NZEB IN THE LOCAL LOW-VOLTAGE GRID ENVIRONMENT IN DENMARK

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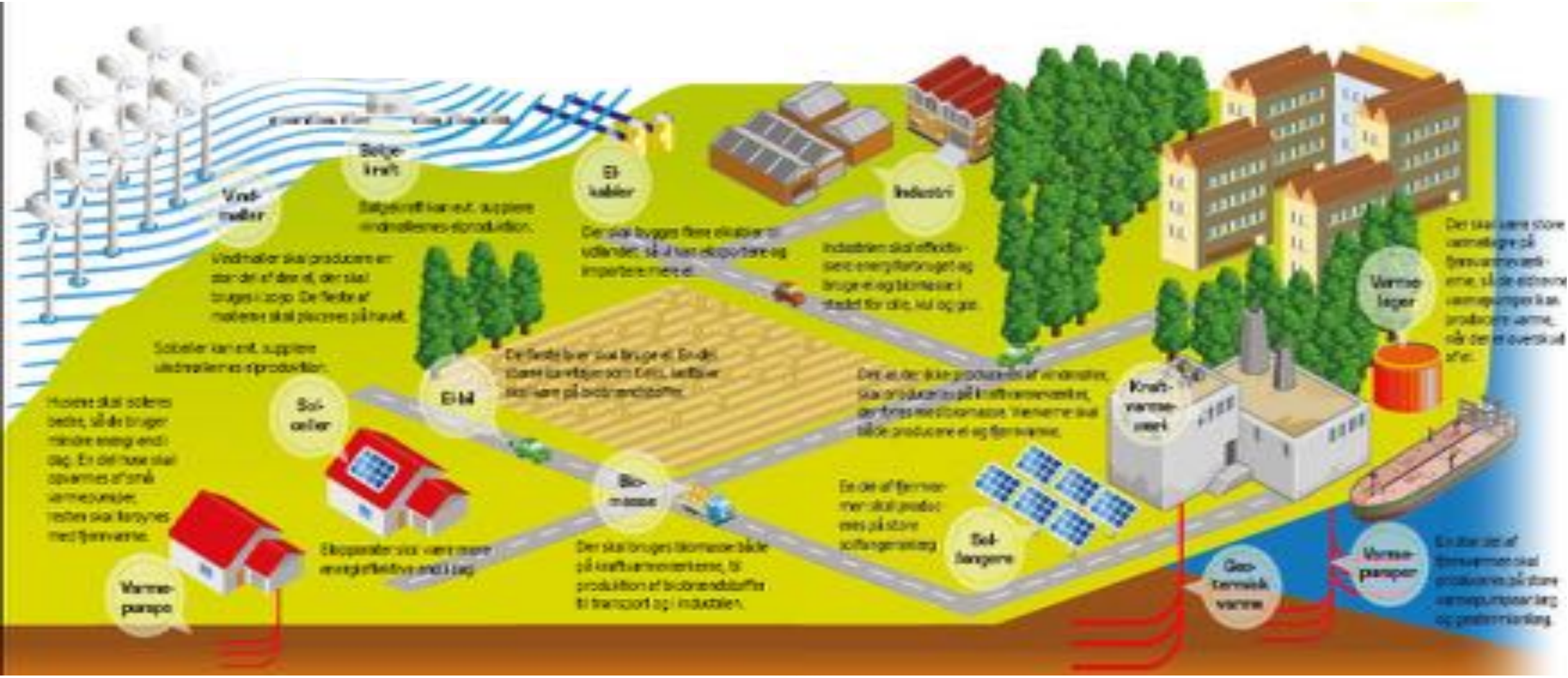
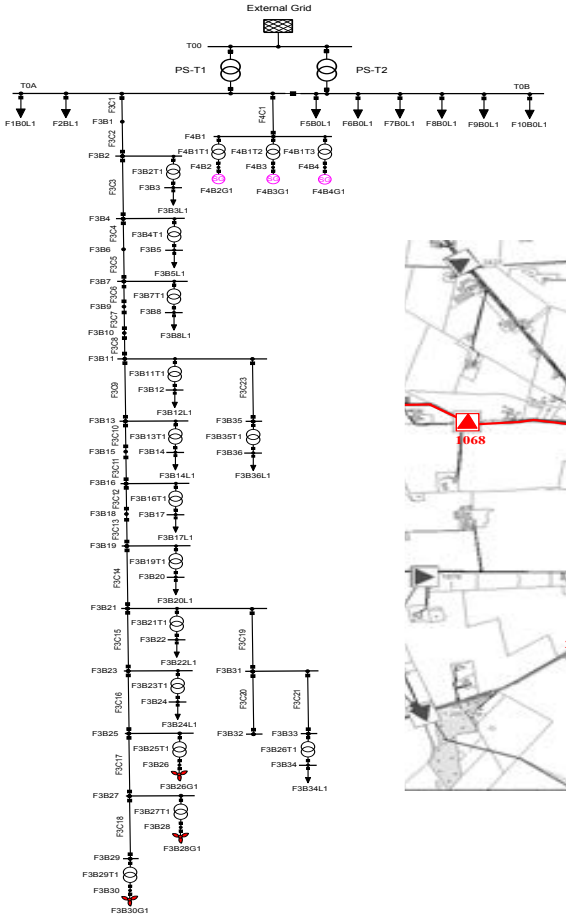
Fossil Free Energy system

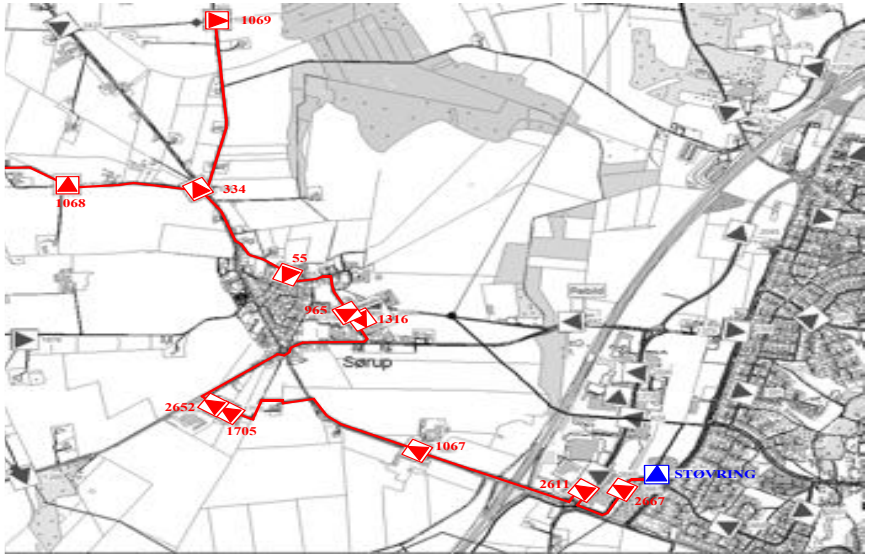


Net ZEB

- Source Net ZEB
- Residence
- Heat pump
- PV

Low-voltage network





Net ZEBs details – type of house

U_{walls} = 0.32 W/m².K
Natural ventilation 0.4 ACH
Infiltration 0.2 ACH

Thermal mass: light (44 Wh/K.m²)
τ = 27 hrs

Heating set-point: 20°C
Design power: 70 W/m²
Primary water tmp: 70°C radiator, 43°C UH

U_{walls} = 0.09 W/m².K
Mechanical ventilation 0.4 ACH (η = 0.8)
Infiltration 0.07 ACH

Thermal mass: medium (53 Wh/K.m²)
τ = 105 hrs

Heating set-point: 21°C
Design power: 25 W/m²
Primary water tmp: 45°C radiator, 30°C UH

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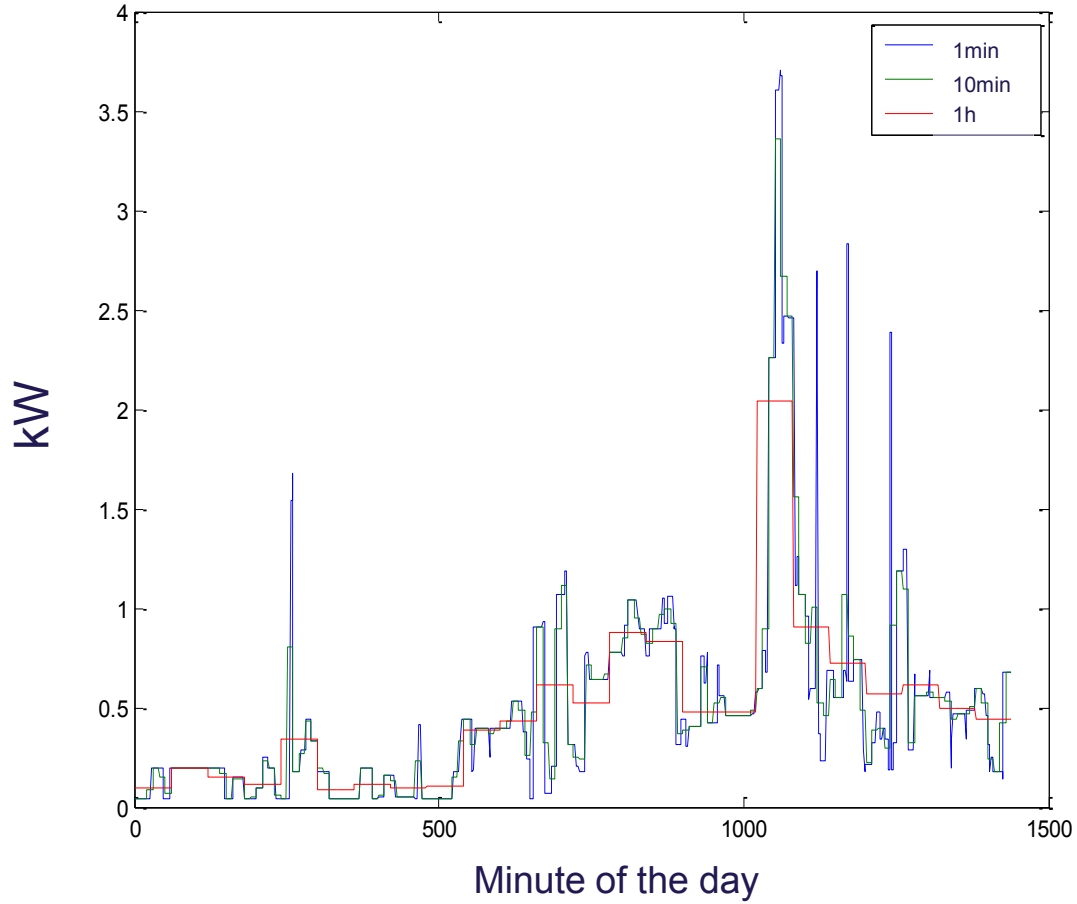
Work done by Jérôme LE DRÉAU

Net ZEBs details – appliances

Main characteristics:

- Empirical-probabilistic bottom-up approach model
- Minimum resolution 1-min
- 35 household appliances (heavy electrical loads e.g. heat pumps not included)
- Single family houses with 1-5 occupants and 3 types of households electricity use (low, medium, high)



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Net ZEBs details – PV

Main characteristics:

- Minimum resolution 1-min
- Size 20-50 m^2 (P_{max} 6kW)
- PV power output:

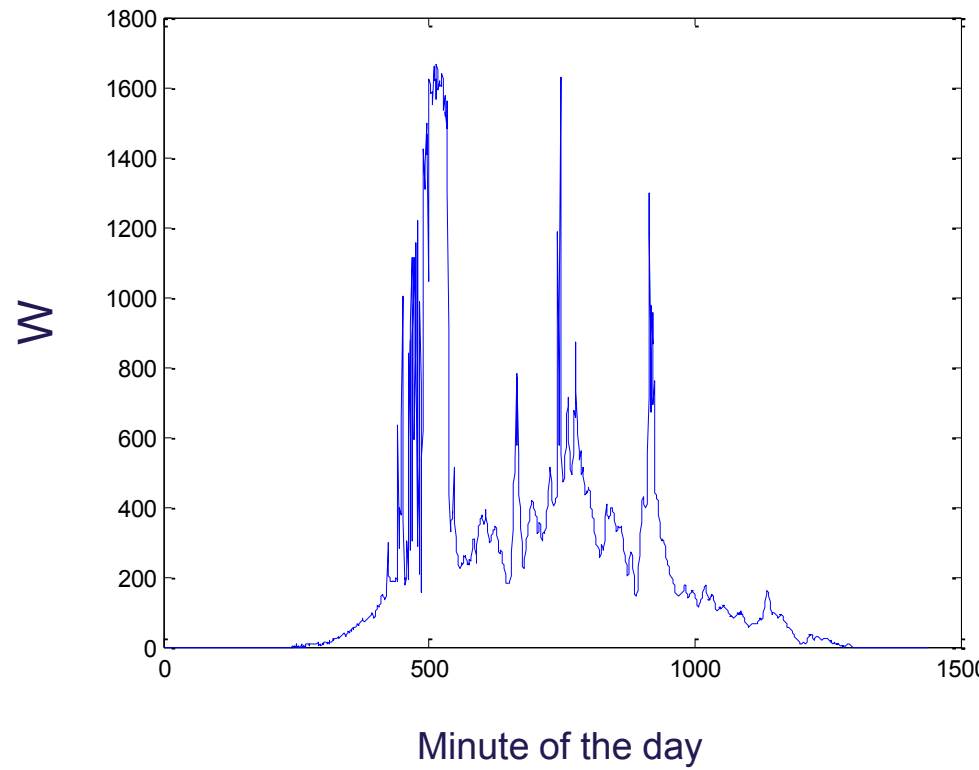
$$P_g = A_c I \eta_{mp} \eta_a \ [W]$$

- Maximum power-point efficiency of PV

$$\eta_{mp} = \eta_{STC}[1 + \mu(T_a - T_{c,STC} + I\frac{T_{c,NOCT} - T_{a,NOCT}}{I_{NOCT}}(1 - \eta_{STC})]$$

- Conversion efficiency at STC

$$\eta_{mp} = \frac{P_{STC}}{I_{STC} A_{ref}}$$



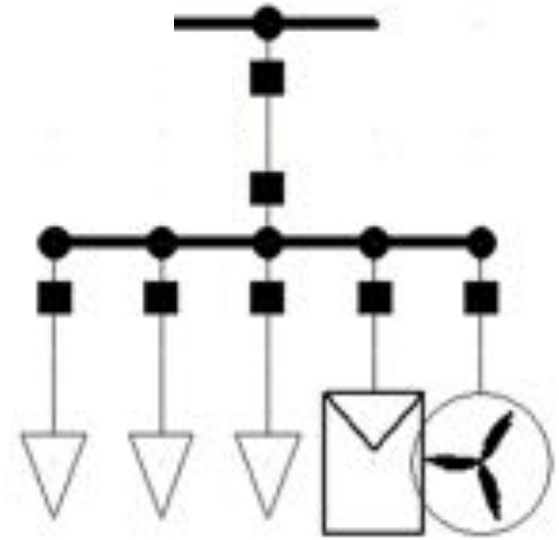
LV network details

Main characteristics:

- The ZEB are only appointed at residential level
- From an electrical perspective, the users living in ZEB are represented by power consumption and generation profiles with 1 min resolutions:
  - Load:
    - CL (1 hour based) – Original provided by the DSO
    - CL (1 min based)
    - HP (1 h based)
  - Generation:
    - PV (1 min based)
    - WP (1 min base) – Not yet

Power Distribution Operation :

- Power Lines and Transformers shout not be loaded more than 80 % at any time.
- European Standart EN 50160: maximum voltage deviation ± 10 % at any bus of the MV and LV system. According to the DSO experience ± 6 %.



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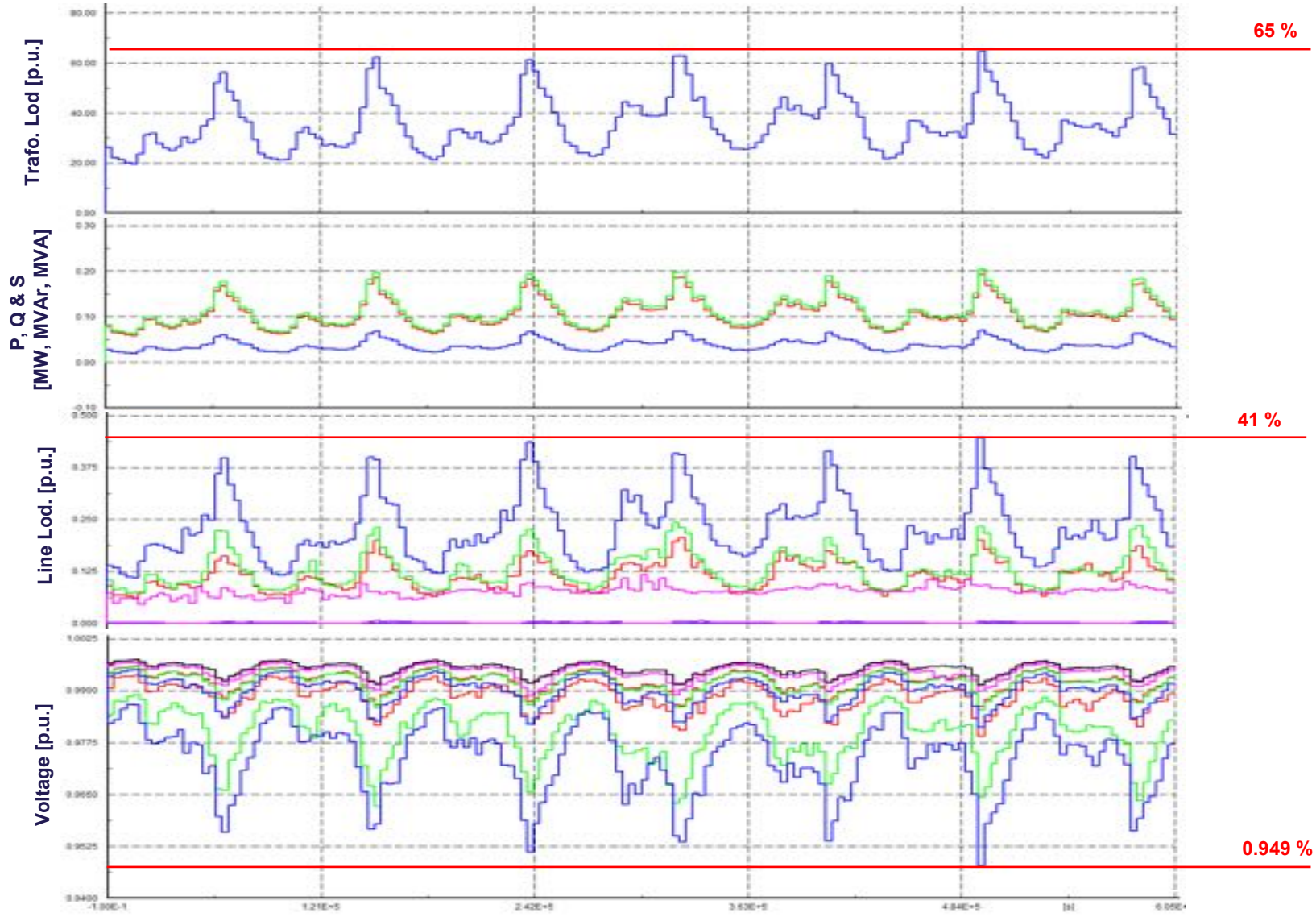
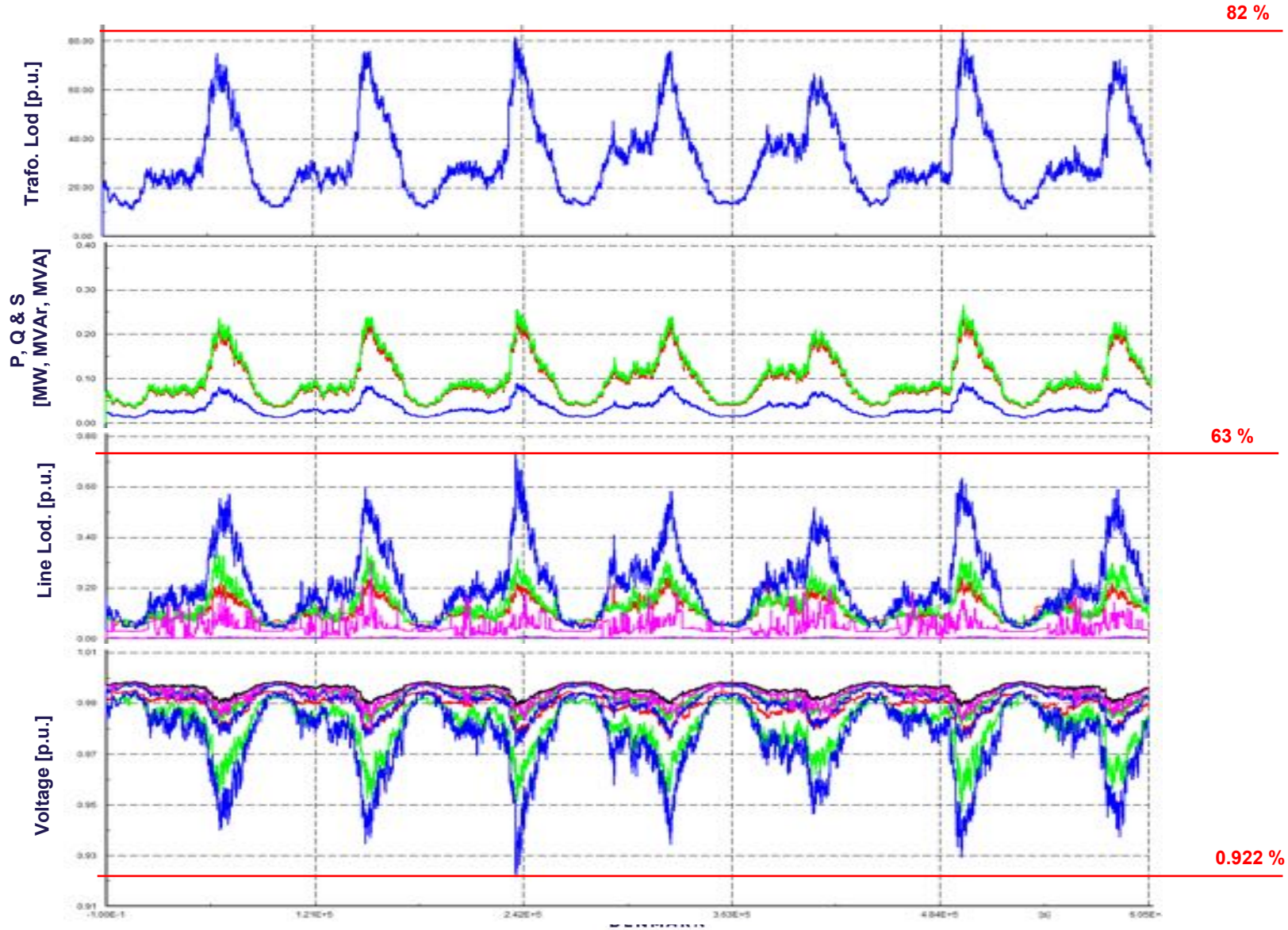
RESULTS

FIRST WEEK OF FEBRUARY – 1 HOUR BASED PROFILES



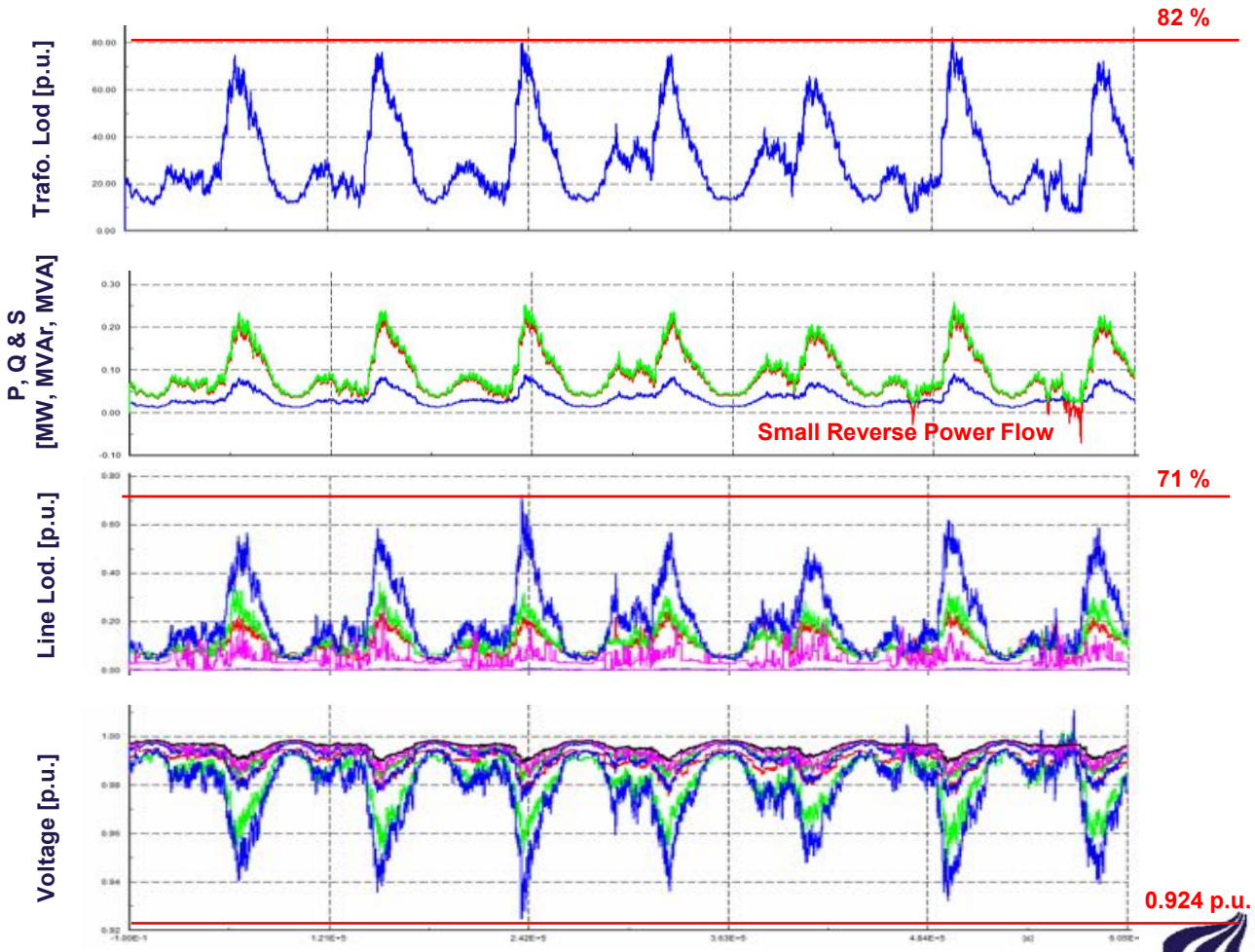
PRELIMINARY RESULTS

FIRST WEEK OF FEBRUARY – 1 MIN BASED PROFILES

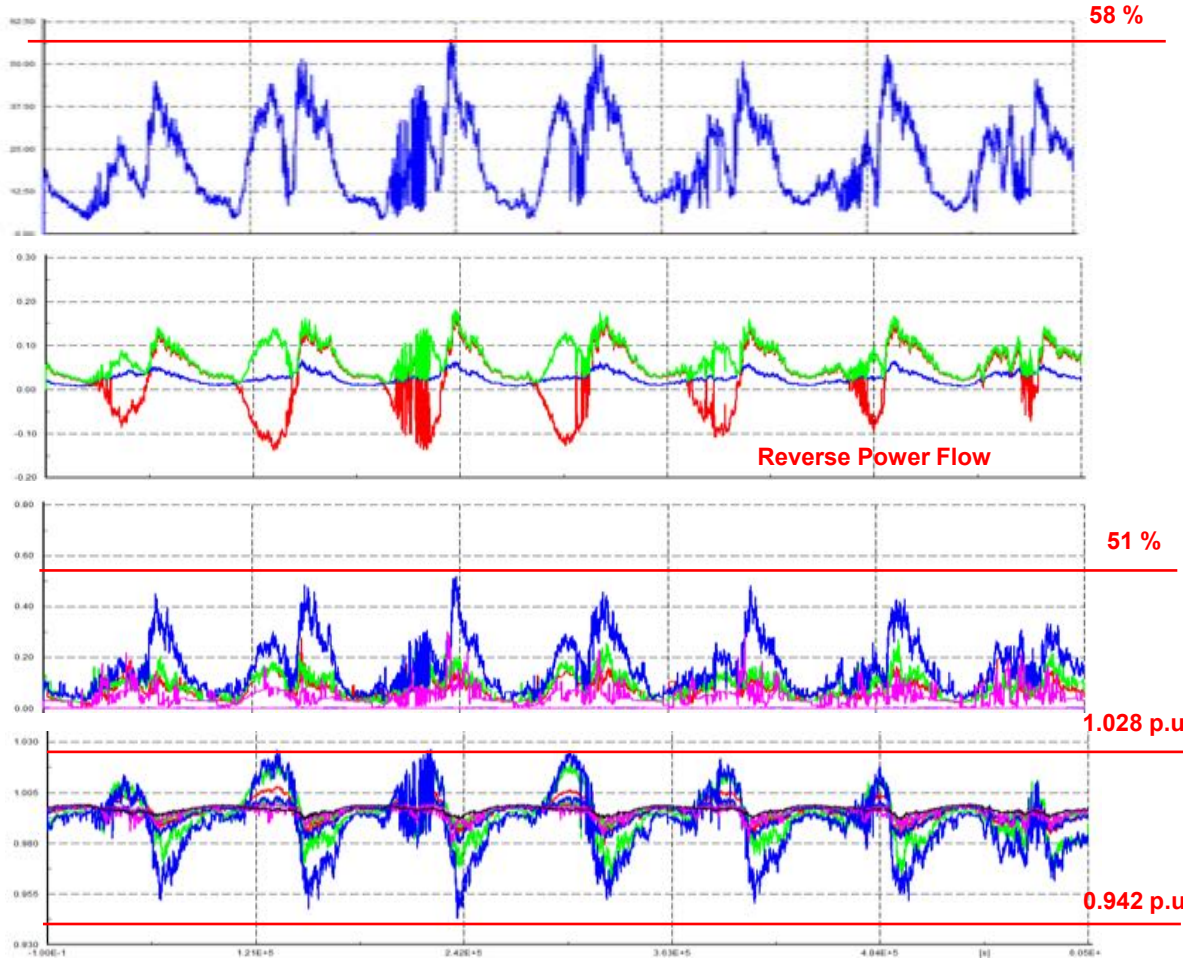


Results

FIRST WEEK OF FEBRUARY – 50% OF PV



SECOND WEEK OF JULY – 50% OF PV



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Conclusions

- High resolution investigation shows the full picture
- More complex LV network operation
- In high latitudes due to revers flow 2 different LV operation strategies for winter and summer
- Single Net ZEB does not create a problem but a group of Net ZEBs connected to a single power line influences the LV network and transformer performance

THANK YOU

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