

The logo for Interreg Central Europe, featuring the word "Interreg" in a large, bold, blue sans-serif font, with "CENTRAL EUROPE" in a smaller, blue sans-serif font below it.

CENTRAL EUROPE




European Union
European Regional
Development Fund


TOGETHER

A map of Europe with a green overlay. The overlay consists of several overlapping, semi-transparent green rectangles of various sizes, creating a layered effect. The text "TAKING COOPERATION FORWARD" is written in white, bold, sans-serif capital letters on the right side of the map.

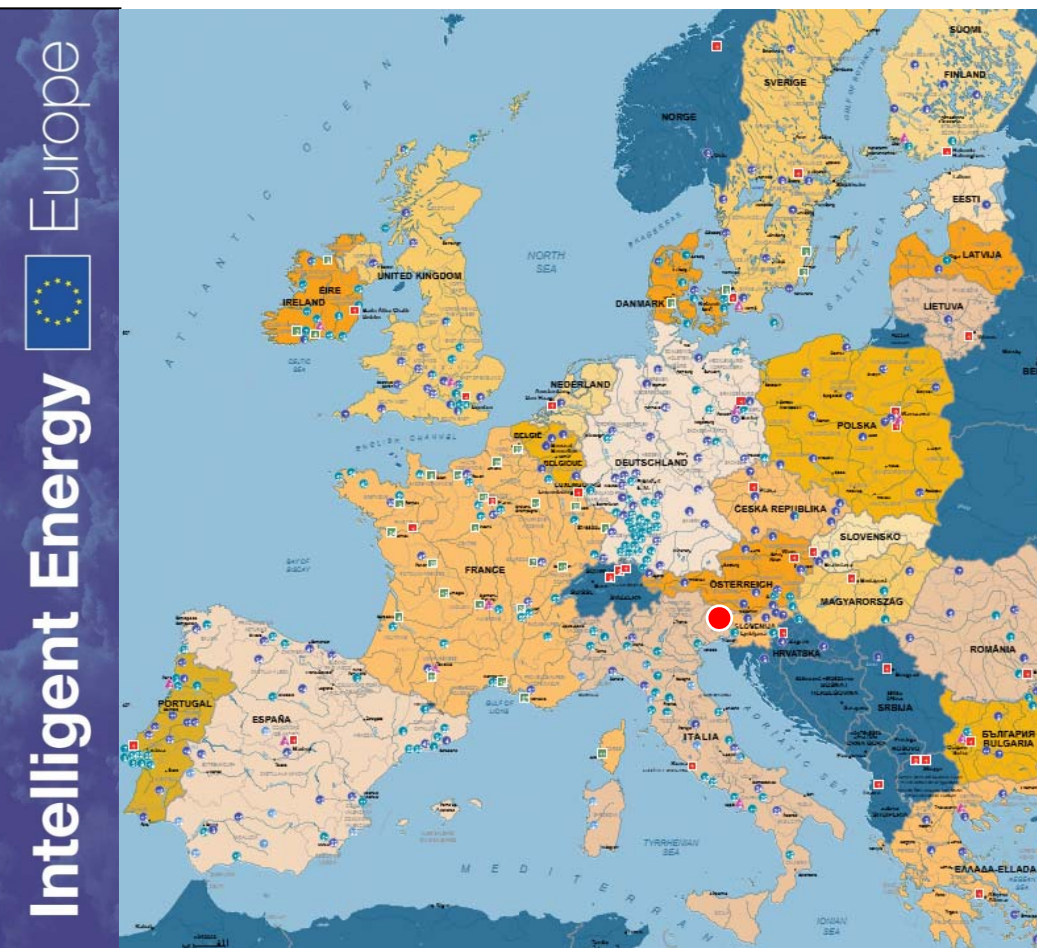
TAKING
COOPERATION
FORWARD

 International Workshop about Energy Consumer Behaviour, Consumption Practices and Rebound Effect
Maribor, 10th April 2018

 **DSM: measurements and initiatives to manage
user behaviour and improve energy efficiency**

 Fabio Dandri (Energy Agency of Friuli Venezia Giulia, Italy)

ENERGY AGENCY OF FRIULI VENEZIA GIULIA



Established in 2006 by local public bodies
(today, 65 members, mainly Municipalities)

Non profit Organization
(legally recognized, Public Equivalent Body)

Permanent staff of 12 people
with scientific and technical background

Works to promote energy efficiency
and use of renewable energy sources

Provides independent advice to public and
private subjects developing sustainable energy
investment initiatives

Develops sustainable energy action plans and
manages the energy cadastre

Trains local professionals in highly specialized
fields of activity related with energy (post
graduate training and vocational training)



What is the meaning of DSM (Demand Side Management)

How can people behaviour influence energy consumption

How can we estimate the behavioural effects through energy needs calculations

The importance of measurements within analytical and behavioural components of DSM

What kind of initiatives can we plan to address the behaviour of building's users toward energy efficiency



How many
Chinas does it take
to support China?

CHINA 2.5

What about some other countries?

FRANCE 1.6

INDIA 1.8

U.S.A. 1.9

EGYPT 2.4

GREECE 3.1

U.K. 3.5

ITALY 4.0

SWITZERLAND 4.2

QATAR 5.7

JAPAN 7.1

WORLD 1.5

RESOURCE CONSUMPTION

source: www.footprintnetwork.org, www.overshootday.org

EARTH OVERSHOOT DAY 2017



2016: 8 August
2015: 9 August
2010: 14 August
2005: 29 August
2000: 25 September

1995: 7 October
1990: 13 October
1985: 6 November
1980: 5 November
1975: 3 December

**DIRECTIVE 2010/31/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
of 19 May 2010
on the energy performance of buildings**

- (3) Buildings account for 40 % of total energy consumption in the Union. The sector is expanding, which is bound to increase its energy consumption. Therefore, reduction of energy consumption and the use of energy from renewable sources in the buildings sector constitute important measures needed to reduce the Union's energy dependency and greenhouse gas emissions.
- (4) Management of energy demand is an important tool enabling the Union to influence the global energy market and hence the security of energy supply in the medium and long term.



DECEMBER 2008 - CLIMATE AND ENERGY PACKAGE "20 20 20" APPROVED TARGETS BY 2020:

20% CUT IN GREENHOUSE
GAS LEVELS
(FROM 2005 LEVELS)



20% IMPROVEMENT
IN ENERGY
EFFICIENCY

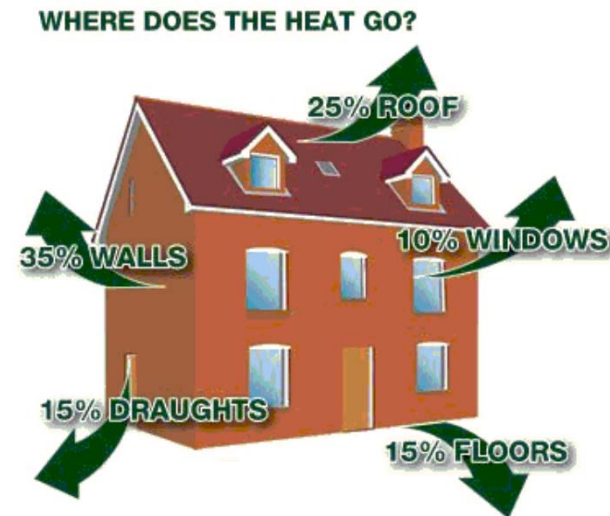


20% OF EU ENERGY
DEMAND FROM
RENEWABLES



THERMAL AND ELECTRIC CONSUMPTION:

- Targeted investment in **technical and technological interventions** can lead to energy savings of up to **50-60%** or more, not to mention additional savings from renewable sources.
- Little money is needed to achieve a reduction of up to **15-20%** in energy consumption through **DSM**, rational use of energy, improved organization and end user awareness.



Demand Side Management

According to Wikipedia, the term DSM was coined following the time of the 1973 and 1979 energy crises. Governments of many countries mandated performance of various programs for energy demand management through financial incentives and education and training campaigns.

Usually, the goal of demand-side management is to encourage the consumer to use less energy during peak hours, or to move the time of energy use to off-peak times such as nighttime and weekends.

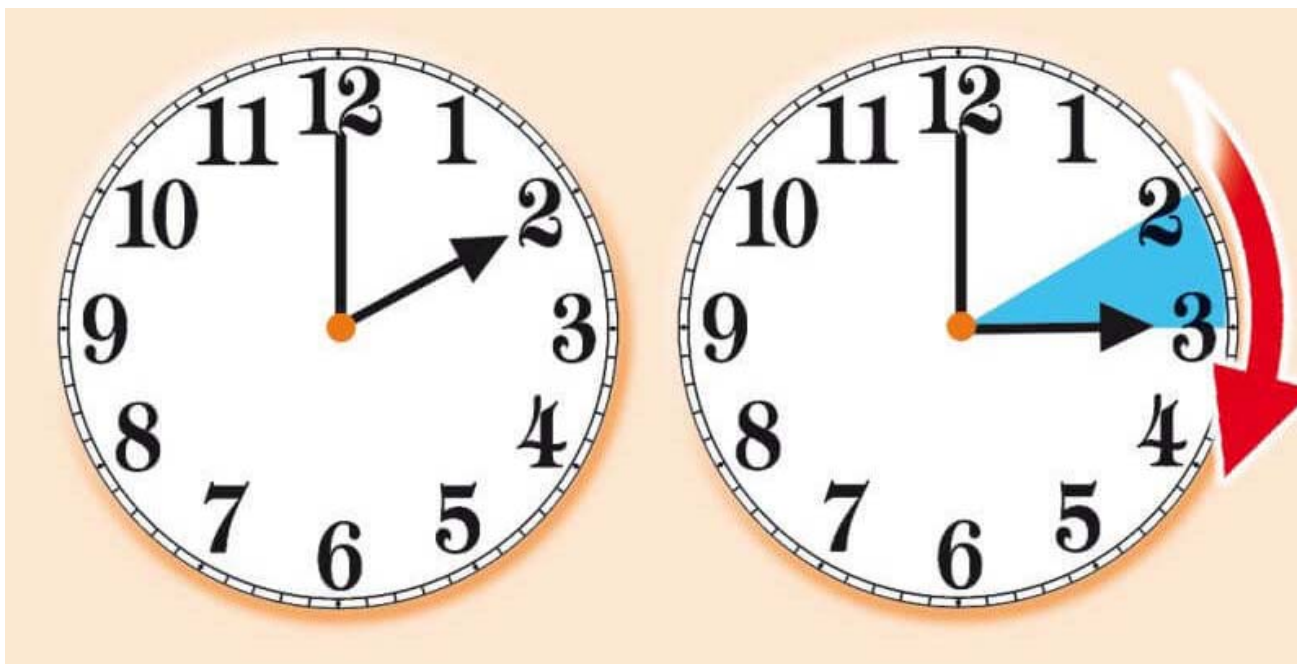
Source: en.wikipedia.org

- Information produces higher levels of knowledge but not necessarily changes in behaviour.
- Incentives and rewards are generally effective in generating energy savings but these can be short-lived.

Source: Staddon, Cyclic, Goulden, Leygue, Spence, "Intervening to change behaviour and save energy in the workplace: a systematic review of available evidence" in Energy Research & Social Science (www.elsevier.com/locate/erss)



DAYLIGHT SAVINGS TIME



Demand Side Management

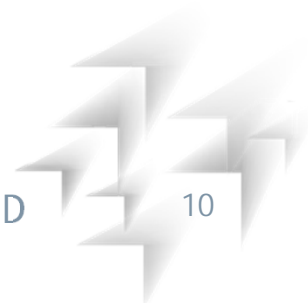
Energy demand management

i.e. to control the time of energy use through:

- peak demand reduction (peak shaving);
- energy demand reduction through energy efficiency;
- supply and demand balance (by managing demand);
- encourage better decisions on the choice of supply sources;
- awareness-raising and consumer information (e.g. energy labels) and incentives (e.g. campaigns for the replacement of old equipment)

Who are the promoters of DSM actions

- governments
- energy providers
- public buildings' owners
- consumers



Energy consumption can increase or decrease considerably depending on 2 behavioural models:

- behavioural models targeting specialized workers managing and controlling technical systems of buildings;
- behavioural models targeting end users (civil servants, students, etc.)

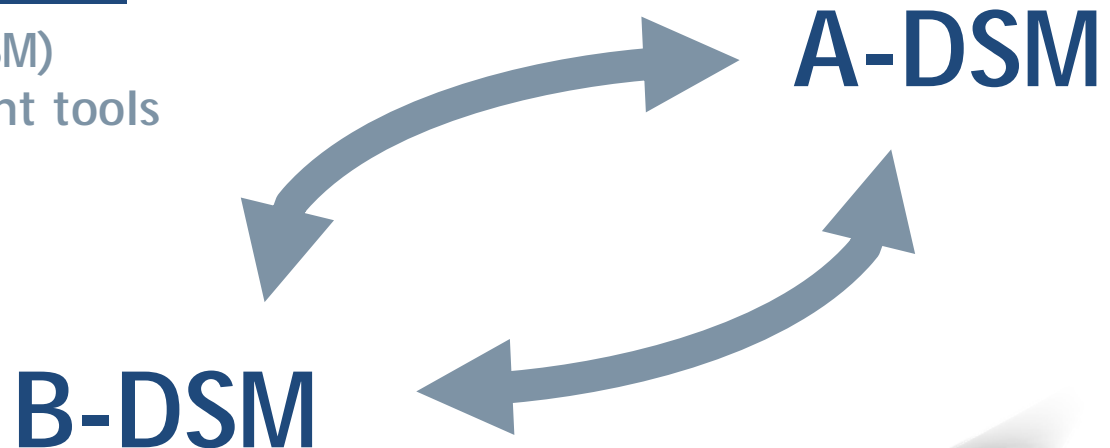


DSM can be classified in 2 categories:

- opportunities for reducing consumption through enhancement of monitoring systems, control, management and automation of buildings (**analytical component, A-DSM**);
- opportunities for reducing consumption through behaviour change at individual level (**behavioural component, B-DSM**).

No measurement means no control!

Both categories (A-DSM e B-DSM) need appropriate measurement tools for the collection and analysis of consumption data.

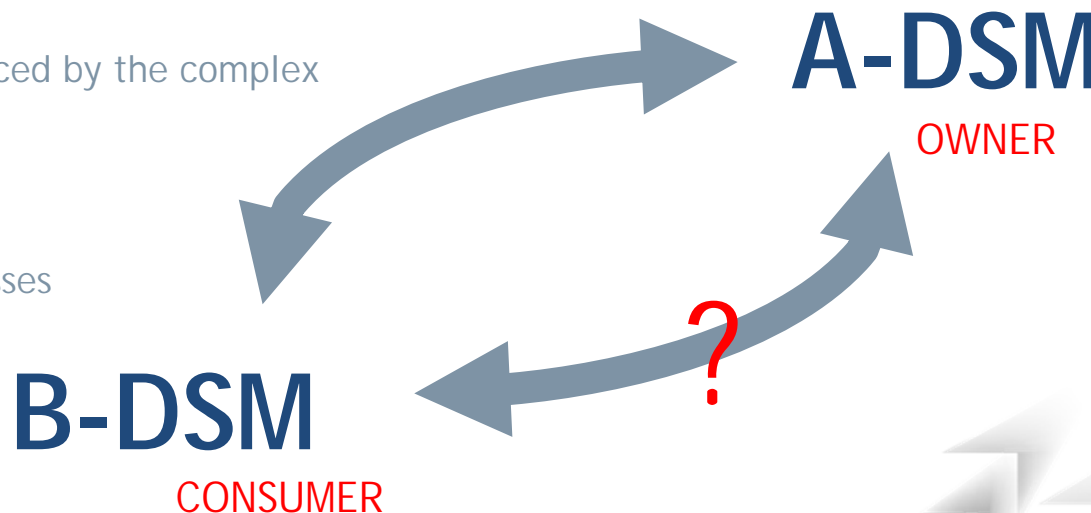


MAIN BARRIERS TO DSM IN PUBLIC BUILDINGS

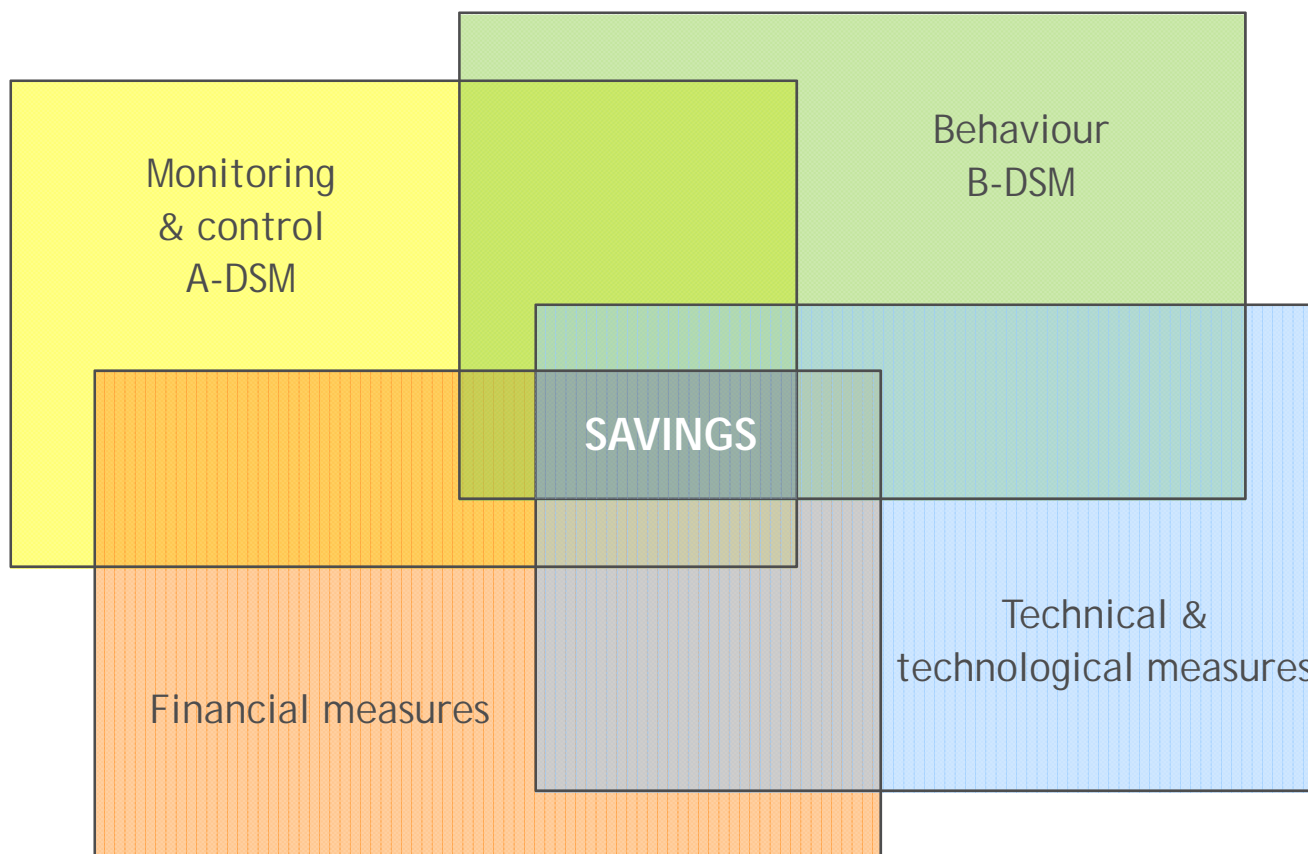
- End users of public buildings do not pay energy.
- End users of public buildings do not own the equipment (therefore, non always keen on taking care of it).
- Behaviour, social and psychological contexts (e.g. behavioural norms and styles, cognitive processes, habits, irrational component in decision-making, etc.).

The end user is not a rational actor, this makes it hard to get accurate estimates.
In particular, human behaviour is influenced by the complex interaction among three factors:

- external factors, like monetary and non-monetary costs;
- internal factors, like cognitive processes and habits;
- social factors, like social norms, cultural aspects and mentality.



ENERGY EFFICIENCY STRATEGIES IN PUBLIC BUILDINGS



VARIABLES AFFECTING ENERGY EFFICIENCY

Energy efficiency depends on:

- **1** technology used
- **2** external factors (weather conditions, location, etc.)
- **3** users behaviour

Example, calculation of energy needed for heating system:

$$Q_{H,nren} = \frac{[(\sum_i U_i \cdot A_i \cdot b_{tr,i} + \sum_i \Psi_i \cdot l_i \cdot b_{tr,i} + \sum_i \chi_i \cdot b_{tr,i}) + (V_n \cdot n \cdot \rho_a \cdot c_a)] \cdot (\theta_i - \theta_{e,j}) \cdot t_j - \eta_{H,gn,j} \cdot [(\sum_i F_{sh,ob,i} \cdot g_{sh,i,j} \cdot g_{gl,i} \cdot A_{g,i} \cdot I_{sol,i,j}) + (\sum_i \Phi_i \cdot t_j)]}{\eta_{gn} \cdot \eta_d \cdot \eta_e \cdot \eta_{rg}} - Q_{H,ren}$$

Diagram illustrating the variables affecting energy efficiency in the heating system calculation formula, categorized by the three main factors:

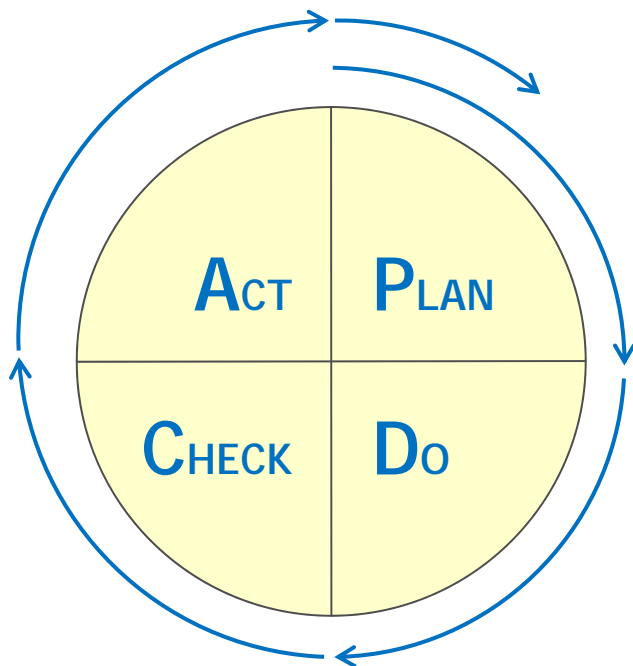
- 1 (Technology used):** U_i , A_i , Ψ_i , l_i , χ_i , V_n , n , ρ_a , c_a , $\eta_{H,gn,j}$, $F_{sh,ob,i}$, $g_{sh,i,j}$, $g_{gl,i}$, $A_{g,i}$, $I_{sol,i,j}$, Φ_i .
- 2 (External factors):** θ_i , $\theta_{e,j}$, t_j , $I_{sol,i,j}$.
- 3 (Users behaviour):** $b_{tr,i}$, $b_{tr,i}$, $b_{tr,i}$, t_j , t_j .

Additional groupings shown in the diagram:

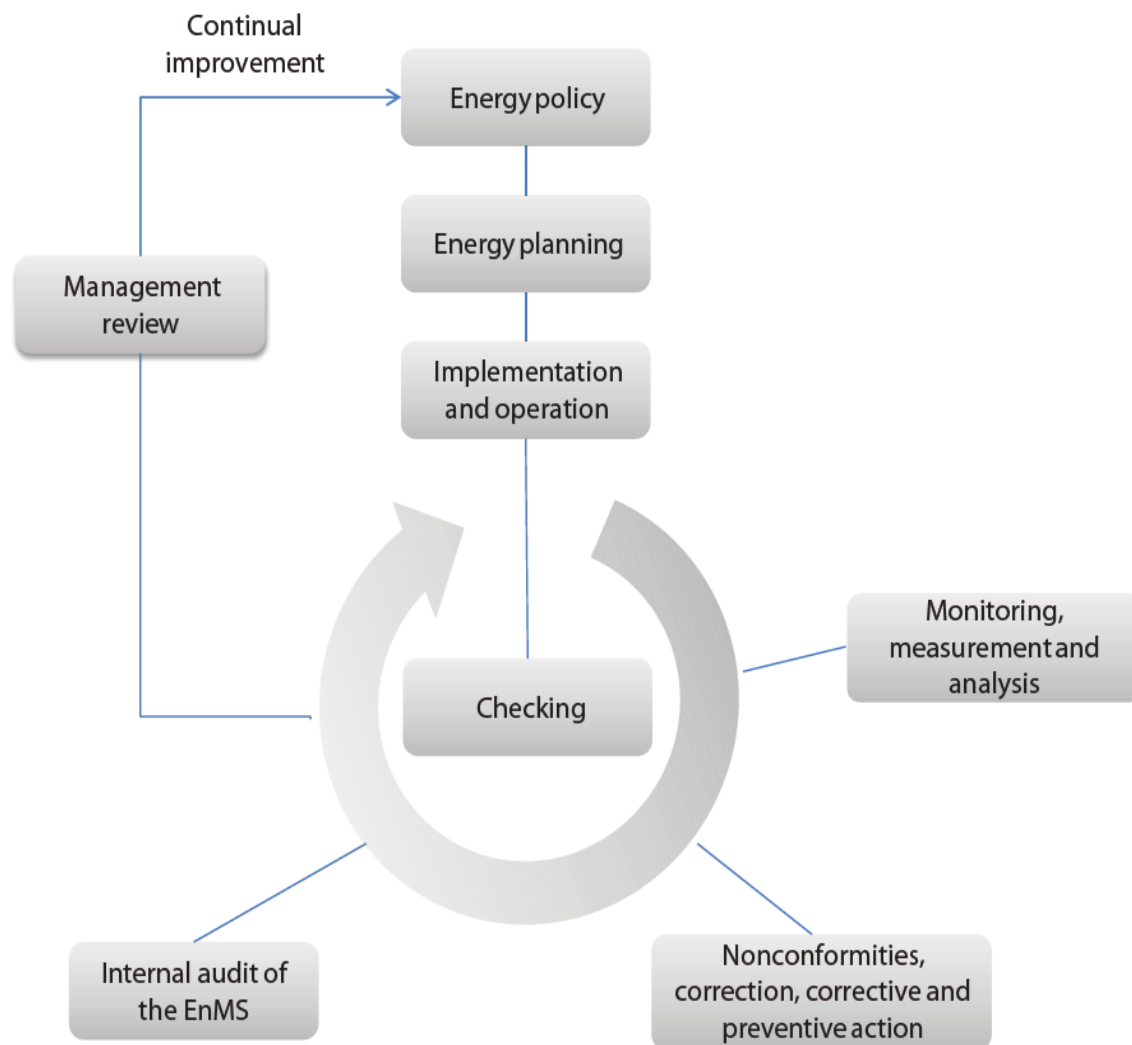
- 1+2:** $(\theta_i - \theta_{e,j}) \cdot t_j$
- 1+2+3:** $\eta_{gn} \cdot \eta_d \cdot \eta_e \cdot \eta_{rg}$
- 1+2:** $(\sum_i \Phi_i \cdot t_j)$
- 1+2:** $Q_{H,ren}$



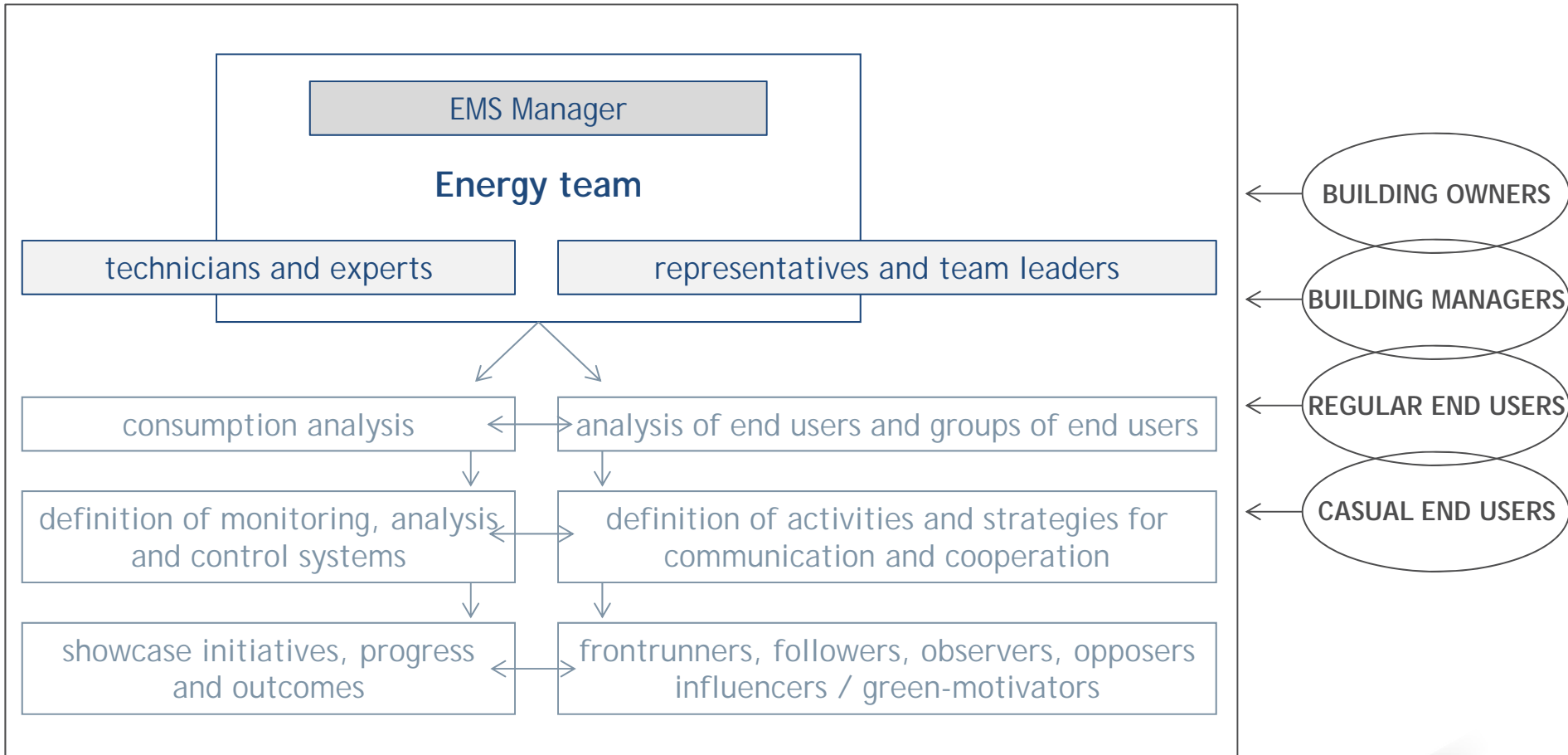
ENERGY MANAGEMENT SYSTEM



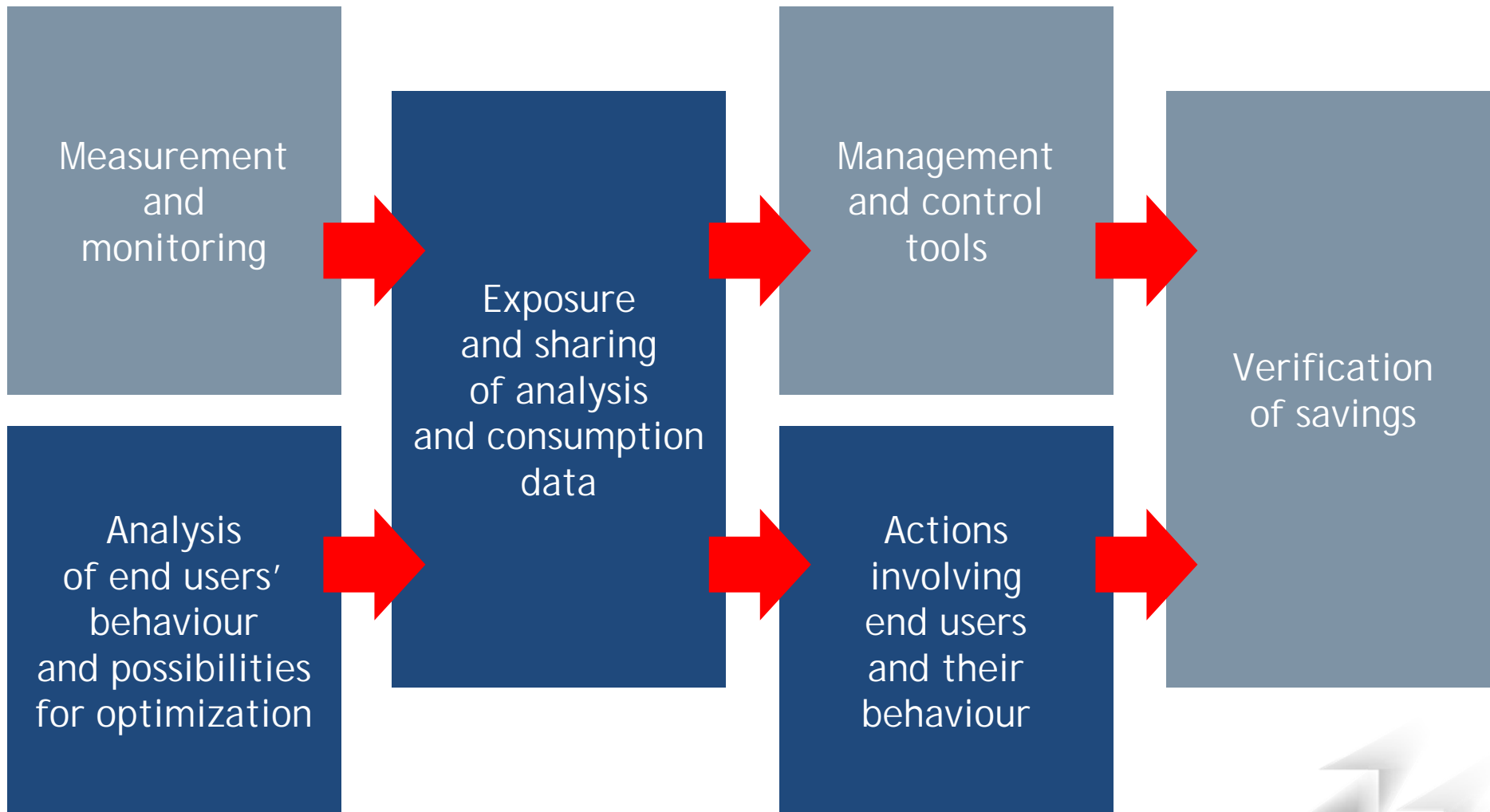
Deming cycle and EMS according to ISO 50001



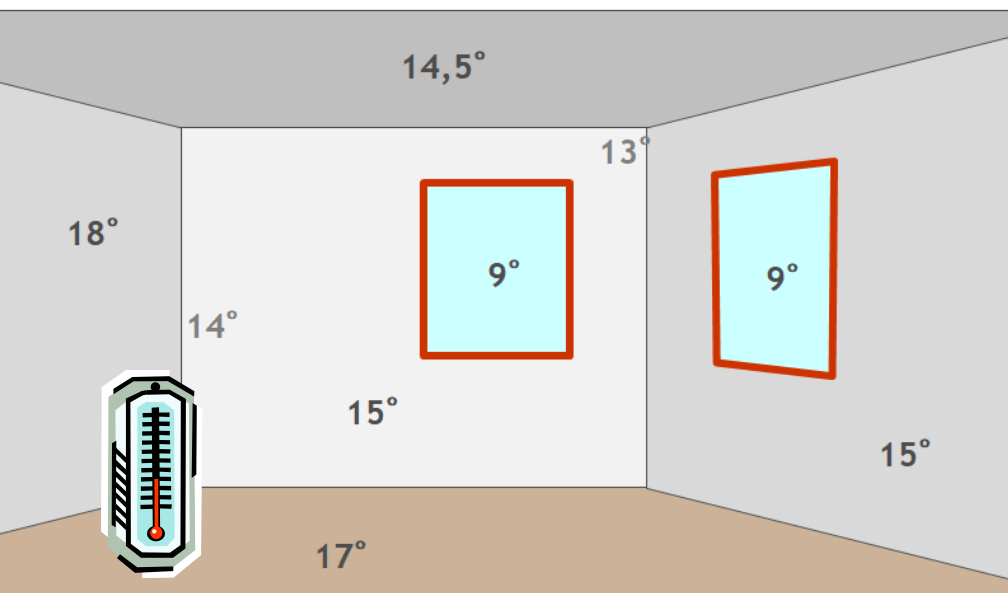
ENERGY MANAGEMENT SYSTEM



A-DSM/B-DSM PROCESS



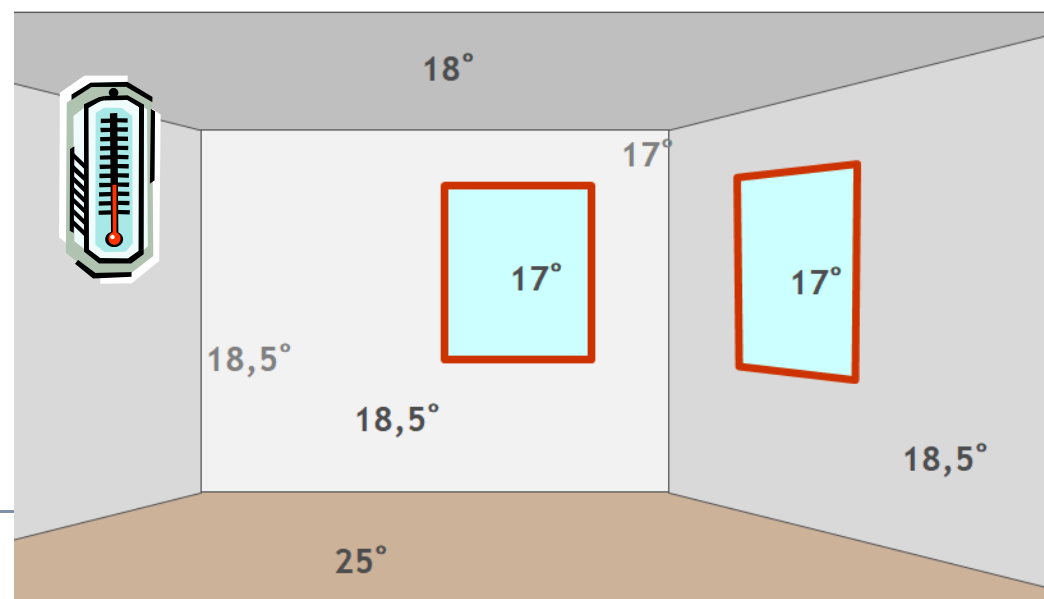
REBOUND EFFECTS



BEFORE REFURBISHMENT

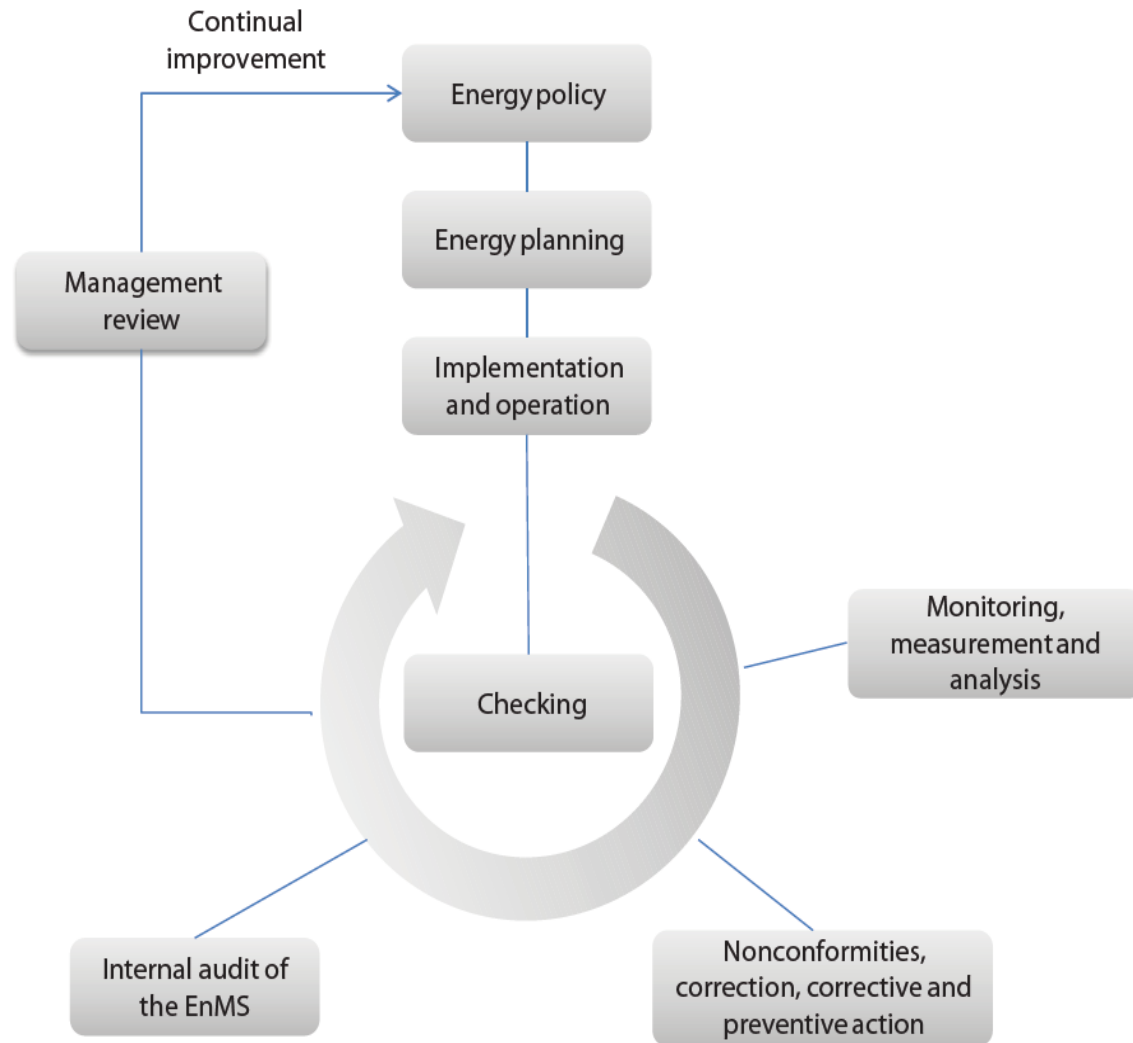


AFTER REFURBISHMENT



How we can have an accurate estimation of B-DSM effects?

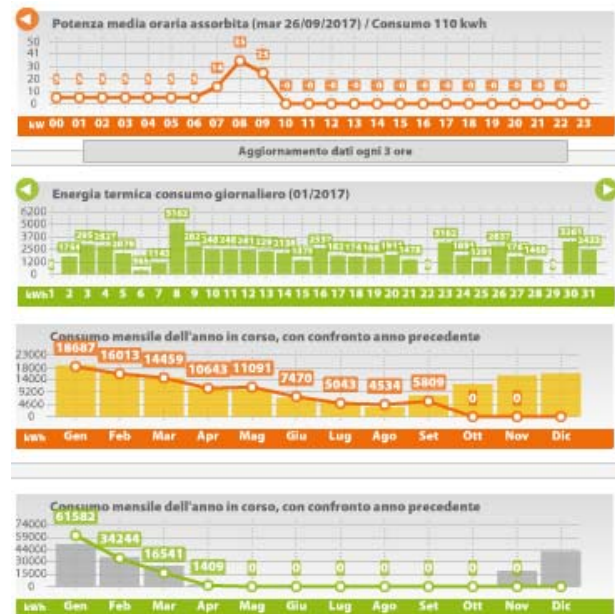
- people behaviour and behavioural changes are not rational
- each person is different
- each response is different and it could be exposed to rebound effects
- the measurement of behavioural effects on consumption is complex



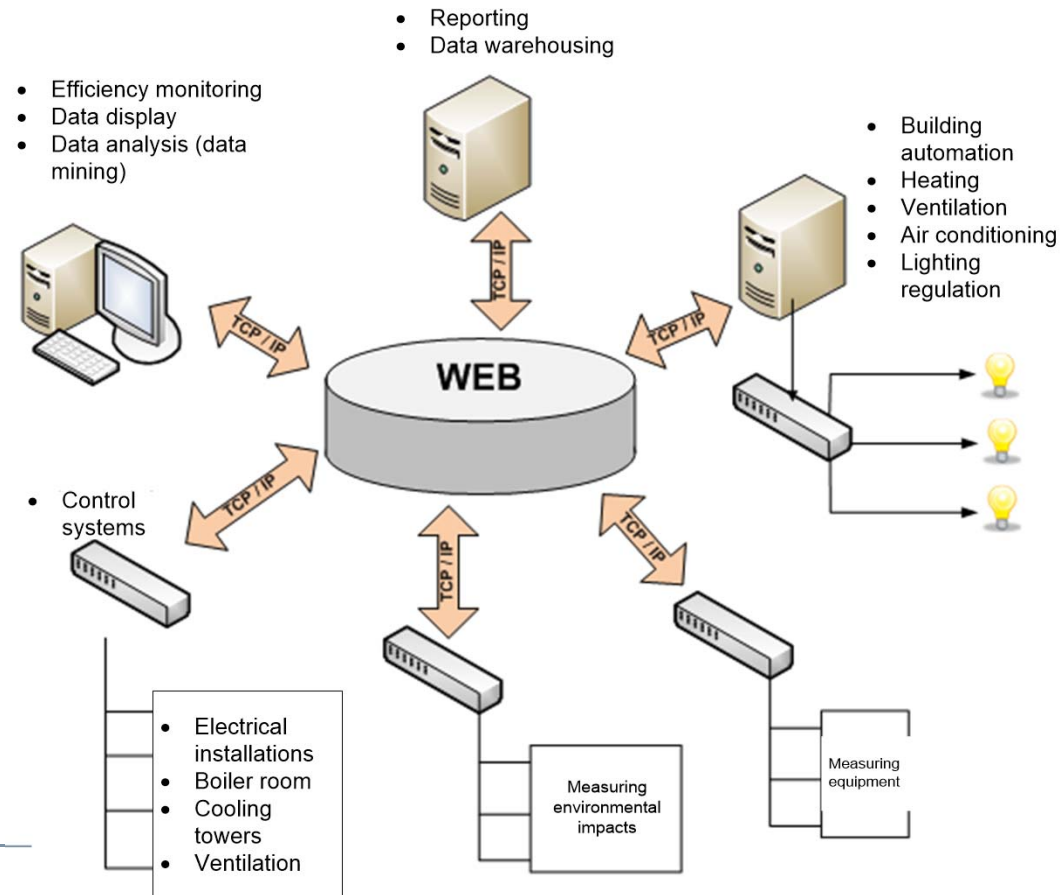
MEASUREMENTS

Important note: individual end users account only for a small amount of energy consumption of the building while measuring systems assess overall consumption

- Implement monitoring and management systems
- Bottom-up data analysis

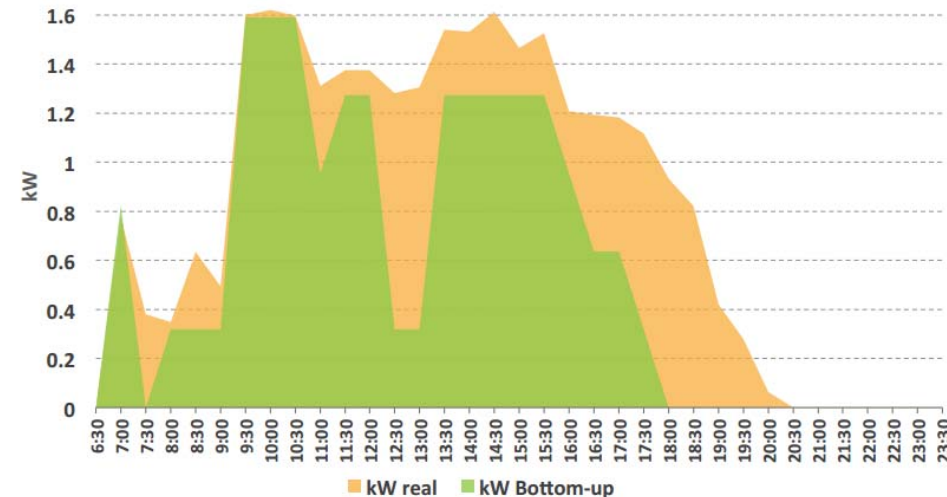


Source: Province of Treviso, www.greenschools.eu



Important note: individual end users account only for a small amount of energy consumption of the building while measuring systems assess overall consumption

- Implement monitoring and management systems
- Bottom-up data analysis



DSM: TIPS FOR INTERVENTION

HEATING AND COOLING	A-DSM	B-DSM
appropriate window management	X	X
keep radiators clean and unobstructed		X
optimize thermostats (temperature, <i>on</i> and <i>off</i> time periods)	X	
if possible, turn off radiators in rooms that are not used	X	X
manage properly shading and curtain systems	X	X
re-adjust working hours and operating hours of the building to optimize space and periods of heating and air conditioning		X
dress comfortably for the weather		X

HOT SANITARY WATER	A-DSM	B-DSM
turn off unused taps	X	X
cut and/or limit hot water use		X
report dripping taps		X



DSM: TIPS FOR INTERVENTION

LIGHTING AND ELECTRONICS	A-DSM	B-DSM
turn off lights and other appliances when leaving the room	X	X
avoid leaving appliances on stand-by and turn off unnecessary lights		X
use the right window treatments (curtains, window blinds and shades)		X
keep lamps and fittings clean		X
set your computer for energy savings		X
reduce monitor brightness		X
arrange interior of the rooms so that natural light exposure is enhanced for working and studying spaces		X
re-adjust working hours and operating hours of the building to optimize natural light use		X

VERTICAL TRANSPORT DEVICES (ELEVATORS)	A-DSM	B-DSM
use the stairs		X



DSM: TIPS FOR INTERVENTION

- Training and awareness-raising campaigns:
 - dissemination (leaflets, brochures, etc.)
 - posters/wall signs
 - direct feedback system



Source: www.energystar.gov/buildings/tools-and-resources/l'oréal-usa-i've-got-power-energy-conservation-challenge-presentation

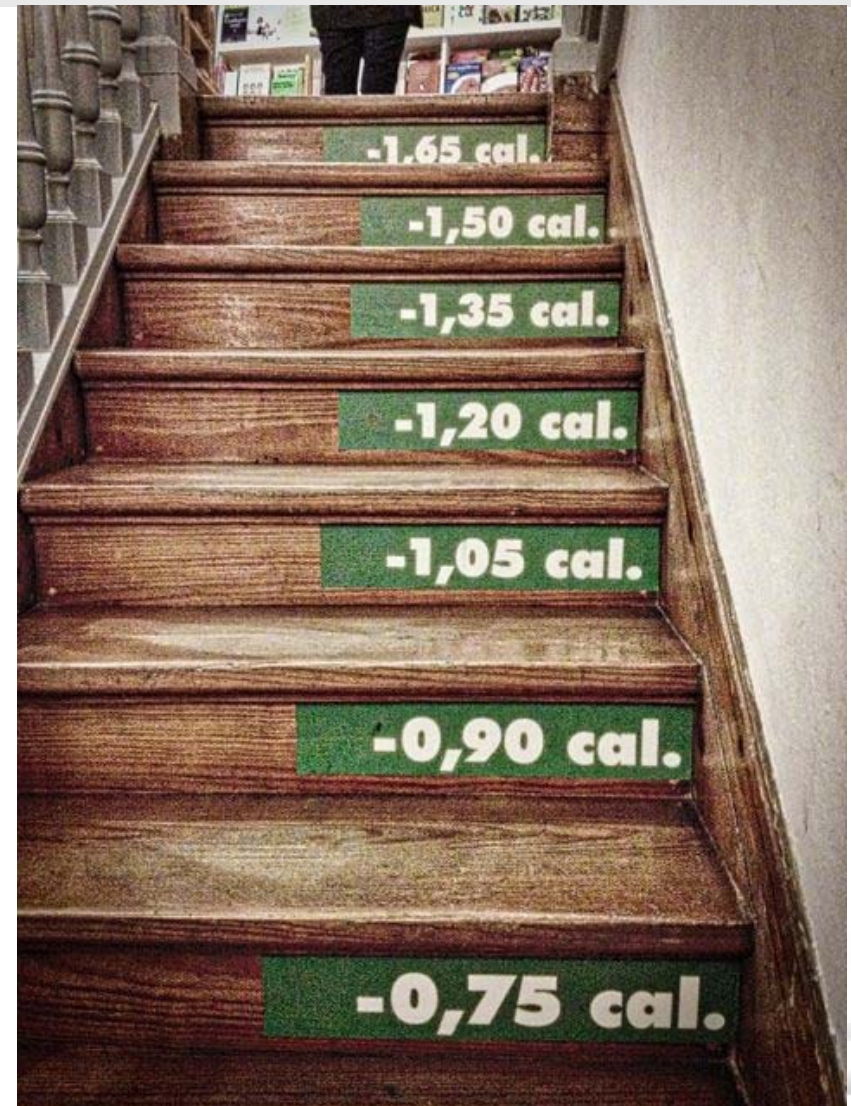


Source: Province of Treviso, Project Together, Training materials del 25/09/2017



Source: Manuel Nina, training materials TOGETHER, Jihlava 2017





- **Training and awareness-raising campaigns:**
 - examples of best practices and success stories
 - energy-saving tips (leaflets, publications, email, etc.)
 - social networking (share experiences, news, tips, contests, etc.)



Stockholm piano stairs



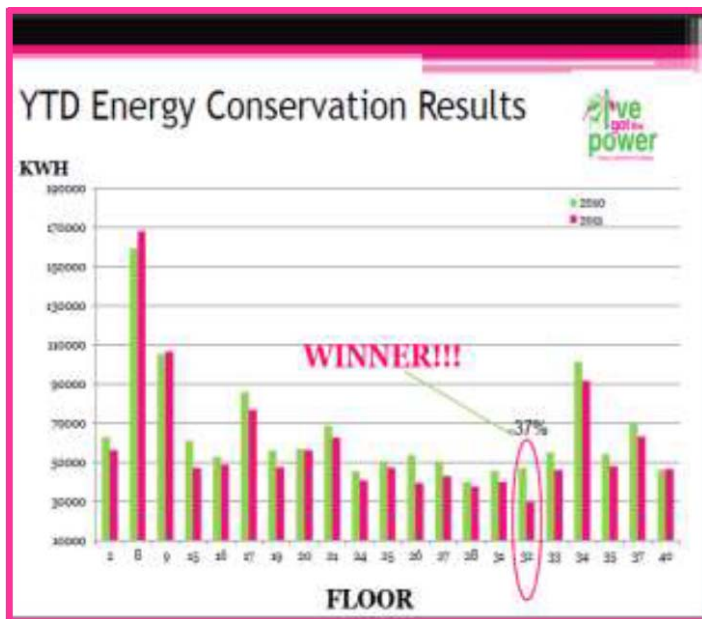
Project Smart Campus, Politecnico of Milan, building "La Nave"



DSM: TIPS FOR INTERVENTION

- Serious game (educational games, app, comics, quiz, etc.)
- Contests
- Incentives (financial, economics, social reward, penalties)
- Exemplary actions and commitment by local authorities and/or testimonials

RENEWABLE ENERGY BINGO					RENEWABLE ENERGY BINGO				
6	8	2	7	9	3	7	9	4	12
3	5	9	2	12	2	12	8	6	5
11	10		4	5	9	5		3	10
4	12	8	6	3	11	4	2	9	3
9	2	7	11	8	6	8	7	11	4



Source: www.energystar.gov/buildings/tools-and-resources/l'oreal-usa-i've-got-power-energy-conservation-challenge-presentation

Energy Chickens

Plug Load Energy
Behavior Change Game



An online game for buildings to reduce plug load electricity and improve occupant well being

Level -2	Level -1	Baseline 0	Level +1	Level +2

Source: energychickens.weebly.com



- Install control systems for building automation
- Changes in building operation and management (space use, operating hours, etc.)
- Rules and regulations

- Information produces higher levels of knowledge but not necessarily changes in behaviour.
- Incentives and rewards are generally effective in generating energy savings but these can be short-lived.

Source: Staddon, Cycil, Goulden, Leygue, Spence, "Intervening to change behaviour and save energy in the workplace: a systematic review of available evidence" in Energy Research & Social Science (www.elsevier.com/locate/erss)

The challenge is for DSM-driven actions to trigger long-lasting behaviour change and to start new habits that actually stick.



THANKS A LOT FOR YOUR ATTENTION !



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www.ape.fvg.it

TOGETHER



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