

ENERGY

Ground Mounted PV projects in France and Germany: Costs and Conditions

Ageing PV assets: repair or replace?

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DNV GL – An independent global classification / certification & technical assurance / advisory company

DNV·GL

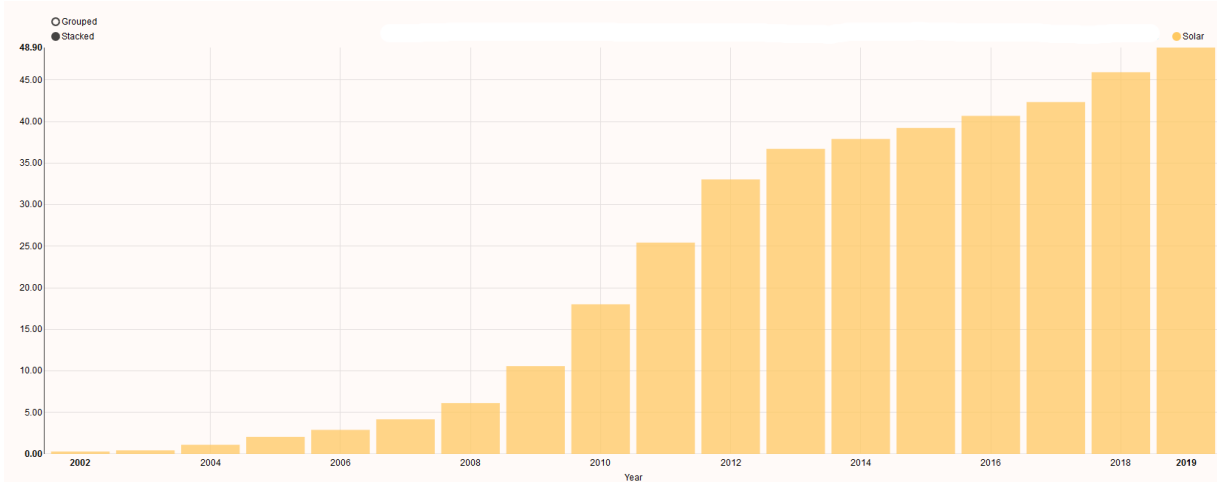


150 years – 100 countries – 350 offices – 12,000 employees – 2 bn €

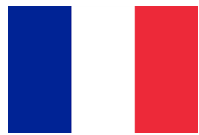
AGENDA

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- 1 Introduction
 - 2 French and German market contexts
 - 3 PV Modules: Degradation and replacement
 - 4 Inverters: Degradation and replacement
 - 5 Balance of Plant: impact of replacements
 - 6 Impacts on Project Contracts
 - 7 Conclusion / Questions

Context: Solar PV in France and Germany

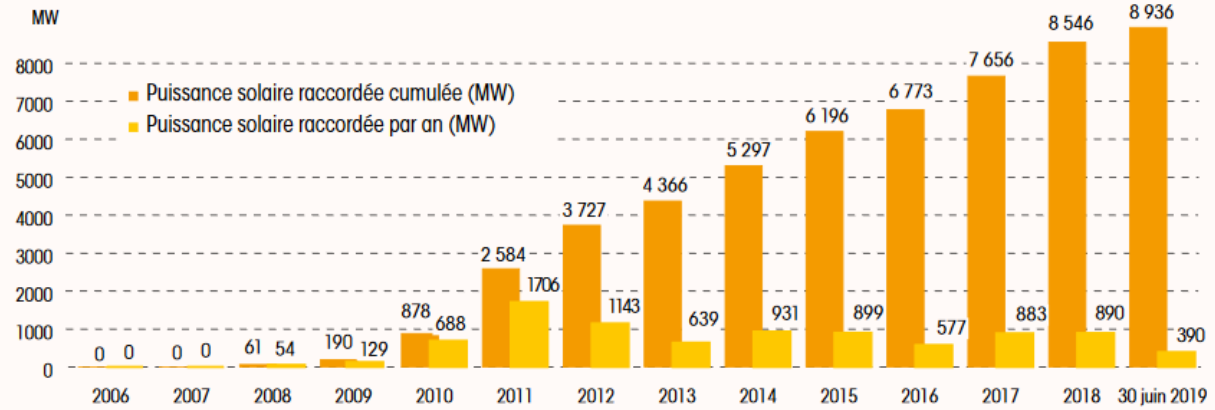


48 GWp with first MWs installed in 2002



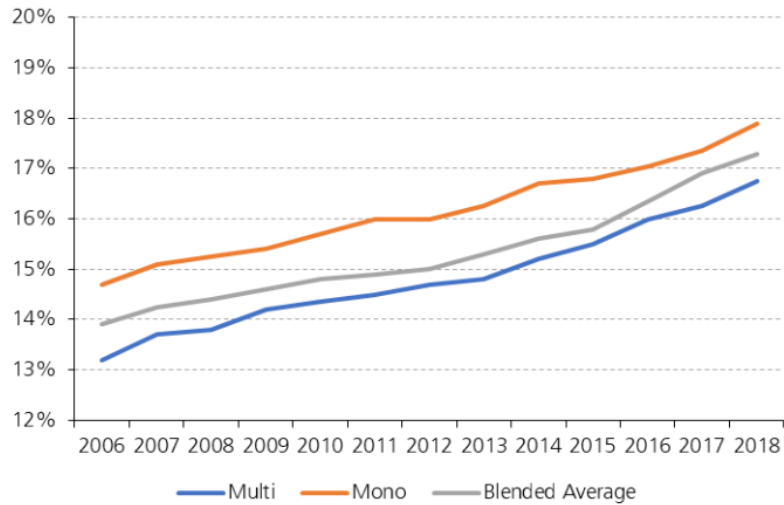
10 GWp milestone in 2020?

Evolution de la puissance solaire raccordée (MW)



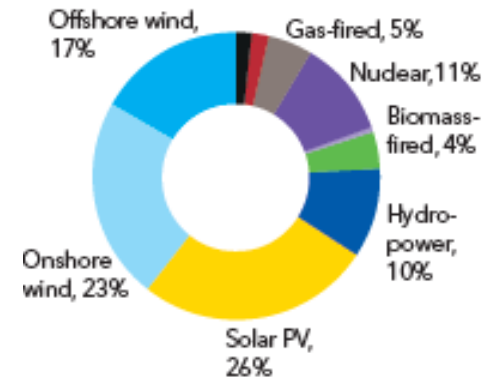
Source: Panorama de l'électricité renouvelable au 30 Juin 2019, RTE

Solar PV Market Trends



Average Crystalline-Silicon PV Module Efficiency (IHS Markit 2019)

2050 electricity mix

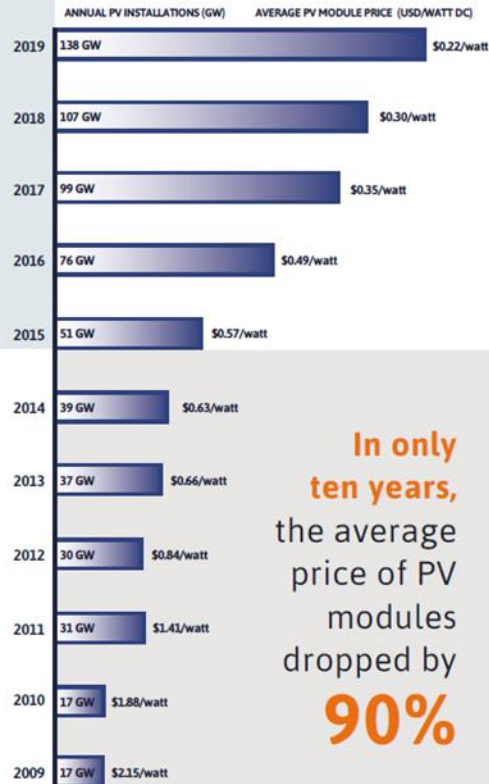


2050 European Electricity Mix Projections, Energy Transition Outlook, DNV GL

<https://eto.dnvgl.com>

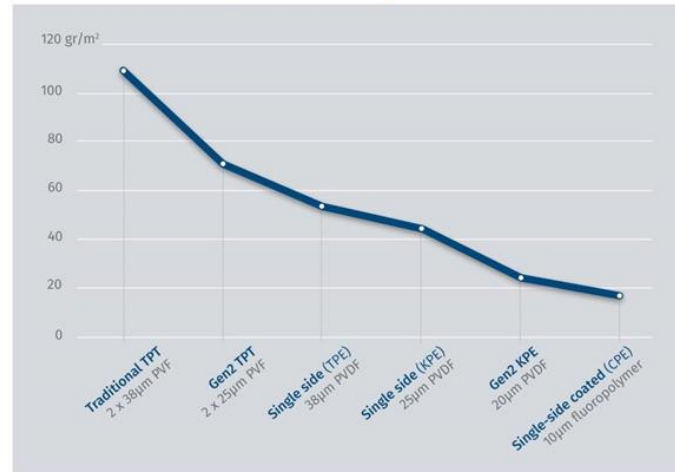
Scaling Production but at what cost?

75%
of the world's
installed solar
PV capacity has
operated for
**less than
five years**



**In only
ten years,
the average
price of PV
modules
dropped by
90%**

Backsheets used in the past are not those used today

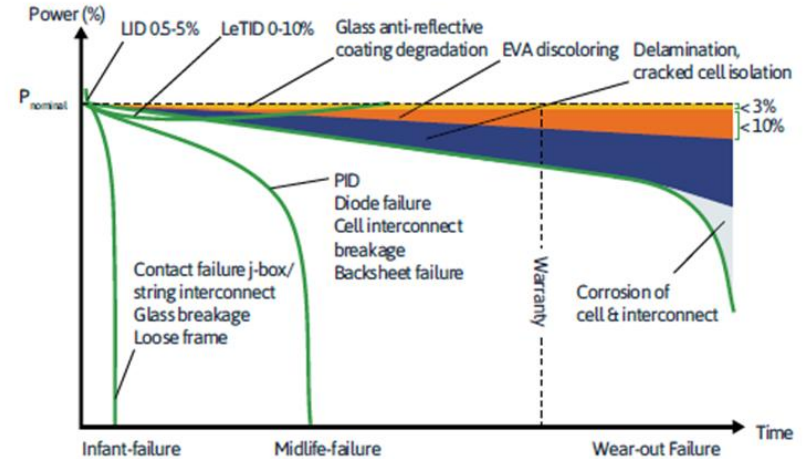
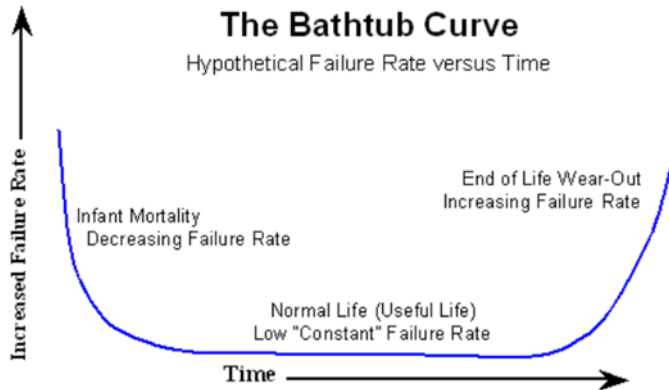


**Under price pressure
fluoro-protection has
decreased over time**

Source: DSM



“Useful life” of a PV Module



Source: IEA PVPS, 2014; LeTID and backsheet failure added by PVEL, 2019

Factors Contributing to the Bathtub curve:

- Failure Rates
- Degradation
- Mismatch

Solar PV Modules

Degradation Factors

- Long term exposure to UV rays
- Moisture/Soiling
- Temperature

Degradation Mechanisms

- Delamination of encapsulant between cell and glass
- Thermomechanical fatigue of cell interconnections
- Cell Microcracks

Mitigation Strategy

- Module Selection Strategy
- Compliance with IEC Standards
- Know your Bill of Materials
- Factory Inspections



Repair or Replace?

Repair

- Some specialised players emerging in this new market: eg. Rinovasol Hoermann NovoSolar
- Need to consider the residual financial value of the repaired module vs buying new
- Bankability of the repair?
- Status of the warranties?

Replace

Is the replacement identical? (W, Voltage, etc)

DC cable sizing, fuse and combiner box selection, inverter/MPPT compatibility.

→ Module Replacement strategy is project specific!

PV Inverters: Snapshot

Inverter Types	Typical Power Ratings	Efficiency	Estimated Market Share*
Central Inverters	100 kWp to several MWp	up to 98.5%	47%
String Inverters	Up to 150 kWp	up to 98%	52%
Micro Inverters	Module Power Range	90-95%	1%

Data: IHS Markit 2018

Degradation Factors

- Weather Resistance
- Temperature and humidity
- Ventilation

Degradation Mechanisms

- Ageing and wear out of internal components
- Corrosion/rust of electrical interface surfaces

Mitigation Strategy

Adequate Preventative Maintenance
Project Sizing
Warranties and Spare Part Strategy

Factors to consider if inverters must be replaced:

- Compatibility with modules
- Civil and Electrical BoP
- Grid Connection

Balance of Plant

- Typical support structures used for ground mounted utility scale projects comprise of rammed steel piles and galvanised steel tables.
- Durability of the design is challenged by factors such as corrosion of elements, UV degradation of non metallic parts and the soil characteristics can also affect the buried elements.
- As part of the O&M operations, regular inspections are required to monitor these degradation phenomena

- In the event that modules are replaced on an existing structure, an important factor to consider is the resistance to wind and snow loads.
- DNV GL notes that there is lack of consensus and caution in the interpretation and applicability of structural Eurocodes for PV plants.

Contractual obligations to check

Grid Connection

- Investigation required to assess additional grid injection capacity in the case of higher module ratings.

Compliance with PPA

- In the case of a Feed in Tariff PPA, developer must check whether there is an authorisation to change components and if there are impacts on the tariff and/or length

O&M contract

- Replacement of components may require a renegotiation of contract
- If an MRA is in place, check the spare part stock and whether module/inverter suppliers can replace the faulty components

Concluding Remarks

- Many technical risks, related to modules or inverters can be anticipated during the early development stages.
- Adequate procurement strategy and contractual framework can contribute to reducing risks and preserving the asset lifetime.
- OPEX (O&M costs and spare parts) related to refurbishment/repair must be modelled accurately. Beyond warranted life of components there is high uncertainty due to the limited field life of installations.
- Higher initial CAPEX can reduce risks and bad surprises/catastrophic failures.

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