SUSTAINABLE PLACES 2018
June 27 - 29, 2018
Aix-les Bains, France

P2ENDURE
PLUG & PLAY BUILDING RENOVATION

4RinEU
Reliable models for deep renovation

proGETonE

MORE-CONNECT

# Clustering workshop
# Deep Energy Renovation: Challenges, Barriers, & Opportunities

June 27th 11:30 – 13:00

# DEEP Energy renovation: Challenges, barriers and opportunities

- Low rate of new building construction and existing building renovation → need to step up pace of building renovation with ambitious performance targets to achieve EU climate change policies.

- Effective technologies alone cannot solve problems. Needs to consider also non-technical aspects.

- The workshop will present four ongoing/completed H20202 projects aiming at improving building energy performance through deep renovation and share successful experiences and challenges

- The interactive discussion will focus on the different technical, financial and social barriers and challenges in building renovation as well as identifying possible project synergies and future research opportunities.

# Agenda / 11:00 – 12:30

**11:30 – 11:35:** Intro to the workshop and it's collaborating projects (Federico Noris, R2M Solution)

**11:35 – 11:45:** Intro to the 4RinEU project (Roberta Pernetti, EURAC Research)
**11:45 – 11:55:** Intro to the P2ENDURE project (Rizal Sebastian, DEMO Consultants)
**11:55 – 12:05:** Intro to the Pro-GET-One project (Annarita Ferrante, Università di Bologna)
**12:05 – 12:15:** Intro to the MORE-CONNECT project (Peter op 't Veld, Huygen Installatie Adviseurs)

**12:15 – 12:20:** Discussion prompts prepared to solicit feedback (Simona d'Oca, Huygen Installatie Adviseurs)
**12:20 – 12:50:** Moderated interactive discussion & action planning (Simona d'Oca, Huygen Installatie Adviseurs)
**12:50 – 13:00:** Conclusions of discussions & action plans documentation (Federico Noris, R2M Solution)

# Projects involved

- **4RinEU:** Robust and Reliable technology concepts and business models for triggering deep Renovation of Residential buildings in EU
- **P2ENDURE:** Plug-and-Play solutions for Energy-efficiency deep renovation of European building stock
- **Pro-GET-OnE:** Integration of Plug-and-Play solutions and users' centered approach to solve both energy and seismic requirements during deep renovation of residential buildings
- **MORE-CONNECT:** Development and advanced prefabrication of innovative, multifunctional building envelope elements for MOdular REtrofitting and CONNECTions

# Intro to the 4RinEU project (Roberta Pernetti, EURAC Research)

4RinEU

Reliable models for deep renovation

# The consortium

**Start date:** 1 October 2016
**Duration:** 48 months

4RinEU
Reliable models for deep renovation

## R&D

IT eurac research

NO SINTEF

Applied Research Centres

## Demo Owners

NL WOONZORG NEDERLAND

NO BOLIGBYGG

ES Agència de l'Habitatge de Catalunya

Social housing agencies

## Consultancy

IT adermalocatelli – Energy audit

ES acciona Infraestructuras – Construction company

IT R2M Research to Market Solution – Research to market

ES AIGUASOL

NL Trecodome

Engineering companies

## Technology partners

DE gumpp & maier solutions made of timber – Manufacturer - prefab timber facades

IT Thermics – Manufacturer - H&C + RES

UK IES – Software developer

# Overview of the project results

4RinEU
Reliable models for deep renovation

**NEEDS**

Technical | Credibility | Social | Financial

Do not allow the targeted 3% renovation rate

**ANSWERS**

RELIABLE BUSINESS MODELS

Cost-Effective Rating System

USABLE METHODOLOGIES

- Cost-optimal energy audit
- Collaborative design platform
- Deep renovation implementation management

ROBUST TECHNOLOGIES

- Sensible Data Handler
- Early Reno
- Comfort Ceiling Fan operation
- Strategies for End of Life
- PPEH
- PMF

To increase efficiency of whole deep renovation process

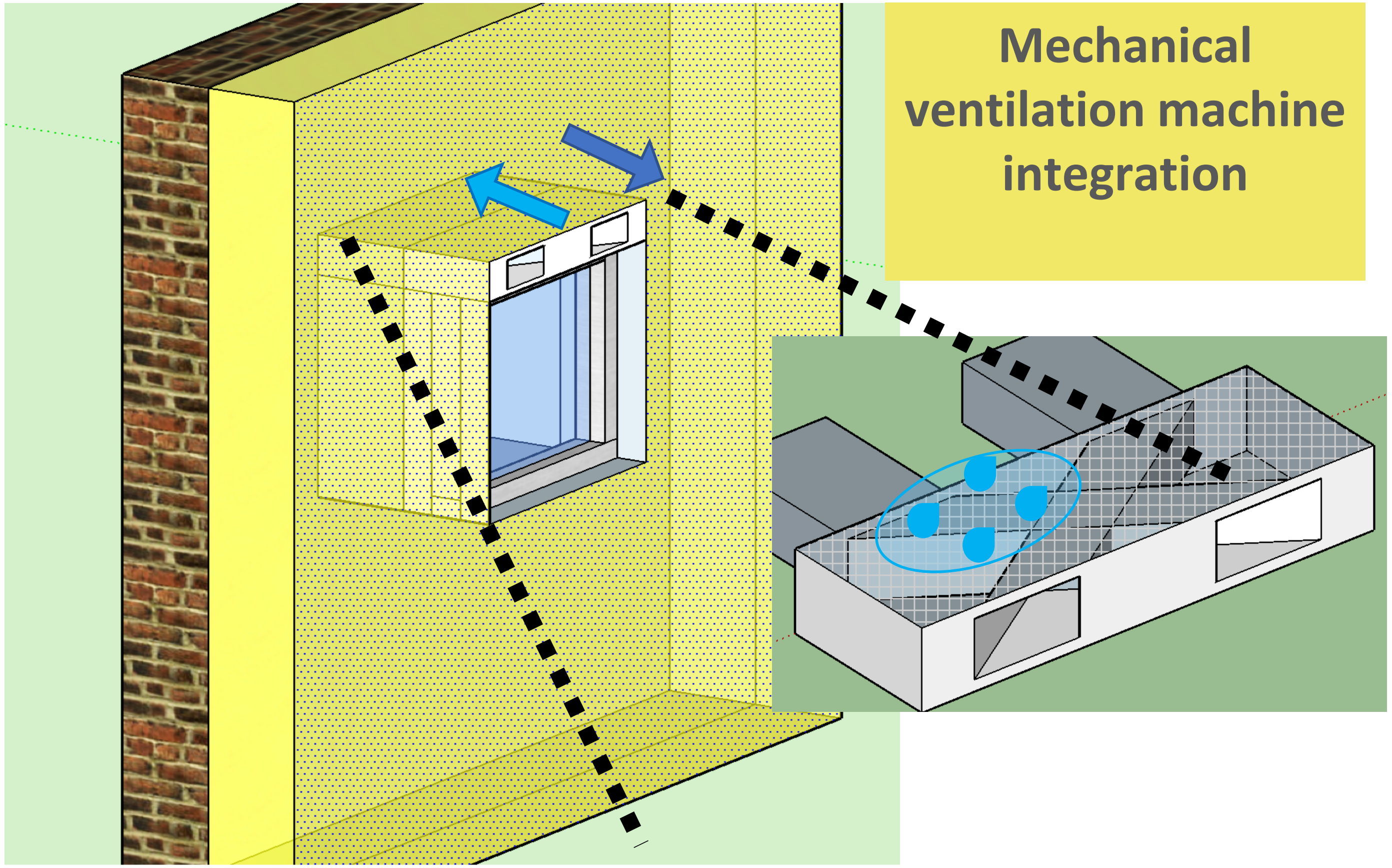
# Prefabricated multi-functional facade

4RinEU
Reliable models for deep renovation

Integrating functions in the prefabricated facade:

- Reduce time of the deep renovation
- Improve the installation of the components
- Simplify the building site

- Components from different companies – fine-tuning
- Complexity to be managed




*Source: eurac research*

# Prefabricated multi-functional facade: 4RinEU approach

4RinEU
Reliable models for deep renovation

Performance simulation and fine-tune

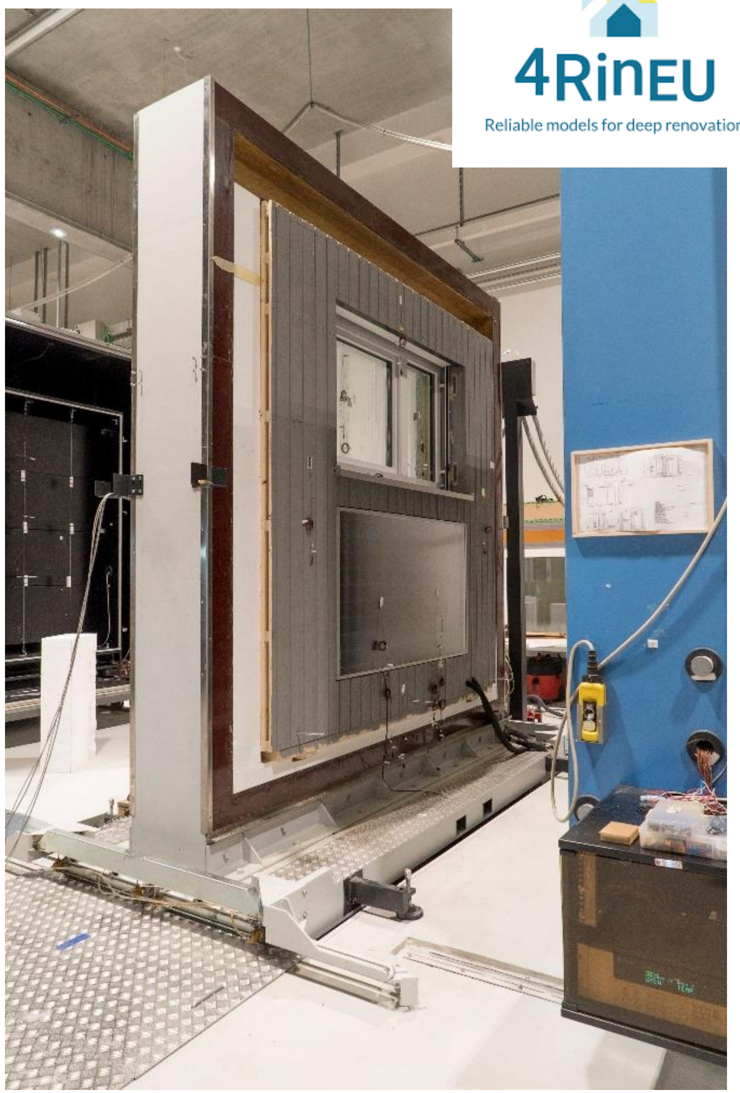
Test results and definitive design

Support the local producers in set-up the PFM

Technology concept → Test of prototypes → Technical specification for the demo → Local producers supply the facade

MECHANICAL VENTILATION MACHINE + SOLAR THERMAL PANEL + WINDOW

Integration tested

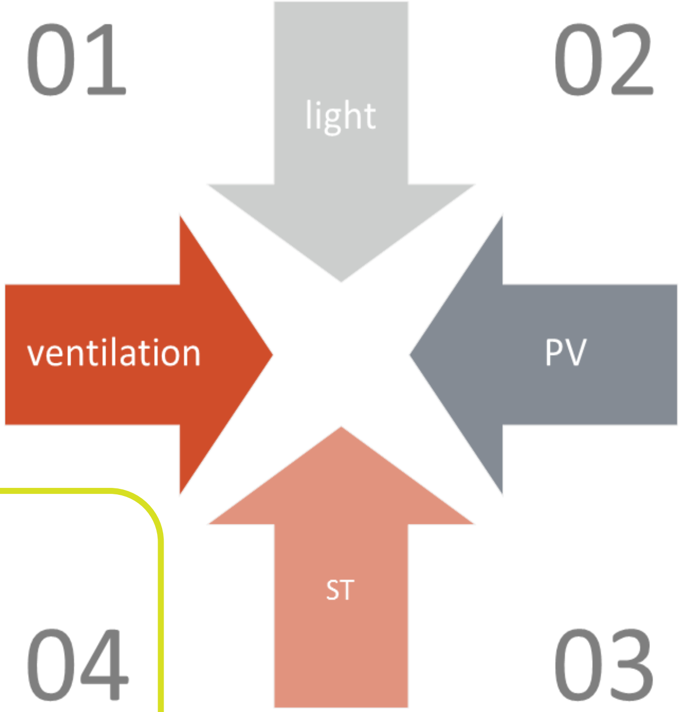


*Source: eurac research*

# **Early RENo:** Early design methodology for RES best use in renovation process

## Daylight 01
In case of changing WWR the issue of daylight should be addressed

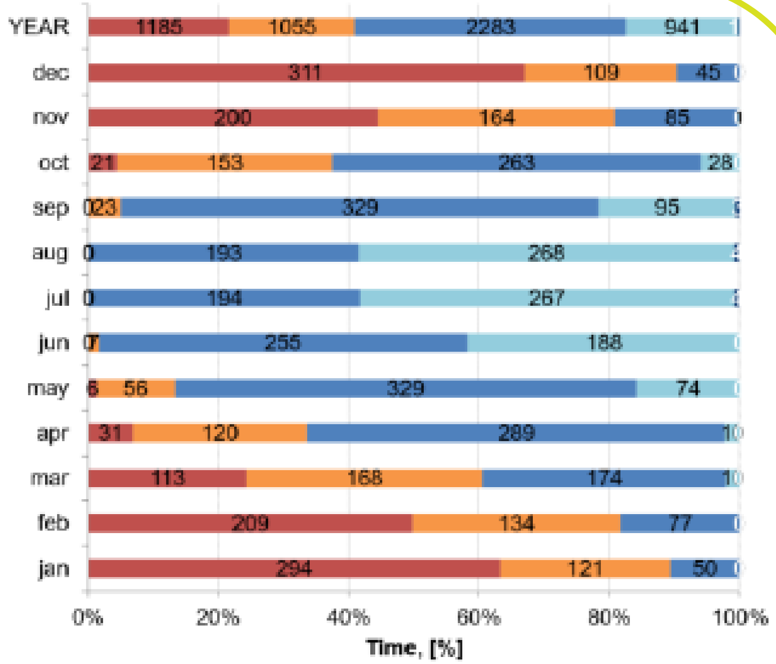
## 02 PV
Define thePV installation matching the production according to the energy demand profile optimising the NPV

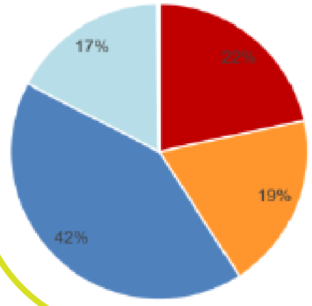



## Natural ventilation 04
Maximize the exploitation of ventilative potential

## 03 ST
Cost-effective integration of solar thermal

## Ventilative cooling potential

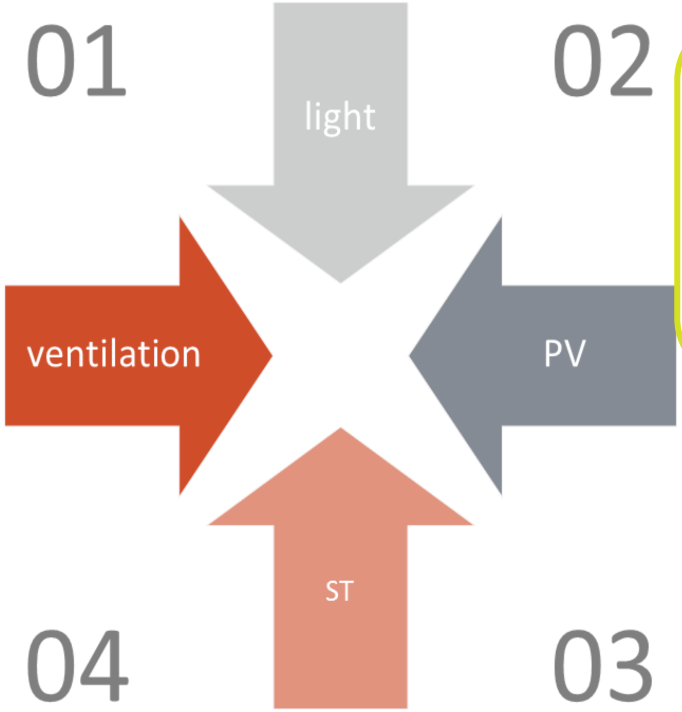



Required airflow rates in VC mode [2]

average 4.11 ± st. dev. 2.12 ach

# **Early RENo:** Early design methodology for RES best use in renovation process



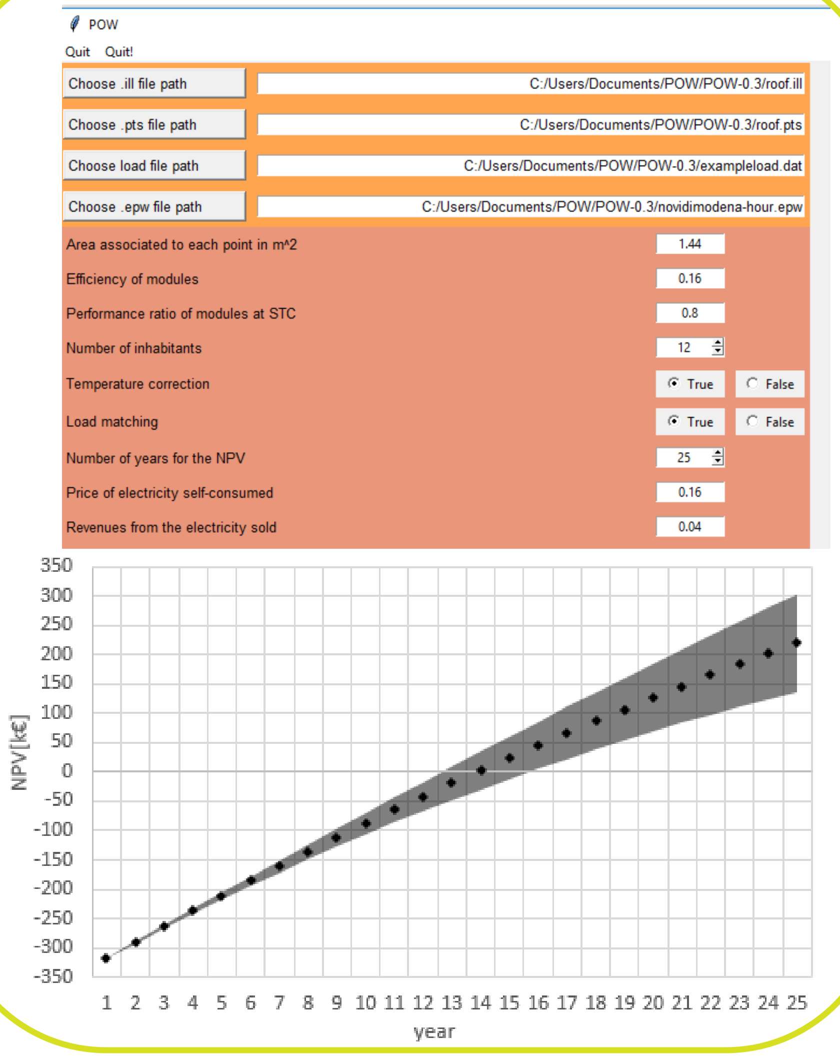

PV

Define thePV installation matching the production according to the energy demand profile optimising the NPV

ST

Cost-effective integration of solar thermal

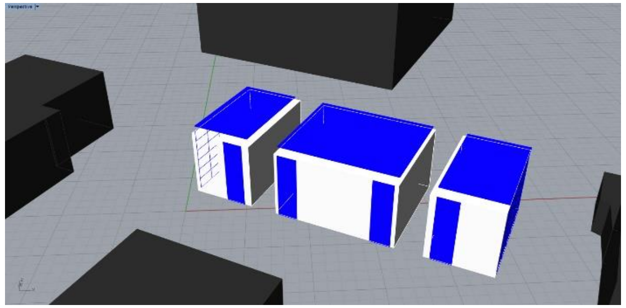
## PV optimization – energetic/economic



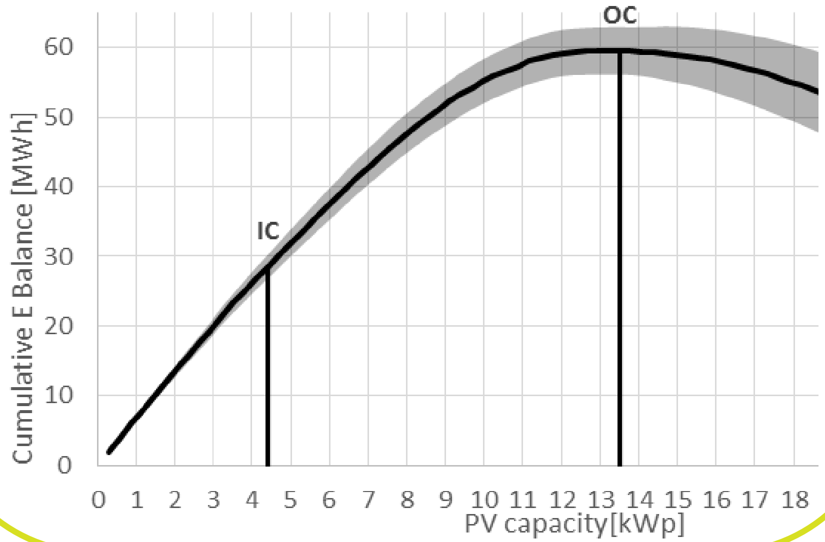
**Early RENo:** **Early design methodology for RES best use in renovation process**

4RinEU Reliable models for deep renovation

## Application of the tool to the demo case 1: Oslo



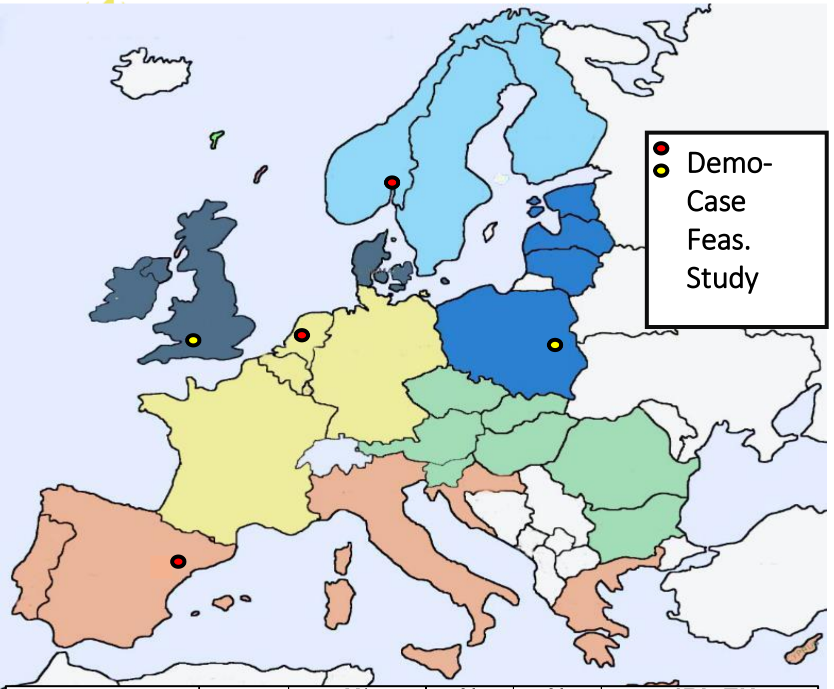
*Source: eurac research*




- Best exploitation of RES available and reliable business model of the installation
- Potential influence on the design

- Accurate results need detailed inputs
- Architectural issues VS optimal installation

# 4RinEU implementation




| Geo-Cluster | HDD | U* [W/m² K] | % SFH | % MFH | 4RinEU Implementation |
|---|---|---|---|---|---|
| 1. Northern | 5445 | 0.27 | 62 | 38 | Demo-Case - Norway |
| 2. North-East | 3958 | 0.22 | 51 | 49 | Early Adopter Poland |
| 3. Cont. West/Central | 2758 | 0.31 | 67 | 33 | Demo-Case - Nederlands |
| 4. Atlantic | 3022 | 0.27 | 84 | 16 | Early Adopter - UK |
| 5. Cont. East | 2956 | 0.32 | 63 | 37 | Hungary |
| 6. Mediterr. | 1363 | 0.85 | 52 | 48 | Demo-Case - Spain |

Europe divided in **6 geoclusters**

Different levels of implementation:

- **3 demo cases** → whole renovation
- **3 Early adopter buildings** → feasibility study
- **12 building archetypes** → performance simulations

ARLY ADOPTER TEAM

FUNDACJA ROZWOJU LUBELSZCZYZNY rok założenia 1990

ÉMI

BUROHAPPOLD ENGINEERING

DEMO CASES

**HAUGERUDSENTERET**
**Oslo - Norway**

**MARIËNheuvel**
**Soest – The Netherlands**

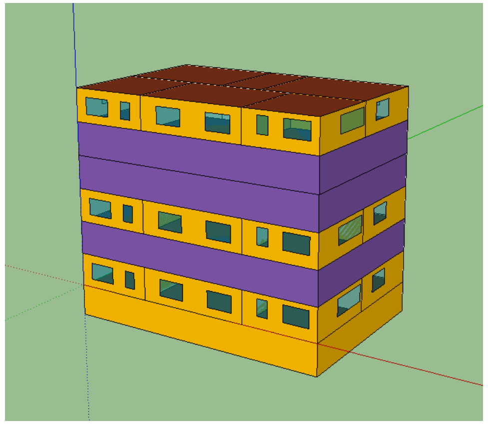
**Bellpuig**
**Spain**

# 4RinEU implementation

4RinEU
Reliable models for deep renovation

BUILDING ARCHETYPES

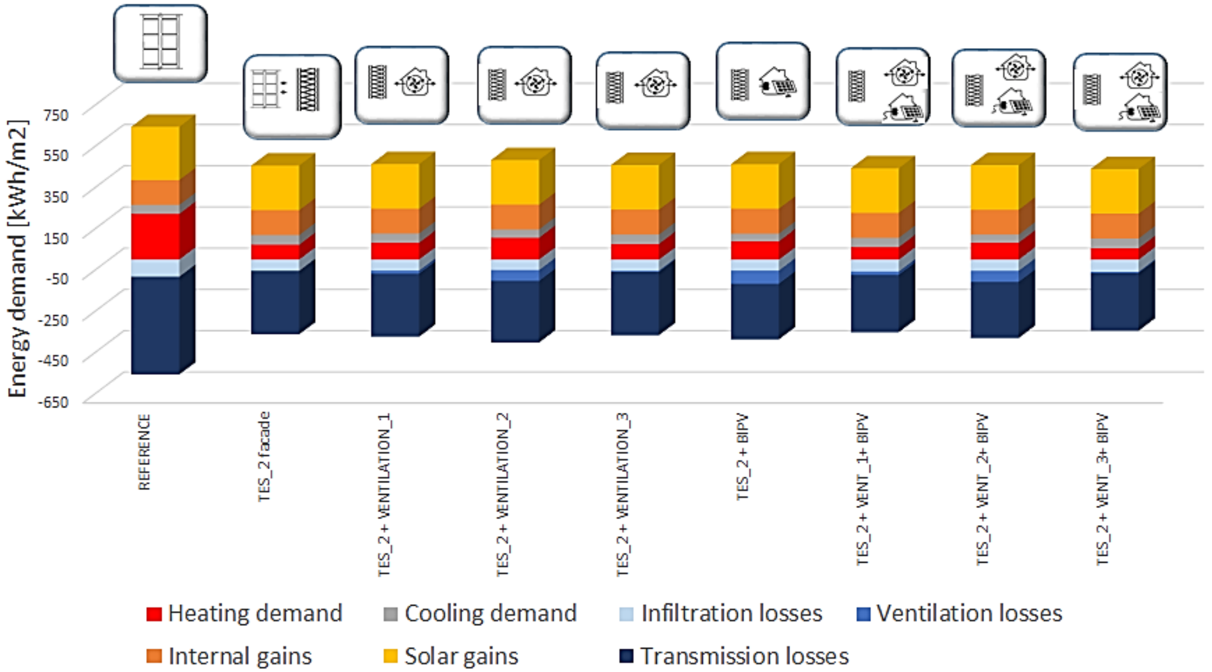
| Geocluster 1 | **Reference Country** | Norway |
|---|---|---|
| | **Reference City** | Oslo |
|  | 4RinEU Code | **G1_NO_SFH_02** |
| | Tabula_Code: | NO.N.SFH.02.Gen |
| | Building Size Class: | SFH |
| | Construction Period: | 1956 ... 1970 |
| | Reference Floor Area: | 228 m² |
|  | 4RinEU Code | **G1_NO_SFH_03** |
| | Tabula_Code: | NO.N.SFH.03.Gen |
| | Building Size Class: | SFH |
| | Construction Period: | 1971 ... 1980 |
| | Reference Floor Area: | 152 m² |



Rapresentative buildings for reference countries

Evaluation of the renovation package performances:

1. Comfort&IAQ
2. Energy
3. Cost
4. CO2 emissions
5. Building site management



# Implementation in the first demo case - Oslo

4RinEU
Reliable models for deep renovation

11/06/18
9:00 a.m

11/06/18
5:00 p.m

11/06/18
6:00 p.m

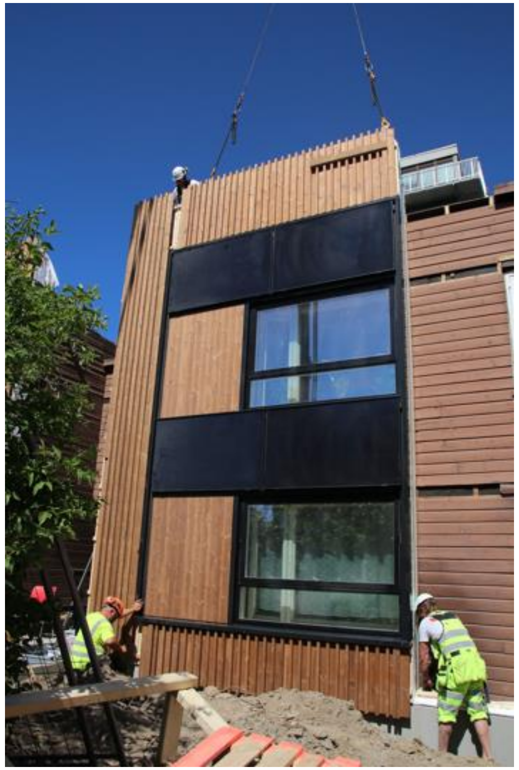
Haugerund senter 9-43 in Oslo/Norway

- Envelope insulation + windows + PV integration + ventilation ducts
- Centralised mechanical ventilation unit

*Source: Boligbygg*

# Implementation in the first demo case

4RinEU
Reliable models for deep renovation



Haugerund senter 9-43 in Oslo/Norway

*Source: Boligbygg*

4RinEU
Reliable models for deep renovation

# THANK YOU FOR YOUR KIND ATTENTION

**Project Coordinator**:

- Roberto Lollini roberto.lollini@eurac.edu,
- Francesco Babich francesco.babich@eurac.edu,
- Roberta Pernetti roberta.pernetti@eurac.edu (eurac research)

**Project website**: www.4rineu.eu

# Intro to the P2ENDURE project (Anna Gralka, DEMO Consultants)

P2ENDURE

PLUG & PLAY BUILDING RENOVATION

# Intro to the P2ENDURE project (Anna Gralka, DEMO Consultants)

P2ENDURE PLUG & PLAY BUILDING RENOVATION

- Start date: 1 September 2016
- Duration: 48 months
- Partners: 16 (8 SME, 5 IND, 2 HES/RES, 1 PUB)
  - DK : Invela
  - DE : Lenze-Luig 3-L-Plan, Fermacell, Technische Universitaet Berlin
  - NL : DEMO Consultants, Huygen Installatie Adviseurs, PANplus Architektuur, Camelot Vastgoed
  - PL : Bergamo Tecnologie, Fasada, Mostostal Warszawa, Miasto Stoleczne Warszawa
  - IT : Becquerel Electric, SGR Servizi, D'Appolonia, Universita Politecnica Delle Marche

# Plug-and-Play product and process innovation for Energy-efficient building deep renovation

P2ENDURE PLUG & PLAY BUILDING RENOVATION

Project objectives:

Upscaling EU-wide implementation of prefab Plug-and-Play (PnP) systems for deep renovation through 4M (Mapping – Modelling – Making – Monitoring) processes.

- 60% net primary energy saving through deep renovation
  - Implementation of PnP prefab solutions for retrofit of building envelopes and MEP systems
  - Energy label improvement through transformation from obsolete public buildings to dwellings
- 15% cost saving compared to traditional renovation techniques
  - Major labour cost reduction through PnP installations
  - Avoidance of construction failure or rework cost on-site thanks to validated PnP solutions
- 50% time saving and thereby reduction of disturbance during renovation
  - 50% faster from production to on-site assembly
  - PnP prefab solutions ready to be implemented without structural changes of the existing building

# New systems, technologies and non-technological innovations

P2ENDURE PLUG & PLAY BUILDING RENOVATION

*1. Integrating and optimising PnP prefab systems and on-site 3D technologies for deep renovation:*

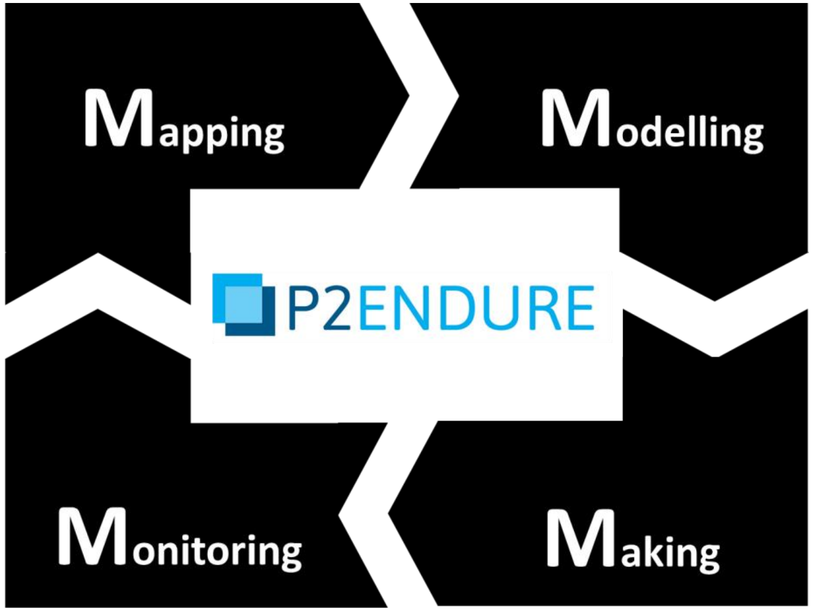
| | |
|---|---|
| **PnP prefab systems and on-site 3D technologies** | PnP components for building envelopes |
| | PnP technical systems |
| | On-site 3D technologies |

*2. Implementing PnP and on-site 3D innovations through 4M modular proceses and ICT tools:*

| | |
|---|---|
| **Modular processes and ICT tools for deep renovation** | 4M modular processes: Mapping – Modelling – Making – Monitoring |
| | e-Marketplace value-chain integration & local factory for district logistics |
| | BIM-based lifecycle information management |

*3. Demonstrating and upscaling the innovative products, processes and tools in real projects:*

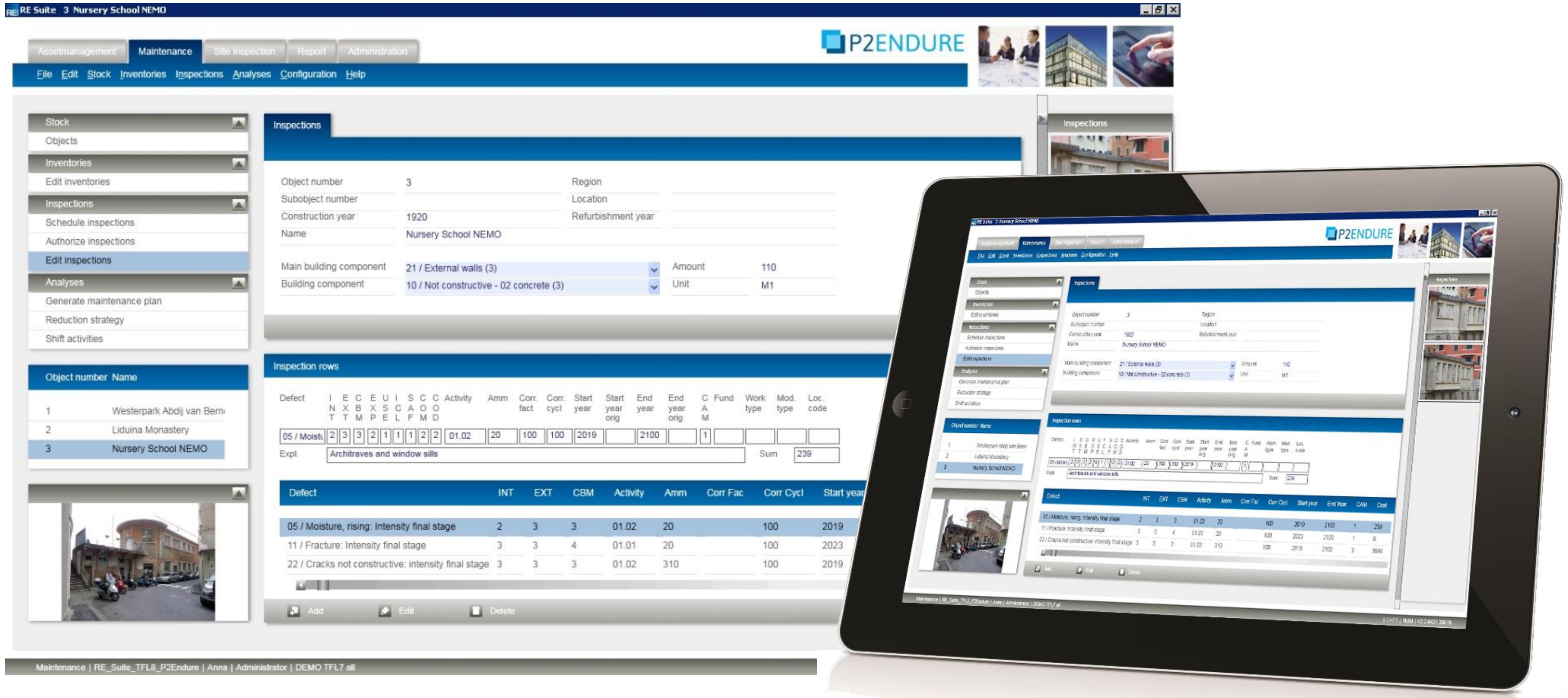
| | |
|---|---|
| **Evidence-based deep renovation solutions with performance monitoring** | Deep renovation of public and historic buildings |
| | Deep renovation of residential buildings and districts |
| | Transformation of public and historic buildings to dwellings |

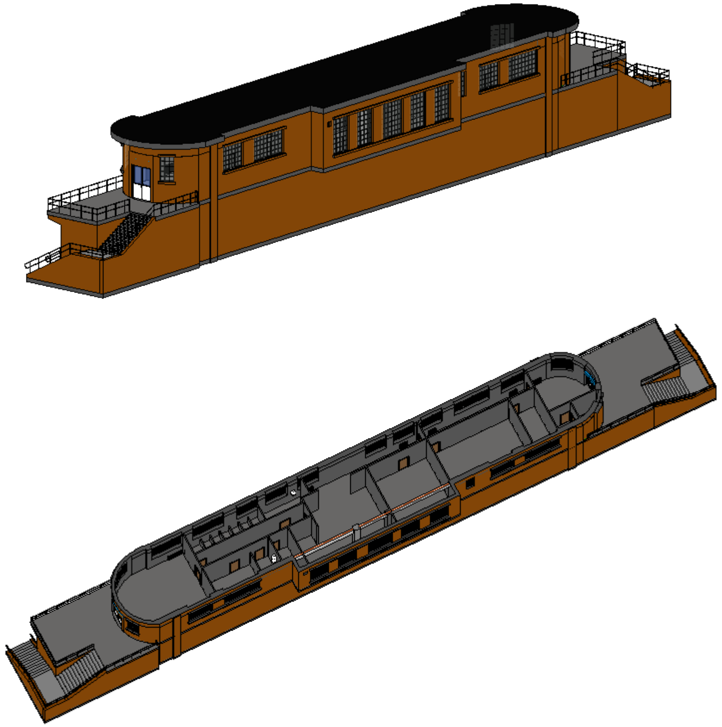


# 4M Modular Processes - Mapping

P2ENDURE PLUG & PLAY BUILDING RENOVATION

Deep renovation of nursery building in Genoa, IT



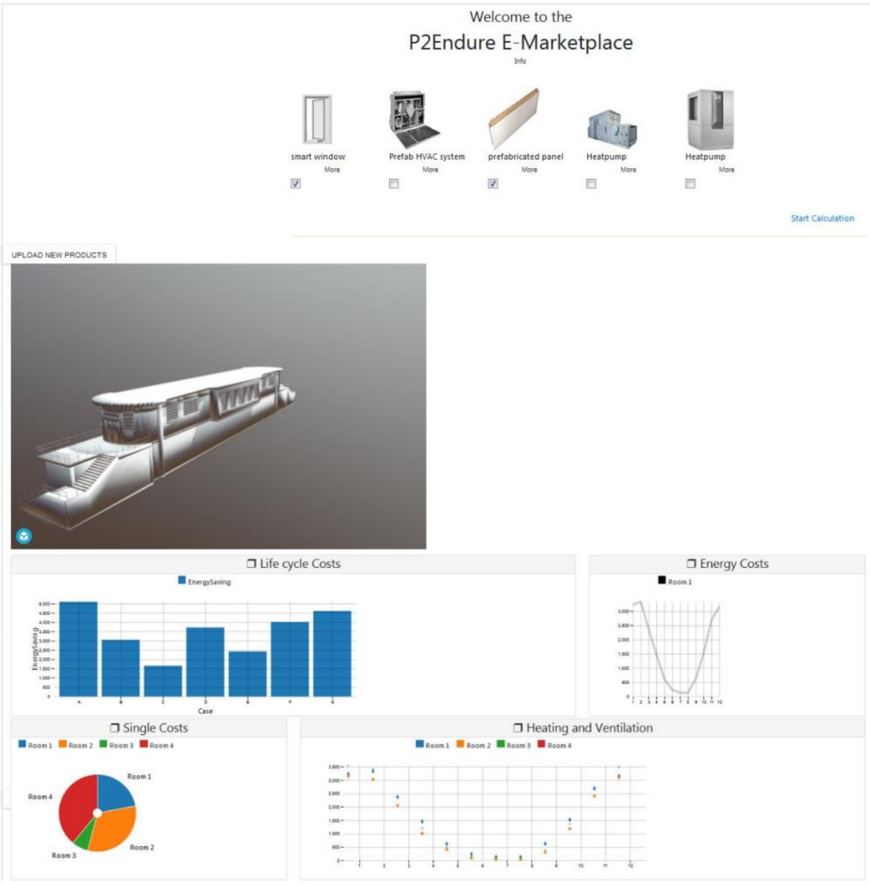



- **Data collections** for building auditing using DEMO RE Suite mobile inspection tool for simplified operation
- **BIM modelling** of the As-Is building

# 4M Modular Processes - Modelling

P2ENDURE
PLUG & PLAY BUILDING RENOVATION

Deep renovation of nursery building in Genoa, IT




**STEP 1** — **EVALUATION of FURTHER DEEP RENOVATION ACTIONS to achieve the 60% OF ENERGY SAVING**

**DEEP REN 01** — Installation of the **SMART WINDOWS (P2Endure tech.)** **28% Energy Saving**

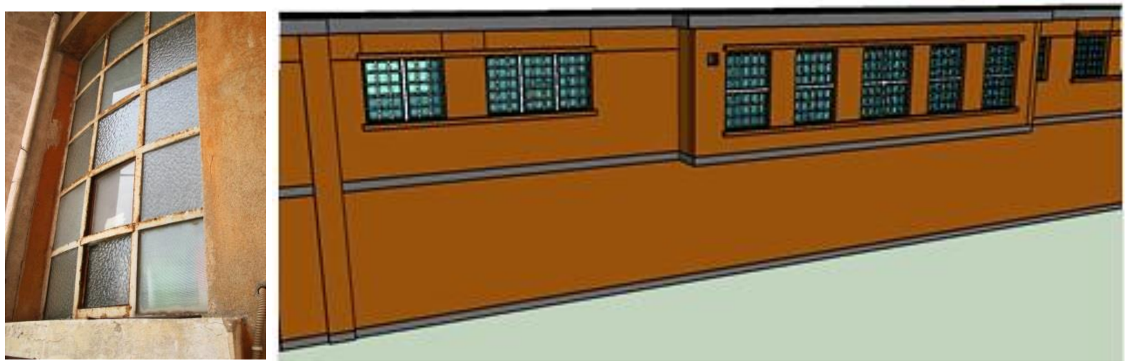
**DEEP REN 02** — Installation of the **SMART WINDOWS + INTERNAL INSULATION** **57 % Energy Saving**

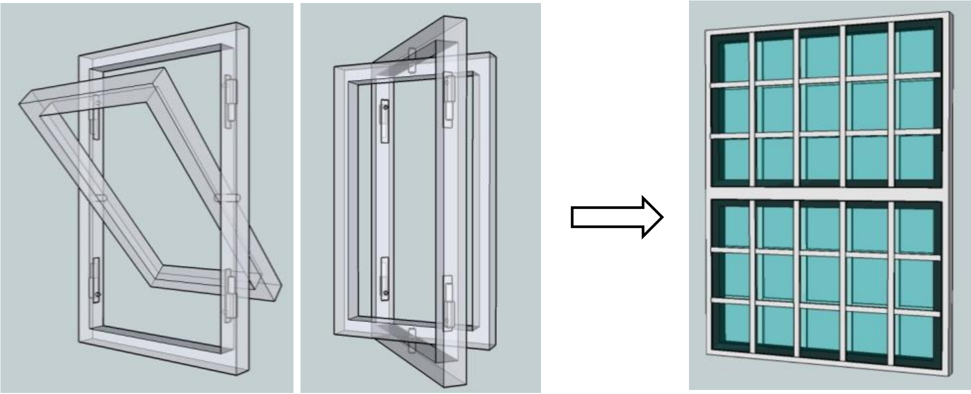
**DEEP REN 03** — Installation of the **SMART WINDOWS + INTERNAL INSULATION + CONDENSING BOILER** **62 % Energy Saving**

- Renovation Design with PnP solutions as smart windows and HVAC engine with **e-Marketplace** and **BIM parametric Modeller**
- Results of **BIM-to-BEM** process for semi-automated conversion to energy model for accurate performance assessment

# 4M Modular Processes – Making and Monitoring

Deep renovation of nursery building in Genoa, IT



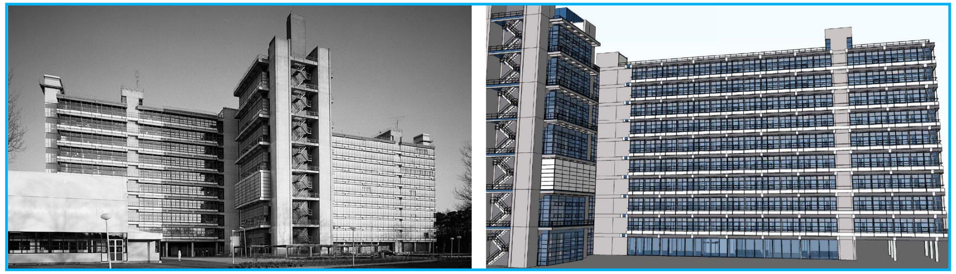


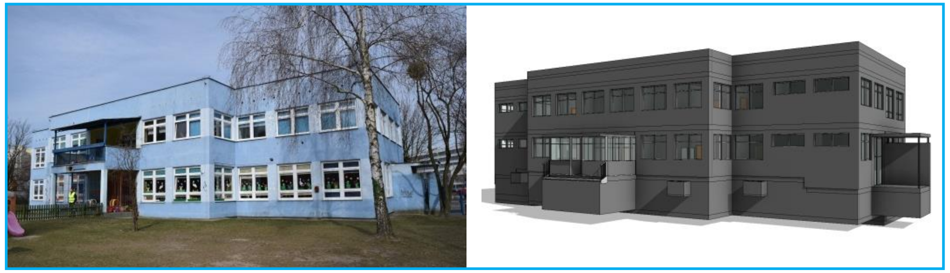
- **Renovation activities**: fabrication and implementation of smart windows from Bergamo Tecnologie – a reversible system for improved performance

- **Comfort Eye** from Università Politecnica delle Marche for IEQ monitoring and assessment, monitoring thermal comfort according to ISO7730 and IAQ

# P2ENDURE demonstrations

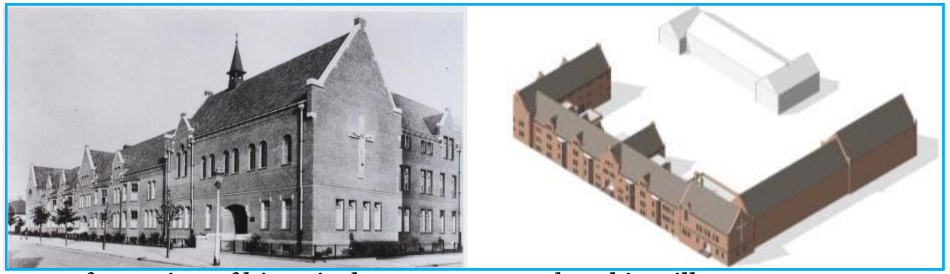
P2ENDURE
PLUG & PLAY BUILDING RENOVATION


Transformation of university building to student housing in Enschede, NL


Deep renovation of public nursery building in Warsaw, PL


Deep renovation of residential building in Ancona, IT


Deep renovation of public nursery building in Gdynia, PL


Transformation of historical monastery to a hotel in Tilburg, NL


Deep renovation of historic residential building in Florence, IT


Residential district renovation in Odense, DK


Deep renovation of historical nursery building in Genova, IT


Transformation of school building to dwellings in Tilburg, NL

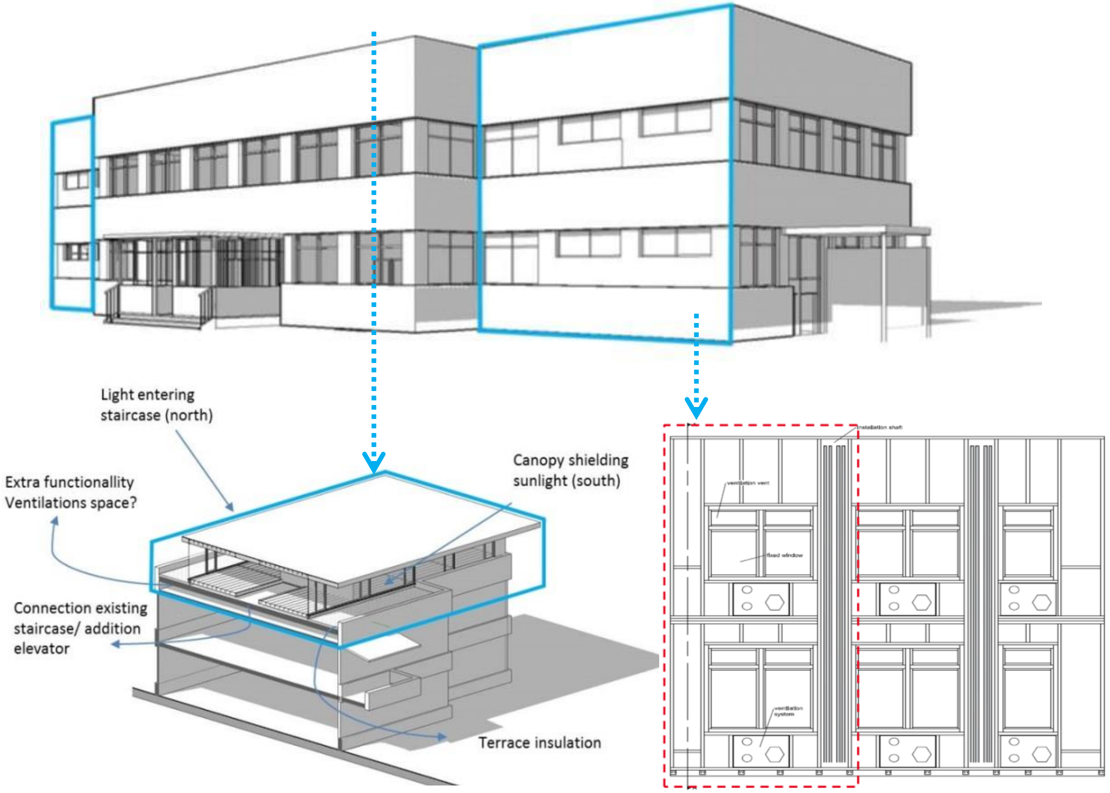

Transformation of public spa building to dwellings in Hürth, DE

# New systems and technologies – other examples

P2ENDURE
PLUG & PLAY BUILDING RENOVATION

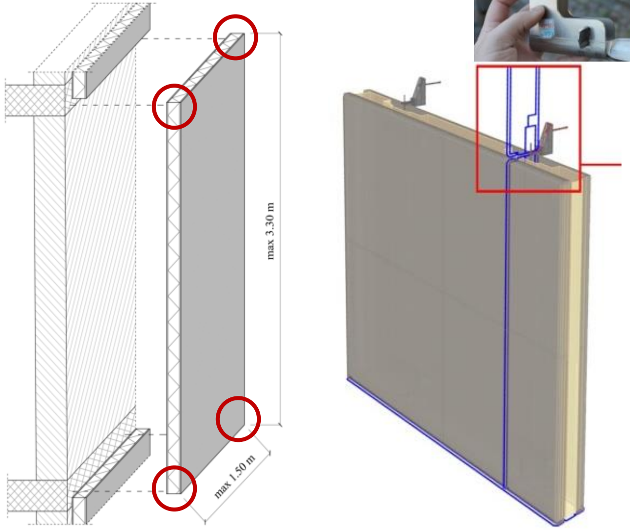
- Deep renovation of nursery building in Warsaw, PL

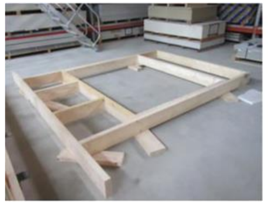

- **3D Point Cloud** from laser scanning




- **PnP rooftop retrofit solution** (PANplus Architecture)
- **PnP façade retrofit solution** (Fermacell)

- Lightweight PnP panels


# New systems and technologies – other examples

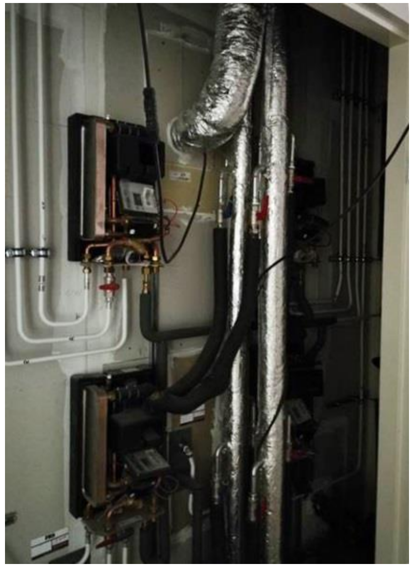
P2ENDURE
PLUG & PLAY BUILDING RENOVATION

- Residential buildings in Odense, DK



- Robot for **3D printing** on-site (Invela)

- Student housing in Enschede, NL



- Prefabricated **bathroom units**

P2ENDURE
PLUG & PLAY BUILDING RENOVATION

## Food for discussion

- BIM-to-BEM energy simulations of pre- and post-renovation scenarios
- E-Marketplace
- Creating renovation passport

## Contact


- Project Coordinator: Rizal Sebastian PhD Rizal@DEMObv.nl, Anna Gralka MSc Anna@DEMObv.nl (DEMO Consultants, NL)

- Project website: http://www.P2ENDURE-project.eu/

# Intro to the Pro-GET-One project (Annarita Ferrante, Università di Bologna)

ProGETonE

# Pro-GET-onE: **Pro**active synergy of inte**G**rated **E**fficient **T**echnologies **on** buildings' **E**nvelopes

| Participant organisation name | Country |
|---|---|
| ALMA MATER STUDIORUM, Università di Bologna (**UNIBO**) CO-ORDINATOR | IT |
| TECHNISCHE UNIVERSITAET MUENCHEN (**TUM**) | DE |
| National and Kapodistrian University of Athens (**NKUA**) | GR |
| HUYGEN Installatie Adviseurs (**HIA**) | NL |
| ACER Reggio Emilia (**ACERRE**) | IT |
| Municipality of Brasov (**BRASOV**) | RO |
| SAVIO SPA (**SAVIO**) | IT |
| Associació LIMA (**LIMA**) | ES |
| BLOOMFIELD S.R.L. (**BLOOMFIELD**) | IT |
| BJW BV (**BJW**) | NL |
| ALIVA Chimica e Sistemi (**ALIVA**) | IT |
| ABT Belgie NV (**ABT**) | BE |
| CLIVET SPA (**CLIVET**) | IT |
| ANERDGY AG (**ANERDGY**) | Switzerland |

Start date: 1 May 2017
Duration: 48 months

Pro-GET-onE is based on the innovative integration of technologies to achieve

## a multi-benefit approach

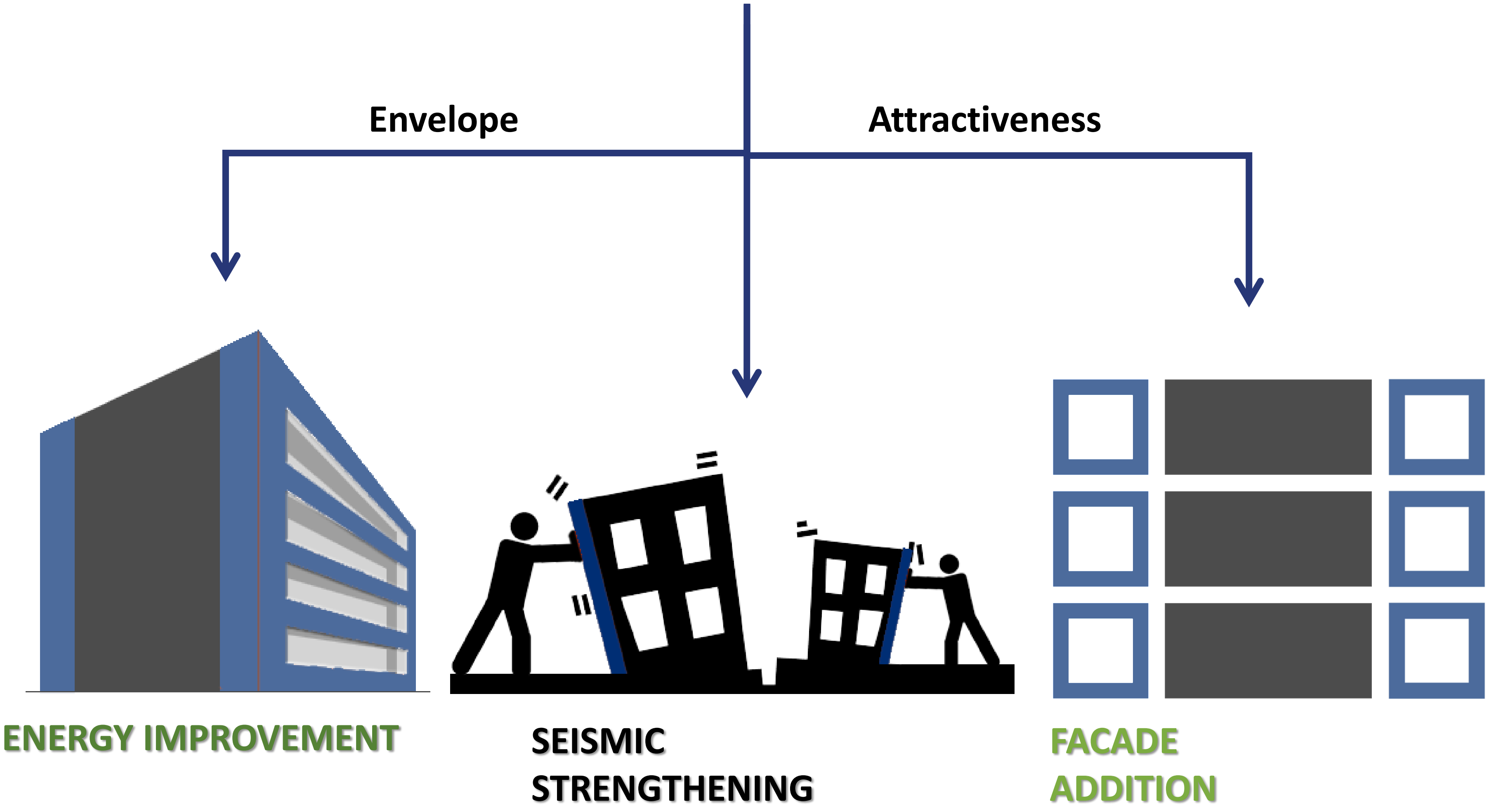
by a closer integration between
**energy and non-energy related benefits**.

Thus, the project aims at combining in a same integrated system the highest performance in terms of:

- **Energy requirements**
- **Safety**
- **Social sustainability**

# "GET"

## InteGrated system



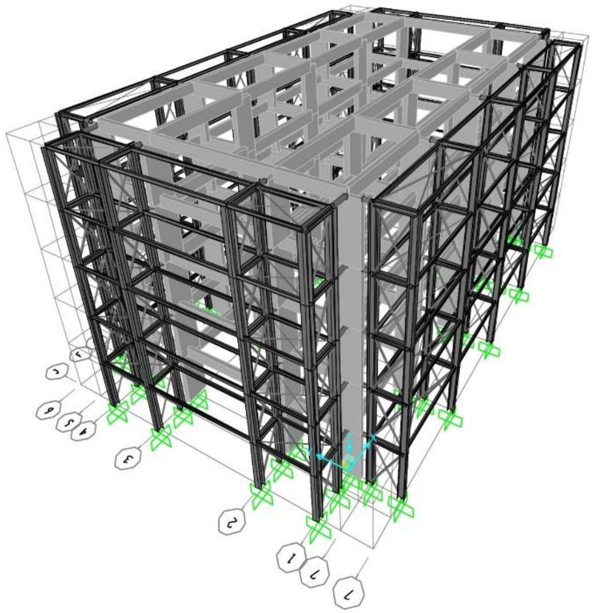
**Energy requirements** – by adding to the existing (or substituting it with)

new pre-fab (plug and play) **highly energy performing envelopes combined with HVAC**


**Safety – using external structures to:**

- **increase the overall structural capacity of the building,**

supporting the new envelopes and the additional spaces

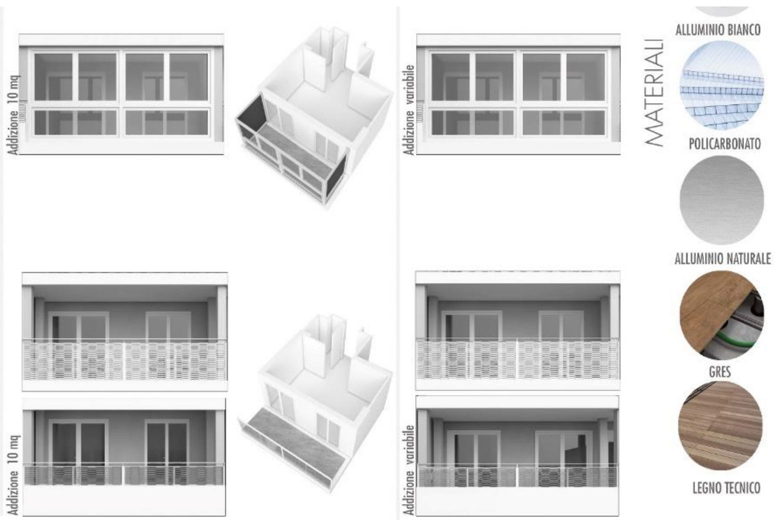


**Social sustainability** – through:

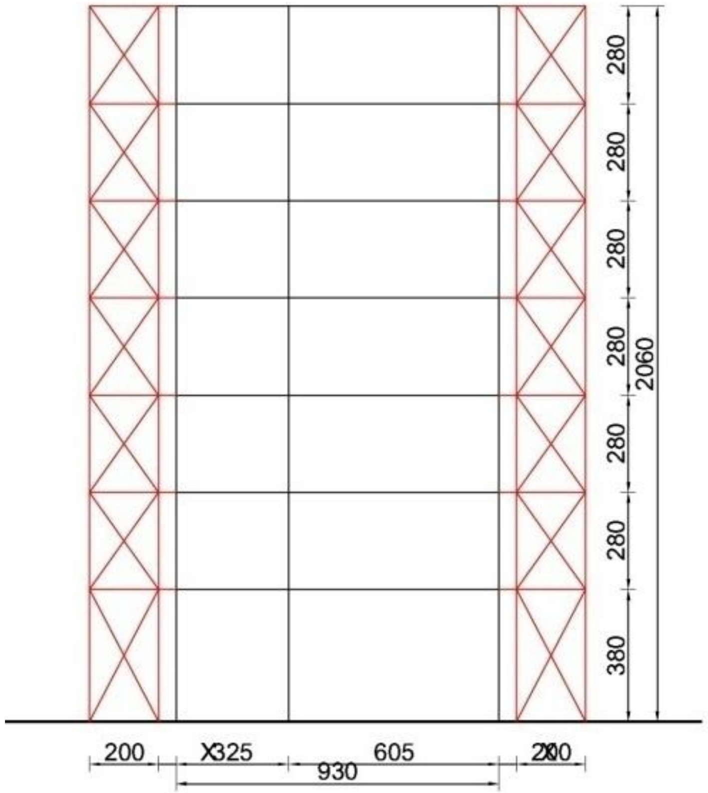
- tailored and customized solutions for users, owners/house managers,
- minimizing disturbance for inhabitants,

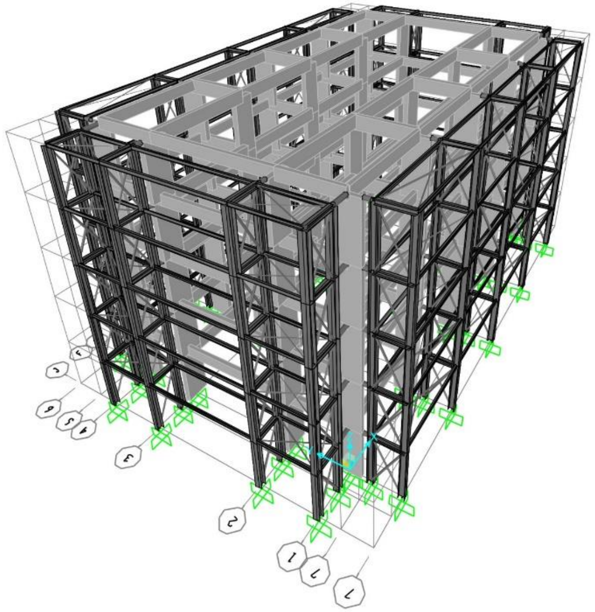
increase of:

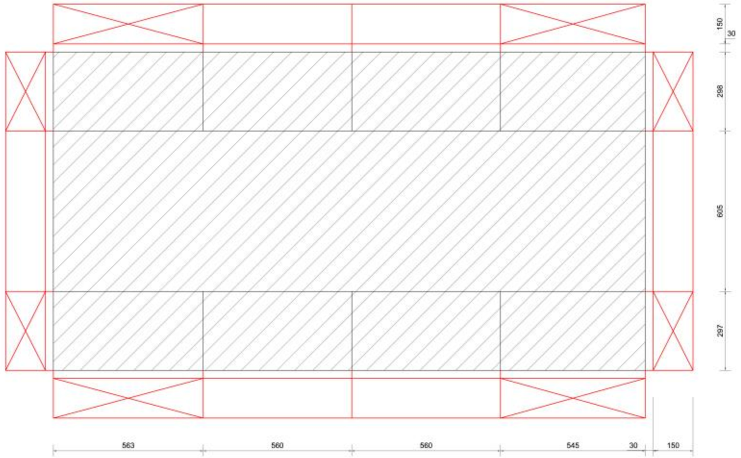
- **the desirability of retrofit options**
- **the real estate value of the buildings**
- **the willingness to pay rather than the mere cost reduction**



# Results so far:






| Frame | Section |
|---|---|
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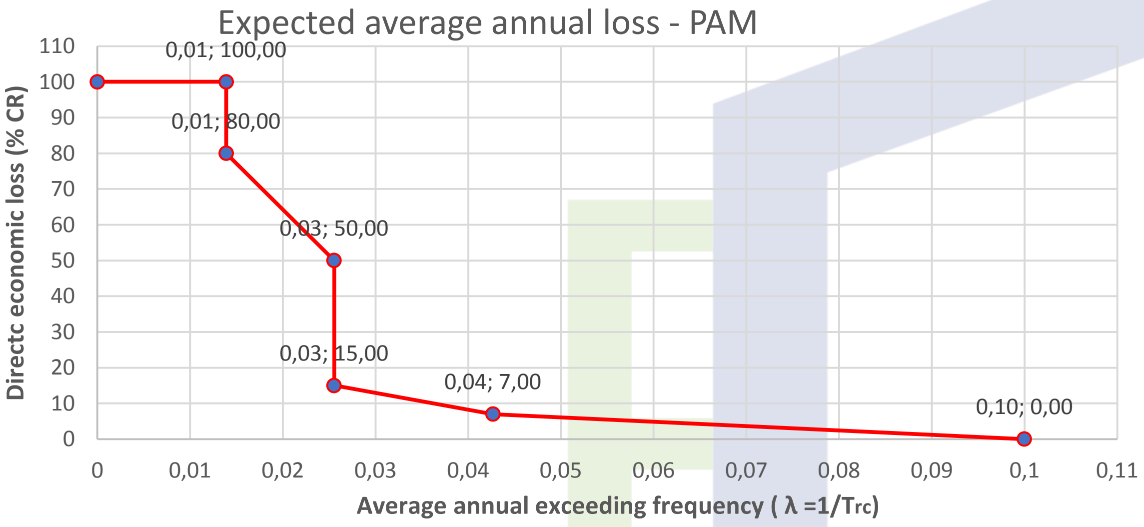
| Transversal Beams | HEA200 |
| Longitudinal Beams | IPE 160 |
| Vertical bracing pipes | 76,1x3,2 |
| Horizontal bracing pipes | 30x2,9 |
| Connections pipes | 193,7x4,5 |

Simulations modelling using FEM software (EN 1998), performed for different residential buildings, have shown an overall reduction of horizontal displacements of the retrofitted structures with a percentage from the 25% up to the 50% and more.

ProGETonE

# Reggio Emilia - Sismabonus

## Before

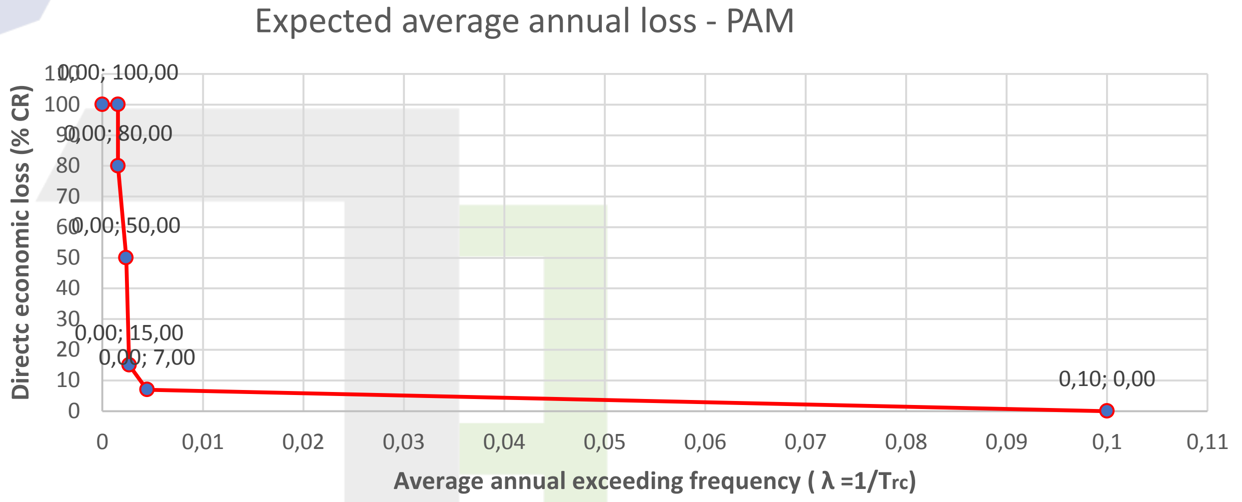



| PAM | IS-V |
|---|---|
| 4.41% | 41.13% |

| Perdita Media Annua attesa (PAM) | Classe PAM |
|---|---|
| PAM ≤ 0,50% | $A^{+}_{PAM}$ |
| 0,50% < PAM ≤ 1,0% | $A_{PAM}$ |
| 1,0% < PAM ≤ 1,5% | $B_{PAM}$ |
| 1,5% < PAM ≤ 2,5% | $C_{PAM}$ |
| 2,5% < PAM ≤ 3,5% | $D_{PAM}$ |
| 3,5% < PAM ≤ 4,5% | $E_{PAM}$ |
| 4,5% < PAM ≤ 7,5% | $F_{PAM}$ |
| 7,5% ≤ PAM | $G_{PAM}$ |

| Indice di Sicurezza | Classe IS-V |
|---|---|
| 100% < IS-V | $A^{+}_{IS-V}$ |
| 100% ≤ IS-V < 80% | $A_{IS-V}$ |
| 80% ≤ IS-V < 60% | $B_{IS-V}$ |
| 60% ≤ IS-V < 45% | $C_{IS-V}$ |
| 45% ≤ IS-V < 30% | $D_{IS-V}$ |
| 30% ≤ IS-V < 15% | $E_{IS-V}$ |
| IS-V ≤ 15% | $F_{IS-V}$ |

## After

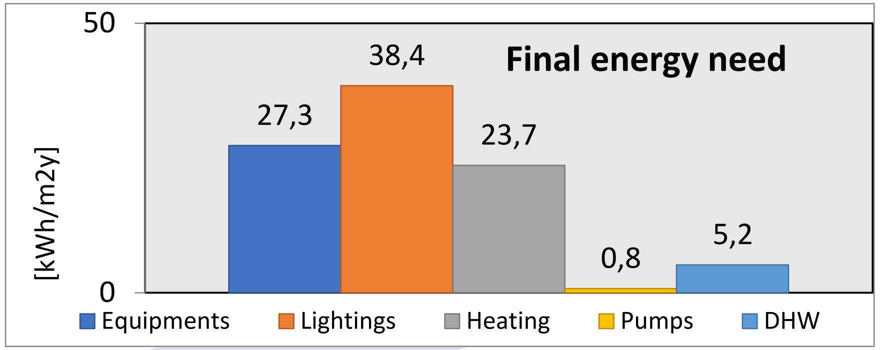



| PAM | IS-V |
|---|---|
| 0.20% | 96.04% |

| Perdita Media Annua attesa (PAM) | Classe PAM |
|---|---|
| PAM ≤ 0,50% | $A^{+}_{PAM}$ |
| 0,50% < PAM ≤ 1,0% | $A_{PAM}$ |
| 1,0% < PAM ≤ 1,5% | $B_{PAM}$ |
| 1,5% < PAM ≤ 2,5% | $C_{PAM}$ |
| 2,5% < PAM ≤ 3,5% | $D_{PAM}$ |
| 3,5% < PAM ≤ 4,5% | $E_{PAM}$ |
| 4,5% < PAM ≤ 7,5% | $F_{PAM}$ |
| 7,5% ≤ PAM | $G_{PAM}$ |

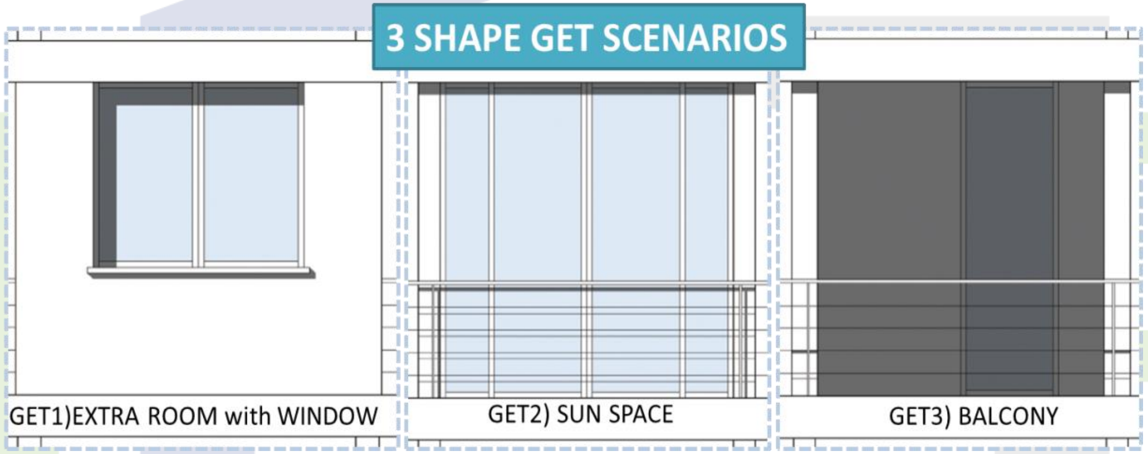
| Indice di Sicurezza | Classe IS-V |
|---|---|
| 100% < IS-V | $A^{+}_{IS-V}$ |
| 100% ≤ IS-V < 80% | $A_{IS-V}$ |
| 80% ≤ IS-V < 60% | $B_{IS-V}$ |
| 60% ≤ IS-V < 45% | $C_{IS-V}$ |
| 45% ≤ IS-V < 30% | $D_{IS-V}$ |
| 30% ≤ IS-V < 15% | $E_{IS-V}$ |
| IS-V ≤ 15% | $F_{IS-V}$ |

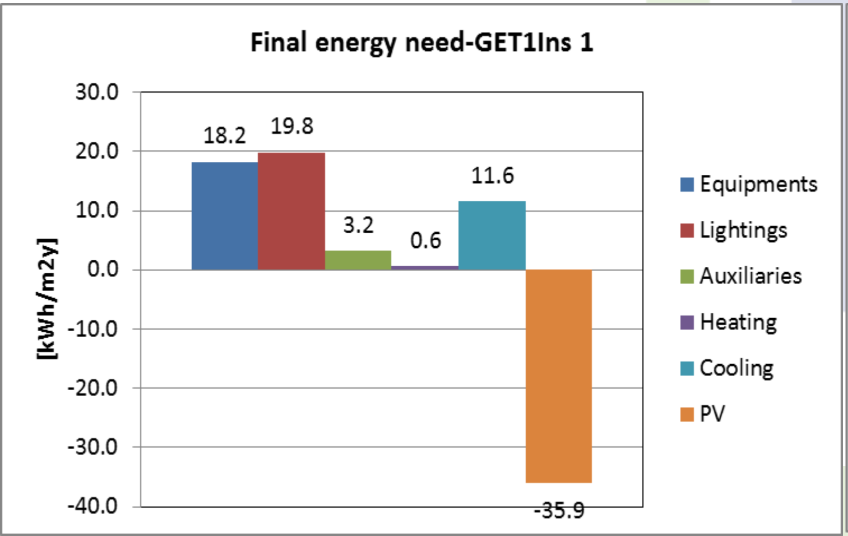
Results of the state of fact

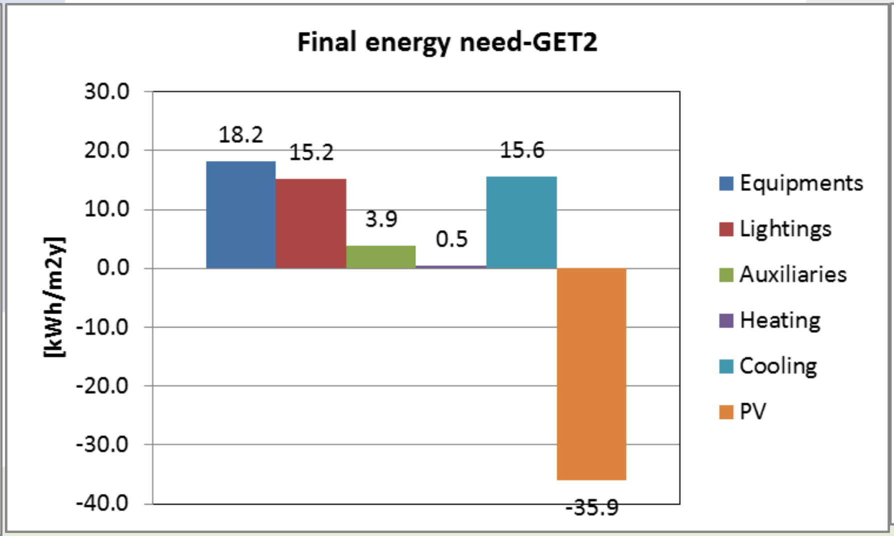


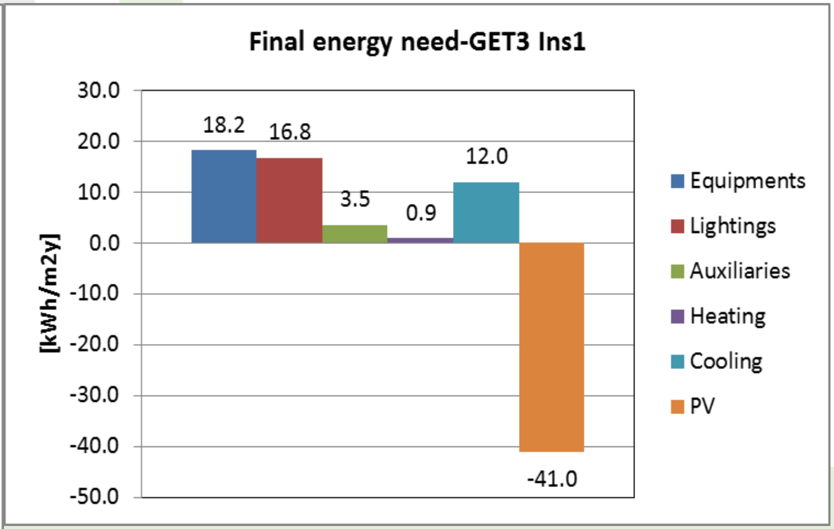

**Total Primary Energy: 188 kWh/m$^2$y**

*Net conditioned building area: ≈2584 m$^2$*



# Case studies


Groningen area


Brasov


Reggio Emilia

SUSTAINABLE PLACES 2018
June 27 - 29, 2018
Aix-les Bains, France

ProGETonE

# Implementation case

## STUDENT HOUSE AT THE CAMPUS OF THE UNIVERSITY OF ATHENS

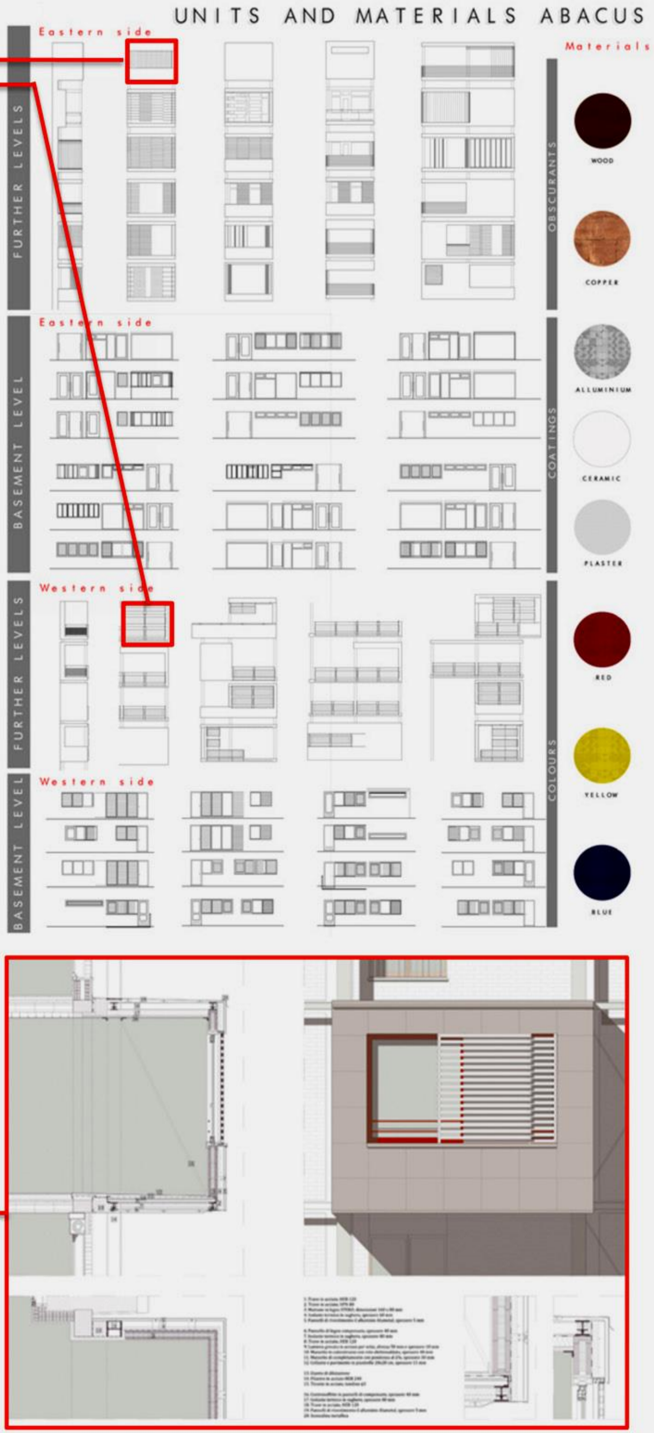

INTERACTIVE USER-DRIVEN SELECTION OF THE DIFFERENT OPTIONS/PACKAGE FROM THE ABACUS-SOFTWARE TOOL

CALCULATION OF THE PRIMARY ENERGY DEMAND RESULTING FROM THE APPLICATION OF DIFFERENT PACKAGE/ MEASURES TO THE REFERENCE RESIDENZIAL UNIT/APARTMENT

average U-value of walls
(W/m $^2$ K)
average U-value of windows
(W/m $^2$ K)
average U-value of windows
(W/m $^2$ K)
Measures based on RES
Heating system
...
other
...

*Initial investment costs*
*(EUR)*
*Running costs*
*(EUR)*
*PAY BACK TIME*
*(YEARS)*

*DETAILED DESCRIPTION OF THE SELECTED MEASURE/VARIANT*




# Tailored and user-orientated solutions

**ABACUS of different options**:

the façade modules will be studied according to the main structural frame and the residential units' utilities.

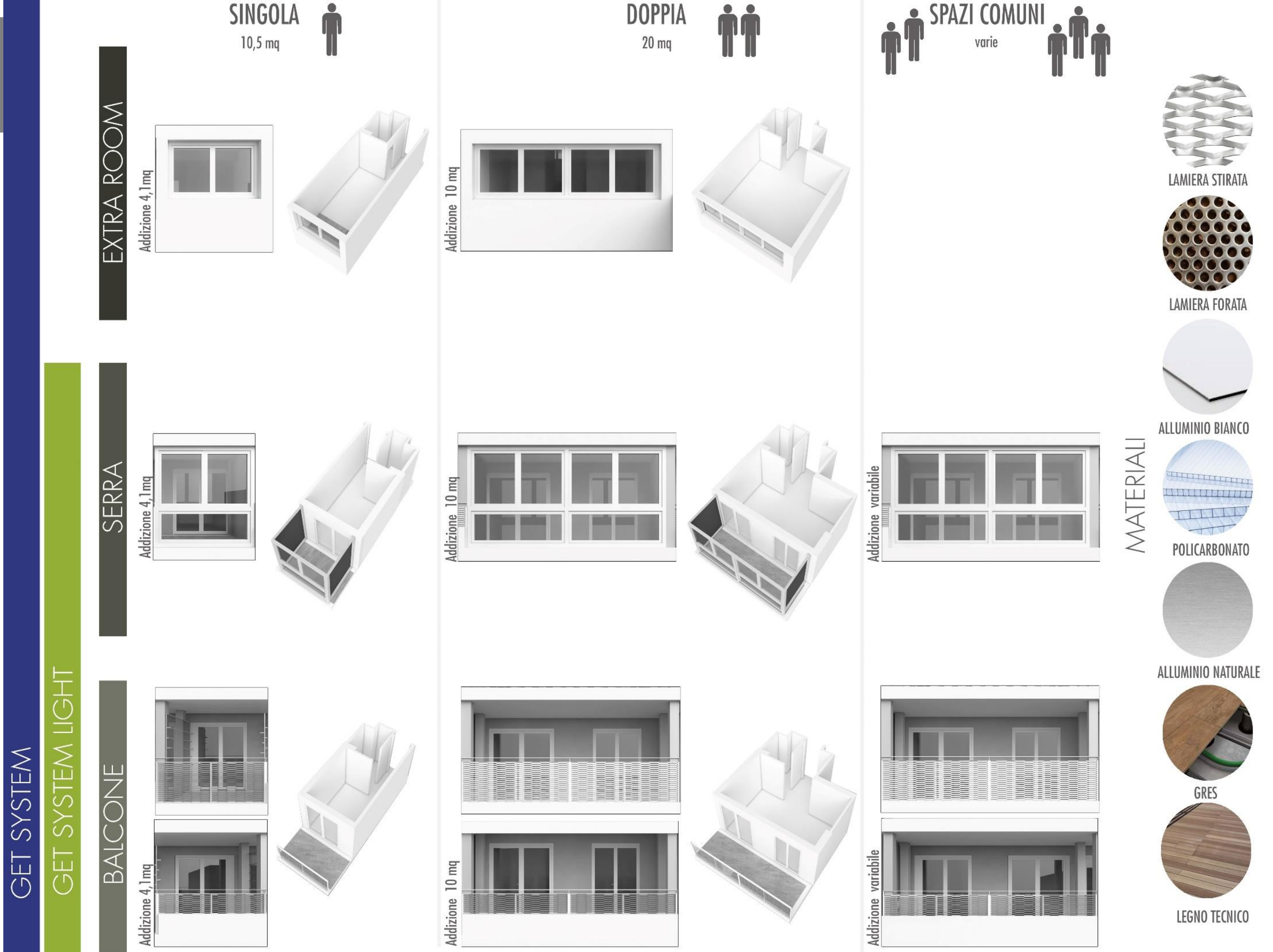
They will be grouped together in **an abacus**

which will become the main design tool (**an open energy performance repository**)

made by planners and professionals **to involve users** in the GET process.

The abacus will be representing the catalogue of a new product line of modules for a possible joint participation between all SMEs partners.

**A readily implementable abacus for the full-scale demonstrator** will be translated into construction documents.



- Project Coordinator: Annarita Ferrante, University of Bologna,
- annarita.ferrante@unibo.it, info@progetone.eu
- Project website: https://www.progetone.eu/

# No Technological Innovation

# with no Legislative Change

## FINAL REMARKS

## Barriers are the dark side of ... the ambition

FULL SCALE DEMOSTRATOR

(MAJOR RENOVATION – INNOVATION)

**i)Technical (Legislative)----**

**ii)Social (Participative)---**

**iii)Economic**

- ENERGY: Bonus for additions (on façade) if connected with energy renovation up to energy class A or nZEB (in Greece); but local restrictions...
- SEISMIC: Additions in Italy are often connected with the seismic upgrade close to the current standards;
- REGULATORY FRAMEWORK: jeopardized and different rules...

# Intro to the MORE-CONNECT project (Peter op ‘t Veld, Huygen Installatie Adviseurs)

MORE—CONNECT

# Project pillars:

## Product innovation

- Modular façade elements
- Modular roof elements
- Modular 'HVAC engines'

## Process innovation

- Advanced geomatics to make inventories and gauging of buildings and buildings stock.
- Web-based and/or digital decision tools to link building characteristics, building (energy) potentials, end-users demands to program requirements, technical solutions, component combinations in concepts, production automation.
- BIM for controlling industrial processes and for enhanced quality assurance.

## **Optimization** between costs, environmental aspects and quality

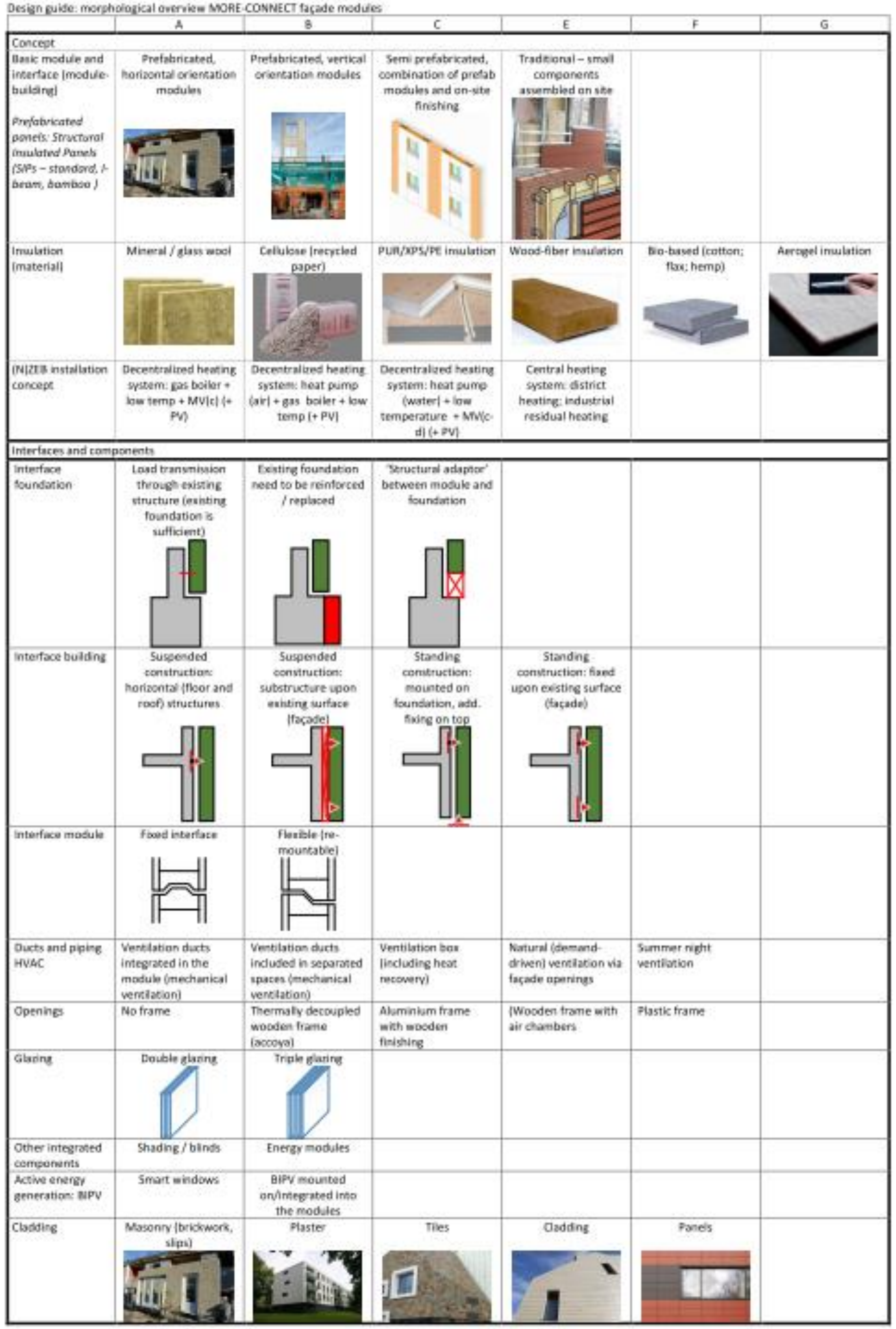
- Integration of components and systems
- Re-design
- Smart connectors

## From a end-users perception

- Development of a one stop shop concept
- Development of a system of performance guarantee
- Development of energy cost guarantee proposition to end-users ('zero on the meter')

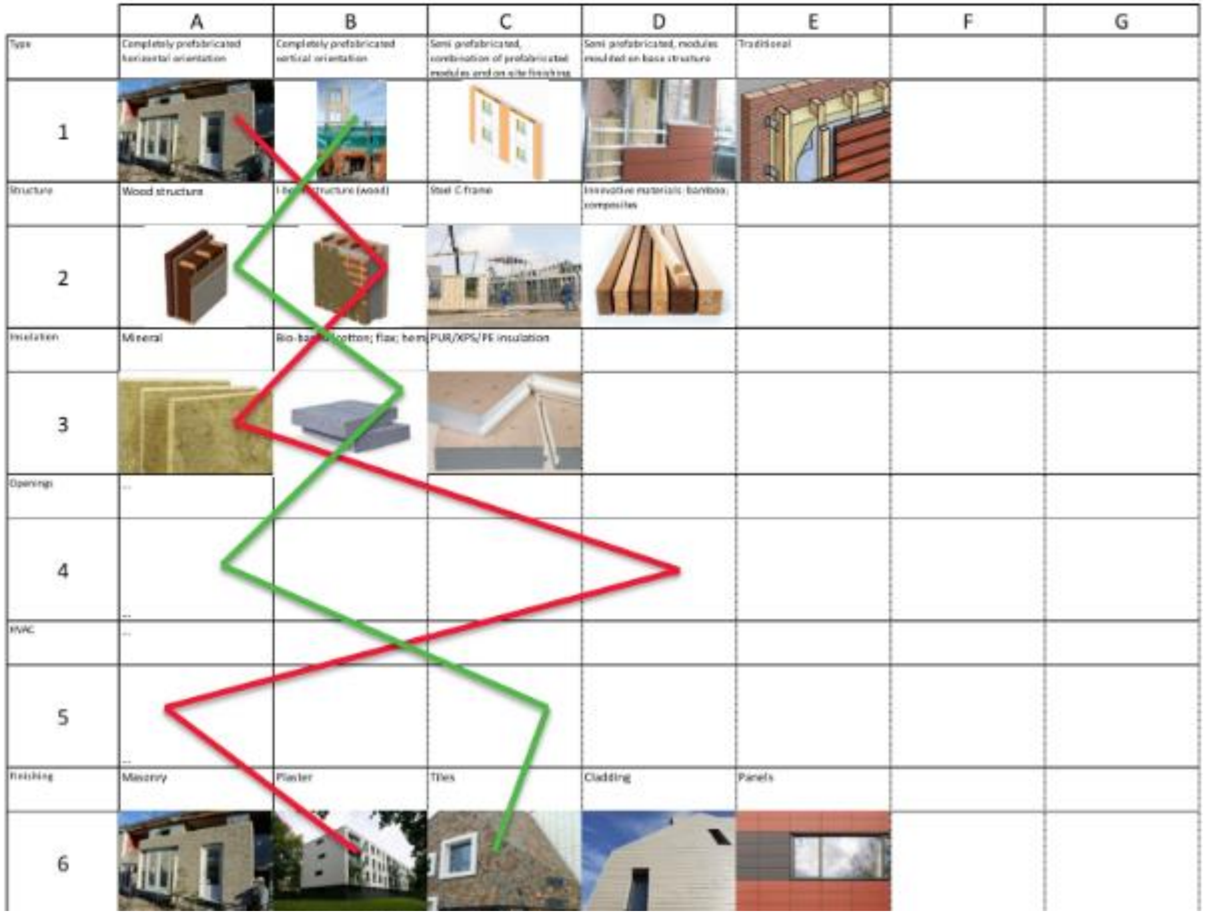
# MORE-CONNECT
# Morphologic design approach

**Technology development**
**Concept development**
**Process Development**
**Demonstration**



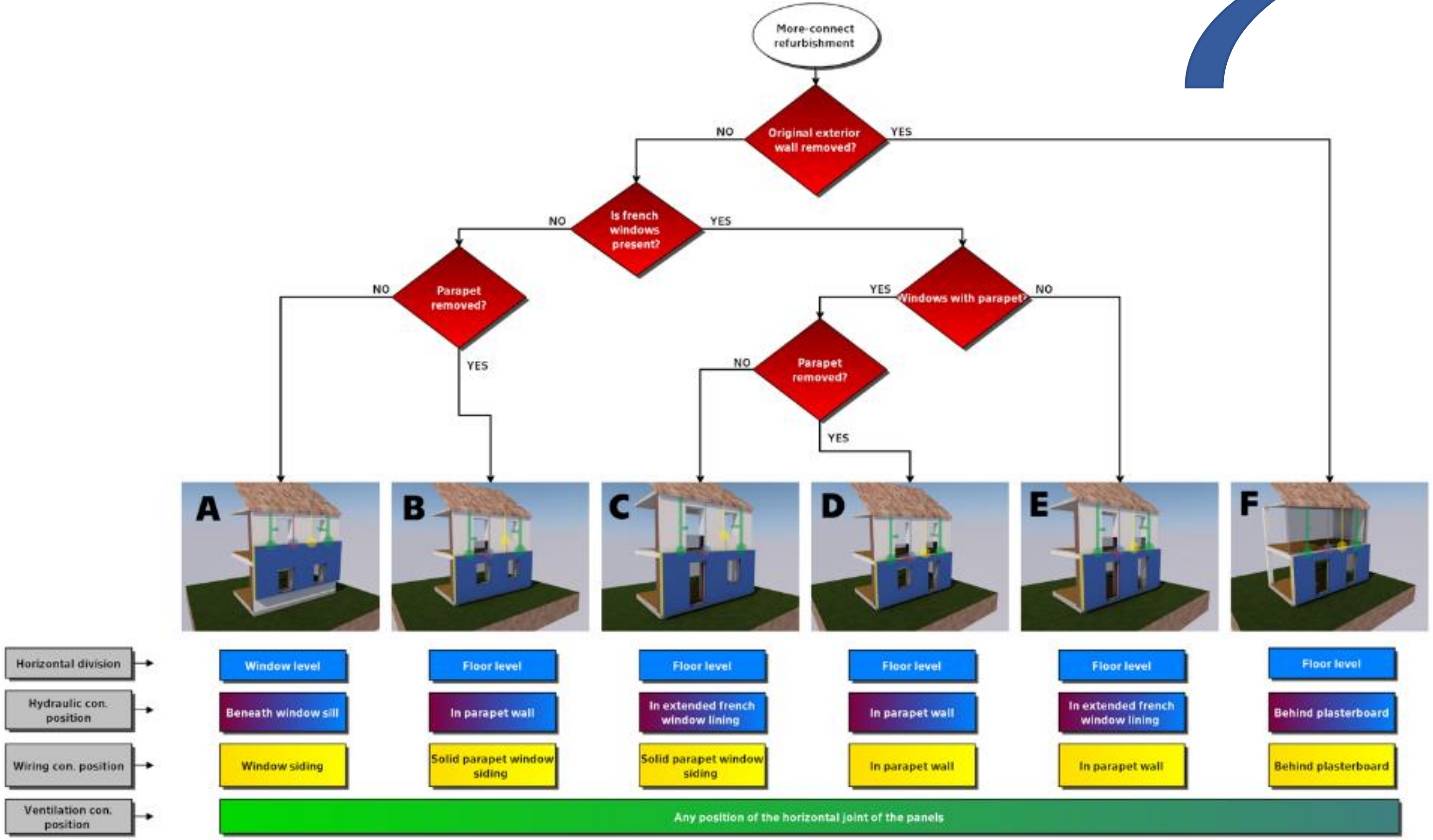
Design guide: morphological overview MORE-CONNECT façade modules

| | A | B | C | E | F | G |
|---|---|---|---|---|---|---|
| Concept | | | | | | |
| Basic module and interface (module-building) *Prefabricated panels: Structural Insulated Panels (SIPs – standard, I-beam, bamboo )* | Prefabricated, horizontal orientation modules | Prefabricated, vertical orientation modules | Semi prefabricated, combination of prefab modules and on-site finishing | Traditional – small components assembled on site | | |
| Insulation (material) | Mineral / glass wool | Cellulose (recycled paper) | PUR/XPS/PE insulation | Wood-fiber insulation | Bio-based (cotton; flax; hemp) | Aerogel insulation |
| (N)ZEB installation concept | Decentralized heating system: gas boiler + low temp + MV(c) (+ PV) | Decentralized heating system: heat pump (air) + gas boiler + low temp (+ PV) | Decentralized heating system: heat pump (water) + low temperature + MV(c-d) (+ PV) | Central heating system: district heating; industrial residual heating | | |
| Interfaces and components | | | | | | |
| Interface foundation | Load transmission through existing structure (existing foundation is sufficient) | Existing foundation need to be reinforced / replaced | 'Structural adaptor' between module and foundation | | | |
| Interface building | Suspended construction: horizontal (floor and roof) structures | Suspended construction: substructure upon existing surface (façade) | Standing construction: mounted on foundation, add. fixing on top | Standing construction: fixed upon existing surface (façade) | | |
| Interface module | Fixed interface | Flexible (re-mountable) | | | | |
| Ducts and piping HVAC | Ventilation ducts integrated in the module (mechanical ventilation) | Ventilation ducts included in separated spaces (mechanical ventilation) | Ventilation box (including heat recovery) | Natural (demand-driven) ventilation via façade openings | Summer night ventilation | |
| Openings | No frame | Thermally decoupled wooden frame (accoya) | Aluminium frame with wooden finishing | (Wooden frame with air chambers | Plastic frame | |
| Glazing | Double glazing | Triple glazing | | | | |
| Other integrated components | Shading / blinds | Energy modules | | | | |
| Active energy generation: BIPV | Smart windows | BIPV mounted on/integrated into the modules | | | | |
| Cladding | Masonry (brickwork, slips) | Plaster | Tiles | Cladding | Panels | |



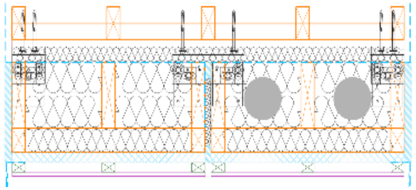
# How to come to a prefab renovation strategy: Basic prefab solutions

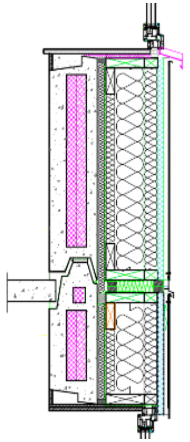
Technology development
**Concept development**
Process Development
Demonstration




Total removal/replacement (the Netherlands)

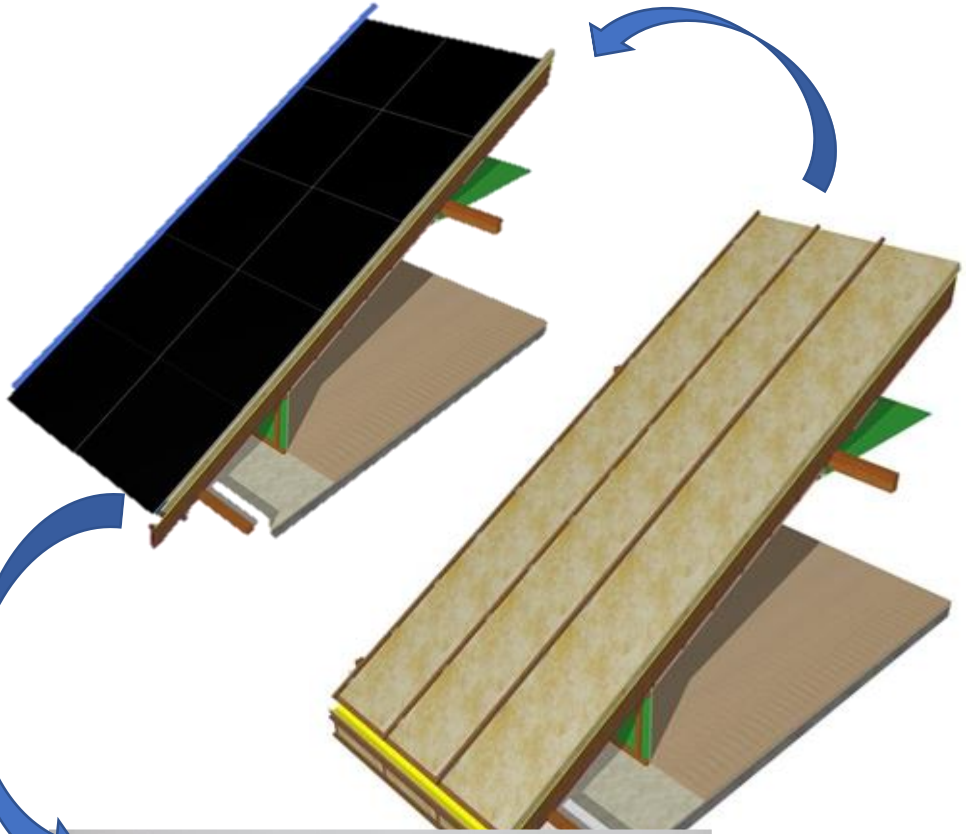
Adding prefab elements (Estonia)





# From generic prefab wall and roof modules…..

**Technology development**
**Concept development**
**Process Development**
**Demonstration**

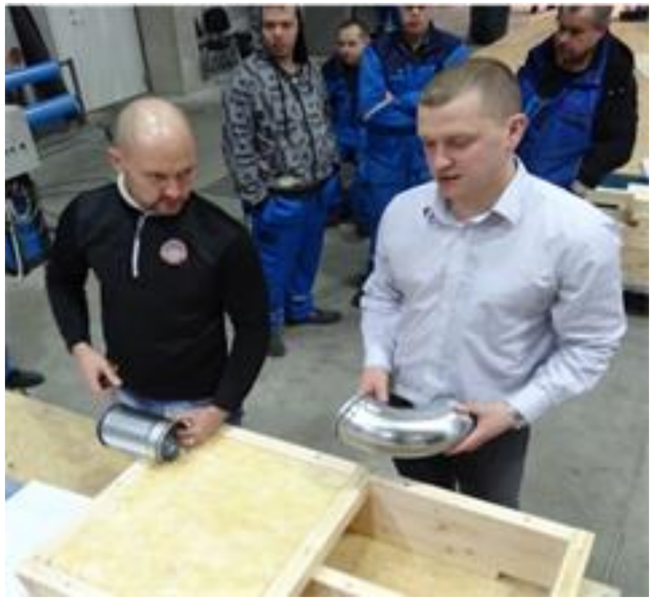


# ....to prototyping and testing
# Example: Estonian modules tested at TUT

**Technology development**
**Concept development**
**Process Development**
**Demonstration**






# ….and prototyping and testing Czech modules at UCEEB lab



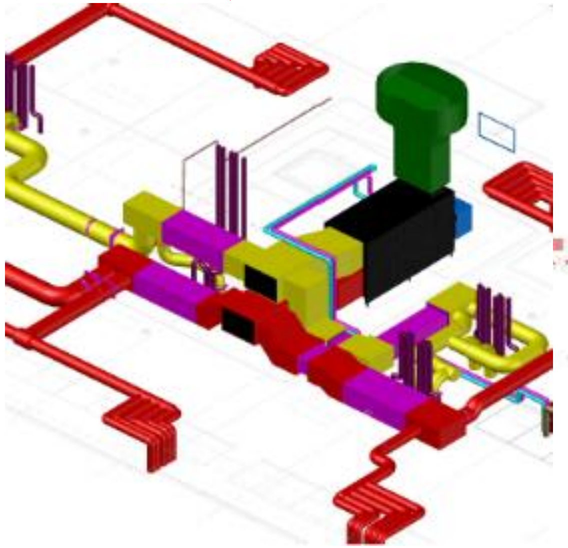


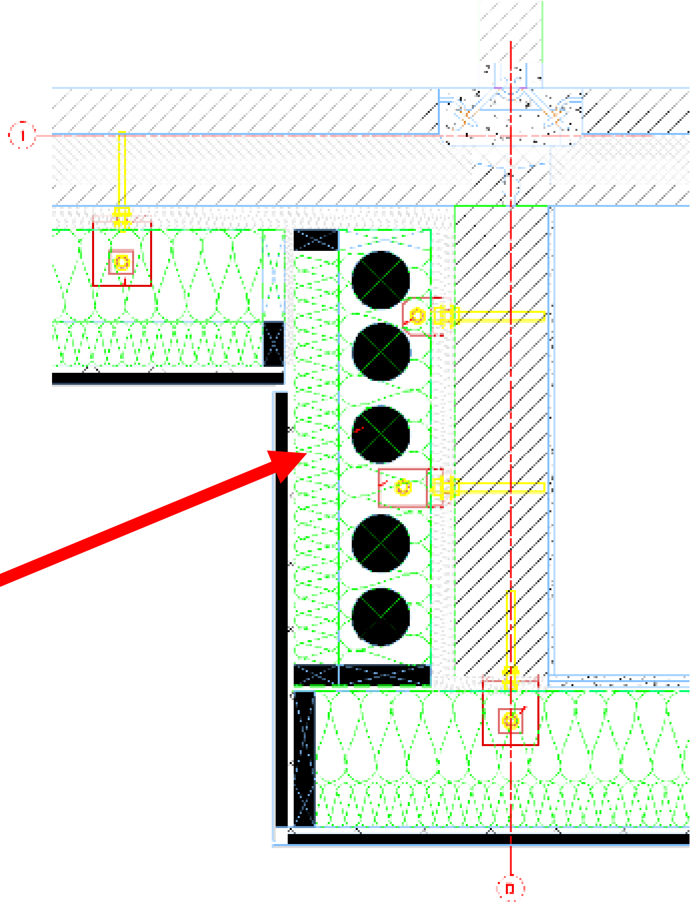
Technology development
Concept development
Process Development
Demonstration

# MORE-CONNECT Tallinn case building

## Prefab ‘engines’ and embedded ducts in prefab façade elements

Technology development
Concept development
Process Development
Demonstration





# Prefab facades and engines for apartment buildings

# MORE-CONNECT demonstration building Akadeemia 5aTallinn, Estonia

Technology development
Concept development
Process Development
Demonstration

Start

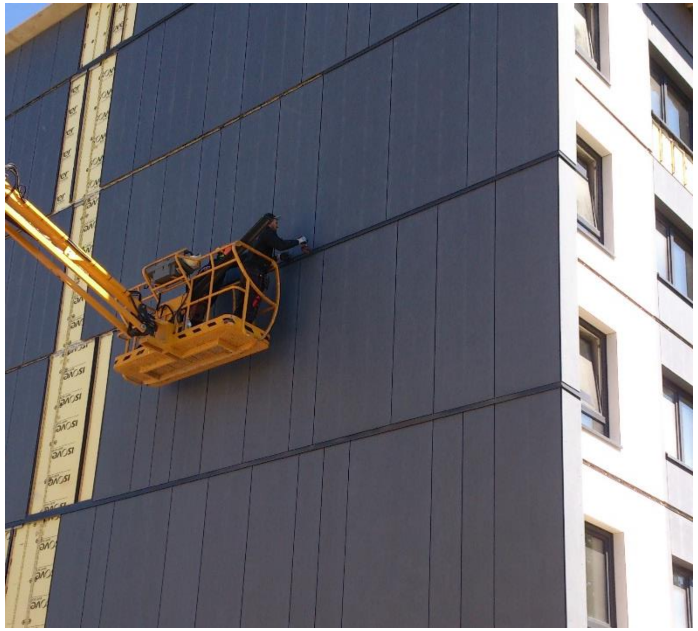
Design

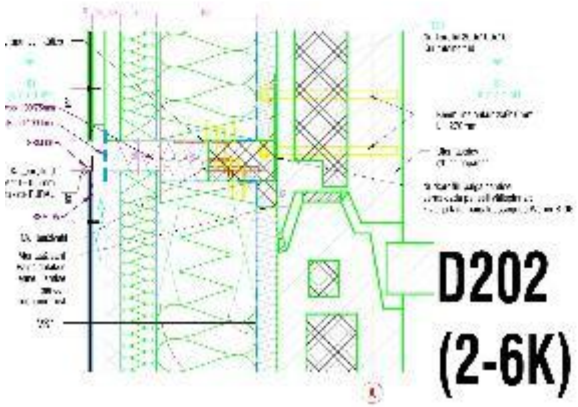
Execution

Completion

# MORE-CONNECT demonstration building Estonia….in practice….. and some lessons learnt

**Technology development**
**Concept development**
**Process Development**
**Demonstration**

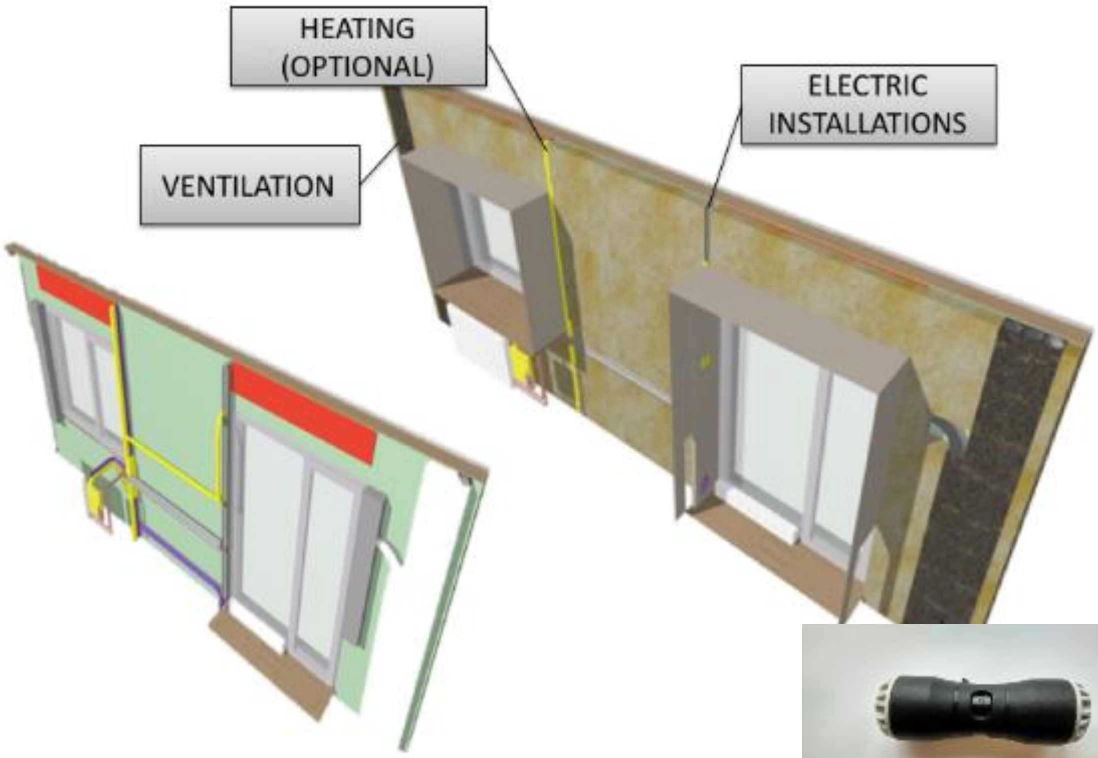


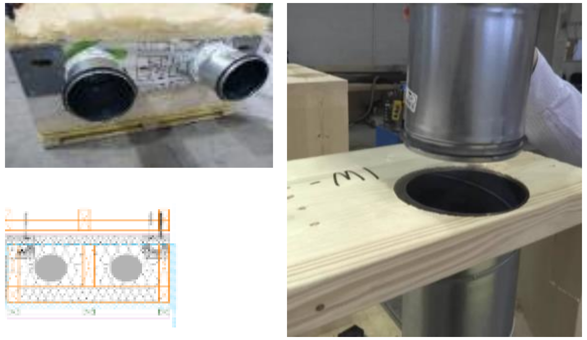

- Very difficult to insulate horizontal joints
- Different gap size in vertical joints
- Fine tuning of production design would help

- Large and heavy boards are very demanding to install
- Too accurate design detail

# Smart Connectors - final design




## Air connectors (ventilation ducts)

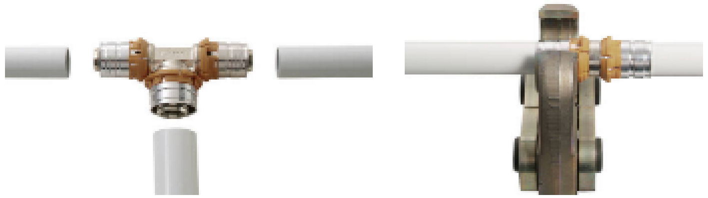


**Technology development**
**Concept development**
**Process Development**
**Demonstration**

## Mechanical connectors

rectification in 3D
anchoring only to the ceiling structures

## Hydraulic connectors (pushfit connectors)



# Smart Connectors – prototyping and testing at UCEEB lab CZ





Technology development
Concept development
Process Development
Demonstration

# Advanced control systems

## Scope definition for the project

- From conceptualization to system components and its integration and communication
- Algorithms and services provided


- Two basic renovation configurations

**Low-cost**

- Equitherm control
- Electric blinds
- Embedded room operator or Thermostat

**High Tech**

- MPC
- Automated and integrated (blinds, heating and ventilation)
- Indoor air quality sensor
- PV forecast service
- Moisture Guard

**Technology development**
Concept development
Process Development
Demonstration

# Advanced controls - prototyping and testing at UCEEB lab CZ

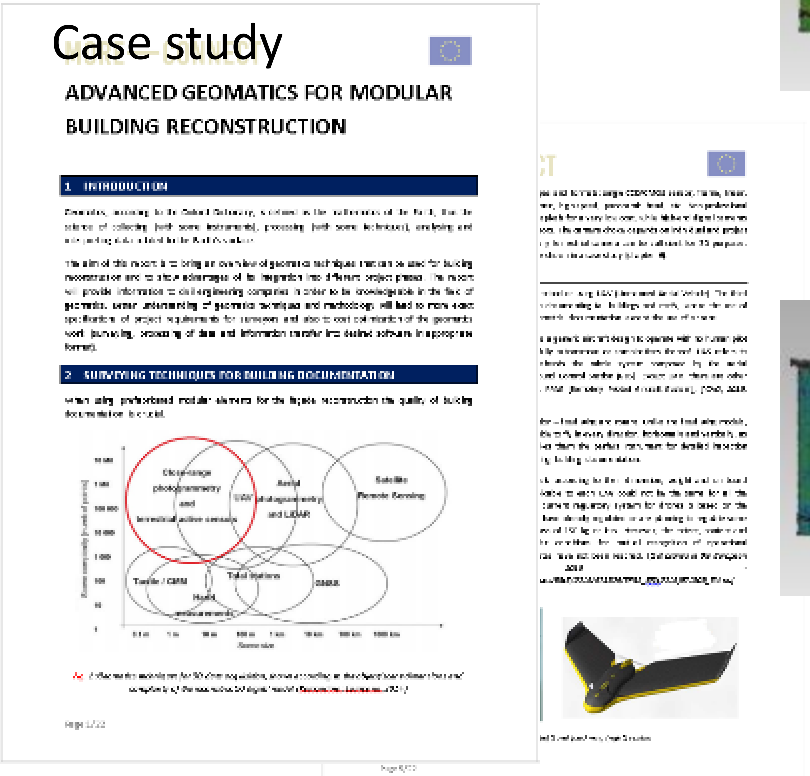
Technology development
Concept development
Process Development
Demonstration





# Advanced Geomatics

- Surveing techniques for building documentation
- Pointcloud processing
- Geomatics integration
- Economics
- Case study


ADVANCED GEOMATICS FOR MODULAR BUILDING RECONSTRUCTION

1 INTRODUCTION

2 SURVEYING TECHNIQUES FOR BUILDING DOCUMENTATION

**Technology development**
**Concept development**
**Process Development**
**Demonstration**

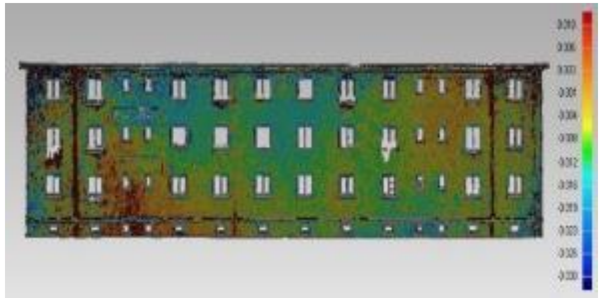
Pentax 645D

Canon EOS 450D

Reflex cameras show low noise level in the data - up to 5mm.

Sony CyberShot DSC-HX50

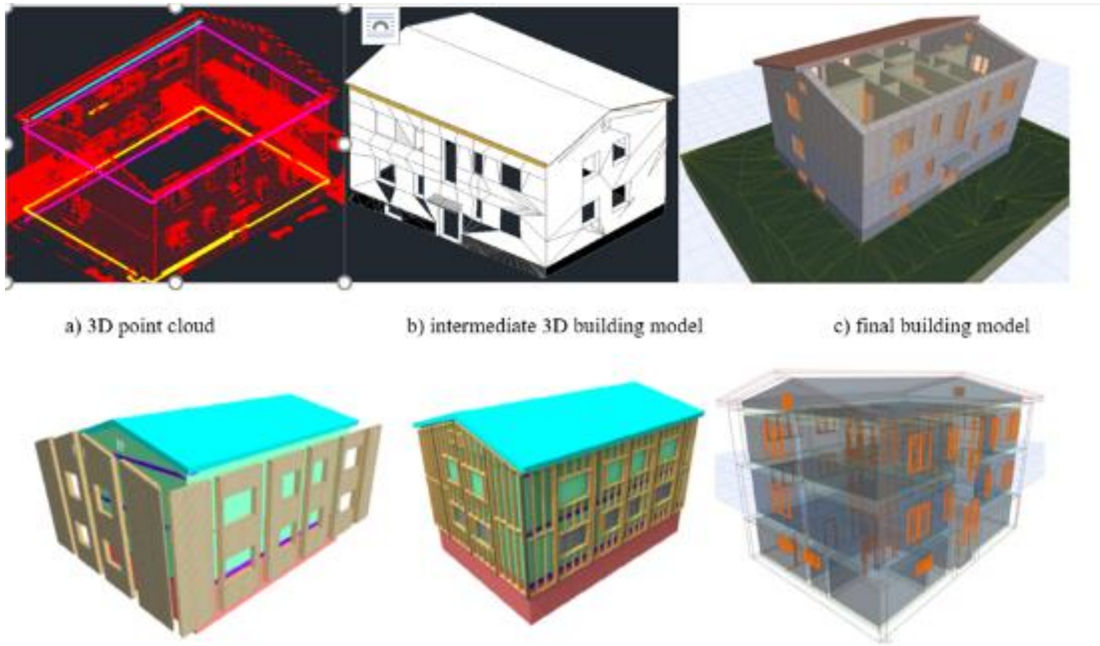
iPhone 5s



Low-cost cameras show significant noise level in the data - up to several centimeters.

# Optimization of BIM Workflow

Technology development
Concept development
Process Development
Demonstration



a) 3D point cloud
b) intermediate 3D building model
c) final building model
d) development of panel layout
e) Thermal blocks for energy simulation

**MANUAL**

- From seperate points
- Create object (walls, windows, doors)
- Average time consumption, easy but does not reflect real situation

**SEMIMANUAL**

- From cross sections
- Create mesh, smartsurface or solid elements
- Convert to object (walls, windows, doors)
- fast, easy, shows real situation, convertations problems

**AUTOMATICAL**

- Create mesh
- Correcting the mesh
- Convert to object
- fast, but needs a lot of work for correcting the mesh and to divide into seperate object types
- Shows real situation

**FROM PHOTOS (automatically)**

- Create mesh
- Divide mesh to seperate
- Correcting the mesh
- Convert to object
- VERY complicate, a lot of photos and correction works are needed

# BIM controlled production lines
# Example: Upscaling production lines at WEBO factory

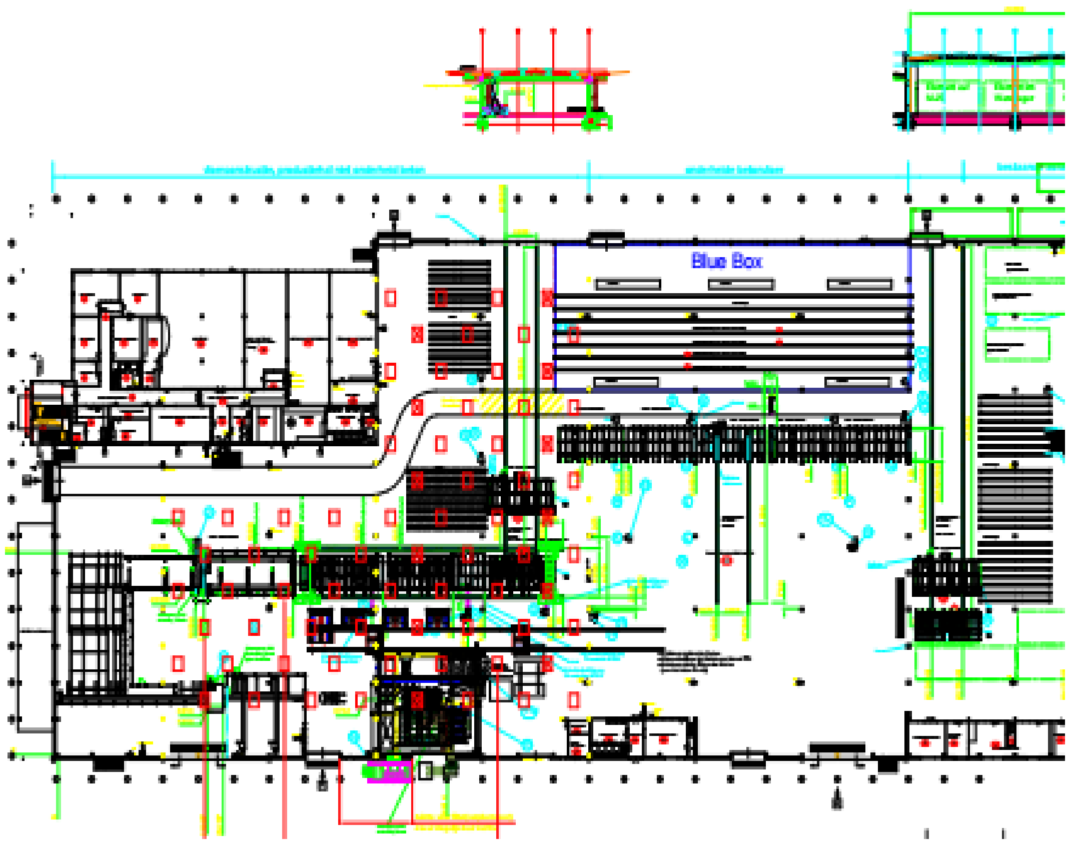
Technology development
Concept development
Process Development
Demonstration

**Phase 1 upscale production aimed at reducing manual work**

- This scenario brings a reduction of manual labour of approximately 50 % combined with an output boost of x1,25.
- Focus in this scenario is on automating the labour work as it is.
- Additional benefits come from automating production preparation and running routing optimization algorithms

**Phase 2 upscale production aimed reducing manual work and upscaling output**

- This scenario is estimated to bring a reduction of over 80% of manual labour combined with an output boost of x50. Output is at 1 set per 11 minutes combined with 10 to 20 % labour needed compared to traditional setup.
- Additional benefits are purchase position, suppliers willing to cooperate on development of easy to assemble base materials, suppliers willing to support development of glue with open-time of 10 minutes, suppliers willing to support multidisciplinary innovation/development



# Lessons learned in MORE-CONNECT

- Prefabrication cannot totally ‘substitute’ traditional retrofitting
- The step we made was the *integration of building services in building elements*, but prefab facades have more or less the same composition as on site constructions > could/should we do some redesign, new materials, etc. for further optimization?
- Same as for installation platforms (‘house engines’) > miniaturization, redesign necessary to downsize dimensions and weight (with at least 35%); could we learn from automotive industry?
- Average cost break down now is:
  - Prefab envelope: 1/3
  - Building services and PV: 1/3 (> not really smart miniaturized engines yet)
  - Finishing, small works, failure costs: 1/3 (aim is < 5% hours spent on site)
  - Problem: Earnings/earning model of traditional companies is often in extra work and failure costs, (often not offered in bids!)
- Technological developments are not the problem, but how to break through a traditional market, dominated by traditional (large) construction companies
  - Still too many layers in the process
  - Clients are still reluctant for innovations
- We have blue prints for new production processes and factories but due to lack of market still on hold
- A step to make is the connection between advanced geomatics and BIM for production; transferring point clouds in BIM is still hand work. BIM to BEM is not really useful.

# Moderated interactive discussion & action planning

# Deep Energy Renovation: Challenges, Barriers, & Opportunities

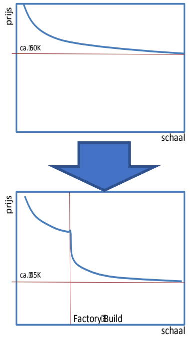
| | Technical | | Financial | | Social | |
|---|---|---|---|---|---|---|
| | Values | Barriers | Values | Barriers | Values | Barriers |
| 4RinEU Reliable models for deep renovation<br>P2ENDURE PLUG & PLAY BUILDING RENOVATION<br>ProGETonE<br>MORE— CONNECT | | | | | | |

| | Technical | | Financial | | Social | |
|---|---|---|---|---|---|---|
| | Values | Barriers | Values | Barriers | Values | Barriers |
| 4RinEU Reliable models for deep renovation | • Prefabricated renovation of the envelope without scaffolding<br>• Integration of functions and elements in the façade (ventilation, ducts, RES)<br>• Optimisation tool for Early Design and RES integration<br>• Plug&Play energy hub for controlling the heating and cooling fluxes within the HVAC system<br>• Replicability potential based on (shared) technical specifications | • Prefabrication does not suit all the buildings: technical constraints (specificities, balconies)<br>• Speed mounting VS dimension of the elements<br>• Integration of components allows to speed-up the process but is complex problem<br>• Accurate design would need detailed inputs – lack of information on the energy profiles | • Reliable costs for the investment due to: reduced failures during the renovation, guaranteed high performance during time<br>• 4RinEU energy audit and Early RENo reduce the uncertainties in terms of performances (circular knowledge transfer)<br>• Prefabricated façade systems allow to increase the building life span | • Investment for the renovation are still high for common users – mass production would be needed to reduce cost of prefabrication<br>• Multi-functional façades have a complex maintenance management (general contractor and agreements are needed) | • Less disturbance of the inhabitants due to reduced time and complexity of the building site<br>• User information about the building operation<br>• Feasibility studies from early adopters | • Lack of trustiness in innovative technologies (and in general in renovation and changes) |

| | **Technical** | | **Financial** | | **Social** | |
|---|---|---|---|---|---|---|
| | Values | Barriers | Values | Barriers | Values | Barriers |
| ProGETonE | • Deep renovation<br>• Seismic reinforcement<br>• Pre-fab plug and play solutions<br>• Reliable technologies | • Integration of different solutions<br>• Legislative barriers<br>• Integrated offer (out of the common, lack of reference actors) | • Increase of the real estate value<br>• Increase of the expected lifetime of the buildings<br>• More resilient buildings (lower insurance costs?) | • Lack of investment<br>• Higher Up-front costs<br>• Lack of supporting schemes (both legislative and financial)<br>• Long payback (even no paid back) in terms of energy (in some MED situations) | • Shorter time and less disturbance<br>• User orientated design<br>• Safer and climate-respectful buildings<br>• Higher IEQ<br>• Focus on user’s willingness to pay | • Lack of awareness and trust in new technologies<br>• Lack of awareness in seismic risk and in energy transition needs<br>• Lack of communication<br>• Short-term oriented vision<br>• Lack of funds<br>• Mismatch between collective and individual needs |

| | Technical | | Financial | | Social | |
|---|---|---|---|---|---|---|
| | Values | Barriers | Values | Barriers | Values | Barriers |
| P2ENDURE PLUG & PLAY BUILDING RENOVATION | • Deep renovation<br>• TRL6 – TRL8<br>• PnP Easy to assembly<br>• PnP monitoring system before and after renovation: the Comfort Eye | • Integration of different PnP solutions<br>• Managing dynamics of real renovation projects<br>• Still just a methodology has been developed: feasibility is still unknown (i.e. how to move from BEM to BIM) | • Faster RoI (Return on Investment) with innovative, energy efficient technologies<br>• Lower costs of renovation and maintenance<br>• Enhancement of the product value chain through the e-market place financial mechanism | • Reducing the production cost of the PnP solutions by increasing volumes<br>• Public procurement (Lack of trust) | • Shorter time and less disturbance during renovation<br>• Higher IEQ<br>• Involvement of local communities through local factory | • Lack of awareness and trust in new technologies, especially from public clients |

# Clustering workshop

| | **Technical** | | **Financial** | | **Social** | |
|---|---|---|---|---|---|---|
| | Values | Barriers | Values | Barriers | Values | Barriers |
| MORE—CONNECT | • Technical solutions for integrated prefab façade and roof elements and prefab HVAC platforms on product level, tested and proven in demos with proven good accuracy<br>• Smart connectors: air, hydraulic, mechanical, and ICT<br>• New advanced geomatics technologies applied and tested in demos<br>• Role of innovative industrial partners i.e. 3D printed facades etc.<br>• Scaffold less renovation demonstrated as effective technology, New BIM controlled automated production lines<br>• Morphological design procedures | • Sizing of prefab elements needs attention.<br>• Elements are still too big and too heavy. Execution is the tricky part maybe miniaturization of elements is needed<br>• Gauging in practice<br>• HVAC platforms still need redesign and miniaturizing!<br>• Point clouds to BIM is the main technical barrier : the process is still too complicated | • Prefab renovation solutions should be able to offer significant cost reduction<br>• Significant cost reduction is expected if Pointclouds2BIm is achieved:<br> | • Cost reduction still not achieved because of lack of scale (now M-C solutions are one-off test products but with 2.0 version in development)<br>• Although roadmap to pointclouds2BIM and steps to make are developed within M-C no one is able or willing to do this | • Short time renovation and less disturbance is possible (proven in 'Energiesprong' already)<br>• New VR technologies to show occupants 'what they get' and 'making own configurations'<br>• Integrated tools to assess energy, embodied energy and costs<br>• One-stop-shop concepts | • Cost break down is:<br>• Prefab envelope: 1/3; Building services and PV: 1/3; Finishing, small works, failure costs: 1/3<br>• Earnings/earning model of traditional companies is often in extra work and failure costs (not in bids!!)<br>• Technology is not the problem, but how to break through a traditional market, dominated by traditional (large) companies<br>• Still too much layers<br>• Clients are still reluctant for innovations<br>• Blue prints for new production processes/ factories but due to lack of market on hold |