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A system perspective to the deployment of flexibility through aggregator companies in the Netherlands

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ABSTRACT

Recent developments in distribution grids, environmental policy, and the energy market liberalisation process, have resulted in a quest for flexibility in power systems operation, with the focus increasingly placed on the aggregation of distributed resources. A generic method is proposed for the identification of opportunities, barriers and potential solutions in developing flexibility mechanisms through aggregator companies by concentrating on the market integration aspects. The method is applied to the Netherlands as a case study, and the outcome is a state-of-the-art review of the electricity market development concerning all relevant issues for advancing the market integration of aggregator companies within the Dutch system and in line with the new European grid codes. Opportunities were framed among six categories which outline the potential for the provision of market-based products and services in the Dutch system, whereas barriers were decomposed into market, regulatory, technical and social issues. A set of recommended actions is provided to facilitate the market integration of aggregator companies in the Netherlands, which point out the need for policy interventions and follow-up research activities.

1. Introduction

The increasing integration of intermittent renewable energy sources (RES) in power systems and the ongoing deregulation of electricity markets have resulted in a quest for flexibility (van Hout et al., 2014). Flexibility is defined as a "general concept of elasticity of resource deployment providing ancillary services (AS) for the grid stability and/or market optimisation" (CEN-CENELEC-ETSI Smart Grid Coordination Group, 2012). Until now, flexibility was mainly sourced from large power plants at the supply-side. However, with the increasing electrification of the transport and heating systems, the further integration of distributed generation, flexible loads and energy storage at the distribution level, the gradual decommission of thermal power plants due to environmental reasons, and the liberalisation of the energy market, the focus of enabling flexibility is increasingly placed at the demand-side in the industry, commercial, and residential sectors. Furthermore, technological developments in electrochemical energy storage are expected to result into significant decrease of technology cost in the coming years, and drive the adoption of battery systems by electricity customers. Especially, lithium-ion stationary battery systems are expected to become economically viable for electricity bill management applications, from the customers' perspective, by 2020 (Telaretti et al., 2016). Unlocking the flexibility at the demand-side is considered a key factor for an effective energy transition, which requires not only the development of technology but also the active participation and empowerment of customers (Expert Group 3 Regulatory Recommendations for Smart Grids Deployment, 2015). In most cases, individual distributed resources cannot contribute to flexibility services on their own because of limited capacity and controllability. Aggregator companies[1] are organisations that can combine these distributed resources into a single system resource which can be utilised for the provision of flexibility services. Demand-side flexibility can be used by various actors to serve several purposes and provide multiple benefits and sources of revenues (Expert Group 3 Regulatory Recommendations for Smart Grids Deployment, 2015). Once a flexible portfolio of distributed resources has been constructed, an aggregator can employ optimisation approaches to address different objectives, such as the participation in load-frequency control (Lampropoulos et al., 2013a), or

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[1] Also called aggregation service providers but referred to as simply 'aggregator' in the remaining part of this paper.

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the scheduling of resources considering economic and environmental objectives (Di Somma et al., 2018). An aggregator might utilise flexibility to take advantage of price differences in wholesale and retail markets for electricity, to participate in markets for AS, and to provide over-the-counter services to other market parties. According to the European Energy Efficiency Directive (E.U, 2012), E.U. Member States shall ensure that Transmission System Operators (TSOs) and Distribution System Operators (DSOs), in meeting requirements for balancing and AS, treat demand response (DR) providers, including aggregators, in a non-discriminatory manner, on the basis of their technical capabilities. To unlock the full potential of demand-side response[2] there is a need for new rules, as an enabling policy, and to remove regulatory obstacles including barriers related to the relationship between independent aggregators and suppliers (ENTSO-E, 2015a).

A generic method is lacking with which stakeholders can identify in a systematic and consistent way barriers and associated solutions for developing flexibility mechanisms through aggregators. As a consequence, current overviews cannot be strictly comparable within the context of different countries (Pause and Caneva, 2016), and consist of an ad hoc set of barriers (Cappers et al., 2013). For this purpose, a generic method is developed which integrates elements from relevant approaches, and further contains a measure to account for country-specific preconditions. A country-specific precondition, e.g. consistency with the market model under question, sets boundaries to the search of potential solutions. Another novel contribution of this paper is a framework for categorising identified barriers. Cappers et al. have proposed a framework for a typology of barriers to DR participation but with sole focus on AS (Cappers et al., 2013). In our proposed framework, barriers are categorised among different areas of identified opportunities for the provision of market-based products and services through aggregators, whereas AS markets only address part of these opportunities. Such a framework has the advantage of making clear which barriers stand in the way for these opportunities to be realised. Furthermore, in the proposed framework, identified barriers are decomposed into their elements which provides clarity for stakeholders on the causes of its existence, and supports the process of identifying solutions to overcome them. The proposed method and framework are applied to the Netherlands as a case study and result in a systematic overview of all relevant issues for advancing the market integration of aggregator companies within the Dutch system.

The main objective of this research is to identify opportunities and barriers and propose solutions and actions for enabling flexibility through aggregators in power systems operations, from scheduling and operations, to verification and settlement within the current systems of programme responsibility (TenneT TSO B.V., 2014), and imbalance settlement in the Netherlands (TenneT TSO B.V., 2015). The research thus addresses the feasibility of new concepts for the provision of flexibility in the energy system by focusing on the market integration aspects. Note that issues related directly to the viability of particular business models of aggregators (e.g. revenue availability and capture for certain applications, cost of enabling technology and control infrastructure at the customer's side, customers' acceptance to certain DR programmes) are left outside of the research scope as those can differ significantly for each business case. The outcome is a set of recommended actions to progress the market integration of aggregators without major changes to the roles and responsibilities of market parties and grid operators, while remaining in line with the new European grid codes. The results are primarily meant to support the Dutch TSO to systematically structure its approach on the market integration of demand-side resources for flexibility services through aggregators in the Netherlands. However, the method as well as most of the findings are applicable and relevant in the broader European context of energy policy. This work aims to create more knowledge and better understanding of the trends at the demand-side, the impact of flexibility deployment through aggregators from a system perspective, and how the envisioned opportunities can be exploited.

In order to identify opportunities, barriers and potential solutions for enabling flexibility through aggregators, this research focused on consistently answering the following questions:

- Which are the **opportunities** for the deployment of flexibility in the energy system through aggregators?
- What stands (**barriers**) in the way for these opportunities to be realised?
- How can the identified barriers be removed (**potential solutions**)?
- Which actions the Dutch TSO and/or the regulator might take to promote the proposed solutions (**recommendations**)?
- What is the importance of the identified barriers and proposed solutions (**priority level**)? Priorities were determined in terms of system impact and ease of implementation.

The paper is structured as follows: The research method is presented in Section 2, whereas the results follow in Section 3. The paper is concluded in Section 4, where also the policy implications are discussed.

2. Research method

The research involved a qualitative approach for identifying opportunities and barriers for developing flexibility mechanisms through aggregators, and determining potential solutions and a plan with prioritised actions. Previous research on the identification of barriers for the deployment and operations of business models for aggregators in several European Member States,[3] employed desk research and questionnaire-based surveys including rankings to determine the most relevant barriers (Pause and Caneva, 2016). Painuly (2001) has proposed a framework for identifying barriers to the deployment of renewable energy technologies and for suggesting measures to overcome them, which is based on literature review, the study of existing projects, and interaction with stakeholders through interviews and/or questionnaires. Our proposed method follows a similar approach where opportunities and barriers were identified, and potential solutions were explored based on the review of the relevant literature and documentation, and interviews with experts and relevant stakeholders in the electricity sector.[4] Rankings performed by the interviewees and the project partners were used to prioritise the identified barriers and proposed solutions. The research method is outlined in two steps (i.e. problem space formulation and development phase) and is graphically illustrated in Fig. 1.

2.1. Problem space formulation

The problem space is a representation of the problems in which the phenomena of interest reside, i.e. opportunities and barriers, and in which the search for potential solutions can take place.

An extensive *literature review* was performed to identify opportunities, barriers and potential solutions for enabling flexibility through aggregators in Europe, and particularly in the Netherlands. The relevance of a barrier should also be addressed in the context of each Member State separately since the status of the market deregulation

[2] Equivalent to the term Demand Response (DR).

[3] The study focused on Austria, Belgium, Germany, France, Italy, Cyprus, Portugal, Spain and the United Kingdom.

[4] The approach followed during the interviews has some similarities with the Delphi method (i.e. the facilitator managed the interactions among the interviewees by collecting their input and filtering out irrelevant information, whereas the interviewees were asked to comment on their own viewpoints as well as on the responses of others), but also a main difference (i.e. the role of the facilitator was not to establish consensus among the interviewees but to reveal option items, including contradictory viewpoints).