# THE BASIC DIRECTION OF DEVELOPMENT OF ELECTRICITY IN COMING DECADES

***D. Oprea, PhD student***
*Technical University of Moldova*

## INTRODUCTION

In January 2007 the European Commission adopted a communication (COM(2007) 1) proposing an energy policy for Europe, with the goal to combat climate change and boost the EU’s energy security and competitiveness. This set out the need for the EU to draw up a new energy path towards a more secure, sustainable and low-carbon economy, for the benefit of all users [1].

One aim is to give energy users greater choice, and another is to spur investment in energy infrastructure. Based on the European Commission’s proposal, in March 2007 the Council endorsed the following targets:

- reducing greenhouse gas emissions by at least 20 % (compared with 1990 levels) by 2020;
- improving energy efficiency by 20 % by 2020;
- raising the share of renewable energy to 20 % by 2020;
- increasing the level of bio fuels in transport fuel to 10 % by 2020.

To achieve the goals that the EU has proposed, are developed different strategies and methods, such as: the use of renewable greater extent, the introduction Smert grids, generation 4 of nuclear power plants, ITER (International Thermonuclear Originally year acronym of Experimental reactor), PV etc. In this article, we try to characterize some of these new innovations and their use in practice.

## 1. POPULATION AND WORLD RESOURCES

In keeping with current trends in 2030 are still 1.4 billion people without electricity. In India, without access to electricity are 600 million people, unlike China, where 98% of people have access to electricity. In the world 1.3 billion lack access to safe drinking water. The 2.4 billion people uses biomass for cooking and heating and 2.5 billion people here live on less than 2US $ / day [2].

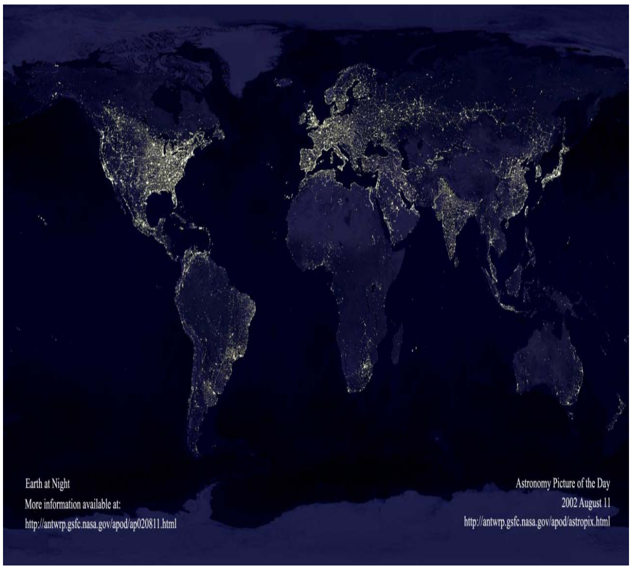



**Figure 1.** Vision above the earth in the night, www.teslasociety.com, update 8.12.11

The increase of this population was 1.6% per annum, up to half the population in less developed countries is 15 years younger than 2 billion of the population has no access to electricity [2], figure 1.

The annual world GDP (543 trillion) needs 11 billion tons of oil equivalent. With the current economic growth, energy consumption is growing annually nearly by annual consumption of Africa.

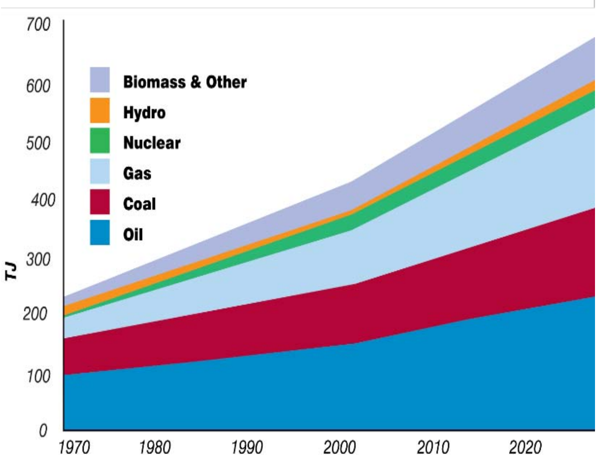



**Figure 2.** The development of world energy demand, source http://bravenewclimate.com

In figure 2 we can see that the fossil fuels will continue to dominate the global energy mix, while oil remains the leading fuel.

How we can easily see in figure 13, most of the energy resources used are conventional sources of energy: oil, gas and coal, but these traditional sources of energy are limited. Regarding RES, namely biomass, water etc. they can not satisfy the entire amount of energy required, and for this reason in the world are working on finding new methods widely on the issue of obtaining energy.

Fast of all are renewable sources of energy, sources what are used in world from past. Targets for renewables in the Member States of the European Union in 2020, see fig. 3.

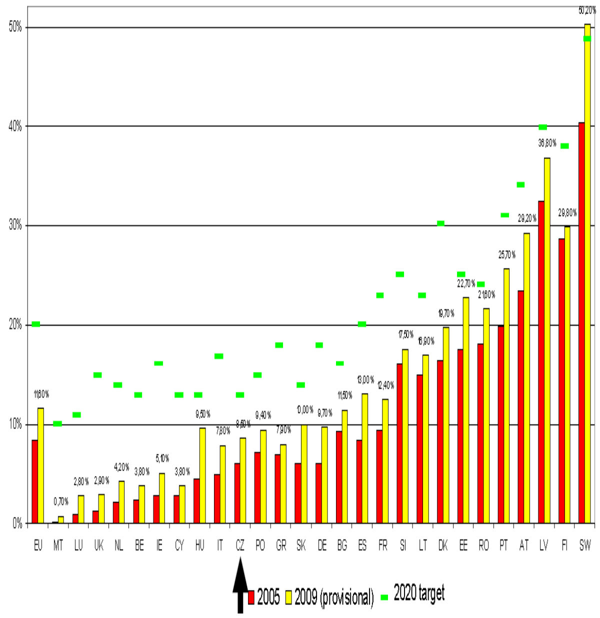



**Figure 3.** EU renewable energy shares [6].

## 2. SMART GRIDS

Highly frequent theme WEC Congress, Rome 2007, were "intelligent network" (rather systems), generally regarded as the basic direction of development of electricity coming decades. Power system consists of the largest, most comprehensive infrastructure ever built. Today's electricity grid, however, is characterized essentially unidirectional flow of electricity, from production through transmission and distribution to the consumer. Production is from the vast majority of centralized and is mainly based on coal and gas.

If we restrict to the electricity grid, Smart Grid is the growth of benefits for producers of services and products, and rigorous optimization to its portfolio. For network operators increase safety and reliability of system operation, increase utilization and improve network capacity, increased flexibility and reduced operating costs. The consumer gains reduce electricity costs through increased competition and the possibility of quick and intelligent response to current conditions in the system, improving the efficiency of their energy consumption or optimal use of their own Mark. Analogous are the benefits for society as a whole [3]. As an "intelligent network" or "Smart Grid" refers to electricity distribution network, which can independently respond to changing load and adapt to it. Extending the concept of Smart Grids bring the past few years associated with the development of renewable energy sources and the type of wind and photovoltaic power plants, especially technological progress and development in the IT component [4].

The fact that renewable energy sources are characterized by instability of its power, unlike the coal plants, gas or nuclear station, smart grids should be directing their role.

Grid in the sunny afternoon when the wind blows gentle and solar power and wind turbines are going full, is forced to absorb much higher performance than what was designed and proposed, when it was assumed that there will be a central resource forever. For exemple in the Czech Republic to happen thanks to the unexpected and uncontrolled growth of photovoltaics, which was supported by generous feed-in tariffs.

Smart grids have next components, see figure 5: Mass Unit 1, 2 alternative energy sources (wind farms, solar panels - electricity from renewable energy sources are used to balance supply and demand on the network), cogeneration units at the site of energy consumption 3, electric 4 (infrastructure of public charging stations), automated control center 5 (control network based on information obtained from the network in real time), Smart home 6 (automatic plugging and unplugging appliances to distribution system, the possibility of postponing consumption of electricity during off-peak electricity consumption), the smart meter 7 (installation of meters will undergo bidirectional transfer of customer information and electrical device directly to the network), electric 8 (can serve as a battery power - charging allows balancing the network so that the battery is connected from the power back depoziting drains), energy storage 9 (electricity produced at the time of lower consumption can be stored in batteries and consumed in the peak), remote controls and sensors 10 (detects fluctuations and disturbances in the distribution system and can automatically isolate the affected part) and isolated part of the distribution network 11 (to minimize possible disturbances and loss of flexibility with the ability to redirect the flow of electricity, and isolate the affected area), the image 5.

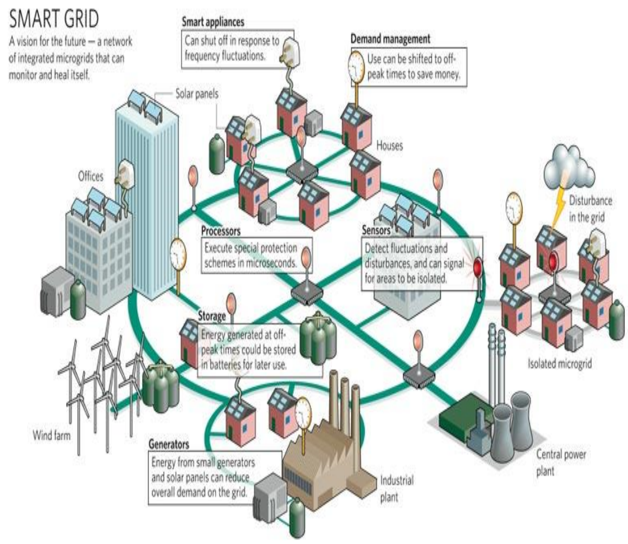



**Figure 4**. Smart Grid, source: www.consumerenergyreport.com, update 8.11.2011

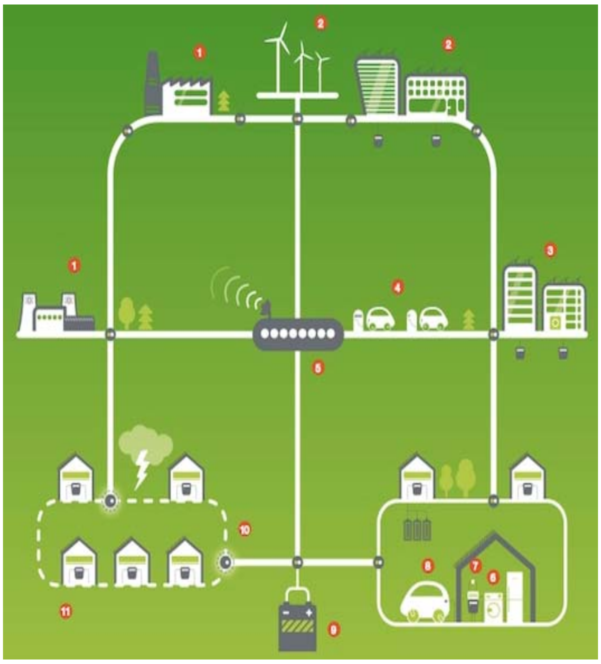



**Figure 5**.Illustration of Smart Grids, source: www.consumerenergyreport.com, update 8.11.2011

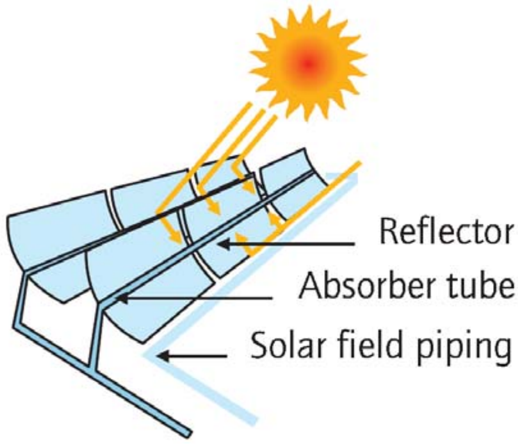
The basic properties of intelligent networks is the ability to bi-directional communication. Thanks to this grid can flexibly respond to changing production and consumption needs

In last year more and more are speacken about Smart Grids, for exemple at WEC conference on Rome and Montreal.

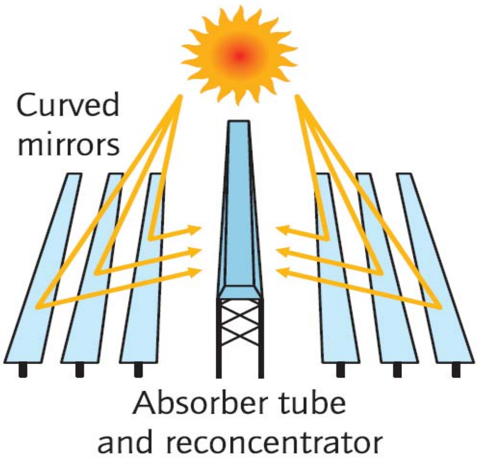
## 3. CONCENTRATING SOLAR POWER (CSP)

Concentrating Solar Power (CSP) systems use lenses or mirrors and tracking systems to focus a large area of sunlight into a small beam.

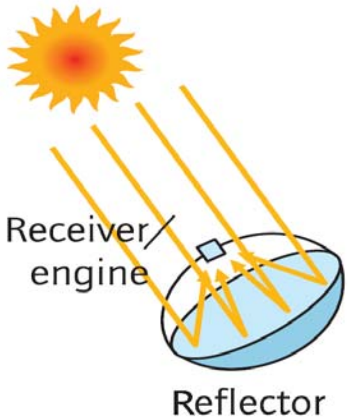
The sunlight hits the Earth’s surface both directly and indirectly, through numerous reflections and deviations in the atmosphere. On clear days, direct irradiance represents 80% to 90% of the solar energy reaching the Earth’s surface. On a cloudy or foggy day, the direct component is essentially zero. The direct component of solar irradiance is of the greatest interest to designers of high temperature solar energy systems because it can be concentrated on small areas using mirrors or lenses, whereas the diffuse component cannot, see figure 6. Concentrating the sun’s rays thus requires reliably clear skies, which are usually found in semi-arid, hot regions [4].



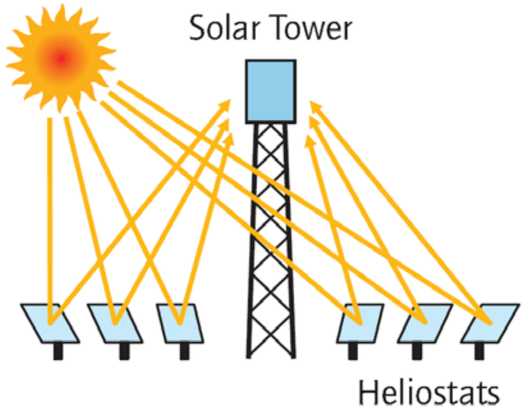

a) Parabolic troughs (line focus, mobile receiver)




b) Linear Fresnel reflectors (line focus, fixed receiver)




c) Parabolic dishes (point focus, mobile receiver)




d) Solar towers (point focus, fixed receiver)

**Figure 6.** Different forms of CSP

The IEA publication Energy Technology Perspectives 2008 (ETP 2008) includes CSP as one of the many cost-effective technologies that will lower $CO_2$ emissions. In the ETP BLUE Map scenario, global energy-related $CO_2$ emissions by 2050 are reduced to half their 2005 level, and CSP produces 2 200 TWh annually by 2050 from 630 GW of local capacities (no exports taken in account). CSP is expected to contribute 5% of the annual global electricity production in 2050.

This graph (figure 7) shows how storage works in a CSP plant. Excess heat collected in the solar field is sent to the heat exchanger and warms the molten salts going from the cold tank to the hot tank. When needed, the heat from the hot tank can be returned to the heat transfer fluid and sent to the steam generator.

In the Advanced scenario of *CSP Global Outlook 2009*, the IEA SolarPACES programme, the European Solar Thermal Electricity Association and Greenpeace estimated global CSP capacity by 2050 at 1 500 GW.

The SolarPACES forecast sees large storage and solar fields that would enable capacity factors of 59% (5 200 hours per year), with a yearly

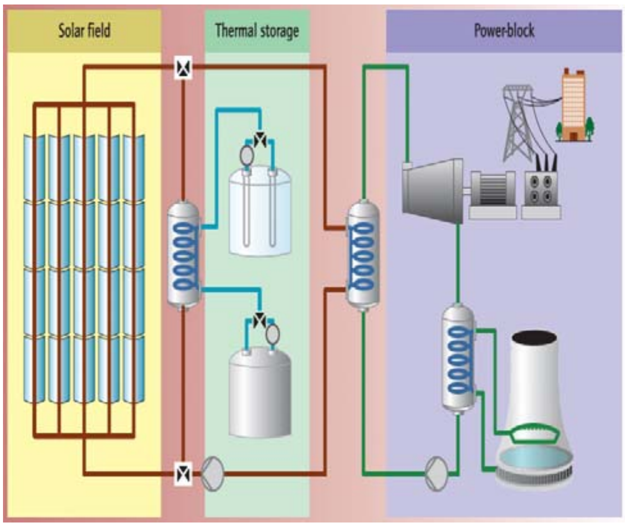



**Figure 7.** Storage system in a trough solar plant, source: SolarMillennium, update 8.12.11

output of 7 800 TWh. In its study of the renewable energy potential in the Middle East/North Africa region, the German Aerospace Center (DLR) estimates that by 2050, CSP plants could provide about half of the region's electrical production, from a total capacity of 390 GW.

According to a recent study by PriceWaterHouse Cooper, Europe and North Africa together could by 2050 produce all their electricity from renewables if their respective grids are sufficiently interconnected. While North Africa would consume one-quarter of the total it would produce 40% of it, mostly from onshore wind and solar power. CSP plants would form the backbone of the export capacities from North Africa to Europe [5].

## 4. NUCLEAR ENERGY

One lump of uranium U 235 weighing 1 kg will replace 3 000 tons of coal, 3 000 tons of coal equal to 5 train, due to this statistical date we can say how effective is the use of nuclear energy. So countries like France (52 blocks, 80% of energy), USA (104 blocks, 20% of energy), Japan (52 blocks), widely used by nuclear energy. As all in the world, nuclear energy has its advantages and disadvantages. Factors acting on the fate of nuclear energy are: the security, economic parameters, cost of fuel used, the possibility of using military population opinion, legislation and policies review, see fig.8 .

Some of the advantages are minimal emissions of greenhouse gases, minimum diversion of price

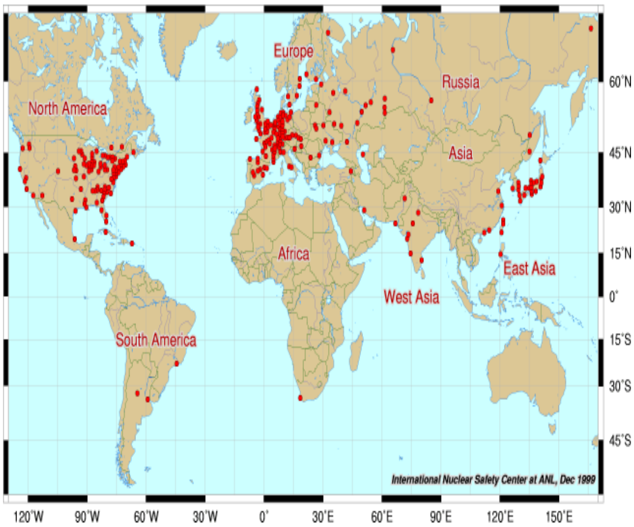



**Figure 8.** World nuclear station, source: http://www.roadtechs.com/atlas/nucatlas.htm

**Figure 9** Nuclear station on Three Mile Island, Source: https://inlportal.inl.gov/portal/, update 8.12.2011.

of fuel (compared with fossil fuels), higher power energy of combustible and one of the most important negative points are damaged.

The greatest damage of nuclear plants that took place in the world are: Three Mile Island in 1979, Chernobyl 1986 and Fukushima 2011.

28th Third 1979 maintenance repairs carried out jam valve with beech, drove a block at 97% power. For some reason there was a halt condensate pump secondary circuit, the loss of water supply caused shutdown of TG and subsequent emergency reactor shutdown. Emergency rods were inserted and the chain reaction stopped completely.

Automatically backup cooling pumps jumped but because of routine maintenance valves were closed to the discharge which was a fundamental violation of NRC (the reactor was to become). The safety valve prim circuit due to the increase of pressure but opened after the pressure drop was blocked in its open position and did not work warning signal upon its opening. Subsequently there was a leak, overheat the core, melting fuel and radioactive elements in the containment ventilation of approximately 481 to 629 GBq (mostly J131).

April 25, 1986 began operation B4 perform an experiment with electricity supply for the cooling of turbine run-block. Performance was reduced from 3200 MW to 1600 MW and disconnected TG1. An exchange of shifts without having been properly instructed new about the experiment and it was not sufficiently technically competent physicist. Reactor power was reduced operator error to 700 MWt (instead of 1000 MWt), operators disconnected the automatic protection leading to a safe shutdown and continued to experiment. They began to control the reactor manually, however, his performance dropped to just 30 MW, using again the function of protection against virtually all pulled the control rod. In the meantime, the "poisoning" of the reactor, ie the accumulation of isotopes Xe135 and Sa149 (acts as a natural absorber of neutrons) and so even after pulling virtually all bars does not respond - which, thanks to the absence of knowledgeable reactor physics in one inning realize operator error.

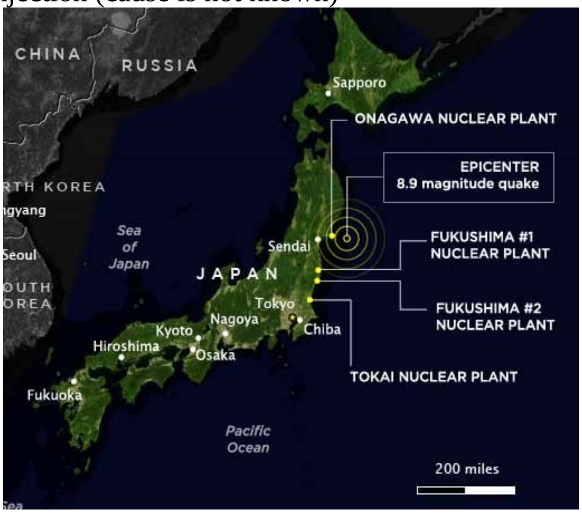
And at finely we will say about last events – Fukushima Dachii. Friday afternoon at 14:46 JST a severe earthquake (magnitude 8.9) occurred off the Northeastern coast of Japan. The earthquake and the resulting tsunami has caused damage and fatalities along the eastern coast of Japan.

**Figure 10.** Chernobyl, source http://www.ki4u.com/three_mile_island.htm, update 8.12.2011.

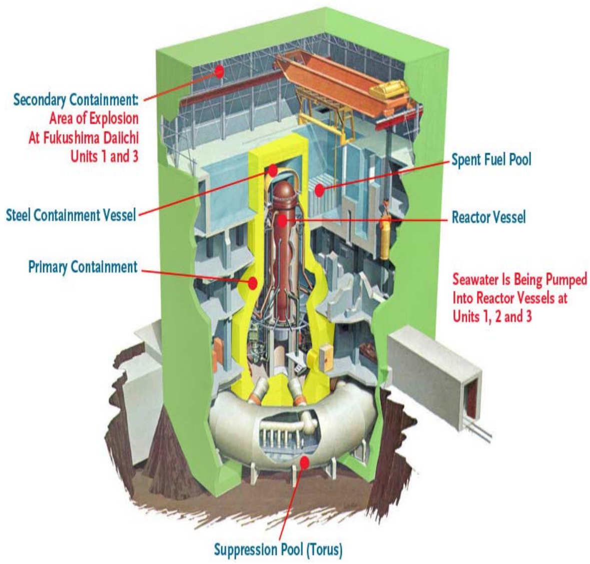
*Onagawa NPP*, units 1, 2, and 3 were in operation and all automatically scrammed due to the earthquake. A fire occurred in the unit 1 turbine building which was extinguished by the onsite fire brigade.

*Fukushima I Daiichi NPP,* units 1, 2, and 3 were in operation and all automatically scrammed due to the earthquake. Units 4, 5, and 6 were shutdown for normal outages. Units 1 and 2 - both emergency diesel generators for both units are inoperable and both units have suffered a loss of offsite power. A mobile emergency generator is on the way to the station.

*Fukushima II Daini NPP* units 1, 2, 3, and 4 were in operation and all automatically scrammed due to the earthquake. Unit 1 experienced a safety injection (cause is not known)




a) Map of Japan, source: http://bravenewclimate.com/, update 8.12.11




b) Boiling Water Reactor Design at Fukushima Daiichi, source update 8.12.11: http://courses.ucsd.edu/rherz/ceng101b/,

c) Fukushima Daiichi after damage, source: http://photos.oregonlive.com/photo-essay/, update 8.11.12

d) Japan after tsunami, source update 8.12.11: http://www.theatlantic.com/infocus/

**Figure11.** Fukushima.

*Tokai Daini NPP* unit 2 was in operation and automatically scrammed due to the earthquake

The remaining Japanese nuclear fleet has seen several minor impacts: Kashiwazaki Kariwa found that approximately 3 liters of water spilled from the Unit 1, 2, 4, and 7 spent fuel pool.

At 00:00 UTC on 15 March a dose rate of 11.9 millisieverts (mSv) per hour was observed. Six hours later, at 06:00 UTC on 15 March a dose rate of 0.6 millisieverts (mSv) per hour was observed. These observations indicate that the level of radioactivity has been decreasing at the site. As reported earlier, a 400 millisieverts (mSv) per hour radiation dose observed at Fukushima Daiichi occurred between units 3 and 4. This is a high dose-level value, but it is a local value at a single location and at a certain point in time. The IAEA continues to confirm the evolution and value of this dose rate. It should be noted that because of this detected value, non-indispensible staff was evacuated from the plant, in line with the Emergency Response Plan, and that the population around the plant is already evacuated.

**Table 1.** Overview of Generation IV Systems, source www.gen-4.org,update 8.12.2011

| System | Neutron Spectrum | Fuel Cycle | Size (MWe) | Applications | R&D Needed |
|---|---|---|---|---|---|
| Very-High-Temperature Reactor (VHTR) | Thermal | Open | 250 | Electricity, Hydrogen, Process Heat | Fuels, Materials, $H_2$ production |
| Supercritical-Water Reactor (SCWR) | Thermal, Fast | Open, Closed | 1500 | Electricity | Materials, Thermal-hydraulics |
| Gas-Cooled Fast Reactor (GFR) | Fast | Closed | 200-1200 | Electricity, Hydrogen, Actinide Management | Fuels, Materials, Thermal-hydraulics |
| Lead-Cooled Fast Reactor (LFR) | Fast | Closed | 50-150 300-600 1200 | Electricity, Hydrogen Production | Fuels, Materials |
| Sodium Cooled Fast Reactor (SFR) | Fast | Closed | 300-1500 | Electricity, Actinide Management | Advanced recycle options, Fuels |
| Molten Salt Reactor (MSR) | Epithermal | Closed | 1000 | Electricity, Hydrogen Production, Actinide Management | Fuel treatment, Materials, Reliability |

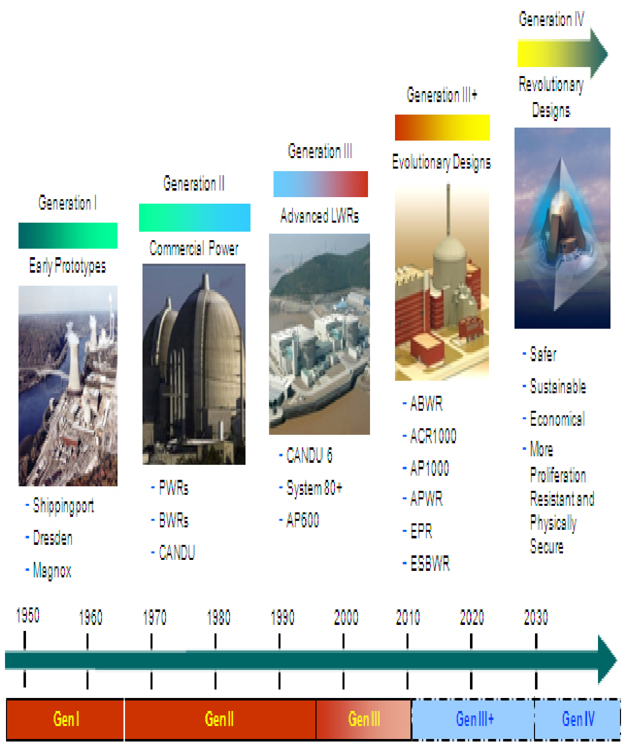



**Figure12.** Evolution of Nuclear Power, Source http://www.gen-4.org/Technology/evolution.htm, update 8.12.011

Generation IV - A new generation of nuclear energy systems, their development is focused on achieving the following objectives:

- More efficient use of fuel (in particular, ensuring at least one type of breeder reactor, enabling the use of 238U and 232Th.
- Reduction of nuclear waste (including resolution of transmutation of actinides in spent fuel),
- Further improve the safety and reliability,
- Further reducing the probability of core damage,
- Elimination of the need to evacuate the area in case of accident,
- Lower cost power production. energy compared with other sources (especially a substantial reduction in investment costs),
- The level of financial risk comparable to other energy projects,
- Increased resistance against the misuse of nuclear materials.

Generation IV project is fundamentally new in the fact that not only comprehensive approaches to the development of new reactors, but trying to solve the fuel cycle of nuclear power plants as a whole. It goes without saying that the targets are very ambitious, the question remains, how is achieved.

## CONCLUSION

Currently working on other projects are impressive, such as: electro mobile, CCS, ITER etc. CCS (Carbon capture and storage), alternatively referred to as carbon capture and sequestration, is a technology to prevent large quantities of $CO_2$ from being released into the atmosphere from the use of fossil fuel in power generation and other industries. ITER (originally an acronym of International Thermonuclear Experimental Reactor) is an international nuclear fusion research and engineering project, which is currently building the world's largest and most advanced experimental tokamak nuclear fusion reactor at Cadarache in the south of France.

All these models are very interesting and deserves a special paper that would describe.

There is no answer to deal with everything, is not an ideal source of energy. Each source from the sun after oil, coal from the nucleus, the gas from the wind, has its advantages and disadvantages. Each country faces the challenge of how to create a balanced energy policy. Such a policy that does not rely too much based on or, conversely, completely ignores any possible source (geographical, geological, physical). Our perception of the order of the four basic requirements for energy policy - security of supply, consideration for the environment, economy, social acceptance - may change from time to time. What is likely to change is a fundamental challenge: to achieve a sustainable compromise between these sources.

### *Bibliography:*

***1***. ***Oprea D.*** *Energy and environment methods to calculate greenhouse gases emission. SIELMEN 2011, Chisinau October 2011.*
**2 Drabova D.** *Rizika a přínosy jaderné energetiky. Zajimavosti jaderne energetiky, pag 59-61.*
***3***. **Lencz J.** *WEC, http://energetik-vv.webnode.cz, update 8.12.2011.*
***4.*** *Ekologické bydleni, www.ekobydleni.eu, update 8.12.2011.*
**5.** *Technology Roadmap Concentrating Solar Power, IEA International Energy Agency, www.iea.org, update 8.12.2011.*
***6. Krejcar R.*** *Energie a Budoucnost. Conferens: EGU Brno, November 2011.*
**7.** *GEMIS- the calculation program, http://www.oeko.de/service/gemis/en/, 15.11.2011.*
**8.** *Global Status Report 2007.*
**9.** *National Inventory Report, Greenhouse Gas Sources and Sinks in the Republic of Moldova 1990-2005. p. 28.*
**10.** *www.arpmnv6.ro/fondul_de_mediu.htm*.

***Recommended for publication: 17.08.2011***