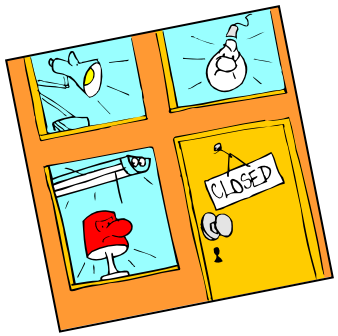
UCL Energy Institute

Assessing changes in energy behaviours of hospital staff: Benefits and challenges of energy audits



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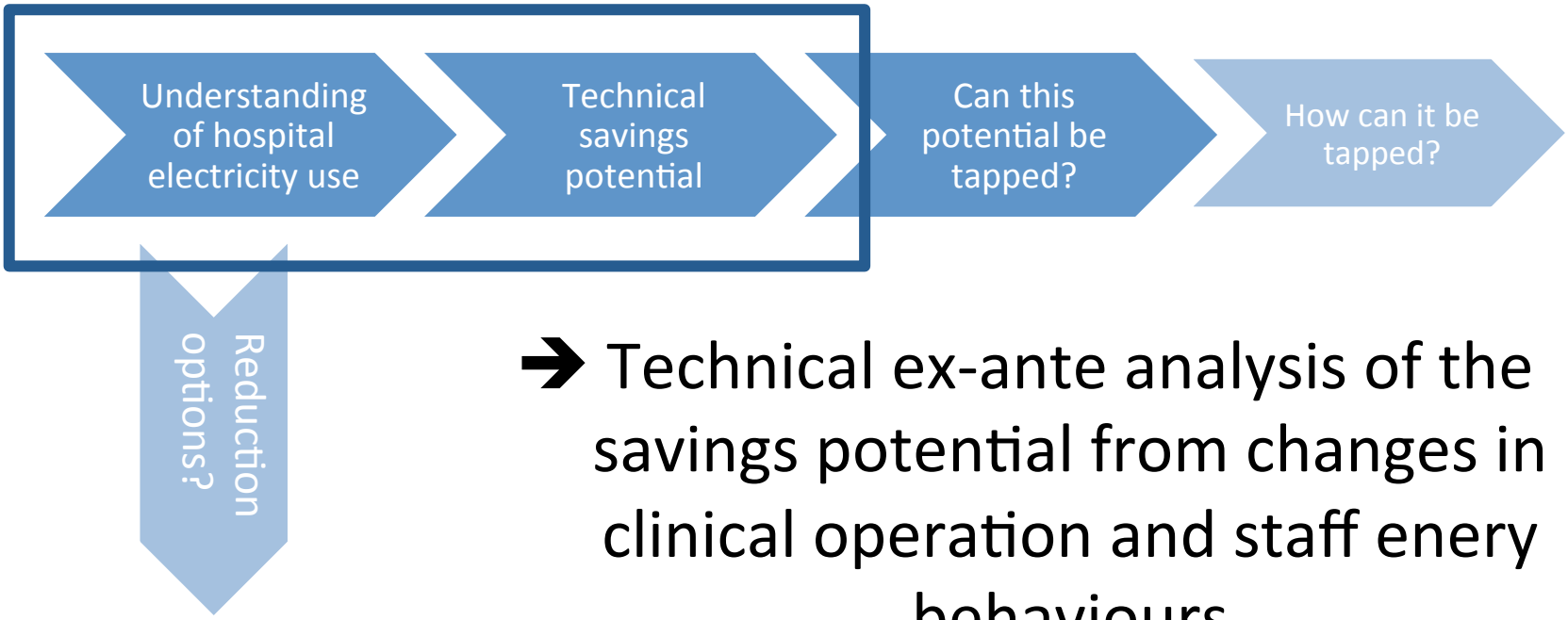
Influence of occupants on building energy use

- in homes ✓

- in offices/university building ✓

- in hospitals ?

To what extent to clinical staff influence electricity use in different hospital buildings and processes?



➔ Technical ex-ante analysis of the savings potential from changes in clinical operation and staff enery behaviours

Methods to understand electricity use at a sub-building level

$$W = \int_{\square} P(t)\, dt \sim P * t$$

- Measurement of appliance electricity consumption at circuit or plug level
- Collection of secondary data on power consumption

- Measurement of environmental variables such as temperatures and lighting levels
- Collection of reported data on building use and processes
  - Time lapse photography
  - Observations of (clinical) activity

Challenges for energy audits in hospitals

Power dimension

- Difficulties in identifying unknown specialist equipment
- Limited availability of energy use information in the literature for specialist equipment
- Estimating average power use from power ratings

Time dimension

- Irregular nature of processes making it for difficult for occupants to describe typical events and average durations of use
- Transient nature of hospital work/employment in some departments resulting in limited knowledge of local customs

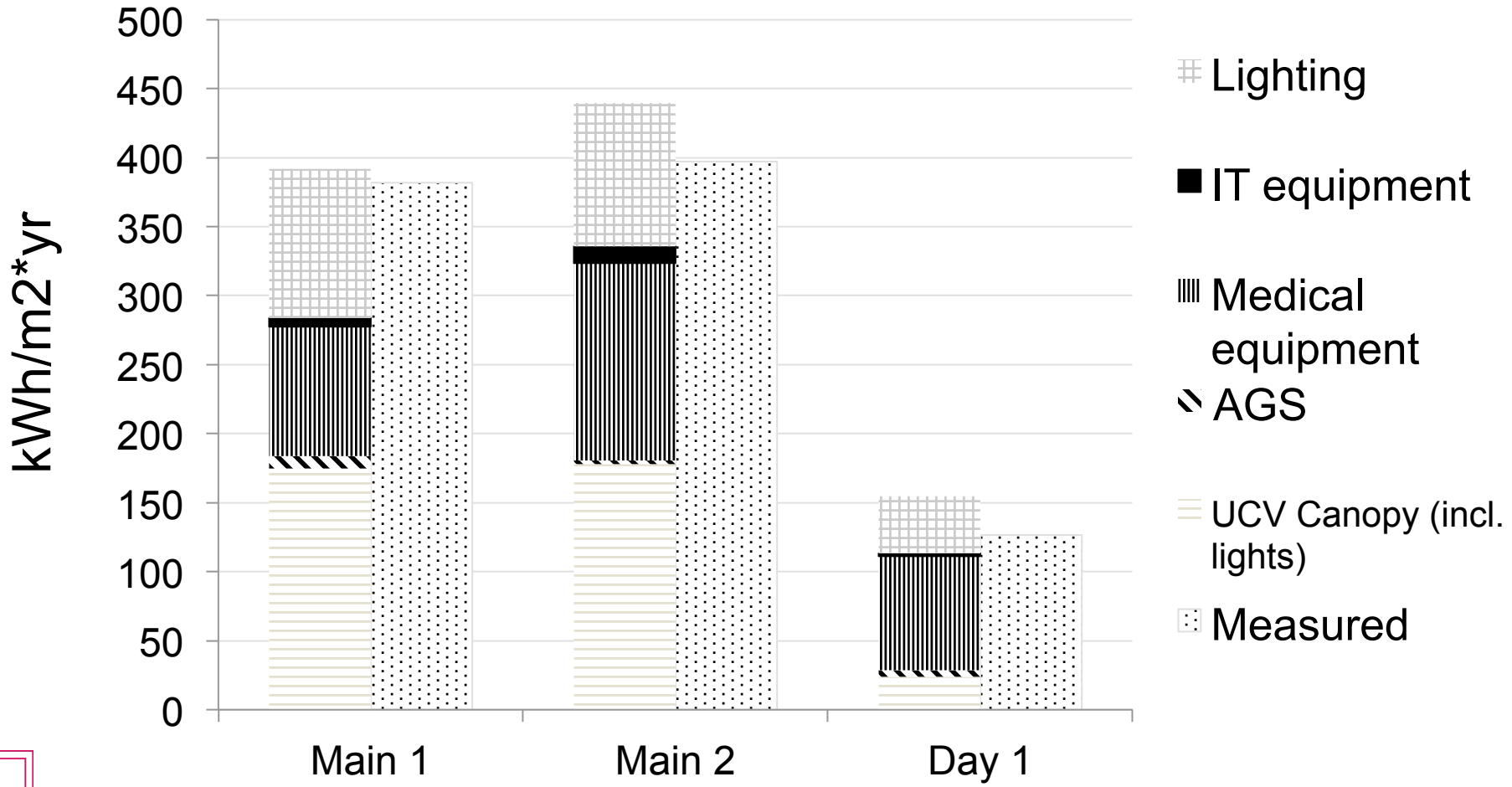
Transparency of data inputs

Example for power consumption of main lighting

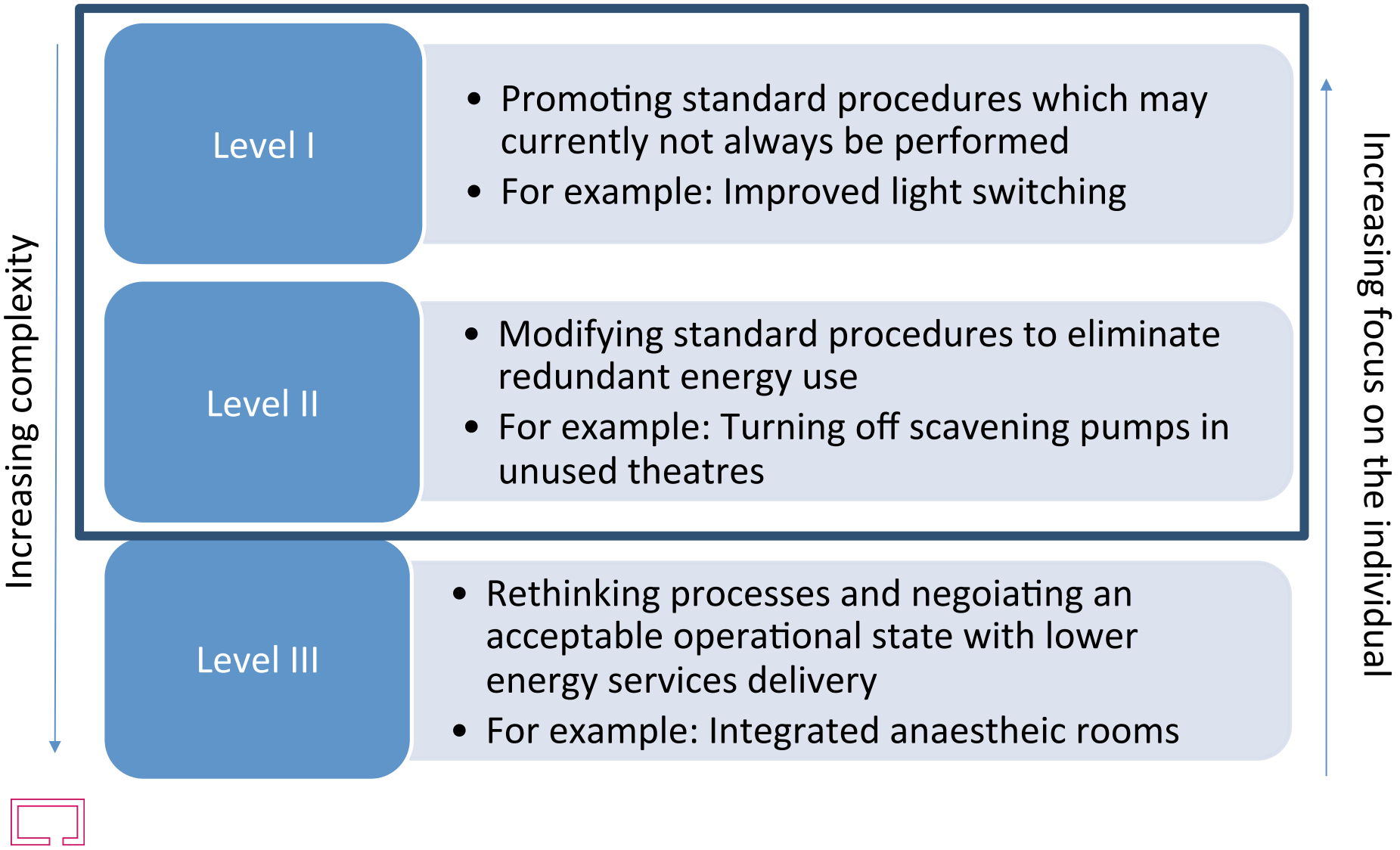
+ CONFIDENCE -	1	Measurement of actual consumption
	2	Actual consumption reported in documentation
	3	Declared wattage observed, consumption of control gear infered based on lamp type
	4	Lamp type observed in detail, Wattage and consumption of control gear inferred
	5	Declared wattage (and/or control gear consumption) reported
	6	Lamp type reported, Wattage / Control gear consumption inferred based on reported data
	7	Other assumptions (e.g. lamps covered: assumptions on lamp type based on shape of luminaire and colour of light, consumption inferred on this basis)

Data collection methods				Hospital 1				Hospital 2				Hospital 3		
				Day theatres	Main theatres	Outpatients	Imaging	Laboratory	Imaging	Surgical Ward	Theatres	Laboratory	Surgical Ward	Outpatients
Electricity use W	Average power P	Measurement of electricity use	Main incomer	O	O	O		O	O	O		O	O	O
			Circuit level				O				O			
			Plug level				O			O				O
		Collection of secondary data (Plate ratings, Technical manuals, Literature)		O	O	O	O	O	O	O	O	O	O	O
	Duration of use t	Measurement of electricity use profiles		O	O	O	O	O	O	O	O	O	O	O
		Measurement of environmental variables					O			O		O	O	O
		Collection of reported data		O	O	O	O	O	O	O	O	O	O	O

Estimated as opposed to measured local electricity use for three theatre departments



Staff-centred options for change in clinical operation

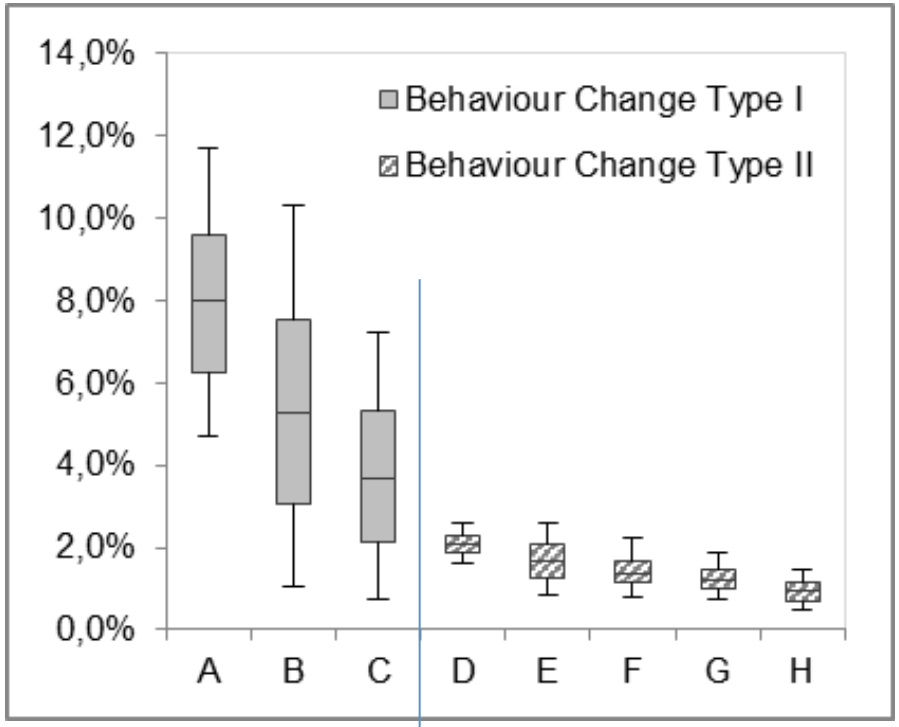


Findings for theatre departments

#	Change	Level	Department	% of total
A	Switching off all lights in the department while not in use over weekends	I	Day 1	8,5%
B	Switching off all lights in unused theatres suits over night	I	Day 1	3,9%
C	Switching off all lights in unused theatres suits over night	I	Main 1	2,7%
D	Looking department overnight: Corridor lights may be switched off	II	Day 1	2,6%
E	Switching of anaesthetic gas scavenging (AGS) plant when theatres are not in use	II	Day 1	2,5%
F	Switching off scrub room lights during surgery	II	Main 1	1,7%
G	Switching off scrub room lights during surgery	II	Day 1	1,5%
H	Switching of AGS plant when theatres are not in use	II	Main 1	1,3%

Methodological reflections

High uncertainty from estinates of the current frequency with which standard procedures are fully carried out



Use of alternative methods for assessment and evaluation recommended

Alternative data collection methods - Considerations

- Project budget
- Access to facilities personell
- Disruption in clinical areas
- Co-benefits such as improved thermal comfort or staff engagement
- Importance of respective end-uses in differente departments

Method	Useful for	Advantage	Disadvantage	Cost
Electricity use at plug level	IT, Catering equipment	- Detailed activity profile available	- Not for sensitive equipment or in clean areas - Large quantity of equipment required	Equipment cost per plug monitor: ~ 50 - 60€
Electricity at circuit level	- Lighting - Power circuits - Fan coil units	- Not or mimimally disruptive to clinical activity	- Intense FM collaboration needed - Feasibility?	Equipment cost per circuit: ~ 50 - 160€
Electricity at main incomer	All local electricity	- Little disruption - Identification of abnormalities (high baseloads, loads in closed areas)	- Large and/or unrelated areas? - No differentiation - FM collaboration	Loggers, single phase boards: ~290 - 450€ Three phase boards: ~1770 - 2000€

Method	Useful for	Advantage	Disadvantage	Cost
Environ-mental variables	Lighting, HVAC	- Little disruptive - High logging frequencies - Data useful to occupants with temperature control issues	- Require calibration to local illumination levels	Temperature loggers only: ~100 - 110€; Temperature, Relative Humidity and Light Levels: ~190€
Occupancy sensors	Lighting use	- Occupancy directly available as binary variable	- Potentially perceived as threat? - Sensitive to positioning	Indicative cost of equipment: ~280€ per logger
Observation of target behaviours, Behavioural Audit	Lighting use, Door and window use	- Clearly linkable, e.g. Night time audits - Potentially combinable with staff engagement	- Very time intensive if more than a spot check - Inter-auditor variation despite training	Roughly 0.5 manhours should be estimated for auditing a department with 500m2 floor area.

Conclusions

- Detailed energy audits:
  - useful in providing information on the importance of different end-uses to guide energy conservation efforts
  - workable tool for the identification of potential savings from campaigns aiming to eliminate redundant energy use in standard procedures (Level II)
  - transparency about assumptions is crucial and will benefit from addressing uncertainties in data inputs
- Alternative data collections methods recommended for Level I changes
  - depending on project aims, the available budget, the access to technical staff and the importance of respective electricity end-uses

Limitations / Further research

- Focus on electricity while many aspects of hospitals electricity use are associated with both heating/cooling and electricity
- Expertise of authors in buildings rather than healthcare – interdisciplinary teams including interested clinicians and technical personal for future projects in healthcare
- Going beyond a technical potential for change by taking account of for organisational, social or individual constraints

Thank you for attention!

ANY QUESTIONS???