**World Federation of Scientific Workers Symposium**

**“A solution for energy, our key to survival”**

**Round-table 2**

**Nuclear as a Bridging Fuel towards Renewables**

***Cosmocaixa (Barcelona) – May 12th, 2015***

The world we know is in turmoil. On the one hand we are about to live through a process of slow change of the environment and of human society with roots in the past that although almost imperceptible to many yet progressively creates the basis for profound changes in the life support capability of the Earth, that will shape the future of generations to come. On the other hand, the major stakeholders on the planet’s resources are in general almost exclusively concerned with raising profits without seriously examining the long and often medium term consequences of their actions. This is true of changes in the biosphere, in the lithosphere and in the outer space as well.

We believe that unless a major revolutionary change of this behavior takes place survival of humankind is doomed. The process of slow change referred above is enliven — pardon the expression — by multiple tragic bloody man-made events such as regional wars and conflicts of the most diverse origin and nature that arise almost everywhere. I daresay these events have as main single cause the growing unjust distribution of wealth which is the fruit of human labour in various forms. Although finding a technically and economically convenient solution to supplying energy to society ─ a necessary ingredient to preclude the problems of food scarcity, water accessibility, education and health ─ I consider that the most important challenges that stand before us are combatting the arms race, achieving the full and complete abolition of nuclear weapons and effectively regulating the so-called *markets*. As long as we are not on a way to reach these goals the just distribution of wealth will not be possible and the present acutely felt tensions and conflicts will not be mitigated and finally eliminated, so that the scientific and technological advances can be used for the good of humankind and the preservation of the natural world.

This said let us have a word about the place of nuclear power for peaceful applications in the decades to come.

In the present day the main contribution to the world’s energy supply is given by the consumption of fossil fuels both conventional and non-conventional. Coal, petroleum and natural gas supply over 80% of world’s primary energy, a percentage of the total that has barely changed during the last decade. Natural gas includes gas trapped within [shale](http://en.wikipedia.org/wiki/Shale) formations or shale gas. Shale gas is extracted using the technology of [hydraulic fracturing](http://en.wikipedia.org/wiki/Hydraulic_fracturing) (fracking) to create extensive artificial fractures in rocks around well bores. In recent years a boom in the extraction of shale gas using fracking took place in the USA and in Canada. This was met with strong opposition from nearby communities because of the serious environmental impacts associated with the technology. Far beyond this rather particular aspect there are a number of good reasons that argue in favour of the progressive reduction of fossil fuel combustion as the main source of the energy required to keep a working society with a sustainable way of life. We will dispense ourselves from discussing such reasons here and now.

The essential question is how to replace fossil fuels. Quoting Vaclav Smil [[1]](#endnote-1) : “renewable energy sources (cannot) take the world by storm”. A path to sustainable energy based on a plan for converting the world’s energy supply entirely into energy supply from renewable energy sources will with high probability take more than one generation to become reality. If one accepts this anticipation one should do whatever is in one’s power to lay one’s hands on the problem and contribute to solve it.

Governments’ policies however show in this respect a remarkable lack of foresight. The lobbying of powerful energy corporations interested in pursuing business as usual in the field of fossil fuels weigh more than the concerned advice of socially responsible scientists. Public opinion in general is not aware of the impacts associated with the extensive use of fossil fuels for lack of access to reliable information. Citizens engaged in environmentalist organizations often defend unrealistic solutions to meet the challenges that lay before us.

Looking back into the evolution of the world’s energy supply one verifies that each major energy source has dominated for a period of about half a century. In the 19th century we had the dominance of coal. In 1840, coal represented a 5% share of the total primary energy supply. By the end of the century it represented 50% of the total. The rest was supplied by wood, charcoal and crop residues (mostly cereals’ straw)[[2]](#endnote-2). A similar pattern is found for oil and natural gas. As of the first decade of the 21st century, the contribution of the “new renewables” ─ wind, solar, geothermal and liquid biofuels ─ was slightly above 3 %. Hydroelectricity amounted to about 2,4% and nuclear about 4,8 % (2012). Nuclear power contributed to satisfy circa 12% of the global electricity demand (2011).

Every energy source has associated risks for the environment, human and animal life. As an example in the past century an estimated 100 thousand workers died in coal mining accidents in the USA alone. Nowadays improvement of safety measures has reduced the number of deaths to an average of 30 a year. Chronic lung diseases are still today a serious cause of diminished life expectancy among miners. Uranium mining is also associated with serious health risks that in many cases only become detectable after several years of work in the mine.

Also the exploitation of the renewable sources of energy -- hydroelectric, solar, wind, geothermal, and biomass -- has significant, if often unacknowledged, environmental consequences. Manufacturing solar collectors, pouring concrete for fields of windmills, and drowning many square miles of land behind dams cause damage and pollution[[3]](#endnote-3). Probably less well known is the fact that a 1,000-megawatt-electric (MWe) coal-fired power plant releases about 100 times as much radioactivity into the environment as a comparable nuclear plant. Worldwide releases of uranium and thorium from coal-burning total about 37,300 metric tons annually, with about 7,300 tons coming from the United States alone[[4]](#endnote-4). Also the manufacture of photovoltaic cells for solar panels generates highly toxic waste metals and solvents that require special technology for disposal.

It is however imperative to significantly increase the world’s energy supply for the very good reason that a large fraction of the world’s population is deprived of essential basic goods and services that depend on the availability of energy and energy distribution mainly as electric power. The incidents, safety failures and accidents involving nuclear power plants that we have witnessed in the course of the last 30 years ─ mainly the Tchernobyl and the Fukushima-Daichi catastrophic disasters and the Three Mile Island plant incident ─ have caused widespread alarm among the populations directly affected and the public in general especially by reason of the long term effects of the dispersion of radioactive elements in the environment with consequences that are not yet entirely quantifiable. These events represented a severe blow to the expansion of nuclear power in many parts of the world and contributed to public distrust of nuclear energy. I believe these accidents could have been avoided by a proper and more disciplined operation of the plants affected and better design of safety systems. In some cases of which Germany is an important example politicians hurried to take the not well measured step of banning nuclear energy by setting a date to shut down existing (and ageing) nuclear power plants and not investing in the construction of new ones. For Germany this meant an increase in the local consumption of coal and at the same time increased recourse to nuclear electricity imported from France.

During the last ten to twenty years several countries *per se* or in association with other technologically advanced partners, have invested considerable efforts in developing new nuclear reactor types some of which are designed for specific purposes like hydrogen production, and integrate among other advances “intrinsic safety” features. The so-called Fourth Generation Reactors are a result of such efforts. The Generation IV are advanced nuclear reactors expected to be deployed between 2020 and 2030. Meanwhile a third generation of advanced reactors including a dozen new nuclear reactor designs are at advanced stages of planning in the USA, the Russian Federation, Europe and Japan[[5]](#endnote-5). The greatest departure from most designs now in operation is that many incorporate passive or inherent safety features which require no active controls or operational intervention to avoid accidents in the event of malfunction, and may rely on gravity, natural convection or resistance to high temperatures. A promising entirely new reactor type already under development is the hybrid fusion-fission reactor (HF2R)[[6]](#endnote-6), a virtually risk free sub-critical reactor, with an external fast neutron source that can be switched on and off at will.

In my opinion the following guide-lines should command world’s policy in the immediate future as far as energy is concerned: the gradual shutdown of coal fired power plants; investing in and bringing on-line advanced nuclear reactors; investing in the development of hybrid fusion-fission reactors and keeping the ITER project going, alive and well[[7]](#endnote-7). Investing heavily in the development of technically and economically viable renewable energy devices and systems.

In China a renewable energy revolution is taking place mainly as far as wind and solar power for electricity production is concerned. The surge in solar power is expected to lead to an installed capacity of 45 GW by the end of this year, a value that leaves the entire world behind[[8]](#endnote-8).

Anyhow, energy savings are probably the most valuable short-term path to alleviate the very pressing needs of energy-hungry communities and nations. One should then work hard in the design of less energy-consuming buildings, processes and equipment.

And last but not least stop war mongers and profiteers involved in the industrial-military complex from spending huge amounts of energy in war games, responsible, among other evils, for the creation of failed states.

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1. Yaclav Smil, “Renewable Energy Sources Could Take the World By Storm”, Scientific American, Jan. 2014 [↑](#endnote-ref-1)
2. Idem, ib. [↑](#endnote-ref-2)
3. Richard Rhodes and Denis Beller, “The Need for Nuclear Power”, in *Foreign Affairs*, Jan-Feb 2000 issue [↑](#endnote-ref-3)
4. Idem, ib. [↑](#endnote-ref-4)
5. Cf. World Nuclear Association (<http://www.world-nuclear.org/info/Nuclear-Fuel-Cycle/Power-Reactors/Advanced-Nuclear-Power-Reactors/> ) [↑](#endnote-ref-5)
6. E.Velikhov, “Future Development of Nuclear Power and Role of Fusion Neutron Source ─ Green Nuclear Power” (<https://www.iter.org/newsline/248/1413> ) [↑](#endnote-ref-6)
7. <https://www.iter.org/proj/itermission> [↑](#endnote-ref-7)
8. See <http://earthtechling.com/2015/04/china-solar-power-surges/> and <http://www.globalresearch.ca/chinas-renewable-energy-revolution-what-is-driving-it/5414533> [↑](#endnote-ref-8)