



Custom integrated PV from idea to market

Words: Menno van den Donker and Bonna Newman

In a drive for even lower costs and higher efficiency, the photovoltaic industry is hugely dominated by the standard rectangular panels of 60 or 72 cells, optimised for installation in large fields and flat roofs, in dry and accessible environments. This has proven a good model for utility-scale electricity production, but people want more.

This is exemplified by Elon Musk's announcement last year, that Tesla will market a solar roof tile, going viral; a demand exists for PV elements integrated into the environment around us—in ways that are efficient, economic, and beautiful.

Products for varied applications like PV roof tiles, PV building skins, floating PV, PV on landfills, and PV noise barriers are still required to be economic and

manufacturable. The best system design choices for these products often require a novel module concept or set of materials.

Dutch energy research centre ECN has established the Solar Elements Living Laboratory (SELL) to work with customers to develop their custom-integrated PV products from the initial idea to market introduction.

Starting with economically and mass-

manufactured solar cells or laminates, the SELL is equipped with tools and experts to design, prototype and test integrated PV products of all sizes, shapes, colours, and applications.

The SELL also combines prototyping with installation and testing in the relevant environment where partners can engage with their customers and target market to collect feedback and enhance the development process.

For many years, ECN has assisted commercial partners in developing numerous PV applications from landfill to rooftop. Based on this experience, we have combined our knowledge and expertise into the SELL. This consists of four development steps universal to integrated PV applications: specify, design, build and validate.



Figure 1: Examples of PV applications developed with assistance from ECN. (a) Floating PV developed together with Sunfloat. (b) Façade PV developed together with SCX Solar, Wallvision and others. (c) Prefab roof PV mounting developed together with Unilin and Rebor.

We work with customers and partners on all applications, to deliver PV products optimised for the intended environment. In recent years, ECN with Dutch industrial partners and local governments have used the SELL method to focus on solar noise barriers designed to line the roads of the Netherlands.

All product development starts with specifications: who wants this, what are the environmental and application-driven boundary conditions and what technologies or materials should be used?

ECN and its partner Solar Energy Applications Centre's (SEAC) have conducted background assessments and published benchmark reports to facilitate this process. Each benchmark report describes the current technologies and products available for a specific market application

and evaluates the costs and benefits.

In the case of the PV noise barrier, thirty-one existing PV noise barriers were identified and evaluated. To develop the Dutch PV noise barrier, the SELL visited and interviewed road authorities and companies active in noise barrier construction, operation and maintenance.

This led the consortium to choose a modular product that can be vertically mounted in any compass orientation. The size required, for successful adoption in the Netherlands and compatibility with typical noise barriers, is 6m x 1m and each panel should weigh > 20 kg/m².

Product design at the SELL focuses on matching market demands with technical features. ECN has developed advanced simulation models to facilitate the design process. Thus it is possible to predict both

annual performance and manufacturing costs of early-stage product designs.

For the PV noise barrier, we calculated electrical yield and performance with a model including orientation, ground albedo, and self-shading. We also constructed a techno-financial cost model to analyse various technology and manufacturing options for the design.

The product design was adapted to ensure minimal costs and maximum energy yield—consisting of bifacial Si-cells encapsulated in 8mm + 8mm glass-glass modules of 3m length. Two of these modules are combined in one frame to realise 6m long products.

Critical to this process is the hands-on building and construction of the product prototype. The SELL includes an advanced workspace in which PV cells or laminates

How ECN helps: SELL

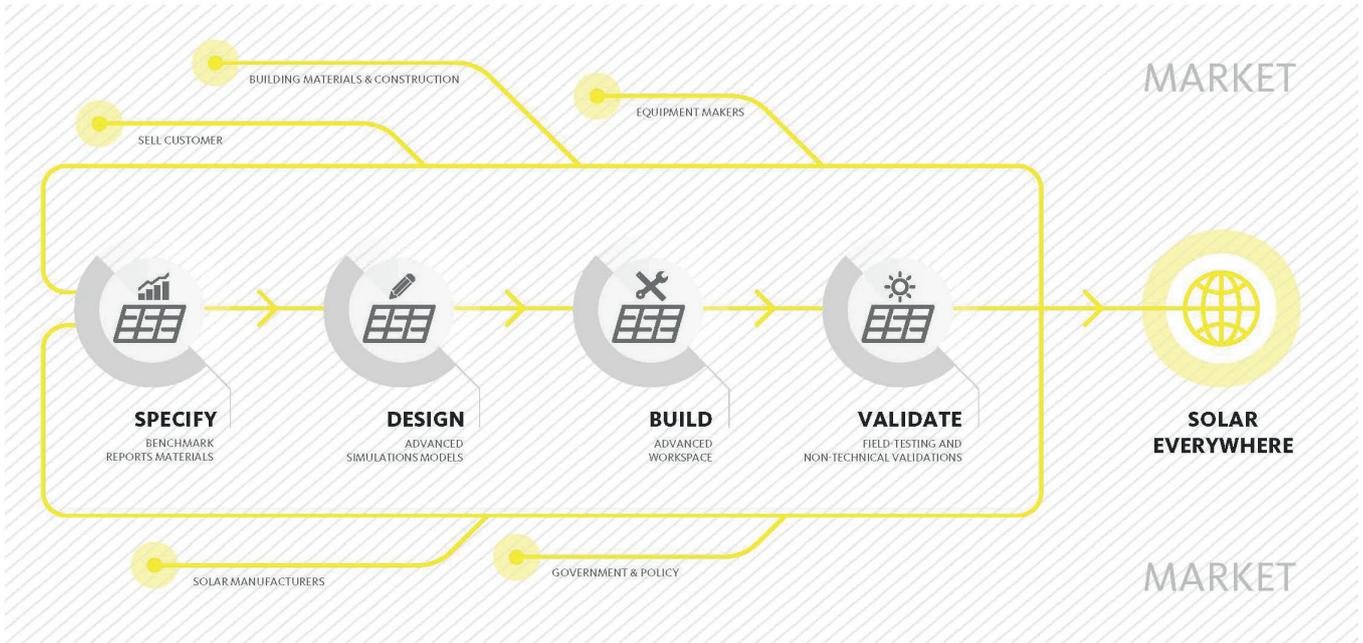


Figure 3. Schematic explanation of the SELL

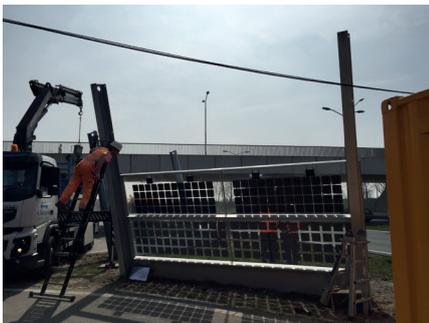


Figure 2. Bifacial solar noise barrier module (a) as specified, designed, and built with ECN for installation along highways in the Netherlands. (b) Solar noise barrier being installed for testing and validation in relevant environment along a highway.

are integrated in (building) products of any shape, colour, material or size using our tools, methods, including 3D gluing, ultrasonic welding, and laser welding, networks of builders and cell/module manufacturers, and experience.

The prototype is immediately characterised with power output measurements, electroluminescence, mechanical strength measurements, delamination susceptibility, hail impact or accelerated lifetime tests, as well as various building standard tests.

In the PV noise barrier development, a prototype 6m x 1m PV noise barrier module was constructed according to design, which met all acceptance criteria including passing four times the standard IEC climate testing, with no measurable performance degradation.

Validation in the SELL not only includes technical specifications but non-technical considerations such as response of the market and validation of the business plan. A prototype is tested in the relevant environment. Users and guests can be invited to participate and comment on the prototype.

A business model for the product can be created by initiating structured discussions

between various stakeholders. To this end, SEAC's SolarBEAT facility is included in the SELL, where a wide variety of building products are characterised and exhibited in a mock built environment.

In the case of the PV noise barrier, a living lab was constructed next to a four-lane local road and the product was extensively studied for a full year. A longer demonstration system (200m) is planned in a follow-up project.

In addition to the PV noise barrier, multiple other products, such as PV facades and PV roof elements have been successfully developed through the SELL approach.

The SELL supports our partners from the initial idea to market of custom-integrated PV products with choice, informed design, building, and validation of both technical and commercial aspects.

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