Nuclear Illusion - Risks and False Myths

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3. The nuclear system

An electric power plant is not a system by itself; if you want to have at your disposal the energy incorporated in the combustible used by the plant, be it coal, gas oil or natural gas, anyway in the state they are found in the Earth's crust, you need a lot of industrial processes and of transportation infrastructures. Uranium, as a combustible, doesn't escape this rule.

However, among all the production chains existing today in order to generate electric energy, nuclear power is surely the most complex energy-producing system ever planned and realized. Moreover, the nuclear system is unique as well for the extraordinary long times it entails. The set of sequences or production chains correlated to a commercial power plant, from start (the building of the plant) to end (safe and definitive disposal of nuclear waste), covers a period of time that can vary between one hundred and one hundred and fifty years.

The whole set of the processes needed to develop and manage the whole nuclear production chain "from the cradle to the grave" is outlined in the **Figure 1 ([1])**.

Each of these processes has its own peculiarities and obviously its costs. The sum total of all these costs, divided by the global quantity of kWh that the reactor will succeed in producing during the whole span of its operative life, determines the real cost of each kWh produced.

In fact, the short history of nuclear technology is studded with financial collapses, sensational bankruptcies and state interventions to save whatever possible. No nuclear undertaking, maybe very few exceptions apart, has ever succeeded to respect expectations, neither concerning building costs, nor the final cost of the energy produced. On the other hand many activities for the treatment of the so called spent nuclear fuel are

([1]) Figure 1 is taken from the authoritative report "Nuclear power - the energy balance" by Jan Willem Storm van Leeuwen and Philip Smith - http://www.stormsmith.nl - commissioned by the Green Group in the European Parliament in 2000.

taken over by the military and it is very difficult to evaluate its costs, nor is the military usually keen to supply and relate such figures in detail.

Even in the United States, homeland of liberalism, where the new state subsidies allocated by Bush administration, confirmed and increased by Obama, will pay almost entirely the investments made to build the next nuclear power plants, Standard & Poor's has declared that it doesn't intend to increase the "rating" of companies involved into nuclear plants building and no private bank is any longer willing to lend money to such companies without State guaranties.

For practical reasons though, and to better analyze the costs, as well as the energy and environmental aspects of nuclear energy, we subdivide the nuclear system in three main blocks, always referring to **Figure 1**:

1. the production of nuclear fuel, i.e. the conversion of uranium ore in elements usable in the reactors (Upstream or Front End);
2. the building, the Operation & Maintenance of the reactor, i.e. the management of the nuclear power plant proper;
3. the management of the exaust combustible, the dismantling & decommissioning of the reactor, the treatment of the nuclear waste and its fitting in safe geological deposits (Downstream o Back End).

According the World Nuclear Association (see **Table 1**), in August 2010 there are 440 nuclear power plants in operation in 30 States, for a total 376 GW electronuclear power installed, that consume about 68.500 tons a year of uranium in order to produce 2.600 TWh/year of Electric Energy, equal to 14% of all the electric energy produced in the planet. Such a quantity of energy, as highlighted in **Table 2**, is equivalent to about 6% of the total primary energy consumed in the world.

We must specify that the primary energy figures presented in **Table 2**, taking into account both the nuclear generation and the hydroelectric generation, have been obtained, according with international conventions, by calculating the equivalent amount of fossil fuels needed to produce the same quantity of electric energy, assuming a conversion factor of 38%, which is tantamount to the average yield of thermoelectric generation in OECD countries. Actually, if we don't take into account this "increase in

value" in terms of equivalent primary energy, the real weights of nuclear energy and hydroelectric energy represent, each, not much more than 2% of world energy consumption.

At present, see **Table 3**, there are 59 new reactors under construction, 24 of which in China and 10 in Russia. China seems to be the predominant country for the further development of nuclear plants. In order to sustain its "frantic" development, China counts on realizing more than 180 further nuclear reactors out to a total of over 180.000 MW, equal to half of the whole world nuclear capacity installed today. China, moreover, aspires to become self-sufficient both in planning and building its nuclear reactors, as well as taking care of all activities connected with them.

An other region where one foresees a strong development of the nuclear sector is East Europe, Russia included, where many reactors already partially built with "Chernobyl-type" technology, need substantial modifications of the original projects, offering thus strong commercial perspectives to the western builders of nuclear plants.

The costs to realize all these new nuclear plants are "astronomical" and evaluations run, at today's prices, over 1.500 Billions Euro. To finance similar programs is not a small thing and international calls for tender launched by various countries require by now, among the qualifications needed to apply for the offers, the financing of the works up even to 100%. On the other hand even the biggest nuclear plant builders are not able to provide for such enormous financing, given the critical situation in which they have been led since the end of last century for the lack of new orders. A visible sign of this crisis is the whirling of mergers & acquisitions, still undergoing, to prevent economical collapses.

With the decline of nuclear power in the western countries, the producers of such plants must base their survival on realizing reactors in the emerging countries. Although from many sides it has been pointed to the fact that energy production in the West shows the limit of the present type of development and one would very much wish, for the emerging countries, a more conscious development based on Distributed Generation and on Renewable Energy Sources, after all business is business, and the newcomers to the banquet of modernity and of plenty are compelled to repeat our very same mistakes.

When companies of many nations concur, typically in consortia, to take part in tenders for the realization of whole nuclear sites, they are also evaluated, besides for the value of the projects and for their technical competence, also for the "financial package" they can offer. The availability of financial assistance on the part of governments that support the

consortia is an advantage when offers are taken into consideration and this is often a mandatory condition in international tenders.

In fact, to be able to offer financing at low rates, governmental guaranties and insurances, less public controls and "softened" environmental prescriptions, all this may represent a meaningful advantage in order to win the bids. To help and assist the national industries in international tenders and then in the following complex negotiations for drawing up contracts, special Export Credit Agencies (ECAs) have been created right to that purpose in OECD countries. ECAs are public agencies that provide loans guaranteed by Governments in order to promote business in developing countries. All industrialized countries have at least one ECA at disposal and the agreements to coordinate ECAs are taken within OECD and in the G8 ([2]) sessions. By the way it is right at Genoa's G8 summit of July 2001, were the agenda was scheduled for discussing how to reform ECAs, as strongly demanded by the NGO that in May 2000, with the signing of the Jakarta Declaration ([3]) asked for "*ceasing massive ECA support for military purchases and white elephant projects, such as nuclear power plants, that would be rejected by OECD bilateral aid agencies and multilateral development agencies such as the World Bank".*

Actually, resistance to ECAs reform is very strong and the opacity clouding their activities and the size of the financing granted and guaranteed by all states is almost total. All the nuclear power plants of China, Romania, Ukraine, Argentina, Lithuania, Mexico, North Korea, India, Iran, Bulgaria, the Czech Republic, are financed via ECAs. G8's ECAs members, except Italy, finance the whole of the Chinese nuclear program. Italy, on the other hand, through Sace, an ECA of her own, guarantees partially the building of the nuclear reactors of Cernavoda, in Romania, carried through by a industrial consortium composed by Italian Ansaldo nuclear and by Canadian AECL.

Besides ECAs, that by themselves have a 24% impact on developing countries' foreign debt, on the front line to finance nuclear power plants we find big Banks as the World Bank that, although in the '90ies it had excluded financing nuclear power plants, as they were considered economically little advantageous besides being dangerous, in 2007 declared to be in favor of financing the building of a nuclear power plant in Egypt. Then there is the European Bank for Reconstruction and Development (EBRD), that has recently

([2]) The G8 countries are: Canada, France, Germany, Italy, Japan, Russia, United Kingdom and USA
([3]) http://eca-watch.org/goals/jakartadec.html

approved to finance the construction of two reactors in Ukraine, after it had refused, at the time of Czechoslovakia separation, to finance the completion of the two Slovak reactors, then financed by Intesa SanPaolo, Italian biggest bank, and build by Enel, the Italian state owned biggest utility. Even the European Bank for Investments (EIB), the biggest world public bank, directly controlled by the Finance Ministers of the European Union, is considering to open a credit line for building nuclear power plants.

From “Illusione Nucleare” – Melampo Editore 2008
Translated by Brown Onion & Revised by Tazio Borges

Figure 1 – The Nuclear System

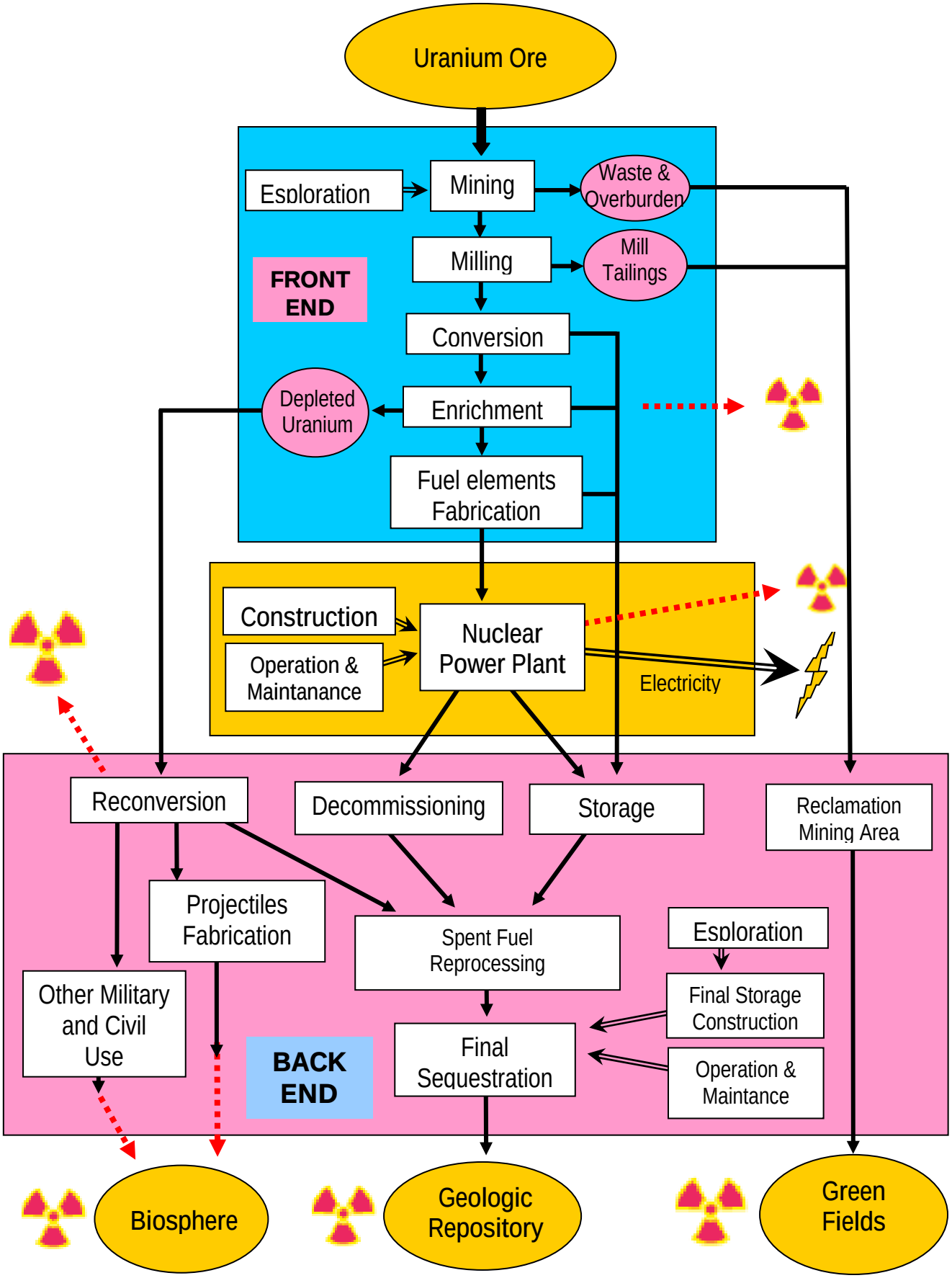

Table 1 – Nuclear Reactors in Operation – August 2010

	Electricity Generation 2009 [GWh]	Electricity [%]	Reactor Operable Aug 2010	MWe installed	Uranium Required 2010 [tons]
Argentina	7.600	7	2	935	123
Armenia	2.300	45	1	376	55
Belgium	45.000	52	7	5.943	1.052
Brazil	12.200	3	2	1.901	311
Bulgaria	14.200	36	2	1.906	272
Canada	85.300	15	18	12.679	1.675
China	65.700	2	12	9.624	2.875
Czech Republic	25.700	34	6	3.686	678
Finland	22.600	33	4	2.721	1.149
France	391.700	75	58	63.236	10.153
Germany	127.700	26	17	20.339	3.453
Hungary	14.300	43	4	1.880	295
India	14.800	2	19	4.183	908
Japan	263.100	29	55	47.348	8.003
Korea RO South	141.100	35	20	17.716	3.804
Lithuania	10.000	76	-	-	-
Mexico	10.100	5	2	1.310	253
Netherland	4.000	4	1	485	107
Pakistan	2.600	3	2	400	68
Romania	10.800	21	2	1.310	175
Russia	152.800	18	32	23.084	4.135
Slovacchia	13.100	54	4	1.760	269
Slovenia	5.500	38	1	696	145
Sud Africa	11.600	5	2	1.842	321
Spagna	50.600	18	8	7.448	1.458
Svezia	50.000	35	10	9.339	1.537
Svizzera	26.300	40	5	3.252	557
Taiwan	39.900	21	6	4.927	863
Ukraine	77.900	49	15	13.168	2.031
United Kingdom	62.900	18	19	11.035	2.235
USA	798.700	20	104	101.216	19.538
WORLD	2.560.100	14	440	375.745	68.498

Source - World Nuclear Association 2010

Table 2 – World Primary Energy Consumption - 2008

World Primary Energy Consumption - 2008 [Million TOE]						
Geographic Areas	**Oil**	**Natural Gas**	**Coal**	**Nuclear**	**Hydro**	**Totals**
North America	**1.045 (39%)**	**680 (25%)**	**604 (23%)**	**213 (8%)**	**140 (5%)**	**2.683 (24%)**
Centre & South America	**341 (48%)**	**170 (24%)**	**32 (4%)**	**7 (1%)**	**159 (22%)**	**708 (6%)**
European Union (27)	**717 (40%)**	**437 (24%)**	**318 (18%)**	**217 (12%)**	**117 (6%)**	**1.805 (16%)**
Former URSS, Turkey	**233 (20%)**	**603 (51%)**	**216 (18%)**	**59 (5%)**	**72 (6%)**	**1.183 (11%)**
Middle East	**293 (51%)**	**269 (47%)**	**6 (1%)**	**-**	**5 (1%)**	**574 (5%)**
Africa	**138 (40%)**	**75 (22%)**	**106 (31%)**	**3 (1%)**	**22 (6%)**	**344 (3%)**
Asia & Pacific	**1.185 (31%)**	**403 (11%)**	**1.896 (50%)**	**123 (3%)**	**194 (5%)**	**3.802 (34%)**
WORLD	**3.953 (36%)**	**2.638 (24%)**	**3.178 (29%)**	**622 (6%)**	**569 (5%)**	**11.099 (100%)**

Source - BP Statistical Review of World Energy - June 2009

- Primary Energy from Nuclear & Hydro are valued according to Average Thermal Plants efficiency of 38% as defined by OECD
- Primary Energy include only commercial fuels. Wood, Peat, Biogas, etc. are excluded.

Table 3 – Nuclear Reactors under Construction, Planned and Proposed

	Reactors under construction	MWe	Reactors Planned	MWe	Reactors Prposed	MWe
Argentina	1	692	2	740	1	740
Armenia	-	-	1	1.060	-	-
Bangladesh	-	-	-	-	2	2.000
Belarus	-	-	2	2.000	2	2.000
Brazil	1	1.270	-	-	4	4.000
Bulgaria	-	-	2	1.900	-	-
Canada	2	1.500	4	4.400	3	3.800
China	24	26.550	33	37.450	120	120.000
Czech Republic	-	-	2	2.400	1	1.200
Egypt	-	-	1	1.000	1	1.000
Finland	1	1.600	-	-	2	3.000
France	1	1.630	1	1.630	1	1.630
Hunghary	-	-	-	-	2	2.200
India	4	2.572	20	16.740	40	49.000
Indonesia	-	-	2	2.000	4	4.000
Iran	1	915	2	1.900	1	300
Israel	-	-	-	-	1	1.200
Italy	-	-	-	-	10	17.000
Japan	2	2.756	12	16.532	1	1.300
Jordan	-	-	1	1.000	-	-
Kazakhstan	-	-	2	600	-	600
Korea North	-	-	0	-	1	950
Korea South	6	6.700	6	8.190	-	-
Lithuania	-	-	-	-	2	3.400
Malaysia	-	-	-	-	1	1.200
Mexico	-	-	-	-	2	2.000
Netherlands	-	-		-	1	1.000
Pakistan	1	300	2	600	2	2.000
Poland	-	-	6	6.000	-	-
Romania	-	-	2	1.310	1	655
Russia	10	8.960	14	16.000	30	28.000
Slovakia	2	840	-	-	1	1.200
Slovenia	-	-	-	-	1	1.000
South Africa	-	-	3	3.565	24	4.000
Switzerland	-	-	-	-	3	4.000
Thailand	-	-	2	2.000	4	4.000
Turkey	-	-	4	4.800	4	5.600
Ukraine	-	-	2	1.900	20	27.000
UAE	-	-	4	5.600	10	14.400
United Kingdom	-	-	4	6.600	6	8.600
USA	1	1.180	9	11.800	22	31.000
Vietnam	-	-	4	4.000	10	11.000
WORLD	57	57.465	149	163.717	341	365.975

Source - World Nuclear Association 2010