# Leafroof

**Alexander Rosemann [1], Guillaume Doudart de la Grée [1], Argyrios Papadopoulos [1], Michael Debije [1], Mark Cox [1], Angèle Reinders [2], Frans van Zeeland [3]**

[1] *Eindhoven University of Technology, Department Built Environment*
[2] *University of Twente, Faculty of Engineering Technology*
[3] *Gemeente Laarbeek*

## Abstract

Conventional solar energy collection technologies have a lot of limitations with respect to their applicability in the urban environment. The PV cells of the buildings need to be oriented towards the South at a specific angle causing restrictions on urban planning. Moreover, the aesthetics of PV cells are not well suited for building design, creating a generally dull and industrial look in urban environment.

The 3TU Lighthouse Leafroof project focuses on creating a roof design, inspired by the natural shape of leaves. By incorporating the Luminescent Solar Concentrator (LSC) technology the system can collect and "trap" solar irradiation and concentrate it to a much smaller area of PV cells located at the centre or the edge of the leaf tiles.

This approach allows more freedom of building orientation and roof inclination compared to the conventional PV system. Subsequently, it enhances freedom in urban planning. The goal of this project is to create a "leaf roof" prototype and form a feasible solar energy collection technology that is competitive to conventional systems.

## Keywords

Luminescent Solar Concentrator; LSC; solar irradiation; roof design; PV; PV cells


Rosemann, A., de la Grée, G., Papadopoulos, A., Debije, M., Cox, M., Reinders, A., & van Zeeland, F. (2015). Leafroof. SPOOL, 2(2), 21-23. doi:10.7480/spool.2015.2.966

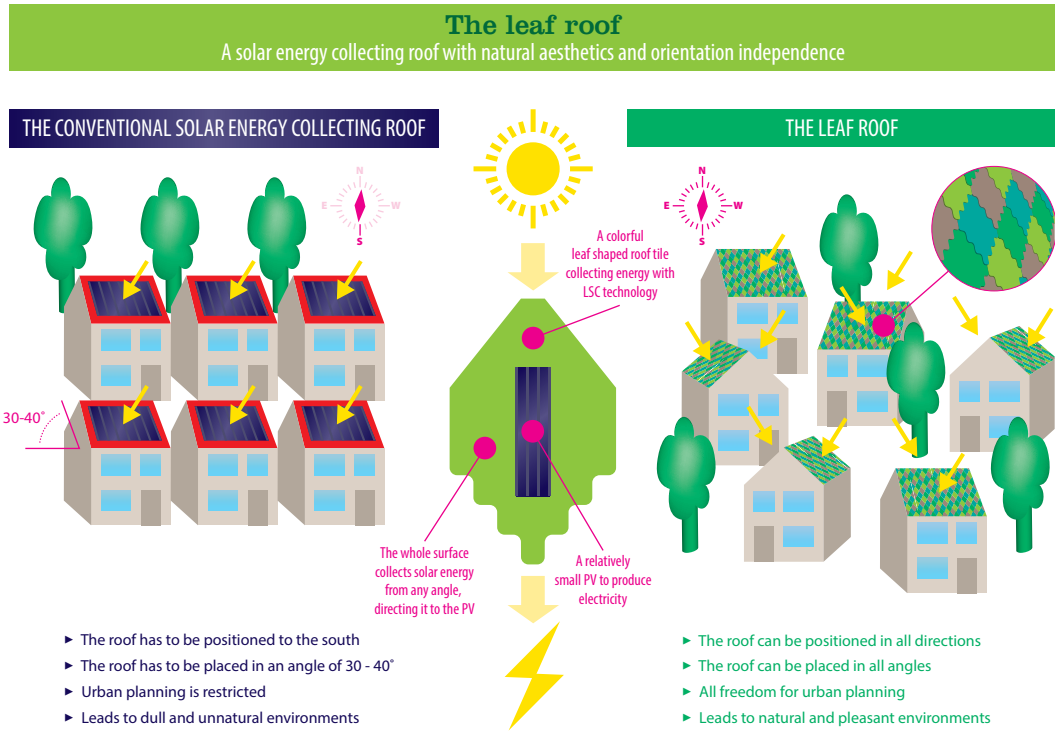


FIGURE 1 Graphical abstract

# Background

According to the International Energy Agency (IEA), the urban environment accounts for 40% of the total primary energy consumption and 20% of the total CO2 emissions. Furthermore, in 2025 a minimum of 6% of the energy supply in the Netherlands has to be provided through solar energy. Solar energy can cover the demand of residential buildings with energy produced directly at the point of its end use. However, a limiting factor for traditional photovoltaic systems in the built environment is their orientation (preferably South) and inclination of the roof (location dependent). The structure of urban planning, especially the existing buildings, does not allow a fixed South orientation and a fixed roof inclination. Moreover, the appearance of traditional photovoltaics is far from looking natural. The result of a small survey, which has been part of some market research efforts, showed that 25% of new home buyers would prefer an aesthetic and sustainable solar collecting roof system, even at a higher cost.


Rosemann, A., de la Grée, G., Papadopoulos, A., Debije, M., Cox, M., Reinders, A., & van Zeeland, F. (2015). Leafroof. SPOOL, 2(2), 21-23. doi:10.7480/spool.2015.2.966

# Concept

Within a joint venture between the University of Twente and the Technical University of Eindhoven supported by the 3TU foundation the research team works on a new innovation that can overcome these disadvantages and can become the new trend in roof design of buildings. The invention is based on Luminescent Solar Concentrator technology, a device for capturing light from a large area and directing it to a relatively small PV (Photovoltaic) cell to produce electricity. In an LSC, sunlight penetrates the top surface of a light guide made from plastic. The light is absorbed by luminescent materials, which are either embedded in the light guide or applied in a separate layer on top and/or bottom of the light guide. The luminescent materials can be organic fluorescent dyes, inorganic phosphors or quantum dots. The absorbed light is re-emitted at longer wavelengths; a fraction of the re-emitted light is trapped in the light guide by total internal reflection. The emitted light is guided to small PV cells attached to edges or the backside of the light guide where it is converted into electricity.

Our product consists of colourful tiles that give a leaf shaped roof perception when integrated in the roof. Therefore, they do not only look natural, but also collect solar radiation and turn it into electrical energy. Because of its natural aesthetics, it is expected to be well received by residents, in contrast to conventional clay roof tiles or roofs covered by conventional PV panels. Its nano-scale technological features enable it to collect solar energy even in cloudy weather and therefore allow the system to be less dependent on orientation. Its shape and dimensions as well as the relatively small PV area boosts its performance. The solar efficiency is estimated to be 4-6%, but real scale tests are required to determine its performance and provide information about further product development. In this project, the final leaf shape and colour appearance will be studied, along with assembling and testing its durability.

Our tiles can simply be connected to a roof using a click-connection system; overlapping of the tiles will waterproof the roof. The technology allows each tile to collect solar radiation and transport it to its centre or edge, where a small solar collector is located. A relatively large collecting area serves a much smaller PV area. The colours of the tiles can be varied to create different appearances.

# Follow-up

The outcome of this project will be a prototype of the leaf roof system that could be installed on roofs. It is expected that a successful completion of this project will lead to a continuation of the collaborative research in this field with the project partners, which have multi-disciplinary knowledge. The team consists of scientific and entrepreneurial experts. The long term goal is to increase the Technology Readiness Level of the leaf roof tile systematically from TRL 2 (technology concept formulated) to TRL 7 (System prototype demonstration in operational environment).


Rosemann, A., de la Grée, G., Papadopoulos, A., Debije, M., Cox, M., Reinders, A., & van Zeeland, F. (2015). Leafroof. SPOOL, 2(2), 21-23. doi:10.7480/spool.2015.2.966