Solar Highways Benchmark Study - Recommendations

From the report *Solar Highways Benchmark Study, an overview and evaluation of existing photovoltaic noise barriers*, we have compiled a list of recommendations.

Noise barrier design

- Standard PV panels do not have the acoustic properties to be used as noise barriers, but additional material is needed.
    - To reach the CROW guidelines of 40 kg/m^2, 16 mm thick glass is needed.
    - Sound absorbing materials can be placed in the construction or placed behind the PV modules.
- In the Netherlands, most noise barriers are tilted away from roads to reflect the noise up. Therefore for a south oriented road the north roadside is most interesting for placing PV noise barriers (PVNB). Most rail noise barriers are tilted towards the railway to reflect the noise towards the rail ballast.
- Placing a noise barrier can cause more noise on the opposite side of the road due to reflections.

PV system design

- A monofacial PVNB will produce the most electricity if it faces south.
- A vertically placed bifacial installation facing east and west will receive roughly the same amount of irradiation as a south oriented installation tilted 35°.
- A vertical bifacial installation facing east and west will produce a double maximum or 'camel type' generation profile, with maxima in the morning and the afternoon.
- A vertical bifacial installation facing east and west will unlikely produce its STC power. Therefore the rated power of the inverter needs to be carefully chosen to minimize costs and maximize inverter efficiency.
- Bifacial cell do not usually show identical performance on both sides. The orientation of the cells should be carefully assessed.
- The minimize cable usage, the PV modules are best arranged in strings and connected to an inverter nearby. Then the inverters can be connected to AC-cables running along the complete length of the PVNB.
- Using aluminum instead of copper cabling for the high power AC cabling could save costs. Also, aluminum cables are less likely to be stolen. A downside of this choice could be that these cables are thicker and do not bend easily.

PV monitoring

- For optimal monitoring, access to DC performance, AC performance, global irradiation, in-plane irradiation, and PV temperature is advisable. For bifacial systems it is necessary to measure the irradiation in both planes of the installation. Irradiation can be measured by pyranometers or reference cells.
- Defining the performance ratio for a bifacial system is not trivial. Different definitions are used. These definitions used need to be clear when different systems are compared.

Shading

- A vertical bifacial PVNB facing east and west will suffer more from shading from traffic than a south oriented PVNB, because it relies on morning and afternoon, when the sun position is low.
- The supporting structure of a PVNB can cause self-shading. Especially bifacial systems can suffer from self-shading because it is difficult to build a support structure that does not produce any shading. Low PVNB can be built with relatively narrow supports.
    - To mitigate this effect the cells can be placed away from the sides or the top of the modules . If the shading is primarily caused by the vertical supports, the cells can best be arranged in vertical strings. If the shading is caused by horizontal supports, the cells should be arranged in horizontal strings.

Safety

- To avoid shards of glass in case of breakage, glass noise barrier modules are usually made from a tempered glass sandwich with a thermoplastic in between. Glass-glass PV modules usually use the same construction.
- Glare can be regarded as a problem by decision makers. Pointing out that PV modules do not produce more glare than glass noise barriers could be a good way to clarify why it is not.

Vandalism and theft

- Theft of PV modules can be a major problem. The best protection from theft seems to be using purpose made, heavy, fully integrated solar modules.
- Cable theft can be a problem. Therefore cables should be inaccessible.
- Graffiti can be a problem, although in most projects we have seen only the non-PV parts of PVNB were affected. Graffiti is relatively easy to clean from glass panels. By comparing the performance of several strings within an installation, graffiti (or other failure-modes) can be detected from a distance.

Ownership and responsibilities

- We have seen various ownership constructions
    - Completely public owned installations
    - Completely private owned installations
    - Combinations:
        - State-owned support structures with municipality owned PV-modules
        - State owned installation, but privately owned electricity, for which the company paid a one-time contribution

Pollution

- For one installation the decrease in performance due to pollution was measured. The performance was 5.5% lower.
- Using high pressure cleaning equipment can damage PV-modules.

Procurement strategy

- Identify and inform possible suppliers in an early stage to maximize the number of participants.

- Do not change procurement details after initial release, as this will discourage possible contenders
- If a procurement for a complete PVNB system is split into two different procurements: one for a noise barrier without PV and one for the PVNB, the additional price for the PV can be calculated.

Stakeholder acceptance

- Stakeholder acceptance will grow if the produced electricity is used for a purpose that 'speaks' to the public, such as charging electric cars or street lamps for a public park.

Other

- Most large construction projects have much longer timescales than PV projects. Because PV prices are very dynamic, PV installers like to finish projects quickly.