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Analysis of EU regulatory framework for the grid integration of renewables in distribution networks and energy storage technologies

Research Project Assignment

Students: Vincent Kocko & Michael Montagu
Professor: Francisco Diaz Gonzalez

ETSEIB

ESCOLA TÈCNICA SUPERIOR D'ENGINYERIA INDUSTRIAL DE BARCELONA

Table of contents

I. Aim of the work

The aim of the work was to provide a document explaining in a detailed and easily understandable manner the different legislative and technical constraints for the integration of renewable energies in a classical network.

II. Introduction

In this report, the European regulatory framework for the grid integration of renewables energies in distribution networks and energy storage technologies will be analyzed. Basically, the report will deal with the measures forming the regulation framework implemented these last years in the European Union in order to integrate them into the electrical grid. Two aspects of these measures will be treated: the general aspect (politics, social dimension etc.) and the technical aspect.

We are studying this subject for two main reasons. Firstly, it's important to understand that regulation is one of the key aspects for the promotion of the integration of renewables and energy storage.

As everything, renewable energies have weakness and several constraints which slow down the boom in their use and their integration into the grid. Among these reasons, the cost is a big issue. It is in fact relatively expensive to implement a renewable power plant and the payback time can be of several years.
The intermittence of these energies is also relevant to quote. For the main kind of renewable sources proposed in the report (wind and solar power plant). On one hand the wind power shows a strongly dependence to the wind speed which is a non-controllable parameter. On the other hand, the photovoltaic power plant has the same problem with the sun which can't be fully controlled by humans. The production of electricity by photovoltaic cells is proportional to the peak sun hour (PSH) of the plant. It is also important to take account the fact that the efficiency is not very high and doesn't produce the quantities needed to answer to the general actual load of household. The produced power is in fact low in comparison to other sources such as nuclear.

An easier integration of renewables into the grid would certainly influence the development of renewable power plants in the future to replace progressively the energy production from fossil fuels sources. The ideal would be of course to achieve an electricity production through 100 % renewables sources. Secondly, this work is really useful because whereas the framework was quite clear for large power plants for the different actors in the energy field, it was not the case until recently for small or medium size generators and it has been clarified only recently.

As energy markets are regulated, it is necessary to understand both the regulatory aspects, the market mechanisms and the technical limits. In the first part of the report named "Analysis of regulations" dedicated to the winter package, an overview of the winter package related to EU energy laws, followed by a description of the EU energy regulation evolution will be made.
The historic context will be explained to understand how energy's regulation in European union has been created and a detailed explanation of the evolution of this regulation will be made to understand the problematics linked to renewable energy and to their integration inside a classical network already drawn.
The steps of this part will be relatively simple and will follow a chronological evolution. Then, the creation of the common market for energy of the European union will open the analyse. This

important step will introduce the third package which is the main challenging energy package of the European union. The common market for energy establishes the base of the winter package. Finally, a full description of the winter package will be made, from a legislative point of view. This new package (in its actual state) will be compared to the previous energy package and its limits will be studied.

The second part of the development is a technical review of a set of regulations for the integration of renewables energies in the grid: "COMMISSION REGULATION (EU) 2016/631 of 14 April 2016 establishing a network code on requirements for grid connection of generators". Basically, the aim of this document published in the Official Journal of the European Union is to settle a precise frame of work for the integration of renewables energies in the grid. The document is applied in the whole European Union and is therefore translated in several languages. It has been signed by Jean-Claude Junker, president of the European Commission in Brussel the 14^{th} April of 2016. According to the document, this regulation set should enter into force three years after his publication, which means in upcoming April. The document contains 72 articles and the structure of the document can be summarized (see Annex 4).

The first part of the analysis will concern the application scope of the modules and how the modules are classified through the notion of significance. The classification is used in the entire regulation. Then, the general requirements that the modules must fulfil will be reviewed. We will see that the rules set out by the regulation are very technical and complete. In a last part, some additional rules for power-park modules will be reviewed.

III. Methodology

The present work has been done in the frame of a Research Assignment Project proposed by the ETSEIB. At the beginning of the semester, a subject has been chosen by the students in an online bank of subjects ("Applications of energy storage systems in wind and photovoltaic parks") and the students have contacted the professor in charge of this subject: Francisco Diaz Gonzalez, which agreed to supervise the students for a Research Assignment Project. Several precise subjects linked to initial one was proposed to the students and the subject "Analysis of EU regulatory framework for the grid integration of renewables in distribution networks and energy storage technologies" has finally been chosen. Then, during the whole semester, a meeting was planned once a week (Tuesday at 15:00) so that the students could explain their advancement on the work to Francisco Diaz Gonzalez, ask him some questions and so that the professor could make some comments to the professor. Basically, the main objective of these meetings was to have an exchange on the subject between the teacher and the students. Before each meeting with the professor, the students met each other to exchange on the subject and to do an update on their respective part to each other.

The first main part of the work was focused on the legislation review of all the directives and regulations which have an impact on the integration of renewable energy into the grid. The Winter package has been chosen for this analysis. This package draws the future for the renewable energy. It gives the rules and promote the renewable energy giving more importance to the costumers and enabling everyone to participate in the transition themselves by producing their own renewable energy and feeding it into the grid. By allowing electricity to move freely to where and when it is most needed via undistorted price signals, consumers will also benefit from cross-border competition. Also, in the study, the winter package and its regulations give all the rules to follow in the case where a renewable power plant has to be introduced into the grid. The winter package contains 8 distinct legislative texts:

- Energy Performance in Buildings
- Renewable Energy Directive
- Energy Efficiency Directive
- Governance
- Electricity Directive
- Electricity Regulation
- Risk-Preparedness
- Rules for the regulator ACER

The winter package is very deep and touches all domains of energy such as gas or solar thermal energy (used for heating for example). The analysis made in this report is purely on the electricity part of the winter package. Then, for the understanding of the text and the context of the winter package, a preliminary part was to understand the reasons of the winter package and what is the current operation for this matter. The third package is shown as a reference in terms of regulation to understand the actual structure of the energy chain. The main part of the beginning of the analysis is dedicated to the evolution of the energy landscape and the apparition of the third package which has deeply changed the use of electricity energy in the European Union.

The second main part of the work is dedicated to the technical review of an example of a set of regulations: "COMMISSION REGULATION (EU) 2016/631 of 14 April 2016 establishing a network code on requirements for grid connection of generators" as explained in the introduction. For this part, the first step was to choose which articles were interesting for the work. To do so, a global review of the document has been done at the beginning of the semester, to understand better the structure of the regulation and have an overview of the content of the different parts. The product of this step is the table shown in the introduction. Thanks to this overview and in collaboration with the professor, three main axes of the regulation have been chosen:

- the application scope of the requirements (developed through the explanation of Article 3: "Scope of application", Article 4: "Application to existing power-generating modules", Article 5: "Determination of significance" and Article 6: "Application to power-generating modules, pump-storage power-generating modules, combined heat and power facilities, and industrial sites").
- the requirements applied for general cases for the different types of modules defined in the first part (excepted type D) (developed through the explanation of Article 13: "General requirements for type A power-generating modules", Article 14: "General requirements for type B power-generating modules" and Article 15: "General requirements for type C power-generating modules").
- the specific requirements for power-park modules for the different types of modules defined in the first part (excepted type D) (developed through the explanation of Article 20: "Requirements for type B power park modules", Article 21: "Requirements for type C power park modules" and concerning offshore power park modules, Article 23: "General provisions", Article 24: "Frequency stability requirements applicable to AC-connected offshore power park modules", Article 25: "Voltage stability requirements applicable to AC-connected offshore power park modules", Article 26: "Robustness requirements applicable to AC-connected offshore power park modules", Article 27: "System restoration requirements applicable to AC-connected offshore power park modules", Article 28: "General system management requirements applicable to AC-connected offshore power park modules".

The type D have been excluded of the study because of the size associated to it: as explained earlier, the knowledge about large modules is already clear. So, the focus of the study has been made on small or medium size installations.

For each part of the work, the same following work methodology has been followed:

- read the articles and choose the main points of regulation to explain.
- explain, reformulate and/or analyse the chosen words in clear and simple technical English to make it understandable by any reader with knowledge in the field.
- show and explain some technical schemes and tables to illustrate the text when it's possible.

IV. Analysis of energy packages

Relevant concepts

ROLE OF THE EUROPEAN PARLIAMENT In adopting the legislative package on internal energy markets, Parliament has strongly supported transmission ownership unbundling in the electricity sector as the most effective tool to promote investment in infrastructure in a non-discriminatory way, fair access to the grid for new entrants, and transparency in the market. Parliament has also stressed the importance of a European common view of mid-term investments. Parliament also obtained recognition of the concept of 'energy poverty'.

The European council: The Council of the EU is the institution representing the member states' governments. Also known informally as the EU Council, it is where national ministers from each EU country meet to adopt laws and coordinate policies.

ISO (Independent system Operator): supply company can own the physical network, but it has to leave O1M and investment decision to an independent company.

ITO (independent transmission system operator): Supply company can own and operate the network the management of the network must be done by a subsidiary company, which makes all financial, technical and other decisions independently from the parent company.

OU (Ownership Unbundling**):** Transmission and transportation grid is owned and managed by a fully independent company: no supply and production company is allowed to hold a majority share in the company nor exercise voting rights or appoint board members

The CEER The Council **of European Energy Regulators (CEER)** is a "not-for-profit" organization in which Europe's national energy regulators voluntarily cooperate to protect consumer interests and to facilitate the creation of a single, competitive and sustainable internal market for gas and electricity in Europe

Rule of aggregator: Vertically-integrated utilities and energy cooperatives will commonly act as aggregators for the energy customers they represent, grouping and organizing them to achieve optimum price and efficiency. By this definition, an aggregator could refer to anything from a business association or municipality to a tenants' association or industrial co-op. A branch of a municipal energy utility could even act as an aggregator for a particular group of consumers. Aggregators need not be allied with, or overseen by, the customers they serve. Energy brokers will often act as aggregators as a way of obtaining better prices or services for their customers while providing administrative and other benefits to energy producers. But in this context, aggregation is usually done in the interest of the customer rather than the producer.

Capacity mechanisms are measures designed to ensure security of electricity supply. Typically, capacity mechanisms offer additional remuneration to electricity capacity providers, on top of income obtained by selling electricity on the market, in return for maintaining existing capacity or investing in new capacity. This additional remuneration may have an impact on competition in the internal electricity market and has to be assessed under EU State aid rules.

Bidding zone: the largest geographical area within which market participants are able to exchange energy without capacity allocation

1. Third package

The following sections of the report are dedicated to providing a comprehensive and detailed analysis of the concept of third package. Also, it is important to make clear this concept because the understanding of winter package and his regulation which is the main goal of this research assignment take in account the understanding of third package.

European market of energy

During the end of the last century the market of electricity was dominated by some companies, usually nationals' companies dedicated to exploit the production, the transmissions and the distribution of electricity. The institution of EU supported by the member states decided to make an EU's internal energy market and then opened the energy market gradually to completion.

The EU plays a key role in the conception of a European market of energy. In particular in the domain of electricity. The initial idea for energy market rules emerged in 1996 with the first liberalization directives on electricity also known like the first package.

Making a European market of energy is one of the priorities of EU. The market of energy in Europe is divided by two groups: the electricity market and the gas market.
The transition to the European market of energy was built gradually by the creation of many laws and regulations combined in legislatives packages. This laws and regulations harmonize the market and ensure the transparency of the European network by regulating the adequate levels of supply, the consumer protection and all the characteristics of flowing in the network.

There are 3 legislatives packages created since the beginning of idea of an unique European market of energy. These packages are implemented by the European parliament and the European council and these regulations are common to the members of EU. Then the latest package, known as the third package was adopted in July 2009.

First Energy Package 1998	Directive 1998/30/EC of the European Parliament and of the Council of 22 June 1998 concerning common rules for the internal market in natural gas
Second Energy Package 2003	Directive 2003/55/EC of the European Parliament and of the Council of 26 June 2003 concerning common rules for the internal market in natural gas and repealing Directive 98/30/EC
Third Energy Package 2009	Regulation (EC) 715/2009 of the European Parliament and of the Council of 13 July 2009 on conditions for access to the natural gas transmission networks and repealing Regulation (EC) No 1775/2005
	Regulation 713/2009 establishing an Agency for the Cooperation of Energy Regulators
	Directive 2009/73/EC concerning common rules for the internal market in natural gas and repealing

Figure 1: Chronology of Energy Packages (Source: European Commission)

The creation of a European market of energy could have huge benefits for consumers from an economic perspective and for industries with the harmonization of operation rules for electricity. Furthermore, in ecological transition of energy resources this opening facilitates the implementation of smart grids. In fact, if EU want to improve and increase the capacity of the renewable energies in the European Union, one of the first thing to notice is that the potential of renewable energy is different and variable in each country of Europe.

There is clearly a big potential in wind power with the countries situated in the north of Europe like Norway, a big potential in solar energy with the countries situated in the sound of Europe like Spain due to their situation in relation to the meridian, the latitude and the longitude and also a big potential of hydroelectric energy in the countries with many mountainous areas like Germany. Then an interconnection of different nationals' European network is crucial to move to optimum use of renewable energies.

Another thing very important with the European market of energy is the fact that a country could be seller and buyer of electricity. For example, if the case of France, Typically the most part of electrical energy consume in France is from nuclear energy and this energy is expensive. The energy market working with the concept of offer-demand and each country try to answer to his demand with the increasing of electricity production. The interconnection of the French network and his cross-border network permit to the France to import the electricity when the proportion of electricity generated by his neighborhood is cheaper than his electricity.

In this way during the rush hour like in Winter it is more money-making and profitable to import the electricity than to improve the capacity of production of the country to answer to the demand. This solution permit to the French household to get an electricity price 35% cheaper than the household of the other countries in Euro-Zone according to the international agency of energy.

Regarding the electricity production itself and its reliability. There is never 0% risk. The big production like nuclear or motor turbine represents a big share in the consumption of a country. The failure of one turbine or the maintenance of one nuclear reactor represents a big lack of energy in the share of consumption of a region or national strategy that's why it's important to have the possibility to fill the gap with a cross-border supplying. Not to mention the climatic disaster each country could face and their impact in a national network.

Then, the European market energy is very important. We will discuss in this report of the actual state of the opening of market, the real impact of this opening market and also the limit on European market of energy regarding the adaptation of the opening market in some countries in the part dedicated to the winter package. To understand the Winter package, it is necessary to introduce the concept of third package which lays the basis and the foundations of the Winter package.

(i) Presentation of third package

As a result of the willingness to transit through a single European energy market the most recent evolution of energy policy came about in the form of the Third Energy Package in 2009.

This third package consists of three regulations and two directives. The difference between directive is important to know because its reveal the difficulties of each countries to adapt the EU's law regarding his own situation and explain how it is complex to create an equitable and cooperative market. According to the website of the European commission the directives require EU countries to achieve a certain result but leave them free to choose how to do so. There is from EU countries a phase of transposition of the directive to national law.

This implies all the countries don't apply the directive in the same time. Whereas a regulation is immediately applicable and uniformly to all EU countries as soon as they enter into force, without needing to be transposed in national law by law in all Member States

The first directive of the third package is a characterization of the rules which governed the internal market in gas (Directive 2009/73/EC) and the second (directive 2009/72/EC) which is more important in our research is dedicated to the common rules for the internal market in electricity. The regulations of the third package contents one which establish the conditions for access to the natural gas transmission networks((EC) No 715/2009), another which established the same rules in the domain of network for cross-border exchange of electricity ((EC) No 714/2009) and the third which is an establishment of an EU institution the agency for the cooperation of energy regulators ACER ((EC) No 713/2009). Adopted in July 2009, all the regulations are the aim to make energy market fully effective and will permit to keep prices as low possible without forgetting to increase standards of service and security supply.

The unbundling as part of the Third Package was a step change from previous Directives. **The new Directives, under Article 9,** introduced a 'structural separation' between TSOs and generation, production and supply activities.

Firstly, the special feature of the third package is the creation of a new system which introduced a separation between Transportation Operators system and production, generation and supply activities. Making this separation is innovative because it will increase the integration of new actors in the different domain of energy chain, so the competition would be equitable and possible. this was one of the big problems of the energy's domain between historical companies of energy and the news one. The third package was created to avoid historical companies using their privileged position in the transmission line to minimize the presence of concurrence.
Secondly another relevant point with the third package is the creation of a Better cross-border collaboration and investment with many standard applicable at each country in the same way. Making the commerce of energy and the links between each state's members easier. Then use a common

technical code in each state's transmission system operators. The result of a kind of this perspective will be improve the EU's state to make cross border's project about renewable energy and will participate to encourage the investment in smart grids.

Finally, the new institutions established by the Third Energy Package to achieve his different goals promote the European unity. The **ACER** (he Agency for the Cooperation of Energy Regulators) which definitely has a legitimacy to be a European agency, plays a central role in the development of European Union wide network and market rules for enhancing competition. It is not linked at any country in particular or at the EU's commission and has an independent voice where the last instance the European regulators group for electricity and gas has not.

The ACER cooper with **national regulatory authorities (NRAs)**in performing their tasks, manage regional and cross regional actions for the improvement of energy market integration. As a new institution also created the **European Network of Transmission system Operators (ENTSO's) which is** an association between gas and electricity transmission system operators It plays the role of collection and publication of electricity generation transportation and consumption data and information for the pan European market.

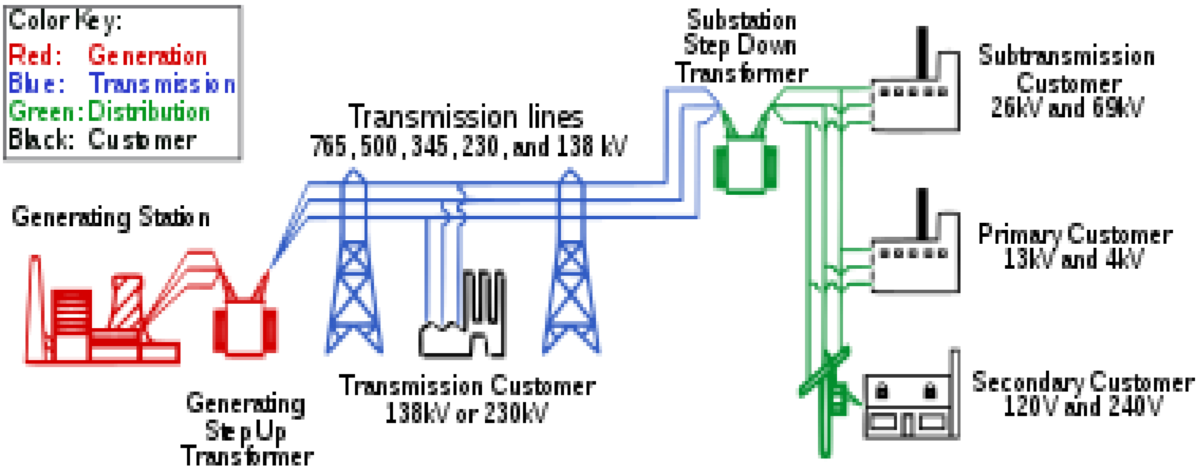


Figure 2: Representation of the different actors linked to the customers

(ii) Actor analysis

The agency: Also known like ACER, the Agency for the Cooperation of Energy Regulators (ACER), as we say above the purpose of acer is to assist national regulatory authorities in exercising, at community level, the regulatory tasks that they performed in the member states and, where necessary, to coordinate their action. The ACER has its own staff and office in Ljubljana (Slovenia), but works together with NRAs and meet regularly with the other stakeholders. It is not an NRA but its complimentary. It has several missions:

- Drafting framework guidelines and issue opinion on network codes (In the framework guidelines and network codes we have the aspect of non-discriminatory rules in the other world who may use infrastructure and how it could be use it.
- Issue opinions on other ENTSO document/plans
- Issue opinions and recommendation whenever asked (or if needed) to European parliament and the commission
- Deciding on cross-border issues if national regulators cannot agree or ask ACER to intervene

- Monitor the functioning of internal electricity and gas market, including network access for electricity produced from renewable energy sources, retail prices and respect of consumer right

The European Network of transmission system operators for electricity: Also known like (ENTSO-E), the entity that I will discuss is ENTSO-E with the E for electricity in our subject has not be confused with the ENTSO-G which another entity created by the third package but related to the gas. So the ENTSO-E is compulsory for network of transport system operation of electricity. This entity:

- Drafts network codes, homogenizing technical (reliability, efficiency and sustainable power system) regulation across Europe.
- Drafts also the ten years network development plan and the regional plans to shape future energy policy for the benefit of each region and each area.
- Ensures the transparency of frameworks

National Regulatory Authorities (NRAs) have a key role to play in ensuring that each European country meets its targets for energy markets and implement all EU regulatory policy. The relevant thing to notice here is all the member state of EU have different kind of regulatory in some countries. For instance, if we take Spain like example, Red Eléctrica de España (REE) is the system operator and the sole and exclusive transmission system operator in Spain. However, it is foreseen that specific transmission facilities belonging to the secondary network can be owned by distribution companies on a case-by-case basis. In annex 1 we can see an exhaust list of national regulatory authorities in Europe. The key role of a National Regulatory Authority is to be active and to act in the interest of consumers, not political one.

After introducing the two main actors in EU's network code, the following sentences will explain the process of adoption of a new code in EU.

The procedure to approve Network Codes

Firstly, the agency starts by writing the framework guidelines, it establishes general principles and serves a basis for drafting the network codes

↓

The ENTSO drafts the network codes a set of rights and obligations that apply to parties operating in the European energy sector

↓

The Agency review drafts of Network code drawn by the ENTSO and issues opinions on them. The goal here is to checking coherence with Framework Guidelines and the aim of Internal energy market EM)

↓

The commission and member states approve the Network Code

↓

Network Code as regulations, apply directly to the EU member states without being transposed into national law

(iii) Analysis of directive and regulations of 3th package

This part will focus to the Second directive and two of three of the regulations of the third package. In order to follow the goal of this research which is the analysis of the winter package. The directive and the regulation not linked to electricity aspect like the first one and the second regulation will not explain here.

Having said that the directive 2009/72/EC, the regulation (EC) No 714/2009 and the regulation (EC) No 713/2009 address different aspect of EU's energy market operation.
We will try to sum up the contain:

The Juridical Structure of energetic actors in EU: the effective separation of networks from activities of generation and supply (effective unbundling)

According the European commission Ownership unbundling can be defined as:
<< a separation of the previously common ownership structure between network and supply activities of a company (supply within this meaning includes retail supply as well as production/generation). In other words, it is separation of all network functions from the other activities — also with respect to the ownership of the assets.>>

The benefits of ownership unbundling of transmission from production are plentiful.
The implementing of Ownership unbundling will generate benefits for the new companies which could be competitors with the historical companies and also generate benefits for the network companies. This strategy is a good manner to answer to a problem which the last package has had in the past by removing a key barrier to entry to the grid by the new companies.

As a result, the application of this part of third package prescribed as mandatory Unbundling of electricity transmission and distribution system operators. If the network operators are independent, they will no incentive any more to discriminate between market actors according the implicit linked. We can have for the new companies which want to be actors will get better access to unused transmission capacity from the network operator which usually seek to optimize the network to make the maximum profit.

With the actual framework and the current rule, the network operator can only generate more revenues if it expands its network. So, the most used is its network the higher the profit could be. Avoid link between DSO, TSO and the others avoid the intrusive pressure for the network operators and regulators.

Furthermore, cross border activities will be facilitated. This independence will favorize a freely cooperation with the Network operators and its neighboring transmission system operators. As a result, an emergence of collaboration and commercial attractiveness with cross borders network companies. Then Cross border investments and EU energy infrastructure capacity will also increase.
Optimization of cross borders relationship is a key point of the Third Package of energy, the main objectives of this regulations is not only to favorize the investments between common structure but also to formalize the structure inside the EU zone in order to be more efficient, more controllable and to have a reliable network.

Then, the Agency created by the third package have to fix the priority for the different network inside the EU zone. It has exclusive power to create according of specification of EU's country, the commercial and technical code. The agency by the third package has to right and the obligation to ensuring that the regulation is respected by the different nationals' authorities responsible of each country.

The EU network adopts with the third package, the common zone of research in electricity code, and has the same annual perspectives for Winter or Summer time in link with the demand. The third package involves the publication coordinated of information about the network access and the implementing each two years the publication of a decennial plan of investment about the network for all the European union. This plan has to contain the models of network, creation of different scenarios and the evaluation of system's capacity. This plan has to be taken account the different investment plan from EU countries and the perspectives of optimization of the trans-European energy network in order to solve the deficiency of European network in terms of interconnexion

The other relevant aspect of the third package when we analyze the contain is the place of the consumers, it stipulates the all consumers are free to choose their suppliers and all suppliers freely to deliver to their customers. Also, the company which supply the energy has the obligation to provide comprehensible information to the customer and this information should be made available to consumers concerning their rights in relation to the energy sector.

This is achieved by fostering an involvement in the broadest possible sense, in matter of reliability of the network, by having a clear bill and the possibility to the consumer of electricity to choose their company depending comparison certified tools without paying any money in the case where the customer would like to change his supplier. We can note also the promoting and facilitating of the electric mobility. In fact, the EU members has to be favorable and implementing the link of loading point of electric vehicle to the distribution network of electricity and open to the third parties, the exploitation of this loading points.

The decision behind the adoption of third package was honorable and permits to ensure an EU's network more reliable, the third package presents lacks in different domains. It revealed with time a big problem in transposition of directives and the application of regulation due to the different level of each country member facing this challenge. All the country did not start to the same point for example The UK could be characterized as the leader of unbundling, since, not only it was the first EU Member State to liberalize its electricity market, but it did it on its own initiative, a decade before the first European Directives were adopted.

In terms of competition, a lot of member states of the EU, which are adopted the third package of energy are limited and the most important producer of energy have stay national company like in France. In some member states, customers have no real possibility of choosing for a new supplier whilst other countries. According the GEODE this possibility is truer in the Nordic countries which are the example of successful working markets.

The lack of market transparency is a real problem in some countries. The national companies in several countries are maintained their status of leader and predominant position. We can note in spite of focusing third package on the unbundling, many countries are insufficient unbundling at the transmission level according GEODE position papers prepared on the EC third energy package: GEODE pp on internal electricity and gas energy market, GEODE pp on unbundling, GEODE pp on generation and GEODE PP on smart metering that are available from the GEODE General Delegation offices.

Limits of the third package is traduced by the fact that; some countries haven't transposed the directive as they have to be done according the third package. Then on February 2014 after verification, the EU commission referred to the COJ for failure to fully transpose the EU internal energy market rules. In fact, since the adoption of the third package Ireland has not completely transposed the electricity Directive (2009/72/EC) which is the purpose of ensuring the generation, transportation and the selling in the competitive markets. The directive had not to be respected because it has not to be fully transposed in March 2011. Ireland had to pay a penalty but had implemented the required provisions of the Directive and the case was discontinued. A number of other Member States have been targeted by the Commission for failure to implement the Energy Package.

Another case is the case of Germany, on February 2015, a letter was issued to the European justice, this letter was followed by a notice in 2016. The actions attributed to the Germany are considered as offences by the law adopted by the European Union according the adoption of third package of energy. Germany doesn't implement the requirement, the country had not a separation and a total independence between the production network and the transmission network as we discussed previously in the principles of third package. In Germany these two entities were unique. The regulation authority in Germany does not have all the power in term of fixing the price of using the network and the modality of network access, balancing services because these different actions are defined by the federal government due to the structure of the country.

According the third package if this entity is not separated, the energy market can't have a real concurrence. In the other worlds the independence of production network and transmission network permit the increasing of the number of providers of electricity, so more concurrence and a decreasing of price.

2. Winter package

It was necessary to understand the third package which is one of the most impacting packages to move towards a common European energy market. The first worldwide agreement on the attenuation of global warming which is enter into force the 4th November, took place in Paris 2015. It's important to mentioned because it is taking account by all the different regulations proposed in the winter package and lead nowadays all the decision which aim to modify the existing energy landscape. Therefore, implementing of ambitious projects of EU depends on majority of a successful transition to a clean energy system.

On November 30th November 2016, the European commission published a series of legislative proposals named "Clean energy for all Europeans" also known under the famous name of Winter package. The winter package contains 8 regulations and is named as "winter package "rightly because two mains reasons. The first one due to the lower temperatures in winter nowadays making obvious allusion to global warming and the second most fundamentally because the new regulations freeze all efforts began until 2008 in order to reform the design and operation of the European Union's electricity market in terms of introducing the energy transition.

The winter package is a huge document including more than 1000 legal text completed by 4000 annexes pages. The goal of the winter package is to improve the energy efficiency in the European common market of 30% and also bring the consumption of renewables energies in Europe to 27% all countries include in 2030. The package covers various parts of the energy sector. The most important issues are grouped into 3 categories, covering each their part of the energy value chain:

The first category is about the remodeling of the market predefined by the different previous package and mostly the third package. These modifications are named the market design (MDI). For this category The Winter package fully revised a part of third package directive 2009/72 and introduces new regulation on the internal electricity market, amending and repealing the regulation 714/2009 and 713/2009 of ACER regulation.

The second has an impact on the energy efficiency (2012/27 EU) and the renewables directive 2009/28 (RED) in order to make a better alignment and integration climate change goals into the new market design.

The last category regroups a group of texts about measures to facilitate the transition to a clean energy economy. The overall objectives of each proposed measure electricity sector (the Risk Regulation) and a proposed regulation on Governance of the Energy Union (the Governance Regulation) both to enter into force on 1 January 2021) are entirely new measures. By achieving these aims, this package can also maximize EU leadership in the clean energy transition, fight against climate change, and help non-EU countries achieve their policy goals. **The WP package includes 8 different legislative proposals** (each with a linked impact assessment), with political agreement having been reached on four of the eight files, as shown below (as of November 2018):

- Energy Performance in Buildings
- Renewable Energy
- Energy Efficiency
- Governance
- Electricity Market Design
- Rules for the regulator ACER

The table below shows us the state of the different legislative proposal of the winter package according to the European commission source:

	European Commission Proposal	**EU Inter-institutional Negotiations**	**European Parliament Adoption**	**Council Adoption**	**Official Journal Publication**
Energy Performance in Buildings	**30/11/2016**	**Political Agreement**	**17/04/2018**	**14/05/2018**	**19/06/2018 Directive (EU) 2018/844**
Renewable Energy	**30/11/2016**	**Political Agreement**	**13/11/2018**	-	-
Energy Efficiency	**30/11/2016**	**Political Agreement**	**13/11/2018**	-	-
Governance	**30/11/2016**	**Political Agreement**	**13/11/2018**	-	-
Electricity Regulation	**30/11/2016**	**Ongoing**	-	-	-
Electricity Directive	**30/11/2016**	**Ongoing**	-	-	-
Risk Preparedness	**30/11/2016**	**Ongoing**	-	-	-
ACER	**30/11/2016**	**Ongoing**	-	-	-

Figure 3: Clean Energy for All Europeans Package - state of play (November 2018)

The development of renewable energies is mainly predicted in terms of electrical production. According to the Agency in 2030 due to the nowadays development in this sector, and if all the regulations of winter package are agreed by the different step without modification, taking account some hypothesis (demography of European Union, growth stock, oil price, etc.) the renewables energies could be in 2030 around 49% of the electrical production in European Union.
This scenario is named the **EUCO30.** The table below is a sum up of EUCO30 in terms of share of renewable energies*:*

	2015	**2016**
Population (million inhabitants)	**505**	**516**
Share of renewable energies in finale consumption in total	**16,1 %**	**21,1%**
Share of ENR consumption in electricity consumption	**28,2%**	**48,7%**
Share of ENR consumption in Hot/Cold Using	**17,4%**	**26,3%**
Share of ENR consumption in transports Using	**6,9%**	**19%**

Source: ***PRIME, Results of the EUCO policy scenarios***

In this scenario in the 49 % of percentage of European electrical production, 27% could be intermittent electricity. An Intermittent electricity is electrical energy that is not continuously available due to external factors that cannot be controlled, produced by electricity generating sources that vary in their conditions on a fairly short time scale. Sources of intermittent electricity include solar power, tidal power, wind power and wave power.

This increasing of use of renewable energy will need to be linked to huge system of energy storage. The Winter package predict to reduce gradually the package of financial aids allocated to these intermittent subsidiaries thanks to a market of electricity transformed. The new aggregators could be playing a fundamental rule in the electrical European landscape.

An aggregator is any organization or individual that brings retail energy customers together as a group with the objective of obtaining better prices, service, or other benefits when acquiring energy or related services. About the consumer, they have an incentive to operate and consume energy from their own installations producing renewable energy as individual citizen or as a community for energy.

The selling of surplus of production is made in market rates. Whereas this price is always very low. According the IFRI (French center of research),the auto-consumers find more benefit to store the surplus of energy produced and consume it later than sell it to introduce it into the grid.

The graph below describes one simple model of production and consumption for an individual equipment with photovoltaic cells and batteries. The graph shows that can it could be interesting for a community to resort to intermediary (aggregator) who will manage in order to maximize the gain according the best opportunities to the market grid.

In fact, the Winter package give to the Aggregator the rights devolved upon to individual auto consumers and also one aggregator which have a lot of installations with each power production below 500 kW keep for each installations the priority of injection given to each installation as planned by the winter package.

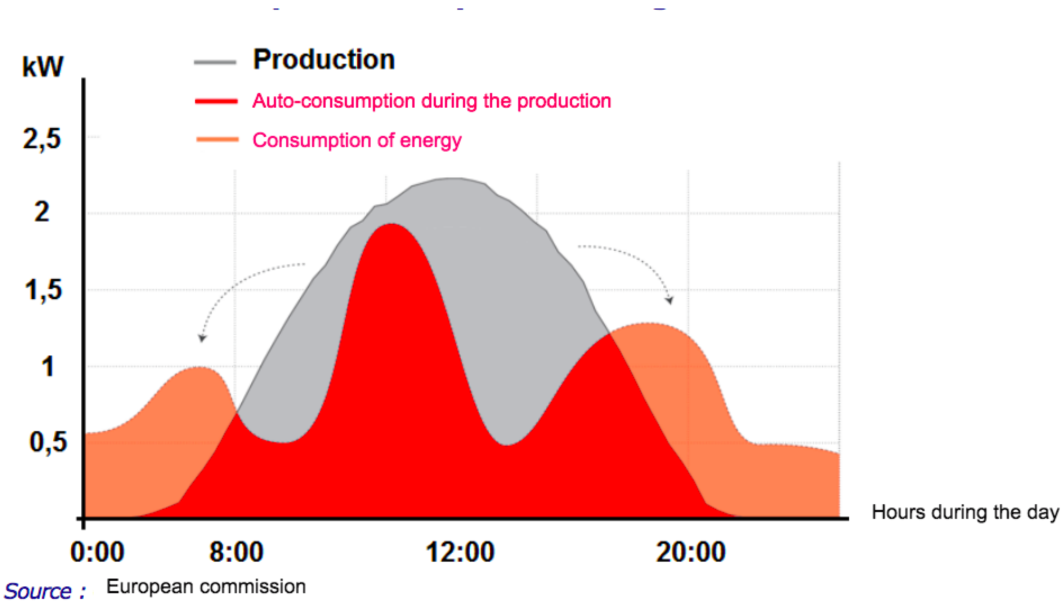


Figure 4: Model of production and consumption for an individual equipment with photovoltaic cells and batteries

(i) Energy storage in winter package

The development of technology and global warming created the pressure to use renewables energy becomes more and more tangible and is senses more and more. Renewables energy with time is becoming more present in grid energy generation. It is obvious that the new regulatory frameworks in energy package in EU as in the word are currently unable to adequately address the question of energy storage. When the current network was designed and implemented, the place of energy storage in the grid was negligible compared to generation and transmission. With large scale energy storage emerging as key to secure, flexible renewable power grids. The regulations of this domain become crucial.

In fact, the third package described below did not anticipate the current importance of energy storage even if she makes clear the need to encourage the electricity storage. The Winter package did it and identifies the significance of energy storage as part of the wider green energy environment and addresses regulatory challenges. The Winter Package make a support for the deployment of energy storage as capital instrument within the framework of the EU energy and climate policy to deliver services to, and improve the flexibility of, the European energy system.

The Winter Package says that the regulators (transmission and distribution) of electricity which have took place with previous packages could not own their own system of energy storage. Only tenders in the storage market could be possible. In the other world That’s mean “Réseau de Transport d'Électricité” (Electricity Transmission Network), usually known as RTE, is the electricity transmission system operator of France. It is responsible for the operation, maintenance and development of the French high-voltage transmission system, which at approximately 100,000 kilometers (62,000 mi), is Europe's largest. As an example, RTE could not own their own batteries of capacitors or something else to manage and modulate voltage of the network.

The energy storage and Electric vehicle charging networks according to article 36 of the E-Directive provides that as a general rule DSOs shall not be allowed to own, manage or develop facilities dedicated to energy storage. Due to the separation of power and the decentralization rules of WP.

The main problem with the storage of energy is in his own definition. This definition issue causes for the EU’s country a difficulty in determining when fees and taxes has to been applied. This would avoid energy storage from being classified as generation or as consumption or as both. Such a status would eliminate the unwarranted double charging (including levies and taxes) that energy storage facilities often face.

As an example, an implementation of energy storage resources could depend of country unfairly face double distribution costs for both charging and discharging. When the Winter package was presented for the first time to be analyze by the different step before to be adopted. The European parliament's committee for industry, research and energy (ITRE) proposed amendments to the winter package. These amendments proposed a new definition of energy storage as a 4th category of energy chain after production, transmission and distribution. These amendments have not been followed and the energy storage in the winter package is not classified as a 4th category so not separate as an independent component of energy chain and network. The Winter Package sum up the energy storage as a part of generation keeping restriction of generation platform and this places restriction on ownership and operation.

In practice these restrictions make that TSOs and DSO are not allowed to be ownership of energy storage platform or to operate on any storage asset large enough to require a specific license.

In one hand They could use these facilities unless following an open tender procedure no other party has expressed an interest in entering this market and storage facilities are necessary for the DSOs to fulfil their regulated tasks for the reliable and secure operation of the distribution system.

In the other hand article 33 of E directive does not prohibit DSOs from rolling out EV charging frameworks, similar conditions are attached as for storage in that it must first be established via an open tender procedure that no other party has expressed its interest in rolling out a recharging network. This situation should be reviewed at five-year intervals. Both EV and storage operations have to be operated by legally unbundled entities, as required under Article 35, and these entities must maintain separate accounts, as required by Article 56 of the E-Directive.

(ii) Creation of ROCs

Regional Operational Centers (ROCs) are the new bodies introduced by the "Winter Energy Package" with the Articles 21(6), 32 - 44, Recitals 33 - 37 and Annex I of the Proposal for a Regulation of the European Parliament and of the Council on the internal market for electricity (recast), 30.11.2016, COM (2016) 861 final 2016/0379 (COD).

Regional Operational Centers will be organized in a legal form stipulated in Article 1 of Directive 2009/101/EC of the European Parliament and of the Council (for example, in United Kingdom in the form of companies incorporated with limited liability).

Regional Operational Centers are intended to complement the role of TSO (transmission system operators) by performing functions of regional relevance.

The Rocks' role will be to make the calculus annually of the maximum amount entry capacity available for the participation of foreign capacity taking into account the expected availability of interconnection and the likely concurrence of system stress between the system where the mechanism is applied and the system in which the foreign capacity is located. For each **bidding zone** border this calculus will be made.

With the adding of new bodies, the European Union Agency for the Cooperation of Energy Regulators (ACER) is assigned the following tasks and competences as regards the Regional Operational Centers:

- monitoring and performance analyses,
- deciding on the ROC's configuration,
- requesting information from ROC's,
- issuance of opinions and recommendations.

The Regional operational have to work with the Transmission system operator They are granted the right to adopt binding decisions addressed to the transmission system operators in respect of the following functions:
- coordinated capacity calculation,
- coordinated security analysis,
- regional sizing of reserve capacity,
- calculate the maximum entry capacity available for the participation of foreign capacity in capacity mechanisms.

The draft regulation further stipulates that transmission system operators must implement the aforementioned binding decisions issued by the Regional Operational Centers except in cases when "the safety of the system will be negatively affected".

(iii) New electricity market design

During the last fifteen years the electricity's landscape has been changed and continue to change right now due to integration of renewable energy in the grid. Unfortunately, the infrastructure for and the initiative for a European electricity system are not follow the rhythm as they should be. As I mentioned in the first part of report with the EUCO30, Europe envisage the share of electricity produced by renewable sources has soared to 29% and will grow up to 50% in 2030, in line with the 2030. As a result, market rules should be adapted to facilitate this development, increase the flexibility of the system and ensure security of electricity supplies. Until the third package we have seen increasing competition and sharing cross border energy. However, the European electricity doesn't flow directly to where it is most needed. As a consequence, some Member States are resorting to purely national assessments and strategies to minimize risks to security of supply, without taking account of the impact on neighboring countries.

it's important to notice also there are a lot of member state of EU where the retail markets are suffering from low level of competition and consumer engagement. The winter package tries to solve these problems.

Despite technical innovation such as the using and implementing of smart grids, the emerging of prosumers and the expansion of the storage domain, consumers are not sufficiently informed nor incentivized to actively participate in electricity markets.

In the wholesale market, the new rules brought by the Winter package touch a variety of principles and technical provisions with real tangible economic effects. Among these the more relevant in our studies are:

- Short term markets will be made overall more flexible and responsive to the rise in variable renewable generation.

- Wholesale price caps will be removed, making prices reflect the real value of electricity in time and location (scarcity pricing) in order to drive investments towards the flexible assets most needed for the system, including demand-response and
storage. More liquid and interconnected markets will increase trade opportunities.

- Dispatch rules will be adapted to the new market reality, creating a level-playing field for larger generation capacities. Rules on priority dispatch will however be maintained for small-scale renewable installations and emerging technologies to ensure their development.

- Grid bottlenecks on the borders will be minimized, among other things by reinvesting congestion revenues into the grid.

- The overall electricity system operation by TSOs will see more coordination on a regional level to ensure most optimal utilization of the grid and better grid stability.

- Better demand participation: remuneration for demand response will be more in line with the flexibility provided by such services, creating a better economic case for distributed resources and for self-generation.

What are the new rules for the retail markets?

Recall that purpose of winter package is to give more power to consumers and an electricity access more secure, clean and competitive. The new rules brought by winter package for the retail electricity in our study case are:

• Consumers will be provided with better information about their energy consumption and their costs through clear electricity bills. Suppliers will have to prominently display basic information on every bill, and report energy costs, network charges and taxes/ levies in the same way for clarity.

• All EU electricity consumers will get free-of-charge access to at least one certified energy comparison tool that meets minimum quality standards in order to provide reliable information about the offers provided to consumers. Switching conditions will be made easier. All switching related charges will be prohibited, except for early termination fees on fixed term contracts. These must be limited in size and contract
s containing them must provide consumers with tangible advantages in return

• Every consumer will also be entitled to a smart meter equipped with common minimum functionalities. Member States not planning to roll-out smart meters are required to assess the cost-effectiveness of a large-scale smart metering deployment on a regular basis. According eugerati 14 European member countries (Austria, Denmark, Estonia, Finland, France, Greece, Ireland, Italy, Luxemburg, Malta, Netherlands, Spain, Sweden and UK) are currently proceeding with large-scale rollout by 2020 or earlier, or have already done so, according to the report.

• Consumers and communities will be empowered to actively participate in the electricity market and generate their own electricity, consume it or sell it back to the market while taking into account the costs and benefits for the system as a whole. (This part is developed in the part of report about "prosumers"

• This necessitates the removal of retail price regulation while ensuring the full and appropriate protection of vulnerable consumers. Targeted price regulation such as social tariffs will be permitted for a transition period to address the needs of vulnerable consumers until their situation can be addressed by appropriate energy efficiency and social policy measures.

• A new EU DSO entity will be created. It will be responsible for putting in place rules on grid management and use and EU-level cooperation with TSOs. It will also work on the integration of renewables, distributed generation, energy storage, demand response and smart metering systems.

(iv) Limits of Winter package

First of all, there is a real absence of nuclear in these new European measures, the future of nuclear energy stays a question which need more clarification by European institutions.

The debate of nuclear seems more concerned the EU's country as the France which is an actual debate according the big rating of nuclear rating in its energy production which could be decrease to 75% to 50%. We will speak about it in the example of application of Winter package in Poland .in one example below

According E3G which is an independent climate change think tank operating to accelerate the global transition to a low carbon economy. The winter package presents some contradiction. The E3G stresses the big contradiction between the treatment of renewable energy and the treatment of funding dedicated to coal. This is could be very hard to understand how Europe could be the number one in terms of renewable energy when the winter package suppresses the priority to introducing in the grid of renewable energy and the financial support for capacity of old coal plant of energy supplying.

In fact, the to keep energy safe and reliable, Winter Package could actually subvention the Energy plants which used fossil energy, to the great displeasure of NGOs environmental as Greenpeace or WWF which are strongly disapproved this part of Winter package.

The article 23 of Design principles for capacity mechanisms in annex 3, with the lack of limit on the total emission limit of CO2 for the new capacity of production created indirectly a pass for a subvention for the new coil plant. The application of this article around 95% of coil plant in European union would be eligible to this subvention until 2026 according euractiv.

Another controversial of Winter package article is Article 11 which corresponds to the Dispatching of generation and demand response in annex 4. This article discusses about the priority of injection electricity in the grid. The previous energy package established the priority of renewable energy that the winter package change.

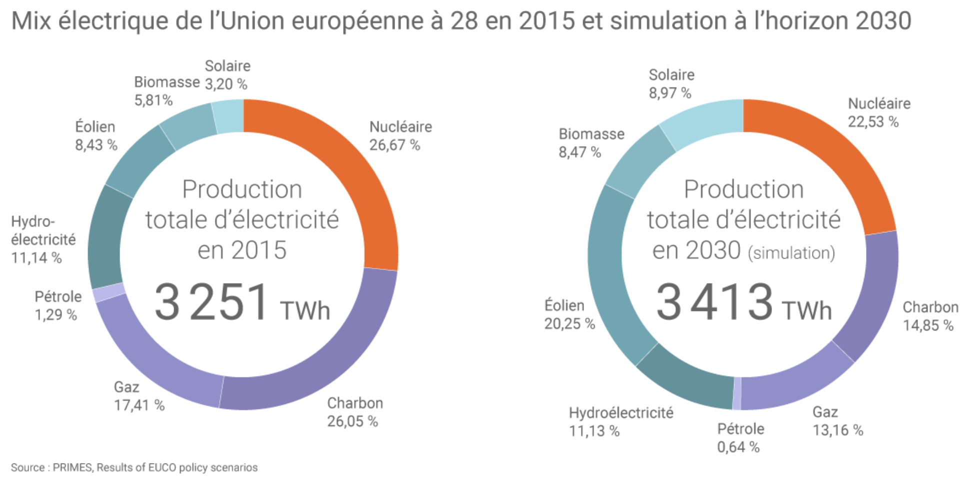


Figure 5: Percentage of energy for each source according EUCO30 - Source: CDE « comité des experts en énergie »

The figure 5 overhead shows us with details the development of renewable energies with the scenario EUCO3. The most impressive development is the development of wind energy and as we say below all the countries have not the same potential for wind energy.

Considering these new modifications, there is the problem of potential which was take account but according some responsible parties of energies depending on country. This scenario is impractical with the deadline. As an example, in France, this scenario which is a part of winter package is of course in the line with the new problem linked to the energy transition and global warming with the agreement completed in Paris.

They supposed to make place a very big investment and big regulations country by country to protect the regions which depend of the other kind of energies. In France it's the nuclear because 80% of energy in France is from nuclear energy and decrease the capacity of nuclear will bring problems because the energy landscape of France has to make face a big modification.

The social aspect is to take account because a nuclear plant is not just a company they participate to region's economy, with an amount worker who have to be take account in case of closing the plant. The reinsertion of this person could be very difficult because it's a specific domain.

(v) Limit of winter package: Use case Poland

The winter package will prohibit to build thermal power plants whose carbon factor would be greater than 550 grams CO2 / kilowatt-hour (g CO2 / kWh). This condemns coal boilers that struggle to produce power at less than 900 g CO2 / kWh.

However, according the "http://www.journaldelenvironnement.net/" a scientist French website on the environment, the average carbon factor of the European generation fleet was already around 300 g CO2 / kWh. A lot of NGOs as Greenpeace accuse the Commission to give slack to the electricians, especially the ancient countries from the communist bloc. This is indeed the case. The suspension of coal-fired power plants would not been voted by Poland, the Czech Republic and Hungary; condemning at the same time the Winter Pack to oblivion. So, the commission initiated in the winter package the principle of the capacity mechanism.

Being deployed Currently in France and 10 other EU countries, this principle of winter package doesn't support really the process of decarbonization. It aims to encourage financially the operators to keep them ready to start their thermal plants in case of big problem of supplying energy (cold wave or unexpected interruption of several production capacities). In other words, the highly coal-mining countries will be able to maintain their electricity generating capacity, in particular to ensure the security of supply for their neighbors. However, these countries will be responsible for supplying green or less carbonaceous electrons. The carbon factor of the European electricity sector will be lower, but not necessarily regionally.

In the case of Poland, it produces almost all of its electricity through thermal plants, such as that of Belchatow, the largest in Europe. The majority are fueled by coal, thanks to the country's very rich coal subsoil (the first in Europe). As part of the EU climate-energy project and considering the Winter package, Poland has committed to reduce its greenhouse gas emissions by 14%, and to increase the share of renewable energies in its mix by 15%. here 2020. For this, Poland will have to reduce the share of coal in its mix: because of its large use, the country is the one that generates the most CO2 per kWh produced in the EU. Poland is planning to put in place a mechanism for purchasing a market, to guarantee the security of electricity supply in the country. In the priorities set by the EU to Poland, in addition to reducing the environmental impact of its energy industry, the country must also vary the sources of electricity production. For this, Poland will develop its energy variety, It plans to develop nuclear energy as part of its future energy system, according to Krzysztof Tchórzewski, the Polish Minister of Energy, because it is low-cost, low-carbon and creates high-value jobs.*(Source: www.gov.pl)* . Mr Tchórzewski told that nuclear energy is a response to the challenges facing Polish economy and the energy sector, especially in the context of EU requirements. The climate policy of the European Union and the winter package compel a further decrease of the share of coal in the energy mix amid the continuously growing demand for electricity.

A regulation profile done and analyse for the integration of renewable energy. The second part of the document will be dedicated to the technical point of view which is also important.

V. Technical review of an example of a set of regulations

1. Applications scope and classification of modules

The CENELEC regulation of April 2016 sets out an applications scope. Firstly, the Regulation shall in normal cases apply to new power-generating modules considered as significant.

Basically, the document lists some systems to which The Regulation shall not apply:

- power-generating modules connected to the transmission system and distribution system (or part of it) on islands of Member States whose systems don't work synchronously with the synchronous zone of Continental Europe, Great Britain, Nordic, Ireland and Northern Ireland or Baltic;
- power-generating modules installed in order to provide back-up power (operating less than 5 minutes per month in normal system state);
- power-generating modules that do not have a permanent connection point and used by the system providers to provide temporarily when the normal system is unavailable;
- storage devices (except some pump-storage power-generating modules).

Generally, the regulation should not apply to existing power-generating modules. Firstly, let's define what is an "existing" module: it is already connected to the network on the date of application of the Regulation OR the power-generating facility owner has concluded a definitive contract for the purchase of the main generating plant by two years after the date of application of this Regulation.

In addition to this, in a specific context (significant factual changes: evolution of system requirements including penetration of renewable energy sources, smart grids, distributed generation or demand response), the TSO may propose to the regulatory authority to extend the Regulation to existing modules. However, this requires a qualitative comparison of costs and benefits, a preliminary approval of the regulation authority and finally an entire quantitative cost benefit analysis indicating the following elements:

- the cost that will have to be paid for these modules to make them comply to the Regulation;
- the socioeconomics benefit of the application of the Regulation;
- the possibility of others measures to achieve the desired performance.

After this procedure, the relevant regulation authority decides about the attribution or not of the extension.

Significance:
The power-generating modules shall comply to some criteria regarding voltage level of their connection point and maximum capacity. The following categories are considered as significant:

- connection point below 110 kV and maximum capacity of 0,8 kW or more (type A);
- connection point below 110 kV and maximum capacity at or above a threshold proposed by each relevant TSO (type B and C) (see below);
- connection point at 110 kV or above (in certain cases it can be less) (type D).

Below the maximum capacity threshold limits for each type:

Synchronous areas	Limit for maximum capacity threshold from which a power-generating module is of type B	Limit for maximum capacity threshold from which a power-generating module is of type C	Limit for maximum capacity threshold from which a power-generating module is of type D
Continental Europe	1 MW	50 MW	75 MW
Great Britain	1 MW	50 MW	75 MW
Nordic	1,5 MW	10 MW	30 MW
Ireland and Northern Ireland	0,1 MW	5 MW	10 MW
Baltic	0,5 MW	10 MW	15 MW

Figure 6: Limits for thresholds for type B, C and D power-generating modules

Offshore modules connected to the interconnected system shall meet the same requirements as onshore modules, except if the requirements are modified by the system operators for this purpose or if the connection of the power plant modules is through a high voltage direct current connection or via a network whose frequency is not synchronously coupled to that of the main interconnected system.

Pump-storage modules shall respect the relevant requirements in generating and pumping operation mode. Pump-storage variable speed power-generating modules shall on another side respect the requirements applicable to synchronous power-generating modules and the ones specific to each type.

Generally, the requirements of the Regulation relating to the capability to maintain constant active power output or to modulate active power output shall not apply to modules of facilities for combined heat and power production integrated to facilities own networks if all these criteria are met:

- the principal purpose of the facility is the production of heat for the production processes of the concerned industrial site;
- heat and generation of power are very linked (a change of heat generation results inadvertently in a change in generation of power and conversely);
- the modules are necessarily of type A, B or C (D possible in certain cases for the Nordic synchronous Area).

2. General requirements for power-generating modules

(i) Type A

Now, let us go through the heart of this regulation: the different requirements that should be fulfilled by the different power-generating modules.
Firstly, we can talk about the regulations imposed regarding the frequency. The following table shows us for each frequency range how long the type A generating power are authorized to work far from the nominal frequency value (50 Hz).

Synchronous area	Frequency range	Time period for operation
Continental Europe	47,5 Hz-48,5 Hz	To be specified by each TSO, but not less than 30 minutes
	48,5 Hz-49,0 Hz	To be specified by each TSO, but not less than the period for 47,5 Hz-48,5 Hz
	49,0 Hz-51,0 Hz	Unlimited
	51,0 Hz-51,5 Hz	30 minutes
Ireland and Northern Ireland	47,5 Hz-48,5 Hz	90 minutes
	48,5 Hz-49,0 Hz	To be specified by each TSO, but not less than 90 minutes
	49,0 Hz-51,0 Hz	Unlimited
	51,0 Hz-51,5 Hz	90 minutes
Baltic	47,5 Hz-48,5 Hz	To be specified by each TSO, but not less than 30 minutes
	48,5 Hz-49,0 Hz	To be specified by each TSO, but not less than the period for 47,5 Hz-48,5 Hz
	49,0 Hz-51,0 Hz	Unlimited
	51,0 Hz-51,5 Hz	To be specified by each TSO, but not less than 30 minutes
Nordic	47,5 Hz-48,5 Hz	30 minutes
	48,5 Hz-49,0 Hz	To be specified by each TSO, but not less than 30 minutes
	49,0 Hz-51,0 Hz	Unlimited
	51,0 Hz-51,5 Hz	30 minutes
Great Britain	47,0 Hz-47,5 Hz	20 seconds
	47,5 Hz-48,5 Hz	90 minutes
	48,5 Hz-49,0 Hz	To be specified by each TSO, but not less than 90 minutes
	49,0 Hz-51,0 Hz	Unlimited
	51,0 Hz-51,5 Hz	90 minutes
	51,5 Hz-52,0 Hz	15 minutes

Figure 7: Minimum time periods for which a power-generating module has to be capable of operating on different frequencies, deviating from a nominal value, without disconnecting from the network

By reading this table the frequency range concerning type A is almost the same for all the zones (47.5 to 51.5 Hz - 47- 52 Hz for Great Britain). The fact that the range is extended in Great Britain is explainable because it's an island and the stability of the grid is consequently less sure. Concerning the time period which is the minimum time for which a power generating module has to be capable of operating deviating from the nominal value (50 Hz), without disconnecting from the network, we can notice some differences between each zone, which can surprise us but could be explained by the system specificities of each zone. Freedom is also let to the TSO in many cases, maybe to take in account the local specificities of the grid and the system. An interesting point to notice is that the exigencies of time period seem higher in the centre of the interval of frequency, which is logical because it's close to 50 Hz. Basically, the term "unlimited" for frequency values between 49 and 51 Hz means that it's authorized to work in this range as a normal operation.

Example: Continental Europe (containing Spain) :

- from 47.5 to 48.5 Hz: Not less than 30 min but to be specified by TSO;
- from 48.5 to to 49 Hz: Not less than the previous value (can be higher);
- from 49 to 51 Hz: Unlimited → CENTER OF INTERVAL;
- from 51 to 51.5 Hz: Minimum 30 min.

An important point described in the CENELEC document is that the frequencies ranges and time period described here are the minimum ones and can be extended by the relevant system operator in coordination with the TSO and power-generating facility owner. However, this has to be done in reasonable ways (the power-generating facilities shall take in account their economy and the technical feasibility of the extension).

Eventually, specific requirements concerning combined frequency and voltage deviations can be set up in order to ensure the best use of the technical capabilities of a power-
generating module.

Another point addressed by the regulation is the capacity of a power generating module to support frequency variations speed: it has to be able to stay connected to the grid and to operate regardless this speed in the limit of a value fixed by the relevant TSO, unless the disconnection is triggered by the protection linked to this variation. This protection is adjusted by the system operator and the relevant TSO.

Some points are also described concerning the limited frequency sensitive mode (overfrequency LFSM-O mode), the settings are by the relevant TSO in coordination with the TSO's of the same area.

- the power generating module has to be capable to activate the active power as a response to the frequency variations at a frequency threshold and drop settings defined by the TSO (figure 7);
- the relevant TSO can also instead choose to authorize in his setting zone the automatic disconnection and reconnexion of the power-generating modules of type A at randomized frequencies, ideally uniformly distributed, above a frequency threshold as determined by the relevant TSO if he is capable to demonstrate to the regulation authority and with cooperation of the facilities owners that it has a limited cross-border impact and maintains the same level of operational security in all system states;
- the frequency threshold shall be between 50.2 and 50.5 Hz;
- the drop settings have to be between 2 % and 12 %;
- the power generating power is capable to active the power response to the frequency variations in an as short as possible initial delay (if the delay is greater as 2 seconds, the owner of the installation has to communicate a technical justification);

- the relevant TSO can require that the power generating module, upon reaching his minimum regulating level is able to:
    - continue to operate at this level OR
    - continue to reduce production of active power
- operate in a stable manner in LFSM-O mode.

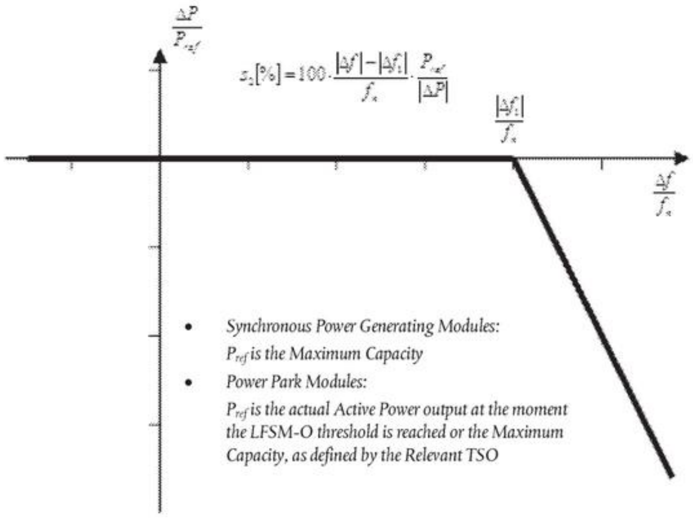


Figure 8: Active power frequency response capability of power-generating modules in LFSM-O

In this figure, Pref is the maximum capacity of the power generating modules and it serves as active power reference for ΔP (the value of Pref_max is specified for each synchronous power generating modules and power park modules and Pref is always a certain percentage of Pref_max depending of the irradiance (for PV modules) / wind speed (for wind turbines) at the location of the modules). ΔP is the change in active power output from the power-generating module. fn is equal to 50 Hz (nominal frequency value). Δf is the frequency deviation (|f-fn|). For large over-frequencies (when Δf > Δf1), the power-generating must be capable to provide a negative active power output change according to the drop S2.

With some exceptions, regardless of changes in frequency, the power generating module shall be capable of maintaining constant output at its target power active value.

The relevant TSO shall specify admissible active power reduction from maximum output with falling frequency as a rate of reduction falling within the boundaries (area in blue in the following figure).

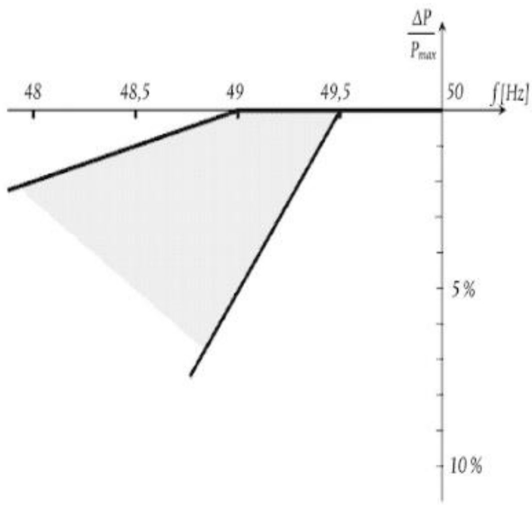


Figure 9: Maximum power capability reduction with failing frequency

- below 49 Hz, the maximum reduction rate is 2 % of the maximum power capacity at 50 Hz per 1 Hz frequency drop;
- below 49.5 Hz, the reduction rate is 10 % of the maximum power capacity at 50 Hz per 1 Hz frequency drop.

The TSO has the freedom to stare the capability in the blue area of the diagram.

The conditions under which a power generating power is capable of connecting automatically to the network are to be specified by the relevant TSO. The conditions have to include:

- the frequency ranges within which an automatic connection is admissible;
- a corresponding delay time;
- maximum admissible gradient of increase in active power.

<u>Example for frequency regulation</u>

To illustrate the frequency regulation policies, we can give the example of the Almacena project in Carmona (near Sevilla) which has consisted in the installation of an energy storage system (lithium-ion battery). Its power is in the range of 1 MW and its capacity of at least 3 MWh. The project has also two other uses: Load Following (Tertiary Balancing) and Renewables Energy Time Shift. The installation is operational since December 2013. The storage system has been installed in the Carmona 400/220kV substation (owned by Red Eléctrica), and is composed of:

- the electrochemical storage equipment;
- the converter system;
- the communication and control systems;
- a user IT application.

The system is connected to the communication systems of Red Eléctrica so that it can be constantly monitored and controlled. The storage system has been installed in a 16-meter-long container. it will contain 30 racks of lithium-ion prismatic cells. The project consists in several phases:

- First phase: the storage system is installed to test load curve modulation and power-frequency regulation with the aim to favour the integration of renewable energies and the improvement of operation services.
- Later phases: the installation has been used as a test platform in order to evaluate the possible contribution of this technology to other operation services such as increase of grid flexibility, stability of the system, etc.

Key parameters of the system have been collected and analysed in order to evaluate, from a technical and economic standpoint, the capacities of the selected technology.

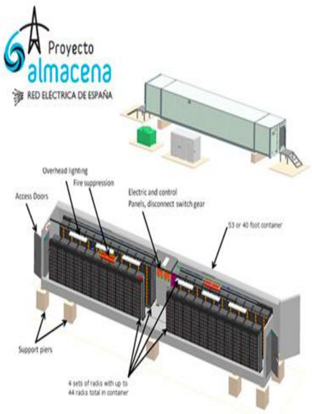


Figure 10: Structure of the Almacena project

(ii) Type B

Firstly, it is important to say that the type B modules have to respect all the rules applied to type A modules except the following point:

- the relevant TSO can also instead choose to authorize in his setting zone the automatic disconnection and reconnexion of the power-generating modules of type A at randomized frequencies, ideally uniformly distributed, above a frequency threshold as determined by the relevant TSO if he is capable to demonstrate to the regulation authority and with cooperation of the facilities owners that it has a limited cross-border impact and maintains the same level of operational security in all system states.

In addition to this, we can notice more points linked to frequency stability that these modules shall respect:

- every module should be equipped with an interface (input port) in order to allow the control of active power output (reducing the active power output through the interface if necessary);
- the system operator has right to specify more equipment able to command at distance the active power output.

Some rules are related to robustness:
In this rule category, we can distinguish different subcategories:

1. Firstly, some points are linked to fault-ride-through capability for symmetrical defaults.

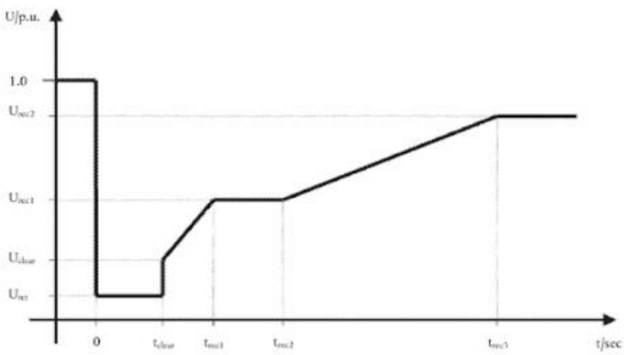


Figure 11: Fault-ride through profile of a power-generating module

In this figure, we can see the lower limit of a voltage-against time profile of the voltage at the connection point. It is expressed as the ratio of the actual value and its reference before the fault (which has a ratio of 1).

- Uret is the retained voltage at the connection point during a fault.
- tclear is the instant when the fault has been cleared.
- Urec1 / Urec2 / trec1 / trec2 / trec3 represent certain key points in the diagram of lower limits of voltage recovery after fault clearance.

- each TSO has to specify a voltage-against-time profile in accordance to the previous figure to the connection point in case of fault conditions, which correspond to conditions in which the power-generating module is capable to stay connected to the network and to continue to operate stably after the power system has been disturbed by secured faults on the secure system;
- the voltage-against-time profile has to express a lower limit of the phase-to-phase voltages at voltage level of the connection point during a symmetrical default, before, during and after the default;

- this lower limit has to be expressed by the TSO using the different parameters of the figure above and respecting the ranges described in the following tables (the applicable table depends on the case of the modules).

Voltage parameters (pu)		Time parameters (seconds)	
U_{ret}:	0,05-0,3	t_{clear}:	0,14-0,15 (or 0,14-0,25 if system protection and secure operation so require)
U_{clear}:	0,7-0,9	t_{rec1}:	t_{clear}
U_{rec1}:	U_{clear}	t_{rec2}:	t_{rec1}-0,7
U_{rec2}:	0,85-0,9 and ≥ U_{clear}	t_{rec3}:	t_{rec2}-1,5

Figure 12: Parameters for Figure 10 for fault-ride-through capability of synchronous power-generating modules

Voltage parameters (pu)		Time parameters (seconds)	
U_{ret}:	0,05-0,15	t_{clear}:	0,14-0,15 (or 0,14-0,25 if system protection and secure operation so require)
U_{clear}:	U_{ret}-0,15	t_{rec1}:	t_{clear}
U_{rec1}:	U_{clear}	t_{rec2}:	t_{rec1}
U_{rec2}:	0,85	t_{rec3}:	1,5-3,0

Figure 13: Parameters for Figure 10 for fault-ride-through capability of power park modules

- Each TSO has to specify and publish the conditions before and after fault to consider for the fault ride through in the following terms:
  - the calculation of the minimum short-circuit power (capacity) at the connection point before the fault (expressed in MVA)
  - the active and reactive power output of the modules at the connection point before the fault and the associated voltage value
  - the calculation of the minimum short-circuit power (capacity) at the connection point after the fault (expressed in MVA)
- at the request of a power-generating facility owner, the system operator provides the conditions to be considered for fault-ride-through before and after the fault on the basis of the calculations for the connection point made in the previous point.
  The TSO can alternatively provide generic values derived from typical cases.
- Given conditions concerning the fault before and after the fault, the module has to be able to remain connected to the network and to continue to operate in a stable manner when the course of the phase-to-phase voltage level at the connection point during a symmetric fault remains above the voltage profile explained earlier, unless the protection scheme for internal electrical faults requires the disconnection of the module from the network. However, the protection schemes and settings in this domain must not jeopardize fault-ride through performance.
- in a compatible way to the last point, an undervoltage protection (fault ride through capability or minimum voltage specified at the connection point voltage) has to be set by the facility owner according to the wider technical capability of the module, unless the system operator requires other settings due to general system management issues (explained later). In general

cases, the different settings have to be justified by the facilities to respect the principle of this point.

2. For fault-right through capabilities in case of asymmetrical faults are specified by each TSO.

Some rules are related to system restoration:

1. the relevant TSO has to specify the conditions under which a module is capable of reconnecting to the network after an incidental disconnection caused by a network disturbance.
2. the installation of automatic reconnection has to respect previous point and requires the previous authorization of the system operator.

Some rules are related to system management:
In this rule category, we can distinguish different subcategories:

1. Control schemes and settings:

- the schemes and settings of the different necessary control devices of the module for transmission system stability and for emergency measures have to be coordinated and agreed between the TSO, the system operator and the facility owner.
- any changes to these schemes and settings are to be specified, coordinated and agreed in the same manner.

2. Electrical protection schemes and settings:

- the system operator has to specify the schemes and schemes necessary to protect the network, taking in account the characteristics of the module. The protection schemes for the module and the network and the settings concerning the module have also to be coordinated and agreed between the system operator and the facility owner. These protection schemes and settings must not jeopardize the performance of the modules.
- the electrical protection of the module has to take precedence over operational controls and take into account the security of the system and the health and safety of staff and of the public and mitigate any damage to the module.
- protection schemes may cover the following aspects:
    - external and internal short current circuit
    - asymmetrical load (negative phase sequence)
    - stator and rotor overload
    - over- and underexcitation
    - over- and undervoltage at the connection point
    - over- and undervoltage at the alternator terminals
    - inter-area oscillations
    - inrush current
    - asynchronous operation (pole slip)
    - protection against inadmissible shaft torsions (for example subsynchronous resonance)
    - module line protection
    - unit transformer protection
    - back-up under protection and switchgear malfunction
    - overfluxing (U/f)
    - inverse power
    - rate of change of frequency
    - neutral voltage displacement
- changes to the protection schemes needed for the modules and the network and to settings for the modules have to been agreed between the system operator and the facility owner before the changes are done.

3. the facility owner has to organize his protection and control devices following this priority ranking:
- network and module protection
- synthetic inertia (if applicable)
- frequency control (active power adjustment)
- power restriction
- power gradient constraint

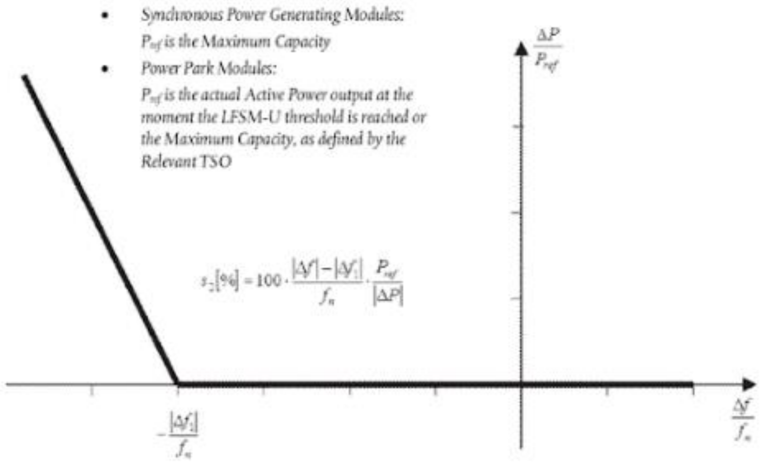
4. information exchange:
- the modules have to be able to exchange information with the system operator or the TSO in real time or periodically with time stamping (as specified by the system operator or by the TSO)
- The system operator and the TSO have to specify together the content of information exchanges including a list of data that has to be provided by the facility owner.

(iii) Type C

Exception made from the following point, the type C power-generating modules have to fulfil all the requirements of type B modules. The exception is the following:
- the relevant TSO can also instead choose to authorize in his setting zone the automatic disconnection and reconnexion of the power-generating modules of type A at randomized frequencies, ideally uniformly distributed, above a frequency threshold as determined by the relevant TSO if he is capable to demonstrate to the regulation authority and with cooperation of the facilities owners that it has a limited cross-border impact and maintains the same level of operational security in all system states.

On another hand, the points concerning frequency stability explained for type B are replaced by the following:
- Concerning active power controllability and control range, the control system has to be able to adjust the active power setpoint according to the instructions given to the facility owner by the system operator or the TSO. The system operator or TSO has besides to establish the period in which the adjusted active power setpoint has to be reached. A tolerance applying to this new setpoint and this period has also to be set up.
- Manual local measures must be allowed in case the automatic remote-control devices are out of service.
- concerning limited frequency sensitive mode (underfrequency (LFSM-U)), some requirements are also set up for type C:
    - the module has to be able to activate the provision of active power frequency response at a frequency threshold with a droop specified by the TSO (in accordance with the other TSOs of the synchronous area):
        - the threshold has to be between 49.8 Hz and 49.5 Hz inclusive
        - the droop settings have to be between 2 and 12 %.

    We can see this on the following figure:



P_{ref} is the reference active power to which ΔP is related and may be specified differently for synchronous power-generating modules and power park modules. ΔP is the change in active power output from the power-generating module. f_n is the nominal frequency (50 Hz) in the network and Δf is the frequency deviation in the network. At underfrequencies where Δf is below Δf_1 the power-generating module has to provide a positive active power output change according to the droop S_2.

Figure 14: Active power frequency response capability of power-generating modules in LFSM-U

- the delivery of active power response in underfrequency has to take different elements in account:
  - the ambient conditions at the instant of the triggering
  - the operating conditions of the module and especially limitations of operation near the maximum capacity at low frequencies and the respective impact of ambient conditions
  - if primary energy sources (like solar or wind) are available or not

- the activation of the response has to be quick (it can't be delayed to much): if the delay is greater than 2 s, the facility owner will have to justify it to the TSO.
- in underfrequency mode, the module must be able to provide a power increase up to the maximum capacity.
- the stable operation of the module has to be ensured in this mode.

- when frequency sensitive mode (FSM) is operating, more rules should apply in addition to the previous rules:
  - the module has to be capable of providing active power frequency response accorded to the parameters specified by the TSO. These parameters have to be in the following ranges:

Parameters		Ranges
Active power range related to maximum capacity $\frac{\|\Delta P_1\|}{P_{max}}$		1,5-10 %
Frequency response insensitivity	$\|\Delta f_i\|$	10-30 mHz
	$\frac{\|\Delta f_i\|}{f_n}$	0,02-0,06 %
Frequency response deadband		0-500 mHz
Droop s_1		2-12 %

Figure 15: Parameters for active power frequency response in FSM (explanation for Figure 15)

For the choice of the values of these parameters, the TSO have to take different elements into consideration:

- in case of overfrequency, the active power frequency response is limited by the minimum regulating level.
- in case of underfrequency, the active power frequency response is limited by the maximum capacity.
- the delivery of active power frequency depends on the three elements listed earlier (ambient conditions and operating conditions near the maximum capacity for low frequencies when at the triggering moment and available primary sources)

The previous given parameters concern the following figure:

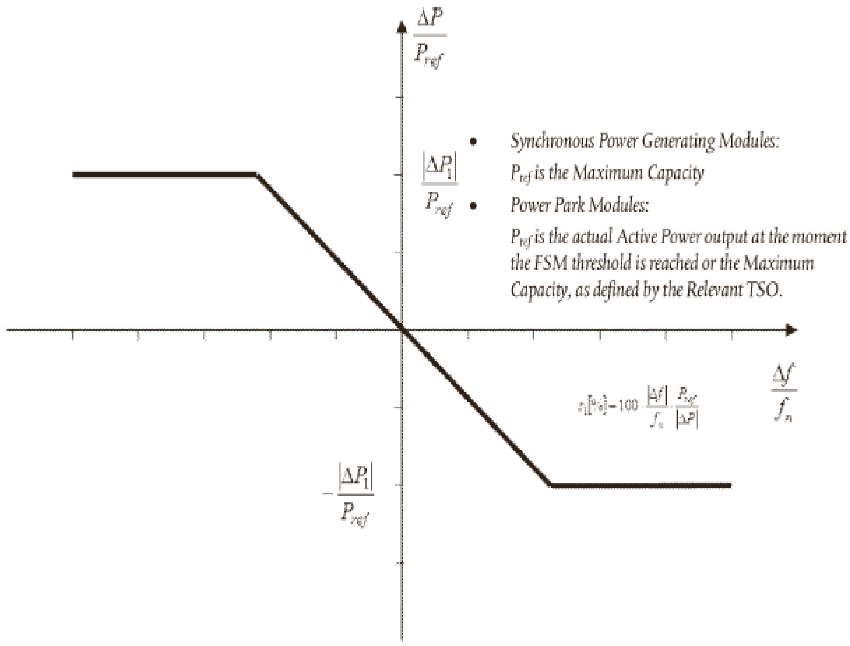


Figure 16: Active power frequency response capability of power-generating modules in FSM illustrating the case of zero deadband and insensitivity

In this graph, Pref is the reference active power to which ΔP is related. ΔP is the change in active power output from the power-generating module. fn is the nominal frequency (50 Hz) in the network and Δf is the frequency deviation in the network.

- the frequency response deadband of frequency response and droop have to be capable to change with time and adapt.
- when a frequency step change happens, the module has to be able to activate full active power frequency response above or equal to the line shown in the following figure:

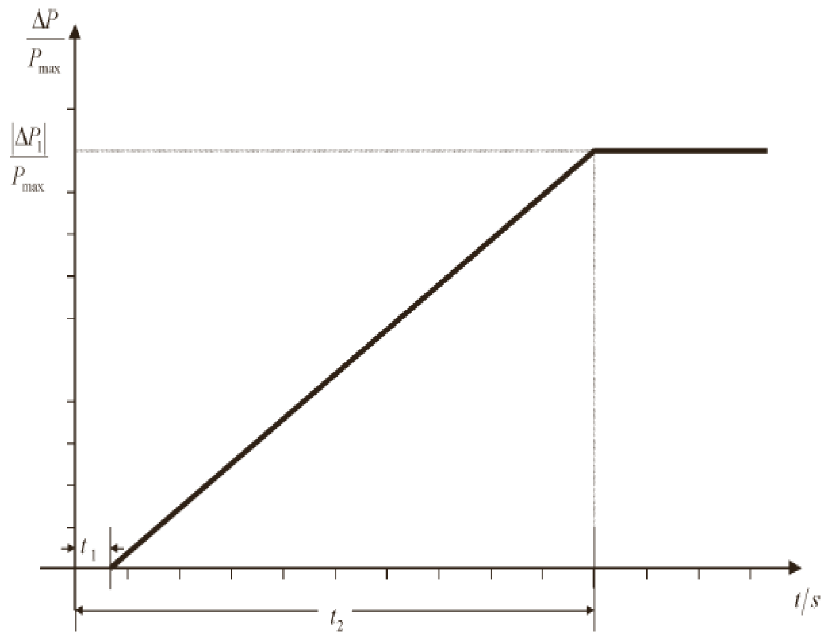


Figure 17: Active power frequency response capability

Pmax is the maximum capacity to which ΔP relates. ΔP is the change in active power output from the module. The p module has to provide active power output ΔP up to the point ΔP1 in accordance with the times t1 and t2 with the values of ΔP1, t1and t2 being specified by the relevant TSO according to the following table. t1 is the initial delay. t2 is the time for full activation.

The parameters have to be set up by each TSO (which have to try to avoid as much as possible active power oscillations for the module). These parameters have to be in the following ranges:

Parameters	Ranges or values
Active power range related to maximum capacity (frequency response range) $\frac{\lvert\Delta P_1\rvert}{P_{max}}$	1,5-10 %
For power-generating modules with inertia, the maximum admissible initial delay t_1 unless justified otherwise in line with Article 15(2)(d)(iv)	2 seconds
For power-generating modules without inertia, the maximum admissible initial delay t_1 unless justified otherwise in line with Article 15(2)(d)(iv)	as specified by the relevant TSO.
Maximum admissible choice of full activation time t_2, unless longer activation times are allowed by the relevant TSO for reasons of system stability	30 seconds

Figure 18: Parameters for full activation of active power frequency response resulting from frequency step change (explanation for Figure 17)

The choice of the parameters has to take possible limitations due to the technologies used into account.

- As for the previous explained case, one rule concerns the authorized delay:
  if the delay concerning the initial activation of active power is greater than 2 s, the facility owner will have to justify it to the TSO (if they can't meet this rule, they have to prove why a greater time is needed.
- The module must be able to provide a full active power frequency response for a period between 15 and 30 minutes, during which the TSO must have regard to active

power increase or decrease and primary energy source of the module. This must however not have any effect on the active power frequency response.
    - All parameters have to be specified by the TSO and notified to the regulatory authority (by the modalities set out by the national regulatory framework).

- concerning frequency restoration control, the module has to have the functionalities complying with the specifications of the TSO in order to restore frequency to its nominal value or to maintain the power exchange flows between control areas at the scheduled values
- concerning disconnection due to underfrequency, the facilities capable to act as a load (including hydro facilities) must be able to disconnect their load in-case of underfrequency. (this requirement doesn't extend to auxiliary supply)
- concerning real-time monitoring of FSM (frequency sensitive mode), different rules apply:
    - In order to monitor the operation of active power frequency response, the communication interface have to be equipped to transfer in real time and secured manner from the facility to the network control centre of the system operator or TSO at their request these different elements:
        - status signal of FSM (on/off)
        - scheduled active power output
        - actual value of the active power output
        - actual parameter settings for active power frequency response
        - droop and deadband
    - the system operator and the TSO have to specify additional signals to be provided by the facilities

In addition to all these frequency stability related requirements, type C modules have also a requirement concerning voltage stability: they have to be capable to disconnect automatically when voltage at the connection point reaches levels set out by the system operator in coordination the TSO.

For type C modules, there are also some rules concerning to robustness:
- in case of power oscillations, the modules have to retain steady-state stability (for any operating point of the P-Q capability diagram
- the have to be able to remain connected to the network and to operate without power reduction, as long as voltage and frequency stay in the specified limits (this requirement should not prejudice the linked points explained in the rules linked to this point explained in the type A modules part → which apply here as well)
- the modules have to be capable to remain connected to the network during single-phase or three-phase auto-reclosures on meshed network lines (if applicable to the network to which they are connected). The parameters of that rule is subjected to coordination and agreements on protection settings explained in type B - modules part.

Another regulation set concerns system restoration:
- the first points of this concerns black start (autonomous start) capability:
    - it is not mandatory without prejudice to the Member State's rights to introduce obligatory rules in order to ensure system security
    - if the TSO asks so, the facility owners must be able to provide a quotation for providing it. (the TSO will maybe such a demand if it considers the system security risky because of the lack of black start capability)
    - a module with black start capability have to be able to start from shutdown without external electrical supply within a time frame set out the system operator and the TSO.
    - a module with black start capability have to be able to synchronise between the limits (set out in type A - modules part)

    - a module with black start capability has to be able to automatically compensate the drops of voltage provoked by the connection of demand
    - a module with black start capability must:
        - be able of regulating load connections in block load
        - be able of operating in LFSM-O and LFSM-U, as previously explained
        - control frequency in case of overfrequency and underfrequency within the active power output range between minimum regulating level and maximum capacity as well as at houseload level
        - be capable of parallel operation of a few power-generating modules within one island
        - control voltage automatically during the system restoration phase
- other points concern the capability to take part in island operation
    - modules can take part in island operation if required by the system operator and:
        - the frequency limits for the island operation are the established in accordance to the points related in part A explanation regarding frequency limits)
        - the voltage limits for the island operation have to be in accordance with the previously voltage related rules explained earlier
    - modules have to be capable of operating in FSM during island operation as explained earlier. In case of a power surplus, the modules must be able to reduce the active power output from a previous operating point to a new one in the P-Q capability diagram. In that sense, the module have to be able to reduce active power output as much as possible but to at least 55 % of the maximum capacity.
    - The way to detect a change from interconnected system operation to island operation has be agreed between the facility owner and the coordination system operator - TSO. The chosen method must not only rely on switchgear position signals of the system operator
    - The modules have to be capable of operating in LFSM-O and LFSM-O during island operation as explained in the type A - modules part.
- other points concern quick re-synchronisation capability:
    - if the module is disconnected from the network, it shall be capable to re-synchronise quickly respecting the protection strategy agreed between the system operator (and the TSO) and the facility.
    - a module with a minimum re-synchronisation time greater than 15 minutes after the deconnection from his power supply has to be designed to toggle to an islanding operation to houseload from any operation point of his P-Q capability diagram. In such a case the houseload operation must be identified only through the system operator's switchgear position signals.
    - modules have to be able to continue to operate following toggling to houseload, independently from any other connection. The minimum operation time has to be specified by the system operator and the TSO (considering the characteristics of prime mover technology).

Another regulation set concerns general system management:

- concerning loss of angular stability or loss of control, a module has to be able to disconnect automatically to preserve the security of the system or prevent damage to the module. The facility owner, the system operator and the TSO have to make an agreement on the criteria used to detect such problems (loss of angular stability or loss of control).
- concerning instrumentation:
    - facilities must be equipped with an instrument providing fault recording and monitoring of the system. The facilities have to record the following parameters:
        - voltage
        - active power
        - reactive power

    - frequency

  concerning this matter, the system operator has the right to specify other parameters to be complied (if a previous reasonable notice is given).
  - the facility owner, the system operator and the TSO have to agree on the settings of the instrument used to record faults, including triggering criteria and sampling rates.
  - the system owner and the TSO have to include an oscillation trigger in the monitoring to detect poorly damped power oscillations.
  - the facilities for quality of supply and system behaviour monitoring have to include arrangements for the facility owner, the system operator and the TSO to access the information. They should also agree on the communications protocols for recorded data.
- concerning simulation models:
  - Simulation models reflecting the behaviour of the module (in steady-state/ in dynamic simulation (50 Hz component)/ in electromagnetic transient simulations) shall be provided by the facility owner at the request of the system operator or of the TSO.
  - the models have to contain some sub-models, depending on if individual components exist or not:
    - alternator and prime mover
    - speed and power control
    - voltage control (and if applicable: power system stabiliser (PSS) function and excitation control system)
    - module protection models (as agreed between the facility owner and the system operator)
    - converter models (in case of power park modules)
  - the previously mentioned request of the system operator has to be coordinated with the TSO and must include different elements:
    - the requested format of the models
    - some documentation on a model's structure and block diagrams
    - an estimation of the minimum and maximum short circuit capacity at the connection point (in MVA or equivalent)
  - the facility owner has to provide recordings of the module's performance to the system operator and TSO if requested (aiming to compare the response of the models with the recordings)

- concerning the installation of system operation or system security devices:
  if the system operator or the TSO considers the installation of new devices to preserve or restore system operation or security necessary, they shall research and agree on a solution to this matter.
- the system operator (and the TSO) have to specify minimum and maximum limits on rates of change of active power output in both direction of change (taking in account the characteristics of the technology).
- the way the neutral-point is electrically put at earth on the network side of the transformers has to respect the specifications of the system operator.

3. Additional requirements for power park modules

(i) Type B

Firstly, let us talk about type B power park modules. These modules shall respect all the general rules for type B except the following one:

- the relevant TSO can also instead choose to authorize in his setting zone the automatic disconnection and reconnexion of the power-generating modules of type A at randomized frequencies, ideally uniformly distributed, above a frequency threshold as determined by the relevant TSO if he is capable to demonstrate to the regulation authority and with cooperation of the facilities owners that it has a limited cross-border impact and maintains the same level of operational security in all system states.

The power park modules of type B have to fulfil more rules which will be explained in this part.
Concerning voltage stability, these modules have to respect the following rules:

- concerning reactive power capability, the system operator has the right to specify it.
- the system operator and the TSO must have the right to specify that a module has to be able to provide fast fault current at the connection point in case 3 -phase faults according to the following rules:
    - the module has to be capable to activate the supply of fast fault current by one of these two ways:
        - ensure the supply of the current at the connection point
        - measure voltage deviations at terminals of individual units of the module and provide the current at these terminals.
    - the system operator and the TSO have to specify:
        - the way and the moment the voltage deviation and its end are determined
        - the characteristics of the fast fault current (ex: domain to measure the voltage deviation and fast fault current
        - the timing and accuracy of the fast fault current
- concerning supplying the fast fault current in case of asymmetrical faults, the system operator and the TSO have the right to set up a rule concerning the current injection.

Other additional rules concern robustness:

- the post-fault active power recovery that the module should be able to provide shall be specified by the TSO as well as the following other elements:
    - the time when the post-fault power recovery begins (voltage criterion)
    - the maximum allowed time for the recovery
    - the magnitude and accuracy for the recovery
- these rules should be compatible with the following principles:
    - interdependency between fast fault current rules and active power recovery
    - dependence between active power recovery times and time of voltage deviations
    - limit of the maximum allowed time for active power recovery
    - compatibility between the level of voltage recovery and the minimum magnitude for active power recovery
    - adequate damping of active power oscillations.

Secondly, let us talk about type C power park modules. These modules shall respect all the general rules for type C and the rules applied for type B power park modules (just above) except the following ones:

- the relevant TSO can also instead choose to authorize in his setting zone the automatic disconnection and reconnexion of the power-generating modules of type A at randomized frequencies, ideally uniformly distributed, above a frequency threshold as determined by the relevant TSO if he is capable to demonstrate to the regulation authority and with cooperation of the facilities owners that it has a limited cross-border impact and maintains the same level of operational security in all system states.
- the following points concerning frequency stability:
    - every module should be equipped with an interface (input port) in order to allow the control of active power output (reducing the active power output through the interface if necessary)

    - the system operator has right to specify more equipment able to command at distance the active power output
- concerning reactive power capability, the system operator has the right to specify it.

(ii) Type C

The power park modules of type C have to fulfil more rules which will be explained in this part.
Concerning frequency stability, the following requirements have to be fulfilled:

- the TSO has the right to specify that the modules are supposed to be able to provide synthetic inertia during very fast frequency deviations.
- the TSO should specify the operating principle of the systems in place to provide synthetic inertia and associated performance parameters.

Concerning voltage stability, the following requirements have to be fulfilled:

- in relation to reactive power capability, the system operator has the right to specify an additional reactive power to be provided if the connection point is neither at the high-voltage terminals of the transformer to the voltage level of the connection point nor at the converter terminals (if there is no transformer). This additional reactive power has to compensate the reactive power demand of the high-voltage line (or cable between the high-voltage terminals of the transformer - or converter terminals, and the connection point. This power has to be provided by the owner of the line or cable.
- with regard to reactive power capability at maximum capacity:
    - the system operator and the TSO have to specify the reactive power provision capability requirement when the voltage varies. To achieve this, a U-Q/Pmax-profile (with any shape within the boundaries of which the module has to provide reactive power at its maximum capacity)
    - the U-Q/Pmax-profile has to be specified by each system operator and TSO respecting the following principles:
        - the U-Q/Pmax-profile has to be included in ts envelope, which is the inner envelope in the figure below
        - the envelope dimensions (voltage range and Q/Pmax range) has to be comprised in the range specified for each synchronous in the table below
        - the inner envelope (U-Q/Pmax-profile enevelope) has to be positionned within the outer enveloped (also represented on the figure below)
        - any shape is authorized for the U-Q/Pmax profile (taking in account the potential costs to deliver the capability of providing reactive power production at high voltage and reactive power consumption at low voltages.
    - the requirement concerning reactive power provision capability applies at the connection point. The voltage range represents the highest and lowest values for profile with other shapes than rectangular. As a consequence, the full reactive power ranger is not expected to be across the steady-state voltage range.

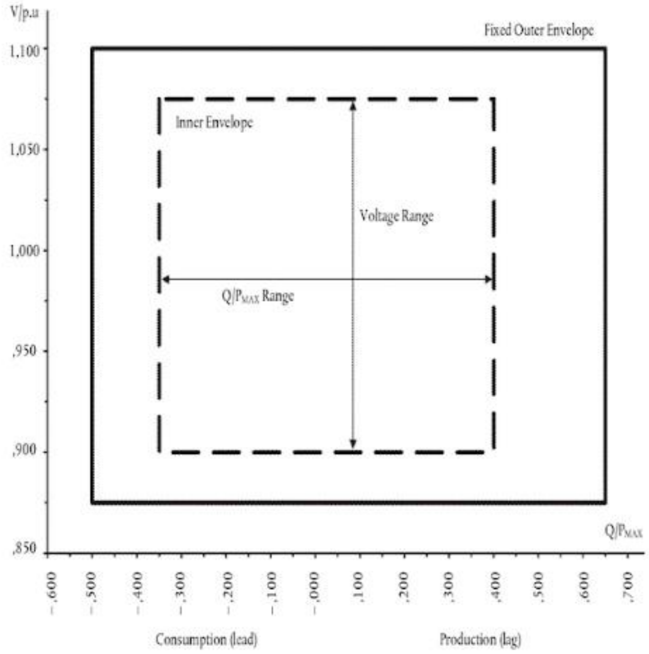


Figure 19: U-Q/P_{max}-profile of a power park module

This diagram represents the boundaries of a U-Q/Pmax profile (at the connection point). It represents the voltage which is expressed by the ratio of the real value at an instant and the maximum voltage pu against the ratio concerning the reactive power (Q) which is expressed by the ratio of Q and the maximum capacity (Pmax). The characteristics of the inner envelope are just indicative.

Synchronous area	Maximum range of Q/P_{max}	Maximum range of steady-state voltage level in PU
Continental Europe	0,75	0,225
Nordic	0,95	0,150
Great Britain	0,66	0,225
Ireland and Northern Ireland	0,66	0,218
Baltic	0,80	0,220

Figure 20: Parameters for the inner enveloppe in Figure 19

The parameters of this table are related to the figure above.

Concerning reactive power capability below maximum capacity, several requirements have to be met:

- The system operator and the TSO have to specify the reactive power provision capability and a P-Q/Pmax profil (with any shape within the boundaries of which the module has to be able to provide reactive power below maximum capacity)
- The P-Q/Pmax profile is specified by each system operator and TSO respecting the following criteria:
    - The P-Q/Pmax has to be included in the P-Q/Pmax profile envelope (represented by the inner envelope in the figure below)
    - The previous table specifies for each synchronous area the Q/Pmax range of the profile envelope.

   - The active power range of the profile envelope for reactive power of zero has to be 1 pu
   - The P-Q/Pmax can be of any shape but conditions for reactive power capability for an active power of zero have to be included
   - The P-Q/Pmax profile envelope has to be positioned within the limits of the outer envelope (see figure below).
- If it operates at an active power output below the maximum capacity and if all units of the park generating power are available from a technical point of view (they are not out of service for some reason), the module has to be able to provide reactive power at any operating point of its P-Q/Pmax profile.
- The module has to be able to move to any other operating point within its profile in reasonable time to obtain the values requested by the system operator.

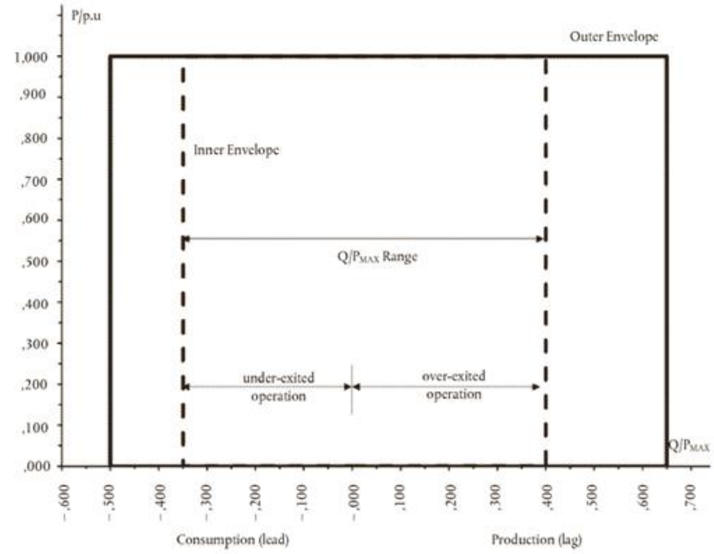


Figure 21: P-Q/P_{max}-profile of a power park module

This diagram represents the boundaries of a P-Q/Pmax profile (at the connection point). It represents the active power which is expressed by the ratio of the real value at an instant and the maximum capacity pu against the ratio concerning the reactive power (Q) which is expressed by the ratio of Q and the maximum capacity (Pmax). The characteristics of the inner envelope are just indicative.

Concerning reactive power control modes, other rules have to be respected:

- The park has to be able to provide reactive power automatically by one of these ways:
   - Voltage control mode
   - Reactive power control mode
   - Power factor control mode
- The module has to be able to contribute to voltage control at the connection point providing reactive power exchange with the network. The setpoint voltage has to cover 0.95 to 1.05 pu (with a maximal step of 0.01 pu). The slope shall have a range of at least 2 to 7 % in steps no greater than 0.5 %. Finally, when the grid voltage at the connection point equals the voltage setpoint, the reactive power has to be zero. These requirements concern voltage control mode.
- The setpoint can be operated with or without a deadband (which can be selected from zero to ± 5 % of the reference (with steps no greater than 0.5 %)
- In case of step change in voltage. The module has to be able to achieve 90 % of the change in reactive power output in time t1 specified by the system operator (between 1 and 5 seconds). The module must also settle at the value specified by the slope within a time t2 specified by the system operator (between 5 and 60 seconds) (with a maximal steady-state reactive

tolerance of 5 % of the maximum reactive power). The time specifications have to be specified by the system operator.

- The module has to be able to set the reactive power setpoint anywhere in the reactive power range, explained in power park type B module, with maximal setting steps the smallest of 5 MVAr and 5 % of full reactive power, which means that the reactive power at the connection point has to be controlled to an accuracy within ± 5 MVar or ± 5 % of the full reactive power. This requirement concerns the reactive power control mode.
- Concerning power factor control mode, the module has to be able to control the power factor at the connection point in the required power range, specified by the system operator respecting the requirements explained previously. The target power factor in the steps has to be smaller or equal to à 0.01. The system operator has to specify the values of the target power factor value, its tolerance and the time authorized to achieve the target power factor in case of a sudden change of active power. The tolerance of the target power factor has to be expressed through the tolerance of its corresponding reactive power which can be either an absolute value or a percentage of the maximum reactive power of the module.
- The TSO, the power park module owner and the system operator have to specify which one of the three exposed reactive power control mode options will be implemented and the associated setpoints. They have also to communicate on the further needed equipment to make the adjustment of the relevant setpoint operable remotely.

The TSO has also to choose whether active power contribution or reactive power contribution has priority during the faults (when fault-ride capability is required). In case of prioritising active power contribution, the provision has to be implemented maximally 150 ms after the fault inception.

Concerning power oscillations damping control, the TSO has the right to specify that a module has to be capable to contribute to it (damping power oscillations). However, the voltage and reactive power control settings shall not affect the damping.

(iii) Specifications for AC- connected offshore power park modules

Other requirements apply to the connection to the network of AC-connected offshore power park modules. We consider that an AC-connected power park module is offshore only if has an offshore connection point. This offshore connection point has to be specified by the TSO. Basically, the term offshore for this part covers two configurations:

- The AC connection is done through a single onshore grid interconnection point at which the offshore power park modules (interconnected offshore and forming an offshore AC system) are connected to the onshore system.
- There are several meshed AC connections at which several offshore power park modules (interconnected offshore and forming an offshore AC system) are connected to the onshore system through one or more onshore grid interconnection points.

Concerning frequency stability requirements applicable to this case, the following points have to apply:

- Every point laid out in general requirements for type A modules (2. of this part) except the following ones:
    - The relevant TSO can also instead choose to authorize in his setting zone the automatic disconnection and reconnexion of the power-generating modules of type A at randomized frequencies, ideally uniformly distributed, above a frequency threshold as determined by the relevant TSO if he is capable to demonstrate to the regulation authority and with cooperation of the facilities owners that it has a limited

cross-border impact and maintains the same level of operational security in all system states;

- The conditions under which a power generating power is capable of connecting automatically to the network are to be specified by the relevant TSO. The conditions have to include:
  - the frequency ranges within which an automatic connection is admissible;
  - maximum admissible gradient of increase in active power;
- Every point concerning frequency stability laid out in general requirements for type C modules (2. of this part);
- Every point concerning frequency stability for type C power park modules (explained in previous part).

Concerning voltage stability, an AC-connected offshore power park module has to be able to stay connected to the grid and operate in the ranges of the network voltage at the connection point (expressed related to reference 1 pu voltage and for the time periods specified in the following table:

Synchronous area	Voltage range	Time period for operation
Continental Europe	0,85 pu-0,90 pu	60 minutes
	0,9 pu-1,118 pu (*)	Unlimited
	1,118 pu-1,15 pu (*)	To be specified by each TSO, but not less than 20 minutes and not more than 60 minutes
	0,90 pu-1,05 pu (**)	Unlimited
	1,05 pu-1,10 pu (**)	To be specified by each TSO, but not less than 20 minutes and not more than 60 minutes
Nordic	0,90 pu-1,05 pu	Unlimited
	1,05 pu-1,10 pu (*)	60 minutes
	1,05 pu-1,10 pu (**)	To be specified by each TSO, but not more than 60 minutes
Great Britain	0,90 pu-1,10 pu (*)	Unlimited
	0,90 pu-1,05 pu (**)	Unlimited
	1,05 pu-1,10 pu (**)	15 minutes
Ireland and Northern Ireland	0,90 pu-1,10 pu	Unlimited
Baltic	0,85 pu-0,90 pu (*)	30 minutes
	0,90 pu-1,118 pu (*)	Unlimited
	1,118 pu-1,15 pu (*)	20 minutes
	0,88 pu-0,90 pu (**)	20 minutes
	0,90 pu-1,097 pu (**)	Unlimited
	1,097 pu-1,15 pu (**)	20 minutes

(*) The voltage base for pu values is below 300 kV.
(**) The voltage base for pu values is from 300 kV to 400 kV.

The table shows the minimum period during which an AC-connected offshore power park module must be capable of operating over different voltage ranges deviating from the reference 1 pu value without disconnecting.

Figure 22: Voltage stability parameters

However, this point shall not be prejudicial to the general requirements concerning robustness and more specifically to fault-ride-through capability for symmetrical defaults for type C power generating modules.

Notwithstanding the parameters of the table, the TSO in Spain has the right to require AC-connected offshore power park modules to remain connected to the network between 1.05 oy and 1.0875 pu for an unlimited period.

In the same spirit, the TSO in the Baltic synchronous area has the right to require AC-connected offshore power park modules to remain connected to the 400 kV network in the voltage range and time periods applied to Continental Europe synchronous area.

The requirements described for type B power park modules (higher in this part) and concerning voltage stability as the ones for type C power park modules apply for this category of modules as well exception made for this point:

- concerning reactive power capability, the system operator has the right to specify it.

Concerning reactive capability at maximum capacity, the parameters concerning figure 19 set out in figure 20 are replaced by the following ones:

Synchronous area	Maximum range of Q/P_{max}	Maximum range of steady-state voltage level in PU
Continental Europe	0,75	0,225
Nordic	0,95	0,150
Great Britain	0 (*) 0,33 (**)	0,225
Ireland and Northern Ireland	0,66	0,218
Baltic	0,8	0,22

(*) At the offshore connection point for configuration 1.
(**) At the offshore connection point for configuration 2.

Figure 23: New parameters for figure 19

Concerning robustness, the general requirements for type C (and the requirements for power park modules for type B) apply for AC-connected offshore power park modules. More specifically, concerning fault-ride-through, the general requirements for the power park modules for type B apply in this case as well excepting the following one:

- For fault-right through capabilities in case of asymmetrical faults are specified by each TSO.

Finally, concerning system restoration and system management, the general requirements for type B and type C apply for AC-connected offshore power park modules.

VI. Conclusions

Regarding the regulations, notably the winter package, the place of renewable energy in the future energy sources repartition is increasing. On the economical point of view, several things as the equity and equality of access to the transmission and distribution network have been accomplished. The evolution of the prosumer's status allows big opportunities for the future of distributed energy. However, using largely or totally renewable energy as a power source in the network need a strong specification in energy storage due to the intermittency of renewable energy. In this particular point, the different directives and regulations have many points to improve. Also, some decisions taken by the European union such as the establishing of principles for capacity could slow down the integration of renewable energy into the grid and their large use.

Concerning the analysis of the regulation "COMMISSION REGULATION (EU) 2016/631 of 14 April 2016 establishing a network code on requirements for grid connection of generators", the first part of the study was dedicated to the classification of the modules into 4 types according to their size. This step was crucial for the rest of the analysis because the requirements are applied according to these types. This first part permitted also to describe the cases where the requirements of this regulation apply or don't apply.
One can then firstly clearly see that the requirements are proportional to the size of the modules.
In fact, for general cases (V.2), one can see that:

- Type A modules have to respect only frequency requirements;
- Type B have to respect almost all requirements concerning type A but in addition to this, requirements concerning, frequency stability, robustness, system restoration and system management;
- Type C modules have to respect almost all requirements for type A and B and additional requirements concerning frequency stability, automatic disconnection regarding voltage stability, robustness, system restoration and system management.

Power park modules regulations points (V.3) are more demanding than the one for general cases:

- For type A, the requirements are the same;
- Type B modules have to respect most of the requirements for general cases and additional ones concerning voltage stability (many points) and some additional ones concerning robustness;
- Type C modules have to respect most of the points previously exposed (general ones for type C and power park modules requirements concerning type B), some additional requirements concerning frequency stability and many additional requirements for voltage stability.

For AC-connected offshore power park modules, most of the previously mentioned requirements apply in this case as well. The main difference concerns voltage stability. It's in fact the main point of this part of the regulation.

VII. Annexes

Annex 1 – Structure of the regulation example

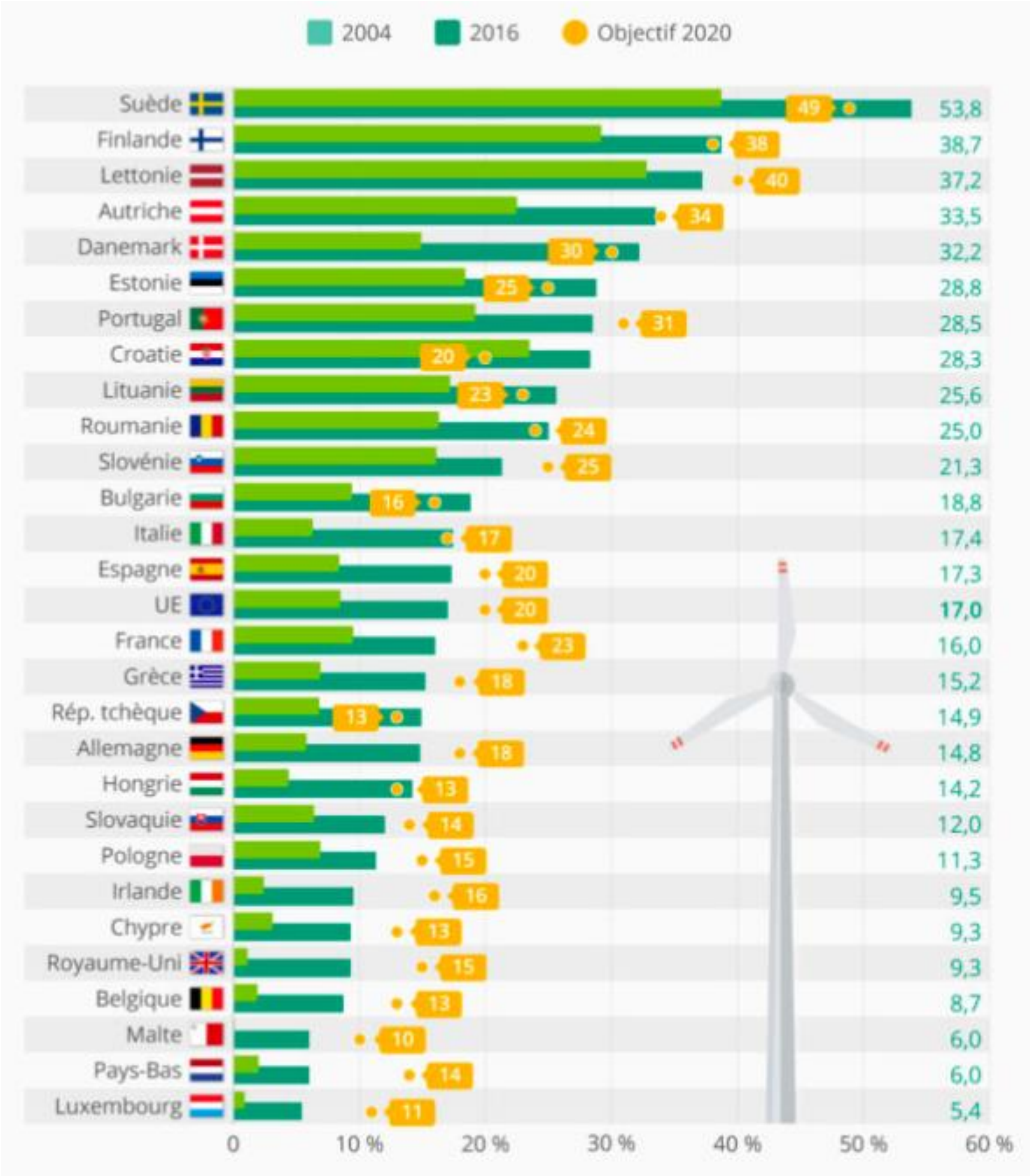
Introduction: Objectives of the rules (rules that must respect the rules)
Article 1: Subject matter
Article 2: Definitions
Article 3: Scope of applications (list of where the regulation should not apply)
Article 4: Applications to existing systems (power-generating modules)
Article 5: Definition of significance (when a power-generating module is significant) – limit of maximum capacity for threshold for type B, C, D
Article 6: Application to power-generating modules, pump-storage power-generating modules, combined heat and power facilities, and industrial sites – rules
Article 7: Regulatory aspects
Article 8: Multiple TSOs
Article 9: Recovery of costs
Article 10-11: Consultation – Stakeholders
Article 12: Confidentiality
Article 13-16: General requirements for power-generating modules (each type)
Article 17-19: Specificities for synchronous modules
Article 20-22: Requirements for park modules
Article 23-28: Requirements for offshore power park modules
Articles 29-37: Operational procedure for each type to connect modules (Rules of installation of new system of energy)
Articles 38-39: Cost benefit analysis
Articles 40-59: Compliance (tests, rules and monitoring)
Articles 60-65: Derogations
Article 66-70: Transitional arrangements
Article 71-72: Final provisions

Annex 2 – National Regulatory Authorities

National Regulatory Authorities

Austria	https://www.e-control.at/ E-control
Belgium	http://www.creg.be Commission de Régulation de l'Electricité et du Gaz (Commission for Electricity and Gas Regulation)
Bulgaria	http://www.dker.bg/ Комисия за енергийно и водно регулиране (Energy and Water Regulatory Commission)
Croatia	https://www.hera.hr Hrvatska Energetska Regulatorna Agencija (Croatian Energy Regulatory Agency)
Cyprus	https://www.cera.org.cy/ Ρυθμιστική Αρχή Ενέργειας Κύπρου (Cyprus Energy Regulatory Authority)
Czech Republic	http://www.eru.cz Energetický regulační úřad (Energy Regulatory Office)
Denmark	http://energitilsynet.dk/ Energitilsynet (Energy Regulatory Authority)
Estonia	http://www.konkurentsiamet.ee Konkurentsiamet (Estonian Competition Authority)
Finland	http://www.energiavirasto.fi/ Energiavirasto (Energy Authority)
France	http://www.cre.fr/ Commission de Régulation de l'Energie (Regulatory Commission of Energy)
Germany	https://www.bundesnetzagentur.de Bundesnetzagentur (Federal Network Agency)
Greece	http://www.rae.gr Ρυθμιστική Αρχή Ενέργειας (Regulatory Authority for Energy)
Hungary	www.mekh.hu Magyar Energetikai és Közmű-szabályozási Hivatal (Hungarian Energy Office)
Ireland	https://www.cru.ie/ Commission for Regulation of Utilities
Italy	www.arera.it Autorità di Regolazione per Energia Reti e Ambiente (Regulatory Authority for Electricity, Gas and Water)
Latvia	https://www.sprk.gov.lv/ Sabiedrisko pakalpojumu regulēšanas komisija (Public Utilities Commission)
Lithuania	http://www.regula.lt Valstybinė kainų ir energetikos kontrolės komisija (National Control Commission for Prices and Energy)
Luxembourg	http://www.ilr.lu Institut Luxembourgeois de Régulation (Luxemburger Regulatory Institute)
Malta	https://www.rews.org.mt Regulator for Energy and Water Services
The Netherlands	https://www.acm.nl/nl Autoriteit Consument & Markt (Authority for Consumers and Markets)
Poland	http://www.ure.gov.pl/ Urząd Regulacji Energetyki (Energy Regulatory Office)
Romania	http://www.anre.ro/ Autoritatea Nationala de Reglementari in domeniul Energiei (Energy Regulatory Authority)
Slovakia	http://www.urso.gov.sk Úrad pre reguláciu sieťových odvetví (Regulatory Office for Network Industries)
Slovenia	https://www.agen-rs.si/ Agencija za energijo (Energy Agency)
Sweden	http://www.ei.se Energimarknadsinspektionen (Energy Markets Inspectorate)
The United Kingdom	www.ofgem.gov.uk Office of the Gas and Electricity Markets

Annex 3 – EUCO20



Annex 4 – Article 23 Design principles for capacity mechanisms

AM 112 1. Any capacity mechanism shall:

(a) not create undue market distortions and not limit cross border trade;
(b) not go beyond what is necessary to address the adequacy concern;
(c) select capacity providers by means of a transparent, nondiscriminatory and market-based process;
(d) be technology neutral;
(e) provide incentives for capacity providers to be available in times of expected system stress; 439.
(f) ensure that the remuneration is determined through a market based process;
(g) set out the required technical conditions for the participation of capacity providers in advance of the selection process;
(h) be open to participation of all resources, including storage and demand side management that are capable of providing the required technical performance;
(i) apply appropriate penalties to capacity providers when not available in the event of system stress; (j) ensure that capacity contracts for existing installations are rewarded for a maximum length of 1 year.

AM 113 2. Capacity mechanisms in the form of strategic reserves shall:

(a) be held outside the market;
(b) be dispatched only where day - ahead and intraday markets have failed to clear and transmission system operators have exhausted their balancing resources to establish an equilibrium between demand and supply;
(c) ensure that during periods where strategic reserves were dispatched, imbalances are settled at the technical price limit applied by the market operators pursuant to Article 9 or at the value of lost load, whichever the higher.
(d) be limited to maximum emissions of 200kg/CO2/kW for the electricity production per year The electricity generated, or the load reduction achieved by resources in the strategic reserve shall not be sold through wholesale electricity markets.

AM 114 3. In addition to the requirements laid down in paragraph 1, capacity mechanisms other than strategic reserves shall: 3. Capacity mechanisms shall:

(a) be constructed so as to ensure that the price paid for availability automatically tends to zero when the level of capacity supplied is expected to be adequate to meet the level of capacity demanded;
(b) remunerate the participating resources merely for their availability and ensure that the remuneration does not affect decisions of the capacity provider whether or not to generate;
5834/2/18 REV 2 BL/st 180 ANNEX TREE.2.B
(c) ensure that capacity obligations are transferable between eligible capacity providers.

Annex 5 – Article 11 Dispatching of generation and demand response

Article 11

Dispatching of generation and demand response

1. Dispatching of power generation facilities and demand response shall be non-discriminatory and market based unless otherwise provided under paragraphs 2 to 6.

2. Member States may provide that when dispatching electricity generating installations, transmission system operators shall give priority to generating installations using renewable energy sources or high-efficiency cogeneration from small generating installations or generating installations using emerging technologies to the extent provided for in paragraph 3.

3. Member States may provide priority dispatch pursuant to paragraph 2 for

(a) generating installations using renewable energy sources or high-efficiency cogeneration with an installed electricity capacity of less than 500 kW; or

(b) demonstration projects for innovative technologies;

4. Where the total capacity of generating installations subject to priority dispatch under paragraphs 2 and 3 is higher than 15 % of the total installed generating capacity in a Member State, additional generating installations shall not become subject to priority dispatch under paragraph 3(a). As of 1 January 2026, paragraph 3(a) shall be applicable only to generating installations using renewable energy sources or high-efficiency cogeneration with an installed electricity capacity of less than 250 kW.

5. Member States shall provide priority dispatch for generating installations using renewable energy sources or high-efficiency cogeneration which have been commissioned prior to [entry into force] and while being subject to priority dispatch under Article 15 (5) of Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency[33] or Article 16 (2) Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources[34] shall remain subject to priority dispatch. As of the date where the generating installation is subject to significant modifications, which shall be the case at least where a new connection agreement is required, priority dispatch shall no longer be applicable.

6. Member States which can demonstrate that, in particular due to lack of well-functioning short term markets, there would be substantial problems arising from the removal of priority dispatch pursuant to paragraph 1 for generating installations using renewable energy sources or high-efficiency cogeneration exceeding the thresholds provided for in paragraph 3, and that these problems endanger fulfilling the targets set out in Article 5 [Renewables Directive] or the objectives set out in Article 14 Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency[35], may apply for the possibility to foresee priority dispatch for these generating installations. The Commission may adopt a decision allowing for the requested priority dispatch to be granted. The Commission shall inform all Member States of those applications before taking a decision, taking into account respect for confidentiality. That decision shall be published in the Official Journal of the European Union. The Commission may provide in its decision that it is subject to conditions which aim at remedying the problems established as a basis for the granted derogation. The decision shall be limited in time.

7. Priority dispatch shall not endanger the secure operation of the electricity system, shall not be used as a justification for curtailment of cross-border capacities beyond what is provided for in Article 14 and shall be based on transparent and non-discriminatory criteria.