External costs of photovoltaics. What is it based on?

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ExternE study (http://www.externe.info/)

The main aim of the ExternE research projects (European Commission, Directorate-General for Research, 2003; European Commission, Directorate-General for Science, Research and Development (DG-XII), 1999; IER, 1997) was to develop a methodology to calculate the external costs caused by energy production and consumption. External costs are defined as the monetary quantification of the socio-environmental damage, expressed in eurocents per kWh. As such, it can provide a scientific basis for policy decisions and legislative proposals like subsidizing cleaner technologies and energy taxes to "internalize" the external costs.

ExternE 2003 brochure

The ExternE 2003 brochure (European Commission, Directorate-General for Research, 2003) gives the impression that electricity production from photovoltaics leads to a greater health damage than the electricity production from gas or nuclear power. Some views about this study were already discussed by (Nickel, 2004).

Aim

The external cost figures for electricity production in the EU and in Germany, given in the ExternE 2003 brochure, are given without references, so it is not clear on which information it is based. This paper aims to retrieve the input data that was used for the calculation of the external costs of photovoltaic systems. Apparently, the two tables "External cost figures for electricity production in the EU for existing technologies" and "Quantified marginal external costs of electricity production in Germany" are based on different calculations. For example the sum of external costs for the different technologies given in the first table are not equal to the values presented in the second.

ExternE data for PV (1): the Kaspar 1995 study

The determination of the external costs of photovoltaics in the upper table in the ExternE 2003 brochure and in (European Commission, Directorate-General for Science, Research and Development (DG-XII), 1999; IER, 1997) are based on only two case studies in only one country, namely Germany. The data are compiled by ISET (Kaspar, 1995) and taken from the 1000 roof program. One case is a 4.8 kWp roof system of 96 polycrystalline silicon PV modules produced by DASA/AEG in 1990 and located in Emstal-Riede with a performance of 730 kWh/y per kWp. The other case is a 13 kWp façade system of 200 frameless polycrystalline modules produced by DASA and located in Bielefeld with an estimated performance of 630 kWh/y per kWp. Material and energy use of 3 inverters, special cabling and measurement systems were not taken into account. The expected lifetime is 25 years. The burdens were quantified using Life Cycle Inventory data of (Hagedorn, 1992), representing technologies from the late eighties of German companies.

ExternE data for PV (2): the Hartmann 2001 study

The external costs of photovoltaics given in the lower table of the ExternE 2003 brochure are very similar to the values in table 4 of (Voß, 2000). In (Voß, 2000) the total life cycle emission of CO_2-equivalents is **216 g/kWh** for PV for an amorphous silicon PV-home application of 5 kWp. Voβ states that this generation technology is "representative for current and near-future technologies operated in Germany". No reference is given to the study on which this is based.
In table 6-8 of the PhD thesis of (Hartmann, 2001), published in the same group of Voβ, the Institute of Energy Economics and the Rational Use for Energy (IER) of the University of Stuttgart, the same value of **215 g/kWh** is given for an ***amorphous silicon 5 kWp system, of which 10.5% is for a backup system (assuming PV is 10% of the electricity mix)***. So we conclude that the PV data in the lower table in the ExternE 2003 brochure are based on this thesis.

Discussion

A citation from pages 89-90 of this thesis (Hartmann, 2001) is "Die Massen- und Energiemengen entsprechen dem aktuellen Stand der Technik (vgl. 'worst-case Daten' in /v. Engelenburg; Alsema 1994/)."

The *worst-case* amorphous silicon data of (Engelenburg, 1993) are data from *mid 80's* and are *not* representative of current or near-future values. Amorphous silicon is not a representative technology. In Europe in 2002 92% of the cell/module production was crystalline silicon and only 8% was amorphous silicon (Maycock, 2003).
Furthermore, PV is currently only a very small part of the German electricity mix, so no backup system is necessary.
Using more recent data of (Alsema, 2003) and assuming a valuation of 19 euro per ton of CO_2, the external cost for global warming will decrease the ExternE 2003 value of 0.33 eurocents per kWh to:
0.21 eurocents per kWh for standard/BOAL multicrystalline silicon roof PV system located in the Netherlands,
0.12 eurocents per kWh for standard/BOAL multicrystalline silicon roof PV system located in South-Europe,
0.09 eurocents per kWh for a future RGS/PV wire free multicrystalline silicon roof PV system located in the Netherlands and 0.05 eurocents per kWh for a future RGS/PV wire free multicrystalline silicon roof PV system located in South Europe.
The new valuation of all other emissions will soon be available as a result of the NewExt project and total damage costs will be calculated.

Conclusions

The aim of the ExternE study was to provide a scientific basis for the external cost calculations, but the lack of referencing and not disclosing the fact that the figures in the ExternE 2003 brochure are based on ancient PV technology, is not an example of good scientific practice.
We are looking forward to the publication of the results of new calculations, which will be conducted in the ExternE-Pol project using LCA emission data described in the new EcoInvent2000 database (Jungbluth, 2003). Other countries than Germany must be included, since the performance of the PV systems is highly dependent on location (solar irradiation).

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