



**Budapest University of Technology and Economics**  
**High Voltage Laboratory**

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**Problems Evoked by the Integration of Renewables as  
Parts of Building Energy Management Systems**

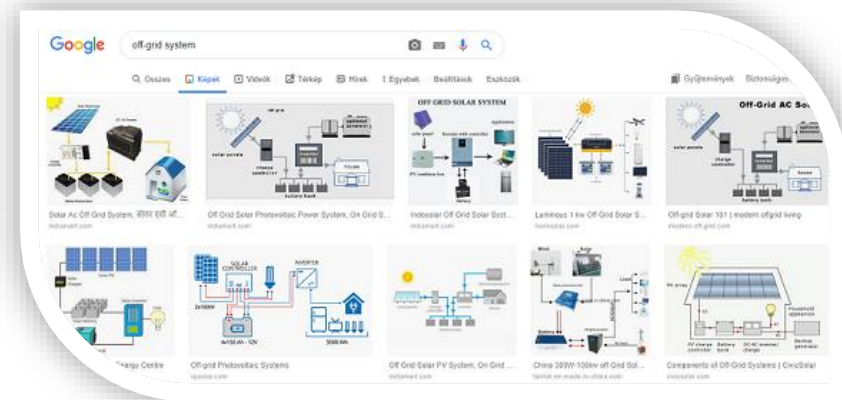


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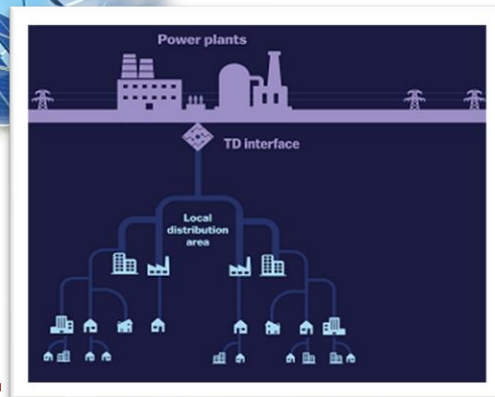
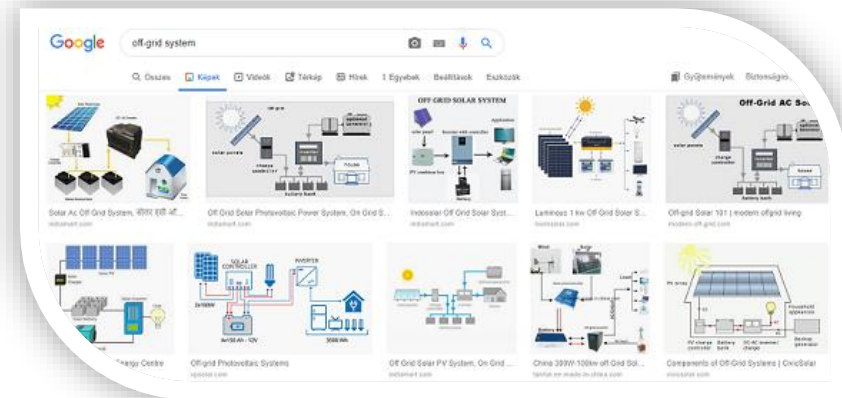
# Raising trends and questions

- Going off-grid
- Power quality & dependability
- Environment-friendliness
- Cost of PV panels



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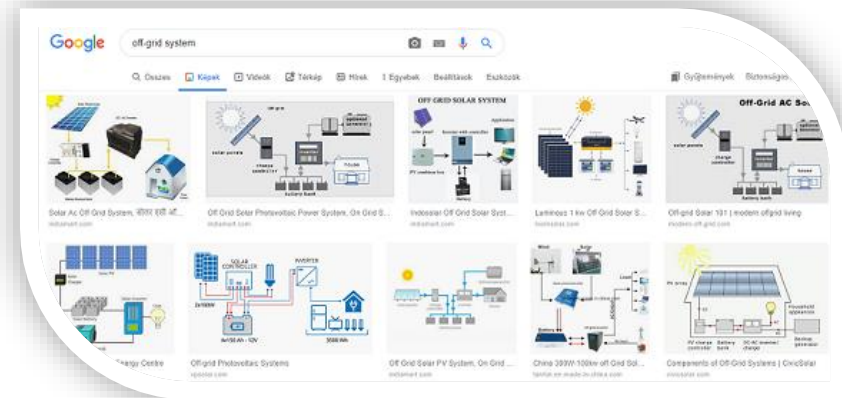
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- Electricity market cooperation
- Unpredictable characteristics
- Grid stability
- Controllable energy producer

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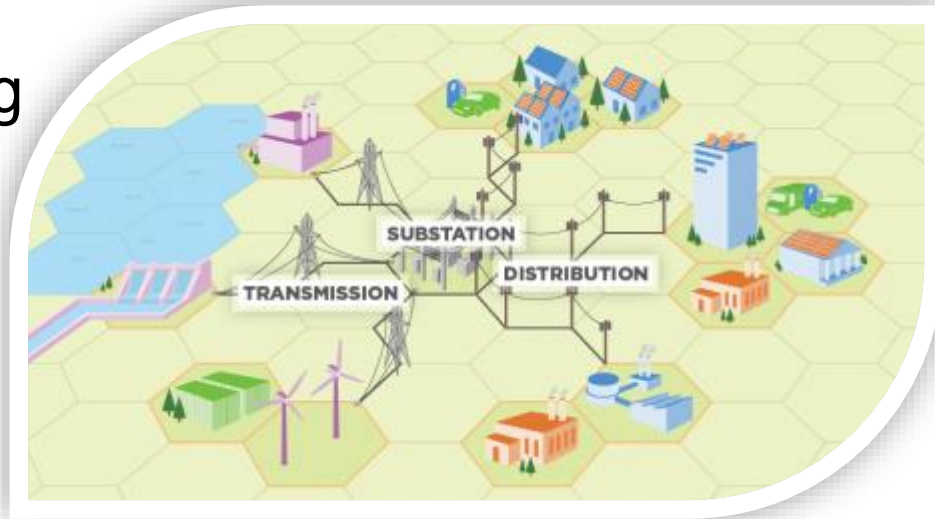


- Electricity market cooperation
- Unpredictable characteristics
- Grid stability
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→ Storing energy ; Reduce consumption

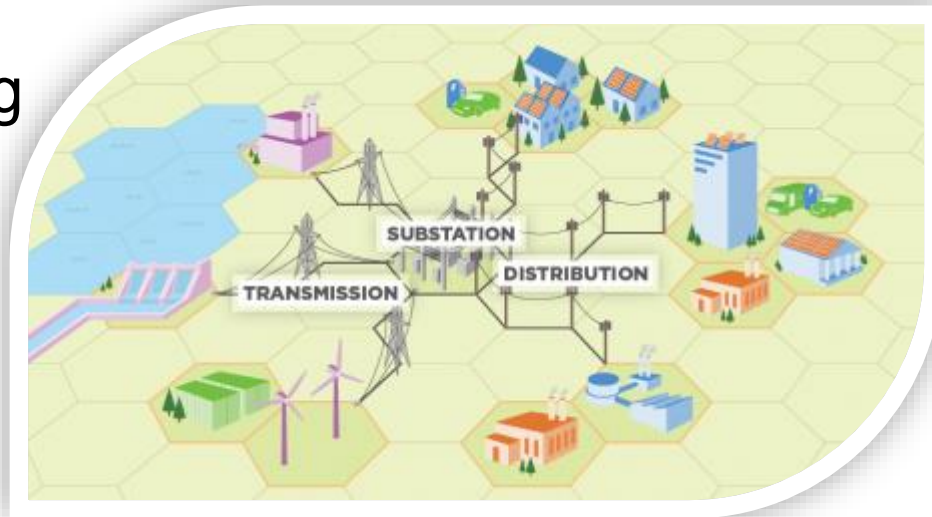
# Focus of this paper

- Residential level, considering
  - Growing demands
  - Growing share of renewables
  - Reverse power flow
  - Economical reasons



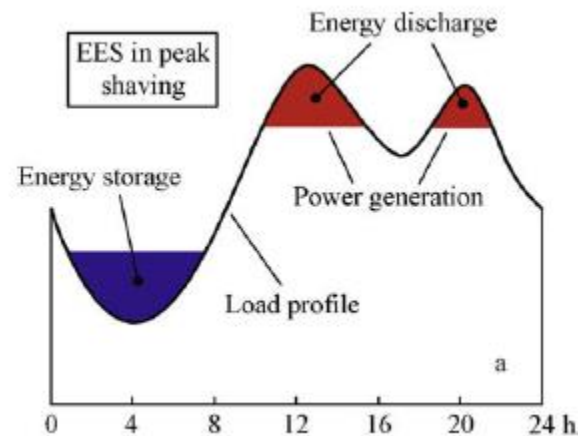
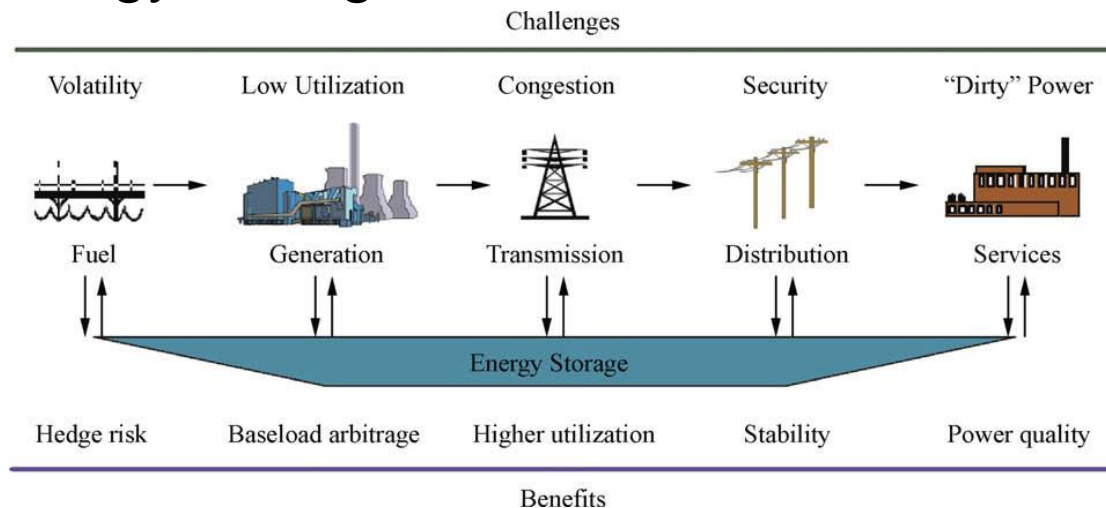
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  - Reverse power flow
  - Economical reasons
- Making change at this level affects the whole system



# Search for proper energy storage

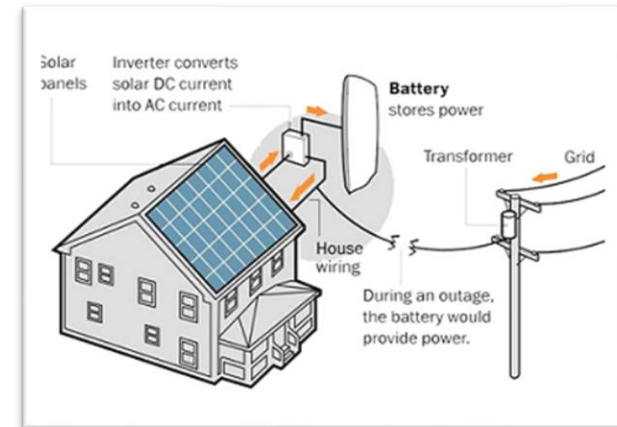
## Energy storage assistance across the line



# Search for proper energy storage

## *Residential level peak-shaving aspects:*

- Energy use 3-10 kWh/day /Hungary/
- Average RES sized to 7 kW /Hungary/
- Several cycles a day for 2-4-hour periods
- Low maintenance at 1500 operated hours/year
- Efficiency
- Respect to the environment

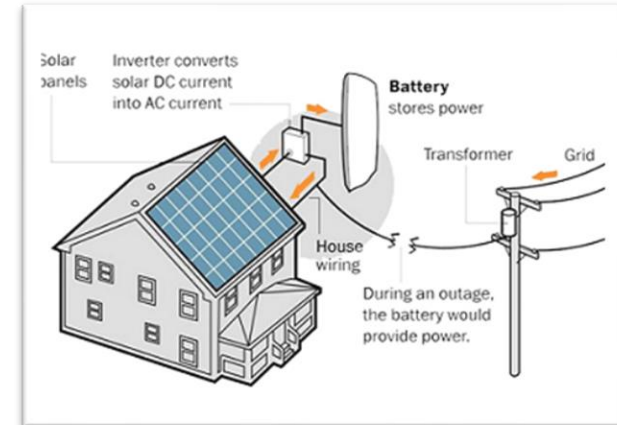




# Search for proper energy storage

## *Residential level peak-shaving aspects:*

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- Low maintenance at 1500 operated hours/year
- Efficiency
- Respect to the environment
- Cost should be viewed against the long term costs of the lack of peak-shaving



# Search for proper energy storage

- Using batteries for residential purpose
- Latest versions are less harmful, more reliable

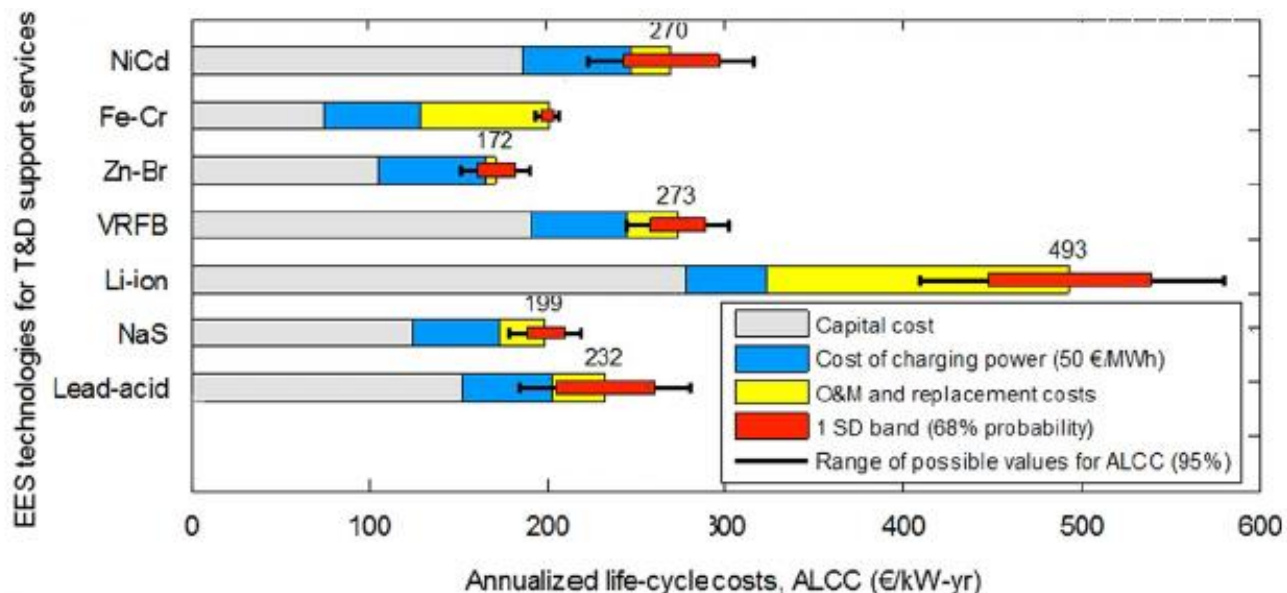
SUMMARY OF THE ANALYSED BATTERY TECHNOLOGIES

| Battery types                 | Lead-acid                 | Nickel based       | Lithium based        | NaS               | Flow based |
|-------------------------------|---------------------------|--------------------|----------------------|-------------------|------------|
| Power range, kW               | 1-50                      | 1-40               | 1-100                | 500-50000         | 30-7000    |
| Power density, kW/kg          | 75-300                    | 150-300            | 150-315              | 150-240           | 50-150     |
| Cost per cycle                | cheap                     | moderate           | expensive            | expensive         | expensive  |
| Efficiency, %                 | 60-95                     | 60-90              | 85-100               | 85-90             | 60-80      |
| Cycles at 80% DOD             | 100-1000                  | 600-2000           | 1000-10000           | 2000-4500         | 1000-10000 |
| Maintainance required, safety | high, stable              | low                | low, safety circuits | high temperatures |            |
| Environment                   | toxic remains, recyclable | Cd is highly toxic | partly recyclable    |                   | recyclable |



# Search for proper energy storage

- Using batteries for residential purpose
- Latest versions are less harmful, more reliable
- Li-ion, of course, wins in efficiency, fails in cost



# Thinking ahead of future grids

- System not designed for distributed power generation  
&  
• High replacement costs
- slow and well designed transition

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1. Intermittent, random, uncertain loads
2. Voltage variation, power flow – transformer regulation
3. Higher voltages – household appliances



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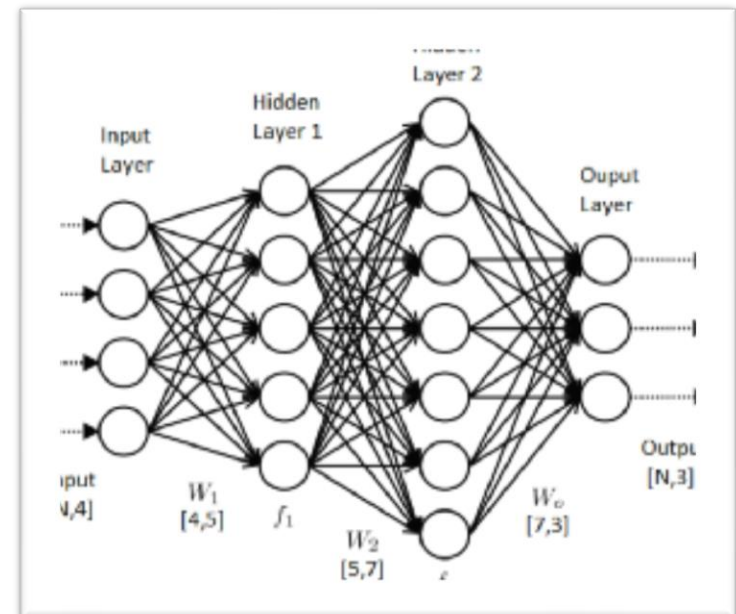
→ Smart energy management



# Using neural networks

## Smart energy management

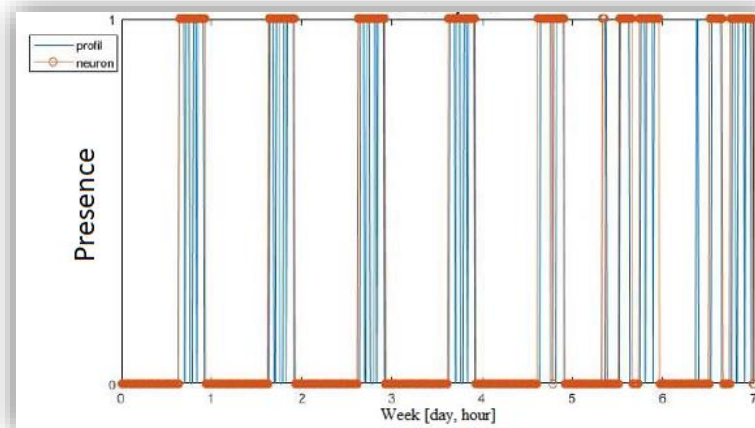
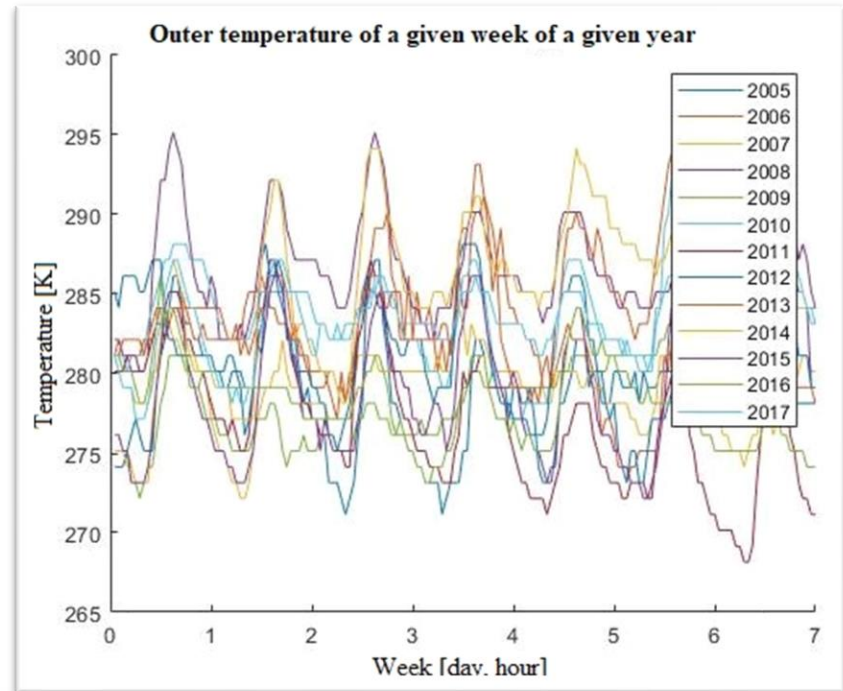
- System with learning mechanism, recall mechanism
- Layers for parallel processing of behaviour patterns



# Using neural networks

## Smart energy management

- System type
- Input type
- Target
- # of layers
- # of neurons
- Data of a certain week
  - Outer temperature
  - Presence profile
  - Heating profile
  - so far.

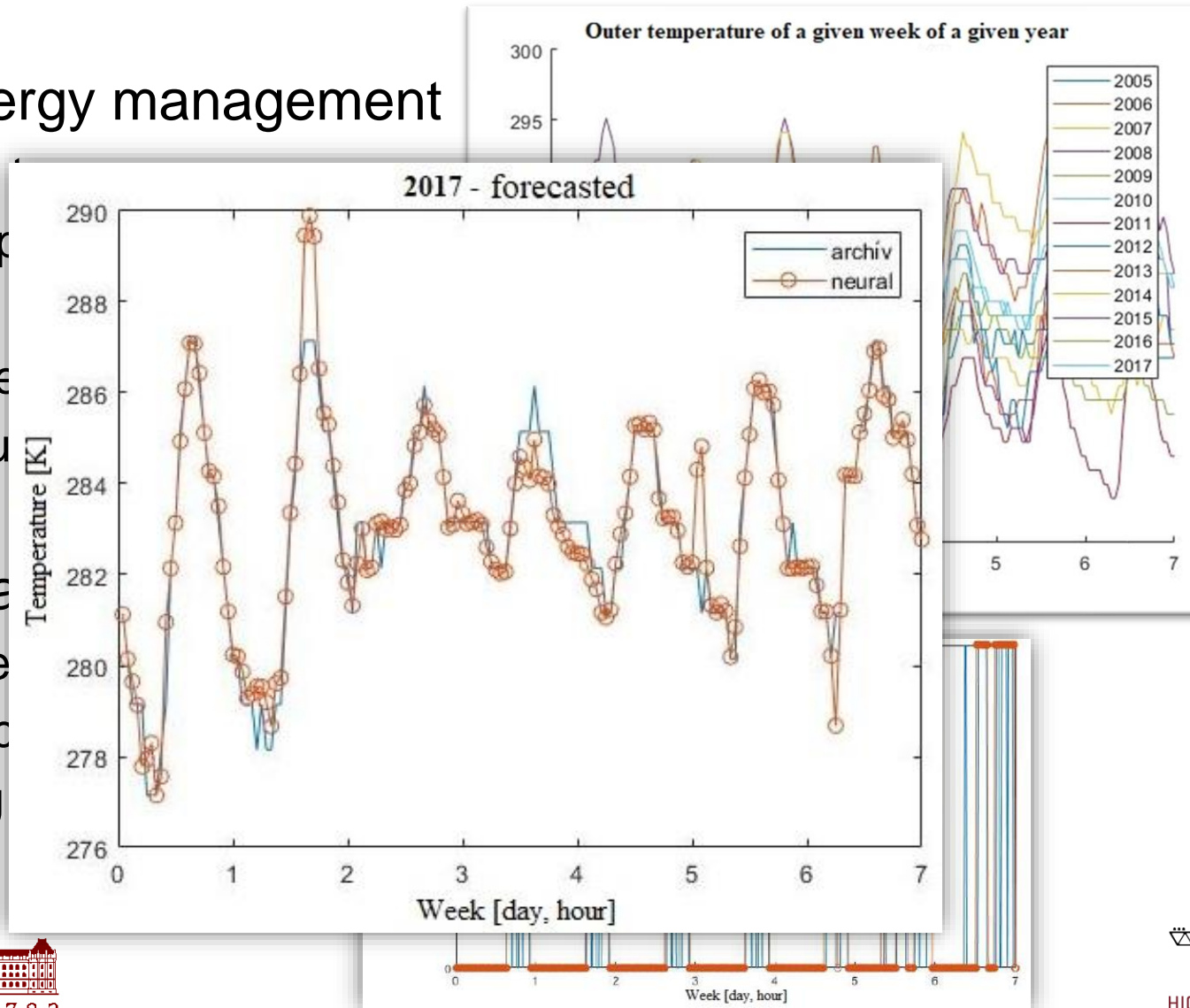




# Using neural networks

## Smart energy management

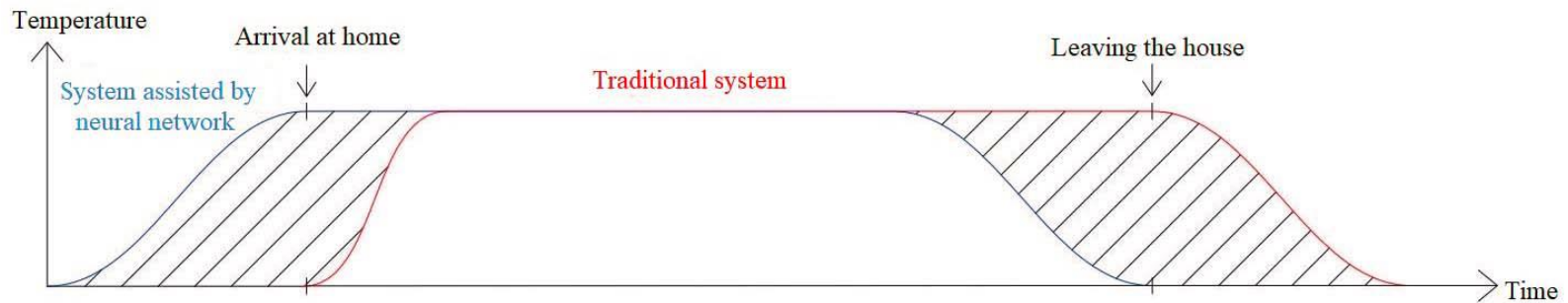
- System
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- Outer temperature
- Presence of heating
- Heating
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# Using neural networks

Future prospects:

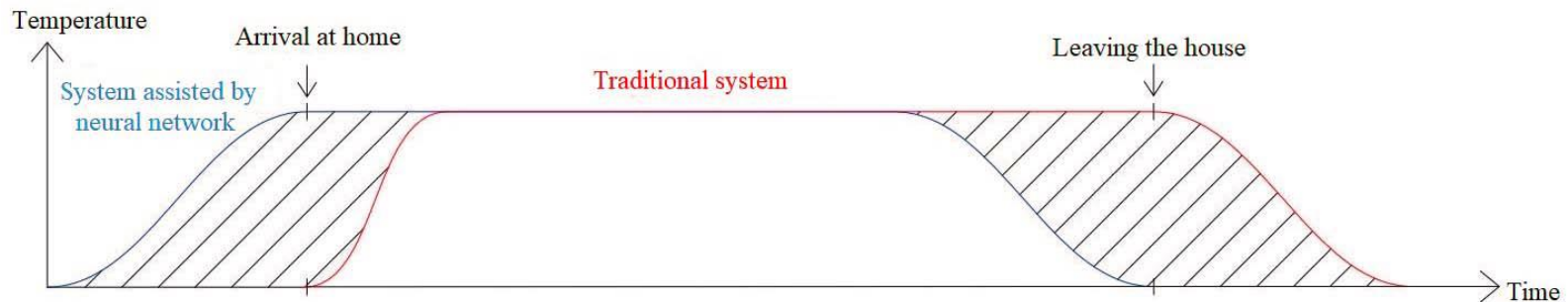
- Expand system for
  - Augmented comfort level



# Using neural networks

Future prospects:

- Expand system for
  - Augmented comfort level



- Adaption for new profiles
- Raised awareness of energy consumption
- Opportunity to link smart home applications



# Thank you for your attention!

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