Research Center
Finance & Information Management

Fraunhofer
FIT

Project Group
Business & Information
Systems Engineering

The Energy Turnaround - A Real-Time Experiment Allowing No Failure or a Major Opportunity for Our Economy?

by

Hans Ulrich Buhl

August 2012

in: Business & Information Systems Engineering, 4, 4, 2012, p.179-182

University of Augsburg, D-86135 Augsburg
Visitors: Universitätsstr. 12, 86159 Augsburg
Phone: +49 821 598-4801 (Fax: -4899)

University of Bayreuth, D-95440 Bayreuth
Visitors: Wittelsbacherring 10, 95444 Bayreuth
Phone: +49 921 55-4710 (Fax: -844710)

www.fim-rc.de

WI-865

The Energy Turnaround

A Real-Time Experiment Allowing No Failure or a Major Opportunity for Our Economy?

DOI 10.1007/s12599-012-0221-9

The Authors

Prof. Dr. Hans Ulrich Buhl (✉)
FIM Research Center Finance & Information Management
University of Augsburg
Universitaetsstrasse 12
86159 Augsburg
Germany
hans-ulrich.buhl@wiwi.uni-augsburg.de

Prof. Dr. Michael Weinhold
Chief Technology Officer (CTO) of Energy Sector
Siemens AG
Wittelsbacher Platz 2
80333 Munich
Germany
michael.g.weinhold@siemens.com

Published online: 2012-05-30

This article is also available in German in print and via http://www.wirtschaftsinformatik.de: Buhl HU, Weinhold M (2012) Die Energiewende. Ein Echtzeitexperiment, das keinen Fehler erlaubt, oder eine große Chance für die Wirtschaft? WIRTSCHAFTSINFORMATIK. doi: 10.1007/s11576-012-0327-1.

When the tsunami hit the Fukushima atomic plant in Japan in March 2011, causing the reactor disaster, it was impossible to predict the consequences for the future of energy supply. Many countries have considerably strengthened their activities since then to realize an energy turnaround, i.e., a switch from nuclear power and fossil fuels to a more sustainable energy supply with increased use of regenerative energy resources such as wind or sun. Whereas only 55 states had political ambitions to expand the use of renewable energies in 2005, this number has increased to about 190 states in 2012. Also a change in attitudes can be observed. Early in 2012, more than 70 % of the French supported a phase-out of nuclear power – even though France was worldwide front-runner in this area with a 75 % nuclear powered energy supply in the end of 2010. Germany takes an uncompromising approach in that it has officially decided to phase out nuclear power completely by 2022, although the economically strong parts in the country's south receive more than 50 % of their electricity from nuclear power plants. This development towards a nuclear phase-out, which can be observed in other countries to a lesser extent, can be considered – in the jargon of BISE – as a 'revolution' more than an 'evolution'. A revolution always comes with risks, but also offers opportunities. In the following we will show that the energy turnaround opens up a wide range of opportunities – if it is addressed responsibly and with a well-conceived plan.

First of all it should be mentioned that this 'revolution' may be a current topic, but in principle is not a new one. Business & Information Systems Engineering (BISE) addressed this issue in a very early stage. For example, in issue 4/2008, the high potential of IS beyond Green IT regarding an energy turnaround was pointed out. Exactly one year later, in BISE 4/2009, the responsibility of our discipline for our planet and the threat of a worldwide resource crisis were discussed. The editorial 1/2012 and the corresponding special focus issue focused on "Smart Grids" and their relevance for the energy turnaround. All in all, we can see that the international community was aware of the energy turnaround's relevance even before the Fukushima reactor disaster. But this is not sufficient. Rather, to ensure the success of the energy turnaround it is essential that single countries do not indulge in blind activism. This is especially important because the aims associated with the energy turnaround, such as an increased use of regenerative energies, will lead to major challenges (e.g., it is Germany's goal to increase the use of regenerative energies from 20 % in 2011 to at least 35 % in 2020). Some of these challenges are briefly mentioned in the following:

- The yield of renewable energies is often difficult to plan and control – e.g., wind and solar energy can only be extracted during suitable weather conditions. This frequently leads to a mismatch between the times of supply and demand.
- These supply risks require energy storage and conventional power plants. Construction projects for energy storage are often in conflict with current regulations concerning environmental protection or are unpopular with the public. Moreover, many concepts regarding the storage of energy are still in research and development phases and thus cannot yet be used commercially. Also, construction projects for conventional power plants are often highly unpopular within the local population.
- Onshore wind parks also have a negative impact on nature and hence are more and more subject to critical valuation by the public.
- The transport of renewable energy requires a massive expansion of the super grid at national as well as international levels. In Germany alone, about 400 kilometers of the current distribution system would have to be enhanced and further 850 kilometers would have to be newly built until 2015. This seems challenging considering that Germany constructed only 90 kilometers from 2006 until 2011. According to the "dena-Netzstudie II", a further 3600 kilometers are supposedly needed by 2020. Also,

the net of interconnectors between different EU countries must be extended on a significant scale.

- Moreover, one must not forget the fact that in some cases the installation of an infrastructure for renewable energies requires considerable amounts of non-energy resources. Scarce resources on the markets like neodymium are for instance used in wind turbines. Prevention is necessary at this point to avoid the energy turnaround becoming an accelerant for an emerging resource crisis in regard to non-energy resources.
- Additionally, the energy turnaround should be designed in a way that avoids threatening the worldwide climate protection goals. For example, as a result of the shutdown of several nuclear plants in Germany in 2011, some energy suppliers compensated the loss of nuclear power by prolonging the lifetime of inefficient coal-fired power plants with high emissions. Some energy suppliers even restarted already shut down plants. This has particularly negative aspects because both the worldwide carbon footprint as well as the concentration of carbon in the atmosphere already reached new peaks in 2010.

These challenges can only be successfully faced with an internationally coordinated and flexible master plan. Thus it must urgently be determined where new power plants are required in order to guarantee the base load at all times and prevent power bottlenecks. Furthermore, the expansion of the infrastructure has to be planned. This plan must look beyond national boarders in order to reduce the problem of the many existing particular interests. Moreover, this master plan should not be static but should include verifiable milestones instead to react flexibly on, e.g., new technologies or price trends.

If such a master plan does not exist (as is the case now), what are the consequences? For example, regenerative energies are occasionally installed in locations with weak return. In 2010, the installed capacity of solar plants in North-Rhine Westphalia (the region in Germany with the lowest sunshine duration in the long-term average) was 1,941 megawatts. However, the installation of renewable energies at locations with strong returns is not possible without grid extension, since in many cases the energy production is far away from load centers. Currently, even the transport of wind power generated in Northern Germany to consumption centers in, e.g., the south of the country fails due to missing power grids. Further obstacles toward a successful energy turnaround are uncertain political conditions, making sustainable planning impossible for both industry and private households. As a result, investments necessary for a successful energy turnaround – such as new power plants, energy-efficient production facilities and processes as well as refitting private households to the use of smart grids – are often held back by investors rather than pushed. For these reasons, it is even more important for politicians to send out a clear message and thus generate planning certainty and willingness to invest.

In lack of a master plan, a nation like Germany is carrying out a real-time experiment on itself without need. This has already caused amazement abroad (International Atomic Agency). The problem is that this experiment is not carried out in a laboratory, but is already real-time. That means that we cannot allow for mistakes, since the consequences might be devastating. For example, if we do not succeed in keeping up an absolute minimum supply, black-outs with enormous impacts might occur (the biggest black-out in U.S. history caused an economic damage of over 6 billion US-Dollar). Moreover, increasing energy costs have already led to the emigration of companies. A prominent example is BMW, which outsourced their (energy intensive) production of carbon fibers for electric cars from Germany to the U.S. As a result, national economies suffer the loss of jobs, know-how and tax income.

However, instead of giving up in the face of these challenges and the corresponding risks, we should concentrate on the tremendous opportunities which come along with the energy turnaround. For the *worldwide* carbon footprint, it is not necessarily important what happens in a single country, but the signal given to the world may be serious. Opportunities thus arising must be taken!

Let us remain with the example of Germany: If the energy turnaround there proves successful and affordable at the same time, then Germany can serve as a role model for a successful energy turnaround. This will most likely lead to an explosion of innovation followed by a boost of growth for the economy. This hypothesis is supported by the mere fact that the German economy was always characterized by its high adaptability. For example, the high oil price did not have a negative impact on the economy of the 'automotive country' Germany in the long run, but rather evoked the automotive sector's creativity and paved the way for further developments of efficient mobility. In analogy, we have to consider the high innovative potential of the energy turnaround as major opportunity for the economy. A large number of innovations already exist that are widely discussed. For example, efficient energy management technologies like smart meters, modern solar and propulsion technologies, machines or materials leading to a high degree of energy efficiency. Generally, an efficiency increase of the whole system, including energy production, transport, distribution, and consumption, is a key element when aiming at a more sustainable energy system. The main objective is not necessarily an efficiency increase to the maximum possible extent of technical feasibility, but to the economically most profitable extent. In regard to this, there is still much space for innovation.

Furthermore, a tremendous potential for innovation is provided by one of the energy turnaround's most important levers, the simultaneous optimization of the connection of electricity, heat and gas. By feeding wind generated power into the heating supply, the heating demands of large parts of buildings (overall more than 30 % of the primary energy consumption) could be met. Further, in doing so, carbon emissions could be decreased. Specific heat storage systems, such as hot tanks in households, could supplement the electricity system, because production fluctuations could be buffered with the help of thermal storage systems. Vice versa, efficient electrical heaters within thermally insulated buildings offer a high potential for the further interlocking of electricity and heat (e.g., heat pumps). In modern low-energy houses, heat pumps are widely utilized and the integration of long-distance heating systems into the electrical system is currently discussed and examined quite intensely.

But that is not all. The shining example of the energy turnaround's innovative power is the highly efficient hydrogen electrolysis with the help of the PEM technology, which has recently been developed and tested by Siemens. The idea of this technology, which is supposed to be ready for the market by 2015, is quite simple: Surplus energy generated from renewable energies is used to produce hydrogen. This can be directly consumed by the chemical industry, where hydrogen networks are already available. Hydrogen can also be used for mobility purposes and may promote a breakthrough of the fuel cell. Moreover, hydrogen can be directly fed into the natural gas network as a supplement. If necessary, this hydrogen can be used to produce synthetic natural gas by means of a further chemical process. In the German gas grid, more than 200 terawatt hours of energy can be saved, which equals three times the German wind and solar power production in 2011. The positive effects are obvious: On the one hand, the above mentioned mismatch problem of production and demand of renewable energy can be solved. For example, wind power generated during the night, when energy demand levels are low, can be saved and utilized later. On the other hand, it is obvious that companies which develop such a technology will also profit from economic gains: Siemens invests one billion Euros annually in the development of new technologies for the energy sector and expects major growth in this sector. Since energy suppliers will be able to reduce supply-induced price fluctuations (e.g., major price falls due to overcapacities), it is obvious that such technology will be met with enthusiastic international response.

Moreover, the development of a "ready to use" solution for the construction of a European carrier network offers high economic potentials. The necessary technology – the so called high-tension DC power transmission – already exists and has been used, e.g., in China, in the extraordinary high and consequently low-loss voltage ranges of 800,000 volts since 2009. A European-wide use of this technology, e.g., in a voltage range of 500 kilovolt, would also induce economic growth in the technology sector, since the global market of power transmission will be between five and nine billion Euros annually for the next five years. According to the estimates of Siemens, the market potential of high-tension DC power transmission is expected to double from three billion Euros per year in the same span of time as the demand is expected to rise enormously.

Even the cut of the subsidies of solar energy in 2012 in Germany may induce positive effects to the economy: Since it is now economically profitable to increase the private consumption of self-produced solar power, it will become important to match production and consumption of solar power.

What can BISE contribute to the use of this enormous potential? First, the large number of decentralized power generators must be coordinated in a functional manner. For this purpose, distribution systems need to be intelligent (smart grid). This intelligence could, e.g., be generated by means of agency systems, which would also be able to manage the consumption in the distribution system in order to buffer production peaks and slacks. In general, it will become more and more important to react to supply and demand in real-time. Regarding this challenge, BISE plays a leading role. Energy suppliers acknowledge this and are aware of the fact that their sector is in need of IS. For example, learning business analytics software can be used for energy traders to evaluate the outcome of auctions and thereby consider external factors such as weather forecasts or maintenance intervals of power plants. For example, the German energy company Vattenfall reported that it can thus win five to ten percent more contracts in energy auctions than in conventional energy auctions without the help of IS.

In addition to this, the international community can contribute to the success of the energy turnaround as well. First, research related to the sustainable use of scarce (energy or non-energy) resources still hardly appears in our universities' curricula. It is up to us to provide the necessary competence for the leaders of tomorrow. Second, regular sustainability sections could be established in journals.

In conclusion, the energy turnaround brings many challenges which require a master plan. This master plan must be cross-border and flexible. The development of such a master plan is above all the responsibility of the politicians. However, energy suppliers, network operators, technology and construction companies, cable manufacturers and last not least the IS industry must make their contribution. At this point it is important to strengthen the involvement of politics and science. It is BISE's responsibility to contribute with coordination and integration.

Beyond the master plan, it is the people who have to contribute to the success of the energy turnaround. We all must be aware of the fact that a successful energy turnaround requires the contribution of every single one of us, but this can only be accomplished with a plan and not overnight. Nationally or even regionally isolated solutions are not sufficient, we need international cooperation. If this awareness grows and is realized with a high level of commitment, this real-time experiment can become a great success!