Outdoor performance of infra integrated PV

Renée Heller PhD, Amsterdam University of Applied Science, The Netherlands
Ir Karl Sewalt, TNO, Delft, The Netherlands

Aim and relevance

- Lack of space in the Netherlands hampers the roll-out of PV
- Highways provide space without compromise to the landscape.
- New is the combination of solar PV with traffic barriers.
- There is a potential of 7.500 km of guiderail in the Netherlands

Figure 1 Left: expert session on safety of design; Right: full scale prototype for safety discussion

Major challenges and requirements

- No prior references, no clear available regulations
- Keep the primary function of the guiderail intact (guiding of vehicles during collisions)
- Switch off immediately and automatically after a collision
- Not distract car drivers in any way

Research questions for testing

- Can we design an integrated mechanically and electrically safe system working under all circumstances?
- What is the performance of an elongated linear PV system with a slight curve of the solar cells?
- What is the effect of pollution by traffic on the performance?
- How rugged and durable is the PV technology and its packaging under nearby traffic conditions?
- Can we realize ease of installation, repair and maintenance?

Figure 3 Left: cover material to give protection to PV and avoid reflections; Right invertors to be placed below ground for safety reasons

Amsterdam University of Applied Sciences work:

- Insight in stakeholders approach to innovation and business case
- Work with new materials, concepts via collaboration

Safety and mechanical results

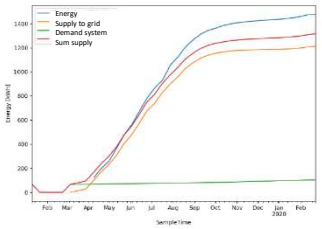
- No incidents regarding safety
- No moisture penetration or defects visible and no repairs needed
- No degradation observed in the performance of the PV

Electrical performance

- System was simulated in SAM (from NREL), the expected performance during the test phase was ~1800 kWh
- System yield measured was 1200 kWh

Figure 2 redesigned MESH system (72m) placed at highway N23 (North Holland, Netherlands)

Research into lower performance:



Figuur 31. Cumulatieve vergelijking energiemetingen kWh-meter en DC-systeem

Not due to individual PV-modules or system components, optimizer threshold values,
Performance Ratio of the PV-modules is low
cable and transport losses of up to ~10%;
Conclude: that cover gave a higher loss than assumed loss of ~20-25 %.

Business Case results

2020 realistation	Pilot design	Pilot realised	100km (2020)	100 km (2022)	1000 km (2025)
Investment (€/m)	763	1800	1700	1302	1302
Maintenance (€/y/m)	8	8	8	8	8
Yield (kWh/y/m)	36	18	80	98	108
LCOE (€/kWh)	1,27	5,85	1,16	0,74	0,67

Long term goal: LCOE 0.12 €/kWh
Results: higher investment costs due to high installation costs and lower yield lead to High LCOE

Conclusions

- Design was allowed on a traffic barrier at road side
- No visual degradation of materials
- No repair was needed during test year
- PV performed less than expected
- Lower performance and higher cost give lower business case

Future improvements:

- Place optimizers or micro-inverters directly below the PV, still maintaining electrical safety
- Instead of a thick cover use, rugged foil laminated on the PV module (no air gap)
- Direct use of electricity to avoid cable losses
- Utilizing the full width of the guide rail with on-size module (a-Si or CIGS) more PV will fit on a m'