Friends of the Earth Europe

Safer Energy For Europe – One Million Europeans against Nuclear

Friends of the Earth Europe Background paper

EU millions on a nuclear expansion programme with fast breeders, on - site reprocessing and so called proliferation resistant reactors

Summary

This Friends of the Earth paper provides an overview of the nuclear research projects hidden in the 7th EU Framework Research Programme and explains the European Commission's funding proposal for nuclear energy.

The international nuclear industry is today heavily promoting nuclear expansion by trumpeting the development of new and better reactors and the so-called closed fuel cycle. The European Commission supports this effort by injecting money into the Generation IV initiative, an international research group. A closer look into this group shows that Generation IV is a mere marketing stunt trying to breath new life into old technologies like spent fuel reprocessing and fast breeder reactors and create new myths like the 'proliferation resistant reactor'.

Reprocessing – the separation of plutonium from spent nuclear fuel – is the most environmentally and human health damaging component of the nuclear fuel cycle - the Sellafield plant and its enormous radioactive discharge being an infamous example of the technology's destructive power. Fast breeders, designed to 'breed' more plutonium than they consume, have historically failed technically and economically (e.g. Superphenix, shut down in 1996).

In an attempt to disassociate from the technological link between nuclear energy and nuclear weapons, the industry talks about developing 'proliferation-resistant reactors'. This is an unattainable goal since nuclear reactors and the nuclear fuel cycle can never be perfectly safe from the potential diversion of fissionable material. Uranium and plutonium can always be abused to build a nuclear or 'dirty' bomb. Adding reprocessing to the mix provides for an even deadlier recipe. Since reprocessing involves the separation of plutonium from spent fuel, by definition it increases the proliferation threat rather than the opposite.

Currently energy as a whole is set to receive €2951 million from the EU budget under the 7th Framework programme, while nuclear power is set to receive €4753 under the Euratom Programme - nuclear fusion alone 3364 million euro.

PART I

New nuclear power plants

The majority of operating nuclear power plants were built in the 1970s and 1980s and are of a Generation II design. Some new designs also being deployed, largely in Asia, are now of a new design, the Generation III. However, to encourage nuclear expansion the industry is now proposing a next generation of reactors (Generation IV) for which a Generation IV International Forum (GIF) has been established. This is a joint research initiative of Argentina, Brazil, Canada, France, Japan, Korea, South Africa, Switzerland, UK, US - EURATOM joined in 2003. GIF wants to realise Generation IV reactors by 2030. These reactor types will need decades of costly research – without any guarantee of success.

- **Generation I:** small reactors operational before the 1970s
- **Generation II:** majority of reactors operating today: the commercial light water reactors deployed since the 1970s
- **Generation III**: They are not radically new nor substantially safer, because basically they share many flaws of the already widely used Light Water Reactors (LWR) While core melt risk is at factor 10 lower than in Generation II, fuel burn up and capacity are higher, planned lifetime is 60 years instead of 30 years – all adding new risks. – The European prototype for an advanced LWR is the 1600 MW EPR (European Pressurized Water Reactor) under construction in Finland, scheduled to become operable by 2009. Four of these so-called advanced reactors are already operating in Japan and two are under construction in Taiwan. (PRIS -IAEA).
- **Generation IV:** is the "new" nuclear power programme with which the industry hopes to achieve a nuclear expansion. According to current estimates, these nuclear systems would reach technical maturity by 2030.

The goals of the Generation IV reactors:
1. Sustainable energy (extended fuel availability, positive environmental impact);
2. Competitive energy (low costs, short construction times);
3. Safe and reliable systems (inherent safety features, public confidence in nuclear energy safety); and
4. Proliferation resistance (does not add unduly to unsecured nuclear material) and physical protection (secure from terrorist attacks)."[1]

There are no substantial safety increases in comparison to the existing reactor types. Furthermore, the extreme conditions these reactors have to work under give rise to significant safety questions, especially as the material to withstand such conditions still has to be developed. Only accident management systems and guidelines are more sophisticated to keep accident consequences better under control. The focus of the project is on developing cheaper designs which can be built without the usual construction delays of nuclear power plants.

[1] Source: http://www.eia.doe.gov/cneaf/nuclear/page/analysis/nucenviss2.html

A key argument against new nuclear power plants is the threat of proliferation and terrorist attacks, therefore the term “”proliferation – resistant reactor” was coined. The idea that a reactor design as such could be called “proliferation resistant” is misleading. Nonproliferation experts agree on the fact, that a reactor can never be proliferation resistant. What is meant is a concept, called “new advanced and innovative fuel cycles”. The proponents of Generation IV claim, that the new reactor systems will burn all the actinides and re-use all the plutonium bred in the new reactors to make use of spent fuel and reduce its volume. New fuel would be produced in a reprocessing plant directly at the site of NPP to reprocess the spent fuel from the reactor.

However, the general idea of making use of existing nuclear fuel longer by reprocessing it (recycling is the new term in the US) also increases the proliferation risk, because here the plutonium needed for a nuclear bomb gets separated out – almost ready to use.

Six reactors are being researched under Gen IV, the EU is participating in the first three of them:

1. **Sodium Cooled Fast Reactor (SFR)** (steering committee leader Japan): This is the old fast breeder as we know it from the past – a concept which was not successful. All breeder reactors had to be closed after major faults and problems in France, Japan, and Russia. Only one of them (the BN – 600 in Russia) is still operating, not as a breeder, but as a Plutonium burner only. The goal is to design a new fast breeder, which would be fuelled with MOX[2] (also reprocessed MOX) and generate electricity and new plutonium. The new plutonium would be made into new MOX by adding U238, which is plentifully available (the higher enriched U235 used for fuel production nowadays is limited). Demonstration reactors: RHAPSODIE/France, EBR-II/USA) (EU - participation).

2. **Very High Temperature Reactor System (VHTR)** (steering committee leader France): its aim is to produce Helium gas with 1000°C at the core outlet. The VHTR is thought to produce electricity with an efficiency of 50% and shall be usable also for producing hydrogen out of water by a chemo - thermal process. (EU - participation).

3. **Gas Cooled Fast Reactor (GFR)** (steering committee leader USA): Helium cooled fast reactor, fuel: Uranium - Plutonium mix with 20% Pu. It should work as a breeder reactor and produce as much plutonium as it is burning up. (EU - participation).

4. **Super Critical Water Cooled Reactor System (SCWR)** (steering committee leader Canada): this is a special type of a High Temperature Reactor (HTR). It should have a higher of efficiency 44% instead of the 35% of existing LWR (Light Water Reactors). Fuel: advanced metallic alloys.

5. **The Lead Cooled Fast Reactor (breeder technology)** and number 6, the **Molten Salt Reactor System** (thermal reactor with a graphite moderator appears to be of less interest, as no country is leading the project).

[2] MOX: is short for "mixed oxide" plutonium fuel made of reprocessed spent fuel.

The Generation IV International Forum (GIF) initiative, which is researching those new reactors, received 10 M€ between 2004-2006 from EURATOM (for 3 reactor concepts: HTR & VHTR, GFR, SCWR).[3]

Hazards of Fast Breeder Reactor (FBR)

The fuel is plutonium. The coolant in the existing FBR prototypes is liquid sodium instead of water, which is one of the biggest problems: When sodium comes in contact with the water or air, it starts to burn. Fast reactors have been designed not only to produce electricity, but also to generate “breed” fuel, namely Plutonium 239 from Uranium 238.

A major hazard of the breeder prototypes were rapid and uncontrollable power excursions, which could cause catastrophic releases of radioactive substances. It is impossible to build containments which could withstand a power excursion accident. Several smaller excursions were responsible for incidents at the Superphenix FBR in France.

Superphenix, Phenix and the Japanese Monju breeder reactor were not successful: the Superphenix had to be shut down in 1996. The Japanese Monju breeder had a severe accident in December 1995 initiated by material degradation in the sodium cooling system. It was the biggest sodium leak in a FBR. 4 days after the event the operator had not determined the exact location nor the exact volume of the sodium leak, which occurred in one of the 3 loops of the secondary cooling system. The reactor was running at 43% power. A second inspection, however, found the volume and density of the white smoke increasing. The chief operator decided to consider the incident as "a medium-scale" leak and moved to manually stop the reactor. Since then the reactor is shut down. The only breeder still under operation is the Russian BN-600 –not breeding, only burning plutonium.

Hazards of High Temperature and Very High Temperature Reactors

The HTR (High Temperature Reactor) contains a large amount of graphite as moderator, one of the biggest safety problems of this technology: the presence of graphite creates a hazard of graphite/air (fire) or graphite/water (hydrogen explosion) reactions, with potentially catastrophic consequences. The HTR is cooled with helium gas. The coolant circuit must be very gas- and water tight to avoid explosions. Material problems can be a hazard for HTR safety. The HTR core: fuel (Uranium. Plutonium or Thorium) is embedded in a graphite shell - so called "pebbles"- The coated fuel pebbles should retain the radioactivity and for this reason no containment building is planned – which reduces construction costs. *It is claimed that fuel temperature will peak at 1600° C in any case, whereas fuel damage will not begin below 2000° C [ESKOM 2005].*
However, the temperature limit of 1600° C is not guaranteed in reality. It depends on successful rapid reactor shutdown, as well as on the functioning of the passive cooling systems (which can be impeded, for example, by pipe breaks and leaks in coolers). Furthermore, fission product releases from the fuel elements already begin at temperatures just above 1600° C. In this context, it is irrelevant that severe fuel damage or melting only occurs above 2000°C. Massive radioactive releases can take place well below this temperature. (Greenpeace 2005). In Hamm in Germany this pebble bed concept was tested and given up completely. Now such a plant (Pebble-Bed-Reactor) might be built in South Africa.

[3] (Schulenberg 2004)

PART II

EU support for Generation IV - Nuclear in the 7th Research Framework Programme

The current EU Commission proposal for the 7th Framework Programme is remarkable as it once again creates a *'special case`* for nuclear power by enabling the provision of nuclear technology from the EU's own research and development budget, separate from all other programmes. Currently energy as a whole is set to receive €2951 million from the EU budget under the 7th Framework programme, while nuclear power is set to receive €4753 under the Euratom Programme[4]. Furthermore, because nuclear R&D comes under the Euratom Treaty, there is no Parliamentary co-decision required, only consultation with the decision taken solely by the European Council.

The Euratom proposal has three areas of funding:

nuclear fusion €3364 million

nuclear fission and radiation protection €607 million

nuclear activities of the Joint Research Centre €782 million

According to the Commission proposal, the "*Joint Research Centre (JRC) activities will focus on Nuclear Waste Management and Environmental Impact, Nuclear Safety, Nuclear Security."* Here we see that Nuclear Safety does not mean to make existing power plants safer, but rather to invest money in new power plants: "The JRC activities will focus on ...Nuclear Safety..... In addition the JRC will contribute *and co-ordinate the European contribution to the Generation IV International Forum R&D initiative..."*

Fusion gets lion's share of energy R&D budget

Research for the future of nuclear fusion is set to receive more funding that all the non-nuclear energy options combined. The Commission proposal states on fusion, *'Fusion has the potential to make a major contribution to the realisation of a sustainable and secure supply for the EU <u>in a few decades from now</u>[5].'* However, this is an optimistic view of commercialisation of fusion and even other Commission publications call fusion a '*long term energy option'*, which will not be commercial until the 2nd half of the 21st Century[6]. Furthermore, the EURATOM Scientific and Technical Committee recently stated it would take twenty years before it could even be determined whether fusion is a viable option for electricity supply in the 21st century at all[7]. Therefore it is very unreasonable to put that many eggs into one basket!

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[4] The Euratom budget is officially only for 5 years and is €3103 million, but the Commission contains data for the additional two years and thus is included for completeness sake.
[5] *COM (2005) 119, Annex 1.*
[6] *Energy from Fusion, European Commission, Community Research, 19315*
[7] *Scientific and Technical Committee EURATOM: The Energy Challenge of the 21st Century: The role of nuclear energy; European Commission, Community Research, EUR 20634 EN, Brussels, 2003*

Sources:

Greenpeace 2005: Nuclear Reactor Hazards, Ongoing Dangers of Operating Nuclear Technology in the 21st Century, Greenpeace International, 2005

PRIS- IAEA: Power Reactor Information System / web service of IAEA

Schulenberg 2004: Schulenberg T. et al. Was ist Generation IV; Forschungszentrum Karlsruhe, Wissenschaftliche Berichte FZKA 6967, 2004

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