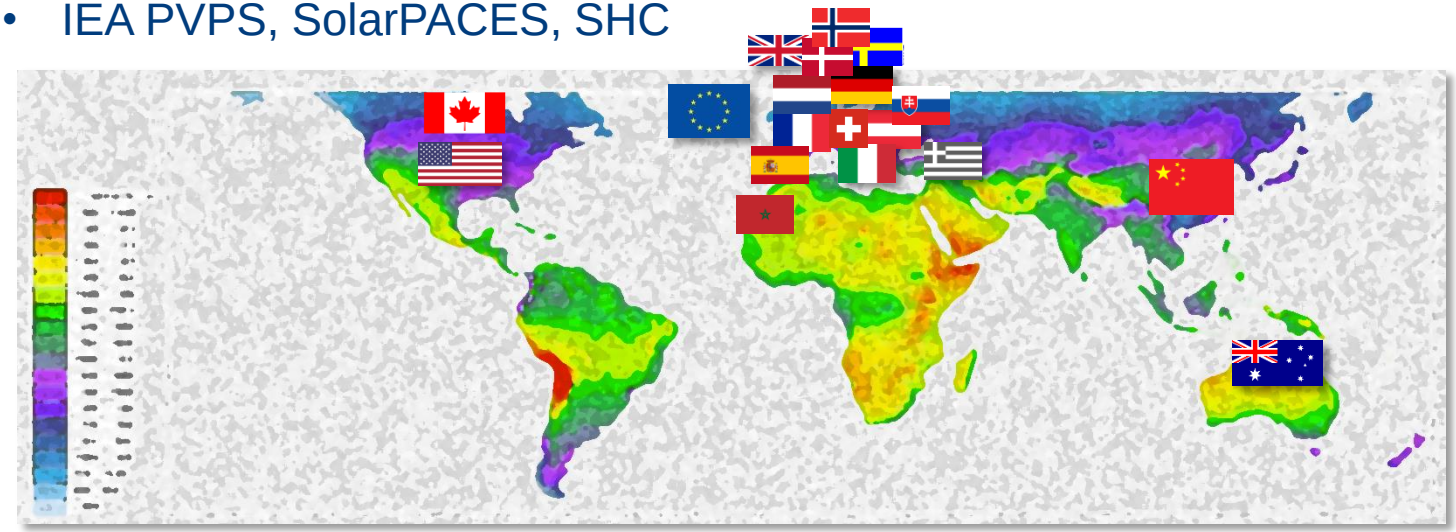
State of the art of solar resource assessments and forecasts

Jan Remund (Meteotest)

Wind Task 51 – kick-off, online: February 2rd 2022

Current status of team

- Universities, research organizations, met services, and service providers
- 19 countries, 50 organizations, ≈90 experts
- IEA PVPS, SolarPACES, SHC



Global horizontal irradiance. Source: www.meteonorm.com Version 8.0

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Task organization

- 1st phase of Task 16: 2017-2020:
  - Solar Resource Handbook concludes the work
- 2nd phase of Task 16: 2020 – 2023:
  - Benchmarks (solar resource data, forecasts), complete update of handbook

- Organized in 4 Subtasks:
  - Subtask 1: **Measurements & Models** (M. Sengupta, NREL, S. Wilbert, DLR)
    - **Ground based methods** [this workshop], models
    - Benchmarking

Task organization

- Subtask 2: **Enhanced data & bankable products** (P. Blanc, Mines Paristech)
  - Quality & format, long term variability,
  - Products, PV at urban scales, Data & models for bifacial modules

- Subtask 3: **Solar forecasting techniques** (E. Lorenz, Fraunhofer ISE)
  - Regional forecasts, Probabilistic forecasts,
  - All sky imagers, firm PV generation

- Subtask 4: Dissemination & Outreach (J. Remund, Meteotest)
  - Reports, **Update of Solar Resource Handbook**
  - ***Workshops***, Webinars, online code archive

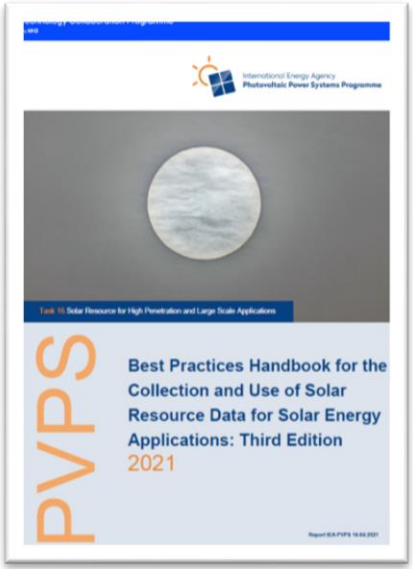
Solar resource bible v3.0*

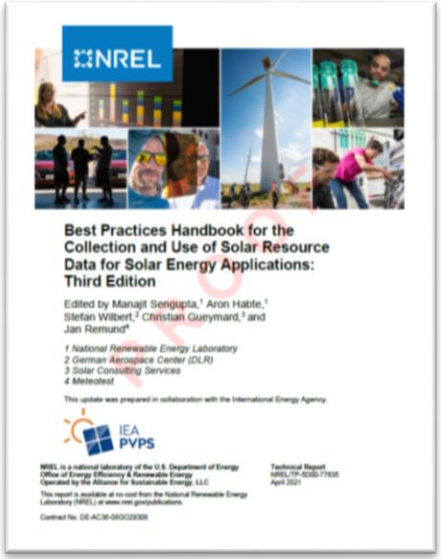
All you ever wanted to know about solar data and forecasts

What data and methods are trustful?

You don’t need always the best … but the most suited

Basics, state of the art & latest scientific results





* Best Practices Handbook for the Collection and Use of Solar Resource Data for Solar Energy Applications: Third Edition

Link: https://iea-pvps.org/key-topics/best-practices-handbook-for-the-collection-and-use-of-solar-resource-data-for-solar-energy-applications-third-edition/

Which data for which use case?

- Needs depend strongly on system size and phase of project

System Size

Phase

	Small	Medium	Large
1. Pre-feasibility & Planning	• Long-term averages • Monthly data • Solar cadastres / maps • Simple shading analysis	• TMY • Hourly data • Shading analysis	• Long-term satellite data • Hourly data
2. Feasibility			• Satellite data • Time series (>10 y) • Ground meas. (> 1 year) • Shading analysis • Further site and technology- specific meteo. parameters (e.g. albedo, soiling)
3. Due diligence & Finance		• Satellite data • Time series (>10 y) • Minute data • Shading • Further site and technology- specific meteo. parameters (e.g. albedo, soiling)	• Satellite data • Time series (>10 y) • Ground meas. (> 1 year) • Minute data • Shading analysis • Further site and technology- specific meteo. parameters (e.g. albedo, soiling)
4. Operation & Maintenance	• Simple monitoring	• Local measurements • Forecasts	• Local measurements • Forecasts

Solar Forecasts

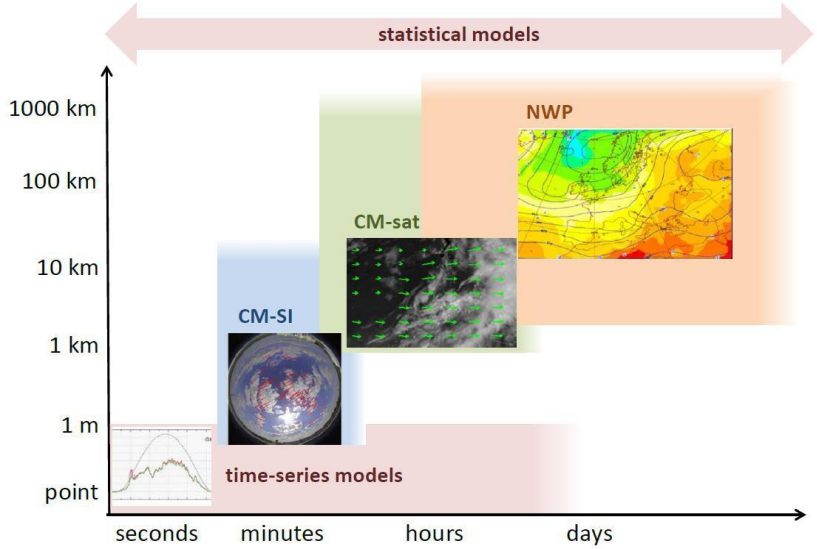
- Optimal Methods depend on spatial and temporal resolution

- Two examples of ongoing work:

  1. All sky imagers (ASI)
     → first benchmark of cloud cams and ongoing studies

  2. Firm PV power
     → make PV deliver electricity 24/7 for whole regions/world

Space and time defining the method



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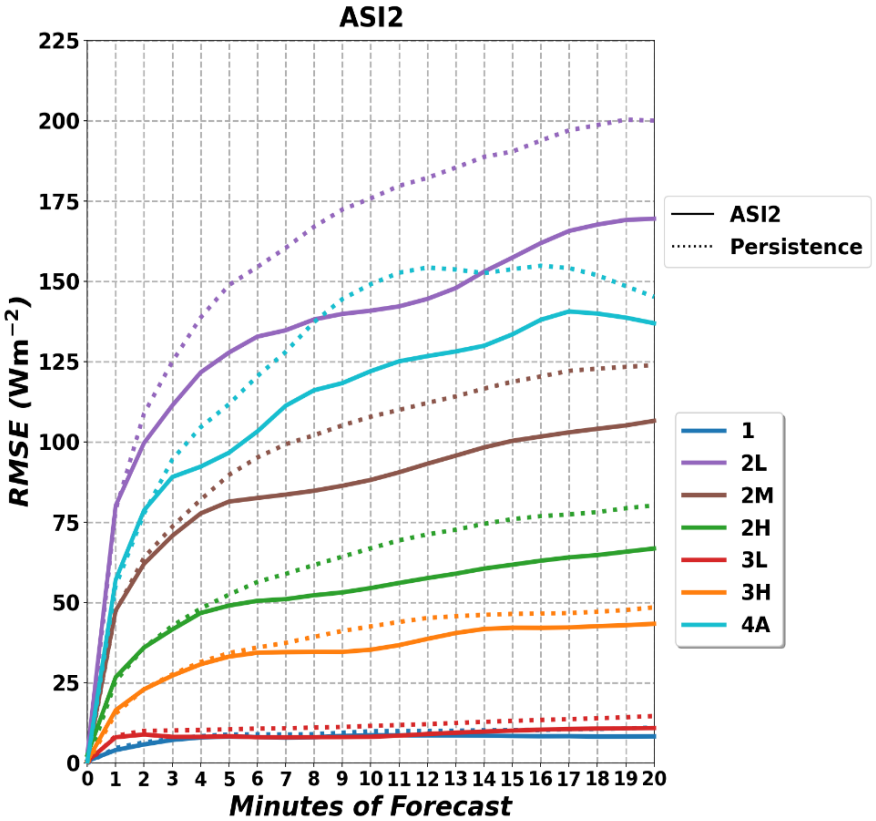
Results of ASI Benchmark for camera “ASI2”

- for all cloud classes better results than persistence
- Advantage especially in cloud classes with high cloud influence (2L, 4A, 2M)



Cloud classes:
1 (almost) clear sky
2L Broken cloud cover with low clouds
2M Broken cloud cover with high, medium and low clouds
2H Broken cloud cover with (medium) high clouds
3L Broken cloud cover with low clouds approx. half of the day, cloudless otherwise
3H broken clouds with high or medium clouds approx. half of the day, cloudless otherwise
4A completely cloudy approx. half of the day, otherwise broken clouds

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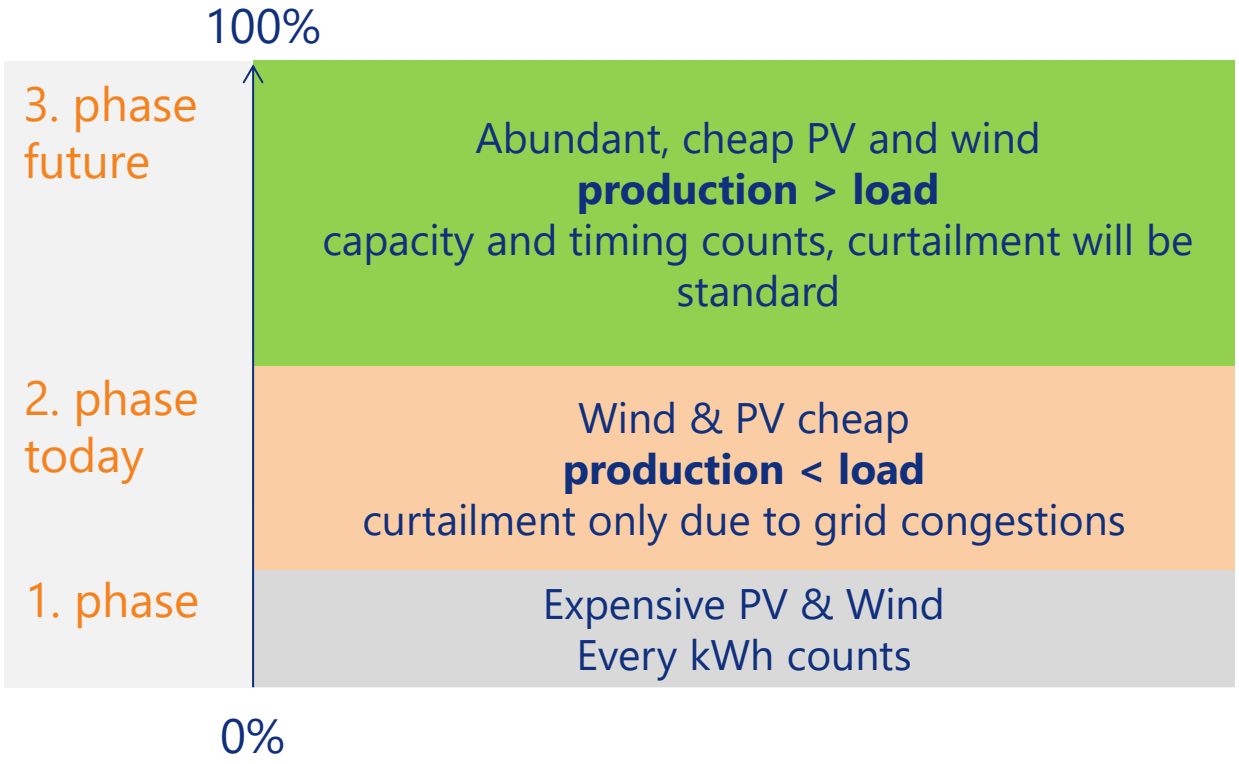
Firm PV Power



For a 100% renewable world **oversizing and storage** is needed → What is the optimal share?

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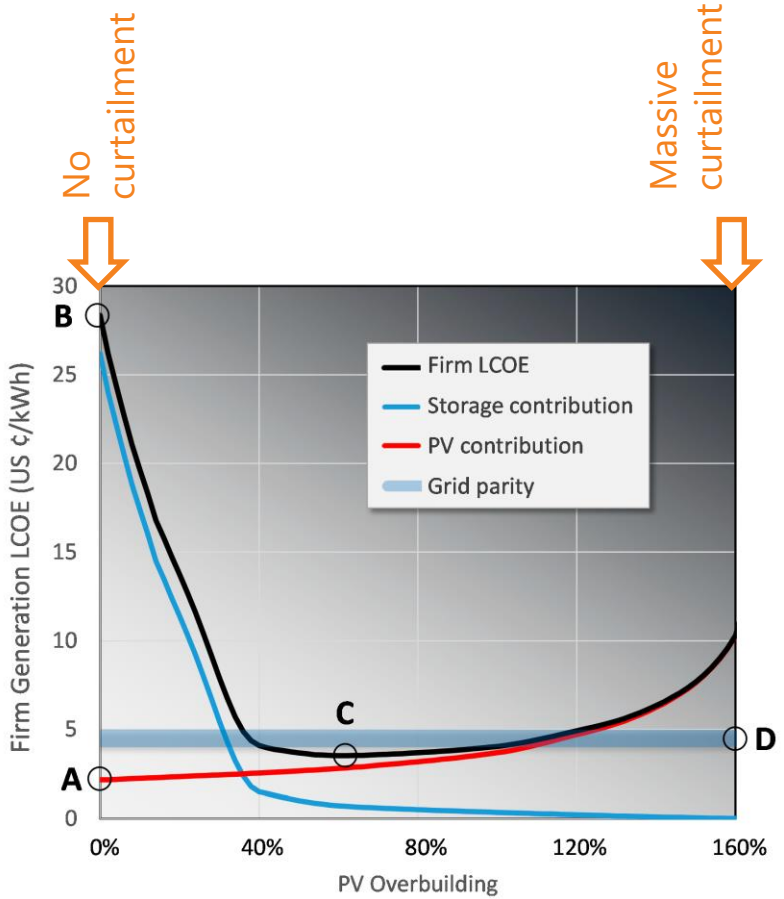
Firm PV Power



$Costs_{storage} > Cost_{PV}$

→oversizing is cheaper

→ Finding the optimum (C)

A = cost of PV alone

B = cost of storage if no curtailment

C = optimal costs

D = todays' system costs

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Firm PV Power – Switzerland

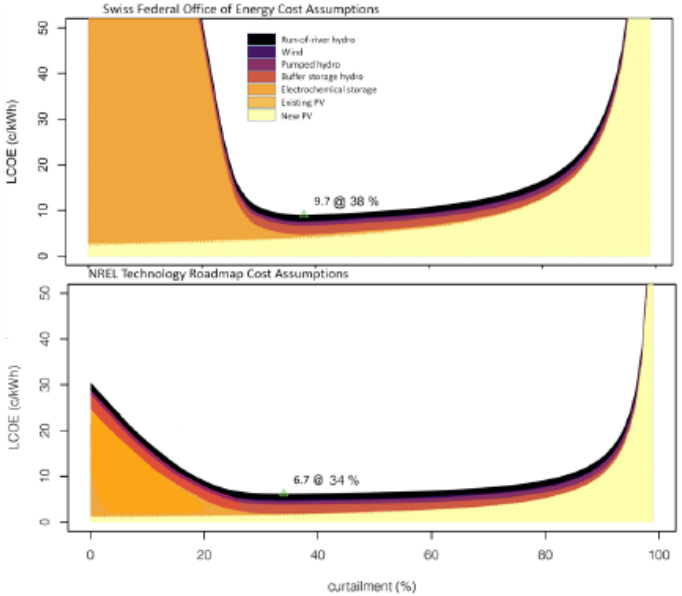

Figure 3. System-wide firm power generation LCOE as a function of dynamic PV curtailment, and respective contribution of all generating and storage resources to this LCOE. The top graph corresponds to the Swiss future cost estimates. The bottom graph corresponds to large scale PV/battery cost estimates from the US technology roadmap. *Note: oversizing and curtailment are related as follows: oversizing = 1/ (1-curtailment).*

CPR / SUNY, Meteotest:

- New study in Switzerland (2021-22)
- First preliminary results:
  - 6.7 – 9.7 cts/kWh
  - 34-38% curtailment

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Conclusions

- Most important concepts, basics and state of the art are concluded in the **Solar Resource Handbook**
- **Ongoing work to defining and lowering uncertainties**
- ASI → first benchmark of cloud cams and ongoing studies
  - useful but needs further scientific work to be used widely (aside niches)
- Firm PV power → make PV deliver electricity 24/7 and whole world
- Forecasts less important in future: curtailment will be dominating

Thank you

On behalf of IEA PVPS Task 16

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