Introduction of the human factor in the EPC/EAP assessment in Wallonia

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UMons
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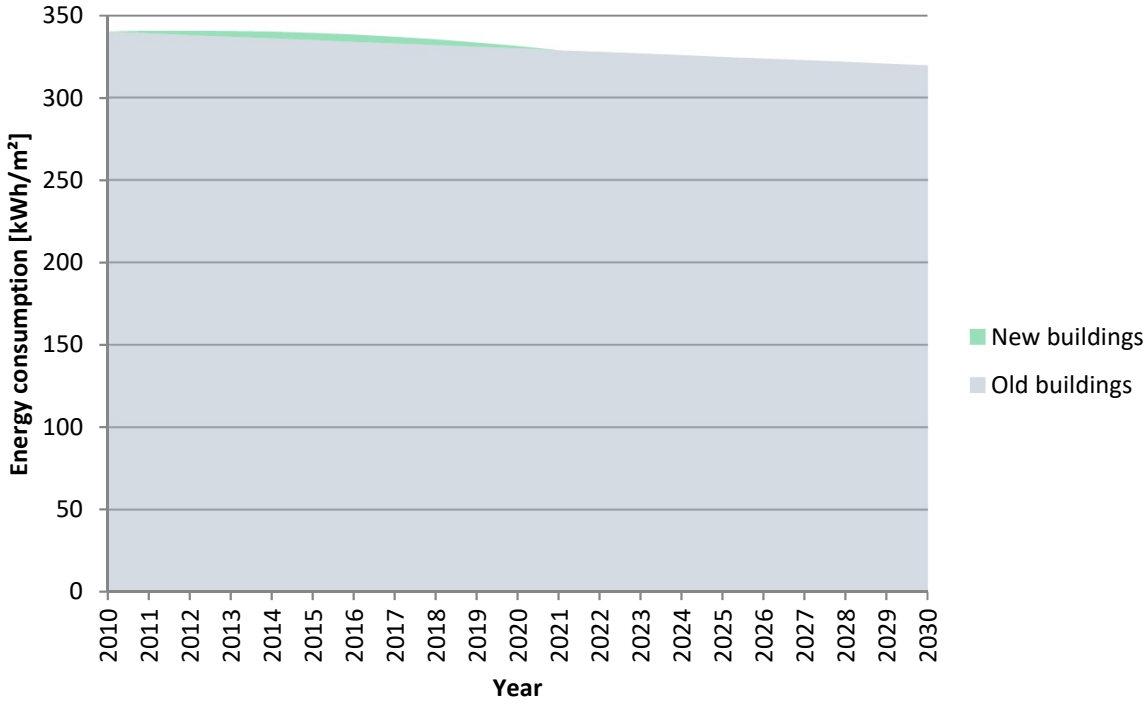
Context:

Energy consumption of residential buildings
(without improvement of existing buildings)



Hypotheses

2010 : average Walloon residential stock consumption: 340kWh/m²

Each year:

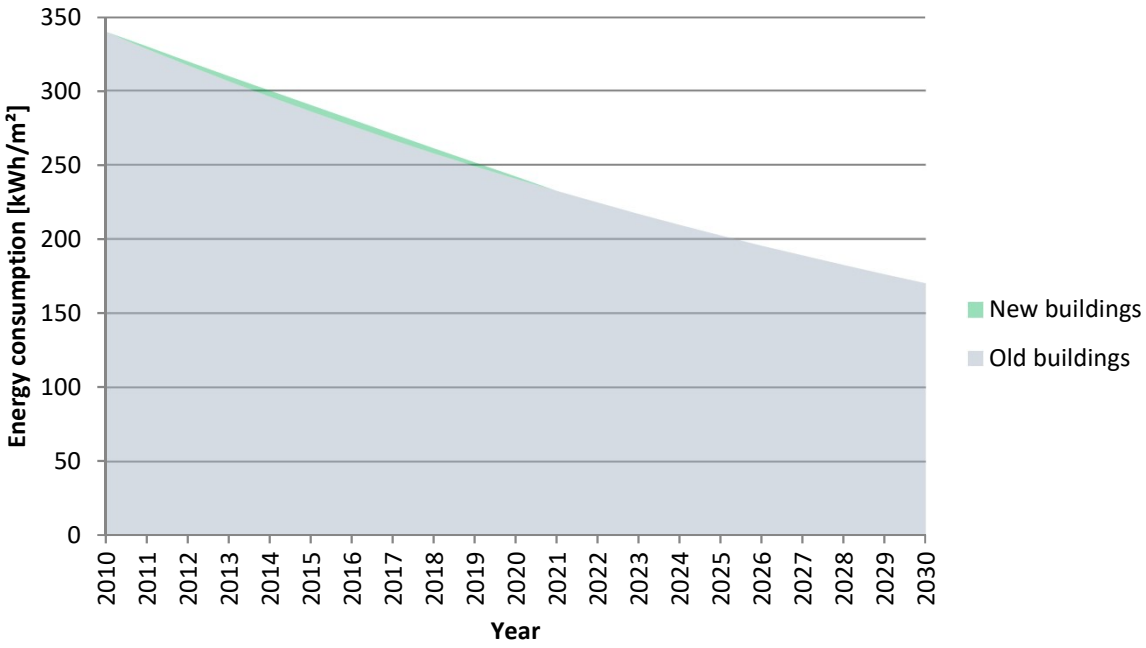
- +1% of new buildings; average consumption: 170kWh/m² (2010 → 2012), then 130kWh/m² (2012 → 2016), then progressive decrease until 2021.
- -0,3% of existing buildings
- No retrofitting

Result: in 2030, the Walloon residential stock

- = 114 % of the 2010 stock
- With an average consumption of 320 kWh/m².an

Context:

Energy consumption of residential buildings
(with improvement of existing buildings: 3,1 %/yr)



Hypotheses

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- Improvement of existing buildings : 3,1%/yr

Result: in 2030, the Walloon residential stock

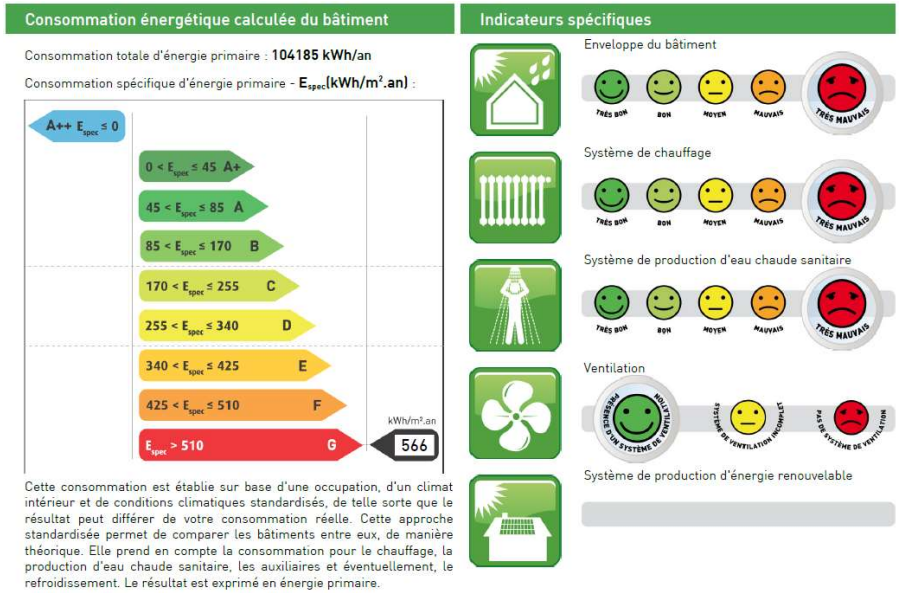
- = 114 % of the 2010 stock
- With an average consumption of 170 kWh/m².an

Smart solutions for smart cities

- Need for
  - Clear info on the problem and its complexity.
    - Monitoring and accurate assessment
  - Intelligent decision-making authorities.
  - Smart citizens, who are aware of their environmental impact, to use smart solutions to their full potential.
    - Best technical or technological solutions are always dependant on installers' skills and users' behaviour
- Could the Energy Performance Certificate / the Energy Audit Procedure be smart solutions?
  - In theory, yes.

The EPC / The EAP…

- … *should* provide “clear” information on the EPB (when it is sold or rented).
  - → Energy Performance as choice criterion and influence on real-estate market
- … *should* increase investments in efficiency (esp. EAP).
- … *could* help build-up databases and strategies (esp. EPC).
- But…
  - Calculation method based on a standardized approach which purposefully gets the human factor out of the equation.
  - “Certify the building, not its users”
  - → Unrealistic results, overestimates consumptions
    - → No appropriation
      → bad reputation and misuse
      - “Disguised tax”, “unhelpful” (esp. EPC)
- Missed opportunity, certainly.



Uncertainty parameters

- Problem: the actual calculation methods are full of (understandable) default values and other uncertainty parameters related to
  - The certifier, the protocol
  - The protected volume, the « used and heated » area
  - The envelope
  - The systems
  - The ventilation
  - The standardisation
- Sociology of energy can enlighten some uncertainty parameters
  - Creation of a questionnaire for a survey
    - → Statistical data (behaviour and socio-demographic variables)
    - → Definition of users' profiles models
    - → Definition of the « input » questionnaire for complementary EPC

Questionnaire

- Need for additional data
  - Socio-demographic / socio-professional variables
    - Household size
    - Daily occupations → occupancy schemes (6)
  - Added building parameters
    - Typology, size, number of exposed facades, location in the block
    - Energy-saving renovation works since the purchase
    - Electr(on)ic equipment (and use, for some)
  - Global temperature management in the house
    - Protected volume vs heated volume (or not)
    - Temperature regulation → set temperatures (or not)
    - Heating system used (or not)
  - DHW needs
  - And… of course, real consumption data (1 year) for heat-DHW production and electricity consumption

Where to stop ?

- Every parameter of the calculation method could be questioned or studied
- What level of detail is necessary ?
  - The goal is to inform potential buyers on a closer range of consumptions in a house they have never lived in… yet.
    - Is it wise to give precise results ?
    - What margin of error is acceptable and compatible with our objectives ?
  - Users scarcely know their yearly (fuel oil, butane/propane and wood) consumptions
    - Natural gas and electricity: monthly bills
  - Value-action or attitude-behaviour gap
    - Reliability issues
  - Other uncertainty parameters interfere in the comparison between real and theoretical consumptions
    - Regarding the assessor, the envelope and systems performances…

Validation

- Example of 3 certified dwellings (1 apartment, 2 houses) ;
  - Use of real consumption data and response to the questionnaire

Row House

Day-time occupation patterns of the house during typical winter days

8h	9h	10h	11h	12h	13h	14h	15h	16h	17h	18h	19h	20h	21h	22h	23h	Workdays	Pattern	Weekends
4														4		0	1	0
4														4	4	0	2	0
4								week days : 3 weekends : 4						4	4	4	3	0
4					week days : 3 weekends : 4			week days : 3 weekends : 4						4	4	1	4	1
4	week days : 3 weekends : 4				week days : 3 weekends : 4			week days : 3 weekends : 4						4	4	0	5	1

For each period, specify the main rooms that are heated during winter, and the set temperatures for each of them

Some questions to be asked :

- Is there a regulation, and therefore a set temperature ?
- What is the set temperature in the living room during winter day time, when you are at home and heating the place ?
- If heated, what is the set temperature in the bedrooms during winter nights ?
- Are the rooms heated during winter days, when you are not at home (and if so, how so?) ?
- Is the bathroom heated at a higher temperature than the living room, when in use ?
- Is the bathroom temperature lowered during winter nights ? And when not in use during winter days ?
- Are the circulation areas heated during winter days ? During winter nights ? If not, are they kept isolated from heated spaces ?

Considered set temperatures		normal	reduced
	night area	21	16
	day area	21	16
	RDJ	NH	NH

NH = not heated

Validation

- Example of 3 certified dwellings

Row House																
Patterns of use				Internal gains evaluation					Heating parameters evaluation							
Number of pattern	$N_{d,j}$ [-]	Description	tO,i,j [s]	$N_{O,i,j}$ [-]	$P_{O,i,j}$ [W]	P_L [W/m²]	P_E [W/m²]	$Q_{i,a,d,j}$ [J]	% of heated volume	Night time part 32,2%	Day time part 30,0%	Average Tset [°C] Heated part	Basement 13,4%	Average global Tset [°C]	Heated periods length [s]	
Week days Pattern 3	4	0h-8h sleep	28800	4	320	0,00	1,72	20361600	62,1%	16	16	16,00	14	15,64	115200	
		8h-9h presence (B)	3600	4	400	1,55	1,72	4091302	62,1%	21	21	21,00	19	20,64	14400	
		9h-16h absence	25200	0	0	0,00	1,72								100800	
		16h-19h presence	10800	3	360	0,00	1,72	8067600	62,1%	21	21	21,00	19	20,64	43200	
		19h-20h30 presence (E	5400	4	400	1,55	1,72	6136954	62,1%	21	21	21,00	19	20,64	21600	
		20h30-22h presence	5400	4	400	0,75	1,72	5160130	62,1%	16	21	18,41	19	18,52	21600	
		22h-24h presence	7200	4	400	0,75	1,72	6880174	62,1%	16	21	18,41	19	18,52	28800	
		Daily total	**86400**					**50697760**							**345600**	
Week days Pattern 4	1	0h-8h sleep	28800	4	320	0,00	1,72	20361600	62,1%	16	16	16,00	14	15,64	28800	
		8h-9h presence (B)	3600	4	400	1,55	1,72	4091302	62,1%	21	21	21,00	19	20,64	3600	
		9h-13h absence	14400	0	0	0,00	1,72								14400	
		13h-16h presence	10800	3	360	0,00	1,72	8067600	62,1%	21	21	21,00	19	20,64	10800	
		16h-19h presence	10800	3	360	0,00	1,72	8067600	62,1%	21	21	21,00	19	20,64	10800	
		19h-20h30 presence (E	5400	4	400	1,55	1,72	6136954	62,1%	21	21	21,00	19	20,64	5400	
		20h30-22h presence	5400	4	400	0,75	1,72	5160130	62,1%	16	21	18,41	19	18,52	5400	
		22h-24h presence	7200	4	400	0,75	1,72	6880174	62,1%	16	21	18,41	19	18,52	7200	
		Daily total	**86400**					**58765360**							**86400**	

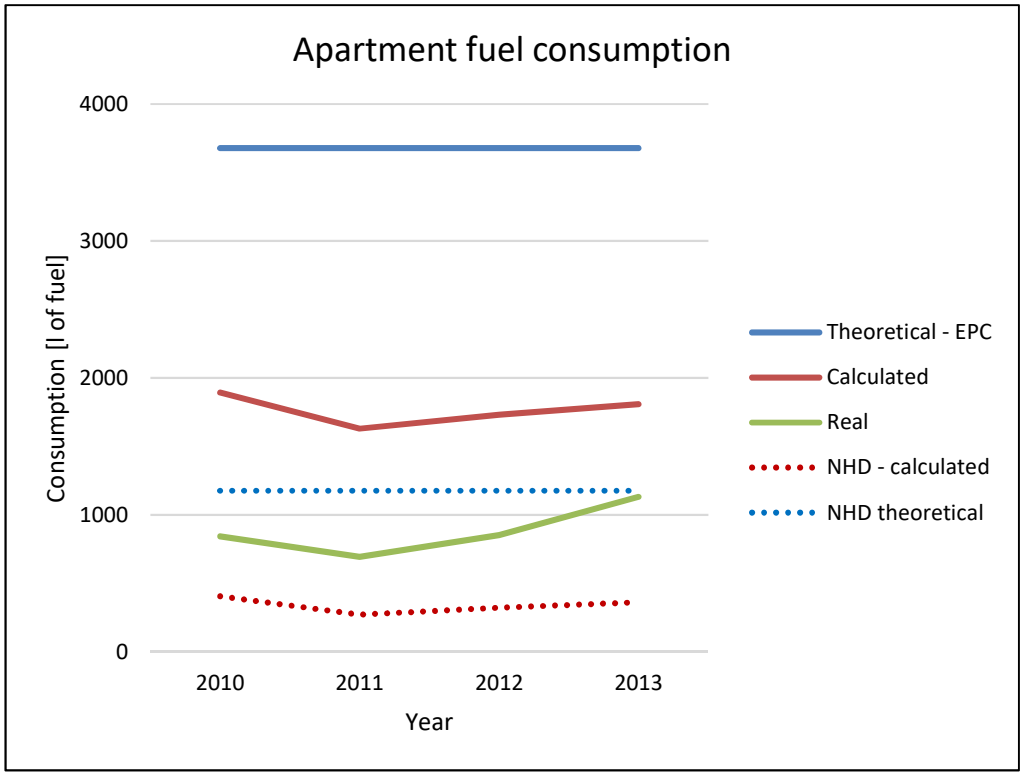
Validation

- Example of 3 certified dwellings

Month	Official			Realistic approach			Heating pattern					DHW
	t_m	$N_{d,m}$	$Q_{l,a,m}$	t_m	$N_{d,m}$	$Q_{l,a,m}$	tm,1	tm,2	tm,4	tm,nh	Check	$Q_{water,net}$
	Ms/month	days/month	[MJ]	Ms/month	days/month	[MJ]	[Ms]	[Ms]	[Ms]	[Ms]	[Ms]	MJ
January	2,6784	31	1199	2,6784	31	1766	0,8928	0,821057	0,3906	0,573943	OK	934
February	2,4192	28	1083	2,4192	28	1595	0,8064	0,7416	0,3528	0,5184	OK	844
March	2,6784	31	1199	2,6784	31	1766	0,8928	0,821057	0,3906	0,573943	OK	934
April	2,592	30	1161	2,592	30	1709	0,864	0,794571	0,378	0,555429	OK	904
May	2,6784	31	1199	2,6784	31	1766				2,6784	OK	934
June	2,592	30	1161	2,592	30	1709				2,592	OK	904
July	2,6784	31	1199	2,6784	31	1766				2,6784	OK	934
August	2,6784	31	1199	2,6784	31	1766				2,6784	OK	934
September	2,592	30	1161	2,592	30	1709				2,592	OK	904
October	2,6784	31	1199	2,6784	31	1766	0,8928	0,821057	0,3906	0,573943	OK	934
November	2,592	30	1161	2,592	30	1709	0,864	0,794571	0,378	0,555429	OK	904
December	2,6784	31	1199	2,6784	31	1766	0,8928	0,821057	0,3906	0,573943	OK	934
						Tset	15,64	20,64	18,52	nh		
						Time per scenario	201600	185400	88200	129600	OK	
						% of total time per scenario	33,33%	30,65%	14,58%	21,43%	OK	
						Part of total heat losses concerned by the heated volume	75%	75%	75%			
						Part of total ventilation losses concerned by the heated volume	80%	80%	80%			

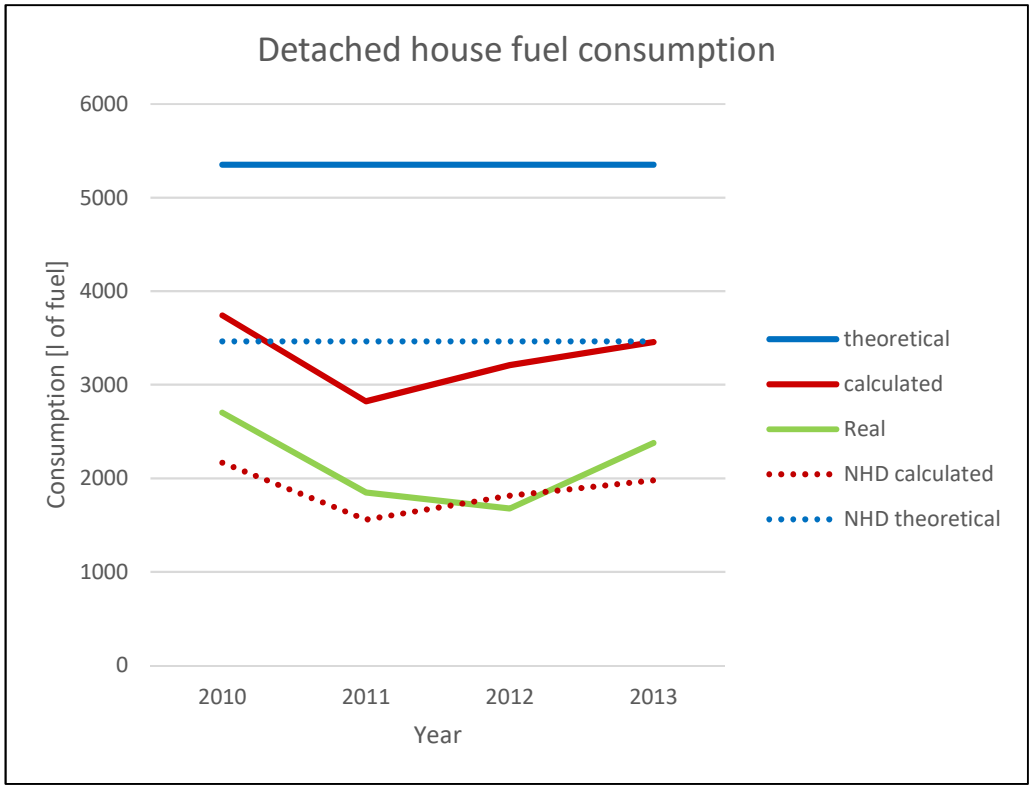
Validation

- Apartment
  - Calculated consumption
    - = 44,3% to 51,5% of the theoretical (EPC) consumption
    - Still 100% (on average) above the real consumption data
  - Particularities:
    - Inhabitant low heat demand in reality
    - Huge impact of default values for the heating (and DHW production) system
      - Esp. the water loop
    - Difficult zoning of heated/ unheated spaces (one “open” floor)



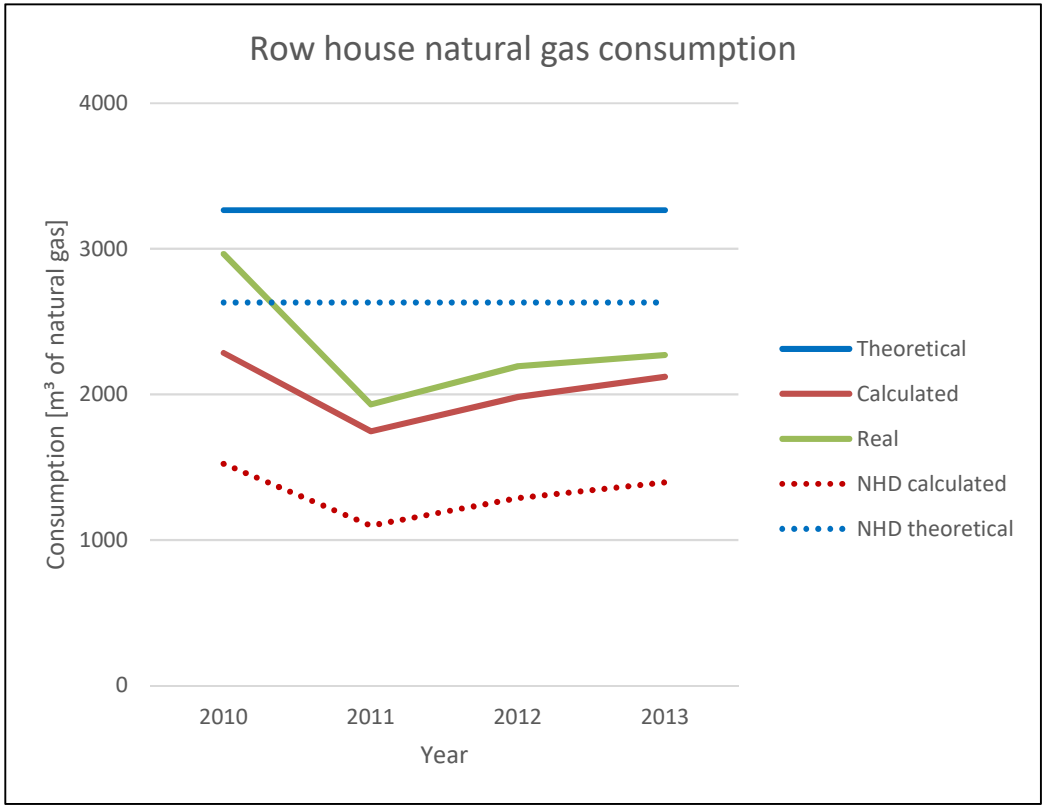
Validation

- Detached house
  - Calculated consumption
    - = 52,8% to 69,9% of the theoretical (EPC) consumption
    - Still 50% (on average) above the real consumption data
  - Particularities:
    - Inhabitants use global temperature management
    - Envelope partly insulated (floor, roofs, old DG…)
    - More precise data on heating (and DHW production) system
    - Zoning night/day
    - 2012 real consumption “drop” : not related to climate



Validation

- Row house
  - Calculated consumption
    - = 53,5% to 70% of the theoretical (EPC) consumption
    - Real consumption data 7% to 30% above calculated consumption… ?
  - Particularities:
    - Inhabitants use global temperature management
    - Envelope globally insulated
      - Thermos effect
    - Presence of “unheated” basement, very difficult to evaluate its influence
    - Very precise data on heating (and DHW production) system



Next step

- Qualitative and quantitative validation
  - Qualitative variables
    - Socio-demographic / socio-professional variables
      - Members' and head's age, gender, level of education, professional situation
      - Right on the dwelling (owner / tenant)
    - Environmental concern (or not), ecological convictions (or not), attitudes and representations
      - Rational use of energy behaviours
    - Temperature management : skills and knowledge, perceived level of control
    - Comfort feeling (air tightness around windows)
    - Ventilation habits (or not) in 4 rooms (living room, bedroom, kitchen, bathroom)
- Influence on renovation strategies (decision-making process)

Thank you for your attention

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