

## **EXECUTIVE SUMMARY**

Gujarat has made stride in environment friendly concept in harnessing the vast potential of Solar Energy through the ground breaking concept of installing Solar Photovoltaic Panels on Canal top.

**1 MWp Canal Top Solar Power Project** is erected on Narmada Branch Canal, owned by Sardar Sarovar Nigam Narmada branch canal (SSNNL), near village Chandrasan, TalukaKadi District Mehsana, Gujarat. This novel concept of using Urjashakti with Jalshakti utilizes the readily available water canal network eliminates use of Land (thereby saving 5 acre of land per 1 MW of generation capacity), while generating green power from abundantly available solar energy, round the year.



Private sector was appreciative of this concept but was reluctant to come forward due to cost considerations for the very first but path breaking initiative. However, this demonstration project has been successfully implemented by GSECL within six months.

### **Innovative concept:**

Cover the canal with solar arrays to....

- a) Save Land use ( conventionally 5 acres /MW)
- b) Save CO<sub>2</sub> emission – 12,80,000 kgs/year
- c) Generate clean and green power, eco-friendly power, strengthening energy security and mitigating huge amounts of carbon emissions.
- d) Save canal water from evaporation – estimated @ 9 million litres/MW/year
- e) Reduction in transmission & distribution losses- as generation is close to consumption point, which can be at remote location.
- f) Generate power with even higher efficiency compared to terrestrial solar power plants due to cooling effect on solar panels by evaporating canal water.

- g) No Rehabilitation & Resettlement issues are involved; such projects can be commissioned faster.

### **Implementation highlights:**

- a) A prototype structure was designed and installed at a separate site, very near to canal – essential and significant learning experience for the implementation team.
- b) Conceptualisation, design, and manufacturing of the special structure with required strength and corrosion protection capabilities, keeping safety of canal on priority.
- c) The canal water is instrumental in lowering the temperature of the solar panels; this further improves the efficiency of the solar plant and yields a higher electricity output.
- d) Minimisation of the transmission loss leading to strengthening of the grid.
- e) Development of the surrounding areas with suitable greenery, encouragement to growth of aqua life.
- f) The project being fully replicable, further projects with higher generation capacity are being planned in the State, on the existing Narmada Main as well as Branch canal.
- g) Employment opportunity for minimum 10-15 persons – unskilled, semi-skilled and skilled depending on length of canal.

### **Replicability:**

- Various state governments have enquired from GSECL about knowhow and other relevant details of this project in order to implement it in their state. Now states/Organisation like Karnataka (1MW), Punjab (100MW), DVC (15MW), Odisha and Chhattisgarh has initiated process for replicating this project.
- Sardar Sarovar Narmada Nigam Limited, a Govt. of Gujarat organisation is executing 10 MW solar PV power plant on Narmada branch canal in Vadodara. Another 10 MW solar plant by SSNNL is commissioned.



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## CANAL ROOF TOP SOLAR VISIT REPORT

- What was the pre-initiative status? What was the eco system before the initiative came into being

The area around the Canal was barren land with limited access by road. Conventionally Solar Plants are set up on ground requiring huge amount of land area. To avoid acquisition of large area of land, the novel concept of setting Solar PV plant on Canal was conceived. By eliminating the use of land, not only deforestation is avoided but reforestation is encouraged through landscaping. Moreover people staying nearby informed that there used to be water theft, trespass and lack of security around this area before this initiative started.

BEFORE



AFTER



- What were the constraints? What were the issues faced by the citizens/stakeholders?

The Canal site is on remote location with no infrastructure such as Roads. Hence it was difficult to transport panels, module mounting structures, Cranes etc. Secondly, this being a pilot project of its kind in the world, no readymade/specified designs or models was available. Hence, a proto type of the plant was installed near the Canal site and all the testing were carried out. In spite of encouragement from Government of Gujarat, no private sector company was ready to invest or execute of its own. So it was decided to implement the project by Government itself through Gujarat State Electricity Company Limited (GSECL). For GSECL, laying of the heavy structure on the canal was a challenge due to length & width of the canal. However, a crane was hired and the whole structure was installed. As this area is scantily habited, no issues were faced by citizens.

- Who conceived the initiative? Was it demand driven, in other words, was the outcome of existing demand by the citizens. Or was it an innovation thought by the administration? Or was it a combination of both?

Gujarat has a large network of river canals measuring 19,000km. Due to shortage and high cost of land, and large network of Narmada Canal, Government conceived this idea. The project was an initiative of Government of Gujarat through its Energy & Petrochemicals Department.

- How is the initiative implemented? What kind of administrative structures are provided for this?

Government of Gujarat put up this idea to private Companies, both national as well as international for implementing this initiative. However, they were apprehensive on feasibility of this project. Hence, ultimately Gujarat State Electricity Corporation Limited (GSECL), a Government Company was assigned this project. Secretary to the Government & MD of GSECL used to oversee and dedicated team of engineers was set up. Civil team was stationed at the site till works were completed. It took five and a half months for the project to go live from design, execution, commissioning and testing.

- Who takes the ownership? In other words, who is responsible for ensuring that the initiative is institutionalised?

Initially Sardar Sarovar Narmada Nigam Limited (SSNNL) was entrusted responsibility to execute this project. Since they had no domain knowledge, Right of Use and Right of Way was given to GSECL. Gujarat State Electricity Corporation Limited (GSECL), a Government Company was assigned this project and is the owner of this project. GSECL visited nearly ten locations along with SSNNL officials. On the basis of radiations and direction of flow of water in the canal, this site was selected. GSECL signed an agreement with Sun Edison as EPC contractor. Designs were approved by GSECL.

- How does this fit into the Organisation's core mandate?

GSECL is a PSU entrusted by Government of Gujarat for generation of electricity. GSECL has already established power plants using coal, lignite, Gas, hydro, wind & Solar as fuel. This pilot project is in line of the main object of the Company and business philosophy of exploiting natural and renewable sources to the maximum possible extent. Moreover it was easier for a Government company to acquire Right of Use of canal water and Right of Way around that area in absence of clearly defined policy.

- How is the initiative impacting the stakeholders?

SSNNL – better maintenance of the Canal, reduced water evaporation, reduced algae formation.

GSECL – Additional power generation through renewable energy source thereby reducing environment pollution.

Citizens - Less voltage fluctuations in the nearby villages, increased livelihood to nearby villagers, no displacement at all.

Society at large - Green energy, Water conservation.

- How has it made things easier and more accessible for the citizens?

People of nearby plant have benefited through improved road, increase in employment opportunities. There is increase of visitors to this plant thereby increasing avenues for income of local population. Also since the area is fenced, less trespassing and theft of water by using illegal water pumps.

- Has it reduced the transaction cost, opportunity cost and increase in efficiencies? If so, how?

The plant is a pilot project located at remote site with no readymade design or model to emulate. The project is located over the water canal and there cannot be a central support or else it could impede the water flow. Hence structure span and strength had to be enhanced for sustainability of the structure. Erection of structures was a challenge due to their robust and heavier size. Also erection had to be done through one side of the canal as there is no support from the centre and access was limited from the other side. Also since the panels are over water which evaporates, it needs to be galvanized thicker than land based projects to avoid rusting. Hence the cost is nearly 30-35% higher than the land based solar projects. However, on the basis of lessons learnt during the erection of this plant, the transaction cost, opportunity cost and increase in efficiencies can be achieved on such new projects. The cost of setting up of 1MW was Rs.17.73 crore and for the Vadodra 10MW plant it came about Rs.10.2 crores per MW. The reduced cost is on better costing of PV invertors' structures and module mounting structures.

#### Cost Breakup

(In Rs. Crores)

PV Modules	7.00
Module Mounting Structure	4.40
Inverter	.90
Civil, Electrical, E&C	5.43
Total	17.73

- Is the initiative office /district/organisation centric? Can this be scales up in the state?

Such projects can be installed by any Organizations or individuals. Already 10 MW Solar PV plant on Canal is commissioned at Vadodara at lower costs. Also, 1 MW plant is being implemented in Karnataka. However to make it attractive for private sector , it will require policy interventions in canal Right of Use, Long term PPAs, Differential tariff from the land based solar projects etc.

- What would it take to scale up? Would it mean addition of resources only? Or would it mean modification of design? Or both?

Other than policy initiatives, it may require project based VGF to encourage private sector participation. Normal resources with modifications in design according to geographical condition of location and Canal direction. It's better to have panels in east west direction to maximize radiations.

- Has it been scaled up already? If so, from when? And who has championed this?

Yes, as mentioned earlier, the scaled up plant is already set up by SSNNL. We are told numerous national and international organizations and Government Agencies have visited GSECL project and have shown keen interest in implementing such project in their area.

- How is the initiative understood by the citizens? Are the processes and steps clear and mean the same to all stakeholders?

It has been welcomed enthusiastically, which is evident from frequent visit of various Groups covering all cross-section of Society like technocrats, delegates, student, Researchers and frequent enquiries from other Indian States to provide them support for setting up similar plants.

- Does this new initiative involve/did it involve change of any laid down guidelines/processes?

Yes, differential tariff policy for canal based solar projects, right of use of canal and right of way around the canals etc. are required to give incentives to all stakeholders.

- When did the initiative came into being? Is the team which championed it, still around?

GSECL's plant was commissioned in March, 2012 and since then it is in operation without any problems. Yes, the team is still around and very much enthusiastic and motivated. Training to second line management also being imparted to maintain continuity.

- If it is a different team, how much of it do they understand and own? Do they have ideas for further improvisation? If yes, have they been implemented?

In continuation, training to develop second cadre of support teams is being carried out.

- Does the entire Organisation understand the impact of the initiative? Have there been discussions on the sustainability of the initiatives – both internally and with the stakeholders – either formal or informal?

Yes. This is being discussed within organization and with its project associates like Sun Edison & GERMI (Gujarat Energy Research Management Institute) and also at

various platforms like Conferences, seminars at national/ international. Various State Governments have also discussed for setting up of new such projects.

- What lessons have you drawn from the initiative? Is it replicable in your State/Ministry?

The Canal roof top scheme is an innovative scheme and Government of Gujarat has successfully implemented the pilot project. The then Hon'ble Chief Minister of Gujarat had put forth the challenge to the private sector for establishing a solar power plant on a canal. While the private sector appreciated the idea, there was a reluctance to come forward. GSECL took up the initiative to establish this path-breaking pilot. The contract agreement was signed with an EPC contractor (Sun Edison) on nomination basis.

**One major learning is, at times Government will have to take up the challenge of implementing the project and successfully demonstrating the technology in order to encourage private sector to come forward. Secondly Government will need to provide a friendly and viable ecosystem like right of canal use, right of way, no bureaucratic and political hurdles, etc. for the private sector to develop new technology and demonstrate successfully.** This project required technology of photovoltaic cells which could be mounted from one side, could withstand adverse weather conditions without getting support from the centre ( to allow uninterrupted water flow), withstand rusting due to water evaporation etc. The project was completed in record 5½ months by the EPC contractor. The Department officials too camped at the project area and fully complemented the efforts of the private partner. Today, this concept is now proven and replicable in entirety with all its advantages globally.

The project has high replicability. High level delegation from various States like Karnataka, Punjab, Haryana, Rajasthan, Chhattisgarh, West Bengal, Andhra Pradesh, Madhya Pradesh, Uttarakhand, Odisha, Jammu Kashmir and Maharashtra have visited and shown interest in replicating this project. Karnataka (1 MW) is ready for commissioning, Punjab (100 MW) and Damodar Valley Corporation in West Bengal (15 MW) has initiated for replicating this project. SSNNL has commissioned in Nov 2014 10 MW Solar PV project on Narmada Branch Canal in Vadodara.

However the efforts are still limited in the Government sector only. Private sector has not come forward fully in taking up such projects on its own without the Government support. This is true for Solar Projects (as power produced is costlier than conventional methods) and more so for Canal roof top Solar which cost nearly 30-35% more than land based solar projects. However with better technology and experience gained, benefits even out any losses due to higher cost (as demonstrated by 10MW Vadodara project) the advantages of canal based solar projects over land based are:

- Zero consumption of land.
- Minimal cost towards site development.

- Greater solar density because of spread out network of canal even in the farthest area.
- Enhanced energy generation because of cooling of solar PV module through evaporating water.
- Saving of 9 million litter/ year of water translate 2500 households getting 10 liters of water all 365 days of year.
- Does not disturb flora fauna.

To make it attractive for private sector, it will require policy interventions in canal Right of Use, Long term PPAs, Differential tariff from the land based solar projects etc. so that large potentials of canal based solar projects could be exploited fully.

- Is there an existing /similar/better initiative already? If yes, how is it different from what you studies? If no, how can you replicate this in your state/Ministry? What does it entail – change in processes, change in systems or anything else? Who should take the lead for the initiative – which department/Ministry?

**Power ministry is implementing De-centralized Distributed Generation (DDG)** scheme for providing electricity access to the un-electrified villages/habitations which are remotely located and where grid connectivity is either not feasible or not cost effective. DDG can be from conventional or renewable sources such as biomass, biofuels, biogas, micro hydro, solar etc. Apart from providing access to electricity to rural households in these villages, electricity access to street lights, schools, community buildings, Panchayat Bhawan are also envisaged under DDG. Areas getting less than six hours of power supply a day can also be covered under DDG. Load per household is nearly 200 W. DDG projects again are owned by State Govt. and implementing Agencies are SREDAs / Depts. dealing with Renewable / State Utilities / CPSUs.

Ministry provides capital subsidy up to 90% of the project cost for:

- A. All equipment, auxiliaries and accessories.
- B. All associated civil works (cost of land to be borne by state government).
- C. Distribution network including access to common facilities.
- D. Cost of plantations (*in case of biomass / biofuels projects only*).

Eligible Project Developers could be State agencies, Technology suppliers, Equipment manufacturers and contractors or Self Help Groups, Users Associations, individuals, Registered Societies, Corporates, Cooperatives, Panchayats etc.

Technology choices for DDG in vogue are Small / Mini Hydro, Diesel generating sets powered by biofuels, Generating sets powered by producer gas generated through biomass gasification (energy plantation should be ensured), Biogas, Solar Photo Voltaic, Wind / diesel / hybrid / new technology etc.

So far, 775 DDG projects with total project cost of approximately Rs 349.39crore have been sanctioned under DDG scheme covering states of Andhra Pradesh, Uttarakhand, Chhattisgarh, Madhya Pradesh, Uttar Pradesh, Bihar, Meghalaya, Rajasthan, Jharkhand, Karnataka, Odhisa, & Kerala which will generate nearly 9.25MW of electricity.

DDG is a micro grid scheme to cover electrified habitations which are far off from the grid connectivity. Most of the projects sanctioned and commissioned are solar based micro grids which are similar to low capacity land based solar projects. At times these projects are delayed due to non-availability of land. Ministry will be keen to explore canal based projects under this scheme and the undersigned as Executive Director of REC and looking after rural electrification will moot a proposal in the ministry. It will not require any change in guidelines or rules except for out of the box thinking as demonstrated in the Narmada canal top 1MW solar project.

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