NEW PV SYSTEM CONCEPT: WIRELESS PV MODULE PROTOTYPE

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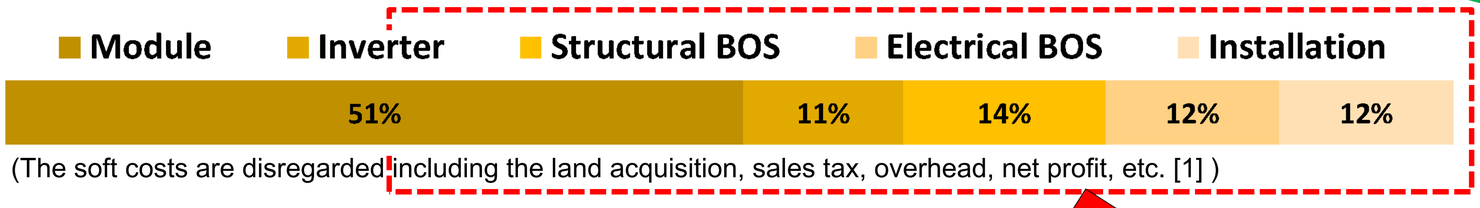
Purpose: Reduction of the state-of-the-art system cost and failure

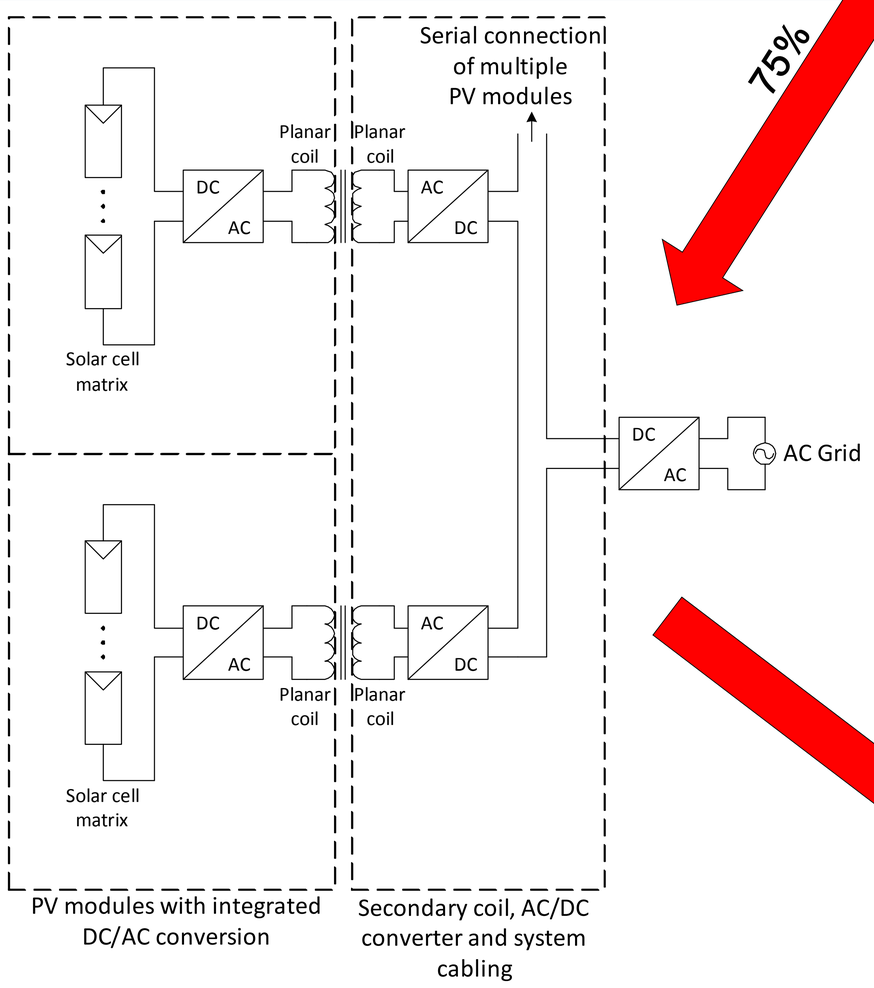
- The goal is to demonstrate the feasibility of a new PV module system using integrated inductive power transfer technology.
- The motivation is to reduce the total PV system costs that account for three quarters of today's total system price.
- Further, the proposed PV system concept should eliminate frequently occurring PV module and system failures [2].



(The soft costs are disregarded including the land acquisition, sales tax, overhead, net profit, etc. [1])

Potential induced degradation (PID)
Connector failures
Junction box defects
Defective bypass diodes

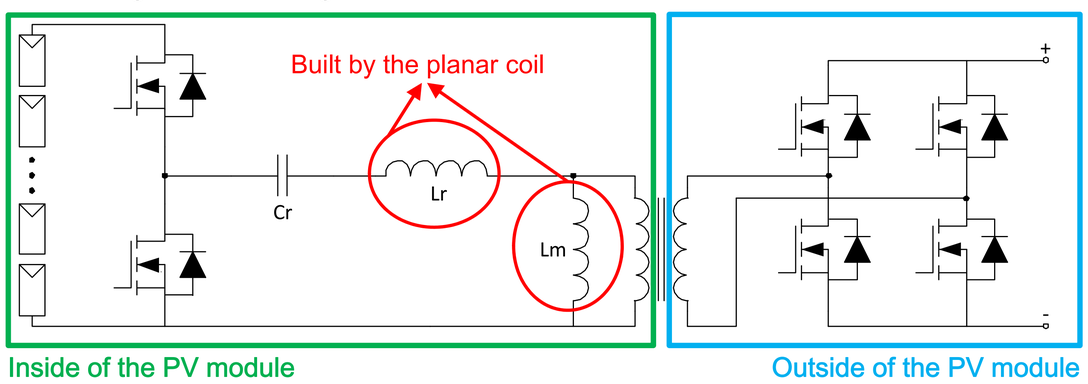
New PV system concept



75%

The goal is to develop a new PV system that uses an integrated inductive power transfer (IPT) technology for the current feed-in from the cell matrix to the string wiring.

- <u>DC/AC conversion inside the PV module (AC module)</u>
  The DC current produced by solar cell matrix is converted into high frequency AC current using a resonant converter. The output of this inverter is connected to a planar coil that generates a magnetic flux.



- <u>Rectifier outside of the PV module</u>
  A second planar coil is placed outside of the PV module on top of the primary coil and converts the magnetic flux into a AC current. Then, the high frequency AC current from the secondary coil is rectified and fed into the system cable. The rectification is made by an active rectifier, which has fewer losses at low voltage applications.

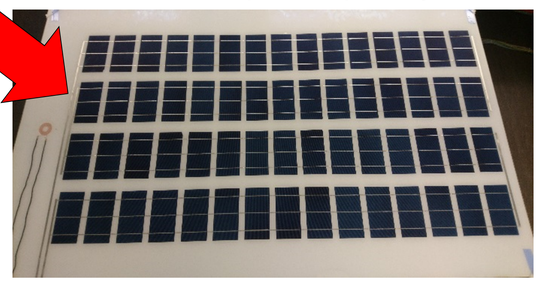
Innovation

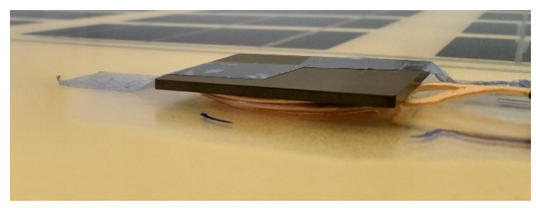
The new PV system concept represents a new solution approach, which affects system components that accounts for three quarters of today's total system. With the new PV system, several advantages arise with the goal to reduce initial system cost as well as operating and maintenance costs for large PV power plant (>100 kWp).

- Galvanic isolation
  - No PID
  - Higher system voltages allowed
  - Less copper needed
- No electrical connectors
  - Saves time on wiring
  - No weather-related connector failure
  - Less electrical installer experience needed
  - No junction box needed
- IPT allows disconnecting under load
  - Reduction in maintenance cost
  - Increased safety of people
  - Increased fire protection (no electric arcs)
- Individual MPP Tracking
  - Less mismatch losses
  - Less shading losses

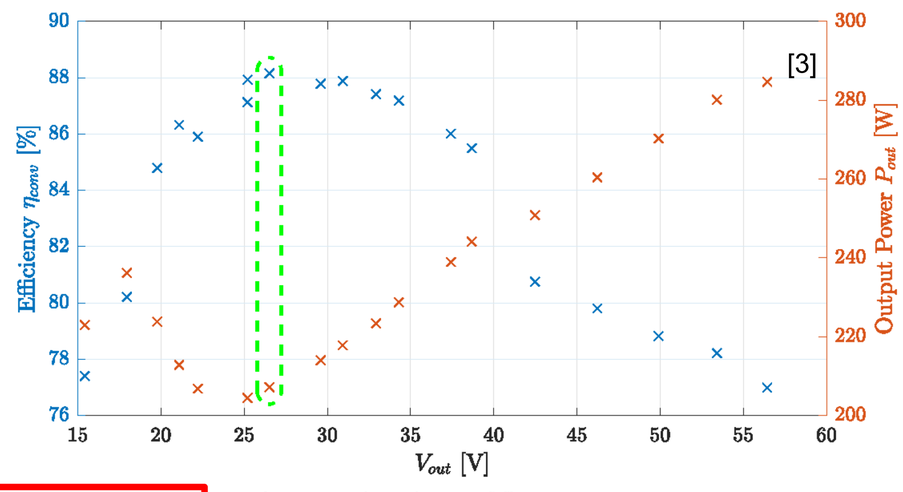
First prototype results

A first wireless PV module prototype is presented. The energy transfer from the solar cells to the string cable is done using the inductive power transfer technology. A half-bridge LLC resonant converter is designed for the DC/AC conversion. The wireless module consists of 60 half cells and an integrated planar coil. The resonant converter is not yet integrated into the module, but it can be connected externally to the planar coil. In this prototype, the energy is transferred from the primary coil to the secondary planar coil placed outside of the PV module on top of the primary coil.





$\eta_{max} = 88.2\%$ bei $P_{out} = 207.2$ W



First measurement results (without any optimisation) !

Loss estimations of first measurements:
- Planar coils: 3.5%
- PCB tracks: 1.0%
- Half-bridge: 2.5%
- Resonant capacitor: 1.0%
- Synchronous rectifier: 4.0%

Outlook

The next steps is to integrate the resonant converter into the PV module. Therefore, different PCB packaging techniques need to be analysed e.g. embedded component packaging. The new wireless PV module will paired with a clickable mounting system. This should enable launching a new product that allows a cost-effective installation with minimum maintenance effort.

Acknowledgment

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https://www.grstiftung.ch/de/media/portfolio~grs-063-16~.html

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[2] IEA PVPS Task 13, Assessment of photovoltaic module failures in the field, Report IEA-PVPS T13-09:2017
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