The importance of sub-hourly input data in PV systems simulation using satellite-based solar model data

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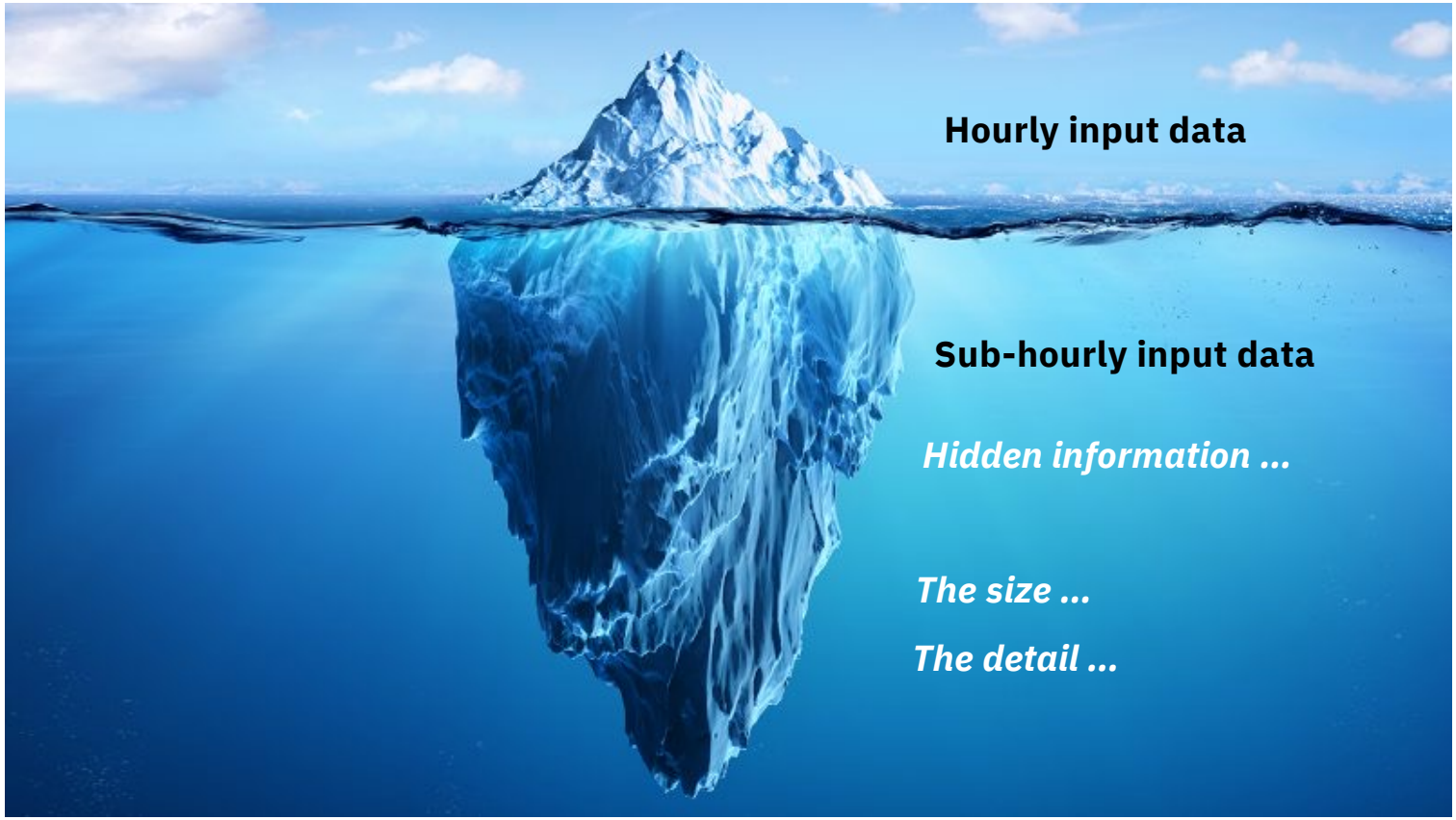

Source: The Iceberg Illusion: The hidden logic of success (theladders.com)

Agenda

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Objective and approach

Results for a specific day, one year, several years

- Clipping losses (CL)
- PV output (PVout)

Conclusions

Objective and approach

Objective and approach

- **Objective: to demonstrate the difference in PV simulation using sub-hourly input data compared to hourly input data**
- **Presentation:**
  - The information that is hidden in case of using hourly input data.
  - Main indicative factors of the difference in PVout calculated using hourly and sub-hourly input data.
- **PV simulations:**
  - Satellite-based solar model data
  - Time resolution: 60-minute, 15-minute, and 1-minute (synthetically generated)
  - DC to AC ratio: 1.1, 1.2, ..., 1.7
  - Time horizon of 1 year (without degradation)
  - Time horizon of 5 years (with and without degradation)
- **PV system configuration:**
  - same for all selected sites,
  - ground-mounted with N-S trackers,
  - bifacial half-cut cells,
  - one inverter.
- Solargis in-house developed **PV simulator**.

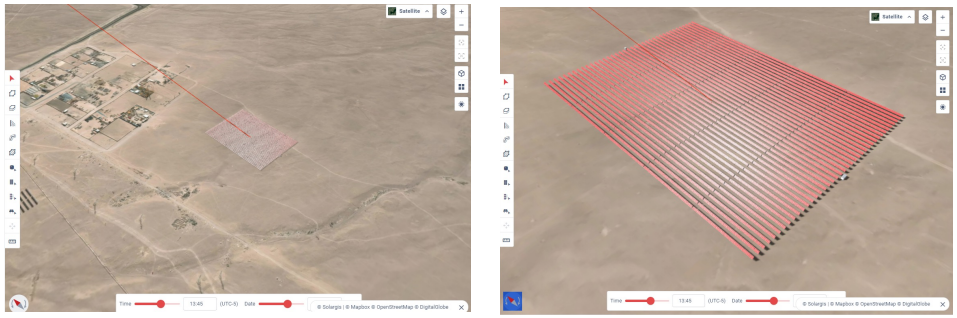
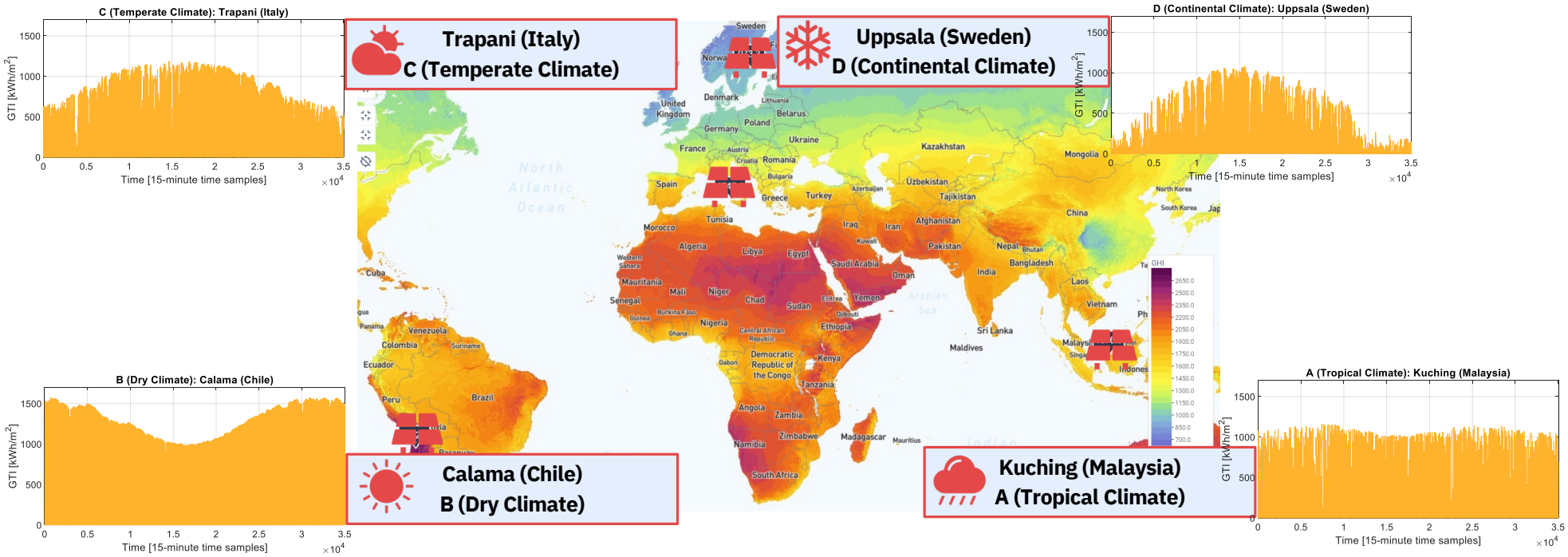


Figure: Two views on the PV system configuration located in one of the sites

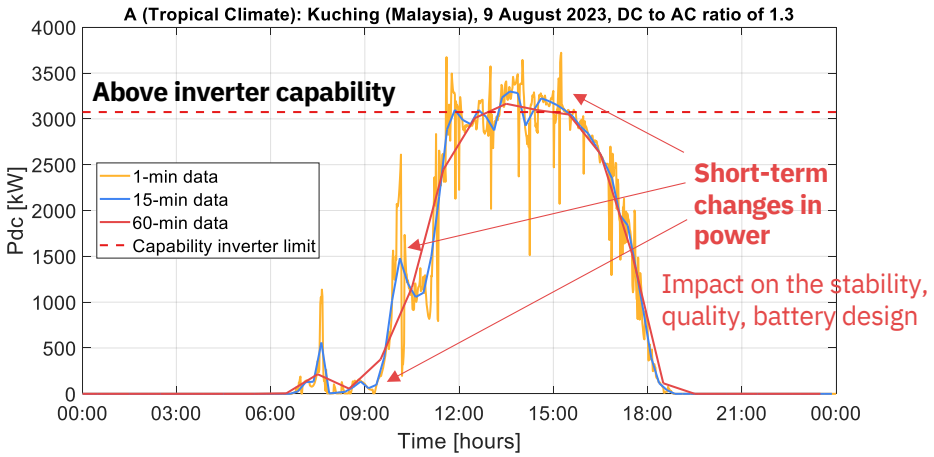
Objective and approach

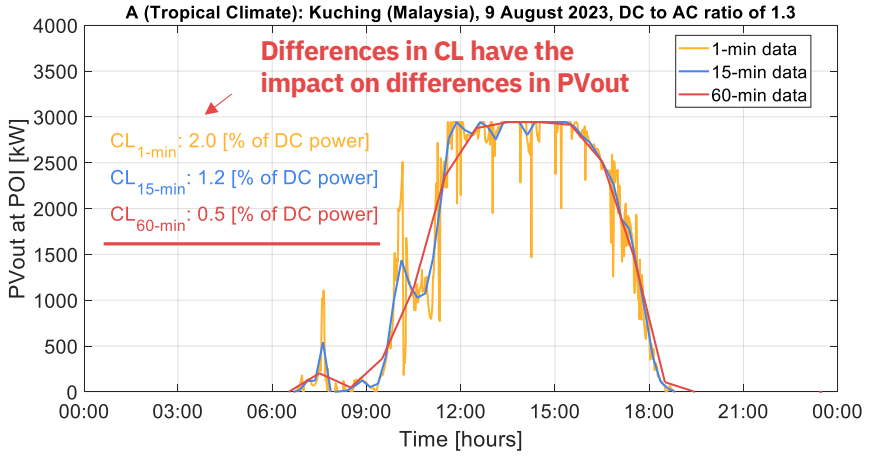
- **Demonstration**: 4 geographical sites from 4 Climate groups (A, B, C, D based on the Köppen-Geiger climate classification)

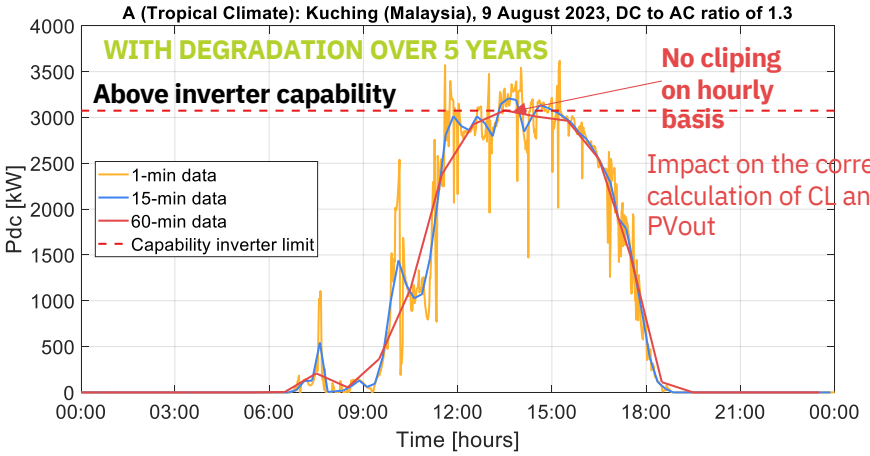


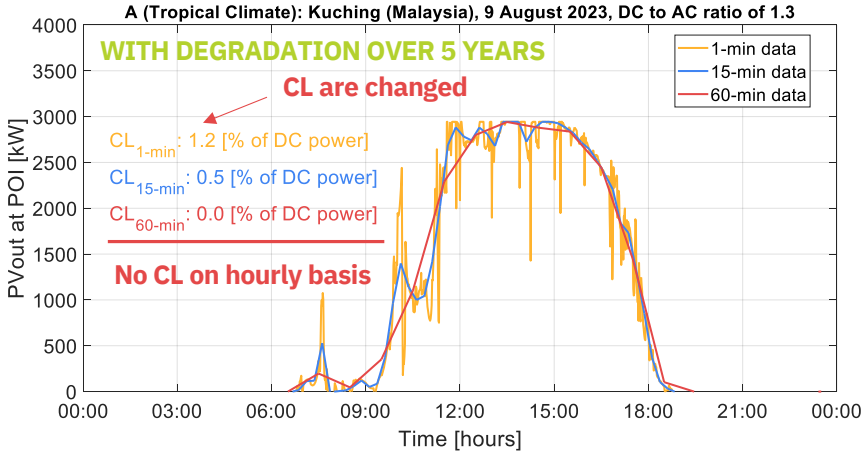
Results

Daily observations: Kuching (Malaysia), CL and PVout

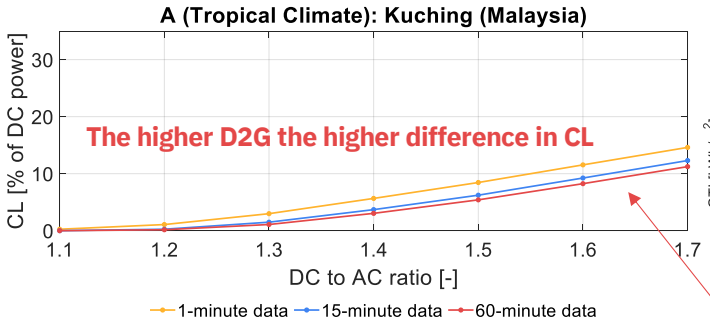


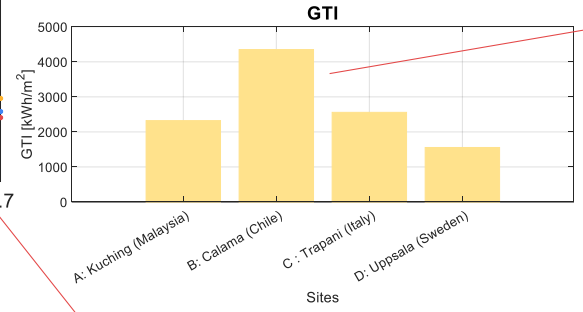


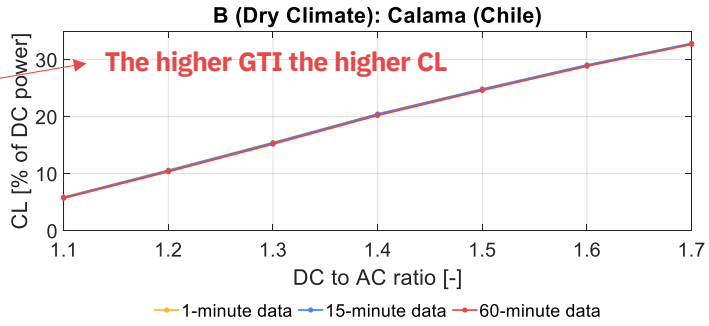


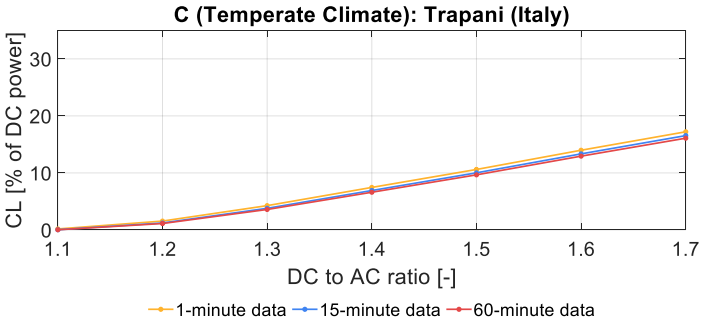


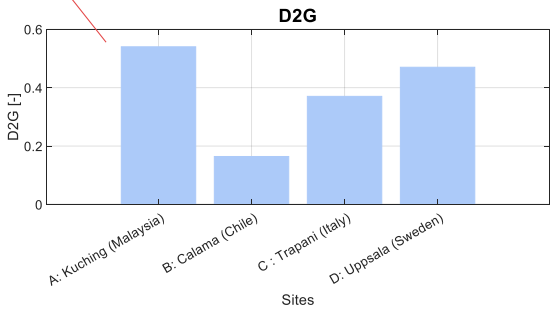
Yearly basis: four sites, clipping losses (CL)

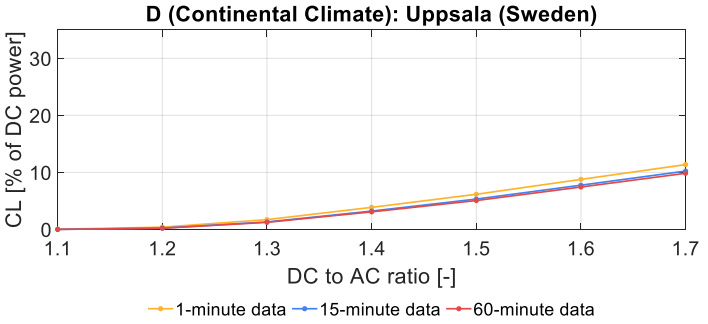






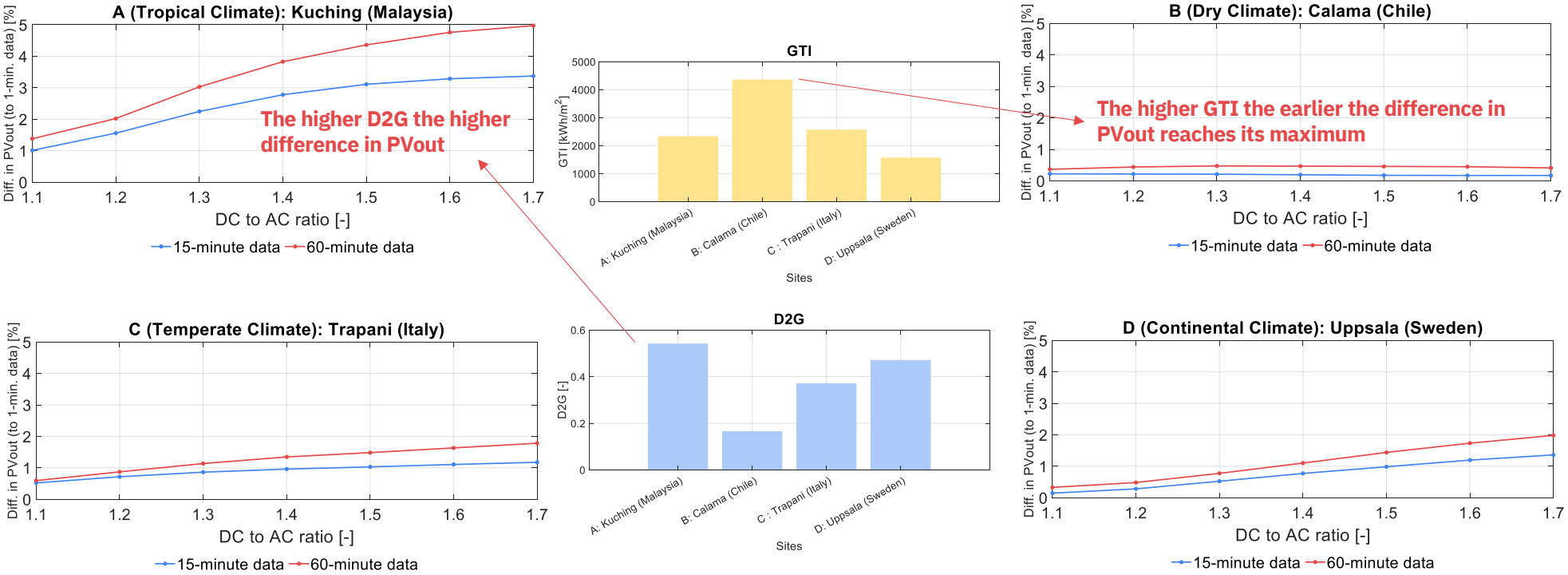






Diffuse/Global horizontal ratio (D2G): Indicative factor of the difference in CL calculated for different time resolution.

Yearly basis: four sites, difference in PVout

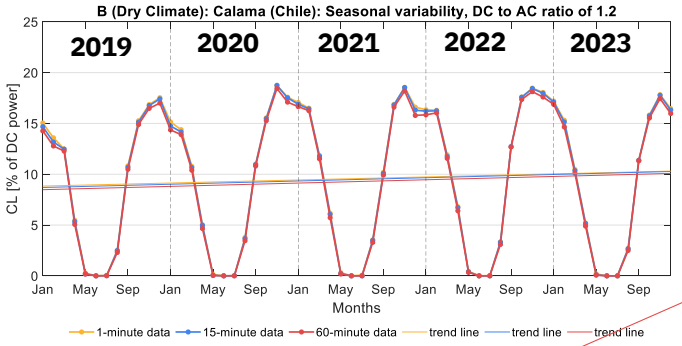


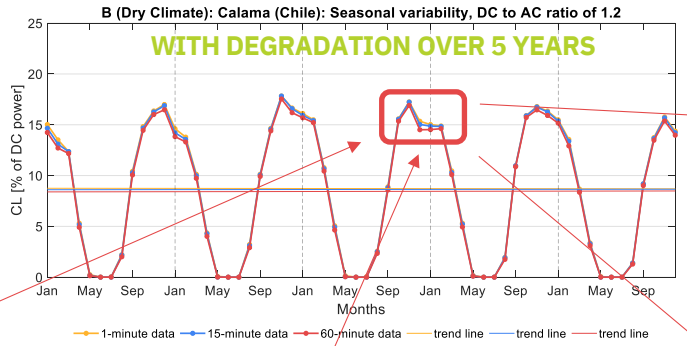
GTI and D2G are indicative factors of the difference in PVout calculated for different time resolution

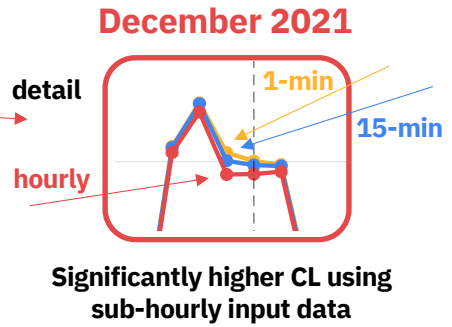
PV output overestimation using hourly data:

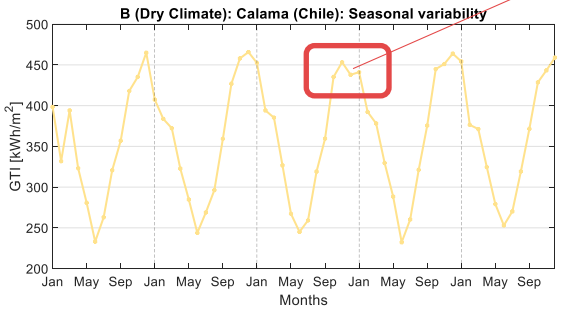
- the highest in tropical climate
- the lowest in dry climate (might be significant as well)

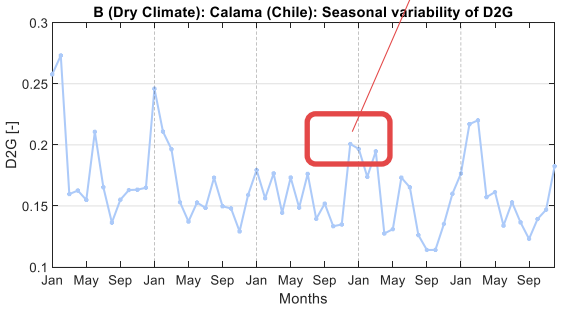
Multiyear PV simulation: Calama (Chile), uncovering the hidden part

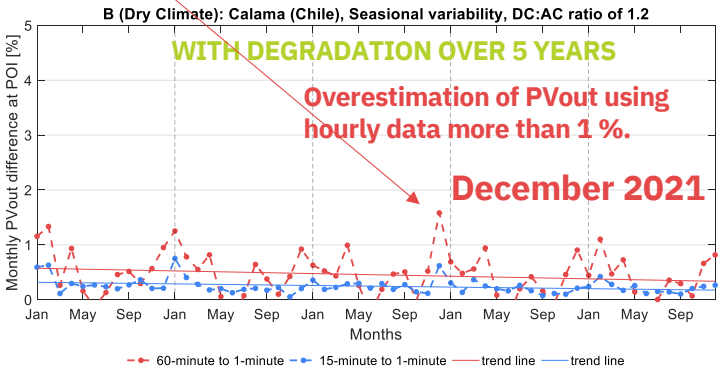












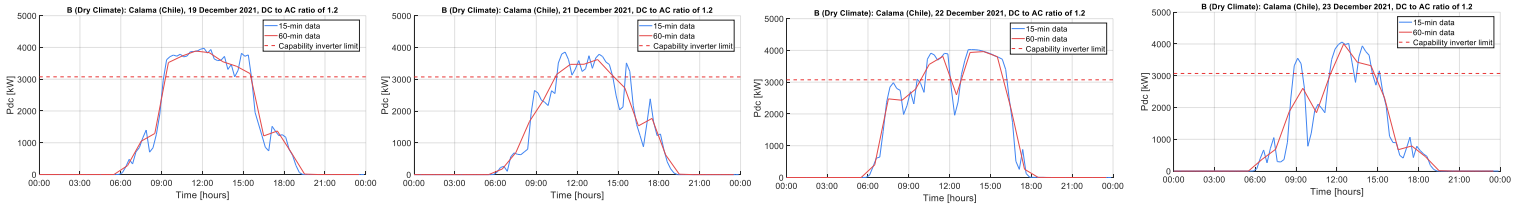
CL and differences in PVout calculated for different time resolution depend on the variation of degradation and climatic conditions changing over time.

In some months the difference in PVout might be higher than in the same months in previous years.

Multiyear PV simulation: Calama (Chile), uncovering the hidden part

The reason of the overestimation of PVout: unique solar irradiance variability during December 2021

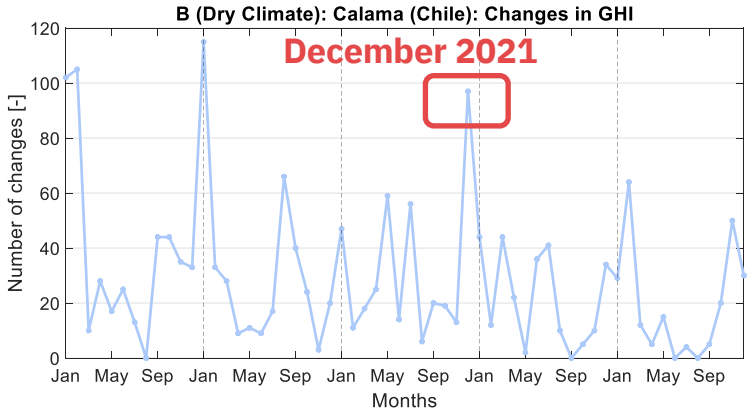
The variability is more significant (uncovered) using sub-hourly input data



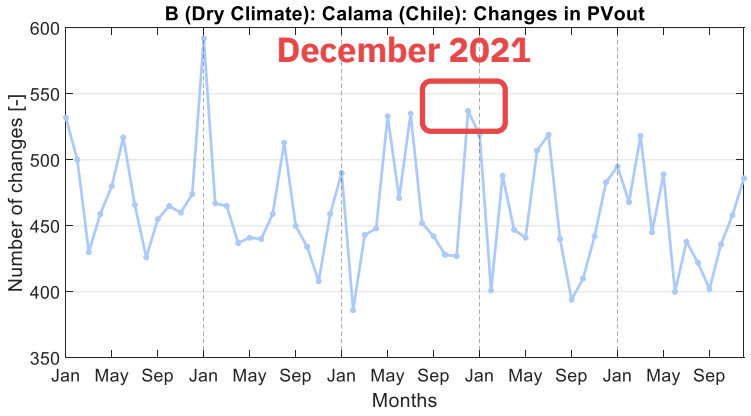
Figures: DC power calculated using hourly and 15-minute data (selected days)

From GHI to PVout variability: impact on the external grid (not only)

Number of GHI changes (above 100 kW/m²)



Number of PVout changes (above 3 % of rated output power)



Conclusions

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- Compared to hourly data, sub-hourly time resolution provides more accurate information on PV system performance, including estimates of clipping losses and PV power output
  - 1-minute data is more accurate
  - 15-minute data is a good compromise considering time of computation and volume of data

- Benefits of sub-hourly data is even more important
  - With increasing DC/AC ratio
  - In regions with intermittent clouds

- Sub-hourly time series quantifies (non-linear) reducing effect of clipping losses over years due to PV system degradation

Overestimation of PV power output when using **hourly** data **relative to sub-hourly** data:

Kuching (Malaysia)
A (Tropical Climate)

Year	1	2	3	4	5	…
15-min. data	0.9%	0.9%	0.8%	0.9%	0.7%	…
1-min. data	3.1%	3.0%	2.9%	2.9%	2.7%	…

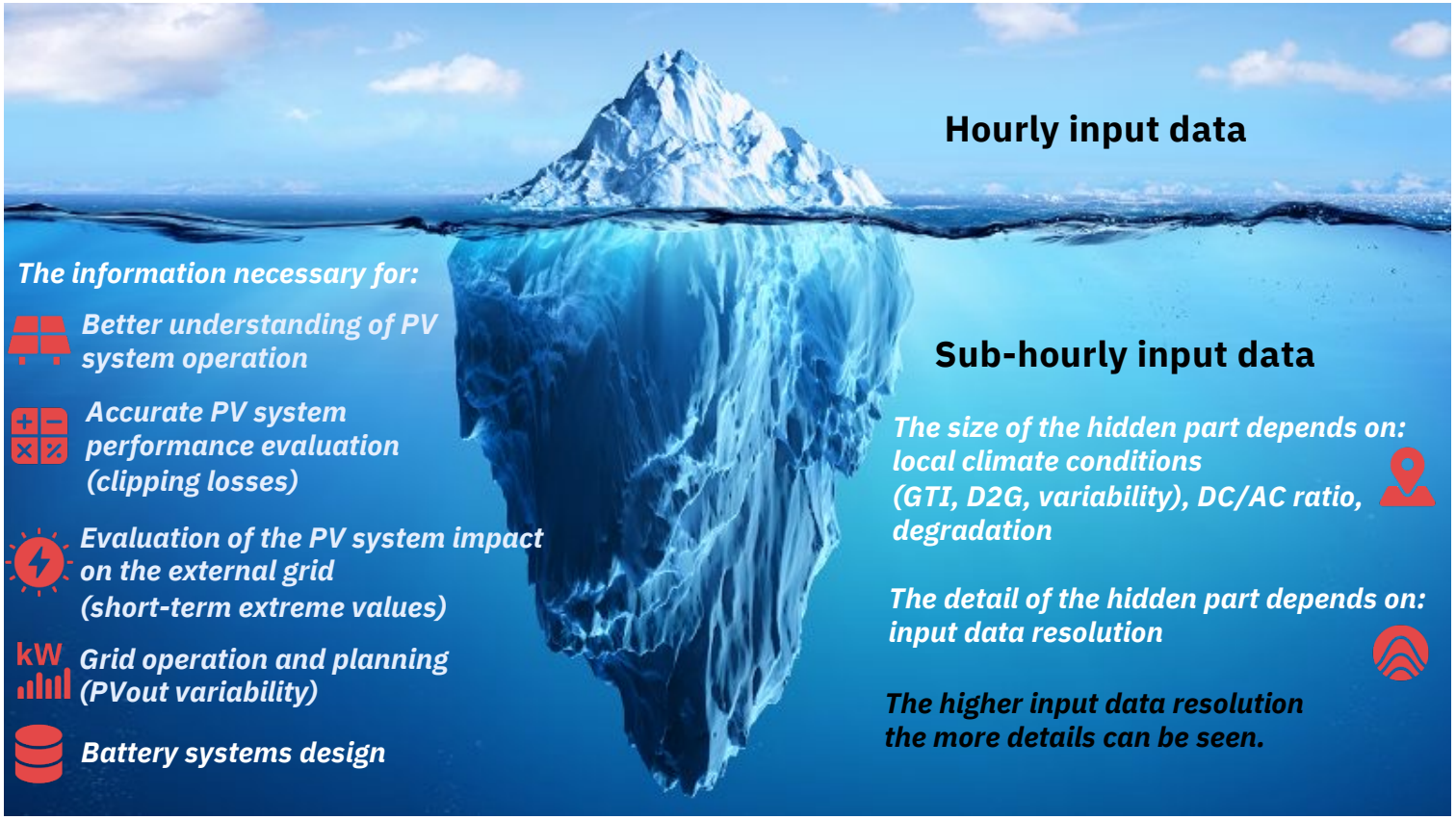
Note: DC to AC ratio of 1.3

Calama (Chile)
B (Dry Climate)

Year	1	2	3	4	5	…
15-min. data	0.3%	0.3%	0.3%	0.2%	0.3%	…
1-min. data	0.6%	0.5%	0.5%	0.4%	0.5%	…

Note: DC to AC ratio of 1.3

Conclusions



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Thank you.

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