



# SMART ENERGY COMMUNITY

VOOR WONINGEN EN  
BEDRIJFSGEBOUWEN

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University of Technology*

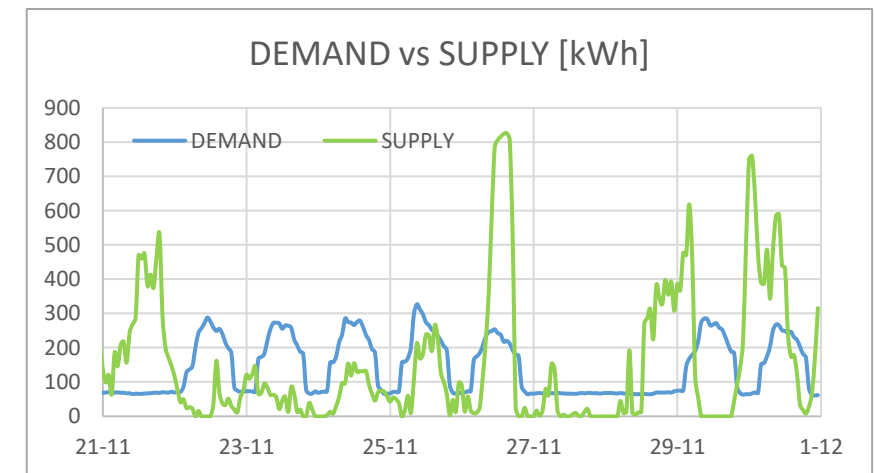
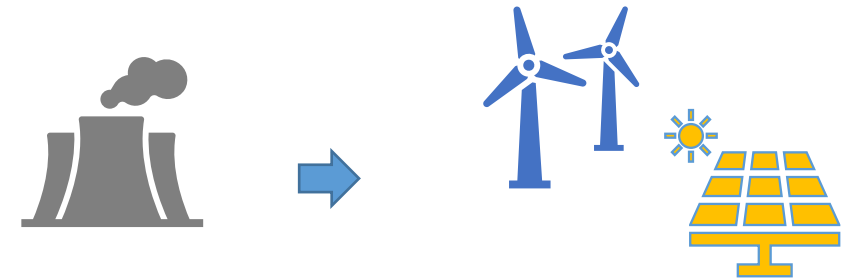


Energy flexibility services from buildings by using adaptive comfort strategies

# SMART ENERGY COMMUNITY VOOR WONINGEN EN BEDRIJFSGEBOUWEN

## NEED FOR ENERGY FLEXIBILITY

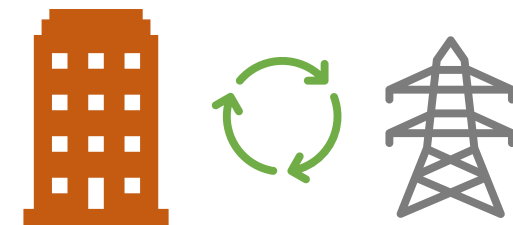
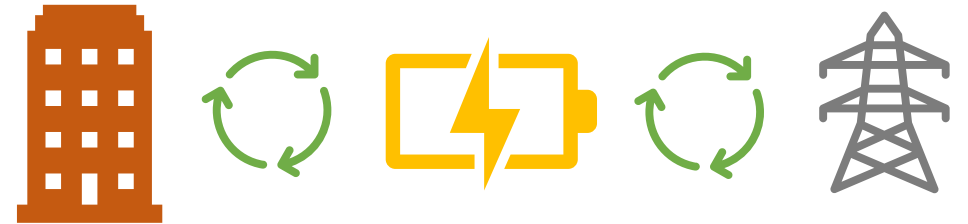
- The human society is facing the difficult **challenge of the energy transition**
- The **increase of renewables in the energy market** leads to high **variability of production: unbalance** in the energy grid and market
- This makes **flexibility** in both supply and demand of electricity **crucial for balancing purposes**
- Providing energy flexibility as a service to **balance the electricity grid** offers interesting business **opportunities**



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## PROVIDE ENERGY FLEXIBILITY

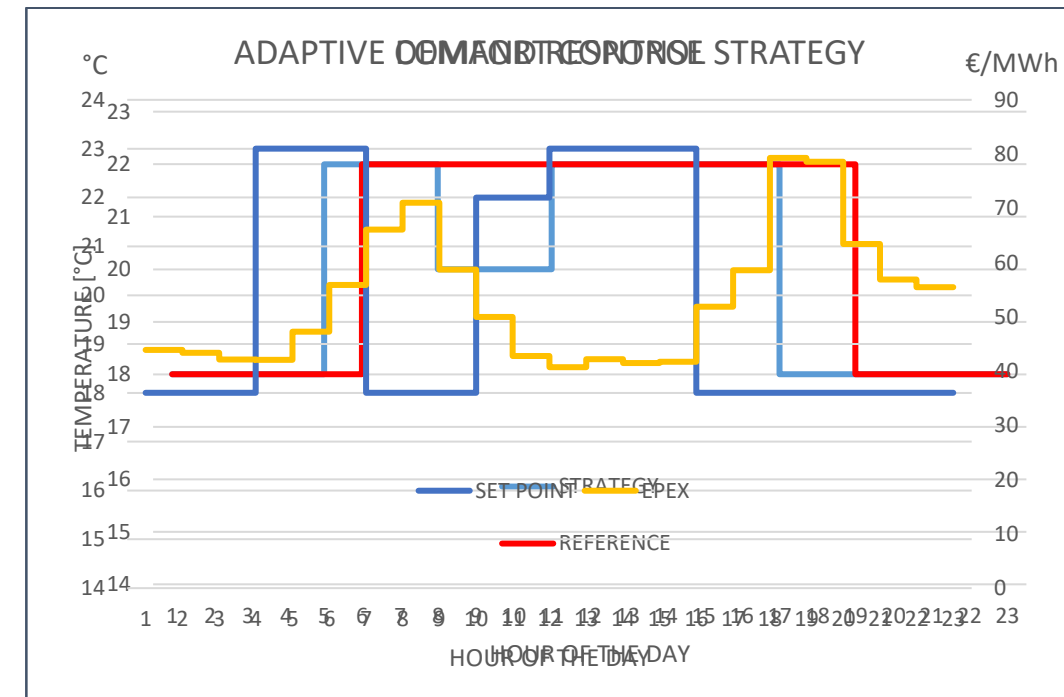
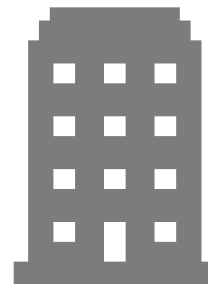
- In the built environment the use of **flexible assets** as batteries or EVs, coupled with PV and HP can provide flexibility to the grid
- This flexibility framework can be **expensive and not fully exploited (e.g. curtailment)**
- Why can't we **provide flexibility from buildings? Can buildings join the energy markets** to provide flexibility?
- The **thermal mass of the building** might be used as a buffer to store and to deliver energy at the right time.  
Only boundary? **Users' acceptance**



# SMART ENERGY COMMUNITY VOOR WONINGEN EN BEDRIJFSGEBOUWEN

## ENERGY FLEXIBILITY BY THERMAL MASS

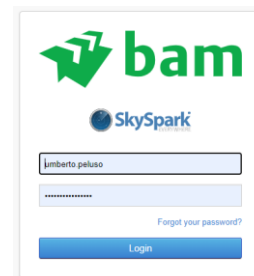
- The **NWO iCare project** (2011-2019) showed that adaptive comfort control strategies can be used to **provide flexibility** in building energy demand **without compromising thermal comfort**
- The amount of flexibility depends on several building characteristics, e.g. window-wall-ratio, Rc-values and the building's thermal mass. **The thermal mass is fundamental. Zero additional cost and full availability!**
- It is possible to store/conserves heat and cold, and use during **Demand Response** events



# SMART ENERGY COMMUNITY VOOR WONINGEN EN BEDRIJFSGEBOUWEN

## ENERGY FLEXIBILITY FOR BUILDINGS BY ADAPTIVE COMFORT STRATEGIES

- Evaluation of thermal comfort and flexibility benefits due to flexible operations in 4 office buildings in the Netherlands
- Investigation on building installation systems operations management to get flexibility



# SMART ENERGY COMMUNITY VOOR WONINGEN EN BEDRIJFSGEBOUWEN

## ENERGY FLEXIBILITY FOR BUILDINGS BY ADAPTIVE COMFORT STRATEGIES

CLUSTERING OF  
COMFORT DATA IN  
STRATEGY AND  
REFERENCE DAYS

STATISTICAL ANALYSIS, evaluating if:  
**No statistically significant difference  
between reference and strategy days**

KRUSKAL-WALLIS TEST

P-VALUE

ACCEPTABILITY –  
REFERENCE/STRATEGY

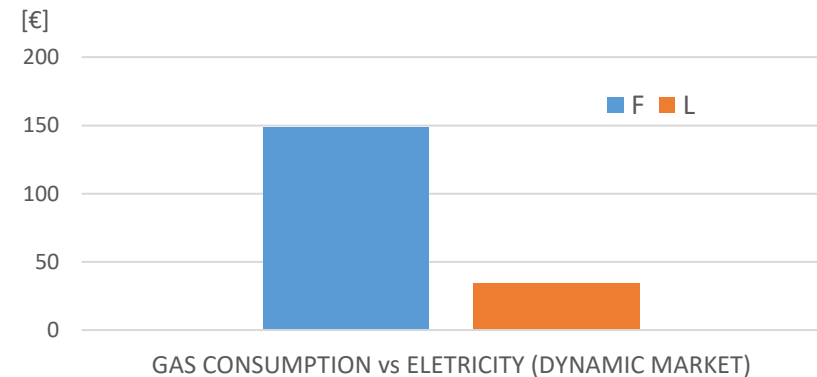
0.55 > (0.05)

SENSATION –  
REFERENCE/STRATEGY

0.19 > (0.05)

THE EXPERIMENT SHOWS THAT THERMAL COMFORT IS  
**NOT JEOPARDIZED** SO IT IS SAFE TO USE THESE  
CONTROL STRATEGIES TO CREATE ENERGY FLEXIBILITY

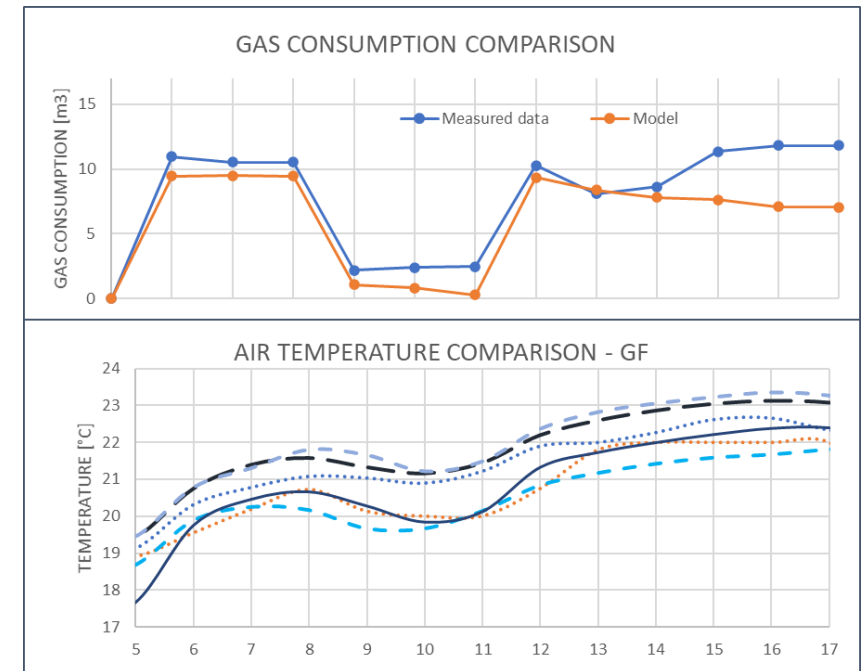
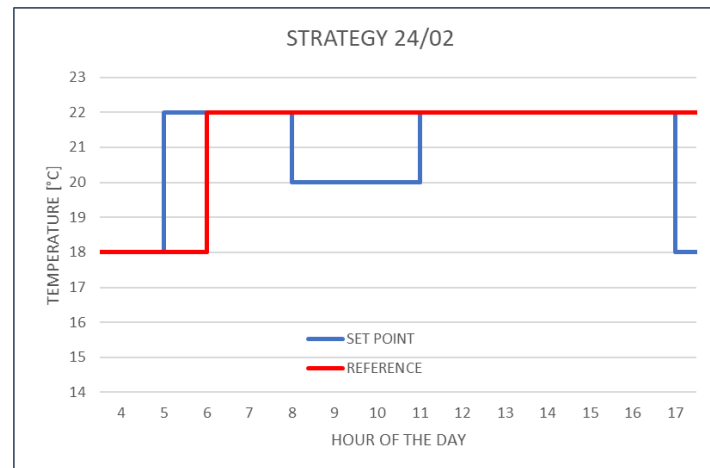
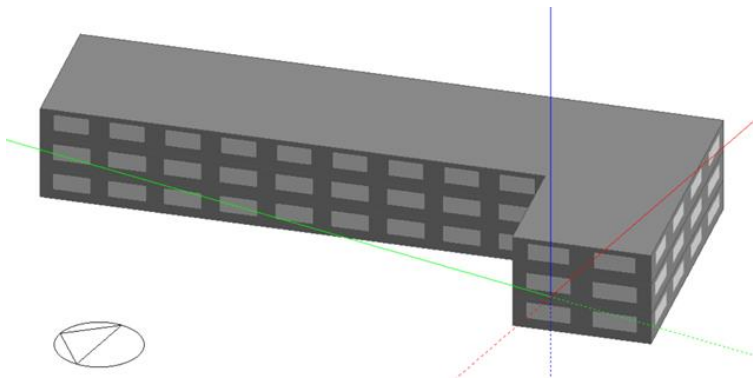
AVERAGE DAILY COST SAVINGS TO REFERENCE DAY



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## ENERGY FLEXIBILITY FOR BUILDINGS BY ADAPTIVE COMFORT STRATEGIES

- Virtual test environment



- Imagine to get these insights for any kind of building...  
for different market, assets, and financial boundaries



# SMART ENERGY COMMUNITY VOOR WONINGEN EN BEDRIJFSGEBOUWEN

## ENERGY FLEXIBILITY FOR BUILDINGS BY ADAPTIVE COMFORT STRATEGIES

- **Developing a tool that can predict the available energy flexibility potential that specific Dutch buildings can provide through their thermal mass and by using adaptive comfort control strategies**
- **The tool compares the predicted energy flexibility to other available energy flexibility sources in the building (battery, heat pumps, EV, PV)**
- **The tool helps to identify which building design show the most potential to be used as an energy flexibility source**





# SMART ENERGY COMMUNITY VOOR WONINGEN EN BEDRIJFSGEBOUWEN

## TOOL MOCKUP AND STAKEHOLDER ENGAGEMENT

### BUILDING INPUTS

GEOGRAPHICAL POSITION

BUNNIK

ORIENTATION

YEAR OF COSTRUCTION

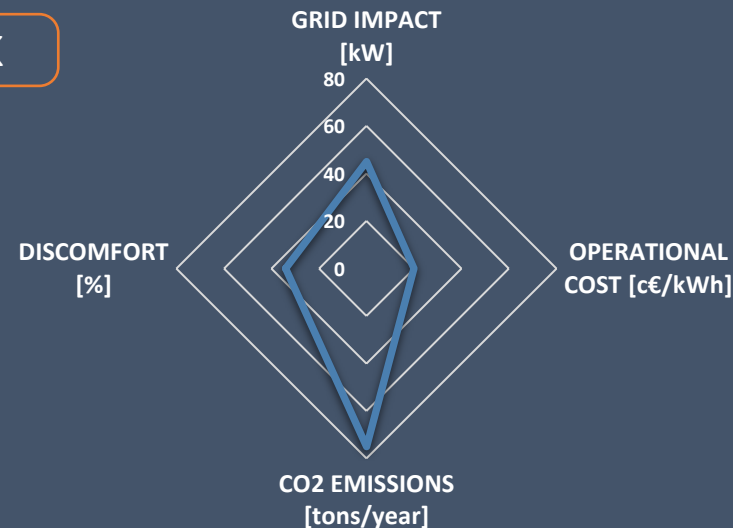
AREA m<sup>2</sup>

1980

CONDITIONABLE VOLUME

LAUNCH

### PERFORMANCE INDICATORS



CLICK HERE FOR  
DETAILED ANALYSIS

CLIK HERE TO EDIT  
YOUR BUILDING

BATTERY SIZE

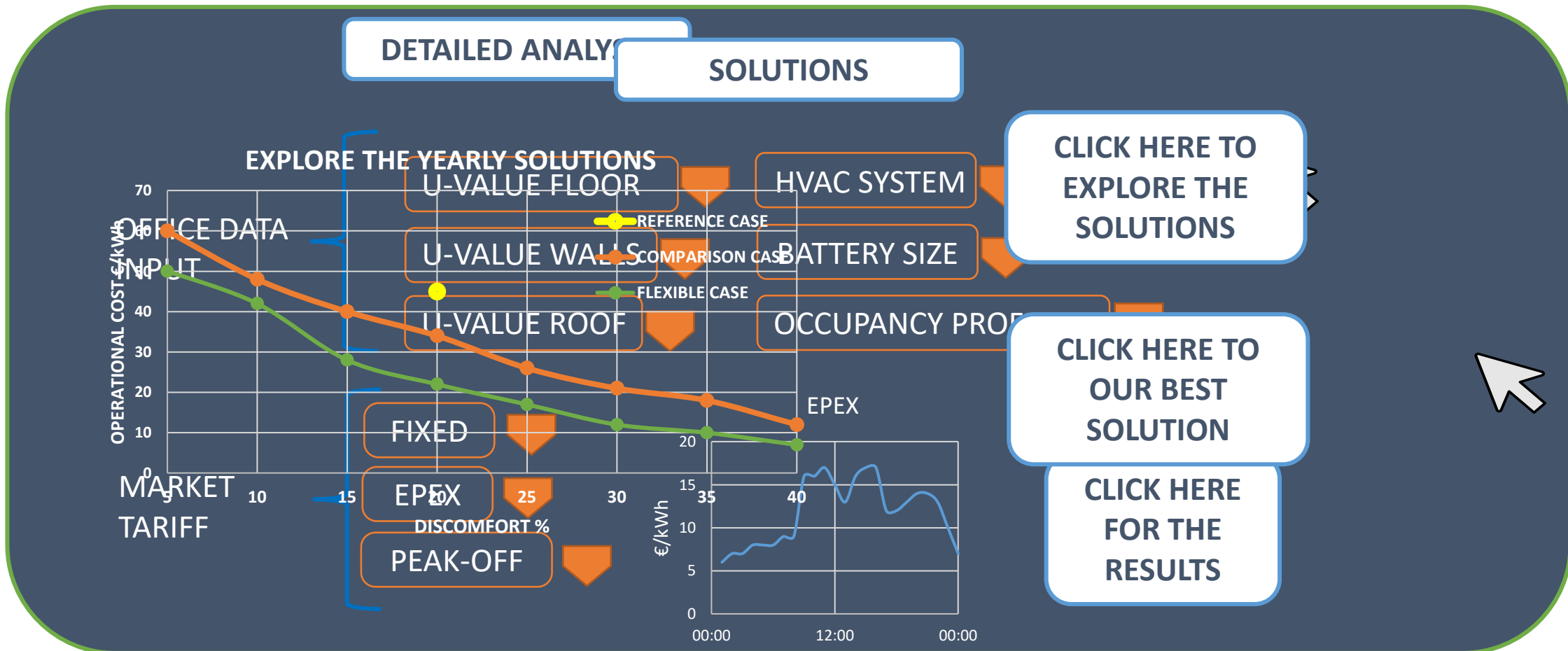
HVAC

NEW ENVELOPE

OUR SUGGESTIONS

# SMART ENERGY COMMUNITY VOOR WONINGEN EN BEDRIJFSGEBOUWEN

## TOOL MOCKUP AND STAKEHOLDER ENGAGEMENT





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## CONCLUSIONS

- **Demonstrated the available flexibility while maintaining the thermal comfort for users** in 4 different office buildings in the Netherlands
- The use of the **thermal mass as a flexibility source can be a cheap and feasible way to manage the energy** in the built environment
- **The tool (in development) will give financial, energy-performance, retrofit, and sustainability insights to get energy flexibility** for building managers, energy service companies and energy aggregators



Project duration: 07/2021 – 07/2023





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**POLL-QUESTION: Within how many years do you think that the use of Smart Control Strategies for office heating will be business-as-usual for most office buildings? (post your arguments in the chat!)**

- 0-1 year
- 1-2 years
- 2-5 years
- 5+ years.





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## Q&A

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The right energy, at the right time!