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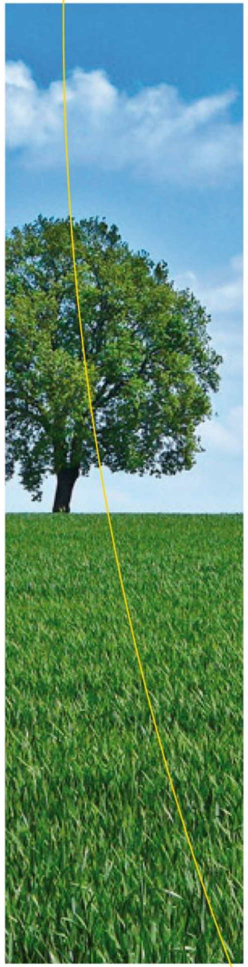

DELIVERABLE REPORT

A System Perspective to the Deployment of Flexibility through Aggregator Companies

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PROJECT DATA

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Contents

Summary

This work focuses on the facilitation of aggregator companies for the provision of flexibility services to the electricity system by using large numbers of dispersed and distributed resources of small capacities. This initiative by TenneT TSO and Utrecht University is about identifying potential barriers and proposing solutions and actions for enabling flexibility in power systems operations, from scheduling and operations, to verification and settlement, within the current systems of programme responsibility and imbalance settlement in the Netherlands.

The project activities address the feasibility of new concepts for the provision of flexibility in the energy system by focusing on the market integration aspects. First, the procedures and requirements regarding the current systems of programme (balance) responsibility and imbalance settlement in the Netherlands were analysed, i.e., operational planning (nomination and scheduling of exchange, bidding for regulating, reserve and incident reserve power), operations (request for upward and/or downward power, and dispatch), and settlement (verification and financial settlement). Subsequently, different options for contributing to system balancing through the bid price ladder (active contribution), voluntary response (passive contribution), emergency power (contracted emergency capacity) and exchange of flexibility, from an aggregation of distributed resources, between market parties were analysed. Finally, regulatory, institutional and technical barriers for developing flexibility mechanisms through aggregator companies were identified, and potential solutions were explored for overcoming identified barriers and complying with technical requirements.

This report provides a state-of-the-art review of the Dutch electricity market and highlights all relevant issues for advancing the market integration of aggregator companies within the Dutch system, and in line with the new European grid codes. Historical and emerging cases of demand response implementations through aggregators in Europe were reviewed and the organisational configurations of these implementations between aggregators and other actors in the electricity sector were documented. A set of characteristics is identified that can be used for describing the business model variations around the aggregator concept in Europe. The opportunities, challenges and possible solutions for enabling flexibility through aggregators are determined. The project results include a set of recommendations and actions to progress the market integration of aggregator companies within the current systems of programme responsibility and imbalance settlement, i.e. without major changes to the roles and responsibilities of market parties and grid operators, as well as the position of TenneT TSO regarding the integration of the aggregator role within the Dutch market model.

The report is completed with discussion, conclusions and recommendations, an overview of the relevant stakeholders who may benefit from the project results and potential for follow-up activities. The most urgent items are summarised in an action plan with recommendations and priorities for TenneT TSO to stimulate the market integration of demand side resources through aggregators companies. Several of the recommended actions to TenneT TSO point out to follow-up research activities.

Samenvatting

Het doel van het project was om te onderzoeken hoe aggregators het beste gefaciliteerd kunnen worden om flexibiliteitsdiensten te leveren aan het elektriciteitssysteem met behulp van een groot aantal kleine decentrale energieopwekkers. Binnen dit initiatief van TenneT en de Universiteit Utrecht werden potentiële barrières en oplossingen voor het bieden van flexibiliteit geïdentificeerd in de verschillende onderdelen van het elektriciteitsysteem vanaf planning van de diensten, uitvoering tot aan verificatie en uiteindelijke financiële afwikkeling. Oplossingen werden gezocht binnen de huidige systemen van programma verantwoordelijkheid en onbalansverrekening in Nederland.

De projectactiviteiten richtten zich op de haalbaarheid van nieuwe concepten voor het bieden van flexibiliteit in het elektriciteitssysteem door te focussen op de aspecten van marktintegratie. Ten eerste werden de procedures en eisen van de huidige systemen van het programma (balans) verantwoordelijkheid en onbalansverrekening in Nederland geanalyseerd. Dat wil zeggen, de operationele planning (nominatie en planning van de levering, bieden voor regel-, reserve- en noodvermogen), uitvoering (verzoek bij opwaarts en / of neerwaarts vermogenssturing), en afwikkeling (verificatie en financiële afwikkeling). Vervolgens zijn verschillende mogelijkheden geanalyseerd die bij zouden kunnen dragen aan de balanshandhaving door middel van de biedladder (actieve bijdrage), vrijwillige vraagrespons (passieve bijdrage), noodstroom (gecontracteerd noodvermogen) en de levering van flexibiliteit door de aggregators. Tot slot zijn regelgeving, institutionele en technische belemmeringen voor de ontwikkeling van flexibiliteitsdiensten door de aggregators geïdentificeerd, en zijn mogelijke oplossingen verkend voor het overwinnen van die barrières die tevens voldoen aan technische eisen.

Dit rapport geeft een state-of-the-art overzicht van de Nederlandse elektriciteitsmarkt en laat alle relevante kwesties ter bevordering van de marktintegratie van aggregators binnen het Nederlandse systeem de revue passeren, die ook passen bij de nieuwe Europese netwerkregels. Alle bekende en nieuwe voorbeelden van vraagresponsimplementaties door middel van aggregators in Europa zijn behandeld en de organisatorische mogelijkheden tussen aggregators en andere actoren in de elektriciteitssector zijn beschreven. Een reeks kenmerken zijn geïdentificeerd die gebruikt kunnen worden voor het beschrijven van variaties in bedrijfsmodellen van het aggregator concept in Europese landen. De mogelijkheden, uitdagingen en mogelijke oplossingen voor het leveren van flexibiliteit door aggregators zijn vastgesteld. De resultaten van het project bestaan onder andere uit een aantal aanbevelingen en acties om de marktintegratie van aggregators binnen het huidige systeem van de programma verantwoordelijkheid en onbalansverrekening te bevorderen, zonder dat er grote veranderingen in de rol en verantwoordelijkheden van marktpartijen en netbeheerders nodig zijn, en met inbegrip van de positie van TenneT met betrekking tot de integratie van de aggregator rol binnen de Nederlandse markt model.

Het rapport eindigt met conclusies en aanbevelingen, een overzicht van belanghebbenden die kunnen profiteren van de resultaten van het project en mogelijke vervolgactiviteiten. De belangrijkste zaken zijn opgenomen in een actieplan met aanbevelingen en prioriteiten voor TenneT om de marktintegratie aan de vraagzijde via aggregators te stimuleren. Een aantal van de aanbevolen acties aan TenneT kunnen leiden tot vervolgonderzoek.

1 Introduction

The increasing integration of intermittent renewable energy sources in power systems and the ongoing deregulation of electricity markets have resulted in a quest for flexibility both for system security and market optimisation purposes [1]. Flexibility is defined as a "general concept of elasticity of resource deployment providing ancillary services for the grid stability and/or market optimisation" [2]. Until now, flexibility was mainly sourced from large generators at the supply-side. Currently, the focus of enabling flexibility is increasingly placed at the demand-side through flexible loads, distributed generation units and energy storage devices in the industry, commercial, and residential sectors. Unlocking the flexibility at the demand-side is considered a key factor for an effective energy transition, which requires the active participation and empowerment of customers [3]. In most cases, individual distributed resources cannot contribute to flexibility services on their own because of limited capacity and controllability. Aggregator companies[1] (also called aggregation service providers) are organisations that can combine these distributed and dispersed energy resources into a single system resource that can be utilised for the provision of flexibility services. Demand-side flexibility could be used by various actors to serve several purposes and provide multiple benefits and sources of revenues [3]. An aggregator company might utilise flexibility to take advantage of price differences between wholesale and retail markets for electricity, to participate in ancillary services markets, and to provide *over-the-counter* services to other market parties[2].

According to the European Energy Efficiency Directive[3], subject to technical constraints inherent in managing networks, E.U. Member States shall ensure that Transmission System Operators (TSOs) and Distribution System Operators (DSOs), in meeting requirements for balancing and ancillary services, treat demand response providers, including aggregators, in a non-discriminatory manner, on the basis of their technical capabilities. To unlock the full potential of Demand Side Response (DSR) 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 [4]. This work aims to create more knowledge and better understanding of the trends at the demand side, the impact of flexibility deployment through aggregator companies, the system impact and how the envisioned opportunities can be exploited.

[1] Referred to as simply 'aggregator' in the remaining part of this report.

[2] Note that the term 'market party' refers to a party that is eligible to participate in the electricity market, i.e. a party that carries the role of the Balance Responsible Party (BRP), or the role of the supplier, or a party that has a contract with the TSO for the provision of a specific service (e.g. emergency power provision) or a combination of the above-mentioned.

[3] Directive 2012/27/EU of the European parliament and of the council of 25 October 2012 on energy efficiency, Article 15 (8).

1.1 Background

This work focuses on the facilitation of flexibility deployment through the aggregation of large numbers of dispersed resources. This initiative by TenneT TSO and Utrecht University (UU) is about identifying potential barriers and proposing solutions within the current systems of programme responsibility [5], and imbalance settlement in the Netherlands [6]. This entails identification of potential barriers and proposing solutions and actions for enabling flexibility in power systems operations (from scheduling and operations, to verification and settlement). The research activities address the feasibility of new concepts for the provision of flexibility in the energy system by focusing on the market integration aspects. The result is a set of recommendations and actions to progress the market integration of aggregators within the current systems of programme responsibility and imbalance settlement, i.e. without major changes to the roles and responsibilities of market parties and grid operators, and in line with the new European grid codes.

Primarily, the results of this project are meant to support TenneT TSO to systematically structure its approach to progress the market integration of demand side resources for flexibility services through aggregators. The ultimate goal is to provide insight into both technical and non-technical challenges in order to facilitate the development of new flexibility products and services by creating knowledge and understanding of the system and the changes that need to take place.

1.2 Research objectives

The main goals of this work (and associated outputs) are about:

1. Enabling novel organisational and cooperative structures for the energy management of demand-side resources through aggregators:
    - documenting (organisational) configurations between aggregators and other actors in the electricity sector (see Section 2.1)
2. Determining opportunities, challenges and possible solutions for enabling flexibility through aggregators (see Section 2.2)
    - identifying possibilities and barriers for the integration of flexibility services through aggregators
    - defining the position of TenneT (and relevant developments)
    - developing a proposal for overcoming identified barriers (potential solutions and associated requirements)
    - developing an action plan with recommendations and priorities for TenneT TSO

1.3 Implementation of the project

The project is in-line with programme line number 3 New opportunities (Nieuwe kansen, in Dutch), under the tender System integration studies 2015 (Systeemintegratiestudies 2015, in Dutch), as it addresses the feasibility of new concepts for the provision of flexibility in the energy system, by focusing on the market integration of large number of dispersed resources through aggregator companies. The project management and core research activities were undertaken by UU, whereas all activities were performed in close collaboration with TenneT that had mainly a consultancy and advisory role in the project. The division of labour was approximately between 84% for UU and 16% for TenneT. The project was performed in accordance with the project plan (see **Table 1**), and without incurring additional cost above the planned budget (see **Table 2**). The only difference compared to the project plan, is that the symposium for relevant stakeholders, which was initially planned for September, will eventually take place in 2017.

Table 1. Overview of the project plan.

WP	Short description	Executors	Results	Planned start and end date
1	Project management	UU	Minutes of meetings, final report, financial report	Jan. 1, 2016 – Sep. 30, 2016
2	Research scope & problem space formulation	UU, TenneT	Problem space formulated and role/position of TenneT defined with respect to market design of balancing and ancillary services markets including flexibility services through aggregator companies.	Jan. 1, 2016 – Feb. 1, 2016
3	Requirements analysis	UU, TenneT	Possibilities for the integration of flexibility services through aggregator companies identified, as well as regulatory barriers and systems engineering requirements for aggregator companies to provide flexibility services to the power system.	Feb. 1, 2016 – May 1, 2016
4	Theoretical proposal development	UU, TenneT	Different (organisational) configurations defined between market parties, aggregator companies and its associated system users. Proposal for overcoming identified barriers.	May 1, 2016 – Aug. 1, 2016
5	Dissemination and exploitation plan	UU, TenneT	Action plan with recommendations and priorities for TenneT TSO to stimulate market integration of demand side resources through aggregators companies. One scientific publication. One symposium for stakeholders.	Jul. 1, 2016 – Sep. 30, 2016

Table 2. Project budget. The table shows the overall project budget per participant divided into the different types of financing (in €).

Participant	Committed own contribution	Requested TSE Subsidy	Project budget
Universiteit Utrecht	53,900*	50,000	118,900
TenneT TSO B.V.	30,000*	0	15,000
Total	83,900	50,000	133,900

* TenneT provided an in-cash contribution to Universiteit Utrecht of 15,000 €.

1.3.1 Dissemination method

Dissemination activities include the publishing of the generated knowledge in a prestigious scientific conference and journal to disseminate knowledge within the academic community; organisation of a symposium to inform market and commercial parties, and development of this project report, including a preliminary action plan to ensure the effective use of the generated knowledge in an effort to maximise the market impact. The plan includes recommendations and priorities for TenneT to stimulate the market integration of demand side resources through aggregator companies. The dissemination activities are summarised as follows:

- **Paper (1).** Part of the results of the project were presented in a scientific conference on the topic of Smart Cities, and the peer-reviewed paper is expected to be published in an edited volume by Springer in 2017. **Paper reference:** *I. Lampropoulos, M. van den Broek, W. van Sark, E. van der Hoofd and K. Hommes, "Enabling Flexibility from Demand-side Resources through Aggregator Companies," in SmartBlueCity conference, Limassol, Cyprus, 2016.*
- **Paper (2).** A second scientific paper, summarising the project results, is planned for submission to a prestigious scientific journal after the completion of the project.
- **Final project report.** A public project report (this document).
- **Symposium.** A symposium is planned, for after the end of the project, to inform market and commercial parties and other relevant stakeholders about the project results and potential for follow-up activities. The symposium will take place in 2017 at TenneT head office in Arnhem. Apart from the project results and potential follow-up activities, the symposium programme will also include an introduction to the Universal Smart Energy Framework (USEF), the position of an aggregator company, the view of a BRP/supplier, the view of TenneT TSO, and will end with a plenary discussion and networking session.

1.4 Literature review and research method

In this section, the literature review and the research method are presented. The method followed in this research is outlined in the following steps (problem space formulation, development phase, and evaluation phase):

- **Problem space formulation** based on the review of the relevant literature and documentation, and interviews with experts in the electricity sector. The problem space is a representation of the problem in which the phenomena of interest reside and in which the search for the solution can take place.
  - An extensive **literature review** was performed to identify trends and barriers for enabling flexibility through aggregators in Europe, and particularly in the Netherlands. The literature review covered the following topics:
    - Procedures and requirements regarding the current systems of programme (balance) responsibility and imbalance settlement in the Netherlands, i.e., operational planning (nomination and scheduling of exchange, bidding for regulating, reserve and incident reserve power), operations (request for upward and/or downward power, and dispatch), and settlement (verification and financial settlement) [5], [6], [7], [8].
    - Different options for contributing to system balancing, i.e. reserves for frequency containment, reserves for frequency restoration through the bid price ladder (active contribution), voluntary response (passive contribution), emergency power (contracted capacity for incident reserves), and flexibility exchange through aggregators between market parties [9], [10], [11], [12] [13].
    - Historical and emerging cases of demand response implementations through aggregators in Europe [14], [15], [16], [17], [18].
    - Policy papers and regulatory recommendations for the deployment of flexibility, data management, and developments at the demand-side and at the distribution level [3], [4], [19], [20], [21].
  - A number of **interviews** with experts were conducted in person and by telephone to discuss and validate the outcome of the literature review. The approach was based on semi-structured interviews, which made it possible not only to validate the outcome of the literature review but also to incorporate additional input based on the interviewees' expertise. The interviewees were selected to encompass a wide range of expertise and experiences, from multiple organisations, which also reflect different perspectives. The interviews were recorded and subsequently were transcribed. Follow-up interviews were conducted, whenever necessary, with requests for additional clarifications and input.

        - The **interviewees** included experts from:
            - The Dutch TSO, TenneT TSO B.V.
            - Commercial parties (BRPs, suppliers, aggregator companies)
            - An association promoting the aggregator concept and the development of flexibility services
- **Development phase**:
    - Documentation of (organisational) configurations between aggregators and other actors in the electricity sector (see Section 2.1):
        - Identification of characteristics that describe the business model variations around the aggregator concept in Europe.
    - Identification of regulatory, institutional and technical barriers for developing flexibility mechanisms through aggregators, and development of a proposal with potential solutions for overcoming identified barriers (see Section 2.2):
        - Comparative analysis by framing the participation of aggregator companies offering flexibility services within the current system of imbalance settlement, in comparison to traditional service providers.
    - Reiterations with the interviewees for clarifications, if necessary, and requests for additional input.
- **Evaluation phase:** Refining the research findings through peer-review.

1.5 Layout

The report is structured as follows: In Section 2.1, historical and emerging cases of demand response implementations through aggregators in Europe are reviewed. A set of characteristics is identified that can be used for describing the business model variations around the aggregator concept in Europe, and the organisational configurations between aggregators and other actors in the electricity sector are documented. Opportunities, challenges and possible solutions for enabling flexibility through aggregators are determined in Section 2.2, whereas the position of TenneT TSO with respect to relevant developments is presented in section 2.3. The report ends with discussion, conclusions and recommendations in Section 3, where the relevant stakeholders who may benefit from the project results and potential for follow-up activities are presented.

2 Project results

2.1 Organisational configurations of aggregators

The liberalisation process of the electricity market and the directives for non-discriminatory access to the network in Europe have contributed significantly towards the creation of competitive markets and a restructuring of the electricity sector [19]. European guidelines, as well as national legislative measures and system designs, are following a market-based approach towards an integrated electricity system and an internal energy market in Europe. This approach is built upon the following three principles [16]:

- **Freedom of connection**: All demand and supply resources can connect into the grid on a non-discriminatory manner.
- **Freedom of transaction**: Market parties can enter into any form of contractual agreements with regard to their demand and supply.
- **Freedom of dispatch**: A connected party has the right to feed into (supply) or take from the grid (demand), within the limits of its connection, at all times. The connected party can accept a (partial) limitation to this right by another market party for a negotiable compensation based on a bilateral contractual agreement.

The Dutch system design is consistent with this approach, and the aggregator concept in the Netherlands is expected to be developed on the basis of these three principles that define an effective liberalised market environment. Before discussing emerging concepts of the aggregator in Europe (see Section 2.1.1), an overview of the system and the commercial domain is provided in the following paragraph.

In Europe, each control area of the interconnected power system [22], is operated by the associated TSO, the legal institution that monitors the transmission network, ensures the connections with other control areas, and organises the markets for operating reserves and cross-border capacity and exchanges. A single control area, such being the case in the Dutch power system, might involve more than one DSO, but every regional distribution system is associated to a single DSO company that operates as a natural monopoly. DSO companies connect individual large system users to the transmission network (e.g. large industrial customers), and provide the distribution of electricity through medium voltage (MV) and low voltage (LV) networks, which subsequently feed a large number of small system users at the LV distribution level. Grid operators are potential users of flexibility services, through the procurement of ancillary services, to perform their core tasks, to defer network reinforcements and investments, and to reduce grid losses [3]. A system user, i.e. a producer and/or consumer of electricity, can own and operate a number of energy demand and/or generation resources, such as distributed energy storage devices, generation units, and loads. The resources of a system user can be characterised as (a) non-flexible, i.e. critical loads which are difficult or impossible to be displaced in time and amount without creating a sense of discomfort to the users, and uncontrollable generators such as must-run generation units, and as (b) flexible, i.e. non-critical loads which are characterised by some degree of flexibility, controllable generators, and energy storage. A system user is connected to the distribution grid at the point of connection (or main metering point) where the energy products of the respective user are measured or computed to support business processes such as calculation of energy volumes, financial settlement etc. For each connection point to the grid there is one associated supplier, i.e. a party that is sourcing, supplying, and invoicing energy to its customers, and a Balance Responsible Party (BRP), i.e. a party that has a contract providing financial security and balance responsibility [22]. The Dutch electricity market is open to competition for small-size system users since July 2004, and customers can switch to the supplier of their preference. For small system users such as residential customers the roles of both the supplier and the BRP are typically taken on by the same market party. Suppliers and BRPs could use flexibility services for portfolio optimisation and/or generation capacity adequacy [3].

An aggregator is or can be in principle responsible for acquiring flexibility from an aggregation of system users, constructing a flexibility portfolio, and developing flexibility services which can subsequently be used either for own purposes (e.g. portfolio optimisation) or as offers to different markets and actors, with the aim of creating value and sharing it with its stakeholders. Aggregators have to agree with their associated system users on the commercial terms and conditions for the procurement, dispatch, and remuneration of flexibility. The financial benefits for the system users depend on the commercial agreements with their associated aggregator and may be in the form of energy bill savings, or other (financial) incentives. Aggregators may develop numerous different propositions for their customers. For better understanding of the possible available options it is relevant to mention the two main types of Demand Response (DR)[4], called explicit and implicit DR [18]:

- **Explicit DR** (also called incentive-based DR) refers to the situation "where the aggregated demand-side resources are traded in the wholesale, balancing, and capacity markets. Consumers receive direct payments to change their consumption (or generation) patterns upon request, triggered by, for example, activation of balancing energy, differences in electricity prices or a constraint on the network. Consumers can earn from their consumption flexibility, individually or by contracting with an aggregator: either a third party aggregator or the customer's supplier. An Explicit DR programme allows a customer to participate in a balancing market as outlined today in the Network Codes. It will also allow for regional demand-side services for DSOs".

[4] Note that the term DR is equivalent to DSR.

- **Implicit DR** (also called price-based DR) refers to "consumers choosing to be exposed to time-varying electricity prices or time-varying network grid tariffs that reflect the value and cost of electricity and/or transportation in different time periods. They respond to wholesale market price variations or in some cases dynamic grid fees. Introducing the right to flexible prices for consumers (provided by the electricity supplier) does not require the role of the aggregator. Implicit Demand Response can be accessed by a wider range of consumers through supplier-enabled dynamic pricing programmes".

2.1.1 Emerging concepts of the aggregator in Europe

In recent years, several organisations, either new or traditional players in the energy sector, have attempted to explore the emerging opportunities for the provision of flexibility services from aggregated demand-side resources. In this section, a set of characteristics is identified around the business model concept of an aggregator by reviewing historical cases and emerging models in Europe [15], [16], [17], [18].

The Aggregator and Targeted Flexible Technologies or Resources. The system users that are associated with an aggregator might participate in its portfolio with either a few or all of their resources. In the case of a customer that is characterised by both flexible and non-flexible types of resources, an aggregator might have an interest to include in its portfolio either only one specific flexible resource, more than one flexible resource, or all the resources, flexible and non-flexible, that are located behind the main metering point at the point of connection of that customer. The different options unveil the interest (or indifference) of an aggregator to a specific targeted technology and subsequently outline different business models. In the case of an aggregator that includes in its portfolio all the resources of a system user, the conditions that influence the position of that system user are direct and unambiguous, and measurements at the point of connection are sufficient for settling any imbalance with the associated BRP and/or supplier. In the case of an aggregator that is interested to include in its portfolio only one or a few selected resources of a system user, the measurements at the point of connection might be insufficient for settlement purposes. Presumably, additional requirements are created for sub-metering behind the point of connection to support the settlement process with the associated supplier and/or BRP. A historical case from France reveals the complications, due to the interdependence of commodities, when different market parties are representing the same system user in different markets but their actions are not coordinated or communicated. In this case, an aggregator used to aggregate flexibility by offering to residential customers a device which could switch off their electrical heating and space conditioning appliances. Consecutively, the aggregator was placing the aggregate flexibility bids to the French TSO market for operating reserves. The call of the bids was resulting into imbalances at the position of the associated supplier, and the dispute whether the aggregator should compensate the supplier or not was sent for settlement in the Council of State [15].

The Balance Responsible Party and the Supplier Roles. At the point of connection of a system user to the grid there should be assigned a BRP and a supplier. In **Fig. 1**, the possible organisational arrangements between two system users, and their associated BRPs and suppliers, are illustrated. The aggregator might take on either (a) the role of the supplier, (b) the role of the BRP, (c) both of these roles, or (d) none of these roles. In the latter situation, the associated suppliers and BRPs must be compensated for the energy supply and any energy imbalance entailed in their positions due to the provision of flexibility services from system users with whom they have contractual relationships. In such a business model the aggregator acts as a third-party that aggregates flexibility from system users and sells it at its own risk to potential buyers, thus creating the need to formalise all the interactions with other market players [16]. In the situation that the aggregator takes on the BRP role, all optimisations are performed directly within the combined portfolio. Otherwise, the aggregator shall define contractual relationships with one or more incumbent BRPs, but can also propose a new BRP to its associated system users. In the situation that the aggregator takes on the supplier role, it becomes possible to offer to its associated system users a supply contract including flexibility options. The supplier can be the incumbent supplier, but the aggregator can propose a new supplier to its associated system users [16].

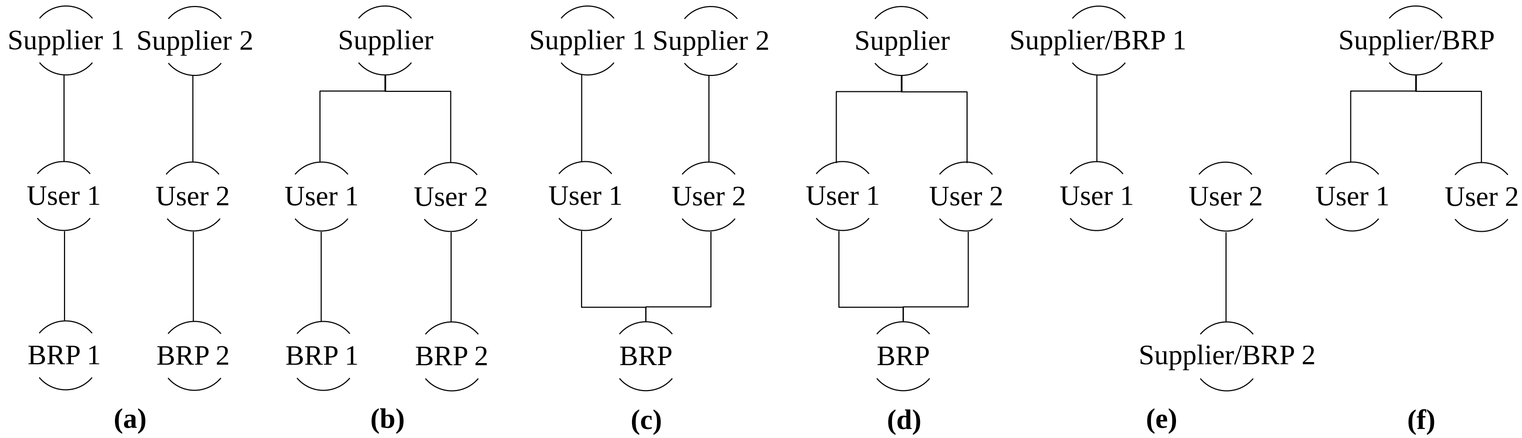

Fig. 1. Possible organisational arrangements between two system users, and their associated BRPs and suppliers, when the roles of the supplier and the BRP are either distinct or combined. (a) Different BRPs and suppliers. (b) Different BRPs but a single supplier. (c) Different suppliers but a single BRP. (d) A single supplier and a single BRP. (e) The roles of the supplier and the BRP are combined, and the system users are associated with a different supplier/BRP. (f) The roles of the supplier and the BRP are combined and the system users are associated with a single supplier/BRP.

The Aggregator and Targeted Customer Segments. An aggregator might target a particular customer segment, e.g. residential, commercial, or industrial customers. Residential customers are in principle non-professionals and are characterised by limited capacity and controllability. Larger system users, such as commercial and industrial customers, that are characterised by significant capabilities of flexibility can also perform within an aggregate portfolio, and might even act as aggregators for optimising their own portfolios [16].

The Aggregator as a Pure Service Provider. An aggregator might act as a pure provider of flexibility services for one of the other roles, i.e. the aggregator provides the means to aggregate flexibility and offers it to one of the other market parties in the value chain instead of trading flexibility at its own risk [16]. This type of business model might be implemented by organisations that have specific knowledge on particular technologies and techniques, e.g. ICT, computer science, etc., and act as providers of integrated technical solutions.

Ancillary Service Provision to Grid Operators. An aggregator might provide balancing services as a Balancing Service Provider (BSP) to its connecting TSO. Note that the BSP term refers to a market participant providing balancing services to its connecting TSO, or in case of the TSO-BSP Model, to its contracting TSO[5]. In the Netherlands, the BSP role has not been formalised, as in the case of the BRP role, and refers to market participants that provide balancing reserves such as regulating, reserve and emergency power. Future conceptualisations consider aggregators as potential providers of a broad range of ancillary services to the TSO and/or DSO institutions. For example, relevant ancillary services towards DSO institutions might include peak shaving activities and/or the means to defer network reinforcements and investments, and to reduce grid losses. However, it shall be clear that ancillary services towards DSO institutions do not include services for local balancing as this task is performed at system level by the associated TSO.

2.1.2 Elements of the business model concept of an aggregator

Following the review in Section 2.1.1, a number of elements were identified that outline the various variations of emerging business models around the aggregator concept. In this section, these elements are classified, under two categories, as activity-specific and service-specific characteristics. Activity-specific characteristics link to the particular knowledge of an aggregator, e.g. regarding a process, resource, technology, technique, customer segment etc. Service-specific characteristics link to the focal services provided by an aggregator, in relation to the distinct roles and responsibilities in deregulated environments. The following classification of identified elements is considered an

[5] ENTSO-E Common Glossary: https://emr.entsoe.eu/glossary/bin/view/ENTSO-E+Common+Glossary/Balancing+Service+Provider

advance in the process of systematically analysing and structuring the business model concept of an aggregator. First, it supports the process of understanding the logic that drives the various business model implementations. Secondly, it can be used to identify potential organisational arrangements, within the various business model concepts, and to inquire the compatibility of those with established market designs and regulatory frameworks.

Identified elements of the business model concept of an aggregator:

1. Activity-specific characteristics.
   a) Targeted types of (flexible) technologies, e.g. aggregation of specific flexible technologies such as the charging stations of electric vehicles, versus aggregation of different types of flexible technologies.
   b) Targeted types of (non-flexible and/or flexible) resources, e.g. aggregation of both flexible and non-flexible resources, versus aggregation of only flexible resources which might be subject to additional requirements for sub-metering.
   c) Targeted types of customers, e.g. aggregation of resources of specific types of customers such as residential, commercial, and industrial, versus aggregation of different types of customers.
   d) Targeted techniques, e.g. utilisation of specific techniques for forecasting, communication, optimisation, and control purposes.
2. Service-specific characteristics.
   a) Energy trade at the wholesale level (BRP role).
   b) Energy trade at the retail level (supplier role).
   c) Pure service provision and no interaction with energy markets (service provider for another market party).
   d) Balancing service provision to the TSO (BSP).
   e) Other ancillary service provision to the TSO and/or DSO.

Each business model variation can be mapped to the above set of characteristics, and through this process it is possible to frame relevant requirements for implementation purposes.

2.2 Opportunities, challenges and possible solutions for enabling flexibility through aggregators

Following the formulation of the problem space (see section 1.4), the opportunities, challenges and possible solutions for enabling flexibility, through aggregators, are mapped in **Table 3**, where an effort has been made to consistently answer the following questions:

- Which are the **possibilities** for the deployment of flexibility in the energy system through aggregators?
  - (Optional) Which opportunities can be expected (at system level) by exploring the identified possibilities?
- What stands (**barriers**) in the way for these possibilities to be realised?
  - (Optional) Which is the **position** of TenneT on the identified issue?
  - (Optional) Are there any relevant developments that are worth mentioning?
- How can the identified barrier(s) be removed (**potential solution**)?
- (Optional) Which are the prerequisites and/or conditions (**requirements**) before this solution can work?
- Which actions TenneT TSO might take to promote the proposed solution (**recommendation**)?
- What is the importance of the identified issue and proposed solution (**priority level**)?
  - Priorities (per table list item) were determined through the discussions with the project partners and the interviews with experts. For each of the listed issues, the project partners and the interviewees were asked to indicate in an intuitive manner the priority level of the identified barriers and proposed solutions in terms of system impact and ease of implementation. The responses were averaged and presented on the basis of the following options: Urgent/Semi-urgent/Nice to have.

The items in **Table 3** are categorised in terms of products and services in the Dutch electricity market. The rationale behind this ordering is that aggregators will mainly seek opportunities within the deregulated segments of the electricity sector, i.e. wholesale trade in spot markets, ancillary services markets, and retail markets. Standard topics included in the 'interrelationships' column in **Table 3** are:

- Products and services:
    - Spot markets (see Section 1 in **Table 3**)
        - APX day-ahead
        - APX intra-day
    - Ancillary services markets:
        - Operating reserves (see Section 2 in **Table 3**). Operating reserves for balancing that are currently traded in the Netherlands are presented in **Table 4**. Other ancillary services which are currently traded in the Netherlands but are not treated in this report are presented in **Table 5**
        - Regional network and congestion management (see Section 3 in **Table 3**)
        - Flexibility service provision between market parties (e.g. aggregators, BRPs, suppliers), (see Section 4 in **Table 3**)
    - Retail markets (see Section 5 in **Table 3**)
- Other issues related to the deregulation process (see Section 6 in **Table 3**)
- Phases (in line with the sequence of actions within electricity markets and power systems operations):
    - Design (incl. long-term planning)
    - Planning (short-term)
    - Operations (real-time)
    - (Financial) Settlement

Table 3. Enabling flexibility through aggregators: Possibilities, barriers, potential solutions and requirements, recommendations and priorities.

	Problem definition (Possibilities, barriers, and the position of TenneT TSO)	Proposal (Potential solution and requirements)	Action Plan (Recommendations and priorities for TenneT)	Interrelationships (Topics in **Bold**)
	Section 1: Spot markets (energy exchanges)			
1	**Possibilities:** Aggregators can trade (flexible) energy in **spot markets** (e.g. day-ahead and intra-day). A shorter settlement period in spot markets is expected to support the exchange of flexible energy. Furthermore, harmonising the settlement periods of spot and balancing markets is expected to result in reduced system imbalances and associated costs due to decreased activation of operating reserves by the TSO especially during ramping hours. **Barriers:** In the APX spot markets, i.e. day-ahead and intra-day auctions, market members can trade hourly instruments. One hour is a relatively long time period for exchanging flexibility options and can be seen as a barrier, especially for aggregators that deal with relatively small capacities. Furthermore, wholesale trade on an hourly basis creates barriers for market parties in effectively structuring their energy schedules/programmes since the imbalance settlement system is based on imbalance settlement periods (ISP) of 15 min.	**Potential solutions:** ▪ Implementation of a 15 min. instrument in the APX spot markets. ▪ Disregard the APX intra-day market and use the ETPA for intra-day trade on a basis of 15 min periods. ▪ To some extent ETPA and APX intra-day market might be considered as competing energy exchanges but can also co-exist in a complementary manner. In the short-term, ETPA can support energy trade on a basis of 15 min. periods. In the medium- to long-term the gradual integration of both markets could be a potential solution. **Requirements:** ▪ The electronic auction systems of APX need to be adjusted.	**Recommendations:** ▪ Implementing a settlement period of 15 min. in day-ahead and/or intra-day would require considerable time, but it is recommended to start considering it as it can enhance market access to flexibility, and support a more efficient use of reserves. TenneT could communicate these issues to APX. However, since April 2015, TenneT does not hold shares in APX[7], thus its influence towards APX has been diminished significantly. ▪ Support the ETPA development (e.g. in	**Spot markets** Phase: **design**

[7] EPEX Press release: https://www.epexspot.com/en/press-media/press/details/press/APX_Group_and_EPEX_SPOT_integrate_their_businesses

	Position of TenneT and relevant developments**:** TenneT performs a number of non-regulated activities for supporting the proper and efficient operation of the energy market. The Energy Trading Platform Amsterdam (ETPA) is a recent development (started in April 2016) which is meant to enable the participation of small customers (i.e. parties connected to the grid starting at approx. 0.5 MW) by lowering the thresholds for market entry. ETPA enables market parties to trade energy in blocks of 15 minutes, one hour, one day, one weekend, or one week. TenneT has a share of about 40% in ETPA[6].	▪ Complexity of market coupling and grid security check in Europe based on 15 min. periods need to be dealt with.	establishing sufficient signatories/liquidity) which is expected to go operational in Dec. 2016. **Priority level:** Nice to have / Semi-urgent	
2	**Possibilities:** Aggregators can perform trade in **intra-day** markets. Effective trade close to real-time can be beneficial especially for relatively small market parties with Demand Response (DR) and intermittent Renewable Energy Sources (RES) within their portfolios. **Barriers:** The APX intra-day market is characterised by low liquidity. **Position** of TenneT and relevant developments: The Power Exchanges and the TSOs from 12 countries have launched an initiative called the XBID Market Project to create a joint integrated	**Potential solution:** The liquidity in the APX intra-day market can be increased by lowering the market entry thresholds (see table list item **3**) and by creating larger market zones, e.g. cross-border, thereby the market parties can benefit not only from the national available intra-day liquidity but also from the available liquidity in other areas. ETPA (see table list item **1**) can enhance the market access of small market parties and enhance intra-day trade. APX intra-day and ETPA could be integrated to increase the APX liquidity, for example, by harmonising the settlement periods and bringing the unmatched offers of ETPA to APX intra-day (and perhaps vice-versa) thus increasing the possibility to match a pending offer.	**Recommendations:** Support the XBID Market Project initiative. Continue to support the development of ETPA, and ensure that its entry requirements are plausible for small market parties. Consider the option of supporting the liquidity of intra-day trade through the integration of ETPA and the APX intra-day market. **Priority level:** Nice to have	**Spot markets** Phase: **design**

[6] Press release (Publication date: 30 March 2016), TenneT to support development of flexible energy trading platform for private sector: http://www.tennet.eu/nl/index.php?id=52&tx_ttnews[tt_news]=1576

	intra-day cross-zonal market for continuous trading[8]. The ETPA platform is expected to provide an alternative option to APX for a different market segment for intra-day trade with low-barriers for new entrants and relatively small customers. TenneT plans to increase its shareholding in ETPA in the medium to long term as part of its non-regulated activities which aim to enhance the efficiency and transparency of the electricity market, and thus facilitating the market as effectively as possible[6].	**Requirements:** Requirements for developing a common IT system linking the local trading systems operated by the Power Exchanges, as well as the available cross-zonal transmission capacity provided by the TSOs for supporting a single intra-day cross-zonal market solution. The success of ETPA depends on whether it can establish sufficient market liquidity.		
3	**Possibilities:** Aggregators can access and trade effectively in the **APX spot markets**. **Barriers:** High entry thresholds for relatively small members, and other operational barriers: 1. The required fixed fees for participation at the APX market(s), i.e. market entrance fee, membership fee (per annum), technology fee (per annum), can be so high that can be interpreted as barriers for participation in the APX spot markets[9], especially for relatively small market parties. The light-membership does not yet solve this problem, because the light-member still requires a full-member to process its orders. This incurs additional costs for light-members (usually in the form of an annual	**Potential solution:** 1. The APX market membership fees (and requirements) can be made more rational. Formalise and lower the requirements for light-members (incl. any additional fees to full-members). Provide guarantees, if possible, to the light-members in the case of default of their full-members. 2. Support the process to improve market procedures and the communication between APX and small market parties, specifically: ▪ Simplify the contractual procedures of APX. ▪ Make transparent the formula which is used by APX for calculating the amount of a collateral for a given transaction.	**Recommendations:** TenneT does not hold shares in APX since April 2015[7], thus its influence towards APX has been diminished significantly and will not be able to play a role in these matters. APX is active in the commercial domain and as such it is a matter of the APX board to decide whether to investigate: 1. The current requirements for APX memberships (incl. applicable fees) and	**Spot markets** Phase: **design**

[8] APX, Cross-border intra-day: https://www.apxgroup.com/services/market-coupling/cross-border-intraday/
[9] Price List – APX Power B.V., Effective Date: 1 January 2015: https://www.apxgroup.com/wp-content/uploads/20141218-APX-Power-BV-Price-List.pdf

	contract between light- and full-members, and the fee for this contract is typically higher than the actual light-membership fee). Furthermore, the light-member has to rely on the full-member and its financial stability to avoid risks. The light-membership was originally meant for enabling large industrial companies (with a grid connection) to trade directly on the APX market (independent from suppliers and without collaterals). 2. Relatively small market parties express concerns about the market procedures, and the efficiency of communication: ▪ Communication with APX is problematic: it takes a long time to receive responses from APX staff, and the responses are often insufficient with respect to argumentation. ▪ Long contracts (e.g. about 60 pages of contract whereas it could be shorter). ▪ Long time periods to bring the contract into effect (requires about three months even for light-members) ▪ APX is not always transparent: For example, APX uses a mathematical formula for calculating the amount of a collateral for a given transaction but the relation between the amount of the collateral and the actual transaction is unclear. It does not seem to be related to the actual transaction risks. ▪ The APX day-ahead auction closure (at 12:00 for the next 12-36 hours) is too early to support the forecast process and the integration of intermittent RES. **Position** of TenneT and relevant developments: TenneT facilitates market access for relatively small market parties by ensuring a level playing field.	▪ Move the Gate Closure Time (GCT) of the APX day-ahead market closer to real-time operations. ▪ ETPA could provide an alternative option for energy trade for small suppliers and/or aggregators. ETPA asks for collateral(s) that are actually linked to the associated risk of a given transaction. In ETPA, a formula is defined for calculating the collateral amount that is covering the exact risk of a transaction.	possible ways for lowering and standardising those. 2. Potential market barriers and possible solutions for valid complaints of market parties. **Priority level:** Nice to have	

Section 2: Ancillary services markets for operating reserves				
4	**Possibilities:** Independent aggregators can offer flexibility services by aggregating the flexibility of distributed resources which fall under the portfolios of different BRPs, suppliers etc. This way aggregators can specialise in aggregating resources of a specific type (e.g. heat pumps or electric vehicles of a particular brand). **Barriers:** Standardised market processes (between suppliers, BRPs and aggregators) are lacking with respect to the provision of operating reserves, especially regarding [18]: ▪ the information exchange, ▪ the **transfer of energy** (i.e. the amounts of energy need to be verified and adjusted in the energy schedules between the customers and their BRPs, suppliers and aggregators after a DR measure), ▪ and the financial settlement. With multiple BRPs and/or suppliers involved in the portfolio of an aggregator, verification and settlement becomes more complex. Currently, standardised processes for the provision of operating reserves through aggregators only exist (or are under development) for the provision of incident reserves (see table list item **9**). The aim of TenneT is to facilitate the exchange of data/info but not to intervene in commercial activities between	**Potential solution:** Establish arrangements and market rules that allow customers to access any service provider (incl. aggregators) of their choice without the need for permission of the BRP and/or supplier. The commercial/communication structure between the aggregators (that sells a flexibility service), the customers, and their BRPs and suppliers needs to be arranged. For example, in the case of a DR measure realised by the contribution of different customers, the imbalance adjustment should be arranged between the BRP of the aggregator and the BRPs of the customers. For the energy supplied to the network but not consumed by the customers, the compensation should be between the involved customers and their suppliers. **Requirements:** The transfer of energy and the financial settlement requires predefined criteria and settlement procedures. Existing contracts between customers with suppliers shall be continued and respected, as well as property rights of suppliers and necessary market procedures, e.g. for the balancing and transfer of energy [3].	**Recommendations:** Development of standard solutions with respect to information exchange, transfer of energy and the financial settlement. Investigate whether (and how) the central connection register system (C-AR) could be used for facilitating the communication and commercial activities between market parties. The C-AR contains all (EAN) grid connections with information about the associated Supplier, BRP and MV (metering responsible party) with each connection. More info about the C-AR (e.g. detailed C-AR attributes list) can be found in [23]. C-AR uses standard messages and more info can be found in the information-code[10]. The C-AR is currently administered by Energie Data Services Nederland (EDSN) which is owned by the grid operators	Products and services: **ancillary services markets: operating reserves** In relation also to incident reserves (see table list item **9**). In relation to the management of smart meter data (see table list item **29**). Phase: **design**, **planning**, **operations**, and **settlement**

[10] Informatiecode Elektriciteit en Gas (Information Code Electricity and Gas): https://www.acm.nl/download/documenten/acm-energie/informatiecode-19-februari-2014.pdf

	market parties. The position of TenneT is to facilitate independent aggregators but without obstructing the operation of incumbent BRPs which is essential for the system.		(incl TenneT & Gas Transport Services (GTS)). **Priority level:** Urgent / Semi-urgent	
5	**Possibilities:** Aggregators can provide primary control reserves (Frequency Containment Reserves (FCR)). This way TenneT TSO will get access to additional capacity for the provision of FCR and the competition on the FCR market will increase. **Barriers:** According to the market rules, each unit that delivers FCR requires a metering system with a 4 sec. resolution. As a consequence, it is difficult for aggregators to provide FCR, because this means that all their aggregated resources would need to be equipped with such a metering device. Note that there is no barrier with respect to imbalance adjustment of the BRP's position due to FCR provision, because the energy requirements in FCR are negligible. **Position of TenneT and relevant developments**: Since January 2016, TenneT is involved in pilot projects to identify new solutions for the provision of FCR. About 17 pilot projects are registered and 4 of them have been selected/qualified for an FCR contract with TenneT for a period of 12 months (starting as soon as possible and ending by the latest in Jan. 2018). More info can be found in the website of TenneT as	**Potential solution:** The rule with respect to the metering system (in relation to the verification of the service provision) needs to be adapted in such a way that it becomes possible for aggregators to provide FCR. **Requirements:** Technical challenges for measuring FCR provision (from an aggregation of distributed resources), and data communication to support the verification and settlement process for FCR need to be solved.	**Recommendations:** Continuing the involvement of TenneT in R&D activities and pilot projects together with research institutions and commercial parties. Such activities can support the design of new market rules to enable the participation of aggregators in FCR provision. **Priority level:** Nice to have / Semi-urgent	Products and services: **ancillary services markets: operating reserves: FCR** Phase: **design** and **settlement**

	part of the Corporate News Innovation[11]. In the same article it is mentioned that TenneT is expected to start, in the course of 2017, with another pilot about contracting of regulating and reserve capacity.			
6	**Possibilities:** Aggregators can provide secondary reserves (automatic Frequency Restoration Reserves (aFRR)). This way TenneT TSO will get access to additional capacity for the provision of aFRR and the competition on the aFRR market will increase. **Barriers:** It is difficult for aggregators to provide aFRR, because the technical requirements are very high (e.g. with respect to the delta signal exchange, response signal). Furthermore, the rule is such that each unit that delivers aFRR requires a metering system with a 4 sec. resolution. The verification of aFRR is based on a visual inspection which is performed manually by TenneT staff [24]. This would be too time intensive for a large number of market parties participating in aFRR provision. **Position of TenneT**: the position of TenneT TSO is that it should be possible for small scale flexible devices to (be aggregated and) participate in the bid ladder for aFRR.	**Potential solution:** The rules for the provision of aFRR (e.g. with respect to the metering system) need to be adapted in such a way that it becomes possible for aggregators to provide contributions. A balance needs to be found between expensive technical solutions and adaptation of rules. The current verification process with visual inspection could be replaced by an automated process [24]. **Requirements:** An aggregator active in aFRR requires the BRP role or a contract with another BRP for imbalance adjustment.	**Recommendations:** Research can be conducted to investigate how aggregators can provide aFRR without major modifications in the existing system. **Priority level:** Nice to have / Semi-urgent	Products and services: **ancillary services markets: operating reserves: aFRR** Phases: **planning, operations** and **settlement**

[11] TenneT is preparing electricity system to increase renewable energy (in Dutch). TenneT bereidt elektriciteitssysteem voor op toename duurzame energie: http://www.tennet.eu/nl/nieuws/nieuws/tennet-bereidt-elektriciteitssysteem-voor-op-toename-duurzame-energie-1/

7	**Possibilities:** Aggregators can provide aFRR for close to real-time balancing. Especially with shorter lead time (i.e. the period between bidding and activation of a bid), aggregators can bring more DR options into the system. The lead time applies also to schedule activated (sa) tertiary reserves (mFRRsa) but does not apply to direct activated (da) tertiary reserves (mFRRda) such as incident reserves. For an overview of the operating reserves that are currently traded in the Netherlands, see **Table 4**. **Barriers:** The time period between bidding and activation of aFRR is currently one full clock hour. Thus the lead time is between 4 and 7 ISPs. This lead time is still too long for effectively integrating DR in aFRR provision and supporting the integration of intermittent RES into the system. **Position** of TenneT and relevant developments: A quarterly contract for the provision of aFRR requires availability of 100% (the amount of contracted capacity should always be available in the form of bids). Market parties that want to be able to withdraw their bids (e.g. due to depletion of their DR capability), can offer non-contracted regulating power. Then, they can benefit from energy prices (not capacity prices) and can withdraw their bids one hour in advance.	**Potential solution:** Reduce the lead-time for bidding for aFRR. A first step could be to make the lead time constant (equal to 4 ISPs). Shorter lead time can be facilitated by automation. **Requirements:** IT and market procedures need to be adapted for reducing the lead-time for bidding for aFRR.	**Recommendations:** Initiate a discussion between the IT department and the department of Markets about a possible reduction of the lead time, and considerations about associated implementation requirements. **Priority level:** Urgent/Semi-urgent	Products and services: **ancillary services markets: operating reserves: aFRR**, and **mFRRsa** Phases: **design**, **planning**
8	**Possibilities:** Aggregators can specialise in providing either upward or downward aFRR for close to real-time balancing, because often demand-side resources cannot be regulated in a symmetric way. This way TenneT TSO will get access to additional capacity for the provision of aFRR. Furthermore, by enabling shorter contract periods (e.g. from quarterly to weekly), providers	**Potential solution:** Enable shorter contract periods and separate contracts for upward and downward aFRR.	**Recommendations:** Continuing the efforts that TenneT is currently undertaking in enabling separate contracts for upwards and downwards aFRR capacity in the tender phase, and considering the	Products and services: **ancillary services markets: operating reserves: aFRR** Phases: **design**, **planning**

	can better plan their resources that are dependent on weather conditions. **Barriers:** The tenders for the provision of aFRR require annual/quarterly contracts with products that are symmetric for upward and downward aFRR capacity (but the bids are not symmetric). Contracts with non-symmetric products are not accepted. The periods for which the aFRR contracts apply, are still too long (currently there is an option for quarterly contracts). **Position** of TenneT and relevant developments: TenneT is committed to implement the procurement for aFRR capacity separately for upward and downward regulation. The Network Code on Electricity Balancing shall define common principles for the procurement of reserves, particularly, procurement in the future shall be made for upward and downward reserves separately [25]. These rules concern secondary and tertiary reserves and so far do not apply to primary control reserves. However, this may change in the future. After a shift from yearly to quarterly contracts, TenneT currently considers weekly contracts for aFRR (but such an implementation is expected to take time).		possibility of weekly contracts for aFRR. **Priority level:** Nice to have / Semi-urgent	
9	**Possibilities:** Aggregators can provide tertiary reserves (manual Frequency Restoration Reserves (mFRR)) for downwards emergency power (i.e. incident reserves or 'Noodvermogen' in Dutch). This is expected to open new opportunities for aggregators to offer this service, especially when such reserves are delivered from demand-side resources and are expected in many cases to be	**Potential solution:** Introducing separate tenders/contracts for upward and downward capacity of incident reserves.	**Recommendation:** Enable the possibility for contracting downwards capacity for mFRR. TenneT has decided on this aspect but the tender has been postponed several times.	Products and services: **ancillary services markets: operating reserves: mFRRda: incident reserves**

	available only at the one side of the spectrum (upwards or downwards). **Barrier:** Currently, TenneT offers contracts only for upwards capacity of incident reserves. See **Table 4**. **Position** of TenneT and relevant developments: It is expected that TenneT will introduce contracts for downwards capacity of incident reserves by 2018. Due to the differences between the service provision of regulating power and incident reserves, the providers of incident reserves receive a higher price for the energy component (+10% of the marginal price, i.e. the last activated bid of regulating power (aFRR)) as part of the system design. The incident reserves are required in emergency situations and therefore the energy price difference is an incentive for successful procurement. In contrast, the capacity payments are much higher for regulating power than for incident reserves (currently are about 10 times more).		**Priority level:** Semi-urgent	Phase: **design**
10	**Possibilities:** Aggregators can provide mFRR for emergency power (i.e. incident reserves). **Barriers:** There is an issue with the verification and the imbalance adjustments of the BRPs. Especially with the entrance of many new parties (portfolio-based aggregators). If you have a portfolio with several connections and several BRPs then it is difficult to make an appropriate imbalance adjustment to the concerned BRPs. The settlement approach for the provision of incident reserves is quite accepted but in practice this is a rather conservative approach to estimate the response of a provider of incident reserves [9]. Currently the total response is calculated based on the difference	**Potential solution:** In the future with an automated process for the settlement of incident reserves provision, it might be possible for TenneT to simply settle for the difference between the measured power (portfolio-based) and a reference value (the expected position of the provider, e.g. based on its e-programmes). One idea is that the providers of incident reserves could provide a forecast to TenneT about their position in the short-term future, e.g. in a time horizon of 5 min. to support the verification of service provision. That idea was worked out in the past at TenneT (around 2010), but was eventually declined by a manager.	**Recommendations:** Conduct research to support automating the verification and settlement processes for the provision of incident reserves**.** **Priority level:** Nice to have	Products and services: **ancillary services markets: operating reserves: mFRRda: incident reserves** Phase: **settlement**

	between the reference value (i.e. the average power measurement in the 5 min. period prior to the activation call time) and the power output 15 min. later [9]. This baseline methodology assumes a rather constant power profile during the service provision (which might span several ISPs) and does not take into account the rebound effect associated with DR (see table list item **26**). The calculated response is an estimation which might result into disputes between market parties about improper allocation of energy volumes and hinder the further development of DR in the provision of incident reserves. **Position** of TenneT and relevant developments: TenneT has contracted incident reserves through aggregators for about 7 years and the most important barriers have been already removed. The activation and termination is by phone call. Currently, TenneT is in discussions with market parties about a new proposal for mFRRda provision [26], see also table list item **11**. Relevant aspects for future research are about automating the process.	**Requirements:** The settlement process of incident reserves provision needs to be redefined and be automated.		
11	**Possibilities:** Aggregators can provide mFRR for emergency power (i.e. incident reserves) through load-shedding measures. **Barriers:** Incident reserves are contracted by the TSO (availability and activation). In the case of load-shedding, the balancing energy is the energy contracted with the supplier(s), but is not any more visible on the metered values of their customers. The result is a loss of revenue for suppliers due to the activation of incident reserves. The lack of exact requirements for settling imbalances between the customers (or their aggregator) and their	**Potential solution:** This is an administrative/commercial issue that should be solved by the market. TenneT could facilitate the development of establishing rules and let the market parties solve their issues in-between them, or act as a supervisor and perform the check on behalf of the commercial parties. **Requirements:** The commercial/communication structure between the aggregators (who sell a product/service to TenneT), the customers (the connected parties), and their BRPs and/or suppliers need to be properly arranged. The structure should	**Recommendations:** Support the design of a standardised solution that enables the proper communication and interaction between market partiesm. The solution should enable that aggregators can facilitate these transactions on behalf of their customers (the connected parties).	Products and services: **ancillary services markets: operating reserves: mFRRda: incident reserves** Phase: **settlement** In relation with profile-based

	suppliers is a barrier for further developing commercial load-shedding for the provision of incident reserves. **Position** of TenneT and relevant developments: Currently, as part of the tendering procedure, TenneT requests that the providers of incident reserves have contractual arrangements with the connected parties and their BRPs, and list them according to Annex 3 of the contract [9]. Typically, the BRP and supplier roles are taken up by the same market party, thus there is no need to list also the suppliers in Annex 3. The **Pool-PV** concept has been introduced, as part of the tendering procedure for incident reserves to solve issues about imbalance adjustments. Note that the term PV (programmaverantwoordelijkheid: program responsibility) is equivalent to the BRP term. When a provider is called to provide incident reserves the total response is measured and is deducted from the imbalance accounts of the BRPs of the connected parties. The total response might be more or less than what was asked by TenneT and the difference is attributed to the **Pool-PV**. The BRP of the actual connection does not face any risks because the imbalance if any goes to the **Pool-PV**. Currently, TenneT is in discussions with market parties about a new concept proposal for the provision of emergency power, which aims to tackle two mains issues [26]: firstly, the shortcoming related to the imbalance adjustment through the **Pool-PV** whereas only the BRPs of the connected parties should be assigned any imbalance according to the market model, and secondly, the role of the supplier which is not present in the current system.	take care that customers compensate their suppliers.	In the future, there might be more than one supplier associated with a unique EAN connection to the grid. Thus, it is recommended to also include a full list of suppliers for each EAN connection in Annex 3 of the contract for incident reserves [9]. The solution must also include a baseline methodology to quantify the performance of flexibility service providers and provide a basis for the **transfer of energy**. Currently, TenneT is in discussions with market parties about a new concept proposal for the provision of emergency power [26]. It is recommended to continue this dialogue and to initiate a research project for investigating the optimal solution. **Priority level:** Urgent	allocation, see table list item **29**. The current issue concerns emergency power (incident reserves), but it is relevant to consider also other products/services and be prepared for future developments (see table list item **4**).

12	**Possibilities:** Aggregators can provide mFRR for emergency power (i.e. incident reserves). **Barriers:** Administration in relation to the Annex 3 of the contract for incident reserves [9] is relatively high and makes the service provision relatively expensive for small suppliers (e.g. E.D. Mij).	**Potential solution:** Automate the process of reporting associated grid connections which provide flexibility services (EAN) on the basis of 15 min. periods and for each day.	**Recommendation:** R&D activities. **Priority level:** Nice to have	Products and services: **ancillary services markets: operating reserves: mFRRda: incident reserves** Phase: **design**, **planning** and **settlement**
13	**Possibilities:** Aggregators can receive payments from capacity contracts for incident reserves. The capacity payments/fees for incident reserves are defined based on a request for tenders (to contract 350 MW capacity of incident reserves according to the ENTSO-E requirements about dimensioning mFRRda). The least expensive bids of the participating suppliers are accepted, and subsequently the capacity fees are defined. **Barriers:** The economic incentives for the provision of incident reserves are reducing. Market parties claim that the capacity payments/fees are relatively low and are decreasing over the past years, whereas the activation times of incident reserves is increasing. For example, a few year ago the activations of incident reserves were about 12-14 times per year and currently is about 40-50 per year. The capacity payment used to be about 50 k€/MW/year and currently is less than 10 k€/MW/year.	**Potential solution:** Considerations for creating additional incentives for contracting capacity for incident reserves.	**Recommendation:** The decreasing capacity fees for incident reserves is a result of the competitive market. Perhaps TenneT could revise the characteristics (e.g. activation/utilisation) for incident reserves. The issue of increasing activations for incident reserves might be related to the large coal-fired power plant that came in operation in 2015 by RWE, in Eemshaven, Groningen, with a capacity of 1560 MW. In the past there was a need to activate incident reserves more frequently but it is expected to be less frequent in the future. This topic could be further investigated through research activities. **Priority level:** Nice to have / Semi-urgent	Products and services: **ancillary services markets: operating reserves: mFRRda: incident reserves** Phases: **design,** and **planning**

14	**Possibilities:** Aggregators can access market information about available FRR and effectively contribute to system balancing. **Barriers:** Recently TenneT had to activate incident reserves (mFRRda), which is a supplementary balancing tool, but these reserves are not visible in the merit order list for FRR (aFRR/mFRRsa). Non-transparency in the market is a barrier for aggregators and other market parties in order to effectively perform their market-based activities. **Position** of TenneT and relevant developments: The position of TenneT is to make the market more transparent by making visible all the reserves that are available at each ISP.	**Potential solution:** Merge the capacity of incident reserves with the FRR merit order list. The resulting bidding ladder (new type) will make the market more transparent by making visible the total available capacity for FRR. **Requirements:** Actions are required to make the incident reserve capacity supplementary to the FRR merit order list.	The process is on-going, and it is expected that TenneT will introduce it before mid-June 2016. **Priority level:** Urgent	Products and services: **ancillary services markets: operating reserves** Phases: **design** and **operations**
15	**Possibilities:** Aggregators can participate in the provision of mFRRsa. **Barrier:** In some cases, TenneT might bypass the bids for mFRRsa in the merit order list by calling the incident reserves, i.e. mFRRda. Market parties are concerned about it and they would like perhaps to use their available mFRRsa capacity for other purposes (own imbalances or passive contribution), especially since mFRRsa receive only payments for the energy component (capacity payments are not applicable). **Position** of TenneT and relevant developments: TenneT might bypass mFRRsa and use directly the incident reserves, in order to effectively deal with considerable system imbalances. Whether to bypass mFRR bids from the merit order list or not is a decision of the human operator, but the exact criteria are not disclosed.	**Potential solution:** A potential solution could be to allow the market parties to withdraw their mFRRsa bids once there is an activation of incident reserves. In this way, the providers of mFRRsa capacity can use it for own purposes.	**Recommendations:** Consider the implementation of the proposed solutions. **Priority level:** Nice to have	Products and services: **ancillary services markets: operating reserves: mFRRsa** In relation to lead time issue, see table list item **7.** Phases: **design** and **operations**

16	**Possibilities:** Aggregators can participate in the provision of aFRR and mFRR. **Barriers:** The minimum bid sizes (in MW) for aFRR and mFRR (see **Table 4**) may prevent small-scale aggregators to offer these reserves.	**Potential solution:** Either make the thresholds lower or remove the bid size constraints for all products. **Requirements:** When min. bid sizes are reduced the bidding system needs to be automated, otherwise the system will become too complex with an increasing number of smaller bids.	**Recommendations:** Consider the option of removing the bid. Size constraints from the bidding process for operating reserves. **Priority level:** Nice to have	Products and services: **ancillary services markets: operating reserves** See min. bid size in **Table 4**.
17	**Possibilities:** Aggregators can provide passive contribution in system balancing. **Barriers:** Aggregators and other market parties face high risks when **system state 2** occurs, especially at the end of the ISP where there is little room for adjustments. System state 2 corresponds to both upward and downward regulation during an ISP [6]. There are two possible explanations for entering into system state 2: 1. Due to an overshoot (too much passive contribution). 2. Due to gaming tactics of major market parties. For example, the parties that participate actively in the bidding ladder have more insight into the balancing state of the system and might influence it in the last minutes of the ISP, e.g. to get one of their other bids in the balancing market. **Position** of TenneT and relevant developments: At TenneT there is an unofficial policy that when incident reserves are activated then the system state 2 is not applied. The reason is that when the system is in emergency state, the TSO needs support to alleviate this situation. Applying system state 2 would demotivate those parties that are	**Potential solution:** Adjust the definition of state 2. Currently, the regulation state is determined by TenneT as follows: where TenneT in any ISP regulates both upward and downward, with the balance delta representing [6]: ▪ neither a continuous non-incremental nor a continuous non-decremental sequence ▪ both a continuous non-incremental and a continuous non-decremental sequence Another definition might be to allow an extra time margin before entering into system state 2). Perhaps the unofficial policy of not applying system state 2 when incident reserves are activated, could become an official policy. Furthermore, TenneT could reconsider the way the marginal price of FRR. Now, a bid called at the last minute of an ISP influences the system state and the imbalance prices in that ISP.	**Recommendations:** The definition of system state 2 can change (it was also done in 2006), there is some liberty in determining system state 2, e.g. through the definition of the Processed Area Control Error (PACE) or the balance delta signal. Perhaps this can be changed again to facilitate aggregators contributing passively to system balancing. R&D activities. **Priority level:** Nice to have	Products and services: **ancillary services markets: operating reserves: passive contribution** Phases: **design** In relation to table list item **21**.

	supporting the system in restoring its balance through passively contribution. Experts at TenneT do not see possibilities for gaming, since all BRPs face a loss when system state 2 occurs. The Dutch system with its dual pricing scheme is quite unique, whereas other systems with single price, are susceptible to gaming because parties can contribute to different directions (upwards and downwards regulation) and cause system instabilities. In the Dutch system a BRP that faces an internal imbalance which worsens the system balance during an ISP will subsequently face financial penalties, and these penalties will also be applied when system state 2 occurs (a losing party cannot turn into a wining party). A BRP that faces an internal imbalance which alleviates the system imbalance during an ISP will subsequently receive financial benefits (through passive contribution), but these benefits will not be applied when system state 2 occurs (a winning party can turn into a losing party). In this way -mentioned instability issue is removed from the Dutch system.			
18	**Possibilities:** Aggregators with acknowledgment of the BRP role can receive revenues from passive contribution in balancing under certain conditions. Any imbalance of a BRP in the opposite direction to that of the system will reduce the use being made of the bid ladder and will be compensated as it results in reducing the collective imbalance price risk. **Barriers:** The level playing field is distorted, because any imbalance of a BRP will be offset at the same price as the requested volume from bids except for the incentive component. The **incentive**	**Potential solution:** Remove/Revise the incentive component. **Requirements:** Adaptations might be required in the imbalance pricing system and price formulation [6].	**Recommendations:** Conduct research activities to investigate the application and historical utilisation of the incentive component, its effect in the imbalance settlement system and possible improvements in its use. **Priority level:** Nice to have	Products and services: **ancillary services markets: operating reserves: passive contribution** Phase: **design**

	component is part of the imbalance price formulation [6].			
19	**Possibilities:** Aggregators can benefit by a measure which enables them to bring their unmatched intra-day market bids to the balancing market. This will support the TSO balancing performance. **Barrier:** This option is not available.	**Potential solution:** Transfer remaining intra-day market bids to the bid ladder for non-contracted aFRR (and/or mFRR). Reduce the lead-time for aFRR (and/or mFRR) products from 1 hour to e.g. 5-15 min., because the intra-day market has a shorter lead time, e.g. 5-15 min. **Requirements:** If such an implementation is allowed then it should be restricted only within the Dutch system and should not be allowed cross-zonal before harmonising the pricing schemes among the interacting systems (see table list item **33**).	**Recommendations:** Perhaps this is more relevant for aFRR as there is not much use of manual reserve power (mFRR). The option of passive contribution can also be used for this purpose but its provision is at the market party's own risk. **Priority level:** Nice to have	Related to table list item **7**. Phase: **design**
20	**Possibilities:** Aggregators can provide FRR (incl. cross-border exchange of reserves). **Barriers:** Regarding the TSO – TSO cooperation for the exchange of mFRRda which entails the inter-TSO cooperation, with TSOs solely procuring reserves from BSPs within their own LFC Block. No foreign BSP-TSO communication is present [27]. Some market parties argue that this scheme is in place only for the benefit of the TSO institutions and not for the market. The complaint towards TenneT is that the benefits stay with the TSO, whereas those should also reach the BRPs/BSPs. When there is an activation of mFRRda (e.g. exchange with BE), the market will not know that these dedicated incident reserves were activated, as this is an internal issue, and the settlement is on	**Potential solution:** The TSO - TSO cooperation concept is considered as straightforward with least prerequisites, and transparent [27]. The (socio-economic) benefits due to reduced balancing costs are for the entire system, whereas the market parties can still trade their available flexibility capacity in the market. In the future, a potential improvement would be to move from bilateral TSO - TSO cooperation to multilateral TSO – TSO cooperation with common merit order list [27]. This would provide aggregators with the possibility to access cross-border markets. **Requirements:** The utilisation of common merit order lists requires the harmonisation of pricing schemes. The issue is that exchanging reserves with another TSO will influence the marginal price and imbalance price in NL, and the imbalance price will not anymore reflect the local scarcity conditions. The condition for mFRRda activation between TSOs,	**Recommendations:** Set clear, objective, and harmonised requirements for cooperation for the exchange and share of reserves, between and within synchronous areas. In relevance with the development of the ENTSO-E Network Code on Electricity Balancing. **Priority level:** Nice to have	Products and services: **ancillary services markets: operating reserves** In relation to table list item **33**. Phase: **design**

	the basis of the contractual relationships with the providers. **Position** of TenneT and relevant developments: Due to the sharing of reserves between TSO institutions (e.g. NL and BE), the involved TSOs save a considerable amount of money for reserve capacity procurements and this leaves more flexible capacity on the market. The benefits from reduced balancing costs are for the entire system.	is that a TSO will only request these reserves when its merit order list resources have been saturated.		
21	**Possibilities:** Aggregators with acknowledgment of the BRP role can provide passive contribution in system balancing. Passive contribution is considered a low-key business model. Its simplicity is considered an advantage. In recent years, there are larger spreads of imbalance prices (compared to wholesale levels) which can result in increased revenues from passive contribution. **Barriers:** Passive contribution is currently becoming less interesting because there are less volumes of total imbalances due to the netting since 2011. Further netting of imbalances between the Netherlands and other balancing areas will have a negative impact to the business model around passive contribution.	**Potential solution:** The design of the passive contribution option might be revised.	**Recommendations:** With decreasing revenues from passive contribution, the focus of the market parties might turn to other products that offer capacity payments (the capacity payment benefit is not applicable through passive contribution). TenneT can revise the design of the passive contribution option in relation to the risks of system state 2 (see table list item **17**) and the incentive component (see table list item **18**). **Priority level:** Nice to have	Products and services: **ancillary services markets: operating reserves: passive contribution** Phase: **design**

Section 3: Regional network and congestion management				
22	**Possibilities:** Aggregators can aggregate the contributions of distributed resources (small generators, demand, RES, and storage) and provide ancillary services including location-specific services to regional network operators, i.e. Distribution System Operators (DSOs), to support them with, for example, congestion management, peak-shaving, and voltage control. This way the DSOs can get access to a variety of resources/services which they might use for performing their tasks, reducing energy losses in their operating networks, and deferring investments related to network reinforcement and network expansion that results from increasing electrification. In the future, a DSO might procure ancillary services from system users, if needed, in a similar way that the TSO procures ancillary services for balancing purposes. By setting a framework where DSOs can buy flexibility options such as peak-shaving services, if needed, this creates a situation with natural incentives for the DSO to upgrade an aged network where peak-shaving services become necessary more frequently (and subsequently more expensive). DSOs should receive relevant data that allows them to assess the impact of activation of balancing services and other flexibility services on their operating grids, and to set predefined limits before activation. If potential constraints are identified, then the DSOs should be able to communicate the	**Potential solution:** Create a flexibility platform with low barriers for participation in intra-day trade and ancillary services. Perhaps in relation to the Concept Mission: Unlocking flexibility MV and LV network [28]. A common platform can be created where flexibility services can be exchanged between TSOs, DSOs and market parties. The provision of location-specific services can be enabled by adding location tags to the customers' flexibility offers. Ideally, the provision of flexibility services shall be organised in a generic way so that they can serve different purposes (i.e. congestion management at the local level and operating reserves at the system level) and various actors (e.g. TSOs, DSOs, market parties). TSOs and DSOs could have access to the required data from a connected party to the grid (i.e. a system user) through an aggregator, however, data integrity and visibility must be ensured for TSOs, DSOs and other market players [20]. The development of the ETPA is expected to provide an option for intra-day trade with low-barriers for new entrants and relatively small customers. If a platform such as ETPA could attribute location tags to the bids then it could be possible to match bids with requests for location-specific services (e.g. by DSOs).	**Recommendations:** Aggregators can play a major role in unlocking flexibility. The regulatory framework and subsequent data management model should support the data exchange, taking into account the needs of TSOs and DSOs to receive relevant information [20]. It is recommended to start a dialogue on whether (and how) a common platform can accommodate transactions of flexibility for different purposes and actors on a level playing field. Prioritise the provision of ancillary services from renewable energy generators and demand side management resources, e.g. operating reserves, and reactive power. Some recommendations with respect to the specified requirements: ▪ Administrative areas can be defined hierarchically, e.g. at the interface of the transmission (HV) and the distribution level (MV/LV). In the case of congestion at the distribution level, the aggregator could select its	Products and services: **ancillary services markets: Regional network and congestion management**

	potential impact with the aggregators/BRPs/TSO, and decide on additional measures. This could be supported by an IT architecture with data exchange interfaces encompassing all DSOs within a TSO's control area [20]. **Barriers:** Currently there is no available platform (not even as a conceptual design) to enable the provision of ancillary services at the local level and the proper communication between system users, market parties and grid operators. **Position** of TenneT and relevant developments: Currently there is no real need for a common platform to deal with congestion at the distribution level as there are no such occurrences (yet). However, these concepts are relevant also for the TSO and the position of TenneT is to be prepared for future developments. TenneT is currently working on a use-case together with Stedin DSO. ETPA is also a partner in this initiative. The primary goal is to define the conceptual issues with respect to flexibility services for congestion management.	**Requirements:** Such a development would require: ▪ Defining administrative areas within the grid and modes of operation (e.g. to indicate which grid areas are in normal operation and which in congestion mode), and installing measuring equipment at substations (e.g. Medium Voltage (MV) and/or Low Voltage (LV) level). ▪ Developing standard communication systems to enable proper communication between grid operators and market parties. Formulating an interaction framework between the TSO and DSOs to avoid conflicting requests and inefficient operations, e.g. in the case that a DSO procures flexibility services which might be in contrast with a request by the TSO for downwards (or upwards) regulation. Major associations and grid operators have agreed that a coordination process is needed to ensure that a flexibility bid can only be activated once and will not cause problems in the grid [20]. ▪ Defining common rules for the verification of the service provision and the financial settlement. The DSO is mostly interested in power capacity, however, adjusting the power demand has an impact on the energy requirements and the programmes of the associated BRPs.	customers who belong to that administrative area based on the location tags of their flexibility offers. If no congestion arises, then the same flexibility offers should be available for other purposes, e.g. for contributions in system balancing. As part of the USEF, a common reference model is defined which is mainly meant to communicate about congestion incidents and congestion areas in the distribution grid. This common reference model can (perhaps) be integrated with the C-AR system to support the exchange of messages in situations of congestion. ▪ Exact criteria shall and can be formulated for coordinating the interaction between the TSO and DSOs, and market parties. The modes of operation shall be prioritised. The logic is that local problems should primarily be addressed by the resources that are located close to the fault occurrence, whereas global (provincial, national) challenges such as system imbalances can	

			be addressed by all system resources. ▪ Adjustments on the positions of the customers' suppliers and its BRPs shall be performed in relation to the transfer of energy (see table list item **4**). In the case of service provision at the distribution level, the remuneration should not be valued less than other ancillary services so that market parties have a natural incentive to reserve resources for this purpose, e.g. these services should be valued at least at the same level with other ancillary services such as contributions in balancing. **Priority level:** Nice to have / Semi-urgent	
23	**Possibilities:** Aggregators can support their customers in managing their peak-demand and and/or generation and let them benefit from lower network (connection) tariffs. Such an approach does not require central control or settlement. The settlement can be on the basis of the customers' locally metered values. **Barriers:** Currently, in the Netherlands, there are little options available in terms of differentiated components in the distribution tariff [21]**:**	**Potential solution:** ▪ The idea of enabling differentiated tariffs for grid connections by the DSOs (in a bottom-up approach), e.g. during certain time periods would provide a price incentive for customers' responsiveness. ▪ Considerations for reducing the disproportionate share of costs borne by residential customers based on their energy consumption (e.g. revise the components of fixed charges and/or capacity charges).	**Recommendation:** Research activities. **Priority level:** Nice to have	Products and services: **ancillary services markets: Regional network and congestion management**

	▪ There is no time of use differentiation in electricity distributions tariff for all consumer groups. ▪ There is a disproportionate share of costs borne by residential customers, and to a lesser extent by commercial customers, based on their energy consumption. ▪ Regarding connection charges, only shallow charges are in effect for consumers and embedded generators and there are no targets and/or incentive schemes in place to enhance hosting capacity. **Relevant developments** [21]**:** In the Netherlands voltage level and the contractual power are the main variables for identifying tariff categories. The distribution tariff for residential customers includes a fixed charge, a capacity charge (the capacity charge depends on the maximum power contracted and billed to end-users in €/kW) and a charge for metering (the metering charge is only applied to small customers). Usually in the countries where the system users pay for a capacity charge, they do not pay for a fixed charge. In the Netherlands, the fixed charge is 215€ (in the average distribution network cost for the year 2013) for households (household consumer are typically defined as having a 3x25A connection with an annual average consumption of 3500 kWh connected to the low voltage grid and a contracted capacity of 6 KW). DSOs have full responsibility for managing and owning the meters, for small customers. Suppliers are responsible for the collection and validation of the data.	▪ Considerations for more sophisticated methods to calculate the connection charges, e.g. offering different options to customers based on their capacity, may provide incentives for the deployment of alternative (smart grid) technologies at the customers' side in order to benefit from lower connection charges. **Requirements:** ICT requirements, tariffs definition, regulatory aspects in relation to ACM. In the Netherlands the main responsible in setting distribution tariffs is by the DSO and the National Regulatory Authority (NRA) [21]: ▪ DSO: Proposes tariffs (and allocations of total income) to the NRA ▪ Government: The minister of Economic Affairs sets the principal tariff structure ▪ NRA: Makes final decision on proposed tariffs		

Section 4: Flexibility service provision towards market parties				
24	**Possibilities:** Aggregators can provide flexibility services to other market parties (BRPs or suppliers), e.g. for portfolio optimisation, management of imbalances etc. **Barriers:** Currently, there are no platforms available to enable the exchange of flexibility services between market parties for optimisation purposes. Existing arrangements are based on contractual agreements between market parties and/or relationships between a (parent) companies and its subsidiaries. **Position** of TenneT and relevant developments: For TenneT it is crucial to enable improved market access to flexibility and enhanced energy exchanges. TenneT has a share of about 40% in the ETPA. ETPA is expected to go operational in Dec. 2016 (see table list item **1**).	**Potential solution:** The ETPA could provide a potential solution as a trading platform capable of providing access to flexible capacity with opportunities to conclude short-term intra-day contracts. **Requirements:** Establishing sufficient liquidity in ETPA (ensure low market entry barriers) and allowing for relatively short-term trade.	**Recommendation:** The development of ETPA can provide considerable options for the exchange of flexibility services between market parties (through short-term trade). Flexibility services are relevant for grid operators (TSO and/or DSO institutions) and commercial parties, thus considerations for developing a common platform for the exchange of flexibility services among various actors are relevant both for system security and market optimisation (in relation to table list item **22**). **Priority level:** Nice to have	Products and services: **Flexibility service provision towards market parties**

Section 5: Retail market for energy supply and demand response				
25	**Possibilities:** New market entrants such as aggregators or small suppliers can compete at a level playing field with incumbent market players in attracting new customers. This could increase the competition in the electricity market. **Barriers:** In some cases, small suppliers have difficulties to attract customers that ask for long-term fixed-price contracts, because the suppliers have to ask for a collateral in return (something pledged as security for repayment of a loan, to be forfeited in the event of a default.). Large suppliers have the financial capacity to provide long-term contacts at fixed price without asking for a collateral. This inequality distorts the level playing. Another barrier for relatively small suppliers (with low financial capacity) is that large suppliers might even offer energy prices to their customers that are below the market prices.	**Potential solution:** Consideration for establishing level playing field with incumbent utilities. Perhaps the regulator (ACM) could take measures that prohibit the distortion of competition, e.g. by not allowing retail sales below the market prices. Though, such measures should be implemented in a manner that does not obscure the free market development.	**Recommendation:** This item is more relevant for the national regulator (ACM) rather than for TenneT TSO. **Priority level:** Nice to have	Products and services: **Retail market for energy supply and demand response**
26	**Possibilities:** Aggregators can develop DR programmes. **Barriers:** ▪ In the Netherlands, the 'Vangnet' regulation is a guarantee scheme to ensure that "reasonable rates" are charged to the retail customers for the supply of electricity and gas. Suppliers have to negotiate with the regulator (ACM) which retail tariffs they may charge even though it is a liberalised market. According to the Dutch ministry of Economic Affairs there are no regulated prices for energy supply in the Netherlands, and the 'Vangnet' regulation is	**Potential solutions:** ▪ The ACM could start promoting DR by publishing the secret calculation method that is used for regulating the supply prices. Adjustments in the regulation or even abolishment of the 'Vangnet' regulation in communication with the regulator (ACM) could be a way forward in stimulating DR but this would require a change of the law. However, even if the ministry could be convinced, then they most probably would not initiate the necessary change of the law, because of fear that there is no sufficient political support for abolishment in Parliament. A mainstream perception among politicians is that suppliers are	**Recommendation:** Research activities. **Priority level:** Nice to have	Products and services: **Retail market for energy supply and demand response**

	nothing more than a 'last resort' regulation to protect customers. However, according to an advisor at an energy supplier company, the way this legislation is interpreted and executed by the ACM makes it a real barrier for developing DR programmes. ACM has many requirements for suppliers that would like to develop demand response programmes for their customers, such as variable pricing schemes, e.g. hourly prices. ACM also 'threatens' suppliers who are charging their customers too much (according to the <u>secret calculation method</u> of the ACM), with public disclosure and an official warning. Suppliers are afraid of getting such an official warning because customers would probably switch in bulk to others and that could lead to bankruptcy of the supplier concerned. This attitude of the ACM might lead to a very conservative behaviour of suppliers and can be interpreted as a barrier for DR. ▪ The lack of standard baseline methodologies to support verification and settlement procedures. ▪ The lack of methods to account for the 'rebound' effect: e.g. the load increase following the activation of a DR measure, and its impact on the positions of BRPs and suppliers.	making big profits at the expense of their customers. ▪ The deployment of electronic meters can support the development of more sophisticated methods for establishing baselines. ▪ Depending on the DR resource (in question) and its operational characteristics, appropriate models can be developed for estimating the 'rebound' effect. Such models can be used for adjusting the positions of involved market parties and defining compensation measures		

Section 6: Other issues related to the deregulation process				
27	**Possibilities:** Aggregators and other market parties can operate in the deregulated sector without competing with subsidiaries set up by grid operators. **Barriers:** Recently grid operators have been setting up subsidiaries in the areas of energy trade and facilitation of energy transactions. According to the law, grid operators (and their subsidiaries) should not engage in any activities that may be regarded as production, supply and trading of electricity.	**Potential solution:** These are quite new developments, and it is still rather early to conclude on the role of such subsidiaries, and possible implications with deregulated activities. It is relevant for TenneT to follow these developments and stay informed about secondary activities developed by grid operators. In the case that such secondary activities, are not related to the infrastructure, and might pose risks to the grid, the Dutch regulator, ACM, shall be informed and take actions. ACM calls grid operators (network companies) to be transparent about their activities.	**Recommendation:** It is advised for TenneT to facilitate a dialogue with the regional grid operators, perhaps through the association of Netbeheer Nederland, to ensure a proper functioning of the market with respect to these developments. **Priority level:** Nice to have	In relation to: **Other issues related to the deregulation process**
28	**Possibilities:** Aggregators and other actors in the sector (suppliers, BRPS, DSOs) can benefit from a proper data exchange among them, especially when the actions of one actor might have an adverse impact on other actors. **Barriers:** Actors currently do not have the resources to communicate all incidents to other actors. As a result incidents like the following are happening. A customer of a relatively small supplier/BRP, E.D. Mij, changed transformer (at his point of connection to the grid) in communication with his DSO, Liander, and was disconnected from the grid for about a week during which he was supplied by a diesel generator. E.D. Mij learned about this incident after having measured a demand of zero at that point of connection, and contacting the customer. Liander declined any responsibility in the imbalance costs faced by E.D. Mij, and stated that this might happen again as that they do not have the resources to communicate between the	**Potential solution:** An automatic warning system based on C-AR could enable proper data exchange among actors. For example, a DSO that disconnects a customer from the grid (due to maintenance/upgrade or any other reason) can place a message in the C-AR, through which the relevant actors can be informed.	**Recommendation:** Investigate the severity of the problem and how the C-AR is currently used for the exchange of notifications due to field work by grid operators (e.g. transformer replacement) and/or metering companies (e.g. instalment of a meter) etc. Investigate which solution is the most suitable for implementation. R&D activities. **Priority level:** Nice to have	In relation to: **Other issues related to the deregulation process**

	department that is responsible for planning of field work and the department that does the communication with the BRPs.			
29	**Possibilities:** Aggregators can develop new services based on the smart meter data of their customers. These new services can make the electricity system more efficient and provide benefits to the customers. **Barriers:** ▪ Currently, in the Netherlands, customers can access their consumption data via a DSO web portal, with quarter-hourly readings available one day after consumption. The resolution of 15 min. readings is perhaps too long to support contributions within an ISP (e.g. balancing close to real-time), whereas the one day delay in accessing the data might hinder the provision of services close to real-time operations. ▪ The deployment of smart meters is slow especially for relatively small customers such as residential customers. There are currently 600,000 smart meters installed in households of small customers in the Netherlands. The total amount of small customers is about 7.5 million, and there are targets in effect to have all small customers´ homes supplied with a smart meter by 2020 [21]. ▪ The profile-based allocation system actually obscures BRPs/suppliers from reaping the full benefits of DR measures. Profile-based allocation means that the BRP/supplier buys the energy at wholesale level based on a predetermined profile of its customers and that the settlement is also based on this profile (followed by a reconciliation process at the end of the year where the market parties have to settle the differences between them based on the annual measured values). **Position** of TenneT and relevant developments: ▪ At the beginning of 2017 small customers will get the option to switch from profile-based allocation to electronic meter-	**Potential solutions:** ▪ Smart meter (consumption) data are stored locally and customers can purchase additional hardware to access real-time metering data via the meter interface P1. This option could provide real-time readings with a resolution of 10 seconds. Nevertheless, a standard solution for close to real-time data access via the central data hub with a resolution of 10 seconds to 1 minute could support the development of new services (incl. access to third parties such as suppliers and aggregators through the meter interface P4 and with the consent of the customers). ▪ Provide incentives to customers to switch from profile-based allocation to electronic meter-based allocation, e.g. by increasing customers' awareness about available options and associated benefits, and by involving the customer in the design process of DR through aggregators. ▪ Phase out the profile-based allocation system and support the development of DR programmes for retail customers by establishing standard allocation solutions based on smart meter readings.	**Recommendation:** Establish official solutions for smart meter data access (standard metering procedures and exchange messages). TenneT could facilitate the data access and the exchange of messages (facilitate the development of a platform and let the market parties and customers to define their business cases). For example, TenneT could facilitate the use of smart meter readings to attribute the actual consumption to the BRP/supplier of each customer. From the market perspective it would be favourable to have open standard solutions instead of contracting specialised products (e.g. such as incident reserves). The C-AR could be used for this purpose, because it contains all (EAN) grid connections with information about the associated Supplier, BRP and BRP and metering responsible party (Meetverantwoordelijkheid in Dutch) with each connection. TenneT could act as facilitator in such a	In relation to: **Other issues related to the deregulation process** Phases: **design**

	based allocation. Next, the profile-based allocation system will be gradually phased out. EDSN is constantly trying to improve the process and the profiles. TenneT has small involvement in the reconciliation process. ▪ TenneT has the ambition to play a bigger role in the area of smart meter data access. The Association of Dutch Energy Data Exchange (NEDU) is also involved in this discussion, as well as the Ministry of Economic Affairs regarding the appointment of a data-hub manager at TenneT. ▪ In the Netherlands, the market reference model on options of handling smart meter data is that of a (regulated) independent central communication platform, i.e. the EDSN, a central data platform owned by network operators. EDSN ensures that only authorized parties receive and send data. EDSN certifies Measuring technology Independent Services Provider (Onafhankelijke Diensten Aanbieder (ODA) in Dutch). Other examples of data hubs owned and controlled by national industry associations are in Sweden, and by the national TSO (energinet.dk) in Denmark [29].	**Requirements:** The ownership of data in relation to privacy issues should be properly arranged. Technical issues regarding data quality via port P4 (low availability/non-timely access of data) have to be solved. .	development or even as the operator of a central data hub. For the latter, it is recommended to TenneT to contact the Danish TSO (energinet.dk) in order to learn from their experience in managing the data hub in Denmark. Furthermore, TenneT could support the process of customers' empowerment through education and by promoting adequate representation of the customers' perspectives in relevant working groups. **Priority level:** Semi-urgent	
30	**Possibilities:** An aggregator can apply for the BRP role and be eligible to trade energy at wholesale level. **Barriers** [5]**:** ▪ The cost of a BRP acknowledgement: The applicant will bear the costs for: a. Registration with the Chamber of Commerce which requires a Legal Entity Identifier (LEI). The LEI is an internationally standardised reference code to uniquely identify a legally distinct entity that engages in a financial	**Potential solution:** One solution could be to reduce the identified barriers, i.e. the cost and the time required for becoming acknowledged as a BRP. Another potential solution could be to provide a niche environment especially for new market entrants and small parties which face disproportional risks. Perhaps, relatively small market parties with Balance Responsibility can merge their portfolios in order to benefit from the netting of imbalances and reduced imbalance costs. One relevant example	**Recommendation:** Given that the identified barriers (e.g. the costs and the time required for being acknowledged as a BRP) are there as essential requirements to ensure a proper functioning of the market, then perhaps the preferred solution is to let the market parties to overcome the identified barriers by forming alliances (e.g. merging their portfolios under PVNED).	In relation to: **Other issues related to the deregulation process**

	transaction. The fee for registering a (pre-)LEI in the Netherlands is made up of 2 components[12]: i. a once-off application and registration fee of € 150,- (ex. VAT); ii. an annual fee for the following years (not a calendar year) of € 100,- (ex. VAT). b. Connecting to the Central Post System of TenneT which requires: i. Application for a Public Key Infrastructure (PKI) certificate (an encryption key for sending and receiving messages). ii. To obtain an EDINE certificate for exchanging messages. c. Bank guarantee (deposit a minimum amount in the business bank account). The initial guarantee amount must be at least €96,000. This amount may be increased depending on the BRP's transaction volumes.). ▪ The average turnaround time for requesting new commercial BRP acknowledgement, and excluding the certification testing, with standard (EDINE) package: The turnaround time is two to three months, in which to a large extent depends on the progress of activities by the applicant (e.g. request bank guarantee and EDINE testing)[13]. ▪ A relatively small market party (or a new market entrant) requires time to build a portfolio with sufficient capacity to support trade and the provision of ancillary services such as balancing contributions. Relatively small BRPs have to be cautious while building up their portfolio, and in some cases	is that of PVNED B.V.[14] which is fully acknowledged as a BRP and as an APX member, and acts as a third party BRP especially for smaller suppliers with the aim to be a BRP for the whole market (not only for DELTA Energy B.V. and Eneco Energy Trade which are both fully acknowledged as BRPs and have each 50% of the shares in PVNED Holding).	**Priority level:** Nice to have	

[12] http://www.kvk.nl/english/how-to-register-deregister-and-report-changes/legal-entity-identifier-lei/faq-lei/
[13] http://www.tennet.eu/nl/customers/contact/frequently-asked-questions.html
[14] http://www.pvned.eu/en/

	they might not accept a new customer, e.g. due to concerns about its size and its impact to the whole portfolio.			
31	**Possibilities:** An aggregator can benefit from having access to a central data hub with information about the characteristics of its customers (e.g. the associated BRPs and/or suppliers, registration of local generation units etc.). Such a data centre could support market operations (e.g. support a simple and straightforward switching process for customers to another BRP/supplier), support system operations (e.g. support quality control by the TSO for balancing contributions), and facilitate aggregators in managing their new customers and developing new proposition for retail customers by getting access in registered information which would not be available otherwise. **Barriers:** Currently, it is not possible for TenneT TSO to know the associated connections of a BRP and/or BSP[15]. Every connection has a unique EAN, but these EANs are not mentioned in the e-programmes of the BRPs, which are portfolio-based. For becoming acknowledged as BRP, there are two options, only trade or fully acknowledged, and it is not necessary to mention which are the associated EAN connections. Without this information, it is difficult for the TSO to exercise a quality control on (some) connections that provide balancing services (e.g. aFRR or mFRRda), which creates a barrier for the development of new (portfolio-based) flexibility services through aggregator companies (e.g. aggregators acting as BSPs). **Position** of TenneT and relevant developments: TenneT would like to know the EAN number of the connections associated with each BRP/BSP/supplier for verification and allocation	**Potential solution:** Establish a central data hub where each unique EAN code is linked to a unique address, and an associated BRP and supplier, incl. information about local generation, flexible demand and storage. For example, by merging the C-AR with the Production Installation Registry (PIR) of energieleveren.nl which is an initiative of the association of network operators (Netbeheer Nederland). The customers that own/operate local generation units can register their plants in PIR, through which the DSOs can be informed and act accordingly to ensure the security of the network. **Requirements:** Cooperation between DSOs who operate the grids below 110/150 kV. Each DSO institution has its own database about the connected parties to their operating grids.	**Recommendation:** TenneT, through its involvement in EDSN/NEDU and Netbeheer Nederland, could facilitate the development of a central data hub (with specific permissions for third parties). From a market perspective it would be favourable to have open standard solutions for data access and TenneT could act as facilitator in such a development. **Priority level:** Semi-urgent	In relation to: **Other issues related to the deregulation process**

[15] Note that for incident reserves, this has become possible through the listing in Annex 3 of the contract [21], see table list item **11**.

	procedures (to know which the actual sources of balancing services are). According to IDs [A.03] and [A.05] in Annex C in [23], the supplier and BRP are conditionally stated in the C-AR system.			
32	**Possibilities:** Aggregators can benefit from an arrangement that enables several BRPs and/or suppliers to be active behind a single connection point to the grid, e.g. different aggregators being active within the same facility and being responsible for different resources such as EV charging, wind installations, and DR. **Barriers:** Policy for separate sub-metering for a single EAN connection is not yet implemented but is expected to be developed in the future through ACM. **Position** of TenneT and relevant developments: Currently, it is obligatory for a single connection point (unique EAN) to have only one BRP and one supplier, and this is aligned with the preference of the TSO. As part of STROOM (new electricity and gas act), a rule has been introduced that enables more than one BRP/supplier to be active on a single connection .TenneT is considering possible ways forward for enabling such an implementation. TenneT is currently trying to remove the profile-based allocation method with the introduction of smart meters (see table list item **29**), but with the introduction of more than one BRP/supplier behind a single connection, TenneT might be obliged to introduce profiling behind the meter. TenneT TSO is uncertain whether to use sub-meters for official settlement procedures, and would prefer for the market parties to solve this issue in-between them.	**Potential solution:** Enable that every connection can have more than one BRP and/or supplier. In that case, the measured values should be separated with separate metering devices for the resources that are assigned to each market party. **Requirements:** Define in the balancing code the relationships that each EAN connection has with market parties (one or more BRP(s) and/or supplier(s)). If you have more than one BRP (and/or supplier) then each BRP and/or supplier shall be attributed to a separate metering system. Aggregators and suppliers can agree on their own terms for settling their positions, and they might employ unofficial sub-metering solutions for this purpose. However, balance responsibility is crucial for the system and an official/standardised solution is necessary with respect to the BRP role. Another requirement is that the costs of extra metering devices should not be higher than the benefits of having more BRPs and/or suppliers on a single EAN connection.	**Recommendation:** Policy for separate sub-metering for a single EAN connection is not yet implemented but is expected to be developed in the future through ACM. There is an ongoing discussion about possible solutions (e.g. possibilities for additional sub-meters in series or parallel configuration). A solution should enable market parties to define their business cases without the need for extensive regulation. R&D activities. **Priority level:** Semi-urgent	In relation to: **Other issues related to the deregulation process**

33	**Possibilities:** Aggregators can benefit from cross border exchange & common procurement of reserves with equal treatment for all parties no matter where they are located. **Barriers:** Balancing markets and balancing products are not harmonised in Europe. Primary control markets can be integrated easily but integrating markets for secondary control through a common merit order list requires to tackle the issue with the different pricing schemes among countries/systems (pay-as-bid, or pay-marginal schemes as in the Netherlands). **Position** of TenneT and relevant developments: There is an on-going discussion in Europe about cross-border balancing and common merit orders with other TSOs.	**Potential solution:** Enabling cross-border exchange of reserves. **Requirements:** Need to harmonise the pricing schemes among different countries/systems.	**Priority level:** Nice to have	In relation to: **Other issues related to the deregulation process**

Table 4. Main characteristics of the operating reserves for balancing that are currently traded in the Netherlands.

Network Code on Load Frequency Control & Reserves (NC LFCR)	Frequency Containment Reserves (FCR)	automatic Frequency Restoration Reserve (aFRR)[16]		manual Frequency Restoration Reserve (mFRR)				Replacement reserves (RR)
Former name	Primary reserves	Secondary reserves		(Directly activated) Tertiary reserves		(Schedule activated) Tertiary reserves	N/A	(Slow) Tertiary reserves
Name (Name in Dutch)	Primary reserve[17] (Primaire reservevermogen)	Regulating power / aFRR direct activated (Regelvermogen)[18]		Incident Reserve / Emergency power / mFRR direct activated (Noodvermogen)	TSO – TSO mFRR direct activated	Reserve power / mFRR schedule activated (Reservevermogen Balanshandhaven)[19]	Passive contribution (Passieve Bijdrage)[20]	N/A
Type (Contracted/Non-contracted)[21]	Contracted	Contracted	Non-contracted	Contracted	Contracted	Non-contracted	N/A	N/A
Contracted capacity (MW)	102 MW (up/down)[22]	340 MW (up/down)[23]	N/A	350 MW (up) / 200 MW (down)[24]	350 MW (up/down)	N/A	N/A	N/A
Capacity - Symmetrical product	Yes [10]	Yes [10]	N/A	No	Yes	N/A	N/A	N/A
Capacity settlement rule	Pay as bid	Pay as bid [10]	N/A	Pay as bid [10]	-	N/A	N/A	N/A

[16] Note that there are two types of aFRR, one contracted and one non-contracted but the merit order lists are merged.
[17] Primary reserves: http://www.tennet.org/english/operational_management/system_data_preparation/primary_reserve.aspx.
[18] Tender for regulating power (2016): 50% annual contracts, and 50% quarterly contracts. Contracts for 100% availability. Mandatory for units >60 MW in accordance with the Network Code.
[19] Mandatory for units >60 MW in accordance with the Network Code.
[20] Call for Emergency power (incident reserves) is announced by TenneT.
[21] Tenders are published on the website of TenneT (http://www.tennet.eu) and TenderNed (www.tenderned.nl).
[22] The total volume is determined on a yearly basis by ENTSO-E regional group Continental Europe (CE). At least 30% must be delivered within the Netherlands whereas the remaining capacity can be delivered through a common auction: https://www.regelleistung.net.
[23] In accordance with ENTSO-E directive: 340 MW for 2016.
[24] Greatest incident minus already existing reserves (2016): 700 MW (upward regulation). 350 MW through TSO - TSO cooperation (DE & BE). Contract for 97% minimum availability per year or quarter [27]. Tender for downward regulation capacity (200 MW) has been announced but not yet released. Emission standards for combustion plants result into less availability for mFRRda.

Capacity payment (fee for contracted capacity)	€/MW/ week[25]	€/MW/annum	N/A	€/MW/annum	-	N/A	N/A	N/A
Indicative capacity fees [11]	350-400 k€/week in 2015 (96 MW up/down)	35.9 M€/annum in 2015 (300 MW up/down)	N/A	6.7 M€ in 2015 (350 MW up). The corresponding price for 2016 for upwards capacity is 11250€/MW/annum whole year 2016[26]	N/A	N/A	N/A	N/A
Energy - Symmetrical product	N/A	No [10]	No [10]	No [10]	No	No [10]	N/A	N/A
Energy payments (compensation for activated energy)	N/A	Marginal price (Inzetprijs Biedladder): Based on the marginal price of the highest bid called		Equal to the product of volume and price per ISP: The price is defined in the contract [9]: the marginal bid price (inzetprijs) + 10%, or the APX day-ahead market price + 200€/MWh or at least 200€/MWh (when the APX day-ahead market price<0).	Price-based[27]	Marginal price (Inzetprijs Biedladder): Based on the marginal price of the highest bid called	Imbalance price: Note that the energy payments are subject to the system state [6]	N/A
Prequalification	Yes	Compliance check of systems on paper only [12]		-	-	-	N/A	N/A
Lead time	N/A	One full clock hour (4-7 ISPs)		N/A	N/A	One full clock hour (4-7 ISPs)	N/A	N/A
Activation method	Automatic	Automatic, based on a merit	Automatic, based on a merit order [10]	Manual[28]	Manual[28]	Manual, based on a merit order [10]	Market response, not activated by TenneT	N/A

[25] Purchase through weekly auctions on: https://www.regelleistung.net. Contracts for 100% availability.
[26] ENTSO-E transparency platform: www.transparency.entsoe.eu https://transparency.entsoe.eu/
[27] The prices that are paid to the balancing service providers do not influence the marginal price of TenneT's normal internal operations.
[28] Manual deployment 24x7x365 by telephone call.

		order [10]						
Deactivation method	N/A	N/A	N/A	Manually at the end of the ISP	Based on human operator decision	Implicit	N/A	N/A
Min. bid size	1 MW	4 MW	4 MW	4 MW (Merit order) 20 MW (Tender) Note: In 2016 there are about 17 contracts between 20-140 MW		4 MW		N/A
Activation ramp rate		≥7 %/min.	≥7 %/min.	≥100 %/ISP	-	≥100 %/ISP	N/A	N/A
Full Activation Time	30 sec.	15 min.	15 min.	10-15 min.	15 min.	15 min.	N/A	N/A
Activation minimum step	N/A	1 MW	1 MW	Mostly full contracts but it can also be less (partial activation with a min. of 20 MW and steps of 5 MW but in general the requirements are for a total of 200-300 MW)	-	4 MW	N/A	N/A
Activation duration	Continuous	≥4 (sec.)	≥4 (sec.)	≥15 (min.)	-	≥15 (min.)	N/A	N/A
Verification method	Ex-post check (Monitoring of plant performance carried out after the event) [10]	Ex-post [10], based on signal visual inspection [24], regularly every day/week [12]		Ex-post [10], based on measurements and a reference value [9]	-	-	N/A	N/A
Settlement method for activated energy	N/A	Based on requested energy (according to the TSO's activation LFC signal) [6], [10]		Based on 5 min. periods, the metered value is deducted from the reference value [13]	-	Imbalance settlement system [6]	Imbalance settlement system [6]	N/A
Share (%) of aFRR in total activated FRR/RR energy[29]	N/A	>80 %		<20 %			N/A	0%

[29] Based on data for February and June 2015 from the ENTSO-E Transparency platform and information provided directly by TSOs [26].

Table 5. Main characteristics of other ancillary services (black start and transmission services) that are currently traded in the Netherlands.

Name (Name in Dutch)	Black start capability[30] (Herstel-voorziening)	Reactive power (Blindvermogen)	Network losses (Netverliezen)
Type (Contracted/Non-contracted)	Contracted	Contracted, the TSO may (partially) own and operate reactive power comp. systems [10]	Contracted
Contracted capacity (MW)	>1200 MW[31]	Need to be estimated[32]	Need to be estimated[33]
Procurement	-	Annual Tender / Request for quotation (RFQ)[34]	Periodic tender (current agreement from 2014 to 2016)
Activation method / Requirements	-	Manual[35], the optimal use is determined based on the TSO's experience [10]	Supply and acquisition of programme responsibility
Challenges	-	Renewables integration where possible, concentration of units in some areas, less availability by (seasonal) gas plants, less coal-fired units starting at 2016.	Variation in production (conventional, offshore, decentralised, international, etc.)

2.3 The position of the system operator

Currently, there is a debate both in the Netherlands and at the European level about positioning the aggregator concept as a new role in the energy system. Different countries approach this topic in different ways in terms of laws and regulations. In the Netherlands, the positioning of the aggregator concept is currently undertaken in the context of the revision of the contractual agreements on emergency power (incident reserves) [9], [26], the Task Force Flex [30], the consultation table Energy [28], and inside the USEF [16], [17], which currently has provided a list of all the different implementation models [31].

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[30] ENTSO-E Common Glossary: The capability of recovery of a Power Generating Module from a total shutdown through a dedicated auxiliary power source without any Electrical Energy Supply external to the Power Generating Facility.
[31] Three recovery facilities in the Netherlands (North, Central & South) and 2 units per facility of at least 200 MW.
[32] Deployment on the basis of effort in the previous period and network developments.
[33] Estimation based on history by taking into account recent and planned developments. There are many dependencies which have a consequence on predictability and the variance is large, e.g. 823.4 GWh (2012), 831.1 GWh (2013), 947.1 GWh (2014).
[34] Invite suppliers (units connected to the HV (110/150 kV) or EHV (220/380 kV) level) into a bidding process to address local problems with local solutions.
[35] Reactive power deployment by phone.

In this section, the basic principles of the Dutch market model, the different USEF implementation models, the conditions under which these models should be integrated into the Dutch market, and the position of TenneT TSO regarding the integration of the aggregator role within the Dutch market model are presented. The Dutch market model is based on the three basic principles of freedom of connection, transaction and dispatch (see section 2.1), coupled with a system of Program Responsibility which is supported by the prominent BRP role, i.e. a party that has a contract proving financial security and balance responsibility [22]. These elements provide the foundation on which the aggregator concept can be integrated in the Dutch system. The USEF has identified seven different implementation models [31], which are distinguished based on the following four criteria: the need to define contractual agreements between the involved parties, the requirement to carry program responsibility in accordance with the BRP role, the need to compensate for any imbalance, and compensation for the transfer of energy. In **Table 6**, these different implementation options are summarised. The applicability of each of these models to a specific context is dependent on the country's market design. For the integration of the aggregator concept in the Dutch market model there are a number of preconditions which are consistent with the current design of the Dutch market:

- The solutions should encourage market forces.
- The solutions should connect as much as possible with the current processes (including data exchange) in the energy market.
- The process must not be disruptive in determining the energy balance, both at national level and at the level of individual parties.
- The imbalance of a connection must be clearly established and assigned to the involved BRP(s).
- The process must be in line with the freedom of dispatch per connection and provide freedoms for the customers of a connection on exploiting their flexibility capabilities in a market-based environment.
- The prices should arise in the market and not be determined or influenced by the TSO.

Unlocking the potential of flexibility in the energy market on the basis of a level playing field for all actors is of great importance. For TenneT TSO there are some crucial issues in further unlocking flexibility and integrating the aggregator concept in the Dutch market, namely making available the necessary data, based on which market parties can complete commercial deals with each other, and ensuring that energy positions can be established beyond doubt and imbalance volumes can be attributed to the correct market parties. TenneT, as a market facilitator, is working in close cooperation with market participants (BRPs, suppliers and aggregators) in order to tackle these issues and ensure the proper market integration of the aggregator concept and a level playing field for all actors in the market. Given the current design of the Dutch market, there is a number of conditions that must be satisfied prior to the integration of the aggregator concept in the Dutch market for each of the seven identified implementation models in the USEF inventory. The position of TenneT TSO and the basic conditions for each of the implementation models are summarised in **Table 6**.

Table 6. Main characteristics of the operating reserves for balancing that are currently traded in the Netherlands *[31]*.

Name	**USEF description**	**TenneT position**
Integrated model	In the integrated model the roles of supplier and aggregator are combined in one market party. Compensation for imbalances and the open supply position are not necessary.	The integrated aggregator model fits into the current market model and requires no adjustments.
Broker model	In the broker model, the aggregator transfers the balance responsibility to the BRP of the supplier. Compensation for the open supply position and the caused imbalance is settled bilaterally based on contractual arrangements.	The broker model fits into the current market model and given the current developments regarding emergency power this model is feasible with only some adjustments. These adjustments concern in particular the use of a bid price ladder for calling the desired product and for the imbalance settlement, whereas the imbalance is assigned to the BRP of the connection.
Contractual model	In the contractual model, the aggregator associates with his own BRP. Balancing parameters are corrected (ex-post) between the BRP of the aggregator and the BRP of the supplier, transfer prices are based on contractual arrangements.	The contractual model is in principle fully applicable and requires no adjustments.
Uncorrected model	In the uncorrected model, no perimeter correction is performed and no volume transfers occur between the BRP of the aggregator and the BRP of the supplier. The activated volume is settled through the regular balancing mechanism.	This model is feasible to implement on the basis of mutual agreements between the parties. For this model there is no need for adjustments in the system. However, due to fairness issues (e.g. fair allocation of imbalance volumes among market parties), this model is not the preferred one.
Corrected model	In the corrected model, the Prosumer's meter readings are modified, based on the amount of flexibility that has been activated by the aggregator. The transfer of energy takes place through the Prosumer, based on retail prices. The aggregator associates with his own BRP.	The corrected model is possible to be facilitated on the basis of current processes. However, some processes have to be adjusted/expanded and the smart meter data must be easily accessible.
Central settlement model	In the central settlement model, the aggregator associates with its own BRP. A central entity (e.g. TSO) corrects the balancing perimeters following a DR activation. Compensation for the open supply position is also settled by this central entity, based on a pre-defined price formula.	This model is readily applicable and feasible within the current system, however one main disadvantage of this model is that it operates with prices that cannot be determined based on market principles. This model will lead to a greater role for TenneT than just market facilitation on the basis of data management and may also require the regulation of additional matters with respect to recognition or certification of aggregators.
Net benefit model	The net benefit model is similar to the central settlement model, yet the cost of neutralising the BRP of the supplier is not born by the aggregator but socialised. Socialisation may be limited to situations where DR brings energy savings.	This is not a preferred model for TenneT because it involves a complex implementation. Especially, TenneT will have to play a much greater role in determining business, which subsequently also requires to be further defined in legislation.

3 Discussion, conclusions and recommendations

In recent years, several business models of the aggregator company have emerged in Europe, in response to a general quest for flexibility in power systems which is mainly driven by the increasing integration of renewable energy sources and the ongoing deregulation of electricity markets. This work contributes to the systematic development of the business model concept of an aggregator company. The main contributions are about a set of identified characteristics that describe business model variations around the concept of an aggregator company (see Section 2.1), and a list of table elements (possibilities, barriers, position of TenneT, proposal, action plan with recommendations and priorities) for mapping opportunities, challenges and possible solutions for enabling flexibility through aggregators in the Dutch system (see Section 2.2). This work supports the process of systematically structuring the business model concept of an aggregator, the development of new flexibility services and appropriate regulatory frameworks. In this section, general recommendations and an action plan with recommendations and priorities for TenneT TSO to stimulate market integration of demand side resources through aggregators companies are provided in Section 3.1. Finally, an overview of the relevant stakeholders who may benefit from the project results and potential for follow-up activities are presented in Section 3.2.

3.1 Recommendations

Based on the above-mentioned, a number of recommendations are drawn up:

- **The aggregator role.** Several foundations and associations promoting the aggregator concept and the development of flexibility services from demand-side resources have emphasised the need to shape and define the aggregator role within the European electricity markets [17], [18].
    - Due to the numerous different implementation options of the aggregator concept, it is difficult (if not infeasible) to define the role of an aggregator as a one-size-fits-all solution. According to the ENTSO-E role model [22]: "The objective of decomposing the electricity sector organisation into a set of domains and roles, is to enable the development of business processes where a relevant role addresses a specific transaction. Business processes should be designed to meet the requirements of the roles and not of the actors. An actor represents a participant in a business transaction. Within a given business transaction an actor consists of a composition of one or more roles". Therefore, the aggregator can be conceived as a new actor in the electricity sector that can carry different roles, e.g. the BRP role, the supplier role. In this context, perhaps it is more relevant to put emphasis on defining the various different roles rather than attempting to define a new role for the aggregator. Such a development shall be coordinated with the development

of the ENTSO-E role model which “has been developed to facilitate the dialogue between the market participants from different countries through the designation of a single name for each role and domain that are prevalent within the electricity sector” [22]. Subsequently, it may become possible to define a specific implementation of the aggregator concept based on a synthesis of pre-defined roles.

    - In the case that an aggregator does not carry the BRP role, it is required to assign its own BRP and the allocation process becomes more complex as synthetic profiles are required to separate the perimeters/positions of the customer’s BRP and the aggregator’s BRP [17]. Solving the issues related to Balance Responsibility, i.e. measure and compensate the involved BRPs, requires primary focus because the operation of incumbent BRPs is essential for the system. Similarly, in the case that an aggregator does not carry the supplier role for its associated customers, and these customers contribute to ancillary services provision, the customers’ suppliers shall be compensated for the contracted supply of energy. Certain measures shall be determined to allow for a transparent allocation of energy volumes and imbalances and the complications are such that they may create an advantage for those aggregators that either carry the BRP/supplier role (e.g. incumbent utilities) or for third parties aggregators that act as pure service providers for other market parties (see Section 2.1.1).

- **Prioritised issues.** By reviewing the listed issues in **Table 3** (opportunities, challenges and possible solutions for enabling flexibility, through aggregators), a number of barriers and potential solutions are prioritised in terms of system impact and ease of implementation for progressing the market integration of aggregators within the current systems of programme responsibility and imbalance settlement in the Netherlands. The most urgent items are summarised in a set of recommended actions for TenneT TSO in **Table 7**. Note that many of the listed recommended actions in **Table 7** point out to follow-up research activities.

Table 7. Priorities and actions for TenneT TSO for supporting the development of flexibility services and the market integration of aggregators.

Rank	Barriers	Recommended actions to TenneT TSO	Link in **Table 3**
1	The lack of exact requirements for settling imbalances between the customers (or their aggregator) and their suppliers is a barrier for further developing commercial load-shedding for the provision of operating reserves for balancing purposes. This barrier relates to the **transfer of energy** issue, i.e. an energy settlement between the aggregator's BRP and the supplier (and/or its BRP), and currently concerns incident reserves (mFRRda). However, in the future, it is relevant to consider also other balancing products and services (see table list item **4** in **Table 3**).	Support the design of a standardised solution that enables the proper communication and interaction between market parties. The solution should enable that aggregators can facilitate these transactions on behalf of their customers (the connected parties). The solution must also include a baseline methodology to quantify the performance of flexibility service providers and provide a basis for the **transfer of energy**. Currently, TenneT is in discussions with market parties about a new concept proposal for the provision of emergency power [26]. It is recommended to continue this dialogue and to initiate a research project for investigating the optimal solution. **Priority level:** Urgent	Table list item **11**
2	Recently TenneT had to activate incident reserves (mFRRda), which is a supplementary balancing tool, but these reserves are not visible in the merit order list for FRR (aFRR/mFRRsa). Non-transparency in the market is a barrier for aggregators and other market parties in order to effectively perform their market-based activities.	The process of making the incident reserve capacity supplementary to the FRR merit order list is on-going, and this item is part of the new concept proposal for the provision of emergency power [26]. It is recommended to TenneT to continue this planned implementation in close cooperation with market parties. **Priority level:** Urgent	Table list item **14**
3	Standardised market processes (between suppliers, BRPs and aggregators) are lacking with respect to the provision of operating reserves, specifically regarding: ▪ the information exchange, ▪ the transfer of energy, ▪ and the financial settlement.	In order to support the process of establishing proper arrangements and market rules that allow customers to access any service provider (incl. aggregators) of their choice, there is a prime need to develop standardised market processes for enabling the proper information exchange between market parties, an indisputable method for defining the transfer of energy, and the financial settlement. It is recommended to TenneT to investigate through R&D activities whether (and how) the C-AR system could be used for facilitating the communication and commercial activities between market parties that are associated with the same EAN connection(s). **Priority level:** Semi-urgent / Urgent	Table list item **4**

4	The time period between bidding and activation of aFRR is currently one full clock hour. Thus the **lead time** (i.e. the period between bidding and activation of a bid) is between 4 and 7 ISPs. This lead time is still too long for effectively integrating DR in aFRR provision and supporting the integration of intermittent RES into the system. The lead time applies also to schedule activated tertiary reserves (mFRRsa) but does not apply to direct activated tertiary reserves (mFRRda) such as incident reserves.	A first improvement could be to make the **lead time** for aFRR constant (equal to 4 ISPs). Shorter lead time can be facilitated by automation. It is recommended to TenneT to initiate a discussion between the IT department and the department of Markets about a possible reduction of the lead time, and considerations about associated implementation requirements. **Priority level:** Semi-urgent / Urgent	Table list item **7**
5	Currently, TenneT offers contracts only for upwards capacity of incident reserves (mFRRda). Introducing separate tenders for upward and downward capacity of incident reserves is expected to open new opportunities for aggregators to offer this service, especially when such reserves are delivered from demand-side resources.	Enable soon the possibility for contracting downwards capacity for mFRR. TenneT has decided on this aspect but the tender has been postponed several times. **Priority level:** Semi-urgent	Table list item **9**

6	Barriers related to **smart metering systems** in the Netherlands: ▪ Currently, customers can access their consumption data via a DSO web portal, with quarter-hourly readings available one day after consumption. The resolution of 15 min. readings is too long to support contributions within an ISP, whereas the one day delay in accessing the data might hinder the provision of services close to real-time operations. ▪ The slow deployment of smart meters, especially for relatively small customers such as residential customers, is hindering the participation of the demand-side in smart grid applications. ▪ The profile-based allocation system actually obscures BRPs/suppliers from reaping the full benefits of DR measures.	Establish official solutions for smart meter data access (standard metering procedures and exchange messages). TenneT could facilitate the data access and the exchange of messages (facilitate the development of a platform and let the market parties and customers to define their business cases). The C-AR could be used for this purpose, because it contains all (EAN) grid connections with information about the associated Supplier, BRP and metering responsible party (Meetverantwoordelijkheid in Dutch) with each connection. TenneT could act as facilitator in such a development or even as the operator of a central data hub. For the latter, it is recommended to TenneT to contact the Danish TSO (energinet.dk) in order to learn from their experience in managing the data hub in Denmark. Furthermore, TenneT could support the process of customers' empowerment through education and by promoting adequate representation of the customers' perspectives in relevant working groups. **Priority level:** Semi-urgent	Table list item **29**
7	Currently, it is not possible for TenneT TSO to know the associated connections of a BRP and/or BSP[15]. Every connection has a unique EAN, but these EANs are not mentioned in the e-programmes of the BRPs, which are portfolio-based. For becoming acknowledged as BRP, there are two options, only trade or fully acknowledged, and it is not necessary to mention which are the associated EAN connections. Without this information, it is difficult for the TSO to exercise a quality control on (some) connections that provide balancing services (e.g. aFRR or mFRRda), which creates a barrier for the development of new (portfolio-based) flexibility services through aggregator companies (e.g. aggregators acting as BSPs).	TenneT, through its involvement in EDSN/NEDU and Netbeheer Nederland, could facilitate the development of a central data hub (with specific permissions for third parties). From a market perspective it would be favourable to have open standard solutions for data access and TenneT could act as facilitator in such a development. **Priority level:** Semi-urgent	Table list item **31**

8	Policy for separate sub-metering for a single EAN connection is not yet implemented but is expected to be developed in the future through ACM. Such a policy implementation will enable different market parties (incl. aggregators) to be active behind a single EAN connection, and specialise in aggregating resources of a specific type (e.g. heat pumps, electric vehicles etc.), however standardised solutions are lacking with respect to the **transfer of energy** and the **rebound effect** (see table list items **4** and **26** in **Table 3**).	There is an ongoing discussion about possible solutions (e.g. possibilities for additional sub-meters in series or parallel configuration). A solution should enable market parties to define their business cases without the need for extensive regulation. It is recommended to investigate possible solutions through R&D activities. **Priority level:** Semi-urgent	Table list item **32**
9	In the APX spot markets, i.e. day-ahead and intra-day auctions, market members can trade hourly instruments. One hour is a relatively long time period for exchanging flexibility options and can be seen as a barrier, especially for aggregators that deal with relatively small capacities. Furthermore, wholesale trade on an hourly basis creates barriers for market parties in effectively structuring their energy schedules/e-programmes since the imbalance settlement system is based on ISPs of 15 min.	Implementing a settlement period of 15 min. in the day-ahead and/or intra-day markets would require considerable time, but it is recommended to start considering it as it can enhance market access to flexibility, and support a more efficient use of reserves. TenneT could communicate these issues to APX. However, since April 2015, TenneT does not hold shares in APX, thus its influence towards APX has been diminished significantly. It is also recommended to TenneT to continue supporting the ETPA development which enables market parties to trade energy in blocks of 15 minutes, one hour, one day, one weekend, or one week. **Priority level:** Nice to have / Semi-urgent	Table list item **1**
10	According to the market rules for FCR provision, each unit that delivers FCR requires a metering system with a 4 sec. resolution. This requirement is a barrier for aggregators to provide FCR through the aggregation of small scale resources because it would require to equip every single resource with such a metering system.	Continuing the involvement of TenneT in R&D activities and pilot projects together with research institutions and commercial parties. Such activities can support the design of new market rules to enable the participation of aggregators in FCR provision. **Priority level:** Nice to have / Semi-urgent	Table list item **5**

11	The technical requirements for aFRR provision are very high (e.g. with respect to the delta signal exchange, response signal). Furthermore, the rule is such that each unit that delivers aFRR requires a metering system with a 4 sec. resolution. The verification of aFRR is based on a visual inspection which is performed manually by TenneT staff [24]. This would be too time intensive for a large number of market parties participating in aFRR provision.	Research can be conducted to investigate how aggregators can provide aFRR without major modifications in the existing system. A balance needs to be found between expensive technical solutions and adaptation of rules. The current verification process with visual inspection could be replaced by an automated process [24]. **Priority level:** Nice to have / Semi-urgent	Table list item **6**
12	The tenders for the provision of aFRR require annual/quarterly contracts with products that are symmetric for upward and downward aFRR capacity. However, most demand-side resources cannot be regulated in a symmetric way, which is a barrier for participation. The periods for which the aFRR contracts apply, are still too long (annual/quarterly contracts). By enabling shorter contract periods (e.g. from quarterly to weekly), providers can better plan their resources (e.g. due to weather dependencies).	Continuing the efforts that TenneT is currently undertaking in enabling separate contracts for upwards and downwards aFRR capacity in the tender phase. It is also recommended to start considering the possibility of weekly contracts for aFRR. **Priority level:** Nice to have / Semi-urgent	Table list item **8**
13	The economic incentives for the provision of incident reserves are reducing, whereas the requirements for contributions are increasing. Market parties claim that the capacity payments/fees are relatively low and are decreasing over the past years, whereas the activation times of incident reserves is increasing.	The decreasing capacity fees for incident reserves is a result of the competitive market. Perhaps TenneT could revise the characteristics (e.g. activation/utilisation) for incident reserves. In the past there was a need to activate incident reserves more frequently but it is expected to be less frequent in the future. The issue of increasing activations for incident reserves could be further investigated through research activities. **Priority level:** Nice to have / Semi-urgent	Table list item **13**

14	Currently there is no available platform (not even as a conceptual design) to enable the provision of ancillary services at the local (distribution) level and the proper communication between system users, market parties and grid operators. The regulatory framework and subsequent data management model should support the data exchange, taking into account the needs of TSOs and DSOs to receive relevant information [20].	It is recommended to start a dialogue on whether (and how) a common platform can accommodate transactions of flexibility for different purposes and actors on a level playing field. Solutions could be developed on top of existing platforms, e.g. the ETPA could facilitate location-specific services by attributing location tags to the submitted bids, whereas R&D activities could address future concepts. Relevant aspects are about defining administrative areas to handle congestion, and exact criteria for coordinating the interaction between the TSO and DSOs, and market parties. Relevant developments that could contribute in this direction are the USEF common reference model for communicating congestion incidents and congestion areas in the distribution grid, and the C-AR system. **Priority level:** Nice to have / Semi-urgent	Table list item **22**

3.2 Project results and potential for follow-up activities

The results of the project are expected to support and drive the development of new business models around the aggregator concept, primarily in the Netherlands which was the focus of this study. New aggregator business models and opportunities support the transitioning to a sustainable energy system, through the effective integration of the demand side in electricity markets, both for market optimisation and the provision of ancillary services. DR resources can support the integration of sustainable energy in the market, and replace fossil-fuelled power generation units for the provision of operating reserves. The follow-up activities are envisioned as R&D projects involving research and knowledge institutions, grid operators, market parties and perhaps local energy service companies and cooperatives that will jointly design flexibility services through aggregator companies in the energy system. The approach might involve theoretical studies, laboratory experiments and small-scale demonstrations, with emphasis on the technological development, taking into account social, regulatory, business and organisational conditions. Specifically, the project results can be used:

- By aggregators and other service providers for exploring opportunities with respect to the provision of operating reserves for balancing (see **Table 4**) and other ancillary services (see **Table 5**) that are currently traded in the Netherlands.
- By regulators and policy makers to enable the necessary regulations and adaptations in the market design that will allow aggregators to compete in a level playing field with incumbent utilities and market parties, and will make the provision of flexibility services possible at different levels (local, regional, and national).

- By the system operator to systematically structure its approach to progress the market integration of demand side resources for flexibility services through aggregators.
- By research and knowledge institutions to further investigate and assess the potential of new business models and the suitability of potential solutions and recommended actions. Note that many of the listed items (recommended actions) in section **2.2** point out to follow-up research activities.
- By business developers for the development of new products, and services, based on solid business models and appropriate enabling policies, as well as novel organisational and cooperative structures for the energy management of demand-side resources by adopting recent advances in ICT.
- By software developers for designing and developing software prototypes for energy management systems, that can enable both wholesale electricity trade functions and the provision of ancillary services to the power system such as fast operating reserves, and local network support.
- By local initiatives which foster renewable energy in their municipalities and which aim to provide flexibility services.

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Acronym list

ACER	Agency for the Cooperation of Energy Regulators
ACM	Autoriteit Consument & Markt
aFRR	automatic Frequency Restoration Reserves
APX	Amsterdam Power eXchange
BE	Belgium (country acronym)
BRP	Balance Responsible Party
BSP	Balancing Service Provider
C-AR	Central register system ('Centraal Aansluitregister' in Dutch)
da	Direct Activated
DE	Germany (country acronym)
DR	Demand Response
DSO	Distribution System Operator
DSR	Demand Side Response (equivalent to the DR term)
EDSN	Energie Data Services Nederland
EHV	Extra High Voltage
ETPA	Energy Trading Platform Amsterdam
FCR	Frequency Containment Reserves

GCT	(Market) Gate Closure Time
GTS	Gas Transport Services (Gasunie Transport Services B.V.)
HV	High Voltage
IGCC	International Grid Control Coordination
ISP	Imbalance Settlement Period
LEI	Legal Entity Identifier
LFC	Load Frequency Control
mFRR	manual Frequency Restoration Reserves (tertiary control reserves)
MV	Medium Voltage
NEDU	Nederlandse EnergieData Uitwisseling (Dutch Energy Data Exchange)
NL	The Netherlands (country acronym)
NRA	National Regulatory Authority
PACE	Processed Area Control Error
RR	Replacement Reserves
sa	Schedule Activated
TSO	Transmission System Operator
USEF	Universal Smart Energy Framework

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