



# Impact of demand response on thermal comfort for a Leisure Centre

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# NOVICE project



New Buildings Energy Renovation Business Models  
incorporating dual energy services



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# Why NOVICE

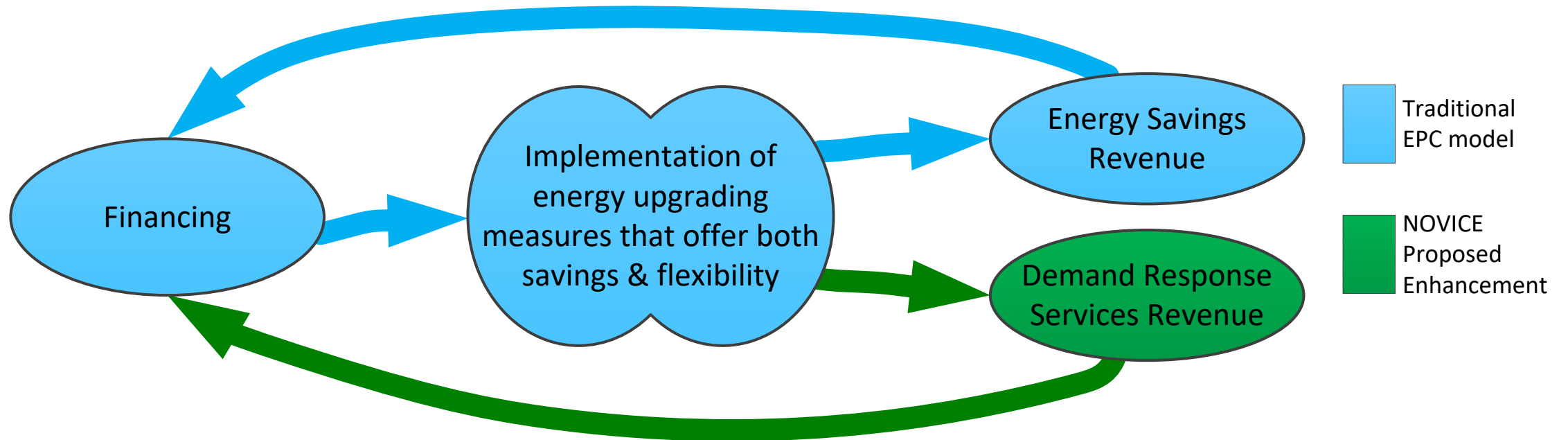


Fig 1: Overview of the NOVICE business model

# DR and Thermal Comfort study



- How much flexibility is available?
- What is the impact on indoor air conditions?
- What is the impact on the thermal comfort?



Fig 2: Ballymun Sports and Leisure Centre

# Ballymun Sports and Leisure Centre



- Spaces:
  - Pool
  - Sports Hall
  - Spinning room
  - Weights room
  - Dance studio
  - Changing rooms (wet and dry)
- Occupancy

Monday - Thursday	Friday	Saturday - Sunday
06:00 – 23:00	06:00 – 21:00	09:00 – 17:00

Table 1: Occupancy hours at the Leisure Centre

# Ballymun Sports and Leisure Centre



- AHUs with VSDs and heat recovery
- 110 kWe CHP unit
  - Heat base load to the low pressure hot water circuit
  - All electricity of site
- Electricity use = 299,897 kWh/y
- Gas use = 1,873,544 kWh/y
- Electricity generated from CHP unit = 311,850 kWh

# DR simulation



- Turning off/down non-essential HVAC equipment
  - All AHUs
  - All extraction fans (except toilets)
  - All LPHW pumps (except DHW)
  - All filtration pumps
- for 2h in October 2018 – Wednesday from 17:00 to 19:00
- CHP turned OFF

# DR simulation analysis



- Monitoring of indoor conditions BEFORE, DURING and AFTER the test
  - T
  - RH
  - CO<sub>2</sub> levels
- Analysis of variation in indoor conditions
- Survey with occupants



# Results of DR simulation

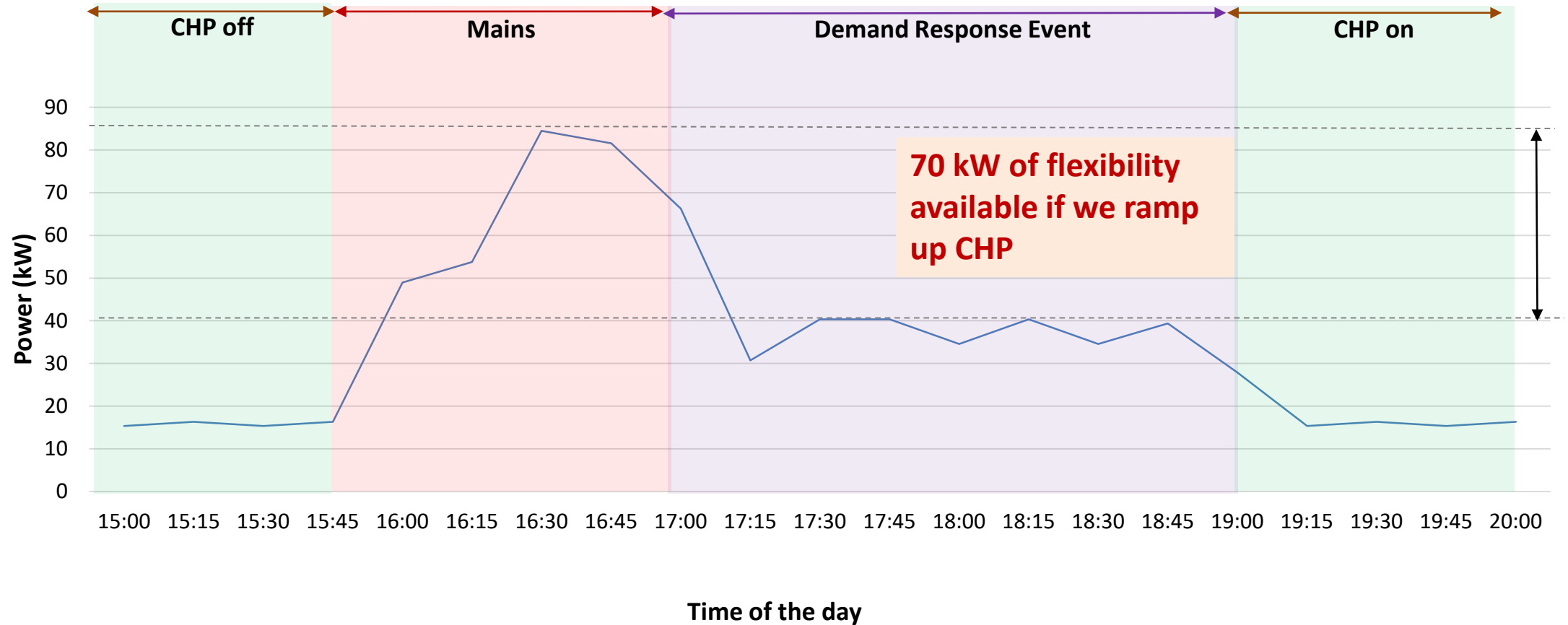


Fig 3: Results of the DR simulation

# Indoor air conditions



- Indoor air temperature

Zone	Indoor air temperature [°C]		
	17:00	18:00	19:00
Pool	23.4	22.3	22.1
Gym	18.6	18.9	18.3
Reception	18.7	19.8	19.3

Table 2: Indoor air temperature change before, during and at the end of the test

- Relative humidity

Zone	Relative humidity [%]		
	17:00	18:00	19:00
Pool	70	75.7	99.1
Gym	64.1	68.7	74.7
Reception	66.4	64.5	67.1

Table 3: Relative humidity change before, during and at the end of the test

# Indoor air conditions



- CO<sub>2</sub> levels

Zone	CO <sub>2</sub> levels (ppm)		
	17:00	18:00	19:00
Pool	745	745	784
Gym	593	942	1073
Reception	530	562	590

Table 4: CO<sub>2</sub> levels change before, during and at the end of the test

Category	Quality	CO <sub>2</sub> above outdoor air (ppm)
IDA 1	High	≤ 400
IDA 2	Medium	400 – 600
IDA 3	Moderate	600 – 1000
IDA 4	Low	≥ 1000

Table 5: Acceptable CO<sub>2</sub> values for indoor air quality (source European Standard EN 13779)

# Thermal comfort survey



- Survey with building users
- A range of question to evaluate satisfaction with T, RH and air quality
  - Control group: before the DR event
  - Test group: during and after DR event
- Participants not told about the DR event to avoid bias



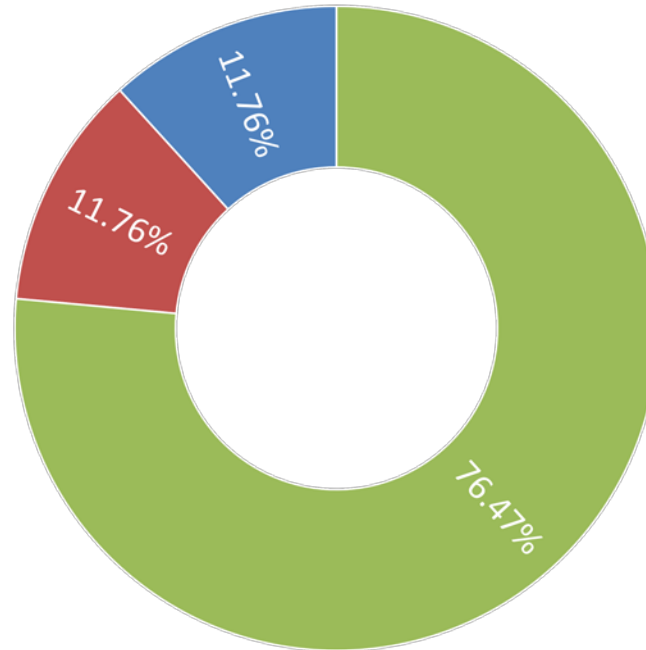
# Thermal comfort survey

1	What is your gender?
2	What was your main activity in the last 20 minutes?
3	How satisfied are you with the temperature in the area we are in now?
4	How would you rate the humidity levels in the area we are in now?
5	How would you rate the air quality in the area we are in now?
6	In which other area of the leisure center did you spend most time today?
7	Thinking about that area, and the time you spent there, how satisfied were you with the temperature in that area?
8	How would you rate the humidity levels in that area at the time you were there?
9	How would you rate the air quality in that area at the time you were there?
10	Did you notice any change in conditions during the time you were there?
11	If you would like to make any other comments about the temperature or air quality at the leisure center today, please do so below.
12	Please indicate which items of clothing from the list below the participant is wearing.
13	What is the date?
14	What is the time now?
15	What time did the DR event start?
16	Record the approximate outdoor temperature and seasonal conditions

# Thermal comfort



Ballymun occupants results



■ Noticed an INCORRECT change ■ Noticed a CORRECT change ■ Did not notice change

Fig 4: Share of occupants that noticed a change in thermal comfort

# Thermal comfort

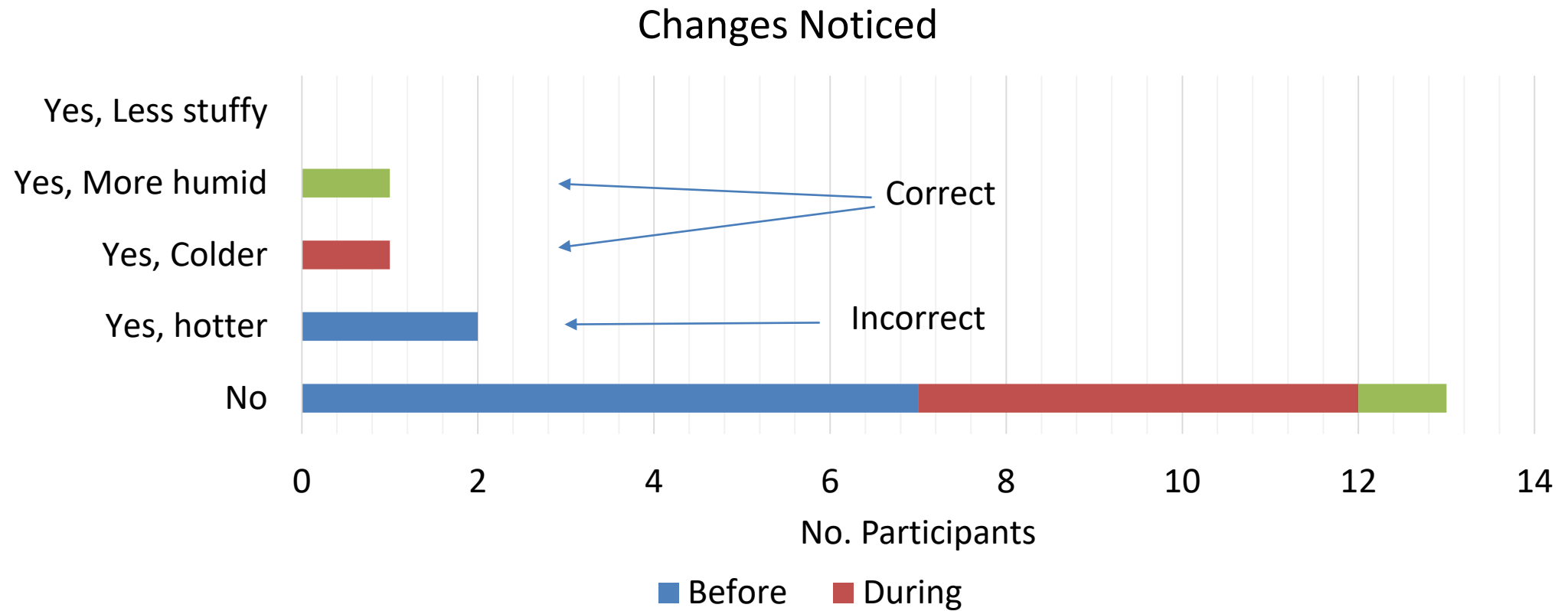


Fig 5: Breakdown of survey results

# Conclusion



- DR flexibility at Leisure Centre of 45 kW
- If allowed to export, more potential – 70 kW
- T remained relatively constant
- RH and CO<sub>2</sub> levels changed more significantly
- Occupants did not notice that a DR event occurred





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**THANK YOU FOR LISTENING!**

**ANY QUESTIONS?**