands. Retrieved from: http://ostseis.anl.gov/guide/tarsands/ (Accessed: March 23, 2013).

109. Patel, Tara. 2011. The French Public Says No to `Le Fracking`. *Bloomberg Businessweek,* March 31. Retrieved from: http://www.businessweek.com/magazine/content/11_15/b4223060759263.htm (Accessed: March 1, 2013).

110. *PESWiki*. 2010. F. M. Chalkalis Gravity Wheel. Retrieved from: http://peswiki.com/index.php/OS:_F._M._Chalkalis_Gravity_Wheel (Accessed: March 20, 2013).

111. *PESWiki*. 2012. Motor-Generator Self-Looped with Usable Energy Left Over. Retrieved from: http://peswiki.com/index.php/Directory:Motor-Generator_Self-Looped_with_Usable_Energy_Left_Over (Accessed: March 20, 2013).

112. ---2012a. Top 5 Exotic Free Energy Technologies. Retrieved from: http://peswiki.com/index.php/Template: Top_5_Exotic (Accessed: March 20, 2013).

113. ---b. Gravity Motor. Retrieved from: http://peswiki.com/index.php/PowerPedia:Gravity_motor (Accessed: March 20, 2013).

114. ---c. Gravity Motors. Retrieved from: http://peswiki.com/index.php/Directory:Gravity_Motors (Accessed: March 20, 2013).

115. ---d. Magnet Motors. Retrieved from: http://peswiki.com/index.php/Directory:Magnet_Motors (Accessed: March 20, 2013).

116. ---e. Vortex Technologies. Retrieved from: http://peswiki.com/index.php/Directory:Vortex_Technologies (Accessed: March 20, 2013).

117. *PhysOrg.com*. 2010. New Record Achieved With Konarka's Power Plastic Photovoltaic Material With 8.3% Efficiency Certification. Retrieved from: http://phys.org/news/2010-11-konarka-power-plastcis-efficiency-certification.html (Accessed: January 14, 2012).

118. *PhysOrg.com*. 2011. Italian Scientists Claim to Have Demonstrated Cold Fusion. Retrieved from: http://www.physorg.com/news/2011-01-italian-scientists-cold-fusion-video.html (Accessed: August 8, 2011).

119. *Popular Science*. 2009. Huge Texas Wind Farm's Turbines Will Be Made in China. Retrieved from: http://www.popsci.com/technology/article/2009-10/huge-texas-wind-turbines-will-be-made-china (Accessed: January 16, 2012).

120. *Portal of Transformation*. 2012. The Domain. Retrieved from: http://www.2012portaloftransformation.com/#/domain/4549297466 (Accessed: January 16, 2012).

121. *Postnote.* 2003. Nuclear Fusion. Retrieved from: http://www.parliament.uk/documents/post/pn192.pdf. (Accessed: August 22, 2011).

122. Poudel, Bharat. 2010. *Government Policies on Micro/Mini Hydro Power Development in Nepal.* AEPC. Retrieved from: http://www.sari-energy.org/PageFiles/What_We_Do/activities/Regional_Workshop_on_Micro_Hydro_Projects_april_20-23_2010/Presentations/Day%204_23_April_2010/6_Rural_Energy_policy_and_RE_subsidy_policy_Bharat_Poudel.pdf (Accessed: April 20, 2013).

123. *Power Technology.com*. 2012. Statkraft Osmotic Power Plant, Norway. Retrieved from: http://www.power-technology.com/projects/statkraft-osmotic/statkraft-osmotic1.html (Accessed: February 7, 2012).

124. *Public Disclosure Commission*. 2013. Lobbying Categories for 2012. Retrieved from: http://www.pdc.wa.gov/MvcQuerySystem/Lobbying/Categories?year=2012 (Accessed: February 25, 2013).

125. *Recharge News*. 2010. Tidal Turbines: The Three-Headed Shape of Things to Come? Retrieved from: http://www.rechargenews.com/news/wave_tidal_hydro/article1286565.ece (Accessed: February 7, 2012).

126. REN21 2012. *Renewables 2012: Global Status Report.* Paris: REN21 Secretariat. Retrieved from:

http://www.ren21.net/Portals/0/documents/Resources/GSR2012_low%20res_FINAL.pdf (Accessed: August 20, 2012).

127. REN21 2012. Renewables *2012: Global status report.* Paris: REN21 Secretariat. Retrieved from: http://www.ren21.net/Portals/0/documents/Resources/GSR2012_low%20res_FINAL.pdf (Accessed: August 20, 2012).

128. *REUK.co.uk*. 2007. Introduction to Tidal Power. Retrieved from: http://www.reuk.co.uk/Introduction-to-Tidal-Power.htm (Accessed: February 7, 2012).

129. *RT Question More*. 2013a. Fish With Radiation Over 2,500 Times Safe Levels Found Near Fukushima Plant. Retrieved from: http://rt.com/news/japan-fish-radiation-fukushima-321/ (Accessed: January 21, 2013).

130. ---2013b. Fukushima Debris Hits Hawaii. Retrieved from: http://rt.com/usa/news/fukushima-debris-hawaii-radiation-285/ (Accessed: January 21, 2013).

131. *Saro`s Corner*. 2011. Toastmasters movement - A flywheel that runs forever. Retrieved from: http://toastmasters.saroscorner.com/2011/01/for-men-may-come-and-men-may-go-but-i.html (Accessed: November 1, 2012).

132. Schneider, Mycle and Antony Froggatt. 2012. *World Nuclear Industry Status Report 2012*. Paris, *London*: A Mycle Schneider Consulting Project. Retrieved from: http://www.worldnuclearreport.org/IMG/pdf/2012MSC-WorldNuclearReport-EN-V2.pdf (Accessed: April 16, 2013).

133. Schneider, *Mycle*, Antony Froggatt, and Steve Thomas. 2011.The *World Nuclear Industry Status Report 2010-2011:Nuclear Power in a Post-Fukushima World: 25 Years after the Chernobil Accident*. Paris, Berlin, Washington: World Watch Institute. Retrieved from: http://www.worldwatch.org/system/files/WorldNuclearIndustryStatusReport2011_%20FINAL.pdf (Accessed: September 5, 2011).

134. *Scrape TV*. 2010. Exploding Oil Rigs Still All The Rage In The Gulf. Retrieved from: http://scrapetv.com/News/News%20Pages/Business/pages-5/Exploding-oil-rigs-still-all-the-rage-in-the-Gulf-Scrape-TV-The-World-on-your-side.html (Accessed: November 1, 2012).

135. Seifried, Dieter, and Walter Witzel. 2010. *Renewable Energy: The Facts*. Washington, DC, London: Earthscan.

136. Sharma, Partha Das. *Mining and Blasting*: Challenges before Mining Industry. Retrieved from: http://miningandblasting.wordpress.com/ (Accessed: November 1, 2012).

137. Shoup, Daniel. 2006. Can Archaeology Build a Dam? Sites and Politics in Turkey's Southeast Anatolia Project. *Journal of Mediterranean Archaeology* 19.2: 231-258 Retrieved from: https://wiki.brown.edu/confluence/download/attachments/67831088/Shoup+JMA+2006.pdf (Accessed: October 31, 2012).

138. Skarja, Metod. 2007. *Novi, Nekonvencionalni Viri Energij.* Ljubljana: Bion. Retrieved from: http://www.bion.si/gradiva-objave/Porocila/Energetika-koncno/Analiza%20RR%20OV%20Energetika_NEKONV%20VIRI_Porocilo.pdf (Accessed: July 30, 2011).

139. Smith, Zachary A., and Katarina D. Taylor. 2008. *Renewable and Alternative Energy Resources.* California, Colorado, England: ABC-Clio, Inc.

140. *South Derbyshire District Council*. Small-Scale Hydro Electricity. Retrieved from: http://www.south-derbys.gov.uk/environment/energy/renewable_energy/small_scale_hydro_electricity/default.asp (Accessed: November 1, 2012).

141. Spellman, Frank R. 2013. *Environmental Impacts of Hydraulic Fracturing.* New York: CRC Press.

142. *Stanford News.* 2012. Cardinal Cogeneration Plant back to normal following disruption. Retrieved from: http://news.stanford.edu/news/2012/august/cogen-shutdown-082012.html (Accessed: November 1, 2012).

143. Steinfeld, Henning, Pierre Gerber, Tom Wassenaar, Vincent Castel, Mauricio Rosales, and Cees de Haan. 2006. *Livestock`s Long Shadow*. Rome: FAO. Retrieved from: ftp://ftp.fao.org/docrep/fao/010/a0701e/a0701e00.pdf (Accessed: February 28, 2013).

144. Sterling, Allan. D. 2011. Fighting the Infection of Cynical Skepticism with Cold Fusion. *PES Network.* Retrieved from: http://pesn.com/2011/01/21/9501749_Fighting_the_Infection_of_Cynical_Skepticism_with_Cold_Fusion/ (Accessed: February 25, 2013).

145. Stohl, A., P. Seibert, G. Wotawa, D. Arnold, J. F. Burkhart, S. Eckhardt, C. Tapia, A. Vargas, and T. J. Yasunari. 2012. *Xenon-133 and Caesium-137 Releases Into the Atmosphere From the Fukushima Dai-Ichi Nuclear Power Plant: Determination of the Source Term, Atmospheric Dispersion, and Deposition.* Atmospheric Chemistry and

Physics. Retrieved from: http://www.atmos-chem-phys.net/12/2313/2012/acp-12-2313-2012.pdf (Accessed: March 1, 2013).

146. Straus, Jacob R. 2008. *CRS Report for Congress*. *Honest Leadership and Open Government Act of 2007: The Role of the Clerk of the House and Secretary of the Senate*. Congressional Research Service. Retrieved from: http://www.fas.org/sgp/crs/secrecy/RL34377.pdf (Accessed: March 5, 2012).

147. Strong, Bob. 2013. Belgium to Build ´Battery Island` to Store Wind Farm Energy. *RT Question more,* January 19. Retrieved from: http://rt.com/news/belgium-battery-island-renewable-319/ (Accessed: January 21, 2013).

148. *TEDX*. 2007. Written testimony of Theo Colborn, PhD, President of TEDX, Paonia, Colorado before the House Committee on Oversight and Government Reform, hearing on The Applicability of Federal Requirements to Protect Public Health and the Environment from Oil and Gas Development. Retrieved from: http://s3.amazonaws.com/propublica/assets/natural_gas/colburn_testimony_071025.pdf (Accessed: September 23, 2012).

149. *The CS Monitor*. 2011. Tidal turbines: New Sparks of Hope For Green Energy From Beneath the Waves. Retrieved from: http://www.csmonitor.com/Innovation/Tech/2011/0516/Tidal-turbines-New-sparks-of-hope-for-green-energy-from-beneath-the-waves (Accessed: February 7, 2012).

150. *The Denki Shimbun.* 2011. Feed-in Tariff Law For Renewable Energy Enacted. Retrieved from: http://www.shimbun.denki.or.jp/en/news/20110826_01.html (Accessed: October 10, 2011).

151. *The Japan Times.* 2012. The Facts on Fukushima`s Fish. Retrieved from: http://www.japantimes.co.jp/opinion/2012/12/26/editorials/the-facts-on-fukushimas-fish/ (Accessed: January 21, 2013).

152. *The New York Times*. 2012. Japan Begins Radiation Inquiry. Retrieved from: http://www.nytimes.com/2012/07/23/world/asia/japan-investigates-reports-of-fukushima-radiation-cover-up.html?_r=0 (Accessed: August 15, 2012).

153. *The Searl Solution*. 2012a. Searl`s Purpose. Retrieved from: http://www.searlsolution.com/johnsearl.html (Accessed: February 8, 2013).

154. ---2012b. The SEG. Retrieved from: http://www.searlsolution.com/johnsearl5.html (Accessed: February 8, 2013).

155. The Sustainability Laboratories. 2009. Low Velocity Hydro Power By VIVACE (Vortex Induced Vibrations Aquatic Clean Energy). *The Sustainability Laboratories.*

Retrieved from: http://www.sustainabilitylabs.org/news/09-01-02/low-velocity-hydro-power-vivace-vortex-induced-vibrations-aquatic-clean-energy (Accessed: March 20, 2013).

156. TheCapitol.Net. 2009. *Smart Grid.* Alexandria: The Capitol.Net, Inc.

157. *Union of Concerned Scientists*. 2009. How Solar Energy Works. Retrieved from: http://www.ucsusa.org/clean_energy/our-energy-choices/renewable-energy/how-solar-energy-works.html (Accessed: January 14, 2012).

158. Valone, Thomas. 2008. *Zero Point Energy: The Fuel of the Future.* Beltsville: Integrity Research Institute.

159. Vrba, Sarah. 2012. Mutant Fukushima Butterflies Reveal Effects of Radiation. *Care2,* August 14. Retrieved from: http://www.care2.com/causes/mutant-fukushima-butterflies-reveal-effects-of-radiation.html (Accessed: August 15, 2012).

160. Wang, Ucilia. 2011. Japan Passes Law to Boost Green Power Generation. *Gigaom,* August 26. Retrieved from: http://gigaom.com/2011/08/26/japan-passes-law-to-boost-clean-power-generation/ (Accessed: October 10, 2011).

161. *Water Conserve*. 2012. Action Alert: Continue to Tell European Union that Tar Sands Oil Is 'Highly Polluting'. Retrieved from: http://www.waterconserve.org/shared/alerts/send.aspx?id=tarsands_highly_polluting (Accessed: March 23, 2013).

162. *Water Conserve*. 2012. Action Alert: Continue to Tell European Union that Tar Sands Oil Is 'Highly Polluting'. Retrieved from: http://www.waterconserve.org/shared/alerts/send.aspx?id=tarsands_highly_polluting (Accessed: March 23, 2013).

163. *Watershed Council*. High Volume Hydraulic Fracturing. Retrieved from: http://www.watershedcouncil.org/learn/hydraulic-fracturing/ (Accessed: April 28, 2013).

164. Weiss, Charles., and William B. Bonvillian. 2009. *Structuring an Energy Technology Revolution.* Massachusetts, England: The MIT Press.

165. Wilson, Carter A. 2006. *Public policy: Continuity and Change.* Illinois: Waveland press, inc.

166. *Wired Science.* 2010. Bottled Wind Could Be as Constant as Coal. Retrieved from: http://www.wired.com/wiredscience/2010/03/compressed-air-plants/ (Accessed: November 1, 2012).

167. Wolchover, Natalie. 2011. Italian Cold Fusion Machine Passes Another Test. *Live Science*, November 3. Retrieved from: http://www.livescience.com/16864-italian-cold-fusion-machine-passes-test.html?utm_source=feedburner&utm_medium=feed&utm_campaign=Feed%3A+Livesciencecom+(LiveScience.com+Science+Headline+Feed) (Accessed: December 13, 2012).

168. *WordPress.com.* 2010. Types of Wind Turbines. Retrieved from: http://energy230.wordpress.com/2010/10/10/types-of-wind-turbines/ (Accessed: January 16, 2012).

169. *World Nuclear Industry Status Report*. 2012. The World Nuclear Industry Status Report 2012. Retrieved from: http://www.worldnuclearreport.org/-2012-.html (Accessed: April 10, 2013).

170. *YouTube*. 2011a. How the Casimir Effect Works. Posted by Raezene. Retrieved from: http://www.youtube.com/watch?v=lPzlv6cvs8A (Accessed: February 8, 2013).

171. ---2011b. Fracking explained with Animation. Posted by A2Lconsulting. Retrieved from: http://www.a2lc.com/blog/bid/39467/Hydraulic-Fracturing-Fracking-Advocacy-and-Lobbying-Presentations (Accessed: September 8, 2012).

172. Yurman, Dan. 2011. Nuclear Progresses in Some Countries Despite Fukushima Fears. *The Energy Collective,* September 26. Retrieved from: http://theenergycollective.com/dan-yurman/65988/some-countries-make-progress-nuclear-energy-despite-fukushima-fears (Accessed: August 13, 2012).

10 RECOMENDED ADDITIONAL SOURCES

1. Bartolomeo, Matteo, Jens Hemmelskamp, David Hitchens, Rene Kemp and Klaus Rennings. 2003. *Blueprints for an Integration of Science, Technology and Environmental Policy.* STRATA Project. Retrieved from: http://193.196.11.222/pub/zew-docs/umwelt/blueprint.pdf (Accessed: August 11, 2011).
2. Bearden, Thomas. 2002. *Energy from the Vacuum - Concepts and Principles*. Santa Barbara, CA: Cheniere Press.
3. Bedini, John and Thomas Bearden. 2006. *Free Energy Generation - Circuits and Schematics.* Santa Barbara, CA: Cheniere Press.
4. Case, David W. and Ronald J. Rychlak. 2010. *Environmental Law.* New York: Oxford University Press, Inc.
5. DiPippo, Ronald. 2008. *Geothermal Power Plants.* Oxford and Burlington: Elsevier.
6. Faaij, Andre P. C. 2004. Bio-energy in Europe: changing technology choices. *Energy Policy* 34: 322-342. Retrieved from: http://www.egea.eu/congresses/wrc08/content/pages/congress/workshops/1/bio-energy.pdf (Accessed: August 11, 2010).
7. Fischer, Carolyn and Richard G. Newell. 2007. Environmental and Technology Policies for Climate Mitigation. *Journal of Environmental Economics and Management* 55: 142-162. Retrieved from: http://www.sciencedirect.com/science/article/pii/S0095069607001064 (Accessed: August 11, 2010).
8. Frass-Ehrfeld, Clarisse. 2009. *Renewable Energy Sources: A Chance to Combat Climate Change.* The Netherlands: Kluwer Law International BV.
9. Goldthau, Andreas, and Jan Martin Witte, ed. 2010. *Global energy Governance: The New Rules of the Game.* Washington, D.C.: Brookings Institution Press.
10. Hefner, Robert A. 2009. *The Grand Energy Transition.* New Jersey: John Wiley & Sons, Inc.
11. Hillstrom, Kevin. 2010. *U.S. Environmental Policy and Politics.* Washington, DC: CQ Press, a division of SAGE.
12. Hodge, B. K. 2010. *Alternative Energy Systems and Applications.* USA: John Wiley & Sons, Inc.

13. Jacobsson, Staffan and Volkmar Lauber. 2004. The Politics and Policy of Energy System Transformation – Explaining the German Diffusion of Renewable Technology. *Energy Policy* 34: 256-276. Retrieved from: http://seg.fsu.edu/Library/The%20politics%20and%20policy%20of%20energy%20system%20transformation%20-%20explaining%20the%20German%20diffusion%20of%20renewable%20energy%20technology.pdf (Accessed: August 11, 2010).

14. Jaffe, Adam B., Richard G. Newell and Robert N. Stavins. 2005. A Tale of Two Market Failures: Technology and Environmental Policy. *Ecological Economics* 54: 164-174. Retrieved from: http://www.sciencedirect.com/science/article/pii/S0921800905000303 (Accessed: August 11, 2010).

15. King, Moray B. 2005. *The Energy Machine of T. Henry Moray: Zero-Point Energy and Pulsed Plasma Physics.* Adventures Unlimited Press.

16. Kivimaa, Paula and Per Mickwitz. 2006. The Challenge of Greening Technologies – Environmental Policy Integration in Finnish Technology Policies. *Research Policy* 35: 729-744. Retrieved from: http://www.sciencedirect.com/science/article/pii/S004873330600059X (Accessed: August 11, 2010).

17. Maltese, John Anthony in Joseph A. Pika. 2010. *The Politics of the Presidency.* Washington, D. C.: CQ Press, a division of SAGE.

18. McGrory Klyza, Christopher and David Sousa. 2008. *American Environmental Policy, 1990-2006: Beyond Gridlock.* Cambridge, Massachusetts: The MIT Press.

19. *NRDC.* 2012. The Role of Natural Gas in America`s Energy Mix. Retrieved from: http://www.nrdc.org/energy/files/energymixII.pdf (Accessed: September 12, 2012).

20. OECD. 2008. *Environmental Outlook to 2030.* OECD publishing.

21. Olson, Robert and David Rejeski. 2004. *Environmentalism and the Technologies of Tomorrow*. Washington, DC: Island Press.

22. Peavey, Michael. 2008. *Fuel from Water: Energy Independence with Hydrogen.* Louisville: Merit, Inc.

23. Rahm, Dianne. 2010. *Climate Change Policy in the United States: The Science, the Politics and the Prospects for Change.* North Carolina, London: McFarland & Company, Inc.

24. REN21. 2011. *Renewables 2011: Global status report.* Paris: REN21 Secretariat. Retrieved from: http://www.un-energy.org/sites/default/files/share/une/ren21_gsr2011.pdf (Accessed: September 5, 2011).

25. Rosen, Johannes. 2007. *The Future Role of Renewable Energy Sources in European Electricity Supply.* Karlsruhe: Universitatsverlag Karlsruhe.

26. Rosenbaum, Walter A. 2008. *Environmental Politics and Policy.* Washington, D. C.: CQ Press, a division of SAGE.

27. The National Academies. 2009. *America`s Energy Future.* Washington, D.C.: The National Academies Press.

28. Valone, Thomas. 2005. *Electrogravitics II: Validating Reports on a New Propulsion Methodology.* Integrity Research Institute.

29. Vandenbosch, Robert, and Susanne E. Vandenbosch. 2007. *Nuclear Waste Stalemate: Political and Scientific Controversies.* Salt Lake City: The University of Utah Press.

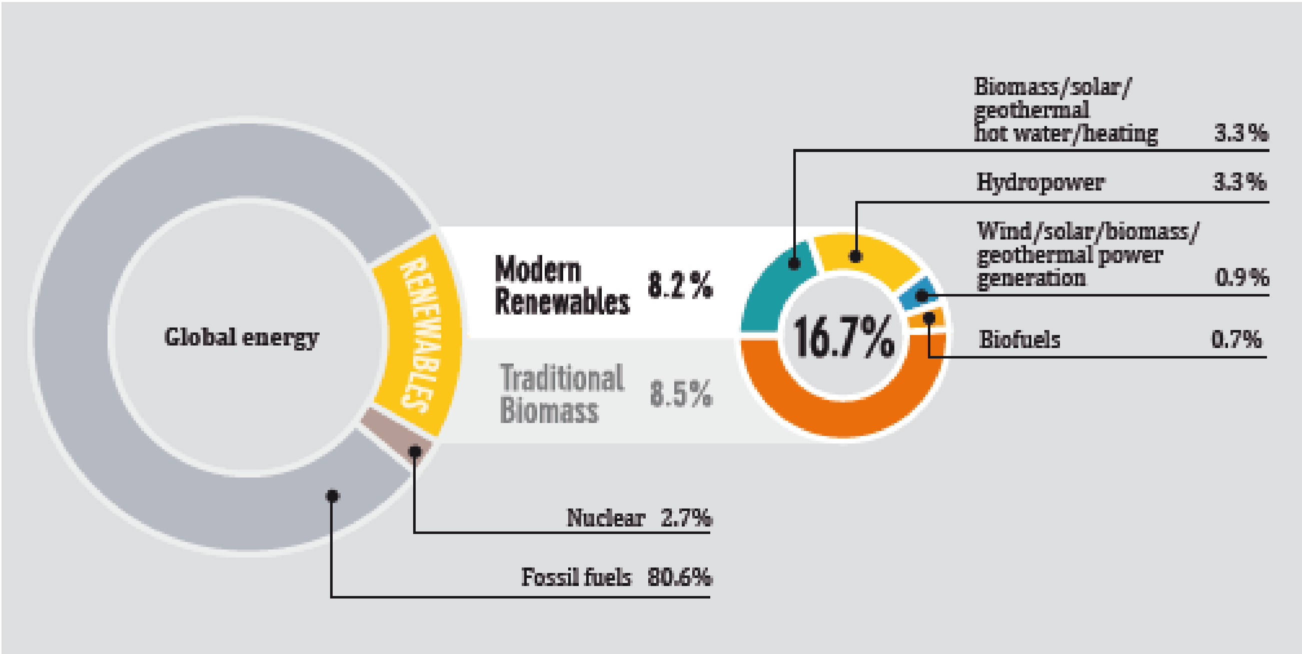
30. Vieira da Rosa, Aldo. 2009. *Fundamentals of Renewable Energy Processes.* Burlington, California, London: Academic Press.

31. Walker, J. Samuel. 2009. *The Road to Yucca Mountain: The Development of Radioactive Waste Policy in the United States.* California, England: University of California Press.

32. Wengenmayr, Roland, and Thomas Buhrke. 2008. *Renewable Energy: Sustainable Energy Concepts for the Future.* Weinheim: WILEY-VCH Verlag GmbH & Co. KGaA.

APPENDIX A: Renewable Energy

A. 1: Renewable Energy Share of Global Final Energy Consumption, 2010



Source: REN21 (2012, 21).

A.2: Top Five Countries in 2011

2012 TOP FIVE COUNTRIES

ANNUAL ADDITIONS/PRODUCTION IN 2011

	New capacity investment	Hydropower capacity	Solar PV capacity	Wind power capacity	Solar hot water/heat capacity[1]	Biodiesel production	Ethanol production
1	China	China	Italy	China	China	United States	United States
2	United States	Vietnam	Germany	United States	Turkey	Germany	Brazil
3	Germany	Brazil	China	India	Germany	Argentina	China
4	Italy	India	United States	Germany	India	Brazil	Canada
5	India	Canada	France	U.K./ Canada	Italy	France	France

TOTAL CAPACITY AS OF END-2011

	Renewable power capacity (incl. hydro)	Renewable power capacity (not incl. hydro)	Renewable power capacity per capita (not incl. hydro)[2]	Biomass power capacity	Geothermal power capacity	Hydropower capacity
1	China	China	Germany	United States	United States	China
2	United States	United States	Spain	Brazil	Philippines	Brazil
3	Brazil	Germany	Italy	Germany	Indonesia	United States
4	Canada	Spain	United States	China	Mexico	Canada
5	Germany	Italy	Japan	Sweden	Italy	Russia

	Solar PV capacity	Solar PV capacity per capita	Wind power capacity	Solar hot water/heat capacity[1]	Solar hot water/heat capacity per capita[1]	Geothermal heat installed capacity	Geothermal direct heat use[3]
1	Germany	Germany	China	China	Cyprus	United States	China
2	Italy	Italy	United States	Turkey	Israel	China	United States
3	Japan	Czech Rep.	Germany	Germany	Austria	Sweden	Sweden
4	Spain	Belgium	Spain	Japan	Barbados	Germany	Turkey
5	United States	Spain	India	Brazil	Greece	Japan	Japan

Note: Most rankings are based on absolute amounts of investment, power generation capacity, or biofuels production; per capita rankings would be quite different for many categories (as seen with per capita rankings for renewable power, solar PV, and solar hot water/heat capacity). Country rankings for hydropower would be different if power generation (TWh) were considered rather than power capacity (GW) because some countries rely on hydropower for baseload supply whereas others use it more to follow the electric load and match peaks.

1 Solar hot water/heat rankings are for 2010. Based on capacity of glazed systems (excluding unglazed systems for swimming pool heating).

2 Per capita renewable power capacity ranking considers only those countries that rank among the top seven for total installed capacity, not including hydro.

3 In some countries, ground-source heat pumps make up a significant share of geothermal direct-use capacity; the share of heat use is lower than the share of capacity for heat pumps because they have a relatively low capacity factor. Rankings are based on 2010 data.

Source: REN21 (2012, 19).

A.3: Selected Indicators

2012 SELECTED INDICATORS

		2009	→	2010	→	2011
Investment in new renewable capacity (annual)[1]	billion USD	161	→	220	→	257
Renewable power capacity (total, not including hydro)	GW	250	→	315	→	390
Renewable power capacity (total, including hydro)[2]	GW	1,170	→	1,260	→	1,360
Hydropower capacity (total)[2]	GW	915	→	945	→	970
Solar PV capacity (total)	GW	23	→	40	→	70
Concentrating solar thermal power (total)	GW	0.7	→	1.3	→	1.8
Wind power capacity (total)	GW	159	→	198	→	238
Solar hot water/heat capacity (total)[3]	GW_{th}	153	→	182	→	232
Ethanol production (annual)	billion litres	73.1	→	86.5	→	86.1
Biodiesel production (annual)	billion litres	17.8	→	18.5	→	21.4
Countries with policy targets	#	89	→	109	→	118
States/provinces/countries with feed-in policies[4]	#	82	→	86	→	92
States/provinces/countries with RPS/quota policies[4]	#	66	→	69	→	71
States/provinces/countries with biofuels mandates[5]	#	57	→	71	→	72

Note: Numbers are rounded. Renewable power capacity (including and not including hydropower) is rounded to nearest 10 GW; renewable capacity not including hydropower, and hydropower capacity data are rounded to nearest 5 GW; other capacity numbers are rounded to nearest 1 GW except for very small numbers and biofuels, which are rounded to one decimal point.

1 Investment data are from Bloomberg New Energy Finance and include all biomass, geothermal, and wind power projects of more than 1 MW, all hydropower projects between 1 MW and 50 MW, all solar projects, with those less than 1 MW estimated separately and referred to as small-scale projects, or small distributed capacity, all ocean energy projects, and all biofuel projects with a capacity of 1 million litres or more per year.

2 Hydropower data and, therefore, also renewable power capacity including hydro, are lower relative to past editions of the GSR due to the fact that pure pumped storage capacity is not included as part of the hydropower data. For more information, see Note on Reporting and Accounting on page 167.

3 Solar heat data include glazed capacity but not capacity of unglazed systems for swimming pool heating.

4 Feed-in and RPS/quota policy totals for 2011 also include early 2012.

5 Biofuel policies for 2010 and 2011 include policies listed under both the biofuels obligation/mandate column in Table 3, Renewable Energy Support Policies, and those listed in Reference Table R14, National and State/Provincial Biofuel Blend Mandates, whereas data for 2009 and earlier have included only the latter.

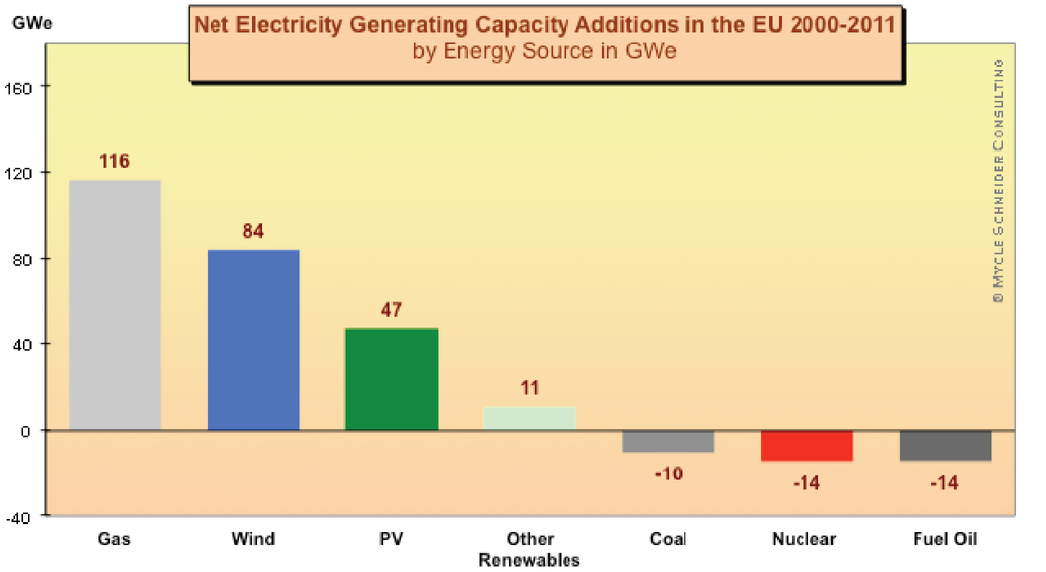
Source: REN21 (2012, 17).

A.4: Renewable Energy Investment in Top 10 Countries 2009-2011 (in billion US$)

Country	2011	2010	2009
United States	48.1	34.0	22.5
China	45.5	54.4	39.1
Germany	30.6	41.2	20.6
Italy	28.0	13.9	6.2
India	10.2	4.0	3.2
UK	9.4	7.0	N/A
Japan	8.6	7.0	N/A
Spain	8.6	4.9	10.5
Brazil	8.0	7.6	7.7
Canada	5.5	5.6	3.5

Source: Schneider and Froggatt (2012, 42).

A.5: Electricity Capacity Additions in the EU, by Energy Source, 2000–2011



Source: MSC, based on EWEA 2012[156]

Note: Other Renewables include large hydro (4 GW), biomass (3 GW), waste (2 GW), concentrated solar power (1 GW), small hydro (0.3 GW), geothermal (0.3 GW), peat (0.2 GW) and tidal/wave (0.01 GW).

Source: Schneider and Froggatt (2012, 45).

APPENDIX B: Warming Potential of Some Gas Relative to Carbon Dioxide

B.1: Lifetimes, Radiative Efficiencies and Direct (Except for CH4) Global Warming Potentials (GWP) Relative to CO2

Industrial Designation or Common Name (years)	Chemical Formula	Lifetime (years)	Radiative Efficiency ($W m^{-2} ppb^{-1}$)	Global Warming Potential for Given Time Horizon			
				SAR‡ (100-yr)	20-yr	100-yr	500-yr
Carbon dioxide	CO_2	See below[a]	[b]1.4×10^{-5}	1	1	1	1
Methane[c]	CH_4	12[c]	3.7×10^{-4}	21	72	25	7.6
Nitrous oxide	N_2O	114	3.03×10^{-3}	310	289	298	153
Substances controlled by the Montreal Protocol							
CFC-11	CCl_3F	45	0.25	3,800	6,730	4,750	1,620
CFC-12	CCl_2F_2	100	0.32	8,100	11,000	10,900	5,200
CFC-13	$CClF_3$	640	0.25		10,800	14,400	16,400
CFC-113	CCl_2FCClF_2	85	0.3	4,800	6,540	6,130	2,700
CFC-114	$CClF_2CClF_2$	300	0.31		8,040	10,000	8,730
CFC-115	$CClF_2CF_3$	1,700	0.18		5,310	7,370	9,990
Halon-1301	$CBrF_3$	65	0.32	5,400	8,480	7,140	2,760
Halon-1211	$CBrClF_2$	16	0.3		4,750	1,890	575
Halon-2402	$CBrF_2CBrF_2$	20	0.33		3,680	1,640	503
Carbon tetrachloride	CCl_4	26	0.13	1,400	2,700	1,400	435
Methyl bromide	CH_3Br	0.7	0.01		17	5	1
Methyl chloroform	CH_3CCl_3	5	0.06		506	146	45
HCFC-22	$CHClF_2$	12	0.2	1,500	5,160	1,810	549
HCFC-123	$CHCl_2CF_3$	1.3	0.14	90	273	77	24
HCFC-124	$CHClFCF_3$	5.8	0.22	470	2,070	609	185
HCFC-141b	CH_3CCl_2F	9.3	0.14		2,250	725	220
HCFC-142b	CH_3CClF_2	17.9	0.2	1,800	5,490	2,310	705
HCFC-225ca	$CHCl_2CF_2CF_3$	1.9	0.2		429	122	37
HCFC-225cb	$CHClFCF_2CClF_2$	5.8	0.32		2,030	595	181
Hydrofluorocarbons							
HFC-23	CHF_3	270	0.19	11,700	12,000	14,800	12,200
HFC-32	CH_2F_2	4.9	0.11	650	2,330	675	205
HFC-125	CHF_2CF_3	29	0.23	2,800	6,350	3,500	1,100
HFC-134a	CH_2FCF_3	14	0.16	1,300	3,830	1,430	435
HFC-143a	CH_3CF_3	52	0.13	3,800	5,890	4,470	1,590
HFC-152a	CH_3CHF_2	1.4	0.09	140	437	124	38
HFC-227ea	CF_3CHFCF_3	34.2	0.26	2,900	5,310	3,220	1,040
HFC-236fa	$CF_3CH_2CF_3$	240	0.28	6,300	8,100	9,810	7,660
HFC-245fa	$CHF_2CH_2CF_3$	7.6	0.28		3,380	1030	314
HFC-365mfc	$CH_3CF_2CH_2CF_3$	8.6	0.21		2,520	794	241
HFC-43-10mee	$CF_3CHFCHFCF_2CF_3$	15.9	0.4	1,300	4,140	1,640	500
Perfluorinated compounds							
Sulphur hexafluoride	SF_6	3,200	0.52	23,900	16,300	22,800	32,600
Nitrogen trifluoride	NF_3	740	0.21		12,300	17,200	20,700
PFC-14	CF_4	50,000	0.10	6,500	5,210	7,390	11,200
PFC-116	C_2F_6	10,000	0.26	9,200	8,630	12,200	18,200

Industrial Designation or Common Name (years)	Chemical Formula	Lifetime (years)	Radiative Efficiency (W m^{-2} ppb^{-1})	Global Warming Potential for Given Time Horizon			
				SAR‡ (100-yr)	20-yr	100-yr	500-yr
Perfluorinated compounds (continued)							
PFC-218	C_3F_8	2,600	0.26	7,000	6,310	8,830	12,500
PFC-318	c-C_4F_8	3,200	0.32	8,700	7,310	10,300	14,700
PFC-3-1-10	C_4F_{10}	2,600	0.33	7,000	6,330	8,860	12,500
PFC-4-1-12	C_5F_{12}	4,100	0.41		6,510	9,160	13,300
PFC-5-1-14	C_6F_{14}	3,200	0.49	7,400	6,600	9,300	13,300
PFC-9-1-18	$C_{10}F_{18}$	>1,000[d]	0.56		>5,500	>7,500	>9,500
trifluoromethyl sulphur pentafluoride	SF_5CF_3	800	0.57		13,200	17,700	21,200
Fluorinated ethers							
HFE-125	CHF_2OCF_3	136	0.44		13,800	14,900	8,490
HFE-134	CHF_2OCHF_2	26	0.45		12,200	6,320	1,960
HFE-143a	CH_3OCF_3	4.3	0.27		2,630	756	230
HCFE-235da2	$CHF_2OCHClCF_3$	2.6	0.38		1,230	350	106
HFE-245cb2	$CH_3OCF_2CHF_2$	5.1	0.32		2,440	708	215
HFE-245fa2	$CHF_2OCH_2CF_3$	4.9	0.31		2,280	659	200
HFE-254cb2	$CH_3OCF_2CHF_2$	2.6	0.28		1,260	359	109
HFE-347mcc3	$CH_3OCF_2CF_2CF_3$	5.2	0.34		1,980	575	175
HFE-347pcf2	$CHF_2CF_2OCH_2CF_3$	7.1	0.25		1,900	580	175
HFE-356pcc3	$CH_3OCF_2CF_2CHF_2$	0.33	0.93		386	110	33
HFE-449sl (HFE-7100)	$C_4F_9OCH_3$	3.8	0.31		1,040	297	90
HFE-569sf2 (HFE-7200)	$C_4F_9OC_2H_5$	0.77	0.3		207	59	18
HFE-43-10pccc124 (H-Galden 1040x)	$CHF_2OCF_2OC_2F_4OCHF_2$	6.3	1.37		6,320	1,870	569
HFE-236ca12 (HG-10)	$CHF_2OCF_2OCHF_2$	12.1	0.66		8,000	2,800	860
HFE-338pcc13 (HG-01)	$CHF_2OCF_2CF_2OCHF_2$	6.2	0.87		5,100	1,500	460
Perfluoropolyethers							
PFPMIE	$CF_3OCF(CF_3)CF_2OCF_2OCF_3$	800	0.65		7,620	10,300	12,400
Hydrocarbons and other compounds – Direct Effects							
Dimethylether	CH_3OCH_3	0.015	0.02		1	1	<<1
Methylene chloride	CH_2Cl_2	0.38	0.03		31	8.7	2.7
Methyl chloride	CH_3Cl	1.0	0.01		45	13	4

Notes:

‡ SAR refers to the IPCC Second Assessment Report (1995) used for reporting under the UNFCCC.

[a] The CO_2 response function used in this report is based on the revised version of the Bern Carbon cycle model used in Chapter 10 of this report (Bern2.5CC; Joos et al. 2001) using a background CO_2 concentration value of 378 ppm. The decay of a pulse of CO_2 with time t is given by

$a_0 + \sum_{i=1}^{3} a_i \cdot e^{-t/\tau_i}$ where $a_0 = 0.217$, $a_1 = 0.259$, $a_2 = 0.338$, $a_3 = 0.186$, $\tau_1 = 172.9$ years, $\tau_2 = 18.51$ years, and $\tau_3 = 1.186$ years, for $t < 1,000$ years.

[b] The radiative efficiency of CO_2 is calculated using the IPCC (1990) simplified expression as revised in the TAR, with an updated background concentration value of 378 ppm and a perturbation of +1 ppm (see Section 2.10.2).

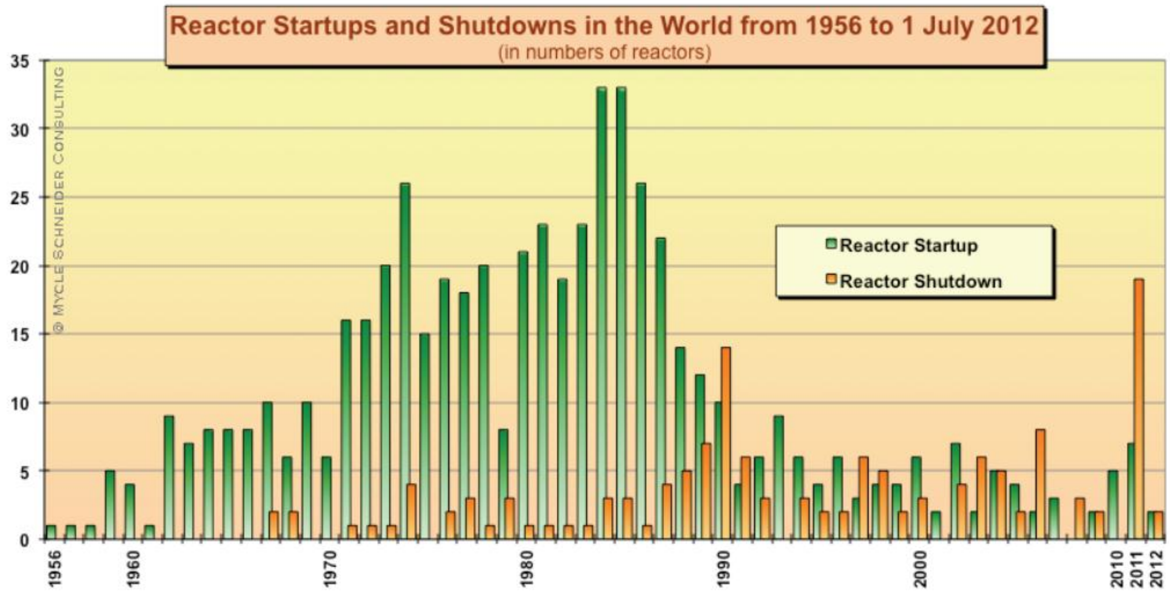
[c] The perturbation lifetime for CH_4 is 12 years as in the TAR (see also Section 7.4). The GWP for CH_4 includes indirect effects from enhancements of ozone and stratospheric water vapour (see Section 2.10).

[d] The assumed lifetime of 1000 years is a lower limit.

Source: IPCC (2007b, 33-34).

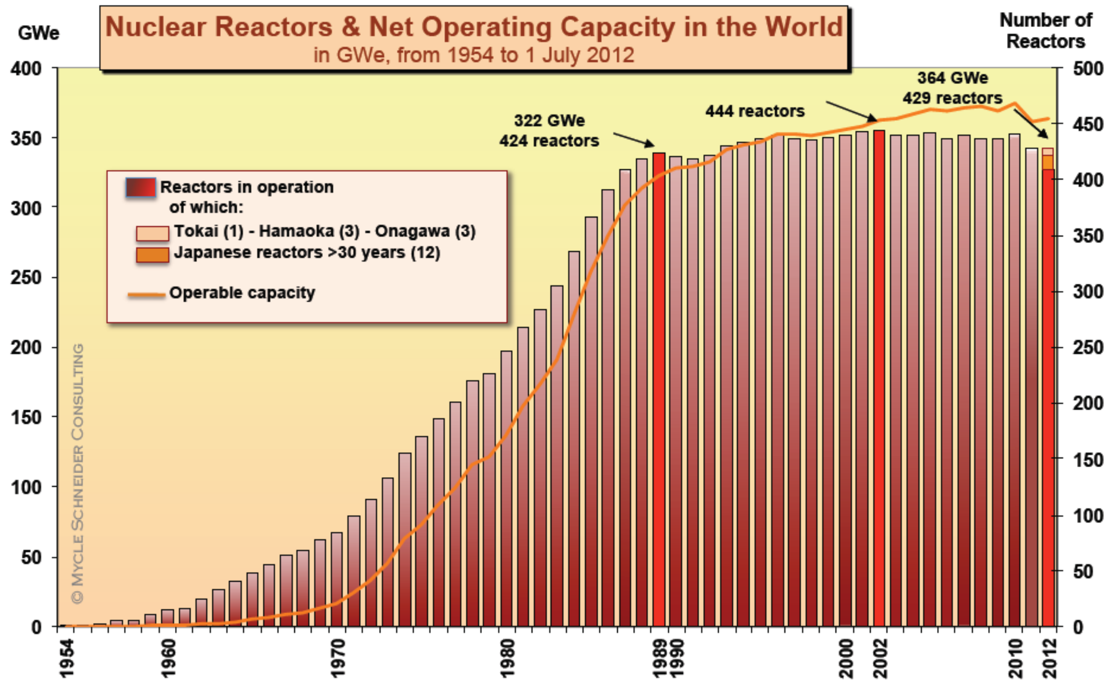
APPENDIX C: Nuclear Energy

C.1: Nuclear Power Reactor Grid Connections and Shutdowns, 1956–2012



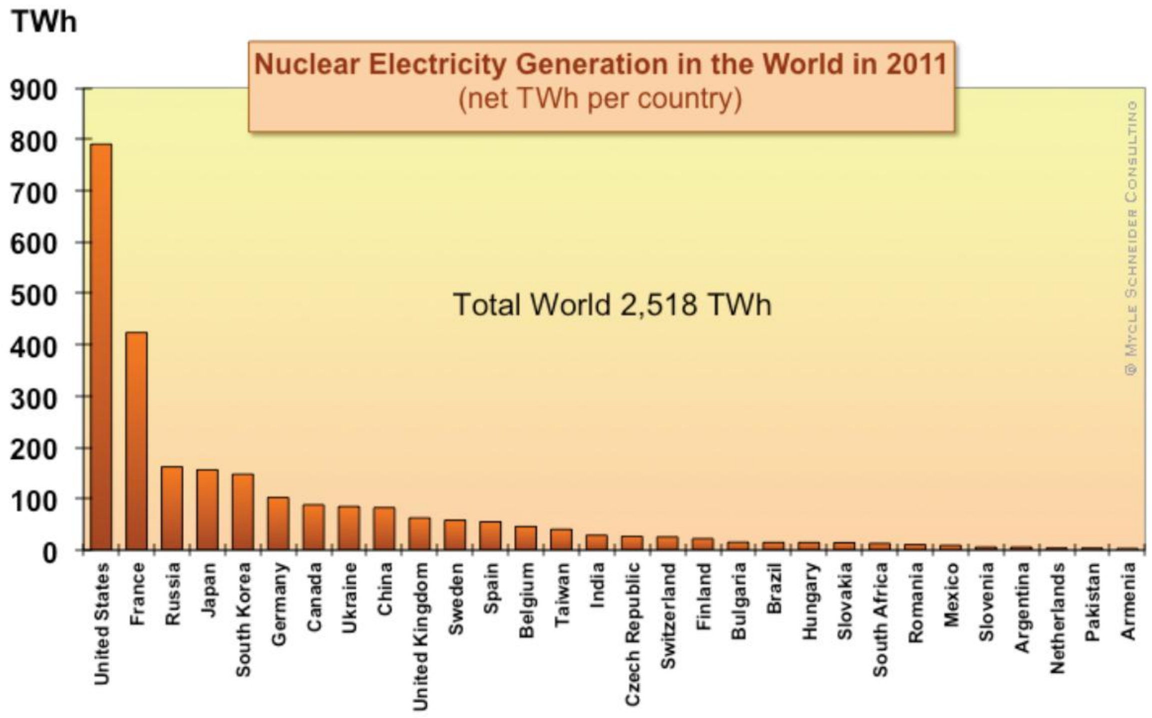
Source: Schneider and Froggatt (2012, 12).

C.2: World Nuclear Reactor Fleet, 1954–2012



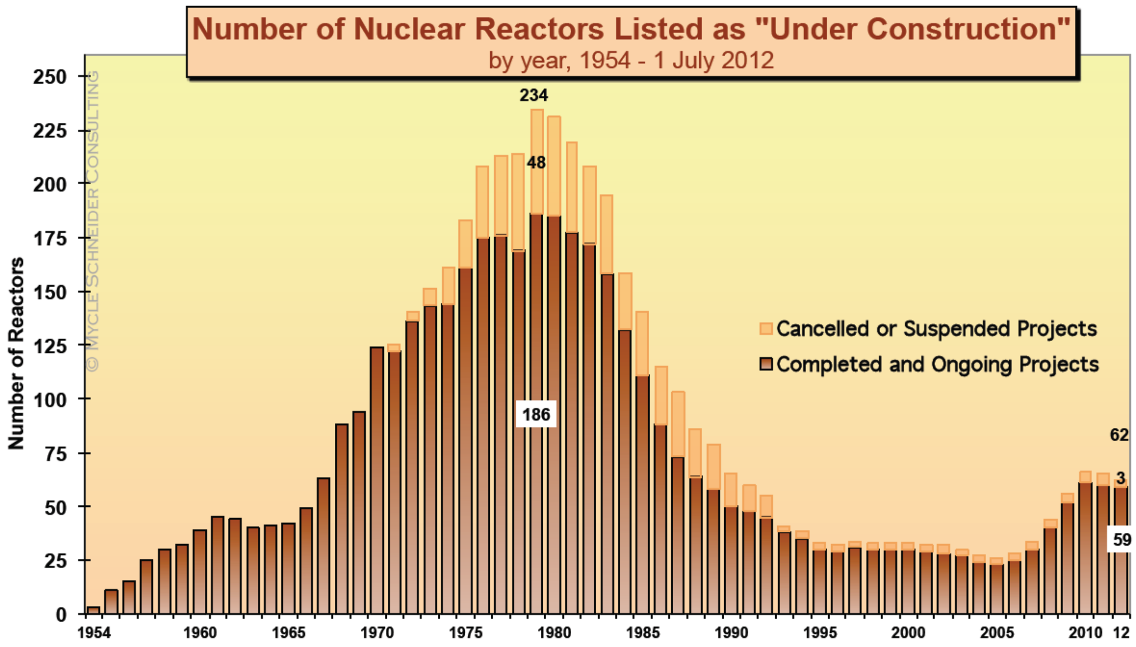
Source: Schneider and Froggatt (2012, 13).

C.3: Nuclear Power Generation by Country, 2011



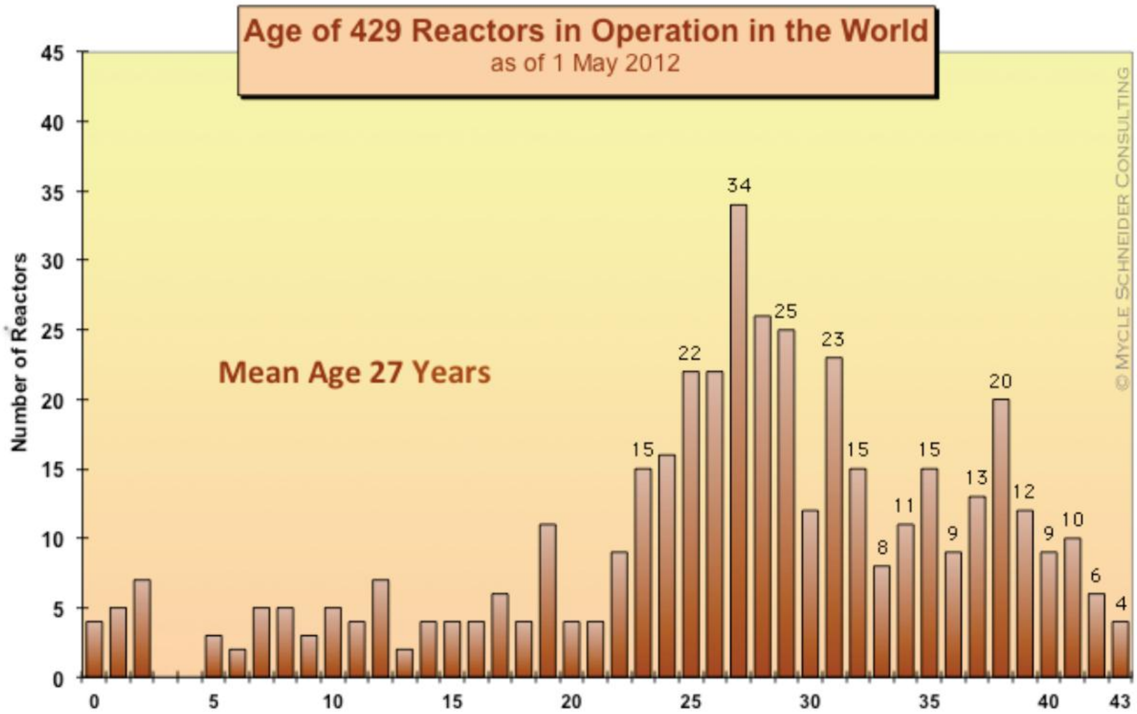
Source: Schneider and Froggatt (2012, 14).

C.4: Number of Nuclear Reactors Under Construction



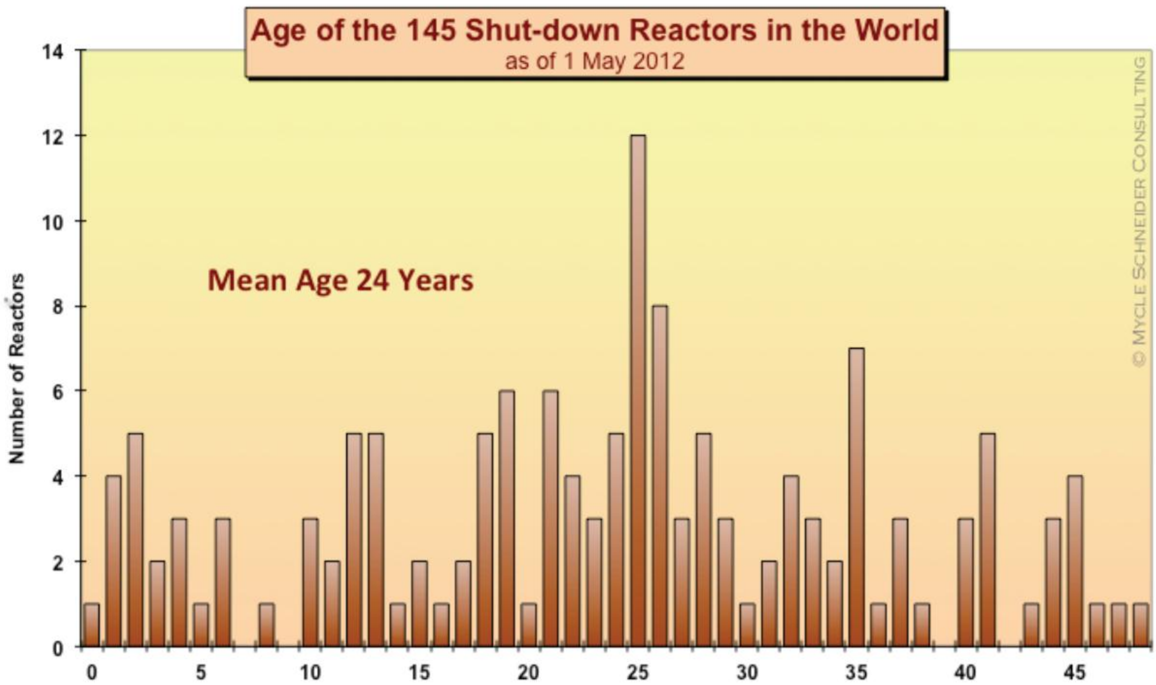
Source: Schneider and Froggatt (2012, 15).

C.5: Age Distribution of Operating Nuclear Reactors, 2012



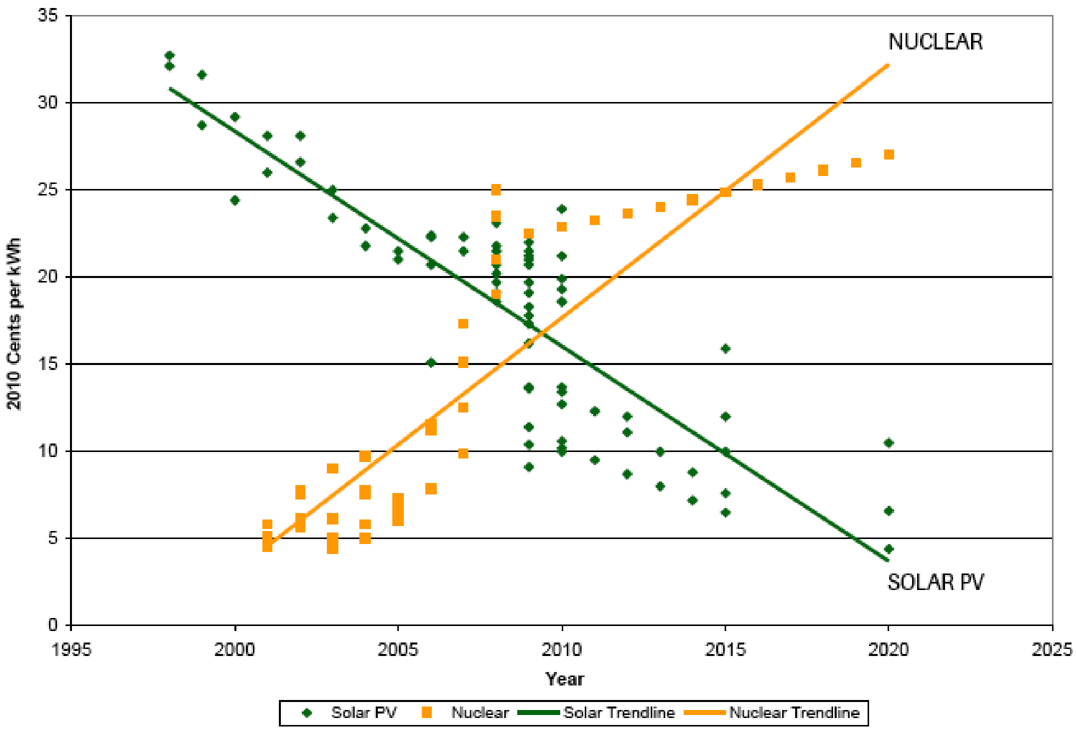
Source: Schneider and Froggatt (2012, 16).

C.6: Age Distribution of Shutdown Nuclear Reactors, 2012



Source: Schneider and Froggatt (2012, 16).

C.7: Solar and Nuclear Costs: The Historic Crossover



Source: Schneider, Froggatt, and Thomas (2011, 36).

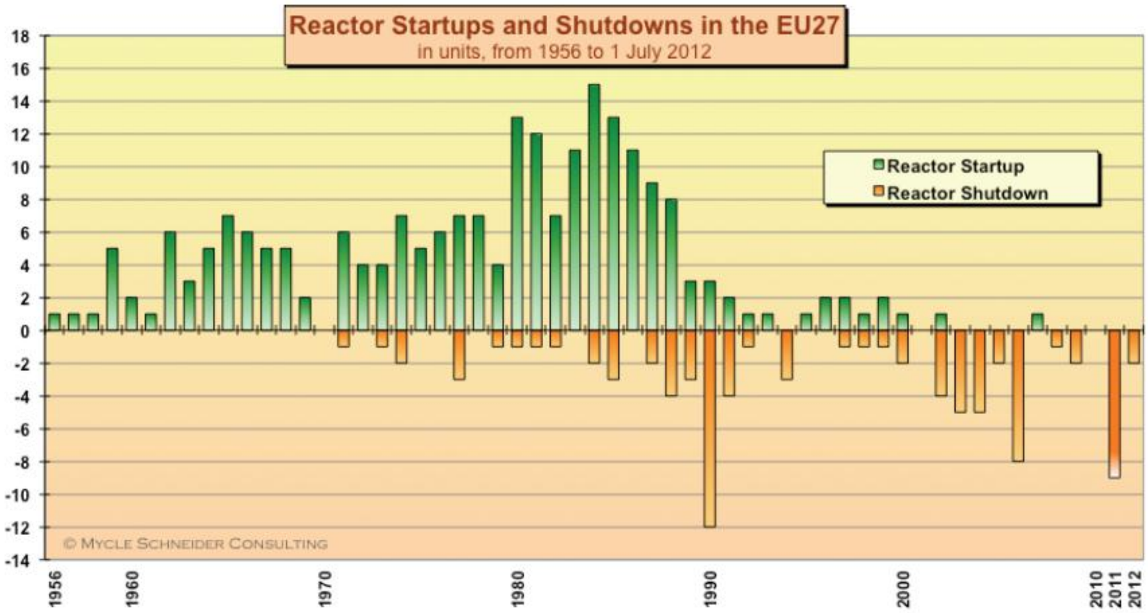
C.8: Construction Time of Nuclear Power Plants Worldwide, 1965–2010

Years	Number of Reactors	Average Construction Time (months)
1965–1970	48	60
1971–1976	112	66
1977–1982	109	80
1983–1988	151	98
1995–2000	28	116
2001–2005	18	82
2005–2010	10	71

Note: The 2005–10 range does not include completion of Romania's Cernavoda 2 unit, which took 279 months, and Russia's Rostov unit, which took 322 months, due to an extended break in construction.
Source: See Endnote 15 for this section.

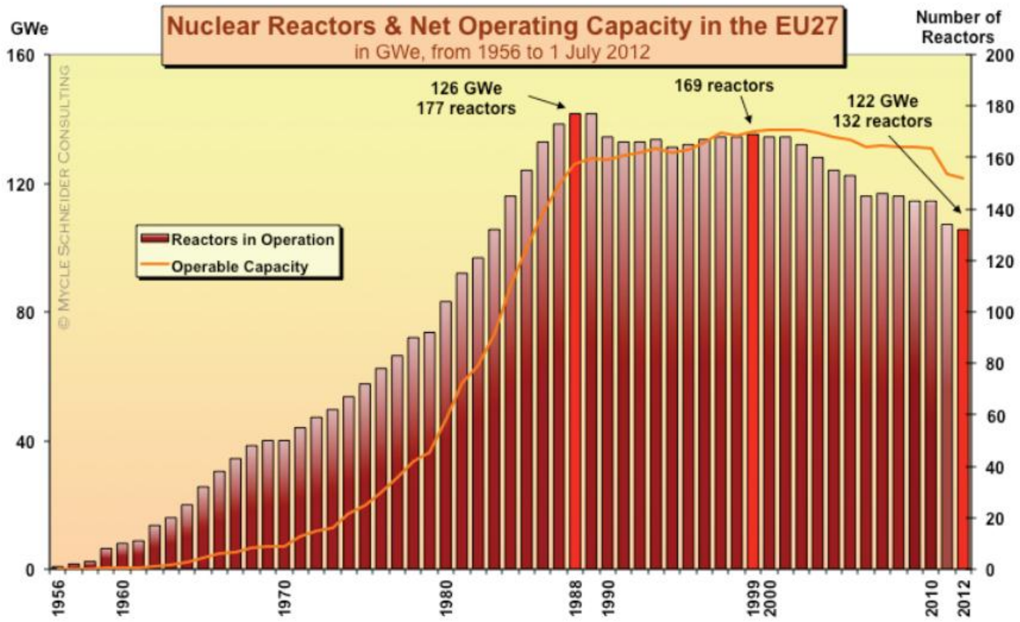
Source: Schneider, Froggatt, and Thomas (2011, 37).

C.9: Nuclear Reactors Startups and Shutdowns in the EU27, 1956–2012



Source: Schneider and Froggatt (2012, 69).

C.10: Nuclear Reactors and Net Operating Capacity in the EU27, 1956–2011



Source: Schneider and Froggatt (2012, 69).

APPENDIX D: New Energy

D.1: Reports of Excess Power from ICCF17

Organization & Author or Presenter	System and Loading	Excess Power or Heat	Power or Energy Gain	Duration of Experiment	Type of Calorimetry
Brillouin Tanzella	Pd/H_2O & Ni/H_2O Electrolysis with axially pulsed cathode current	As much as 63W	Power gain up to 2	Few hours	Thermometry & mass flow with heat loss add-back
Changchun University Tian	Pd in D_2 gas with resistive heater	87 W average and 300 MJ	Energy gain of 1.2	40 days	Thermometry
ChrononixUSA Sinha	Pd wire with axial current in D_2O or H_2O with NaOH	60 eV/Pd atom	Not Reported	1 Hour	Modeled xPower based on thermometry
Coolescence Dmytriyeva	H & D loading of Pd on various oxide supports	~30 J excess with D	Not Applicable	< 60 minutes	Thermometry in isothermal chamber
Defkalion Koulouris	Proprietary Ni powder with spark ignition	Up to 92 Watt-Hour per cyle	Energy gain up to 23	6 weeks (no data disclosed)	Not Disclosed
Dixie State College Mel Miles	Pd/D co-deposition in ammonia electrolyte	200 mW	Not Reported	250 hours	Open cell & isoperibolic calorimeter
First Gate Tech. Stringham	Pd in D_2O with ultrasonic loading	40 W	Power gain of 1.8	Not Given	Mass flow calorimetry
Frascati National Lab Celani	H-Loaded $Cu_{55}Ni_{44}Mn_1$ with treated surface	Demo at ICCF17 gave 18 W	~1.3	Days	Thermometry
Jet Energy Inc. Swartz	Nanor™: Sealed nano ZrO_2+NiPd with D and DC current	60 mW	Energy gain 5-16	Weeks	Thermometry
Kobe University Kitamura	H & D loading of silica-included PdNi	2 eV/atom	Not Applicable	100 minutes	Water mass flow
Kobe University Sakoh	H & D into CuNi on ZrO_2 (~$Cu_{12}Ni_{88}$)	4 W max 800 eV/Ni atom	Not Applicable	100 hours	Thermometry
Lenuco Miley	Proprietary nano Pd + D. Cycled pressure to maintain heat	Excess energy up to 4 kJ	Energy gain up to 15	Minutes	Thermometry
NRL - Dominguez Electrolytic Loading	D_2O electrolysis of PdRh with metal & metal oxide powders	Bursts of up to ~10 W with up to 70 kJ	Up to 40	Minutes to hours. Max ~ 20 hours	Hart calorimeter (water mass flow)
NRL - Kidwell Gas Loading	D loading of nano Pd grown *in situ* on alumina spheres	0.1 mW/g	Not Applicable	Days	Hart calorimeter (water mass flow)
Samar+ Company Karabut	Pd, Re coated Pd and nano-Pd electrolysis	Excess powers of 120-280 W	Energy gains of 2 - 3.4	Not Given	Heat capacity and flow calorimeters
SPAWAR Szpak	Pd-D and Pd-H co-deposition	10 eV per Pd atom	Not Given	Not Given	Thermometry
SRI McKubre	Electrolytically loaded, sealed & exploded in LN_2 by electrical pulse	Excess energy up to 1.2 J	Energy gain up to 2.2	Sub-Second	LN_2 mass loss
Toyota Hioki	H & D loading of Pd on zeolite and Pd on FSM	~80 J excess with D	Not Applicable	< 100 minutes	Water mass flow

Source: Nagel (2012, 14).

11 POVZETEK V SLOVENSKEM JEZIKU

1 UVOD

Človeštvo se vsak dan sooča z negativnimi posledicami svojih dejanj. Našo družbo prežemajo socialna in gospodarska nasprotja, vojne in okoljski problemi kot so onesnažen zrak, dviganje gladine oceanov in taljenje ledenikov. Pri tem pomembno vlogo igra raba energije. Čas je, da začnemo bolje skrbeti za zdravje našega planeta in posledično človeštva. Pri tem je pomembna transformacija tehnologij, ki prevladujejo v energetiki. Preiti moramo iz konvencionalnih v alternativne, oziroma še bolje v nove vire. Potrebujemo vire, ki ne sproščajo toplogrednih plinov in ne povzročajo ostalih okoljskih problemov, so varni za uporabo in so dostopni vsemu človeštvu.

2 TRENUTNO DOSTOPNI VIRI

Trenutno človeštvo pridobiva 83% vse energije iz fosilnih in jedrskih goriv (REN21 2012). Ostali odstotki pokrivajo vodne in alternativne vire, kot so solarna, vetrna, geotermalna energija in energija biomase.
Kljub številnim pridobitvam, ki smo jih bili deležni z uporabo teh goriv in razvojem industrije, sodobni način življenja zahteva vse večjo potrebo po energiji, kar pa s seboj prinaša tudi slabosti in povzroča okolju in človeštvu negativne posledice.

2.1 Pomanjkljivosti uporabe fosilnih goriv in jedrskega goriva

<u>Problemi, s katerimi se soočamo ob uporabi fosilnih goriv:</u>

- produkt izgorevanja so strupeni in toplogredni plini, kot sta ogljikov dioksid (CO_2) in metan (CH_4), kar povzroča klimatske spremembe,
- potrjene zaloge fosilnih goriv obstajajo v omejenih količinah,
- podzemno izkopavanje premoga je ena najnevarnejših aktivnosti pri pridobivanju fosilnih goriv,
- morebitne nesreče (razlitja) ob transportu nafte lahko povzročijo obsežno škodo okolju,
- nestabilnost cen nafte in zemeljskega plina lahko povzroča večjo gospodarsko škodo,
- naftovodi in plinovodi ter skladišča nafte in plina so lahko tarče teroristov,

- nenehno prizadevanje za črpanje večjih količin nafte je povzročilo porast nedemokratičnih režimov po svetu (Campbell in Price 2008, Komor 2004, Natowitz in Ngo 2009)

Problemi, s katerimi se soočamo ob uporabi jedrskega goriva:
- jedrski odpadki so nevarni zaradi njihove radioaktivnosti,
- države, ki imajo jedrske obrate, imajo probleme z namestitvijo odlagališč za visoko radioaktivne jedrske odpadke,
- velike nesreče v obsegu, kot sta bili v Černobilu (1986) in Fukušimi (2011),
- jedrski obrati so lahko tarča terorističnih in vojaških napadov,
- jedrska energija prinaša visoke finančne tveganosti, tako zaradi odpadkov kot odlagališč (Macfarlane in Ewing 2006, Makhijani 2008, Manning in Garbon 2009, Ngo in Natowitz 2009).

Problemi z vodno energijo:
- gradnja jezov povzroča emisije, prah, hrup, dogajajo se nesreče,
- jezovi posežejo v okolje, vplivajo na kakovost vode, rečno okolje nadomesti jezersko okolje, prvotno okolje se uniči, ljudje se morajo preseliti,
- vodne akumulacije se zasipajo in zamuljijo (težke kovine) (Ngo in Natowitz 2009).

2.2 Alternativni viri

Če posamezniki, države in institucije ne bodo začeli ukrepati že danes, bo kasnejše ukrepanje veliko dražje. Poleg tega so posledice naših vplivov na okolje lahko že ireverzibilne. Na izzive se moramo odzvati takoj in ne smemo odlašati, da ne bo prepozno. Ena izmed prehodnih možnih rešitev so alternativni viri. Ti so obnovljivi, relativno čisti, načeloma dostopni povsod po svetu in pogojno neomejeni.

Med alternativne vire, ki se po svetu najpogosteje uporabljajo štejemo izkoriščanje energije sonca, vetra, biomase, geotermalne energije in vode.

2.2.1 Pomanjkljivosti uporabe alternativnih virov

Alternativni viri imajo razne omejitve.

a) Problemi s solarno energijo:

- na voljo je le podnevi,
- njena intenzivnost je odvisna od vremena in letnih časov,
- fotoelektrični sistemi so zelo dragi (Komor 2004, Ngo in Natowitz 2009).

b) Problemi z vetrno energijo:

- vetrovi so lahko nestalni in prekinjajoči,
- če je veter premočan lahko uniči turbine,
- vetrne turbine so običajno nameščene na vetrnih in nenaseljenih lokacijah, kar povzroči visoke stroške prenosa elektrike na naseljena območja,
- lokacije z vetrnimi turbinami so lahko glasne,
- gradnja vetrnih turbin na vodi je dražja, saj morajo vetrnice vzdržati silo vetra in valov, ravno tako je drag prenos elektrike na naseljena območja,
- nekaterim se vetrne turbine zdijo vsiljive in jim predstavljajo obliko vizualne onesnaženosti (Komor 2004, Ngo in Natowitz 2009).

c) Problemi z energijo biomase:

- gorenje biomase proizvaja CO_2,
- proizvodnja za biogoriva izrinja iz polj proizvodnjo hrane, kar pripelje do povišanih cen hrane,
- pretirano sekanje gozdov lahko povzroča erozijo,
- nekatera žita ne uspevajo na istih mestih vsako leto (Ngo in Natowitz 2009).

d) Problemi z geotermalno energijo:

- geotermalni viri so na voljo le na nekaterih področjih oziroma le v nekaterih državah,
- na nekaterih mestih pod zemljo je lahko hitrost toplotnega toka prepočasna,
- nekateri trdijo, da je geotermalna energija omejena in se lahko izčrpa (Komor 2004, Ngo in Natowitz 2009).

e) Problemi z vodno energijo (novejši pristopi):

- valovi so nepredvidljivi in nestalni,
- OTEC elektrarne imajo nizek izkoristek,
- gradnja OTEC elektrarn je tudi do 4 krat dražja od gradnje konvencionalnih elektrarn na fosilna goriva,
- elektrarne, ki izkoriščajo energijo valov potrebujejo dolge daljnovode, saj se raztezajo po oceanu in so zato zelo drage,
- elektrarne, ki izkoriščajo energijo plime in oseke, so drage, saj so izpostavljene koroziji in nečistoči,
- nekateri zagovarjajo, da tehnologije, ki temeljijo na izkoriščanju temperature, soli in morske biomase nimajo veliko možnosti za prodor na trg (Craddock 2008, Aswathanarayana, Harikrishnan and Sahini 2010, Haven 2011).

Uvajanje alternativnih virov spremljajo visoki stroški in druge pomanjkljivosti. Alternativni viri ne bodo zadostili potrebam današnje hitro rastoče družbe. Zato bomo z njimi le premostili obdobje do razvoja novih virov.

3 NOVI VIRI ENERGIJE

Našteti problemi s fosilnimi gorivi, jedrsko energijo in alternativnimi viri, bi se lahko odražali v svetovnem prizadevanju, da bi vire, ki jih trenutno uporabljamo, postopoma popolnoma zamenjali z viri, ki so okolju prijazni, cenovno ugodni, dostopni povsod po svetu in zadoščajo potrebam vsega človeštva.
Vlade in javnost težko sprejemajo in podpirajo alternativne energetske tehnologije. Še težje bomo sprejeli in podprli nove energetske tehnologije, kot sta hladna fuzija in ničelna energija.

Za nove vire energije je značilno, da njihov princip delovanja sega preko okvirov splošno sprejete znanstvene paradigme. Ti viri oziroma na njih temelječe naprave oddajajo več energije, kot jim jo dovajamo iz že znanih virov (Skarja 2007).

V grobem delimo nove vire energij na dve skupini (Skarja 2007):

- *Prosto-energijske naprave* (free-energy devices), ki črpajo energijo iz *ničelne energije* (zero-point energy) kvantnega vakuuma. Dodatni vir energije, ki močno dvigne izkoristek celotnega procesa pri teh napravah, ni popolnoma znan.

- *Hladna fuzija*. Pri hladni fuziji gre za jedrske reakcije, kjer se zlivajo jedra pri sobnih temperaturah in tlaku, z relativno preprostimi napravami. Pri zlitju dveh lahkih jeder v težje jedro, se sprosti mnogo večja količina energije, kot je bila dovedena.

3.1 Ničelna energija

Ničelna energija (Valone 2007) je vir potencialno neomejene čiste energije. Predstavlja minimalno energijo, ki jo lahko ima atom. Je kinetična energija, ki jo ohranjajo molekule snovi pri absolutni ničli. Nahaja se povsod v vesolju in je znana pod imenom "fizikalen vakuum". Ponuja skoraj deset do osemnajstkrat več energije na isto prostornino kot jedrski reaktorji.
Ničelna energija bi v prihodnosti lahko razložila pojav hladne fuzije.

3.2 Hladna fuzija

Leta 1989 sta profesor Martin Fleischman in profesor Stanely Pons, oba kemika, na medijski konferenci predstavila hladno fuzijo. Trdila sta, da sta odkrila jedrsko fuzijo, ki deluje pri sobni temperaturi.

Hladna fuzija je jedrski proces, ki se zgodi ob zlitju navadnega vodika in izotopa vodika (devterija). Zlivanje se dogaja pri sobni temperaturi ob prisotnosti kovin, kot so paladij, nikelj in litij. Hladna fuzija ne proizvaja nobene, oziroma zelo majhne količine radioaktivnosti in proizvede očitno več energije kot jedrska fizija (Krivit and Winocur 2004).

3.2.1 Verodostojnost hladne fuzije

Ker po objavi Martina Fleischmana in Stanley Ponsa leta 1989, mnogim uglednim laboratorijem po svetu ni uspelo ponoviti rezultatov njunega eksperimenta, je prevladalo splošno mnenje, da gre za eksperimentalno napako.

Danes raziskovalci na tem področju trdijo, da so večino vzrokov za slabo ponovljivost odkrili in da so sposobni efekt napovedljivo sprožiti. Jedrska aktivnost pri procesu hladne fuzije je bila dokazana leta 2006 s standardnimi slednimi jedrskimi detektorji. Hladna fuzija tako postaja pomembno raziskovalno polje, ki ga sprejema tudi širša znanstvena skupnost in postaja ena izmed veljavnih potencialnih energij, ki bi lahko končala krizo v energetiki (Skarja 2007).

Institute of high energy physics, kitajske znanstvene akademije trdi, da je bila hladna fuzija ponovljena že skoraj 17 000 krat (Sterling 2011).

Januarja 2011, sta italijanska znanstvenika Andrea Rossi and Sergio Focardi razglasila, da sta razvila hladno fuzijsko napravo, ki ob 400W dovedene energije producira 12400W odvedene energije. Namesto paladija sta uporabila nikelj (PhysOrg.com 2011).

4 KLIMATSKE SPREMEMBE

Človeške aktivnosti, kot so emisije zaradi uporabe fosilnih goriv, sekanje gozdov in nekateri industrijski procesi, so v večini primerov najbolj odgovorni za povečanje toplogrednih plinov v ozračju, kar se posledično kaže v klimatskih spremembah. Klimatske spremembe kot so povečane količine padavin, povečane temperature oceanov, ekstremni vremenski pojavi, taljenje ledenikov, daljša sušna obdobja, poplave, so posledica intenzivne uporabe fosilnih goriv, ki se je začela z industrijsko revolucijo v 18. stoletju (Farrugia 2010).

V letih od 1970 do 2004, se je količina toplogrednih plinov v ozračju povečala za 70 odstotkov. Količina ogljikovega dioksida se je povečala predvsem zaradi povečane uporabe fosilnih goriv v transportu, ogrevanja in hlajenja zgradb in sekanju gozdov. Količina metana se je povečala predvsem zaradi človeških aktivnosti v agrikulturi, uporabe zemeljskega plina ter zaradi odlagališč odpadkov. Količina dušikovih oksidov se je povečala predvsem zaradi uporabe gnojil in izgorevanja fosilnih goriv (IPCC 2007a).

4.1 Potencial globalnega segrevanja

Primerjava toplogrednih plinov glede na njihov potencial globalnega segrevanja (GWP) je smiselna saj upošteva, da so nekateri plini kljub manjši količini v zraku pravzaprav nevarnejši od drugih. V 100-letnem obdobju se enaki količini metana in ogljikovega dioksida razlikujeta po tem, da je metan 25 krat bolj škodljiv kot ogljikov dioksid. V enakem obdobju ter enaki količini pa je didušikov oksid 298 krat bolj škodljiv od ogljikovega dioksida. GWP metana v

20-letnem obdobju pa je celo 72, kar pomeni, da je v krajšem obdobju še bolj škodljiv (IPCC 2007b).
Zato je pomembno, da upoštevamo tudi druge toplogredne pline in ne samo ogljikovega dioksida. Živinoreja je odgovorna za 18 odstotkov izpustov toplogrednih plinov, kar presega količino izpustov toplogrednih plinov pri transportu. Živinoreja predstavlja 9 odstotkov izpustov ogljikovega dioksida, 37 odstotkov metana in 65 odstotkov didušikovega oksida. Prav tako je gojenje živine odgovorno za 64 odstotkov izpustov amoniaka (Steinfeld et al. 2006).

5 JAVNE POLITIKE

Vlade po svetu poskušajo povečati kvaliteto življenja s pomočjo javnih politik. Da bi vzpostavile učinkovite politike, si morajo zastaviti jasne cilje, ki morajo vključevati zmanjševanje škodljivosti okolju, razpršenost virov, minimaliziranje ekonomske škode in spodbujanje gospodarstva (Komor 2004).

5.1 Mehanizmi spodbujanja alternativnih virov energije

Vlade po celem svetu so sprejele strategije, s katerimi poskušajo spodbujati uporabo alternativnih virov energije. Najpogostejše strategije so: sistem fiksnih zagotovljenih odkupnih cen (FIT), sistem kvot (RPS), zeleni certifikati, prostovoljni pristopi, "net metering", raziskovanje in razvoj, "system benefits charges", davčne olajšave in sistemi ponudbe (Mendonca, Jacobs, and Sovacool 2010).

Leta 2012 so mnoge države po svetu že imele aktivne politike, načrte ali cilje za alternativne vire energije in blažitev klimatskih sprememb. Uporaba alternativnih virov vključuje energetsko varnost, zmanjšano odvisnost od uvoza fosilnih goriv, zmanjšanje toplogrednih plinov, preprečitev izgube biodiverzitete, izboljšuje zdravje, ustvarja delovna mesta, razvoj podeželja in dostop do energije. Politiki v energetskem sektorju, ki se po svetu najpogosteje uporabljata, sta sistem zagotovljenih odkupnih cen ter sistem kvot. Vsaj 65 držav po svetu in 27 zveznih držav v ZDA uporablja sistem zagotovljenih odkupnih cen in vsaj 18 držav po svetu uporablja sistem kvot (REN21 2012).

6 LOBIJI

Lobiji so del moderne demokratične politike. Lobisti poskušajo vplivati na politike, da se odločajo v njihovo korist. Lobisti lahko zastopajo interese firm ali pa na neprofitni osnovi zastopajo lastne interese (Javens 2011).

Da bi potencialno pridobili politike na svojo stran, lobisti večino svojega časa preživijo v kontaktu s politiki, ki so povezani s področji, ki zadevajo njihove interese. Tudi vlade kontaktirajo lobije, saj tako pridobijo poleg političnih tudi tehnološke informacije ter preko njih spoznajo kaj javnost pričakuje in kako bo reagirala na neko novo vladno pobudo (Kernell in Jacobson 2006).

6.1 Negativni vidiki lobiranja

Lobiranje ustvarja neenakost pri procesu kreiranja politik. Tisti, ki imajo več denarja in boljše politične zveze so vplivnejši. Naftni lobi je eden najvplivnejših lobijev in je hkrati tudi na vrhu seznama največjih onesnaževalcev. Vpliva na vladne politike s svojimi denarnimi prispevki, s čimer povzroča zakonodajno inertnost in zanemarja globalno segrevanje. Bitke močnejših z šibkejšimi tako prinesejo škodljive vplive na celotno družbo (Hessenius 2007, Javens 2011, Ashbrook 2012).

7 POSEL IN INOVACIJE

Niti izumitelji niti vlagatelji ne vedo kako dolga je potrebna pot od začetka koncepta do produkta primernega za trg. Čas se še posebej podaljša, ko gre za prelomne inovacije na področju energije, saj jim primanjkuje akademske in vladne podpore. Da bi se uveljavili novi viri energije, se je potrebno soočiti s politiko, inercijo, strahom in pohlepom. Apatija, politično nasprotovanje in sovraštvo predstavljajo večje ovire kot tehnološki izzivi pri preprečevanju novim tehnologijam, da uspejo prodreti na trg (Garbon in Manning 2009).

Poslovneži redko financirajo inovacije, če le te niso že dokončno razvite. Koncepti, ki vključujejo nove fizikalne principe, se smatrajo za preveč rizična finančna vlaganja. Zato raziskovalcem in izumiteljem, ne preostane nič drugega, kot da najamejo osebno posojilo in se zadolžijo.

7.1 Zeleno gospodarstvo

Ozelenitev gospodarstva bi prineslo nove tehnologije, industrijo, delovna mesta, varno okolje ter izboljšano domačo energetsko varnost.

Zelena delovna mesta lahko nastanejo v različnih sektorjih, kot so arhitektura, gradbeništvo, proizvodnja in finance. Prinesejo okoljsko prijazne produkte in delovna mesta povezana z izobraževanjem, zdravjem, omogočajo prestrukturiranje delovnih mest ter so pogosto lokalno prilagojena (Mendonca, Jacobs in Sovacool 2010).

7.2 Povezava med univerzami in korporacijami v procesu inovacij

Korporacije pogosto delujejo pod pritiskom konkurenčnosti. Da bi bile nenehno v koraku s časom ter novostmi, pridobivajo znanja tudi iz zunanjih virov. Tako so pogoste iniciative vlad, da bi se univerze povezale z industrijskimi inovacijami. Posledično bi se vzpostavilo tudi mednarodno sodelovanje pri razvoju novih tehnologij, znanstvene inovacije bi se predstavile na trgu, povečala bi se stopnja inovacij in kreirale bi se vladne raziskovalne politike, ki bi vodile k večji stopnji uporabe znanstvenih inovacij (Greenhuizen et al. 2010).

8 JAVNOST

Javnost mora postati občutljiva na okoljske probleme, postati mora aktivna in podpirati reševanje okoljskih problemov. Dosežki v prihodnosti so odvisni od zanesljivosti javne in politične podpore v času, ko tekmujejo politične prioritete in se ustvarjajo politike, ki najbolje ustrezajo aktualnim težavam (Kraft 2011).

Državljani so dovolj izobraženi, da lahko osvojijo nekaj osnov znanosti in tako spremljajo kam se razvijajo energetske tehnologije. Lahko bi postali pozorni na to ali so tehnologije škodljive in izbrane zato, da peščica ljudi z njimi dobro zasluži ali zato, ker so v sozvočju z naravo in na razpolago vsakomur (Garbon in Manning 2009).

8.1 Mediji

Tisti, ki v ZDA pišejo in ustvarjajo oglase, članke in knjige nenehno ponavljajo, prepričujejo ljudi o nevarnosti novih tehnologij. Zdi se, da ljudje začenjajo verjeti, da je čisto pravzaprav umazano. Pogosto informacije o novih tehnologijah ne uspejo prodreti v znanstvene revije, saj nekaj le teh obvladuje trg in tako selekcionira, kaj bo objavljeno. Na srečo hitro naraščajoče število novodobnih izumov, ki so pogosto tudi znanstveno dokazani, kroži po internetu, kjer vsakdo lahko dostopa do teh informacij (Garbon in Manning 2009).

8.2 Open Source

Open Source je gibanje, ki se razvija na Internetu. Namenjeno je tudi objavi izumov posameznih raziskovalcev in izumiteljev, ki si svoje iznajdbe ne želijo vzeti za svojo last in jo patentirati, temveč deliti s čim večjim številom ljudi. Posledica tega je, da drugi raziskovalci to informacijo opazijo ter jo s svojimi idejami poskušajo nadgraditi. Tak pristop pomaga, da se tehnologije razvijajo hitreje kot običajno.
Javno objavljanje idej in izumov seveda vodi h kopiranju. Izumitelj ima kljub temu, da ni patentiral svojega izuma, še vedno možnost zaslužka. Originalen izumitelj bo spoštovan po vsem svetu in zato iskan kot svetovalec v na novo ustanovljenih družbah. Napiše lahko knjige in ima predavanja (Garbon in Manning 2009).

9 Pomembnost javnih politik pri procesu uveljavljanja novih virov energije

Gospodarstvo mora voditi odgovorna vlada na osnovi principov altruistične demokracije. Politiki morajo postati odgovorni ljudem in vzpostaviti mirno, pravično in trajnostno prihodnost. To lahko dosežejo tako, da tisto, kar je znanstveno in tehnično realno in potencialno koristno, prenesejo v področje možnega in aktivnega (O`Leary 2009).

Ni problem v iskanju čistih tehnologij, ki bi bile dovolj učinkovite, da bi nadomestile fosilno in jedrsko energijo. Problem je političen. Problem so že ustaljena in splošno razširjena mnenja (Garbon in Manning 2009).

Manjšina uradnikov, ki delujejo v vladi, industriji, vojski in na univerzah vedo za obstoj revolucionarnih novosti na področju novih energij. Toda te niso zaželjene pri tistih, ki kontrolirajo svetovne finance, saj bi z njimi oslabili zdajšnje korporacijske in politične strukture. Borza profitira iz financiranja dragih električnih podjetij. Vrtanje nafte in plina ustvarja osebna bogastva. Vlada je deležna dohodka od davka na gorivo. Celo trgovanje z radioaktivnimi odpadki, je postalo industrija. Naftna in vojna industrija namenjata precejšne vsote denarja za lobiranje. Izdelovalci orožja imajo kontrolo nad izumitelji, pravicami patentiranja in trdijo, da je revolucionaren napredek razdiralna tehnologija, kar naj bi pomenilo, da predstavlja grožnjo dobičku naftnih podjetij in je zato predmet nacionalne varnosti. Trdijo, da bodo nove tehnologije spodkopale gospodarstvo. (Garbon in Manning 2009).

King (v Garbon in Manning 2009, 208) opiše osem načinov, zaradi katerih so bili revolucionarni energetski izumi blokirani, še preden so začeli svojo pot na trg:

- akademsko zatrtje,
- blokiranje financiranja,
- blokiranje patentov,
- pravdanje,
- grožnje izumitelju,
- uničenje lastnine,
- kriminalizacija izumitelja,
- umor.

King trdi, da problemi izhajajo iz treh skupin. Prva, akademska, običajno ignorira, smeši in obtožuje izumitelje prevar. Druga skupina so ljudje iz poslovnih in industrijskih krogov, ki ne želijo, da bi se zgodile revolucionarne spremembe na področju novih tehnologij, če to pomeni, da ne bi več imeli monopola oziroma bi morali na novo opremiti svoje tovarne. Tretja skupina so tajni projekti, za katere včasih tudi sami voditelji držav ne vedo, da obstajajo. Vojska in industrija zanje dobita milijarde dolarjev, vendar ni javnih informacij o tem, čemu je bil namenjen ta davkoplačevalski denar.

O`Leary (2009) doda še skupino okoljevarstvenikov, ki zagovarjajo alternativne vire energij. Le-ti se bojijo potencialne zlorabe novih energij.

Svoboda znanstvenikov in raziskovalcev, da lahko raziskujejo, kar jih zanima in kar v njihovih očeh pomeni potencialno vrednost za družbo, je bistvena za napredek človeštva. Če omejujemo njihove raziskave na to, kar je že v poznanih in sprejetih okvirih, se ne more zgoditi več nobena nova znanstvena revolucija (Krivit in Winocur 2004).

10 Predlogi in priporočila za financiranje raziskav in razvoja na področju novih virov energije

Potrebno bi bilo izvesti bazične raziskave, ki bi potrdile, da so novi viri možni. Nato bi bilo potrebno izdelati praktične delujoče laboratorijske prototipe, iz katerih bi razvili tehnologije, ki bi šle v proizvodnjo.

Skarja (2007) predlaga štiri faze, ki bi potrebovale finančno podporo:

- V prvi fazi, gre za pregled področja z nekonvencionalnimi viri, študijo teh virov in izbor najbolj perspektivnih.
- V drugi fazi bi raziskali nekaj patentov ter poskušali znanstveno razložiti njihovo delovanje.
- V tretji fazi bi pripravili načrt za izdelavo prototipa izbranih naprav in jih skušali izdelati. Sledili bi poskusi v laboratorijih.
- V kolikor bi se ti poskusi obnesli, bi zasnovali načrt tehnologije za izkoriščanje takega vira in vključitev v energetski sistem.

Če bi raziskovalci imeli finančno podporo, bi lahko zaposlili skupino ljudi, ki bi pomagali pri projektu oziroma bi si zagotovili asistenta, in tako pospešili fazo raziskovanja in razvoja (Garbon in Manning 2009).

11 Posledice vlaganja v raziskovanje in razvoj novih energij

Posledice vlaganja v raziskovanje in razvoj novih energij bi lahko bile (Energy Innovation Act of 2007):

- Proizvodnja energije postane decentralizirana, poceni in lahko dostopna.
- Prenehanje izgorevanja fosilnih goriv.
- Zmanjšanje globalnega segrevanja in stabilizacija klimatskih vzorcev.
- Čisti zrak zaradi prenehanja onesnaževanja industrije in transporta.
- Veliko zmanjšanje okoljskih škod kot posledica ekstrakcije naravnih virov.
- Transport fosilnih in nuklearnih goriv je zelo zmanjšan.

- Dolgotrajno živeči radioaktivni odpadki se zmanjšajo ali eliminirajo.
- Recikliranje odpadkov se zelo poveča, ker je na voljo energija po nizki ceni.
- Zmanjšanje onesnaževanja vode in prsti zaradi dostopnosti nizkocenovne energije.
- Ni več potrebe po dragih, nevarnih električnih daljnovodih, ki posegajo v krajino.
- Ranljivost centraliziranih električnih omrežij je zelo zmanjšana.
- Prenehanje graditve hidroenergetskih jezov, ki degradirajo okolje.
- Restavracija in prezervacija gozdov, ki so bili prej izsekani za kurjavo.
- Velika ekspanzija globalne ekonomije.
- Globalni življenjski standard se zelo poveča.
- Dobro uspevajoče lokalne trajnostne ekonomije.
- Stopnja izobraženosti se izboljša v celotnem svetu v razvoju.
- Stopnja rodnosti v tretjem svetu se zmanjšuje kot posledica izobražene globalne populacije in višjega življenjskega standarda.
- Nova doba vesoljskih potovanj je mogoča zaradi razvoja naprednih pogonskih sistemov in sistemov za oskrbo z energijo.
- Prenehanje geopolitičnih napetosti in vojaških konfliktov zaradi nestabilnih dobav fosilnih goriv in ostalih naravnih virov.
- Povečanje nacionalne varnosti, zmanjšanje vojaških izdatkov in zmanjšanje tveganja za vojaško osebje in civile.
- Zmanjšanje širjenja potencialno destruktivnih nuklearnih tehnologij.
- Sprostitev silnega vala človeške kreativnosti, ker so ljudje osvobojeni garanja za osnovno preživetje, kar ustvari nepredstavljivi napredek v socialnih in materialnih pogojih.
- Globalna kultura medsebojne delitve in kooperacije.
- Možnost pravega in trajnega svetovnega miru.

Javne politike bi morale financirati raziskave in razvoj novih energij, kar bi pripeljalo do možnosti poceni, čistih, varnih in decentraliziranih tehnologij. Faze razvoja morajo postati javne. Politike morajo zagotoviti javne forume za diskusije o vključitvi novih energij, ki bi ublažile klimatske spremembe in onesnaženje, nudijo naj izobraževanja za javnost in naj pripravijo načrt, ki bo pomagal obstoječi industriji in vladam, da bodo lahko prešle potrebno spremembo k novi energijski ekonomiji (O`Leary 2009).

ZAKLJUČEK

Energija je osnovni tehnološki temelj vseh civilizacij. Ljudje so stoletja uporabljali človeško moč in moč živali. Glavni vir energije se je z industrijsko revolucijo v 18. stoletju počasi spreminjal. Še vedno je v procesu tranzicije, kajti viri energije, ki jih uporabljamo danes, so omejeni in ljudje se vse bolj zavedajo, da uporaba konvencionalnih virov energije, kot so fosilna goriva in jedrska energija, prinaša negativne posledice za okolje in ljudi. Rešitev problema konvencionalnih virov energije so alternativni in novi viri energije.

Med svojim raziskovanjem sem spoznala, da alternativni viri energije niso končni odgovor na probleme, s katerimi se soočamo pri uporabi konvencionalnih virov energije. Alternativni viri energije so relativen odgovor v prehodnem obdobju. Na dolgi rok jih bodo morali zamenjati novi viri energije.

Uporaba energije je v naši civilizaciji tako globoko ukoreninjena, da ne more potekati brez pravil, ki jih postavijo države. Zaradi kompleksnosti tega področja, so države s svojimi vladami pri tem udeležene od vsega začetka. Države so postavile svoje politike, standarde, financiranje, lokacije, mednarodne sporazume itd.

Da bi bila politika učinkovita, je potrebno dojeti, da morajo imeti tisti, ki politike kreirajo, znanje na področju tehnologij in politike. Če ne vemo, katere tehnologije so na trgu, katere tehnologije imajo potencial za komercialno uporabo in kakšne so prednosti ter pomanjkljivosti konvencionalnih, alternativnih in novih virov energije, potem je prav mogoče, da politike, ki so uveljavljene ali pa so v nastajanju, ne bodo dovolj učinkovite za rešitev mnogih problemov, s katerimi se človeštvo danes sooča.