
SUSTAINABLE PLACES 2023
R2M
RESEARCH TO MARKET
SOLUTION
POLITÉCNICA
June 14-16 2023, Madrid, Spain
Hybrid event

SUSTAINABLE PLACES 2023

giga regio factory by energie Sprong

StepUP

BuildUPspeed

INFINITE BUILDINGRENOVATION

DRIVE

PLURAL

SWITCH2SAVE

ENSNARE

50 Shades of Industrial Deep Energy Retrofit

14 June, 2023 - Madrid, Spain

sustainableplaces.eu

R2M SOLUTION

POLITÈCNICA

The involved projects

From the call - LIFE21-CET-BUILDRENO:

- **BuildUPspeed** – Introducing a Market Activation Platform to speed up Deep Renovation of EU building stock, enhanced by attractive, high quality Industrialized Solutions, offering evidence-based performances
- **GigaRegioFactory -** going next stage in market uptake and factory development for more affordable Net Zero energy renovation industrialised solutions packages

From the call LC-EEB-04-2020 - Industrialisation of building envelope kits for the renovation market (IA):

- **INFINITE** - Industrialised durable building envelope retrofitting by all-in-one interconnected technology solutions
- **PLURAL** – Plug-and-Use renovation with adaptable lightweight systems
- **ENSNARE** - ENvelope meSh aNd digitAl framework for building Renovation

From the call LC-SC3-EE-1-2019 - Decarbonisation of the EU building stock: innovative approaches and affordable solutions changing the market for buildings renovation:

- **DRIVE 0** - Driving decarbonization of the EU building stock by enhancing a consumer centred and locally based circular renovation process
- **StepUp** - Solutions and Technologies for deep Energy renovation Processes Uptake

From the call LC-EEB-01-2019 - Integration of Energy Smart Materials in non-residential Buildings

- **Switch2Save** - Lightweight Switchable Smart Solutions for Energy Saving Large Windows and Glass Facades

Title and abstract of the workshop

Title: 50 shades of industrial deep energy retrofit

Abstract:

Towards further energy efficiency and decarbonisation of the EU building stock, Modularity and Industrialisation of building envelope kits (Industry 4.0) for the renovation market are key strategies to improve both production and resource efficiency in constructing and retrofitting housing. Moreover, IPCC highlighted it once again in its March 2023 report, “Efficient Building” holds the biggest carbon abatement potential at cities level. 100 millions housing units have to be deep energy retrofitted by 2050. The challenge is big and there will no other ways that doing better and faster in a more efficient way to deliver it: going industrial. The issue is not anymore “should we industrialize deep energy retrofit?”. Prove of relevance and performance have been done through various initiatives at EU level. Past 5 years helped jump from 100’s of NZEB retrofit housing with industrialized methods to more than 10 000’s. Not all buildings types fit such retrofit methods, but it has been demonstrated that, given regions, up to 30 to 50% of housings can be retrofit this way to A or B level energy label. There is not “one single way” to industrialize deep energy retrofit. Different approaches fit different contexts. Our challenge is now to blend the best of the different proven industrialization approach given building typologies, climate and countries. There are 50 shades of industrialized deep energy retrofit but it is high time that every region and member state get serious about which ones it want to embrace. For now EU has set 7 industrial alliances of high priority: 1. raw material, 2. clean hydrogen, 3. battery, 4. plastic, 5. data / edge and cloud, 6. semi conductor, 7. renewable and low carbon fuel. The one is missing which will solve 40% of EU emission due to buildings, building an Industrial Alliance for Deep Energy Retrofit. Pioneers and front-runners of that emerging industry will share their feedback and lesson learnt, to build on the next stages of needed policies to quickly jump from the 10 000’s to the millions of housing deep energy retrofitted. This workshop is organized by several European projects on industrialized, modular renovation, both on development and market uptake and is endorsed by several chapters of Energiesprong. Circular renovation and circular economy are key in these projects as well.

Aim of the workshop

Problem statement:
Industrialization and factory based housing solutions, both for new built as retrofit market, are seen as attractive alternatives to traditional and project-oriented construction and deep-renovation practices to boost the production efficiency overall quality delivered in material efficient and cost-effective way. However, the history of factory-based construction in housing is paved with failure and many factories were not able to survive in a highly versatile market. ***What are the key conditions for establishing deep-renovation factories – in line with the provision of EU deep-renovation kits - to meet EUs 2050 zero carbon emission goals?***

Aim of the workshop:
1. To identify the key challenges and key factors that hinder the uptake of industrialization and the establishment of deep-renovation factories, and;
2. To unravel examples of relative successfull deep-renovation 'factories' have shown to be successful (in number of renovated dwellings and period these factories have been operational).

Chair:	Peter Op 't Veld (Huygen I&A)
Discussion moderators:	John van Oorschot (Zuyd UoAS)
	Maria Sara Di Maggio (ABT)

Expected outcome

Expected outcome:
A positioning paper with policy recommendations on industrialized renovation.
(……like the positioning paper we drafted after SP2021: Boosting the Renovation Wave with Modular Industrialized Renovation Kits: mapping challenges, barriers and solution strategies)

Program

Time	Title	Objective
5 min	Welcome & programme introduction	
25 min	Introduction to the projects and facts	Each project 3 min pitch, focusing on state of the art, numbers of renovation incentivized Proven approaches to industrialization and related KPIs
15 min	Keynote: 50 shades of industrial deep energy retrofit (Sébastien Delpont – EnergieSprong France)	Why do we need to promote and accelerate industrial renovation?
30 min	**Roundtable– Part 1** Discuss the key challenges and key factors that hinder the uptake of industrialization based on project experience	Discuss the key challenges and key factors that hinder the uptake of industrialization based on project experience: are there similarities among the Netherlands, France, Italy context? Are there political, geografical, cultural differences?
30 min	**Roundtable– Part 2** What approaches and models have been shown to be successful ? What are the lessons learnt from these projects?	Discussion around the preconditions to successfully introduce mainstream deep renovation techniques in each EU country. What are approaches are successful in what country? What are the new models like: e.g. Giga Regio Factory, Pop Up Factory, PreFab Lab... What differentiation shall be made, e.g. by climate region, by building typology, by cultural factors?
15 min	Final remarks & Conclusions	Wrap up on the needed steps to move beyond the 10,000 deep renovations per year; what actions must be taken? Next steps towards a positioning paper

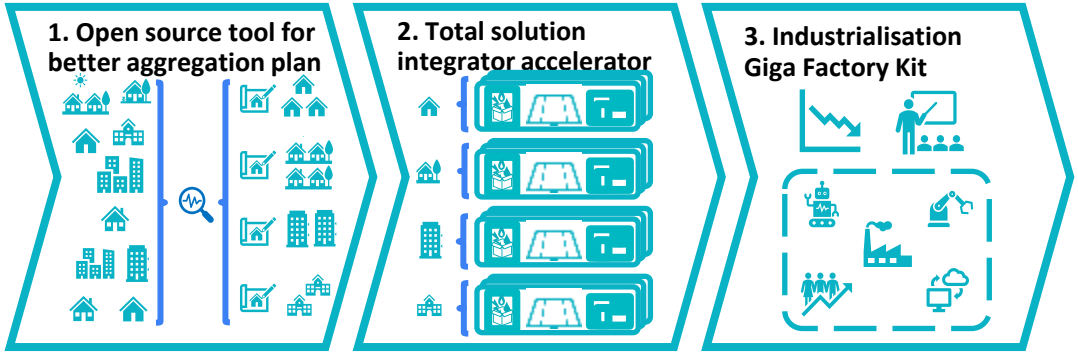
Project Pitches

PLANNING NEXT STAGE OF INDUSTRIALISED DEEP ENERGY RETROFIT

Coordinator: GreenFlex, France
Sebastien Delpont, Coordinator
Duration: 2023 -2025
Funding: LIFE CET
Website: www.energiesprong.org

Why: Giga Regio Factory aims to set Open Source & free tools & facilitation actions, based on lessons learnt of Energiesprong projects delivered in the Netherlands, France, Germany and Italy in order for the market for deep energy retrofit using industrial methods to scale up from thousands to hundreds thousands, and to activate new development in Belgium.

How:



What:

1. Developing an open-source tool for the qualification of houses to better qualify them and developing smarter aggregation strategy for large collective industrial r

- Develop an exhaustive library of solutions, per each key housing archetype
- Develop buildings & district qualification tool to assess value of multi-local aggregation
- Cross data to give order of magnitude of prices, global costs/economical balance and impacts

2. Total solution integrator accelerator: intensive coaching for key market players

- Training sessions / workshops / MOOCs to facilitate implementation of solution catalogues for development of their own offers for selected archetypes
- Case study on a typical project case / tender call: support to formalize an offer

3. Industrialization Giga Factory kit: supporting Prefab industrial SME thinking next stage development if the demand ramp up well and fast

- Development of a business plan tool for companies based on their position on the value chain, to assess the investments to be made and help them bring their projects to financers
- Support for the deployment of giga factories: studies, investments, feasibility assistance

Main outcomes & conclusions:

- Building typologies matters and proper housing stocks qualification is very much needed
- Regular volume of homes of homogenous typologies are key to deliver an activity that fit needs of a factory
- Demand should be organized in time at regional volume to get a good volume allowing for better prices
- Economics of a project in matter of cost & benefits should also be considered at local level based on real site data
- Interactor cross visibility and transparency on relevant building and market prices are key to build trust
- National market maturity & economics differs but more the most, analysis have the same basis in all countries
- Synergized demand planning & offer planning are needed to avoid for inability to deliver or business failure
- Business need to develop factories to be though through in matter of machine & investments

Proven approaches towards industrialization:

- Lean construction methods applied
- Full offsite retrofit solutions applied
- Mix of offsite & traditional retrofit solution applied
- Project aiming for Net Zero in one step or in two steps
- Applied on individual housing & collective housing
- Testing having place in social housing

Industrialization issues to be resolved:

- Collecting updated data from different markets players
- Accepting data to be made public to help market grow
- Understanding there is no one single way to go “industrial”
- Changing their habits in matter of “working together” on the demand side and reconsidering TCO calculation

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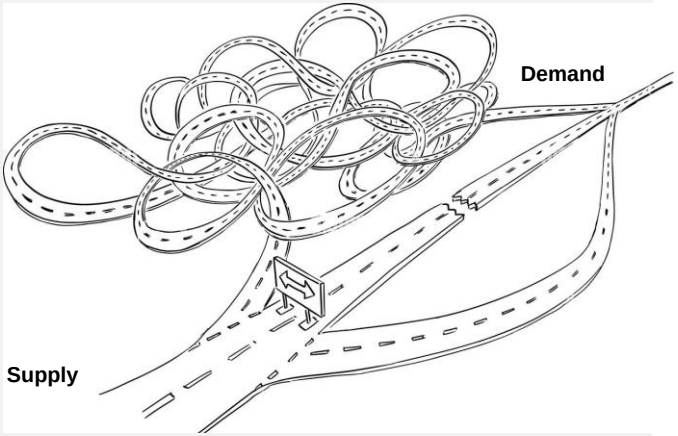
BuildUPspeed

Coordinator: Huygen IA
Duration: 2022 -2024
Funding: LIFE 2M.

Website: www.buildupspeed.eu



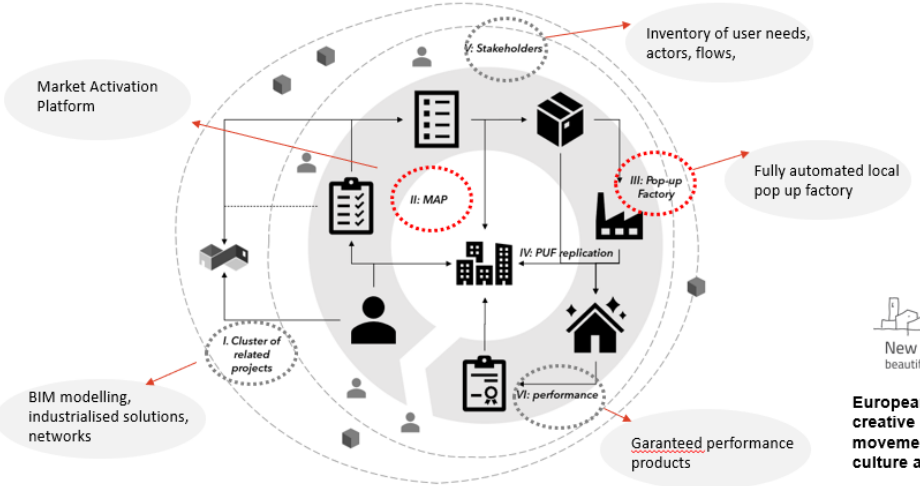
Why: BuildUPspeed aims to contribute to the decarbonization of the EU building stock and to **accelerate deep renovation processes** by fostering a market uptake of valuable key results of:

a) Recent European projects on industrialized renovation, **enhancing a people and context -centred renovation process at a local and pan-EU level**.

b) The approach and legacy of several chapters of the **'Energiesprong'**

How: BuildUPspeed will develop and **implement digital and physical Retrofitting Market Activation** Platforms and will validate them on a national MS level in five Pilot Markets and pop-up Factories, representative of singular social-geographical-economical-policy ecosystems in Europe with the objective for a further roll out in other MS's and at the European level

What: BuildUPspeed will achieve this by following five key pillars:



New European Bauhaus
beautiful | sustainable | together

European Bauhaus aims to be a creative and interdisciplinary movement, at the crossroads of **art, culture and science**

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Main outcomes & conclusions:

(expected outcomes as project started November 2022)

The BuildUPspeed online **Retrofitting Market Activation Platform** general viewer module with requirements, architecture and suitable technologies

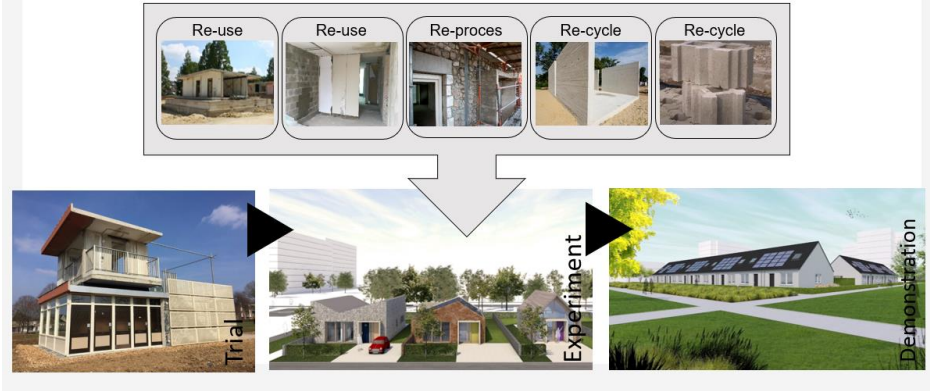
Two operational local pop-up factories and **five blueprints** for local factories in place for the BuildUPspeed countries, **three additional blueprints** for local factories in selected remote areas and a fully elaborated script how to establish local factories including blueprints and supporting activities

The BuildUPspeed approach and Market Activation Platform implemented in **5 ecosystems (France, Austria, Spainm Netherlands, Italy).**

The BuildUPspeed **go-to-market exploitation Action Plans l**ocally adapted for boosting the impact in each of the **five pilot markets** and at MS-level, including scouting, analysing and assessing innovative solutions from relevant EU projects as well as from local best practices

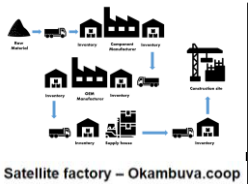
Proven approaches towards industrialization:

- Several experiments took place with pop-up factories, like in the UIA SuperLocal project, the Netherlands, but the concept is still not mainstream.



Industrialization issues to be resolved:

- Quality Control and warranties for urban mined materials
- Defining different business models for pop-up factory



INFINITE: Industrialised durable building envelope retrofitting by all-in-one interconnected technology solutions

Coordinator: Eurac Research

Duration: 2020-2025

Funding: H2020, €8M

Website:
https://infinitebuildingrenovation.eu/

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Why:

The complete decarbonisation of the buildings sector is fundamental to achieve climate neutrality in Europe. To increase the renovation rate of the building stock and meet EU objectives of deep, quality and large-scale renovation, concrete actions are needed: the industrialisation of the process is the approach that seems the most promising.

What:

INFINITE aims to increase the market penetration of industrialised all-in-one envelope systems for the nZEB building renovation (from 1st to 2nd generation of systems), with the ultimate goals of

- Demonstrating tools, techs, business to boost the adoption in real market.
- (Understanding and) showing the “where and how” Renovation4.0 can have success.

How:

- Developing design and process management tools throughout the life cycle
- Developing five all-in-one industrialised building envelope kits, designed to cover nZeb retrofit needs, with the flexibility and replicability needed to cover the redevelopment needs of the European building stock
- Digitalising the building process through the development of a BIM platform
- Testing the technologies on three real demo cases, providing stakeholders with evidence of the performance of the kits with a BMS tool
- Developing a shared framework of knowledge for the promotion of deep retrofit solutions in Europe

Main outcomes & conclusions at M30:

Stakeholders and building stock analyses driving the development process

LCA+LCC optimized kits, Design for Assembling & Disassembling principles adopted

Performance and functional mockups of industrialised multifunctional façade

BIM platform with dedicated plugins for energy, LCA-LCC, installation, O&M

“Soft developments”: network, lobbying, Observatory and Knowledge hub

Proven approaches towards industrialization :

Time and disturbance reduction

Less waste in construction site and high shares of reuse, recycle and recover during manufacturing

Distance constraints for environmental and costs impacts

Central brain for mgm and design, plus local suppliers networks are key!

Industrialization issues to be resolved:

Need to switch to an approach based not only on economic initial investment. Costs reduction ambition is critical.

Co-multiple benefits to be valorised: quality, comfort, data, …

There seems to be an optimum in the retrofit choice: how much is the deep retrofit too much?

EoL towards recycle – reuse plays a central role

Transport bottleneck

New value chain still sub optimal.. Missing a real system integrator and “industrialised design specialist”

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PLUG-AND-USE RENOVATION WITH ADAPTABLE LIGHTWEIGHT SYSTEMS

Coordinator: National Technical University of Athens, Greece
Maria Founti, Coordinator
Duration: 2020 -2024
Funding: H2020
Website: www.plural-renovation.eu

Why: PLURAL aims to design, validate and demonstrate a palette of versatile, adaptable, scalable, off-site prefabricated Plug-and-Use (PnU) kits. It targets:

a) Near zero energy consumption of buildings renovated with PnU kits
b) Cost-effective renovation
c) Fast-track renovation
d) Environmentally-friendlier deep renovation
e) Flexibility – Adaptability

How: The **PnU kits** integrate various renewable energy technologies in prefabricated façade components. PLURAL optimizes their performance for different building types, climates and socio-economic conditions and demonstrates the integration of hybrid passive and active systems into one kit and their ability to work together in synergy for façade retrofitting, reaching NZEB.

What:

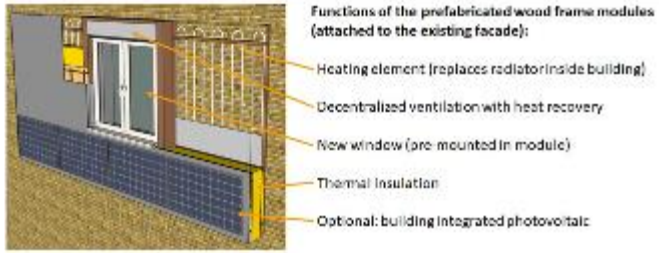
- Three PnU kits: the **SmartWall, the ConExWall**(external Wall Heating and Cooling kit) and the **DENcomfort with eAHC** (external Advanced Heat and Cool recovery kit)
- Six demonstration sites implementing the PnU kits (3 real and 3 virtual) Three real sites: in Greece, Spain and the Czech Republic, featuring different climate conditions, heating/cooling needs and user requirements
- Enhancement of occupant satisfaction via a **user centric approach** that implements learning based control methods and strategies.
- A **Building Information Modelling** (BIM) based **data handling platform** and a **Decision Support Tool** (DST) are developed to enable the optimal component selection, and integration, best PnU kit design, faster and low-cost manufacturing and installation.
- PLURAL focuses on how to manufacture the PnU kits minimizing energy use and material waste (implementing **lean manufacturing principles-F.Q.Ps**).
- Develops **training tools** for main stakeholders (planners, installers, building owners and end users);
- Improves the **life cycle based (LCA, LCC) performance standards** applied in the building sector.

Main outcomes & conclusions:

Functions of SmartWall (AMS)

- Versatile prefabricated panel developed by AMS that can be installed externally or internally to an existing building façade.
- It consists of a metal or other material frame, insulation materials, gypsum/cement boards for covering and various types of coatings for finishing and rendering.
- Depending on the position and the existing wall that is going to be attached, the SmartWall may include a window, or door with a shutter or blind.
- SmartWall also can feature a big variety of electro-mechanical equipment to cover any demand of the building renovated.
- This includes space in the panel for a heating/cooling unit that can be diversified depending on the application or the renovation scheme.

Functions of the ConExWall (SPF)



The aBAC prototype

The UBEcomfort Wall prototype (DeltaVELUX)

Proven approaches towards industrialization:

- LEAN manufacturing of off-site prefabricated hybrid (including active and passive systems) façade kits.
- By using the LEAN management system, a toolbox of interactive looping actions is created among different tasks of the manufacturing process where the outcome of each task is developed, evaluated, corrected (if necessary), redesigned and redeveloped in a constant loop.
- Performance and efficiency of the manufacturing process is constantly under control, while at each looping action is optimized; gradually becomes more efficient / productive.
- The implementation of the LEAN manufacturing methodology for the PnU kits can reduce investment, time and effort leading to significant overall reduction in time and cost for prefabrication, this justifying its choice.

Industrialization issues to be resolved:

- PnU kit design and RES need to be adapted to building characteristics
- Industrialization, component integration as part of the manufacturing: new business models
- Lack of regulatory framework for active building façade components
- Acceptance (industrial, end-user and social): Restricted due to lack of large-scale demonstrations, long-term performance evaluation, harmonized standards, economies of scale to reduce costs

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ENvelope meSh aNd digitAl framework for building REnovation

Coordinator: TECNALIA R&I
Consortium: 19 partners
Duration: 2020 -2025 – 49 Months
Funding: H2020, 10.17 M€
Website: www.ensnare.eu

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Why: The main goal is to **boost the implementation of NZEB renovation packages in Europe**, focused on **residential** buildings. To foster the adoption of energy efficiency systems, products and building solutions thanks to the improvement of the process and demonstrating the increase of the efficiency, habitability and performance of the European building stock and, ultimately, to promote the integration of the main actors of the renovation sector into a common working framework.

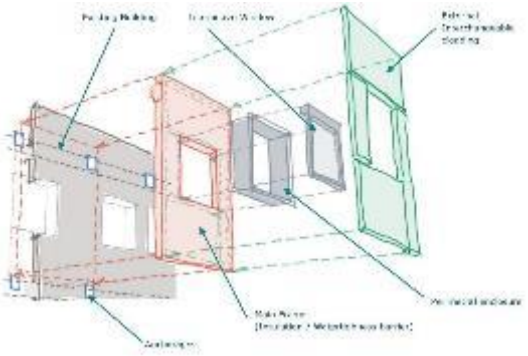
How: The overall contribution of ENSNARE is to provide a **systemic methodology** combining **products, systems and solutions** that will contribute to boost the adoption of novel and advanced technologies in **the renovation sector** looking to achieve high energy efficiency standards for buildings.

What: The project develops Two Key Structures as supporting framework:

- Modular envelope mesh facilitating mechanical assembly & interconnection, for the following products:
  1. Industrialized modular façade panels based on aluminium technology for façades.
  2. Solar façade. Integrated renewable solar systems (PV, ST, PVT).
  3. Smart window with heat recovery
  4. Energy production and storage coupled to the solar façade
- A digital platform supporting all stages of the renovation process, with the following modules:
  1. Early decision support tool
  2. Automated data acquisition tool
  3. Smart BEMS and Digital Twin

Main outcomes & conclusions:

Initial concept. Samples manufactured and tested.



Scaling up process for the demonstrating activities

… Still in progress

Proven approaches towards industrialization:

- The modular solution with high degree of adaptability can be accommodated to alternative renovation scenarios.
- The implementation of the solar technologies in the façade, requires a complete definition of the energetic network, together with the façade renovation project.
- This high degree of versatility needs to be supported by design tools that clearly determine the limits for the application of alternative technologies; constructive and energetic.
- The interconnection between stakeholders during the project's evolution (design, manufacturing, installation and operation), is key to exchange the necessary information and to assure a good coordination between different participants in the renovation activities.

Industrialization issues to be resolved

- There's no standard sufficiently developed for the solar façade concept, when integrating solar technologies.
- Lack of a long-term view in the sector where just acquisition costs are considered. LCA tools to support.
- The durability for this integrated solutions still to be further demonstrated and quantified. Also, maintenance activities differentiating technologies to be developed.
- A better deployment of the digital technologies is needed together with an increasing culture to adopt shared models to develop projects in collaboration.

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DRIVE 0 - Driving decarbonization of the EU building stock by enhancing a consumer centred and locally based circular renovation process

The project deals with the promotion of strategies for the **decarbonisation of the existing building stock** through the implementation of **deep renovation interventions**. The project aims at promoting the adoption of a **circular approach** in renovation processes that, in order to be attractive and effective, must be based on the customer's actual needs.

According to the DRIVE 0 approach, circular retrofitting is based on the use of energy from renewable sources and the use of materials from biological or technical cycles, in which waste production is minimised and **end-of-life strategies with a positive impact** on the **environment** are envisaged.

DRIVE 0
Grant agreement ID: 841850

DOI
10.3030/841850

Start date
1 October 2019

End date
31 December 2023

Funded under
SOCIETAL CHALLENGES - Secure, clean and efficient energy

Total cost
€ 4 819 143,75

EU contribution
€ 3 999 505,63

Coordinated by
Huygen Installatie Adviseurs
Netherlands

We want to **accelerate** deep **renovation** processes by enhancing a consumer centered circular renovation process in order to make deep renovation **environmentally friendly**, **cost effective** and more attractive for consumers and investors.

www.drive0.eu

SUSTAINABLE PLACES 2023

DRIVE

Main outcomes & conclusions:

- Circular product (re-)development by WEBO, Timbeco, Factory 0, ALIVA, Vision Built, Knauf Insulation
- Development of user friendly tools & methods for assessing the level of circularity and hence supporting choices in the project development:
  - EASY tool – simplified method developed for assessing the circularity level of single 2D & 3D solutions or an overall building.
  - Development of DfD tool – reference details for disassembly, method allowing assessing detachability.
  - Circular benchmarking of buildings – building environmental assessment, building circularity indicators and DfD criteria.
- The morphological design approach and guidelines for modular, circular deep-renovation approach
- Proposed circular business models for the Drive 0 companies & transition pathways analyses
- Different engagement & awareness raising tools (DIY catalogue, www.circularhomes.eu platform, Circular contest, Drive 0 board game, card game etc.)
- 7 demonstration buildings in Estonia, Greece, Ireland, Italy, the Netherlands, Slovenia, and Spain.

Proven approaches towards industrialization :

- Preconditions essential for enhancing overall quality and efficiency of industrialized projects
- Technical implementation of industrially produced shell retrofits and integrated ventilation/heating systems.
- Smaller scale single issue renovation items; e.g. window frames, heat-pumps, cavity wall insulation (all quite industrially produced. Installing still takes a lot of man-hours).

Industrialization issues to be resolved:

- Fostering transparency in procurement.
- Scaling the production of retrofits in order to make production more profitable and increase quality.
- Integrating single issue renovation items and increasing the speed of these interventions. This creates scale, which in turn, creates a higher level of industrialization.
- Creating scale in order to industrially incorporate urban mining materials in ‘new’ products aimed at renovation.
- Facilitating new organization structures for contracting industrialized renovation works (for example, direct contract between client and supplier of industrial solutions)

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StepUP: Solutions and technologies for Deep renovation processes uptake

Coordinator: Integrated Environmental Solutions LTD

Duration: 2019-2023

Funding: H2020, EU.3.3, €4M

Website: **https://www.stepup-project.eu/**

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Why:

StepUP project is developing **affordable solutions and technologies** aimed at transforming the energy renovation market and **making the decarbonisation of existing buildings a reliable, attractive and sustainable investment.**

What:

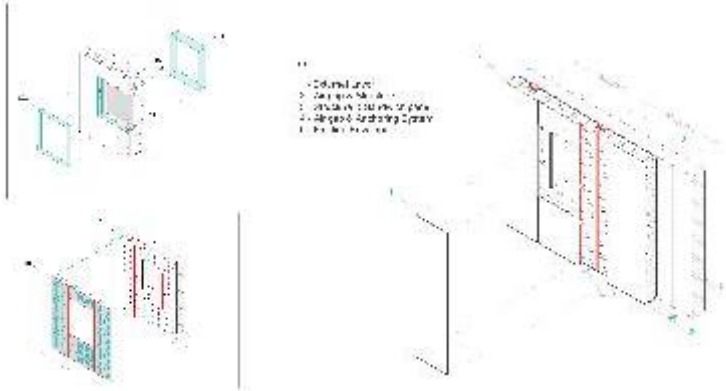
by developing a **new process for deep energy renovation** with fast design to operation feedback loops. This will **reduce the performance gap and optimize investments,** while scaling up promising **Plug&Play technologies** to minimize disruption, as well as **maximizing impact on energy, costs, and user comfort**.

How:

- **Making renovation more attractive and reliable** with a new methodology based on near-real time data intelligence
- **Reducing the performance gap** to 10% by developing an integrated life-cycle software platform
- **Optimising renovation investments** by developing innovative financial models
- **Minimise time on site** to 40% of current renovation onsite work by creating a market-ready modular renovation package of Plug & Play technologies
- **Accelerate the renovation market** via an interoperability protocol for renovation solutions, enabling compatibility of StepUP with third-party market products
- **Offering new Plug & Play technologies.**

Main outcomes & conclusions:

- A P&P façade compatible with existing buildings or new buildings developed by Manni Group
- Prefabricated solution with a high degree of modularity, intercompatibility and intereroperability with third party products which means versatility on the design.
- Active and passive technologies compatible with the system.



Proven approaches towards industrialization :

- A P&P system compatible with deep renovation projects with preliminary works needed.
- Easy installation and time saving.
- Improvements in Energy performance through a passive and active solutions.
- System designed to be disassembled and compatible with existing technologies in the market.

Industrialization issues to be resolved:

- Difficulties to engage third party Companies. No sharing knowledge philosophy between companies.
- Lack of qualified installers. Training is needed.
- More preliminary works needed in order to leave ready the existing building.
- Incorporation of the industry and construction company during the design phase of the project. Lack of knowledge in the designers, architects and engineers on this field.

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Switch2Save: Lightweight switchable smart solutions for energy saving large windows and glass facades

Coordinator: Fraunhofer FEP

Duration: 2019-2023

Funding: H2020, 5.5 M€

Website: https://switch2save.eu

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@Switch2Save_EU

Switch2Save

Why:

Switch2Save addresses the challenge of increased energy demand in buildings with high WWR.

Between 25 and > 60% of total energy transfer through building envelopes is driven by glass based components such as windows, glass facades and glass roofs. Buildings with high WWR can have 35% higher heating demand and increased cooling demand by a factor of 1.5 to 5: Non-residential buildings often make use of large windows or glass facades for building-functional and representative reasons. These buildings suffer the most from increased energy demand and therefore present a greater market potential.

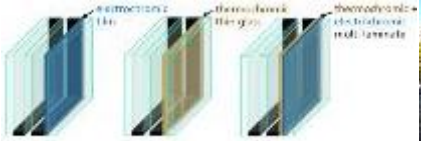
What:

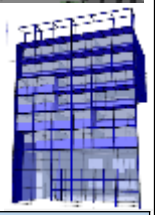
Switch2save targets **active management of radiation energy transfer** through glass-based building envelopes by integrating transparent energy smart materials with switchable total energy transmission values (g-value) (electrochromic-EC or thermo-chromic-TC systems). **Intelligent switching** of those IGUs allows significant reduction of both heating energy demand in winter and cooling energy demand in summer.

How:

- Development of lightweight combined **EC and TC smart insulating glass units** (identical in form factor to a standard IGU) which offer energy savings, low-cost potential & increased design opportunities compared to state-of-the-art smart shading solutions, enhanced occupant comfort)
- Replacement of windows and glass facades possible with the currently used techniques/ **no specific training required**
- **Demonstration and verification of the Switch2Save prototypes** in real life operational environment (office building in SE, hospital in GR, mock up building in GR)
- Modelling of the effect of Switch2save technology in **2 virtual demonstrator buildings** to ensure replicability to larger markets and multiple building types (retail building in BE, office/ education building in GR)

Main outcomes & conclusions:





Symbol	# of Panes	First Pane	Gas Fill	Middle Pane(s)	Configuration	U-value [W/(m^{2}K)]	Preliminary Payback (Years) – Virtual Retail Building (BE)
T0	Triple	Reference case			4 mm Low-E Glass - 18 mm Argon - 4 mm Clear Glass - 18 mm Argon - 4 mm Low-E Glass - Interior shade	0.55	3,38
T1	Triple	EC	18 mm Argon (95 % filling)	Low-E glass 4 mm	EC - 18 mm Argon - 4 mm Low-E Glass - 18 mm Argon - 4 mm Low-E Glass	0.54	10,57
T2	Triple	EC	12 mm Krypton (95 % filling)	Low-E glass 4 mm	EC - 12 mm Krypton - 4 mm Low-E Glass - 12 mm Krypton - 4 mm Low-E Glass	0.49	11,13
Q1	Quadruple	EC	20 mm Argon (95 % filling)	Low-E glass 4 mm	EC - 20 mm Argon - 4 mm Low-E Glass - 20 mm Argon - 4 mm Low-E Glass - 20 mm Argon - 4 mm Low-E Glass	0.35	13,28
Q2	Quadruple	EC	14 mm Krypton (95 % filling)	Low-E glass 4 mm	EC - 14 mm Krypton - 4 mm Low-E Glass - 14 mm Krypton - 4 mm Low-E Glass - 14 mm Krypton - 4 mm Low-E Glass	0.31	13,81
Q3	Quadruple	EC	14 mm Krypton (95 % filling)	Heat mirror PET	EC - 14 mm Krypton - HM PET - 14 mm Krypton - HM PET - 14 mm Krypton - 4 mm Low-E Glass	0.37	14,36
Q4	Quadruple	EC-TC	14 mm Krypton (95 % filling)	Low-E glass 4 mm	EC-TC - 14 mm Krypton - 4 mm Low-E Glass - 14 mm Krypton - 4 mm Low-E Glass - 14 mm Krypton - 4 mm Low-E Glass	0.31	15,50
			14 mm		EC-TC - 14 mm Krypton - HM PET - 14		

Proven approaches towards industrialization :

- Highly efficient technology: Proved energy savings of 10-35%
- Low disruption/ Easily integrated technology: When it comes to renovation of old windows and the window already has an IGU it is possible to remove and replace the old IGU with the Switch2save solution, placing the control system in a small box on the window frame. Depending on the type of window frame used, this may be a more cost effective way than replacing the whole window.
- Offering flexibility/ adaptability when it comes to control systems: The glazing can be controlled in a variety of ways, including integrating it into the building energy management system. Switch2save does neither alter the construction of the walls, nor the windows themselves
- Contribution to the development of ISO 18543, informing durability testing requirements

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Industrialization issues to be resolved:

- How to “monetize” co-benefits arising from the use of S2S technologies (increased occupant comfort→ increased productivity, health & well-being, reduction of absenteeism…)
- Achieving reduced production costs: How to reach economy of scale, which would require large production volumes
- Certification needs
- Standardization of testing methods: e.g. long term durability testing, fire testing etc
- Coating processes need further development and testing to ensure high quality of end product
- Development and testing of new IGU configurations in real environments
- Break down of the value chain: need for further harmonisation of the activities of the value chain to reduce production time and production failures
- Address end users’ mistrust on lifetime, maintenance requirements and durability: Reference installations (real scale demos) are needed to build confidence

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KEYNOTE - 50 shades of industrialization

John van Oorschot

June 14, 2023 - Madrid, Spain

sustainableplaces.eu

R2M RESEARCH TO MARKET SOLUTION

POLITÉCNICA

About industrialization in construction

- Industrial (house)building aims at raising efficiency, customization and sustainability by rationalizing the construction process through the adoption of production technologies and methods found in highly industrialized mass-production industries

- **Industrial housing system (IHS):** the application of mass-customization principles to construct or renovate housing

- IHS involve on- and off-site production methodologies within a controlled environment, and delivered through a well-coordinated integrated system
- IHS combine an efficient on-site method [to construct the load-bearing system] with a growing number of add-on prefabricated elements as a result of increased prefabrication and variation

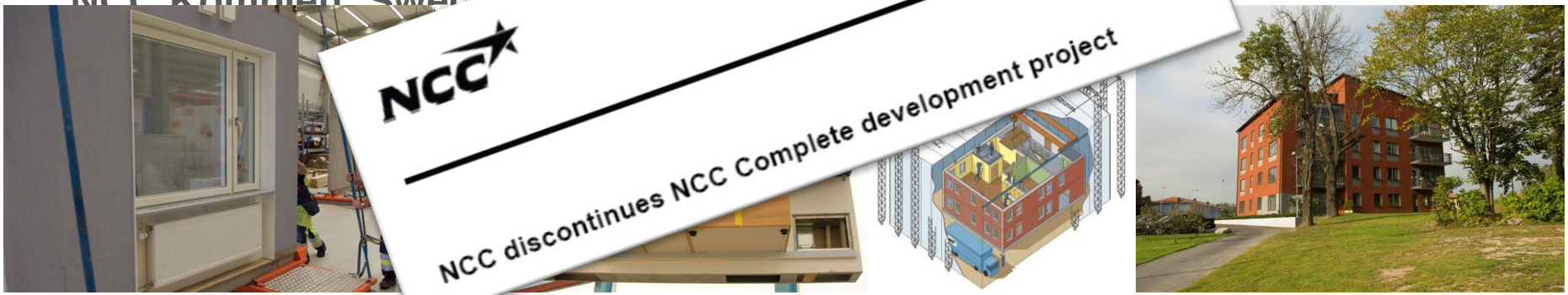
Van Oorschot, J. A. W. H., Halman, J. I. M., & Hofman, E. (2019). The continued adoption of housing systems in the Netherlands: A multiple case study. *J. Constr. Eng. Manag. Innov*, *2*, 167-190.

About industrialization in construction

However,

Despite the reported benefits, many industrial ho[illegible]s are hardly applied beyond their demonstration s[illegible]f subsequent projects: **the hi[illegible]of failures**

NCC Komplett, Swed[illegible]



PRESS RELEASE
from NCC

2007-11-22
No 59/07

NCC

NCC discontinues NCC Complete development project

Source: http://www.ncc.se; husfa468.jpg (468×527) (wordpress.com)

About industrialization in construction

About industrialization in construction

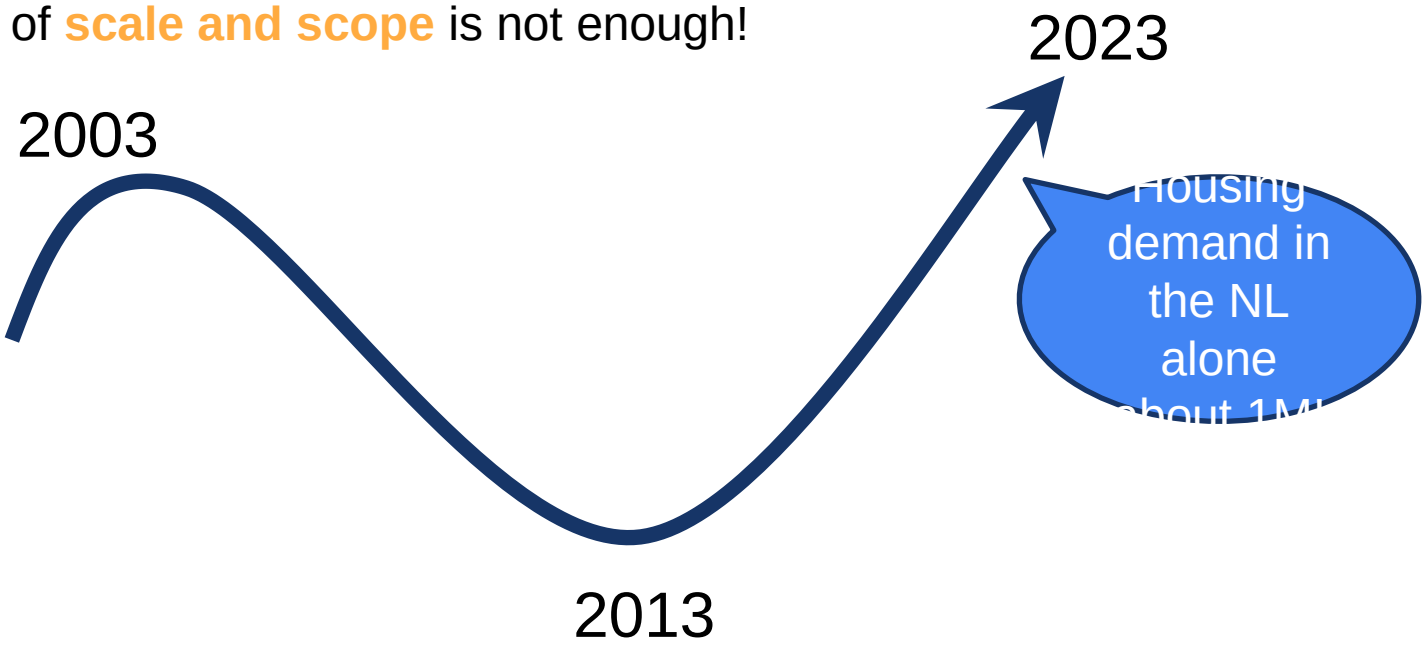
Establishing a successful IHS:

1. The first stage: A process of **product & process standardization** (1990-98)
    - A Project-Independent Coalition with Preferred Subcontractors and Suppliers
    - A Standardized Development and Production Process
    - A Stable Production Team in Terms of Composition and Members
    - A Well-Considered Balance between Regionally and Centrally Directed Activities
2. The second stage: **Standardized variety** (1998-2008)
3. The third stage: **Differentiation** (since 2008)
4. The fourth stage: **Service orientation**

Van Oorschot, J. A. W. H., Halman, J. I. M., & Hofman, E. (2019). The continued adoption of housing systems in the Netherlands: A multiple case study. *J. Constr. Eng. Manag. Innov*, *2*, 167-190.

About industrialization in construction

The promise of **scale and scope** is not enough!



About industrialization in construction

Preconditions to establish a successful IHS:

1. **Evolutionary** process (in contrast to revolutionary!) to establish both market and industry maturity → from a focus on standardization, to standardized variety, to differentiation, towards the inclusion of a service orientation.
2. Adherence to the principles of a **territorial (local) economy**
3. **Coherent organization and management** of the successive stages in a housebuilding process: a well-coordinated planning and control is needed that integrates the interrelated processes of design, manufacturing, (on-site) assembly and other related processes such as procurement, sales and marketing
4. Importance of maintaining a **cost leadership** position in the market and to keep pace with **changing market** requirements by further improving and developing the existing housing system;

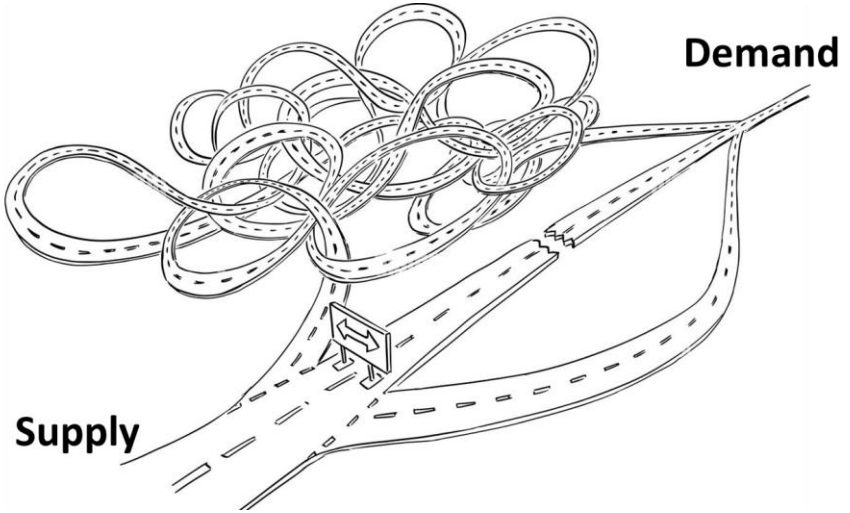
Van Oorschot, J. A. W. H., Halman, J. I. M., & Hofman, E. (2019). The continued adoption of housing systems in the Netherlands: A multiple case study. *J. Constr. Eng. Manag. Innov*, *2*, 167-190.

About industrialization in construction

Industrialization & deep-renovation

Local pop-up factory concept

A factory in the district itself for the time of the district retrofitting program. The factory will produce and assemble industrialized prefab building components that will be installed in the deep-renovation projects.

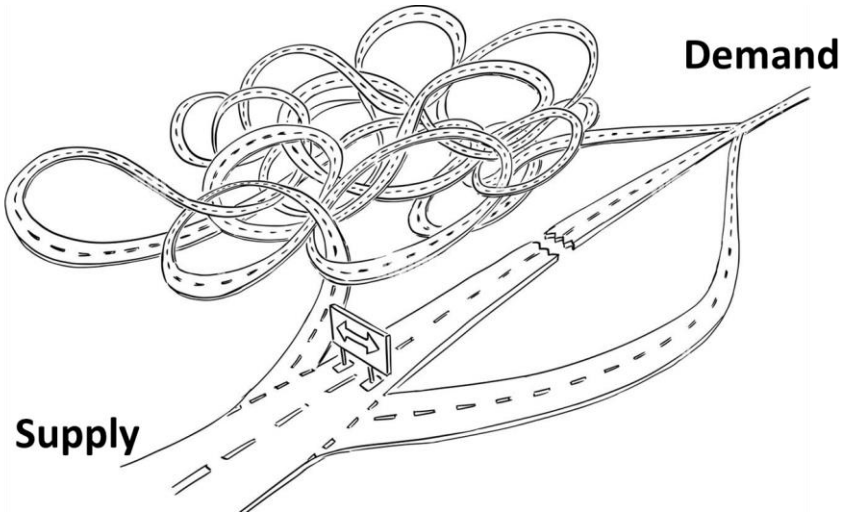


About industrialization in construction

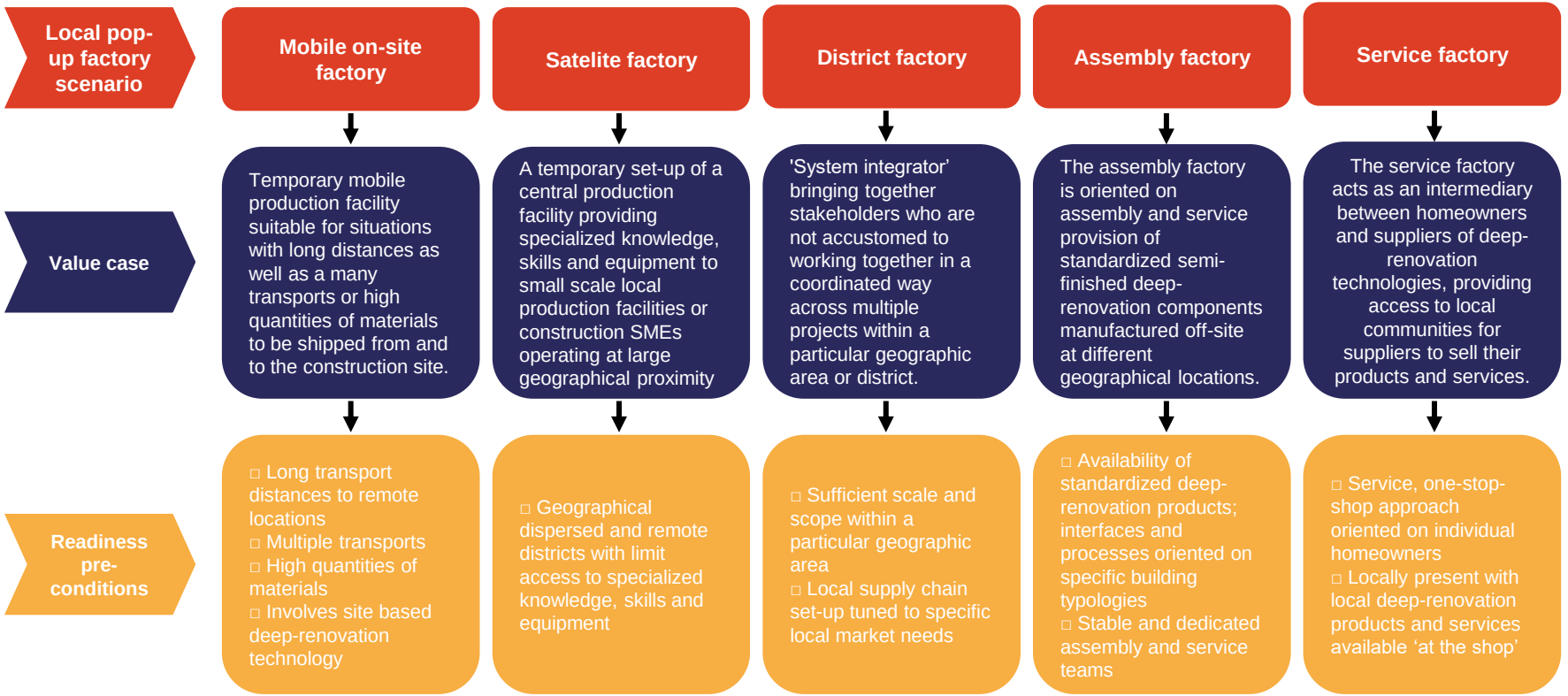
Industrialization & deep-renovation

Local pop-up factory concept

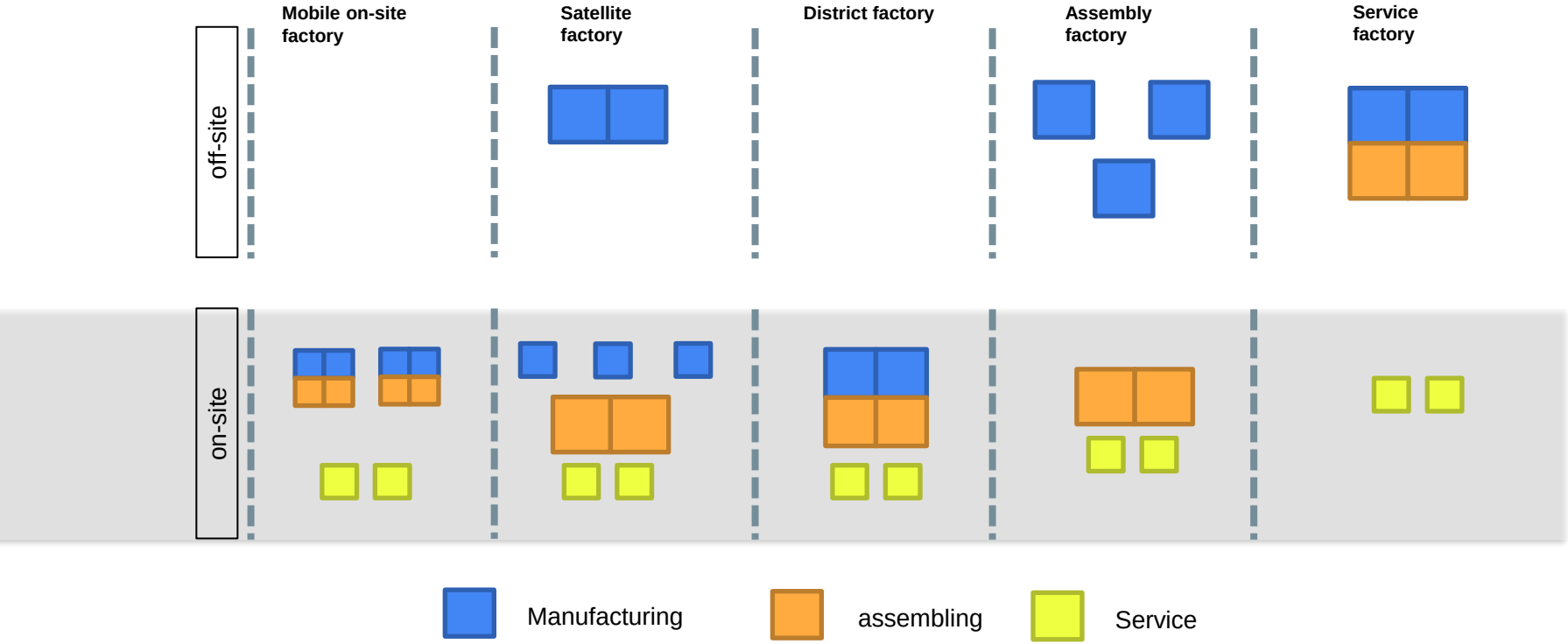
- Implementation and the success of this concept highly depends on the **maturity** and the **readiness** of the local or even national markets.
- The implementation can differ in **a wide range, from pop-up services to fully operational pop-up factories**.



About industrialization in construction

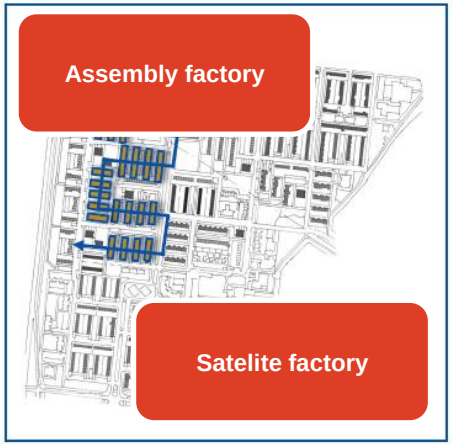


About industrialization in construction



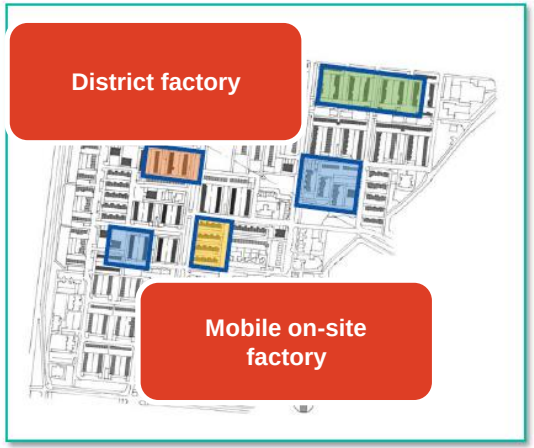
About industrialization in construction

A. COLLECTIVE PURCHASE OFFER



Ideal for collective purchasing, but the ambition of these single measures is not focused far enough on goals set in 2030-2050.

B. COLLECTIVE DEVELOPMENT DEMAND-OFFER

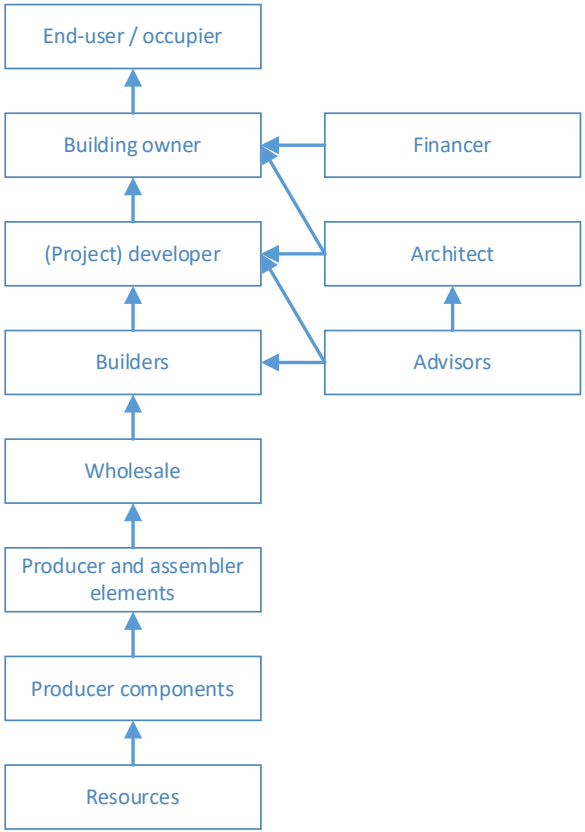


Ideal for a clear collective demand from market parties based on repeatable solutions, making it interesting for (local) entrepreneurs to start making private home-owners in the same neighborhood more sustainable.

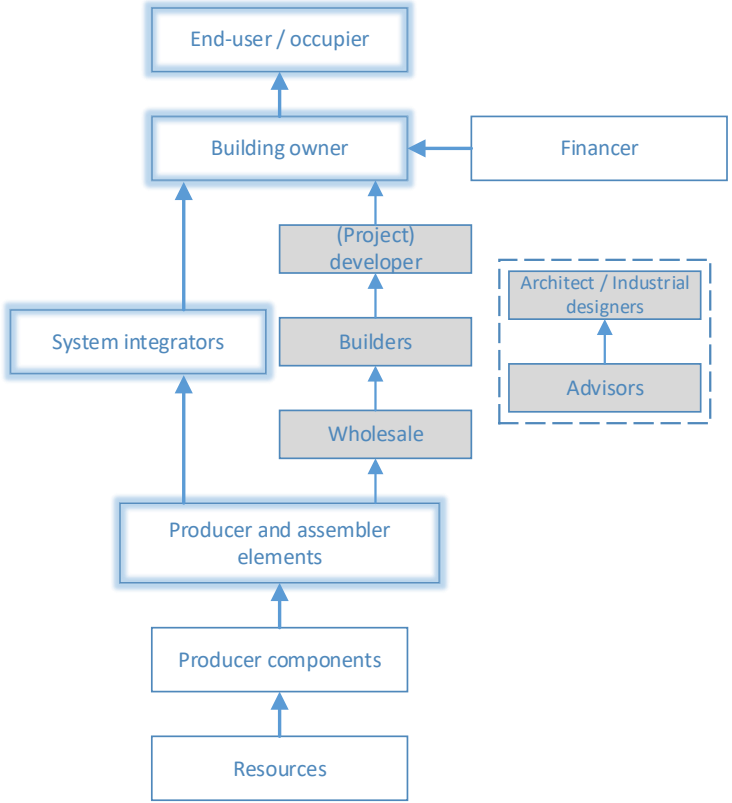
C. INDIVIDUAL PURCHASE DEMAND

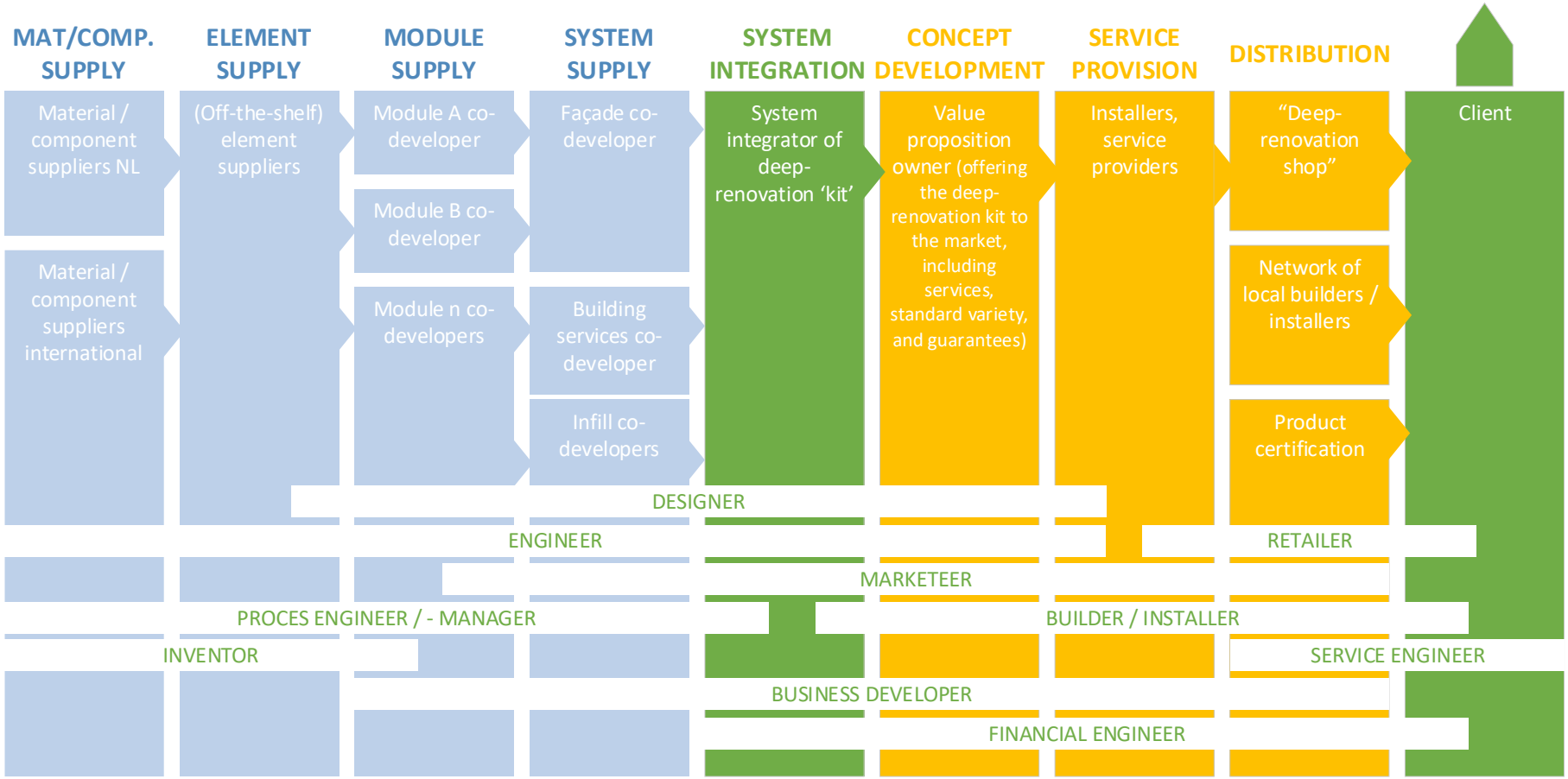
Ideal for the individual home owner, but costs a lot of capacity from market parties (high risk and, low earnings).

Traditional Supply Chain Set-up



Impact of modularity on the traditional supply chain




MAT/COMP. SUPPLY
ELEMENT SUPPLY
MODULE SUPPLY
SYSTEM SUPPLY
SYSTEM INTEGRATION
CONCEPT DEVELOPMENT
SERVICE PROVISION
DISTRIBUTION
Material / component suppliers NL
Material / component suppliers international
(Off-the-shelf) element suppliers
Module A co-developer
Module B co-developer
Module n co-developers
Façade co-developer
Building services co-developer
Infill co-developers
System integrator of deep-renovation 'kit'
Value proposition owner (offering the deep-renovation kit to the market, including services, standard variety, and guarantees)
Installers, service providers
"Deep-renovation shop"
Network of local builders / installers
Product certification
Client
DESIGNER
ENGINEER
MARKETEER
PROCES ENGINEER / - MANAGER
INVENTOR
BUSINESS DEVELOPER
FINANCIAL ENGINEER
RETAILER
BUILDER / INSTALLER
SERVICE ENGINEER

About industrialization in construction

1. **Megatrend Sustainability:** reduction of transport and therefore CO2 emissions
2. **Rising logistics costs:** reduce physical transports
3. **Individuality and mass customization:** individual products
4. **Democratization of Design and Open Innovation:** Involvement of the customer in product development
5. **Proximity to the market and point of consumption:** Just-In-Time delivery and shorter delivery times
6. **Production at the place of critical resources:** e.g. raw materials or highly qualified human resources
7. **Regionalism and authenticity:** Authenticity in special cases

SUSTAINABLE PLACES 2023

Thank you!

Like to discuss further? Feel free to contact me:

john.vanoorschot@zuyd.nl

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R2M RESEARCH TO MARKET SOLUTION

POLITÉCNICA

Structure of the workshop

Round table session 1:

- Step 1 [10min]: collecting the barriers to industrialization in the deep-renovation market (**red post-its**)
- Step 2 [5min]: order the barriers by putting them in categories.
- Step 3 [5min]: every participant is asked to select the top 3 most important barriers by putting a small sticker on the corresponding post-its.
- Step 4 [15min]: discussion of answers/roundtable

Structure of the workshop

Round table session 2:

- Step 1 [10min]: collecting the preconditions for industrialization in the deep-renovation market (**green post-its**)
- Step 2 [5min]: order the preconditions by putting them in categories (same set of categories as for the barriers)
- Step 3 [5min]: every participant is asked to select the top 3 most important preconditions by putting a small sticker on the corresponding post-its
- Step 4 [15min]: discussion of answers/roundtable

Type of barriers | preconditions

1. Construction proces	2. Cost / value	3. Expertise, skills & knowledge	4. Logistics & site operations
5. Regulatory / Building Code	6. Industry & market culture (client's desire, negative stigma's, unfamiliarity, lowest cost orientation)	7. Supply & procurement, also including liability, quality and certification issues	8. Other

Final remarks & Conclusions

- Wrap up on the needed steps to move beyond the 10,000 deep renovations per year; what actions must be taken?
- Next steps towards a positioning paper