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THE MODERNIZATION OF ELECTRICITY NETWORKS: A SUGGESTED FRAMEWORK FOR ANALYSIS

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Overview

The electricity sector is in motion. What in most countries once has been a monopolistic and relatively static sector has in recent decades turned into a dynamic sector. Governments around the world have eagerly adopted the liberalisation paradigm and have acted accordingly by trying to insert market mechanisms in the electricity sector. However, there is a growing concern that these reforms might have resulted in electricity networks with insufficient incentives for modernisation. Modernisation, - i.e. replacement, expansion or innovation of current networks - is needed to guarantee reliability of electricity supply, to enhance the efficiency and productivity of the sector, and to enable innovative services in the electricity sector.

The need for modernisation is supported by a number of recent incidents and near incidents related to electricity networks. There are numerous examples of recent current black outs in several countries of which the California crisis was probably the most prominent. The California electricity crisis has awakened fears that liberalisation may be unsustainable without careful design institutional regulatory arrangements (Newbery, 2001). In addition, unanticipated electricity generation by wind turbines in the north of Germany resulted in a sudden transport capacity demand of the Dutch network thereby jeopardising the network's stability. These are just a two of many examples indicating problematic issues of this vital infrastructure. The aging of the networks in Europe and the general lack of pro-activity of the main actors adds to the problem. The proper way of modernisation is, however, still subject of debate. Moreover, there is by now no widely accepted view on approaching the problem of modernisation. Hence, we can observe a big variety of institutional arrangements between different countries each with different performance outcomes. The key objectives of this paper include the proposal of a framework for assessing the dynamics in the modernisation process of electricity networks. With this framework one could identify the drivers and barriers for the modernisation of networks and analyse the co-evolution of the institutions and technology. Moreover, one could assess the risks and performance involved in the various process stages of modernisation. This approach would result in taxonomy of coherency of institutions and technology. Furthermore, this research aims to contribute to policy studies in general. For example, scenario studies are often solely based on technological extrapolation. This research will propagate the benefits for a more integral scenario approach, including the institutions to come to a broad systematic identification of barriers for network modernisation. With the insight in the dynamics of the institutional and technological pathways and the technological and institutional barriers and drivers involved, we can construct scientifically based policy recommendations for the modernisation of the electricity sector. It may provide a tool for policy makers by specifying the conditions for self-sustained private sector modernisation compared to directed modernisation by the public sector.

Results

The proposed analytical framework is presented in figure 1. Starting from the left top going clock wise direction, the (1) institutions, 'the rules of the game', influence the (2) individual actor in the modernisation process. Next to (1) institutions, the (2) actor is constrained by the (4) network technology characteristics. This causes the actor to perform a certain action, a kind of behaviour with regard to modernisation, in this case the selection and implementation

of technology onto the network (3). This changes the (5) service characteristics and functionality of the network accordingly. These performance/service characteristics have an influence on the institutions. For example, a low performance might induce the formal institutions (e.g. the regulation) to be adapted. This concludes the cycle of modernisation. The (6) coherence refers to the institutions and the technology. The hypothesis is that a certain kind of coherence is required for an optimal performance of the network. Moreover, one might expect different modernisation actions with different degrees of coherence. Throughout the modernisation cycle (7) barriers are involved, which cause the cycle to be blocked in certain ways. A particular barrier is a (9) risk e.g. as perceived by the individual actor as this might hamper the modernisation process. For example, innovative technology is not yet proven technology and can therewith be classified as more risky than conventional 'proven' technology. This might tend the actor to invest in more conventional technologies. Drivers (8) can also be found throughout the modernisation cycle. For example, the ageing of the networks might result in new formal institutions to upgrade the network. Moreover, addition of technological devices might make electricity control easier and in that way trigger the change to a new institutional arrangement. Note that, although I will not neglect the institutional part of the modernisation process, the focus is on the modernisation of the physical technical network.

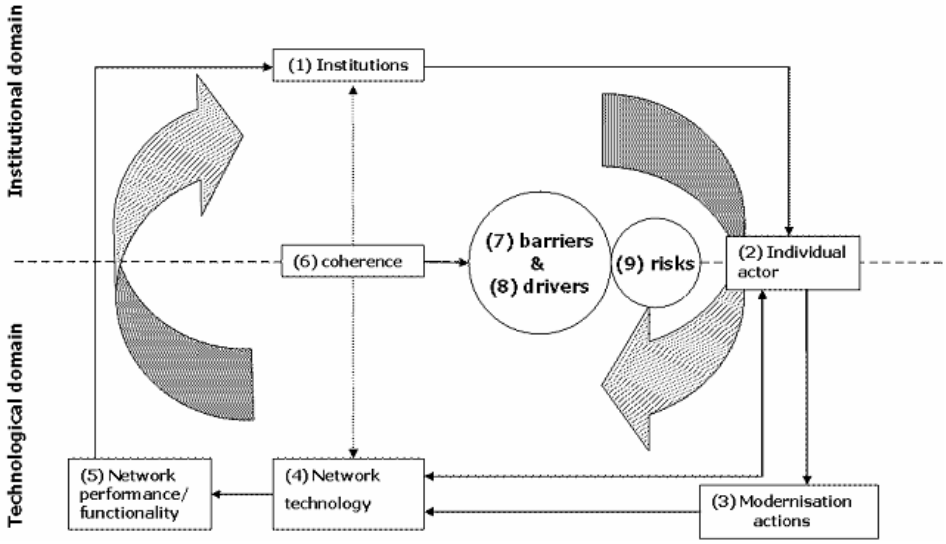

Figure 1. The analytical framework

Keeping the steps of the modernisation process in mind, the following section will go into more detail of the analytical framework and its concepts.

Conclusions

The paper proposes an analytical framework to the dynamics of the modernization process of electricity networks. This could be used to analyse the co-evolution of technology and institutions. Moreover, it might serve as a tool for a broad inventory of the barriers and drivers to the modernization of electricity networks.

This paper is part of ongoing research. Further research steps are proposed using the analytical framework. A direction for further research would be to conduct case studies and operationalise the concepts. Furthermore, a survey is suggested to make a quantitative analysis of the patterns, commonalities and differences among modernization paths. This would give policy makers the insight on to construct integral policies for the urgently needed modernization of electricity networks.