GERMANY'S GOODBYE TO COAL POWER TECHNOLOGY

Stefan Vögele, Institute of Energy and Climate Research - Systems Analysis and Technology Evaluation, Forschungszentrum Jülich, D-52425 Jülich, Germany, +49 2461/613393, s.voegele@fz-juelich.de
Paul Kunz, Institute of Energy and Climate Research - Systems Analysis and Technology Evaluation, Forschungszentrum Jülich, D-52425 Jülich, Germany, +49 2461/613393, paul.kunz@gmx.de
Dirk Rübbelke, TU Bergakademie Freiberg, Schloßplatz 1, D-09596 Freiberg, Germany, +49 3731/392749, Dirk.Ruebbelke@vwl.tu-freiberg.de

Overview

Studies on diffusion processes mostly focus on the market penetration of new technologies and less on phasing-out processes from the perspective of the "outdated" technology. Using the example of the coal power plants in Germany we want to take a closer look on phasing-out processes taking not only economic but also social, political and technical aspects into account. Coal power plants are used as an example because their phasing-out is considered as a main part of the transformation process towards a sustainable society. The case study is meant to lead to a better understanding of complex innovation processes focusing on the saturation and decline stage of technologies which have been a core element in the energy system for a very long period.

Methods

One of the approaches which have frequently been used for analyzing diffusion processes is the multi-level perspective approach (see e.g. [Geels & Verhees, 2011, Geels, 2002, Araújo, 2014, Foxon et al., 2010, Verbong & Geels, 2010]). Usually this approach is used for describing the links between landscapes, regimes and niches focusing on selected technologies and analyzing the impacts of windows of opportunities as well as changes in regimes on diffusion processes of technologies (Fig.1). We will use this approach for analyzing the process of pushing back coal power plants into niches in Germany. Landscape en-compasses given factors like demographic trends, political ideologies, societal values, and macro-economic patterns. In principle the landscape changes slowly. A regime reflects the interactions of science, technology, politics, markets, user preferences and cultural meanings forming a set of rules and institutions. Despite the dynamics within the regime resulting from learning effects and other kinds of ongoing incremental changes, usually regimes have a high degree of stability. The systems where radical innovations emerge are called niches. According to Geels [2011] they are characterized by articulation of expectations or visions, building of social networks and great learning and articulation processes. Momentums within the niches as well as shock and other kind of stresses on the landscape level can affect the regime by creating windows of opportunities or windows of threats for innovation processes.

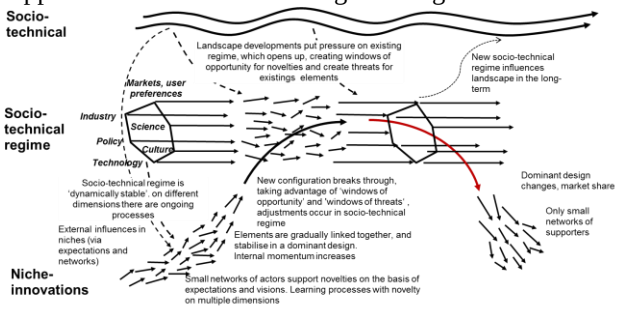

Fig 1: Multi-level perspective on innovation processes (Source: own compilation based on [Geels & Schot, 2007]

Results

For a very long period the use of indigenous hard coal was supported in Germany by the government by granting coal-fired power stations tax advantages or subsidies and by enacting restrictions on the building of oil and natural gas power stations. The first support schemes for coal power plant were introduced in the sixties of the last century. The oil crises in the seventies motivated the German Government to extend the support for the use of coal in power plants. Examples are the "coal penny" ("Kohlepfennig") introduced as compensation for add-on costs resulting from using domestic instead of imported coal and the large subsidy programs for the development of long-distance heat supply systems as well as the building of coal-fired CHP power plants. In addition energy research programs were implemented for supporting the development of new coal power plant technologies. The electricity market was split into regional monopolies with coal-fired power plants dominating electricity production whereas coal technologies mainly faced competition from nuclear power plants. The power plant construction sector provided sufficient room

for a large number of companies. All in all, coal-fired power plants were well integrated in the regime. With the increasing use of coal- and oil-fired power plants a lot of environmental problems emerged (namely smog and acid rain). In reaction to environmental concerns the Ordinance on Large Combustion Plants with emission limits for SO_2, NO_x and dust was enacted at the beginning of the 80's. Because of long transitional periods and the potential for the sector to pass on additional costs, the regulations didn't affect the regime significantly.

The situation for coal-fired power plants changed in the 90's: At first the quasi-prohibition of the construction of gas- and oil-fired power stations was repealed and the coal penny was declared to be unconstitutional. A renewed amendment of the electricity generation laws and new regulations for compensations were the consequence. In reaction the minimum generation of electricity quantities of domestic hard coal was reduced gradually. The liberalisation of the electricity market at the end of the 90's also represented another drastic break for the coal power industry. The immediate complete opening of the monopolized electricity market meant that many enterprises were exposed to enormous pressure to decrease their costs, which led to extensive saving measures. Uncertainties about the refinancing of coal-fired power plants resulted from focusing on running costs in the electricity markets, cost increases caused by the emission trading scheme (established in 2004), lower utilization rates resulting from an increasing share of renewables in the regime contribute to a decrease in the willingness of building fossil-fired power plants. This attitude is supported by lacks of acceptance by the public with respect to new coal-fired power plants. Because the running costs of coal fired power plants are still lower than the ones of gas-fired plants the utilities are interested in using their existing coal-fired plants as long as possible. Despite a high increase in R&D expenditures for renewables, the R&D expenditures for fossil power plants are still on a relatively high level. Against the backdrop that Germany will miss its GHG-reduction target of 40% (compared to 1990) by 2020, regulations like a 'climate levy' for coal power plants have been discussed. At last, the German government and the energy companies RWE, Vattenfall and Mibrag agreed on put lignite power plants capacities on standby.

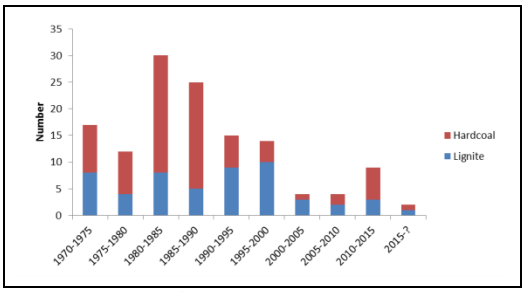

Fig 2: Number of coal power plants built per period (Source: [Bundesnetzagentur, 2015])

The building of new coal-fired plants was cancelled because of (1) limited political support, (2) increasing pressure from the growing market share of renewables coming from niches and becoming a central element of the regime, (3) mayor changes in the power plant construction sector due to long period of low demand for new power plant in Germany, (4) decreasing public acceptance and (5) being unable to make a great contribution to reaching GHG reduction targets. Cost advantages of coal-fired power plants in comparison to gas-fired ones and the vintage structure of the existing power plant stock are the main reasons which support the willingness of utilities for putting new coal-fired power plant into operation. So, it can be expected that in future coal power plants will only be used in niches (e.g. as backup capacity or CHP) where they will be still accepted by the public.

Conclusions

With the help of the multi-level perspective approach it is possible to analyse the innovations of technologies in a systematic way, highlighting that innovation processes are influenced by different factors. The set of factors includes economic, political, technical elements as well as factors on the societal level. As the example shows beside windows of opportunities there are also windows of threats which impact the position of a technology in a regime. The resilience of a regime against influences from changes in the landscape and the interaction with niches can change over time. Techniques can become outdated, losing their backing in the system and end in niches whereas the definition for niches (as it is used in multilevel perspective approach) has to be used slightly different because the way into the niches is linked with experience gained before whereas the way from the niche into regime isn't. This concerns particularly the niche-criteria "design finding".

References

ARAÚJO, K. (2014) The emerging field of energy transitions: Progress, challenges, and opportunities. *Energy Research and Social Science,* 1**,** 112-121.

BUNDESNETZAGENTUR (2015) *Kraftwerksliste Bundesnetzagentur* http://www.bundesnetzagentur.de, 19/11/2015.

FOXON, T. J., HAMMOND, G. P. & PEARSON, P. J. G. (2010) Developing transition pathways for a low carbon electricity system in the UK. *Technological Forecasting and Social Change,* 77:8**,** 1203-1213.

GEELS, F. W. (2002) Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. *Research Policy,* 31:8–9**,** 1257-1274.

GEELS, F. W. (2011) The multi-level perspective on sustainability transitions: Responses to seven criticisms. *Environmental Innovation and Societal Transitions,* 2011:1**,** 24-40.

GEELS, F. W. & SCHOT, J. (2007) Typology of sociotechnical transition pathways. *Research Policy,* 36:3**,** 399-417.

GEELS, F. W. & VERHEES, B. (2011) Cultural legitimacy and framing struggles in innovation journeys: A cultural-performative perspective and a case study of Dutch nuclear energy (1945–1986). *Technological Forecasting and Social Change,* 78:6**,** 910-930.

VERBONG, G. P. J. & GEELS, F. W. (2010) Exploring sustainability transitions in the electricity sector with socio-technical pathways. *Technological Forecasting and Social Change,* 77:8**,** 1214-1221.