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IMPACT OF HUGE VARIATION IN COST OF DEBT AND REVERSE AUCTION PROCESS ON FEASIBILITY OF SOLAR PV PROJECTS UNDER PRESENT POLICY FRAMEWORK IN INDIA

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Solar PV, Energy Policy, Project Feasibility, India, Financial challenges, Reverse auction

ABSTRACT: The Union Government as well as many State Governments of India has introduced solar PV policies to promote solar PV technologies. The key feature of these policies is selection of through reverse auction. Currently, huge variation in cost of debt is prevailing in Solar PV market. In this paper, impact of financial challenges posed by variation in cost of debt and reverse auction process on economic feasibility is analyzed This analysis has been done by comparing cash flows and other financial parameters such as Net Present Value (NPV), Internal Rate of Return (IRR) and Pay Back Period (PBP).

1. INTRODUCTION

India has a very high potential for solar energy as most of its regions have around 300 clear sunny days with solar radiation ranging from 4 KWh/m2 to 7 KWh/m2. The Indian energy portal estimates that 12.5 % of India's total land mass or in other words, the area of around 43,000 Km2 can be used to generate solar energy.

In the year 2008, Govt. of India has launched National Action Plan on Climate Change (NAPCC) in order to address the issues related to climate change. The NAPCC is divided into eight missions that address critical issues related to climate change (Government of India, 2008). NAPCC has outlined measures to advance technological deployment, technological shift and other adoption methods to mitigate effects of climate change. As per this action plan, The Union Government (Central Government) has decided to increase the share of renewable energy up to 15% of total energy generation through favourable energy policies.

To promote renewable energy market, Central Government has set targets for Renewable Purchase Obligation (RPO), in which power utility companies and captive power consumers have to purchase certain quantity of renewable energy. As per the direction given by the Central Government under Electricity Act 2003, various State Electricity Regulatory Commissions (SERCs) have set their respective RPO targets. SERCs have outlined specific RPO targets for different renewable technologies such as bio gas, wind energy and solar technologies. (Solar PV and Solar thermal) (Ministry of Law & Justice, 2003).

As per NAPCC, various State Governments and Central Government have introduced solar energy polices to promote investment in solar PV technologies at large as well as small scale. The market growth of Solar PV is very promising in India but at the same time many articles have been published highlighting financial challenges faced by the project developers. In India, project developers can be classified broadly in two main categories:

- Domestic Project developers: These project developers can finance their projects by acquiring loan either from domestic banks or from foreign banks by hedging foreign currency.

- Multinational project developers: These project developers can finance their projects by acquiring loan from foreign banks without hedging foreign currency.

Project developers have mainly three solar policies under which they can develop large MW scale Solar PV plants.

The solar policy framework is in place since the year 2010 in India. However, there is still ambiguity about attaining financial feasibility of solar PV projects under existing solar energy policies due to huge variation in cost of debt and competition among them in the reverse auction process (reverse competitive bidding).
In reverse auction process, first, the government defines total capacity, to be allotted with provision of maximum level of supporting incentives (such as feed in tariff or capital subsidy). The declared capacity will be allotted through reverse auction process in which the interested project developers have to bid (for project of desired capacity) with lower requirements of supporting incentives than maximum level. The project developers (bidders) with lowest requirement of supporting incentives will be selected and invited to sign agreement for developing solar PV plants. This process is similar to tender process implemented in Ireland in the year 1994. Similar kind of tender processes are currently in place in France as well as in Denmark. (Kitzing, Mitchell, & Morthorst, 2012).

This paper aims to assess the financial feasibility of grid connected MW scale solar PV projects attained by different project developers under present state level solar policies as well as national level solar policy known as Jawaharlal Nehru National Solar Mission (JNNSM). It analyzes ability of existing solar policies to attract different types of project developers. Three states (Sharma, Tiwari, & Sood, 2012) namely Gujarat, Rajasthan & Tamil Nadu with the most favourable solar radiations are selected for this analysis.

The objectives for the above mentioned analysis are as follows:

- It will give an idea about existing solar policies in India.

- It will provide an estimation of financial feasibility attained by different categories of project developers for their large scale solar PV projects under JNNSM and state level solar policies.

- It gives basis to the government stakeholders for new improvement in solar policies in such a way that the impact of financial challenges faced by the project developers can be mitigated.

2. OVERVIEW OF SOLAR POLICIES

Existing solar policies in India can be classified in three main categories, under which project developers can develop large scale solar PV plants:

- Renewable Energy Certificate (REC) mechanism,
- National level solar policy (i.e. JNNSM)
- Various state level solar policies

REC Mechanism: REC is a market driven mechanism in which project developers, who have not signed PPA under JNNSM or state level solar policies with any kind of benefits (such as feed in tariff, capital subsidy, tax exemption etc.) can avail REC certificate for every sale of 1000 MWh electricity at market price prevailing in the Energy Exchange. This mechanism has been adopted from concept of green certificates prevailing in few European countries such as UK and Italy. (Kitzing et al., 2012) These certificates can be traded through Energy Exchange within price band decided by CERC from time to time. Potential buyers of these certificates are captive consumers and electricity utility companies who can't comply with their RPO targets by developing Solar PV plants themselves. Central Govt. has not outlined REC price band beyond the year 2017. There is too much uncertainty and ambiguity regarding future of this mechanism. Thus, getting financial closure of Solar PV project under this mechanism is mostly impossible in the absence of Government guidelines for future REC prices. Therefore, this mechanism is not considered for subsequent analysis with assumption that that under the existing condition, project under this mechanism is not economically viable. (Central Electricity Regulatory Commission, 2014b).

Jawaharlal Nehru National Solar Mission (JNNSM): JNNSM was announced in the year 2010 by the Central Govt. of India in order to promote solar based technologies. This mission has set ambitious target of setting- up 20 GW of solar based power plants by the year 2022. The details of phase wise deployment of solar based generation are shown in Table 1 (Ministry of New & Renewable Energy, 2012).

TABLE 1 *Capacity addition targets under JNNSM*

Segment	Phase I (2010-13)	Phase II (2013-17)	Phase III (2017-22)
Utility grid Power (incl. rooftop)	1100 MW	10,000MW	20,000MW

Under JNNSM Phase 1 (from year 2010 to year 2013), total capacity of 950 MW was allotted in two separate batches for solar PV technology with maximum feed in tariff of Rs. 17.10 for batch 1 and Rs. 15.4 for batch 2. The projects were selected through reverse competitive bidding route in which project developers had to bid with lower tariff than declared feed in tariff. The projects were selected with an average tariff of Rs. 12.12/kWh for 25 years in batch 1 and with an average tariff of Rs.8.77/kW for 25 years in batch 2. (Ministry of New & Renewable Energy, 2013).

In the year 2013, JNNSM Phase 2 was initiated. Under Phase 2, total capacity of 750 MW has been allotted for solar PV technology. Project developers still resist for investing in solar PV projects due to the upfront capital investment, required commercial viability and issues relating to attaining financial closure because of weak balance sheets of nodal agencies as well as utility companies with whom PPA had to be signed. Considering above constraints under Phase 2, capital subsidy in terms of VGF is offered by the government to attract more investment in solar PV projects. Features of VGF are mentioned as follows:

- In order to reduce financial burden on utility companies, tariff of Rs.5.45/kWh is fixed for 25 years.
- Govt. will provide VGF either up to maximum 30 % of capital cost or Rs. 250 million/MW, whichever is lower.
- The projects will be selected through reverse auction process route, in which project developers have to bid for a project of desired capacity with requirement of VGF (equal or less than 30% of the capital cost). The total capacity of 750 MW declared in JNNSM phase 2 will be allotted to bidders with the lowest VGF requirement (Ministry of New & Renewable Energy, 2013). Similar kind of tender process was implemented in Ireland (in AER 1) in year 1994.(Kitzing et al., 2012).

State Level support schemes: In addition to JNNSM, many State Governments in India have launched state level solar policies with additional allocation capacity separated from JNNSM to promote solar PV in their states. They have introduced preferential tariff (feed in tariff) higher than the market price of electricity to support market development of solar PV. As mentioned in pervious section, three states namely Gujarat, Rajasthan and Tamil Nadu have been selected for this analysis. The feed in tariff and key features of state level solar policies of selected states are explained in Table 2:

States	Declared tariff By SERC (for 25 years)	Key features	Nodal agency
Gujarat	6.77 (Rs/KWh) (Gujarat Electricity Regulatory Comission, 2015)	• Electricity duty on power generated by solar PV projects is exempted. • Gujarat Electricity Transmission Corporation (GETCO) is facilitating installation of transmission line between power plant and nearer substation. • Cross subsidy surcharge is not applicable for open access obtained for third party sale within the state. • Wheeling & transmission charge will be 2 % of total energy fed in to the grid (Govt. of Gujarat, 2009).	Gujarat Energy Development Agency (GEDA): It helps project developers in identifying land, providing necessary water supply at the site and other clearance procedures(Govt. of Gujarat, 2009).
Rajasthan	6.74 (Rs/KWh) (Rajasthan Electricity Regulatory Comission, 2015)	• Government land will be allotted. Necessary water supply will also be provided by the State Government. • Industrial grant applicable under state industrial promotion scheme will be provided to solar PV projects • Electricity duty on power generated by solar PV will be exempt(Rajasthan Renewable corporation Ltd, 2014)	Rajasthan Renewable Energy Corporation (RREC): It is nodal agency for providing necessary approval, process of land allotment, bidding process and project registration process. It will also help to coordinate with the State Government and getting loans & grants if required. (Rajasthan Renewable corporation Ltd, 2014)
Tamil Nadu	7.01 (Rs/KWh) (Tamil Nadu Electricity Regulatory Comission, 2014)	• Solar Power plants have been identified at industrial units by state government and tax benefits as per Tamil Nadu industrial policy will be provided. • 100% Electricity duty exemption will be provided for first 5 years from the date of commissioning (Govt. of Tamil Nadu, 2012)	Tamil Nadu Energy Development Agency TEDA: It is a nodal agency for single window clearance which includes all statutory clearances, approval of power evacuation from state transmission utility and clearance from pollution control board within 30 days. So the project will be commissioned in first 12 months from signing PPA (Govt. of Tamil Nadu, 2012).

Until now all the states except Gujarat have introduced reverse competitive bidding in feed in tariff declared by their SERCs. However in 2015, even the State Gujarat has introduced reverse competitive bidding in feed in tariff. The project developers bidding with lowest tariff than declared maximum feed in tariff will be given opportunity to sign PPA. Currently, similar kind of tender process is implemented in France. (Kitzing et al., 2012).

3. THEORETICAL BACKGROUND OF FINANCIAL PARAMETERS USED FOR THIS ANALYSIS

In this section, financial parameters used for this feasibility analysis are explained.

Cost of Equity: Cost of Equity is the rate of return which shareholders ask as compensation for investing their capital. In this paper, cost of equity is estimated using bond-yield -plus- risk premium approach. According to this approach, cost of equity is divided in two parts, a) base rate of government bonds, which is also called risk free return and b) risk premium asked by equity holders for investing their equity. It is represented by the following formula (Baker & Powell, 2009):

$$k_e = b_r + R_p \quad (1)$$

Where (k_e) is cost of equity is, (b_r) is base rate of government bond and (R_p) is risk premium.

Risk premium is linearly proportional to risk involved in project in which equity is invested. Risk estimation is very subjective matter, thus, risk premium asked by equity holder is also very subjective. In India, cost of equity asked by shareholders ranges from 10% to 15% (Nelson, Shremali, Goel, Kanda, & Kumar, 2012), lower than expectation of shareholders investing in matured solar markets of Europe and US. The reason behind lowering cost of equity is to increase market share in newly emerging solar market. In India, Project developers charge very low risk premium of 2% (below market level) to maximum 7 % in order to increase market despite of lots of risk involvement in solar PV project.

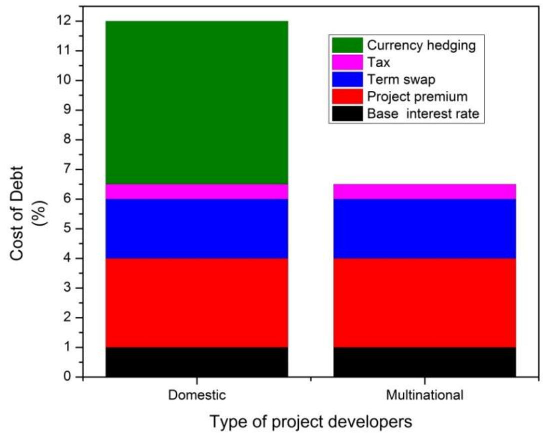
Cost of Debt: Cost of debt is the rate of interest expected for lending money. Usually, the rate of interest on debt prevailing in the market is referred as cost of debt before tax. The rate of interest after adjusting tax is referred as effective cost of debt (Khan and Jain, 2007) represented by:

$$k_{de} = k_d(1 - T) \quad (2)$$

Where (k_{de}) is effective cost of debt, $(\mathrm{k_d})$ is the cost of debt before tax and (T) is tax rate.

In developing country like India, growth requires with huge investment in infrastructure project. This requirement creates huge demand of debt finance, resulting high interest rate (Nelson et al., 2012). The other sources of debt funding such as corporate bond markets and non-banking financial institutions are underdeveloped. Risk perception due to poor credit rating of many state electricity utility companies (B+ or less) and asset liability mismatch forced many commercial banks to put restriction in financing solar projects (Umamaheswaran & Rajiv, 2015). This self-imposed restriction by local commercial banks resulted in scarcity of debt fund in the local market. Under this condition, domestic project developers are left with only one alternative: to get debt fund from foreign lenders. However, due to high volatility in currency exchange, domestic project developers have to hedge foreign currency which adds about 5 to 7 % to the cost of debt (Nelson et al., 2012). On the other side, due to receivable income in foreign currency, multinational project developers can save cost of currency hedging, which gives them significant edge over domestic project developers. The breakup of cost of debt acquired by domestic developers and multinational developers are shown in Figure 1:

FIGURE 1: *Breakup of cost of debt acquired from foreign lenders**



**Domestic project developers have to pay very high cost of debt compare to multinational project developers due to high cost of currency hedging (Nelson et al., 2012)*

Annual Cash flow (after tax): Annual cash flow after taxation is calculated by the following formula:

$$C_t = I_n - T_n \quad (3)$$

$$I_n = E_n * T_{Kwh} - C_{o\&m} - I_c - I_p \quad (3.1)$$

$$T_n = (I_n - Dp) * T \quad (3.2)$$

Where (C_t) is annual cash flow after tax, (I_n) is annual taxable income, (T_n) is annual payable tax (E_n) is annual exported energy to grid, (T_{Kwh}) is Tariff for exported energy to grid, $(C_{o\&m})$ is annual O&M cost, (I_c) Annual payable insurance premium, (I_p) interest paid, (Dp) annual allowable depreciation as per taxation law and (T) is annual tax rate.

Weighted Average Cost of Capital (WACC): WACC represent minimum rate of return which is used for discounting cash flows generated by the business asset. WACC must be greater than or equal to cost of financing those assets employed in proportions. WACC is calculated based on following formula (Hawawini & Viallet, 2011):

$$WACC = \frac{D}{E+D}k_d(1-T) + \frac{E}{E+D}k_e \tag{4}$$

Where (*D*) represents Cost of debt , (*E*) is equity,(k_d) is cost of debt before tax,(k_e) is cost of equity and (*T*) is tax rate.

Net Present Value (NPV): Net Present Value (NPV) is calculated based on following formula:

$$\sum_{t=1}^{N} \frac{C_t}{(1+r)^t} - C_0 \tag{5}$$

Where (N) is project life time (yrs.), (C_t) is annual cash flow at t^{th} year, (r) is WACC and (C_0) is initial capital investment.

Selection criteria for project based on NPV: If NPV of project is positive, the project is feasible & generating a profit (Keown & Martin, 2009). However, if NPV is negative, project is not feasible & is creating a loss (total cost of financing business assets employed in the project is higher than profit generated by the project).

Among the projects with positive NPV, the project with higher NPV is considered more feasible.

Internal rate of return (IRR): IRR is calculated based on the following formula:

$$C_0 - \sum_{t=1}^{N} \frac{C_t}{(1+IRR)^t} = 0 \tag{6}$$

Where the terms have their usual meaning presented in previous equations.

Projects with IRR greater than WACC is considered as financially feasible. *(Keown & Martin, 2009)*.

In this paper, IRR of equity cash flows is calculated. Therefore, the project becomes financially feasible only if IRR of equity cash flow is higher than the cost of equity.

4. RESEARCH METHOD

This paper aims to analyze financial feasibility of grid connected MW scale solar PV project attained by different project developers under present state level solar policies as well as JNNSM.

As mentioned in the previous section, broadly, project developers in India can be classified in two categories. Further they are classified in four sub categories for the following analysis.

Type A: These are the domestic companies which can borrow loan either from domestic banks or from foreign banks by hedging foreign currency. These companies keeps their cost of equity very low (around bond yield rate) with lowest risk premium.

Type B: These are the domestic companies which can borrow loan either from domestic banks or from foreign banks by hedging foreign currency. Cost of equity of these companies is high because of market driven risk premium.

Type C: These are the multinational companies which can borrow loan from foreign banks without hedging foreign currency. These companies also keeps their cost of equity very low (around bond yield rate prevailing in that country) with lowest risk premium.

Type D: These are the multinational companies which can borrow loan from foreign banks without hedging foreign currency. . Cost of equity of these companies is high because of market driven risk premium.

The assumption of cost of debt and cost of equity of all these four types of project developers are shown in Table 3.

TABLE 3: *Cost of debt and Cost of equity of four types of project developers selected for this analysis*

Type of Project Developers	Cost of debt (%)	Cost of equity (%)
Type A	12.00	10.00
Type B	12.00	15.00
Type C	6.00	10.00
Type D	6.00	15.00

As mentioned in previous section, three states with the highest solar irradiation namely Gujarat, Rajasthan and Tamil Nadu have been selected for this analysis. Selections of locations at different states are done based on their favourable solar irradiation level and ease of land allocations facilitated by various state governments for Solar PV plant development. The latitude and solar irradiation data of selected locations are mentioned in following Table 4.

TABLE 4. *Latitude and annual solar irradiation data of selected locations*

Locations	Latitude & Longitude	GHI (kWh / sq. m) (annually)
Charanka - Gujarat	23.9°N & 71.2°E	2063.1
Jodhpur - Rajasthan	26.3°N & 73.0°E	2306
Ramanathapuram - Tamilnadu	9.4°N & 78.9°E	1887

This study aims to answer mainly four questions:

- How much financial feasibility of solar PV projects under JNNSM is attained by different types of project developers without any reverse competitive bidding in VGF at selected locations?
- How much financial feasibility of solar PV projects under state level solar policies attained by different types of project developers without any reverse competitive bidding in feed in tariff (FiT) at selected locations?
- How reverse competitive bidding in VGF will impact financial feasibility of solar PV projects under JNNSM attained by different types of project developers at selected locations?
- How reverse competitive bidding in FiT will impact financial feasibility of solar PV projects under state level solar policies attained by different types of project developers at selected locations?

The technical design and simulation of PV plant at different locations is carried out using PV Syst software (PVSYST, 2013). In absence of any scientific publications in this area, input parameters for simulations are assumed on basis of practices, followed by EPC (Engineering, Procurement and Construction) service providers in India. Financial input parameters are assumed based on various regulatory orders and government documents.

For simulation, polycrystalline silicon based modules have been selected. Other technical specifications of solar PV plant assumed for simulation are mentioned in following Table 5

TABLE 5. *Technical specifications of Solar PV plant*

Technical specification	Data
Plant Capacity	5 MW
Module capacity	275 Wp
module life time	25 Years
Inverter capacity/total no. of inverter	500KWac/ 10
Inverter life time	13 Years

- The degradation rate of solar PV plant performance is assumed at 1% per year.
- Tilt angle of PV module w.r.t horizontal plane is assumed as latitude of location and azimuth angle is assumed as zero (south facing).

Other input data assumed for this feasibility study are mentioned in the following Table 6.

TABLE 6. *Financial inputs used for this feasibility study*

Financial Parameters	Values
Capital Cost	Rs. 60500000 (Rs. /MW)
O & M cost	Rs. 1512500 (for 5MW)(with escalation of 5.72% per year)
Insurance Cost	Rs. 1512500 (Fixed) (for 5 MW)
Debt: Equity Ratio	70% : 30%
Loan tenure	10 years
Minimum Alternative Tax rate (first 10 years)	20.08%
Corporate tax	32.45 %

Like any other democratic country, changing corporate tax drastically is very politically sensitive issue and also has major impact on overall economy. So, it is assumed that corporate tax will remain stable throughout the project life cycle.

The cost of land is included in capital cost. Capital cost specified in Table 5 is decided from the regulatory order of benchmarking capital cost of Solar PV project by CERC (Central Electricity Regulatory Commission, 2015)

To promote Solar PV, Govt. of India has declared tax holiday for the first 10 years in interim Budget 2014-15 in July, 2015. However, as per Income tax section 115JB, if tax payable is less than 18.5% of book profit, then concerned companies have to pay Minimum alternative tax (MAT) at a rate declared in CERC tariff order(Central Electricity Regulatory Commission, 2014a).

Administrative and other costs such as wheeling charges and transmission costs are included in O & M cost.

It is assumed that O & M cost will escalate at the rate of 5.72% per year (as per CERC Order) (Central Electricity Regulatory Commission, 2014a)

Inverter life time is assumed as 13 year (Gujarat Electricity Regulatory Commission, 2015) and its replacement cost is added in O&M cost of 13th year

Project developers always discount their cash flows with high cost of equity because high cost of equity is always associated with high risk factor. To negate effect of risk, in this paper, risk free component of cost of equity is considered as 8% (interest rate given on various long term government bonds issued by the Govt. of India) per annum.

The benefit of accelerated depreciation is not considered in this analysis

Using output of technical simulation & financial input parameters mentioned above, annual cash flows of solar PV project are calculated at all selected locations using eq.3. For each selected location, four different cash flows of single project under same policy are generated (by varying WACCs of all four different types of project developers). So, for each selected location, there are total eight cash flows (four of same project under state level policy & four of same project under JNNSM)

As a first step of feasibility analysis, NPVs of all eight cash flows of the solar PV project at each selected location are calculated.

At second step, impact of reverse competitive bidding (in VGF in case of JNNSM & in feed in tariff in case of state level policies) is measured by performing sensitivity analysis (Bidding VS WACCs of different project developers) and analyzing sensitivity of NPV.

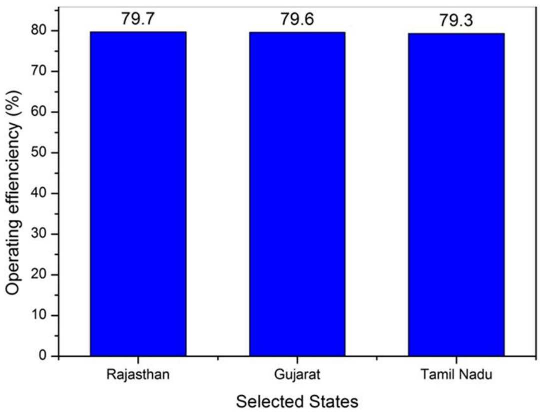
At third step, IRR -equity and PBP of all Cash flows with positive NPV are calculated.

5. RESULTS AND DISCUSSION

The results of PV system simulation are shown in Figure 2 & Figure 3. From the results, it can be observed that the highest energy generation is in Rajasthan followed by Gujarat and Tamil

Nadu. Performance Ratio of Solar PV plants in all selected locations are turning out to be approx. 80%, while transmission loss from plant to grid is turning out to be 2% to 5% .

FIGURE 2: *Power generation by solar PV plant in first year after commissioning of project*



The results of feasibility analysis of solar PV plant under state level policies and JNNSM for each selected location are shown in Table 7 & Table 8 respectively and discussed subsequently.

Rajasthan: Rajasthan has the highest solar radiation (see Table 4) among selected states. Due to very high solar radiation, potential of energy generation from Solar PV project in this state is the highest among the selected states (see Figure 2). The highest solar potential will attract many project developers for bidding. In case of projects under JNNSM, it can be observed (from Table 8**)** all four types of project developers can make project feasible with positive NPV and high IRR- Equity in absence of reverse bidding process in VGF (capital subsidy). However, as aggression in bidding increases due to competition, the scope of making project feasible decreases and only the project developers of Type C can make project feasible without any requirement of capital subsidy. In case of project under state policy, it can be observed from Table 7 that the project developers of Type B can't make project feasible even if there no reverse competitive bidding process and full capital subsidy is given to them. While, The other project developers (Type A, Type B and Type C) can make project feasible with reasonable profit and survive in certain level of bidding. However, as competition in bidding increases, their ability to make feasible project decreases.

Gujarat: Gujarat has also favourable condition for solar PV project in terms of solar radiation (see Table 4). It is the second best location for solar PV project among the selected states with potential of energy generation lower than Rajasthan but higher than Tamil Nadu (see Figure 2). From Table 8, it can be observed that in case of Solar PV project under JNNSM, project developers of Type B can't make project feasible even if full capital subsidy is given to them (in absence of any reverse competitive bidding) while Other three types of project developers can make project feasible with full capital subsidy. Under reverse competitive bidding process, only project developers of Type C have best scope of making project feasible. However, they also cannot survive in absence of capital subsidy. From Table 7, it can be observed that in case of the Solar PV project under state level policy, only the project developers of Type C can make project feasible irrespective of level of aggression in bidding.

TABLE 7. *Results of feasibility analysis of projects under state level policies: (with and without competitive reverse bidding)**

State	Bidding with reduction in tariff	Type	NPV (Rs. Millions)	IRR -Equity (%)	PBP (Yrs.)
Gujarat	0% (without any competitive bidding)	A	-20.35	N/A	N/A
		B	-78.02	N/A	N/A
		C	57.84	20	8
		D	-5.46	N/A	N/A
	5%	A	-38.31	N/A	N/A
		B	-92.82	N/A	N/A
		C	37.75	18	8
		D	-22.19	N/A	N/A
	10%	A	-56.27	N/A	N/A
		B	-107.63	N/A	N/A
		C	17.66	16	9
		D	-38.92	N/A	N/A
Rajasthan	0% (without any competitive bidding)	A	20.73	19	8
		B	-44.17	N/A	N/A
		C	103.77	24	7
		D	32.79	24	7
	5%	A	0.69	17	8
		B	-60.66	N/A	N/A
		C	81.39	22	7
		D	14.15	22	7
	10%	A	-19.31	N/A	N/A
		B	-77.31	N/A	N/A
		C	59.00	20	8
		D	-4.49	N/A	N/A
Tamil Nadu	0% (without any competitive bidding)	A	-60.09	N/A	N/A
		B	-110.78	N/A	N/A
		C	13.38	16	9
		D	-42.48	N/A	N/A
	5%	A	-76.06	N/A	N/A
		B	-123.95	N/A	N/A
		C	-4.47	N/A	N/A
		D	-57.36	N/A	N/A
	10%	A	-92.03	N/A	N/A
		B	-137.11	N/A	N/A
		C	-22.34	N/A	N/A
		D	-72.24	N/A	N/A

*Highlighted row shows cases of projects feasible with positive NPV

TABLE 8. *Results of feasibility analysis of projects under JNSSM: (with and without competitive reverse bidding).**

State	Bidding with reduction in VGF requirement	Type of project developers	NPV (Rs. Millions)	IRR-Equity (%)	PBP
Gujarat	30%(without any competitive bidding)	A	23.46	20.07	8
		B	-23.51	N/A	N/A
		C	82.68	25.83	6
		D	31.31	25.83	6
	15%	A	-33.46	N/A	N/A
		B	-79.64	N/A	N/A
		C	31.1	18	8
		D	-19.69	N/A	N/A
	0%	A	-90.38	N/A	N/A
		B	-135.75	N/A	N/A
		C	-20.95	N/A	N/A
		D	-70.7	N/A	N/A
Rajasthan	30% (without any competitive bidding)	A	57.95	25	7
		B	4.91	25	6
		C	121.27	32	7
		D	63.44	32	6
	15%	A	1.03	17	8
		B	-51.2	N/A	N/A
		C	69.67	22	7
		D	12.44	22	7
	0%	A	-55.89	N/A	N/A
		B	-107.32	N/A	N/A
		C	18.08	16	9
		D	-38.56	N/A	N/A
Tamil Nadu	30% (without any competitive bidding)	A	7.72	15	9
		B	-57.15	N/A	N/A
		C	37.04	19	9
		D	-6.68	N/A	N/A
	15%	A	-74.25	N/A	N/A
		B	-113.27	N/A	N/A
		C	-14.54	N/A	N/A
		D	-57.69	N/A	N/A
	0%	A	-131.17	N/A	N/A
		B	-169.39	N/A	N/A
		C	-66.13	N/A	N/A
		D	-108.7	N/A	N/A

*Highlighted row shows cases of projects, feasible with positive NPV

Tamil Nadu: Tamil Nadu has the lowest solar radiation level and energy generation potential among the selected states (from Table 4 & Figure 2). From Table 8, it can been seen that in case of project under JNNSM, only Project developers with low cost of equity (Type A and Type C) can make project feasible if full capital subsidy is given to them (in absence of reverse competitive bidding). However, none can survive in reverse competitive bidding. From Table 7, it can be observed that only project developers of Type C can make project feasible under state policy if there is no reverse competitive bidding in feed in tariff.

6. CONCLUSION AND POLICY IMPROVEMENT

Conclusion:

Under present policy framework, domestic Project developers (Type A and Type B) have very little scope of making project feasible only if there is no reverse competitive bidding.

Under reverse competitive bidding (either in JNNSM or in state policies), the multinational project developers with low cost of equity (Type C) have best chance to survive. However, aggression in bidding can reduce their ability to make project feasible significantly.

Three states with the highest solar potential are selected for this analysis. So, based on this analysis, it is safe to assume that project developers have lower scope of making project feasible at other states in India than these three selected states.

Policy improvement:

As a variation of solar potential at different locations have very significant impact on project feasibility, in case of JNNSM, The Central government should adopt differential tariff based on locations. So, project developers at all locations have fair chances to make project feasible with acceptable NPV and IRR-equity. While all the State governments should design their policies in such way that their states can also attract project developers by providing alternatives to the states with higher solar potential, such as Rajasthan.

Domination of multinational players may poses serious challenges to energy security of the country So, while designing solar policies, both the Central Government stakeholders and the State Government stake holders should consider high cost of debt bared by domestic project developers (due to either high interest rate asked by domestic banks or high current hedging cost) and revise the policies in such a way that they can get fair opportunity against the multinational players.

To survive in reverse competitive bidding, the project developers have to keep cost of equity at very low level (sometimes even below the market level), which poses serious challenges for them to run their projects with acceptable level of profit. So, until solar markets gets matured, instead of reverse competitive bidding, governments should allot projects on basis of either first cum first serve or by lottery system .

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