New business models enabling higher flexibility on energy markets

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Abstract

Energy markets – and particularly electricity markets – are faced with a strong need for more flexibility, mainly due to the fact that the share of renewable energy sources in energy supply is steadily increasing. The current model of ensuring demand-supply match mainly by investments into supply and transmission infrastructure needs to be complemented by demand-centric solutions – usually summarised under the term demand response (DR).

Due to digitalisation the technical possibilities to integrate small- and medium-sized prosumers (residential, tertiary, decentral power and heat storages, micro-grids etc.) into DR activities are continuously expanding: innovative platforms allow for bundling of small/medium-sized capacities; transaction cost are reduced through automated dispatching; communication with switchable, "smart" appliances is becoming cheaper; new technologies are available to ensure secure data handling for easier forms of "smart contracts"; etc. But hand in hand with expansion of DR potentials, there is also a need to adapt and further develop current DR business models to cope with new challenges.

Against this background, this paper

- gives a brief summary on the most current technological developments that will lead to a continuous expansion of DR potentials over the next decade
- presents an overview on the core elements of the regulatory framework in EU countries which are relevant for DR activities
- describes business models that are currently applied on the market and analyse the limitations of these business models
- derives from there new business models that enable increasing flexibility on energy markets, including a clarification of roles and responsibilities of future DR service providers and their position as a market facilitators.

The paper is based on research work currently implemented in the frame of a bundle of national and European projects dealing with the development of suitable business models for future DR markets.

Setting the scene

The energy system is undergoing a paradigm shift as it evolves from the historic structure of centralised energy generation towards a network of distributed prosumers. Consumers are increasingly being encouraged and empowered to actively participate in the energy network with respect to consumption and generation. The future energy system will be a smart system, where all energy entities are given the opportunity to participate in the market place. This is reflected in the latest round of EU energy market legislation (European Commission 2018).

One of the main elements of energy transition implies an increasing share of renewable energy sources such as wind and solar in our energy mix. However, that also implies that the volatility of the electricity system will increase and that the energy system has to be managed in a more complex manner than it used to be. The supply of renewable energy is always subject to major fluctuations on a seasonal as well as on a daily scale and the future power network will require major investments in order to be able to cope with smaller and more decentralized generation units and to guarantee grid stability.

One important element in coping with the challenge of increasing need for flexibility is the demand side. If the demand side patterns are better adjusted to the supply patterns of the renewables this will reduce investments required on the supply side. This concept is called demand response (DR): Peaks and shortages of electricity supply are communicated to the consumers who reply by adapting their current consumption.

For large power consuming companies various DR approaches are already reality. But could the concept of DR also work for small and medium-sized customers from the residential or tertiary sector? And how could digitisation of our daily lives (smart meters, smart homes) help to make smaller-scale DR implementable? For seizing the potential of renewables efficiently, widely spread demand response is necessary in order to minimise the investments in large scale energy distribution and storage units.

Technical solutions that support the extension of DR towards small and medium sized prosumers are already in place, but there is still a need for the development of appropriate business models. There is some incentive for all parties involved to make use of DR as it saves costs for consumers, whereas for suppliers it can work as a tool to better balance their portfolio and optimise the sourcing costs. DR service providers also may be third parties that act as DR aggregators, who conclude contracts directly with consumers, pooling together their DR capacities and selling them on the flexibility market. Clarifying the roles and responsibilities of all these players needs to be accomplished in order to create a sound DR environment.

IMPORTANT DEFINITIONS

In the context of this paper, the term **flexibility market** is understood as a part of the electricity market, where electrical loads on the side of final energy consumers are potentially or actually changed as a result of DR activities. This includes loads of consumption of electricity (heat pumps, ventilation, cooling, etc.) and of decentral electricity production and storage (PV, batteries, CHPs, etc.) as well as micro-grids. Possible activities are: switch loads on or off as well as adaptation of load levels.

Furthermore we distinguish the two major forms of income streams from DR as follows:

- **Explicit use of DR:** According to the Smart Energy Demand Coalition [SEDC, 2016] explicit demand-side flexibility is defined as committed, dispatchable flexibility that can be traded (similar to generation flexibility) on the different energy markets (wholesale, balancing, system support and reserves markets). This is usually facilitated and managed by an aggregator that can be an independent service provider or a supplier. This form of demand-side flexibility is often referred to as "incentive driven" demand-side flexibility and its main income stream is remuneration for flexibility services from Transmission System Operator (TSO) Distribution System Operator (DSO) or Balance Responsible Parties (BRP).
- **Implicit use of DR:** According to SEDC [2016] implicit demand-side flexibility is defined as the consumer's reaction to price signals. Where consumers have the possibility to choose hourly or shorter-term market pricing, reflecting variability on the market and the network, they can adapt their behaviour (through automation or personal choices). This type of demand-side flexibility is often referred to as "price-based" demand-side flexibility and its main income stream is the energy cost savings that are achieved by shifting loads.

As the paper has a focus on the participation of **small and medium-sized prosumers** in the DR market, we define this group as consisting of the following sub-sections: average residential consumer/prosumers; average tertiary consumer/prosumer; industrial SME (with small share of energy cost in overall production cost); small-scale, decentral electricity producers (e.g. PV) and/or storage provider (mainly batteries). This is distinguished from large-scale DR – such as load shift activities related to industrial processes – and from power balancing by peak-load electricity production/storage in large facilities (e.g. pumped-storage plants).

Digitisation as a driver for development of DR markets

The main barrier why small- and medium sized prosumers are hardly part of DR markets – even if the overall technical potential for load shift is high – is related to high transaction cost in this sector. The ratio between achievable benefits – e.g. for one household the cost savings are hardly beyond a level of €100 – and the effort to access broadly decentralised DR potentials is (perceived as) unattractive.

On the other hand digitisation leads to a reduction of transaction cost and brings small- and medium sized prosumers into the game again. In the following, the most relevant technological developments are described in further detail.

SMART DEVICES

Participation of small and medium-sized prosumers in DR-markets fundamentally depends on the availability of smart and switchable devices which can be easily incorporated into a DR platform. In this context, we consider a device as switchable or "smart" if the following conditions apply:

- The device is able to communicate its energy consuming status (e.g. on/off, high/low performance, standby) to a higher-level node or gateway.
- The device is able to receive and process an external signal which interferes with its internal control system. The signal may come from a gateway, remote controlling device or the power line.

Tables 1 and 2 summarise the estimated market development of DR enabled devices and appliances based on the Ecodesign Preparatory Study on Smart Devices [VITO et al. 2017].

Altogether the main conclusions from a comprehensive analysis [cf. Leutgöb, Amann 2018] are that the market share of smart and switchable devices is currently very low and is expected to grow comparably slowly over the next 5–10 years. There exist, however, several areas where the prospects are more promising, such as heat pumps or air conditioners. In addition, the integration of building automation systems as well as of storage systems (heat and electricity) and decentralised electricity production in DR activities will facility DR at small and medium-sized prosumers.

Table 1. Installed units of houseware in the EU28 in 2010 (reference) and 2015, 2020, 2030 (estimates) (adapted from VITO et al. 2017).

		2010	2015	2020	2030
Dishwashers	Total installed appliances	82,799,000	98,345,000	115,036,000	148,553,000
	Number of smart appliances	0	0	575,18	29,710,600
	Share of smart appliances [%]	0	0	5	20
Washing machines	Total installed appliances	185,828,000	196,821,000	200,805,000	204,744,000
	Number of smart appliances	0	252,335	10,040,250	40,948,800
	Share of smart appliances [%]	0	0.13	5	20
Tumble dryers	Total installed appliances	62,723,000	47818000	71801000	77778000
	Number of smart appliances	0	0	3590050	3111200
	Share of smart appliances [%]	0	0	5	40
Household refrigerators and freezers	Total installed appliances	297,800,000	303,200,000	308,000,000	317,600,000
	Number of smart appliances	0	147,81	15,400,000	63,520,000
	Share of smart appliances [%]	0	0.05	5	20

Table 2. Estimation of the installed base of DR enabled HVAC appliances in the EU27 (adapted from VITO et al. 2017).

		2010	2015	2020	2030
Electric radiators	Total installed appliances	221,000,000	220,920,000	213,000,000	203,275,000
	Number of smart appliances	442	6,627,600	19,170,000	42,687,750
	Share of smart appliances [%]	0.2	3	9	21
Air conditioners	Share of smart appliances [%]	7	16	30	45
Heat pumps	Total installed appliances	7,400,000	9,750,000	10,430,000	10,930,000
	Number of smart appliances	518	1,560,000	3,129,000	4,918,500
	Share of smart appliances [%]	7	16	30	45
Electric boilers	Total installed appliances	1,100,000	1,100,000	1,100,000	1,100,000
	Number of smart appliances	4,4	22	77	198
	Share of smart appliances [%]	0.4	2	7	18
Built- in electric inertia radiators	Total installed appliances	13,800,000	13,775,000	13,700,000	13,550,000
	Number of smart appliances	6,9	137,75	548	1,084,000
	Share of smart appliances [%]	0.05	1	4	8

IMPROVED SOFTWARE SOLUTIONS FOR DR AGGREGATION

Over the last 5–10 year various software platforms have been developed and introduced on the market that support the work of "DR specialists", mainly DR aggregators. Several of these solutions are proprietary platforms, which have been developed "on the job" by aggregators themselves (e.g. KiWi platform), other platforms have been developed as open source solutions (e.g. as Niagara platform). In addition, some of the platforms are combined with proprietary hardware that is installed on customer premises to allow for accurate metering and control of assets.

The participation of small and medium-sized prosumers in flexibility markets will require further development and additional features and functionalities of the software platforms, among others in the following areas: Handling small and medium loads; user clustering; grid stability assessment and load forecast (mainly for the case of clustering of small loads); improvement of price forecasting tools; enhancement of interoperability features; virtual power plant services to enable improved management of energy storage systems in conjunction with RES generation.

SMART CONTRACTS

Time-resources spent for the conclusion of contracts as well as all activities related to monitoring of contract implementation (including billing) represent a considerable share of transaction cost if we talk about small and medium-sized clients. Therefore digitisation related to facilities of contracting activities – sometimes summed up under the term smart contracts" – are important in our context. In the further development of smart contracts the **blockchain technology** play a major role: Hereby, a blockchain is a growing list of records, called blocks, which are linked using cryptography. Blockchains are readable by the public and are tamper-proof which makes them useful for ensuring security and traceability of contractual matters. In its final form, the functionalities for smart contracts need to be incorporated in DR software platforms, as described above.

RELATIONSHIP BETWEEN DR AND ENERGY EFFICIENCY

The relationship between DR and energy efficiency is a bit ambiguous. In theory, for most DR activities there exists a technical trade-off between DR and energy efficiency. This is particularly the case, if the potential for load shift depends on the availability of a storage system, as each storage will lead to additional energy losses. Just to give one example: If a heat pump is producing heat outside of business hours and fills a storage this process will lead to additional losses compared to a "just-in-time" delivery of energy.

In real life, however, many systems and facilities are not operated in an optimal way. In these cases, switching off an appliance or switching on an appliance later as a result of DR does not necessarily bring about an immediate deviation from required comfort levels, but reduces energy consumption directly. In this context, digitisation helps to detect short-comings in building operation and in achieving an (economic) optimum of well-balanced application of DR in an energy-efficient facility.

Regulatory framework conditions on the move

Technical solutions for DR as well as related business models have to be embedded in the existing regulatory framework. Even though liberalisation of the electricity market is a European project starting already in 1996with the first EU Directive 96/92/EC concerning common rules for the internal market in electricity, regulatory framework conditions for the participation of market players in DR is still quite different across European countries. Figure 1 summarises the analysis performed by the Smart Energy Demand Coalition (SEDC 2017).

This analysis shows to which degree the regulatory framework allows for explicit Demand Response and differentiates the following main groups:

- Advanced countries with an active DR market, such as France, Belgium, United Kingdom, Ireland. Internationally, it is the US that serves as a role model for the activation of DR through appropriate framework conditions.
- Intermediate countries with a partially open DR market, such as Austria, Germany and most Scandinavian countries.
- Countries with closed DR markets, such as Greece, Spain, Portugal and Cyprus.

Narrowing down the assessment to the chances for participation of small and medium sized loads in the flexibility market, we find out that even in the advanced markets there exist several barriers (Leutgöb, Amann 2018). The following framework elements will reinforce the integration of small and medium-sized prosumers in flexibility markets:

- **Clear definitions of the roles of market participants**, especially of independent aggregators and their relation to balancing responsible parties/retailers and other market participants: In several countries demand response potential (i.e. switchable electrical loads) may only be offered to independent aggregators with the approval of the energy providers. This makes participation in the flexibility market more complicated and it increases transaction costs that are a main barrier for small and medium loads. However, in some countries templates exist and due to the liberalisation of the electricity market, energy providers can be changed easily.
- **Adaptation of technical requirements for flexibility products:** Traditionally, demand response products on the electricity market were created for large generation units. Today, system needs and technical requirements have changed and this should be reflected in the definition and requirements of products. For example, the minimum size of aggregated loads, maximum duration of availability, recovery periods and standardised procedures for prequalification (aggregated loads instead of technical units; one prequalification for several products etc.) are important factors necessary to intensify participation of DR. This is of high relevance especially for demand response applications where a large number of small and medium loads should be aggregated automatically.

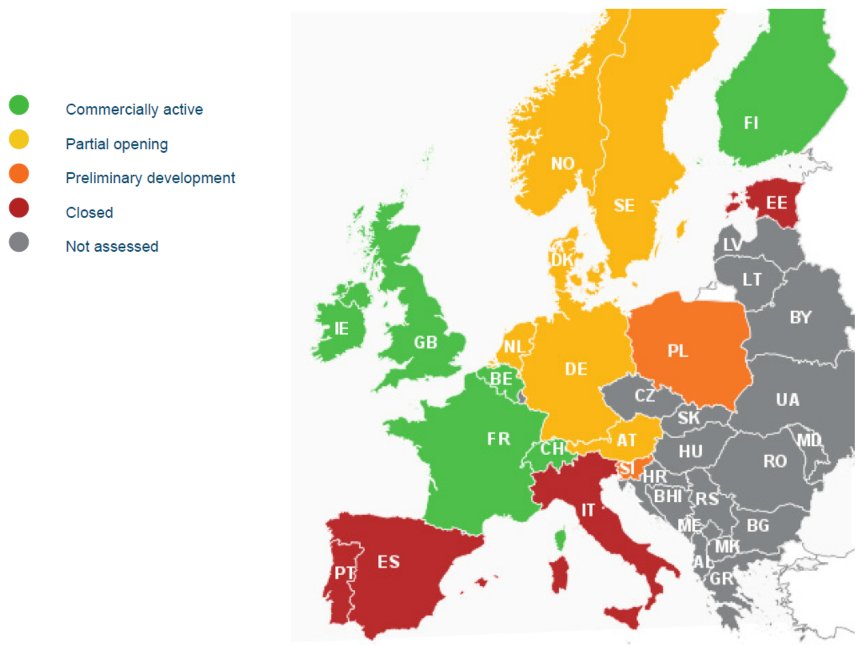

Figure 1. Map of explicit demand response development in Europe (SEDC 2017).

- **Roll-out of smart meters:** Integration of small and medium loads requires short term (real time) metering of electrical power on the side of consumers, extended by smart devices that allow for changing loads or switching devices automatically. As the roll-out of smart meters has already started in most of the European countries, this may help to integrate small and medium loads in flexibility markets. However, not all smart meters will have the functionality for remote control necessary for demand response. Additionally, measurement and verification also requires adequate metering.
- **Clear requirements for measurement and verification:** Measurement and verification is required in order to quantify the effect of demand response event (e.g. reducing electrical load for a certain period of time). Compensation will be given for load curves without any demand response event. Similar to Measurement and Verification (M&V) in energy performance contracting, demand response requires a high temporal resolution (hours to minutes) and it should take place at the level of aggregated loads. A commonly agreed (simple) methodology is a main precondition for the reduction of transaction cost.
- **Appropriate tariff structures** should be able to incentivise demand response while including price signals for the integration of renewable energies. This should not only include tariffs for energy consumption (time-of-use tariffs) but also flexible grid tariffs that reflect the status of the grid and the need for balancing demand and response in the electricity system.

It has to be underlined, however, that the regulatory framework conditions in many countries are improving. Regulators are interested to facilitate the expansion of DR in balancing markets with the aim to strengthen competition among market players by building a counterweight to the current supply-side "top dogs".

DR business models for small and medium-sized prosumers

Against the background of improving technical opportunities due to digitisation, and taking into account regulatory frameworks that are incrementally adapting to the integration of DR, in this chapter we will analyse DR business models for small and medium-sized prosumers. Over the last few years, the DR market has developed several business models by which the value of potentials for load shift is priced, offered and sold on the flexibility markets.

At the moment, the existing business models are applied only for large-scale DR, therefore we will need to assess

- whether the existing business models are appropriate also for the participation of small and medium-sized prosumers, or
- whether there is a need for the definition of new/adapted business models.

In this context, business models are defined by assigning specific roles to various stakeholders. In the context of small and medium-sized DR the following **roles and responsibilities of stakeholders** are important:

- **Users/Clients** are defined in our context as owners of technical equipment that comprises DR potential. For the operation of this equipment they have concluded an energy supply contract with a retailer.
- A **retailer** is an individuals and legal body that is selling electricity to customers for profit. This can either be an electricity supplier with own power production facilitates or a wholesale company that purchases electricity for the purpose of resale.
- **DR aggregator**: are defined here as a third-party service provider that contracts with the individual demand sites (industrial, commercial or residential consumers) and aggregates them together so that their DR potential can be offered to TSO, DSO or BRP.
- Furthermore **Transmission System Operator (TSO), Distribution System Operators (DSO)** and **Balance Responsible Parties (BRP)** are crucial stakeholders for any DR business model as they represent important revenue streams.

A usual way to **categorise DR business models** is related to the different nature of the related income streams: Explicit DR or implicit DR. Furthermore, one business model is related to the specific case of microgrids.

- Explicit DR as stand-alone service
- Explicit DR combined with EES
- Implicit DR service for optimal use of time-of-use (TOU) contracts
- Implicit DR including power supply
- Microgrid Management

In the following, we will describe these generic DR business models in further detail and assess to which degree and under which conditions they may become a tool for the incorporation of small and medium-sized prosumers in flexibility markets.

BUSINESS MODEL "EXPLICIT DR AS STAND-ALONE SERVICE"

In this business model, a DR Aggregator is bundling DR potentials from different clients, which are too small as stand-alone potentials to be offered to the various flexibility markets. The main characteristics of this business model are as follows (cf. Figure 2):

- The **aggregator acts as facilitator**. He has access to the DR potentials of clients and manages them towards the various flexibility markets. Depending on the regulatory framework he may offer the DR potentials either on the electricity balancing market (tertiary or secondary control markets) or he may participate with these loads in a balance group, represented by a BRP.
- The **income streams** originate from payments either from the TSO/DSO or from the BRP – in the latter case, these payments would reflect reduced balance power expenses in a balance group. Depending on the contractual agreement, the aggregator will usually pass on a certain share of these payments to the clients in his portfolio.

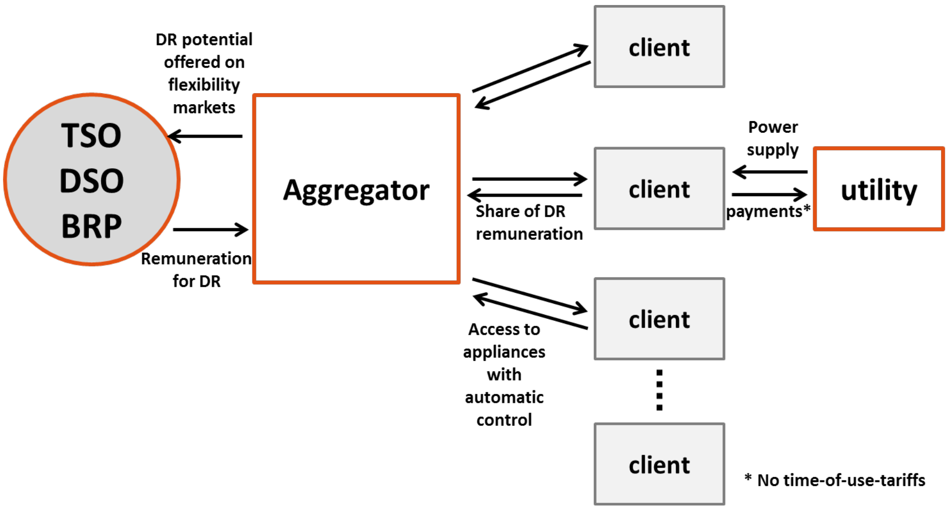

Figure 2. Business Model Explicit DR as stand-alone service.

- The service of DR aggregation has **no interlinkage to power supply** or any other service to be provided for the client. In other words, this means that in this business model many interfaces need to be managed.

The business model of explicit DR as stand-alone service is a standard approach widely used for commercial exploitation of large DR potentials, e.g. in industrial plants (typical case cement industry). The transferability to small and medium-sized prosumers depends on better and cheaper incorporation of small and medium loads from the residential and tertiary sector and on higher reliability of DR potentials which are achieved by bundling of small- and medium-sized loads. In particular this addresses the following factors:

- **Improvements to software solutions for aggregation** of small and medium-sized loads: Among other issues, there is a clear requirement to improve the functionalities related to bundling of small loads, to availability forecast as well as to automatic dispatching functions.
- **Easy access to a large number of switchable devices** needs to be ensured (cf. the section above on latest market development regarding so-called smart devices): If, for example, the access would require up-grade of existing devices, the cost-benefit ratio of such activities would become negative very quickly.
- **Attractive value proposition to the clients:** A more detailed analysis of the user perspective, and namely of the users' willingness to participate in DR programmes (Leutgöb, Amann 2018) concludes that only a limited share of households will react to economic incentives for DR-participation, as the savings achievable for single households are expected to be quite small in most cases. In the tertiary sector the economic incentive has a higher weight than in the household sector, but in return comfort and availability consideration represent a more important barrier. Therefore, the value proposition thus needs to be adapted to the specific customer segment.
- **Distribution channels and customer relationships:** The aggregator needs to be able to address a large number of small and medium-sized customers at low cost. The distribution structure needs to achieve economies of scale very quickly, otherwise the sales cost will exceed the total achievable margin from the sum of single clients[1].

Altogether, we conclude that the business model related of explicit DR as stand-alone service has to cope with considerable barriers, mainly related to easy and cheap access to the clients as well as to the formulation of an attractive value proposition due to the fact that the service is offered as stand-alone service. Thus the transfer of this business model to small and medium-sized customers will be rather difficult except for those customers that are somewhere between a medium and a large customer, such as large non-residential buildings. But even for this target group a combination of DR-services with other service components – as considered in the business models below – may be more attractive than the stand-alone service.

BUSINESS MODEL "EXPLICIT DR COMBINED WITH EES"

In its general approach, this business model is similar to explicit DR as stand-alone service – as described above – but the DR aggregation service is embedded into a more comprehensive energy efficiency service (EES). This approach, which is sometimes referred to as "**dual service**", is characterised by the following peculiarities:

- As described above, there exists a **trade-off between energy efficiency and demand response**, as load shifts in many cases will lead to an increase of energy consumption. Therefore, the main challenge of a dual service is to find an optimised solution for this trade-off on a day-to-day basis.
- EES and DR services require different fields of expertise and competencies. Whereas the core knowledge of EE service providers (frequently called ESCOs) is related to

1. This challenge of sales cost for overall profitability is similar to the one small-scale energy efficiency services are confronted with. It can by analysed by means of a multi-level contribution margin calculation (cf. Leutgöb et al., 2011).

the operation of technical equipment, the success of DR service providers (usually provided by a DR Aggregator) is mainly based on a thorough understanding of the flexibility markets. Therefore, the combination of both services into one integrated offer is not easy and requires clear and transparent definition of the **ESCO's and the DR Aggregator's role**.

Except of a few pilot projects, we are not aware that dual services are already offered on European markets. In any case, this business model is closely linked with the development of EES markets. If EES are increasingly offered also to small and medium-sized customers, DR-potentials could be harvested in this sector, too.

The business model of dual energy services can enforce further monetisation of energy savings by exploiting their potential to be used in the DR market (as soon as national DR markets reach maturity). Furthermore, the business model of dual energy services gives way to higher market penetration of EE-upgrades of buildings and installation of RES-systems both in the building/district and the grid scale facilitated by the provision of DR services (including system charges optimisation and direct grid services).

We expect that the business model can become successful in the medium term within the following set of framework and provided that the following preconditions are fulfilled:

- The package consists of **EES as guiding service** and DR as add-on service. There need to be clear rules for the collaboration between the ESCO and the DR Aggregator. In this context, the functionality of price forecasting gains increasing importance as it supports solving the trade-off between energy efficiency and load shifting in optimised way.
- The **main target groups will be the same as for the EES business**, which – because of transaction costs – are limited to customers with energy cost beyond €20,000 to €30,000/a in most European markets.
- The **project structure needs to be adapted to the specific customer**: The main structuring elements of an ESCO contract refer on the one hand to the detailed definition of responsibilities of the ESCO and the related interface to the responsibilities of the client, and on the other hand to the remuneration model – often subdivided into the guaranteed savings model and into the shared savings model. By introducing the DR-component into the project, the additional structural element of implicit versus explicit DR arises.

BUSINESS MODEL "IMPLICIT DR SERVICE FOR OPTIMAL USE OF TOU-CONTRACTS"

This business model starts from the fact that already now a certain group of electricity customers have electricity tariffs with different price levels depending on the time of consumption. In theory, we can differentiate the following pricing arrangements [Cooke, 2011]:

- **Time-of-use (TOU) pricing** refers to a flexible pricing structure incorporating different unit prices for usage during different time periods within a day. TOU rates reflect the average cost of generating and delivering power during those time periods. The simplest way of TOU tariffs are day-night tariffs, but more disaggregated tariff structures are developing currently on the market.
- **Real-time-pricing (RTP)** refers to pricing based on real-time movements in electricity prices based on trade in spot markets, balancing markets or other exchanges. It links hourly or half-hourly prices to corresponding changes in real-time or day-ahead power costs. In this case, customers need to be informed about expected RTP prices on a day-ahead or hour-ahead basis to elicit load response.
- **Critical peak pricing (CPP)** is a hybrid combining traditional time of use rates and real time pricing design. The basic rate structure is time of use. However, provision is made

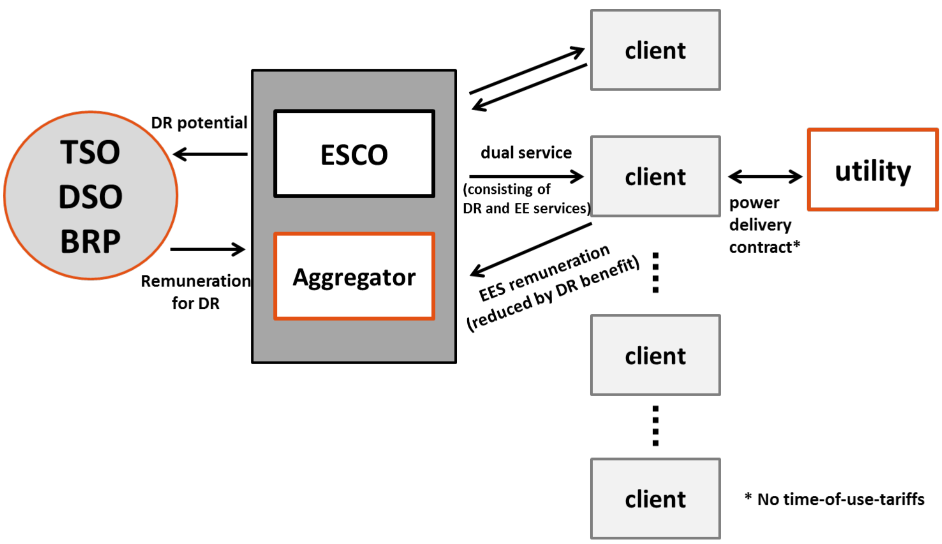

Figure 3. DELTA Business Model 1B Explicit DR combined with EES.

for replacing the normal peak price with a much higher predetermined critical peak pricing event price under specified conditions.

In EU countries electricity tariffs consist of one component related to electricity delivery and one component related to the utilisation of the grid, where the latter is defined by regulation. Therefore the time-dependent structure of the tariff may relate either to one of these components or to both of them. For small and medium prosumers the only time-dependent pricing model that is currently available on the market is TOU contracts, whereas RTP does not exist in this sector. We expect that in the near future more different and more differentiated TOU tariffs will be offered on the market. In addition, we may see in the near future CPP also for medium-sized prosumers, mainly if, for example, a customer with a larger portfolio will explicitly search for a time-dependent tariff for a whole pool of facilities.

The business model related to implicit DR service for optimal use of TOU contracts is characterised by the following elements and success factors related to the its application for small and medium-sizes prosumers:

- The service provider – let's call it **flexibility service company (FLESCO)**, corresponding to the widely used term ESCO – takes care of load shifts at the equipment of the client in a way that the client takes maximum benefit of an (existing) TOU tariff. The FLESCO's remuneration may be either fixed or performance-based.
- The economic advantageousness of the business model is depending on the **spread between high and low price in the tariff structure**. Only if the spread is sufficiently high the achievable savings will be attractive for clients to engage a DR specialist. If perhaps in future dynamic pricing models (CPP, RTP) will be increasingly available on the market there will be a higher need for external expertise.
- Implicit DR services for optimal use of TOU-contracts **can be offered as stand-alone services**. In this case, however, the disadvantages related to all stand-alone DR services apply (high transaction cost require quick achievement of economies of scale, and thus well-established distribution channels and customer relationships).
- We expect that the service will be more successful, if it is **embedded in services which are already offered on the market**. On the one hand, the service is strongly linked to the role of a technical facility manager, as they are usually aiming for a reduction of operating cost. On the other hand, there is an interlinkage with consultancy services related to the identification of the most attractive energy tariff.
- The **most promising target group** are medium-sized are those customers that have already outsourced the facility management to an external partner. In this case, the service may be offered as add-on to existing service elements (cross-selling potential). This approach will require, however, cooperation between facility management companies, which have a solid position at their customers, and DR specialists, such as DR aggregators.
- From the **technical point of view** there exist two crucial success factors for FLESCOs: i) know-how in operating facilities, easiest by means of master control systems (such as building management systems); ii) capability to manage information about price signals – potentially dynamic price signals –at the customers metering points for a larger number of customers.

BUSINESS MODEL "IMPLICIT DR INCLUDING POWER SUPPLY"

This business model related to implicit DR including power supply combines DR services with the role of a retailer on the electricity market. The model is characterised by the following main elements:

- In addition to its usual function of selling electricity to customers, the **retailer has access to DR potential at the customers' sites** and is allowed to shift loads within the contractually agreed limits. Therefore, the business model goes beyond offering TOU tariffs, but includes active management of DR potentials at the customers.
- From the retailer's point of view, the access to **DR potential represents a value** as it may lead to savings both in wholesale prices and in balancing energy payments, since these prices are subject to high fluctuations depending on time of purchase. The more the retailer will be able to adapt the consumption patterns of his customer to the off-peak times on the market, the better will be his average wholesale price.
- In addition, the business model is particularly attractive for retailers that are also producers with a **high share of fluctuating renewables sources (wind, PV) in their supply portfolio**. By activating DR potentials, they can reduce the gap between supply and demand and thus reduce balancing energy payments.

The business model has a high potential of transferability to small and medium-sized prosumers. The following factors, however, are important for successful market penetration:

- Generally, **retailers are in a good starting position** and can get comparably cheap access to DR-potentials as they have established working distribution channels and customer relationships (including billing) which may help them in offering DR as add-on to existing services.
- The **customer will require an incentive**, so that he is willing to grant access to his technical systems to an external party. The most obvious incentive is to receive a favourable electricity tariff. But for small- and medium-sized customers also non-financial incentives may be decisive – such as environmental considerations or enthusiasm for the most current technical developments.
- Because of comparably low transaction cost for retailers when accessing their customers we assume that the business model may be also **applicable to the household sector**. Here the main barrier is the access to switchable devices in a way that they can be automatically managed (without manual interventions on a case-by-case basis). Taking into consideration the assessment on smart devices as presented above, the most relevant DR potentials in the short and medium term are heat pumps, air conditioners and possibly electrical heat storage systems. Also electric batteries might be relevant in this context, but their market is yet quite limited.

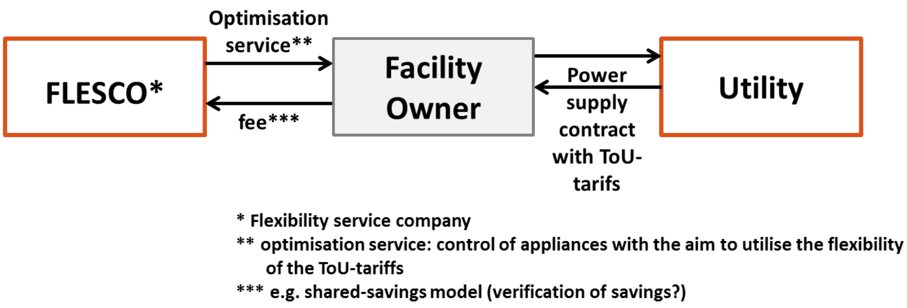

Figure 4. DELTA Business Model 2A Implicit DR service for optimal use of ToU-contracts.

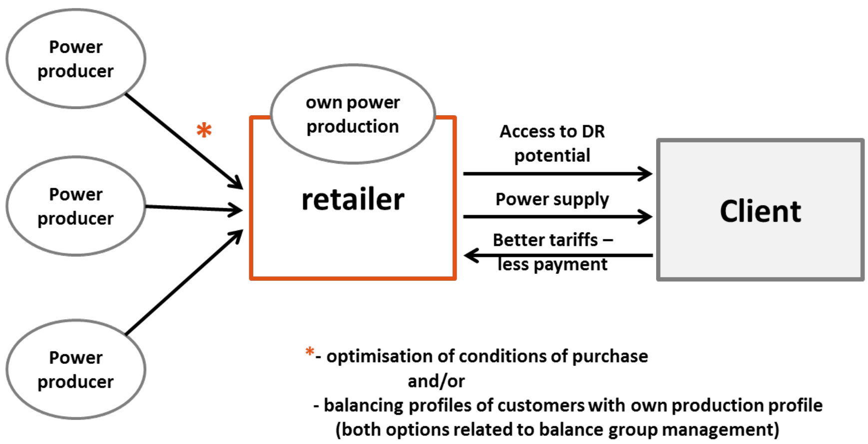

Figure 5. DELTA Business Model 2B Implicit DR including power supply.

- To certain degree, energy retailers are able to play a role on increasing market penetration of smart devices. They could prepare and distribute **programmes where the (subsidised) sale of smart devices is combined with a special tariff** that allows for implicit DR. In the past similar programmes have been successfully implemented by utilities related to the dissemination of highly energy efficient appliances and they might be adapted to the case of increased DR participation of small and medium-sized prosumers.
- Furthermore, the retailer will require **suitable software platforms** that are to bundle and to dispatch automatically as many DR potentials at the costumer's side as possible. The retailer will have core interest in the platforms ability to synchronise the use of DR potentials with productions patterns – if the retailer is also an electricity producer – and/or with price signals on the wholesale market.

BUSINESS MODEL "MICROGRID MANAGEMENT"

According to the US DoE Microgrid Exchange Group a microgrid can be defined a group of interconnected loads and distributed energy resources (such as distributed generators, storage devices, or controllable loads) within clearly defined electrical boundaries that acts as a single controllable entity with respect to the (macro)grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode (Berkley Lab, 2018).

- If operated in **island-mode** the microgrid manager has to ensure at each point in time that power supply is equal to power demand. In achieving this prerequisite, the exploitation of DR potentials including proactive operation of storage devices is decisive.
- If operated in **grid-connected mode** the microgrid manager can make use of the DR potentials available internally in the microgrid. He can either offer the loads in tenders of TSO, DSO or BRP (explicit DR) of optimised electricity cost by adapting the load profile of the microgrid to dynamic pricing (implicit DR).

Microgrid management is a very relevant business model for the activation of medium-sized DR potential that qualify for formation of a microgrid. The most relevant application fields for this business model will be those cases where a complex demand structure is complemented by decentral renewable energy production on the site or nearby the site (e.g. university campus, green-field neighbourhood development, business parks etc.).

However, in practically all EU countries the **regulatory environment is a current blockage for microgrid development**. According to Energati [2018] Europe is accounting for just 9 %

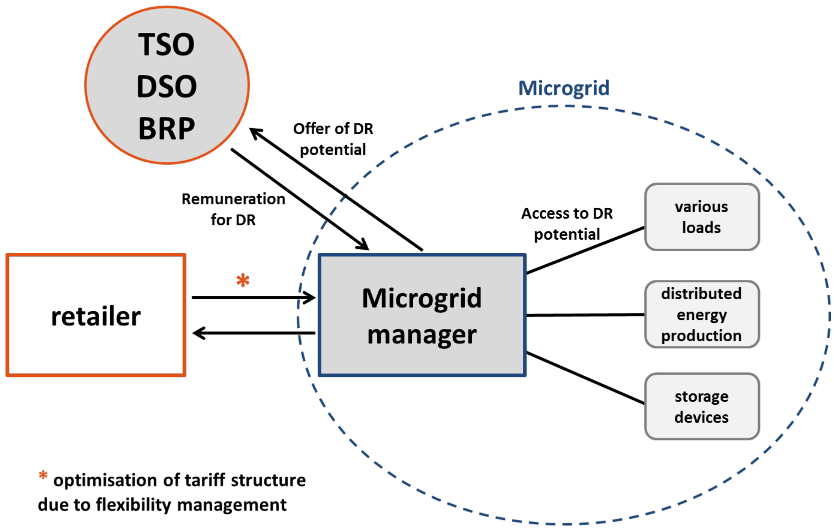

Figure 6. Business Model Microgrid Management.

of the global microgrid capacity. There are, however, several pilot microgrids, e.g. related to university campuses or to industrial and commerce centres.

A professional software solution for managing and dispatching the various loads is a "must" for microgrid managers, independently from whether they operate the microgrid in island-mode or grid-connected mode. The larger and more complex the microgrid the more relevant a professional platform is to dispatch the interconnected loads and distributed energy resources and to optimise the exchange with the external macrogrid.

Conclusions and recommendations

Within the next 5–10 years, we expect a series of technological developments – to be summed up under the term "digitisation" – that will profoundly facilitate the participation of small and medium-sized prosumers in flexibility markets. But hand in hand with expansion of DR potentials, there is also a need to adapt and further develop current DR business models to cope with new challenges. Against the background of the analysis as presented above, we come up with the following conclusion and recommendations:

- Easy access to switchable devices at prosumers' side is decisive. From the technical point of view a lot is possible, but market penetration of the technical innovations lags behind. In the short-term larger buildings with building **automation systems, heat pumps, air conditioners, possibly electric heat storage system** and similar appliances are most promising for DR business models. Also **electric batteries** might be relevant in this context, although except for Germany their market is yet quite limited.
- The slow market penetration of innovative switchable devices and technologies is closely linked with **deficits in the value proposition:** When analysing the main incentives inducing small and medium-sized prosumers to participate in DR programmes we have to conclude that only a limited share of households will react to economic incentives for DR-participation, as the savings achievable for single households are expected to be quite small in most cases. In the tertiary sector, the economic incentive has a higher weight than in the household sector, but in return comfort and availability consideration represent a more important barrier. Generally, there will be a need to complement economic incentives by environmental arguments, as well as by guarantees on availability, data security etc.
- Altogether, the success of any DR business model aiming at the residential and tertiary sector is **largely dependent on cutting down transaction cost**. As the financial savings may be small for the single user all cost related to distribution to and communication with the potential customer need to be very low, too. Therefore, it will be decisive to **make use of existing distribution and information channels** related to the target groups addressed.
- Whereas we have identified a number of business models that are applicable for the medium-sized prosumers – e.g. larger non-residential buildings, microgrids, business parks etc. – we assume that only the business model related to implicit DR including power supply is appropriate to address household clients. This is because of **a good starting position of retailers** that can get a comparably cheap access to DR-potentials as they have established well-functioning distribution channels and customer relationships (including billing). Generally, those business models where the **DR service is embedded in a larger service package** – such as EES, facility management, supply of electricity – are more promising than DR services offered as stand-alone service. This is mostly related to the impact of transaction cost on profitability.
- Depending on the business models applied **additional functionalities of DR aggregation platforms** may become decisive from the operators' point of view. Just to give two examples: For business models based on explicit DR, a major feature is the better and cheaper incorporation of small and medium loads combined with automatic

dispatching. For business models based on implicit DR the functionality of administering and keeping up-dated information about price signals at the customers metering points becomes a crucial success factor.

- Last but not least, further **development of the regulatory framework for DR is required** in order to facilitate participation of small and medium-sized customers in the flexibility markets. Although during the last years, conditions and requirements for market access of demand response have improved in most EU countries a longer list of improvements still has to be implemented: For example, clear definition of the role and responsibility of independent aggregators and their relation to BRPs/retailers and/or other market participants; reduction of administrative efforts and upfront costs; definition of technical standards (e.g. for data exchange), standardised procedures for prequalification for participation in balancing markets and requirements for measurement and verification should be further developed within the national context but also across EU Member States.

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