ANNEX 3

ANALYSIS AND EXPLANATION OF THE CONVERSION FACTOR FOR SOLAR THERMAL COLLECTORS

1. BACKGROUND

It is a standard industry practice to use the area of the collectors to express the capacity of solar thermal collectors. The determination of the physical area is a simple and practical way of verifying the capacity of the solar thermal systems, as is commonly found in manufacturers' specifications. Currently the output capacity of the small scale renewable energy CDM projects is limited to 15 MW and in accordance with the guidance from the EB, the equivalent that is relevant for thermal applications, including solar energy, is 45 MWth. This note provides the conversion factor for converting this SSC limit, expressed in power units, to collector area in m^2.

2. SOLAR COLLECTORS AND USE

There are primarily three types/designs of solar thermal collectors relevant to the SSC methodologies. These collector types and their usage in annex I and non-annex I countries is explained below:

- **Unglazed plat plate collectors** – these solar thermal collectors are usually made of a black polymer, without a frame, with a glass cover and insulation on the backside. These collectors are low cost but have high thermal losses. Unglazed flat plate collectors are generally popular in annex I countries, especially North America and Australia.

- **Glazed flat plate collectors** – is a flat plate absorber fixed in a frame, with a single and double layer of glass on the top and an insulation panel at the backside. These are the most popular type of solar thermal collectors and are used in hot water, space heating and process heating applications. These are widely used both in Annex I and non-Annex I countries.

- **Evacuated Tube Collectors** – these are collectors with the absorbers enclosed in a sealed vacuum tube. These are relatively expensive but have a high efficiency. These collectors are used in high temperature applications such as hot water, space heating, and process heating applications. These are very popular in China and are also used in annex I countries.

Thus the most popular collector types/designs used in non-annex I countries are glazed flat plate collectors. The evacuated tube collectors are also widely used in China. This document, therefore, presents the conversion factor for the glazed flat plate collectors and evacuated tube collectors.

3. CONVERSION OF MW$_{TH}$ TO AREA

3.1. Definition of Area

Three definitions of area are used to define the flat plate solar thermal collectors – (i) gross area, (ii) absorber area, and (iii) aperture area. The gross area is defined as the outer dimensions of the collectors (e.g. including the frame, glazing etc.). Aperture area is the area over which the solar radiation enters the collector. Absorber area is defined as the dimensions of the absorber. For unglazed flat plate collectors the gross area, the aperture area and the absorber area are the same. The aperture area is the most relevant area from the energy conversion point of view. Therefore, the conversion factor is expressed in terms of aperture area.

3.2. Specific Nominal Capacity

The conversion factor is based on the specific nominal capacity of the collector. The specific nominal capacity is the nominal capacity per unit aperture area (W/m^2) of the collector. The nominal capacity is defined as the instantaneous thermal output of the collector under the following operating conditions:

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Nominal Solar radiation (G)   = 1000 W/m^2

Ambient Air Temperature (T_a)   = 20°C

Collector mean fluid temperature (T_m) = 50°C

Specific Nominal Capacity (P/A) = $\mathbf{G * \eta_o - a_1 * (T_m - T_a) - a_2 * (T_m - T_a)^2}$

Where,

η_o	= Zero Loss Efficiency
a_1	= First order heat loss coefficient (W/m^2 .K)
a_2	= Second order heat loss coefficient ($W/m^2.K^2$)

3.3. Calculations

Average values for parameter η_o, a_1, a_2 were sourced from a study done by the European Solar Thermal Industry Federation (ESTIF) that tested collectors in Europe[1]. The values are given below.

Glazed Flat Plate Collectors - η_o = 0.78, a_1 = 3.2 W/m^2 .K, a_2 = 0.015 $W/m^2.K^2$

Evacuated Tube Collectors - η_o = 0.76, a_1 = 1.2 W/m^2 .K, a_2 = 0.008 $W/m^2.K^2$

Specific Nominal capacity for glazed flat plate collectors (P/A)	= $1000 * 0.78 - 3.2*(50-20) - 0.015*(50-20)^2$
	= **671 W/m^2**
Therefore glazed flat plate collector area equivalent to 1 MW_{th}	= **1490.3 m^2**
Specific Nominal capacity for evacuated tube collectors (P/A)	= $1000 * 0.76 - 1.2*(50-20) - 0.008*(50-20)^2$
	= **717 W/m^2**
Therefore evacuated tubular plate collector area equivalent to 1 MW_{th}	= **1394.7 m^2**

It may be noted that the IEA solar heating and cooling implementation agreement in consultation with the European and North American solar thermal industry associations have agreed a conversion factor of 700 Wth/m^2 or 1MW_{th} = 1428.5 m^2. ESTIF has informed (personal communication) that the IEA official statistics will be using this conversion factor from 2007.

4. CONCLUSIONS

Based on the above analysis the following conclusions can be made:

1) The solar thermal collector types/designs commonly found in non-annex I countries are glazed flat plate collectors and evacuated tube collectors;

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[1] Test results from 2004 based on the EU standard EN 12975.

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2) It is appropriate to use the aperture area of the collector to define the eligibility limit using the proposed conversion factor;

3) The conversion factors are:

    4) Glazed flat plate collectors: 671 W_{th}/m^2; and

    5) Evacuated tube collectors: 717 W_{th}/m^2

5. RECOMMENDATIONS

The SSC WG recommends to the EB the following options:

1) For thermal applications of solar energy projects[2],

    a. For glazed flat plate collectors "maximum output" shall be calculated using a conversion factor of 671 W_{th}/m^2 of aperture area of the collector i.e. the eligibility limit in terms of aperture area is 67000 m^2.

    b. For evacuated tubular plate collectors "maximum output" shall be calculated using a conversion factor of 717 W_{th}/m^2 of aperture area of the collector, i.e. eligibility limit in terms of aperture area is 62700 m^2.

2) For thermal applications of solar energy projects[2], 'maximum output' shall be calculated using a conversion factor of 700 W_{th}/m^2 of aperture area of the collector (glazed flat plate or evacuated tubular) i.e. eligibility limit in terms of aperture area is 64000 m^2 of the collector.

Project participants may also use other conversion factors determined as per the procedures prescribed for 'equipment performance' under paragraph 5 of the 'General Guidance' to the indicative methodologies for the SSC, however it shall be justified why the chosen conversion factor is more appropriate to the project activity.

As recommended in the 5th meeting of the SSC-WG, the option 2 above will be simpler to implement and will be consistent with other initiatives.

The guidance, when approved by the Board, shall be incorporated as Paragraph 7 d of the 'General Guidance' to the Indicative Simplified Baseline And Monitoring Methodologies For Selected Small-Scale CDM Project Activity Categories.

REFERENCES

1) ESTIF/Nielsen, 2004, Recommendation: Converting solar thermal collector area into installed capacity

2) ESTIF/Brechlin/Nielsen, 2006, Personal Correspondence

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[2] This conversion is not applicable for solar thermal parabolic and trough type collectors used for high grade solar thermal energy applications.