Dimensioning of Decentralized Photovoltaic Storages with Limited Feed-In Power and Their Impact on the Distribution Grid

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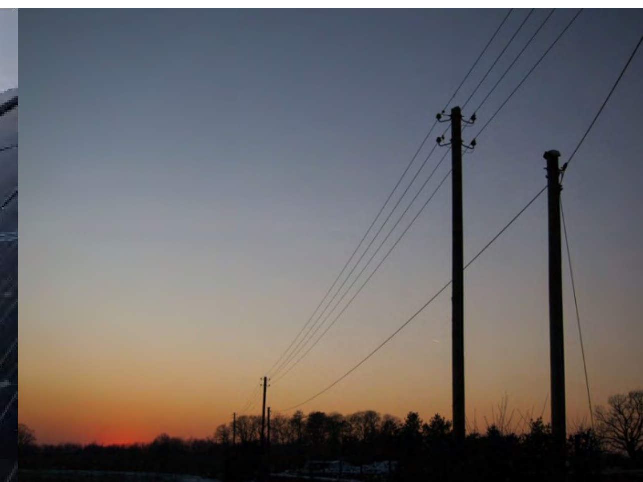
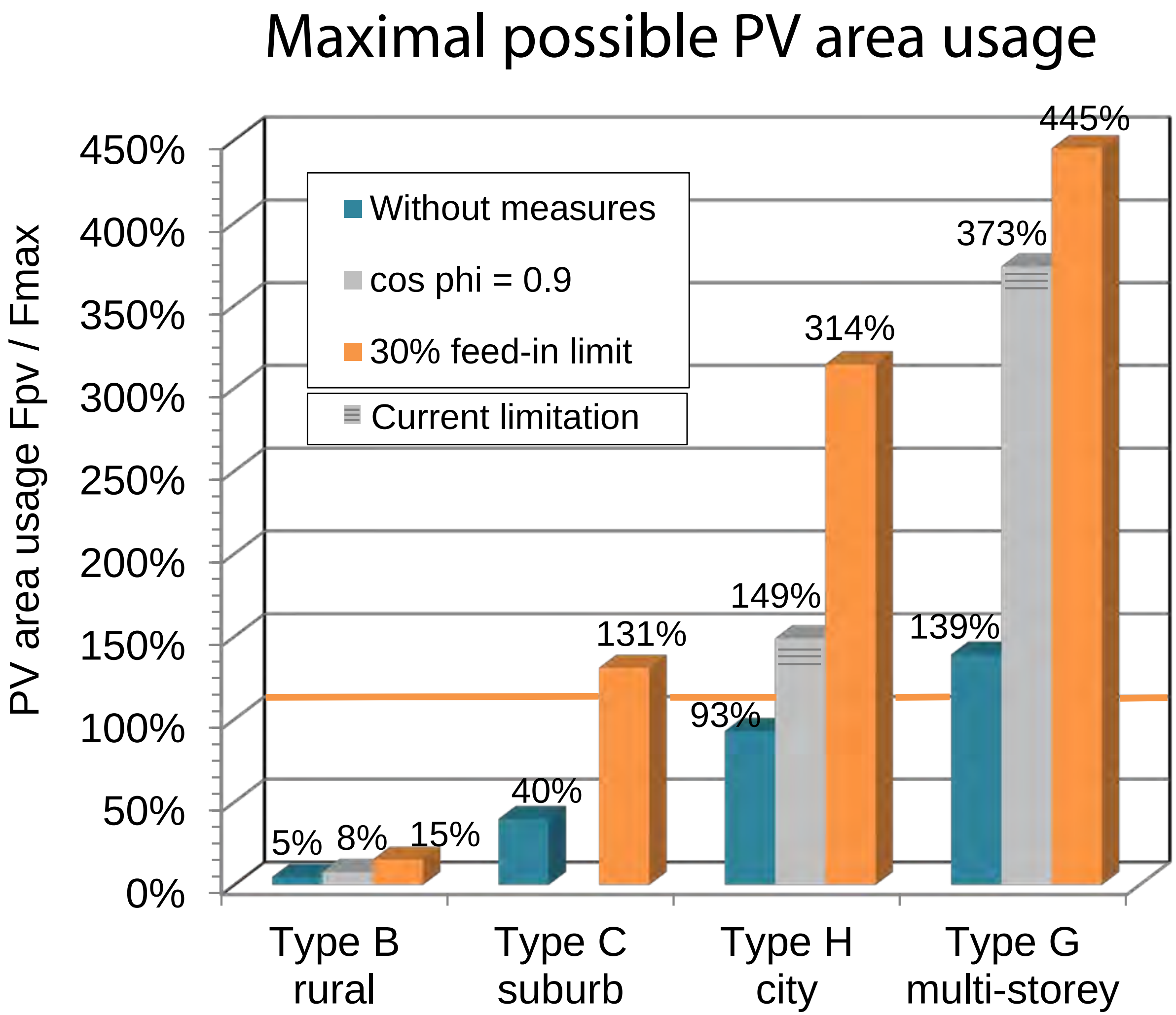
Content

- Optimal storage size for PV system with
  - Feed in limitation
  - Self consumption
- Control method for combination



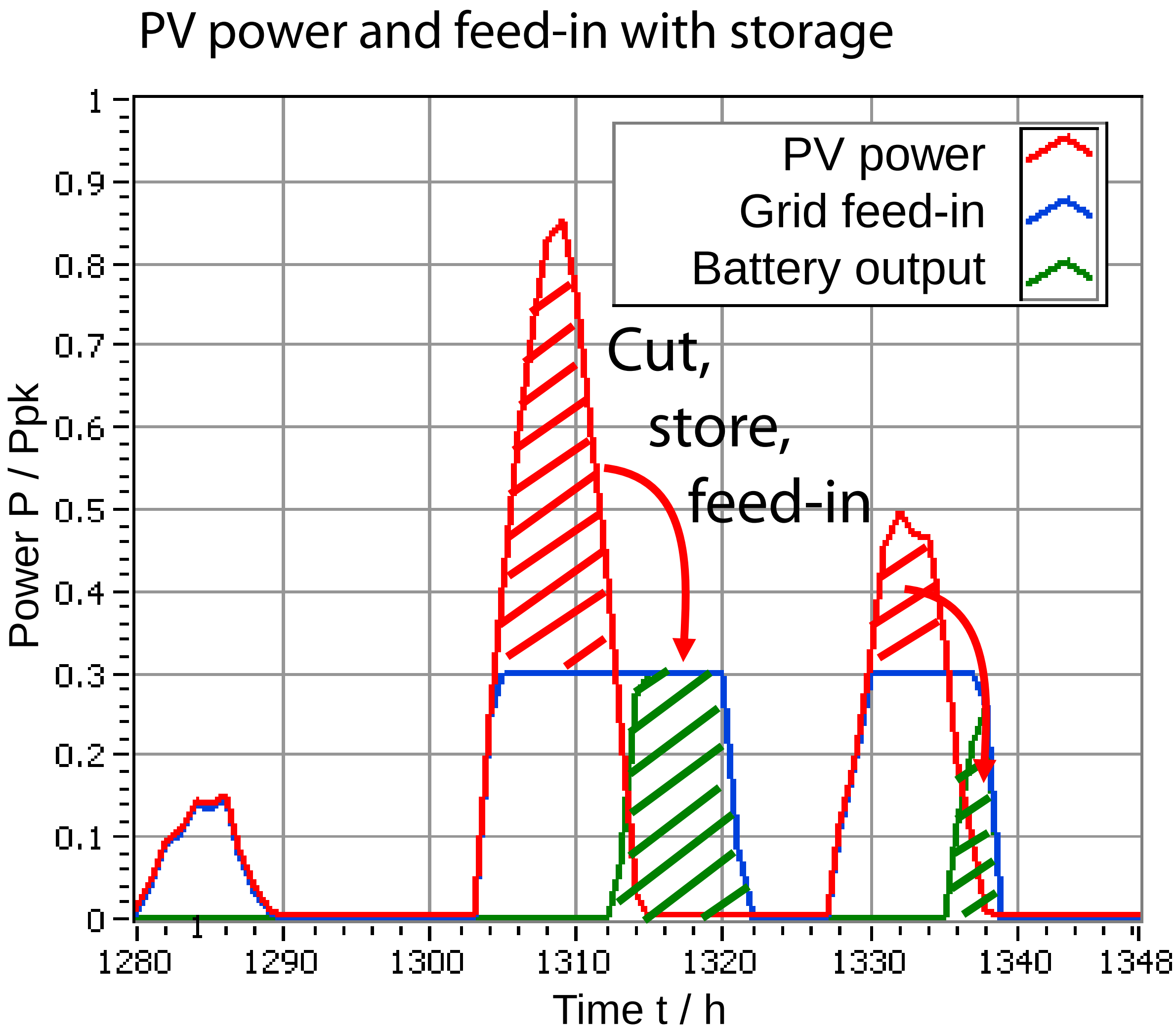


Limitation of PV-Area usage



- PV-Area is limited due to grid constraints espcially in
  - Rural areas
  - Suburbs
- Storage helps to exploit the potential

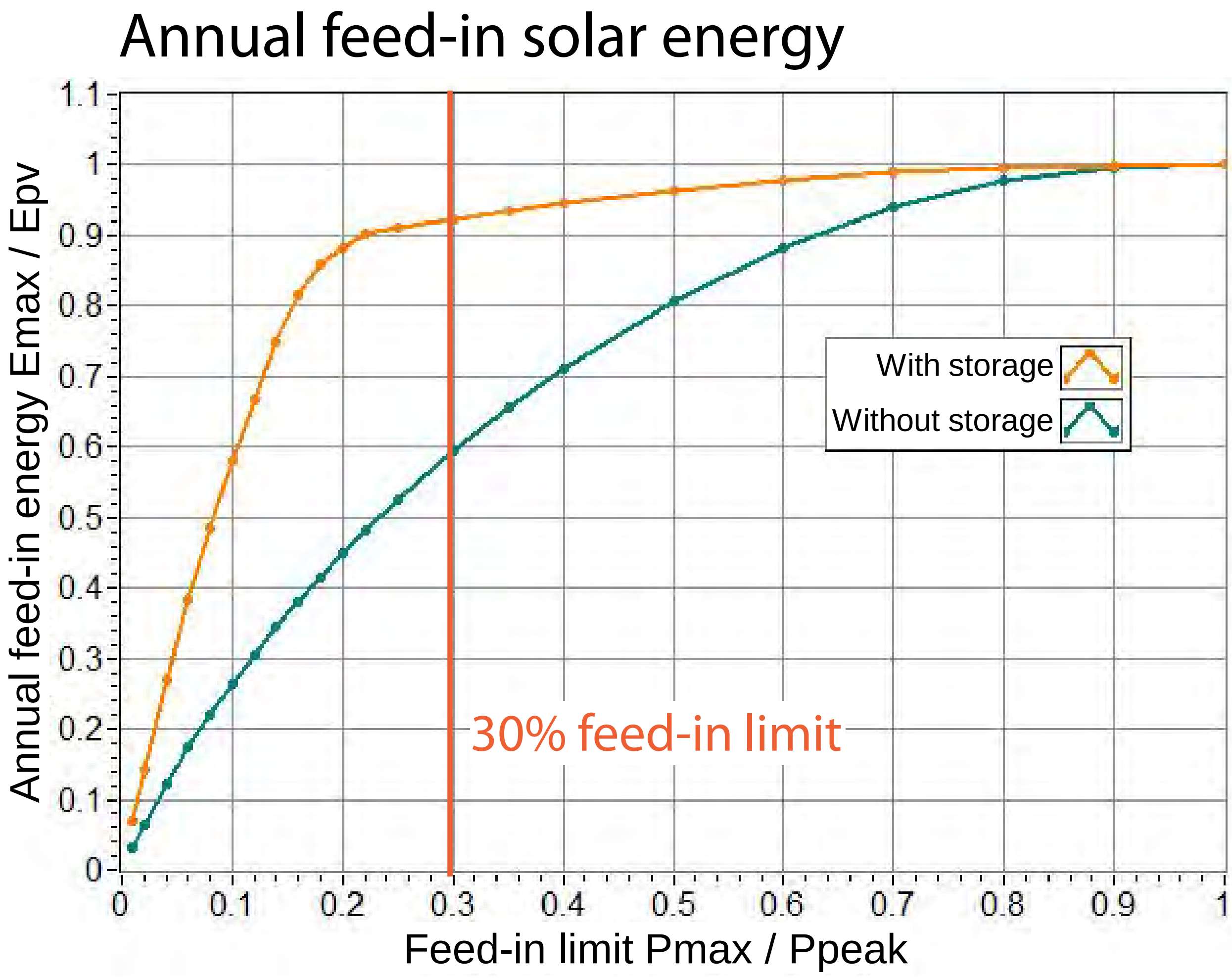
Storage operation with limited feed-in



Basic idea:

- Cut feed-in
- Store excess
- And feed-in later

Impact of feed-in limitation

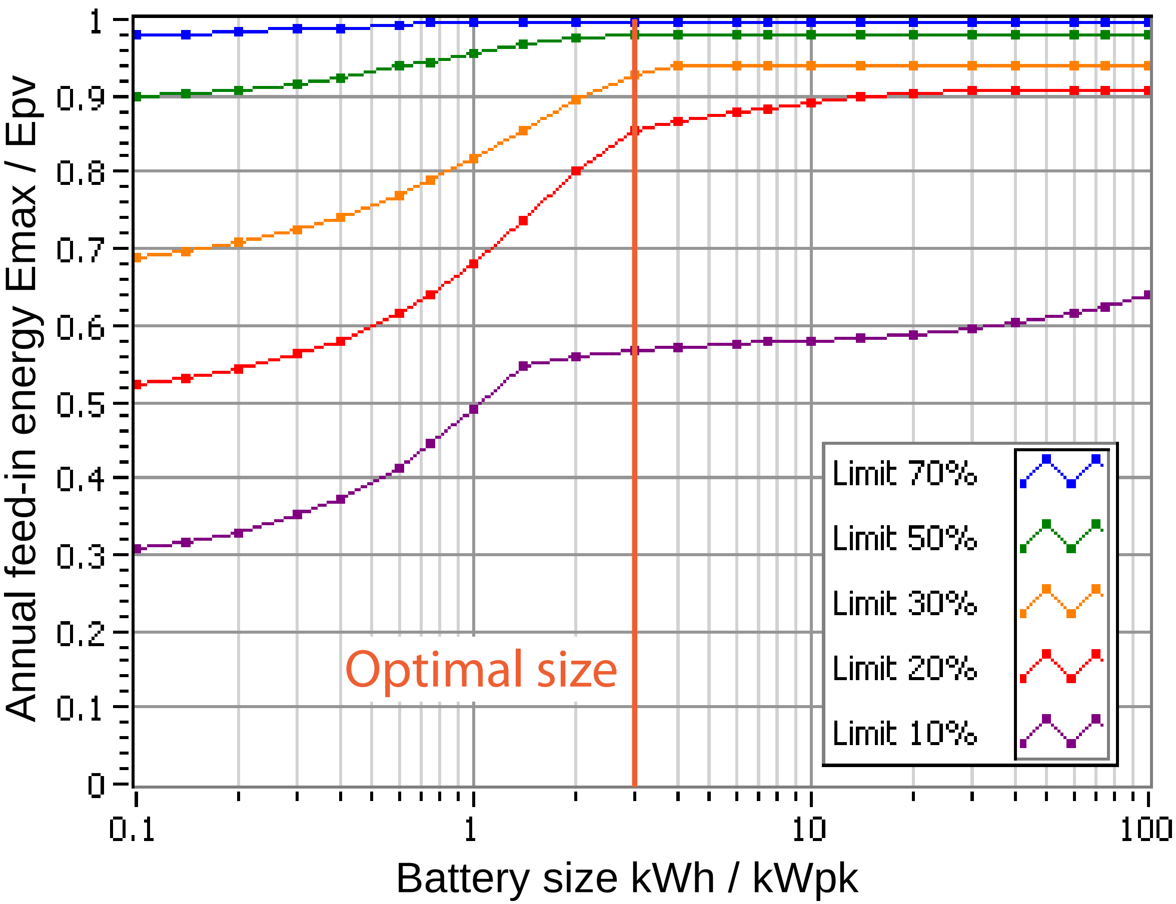


30% of peak power limitation:

- Without storage: 2/3 of yearly PV energy can be fed- in
- With storage: 90% of yearly PV energy can be fed- in

Battery size for feed-in optimization

Feed-in energy as function of the battery size



- Scales with Size of the PV system
- Optimal storage size of about 3 kWh/kWpk

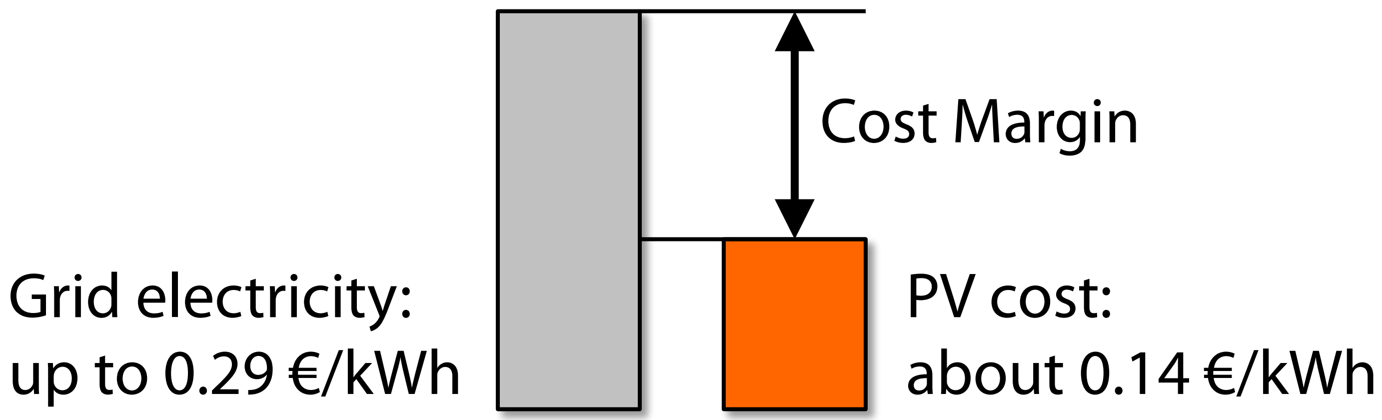
Dezentrale Speicher

Quelle:
G.Mester
für SFV

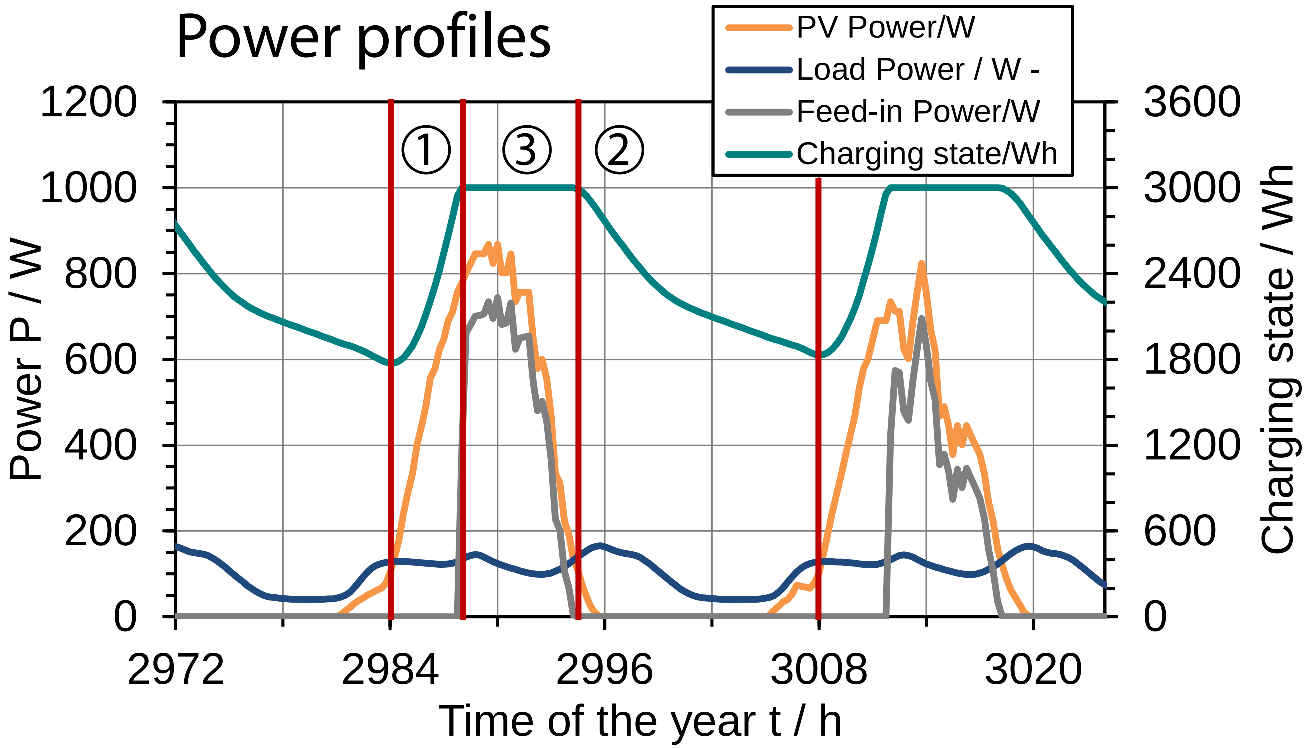
Storage for self consumption

Motivations:

- Independence of big companies
- Save money:
  Grid parity by far exceeded in Germany



Storage operation with self consumption



Operation priorities

① Sunshine
- 1. Self-consumption
- 2. Load battery
- 3. Grid feed-in

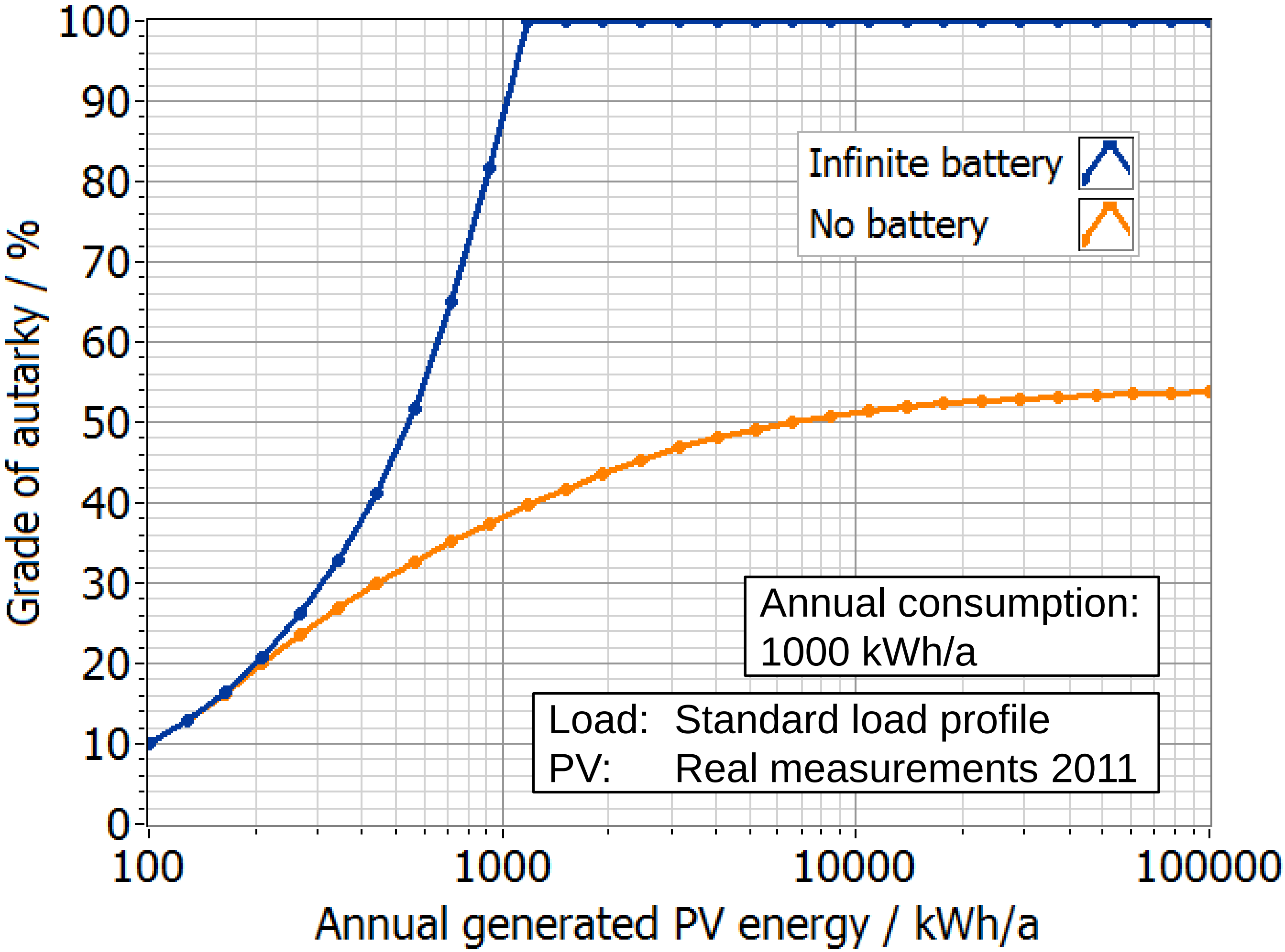
■ Dark

②
- 1. Discharge Battery (No grid feed-in)
- 2. Grid operation

■ Full battery:

③ High feed-in power, **No grid benefit!**

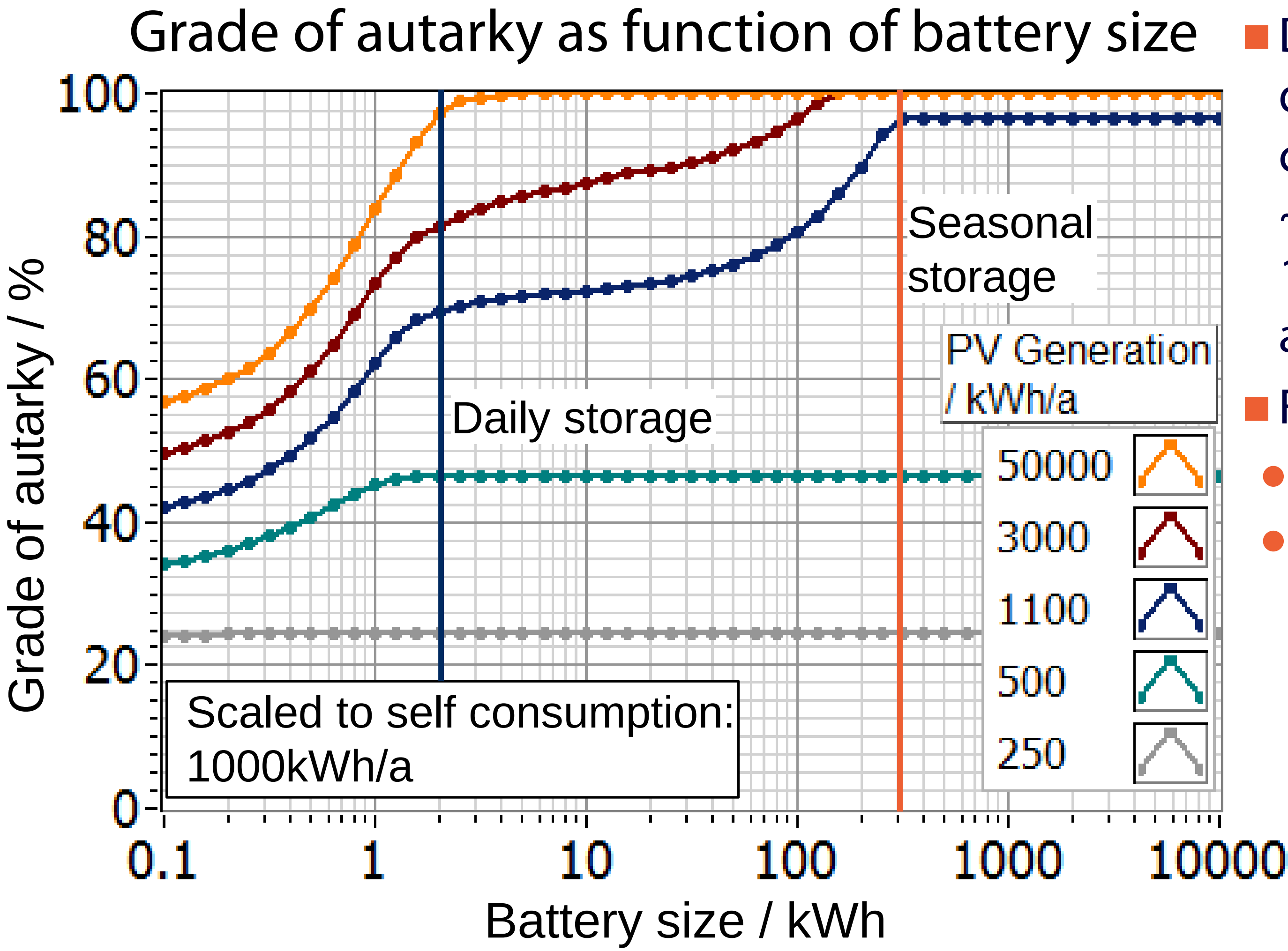
Grade of autarky



- Figure of merit:
  Grade of autarky
- No storage:
  max. ~50% autarky

Initial battery status:
equal to end of year status
for all simulations

Battery size for autarky optimization

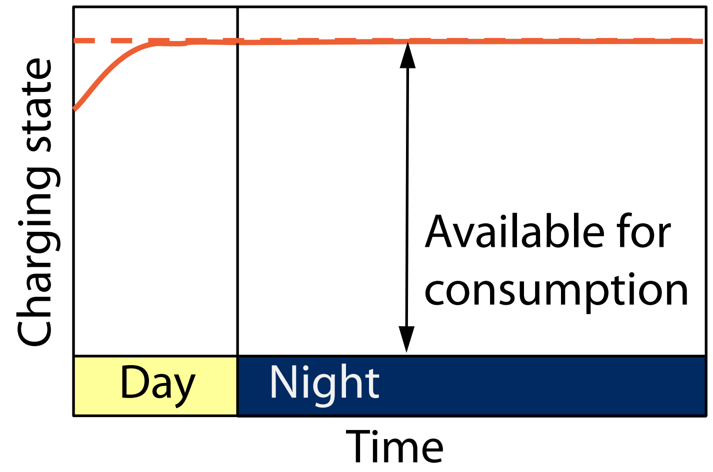


- Daily storage only dependent on consumption: ~2 kWh battery for 1000 kWh/a annual consumption
- Full autarky only with
  - Seasonal storage or
  - Oversized PV system

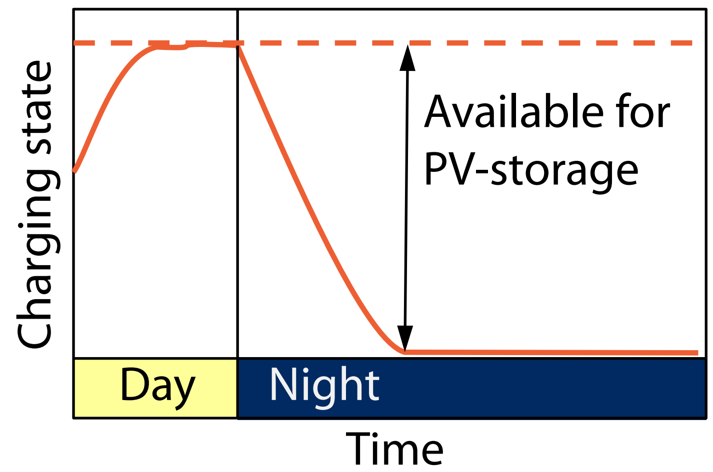
Combine feed-in limitation and self consumption

Simple modes of operation:

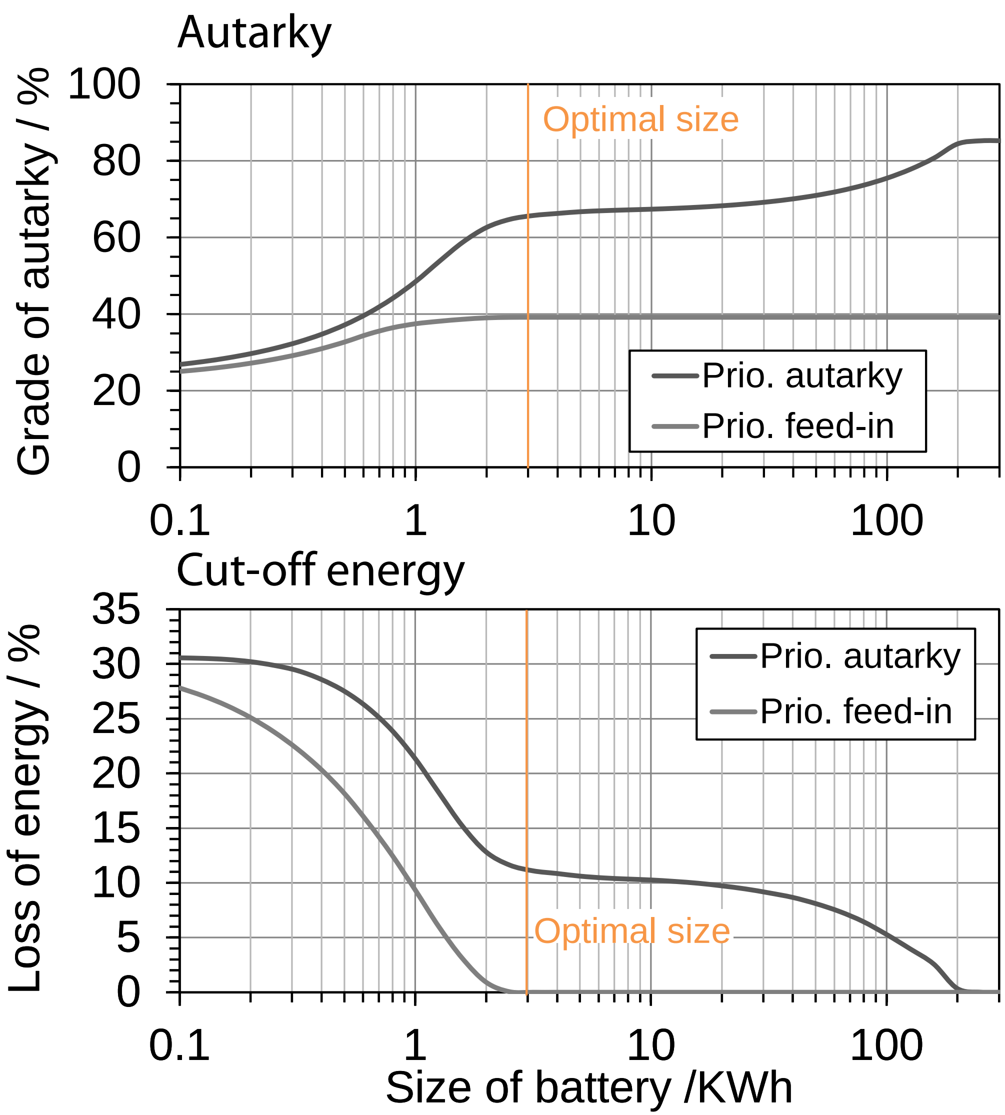
- Prioritization of autarky:
  Energy cannot be stored and gets lost



- Prioritization of feed-in:
  Less autarky



Simple modes of combined operation



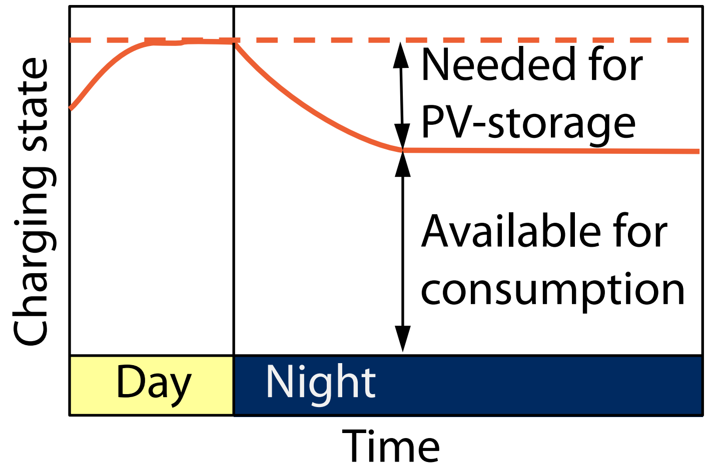
Prioritization of **Autarky**:
Charge as much as possible

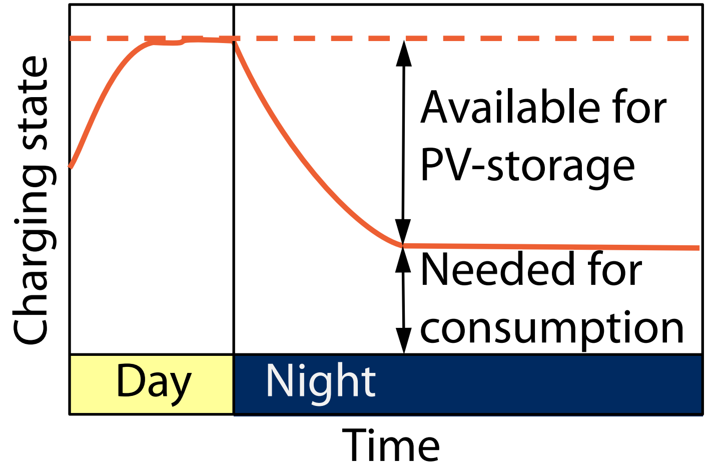
Prioritization of **Feed-in**:
Discharge as soon as possible

Parameters:
PV generation: 1000 kWh/a
Consumption: 1000 kWh/a
Feed-in limit: 30%

Smart modes of combined operation:

- Only degree of freedom: Discharge in the night
- Emphasis of autarky, consider feed-in:
  - Estimate excess PV generation of next day
  - Deplete until storage space for next day's generation available
  - -> Autarky remains more probable, energy may be lost.
- Emphasis of feed-in, consider self consumption:
  - Estimate consumption of next day
  - Deplete, but leave next day's consumption in storage
  - -> Loss of energy less probable, grade of autarky may decrease



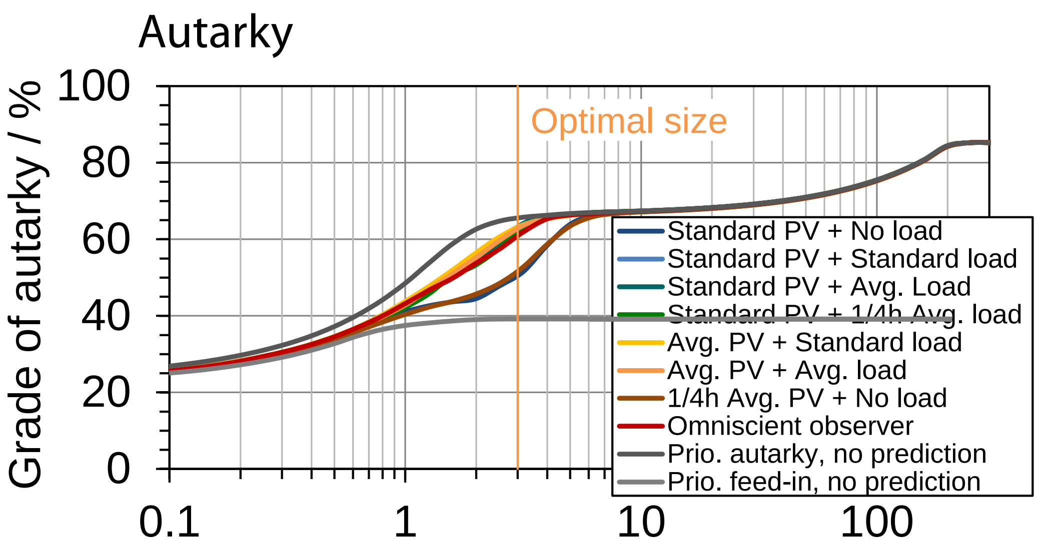


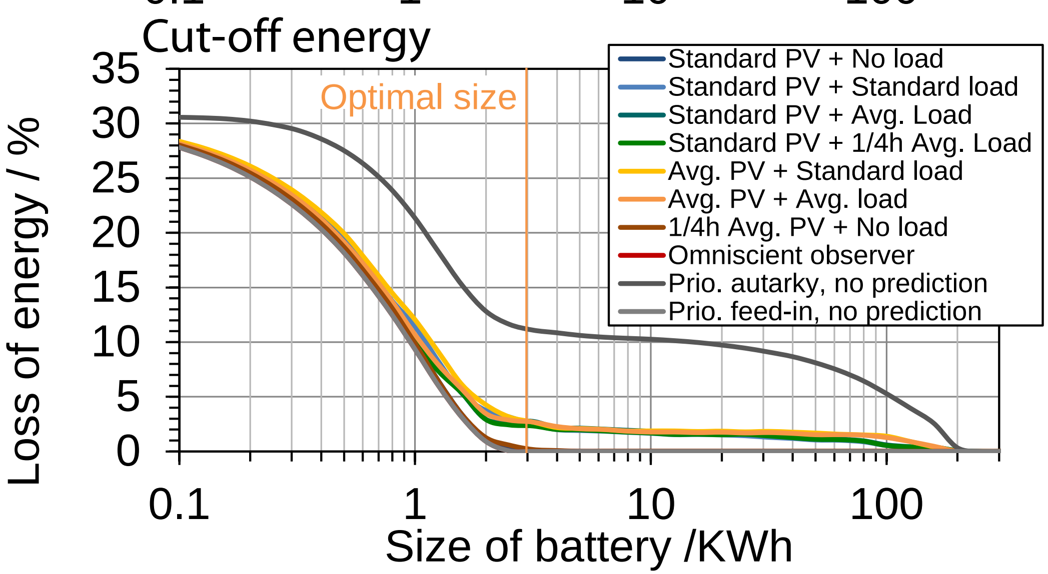
Smart modes of combined operation

How "smart" is necessary?

- Reference: omniscient observer
- PV prediction:
  - Daily running average
  - Standard PV profile
  - (Weather forecast)
- Load prediction:
  - Daily running average
  - Standard load profile
  - (Learning observer)

Smart modes: Omniscient observer





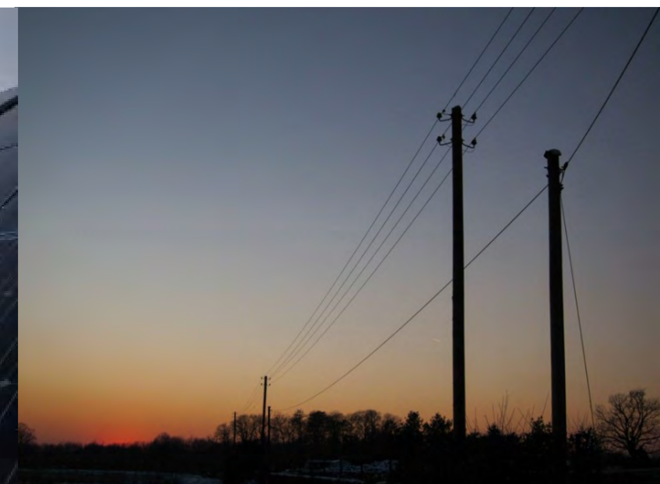
Recommended prediction method:

- Emphasis on autarky
- Consider feed-in
- Simple averaging of
  - Past consumption
  - Past PV-generation
- Only 3% loss of feed-in

Operation mode:
Emphasis on autarky, consideration of feed-in
Parameters:
PV generation: 1000 kWh/a
Consumption: 1000 kWh/a
Feed-in limit: 30%

Summary

- Optimal size: Daily storage
  - Feed-in limitation: 2 kWh / 1000 kWh/a
    Scaled to annual PV energy
  - Self consumption: 3 kWh / 1000 kWh/a
    Scaled to annual consumption
- Simple control by using averaged past data



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