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Roadmap and action plan for the first cross-border solar project

Smart Specialisation Solar Partnership

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Contents

Abstract

This report proposes the use of a legitimization function of the Technological Innovation System (TIS), as an analytical framework to develop a roadmap and action plan for deploying cross-border renewable projects in Europe. This approach assesses the role, competences and critical issues of a subset of the key stakeholders. Based on this information, a set of actions are proposed as to achieve the social acceptance towards cross-border renewable projects in Europe. To conclude, a solar project in Extremadura is studied in order to validate this approach.

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Executive summary

Policy context

In the 2014-2020 programming period, the European Structural and Investment Funds (ESIF) are supporting 11 investment energy priorities also known as thematic objectives (TO). In this context, the Smart Specialization Platform on Energy (S3PEnergy) is supporting the optimal and effective uptake of the ESIF for energy, identifying the most cost-effective technologies and innovative solutions to support the EU energy policy priorities.

To this end, the S3PEnergy has facilitated the creation of Smart Specialization Energy Partnerships, offering interactive and participatory arenas for interregional cooperation along shared priorities related to energy. Solar energy is present at the RIS3 ([1]) strategy of many EU regions. As a result, a solar European partnership has been created to promote solar electricity generation and distribution in Europe and maintain the European solar power industry leadership.

Key conclusions

Cross-border renewable electricity exports in Europe could bring multiple benefits for European countries and regions. However, despite the expected benefits, some obstacles currently prevent the materialization of such projects.

As a way to overcome the existing obstacles, this policy report defines a tailor-made roadmap and action plan to deploy cross-border solar electricity trade projects in Europe, based on the concept of a first cross-border solar First of a Kind (FOAK) project in Extremadura, Spain.

The approach is based on the legitimization function of the Technological Innovation System (TIS) which implies that in order to successfully deploy any new technology – including new concept such as solar cross-border renewable electricity projects in Europe, it is necessary to acquire the key stakeholders' support and legitimization towards the project. As a first step, the authors suggest selecting a subset of key actors within the relevant stakeholder system. The second step consists in assessing their role, competences and most critical issues when considering cross-border electricity projects. Next, based on this information, a roadmap and action plan is proposed.

Main findings

When considering cross-border solar electricity projects in Europe, this report has focused on the following key stakeholder categories: (i) politics and policies (at the European level, country level including host, off-taker and transit countries as well as regional policy makers), (ii) supply (industry and research community as well as distribution and trade actors) and (iii) influencers (potential consumers and citizens in participating countries). Based on a stakeholder consultation process, their competences and critical issues have been identified. Next, a set of recommended measures are proposed as a way to increase their social acceptance towards cross-border renewable electricity projects.

As to the Extremadura case study, an action plan has been drafted taking into consideration its specificities. Results from the analysis indicate that some common "critical issues" appear to be relevant by several stakeholder categories and, as such, require special attention. Such key issues include: (i) increase advocacy efforts, (ii) demonstrate the electricity system value, (iii) foster synergies with other research initiatives, (iv) business plan development, (v) coordinate EC support, (vi) definition of the techno-economic configuration of the plant and (vii) ensure social acceptance by civil society.

([1]) http://s3platform.jrc.ec.europa.eu/s3-guide

For each one of these critical issues, the authors propose an action plan (structured around three time periods) that, if fully implemented, should contribute to the successful deployment of the first cross-border solar FOAK project in Europe.

Lessons learned from the implementation of this action plan should help other regions better exploit their renewable electricity export potential across Europe.

Related and future JRC work

As for the next steps required to materialize a cross-border solar FOAK electricity project, the authors highlight the need for a strong collaboration between industrial players, regulators, managing authorities, research institutions, civil society and relevant European Commission representatives. In this context, the Solar Smart Specialization Partnership plays a very important role in facilitating such interaction and supporting region in developing such networks.

Furthermore, this report proposes a set of actions which require the knowledge and expertise from JRC (such as impact assessments, energy systems modelling, etc.).

Quick guide

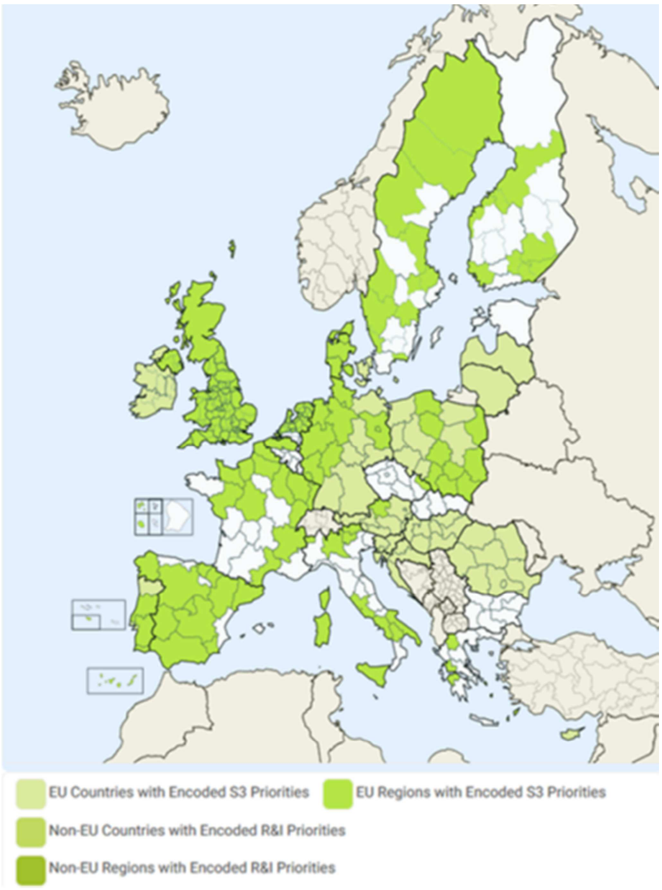
Europe must decarbonize its economy in a cost-effective way while improving its energy security, fostering social and economic development, gaining leadership in the Renewable (RES) technologies and moving towards an integrated and well-functioning Energy Union. Producing and exporting solar electricity from Southern to Central/Northern European countries can contribute to achieve many of such goals. On the one hand, regional renewable generation can help decarbonize the European power system in a cost-effective manner by generating renewable electricity where the resource is most abundant and generation and/or system costs are lower. On the other hand, regional cooperation is a step forward towards a more integrated, well-functioning and cohesive Energy Union, and ultimately to the 2020 and 2030 European strategy. Finally, since the best solar resource potential is found in some of the less developed regions in Europe, the deployment of such projects could create remarkable social and economic impacts for such regions, contributing to reduce regional disparities within Europe.

1 Introduction

1.1 Introduction to the Smart Specialization Platform on Energy

The Smart Specialization Platform on Energy (S3PE) is a joint initiative of the Directorates-General for Regional and Urban Policy, Energy, and the Joint Research Centre (JRC). The S3PE is planned to become an enabling tool for regions to coordinate, rationalize and plan their respective energy strategies, develop a shared vision on knowledge-based energy policy development and set up a strategic agenda of collaborative work. The Smart Specialization (S3) is aligned with the Energy Union R&D and competitiveness priorities and promotes the energy related Thematic Objective (TO) TO1, Research and innovation, TO4, Low carbon economy and TO7, sustainable transport, together with the commitment to the Strategic Energy Technology Plan (SET plan) 10 key actions.

Figure 1. Regions with energy priorities included in their S3 Strategy ([2])



Source: JRC EYE@RIS3

The main objective of the S3PE is to support the optimal and effective uptake of the Cohesion Funds (CF) allocated to energy and to better align energy innovation activities at national, local and regional level. This is achievable through the identification of the best technologies and innovative solutions that support in the most cost-effective way the EU energy policy priorities. The S3PE contributes to EU energy policy priorities by facilitating partnerships between EU regions that have identified renewable energy technologies and innovative energy solutions as their S3 priorities and by promoting alignment between local, regional, national and European activities on energy

([2]) http://s3platform.jrc.ec.europa.eu/map sustainability, competitiveness and security of supply. In this context, cooperation across EU regions and member states (MS) sharing solar energy as priorities has been materialized in the creation of the Solar S3 Partnership.

The Solar S3 partnership ([3]) is focused on the export of solar electricity from South to Central/North Europe which is aligned with the TO4 generation and distribution of renewable energy across Europe. As such, the S3 in solar energy is supported by three pillars: regional development, maintaining the competitiveness of full value chain of the concentrated solar power (CSP) European industry and strengthening its technological development.

1.2 Background, motivation and objectives of the study

A project involving cross-border solar electricity trade from South to Northern Europe is expected to bring multiple benefits at the regional, national and European levels. However, as of today, the promotion and deployment of such project still face a myriad of hurdles of heterogeneous nature.

The recently published JRC-policy report *"Promoting Solar Electricity Exports from Southern to Central and Northern European Countries. Extremadura Case study"* also commissioned by the Solar Smart Specialization (S3P) Partnership, attempted to answer two key questions: (i) What is the value proposition of solar electricity exports in Europe? And (ii) How could such projects become bankable? (Caldés and Díaz-Vazquez, 2018).

As for the first question, Caldés and Díaz-Vazquez (2018) concluded that the value proposition of solar electricity exports within Europe is noteworthy. Besides contributing to energy and climate objectives, exporting solar electricity from South to Central/North Europe could also contribute to job creation and economic growth in some of the less developed regions in Europe. Furthermore it could help maintain the European industrial and research leadership in solar technologies and CSP in particular. Finally, deploying such projects could also contribute to improve the techno-economic performance of solar technologies in Europe. With regards to the second question, the report concluded that there exist various and complementary alternatives to make cross-border solar electricity projects bankable. As for the possibility to make use of the Cooperation Mechanisms of the Directive 28/2009/EC, an important challenge resides in mobilizing the required political interest and support from key stakeholders in both host and off-taker countries. As for the EU funding, among other financial support mechanisms at the EU level, this policy report highlights InnovFin Energy Demonstration Project (EDP) facility as a suitable instrument for First-Of-A-Kind (FOAK) commercial scale projects. Finally, the authors also conducted a pre-feasibility assessment of a solar FOAK project in Extremadura, a region in Spain that seems to have the perfect framework conditions to host such type of project. The report concluded that, in order to realize such project in Extremadura, coordinated efforts by all relevant stakeholders needed to be put in place to move forward in the right direction (Caldés and Díaz-Vazquez, 2018).

As a follow-up report of Caldés and Díaz-Vazquez (2018), **this work aims at going one step further by, proposing a roadmap and action plan to deploy cross-border renewable electricity trade projects in Europe and, in particular, for a solar FOAK project in Extremadura.**

To achieve this goal, the authors have followed an analytical approach based on the Technological Innovation System (TIS) which starts by selecting a subset of key actors within the cross-border electricity projects. For this subset of actors, their role, competences and most critical issues when considering cross-border electricity projects have been assessed. Next, based on this information, an action plan has been drafted taking in consideration the recommended measures that would need to be implemented to reach those key stakeholders´ full support. The legitimation of cross-border RES

([3]) http://s3platform.jrc.ec.europa.eu/s3-energy-partnerships-solar-energy projects by the key stakeholders should be considered as a necessary (but not sufficient) condition for the project future realization. Lastly, taking this case study's specificities, this approach has been applied to the Extremadura case study. As a result, a roadmap and action plan for the first solar cross-border electricity project to be deployed in Extremadura is proposed.

1.3 Methodology and report structure

The analytical framework used to propose a roadmap and action plan for cross-border electricity trade projects builds on the **Technology Innovation System** (TIS) approach which is defined as a "network(s) of agents interacting in a specific technology area under a particular institutional infrastructure for the purpose of generating, diffusing and utilizing technology" (Carlsson and Stankiewicz, 1991).

Compared to other analytical frameworks ([4]), one of the advantages of the TIS approach is that it provides an integrated, systemic framework for the analysis of drivers and barriers that takes into account all the potential factors and their interrelations. In other words, it provides a detailed structure for understanding the interplay between policies and cultural, technical and economic developments. In this way, the success of innovative energy technologies implying a system change is not only dependent upon the technical characteristics of relevant technologies, but equally on the existence of a supportive social, political and economic context (OECD, 2015).

The functional perspective in the TIS is defined by six specific system functions which are related to the interactions between the three components of an innovation system: actors, networks and institutions, see Table 1, (Bergek et al 2008; Hekker et al., 2011; Bergek and Jacobsson 2008).

([4]) Environmental economics, diffusion modelling approaches, literature on learning effects, etc.

Table 1. TIS functions

TIS Function	Description
Knowledge development and diffusion	This function captures the breadth and depth of the current knowledge base of the TIS, and how knowledge is diffused and combined in the system. Various types of knowledge serve as inputs for innovation, including R&D and learning effects.
Guidance of the search	This refers to activities that can affect the visibility of specific needs among technology users and the incentives for the organizations to enter the TIS.
Entrepreneurial experimentation	Entrepreneurial experimentation implies a probing into new technologies and applications, with successes and failures.
Market formation	Market formation normally goes through three phases with quite distinct features: nursing, bridging and mass markets.
Legitimation	Legitimacy refers to social acceptance and compliance with relevant institutions. The new technology needs to be considered desirable by relevant actors in order for resources to be mobilized, for demand to form and for actors in the new TIS to acquire political strength. This process is complicated by competition from adversaries defending the existing TIS. The purposeful creation of legitimacy by lobbying networks counteracts resistance to change.
Resource mobilization	This refers to the extent to which the TIS mobilizes competence/human capital, financial capital and complementary assets in order to make the various processes in the innovation system possible.

Source: Bergek et al (2008), Hekkert et al (2011), Dutschne et al. (2018)

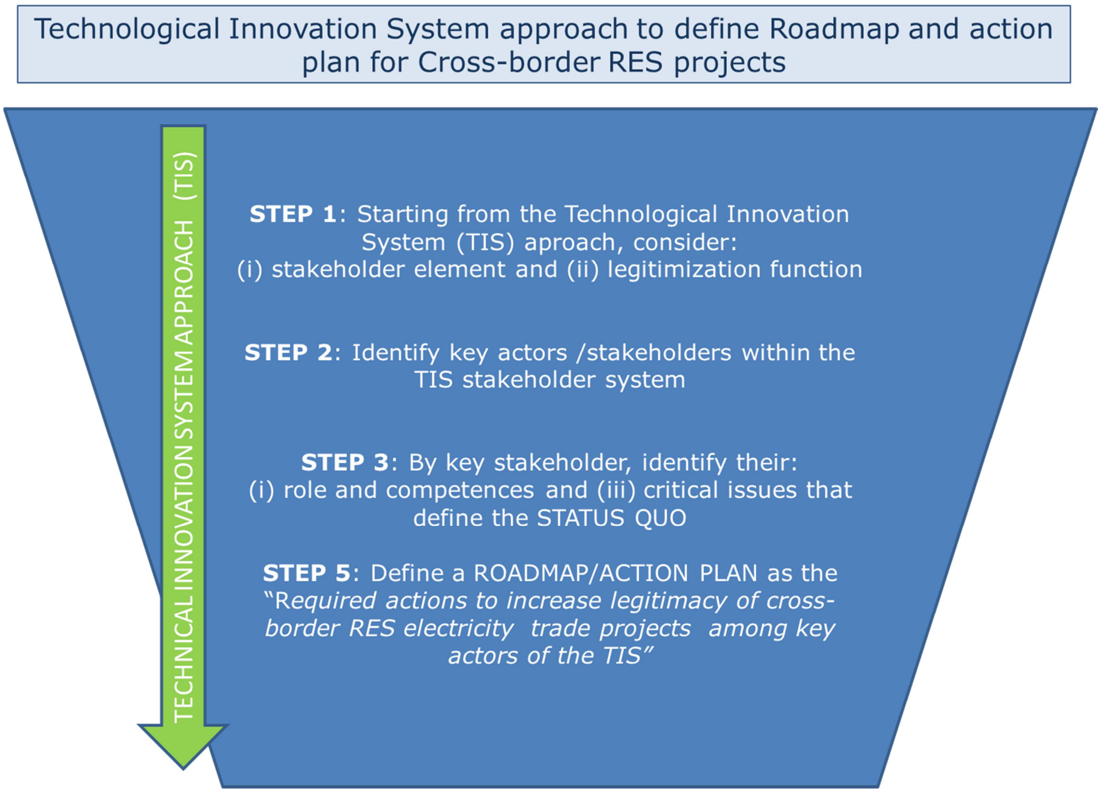
As expected, some functions are more important than others depending on the stage of the TIS. In the case of cross-border renewable electricity projects, resource mobilization and, most important, legitimation of the TIS stands out. As argued in del Río et al (2018), there still exist multiple barriers to both the use of the cooperation mechanisms and a wider deployment of CSP technologies. Thus, achieving the support of the relevant actors (legitimization function) becomes a crucial aspect for the future materialization of such type of projects. As such, the legitimation function has been the cornerstone of this report around which a diagnostic of the current situation, a roadmap and action plan has been elaborated.

According to the TIS literature, "legitimacy" refers to social acceptance and compliance with relevant institutions. In this case, the new technological concept – cross-border renewable electricity trade projects – needs to be considered desirable by relevant actors in order for resources to be mobilized, for demand to form and for actors in the new TIS to acquire political strength.

In this report, following the TIS perspective, the market, policy and regulatory drivers and barriers have been considered as a way to assess the status quo and prospects for cross-border electricity trade projects (see Caldés and Díaz-Vazquez, 2018). Next, within this broader goal, this report has focused on the "stakeholder" element of the TIS and, in particular, the legitimacy functions of the TIS. In this way, a roadmap for cross-border renewable electricity trade project has been defined as the required set of actions that will make the legitimacy and support toward cross-border renewable electricity projects increase for each one of the identified key actors of the stakeholder system ([5]).

([5]) It is important to highlight that the proposed actions are necessary but not sufficient to guarantee the materialization of cross-border RES projects. It is recommended that a similar roadmap configuration analysis was conducted for the other TIS functions.

Figure 2. Proposed application of the TIS approach to draft an action plan



Source: Own elaboration

The **data and information** required for the analysis have been gathered throughout a comprehensive literature review and, most important, a stakeholder consultation ([6]) that took place throughout the first semester of 2018 with key actors ranging from independent experts, market participants, civil society representatives, regulators and decision makers at that European, National and Regional level ([7]) who have provided their view on the most critical issues when it comes to cross-border RES projects in Europe.

As to the **targeted audience** of this report, it comprises European regions´ authorities interested in cross-border electricity projects and Extremadura in particular. It also includes National policy makers from potential host, off-taker and transit countries as well as EC decision makers interested in cross-border electricity projects. Similarly, project developers, CSP and PV industry representatives, scientific community as well as regulators and grid operators may also find some useful insights regarding the conditions required to unleash the potential benefits of cross-border electricity projects in Europe.

The **structure of the report**, illustrated in Figure 3, is as follows:

After this introductory section, section 2 introduces the stakeholder system for cross-border RES projects and, for the selected key actors, discusses their role and competences as well as their most relevant issues and concerns when considering cross-border electricity trade projects.

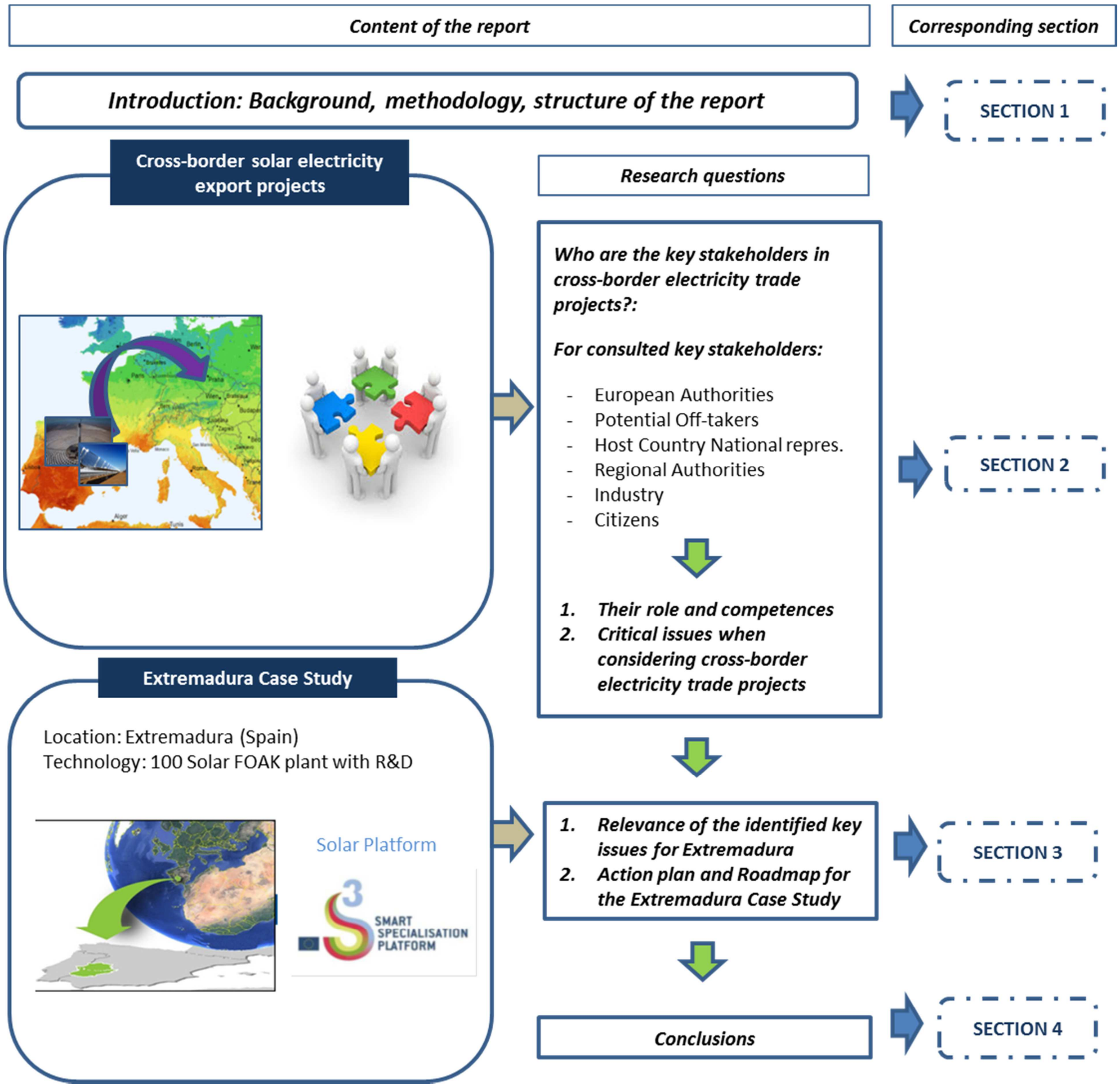
Next, in section 3, for the identified key issues in the previous section, the particularities of the Extremadura case study are assessed and a roadmap and action plan is proposed.

Finally, in section 4, the main conclusions of this work are presented.

([6]) Such consultation took was conducted through open-ended informal interviews during bilateral meetings and stakeholder consultation workshops.

([7]) Information was also gathered as a result of the participation in various meetings with key informants from, among others, DG-Ener, MINETAD and MS representatives.

Figure 3. Structure of the report and key questions



Source: Own elaboration

2 Key stakeholders in cross-border solar electricity projects.

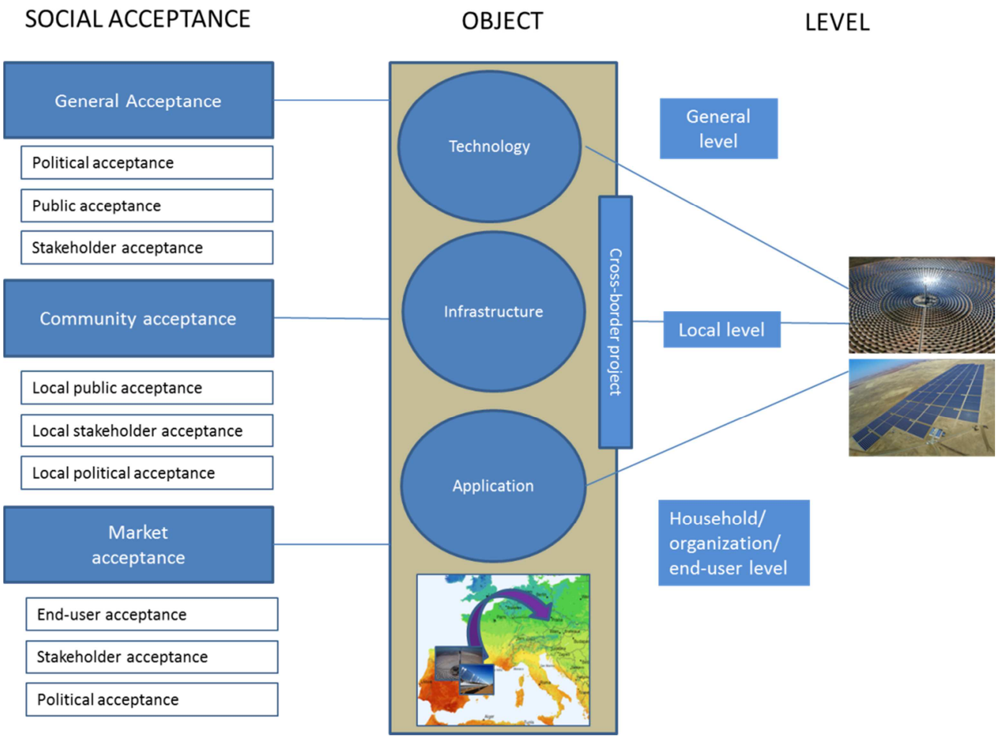
Within the Technological Innovation System (TIS) perspective ([8]), the stakeholder system is the backbone of this report. According to Upham et al (2015), social acceptance is defined as "a favourable or positive response relating to a proposed or in situ technology or socio-technical system, by members of a given social unit (country or region, community or town and household, organization)". As introduced in the previous section, both the roadmap and action plan towards the deployment of cross-border solar electricity project have been proposed by considering what are the most urgent actions required to obtain the key stakeholders social acceptance.

As described in Dutschne et al (2018), social acceptance towards cross-border solar electricity projects has three dimensions: socio-political, local and market acceptance. First, socio-political acceptance in all involved countries is relevant –i.e. in the countries providing electricity, the countries through which the electricity is transferred as well as those countries where the electricity is consumed. In contrast to socio-political acceptance, community acceptance refers to the attitudes and behaviours exhibited by neighbours of installations or others somehow affected by an innovation or technology without actually using it. Finally, market acceptance refers to the acceptance of a technology that is manifested by market actors which, in this case, includes component manufacturers, project developers, Distribution System Operators (DSOs) and Transmission System Operators (TSOs) as well as utilities and energy consumers including households but also industry. Figure 4 illustrates the European dimension of social acceptance for solar technologies and renewable energy cooperation.

In summary, as depicted in Figure 4, social acceptance is a concept that allows for a broader perspective on the roles of different actors, their expectations and interactions, and the diverse materialization of technologies at different scales (Devine-Wright & Batel, 2017).

([8]) The TIS is comprised of three building elements: actors, networks of actors and institutions.

Figure 4. Social acceptance



Source: Adapted from Dutschne (2018)

According to Dutschne et al (2018), the stakeholder system of cross-border solar electricity projects is comprised of various categories: politics and policies, research and education, supply, electricity distribution, demand and support organizations (see Box 1).

Box 1. Stakeholder system of cross-border electricity projects

Politics and Policies category includes stakeholders from the National and regional executive bodies (ie: ministries or directorates) within in each involved country and region. Furthermore, at the European level ([9]), the European Commission regulates regional cooperation support instruments and other technology support policies. Additionally, national or international regulators or grid agencies may also play an important role within this category (ie: ACER, the Agency for the Cooperation on Energy Regulations).

Research & Education category also plays an important role regarding both technology development and diffusion (i.e: research institutes and universities). The focus of the ongoing research lies in the development of the technology but also deals with questions of suitable support policies ([10]).

([9]) For example, DG-Ener, DG-RTD, DG-Regio
([10]) For example the MUSTEC project (www.mustec.eu) consortium includes seven European research centres.

The ***Supply*** block can be divided into two blocks: the **development phase** and the subsequent **operation phase**. The ***Development Phase*** comprises the project development, including engineering, procurement and construction (ECP) and component manufacturing. The stakeholders on the project development side are usually the initiating project developers and the recruited ECP-partners with expertise in technology development, investment and organisation. Typical tasks within this step are market analyses, site selection, engineering and design, licensing, financing and construction. Component manufacturers, and their upward suppliers deliver the technical solutions, which, in the case of CSP, can be very different due to the various technological approaches, but mainly include mirroring systems, receptors (including heat transfer fluids), storage, steam generators, turbines, piping, control systems, cooling systems, electrical systems and auxiliary systems (Caldés-Gómez & Díaz-Vázquez, 2018). Next, once the construction of the plant is finished, the **operation phase** begins. The important stakeholders in this phase are the plant owners and the companies responsible for operation and maintenance, which, for CSP, include for example cleaning and renewal of the reflectors.

An additional block considers the management of **electricity distribution**. This includes energy exchange markets and transmission system operators, who do not classify as either supply or demand side of the electricity market, but are involved in the coordination of both. While energy exchange markets manage the financial side of the trade procedure, transmission grid operators ensure the technical viability. Since the electricity network load always needs to be balanced, the technical viability is especially challenging when intermittent sources are feeding into the grid. As CSP offers the possibility to store energy, it has the potential to be a baseload power source, which could reduce the complexity for grid operators. However, the local distribution grid operators might play a minor role in this distribution of CSP, as it is more a matter of long-distance and cross-border transportation.

Demand includes utilities and regular consumers, who can be both households and industry consumers. Since large industrial consumers can also make contracts with CSP plant owners directly or implement CSP within their sites, they are considered apart from the distribution organisation.

The ***Support Organisations*** category includes three subcategories: finance and capital, network organisations and promoters and consulting. Finance and capital include all investors (ie: banks and private investors). Network organisations exist at the national and the European level and aim at promoting the development and adoption of CSP[11]. Consulting plays an important role for CSP, especially in the supply side. For example, many companies, who accompany the development and execution of new CSP projects, also offer consulting services for the various steps of the project development, including site selection, technology selection or financing.

Finally, the ***Influencers*** category is considered as a foundation. This group includes civil society as voters, local residents and employees/labour unions, media and other opinion leaders. The interests of these groups, whose degree of acceptance can be a driver or a barrier to CSP implementation, incorporate the soft institutions like norms and ethics from the TIS. Media also plays a role in this group by shaping opinions and providing information to the public.

Source: Dutschne et al. (2018)

Among such categories and based on expert consultation, the authors have focused on a reduced number of stakeholder categories ([12]) included in Table 2, and highlighted in red boxes in Figure 5. Such prioritization is based on an analysis of the urgency to increase the legitimacy of cross-border RES projects by some key actors and the need to obtain their support (as a necessary but not sufficient condition).

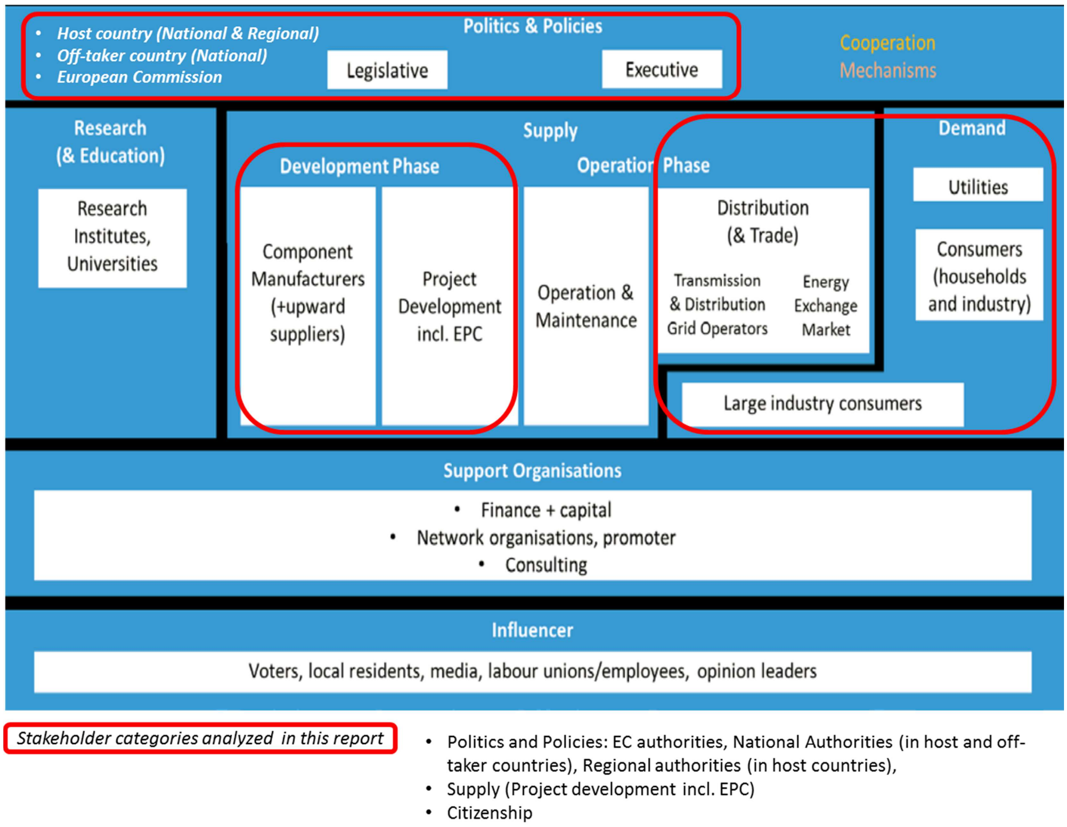
([11]) Protermosolar at the National level and ESTELA at the EU level
([12]) As for the "finance and capital" group, see Caldés and Díaz-Vazquez (2018)

Table 2. Consulted stakeholder categories and actors

Stakeholder category	Consulted Actors
Politics and Policies	EC representatives (DG-Ener, DG-Regio, DG-RTD), National authorities (in both Spain and potential off-taker countries such as Germany, Luxemburg, Belgium, etc) and Regional authorities in the host country (Extremadura Government)
Supply	Private Utilities/RES Industry, research community, TSOs, distributors and trade actors.
Demand	Potential consumers and citizens in participating countries (Civil society organizations)
Influencers	

Source: Own elaboration

Figure 5. Actors in cross-border electricity trade projects



Source: Adapted from Dutschne et al. (2018)

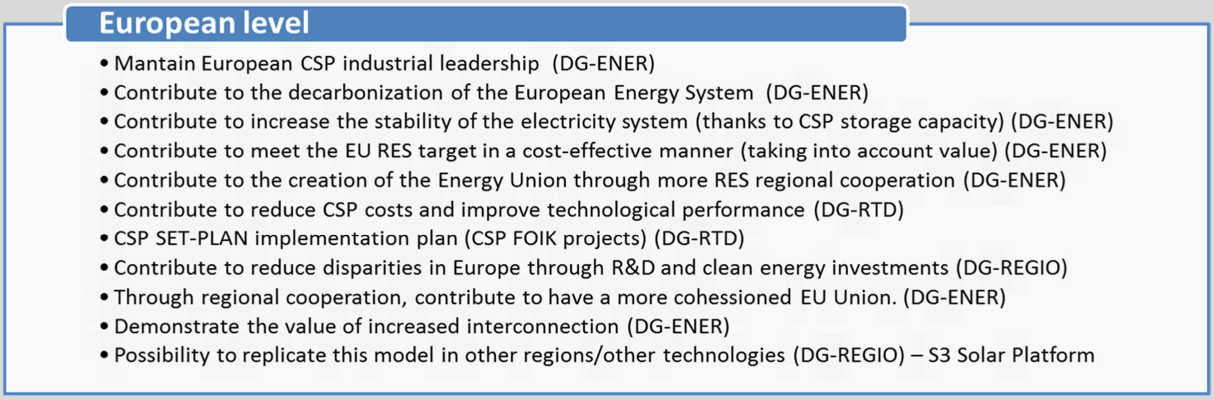
The consideration of the interests and concerns of such heterogeneous group of stakeholders is aligned with Umpfenbach et al (2015) who recommended that, "in order to achieve successful regional cooperation initiatives through pragmatic and practical solutions, participation of all relevant stakeholders must be ensured". Along the same lines, Gephart et al. (2015) suggests to make potential gains of cooperation evident to political leaders and the public in the involved countries to facilitate political and public acceptance.

2.1 Politics and Policies

2.1.1 European Representatives

As explained in detail in Caldés and Díaz-Vazquez (2018), there exist various reasons that explain the European interest in cross-border solar electricity projects that go well beyond purely EU energy policy arguments. Box 2 summarizes the most relevant reasons that justify the European interest and added value of such type of projects (and the corresponding EC Directorates).

Box 2. EU added value of solar cross-border electricity projects



Source: Adapted from Caldés and Díaz-Vazquez (2018)

In turn, European authorities may support solar cross-border electricity trade projects in Europe through, among others, regulation, financial support schemes, research grants, etc. While some instruments already exist (like the RES Directive 28/2009/EC), some others are currently under discussion (like the concept of cross-border renewable energy projects ([13]) or the new post 2020 governance regulation).

Among the various instruments aimed at incentivizing and enabling cross-border solar electricity trade in Europe, the cooperation mechanisms of the RES Directive 28/2009/EC stand out. This instrument was originally designed as a way to achieve the 2020 EU RES target in a cost-effective manner while providing MS with some flexibility to meet their National RES targets. Annex I provides a brief description of the four types of cooperation mechanisms as described in Articles 5, 7, 9 and 11 of the RED.

As argued in Caldés and Díaz-Vazquez (2018), despite the expected benefits from cooperation, the use of the Cooperation Mechanisms has been limited – only four cooperation mechanisms implemented since 2009. However, according to consulted experts, MS will likely increase their use of the cooperation mechanisms in the future (among other reasons as a way to meet their 2020 National RES targets or as part of their National Energy and Climate Plans).

European authorities can also support the deployment of cross-border renewable solar electricity cooperation projects by providing financial support through a variety of instruments (such as InnovFin Energy Demo Project (EDP) Facility, EFSI funds, FEDER, INTERREG, etc). As described in detail in Caldés and Díaz-Vázquez (2018), together with the support provided by the cooperation mechanisms, such instruments can help reduce the financial gap and make cross-border electricity trade projects bankable.

At the same time, Europe can also support cross-border solar electricity projects through research programmes like the H2020. While some research grants are aimed at developing new concepts or improving the performance of RES technologies (CAPTURE, MOSAIC, HYSOL, GRIDSOL etc), some other grants are more policy research oriented.

([13]) Cross-border Renewable Energy Projects (https://ec.europa.eu/commission/publications/connecting-europe-facility-digital-europe-and-space-programmes_en)

Among such type of projects, H2020 MUSTEC project is of particular relevance for this topic because it aims at exploring the CSP market uptake opportunities through energy cooperation ([14]). Similarly, the CA-RES project ([15]) constitutes an ideal platform for MS to discuss, among other topics related to the implementation of the RES Directive, cooperation initiatives among MS.

Finally, it is worth mentioning the a SET-Plan CSP temporary working group (TWG) which aims at coordinating efforts from the industry and, most important, the research community to implement the CSP Initiative for CSP in Europe which includes the deployment of a "*…solar first of a kind (FOAK) project which would not only include technological innovation but would also be the first project in implementing the exchange of dispatchable solar thermal electricity among European regions using the cooperation mechanisms scheme of the RES Directive. This plant would sell its production on commercial basis to a central European off taker…" (*SET Plan CSP Temporary working group, 2017*)*

Finally, through the Smart Specialization platform on Energy (S3PE), DG-REGIO has supported the creation of the Smart Specialization Solar Partnership ([16]) which is playing a key role in supporting the future deployment of solar RES cooperation projects.

When European Authorities were asked about the most **critical issues** potentially affecting (positively or negatively) the future of cross-border solar electricity projects, three issues stand out: (i) the actual role of renewable energy cooperation will have in the Energy Union, (iii) the upcoming regulatory regime defined in the RES directive recast and governance (Winter package) and (iii) the success of new instruments like the cross-border renewable electricity projects.

Regional cooperation is conceived as a corner stone to ensure an effective and affordable energy transition in the EU, taking advantage of trade within the internal market, safeguarding security of energy supply, coordinating climate adaptation measures and optimising the cost-effectiveness of actions (DG-ENER, 2018) ([17])

In this context, as highlighted in recent discussions ([18]), the EC wants to promote a cooperative RES deployment where the resources are most abundant, where the overall system costs would be minimized (e.g.: reduced need for backup, avoided grid investments, etc) and where overall social benefits would be maximised (e.g. increased security of supply, GHG savings, avoided local air pollution, employment effects, innovation effects, etc).

The EC is fully aware that the cooperation mechanisms (defined in articles 6-11 Directive 2009/28/EC) have failed to deliver according to the initial expectations. Nevertheless, their use is expected to increase as the 2020 deadline to meet the 2020 National RES target approaches but also as an option for MS to fulfil their National Energy and Climate Plans in the post 2020 time frame.

The existence of multiple barriers of heterogeneous nature has prevented MS of making a wider use of the cooperation mechanisms. Table 3 lists some possible drivers and barriers to the use of the cooperation mechanisms by Member States during the 2009-2017 period.

([14]) MUSTEC project (www.mustec.eu)
([15]) CA-RES project (www.ca-res.eu)
([16]) http://s3platform.jrc.ec.europa.eu/s3-energy-partnerships-solar-energy
([17]) Background paper "Towards a more Europeanised approach to renewables policy" prepared for the Stakeholder consultation workshop that took place on March 5th in Brussels.
([18]) Stakeholder consultation workshop (March 5th, Brussels).

Table 3. Member States drivers and barriers to use the cooperation mechanisms

Drivers	Barriers
Cost savings in MS target achievement	Lack of market and grid integration
Dispatchable RES (improve system manage.)	Lack of sanctions for non-compliance with 2020 RES targets
Contribute to the long term energy mix decarbonisation	Uncertainty about the design options to implement coop. Mechanisms
Foster political and economic relations with other MS	Potential resistance from transit countries
Domestic industrial interests	Uncertainty in forecasting RES target compliance
Improve security of supply (diversification of RES sources)	Difficulties in communicating benefits
Obligation to open support schemes	Resistance to loose sovereignty and control over energy market
Generate revenues from domestic resources	Uncertainty about the post 2020 regulatory framework
Attract foreign investments to deploy domestic plants	Unambitious post 2020 RES targets
New domestic jobs and industrial opportunities	Public opposition from off-taker country (taxpayers money)
Foster technology research and knowledge transfer	Public opposition from host country (NIMBY)
Contribute to improve tech performance and cost reductions	Public opposition from transit country (electricity grid)
Jointly test new support schemes	Challenges in quantifying indirect associated costs and benefits
Move towards creation of an internal energy market	"First mover risk"
Political support at the regional	Limited interconnection capacity between some MS
EU guidance in using the cooperation mechanisms	Uncertainty on state aid compliance
Political support at the EU level	Heterogeneous. regulated energy prices/ support schemes across MS
Public support (environmental concerns)	Oligopolies (lack of realized competition)
Public support (socio-economic benefits)	Lack of political support at the National level
Public support (pro-European values)	

Source: Caldés et al. (2019)

Not opting for a cooperative approach in meeting the EU RES target constitutes a missed opportunity that translates into higher costs and/or reduced benefits for European consumers, taxpayers and citizens of meeting a given renewables target. Also, as highlighted in DG-Ener (2018), these costs are expected to increase in the future when higher shares of RES (in accordance to the EU commitment under the Paris agreement) also imply higher grid and integration costs unless an optimisation of RES deployment across Member States is undertaken.

As summarized in DG-Ener (2018), the optimization of RES deployment through regional cooperation in the future is likely to be prevented by two main reasons:

a) Coordination failures between MS and/or different stakeholders
b) Currently limited tools at the EU level to ensure the collective 2030 EU RES target is met in a cost-effective way and to incentivize regional RES cooperation

2.1.2 Discussions around the Winter Package.

On November 30th 2016, the EC presented the "Clean energy for all Europeans´ package" legislative proposals that covers various aspects such as, among others, energy efficiency, renewable energy, the design of the electricity market, security of electricity supply and governance rules for the Energy Union (COM(2016) 860 final).

Aware of the important role that regional cooperation is expected to play in the European Energy Transition, the Commission´s proposal on Governance of the energy Union and the recast of the Renewable Directive promote regional cooperation in several ways.

On the one side, the proposed regulation on **Governance of the Energy Union**[19] (COM (2016) 759 final/2) has been designed to integrate and simplify planning, reporting and monitoring obligations of the EC and the EU MS in the 2030 Climate and Energy Framework. The regulation mandates the creation of national energy and climate plans to be prepared by MS biannually on the basis of binding templates and monitored annually by the EC. It also lists some measures that the EC can take to ensure that MS collectively meet their RES energy and energy efficiency targets. In particular, the governance system is expected to be reliable and should encourage enhanced regional cooperation and consultation as well as exchange of information and best practices in constructive dialogue between MS and the EC[20] (EPRS, 2017).The regulation also empowers the EC to request additional measures from MS in the event that the 2030 climate and energy goals risk not being met. To this end, the EC may request MS to adjust the share of renewable energy used and/or contribute financially towards setting up a financing platform at the EU level to develop renewable energy projects. MS would be required to contribute to this financing platform if they fail to meet their baseline share of energy from renewable sources.

Under this circumstances, consulted experts indicate that the main challenge will be that the prosed Governance compensates the lack of national binding targets after 2020 as the EC leaves it entirely to MS to ensure that their contributions add up to the EU target.

As for the proposed **revised Renewable Energy Directive** (COM(2016) 767 final/2), its objectives are to: (i) lower the overall system costs of reaching the 27% RES target and (ii) drive a gradual alignment of support schemes (at discretion of MS) and generate fewer distortions in the internal market. In this sense, Article 5 of the proposed revised Renewable Energy Directive indicates that "*MS shall open support […] to generators located in other MS under the conditions laid down in this Article*". The proposal indicates that it should apply to at least 10% of newly-supported capacity over 2021-2025 and 15% over 2026-2030. Furthermore, it indicates that the allocation between MS of electricity supported through opened schemes shall be subject to a cooperation agreement "*following the principle that energy should be counted towards the MS*

([19]) https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/governance-energy-union
([20]) http://www.europarl.europa.eu/RegData/etudes/BRIE/2017/599279/EPRS_BRI(2017)599279_EN.pdf

funding the installation". Finally, the proposal also states that EC may propose to increase those percentages based on the assessment of the benefits by 2025.

Again, according to consulted experts, current discussions focus around (i) the mandatory vs voluntary nature of the opening of the RES support, (ii) the percentage of newly-supported capacity and (iii) the possibility to linking such obligations to the actual interconnection levels or limiting the obligations to direct neighbours.

As for the ongoing discussions, there is a political commitment to finish the "trialogue process" -ongoing discussions and negotiations between the European Commission, the EU Council and the Parliament- by June 2018.

2.1.3 Cross-border Renewable Energy Projects

Additional to the ongoing discussions around the regulatory elements of the so-called Winter Package, the industry and Member States have urged the EU to look into options for EU funding for joint projects and encourage their uptake (DG-ENER 2018).

In order to overcome MS coordination failures and incentivize regional RES cooperation, the EU consulted with stakeholders the possibility ([21]) and recently proposed ([22]), as part of the Connecting Europe Facility (CEF) ([23]), a new instrument to support cross-border RES cooperation named "Cross-border Renewables Projects" (previously known as Renewable Energy Projects of European Interest; RES-PEIs).

As was discussed in a recent stakeholder consultation workshop ([24]) held in Brussels, the concept of **cross-border renewable energy projects** emerges as a way to foster the Europeanization of renewables policy, underpinning the new EU level renewables target and the opening of support schemes as proposed by the Commission in the Renewables Directive and paving the way for further voluntary cooperation in the field.

Specific enabling action for cross-border renewable energy projects (implying a cooperation between at least two MS) on a joint RES investment or their cooperation involving any RES technology could foster the uptake of such cross-border renewable projects and generate positive cross-border impacts for the region, inter alia in terms of cost-effective RES deployment, enhanced system integration, smoothened-out variability over a larger region (DG-Ener 2018).

While still under discussion, the projects that meet the cross-border renewable energy eligibility criteria, could potentially access dedicated funds for pre-feasibility analysis and, eventually, some form of grants to deploy the project.

2.1.4 Potential off-taker and host country authorities

National authorities of potential **off-taker countries** play a very important role as they are the ones responsible for exploring cooperation options with other MS, starting the negotiations with other MS and, ultimately, signing the Memorandum of Understanding (MoU) which is the last required step to materialize a cooperation agreement between two countries.

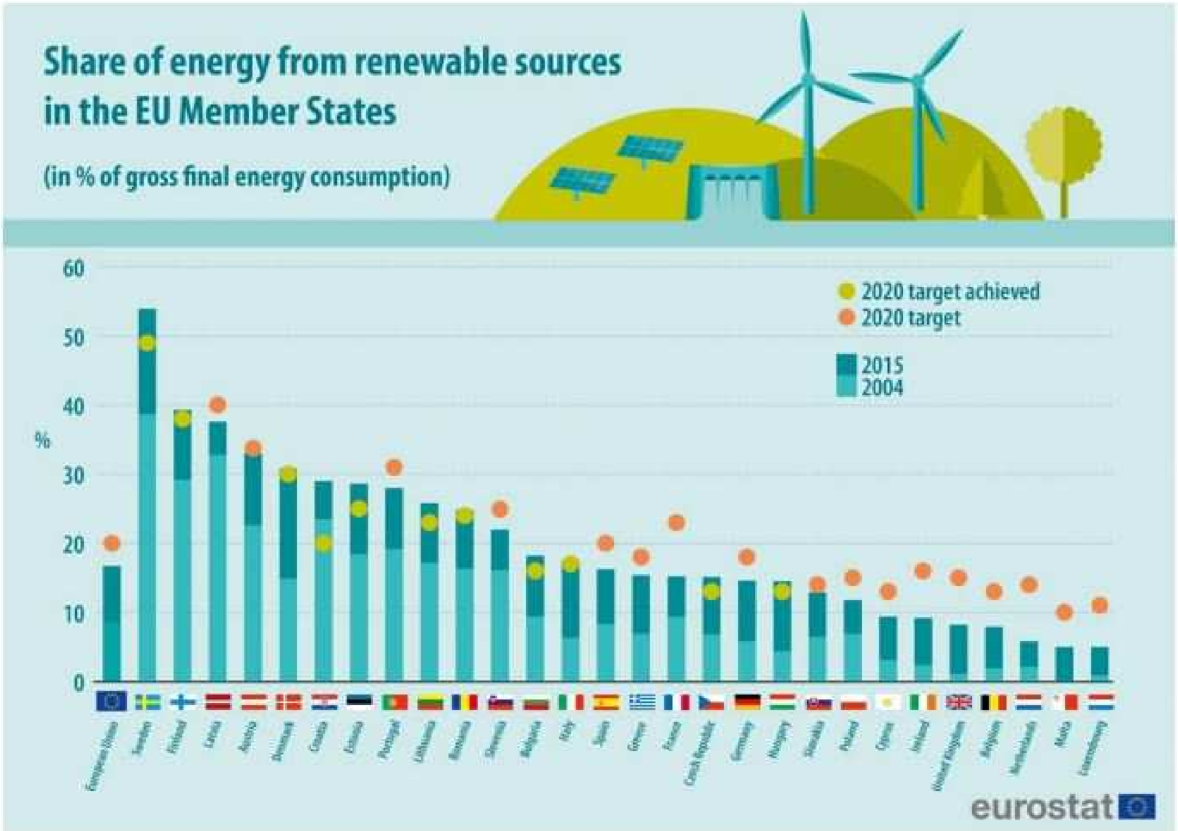
As such, it is of critical importance that authorities in the potential off-taker countries in Europe are informed about the portfolio of potential renewable cooperation projects in Europe so that they can consider as an option to fulfil their National 2020 RES targets or as an element of their National Energy and Climate Plans.

When considering MS progress towards meeting their 2020 RES National target and the most recent RES developments (Eurostat 2018), some countries appear to be more

([22]) COM(2018) 438 final
([23]) The Connecting Europe Facility (CEF) is a key EU funding instrument to promote growth, jobs and competitiveness through targeted infrastructure investment at European level. https://ec.europa.eu/inea/en/connecting-europe-facility/cef-energy
([24]) Stakeholder consultation workshop (March 5th, Brussels).

challenged than others. As of today, when only considering their trajectory in meeting their 2020 RES target, France, Germany, Cyprus, Ireland, United Kingdom, Belgium, Netherlands, Malta and Luxemburg could potentially be "off-taker countries ([25])" interested in using the cooperation mechanisms as a way to fulfil their 2020 RES targets, Figure 6.

Figure 6. Member states progress towards the 2020 RES target



Source: Eurostat (2018)

However, as demonstrated by the underutilization of the cooperation mechanisms of the RES directive, besides the cost-savings arguments in achieving the National 2020 RES targets through cooperation, there exist other factors that have influenced (both positively and negatively) countries decision to use the cooperation mechanisms in the past.

Results from a very recent study where more than forty drivers and barriers were identified and ranked based on a dedicated survey to member states (Caldés et al. forthcoming), that the top five barriers that have prevented MS from using the cooperation mechanisms include: public opposition in off-taker countries, heterogeneous regulated energy prices and support schemes, difficulties in communicating the benefits of cooperation, resistance to loose sovereignty and control over national energy market and uncertainty about the design options to implement the cooperation mechanisms. On the other side, the most relevant drivers for MS to cooperate have been: cost savings in

([25]) "Off-taker countries" refer to those countries potentially interested in using the cooperation mechanism as a way to fullfil their 2020 RES targets while "host countries" refer to those countries that already meet their 2020 RES target and could host additional RES projects to fullfill other MS´s 2020 RES targets. Finally, "transit" countries are those countries that do not directly participate in the cooperation agreement but will be indirectly affected by the physical transfer of the electricity (for example: in a Joing project with physical transfer between two countries that are not neighbours).

MS target achievement, contribution to improve technology performance and cost reductions, EU guidance in implementing the cooperation mechanism, new domestic jobs and industrial opportunities and move towards the creation of an internal energy market.

According to consulted experts and MS representatives, it is advisable that countries conduct a pre-feasibility assessment taking into consideration, among others, the existing National grid infrastructure, the interconnection capacity with neighbouring countries, demand profiles, required environmental permits, alignment with National legislation, etc. Furthermore, it is recommended that countries conduct a pre-assessment of the most relevant direct and indirect costs and benefits in order to evaluate if there is a net social benefit from the cooperative approach compared to the domestic approach. Finally, it is recommended that MS communicate the benefits of such cooperation agreement to the population in order to reduce the risk of public opposition.

2.1.5 Regional authorities

As argued in Caldés and Díaz-Vazquez (2018), solar projects can generate relevant impacts in the form of economic activity and job creation in a diverse range of sectors as a result of the direct, indirect and induced effects. Similarly, investments in research and development as well as in low carbon economy often trigger new investments opportunities in other sectors. Furthermore, the deployment of such type of projects could benefit the region and municipality by providing visibility at the national and international level. Finally, the possibility to articulate this project within the S3PEnergy could trigger cooperation opportunities with different regions in Europe.

However, it is important to note that some renewable energy projects have also encountered public opposition for example, due to the so called "NIMBY" (Not in my backyard) effects. In order to minimize such risk, it is important to put in place efficient communication and consultation campaigns and, to the extent possible, minimize the negative impacts and ensure that a large fraction of the socio-economic benefits of the project (for example, in terms of job creation) reach local and regional population.

Although the role of regions is somehow limited (the cooperation agreements are done at the country level), they can play a critical role in promoting or opposing to such type of projects. Furthermore, from an administrative point of view, whenever applicable, regions can also facilitate the permitting procedures or tendering processes.

2.2 Supply

2.2.1 Industry & research

Preserving the European leadership in renewable technologies is very important because of many reasons. Proof of that is that one of the objectives of the Energy Union is to "become world leader in Renewables". This is particularly the case for CSP as most of the value chain is spread throughout various countries in Europe (Caldés and Díaz-Vázquez, 2018; IDEA 2017).

Furthermore, very related to the industrial CSP leadership, Europe still holds a research leadership position in solar technologies and in CSP in particular. Proof of this is that out of 40 facilities identified in the EU-Solaris project, more than half of those are located in Southern Europe, and twenty one of those are located in Spain (Weizmann, 2014).

However, according to consulted experts, this European research and industrial leadership in CSP could quickly change due to the ambitious initiatives recently launched in other world regions. In this sense, consulted experts indicate that, besides the expansion of CSP around the world, the installation of new plants in Europe is a pre-requisite to protect the European industry´s leadership from erosion in the global market. Along this line, ESTELA states that "it is important to be aware about the growing threat on EU technology leadership with serious take-overs at lower costs of industry know-how holders and R&D infrastructure by non-EU companies acting on nonmarket economy grounds" (ESTELA, 2017).

For the above mentioned reasons, the European CSP industrial and research community has a remarkable interest in supporting the concept of cross-border solar electricity projects in Europe because, as of today[26], it is one of the only options for more CSP plants to be deployed in Europe. In this sense, the European Energy Research Alliance joint programme recently stated that "the existing absence of commercial CSP projects in Europe severely threats the viability of the whole industrial sector" (EERA CSP, 2017).

The role that industry plays in supporting cross-border solar electricity projects is fundamental. Industry players are the ones that have the knowledge and expertise to propose alternative techno-economic configuration proposals, assess the viability of alternative business models, undertake the investment risk, execute and operate the project and are responsible for selling the electricity to the off-taker.

Research community is also expected to play a very important role particularly in the proposal of innovative techno-economic configuration of projects such as those that would classify as FOAK (First of a Kind Projects). According to Burnham et al. (2013), FOAK commercial demonstration projects are essential to demonstrate the technical and commercial viability at the industrial scale of new generations of energy technologies and solutions to achieve a cost-competitive, sustainable and secure energy sector by 2050. Furthermore, research and development will also contribute to reduce costs down and improve the performance of the technology.

Finally, renewable technology European Industry and Research associations (such as ESTELA, SolarPower Europe, Protermosolar, etc) can lobby and advocate in favour of cross-border electricity projects among EU and National policy makers.

As to the **critical issues** (both barriers and drivers), consulted industrial and research actors identified the following drivers and barriers to CSP deployment (del Río et al. 2018) and to cross-border renewable energy projects in general, Table 4:

Table 4. Drivers and Barriers to CSP and to cross-border electricity trade projects.

DRIVERS	BARRIERS
Techno-economic factors	
Different CSP designs and technological competition	Limited resource potentials in Europe
Technological development in niches	High costs
Hybridization	Lower and uncertain cost reductions
Significant cost reductions	Competition with solar PV and other RES
Higher value compared to other, intermittent renewable energy sources	Access to credit
Industry consolidation (mergers and acquisitions) and vertical integration	Uncertainty of the system value of CSP
CSP capacity to replace base-load capacity (coal and nuclear) in Europe	Uncertainty about the direct/indirect costs and benefits of cross-border electricity trade projects
Legal and administrative	

(26) Currently, there is no CSP support schemes in Southern European countries

Deployment support	Legal and administrative barriers
Policy factors	
Innovation support	Uncertainty and retroactive policies
Possibility to access financial support instruments (ie: InnoFin EDP)	Insufficient incentives for cross-border RES cooperation in Europe
Social acceptability	
Support for CSP by the general population of the country	Limited awareness and political support towards the cross-border electricity projects concept and its associated techno-economic benefits
Cross-border electricity could contribute to EU integration/cohesion	Persistence of wrong myths about the CSP

Source: Adapted from del Río et al. (2018)

Among the various barriers, consulted experts indicate that when it comes to cross-border solar electricity projects, the most critical issues are:

— Definition of a business plan which could entail three possibilities:

  (a) use the cooperation mechanisms with an MS off-taker

  (b) sell the electricity to a private off-taker in the importer country and

  (c) a European utility decides to make an investment in the host-Southern European country at the same time that purchase the electricity in the off-taker country.

— Minimize the regulatory risk of the investment (which adds to other existing risks such as the technology risk, currency risk, etc.)

— Find an off-taker (private or public) that values the attribute of the produced electricity (flexible electricity) and thus is willing to pay a "premium" for it.

2.2.2 Distributors, traders

Various actors from different countries and institutions may be involved in the transportation and final distribution of the electricity produced in one country to another country where a retailer (supplier or marketer) supplies the electricity to the final consumers.

To illustrate the complexity of such transactions, Figure 7 shows the participating institutions as well as regulatory requirements that would apply in a cross-border electricity trade case where the electricity was produced in one country, went through a second country (acting just as transit country) and was finally consumed in a third country.

It is important to note that the scheme illustrated in Figure 7 may be simplified to a great extent when some actors undertake various roles and responsibilities. For example, beyond their usual competences, traders may also take the responsibility to deal with the compensation mechanisms with the clearing chamber and take care of the cross-border transmission capacity rights whenever needed.

Furthermore, it is important to clarify the following items:

As to the communication requirements (1): it is necessary to communicate the bilateral contract (nomination of energy program) and notification of use (if necessary) of physical cross-border transmission capacity rights.

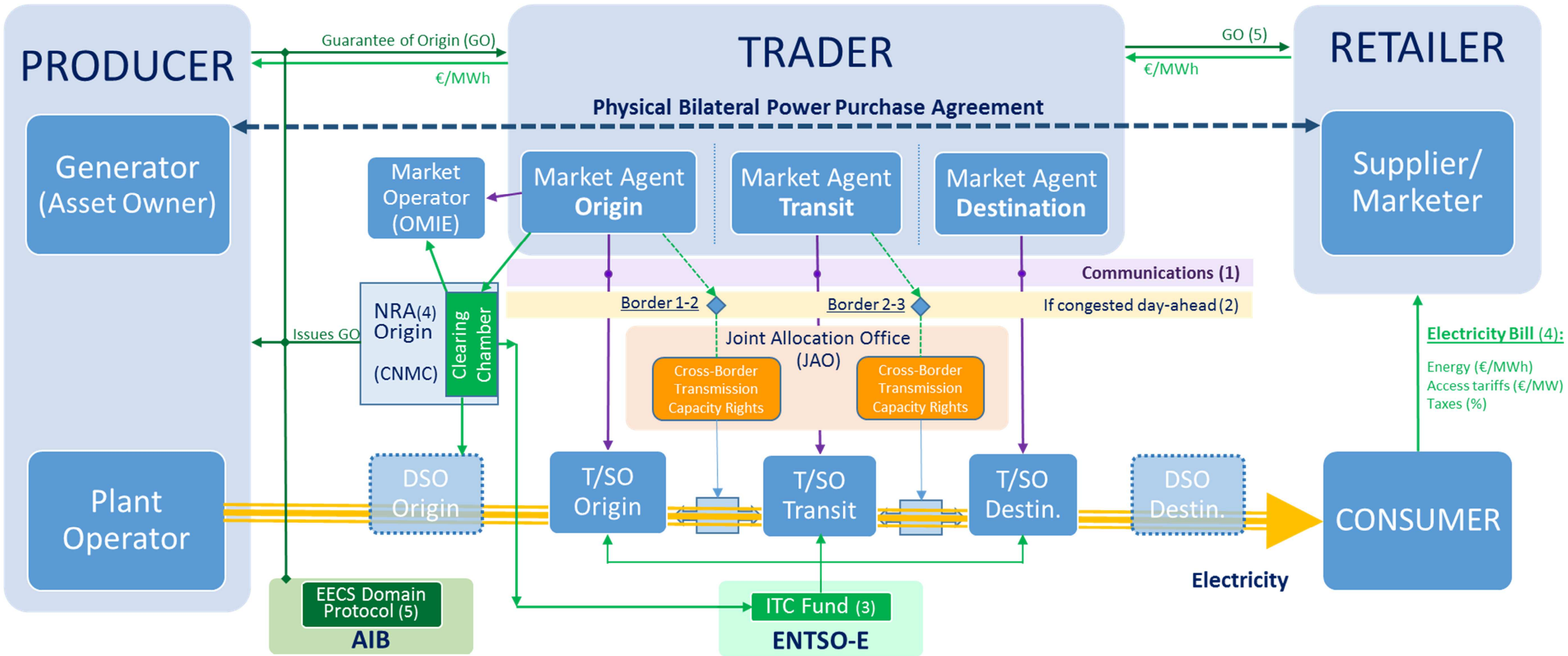
As to use of cross-border rights (2), the previous day to the transaction, it is possible to identify if the border will be congested or not and decide to acquire and use cross-border rights.

As to the Inter-Transmission Operator Compensation Mechanism (ITC), represented in light green in the Figure 7, it aims at compensating for hosting cross-border flows (EU Reg. 838/2010) in the form of additional losses in national systems and for making infrastructure available.

As to the National Regulatory Agency (NRA) shown in the light blue box (4), it is in charge of distributing access tariffs and taxes in the destination country depending on existing national regulations.

Finally, a Guarantee of Origin (GO) that is passed from the producer to the trader and further to the retailer, it represents 1MWh from Renewables. The Association of Issuing Bodies (AIB) manages the European Energy Certificate System (EECS) which certifies and registers each GO (According to the EU Directive 28/2009)

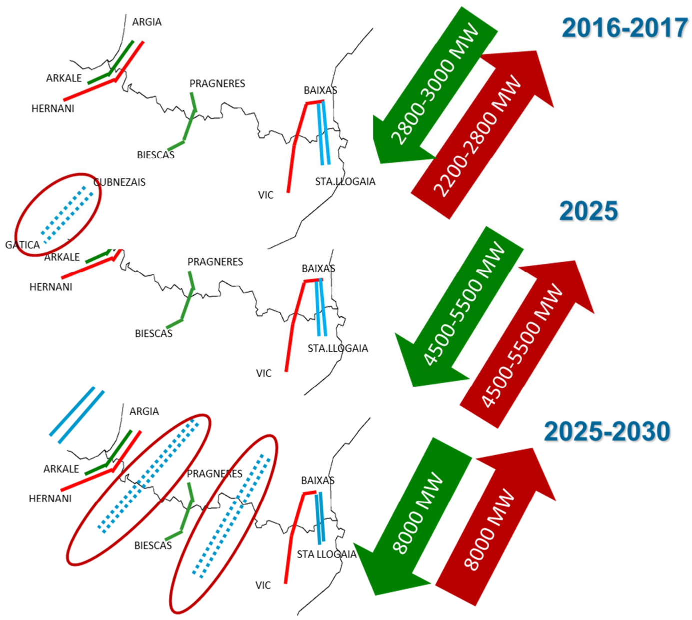
Figure 7. Electricity Export Scheme



Source: ACS SCE (2018)

Consulted experts indicate that, as of today, the most important challenge for the large scale deployment of cross-border renewable electricity projects is the limited interconnection between some EU countries (mainly between Spain and France as shown in Figure 8). However, it is important to note that for the first cross-border RES pilot projects (ie: 100-200 MW CSP projects), the existing interconnection capacity would be sufficient.

Figure 8. Present and future interconnection (France-Spain)



Source: Adapted from REE (2017)

Furthermore, consulted experts indicate that higher volumes of cross-border electricity transactions would be desirable in order to increase the business volume and create a real market (with agents in all countries).

Additionally, experts indicate that it is crucial to standardize (to the extent possible) all transactions ([27]).

Finally, limited cross-border transmission capacity rights are a limiting factor (as they translate into higher uncertainty and transaction costs).

2.3 Influencers/Demand

2.3.1 Citizenship

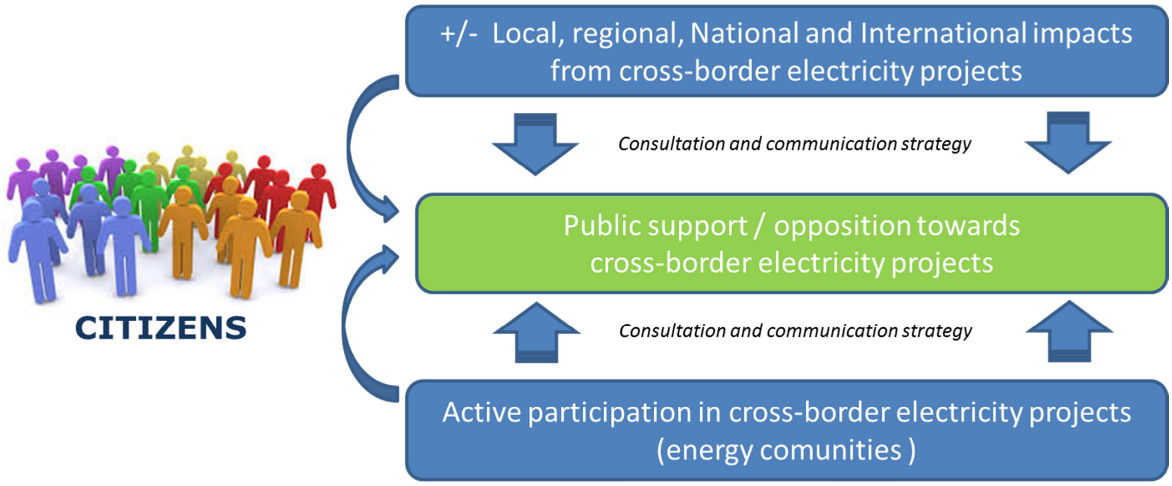
Citizens may be affected by cross-border electricity trade projects in many ways (eg: as consumers of the electricity, as population living next to the project site, as employees in the plant, etc.). Consequently, as a result of the relative importance, magnitude and sign of cross-border renewable electricity project impacts on their lives, they may support or oppose to the deployment of cross-border electricity projects.

Furthermore, as explained by the European federation of renewable energy cooperatives RESCOOP ([28]), citizens may also take a more pro-active role in cross-border electricity

([27]) European traders associations (CET) are working towards the creation of standarized templates for cross-border electricity trade transaction.
([28]) www.rescoop.eu

trade projects under a variety of participation schemes which, in turn, will likely positively influence their support towards such projects, Figure 9.

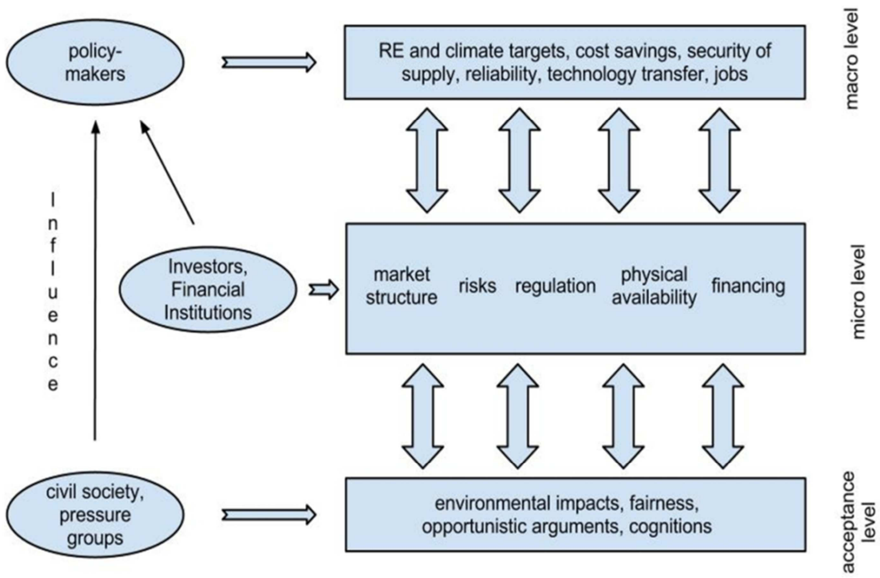
Figure 9. Potential sources of citizens´ support/opposition



Source: Own elaboration

In any case and as illustrated in Figure 10 below, citizens (in host countries, off-taker countries and transit countries) may play an important role as they influence policy makers and, as such, may positively or negatively influence the materialization of cross-border renewable electricity projects. As shown in the Figure 10, the issues that matter to citizens differ to those that matter for the other influencing groups. While policy makers care, among other issues, about RES and climate targets, cost savings, security of supply, technology transfers and private sector actors care about risks, regulation, financing, etc. civil society usually care about environmental impacts, fairness, cognitions, etc.

Figure 10. Levels influencing the decision making process in the energy sector



Source: BETTER project

For the above mentioned reasons, it is fundamental to consider citizens by first conducting a preliminary assessment of the possible impacts of cross-border electricity projects in the population of the potential host, off-taker and transit countries. Next, it is important to prioritize on the most relevant impacts that greatly determine the social acceptance/opposition to the project and put in place the necessary measures to maximize the potential positive impacts while minimizing the negative ones. Simultaneously it is important to put in place an effective consultation and communication strategy.

Furthermore, it is recommended to consider the possibility to foster some innovative engagement and participation schemes.

According to REScoop.eu ([29]), **active customers**, referred to generically as ‘energy prosumers’, are individual citizens, households, non-commercial organizations, public entities and SME’s that not only consume energy, but also actively participate in the energy market, either individually or collectively, including through an ‘energy community’. Active participation in the market may consist in producing renewable energy, enhancing energy efficiency and/or energy system management and grid integration of fluctuating renewable energy sources through demand side response, aggregation, storage, etc.

Similarly, an **Energy Community** is a legal entity where citizens, SMEs and local authorities come together, as final users of energy, to cooperate in the generation, consumption distribution, storage, supply, aggregation of energy from renewable sources, or offer energy efficiency/demand side management services. According to consulted experts, energy communities may contribute to social innovation and regional development objectives and could potentially fit and participate in a cross-border renewable electricity scheme.

According to RESCOOP, the definition of an energy community should be framed concretely around governing statutes of entities that integrate the following operative principles that distinguish them from traditional commercial energy undertakings: (i) Concern for community – the aim of the undertaking is to provide economic, social and environmental benefits for their members or the local area or areas where they are active, rather than being profit driven, (ii) Provide for open, voluntary participation - Membership in a cooperative is open to all persons as final users of its services and that are willing to accept the responsibilities of membership, (iii) Democratic governance of the undertaking – direct democratic governance based on equal decision making rights (i.e. one-person-one-vote) and (iv) Autonomy and independence – the undertaking is controlled by the members or shareholders who are participating as final users; outside investors or undertakings participating in the community must not have a controlling position within the board.

([29]) https://www.rescoop.eu/definitions

3 Extremadura Case study; specificities by key stakeholders

In order to propose a tailor made roadmap and action plan to deploy the first cross-border solar electricity project in Extremadura, the information provided in the previous section has been revisited taking into consideration the specificities of that particular case study.

In a nutshell, the Extremadura case study concept consists in the construction of a first of a kind solar electricity project whose production would be exported and consumed in Northern Europe. Extremadura is a solar resource abundant region in Southwest Spain which gathers many other attributes which, in principle, make it an ideal location for the first solar cross-border electricity project. For more information on this case study, see Caldés and Díaz-Vazquez (2018).

3.1 EU authorities

In the light of the "cross-border renewable electricity projects" concept proposed in a recent communication (COM(2018) 438 final), it is recommended that Extremadura proposes this project concept as an eligible cross-border renewable electricity project by demonstrating its multiple EU added values and contributions to EU policy objectives in a qualitative but also quantitative way.

For example, as to European research and innovation policy objectives, the deployment of a solar FOAK project in Southern Europe is one of the goals of the Implementation plan of the SET Plan for CSP which could potentially contribute to decline the technology costs and improve its performance. Similarly, as for the alignment with EU regional policy objectives, by investing in low carbon economy and R&D projects, it would be possible to contribute to fostering prosperity and growth in some of the less developed regions in Europe. In turn, by creating jobs and economic growth in these regions, social and economic disparities in Europe are reduced. Finally, as to EU energy and Climate policy objectives, the deployment of the solar FOAK project in Europe could contribute to maintain European leadership in renewables, decarbonize the European Energy System (by substituting coal and nuclear in Europe), increase the stability of the energy system thanks to the storage capacity of CSP, help meet the 2020 RES target in a cost effective manner as well as contribute to create a more cohesive and well-functioning Energy Union through renewable energy regional cooperation. Furthermore, as argued in Caldés and Díaz-Vazquez (2018), through a concrete case study, it would be possible to demonstrate the value of increased interconnection and cooperation between Member States.

For the above mentioned reasons, it is important to demonstrate such added values by, whenever possible, quantifying such impacts. Table 5 shows, for each one of the above mentioned EU added values, a proposal of possible indicators and measurement methodologies.

Table 5. EU added values and measurement proposals

EU Added Values Value added	Indicator	Methodology	Comments
Help maintain the European CSP industrial leadership	-Number of EU companies directly participating in the project. -Impact on the European Gross Domestic Product (GDP) across economic sectors	-Analysis of EU content of the project value chain. -Multi-Regional Input-Output analysis	-2 scenarios could be considered (with/without cross-border projects) so that the net effect could be estimated.
Contribute to the decarbonisation of the European Energy System	-CO2 emission reduction associated to the penetration of solar cross-border electricity projects in the EU energy system.	-Life Cycle analysis of two alternative technologies -Energy System modelling (HIREPS)	-Again, the net effect could be estimated by considering 2 scenarios
Contribute to increase the stability of the electricity system (thanks to CSP storage capacity)	-Savings in back-up capacity -Other system related indicators	-Estimate what would be the electricity system cost under two scenarios	
Contribute to meet the EU RES target in a cost-effective manner (taking into account the total system cost; not just the LCOE)	-Total system costs savings associated to a cooperative scenario vs a fragmented/domestic approach in meeting the MS RES targets.	-Total system costs under the cooperative scenario compared to the total system cost under a cooperative scenario (i.e: Green-X model)	Will be addressed in MUSTEC (at a later stage)
Contribute to the creation of the Energy Union through more RES regional cooperation	-Increase in the number of other cooperation agreements resulting from the renewable energy cooperation agreement.	-Desk research -Qualitative research with MS representatives	
Contribute to reduce costs and improve technological performance of a hybridized PV/CSP plant	-Reduction in LCOE and other technology performance improvements resulting from the hybridization of the plant (CSP/PV)	-LCOE calculations	
CSP SET-PLAN implementation plan (CSP FOIK projects)	-Number of success solar FOAK projects following the Extremadura one	-Number of solar FOAK projects in the EU pipeline	-Positive effects resulting from not having "first mover risk"
Contribute to reduce disparities in Europe through R&D and clean energy investments	-GDP growth in South Europe/Spain/Extremadura resulting from the solar FOAK projects compared to the alternative scenario	-Multiregional Input-Output analysis and value chain analysis.	-This analysis will be done in MUSTEC at a later stage
Through regional cooperation, contribute to have a more cohesioned EU Union.	-Number of EU regional cooperation agreements resulting from this project.	-Desk research -Interviews with regional authorities	-Facilitated through the Solar Partnerhsip
Demonstrate the value of increased interconnection	Net impact of increased interconnections/cooperation projects in terms of jobs, GDP, CO2 emissions, electricity system cost, etc	-FISA (Framework for Integrated Sustainability Assessment) -Hireps Model	

Possibility to replicate this model in other regions/other technologies	-Number of interested regions/countries in deploying similar cross-border electricity projects.	-Qualitative research.	

Source: Own elaboration

3.2 Potential off-taker countries and host country authorities

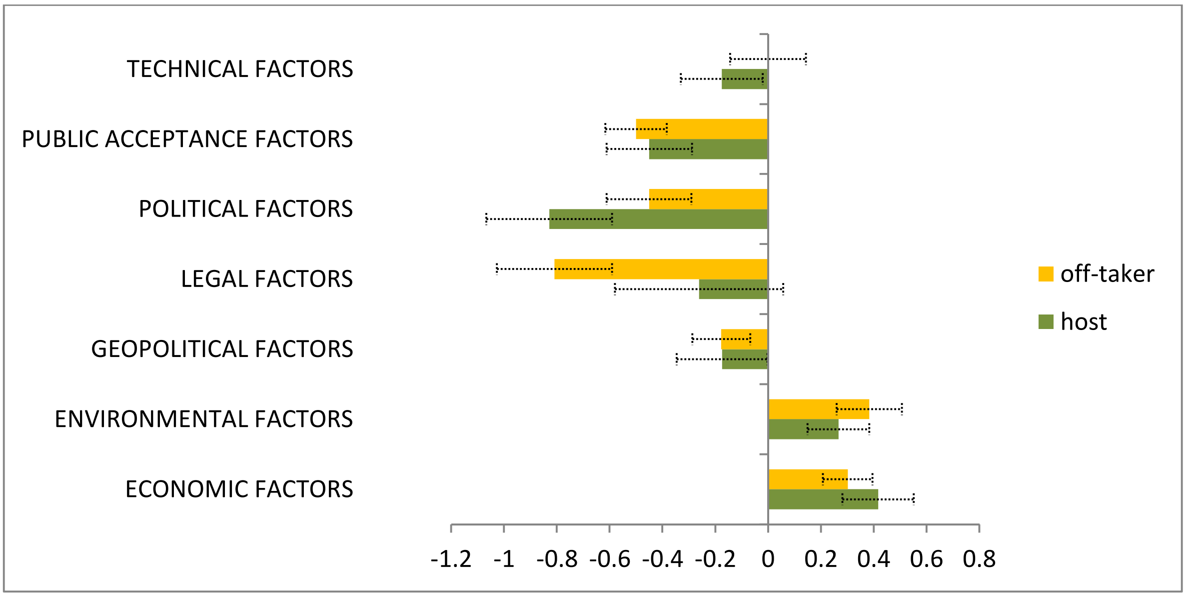
According to a recent study (Caldés et al. 2018), multiple factors explain the limited use of the cooperation mechanisms in the past and are likely to determine countries decision to cooperation in the future.

As shown in Figure 11 where the relevance of different categories of factors have been ranked from -3 to +3 (being 0 non relevant factor), the most important barriers to cooperate for potential off-taker countries have been legal, public acceptance and political factors. On the other side, those factors that have played a positive role include environmental and economic factors. As for potential host countries, the most important barriers have been political, public acceptance and legal factors while the drivers have been economic and environmental factors.

These results proof the myriad of factors potentially affecting the readiness to cooperate and the heterogeneous relevance of these factors. Similarly, it is clear that the barriers seem to have outreached the perceived benefits.

The implications of this study for Extremadura is that potential off-taker countries should be approached and consulted to understand such complexity and assess the potential interests of such countries to cooperate with Spain. Additionally, special attention should be devoted to the compliance of the agreement with National legislation, issues of public acceptance (for example, citizens in off-taker countries may oppose to spend tax-payers money to create jobs and investments in another country). Finally, it is very important to generate political support among decision makers in the off-taker country. For the two latest reasons, advocates for the Extremadura case study must demonstrate and communicate the benefits of the cooperation agreement for the off-taker country. Such benefits will change depending on the off-taker priorities but they may range from industrial interest, costs savings in achieving National RES targets, the possibility to transfer technology know how, etc.

Figure 11. Factors influencing MS decision to cooperate (2009-2017)



Source: Caldés et al. (2019).

As it is the case for off-taker countries, in order to obtain the required political support in host countries, it is fundamental to demonstrate and communicate the associated benefits of the agreement. In the case of this case study host country (Spain), there are many of such benefits. Among other benefits, this project could contribute to preserve the Spanish industry and research leadership in CSP. Furthermore, it would be possible to contribute to reduce costs and increase the technological performance of a technology that is expected to play a key role in the future Spanish system (Protermosolar, 2018) without compromising public funds or affecting the final electricity consumer prices. Additionally, the deployment of new plants in the rural and sunniest parts of the country would contribute to generate economic and employment opportunities in rural areas that have been severely hit by the crisis. Next, by deploying a solar FOAK project in Spain it would be possible, in the longer term, to contribute to further decarbonise the Spanish Energy Mix (this is true even in the case when cooperation mechanisms are used as the export period is limited and the plant will eventually generate to satisfy the Spanish electricity demand). Finally, the deployment of the solar FOAK project could be used by the Spanish Government as a way to advocate about the multiple benefits of cross-border renewable electricity trade in Europe and as an additional argument to advocate for an urgent increase of the limited interconnection capacities between Spain and France (the existing interconnection capacity is sufficient for a reduced number of projects but limits the amount of electricity that could be exported in case more of such projects would be deployed).

Box 3. Benefits of a solar FOAK project for Spain

National level

- Contribute to mantain Spanish CSP industry and research leadership
- Contribute to reduce costs and increase technological performance of a valuable technology for Spain without compromising Spanish Public funds nor afecting final electricity consumers´ price.
- New jobs and economic activity in rural areas in deprived areas of the country severely hit by the crisis
- Contribute to decarbonize the energy mix
- Have further arguments to advocate for urgent increase of interconnection capacity between SP/FR

Source: Caldés and Díaz-Vázquez (2018)

As it is the case for off-taker countries, to obtain the support from the National Authorities and citizens it is important to quantitatively demonstrate such net benefits. For this purpose, it would be desirable to conduct a comprehensive cost-benefit analysis by considering relevant impacts such as the effects on the National grid system, on the electricity price, on the environment, on the economy, on job creation, etc.

In this regards, the Spanish CSP industrial association has recently published a report aimed at demonstrating the role that CSP can play in the future Spanish energy mix (Protermosolar, 2018).

3.3 Regional authorities (Extremadura)

At the **Regional level**, and as demonstrated by several impact assessment studies (Rodriguez et al. 2017, Deloitte 2011), these type of projects can lead to an increase in economic activity and job creation in a diverse range of sectors as a result of the direct, indirect and induced effects. Similarly, investments in research and development as well as in low carbon economy often trigger new investments opportunities in other sectors. Furthermore, the possibility to have the support of DG-REGIO through the Smart Specialization Strategy could trigger cooperation opportunities with different regions in Europe. Finally, the deployment of such project would benefit the region and municipality by providing visibility at the national and international level.

Box 4. Benefits of a solar FOAK project for Extremadura

Regional level

- Job creation and economic stimulation
- R&D investments that increase R&D capacity - driver for new investments
- New R&D and industrial colaboration with other regions
- Further decarbonization of Extremadura energy system – global and local environmental effects.
- International and national visibility

Source: Caldés and Díaz-Vázquez (2018)

In turn, Extremadura authorities may contribute to the realization of this project in many ways. Among others, regional authorities may facilitate the selection and provision of the site, grant grid connection permits and facilitate the relation with local authorities.

For example, Extremadura could potentially articulate a competitive tender process under the regime "*Asociación para la Innovación*" ([30]) (BOE-A-2017-12902). The "*Asociación para la innovación*" (partnership for innovation) is a new recruitment procedure which attempts to respond, in terms of public procurement, to innovation. This formula contemplates the peculiarities of innovation and outlines the need to address it with a regulated collaboration and sharing of risks between the public sector and the private sector. In the end, the law establishes an innovative method when dealing with hiring for innovation.

Law 9/2017 (November 8) on Contracts of the Public Sector, transposes the European directives 2014/23/EU and 2014/24/EU on the contracting in the sector public. In this sense, the law is innovative both in its global approach and in some of the mechanisms it regulates. This law includes two features that are particularly interesting for the solar FOAK project.

On the one side, this law considers innovation as a value, to the extent that it requires the definition of innovation, together with social and environmental considerations, in the object of the contract. On the other side, it creates a specific procedure, which allows the awarding bodies to establish a long-term partnership with a view to the development and subsequent acquisition of new products, services or innovative works. This procedure is foreseen for the cases in which it is necessary to carry out research and

([30]) https://www.boe.es/buscar/doc.php?id=BOE-A-2017-12902 development activities regarding works, services and innovative products, for their subsequent acquisition by public administrations. That is, cases in which innovative products not available in the market are needed (like a FOAK project). In such cases, the public body may decide to create an association for innovation with one or more partners that carry out research and development activities separately. Once the research and development work has been completed, the contracting body will evaluate the results and their costs, before deciding on the acquisition of the resulting works, services or supplies, in accordance with the provisions of the specific administrative clauses. The estimated value of the supplies, services or works will be in proportion with respect to the investment necessary for its development[31]

3.4 Industry and Research

As displayed in Box 5, "*a solar FOAK project would not only include technological innovation but would also be the first project in implementing the exchange of dispatchable solar thermal electricity among European regions using the cooperation mechanisms scheme of the RES Directive. This plant would sell its production on commercial basis to a central European off-taker with a given spread over the average pool price as the electricity would be delivered on the selected window time over the day by the off taker. At the same time this plant could profit from other EU financial sources as well as European Structural Funds*".

Box 5. Solar FOAK projects main requirements

— Demonstrate at commercial scale crucial technology solutions.

— Include storage to provide fully dispatchable power (flexible generation).

— Have high potential of replication in Europe and worldwide.

— Make use of cooperation mechanisms of the RES Directive

— Combine financial instruments (loans, guarantees) with grants, structural funds and promoters´ equity.

— Have a business plan including PPA agreement with off-taker interested in value of CSP dispatchable power.

— Have an overall cost estimated at a minimum of 900m€.

Source: SET Plan CSP Temporary Working Group (2017)

Taking into consideration the current situation of both European CSP industry and research community, the deployment of the First of a Kind (FOAK) solar project could contribute to foster some of the existing drivers (see first column of Table 6) while contributing to overcome the existing hurdles (third column of Table 6) for the deployment of solar technologies in Europe. The second and fourth columns show what could be the contribution to the FOAK project in Extremadura to the existing drivers and barriers respectively.

Table 6. Drivers and Barriers for CSP deployment and the solar FOAK project.

DRIVERS	Relevance for the solar FOAK project	BARRIERS	Relevance for the solar FOAK project
Techno-economic drivers		*Techno-economic barriers*	
Different designs and technological competition	As an innovation project, the FOAK project will have different/novel designs	**Limited resource potentials in Europe**	With the proposed cross-country cooperation scheme the best solar resources would be exported to Cent./Nort. Europe
Technological development in niches	N/A	**High costs**	There would be a great incentive to bring the costs down as much as possible. Such deployment would also contribute to bring costs further down
Hybridization	It is very likely that the FOAK will include a hybridization between PV/CSP	**Lower and uncertain cost reductions**	A tender scheme and the resulting bid would contribute to demonstrate the downward cost trend
Significant cost reductions	The FOAK project may test new technological developments aimed at further reducing CSP costs.	**Competition with solar PV**	The hybridization scheme would demonstrate the possibilities and advantages of the PV/CSP hybridization (the technologies would not compete but cooperate)
Higher value compared to other, intermittent renewable energy sources	The FOAK project would operate as a "peaker" by generating and exporting the electricity when is most needed.	**Access to credit**	The proposed scheme could potentially combine various funding sources (coop. mex and/or blend of other financial sources)
Industry consolidation (mergers and acquisitions) and vertical integration	N/A		N/A
Policy Drivers		*Legal and administrative barriers*	
Deployment support	The FOAK project would make use of the cooperation mechanisms as a support	**Legal and administrative barriers**	
		Policy barriers	
Innovation support	Given its R&D component, the project would be eligible to receive such type of support	**Uncertainty and retroactive policies**	The FOAK would not depend on National Support policies. The funding scheme would provide certainty.
Social Acceptability drivers		*Social Acceptability barriers*	
Support for CSP by the general population of the country	In Spain and Extremadura there is a wide acceptance to this technology.		

Source: Adapted from Del Río et al. (2018)

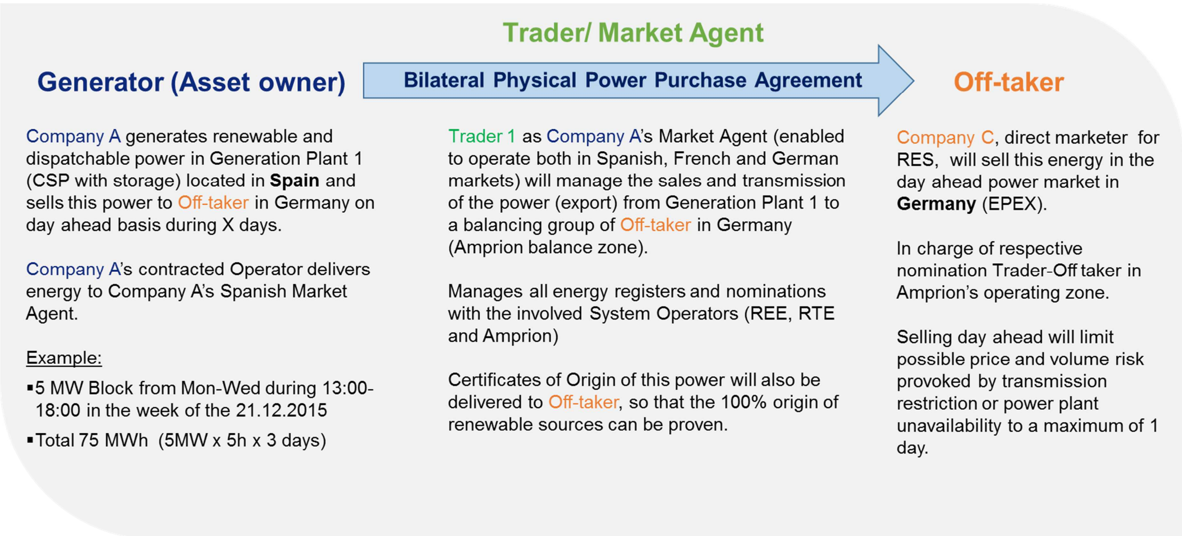
3.5 Distribution and Trade

During the consultation process with potential off-taker MS representatives, some of them expressed doubts about the regulatory and technical feasibility of solar electricity trade in Europe. For this reason, this section attempts to shed some light as to the feasibility of such transaction with a hypothetical electricity transaction case between Spain (producer country) and Germany (potential off-taker country) developed by Cobra (2018).

Let´s assume that Company A generates renewable and dispatchable power in a Generation 1 (which could very well be the solar FOAK plant in Extremadura) and sells it to an off-taker in Germany on a day ahead basis during X days.

As illustrated in Figure 12, let´s assume that the total amount is 75 MWh in three blocks (5MW block from Mon-Wednesday during 13:00-18:00 in the week ([32]), which is 5MW*5h*3 days). Trader 1 as Company A´s Market agent (enabled to operate in Spain, France and Germany) manages the sale and transmission of the power (export) from Generation Plant 1 to a balancing group of Off-taker in Germany (corresponding to the Amprion balance zone). The trader is responsible for managing all energy registers and nominations with the involved TSO (REE, RTE and Amprion). Additionally, the Certificates of Origin will be delivered to the off-taker (so that 100% renewable origin can be proven). To the other end (Germany), a direct marketer for RES (Company C) will sell this energy in the day ahead market (EPEX).

Figure 12. Overview of actor involved in the power export



Source: ACS SCE (2018)

Under this circumstances, the resulting selling and buying prices, the formulas to estimate the selling price for each hour (Generator to Trader), the buying price (Off-taker to Trader) and the deviation cost (Off-taker to Trader) are as follows:

<u>Selling price</u> for each hour (Generator to trader):

$SP=PMD_{GR} – Cap_{FR\text{-}DE}$ where:

PMD_{GR}: German electricity spot market price (€/MWh) ([33])

$Cap_{ES\text{-}FR}$: Yearly transmission capacity cost acquired by Trader in Spain-France border (€/MWh)[34]

([32]) Let´s assume that the week was that of the 21/12/2015
([33]) Source: www.epex.com

$Cap_{ES\text{-}FR:}$ Yearly transmission capacity cost acquired by trade in France-Germany border (€/MWh)

Buying price (Off-taker to trader):

$BP=PMD_{GR}$

Deviation cost (Off-taker to trader):

$DC_M=DSV*CD_{Market}$ where:

DC_M: Deviation cost for imbalances (€)

DSV: Difference between energy produced by Generator and agreed bilateral program (MWh)

$DC_{Market:}$ Deviation cost published by REE for each hour (€/MWh) ([35])

Applying the example values to these formulas, the estimated cost would be of about 2.000 €

-Exported capacity: 5MW Block during 1-6 pm during 3 days

-Dates of export: 21-23/12/2015

-Total Exported Energy: 5MW * 3 days *5 hours/day= 75 MWh

-Market price delta: 60 €/MWh (Spanish Pool price) – 40€/MWh (German pool price) = 20 €/MWh

-Estimated Transport cost= 5€/MWh (assuming trader does not apply handling fees for the pilot).

Estimated negative price delta of example: 25 €/MWh*75 MWh=1875 €

The required steps for this transaction to take place include:

-Signing EFET standard contracts for international power export/purchase or energy including certificates of origin for renewable power

-Signing a MoU between Generator, Trade and Off-taker

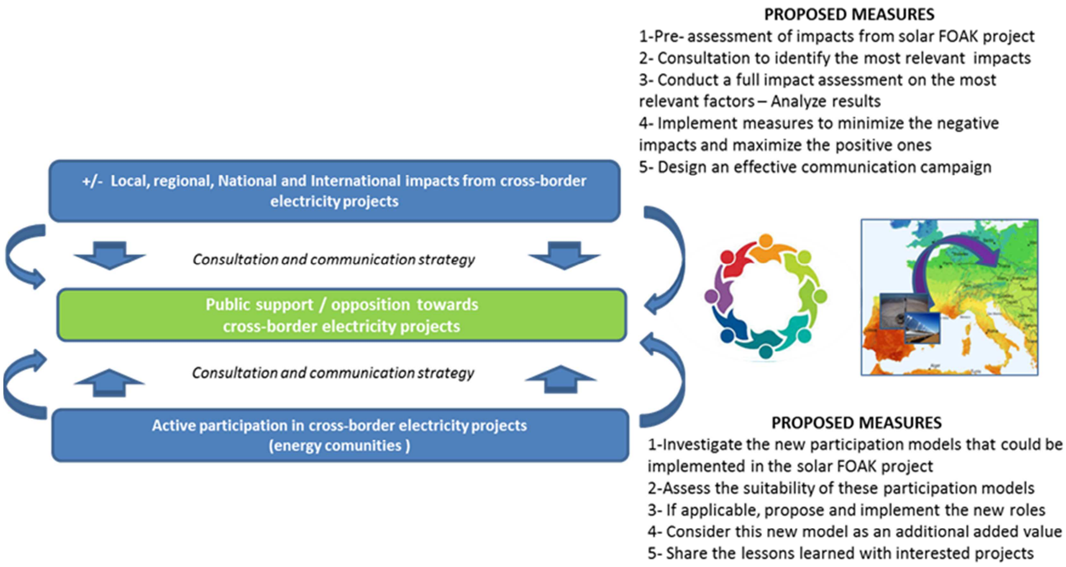
In this respect, it must be kept in mind that Guarantees of origin borne for exportation in Spain cannot be transferred and the producer renounces to any recognized special retribution regime for each Guarantee of Origin.

3.6 Demand/Influencers

As introduced before, while the public acceptance towards renewable energy projects in Extremadura has been positive, it is important to conduct a preliminary assessment of all possible project impacts on citizen´s livelihoods, prioritize the most important ones and put in place the necessary measures to maximize the potential positive impacts while minimizing the negative ones. Furthermore, it is recommended to investigate innovative engagement and participation schemes and assess its suitability for this case study. In case new participation roles were implemented, this could be considered as an additional added value of the project and, as such, should be communicated. Finally, the lessons learned from this experience should be shared among other interested projects/actors in Europe.

([34]) Source: www.casc.eu
([35]) www.esios.ree.es

Figure 13. Proposed measures to increase public support

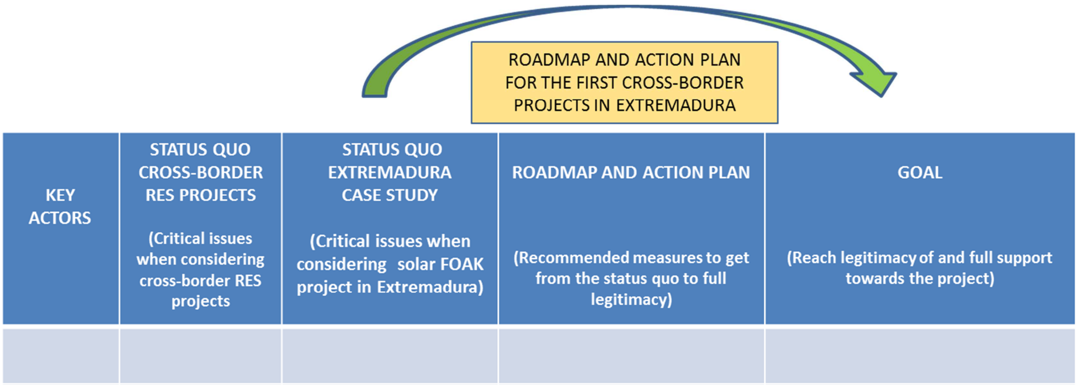


Source: Own elaboration

4 Roadmap and Action plan for Extremadura

As a way of summarize the information presented above, the next Table 7 present, for each one of the analysed key stakeholders (European Authorities, off-taker countries, host countries, regions, industry and research community and citizenships): the critical issues (perceived as opportunities or hurdles) when it comes to cross-border RES projects (second column). As introduced before, such conditions define the "status quo" that defines the departure point from which the action plan is drafted. The third column displays Extremadura´s specificities when it comes to the above mentioned critical issues. Next, the fourth column presents a set of proposed measures to go from the "status quo" situation to the objective situation where legitimacy and full support towards the project is achieved (summarized in the last column).

Figure 14. Proposed steps to draft a roadmap and action plan for Extremadura



Source: Own elaboration

Table 7. By key stakeholder: Summary of critical issues, relevance for Extremadura, recommended actions and ultimate goal.

ACTORS	STATUS QUO Critical issues when considering cross-border electricity projects	EXTREMADURA specificities	Recommended measures for Extremadura (to go from the STATUS QUO to the GOAL)	GOAL (full legitimacy and support achieved)
EU DECISSION AND POLICY MAKERS	-DG-ENER: **2020 RES Target achievement** by MS. How to foster RES cooperation among MS as a way to achieve their 2020 RES targets in a cost-effective manner. -DG-ENER: Post 2020 - Ongoing negotiations around the **Winter Package** (RES Directive, Governance, etc). **-DG-ENER: Cross-border RES projects.** The concept is currently being discussed (eg: eligibility criteria (EU added value measurement, potential support through feasibility studies and grants). -DG-ENER: Need to demonstrate the technical feasibility and value added of **cross-border electricity trade** projects. -DG-RTD: Want to preserve or recuperate **EU industrial and research leadership** in Renewables (SET PLAN, H2020) -DG-REGIO: **Support EU regions** in deploying low carbon and R&D investments (S3P) and reduce inequality within EU.	**Solar FOAK project EU Added Values:** -Capable of producing electricity base load alternative to substitute coal and nuclear. -First cross-border solar project in Southern EU. - First coop. mechanisms with physical export in Europe. -Contributes to reduce regional disparities. - Europeanization of the CSP value chain. - R&D EU added value leadership. **Potential EU support** (cross-cutting EU interest): This project is a cross-cutting project of EU interest as it is being supported by DG-Regio (S3P), DG-RTD (SET PLAN IGW for CSP and H2020) and DG-Ener (ie: Coop. Mechanisms/Cross-border RES projects concept). The first estimations of the techno-economic configuration of the project (to proof the viability and added value of the project) are still missing Need to **estimate the project impact and demonstrate the added value** to the EU, host and off-taker system. Need more efforts in terms of communication and **advocacy** to potential interested countries as well as EU authorities.	Define a **preliminary techno-economic configuration asap** to demonstrate the viability of the project and increase credibility of the concept. Use the value proposition of solar electricity exports (Caldes & Díaz-Vazquez, 2018) for advocacy purposes within the EU and position the project as an ideal **cross-border RES project**. Propose a way to **measure the EU added** value to get stronger arguments (make a proposal) and **develop a full cost-benefit analysis** (possibly through RES-PEI support). Need to demonstrate the **technical and regulatory feasibility as well as impacts to the EU system as well as involved countries** (look for EU energy system modelling expertise within the EC). Use the **support and expertise from existing H2020 related projects** (ie: MUSTEC). Make use of the **IGW of the SET PLAN** as catalyst platform. Use the support provided by the S3P (**Solar Partnership**) Try to **maximize the EU local content by** using the mapping report (IDEA) Try to involve as many EU regions as possible and **look for cooperation among EU regions.** Look for **internal synergies** and partnerships between DG-ENER, DG-REGIO, DG-RTD	-The EU value of the project has been demonstrated in a qualitative and quantitative way. -The value proposition of the Solar FOAK project is credible, robust and well-known across Europe. -The solar FOAK project in Extremadura is the first cross-border RES project and is eligible to receive support to conduct a pre-feasibility assessment and support for its actual deployment. -The solar FOAK project in Extremadura is also considered as an eligible project for the gap filler mechanism of the new Governance (if applicable) and is well known and considered by other MS. -The technical feasibility of cross-border solar electricity projects has been proven and the benefits to the EU electricity system have been demonstrated. -The project has a large EU local content (many EU companies have participated in the project) and has a remarkable R&D component. -The project has been supported by H2020 projects (eg: MUSTEC) and is currently a success case study being analyzed in H2020 projects. -The project in Extremadura is one of the FOAK projects that has been achieved within the IGW of the SET Plan for CSP. -EU Regions have played a key role as catalizers of the projects (with the support of the S30 Solar Partnerhsip).

ACTORS	STATUS QUO Critical issues when considering cross-border electricity projects	EXTREMADURA specificities	Recommended measures for Extremadura (to go from the STATUS QUO to the GOAL)	GOAL (legitimacy and support achieved)
OFF-TAKER COUNTRIES	-Compliance with the **2020 National RES targets** and their role as host country (RES surplus) or off-taker country (RES deficit) -**Search for suitable RES projects in Europe** (as a way to fulfill their RES targets abroad) -Identification and quantification of **key factors** (besides cost savings in meeting the 2020 RES targets) that condition their participation in RES cooperation. -Discussion about the future role that RES cooperation will play in the future (**winter package**). **-**For potential cooperation projects, off-taker countries must assess its suitability with their (i) maximum support that the corresponding government is willing to provide to account for the RES production (cooperation mechanisms) and (iii) off-taker electricity demand profile -Doubts about the technical and economic feasibility of the **cross-border RES projects.**	-The project is still in its **conceptualization phase** (which may generate some mistrust among off-takers) - The project could be cost-competitive with other RES technologies when considering the **system value.** -Solar Technologies have a **high EU content** (which may match with off-taker industrial interests) -The solar FOAK project has a remarkable **R&D** component (which may be of interest for the off-taker country). -The project has **other attributes** that could be of interest for potential off-taker countries (ie: contributes to reduce inequality in Europe, maintain EU industrial and research leadership). -The project is eligible to receive **financial support from various sources** (EFSI, INNOFIN, etc). This would reduce the financial gap and the required support by the off-taker. -Potential off-taker countries are not all familiar with the CSP technology and its advantages compared to other RES technologies.	-**Advance in the techno-economic configuration** characteristics of the plant. -**Consider the potential off-taker countries´ needs, preferences** as well as economic, technical and regulatory requirements. -Assess **other key issues** for potential off-takers: Are there other industrial or geopolitical issues to take into account? -Approach Belgium, Netherlands, Germany, France and Luxemburg (likely 2020 off-taker countries) -Once the project configuration and the business model is ready, inform MS about the project and its technical and economic characteristics**.** **-**Try to get the **support from the EC** for communication and advocacy actions (eg: S3P, MUSTEC, CA-RES, IWG of the SET PLAN, etc) -Communicate and advocate for the **advantages of the solar FOAK project over other technologies/regions** (taking into account the off-taker interests) -Need to explore the "**system value**" according to the requirements of the off-taker (eg: peak or load demand etc). -Demonstrate the **technical and regulatory feasibility of electricity exports** from Spain.	-Potential off-taker countries (in both the 2020 and post 2020 framework) are well informed about the project. -The advantages of the solar FOAK project over other RES projects in Europe have been identified, quantified and demonstrated. -The solar FOAK project is considered as a success example for other similar cross-border electricity trade projects in Europe. -Various MS have expressed their interest in the solar FOAK project in Extremadura as a way to achieve their RES 2020 targets as well as in their National Energy and Climate Plans beyond 2020. -As a result of this project, all the expected benefits (beyond cost savings) have been materialized.

ACTORS	STATUS QUO Critical issues when considering cross-border RES projects	EXTREMADURA specificities (Spain as a host country)	Recommended measures for Extremadura (to go from the STATUS QUO to the GOAL)	GOAL (legitimacy and support achieved)
HOST COUNTRIES	-Compliance with the **2020 National RES targets** and their role as host country (RES surplus) -Need to consider and quantitatively assess the **direct and indirect costs & benefits** of the project for the country electricity system and its citizens. -**Consideration of all issues** that may hinder or prevent cooperation RES cooperation agreement with other MS. -Doubts about the **technical and regulatory feasibility of cross-border electricity exports** -**Limited interconnection capacities** between some MS.	-Spain is expected to meet the 20% RES 2020 targets (**potential host-country**). -Spain has **limited interconnection capacity** between France and Spain (but sufficient for a pilot project). -Spain advocates for EU market integration and urges increase interconnection capacity between SP-PT -Spain has **perfect solar conditions** and experience in CSP and PV. Furthermore, it is an industrial and research leader in CSP. -Spain supports the concept of **cross-border RES projects** (as long as there is a real market integration in Europe) -Spain does not currently have a suitable support schemes for CSP. -The National Government is still **unclear about the net impacts of the project for Spanish consumers and for the electricity system**. -Uncertainty about the **feasibility and implications of the RES electricity exports** for Spain.	-In collaboration with the Spanish Government and DG-ENER, conduct a **pre-feasibility assessment** (CBA) of the project where all direct and indirect costs and benefits are considered. -In collaboration with the involved ministries, assess what other factors (industrial interests, geopolitics, R&D etc) could hinder/foster the interest of Spain for cross-border electricity projects with other countries and somehow influence in the final configuration of the project -Demonstrate the **feasibility of cross-border electricity trade scheme** from Spain to an off-taker country (involved REE). **-**With regards to **interconnections**: - Urge ENTSEO-E to incorporate in their Cost-Benefit analysis of new interconnections investments, the benefits of having more cross-border electricity projects. -Use the solar FOAK project in Extremadura to demonstrate the benefits of having more interconnection capacity between France and Spain – Use this case as an additional argument to advocate for urgent increase of the interconnection between France and Spain. -Join forces with all interested/involved stakeholders in Spain to define a **coordinated strategy and work plan**.	-A comprehensive Cost Benefit analysis has been conducted and the uncertainties have been dissipated as to the physical and regulatory feasibility as well as to the net impact. -The Spanish Government fully supports the project. -Important socio-economic benefits in Spain will occurred as a result of this project (in terms of job creation, economic stimulation etc). -The realization of this first cross-border solar electricity trade project could be used by the Spanish Government to demonstrate the additional benefits of higher interconnection capacity SP-FR (more of such projects could be realized). -The realization of this first cross-border solar electricity trade project could demonstrate the benefits that such a project could have for Spain as well as for other involved countries. -The project has positive geopolitical implications for Spain (as a country that supports RES integration, cooperation within EU.

ACTORS	STATUS QUO Critical issues when considering cross-border RES projects	EXTREMADURA specificities	Recommended measures for Extremadura (to go from the STATUS QUO to the GOAL)	GOAL (legitimacy and support achieved)
REGIONS	-Regions usually play a **limited role** for the implementation of cooperation mechanisms -Regions will be the **most affected** by the positive/negative local and regional impacts. -Currently, **EU and the S3P** in particular are providing **valuable support to regions** interested in cross-border electricity projects. -When applicable, regions can facilitate the deployment of such projects by providing administrative support.	-Extremadura **fully supports** this project (for the various benefits that it would bring to the region in terms of jobs, economic development, etc). -Extremadura is currently **leading the Solar Partnership** and has the support from the European Commission. -Extremadura is eligible to receive **EFSI funds** -Extremadura has the **capacity to organize and lead a tender process** (for example, through "*Asociación para la innovacion"*) -Extremadura is a **world leader in renewables** (including CSP). -The **regional government** is fully committed to this project and has the will and capacity to mobilize the required support in Spain and Europe. -There is **public support** towards RES -To move forward, Extremadura must have a preliminary techno-economic configuration of the plant (which is still missing).	-Continue the **discussions/work with the Spanish National Government** (MINETAD and MINECO) to increase their political support. -Explore the possibility to organize a **tender process** through the "*Asociación para la innovación"* -Have a **leading role** in coordinating Spanish stakeholders interested the project (in collaboration with other key actors ESTELA/S3P/etc) -Contact **other regions** interested in the project (eg: in Portugal, France, Germany, etc) so that they can also raise support among their corresponding National Authorities. -Further collaborate and benefit from the support provided by DG-REGIO (through the **Solar Partnership**). -Participate in the MUSTEC and other relevant projects (ie: as an Advisory Board Member) -Continue the **advocacy efforts in Brussels** (through DG-REGIO, DG-RTD, DG-ENER). -Start a **consultation/communication** campaign to eliminate any risk of public opposition.	-Extremadura has acted as catalyzer in mobilizing support from all involved actors (at the National, international and regional level). -Extremadura will be part of the MUSTEC advisory board and will participate in other relevant EU initiatives and projects. -Extremadura benefits from a wide range of positive impacts as a result of this project (ie: jobs, new investments and economic activities, international and national visibility and recognition, etc) -More RES projects are deployed in Extremadura and other regions benefit and take advantage of the lessons learned from this case study.

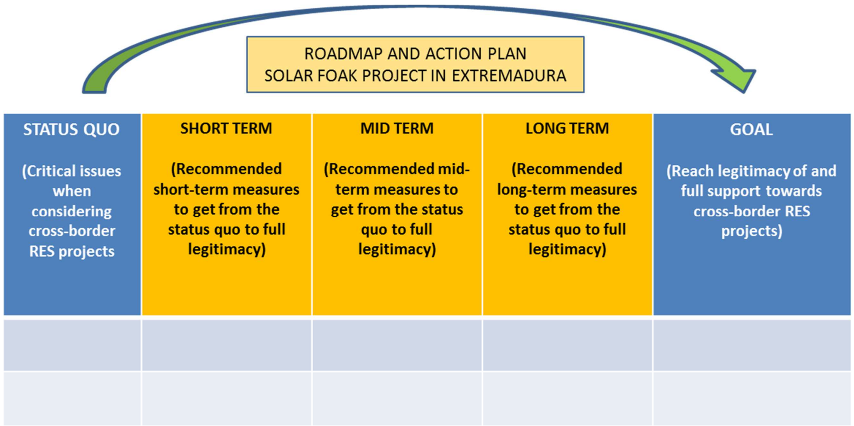
ACTORS	STATUS QUO Critical issues when considering cross-border RES projects	EXTREMADURA specificities	Recommended measures for Extremadura (to go from the STATUS QUO to the GOAL)	GOAL (legitimacy and support achieved)
INDUSTRY & RESEARCH COMMUNITY	-EU industry is losing market share against other international competitors (ie: China) -**RES Cooperation (with a private or public off-taker)** is a possibility to deploy new RES projects in Europe in a cost effective manner while contributing to maintain EU industrial and research leadership. -Industrial partners have the most up-to-date **techno-economic data**. -**RES costs** have gone down dramatically for some technologies (mostly wind and PV technologies) -**Industry and Research community** can cooperate to propose valuable innovative system designs (ie: FOAK projects). -The possibility to produce renewable high-value, **dispatchable power** on demand will be more valuable in the future (with larger shares of variable RES) as well as to replace coal and nuclear in Europe. -Still need to debunk some fake miths around CSP and demonstrate the added value of the technology.	-A preliminary techno-economic configuration is not yet defined by the industry. -Still need to find an interested off-taker (country, private) that values the flexibility provided by the CSP plants. -CSP still requires support to cover the financial gap (generation cost – electricity market price) -The FOAK could potentially include a PV/CSP hybridation which brings the advantages of both technologies. -A solar FOAK project would be eligible to some financial support schemes. -ESTELA and PROTERMOSOLAR (the European and Spanish Solar Thermal Electricity Association) support the cross-border solar electricity concept. -CSP still maintains EU industrial leadership but is losing competitiveness. -The CSP IGW of the SET Plan includes deployment of FOAK projects for export. -Most of the value chain of CSP is European.	-Industrial players should be invited and encouraged to propose alternative techno-economic configurations under a coordinated, transparent and suitable incentive scheme. -Potential off-taker countries´ interests are investigated so to identify their preferences, demand profile and willingness to engage in a cooperation mechanism. -Industrial interests of other potential countries have been identified. Interested industrial players advocate for the project in their countries/regions. -Once a preliminary techno-economic configuration has been defined, potential off-taker countries and other potential private off-takers are informed about the benefits and added value of the project (compared to other alternatives). -Suitable business plans have been identified and alternative support instruments (EU funds, cooperation mechanisms, cross-border RES project funds, etc) have been explored in detailed. -Must find ways to minimize the risk of the investment by interested industrial players. -The solar FOAK project should be considered as an eligible and attractive cross-border electricity project. -Explore the possibility that a European Utility develops the project in Spain and exports the electricity to an interested private off-taker. -In collaboration with EU research institutions, ensure that the project includes an R&D component which increases its attractiveness.	- The project techno-economic configuration is defined and matches with the interests and needs of interested off-taker countries or private off-taker. - A large number of EU companies participate in the project (EU local content is achieved throughout the value chain). - The project includes attractive R&D elements (with the participation of EU research centers) which increase its attractiveness. - The R&D component of the project contributes to increase its techno-economic performance and cost reduction. - As a result of this first pilot project, more CSP projects are deployed in Europe. - The project is fully bankable and technically viable. - The project contributes to demonstrate the dipatchability value of the technology in Europe. - The project is conceived as part of the IGW of the SET plan which aims at deploying a first solar FOAK which electricity is exported to Northern Europe. - The project is an eligible cross-border RES project (and receives support to conduct a pre-feasibility study and grants to deploy the project).
ACTORS	**STATUS QUO Critical issues when considering cross-border RES projects**	**EXTREMADURA specificities**	**Recommended measures for Extremadura (to go from the STATUS QUO to the GOAL)**	**GOAL (legitimacy and support achieved)**
CITIZENSHIP	-Citizens can play various roles within cross-border renewable electricity projects (as consumers, as investors, as workers in the plant, as influencers, etc). -Public opinion (support or opposition) is often determined by the type, magnitude and sign of the impacts they receive from the project. -Citizenship can play are expected to play an increasingly important role in the formation of the EU energy market. -New participation roles are being implemented in various countries.	-The project could generate important socio-economic impacts in terms of job creation, economic stimulation across a variety of sectors (as long as most of the value chain remains in Europe). -The project in Extremadura could be a pilot project in which some forms of citizenship participation was tested. -This could be seen as an added value (and thus, another argument to qualify as a Project of European Interest – PEI)	A preliminary study about the role that citizenship could play in the project (as an investor, trader and purchaser of the electricity) should be conducted. A preliminary assessment of the direct and indirect impacts on citizens should be conducted in order to put the necessary measures to reduce the bad ones and stimulate the good ones. It is important to start a communication strategy to minimize the possible risk of public opposition	An effective consultation and communication campaign has been put in place in all involved countries to assess the social perception towards cross-border RES projects. New citizenship engagement and participation modes have been tested in the solar FOAK project (as a way to increase the social acceptance towards the project). Citizens in host, off-taker and transit countries support the project as they are aware and benefit from the positive effects (in terms of job creation, economic activity, decarbonization, etc). Corrective measures have been put in place to minimize the potential socio-economic and environmental negative effects (eg: visual impacts, etc).

Source: Own elaboration

Finally, based on the information presented in the previous sections, a set of "critical issues" have been identified as being relevant by various stakeholders. As such, tackling these issues should gear the next steps. Such key themes include: (i) advocacy (ii) demonstration of electricity system value, (ii) synergies with research initiatives, (iv) Business plan development, (v) EC support, (vi) techno-economic configuration of the plant, (vii) social acceptance.

For each one of these key issues, a set of recommended actions –to be implemented in the short/medium/long term- are proposed as a way to move forward towards the legitimization and full support by the key stakeholders ([36]) as a pre-requisite for the materialization of the solar FOAK project in Extremadura, Table 8.

Figure 15. Proposed steps to draft a timely action plan for Extremadura



Source: Own elaboration

([36]) It is important to note that this is a necessary but not sufficient condition since the analysis included in this report does not cover the whole spectrum of actors of the system but only the key ones.

Table 8. Action plan for the first solar FOAK in Extremadura

TOPIC	SHORT TERM	MEDIUM TERM	LONG TERM	Involved actors
ADVOCACY AMONG POLICY MAKERS	*-Use the existing value proposition (Caldés & Díaz-Vazquez 2018) to* ***advocate*** *within the EU – position the project* ***as a potential RES-Projects of European Interests*** ***-****Join forces with other interested parties to coordinate advocacy efforts (Estela, Protermosolar, Extremadura regional government and Spanish government, etc)*	*-Propose a study to identify and* ***quantify the EU added values*** *of the projects.* *-Propose a study to identify and quantify the direct and indirect* ***costs and benefits*** *for Spain and potential off-taker countries*	*Develop a* ***full cost-benefit analysis*** *of the project (as RES-PEI support)* ***Share methodology and findings*** *for other interested regions/countries/RES technolog.*	*-Extremadura and Spanish government authorities* *-DG-ENE, DG-REGI, DG-RTD.* *-CBA Experts/Consultants* *-Solar Partnership members* *-ESTELA/PROTERMOSOLAR*
DEMONSTRATION OF ELECTRICITY SYSTEM VALUE	***-Demonstrate*** *the physical and regulatory feasibility of the electricity* ***physical exports*** *(see section 3.1.2.2 of this report)* *-For Spain, use the results and Spanish model used in Protermosolar (2018) as well as other modelling tools (ie: TIMES Spain) to demonstrate the value of CSP for the Spanish System.*	*-Assess the* ***system impact*** *of the project in the EU, National and Off-taker countries (possibly with the support from DG-ENER)* *-Urge* ***ENTSO-E*** *to enlarge the scope of their CBA by considering the additional benefits of increased interconnections in terms of having more RES cooperation projects*	*-Use the project as an additional argument to* ***increase interconnection capacities between SP-FR***	*-Extremadura and Spanish government authorities* *-ENTSO-E, REE and other involved TSO* *-Energy Systems Modelling experts (DG-ENER; JRC)* *-Solar Partnership members* *- Electricity system Experts and researchers* *-Off-taker and transit countries representatives.*
SYNERGIES WITH RESEARCH INITIATIVES	***Identify*** *synergies with existing* ***H2020 projects*** *(MUSTEC, HYSOL, CA-RES, STAGE-STE, GRIDSOL, PREFLEXMS, RESCOOP, etc) and contact project coordinators.*	***Engage and collaborate*** *with relevant* ***H2020.*** *Synergies are identified and materialized.*	*Use the results/findings from the assessment of the project for future research.*	*Extremadura, DG-RTD,* *H2020 project coordinators* *Solar Partnership*
	Contact, engage and look for synergies/collaborations with the participants of the ***CSP Implementation Working Group (IWG) of the SET plan.***	*Use the IWG of the SET plan as a consultation and* ***dissemination platform.*** *Propose the Extremadura solar FOAK project as the* ***first FOAK project*** *(to be supported by the IWG of the SET plan)*	*One or two SOLAR FOAK will be constructed – contributing to accomplish the IGW SET plan goals.*	*DG-RTD (CSP specialists and JRC)* *Spanish Authorities (MINECO, MINETAD)* *Extremadura* *Solar Partnership* *IWG of the CSP SET Members*
BUSINESS PLAN	*Based on the information provided in Caldés and Díaz-Vazquez (2018), further investigate about the eligibility of the Extremadura case to the existing* ***EU financial support instruments****.* *Contact with industry actors, relevant EU representatives and financial institutions.*	*-LCOE of the plant and financial gap/required support is known.* ***-Finalize a business plan*** *for the solar FOAK project in Extremadura*	***Share the lessons learned*** *as to the business plan for the solar foak project to other interested regions/technologies*	*Financial institutions (EIB, EBRD, etc), DG-REGIO (ESI funds), private banks, etc* *Extremadura government, Solar Partnership, ESTELA*
EC SUPPORT	*Continue benefiting from the support provided by the* ***S3P through the Solar Partnerhsip****.*			*Extremadura and other* *Solar Partnership members.* *DG-REGIO authorities; JRC* *ESTELA, IDEA*
	Use the EU industrial mapping report (IDEA, 2018) to identify and contact potential ***interested partners/regions across Europe***	*If interested, incorporate other regions in the project*	*Extremadura case study as lessons learned for other regions.*	
	Incentivize the ***dialogue and coordination of EC suppor****t (DG-REGIO, DG-ENER, DG-RTD)* *Propose the possibility to organize a* ***dedicated workshop*** *to present the various elements/interests/views of cross-border solar electricity projects in Brussels (with the participation of DG-RTD, DG-ENER, DG-REGIO and other actors). When successful, organize another workshop to present the results/lessons learned.*			*Solar Partnership* *DG-RTD representatives* *DG-ENER representatives* *DG-REGIO representatives*
TECHNO-ECONOMIC CONFIGURATION OF THE PLANT	*Start organizing a* ***tender process*** *(ie; "Associación para la innovación")*	*Advance in the* ***techno-economic configuration of the plant***	*Start* ***construction*** *of the plant*	*Industry, ESTELA, ExtremaduraSolar Part.* *Awarded companies*
	Investigate the ***technical and economic needs*** *and limitations of potential* ***off-taker countries*** *(France, Germany, Luxemburg, Belgium, Netherlands)*	*Communicate and advocate for the* ***advantages of such configuration*** *over other competing technologies/regions*	*Sign a Memorandum of understanding* ***(MoU)*** *between Spain and interested off-taker country/ies.*	*Solar Partnership members & Extremadura* *MUSTEC, CA-RES projects* *ESTELA, Energy System modellers* *Spanish Government* *Off-taker national authorities*
	Besides techno-economic factors, investigate ***other relevant key factors*** *possibly influencing willingness to import the electricity*	*Start* ***negotiations*** *with those countries potentially interested.*		
SOCIAL ACCEPTANCE	***Investigate the potential roles that citizens could play*** *in the project (investors, consumers, etc)*	***Propose*** *a more* ***active*** *role of citizens in the project*	***Share*** *the lessons learned*	*-Extremadura government authorities* *-Experts in risk assessment and social perception.* *-Experts in impact assessment methods.*
	Through a ***consultation*** *process, identify the most relevant impacts for citizens (jobs, environmental impacts, visibility, etc)*	*Conduct a* ***project impact assessment*** *and propose measures to maximize the positive impacts while minimizing the negative ones.*	***Communicate*** *the findings to the interested population.*	

Source: Own elaboration

5 Conclusions

Cross-border renewable electricity import-exports in Europe could bring multiple benefits for Europe as well as for the involved countries and regions. However, despite the expected benefits, some obstacles currently prevent the materialization of these types of projects.

Under the auspices of the solar smart specialisation partnership and as a follow-up report of Caldés and Díaz-Vázquez (2018), this policy report proposes a framework to define a roadmap and action plan to deploy cross-border renewable electricity trade projects in Europe. This approach is validated thanks to a tailor-made action plan to materialize the first cross-border solar FOAK project in Extremadura.

The proposed analytical approach is based on the legitimization function of the Technological Innovation System (TIS) which implies that in order to successfully deploy any new technology it is necessary to acquire social acceptance by the key stakeholders (Bergek et al.; 2013). Following this approach and as a first step, the authors suggest selecting a subset of key actors within the relevant stakeholder system. The second step consists in assessing their role, competences and most critical issues when considering cross-border electricity projects. Next, based on this information, a roadmap and action plan is proposed taking into consideration those measures that should be implemented to obtain the stakeholders´ support (social acceptance) towards the project.

Among all actors confirming the stakeholder system of cross-border renewable electricity projects, this report has focused on the following key stakeholder categories: (i) politics and policies (at the European level, country level including host, off-taker and transit countries as well as regional policy makers), (ii) supply (industry and research community as well as distribution and trade actors) and (iii) influencers (potential consumers and citizens in participating countries). In order to identify their role, competences and critical issues, a stakeholder consultation process has been conducted. Next, a set of recommended actions has been proposed as a way to obtain their support and legitimization towards cross-border renewable electricity projects.

As to the Extremadura case study, the analysis described above has been conducted taking into consideration its particular specificities. Results from the analysis show that some common "critical issues" appear to be relevant by several stakeholder categories and, as such, require special attention. Such key issues include: (i) advocacy needs, (ii) demonstration of electricity system value, (iii) synergies with research initiatives, (iv) business plan development, (v) EC support, (vi) techno-economic configuration of the plant and (vii) social acceptance by civil society.

For each one of these critical issues, the authors propose an action plan (structured around three time periods) that, if fully implemented, should contribute to the successful deployment of the first cross-border solar FOAK project in Europe.

Lessons learned from the implementation of this action plan should help other regions better exploit their renewable electricity export potential across Europe.

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List of abbreviations and definitions

CF	Cohesion Fund
CSP	Concentrated Solar Power
EC	European Commission
EFSI	European Funds for Strategic Investment
EIB	European Investment Bank
ERDF	European Regional Development Fund
ESF	European Social Fund
ESIF	European Structural and Investment Funds
ESTELA	European Solar Thermal Electricity Association
FOAK	First Of A Kind
JRC	Joint Research Centre
LCOE	Levelised Costs of Electricity
MS	Member State
PPA	Power Purchase Agreement
RED	Renewable Energy Directive
RES	Renewable Energies
R&D	Research and Development
S3	Smart Specialization
S3P	Smart Specialization Platform
SET plan	Strategic Energy Technology Plan
TIS	Technological Innovation System
TSO	Transmission System Operator

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Annexes

Annex 1: Typologies of cooperation mechanisms and successful cases

There exist four possible cooperation mechanisms that MS can choose from Box 6, summarizes the four types of cooperation mechanisms of the RES Directive. Article 6, 7 and 11 are suitable for cooperation agreements within the European territory whereas Article 9 is only suitable for cooperation agreements between EU MS and Neighbouring countries.

Existing cooperation initiatives

Box 6. Cooperation mechanisms of the RES Directive (2009/28/EC)

— Article 6: Statistical transfers

In this case, renewable energy (electricity, heat or transport energy) which has been produced in one Member State is virtually transferred to the RES statistics of another Member State, counting towards the national RES target of that Member State.

— Article 7: Joint Projects between EU Member States

Allows EU Member States to finance a RES project jointly thus sharing the costs and benefits of the project and developed under framework conditions jointly set by two or more MS (i.e. a specific new plant is identified and the output of the plant is shared (statistically) between to cooperating Member States). The involved MS define which share of the energy production counts towards which MS target.

— Article 9: Joint Projects with third countries

Joint projects can also be implemented between Member States and third countries (i.e.: countries outside the EU). A precondition is that an amount of electricity that equals the electricity amount generated from RES and subject to this joint project is physically imported in o the EU (For more information on this option, see www.better-project.net).

— Article 11: Joint Support Schemes

Under this scheme, Member States merge or coordinate (parts of) their RES support schemes and jointly define how the renewable energy produced is allocated to their national targets.

Source: Caldés and Díaz-Vázquez (2018)

As of today, only four successful cases of cooperation mechanisms in Europe exist (table 10) ([37]).

([37]) For more detailed information on such agreements as well as on the failed attempts between other MS, see Gephard et al. (2015).

Table 8. Existing cases of use of cooperation mechanisms in Europe

Cooperating Countries	Coop. Mechs.	Type of agreement	Technology	Year
Sweden/Norway	Art. 11	Joint Certificate Scheme	All RES technology	January 2012
Germany/Denmark	Art. 11	Mutually-opened auctions	Ground Mounted PV installations	July 2016
Luxemburg/Lithuania	Art.6	Statistical Transfer	All RES technologies	October 2017
Luxemburg/Estonia	Art.6	Statistical Transfer	N/A	November 2017

Source: Caldés and Díaz-Vazquez (2018)

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