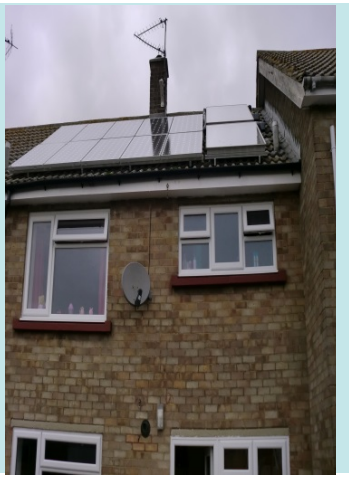
Environmental *Change* Institute

Low-carbon refurbishments: How passive or active are technologies, users and their interaction







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eceee 2013 Summer Study on energy efficiency, 3-8 June, France

Outline of Presentation

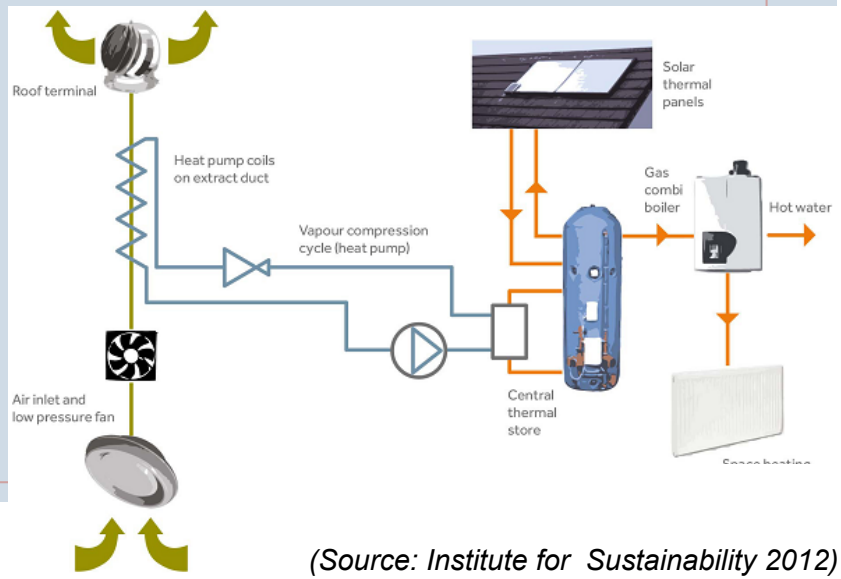
- Approaches and methods to understand ‘interaction’
- Past-experience of occupants’ interaction with heating and ventilation
- Post-experience interaction with low-carbon measures
- Conclusions

The study

Aim: ***The type of interaction(s) (direct/ indirect, passive/active) exist between deep retrofitting interventions and occupants' behaviour***

TSB Retrofit for Future programme

- Low-carbon retrofit strategies to achieve 80% CO_2 reduction
- Innovative solutions, combined systems and low-carbon measures
- Social housing tenants

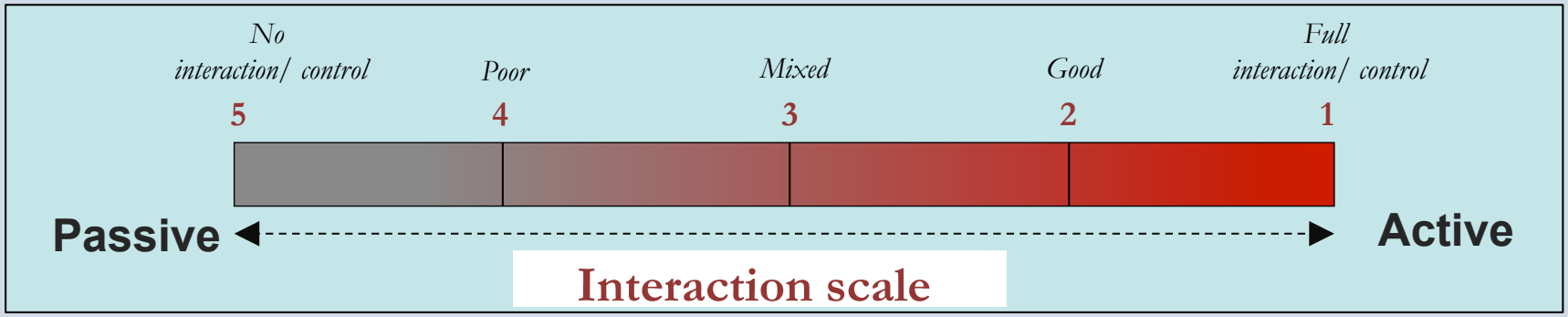


(Source: Institute for Sustainability 2012)

Terms used

- *'interaction':* *control-oriented actions between occupants' routinised behaviours and elements of the building system*

- *'passive' or 'active':* *level of occupants' interaction with the heating and ventilation systems prefigured by the technology and measures installation or by occupants' (users') practices.*



- *'direct' or 'indirect':* *interacting directly with the measure's controls or indirectly via other technologies*

Data sources

Data type (collected/ provided):	RfF	Study	
		Primary source	
Essential Information phone survey	√		Provided
Observations walk-by (external)- BPE/POE	√	√	Data collected: Visual material, building environment external physical characteristics checklist
Observations walk-through (internal)- BPE/POE	√	√	Data collected: Visual material, building environment internal physical characteristics checklist
Semi-structured interview -BPE/POE	√	√	Data collected: Interview recordings, discussion observation notes
In-situ metering/spot checks- BPE/POE		√	Data collected: Temperature, CO_2 , RH metering in all occupied rooms
			Secondary sources
TSB Retrofit for the Future Database 1 year monitoring	√		Provided
TSB Retrofit for the Future Case studies documentation	√		Provided
Modelling data (PHPP/SAP)	√		Provided
Building tests (e.g. airtightness, thermal imaging, etc.)	√		Provided
Degree Days Data		√	Additional data for performance line calculation
Location data		√	Additional data: building characteristics (Orientation, aerial views)

Interdisciplinary methodological approach

know-how and embodied habits, institutionalised knowledge, engagement and technologies (Gram-Hanssen 2010)

what is scripted by the technical intervention, and what level of interaction is left to users to create their own microenvironment

if a change occurs such as to produce discomfort, people react in ways which tend to restore comfort (Nicol and Humphreys 2002)

users' past and post-experience on the route to learning about the refurbished building environment, *(Vischer 2008)*

Past-experience: Occupants' interaction

PASSIVE

Key factors affecting interaction:

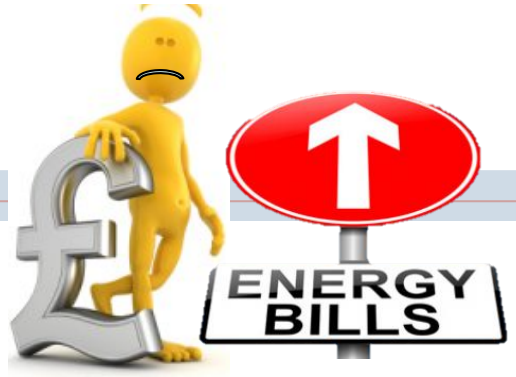
- **Poor condition of the building fabric**

  e.g. draughts and extreme cold indoor conditions

- **Scripted technology and products**

  e.g. lack of heating controls in storage heaters

- **Energy costs**



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Past-experience

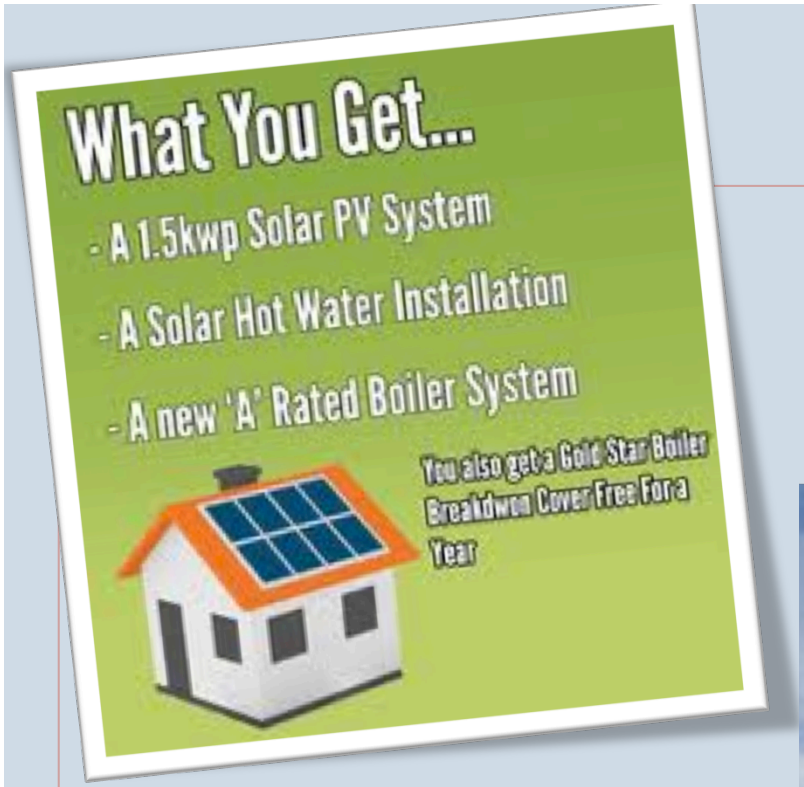
- Thermal comfort and controls:

"…*it was bloody freezing ...we used to wear gloves, hats, scarfs and coats in the house....we had no choice…" (Occ. TSB036*)

- Energy saving behaviour: varies in the sample affected by the poor condition of the building fabric and occupants' personal habits

- Routinised practices:

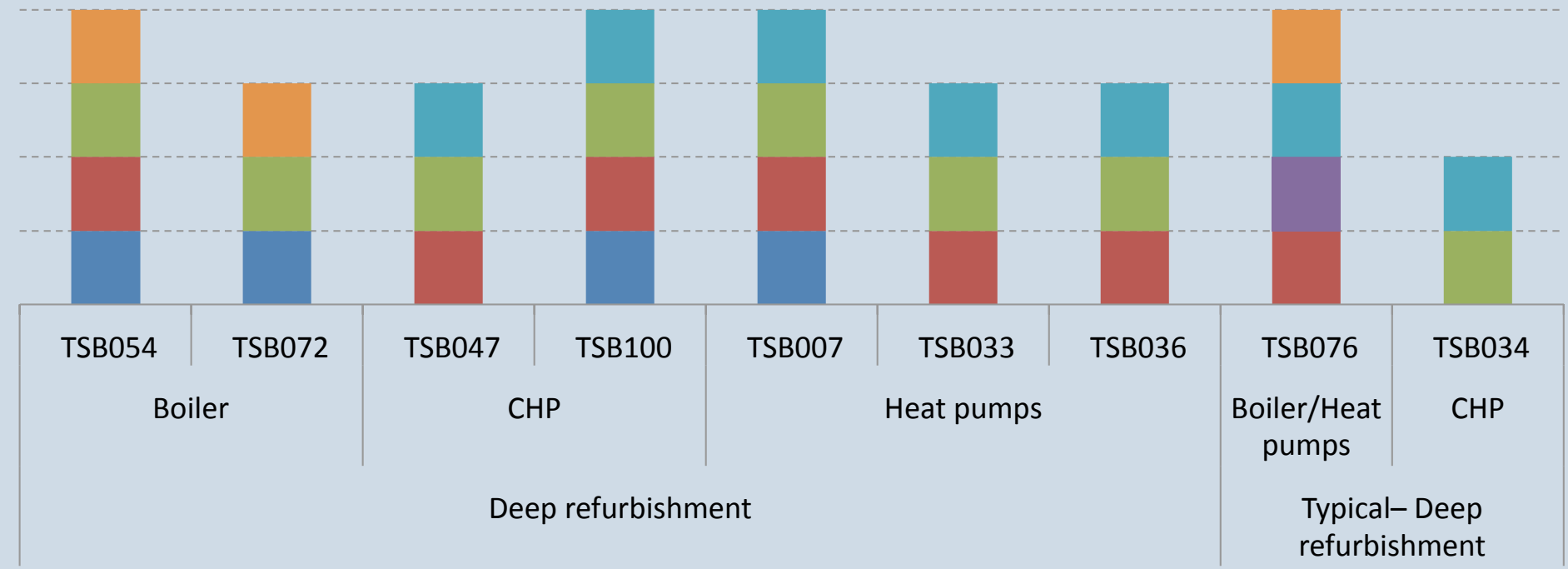
"…we've always slept even the coldest of days with the bedroom window open...because I like the cool air I don't like to sleep in warm bedroom I like to have a cold bedroom… (Occ. TSB036)



… past, post- experience any change?

Occupants' practices ...

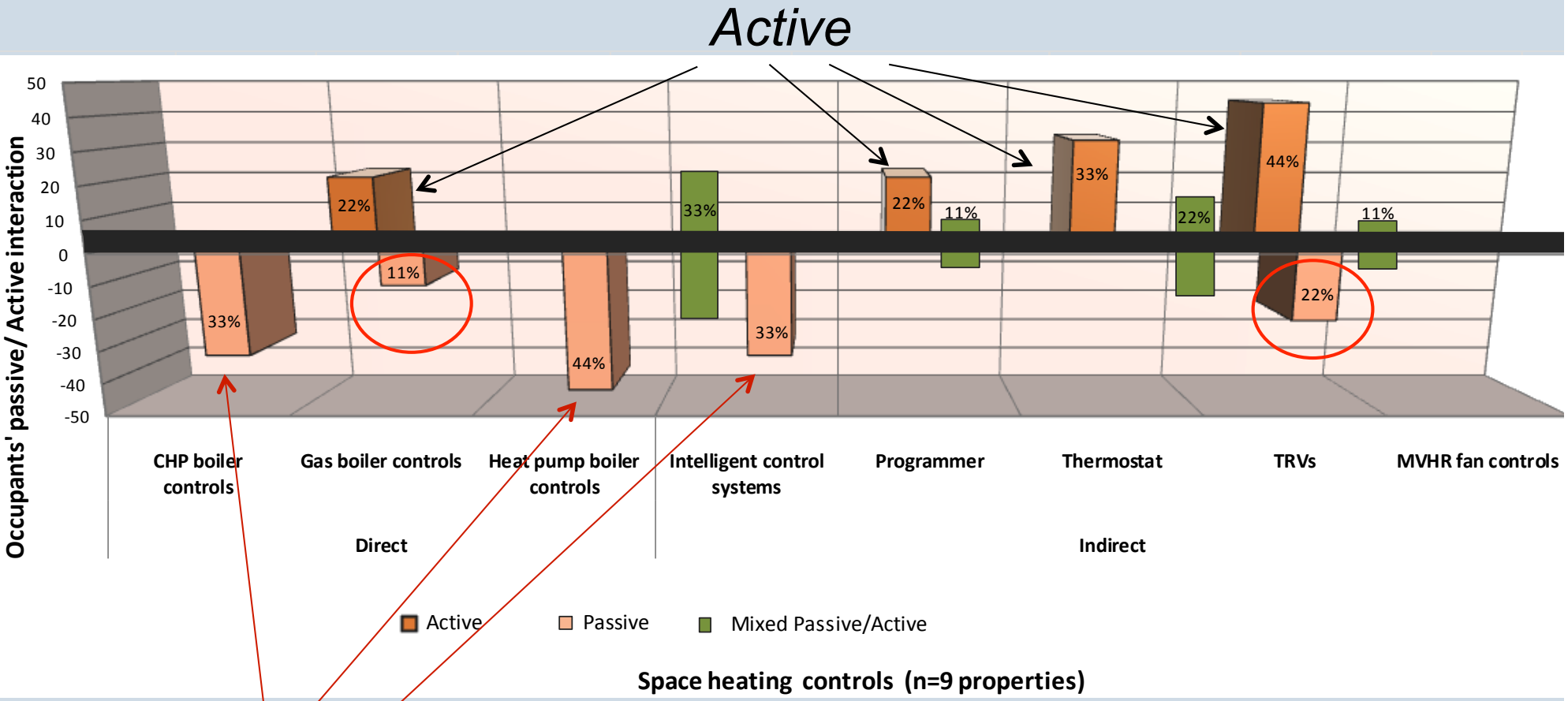
Deep whole-house low-carbon refurbishment case studies



- Convetional heating controls
- Intelligent heating controls
- MEV systems
- MVHR systems
- Solar PV
- Solar thermal

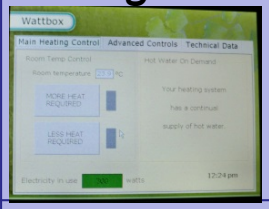
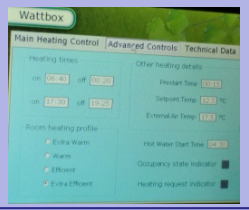
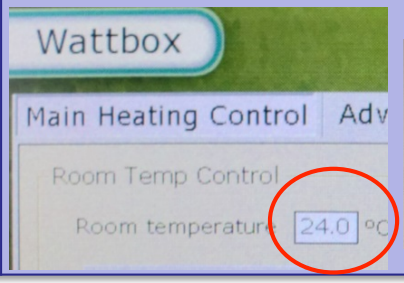
Level of refurbishment of the TSB Retrofit for Future programme properties (n=9) with low-carbon measures

Post-experience: Interaction with heating controls

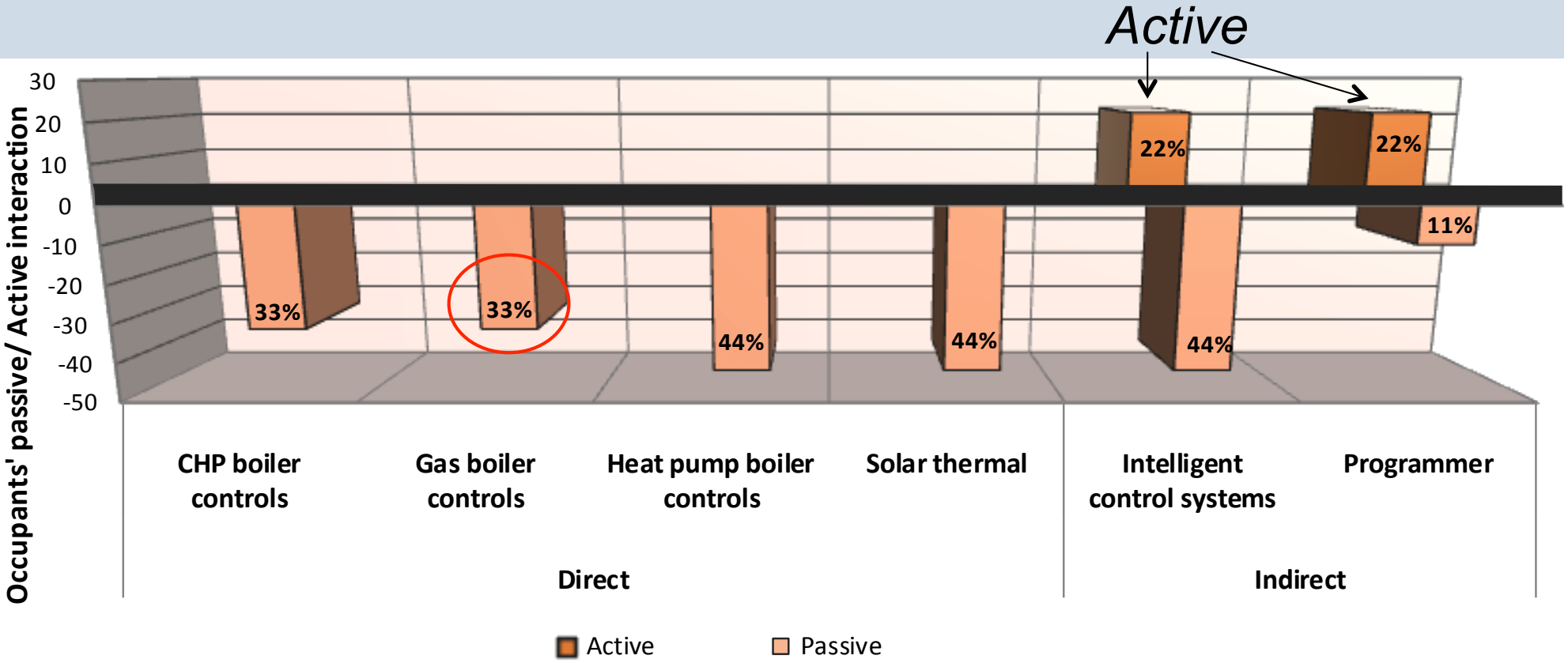


Behavioural constraints feeling "afraid" to have interaction with such a complicated and expensive piece of equipment…

Interaction with heating controls

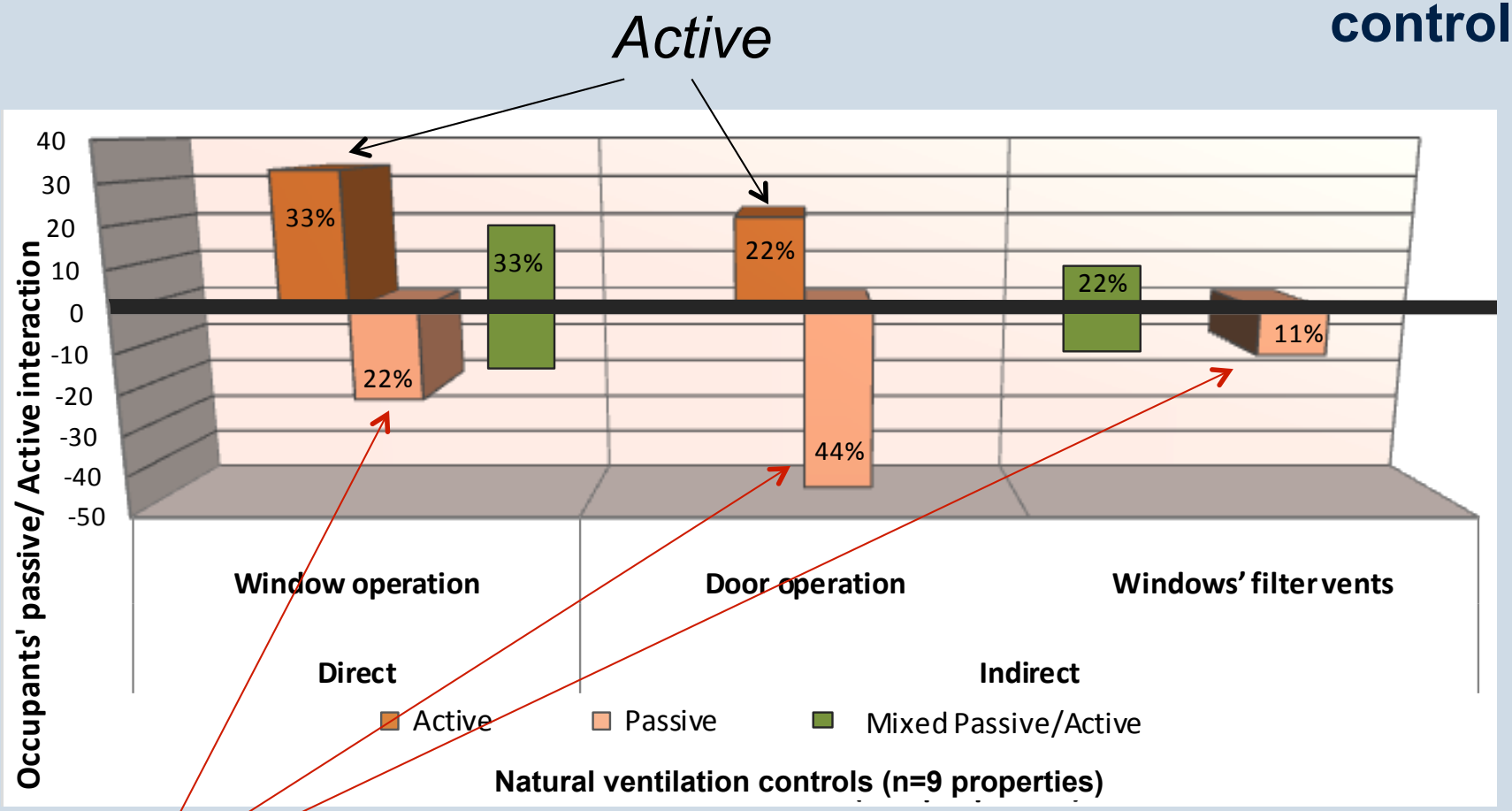
Key factors	Occupant (user)	Technology	Interaction
Knowledge	*Past experience and know-how*	*Conventional controls*   	**Active**
	- Level of training: *"…told not to touch…."* *- Type of training and person provided*	*Intelligent controls*   	**Passive**
Scripted technology	*Level of control left to the user:* *"... doesn't allow instantaneously change temperature settings ..."*	*Wattbox 'learning' process or locked control options*   	
Habits, routinised practices & awareness	*- Regulate comfort levels by leaving windows open:* *"…it's how I grow up"* *- Energy cost concerns*	 	**Mixed passive / active**

Post-experience: Interaction with hot water controls



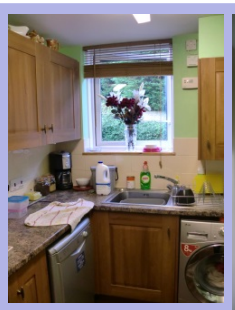
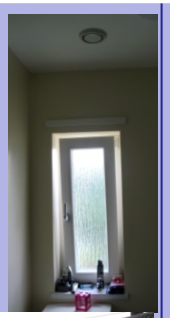
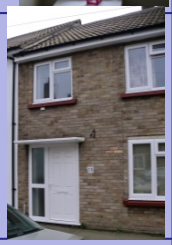
Default settings and low level of control in indirect /direct intelligent or conventional controls

Post-experience: Interaction with natural ventilation controls

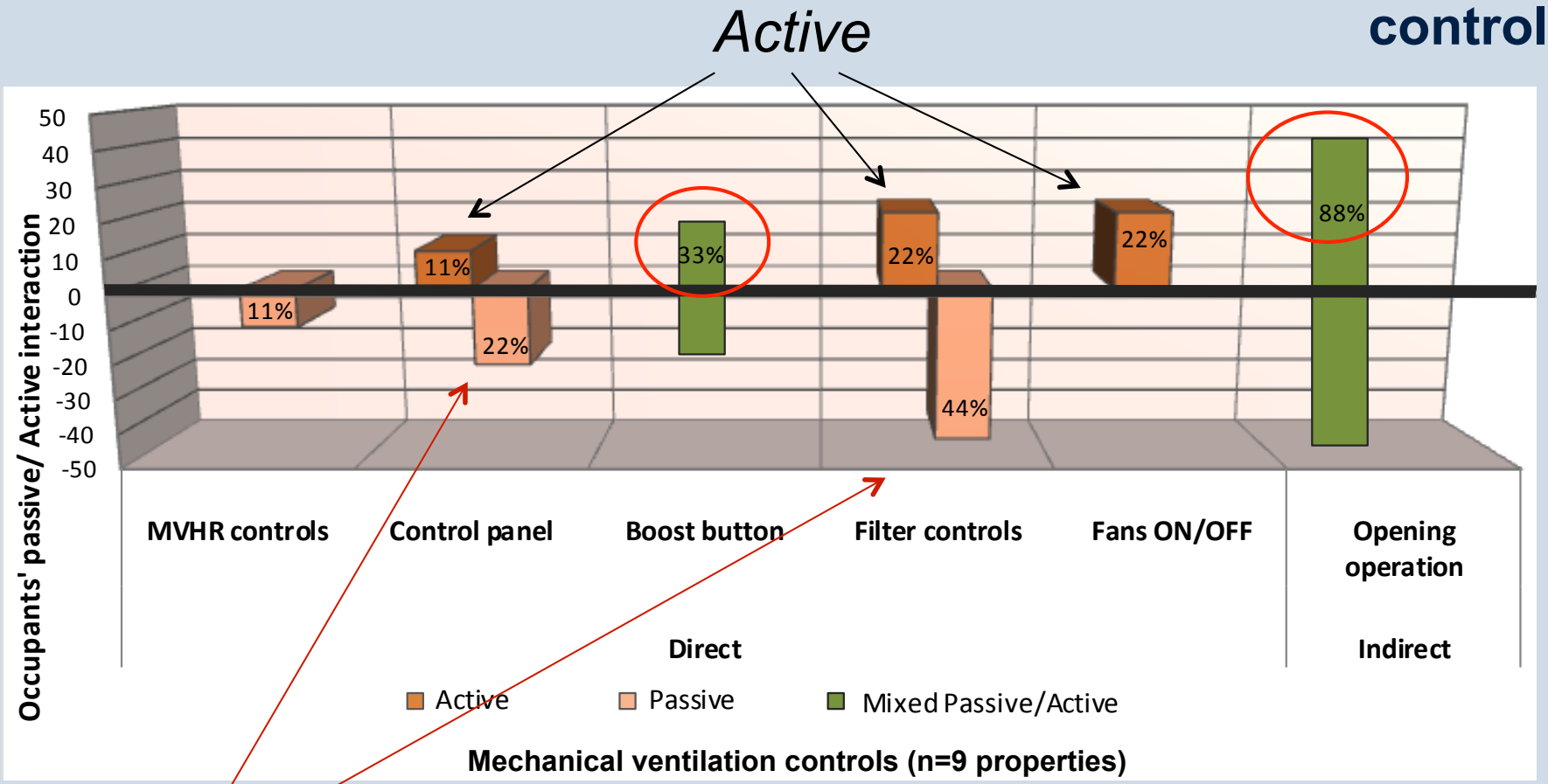


Technical and behavioural factors affecting direct /indirect natural ventilation controls

Interaction with natural ventilation controls

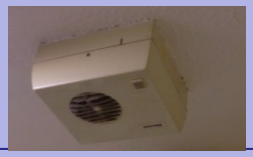
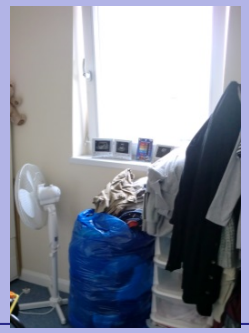
Key factors	Occupant (user)	Technology	Interaction
Habits & comfort preferences	- *Airing, smoking cooking and bathing practices* - *Regulating comfort levels*	*Windows and doors*  	**Active**
Behavioural	*Levels of privacy and security*	*Windows and doors* 	**Mixed passive / active**
Knowledge	*Level of information and demonstration of the measure*	Windows trickle vents 	
Scripted technology	- *Level of control left to the user* - *Difficulty of operation*	*Design or installation failures*   	**Passive**

Post-experience: Interaction with mechanical ventilation controls



Poor training and mixed understanding of mechanical ventilation controls with natural ventilation controls

Interaction with mechanical ventilation controls

Key factors	Occupant (user)	Technology	Interaction
Knowledge	*Past experience and know-how*	*Conventional fans*  	**Active**
	- Level and type of training *- Users proactivity in learning*	*MVHR system controls*   	**Mixed passive / active**
Behavioural	*- Regulating comfort levels* *- Energy cost concerns* *- Airing, smoking, cooking and bathing practices*	*MEV/MVHR/Fans*   	
Scripted technology	*Level of control left to the users*	*Design or installation*  	**Passive**

Summarizing

Past-interaction:

- **Active measures** as performed used to involve direct interaction with **passive users**

Post-interaction :

… the change

- **Active low-carbon measures** as designed and installed have fostered direct interaction involving **active users**
- **Active low-carbon measures** designed to be active but installed to respond in a mixed active/passive way to occupants' in-use controls tend to involve **passive users**
- **Passive low-carbon measures** designed and installed for passive users tend to involve indirect interactions with **mixed passive/active users**

Key messages

Factors affecting interaction with new low-carbon measures:

- **Poor level of information/training** and the **lack of expertise** to demonstrate low-carbon measures controls

- **Design and installation faults** of combined systems resulting to **operational limitations** at the in-use stage

- Occupants' **mixed understanding** of low-carbon measures and costs resulting to **occupants' behavioural changes** in habits, routinized practices and comfort preferences

Thank you for your attention!

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