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Behaviour Demand Response in District Heating

A simulation-based assessment of potential energy savings

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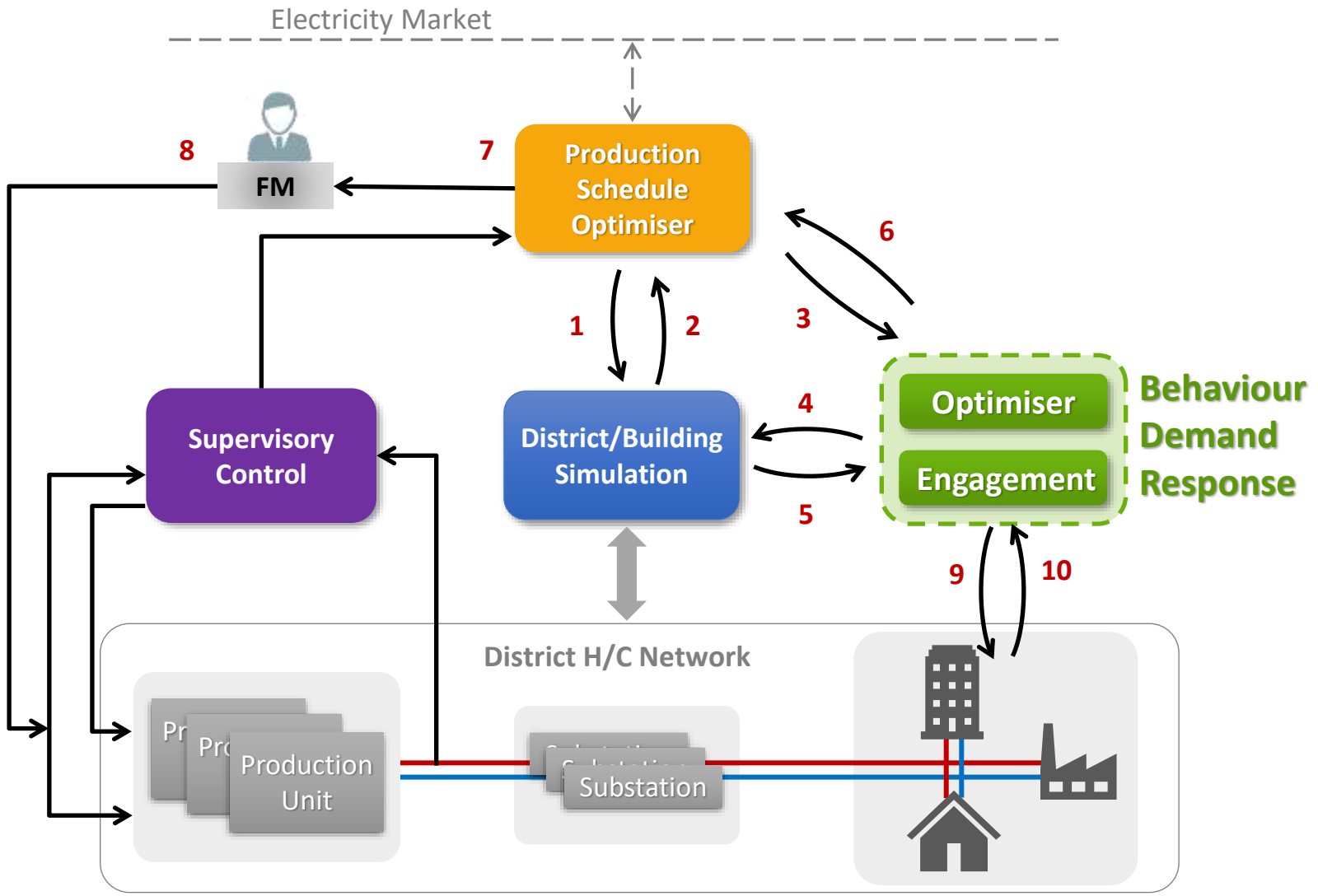
BDR Challenges

- **Monetary incentives alone with smart meters shows low participation** leaving 70%-90% of customers unengaged in residential sites**.**
- People's **engagement weakens** in long run
- **Monetary incentives are not applicable in office buildings and work environment.** !

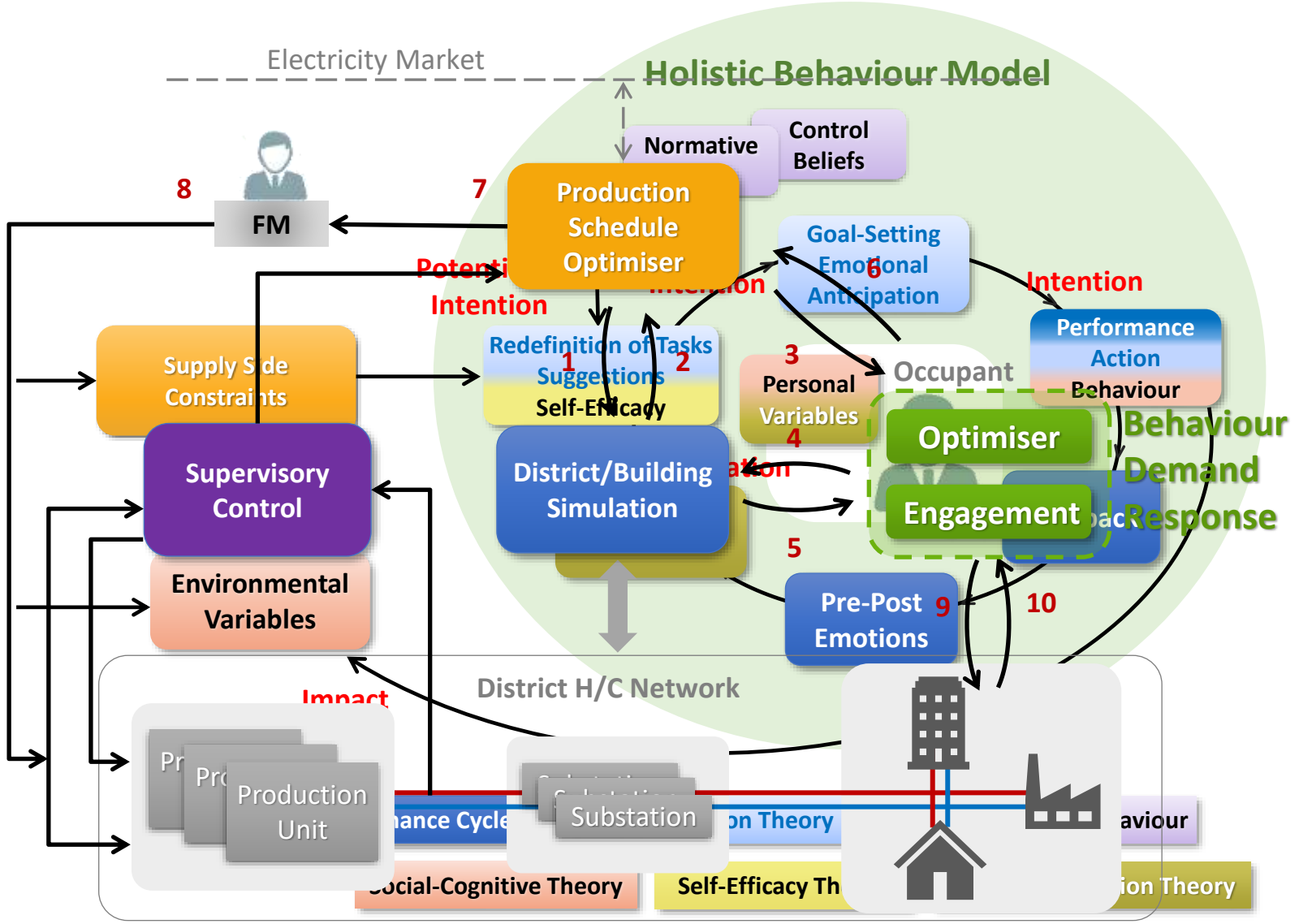
How influence people's behaviour also in the long-term? ?

→ We apply **well defined behavioural theories** and their inventory tools, from **psychology and social behavior science**

Integration of BDR with Production Optimisation

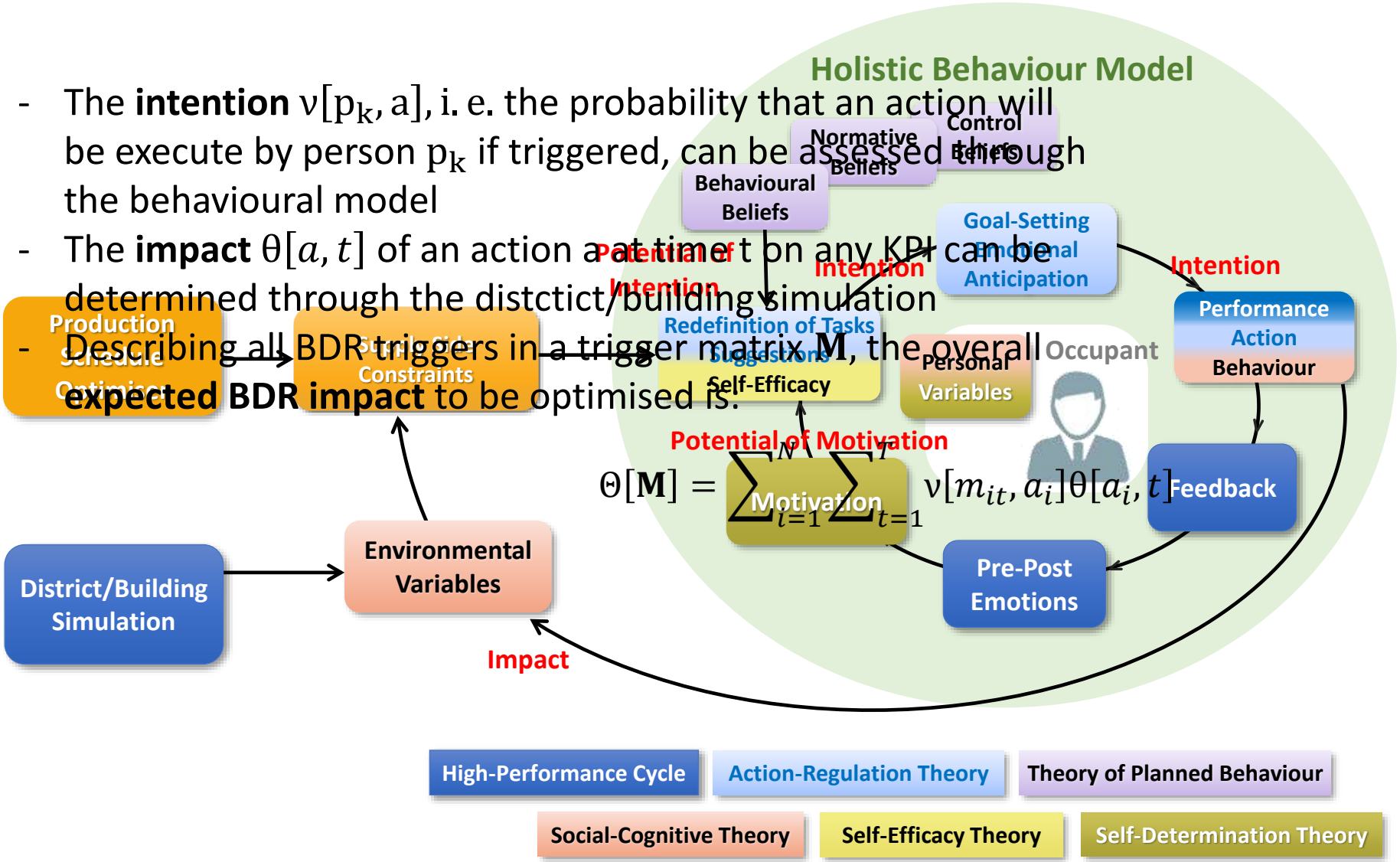


Behaviour Modelling to Enable Optimisation



Behaviour Modelling to Enable Optimisation

- The **intention** $\nu[p_k, a]$, i. e. the probability that an action will be execute by person p_k if triggered, can be assessed through the behavioural model
- The **impact** $\theta[a, t]$ of an action a at time t on any KPI can be determined through the distctict/building simulation
- Describing all BDR triggers in a trigger matrix $\mathbf{M}$, the overall **expected BDR impact** to be optimised is:

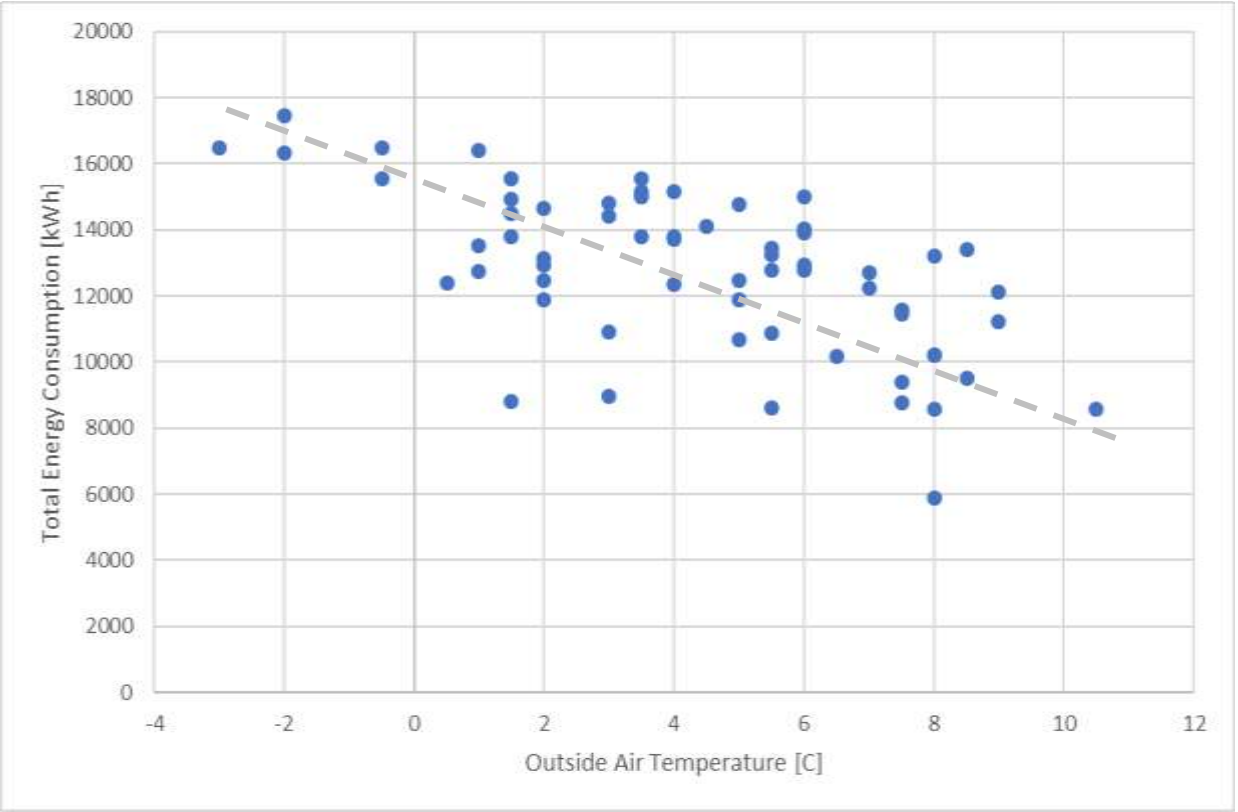


Additional context constraints

- **Exclusivity**: Make sure that mutually exclusive actions are not allowed, for instance that no two people are asked to perform the same action at the same time
- **Refractory period**: Make sure that the same action is not triggered again for a reasonable period of time, so that long-term motivation is not jeopardised.
- **Feasibility**: Only send BDR triggers that are possible in the given context conditions, e.g. do not ask people to lower the thermostat if the minimum comfort temperature is not met
- **Presence**: Only send BDR triggers to people that are present where the action is to be taken.

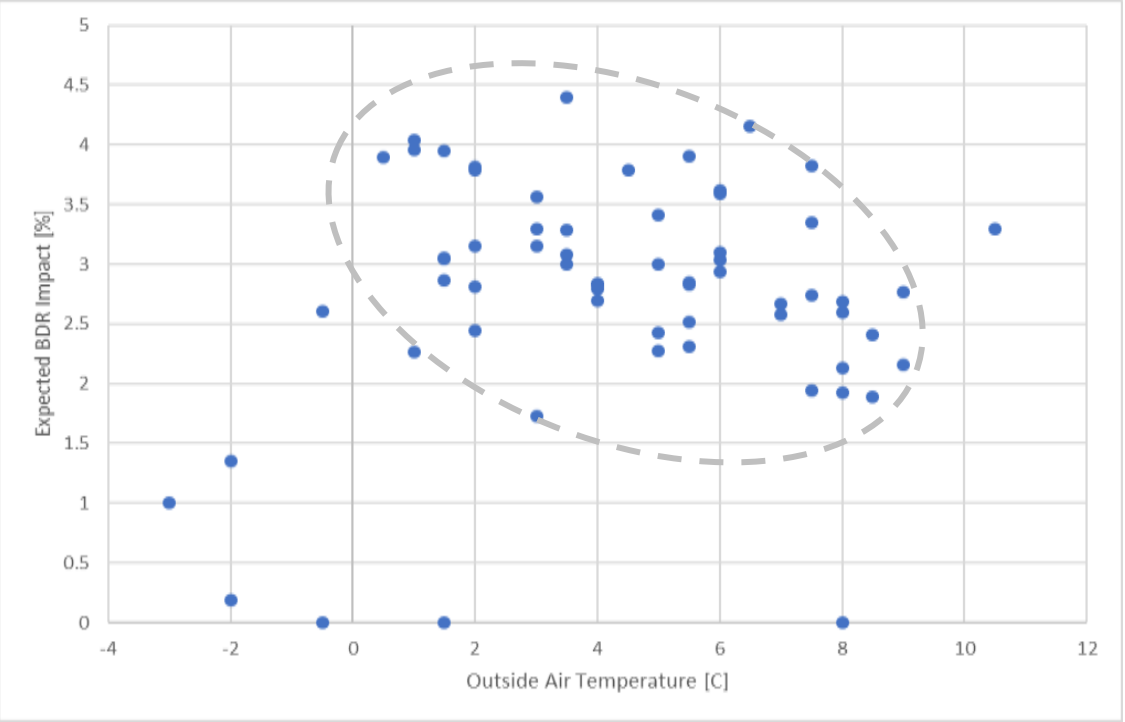
Experimental evaluation

- The total energy consumption of the heating system of the CIT Bishopstown campus for he heating season 2018/2019 was calculated using a calibrated simulation tool



Experimental evaluation

- A subset of 12 rooms covering a total area of 617.39m2 (2.29%) and distributed across 9 of the 15 heating circuits was instrumented to assess actual context conditions
- The expected BDR impact was optimised for temporarily altering thermostatic setpoints in these 12 rooms to as low as 18C for a maximum of 2h per day using a sample from the CIT population according to the intention study



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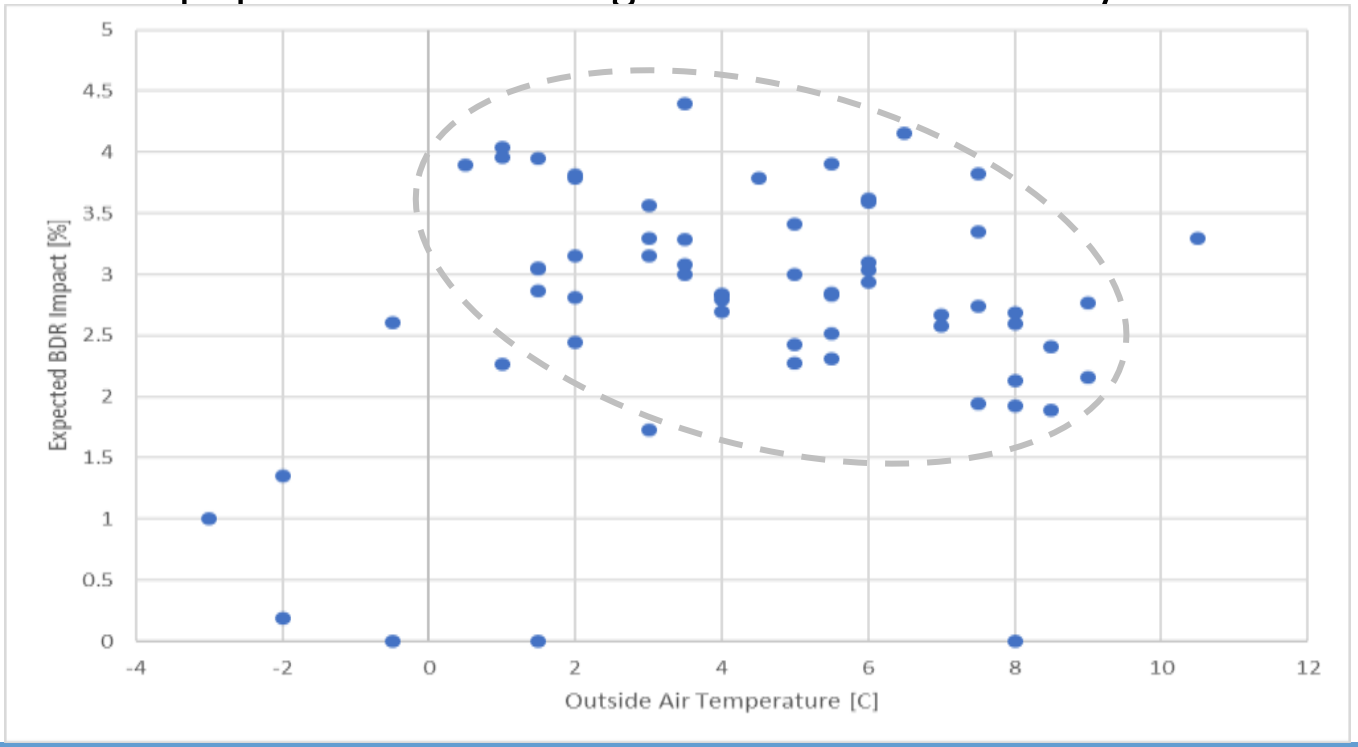
Relative Expected BDR Impact (Intention=53.63%)	Median	**2.83%**
	Maximum	**4.39%**
Maximum DR Potential (Intention=100%)	Median	**5.29%**
	Maximum	**8.19%**



Two main benefits of the developed BDR approach

1. **More appropriate suggestions** and support tools based on the individual's attitudes and personality can be provided to users **to ensure better long term commitment**

2. **The district heating optimiser can select the most appropriate individuals** to perform certain control tasks,

   With a higher probability of this action being taken

   resulting in **more efficient and more predictable system operation**