

## Implementation of Industrial Ecology Principles in the Production and Recycling of Solar Cells and Solar Modules

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**Abstract :** Three opportunities for implementation of industrial ecology principles in the real industrial production of c-Si solar cells and modules are presented in this study. It includes: material flow dematerialisation, product modification and industrial symbiosis. Firstly, it is shown how the collaboration between R&D institutes and industry helps to achieve significant reduction of material consumption by a) refuse from phosphor silicate glass cleaning process and b) shortening of silicon nitride coating production step. Secondly, it was shown how the modification of solar module design can reduce the CO<sub>2</sub> footprint for this product and enhance waste prevention. It was achieved by implementing a frameless glass/glass solar module design instead of glass/backsheet with aluminium frame. Such a design change is possible without purchasing new equipment and without loss of main product properties like efficiency, rigidity and longevity. Thirdly, industrial symbiosis in the solar cell production is possible in such case when manufacturing waste (silicon wafer and solar cell breakage) also used solar modules are collected, sorted and supplied as raw-materials to other companies involved in the production chain of c-Si solar cells. The obtained results showed that solar cells produced from recycled silicon can have a comparable electrical parameters like produced from standard, commercial silicon wafers. The above mentioned work was performed at solar cell producer Soli Tek R&D in the frame of H2020 projects CABRISS and Eco-Solar.

**Keywords :** manufacturing, process optimisation, recycling, solar cells, solar modules, waste prevention

**Conference Title :** ICWMEE 2019 : International Conference on Waste Management and Environmental Engineering

**Conference Location :** Sydney, Australia

**Conference Dates :** January 30-31, 2019