



GRID INTEGRATED SOLAR SYSTEM

AGENDA

The Challenge

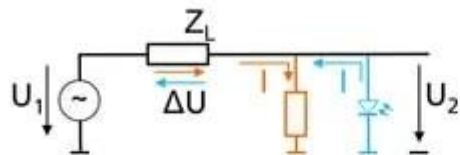
Solutions for grid integration

Grid planning with renewables

Conclusion



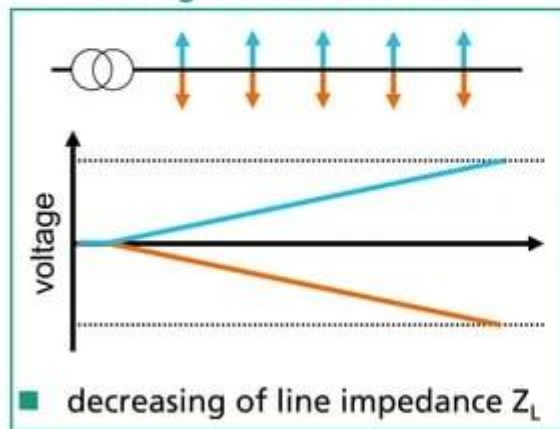
What is the challenge for grid integration? And its classical solution



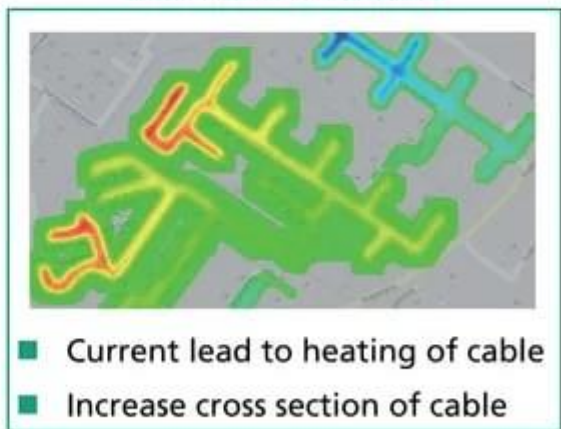
$$U_2 = U_1 - Z_L I \rightarrow \text{voltage decrease}$$

$$U_2 = U_1 + Z_L I \rightarrow \text{voltage increase}$$

voltage band violations

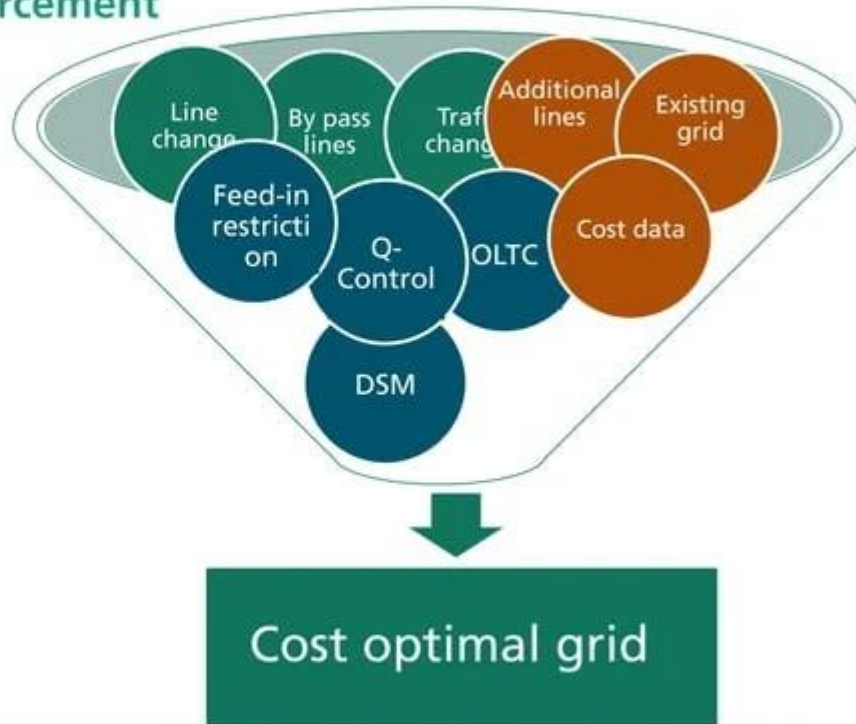


thermal limitations



Optimal grid expansion

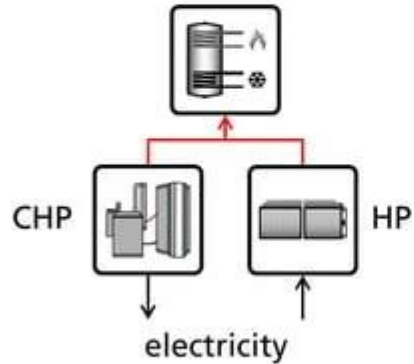
Avoid grid reinforcement



Operation of Local Systems

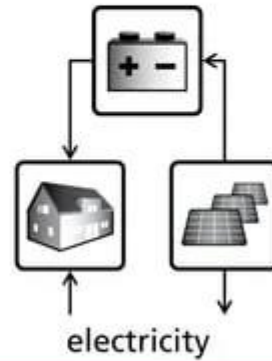
Electric thermal systems

- Thermal storages offer the possibility to decouple thermal and electric processes



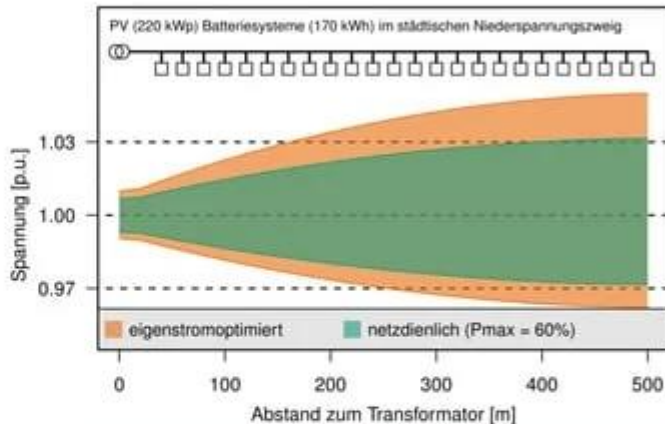
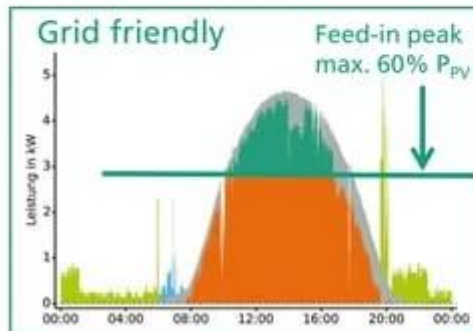
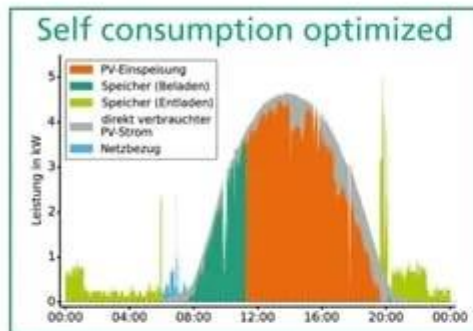
PV-Battery Systems

- Local self consumption of electricity from PV
- Grid oriented operation



▶ What are services for the Smart Grid?

Grid-friendly operation of PV battery systems

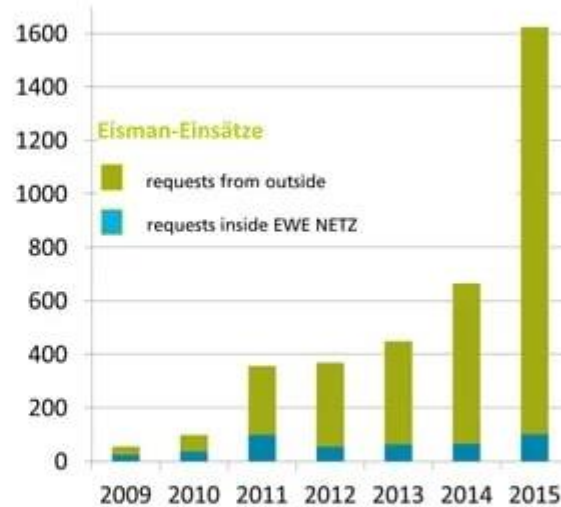


- Self consumption optimization does not avoid grid peaks
- Grid friendly operation: up to 66% surplus PV can be installed.

External Feed-in Reduction requests

Electricity grids are increasingly stressed

- Increasing feed-in of fluctuating renewables affects grids operation
- Feed-in management becomes more important
- Decentralized feed-in of renewables influences dimensioning of electricity grids.



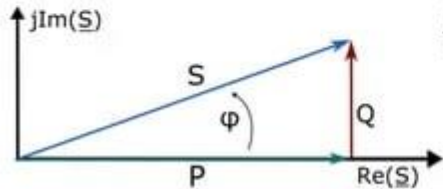
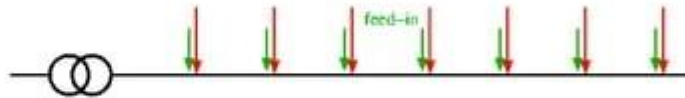
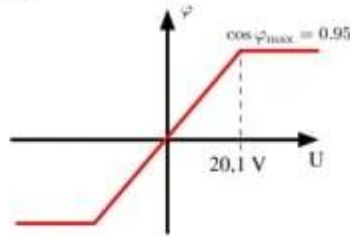
source: EWE NETZ GmbH



This energy can be used better instead of shutting off.

Integration: reactive power control

- Voltage will be stabilized by changing the phase between voltage and current.
- Increasing of inverter nominal power
- Increasing of losses
- Reactive power control is defined in grid connection guidelines.

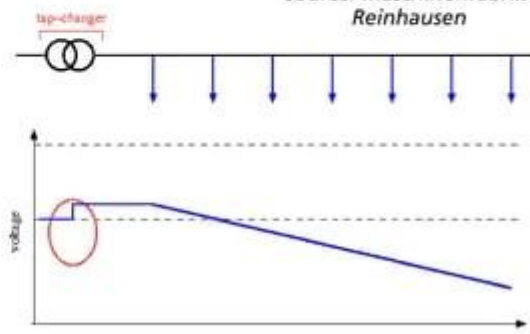
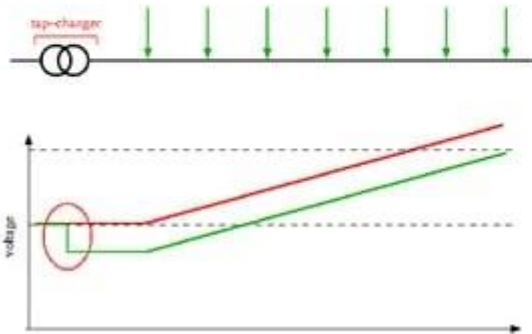


Integration: voltage control with tap changer

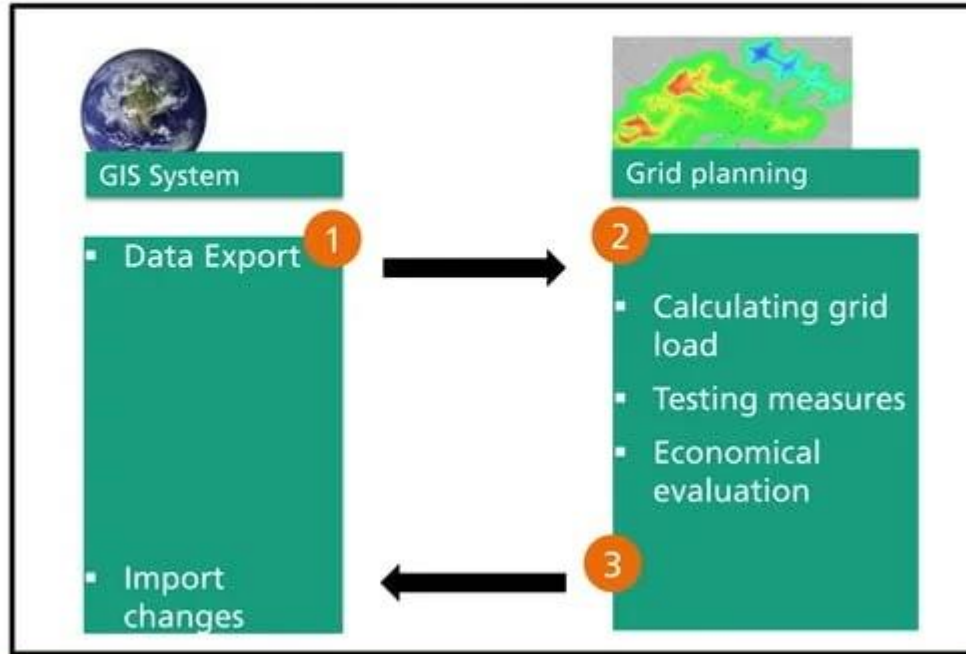
- Usage of variable tap-changer at transformer
- Dynamic adaptation of voltage a point of connection
- Usage of the full voltage range
- No reduction of PV necessary.



source: Maschinenfabrik
Reinhausen



The planning process of a local DSO



NEMO Use Case – Reference Ringkøbing

Step 1: Problem

2

Expected Development

Decentralized production

Photovoltaic: 180 kWp

Combined heat: 0 kW

Heat

Needed heat: 50 MWh

Heatpump: 50 %

Storage per HP: 3 h

Electrical Storages

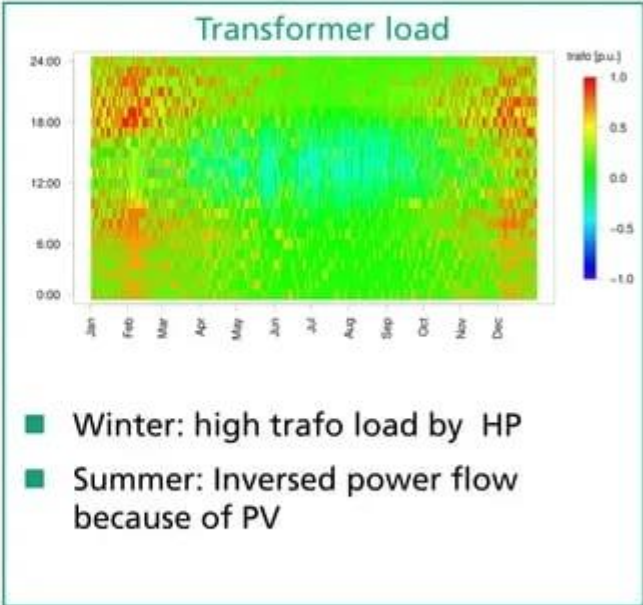
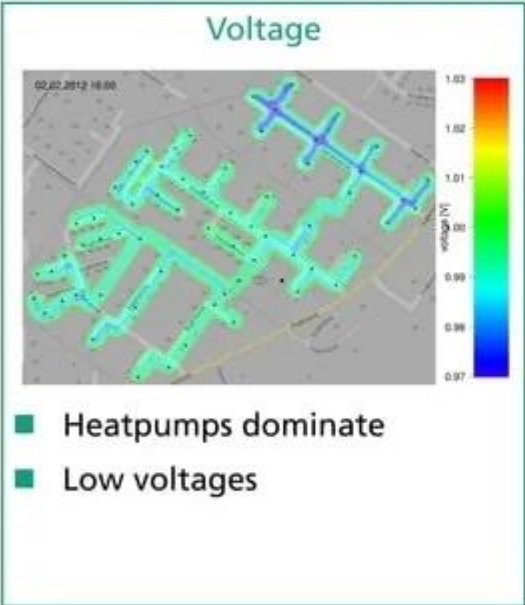
EV: 0

PV-batteries: 0 kWh



NEMO Use Case – Reference Ringkøbing

Step 2: Identifikation



NEMO Use Case – Reference Ringkøbing

Step 3: Definition of possible solutions

2

Solution possibilities

■ Grid reinforcement

conventional

OLTC

Q-Control

■ Intelligent Control

Demand Side Management

Local energy management

grid friendly PV

NEMO Use Case– Reference Ringkøbing

Step 4: Solution with convention reinforcement

2

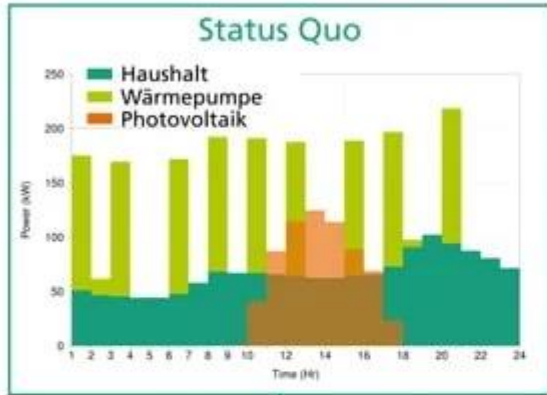


- Conventional reinforcement
- Replace cables : 1,1 km NAYY 4x240
 - Change transformer: 400 kVA

NEMO Use Case– Reference Ringkøbing

Step 5: Solution with Demand Side Management

2



Cost*:
23.000 €

- Demand Side Management**
- Reducing peak load : 220 kW → 170 kW
 - Replace cables: 0,3 km NAYY 4x240
 - Change transformer: not necessary

Conclusion

- Decentralized generation can lead to
 - Violations of voltage bands
 - Violation of thermal restriction
- Beside conventional reinforcement
 - Energy Management
 - Low voltage on load tap changers
 - Reactive power control



Gird planning has become a multi criteria optimization problem.