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ScienceDirect

Energy Procedia 49 (2014) 1869 – 1878

Energy Procedia

SolarPACES 2013

National incentive programs for CSP – Lessons learned

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Abstract

Acknowledging that Concentrated Solar Power (CSP) stands out among other renewable technologies for technical features such as dispatchability - through storage and hybridization - and its potential for higher macroeconomic impact on the local economy, national and regional governments have set up incentive programs to promote the development of large scale solar thermal plants in recent years. These support mechanisms have largely contributed to the rapid growth of the global market since 2007. While Spain and USA remain leaders, representing most of the current ~2.5 GW in operation, other countries have emerged within a short time as very ambitious players.

In our research, we reviewed some of the most relevant national incentive programs introduced worldwide: Spain, India, South Africa, Morocco and Australia. The paper will give an overview of the mechanics of the different markets, covering key aspects such as: capacity allocation, phases and timelines, qualification criteria, technical and financial requirements, local content requirements, etc, and how these elements affected competition, tariffs and the global outcome of the programs.

The lessons learned from the analysis constitute a useful set of guidelines for policy makers and developers, and could contribute to the design of future effective support mechanisms that will pave the way for the further uptake of CSP technologies.

The research presented in the paper has been undertaken in the framework of a technical assistance to the Ministry of New and Renewable Energy of India on the preparation of the Utility Scale Concentrated Solar Power Program.

Selection and peer review by the scientific conference committee of SolarPACES 2013 under responsibility of PSE AG.
Final manuscript published as received without editorial corrections.
Keywords: CSP, Policy, Market, Incentives, FIT.

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doi:10.1016/j.egypro.2014.03.198

1. Introduction

Concentrated Solar Power (CSP) stands out among other renewable technologies for technical features such as dispatchability - through storage and hybridization - and for its potential for higher macroeconomic impact on the local economy. Acknowledging this, national and regional governments have set up incentive programs to promote the development of large scale solar thermal plants in recent years. These support mechanisms have largely contributed to the rapid growth of the global market since 2007. While Spain and USA remain leaders, representing most of the current ~2.8 GW in operation, other countries have emerged within a short time as ambitious players.

We have reviewed and compared some of the most relevant national incentive programs introduced worldwide (Spain, India, South Africa, Morocco and Australia) and their global outcomes. The key lessons learned from the analysis could contribute to the design of more effective support mechanisms in the future.

Acronyms

ARENA	Australian Renewable Energy Agency
BBBEE	Broad Based Black Economic Empowerment
CNE	National Commission of Energy
CLFR	Compact linear Fresnel reflector
COD	Project Completion Date
CRS	Central Receiver System
DRET	Department of Resources, Energy and Tourism
EIA	Environmental Impact Assessment
EIF	Education and Investment Funds
EOI	Expression of Interest
FC	Financial Close
GEDA	Gujarat Energy Development Agency
GPCL	Gujarat Power Corporation Limited
JNNSM	Jawaharlal Nehru National Solar Mission
LCOE	Levelised Cost of Energy
LSREC	Large Scale Renewable Energy Certificate
MASEN	Moroccan Agency for Solar Energy
MEM	Ministry of Energy and Mines
MEMEE	Ministry of Energy, Mines, Water and Environment
MNRE	Ministry of New and Renewable Energy
MRE	Minister for Resources and Energy
MSP	Morocco Solar Plan
NVVN	NTPC Vidyut Vyapar Nigam
ONE	Office National de l'Electricite
PD	Parabolic Dish
PPA	Power Purchase Agreement
PT	Parabolic Trough
RE	Renewable Energy
REIPPPP	Renewable Energy Independent Power Producer Program
TES	Thermal Energy Storage

2. Program description

An overview of the mechanics of the different markets is provided in Table 1, covering key aspects such as: capacity allocation, phases and timelines, qualification criteria, technical and financial requirements, local content requirements.

2.1. Spain: RE policy (RD 661/2007)

The Spanish RE policy RD 661 2007, implemented in May 2007 was the first large scale CSP program worldwide [2]. The policy proposed the development of hundreds of MW of renewable energy projects using a Feed in Tariff approach, on the basis of fulfillment of a set of requirements at a given date. The policy did not include requirements for proven technology.

2.2. Morocco: Morocco solar plan

The Government of Morocco launched the MSP in 2009 with the goal of developing 2,000 MW of solar power by 2020 in 5 selected locations. The government will finance the cost of the MSP and set up MASEN to help develop the projects. The bidders have to demonstrate previous experience in developing, operating and managing thermal power plants and development of one thermal solar power plant [3]. MASEN has specified the technology to be used in the first 3 projects.

2.3. India: Gujarat phase 1

The Gujarat Solar Power Policy 2009 was published in January 2009 by the Government of Gujarat, India and was subsequently modified on 22 June 2010. The initial goal was to develop 500 MW by 2014. To participate in the bidding process, companies had to be or tie up with a proven solar technology supplier and had experience in developing power projects of the similar capacity over the past 10 years [4, 5].

2.4. India: JNNSM

The JNNSM was published in July 2010 by the Government of India. The goal of the program was to establish the policy framework for the deployment of 20,000 MW of solar power by 2022. Bidders have to be a technology provider (or have a tie up with one) with experience in design and engineering of solar thermal power plants or achieved financial close for at least one project based on the proposed technology.

2.5. South Africa, REIPPPP

The Department of Energy introduced the REIPPPP in August 2011. The goal is to develop 3,725 MW of renewable energy capacity by 2016 and the program is structured in bidding windows, using a competitive FIT approach. For the initial two windows, CSP bidders have to demonstrate that their key contractors have experience in at least 2 projects of comparable scale and that the key components (solar collectors, receivers and thermal storage system) have been in operation for at least 24 months in 2 previous commercial projects [6].

2.6. Australia: Solar Flagship Program

The Solar Flagship Program was announced in December 2009 by the Australian Government in order to develop up to 4 large-scale solar projects (1 GW by 2015) across 2 funding rounds. In July 2010 the Government announced the establishment of ARENA to manage the RE initiatives [9, 10]. Project developers were required to demonstrate that the technology had been in operation for 12 months.

Table 1. Worldwide CSP bid process key aspects

COUNTRY	**SPAIN**	**MOROCCO**	**INDIA**	**INDIA**	**SOUTH AFRICA**	**AUSTRALIA**
Program	**RD 661/2007**	**MSP**	**Gujarat 1 [7]**	**JNNSM[8]**	**REIPPPP**	**Solar Flagship**
Date	26 May 2007	Nov 2009	6 Jan 2009 Modified on 22 Jun 2010	25 Jul 2010	Aug 2011	Dec 2009
Authority/ Regulator	MEM	MASEN, ONE and MEMEE	GEDA	MNRE	NERSA	MRE, DRET.
Type of incentive	FIT	FIT + PPP	FIT	FIT	FIT	Grants + LSREC + local PPA
Key Evaluation criteria	Chronological order (fulfilment of certain requirements at a given date)	Lowest bidding tariff price (from a short list based on technical and financial)	Lowest bidding tariff price (plus technical and financial requirements)	Lowest bidding tariff price (plus technical and financial requirements)	Lowest bidding tariff price (plus technical , financial and local economic requirements)	1- Applicants shortlist. 2- EIF evaluation
Phases/Rounds	Single registration round	Multiple (Currently in Phase2)	Multiple	Multiple (3 rounds)	Multiple (5 bidding windows; currently in W3)	Multiple (2 rounds)
Timelines for bidding process /registration	Registration by 06 May 2009. Projects classified in 4 phases	P1 EOI submission: May 2010 Prequalification: December 2010 Awarded bidder: September 2012 P2 EOI submission: March 2013 Prequalification: August 2013	Policy published: 6 January 2009 Projects allocated in August 2009	EOI: 5 weeks Bid Submission: 2-3 weeks from EOI Period for PPA signature (once bidders awarded): 1 month	Bid submission: 11/2011 (W1), 03/2012 (W2), 08/2013 (W3) Announcement of preferred bidders: 12/2011 (W1), 05/2012 (W2), 10/2013 (W3) FC deadline: 11/2012 (W1), 12/2012 (W2), 07/2014 (W3)	Program launched: December 2009. Bid submission: 15 February 2010. Announcement of selected projects: June 2011. FC planned to be before end 2011 (Extended until June 2012).
Timelines for implementation	36 months from announcement	30 months from signing of PPA	28 months from signing of PPA	28 months from signing of PPA	27 months from FC 38 months from announcement	N/A
Total capacity available (MW) (In bold, phases already developed)	Initial target: P1~850MW + P2~1350MW + P3~1850MW + P4~450MW Allocated**:** **P1: ~900MW +** **P2: ~550MW +** **P3: ~500MW +** **P4: ~550MW**	Ouarzazate: 500MW (**P1 160MW**, P2 300MW) Ain Beni Mathar: 400MW Boujdour: 100MW Tarfaya: 500MW Laayoune: 500MW	**P1: 500 MW (716 MW awarded)** Other phases: up to 3GW (including P1)	P1: 1,000 - 2,000 MW, 2 batches **Batch 1:** 150 MW PV / **500 MW CSP** **Batch 2:** 350 MW PV P2: 2,000 – 8,000 MW P3: N/A	1,000 MW from 2016 to 2025 **W1 : 150 MW** **W2: 50 MW** W3: 200 MW	**Round 1: up to 400 MW (PV+ CSP)** Round 2: To be defined (600 MW foreseen)
Number of projects	No limitation	P1: 1 project P2: 2 projects	No limitation	No limitation (for CSP projects)	No limitation	1 project CSP (+ 1 project PV).
Project Min-Max capacity	CSP: 50 MW	CSP: 100-200 MW	CSP: 5MW - No upper limit	CSP: 5 - 100 MW	CSP: 1-100 MW	Round 1: > 150 MW
Thermal Storage	Not a requirement	3 hour of TES capacity	Not a requirement	Not a requirement	Not a requirement in W1, W2 & W3	Merit awarded if included
Hybridization / Fossil Fuel	Yes	Yes	No	No	Yes	Yes
Land / solar conditions	Developer	MASEN	GEDA and GPCL assistance	Developer	Developer	Developer
Water	Developer	MASEN	GEDA and GPCL assistance	Developer	Developer	Developer

Grid Connection	Developer	MASEN	Developer	Developer	Developer	Developer
Local content	N/A	30% of the total EPC Cost	No restrictions	30% of local content costs	BBBEE and local development	Local industry participation and regional development are considered for the bid evaluation
EIA	Developer	MASEN	GEDA and GPCL	Developer	Developer	Developer
PPA - Duration	25 years, then reduced tariff	25 year	25 years	25 years	20 years	None
PPA - Offtaker	Distribution companies and CNE	ONE (and MASEN, virtually)	N/A	NVVN	ESKOM	Not specified
PPA - Tariff	Fixed price Market price+bonus	FIT fixed by competitive bidding.	FIT	FIT fixed by competitive bidding	Competitive bidding	To be negotiated + RECs market
EOI/Bid bond & bank guarantees	Pre-registration guarantee Grid access guarantee	N/A	PPA bond (once project awarded)	Non-refundable EOI bond Bid Bond	Non-refundable fee Bid guarantee	Not required
Company Capacity and funding	Financial resources or funding to undertake 50% of the investment	Minimum net worth requirement. Experience in other CSP projects	Internal resource generation: ~240kUSD/MW Net Worth: ~400 kUSD/MW Annual Turnover: ~960 kUSD/MW	Net worth of bidder > ~639 kUSD /MW	Fully developed and agreed shareholders agreement. Breakdown of the sources and uses of the fund	Private and public project funding at a ratio of at least 2 USD for every 1 USD from the program

3. Main outcome

The main outcomes of the various incentive programs are summarized in Table 2.

3.1. Spain: RE policy (RD 661/2007)

The Spanish RE Policy was a massive success in terms of number of projects implemented, solar industry development, demonstration of technology, job creation, expansion of know-how and expertise.

However the economic climate in Spain, the electricity market historical tariff deficit (which is not a result of the support mechanism to renewables) and the high initial FITs for renewable generation resulted in different changes in the regulation. For CSP, the total number of hours of annual operation has been limited retrospectively and new taxes have been introduced. In 2012 the economic incentives for new facilities have been ceased impeding government initial targets to be reached. As a result, and despite the ongoing discussions between the industry and the government, it does not appear that more capacity will be developed in the near future (apart from the plants already pre-registered).

3.2. Morocco: Morocco solar plan

The involvement of MASEN in the development of the project (site, infrastructure and pre-feasibility studies) has contributed to lower LCOE and increased participation of bidders. The well-defined qualification criteria and the specific requirement for project participants' to be involved in the equity of the project resulted into experienced and reputable companies establishing consortiums to participate in the bid process.

3.3. India: Gujarat phase 1

The Gujarat's Solar Power Policy 2009 was the first commercial scale incentive program for CSP in India, and one of the first large scale CSP programs worldwide. The policy attracted significant interest and ten solar thermal projects were awarded however only one project is currently going ahead with solar thermal technology. The rest of the projects have been cancelled or changed to PV plants.

3.4. India: JNNSM

The JNNSM is the second commercial scale incentive program for CSP in India. It generated great interest from local players and seven projects were awarded.

With significant delay with respect to a very optimistic timeframes, several projects reached financial close and are currently under construction. Most project developers required an extension in the COD which was been finally granted (10 months) by the MNRE (only one of the seven projects awarded under the JNNSM in India has been commissioned on time).

The projects going ahead will have a significantly low LCOE (compared with international benchmark), include local and international players (contributing to the transfer of technology) and have over a 30% of local content (developing the local industry). Therefore, if the other 6 projects successfully achieve commercial operation within the revised deadline, the program will have met all its goals.

3.5. South Africa: REIPPPP

There was a lack of competition in both W1 and W2, which led to very small discounts from the cap tariff and significantly higher prices than other plants being developed at the same time elsewhere. For W3, which is currently under evaluation, 200MW have been allocated to CSP. Changes in the proven technology requirements, tariff structure and a lower tariff cap, is expected to lead to more competition and lower bidding prices.

The technical requirements were put in place to ensure the success of the projects. Moreover the combination of local content and long term target for installed CSP capacity is intended to develop the local industry. However developers have been arguing that the current targets of installed capacity are not sufficient to reach critical mass.

3.6. Australia: Solar Flagship Program

The Australian Solar Flagship program proposed an approach that maximized the size of each project. The large nominal capacity of the selected project (250MW) proved to be an issue in order to obtain funding. The PPA, which should have been negotiated with local off-takers, was never signed.

As a result, ARENA announced withdrawal of funding for the selected CSP project on 12 November 2012. The failure of Round 1 of the Solar Flagship Program has put on hold any further rounds of the program.

Table 2. Outcomes of large scale incentive programs for CSP worldwide.

COUNTRY	SPAIN	MOROCCO	INDIA	INDIA	South Africa	AUSTRALIA
Program	**RE Policy**	**Morocco Solar Plan**	**Gujarat Ph 1**	**JNNSM**	**REIPPPP**	**Solar Flagship**
Number of bidders / Awarded projects	104 requests (4,499 MW) 60 approvals (2,423 MW)	200 EOI 19 pre-qualifified 4 preselected 3 offers	34 awarded for PV 10 awarded for CSP	66 bids 7 awarded	W1: 53 bids for all technologies, 2 bids for CSP W2: 79 bids for all technologies, 1 bid for CSP	42 proposals 4 PV proposals and 4 CSP proposals short-listed 3 full applications submitted
Total Capacity allocated	2,525 MW	P1: 160 MW P2: 300-340MW	351 MW CSP (+365 MW PV)	470 MW (+30 MW)	W1: 150 MW W2: 50 MW	250 MW
Number of projects allocated	61 (46 in operation, 7 in construction, 8 cancelled	1	10 (including 1 international company)	7 (+3)	W1:2 W2:1	1
Tariffs (USD/kwh)	Fixed regime: 0.35 for 25 years, 0.28 thereafter Variable regime Lower limit: 0.33 Cap: 0.45	0.1879	FIT 4.5 for 12 first years 8.9 until 25th years (Fixed on December 2010).	22.8 - 27.24 (Fixed by December 2010)	W1: 0.3229 W2: 0.3024	N/A
Tariff indexation	Annual review of fees	N/A	N/A	Fixed tariff rate, not inflated throughout project life.	Annual full tariff review for the 5 first years; then every 3 years.	N/A
Debt/equity ratio	Different cases: 50/50 - 60/40 - 70/30	70/30	N/A Foreseen as for JNNSM	~70/30	Confidential Foreseen between 70/30 and 80/20	N/A FC never reached
Lenders involved	Private Banks (mostly Spanish banks)	Donors (IFIs) and private partners	N/A Potential lenders from JNNSM	Mostly Indian lenders and some contribution from international banks and IFIs	Mix of international lenders (IFIs, including World Bank) and private national lenders	N/A FC never reached
Project going ahead	50 PT projects: 39 in operation, 7 in construction 4 CRS projects: 3 in operation, 1 cancelled 8 PD projects: 1 dismantled, 7 cancelled 2 CLFR in operation	1 PT project: 160 MW with three hours molten salts of TES capacity	1 project (25 MW, Cargo Motors)	Currently under construction: 4 PT projects 1 CLFR	200 MW W1: 2 projects (100 MW PT and 50 MW CRS) W2: 1 project (50 MW PT)	One 250 MW CLFR project cancelled

4. Lessons learned

The lessons learned from our review constitute a useful set of guidelines for policy makers and developers, and could be applied in the design of effective support mechanisms that will pave the way for the further uptake of CSP technologies.

4.1. Competitive tariffs

The Spanish RE Policy was a first of a kind program, with no competitive bidding, but a common set tariff for all the allocated plants, which resulted in a relatively high tariff. In comparison, subsequent processes such as the JNNSM and the MSP, benefited from a competitive bidding approach and a more mature sector, achieving significant lower tariffs for the awarded projects.

Nevertheless the REIPPPP has shown that competitive bidding is not always as successful as expected if a lack of competition occurs. Also, the Indian experience, especially in the case of the Gujarat program, illustrates that acute price competition could impede project completion if the bidding price is too optimistic. Aggressive pricing also has an effect on the willingness of experienced international developers to participate. For the Gujarat Phase1, nine out of ten projects were awarded to local players and for the JNNSM program, all the developers were Indian companies. In order to achieve the offered bidding price, local developers had to aim for a very tight budget implying significant difficulties to secure solid EPC contractors/technology providers and an additional challenge in order to reach financial close due to lender's concern with the project participant's technical capabilities.

4.2. Project development

Securing land, permits and infrastructure can be challenging and costly for international developers in certain countries. Also, a minimum of on-site measured meteorological data is a common requirement for CSP plant (if not for the implementing agency, at least for the lenders) which means that the site needs to be selected and under study at a very early stage.

The JNNSM, for example did not require on-site data which, combined with the lack of solar experience of the local developers, led to an overestimation of the solar resource. This has caused, in some occasions, changes in the plant's design and delays in the project finance process.

The experience of the MSP is a positive example of how the solar park concept facilitates the project development and contributes to lower tariffs. Key aspects of the MSP for Phase 1 and 2 are:

- The site was already selected, all the permits cleared and the common infrastructure (roads, water, grid connection) provided by MASEN, hence reducing the development costs for the bidders.
- All the pre-feasibility studies (geotechnical, EIA and solar resource) had been undertaken in advance which minimized the uncertainties for the bidders.

4.3. Technical criteria

In the Spanish RE Policy, there was no requisite for proven technology. This provides interesting room for innovation but increases the risks of projects not realizing, due to technical challenges or difficulties in the project finance process. For example, PD technology didn't prove to be ready for commercialization in Spain. All eight PD projects that were pre-assigned are the only ones from the initial allocation that have been cancelled.

The REIPPP criteria for proven technology in W1 and W2 was stringent, aiming to maximize the chances of successful completion and operation of the awarded projects. However, this prevented some technologies to be eligible and had a negative effect on competition. Changes in the proven technology requirements have been introduced in W3.

The Spanish policy allowed for hybridization and all the plants include natural gas as supplementary fuel. The use of gas facilitates the operation of the CSP plants, particularly for start-ups and transients, and is economically in favor of the operators as all the electricity generated is eligible for the same tariff. The Australian Solar Flagship Program also allowed hybridization (the selected project was planned as a solar/thermal gas hybrid plant in order to maximize the operating hours). The JNNSM in India did not provide allowance for hybridization and use of supplementary fuel, which could limit the operability of the projects under transient conditions, but ensures a 100% renewable generation.

In Spain, several developers opted for storage (from 6 to 15 hours of TES) since the limitation of the installed capacity to 50 MW and the higher electricity price in the spot market in the evening makes it very interesting in the national context. In the case of the JNNSM in India, the tariff was fixed and the energy storage was not a

requirement. Therefore most of the projects have opted not to include thermal storage systems in order to reduce the technical complexity of the projects and the CAPEX.

The JNNSM technical criteria required the developer to be an experienced technology provider or to have a tie with one. However, in the latter case, the technology provider was not required to participate in the project equity, or to have a binding contract with the project company, which resulted in changes of technology providers or re-negotiation of the terms. In most projects international technology providers have partnered with local companies to provide competitive EPC proposals. This approach is positive since it will contribute to the technology transfer and development of the local solar industry.

4.4. Program timeframes

In the Spanish experience, all projects were awarded at the same time and therefore the program has neither benefited from cost reduction as the industry developed and the technology matured, neither of the lessons learned from the first plants built.

In South Africa, the multiple bidding windows approach of the REIPPPP had two positive outcomes:

- In the case of other generation technologies contemplated in the program the average prices offered fell significantly from W1 to W2 (by 40% for PV and more than 20% for wind).
- The W2 preferred bidders offered superior local content terms (rising from 21% to 36.5% for CSP projects)

Also in the JSSNM, Round 2 for CSP has been put on hold subject to the successful completion of the first projects, with the intention to set realistic targets and improve the process.

The timelines for the bidding process and the project implementation were very optimistic in the case of India. By contrast, the extensive timeframe for the bids preparation in the MSP allowed bidders enough time to establish solid consortiums and carefully prepare their proposals.

4.5. Project funding

Some of the key elements in the lender's due diligence for this type of projects include the technology risk and the off-take risk. Technology risk is easier to mitigate for projects employing proven technologies, while the off-take risk is fundamentally related to the PPA.

The REIPPPP includes a PPA with the off-taker with all the conditions defined upfront which tends to facilitate the financial close of the projects. Similarly, the PPA for the MSP was not subject to negotiation with a private off-taker and it was signed only two months after the winning bidder announcement.

In contrast, the project awarded in Australia was not able to sign a long term PPA, which eventually caused the cancelation of the project. The innovative technology and the scale of the project were also detrimental in securing the necessary funds.

Finally, project financing for the MSP and some Indian projects has been facilitated by Export Credit Agencies and International Funding Institutions.

5. Conclusions

Competitive bidding generally leads to significant price reduction although extremely acute competition can impede project completion. Good practices that contribute to increased participation of bidders and lower LCOE include strong qualification criteria, balanced requirements for proven technology, facilitation of land, permits and infrastructures, and a PPA secured upfront.

The possibility for partnership of international technology providers with local companies is positive since it contributes to the technology transfer and development of the local solar industry.

Multiple phase programs enable benefits of cost reduction, superior local content terms and application of the lessons learned in previous rounds. However sufficient timeframes for each of the phases are necessary so that bidders fully demonstrate all the requisites.

Financing is facilitated by the participation of experienced and reputable companies, and in some cases byt the support of international financial institutions. A preliminary financial agreement as a requisite for the bidders facilitates the financial close once the project is awarded.

Acknowledgements

The research presented in this paper has been undertaken in the framework of a technical assistance to the Ministry of New and Renewable Energy of India on the preparation of the Utility Scale Concentrated Solar Power Program.

Disclaimer

The contents of this paper are the authors' sole responsibility. They do not necessarily represent the views of the Asian Development Bank or Mott MacDonald.

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