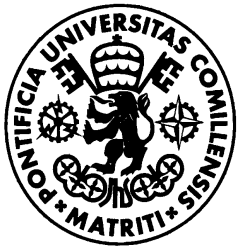

UNIVERSIDAD PONTIFICIA COMILLAS

ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA (ICAI)

OFFICIAL MASTER'S DEGREE IN THE ELECTRIC POWER INDUSTRY

Master's Thesis

ASSESSMENT OF THE NEW ACCESS AND CONNECTION TO DISTRIBUTION NETWORKS REGULATION IN THE SPANISH ELECTRICITY SYSTEM

Author: **Héctor Cuenca García**
Supervisor: **Rafael Cossent Arín**

Madrid, July 2021

Official Master's Degree in the Electric Power Industry (MEPI)

Master's Thesis Presentation Authorization

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16/07/2021

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Authorization of the Master's Thesis Coordinator

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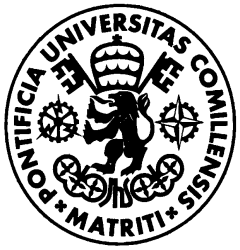

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Abstract

The approval of the “Clean Energy for all Europeans” package in 2019, made all European Member States develop and implement important measures in their energy policies in order to contribute to a clean energy transition for the whole continent, setting challenging targets for year 2030, considering renewable energies integration as an important objective for a greener future. For this reason, each country developed an integrated National Energy and Climate Plan in which they specified the measures that would be implemented to individually contribute to European targets.

In the case of Spain, the already approved PNIEC plan specifies all the national targets that must be achieved before 2030. Among them, an increase of renewable electricity generation power of 60GW with respect to 2020 levels must be installed by private companies, achieving an overall installed capacity of almost 120GW in Spanish system.

To host this amount of renewable power, it is necessary to develop and invest in transmission and distribution networks, but it is also necessary to implement an access and connection regulation that ensures a simple and efficient process and the subsequent commissioning of installations.

In 2020, Spanish government decided to modify the legislation and regulation that applied to the Access and Connection procedure, together with the actions to be done after obtaining the permissions in order to ensure the consistency and firmness of projects that applied to be connected to the network and homogenize the applications towards distribution and transmission networks in a single methodology. This decision was the result of the analysis of applications that showed a speculative behavior among promoters of renewable installations that did not end in the commissioning of installations, the real objective of PNIEC targets, and eliminate the asymmetries of the application processes.

This thesis has confirmed the evolution from previous, prior to 2020 reform, to new Access and Connection regulation considering a set of regulatory attributes defined to measure the contribution to renewable integration and the efficiency of the process. The quantitative analysis has confirmed the existence of the inefficiencies detected by Spanish government that led to the change of regulation such as application concentration in transmission network of more than 80%, lack of transparency and low rate of commissioning of installations with permissions granted, less than 25%. However, it has also detected that applying this new regulation to the current levels of already granted Access and Connection permissions, will allow, in the worst case, to install approximately 70GW of renewable power, a figure that ensures reaching PNIEC targets of increasing renewable installed capacity of 60GW.

However, this evolution could be even more efficient and contribute to reach 2050 long-term objective of 100% renewable energy in Spanish generation mix. The thesis has proved that international best practices such as implementing Connection charges estimators, simplification and reduction of administrative procedures and costs, forcing to share upstream network influence, and allowing to grant non-firm access permissions, would provide a more efficient Access and Connection procedure, complementing the recently approved methodology.

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Chapter 1: Introduction

1. Motivation

The “Clean energy for all Europeans” package (European Commision, 2019), passed between June 2018 and June 2019, updates the common EU energy policies to support a cleaner energy transition and consequently contribute to support Paris Agreement for reducing greenhouse gas emissions.

This European package is formed by 5 pillars:

- Energy performance in buildings
- Renewable energy support with a binding target of 32% in 2030 EU energy mix.
- Energy efficiency: setting the target of at least 32.5% energy efficiency in 2030
- Regulation on the governance of the Energy Union and Climate Action
- Electricity market design for a greater renewable integration.

As a part of this package, the Regulation 2018/1999 on the Governance of the Energy Union, sets common rules for planning, reporting and monitoring to ensure that decisions are synchronized with the Paris Agreement (European Comission, 2016). Therefore, under this regulation each EU Member State must develop a 10-year integrated National Energy and Climate Plan (NECPs) for the 2021-2030 period that describes how each country plans to contribute to the achievement of the common European objectives.

As a result, the Spanish government developed the “Plan Nacional Integrado de Energía y Clima” (PNIEC) which details the national targets to be fulfilled in the period 2021-2030 in order to contribute to the European Clean Energy Package requirements previously described (Ministerio para la Transición Ecológica y el Reto Demográfico, 2020). This document establishes different working lines that can be classified in the following groups:

- Electrification and decarbonization of the economy
- Improvement of energy efficiency
- Security of energy supply.
- Energy R&D promotion.

According to the studies on which PNIEC is based, the expected results that will be obtained in year 2030 will be the following (Ministerio para la Transición Ecológica y el Reto Demográfico, 2020):

- 23% reduction of greenhouse gas emissions with respect to 1990 levels with the long-term objective of reaching 90% reduction with respect 1990 levels in 2050, according to already approved Long-term decarbonization strategy (Ministerio para la Transición Ecológica y Reto Demográfico, 2020).
- 42% renewable energies use over the final use of energy.
- 39,5% energy efficiency improvement
- 74% renewable share in the electricity generation mix in 2030 with the intention of reaching 100% in 2050 according to already approved Long-term decarbonization strategy (Ministerio para la Transición Ecológica y Reto Demográfico, 2020).

Regarding renewables integration and support, the objective is to install approximately 60 additional GW of renewable generation plants by 2030 in comparison with the year 2020 installed capacity levels, considering different types of technologies, with an overall renewable installed capacity of approximately 120 GW (Ministerio para la Transición Ecológica y el Reto Demográfico, 2020):

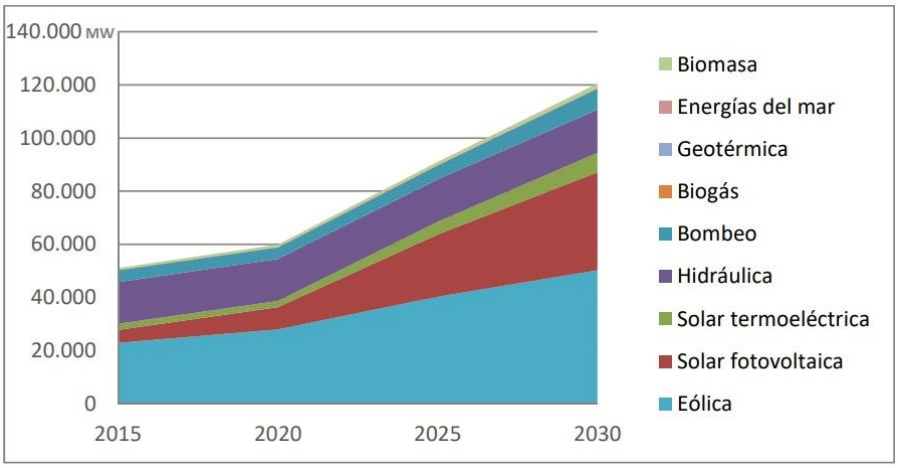


Figure 1 PNIEC Renewable Energy integration objective evolution (Ministerio para la Transición Ecológica y el Reto Demográfico, 2020)

This ambitious objective requires the investment and development of the transmission and distribution networks in order to increase their hosting capacity and be able to integrate this amount of renewable power, in consonance with the huge amount of 313,5 GW of access applications received by Spanish System Operators at date 30th June 2021 (Red Eléctrica de España S.A.U., 2021). However, without the certainty of assuring that this 313,5GW of access applications (Red Eléctrica de España S.A.U., 2021) are related to firmed projects, it is also necessary to update and develop a clear and consistent Access and Connection regulation that coordinates the application process and eliminates asymmetries in order to increase the efficiency, allowing to achieve PNIEC and European targets in consequence.

For this reason, during the year 2020, Spanish Government and Spanish Regulator, CNMC, developed a set of Royal Decrees in order to update current regulation in that moment, to ensure that 2030 renewable integration targets are achieved by settling new requirements and constraints to renewable installations that already have been granted access to the network, and fix a more restrictive and defined access and connection application procedure than the previous one, to ensure the consistency and firmness of renewable projects.

This update of the regulation is due to the results obtained in previous regulation in which it was detected that a large number of projects were not accomplishing with the administrative requirements for the final commissioning of the installations, which is the real objective of PNIEC, but increasing speculation of land and access permission. For instance, according to the information provided by the Ministry of Ecological transition and demographic challenge (Ministry of Ecological Transition and Demographic challenge, 2020), there was a number of 430.000MW of access application during the previous year and a half before the 24th June 2020, what supposed a monthly average of 30.000MW applications when the maximum peak demand in Spain had been 45.000MW. Additionally, regulation in that moment stated that after

achieving the access permissions, promoters had 6 months to apply for the connection permission. In these conditions, at date of 24th June 2020 there were granted an amount of 110.000MW of access permissions but only 60% of this value had already been granted with connection permission.

Apart from this, the asymmetries between distribution and transmission networks is reflected in the fact that distribution networks have been traditionally considered as an enemy for the integration of renewable installations due to the lack of transparency of information about their assets, and the fact that in distribution reinforcements are paid by promoters whereas in transmission, reinforcements are socialized (Ojea, 2019), leading to applications concentration in the transmission networks, where promoters of renewable installations have had more information available, despite the fact that costs in the transmission networks are normally higher than in distribution due to the higher voltages and larger distances to the connection points as it is a lower meshed grid. For this reason, this new regulation also tries to minimize these differences by standardizing both networks processes and requiring distribution and transmission operators to share information about their infrastructure and, in consequence, facilitate the study of connection possibilities for renewable promoters.

The aim of this thesis is to analyze both previous, prior to the 2020 reform, and new regulation, highlighting the main differences between them and determine if there has been an improvement with the new changes that facilitates the integration of renewable generation installations to achieve PNIEC targets. In order to achieve this, a set of assessment criteria are firstly defined and then applied to both regulatory frameworks. Furthermore, the thesis provides additional recommendations to improve the current network access regulation based on the best practices observed in an international review. The final goal is therefore to support Spain to achieve its energy policy goals by 2030 in an effective and efficient manner.

2. Objectives

The main objective of this thesis is to evaluate the evolution from previous, prior to 2020 reform, to recently approved Access and Connection regulation in order to assess the achievement of PNIEC targets in 2030 and, based on this analysis, provide additional initiatives that complement new regulation, considering alternative best practices applied in other countries, to increase the efficiency of the Access and Connection procedure in Spain and, in consequence, contribute to the achievement of energy and climate policy goals by 2030.

Specific objectives of the thesis are described hereunder:

- To study, analyze and understand previous and new Access and Connection regulation and procedures that apply to the distribution networks.
- To define attributes that evaluate Access and Connection regulation contribution to renewables integration
- To evaluate if the change in regulation contributes to the targets of RES integration defined in PNIEC
- To research about international methodologies and tools and prepare self-contribution alternatives to enhance regulation
- To analyze associated costs of renewable projects

- To analyze registered Access and Connection applications and find patterns and tendencies.

3. Structure

Firstly, a theoretical description of both regulations shall be made, describing the Access and Connection processes through a flowchart, and grouping related stages in a set of clusters to facilitate the description and subsequent analysis.

According to the clusters previously formed, a theoretical analysis shall be made using a set of attributes that evaluate the contribution to increase the efficiency of the Access and Connection procedure and the achievement of PNIEC targets in consequence. This analysis will consist on assigning scores to each attribute with the objective of comparing both regulations and detect evolutions and weaknesses between previous and new regulation. These attributes shall cover different topics like transparency, time scope, simplicity, etc.

The results of the analysis shall be used to detect inefficiencies and possible weaknesses of the new regulation that will be amended through an international research of alternative or complementary best practices that could help to increase the efficiency of the Access and Connection procedure to contribute to the achievement of Renewable integration goals. This improvement shall be analyzed using the previously defined attributes, assigning the new scores if these alternatives would be implemented.

In order to sustain the already done update of regulation, and support the best practices that would increase the efficiency of the process, a quantitative analysis of the historical application data, and a study of the economic costs associated to 4 representative RES projects with different characteristics shall be carried out.

These analyses will allow to detect historical tendencies, inefficiencies and relevant information that will allow to provide the associated conclusions and final statement about the possibilities of achieving PNIEC renewable integration goal.

4. Definitions

RD 1183/2020 defines a set of concepts that shall be used in this thesis:

- Access right: Right to use the network based on a legal and regulatory conditions.
- Right of connection to a point of the network: right to physically connect an installation to the existing or planned distribution or transmission network.
- Access permission: granted by a network system operator (SO) for the use of the network to which an installation is connected.
- Permission of connection to a point of the network: granted by network Owner (NO) to allow the physical connection of an installation to the transmission or distribution network.
- Node: Point to which an installation is connected where at least three lines meet, or a line is open.

- Position: Points of the network that allow the physical connection of power lines and transformers.
- Upstream network: network to which is connected another type of network with a lower voltage level (i.e.: distribution to transmission) and in which an installation can create influence.
- Upstream System Operator: System operator of the upstream network.
- Access capacity: Maximum active power that can be injected to the network according to what is specified in the access permissions and Technical access contract.
- Connection to the network: procedure to carry out the physical connection of an installation to the transmission or distribution network.

It is important to highlight that in Spain, the Network Owner and the System Operator is the same entity although they are different departments in the same company.

Chapter 2: Access and Connection to distribution network procedures description

In this chapter, it shall be described and explained the Access and Connection procedures to distribution networks for both previous and new regulation.

The first point shall be dedicated to theoretically described previous regulation description, and the second point for new regulation. For each regulation, an illustrative flowchart diagram shall be developed to summarize the process. Subsequently, steps with a strong relationship shall be grouped in a set of clusters to facilitate the explanations and the analysis of chapter 3.

After having explained each regulation, a theoretical comparison between both procedures shall be carry out to identify and highlight differences and similarities.

Prior Access and Connection regulation passed in year 2000 by RD 1955/2000 (Ministerio de Economía, 2000), describing the stages that promoters had to follow until receiving the permissions. This methodology was applied, with slight updates, until 2020 when Spanish government decided to reform this regulation in order to standardize transmission and distribution procedures through RD 1183/2020 (Ministerio para la transición ecológica y reto demográfico, 2020), and also to define the actions to carry out until obtaining the permissions in RD 23/2020 (Ministerio para la transición ecológica y reto demográfico, 2020), as a result of the speculative behavior of promoters, detected in applications data and explained in the introduction of RD 23/2020 (Ministerio para la transición ecológica y reto demográfico, 2020).

1. Previous Access and Connection procedure regulation description (2000-2020)

The Regulation that have stated the Access and Connection procedure to distribution networks until 24th June 2020, was described in Chapter 2 of Title IV of RD 1955/2000 (Ministerio de Economía, 2000).

Before explaining the whole process, it is important to highlight that Article 63 of RD 1955/2000 (Ministerio de Economía, 2000) states that generators connected to the distribution network create influence in the upstream network (transmission) considering one of the following options:

a) Generator or group of generators [1] whose total power higher than 50MW.
b) Generator or group of generators whose total power is higher than 5% of short-circuit power (S_{cc}) in the connection node between distribution and transmission networks.

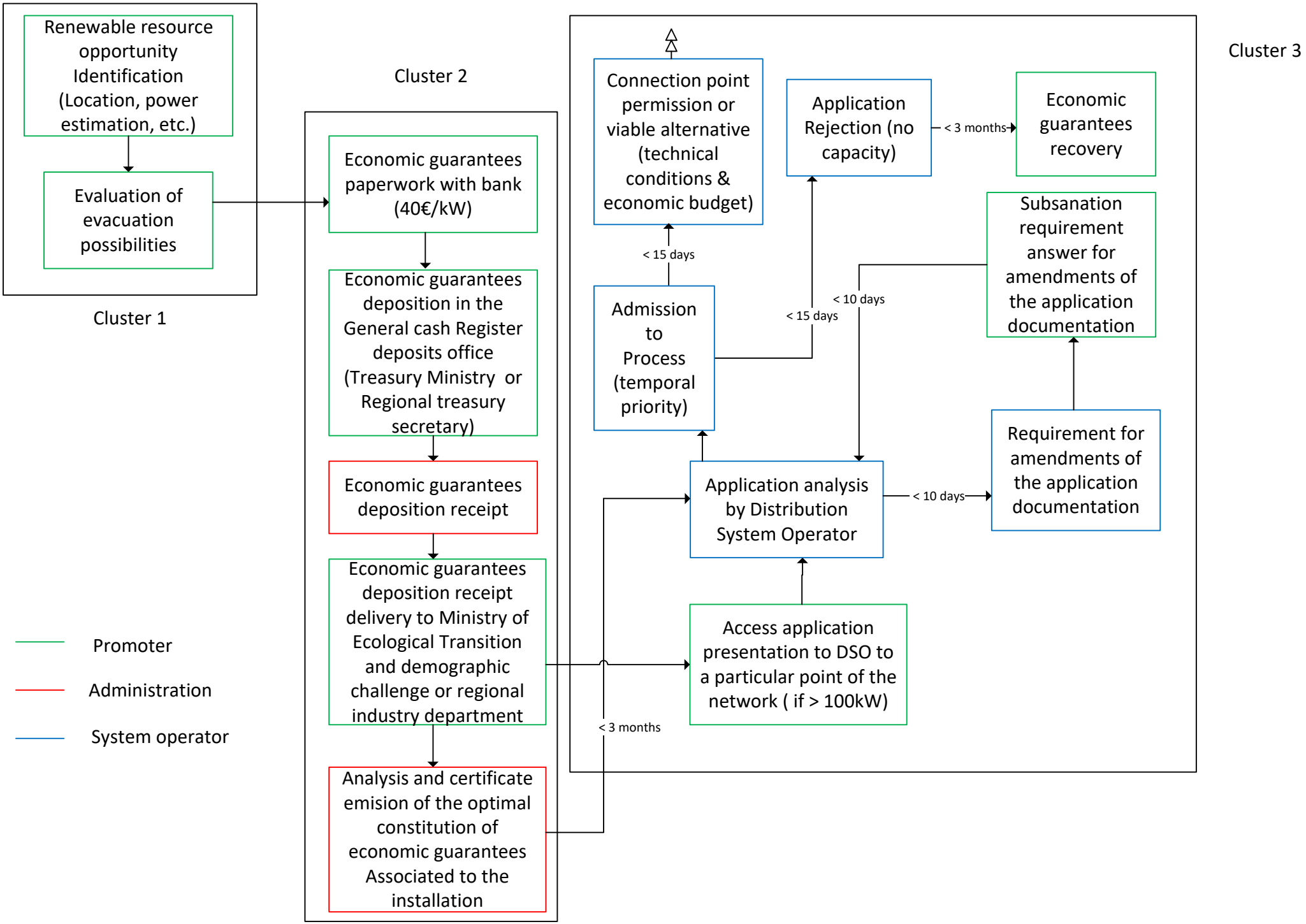
[1] Installation formed by one or more electricity generation modules (technologies) or energy accumulation technologies that inject electricity to the network, connected all of them to the network through the same position of the node. RD 1183/2020 (Ministerio para la transición ecológica y reto demográfico, 2020)

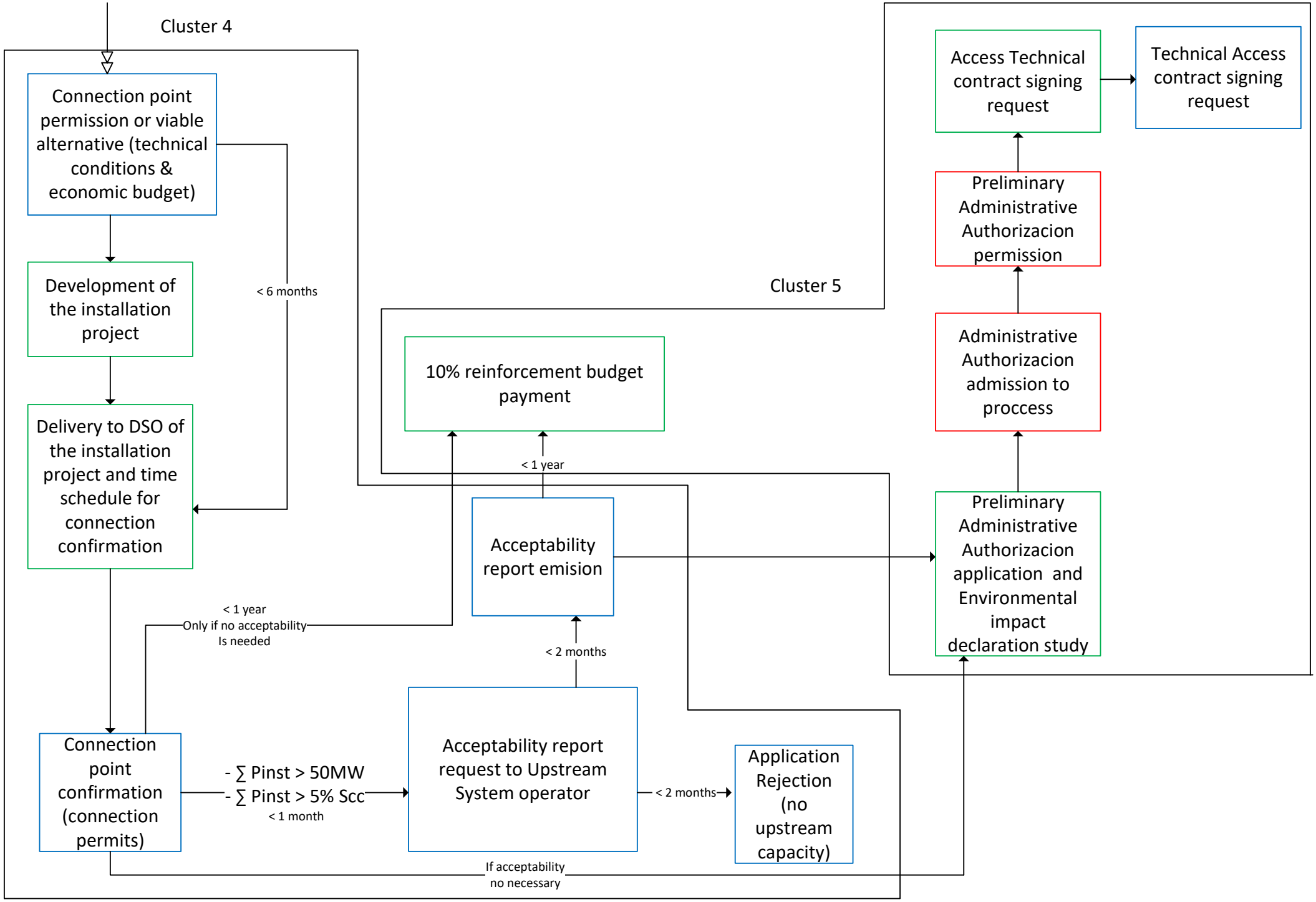
This means that for the installations that comply with one of these requirements, it is mandatory to have enough access capacity to host the power of the installation, not only in the distribution network but also in the upstream transmission network with the consequent and mandatory Acceptability concession by the upstream system operator, in this case the Transmission network. This issue shall be explained in the following points.

1.1. Previous Access and Connection regulation flowchart diagram

In this paragraph, the flowchart diagram that describes the different steps for Access and Connection to distribution networks procedure that was into forced until 24th June 2020, according to previous regulation: Article 62 of RD 1955/2000 (Ministerio de Economía, 2000), shall be developed.

In order to facilitate the subsequent explanation and the analysis of the whole process in chapters 3 and 4, a set of clusters that comprise stages with a strong relationship have been created and shown in the flowchart:


Renewable resource opportunity Identification (Location, power estimation, etc.)
Evaluation of evacuation possibilities
Cluster 1
Cluster 2
Economic guarantees paperwork with bank (40€/kW)
Economic guarantees deposition in the General cash Register deposits office (Treasury Ministry or Regional treasury secretary)
Economic guarantees deposition receipt
Economic guarantees deposition receipt delivery to Ministry of Ecological Transition and demographic challenge or regional industry department
Analysis and certificate emision of the optimal constitution of economic guarantees Associated to the installation
Cluster 3
Connection point permission or viable alternative (technical conditions & economic budget)
< 15 days
Admission to Process (temporal priority)
Application Rejection (no capacity)
< 3 months
Economic guarantees recovery
< 15 days
< 10 days
Subsanation requirement answer for amendments of the application documentation
Application analysis by Distribution System Operator
< 10 days
Requirement for amendments of the application documentation
Access application presentation to DSO to a particular point of the network (if > 100kW)
< 3 months
Promoter
Administration
System operator


Cluster 4
Connection point permission or viable alternative (technical conditions & economic budget)
Development of the installation project
< 6 months
Delivery to DSO of the installation project and time schedule for connection confirmation
Cluster 5
10% reinforcement budget payment
< 1 year
Acceptability report emision
< 1 year
Only if no acceptability
Is needed
< 2 months
Connection point confirmation (connection permits)
- ∑ Pinst > 50MW
- ∑ Pinst > 5% Scc
< 1 month
Acceptability report request to Upstream System operator
< 2 months
Application Rejection (no upstream capacity)
If acceptability no necessary
Access Technical contract signing request
Technical Access contract signing request
Preliminary Administrative Authorizacion permission
Administrative Authorizacion admission to proccess
Preliminary Administrative Authorizacion application and Environmental impact declaration study

The clusters that have been created and deployed in the previous diagram are the following:

- Cluster 1: Natural resource and connection possibilities study
- Cluster 2: Economic guarantees paperwork
- Cluster 3: Access application and analysis & viability
- Cluster 4: Connection application + Acceptability request
- Cluster 5: Actions after A&C permits

1.2. Previous Access and Connection regulation clusters description

In this point, the theoretical explanation of the predefined clusters shall be provided to describe the whole process of previous Access and Connection regulation.

Cluster 1: Natural resource and connection possibilities study

Although it is not a regulatory stage, the first step was to identify a location with enough natural resources to ensure that, in the case that the access and connection to the electrical network was achieved, it could become profitable, and as a result, evaluate the connection possibilities to the electrical network.

Natural resources are a critical element in order to be able to develop a profitable installation. This is because the larger the number of hours of natural energy, the more profitable the installation shall be as the energy produced shall be higher.

The initial decisions that were taken in this stage could be modified through an upgrade with the possibility to change the location of the installation without any limitations. Moreover, if the proposed connection point was not suitable it could be modified to another related to the initial one.

Another relevant aspect related to land selection are the connection possibilities as it directly affects costs. For instance, higher voltages and larger distances to the connection point mean larger costs for the future project. In this context, previous regulation allowed to make Access and Connection applications to distribution networks in existing installations (substations or power lines) or those that were included in the approved investment plan.

However, Distribution System Operators didn't have the obligation of making public information of their assets, despite the fact that distribution networks are larger than transmission networks covering more land, facilitating connection possibilities and also with lower voltages in their power lines, what means lower connection charges. Factors that could mean a great advantage over transmission networks but as they weren't required by regulation, promoters couldn't know about connection possibilities unless making local visits but always without any information, what at the end hindered the consideration of distribution networks as a connection possibility.

Cluster 2: Economic guarantees paperwork

According to article 66.bis of RD 1955/2020 (Ministerio de Economía, 2000), Economic guarantees of 40€/kW for renewable installations had to be deposited in the General cash deposits office of public administration: Treasury Ministry if installation power was higher than 50 MW or any installation (connection node, power line or generation installation) was in a different Autonomous Community, or Treasury secretary of Autonomous Community, if installation power was lower or equal than 50 MW and if all installation (connection node, power line or generation installation) were all in the same region. Installations with a power equal or lower than 15 kW didn't require to present an economic guarantee.

Although it is a combination of administrative and regulatory process, the procedure to deposit, communicate and constitute the economic guarantees by Spanish Administration was according the next steps:

1. Generation of the economic guarantee associated to the installation with the corresponding bank. RD 1955/2000 (Ministerio de Economía, 2000) made mandatory to indicate in the text:
    a. Name of the installation
    b. Type of technology
    c. Location
    d. To make mention to the article 66 bis. of RD 1955/2000
    e. Peak power (Used to calculate the amount with 40€/kW).
    f. Economic amount
2. Deposit the economic guarantees in the General Cash Deposits office of the Treasury Ministry, or the Treasury secretary of the Autonomous Community, depending on the conditions previously described.
3. Treasury Ministry or Treasury secretary of the Regional Administration emitted the Economic guarantees deposit receipt.
4. Official communication by the promoter to Ministry of Ecological Transition and demographic challenge or regional industry secretary of the Autonomous Community (depending on the peak power and location of installation as happened with the deposit of the economic guarantee) annexing the Economic guarantees deposit receipt and indicating the distribution or transmission network where was intended to connect the future installation. Any mistake made necessary a correction of the provided information.
5. Ministry of Ecological Transition and demographic challenge or regional industry secretary of Autonomous Community (depending on the installation power and location of the installations), had a maximum of 3 months to emit and deliver directly to the corresponding System Operator a certification of the optimal constitution of the economic guarantee, being this documentation a mandatory requirement to allow the System Operator to analyze the application according to what is specified in article 66bis of RD 1955/2000 (Ministerio de Economía, 2000).
   If this communication was not received, the System Operator blocked the application until the reception from the Administration.

Cluster 3: Access application and analysis & viability

In parallel with the communication with the optimal constitution of the economic guarantees from the Administration to the system operator of the network where it was intended to connect, promoters could initiate the Access application with all the documentation required by the System Operator. Installations with a power less than 100kW didn't require to apply, but simply notify the DSO about the connection (Ministerio de Economía, 2000).

Once the application was made and the official communication by the Administration was received by the System Operator, the analysis of the documentation could start. If the application was made but the communication of the economic guarantees hadn't been received, the System Operator blocked the application status until the receival.

During the analysis, if any mistake or missing information was detected, the System Operator had 10 days to ask for a requirement for amendments to the applicant. If these 10 days were exceeded the application had to be admitted to process.

The applicant had also 10 days to answer this requirement, if existed, and there were no limits to the number of requirements. If these 10 days were exceeded the application was rejected.

Once the application was admitted to process (no temporal limits for this status since the previous step), the DSO had 15 days to whether reject the application justifying this decision, or grant the connection point or viable alternative with the technical conditions and economic budget associated to this connection point. Alternatives or other proposals provided by the applicant were not accepted.

As capacities were not published, system operators calculated the available capacity as a 5% of the short-circuit power in the connection point and based on this require reinforcements to host the applied capacity.

Cluster 4: Connection application + Acceptability request

When the access was granted, the applicant had 6 months to deliver the installation project and time schedule to confirm the connection point.

Once this was delivered, RD 1955/2000 (Ministerio de Economía, 2000) established that the DSO had a limit of 1 month to request the Upstream System operator the acceptability report if one of the following conditions was met as it was considered that the installation created influence in the upstream network an required available capacity to be assigned:

a) Generator or group of generators whose total power higher than 50MW.
b) Generator or group of generators whose total power is higher than 5% of short-circuit power (S_{cc}) in the connection node between distribution and transmission networks.

Upstream system operator had a maximum of 2 months to emit the Acceptability report. If positive, the applicant could start the administrative procedure to achieve the previous administrative authorization, if negative, economic guarantees could be recovered by the applicant and the Access was canceled.

Cluster 5: Actions after A&C permits

Promoters of installation which had been granted with Access and Connection permission and Upstream network Acceptability (if needed), had a maximum of 1 year to pay a 10% of the reinforcements budget necessary to carry out the physical connection to the distribution network, if they were needed. The left 90%, was through an agreement contract between the DSO and the applicant until the commissioning of the installation.

In these conditions, promoters could start the Administration procedure to achieve the Administrative Authorization and the positive environmental impact declaration.

Once the Preliminary Administrative Authorization for the installation and the evacuation infrastructure had been granted, the promoter and the DSO signed the Technical Access Contract to establish the Operation & Maintenance conditions, ownership, etc.

After these milestones, when the project was advancing Construction Administrative Authorization and the subsequent Exploitation Authorization were the following stages.

2. New Access and Connection procedure regulation description (2020)

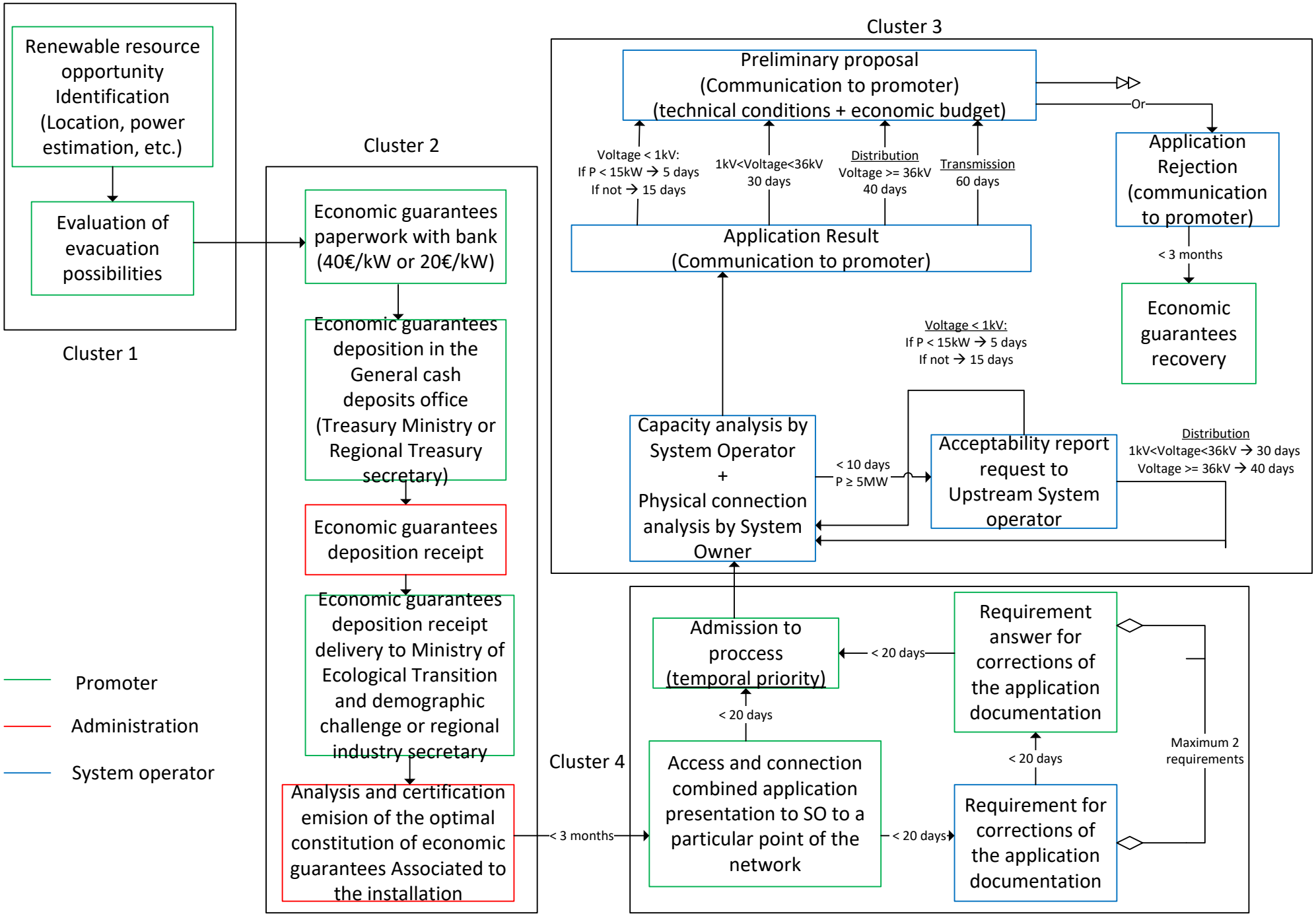
As a result of the speculative situation with the asymmetries and inefficiencies explained in Chapter 1, during the year 2020, Spanish government approved and put into force new legislation to regulate Access and Connection to distribution and transmission networks in order to ensure a better integration of renewable energies in the electricity system through RD 23/2020 (Ministerio para la transición ecológica y reto demográfico, 2020) to reduce the speculation and ensure the commissioning of installations with access and connection permissions already granted, and RD 1183/2020 (Ministerio para la transición ecológica y reto demográfico, 2020) to regulate and redefine the new Access and Connection application procedure to transmission and distribution networks using the same stages and requirements for both grids. Moreover, to adapt and coordinate this legislation, Spanish regulator, CNMC, is developing a set of Circulars like the already approved Circular 1/2021 (CNMC, 2021).

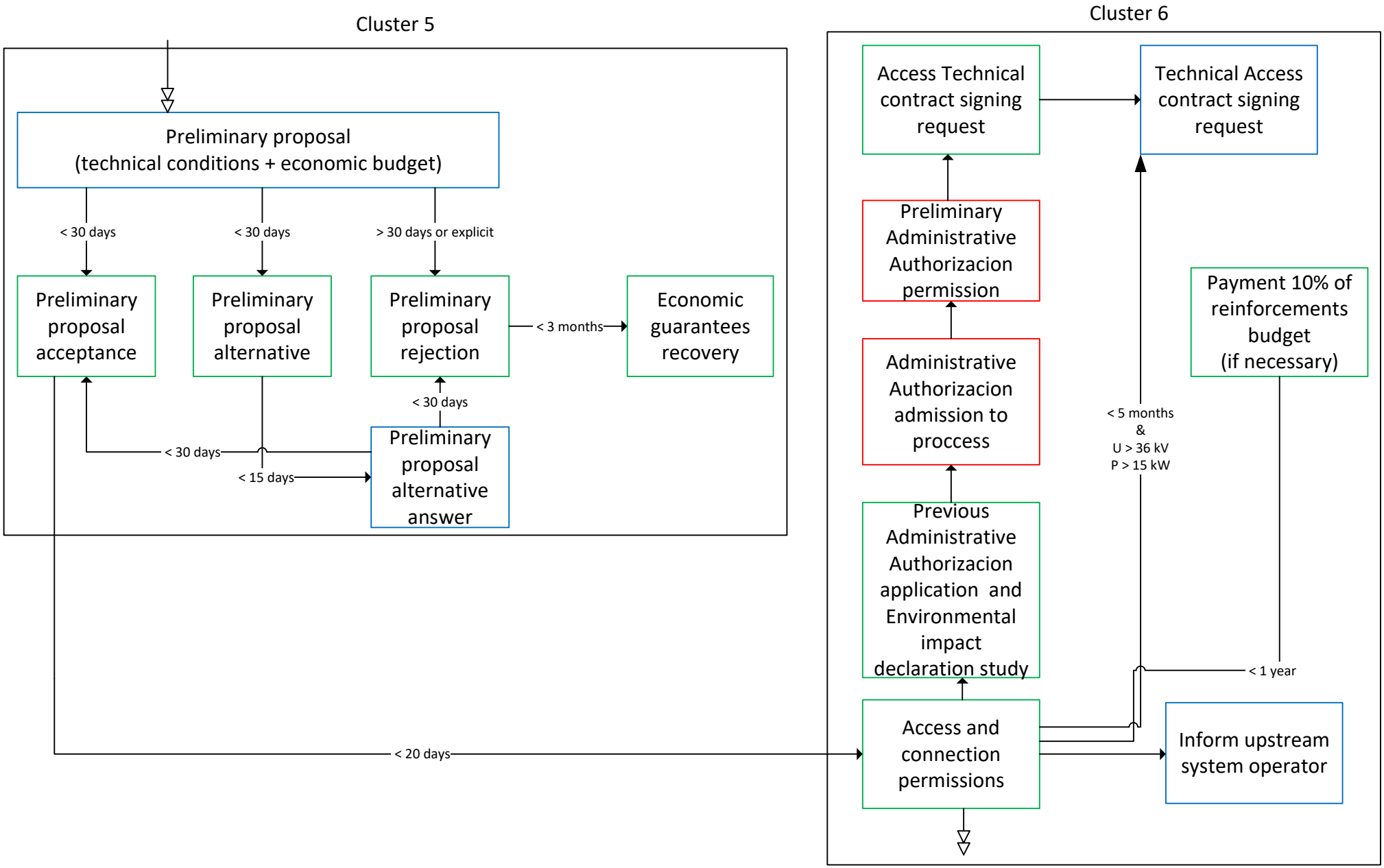
Second additional disposition of Circular 1/2021 (CNMC, 2021), states that generators connected to the distribution network create influence in the upstream network (transmission) if the total connected power to is higher than 10 MW and individual installations have a power above 5MW in peninsular electricity system, and 5 MW in total with individual power of 1 MW in island electricity systems, so an Acceptability by the upstream System Operator shall be mandatory in this cases.

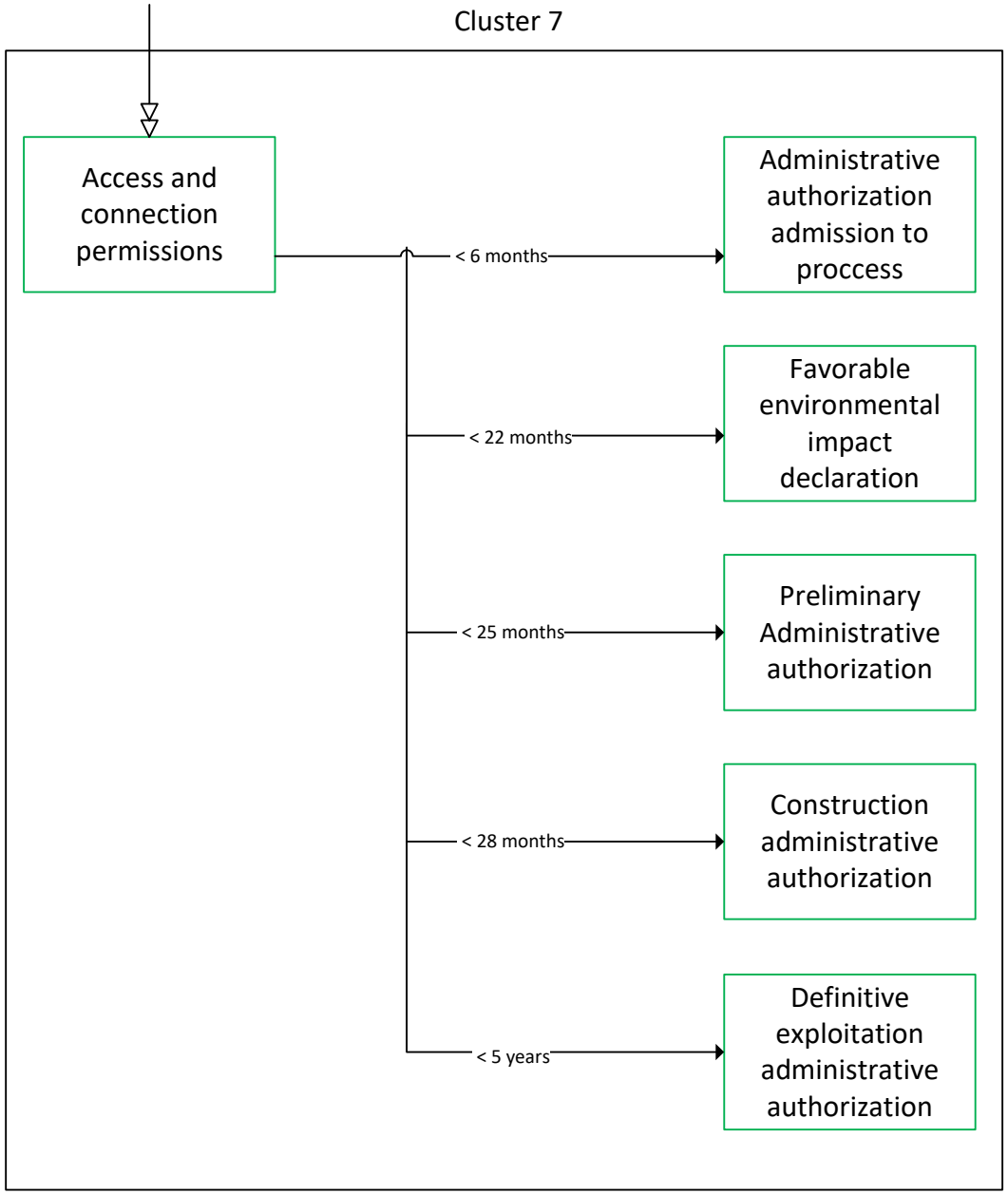
2.1. New Access and Connection regulation flowchart diagram

In this paragraph, the flowchart diagram that describes the different stages of new Access and Connection to distribution networks procedure describe in Chapters III and IV of RD 1183/2020 (Ministerio para la transición ecológica y reto demográfico, 2020), shall be developed.

In order to facilitate the subsequent explanation and the analysis of the whole process in chapters 3 and 4, a set of clusters that comprise stages with a strong relationship have been created and shown in the flowchart:


Cluster 1
Renewable resource opportunity Identification (Location, power estimation, etc.)
Evaluation of evacuation possibilities
Cluster 2
Economic guarantees paperwork with bank (40€/kW or 20€/kW)
Economic guarantees deposition in the General cash deposits office (Treasury Ministry or Regional Treasury secretary)
Economic guarantees deposition receipt
Economic guarantees deposition receipt delivery to Ministry of Ecological Transition and demographic challenge or regional industry secretary
Analysis and certification emision of the optimal constitution of economic guarantees Associated to the installation
< 3 months
Cluster 3
Preliminary proposal (Communication to promoter) (technical conditions + economic budget)
Or
Application Rejection (communication to promoter)
< 3 months
Economic guarantees recovery
Voltage < 1kV: If P < 15kW → 5 days If not → 15 days
1kV<Voltage<36kV 30 days
Distribution Voltage >= 36kV 40 days
Transmission 60 days
Application Result (Communication to promoter)
Voltage < 1kV: If P < 15kW → 5 days If not → 15 days
Capacity analysis by System Operator + Physical connection analysis by System Owner
< 10 days P ≥ 5MW
Acceptability report request to Upstream System operator
Distribution 1kV<Voltage<36kV → 30 days Voltage >= 36kV → 40 days
Cluster 4
Admission to proccess (temporal priority)
< 20 days
Requirement answer for corrections of the application documentation
< 20 days
Access and connection combined application presentation to SO to a particular point of the network
< 20 days
Requirement for corrections of the application documentation
< 20 days
Maximum 2 requirements
Promoter
Administration
System operator


Cluster 5
Preliminary proposal
(technical conditions + economic budget)
< 30 days
< 30 days
> 30 days or explicit
Preliminary proposal acceptance
Preliminary proposal alternative
Preliminary proposal rejection
< 3 months
Economic guarantees recovery
< 30 days
< 30 days
< 15 days
Preliminary proposal alternative answer
Cluster 6
Access Technical contract signing request
Technical Access contract signing request
Preliminary Administrative Authorizacion permission
Payment 10% of reinforcements budget (if necessary)
Administrative Authorizacion admission to proccess
< 5 months
&
U > 36 kV
P > 15 kW
Previous Administrative Authorizacion application and Environmental impact declaration study
< 1 year
Access and connection permissions
Inform upstream system operator
< 20 days


Cluster 7
Access and connection permissions
< 6 months
Administrative authorization admission to proccess
< 22 months
Favorable environmental impact declaration
< 25 months
Preliminary Administrative authorization
< 28 months
Construction administrative authorization
< 5 years
Definitive exploitation administrative authorization

The clusters that have been created and deployed in the previous diagram are the following:

- Cluster 1: Natural resource and connection possibilities study
- Cluster 2: Economic guarantees paperwork
- Cluster 3: Access and connection application
- Cluster 4: Applications study and capacity viability & assignment
- Cluster 5: Application result: Preliminary proposal or rejection
- Cluster 6: A&C permissions and network contract
- Cluster 7: Administrative milestones

2.2. New Access and Connection regulation stages description

In this point, the theoretical explanation of the clusters shall be provided to describe the whole process of new Access and Connection regulation.

Cluster 1: Natural resource and connection possibilities study

As happened with previous regulation, they first step in any renewable installation candidate is to identify the location with enough natural resources to ensure that, in the case that the connection to the electrical network is achieved, it can be profitable, and apart from this, to evaluate the evacuation possibilities to the electrical network, an aspect that also affect the profitability of the installation due to associated costs..

Since the approval of RD 23/2020 (Ministerio para la transición ecológica y reto demográfico, 2020), different issues must be considered in this analysis and the decisions that are taken in this step can be considered the most important ones in the whole process, as the possible associated economic risks that can rise later due to the constraints of this new regulation, are strongly related to the selection of the location of the possible renewable plant and the choice of the connection point to the electricity network:

- Land selection: RD 23/2020 (Ministerio para la transición ecológica y reto demográfico, 2020) has made the selection of the land a critical aspect, as for future upgrades of the installation (considering that access and connection permissions have been already granted), the distance between centroids of the initial land and the upgraded land must be below 10 km, this requires that promoters have already initiated and advanced the purchase of land before initiating the Access and Connection application.
  As explained before, natural resources are a key element in order to be able to develop a profitable installation, so it is necessary to ensure that purchased land has enough natural resource to ensure the profitability of the installation.
- Network connection point selection: RD 1183/220 (Ministerio para la transición ecológica y reto demográfico, 2020) make requires Systems Operators of Distribution and Transmission networks, to publish information about their assets apart from sharing the associated available access capacity. This information allows promoters to study the best connection solution taking into account that it directly affects the profitability of the installation due to factors like length of evacuation power lines and voltage. It is important to highlight that distribution networks are denser than transmission

networks, covering a larger space and facilitating the connection and that they are cheaper than transmission connections due to lower voltages.

Transparency in distribution networks is going to facilitate the integration of renewable projects as connection possibilities studies are facilitated because of the information that System Operators have to published is described in article 12 of Circular 1/2021 (CNMC, 2021) of public information.

RD 1183/2020 (Ministerio para la transición ecológica y reto demográfico, 2020) allows to carry out access and connection applications towards existing installations (substations or power lines) or those included in the investment plan.

Cluster 2: Economic guarantees paperwork

Article 23 of RD 1183/2020 (Ministerio para la transición ecológica y reto demográfico, 2020) requires that economic guarantees of 40€/kW for conventional renewable installations, or 20€/kW for hybridization of renewable installations with access and connection permits already granted (PV+W, Hydro + PV, etc.) must be deposited in the General cash deposits office of public administration: Treasury Ministry if installation power is higher than 50 MW or any installation (connection node, power line or generation installation) is in a different Autonomous Community, or Treasury secretary of Autonomous Community, if installation power is lower or equal than 50 MW and if the whole installation (connection node, power line or generation installation) is all in the same region.

Installations with a power equal or lower than 15 kW shall not be required to present an economic guarantee.

This economic guarantee shall be recovered with the commissioning of the installation.

Although it is a combination of administrative and regulatory process, the procedure to deposit, communicate and constitute the economic guarantees by Spanish Administration is carried out according the next steps:

1. Generation of the economic guarantee associated to the installation with the corresponding bank. Article 23 of RD 1183/2020 (Ministerio para la transición ecológica y reto demográfico, 2020) make mandatory to indicate in the text:
    a. Name of the installation
    b. Type of technology
    c. Location
    d. To make mention to the article 23. of RD 1183/2020
    e. Installed power (Used to calculate the amount with 40€/kW or 20€/kW if it is a hybridization).
    f. Economic amount
2. Deposit of the economic guarantees in the General Cash Deposits office of the Treasury Ministry, or the Treasury secretary of the Autonomous Community, depending on the conditions previously described.
3. Treasury Ministry or Treasury secretary of the Regional Administration emission of the Economic guarantee's deposit receipt.

4. Official communication by the promoter to Ministry of Ecological Transition and demographic challenge or regional industry secretary of the Autonomous Community (depending on the installed power and location of installation as happened with the deposit of the economic guarantee) annexing the Economic guarantees deposit receipt and indicating the distribution or transmission network where is intended to connect the future installation. Any mistake made necessary a correction of the provided information.
5. Ministry of Ecological Transition and demographic challenge or regional industry secretary of Autonomous Community (depending on the installation power and location of the installations), have a maximum of 3 months to emit and deliver to the promoter a certification of the optimal constitution of the economic guarantee, being this documentation a mandatory requirement to attach in the Access and Connection application to the System Operator.
   If this communication is not attached by the promoter, the System Operator reject the application.

Cluster 3: Access and connection application

According to Article 10 of RD 1183/2020 (Ministerio para la transición ecológica y reto demográfico, 2020), promoters whose candidate installations are subject to present an access and connection application, shall present to the system operator of the network to which they want to be connected, an application attaching the documents with the information that are defined by the Spanish regulator CNMC in the Article 3 of Circular 1/2021 (CNMC, 2021):

- Applicant identification and contact data.
- Copy of the communication of optimal constitution of the economic guarantees by the corresponding Administration.
- Simple project of the installation
- Installation identification: Technology, requested access capacity and location coordinates. In case of hybridization, identification of the different generation modules, and description of accumulative batteries, if it is the case.
- Specific Connection point to the distribution/transmission network.
- Single-line diagram of the connection infrastructures.
- Contracted power of the auxiliary services.
- If self-consumption with surplus, consumption contracted power.
- Installation economic budget

Once the application has been made by the promoter, the System Operator of the network that receives the application shall have a maximum of 20 days to ensure that all the information provided is correct and notify the admission to process of the application or, on the contrary, require a correction to the applicant in order to modify or add missing data according to what is required by Circular 1/2021.

The possible requirement for correction must perfectly describe all the mistakes to correct. However, information and documents not included in the CNMC requirements for an application cannot be asked to be submitted, only complementary data, and there shall be a maximum of 2 requirement for corrections of an application.

The applicant has a maximum of 20 days to answer the requirement and, in the case that the answer is not submitted within the maximum of 20 days, the application will be canceled and rejected.

The System Operator shall have 20 days to analyze and respond to the answer of the applicant to the requirement or second requirement. In the cases that the 2nd requirement continues to be wrong, the application shall be canceled and rejected.

In the cases that the System Operator exceeds the maximum of 20 days to analyze the corrected information and documents of the requirement, the application shall be admitted to process.

Once the applicant has delivered the information of the first or second requirement, or the initial application, if everything is correct, the System Operator shall have a maximum of 20 days to notify the admission to process of the application.

Cluster 4: Applications study and capacity viability & assignment

Article 11 of RD 1183/2020 (Ministerio para la transición ecológica y reto demográfico, 2020) states that access and connection application analysis shall be made once it has been admitted to process by the system operator, and in this moment temporal priority to occupy access capacity shall be applied based on the date and hour of the admission to process to ensure an effective competition. In the case of coincidence of several applications having been admitted to process at the same date and hour, the distinction element shall be the date and hour when economic guarantees were officially constituted by the corresponding Administration (Ministry of Ecological Transition and demographic challenge or regional industry secretary).

Initially, the System Operator of the network where the application is made, shall analyze if there is available access capacity in the connection point of the application with the possibility of contemplating possible reinforcements (paid by the applicant) to increase the hosting capacity of that particular point of the distribution network. In parallel, it shall be determined if it is viable a physical connection to the proposed substation or powerline.

As explained in the introduction of this point, according to the Second additional disposition of Circular 1/2021 (CNMC, 2021), if the power of a set of generators to be connected in the same connection point is larger than 10MW in peninsular network, or 1MW in insular network, only considering for this figures installed powers of generators larger that 5MW or 0,5MW respectively, it is be considered that these generators creates influence in the upstream network (transmission), requiring an Acceptability to host that capacity by the upstream System Operator in its network. For this reason and theses cases, it shall be mandatory that the System Operator of the distribution network that receives the application requests to the upstream System Operator (transmission network) in a period no longer than 10 days since the admission for processing the application, an acceptability report of the capacity and technical affections in the upstream network.

The maximum time that the upstream System Operator has for delivering the acceptability report shall depend on the voltage of the connection point between the network and the

upstream network as defined in article 13 of RD 1183/2020 (Ministerio para la transición ecológica y reto demográfico, 2020):

	Voltage < 1kV	1kV ≤ Voltage < 36kV	36kV ≤ Voltage	Transmission
P ≤ 15kW	≤ 5 days	≤ 30 days	≤ 40 days	≤ 60 days
P > 15kW	≤ 15 days	≤ 30 days	≤ 40 days	≤ 60 days

Table 1 Maximum deadline for submitting upstream Acceptability report

Upstream system operator must not require additional information than the provided in the initial application already submitted to downstream System Operator and must respect the temporal priority of all the applications that are received.

Once the analysis has been made and the acceptability report is received, possible results can be:

- Application acceptance: Enough capacity in the network and in the upstream network to host the installation.
- Application rejection: no capacity in the network or the upstream network directly communicated to the applicant or rejection for connection unviability.
- Application partial acceptance: if there is less capacity than the demanded in the application, promoter must accept this available capacity.

Cluster 5: Application result: Preliminary proposal or rejection

If, after the application analysis, the result is that there is available access capacity, the System Operator shall notify to the promoter a proposal, based on what is stated in Article 12 of RD1183/2020 (Ministerio para la transición ecológica y reto demográfico, 2020), that shall include what is describe hereafter:

- Proposal of access capacity to be granted (equal or lower than the requested in the application).
- Technical requirements for the connection point: voltage, exact location, etc.
- Maximum and minimum Short-circuit power for protection devices design and voltage fluctuations.
- Possible temporal generation prohibitions or curtailments due to network status or Operation & Maintenance operations
- Technical and regulatory requirements for the private connection infrastructure.
- Specific technical works necessary for the physical connection process.
- Economic budget that shall include the technical and labor needs for the connection, possible reinforcements to increase the existing capacity and host the proposed power, and other possible costs such as engineering hours, manufacturing, etc.
- Possible agreements between applicants.

In the cases of a negative application analysis, a justifying memory shall be provided, together with an alternative connection option that the promoter can accept or reject.

The maximum time to deliver the result of the analysis, and the preliminary proposal depends on the voltage of the connection point where the installation is intended to be connected as defined in article 13 of RD 1183/2020 (Ministerio para la transición ecológica y reto demográfico, 2020):

	Voltage < 1kV	1kV ≤ Voltage < 36kV	36kV ≤ Voltage	Transmission
P ≤ 15kW	≤ 5 days	≤ 30 days	≤ 40 days	≤ 60 days
P > 15kW	≤ 15 days	≤ 30 days	≤ 40 days	≤ 60 days

Table 2 Maximum deadline for preliminary proposal delivery

These due dates shall be computed since the application is admitted to process, and for the cases that require an acceptability report from the upstream System Operator, it shall be the sum of all the maximum days of both Acceptability report and Preliminary proposal.

Since the preliminary proposal is submitted, according to article 14 of RD 1183/2020 (Ministerio para la transición ecológica y reto demográfico, 2020), the applicant shall have a maximum of 30 days to accept the proposal, submit an alternative or reject the proposed connection point. If this maximum of 30 days is exceeded, the System Operator shall consider that the proposal is rejected, terminating the access and connection process.

For the cases that an alternative is presented by the applicant, a revision of specific aspects will be carried out by the System Operator (with possibility of requesting more information and data). In this situation, in a maximum of 15 days since the reception of the alternative or the possible request of more information answer, the System Operator shall notify the decision about this alternative, having the applicant a maximum of 30 days to accept or reject the new proposal.

If a preliminary proposal is being reviewed, other applications with less temporal priority will be suspended until the reviewed is finished as it may affect the result of the review.

In distribution networks with voltages equal or less than 36 kV, the preliminary proposal shall not be considered accepted until there is a payment agreement of the infrastructure that the Network Owner must develop to host the generation installation.

Cluster 6: A&C permissions and network contract

Article 15 of RD 1183/2020 (Ministerio para la transición ecológica y reto demográfico, 2020) states that once the preliminary proposal and the technical and economic requirements have been accepted, the System Operator shall have a maximum of 20 days to deliver applicants the official access and connection permissions since the notification of the preliminary proposal acceptance.

Official Access and Connection permissions shall include:

- Identification of the economic guarantees communicated to the Administration by the promoter.
- Identification of the installation with permissions granted and generation modules in case of hybridization.

- Exact location of the connection point.
- Technical conditions linked to the connection. Subject to modification for 6 months since the emission of the permits.
- Economic budget linked to the connection. Subject to modification for 6 months since the emission of the permits with a maximum of increase of 20%.
- Date of the Access and Connection granting.
- Due date of the Access and Connection permissions in case of not advancing with following stages.

Once the renewable installation has been granted with access and connection permission, the promoter can apply to the Previous Administrative Authorization application with the corresponding administration, and the subsequent Environmental impact declaration study. As happens with the economic guarantees communication, the corresponding Administration to process renewable installation projects can be, in this case, Ministry of Industry or corresponding Industry Secretary of the Autonomous Community where is located the project, depending on the power of the installation (higher or equal/lower than 50MW) and the location of the whole project (single Autonomous Community or various).

In a maximum of 6 months, it is necessary to obtain from the Administration the admission for administrative processing the application, if there are not requirements for corrections or modifications. Once the project and paperwork are analyzed, the renewable project is granted with the Preliminary administrative Authorization.

In parallel of administrative procedures, Article 21 of RD 1183/2020 (Ministerio para la transición ecológica y reto demográfico, 2020) requires promoters to sign the Technical Access Contract with Network Owner of which the installation will be connected, in a period no longer than 5 months since the emission of the access and connection permissions, except installations that comply with one of the following exemptions:

- Voltage of the network to be connected equal or lower than 36kV.
- Self-consumption installations without surplus.
- Installations with a production power equal or lower than 15kW.

This contract shall reflect the technical obligations of the owners of the installation with the Network owner to which they shall connect: Operation & Maintenance, ownership of private infrastructures, etc.

Moreover, Article 21 of RD 1183/2020 (Ministerio para la transición ecológica y reto demográfico, 2020) also requires that promoters of installations with access and connections permissions to a network with a voltage equal or higher than 36kV to pay the 10% of the works to be made in the network to carry out the physical connection to the connection point and possible associated reinforcements, in a maximum of 1 year since the emission of the permissions,.

The left 90% shall be paid through a contractual agreement between the Network Owner and the promoter before the installation is put into service and physically connected to the network, current Legislation does not enter in regulating this agreement.

Cluster 7: Administrative milestones

In order to ensure the firmness of promoted projects, Article 1 of RD 23/2020 (Ministerio para la transición ecológica y reto demográfico, 2020), establishes that Installations which have been already granted access permissions, must prove the compliance of the subsequent administrative milestones with the Ministry of Industry or Autonomous Communities, in a deadline no longer of the indicated hereafter:

- Access permits granted from 28th December 2013 to 31st December 2017 (included):
    - Preliminary administrative authorization admission: 3 months
    - Favorable Environmental Impact declaration obtaining: 18 months
    - Preliminary administrative authorization obtaining: 21 months
    - Construction administrative authorization obtaining: 24 months
    - Definitive exploitation administrative authorization obtaining: 5 years

- Access permits granted from 31st December 2017 to 24th June 2020, and dates in advanced:
    - Preliminary administrative authorization admission: 6 months
    - Favorable Environmental Impact declaration obtaining: 22 months
    - Preliminary administrative authorization obtaining: 25 months
    - Construction administrative authorization obtaining: 28 months
    - Definitive exploitation administrative authorization obtaining: 5 years

These deadlines start counting from the approval or RD 23/2020, 24th June 2020, for projects with Access permissions before that date, or since the granting of Access and Connection permissions if these are granted after that date

If these milestones are not presented in the maximum time indicated before, economic guarantees shall be executed and granted permits for installations shall be eliminated, although, Hydro pumping technologies can extend this time windows, but for a period no longer of 7 years.

The only exception for not executing the economic guarantees for a milestone declaration cause, shall be a negative Environmental Impact Declaration for external causes of the promotor.

3. Comparison between previous and new Access and Connection regulations

In order to analyze the evolution between both regulations, clusters of previous and new procedures described in paragraphs 1 and 2 of this chapter, shall be compared in order to highlight the main differences to identify the main changes and improvements. As the number of clusters doesn't coincide (5 vs. 7 respectively), the comparisons shall be carried out with clusters of similar characteristics as indicated in the following table:

Comparison	Clusters	
	Previous regulation	New regulation
1	1	1
2	2	2
3	3-4	3-4-5
4	5	6-7

Table 3 Clusters comparison

3.1. Comparison 1.

This comparison relates cluster 1: Natural resource and connection possibilities study of both regulations

The first preliminary stages of analyzing land and natural resources to study the viability of the installation are the same as it is a cost-benefit analysis that each candidate has to carry out before analyzing connection possibilities and starting the Access and Connection procedure.

However, the greater difference that new regulation applies are the constraints established through RD 23/2020 (Ministerio para la transición ecológica y reto demográfico, 2020) in which the location that will be used in the Access and Connection application is extremely relevant because, for future upgrades once the Permissions are granted, promoters can modify the location of the installation with a limitation of 10 km between the center of the original and final location.

This new restriction, although it doesn't directly apply in this cluster but is directly related, is extremely relevant as promoters that initiate an Access and Connection application without ensuring the location of the plant, can put at risk the economic guarantees of the installation. With this decision, Spanish government tries to minimize the speculation that has risen with previous regulation that didn't put limits to any future modification, leading to create a trading business of Access Permissions that didn't end in the commissioning of new installations, which at the end is the main objective of PNIEC.

In this point, the larger improvement is the obligation of all System Operators (transmission and distribution) to publish information about their assets together with the associated available access capacity, An important change contributing to increase the transparency and facilitating the connection possibilities study as this was a the main weakness of previous regulation. An improvement that will contribute to increase renewable penetration in distribution networks.

3.2. Comparison 2.

This comparison relates Cluster 2 of both regulations: Economic guarantees paperwork.

Both regulations establish that the presentation and constitution of economic guarantees are mandatory for any Access and Connection application except for installations of a power lower than 15kW.

They also share the consideration of the value of 40€/kW to calculate the amount of the economic guarantee, but RD 1183/2020 (Ministerio para la transición ecológica y reto demográfico, 2020) covers the hybridization of installations with Access and Connection Permissions already granted for which the amount of the economic guarantees is 20€/kW, an aspect that was not previously considered, with the difference that new regulation calculates the amount of the economic guarantee with the installed power and previous regulation did with peak power, a difference that only applies to photovoltaic installations.

The process of deposit and communication to the respective Administration remains the same, if the power is equal or lower than 50 MW and the whole installation (generation facility power line and connection node) is in the same Autonomous Community, it is dealt in the treasury and industry secretary of the specific Autonomous Community, if one of this conditions is no met, it is dealt in the Treasury Ministry and Ministry of Ecological Transition and demographic challenge respectively. However, the main difference now is that with new regulation the communication from the Administration (Ministry of Ecological Transition and demographic or industry secretary of the specific Autonomous Community) about the constitution of the economic guarantee is directly communicated to the promoter and it is a mandatory document to attach in the application (if not, it is rejected), whereas with previous regulation it was delivered to the corresponding System Operator of the network and the promoter made the application without knowing if it had been delivered. This is an increase of efficiency, undoubtably.

3.3. Comparison 3

This comparison relates cluster 3 and 4 of previous regulation: Access application and analysis & viability and Connection application + Acceptability request, with clusters 3,4 and 5 of new regulation: Access and connection application, Applications study and capacity viability & assignment and Application result: Preliminary proposal or rejection,

There has been a total change in the Access and Connection application procedure between both regulations. RD 1183/2020 (Ministerio para la transición ecológica y reto demográfico, 2020) has homogenized the application stages for Distribution and Transmission networks as they were completely different in previous regulation, starting with the fact that now access and connection applications are sent at the same time at the beginning of the process while RD 1955/2000 (Ministerio de Economía, 2000) stated that they were independent and consequent applications. This issue requires that System Operators must analyze at the same time if there is enough capacity to host the installation and if the proposed physical connection is viable or not, looking for reducing the time scope of the whole process.

Another important change is that RD 1183/2020 (Ministerio para la transición ecológica y reto demográfico, 2020) fixes a maximum of 2 requirement for corrections in order to modify the

documentation an amend mistakes or missing mandatory information, whereas previous regulation didn't state a maximum number of requirements what could delay the process. This also means an increase of efficiency in terms of time.

An important improvement of new regulation in comparison with previous procedure, is that once the application is admitted to process, the system operator must request the upstream system operator its acceptability for the cases that is required before delivering an answer to the applicant. A real improvement, taking into account that in traditional regulation, the acceptability report was requested by the system operator after having granted the Access permission without knowing if there was enough capacity in the upstream network, in the cases that it was needed, what could mean a rejection by the upstream system operator after the whole Access and Connection procedure, after having submitted a project of the installation and time schedule in a time no longer than 6 months. This aspect could suppose a time and economic inefficiency, consuming resources from both promoters and System Operators, a clear inefficiency that has been corrected in new regulation, combining the Access and Connection possibility.

Related to the Acceptability report, there has been a change in conditions for which it is mandatory: RD 1183/2020 (Ministerio para la transición ecológica y reto demográfico, 2020) establishes that it must be requested if the total power of a set of generators to be connected in the same connection point is larger than 10MW in peninsular network, or 1MW in insular network, only considering for these figures installed powers of generators larger that 5MW or 0,5MW respectively, whereas RD 1955/2000 (Ministerio de Economía, 2000) required this report if total power of all the installations connected to the same point were higher than 50MW, or if the sum of power of all installations connected is higher than 5 % of the Short-circuit power of the connection point between the network and the upstream network. As the regulator expects an increase of applications in the distribution network has reduced the constraints for which Acceptability report is mandatory.

3.4. Comparison 4

This last comparison compares Cluster 5: Actions after A&C permits of previous regulation, with Clusters 6 and 7 of new regulation: A&C permissions and network contract and Administrative milestones

Regarding the actions after access and connections permissions, the main difference is that new regulation establishes a deadline for signing the technical access contract between the System Operator and promoter for any installation, except self-consumption with a surplus lower than 15kW, to a maximum of 5 months, instead of the whole year that was settled by RD 1955/2000 (Ministerio de Economía, 2000), and just if the installation is going to be connected to a voltage larger than 36kV and a power of 15kW.

The deadline for the payment of 10% of the budget of possible reinforcements and physical connection continue being 1 year. None of the regulations determine periods or deadlines for the 90% left.

However, as explained before, Spanish government is trying to ensure that installations with Access and Connection permissions are commissioned as soon as possible, and for that reason approved RD 23/2020 (Ministerio para la transición ecológica y reto demográfico, 2020), in order to fixed deadlines for administrative milestones that every promoter has to fulfill before a maximum deadline, once the Access and Connection permissions are granted to ensure that projects advanced and are not delayed until the commissioning.

3.5. Summary

Comparison	Previous regulation (2000-2020)		New regulation (2020)	
1	**Cluster 1**	- Natural resource and location studies. - No future constraints - No information of network assets and access capacity	**Cluster 1**	- Natural resource and location studies - Constraint of technology and land selection in future updates (Max. 10 km distance) - Publication of network assets information, location, and capacities
2	**Cluster 2**	- Economic guarantees if power >15kW of 40€/kW - Deposit in Ministry if power >50MW and regional if power ≤50MW and within same Autonomous Community - Communication to Ministry if power >50MW and regional if power ≤50MW and within same Autonomous Community - Effective constitution from Administration to System Operator	**Cluster 2**	- Economic guarantees if power >15kW of 40€/kW and 20€/kW in hybrid installations - Deposit in Ministry if power >50MW and regional if power ≤50MW and within same Autonomous Community. - Communication to Ministry if power >50MW and regional if power ≤50MW and within same Autonomous Community - Effective constitution from Administration to System Operator (Mandatory for application)
3	**Cluster 3 & 4**	- Two subsequent applications: access and connection (max. 6 months) - No limit to requirement of corrections - Acceptability report after A&C permissions - Acceptability report only if total power > 50MW or >5% S_{cc} - Accept/Reject connection point at any moment	**Cluster 3, 4 & 5**	- Single simultaneous Access and Connection application - Maximum of 2 requirement of corrections - Acceptability report during application analysis before result - Acceptability report only if power > 5MW and total power >10MW - Accept/Reject/Alternative preliminary proposal
4	**Cluster 5**	- Technical access contract signing in 1 year and if power >15kW in >36kV - 10% budget payment in < 1 year	**Cluster 6 & 7**	- Technical access contract signing in 5 months for any installation except self-consumption with surplus <15kW - 10% budget payment in < 1 year - Administrative milestones until commissioning

Table 4 Summary of differences between regulations

Chapter 3: Access and Connection to distribution network procedures analysis

In this chapter, previous and new regulation shall be analyzed using a set of predefined attributes selected to evaluate the contribution of each regulation for renewable energies integration in distribution networks from a regulatory point of view, with the objective of detecting the possible evolution between both regulations and making a final assessment.

1. Assessment methodology

The attributes that shall be used to analyze both regulations have been selected based on the theoretical requirements to increase the efficiency of the process as a whole in order to contribute to facilitate renewables penetration in distribution networks:

- Administrative efficiency and simplicity: this attribute shall measure the temporal efficiency of relationship with Public Administration and System operators and, additionally the lack of complexity of the associated process and paperwork.
- Network Information transparency: this attribute shall measure the available information published by system operators about their assets, that promoters have at their disposal to analyze and select the optimal connection solution for their installations.
- Connection charges information: related of previous attribute, this one analyzes the information and transparency related to connection charges associated to the connection point of the installation.
- Entry barriers for new companies (competition): this attribute is based on the competition among companies and facilitates to enter in the renewables sector of non-traditional enterprises of the sector, especially smallest companies with less financial resources.
- Project Firmness: measurement of the consistency of the projects, understanding this as the proper administrative and technical advance since the first steps of analyzing possibilities until the final construction and commissioning of the installation.
- Efficient use of the network: this attribute is based on the optimal use of all the available connection points of the network: application concentration in particular connection points Vs. homogeneous distribution of application over the network.
- Capacity allocation: based on the methodology used by the system operator to grant capacity and ensure an efficient competition.
- Capacity use: measure the efficiency of the use of the network considering all possibilities to ensure that promoters have various possibilities such as flexibility, always ensuring the stability of the network.
- Temporal scope: measurement of the temporal efficiency of the process. The objective is to reduce deadlines as much as possible.
- Economic efficiency: this attribute measures the efficiency of the economic costs incurred during the Access and Connection process based on the final benefit/result that is obtained (Permissions, reduce of power, rejection, etc.)

In the following points, the analysis of previous and new regulation shall be carried out using a matrix to assign a score to the previous attributes with respect to each of the clusters (groups of stages of the process) explained in the chapter 2.

The methodology that has been used to assign each score for the assessment has been with a numerical criterial:

- 0: must be improved.
- 1: Acceptable but subject to improvement.
- 2: Acceptable

It is important to highlight that score 2 means that the result of the attribute is acceptable but always there is room for improvement.

2. Previous Access and Connection to distribution networks regulation

The resultant matrix with the scores assigned to the attributes of each cluster for previous regulation, which will be further discussed in subsequent sections, is the following:

	Administrative efficiency and simplicity	Network Information transparency	Connection charges information	Entry barriers for new companies (competition)	Project Firmness	Efficient use of the network	Capacity allocation	Capacity use	Temporal scope	Economic efficiency
Cluster 1: Natural resource and connection possibilities study	N/A	0	0	1	0	0	N/A	0	2	1
Cluster 2: Economic guarantees paperwork	0	N/A	N/A	1	1	N/A	N/A	N/A	0	N/A
Cluster 3: Access application and analysis & viability	1	0	0	2	1	0	1	0	1	1
Cluster 4: Connection application + Acceptability request	0	2	2	2	1	1	N/A	1	1	1
Cluster 5: Actions after A&C permits	1	N/A	N/A	2	2	N/A	N/A	N/A	0	N/A

Table 5 Previous Regulation Matrix scores

2.1. Cluster 1: Natural resource and connection possibilities study

- Network Information transparency (Score = 0)

As explained before, previous regulation created huge difficulties to find possible connection points in the distribution network due to the lack of transparency of related infrastructure. This was because DSOs had no obligation to publish information about their assets and associated capacity, in order to facilitate connection possibilities to promoters.

This fact created many difficulties to analyze possible evacuation points in the distribution network, and make promoters to always look at the transmission network as a more reliable solution, creating a concentration of application on this type of grid, despite the fact that distribution networks cover more geographical space and connection charges are cheaper due to lower voltages.

- Connection charges information (Score = 0)

Related to previous attribute, apart from not publishing information and capacities of distribution assets, DSOs did not have the obligation of publishing associated connection charges, which are extremely relevant to evaluate the profitability of the installation as there exist the possibility of having an installation that is not economically profitable due to the cost of connection to the network (reinforcements, connection infrastructure, etc.) and this information is not known in this important stage of the process.

- Entry barriers for new companies (competition) (Score = 1)

Although the lack of information about distribution assets affected in the same way to all type of promoters, competition was affected due to the fact that not publishing an estimation of connection charges could be a possible entry barrier for companies with less capital power. This issue can create entry barriers to less powerful promoters because companies with larger financial possibilities promote installations with larges powers that can offer larger profitability covering more easily the connection charges.

- Project Firmness (Score = 0)

As explained before, future updates once the permissions are granted, were allowed without any restriction, so with previous regulation the initial selection of the location was not important because it could be changed later once the access and connection permits were granted and if the land could not be finally contracted, it was possible to reject the permissions and recover the economic guarantee without economic risks. This aspect has contributed for years to increase the speculation of lands and capacities affecting and delaying firm projects in the benefit of companies that at the end didn't build renewable installations.

- Efficient use of the network (Score = 0)

As indicated in previous attributes, the lack of information about the assets and associated connection charges made difficult to efficiently exploit the network and ended in a concentration of applications in the transmission network without taking advantage of the upwards that distribution network offers.

- Capacity use (Score = 0)

Previous regulation didn't make DSOs to share possible generation curtailments linked to the status of the network flows, an issue that is known in future stages, or offer the possibility of granting non-firmed access before and after making the application.

- Temporal scope (Score = 2)

As previous regulation didn't fix any limit or restriction to carry out updates after access and connection permissions were granted, the selection of plant normally was preliminary what helped to advanced quickly in this stage but contributing to increase speculation of permissions and land reducing the score of project firmness. However, the lack of information of distribution networks reduced temporal scope score, as it was an issue that normally created a delay to study alternatives.

- Economic efficiency (Score = 1)

Related to what was explained in the "Entry barriers for new companies (competition)" paragraph the lack of estimation of related connection charges that are known in later stages, could directly affect economic efficiency as companies may start the access and connection application for an installation, and once they received the economic budget reject the offer due to the required economic amount, undoubtably leading to a waste of money and time in developing unaffordable installations.

2.2. Cluster 2: Economic guarantees paperwork

- Administrative efficiency and simplicity (Score = 0)

As described in the explanation of Chapter 2, RD 1955/2000 (Ministerio de Economía, 2000) established that it was mandatory the deposit of an economic guarantee of 40€/kW in the General cash deposit office of the public administration: Treasury Ministry if peak power of the installation was higher than 50MW or the any installation was in a different Autonomous Community, or Autonomous Community Treasury Secretary if peak power of the installation was equal or lower than 50MW and the whole installation and connection point was in the same Autonomous Community. Moreover, in the economic guarantee it was mandatory to refer to the article 59 bis or 66 bis of RD 1955/2000 depending on if the access application was for the transmission or distribution network, respectively. After the deposit of the economic guarantee, it was mandatory to communicate the deposit to the Ministry of Ecological Transition or Industry Secretary of the Autonomous Community, depending on the same conditions than the deposit.

Summarizing, this bureaucratic procedure of selecting one administration or other depending on the peak power or location of the installations, contributes to increase the complexity and reducing the efficiency of time, what could end in an enlargement of the whole process if the peak power of an economic guarantee deposited in an Autonomous Community was later increased in a value higher than 50MW, making necessary to change the administration were it was initially processed and cancel the original guarantee, a clear inefficiency.

Moreover, the fact that each administration had its own procedure and models contributed to mitigate efficiency and simplicity.

- Entry barriers for new companies (competition) (Score = 1)

The fact that administration procedures are not regulated can contribute to create lobbies with certain companies, directly affecting the competition.

- Project firmness (Score = 1)

The fact that the rejection of Access and Connection permissions, once they were granted, didn't put at risk the initial deposited economic guarantee, contribute to increase speculation and reduce project firmness in consequence.

- Temporal scope (Score = 0)

The whole bureaucratic procedure for developing, depositing and communicating the economic guarantee to the Ministry or Autonomous Community and the subsequent communication of the Administration to the System Operator in a maximum time limit of 3 months, apart from reducing the simplicity and efficiency, delays the application and the whole process.

2.3. Cluster 3: Access application and analysis & viability

- Administrative efficiency and simplicity (Score = 1)

The fact that RD 1955/2000 (Ministerio de Economía, 2000) left the decision to System Operators of what documentation was necessary to be provided by promoters and the information available, led to a lack of homogeneity that made the application process easier in some networks than others that were more tedious or required more specific documentation creating unbalanced concentrations.

- Network Information transparency (Score = 0)

In this moment, the situation was the same than in Cluster 1: "Natural resource and connection possibilities study", information was not published, so applications were made without knowledge of the assets and associated capacities. Moreover, acceptability from upstream system operator was unknown, so it was possible that DSO granted the access and upstream system operator reduced the power or rejected the application in future stages.

- Connection charges information (Score = 0)

As happened with the attribute Network Information transparency No information related to economic requirements was published and known in the moment of applying.

- Entry barriers for new companies (competition) (Score = 2)

The fact that each DSO decides what information, documentation and studies were required for the application could affect indirectly competition, as these different requirements may lead small companies to face different expenses related to connection studies or pre-payments that could lead the installation to be not profitable.

In this aspect, an advantage for installations with a power less than 100kW didn't require an Access and Connection application but an official notification to the DSO. This was a good measure for small companies that normally promote lower powers than more powerful companies, compensating the requirements and reducing entry barriers for small companies.

- Project firmness (Score = 1)

As happened in Cluster 1: "Natural resource and connection possibilities study" cluster, as future updates of the permissions were allowed without restrictions, the initial selection was not important and could be changed later, once the access and connection were granted. In the cases that the land could not be finally contracted, it was possible to reject the permissions and recover the economic guarantee without economic risks. This issue contributed to increase the speculation of lands and capacities affecting and delaying firm projects in the benefit of companies that at the end didn't build renewable installations, contributing to increase speculation.

- Efficient use of the network (Score = 0)

The lack of available information ended in an inefficient use of the network, as promoters focused on applying to the transmission network or particular points of the distribution network.

This situation didn't contribute to make an efficient use of the network as applications concentrated on specific nodes instead of on a widespread situation covering more points of the network.

- Temporal scope (Score = 1)

Once the application was made by the promoter and the economic guarantee constitution was communicated by the Administration, the System Operator started to analyze the application and, in 10 days, must have admitted for processing the application and reserve temporal priority or, on the other hand, require a correction of information or documents not included in the application for which the applicant had another 10 days for answering this requirement. The problem was that there was no limit for the number of requirements for corrections what means that DSO could use this tool for extending the time to analyze applications and delay the access process for self-interest if, for instance, they have a large number of applications to analyze.

In terms of granting or rejecting the access application, the DSO had a maximum of 15 days to send the answer, which is a reasonable deadline that contributed to reduce the temporal scope.

- Capacity allocation (Score = 1)

When the application was admitted to process, capacity was reserved in a first in, first out method, what means that the first application to reach this milestone was the first to be analyzed. This method was effective in terms of contributing to increase competition, however, acceptability from upstream system operator was not given yet, so it was possible that DSO granted the access and upstream System Operator reduced the power or rejected the application, directly affecting capacity assignment.

- Capacity use (Score = 0)

As explained in the previous attribute, capacity was granted in a first in, first out criteria. However, it was not considered the possibility of granting non-firm access capacity considering flexibility and based on the conditions of the network, allowing to inject more energy or curtail production. The criteria for calculating firm access capacity was considering a 5% of short-circuit power in the connection point of the network. In this moment it wasn't known yet possible curtailments due to network constraints until the delivery of the technical conditions once the permissions were granted.

- Economic efficiency (Score = 1)

In this cluster, companies reached this stage without information, and once the access was granted and the economic budget known in following stages, reject the permissions because of the unaffordability of the installations due to the associated costs, an issue that led to a waste of money after all the expenses incurred among them: studies, land, etc. Moreover, acceptability from upstream system operator was not given yet, so there existed the possibility of having a profitable and advanced installation with a perfect location and obtain a negative acceptability from upstream system operator.

2.4. Cluster 4: Connection application + Acceptability request

- Administrative efficiency and simplicity (Score = 0)

As explained in the procedure description of Chapter 2, RD 1955/2000 (Ministerio de Economía, 2000) established that in this stage, DSO had to request the Acceptability report after having granted the access to the installation and providing the technical and economic budget to promoter. An inefficiency, as it was possible that after the whole process, the upstream system operator rejected the access because there was not enough capacity in the upstream network ending in an economic loss (projects, permits, economic guarantees, etc.) and delay of time.

- Network Information transparency (Score = 2)

When the connection point was granted, the applicant received from the DSO all the information and exact location of the connection point and associated technical and economic requirements for the connection in order to accept the conditions or not.

- Connection charges information (Score = 2)

In this moment, the applicant had the information associate to the economic budget and technical requirements needed for the physical connection.

- Entry barriers for new companies (competition) (Score = 2)

In this moment, all companies were in the same status, so competition is not affected as temporal priority was already applying.

- Project firmness (Score = 1)

As happened in the whole process, even though the connection point was granted in this stage, promoters could update the location, power, and connection point later without any type of restrictions or reject the permissions if self-interest conditions were not met.

- Efficient use of the network ((Score = 1)

In this moment, DSO could propose another connection point to the applicant in order to make a better use of the network. However, the lack of additional information and the uncertainty of the acceptability report from the upstream network could avoid this solution and normally ended in the initial connection point.

- Temporal scope (Score = 1)

When the connection point is granted, the applicant received the technical and economic conditions related to the access and had 6 months to deliver a project of the installation and time schedule in order to confirm the connection point. These 6 months is a long period that may delay other firmer projects if at the end the connection point is not accepted.

Moreover, Upstream system operator had a maximum of 2 months to emit the Acceptability report, if positive the applicant could start the administrative procedure to achieve the previous administrative authorization, if negative, economic guarantees could be recovered by the applicant. The time period of 2 months seems to be long as in less time is possible to determine if there is capacity or not in the upstream network.

- Capacity use (Score = 1)

As explained before, Regulation didn't consider the possibility of applying flexibility and non-firm access in order to grant permissions subject to the situation of the network. Additionally, possible curtailments associated to network conditions were known with technical conditions that had to be signed by the applicant.

- Economic efficiency (Score = 1)

Acceptability from upstream system operator was given after the whole process, so it was possible that Upstream System Operator reduced the power or even reject the acceptability request, what could lead to the rejection of the access. Power reduction or access rejection could mean an economic inefficiency as the incurred expenses made until this moment were lost as the installation could become non-profitable.

2.5. Cluster 5: Actions after A&C permits

- Administrative efficiency and simplicity (Score = 1)

After having granted the connection point and received the acceptability from upstream system operator, if needed, promoter could start the administrative procedure to obtain the administrative authorization. The problem in this point is that each administration has its own methodology, procedures and requirements and, as happens with the economic guarantees, depending on the power and location of the whole installation (different regions), it had to be made in the Ministry or Regional government. The administrative procedures were clearly inefficient since the beginning of the process.

- Entry barriers for new companies (competition) (Score = 2)

Although administrative procedure was not regulated, the tediousness of the process was usually related to the power of the installation so smaller promoters had benefits in terms of administrative dealings whereas bigger companies face greater difficulties as installations had more environmental difficulties.

- Project Firmness (Score = 2)

In this situation, if the 10% of the budget had been already paid, the firmness of the project was clearer as the promoter had incurred in an important expense and had perfect information.

- Temporal scope (Score = 0)

Having a maximum deadline of 1 year for paying the 10% of the budget needed for the physical connection in order to start the building process and signing the technical contract of Access, ensured the commitment of the promoter and settled some regulatory time limits, however, the Administration had no regulatory deadlines to grant the necessary authorizations and it depended on the region or Ministry as each one had its own procedure and time.

3. New Access and Connection to distribution networks regulation

The resultant matrix with the scores assigned to the attributes of each cluster for new regulation, which will be further discussed in subsequent sections, is the following:

	Administrative efficiency and simplicity	Network Information transparency	Connection charges information	Entry barriers for new companies (competition)	Project Firmness	Efficient use of the network	Capacity allocation	Capacity use	Temporal scope	Economic efficiency
Cluster 1: Natural resource and connection possibilities study	N/A	2	0	1	2	1	N/A	0	2	1
Cluster 2: Economic guarantees paperwork	0	N/A	N/A	1	1	N/A	N/A	N/A	0	N/A
Cluster 3: Access and connection application	1	2	0	2	2	1	N/A	0	2	1
Cluster 4: Applications study and capacity viability & assignment	1	N/A	N/A	2	N/A	2	2	1	2	N/A
Cluster 5: Application result Preliminary proposal acceptance or rejection	2	2	2	2	1	2	2	1	1	2
Cluster 6: A&C permissions and network contract	0	N/A	N/A	N/A	2	N/A	N/A	N/A	1	N/A
Cluster 7: Administrative milestones	1	N/A	N/A	2	2	N/A	N/A	N/A	1	N/A

Table 6 New Regulation Matrix scores

3.1. Cluster 1: Natural resource and connection possibilities study

- Network Information transparency (Score = 2)

Article 5 of RD 1183/2020 (Ministerio para la transición ecológica y reto demográfico, 2020) and Article 12 of Circular 1/2021 (CNMC, 2021), obligate DSOs and TSOs to publish online information about their assets and associated access capacity, in order to allow promoters to select the evacuation possibilities and choose the best solution to make the consequent Access and Connection application. An important improvement and increase of transparency.

Many Spanish distributors are publishing access capacities through availability maps, such us I-DE:

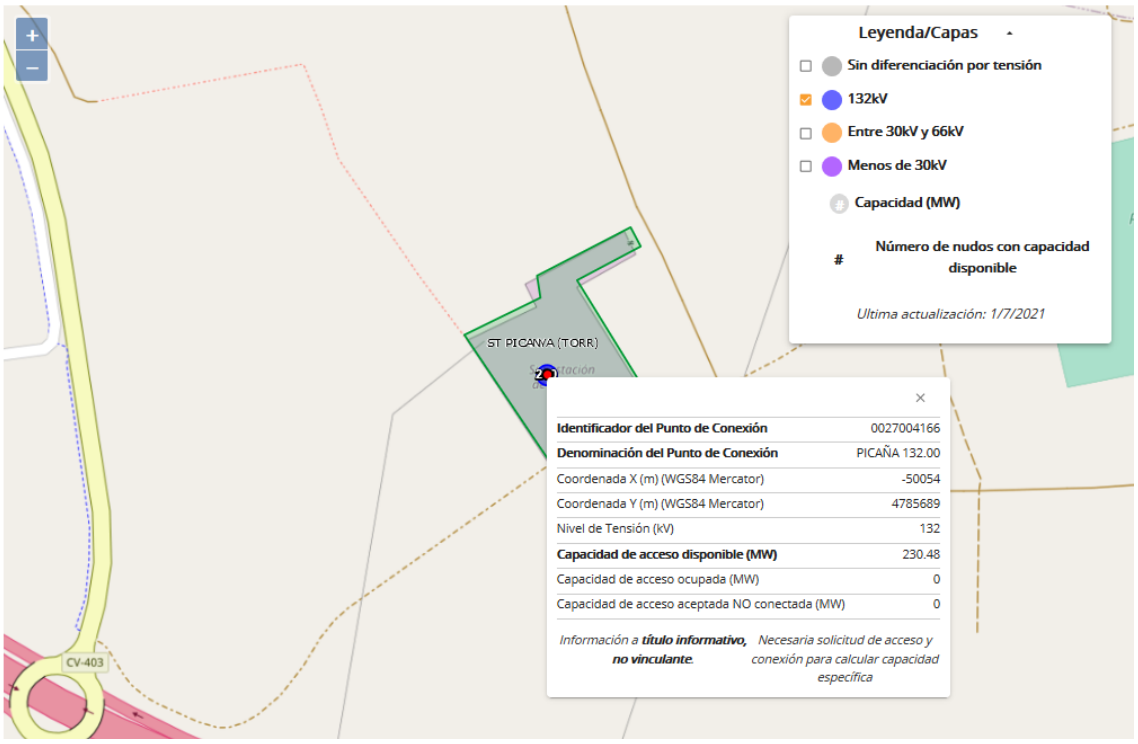


Figure 2 I-DE capacity availability map (I-DE Redes Eléctricas Inteligentes SAU, 2021)

On the other hand, others have decided to publish information through look-up tables with all the information, such as E-distribución:

1 de julio de 2021

						CAPACIDAD DE ACCESO (MW)																				
							OCUPADA											ADMITIDA Y NO RESUELTA									
								Desglose por Posición de Subestación											Desglose por Tecnología								
Comunidad Autónoma	Provincia	Subestación	Ubicación (Latitud)	Ubicación (Longitud)	Tensión (kV)	DISPONIBLE	TOTAL	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	TOTAL	Eólica	Fotovoltaica	Hidráulica	Solar Térmica	Resto de Tecnologías	Nudo de Afección Mayoritaria en la Red de Transporte	Comentarios
01 - Andalucía	Almería	AGUADULC	36,81353065	-2,59894120	66	0,0	0,0											0,0						BERJA 220	
01 - Andalucía	Almería	AGUADULC	36,81353065	-2,59894120	20	0,0	0,0											0,0						BERJA 220	
01 - Andalucía	Almería	ALBOX	37,36760039	-2,14275813	66	0,0	0,0											0,0						LITORAL 400	
01 - Andalucía	Almería	ALBOX	37,36760039	-2,14275813	25	0,0	0,0											0,0						LITORAL 400	
01 - Andalucía	Almería	ALCOLEA	36,96945935	-2,96340343	66	0,0	0,0											0,0						BERJA 220	
01 - Andalucía	Almería	ALCOLEA	36,96945935	-2,96340343	20	0,0	0,0											0,0						BERJA 220	
01 - Andalucía	Almería	ANDARAX	36,83972685	-2,43184366	132	0,0	0,0											0,0						LITORAL 400	
01 - Andalucía	Almería	ANDARAX	36,83972685	-2,43184366	66	0,0	0,0											0,0						LITORAL 400	
01 - Andalucía	Almería	ANDARAX	36,83972685	-2,43184366	20	0,0	0,0											0,0						LITORAL 400	
01 - Andalucía	Almería	BELEN	36,85036533	-2,47457758	66	0,0	20,0	20,0										0,0						LITORAL 400	
01 - Andalucía	Almería	BELEN	36,85036533	-2,47457758	20	0,0	0,0											0,0						LITORAL 400	
01 - Andalucía	Almería	BENAHADU	36,90854419	-2,46580356	132	0,0	85,5	44,6	40,9									0,0						BENAHADUX 220	
01 - Andalucía	Almería	BENAHADU	36,90854419	-2,46580356	66	0,0	71,9	39,6	22,4	9,9								0,0						BENAHADUX 220	
01 - Andalucía	Almería	BENAHADU	36,90854419	-2,46580356	20	0,0	9,3	5,0	4,3									0,0						BENAHADUX 220	
01 - Andalucía	Almería	BERJA	36,83278389	-2,92343370	66	0,0	24,0	24,0										0,0						BERJA 220	

Figure 3 E-distribución look-up capacities table (E-Distribución SAU, 2021)

- <u>Connection charges information (Score = 0)</u>

Even though the new regulatory requirement of publishing information about distribution and transmission facilities together with the associated capacity will help promoters to select the best connection point, an estimation of connection charges is not provided. An important and relevant issue as it affects the studies to evaluate the profitability of an installation and may be a barrier for less competitive companies once the connection charges are known in following stages.

- Entry barriers for new companies (competition) (Score = 1)

The fact of not publishing information about estimated connection charges, may affect less competitive promoters as their installations cannot be profitable once the costs are known in future stages.

However, since the approval of RD 23/2020 (Ministry of Ecological Transition and Demographic challenge, 2020), initial land selection is important because Annex II states that in future updates, once the access and connection permissions are granted, there is a constraint that fix in 10 km the maximum distance between initial and new proposed location centers, a measure that enhance competition as normally big companies promote installations of higher power and have more difficulties in finding enough land for the installation since the beginning of the application. This aspect balances the problem of not knowing the connection charges beforehand.

- Project Firmness (Score = 2)

As explained in the previous point, the approval of the RD 23/2020 (Ministerio para la transición ecológica y reto demográfico, 2020) whose Annex II fixes a set of constraints in order to avoid access and land speculation after obtaining the permissions:

- 10 km is the maximum distance between initial and new location centers.
- Technology cannot be changed once the permits have been granted.
- 5% maximum repowering of the installation.

Moreover, Article 1 of RD 23/2020 (Ministry of Ecological Transition and Demographic challenge, 2020) makes promoters to justify a set of Administrative Milestones once the Access and Connection permissions are granted, to ensure that every installation that obtains Access and Connection permissions is put into service, with the risk of losing the mandatory economic guarantees.

All these measures that apply after obtaining the permissions, contribute to ensure project firmness since the initial stages before making the application.

- Efficient use of the network (Score = 1)

The fact of publishing information about distribution assets (location, capacity, etc.) allows to make a better use of the network, as promoters can choose the best available connection point depending on the initial location of the installation. However, the lack of connection charges estimation can distort the connection point selection after knowing the associated amount once the application is made.

- Capacity use (Score = 0)

Among the information that is mandatory to publish, regulation doesn't make DSOs to share possible generation limitations linked to network contingences. This information is shared in future steps once the permissions are granted. In order to enhance this issue it would be recommended to publish information about possible curtailments for firm access to allow promoters to study if it is profitable or not.

- Temporal scope (Score = 2)

The constraints relate to initial location selection settled by Annex II of RD 23/2020 (Ministerio para la transición ecológica y reto demográfico, 2020) already described, delay the process as land selection has become an important driver before making application due to the fact that it requires deeper researches in order to select the optimal location and comply with regulation in future steps.

- Economic efficiency (Score = 1)

The fact that connection charges and possible production limitations are provided once the access and connection permissions are granted, may lead promoters to reject these permissions as it can make the installation unprofitable and waste the preliminary researches, acquisitions, projects and economic resources. So, the lack of relevant information at the beginning of the process can deteriorate the economic efficiency of a candidate project, ending in declining the permissions.

3.2. Cluster 2: Economic guarantees paperwork

- Administrative efficiency and simplicity (Score = 0)

As happened in previous regulation, Article 23 RD 1183/2020 (Ministerio para la transición ecológica y reto demográfico, 2020) estates that must be deposited in the General cash deposits office of public administration, Treasury Ministry if installation power is higher than 50 installed MW or Treasury secretary of the corresponding Autonomous Community, if installation power is lower or equal than 50 installed MW and the whole installation is in the same Region. This bureaucratic procedure of selecting one administration or another depending on the installed power continue contributing to reduce the simplicity, efficiency and could end in an enlargement of the whole process if the installed power is later increase in a value higher than 50MW, making necessary to change the administration where it was initially processed and cancel the original guarantee, what means a lack of economic and time efficiency.

To increase the lack of simplicity, there is still no change in the fact that each administration has its own models and procedures, being different in each Autonomous Community and Ministry at national level. A clear lack of homogeneity.

Moreover and without any change, when the economic guarantee is deposited and the Treasury Administration (Regional or National) emits the deposit certificate, it is necessary to officially communicate to the Ministry of Ecological Transition and demographic challenge or Autonomous Community industry secretary (depending on the installed power and unique region).

All these issues clearly contribute to increase inefficiencies and reduce simplicity.

- Entry barriers for new companies (competition) (Score = 1)

The fact that installations with a power equal or lower than 15 kW don't require to present an economic guarantee contribute to facilitate the participation of less economically powerful companies that normally promote smaller installations. A good measure to ensure competitiveness of smaller companies with less economic power against traditional big companies.

- Project firmness (Score = 1)

Related to what is explained in the previous paragraph about surety bonds, the fact that they came from non-conventional investment banks from other countries and that, in the case of execution of the guarantee, there was a small chance to lose this money, contributes to increase speculation in the business.

However, regulation required that in text of the economic guarantee, the type of network to which was intended to connect (transmission or distribution) was indicated, what slightly helped to reduce speculation, particularizing the type of network.

- Temporal scope (Score = 0)

The tedious bureaucratic procedure of having different administrations depending on the location and the power for both depositing and communicating the economic guarantee, having each one its time, model and procedures slow and enlarge the time of the economic guarantees processes.

Moreover, the fact that the corresponding Administration has a maximum 3 months to communicate the correct constitution of the economic guarantees to the promoter is an excessive time for such a simple procedure that avoid promoters to carry out the application until they have this communication at their disposal.

3.3. Cluster 3: Access and connection application

- Administrative efficiency and simplicity (Score = 1)

Article 10 of RD 1183/2020 (Ministerio para la transición ecológica y reto demográfico, 2020), states that once the official communication of the economic guarantees optimal constitution is received by the promoter, combined Access and Connection application can be submitted to the DSO. In this case, new regulation has homogenized application to distribution and transmission network, a fact that contributes to the simplicity of the process and better understanding.

As the Access and Connection application are made at the same time, the process is simplified, however, among the documents required by RD 1183/2020 to be included in the application, a project with single-line diagrams of the connection infrastructure is mandatory. The problem with this is that the agent has no information about possible existing or predesign infrastructure of other promoters who already have permissions in the same connection point, an issue that will make promoter to adapt their installations to this previous infrastructure. This may entail a redesign of the infrastructure project in future stages leading to economic and time inefficiencies.

- Network Information transparency (Score = 2)

Article 5 of RD 1183/2020 (Ministerio para la transición ecológica y reto demográfico, 2020) obligates DSOs to publish information about their assets and associated capacity according to what is specified in Article 12 of Circular 1/2021 (CNMC, 2021) that sets the information that they must make public. A great different and improvement in comparison with previous regulation.

- Connection charges information (Score = 0)

The situation is the same that in previous regulation and Cluster 2, no information related to connection charges estimation is mandatory to be shared with promoters by System Operators, so applications are made without the important fact of economic requirements for the physical connection.

- Entry barriers for new companies (competition) (Score = 2)

Chapter IV of RD 1183/2020 (Ministerio para la transición ecológica y reto demográfico, 2020) establishes a shorten Access and Connection procedure for installations with a power lower than 15kW that entails a reduction of the periods to the half, facilitating by shortening deadlines the competition for less powerful companies. However, the specified requirements of the general procedure are the same and there is no distinction in terms of temporal priority for an application. A slight improvement in competition for smaller companies.

- Project firmness (Score = 2)

As happens in the Cluster 1, "Natural resource and connection possibilities study", the decisions taken and provided in the documentation of the initial application are extremely relevant, as in future updates once the permissions are granted, there are huge constraints for modifications. A measure that enhance project firmness and mitigates speculation ensuring that applicant projects end in the construction and commissioning of the installation.

- Efficient use of the network (Score = 1)

The fact that information about the assets is published allows to make a better use of the network contributing to a good distribution of application along the network. In this step, promoters have already decided the best connection possibility. However, the lack of information about connection charges can lead to permits rejection in future stages due to the associated economic amount.

- Capacity use (Score = 0)

As happens with previous regulation, DSOs don't publish information about possible generation curtailments due to system contingences, and granting capacity considering flexibility is not contemplated by the regulation, so the application is made without possible curtailments information and in a firmed access methodology, two issues that could be more efficient.

- Temporal scope (Score = 2)

When the documentation is presented to carry out the application, the regulatory procedure states 20 days for the DSO whether to admit for processing the application or require a modification or additional documentation to correct the information and documentation of the application. The maximum number of requirements is 2. With these figures the temporal scope is fixed and constraint in order to accelerate the process.

Temporal priority to occupy access capacity is fixed when the application is admitted to process and cannot be delayed with a large number of requirements (maximum 2).

Moreover, shorten procedure reduces time scope of smaller installations with a power lower than 15kW.

- Economic efficiency (Score = 1)

The fact that for the application it is mandatory to attach a project without information of other promoters existing or in developing process infrastructures, can lead to remake the presented project once applicants have this information in future steps. The fact that connection charges and possible curtailments are unknown can also reduce the economic efficiency once this information is provided to promoters due to the economic unviability of the installation.

3.4. Cluster 4: Applications study and capacity viability & assignment

- Administrative efficiency and simplicity (Score = 1)

After admitting the application, DSOs analyzes the capacity access and the possible physical connection with the documentation provided in the previous step at the same time. At the same time, acceptability report to upstream system operator must be requested before communicating any information to the promoter.

At first sight, this whole process can seem complex but if DSOs are able to organize themselves and automatize steps, the efficiency of the whole procedure is enhanced as it is only to make a single application just before obtaining the granting or rejection of the connection point, in lower steps in comparison with previous regulation. So, efficiency and simplicity of the application increases.

- Entry barriers for new companies (competition) (Score = 2)

As explained before, installations with smaller power that normally are connected to lower voltages have different advantages such us shorter deadlines, being candidate for the shorten procedure if their power is lower than 15kW or not depending on the acceptability report from the upstream network. These facts favor less competitive companies that normally promotes smaller installations in front of bigger companies with larger installations.

- Efficient use of the network (Score = 2)

In case that the proposed connection point submitted by the applicant is not valid, DSOs can propose another possibility that allows them to make a better use of the network considering system contingences in the preliminary proposal that later has to be accepted.

- Capacity allocation (Score = 2)

The criteria to assign capacity is the first in, first out criteria that favors competition, as the first one to arrive is the first to get the capacity.

- Capacity use (Score = 1)

During the studies that DSO must made to evaluate the application, there is the possibility to make a preliminary proposal to a promoter in the next stage, subject to generation curtailments if there is not another suitable connection point that is not affected by the contingences of the network. However, these contingences associated to generation are not published to promoters and are shared in the following stage, "preliminary proposal".

- Temporal scope (Score = 2)

Article 13 of RD 1183/2020 (Ministerio para la transición ecológica y reto demográfico, 2020) establishes deadlines since the admission of the application, including the acceptability request, giving less time for delivering the preliminary proposal for lower voltages, that in principle are associated to lower voltages. The figures provided for delivering the preliminary proposal are reasonable, as the larger the voltage, the longer the time needed to evaluate a connection since renewables installations connected to large voltages can directly affect security and quality of supply.

3.5. Cluster 5: Application result: Preliminary proposal or rejection

- Administrative efficiency and simplicity (Score = 2)

Based on Article 12 of RD 1183/2020 (Ministerio para la transición ecológica y reto demográfico, 2020), when the preliminary proposal is delivered to the applicant, including both technical and economic budget, the promoter can accept, reject or proposed a connection alternative to the System Operator.

The lack of definition in the regulation about the scope related to the alternative that the promoter can offer, may lead to inefficiencies as it is not clear what type of proposal the DSO can accept or not. An important issue that can generate administrative conflicts between both agents

- Network Information transparency (Score = 2)

In the stage of preliminary proposal, the applicant receives full information about the connection point that is being offered by the System Operator, together with technical requirements in order to evaluate the viability and if the proposed connection is suitable or not.

- Connection charges information (Score = 2)

Together with the technical information, the preliminary proposal includes an economic budget that covers and details the overall expenses necessary to carry out the physical connection and associated reinforcements in the network to host the offered capacity of the installation.

- Entry barriers for new companies (competition) (Score = 2)

In this stage, temporal priority is already applying so there is no difference or advantages among promoters, every application must receive a preliminary proposal according to temporal order or, in the cases that there is no capacity, an official rejection. Moreover, in order to benefit smaller installations that, as explained, are promoted by less economic powerful companies, shorten procedure can be applied to installations with a power below 15kW, what makes that deadlines become half of the ordinary procedure, but always respecting the temporal priority of applications.

- Project firmness (Score = 1)

As described in the explanation, the rejection of the preliminary proposal implies the recovery of the economic guarantees, an issue that could become a perverse incentive for Access permission speculation as promoters could reach this point and finally reject the proposal delaying other more consistent projects or even not allowing them to reach this stage due to the pre-conceded access capacity. However, as recent regulation is focusing on ensuring project firmness, most of the installations that reach this stage shall advance and accept the proposal as it doesn't make sense to advance to this stage with all associated costs (projects, economic guarantees, administrative procedures, etc.) and reject the proposal, as it would be an economic inefficiency.

- Efficient use of the network (Score = 2)

Preliminary proposal delivered to the applicant includes the most suitable connection point after the analysis carried out in previous steps by system operator. If the applicant proposes an alternative proposal, it can be accepted or not by the DSO depending on the viability and possible network contingences.

- Capacity allocation (Score = 2)

Information provided in the preliminary proposal delivers the power capacity granted based on the available access capacity of the connection point after application with previous temporal priority, acceptability from upstream system operator and physical connection requirements. Granting capacity is based in a first in, first out model to favor competition.

- Capacity use (Score = 1)

Technical requirements that are delivered in the preliminary proposal, include possible generation curtailments in cases of system contingences that can limit the production depending on the status of the network. This situation is provided to the applicant in order to make them know the possible curtailment situation that can be accepted or rejected by the applicant. This situation can be temporal until reinforcements are implemented or can be

continues. In this last case, there are no other connection alternatives, as System Operators have the obligation of providing the most suitable connection possibility to the applicant.

However, regulation doesn't set any procedure on how to deal with possible curtailments and let DSOs decide how to proceed.

Apart from this, regulation only contemplates firm accesses and the use of flexibility for non-firmed access is not a possibility in this moment.

- Temporal scope (Score = 1)

Regulation estates a maximum of 30 days for the applicant in order to decide if the proposal is accepted or not, or to propose an alternative to the DSO. If an alternative is carried out, the DSO shall have 15 days to analyze it, and then another 30 days for the applicant to accept the final proposal. These deadlines given to the applicant decisions are excessively long and could be perfectly shorten in order to have a smoother process as analyzing this decision doesn't require such a long time. On the other hand, time periods given to the DSO are understandable as deeper technical and economic researches must be carried in order to study the alternative proposal made by the applicant.

Periods are reduced to the half with the shorten procedure for installations lower than 15kW.

- Economic efficiency (Score = 2)

After receiving the proposal, the applicant can suggest an alternative for the connection using the information provided by the System Operator. Despite the fact that it may require modifying documents and the consequent expenses, it can help to reduce the economic budget if there is something not contemplated by the DSO.

3.6. Cluster 6: A&C permissions and network contract

- Administrative efficiency and simplicity (Score = 0)

When permissions are officially granted, promoters can start the administrative process, that is one of the most tedious activities since there are no regulated time and each Administration has its own models, procedure and paperwork, so promoters are highly affected since complexity and requirements can vary, depending on the location and the power of the installation (Ministry or Regional). The lack of homogeneity is a great impediment to efficiency and simplicity as happened with previous regulation.

- Project firmness (Score = 2)

Signing the Technical Access Contract and the obligation of paying 10% of the budget needed for the connection ensure firmness of projects as it is an economic compromise to connect the installation to the network, making a considerable expense with the initial payment. Projects that reach this stage practically will be commissioned in the following years.

- Temporal scope (Score = 1)

Article 15 of RD 1183/2020 (Ministerio para la transición ecológica y reto demográfico, 2020) fixes in 20 days the deadline for delivering the official Access and Connection permissions since the acceptance of the Preliminary Proposal. An excessive time as all the information has been already provided and it is just necessary to develop the official document.

Apart from this, promoters shall have a maximum of 1 year to pay at least the 10% of the economic budget required by the DSO for allowing the future physical connection, and 5 months for signing the Technical Access Contract with the DSO according to Article 21 RD 1183/2020 (Ministerio para la transición ecológica y reto demográfico, 2020) except installations connected to a voltage equal or lower than 36kV, self-consumption without surplus or installations with a power equal or lower than 15kW.

Although 1 year for the payment can seem long, it can be considered an optimal figure as it possible that due to Administrative requirements, updates of the access and connection permissions are mandatory for changes (type of network, outline of the network, etc.). On the other hand, 5 months for signing the Technical Access contract with the DSO can be a short time as for its signing is mandatory to attach the preliminary Administrative Authorizations of the installations and infrastructures granted by the Ministry or Autonomous Community (depending on the power and location), for which there is not a regulated time that applies and can suppose a delay of the administrative procedures.

3.7. Cluster 7: Administrative milestones

- Administrative efficiency and simplicity (Score = 1)

Article 1 of RD 23/2020 (Ministerio para la transición ecológica y reto demográfico, 2020) fixes a set of administrative milestones that promoters must justify to System Operators in order to avoid economic guarantees execution. The issue of these justifications is that it is necessary to attach the corresponding Administrative Authorizations granted by the Ministry or Regional administrations, that explained before, there is a lack of homogeneity having each one its own procedure and paperwork, obstructing the simplicity and efficiency depending on the location and power.

- Entry barriers for new companies (competition) (Score = 2)

No single company is benefited by theses administrative milestones as all of them must present the administrative authorizations. Small companies may have more advantages as their installations are smaller and it is easier to obtain Administrative Authorizations rather than big installations with extent locations, more suitable to have environmental restrictions.

- Project firmness (Score = 2)

Administrative milestones contribute to ensure that projects advance and are not intentionally delayed for speculation, putting at risk the amount of money of the economic guarantee until the commission of the installation, fixing very well-defined deadlines for each administrative stage.

- Temporal scope (Score = 1)

Setting explicit temporal deadlines to Administrative Milestones is complicated as it is difficult to standardize time scopes of the stages that a project follows until the final commissioning due to possible technical or environmental difficulties. For this reason, regulation has considered wide time periods for justifying these milestones, trying to cover possible difficulties. A possible solution would be to shorten time limits for specific conditions such as power and location instead of trying to standardize in a single solution.

4. Comparison and evolution between previous and new Access and Connection regulations assessments

As a result of previous analysis of both previous and new regulation, in this paragraph a comparison between them shall be made in order to evaluate the possible regulatory evolution and improvements for renewables integration in the Spanish electricity network.

In order to carry out this evaluation, the attributes that have been used for the analysis shall be used to compare both regulations as a whole without using the clusters of previous points. A possibility to make the comparison would have been to calculate the average of all the attributes and compare the results, but this option would have created distortions as the number of clusters is not the same, and some scores of the attributes are enhanced in subsequent clusters. For this reason, a theoretical comparison would be used as a more reliable option and, at the end, a graphical comparison shall be used to show the evolution of each of the attributes.

4.1. Theoretical explanation of attributes evolution from previous to new regulation

- Administrative efficiency and simplicity:

This attribute is one of the weakest in both regulations and it is strongly related to the complexity of the Administration in Spain. The most relevant issue is that depending on the power (50 MW) and the location of the installation: network infrastructure and connection point (one Autonomous Community vs. more); the economic guarantees deposit and communication, and project administrative processing, after Access and Connection permissions, must be carried out in the Ministry or at Autonomous Community level.

This problem increases complexity and inefficiency due to the lack of homogeneity among Administrations, as all of them have their own procedures, models and paperwork, that in some cases are smoother but in others can hinder project processing and delay the final commissioning.

None of the regulations try to equalize these administrative differences apart from defining the Authorizations needed by an installation for its commissioning and leave the decisions of all related to paperwork to national or Autonomous Community governments that are subject to change after political elections that may modify criteria every four years.

Referring to the administrative procedure related to the Access and Connection application with the corresponding System Operator, there is a slight increase as a result of the homogeneity between transmission and distribution access and connection application, as in previous regulation it was completely different. This means that applicants must deliver the required documents in one single application for both Access and Connection application instead of two different stages with temporal separation, and once it is analyzed by the DSO, they receive the preliminary proposal to accept, reject or propose an alternative without any subsequent step. This supposes an increase of efficiency as the whole process have been simplify.

In conclusion, even though the Access and Connection administrative procedure with the corresponding System Operators has been enhanced and it is more efficient, the “administrative

efficiency and simplicity" attribute hasn't practically improved with the new regulation as a result of not trying to regulate and control Administration (Ministry or Regional governments) paperwork, procedures and models that lead to a lack of homogeneity at national level and contributes to increase complexity depending on the location and power of the installation.

- Network Information transparency

This attribute has been the greater improvement with new regulation as it makes mandatory to publish information about the assets and associated capacity of the distribution and transmission network. This fact allows promoters to have at their disposal critical information to study connection possibilities in the first stages and select in consequence the best connection solution for the future installation.

In comparison, with previous regulation only TSOs had the obligation to publish the available access capacity of the transmission nodes, having a total lack of information about distribution network facilities and corresponding capacity leading to create a congestion of application in the transmission network, a clear unbalance that didn't take advantage of the benefits of distribution network such as lower costs, shorter power lines, etc. So, publication of network information has been a real improvement not only in this attribute but in most of them.

- Connection charges information

This attribute is the greater weakness of both regulations, as the associated connection charges are not known by promoters until Access permissions are granted. None regulation makes System operators to publish connection charges calculators or estimations that facilitate promoters to study the economic viability of the installation, an important aspect specially for smaller installations that can suppose the rejection of the permissions after the budget is sent at the end of both processes.

This issue needs to be improved in future revisions of regulation.

- Entry barriers for new companies (competition)

Shorten Access and Connection procedure and the corresponding shortening of deadlines applicable to lower power and voltages, have allowed to have a slight improvement in this attribute regarding previous regulation, contributing to favor installations with lower powers in terms of time that normally are promoted by more financially limited companies.

Although previous regulation only required Access application for installation whose power was above 100kW and new regulation requires it for any case except self-consumption with surplus with a power lower than 15kW, this change is understandable due to the expected increase of applications that can create instabilities in the network.

Apart from this, there are other exemptions like non-mandatory acceptability report for installations below 5MW or shorter periods and intermediate steps for smaller installations for Acceptability (when needed) or preliminary proposal delivery. An advantage in terms of time for smaller installations.

The main aspect is that both regulations are based on the principle of fair competition: permissions are granted in a first in, first out criterion to promote efficiency among promoters to achieve Access capacity.

- Project Firmness

The approval of RD 23/2020 (Ministerio para la transición ecológica y reto demográfico, 2020) in the new regulation has allowed to ensure the firmness of projects. The constraints established to guarantee that an installation is the same after an update (mainly the fact of allowing a maximum distance of 10 km between the initial and updated centroid of the installation) and the obligation of justifying administrative milestones, once the Access and Connection permissions are granted, putting at risk the economic guarantees of the installation, contribute to reduce speculation related to land and permissions that previous regulation has stimulated to create.

Previous regulation didn't set any type of limitation for future updates, an aspect that was used by many companies to make land speculations with large powerlines that were impossible to build and negotiate access and connection permissions with other companies (submarkets) delaying or even not achieving the commissioning of the installation.

The mandatory justification of administrative milestones that are described in cluster 7 of new regulation, ensures the administrative and technical advance of installations through all the necessary stages related to the Administration until the final commissioning of the installation in a maximum deadline. This measure looks to ensure that every installation that is granted with Access and Connection permission is finally constructed and commissioned instead of speculating through buy & sell markets and permissions that doesn't end in the connection of renewable installations to the electricity network.

- Efficient use of the network

The fact that information about distribution assets is published and available for promoters before carrying out an application suppose a real improvement of this attribute, as it is easier to make a more efficient use of the network and have applications more properly distributed among the whole network, avoiding applications concentration.

This attribute is particularly enhanced in the first stages of new regulation when studying possible locations for the future installation. A real improvement as in previous regulation due to the lack of information it was especially difficult to find connection points in the distribution network.

- Capacity allocation

Capacity assignment criterion continues being the same in both regulation, first in, first out: the first one to arrive is the one that gets the capacity, contributing to increase competition among promoters and benefiting efficiency in applications development.

Particularly, there is an important improvement in comparison with previous regulation, as applications that were granted access by the corresponding DSO, didn't have the certainty of

having the mandatory acceptability of upstream system operator, in the cases that was needed, with the possibility of having a reduction or total rejection of the capacity until the last stage of the process and the consequent economic expenses and time. This inefficiency has been corrected in new regulation as the information that is provided to the applicant in the preliminary proposal already includes the possible upstream constraints and the consequent Acceptability report, erasing the uncertainty that existed in the previous regulation.

- Capacity use

There has not been any change in this attribute because there are two regulatory inefficiencies that have not been corrected: Promoters don't know beforehand possible generation curtailments due to network contingences until the preliminary proposal is delivered and regulation does not consider Capacity flexibility combining firm and non-firm capacity for renewable generation.

- Temporal scope

New regulation has settled shorter deadlines in the whole process for both promoters and system operators, adapting time limits depending on the voltage where the application is directed and power of the installation. The improvement has not been totally satisfactory because regulation does not set reasonable limits to the corresponding Administration in the communication of optimal constitution of the economic guarantees and does not fix limits for administrative paperwork after Access and Connection permissions.

In comparison with previous regulation, procedures between system operator and promoters have been shorten and has limited the number of possible requirements to a maximum of 2, however procedures with Administration haven't changed.

A weak point of new regulation subject to improve is that maximum time for delivering the preliminary proposal is increased for the cases that acceptability report is required doubling the number of days set for the preliminary proposal for receiving the acceptability report from upstream System Operator, ending in a duplication of total time until the proposal is presented to the applicant delaying the process. It is not an excessive number of days, but it could be reduced.

- Economic efficiency

In both cases Economic efficiency is improvable. The problem was bigger in previous regulation because of the fact that after the whole Access and Connection process there was the possibility of finally not getting the access capacity for the cases that it was mandatory to require an Acceptability report due to the possibility of not having enough available capacity (or nothing) in the upstream network, what meant a rejection of the application. This fact could imply a waste of economic and working resources after a long time dealing with the administration and system operator and having invest an important amount of money in lands, projects, etc.

The weakness of new regulation is the fact that promoters must carry out the Access and Connection application attaching an estimated connection project without the knowledge of the

possible existing or in development network infrastructure from other promoters that may require a modification of the presented project to adapt the documentation of the application.

In this case, the possible economic losses shall be lower than the implications of previous regulation and, though the problem with the acceptability has been solved, this inefficiency has been created in order to simplify the application process, but possible economic expenses shall be lower than in previous regulation.

4.2. Summary of Attributes evolution from previous to new regulation

Based on the theoretical explanation of the evolution for each attribute, the following scale of colors graphically summarizes each assessment between both regulations.

There are three evaluation possibilities:

- Red: Improvable
- Yellow: Acceptable but improvable
- Green: Improvement

Attributes	Previous regulation (2000-2020)	New regulation (2020)
Administrative efficiency and simplicity		
Network Information transparency		
Connection charges information		
Entry barriers for new companies (competition)		
Project firmness		
Efficient use of the network		
Capacity allocation		
Capacity use		
Temporal scope		
Economic efficiency		

Figure 4 Attributes assessment from previous to new regulation

5. International best practices and recommendations for Spain

Based on the analysis and description of new regulation, and considering the weaknesses detected in these points, a set of improvements that have been implemented in other countries and other self-developed alternatives shall be provided in this point in order to enhance new regulation Access and Connection process, by improving the attributes that have been previously used to analyze both regulations.

5.1. Connection charges estimators

One of the weakest points of both regulations that has not been corrected, is the lack of information related to connection charges. An important issue specially at the beginning of the process before making the Access and Connection application, as it has important economic implications regarding the profitability of the future installation.

Although the economic budget is provided to the applicant in future stages, an estimation of connection charges would allow to have available useful information, especially important for smaller installations whose economic viability is more limited than large installations with a higher power that will produce more electricity after the commissioning.

In this situation, connection charges estimators are tools commonly required by regulation in many countries that allow promoters to approximately calculate the economic amount that will be imposed by DSOs in order to carry out the physical connection to the assets of their network. The objective of this applications is to contribute to increase the transparency of DSO's assets information together with other data such as the name, location, and available capacity.

The implementation of this type of application would allow promoters to carry out a more reliable economic study of connection possibilities at the first stages of the process in which, not only knowing the location and available capacity of each asset of the network but having an estimation of the future connection costs. Current regulation is inefficient in this aspect as it can lead applicants to reject the preliminary proposal once the receive the economic budget for the connection point due to the amount of money necessary to pay to the DSO.

It is important to state that for large installations is almost impossible to precisely estimate a budget with a general criterion that provides realistic information as deeper network studies are required.

Looking at international regulations, two types of tools can be found:

- Connection charges calculators: countries like Portugal (E-Redes, 2021) and the United Kingdom (Scottish Power Energy Networks, 2021) (Northern Power Grid, 2021)require their DSOs to develop simple but useful tools in which promoters fill out specific information of the installation and evacuation powerline, and the tool provides an estimation of the associated connection charges The information of the installation that normally is necessary to introduce is:
    - Type of property: Domestic or Non-domestic
    - Location (type of network): Urban or Rural
    - Length from the installation to the connection point.

- Power of the installation.
- Voltage level or Current interval

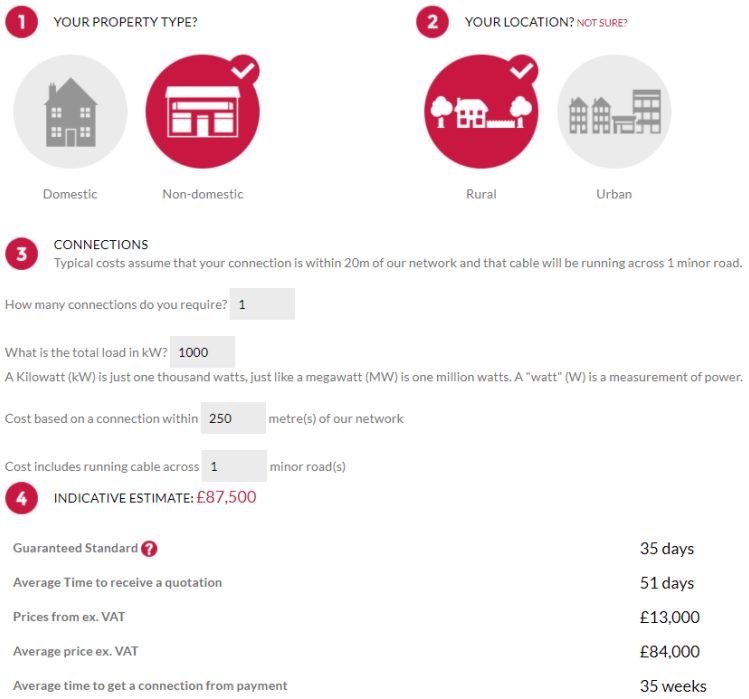
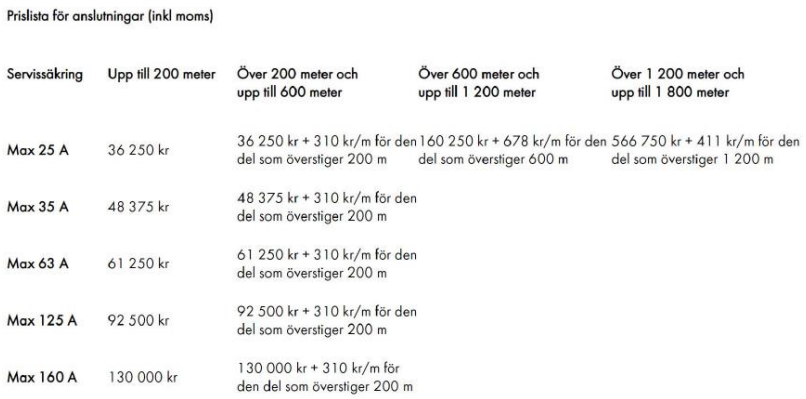


Figure 5 Northern Power Grid connection indicative Price (Northern Power Grid, 2021)

However, these tools set a limit to the power of the installations, approximately 2 MVA, to avoid deviations that can lead to wrong estimations of larger installations as they require a deeper and individual study of the network.

- Look-up tables: this type of tools that are used in Sweden (Ellevio, 2021), Italy ((e-distribuzione, 2021), instead of requiring promoters to fulfill a set of data in a tool, directly provides information related to connection charges estimations base on the current demanded by the installations, which is the result of the power and voltage, and the distance, in intervals, to the connection point. Results are less reliable than calculators due to the lack of accuracy of powerlines distances and power/voltage ratio, and other type of information, but can be useful for making estimations.



Prislista för anslutningar (inkl moms)

Servissäkring	Upp till 200 meter	Över 200 meter och upp till 600 meter	Över 600 meter och upp till 1 200 meter	Över 1 200 meter och upp till 1 800 meter
Max 25 A	36 250 kr	36 250 kr + 310 kr/m för den del som överstiger 200 m	160 250 kr + 678 kr/m för den del som överstiger 600 m	566 750 kr + 411 kr/m för den del som överstiger 1 200 m
Max 35 A	48 375 kr	48 375 kr + 310 kr/m för den del som överstiger 200 m		
Max 63 A	61 250 kr	61 250 kr + 310 kr/m för den del som överstiger 200 m		
Max 125 A	92 500 kr	92 500 kr + 310 kr/m för den del som överstiger 200 m		
Max 160 A	130 000 kr	130 000 kr + 310 kr/m för den del som överstiger 200 m		

Figure 6 Ellevio Connection charges estimator look-up table (Ellevio, 2021)

If one of these tools were required and implemented by regulation, promoters would have at their disposal useful information in the critical point of studying the evacuation possibilities of candidate installations. Moreover, as this information is more realistic for smaller installations, competition would increase and reduce market abuses, benefiting less financially powerful companies that normally promote smaller renewable installations, for which connection charges can be extremely relevant.

A possible to solution to enhance Spanish regulation would be to implement connection charges calculators for small installations, fixing a maximum of 2MVA, as happens in other countries, to ensure the accuracy of the estimations, and for larger installations implement look-up tables based on statistics as there is enough historical data that can be used to deliver estimations.

Connection charges information would also contribute to project firmness, as connection charges are approximately known beforehand contributing to reduce the rejections of preliminary proposals once the exact economic budget is provided.

5.2. Administrative procedures simplification and associated costs reduction

Another important weakness that affects both previous and new Spanish Access and Connection regulation is the complexity of all the paperwork and procedures with Public Administration, specially the lack of homogeneity in the economic guarantee deposit and communication, and project paperwork after the Access and Connection permissions. There are important differences and asymmetries that affect depending on the location and power every Autonomous Community, and Ministry, as each Administration have different deadlines, models, procedures, etc.

The fact that the location and power leads to deal with a specific Administration or another, directly affects applications and can create asymmetries in the network and projects to avoid relationships with specific Public Administrations that present more paperwork difficulties and longer deadlines as they don't have a standard administrative procedure.

In this situation, there are two self-developed proposals that can enhance and simplify the process and in consequence, mitigate difficulties and asymmetries with the objective of shortening and facilitating administrative procedures through standardization:

- Single administrative contact point: The objective of this proposal is to eliminate the obligation to process projects and authorizations at national level (ministry) or regional level (Autonomous community) depending on the criteria exposed in the regulation explanation. In consequence, there would be a standardization for the whole procedure independently from the location and power of the future installation. This measure would eliminate differences, asymmetries and difficulties among regional and national administration with a common process for all projects, unifying criteria and avoiding disadvantages and delays that can create applications concentration in some regions, favoring an efficient use of the network, and obviously, if the difference between national and regional administration disappears, Administrative efficiency and simplicity ratios would increase in the first stage of the process when depositing and communicating the economic guarantees, and after Access and Connection permissions

are granted when processing and requesting Administrative authorizations for justifying the required administrative milestones.

- Regulatory deadlines to Public Administration paperwork: New regulation has set specific requirements and constraints to promoters of renewable installations and system operators to ensure the advance of the installation until the commissioning, but there are not enough requirements that applies to Public Administration deadlines and those that apply are oversized, such us the 3 months to communicate the effective constitution of the economic guarantees. In consequence, public entities don't have reasonable limits and constraints to their procedures, an issue that, at the end, can delay the connection and commissioning of installations and even affect competition as there are Public Administrations that hinder projects processing.
  Firstly, the maximum 3 months for the communication of the effective constitution of the economic guarantees is excessive for a simple process that should not take more than a week. If this limit is reduced the temporal scope of this stage would be also reduced and competition would be enhanced eliminating possible time differences among Administrations, regional or national.
  Secondly, regulation should state deadlines for delivering Administrative Authorizations aligned with the limits for justification of the milestones. This would be an important improvement of time scope setting limits to the deadline that favor the advanced of the installation until the construction and commissioning. Regulatory deadlines would increase simplicity and competition and reduce time scope of the process.

- Administrative cost reduction: In Point 6.2 of Chapter 6, it is detailed the huge amount of money that promoters must waste in Administrative procedures, approximately 80% of non-building costs. A sunk cost that does not provide value to the project and could be efficiently reduced. These low administrative costs are already applied in other countries such as Germany and the UK as shown in the following figure:

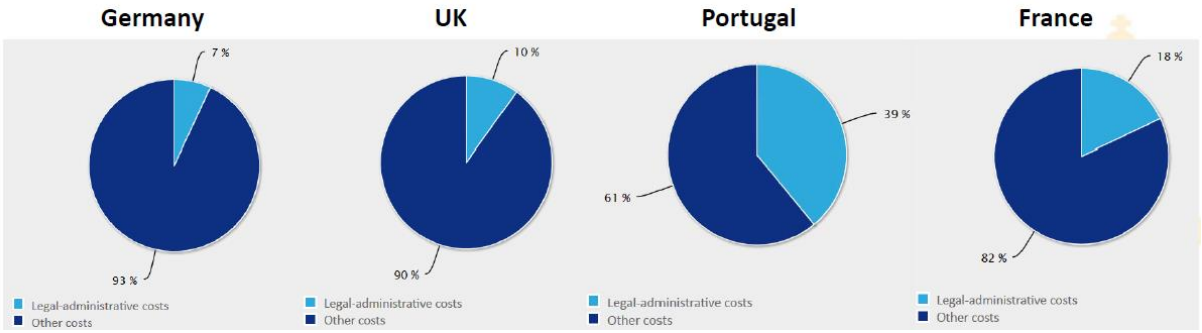


Figure 7 % share of administrative costs in EU countries (Jäger-Waldau, 2019)

5.3. Upstream influence information

In order to contribute to increase project firmness, the idea is when publishing information about distribution assets and the associated capacity, DSOs should make public the transmission node to which their assets make influence in the upstream network to know beforehand if, despite the availability of capacity in the distribution network, there is enough capacity in the upstream network to host influence of the downstream installation. Some DSOs already shares this relationship between distribution and transmission such as E-Distribución (E-Distribución SAU, 2021) in their network assets information module, but it is not mandatory so most of them don't defines this relationship.

Indicating the upstream node to which the distribution asset creates influence, should be enough as there are installations that doesn't require acceptability report, and promoters whose installation requires Acceptability report can consult the available capacity in the upstream network.

The objective is to avoid making the Access and Connection application without knowing if there is enough capacity in the upstream network to host the influence caused in the distribution network, contributing to increase project firmness, economic efficiency and making an efficient use of the network since the initial stages.

5.4. New types of access (Non-firm access)

The traditional methodology for granting access is "firm access" criteria considered by previous and new regulation, combined with a first in, first out criteria in terms of temporal priority, what means that the first application to be submitted without any requirement for correction is the first to be analyzed over a fixed capacity that, in principle, after implementing possible reinforcements won't suffer any type of curtailment

However, there exist other methodology that could be implemented in order to make a better use of the network capacity. Non-firm access implies that installations subject to this type of access can inject electricity to the network subject to possible curtailments depending on the moment of the day or network status, and through agreements between the DSO and the promoter. This type of access has been recently supported and applied by OFGEM (British regulator).

If these two types of access were combined, the result would be an Access for 100% of firm capacity, complemented with a non-firm Access in which additional capacity can be granted but subject to curtailments depending on the status of the network. The status of the network can be defined in real time or based on historical information.

This combination was initially considered in the draft of CNMC Circular 1, but at the end was not approved because DSOs are not prepared yet for the required mandatory permanent monitoring of the network. This type of access would benefit the integration of more renewable power in those areas with more natural resource.

OFGEM (British regulator) has included new alternatives for non-firm access in the course of the Significant Course Review working paper in 2019 (SCR) (Office of Gas and Electricity Markets (OFGEM), 6) that could complement the firm access as indicated the previous paragraphs:

- Static time-profiled non-firm access: Depending on the hour and the day of the week it would be allowed to inject more, less or no energy, based on a predefined peak or off-peak schedule. The advantage of this alternative is that it is not necessary to install grid monitoring equipment, but it requires a deep study of the network situation as it is a non-adaptative methodology and any mistake could cause a contingency in the system. This solution could be useful for small generators whose influence in the network is not so relevant and can be useful for ancillary services contracted by the future figure of the DSO.
- Dynamic time-profiled non-firm access: this alternative requires the installation of continues monitoring devices to determine the capacity in excess of the firm access that can be injected in the network. The main advantage is that the security of the network, as it is an adaptative methodology that allows or not to inject energy depending on the network status. However, the main disadvantage is the negotiation between generators and System Operators, combined with the uncertainty of production that at the end affects the remuneration of the project, and in consequence its viability. So, an estimation of production should be provided by the System Operator to facilitate the economic study by promoters.

  Monitoring devices combined with communication producer-DSO-TSO through control centers would be the optimal relationship layout, using existing figures, like production control centers for installations above 5MW, adapting regulation to allow the communication among system operators and producers for contracting services through market mechanism.

Although it requires that DSOs publish beforehand the admissible production levels for the non-firm access component, complementary access with Dynamic time-profiled non-firm access would be the optimal solution for the objective of increasing the hosting capacity of the network. Smart Grids are increasing their penetration in Spanish network and these devices allow to have a permanent monitoring of the network providing real time information needed for adapting renewable generation to the conditions of the network, contributing to the European requirement for TSOs/DSOs of transparency to ensure effective competition. This methodology is especially useful for those geographic areas that are more suitable for renewable generation (cheaper land, more natural resources, etc.) but connection nodes are without firm hosting capacity.

The objective of complementary access, combining the current firm access with an excess of non-firm access, is to ensure a better use of network capacity and increase the integration of renewables subject to possible curtailments that promoters have to accept through a contract in order to obtain the Access and Connection permissions once the capacity of the firm access is fully occupied.

However, for the full integration of non-firm access through the optimal dynamic method, regulatory definition of distributors as system operators is totally necessary in order to allow the procurement of ancillary and balancing services through markets mechanism as defined in the new European directive of the Clean Energy Package (European Parliament and the Council of the European Union, 2019).

5.5. Expected impact of recommendations and best practices

In this point, it shall be analyzed the expected results of the attributes that would be obtained if previous tools and initiatives were developed and implemented in new Access and Connection regulation.

As a summary the main contribution of these ideas and methodologies would be the following:

- Connection charges estimators: This tool would be especially useful in clusters 1 and 3: "Natural resource and connection possibilities study" and "Access and connection application", in order to provide estimations of connection charges to promoters and in consequence facilitate the best connection point choice among all possibilities. It will be also important to contribute to project firmness in the Cluster 5: "Application result: Preliminary proposal acceptance or rejection", as connection charges will be approximately known before reaching this stage and promoters normally wouldn't reject a proposal as a consequence of the required economic amount, except larger installations that, even DSOs can provide estimations based on historical data, require deeper studies as deviations can be larger due to the lack of homogeneity on the type of connections of this type of installations with larger power.
- Administrative procedures simplification: These measures would be an important improvement as it is the main weakness of the process, consisting on stablishing a single contact point for administrative procedures and setting reasonable deadlines and standard procedures. These changes would be a huge benefit for the whole process, contributing to simplicity, efficiency, time scope and project firmness, from the first stages until the process to the final commissioning of the installation. Moreover, the reduce of administrative costs will suppose important savings contributing to increase economic efficiency, especially for small companies with less financial resources. This improvement can be considered as critical for achieving PNIEC targets in year 2030.
- Upstream influence information: This slight modification on relating distribution network assets to upstream network nodes would ensure an increase in project firmness and economic efficiency avoiding to develop the resources and land studies of cluster 1, deposit and communication of economic guarantees in cluster 2, and making the Access and Connection application of cluster 3 without knowing if there is enough capacity in the transmission network that can host the power of the installation.
- New types of access: Although this measure, that has been promoted other countries such as the UK and Germany, can contribute to increase the concentration of application in specific zones of the network, the inclusion of complementary access can contribute to modernize the network through smart grid devices and, consequently, make a better use of the capacity of the network, adapting the generation to the current status of the grid. The main problem of this measure is that promoters must accept the curtailments that the DSO can make depending on the conditions of the network.

  Possible concentration of applications in specific zones of the network would be mitigated due to these necessary curtailments required in peak hours that would be informed beforehand by System Operators. Some technologies like photovoltaic or photothermal installations can be penalized in the non-firm access component as their

production schedule is more limited than wind turbines, also compensating the concentration of applications.

As a result, the evaluation matrix that relates the clusters of the process, implementing these initiatives, and the attributes would have the following values:

	Administrative efficiency and simplicity	Network Information transparency	Connection charges information	Entry barriers for new companies (competition)	Project Firmness	Efficient use of the network	Capacity allocation	Capacity use	Temporal scope	Economic efficiency
Cluster 1: Natural resource and connection possibilities study	N/A	2	1	1	2	1	N/A	1	2	2
Cluster 2: Economic guarantees paperwork	2	N/A	N/A	1	1	N/A	N/A	N/A	1	N/A
Cluster 3: Access and connection application	1	2	1	2	2	1	N/A	1	2	2
Cluster 4: Applications study and capacity viability & assignment	1	N/A	N/A	2	N/A	2	2	2	2	N/A
Cluster 5: Application result: Preliminary proposal acceptance or rejection	2	2	2	2	2	2	2	2	1	2
Cluster 6: A&C permissions and network contract	2	N/A	N/A	N/A	2	N/A	N/A	N/A	1	N/A
Cluster 7: Administrative milestones	2	N/A	N/A	2	2	N/A	N/A	N/A	2	N/A

Table 7 Improvements to New Regulation Matrix scores

In this matrix, it can be confirmed that the evolution of the attributes as all the weakest scores are improved and above an acceptable qualification. This means that the regulation would be more consistent and PNIEC targets would be more easily achieved if these affordable modifications would be implemented.

Analyzing and comparing the overall evaluation of each of the attributes with respect previous and new regulation (without these best practices), it is highlighted the evolution of all of the attributes and the increase of the efficiency. To graphically show this advance, the following scale of colors graphically summarizes the assessment of the attributes, with three evaluation possibilities:

- Red: Improvable
- Yellow: Acceptable but improvable
- Green: Improvement

Attributes	Previous regulation (2000-2020)	New regulation (2020)	New regulation (Enhanced)
Administrative efficiency and simplicity			
Network Information transparency			
Connection charges information			
Entry barriers for new companies (competition)			
Project firmness			
Efficient use of the network			
Capacity allocation			
Capacity use			
Temporal scope			
Economic efficiency			

Figure 8 Attributes assessment for previous, new and enhanced regulation

It is important to highlight that it is almost impossible to obtain a high score in every attribute, as trying to improve one as much as possible could imply worsen another

6. Thesis statements numerical justifications

In this chapter, a quantitative analysis shall be developed in order to sustain the main weaknesses and inefficiencies detected in previous chapters and for which a set of improvements and initiatives has been provided in paragraph 5 of Chapter 3.

The first point will consist on an analysis of historical applications to both transmission and distribution networks in order to make simple statistical calculations to provide conclusions that sustain why the change from previous regulation to new regulation was necessary and why the initiatives and improvements could complement this regulatory change.

Finally, an analysis of the economic costs associated to a set of representative projects shall be carried out to evaluate where the invested money of promoters goes in each situation, such as different locations of Spain, power levels (to process the project at Ministry or Autonomous Community level) or most relevant technologies (Photovoltaic and Wind), to cover all the possibilities and evaluate the most relevant differences.

6.1. Historical applications analysis

As explained in the introduction, in this paragraph an analysis of the historical applications to the Spanish distribution and transmission networks shall be developed. The information that will be analyzed has be obtained from the official website of the Spanish Transmission System Operator (Red Eléctrica de España S.A.U., 2021). Article 4 of RD 1183/2020 (Ministerio para la transición ecológica y reto demográfico, 2020) requires every System Operator to develop online webpages devoted to manage Access and Connection applications and provide information related to the status of these applications. However, at the date of developing this thesis, this information has not been published yet due to the moratorium of application that ended at date 1st July 2021, so for this analysis it will be necessary to use the historical information provided by Spanish TSO at date 30th June 2021.

This information only focuses on the three main renewable technologies in Spain: Photovoltaic, wind and photothermal. As the objective of this analysis is to evaluate the achievement of PNIEC targets of renewables integration in the 2030, this simplification of the main types of technologies is accepted as the contribution of the rest of technologies is negligible in terms of the measurements of power levels.

The information collected from the Spanish TSO official website (Red Eléctrica de España S.A.U., 2021) for each type of technology shall be the indicated in the following graphs. Whole information of historical applications is depicted in Annex 1 of the Thesis:

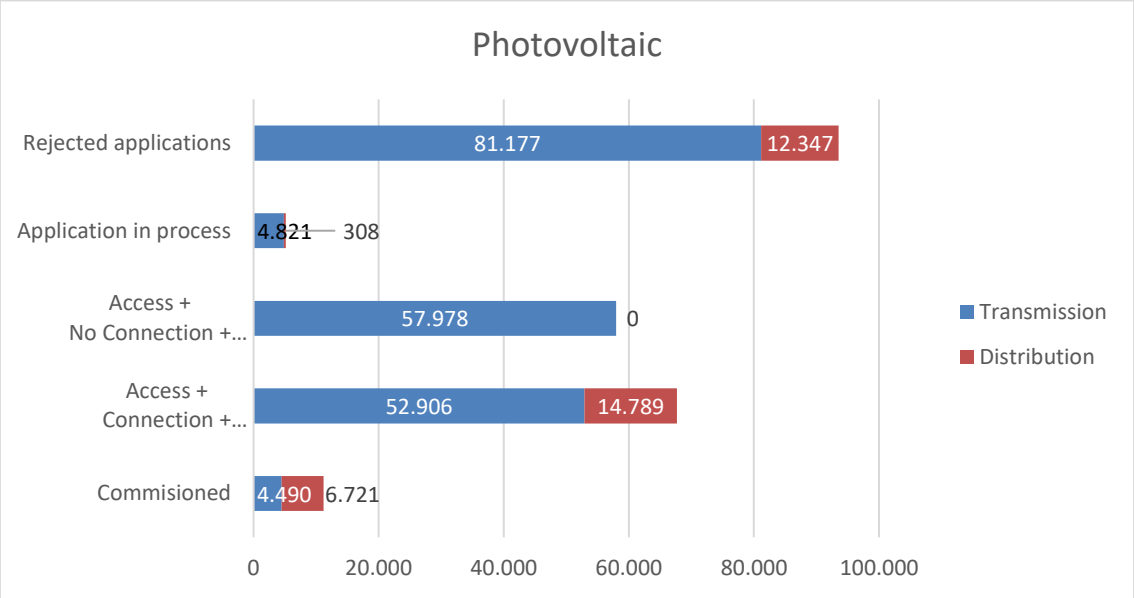


Figure 9 Photovoltaic applications 30th June 2021

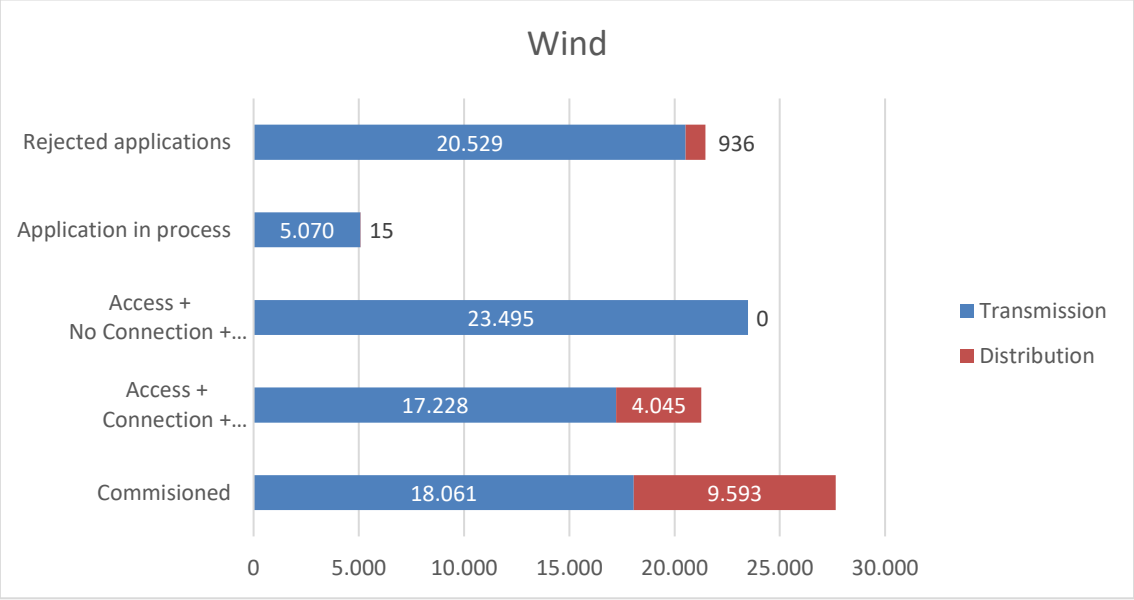


Figure 10 Wind applications 30th June 2021

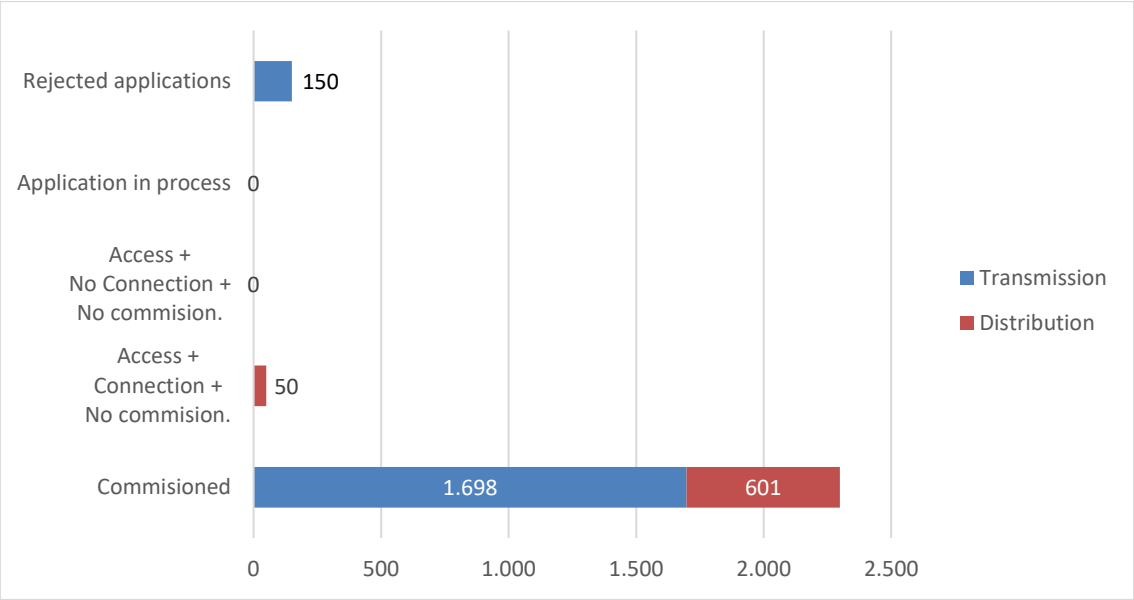


Figure 11 CTS applications 30th June 2021

As a result, the information for all technologies shall be the sum of the following table:

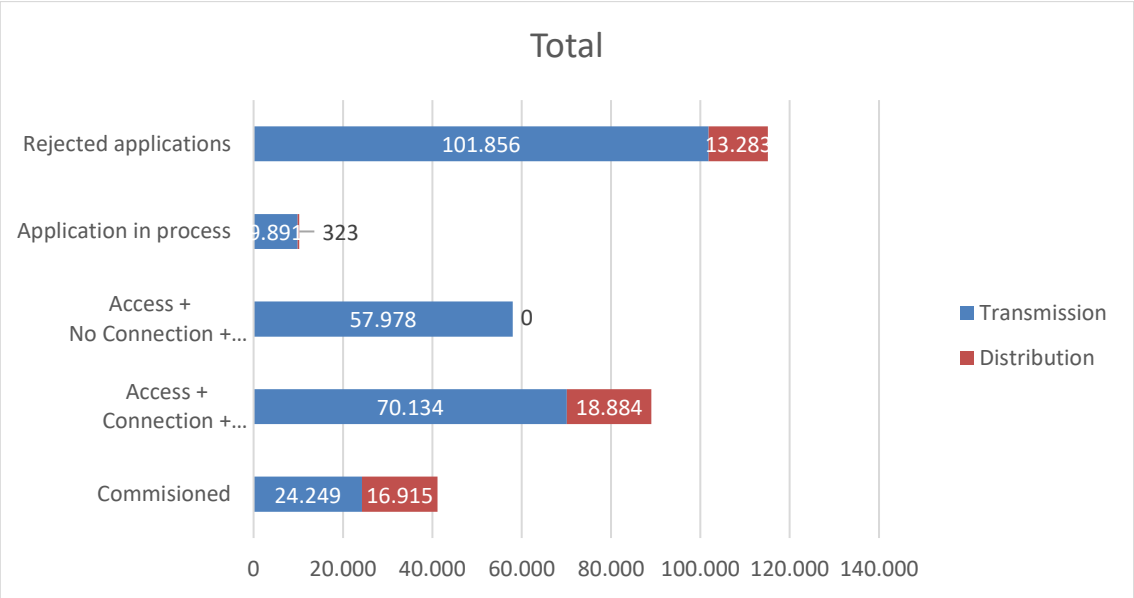


Figure 12 Total applications 30th June 2021

6.1.1. Transmission applications concentration

One of the main drivers that led to a change of the regulation was the concentration of applications in the transmission network due to the lack of transparency in distribution assets with their associated access capacity, and the inefficiencies detected in the Application process to distribution network that difficulted obtaining the permissions.

This statement can be confirmed if total access applications, accepted, rejected and in process, are compared:

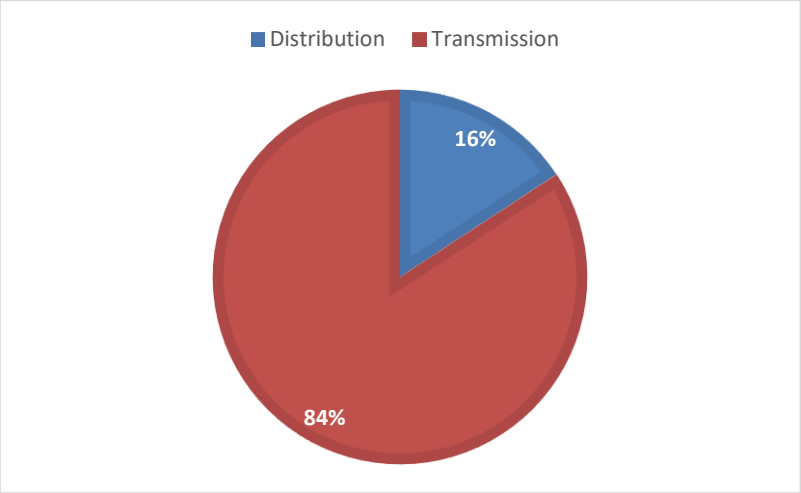


Figure 13 Transmission vs. Distribution applications

With this information, historically there has been a clear concentration of applications in the transmission network in terms of power (MW). The objective of new regulation is to balance this difference through the increase of transparency in network assets, and enable to take advantage of the opportunities that distribution network can offer, such as lower connection charges, more geographical coverage, etc.

6.1.2. Installations commissioning

When Spanish government approved and put into force RD 23/2020 (Ministerio para la transición ecológica y reto demográfico, 2020), the objective was to promote installations commissioning, as the regulator had detected that most of the projects didn't administratively advanced until the final connection of the installation to the network. For this reason, this legislation fixed a set of administrative milestones that promoters have too justify after obtaining Access and Connection permissions, defining a maximum deadline for each one until the final commissioning of the installation.

To justify this measure, Spanish government used data from applications of previous year and a half. However, focusing on historical data of applications with already granted permissions, this small share of commissioning is more evident:

(MW)	Total MW with permissions and commissioned	Total Non-commissioned MW with permissions	Commissioned	**% Commissioned**
Distribution	35802	18884	16915	**47,25%**
Transmission	152360	128112	24249	**15,92%**
Total	188162	146994	41164	**21,88%**

Table 8 % Commissioned applications

Studying these figures, it is clear the % of commissioned installations over total granted permissions, 21,88%, is really small and supports the decisions of Spanish government to put into force a regulation that ensures the commissioning of installations in a deadline of no more than 5 years since obtaining the permissions, subject to justifiable exemptions according to RD 23/2020 (Ministerio para la transición ecológica y reto demográfico, 2020).

Focusing on the type of network, it can be observed that the share of commissioned installations in distribution network is far larger than in transmission. The main reason is that there is a lower amount of MW with permissions in this network, but also it is due to the easier construction and administrative processes with the conditions offer by distribution system, as voltages are lower, and installations are normally smaller. Two important issues that are mainly related to lower environmental restrictions and constraints, in contrast with installations with permits granted in the transmissions network that normally have a greater environmental impact due to their larger geographical occupation and high voltages that require more security distances.

6.1.3. Connection applications

Related to the previous paragraph, another driver that led Spanish government to conclude the existence of a speculative behavior among promoters, was the large amount of power that had been granted with access permissions and had not received the connection permissions. Although this situation only applies to transmission network and is based on previous regulation, if the historical data at date 30th June 2021 is analyzed, considering only installations with permissions and not commissioned, this statement is reinforce even a year after the approval of RD 23/2020 (Ministerio para la transición ecológica y reto demográfico, 2020) as many projects obtained access permissions at the end of 2020 as a result of the permissions refusals that was authorized by RD 23/2020 until September 2020:

(MW)	Access + Connection (No commision.)	Access + No Connection (No commision.)	**% Access + No Connection + (No commision.)**
Transmission	70.134	57.978	**82,67%**

Table 9 Access permissions without Connection

However, as for justifying the administrative milestones defined in RD 23/2020 (Ministerio para la transición ecológica y reto demográfico, 2020) the deadline starts counting since access permissions date, and for obtaining the necessary Administrative Authorization it is mandatory to have connection permissions, it is expected that in the following months the % of power with access permissions without connection will progressively be reduced.

6.1.4. Type of installation analysis

Differencing and analyzing the data according to the three types of defined installations, different conclusions can be provided:

- Photovoltaic technology has become the most relevant driver for renewables integration and can be checked as a dominant share of all applications made belong to this technology. Wind natural resources has reached an important level of scarcity as most suitable locations are not available and present more environmental issues, whereas PV technology is more easily installed, and Spain location can offer a relevant number of production hours that allow the profitability of installations:

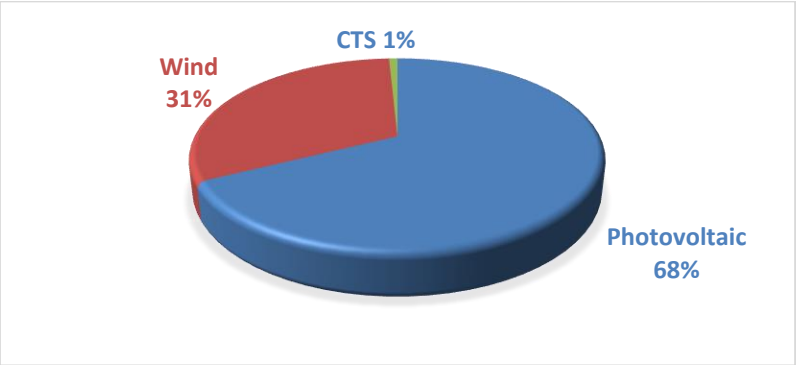


Figure 14 Applications % share technology

- Most of the commissioned installations belong to wind resources as photovoltaic technology has become economically competitive in recent years. Years ago, this technology needed public subsidies that contribute to ensure the viability of the installations; however, recent researches and technological advances has allowed to reduce costs. In following years, most of the commissioned installations will belong to photovoltaic technologies as wind resources are every year scarcer:

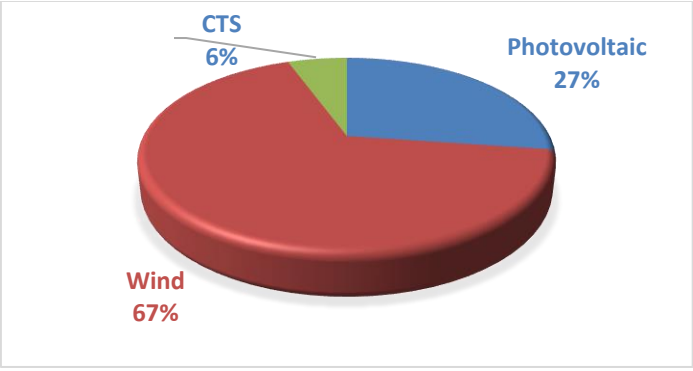


Figure 15 Technology commissioning share

- Regarding the commissioning of installations according to each technology, the contribution of photothermal can be considered negligible and cannot be analyzed due to the poor power in comparison with the other two technologies and majority of installations are already producing electricity.

  Regarding the data, it is clear that most of technology that is already working and connected to the network belongs to wind resource. The reason has been previously described and is no other that wind energy has been for many years the only viable and profitable renewable energy able to be competitive without the necessity of public financial support. However, recent technological advances have allowed to develop a very competitive photovoltaic technology that in following years will increase its commission and connection to the network. This statement is supported by PNIEC target of renewable integration, that considers an important installation of this type of technology as one the main drivers to increase renewable electricity generation:

	A&C Permissions + Commissioned (MW)	Commissioned (MW)	**Commissioned %**
Photovoltaic	113.390	11.211	**9,89%**
Wind	72.423	27.654	**38,18%**
Photothermal	2.349	2.299	**97,87%**
Total	188.162	41.164	**21,88%**

Table 10 % commissioning by type of technology

6.1.5. Location concentration

In order to evaluate what Spanish regions have more application concentration, an analysis of the available capacity saturation of the substations in each Autonomous Community has been made:

Region	Total Substations	Available	% saturated substations
Andalucía	70	10	85,71%
Aragón	46	17	63,04%
Asturias	8	8	0,00%
Cantabria	6	6	0,00%
Cataluña	33	16	51,52%
Castilla-La Mancha	38	5	86,84%
Comunidad Valenciana	38	18	52,63%
Castilla y León	75	14	81,33%
Extremadura	23	2	91,30%
Galicia	38	23	39,47%
Madrid	25	9	64,00%
Murcia	11	2	81,82%
Navarra	11	2	81,82%
País Vasco	15	15	0,00%
La Rioja	6	2	66,67%

Table 11 % full substations in Autonomous Community

As observed in the %, there are many regions whose available capacity is highly saturated and others that offer an important connection opportunity. This can mean that many substations have a low number of applications due to the orographically complexities of reaching them through a powerline or processing projects with the corresponding Administration, and others that don't present these problems and facilitate the large number of applications that are received.

Apart from geographical issues, many Autonomous Communities see renewables integration as an opportunity to obtain economic benefits and reduce the depopulation of their provinces, for that reason administrative projects processing are facilitated. On the other hand, other regions see renewables as an impact for other activities such as tourism and other environmental activities. In this context, recent publication of Spanish Ministry of ecological transition and demographic challenge (Ministerio para la Transición Ecológica y el Reto Demográfico, 2021) and RD 12/2021 (Ministerio para la Transición Ecológica y Reto Demográfico, 2021) that set the celebration of access capacity auctions in the transmission network, specified the economic impact in the regions where the auction is celebrated as important aspect to win the capacity. This entails that Spanish government is also interested in renewables integration, not only as a green energy transition, but also as an economic driver to fight depopulation in rural areas.

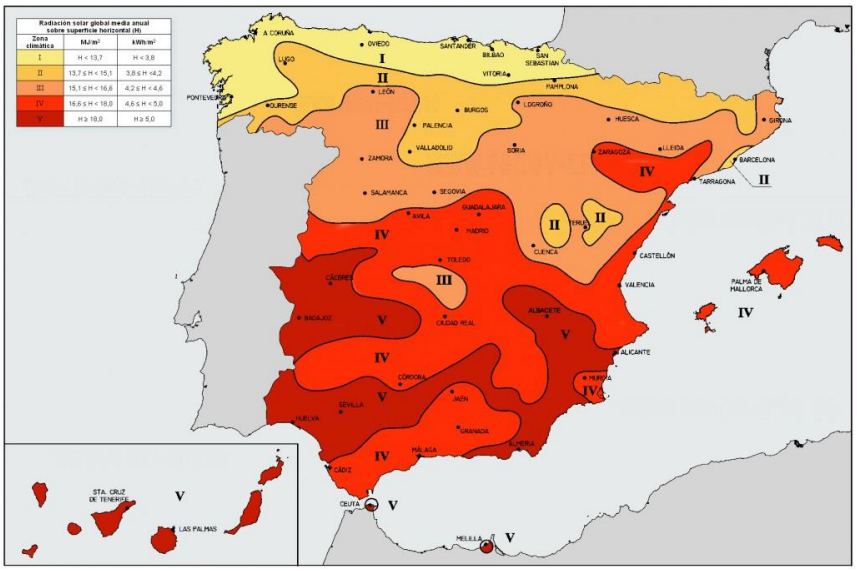


Figure 16 Map of solar natural resource (MINISTERIO DE VIVIENDA, 2006)

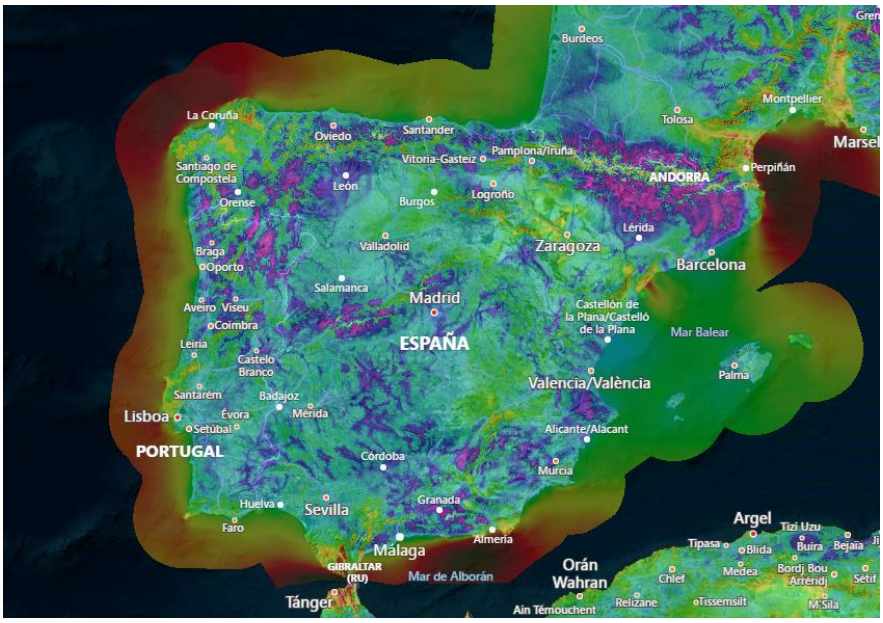


Figure 17 Map of wind natural resource (Global Wind Atlas, 2021)

If, for instance, the natural solar resource in some communities such as “Valencia” is compared with the level of substations saturations, 52,63%, it is non-correlated the fact that a region with such as natural resource levels has a low number of applications in their network, and others like “Extremadura”, “Andalucía” or “Castilla la Mancha” are almost without access capacity. The same situation happens in region in the north of Spain such as “País Vasco” and “Asturias” with a huge wind potential but having the capacity of their substations almost available for applications. The explanation is difficult to justify, but the facilities offered by some administrations are an important issue that directly affects to these figures. Many administrations reject the integration of renewables as they directly affect tourism due to the visual impact of the installations, but also orography of the land affects the location of installations leading to search for optimal locations.

With this information, it is supported the necessity of implementing the Complementary-Access methodology adding a non-firm access component once the firm access capacity is totally granted subject to possible curtailments according to network conditions, as there are many locations that provides a good natural resource, cheaper land and other opportunities that cannot be used due to the lack of capacity. Moreover, technologies such as batteries will allow to accumulate energy in curtailment hours and produce when possible.

6.1.6. PNIEC targets

The objective of PNIEC is to install a power of 60GW in year 2030 with respect 2020 levels. As can be seen in the overall capacity situation of table 10, in this moment there is a installed capacity of approximately 47GW, and an already granted capacity without commissioning of almost 147 GW.

With this last value, even in the worst case that 50% of that capacity was lost due to environmental restrictions and only considering photovoltaic, wind and photothermal technology, the value would be of 73 GW of renewable energy that will be connected to the network and producing clean electricity in a maximum deadline of 5 years, 2026, according to the milestones defined in RD 23/2020 (Ministerio para la transición ecológica y reto demográfico, 2020) due to the risk of economic guarantees execution. Adding to this figure, contribution from other resources, such as hydro, the objective of 120 GW will be achieved in time.

Moreover, in 1st July 2021 the moratorium of access established last 24th June 2020 will end and new access and connection applications can be made to obtain more capacity. This end of the moratorium, together with the Capacity auctions defined in RD 1183/2020 (Ministerio para la transición ecológica y reto demográfico, 2020) will increase the granted capacity. These measures together with the administrative milestones defined by RD 23/2020 (Ministerio para la transición ecológica y reto demográfico, 2020) will ensure that, in the worst case of 73GW already granted, PNIEC targets will be accomplished.

6.1.7. Conclusions

- There exists a concentration of applications in transmission network: 84%
- Only 21,88% of installations with Access and Connection permissions are commissioned. Administrative milestones will ensure the commissioning of installations in following years
- 82,67% of installations with Access permissions do not have Connection permissions. Administrative milestone will reduce this number in following months.
- Although most of the installations producing electricity are wind resource, 67%, most of the applications belong to photovoltaic technology, 68%, because of industrial advances becoming a competitive technology.

- Different issues such as land orography and administrative paperwork have led promoters to saturate more substation in some regions, ensuring the necessity of standardizing and simplifying administrative procedures and supporting the implementation of non-firm access subject to network conditions.
- In worst of the cases of losing 50% of granted capacity due to environmental restrictions (there are no other possibility), PNIEC targets will be reached in year 2030 as a result of the current amount of renewable power with Access and Connection permissions.

6.2. Economic analysis of representative RES projects

As indicated in the introduction of this chapter, in this paragraph an economic analysis of the cost associated to renewable energy projects shall be carried out. In order to cover a wide range of alternatives different considerations will be considered:

- Main types of technologies: Photovoltaic and wind.
- Different types of networks: Transmission and distribution
- Different locations of Spain (Public Administration).
- Different installation power (Ministry or Autonomous Community)

With these requirements, standard projects without any particularity have been chosen, and the associated costs without taxes and data are the ones exposed in the following table:

	Case 1	**Case 2**	**Case 3**	**Case 4**
Technology	PV	Wind	PV	Wind
Power	50	36	130	150
Location	CLM	CyL	Andalucía	Cantabria
Administration	Regional	Regional	Ministry	Ministry
Network	Distribution	Distribution	Transmission	Transmission
Connection point	Substation	Metallic structure	Substation	Substation
Natural resource study	2.200,00 €	6.000,00 €	4.700,00 €	6.000,00 €
Environmental impact study	6.160,00 €	8.008,65 €	16.016,00 €	29.250,43 €
Project for A&C application	3.000,00 €	3.000,00 €	3.000,00 €	3.000,00 €
Detailed project for administrative paperwork	56.800,00 €	57.350,00 €	78.350,00 €	84.290,00 €
Administrative fees (overall)	15.853,40 €	16.597,96 €	124.662,27 €	247.525,05 €
Construction Budget (installation)	29.151.189,34 €	30.549.855,56 €	75.793.092,23 €	98.351.566,65 €
Construction budget (privative network)	3.528.082,66 €	3.143.845,20 €	7.516.244,26 €	8.828.934,80 €
Connection charges	473.657,00 €	193.600,00 €	1.439.754,00 €	1.439.754,00 €
Total	**33.236.942,40 €**	**33.978.257,37 €**	**84.975.818,76 €**	**108.990.320,93 €**

Table 12 Associated costs of renewable projects

Related to the connection charges and budget, there are two types of costs: those required by the system operator to carry out the physical connection to their network (Connection charges), and others necessary to be implemented by the promoter to connect their installation to the distribution or transmission network (Construction budget, privative network), a budget that change depending on the installation location and the distance of the power line.

Based on this data, in the following points a set of conclusions will be provided. However, due to the large amount of money of the construction budget of the installation that represents an important percentage of the total costs, these values will not be used in the conclusions to avoid distortions.

1. Natural resource study is higher for wind than solar. This is obvious as wind is a more variable resource that need a deeper study, whereas solar is much more stable and normally only needs a study to calculate the power and number of hours for production, an important issue for the viability of the installation.
2. Environmental impact study varies with the power of the installation due to the higher occupation of land. There is a slight difference between solar and wind, as wind normally requires deeper studies in other issues such as influence on birds, noise, etc.
3. Administrative fees vary dramatically with the administration that does the paperwork. Autonomous communities are much cheaper than Ministry. The necessity of implementing a single Administration is evident with these figures as it is not understandable these important economic differences that directly impact on promoters independently of the economic muscle of the company.
4. The necessity of implementing a single Public Administration is much clearer due to the important difference in the projects required by each Administration. The models require by Industry secretaries of Autonomous Communities are cheaper than the model demanded by the Ministry.
5. The projects demanded by system operators to analyze the Access and Connection application and grant permissions don't represent a relevant share in the overall associated costs.
6. The economic advantage of connecting an installation in the distribution network is evident as connection charges are much lower, and the privative network is also lower due to the lower voltage. For the same length of the powerline, the budget is almost the half. In this aspect, the increase of transparency required by new regulation will make that many promoters implement their strategy in the distribution network for this economic benefit.
7. Another economic advantage of connection to distribution network is the possibility of connecting the installation to a metallic structure of a powerline instead of a new position in a substation. A possibility that is not offered in the transmission network, as regulation only allows to connect to a position of a substation. This advantage can be seen between Case 1 and 2 that have a connection to a substation and to a metallic structure respectively.
8. Excluding all the costs associated to construction budget (Installation, privative network and connection charges), the associated costs related to Administrative paperwork, fees and administrative project, represent an important % share:

	Case 1	Case 2	Case 3	Case 4
% Administration associated costs	86%	81%	90%	90%
Administrative associated cost per MW	1.453,07 €	2.054,11 €	1.561,63 €	2.212,10 €

Table 13 Administrative costs

This is amount of money could be considered as a sunk cost because they don't provide value to the project, but it is a cost that could be avoided if administrative paperwork were more efficient. Using only the construction project should be enough and would be a more efficient solution.

9. The overall cost per kW of each project, including the construction, studies, paperwork, etc. shall be the following:

	Case 1	Case 2	Case 3	Case 4
Costs per kW	664,74 €	943,84 €	653,66 €	726,60 €

Table 14 Costs per kW

These values show that photovoltaic technology, of cases 1 and 3, has become a competitive driver for renewable integration as the costs per kW are lower than wind technology (cases 2 and 4). However, this slight difference is compensated by the number of producing hours that are higher for wind. As explained in the core of the thesis, wind resources are scarcer as optimal locations with enough natural resource are already occupied, so photovoltaic technology has to be the real driver of renewable integration to achieve PNIEC targets.

Conclusions

European energy policies are moving to a clean and green energy transition that implies an important penetration of renewable energy in the electricity generation mix according to the Clean Energy Package. To comply with European regulation of the Clean Energy Package, EU member states must develop a 10-year integrated National Energy and Climate Plan (NECPs) for 2021-2030 period in order to contribute to the Clean Energy Transition.

The Spanish 10-year integrated National Energy and Climate Plan (PNIEC), implies an increase of renewable generation power of 60GW with respect to year 2020 levels. This huge level of renewables penetration requires on the on hand, a network development able to host the increase of power, and on the other hand a regulation that ensures an efficient Access and Connection process that ends in the commissioning of installations.

In this situation, Spanish government detected an increase of speculative behaviors among renewable promoters that ended in a change of regulation in year 2020 in order to ensure the final commissioning of installations, the real objective of PNIEC.

- RD 1183/2020: that updates and regulates the Access and Connection applications, homogenizing and erasing differences between the procedure to distribution and transmission network.
- RD 23/2020 that legislates the actions to be carried out after the Access and Connection permissions to ensure the final commissioning of the installations in a period no longer than 5 years.

To host new renewable installations, distribution networks are becoming a relevant driver due to their economic and technical advantages and the massive concentration that has been created in transmission network. Moreover, public opinion and Administrations are looking for smaller installations that creates a lower visual impact.

In this context, the main conclusions provided by this thesis are described hereunder

- There has been an evolution and increase of efficiency in the Access and Connection procedure from previous, prior to the 2020 reform, to new regulation, approved in June 2020.
- The change in the Access and Connection regulation will ensure the commissioning of approximately 70GW, in the worst case of losing 50% of current Access permissions already granted, of renewable installations allowing to reach the objective of integrating 60GW of renewable installations before 2030.
- Administrative milestones from RD 23/2020 (Ministerio para la transición ecológica y reto demográfico, 2020) Will ensure the commissioning of this 70GW in a time scope of maximum 5 years, what means year 2026, putting at risk the associated economic guarantees.
- Distribution networks are going to become an essential driver for renewable projects in following years, combining the economic advantages of lower charges with more geographical widespread, allowing promoters to consult information of the assets

- The implementation of Connection charges estimators, simplification and reduction of administrative procedures and associated costs, forcing to share upstream network influence and allowing to grant non-firm access permissions, according to international tendencies, would suppose an evolution that complement new Access and Connection regulation supporting the achievement of long-term goals of producing 100% renewable electricity in Spanish generation mix of year 2050 in a more efficient manner.

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Annex 1: Historical applications tables

Historical applications analysis

Photovoltaic								
[MW]	**Commissioned**	Access + Connection + No commision.	Access + No Connection + No commision.	**Total Acc+Conn. + No commission.**	**Total Acc+Conn. + No commission. + Commission.**	Application in process	Rejected applications	**Total**
Distribution	**6.721**	14.789	-	**14.789**	**21.511**	308	12.347	**34.166**
Transmission	**4.490**	52.906	34.483	**87.389**	**91.879**	4.821	81.177	**177.877**
Total	**11.211**	67.695	34.483	**102.178**	**113.390**	5.129	93.524	**212.043**

Table 15 Photovoltaic applications 30th June 2021

Wind								
[MW]	**Commissioned**	Access + Connection + No commision.	Access + No Connection + No commision.	**Total Acc+Conn. + No commission.**	**Total Acc+Conn. + No commission. + Commission.**	Application in process	Rejected applications	**Total**
Distribution	**9.593**	4.045	-	**4.045**	**13.639**	15	936	**14.590**
Transmission	**18.061**	17.228	23.495	**40.723**	**58.784**	5.070	20.529	**84.383**
Total	**27.654**	21.273	23.495	**44.768**	**72.423**	5.085	21.465	**98.973**

Table 16 Wind applications 30th June 2021

CSP								
[MW]	**Commissioned**	Access + Connection + No commision.	Access + No Connection + No commision.	**Total Acc+Conn. + No commission.**	**Total Acc+Conn. + No commission. + Commission.**	Application in process	Rejected applications	**Total**
Distribution	**601**	50	-	**50**	**652**	-	-	**652**
Transmission	**1.698**		-	**-**	**1.697**	-	150	**1.847**
Total	**2.299**	48	-	**48**	**2.349**	-	150	**2.499**

Table 17 Photothermal applications 30th June 2021

Total								
[MW]	**Commissioned**	Access + Connection + No commision.	Access + No Connection + No commision.	**Total Acc+Conn. + No commission.**	**Total Acc+Conn. + No commission. + Commission.**	Application in process	Rejected applications	**Total**
Distribution	**16.915**	18.884	0	**18.884**	**35.802**	323	13.283	**49.408**
Transmission	**24.249**	70.134	57.978	**128.112**	**152.360**	9.891	101.856	**264.107**
Total	**41.164**	89.016	57.978	**146.994**	**188.162**	10.214	115.139	**313.515**

Table 18 Total applications 30th June 2021

Transmission applications concentration

Network	Total MW	**% share**
Distribution	49.408	**15,76%**
Transmission	264.107	**84,24%**
Total	313.515	**100,00%**

Table 19 Transmission vs. Distribution applications

Type of installation analysis

	Total applications (MW)	**% share**
Photovoltaic	212.043	**67,63%**
Wind	98.973	**31,57%**
Photothermal	2.499	**0,80%**
Total	313.515	**100,00%**

Table 20 Applications % share technology

Technology	Commissioned (MW)	**% commissioned**
Photovoltaic	11.211	**27,23%**
Wind	27.654	**67,18%**
Photothermal	2.299	**5,58%**
Total	41.164	**100,00%**

Table 21 Technology commissioning share