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# The Co-benefit Concept as an Assessment Paradigm to Smart Energy District Projects

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Co-benefits...?

Smart and Sustainable  
Energy District  
Projects...?

**ONE PROJECT**



**ONE GOAL**



**SEVERAL CO-BENEFITS**

A co-benefit is any socio-economic and environmental **positive effect** related to the execution of a project, exceeding the primary goal, regardless if intentional or not.

## SMART AND SUSTAINABLE ENERGY DISTRICT PROJECTS (SSEDPs)

“European international co-funded cooperation projects, applying outstanding **energy technologies** within urban settlements, involving multiple stakeholders and including the local authority into the consortium”

(Bisello et al. 2016)

### DISTRICT GOALS



- (i) reducing CO<sub>2</sub> emissions (tons)
- (ii) reducing energy needs (kWh)



**MAIN GOALS**



CO<sub>2</sub> (tons)

Energy (kWh)

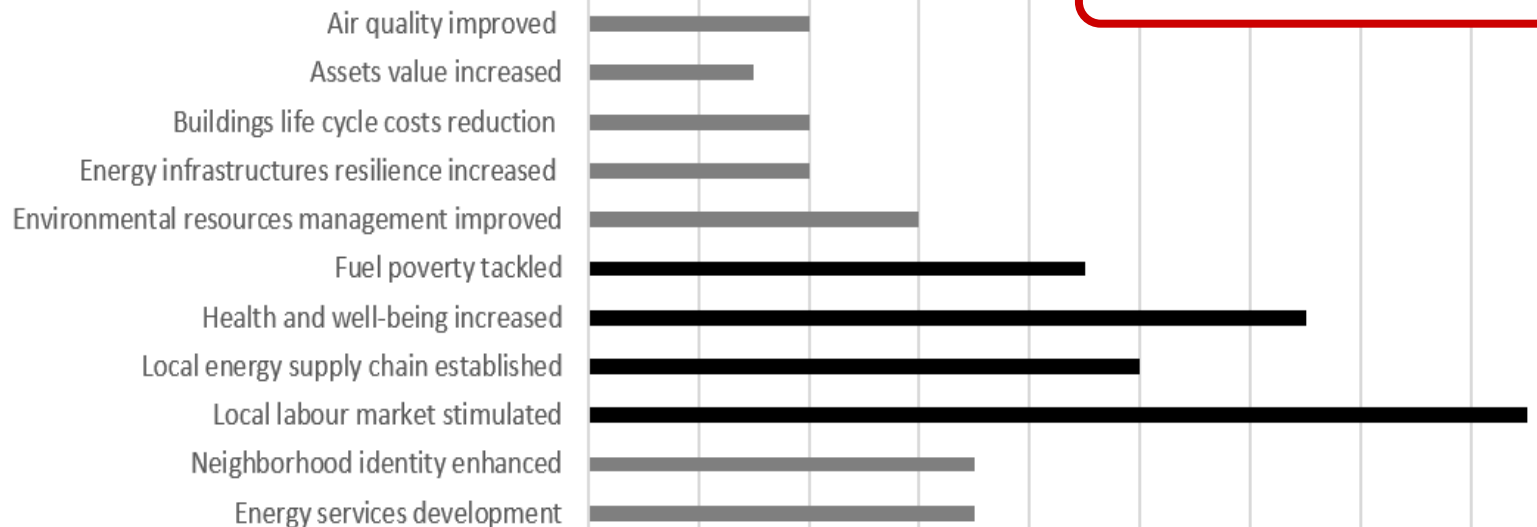
**CO-BENEFITS**

- .....
- .....
- .....

Number SSEDPs mentioning t

**19 RECURRENT  
CO-BENEFITS**

**Co-benefits related to "hard measures"**



**Co-opportunities related to "hard measures"**



**Co-benefits related to actions on stakeholders**



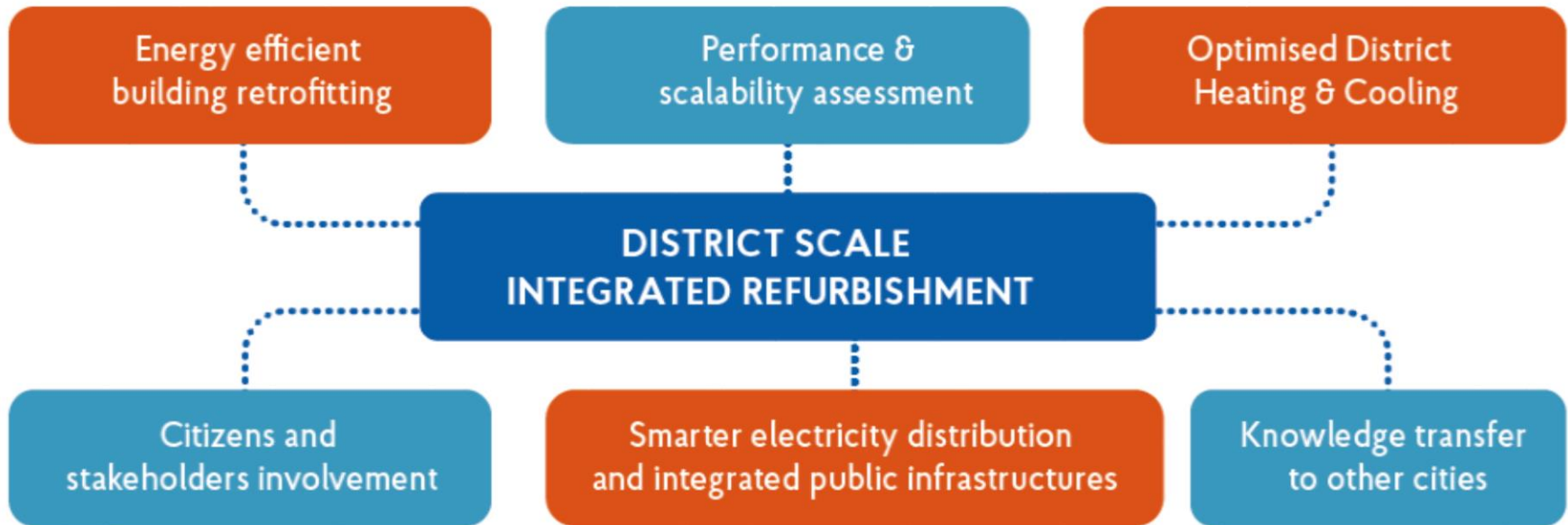
**Co-benefits related to project design and management**



# The SINFONIA Smart City Project



FP7 8.8.1 Energy SCC  
STARTED IN JUNE 2015  
FIVE YEARS PROJECT



# SINFONIA. Low carbon cities for better living

With 80% of European citizens living in urban areas, cities have a crucial role to play in the transition towards a low-carbon economy. Faced with the challenge of becoming more energy efficient, cities need to develop development strategies that will make them

play a crucial role to play in the transition towards a low-carbon economy. Faced with the challenge of becoming more energy efficient, cities need to develop development strategies that will make them **the quality of life of their citizens** at the system level and develop integrated urban development strategies that will make them better places to live.

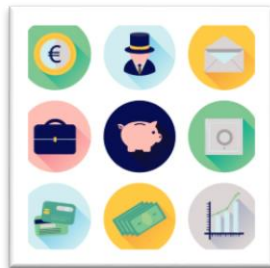


SMART MOBILITY & CONNECTIVITY



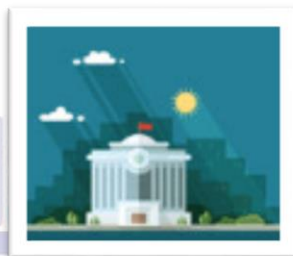
SMART BUILT ENVIRONMENT

SMART NATURAL ENVIRONMENT



SMART ECONOMY

SMART SERVICES



SMART GOVERNANCE

SMART COMMUNITY



Sinfonia





Smart natural  
environment

**Local air quality improved**

**Environmental resources management  
improved**



Smart  
services

**Health and well-being of residents  
increased**

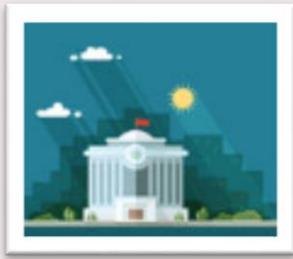


Smart  
community

**Fuel poverty tackled**

**Users awareness on energy-related  
issues increased**

**Neighbourhood identity enhanced**



Smart  
governance

**Innovation in processes  
and decision-making**

**Territorial attractiveness increased**

**Institutional relationship and networks  
created**



Smart  
economy

**Local labour market stimulated**

**Positive change in local tax revenue**

**Softer loan conditions**

**Local energy supply chain established**

**Energy services developed**

**Innovation in technology development  
and adoption**

**Professional skills development**

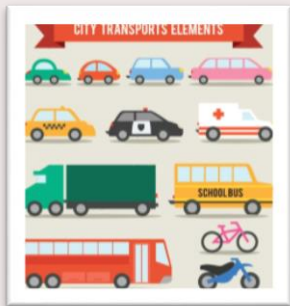


Smart build environment

**Property value increased**

**Costs reduction of buildings life cycle**

**Resilience of energy infrastructures increased**

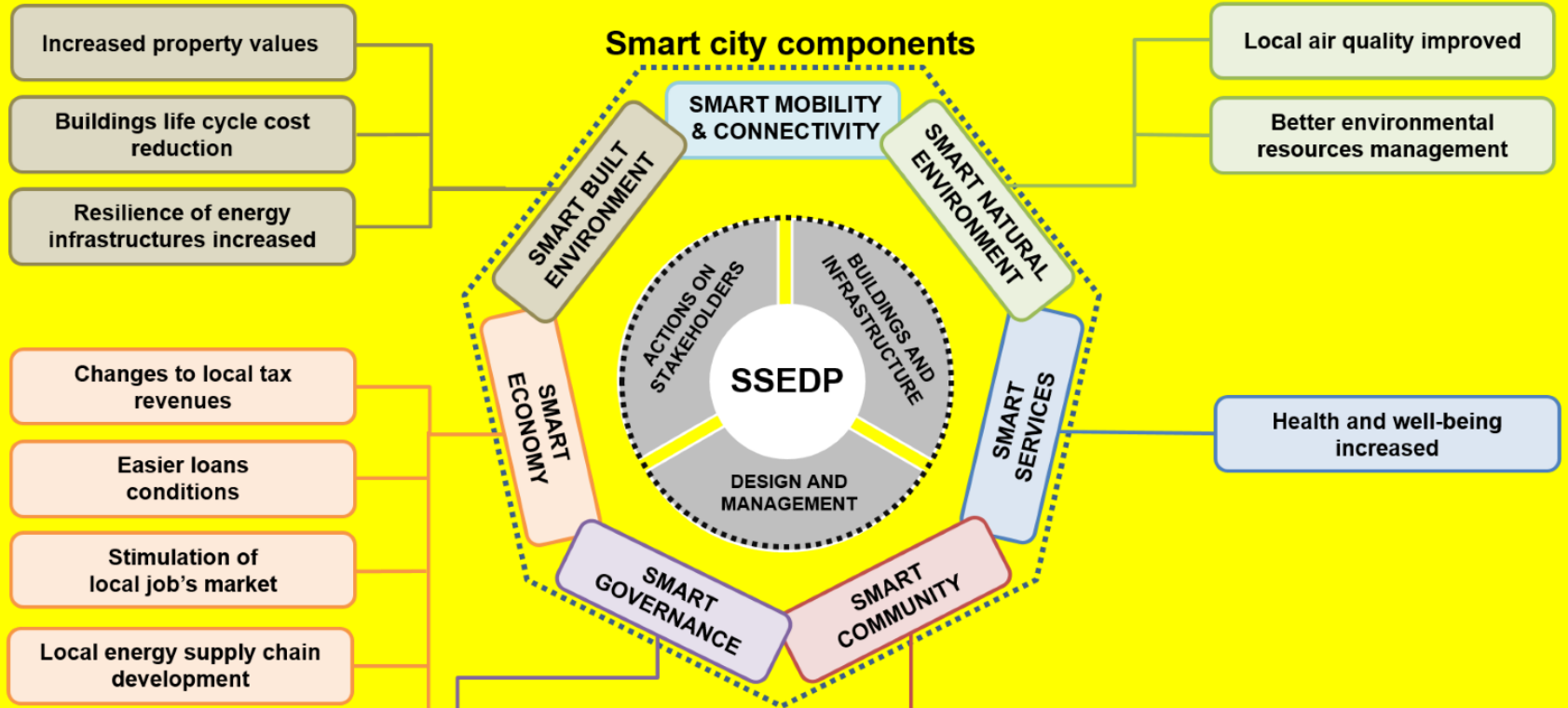


Smart mobility & connectivity

?

# Urban co-benefits framework

## Smart city components



**1. WORLD CAFÉ METHOD  
AMONG PROJECT  
PARTNERS**

**Eliciting  
knowledge and  
group thinking on  
complex topics**

**4 SPECIFIC INVESTIGATIONS**



# THE INDIVIDUAL QUESTIONNAIRE

Smart city components	Co-benefits	Relevance 1=not relevant 5= very relevant					Likelihood R = Remote L = Likely				Ranking
		1	2	3	4	5	R	U	P	L	
Smart natural environment	Local air quality improved	1	2 ✓	3	4	5	R	U	P ✓	L	<b>2nd</b>
	Environmental resources...	1	2	3	4 ✓	5	R	U	P	L ✓	<b>1st</b>
...	...										...

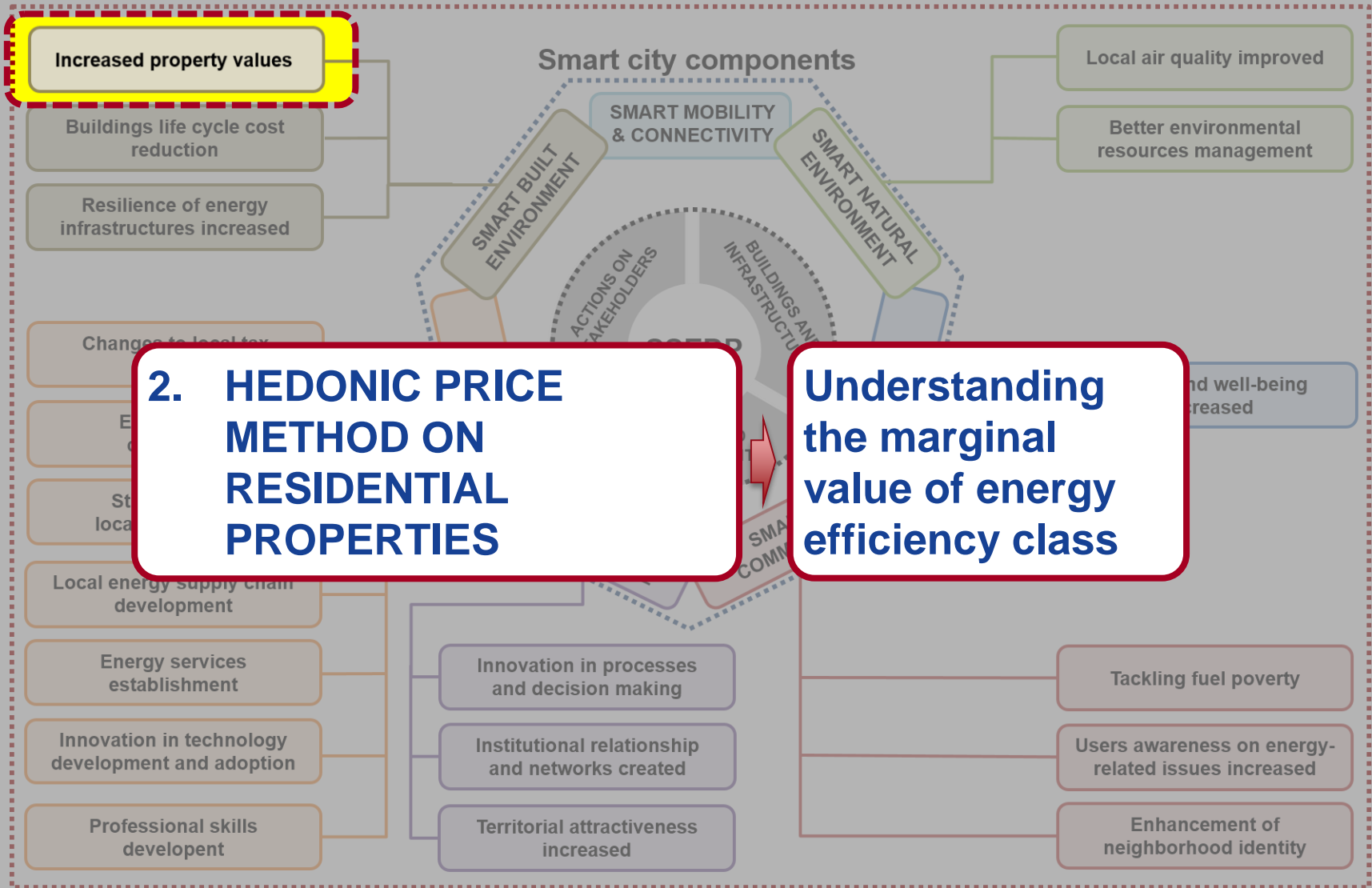
# THE WORLD CAFÉ



RED: the median of inverted ranking multiplied by the number of individuals mentioning the co-benefit

BLUE: the percentage of consensus expressed by respondents on the single position (from 1<sup>st</sup> to 5<sup>th</sup>).





4 SPECIFIC INVESTIGATIONS

ASKING\_PRICE

SQMPRICE

Observed General G: 0.026891  
 Expected General G: 0.033759  
 Variance: 0.000002  
 z-score: -5.597273  
 p-value: 0.000000

Observed G  
 Expected G  
 Variance  
 z-score  
 p-value

ASKING\_PRICE

SQMPRICE

COType  
 ● All other values  
 ● HH - clusters of high values  
 ● HL - outliers high values  
 ● LH - outliers low values  
 ● LL - clusters of low values

COType  
 ● All other values  
 ● HH - clusters of high values  
 ● HL - outliers high values  
 ● LH - outliers low values  
 ● LL - clusters of low values

CASE

Observed General G: 0.026891  
 z-score: -5.597273  
 p-value: 0.000000

Significance Level (p-value)  
 Critical Value (z-score)  
 0.01 < -2.58  
 0.05 -2.58 - 1.96  
 0.10 -1.96 - 1.65  
 0.10 1.65 - 1.96  
 0.05 1.96 - 2.58  
 0.01 > 2.58

Observed General G: 0.026752  
 z-score: -7.133826  
 p-value: 0.000000



Model\_ABCDEF

EPC class	G	F	E	D	C	B	A
Price (mq)	€ 3,033	€3,074	€3,115	€3,156	€3,199	€3,241	€3,285
Premium (€)	-	€ 40	€ 81	€123	€165	€ 207	€251
Premium (%)	-	1.3%	2.7%	4.1%	5.4%	6.9%	8.3%

Model\_AB\_CD\_EF

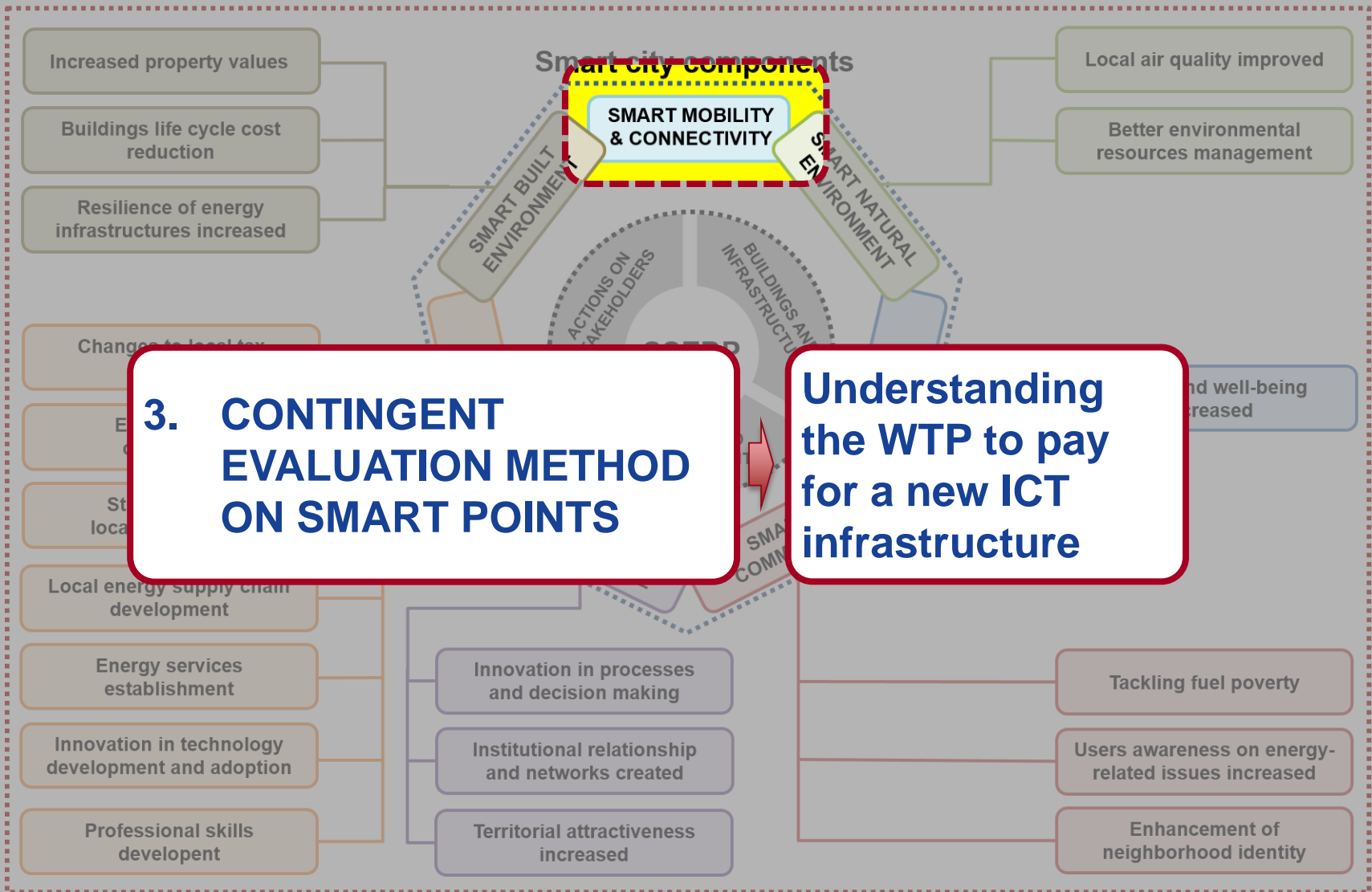
EPC class	G	E or F	C or D	A or B
Price (mq)	€ 3,115	Not statistically significant	€ 3,311	€3,412
Premium (€)	-		€196	€296
Premium (%)	-		6.3%	9.5%

Table 8: Price premium on a standard apartment gained by EPC class improvement

**Ceteris paribus, the better the energy performance class, the higher the property value**

**Energy efficiency gains a price premium (~ 9% A-B)**





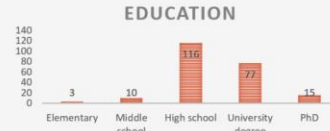
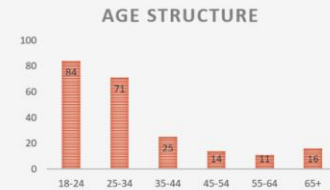
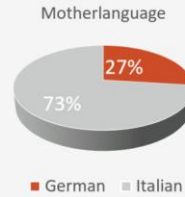
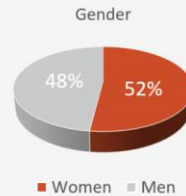
### 3. CONTINGENT EVALUATION METHOD ON SMART POINTS

### Understanding the WTP to pay for a new ICT infrastructure

### 4 SPECIFIC INVESTIGATIONS

## Results

221 Complete  
questionnaires:  
3536 Observations

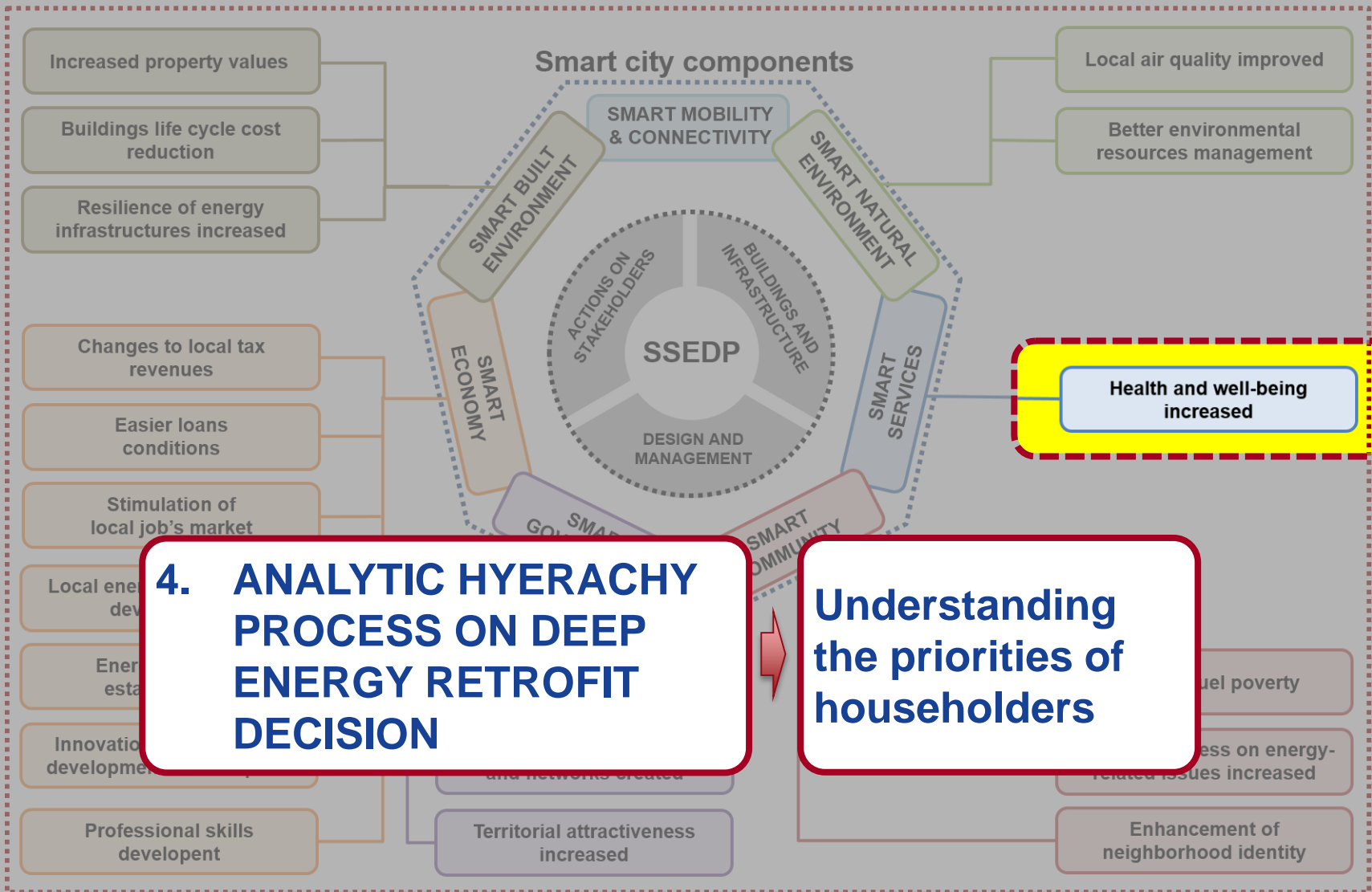


## Results

Attributes	MNL		
	Estimate	Std. error	Signif.
SOS	0.98	0.24593	***
WATER	0.94	0.17552	***
WIFI	1.49	0.20919	***
E_DEVICES	1.27	0.24841	***
E_BIKES	0.94	0.26922	***
E_CARS	1.82	0.34712	***
I_WHETHER	0.38	0.30919	
I_TOURISTS	0.95	0.24985	***
I_RESIDENTS	1.41	0.24156	***
M_CHARGE	0.71	0.24982	**
M_TRAFFIC	1.51	0.24229	***
M_PARKING	1.58	0.23408	***
SQ	0.53	0.34851	
COST	-0.415	0.03587	***

## Results

Attributes	MXL		
	Estimate	Std. error	Signif.
SOS	1.02	0.2315	***
WATER	0.94	0.1893	***
WIFI	1.23	0.2558	***
E_DEVICES	1.03	0.2517	***
E_BIKES	0.92	0.3865	*
E_CARS	1.73	0.4248	***
I_WHETHER	0.13	0.2815	
I_TOURISTS	0.46	0.3285	
I_RESIDENTS	1.07	0.3636	**
M_CHARGE	0.66	0.1436	***
M_TRAFFIC	1.25	0.2299	***
M_PARKING	1.23	0.2778	***
SQ	0.43	0.6942	
COST	-1.0121	0.1390	***



**4. ANALYTIC HYERACHY PROCESS ON DEEP ENERGY RETROFIT DECISION**

**Understanding the priorities of householders**

**4 SPECIFIC INVESTIGATIONS**

# AHP Modelling

Deep Energy Retrofit

Design and spatial quality

Economic benefits

Environmental benefits

Thermal comfort benefits

Acoustic comfort benefits

Lower energy bills

Increased assets value

High tax deductions

Reducing air pollutant emissions

To be a good example for the community

Better thermal insulation (building envelop)

Better indoor daylight

Better indoor air quality

Better thermal management in rooms

Reduced noise nuisances from outside

Reduced noise nuisances from other dwellings

Reduced room to room disturbance



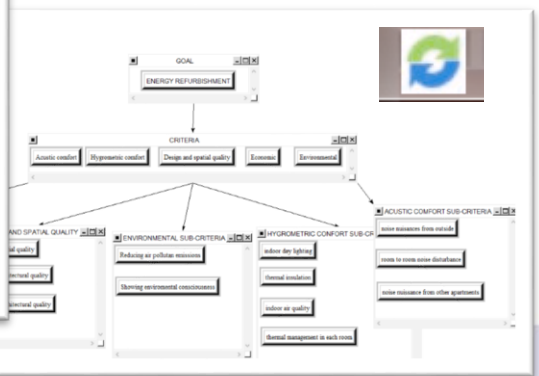
Nel dare la risposta Le chiedo di tenere sempre presente questa domanda principale:  
**QUALE TRA I SEGUENTI BENEFICI VALUTA PIÙ IMPORTANTE NELLA DECISIONE DEL SUO COMMITTENTE DI INTRAPRENDERE UNA RISTRUTTURAZIONE ENERGETICA RADICALE DELLA ABITAZIONE?**  
 La risposta può prevedere i seguenti giudizi (QUANTO UN ASPETTO È PIÙ IMPORTANTE DELL'ALTRO):  
 1. UGUALE  
 3. POCO  
 5. ABBASTANZA  
 7. MOLTO  
 9. ESTREMAMENTE  
 Può anche esprimere GIUDIZI INTERMEDI TRA LE ALTERNATIVE PROPOSTE (2, 4, 6, 8.)

TEMI GENERALI

Quale tra i seguenti benefici valuta più importante? O il reputa di uguale importanza?	
1	Benefici di comfort termo-igrometrico
2	Benefici di comfort termo-igrometrico
3	Benefici di comfort termo-igrometrico
4	Benefici di comfort acustico
5	Benefici di comfort acustico
6	Benefici di comfort acustico
7	Benefici di comfort acustico
8	Benefici di qualità estetica - architettonica
9	Benefici di qualità estetica - architettonica
10	Benefici di convenienza economica

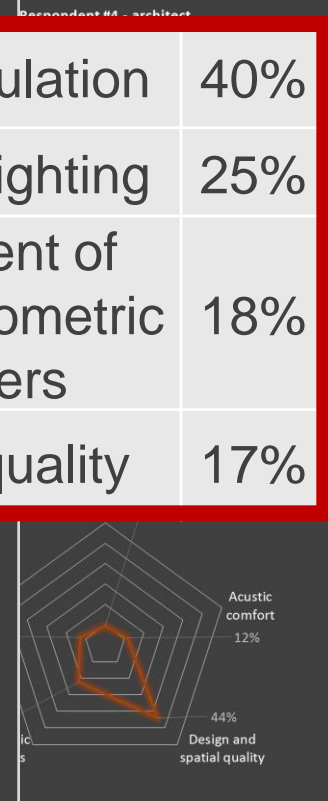
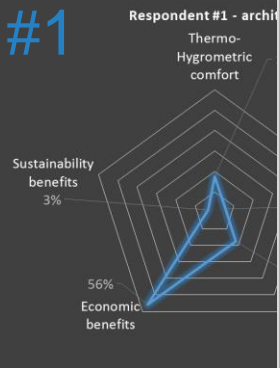
ELEMENTI DI DETTAGLIO

Con riferimento a...	... quale tra i seguenti elementi valuta più importante? O il reputa di uguale importanza?		
11	Benefici di comfort termo-igrometrico	Avere un miglior isolamento termico complessivo	Avere una migliore qualità dell'aria nell'appartamento
12	Benefici di comfort termo-igrometrico	Avere un miglior isolamento termico complessivo	Poter gestire i parametri termo-igrometrici nei singoli vani
13	Benefici di comfort termo-igrometrico	Avere una migliore qualità dell'aria nell'appartamento	Poter gestire i parametri termo-igrometrici nei singoli vani
14	Benefici di comfort termo-igrometrico	Avere una maggiore illuminazione naturale	Avere un miglior isolamento termico complessivo
15	Benefici di comfort termo-igrometrico	Avere una maggiore illuminazione naturale	Avere una migliore qualità dell'aria nell'appartamento
16	Benefici di comfort termo-igrometrico	Avere una maggiore illuminazione naturale	Poter gestire i parametri termo-igrometrici nei singoli vani
17	Benefici di comfort acustico	Rumori dall'esterno dell'edificio	Rumori interni
18	Benefici di comfort acustico	Rumori dall'esterno dell'edificio	Rumori da abitazioni confinanti dell'edificio
19	Benefici di comfort acustico	Rumori da abitazioni confinanti	Rumori interni
20	Benefici di qualità estetica - architettonica	Migliorare la distribuzione degli ambienti interni	Migliorare l'aspetto esterno dell'edificio
21	Benefici di qualità estetica - architettonica	Migliorare la qualità delle finiture appartamento	Migliorare l'aspetto esterno dell'edificio



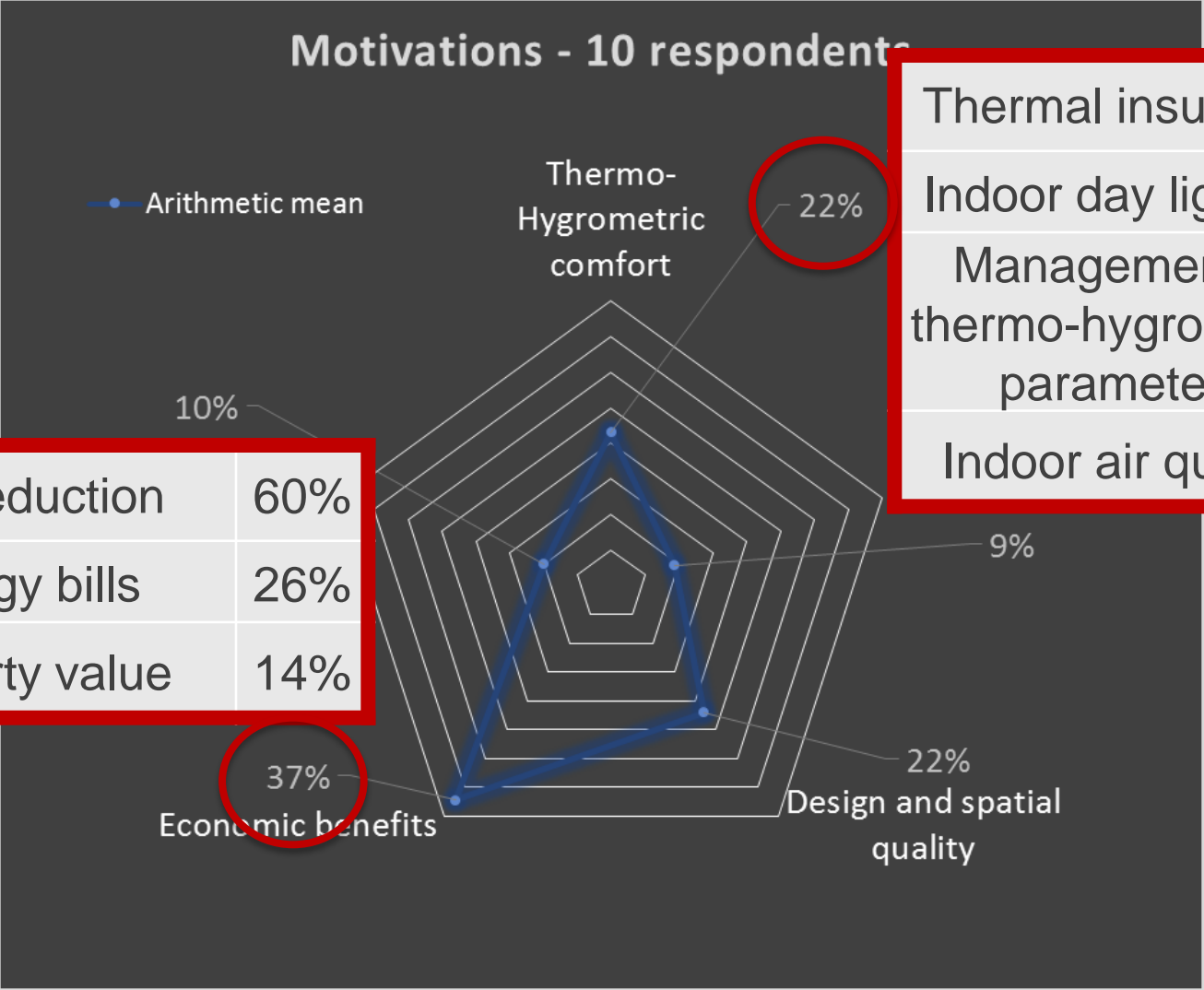
# Results

## Motivations - 10 respondents

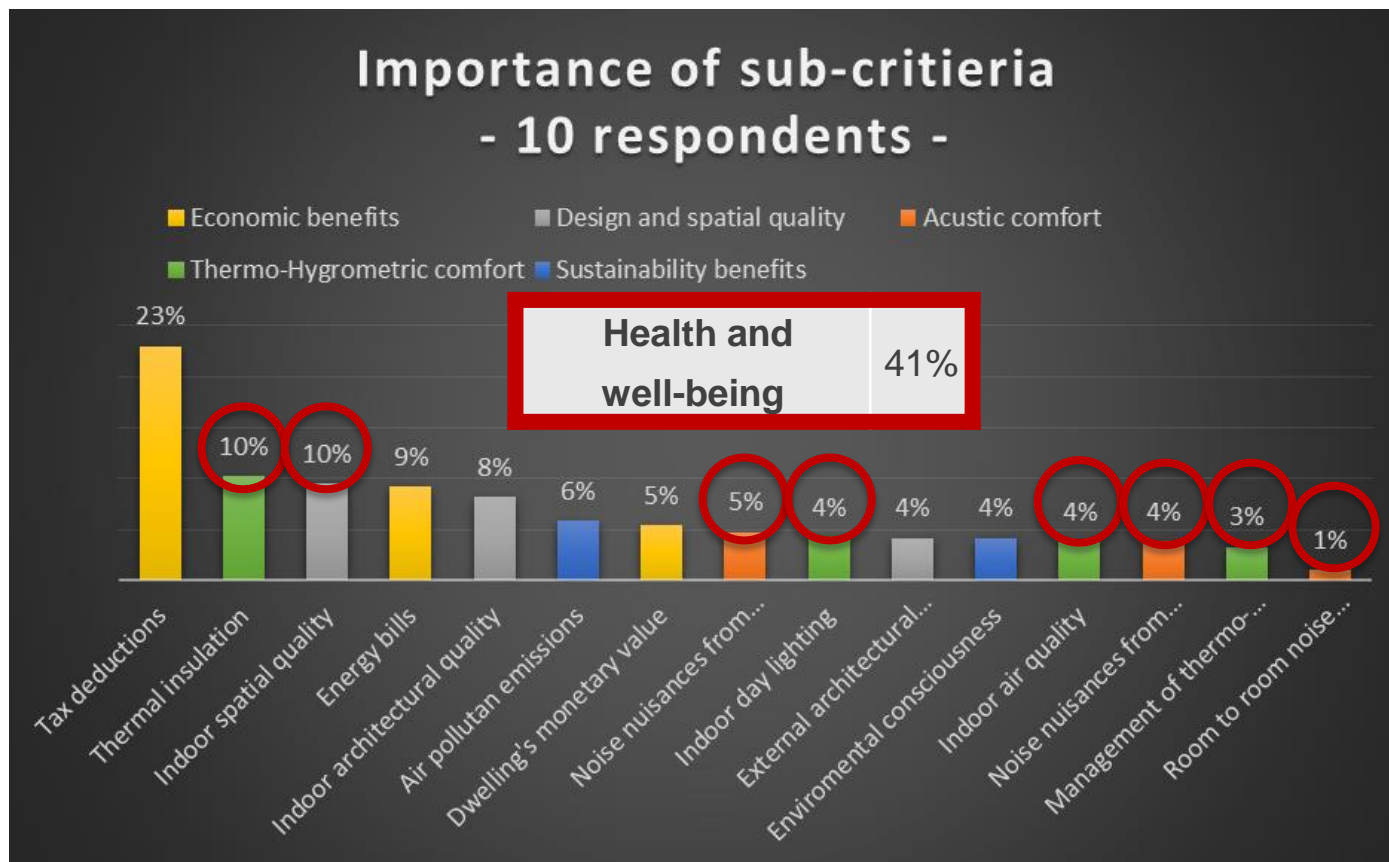


Thermal insulation	40%
Indoor day lighting	25%
Management of thermo-hygrometric parameters	18%
Indoor air quality	17%

Tax deduction	60%
Energy bills	26%
Property value	14%



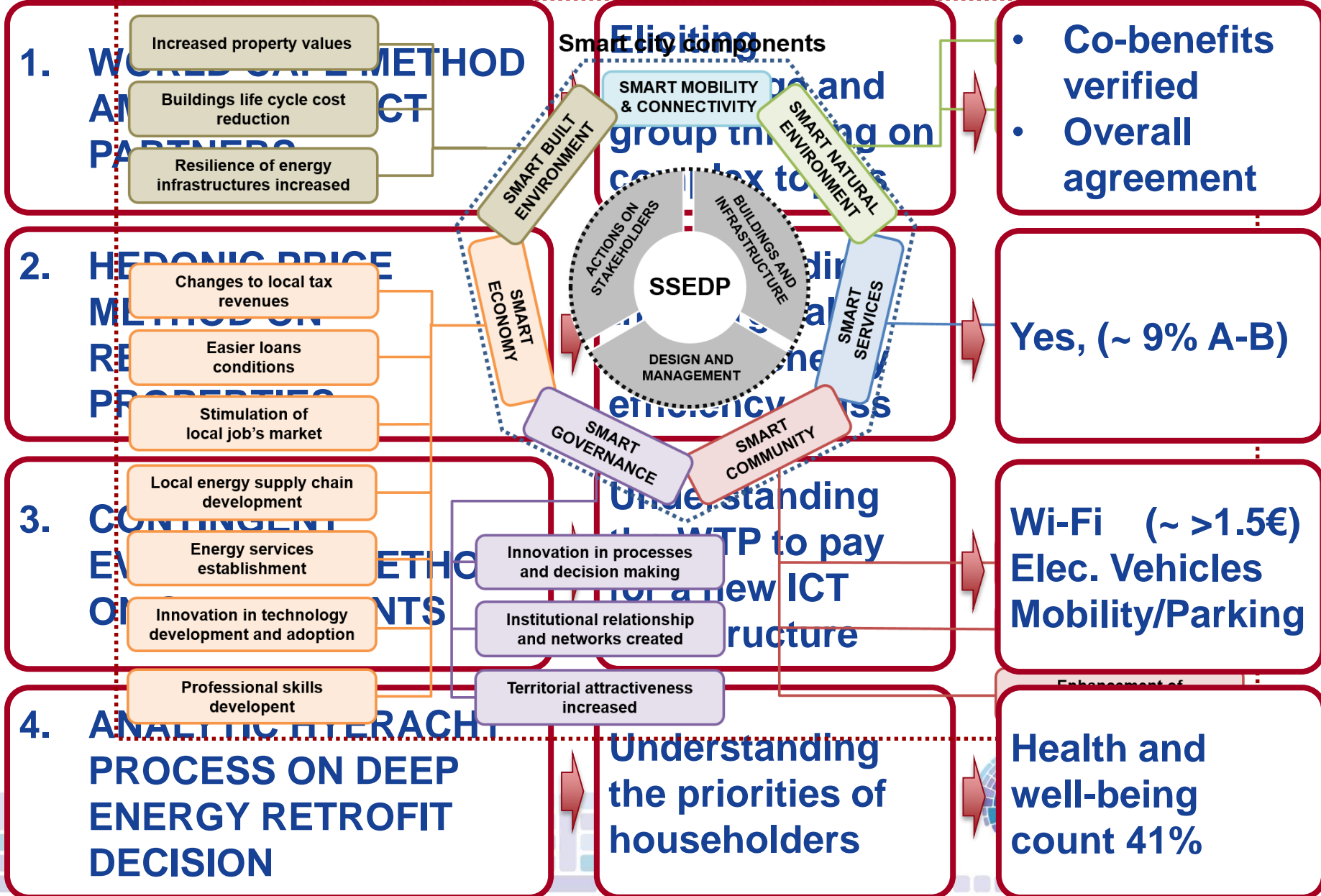
# Which co-benefits are expected by citizens undertaking deep energy retrofit works, on their own residential building?



The focus is on a specific typology of stakeholder  
-> house owners

# 4 SPECIFIC INVESTIGATIONS TO FRAME THE CO-BENEFITS

Urban co-benefits framework



February 19<sup>th</sup>, 2019

**THANK YOU! ANY QUESTIONS?**



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