EuroPHit

Practical implementations of EnerPHit step-by-step retrofit

Simon Camal

La Maison Passive

19th Passive House Conference, Leipzig, 2015

Co-funded by the Intelligent Energy Europe Programme of the European Union

LA MAISON PASSIVE

Summary

EuroPHit

1. Audit
2. Design
3. Reduce costs

1. AUDIT

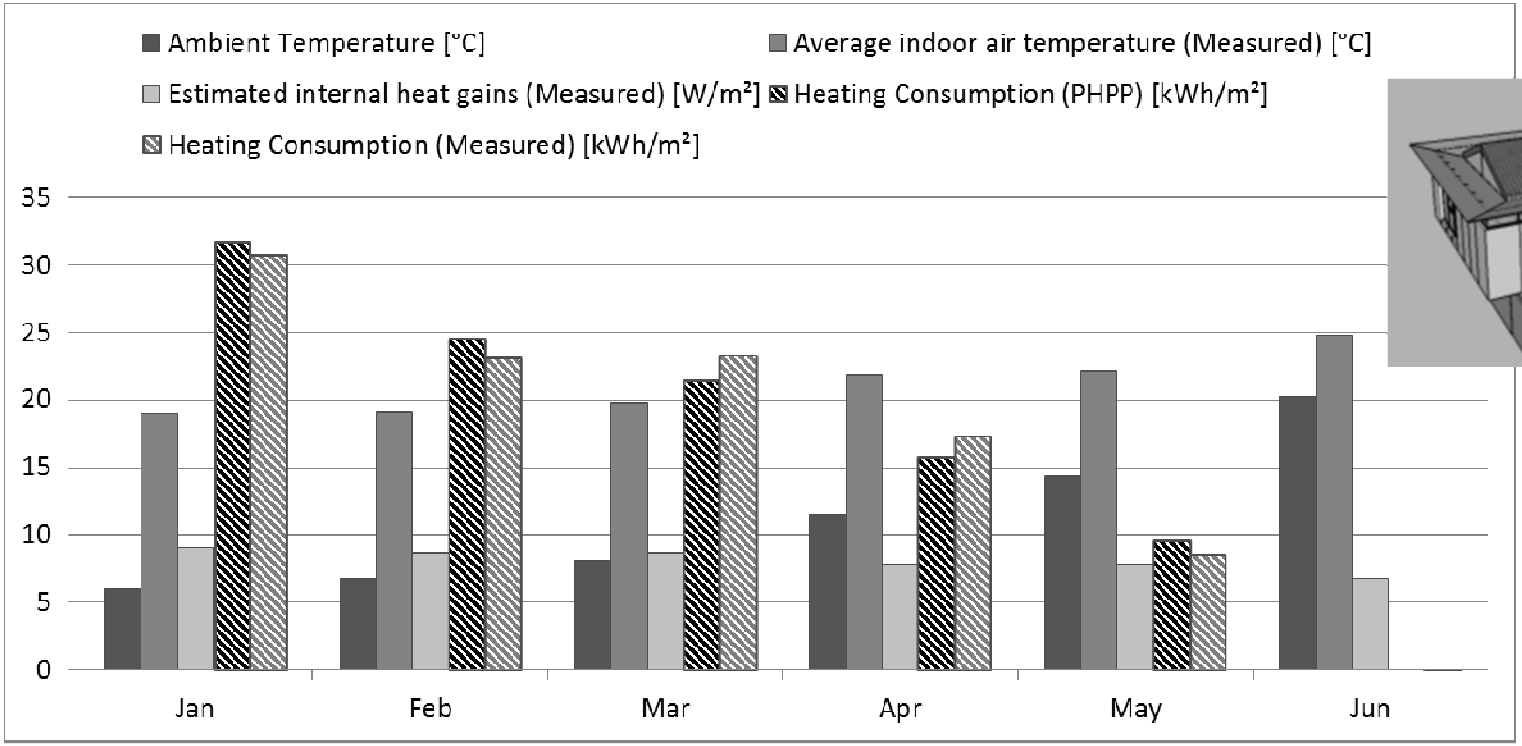
Co-funded by the Intelligent Energy Europe Programme of the European Union

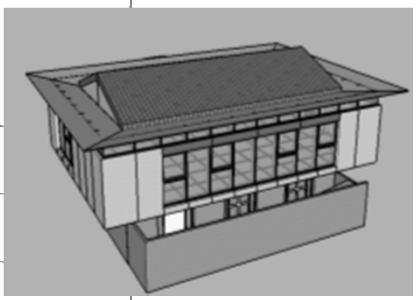
PHPP to model existing buildings ?

EuroPHit

Recalibrated PHPP9 with monitoring data on existing office building

- Timber frame, double glazing, extract only, n50 = 6,8 h^{-1}
- Heat supply : 60% pellets, 40% gas
- PHPP heating consumption matches monitored levels (150 kWh/m².a, ± 10% monthly)





Observer Project Archipente, Rhone Alpes, FR. Data : 01/14-06/14

Co-funded by the Intelligent Energy Europe Programme of the European Union

LA MAISON PASSIVE

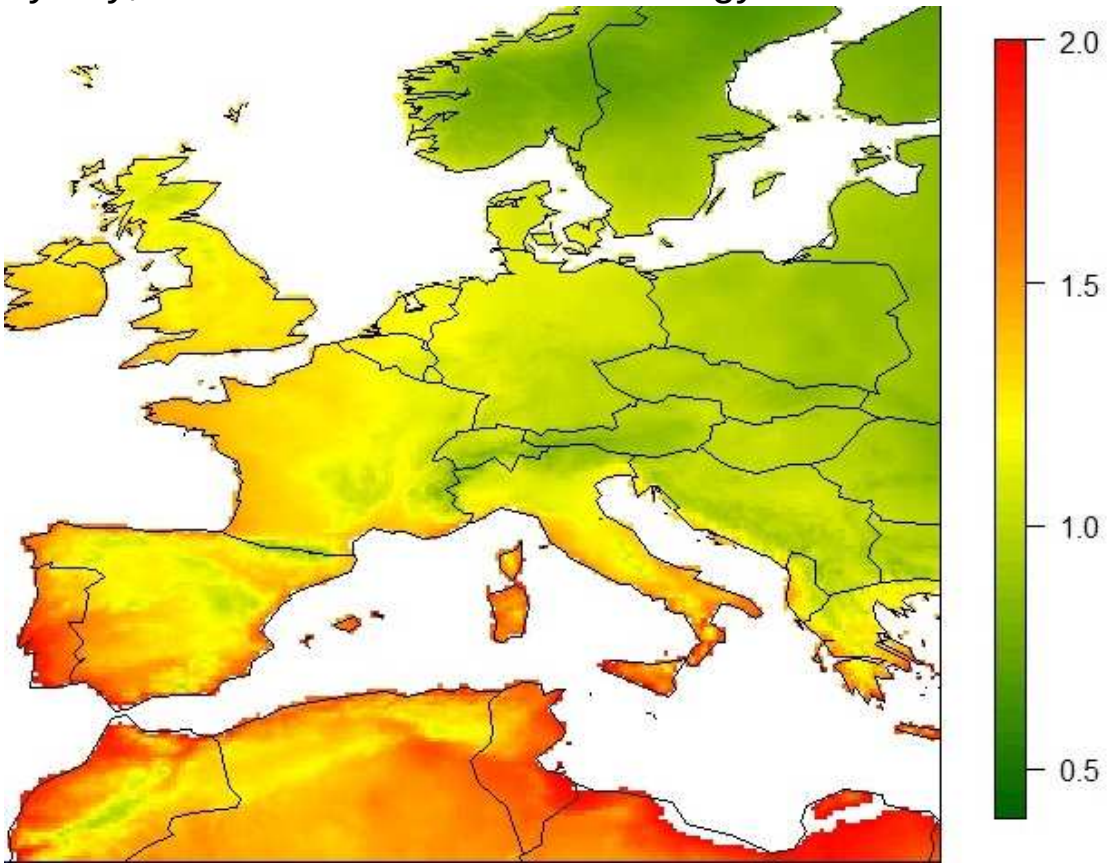
Efficiency for comfort : windows

EuroPHit

Passive House quality even with hotter winters ?

Minimal Uw [W/(m².K)] for winter comfort, average minimal temperature in winter

-> Comfort is not the only key, have a look at the winter energy balance !



Climate Data: CRU, NASA SSE

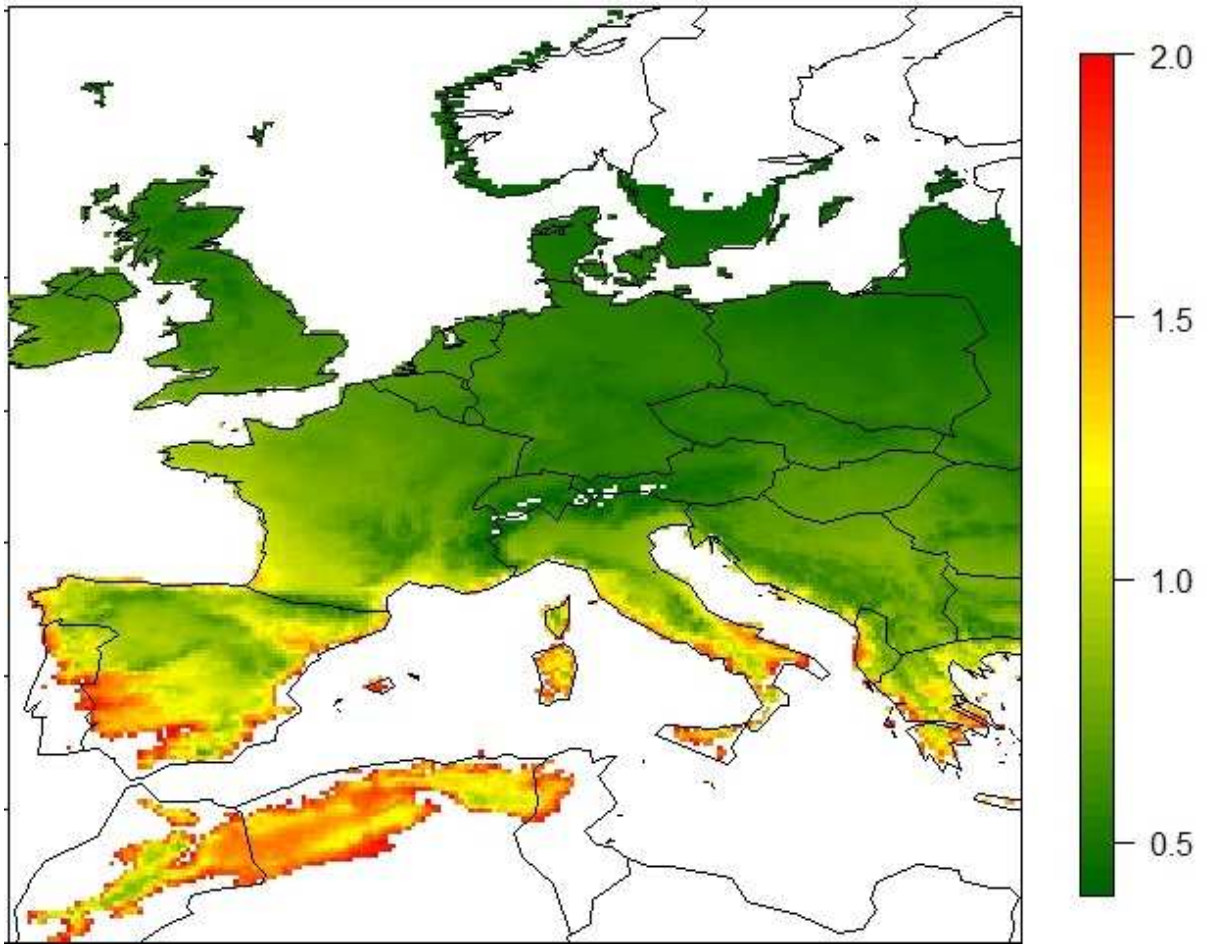
Co-funded by the Intelligent Energy Europe Programme of the European Union

LA MAISON PASSIVE

Winter energy efficiency : windows

EuroPHit

Minimal Uw [W/(m².K)] for positive energy balance on windows



g = 55%

22% of the solar horizontal irradiation reach windows

Climate Data: CRU, NASA SSE

Co-funded by the Intelligent Energy Europe Programme of the European Union

LA MAISON PASSIVE

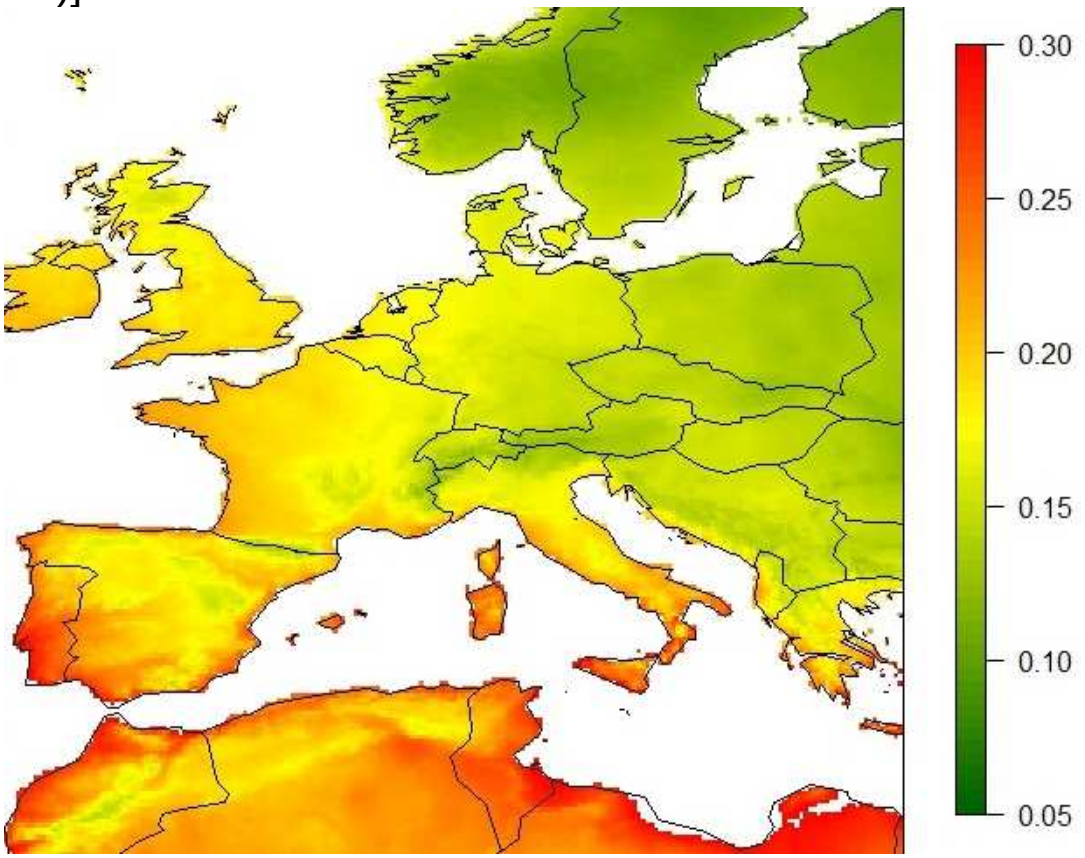
Efficiency for comfort : walls

EuroPHit

Passive House quality even with hotter winters ?

Yes ! But comfort must be completed by an economical assessment

Minimal U-value [W/(m².K)] in walls for winter comfort



Climate Data: CRU, NASA SSE

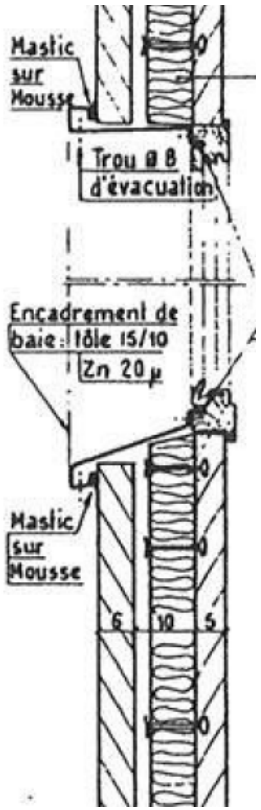
Co-funded by the Intelligent Energy Europe Programme of the European Union

LA MAISON PASSIVE

Economical efficiency : components

EuroPHit

Is it worth to retrofit a wall already insulated?



Example : Prefab concrete panels 1978

- 8 cm mineral wool insulation
- U = 0,47 W/(m².K)

Example : Concrete form wall 1973

- 10 cm interior insulation with mineral wool
- U = 0,35 W/(m².K)

Co-funded by the Intelligent Energy Europe Programme of the European Union

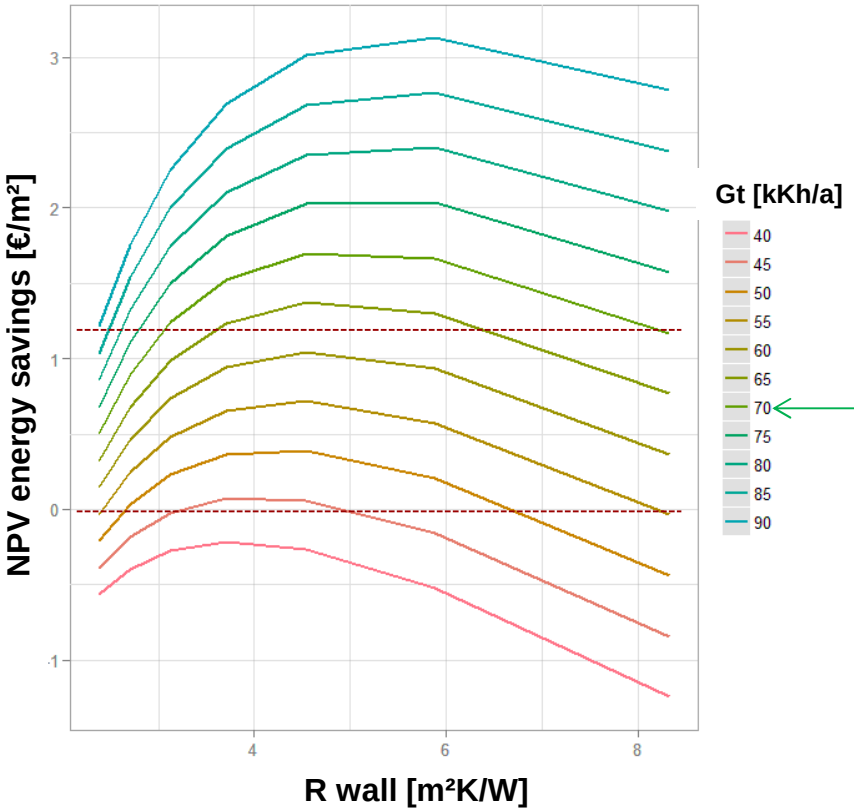
LA MAISON PASSIVE

Is it worth to retrofit a wall already insulated?

EuroPHit

Example ETICS on prefab concrete panels 1978 (thousands of buildings)

- Existing: 8 cm mineral wool insulation, U = 0,47 W/(m².K)
- Investment ETICS: 90-150 €/m² wall according U-value, Render : 35€/m²



Case Study Courcelles, FR

- Direct electric heaters, 15 c€/kWh, investment period 20 years, residual value on extra **30 years**

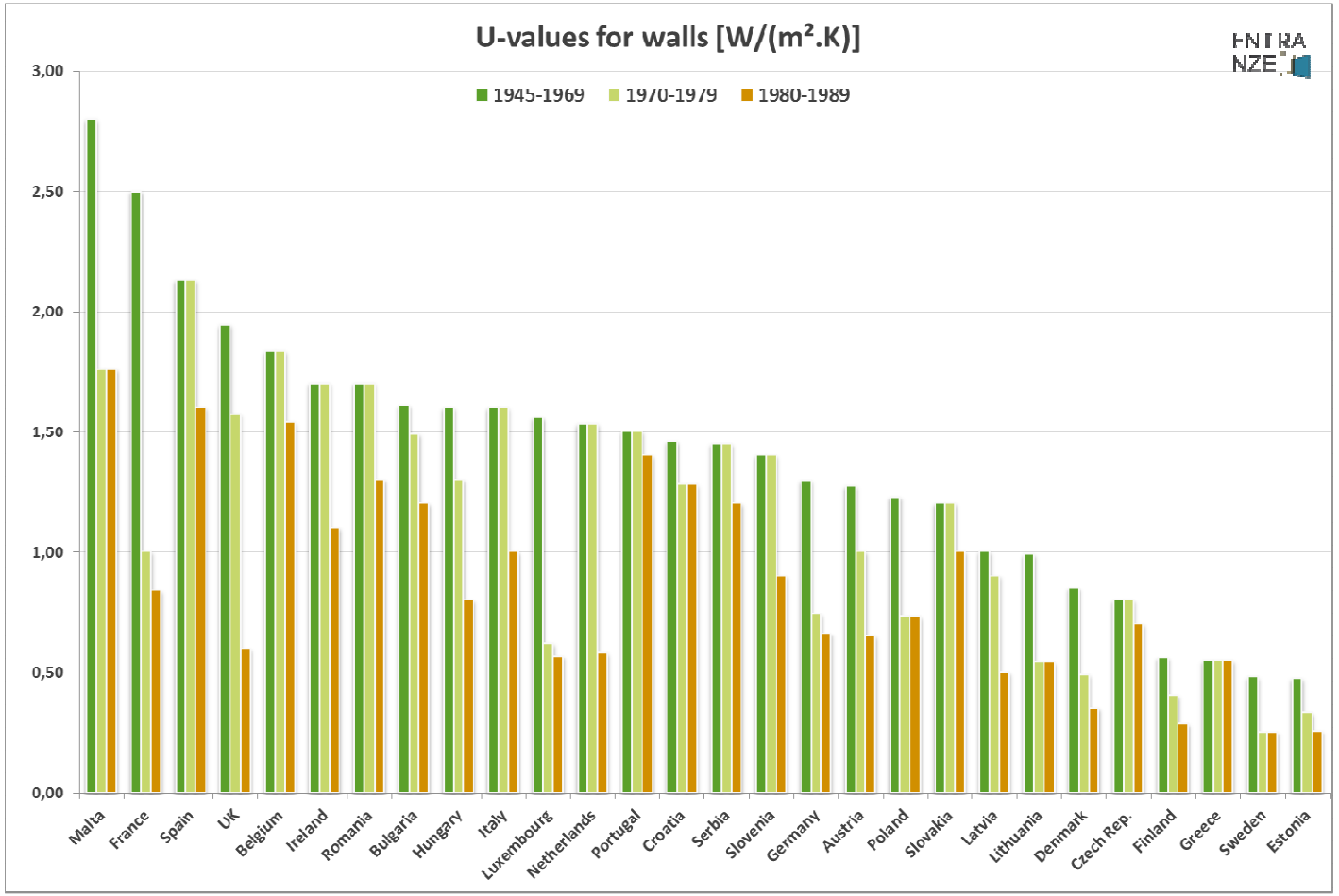
Co-funded by the Intelligent Energy Europe Programme of the European Union

LA MAISON PASSIVE

Economical efficiency : components

EuroPHit

Compare your building to the average figures of your country



Co-funded by the Intelligent Energy Europe Programme of the European Union

LA MAISON PASSIVE

Initial airtightness

EuroPHit

Is the initial airtightness relevant to the economic analysis ?

- Office in timber frame to be retrofitted
- Mechanical ventilation extract only
- Initial airtightness test : n50 = 6,8 h^{-1}

Was it worth to do an initial blower-door test ?

- Yes, as a guidance for the airtightness design
- Yes, as it helped calibrating the PHPP
- Instead of a pessimistic n50 = 10 h^{-1},

- 17 kWh/(m^2.a) heating demand (PHPP)

+ 18 €/m^2 net present value (test cost: 2 €/m^2)

Observer Project Archipente, Montbrison, FR

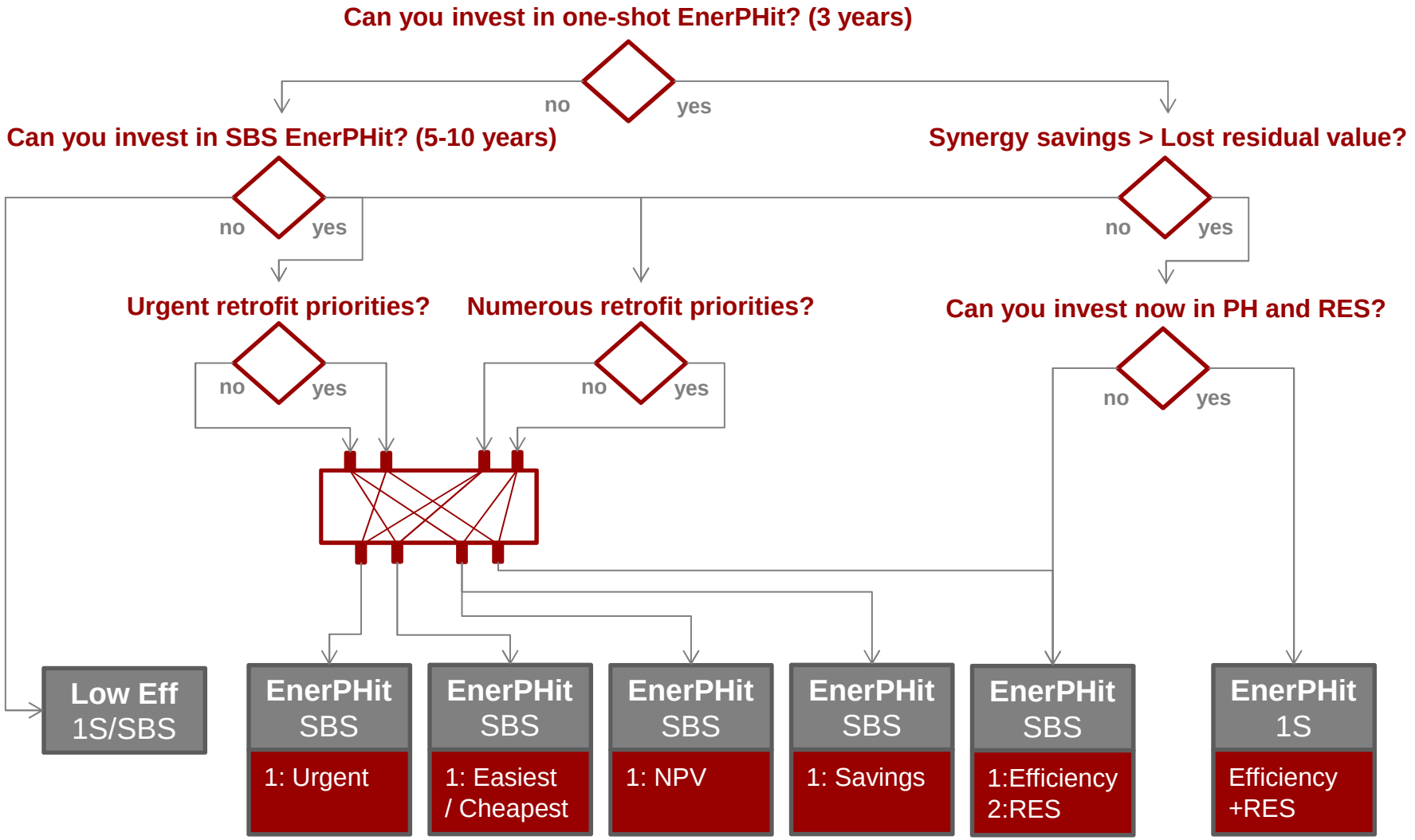
archipente

2. DESIGN

Co-funded by the Intelligent Energy Europe Programme of the European Union

Decision Graph

EuroPHit



Co-funded by the Intelligent Energy Europe Programme of the European Union

LA MAISON PASSIVE

Keep tenants inside

EuroPHit

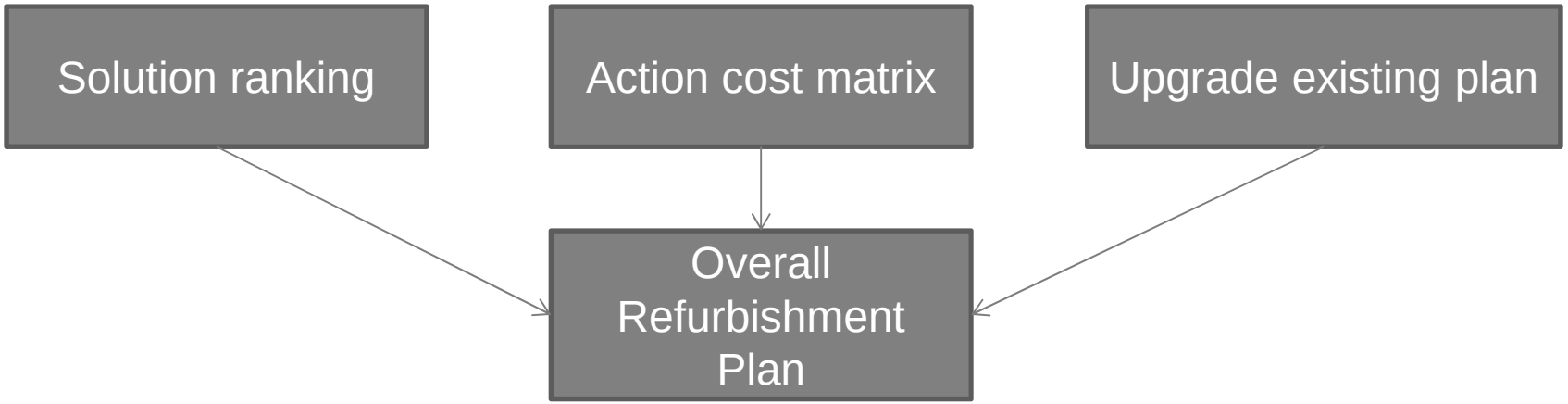
- **Use**
  - → **No additional insulation on slabs**
  - → **Absestos: define if in-situ is possible**
- **Noise** → **Minimize cuts, holes and fixations**
- **Light** → **Minimize scaffolding duration / avoid scaffolding**
- **Privacy** → **Couple deep interventions inside dwellings** → eg Ventilation ducts and DHW plumbing

Co-funded by the Intelligent Energy Europe Programme of the European Union

LA MAISON PASSIVE

Setting up an Overall Refurbishment Plan

EuroPHit



Example on Case Study Courcelles, France

- Multifamily social housing
- 2 x 16 dwellings
- Prefab concrete panels
- Heating and DHW individual, direct electric
- Existing heating demand = 90 kWh/(m².a)
- Existing PE demand = 390 kWh/(m².a)

Co-funded by the Intelligent Energy Europe Programme of the European Union

LA MAISON PASSIVE

Solution ranking

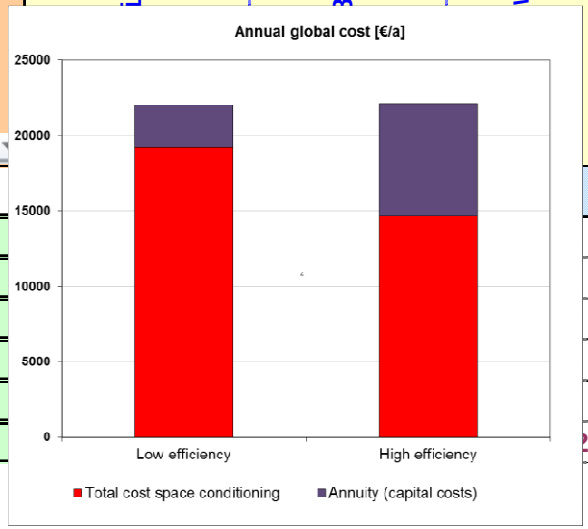
EuroPHit

1. Define solutions with owner/investor
2. Rank these solutions (use PHPP9 Variants)

Comparison

Input: comparison configuration

	3	1-1: Existing	ing	35%	ws	4: Walls U = 0.12
Description	MVHR					
Component type	Ventilation system ('Ventilatio					
Component		1				4
Results						
"Lower Efficiency" variant	7-Min Efficiency (RT-Ex)					
Heating demand		91.7				26.2
Heating load		38.9				14.5
Overall specific space cooling demand						
Cooling load						
"Higher Efficiency" variant	2-2: MVHR 85%					
Overheating frequency		1.1				3.3
Primary Energy Consumption		387.9				204.4
Investment costs [€]	52000					
Annual maintenance costs [€/a]	800					
Investment costs [€]	137600					
Annual maintenance costs [€/a]	1600					
Financial support (present value) [€]						



Centralised MVHR vs standard maintenance on existing extract unit (16 dwellings)

Present Value Energy savings (20a) = 57 €/m²TFA

Co-funded by the Intelligent Energy Europe Programme of the European Union

LA MAISON PASSIVE

Solution ranking

EuroPHit

1. Define solutions with owner/investor
2. Rank these solutions (use PHPP9 Variants)
3. Identify best candidates for first step
4. Check for incompatibilities

Result in this case: **First step =** Ventilation

Most Urgent	Easiest/Cheapest	Best NPV	Highest Savings
Windows	Windows	Roofs	Ventilation
Heating&DHW	Walls	Walls	Windows
Walls	Heating&DHW	Ventilation	Walls
Ventilation	Roofs	Heating&DHW	Heating&DHW
Roofs	Ventilation	Windows	Roofs
Slabs	Slabs	Slabs	Slabs

Co-funded by the Intelligent Energy Europe Programme of the European Union

LA MAISON PASSIVE

Action cost matrix

EuroPHit

Which retrofit path?

Lines: Before Columns: After	Windows	Walls	Ventilation	Heating	**Total induced costs**
Windows					
Walls					
Ventilation					
Heating					
Total incurred costs					

[€/dwelling], 20 year period
Cost calcuation: Investment (Synergies) + Lost Residual Values – Energy savings

Co-funded by the Intelligent Energy Europe Programme of the European Union

LA MAISON PASSIVE

Action cost matrix: Example Courcelles

EuroPHit

Windows

- New triple glazing PVC window installed in the inner insulation layer
- Investment = 8.8 k€/dwelling
- Energy savings (PHPP9) = 5.5 k€/dwelling

Walls

- Airtightness: exterior concrete panel + sealing
- 200mm EPS glued on exterior panel, sealed air layer
- Investment = 6.3 k€/dwelling
- Energy savings = 4.7 k€/dwelling

Windows before Walls

- Intermediate then final connection to walls
- Investment = 0.9 k€/dwelling
- Energy savings = 0.1 k€/dwelling

Walls before Windows

- Intermediate then final connection to windows
- Investment = 2 k€/dwelling
- Energy savings = 0.1 k€/dwelling

Co-funded by the Intelligent Energy Europe Programme of the European Union

www.europhit.eu

LA MAISON PASSIVE

Action cost matrix

EuroPHit

Lines: Before Columns: After	Windows	Walls	Ventilation	Heating	**Total induced costs**
Windows	8800-5500= 3300	900-100= 800	2000- 0 = 2000	0	6100
Walls	2000-100= 1900	6300-4700= 1600	0	0	**3500**
Ventilation	0	0	9300-4300= 5000	0	**5000**
Heating	Heating oversized = 3000	Heating oversized = 3000	Heating oversized = 3000	10300-8000= 2300	11300
Total incurred costs	8200	5400	10000	**2300**	

[€/dwelling], 20 year period
Cost calcuation: Investment (Synergies) + Lost Residual Values – Energy savings

Co-funded by the Intelligent Energy Europe Programme of the European Union

LA MAISON PASSIVE

Upgrade refurbishment plan

EuroPHit

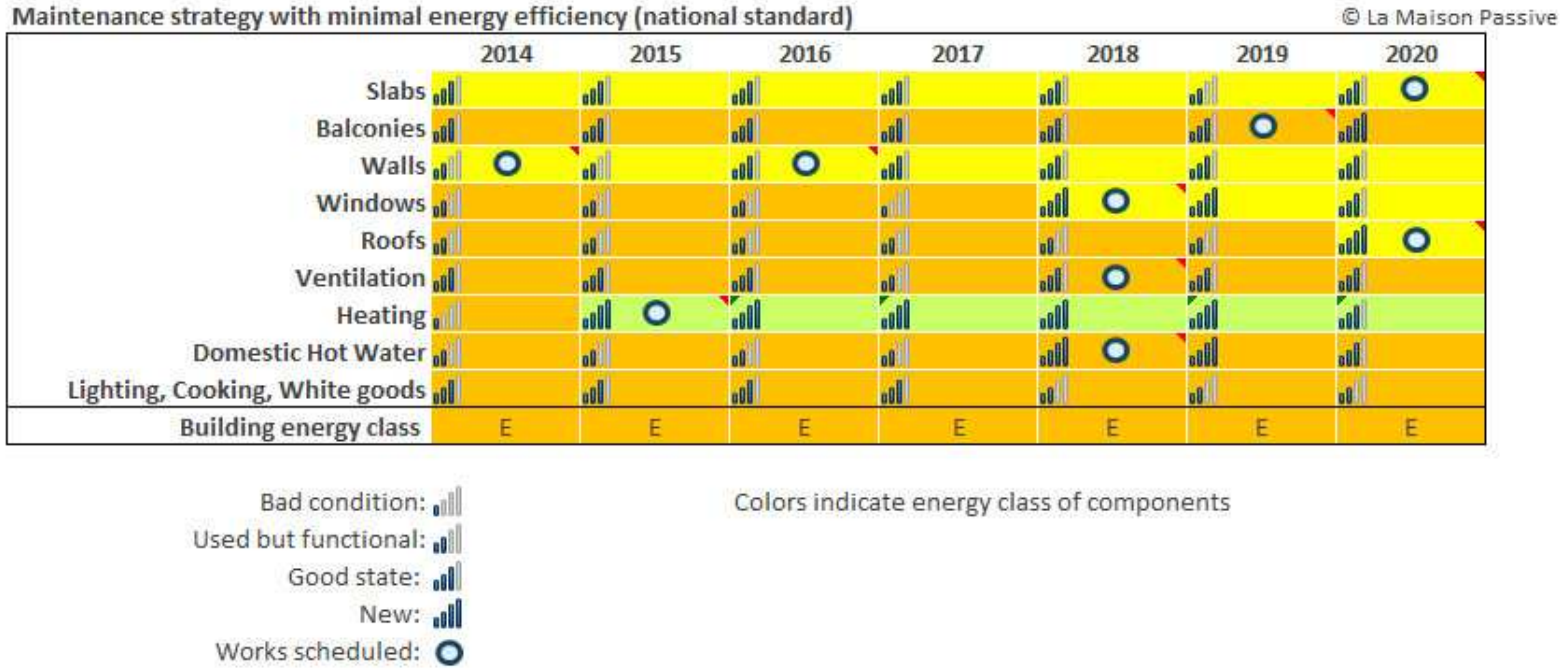
1. **Build up a low-efficiency retrofit scenario (either national standard or low energy label)**
2. **Modify it to embed EnerPHit efficiency**
3. **Chose measures according to priorities defined with investors:**
   - Occupants comfort
   - Building health
   - Positive Net Present Value of single measures or group of measures
   - Technical feasibility

Setting up an overall refurbishment plan : Example

EuroPHit

Base scenario, minimal energy efficiency as required by national standard

- Investment required (6 year period) : 22 k€/dwelling
- Global cost on 20 years : 34 k€/dwelling
- Total energy bill (with white goods) : 1650 €/dwelling.a
- Scheduled measures : window replacement, new paint on walls, change electric heaters, replace sanitary facilities



Co-funded by the Intelligent Energy Europe Programme of the European Union

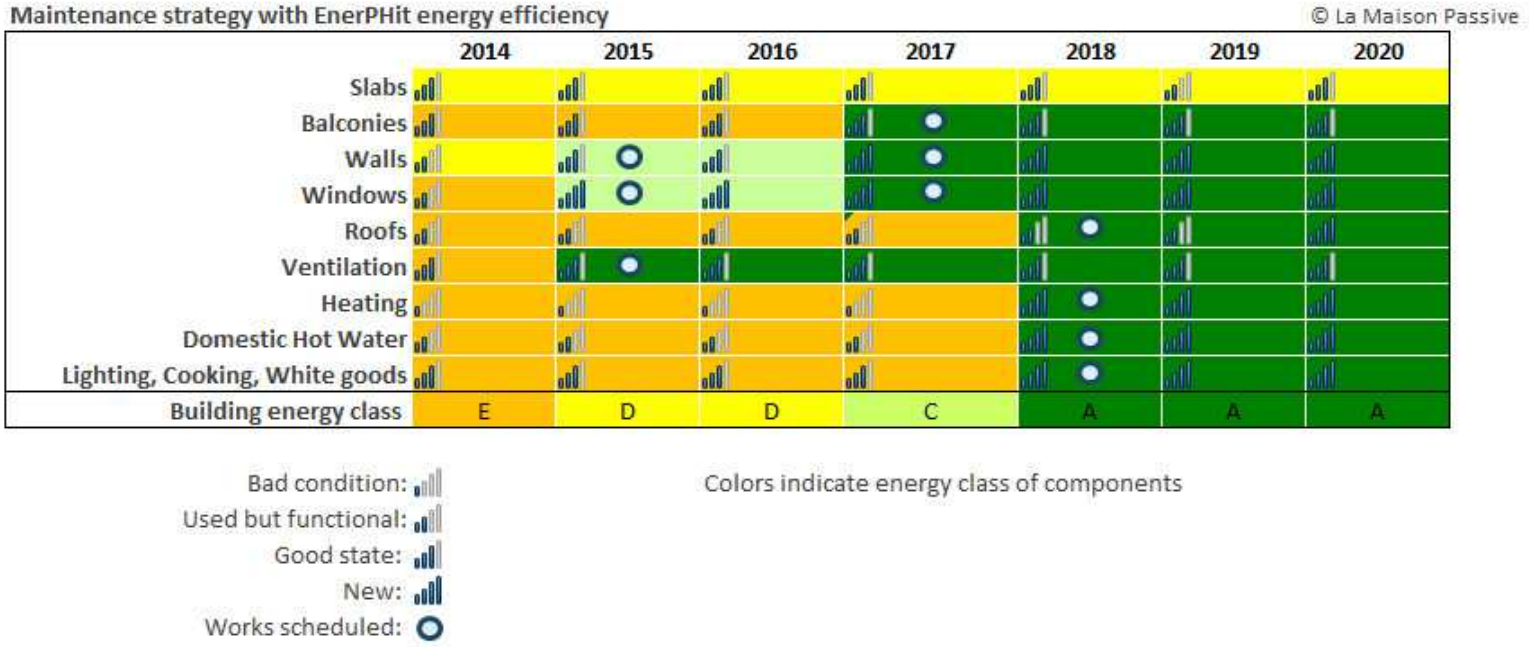
LA MAISON PASSIVE

Setting up an overall refurbishment plan : Example

EuroPHit

EnerPHit scenario

- Investment required (6 year period) : 41 k€/dwelling
- Additional investment for EnerPHit : 19 k€/dwelling
- Global cost on 20 years : 48 k€/dwelling
- Total energy bill (with white goods) : 400 €/dwelling.a
- Scheduled measures : phB windows, MVHR, ETICS, Insulation roof, Air/Water heat pump for heating/DHW



Co-funded by the Intelligent Energy Europe Programme of the European Union

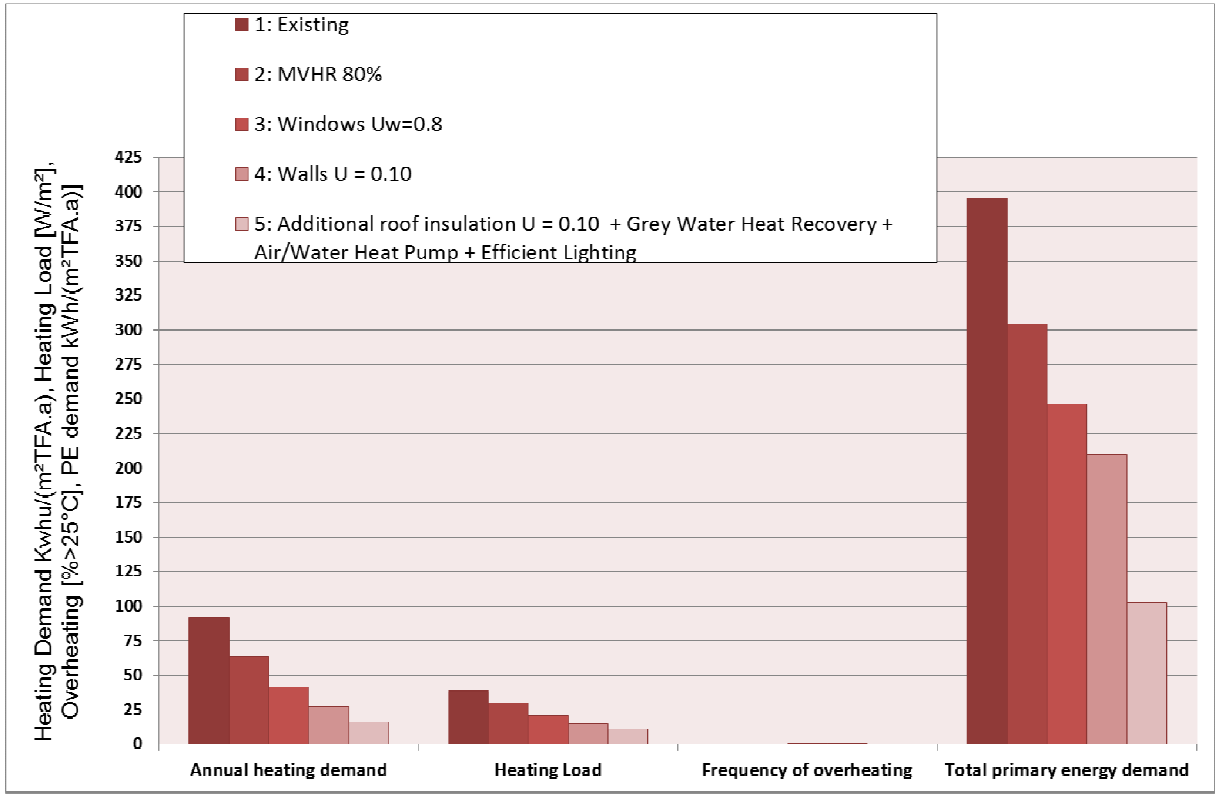
LA MAISON PASSIVE

Setting up an overall refurbishment plan : Example

EuroPHit

PHPP9 Variants

- 85% reduction in heating demand
- 75% reduction of Primary Energy consumption



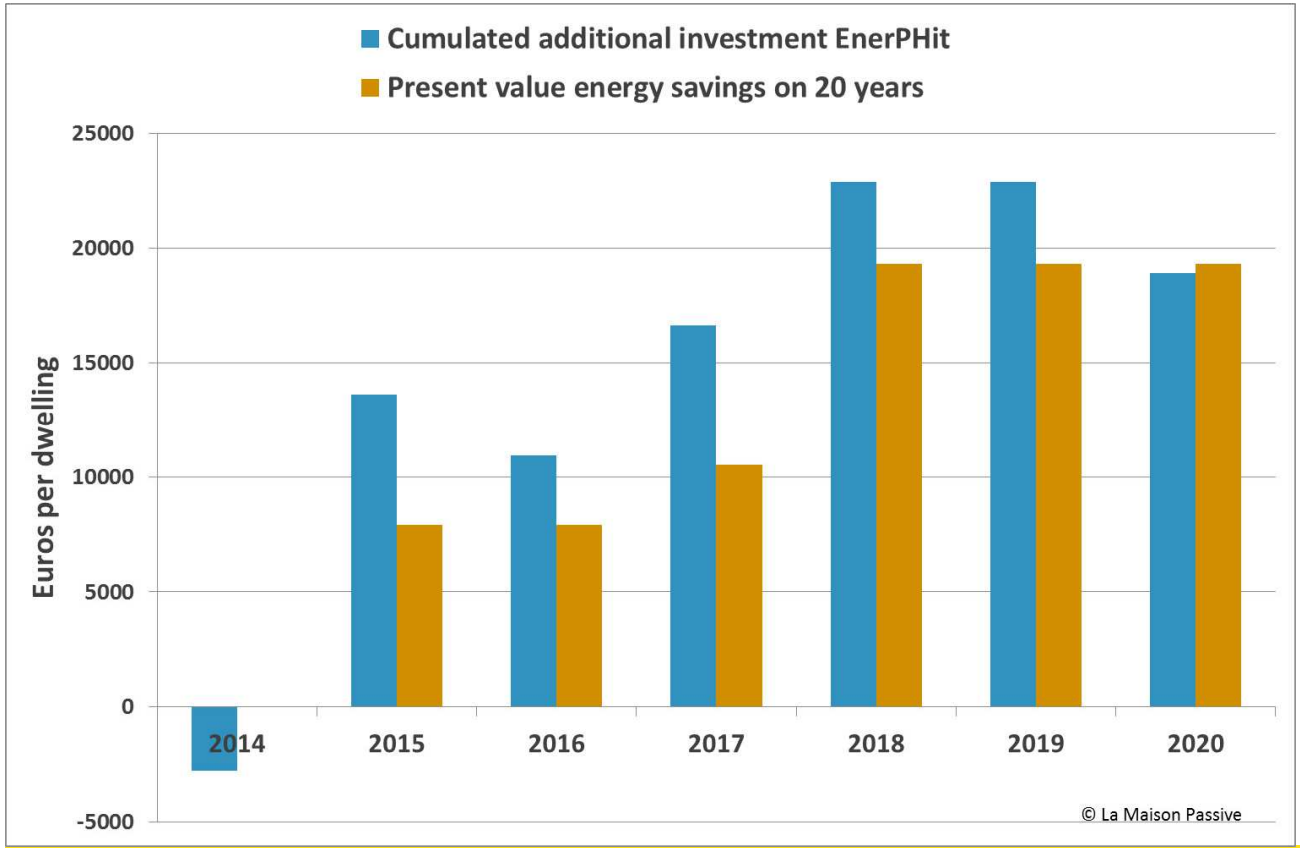
Co-funded by the Intelligent Energy Europe Programme of the European Union

LA MAISON PASSIVE

Setting up an overall refurbishment plan : Example

EuroPHit

- Calculation made with PHPP9, Variants and Comparison Sheet
- Additional EnerPHit investment balanced by energy savings on a 20 year period
- ! Energy savings can't always be fully recovered by investors (here roughly 50%)



Co-funded by the Intelligent Energy Europe Programme of the European Union

LA MAISON PASSIVE

3. REDUCE COSTS

Co-funded by the Intelligent Energy Europe Programme of the European Union

Airtightness

EuroPHit

Is it always necessary to renew the existing render to get an airtight layer on walls ?

- Airtightness test after replacement of windows and doors, airtight membrane on roof : n50 = 0.7 h-1
- Why ? Relatively airtight concrete form wall with cement render
- Not the case with masonry !

Do we save money here ?

- Avoid scraping and refill of existing render: - 30 €/m²
- Need to test bonding strength: + 5 €/m²
- Avoid dowels: ± 40 €/m²

Observer Project Sauvage, Lyon, FR

Co-funded by the Intelligent Energy Europe Programme of the European Union

LA MAISON PASSIVE

Total annual cost

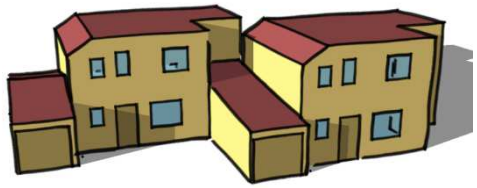
EuroPHit

Step: ETICS + Garage slabs & roofs

-100 kWh/(m².a) heating demand
Investment EnerPHit = 190 €/m²TFA
Investment Minimal = 34 €/m²TFA
Energy savings = 177 €/m²TFA

Gain on total annual cost for heating (gas) after step:
-266 €/dwelling.a

	Economic viability						
Total annual costs	11.31	2889	10.27	2623	**1.04**	**266**	€/a
	Maximal economically viable additional investment costs				**176.84**	**45172**	€
	Cost per kWh of saved final energy				**6.0**		Cent/kWh



Case Study Auby, FR

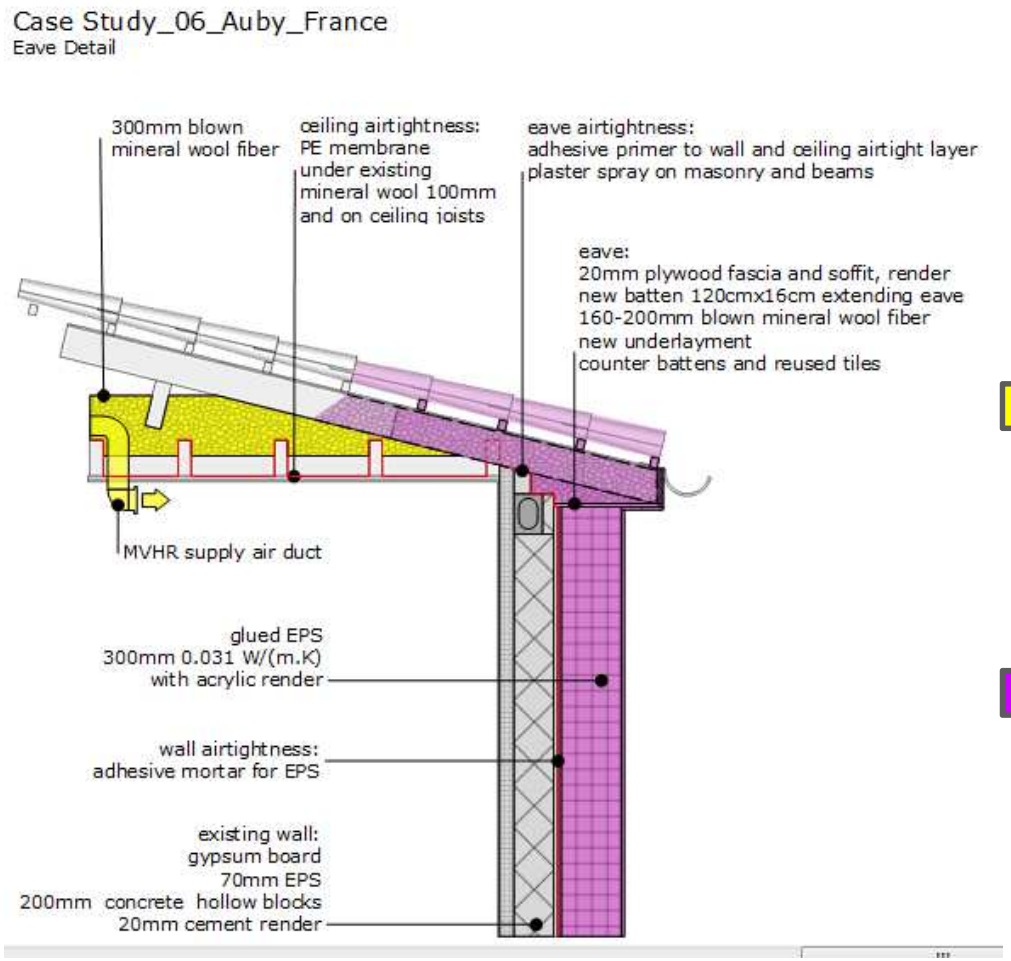
Co-funded by the Intelligent Energy Europe Programme of the European Union

LA MAISON PASSIVE

Find reproductible solutions

EuroPHit

Ceiling + MVHR before Wall



Ceiling+MVHR (2015)
Investment = 14 k€/dwelling
Total annual cost = + 97 €/a
Price saved energy = 8 c€/kWh

Walls+Eave (2018)
Investment = 16 k€/dwelling
Total annual cost = - 247 €/a
Price saved energy = 6 c€/kWh
Ψ_{eave} = 0.05 W/mK

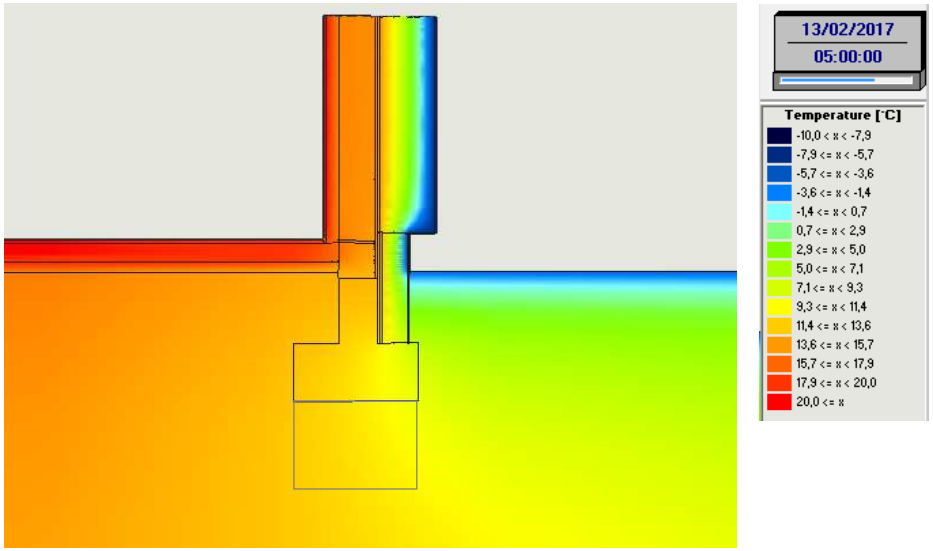
Co-funded by the Intelligent Energy Europe Programme of the European Union

LA MAISON PASSIVE

Perimeter insulation

EuroPHit

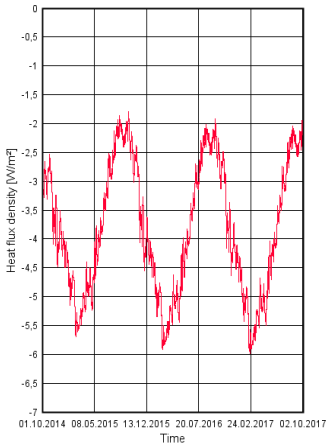
160x600 mm vertical perimeter insulation xps
Small houses B'= 5 m
Still 15°C below slab at end of winter
Heating demand reduced by 1 kWh/(m².a)
Depth more relevant than width



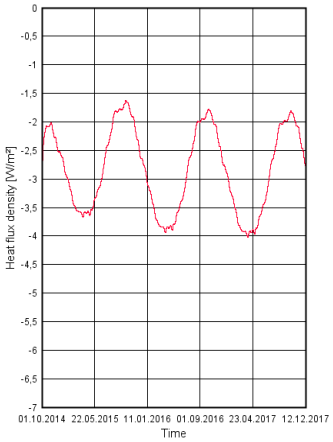
Wufi 2d

Average heat flow through slab [W/m²]

before

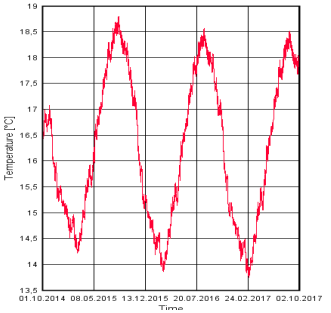


after

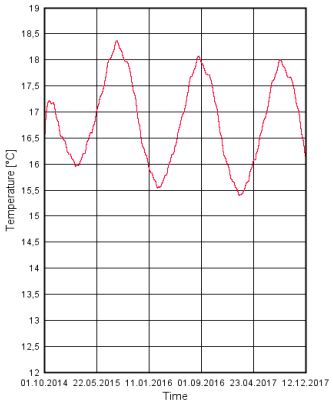


Temperature below slab [°C]

before



after



Co-funded by the Intelligent Energy Europe Programme of the European Union

Perimeter insulation

EuroPHit

Is it worth?

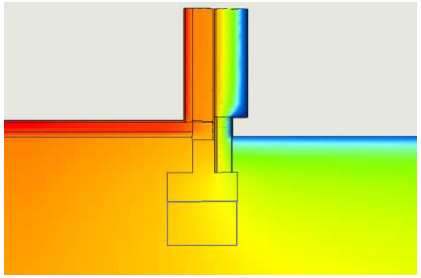
Heating demand reduction = - 1 kWh/(m².a)

Needed here to reach EnerPHit

Investment ~ 40 €/m²TFA

Negative Net Present Value, but…

Cheaper than insulate slabs from the inside!



Wufi 2d

POLLET INGENIERIE

Observer Project Sauvage, Lyon, FR

Co-funded by the Intelligent Energy Europe Programme of the European Union

LA MAISON PASSIVE

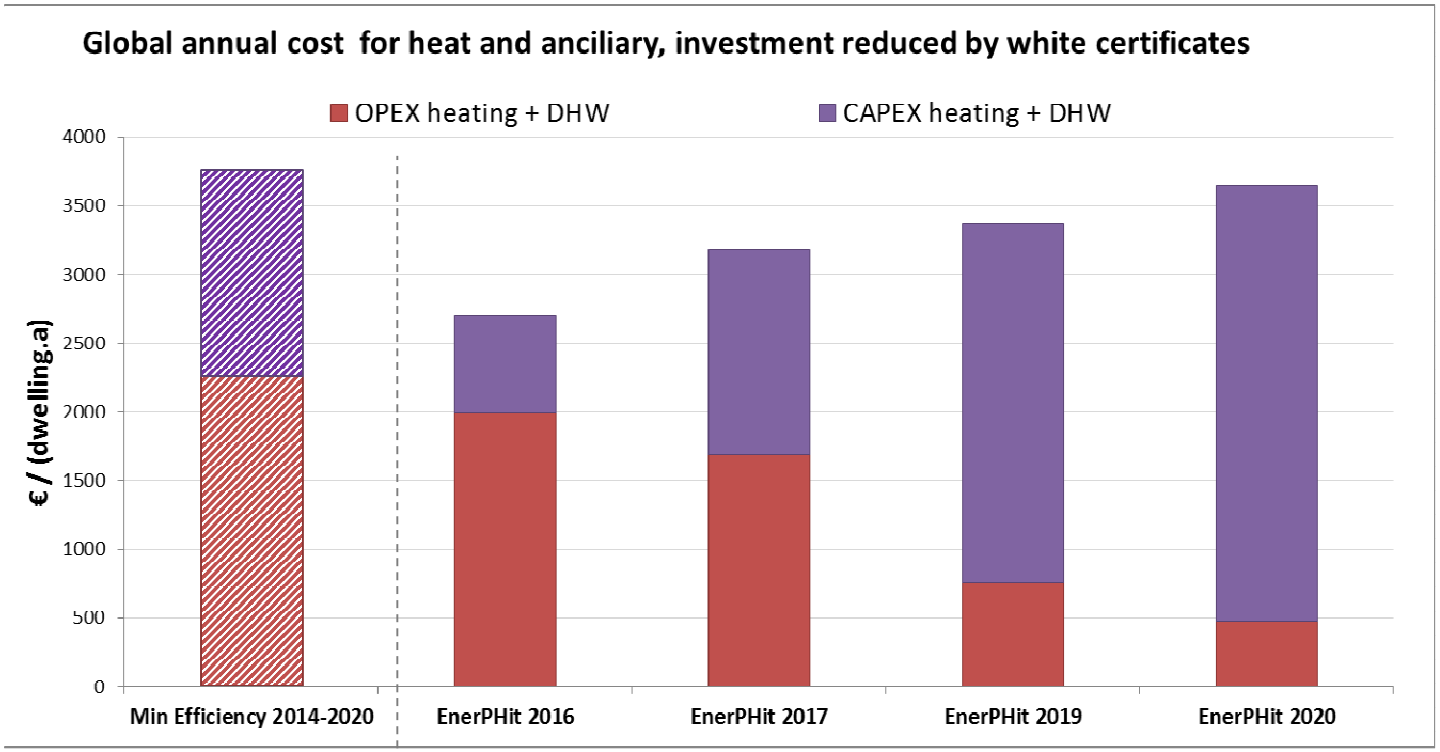
Total annual cost

EuroPHit

Here EnerPHit can be reached without additional total cost

White certificates : - 3% to -10% investment in opaque components

Assessment on 20 years + Residual values on extra 10 years



Co-funded by the Intelligent Energy Europe Programme of the European Union

LA MAISON PASSIVE

Couple interventions when ripe

EuroPHit

Windows+Walls vs Walls before Windows

Windows+Walls:

Take out window+shutter

= 190 €/window

Lost residual value

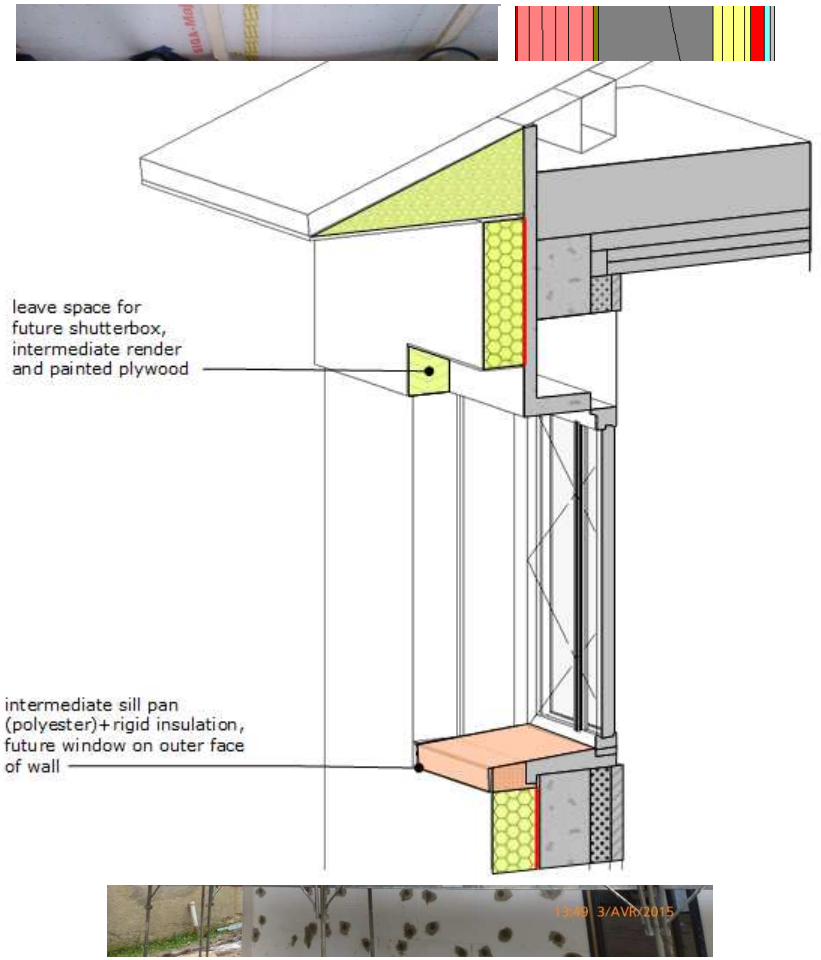
~ 100 €/window

Install new window+shutter

= 1250 €/window

Walls before Windows:

Invest = 300 €/window



Co-funded by the Intelligent Energy Europe Programme of the European Union

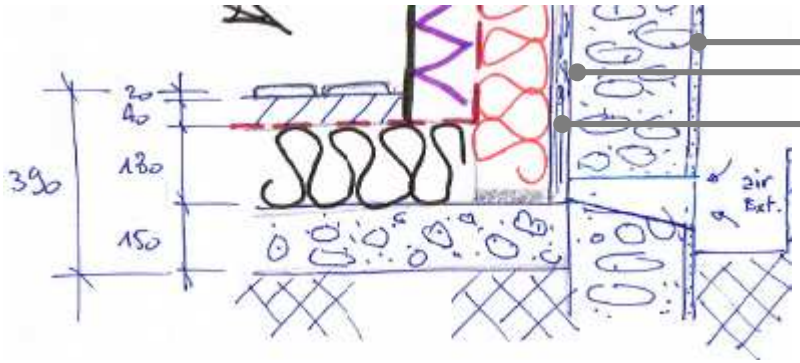
LA MAISON PASSIVE

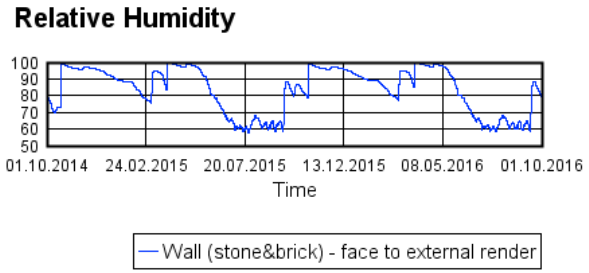
Interior insulation of massive walls

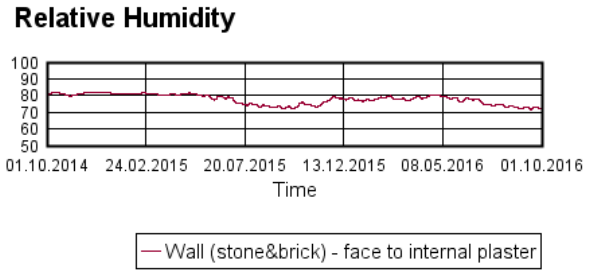
EuroPHit

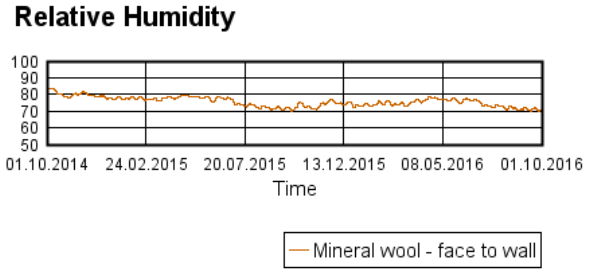
Necessary to create a ventilated air cavity between insulation and wall?

- PU 40mm+Intello+Mineral wool 180mm
- Ventilated air cavity 27mm?









Without, spare on space and labour cost

- Careful airtightness
- Sensible to diffusive and capillary properties of wall

Observer Project Genh, Marseille, FR

Co-funded by the Intelligent Energy Europe Programme of the European Union

LA MAISON PASSIVE

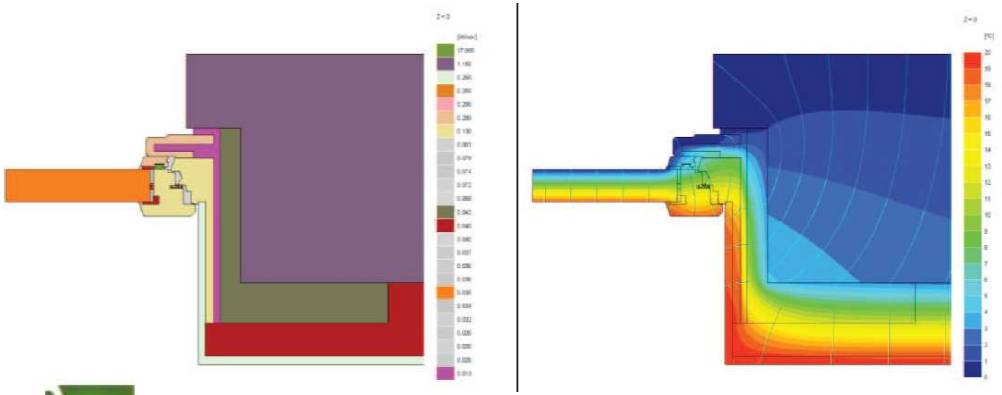
Innovative window installation

EuroPHit

Prefabricated window installation with aerogel and cork

- Thought for interior insulation of listed buildings, step-by-step possible
- 745 €/m² (excl. VAT) installed
- $\Psi_{installed,lateral}$=0.06 W/(m.K)
- $\Psi_{installed,bottom}$=0.03 W/(m.K)

Tillieux Menuiseries, Reawin A+ Tip Tep



Co-funded by the Intelligent Energy Europe Programme of the European Union

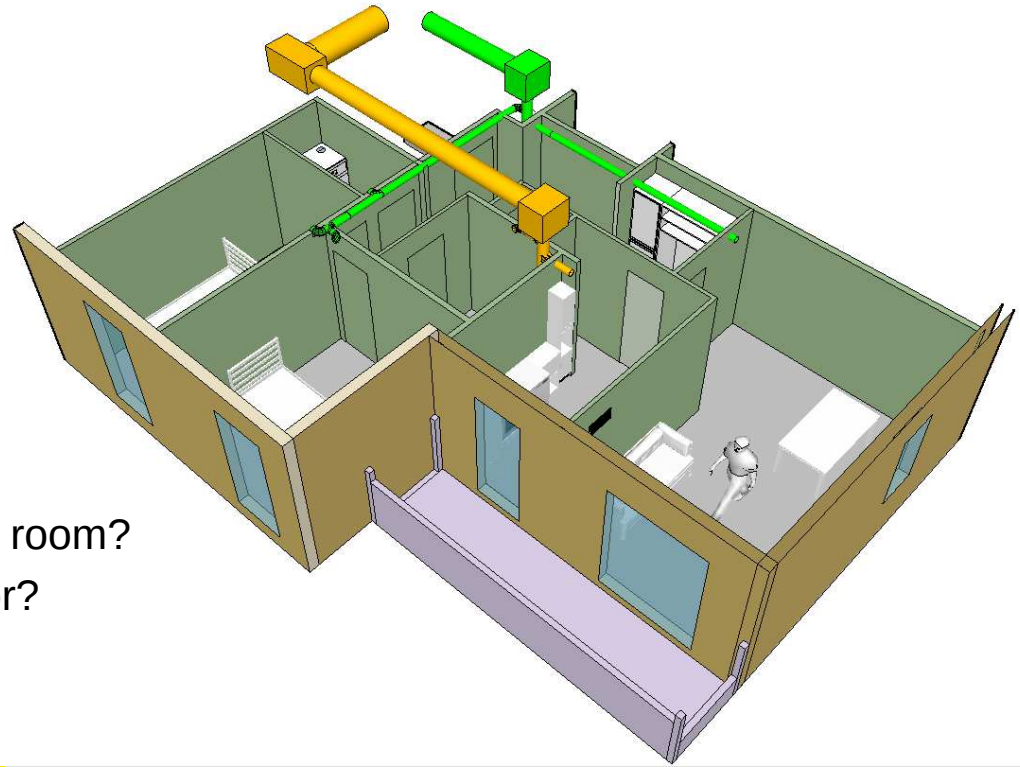
Cascade ventilation

EuroPHit

- Supply air in bedrooms (20 m3/h each), living room (60 m3/h)
- Transfer vent from living room to kitchen
- Cellar: 10 m3/h supply air to minimize duct length
- Extract (existing) in kitchen, bathroom and WC, total 120 m3/h / 0,5 h-1

Reuse existing extract ducts

- Total investment: 8.6 k€/dwelling



Expanded cascade ventilation?

- Can we delete the air inlet in the living room?
- Can we blow fresh air from the corridor?

Co-funded by the Intelligent Energy Europe Programme of the European Union

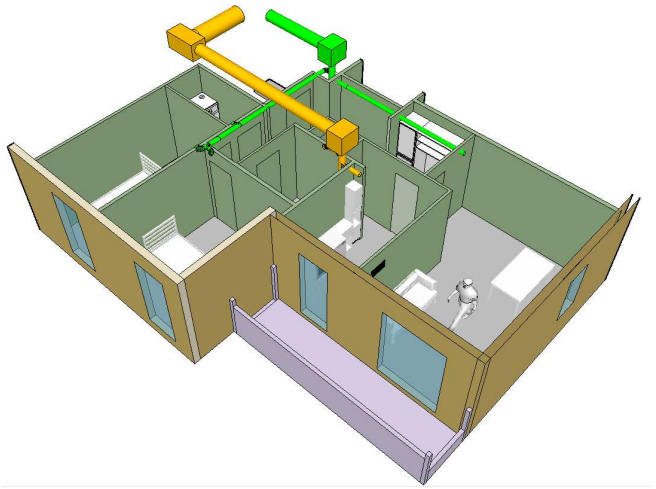
LA MAISON PASSIVE

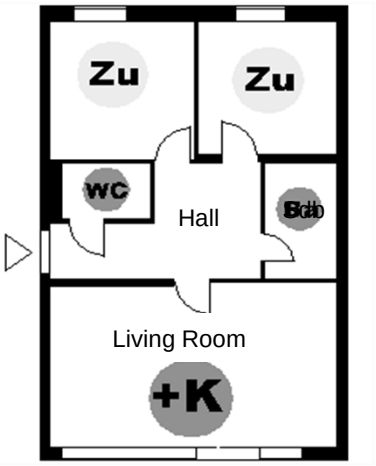
Cascade ventilation

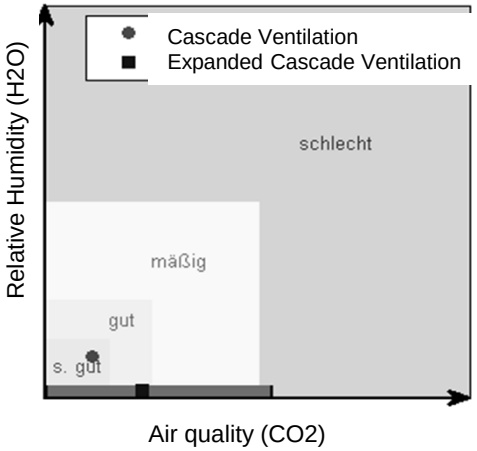
EuroPHit

Expanded cascade ventilation

- Air quality would be too low here if no supply air in living room
- Works better if bedrooms have direct link to living room







Tool: Univeristät Innsbruck

Air/Water Heat Pump on extract air

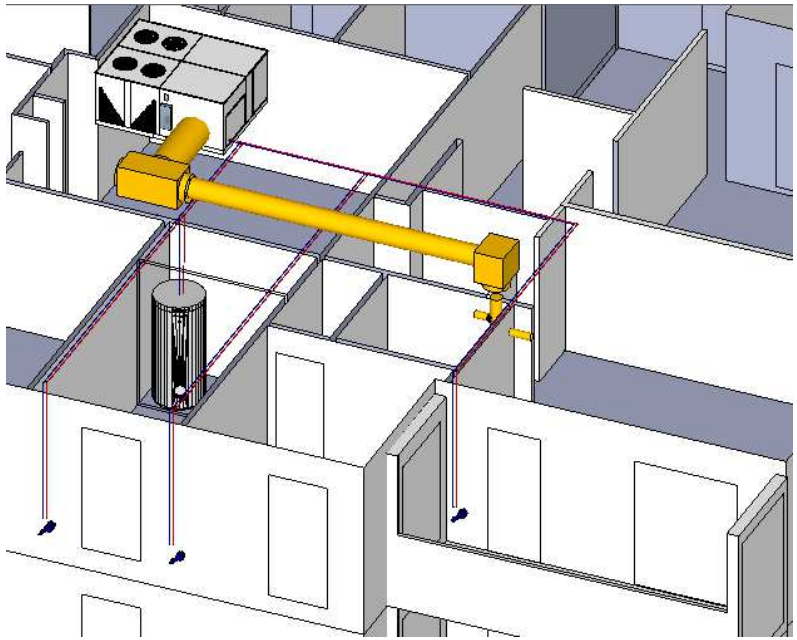
EuroPHit

A suitable solution for EnerPHit ?

- Outdoor unit 20 kW, Hydraulic modules with 150 L storage in cellars
- Outdoor air pre-heating via air/water heat exchanger

and variable flow from damper and small fan CO2-regulated

- Heating demand 20 kWh/(m².a)
- Primary energy demand 115 kWh/(m².a)



Co-funded by the Intelligent Energy Europe Programme of the European Union

LA MAISON PASSIVE

Conclusion

EuroPHit

Overall Refurbishment Plan

- Upgrade existing plan with EnerPHit quality is possible: budget shifts towards envelope
- Identify intermediate states

Prove cost-efficiency

- PHPP9 Variants and Comparison Worksheets
- Capital cost up to 90% of total cost for EnerPHit

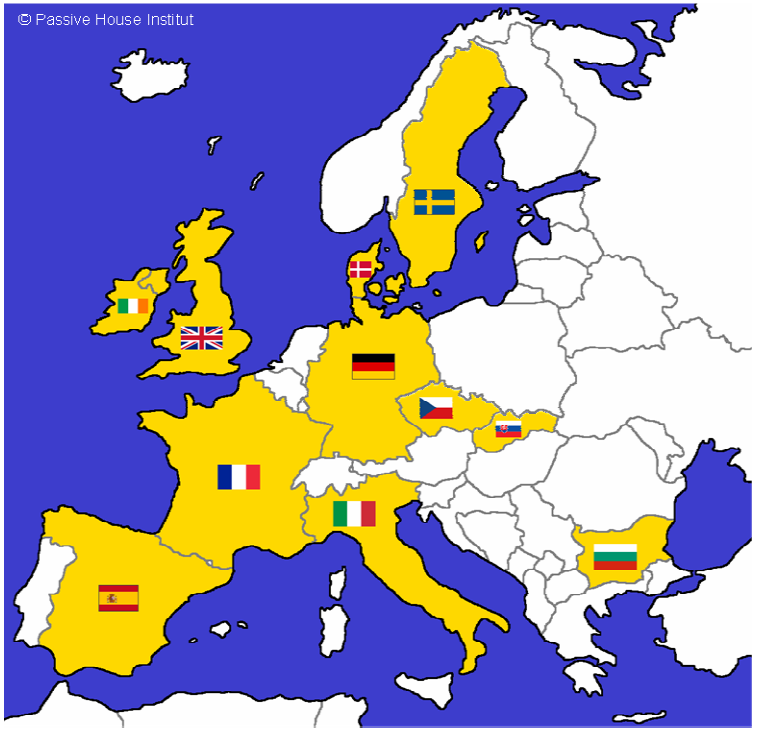
Reduce costs

- Reproductible solutions
- Cascade ventilation
- New products which make EnerPHit easier
- Financial support for design, quality insurance and product development

EuroPHit

Thank you
for your attention

www.europhit.eu



Partners:

Passive House Institute

International PASSIVE HOUSE Association iPHA

ZEPHIR Zero Energy and Passivhaus Institute for Research

La Maison Passive France

Attrea

bre

ASKEEN

MosArt

onyx

IGPH

INTRESSEGRUPP PASSIVHUS

PLATAFORMA EDIFICACIÓN PASSIVHAUS

Passivhus.dk

iepd INŠTITÚT PRE ENERGETICKY PASÍVNE DOMY

EnEffect group

Supporters:

ENERGY EFFICIENCY AND RENEWABLE SOURCES FUND

CENTER FOR BÆREDYGTIGT BYGGERI

GEOCAPITA

Husbanken

NESTVED

SAINT-GOBAIN

KfW Bankengruppe

Co-funded by the Intelligent Energy Europe Programme of the European Union