

25 Years of Technological and Economical Learnings in PV Systems

Findings for one generation of PV applications

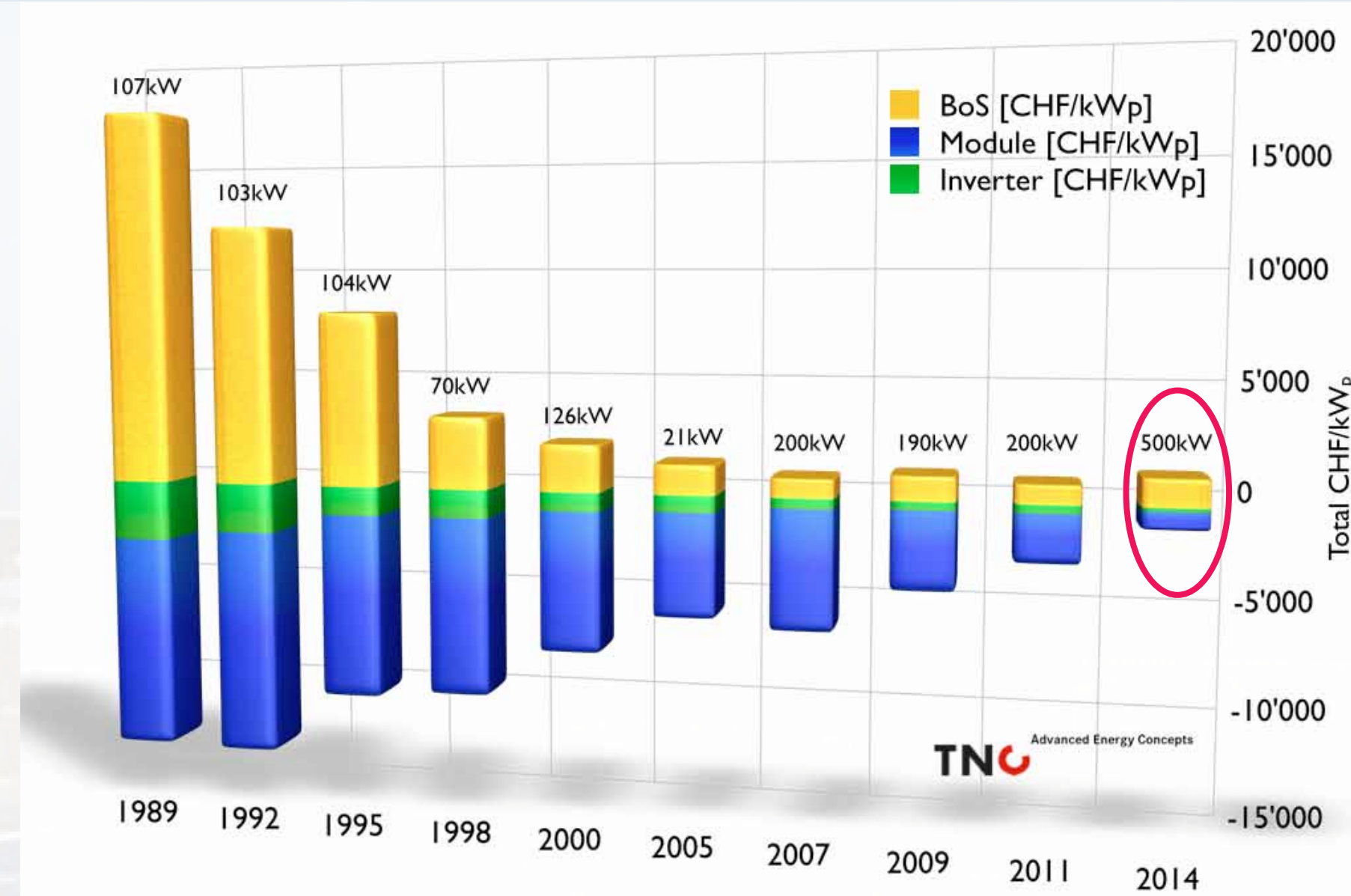
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Purpose of this work

Long time experience by TNC Consulting over 25 years on design and operation of PV plants is used to look back on technological, economical and performance development and give an outlook on possible future challenges. The point of view of a system engineer is stressed, with a focus on Balance of System (BoS) costs, but also quality and performance issues of PV plants, all influencing Levelized Costs of Energy (LCoE). Analysis of the cost structure of PV systems over a period of 25 years shows a strong overall decrease in BoS costs similar to module and inverter costs, but also an increase for BoS in most recently realized PV plants, increasing the share of BoS on overall system costs. In order to reduce LCoE, BoS costs must be understood correctly and reduced for future projects. An outlook on necessary steps to achieve lower LCoE is given.

Development of BoS cost share over time

The share of BoS on PV system costs sank from 58% in 1989 to around 20% (except 2007 with 13%, due to high module prices). Most recent plants show a rising share of BoS costs of up to 51%. Analysis of the BoS costs show mainly legal framework and administration responsible for the rise, while mounting structure costs show further reductions. Non-technical elements will be key to further PV system cost reductions in near future. The data analysed is based on operational PV plants in Switzerland with nominal power ratings from 30...100 kW_p.

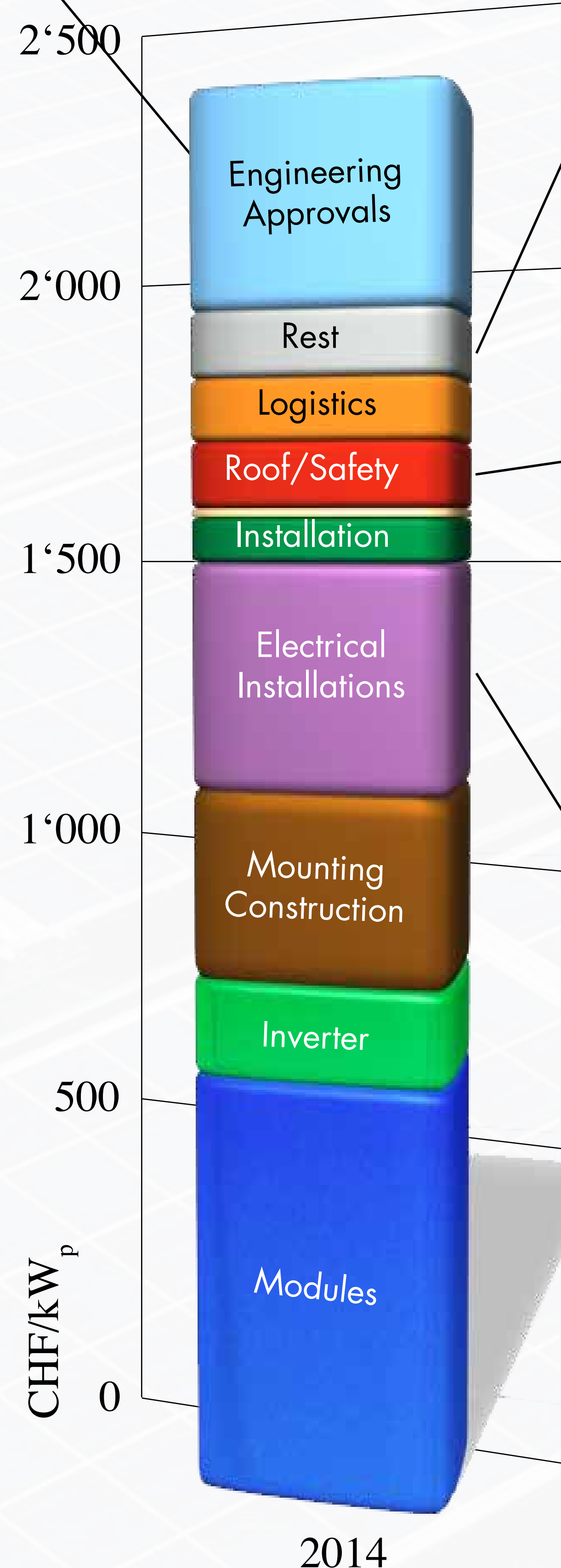


To reach a satisfactory level of integration of the PV plant and obtain the construction permit, using blind modules in corner areas of the roof was necessary.

Engineering and approvals

Project development, approvals and legal framework have become far more complicated. For successful PV projects, careful planning is essential.

Analysis of BoS costs of 30...90 kW_p PV plants



(1 CHF=0.82 EUR, Stand August 2014)



The national insurance company SUVA published requirements for safety installations necessary on buildings when operating PV plants. Costs of these safety installations can reach up to 32% of PV system costs for a 30 kW_p PV plant. Avoiding installation of lifelines is only possible by accepting reduced available roof area.



Requirements for electrical installations range from different levels of surge protection devices to firefighter switches. Different authorities publish requirements from their point of view. For PV plants with AC nominal power >30kVA, additionally special energy meters have to be installed, which have high operational costs.

Mounting constructions and overall quality assurance

- Mounting constructions have been optimised under cost pressure of FiT, using low elevation angles and almost no distance to roof surfaces. This leads to reduced yields, i.e. with snow not being able to slide off modules.
- Cost pressure can also tempt to outsource work load to less qualified workers, often resulting in lower quality of installations and higher efforts required by plant owners to secure quality standards, adding to BoS soft-costs.
- Cost optimization in key components such as inverters can lead to lower reliability and shorter MTTF.

Conclusions

- After a decrease of BoS costs, BoS share increased in most recent projects, becoming the dominating cost component.
- While PV components have become more installer-friendly, approval and legal processes have become far more complicated.
- More detailed and up-to-date information of involved authorities is necessary for a better understanding of the processes to create framework suitable for successful PV applications.
- We need a masterplan to streamline and harmonize the process of legal and technical approvals for PV in order to further reduce total costs of PV energy.
- Price pressure should not lead to reduction in quality, reliability and yield, all having negative influence on LCoE.