H2020 PROGRAMME

H2020-EE-2014-2-RIA
Research & Innovation Action

OrbEEt

Organizational Behaviour Improvement for Energy Efficient Administrative Public Offices

Co-Funded by the EU Horizon 2020 research and innovation programme under grant agreement No 649753

GRINDROP
Smart Homes and Living Offices

Christos Malavazos,
Co-Founder and CTO

The OrbEET Consortium

Social Sciences

BPM

Public Admin

ICT

Energy

Coventry University

www.boc-group.com

Friedrich-Alexander-Universität Erlangen-Nürnberg

HYPERTECH
INFORMATION TECHNOLOGY

GRINDROP
Smart Homes and Living Offices

Solintel

Balkanika ENERGY

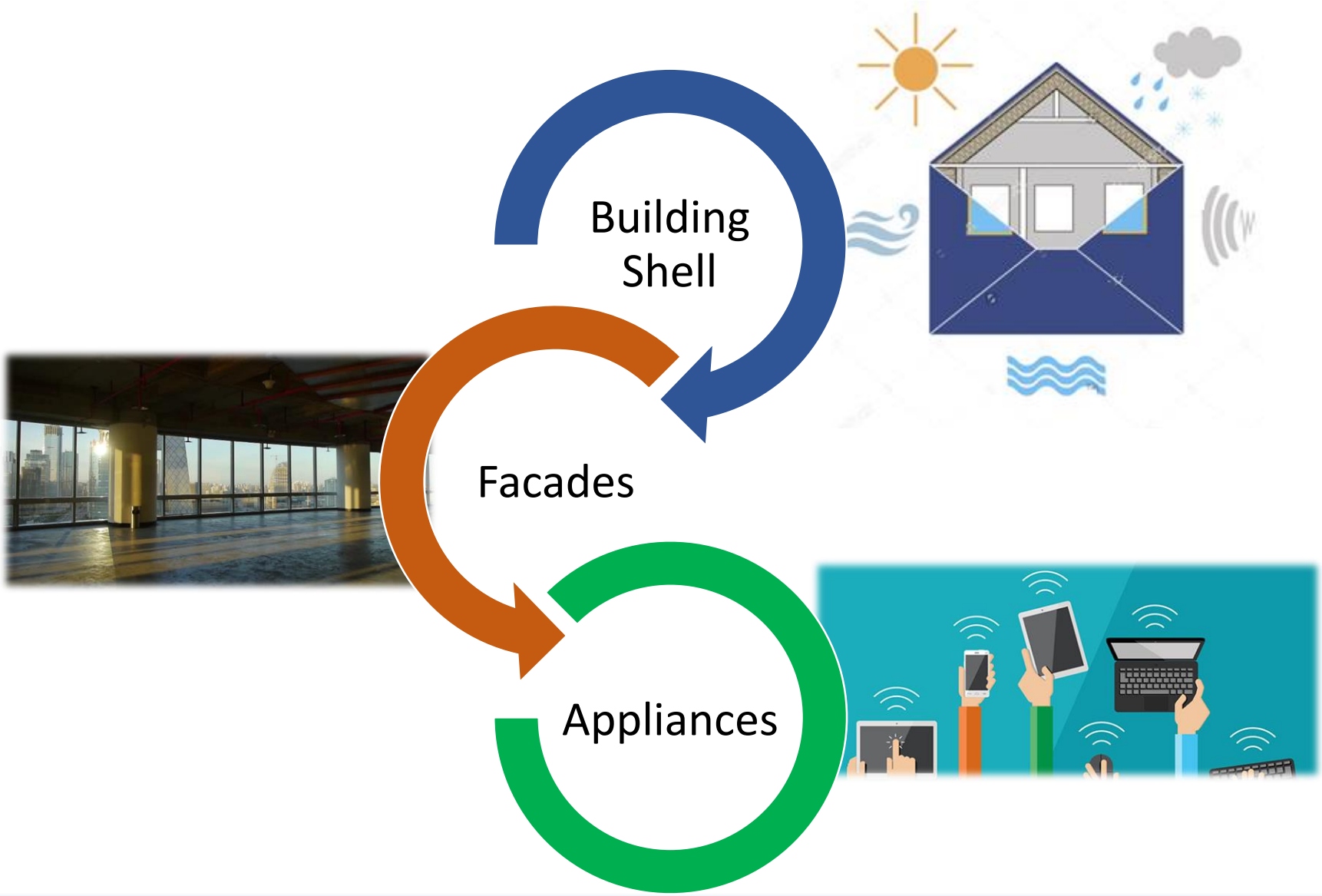
GRINDROP

HueMate

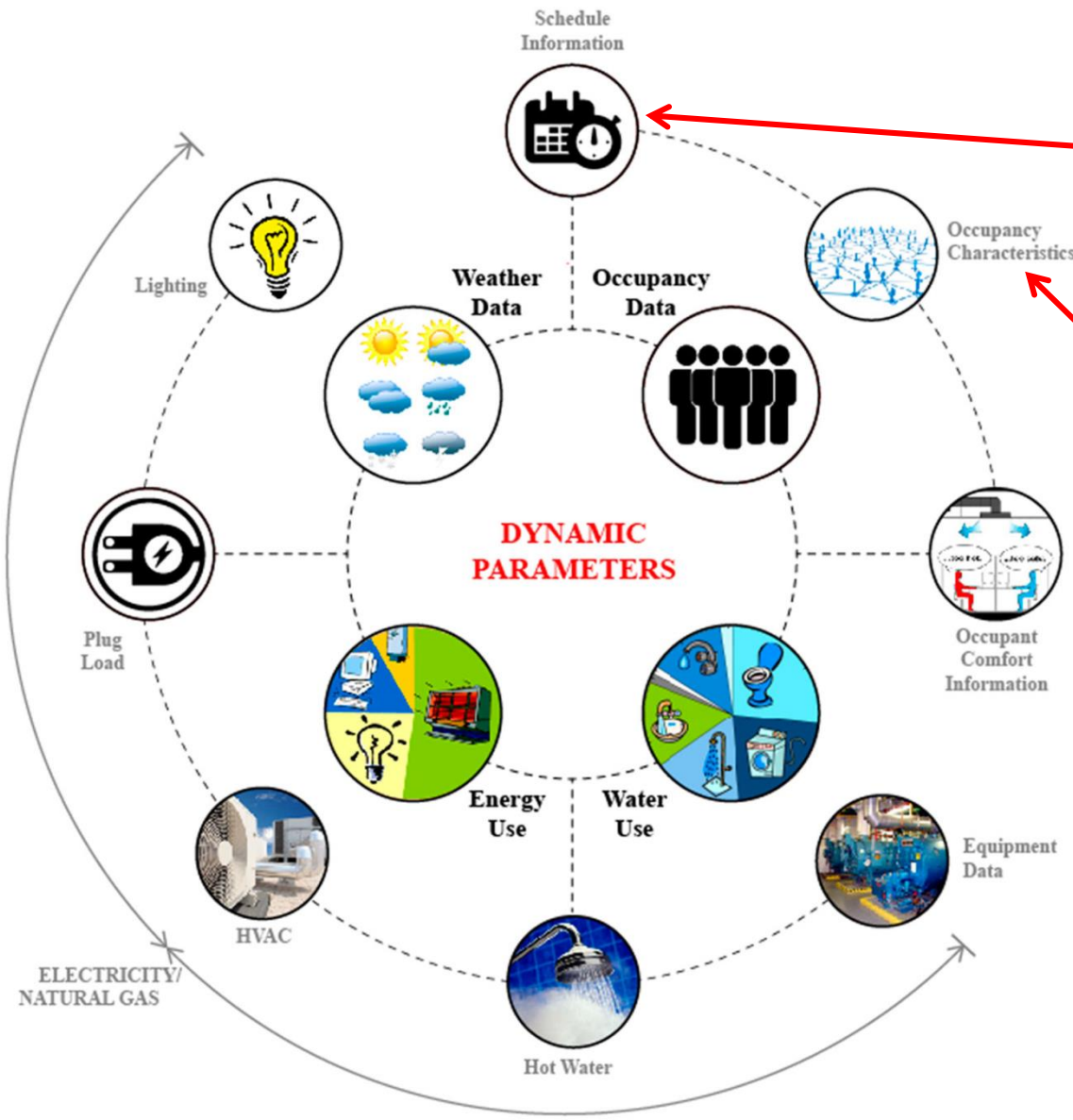
DOME

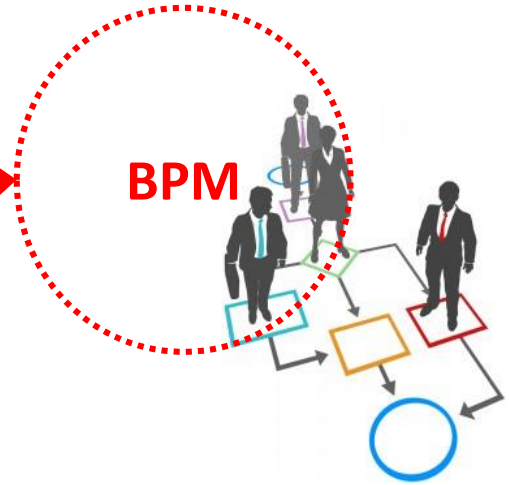
uela

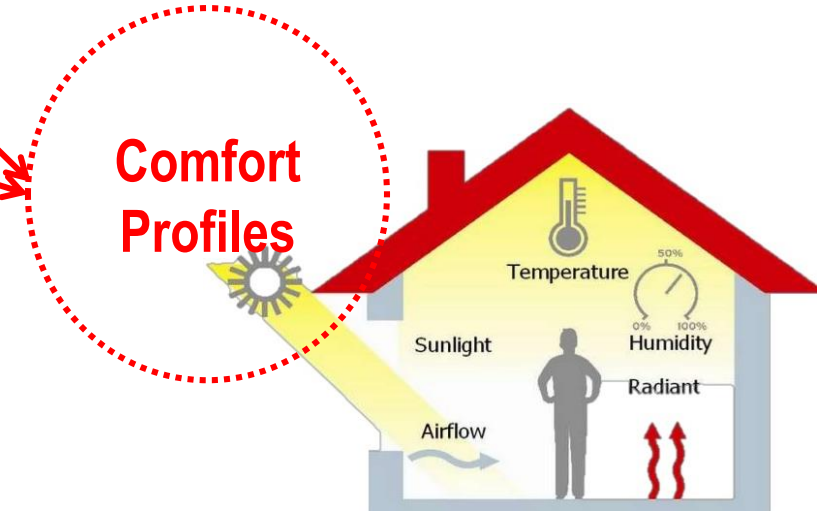
Building DNA: The 3 Genes Myth



Dynamic Factors of Energy Uses







Taxonomy of data types (dynamic parameters) in a building.
Mantha, Menassa & Kamat, 2015, University of Michigan

Savings through Building Control

Energy savings from monitoring and controlling HVAC system operations in buildings.

Strategies	Savings	Source
Occupancy-based demand response HVAC control strategy	20%	Erickson and Cerpa, (2010)
Fully integrated building, HVAC, and contr simulations	60%	Mathews et al. (2001)
Evaluating performance indices and implen HVAC control principles		
Interaction between lightning and space co		
Occupancy-based system		
HVAC Equipment right-sizing		
Predictive controllers for energy savings		
Regulating the indoor set point temperature		

Energy savings from monitoring and contr

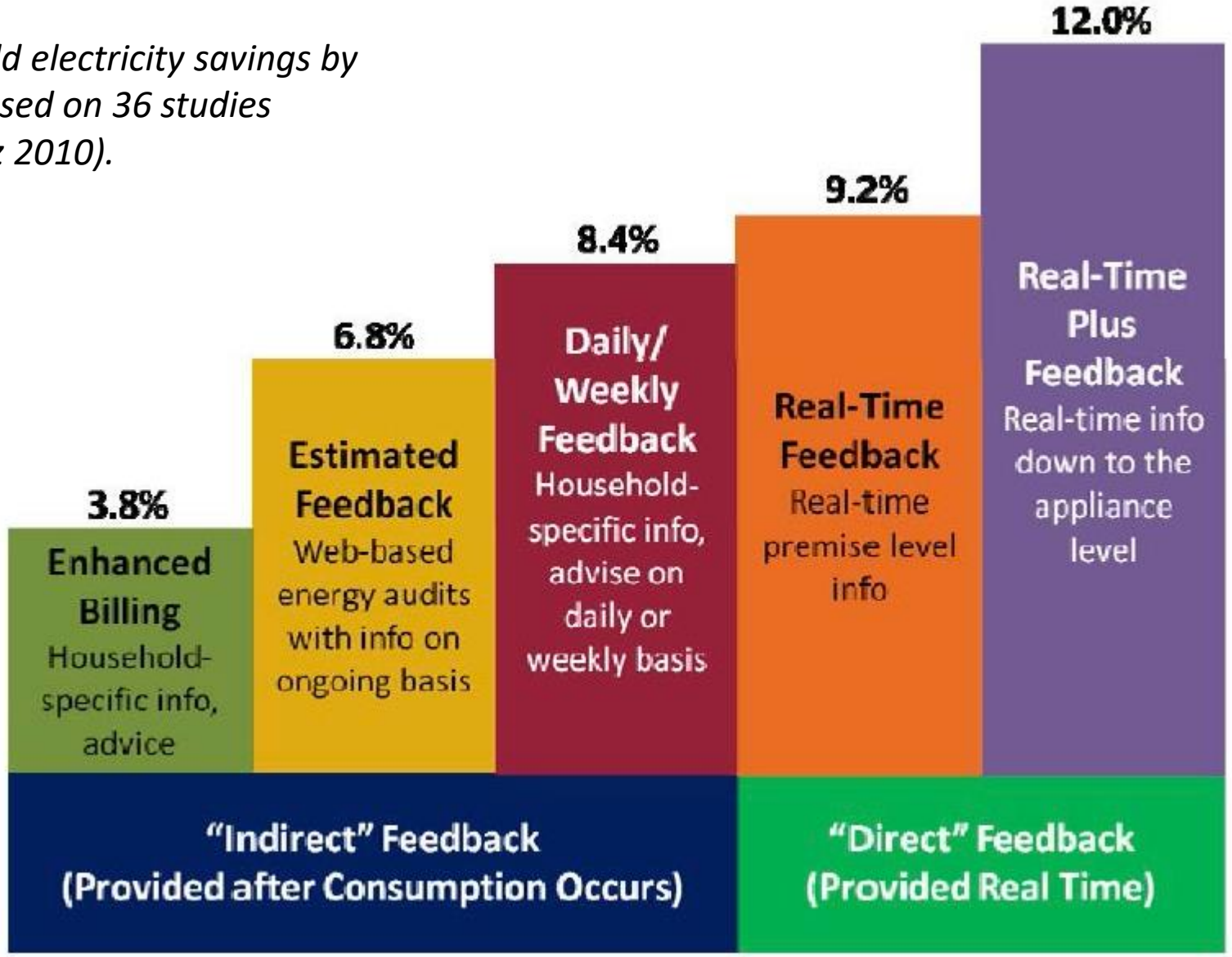
Strategies	Percen of sav	
Daylighting	20–8	
Personal tuning: using automatic dimming control for lighting	43	
Using occupancy sensors	30	Chung and Burnett (2001)
Multiple types	28–61	Fernandes, Lee, DiBartolomeo, and McNeil, (2014) and Building Design and Construction [BDC] (2010)

Energy savings from monitoring and controlling plug loads and per appliance power consumption in real time.

Strategies	Savings	Source
Sensor-based intelligent system	Not quantified	Anastasi, Corucci, and Marcelloni (2011)
Serious game interventions	7–23%	Orland et al. (2014)
RECognition of electrical Appliances and Profiling in real time (RECAP)	Not quantified	Ruzzelli et al. (2010)
Plug load energy management solution	43–67%	Ghosh et al. (2013)
ViridiScope	Not quantified	Kim, Schmid, Charbiwala, and Srivastava (2009)
Energy-efficient PPL equipment and design strategies	47%	Lobato, Pless, Sheppy, and Torcellini (2011)
Appliance activity monitoring using wireless sensors	Not quantified	Schoofs et al. (2010)

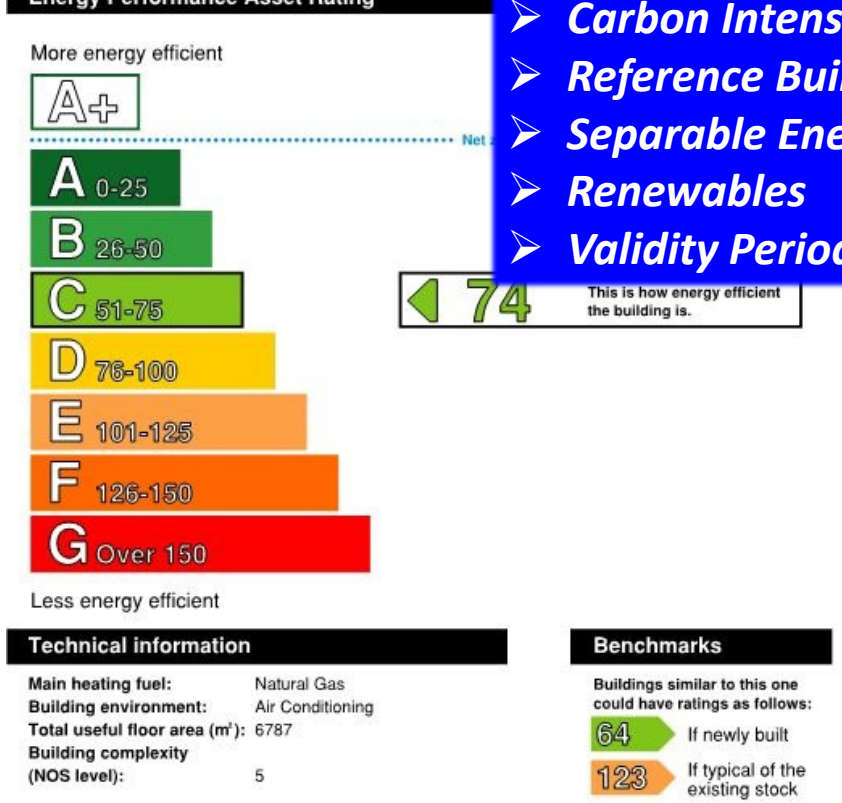
Savings Through User Feedback

Average household electricity savings by feedback type, based on 36 studies (Erhardt-Martinez 2010).



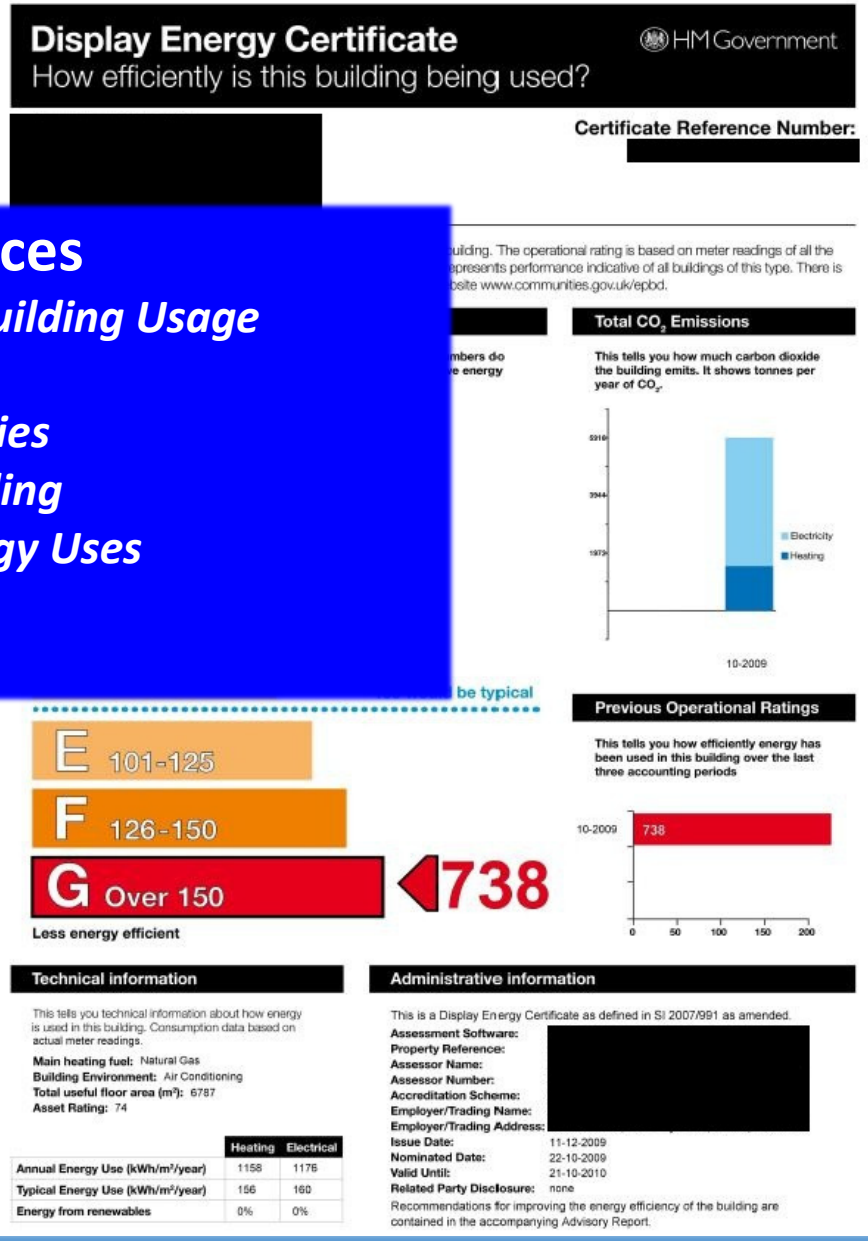
Energy Performance Certificates

Asset Rating



Main Differences

- ***Occupancy & Building Usage***
- ***Plug Loads***
- ***Carbon Intensities***
- ***Reference Building***
- ***Separable Energy Uses***
- ***Renewables***
- ***Validity Period***



Operational Rating

Operational Rating: What is missing ?

Gaps in existing Operational Rating methods

- ***Occupancy*** *(Average Occupancy Density normalized based on building operating hours)*
- ***Ambient Conditions****: Only HDD are used (no CDD are taken into account) and no daylight information (Pro-Rata Basis Calculation for Lighting)*
- ***Organizational*** *Aspects not considered*
- ***Plug Loads*** *(no detailed account of specific types of office loads)*
- ***Baselining*** *based on* ***Annual*** *Measurements*

The OrbEET Framework

Real Time energy and context data monitoring

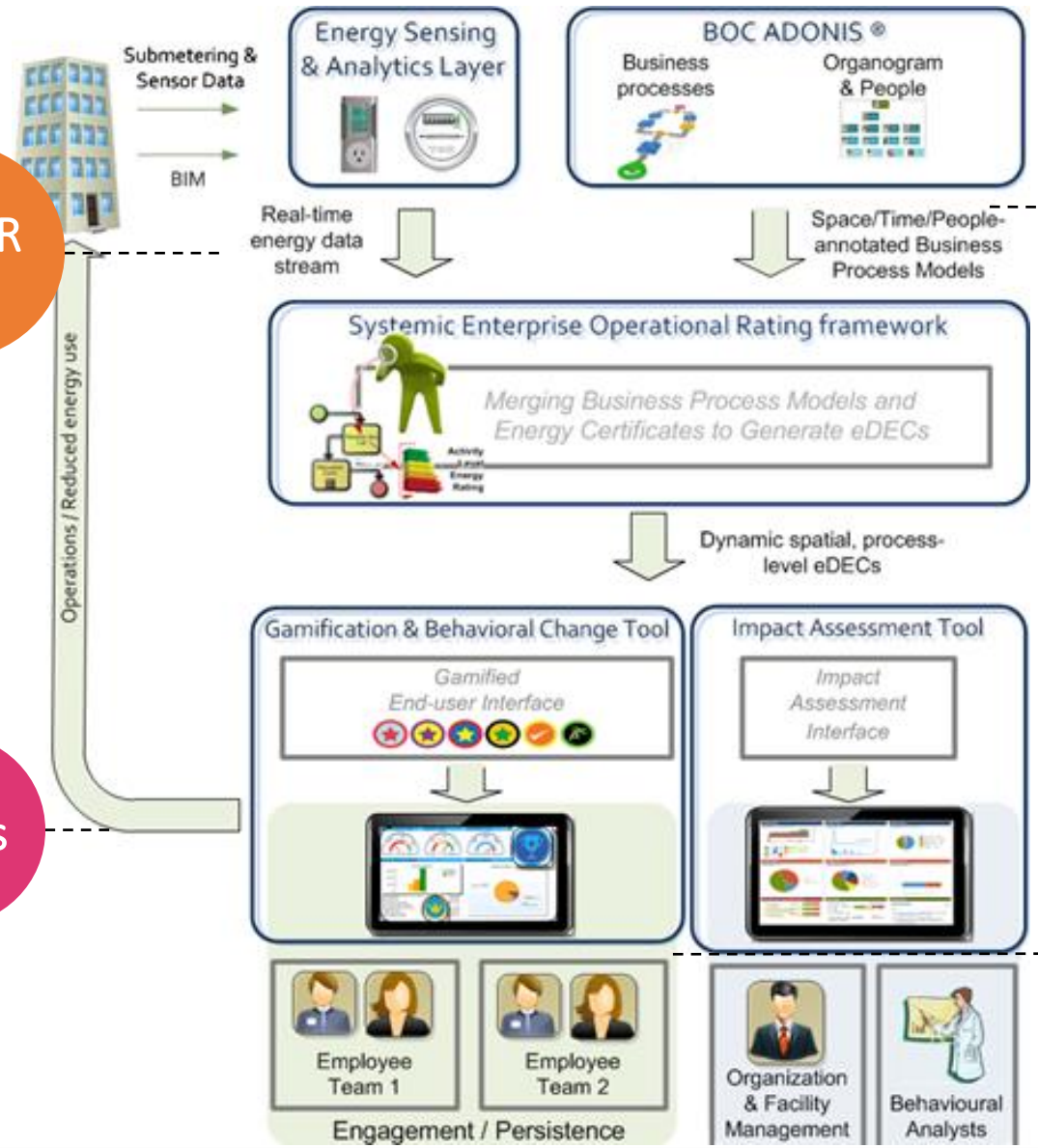
Dynamic Baselining

SENSOR DATA

eDECs-Enhanced Display Energy Certificates

eDECs

Relevant
Timely
Holistic Feedback



BUSINESS PROCESS

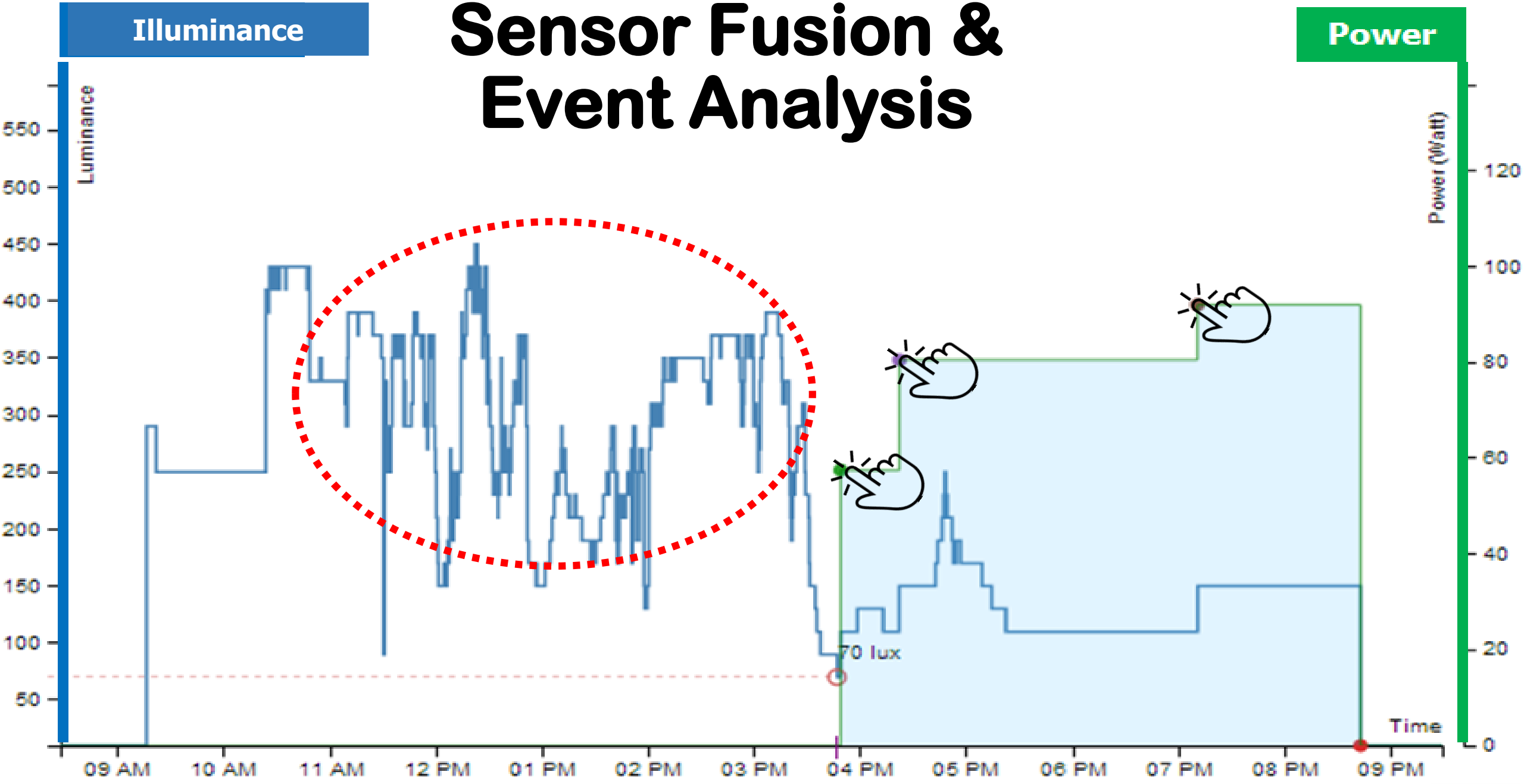
Incorporation of Building Specific Business Processes

GAMIFICATION

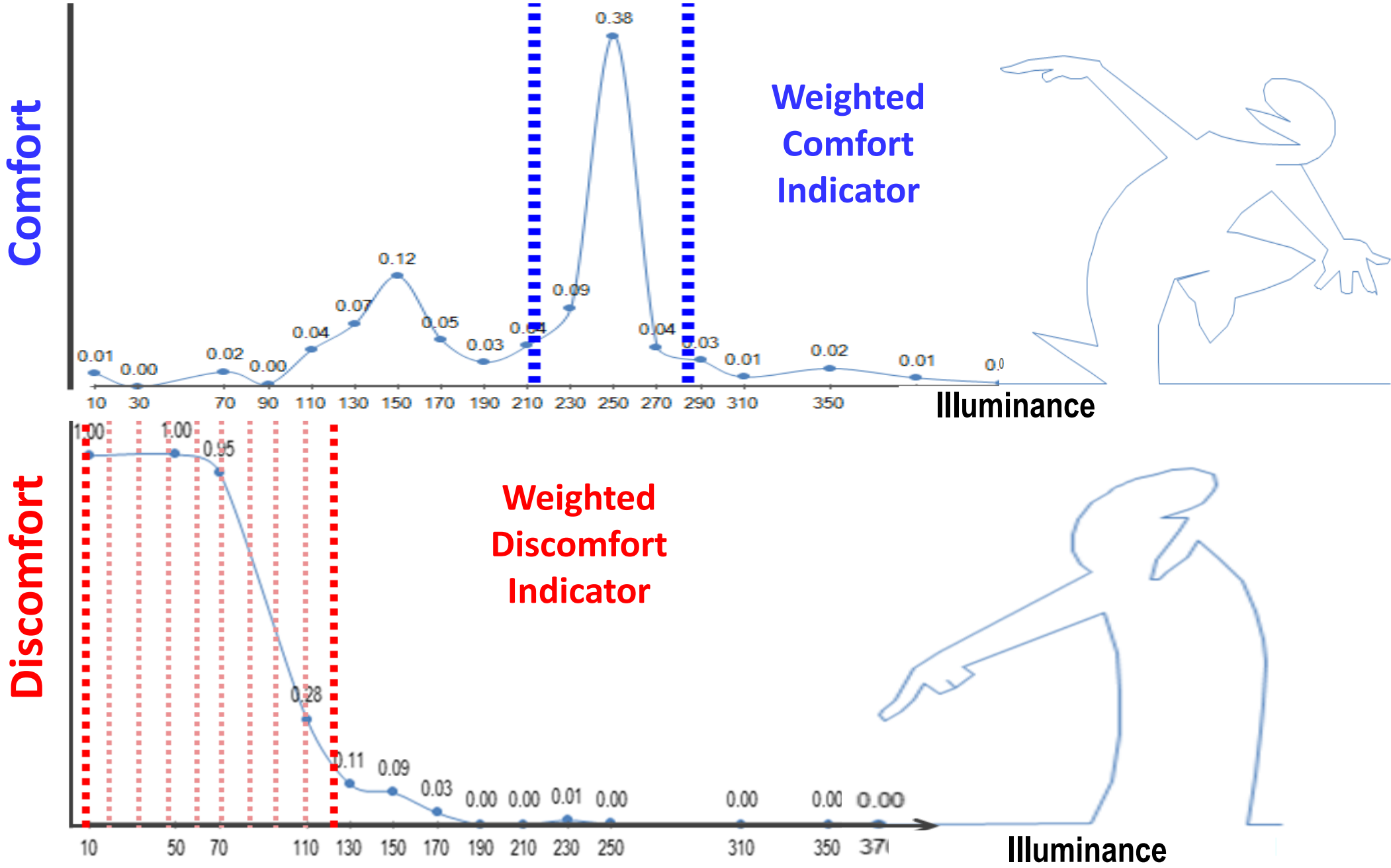
Gamification Tool for behavioural change campaigns

Emotional Design

Sensor Fusion & Event Analysis



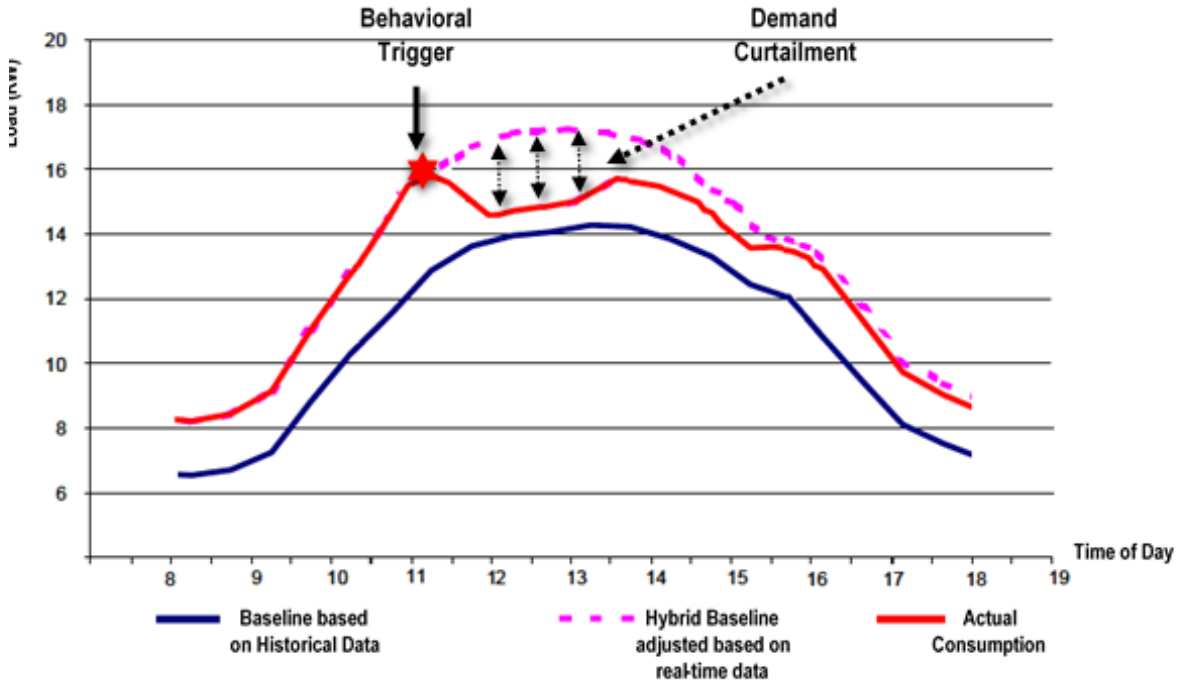
Comfort Profiling



OrbEET Hybrid Baselining

PROS & CONS OF IPMVP OPTIONS AGAINST ORBEET CHALLENGES

Characteristics	Option B	Option C	Option D	Hybrid
Sub-metering information	X			X
Ability to Assess savings at the level ECM was applied	X			X
Routine and non-routine dynamic adjustments required	X	X		X
Whole facility level (> than 1 ECM)		X	X	X
Prerequisite: Energy savings > 10%		X		X
Performance Measurement based on Energy Simulation			X	X
Low-cost efficient non-intrusive infrastructure		X	X	X
Varying measurement periods per load	X		X	X



Enhanced Display Energy Certificates - eDECs

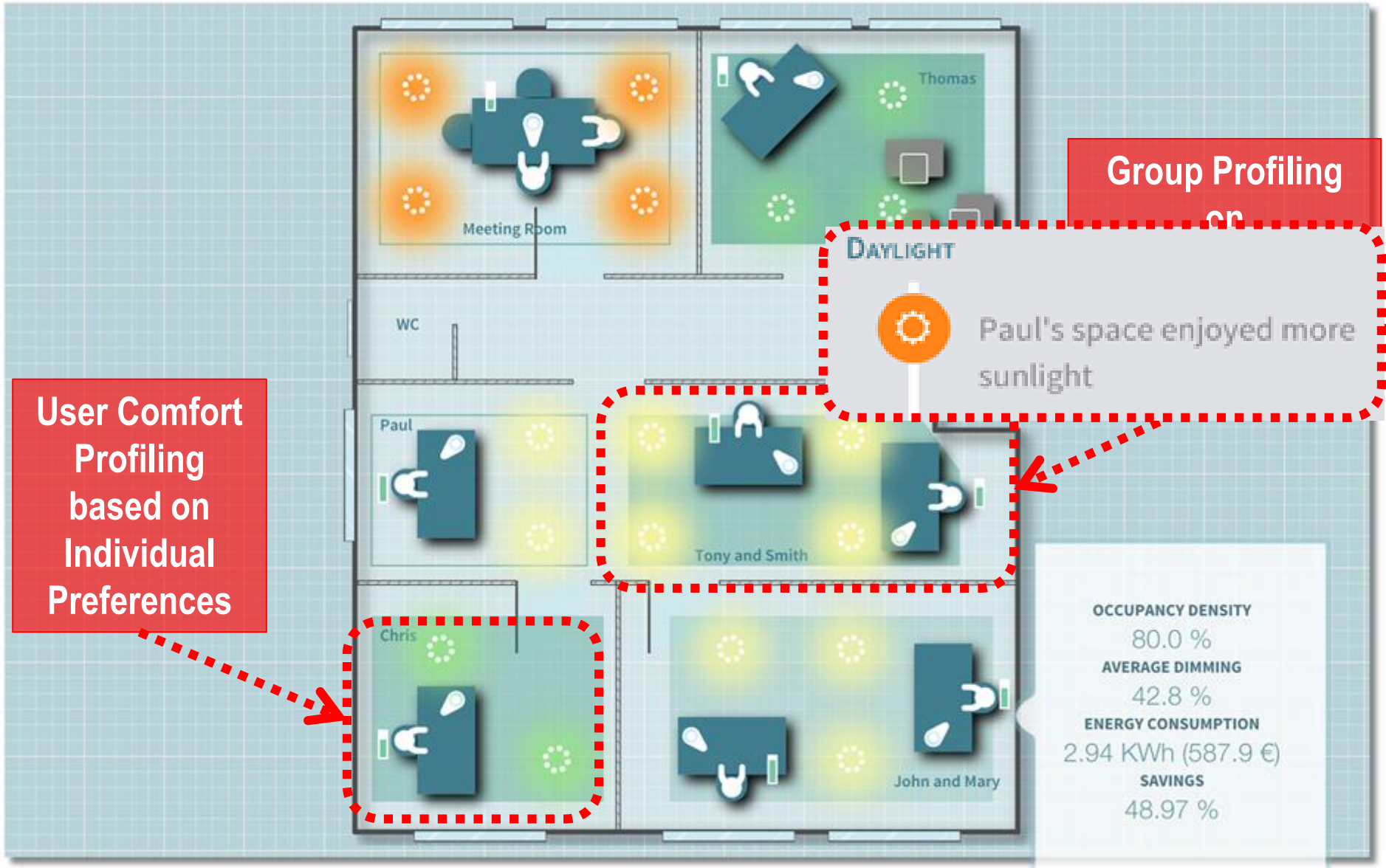
Organizational Aspects

Comfort Aspects

Facility Manager

OPERATION MODE | CONSUMPTION

09/11/2015 9:00 AM - 13/11/2015 3:00 PM



User Comfort Profiling based on Individual Preferences

Group Profiling on

DAYLIGHT

Paul's space enjoyed more sunlight

OCCUPANCY DENSITY
80.0 %
AVERAGE DIMMING
42.8 %
ENERGY CONSUMPTION
2.94 KWh (587.9 €)
SAVINGS
48.97 %

PEOPLE

- Most occupied space was Paul's
- Brightest space was Meeting Room
- Darkest space was Thomas's

LIGHTS

- Meeting Room space used more light
- Thomas's space used less light
- Most efficient space was Chris's

DAYLIGHT

- Paul's space enjoyed more sunlight
- Tony & Smith space received the least sunlight
- Luminance 368 lux

ENERGY

- Consumption 590 kWh
- CO2 emissions 342 kg

OrbEEt Pilot Validation

AUSTRIA

BULGARIA

GERMANY

SPAIN

FUTURE WORK

- **Extensive Validation** *focusing on effectiveness, cost-efficiency, user acceptance as well as persistence of effect*
- **Integration** with the **OrbEEt Behavioural & Gamification Platform**
- **Open Reference OrbEEt Models**
- *Generic OrbEEt* ***Interfaces for Building Automation***

OrbEEt

www.orbeet.eu

Christos Malavazos,

Co-Founder and CTO

www.grindrop.com

c.malavazos@grindrop.co.uk