EFFICIENT INTEGRATION OF VARIABLE RENEWABLES AND CONTROLLABLE LOADS: IS IT POSSIBLE WITH CURRENT EU ELECTRICITY MARKET DESIGN?

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Overview

As part of the transition to a low-carbon economy (new) developments are unfolding in the electricity sector such as (i) the growth of generation from renewable sources (PV, wind) that are less controllable than traditional power plants and (ii) the increase in the use of 'controllable loads' such as heat pumps and the batteries of electric vehicles (of which the use can be shifted in time). From a social perspective, the integration of these renewables and controllable loads should preferably be done in a technically reliable and economically efficient way. Several technical and economic studies have analysed how this could be done (e.g. IEA 2011, RICHSTEIN *et al.* 2012, ZAPATA RIVEROS *et al* 2012). However, the question remains whether such strategies to efficiently and reliably integrate those new developments fit in the current EU market design and regulation for the electricity market. This is the central question we address in this paper.

The current EU electricity market structure is based on the old 'paradigm' of the electricity system: centralised, dispatchable generation that is top-down transported to the end users over a network with more than sufficient capacity: power supply follows power demand. The developments considered in this paper deviate from this paradigm as these concern controllable *demand* and non-controllable *supply*. In the electricity industry it is a legitimate question how such a technological change interacts with the existing legal and institutional arrangements (KÜNNEKE *et al.* 2010). For example, the 'new' development of the intelligent coordination of grid operation and the operation of loads and local production units, which is the essence of a 'smart grid', was found to be problematic within the current EU legal framework (KNOPS & DE VRIES 2012).

With regard to the EU market design and regulation for electricity we focus on the principles underlying the market structure, such as the unbundling requirement for network operators, and the principles underlying the tariff structure for electricity transport. These principles are key elements of the liberalised EU power market and will not easily be changed. In addition, we must also consider EU legislation that supports renewables and energy efficiency measures as these interact with the general rules for the electricity market.

In this paper we will assess the current market design as laid down in the current legal framework for electricity at the EU level and for the Netherlands (an EU member state that has very strict unbundling requirements for distribution network operators, much stricter than the EU at large) with regard to the question whether the economically efficient and technically reliable integration of the new developments described above would fit in that framework. First, we will analyse what view of the technical functioning of the system underlies the current market organisation and how this view has framed the EU (and Dutch) electricity legislation. Second, we will consider several scenarios for the efficient and reliable integration of the less-controllable renewable sources and/or the controllable loads and assess to what extent they would fit in the current legal framework (for the EU and the Netherlands). Third, based on that assessment we shall suggest ways of solving potential problems posed by the legislation that is hindering the integration of the considered developments. Finally, we will conclude.

Methods

A literature review is used to select the most relevant scenarios showing how renewables such as PV and wind can be integrated in an economically efficient way that preserves the technical reliability of electricity supply, and scenarios about how heat pumps and/or electric vehicles can be integrated into the system in an efficient and reliable manner.

For the assessment of the EU and Dutch legal framework for the electricity industry we apply an analysis of the relevant legislative documents and case law. The method that is being used for this analysis is the 'function-based legal design & analysis' (FULDA) method, that has been elaborated in KNOPS (2008). This method allows, first, a systematic analysis (and assessment) of the legal organisation of the electricity market, taking into account the relevant economic, legal, technical and policy aspects. Second, the FULDA method can be used to, subsequently, design a legal framework that is suited for the allowing the effective integration of the developments that we consider in this paper.

Results

The first result is an assessment of the issue how well the scenarios for an efficient and reliable integration of renewables such as PV and wind, as well as the large-scale integration of heat pumps and electric vehicles fit in the current market design as laid down in the current legal framework for the EU electricity market in general and the Dutch electricity market in particular. This involves an inventory of barriers to the realisation of those scenarios in case they do not fit well in the current legal regime.

Second, based on that assessment, concrete proposals are made as to how to design a coherent regulatory framework that would enable the developments considered in this paper (in an efficient and reliable manner) in the EU and Dutch context.

Conclusions

The successful integration of renewable energy sources such as PV or wind, as well as the large-scale use of heat pumps and electric vehicles in the European electricity system not only requires studies about the technical and economic optimisation, but also a thorough analysis about legal and institutional feasibility of the 'optimal integration scenarios'.

The analysis in this paper shows that under the current EU rules for the electricity market the integration of non-controllable renewables and an increasing number of heat pumps and electric vehicles is likely to be sub-optimal. This is due to the fact that under the current market design the 'total' efficiency of generation, transport and system operation is *not* leading. For example, in many cases, renewable electricity has priority access to the grid and its sale is guaranteed, which means that it even produces when it causes very high network costs. With respect to electric vehicles (or heat pumps) is it crucial that their power consumption can be spread out over non-peak times in order to minimise additional investment in the capacity expansion of the networks, but under the current legal framework consumers are free to use their appliances whenever they want. As grid operators are under a duty to build a network with sufficient capacity to meet reasonable demand, they would still need to expand for the possibility that all new appliances are used at peak time.

In the Netherlands, which applies much stricter rules for the unbundling of network operators than the minimum EU requirements, the current legal framework is an even stronger barrier than at EU level.

Therefore, if the EU and its member states believe in the potential of renewables as well as heat pumps and electric vehicles in the desired transition to a low-carbon economy, they should work on creating an EU legal regime that fosters their efficient and reliable integration. Suggestions as to how such a regime should look like are made in this paper.

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