Impact on the environment of solar and wind energy installations

Summary:

1. Introduction

The following factors are of special importance in evaluating the environmental impact of installations that produce thermal energy or electricity:

- Gain factor
- Environmental impact

The gain factor is a measure of how many times the energy necessary for the manufacture and operation of an installation can be produced by the same installation. A factor of more than one means that non-renewable energy is being saved, i.e. that the installation is producing more heat or electricity than is required for its manufacture and operation.

Depending on the type of technology the environmental impact will be measurable in terms of the following parameters: emissions, surface area occupied and compatibility with the area, possibility of restoring site to prior condition, influence on flora and fauna.

2. Thermal installations (Solar thermal)

Gain factor: in the case of solar installations the gain factor is roughly seven, i.e. about seven times as much energy is produced as is required for the manufacture and disposal of the unit. Space heating and hot water preparation with non-renewable sources of energy such as oil, natural gas and electricity (CH- and EU-Mix) have a gain factor of significantly less than one.

Since solar installations are at best able to cover only part of the heating requirement a second source of heat must also be taken into consideration. Since the gain factor of solar installations is better than that of any oil, gas or electric system, the result for the combined system will still be better than for the second source on its own. It follows that combining the two types of technology, solar and conventional, makes economic as well as ecological sense.

Combining solar thermal and wood heating system is a special case, since the gain factor for the wood heating system, which is higher than that for the solar system, is reduced in combined use. On the other hand the total output of polluting emissions improves. This is because the solar collectors reduce the need for wood heating in relatively mild conditions, when it would be less efficient.

Environmental impact: solar collectors are entirely emission-free, and are manufactured from materials that are to a great extent recyclable.

Space requirement: roughly 1 m^2 of solar collector covers 50% of the hot water requirement of a single person. This means that only a small part of the roof space currently available nationwide would be required to meet Switzerland's solar water heating needs.

"Solar energy is available in sufficient quantities only in the summer": this is true of the most populous areas of Switzerland on the plateau, but not in the surrounding mountains where the potential is much more promising. This is not to say that solar technology makes sense only in high altitudes however. Solar installations are best used in milder conditions when conventional heating systems can only operate inefficiently (at part load) with a high rate of polluting emissions. Even on the plateau solar energy is capable of meeting all the heating requirements of a building.

3. Photovoltaic installations (solar PV electricity)

Background data: Photovoltaic systems or "solar PV" is capable of covering 20-30 per cent of the electricity demand in central Europe over the long term, without having to create new support surfaces specifically for this purpose. Existing surfaces would be sufficient. The world market is currently growing at an annual rate of some 25 per cent.

Gain factor: the gain factor with solar PV is around four at present. Recent studies show that the gain can be expected to improve considerably as the technology's market share increases.

Environmental impact: solar PV installations produce no emissions in operation. The solar cells and other installation components currently on the market are made of materials that can be disposed of without harm to the environment.

Space requirement: solar PV installations are particularly well suited for integration in existing structures such as facades, roofs, noise abatement installations, etc., requiring a simple hook-up to the grid for feed-in of the electricity generated. The surface area requirement is thus insignificant and this is unlikely to change until such a time as solar PV is called upon to meet a much greater proportion of total electricity demand than at present.

4. Wind installations

Background data: a 1996 study on the development potential for wind generated electricity in Switzerland showed that even allowing for nature and landscape protection restrictions, it

would be possible to meet about 3.5 per cent of total electricity demand (1995) with wind turbines, at a production cost of less than SFr0.40/kWh.

Switzerland currently has 14 installations with a total installed output of 2.8 MW. Total production in 1999 amounted to 3,200 MWh of electricity, which roughly corresponds to the consumption of 1000 households.

For the larger units (>2 MW) the production cost amounts to just SFr0.20/kWh more or less (excluding transport and service costs).

Gain factor: during their lifetime wind installations yield 40-80 times more energy than is required for their manufacture and dismantling. This gives wind energy a gain factor second only to that of hydropower (factor of ±180).

Environmental impact: wind energy produces neither pollution nor waste.

Impact on the landscape: wind installations do have a definite impact on the landscape. This can be kept to a minimum however by careful selection of the location. When deciding on the location existing encumbrances such as the pylons of high voltage transmission lines, transport infrastructure, and so on should also be taken into consideration.

Space requirement: the surface area necessary for the foundation of a 600 kW wind installation is 100 m^2. However the area below the turbine can still be used for agricultural purposes including grazing livestock, etc..

Emissions: when it comes to noise, wind installations of the new generation have been described as "whispering giants". At a distance of 300 metres the whirring of the rotor blades is usually imperceptible against such background noise as the rustling of leaves on a windy day. The mechanical parts of modern units scarcely produce any noise at all, thanks to the tremendous progress made in this field, and the aerodynamic design of state-of-the-art rotor blades allows these to operate in virtual silence. Thanks to a rather late start in this field, Switzerland has been able to take full advantage of the new technology. It is therefore rather pointless to compare Swiss installations with older technology still in use in other countries such as the United States.

In view of the rather piecemeal pattern of the Swiss landscape there is little room for the large-scale wind parks found in many other countries. Thanks to efficient co-ordination at the regional/cantonal level and the active involvement of landscape and nature protection groups, the development of wind energy has been kept under control, and there are no "wildcat" turbines scattered about.

5. For additional information

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