Defining 'utility-scale' solar

How we arrived at the threshold of 4MW$_{AC}$

The expression 'utility-scale solar' is increasingly widely used for large-scale grid connected photovoltaic generation; but there are wide variations in the way in which this is interpreted and in particular the power capacity of systems that qualify as 'utility-scale'.

As the leading international commentator on this sector, Wiki-Solar consulted on the definition and will now be adopting the following approach.

The Wiki-Solar definition:

1. Wiki-Solar has now adopted a threshold level defined in terms of the rated AC output[1] of the station, to ensure that figures are comparable to other energy options such as wind or thermal power generation.
2. The threshold level above which solar generating stations are counted as 'utility-scale' will be 4MW$_{AC}$.
3. The level has been chosen, following consultation, because it covers the majority of relevant power plants, and is roughly equivalent to 5MW$_P$ (solar peak megawatts DC).

The process and rationale for adopting this approach is outlined below.

1 Considerations for setting the threshold

1.1 Historical precedents

A published academic paper[2] highlighted how different actors had defined the lower limits for utility scale solar anywhere between 25 kW and tens of megawatts. Wiki-Solar[3] had been one of the highest; the US administration's National Renewable Energy Laboratory set the limit at 5 MW[4]; one International Energy Agency publication[5] suggests 1 MW, as does the US Energy Information Administration[6]. Authorities like the International Renewable Energy Agency[7] use the term without apparently defining it.

Different world legislatures also set cut-offs for policy measures which can be loosely attributed to utility scale. The German government, for example, in 1012 removed the feed in tariffs from installations about 10 MW, leaving them in place for smaller domestic and commercial applications[8]. The government of Punjab designated a separate program for large-scale solar applications about 5 MW[9]. The UK government designated its feed in tariffs to apply to domestic and commercial applications up to 5 MW$_P$[10] with the Renewables Obligation deemed to serve utility scale applications of higher capacities. It is now raising the threshold to 10 MW$_P$ for some applications[11].

1.2 What the words seem to mean

The expression 'utility-scale' of course implies the level at which major energy producers would supply power to the grid. In the case of coal and nuclear power stations this can be as high as 5-8 GW, and the largest hydropower plants are over 10GW. At the other end of the scale, utilities in some parts of the world routinely generate power through hydropower stations, biomass plant and diesel gen-sets down to fractions of a megawatt. The UK government, for example, records plants down to 1 MW_{AC}[12].

In the case of solar power generation, our aim was that the expression 'utility-scale' should be should relate to the level at which systems are typically designed to feed merchant power into the grid; as opposed to those intended primarily to serve a local energy user or distributed power application. We acknowledge that such applications can spread down to the kilowatts scale, but have established that the threshold at which most systems are designed for feeding merchant power into the grid is of the order of a few megawatts.

1.3 Other considerations

As our aim in refining this definition is to improve the availability of data, it is worth noting that there is a trade-off between the threshold chosen and quality of information. The lower the limit is set, the more projects fall within the definition of utility scale. From the perspective of an information resource such as Wiki-Solar, this would lead to a larger database and the probability of less complete and less reliable data.

For example, the number of operating projects of 10 MW_P+ was approximately 600, as at mid-2013. At a threshold of 5 MW_P+, the number of such projects doubles, while the cumulative capacity they represent increases by 20% from some 15 to 18 GW_P. Because of the high number of projects in the range 5 to 10 MW_P, and the fact that they are relatively less noteworthy than the larger projects, the data in this range is likely to be less complete and less reliable.

2 Consultation process and results

Because this is a nuanced decision, Wiki-Solar decided to implement a public consultation on the matter and seek the views of representative parties in the industry. This survey was conducted through an online portal on the Wiki-Solar website[13] in the second half of 2013.

All the responses came from Europe, Asia and North America. This is perhaps unsurprising as the vast majority of installed utility-scale capacity is in these continents. The results were as follows.

2.1 DC or AC threshold

There was a modest majority – 50% – for expressing the threshold in terms of megawatts peak (MW_P), rather than the rated AC output – 42%. The remaining 8% held that either measure was acceptable.

Notwithstanding this outcome, we have decided to adopt the MW_{AC} rating, for the reasons described in 4.1 below.

2.2 Capacity threshold

The consultation results were as follows:

Threshold:	1 MW	2 MW	5 MW	10 MW	50 MW	100 MW	Other
Votes:	25%	-	48%	27%	-	-	-

Table 1 Proportion of support for each threshold option

Most support for the 5 MW threshold came from Europe and India, where some regulatory measures are related to this (or the sub-10 MW) range. The 10 MW level received more support from America and other parts of Asia.

As discussed in 4.2 below, we intend to adopt a threshold based on the consensus level.

3 Analysis

In addition to the consultation, we analysed the indicative coverage that would be obtained at various cut-off levels.

3.1 Utility power plant databases

While many national databases of utility power plants list stations down to (and sometimes below) 1 MW_{AC}, the overwhelming majority of the capacity listed is above 10 MW_{AC}, as shown by the sample in this table:

Coverage within Power station databases	Capacity at or above MW 1	4-5	8-10
EIA: USA new capacity 2012/13	100.0%	99.4%	98.9%
DUKES[12]: UK operational plant	100.0%	99.9%	99.7%
BMWi: Germany operational	100.0%	100.0%	99.9%

Table 2 Proportion of listed utility generation capacity above each of three threshold levels

For the purposes of comparison within the present utility electricity generation portfolio of most developed countries, therefore, there is little to justify a threshold below 10 MW_{AC}.

3.2 Solar power databases

There are few databases of utility-scale solar power plants, of which Wiki-Solar's is probably the most comprehensive. For each known database, the proportion of capacity above the same three thresholds is shown in table:

Coverage within Solar power databases	Capacity at or above MW 1	4-5	8-10
Wiki-Solar: Operational worldwide	100.0%	98.4%	80.3%
SEIA: Operational plant in USA	100.0%	98.0%	87.3%
MNRE: Operational plant in India	100.0%	81.2%	51.6%
Wiki-Solar: Total worldwide	100.0%	98.9%	91.7%

Table 3 Proportion of listed PV generation capacity above each of three threshold levels

Based on these results, a threshold of 4-5 MW would capture the majority of listed capacity.

If using the higher threshold of 10 MW, a higher proportion (typically perhaps 15-20%) of large-scale solar capacity would be excluded.

4 Conclusions

4.1 DC or AC threshold

Because a DC or 'peak' rating is almost unique to photovoltaic systems (as further discussed in our 'capacity rating' paper[1]), we have concluded that it is best to adopt the industry standard AC rating as the factor on which the threshold is based.

This will therefore exclude conversion losses and enable simple direct comparisons with other technologies, such as wind and thermal technologies, including concentrating solar power (CSP), fossil-powered and nuclear generation.

4.2 Capacity threshold

Both analyses in sections 2.2 and 3.2 above support a threshold of about 5 MW as providing the most comprehensive information for utility-scale solar generation. Because of the number of respondents who expressed their preference in MW_P, we have decided to set the threshold at 4 MW_{AC}, because this is roughly equivalent to 5 MW_P.

We note that lowering the threshold from the existing[3] 10 MW_P (approximately 8 MW_{AC}) may have some impact on the completeness and accuracy of our data, for the reasons given in 1.3 above.

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1 Refer to the Wiki-Solar Glossary paper: *Capacity rating for solar generation stations*

2 Patrick Donnelly-Shores, University of Berkeley: *How big is "utility-scale" solar?*

3 Which initially adopted the threshold of 10 MW_P, above which solar power plants were deemed to be utility scale

4 Referred to in: *Two New Reports on Utility-Scale Solar from NREL*. No rationale is offered for the 5 MW figure, which is assumed to be MW_{AC}.

5 See page 10 of *Technology Roadmap: Solar photovoltaic energy*, though other parts of this report, and other publications such as Topic: Renewables seem less specific.

6 See *Utility-scale installations lead solar photovoltaic growth*, which also clarifies that its figures are in MW_{AC}.

7 For example *RE Technologies Cost Analysis: SOLAR PV* refers to utility-scale system both above and below 10MW

8 *Germany approves reduced solar feed-in tariffs*

9 Request for proposal document for new grid connected Solar photovoltaic power

10 *Eligible energy sources*

11 *More community energy projects to get support under Feed-in Tariffs*

12 Electricity: chapter 5, Digest of United Kingdom energy statistics (DUKES)

13 Available at: http://wiki-solar.org/data/glossary/utility-scale.html