Current Project Structures and Financing Opportunities for CSP Projects

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ESTELA, European Solar Thermal Electricity Association
ABOUT THE PROJECT

In the light of the EU 2030 Climate and Energy framework, MUSTEC - Market uptake of Solar Thermal Electricity through Cooperation aims to explore and propose concrete solutions to overcome the various factors that hinder the deployment of concentrated solar power (CSP) projects in Southern Europe capable of supplying renewable electricity on demand to Central and Northern European countries. To do so, the project will analyse the drivers and barriers to CSP deployment and renewable energy (RE) cooperation in Europe, identify future CSP cooperation opportunities and will propose a set of concrete measures to unlock the existing potential. To achieve these objectives, MUSTEC will build on the experience and knowledge generated around the cooperation mechanisms and CSP industry developments building on concrete CSP case studies. Thereby we will consider the present and future European energy market design and policies as well as the value of CSP at electricity markets and related economic and environmental benefits. In this respect, MUSTEC combines a dedicated, comprehensive and multi-disciplinary analysis of past, present and future CSP cooperation opportunities with a constant engagement and consultation with policy makers and market participants. This will be achieved through an intense and continuous stakeholder dialogue and by establishing a tailor-made knowledge sharing network.

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<tr>
<td>APEC</td>
<td>Asia-Pacific Economic Cooperation</td>
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<tr>
<td>BDO</td>
<td>Build-Develop-Operate</td>
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<td>BOO</td>
<td>Build-Own-Operate</td>
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<tr>
<td>BOOT</td>
<td>Build –Own –Operate –Transfer</td>
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<tr>
<td>BOT</td>
<td>Build-Operate-Transfer</td>
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<td>CEF</td>
<td>Connecting Europe Facility</td>
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<td>CF</td>
<td>Cohesion Fund</td>
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<td>CORFO</td>
<td>Corporación de Fomento de la Producción de Chile</td>
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<td>CSP</td>
<td>Concentrated Solar Power</td>
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<td>EAFRD</td>
<td>European Agricultural Fund for Rural Development</td>
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<td>EDP</td>
<td>Energy Demonstration Projects</td>
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<td>EFSI</td>
<td>European Funds for Strategic Investment</td>
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<td>EIB</td>
<td>European Investment Bank</td>
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<td>EMFF</td>
<td>European Maritime and Fisheries Fund</td>
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<td>EPC</td>
<td>Engineering, Procurement, and Construction</td>
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<td>ERDF</td>
<td>European Regional Development Fund</td>
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<td>ESF</td>
<td>European Social Fund</td>
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<td>ESIF</td>
<td>European Structural and Investment Funds</td>
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<td>ESTELA</td>
<td>European Solar Thermal Electricity Association</td>
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<tr>
<td>ETS</td>
<td>Emission Trading Scheme</td>
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<td>EU</td>
<td>European Union</td>
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<td>FIT</td>
<td>Feed In Tariff</td>
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<td>FIP</td>
<td>Feed in Premium</td>
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<td>FOAK</td>
<td>First of a Kind</td>
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<td>GCC</td>
<td>Gulf Cooperation Countries</td>
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<td>HTF</td>
<td>Heat Transfer Fluid</td>
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<td>IEA</td>
<td>International Energy Agency</td>
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<tr>
<td>IPP</td>
<td>Independent Power Producer</td>
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<td>IRR</td>
<td>Internal Rate of Return</td>
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<td>ISCC</td>
<td>Integrated Solar Combined Cycle</td>
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<td>ITC</td>
<td>Investment Tax Credit</td>
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<td>KISR</td>
<td>Kuwait Institute for Scientific Research</td>
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<td>MASEN</td>
<td>Moroccan Agency for Solar Energy</td>
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<tr>
<td>MENA</td>
<td>Middle East and North Africa</td>
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<tr>
<td>MFF</td>
<td>Multi-annual Financial Framework</td>
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<tr>
<td>NER</td>
<td>New Entrants’ Reserve</td>
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<td>O&amp;M</td>
<td>Operation &amp; Management</td>
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<tr>
<td>OECD</td>
<td>Organisation for Economic Co-operation and Development</td>
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<td>OEM</td>
<td>Original Equipment Manufacturer</td>
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<td>Abbreviation</td>
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<tr>
<td>PPA</td>
<td>Power Purchase Agreement</td>
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<td>PPP</td>
<td>Public-Private Partnership</td>
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<td>PUA</td>
<td>Build-Operate-Transfer</td>
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<tr>
<td>PURPA</td>
<td>Public Utility Regulatory Policies Act</td>
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<td>R&amp;D</td>
<td>Research and Development</td>
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<td>REIPPPP</td>
<td>Renewable Energy Independent Power Producer Procurement Program</td>
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<tr>
<td>RES</td>
<td>Renewable Energy Sources</td>
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<td>RETs</td>
<td>Renewable Energy Technologies</td>
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<td>RPS</td>
<td>Renewable Portfolio Standard</td>
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<td>SEGS</td>
<td>Solar Energy Generating Stations</td>
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<td>SPV</td>
<td>Special Purpose Vehicle</td>
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<tr>
<td>STE</td>
<td>Solar Thermal Energy</td>
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<td>TES</td>
<td>Thermal Energy Storage</td>
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<td>TO</td>
<td>Thematic Objective</td>
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<td>USA</td>
<td>United States of America</td>
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EXECUTIVE SUMMARY

The purpose of this report is to identify the existing business models for CSP structuring and financing opportunities across Europe, providing thus the base for the derivation of new appropriate models.

Considering the complexity of the CSP value chain in terms of engaged actors across the different stages, no business model is identical to the other. Having this in mind, it was decided to approach the different business models in place by mapping their characteristics, as well as the parameters affecting their evolution.

The identification of these parameters, realised through literature survey and in collaboration with a CSP industrial stakeholder, COBRA, has been thoroughly analysed in the analytical framework, followed by the methodological approach adopted for the work conducted under this report.

The restricted engagement of the CSP industry in the survey allows us to draw some interesting preliminary conclusions, but not extract fully valid trends. It is demonstrated that overall the CSP industry has been forced to make adjustments to its original business models, by adding additional services and covering more stages of the CSP value chain, reaching approximately 50% coverage of these stages. Moreover, due to the CSP deployment rates, they have been forced to modify their value proposition, by adding other technologies. The conditions are considered mature enough for all CSP value chain phases to be undertaken at a host country, outside EU, partially or fully.

Considering that the revenue, policy and regulatory associated risks and barriers are ranked the highest, it is expected that the transformation of the electricity market, so that ancillary and balancing services are provided, combined with the carbon emission allowances, will offer additional revenue streams. Moreover, the type of support mechanism offered is not considered as crucial as its stable application. Technical related barriers are not a significant concern for the CSP industry, while for project financiers they are taken into consideration, but are not their primary concern.

Finally, as regards the financing opportunities available at EU level, although currently it is a transition period as we reach 2020, the existing programs as well as the future ones planned are designed so as to support primarily demonstration technologies.

The structure of the current report stands as following. Further to the Introductory Section 1, Section 2 focuses on the description of the support mechanisms in place in the countries that the EU CSP industry is mainly activated, while Section 3 analyses the CSP value chain and financing models adopted. Section 4 presents the analytical framework and Section 5 the methodological approach. The survey results are analysed under Section 6, while the available financing opportunities under Section 7. Conclusions are provided in Section 8.
1 INTRODUCTION

The purpose of this report is to identify the existing business models for CSP structuring and financing opportunities across Europe, providing thus the base for the derivation of new appropriate models.

CSP projects can be particularly complicated, entailing a great range of stakeholders across the entire business process.

The different arrangements used for CSP deployment worldwide are not able to justify a single business model that has been deemed successful. The private sector initiatives in the United States of America (USA), the auction mechanisms in South Africa, the public feed in tariffs mechanisms in Spain, reveal that CSP business models can vary significantly, since they depend largely on the respective governmental policies and thus need to be carefully examined.

This analysis will attempt to describe the structure of CSP projects starting with a disaggregation of CSP projects into the most important components and phases. Each phase is characterized by a number of stakeholders and issues that will need to be mapped and explained. Besides an extensive literature review and collaboration with a CSP industrial stakeholder for the identification of the most important parameters affecting the CSP industry’s adopted business models, a survey among companies activated in the CSP sector has been realised and the results are presented in detail.

Furthermore, assuming that CSP will play a significant role in Europe’s decarbonization efforts, financing mechanisms and special purpose vehicles must exist or need to be developed. Funding mechanisms on national and European level, the role of the public and private sector, existing public-private partnerships that have proved to work effectively will be brought to the fore, identifying financing opportunities that could support CSP projects.

The ultimate scope of this analysis is to provide a clear picture of CSP’s value chain and the allocation of the costs & benefits across this chain and to the relevant stakeholders. Having this picture as a background, this analysis will eventually act as a springboard for the derivation of new business models that can contribute to further CSP deployment.
2 Review of Support Mechanisms for CSP Deployment

2.1 Introduction

The development of Renewable Energy technologies in general, and CSP specifically, has been based for many years on governmental support mechanisms in order to meet the financial viability threshold for their implementation. According to Tian et al. (2019) market pressure and government policy are the direct external factors that promote business model innovation. Considering these facts, existing support mechanisms are a parameter which still remains crucial for the CSP industry; it is thus considered interesting to study the reaction of the CSP industry’s adjustment to the market tools and mechanisms in place.

A short review of the main support mechanisms that have been used in the United States of America, Europe, and Middle East and North Africa (MENA) region till now in order to stimulate the CSP market is provided in the next sections. This geographical selection has been realised considering that the European CSP industry has been engaged in the CSP deployment in these areas as well.

2.2 United States of America

In the period 1984-1990, nine (9) Solar Energy Generating Stations (SEGS) were built in the Californian desert by Luz company, under the Public Utility Regulatory Policies Act (PURPA), a PPA scheme based on avoided costs of additional fossil fuel generation. With the fall of the natural gas price in the late 1980s, the PURPA tariffs fell too, resulting in the company’s bankruptcy in 1992. This halted further CSP construction in the US (Lilliestam, 2018).

Another instrument utilized to encourage investment in solar technologies is the Investment Tax Credit (ITC), a fiscal incentive enacted in 2006 and extended in 2015, resulting in the reduction of investor’s tax liabilities to the value of a certain percentage (30% in the case of past ITC) of the installed cost of the project (SEIA, 2019).

The 1705 renewable energy loan guarantee program, established in 2009 as a part of the American Recovery and Reinvestment Act, has successfully increased innovation and investment in utility scale PV and CSP. The maximum guarantee was 80% of total project costs, and the government explicitly did not assume any risks associated with pre-construction (Cox et al., 2015). Several CSP plants have been constructed utilizing this loan guarantee program, such as Mojave Solar One (250 MW – $1.2 billion loan guarantee), Crescent Dunes (110 MW - $737 million loan guarantee), Ivanpah (392 MW - $1.6 billion loan guarantee) and Solana (250MW - $1.45 billion loan guarantee)1.

1 https://www.energy.gov/lpo/portfolio/portfolio-projects
A Renewable Portfolio Standard (RPS) or obligation scheme is a system that obliges utilities or consumers to source a certain percentage of their power from renewable energy sources. In the USA, the establishment of RPS supported investment in CSP by ensuring that suitable PPAs could be developed with utilities (Solangi et al., 2011). This resulted in the successful commissioning of the 64MW Nevada Solar One project in June 2007, as well as several other planned CSP projects.

The key lesson learnt from the deployment of the CSP market in the USA according to Fred Morse\(^2\) is that policies make markets. In the early 2000s a successful effort was made to get the Western Governors Association to agree on a target of 1,000 MW of CSP. This unprecedented target along with the adoption of the RPS, set the stage for what happened next (HeliosCSP, 2018). Today, as a result of the above mentioned support mechanisms, over 1,800 megawatts (MW) of CSP plants operate in the United States (SEIA, 2018). Other lessons include the need for governments to properly deal with the subsidy imbalance between fossil fuels and CSP, as well as that long-term, low interest debt is a great catalyst for CSP (HeliosCSP, 2018).

### 2.3 Spain

The dominant policy instrument for the promotion of electricity from renewables in Spain was a FIT which had been in place since 1994. In 1998 two alternative payment options for green electricity generators were introduced, a fixed tariff scheme and a premium tariff, which was paid on top of the electricity market price (Haas et al., 2011). These support mechanisms were adopted for the first time by the Spanish government through the Royal Decree 2818/1998. With the Royal Decree 1955/2000, Solar Thermal Energy (STE) was relocated to a group with lower FIT and premium prices, while the Royal Decree 841/2002 reinstated STE to the previous group, but with lower premium (no FIT applied) compared to 1998. Royal Decree 436/2004 enforced FIT and premium at the range of 1998, resulting in the commencement of the 11 MW PS10 CSP by Abengoa in 2004, and the 50 MW Andasol CSP by Sener. Enactment of Royal Decree 661/2007 improved further FITs and premiums offered for CSP, boosting the CSP activity and leading to the construction of 48 additional plants. In 2010, the Spanish economy started to feel the consequences of the global crisis that broke out in 2008 and the government was being more conscious about the cost of this expansion of the renewable sector. The Royal Decrees issued at that period reduced the net value of the incentives for power generation with CSP, limited the number of operating hours eligible for this financial support and set a grid access toll for all power generation plants. The whole renewable energy sector came to a halt in 2012 with the enactment of Royal Decree Law 1/2012, while Royal Decree 413/2014 did not allocate financial support for power generated from auxiliary fuels in hybrid CSP plants (San Miguel and Corona, 2018).

The policies adopted by the Spanish government led to a period of rapid CSP expansion in Spain (2007-2013), resulting to 2,300 MW installed capacity over 7 years. Under this scheme, a whole new

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\(^{2}\) Fred Morse has been involved in CSP since its beginning in the USA and has managed the CSP R&D program under Presidents Carter and Reagan.
industry of European, primarily Spanish and German, manufacturers and developers was created. All were initially inexperienced with CSP – no new station had been built anywhere in the world for 17 years – but they rapidly gained experience, and all Spanish projects were set up by European developers, built by European Engineering, Procurement, and Construction (EPCs) companies using European CSP-specific components. This development came to an end as the government cancelled the FIT scheme in late 2012 – but the industry remained and kept a dominant, but weakening, position until the present day (Lilliestam, 2018).

2.4 Morocco

Morocco doesn’t offer support mechanisms in terms of Feed-In Tariffs etc. For low- and medium-voltage solar PV, a remuneration policy framework, be it a FIT, net-metering or a self-consumption scheme was to be implemented in 2018 (Redouane et al. 2018), but its current status is unknown.

According to Frisari and Stadelmann (2015), the key features of the CSP policies under the Moroccan Solar Plan include:

- **Two-stage competitive bidding**: To procure solar power in a cost-effective manner and ensure reliability of the power, the Moroccan Agency for Solar Energy (MASEN) has issued a two-stage competitive bidding with first a check on technical and financial eligibility of bidders, and then an auction on project costs.

- **Long-term PPA and guaranteed offtake**: To provide long-term revenue certainty to the solar power developer, MASEN enters in a 25-year PPA set at the price prevailing from the bidding. The contract obliges MASEN to guarantee the purchase the agreed amount of solar power from the project.

- **Public-Private Partnership**: The PPP model allows the government to share costs and risks with international and private financiers and project developers, with the potential of keeping interests aligned. Performance guarantees issued by the private developer completely shield the domestic public actors from construction and technical risks.

- **Guarantees for viability gap funding**: To mitigate the off-taker default risk, the Government of Morocco has provided MASEN with a guarantee to ensure its financial viability. International financial institutions have awarded the government a credit facility to be used to cover MASEN financial obligations.

A successful example of the above policies is the development of Noor I, II and III CSP plants in Ouarzazate. Noor I was built utilizing a successful public-private partnership between MASEN and a private sponsor that was selected through a competitive two-stage auction. Ultimately, the project was successful in effectively spreading risk, with the public partners assuming much of the political, financial, and commercial risk and the private partners taking on the construction and performance risks. Noor I provides a testing ground for a PPP model applied to a renewable technology with a significant viability gap and upfront investment needs that neither the domestic financial sector nor
forei

g private investors can manage alone. Concessional loans and grants also played a significant role in the financing of the project (Frisari and Stadelmann, 2015; Cox et al., 2015).

2.5 Chile

Law 20.257, also known as non-conventional renewable energy law, voted in 2008 and amended in 2013, established the Renewable Portfolio Standard (RPS), namely created the obligation for utilities with over 200 MW of thermal installed capacity to implement at least 20% of electricity produced by RE sources within their energy mix by 2025.³

A tender mechanism to encourage the development of RE sources was introduced in the National Energy Strategy 2012-2030, accompanied by specific incentives such as soft loans, tax incentives, and subsidies from the government to mitigate the risk for projects and achieve grid parity, e.g. consideration of establishing a guaranteed twelve year PPA scheme. Also Law 20/25 introduced a quota system. (Baldini and Perez, 2016).

The Ministry of Energy, through the Corporación de Fomento de la Producción de Chile (CORFO), published the first CSP tender in February 2013. A bidding process under CORFO, providing soft financing and an upfront grant, was awarded to Abengoa Solar and enabled the first 110 MW tower CSP plant (Cerro Dominador) in Atacama desert. The project is unique for two main reasons: it will have the highest storage in the world lasting up to 17.5 hours, and will be the largest CSP project in Latin America (Servert et al., 2015).

2.6 Israel

With an initial parabolic trough plant of 100 MW, the Israeli Ministry of National Infrastructure, overseeing the energy sector, decided in November 2001 to introduce concentrating solar power as a strategic ingredient in the Israel electricity market from 2005. The government bidding for the Ashalim solar complex started back in 2006, while the government issued a pre-qualifying tender for constructing two 80-125 MW solar thermal power stations at Ashalim in the Negev desert by end of 2008 (CSP today, 2008). The contract was awarded on the basis of a Build-Operate-Transfer (BOT) model and the first 121MW configuration became operational in 2017⁴.

Nevertheless, current CSP incentives in the country are unclear. The Public Utility Authority (PUA) published its last thermo-solar regulation in 2013, which was for 2013-2014 but it has not updated it since then. The FIT was originally set at 26.1-28 US cents/kWh for the first 200 MW. Ashalim’s FIT rate was finally set to 20.6 US cents/kWh in 2015 – far from its original FIT discussions for 31 US cents/kWh.⁵

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2.7 South Africa

In 2009, the government began exploring feed-in tariffs (FIT) for renewable energy. These tariffs were designed to cover generation costs plus a real after tax return on equity of 17% and would be fully indexed for inflation; nevertheless this support scheme was cancelled in 2011 in favour of a competitive auction, known as the Renewable Energy Independent Power Producer Procurement Program (REIPPPP). The REIPPPP program led among others to new CSP plants of different sizes at different sites. The plants were subsequently introduced in the system as grid-connected renewable energy Independent Power Producers (IPPs) (Baldini and Pérez, 2016; IRENA, 2013).

The development of the REIPPPP was rolled out in five phases from 2010 to 2014. In the first bidding round (Bid Window), the average bidding prices were R2.69/kWh (0.248 €/kWh\(^6\)), and the projects developed include KaXu Solar 1 (100 MW with Thermal Energy Storage (TES) of 3 hours) and Khi Solar 1 (50 MW, 2 hours TES). The Bokpoort project (50 MW, 9.5 hours TES) under the second bid window offered a bid price of R2.51/kWh (0.251€/kWh). Projects awarded under the third bid window have a new tariff system: a base price of R1.65/kWh (0.122€/kWh) payable for 12 hours every day and a 270% premium on the base price payable for electricity dispatched during the 5 peak demand hours. These projects include Xina Solar One (100MW, 5 hours TES) and Ilanga CSP 1 (100MW, 5 hours TES). Kathu Solar Park (100MW, 4.5 hours TES) and the Redstone project (100MW, 12 hours of TES) were awarded under bid window 3.5, while no CSP plant was awarded under bid window 4 \(^7\), \(^8\). All CSP plants mentioned above are operational, besides the Redstone project.

Despite the REIPPPP's unquestionable success, a much-discussed shortcoming has been the associated high transaction costs for participating bidders, where this encompasses all costs incurred in bid development and up to commercial operation date (Eberhand and Naude, 2017).

2.8 GCC Countries

The lack of a clear policy framework is one of the main reasons for limited solar activity in the Gulf Cooperation Countries (GCC), as regulation dedicated to attracting investment in renewables remains in its infancy. Most of the deployment to date in the GCC has been state sponsored. Nevertheless, in the long run, the GCC will offer opportunities in the energy generation value chain to the private sector as well. In order for this to become possible, an important decision in this direction would be the removal of subsidies from the energy and the electricity sector.

So far, Kuwait, Saudi Arabia and the United Arab Emirates have progressed in the deployment of CSP plants, some of which are really ambitious.

\(^6\) All currency conversions are based on the exchange rate between euro and South African Rand, valid on the bid submission date.


More specifically, Kuwait has had several small- to mid-scale demonstration solar projects in recent years. Shagaya, developed by the Kuwait Institute for Scientific Research (KISR), consists of 10 MW of solar PV capacity, 10 MW of wind, and 50 MW of CSP, all three of them being operational. An engineering, procurement and construction contract was awarded for the CSP component, following a tendering process (IRENA, 2019).

In Saudi Arabia, the new National Renewable Energy Programme was launched in 2016. Under this programme, the government has pushed ahead with ambitious plans for several rounds of auctions, with a major role for solar power, in order to support deployment. The first round was launched in October 2017, with the issuance of tenders for two renewable energy projects, one solar and one wind (IRENA, 2019).

Dubai 1 Integrated Solar Combined Cycle (ISCC) will include a 43 MW parabolic trough array, under an EPC contract, while two other ISCC projects are progressing simultaneously in the kingdom: the 1,390 MW Waad Al Shamal plant with 50 MW CSP and the 3,600 MW Taiba facility with a provision of 180 MW CSP. The Taiba project was procured and tendered using the OEM (Original Equipment Manufacturer) and EPC (Engineering, Procurement, and Construction) models. However, although bids had been submitted, considerations to switch the development mode of the project to an independent power producer (IPP) model have risen and are causing delays.

Abu Dhabi’s 100 MW Shams 1 became the first CSP plant in the GCC when it was commissioned in 2013. The project was completed under a special purpose vehicle created for this reason, led by Masdar, in collaboration with Total, Teyma and Abengoa Solar, under a 25-year build, own and operate contract (IRENA, 2019).

Dubai’s Mohammed bin Rashid Al Maktoum Solar Park is the largest single-site solar park in the world. The fourth phase commenced in 2017 with the auctioning of 700 MW of CSP capacity, at a bid of 7.3 US cents/kWh, the lowest price for CSP anywhere in the world at the time. The project has a 35 years PPA in place for the CSP component (IRENA, 2019).

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3  CSP VALUE CHAIN AND FINANCING MODELS

3.1  CSP Value chain

In order to describe the way a business model is being structured, a better understanding of the CSP value chain is required and thus briefly described in this section. Two major processes can be identified, the upstream and the downstream ones; upstream activities are those close to the exploitation of natural resources and refer to the supply network for all materials required for building a CSP plant, while downstream activities add value to the products through manufacturing or customisation. An overview of the CSP value chain is presented in Figure 1, where also the essential partners to establish a CSP plant are included, namely the financing and the political institutions.

*Figure 1: CSP Value Chain*

*Source: Own elaboration based on World Bank (2011) and Herrera (2013)*
It should be noted that in the above figure, the activities are not referred in the chronological order they are taking place, but are rather grouped per type of activity (upstream/ downstream). Nevertheless, the main activities involved in the CSP value chain are briefly described below in a chronological order.

- **Project development.** Includes the concept engineering, the conduction of technical and economic feasibility studies, the site selection, as well as the determination of general requirements.
- **Identification of the suppliers for the required raw material, such as concrete, steel, glass, sand, copper and other chemicals.**
- **Manufacturing and supply of CSP components and in particular:**
  - CSP key components construction. This includes the R&D, design and construction of components such as mounting structure, mirrors and receivers. R&D may not necessarily be conducted by the companies manufacturing the product.
  - CSP secondary components construction. Electronic equipment, cables and piping are some of the secondary components in the CSP supply chain.
  - Other CSP components. R&D, design, manufacturing and supply of components such as heat transfer fluid (HTF) system (piping, insulation, heat exchangers, pumps), power blocks, control systems, storage, pylons and trackers, which are comprising this category. As previously mentioned, R&D may not necessarily be conducted by the companies manufacturing the product.
- **Engineering, Procurement, Construction.** Focuses on detailed engineering of the project, the procurement of specific activities among subcontractors and the consequent construction of the plant.
- **Operation and Maintenance of the CSP plant.**

Currently, the above processes are covered either directly by the CSP industry, or by many of their suppliers and local manufacturers, especially in countries where CSP activity is booming.

An overview of the main European companies engaged in the above described activities is presented in Table 1.

### Table 1: EU Companies in the CSP value chain

<table>
<thead>
<tr>
<th>Value Chain Activity</th>
<th>Companies active</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw material suppliers</td>
<td>BASF, SQM</td>
</tr>
</tbody>
</table>
### Key Components
- Mounting structure: Abengoa, Acciona, Cobra, Siemens  
- Mirrors: Absolicon, Airlight Energy, Flabeg, Grenzebach, Roglass, Solarlite, Soltigua, TSK Flagsol  
- Receivers: CMI Solar, Schott Solar AG, Siemens

### Secondary Components
- Abengoa (piping), Acciona (piping), Cobra (piping), Kraftanlagen (piping, valves), Leoni (cables and cable systems), ROBA (piping)

### Other Components
- Aalborg CSP (steam generation systems, heat exchangers)  
- Abengoa (storage)  
- BASF (storage, heat exchangers)  
- Dow chemicals (HTF)  
- ERK Eckrohrkessel (heat exchangers, steam generators, back up boilers)  
- HAWE (trackers, pumps)  
- KAEFER (insulation, storage, heat exchangers)  
- Kraftanlagen (turbine, power block, insulation)  
- KSB (pumps and valves)  
- LEONI (control systems, automations)  
- ROBA piping (storage, heat exchangers)  
- Sener (storage)  
- Siemens (heat exchangers, steam generation turbines, power blocks)  
- TSK Flagsol (Storage, HTF and control systems)

### EPC
- Aalborg CSP, Acciona, ACS Cobra, Empresarios Agrupados, Engie Solar, Fichtner Solar, Kraftanlagen, Sener, Solarlite, TSK Flagsol

### Operation and Maintenance
- Abengoa, Acciona, ACS Cobra, Kaefer, Kraftanlagen, Solarlite  
- CSP, TSK Flagsol

All companies are presented in alphabetical order.

*Source: Own survey, utilizing data from World Bank (2011) and Stakeholders Mapping Report (MUSTEC D3.1)*

According to World Bank (2011) the five largest cost groups in the overall CSP value chain for a 50MW reference CSP plant with 7 hours of storage include:

- Solar field equipment and HTF (38.5%),  
- other costs (19.5%), including project development, management and financing,  
- site related costs (17%) such as labor, site preparation and infrastructure, piping and electric installations,  
- power block (14%),  
- thermal storage system (11%).
3.2 Financing Models

One of the most significant parameters for the deployment of CSP projects is the mitigation of risks, especially with regards to the mobilization of the required capital. According to Frisari et al. (2013), risk is the single most important factor preventing renewable energy projects from finding investors.

The most significant financing models that have been used in the deployment of CSP plants, in line with the literature survey, are described in the following paragraphs. These models are engaging significant actors of the CSP value chain, as described above and are able to mitigate to a large extent the significant risks that CSP investments have.

3.2.1 Public – Private Partnership (PPP)

According to OECD, one can define a Public–Private Partnership (PPP) as an “agreement between the government and one or more private partners … according to which the private partners deliver the service in such a manner that the service delivery objectives of the government are aligned with the profit objectives of the private partners and where the effectiveness of the alignment depends on a sufficient transfer of risk to the private partners” (Meaney and Hope, 2012).

The establishment of a Special Purpose Vehicle (SPV) in PPPs is one of the key steps. An SPV is a legal entity that undertakes a project and is established under the relevant Act of a country through an agreement (also known as memorandum of association) between the shareholders or sponsors. This agreement sets the basis on which the company is established, including details concerning its ownership structure, management control and corporate matters, authorized share capital and the extent of the liabilities of its members. The main purpose of the SPV is to facilitate financial transaction, to establish legal rules and regulations and to frame contracts between the parties involved in the concerned project. All contractual agreements between the various parties are negotiated between themselves and the SPV.

In the area of infrastructures and utility services, PPPs, despite some of their challenging features, are one of the tools in a policy maker’s arsenal which help to increase investment in infrastructure services and improve its efficiency. One of the main advantages of PPP is that, unlike privatization, the government retains strategic control over the project and the ownership of its assets. PPP offers multiple options or structures (Tatofie, 2012).

Some of these options that are commonly used, in line with the literature survey, include:

- Build-Develop-Operate (BDO), where the private actor acquires and develops assets from the public agent, and operates it;

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10 https://www.unescap.org/ttdw/ppp/ppp_primer/211_special_purpose_vehicle_spv.html
• Build-Own-Operate (BOO), where the private actor builds and operates a new asset under the specification of the public agent, but it retains its ownership. In the original agreement, requirements of the public sector are stated and the regulatory authority takes control;
• Build-Operate-Transfer (BOT), where the private actor builds and operates an asset but the ownership is transferred to the public agent at a later date. A BOT agreement starts the transfer to the government at an earlier point of time (5 years instead of longer periods of 20 to 30 years for BOOT contracts). The Build – Own – Operate – Transfer (BOOT) structure differs from BOT in that the private entity owns the works, while the contract encloses a final transfer of the plant ownership to the government or to another entity at a previously agreed-upon price or the market price (Meaney and Hope, 2012; Worldbank, 2011). The BOT model is one of the more widely used for the development of CSP projects.

The typical structure of a PPP model for a CSP project is presented in the figure below.

![Figure 2: PPP typical structure](source: Own elaboration based on OECD (2014) & IEA Technology Collaboration Programme (2017))

Some indicative PPP projects are outlined under Table 2.

**Table 2: Indicative CSP projects developed under PPP models**

<table>
<thead>
<tr>
<th>PPP model</th>
<th>CSP Project</th>
<th>Country</th>
<th>Engaged Actors (Private/ Public)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOOT</td>
<td>Noor I, II and III Ouarzazate</td>
<td>Morocco</td>
<td>ACWA Power / MASEN</td>
</tr>
<tr>
<td>BOO</td>
<td>Shams 1</td>
<td>Abu Dhabi / UAE</td>
<td>Total, Teyma, Abengoa Solar / Masdar</td>
</tr>
</tbody>
</table>
Other PPP projects include those developed under the Renewable Energy Independent Power Producer Procurement Program (REIPPPP) in South Africa, such as the Kathu Solar Park, the Ilanga CSP 1, the Xina Solar One project, the Bokpoort and the Redstone projects.

3.2.2 Independent Power Producer (IPP)

According to the definition by World Bank (1995), Independent Power Producers (IPPs) are typically limited liability, investor-owned enterprises that generate electricity either for bulk sale to an electric utility or for retail sale to industrial or other customers with certain conditions.

The IPP concept originated in the United States in the 1970s as a result of the 1972 Public Utility Regulatory Policies Act (PURPA), while the first international IPP project was completed in the early 1980s in Turkey (Kistner and Price, 1999). IPPs are therefore a result of privatization and economy liberalization in infrastructure in various parts of the world. Since the early 80s’, IPPs have taken various forms as the electricity markets evolved in various countries and regions. The evolutions are closely related to dynamics of structural/regulatory, economic/financial, technological, and environmental conditions.

IPPs are therefore non-utility generators, which provide the risk capital for the construction of the project, operate the asset, and take the business risk of the venture (Stadelmann et al., 2014).

APEC (1997) highlights some of the desirable features of IPP programmes, such as:

- IPPs have promoted open competition and thus encouraged lower cost development when conducted in a fully transparent environment;
- A sound structure of IPPs ensures that most of the project risks have been the responsibility of the private sector;
- The private sector has provided wider access to capital markets;
- The respective project’s financing is "off" the government’s balance sheet, allowing governments to allocate scarce resources to other priority areas;
- Governments have been able to benchmark existing public sector units in power generation against comparable private sector operations. This results in both IPPs and existing public utilities improving their performance.

The structure of an IPP project is presented in the following figure. One of the main differences with the PPP model is that the IPP is not engaging in any arrangement or concession agreement with the Government. Of course, IPPs can play an important role in the PPPs, by engaging in the establishment of the SPVs.
A CSP project in the MENA region developed as IPP is Dubai’s Mohammed bin Rashid Al Maktoum Solar Park.

3.2.3 Green Bonds

Although green bonds are not considered a stand alone financing mechanism, they are highlighted in this section on one hand due to their gradually growing importance in financing renewable energy projects, including CSP ones, and on the other due to the new opportunities they offer to actors engaged in the CSP value chain for the expansion of their current business model.

A green bond is differentiated from a regular bond by its label, which signifies a commitment to exclusively use the funds raised to finance or re-finance “green” projects, assets or business activities. Green projects are projects that promote progress on environmentally sustainable activities. Green bonds provide an opportunity to mobilize capital for green investments helping investors to make informed and explicit decisions. Green bonds are a means of attracting new investors and hence mobilizing liquidity for green investments (EC, 2016).

An indicative idea of how a bond project is structured is provided in the following Figure.
In 2011, one of the first green bonds for a CSP project was issued in the United States, namely the $702MM Project Bond for NextEra Genesis Solar, a single-site CSP project with a capacity of 250MW (Credit Agricole, 2016). In line with the same source, in Spain bonds have been issued in 2015 for Solaben 1 and 6 CSP plants by Abengoa (285 million €).

Other green bonds issued so far for CSP projects are summarised in Table 3.

Table 3: Green Bonds for CSP projects

<table>
<thead>
<tr>
<th>Bond Issuer</th>
<th>CSP Project</th>
<th>Financing (million)</th>
<th>Amount allocated to green projects (million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>African Development Bank Group (AFdB)</td>
<td>Noor I, Ouarzazate</td>
<td>168.00 €</td>
<td>93.29 €</td>
</tr>
<tr>
<td>AFdB</td>
<td>Noor II, Ouarzazate</td>
<td>72.00 €</td>
<td>71.16 €</td>
</tr>
<tr>
<td>AFdB</td>
<td>Noor III, Ouarzazate</td>
<td>28.00 €</td>
<td>26.08 €</td>
</tr>
<tr>
<td>AFdB</td>
<td>Xina Solar One</td>
<td>926.72 ZAR</td>
<td>839.26 ZAR</td>
</tr>
</tbody>
</table>

Source: Dentons (2016)

4 Analytical Framework

Business models since the early ‘00s have become a buzzword, that although is widely used, still a definition to be widely accepted by the business community and scholars is lacking (Björkdahl and Holmén, 2013, Shafera et al., 2005).

According to Biloshapka and Osiyevsky (2018), management scholars and practitioners generally agree that the primary functions of a business model are value creation and value capture. However, the meaning (conceptualization) of these terms, their measurement, and the factors and mechanisms affecting them remain contentious. Therefore, the business model concentrates on describing a company's or organisation's core strategy to generate economic value, normally in the form of revenue. This value creation can be identified across the whole value chain components, from the way a product is designed, manufactured and eventually marketed and sold.

The CSP industry comprises by many different actors with varying and sometimes complementary roles, as there are many companies active in several parts of the CSP value chain (see Table 1). In particular, some of these companies consider a key part of their business model to extend their activities throughout the value chain, thus having access to multiple revenue streams. Sosna et al. (2010) consider business model innovation as a strategic renewal mechanism for organizations facing changes in their external environment.

Considering the complexity in depicting the overlapping business models for the different actors in the CSP industry, this analytical framework focuses on identifying all the parameters affecting the CSP industry’s deployment, and thus the development and evolution of their business models.

To this end, in order to identify the opportunities, as well as the challenges for the evolution of the CSP industry’s business models, an answer to the following key questions was pursued:

- How familiarised is the CSP industry with the different support mechanisms and the main financing models in place?
- How are financial data, such as the debt and equity ratio requirements affected by external parameters?
- Which are the most important and most probable risk factors, as well as barriers, affecting a project’s implementation?
- Which are the key characteristics for the business models of the CSP industry in place?
- What is the value creation and companies’ activation over the CSP value chain?
- How can local companies outside EU be strengthened so as to contribute to the CSP value chain in their countries?

The varying parameters affecting the CSP industry’s deployment rate and structure are analysed in the following sections.
4.1 Support mechanisms and Financing Models

The support mechanisms in place are considered one of the most important factors for the deployment of renewable energy technologies, and CSP projects in particular. To this end, a review of the current support mechanisms for CSP projects in EU, the United States and the MENA region, where these projects have been implemented with the active engagement of EU companies was realised under Section 2. Summarising the findings of the review, the adopted support mechanisms include Feed in tariffs, Feed in premiums, Two tier tariffs, Tax incentives, Renewable portfolio standards (Quota systems) and Auctions, in line with Abolhosseini and Heshmati (2014) and Ecofys (2013).

Nevertheless, the business market is continuously evolving and new support mechanisms may be offered in the future. In this framework and considering the growing size of corporations at the international level, a new support mechanism, the Corporate Purchase Power Agreements (PPAs) was studied as well. A Corporate PPA allows corporate consumers to purchase power on a long term basis directly from renewable energy generators without being co-located (Bird & Bird). Corporate sourcing of solar and renewables is a growing phenomenon. In 2017 more than 1 GW of corporate renewable PPAs were signed in Europe12. Although this mechanism has never been used for CSP projects, it may offer an alternative for the future.

According to Lilliestam et al. (2018) for the further deployment of CSP, support mechanisms designed so as to both reward the key advantage of CSP – its dispatchability – and balance a firm downward cost pressure, so as to trigger cost reductions and new more efficient plant designs, are needed. A time-of-day bonus, a long term path for decreasing support, and a high or no capacity limit in the support schemes are possible and well-known ways to include these requirements in national auction or feed-in tariff systems.

Concerning financing for CSP projects, since it remains one of their most significant challenges, the familiarisation of the CSP industry with the financing models in place needs to be validated. So in line with Section 3.2, the models examined include PPPs, IPPs and Green Bonds. Also, considering BOT structure is one of the most widely used, it has been considered worth inquiring separately this parameter as well.

4.2 Impact of external parameters on financial data

The costs of attracting capital are an important aspect for the project developers in the financial profitability of the project. There are two important sources of capital for project developers: debt and equity. Debt is provided by banks and financial institutions, equity is obtained by (private) investors. Cost of equity can also be used as a proxy for investment risks: when equity can be attracted at lower costs, investors perceive low risk (Diacore, 2016).

According to IEA Technology Collaboration Programme (2017), to measure economics for solar projects, the two most important figures are the project internal rate of return (Project IRR) and the equity internal rate of return (Equity IRR). The project IRR is independent of the financing scheme or the sources of such capital. Concerning the interest rate, if it is lower than the project IRR, and there are lenders willing to cover part of the debt, the debt cost is lower than project IRR, and the remaining portion of its cash flow that is not needed to cover principal and interest of lenders can be used to pay dividends. As a consequence, the phenomenon of leverage effect takes place, namely the equity IRR is higher than the project IRR. Under a given electricity sales scheme such as a feed-in tariff, an equity investor would therefore strive to maximize leverage (debt share) in order to minimize his equity investment and maximize equity IRR. On the other side, in a process where competitiveness of the power price is key, a high leverage and low capital cost can contribute to the competitiveness of the project by lowering the capital cost (IEA Technology Collaboration Programme, 2017).

In line with the international literature (Zhang and Smith, 2008; Frisari and Feas, 2014; Caldes – Gomez and Dia – Vazquez, 2018), the debt / equity ratio in CSP projects can range from 75/25, to 70/30 and 60/40. Since it was considered by the consortium extremely difficult to acquire feedback from the CSP industry on the preferred debt / equity ratios per supporting structure, the analysis focuses on whether and how the debt ratio is affected by the use of different support mechanisms offered, as well as whether and how is the equity ratio affected by parameters, of which some are related to the risks and barriers encountered. Six parameters were selected by the authors, in collaboration with COBRA who provided the CSP industry viewpoint, as the prevailing ones for impacting on the sponsors’ decision making process, namely the policy and regulatory framework in the country, the project developer’s track record, PPAs in place, state guarantees, energy yield predictions and operator’s experience in similar types of projects.

4.3 Risks and Barriers

In the international literature there are numerous studies related to risks associated with the deployment of renewable energy. Besides studies addressing risks for the deployment of renewable energy projects in general (Diacore, 2016), there are many studies and commentaries that are CSP specific (Komendantova et al., 2012; Zou et al., 2012; Lilliestam and Patt, 2015; Schinko, 2015; Richardson, 2016).

The authors, based on the above literature, has selected the main risks that CSP investments are faced with as mentioned below:

- Policy risk: Low level of political stability in a country, including lack of support from local governments.
- Regulatory risk: Refers to the uncertainty regarding governmental energy strategy and power market deregulation and liberalisation.
• Country risk: Refers to a set of factors that can adversely affect the profits of all investments in a country. These factors include political stability, level of corruption, economic development, legal system and exchange rate fluctuations.

• Revenue risk: Uncertainties regarding governmental energy strategies, exchange rates, market distortions such as fossil fuels’ subsidies, limitations to energy market liberalization etc.

• Financial risk: Limited availability of local or international capital, lack of familiarity and skills with project finance structure, uncertainty regarding the long term solvency of project partners etc.

• Administrative risk: Refers to the difficulties, complexity and time required for project developers to acquire all related permissions and licenses.

• Technical risk: Risks regarding lack of infrastructures for grid connection, interconnections, as well as the efficiency of the technologies adopted.

• Transit risk: This relates to the transport of key components across long distances, often overseas, and potential damages in the equipment.

• Construction risk: Risks involved in the development of CSP plants, due to reasons such as lack of contractor experience, limited access to land and unclear land ownership etc.

• Operational risk: Risks concerning on-site fires and other incidents.

• Resources risk: Availability of natural resources, such as accurate measurements of DNI, land and water.

As regards the barriers, according to Schinko (2015), 42 factors have been identified across the nine risk categories described above. The authors in collaboration with COBRA, considering the interrelationship between some of these factors, as well as the need to simplify the number of parameters to be addressed to the CSP industry actors, have selected the following seven, in order to map their impact on CSP projects so far, as well as in the future:

• Sufficient incentives provided at the policy level through the PPAs.

• Instability of national regulations regarding the prices of the PPA.

• Exchange rates.

• Lack of interconnections.

• Land access and availability issues.

• Lack of CSP experience of the company itself.

• Lack of skilled contractors at local sites.

4.4 Characteristics of CSP industry business models

Considering the complexity issues for depicting the business models of different CSP actors as previously mentioned, the focus of the analysis lays on the adjustments that the companies have realised to their business models.
Richter (2013) discusses the business model conceptualisation and its respective pillars, namely:

- **Value Proposition pillar**: The value proposition describes the product or service that is offered to the customer, e.g. shifting from production of electricity at large amounts, to production under peak demand.
- **Customer interface pillar**: Comprises the overall interaction with the customer. It consists of customer relationship, customer segments, and distribution channels. This pillar has not been taken into consideration for the CSP business model.
- **Infrastructure pillar**: The infrastructure describes the company's organization of value creation. This section concentrates on the organizational structure, know-how and partnerships.
- **Revenues pillar**: Represents the relationship between costs to produce the value proposition and the revenues that are generated by offering the value proposition to the customers.

Based on the above framework, the validation of the CSP industry's business models aims to identify i) whether they maintain the original structure; ii) whether they have adapted the value proposition pillar, including other RE technologies or additional services; iii) whether they have adjusted the infrastructure pillar to include more stages of the CSP value chain; iv) the collaboration possibility with reliable manufacturers of CSP components in other countries was investigated, in terms of potential adjustment of the current business model; v) and finally whether the revenue model and profit margin has been adjusted to cope with the lower prices of the PPAs offered.

### 4.5 Value created over the CSP value chain

The value creation along the CSP value chain is considered to provide a reliable indicator of the collaboration opportunities or the conflicting interests between the different actors. Therefore, the focus is placed on identifying the contribution of each pillar in the overall creation of value, as well as whether the conditions are mature enough for collaborations to be realised with local actors at host countries outside EU.

In line with the analysis conducted under Section 3.1, the following steps of the value chain have been adopted: i) Project Development; ii) Materials production and supply; iii) Components (key, secondary, other) production and supply; iv) Plant Engineering and Construction; v) Operation and Maintenance.

### 4.6 Strengthening local elements of the CSP value chain

Having mapped the maturity of local collaborators across the different levels of the CSP value chain in non EU countries, the main drivers required for enhancing their operation are surveyed per CSP component.

The components’ classification differentiates from the one previously used, as it has been more thoroughly analysed in order to include all potential services offered by local stakeholders, such as
civil works, installations, EPC engineering, assembling, construction of receivers / mirrors, mounting structures, heat transfer fluid, connection piping, storage system and electronic equipment (Worldbank 2011).

The main drivers have been identified by the WorldBank (2011) report and include:

- attractiveness of local markets,
- technology transfer for capacity building,
- technological expertise, including precision of processes and lifetime stability,
- training and education of workforce, including structure and skills of the workforce,
- large financial investments in production capacities;
- competitive location factors including attractive costs for local manufacturing, availability of required raw materials, and infrastructure and logistic networks;
- improvement of quality standards;
- improvement of regulatory framework with financial and legal issues.

This analytical framework has been utilized in the methodological approach adopted in order to get the CSP industry’s insights, as presented in the next chapter.
5  METHODOLOGICAL APPROACH

The methodological approach adopted in order to gain some insights from the CSP industry regarding the parameters affecting its deployment, and thus the development and evolution of their business models, was based on the following three steps:

• Step 1: Literature review.
• Step 2: Development of analytical framework.
• Step 3: CSP industry survey.

These steps are analysed in more detail in the following paragraphs.

5.1 Literature survey

An extensive literature review was realised, covering all thematic areas related to the business models’ structure for the CSP industry. The focus of the search was placed on identifying all the relevant literature, accompanied with tangible examples. The main areas studied include:

• the support mechanisms used for CSP deployment at a worldwide basis, although emphasis was placed in countries where EU companies’ engagement is significant,
• the CSP value chain components and how these are addressed by the EU CSP industry,
• the financing models in place and examples of CSP projects developed in line with them,
• the financing parameters that may affect the business model adopted,
• business opportunities for collaboration created in upstream or downstream activities,
• risks and barriers for CSP development.

The desk survey conducted covered scientific papers, reports from industry and research organizations, as well as other institutions (the European Commission, IRENA, OECD, IEA, Worldbank etc.). Also, news items from newspapers, governmental and CSP company websites were reviewed.

5.2 Analytical Framework

Based on this literature review conducted, an initial set of 15 questions was drafted, touching upon the financing, business and industrial environment regarding the deployment of CSP.

Considering that many of these questions were addressing a multidisciplinary set of subjects, and several actors within a company should be engaged in order to get the proper feedback, while also overall time limitations needed to be considered, following consultation with COBRA and ESTELA, these questions were restructured, reaching a final number of nine (9).

The final topics selected, although they cover a variety of issues, are characterised by the following parameters:
• Broad geographical range of CSP projects, with focus on countries where EU CSP industry has a strong presence.
• Broad time period of tools / mechanisms used for CSP projects, as many of these have been used for several years, with their variations.
• Risks and parameters affecting primarily the core parts of the CSP value chain, and not industrial actors with small exposure to CSP.

In the selection of the parameters and the formulation of the questions, extensive collaboration with COBRA took place, besides the rest of the partners’ contribution, resulting in the questionnaire’s final format through review and comments.

5.3 CSP Industry Survey

The main focus of this survey was to map to the extent possible some aspects of the decision making process the EU CSP industry makes regarding the implementation or not of a new project.

To this end, the European Solar Thermal Electricity Association (ESTELA) undertook the conduction of the survey among its members. The questionnaire was shared electronically for the 1st time on January 21st, and follow up rounds of reminder e-mails were sent out on February 8th and February 21st. Also, the questionnaire was distributed in a printed form during ESTELA’s general assembly meeting on the 1st of February 2019.

Overall, out of the 30 members contacted, only 5 questionnaires were collected. The companies’ answering will remain anonymous for confidentiality reasons, besides COBRA, which consented to be mentioned. The response rate is around 17%, which is not considered satisfactory overall. Nevertheless, this is understandable considering that there is only a handful of companies activated in the EU CSP industry sector, especially plants owners and developers, while some of the companies receiving the survey found it not relevant to their experiences. Additional reasons are assumed to be the questionnaire’s higher complexity, and in particular the multidisciplinary nature of the questions, requiring the engagement of more than one actor from each company, while confidentiality concerns cannot be ruled out.

Due to the nature of the survey’s topic itself, these challenges were known to the authors’ team in advance, and all possible efforts were placed in order to tackle them to the extent possible, as previously described. However, this doesn’t refute the usefulness of the exercise, and the fact that meaningful conclusions were derived.
6 Survey Results

The first question’s aim was to map the experience of the CSP industry with the different support mechanisms in place so far, as well as its willingness to realise a CSP project using these mechanisms in the future.

The responses to “How would you characterize your company’s CSP experience with these support schemes so far?” in a scale of -3 to 3 are presented in Figure 5.

As expected, the feed in tariffs were the option that all companies expressed high familiarization, closely followed by relevant support schemes such as feed in premiums and two tier tariffs. On the other hand green certificates (quota systems or renewable portfolio standards) where the ones that only one company expressed a satisfactory familiarization.

With reference to “How probable would be for your company to implement a CSP project in a country under this support scheme?” question, the responses are available in Figure 6.

Compared to the previous question, the answers are more or less at the same level, besides a significant increase primarily for Corporate PPAs, and to a second degree for two tier tariffs.
The second question was exploring the connection between the debt ratio and the type of support mechanism adopted, and was phrased as “How strongly you believe the debt ratio for a CSP project would be increased based on the type of support mechanism adopted?”. 

It should be noted that the question was answered by 4 out of 5 companies. As expected, the support mechanism considered more reliable by the developers in order to ensure higher debt ratios is feed in tariffs, followed close by feed in premiums and two tier tariffs. The mechanism considered less probable to ensure a higher debt ratio is green certificates, followed by corporate PPAs and tax incentives.
The third question was exploring another financing source of CSP projects, namely equity funding, and its relation with selected uncertainty parameters, and more specifically “how uncertainties in each parameter affect the equity ratio required by project financiers?”

![Figure 8: Equity ratio and uncertainties](image)

With regards to the uncertainties impacting more severely on the equity ratio, those of financial and regulatory nature where ranked significantly higher compared to the technical ones, including the operators’ track record. This is mainly attributed to the fact that the technical related questions received varying rates, with some responses stating that forecasts are so secure today that this parameter is not really affecting the decision making process.

Additional uncertainties mentioned by the respondents include offtaker’s bankability, O&M contractor’s guarantees and EPC warranties and performance guarantees, all with significant impact on the equity ratio.

Next question focused on the experience of the CSP industry with the different financing models available. 4 out of 5 companies answered it and the results are presented in Figure 9.

All companies demonstrated experience in working as independent power producers, while only half of them had experience in public – private partnerships. Only 1 out of 4 was familiarized with the concept of the Green bonds as well as BOTs.
Question No.5 focuses on the importance and probability of each risk for the realization of a CSP project. More specifically, the results to the question “How important is each risk on your decision for the realization of a project?” are presented in Figure 10, while responses to “How probable is each risk during the implementation of a CSP project?” are presented in Figure 11.

The risk with the highest impact on the CSP industry’s decision on whether to realise a project or not is the regulatory one, followed closely by the policy and revenue risks. Next in line are the financial and country risks. The least important ones seem to be the administrative risk, followed by the technical and transit risks.
Considering the probability of these risks, the overall picture is not as clear as before. Financial risks demonstrate the most significant probability, followed closely by the resources and country risks at the second place. The least probable risk seems to be the technical one, but this is due to the largely varying answers, and cannot thus be considered reliable.

The sixth question focuses on rating selected parameters of the above risk categories with regard to their overall weight on the implementation of a CSP project so far and in the future. Figure 12 presents “How has each barrier affected on the implementation of your CSP projects so far?”

**Figure 11: Probability of risk categories during project implementation**

**Figure 12: Barriers affecting CSP project implementation so far**
Consistent to the previous question, the most important barriers relate to the regulatory (instability of national regulations regarding PPA prices) and policy risks (sufficient incentives provided), and the least important ones to the construction risk (lack of CSP experience and skilled contractors). Lack of infrastructures (technical risk) scores significantly higher compared to the overall risk category, but this can be attributed to the reasons explained above. Impressive is also the inconsistency regarding the resources risk, which although it scored really high in the risk categories, the relevant barrier (land access and availability issues) is considered to be a parameter of medium importance.

The overall picture remains the same for the expected barriers to CSP projects in the future (Figure 13). The only parameters demonstrating a mild reduction are the lack of interconnections, the lack of experience of the company itself, as well as skilled local contractors, which considering the technology’s learning curve, as well as the interconnections’ set targets at the EU level, pose a declining trend.

The following question tries to identify the qualitative characteristics of the business models adopted by the CSP industry, and any changes realised so far. To this end, the companies were asked to “indicate with a Yes or No the characteristics that apply in your company’s business model, and provide a short explanation in case of a positive answer”.

Six specific characteristics were included in this question, and the results are displayed in Figure 14. It should be noted that one company didn’t answer the last question.

**Figure 13: Barriers potentially affecting CSP project implementation in the future**

![Bar chart showing the categories of barriers and their scores](chart.png)
The first conclusion is that the CSP industry has taken the necessary measures in order to adjust and adapt to the changing situation, by including additional services and covering more stages of the CSP value chain. In the initial data provided by the companies when filling in the questionnaire, their profile is described as EPC and / or technology providers. Additional services offered include provision of consultancy and engineering services, quality assurance and optimization and financing. With regards to the CSP value chain, additional stages include project development, O&M services, technology construction and supply (main components). The majority of the companies have changed their business models’ value proposition by adding other technologies, namely PVs; however some other companies mention flexibility in using renewable technologies, depending on the specific needs.

The eighth question focuses on the percentage of the value chain created per phase, as presented in Figure 15 below.

The phase contributing the most to the CSP value chain is related to the components, followed by the EPC process. The remaining phases (project development, materials, O&M) are at similar contributions.
The majority of the companies answered were covering all CSP phases besides materials in their business model. Moreover, they all consider the conditions mature enough for all CSP value chain phases to be undertaken at the host country, outside EU, partially (40% of the answers) or fully (60%).

With regard to the last question, the companies were asked to evaluate the required conditions in order to enhance CSP local manufacturing in countries outside EU. The CSP value chain was broken down in more specific components, in line with the report by Worldbank (2011). The results per component are presented in Figure 16. It should be noted that not all conditions were considered relevant per component; that is the reason that some components have been evaluated against fewer parameters compared to the rest.

Local demand is considered the most important parameter for the production of relevant components such as receivers, mirrors, and connection piping, followed closely by electronic equipment and mounting structures.

Improvement of quality assurance standards plays a significant role across all components, receiving though the highest scores in installation, assembling and civil works, as well as specific components produced, such as receivers and mirrors. The components with the lowest scores for this parameter were EPC engineering and electronic equipment.

Training/ education has a significant contribution primarily in installation works, and secondarily to the construction of CSP components such as receivers, mirrors, connection piping, electronic equipment and storage system.
Competitive location factors seem to have a slightly higher impact on civil works, mounting structures, heat transfer fluid and connection piping, while technological know how is mainly needed in storage systems, followed by EPC and electronic equipment.

On the other hand, parameters such as financial investments required were considered to have an average contribution only to components such as mirrors and heat transfer fluids. The same impact was considered to have also the investment and regulatory framework on components, such as receivers, mirrors and mounting structures.
7 Financing Opportunities

Section 2 focused on a thorough review conducted on the support mechanisms adopted for the deployment of CSP in countries where the European CSP industry has an active presence. Concerning EU, the analysis’ focus was on Spain, as the pioneering country that has developed this technology, considering that in the rest of the EU countries the CSP deployment is at very low levels. More specifically, according to the CSP guru database\(^{13}\), there is only the Alba Nova 1 Fresnel power station of 12 MW in operation in France and the Archetype SW550 Trough Power station of 30 MW in Italy, still under construction. The change of the regulatory framework in Spain and the cancellation of the FIT scheme acted as a signal to the rest of the EU countries, which gradually phased out the adoption of these schemes.

Under Section 3.2, an overview of the financing models (PPPs, BOT, IPPs, Green Bonds), also applicable for CSP projects was provided, accompanied by indicative CSP projects that have been deployed so far utilising these models. From the examples provided, it is evident that these financing models have been used so far for CSP projects indicatively in Morocco, Israel and Abu Dhabi, but not in EU countries. This doesn’t mean of course that in the future, the same models won’t be used for EU based CSP projects, provided that the overall conditions for their deployment are more favourable.

Having therefore surveyed the support mechanisms, as well as the financing models that can potentially also impact on the business models of the CSP industry, this chapter focuses on the financing opportunities currently available for CSP projects at the EU level.

Considering that at the time of this report, it was a transition period for all the programs ending in 2020 and the new ones waiting to be launched, the following figure presents where each of the existing, as well as the future tools to be presented under this section, could support low carbon energy related technologies.

\(^{13}\) [https://csp.guru/](https://csp.guru/)
7.1 Innovation Fund

Demonstration projects of innovative renewable energy and energy storage are eligible for support under the Innovation Fund, a financing instrument put forward through the legislative proposal for the revision of the European Union Emission Trading Scheme (EU ETS) directive (COM (2015) 337).

The Innovation Fund is a part of a larger landscape of both national and EU funding instruments, many of which include low-carbon technologies as a focus area (European Commission, 2019):

- It will complement EU research and innovation efforts, currently funded through the Horizon 2020 programme, and in the next Multi-annual Financial Framework (MFF) via the Horizon Europe programme.
- It also complements EU funding tools which catalyse investment into market-ready low-carbon technologies and infrastructure, such as InvestEU, the Connecting Europe Facility (CEF), the LIFE programme, the Modernisation Fund (as set up by the revised EU ETS Directive and financed from EU ETS revenues), and the Cohesion Funds.

The Innovation Fund synergies are also presented in the following figure.
Therefore, the Innovation Fund will focus on highly innovative technologies and big flagship projects with European added value that can bring on significant emission reductions, aiming towards sharing the risk with project promoters to help with the demonstration of first-of-a-kind (FOAK) projects\(^\text{14}\). In line with the Climate and Strategy Partners Report (2017), at least 400 million allowances should be reserved from 2021 onwards for this purpose. In addition, a further 50 million of the unallocated allowances from 2013-2020 should be set aside, together with remaining funds from the second call of the existing NER 300 Programme, to enable earlier support to eligible projects, before 2021.

The first call is expected to be launched by the Commission in 2020, followed by regular calls until 2030. The Innovation Fund will support up to 60% of the additional capital and operational costs linked to innovation. The grants will be disbursed in a flexible way based on project needs, taking into account the milestones achieved during the project lifetime, while up to 40% of them can be given based on pre-defined milestones, before the whole project is fully up and running\(^\text{13}\).

### 7.2 Modernisation Fund

The revised ETS Directive\(^\text{15}\) for 2021-2030 establishes a Modernisation Fund to support low-carbon investments in the energy systems and modernising the power sector by boosting energy efficiency and renewable energy, and facilitating a just transition in carbon-dependent regions of 10 EU

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Member States: Bulgaria, the Czech Republic, Croatia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania and Slovakia\textsuperscript{16}.

The fund will be sourced with allowances corresponding to 2% of the total quantity in phase 4 (2021-2030) of the EU – ETS framework, auctioned in accordance with the rules and modalities set out for auctions taking place on the common auction platform\textsuperscript{16}.

As the Modernisation Fund is still under design, it is not clear whether it could be a financing opportunity for CSP, although it focuses on promoting Renewable Energy Technologies (RETs) in the power sector.

7.3 Horizon 2020

The grant-based H2020 programme can be utilised for innovation actions to support low carbon technologies and services. The H2020 work programme 2018-2020 includes topics for solar technologies including CSP and PV, to bring the technology from TRL 4-5 to TRL 6-7. The EC considers proposals requesting a contribution from the EU budget ranging between 2-5m\(\text{€}\) to 15-20m\(\text{€}\) for higher TRLs. This means that Horizon 2020 is only suitable for solar FOAK projects, and more specifically concerning the proof of concept, namely to open the project’s test sites, pilot and demonstration facilities (Caldes- Gomez and Diaz – Vazquez, 2018).

Upon its completion, it will be replaced in the next Multi-annual Financial Framework (MFF) via the Horizon Europe programme, currently under design.

7.4 European Structural and Investment Funds

Objective of the European Structural and Investment Funds (ESIF) is to invest in job creation and sustainable economy growth. ESIF comprises of five main funds, working together to support economic development across all EU countries, in line with the objectives of the Europe 2020 strategy\textsuperscript{17}:

- European Regional Development Fund (ERDF)
- European Social Fund (ESF)
- Cohesion Fund (CF)
- European Agricultural Fund for Rural Development (EAFRD)
- European Maritime and Fisheries Fund (EMFF)

All EU regions may benefit from the ERDF and ESF. However, only the less developed regions may receive support from the Cohesion Fund.

\textsuperscript{16} COM(2018) 842 final, Report on the functioning of the European carbon market
\textsuperscript{17} https://ec.europa.eu/regional_policy/en/funding/
During the programming period 2014–2020, ESIF play an essential role in promoting innovation in the field of energy, through boosting the shift towards a low-carbon economy in all sectors. Around € 40 billion have been allocated by the Cohesion Policy funds (ERDF, ESF and CF) to these objectives in the energy field, namely under Thematic Objective 4 (TO4) on “Supporting the shift towards a low-carbon economy” 18. Both thematic objectives under ERDF, namely TO1 on “Strengthening research, technological development and innovation” and TO4 can assist the deployment of renewable energy technologies, and especially of solar FOAK projects.

7.5 InnovFin Energy Demonstration Projects

InnovFin Energy Demonstration Projects (EDP) is directly deployed by the European Investment Bank (EIB). InnovFin EDP provides loans, loan guarantees or equity-type financing typically between EUR 7.5 million and EUR 75 million to innovative demonstration projects in the fields of energy system transformation, including but not limited to renewable energy technologies, smart energy systems, energy storage, helping them to bridge the gap from demonstration to commercialisation19.

This programme is highly suitable to support solar FOAK projects.

7.6 European Funds for Strategic Investment

European Funds for Strategic Investment (EFSI) is an initiative launched jointly by the EIB Group – the European Investment Bank and European Investment Fund – and the European Commission to help overcome the current investment gap in the EU. EFSI is a EUR 26 billion guarantee from the EU budget, complemented by a EUR 7.5 billion allocation of the EIB’s own capital, totalling an amount of EUR 33.5 billion, aiming to unlock additional investment of at least EUR 500bn by 2020.20

EFSI among others focuses on strategic infrastructure on energy, as well as renewable energy and resource efficiency and in particular of investments that are difficult to be financed through the market. Projects under the EFSI need to address sub-optimal investment situations and market gaps as part of the eligibility criteria. Also, projects supported under the EFSI need to reinforce the concept of additionality. In other words, only projects that would not have happened at the same time or to the same extent without EFSI financing should be chosen. Further to the above, in view of their importance for the electricity single market, cross-border infrastructure projects (including services) have been identified as providing additionality (Caldes- Gomez and Diaz – Vazquez, 2018).

An overview of the financial schemes supporting FOAK projects is presented in Table 4.

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### Table 4: Financial schemes supporting solar FOAK projects in the EC (to TRL 9 with its emphasis on deployed and proven technologies)

<table>
<thead>
<tr>
<th>Scheme</th>
<th>Type of instrument</th>
<th>Delivery body</th>
<th>Status</th>
<th>Budget</th>
<th>Project Funding level</th>
<th>Suitability for the solar FOAK project</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>InnovFin EDP</strong></td>
<td>Loans and guarantees</td>
<td>EC: (DG RTD 100% guarantees) + EIB</td>
<td>First come served</td>
<td>300 m€ + 438m€(3) (to 2020)</td>
<td>7.5m€-75m€ (most common) 50-60% co-financing(2)</td>
<td>Very High: Innovative demonstration projects in the fields of energy system transformation, helping to bridge the gap from demonstration to commercialization.</td>
</tr>
<tr>
<td><strong>Innovative Funds</strong></td>
<td>Grants, debt, equity</td>
<td>EC (DG CLIMA), EIB, MS</td>
<td>Proposed (2021-2030) Inspired at InnovFin EDP</td>
<td>2bn€</td>
<td></td>
<td>High: Next financial perspective</td>
</tr>
<tr>
<td><strong>European Funds for Strategic Investment</strong></td>
<td>Loans and loan guarantees</td>
<td>EC and EIB</td>
<td></td>
<td>21bn€</td>
<td>50m€-75m€(3)</td>
<td>Medium: Current projects have not shown high appetite for risk</td>
</tr>
<tr>
<td><strong>H2020 projects</strong></td>
<td>Most grants</td>
<td>EC</td>
<td>Work program 18-19(4)</td>
<td>30bn€</td>
<td>10m€-15m€</td>
<td>Low: Applications for Innovation Actions bringing the technology from TRL 5-6 to 6-7</td>
</tr>
<tr>
<td><strong>InnovFin large project</strong></td>
<td>Loans and guarantees</td>
<td>EIB</td>
<td></td>
<td>25bn€ (to 2020)</td>
<td>25 - 300 m€</td>
<td>Medium: It has shown low appetite for risk.</td>
</tr>
<tr>
<td><strong>European Structural and Investment Funds</strong></td>
<td>Grants, loans, equity</td>
<td>EC (DG REG) + MS</td>
<td>Work program 2014-20</td>
<td>5.8 bn€ for T&amp;D-RES</td>
<td></td>
<td>Medium: No evidences for SET FOAK at Inter regional level.</td>
</tr>
</tbody>
</table>

(1) The InnovFin EDP instrument has already been amended to enable it to absorb unspent NER 300 funds. Consequently, extra resources coming from NER 300 are foreseen to become available through InnovFin EDP towards the end of 2017. The instruments that are foreseen to be used for this exercise, as they can ensure timely support to projects of a similar scope, are InnovFin Energy Demo Projects (EDP) and Connecting Europe Facility (CEF) Debt. The former can finance projects in innovative renewable energy, CCS, smart energy systems and storage; the latter the use of renewables in the transport sector. Both are managed by the European Investment Bank.

(2) The threshold for NER 300 is 50% although smaller interventions have been committed. Under the proposed Innovation Fund, up to 60% of relevant project costs may be supported.

(3) Unspecified. However, in the renewables and resource efficiency space, projects to date suggest that a minimum of 50-75m€ is put forward for a guarantee under the Fund.

(4) The adoption and the publication of the work programme by the EC are expected in October 2017.

Source: Caldes-Gomez and Diaz – Vazquez, 2018
8 CONCLUSIONS

This report aimed initially at the mapping of the CSP projects’ structure and value chain, so as to identify the applicable business models in the CSP industry, as well as the identification of the available financing opportunities.

Considering the challenging business environment that the CSP industry is activated in, given the stall observed in CSP projects’ deployment in EU, and the relatively low development rate in other markets, a higher adaptability is observed among the companies that still remain active.

Since no business model fits all cases, an extensive review for the identification of the parameters that could affect the evolution of the CSP industry’s business models, in collaboration with a CSP industrial stakeholder, COBRA, was realised.

These parameters include the familiarisation of the CSP industry with different support mechanisms applied in the host countries, as well as varying financing models, the risks and barriers for the implementation of an investment, the key characteristics of the business models of the CSP industry in place, the value creation across the CSP value chain, as well as the potential role and contribution in the CSP value chain of local actors in the host countries.

As mentioned before, the restricted engagement of the CSP industry in the survey allows us to draw some interesting preliminary conclusions, but not extract fully valid trends. More specifically, the results from the survey among the CSP industry demonstrate that:

- The FiT scheme was as expected the support mechanism that all stakeholders were familiarized with. Nevertheless, although their familiarization with other support mechanisms was evaluated as average, besides green certificates which ranked really low, they all express their high willingness to invest in CSP in the future under these support mechanisms and especially FiTs, two tier tariffs, corporate PPAs, feed in premiums (FIPs) and auctions. Tax incentives as a stand alone support mechanism has medium impact, while green certificates rank even lower, as a possible sign of negative experience with their use. Therefore, although FITs are not being further applied, it is evident that other support mechanisms can be the basis for the further deployment of CSP.
- The debt ratio ensured for a CSP project is highly related to the support mechanism applied, with higher debt ratios achieved primarily with FiTs, FIPs and two tier tariffs, and secondarily with auctions. Debt ratios achieved with tax incentives and green certificates remain at lower levels again, while also corporate PPAs are ranked last to this aspect.
- Regarding the equity ratio required by project financiers, the parameters whose uncertainty mostly affects it are the PPAs price, the state guarantees and the policy and regulatory framework of the host country; they are therefore of mainly policy and financial nature. The
technical related parameters, such as energy yield projections, project developer’s track record and operator’s experience were assigned a medium significance.

- The CSP industry is primarily familiarized with the IPPs financing model, followed by the PPPs. Green bonds and BOTs scored significantly lower.

- The risks weighting the most during the decision making process for the realization of a CSP investment or not are primarily the regulatory risk, followed closely by the policy and revenue risks. This is in line with a previous question on the equity ratio. At a medium to high level were ranked the financial and country risks, while at a low to medium level were evaluated the construction and operational risks, as well as the resources associated risks. The lowest scores were achieved by the technical, administrative and transit risks.

- As regards the probability of the above risks, the situation changes, with the financial, resources and country risks ranking the most, but none of them exceeding an average score of 1.5. At low to medium level is the probability of regulatory and revenue risks, while low to very low is considered the probability of operational and policy risks. Construction and transit risks have a very low probability, while technical risks at the operational phase have zero probability.

- The specific barriers having affected the most on the CSP projects’ implementation so far are incentives provided at the policy level through the PPAs, followed by the instability of national regulations regarding the PPAs price. Exchange rates, land availability issues and lack of interconnections scored at a medium level, with the lowest barriers being the lack of experience of the company and local contractors in the host country. Considering the significance of the above mentioned barriers for future CSP project implementation, the overall picture remains the same, as evidence of the CSP industry’s belief that nothing is expected to change in the near future.

- The adaptability of the CSP industry’s business models is evident, as 60% of the companies have proceeded in adjustments, by covering more stages of the CSP value chain and including additional services, such as provision of consultancy and engineering services, quality assurance and optimization and financing. With regards to the CSP value chain, additional stages include project development, O&M services, technology construction and supply (main components). The majority of the companies have changed their business models’ value proposition by adding other technologies, namely PVs, but other RETs as well, depending on the case.

- When considering the CSP value chain, the phase contributing the most is related to the components (46%), followed by the EPC process (24%). The remaining phases (project development, materials, O&M) are at similar contributions, around 10% each. The majority of the companies answered were covering all CSP phases besides materials in their business model.

- Concerning the most important conditions for enhancing local manufacturing of CSP components in the host countries, these include the increase of local demand connected to the
production of key components, followed by quality assurance standards that play a significant role across all components and training/education, especially concerning installation works.

It seems that overall the CSP industry has been forced to make adjustments to its original business models, by adding additional services and covering more stages of the CSP value chain, reaching approximately 50% of these stages. Moreover, due to the CSP deployment rates, they have been forced to modify their value proposition, by adding other technologies. The conditions are considered mature enough for all CSP value chain phases to be undertaken at the host country, outside EU, partially or fully.

Considering that the revenue, policy and regulatory associated risks and barriers are ranked the highest, it is expected that the transformation of the electricity market, so that ancillary and balancing services are provided, combined with the carbon emission allowances, will offer additional revenue streams. Moreover, the type of support mechanism offered is not considered as crucial as its stable application. Technical related barriers are not a significant concern for the CSP industry, while for project financiers they are taken into consideration, but are not their primary concern.

Finally, as regards the financing opportunities available at EU level, although currently it is a transition period as we reach 2020, the existing programs as well as the future ones planned are designed so as to support primarily demonstration technologies.
9 REFERENCES


Dentons (2016). “A guide to project finance”.


10 APPENDIX

CSP Industry Questionnaire

This survey is conducted within the EU H2020 financed project Market Uptake of Solar Thermal Electricity through Cooperation – MUSTEC.

All answers provided will remain confidential, and only aggregated data will be published. Please fill in your company’s details below and answer all questions, unless indicated otherwise, from -3 to 3, in line with the below guidelines.

Please return the filled in questionnaire by **February 11th**. For any questions or clarifications needed, do not hesitate to contact us.

<table>
<thead>
<tr>
<th>Company name</th>
<th>Country based</th>
<th>Countries activated</th>
<th>Industry type</th>
</tr>
</thead>
</table>

Please rate all questions, unless indicated otherwise, from -3 to 3 with the following match to the linguistic variables

-3: Extremely low
-2: Very low
-1: Low
0: None
1: High
2: Very high
3: Extremely high
Question No. 1: Please rate each support scheme mentioned below on a scale of -3 to 3, taking into consideration its current and future impact on your company’s CSP projects. These support mechanisms cover a wide geographical area, and more than one may be applicable in your case, depending on the countries the company is active.

<table>
<thead>
<tr>
<th>Support Scheme</th>
<th>How would you characterize your company’s CSP experience with these support schemes so far?</th>
<th>How probable would be for your company to implement a CSP project in a country under this support scheme?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed in tariffs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feed in premiums</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two tier tariffs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tax incentives</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auctions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green certificates (Quota/Renewable Portfolio Standard)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corporate PPAs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Support Scheme: Please fill in</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note: During its expansion, CSP has met a variety of support mechanisms that allowed (or prohibited) its deployment. Tax/investment incentives were given in the US, the FiT mechanism was applied in Spain, auctions with strong state involvement were organized in Morocco, a two-tier tariff was set up in South Africa.*

Question No. 2: Please indicate on a scale of -3 to 3, how strongly you believe the debt ratio for a CSP project would be increased based on the type of support mechanism adopted.

<table>
<thead>
<tr>
<th>Support Mechanism</th>
<th>Debt ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed in tariffs</td>
<td></td>
</tr>
<tr>
<td>Feed in premiums</td>
<td></td>
</tr>
<tr>
<td>Two tier tariffs</td>
<td></td>
</tr>
<tr>
<td>Tax incentives</td>
<td></td>
</tr>
<tr>
<td>Auctions</td>
<td></td>
</tr>
<tr>
<td>Green certificates (Quota/Renewable Portfolio Standard)</td>
<td></td>
</tr>
<tr>
<td>Corporate PPAs</td>
<td></td>
</tr>
<tr>
<td>Other Support Mechanism: Please fill in</td>
<td></td>
</tr>
</tbody>
</table>

Question No. 3: Please rate on a scale of -3 to 3 according to your knowledge, how uncertainties in each parameter affect the equity ratio required by project financiers.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Impact on equity ratio required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Yield Predictions</td>
<td></td>
</tr>
<tr>
<td>Policy and regulatory framework of the host country</td>
<td></td>
</tr>
<tr>
<td>Project developer’s tracking record, including experience in the host country</td>
<td></td>
</tr>
<tr>
<td>Operator’s experience in similar types of projects</td>
<td></td>
</tr>
<tr>
<td>Power Purchase Agreement price</td>
<td></td>
</tr>
<tr>
<td>State guarantees</td>
<td></td>
</tr>
<tr>
<td>Other Parameter: Please fill in</td>
<td></td>
</tr>
</tbody>
</table>
Question No. 4: Please indicate with a tick symbol the financing models you have used for financing any of your CSP projects

<table>
<thead>
<tr>
<th>Financing model</th>
<th>Has been used for financing a CSP project by your company</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green Bonds</td>
<td></td>
</tr>
<tr>
<td>Build – Operate – Transfer (BOT)</td>
<td></td>
</tr>
<tr>
<td>Independent Power Producer (IPP)</td>
<td></td>
</tr>
<tr>
<td>Public – Private Partnership (PPP)</td>
<td></td>
</tr>
<tr>
<td>Other financing model: Please fill in</td>
<td></td>
</tr>
</tbody>
</table>

Question No. 5: Please rate each risk on a scale of -3 to 3, taking into consideration its overall weight (importance and probability) on your decision making process

<table>
<thead>
<tr>
<th>Risk category</th>
<th>How important is each risk on your decision for the realization of a project?</th>
<th>How probable is each risk during the implementation of a CSP project?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Policy risk</td>
<td></td>
<td></td>
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<tr>
<td>Regulatory risk</td>
<td></td>
<td></td>
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<tr>
<td>Country risk</td>
<td></td>
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<tr>
<td>Revenue risk</td>
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<tr>
<td>Financial risk</td>
<td></td>
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<tr>
<td>Administrative risk</td>
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<tr>
<td>Technical risk</td>
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<tr>
<td>Transit risk</td>
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<tr>
<td>Construction risk</td>
<td></td>
<td></td>
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<tr>
<td>Operational risk</td>
<td></td>
<td></td>
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<tr>
<td>Resources risk</td>
<td></td>
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<tr>
<td>Other risk: Please fill in</td>
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</tr>
</tbody>
</table>

- Policy risk: Low level of political stability in a country, including lack of support from local governments.
- Regulatory risk: Refers to the uncertainty regarding governmental energy strategy and power market deregulation and liberalisation.
- Country risk: Refers to a set of factors that can adversely affect the profits of all investments in a country. These factors include political stability, level of corruption, economic development, legal system and exchange rate fluctuations.
- Revenue risk: Uncertainties regarding governmental energy strategies, exchange rates, market distortions such as fossil fuels’ subsidies, limitations to energy market liberalization etc.
- Financial risk: Limited availability of local or international capital, lack of familiarity and skills with project finance structure, uncertainty regarding the long term solvency of project partners etc.
- Administrative risk: Refers to the difficulties, complexity and time required for project developers to acquire all related permissions and licenses.
- Technical risk: Risks regarding lack of infrastructures for grid connection, interconnections, as well as the efficiency of the technologies adopted.
- Transit risk: This relates to the transport of key components across long distances, often overseas, and potential damages in the equipment.
- Construction risk: Risks involved in the development of CSP plants, due to reasons such as lack of contractor experience, limited access to land and unclear land ownership etc.
- Operational risk: Risks concerning on-site fires and other incidents.
- Resources risk: Availability of natural resources, such as accurate measurements of DNI, land and water.
Question No. 6: Please rate the selected parameters mentioned below, associated to the risks of Question No. 5, on a scale of -3 to 3, taking into consideration its overall weight on the implementation of a CSP project so far and in the future

<table>
<thead>
<tr>
<th>Parameter</th>
<th>How has each barrier affected on the implementation of your CSP projects so far?</th>
<th>How significant is each barrier on the implementation of potential CSP projects in the future?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sufficient incentives provided at the policy level through the PPAs</td>
<td></td>
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</tr>
<tr>
<td>Instability of national regulations regarding the prices of the PPA</td>
<td></td>
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<tr>
<td>Exchange rates.</td>
<td></td>
<td></td>
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<tr>
<td>Lack of interconnections</td>
<td></td>
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<tr>
<td>Land access and availability issues</td>
<td></td>
<td></td>
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<tr>
<td>Lack of CSP experience of the company itself</td>
<td></td>
<td></td>
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<tr>
<td>Lack of skilled contractors at local sites</td>
<td></td>
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</tr>
</tbody>
</table>

Question No. 7: Please indicate with a Yes or No under the respective column the characteristics that apply in your company’s business model, and provide a short explanation in the second column in case of a positive answer

<table>
<thead>
<tr>
<th>Business Model characteristics</th>
<th>Yes / No</th>
<th>Short explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>The company maintains its original business model structure</td>
<td></td>
<td></td>
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<tr>
<td>The company has adapted its business model value proposition, including other RE technologies. If yes, which?</td>
<td></td>
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</tr>
<tr>
<td>The company has adapted its business model value proposition including additional services. If yes, which?</td>
<td></td>
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<tr>
<td>Does your business model’s infrastructure pillar cover more stages of the CSP value chain?</td>
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<tr>
<td>Would the existence of reliable manufacturers of CSP components / collaborators in other countries make you adjust your business model? How?</td>
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</tr>
<tr>
<td>Have you adjusted your revenue model and profit margin to cope with current CSP PPAs? How?</td>
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</tr>
</tbody>
</table>

- Value Proposition pillar: The value proposition describes the product or service that is offered to the customer, e.g. shifting from production of electricity at large amounts, to production under peak demand.
- Infrastructure pillar: The infrastructure describes the company's organization of value creation. This section concentrates on the organizational structure, know-how and partnerships.
- Revenues pillar: Represents the relationship between costs to produce the value proposition and the revenues that are generated by offering the value proposition to the customers.
Question No. 8: Please provide a rough estimation in % of the value chain created per phase below, and tick on the phases included under your business model, as well as those that can be realised locally in other non EU countries.

<table>
<thead>
<tr>
<th>CSP value chain phase</th>
<th>% of the CSP value chain created</th>
<th>Please put a tick symbol if this phase is included under your business model</th>
<th>Please put a tick symbol if conditions are mature for the phase to be undertaken locally at the host country (outside EU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Development</td>
<td></td>
<td></td>
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<tr>
<td>Materials (glass, steel, sand, concrete etc.)</td>
<td></td>
<td></td>
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<tr>
<td>Components (mirrors, HTF, mounting structure, pumps etc.)</td>
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<tr>
<td>Plant engineering and construction (EPC)</td>
<td></td>
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<tr>
<td>Operation and maintenance</td>
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</tbody>
</table>
Question No. 9: Please rate the required conditions for enhancing local manufacturing per CSP component outside EU in the white cells below on a scale of -3 to 3. This question applies to companies based in EU and active in non EU countries.

<table>
<thead>
<tr>
<th>Component</th>
<th>Local demand</th>
<th>Technological know how</th>
<th>Training education</th>
<th>Financial Investment</th>
<th>Competitive location factors</th>
<th>Improvement of quality &amp; assurance standards</th>
<th>Investment regulatory framework</th>
<th>Other (Please fill in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Civil work</td>
<td></td>
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<tr>
<td>Installations</td>
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<tr>
<td>EPC engineering</td>
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<tr>
<td>Assembling</td>
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<tr>
<td>Receiver</td>
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<tr>
<td>Mirrors (Flat &amp; Parabolic)</td>
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<tr>
<td>Mounting structure</td>
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<tr>
<td>Heat Transfer Fluid</td>
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<tr>
<td>Connection piping</td>
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<tr>
<td>Storage system</td>
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<td></td>
<td></td>
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<tr>
<td>Electronic equipment</td>
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<td></td>
</tr>
</tbody>
</table>

- Local demand: attractiveness of local markets
- Technological know how: technological expertise, technology transfer for capacity building, including precision of processes and lifetime stability
- Training education: training and education of workforce, including structure and skills of the workforce
- Financial investments: large financial investments in production capacities
- Competitive location factors: factors including attractive costs for local manufacturing, availability of required raw materials, and infrastructure and logistic networks
- Improvement of quality standards (e.g. ISO 14001)
- Improvement of regulatory framework with financial and legal issues
WHO WE ARE

The MUSTEC consortium consists of nine renowned institutions from six European countries and includes many of the most prolific researchers in the European energy policy community, with very long track records of research in European and nationally funded energy policy research projects. The project is coordinated by Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas-CIEMAT.

<table>
<thead>
<tr>
<th>Name</th>
<th>Country</th>
<th>Logo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas – CIEMAT</td>
<td>ES</td>
<td><img src="CIEMAT.png" alt="CIEMAT Logo" /></td>
</tr>
<tr>
<td>University of Piraeus Research Center – UPRC</td>
<td>GR</td>
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<tr>
<td>Technische Universität Wien - TU WIEN</td>
<td>AT</td>
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<td>European Solar Thermal Electricity Association – ESTELA</td>
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<td>COBRA Instalaciones y Servicios S.A – COBRA</td>
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<tr>
<td>Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V. – Fraunhofer</td>
<td>DE</td>
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<td>Agencia Estatal Consejo Superior de Investigaciones Cientificas - CSIC</td>
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<tr>
<td>Fundacion Real Instituto Elcano de Estudios Internacionales y Estrategicos – ELCANO</td>
<td>ES</td>
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The project has received funding from the European Union’s Horizon 2020 research and innovation program under grant agreement No 764626

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