

# DELTA GREEN

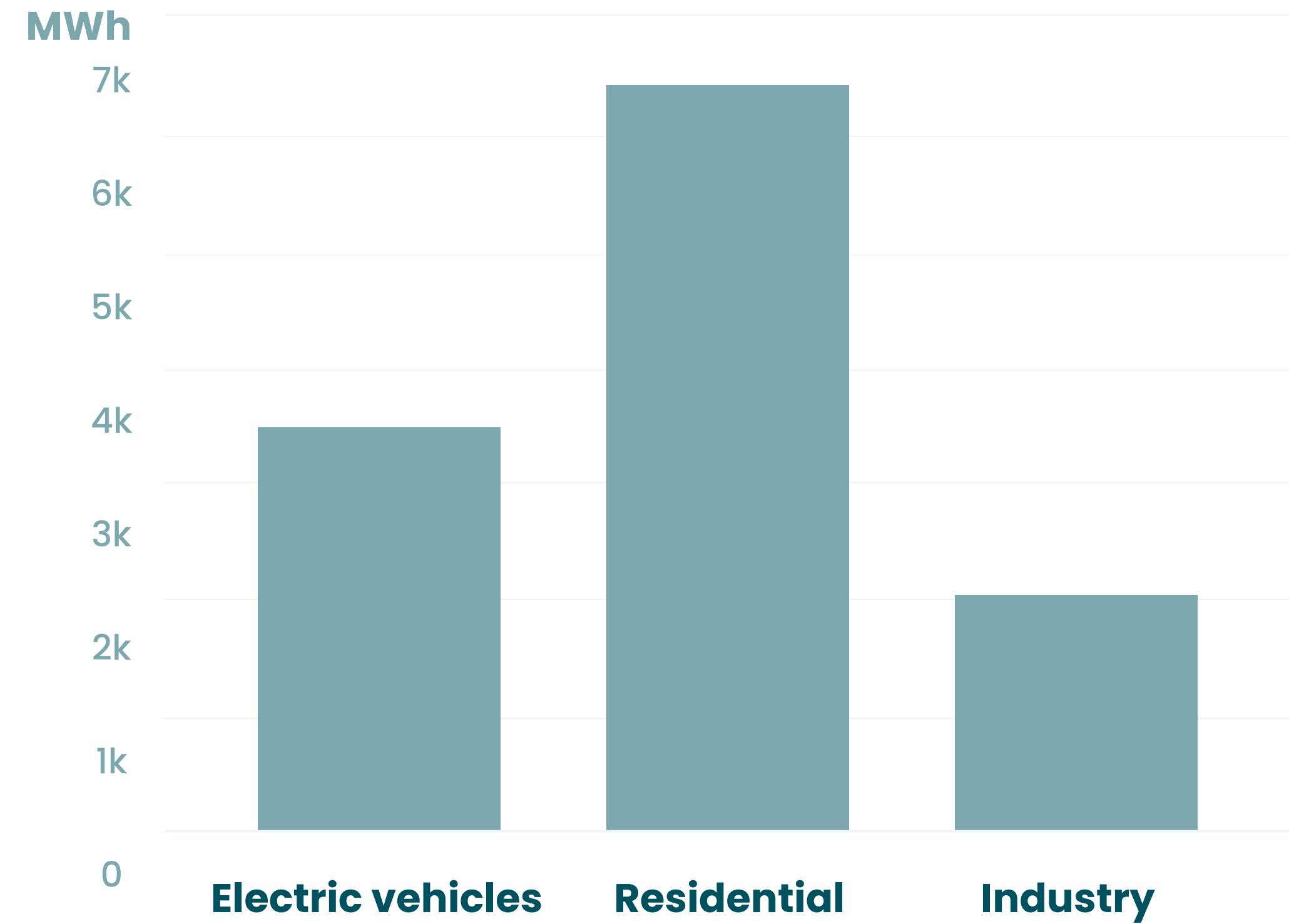
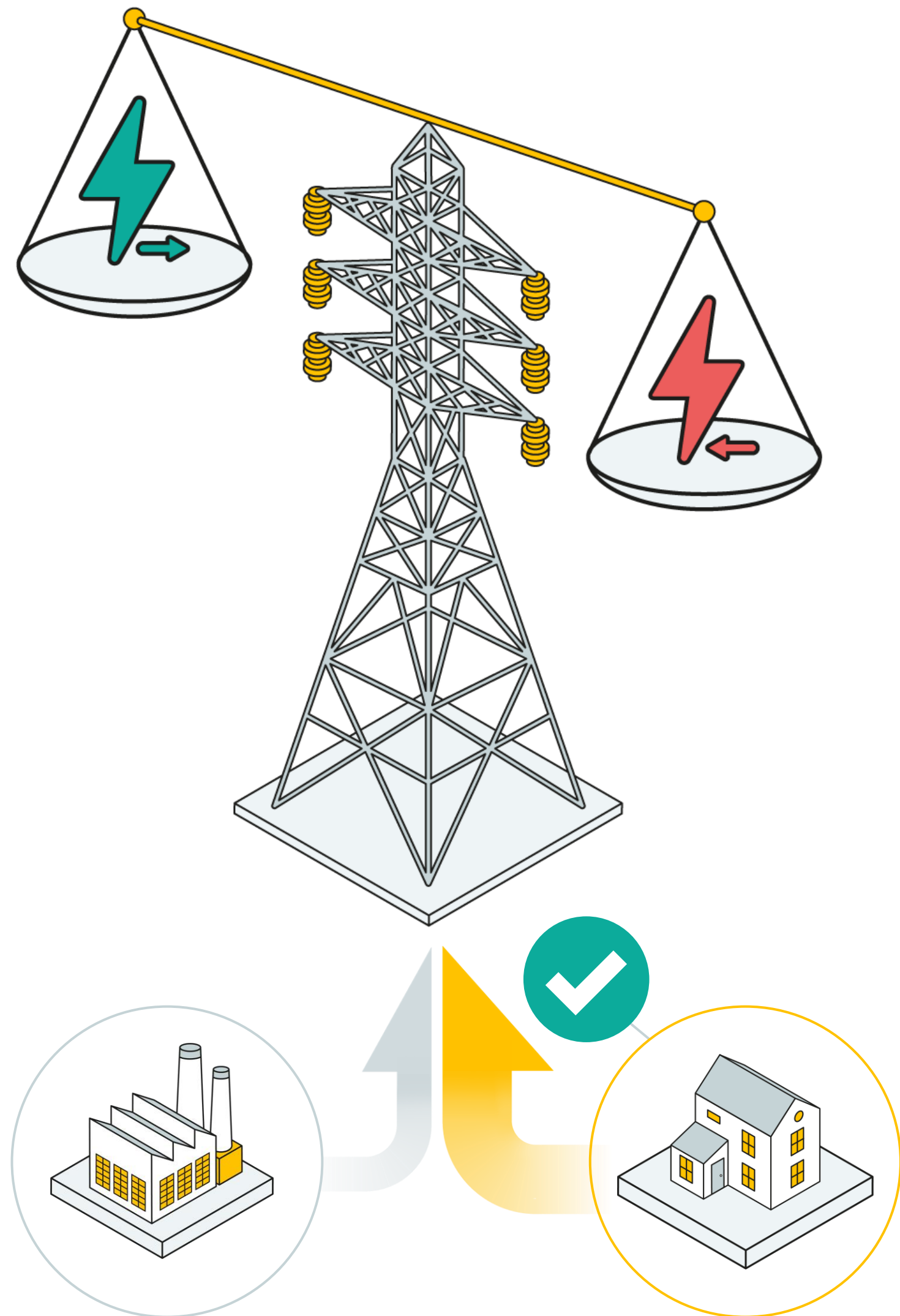
**Residential battery flexibility:  
Spot optimization and  
ancillary services case study**

**UNIVERZITA J. E. PURKYNĚ V ÚSTÍ NAD LABEM**

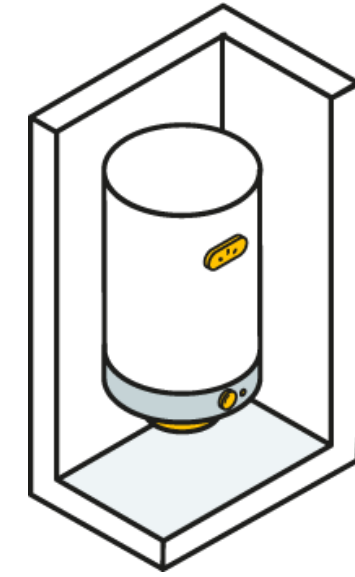
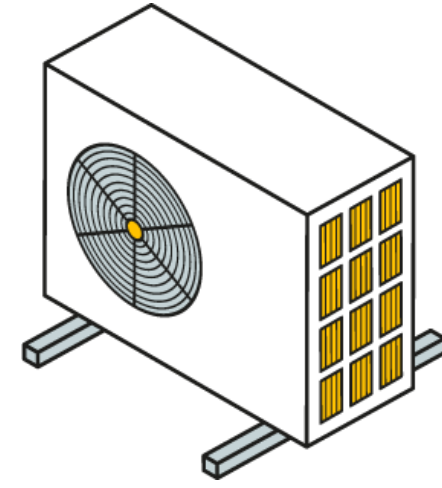
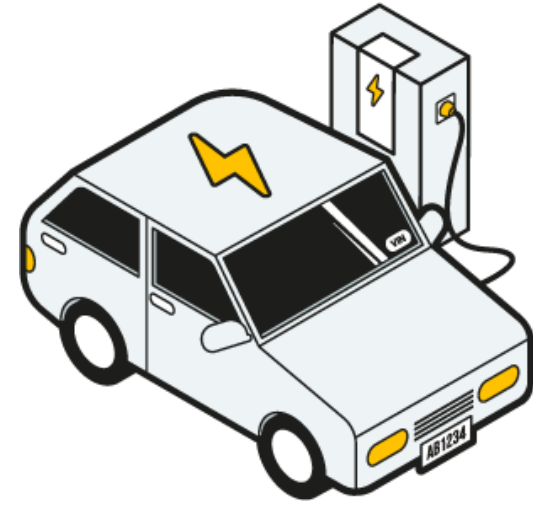
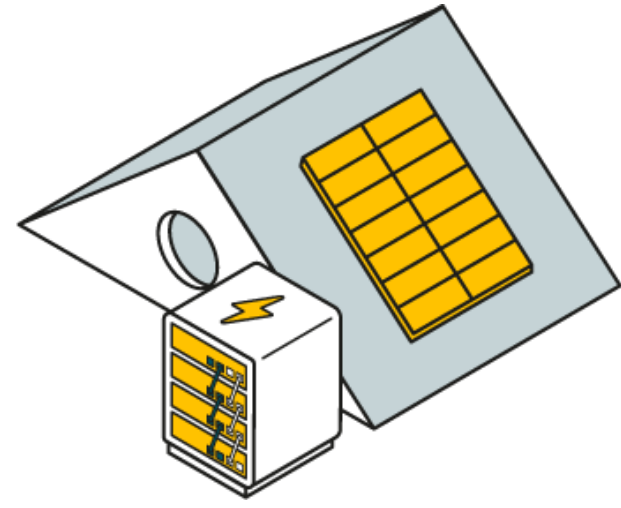
**Fakulta sociálně ekonomická**



# UNTAPPED POTENTIAL



Source: Nano Energies, *Decreasing the need for fossil capacity with flexibility*



 **victron energy**  
BLUE POWER

 **SOLAX**  
POWER

 **GOODWE**  
YOUR SOLAR ENGINE

**solar**edge

**GROWATT**



**ŠKODA**



**TESLA**



**NISSAN**



**Ford**



**KIA**



**HYUNDAI**

 **AC Heating**  
absolutely clever heating

 **NIBE**

 **IVT**

 **AC Heating**  
absolutely clever heating

 **Vaillant**

 **DRAŽICE**

 **Buderus**





# Spot optimization



# PARAMETERS

## Energy

- PV production
- Consumption

## Price

- Day ahead price
- All variable fees for buying and/or selling electricity

## Technical parameters - battery

- Initial charge
- Capacity
- Max power in/out

## Household parameters

- Max power in/out

## Custom

- Battery ammortization

# DATA

## DATA

- Data from 1.3.2023 – 29.2.2024
- Households with PV and battery
- 5 → 44 households
- 176k data points – averaging 20 households
  
- 1-4s granularity averaged to 1h for evaluation purposes
- Real metered data and back test optimization



# OPTIMIZATION

## Linear programming model

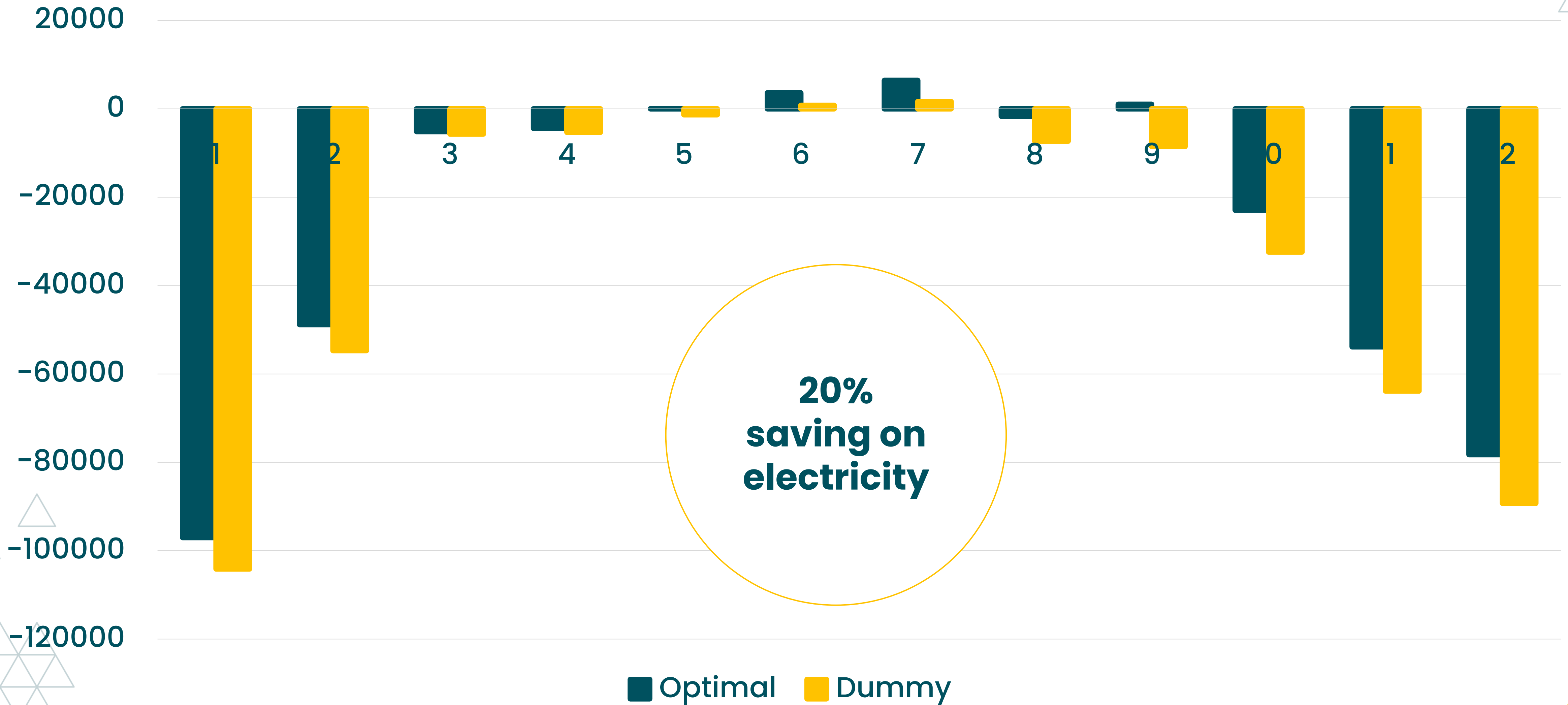
- Cost for household as the objective function based
- Taking into account all parameter constraints
- Uncertainties of input taken into account as sensitivity of the model

## Dummy model

- Dummy model as counterfactual
- Charge when excessive energy, discharge to household whenever possible

# RESULTS

Net for households





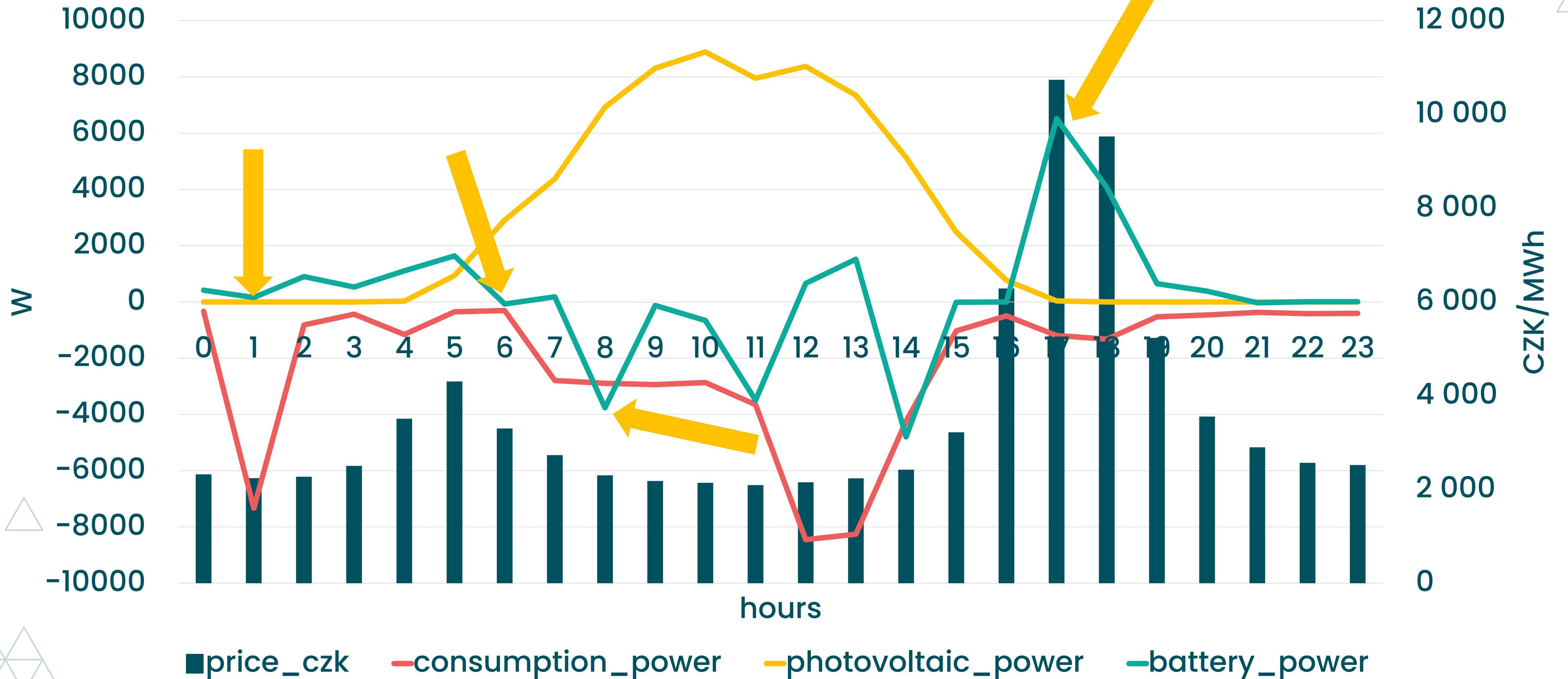
# EXAMPLES

## Example of identified covered scenarios

- Morning PV to grid
- Evening discharge to grid
- Negative electricity prices
- Do not use battery when electricity is cheap
- Charge battery from grid

# 11.9.2023

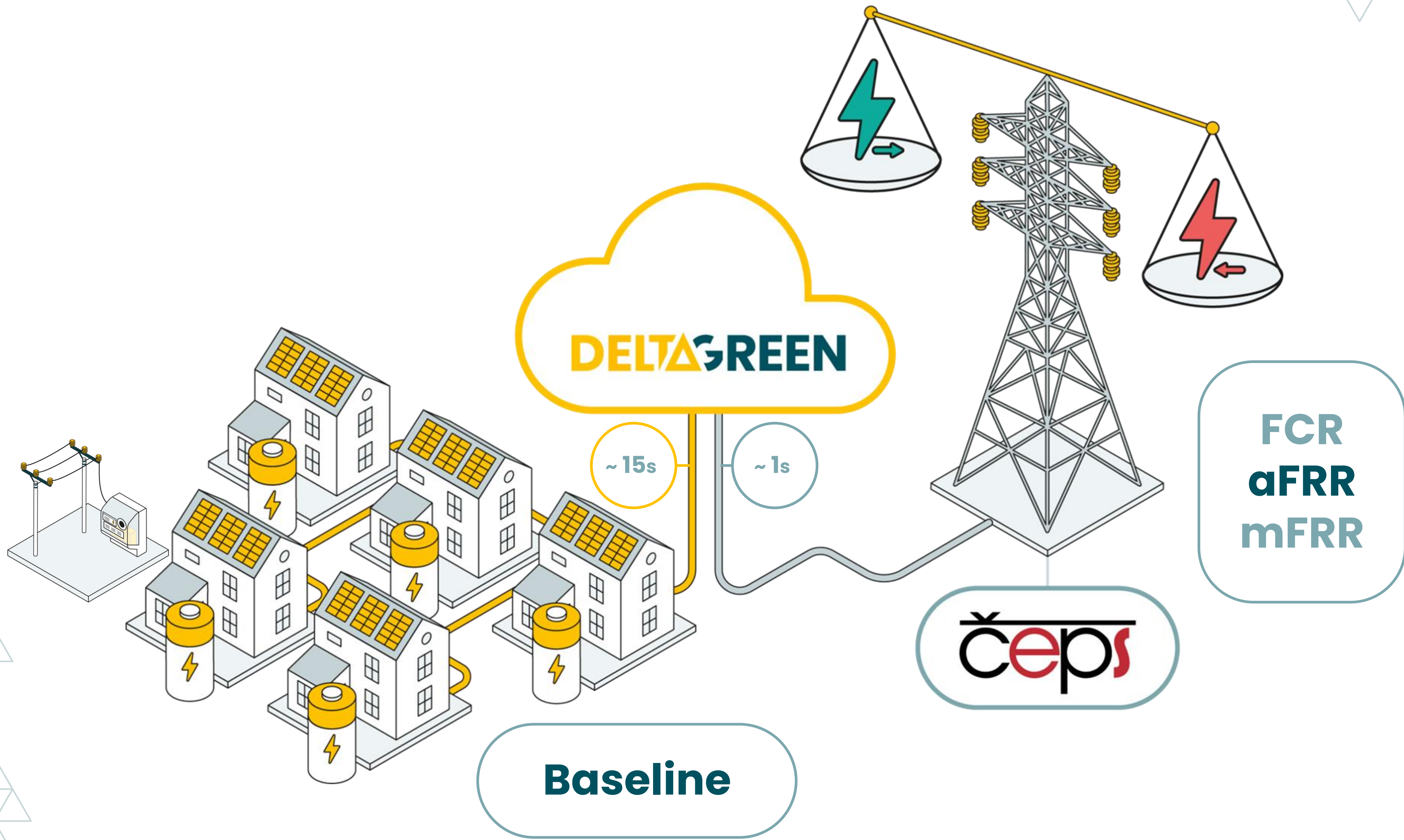
## 11.9.



# Ancillary services – pilot







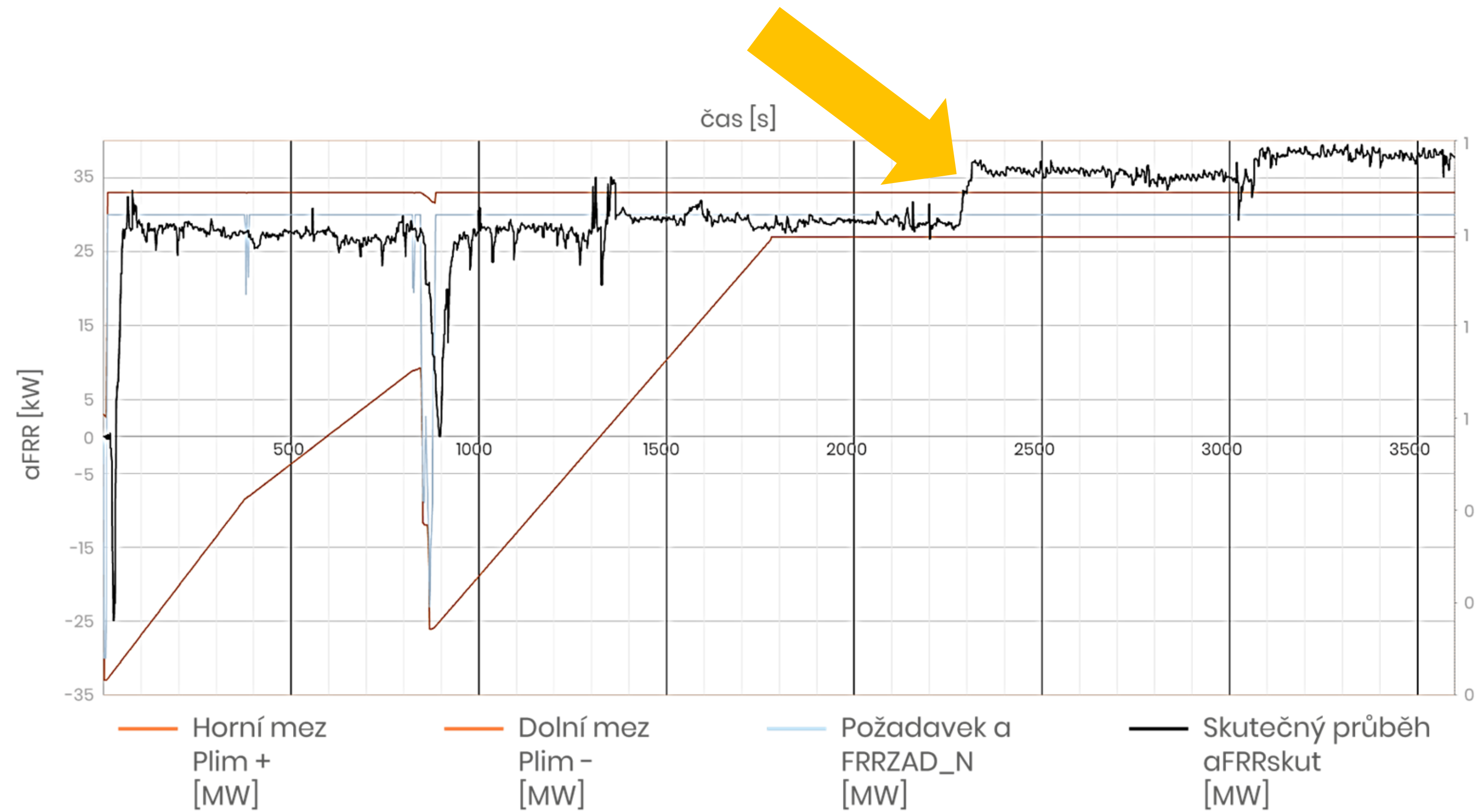


# Test 1

11. 12. 2023  
3:00 - 4:00

23

30<sub>kw</sub>





# Test 2

12. 12.  
2023  
4:00 - 4:15

24

120<sub>kw</sub>

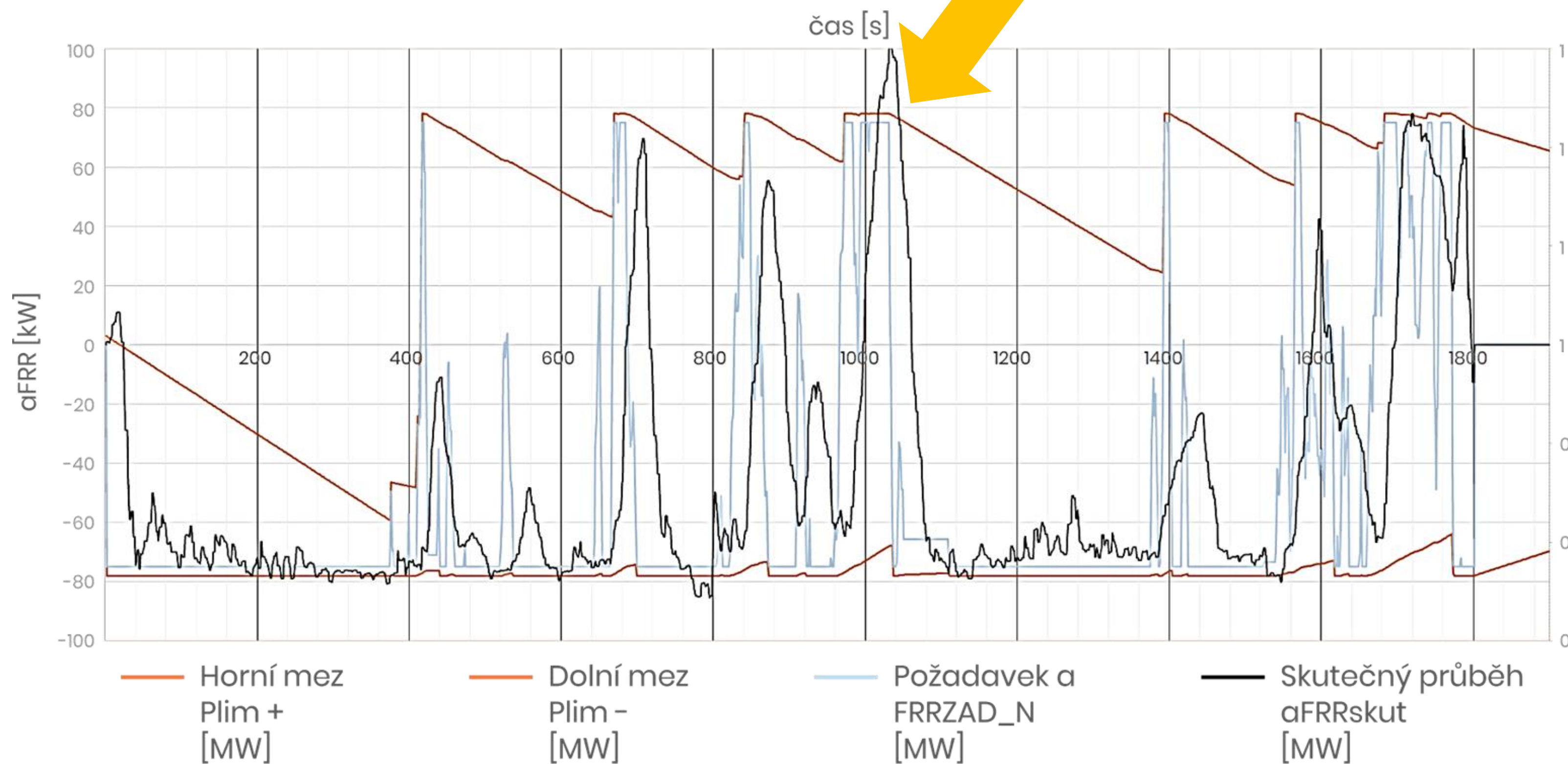


# Test 3

13. 12.  
2023  
3:00 - 3:30

27

75<sub>kw</sub>



# SUMMARY

- Spot optimization may reduced costs by 20%
- Conditions on the energy markets are the main driver
- Residential batteries on low voltage can provide reliably ancillary services

Thank you! 