

# Reducing energy consumption in a tertiary building using Nudges

Rabab Akkouche, Sandrine Selosse, Gilles Guerassimoff  
MINES ParisTech, PSL Research University,  
Centre for Applied Mathematics, Sophia Antipolis

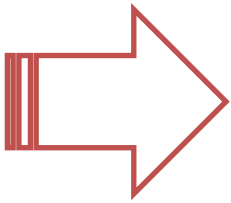
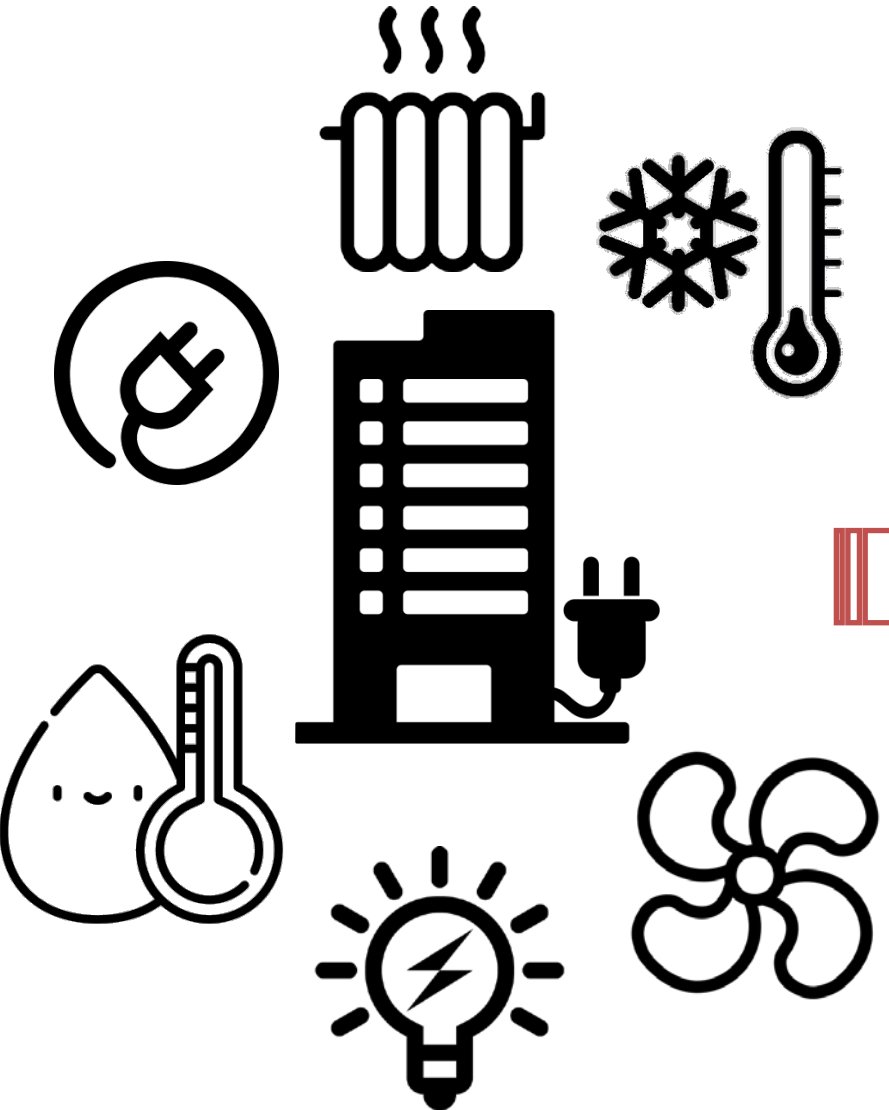
21 April 2021



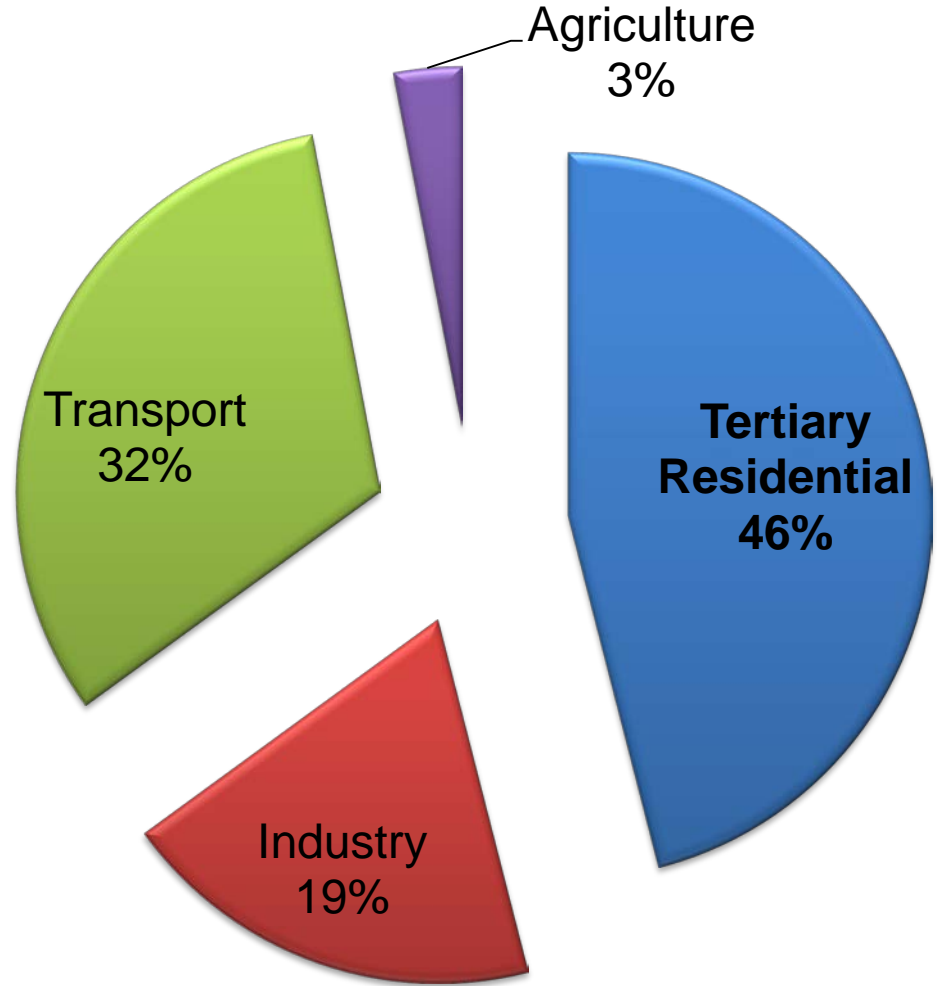


- 1 General Context
- 2 Dynamic Thermal Simulation
- 3 Nudges for changing behaviors
- 4 Methodology
- 5 Results
- 6 Conclusion and Perspectives

# 1 General Context



**FINAL ENERGY CONSUMPTION BY SECTORS**  
**TOTAL : 144 Mtep in 2018**



Source : calculs SDES, d'après les sources par énergie

# 1 General Context



**The building**

- Performance of the envelope
- Insulation
- Architecture
- « Bioclimatic » Design
- Performance of materials



**Improve energy efficiency in buildings**



**Efficient equipments**

**Active Energy Efficiency**



- Technological solutions
- Monitoring
- Energy consumption regulation and control

# 1 General Context

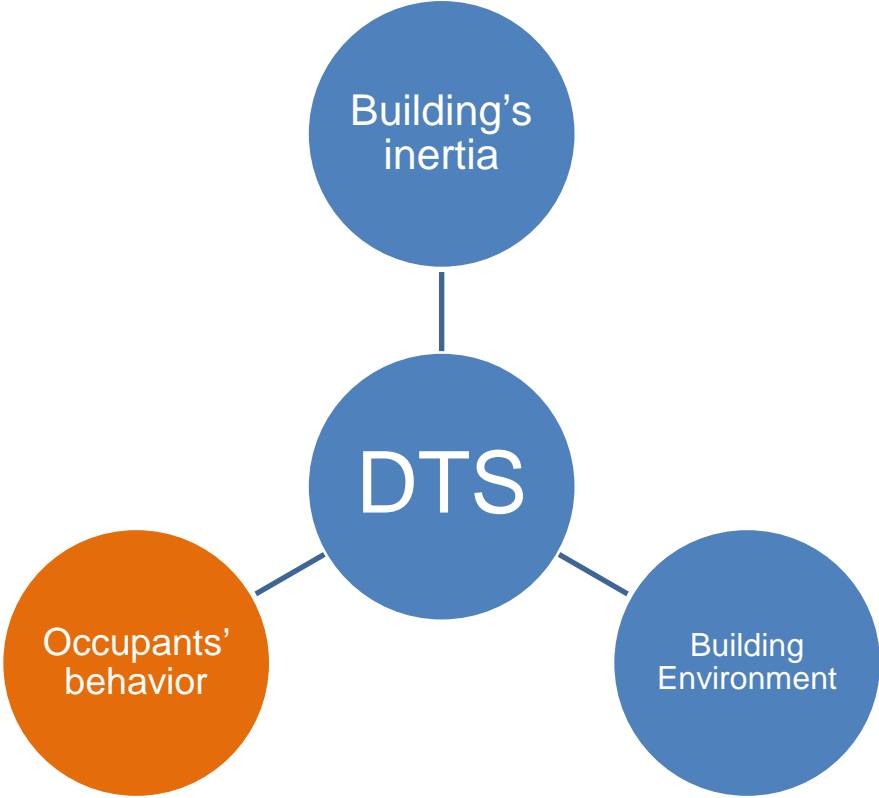


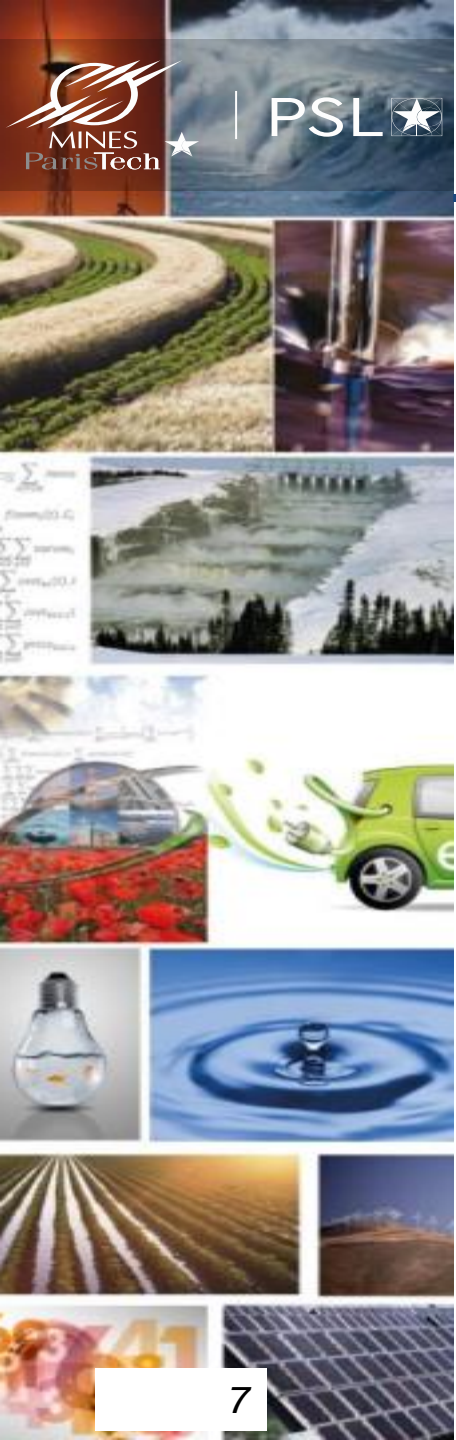
- **Performance Gap** : Gap between energy consumption predictions and real ones
- Technological solutions **must be combined** with a **behavioral approach**



## 2 Dynamic Thermal Simulation

- Dynamic Thermal Simulation (DTS) is used to predict the way a building responds when subject to external environmental factors
- It is also a way to prove the energy performance of buildings and achieve certain ratings.





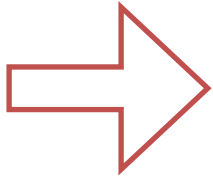
## 2 Dynamic Thermal Simulation

- **Two solutions :**
  - Improve occupants' behavior models in order to recreate real behavior in simulation tools.
  - Educate occupants by changing their behavior without any restriction and by respecting their comfort
- **Questions:**
  - How can we change behavior without restrictions on occupants ?
  - How can we simulate this change without experiment ?

3

# Changing behaviours: NUDGE CONCEPT

## NUDGE



Transform incentives to actions by making individuals choose the wished decision

A low cost solution

Use of cognitive biases

No use of financial incentives or order

Doesn't affect choices based on explicit preferences



Giving information is not enough

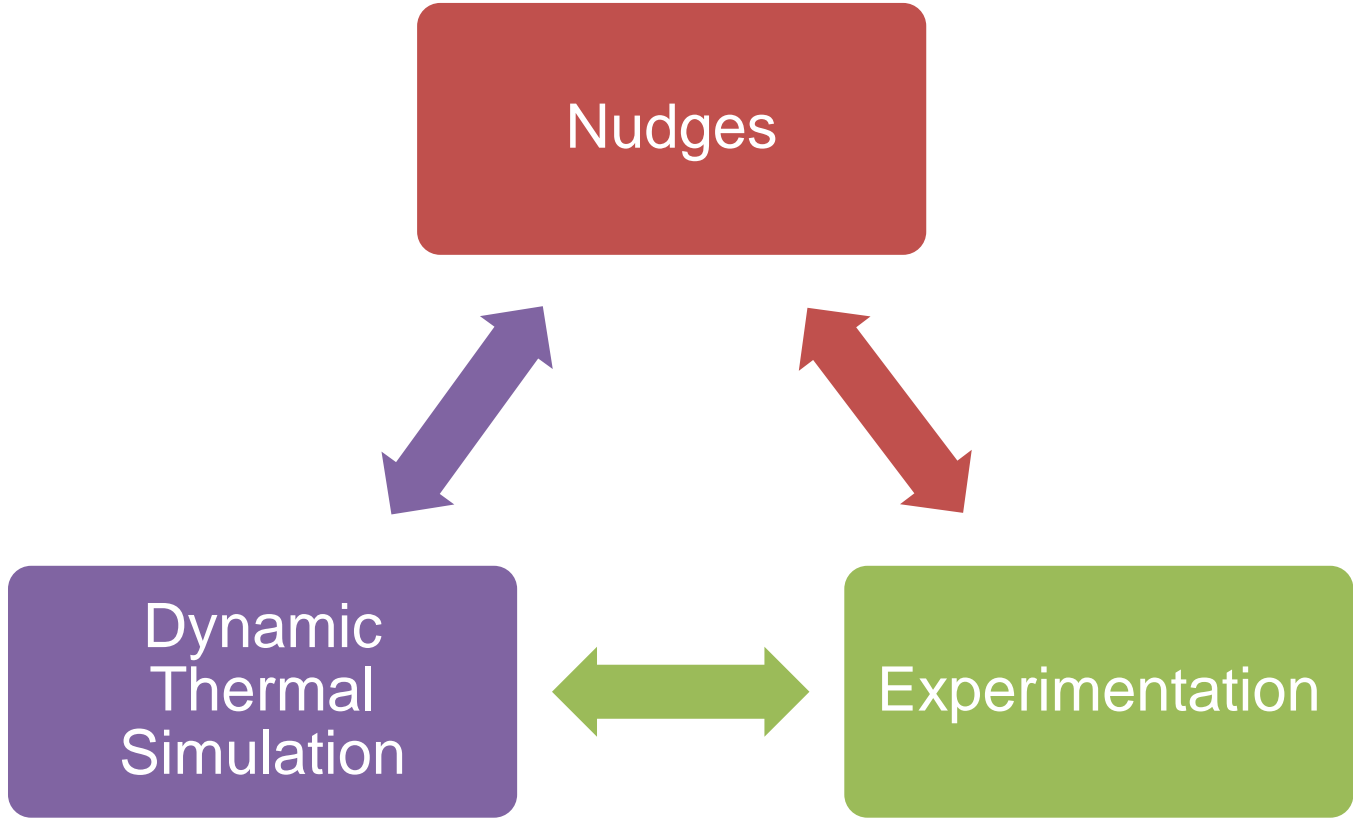


“To count as a mere nudge, the intervention **must be easy and cheap to avoid**. Nudges are not mandates. Putting fruit at eye level counts as a nudge. Banning junk food does not.”  
 [Thaler et Sustein , 2008]

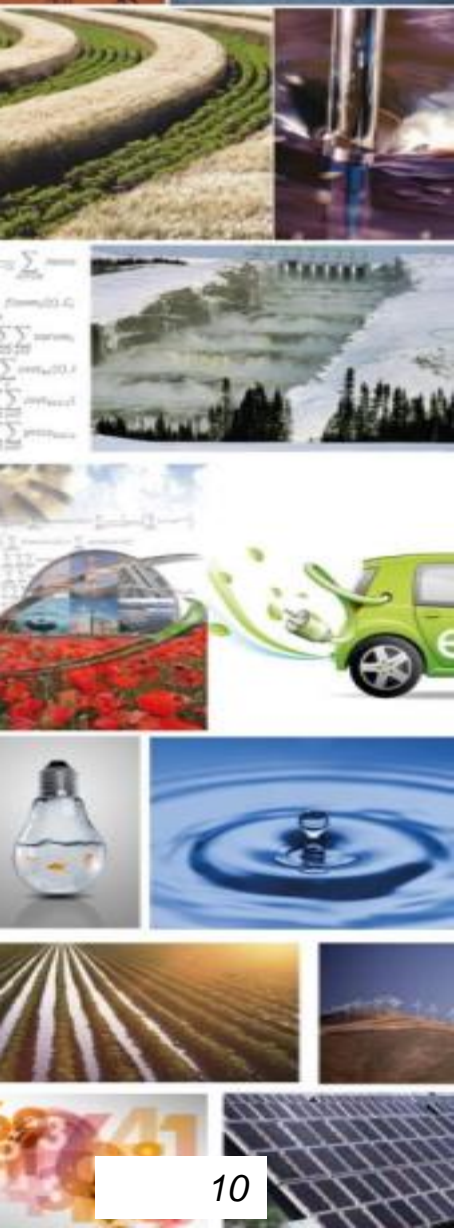




# 4 Methodology



# 4 Methodology

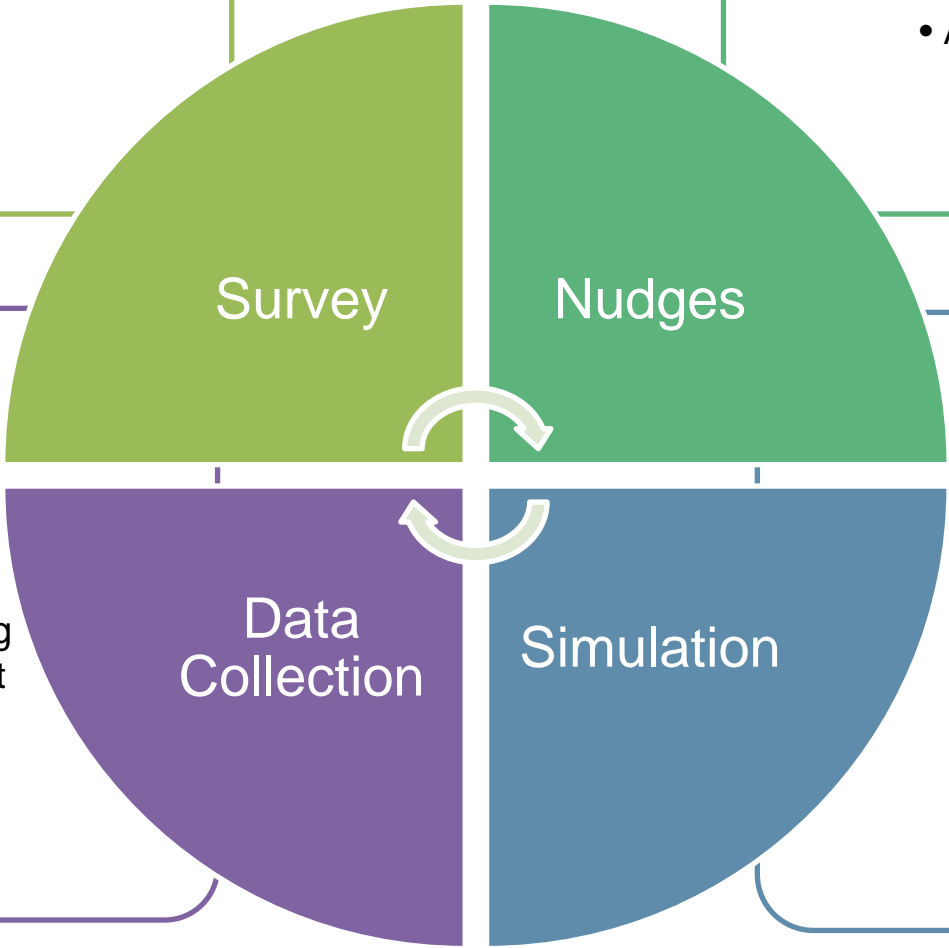


- Understand behaviors, define those to be changed
- Understand motivations
- Occupant's profiles

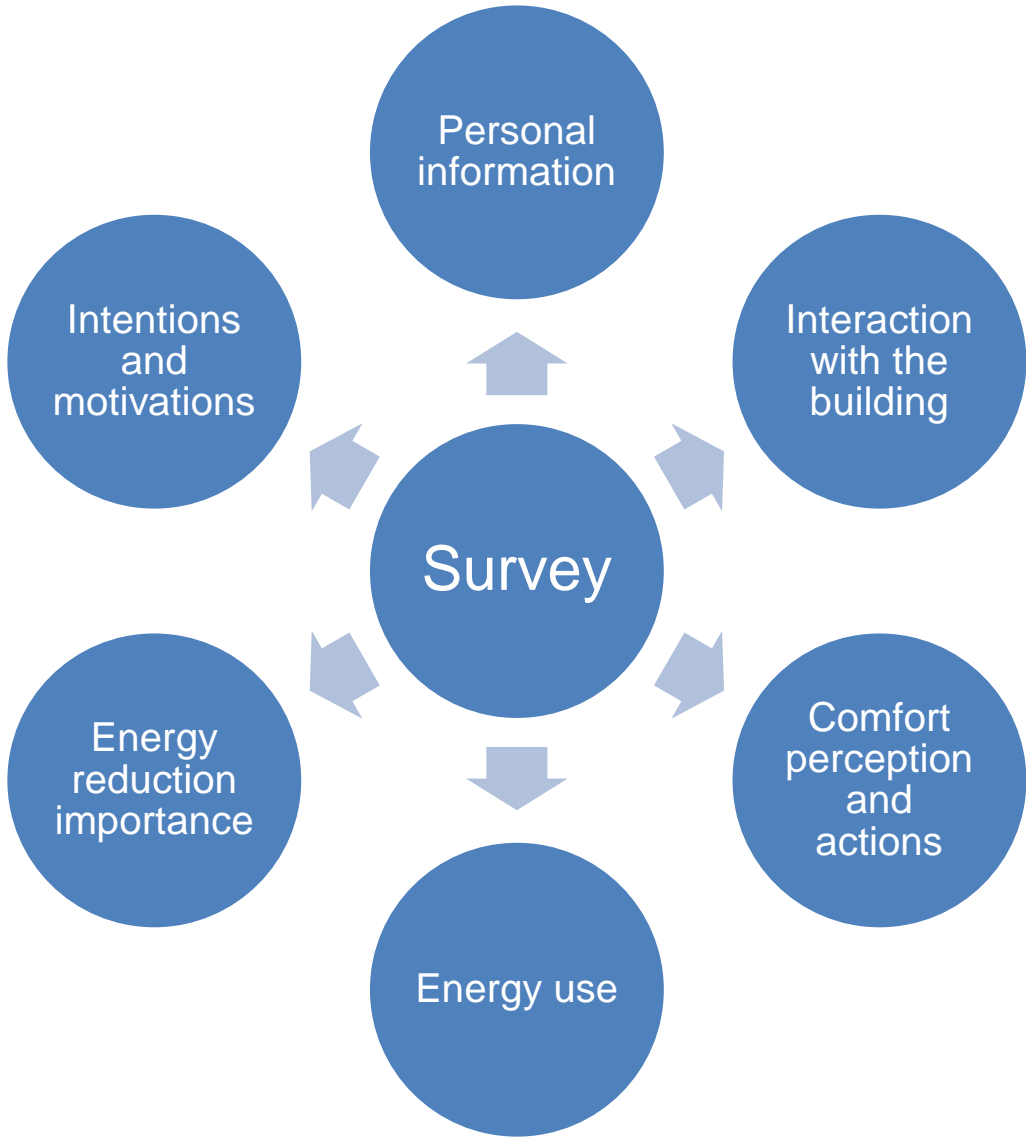
- Applying different types of Nudges to different offices
- Adapting Nudges to energy consumption evolution

- Energy consumption
- Door opening
- Window opening
- Temperature set point
- Occupancy
- Energy consumption

- Simulating energy reduction based on occupants' behavior change
  - Integrating behaviour models for more accurate results
- Quantifying energy reduction based on used Nudge



# 4 Methodology: Survey



# 4 Methodology: NUDGES



## Peer to peer comparison

- Comparing occupants' consumption to their colleagues
- Benchmarking eco-friendly behaviors of other occupants
- Giving suggestions in order to reduce consumption



## Feedback

- Giving feedback to occupants about their energy use
- Tailored messaging



## Moral appeal

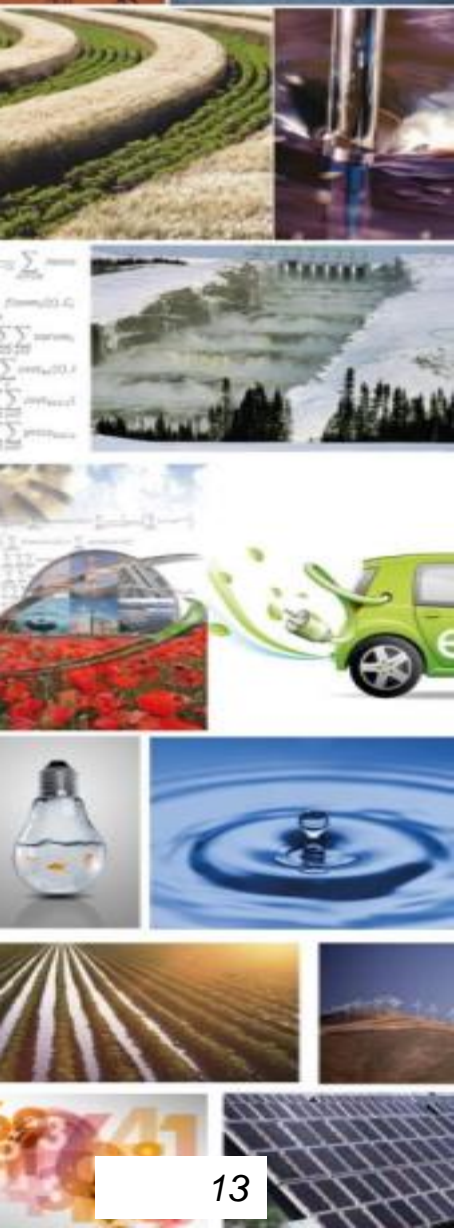
- Messages expressing a responsible consideration and human consequences of global warming
- Using pictures



## Social reviews

- Defining right behaviors adopted by the majority

5 Results



**Office building**

- 3 floors
- 1 meeting room
- 1 kitchen
- **34 Offices**

Localisation: **Nice, France**

**50 Occupants**

# 5 Results

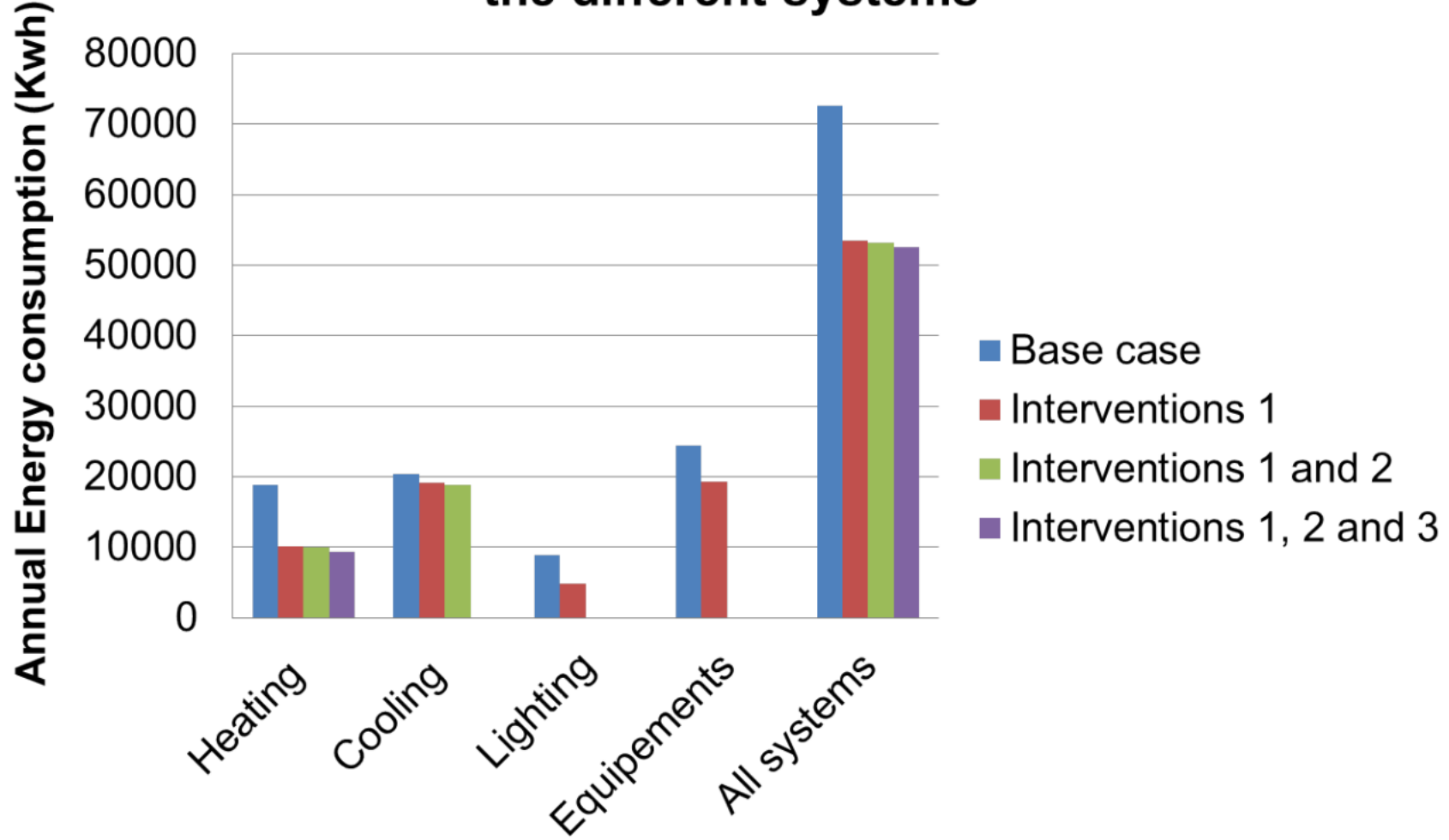


Behavior Change	Heating	Cooling	Lighting	Devices
1	<ul style="list-style-type: none"> <li>- Night / Weekend Mode: 16 C°</li> <li>- Absence more than 2 days: 8 C°</li> </ul>	<ul style="list-style-type: none"> <li>- No cooling at night</li> <li>- Open windows at night</li> </ul>	<ul style="list-style-type: none"> <li>- Switching off lighting when leaving office</li> </ul>	<ul style="list-style-type: none"> <li>- Switching off computers when leaving office</li> </ul>
2	<ul style="list-style-type: none"> <li>- Turn off heating if a window is open</li> </ul>	<ul style="list-style-type: none"> <li>- Open windows in the morning with no cooling</li> <li>- Using shutters</li> </ul>		
3	<ul style="list-style-type: none"> <li>- Close shutters in winter evenings</li> <li>- Turn Off Heating 1 hour before leaving the office</li> </ul>			

# 5 Results

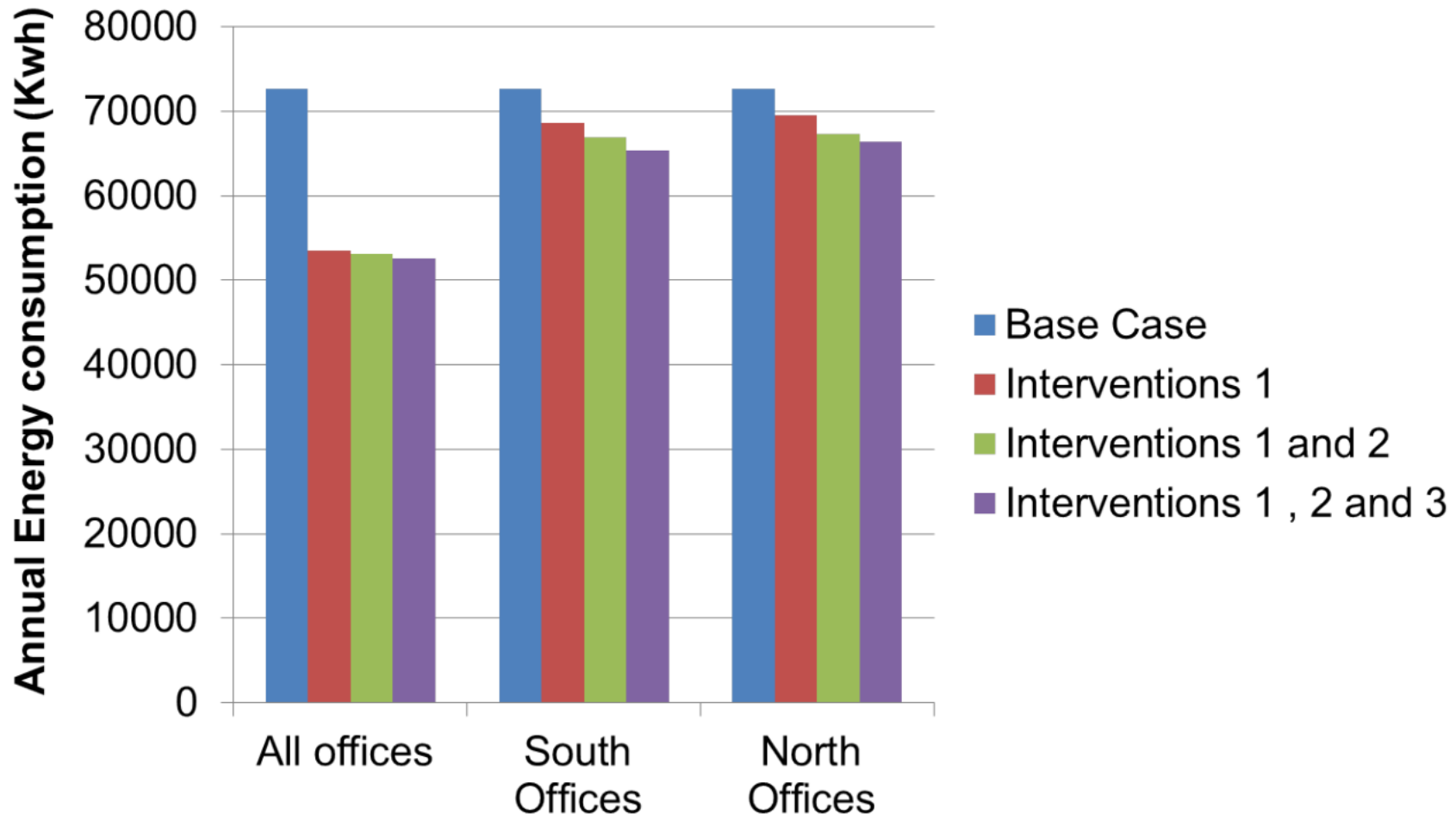


## Energy savings based on behavior change for the different systems



**5 Results**

**Energy savings based on behavior change in different offices**





## 5 Conclusion and Perspectives



- Importance of changing occupants' behaviors in reducing energy consumptions in tertiary buildings
- Impact of offices location in reducing energy consumption
- Integrating behavior models in order to have more accurate results in predicting energy consumptions
- Defining occupants' patterns depending on experimental results in order to quantify the impact of Nudges
- Suggesting the type of Nudges to use depending on occupant's response to the different intensives used