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The end of nuclear power?

Time to rethink international energy policy

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- The nuclear accidents in Japan constitute a turning point for international energy policy. While initial indications of a shift in thinking can be seen in some cases such as Germany, Switzerland or even China, other countries, such as Russia or France, are unswervingly continuing along the planned path of an expansion of nuclear energy.

- In actual practice, it seems that an expansion of nuclear energy, widely discussed for several years now, is failing to materialise as a result of economic and environmental misgivings as well as various security and safety risks.

- The accidents in Fukushima have once again demonstrated the urgent need for a global phase-out of nuclear energy. To promote a change in the direction of sustainable energy, investment in renewable energy and energy efficiency is needed instead of in traditional energy sources.

Dialogue on Globalization

Even if it is not yet possible to ascertain the scale of the nuclear disaster, the events in Japan will also be a turning point for international energy policy. The massive accidents in Fukushima have emphatically underscored that the dangers of nuclear energy cannot be controlled by human beings despite all the technological progress which has been made and all the safety precautions instituted. The cataclysmic reports on the nuclear accidents in Japan and concern over their possible impact have added new fuel to the debate over the lifetime and phase-out of German nuclear power plants as well as the international debate over nuclear energy. While there are initial indications of a rethinking in some countries such as Germany, Switzerland or even China, the Russian and French governments, for example, have announced that they intend to carry on with an expansion of nuclear power as planned. Over the medium term, this raises the question as to what extent the events in Japan will have an impact on civil use of nuclear power around the world.

A global renaissance for nuclear power?

An approaching global renaissance for nuclear power has been a subject of discussion for several years now. After being touted as *the* hope for a safe and cheap supply of energy in the 1950s and 60s, disillusionment set in over the following decades. Unforeseen increases in the cost of constructing and operating new plants, which had to be cushioned by political subsidies and tax exemptions, contributed to this as did the reactor meltdown in Chernobyl and growing public opposition. One of the reasons underlying the present renaissance of atomic energy was a report by the International Energy Agency (IEA) in 2004 predicting that atomic energy, which has a low output of CO_2, would assume a new leading role against the background of the discussion over global climate protection. On top of this, other countries in addition to Japan such as China, India, Russia and the USA, but also countries in the Middle East, have announced in the last few years that they intend to build dozens of new reactors and increase the share of nuclear energy in their national energy mix.

At present 2560 billion kilowatt hours of electricity are produced by 443 reactors in 29 countries throughout the world, accounting for 14 % of global energy production. In addition, a total of 62 new reactors are being built in

Global primary energy mix 2008

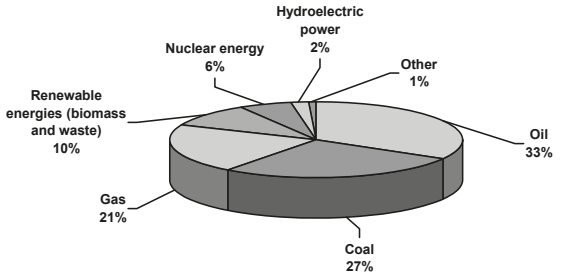

Diagram by the author. Source: International Energy Agency (IEA) 2010. Key World Energy Statistics.

14 countries right now: 27 of them in China alone, ten in Russia, five each in Korea and India, two each in Japan, Canada and Slovakia and one each in Argentina, Brazil, Iran, Finland, France, Pakistan and the USA. An additional 158 reactors are in the planning stage worldwide (World Nuclear Association, March 2011). In despite of what at first glance would appear to be the massive expansion of nuclear energy, it has only played a very minor role in world energy production to date: according to the International Energy Agency (IEA), nuclear power only accounted for 6 % of primary energy production in 2008. Moreover, the construction of power plants has dragged on for decades in many countries as a result of massive delays in planning and construction, such as in the case of the Brazilian reactor Angra III. With the exception of Finland, contracts for new plants have above all been awarded in Asian countries in the last few years. Here, though, nuclear energy only accounts for a negligible part of the power supply: 2.2 % in India in 2009, and merely 1.9 % in China. The only Asian exceptions are Japan with 28.9 % and South Korea with 34.8 %. Nor do forecasts suggest any imminent renaissance of global nuclear energy: the IEA is only forecasting a global increase to 8 % of the primary energy supply by 2035.

Even if the facts do not indicate any large-scale, rapid expansion in global use of nuclear energy in the coming years, it is nevertheless clear that many countries and in particular the rapidly growing newly industrialising countries are looking for ways to meet skyrocketing demand for energy. In times when resources are becoming ever scarcer, with volatile oil and gas prices and a need for energy security, the expansion of atomic energy appears to many countries to offer what would seem to be an attractive possibility with which to diversify the national

Expansion of global nuclear energy – March 2011

Country (selected)	Power produced with nuclear energy		Reactors in operation	Reactors under construction	Reactors under planning	Reactors proposed
	In billions of kWh	As a % of power production				
China	65.7	1.9	13	27	50	110
Germany	127.7	26.1	17	0	0	0
Finland	22.6	32.9	4	1	0	2
France	391.7	75.2	58	1	1	1
India	14.8	2.2	20	5	18	40
Japan	263.1	28.9	55	2	12	1
Jordan	0	0	0	0	1	0
Pakistan	2.6	2.7	2	1	2	2
Russia	152.8	17.8	32	10	14	30
South Korea	141.1	34.8	21	5	6	0
Turkey	0	0	0	0	4	4
USA	789.7	20.2	104	1	9	23
Worldwide	**2560**	**14**	**443**	**62**	**158**	**324**

Table by the author. Source: World Nuclear Association 2011: World Nuclear Power Reactors & Uranium Requirements. World Nuclear Association, 2 March 2011.

energy mix and reduce dependency on energy imports. The lower CO_2 balance for nuclear power and its supposed contribution to international climate protection efforts are also frequently cited in this connection. The relatively low percentage accounted for by nuclear energy in de facto terms is not least due to economic and environmental misgivings as well as safety and security risks – arguments against the peaceful, non-military use of nuclear energy.

Nuclear energy – an environmental and economic dead-end instead of contribution to climate protection

The fact that peaceful use of nuclear energy poses security and safety risks is not a new realisation. Many nuclear accidents such as the super meltdown in Chernobyl almost exactly 25 years ago or smaller incidents over the last few decades have illustrated that there can be no safe reactors in spite of all the technological progress which has been made and regardless of how strict safety precautions are. Accidents are possible in any reactor, regardless of the type, the consequences of which will be with us several thousand years. What is more: no country in the world has been able to come up with an acceptable method of permanent storage for nuclear waste in a form accepted by society. Only Finland is planning a permanent storage site which has gone through the first permit stage without encountering any major opposition – in other countries planning procedures for nuclear storage have become bogged down in the face of disputes over safety and political conflicts. According to the International Atomic Energy Agency (IAEA), more than 2.8 million cubic metres of radioactive waste are produced each year in the world – a problem which will be exacerbated by the expansion of nuclear energy in many countries. As a result of the long half-lives of many radioactive substances, secure storage will have to be assured for several tens of thousands of years.

It is also disputed whether nuclear energy really constitutes a climate-friendly alternative to renewable energies: while it is indeed true that a nuclear power plant does not produce any CO_2 in operation, if one takes into account the entire cycle of construction and operation all the way to decommissioning and in particular includes the mining of uranium and manufacture of fuel rods in the equation, greenhouse gases certainly are produced, as fossil energy fuels are used for many of these processes (Öko-Institut 2009). On top of this, the potential for reduction of CO_2 emissions in this sector is not particularly high because of the low percentage of nuclear energy in global primary energy production. It will moreover

scarcely be possible to build enough reactors in the near future in order to reduce the global emissions balance. According to the Massachusetts Institute of Technology (MIT), expansion of the current 443 to at least 1000 new reactors in the world would be necessary to even only have a marginal effect on global warming (Greenpeace 2007). To reach the target accepted by the international community of states at the World Climate Summit in Cancun of keeping global warming to below 2°, global greenhouse emissions would have to decline by at least 50 % by 2050. Because the average time required to put a reactor into operation from the planning to commissioning takes approximately 10 years, nuclear energy cannot provide any speedier contribution to a reduction of emissions.

An expensive departure from the path towards a sustainable energy supply

It is frequently argued that there are no alternatives to fossil fuels and nuclear energy because renewable energies are too expensive and only economical if subsidised. It must be pointed out, however, that nuclear energy itself even without any accidents is the most expensive way of producing electricity, as it is only economically viable in many countries through various forms of open or hidden subsidisation. In addition to government start-up financing for major nuclear projects, direct subsidisation to preserve safety standards and tax exemptions, nuclear power is also promoted in a hidden manner by not passing on the enormous costs which accrue i. e. through the temporary and final storage of radioactive waste to consumers in the form of energy prices. These costs, rather, are borne by society as a whole and will be in the future as well. The companies operating nuclear power plants, for example, profit from the fact that they do not have to to take out liability insurance commensurate with the risk involved. In the event of a nuclear accident, operators only have to pay a fraction of the damage. The majority of the costs have to be assumed by the state – and thus taxpayers. Tax advantages emanate from the fact that uranium is not taxed and the German nuclear power companies have non-taxed provisions amounting to €35 billion which is supposed to be used in the future for the disposal of radioactive waste or the decommissioning of plants. In sum total, one kWh of capacity at nuclear power plants requires approximately three times as much investment as gas and steam-powered power plants – even setting aside the costs of permanent storage and other subsequent costs (Umweltinstitut München 2011). According to a study by Forum Ökologisch-Soziale Marktwirtschaft, subsidies for electrical power from nuclear power plants in Germany over the period 1950-2010 amounted to €304 billion. If one takes this into account, nuclear energy is the most expensive form of electrical power production (Greenpeace 2010). Macroeconomic costs or costs to public health systems caused by nuclear accidents such as the one taking place in Japan right now are also imposed on the general public. Moreover, the example of the nuclear reactor Olkiluoto 3 in Finland shows that the construction of new plants frequently takes longer and is more expensive in actual practice than projected: the Finnish reactor was originally slated to cost €3 billion – the price-tag at present is €6 billion and it is still not ready to operate. Last but not least, in analysing nuclear energy from the perspective of how economical it is, one must note that the nuclear sector does not offer any long-term development opportunities or job potential: in Germany, for example, 35,000 people work in the nuclear energy sector, while this figure in the renewable energy sector has already reached 340,000 persons.

An additional problem with nuclear power as an energy source over the long term is the finiteness of uranium resources. Regardless of whether one believes the estimates of the International Atomic Energy Agency, analyses by various nuclear power companies or the forecasts of Greenpeace, which are based on different estimates of global resources and projections of future consumption, all the forecasts on the estimated availability of proven uranium resources vary between 20 and barely 200 years (see, for example, Areva 2009). Proven uranium sources are also distributed very unevenly throughout the world: a majority of the deposits of this resource are found in Australia (31 %), Kazakhstan (12 %), Canada and Russia (with 9 % each). China and India, on the other hand, which are planning to expand nuclear energy on a large scale, have a relatively low share of available uranium resources (China has approximately 3 % and India 2 %), which is why the future development of nuclear energy will inevitably also go hand in hand with the need to import uranium. The price of uranium, which has already doubled since 2004, will moreover probably continue to rise with growing demand (Umweltinstitut München 2011).

Proven and exploitable global uranium resources – 2009

	Uranium in tonnes	Global share in %
Australia	1,673,000	31 %
Kazakhstan	651,000	12 %
Canada	485,000	9 %
Russia	480,000	9 %
South Africa	295,000	5 %
Namibia	284,000	5 %
Brazil	279,000	5 %
Niger	272,000	5 %
USA	207,000	4 %
China	171,000	3 %
Jordan	112,000	2 %
Uzbekistan	111,000	2 %
Ukraine	105,000	2 %
India	80,000	2 %
Mongolia	49,000	1 %
Other	150,000	3 %
Total	**5,404,000**	

Source: World Nuclear Association 2009.

Advocates of nuclear energy frequently confront this constraint with an unshakable belief in progress, expressed either in the hope that new uranium resources will be discovered or new technologies developed. These include the new, so-called „Generation IV" reactors, which are supposed to be cheaper, safer and easier to secure against proliferation. But so far these only exist on paper and as a result of various technical difficulties are far from being realised. What is worse: many countries which are in the process of expanding nuclear energy lack the capital and technical know-how required to build and operate safe, secure reactors. In many cases the new members of the nuclear club do not have suitable sites or adequately trained technicians to guarantee the safe and secure operation of nuclear power plants. One prime example here is Jordan: in order to reduce its dependency on energy imports, which eat up a large share of its Gross National Product, the country is banking on an expansion of nuclear energy. Due to lack of alternatives, the reactor which is being planned at present can only be built in an area where there is a great risk of earthquakes.

Military versus civil use – a smooth transition?

It is scarcely possible to discuss non-military use of nuclear energy without broaching the topic of nuclear weapons. In particular with a view to the new members of the nuclear club in the Mediterranean area, there is scepticism as to whether nuclear energy would really only be used for civil purposes or whether these countries want to have a military option as a result of the threat posed by the Iranian nuclear program. The possibility of a multilateral framework for peaceful use of nuclear energy under the auspices of the International Atomic Energy Agency (IAEA), such as an enrichment facility run by the IAEA, with the aim of countering the danger of nuclear proliferation have been under discussion for a long time. This would allow all new countries with nuclear capabilities to acquire fuel at fair conditions subject to international controls. The fact that none of the proposals has been implemented to date is largely due to the fact that no international agreement could be reached: countries which are in the process of expanding nuclear energy distrust the ‚old' nuclear powers and fear that multilateral arrangements would in reality keep technologies away from them. They would furthermore become so dependent that they could not set up any independent fuel production in their own country. Nor has the question of access been resolved – for example, who is to have access under what conditions and what criteria are to apply.

What alternatives are there?

In spite of the obstacles discussed above, many countries are pursuing the planned expansion of nuclear energy undeterred, at the same time missing the chance to move in the direction of a sustainable energy supply. One popular counter-argument is that phasing out nuclear energy in one country would only lead to nuclear energy being purchased from other countries. By the same token, it is feared that the nuclear sector in other countries would receive an economic boost. A global phase-out scenario would of course be the ideal case – individual countries would have to lead the way by setting a good example, however, showing that the phase-out of nuclear energy and the promotion of a sustainable energy supply can help develop the economy and serve as an engine of job-creation. Moreover, climate protection cannot be attained by the expansion of nuclear power,

but rather only through the rapid reduction of use of fossil energy sources and an increase in energy efficiency and promotion of sustainable energies. The latter produce comparatively lower CO_2 emissions and moreover do not pose the same environmental and safety risks involved with use of nuclear energy. On the contrary, the further spread of nuclear power means an expensive departure from investment in renewable energies, energy efficiency and decentralised energy systems.

Germany and the EU should be role models leading the way to a globally sustainable structure in energy policy and show that improvements in energy efficiency and an expansion of renewable energies coupled with economic growth and a reduction in national CO_2 emissions are possible. An important step in this direction, as it were, was the introduction of the German Renewable Energies Act (*Erneuerbare-Energien-Gesetz* – EEG), which in addition to economic gains such as the creation of more than 300,000 new jobs has led to a leap in the share of renewable energies from 0 to 16 % in barely ten years. With few exceptions, no substantial expansion of nuclear energy is taking place anywhere in Europe: one reactor each is being built in Finland and in France at present, 17 additional ones are being planned (two in Bulgaria, one in France, one in Great Britain, six in Poland, two in Romania and two in the Czech Republic). On the whole, however, the share of nuclear power plays a major role in the electrical power supply in many countries. This especially applies to France, with 75.2 %, and Belgium with 51.7 % and for some Eastern European countries. The fact that there are other alternatives are shown by studies such as, for example, the impressive Roadmap 2050, published by the European Climate Foundation in 2010. This comprehensive scenario study traces out practical paths with which to establish a low-emissions economy in Europe on the basis of renewable energies and at the same time attain the European objectives of energy security, climate protection and economic growth. The study comes to the conclusion that the EU could reduce its emissions by switching to 80 % renewable energy by 2050 without causing electrical power costs to rise in comparison to the current energy mix.[1] In addition to national initiatives, Germany should work for progress at the European level in the area of renewable energies and energy efficiency. Europe is in a position to become a non-nuclear zone in the long term and thus carry out the switchover to sustainable energy associated with this and serve as a role model for a safer world. By the same token, this would offer an opportunity to establish a *green economy* within Europe and assume a leading position in the world in the area of green technologies and innovation.

At the international level the disaster in Fukushima has once again shown that a global phase-out of atomic energy is urgently necessary. In order to promote a switchover to sustainable energy, it is necessary to invest in renewable energy sources and energy efficiency instead of traditional energies. Nuclear power is not a viable alternative for the future – the world needs an energy supply which is not harmful to human beings and the environment and which will still be viable in several hundred years.

1. Researchers led by Jiang Kejun at the *Energy Research Institute* of the *National Development and Reform Commission* have also devised a Roadmap 2050 for China. They have concluded that it would be possible for China to transform itself into a low-carbon society without sacrificing development.

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