The making of Solar Highways

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Topics

• Tender offering
• Design
• Construction
• Safety
• Maintenance
• Next steps and developments
Tender offering
Tender offering

- Higher minimum peak power (238 vs 200 kWp)
- 100% modularity
- PV panels 2 m high
- Minimizing shadow effect of posts
- Higher cell cover density
- Optimal cell string configuration
- Higher glass energy transmission
- Integration of optimizers
- Vandal-proof functionality
Tender offering

- No traffic measures necessary to repair defective components
++ Shorter recovery times due to spare parts in stock
- Monitoring and failure alerts at optimizer level
- Cleaning without nuisance
++ Smooth transfer from monitoring phase to management phase
++ Optimal maintenance regime based on (trend) analysis
Integral design

- PV panel
- Modular noise barrier element
- Electrical system
- Noise barrier
Construction
Production

• Production of 276 bifacial PV panels at Scheuten (NL)

• Production and assembly of 138 aluminum modular noise barrier elements with integrated PV panels and optimizers at Bayards (NL)
Realization

- Mounting noise barrier elements between posts
- Installing inverters and connecting PV panels to the grid (together with Libra Energy, NL)
- Commissioning: 6 December 2018
Safety
Safety for workers

- All mounting, installation and maintenance work can be done from the “residents side” of the barrier
  - Noise barrier
  - Electrical system
Safety for drivers

• Regular safety measures for noise barriers
  • E.g. emergency doors and escape routes
Electrical safety for stakeholders

• Electrical system designed according to applicable standards and norms:
  • NEN1010
  • IEC 61730 (safety)
  • IEC 62305 parts 1 to 4 (lightning protection)
  • IEC 62446-1: 2016

• Grounded AC grid
  • 2 grid connections, grounding by Enexis
Electrical safety for stakeholders

- Inverters
  - Can be switched off manually
  - Switch off automatically in case of leakage current

- Lightning protection
  - Attachment of noise barrier elements to the steel posts, which are connected to a copper pipe on the steel tubular posts (that function as earthing)
Electrical safety for stakeholders

- Maximum short circuit voltage of cell strings: 69.9 V
  - Below safe contact voltage of 110 V (DC)
- Optimizers go in safety mode (output voltage of 1 V) in case of:
  - short circuit
  - temperature > 85°C
  - switching off inverter
  - disconnection from the grid
Maintenance
Periodic inspections

- Noise barrier structure and parts
- PV panels (incl. integrated power electronics)
- Substations (incl. invertors, distribution boxes, grid connection, monitoring equipment)
- Condition measurement (according to NEN 2767)
Periodic maintenance

- Rotating parts emergency door
- Vegetation
- Distribution boxes (according to NEN 3140)
- Cleaning test areas (different intervals)
Corrective maintenance

- Repair and replacement work depending on failure
  - Noise reduction function (e.g. caused by car accident)
  - Solar energy harvesting function (e.g. caused by graffiti, vandalism or failures of electrical components)
- Spare parts on stock
  - E.g. 4 noise barrier elements
Incidents

- October 2018: one PV panel damaged (vandalism)
  - Replaced December 2018

- November 2018: graffiti on concrete plinth (vandalism)
  - Not removed
Incidents

• March 2019: optimizer not receiving power input (defective clip in junction box)
  - Replaced junction box clip in April 2019

• April 2019: graffiti on a number of PV panels (vandalism)
  - Removed within few days
Incidents

- May 2019: one PV panel damaged (vandalism)
  - Replaced within few days

- June 2019: malfunctioning inverter (bad string cable connection)
  - Replaced string cable connector within few days
Incidents

- August 2019: two malfunctioning optimizers (bad pin connection glass plate)
  - Replaced strip
Next steps and developments
Next steps and developments?

- New commercial tenders DBM(O)
- Optimization, cost down and productizing (TRL 8-9)
- Project Rolling Solar (Interreg EMR)
  - Application of thin film
  - New demonstrators in test setup
- Integration in microgrid