Developments affecting the design of long-term markets

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Executive Summary

Introduction

This report makes part of Work Package (WP) 3 of "Market4RES" project and is focused on the developments affecting the design of long-term markets. The report is structured as follows:

- In Chapter 2 the possible use and design of Capacity Remuneration Mechanisms (CRM) will be assessed;
- In Chapter 3 an assessment of the long-term effects of support mechanisms to Renewable Energy Sources (RES) generation will be carried out;
- Chapter 4 will deal with the participation of demand in long-term markets;
- Finally, in Chapter 5, the design of long-term cross-border products will be assessed.

This report aims at identifying and characterizing the most promising modifications to the design of markets in the Target Model (TM), as well as the most promising design options for new markets to be developed, allowing the European electricity system to operate satisfactorily in a context of very high penetration levels of RES generation. With this purpose, several design options were considered for those market developments that are still pending in the TM.

Market design options studies

In **Chapter 2** it is carried out an evaluation of several design elements regarding the design of CRM with long-term effects. In this sense, the work under this chapter analyses:

- the alternatives available for the product definition in which the most important components of the contract considered are the existence of Firm supply, the inclusion of a Financial energy contract and Physical energy delivery obligation;
- if the procurement mechanism should follow a Price or a Quantity based approach meaning that the entity making the procurement defines a price for the capacity leaving the quantity definition on the market participants or, alternatively, the overall amount of capacity to be purchased is previously defined and the price is fixed in a competitive process;
- if the quantities to be procured are defined in a centralized manner by one central entity or, alternatively, if quantities are defined in a bilateral or decentralized manner by each market party which bears the responsibility to ensure their long-term supply;
- the alternatives for product definition and procurement process responsibility in which three alternative design options were considered: i) a central entity is in charge of defining the product(s) and the procurement is carried out by means of a centralized auction, ii) standard products are centrally defined but the procurement occurs in bilateral or organized markets and iii) the procurement and the type of products is freely defined by market parties;

- the design elements regarding cross-border participation in which four alternatives were considered: i) a single and homogeneous CRM for all Europe with the same capacity mechanism rules and the same Security of Supply criterion or, at least, criteria of which the difference can be translated in terms of the mechanism's parameters; ii) national mechanisms implicitly considering the contribution of neighbors in which each system can have a different CRM but takes into account the contribution coming from interconnections statistically; iii) explicit participation of foreign capacities in which each system has a different CRM but allows neighbours to participate as sellers in the mechanism and, iv) different isolated CRM in which each system has a different one and seeks for national supply sufficiency.

In **Chapter 3**, different support mechanisms to RES generation and its long-term implications are analysed. The assessment considers 12 different support mechanisms:

- Long-term capacity auctions,
- Long-term clean energy auctions,
- Net metering of demand and generation per network user for computations of regulated charges,
- Feed-in tariff with regulated prices,
- Feed-in tariff resulting from an auction,
- Regulated feed-in premium (with and without price cap and floor),
- Feed-in premium defined by auction (with and without price cap and floor),
- Certificates scheme with quota,
- No support, and
- Support conditioned to the provision of grid services.

The assessment criteria used in this chapter are grouped in four main categories: Efficiency, Effectiveness, Robustness and Implementability.

In **Chapter 4**, the application of Implicit or Explicit mechanisms for Demand side participation is analysed.

- Under implicit mechanisms demand can be implicitly used in capacity markets where suppliers have, under the mechanism's provisions, an obligation based on their actual (measured) consumption.
- Under explicit mechanisms the participation of demand in capacity markets can be envisaged through a process allowing demand response to compare with traditional generation and FIT in a more or less standard capacity product.

The assessment criteria used in this chapter are grouped in three main categories: Efficiency, Implementability and Fairness.

In **Chapter 5**, different long-term cross-border hedging instruments are analysed. The considered cross-border products are classified in two groups, depending on whether they are or not linked to physical cross border capacity.

- In case they are linked to a physical interconnector or corridor, the products are managed and issued by the Transmission System Operator (TSO) on the primary market in which Physical Transmission Rights (PTRs) and Financial Transmission Rights (FTRs) are considered.
- In case there is link to physical cross-border capacity, any financial entity can act as a counterpart of the product and this is the case of Contracts for Differences (CfDs).

The assessment criteria used in this chapter were divided in three main categories: Efficiency, Robustness and Implementability.

Assessment of market design options

During the drafting of this report, an assessment and discussion was carried out on the set of relevant criteria that would be most adequate for the evaluation of each design option. These set of criteria was submitted to stakeholders consultation last June 2015 whose feedback was taken into account in the process of choosing the relevant evaluation criteria used in the report.

An evaluation of each design option is performed using the chosen criteria and, in the end, based on this evaluation it is possible to identify the most promising market design options for pending developments in the long-term. The final assessment is not the result of a simple arithmetic average of the grades obtained by each design option under each criterion but is rather the result of a more qualitative analysis. A design option obtaining an overall good average is not chosen if it performs poorly on a specific key criteria considered. The main conclusions under each chapter are described in the following paragraphs and detailed in Chapter 6 – Conclusions.

As for the design of **Capacity Remuneration Mechanisms**, the main conclusions are that financial options with a high strike price is a promising design element, expressing the system needs in terms of a price-quantity curve is preferable over defining a fixed price. The procurement through a centralized auction would be effective, efficient and accepted widely, even when not allowing a large variety of products to be traded. Lastly, cross-border provision of firm capacity should be allowed to increase the efficiency in the provision of this product (through statistical means).

The most promising **RES support mechanisms** are those with a market nature, namely Long-term clean energy or capacity auctions and Feed-in Tariff or Feed-in Premium auction schemes. These mechanisms result in the most cost-competitive RES generation that is compatible with the achievement of RES deployment objectives being installed in the system and could be accepted by authorities and stakeholders.

Demand side participation mechanisms of all kinds should be allowed to provide flexibility for consumers to participate in long-term markets. Implicit schemes are simpler, and cheaper to implement and definitely contribute for a market functioning improvement. Explicit schemes are more complex and expensive to implement but introduce more competition in the market. The specific choice to be made could depend on the specific circumstances existing in each system.

Lastly, the analysis on **Cross-Border Products**, concludes that Financial Transmission Rights are the preferable option but that Physical Transmission Rights with a Use It or Sell It clause may also be a sensible option.

Abbreviations

CACM – Capacity Allocation and Congestion Management

CFD – Contract for Differences

CRM - Capacity Remuneration Mechanisms

DAM – Day-ahead Market

DSR – Demand Side Response

EC – European Commission

ETS – Emissions Trading System

EU – European Union

FCA – Forward Capacity Allocation

FIT – Feed-in Tariff

FIP – Feed in Premium

FTR – Financial Transmission Rights

IEM – Internal Energy/Electricity Market

LT – Long-term

NC – Network Code

PTR – Physical Transmission Rights

RES – Renewable Energy Sources

SoS – Security of Supply

TM – Target Model

TSO – Transmission System Operator

UIOLI – Use it or Lose it

UIOSI – Use it or Sell it

WP – Work Package

Market4RES

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1 Introduction

This is the first report within WP3 of project "Market4RES" and it is focused in the developments affecting the design of long-term markets. The second report within WP3 deals with the short-term markets[1].

The 2030 targets agreed by the October 2014 European Council, aiming at reducing greenhouse gas emissions, increasing renewables share in energy consumption and improving energy efficiency, means an ambitious change of the electricity system towards decarbonisation. This change implies having a more flexible system capable of integrating high levels of renewables and ensuring adequate levels of security of supply (SoS).

In order for these changes to be done in a cost-effective manner it is needed to adapt the current market design, which was built taking into account the traditional electricity system, so that obstacles for renewable energy are removed and right signals are sent to market participants for sufficient investment to ensure an adequate level of capacity for the system needs.

In relation to system adequacy, the relevance of longer-term (LT) adequacy measures is being increasingly acknowledged. In this sense, in November 2012, in the Communication "*Making the internal energy market work*", the European Commission (EC) discussed the current situation in Europe with respect to the implementation of long-term security of supply mechanisms:

"Some member states have introduced or plan to introduce separate payments for the market availability of generation capacity, as they are concerned that the 'energy only' market will not deliver sufficient investment in generation"

At the same time, the EC warned about the major risks stemming from the current situation:

"If capacity mechanisms are not well designed and/or are introduced prematurely or without proper coordination at European Union (EU) level, they risk being counterproductive", and *"Poorly designed capacity mechanisms will tend to distort investment signals"*

Taking into account the risks at stake, this report aims at identifying and characterizing the most promising modifications to the design of markets in the TM, as well as the most promising design options for new markets to be developed, allowing the European electricity system to operate satisfactorily in a context of very high penetration levels of RES generation. Developments of electricity markets to be identified within this should result in the achievement of long-term EU energy policy objectives related to the economic efficiency of the development and operation of the system, its sustainability, and the preservation of adequate levels of security of supply.

[1] See D3.2 «*Developments affecting the design of short-term markets*»

With this purpose, several design options will be considered for those market developments that are still pending in the TM. At the same time, well-functioning elements of this Model and main pillars of EU-energy policy like the Emissions Trading System (ETS) are to be preserved, though upgrades to these may need to be considered so that they can perform their function efficiently also in a high-RES future.

This report is structured as follows:

- In Chapter 2 the possible use and design of CRM will be assessed;
- In Chapter 3 an assessment of the long-term effects of support mechanisms to RES generation will be carried out;
- Chapter 4 will deal with the participation of demand in long-term markets, and
- Finally, in Chapter 5, the design of long-term cross border products will be assessed.

During the drafting of this report, an assessment and discussion was carried out on the set of relevant criteria that would be most adequate for the evaluation of each design option. These set of criteria was submitted to stakeholders consultation last June 2015 whose feedback was taken into account on the process of choosing the relevant evaluation criteria used in the report.

In the end of this report, one should be able to identify the most promising market design options for pending developments in the long-term. The functioning of the selected regulatory developments that are suited to being implemented up to the year 2020 will be subsequently simulated in WP4, and then WP5 carries out a quantitative assessment of the most promising design options and identifies the best suited ones for their implementation. The implementation of these is finally discussed in WP6.

2 Design and use of Capacity Remuneration Mechanisms

2.1 Context and objectives

Some EU governments have reconsidered (or are reconsidering) the need for intervening by implementing a CRM to ensure electricity supply in the long-term.

A mixed combination of different market and regulatory failures are often considered to be behind this major problem that threatens long-term security of supply.

2.1.1 Guidance to ensure generation adequacy

The EU, in their staff working document (EC, 2013), presented a guidance to properly ensure generation adequacy in the Internal Energy Market (IEM). This guidance establishes that the energy only market should be given an opportunity to encourage appropriate investments.

To ensure security of supply in the long-term, the EU compels public authorities to undertake periodic assessments of the generation adequacy situation in their Member State. A key issue as regards this assessment is that it has to take account of three aspects, namely: (i) developments at regional and Union level, (ii) the effect of European policy objectives, and (iii) the potential of demand response.

Where as a result of the previous assessment, a concern about generation adequacy emerges, its causes should be first properly identified. Once identified, to the extent possible, they should be removed to allow the energy only market work and give proper long-term incentives.

Only when all the previous steps have been taken and the long-term investment problem remain, Member States may opt to intervene by implementing a CRM mechanism to ensure generation adequacy.

Additionally, the Commission has recently stated that CRM may include State aid (within the meaning of Article 107(3) TFEU). In such cases, Member States are subject to a notification obligation under Article 108(3) TFEU. The Energy and Environmental Aid Guidelines (EEAG) adopted in 2014 contain specific criteria to assess State aid for CRMs.

2.1.2 Avoiding distortion in the Internal Electricity Market

As regards the design of these CRM, the Commission has repeatedly stated that this explicit type of intervention should look for avoiding distortions on cross-border trade and in general on the effective functioning of the IEM.

However it is fundamental to acknowledge that this intervention will unavoidably affect the evolution of the market (bringing new investments will affect short-term market prices, this is inescapable). But let us recall that the initial hypothesis is that the market is not functioning properly, therefore if we do not “alter” it, we will not be solving the problem.

That being said, the major problem affecting this long-term dimension of electricity supply is that national initiatives have taken place in an uncoordinated manner, resulting in impacting the progress of achieving the objectives of European regulation. This situation has raised the EU Comission and ACER alarms, who precisely perceive these national movements, if not properly designed and coordinated, as a potential threat to the proper development of the IEM.

This concern has been recently expressed by the EU Commission in the launched sector inquiry on CRMs (EU Commission, 2015)):

> *"As these capacity mechanisms are mostly being planned or introduced in an uncoordinated manner they risk being inefficient and materially distorting cross-border trade and competition between the various capacity providers. Generally, they risk distorting price formation in the internal electricity market. Moreover, they may include only certain generation technologies or exclude non-generation activities such as demand side response. They may also disregard the contribution that capacity providers outside national borders and improved interconnection with neighbouring markets can make to ensure security of electricity supply."*

2.1.3 Objective of this chapter

In this chapter we take as starting point the situation where, after following the EU recommendations, a CRM is still deemed as necessary in a Member State. Therefore, we do not aim here at comparing the energy only with the different CRM approaches. A fully-functional energy market is undoubtedly the desired scenario when workable.

This chapter focuses on how to properly design CRM to ensure security of supply efficiently. That is, we deal with the aforementioned problem of avoiding introducing negative distortions in the IEM.

To study and critically assess the alternatives of design, our approach consisting in identifying the most relevant design elements, is introduced and justified in section 2.1. Then the design alternatives for each element and the corresponding assessment is carried out in the following sections (2.2 up to 2.6).

2.2 Design elements[2]

There are two major approaches to classify CRM design options:

- The classical way to proceed has been to resort to well-known labels that refer to already implemented design experiences (e.g. Capacity Markets are used to refer to the different PJM and NY-ISO mechanisms implemented in the last decade, Reliability Options to refer

[2] The analysis of the CRMs' design elements carried out in this report draws on Batlle et al, 2015.

to the Colombian and ISO-NE mechanisms, Strategic Reserves to the Sweden mechanism, etc.).

  - ACER's examination of CRMs and the internal market for electricity (ACER, 2013), set out a classification of CRMs based on this criterion. The taxonomy included five options: capacity payment, capacity obligation, capacity auction, reliability option and strategic reserve.
  - Generally speaking, this alternative of resorting to these labels is simple, but limits the characterization of the mechanisms. Indeed, when going into the details it is easy to find that under the same label quite different mechanisms may be included (e.g. the PJM's Capacity Market has significantly evolved and improved with different redesigns in the last decade, the general label of Capacity Market however has not changed).

- The second alternative, which is more complex but which also allows deeper detailed in the characterization, is to identify all relevant design decisions that need to be defined by the regulator when designing a CRM.
  - This second alternative is in line with some publications on the topic, such as FERC (2013) and Batlle et al (2015).

In this section, we have opted for using the second alternative consisting of detecting the most relevant decisions as regards the CRM design. These decisions have been termed here as design elements. In this project, there have been considered five design elements, namely:

- The product,
- Whether the mechanism is price-based or quantity-based,
- The party defining the quantity of the product to be purchased,
- The counterparty purchasing the product in the mechanism,
- Cross-border participation of resources.

In the following, the previous design elements are briefly described one by one, also characterising the available design alternatives in each case. These alternatives are also assessed against different criteria with the objective of identifying best practices.

Before proceeding with the analysis it is worth noting that, since mechanisms need to be tailored to the peculiarities of each power system and the prevailing market failures, it will not be always possible to provide general guidelines valid for every condition.

2.3 The product: design alternatives and assessment

2.3.1 Design options

The variety of products that the regulator can define has received several names, such as capacity obligations, capacity credits, financial reliability options (or contracts), physical reliability options, strategic reserves, firm energy contracts etc. As it happens with the names used for

CRM, the use of product names is vague and can be misleading, for it is not clear what commitments are associated to each of these names.

In general, the product can be more properly defined based on three complementary components (each of them may or may not be included in the product definition) and the time terms associated to the contract (or commitment).

The three basic components of the contract are:

- Firm supply: a limit on the tradable quantity acknowledged in the mechanisms to the different generating units (or demand resources). It represents the expectation of the contribution of the resource to the Security of Supply problem. In other words, it represents the expectation of production during critical periods. Critical periods may be defined as (i) the period with high demand, (ii) the periods with high or low temperature, (iii) the periods with low hydrology inflows, (iv) the periods with abnormally high prices, etc.
- Financial energy contract: whether or not the product includes a financial energy contract. Three types of financial contracts have been used in practice in the products procured in CRMs, namely: (i) a forward contract, (ii) an option with a strike price in the order of the variable cost of generators and (iii) an option with a high strike price.
- Physical energy delivery obligation: the product may involve delivering physically energy when some conditions are met. Typically the physical energy delivery is required in critical periods. In case the energy is not physically delivered in such circumstances, a penalty is defined.

As was just pointed out, these components are optional and complementary. This way, a product may consist of one, two or the three components mentioned above. As a way of example, the following products could be defined in a mechanism:

- A firm supply requirement, with no financial energy contract and no physical energy delivery obligation (this has been the scheme in some capacity payments).
- A firm supply requirement and a financial energy contract, but without any type of physical energy delivery obligation (this corresponds to the scheme implemented in Colombia).
- A firm supply requirement with a physical energy obligation. This corresponds to the scheme implemented in PJM or New York.
- A firm supply requirement with a financial energy contract and also a physical delivery obligation. This corresponds to the scheme implemented in New England.

On the other hand, the product is also defined by two relevant time terms defining the commitment:

- The lead time (or lag period): is the time that separates the contract signature from the date when the contract enters into force.
- The contract duration: the duration of the commitment

2.3.2 Introduction of assessment criteria

We assess the previous design options against some of the following criteria (the criteria used will change depending on the design element being analysed):

- Effectiveness in reaching some usual targets,
    - Dealing with risk aversion and by providing long-term hedging instruments to properly hedge investments,
    - Attracting new physical capacity,
    - Ensuring the availability of resources when needed,
- Participation of generation and demand in short and long-term markets,
- Robustness against changing conditions in the system and market power,
- Cost involved in the mechanism.

2.3.3 Assessment of design options

As previously stated, the product may consist of one, two or the three components mentioned. Here we analyze the value of adding each component and assess the potential alternatives.

Firm supply component

This is a common feature included in the product definition involved in CRMs and serves to ensure there is physical and reliable back-up. Firm supply is known with different names depending on the system: capacity credit, energy credit, firm capacity or firm energy are just some examples.

Adding a “firm supply” requirement component in the product definition increases the effectiveness in bringing new capacity. International experience recommends adding this component in the requirements associated to the product. The downside of including it, is that calculating the firm supply associated to the different resources is a controversial issue.

As regards the alternative ways to define the critical or scarcity period the most efficient and robust alternative is to do it based on price signals. All other alternatives may prove to be efficient, but most probably not robust against changes in the system conditions.

Defining the scarcity periods is a controversial issue, for it affects the firm supply acknowledged to the different resources and therefore the potential remuneration perceived in the mechanism.

The table below, qualitatively assesses the advantages of including the firmness supply component in the product definition.

		Not include firmness requirement	Include firmness requirement
Effectiveness	*Attracting new physical capacity*	Fair	Very Good
	Ensuring resources are available when needed	Poor	Good

Table 1 – *Assessment of firmness supply component in the product definition according to Effectiveness criterion*

Financial energy contract

Including a financial energy contract in the product definition reduces the risk exposure for generation and demand. How much to hedge agents is an open question that depends on the system and on the agent's prefferences. However, it is worth noting that a fully hedged product would reduce in practice (or even eliminate) incentives for participation in short and long-term markets.

The table below shows the trade-off between hedging capacity suppliers (generators or demand) and keeping incentives to participate in markets. As mentioned above, the three alternatives considered are (i) a forward contract, (ii) an option with a low strike price and (iii) an option with a high strike price (above the variable cost of plants). Generally speaking, a very high strike price provides a good balance both hedging prices during scarcity conditions while also keeping incentives to participate in long-term markets. This option is often known as "reliability option".

	No financial contract	Forward contract	Option with low strike price	Option high strike price (scarcity price)
Hedging generator	Poor	Very Good	Very Good	Good
Hedging demand	Poor	Very Good	Very Good	Good
Incentives demand participate LT market	Very Good	Poor	Poor	Good

Table 2 - *Assessment of Financial energy contract in the product definition*

Physical energy delivery obligation

Introducing a physical energy delivery obligation increases the incentive to be available when most needed. This increases the effectiveness of the mechanism but at a cost: it increases the risk for generators, and therefore it increases the cost associated to the mechanism.

	No penalty for non-delivery	Penalty for non-delivery
Additional short-term availability incentive when scarcity	Poor	Very Good
Hedging generator	Poor	Fair
Hedging demand	Fair	Good
Procurement cost	Good (Lower)	Poor (Higher)

Table 3 - *Assessment of Physical energy delivery obligation according to Effectiveness criterion*

The discussion on whether or not to introduce a penalty is a contentious topic. However, there is an increasing trend of adding it in the product definition. PJM or ISO-NE capacity mechanisms are being redesigned at the time of this writing in this direction of including a penalty for non-performance.

Important elements of the penalty definition are the price level and contractual consequences in case of not delivery (e.g. removing participant from a list of preferred suppliers, increasing prequalification requirements, etc).

Lead time (or lag period)

The lead time indirectly conditions whether new investors will be able to participate in the mechanism even if they have not yet started constructing the projects (e.g. the generating plants). Allowing new investors to participate before constructing their projects is a desirable characteristic, for it reduces the investors' risk and also increases the competition in the mechanism.

In general, the projects which take longer than the lag period to be built will not be able to participate in the mechanism. That is, if the product is to be provided in two-years time (lag period of two years), and it takes three years to build the plant, this potential new plant will obviously not be able to participate. An extreme situation arises when the lag period does not allow any new investment to participate (this was the case for instance in the former short-term ICAP markets which was in place some years ago in the Northeast USA).

There is a certain consensus on the fact that setting lead times closer to construction times increases the effectiveness of risk hedging for new plants (3 years seems reasonable in the European context).

Lower lag periods increase the risk for investors in new capacity, thus reducing the effectiveness to bring new capacity. This in the end also affects the efficiency of the mechanism. On the other hand, excessively long lag periods (e.g. 10 years) also unnecessarily increases the risk to investors.

A major problem appears when the construction time of the different technologies differs to a large extent. This is the problem in Latin America, where large hydro projects take significantly more time to be built than e.g. a regular combined cycle gas turbine plant. How to deal with this problems falls out of the scope of the present analysis.

Contract duration

Large investments usually require long-term contracts in order to obtain the project finance conditions that will allow the plants involved to be bankable.

On the other hand, very long-term contracts involve increasing the risk for the demand (locking the price of energy in the very long-term is not desirable either). 5-7 years of contract duration is considered in international experience as a reasonable trade-off for contracts being offered to new investors.

2.4 Price versus quantity based: design alternatives and assessment

2.4.1 Design options

In price mechanisms, an administratively determined payment, often known as the "capacity payment", additional to the income derived from the energy (short-term) market, is provided in exchange of the product. The quantity of capacity that will bring the mechanism is entirely left to the market.

In quantity-based mechanisms, a specific quantity of the product is defined and the price is fully determined by the market. Quantity mechanisms can involve a perfectly inelastic quantity requirement (i.e. a fixed quantity of the product) or conversely the requirement can be elastic (i.e. it can be expressed by means of a price-quantity curve).

2.4.2 Introduction of assessment criteria

Three assessment criteria are considered with respect to this design element:

- the expected efficiency,
- the implementability in the context of the EU legislation, and
- the robustness against market power and potential changing conditions.

2.4.3 Assessment of design options

Efficiency

Resorting to a fixed-price mechanism may result in a security of supply that is either too large or too small if the regulator does not accurately estimate the cost of new capacity. Analogously, resorting to a fixed quantity may result in too high a price (particularly if the regulator does not expect much competitive pressure).

A price-quantity curve requirement better reflects the utility each security-of-supply level provides to the buyer (e.g. the regulator acting on behalf of the demand).

The typical price-quantity demand function for the product, based on the Columbian and NE-ISO mechanisms is shown in the Figure below. The curve is based on the definition of two parameters, M1 and M2. The curve bids the targeted reference quantity (D) that achieves the reliability criteria at the CONE (cost of the new entrant). For lower quantities the price increases and for higher quantities the price bid decreases.

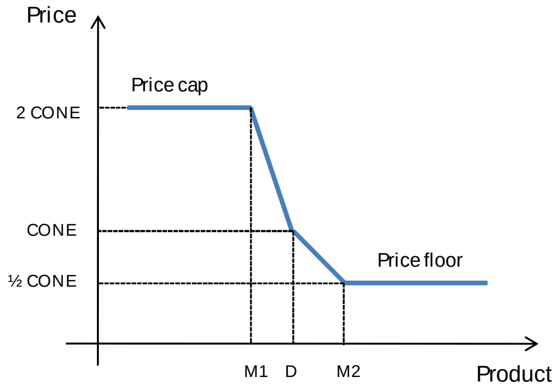

Figure 1 - *Price-Quantity demand function for the product*

Implementability

Although in principle both price and quantity based mechanisms could be ideally implemented in the EU (as has been the case in the past), the fact is that implementing a price mechanism under the current EU legislation can be more problematic than a quantity (or price-quantity) based one.

Since price mechanisms offer a fixed price support irrespective of the actual system need, price mechanisms can be seen in certain cases as a hidden state aid to generation. This non-market based remuneration is a questionable and not allowed solution in the EU to solve the missing money problem due to overcapacity.

According to EU Commission (2013), it is essential to distinguish between missing money and missing capacity:

> *"In liberalized markets, investments are not guaranteed by the State. Only where there is a real threat to generation adequacy and security of supply as a result of closure or mothballing does the financial viability of existing plant become a matter of public concern. It is very important that there should not be state support to compensate operators for lost income or bad investment decisions."*

Robustness against market power

The mechanism less prone to market power exercise as regards the mechanism price remuneration is the price-based mechanism (since agents can not affect it). On the other hand, a fixed quantity requirement can give incentives to exercise market power.

A Price-quantity curve requirement helps partially reducing market power and also provide more information to agents about how far the system is from suffering a scarcity.

Robustness against the scenario where the mechanism is no longer needed

Quantity or price-quantity mechanisms allow the price to naturally go down to zero when no more additional capacity additions are needed (because for instance the market starts to work properly).

2.5 The quantity purchased: design alternatives and assessment

2.5.1 Design options

There are two main design alternatives:

- Centralized: one central entity is in charge of defining the quantity to be procured.
- Bilateral (decentralized): market parties are those that bear the responsibility defining the quantity to be procured so as to ensure their long-term supply.

2.5.2 Introduction of assessment criteria

The assessment criteria used are the following:

- Efficiency, and in particular the potential imperfections costs, the effectiveness in securing the long-term supply and the global coherence (i.e., avoiding distorting the energy market).
- The transparency of the decisions associated to the design.

2.5.3 Assessment of design options

Efficiency

Imperfection costs

In a '**Centralized CRM**', the definition of how much capacity is needed by a central entity raises incentivization issues, as this entity is likely to be risk averse and not bearing the costs of its own decision. Notwithstanding this, it could lead to overinvestments in the long-term as centralized capacity mechanisms function only briefly several years ahead of time and, therefore, it might not adapt to overcoming events. Therefore, this option might not be capable to correct imperfection costs arising ex-post. For this reason, the performance of this alternative is in-between **Poor** and **Fair**.

'Bilateral CRM' tend to be more flexible to overcoming events and, from that point of view, it could avoid the risk of imperfection costs arising ex-post (e.g. overcapacity). Thus, the performance of this approach is **Good**.

Effectiveness

We consider that '**Centralized CRM**' mechanisms would perform **Fairly** under this criterion because the capacity amount is defined a number of years in advance which could lead to overcapacity and excessive capacity payments.

We consider that the performance of '**Bilateral CRM**' mechanisms is **Good** under this criterion because it allows achieving security of supply targets avoiding overcapacity and excessive capacity payments.

Global coherence

'**Centralized CRM**' would perform **Fairly** under this criterion since the pricing of the capacity is set through a competitive mechanism. However, since the capacity amount is defined a number of years in advance this could lead to overcapacity affecting the functioning and the price signals of energy markets.

The performance of '**Bilateral CRM**' is **Good** under this criterion since the pricing of the capacity is set through a negotiated mechanism and that avoids overcapacity since the amount of capacity contracted is more adaptable to the evolution of the system needs.

Transparency

The performance of '**Centralized CRM**' is in-between **Fair** and **Good** under this criterion since transparency of the decisions taken by the central entity can be challenging and not always clear.

The performance of "**Bilateral CRM**" is in-between **Good** and **Very Good** under this criterion, since this approach has the pontential to be more transparent if market agents clearly justify the capacity requirements defined.

In the following table it is summarized the assessment as regards to which party should define the quantity to be purchased.

		Centralized CRM	Bilateral CRM
Efficiency	*Imperfection costs*	Poor / Fair	Good
	Effectiveness	Fair	Good
	Global coherence	Fair	Good
Transparency		Fair / Good	Good / Very Good

Table 4 - ***Assessment of which party should define the quantity to be procured***

Althoug this is our general point of view, this is clearly a controversial issue. In the end it is not possible to establish as a universal law that market agents are in a better position to take all relevant decisions. The need of a CRM is a clear example of their inability to do this.

2.6 Procurement mechanism: design alternatives and assessment

2.6.1 Design options

There are three main design alternatives as regards who defines and purchases the product:

- Centralized: one central entity is in charge of defining the product(s) and the procurement is carried out by means of a centralized auction
- Decentralized (with standard centrally defined products): one central entity is in charge of defining the product(s), but market parties are those that bear the responsibility of procuring the product(s) in bilateral or organized markets.
- Decentralized (without standard products): some design elements of the products are not standardized (typically the contract duration or lead time) and market parties bear the responsibility of procuring themselves the product(s) in bilateral or organized markets.

2.6.2 Assessment criteria

The assessment criteria that will be used to analyze the design options are:

- Efficiency, and particularly:
  - the marginal cost reflectivity of the mechanisms,
  - the capacity to bring efficient investments even where economies of scale or lumpiness in investment can be relevant (and the efficient investment is a relatively large plant when compared to the system size),
  - whether or not the mechanism is prone to vertical market power exercise,
  - if it allocates naturally the costs according to a cost causality criterion, and

- if the diversity of products is enough;
- Implementability and experience.

2.6.3 Assessment of design options

Efficiency

Marginal cost reflectivity

The performance of some **centralized CRM** is **Very Good** under this criterion. Particularly, when the mechanism involves a centralized marginal auction (cleared at the marginal offer), marginal cost reflectivity is achieved.

The performance of **Bilateral (decentralized) alternatives** is in-between **Good** and **Very Good** under this criterion. Obligated parties engage in trading to minimize the cost of their obligation, which should generate liquidity and prices reflecting the marginal system cost. However, if the price is negotiated bilaterally, there could be room for resulting lower prices to be paid to existing capacity. The development of organized market platforms with a clearing of offers and demand would solve this difficulty. The assessment of this model can vary depending on the functioning of the bilateral market, and an organized market is likely to be necessary for this model to perform very good.

Cost causality

The performance of **centralized approach** is in-between **Fair** and **Good** under this criterion. The central entity in charge of the procurement of capacity has to recover its costs, and the cost causality directly depends on the accuracy of the cost sharing principles. Although this is not explicit it is expected that these costs are transferred to end consumers.

The performance of **bilateral approach** is in-between **Fair and Very Good** under this criterion. This mechanism defines that capacity is purchased by the suppliers so it is expected that the costs will be transferred to the end consumers, which in the end benefit from the capacity. The cost causality depends on the accuracy of the obligation faced by suppliers, how precisely it reflects their individual needs for a firm supply.

The price paid for the capacity can differ from supplier to supplier depending on their hedging strategies. This allows competition based on hedging strategies, which reinforces cost causality.

Diversity of product traded in the market

'**Centralized CRM**' and '**Decentralized with standard products**" would perform **Poorly** up to **Fairly** under this criterion as it defines a single lead time and contract duration.

The performance of the fully **decentralized approach (with non-standard products)** is **Very Good** under this criterion as it allows trading in different lead times and different contracts durations can better FIT agents' preferences.

Economies of scale and lumpiness in investment

The acquisition of the product through a **centralised auction**, enables/can generate economies of scale (clustering different sometimes small and numerous regulated retailers, so as to make possible for large investments to participate). Thus, the performance of this options is **Very Good.**

Vertical market power

Centralizing the acquisition of the product by means of an auction, enhances transparency while preventing vertical integrated companies from taking advantage of obscure agreements. Thus, its performance is **Very Good** under this criterion.

Decentralized acquisitions, if carried out by means of open auctions, can also fight against vertical market power exercise. The performance of this option is **Fair**.

Implementability, experience and other comments:

We consider that **any option** under this design feature doesn't affect the functioning of the TM, doesn't create, *per se*, discrimination between cross-border contracts and national contracts and doesn't violate the principles established in the State Aid Control Legislation since they are all market based options.

Capacity obligations to ensure Security of Supply imposed on market parties as a public service obligation are explicitly authorized by the Security of Supply Directive and therefore fully compliant with the Target Model.

If well designed and supported by documentation, any mechanism is deemed to be simple and transparent to the relevant stakeholders. Thus, the performance of any approach under this criterion is **Very Good**.

As regards the experience, **all approaches** would perform **Very Good** under this assessment criterion as demonstrated in other systems and/or countries where the presented models are widely applied. Centralizing the acquisition of the product by means of an auction can increase competition.

2.6.4 Summary of the assessment

In the following table, a summary of the assessment is presented. According to this, the centralized approach reveals to be more consistent in the overall assessment criteria under analysis and for that reason would be the most promise design option.

		Centralized (standard products and auction)	Bilateral / Decentralized	
			standard products and bilateral	non-standard products and bilateral
Efficiency	*Marginal cost reflictivility*	Very Good	Good / Very Good	Good / Very Good
	Cost causality	Fair / Good	Fair / Good / Very Good	Fair / Good / Very Good
	Diversity of products	Poor / Fair	Poor / Fair	Very Good
	Economies of scale and lumpiness	Very Good	Fair / Good	Fair / Good
	Vertical Market power	Very Good	Fair	Fair
Implementability		Very Good	Very Good	Very Good
Experience		Very Good	Very Good	Very Good

Table 5 - *Summary of the assessment of procurement mechanism design options*

2.7 Cross-border participation: design alternatives and assessment

A wide regional coordination in long-term planning has significant benefits in an integrated European power system. This is why CRMs need to be properly coordinated and open to cross-border participation.

2.7.1 Design options

Four design options are considered for the coordination and participation of foreign capacity resources in national CRM:

- Single and homogeneous CRM for all Europe: the whole Europe agrees on adopting the same capacity mechanism rules and the same SoS criterion or, at least, a criterion of which the difference can be translated in terms of the mechanism's parameters;
- National mechanisms implicitly considering the contribution of neighbors. Each system can have a different CRM but takes into account the contribution coming from interconnections statistically. This is carried out by accounting for the correlation of stress periods in the national electricity market and its interconnected systems;
- Explicit participation of foreign capacities: each system has a different CRM but allows neighbours to participate as sellers in the mechanism (therefore the neighboring participants acquire an explicit commitment);
- Different isolated CRMs: Each system has a different CRM and seeks for national supply sufficiency.

2.7.2 Introduction of assessment criteria

Efficiency in the IEM regional context

How the scheme allows for an integrated long-term expansion of the European power system.

Implementability

It will be essential to ensure CRM coherence with the following regulation and legislation:

- Coherence with Article 16.3 of Regulation 714/2009: "The maximum capacity of the interconnections and/or the transmission networks affecting cross-border flows shall be made available to market participants, complying with safety standards of secure network operation.
- Coherence with Directive 2009/72 Article 42: Safeguard measures, which states that *"In the event of a sudden crisis in the energy market and where the physical safety or security of persons, apparatus or installations or system integrity is threatened, a Member State may temporarily take the necessary safeguard measures".*

And also coherence with the SoS Directive:

- Article 4.3 in the Security of Supply Directive (2005/89/EC), states that "in taking the measures referred to in Article 24 of Directive 2003/54/EC and in Article 6 of Regulation (EC) No 1228/2003, Member States shall not discriminate between cross-border contracts and national contracts".
- The first statement of the Security of Supply Directive mentions that "The guarantee of a high level of security of electricity supply is a key objective for the successful operation of the internal market and that Directive gives the Member States the possibility of imposing public service obligations on electricity undertakings, inter alia, in relation to security of supply".
- Coherence with the State Aid Control Legislation: CRM should not violate the principles established in the State Aid Control Legislation.

Simplicity and Transparency

Fairness

All resources should ideally be able to compete in a level playing field and get remunerated for the services they provide. On the contrary the market would be segmented in favor of some participants

2.7.3 Assessment of design options

Efficiency

From a theoretical point of view, having a **single CRM** all over Europe can present some efficiency problems. Capacity may not be needed for the same reasons in all countries and defining a common concept of security of supply and required products may not be feasible. When this is the case, imposing a homogeneous CRM and the capacity requirement computed for each country may not reflect its actual need. Since this is the situation in the EU, the single CRM approach performs **Fairly** by this criterion.

Having **different CRM with a statistical account of interconnections** performs well by this criterion because products can be tailor made to FIT the needs of the relevant system, while ensuring that only the necessary amount will be procured (no overcapacities). However, only domestic capacities can compete on the supply side, which excludes potentially cheaper foreign capacities. This approach performs **Fairly** up to **Good** under this criterion.

Having **different CRM allowing the participation of foreign capacities** solves the potential imperfection of the uniform demand modeling that is implied with a homogeneous CRM for all Europe. As it lets domestic and foreign capacities compete on an equal foot, it allows for the least expensive capacities to emerge. However, if not associated with binding rules and multilateral agreements to ensure that the insurance sold by foreign capacities will really benefit the consumers who paid for it, it could lead to free riding issues and distort the whole CRM. It therefore performs **Fairly up to Very Good** by this criterion, depending on the associated governance framework for SoS.

Having **different isolated CRM** performs **Poorly** when it comes to efficiency since the capacity requirement in a given country is by far overestimated by not taking interconnections into account. Moreover, only domestic capacities can compete which excludes potentially cheaper foreign capacities.

Implementability

Having a **single homogeneous CRM** for all Europe performs **Poorly** under this criterion since it would require a high degree of harmonization of SoS assessment methodologies, to deeply revise the target models (since the flows on the interconnections could no longer be determined by short-term energy price differentials anymore). Management of SoS at EU level could even require modifications of European treaties.

The performance of **statistical taking into account of interconnections** is considered **Good** when it comes to implementability since, the statistical consideration mean that no action is taken on the flows on the interconnectors to solve domestic SoS issues and the spirit of the TM is therefore respected. However, cross-border contracts to ensure SoS are not allowed by this option.

Having **different CRM with explicit participation of foreign capacities** performs **Fairly**[3] under this criterion as it requires multilateral agreements between Member States on the management of scarcity situations.

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[3] To perform Fairly, the design should respect Regulation 714 (article 16.3). Interconnection capacity cannot be reserved in advance so as to maximize cross-border capacities available to market players for energy trading purposes. Some designs repect this condition.

Having **different isolated CRM** performs **Fairly** under this criterion since no revision of the TM is needed but it would still prevent the establishment of cross-border contracts to ensure SoS.

Simplicity and Transparency

Having a **single and homogeneous CRM** all across Europe performs **Poorly** when it comes to simplicity since it raises significant harmonization issues and having rules allowing capacities to ensure SoS in a country compatible with those of the energy markets is very challenging.

The performance of **statistical taking into account of interconnections** is considered **Very Good** under this criterion as it is quite simple (it does not complicate the procurement mechanism). Transparency is ensured if the TSO publishes the coefficient representing the taking into account of interconnection well ahead of the delivery period.

Participation of **foreign capacities** would require a complex augmentation of the market design of CRMs, which is detrimental to simplicity. This option therefore performs **Fairly** with respect to this criterion.

Having **different isolated CRM** is the simplest option and therefore performs **Very Good** under this criterion.

Fairness

Having a **single homogeneous CRM** across Europe performs **Good** under this criterion since all capacities would participate in similar mechanisms.

Having **different CRM with a statistical consideration of interconnection** performs **Poorly** under this criterion as foreign capacities could not compete with domestic capacities. They could contribute to keep neighbor's security of supply but would not get remuneration for that.

Having **different CRM allowing the participation of foreign capacities** performs **Fairly** under this criterion since foreign capacities could probably not participate in a domestic mechanism on equal footing with domestic capacities due to interconnection restrictions.

Having **different isolated CRM** performs **Poorly** under this criterion as foreign capacities could not compete with domestic capacities.

2.7.4 Summary of the assessment

In the following table, a summary of the assessment is presented. As it has been discussed, the statistical account of the interconnection or the explicit participation of foreign capacities are the preferred design options.

	Single and homogeneous CRM for all Europe	Statistical account of the interconnections	Participation of foreign capacities	Different isolated CRM
Efficiency	Fair	Fair / Good	Fair / Good / Very Good	Poor
Implementability	Poor	Good	Fair	Fair
Simplicity & transparency	Poor	Very Good	Fair	Very Good
Fainess	Good	Poor	Fair	Poor

Table 6 - *Summary of the assessment of cross-border participation design options*

3 Long-term effects of support mechanisms to RES generation

This section aims to describe the analysis carried out to determine which support schemes to RES generation, or ad-hoc schemes developed for the integration of RES generation in markets, are the most promising ones.

Support schemes will be assessed from the point of view of their effects on the functioning of the system in the long-term, since they may have an impact on investment decisions made by conventional and RES generation (as intended).

Therefore, section 3.1 provides a brief characterization of the relevant design options to support RES generation. Then, section 3.2 presents the relevant assessment criteria considered in the long-term. Section 3.3 performs the assessment of the relevant design options by applying a system of grades so that it is possible to rank all the design options at stake according to their performance in each criterion. Lastly, in section 3.4, the most promising design options are identified along with the ones to discard.

3.1 Relevant design options to support RES generation

This section provides a characterization of the most representative design options that can be considered for the support of RES generation in the long-term.

For each design option, a brief description is provided followed by its main features, which includes for instance: the level of stability of RES revenues (price earned by the RES energy producer); the level of correlation of RES prices with short term market ones (reflecting marginal costs); the level of technology targeting or even the level of efficiency in the use of public funds (technology specific subsidies may limit public funds devoted to support these technologies), among others.

3.1.1 Long-term capacity auctions

This is a system of long-term generation capacity auctions, whereby support to a predefined amount of RES generation capacity of a certain technology to be installed (being the amount decided by authorities and the technology that, or those, that need to be supported to get mature) results from bids accepted in the auction. Depending on the auctions' design, remuneration to RES generators can be allocated either under a pay-as-bid arrangement, whereby each bidder is granted the price he has offered, or under pay-as-clear arrangement, whereby the marginal capacity bid accepted would be setting the price paid for each unit of generation capacity installed.

Level of stability of RES revenues

Revenues from the long-term capacity auction only refer to complementary revenues required by RES promoters to decide to install new generation. Part of the revenues of RES generation would be earned in the rest of markets. Thus, the stability of revenues is medium.

Level of correlation of RES prices with short term market (reflecting marginal costs)

Short term revenues of RES operators fully coincide with those earned in short term markets since revenues in the long-term auction are normally fixed (only depend on the amount of capacity installed). Thus, short term prices earned by RES are fully reflective of short term marginal supply costs.

Are prices earned by RES generation computed through a market process?

Yes, they are, both in the long and the short term.

Level of technology targeting

According to their specific design, long-term capacity auctions can be run for either specific technologies (technology-specific auction) or can be open to all technologies (technology-neutral auction). Thus, technology targeting may occur depending on policy objectives.

Level of efficiency in the use of public funds

Being support provided through a market process, competition pressures drive support requested down. But uncertainty about market revenues in the short term may increase the cost of financing of investments, and therefore, increase support requested.

The level of funds transferred to RES generation through long-term auctions and other markets may be high. Normally, these would not come from the public budget, but they potentially could as the design option, *per se,* does not define the origin of the funds.

Priority for RES generation in the dispatch

Priority of dispatch for RES generation does not depend on the support scheme but rather on decisions made by authorities and the principles set in European legislation, namely in the Renewable Energy Directive.

Level of centralization of prices earned by RES generation

Prices earned by RES generation (also those corresponding to support) are computed centrally in an auction. These auctions may be national or European wide.

3.1.2 Long-term clean energy auctions

Remuneration conditions affecting the compulsory supply of a certain block of clean energy (predefined amount of it) are set through an auction process taking place in the long-term.

Level of stability of RES revenues

Prices earned by RES generation for predefined amounts of the clean energy they produce are largely defined in the long-term. The equivalent price earned by RES generation for this amount of electric energy produced may not be fully fixed (depending on whether a full price, a premium, or a CFD with regards to some reference price level is set in the auction). The amount of power produced that is not covered by the contract would be remunerated according to conventional energy prices. Thus, the level of stability is medium.

Level of correlation of RES prices with short term market (reflecting marginal costs)

Variable, depending on whether a full price (no correlation), a premium (medium level of correlation), or a CFD with regards to some reference price level (low level of correlation) is set in the auction.

Are prices earned by RES generation computed through a market process?

Yes, prices earned by RES generation are computed through a market process.

Level of technology targeting

Auctions may be specific to a certain technology or addressed to different clean technologies in the system.

Level of efficiency in the use of public funds

Normally, funds provided to RES generation are collected from tariffs paid by consumers. Thus, no use of public funds.

The overall level of funds transferred to RES generation depends on the technologies targeted and the level of RES development the authority sets.

Priority for RES generation in the dispatch

Priority of dispatch for RES generation does not depend on the support scheme but rather on decisions made by authorities and the principles set in European legislation, namely in the Renewable Energy Directive.

Level of centralization of prices earned by RES generation

Prices are computed through centralized auctions organized at system level (should probably take place for all the European system jointly).

3.1.3 Net metering of demand and generation per network user for computations of regulated charges

Net power production and demand over certain periods of time are netted out in order to compute the level of regulated charges paid by the corresponding network user. Thus, a sort of subsidy can be deemed to be applied to the latter.

Level of stability of RES revenues

Low level of stability.

Level of correlation of RES prices with short term market (reflecting marginal costs)

Energy prices earned are fully coupled with energy short term market prices.

Are prices earned by RES generation computed in a market process?

Yes, energy prices are. Only regulated charges are affected by this.

Level of technology targeting

No technology targeting is taking place, in principle.

Level of efficiency in the use of public funds

Level of use of public funds is limited or null. Funds indirectly paid (subsidy) to RES operators are provided by the rest of network users (conventional generators and consumers).

Priority for RES generation in the dispatch

Priority of dispatch for RES generation does not depend on the support scheme but rather on decisions made by authorities and the principles set in European legislation, namely in the Renewable Energy Directive.

Level of centralization of prices earned by RES generation

Energy prices earned by RES generation normally result from centralized (short or long-term) markets. Subsidies are decided by administrative authorities in the system.

3.1.4 Feed-in Tariff with regulated prices

Administratively set a tariff for every MWh produced over a given period.

Level of stability of RES revenues

High level of stability of prices.

Level of correlation of RES prices with short term market ones (reflecting marginal costs)

No coordination of price earned by RES with short term market ones.

Are prices earned by RES generation computed in a market process?

No, prices are admistratively set by authorities.

Level of technology targeting

This normally occurs as to encourage developing of RES.

Level of efficiency in the use of public funds

Financing for RES may not only come from the public budget (may be paid by electricity consumers).

Priority for RES generation in the dispatch

Evidence in several countries making use of FIT to support RES suggest that priority of dispatch does not depend on the design of the FIT itself but rather on decisions made by authorities and the principles set in European legislation, namely in the Renewable Energy Directive.

Level of centralization of prices earned by RES generation

Prices earned by RES generation are centrally computed by administrative authorities.

3.1.5 Feed-in Tariff with auction

A tariff for every MWh is provided for a given period but the level is the result of an auction taking place in the long-term.

Level of stability of RES revenues

High level of stability of prices.

Level of correlation of RES prices with short term market ones (reflecting marginal costs)

No coordination of price earned by RES with short term market ones.

Are prices earned by RES generation computed through a market process?

Yes, prices are computed through an auction taking place in the long-term.

Level of technology targeting

FIT can be either set for mature technologies as well as non-mature ones depending on the auctions design.

Level of efficiency in the use of public funds

Normally, large amounts of funds are transferred to RES technologies through this scheme (no technology targeting). In principle, these would not come from the public budget, but they potentially could as the design option *per se* does not define the origin of the funds.

Priority for RES generation in the dispatch

Evidence in several countries making use of FIT to support RES suggests priority of dispatch does not depend on the design of the FIT itself but rather on decisions made by authorities and the principles set in European legislation, namely in the Renewable Energy Directive.

Level of centralization of prices earned by RES generation

Prices earned by RES generation are centrally computed in an auction.

3.1.6 Feed-in Premium regulated with no price cap and floor

Administratively set a premium on top of the market price for every MWh produced over a given period.

Level of stability of RES revenues

Medium level of stability, since part of RES revenues depend on the energy market prices and the volume of energy served.

Level of correlation of RES prices with short term market (reflecting marginal costs)

Prices earned by RES generation are correlated with energy market prices.

Are prices earned by RES generation computed in a market process?

Yes, as far as the energy market component is concerned. The premium part of revenues is administratively set by authorities.

Level of technology targeting

Premiums are normally set for each technology. Thus, high level of technology targeting.

Level of efficiency in the use of public funds

A separate premium may be set for each technology supported. Thus, it is possible to tune it, to some limited extent, to the level of revenues required by this technology, thus minimizing public funds devoted to supporting RES technologies. There is a risk of having RES generation earning prices that are very high or low associated with market prices being very high or low. Some waste of public funds may occur then.

Level of premiums is efficient to the extent authorities are able to accurately determine the level of costs of each technology and the level of prices.

Priority for RES generation in the dispatch

RES generation under this scheme has incentives to be the last to disconnect (since it enjoys an extra premium). However, priority of dispatch for RES generation does not depend on the support scheme but rather on decisions made by authorities and the principles set in European legislation, namely in the Renewable Energy Directive.

Level of centralization of prices earned by RES generation

Premiums earned by RES generation (of each technology) are computed centrally (all power plants of the same technology get the same premium). However, premiums may be the same across the whole system, or they may be differentiated according to the area where they are applied. Besides, the market price component may vary across zones or nodes, if some geographical differentiation of prices exists.

3.1.7 Feed-in Premium regulated with overall price cap and floor

Administratively set a premium on top of the market price for every MWh produced over a given period. However, there is a maximum (cap) and a minimum (floor) level for the overall price resulting from adding up market price and premium.

Level of stability of RES revenues

Higher revenue stability than non-constrained FIPs, but lower than that on FIT. Volatility also associated with energy market prices and the volume of energy served. However, this is limited to the range between the price cap and floor set.

Level of correlation of RES prices with short term market (reflecting marginal costs)

Prices earned by RES generation are correlated with the energy market prices, though correlation is lower than that under non-constrained FIPs, because this correlation does not exist for very high and very low market prices.

Are prices earned by RES generation computed through a market process?

Yes, as far as the energy market component is concerned, and as long as prices keep within the range between the cap and floor set. The premium part of revenues is administratively set by authorities.

Level of technology targeting

Premiums, price caps and floors, are normally set for each technology. Thus, high level of technology targeting.

Level of efficiency in the use of public funds

A separate premium, as well as price cap and floor, may be set for each technology supported. Thus, it is possible to tune it to the level of revenues required by this technology, thus minimizing public funds devoted to supporting RES technologies. More control than FIPs without price caps and floors over final prices earned by RES generation being supported.

Level of premiums is efficient to the extent authorities are able to accurately determine the level of costs of each technology and the level of prices.

Priority for RES generation in the dispatch

RES generation under this scheme has some limited incentives to be the last to disconnect (since it enjoys an extra premium). However, priority of dispatch for RES generation does not depend on the support scheme but rather on decisions made by authorities and the principles set in European legislation, namely in the Renewable Energy Directive.

Level of centralization of prices earned by RES generation

Premiums earned by RES generation (of each technology), as well as final prices caps and floors, are computed centrally (all power plants of the same technology get the same premium). However, premiums, price caps and floors may be the same across the whole system or they may be differentiated according to the area where they are applied. Besides, the market price component may vary across zones or nodes, if some geographical differentiation of prices exists.

3.1.8 Feed-in Premium resulting from an auction with no price cap and floor

A premium on top of the market price is set for every MWh produced and over a given period, but the level of the premium results from an auction.

Level of stability of RES revenues

Medium level of stability as part of RES revenues depend on the energy market prices and the volume of energy served.

Level of correlation of RES prices with short term market (reflecting marginal costs)

Prices earned by RES generation are correlated with energy market prices.

Are prices earned by RES generation computed through a market process?

Yes, both the energy price market and the premium level are computed through a market process.

Level of technology targeting

Premiums are normally set for each technology. Thus, high level of technology targeting.

Level of efficiency in the use of public funds

A separate premium is applied for each technology supported. Thus, it is possible to tune it, to some limited extent, to the level of revenues required by this technology, thus minimizing public funds devoted to supporting RES technologies. There is a risk of having RES generation earning prices that are very high or low associated with market prices being very high or low. Some waste of public funds may occur then.

Level of premium is efficient to the extent that there is a high level of competition in the auction where these premiums are determined.

Priority for RES generation in the dispatch

RES generation under this scheme has incentives to be the last to disconnect (since it enjoys an extra premium). However, priority of dispatch for RES generation does not depend on the support scheme but rather on decisions made by authorities and the principles set in European legislation, namely in the Renewable Energy Directive.

Level of centralization of prices earned by RES generation

Premiums earned by RES generation (of each technology) are computed centrally (all power plants of the same technology get the same premium). However, premiums may be the same across the whole system, or they may be differentiated according to the area where they are applied. Besides, the market price component may vary across zones or nodes, if some geographical differentiation of prices exists.

3.1.9 Feed-in Premium resulting from an auction with overall price cap and floor

A premium on top of the market price is set for every MWh produced and over a given period, but the level of the premium results from an auction. Moreover, there is a maximum (cap) and a minimum (floor) level for the overall price resulting from adding up market price and premium.

Level of stability of RES revenues

Higher revenue stability than non-constrained FIPs, but lower than that on FIT. Volatility also associated with energy market prices and the volume of energy served. However, this is limited to the range between the price cap and floor set.

Level of correlation of RES prices with short term market (reflecting marginal costs)

Prices earned by RES generation are correlated with energy market prices, though correlation is lower than that under non-constrained FIPs, because this correlation does not exist for very high and very low market prices.

Are prices earned by RES generation computed in a market process?

Yes, as long as the overall price (energy market pus premium) keeps within the range between the cap and floor set.

Level of technology targeting

Premiums, price caps and floors are normally set for each technology. Thus, high level of technology targeting.

Level of efficiency in the use of public funds

A separate premium, as well as price cap and floor, is applied for each technology supported. Thus, it is possible to tune it to the level of revenues required by this technology, thus minimizing public funds devoted to supporting RES technologies. More control than FIPs without price caps over final prices earned by RES generation being supported.

Level of premium is efficient to the extent that there is a high level of competition in the auction where these premiums are determined.

Priority for RES generation in the dispatch

RES generation under this scheme has some limited incentives to be the last to disconnect (since it enjoys an extra premium). However, priority of dispatch for RES generation does not depend on the support scheme but rather on decisions made by authorities and the principles set in European legislation, namely in the Renewable Energy Directive.

Level of centralization of prices earned by RES generation

Premiums earned by RES generation (of each technology), as well as final prices caps and floors are computed centrally (all power plants of the same technology get the same premium). However, premiums, caps and floors may be the same across the whole system or they may be differentiated according to the area where they are applied. Besides, the market price component may vary across zones or nodes, if some geographical differentiation of prices exists.

3.1.10 Certificate schemes with quota

Introduction of minimum shares of RES (quota) for several years per renewable technology or to all technologies. Suppliers would be responsible to buy certificates in a certain amount of its consumption.

Level of stability of RES revenues

High Volatility of RES revenues, since both the short term energy market price and the certificate price could exhibit some volatility. Volatility of the certificate price depends on when RES producers sell these (if in the long-term or in the short term).

Level of correlation of RES prices with short term market (reflecting marginal costs)

Prices earned by RES generation are correlated with energy and certificate market prices. Correlation is higher over a certain period of time if certificates have been sold in the long-term for this period. Otherwise, correlation of final prices with energy market prices is lower.

Are prices earned by RES generation computed through a market process?

Yes, both energy market and certificate prices are computed through a market process.

Level of technology targeting

Quotas could be either common to all technologies or specific to certain technologies, depending on the authorities' objectives. Thus, the level of technology targeting may be high or low.

Level of efficiency in the use of public funds

No public funds involved in the direct support of RES energy production, but an increase in electricity prices is expected. Public funds can be devoted to other goals, like infrastructure development.

Priority for RES generation in the dispatch

Priority of dispatch for RES generation does not depend on the support scheme but rather on decisions made by authorities and the principles set in European legislation, namely in the Renewable Energy Directive.

Level of centralization of prices earned by RES generation

Energy prices are centrally cleared in energy markets. However, a separate energy price may be computed for each area according to system constraints. Certificate prices are not computed centrally. However, if efficiently negotiated, certificate prices should be common for all generators within each area, if a separate quota is set for each area, or they should be common to the whole system, if a single quota is defined for all the system.

3.1.11 No support scheme

RES generators would sell every MWh produced at the best price offered in the energy market.

Level of stability of RES revenues

High volatility of revenues as operators are exposed to fluctuations of electricity price, which in turns depends on factors beyond RES operators' control.

Level of correlation of RES prices with short term market (reflecting marginal costs)

Prices earned by RES generation are the same as those earned by any other type of conventional generator producing power at the same time (with a similar profile). Thus, total correlation with energy market prices.

Are prices earned by RES generation computed through a market process?

Yes, energy prices are computed through a market process.

Level of technology targeting

There is no technology targeting as no support to RES generation is granted.

Level of efficiency in the use of public funds

No public funds devoted to the direct support of RES energy production in the short term to promote the deployment of this generation.

Priority for RES generation in the dispatch

Priority of dispatch for RES generation does not depend on the support scheme but rather on decisions made by authorities and the principles set in European legislation, namely in the Renewable Energy Directive.

Level of centralization of prices earned by RES generation

Prices earned by RES generation are centrally computed in organized markets (day-ahead and intraday ones). They may exhibit geographical differentiation according to local constraints set.

3.1.12 Support conditioned to the provision of grid services

In this case, support to RES generation, which tend to be of a FIP or FIT type, is largely contingent on the provision of voltage support service by this RES generation. RES generation not providing voltage support earns some basic support which is much lower than that earned by RES generation providing voltage support (Scheme implemented in Germany).

Level of stability of RES revenues

The stability of revenues of RES generation from support depends on the particular scheme adopted (FIT, FIP, others). Some stability for FIT or FIP.

Level of correlation of RES prices with short term market (reflecting marginal costs)

The correlation between RES short term revenues and market prices depends on the particular scheme adopted (FIT, FIP, others). Low correlation with FITs, higher with FIP.

Are prices earned by RES generation computed in a market process?

Prices earned by RES generation may or may not be computed in a market process (could be determined administratively or through an auction).

Level of technology targeting

Targeting of technologies is common if FITs or FIPs are applied in combination with the requirement to provide voltage support.

Level of efficiency in the use of public funds

Funds to be transferred to RES generation through support may be high for FITs or FIPs but normally do not come from the public budget (included in tariffs).

Priority for RES generation in the dispatch

Priority of dispatch for RES generation does not depend on the support scheme but rather on decisions made by authorities and the principles set in European legislation, namely in the Renewable Energy Directive.

Level of centralization of prices earned by RES generation

Support payments to RES generation may be centrally computed either by central authorities (if FITs or FIPs are administratively determined) or in the market (if they are determined in an auction).

3.2 Relevant assessment criteria

This section provides the main categories of criteria considered to assess the above-mentioned design options to support RES generation in the long-term.

A description of these categories is provided below, with specific criteria considered within each of these categories.

3.2.1 Efficiency

Among the several possible ways to organize the delivery of a good or a service, markets usually have one main advantage: economic efficiency.

They should be able to minimize the overall system cost of provision of the product transacted in them. This should therefore be one criterion they are benchmarked against.

Several aspects of the functioning of a market design option are related to its efficiency:

Marginal cost reflectivity

Prices resulting from the market should reflect the net cost (net cost of all present and future revenues), per unit of power installed, for the marginal RES generation plant (of the corresponding technology). The marginal RES generation plant in this context corresponds to the RES power plant, among those (of the corresponding technology) that are needed in the system that requires the highest unit support payment in order for it to be installed. Marginal costs may vary across systems and technologies. It is expected that design options carrying out competitive market processes, for example FIT with auction, could perform better under this criterion.

Liquidity

Liquidity is a measure of the ability to buy or sell the product without affecting much its price and without incurring significant transaction costs. In order to ensure liquidity, it is essential that a large number of buyers and sellers are willing to transact the product. Mechanisms that fix long-term prices do not foster liquidity in the long-term markets. On the other hand, mechanisms in which remuneration is dependent on short-term market prices will create the need for producers to hedge their production fostering long-term market liquidity.

Diversity of products traded in the market

Availability of a complete set of products and timeframes to trade them. Not all stakeholders are equally interested in providing (demanding) a particular product or participating in a certain mechanism. If the social welfare is to be maximized, the set of products/mechanisms made available to parties has to account for this fact. For example, the characteristics of the ideal long-term contract needed to hedge a new generating facility differ depending on whether it is a wind farm, a nuclear power plant or an open cycle gas turbine. The same applies for the available timeframes where the products can be traded. Thus, the bigger the diversity of products and timeframes made available to market players is, the easier will be the fulfilment of their needs as regards the hedge of its long-term investments.

Market transparency

In order to foster competition between market agents, they should all face the same conditions to participate in a market, and have access to the same information. The conditions and information are encompassing all past, current and future elements influencing the level of competition among agents. It should be taken into account that incumbent market participants may have an advantage in terms of more access to information and trading experience than new entrants as well as large market players over smaller generation asset owners. Being it said, those market design options which are computed through a market process (such as auctions or tenders) tend to be more transparent than the ones centrally computed by administrative authorities.

3.2.2 Effectiveness

Markets are created with the aim to achieve certain goals, which often have been previously defined as policy objectives. Thus, markets must also be assessed according to their ability to succeed in fulfilling the goal they are pursuing. Note that the effectiveness of a market in achieving a policy objective does not need to go hand in hand with the economic cost of provision of the product negotiated in the market. Thus, the efficiency and effectiveness of a market design option are two concepts to consider separately.

The diversity, or range, of products offered in a market can attract agents and facilitate the achievement of the policy objectives of these markets. Analogously, in the achievement of a certain objective, both the level of coherency among the several markets established, and the completeness of this set of markets may play a relevant role.

In order to succeed in fulfilling certain policy objectives, long-term market designs to be implemented should incentivize as far as possible the installation of a large enough amount of RES generation. This could be achieved throughout the application of scheme of prices applied to RES generation, for instance, or even by granting to market agents the possibility to trade and negotiate in a range of market designs sufficiently attractive to them. Under this criterion the market design options should be evaluated for their capacity to attract new RES generation in an amount compatible with the policy objectives defined.

3.2.3 Robustness

There is nothing sure about the future, the context of a market can evolve. If a market design is too specific to certain circumstances, it will lose its efficiency as the context evolves. A good market design should therefore ensure robustness to changes in fundamentals (fuel prices, demand…), which can be assessed by considering its behaviour on a range of realistic scenarios.

Markets should also be resilient to political intervention to the extent possible. Thus, market outcomes should not be easy to manipulate by authorities according to non-legitimate interests . This could limit the political disturbance of market operation.

The market design to be implemented should ensure, as far as possible, the long-term economic efficiency and, at the same time, comply with long-term system security, emission and RES targets. Hence, the optimal market design is one where its output is sustainable under several contexts so that it can be accepted by all stakeholders. For instance, defining a high level of FIT considering a general rise of fuel prices scenario could reveal to be unsustainable in the long-term if that scenario does not occur. Moreover, a long-term market design which clearly separates public support from market revenues tend to be more robust as they are less related to political intervention whatsoever.

3.2.4 Implementability

This relates to how easy the implementation of a market is, or the difficulties authorities may face in its implementation and day-to-day functioning. There are several dimensions to the implementability of a market:

Simplicity of the market

In principle, the simpler the scheme of support payments applied to RES generation is to understand, the more predictable its output will be, and, therefore, the easier its acceptance by parties will be.

Experience with the implementation of a market in other systems

Authorities and stakeholders tend to rely more easily on schemes that have been widely applied.

Applicability to other timeframes and contexts (scalability, replicability)

In principle, the easier the extension of a market design option to other markets and timeframes is, the easier its implementation will be. That being said, the question here is to assess whether a given long-term market design is always replicable in the context set in other systems than that for which it has been originally developed, and whether it results in satisfactory cross-border solutions or not, namely if the development of a pan-European solution based on that market design is feasible or not.

3.3 Assessment of the design options to support RES generation

Bearing in mind the relevant design options to support RES generation (presented in section 3.1) and the specific criteria considered to assess them taking into account its long-term effects (presented in section 3.2), we are finally in conditions to proceed with the assessment of the design options at stake.

With the purpose of having an overall ranking of the aforementioned design options, we have applied for each combination of a RES support scheme and specific criterion one of the following set of grades: **Very Good**, **Good**, **Fair** and **Poor**. A + sign indicates a grade between the grade shown and the next better one. On the contrary, a – sign indicates a grade between the grade shown and the previous worst grade.

Note also that a full evaluation of a market design option by no means is the average of the grades obtained for all criteria, as a sufficiently poor evaluation in one criterion in principle can disqualify this scheme entirely. Moreover, some criteria may be more important than others.

3.3.1 Efficiency

Marginal cost reflectivity

In the option **net metering of demand and generation to compute regulated charges**, there is a socialization of the cost of renewables via the network charges across all market participants with the RES generation benefiting from network charges, paid by the other network users. Consequently, the network charge would act like a FIP.

In the long-term, the total cost plus the socialized network charges (in the benefit to the RES producer) would need to reflect the revenue received. The regulated charges mean that there is no price discovery mechanism for the level of subsidy. As an aside, the manipulation of the network charges means that it will distort the marginal cost of the network charge. As there is standardisation of the network charge across all the technologies the charges will not relate to the marginal cost of the generation.

If the network charge is small relative to the cost of electricity, then the revenue received from the production could be close to long-term marginal cost of energy supply. However, if this was the case, then there is limited value through supporting the technology through subsidies and would unlikely meet policy objectives.

Then, reductions in network charges enjoyed by RES (or by consumers installing RES locally) are unlikely to reflect the marginal subsidy needed for RES generation of the targeted technology to install the required amount of RES generation capacity. In other words, support would not correspond to the extra revenues needed by RES generation, beyond those it is expected to earn in other markets, to trigger required investments. They would not cover the “investment gap” or marginal RES generation needed. Then, under this perspective, support earned does not allow RES generation to be installed to earn some revenues that correspond to the long-term marginal, or incremental, cost of RES generation capacity. Thus, the performance of this option is **between Poor and Fair**.

When **FIT with regulated prices** are applied, the revenue received by the RES generator is unrelated to the market prices and the long-term marginal cost. Generation will be run as long as short term variable costs are lower than the FIT received. This support is not reflecting long-term marginal costs of new RES generation because it is being set through an administrative process. Thus, the performance of this option is **Poor**.

Under **FIT computed in an auction process**, the tariff could reflect long-term marginal cost (or total cost). However, the revenue generation is unrelated to the market prices so marginal cost is irrelevant as a short term operation signal. An auction is a market based mechanism which should reflect long-term marginal costs. The performance of this option is **Good**.

For **FIP regulated with no price cap and floor**, the premium is set without any market based price discovery mechanism and so does not necessarily relate to any views on long-term marginal cost, however the premium requires RES generators to generate and get paid at a market rate (plus the premium). This is true for the long or short term. The performance of this option is **Poor.**

For **FIP regulated with overall price cap and floor**, the remuneration mechanism applied is between the FIP without a cap and floor and a FIT. Both the premium and the cap and floor limits are set without any market based mechanism consequently that may not relate to long-term marginal costs. Then, the performance of this is **Poor**.

For **FIP resulting from an auction with no price cap and floor**, the revenue received by the RES generator is related to the market prices. Assuming that total project costs are met through the premium and the market price, the generation will be built and run until the marginal costs (minus the premium) are in excess of the market price. The premium is set through a competitive auction so will allow RES-generators to compete against each other revealing long-term marginal costs. The FIP is not constrained so will allow RES generation to fully reflect marginal costs through market mechanisms. However, the performance is not very good because support to RES is generally associated with capacity installed, rather than energy sold. The performance of this option is **Good.**

For **FIP resulting from an auction with an overall price cap and floor**, the mechanism applied is between the FIP without a cap and floor and a FIT. The premium is set through a competitive auction so will allow RES-generators to compete against each other in terms of long-term marginal costs as long as prices are within the cap and floor administratively set. The marginal cost price reflectivity would be rated **Fair** if the marginal cost price was **beyond the cap and floor** and **Good** if **within it.**

For **Long-term capacity auctions** (per MW of installed capacity support), similarly to traditional power plants, the investment decision is made on the expected market prices (plus the subsidy in this case). Depending on the design of the mechanism, this scheme could be very good as the amount of support per unit of installed capacity shall be determined through an auction process. As a drawback, this scheme is more riskier to the producer (it is exposed to short-term market prices) which could lead to an increase in the final support per MW of installed capacity. Notwithstanding, its performace can be generally considered **Very Good** (basically because there is a marginal cost reflectivity both in the long and the short-term).

Under **Certificate schemes with quota**, the market prices will be heavily influenced by the certificate value. The certificate would act as a FIP. The certificate market should act in a similar way to a FIP market with auction. The difference is who pays for the subsidy.

Subsidies, even if distorting short term market prices, may reflect well, together with these prices, long-term marginal costs of the RES generation technology targeted. However, the performance of the scheme is not very good because subsidies should be theoretically associated with capacity installed, instead of energy sold, as argued above. Then, the performance of this option is **Good.**

Under **Long-term clean energy auctions**, these auctions will lead to a competitive tendering for long-term supply. The auction should reveal the long-term marginal costs of the plant. This is true for all the subsidy designs. Depending on the exact design, the performance of the scheme under this criterion could be similar to that under FIP or FIT auction schemes. Hence, its performance can be generally considered **Good.**

When **No support** is provided, RES generation would be installed if long-term costs are expected to be covered by expected revenues from the market. Although in several regions of the EU RES (in particular onshore wind and solar PV) prove to be competitive vis-à-vis conventional energies, in some cases revenues earned by RES generation would not be enough to cover costs of marginal RES generation to be installed to achieve the RES deployment objective. Under normal trading conditions market parties have to bid/generate taking into account marginal cost. Then, this scheme is not behaving well because it doesn't allow to discover the marginal cost price of achieving the RES deployment objectives. Performance is therefore considered **Poor.**

When **RES support is conditioned by the provision of grid services**, the deployment of certain amounts of RES generation capacity to accelerate the development of these technologies (which is the objective of RES support) is not related to the provision of voltage support needed. These are two different products that should be contracted separately. By linking them, authorities are not allowing for the least expensive RES generation possible, required to comply with long-term RES deployment objectives, to be installed in the system. Then, the level of support payments needed to be applied under this scheme in order to achieve RES generation deployment targets will be higher than those payments that would otherwise have been needed to cover, together with market revenues, the long-term cost of marginal RES generation needed to comply with these targets if the condition on the provision of grid support services had not been in place. Then, the long-term cost reflectivity of this scheme is **Poor.**

Liquidity

In the option where there is a **net metering of demand and generation to compute regulated charges**, given that any solution that promotes local netting will decrease liquidity as neither supply nor demand needs to enter the market unless the RES generation does not deliver, the performance of support in terms of liquidity of long-term markets is **Poor**.

When **FIT with regulated prices** are applied, there is no need to trade as revenue is unrelated to energy prices. Generators would spill directly into the grid due to priority dispatch. Then, the performance is **Poor**.

Under **FIT computed in an auction process**, in the Energy market, there is no need to trade as revenue is unrelated to energy prices. Generators would spill directly into the grid due to priority dispatch. In the FIT Auction market, auctions may not be the best way to get many players in the market because they have to be big companies (since it is costly to bid in a call for tender) and small business and cooperative financing are somehow diverted from the access to the subsidy. Thus, the performance of this option is **Poor**.

For **FIP regulated with no price cap and floor**, regarding the Long-term energy market, participation in the long-term market would provide a hedging opportunity and therefore an incentive for the generators to participate. The volume bid would be the same as without subsidy. Only the bid prices will differ. The performance of this option is **Good**.

For **FIP regulated with overall price cap and floor**, as far as Long-term energy markets are concerned, within the boundaries of the cap and floor, the liquidity of the market should be at least the same as the FIP without a cap and floor. If there is a specific market referenced for the cap and floor, then, that market could see an increase in its liquidity as it provides the perfect hedge for the generation. This is true for short and long-term. Then, the liquidity of this option is **Good**.

For **FIP resulting from an auction with no price cap and floor**, in the Energy market, the market parties need to participate in the market. Participation in the long-term market would provide a hedging opportunity and therefore an incentive for the generators to participate. The volume bid would be the same as without subsidy. Only the bid prices will differ.

Evidences from countries rolling out auctions in the EU suggest that auctions design is crucial to reach a balance between high participation and efficient bidding. The performance of this option is **Good**.

For **FIP resulting from an auction with an overall price cap and floor**, within the boundaries of the cap and floor, the liquidity of the market should be at least the same or improved compared to the FIP without a cap and floor. If there is a specific market referenced for the cap and floor, then that market could see an increase in its liquidity as it provides the perfect hedge for the generation. True for short and long-term.

Evidences from countries rolling out auctions in the EU suggest auctions design is crucial to reach a balance between high participation and efficient bidding. The performance of this option is **Good-**.

For **Long-term capacity auctions** (per MW of installed capacity support), in the Energy market, impact would be very good as the subsidy would not impact the functioning of the energy only market. Regarding the subsidy distribution, we do not know yet how this could be distributed. An auction would have the same limitations as mentioned in the other schemes. The performance of this option is **Very Good**.

Under **Certificate schemes with quota**, in the Energy market, the market parties would participate in the market. Given a separation of the certificate and the energy markets price, this scheme creates a potential for plant to move in and out of the money more frequently. This would promote liquidity as generators would be able to profit through selling and buying back the electricity and certificates as the prices move. If the certificate's price was dynamic then this would create additional churn (liquidity) in the market beyond that which would have been seen just through changes in the electricity price.

In the Certificate market, the liquidity could be affected if the scheme is overly complex or has significant barriers to entry for smaller players. Experience in Belgium shows that this is not necessarily a big risk for small parties not participating. However, the Belgian experience showed the need to perfectly set the quota and the cap and floor (as prescribed in the Belgian model).The performance of this option is **between Fair and Good.**

Under **Long-term clean energy auctions**, if the support mechanisms allow the RES generation plant in and out of the money then liquidity will improve. In the example of the CfD, it can benefit liquidity in the referenced market(s) as it allows market participants a perfect hedge against prices. Typically RES generation is referenced against short-term CfDs but could also apply for longer term markets. The performance is **Poor** under **FIT, Fair** under **CfD** and **Good** for **FIP**.

When **No support** is provided, RES generation would have to participate in the market and bid according to marginal cost. Then, the impact of this scheme on liquidity is **Very Good.**

When **RES support is conditioned by the provision of grid services**, there might be some shift in liquidity from the short-term energy market to the ancillary services market depending on the volume contracted. Liquidity will be reduced from RES generators not participating in the market. All other RES would bid according to marginal cost. The participation of RES-gen in ancillary services would displace existing conventional generation in the ancillary service market. Liquidity in the market would be the same as if RES did not participate in the ancillary support scheme as it would only displace conventional generation either in the regular or ancillary market. The effect of this option on market liquidity is, thus, **Fair**.

Diversity of products traded in the market

FIT with regulated prices gives administrative authorities the possibility to define a diversity of FITs and timeframes that could be designed to match the needs of different RES technologies. However, since tariffs, products and timeframes are fixed and centrally defined by administrative authorities there is no market process whatsoever. This means that although this design option might provide flexibility to market players regarding diversity of products and timeframes, such diversity will not be available for trade in the market. For these reasons, the fulfilment of market players' needs as regards of its long-term investments may be partially met. The performance of this option is **Fair**.

FIT with auction gives administrative authorities the possibility to define a diversity of products and timeframes to be auctioned that could be designed to match the needs of different RES technologies. Although the tariffs are defined through a market process, the diversity of products and timeframes auctioned are fixed and centrally defined by administrative authorities. This means that although this design option might provide flexibility to market players regarding diversity of products and timeframes, the fact that the tariff is fixed for a long-term period this diversity will not be available for trade in the market. For these reasons, the fulfilment of market players' needs as regards of its long-term investments may be partially met. The performance of this option is **Fair**.

FIP regulated with no price cap and floor gives administrative authorities the possibility to define a diversity of premiums and timeframes that could be designed to match the needs of different RES technologies. Although the definition of premiums and timeframes is not done through a market process, since RES promoters are dependent of market prices, there is the possibility for them to use market processes for hedging reasons, provided that enough liquidity exists. The performance of this option is **Good**.

FIP regulated with overall price cap and floor gives administrative authorities the possibility to define a diversity of premiums and timeframes that could be designed to match the needs of different RES technologies. In addition to the "FIP only" option, the authorities have also the possibility to define caps and floors which would probably help to better suit different needs and to increase diversity. However, the introduction of caps and floors makes the RES promoters less exposed to market prices make them less keen to use market processes for hedging. The performance of this option is **Good**.

FIP resulting from an auction with no price cap and floor gives administrative authorities the possibility to define a diversity premiums and timeframes to be auctioned that could be designed to match the needs of different RES technologies. The performance of this option is **Good.**

FIP resulting from an auction with overall price cap and floor gives administrative authorities the possibility to define a diversity premiums and timeframes to be auctioned that could be designed to match the needs of different RES technologies. In addition to the "FIP only" option, the authorities have also the possibility to introduce caps and floors that could be also subject to auctioning, which would probably help to better suit different needs and to increase diversity. The performance of this option is **Good**.

Long-term capacity auctions (per MW of installed capacity support) gives administrative authorities the possibility to define a diversity of products and timeframes to be auctioned that could be designed to match the needs of different RES technologies. Then, the performance of this option is **Good**.

For **Certificate schemes with quota** the performance may vary depending on how they are adopted. If quotas are common to all technologies (no technology targeting), the design option could provide little flexibility to market players regarding diversity of products available to trade in the market since the certificate prices would only allow for the introduction of more mature technologies. Should it be the case where some technology targeting exists than a diversity of certificate prices will co-exist, allowing for different technologies to participate in the market. The performance of this option is **between Fair and Good**.

Long-term clean energy auctions could provide some flexibility to market players regarding diversity of products available to trade in the market as auctions may be specific to a certain technology or addressed to all mature clean technologies in the system. On top of that, prices earned by RES generation for predefined amounts of clean energy may vary according to market needs (full price, premium or even a contract for differences w.r.t. some reference price level set in the auction). As for the diversity of timeframes, even though the amounts of clean energy are defined in the long-term, auctions may take place in several timeframes (from short to long-term). For these reasons, the fulfilment of market agents' needs as regards of its long-term investments may be met. The performance of this option is **Good.**

Net metering of demand and generation per network user for computation of regulated charges is in principle more suited for specific technologies so it does not provide flexibility to market players regarding diversity of products and timeframes available to trade in the market. For these reasons, the fulfilment of market agents' needs as regards of its long-term investments is barely met. The performance of this option is **Poor.**

When the **RES support is conditioned to the provision of grid services** or even when **No support** is given at all, RES producers get the same treatment as any other conventional producers (no diversity of products). The performance of these options is **Poor.**

Market transparency

FIT with regulated prices does not provide market transparency as tariffs are centrally computed by administrative authorities and not in a market process. However, FIT prices are clear and transparent. At the same time, this design option sometimes includes complex mechanisms for the tariff computation which could be hardly understood by new entrants or small generation asset owners in comparison to incumbent and large market participants. Thus, the performance of this option is **Poor.**

FIT with auction provides market transparency as tariffs are centrally computed in an auction as well as the amount to be allocated in the long-term. In this sense, it could be stated that all market players have access to the same information and conditions to participate in the market. Thus, the performance of this option is in **between Good and Very Good.**

For **FIP regulated with or without a price cap and floor,** although prices earned by RES generators are linked to energy market prices, these design options provide little market transparency since premiums, price caps and floors (where applicable) are administratively set. In this sense, it could be stated that all market players have access to some part of the information and conditions to participate in the market. Thus, the performance of these options is **Fair.**

FIP resulting from an auction with or without a price cap and floor provides market transparency as prices earned by RES generators are linked to energy market prices and the level of premiums results from an auction where could be set a price cap and floor. Moreover, both the amount and period are known before the auction take place. In this sense, it could be stated that all market players has access to the same information and conditions to participate in the market. Thus, the performance of these options is **Very Good.**

Long-term capacity auctions (per MW of installed capacity support) provides market transparency as prices earned by RES generators are linked to energy market prices and the level of support per MW of installed capacity results from an auction. Moreover, both the amount and period are known before the auction take place. In this sense, it could be stated that all market players has access to the same information and conditions to participate in the market. Thus, the performance of this option is **Very Good.**

Certificate schemes with quota provides market transparency as prices earned by RES generators are linked to energy market prices and certificate market prices. Nevertheless, it should be ensured that both the quotas of RES to be met and period are known in due time. In this sense, it could be stated that all market players has access to the same information and conditions to participate in the market. Thus, the performance of this option is **Very Good.**

Long-term clean energy auctions provides market transparency as prices earned by RES generators results from an auction taking place in the long-term. Nevertheless, it should be ensured that both the amount of clean energy and period are known in due time before the auction take place. In this sense, it could be stated that all market players has access to the same information and conditions to participate in the market. The performance of this option is **Very Good.**

Net metering of demand and generation per network user for computation of regulated charges provides little market transparency because the value of the RES production depends partially on the level of regulated access tariffs which are typically decided by administrative authorities for one year periods. The incumbent market participants might have a better insight on the long-term evolution of access tariffs scenario. Also, the tariff of the energy sold to the grid is decided by administrative authorities. However, the value of the RES production is also dependent of the energy short term market prices which are fully transparent to market players. Overall, it could be stated that all market players has access to some part of the information and conditions to participate in the market. Thus, the performance of this option is **Fair.**

When **No support** is granted, the remuneration of RES generators fully derives from the short-term market prices (day-ahead and intraday). Thus, the performance of this option is **Very Good.**

When the **RES support is conditioned to the provision of grid services** the remuneration of RES generators derives not only from the short-term market prices (day-ahead and intraday ones) but also from ancillary services market prices that may vary across areas. These services are more of a local nature than energy supply which means that market players may not fully internalize this price. In this sense, it could be stated that all market players has access to some part of the information and conditions to participate in the market. Thus, the performance of this option is **Fair.**

3.3.2 Effectiveness

Reaching a predefined quantity of energy produced by RES in the system may be slightly difficult through a price-based mechanism such as **FIT with regulated prices or FIP regulated with or without a price cap and floor**[4]. Notwithstanding, if the administrative authorities reviews the FIT or FIP level on a regular basis, it makes it possible to adjust the speed of growth of RES installed capacity relatively well. If the price is set too high however, the target may be overtaken, at the detriment of the agents financing the subsidy. Thus, the performance of these options is **Fair.**

If **FIT with auction or FIP resulting from an auction with or without a price cap and floor**[5] is applied, it will allow the administrative authorities to predefine the quantity of energy produced by RES and to let to the market to decide the required price to reach this level. From a more practical point of view however, there is no control on the total cost of the subsidy and the inability to raise the corresponding taxes high enough may force the administration to revise the rhythm of the tendered capacity and therefore hinder its capacity to reach the initial targets. Thus, the performance of these options is **Good.**

Under **Long-term capacity auctions** (per MW of installed capacity support), RES capacity is supported instead of energy. Most of the time (and it is the case in Europe), policy objectives are formulated in terms of energy (or percentage of the overall consumption or generation). Therefore, if auctioning capacity has the advantage in terms of effectiveness of being a quantity-based support scheme, it requires to apply an average load factor and this may be source of some uncertainty[6]. Finally, for most generation technologies (i.e. all except peaking RES technologies), the fact of subsidizing capacity introduces a bias on investment decisions because their capacity value is very small when compared to their energy value; when considering the investment options, project carriers could choose to install more powerful machines producing less energy (e.g. with oversized electric generator for wind turbine but a smaller rotor than in the case maximizing their revenues was equivalent to maximize their production). This behaviour

[4] The existence of a price and/or a floor has no influence on the effectiveness of the support scheme, except their absence could increase the risk taken by project carriers, reduce the willingness of banks to finance them and therefore make projects more expensive, thus limiting governments' ability to reach very high targets.
[5] The existence of a price and/or a floor has no influence on the effectiveness of the support scheme, except their absence could increase the risk taken by project carriers, reduce the willingness of banks to finance them and therefore make projects more expensive, thus limiting governments' ability to reach very high targets.
[6] Simply because it depends on (i) technology and (ii) meteorology or more generally the availability of the inputs and, for dispatchable technologies, of their cost and the wholesale electricity market prices. Thus, although it seems reasonable to evaluate the amount of electricity produced over a year by one GW of wind turbines, it seems much less obvious for biomass-fired thermal plants. This uncertainty is even reinforced in the case of technology-neutral auctions because there are significant discrepancies in the average load factors across technologies.

would lower the load factor and make it even more difficult to reach an energy target on the basis of the subsidized capacity. Thus, the performance of this option is **Fair.**

The performance of **Certificate Schemes with quota** is theoretically **Good.** In practice however, they may induce high risks on projects and make capital eager to finance RES projects scarcer. The high cost of capital in turn limits the administrative authorities' ability to set high penetration targets the resulting tax rise may be unbearable for tax-payers.

Just like with FIT and FIP auctions, **Long-term clean energy auctions** are based on a quantity set up in advance by the administrative authorities. They may even induce less risk on the projects since their revenue is less dependent on the quantity they produce during the contract time span. Likewise, their effectiveness may be reduced by the fact that the total cost of the mechanism is undetermined and may rise too fast for the tax-payers. Thus, the performance of this option is **Good.**

As for the **net metering of demand and generation per user for computation of regulated charges** the quantity of RES in the system is poorly at the hand of the administrative authorities as it only depends on the price difference between the regulated charges (including taxes and network charges) and the cost of RES technologies. Thus, the performance of this option is **Poor.**

When **No support** is granted, the quantity of RES in the system is not at all at the hand of the administrative authorities since it only depends on the (forecast) price difference between the wholesale price and the cost of RES technologies. Thus, the performance of this option is **Poor.**

Making the provision of **RES support conditioned to the provision of grid services** is an overlay that should have no influence on the effectiveness of the mechanism in providing the appropriate amount of investment in RES. For this reason, **no grade** is set.

3.3.3 Robustness

For **FIT with regulated prices** tariffs are administratively set by the authorities making it vulnerable to political intervention. This can affect the willingness for long-term investment in RES. Besides, the investment in conventional generation would also be affected by the level of tariffs administratively set (very low tariffs would discourage investments in conventional to a lower extent than high level of tariffs). Thus, the performance of this option is **Poor.**

Regarding **FIT with auction**, since the level of tariffs is centrally computed in an auction this design option is more robust than a FIT with regulated prices as there is a competitive process in the allocation of the FIT. For this reason, the authorities would have less legitimacy to intervene. Thus, the performance of this option is **Good.**

Under **FIP regulated with or without a price cap and floor**, premiums are administratively set – with or without a price cap and floor - on top of market price despite the fact that part of the remuneration of RES production is dependent of short term market price fluctuations. So, it could be stated that they are vulnerable to political intervention. This can affect the willingness for long-term investment in RES. Besides, the investment in conventional generation would also be affected by the level of premiums, price caps and floors (where applicable) administratively set (very low premiums would discourage investments in conventional generation to a lower extent than high level of premiums). Thus, the performance of these options is **Fair**.

For **FIP resulting from an auction with or without no price cap and floor** as the level of premiums, price caps and floors (where applicable) are set through an auction, there is a competitive process in the level definition, which reduces the legitimacy for political intervention. In addition, the willingness to invest in conventional generation would only depend on the short term market prices expectations and the level of premiums, price caps and floors (where applicable) set under the auction. Thus, the performance of these options is **Good.**

Regarding **Long-term capacity auctions** (per MW of installed capacity support) as the level of support per MW of installed capacity results from an auction process there is a competitive process in the support level definition, which reduces the legitimacy for political intervention. In addition, the willingness to invest would depend on the short term market prices expectations and the level of support set under the auction. Thus, the performance of this option is **Good.**

When it comes to **Certificate schemes with quota** the willingness for long-term investments in RES would be linked to the certificate market prices and its competitiveness despite the fact that part of the remuneration of RES production is dependent on the short term price fluctuations. Indeed, since the prices of certificates are very much dependent on the quotas level defined, this design option is also very exposed to political intervention. For these reasons, the willingness for long-term investments in RES would be affected. Thus, the performance of this option is **Fair.**

Where **Long-term clean energy auctions** are applied, the fact that it is based on an auction backed by a contractual framework makes it more resilient to political intervention and therefore the willingness for long-term investment in RES would not be affected by this. Thus, the performance of this option is **Good.**

For **Net metering of demand and generation per network user for computation of regulated charges** the resilience to political intervention is considered low since the level of remuneration is only partially dependent on administrative tariffs (regulated access charges) and the percentage of energy sold to the grid. Nevertheless, if this design option becomes very successful, consumers without PV could perceive it as unfair. Therefore, the willingness for long-term investment in RES would not be affected by this at least in a significant level. Thus, the performance of this option is **Good-**.

When **No support** to RES-E generation exists, there is no dependency on political intervention whatsoever. Thus, the performance of this option is **Very Good.**

Under the option where **RES support is conditioned to the provision of grid services**, support is contingent on the provision of grid support services (voltage control), which is a condition largely non-dependent on political intervention. However, authorities could arbitrarily change the condition for the provision of support, as done earlier, which affects also the willingness for long-term investment in RES. Thus, the performance of this option is **Fair.**

3.3.4 Implementatbility

Simplicity of the market

In principle, **FIT with regulated prices** is a scheme easy to understand by all the parties involved. However, in certain circumstances, there could be some complexity in the way FITs are designed and adopted in a particular system or area (e.g. regressive tariffs set according to the number of produced hours, generation profiles, etc.) which may lead to a decrease on the level of simplicity. Thus, the performance of this option is in **between Good and Very Good**.

FIT with auction, FIP resulting from an auction with or without a price cap and floor and Long-term clean energy or capacity auctions could all have mixed performance as auctions' rules and overall design can be either well understandable or unclear for participants. Thus, the performance of this option could either be **Fair or Good**.

In principle, **FIP regulated with or without a price cap and floor** is a scheme easy to understand by all the parties involved since the support payment is based in very simple variables - short term market prices, regulated premiums or even price cap and floors. Thus, the performance of these options is **Very Good**.

When it comes to **Certificate schemes with quota** there is a higher level of complexity embedded. Indeed, the support payment derives from a certificate market price which could not be easy to understand or predict by all the parties involved. Thus, the performance of this option is **Fair**.

For **Net metering of demand and generation per network user for computation of regulated charges**, the value of the RES production will depend on the evolution of grid tariffs which might not be easy to understand or predict by all the parties involved. Thus, the performance of this option is **Fair**.

When **No support** to RES generation is given, the investment decision only depends on a very simple variable – the (forecast) of short term market prices. Thus, the performance of this option is **Very Good**.

Where the **RES support is conditioned to the provision of grid services** there could be a grid support services participation (voltage control) which might not be easy to understand or predict by all the parties involved regardless the support payment is based on the short term market prices. Thus, the performance of this option is **Fair**.

Experience with the implementation of a market in other systems

FIT with regulated prices has been very widely implemented (e.g. Portugal), sometimes in complement of other schemes, so their performance is **Very Good**.

Regarding **FIT with auction** and **Long-term clean energy or capacity auctions,** as there is no consolidated experience in the EU, the performance of such schemes is **Poor**.

FIP regulated or resulting from an auction without a price cap or floor has been implemented in many countries (e.g. Germany). Thus, the performance of this option is **Good.**

FIP regulated or resulting from an auction with a price cap or floor has been implemented in many countries (e.g. Spain). Thus, the performance of this option is **Good.**

Certificate schemes with quota have been implemented in a few countries (e.g. the UK). Thus, the performance of this option is **Fair.**

Net metering of demand and generation to compute regulated charges has been implemented before, sometimes in complement of other schemes (e.g. the US, Italy). Thus, the performance of this option is **Good.**

As for **No support** it is hard to say if it has been implemented in a great number of countries (those having liberalized before starting to support RES) or not at all (if implementation means "in countries with a significant share of renewables"). For this reason, **no grade** was set.

Grid connection (and hence support) is always conditioned to minimum requirements, therefore it is only a matter of threshold to decide what kind of requirements should be taken into account here. The requirements also depend on the voltage level or size of the installations. In many countries requirements to ensure grid services such as voltage control exist on relatively large installations. Thus, the experience with the implementation of **support conditioned to the provision of grid services** by RES generation is large. This mechanism may be deemed to have a **Very Good** performance.

Applicability to other timeframes and contexts (scalability, replicability)

FIT with regulated prices and **FIT with auction** can easily be extended to wide areas (with the benefit, if the FIT price is the same all across the area, of encouraging RES generators to settle where the resource is the most abundant; price homogeneity does however not work if each subpart of the area pursues individual RES targets). They can be set up within a wide range of overall market designs provided that generation devices are equipped with dedicated meters. Thus, the performance of these options is **Good.**

FIP regulated or resulting from an auction with or without a price cap and floor can easily be extended to wide areas (with the benefit, if the FIP is the same all across the area, of encouraging RES generators to settle where the resource is the most abundant and where the difference between RES production cost and market price is lower; price homogeneity does however not work if each subpart of the area pursues individual RES targets). They can be set up within a wide range of overall market designs provided that generation devices are equipped with dedicated meters.

However even if the reference (the implicit FIT price) is the same across the area, the computation of the premium may be very difficult if the wholesale market design vary significantly between the different countries, thus creating bias that may alter competition between the areas.

Moreover these mechanisms require the beneficiaries to reach a reasonable size (it could be through aggregation) so that they can participate in markets and efficiently manage the assets and imbalances. Thus, the overall performance of these options is **Fair**.

Certificate schemes with quota can easily be extended to wide areas provided the penetration target is set for the whole area (with the benefit of encouraging RES generators to settle where the resource is the most abundant and where the difference between RES production cost and market price is lower; price homogeneity does however not work if each subpart of the area pursues individual RES targets) . As the producers will have to participate in markets and manage a significant risk, they must reach a reasonable size. Thus, the performance of this option is **Good**.

In principle, **Long-term clean energy or capacity auctions** would require a central buyer which may be difficult to extend across wider areas. However, it should be possible to set up decentralized long-term clean energy or capacity auctions which may be more suitable for extension. Thus, the performance of this option is in between **Fair** and **Good**.

Net metering of demand and generation to compute regulated charges can be easily extended to wide areas (the incentive however not being the same in each area according to resource and the retail price). They can be set up within virtually all kind of overall market designs even where generation devices are not equipped with dedicated meters. Thus, the performance of this option is **Very Good**.

No support could theoretically exist anywhere. Thus, the performance of this option is **Very Good.**

RES support conditioned to the provision of grid services could be extended to several areas, however it should be taken into account the fact that the value of different grid support services (hence the relevant services) may not be the same in each country. These requirements may also be differentiated across the technologies and installation size because it may be too expensive to equip small ones with the controlling devices required to provide these services. Thus, the performance of this option is **Fair.**

3.4 Summary and Conclusions

The following two tables are a summary of the assessment made for each design option for RES support regarding their long-term effects according to the specific assessment criteria considered before.

Design Options	ASSESSMENT CRITERIA								
	EFFICIENCY				EFFECTIVENESS	ROBUSTNESS	IMPLEMENTABILITY		
	Marginal Cost reflectivity	Liquidity	Diversity of Products traded in market	Market Transparency			Simplicity of the market	Experience with implementation	Applicability to other timeframes and contexts
Long-term capacity auctions	Very Good	Very Good	Good	Very Good	Fair	Good	Fair / Good	Poor	Fair / Good
Long-term clean energy auctions	Good	Poor (FIT); Fair (CFD); Good (FIP)	Good	Very Good	Good	Good	Fair / Good	Poor	Fair / Good
Net metering of Demand and Generation per network user for computations of regulated charges	Poor / Fair	Poor	Poor	Fair	Poor	Good (-)	Fair	Good	Very Good
FIT with Regulated Prices	Poor	Poor	Fair	Poor	Fair	Poor	Good / Very Good	Very Good	Good
FIT with Auction	Good	Poor	Fair	Good / Very Good	Good	Good	Fair / Good	Poor	Good
FIP regulated with no price cap and floor	Poor	Good	Good	Fair	Fair	Fair	Very Good	Good	Fair
FIP regulated with overall price cap and floor	Poor	Good	Good	Fair	Fair	Fair	Very Good	Good	Fair
FIP resulting from an auction with no price cap and floor	Good	Good	Good	Very Good	Good	Good	Fair / Good	Good	Fair
FIP resulting from an auction with overall price cap and floor	Fair / Good	Good (-)	Good	Very Good	Good	Good	Fair / Good	Good	Fair
Certificate Schemes with Quota	Good	Fair / Good	Fair / Good	Very Good	Good	Fair	Fair	Fair	Good
No support scheme	Poor	Very Good	Poor	Very Good	Poor	Very Good	Very Good	-	Very Good
Support conditioned to the provision of grid services	Poor	Fair	Poor	Fair	-	Fair	Fair	Very Good	Fair

Table 7 – *Summary of the assessment of each design option for RES support in the long-term*

	Weakest Design Options	In-between Design Options	Strongest Design Options
Efficiency Criterion	✓ FIT with regulated prices ✓ Net metering of D and G ✓ Grid support services	✓ FIT with auction ✓ FIP regulated ✓ No support scheme	✓ LT clean energy auctions ✓ FIP resulting from auction ✓ Certificate schemes ✓ LT capacity auctions
Effectiveness Criterion	✓ Grid support services ✓ No support scheme ✓ Net metering of D and G	✓ FIT with regulated prices ✓ FIP regulated ✓ LT capacity auctions	✓ LT clean energy auctions ✓ FIT with auction ✓ FIP resulting from auction ✓ Certificate schemes
Robustness Criterion	✓ FIT with regulated prices	✓ FIP regulated ✓ Certificate schemes ✓ Grid support services	✓ No support scheme ✓ LT clean energy auctions ✓ Net metering of D and G ✓ FIP resulting from auction ✓ FIT with auction ✓ LT capacity auctions
Implementability Criterion	✓ LT clean energy auctions ✓ Certificate schemes ✓ FIT with auction ✓ FIP resulting from auction ✓ LT capacity auctions	✓ FIP regulated ✓ Grid support services ✓ Net metering of D and G	✓ No support scheme ✓ FIT with regulated prices

Table 8 - *Weakest and Strongest design options for RES support in the long-term in each assessment criteria*

Based on what has been discussed above, the following table provides an overview of the design options for RES support that has performed with the highest scores (mainly Very Good and Good grades), average scores (mainly Fair grades) and lowest scores (mainly Poor grades) in the overall assessment criteria considered.

Assessment Criteria	Design Options
Strong Grades	✓ FIP resulting from auction ✓ Long-term capacity auction ✓ Long-term clean energy auction ✓ FIT with auction ✓ No support scheme [(1)]
Average Grades	✓ Certificate Schemes with Quota ✓ FIP regulated
Weak Grades	✓ Net metering of Demand and Generation ✓ Provision of grid support services ✓ FIT with regulated prices

[(1)] Although with overall strong grades in the assessment criteria hereby considered, we would discard this design option since it performs very poorly under the Effectiveness criterion and, therefore, cannot comply with the policy objectives set for RES targets in the Long-term.

Table 9 - *Design options for RES support in the Long-term with the highest and lowest grades in the overall assessment criteria*

Lastly, a summary of the main reasons why the design options for RES support based on auctions - Long-term clean energy and capacity auctions, FIT with auction and FIP resulting from an auction - have been retained, together with those for which other design options have not, is provided in the table below.

Design Options	Weak arguments (-)	Strong arguments (+)
✓ FIP resulting from auction ✓ Long-term capacity auction ✓ Long-term clean energy auction ✓ FIT with auction ✓ Certificate Schemes with Quota	• LT clean energy and capacity auction: Less easy to extend to wide areas and to a wide range of overall market designs since it probably requires a central buyer • FIT with auction: Poor liquidity – No need to trade as revenue is unrelated to spot market prices • FIP resulting from auction & Certificate schemes: Increased project risk dependent on spot market prices may raise difficulties to obtain finance to new projects • Few consolidated experience with implementation in the EU	• Tend to reveal total cost of each MW in the bid for new projects in LT • Tend to foster liquidity as revenues (partially) depends of spot market prices (except for FIT with auction) • Effective to meet LT RES targets • Resilient to LT political intervention • If designed according to good practices, it is simple to understand by all stakeholders • All market players has access to the same information and conditions (no discrimination)
✓ FIP regulated ✓ Net metering of Demand and Generation ✓ Provision of grid support services ✓ FIT with regulated prices	• May not reflect total cost of each MW for new projects in LT (may be set to high or too low) • Does not foster liquidity as revenues are administratively fixed in LT (except for Net Metering) • Incumbents may have better insight information when compared to new entrants (discrimination may exist) • Fails to meet LT RES targets • Less resilient to LT political intervention (except for Net Metering)	• Implemented throughout several EU countries • Relatively simple to understand by all stakeholders • Easily extendable to wide areas and to a wide range of overall market designs

Most promising design options (overall strong grades) — Discarded design options (overall weak grades)

Table 10 - *The most promising design options for RES support in the Long-term and the discarded ones*

4 Participation of demand in long-term markets

Demand may be regarded as slightly specific when it comes to its participation in long-term markets. Let apart energy efficiency (i.e. long-term demand response in *energy*), demand response essentially corresponds to a peaking technology, since the utility to consume of most electricity consumers is relatively high when compared with the variable cost of most production technologies. Therefore demand response has a lot of value for the capacity it saves and the flexibility it brings. Hence, the options for the integration of Demand Side Response (DSR) in electricity markets can be split in two complementary parts:

- their valuation through capacity instruments (long-term flexibility or capacity market, and operational reserves),
- and their effective activation in the energy markets.

Although regulation of DSR in capacity and reserve markets is very similar, for global coherence reasons, the analysis of the latter can be found in the Market4RES report D3.2 *"Development affecting the design of short-term markets"*, along with the analysis of the options to enable DSR in short-term energy and balancing markets.

In the present report, the analysis is therefore focused on the participation of DSR in capacity markets.

4.1 Conditions of a market for Demand Side Response

Several technical and institutional aspects constrain the development of demand response:

- most consumers remain equipped with meters that are not sophisticated enough to precisely measure their efforts in terms of load shedding which limits the opportunity to value demand response through the retail market;
- wholesale and balancing markets require minimum quantities that are incompatible with the shedding capability of most consumers; their actions must therefore be coordinated by an aggregating entity;
- in the absence of intended market arrangements, the supplier being in most case the intermediary between the wholesale market (its price reflecting the value of electricity at a given time) and the consumers, it has exclusive access to its consumers' flexibility; there is therefore no competition in the aggregating market which restrains the development of DSR and limits it to an implicit tool to balance the suppliers' own portfolios.

There are therefore three steps in building a DSR-capable market design:

(i) a DSR-compatible market design enables explicit participation of demand in all markets, which means setting up the necessary financial arrangements and measurement and verification methods to enable aggregators to sell energy blocks backed with load shedding exactly as if they were backed with production (and, in fact, they *are* since the energy initially produced to cover the consumption of the shed consumers is sold to another one);

(ii) a DSR-friendly market design involves an adapted governance framework to make it possible for aggregators to fully compete with suppliers by not requiring the approval of the latter for their actions on their consumers' load and benefitting from high level of confidentiality on the result of these actions; moreover, specific market products (especially in minimum bid size) are set up;

(iii) finally energy policy-makers may want to foster DSR through specific support schemes; their range is roughly the same as for support to RES and they will not be studied in detail in this chapter; however it should be noted that subsidies proportional to capacity (long and short term DSR capacity auctions for instance) could be much more relevant –less distortive – than in the case of RES: because of its characteristics as a flexible (short term) and peaking technology, a large share of DSR's value lies in capacity.

4.2 Relevant design elements of Demand Side Response

Capacity markets aim at providing an insurance against long-term or short term risk on security of supply, i.e. supply being temporarily unable to match demand, leading to load curtailment. Traditionally, generation units provide the system with available capacity, ready to be called upon either by the short-term players, i.e. both the market and the SO.

4.2.1 Implicit participation

On the one hand, demand can be implicitly used in capacity markets where suppliers have, under the mechanism's provisions, an obligation based on their actual (measured) consumption.

More precisely, in power system implementing a capacity mechanism where the suppliers have an obligation representing their actual contribution to the risk on security of supply, it should also be an option. This contribution should indeed be very much correlated with the consumption of their customers during peak periods, and, therefore, suppliers should theoretically have the opportunity to reduce their obligation by setting up ways to limit this consumption, i.e. incentives or direct control enabling to influence the demand they supply.

4.2.2 Explicit participation

On the other hand, explicit participation of demand capacity markets can be envisaged through a process allowing demand response to compare with traditional generation and FIT in a more or less standard capacity product. This theoretically involves:

- a qualification process, by which the operator of a DSR facility shows its ability to globally alter the load of the consumers constituting this facility so as to actually replace an increase in production by a decrease in consumption;
- a certification process, by which the operator commits to a level of availability;

- a verification process, possibly associated with a penalty scheme in case the availability commitment is not observed. In practice, it can be quite difficult to measure the level of availability of demand response.

4.2.3 Mutual compatibilities and exclusions

The participation of demand in reserve and capacity markets can therefore be envisaged in the following ways:

- explicitly through certification; in this case available load shedding capacity plays the exact same role as available generation;
- implicitly if the suppliers have an obligation in the mechanism based on the consumption of their customers during specific periods of time (peak hours).

Whereas the same consumers cannot participate implicitly and explicitly at the same time in a capacity market (to the extent that if they reduce their consumption during peak hours or scarcity hours, they may no longer be available to reduce it further if activated through explicit arrangement to provide energy for the market or for balancing, respectively), the two options can be offered, allowing DSR operators (including suppliers) to choose which is the most relevant for the DSR "objects" they manage.

Depending on the market arrangements, it may also be possible (and sometimes encouraged) to participate in a capacity market and in reserve markets. For instance, a DSR-able site offering operational reserve (explicit participation) may have been certified for providing long-term capacity if the capacity mechanism's certification process is based on physical availability of the capacity during a peak period (regardless of its participation in any short term market). However, if it is used by a supplier to reduce its obligation under the capacity mechanism, it can of course no longer be used to provide reserve during these hours nor by the supplier to adjust its imbalances to avoid being short in a reserve scarcity period (provided this period is included in the capacity mechanism's peak hours) since it has already been shed.

Thus, explicit participation in capacity and flexibility markets may be fully compatible, whereas implicit participation in one or the other of these markets may partly prevent to use DSR for other purposes (since implicit use requires actual activation). Therefore, the options cannot be assessed one against the others and they should be seen as different bricks of market design, each one revealing a part of the value of demand response (all the more as demand response objects are extremely diverse).

4.3 Relevant assessment criteria

Note that these criteria are the same as those used to assess short-term options in the Market4RES report D3.2 *"Development affecting the design of short-term markets"*.

4.3.1 Efficiency

1. **Marginal cost reflectivity**: efficient DSR activations are based on an arbitrage between the market value of energy and its usage value at a specific point in time. The market design must ensure that DSR is activated when instant market value goes above the consumer's usage value.
2. **Cost causality**: DSR dedicated companies with direct market activity are new entities in the market design. Their activity interferes with existing market entities, such as BRPs. Overall efficiency requires that the incentives for all parties are preserved, by ensuring which must ensure that they bear the costs associated with their activity.
3. **Liquidity**: does the DSR market design foster market activity rather than internal portfolio optimization?

4.3.2 Implementability

1. **Feasibility**: DSR resources are technically complex and difficult to manage, and their management requires dedicated expertise. In this regard, market design assessment must take into account the fact that whether dedicated DSR companies specializing in aggregation are allowed to operate or not.
2. **Compatibility & simplicity**: These 2 criteria can be assessed together, to consider the additional market design complexity associated with DSR participation.
3. **Implementation costs**: The massive roll out of smart meters represents a significant implementation cost to enable DSR. More "targeted" market designs can feature lower implementation costs.
4. **Level of use of public funds**: DSR is a politically attractive technology / activity, which can attract public support. This criterion must be put in perspective with the Effectiveness criteria.
5. **Scalability**: Is the market design for DSR compatible with existing cross border solutions or not?

4.3.3 Fairness

1. **Competition**: is unbundling between DSR and Supply possible? Can independent DSR companies have access to consumers without the authorization of their supplier?
2. **Confidentiality** (applies only where competition exists): are DSR activations individually notified to suppliers? Is consumer data managed by the DSR service provider kept confidential or is it accessible by potential competitors?
3. **Allocation of implementation costs.**
4. **Level playing field for DSR**: are the incentives for DSR equivalent to the ones for generation?

4.4 Assessment of the design elements of Demand Side Response

4.4.1 Implicit participation in capacity markets

Efficiency

If the consumers bear the responsibility for SoS, they can arbitrage between contracting with capacity holders or reducing their consumption; to that extent, implicit participation of DSR in capacity mechanisms can be seen as the part of the demand curve that is not at any price; this option **improves marginal price (in fact utility) reflectivity** of a capacity mechanism. This said, fully activating demand response may not be the best option for all kinds of DSR and having it simply available could be enough to ensure SoS, therefore implicit participation may be too costly to represent the value of all types of demand response in a perfect manner.

The consumer theoretically arbitrates between consumption and DSR activation according to his utility to consume during the periods of tension on SoS given the price of capacity: **cost causality is excellent**, leading to maximizing social welfare. However, in practice the final consumers may participate in the mechanism through their supplier and the price signal may be altered when it reaches the consumers.

Allowing implicit participation of demand in capacity mechanisms increases the number of options to ensure SoS and the price-elasticity of demand, therefore it has a **positive impact on liquidity.**

Implementability

This option is by far easier to set up than explicit participation since the decrease in SoS risk induced by the activation of demand response during periods of peak is much more obvious; it is therefore only a matter of computation of how much it decreases it. As a consequence this option is **easily feasible**.

By obviously reducing the risk of (unwanted) loss of load, this option is **compatible with any kind of mechanism** which relies on the actual consumption as measured (and not only on a probabilistic *ex ante* vision of consumption).

Implementation costs should be relatively low although this option requires having a good knowledge of the consumption and the depth of the shedding that took place.

This option **does not require the use of any public funds** (depending on who is held responsible for SoS in the mechanism but, should it be a centralized body such as the State or the TSO, there would be no incentive at all for implicit demand response).

Scalability is not relevant to this option.

Fairness

This option decreases market power in the mechanism by elasticizing demand but it does not let third parties reach consumers and operate demand response in capacity markets freely from the supplier's consent. Its **impact on competition is therefore limited.**

Implementation costs are fairly allocated since they are fully borne by the supplier.

This option **allows to extend the role of demand response** beyond what generation is able of but, if implemented without explicit participation, does not create a level playing field with generation.

4.4.2 Explicit participation in capacity markets (DSR dissociated from supply)

Efficiency

Assuming a perfect control process (i.e. that it is possible to perfectly measure DSR availability), explicit participation in capacity markets allows commandable demand response objects to compete on equal footing with generation capacity thus allowing to significantly reduce the cost of ensuring SoS by **reflecting the marginal cost** of using a new way to deal with it (namely DSR). However it may not be suitable for all kinds of demand response objects (for instance time of use tariffs) and may be complemented with implicit DSR participation for full efficiency.

Setting it up **improves cost causality** as compared to not allowing DSR explicit participation since consumers can decide that they are willing to help the system by being available to reduce their consumption in periods of scarcity, if the price for this service (availability) is high enough. The consumers who do not want to provide this service at any price thus bear the cost of their inelasticity. It also increases the number of options to ensure SoS and the price-elasticity of supply, therefore it has a **positive impact on liquidity.**

Implementability

Having demand response explicitly participating in a capacity mechanism implies being able to certify it, which is extremely uneasy since, potentially, every single load can be considered as able to respond from the moment it has a circuit breaker. The control process is therefore key and may be very complex to design and introduce bias; for these reasons, this option suffers from a **poor feasibility.**

For the same reason (very complex monitoring process), it **cannot be regarded as simple**; it however makes SoS mechanisms a powerful tool to promote demand response, hence a **good compatibility** with the European energy policy objectives.

Setting up explicit participation of DSR may be expensive because of the need for a very complex control process, but it should still be very far from the benefit, hence such an option should be regarded as **good from a cost perspective.**

DSR participation in a capacity market **should not involve the use of public funds** except if DSR is subsidized and the operator's participation in such a market is covered by a management premium.

Finally, the technological **scalability** of this option is **relatively good**; however it may require a relatively precise control on load which may exclude small loads. Cross-border participation (geographical scalability) depends on future arrangements on coordinated management of interconnection capacity during peak periods.

Fairness

The **impact of this option on competition is good.** Competition in the capacity mechanism is improved by explicit participation of demand response. According to the precise arrangements, it is feasible for a third party (independent from the supplier) access to the consumers, which creates competition at this level. However, a high level of confidentiality must be ensured so as to ensure a level playing field between aggregators and suppliers.

Implement costs **may not be perfectly fairly allocated**, in particular those linked to monitoring and verification processes, could be partly borne by the system operator.

This option **creates a level playing field** for DSR to participate on equal footing with generation in capacity markets.

4.5 Summary and Conclusions

The following tables synthesize the previous analysis. Overall, neither of the options should be preferred but both of them should be implemented where relevant (i.e. in systems where a capacity mechanism exists) to make room for all types of demand response objects and of market arrangements (operated by the supplier in portfolio or marketed; operated and marketed by a third party).

		Implicit participation	Explicit participation
Efficiency	Marginal cost reflectivity	Good	Very good
	Cost causality	Very good	Very good
	Liquidity	Poor	Very good
Implementability	Feasibility	Good	Poor
	Compatibility & simplicity	Very good	Fair
	Implementation costs	Very good	Good
	Level of use of public funds	Very good	Very good
	Scalability	N/A	Fair
Fairness	Competition	Fair	Good
	Confidentiality	Poor	Good
	Allocation of implementation costs	Good	Fair
	Level playing field for DSR	Very good	Very good

Table 11 – ***Detailed summary of the assessment of each design element***

	Efficiency	
Implicit participation	Good / very good	Allows DR to compete in the mechanism, therefore improves its overall efficiency. Well suited to lower variable cost options since they have to be activated.
Explicit participation	Good / very good	Allows DR to compete in the mechanism, therefore improves its overall efficiency. Well suited for higher variable cost options since only availability is required.

Table 12 - *Assessment of design elements according to Efficiency criterion*

	Implementability	
Implicit participation	Good	Reasonably complex, relatively scalable since a large part of demand can participate. No use of public funds.
Explicit participation	Fair	Costly and very complex, especially regarding the monitoring/control process. Scalability may be limited due to the need for some degree of precision.

Table 13 - *Assessment of design elements according to Implementability criterion*

	Fairness	
Implicit participation	Fair	Decreases market power in the mechanism by elasticizing demand. But only suppliers can participate: little competition and no confidentiality issue.
Explicit participation	Good	Increases competition in the supply side. Confidentiality is an issue for DSR to be operated by aggregators.

Table 14 - *Assessment of design elements according to Fairness criterion*

5 Long-term cross-border products

5.1 Introduction

5.1.1 The role of long-term energy markets

Well-functioning long-term energy markets are an essential piece of the electricity market. Having available long-term hedging tools is relevant for all market participants, but in particular it turns to be fundamental for independent non-vertically integrated generators and retailers.

Furthermore, a liquid and efficient forward market provides optimal long-term price signals about future market expectations. In turn, these markets should help to effectively promote long-term security of supply. Let us recall that when reviewing the reasons behind the market failure affecting adequacy, we pointed out that the lack of well-functioning (very) long-term markets was one of the major reasons behind the problem.

5.1.2 Long-term cross border tools

Long-term cross-border risk-hedging tools are a central feature of the EU TM. These hedging instruments allow to manage the risk associated to price differentials between zonal short-term markets caused by inter-zonal congestion.

The Network Code (NC) on Forward Capacity Allocation (FCA)[7] sets out rules regarding the type of long-term transmission rights that can be allocated via explicit auction. This NC gives room to several forms of cross-border risk hedging instruments, including products of different nature (physical or financial) and also providing guidelines about how the products may compensate the holder in case their right is curtailed.

5.1.3 The objective of this chapter

The major objective in this chapter is to analyze the characteristics of these cross-border products, identifying some relevant design elements and discussing the pros and cons of the different design options.

Additionally, in the Annex, we also identify and briefly describe the typical measures that can be implemented at a Member State level to improve the liquidity of national long-term markets. Although improving liquidity at a national level is not an objective of the TM *per se*, it is closely linked to the well-functioning of the long-term cross-border dimension.

[7] See http://networkcodes.entsoe.eu/market-codes/forward-capacity-allocation/.

5.2 Design options for long-term cross-border energy products

5.2.1 Nature of the products

The assessment in this chapter is focused on the nature of the products. Cross-border products can be classified in two groups, depending on whether they are or not linked to physical cross-border capacity. In case they are linked to a physical interconnector or corridor, the products are managed and issued by the TSO on the primary market. If they are not, any financial entity can act as a counterpart of the product.

Products managed by the TSO (linked to cross-border capacity)

There are two groups of products that are managed by the TSO, namely, the Physical Transmission Rights and the Financial Transmission Rights:

Physical Transmission Rights (PTRs): Physical transmission rights provide the option to transport a certain volume of electricity in a certain period of time between two areas in a specific direction. It is worth noting that physical transmission rights involve a day-ahead nomination process of the holder with the TSO, to make effective the physical use of the interconnection.

PTRs are prone to market power exercise. When simple Physical Transmission Rights exist, there is a risk that one party may reserve transmission capacity in order to hinder transmission. That is, agents could not nominate their contracted capacity with the sole purpose of reducing cross-border exchanges (and as a consequence benefiting from higher prices in their zone). For this reason, "plain" PTR is not an alternative to be considered today in the Internal Electricity Market. However, there are two PTR-based products that avoid this problem and comply with the FCA rules:

- *PTR Use it or lose it (UIOLI)*: if the owner does not nominate his capacity right in due time, then he loses it (with no compensation) and the capacity is reallocated to the subsequent auction (day-ahead).
- *PTR Use it or sell it (UIOSI)*: if the owner does not nominate his capacity right, then the capacity is reallocated to the subsequent auction (day-ahead) and the initial owner gets the price at which the capacity is resold (usually the day-ahead market price differential in case market coupling applies at the day-ahead stage, or the price of the day-ahead explicit auction otherwise).

Financial Transmission Rights (FTRs) are financial instruments that enable holders of such instruments to manage price differentials between zonal short-term markets caused by inter-zonal congestion. There are two types of FTRs: FTR options and FTR obligations.

- *FTRs as options* entitle their holders to receive a financial compensation equal to the positive (if any) market price differential between two zones during a specified time period in a specific direction. Therefore, for options to be auctioned two products need to be implemented, one in each direction of transmission over the interconnection. Note that the design of a FTR option is similar to the design of a PTR UIOSI, but where it is not possible to nominate.

- *FTRs as obligations* in contrast also oblige holders to pay for a negative market price differential. This way, the settlement of an obligation may be positive or negative for the buyer, while the settlement of an option will always produce positive income for the buyer.

Products that are not managed by the TSO

In the context of cross-border energy products it is used the generic name of Contracts for Differences (CfD) to refer to any derivative products on the price differentials, being either between a reference price (e.g. system price as in the Nordic market) or between two price areas. Their issue is potentially independent of TSOs.

Hedging vs speculation

In general, all the previous instruments can be used either as hedging mechanisms for physical power delivery or as financial investments. Participants who use these instruments as hedging mechanisms generally acquire the instruments in a quantity that is consistent with their expected energy delivery/procurement. When used as a hedge, the instruments serve to lock in the price of congestion at the purchase price of the derivative. When purchased as an investment, they are used as a financial tool to speculate whether the congestion rent will be greater than the purchase price.

5.2.2 Injection/withdrawal (flowgate vs point to point)

Any of the previous cross-border products can be defined between any two points (nodes or zones) or conversely they can be referred to specific interconnections. The first type of product is known as point-to-point and the second as flowgate. This way we may for instance sign a Point-to-Point FTR Option or a Flowgate PTR UIOLI.

5.2.3 Time terms of the contract

The previous products can be sold on different timeframes. Typically, long-term hedging tools are sold on

- Yearly basis (e.g. for the following year)
- Monthly basis (e.g. for the next month)

5.2.4 Firmness of the products

Firmness of cross-border capacity products defines whether the issuer can curtail the capacity allocated. In other words, the firmness of the cross-border product reflects the level of commitment of the TSO to honor the right sold in case there is an event affecting the network. Although this design feature has been considered outside of the scope of the assessment, next we provide a brief description of some design alternatives in this respect.

A distinction is generally made between physical firmness and financial firmness:

- Through physical firmness the issuer commits to honoring the transmission right sold to users regardless of operational difficulties, except in case of *Force Majeure*;
- Through financial firmness the issuer commits to providing to the right holder an equivalent financial compensation, except in case of *Force Majeure*.

Since the main goal of long-term transmission rights is to hedge players against the zonal short-term markets differential, there is equivalence if, in the event of a curtailment in its long-term right, a market participant obtains payment by the TSO of this spread applied to capacity not being honored. For this reason we will exclusively deal with financial firmness.

There are different design alternatives as regards financial firmness and the associated compensations, being the most relevant:

- Full financial firmness: in case of curtailments before the nomination stage, capacity owners are compensated by the day-ahead market price differential, if positive (except in case of *Force Majeure*).
- Capped compensation: in case of curtailments before the nomination stage, capacity owners are compensated by the day-ahead market price differential if positive, but there is a cap on the price differential.
- Compensation based on initial payment: for example the 110% rule applied at the FR-IT border (if there is a curtailment, the right holder only receives compensation equal to 110% of the auction price at which the right had been sold).

5.3 General assessment criteria

5.3.1 Efficiency

Market and system modeling imperfection costs

Determining and assigning cross-border capacity is a quite complex issue that will most likely be subject to imperfections. In this respect, very long-term cross-border products are subject to very high uncertainty.

Liquidity

We make distinction between short-term liquidity and long-term liquidity.

- Short-term liquidity (day-ahead energy market): whether the product may undermine or facilitate the liquidity in the short-term market.
- Long-term liquidity (cross-border products market): whether the product may undermine or facilitate the liquidity in the long-term.

Ensures physical delivery

Whether or not the product helps ensuring a fully hedged physical delivery to the holder of the right. This is only an issue if there are price caps in place that may hinder short-term efficiency. Without price caps, efficient physical delivery will always take place as a result of the Price Coupling of Regions.

Diversity and hedging characteristics of products traded in the market

It is relevant to assess how the different products hedge the preferences and needs of the different agents involved. Let us recall that the TSO is also a relevant agent, and some products may over or under hedge. As acknowledged in the NC on FCA, optimal design alternatives for the products may depend on a case by case basis.

5.3.2 Robustness

Robustness against market power: whether the product can be prone to market power exercise.

5.3.3 Implementability

Requirements

What the requirements to implement the product are.

Experience with implementation

Whether or not and to what extent, there is international experience with the implementation of the different products.

5.4 Assessment regarding the nature of the products

5.4.1 Efficiency

Market and system modeling imperfection costs

Imperfection costs are more related to the time terms than to the nature of the product. In this sense, very long-term cross-border products are subject to higher uncertainty, and therefore are also subject to larger imperfection costs.

Short-term liquidity

Both the **PTR with UIOLI and UIOSI** perform **Fairly up to Good** under this criterion. However, the products can be nominated even though in the opposite direction to the economic direction (i.e. from high-price zone to low-price zone).

The performance of **all financial products** is considered **Very Good** under this criterion, since they do not reduce at all the available cross-border capacity in the short-term markets.

Long-term liquidity

Financial products can attract more easily speculators, thus increasing the liquidity of the cross-border product markets compared to physical rights where one needs to be able to have physical positions in the market (i.e. be BRP).

Compared to FTRs, CfDs though suffer from a lack of liquidity due to the fact that there is no primary market where TSOs are counterparts. This is particularly the case for borders where the price difference is more predictable, since – except TSO - no other market parties are natural risk takers on these borders. In other words, if TSO are not selling capacity rights, it is often the case that no one is willing to be counterparts to traders willing to hedge.

Ensures physical delivery

In the presence of (non-homogenized) price caps, efficient physical delivery is ensured only whith physical contracts (any of the three alternatives being considered). Financial contracts can fail to provide physical delivery with certainty when the price cap is reached in one zone.

Diversity and hedging characteristics of products traded in the market

From different stakeholders consultation processes it seems that the products analyzed are sufficient to satisfy the different appetites for risk of the different agents. The PTR, PTR with UIOLI or OIOSI, and the Finacial option offer a partial hedge. The FTR obligation and the CfD offer a total hedge. Which one is more suitable will depend on the agents risk appetite.

The discussions is more on the side of the time terms. Yearly products might be insufficient to properly hedge some agents' risk, which may need up to three years contracts.

5.4.2 Robustness

Except for the plain PTR, the performance of all other products is considered **Very Good** with respect to their robustness against market power.

5.4.3 Implementability

Requirements

PTRs have the advantage of not requiring to close energy positions at the Power Exchanges. Indeed, PTR with UIOLI do not even require zonal price computation. On the downside, PTRs require nominating the capacity. PTRs Nomination Rules can be complex and they shall contain at least the following information: a) entitlement for PTRs holder to nominate; b) minimum technical requirements to nominate; c) description of the Nomination process; d) Nomination timings; and e) format of Nomination and communication.

PTRs and PTRs with UIOLI can be implemented even if there is no zonal (or nodal) computation of prices. All other alternatives require an explicity computation of prices.

Although agents usually consider physical and financial products as virtually equivalent, they have sometimes expressed that financial products are easier to implement (particularly regarding the specification of procedures) and provided greater liquidity (both in the long-term market because of the easier entry for financial players than in the short term due to the fact that all capacity is available for the day-ahead market). Among financial products, a number of agents have expressed a preference for options rather than obligations. Another advantage of financial rights is very practical and relates to the absence of nomination deadline.

(THEMA, 2011) states that there is no generic solution that is the "best one" for all markets and interconnections. When an efficient day-ahead market (DAM) is lacking, the preferred solution would be a PTR UIoLI. When an efficient DAM is introduced, market players can no more trade directly across the borders since capacity is made available to the whole market and optimized in the implicit auction. But other needs and opportunities for forward cross-border trading may arise.

Experience with implementation

In most of Europe, TSOs or interconnector operators offer the physically available transmission capacity to the market in advance via explicit auctions, in the form of flowgate PTRs with UIOSI, over different time horizons (i.e. yearly, monthly). In Nordic countries, CfDs have been in place for years.

The prevalent market mechanism for defining transmission rights in North American is through point to point financial instruments.

5.4.4 Summary and Conclusions

The following table summarizes the assessment carried out in this chapter. As it can be checked, FTRs, in its different forms, are the alternatives that present more desirable properties.

		TSO					Market agents
		PTR	**PTR with UIOLI**	**PTR with UIOSI**	**FTR option** max(0, Pa-Pb)	**FTR obligation** (Pa-Pb)	**CFDs** (Pa-Pb)
Eficiency	Short-term liquidity	Poor	Poor	Good	Very Good	Very Good	Very Good
	Long-term liquidity (attracts speculators)	Poor	Poor	Very Good	Very Good	Very Good	Very Good
	Ensuring physical delivery	Very Good	Very Good	Very Good	Poor	Poor	Poor
	Hedging	Partial hedge (higher premium)				Complete hedge (lower prem.)	Complete hedge (lower prem.)
Implementability	Requires selling energy in the PX	No (but requires nomination)	No (but requires nomination)	No (but requires nomination)	Yes	Yes	Yes
	Requires PX (for zonal price computation)	No	No	Yes	Yes	Yes	Yes
	Experience with Implementation	Good	Very Good	Very Good	Very Good	Very Good	Very Good
Robustness	Market power	Poor	Very Good	Very Good	Very Good	Very Good	Very Good

Table 15 - *Summary of the assessment of the cross-border energy products*

5.4.5 Brief comments of other design elements

Flowgate vs point to point

One major issue of point to point cross-border products is that it has to be auctioned by a central authority such as an ISO and any secondary trading takes place through. Despite this drawback it is also acknowledge the higher efficiency that is reached when point to point products are implemented (as it is the case in the US markets).

Firmness

The improvement in contract firmness can in fact present a relevant risk for TSOs. For the TSO it would be a problem if curtailments occur during times at which the price spread is higher than the price of the auction where the right was acquired. The key question here is whether that risk can be effectively managed by the TSO itself.

5.4.6 Annex – Liquidity in national long-term energy markets

National liquid forward markets are essential for the well-functioning of the regional market. Indeed, if two areas have liquid forward markets towards their local area price there is de-facto no need for a forward cross-border market. Cross-border risk could then be managed by buying one forward and selling the other.

Since not all national markets ensure enough liquidity, some Member States are evaluating the possibility of implementing some measures focused on enhancing this liquidity. Among these measures, two of the most successful ones are the introduction of a clearing house or the introduction of a market maker (see I-SEM, 2015):

Introduction of a clearing house

The introduction of an exchange/clearinghouse can reduce the credit requirements linked to forward trading by allowing collateral to be posted centrally rather than on a bilateral basis.

Introducing a market maker

This options has been introduced recently in the UK, and it is being evaluated in the I-SEM (I-SEM, 2015). The concept of "market markers" is a well-known liquidity promoting measure that has its origin in financial markets.

A market maker it is typically regulated through a contract that defines some rules for the market maker's obligations (bid/offer spreads, MWs offered, etc.)

The aim of market making is to provide firms with continuous opportunities to trade forward products. Market making helps to improve both price discovery and product availability.

Market making is one of the more common approaches taken to improving liquidity in a commercial context and is a feature of the most liquid power markets in Europe (e.g. Nordpool and Germany).

Market maker approach can be implemented in various forms (I-SEM, 2015):

- Voluntary participation ("auction" of a required quantity of MWs to be part of the market): This is the most common way of implementing this where the market operator/regulator will define the required service and contract the desired number of market participants to deliver this service. Many of the power markets in Europe are using this; some in the physical markets (Nord Pool Spot has three market makers in the IDM) and most Financial markets use this for some of their products[8];
- Mandatory for some volumes or all;
- Mandatory on some market participants (like GB on the largest parties, California).

Ofgem has implemented a mandatory regime for selected market participants covering market maker requirements. The arrangements are given effect through the “Secure and Promote” licence condition, which promotes robust reference prices for forward products through a market making obligation on the six largest vertically integrated companies.

[8] Some references to voluntary schemes are at: http://www.nasdaqomx.com/commodities/markets/marketmakers

6 Conclusions

The development of power systems in the future shall make the deployment of large amounts of RES generation capacity compatible with having a large enough amount of firm capacity. Besides, in order for both products to be provided in an efficient way, markets in Europe should integrate through an efficient use of transmission capacity. Not only generation, but also demand shall be central to the achievement of these objectives.

In line with this, main required developments that are related to the functioning of long-term markets, as analyzed in this report, are associated with the topics that follow:

1. Mechanisms for the provision of firm capacity.
2. Long-term effect of mechanisms driving the installation of RES generation.
3. Participation of demand in long-term markets.
4. Design of long-term cross-border products from the use of the transmission grid.

As for the design of **Capacity Remuneration Mechanisms**, financial options with a high strike price, seem to achieve the right balance between the provision of certainty to investors in firm capacity and the provision of incentives for agents to participate in short term markets. Regarding the price vs. quantity nature of the mechanism to contract firm capacity, expressing the system needs in terms of a price-quantity curve seems preferable. This avoids that the amount of firm capacity contracted is too high or too low, as well as the possibility that its price is too high. At the same time, it allows its price to be low if possible. Setting a price-quantity curve partially curves market power and would be implementable in the EU.

The procurement should probably take place through a centralized auction, which would be effective and efficient, and would be accepted widely, even when not allowing a large variety of products to be traded. Lastly, cross-border provision of firm capacity should be allowed to increase the efficiency in the provision of this product and the amount of transmission capacity available for this should be computed through statistical means, since this is most reliable.

RES support mechanisms to be applied, according to their long-term effects, should be of a market nature in order to increase their efficiency and reduce the possibility that authorities manipulate support payments made. Long-term clean energy or capacity auctions and FIT or FIP auction schemes should all result in the most cost-competitive RES generation that is compatible with the achievement of RES deployment objectives being installed in the system. Besides, some of these mechanisms could be accepted by authorities and stakeholders, since experience exists with the application of some of them throughout the EU.

Demand side participation mechanisms of all kinds should be allowed to provide flexibility for consumers to participate in long-term markets. Implicit schemes are simpler, and cheaper to implement. They should achieve an increase in market functioning, since they allow the activation of demand. However, no competition in access to DSR resources takes place, which could limit overall efficiency. Explicit schemes allow competition to take place in managing flexible demand. However, they are complex and expensive to implement. Besides, when implementing the latter, confidentiality issues may arise. The specific choice to be made could depend on the specific circumstances existing in each system.

Lastly, when discussing **Long-Term Cross-Border Products**, one should generally prefer Financial Transmission Rights over Physical ones, since they do not condition the physical use made of interconnection capacity. Physical Transmission Rights with a Use It or Sell It clause may also be a sensible option, especially when countries need to guarantee their access to firm generation capacity in other systems.

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