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Life cycle analysis of photovoltaic roof tile

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This master's thesis is carried out as a part of the education at the University of Agder and is therefore approved as a part of this education. However, this does not imply that the University answers for the methods that are used or the conclusions that are drawn.

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Abstract

In this project the main task was to find the environmental sustainability of a photovoltaic (PV) roof tile, with a focus on the energy payback time (EPBT) and global warming potential (GWP)/ CO_2 footprint. In this report, a comparative life cycle assessment has been conducted on two selected photovoltaic technologies used in Norway; the PV roof tile and a conventional PV panel. A total of five cases were examined in this analysis. The primary focus was concentrated on the monocrystalline PV roof tile, where four different cases of the product were considered. The cases in question had differences in location of manufacturing, and two separate purification processes for silicon were considered; the modified Siemens process and the Elkem Solar Silicon process. The fifth case in this report was based on the conventional photovoltaic panel.

For the purpose of examining the electrical performance of the chosen systems, measurements were carried out for two available PV roof tiles. Since there are no complete datasets available for the evaluation of annual performance of the PV roof tile, this was estimated for two locations in this project; Spain and Norway. The results from examining the solar irradiation in these two locations show that the energy payback time (EPBT) and global warming potential (GWP) is highly dependent on installation site. The EPBTs for the PV roof tile systems were ranging between 1.40 and 6.91 years, and the GWPs/CO_2 footprints were ranging between 30 and 70 g CO_2 eq./kWh. The project also gave interesting insight into the importance of electricity mixes considered for an LCA, both for the installation and production of the product. The Spanish production of electricity is having a significantly higher potential impact on climate change than the production of electricity in Norway. When comparing with Norway, installation of PV systems in Spain is therefore a better way of avoiding potential environmental impacts. The irradiation is also higher in Spain, and the PV roof tile system will produce more energy at this location, leading to a low GWP and EPBT.

Seen from an environmental perspective the use of conventional photovoltaics and building integrated photovoltaics are good solutions. Even the highest GWP in this report is over 15 times lower than the non-renewable energy source of coal. If PV systems are installed, the demand for non-renewable energy sources can be reduced. Hence the impacts on the environment will become lower than if non-renewable sources had been used for the same amount of energy produced.