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Ref: IEGC/ 2019/01

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Shri S C Shrivastava,
Chief Engineering
Central Electricity Regulatory Commission
Member Convenor,
Expert Group to Review "Indian Electricity Grid Code and other related Issues"

Sub: Views/ suggestions for review of "Indian Electricity Grid Code" regd flexibility to implement Solar plant behind AC System design

Respected Sir,

As you are aware, India has already achieved over 30 GW of solar capacity and is well on track to achieve solar target of 100 GW by 2022. Also, owing to supportive government policies, regulatory framework and optimal system design capabilities of the developers, India has consistently achieved one of the lowest solar tariffs in the world in any given time-frame. One of the key factors, which has enabled competitive solar tariffs in the country is the flexibility given to developers under the issued tenders to choose right solar technologies to design solar plants capacity in such an optimal manner so that infrastructure assets like invertor and AC system is optimally utilised.

In line with optimal design of solar DC system, following aspects are also need to be looked into:

- Ability to optimally size DC capacity of the solar plant subject to the inverter's parameters and other technical constraints to generate maximum clean energy. This has helped minimize CAPEX requirement for per unit of solar energy generated resulting in unanticipated lower tariffs.
- BY optimising DC capacity for a given AC capacity restricted by invertor and other AC infrastructure, solar energy with relatively more flat profile can be injected in the grid. This is more desirable from grid stability considerations.
- Degradation of solar output with the time requires to have more DC capacity to maintain desired CUF during the time period of PPA.
- As per CEA's Technical standard for connectivity, the generating stations shall be equipped to respond to grid frequency.

In regard to DC capacity for a given AC capacity, CERC in its past orders for determination of benchmark solar plant cost has not put any limitation on the DC capacity. In-fact while determining benchmark cost, it is mentioned in the CERC order that they have not considered any extra cost in case any developer wishes to develop Solar plant with higher DC capacity and generate more energy for a given AC capacity as the additional cost toward this will be compensated through sale of additional energy generated. Also, CERC has stated in its order that the developer can optimize the performance of the plant for maximum generation vis-à-vis cost by suitable selection of DC capacity and inverter. Additional DC capacity MWp requirement for 1 MW AC could vary from location to location.

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Therefore, CERC has not put any restriction on designing of DC capacity for solar plant has infact left it to the prerogative of the developer to optimally design the plant for efficient generation. Accordingly, CERC has not considered additional cost for it as otherwise it would have limited the design flexibility and thereby efficient generation from the solar plant.

However some of the DISCOMs have mis-interpreted CERC order and have been asking the developer to restrict DC capacity to only 10 % more than a given AC capacity. Infact at some of the old solar generating plants which were commissioned earlier, developer is being asked to restrict its DC capacity and remove the additional DC panel. Thus, there is a need to make clarification in this regard that as such there is no limitation to DC capacity so long the power injected into the grid is restricted to contracted AC power.

Keeping above aspects in view, a note is prepared in regard to providing flexibility to solar developers in optimising their DC capacity for a given AC capacity. This note is enclosed for the kind perusal by the IEGC review committee and it is requested that a clarification at suitable place in IEGC may be included so that solar plant developer has flexibility in optimally designing the DC capacity for a given AC capacity of Solar generating station and it clarifies to all the DISCOMs that there is no limitation of DC capacity for contracted AC capacity while optimally planning and designing the solar plant.

With Kind regards

Yours Faithfully

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Y K Sehgal
Executive Director, Greenko Group
Authorized Signatory

Solar Power Projects: Need to Enable Full Flexibility in Solar Plant Design Behind AC System

India has already achieved over 30 GW of solar capacity and is well on track to achieve solar target of 100 GW by 2022. Also, owing to supportive government policies, regulatory framework and optimal system design capabilities of the developers, India has consistently achieved one of the lowest solar tariffs in the world in any given time-frame. One of the key factors, which has enabled competitive solar tariffs in the country is the flexibility given to developers under many tenders to choose right solar technologies and to design solar plants most optimally. These include;

- Flexibility in choosing Single Axis Tracker (SAT), Dual Axis Tracker, Seasonal trackers or Fixed tilt structures depending of geographical and solar resource considerations.
- Ability to size DC capacity of the plant to derive maximum clean energy subject to the inverter's parameters and other technical constraints. This has helped minimize CAPEX per unit of solar energy generated resulting in lower tariffs.
- Flexibility in using any kind of proven solar PV technology such as poly crystalline, mono crystalline, concentrating solar PV etc.

These have been allowed consistently in the country and has resulted into desirable outcome. Technology related opportunities in solar projects and its policy & regulatory considerations are as below;

- **Opportunities Presented by Evolving Inverter Technologies and Power Electronics:** as the solar inverter technologies have been evolving consistently during last few years, inverter manufacturers have offered warranties with increasing DC:AC ratio, allowing developers to optimize the plant design and achieve lower levelized cost of electricity (LCOE). This has been one of the key factors, India has achieved fast reduction in solar tariffs. Currently, almost all leading inverter manufacturers e.g. SMA, Sungrow, TMIEC and many others offer opportunities of DC: AC oversizing in the range of 1.6-1.7.

- **Use of Solar Tracker Technologies to flatten solar generation curve:** at many locations, solar tracker technologies (SAT and Dual Axis) have proved to be helpful in reducing LCOE from solar as more additional units could be generated compared to the incremental CAPEX. Also, tracker technologies have helped in flattening the solar generation curve and make the energy more useful for the off-takers.

- **Competitive Bidding Guidelines for Solar**: ***The MNRE/MoP, Govt. of India, has neither prescribed any DC capacity capping under the Competitive Bidding Guidelines for Solar PV, dt. 3rd Aug 2017, nor under the Technical Requirements for Grid Connected Solar PV Power Plants. These guidelines also allow all types of proven solar and tracker technologies.*** One of the objectives of the competitive bidding guidelines has been to achieve lower solar tariffs in line with objectives of National tariff Policy. Allowing maximum DC capacity per MW AC and other design flexibility behind the AC system have helped in meeting this objective.

- **National Solar Mission and Other Tenders**: The opportunity of higher DC:AC ratio and use of all types of solar PV technologies have been properly leveraged under National Solar Mission tenders. From, Phase II of National Solar Mission, all the tenders run by SECI and NTPC allowed uncapped DC capacity per MW of AC contracted capacity in line with evolving inverter technologies. These tenders have also allowed all types of proven solar technologies for optimal DC plant designing. Many states also followed the trend (Ref: Annexure A).

- **International Experience**: Even the global experience of the recent solar tenders in countries such as Jordan, Saudi Arabia, Zambia, etc. is the same, where the tender documents do not specify any limitation of DC sizing or any technology/design restrictions behind the AC system. As a standard practice worldwide, DC plant design including the DC sizing is always left to the generator's discretion, while specifying only other conditions in the PPAs / contracts.

- **CERC Regulations**: Central Electricity Regulatory Commission in its tariff order for solar (Determination of Benchmark Capital Cost for Solar PV power projects and Solar Thermal power projects applicable during FY 2016-17) dated 23rd March 2016 opined on the DC sizing issue;

  "Some stakeholders have requested that module costs should be considered 10-20% higher than rated capacity. ***Additional modules are deployed by some developers to optimise the performance of the plant, especially the inverters****. Nevertheless, additional units of electricity are generated with the extra module capacity, resulting in higher earnings of feed in tariff. The commission is of the view that the remuneration due to additional units generated sufficiently covers additional costs in such a case."*

Hon'ble CERC in its order recognized that DC oversizing is a practice in order to optimize performance of the plant, especially the inverter. Hon'ble commission's only take away in the matter was that higher generation from more DC capacity would compensate for the higher capex and benchmark capital cost in case need not be increased. **Hon'ble commission didn't prescribed any ceiling in DC:AC oversizing.**

Freedom in designing the DC system and sizing of DC capacity has been one of the factors contributing to the competitive solar tariffs, as generators pass the favorable cost-benefit trade-off to the DISCOMs

Keeping above in view, it is requested that for optimal development of Solar generating station, following aspect may be considered suitably in the IEGC:

Solar developer shall plan and design there DC/ AC system in an optimal manner so that for a given AC capacity, the solar energy is optimally and efficiently harnessed. The developer shall have flexibility to plan DC capacity /Invertor capacity or adopt any other technology to supply the committed energy from solar generation so as to give the committed performance during the PPA period .

Annexure – A: Solar Competitive Bids Clauses

	Solar Competitive bid	Relevant Clause
1	750 MW SECI (NSM Phase II Batch I) 2013	Clause 3.8 Power Generation by Solar Power Developers *"While the SPD would be free to install DC solar field as per his design of required output, including his requirement of auxiliary consumption, he will not be allowed to sell any excess power to any other entity other than SECI (unless refused by SECI)."*
3	440 MW UP Solar Park bid SECI (NSM Phase II Batch III Tranche III) 2015	Clause 3.9 Power Generation by Solar Power Developers *"While the SPD would be free to install DC solar field as per his design of required output, including his requirement of auxiliary consumption, he will not be allowed to sell any excess power to any other entity other than SECI (unless refused by SECI)."*
4	500 MW Ghani / Kurnool solar park bid in AP NTPC (NSM Phase II Batch II Tranche I state-specific bundling scheme) 2015	Only annual energy commitment has been specified, no mention of DC capacity limit
5	500 MW Pavagada solar park bid in Karnataka NTPC (NSM Phase II Batch II Tranche I state specific bundling scheme) 2015	Only annual energy commitment has been specified, no mention of DC capacity limit
6	500 MW Kadapa solar park bid in AP NTPC (NSM Phase II Batch II Tranche I state specific bundling scheme) 2016	Only annual energy commitment has been specified, no mention of DC capacity limit
7	860 MW taluka-level bid	Only annual energy commitment has been specified, no

	in Karnataka KREDL 2017	mention of DC capacity limit
8	450 MW bid in Maharashtra SECI (NSM Phase II Batch IV Tranche III) 2016	Clause 3.9 Power Generation by Solar Power Developers, *"While the SPD would be free to install DC solar field as per his design of required output, including his requirement of auxiliary consumption, he will not be allowed to sell any excess power to any other entity other than SECI (unless refused by SECI)."*
9	750 MW Ananthapuramu solar park bid in AP NTPC 2018	PPA clause 4.4.2 *"SPD shall however be entitled to install DC solar field as per its design of required output, including its requirement of auxiliary consumption and to reconfigure and repower the Project from time to time during the term of the PPA."*
	1200 MW ISTS bid SECI, RE + Storage Aug 2019	Clause 8 Power Generation by Solar Power Developers *"While the SPD would be free to install DC solar field as per his design of required output, including his requirement of auxiliary consumption, he will not be allowed to sell any excess power to any other entity other than SECI (unless refused by SECI)."*