“Innovative Business Models for Market Uptake of Renewable Electricity unlocking the potential for flexibility in the Industrial Electricity Use”

Business models and market barriers

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IndustRE

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List of abbreviations and acronyms

BRP	Balance Responsible Party
BSP	Balancing Service Provider
CHP	Combined Heat and Power
DA	Day-ahead
DG	Distributed Generation
DNO	Distribution Network Operator
DSO	Distribution System Operator
EC	European Commission
EED	Energy Efficiency Directive
EU	European Union
FCR	Frequency Containment Reserves
FFR	Firm Frequency Response
FID	Flexible Industrial Demand
FIP	Feed-in premium
FIT	Feed-in tariff
FRR	Frequency Restoration Reserves
GC	Green Certificates
LCOE	Levelised Cost of Electricity
NRA	National Regulatory Authority
PV	Photovoltaic
RES	Renewable Energy Sources
RD	Royal Decree
RR	Replacement Reserves
SO	System Operator
SWD	Staff Working Document
TSO	Transmission System Operator
VRE	Variable Renewable Energy

Executive Summary

The IndustRE project has identified the flexibility potential of the largest and most energy intensive industrial electricity demand as an opportunity that, through innovative business models, could allow industrial consumers to reduce electricity costs while bringing significant benefits to the system, including further growth and integration of renewable energy in a cost-effective way.

In this context, this document defines and describes the most suitable **business models** for the exploitation of demand flexibility by industrial consumers, either on their own or involving certain interaction with Variable Renewable Energy (**VRE**) generation.

The second objective of this report is to provide a **clear picture of the regulatory and market frameworks**, highlighting how they affect the implementation of these business models, especially in a set of target countries defined in the context of the IndustRE project (Belgium, France, Germany, Italy, Spain and UK).

The views and opinions of relevant stakeholders, such as system operators, regulators, industries and market agents, regarding existing barriers and opportunities for these business models have been collected in an extensive **consultation process** and are summarised here.

Finally, a set of preliminary **recommendations for regulators and policymakers** to help them improving the regulatory and market conditions are presented. These recommendations will be improved with new findings throughout the progress of the IndustRE project.

Business models

A **business model** can be understood in this project as a set of **flexibility business strategies** chosen by Flexible Industrial Demand (**FID**) in relation to its electricity consumption in order to generate economic benefits. These strategies could arise from combining a variety of **instruments** to obtain economic benefits from different **sources** of revenues and savings.

The main **sources of savings** in the energy bill are the reduced cost of the electric energy and the avoided or reduced payment of network and other regulated charges, while the main **source of revenues** is the remuneration obtained in return for the explicit provision of flexibility services. Three **tools** have been identified at the disposal of the FID to grasp benefits from these sources: its own **load flexibility** to adjust consumption schedules in time in response to the signals received, the establishment of **bilateral contracts with VRE generators** and the installation of **on-site VRE** generation at its own premises.

A **business model** can then be regarded as the business opportunity that results from putting several of these strategies together into an actionable framework in a realistic and

feasible way. As a result of this, as can be seen in Table 1, five different business models have been identified:

Table 1 Categorization of business models (I-V) as combinations of flexibility business strategies for industrial consumers, which result from the different sources of savings and revenues and the available tools to capture them

		Available tools		
Savings/Revenues sources		**Flexible demand only**	**+ Contract with VRE generator**	**+ On-site VRE generation**
Savings	Energy costs	I, II: **Supplier price response** (react to time-varying prices from a supplier); **Market price response** (react to real time market prices)	III: **Long-term electricity supply** (establish long-term energy contract with VRE)	V: **Long-term electricity supply** (through self-consumption)
	Network and other regulated charges	I, II: **TOU network tariff response** (reduce peak demand in accordance with network tariff structure)		V: **Volumetric tariff response with on-site VRE** (reduce net demand)
Revenues	System services	II: **Balancing service provision** (provide frequency control reserves and balancing services); **Other services provision** (capacity remuneration, load interruptibility, distribution network services)	IV: **Bilateral balancing service provision** (establish flexibility contract to support VRE balance)	

I. **Electricity Bill Reduction**, with the use of the FID's own flexibility in reaction to the electricity price.

II. **System Service Provider**, with the possibility of providing almost any type of frequency control and balancing services to the system operator, and also other ancillary services to DSOs or participate in mechanisms of capacity remuneration and load interruptibility managed by TSOs. The optimization of load schedules in relation to the price of electricity (model I) is taken for granted in this model.

III. **Electricity Supply Contract with off-site VRE**, through the establishment of a long-term bilateral electricity supply contract with a (VRE) generator off-site the consumer's premises under more stable and predictable conditions than being exposed to the market.

IV. **Balancing Service Contract with off-site VRE**, through the establishment of a flexibility contract with a (VRE) generator off-site the consumer's premises for the provision of flexibility services to minimize imbalances, possibly including in this contract the supply of electricity (model III).

V. **Electricity Bill Reduction with on-site VRE**, from the avoided payment of network and other regulated volumetric (€/kWh) charges. In addition to this, the FID would avoid the risks of being exposed to the market price volatility regarding the volume of self-consumed electricity, just like in business model III, as the cost of this energy would only depend on the Levelised Cost of Electricity (LCOE) of this on-site VRE generation.

Regulatory and market framework analysis and stakeholders' views

A regulatory analysis has been carried out with the aim of identifying the main regulatory barriers that could be impeding the implementation of these business models in a set of target countries: Belgium, France, Germany, Italy, Spain and United Kingdom.

In view of this analysis, it can be said that business **model I** is feasible and implemented in all target countries. FID may have direct access to the market or receive offers of time-varying retail prices from specialized retailers. Furthermore, network tariffs across the target countries generally present a cost-reflective structure. Given that the share of the energy cost in the final retail price prevails over regulated charges for large consumers, the interest of this model for FID would be primarily focused on the time-variation of the energy cost component of the retail price.

In contrast, the application of business **model II** presents more difficulties and regulatory barriers than model I. Overall, there is a growing trend in Europe of modifying the design of ancillary services and balancing energy markets and mechanisms to allow the participation of demand-side resources. While Belgium, France and UK provide regulatory frameworks that enable consumers to provide capacity reserves and balancing products, some regulatory barriers remain in Germany, while consumers are not legally allowed at all in balancing programs in Italy and Spain. Capacity remuneration mechanisms are also being gradually introduced across Europe, with the aim of allowing demand-side participation, e.g. in the UK, with on-going discussions about it in Italy and France. Moreover, load interruptibility programs managed by the SO are present in all target countries, in many of which they represent a significant source of income for industrial consumers.

The establishment of **bilateral contracts** between the industrial consumer and a VRE generator for the **supply of electricity** (**model III**) is still only hypothetical nowadays in the European context because of the existence of VRE support schemes in all countries. To the extent that VRE investments are guaranteed by regulatory subsidies, VRE generators will be less incentivized to be competitive and establish long-term bilateral contracts to secure their revenues and minimize risk-exposure. Nevertheless, the EU energy policy strategy foresees VRE progressive market integration with reduced support incentives, so this model would increasingly make more sense in the future.

Moreover, the establishment of **long-term bilateral contracts** for the provision of **balancing services** by the FID to assist VRE generators to minimize their imbalances (**model IV**) is also mostly hypothetical for the time being. In principle, VRE generators are increasingly required to bear some responsibility over their own generation imbalances in most countries so this business model is gaining interest from their perspective. Notwithstanding this, model IV is not generally possible or attractive in the target countries because of the design of imbalance settlement arrangements. Even though the level of aggregation of imbalances permits this model in Belgium, Germany and UK, the single imbalance pricing scheme provides little incentive to aggregation of consumption and generation units. On the other hand, a dual imbalance pricing system encourages aggregation of consumption and demand imbalances in France, Italy and Spain. However, in Italy and in Spain imbalances are settled separately for generation and consumption units so this model is only possible in France.

Finally, business **model V**, which involves the **on-site** installation of **VRE** generation by the industrial consumer, could be an attractive decision for the FID, who could benefit from paying lower network tariffs and other regulated charges as long as these were charged through a volumetric rate (€/kWh) on net demand. Partial exemptions from paying certain regulated charges on self-consumed energy remain in certain countries (France, Italy, Germany) while in others, these exemptions are gradually being cut down or eliminated (e.g. Spain and the Flemish region of Belgium) so the attractiveness of this model is progressively being reduced in these regions. In contrast, self-consumption is strongly incentivized for industrial consumers in the UK and Belgium (except for the Flemish region), where prosumers are exempted from paying any network and system costs on self-consumed electricity because tariffs are applied on net consumed electricity.

Stakeholders' views collected in the consultation process are generally in accordance with the regulatory analysis regarding the feasibility of these business models in the target countries. Diverse opinions have been observed among respondents to the consultation in relation to the perceived attractiveness of each of these models and the actual current practices among industries. In general, many industrial consumers already optimize their industrial processes in reaction to time-varying prices and capacity network charges to optimize their electricity bills (model I). Regarding the provision of flexibility services (model II), the main barriers still observed in those countries with reserve capacity and balancing markets that are open to the participation of consumers are the technical requirements for prequalification and participation. In relation to the establishment of bilateral contracts between FID and VRE (models III and IV), stakeholders agree in that VRE support schemes strongly limit the attractiveness of this approach. They also feel that the imbalance settlement rules do not incentivize or allow VRE to resort to FID load flexibility to minimize imbalances within their portfolio. Finally, the main concerns related to the installation of on-site VRE by the FID are related to the growing trend to charge at least part of the network and system costs on self-consumed energy and to the intermittency of the generation source.

Policy recommendations

In view of the main findings of the analysis, a list of recommendations is provided with the aim of helping regulatory authorities and policy makers to remove the main regulatory and market barriers that prevent an efficient application of the business models described in this report:

1. Ensure that market design rules guarantee that large consumers have **direct access** to wholesale electricity markets.
2. Ensure that **tariff design** for network costs is based on cost-causality (i.e. each user must pay for the actual costs incurred), in order to encourage network users to employ their flexibility to make a more efficient use of the grid capacity.
3. It is highly recommended that **network tariffs** consist of a fixed component related to the grid connection and a time of use (TOU) dependent capacity component (€/kW) reflecting the contribution to network peak utilization. In contrast, flat and purely volumetric tariffs should be avoided.
4. **Regulated charges** that are not directly related to the use of electricity networks should be separated, in such a way that they do not distort electricity market prices and cost-reflective network charges.
5. Open up **reserve capacity** and **balancing markets** to the participation of the demand.
6. In those countries where reserve capacity and balancing markets are already open to the demand side, make sure that **technical conditions** do not impose unfair barriers for participation on a level playing field. In this regard, the following recommendations are provided to facilitate the involvement of consumers in these markets:
    - Reduce minimum bid sizes.
    - Allow the participation of aggregated loads.
    - Separate the procurement of reserve capacity and balancing energy.
    - Split the provision of upward and downward balancing products, so that the requirement of symmetry is eliminated.

- Enable a centralized mechanism or standard procedures to facilitate financial adjustments between involved agents, especially between aggregators and BRPs/suppliers to adjust imbalances caused by demand response actions.

7 Gradually require **VRE** generators to bear **responsibility** for their **imbalances**.

8 Move towards a **single imbalance pricing system**, so that imbalance prices reflect the actual imbalance costs and, as such provide the correct incentives to value flexibility, avoiding distortions to the real time signal sent to market participants.

9 In the case of remaining in a dual imbalance pricing system, where imbalances receive an additional penalty on top of the price representing the balancing procurement costs, **allow the aggregation** and compensation of **imbalances** from different consumption and generation units in the settlement of imbalances within a BRP area.

10 If a **capacity remuneration** mechanism is in place, open it to the participation of consumers and facilitate their involvement on a level playing field with generation resources.

11 Adapt existing **load interruptibility** mechanisms with the creation of more competitive and dynamic market instruments, in line with the standard procedures for the provision of reserve capacity and balancing services.

12 Progressively abandon **net-metering** policies and allow self-consumption from on-site VRE ensuring an adequate **network tariff design** (as indicated in recommendation 2). In this sense, network tariffs should provide end users with efficient economic signals based on net hourly consumption/injection, regardless of what is behind the meter, and on their contribution to the actual utilization of the grid.

13 Adapt the regulatory framework of **distribution network operation** and implement the mechanisms that would allow DSOs to use active network management solutions that include the market procurement of local network services provided by FID, such as power reductions and reactive power and voltage control, for alleviating congestion and voltage problems, and in the long term possibly avoiding network reinforcements.

14 Encourage the **harmonization** of flexibility mechanisms across the **EU** in line with the previous recommendations and the best practices identified in different countries.

1 Introduction

Electric power systems are currently facing new challenges to sustainably satisfy an increasing load with high peaks, which generally occur during a reduced number of hours per year, and to absorb a growing penetration of intermittent renewable energy sources. Load flexibility is widely recognized as a key resource to face these challenges, which would enable a more efficient operation of the available resources in electric power systems, thus facilitating the growth and integration of variable renewable energy more cost-effectively. Making electricity demand response happen is also an essential component of the European Union's (EU) strategy to increase economic efficiency in electric power systems across Europe, as reflected in numerous EU initiatives, including the third Energy Package, with Directive 2009/72/EC (EC 2009), the Network Codes and the Energy Efficiency Directive (EED) (EC 2012). More specifically, the EED urges National Regulatory Authorities (NRA) across Europe to take the responsibility of facilitating demand response for all consumers.

The IndustRE project has identified the flexibility potential of the largest and most energy intensive industrial electricity demand as an opportunity that, through innovative business models, could allow industrial consumers to reduce electricity costs while bringing significant benefits to the system, including further growth and integration of renewable energy in a cost-effective way. Partly due to a lack of sufficient experience and understanding of the power sector by these consumers, and also because of the inexistence of the appropriate regulatory and market frameworks in many countries, much of this potential flexibility has traditionally been locked for many of these consumers.

The overall objective of the IndustRE project is to use the potential for flexibility in energy intensive industries to facilitate further uptake of variable renewable electricity, through innovative business models and regulatory improvements. In this context, one of the main objectives of this document is to define and describe the most suitable business models for the exploitation of demand flexibility by industrial consumers, either on their own or involving certain interaction with variable renewable energy generation.

The second objective of this report is to provide a clear picture of the regulatory and market frameworks, highlighting how they affect the implementation of these business models, especially in a set of target countries defined in the context of the IndustRE project (Belgium, France, Germany, Italy, Spain and UK), as indicated in Figure 1.1. In this sense, given the particular market circumstances of each country, the actual regulatory impediments for each business model are differentiated in this document from the likelihood of finding a real business opportunity. This is the main focus of this work, while the evaluation of the economic viability of these business models in terms of costs and technical requirements for the industrial consumer is out of the scope of this report, but will be addressed in future stages of the IndustRE project. Also the views and opinions of relevant stakeholders, such as system operators, regulators, industries and market agents, regarding existing barriers and opportunities for these business models have been collected in an extensive consultation process and are summarized in this document. Finally, general recommendations for regulators and policymakers to help them overcome these regulatory and market obstacles are offered.

Figure 1.1 Scope of the project: IndustRE target countries

This document stems from work carried out in previous tasks of Work Package 2 of the IndustRE project, presented in the following working documents: the preliminary definition of the business models (T2.1), see (Papapetrou 2015), the screening of the regulatory and market frameworks of the target countries (T2.2), see (Vallés et al. 2015), and the stakeholder consultation process (T2.3), see (Jezdinsky & Nuño 2016).

The remainder of the document is structured as follows:

- In Section 2, a detailed classification of the business models considered in the IndustRE project and their definitions are provided.
- In Section 3, the business models are explained in more detail and the regulatory and market frameworks are analysed in relation to the aspects that are relevant for each of them, particularizing in the situation of the target countries, so that the main barriers that currently may block their implementation are identified.
- In Section 4, the views and impressions of relevant stakeholders from the target countries who were consulted in the course of Task 2.3, regarding the feasibility and interest of these business models, are presented.
- The document concludes with Section 5, where a series of regulatory and policy recommendations are given that could enable the business models work more effectively in a European context.

2 Definition of the business models

The aim of this section is to describe a series of business models[1] for the commercial exploitation of flexible electricity demand by large industrial consumers, with or without any interaction with Variable Renewable Energy (VRE) generation resources. Throughout the report, this flexibility potential will be referred to as Flexible Industrial Demand (FID).

A business model can be understood in this project as a set of strategies chosen by the industrial consumer in relation to its electricity consumption flexibility in order to generate economic benefits. For instance, these consumers could find several ways to reduce their electricity bills by modifying consumption schedules according to the price signals received or could even acquire additional revenues in return for offering flexibility services to other electricity system agents, or choose to do both at the same time. VRE also plays a significant role in these strategies, enabling the FID to combine decisions regarding electricity consumption with other strategies that include contractual arrangements with VRE generators or having VRE generation units installed on-site.

It can be seen that a multitude of business strategies could arise from combining a variety of instruments at the disposal of flexible industrial consumers to obtain economic benefits from different sources. These **flexibility business strategies**, which are described with more detail in Subsection 2.1, are the basis to build what we will call a business model. A **business model** can then be regarded as the business opportunity that results from putting several of these strategies together into an actionable framework in a realistic and feasible way. A concrete proposal of business models for energy intensive industries is presented in Subsection 2.2. Each business strategy will be analyzed separately in more detail in Section 3, where their feasibility and applicability in the regulatory frameworks of the different target countries is discussed.

Depending on the possible rewards that can be reaped by the industry in exchange to their electricity demand flexibility, certain industrial consumers might decide to activate more flexibility or even enhance their flexibility potential through capital investment in e.g. energy storage, CHP unit and/or production equipment/capacity upgrades. The cost of activating the flexibility and of enabling higher flexibility through capital investment varies widely depending on the industry and the specific case. In this document we do not look at these costs. The costs have to be dealt with on a case-by-case basis. The IndustRE project will facilitate the identification of these costs and their comparison with the possible benefits of

[1] These improved up-to-date classification and definitions stem from previous elaborations developed in other tasks of this Work Package of the IndustRE project, more specifically in (Papapetrou 2015) and further on used in (Vallés et al. 2015) and (Jezdinsky & Nuño 2016). See the Annex (Section 8) for more information.

implementing the proposed business models in the methodology that will be developed within WP3. All results will be available in the project website[2].

2.1 Flexibility business strategies

Industrial consumers can decide among multiple strategies in relation to the way they consume electricity and the sources from which they procure this electricity in order to save money or make additional revenues. A possible way of categorizing these strategies is by considering that they result from a combination of sources of revenues and savings with a set of instruments available for the consumer.

2.1.1 Sources of revenues and savings

The context in which industrial consumers procure electricity from the electric power system for their productive activities reveals where the different sources of revenues and savings are. Large industrial consumers, connected to the medium or high voltage grid[3] generally have the following possibilities for buying electricity in a competitive environment:

- Purchase energy directly from the **wholesale electricity market** or through **bilateral contracts** with **generators** and, separately, pay the use of system charges, or **network charges, other regulated charges**, and **taxes** as defined by the regulation according to their level of voltage and power/energy consumed.
- Sign a contract with a **supplier**, who in turn charges them for the consumed energy. Usually, the supplier also charges them the **network charges, other regulated charges** and **taxes** according to options provided by the existing regulation and the agreed conditions.

In whichever of these situations, the final retail price that has to be paid for the electricity supply is made up of the following components, as shown in Figure 2.1. The two latter are defined by regulation while the former is market-based and therefore depends on the option which the FID chooses to buy electricity, among the aforementioned alternatives.

- Cost of energy
- Network (regulated) charges
- Other regulated charges and taxes

[2] http://www.industre.eu/

[3] With an average consumption in the range of some MW (some GWh per year), as defined in (Papapetrou 2015).

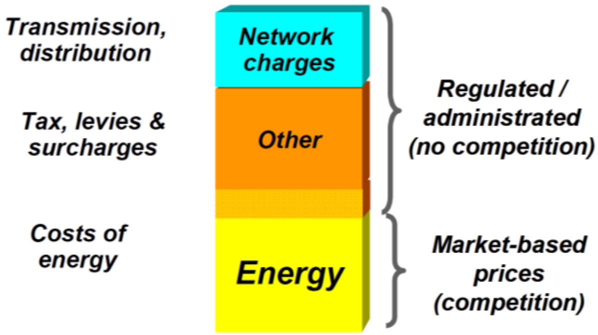

Figure 2.1 Breakdown of electricity retail prices in a competitive environment (Source: Eurelectric)

Moreover, regardless of the options that the FID have for their electricity procurement, industrial consumers may sometimes be allowed to participate explicitly in the provision of flexibility services to different system operators or agents, either directly or through an aggregator.

With this in mind, the three main sources of savings and revenues for a FID would be:

- On the one hand are those options that industrial consumers have to **save** money by cutting their electricity bill:
    - Either by cutting down the **cost of electric energy**.
    - And/or by moderating the amount paid in **network and other regulated charges**.
- On the other hand, we can find the **remuneration** obtained in return for the explicit provision of **flexibility services** by the FID.

2.1.2 Available tools for industrial consumers

The FID can make use of different instruments to grasp economic benefits from the aforementioned sources. In particular, three tools have been identified:

- The main tool that the FID could use is its own **load flexibility** to adjust consumption schedules in time in response to the signals received, with any time notice, in the form of prices or incentives, requests, etc.
- In addition to this flexibility, the FID could also establish **bilateral contracts with VRE generators**, or any type of generator, and agree certain advantageous conditions of electricity supply or flexible behaviour.
- Finally, the FID could have installed, with their own resources or by a third party, **on-site VRE** generation at its own premises, behind the meter, in order to benefit from different schemes of self-consumption.

2.1.3 All together: flexibility business strategies

By contrasting the identified sources of revenues (from the explicit provision of flexibility services) and savings (in energy costs and in network tariffs and other regulated charges) and the available tools for the FID to grasp economic benefits from these sources (load flexibility, bilateral contracts with other generators and installation of on-site VRE generation), we have identified a series of flexibility business strategies, which are summarized in Table 2.1.

Table 2.1 Flexibility business strategies for industrial consumers, resulting from the different sources of savings and revenues and the available tools to capture them

		Available tools		
Savings/Revenues sources		**Flexible demand only**	**+ Contract with VRE generator**	**+ On-site VRE generation**
Savings	Energy costs	**Supplier price response** (react to time-varying prices from a supplier); **Market price response** (react to real time market prices)	**Long-term electricity supply** (establish long-term energy contract with VRE)	**Long-term electricity supply** (through self-consumption)
	Network and other regulated charges	**TOU network tariff response** (reduce peak demand in accordance with network tariff structure)		**Volumetric tariff response with on-site VRE** (reduce net demand)
Revenues	System services	**Balancing service provision** (provide frequency control reserves and balancing services); **Other services provision** (capacity remuneration, load interruptibility, distribution network services)	**Bilateral balancing service provision** (establish flexibility contract to support VRE balance)	

The identified flexibility business strategies for industrial consumers within each category of savings or revenues are described below:

Reduced energy costs (reduced payment for the energy component of the electricity bill)

- **Supplier price response**

The FID could be exposed to time varying prices offered by a supplier. By using its own flexibility to shift consumption from higher to lower price periods, the consumer could benefit from paying less for the consumed energy.

- **Market price response**

Alternatively, the FID could have direct access to the wholesale electricity market and in a similar way use its own flexibility to benefit from managing consumption in response to the hourly changing prices.

- **Long-term electricity supply**

This business strategy involves any contractual arrangement established between a VRE generator and a FID for long-term supply of electricity. A VRE generator could find it worthwhile to reduce risks and uncertainties related to the variable and intermittent nature of VRE and to the price volatility of the market by entering into a long-term electricity supply contract with a FID. This would be a way of securing revenues and ensuring the recovery of the investment made. In turn, the FID could be willing to establish a long-term bilateral contract for the supply of electricity with a VRE generator under stable and predictable conditions, e.g. avoiding the market price volatility, and possibly benefitting from other advantageous conditions, e.g. a relatively low price in comparison to the expected wholesale market price.

Given the variability and intermittency of VRE, either the FID would have to assume the risk of this variability by partly adjusting its consumption to the VRE generation profile (with energy storage or flexible loads), or either the FID or the VRE generator would have to purchase the resulting non-served demand in the market, assuming as well the costs of imbalances.

From the perspective of the FID and regarding the energy market price, this alternative could be equivalent to deciding to invest on on-site VRE generation, or even to contracting this investment to a third party.

Reduced payment for network and other regulated charges

- **Time-of-Use (TOU) network tariff response**

The FID could reduce the payment of network charges by using its own flexibility to lower its peak demand and/or consumption in accordance to the network tariff structure. Generally this is possible if the tariff includes a charge on peak or installed capacity (€/kW), or even if there is time differentiation in this and other charges (e.g. the volumetric charge), thus penalizing consumption during the peak.

- **Volumetric tariff response with on-site VRE**

The FID could have on-site VRE generation installed behind the meter so as to reduce net demand and therefore pay less for certain network and other regulated charges that are charged with a volumetric rate on this net demand (€/kWh).

Offering of flexibility services to the power system

- **Balancing service provision**

By using its own load flexibility, the FID could provide reserve capacity, either directly or through an aggregator, to provide frequency control and balancing services to the System Operator (SO).

- **Bilateral balancing service provision**

The FID could modify consumption in response to signals from a VRE generator that is a Balance Responsible Party (BRP), so as to support the balancing of its demand-generation portfolio.

- **Other services provision**

This includes any other services where the FID could offer its own load flexibility, such as participating in capacity remuneration mechanisms or in load interruptibility programs, or providing ancillary services to distribution network operators.

2.2 Business models for flexible industrial consumers

In general, all the business strategies previously described are interrelated, i.e. the actions taken by the consumer using any of them affects the resulting load changes and savings or revenues and the possibilities of using other strategies simultaneously. For instance, the load profile associated with the first category of strategies, i.e. reduced energy costs, affects the potential reserve capacity that the FID could offer in flexibility services to the power system, and at the same time the resulting load profile could impact on the network tariff payments. At the same time, it is natural to think that a consumer taking the burden of managing its own consumption with flexibility as required by one of these strategies would be willing to follow other strategies that required similar actions and instruments all at once, making a compatible selection and co-optimization of the different available options.

In this context, the aforementioned business strategies have been grouped into five (I-V) clearly identified business models, each of which comprises one or more flexibility business strategies[4] that are compatible and synergic between them, as shown in Figure 2.2. These business models are described below.

Saving/Revenue sources		Available tools: Flexible demand only	Available tools: + Contract with VRE generator	Available tools: + On-site VRE generation
Savings	**Energy costs** (I)	Supplier price response; Market price response	Long-term electricity supply (III)	Long-term electricity supply (V)
	Network and other regulated charges	TOU network tariff response		Volumetric network tariff response with on-site VRE
Revenues	**System services** (II)	Balancing service provision; Other services provision	Bilateral balancing service provision (IV)	

Figure 2.2 Categorization of business model for flexible industrial consumers from the combination of different flexibility business strategies.

I. Electricity Bill Reduction

This business model represents the strategy used by an industrial consumer to adjust its consumption with its own flexibility in reaction to the entire electricity price, involving not only the price of energy, found in the market or established by the retailer, but also the structure and values of the network tariff and other regulated charges, especially if the latter are capacity based (€/kW). Therefore, this business model comprises the grouping of the following strategies: **Supplier price response**/**Market Price Response** and **TOU Network Tariff response**, as can be seen in Figure 2.2.

II. System Service Provider

An industrial consumer engaging in the business model of becoming a system service provider would be willing to offer almost any type of frequency control and balancing services to the system operator, and also offer other ancillary services for distribution network operators or participate in mechanisms of capacity remuneration and load interruptibility. Such a sophisticated industrial consumer would, naturally, still take

[4] Note that in previous tasks of the Workpackage, business models had different numbering and names. The correspondence between these and the previous nomenclature is presented in Annex 1: Correspondence between old and new classifications of business models in different deliverables of WP2.

serious consideration of the price signals received from the market/retailer and the network tariffs in order to optimize any decision of load adjustment. Therefore, this business models comprises the grouping of the following strategies: **Balancing Service Provision** and **Other services provision**, in addition to the ones included in the previous business model (**Supplier price response**/**Market Price Response** and **TOU Network Tariff response**), as can be seen in Figure 2.2.

III. Electricity Supply Contract with off-site VRE

This business model comprises the establishment of a long-term bilateral electricity supply contract with a generator off-site the consumer's premises under more stable and predictable conditions than being exposed to the market. This generator can in principle be of any type but in this case we focus on the interesting case of a VRE generator. Therefore, this business models comprises the strategy of **Long-term electricity supply**, as can be seen in Figure 2.2, with the perspective of the contract with an off-site VRE generator.

IV. Balancing Service Contract with off-site VRE

The FID could establish a bilateral contract with a generator, for instance a VRE generator, possibly including in this contract the supply of electricity (business model III), for the provision of flexibility services to help this generator to minimize imbalances. Therefore, this business model comprises the grouping of the following strategies: **Long-term electricity supply,** with the perspective of the contract with a VRE generator, and **Bilateral balancing service provision**, as can be seen in Figure 2.2.

V. Electricity Bill Reduction with on-site VRE

Alternatively, the FID could decide to have VRE generation units installed on-site in order to benefit from the avoided payment of network and other regulated volumetric (€/kWh) charges. In addition to this, the FID would avoid the risks of being exposed to the market price volatility regarding the volume of self-consumed electricity, just like in business model III, as the cost of this energy would only depend on the Levelised Cost of Electricity (LCOE) of this on-site VRE generation.

Therefore, this business model comprises the grouping of the following strategies: **Volumetric tariff response with on-site VRE** and **Long-term electricity supply,** with the perspective of the on-site VRE generation, and as can be seen in Figure 2.2.

It must be noted that on-site VRE generation can be installed by the consumer with its own investment or both the installation and the investment can be carried out by a third party under contractually agreed financing conditions, but the rationale of this model is still the same under both circumstances. The regulatory and market framework though can treat these two cases differently, affecting their attractiveness and feasibility, as we will see in chapter 3 and in deliverable 3.1, where the model contracts are developed.

3 Regulatory analysis of the applicability of the business models

The aim of this section is to provide a more detailed description of the aforementioned business models and, within each, to identify the key regulatory aspects that determine their feasibility in each of the particular national contexts.

The regulatory analysis has been structured according to the individual business strategies that were described in 2.1, which grouped together would result in the specific business models that were defined in 2.2. Given that the same business strategy can be a part of several business models, the assessment is more straightforward and repetitiveness is avoided if we focus on each individual element of the business models separately.

3.1 Reduced energy costs

This category of business strategies comprises all the possibilities that the FID have to reduce the energy component of the bill when buying electricity. These strategies require the FID using its demand flexibility to manage electricity consumption so as to pay less for the energy consumed. The last strategy ("Long-term electricity supply") also assumes a relationship between FID and VRE generation through a long-term bilateral contract.

3.1.1 Supplier price response

If TOU or more dynamic time-varying pricing signals are offered by a supplier, reflecting the actual and expected prices of the electricity market, the FID can freely decide to respond to these signals by shifting consumption from higher to lower price periods, thus benefiting from paying less for the consumed energy. This business strategy would be feasible and actually effective if suppliers were able and willing to make these pricing offers to consumers and FID were able to respond to them. In addition, the more significant the energy purchase component in the final retail price, the more attractive for the FID to respond to these time varying electricity prices.

Note that this business strategy can be part of business models I: Electricity Bill Reduction and II: System Service Provider.

Key questions

- Is any type of **regulated flat tariff** offered in advantageous conditions to large industrial consumers? If so, this strategy would not be attractive.
- Does the energy purchase component account for a significant **share** of the final **retail price** for the FID? Otherwise, this option may lose attractiveness for FID.
- Is there a really competitive and transparent retail market? In principle according to EU legislation that is a necessary condition but in practice **retail market** functioning for industrial consumers varies from country to country within the EU.

- Are consumers effectively offered to choose these price signals by **suppliers**? This indicates the likelihood of this scheme happening.

Key answers: available regulatory evidence

The EU third energy package includes rules designed to ensure a competitive and transparent retail electricity market, both for industrial and domestic consumers. Even if for residential consumers this is a more recent phenomenon, it is generally acknowledged that electricity retail markets across Europe have been open to competition for industrial consumers for a few years now.

Regarding the share of the energy purchase component in the total final price of electricity for industrial consumers, it can be seen in Figure 3.1 that in most of the countries this is the largest component, in spite of country-by-country differences. This aspect improves the attractiveness of this business model in all countries in general.

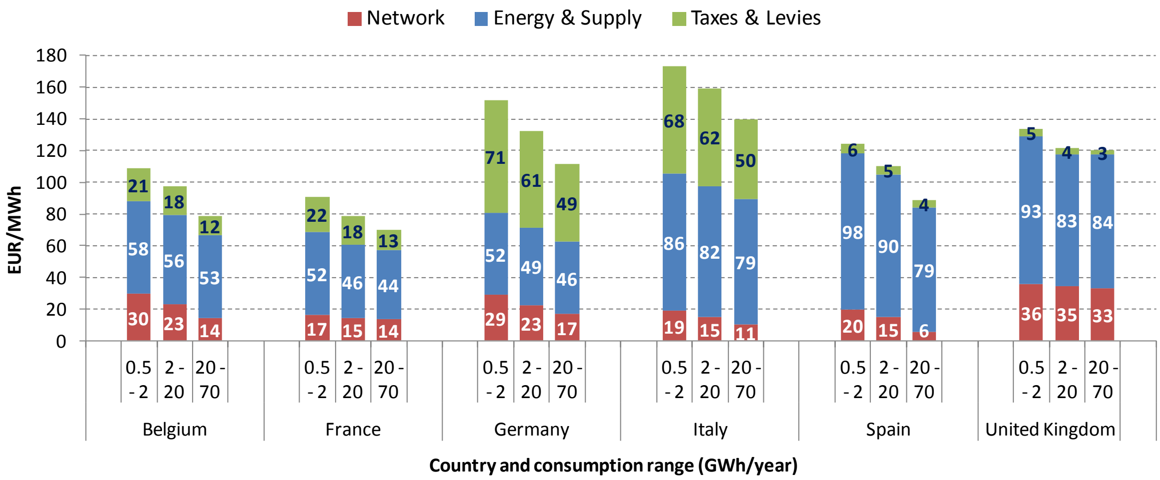

Figure 3.1. Final average electricity prices for industrial consumers of different sizes, in GWh per year: 0.5 GWh < Cons. < 2 GWh, 2 GWh < Cons. < 20 GWh, 20 GWh < Cons. < 70 GWh. Source: Eurostat[5]

Thus, this business model does not encounter regulatory barriers in any of the target counties, the only possible exception being France due to the existence of a special regulated pricing regime for large industries, called ARENH.

France has a long tradition of integral regulated tariffs for all types of consumers, even though the electricity retail market was opened to competition in 2007. As reported by the French NRA, CRE (CRE 2015), by the end of 2015, integral regulated tariffs for consumers connected to voltage levels > 36 kV are being phased out, so most industrial consumers will

[5] Electricity prices components for industrial consumers - annual data (from 2007 onwards), nrg_pc_205_c – Eurostat – Data Explorer.

be obliged to go to the free retail market to purchase electricity. However, large industrial consumers with high baseload consumption may benefit from purchasing a share of their electricity consumption under the ARENH (Accès régulé à l'électricité nucléaire historique), a regulated price, usually below the market price (42 €/MWh since January 2012), set by the government for most of the nuclear energy generated by EDF.

3.1.2 Market price response

By having direct access to the wholesale electricity market to buy electricity, the FID may benefit from managing consumption in response to the hourly changing prices according to their own flexibility. Price risk is higher than in the previous approach, but the potential savings could be larger as well if the FID is able to adjust load flexibility on an hourly basis.

Note that this business strategy can be part of business models I: Electricity Bill Reduction and II: System Service Provider.

Key questions

- Are there any **administrative barriers**, such as complex procedures, entry fees and warranties, etc. that make it difficult for the FID to have access to the wholesale electricity market? If there were significant barriers that prevented the FID from gaining access to the market, this strategy would not be possible.
- Does the energy purchase component account for a significant **share** of the total final **price** for the FID? Otherwise, this scheme may not be attractive for the FID. Note that this question is also relevant for the previous strategy ("Supplier price response").

Key answers: available regulatory evidence

Generators compete in the wholesale electricity market to sell electricity to large industrial consumers and suppliers. In principle, there would be no regulatory barriers for this model and in fact it is believed that large consumers can actually purchase their energy directly in the market and avoid any intermediaries.

In practice, the different coupled platforms across Europe (e.g. APX, Belpex, EPEX Spot, GME, Nord Pool and OMIE) may present specific requirements for participation that could impose difficulties for certain consumers to have direct access to the market so they may prefer to sign contracts with specialized retailers. Some examples would be: restraining requirements on the volume of bids, too high fixed charges and full acknowledgement as BRP to participate. Nonetheless, this is not a barrier itself but a difficulty for the profitability of this model for certain type of consumers.

In relation to the share of the energy purchase component in the total final price of electricity for industrial consumers, as was indicated in the previous business strategy and was shown in Figure 3.1, the fact that in most countries it is the largest component in the final price improves the attractiveness of this business.

3.1.3 Long-term electricity supply

When VRE generators are exposed to the risks and uncertainties of their variable generation and the conditions of the market, they may be willing to enter into a long-term bilateral contract by which they sell electricity directly to a FID for a stable, even if possibly low, price[6]. This is a way of securing their revenues and ensuring the recovery of the investment made. On the other hand, by signing this contract, the FID may accept to assume the risk of being supplied a less predictable and variable amount of power at a lower price than would have with a normal supplier or in the market, either by partly adjusting consumption to this variability (with energy storage or flexible loads) or/and by purchasing the resulting non-served demand in the market. Other arrangements between VRE and FID under long-term contracts may also be possible.

Similarly, the FID that decides to install its own on-site VRE in order to reduce their electricity bill regarding energy purchases in the market may have similar financial advantages. This scheme of on-site generation is also proposed in the strategy "*Volumetric tariff response with on-site VRE*", with the aim, in addition, of reducing network tariffs and other regulated charges. The key questions in relation to self-consumption regimes are studied in section 3.2.2.

Note that this business strategy is part of business models III. Electricity Supply contract with off-site VRE and V. Electricity Bill Reduction with on-site VRE.

Key questions

- Would VRE generators be willing to establish long-term bilateral contracts to sell their energy directly to certain consumers, for example, if they are increasingly exposed to the risks of the market as **RES support schemes** are being revised or phased out? This aspect would indicate the likelihood of this model happening.
- Given that long-term bilateral contracts are generally possible in all countries, the question is: are long-term **bilateral contracts** a common practice? This aspect would reflect the existence of a real business opportunity in this model.

[6] Note that any type of generator with similar preferences could be willing to sign a similar supply contract with industrial consumers in order to reduce exposure to price volatility and instability, but this is specially the case of VRE generators.

Key answers: available regulatory evidence

The extent to which VRE generators may be willing to develop innovative contractual arrangements with FID depends mainly on the current regulation on support schemes for renewable energy. In so far as the expected profitability of VRE investments is guaranteed by regulatory subsidies, VRE operators will be decoupled from actual market conditions and therefore will be less incentivized to be competitive and establish long-term bilateral contracts to minimize risk exposure.

The current RES support schemes found across target countries are presented in Table 3.1.

Table 3.1 Main categories of RES support schemes and specific mechanisms found in the target countries[7].

	Price regulation	Quantity regulation
Capacity-based	Subsidies to investments, tax discounts, e.g. in Italy for solar PV since 2013.	Auction, as the newly introduced system of subsidies for new capacity in Spain. Also recently in Germany for PV.
Generation-based	Fixed tariffs, or Feed-in tariff, FIT (since 2012 in Italy for small units, also in Germany, and soon in UK also for small units). Premiums on top of the wholesale market price, or Feed-in premium, FIP (since 2012 in Italy for P>60 kW, also in Germany). A kind of FIP, CfD, recently in UK.	Compulsory shares (quotas) of RES for generators, e.g. in Belgium, and green certificates (GC), e.g. previously in Italy (will disappear by 2015) and still in UK (ROC's).

In this sense, this business strategy is still only hypothetical across Europe and although there are no other relevant barriers than the existing VRE support schemes, the probability of it happening in the conditions previously described is still low. Only under the assumption that other motivations guide the decisions of FID, such as the preference of green electricity

[7] For more details on RES Support schemes across Europe, see Appendix 1 of the Commission SWD "European Commission guidance for the design of renewable support schemes accompanying the document Communication from the Commission: Delivering the internal market in electricity and making the most of public intervention", accessible in https://ec.europa.eu/energy/en/topics/renewable-energy/support-schemes.

from RES with respect to conventional generation, may this model be attractive in the current circumstances.

Notwithstanding, the EU energy policy strategy foresees a progressively market integration of VRE Sources with reduced support incentives, so this business model would increasingly make more sense in the future. In particular, according to the European Commission "Guidelines on State aid for environmental protection and energy 2014-2020" (EC 2014), from 1 January 2016 to all new aid schemes and measures aid will be "granted as a premium in addition to the market price (premium) whereby the generators sell its electricity directly in the market". Furthermore, the new renewable energy directive (REDII)[8] for the period 2020-2030, foreseen before the end of 2016, will provide the EC guidelines in relation to RES participation in the market and support schemes for beyond 2020.

[8] https://ec.europa.eu/energy/en/consultations/preparation-new-renewable-energy-directive-period-after-2020

3.2 Reduced payment for network and other regulated charges

This category of business models comprises all possibilities that the FID have to reduce their payment of network and other regulated charges. The FID can achieve this by using own flexibility to adjust the consumption profile to the tariff structure ("*TOU network tariff response*") or by reducing the net demand with the assistance of on-site generation behind the FID meter ("*Volumetric tariff response with on-site VRE*").

3.2.1 TOU network tariff response

If FID are exposed to, or may choose to be exposed to, a network tariff structure that incentivizes peak load reductions, these consumers can indirectly benefit from lower network charges as long as they are flexible enough to shift part of their electricity consumption off the peak periods. A network tariff based on a capacity charge (€/kW), which could present time differentiation, generally incentivizes peak load reductions, but only if overall it accounts for a significant share of the final energy bill. If a volumetric component (€/kWh) also exists in the network tariff, as long as it presents time-of-use differentiation, consumers may be further incentivized to reduce the peak consumption at least during times of network stress conditions. In general, this flexibility to reduce network charges, should be co-optimized with the possibility of reducing energy payments (this is exactly the philosophy of business model "I. Electricity Bill Reduction") by shifting electricity consumption from high to low price hours. Note that both objectives may conflict between each other when time-of-use periods reflecting network stress for network charges differ from prices patterns in the electricity market. This situation would be more likely to happen in systems with high volumes of distributed VRE penetrations because in those cases, the stress of the distribution network would not necessarily coincide with periods of peak demand anymore but also with intervals of high VRE generation in the area, and as such should be reflected in the network tariff structure but probably not in the wholesale electricity price.

Note that this business strategy can be part of business models I: Electricity Bill Reduction and II: System Service Provider.

Key questions

- Does the **network tariff structure** provide consumers with a sufficiently sound signal to incentivize peak load reductions, e.g. with a capacity charge and/or time-of-use differentiation?
- Does the network charge represent a significant **share** of the final electricity **retail price** for FID? If not, the incentive provided by the network tariff may not be sufficiently strong for this model to be a business opportunity for the FID.

- Are there relevant **exemptions and reductions** of the network charges for large consumers? Like the previous question, this is an indicator of the attractiveness of reducing peak load in response to the network tariff.

Key answers: available regulatory evidence

The main pieces of EU energy legislation, namely the Electricity Directive 2009/72/EC (EC 2009) and the Energy Efficiency Directive (2012/27/EU) (EC 2012), state that network tariffs should be non-discriminatory and cost-reflective, and encourage energy efficiency by providing customers with economic signals for the optimal utilization of the network infrastructure assets.

In this sense, as pointed out in (EC 2015), the commonly used fixed volumetric tariffs (€/kWh) fail to reflect actual costs of transmission and distribution activities and incentivize only a reduction of overall consumption, thus having little or no effect on peak demand. In contrast, capacity charges (€/kW) generally motivate peak load reductions, but their effect is only relevant if overall the network tariff payment accounts for a significant share of the final energy bill. Furthermore, if time differentiation (or time-of use) is made for the volumetric, and or capacity, components of the tariff, consumers are further encouraged to manage consumption in order to reduce their peak load.

Notwithstanding, the Electricity Directive 2009/72/EC (EC 2009) provides great flexibility to NRAs in the development of their tariff setting methodologies. As a result, it is generally observed that network tariff structures are very different among Member States (MS).For instance, each of them presents a different variety of types of charges (fixed, volumetric, and capacity).

Network tariffs include a capacity charge on peak consumption (or contracted capacity), at least for large consumers connected to high voltage levels of the transmission and distribution grids, in all target countries: **Belgium**[9], **France**[10], **Spain**[11], **Italy**[12], **Germany**[13] and **UK**.

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[9] In Belgium, the federal regulatory authority (CREG) sets the transmission tariffs and until recently has been in charge of setting the distribution tariffs, which are now in the hands of the regional regulators (VREG, CWAPE and Brugel). High voltage consumers (V > 26 kV) are only charged a capacity payment in €/kW. Consumers connected to lower voltage levels are optionally charged a volumetric tariff with differentiation between peak and off-peak hours in addition to a capacity payment if they have peak measurement equipment.

[10] The French energy Regulatory Commission (CRE) sets the network tariffs. The tariff for the highest voltage levels (HTB, V ≥ 50 kV), also called the public electricity transmission user tariff, TURPE 4 HTB, came into force on 1st August 2013 and is applicable for a period of 4 years (https://clients.rte-

In addition to this, **Belgium**[9], **France**[10], **Spain**[11] and **UK** present time-of-use differentiation for the volumetric charge, accounting for a few periods that are defined by season of the year and time of the day. In contrast, the volumetric charge in **Italy**[12] and **Germany** does not have time differentiation. However, in **Germany**, it seems that the rules used to calculate the energy and capacity charges by DSOs[13] in their particular zones are aimed to reflect the probability of the individual contribution of the network user to the peak demand of the network, as reported by . In addition, some consumers in Germany may benefit from tariff reductions applied by their DSOs according to their consumption behaviour[14].

Exemptions to pay for part of certain regulated charges and tax reductions are sometimes awarded to large consumers, for example in **Italy**[15] and in **Spain**[16]. These measures

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france.com/lang/an/clients_producteurs/services_clients/tarif.jsp) and has a different definition and structure from TURPE 4 for lower voltage levels (HTA and BT).

[11] In Spain, the government sets the so-called “access tariffs”, which recover both network and other regulated costs. These tariffs include volumetric and capacity charges, which for consumers connected to high voltage (levels NT1-NT4) have time differentiation between six periods based on the electrical season of the year, the day of the week and the hour of the day. The latest values can be found in a friendly format in https://www.iberdrola.es/02sica/gc/prod/es_ES/hogares/docs/Triptico_tarifas2015.pdf.

[12]As defined by the Italian NRA, the specific values for each tariff group and charge can be found in http://www.autorita.energia.it/it/elettricita/auc.htm. In addition to network service charges, other general system charges of different categories are included in the final tariff.

[13] The framework for tariff structure rules is set in Germany in the Ordinance on Tariffs for Access to the Electricity Supply Grid (Stromnetzentgeltverordnung (StromNEV)) and the Ordinance on Incentive Regulation (Anreizregulierungsverordnung (ARegV)). DSOs are appointed to individually convert their allowed revenues, as calculated by the NRA, into the final tariffs according to these rules. Therefore, the final tariff values lack harmonization among different DSO zones.

[14] In Germany, consumers may experience network tariff reductions according to their characteristics and consumption behaviour. In particular:

- § 19 sec. 2 clause 1 of StromNEV. Users with peak load desynchronized from the system peak load at transformer level (a number of concrete conditions are to be fulfilled) are applicable to network charges reduction up to 80%.
- § 19 sec. 2 clause 2 of StromNEV. Users with power consumption more than 10 GWh/year and hours of use amounting to at least 7,000 h/year. Reduction of network tariff of 80% (7000 h/year), 85% (7500 h/year), 90% (8000 h/year).

[15] Some exemptions to pay part of the regulated charges and taxes are established by regulation for large intensive industries in Italy. For instance, for an annual consumption higher than 8 GWh (MV) and 12 GWh (HV), consumers are exempted from paying the “type A” components of the general system charges.

[16] The Spanish Law 28/2014 of 27th November on Special Taxes allows industrial consumers whose electricity consumption purchases exceed 5% of their production value, or those whose electricity costs account for more

contribute to further reduce tariff levels, making the network signal less intensive to incentivize peak load reductions.

Moreover, regardless of tariff structure issues, the relative weight of network charges in the final electricity price affects the intensity of the signal sent through the network tariff to encourage consumers to cut peak consumption. As shown in Figure 3.1, which displays the components of the average final electricity prices paid by industrial consumers in 2014, the network charges generally account for a relatively low share of the price in all countries[17].

In conclusion, the structure of the tariff is helpful to enable this business strategy in **Belgium**, **France**, **Italy**, **Spain** and **UK**, and in principle also in **Germany**. However the relatively low weight of the network charge in the final electricity bill and the available exemptions and tax reductions in some countries possibly make this scheme not so attractive for large industrial consumers by itself, but can be an interesting additional saving to the additional energy bill reduction for flexible users under certain circumstances.

3.2.2 Volumetric tariff response with on-site VRE

By installing on-site VRE generation behind the meter while still being connected to the network, and in principle without the need for any flexibility, the FID could benefit from paying lower network tariffs and other regulated charges. Self-consumption from on-site VRE allows the FID to reduce net electricity demand (i.e. consumption not satisfied with self-generation and so, withdrawn from the grid). Thus, insofar as the FID is charged through a volumetric rate (€/kWh) on this net demand for network and other regulated costs[18], the FID could avoid part of those payments with on-site VRE[19]. The incentive to install on-site VRE to reduce these payments is even higher when a net-metering policy is in place, by

than 50% of the overall cost of a product, to have their tax base for the Special Tax on Electricity reduced by 85%.

[17] It must be noted that final electricity prices for households and other small electricity consumers are in general considerably higher in all cost components, especially in those corresponding to regulated charges.

[18] Note that if the owner of the VRE generator only received the market price, or a Feed-in tariff, for the energy injected in the network and is not relieved of other charges associated to consumption, there would be no advantage in VRE generation being on-site rather than off-site.

[19] From the perspective of global system efficiency, there is a commonly acknowledged concern with regard to network tariffs that only have a volumetric component being charged on prosumers' net demand because they may lead to cost-recovery problems or cross-subsidies, as described in (Eid et al. 2014). Basically, the reduction of revenues collected through these tariffs due to self-consumption would result in insufficient cost-recovery for network and other regulated activities or, instead, force an increase in the value of the volumetric rate as the same total costs would have to be paid by fewer consumers (or fewer kWh of net consumption). This would be detrimental for consumers without on-site generation, who could end up being charged excessively.

which the FID may offset consumption with self-generation, not instantly, but within a whole billing period.

Note that this business strategy is a part of business model V: Electricity Bill Reduction with on-site VRE.

Key questions

- Is **self-consumption** allowed? If a consumer is allowed to have on-site VRE generation behind the meter while still being connected to the network may benefit of reduced regulated payments. Without this condition, this business model would not be possible.
- Are there **incentives** for self-consumption e.g. are regulated charges volumetric and charged on net demand, or is net-metering applied?

Key answers: available regulatory evidence

A variety of national schemes for self-consumption of renewable energy can be found across Europe. The Commission Staff Working Document about "Best practices on Renewable Energy Self-consumption", SWD(2012) 141, which accompanies the document COM(2015)339 (European Commission 2015) of 15/07/2015, provides a good overview in this sense.

According to this document, self-consumption from own generation, behind the consumer's meter, is allowed in most countries under certain circumstances. Furthermore, the self-consumed and the excess energy fed into the grid can be valued following one of these approaches:

- A feed-in-tariff/premium approach on all instantly self-consumed and/or excess energy injected into the grid.
- Net metering approach, which is a billing system by which the excess electricity injected into the grid can be used to offset net consumption, not instantly but cumulatively throughout a whole billing period, e.g. a month or a year.
- Market value approach, by which the electricity that is not self-consumed but injected (instantly) into the grid would be rewarded at a market price.

Consumers under any of these schemes may be exempted from, or asked to contribute to, the total or partial payment of the network and other regulated charges on self-consumed energy/power, and not only on net consumption (when the self-produced electric energy is not sufficient to satisfy the consumption requirements). The situation in each of the target countries regarding the applicability of this business model is summarized below.

It can be seen that only **Belgium** among the target countries actually presents a net metering policy, but it is limited to small units (below 10 kW), so very large industrial consumers cannot benefit from this policy.

It can also be observed that, overall, in other countries this model is incentivized to some extent for large industrial consumers. This is done by exempting them from paying certain regulated charges on the self-consumed energy, such as a series of taxes (e.g. in **France**), part of the network charges (e.g., the exemption to pay for 95% of the volumetric part of the system charges under the SEU scheme in **Italy**, and in **Germany** the requirement to pay only for a RES-surcharge on self-consumed energy that corresponds to a reduction of the normal grid tariff and other regulated rates) or any grid and system charges at all, as in the **UK** and Belgium, creating an important incentive for self-consumption from on-site VRE.

On the contrary, grid tariff exemptions on self-consumed electricity are gradually being cut down or eliminated in other places, e.g. in **Spain** (prosumers are required to pay the network access tariffs on the net consumption plus an additional charge for grid and system costs on the self-consumed electricity) and in the Flemish region of **Belgium** (a specific distribution network tariff for prosumers was launched in July 2015), so the attractiveness of this model the way it has been described is progressively being reduced in these regions.

Belgium

Renewable energy installations with an installed capacity below 10 kW can allow consumers to benefit from a yearly net metering system. This system entails that the amount of electricity produced from the VRE is deducted directly from the general electricity bill of the consumer and no additional remuneration is foreseen for the excess electricity generation injected in the grid.

For RE with a capacity over 10kW, typically two meters are installed:

- A meter which measures the RE production: this meter reading is used in order to quantify the production of the RE source and is used for the subsidy/incentive calculation.
- A bi-directional grid connection meter: typically there is still a single grid connection but with separate meter readings for injection and consumption. When the plant consumption is greater than the RES production, this will be registered on the consumption meter reading, when plant consumption is below the RES production, this will be registered on the injection meter reading. Consumption and injection are subject to different grid costs and additional charges.

The above implementation creates an important incentive for medium sized companies, where the peak consumption is lower than the peak production of the VRE. In that case the company will alternate between grid injection and grid consumption and FID can be used to increase consumption at moments of injection and reduce consumption at moments of net consumption.

In addition, from July 2015, in the Flemish region, a specific tariff for prosumers was launched to make prosumers contribute to pay for the distribution network (67 – 106 €/kW installed).

France

As stated in (European Commission 2015), self-consumption is allowed in France (under decree law n° 2008-386 - 23rd April 2008). A convention can be subscribed whereby all electricity produced is consumed on-site and the consumer is exonerated from paying a series of taxes, such as VAT, the Renewable and Social surcharge (CSPE) and the Municipal tax (TICFE).

Germany

As is also reflected in SWD(2012) 141 (European Commission 2015), the review of the German Renewable Energy Act (EEG) in 2012 has introduced a limiting factor for grid injection which is favouring direct consumption: with only 90% of the production eligible for a FIT (for systems above 10kWp), the legislation promotes self-consumption over pure production. For the excess energy injected into the grid, the consumer is paid the market price.

Regarding grid tariffs and other charges, since 01/08/2014, self-consumed energy is totally exempted if < 10 kWp and < 10 MWh/year, while above those levels, a reduced RES-surcharge is applied on self-consumption that corresponds to a gradually increasing percentage of these charges, as follows: 30% by 2015, 35% by 2016 and 40% by 2017.

Italy

For generation units < 500 kWp, owned by the consumer, there is a net-billing system in place since 01/01/2015, as an alternative to net metering, by which the value of the excess energy injected into the network is calculated at the wholesale price and such value can be used for subsequent periods or is instead paid to the customer (European Commission 2015).

For RES (or high-efficiency CHP) higher unit sizes, with an upper limit of 20 MW, there is a scheme in place called SEU[20] (*"Sistemi Efficienti di Utenza")*, by which large consumers can self-consume or sell the excess energy at a market price. Since 2014, under the SEU scheme, industries with on-site generation are exempted from paying 95% of the volumetric part of the general system charges on the self-consumed electricity, encouraging self-consumption.

[20] SEU requires a private connection between a VRE plant and a single industrial consumer.

Spain

The technical and economic conditions for self-consumption are regulated by the Royal Decree (Real Decreto) 900/2015 of 10th October 2015.

According to this regulation, two modalities for self-consumption are contemplated: i) consumers with on-site RES generation capacity < 100 kWp for self-consumption (excess energy fed into the grid is not remunerated) and ii) consumers with officially registered generation facilities for self-consumption, who could optionally perceive economic remuneration for the energy injections to the grid, according to the specific regulation in place for the generation technology in question. In any case, installed generation capacity must be below the consumption contracted capacity.

Under both modalities, the consumer with self-consumption must pay for a series of regulated charges to contribute to economically sustain the electricity system costs under the following conditions:

- **Network access tariffs**, including a volumetric charge and a capacity charge, applied respectively on the hourly net demand[21] supplied from the grid and on the contracted capacity, controlled in the connection point to the grid (net capacity).
- **Charges associated to the electricity system regulated costs**, aimed at recovering regulated costs such as renewable energy subsidies, the budget deficit annuity and the extra costs from non-peninsular systems. This charge would be applied on total hourly consumption, i.e. the electricity withdrawn from the grid plus the self-consumed energy.
- **Charges for other services of the system**, or "support charge", which is a specific charge determined by the Ministry of Industry and energy aimed at recovering the costs incurred by the system to support the connection of self-consumption, which would not be necessary if the prosumer were not connected to the grid. This charge would be applied on hourly self-consumed energy.

During a transitional period during which the charges associated to the electricity system regulated costs are to be defined, the contribution to grid and system costs will temporarily be done through a capacity charge (€/kW) and a volumetric charge (€/kWh), applied on self-consumed energy and the capacity actually required for self-consumption, i.e. the difference between the total contracted capacity for consumption and the capacity actually measured in the connection point to the grid (net capacity). During this transitional period, consumers that are connected to the LV network with installed capacity below 10 kW, consumers living in extra-peninsular systems, and consumers with cogeneration (until December 2019) will be exempted from paying this contribution to grid and system costs.

[21] Consumption not satisfied with self-generation.

United Kingdom

According to SWD(2012) 141 (European Commission 2015), a feed-in-tariff approach is implemented in the UK, by which small-scale PV and wind systems (<50 kWp) eligible to receive a feed-in-tariff are given not only a generation tariff for the energy production (that is self-consumed), but also a bonus for up to 50% of the excess electricity fed into the grid. For an installed capacity > 50 kWp and < 5 MWp, there is only a feed-in-tariff paid to the energy generation.

Regarding grid and system costs, prosumers are exempted from paying any of them regarding the self-consumed electricity, strongly incentivizing self-consumption among industrial consumers. The tariff structure further incentivizes industrial consumers to self-consume, so they will try to forecast peak demand periods and manage their injection/withdrawals during those hours (either by using on site generation or by reducing their consumption).

3.3 Offering flexibility services to the power system

In this category are included all strategies that involve the explicit provision of flexibility services to the system by the FID, generally to the TSO or even to the DSO, but also to other system agents such as Balance Responsible Parties (BRPs), either directly or through an aggregator. In these business strategies, the FID receives direct payments for their availability to change their consumption upon request, and possibly for the actual changes in consumption, based on agreed conditions and circumstances.

The following business strategies are differentiated within this category:

3.3.1 Balancing service provision

This strategy consists in the FID offering reserve capacity, either directly or through an aggregator, to provide frequency control ancillary services and balancing energy to the System Operator (SO), comprising the following:

- Frequency containment reserves (FCR)
- Frequency restoration reserves (FRR)
- Replacement reserves (RR)

There are a number of markets and mechanisms used by SOs (e.g. compulsory procurement with/without remuneration, tendering or bilateral contracts.) to ensure they have enough operating capacity reserves from network users to call upon to deliver balancing energy in real time, which can be classified under the aforementioned categories. In some countries, FRR and RR may need to be further broken down into a number of separate categories.

Participation in reserve capacity and balancing markets opens significant opportunities for the development of demand-side response among FID (ENTSO-E 2015). According to these business strategies, the FID will offer the flexibility to continuously increase/decrease its demand according to the frequency of the grid and the frequency regulation signals received by the SO. Thus, the value of this service is mainly in the reserve capacity made available by the FID and the rapidness of the response. This business model requires a very fast response by the FID, as the intervals for the load increase/decrease are in the scale of seconds to a few minutes, as well as very fast and reliable communication infrastructure (except for FCR where the activation of this reserve is made locally).

It is remarkable that this model also comprises the provision of balancing energy directly to specific markets and mechanisms as a Balancing Service Provider (BSP) without the previous commitment of reserve capacity. Also note that this business strategy belongs to business model II: System Service Provider.

Key questions

- What mechanisms or markets for frequency control ancillary services and balancing energy are implemented in which the demand side can participate and how are these services (mandatory and non-remunerated or voluntary and remunerated)? This is an essential prerequisite for the applicability of this type of strategy.
- Do the technical and economic requirements for the provision of these services allow the participation of individual large consumers (minimum bid requirements, penalties for not complying, response times, etc.)? This indicates its likelihood of happening and its attractiveness for FID as a real business opportunity.
- Is aggregation of loads allowed? Are there any specialized demand aggregators providing reserves and balancing services? This is another indicative of the likelihood of these approaches happening.

Key answers: available regulatory evidence

Across Europe, both the balancing products and the arrangements by which these are procured by TSOs are very diverse and have been designed according to national specifities. Overall, there is a growing trend in Europe of modifying the design of ancillary services and balancing energy markets and mechanisms to allow the participation of demand-side resources. Still, tight access rules and strict preconditions to bid capacities and energy sometimes prevent large potentials of demand side resources to engage in balancing markets.

In the current context, among the target countries studied in this project, it can be concluded that **Belgium**, **France** and **United Kingdom** provide a regulatory framework that enables the practical application of at least some of these services. **Germany** has opened its ancillary service and balancing markets to the involvement of the demand side although some practical barriers for participation remain. In contrast, in **Italy** and in **Spain** consumers are not allowed to offer operating reserves and balancing energy to the SO. A good overview of the openness of these markets to the participation of industrial consumers is presented in (SEDC 2015). More details for each target country are summarized below.

Belgium

Primary and Tertiary Reserves allow the participation of consumers with specific products for demand (R1-Load, R3-DP, ICH), whereas Secondary Reserve does not. Strategic Reserves, a type of RR, which were introduced in 2014 to ensure security of supply during winter periods, count on the participation of the demand side as well, also with a specific product for the demand (SDR).

Program requirements generally facilitate the participation of flexible consumers, e.g. minimum bid sizes are of 1 MW, and many of them have a limited number of activations per year. Furthermore, the availability payments in these reserve markets, and the additional activation payments in the Strategic Reserve, can be deemed as attractive.

Aggregators are allowed but they need prior agreement of the customer's supplier/BRP to contract with the customer, which imposes a considerable difficulty for their activity.

It must me noted that Elia, the Belgian TSO, is designing a completely new bidding platform to restructure mainly the Secondary reserves market. Within this market, totally different products are expected to be available, still enabling the participation of consumers, but at the time of writing this report, the date of implementation is not decided.

France

Large industrial consumers have been allowed to participate in the balancing mechanism since 2003, and all ancillary services have been recently opened up to the participation of other demand-side resources, including aggregated loads by third party aggregators.

In particular, the following ancillary services and mechanisms are in principle accessible to the demand in each category of reserves:

- Within **FCR**: the Primary control (*Réglage Primaire de la Fréquence*)
- Within **FRR**: the Secondary Control (*Réglage Secondaire de la Fréquence*) and the Fast Reserve (*Réserves Rapides*)
- Within **RR**: the Complementary Reserve (*Réserves Complémentaires*) and the so-called Demand Response Call for Tender (*Appel d'Offres d'Effacement*).

In addition to this, the programs' requirements have been adjusted to better match the capabilities of the demand side. Minimum bid sizes are set at 1 MW for Primary and Secondary Control and at 10 MW for Fast Reserves and both types of RR (an improvement with respect to the earlier 50 MW). Primary and Secondary Control for demand-side participation are based on bilateral contracts and limited to certificated consumption sites and aggregated loads since 2014.

Germany

In principle, demand-side resources, including aggregated loads, are nowadays legally allowed in all balancing market programs in Germany (Primary Control Reserve, Secondary Control Reserve and Minute Reserve). As described in (Mott MacDonald 2013), since 2008, an improved market design allows demand side resources to provide balancing services, e.g. in the "minute reserve" (RR) market, in which the auctioning time-frame for capacities was reduced to the day-ahead and minimum bid requirement was lowered to 5 MW. Under this scheme, large industries are able to provide up to 20% of the hourly demand for reserve capacities in the tertiary balancing market.

Notwithstanding, some barriers and practical difficulties for participation remain. For instance, in the secondary reserve market, balancing capacities have to be committed on a weekly basis, which is much more difficult for consumers to meet than the day-ahead commitment (see Table 3.2). Furthermore, there are currently no specific rules on rights and obligations of aggregators in the electricity market, making third-party aggregation very difficult in Germany (aggregators require bilateral permission from multiple parties, including the consumers' BRP and supplier, without any standards and usually against the interest of these), as indicated in (SEDC 2015).

Table 3.2 Auctioning rules on the German balancing markets. Source: (BMWi 2015).

	Frequency of auction	Product duration	Minimum bid size	Pooling
MR	Each working day	4 hours	5 MW	Yes
SRR	Weekly	High (Mon. – Fri. 8 a.m. – 8 p.m.), Low (Mon. – Fri. 8 p.m. – 8 a.m.; Sat. – Sun., public holidays: all day)	5 MW	Yes
PRR	Weekly	1 Woche	1 MW	Yes

In a recently published White Paper by the German Federal Ministry of Economic Affairs and Energy (BMWi 2015) various measures to transform the electricity market design in the near future are proposed, including a series of actions to ensure the further development of balancing markets in order to allow more market-based demand-side management. Among the specific proposals are: the opening up of balancing markets for new providers and clarifying the rules for the aggregation of flexible consumers. In particular, the Federal Network Agency commits itself to give particular attention to the following aspects[22]:

- Shortening the blocks for the secondary balancing capacity, given that currently providers can only bid for very long blocks, i.e. a full weekly peak load period or a full weekly low demand period. This way, the estimation of available resources would not require so much time in advance.
- Auctioning secondary balancing capacity and minute reserves for each calendar day, not only the working days, so that this shortens times between gate closure and delivery.
- Shortening the product length of the minute reserve from four-hour blocks to, e.g., hourly blocks.
- Simplifying access for the aggregators to the balancing electricity markets.

[22] Some additional aspects not necessarily directly related to the facilitation of demand-side participation in the balancing markets are:

- Setting prices for balancing energy in the minute reserve and the secondary balancing capacity via uniform pricing (marginal pricing instead of pay-as-bid) for more efficient outcomes.
- Enabling for more providers to supply balancing energy. So far, grid operators can only call on the balancing energy they need at short notice from previously contracted reserve capacities.
- Shifting the gate closure to offer secondary balancing capacity, before the minute reserve and the day-ahead auction of the spot market.

Italy

In Italy, demand-side resources do not have access to the balancing market or the provision of ancillary services: Primary Frequency Control is compulsory for generators and not remunerated, while Secondary and Tertiary reserves are paid services but not open to load participation. Thus, this business model is not applicable in the current Italian regulatory framework.

Spain

Similarly as in Italy, nowadays in Spain, demand-side resources do not have access to the balancing market or the provision of ancillary services: Primary Frequency Control is also compulsory for generators and not remunerated, while Secondary and Tertiary control are paid services but not open to load participation. In such scenario, aggregated loads participating in any type of service provision are not allowed either. Thus, this business strategy is not applicable in the current Spanish regulatory framework.

United Kingdom

At the present time, all balancing service markets are open to consumers and aggregated loads, and some of them are specifically designed for demand participation, so this business strategy is applicable in the UK.

Consumers have been participating for a long time (since 2011) in the Short-Term Operating Reserve (STOR) program, a form of RR, but recently their contribution has fallen due to the difficulties of sustaining a long participation window (11-13 hours per day), a daily weekday participation and a long period of time between contracting and payment. For this reason, a new program called STOR-runaway has been introduced by 2015/16 for which only demand side can participate (200MW) so as to incentivise new market participants.

There is also a specifically dedicated program to demand-side response called the Demand-Side Balancing Reserve (DSBR), a form of RR, introduced in the winter 2014-2015. Under this scheme, large electricity users volunteer to reduce their demand in tranches of 1 MW or smaller aggregated units during winter weekday evenings from 4 p.m. to 8 p.m. in return for a payment.

Fast Reserve Firm Service (FRFS), a form of FRR, and Frequency Control Demand Management (FCDM), a type of FCR, allow aggregated demand participation as well. FCDM is specific for demand response providers, with a minimum bid size of 3 MW, and is used to manage large deviations of the frequency with a few events, each of 30 minutes, per year. In contrast, FRFS is not attractive for consumers because its requirements are difficult to be met, e.g. a 50 MW minimum bid size and a frequency of 10-15 activations per day.

Firm Frequency Response (FFR), a form of FCR, is open to demand-side resources, with a minimum capacity of 10 MW.

3.3.2 Bilateral balancing service provision

The idea of this strategy is that the FID commits itself to modify consumption in response to signals from a VRE[23] generator that is a Balance Responsible Party (BRP), so as to support the balancing of its demand-generation portfolio. A VRE generator assuming the role of BRP[24] may have the possibility of interacting bilaterally with one or more FID to partly compensate the generation imbalances within its BRP perimeter. The FID could benefit from having a flexible behaviour by acceding to adjust consumption according to the signals received from the BRP, in return for some remuneration or lower electricity prices (see model V) based on the savings obtained by the VRE generator in reducing imbalances, according to contractual conditions among them.

Note that this business strategy belongs to business model IV: Balancing Service Contract with off-site VRE.

Key questions

- What **balancing responsibilities** do market players, in particular VRE generators, have? Without any responsibilities they would not be incentivized to reduce imbalances with the help of demand flexibility. This is a clear indicative of the likelihood of this business strategy happening.
- What is the **imbalance pricing scheme** in place?
    - If there is a **single imbalance pricing** scheme, without necessarily aggregating several generation and/or demand units, imbalances in different directions can be compensated with a similar price. Therefore, aggregation does not represent a significant advantage, so FID would participate individually or with other FIDs as BSPs as in the previous business strategy.
    - If there is a **dual imbalance pricing** scheme, when the BRP imbalance is opposite to the grid needs, there is an extra penalty on top of the price representing the balancing procurement costs. Therefore, there is an additional incentive to avoid any type of imbalance. In this case, the possibility of aggregating a large number of demand and/or generation units

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[23] This business model is the same for generators with and without VRE, but this is the focus of the IndustRE project so this is why the emphasis is put on VRE generators.

[24] A BRP is an entity responsible for the equilibrium between injections and off-takes in a set of points (electrical HV buses) in the network with respect to the program declared at gate closure. Retailers and generators usually take the role of BRP. Sometimes large industrial consumers assume this role, if they have no retailer. Other times, BRPs are third parties.

within a BRP perimeter represents a significant advantage because it increases the possibilities of reducing imbalances, so this business scheme would be more attractive.

- Which is the allowed level of aggregation to measure and settle imbalances (e.g. number of units, technologies, areas, ownership, demand and/or generation, etc.)? This is particularly relevant in the case of a dual imbalance pricing scheme. If there is no possibility of aggregating demand and generation, or units of different ownership, to measure and settle imbalances, this business strategy is not possible.

Key answers: available regulatory evidence

Balance responsibility

The latest update to the regular CEER Status Review of Renewable Energy and Energy Efficiency Support Schemes in Europe (CEER 2015) indicates that RES plants in most European countries bear some **responsibility for their imbalances**, in the same manner as any other conventional plants. In particular, as reviewed by the European Wind Energy Association (EWEA) in (EWEA 2015), wind power generators, like other renewable energy generators, are balancing responsible in **Belgium**, **Italy**, **Spain** and **UK**, while in **France** they are not and in **Germany** they are only partly responsible.

In particular, the following aspects regarding recent changes and specifities of some of the target countries are worth commenting:

- According to (Chaves-Ávila et al. 2014), in **Germany**, before 2012, RES-E generators could only sell their energy to the TSO and receive a Feed-in-tariff in return, and were exempted from any balancing responsibility (it resided within the TSO). From 2012 on, RES generators in Germany also have the option of directly selling (marketing) their energy in the market (and receiving a premium on top of the market price), or bilaterally. Only in the latter case, under the direct marketing scheme, RES plants bear balancing responsibility (they account for more than 50% of the RES electricity produced).
- In **Italy**, VRE generators are not entitled balancing responsibilities before 2012 but the Italian NRA (AEEG) revised the procedures for allocating the costs of imbalances from RES generators through the AEEG regulation 281/2012/R/EFR for the application of imbalance payments to VRE power plants, in order to promote better forecasting from RES. Thus, since 1 January 2013, all VRE generators bear balancing responsibility with certain tolerance bands for each technology, i.e. percentages of error for which imbalances are not penalized.
- According to (Chaves-Ávila et al. 2014), in **Belgium**, like in Italy, the responsibility is shared between the RES generators and the TSO, with tolerance margins for offshore wind farms of 30% of final energy imbalance.

- In the **UK**, only plants of installed capacity above 30 kW are fully balance responsible like any other market party.

Moreover, according to the European Commission "Guidelines on State aid for environmental protection and energy 2014-2020"**Fehler! Textmarke nicht definiert.**, from 1 January 2016 renewable energy generators should be "subject to standard balancing responsibilities, unless no liquid intra-day market exists".

Imbalance settlement and imbalance pricing mechanism

Imbalance settlement concerns the rules applied to the determination of the individual imbalance volumes of balance responsible parties (BRPs) and regarding how balancing costs are allocated among imbalanced BRPs[25] through the imbalance prices, as well as when and how frequently this financial settlement takes place. A good overview of the imbalance pricing mechanisms applied in some European countries can be found in (Chaves Avila 2014).

The rules regarding the imbalance settlement also affect the level of aggregation allowed in the BRP portfolio, and so to determine the individual imbalances of BRPs. There are two main possibilities to define imbalances for a single BRP: BRPs may have to balance production and consumption (i) separately or (ii) combined. If production and consumption are separately balanced, overestimations (or under) of one of them cannot be compensated with overestimations (or under) of the other. This is of special importance in the presence of a dual imbalance pricing system.

France

Under the Balance Responsible Entity (BR) system (Chaves Avila 2014; RTE 2015a; RTE 2015b) operating in France, each electricity generator connected to the public transmission or distribution systems and each electricity consumer is responsible for the imbalances between the injections and extractions of electricity it operates. Alternatively, it may enter into a contract with a BR, which will take responsibility for the imbalances or ask one of its suppliers to do so. Each BR defines its own balancing perimeter by creating and declaring a portfolio of businesses to the TSO (RTE) and the DSOs[26].

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[25] As remarked in (Fernandes et al. 2016), typically the costs of activating balancing energy are allocated to imbalanced BRPs through the imbalance settlement while the costs of procuring balancing capacity are socialized among grid users through network tariffs.

[26] According to section C.14 of (RTE 2015b), a BR must declare to RTE and the DSOs concerned its portfolio of activities, referred to as the Balance Perimeter, used to identify injections and extractions, this is: consumption or generation sites, purchases or sales of energy on the power French exchanges, imports and exports with neighbouring System Operators, and load reduction programmes of demand side management operators.

For each half-hourly settlement period, RTE calculates the BR's imbalance as the difference between **total injection** and **total extraction** of energy within this balancing perimeter, thus, possibly aggregating and **compensating imbalances** from **generation** with imbalances from **consumption**.

Dual imbalance pricing is applied in France. The price of imbalances is calculated for each settlement period according to the value of the imbalance (positive or negative) of the BR and the direction of the balancing trend of the system, using the average weighted price of upward or downward activated balancing energy bids, adjusted with a "k" factor, which is periodically approved by CRE, the French NRA.

Belgium

As reported in (Chaves-Ávila et al. 2014), (Chaves Avila 2014) and (Elia 2016), since 2012 the imbalance pricing scheme in Belgium consists of a **single pricing** based on the marginal prices of activated balancing energy bids with an additional incentive applied in case of large system imbalances. Every access point on the transmission grid is managed by a so-called Access Responsible Party (ARP), or BRP, a role which can be taken by the retailer or by an appointed third party (major customer, generators, trader, etc.). The ARP is responsible for maintaining quarterly-hourly balance between **injections and off-takes** from the grid users within the designated perimeter.

Germany

As explained in (Chaves-Ávila et al. 2014) and (van der Veen & Hakvort 2010), in Germany, BRPs can have responsibility over **both energy production and consumption**, being able to offset consumption imbalances with production imbalances and vice versa. Each BRP must belong to a single TSO within the country. Regarding time and frequency, Germany applies a monthly settlement, which takes place several weeks after the month. Germany applies a **single imbalance pricing** mechanism. Imbalance prices correspond to the average costs of the activated reserves, this is, all net costs of activated balancing energy bids are calculated and these are divided by the net activated energy volume, which can be explained because selected BSPs are paid as bid, instead of marginal prices.

Italy

Hourly imbalance prices are calculated by Terna, the Italian TSO, in compliance with articles 39 and 40 of Resolution No. 111/06[27] of the Italian regulatory agency AEEGSI.

[27] https://www.terna.it/en-gb/sistemaelettrico/transparencyreport/balancing/imbalanceprices.aspx

A review of the imbalance settlement arrangements was proposed under consultation 163/2015/R/EEL of April 2015, see Ref. (AEEGSI 2015), without a clear decision to modify the existing regulation before the foreseeable adoption of the European balancing network code in the near future.

On the basis of the current rules, imbalances are settled separately for each **individual unit**. A different mechanism is used for those units empowered to participate in the provision of ancillary services for frequency control, balancing and congestion management (the so-called Mercato per il Servizio di Dispacciamento, or MSD) and for those that are not certified because they do not meet the technical requirements.

A **dual pricing mechanism** based on the marginal costs of balancing services is applied for units eligible to participate in the MSD balancing market. Instead, a **single imbalance price** that corresponds to the average costs of the activated reserves is settled for units not enabled to participate in the MSD. Thus, imbalances from **demand** units are necessarily settled **independently** of those from certified **generation** units and cannot be compensated. In both cases, the prices are settled separately for each of the two areas of Italy: the North and the South.

Spain

According to (Fernandes et al. 2016), **BRPs**[28] in Spain are required to send **disaggregated** energy schedules per each **generation** and **consumption unit** under the responsibility of the BRP to the TSO for the settlement of energy imbalances. Note that a single generation unit can be composed of several installations of the same technology that belong to the same BRP and a single consumption unit can be defined for the aggregation of all consumption units within the same BRP.

Thus, as explained in (Fernandes et al. 2016), for each hourly settlement period **imbalances are calculated separately** for the aggregation of **consumption units** within the same BRP and the aggregation of **generation units** within the same BRP, differentiating in this case between conventional and renewable generation units, and those providing Secondary Reserves or not.

Imbalances are settled according to a **dual price system**, under which BRPs that deviate in the same direction as the overall system imbalance are settled at the weighted average price of upward or downward activated energy bids from the deviation management, FRR and RR markets within the settlement period, while BRPs that reduce the system imbalance are settled at the DA market price.

[28] BRPs in Spain include production and/or consumption units, electricity retailers, direct consumers (i.e. consumers that buy electricity directly in the market) and market representatives (i.e. third-parties that represent generation and/or consumption units in the market). BRPs can present aggregated offers to the day-ahead and intraday markets while only individual offers (per unit) are allowed in the balancing markets.

UK

Great Britain's NRA, Ofgem, launched in 2012 a review of the Balancing and Settlement Code (BSC), the so –called Electricity Balancing Significant Code Review (EBSCR)[29], which was completed in 2014. Following the conclusions of the EBSCR, under the directions from Ofgem, the modification proposal P305 (Ofgem 2015; ELEXON 2015) was raised by the TSO, National Grid (NGET), to modify the imbalance settlement and imbalance price arrangements, to be implemented on 5th November 2015.

Under the current balancing arrangements of the BSC, a **single imbalance price** called "cash-out" price is applied to the BRPs instead of the previous dual imbalance prices, based on the marginal cost of balancing energy (balancing mechanism bids and offers accepted by National Grid as well as the Balancing services used) for every half-hourly Settlement Period.

Applicability of this business strategy

Overall, VRE generators are increasingly required to bear balancing responsibilities so this business strategy is gaining interest for VRE. Notwithstanding, when a single imbalance pricing mechanism is applied, as in **Belgium**, **Germany** and **UK**, imbalances in different directions can be compensated with a similar price so aggregation of generation and consumption units does not represent a significant advantage, making this business strategy less attractive for FID. In the other target countries, i.e. **France**, **Spain** and **Italy**[30], a dual imbalance pricing system is applied, providing a clear incentive to avoid any type of imbalances making this strategy more attractive. In this case, the possibility of aggregating a large number of demand and/or generation units within a BRP perimeter contributes to minimize imbalances and so represents a significant advantage. However, in **Italy** and in **Spain** imbalances are settled separately for generation and consumption units so this model is not possible. Thus, only in **France** this business strategy is possible under the current circumstances.

3.3.3 Other services provision

The FID could have the opportunity of participating in the provision of services for reliability enhancement other than balancing and frequency control ancillary services to the system, such as: capacity remuneration mechanisms or load interruptibility mechanisms managed

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[29] https://www.ofgem.gov.uk/electricity/wholesale-market/market-efficiency-review-and-reform/electricity-balancing-significant-code-review

[30] It is applicable for certified units to participate in the MSD balancing market.

by the SO and ancillary services offered to distribution network operators. The feasibility of the FID participating each of these services is analysed below.

Note that the following business strategies belong to business model II: System Service Provider.

- **Capacity remuneration mechanisms managed by the SO**

Capacity remuneration mechanisms exist to ensure the system generation-peak demand adequacy for the medium to long term. The FID can participate in these mechanisms, e.g. through an auction system, by committing to reduce demand during system stress conditions as determined by the SO, in exchange for some remuneration to the committed capacity. In turn, the system benefits from an additional capacity resource that may be less expensive than expanding generation capacity.

Key questions

- Is there any specific capacity remuneration mechanism **implemented** that is open to the participation of the demand side? This is an essential prerequisite for the applicability of this business strategy.
- Do the technical and economic **requirements** for the participation in such mechanism encourage the participation of individual large consumers (minimum bid requirements, penalties for not complying, deployment times, etc.)? This indicates the likelihood of this approach happening and its attractiveness for FID as a real business opportunity.

Key answers: available regulatory evidence

An increasing number of European countries are taking actions to improve security of supply by introducing capacity mechanisms. The European Commission is currently running an inquiry to all Member States about the measures being taken regarding capacity mechanisms, a report about which is expected soon (see [31]).

Different forms of capacity remuneration mechanisms have been in place in **Spain** ever since the liberalization process started with Law 54/1997, but only addressed to generation units. Also in **Italy**, capacity remuneration is in place only for generators that are eligible for participation in the markets for frequency control, congestion management and balancing services (MSD) (see AEEGSI 48/2004). For the time being, a capacity remuneration mechanism was implemented in the United Kingdom at the end of 2014, and another one is expected to start running in **France** in 2017, both of them open to generation and demand-

[31] http://ec.europa.eu/competition/sectors/energy/state_aid_to_secure_electricity_supply_en.html

side participation. Notwithstanding, even though aggregated demand has access to the British Capacity Market, in practice participation rules are considered to be strongly biased in favour of generation. Evidence of this is the fact that in the first auction almost all capacity for the next 15 years has been contracted to generation resources (SEDC 2015). In Italy, the NRA has approved the implementation of a tender-based capacity market for the end of 2015, in which the demand-side resources should also be able to access from the very beginning.

Hence, this scheme for FID participation is only being implemented in **UK**, but with practical difficulties, and is expected to be feasible in Italy and France soon.

- **Load interruptibility mechanisms managed by the SO**

Through load interruptibility mechanisms, the SO procures power capacity for load interruptions to carry out different operational procedures, such as network congestion management, emergency situations, etc. In this service, energy-intensive FIDs with a relatively flat profile commit themselves to lower their active power demand to predefined values when requested by the SO. In return, they are remunerated for available capacity as well as for the energy effectively interrupted. The assignation of this service and the determination of the incentives are generally done though competitive auctions. The FID providing this service do not require high ramping speeds and are notified in advance for the load changes required.

Key questions

- Is there any specific load interruptibility mechanism implemented?
- Do the technical and economic requirements for the participation in such mechanism encourage large individual consumers to participate? This indicates the likelihood of this approach happening and its attractiveness for FID as a real business opportunity.

Key answers: available regulatory evidence

Some type of load interruptibility mechanism exists in all target countries, mostly addressed to large industrial consumers, so this business strategy for FID is applicable in all of them. Under these mechanisms, FID consuming continuously large volumes of electricity commit certain blocks of capacity that can be reduced or interrupted upon request with a fixed notice time, for a predefined maximum duration and up to a maximum number of hours per year.

Some particularities and recent reforms identified in certain target countries are the following:

In **Belgium**, Interruptible Contracts comprise one of the two facets of the Tertiary Reserve service and it is expected that it will be phased out in the coming years according to (SEDC 2015).

In **Italy**, interruptibility services have traditionally been regulated by contracts between TERNA and the service providers that were auctioned on a monthly basis. Resolution of 20 June 2014, 301/2014/R/eel from the NRA established a new discipline for interruptibility services starting from 1 January 2015, by which: 75% of interruptibility services are purchased through pluriannual auctions, and 25% through annual auctions, and industries have the possibility to buy back (permanently or only for a predefined period) the interruptible capacity from Terna once one third of the total duration of the contract has passed. The Italian regulation foresees a premium of 135 000 €/MW/year for production units which allow instantaneous interruptions and a premium of 90 000 €/MW/year for production units which allow emergency interruptions (within a few seconds).

In **Spain**, the interruptibility service is an auction-based system regulated by Order IET/2013/2013[32], remunerated for available capacity, according to the results of the annual auction, and for energy effectively interrupted, based on a reference price calculated every trimester by the Ministry of Energy. According to the results of the auction of November 2014, the 2 000 MW for 2015 were sold to the Spanish TSO, REE, for M€ 352, i.e. for 176 339 €/MW/year on average[33]. The reference price for the settlement associated to an energy reduction order in this service to be applicable in the first trimester resulted in 48.20 €/MWh[34].

In the **UK**, the Demand Side Balancing Reserve (DSBR) is a specific mechanism that resembles demand interruptible services.

- **Ancillary services to distribution network operators**

The FID could contribute to increase reliability and security in distribution networks by providing services directly to distribution system operators (DSOs). DSOs would use resources offered by FID such as power reductions and reactive power and voltage control, for alleviating congestion and voltage problems.

[32] http://www.boe.es/boe/dias/2013/11/01/pdfs/BOE-A-2013-11461.pdf

[33] http://www.esios.ree.es/web-publica/, *Servicio de Interrumpibilidad > Resultados*

[34] http://www.boe.es/boe/dias/2015/02/09/pdfs/BOE-A-2015-1221.pdf

Key questions

- Is there any specific mechanism or market for ancillary services to DSOs **implemented** that is open to the participation of the demand side? This is an essential prerequisite for the applicability of this business strategy.
- Do the technical and economic **requirements** for the participation in such mechanism encourage the participation of individual large consumers? This indicates the likelihood of this model happening and its attractiveness for FID as a real business opportunity.

Key answers: available regulatory evidence

Overall, mechanisms for this type of ancillary services at the distribution level are not implemented across Europe, and a few are only being tested in a pilot phase[35]. The most significant advances in the development of large-scale trials can be observed in the **UK**, where the Innovation Stimulus programme, under the RIIO-ED1 distribution price control beginning in April 2015, incentivizes innovation, including the adoption of active demand-side management procedures by all Distribution Network Operators (DNOs) when these are cost-effective.

The inexistence or immaturity of these procedures and an accompanying regulatory framework is the main barrier to the applicability of this business strategy for FID in all target countries.

[35] See http://ses.jrc.ec.europa.eu/smart-grids-observatory for more information of current and recent smart grid research and demonstration pilot projects.

4 Stakeholders' views

This section provides a summary of the main observations made by relevant stakeholders (industry representatives, system operators, regulators, policymakers, research institutions, consultancies and market agents, such as renewable energy generators or aggregators, among others) regarding their perception about the feasibility and attractiveness of the business models presented in this document. This input has been collected from the consultation process that was carried out in the context of Task 2.3 (Jezdinsky & Nuño 2016), through an online questionnaire, individual interviews and the feedback received in a Workshop held on 27th October 2015 in Brussels[36]. These views are contrasted with the regulatory evidence already presented in Section 3.

4.1 Electricity Bill Reduction (I)

Based on the reaction to final electricity prices (including the energy cost component, the network tariff, the other regulated charges and taxes) by shifting consumption from high to low price hours, this business model can be considered feasible and is recognized to be implemented in all the target countries, even if it is not always attractive. Some particular views in relation to each country are presented below.

Belgium

According to stakeholders' comments, this model is applied in practice, mainly in relation to the component of the price that accounts for the cost of energy, although direct access to the market is limited so time varying prices are believed to reach customers mostly through retailers. Peak capacity network tariffs are present but are deemed too low in comparison to the other components of the price, as suggested in 3.1, so the strength of the incentive is seen as limited. Some stakeholders recommend dynamic peak capacity structure for the network tariff to be more cost-reflective, while others give more value to simplicity.

France

The long tradition of regulated tariffs and the regular practice of large industries with a flat profile of signing ARENH contracts for a stable and low price are regarded as the main barriers for this model in France. As indicated in 3.1, regulated tariffs for large consumers are being phased out while ARENH remains. It is the impression of some stakeholders that the ARENH price regime is likely to become more market price-oriented in the near future.

[36] http://www.industre.eu/news/events/details/workshop-on-innovative-business-models

Germany

Some remarks are made about the difficulties of having direct access to the wholesale market even for very large consumers due to the technical conditions required for participation. In addition to this, certain stakeholders do not see a significant potential economic benefit in cutting down peak consumption in response to the network tariffs because large plants usually have already optimized their operational processes to have a relatively flat profile. Furthermore, there already is a grid tariff reduction of up to 80% for large energy-intensive consumer, i.e. of at least 10 GWh and 7 000 of electricity consumption per year (see [14]), which is regarded as a much more relevant source of revenue than peak shaving. In spite of this, it is suggested by some of these stakeholders that the network tariff structures should be modified to be more cost-reflective than they currently are.

Italy

It is recognized that time-varying pricing products are being offered by retailers to all types of customers. It is observed that in spite of the massive deployment of smart meters, only consumers with contracted power higher than 55 kW are effectively charged on hourly consumption due to the lack of appropriate communication infrastructure. Furthermore, some stakeholders believe that the biggest saving potential in relation to this business model lies in the reduction of the peak demand (contracted power in the case of small consumers) to pay less for the capacity component of the network tariff.

Spain

The time differentiation of the capacity and volumetric components of network tariffs for large consumers are perceived as a good incentive for peak shaving but only in the case of industries with modular processes. In contrast, it is mentioned that base-load running industries, such as aluminium and steel, could find it less attractive to further reduce peak consumption or contracted capacity due to the requirements of the operational processes. The inclusion of regulated charges not directly related to the supply of electricity in the network tariff and regulatory stability are some of the main worries among stakeholders.

UK

It seems to be commonly acknowledged that industrial and commercial consumers already shift loads to avoid peak charges from network tariffs. Large industrial users of electricity even switch off their plants during specific moments of the year to avoid very high transmission charges which occur during a few moments per year, which provides them with an opportunity to reduce their energy bill.

4.2 System Service Provider (II)

As was discussed in section 3.3**,** Belgium, France and United Kingdom apparently provide an adequate regulatory framework for allowing consumers to provide operating reserves and balancing energy to the SO, while Germany enables it but presents some practical barriers and in Italy and in Spain consumers are not even allowed to provide any of these services. A capacity remuneration mechanism open both to generation and demand-side participation was implemented in the United Kingdom at the end of 2014, and others are expected to start running in Italy, already this year, and in France in 2017. Some form of interruptibility mechanism exists in all target countries. In general, stakeholders agree with this vision regarding the applicability of this business model. Some particular views in relation to each country are presented below.

Belgium

Even if Belgium is already widely open to the provision of balancing services by end consumers, either directly or indirectly (via independent aggregator), some existing barriers for participation remain and are expected to be removed in the near future, in particular through the implementation of a more transparent bidding system directly accessible by industrial consumers and aggregators. Currently, the main difficulty perceived by stakeholders for participation in these services is related to the compensation of imbalances originated by demand response actions. In this sense, end consumers willing to participate are required to become a BRP or, instead, provide the service indirectly through an independent aggregator who should establish an arrangement with the corresponding BRP/supplier to compensate for the consumption imbalances originated in its perimeter.

France

As mentioned before, primary and secondary reserves are open to FID since 2014 and a capacity mechanism open to demand resources is under discussion for implementation in the near future. An important barrier highlighted by stakeholders is the requirement of symmetric products (flexibility has to be offered upward and downward in the same amount).

Germany

Stakeholders are optimistic regarding the potential benefits of offering reserve capacity by industrial consumers once they manage to be prequalified for it. The prequalification process and certain technical constraints for participation, such as minimum bid sizes, and long duration blocks, restrict the participation of smaller consumers. In relation to the interruptibility service, a scarce participation and the duplicity of flexibility resources leads stakeholders to think that the regulator should cease this mechanism and integrate it into one of the existing balancing services.

Italy

Even though operating reserves and balancing markets are closed to the participation of consumers, stakeholders point out that the NRA is apparently opening up to this possibility through strategic guidelines and a consultation process for the period 2015-2018. The interruptibility service continues operating normally.

Spain

Balancing services are currently closed to the participation of consumers, but it is believed that the TSO and the industries have started conversations for a future opening of these services to flexible demand, such as FID.

UK

Stakeholders perceive that there is a growing and competitive market for these services, especially for the STOR service, with conditions that facilitate the participation of even small consumption units. However, some stakeholders still warn about the need to open these services to even smaller loads.

4.3 Electricity Supply / Balancing Service Contract with off-site VRE (III - IV)

Business models III and IV are two alternatives for the establishment of bilateral contracts between FID and VRE, either for the supply of electricity in the long term (e.g. 1 year) or also for the provision of flexibility services to support the balancing of the VRE generation portfolio. As has been concluded in the analysis of section 3, the incentives for VRE generators to develop innovative contractual arrangements with FID for electricity supply (model III) are limited in the current EU scenario due to the existing VRE support schemes, which already protect VRE generators from market conditions and risks. In addition to this, even though VRE generators generally bear some responsibility over their own generation imbalances, business model IV is not generally possible or attractive, either because a single imbalance pricing system is in place (Belgium, Germany, UK), making aggregation of generation with demand unnecessary, or because there is a dual pricing system that incentivizes the aggregation of imbalances from generation and demand but this aggregation is not allowed (Spain and Italy). Only in France model IV is feasible and attractive because there is a dual pricing system and it is possible that a BRPs aggregate demand and consumption in the settlement of imbalances within their perimeter. Stakeholders generally agree with this analysis. Some particular views in relation to each country are presented below.

Belgium

It is observed that bilateral electricity sales are not common in Belgium, especially concerning independent VRE generators. Stakeholders are aware that it is feasible to balance generation with consumption flexibility from a third party, but not economically attractive due to the single pricing mechanism.

France

It is acknowledged that VRE generators are not usually entering bilateral agreements with industrial consumers as their guaranteed feed-in tariffs are economically a better option.

Germany

Business model IV is found feasible but not attractive, given that in a single pricing system the balancing function between production and demand is provided by the market. There are no special remarks about model III.

Italy

Aggregation of production and consumption units in the settlement of imbalances is not possible, so business model IV is not feasible. Meanwhile, bilateral agreements between FID and VRE are not regarded as attractive in general.

Spain

Electricity supply bilateral contracts exist but are regarded as not economically interesting for FID and VRE or are still under an exploration phase. Furthermore, the aggregation of generation and consumption units in the settlement of imbalances is not possible either so business model IV is known to be not applicable.

UK

There is a general feeling that existing subsidies for VRE generation remove any incentive for bilateral arrangements between FID and VRE.

4.4 Electricity Bill Reduction with on-site VRE (V)

Installing on-site VRE generation may allow consumers to benefit from paying lower network and other regulated charges inasmuch as these are charged through a volumetric component (€/kWh) on net demand (total demand minus self-produced electricity). Self-consumption from on-site VRE generation could have other advantages for consumers, such as a relatively low cost of the consumed energy in comparison to the expected wholesale or retail market price. According to the particular regulation on self-consumption in each country, there is a wide variety of approaches. Thus, depending on the country, a FID could find more or less incentives to install on-site VRE for this purpose. Some particular views in relation to each country are presented below.

Belgium

According to regulation, yearly net metering is possible for small on-site generation units (< 10 kW) but for larger units, consumers cannot avoid paying for network and other regulated charges because consumption and generation are metered and charged/compensated separately.

Some industrial consumers admit that on-site VRE reduces their dependency on a supplier and their exposure to the market. Stakeholders comment that CHP is preferred over VRE for self-consumption, due to administrative burdens and physical difficulties to install VRE technologies on-site.

France

Self-consumption is allowed in France and all electricity produced and consumed onsite is exempt from paying a series of taxes.

Stakeholders do not have great expectations about the benefits of this model with respect to paying the wholesale market price (plus grid and other regulated charges) for the electricity consumed.

Germany

According to the latest "Renewable Energy Sources Act", self-consumed energy is totally exempted from network tariffs and other charges if generation remains within certain limits (<10 kW, < 10 MWh/year), while above those limits consumers are charged for a fixed part of these charges (30% by 2015, 35% by 2016 and 40% by 2017), reducing the incentive for self-consumption at a large scale.

According to some stakeholders' views, consumers with on-site VRE will gradually have to pay for the full amount of network and other regulated charges so they are pessimistic about this model. Industries are concerned about the future evolution of the Renewable Energy Sources Act.

Italy

Since 2014, under the so-called SEU scheme, industries with on-site generation are exempted from paying 95% of the volumetric part of the general system charges on self-consumed electricity.

Stakeholders see the SEU scheme encouraging for self-consumption at industrial level.

Spain

The recently approved regulation (October 2015) requires prosumers to pay for grid and other regulated charges through a series of specific rates. In particular, in addition to the usual “access tariff”, which is charged on hourly net electricity consumption, consumers with on-site generation are compelled to pay for two additional charges, one on self-consumed energy and another on total consumed energy, so as to contribute to the recovery of system regulated costs.

Stakeholders do not see self-consumption attractive anymore due to the requirement of paying these additional charges to compensate for the reduction in the amount paid through the “access tariff”.

UK

Prosumers are exempted from paying any network and system costs on self-consumed energy, strongly incentivizing self-consumption among industrial consumers.

Nevertheless, some stakeholders see that the need for a contract with a supplier to purchase the residual electricity (the volume not generated with on-site VRE), or a power purchase agreement to sell the exceeding electricity, imposes a considerable burden to FID for this business model.

5 Conclusions and policy recommendations

In this document, a series of innovative business models that industrial consumers could adopt to commercially exploit their own electricity demand flexibility (FID), possibly involving certain interaction with VRE generation, have been proposed. Business models have been defined attending available sources of savings or revenues and available instruments to grasp benefits from those sources. As a result of this, five different business models have been identified, each corresponding to a set of individual strategies oriented to a common objective in a realistic and feasible way:

VI. Electricity Bill Reduction
VII. System Service Provider
VIII. Electricity Supply contract with off-site VRE
IX. Balancing Service Contract with off-site VRE
X. Electricity Bill Reduction with on-site VRE

5.1 Conclusions from the regulatory analysis

A regulatory analysis has been carried out with the aim of identifying the main regulatory barriers that could be impeding the implementation of these business models in a set of target countries: Belgium, France, Germany, Italy, Spain and United Kingdom.

On account of this analysis, it can be said that business **model I**, which is based on the **reaction to final electricity prices** by shifting consumption from high to low price hours, is feasible and implemented in all target countries. Industrial consumers may either have direct access to the wholesale market and be exposed to hourly changing prices or sign supply contracts with specialized retailers, from whom they may receive offers of time-varying retail prices. It also seems that network tariffs across the target countries present a cost-reflective structure, including a capacity charge (€/kW) at least for consumers connected to high voltage levels, and time-differentiation of the volumetric (€/kWh) component in most of them (with the exception of Italy and Germany). It has also been observed that the share of the energy cost in the final retail price prevails over the network tariff and other regulated charges for large consumers. Thus, the interest of this model for FID, without forgetting the importance of the network tariff, would be primarily focused on the time-variation of the energy cost component of the retail price.

In contrast, the application of business **model II**, which entails more sophistication than the plain reaction to electricity prices because it involves the explicit **provision of flexibility services** to other system agents (balancing services and others), presents more difficulties and regulatory barriers than model I. Overall, there is a growing trend in Europe of modifying the design of ancillary services and balancing energy markets and mechanisms to allow the participation of demand-side resources. Belgium, France and UK provide a regulatory framework that enables consumers to provide capacity reserves and balancing products, while some regulatory barriers remain in Germany and consumers are not legally allowed at all in balancing programs in Italy and Spain. Among the main barriers for this model are tight access rules and strict preconditions to qualify as a BSP remain in many countries, the lack of standardization in the contractual arrangements required and unclear rules in the definition of the responsibilities of different agents involved (consumer, BRP, aggregator, etc.). Capacity remuneration mechanisms are also being gradually introduced across Europe, with the aim of allowing demand-side participation. Among the target countries, capacity mechanisms with allowed participation of consumers have been implemented only in the UK, although with practical difficulties, and are expected to be feasible in Italy and France in the upcoming year. In contrast, some type of load interruptibility program managed by the SO and addressed to large intensive industrial consumers has been in place for some years in all target countries. In fact, in some countries load interruptibility programs represent a significant source of income for industrial consumers.

Furthermore, the establishment of **bilateral contracts** between the industrial consumer and a VRE generator for the **supply of electricity** (**model III**) is still only hypothetical nowadays in the European context because of the existence of VRE support schemes in all countries. To the extent that VRE investments are guaranteed by regulatory subsidies, VRE generators will be less incentivized to be competitive and establish long-term bilateral contracts to secure their revenues and minimize risk-exposure. Nevertheless, the EU energy policy strategy foresees VRE progressive market integration with reduced support incentives, so this model would increasingly make more sense in the future.

Moreover, the establishment of **long-term bilateral contracts** for the provision of **balancing services** by the FID to assist VRE generators to minimize their imbalances (**model IV**) is also mostly hypothetical for the time being. In principle, VRE generators are increasingly required to bear some responsibility over their own generation imbalances in most countries so this business model is gaining interest from their perspective. Notwithstanding, this model is not generally possible or attractive in the target countries. On the one hand, it is possible but not so attractive in those countries where a single imbalance pricing system is in place (e.g. in Belgium, Germany and UK), where imbalances in different directions can be compensated with a similar price and so the aggregation of generation with demand by the same BRP is unnecessary. On the other hand, in countries with a dual imbalance pricing system (e.g. in France, Italy and Spain), imbalances are strictly penalized and so aggregating a large number of demand and/or generation units within a BRP perimeter could help BRPs to minimize imbalances. However, in Italy and in Spain imbalances are settled separately for generation and consumption units so this model is only possible in France.

Finally, business **model V**, which involves the **on-site** installation of **VRE** generation by the industrial consumer, could be an attractive decision for the FID, who could benefit from paying lower network tariffs and other regulated charges as long as these were charged through a volumetric rate (€/kWh) on net demand. The incentive to install on-site VRE to reduce these payments is even higher when a net-metering policy is in place, by which the FID may offset consumption with self-generation, not instantly, but within a whole billing period; however, this option would discourage the activation of demand flexibility by the industrial user. Among the target countries, net metering is only applied in Belgium for small on-site generation units (below 10 kW). Partial exemptions from paying certain regulated charges on self-consumed energy remain in certain countries (France, Italy, Germany) while in others, these exemptions are gradually being cut down or eliminated (e.g. Spain and the Flemish region of Belgium) so the attractiveness of this model is progressively being reduced in these regions. In contrast, self-consumption is strongly incentivized for industrial consumers in the UK and Belgium (except for the Flemish region), where prosumers are exempted from paying any network and system costs on self-consumed electricity because tariffs are applied on net consumed electricity.

5.2 Conclusions from the stakeholders' views

Stakeholders' **views** collected in the consultation process are generally in accordance with the regulatory analysis regarding the feasibility of these business models in the target countries. Diverse opinions have been observed among respondents to the consultation in relation to the perceived attractiveness of each of these models and the actual current practices among industries. In general, it appears that many industrial consumers already optimize their industrial processes in reaction to time-varying prices and capacity network charges to optimize their electricity bills (model I). Regarding the provision of flexibility services (model II), the main barriers still observed in those countries with reserve capacity and balancing markets that are open to the participation of consumers are the technical requirements for prequalification and participation. In relation to the establishment of bilateral contracts between FID and VRE (models III and IV), stakeholders agree in that VRE support schemes strongly limit the attractiveness of this approach. They also feel that the imbalance settlement rules do not incentivize or allow VRE to resort to FID load flexibility to minimize imbalances within their portfolio. Finally, the main concerns related to the installation of on-site VRE by the FID are related to the growing trend to charge at least part of the network and system costs on self-consumed energy and to the intermittency of the generation source.

5.3 Regulatory and policy recommendations

In view of the main findings of this analysis, a preliminary list of recommendations is provided below with the aim of helping regulatory authorities and policy makers to remove the main regulatory and market barriers that prevent an efficient application of the business models described in this document. These recommendations will be improved with new findings throughout the progress of the IndustRE project.

1. Ensure that market design rules guarantee that large consumers have **direct access** to wholesale electricity markets.
2. Ensure that **tariff design** for network costs is based on cost-causality (i.e. each user must pay for the actual costs incurred), in order to encourage network users to employ their flexibility to make a more efficient use of the grid capacity.
3. It is highly recommended that **network tariffs** consist of a fixed component related to the grid connection and a TOU dependent capacity component (€/kW) reflecting the contribution to network peak utilization. In contrast, flat and purely volumetric tariffs should be avoided.
4. **Regulated charges** that are not directly related to the use of electricity networks should be separated, in such a way that they do not distort electricity market prices and cost-reflective network charges.
5. Open up **reserve capacity** and **balancing markets** to the participation of the demand.
6. In those countries where reserve capacity and balancing markets are already open to the demand side, make sure that **technical conditions** do not impose unfair barriers for participation on a level playing field. In this regard, the following recommendations are provided to facilitate the involvement of consumers in these markets:
   - Reduce minimum bid sizes.
   - Allow the participation of aggregated loads.
   - Separate the procurement of reserve capacity and balancing energy.
   - Split the provision of upward and downward balancing products, so that the requirement of symmetry is eliminated.
   - Enable a centralized mechanism or standard procedures to facilitate financial adjustments between involved agents, especially between aggregators and BRPs/suppliers to adjust imbalances caused by demand response actions.
7. Gradually require **VRE** generators to bear **responsibility** for their **imbalances**.
8. Move towards a **single imbalance pricing system**, so that imbalance prices reflect the actual imbalance costs and, as such provide the correct incentives to value flexibility, avoiding distortions to the real time signal sent to market participants.
9. In the case of remaining in a dual imbalance pricing system, where imbalances receive an additional penalty on top of the price representing the balancing procurement costs, **allow the aggregation** and compensation of **imbalances** from

different consumption and generation units in the settlement of imbalances within a BRP area.

10 If a **capacity remuneration** mechanism is in place, open it to the participation of consumers and facilitate their involvement on a level playing field with generation resources.

11 Adapt existing **load interruptibility** mechanisms with the creation of more competitive and dynamic market instruments, in line with the standard procedures for the provision of reserve capacity and balancing services.

12 Progressively abandon **net-metering** policies and allow self-consumption from on-site VRE ensuring an adequate **network tariff design** (as indicated in recommendation 2). In this sense, network tariffs should provide end users with efficient economic signals based on net hourly consumption/injection, regardless of what is behind the meter, and on their contribution to the actual utilization of the grid.

13 Adapt the regulatory framework of **distribution network operation** and implement the mechanisms that would allow DSOs to use active network management solutions that include the market procurement of local network services provided by FID, such as power reductions and reactive power and voltage control, for alleviating congestion and voltage problems, and in the long term possibly avoiding network reinforcements.

14 Encourage the **harmonization** of flexibility mechanisms across the **EU** in line with the previous recommendations and the best practices identified in different countries.

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7 Revision history

Table 7.1. Revision history

Version	Date	Authors	Notes
0.1	24/11/2015	Mercedes Vallés, Pablo Frías and Tomás Gómez (IIT – Comillas)	First draft with an outline of the main contents and a detailed updated definition of the business models.
0.2	15/12/2015	Mercedes Vallés, Pablo Frías and Tomás Gómez (IIT – Comillas), with contributions from Jef Verbeeck and Daan Six (VITO), Fernando Nuño (ECI), Thomas Maidonis and Michael Papapetrou (WIP).	Second draft with a definitive definition of the business models and a preliminary overall analysis of the regulatory framework regarding the identified key questions in some business models.
0.3	22/12/2015	Mercedes Vallés, Pablo Frías and Tomás Gómez (IIT – Comillas), with contributions from WIP, ECI and VITO.	Third draft including a preliminary overall analysis of the regulatory framework regarding the identified key questions in all business models.
0.4	02/02/2016	Mercedes Vallés, Pablo Frías and Tomás Gómez (IIT – Comillas), with contributions from WIP, ECI, VITO and SER.	Draft with feedback and contributions from WIP, VITO, ECI, and SER, where only the stakeholders' views are missing.
0.5	19/02/2016	Mercedes Vallés, Pablo Frías and Tomás Gómez (IIT – Comillas) with contributions from ECI.	First complete draft.
1.0	11/03/2016	Mercedes Vallés, Pablo Frías and Tomás Gómez (IIT – Comillas) with contributions and feedback from all project partners.	Final version.

8 Annex 1: Correspondence between old and new classifications of business models in different deliverables of WP2

This Annex provides information about the equivalence between the original definition of business models that was presented in deliverable D2.1 (Papapetrou 2015), D2.2 (Vallés et al. 2015), and D2.3 (Jezdinsky & Nuño 2016). This information is summarized in the figure below.

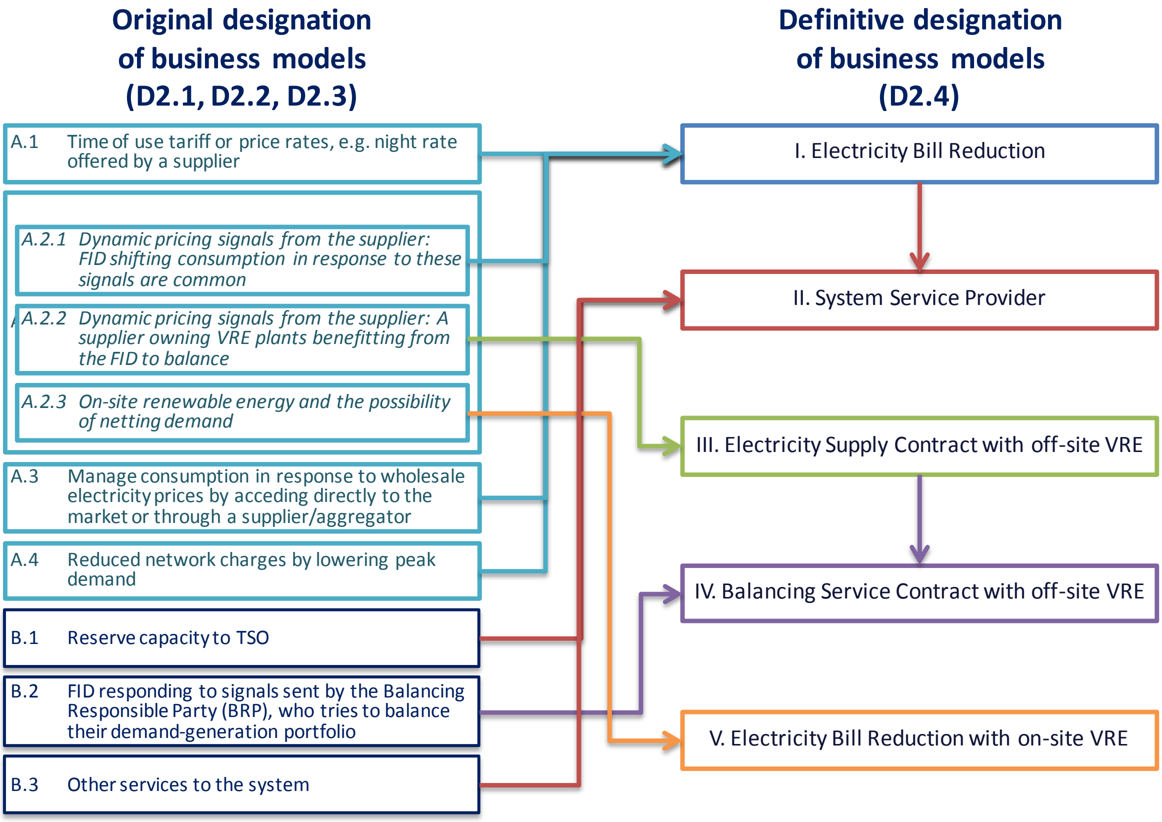

Figure 8.1. Correspondence between the original definition of business models and the definitive one