Chances of a transnational electricity supply with renewable Energies for South America

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1. Could you explain your proposal of an international power grid for electricity supply?

I have studied in detail the possibilities of a totally renewable electricity supply for Europe and its neighbourhood on the basis of different scenarios, whereby the scenario area actually covers about 1.1 billion inhabitants and an electricity consumption of about 4000 TWh/a. The focus was the question of how the electricity supply should be developed to lead to the most economic solution. This question was considered, for example, for scenarios based only on techniques available today.

Also examined was the possible influence which the use of some new technologies – in so far as they are still under development – could have on the future options of the electricity supply, on the basis of some examples. The conception of the future electricity supply was aimed to meet criteria of the greatest possible objectivity, to provide genuine comparability of different resulting scenarios.

To achieve this aim a mathematical optimization approach was implemented. The target of the optimization was to find the ideal system of power plants and transmission systems to provide the least cost solution for the electricity supply. As options for the electricity production the use of renewable energies with hydro-electric power plants, wind energy converters, Energy Towers, biomass power stations as well as solar and geothermal power stations are considered amongst others. Dependent on the selected conditions, this resulted in different scenarios establishing a broad basis for future political decisions. The scenarios present options for a future organization of the electricity supply and point out the impact of different - also political conditions.

The starting point is a conservative base case scenario. It is a scenario for an electricity supply relying entirely on renewable energies, all of which are based on technologies available today and calculated with today's costs of all components. This base case scenario can accordingly be understood as a kind of conservative Worst Case estimation for our future options of a renewable electricity supply.

As a result of the optimization for the base case scenario, the largest proportion of the electricity production is from wind energy. Biomass and currently existing hydropower take over the predominant part of the back-up function within the supply area which is interlinked with powerful HVDC (High Voltage Direct Current) transmission. The calculated costs of electricity production and HVDC transmission together are about 4.65 €ct/kWh and therefore relatively close to the current costs of electricity produced with conventional technologies.

They are actually lower than today's prices on the electricity stock exchange in Germany (The monthly average price for the cheap base load Cal-08 in 2007 always was roughly between

5.2 and 5.6 €ct/kWh. At gas prices in 2006 of about 3.5 €ct/kWh for industrial consumers in Germany, electricity from newly erected combined-cycle gas power stations had already reached a significantly higher level of 7 - 8 €ct/kWh$_{el}$.

In the resulting optimal configuration for this scenario, nearly 70% of the power originates from wind energy produced from wind turbines with a rated power of 1040 GW. A HVDC transmission system connects the good wind sites with the centres of demand while also powerfully integrating existing hydropower storage facilities, thus providing backup capacities that are enhanced by regional biomass power and given additional support by solar thermal electricity production. About 42% of the electricity produced is interregionally transmitted via the HVDC-System.

The cross-national electricity transport via HVDC is used in order to realize smoothing effects of the weather-dependent electricity production from renewable sources, to make the best production sites accessible for common use and to enable the use of hydropower as well as the decentralized biomass with its inherent storage capability for common duties within the supply area. Thus electricity transport proves to be one of the keys to an economical electricity supply. This can be interpreted as a recommendation for action for political decision-makers, who thus should deliberately pursue international co-operation in the field of renewable energy use and include in particular the issue of international electricity transmission.

The scenarios constitute a detailed and reliable basis for crucial political and technological decisions about our future electricity supply. They show that - even under conservative assumptions - an exclusively renewable electricity supply is possible with international cooperation and could be realized without any significant economic problems. Due to techno-economic learning in the long-term the renewable electricity supply would probably be even cheaper than conventional supply. The much-debated costs of mitigating the climate change could, with the clever use of renewable energy, even turn out to be economic mitigation profits. The promising results place the responsibility for future action in the field of policy. A substantial task of the policy-makers would be to organize the necessary international co-operation and to develop legal and economic instruments for a transformation of our electricity supply.

It is clear that the general result of the scenarios for Europe and its neighbours holds for most areas world-wide which have a size similar to the one in the European/Transeuropean example. In some cases technical problems resulting from the lack of accurate data or unavailable information about the future development of the usability of hydropower lead to higher uncertainties. If these problems were overcome, a much more reliable assessment would be possible. In the light of such an assessment the details would of course have to be adapted to the local conditions but the general positive conclusion of the feasibility of an economically viable renewable electricity supply can be expected to hold anyway. Therefore it is very reasonable to estimate that the general results of the scenarios can be transferred to other world regions even if in some cases e.g. in South America some more detailed information – especially on the local wind conditions - would be welcome to reduce uncertainties.

2. What feedback have you gotten from the European community? Have you found any obstacles? Please explain.

There is not yet an official feedback of the EU. But there is a growing public awareness of the potentials of international renewable energy cooperation. E.g. the WBGU (German Advisory Council on Global Change) proposes as *Lighthouse Project 1 "A European Supergrid" in its Policy Paper 5 "New impetus for climate policy: making the most of Germany's dual presidency". According to the WBGU the Supergrid should be a trans-European high-capacity power grid with a transmission capacity of around 10 GW, which aims to safeguard an affordable supply and is also needed in order to smooth the substantial fluctuations in feed-in, e.g. from wind farms, and to make the output of Norway's large hydro storage power plants available to the rest of Europe. It would also provide links to other grids (e.g. in North Africa) and make a major contribution to European grid stability. The connection to major offshore wind farms and high-capacity marine energy systems in Northern Europe could thus be achieved at affordable cost; the same applies to hookups to on-shore wind farms in regions of Africa with very high wind speeds or to solar thermal plants in regions with intense solar irradiance.*

So the WBGU proposal is in line with the results of my research. Also the German Green Party proposes the international cooperation and many other encouraging sings e.g. from the big European Utilities can be recognised.

3. Environmentally speaking, could you point out the main factors that make it indispensable for South American countries to start applying alternative energies?

In South America we can see a development to an expansion of the use of fossil energies for electricity production. So the dominance of hydropower is shrinking. This trend will badly influence the climate due to the CO2 emissions caused by the use of fossil fuels. If there is a need to explain why we must avoid dramatic climate changes we could look where in the world the changes might be most harmful. There are many very poor countries which are amongst the most badly harmed losers of the anticipated climate change. If we look from a more selfish South American position things are not much better.

I do not know if this is common knowledge but I would like to point out that the Amazon is in highest risk because of the climate change. Even if the world wide CO2 emissions would only increase by 1% per year between 1990 and 2070 the precipitation might decline by more than 50% in most parts of the Amazon Forrest. Also other parts of South America might be faced with the same problem. It might be worth mentioning that the emissions rose by 4.5% in 2004. So 1% already is quite ambiguous. Speaking provocatively this means we have to act now if we do not want to see the Amazon forest as Amazon steppe. Without much doubt there would be many negative consequences of the climate change for South American countries like water shortage, declining hydropower potentials in some areas, big problems for agriculture and many others.

4. What obstacles do you think you will encounter in Latin America for your proposal?

I am not at all an expert for South America. I would like to answer this question from a European point of view. Here the biggest problems are of political nature. In contrast to the growing public awareness of the climate problem and the growing frequency with which the issue is picked up in political speeches, endeavours to counteract the climate change do not always seem to be adequately committed. This may be seen as being reflected in the fact of the steadily shrinking federal budget for energy research e.g. in Germany or by the declining annual rates of emission reduction. It also may be seen as being reflected in the fact that many of the measures which have been set up are not very effective but nevertheless have not been replaced by better ones. However, there are methods, strategies and technologies available which are suitable to counteract the climate change in a manner which is easily affordable by the society. Even better ones may be found - better methods, better technology and better strategies - if enough effort was made to find them. Climate change is often seen as one of the biggest challenges mankind has ever been faced with. But the chances are that it is negligence rather than the practical infeasibility of the problem which will cause us real trouble. It is time to act. Politics but also industry has the responsibility now. This has to be understood everywhere in the World and has to lead to the introduction of consequent measures.

5. In your documents the solar electricity seems to be the most viable alternative energy for Venezuela. Have you conducted any studies to learn in which type of energy each country of South America could contribute?

In fact it is the wind energy which might be the dominant source of electricity assisted by hydropower and biomass as main back-up components. This is the result of the scenario optimisation for Europe and its neighbourhood. The result will be different in other world regions. In South America I would expect that hydropower will be more important than in the European example. The unutilised potentials seem to be quite huge. One of the important qualities of hydropower is the possibility to store energy and to use it when the electricity is needed. This especially holds for the storage hydropower type which therefore is extremely valuable in a system which gets a huge proportion of its electricity from fluctuating production from other renewable sources. A high proportion of electricity from storage hydropower therefore allows concentrating on the use of the best wind sites for production from wind energy. Therefore it is less important to distribute the wind energy in a manner providing smooth production by using sites with very different temporal production patterns even if this necessitates using sites with lower annual production and therefore higher costs. So a system with higher shares from hydropower could lead to lower overall costs of electricity. Therefore I would presume that the conditions are quite good in South America.

To come back to your question: At the present cost for solar electricity the part of solar electricity production is only relatively small. But according to a scenario optimisation in which the costs of the mirror fields of solar thermal power plants were reduced by half below the current costs – as is anticipated in the near future – solar thermal plants would already constitute about 13% of all electricity generation. In this case, the overall electricity costs are significantly reduced below those of the base-case scenario. This example illustrates that solar thermal generation presents an economically attractive perspective for the future that can be realized fairly easily in view of minimal cost regression factors. Also in South America there are some very good areas for solar thermal electricity production. So I would presume that also this kind of electricity production has a good perspective in South America. But

Venezuela is not amongst the states with the best conditions for solar thermal electricity production. According to my data there should be some quite interesting wind Potentials in the northernmost part of Venezuela.

But there are also other kinds of renewable electricity production which might offer very interesting chances in South America. I just would like to mention the “Energy Towers” concept even if it might appear somehow visionary. The principle of the Energy Tower is that hot and dry air streams from above into a large tube (one could also call it a giant chimney), water is injected to cool the air, which thus becomes denser than the air autside of the chimney and therefore falls down and drives some turbines at the bottom of the shaft. But I do not want to go into details of this technology here.

Since the implementation of a electricity system like the one resulting from the optimisation for the base case or similar scenarios will take many years, an attempt has been made to include some promising power generation technologies already on the horizon in somewhat speculative scenarios. One includes the use of Energy Towers. Should the assumptions used for Energy Towers hold true, especially the economic ones, then – according to the optimisation - those power plants would dominate with a generation in the European/Trans-European example to the equivalent of almost halve of the total annual electricity consumption in the scenario area. The overall generation cost is with just below 4.1 €ct/kWh about 12% less than in the base case scenario. This scenario shows that further development of this technology might be worth while. Therefore research into the technology is needed, aiming to reduce the financial risk involved with building such a type of power plant and focussing on everything necessary to build a prototype of this kind of power plant which has not yet been tested. Generally, one can derive from that result that there should be more research grants and more venture capital devoted even to speculative ideas, which might have the potential to deliver energy at low prices and from different renewable sources.

The best conditions for Energy Towers in South America are at the west coast in Chile and Peru.

6. Have you received any response from PDVSA representatives or any other authority qualified to discuss the subject?

No I have not yet received any response.

7. As Venezuela is one of the four most important oil exporters in the world, how do you consider this proposal, even if only applied in Europe, could affect the oil business? Please explain.

There are many different aspects. One is that Oil will run out sooner or later. Therefore it might be reasonable to invest parts of the income from oil into a sustainable energy future.

In Europe coal firing accounts for the biggest part of electricity production from fossil fuels. Gas and oil only are of minor importance. So the change to a renewable electricity system would not essentially affect the oil consumption directly. But the cheap renewable and

therefore largely CO2-neutral electricity could also be used to electrify other consumption sectors. This might effect the oil consumption. E.g. the space heating in Germany accounts for roughly 20% of the German CO2-emissions and is on the one hand mainly driven by oil and gas and on the other hand not so difficult to make it more efficient and to electrify.

I am not an expert for oil and gas neither for the particularities in Venezuela. But I could quite well imagine that the Venezuelan gas could be used to support the transition to the totally renewable electricity supply of South America. It could be used for electricity production supporting the stability of the young growing international electricity grid as back-up. In many oil exploring regions there is natural gas as a by-product of the oil. This gas was often only flared (burned). It would be a better use to utilise it for electricity production. The electricity production from this gas would be somehow CO2-neutral since this gas would be burned anyway. The oil and gas experts of Venezuela may know if this idea makes sense for their country.

8. Could you explain why countries such as Venezuela should consider getting involved in this international electricity supply project?

The results of my work about the European/Trans-European electricity supply suggest that there are affordable ways to an electricity system powered solely by renewable and climate friendly energy sources are possible also in other world-regions if the resources are pooled and shared through a unified electricity grid. This most likely also holds for South America.

Since climate protection is an international issue this possibility should be considered with high emphasis.

The idea of the translational electricity supply has some similarities with the projected South American gas pipeline network. It could be a multinational project with high and long lasting social and economic revenue for the states and the people of South America. South America could be a promising starting point for an international development towards a sustainable electricity supply. The international renewable electricity supply could also be a project of identification strengthening the South American cooperation. Venezuela might play a key role in its development.

Furthermore I am quite convinced that the macroeconomic outcome of the investments involved in the construction of such an international electricity system could be very beneficial for South America as well as for Venezuela in particular.

9. There Have been comments on possible damages that this grid might cause. Could you explain what do you estimate the damage to the Amazon forest could be?

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The fluctuating nature of the production of electricity from certain renewable energies – like wind energy - can be handled by an international cooperation due to smoothing effects gained by production from very different (distant) sites. This renewable electricity supply could significantly contribute to reduce the risk anticipated from the climate change. As mentioned

before, this could contribute to safe the rain forest in South America, which is in danger to disappear. The possible damage from the climate change for the rain forest is much higher as any damage the electricity grid could cause. But nevertheless it should be discussed where to build the connecting electricity grid. May be there are routes which do not necessarily have to cross the Amazon. May be there are routes through the Amazon which are not so harmful, e.g. along the existing road and path network. As it is necessary to use some certain – not direct – paths through the Mediterranean Sea in the European/Trans-European example because of the high costs of sea cables there may be other reasons to go around some regions in South America. According to the results for the European/Trans-European electricity supply this in fact would not overly reduce the worth of the international cooperation.