Replacement of the North Corean nuclear plans by renewable energies

In order to protect the international community against North Corean nuclear weapons, it is essential to bring the North Corean nuclar programm to an end. Of cource, North Corea needs more energy to develop. But as already seen in the past, nuclear power is unable to solve North Corea's energy problems. All the extensive plans in order to expand the nuclear power could not be fulfilled, many funds have already been used improperly – also funds coming from South Corea. Nuclear power is too expensive, it has massive problems concerning security and disposal – and is often misused for the production of nuclear weapons. In the end, there is not even enough uranium in the world to realise the plans of many coutries for nuclear expansion.

It is good that the international community claims the shut-down of the nuclear facilities in North Corea. On the other hand, the wishes of North Corea for the delivery of other energy sources instead are understandable.
Now North Corea has been assured one million tons of heavy oil and an amount of electricity which is unknown to me. In principle, these shall be a compensation for the two reactors in Kumbo that are unfinished and not to built further. Thus an electric power of 2 giga-watt has to be replaced if the facilities in Nyonbyon are not regarded as they produce much energy, but would have to be shut down, too.

Renewable energies instead of heavy oil
My proposal is to deliver the energy not as heavy oil, that is harmful to the climate, but a mix of renewable energies. The advantages of investment for renewable energies instead of deliveries of heavy oil are self-evident:
- North Corea abadons its nuclear facilities but still gets energy.
- The problem is avoided that expensive and rare heavy oil would be delivered. Today, heavy oil is already quite rare and its price increases continuously.
- North Corea gets the start for an energy supply which is independant and compatible with the climate. Once installed, the facilities provide energy for decades without the need for combustibles – except for the bionergies.
- North Corea can establish new jobs and thus ease poverty.
- The installation of the necessary infrastructure for renewable energies causes one-time, manageable costs instead of continuous payments for heavy oil delieveries for decades.
- The factories for the renewable energies can be built in South Corea. So South Corea can use them also for itself and the export to other countries in order to establish an own, reliable energy supply, climate protection and jobs.
- The buildup for a supply with renewable energies is a huge contribution for climate protection, whereas the combustion of heavy oil is extremely harmful to the climate.
- Typical environmental problems like e.g. the emission of pollutants are largely avoided, so that immediate financial advantages can be achieved as costs for the mending of environmental damage are prevented.

Program for renewable energies in North Corea
How much energy and respectively how many facilities for renewable energies are needed?

Unfortunately, the information that reaches us in Germany is very sparse. The result of the negotiation is also unknown to me in all details, so that my calculations are based on assumptions that are not absolutely secure.

The two nuclear reactors that provide two gigawatt of electrical power can produce about 14TWh per year if they run properly. One million tons of heavy oil approximate 1,1 TWh of energy. The question is now how many facilities of reneweable energies are needed to substitue the two nuclear reactors.

A mix of renewable energies would be the best option as it is suitable to guarantee security of supply, especially concerning the natural fluctuations given by wind and solar radiation. A further advantage of renewable energies is that they produce energy locally so that big and expensive distribution networks are not necessary. On the contrary, some villages and cities can be developed as isolated applications avoiding the connection to an expensive central electricity network.

Wind energy plants, biogas plants and engines running on vegetable oil are already highly developed. They shall provide most of the electricity. Biogas and geothermal energy systems can use the waste heat caused by the power generation for domestic heating at the same time. Substitution of oil can happen with solar collectors and bio fuels as well.

Concerning the particular technologies:
The number and dimension of the facilities are only proposals and can be altered in any order.

Wind energy plants:
Wind energy plants producing 500kW – 5MW are highly developed.
Proposal: 1000 wind energy plants with each having 2.5MW sum up to 2.5 GW of power.
With 2500 full load hours per year they provide: 6.25TWh

On kW of wind power costs about 1000 EURO. These costs apply for industrial nations with high labour costs for the production of wind energy plants. So the costs for 2.5 GW wind power will be approximately 2.5 billion EURO.
Built up in North Corea and perhaps produced in South Corea, the costs could be much lower because of the lower labour costs.

Good locations at the coast can achieve better yields of electricity. At the same time, the installation of small wind energy plants in rural areas for a local village supply can be reasonable. Although together they can produce great amounts of energy, they are not considered in this calculation.

Useful for a comparison is the fact that in Germany alone in the year 2006, 2.2GW of wind power has been installed.

Because of its many shore lines, North Corea probably has a better wind supply than Germany, so that a considerably less number of wind energy plants are necessary.
Example: In areas with 4000 full load hours only 250 wind energy plants which each providing 5 MW are enough to produce 5 TWh of electricity.

Water power plants
Proposal: 500 water power plants each providing 1000 kW sum up to 0,5GW
With 6000 full load hours per year they provide: 3 TWh
On kW of wind power costs about 8000 EURO. So the costs for 0.5 GW water power will be approximately 4 billion EURO.

Useful for a comparison is the fact that in Bavaria – which is smaller than North Corea – 2,8 GW of water power are installed, which provide 13TWh per year.

The performance of the water power plants can be considerably less, but in singular cases also higher. The number of plants would be altered accordingly. Especially with small water power plants many water power potentials could be made accessible in North Corea which is montainous without causing ecological problems by building great embankment dams.

Notice that small water power plants are a well established technology for decades that can be installed quickly.

Biogas plants
Proposal: 2000 plants each providing about 250 kW sum up to 0,5GW
With 8000 full load hours per year they provide: 4 TWh

The potential for the production of biogas is much higher than 4 TWh. You can see an estimation in the attached presentation.

Useful for a comparison ist the fact that in Germany 0.35 GW of new biogas plants have been built in the year 2006.

The costs per kW are about 2000 EURO. That means that for 0.5 GW 1 billion EURO is necessary.

Notice that biogas plants provides besides electricity also twice as much heat, that can be fed in radiators or used in the industry in many cases.

Additionally, biogas can be extracted from agricultural waste and the food and animal industry which means an enormous discharge for the environment. The fermented substrate leaving the biogas plants is also an excellent fertilizer so that the delivery of high amounts of expensive mineral fertilizer can be substituted.

Block heat and power plants running on vegetable oil
Proposal: 200 plants each providing 500 kW sum up to 0,1GW
With 8000 full load hours per year they provide: 0,8 TWh

The costs correspond to commen big diesel aggregates.

Heat and power plants running on vegetable oil are a well established technology. Besides electricity they provide about the same amount of heat that can be fed in radiators or used in the industry in many cases.

Geothermal energy systems
The possibilities of geothermy in North Corea are unknwon in this counrty, the geothermical potentials must be investigated first. As Northern Corea is an older massif, there will probably be no near-surface electricity potentials that could quickly be made accessible. So new methods to make deep geothermie accessible (enhanced Geothermal Systems) would be reasonable, like they are established in Germany at the moment. For this reason nothing concrete is proposed here.

Wave and tidal energies
Wave and tidal energies are still being developed, nevertheless some promising plants exist for example in Great Britain, USA, China, Japan. So, if well introduced on the market, a big potential could be made accessible in North Corea as there are wide coast lines.

Photovoltaics
Photovoltaics are still not able to produce great amounts of electricity on a competitive basis as a substitute for nuclear power plants. Nevertheless about 1 GW of photovoltaics should be installed in order to build up the necessary know-how. In about 15 years photovoltaics can expectedly be installed on a competitive basis.

1 GW of photovoltaics with 1000 full load ours per year provide: 1 TWh

1 kW for large scale plants need about 4000 Euro of investment costs. This would sum up to 4 billion EURO. This figure is not included in the proposal, is only serves as an example calculation of photovoltaics.

Sum of provided electricity
With this programm, more than 14 TWh of electricity are provided. So the power supply of about 14 TWh of the two planned nuclear reactors can be substituted completely.

Comparison of costs:
For the substitution of the nuclear power plants:
The costs of this proposal are approximately about 7.7 billion EURO. This estimation has been calculated as an upper limit. With a detailed analysis, the costs can probably be further reduced because of the lower labour costs in North Corea. Additionally, the installation of the corresponding factories in South or North Corea would lead to a more efficient production. Up to now, the experience taught us that the more facilities are produced, the costs sink noticeably.
Both effects could lead to a considerable reduction of costs, so that possibly only 5 billion EURO would be necessary.
But exactly, this can only be calculated by experts of the particular sectors on site.

The aimed costs for the nuclear reactors should be about 5 billion EURO. However, according to experience, the costs during the installation of nuclear reactor always turn out to be higher than planned before. Additionally, costs for the necessary infrastructure like the disposal of nuclear waste or the production of fuel elements are mostly not contained in the calculations.

A direct comparison of the investment costs for nuclear energy with renewable energies is not valid anyway.
With the exception of biogas and vegetable oil plants, renewable energies do not cause any costs for combustibles. The costs for biogas can be kept extremely low because biogenous waste is often available for free.

This presented program for renewable energies stands out by the fact that almost no costs for combustibles and only low costs for maintenance are needed. On the one hand, wind, water and biogenous residues will be available for decades.

On the other hand, nuclear power causes considerable working costs, especially for the supply with fuel elements and for the disposal. The reserves of uranium in the world are limited. The prices for uranium that rose considerably in the last years are an unmistakeable evidence for

that. So the necessary costs to run a nuclear power plant for the next decades cannot be estimated reliably.

Thus the total costs for the investment and running of renewable energies are considerably lower than the nuclear power solution.

Comparison of costs for the substitution of 1million tons of heavy oil:
If only the amount of the promised 1 million tons of heavy oil and not the energy production of the nuclear power plants was substituted, only 8% of the estimated costs would be necessary as only 1.1 TWh and not 14 TWh would have to be substituted.

With a simple linear calculation, this would mean about 400 million EURO of investment costs for reneweable energies. The fact that then 1,1 TWh of renewable energy will be provided for decades instead of the one-time delivery of heavy oil must also be regarded. So the 400 million EURO for investments would be much lower than the 350 million dollar for the delivery of heavy oil.

This would happen without any burden for the environment, whereas the burning of heavy oil is a high burden for the climate.

The world bank could finance the renewable energies programm for North Corea.

Heat and fuels made of renewable energies
Additionally to the power generation, a program for the generation of North Corea's own fuels and solar heat should be designed.

Solar panels for the generation of heat
They can be installed shortly after the build of appropriate factories. South China can be an example, where now most of the solar panels are installed throughout the world. They substitute great amounts of heavy fuels and are thus able to substitute the heavy fuel deliveries.

Generation of vegetable oil
The generation of natural vegetable oil delivers fuels for vegetable oil plants on the one hand; they can also substitue diesel fuels for the traffic. Especially in agriculture they are convenient for tractors, but also for lorries and other diesel vehicles.
As North Corea probably has a vehicle fleet with older diesel engines, only a marginal conversion to vegetable oil would be necessary. Most diesel engines of the former decades are a priori suitable for vegetable oil.
The use of pure natural vegetable oil also has the advantage that farmers can produce their own fuels without the need for complicated technologies like refinement. In principle, local oil squeezers and filtration devices are sufficient. They are a well established technology and easy to install. Oilplants, best the ones that grow traditionally on the ground, can substitute great amounts of heavy oil.
A vegetable oil programm for North Corea makes more sense than one-time deliveries of heavy oil. The vegetable oil can be harvested every year, whereas a delivery of heavy oil is burned quickly without substitution.

Steps to realisation

If South Corea is serioulsy interested in a renewable energies program for the substitution of North Corea's nuclear reactors, an appropriate proposal has to be brought into the negotiations with North Corea.
However, the elaboration of a precise proposal needs further concretion.
It would make sense to assemble a delegation of experts of the particular branches, and to work out the necessary details locally in South Corea with these experts.
If desired, I would be ready to prepare such a delegation and, if necessary, to lead it. It would be helpful if the most important details were send to Germany, so that the delegation could become aquainted with them.
I think that it is possible to work out a concrete program with the Corean experts within two days.

At the same time, a similar program for South Corea could be worked out.

I would be glad if a realisation would be possible. It would help to solve many problems at the same time as it would: terminate the nuclear plans of North Corea, secure the energy supply for North Corea, protect the climate, reduce poverty and do local environment protection.

Berlin, February 22nd, 2007
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