Distributed Renewable resources Exploitation in electric grids through Advanced heterarchical Management

DREAM electricity market design

WHITE PAPER

Rieke Bärenfänger, University of St. Gallen, rieke.baerenfaenger@unisg.ch

Damian Daniluk, Fraunhofer IML, damian.daniluk@iml.fraunhofer.de

20th October 2014

Abstract

In order to achieve goals stated in the EUs directive 2009/72/EC and the "Energy 2020" strategy initiative, current distribution and retail markets will have to be developed further, alongside the necessary condition of wide dissemination of the required infrastructure (i.e., smart meters in houses). Such developments are encouraged by the EU's general wish for a liberalized energy market that provides for free connection, transaction, and dispatch, i. e. free access to the grid to all parties, the right to engage in energy transactions with each other, and the right to take and feed into the grid. This encourages activities like the DREAM project to rethink current actors' functions and their interactions as well as the enabling technical and market conditions.

This publication is developed within the frame of the DREAM project, financially supported by the European Commission through the Seventh Framework Programme (FP7)

Conceptual view on the new energy marketplace in DREAM: roles and interactions in the energy value chain

Most new concepts for demand response mechanisms follow the idea that in order to do this efficiently and in a market-oriented way, there is a need for a new “Aggregator” role in the market. This actor has both the resources and the incentives to bring “intelligence” to the distributed energy resources and offer their flexibilities, which have so far been unused, to other actors on the market. Although the approaches have this basic idea in common, the ways to implement it technically and commercially are different.

In DREAM, the so-called “Flexibility Aggregator” or in short “Aggregator” represents all the distributed resources connected to his portfolio on LV and/or MV levels. At this stage of the new market design, it is still open which legal entity(/ies) will practically execute the role of the Aggregator. Three possible options would be an independent commercial entity, the DSO, or the electricity supplier/BRP, which will be evaluated in later project stages along with an analysis of the business models of the respective actors. Regardless of who will eventually impersonate the Aggregator, this role creates new interactions with the other market participants, which is illustrated in the following figures and explained in Table 1. These figures illustrate the changes in the market designs on a conceptual level. Thus, they do not aim to specify the nature of the commercial or commodity interactions or the time frames in which the interactions take place.

Current market design

The first figure shows the market participants in the current situation without demand response mechanisms and their basic interactions with each other and the energy markets. The DSO does not participate in the balancing market, because in the traditional market design balancing lies in the sole responsibility of the TSO. In this (already liberalized) market, independent suppliers source energy from the market and sell it to consumers. For the sake of simplicity, the “Supplier” and “BRP” roles are combined in one role because in reality they will often be united within a single market party. Theoretically, a supplier can of course delegate the BRP responsibility for his customers to another BRP, in which case he will no longer have a direct commercial interaction with the TSO, but instead with the BRP.

The interactions between the actors are explained in Figure 1.

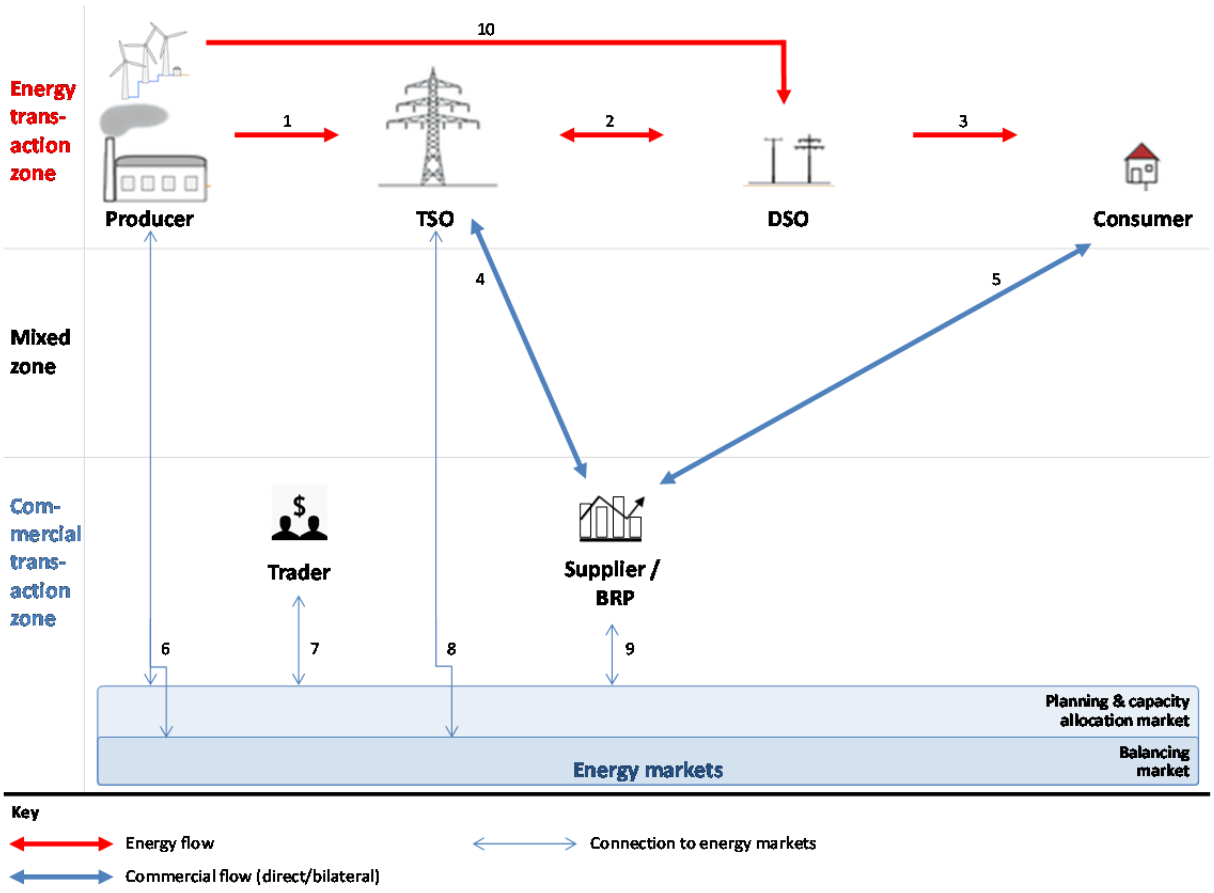

Figure 1: Current market design of the energy supply chain including interactions

New DREAM market design

Figure 2 depicts the conceptual view on the new DREAM market design. Here, the new actor "Aggregator" is introduced. The Consumer becomes a Prosumer and is assumed to possess manageable load, storage, and/or production devices. With the Aggregator's participation in the market as mediator for flexibilities from Prosumers towards low voltage as well as higher grid levels, a new balancing market for the distribution level (involving DSOs and Aggregators) can be created next to the conventional balancing market with TSOs as core actor. Suppliers/BRPs can also acquire flexibilities for their own capacity planning and schedule optimization via the market from the Aggregator.

The changed and new interactions in comparison to the original market design are also explained in Table 1 and Table 2.

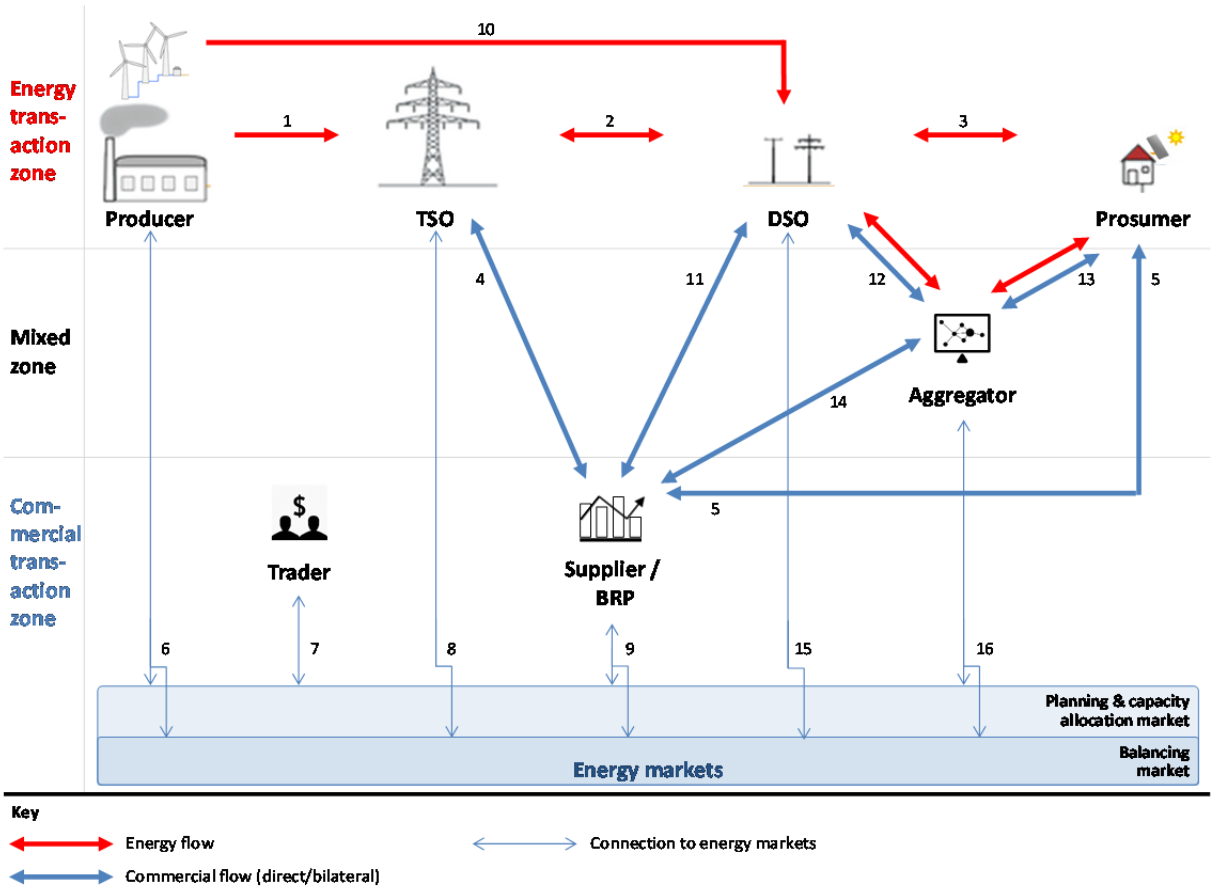

Figure 2: DREAM market design of the energy supply chain including interactions

No.	Interacting roles	Type of flow (E / C) [1]	Explanation valid for both scenarios when no difference exists, otherwise:	
			Explanation for current market design	Explanation for DREAM market design
1	Producer – TSO	E	(Large) Power producer routes energy (kWh) to TSO as agreed upon in schedule.	
2	TSO – DSO	E	TSO routes energy (kWh) from HV to MV/LV networks. Due to the growing amount of DC capacity, a local situation can occur in which supply exceeds demand. In this case, the surplus of electricity is fed upwards into the transmission grid, after which the TSO transports it to other distribution networks.	
3	DSO – Consumer	E	DSO routes energy (kWh) on LV network to (small) Consumer.	DSO routes energy (kWh) on LV network to Prosumer. In turn, the prosumer may also provide energy to the grid.
4	TSO – Supplier/BRP	C	C: BRP tells TSO expected schedule in balance area. *Imbalance settlement after real time*: TSO charges BRP for imbalances.	
5	Supplier/BRP – Consumer	C	C: Supplier sells energy (kWh) to Consumer.	Supplier sells energy (kWh) to prosumer. In turn, the Prosumer may also sell his energy to the Supplier.
6	Producer – Markets	C	Producer sells capacity (kW) via energy markets. This happens both on planning & capacity allocation (wholesale) markets and – if required and if allowed to do so – on balancing market.	
7	Trader – Markets	C	Trader trades capacity (kW) on planning & capacity allocation market to profit from price variations.	
8	TSO – Markets	C	TSO trades (buys and sells) energy (capacity) in the form of ancillary services on the balancing market to ensure real-time grid stability.	
9	Supplier/BRP – Markets	C	BRP trades (buys and sells) energy (capacity) on energy markets. (a) Planning & capacity allocation (wholesale) market: trading to balance supplies and consumptions in his balance area based on forecasts (portfolio optimization).	BRP trades (buys and sells) energy (capacity) on energy markets. (a) Planning & capacity allocation (wholesale) market: trading to balance supplies and consumptions in his balance area based on forecasts (portfolio optimization). (b) Balancing market: participation in new (near-) real-time balancing market on distribution level by using the flexibility provided by the Aggregator.
10	Producer - DSO	E	DG (distributed generation) operators electricity is fed directly into the distribution network of DSO.	
11	Supplier/BRP – DSO	C	*- interaction does not exist in current market design -*	DSO needs visibility of the planned actions in his grid to be able to check for network constraints. This is the same argumentation as for interaction No. 12, tbd. later if both are necessary and who will inform the DSO.

Table 1: Explanation of interactions in electricity markets (Part 1/2)

[1] E = energy flow; C = commercial flow

No.	Interacting roles	Type of flow (E / C) [2]	Explanation valid for both scenarios when no difference exists, otherwise:	
			Explanation for current market design	Explanation for DREAM market design
12	Aggregator – DSO	E & C	*- interaction does not exist in current market design -*	E: Exchange of energy (kWh) between DSO and Aggregator as the Aggregator manages the flexibilities coming from Prosumers towards DSO. The Aggregator is therefore involved in the physical flow of energy. C: DSO needs visibility of the planned actions in his grid to be able to check for network constraints. There may also be financial compensation between DSO and Aggregator for flexibilities.
13	Aggregator – Prosumer	E & C	*- interaction does not exist in current market design -*	E: Routing of energy (kWh) between Aggregator and Prosumer. C: Contracts between Prosumer and Aggregator about use of DER and compensation.
14	Supplier/BRP – Aggregator	C	*- interaction does not exist in current market design -*	C: BRP can buy flexibilities to optimize his portfolio from Aggregator.
15	DSO – Markets	C	*- interaction does not exist in current market design -*	DSO buys energy (capacity) in the form of flexibilities on the new balancing market to ensure (near-) real-time distribution grid stability.
16	Aggregator – Markets	C	*- interaction does not exist in current market design -*	The aggregator sells his flexibilities / capacities to the markets.

Table 2: Explanation of interactions in electricity markets (Part 2/2)

[2] E = energy flow; C = commercial flow