

# “Towards Industrialized Zero Energy Retrofit” by a prefabricated FacadeModule

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  - PROCESS
  - PROBLEM STATEMENT
  - METHODE

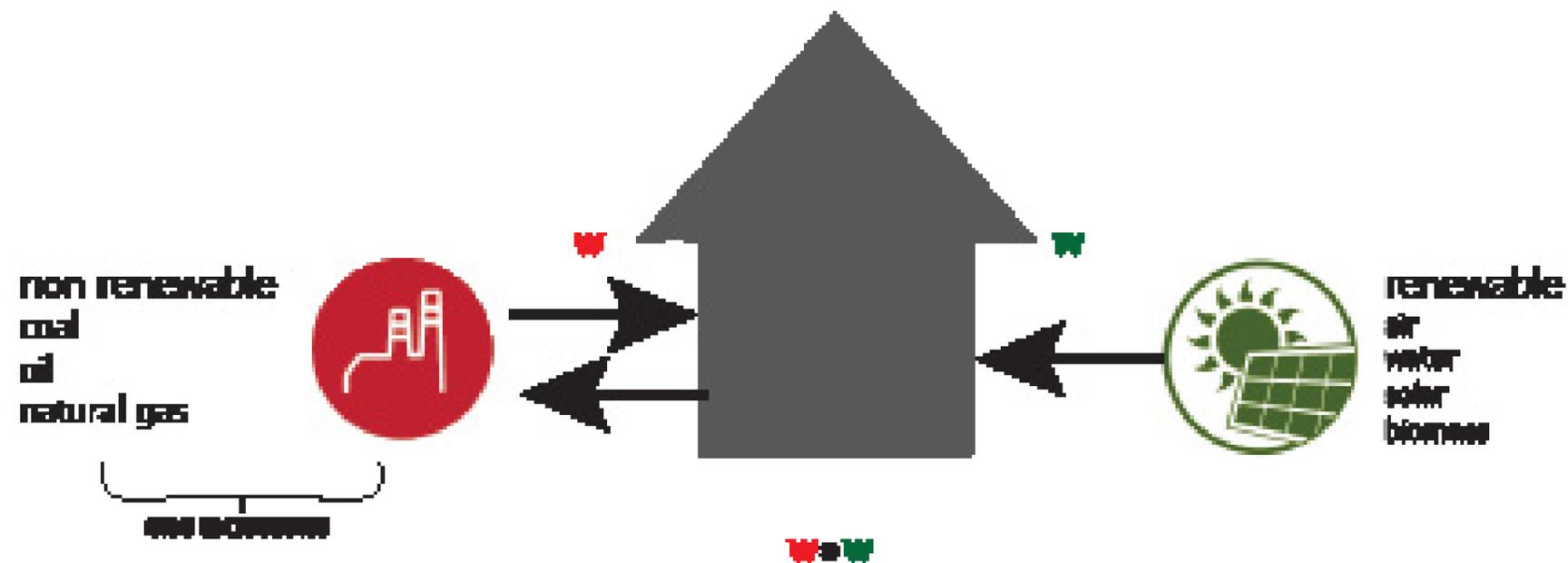
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- ANALYSIS STUDY
- INTEGRATED MULTIFUNCIONAL FACADES
  - NON-TRADITIONAL BUILDING TYPOLOGY

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- DESIGN
- DESIGN STRATEGY
  - DESIGN DEVELOPMENT
  - FINAL DESIGN

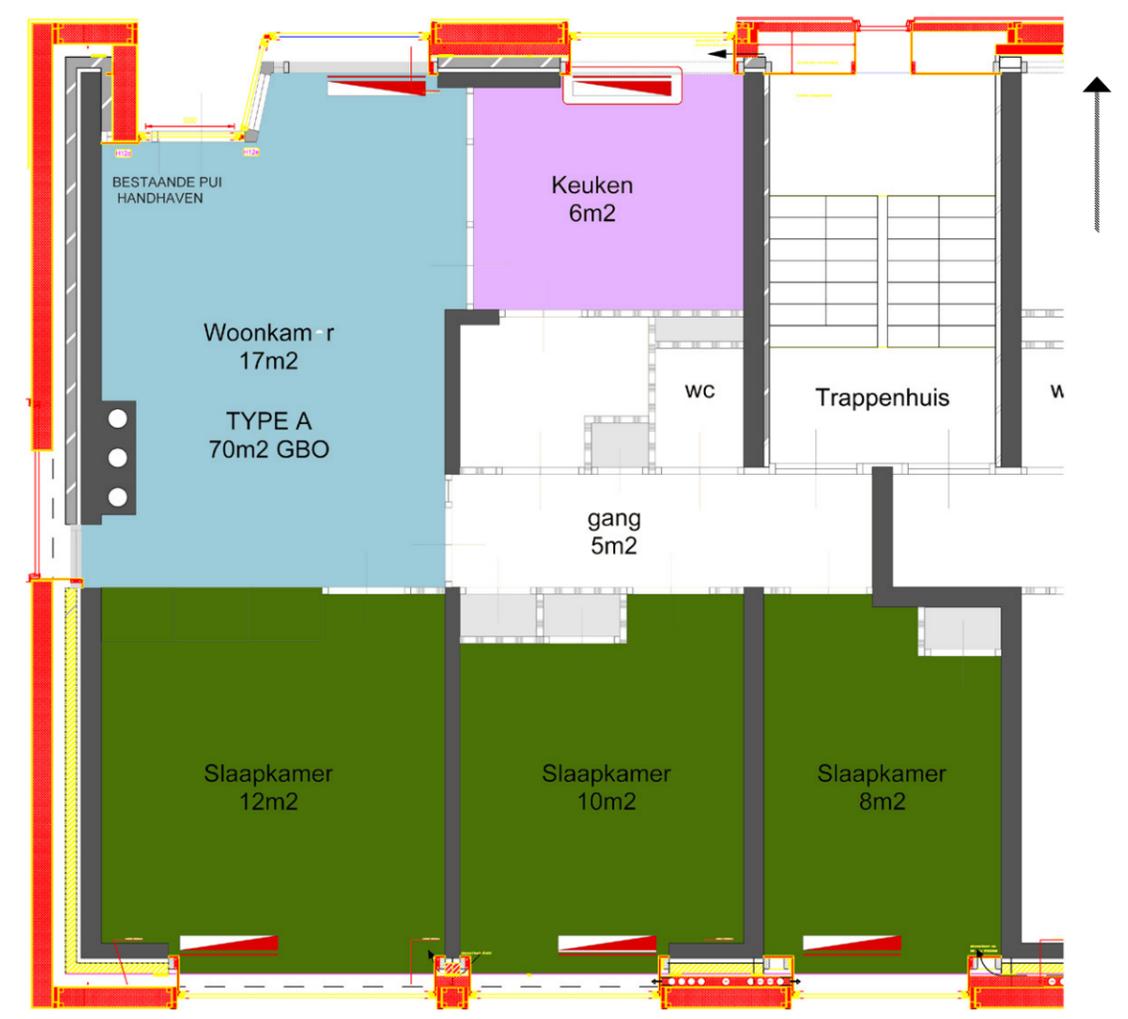
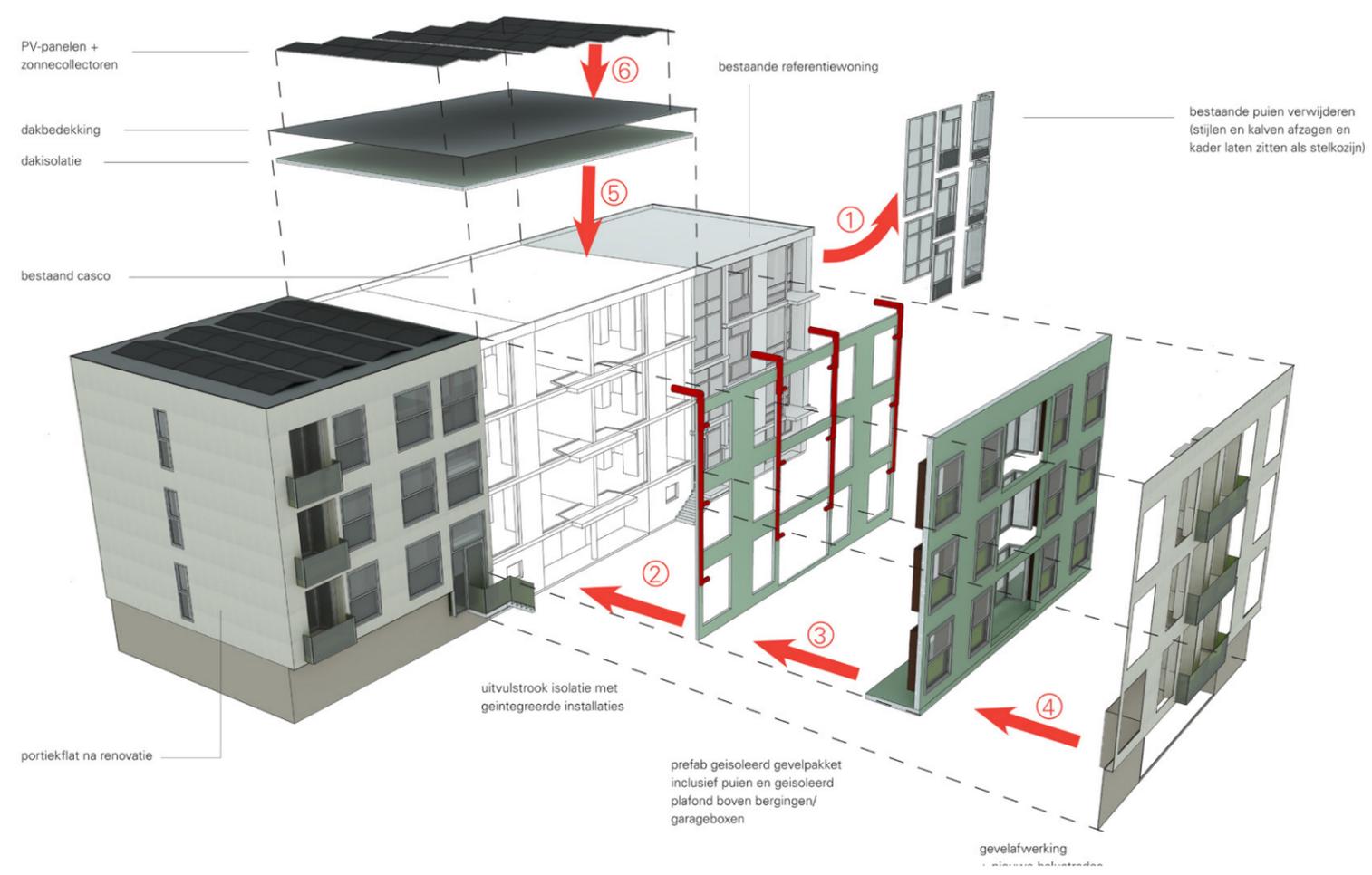
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- DISCUSSION
- EVALUATION
  - CONCLUSIONS
  - RECOMMENDATIONS

- CO2 Emissions Rising
- Buildings Biggest CO2 Consumers
- EU-GOAL 20-20-2020
- Building stock growth with 1%
- Focus on existing Building stock

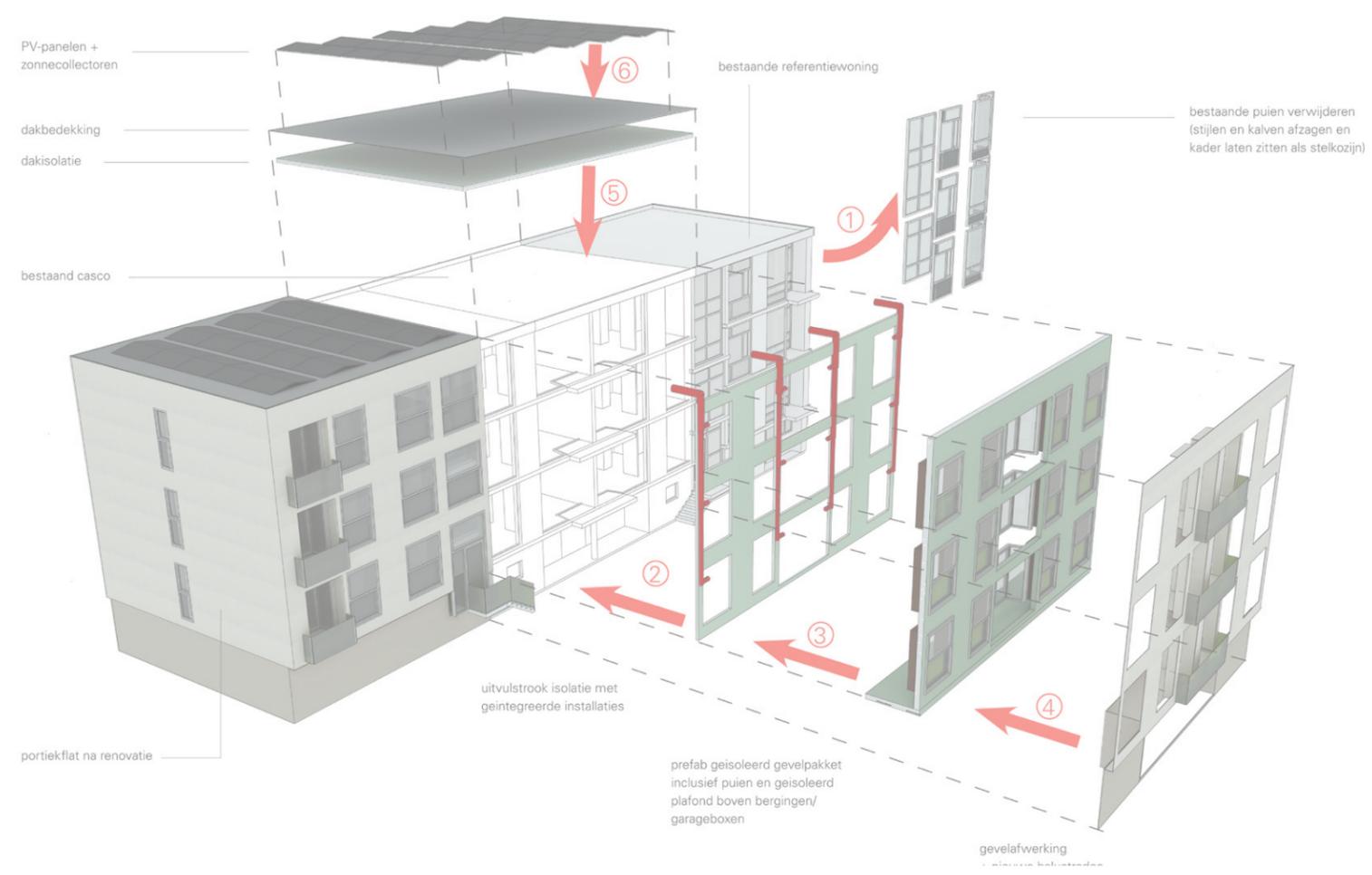
--> ZERO ENERGY REFURBISHMENT



# 2ndSkin BAM PROJECT



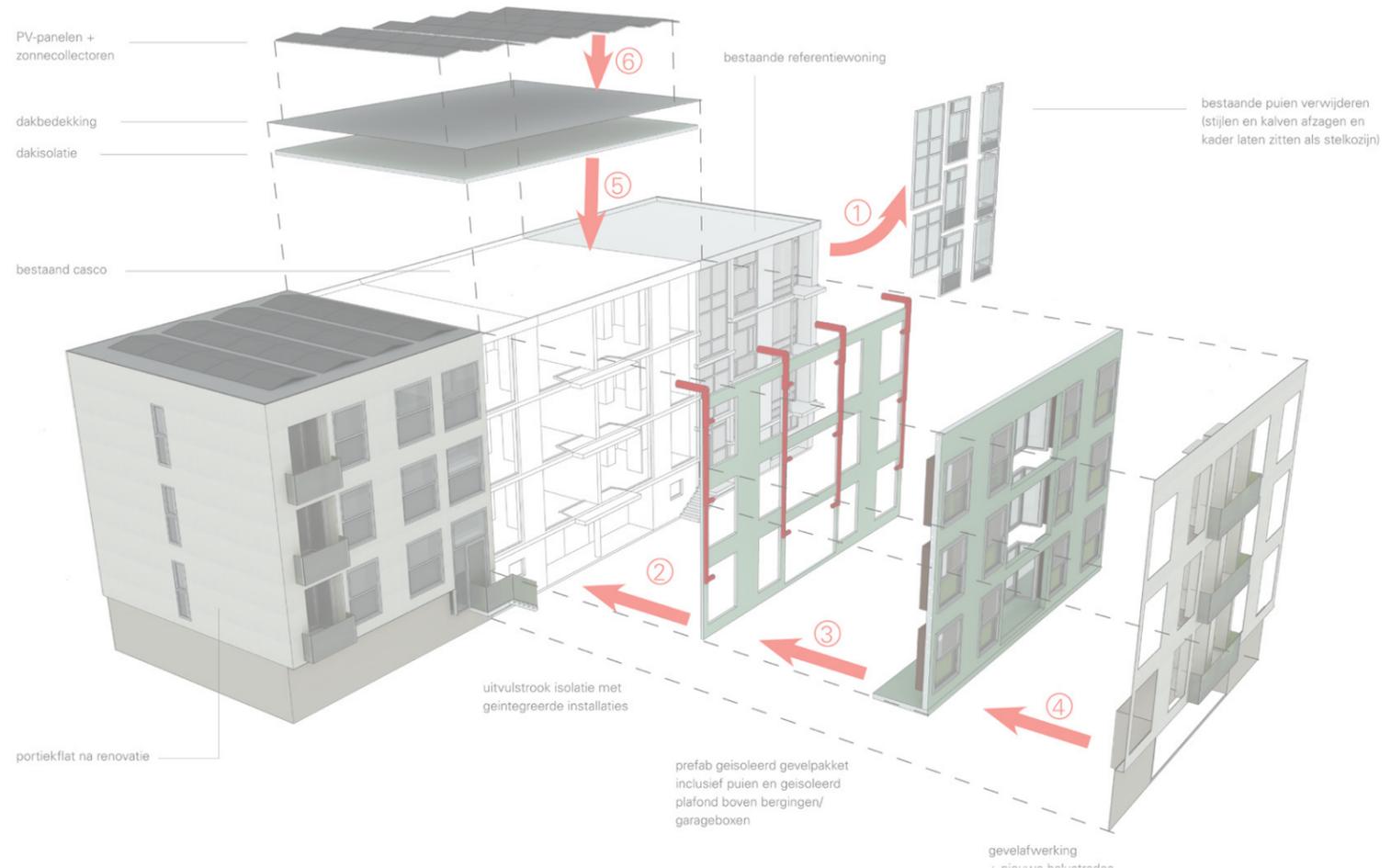
AMBITION ENERGY NEUTRAL - '0' OP DE METER || PORTIEK homes from the PERIODE 1945-1970 || INDUSTRIALISED APPROACH



AMBITION ENERGY NEUTRAL - '0' OP DE METER || PORTIEK homes from the PERIODE 1945-1970 || INDUSTRIALISED APPROACH

**INNOVATIVE APPROACH:**

OPTIMIZE THE **PREFABRICATION & ASSEMBLY** OF A **INTEGRATED** BUILDING ENVELOPE THAT CONTAINS PARTS OF THE **BUILDING SERVICES**, SUCH AS VENTILATION DUCTS.



AMBITION ENERGY NEUTRAL - '0' OP DE METER || PORTIEK homes from the PERIODE 1945-1970 || INDUSTRIALISED APPROACH

## INNOVATIVE APPROACH:

OPTIMIZE THE **PREFABRICATION & ASSEMBLY** OF A **INTEGRATED** BUILDING ENVELOPE THAT CONTAINS PARTS OF THE **BUILDING SERVICES**, SUCH AS VENTILATION DUCTS.

WHY?

- Minimize inconvenience to residents
- Efficiency on the building site
- Mass- implementation of concept

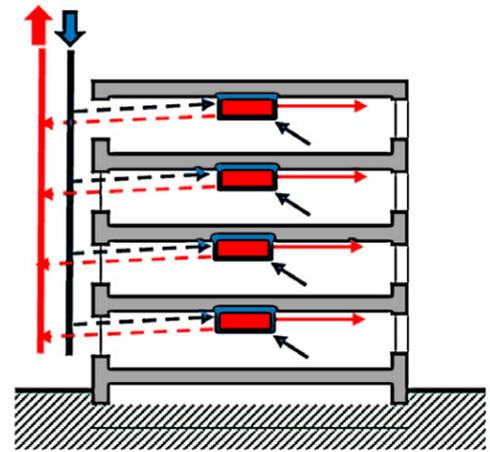
HEATING

1

GAS



VENTILATION



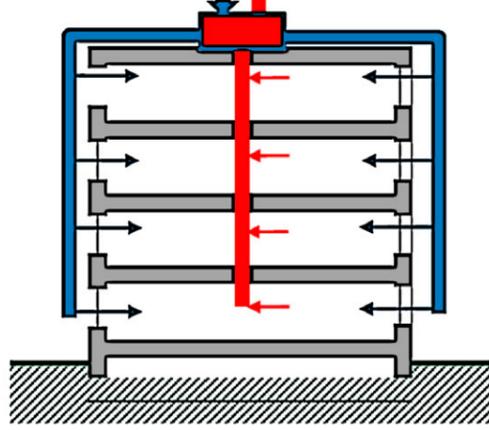
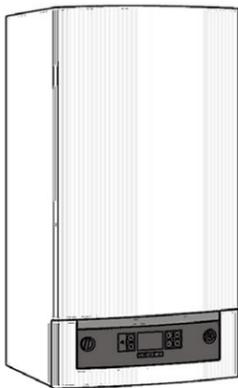
INSIDE SYSTEM



Don't meets 2ndskin requirements

2

HR - GAS & ELECTRIC



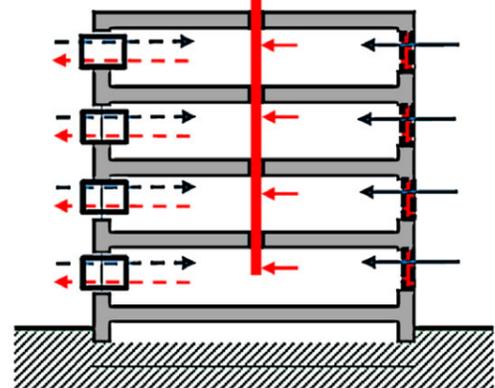
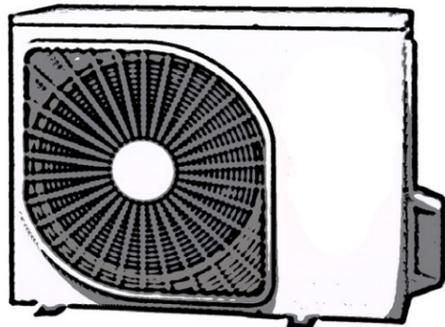
CENTRAAL VENTILATION



Current 2ndSkin Design

3

ALL ELECTRIC



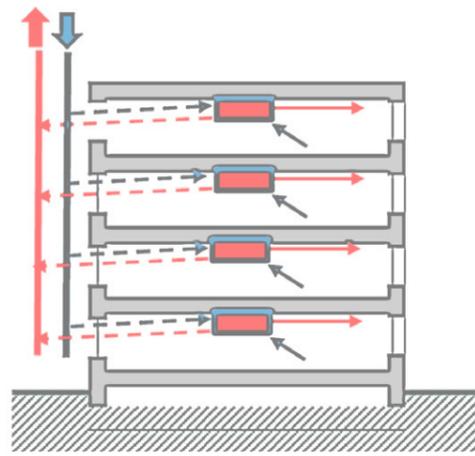
DECENTRAL VENTILATION



Next/future Design Needs investigation

1

GAS



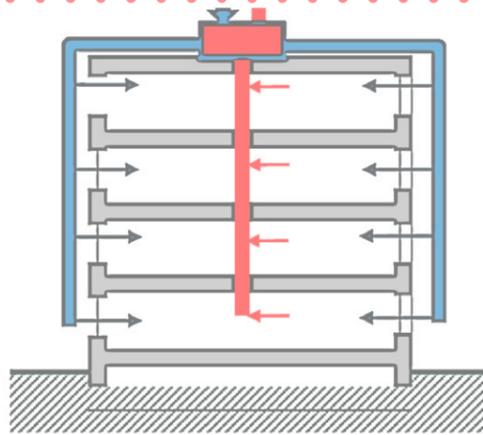
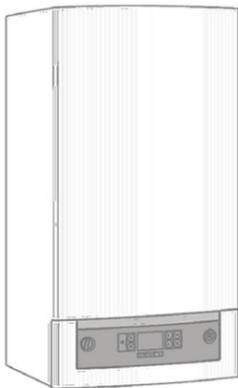
INSIDE SYSTEM



Don't meets 2ndskin requirements

2

HR - GAS & ELECTRIC



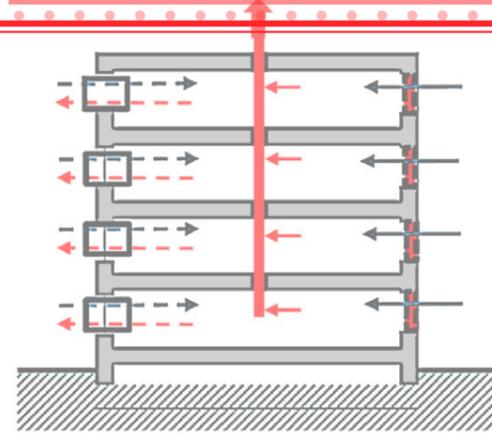
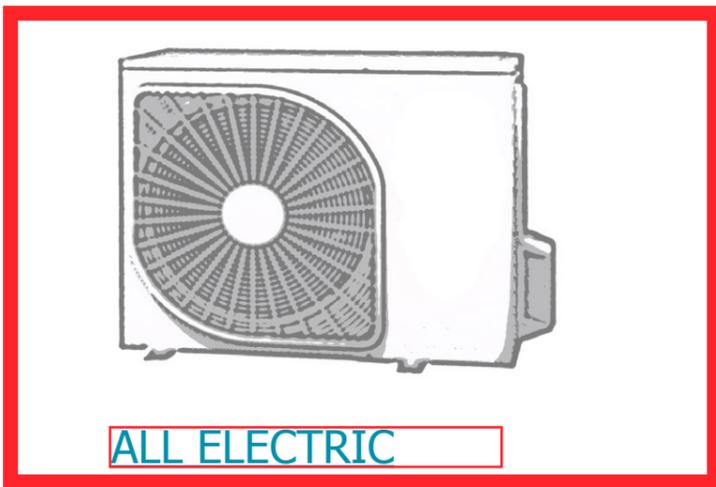
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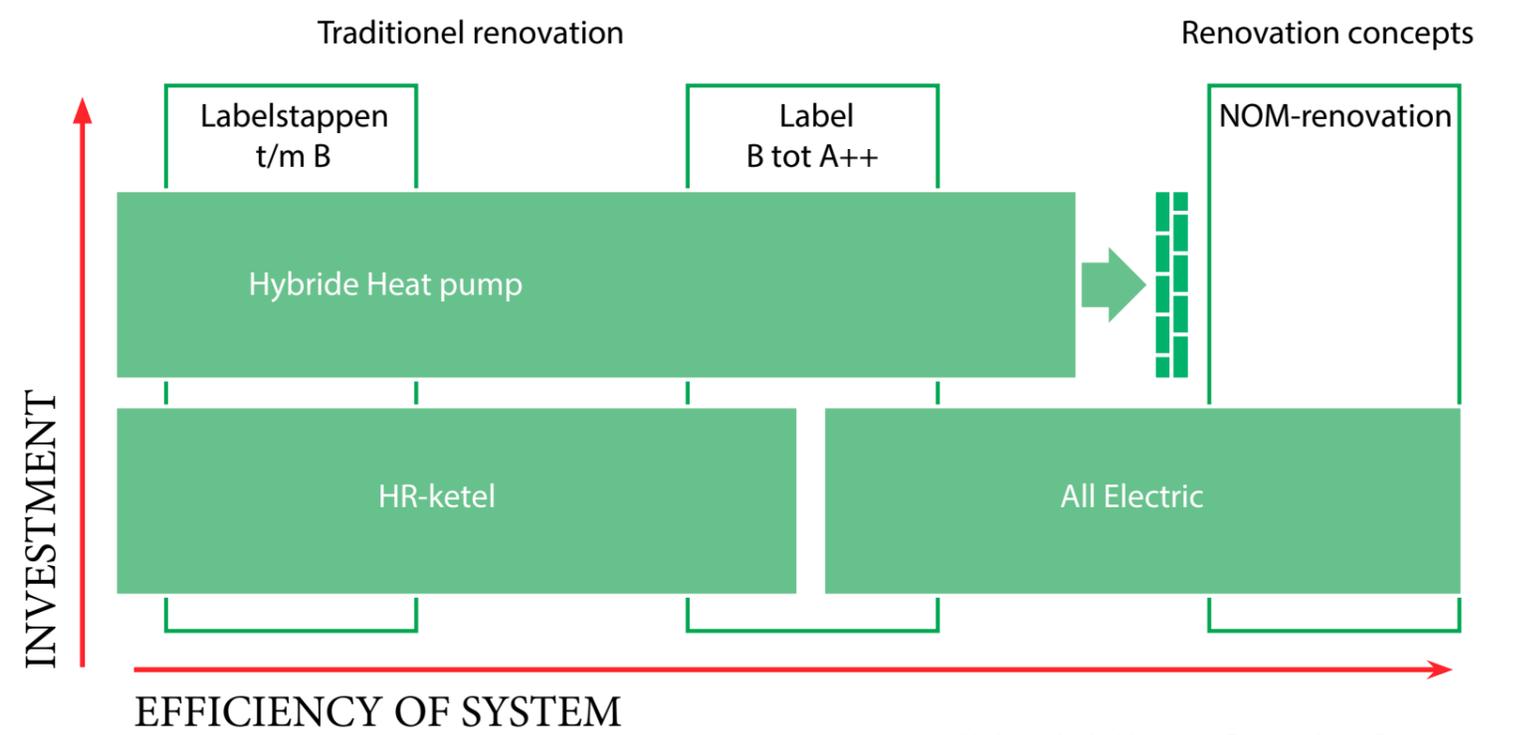
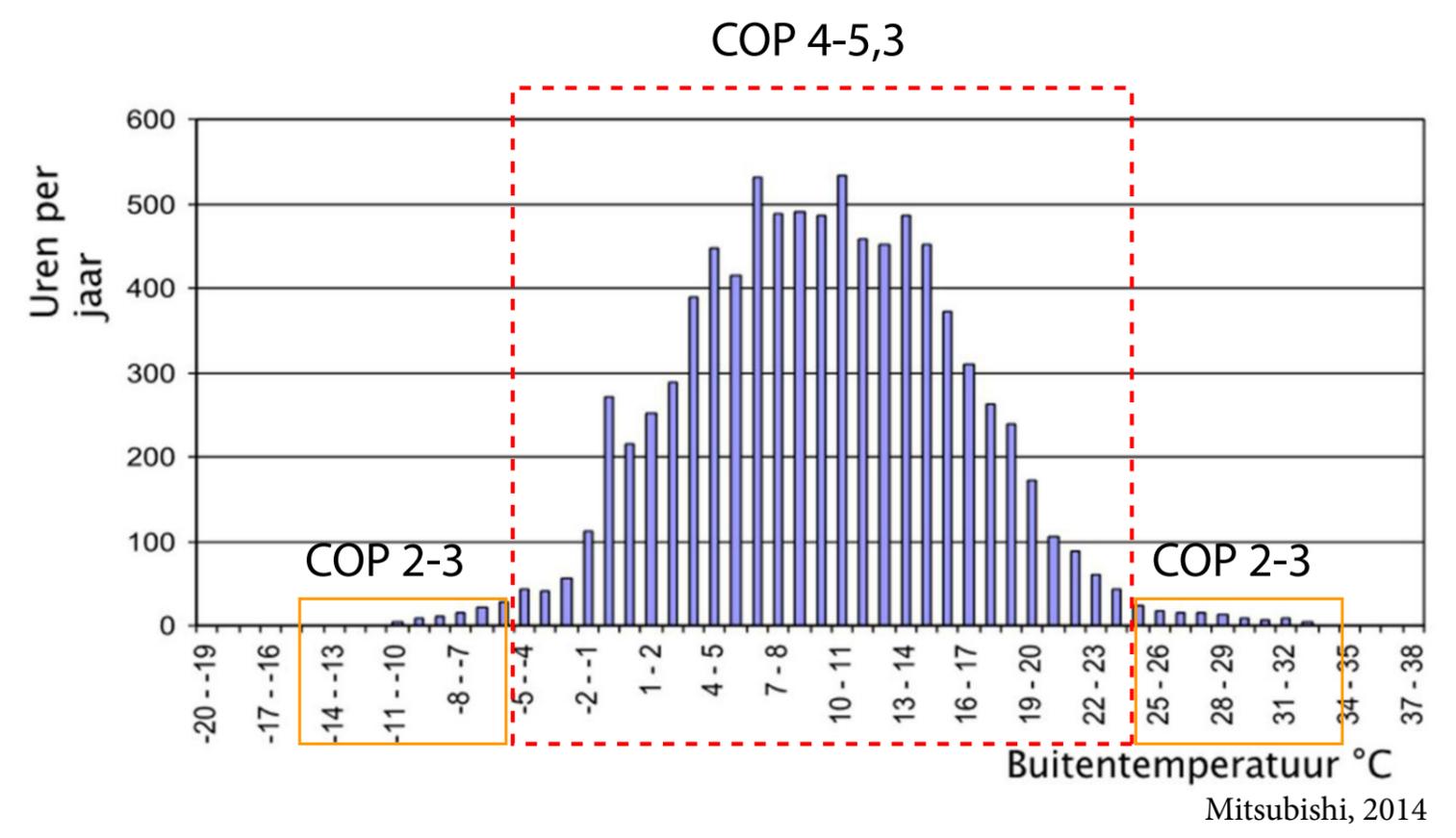
DECENTRAL VENTILATION



Next/future Design Needs investigation

- **HIGHER EPC --> 0 OR - 0,2**  
ENERGIE PRESENTATIE COFFICIENT
- **HIGHER EPV**  
ENERGIE PRESENTATIE VERGOEDING
- **HIGHEST COP OF 5,3 (KIWA)**  
COEFFICIENT OF PERFORMANCE

- **LOWER CO<sub>2</sub> --> NO GAS**
- **Fits in Dutch climate**
- **SAFETY --> GAS = 30<sup>TH</sup> death**



Universiteit Utrecht Copernicus Institute of Sustainable Development, 2015

- **HYPOTHESIS  
TOPIC/PERSPECTIVE**

*"OPTIMIZE PREFABRICATION & ASSEMBLY  
TECHNIQUE OF INTEGRATED FACADE"*



*INTEGRATION OF DECENTRAL  
VENTILATION / VENTILATION DUCTS*

- **P1 PRESENTATION**

*"WHAT FACADE AND BUILDING SERVICES  
COMBINATION CAN BE DESIGNED?"*

- **P2 PRESENTATION**

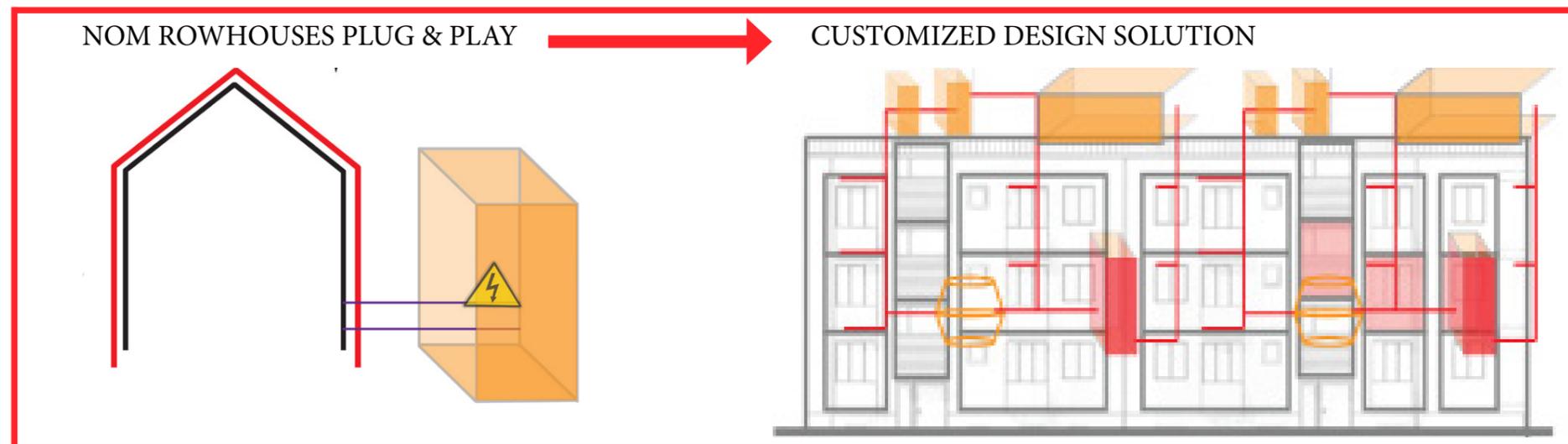
*"HOW CAN VENTILATION SYSTEM GET  
INTEGRATED IN A FACADE SYSTEM?"*

- **P3/4 PRESENTATION**

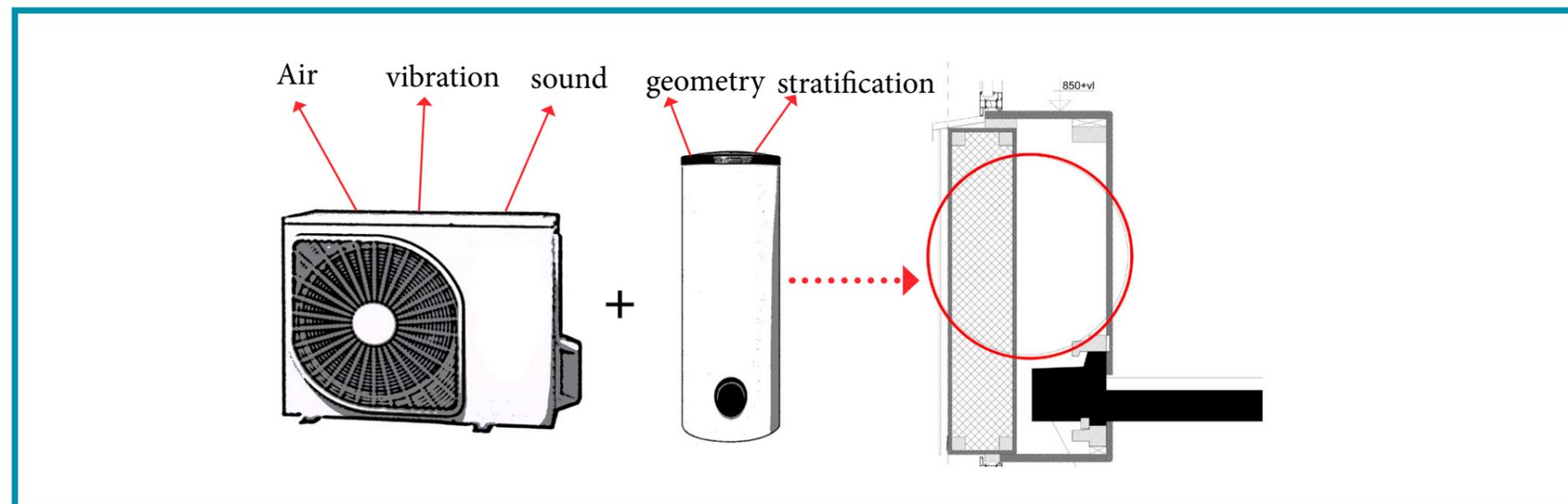
*'HOW CAN ALL ELECTRIC COMPONENT GET INTEGRATED  
IN A PREFABRICATED FACADE MODULE, TO UPGRADE THE  
BUILDING ENVELOP FOR DUCH POST-WAR APARTEMENTS  
TO MAKE THEM ZERO ENERGY (EPC "0")?'*

# PROBLEM STATEMENT

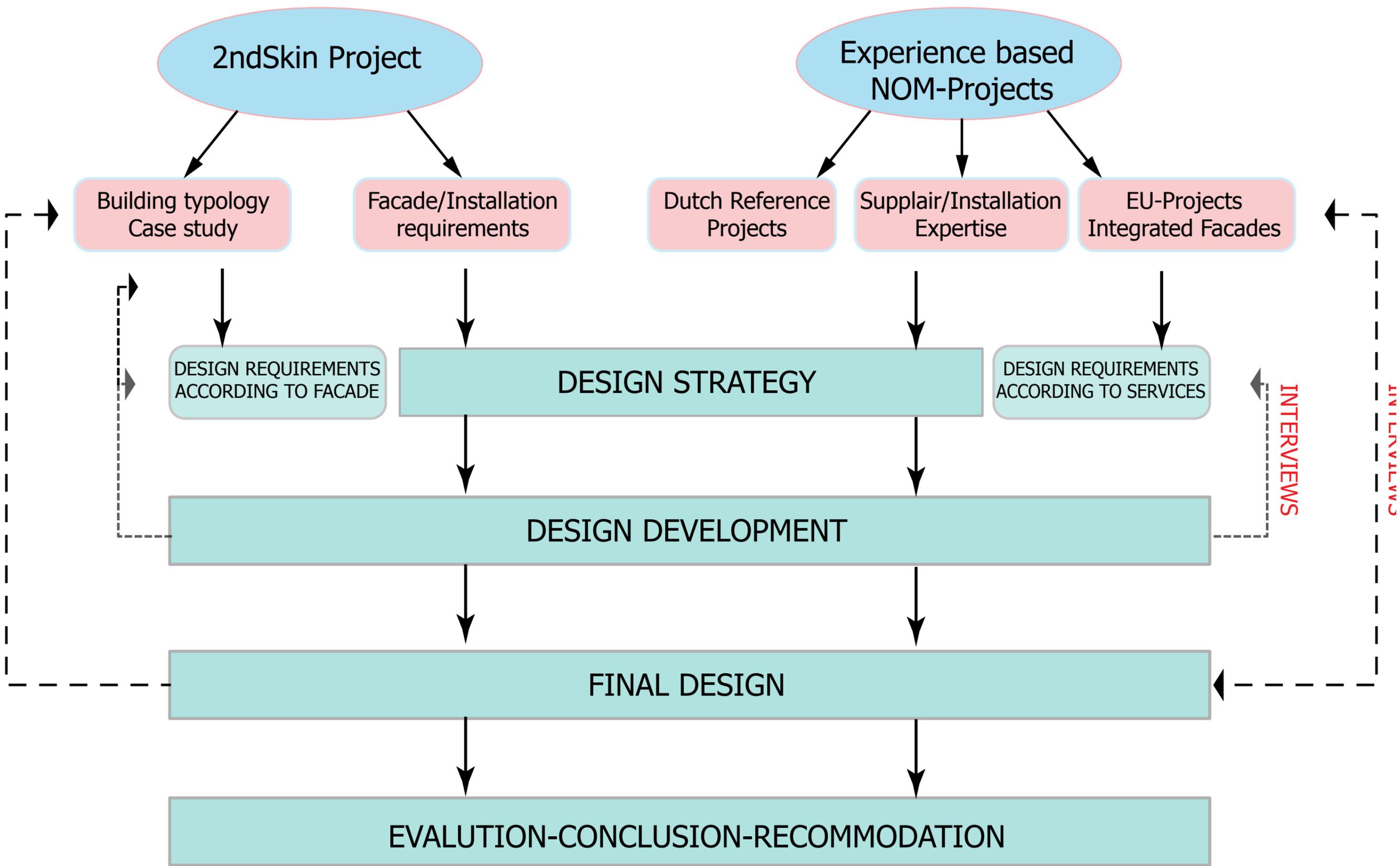
ALL ELECTRIC EQUIPEMENT ARE NOT DESIGN TO INTEGRATE IN THE FACADE. THEREFORE, THE CURRENT SOLUTIONS **SPREAD THESE COMPONENTS ON THE ROOF AND STAIRCASE**. THIS LEADS TO CUSTOMIZED PREFABRICATION AND ASSEMBLY TECHNIQUES.



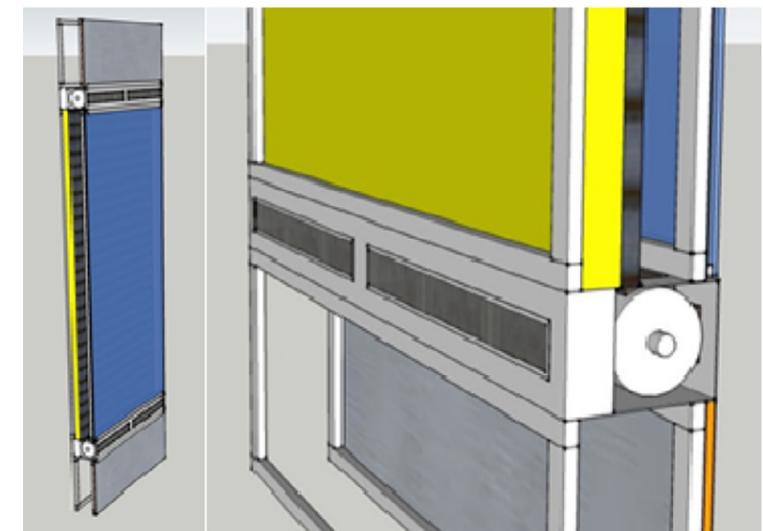
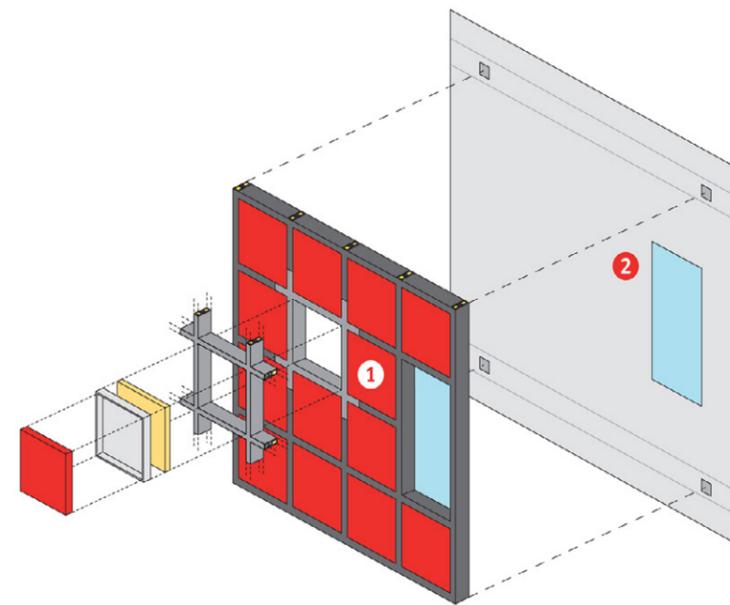
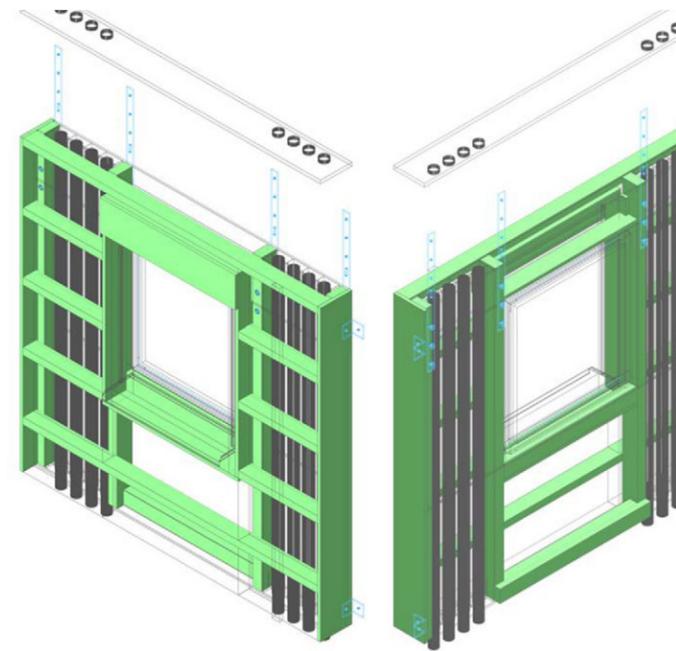
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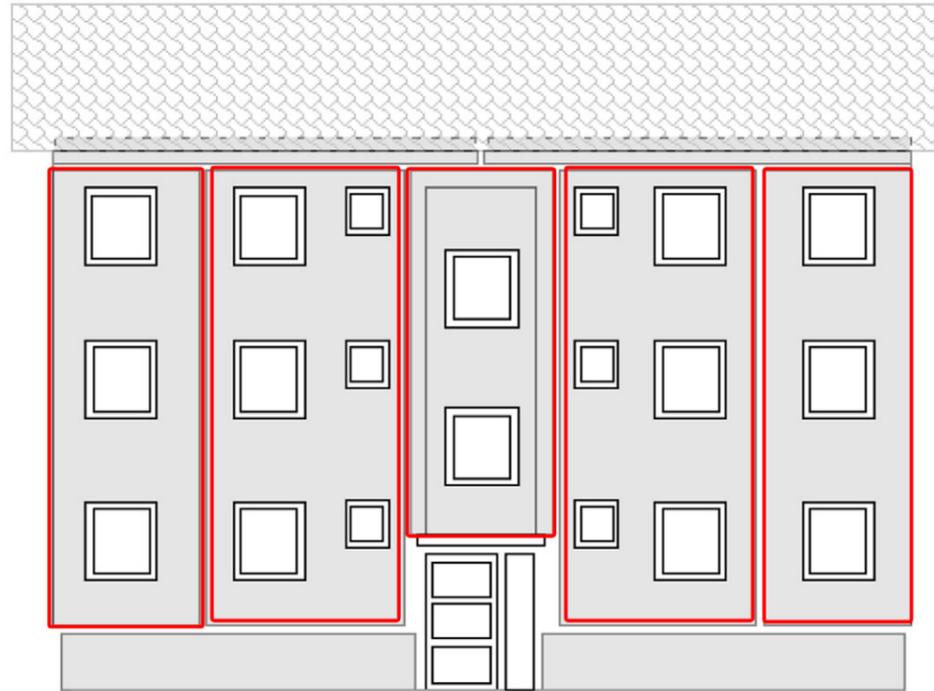
# METHOD



# INTEGRATED MULTIFUNCTIONAL FACADE

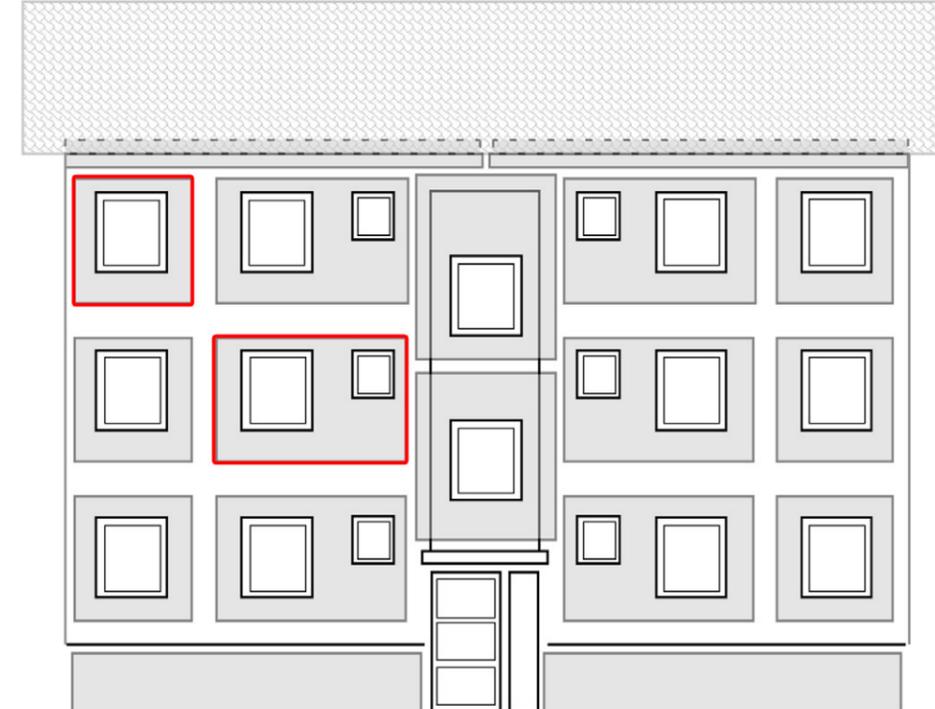


## LARGE SCALE FACADE ELEMENTS



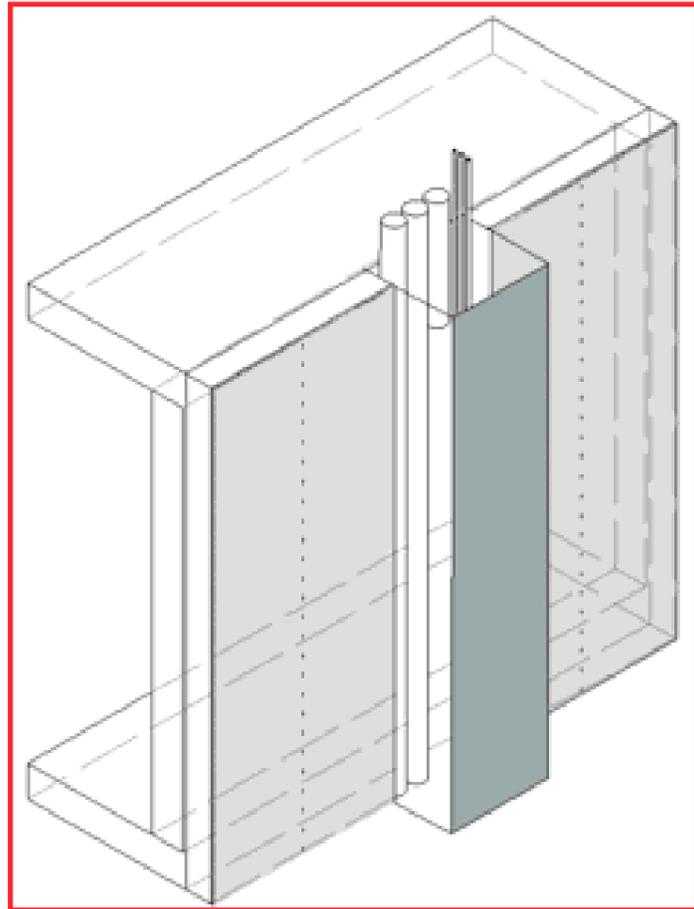
- **Higher transport costs**
- **Fast assemblage methode, if full prefabricated.** Included window, new systems etc.
- **Mostly in unhabited state**

## SMALL SCALE FACADE ELEMENTS



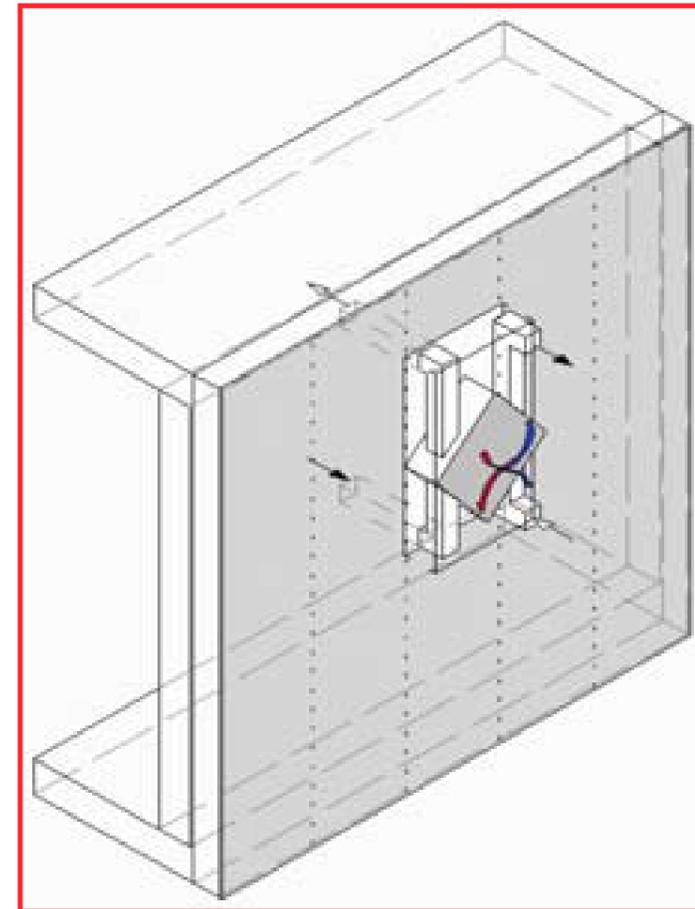
- **Low transport cost**
- **Fast assemblage methode, if full prefabricated.** Included window, new systems etc.
- **Mostly in occupied state**

## CONNECT



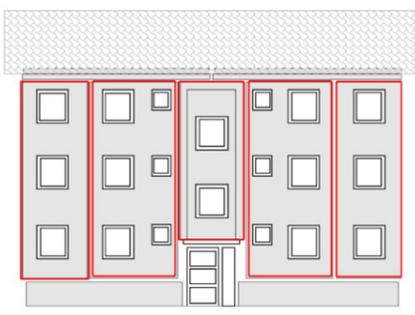
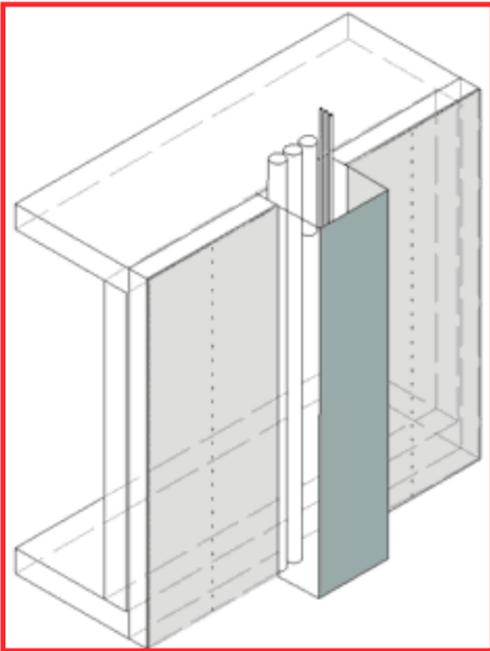
- **Difficult integration of technology**
- **Main difficulty are the windows, Mostly separate parts**
- **Because of duct integration**

## INTEGRATE



- **Flexibility in design**
- **Easier to integrate technology**
- **Traditional retrofit process**

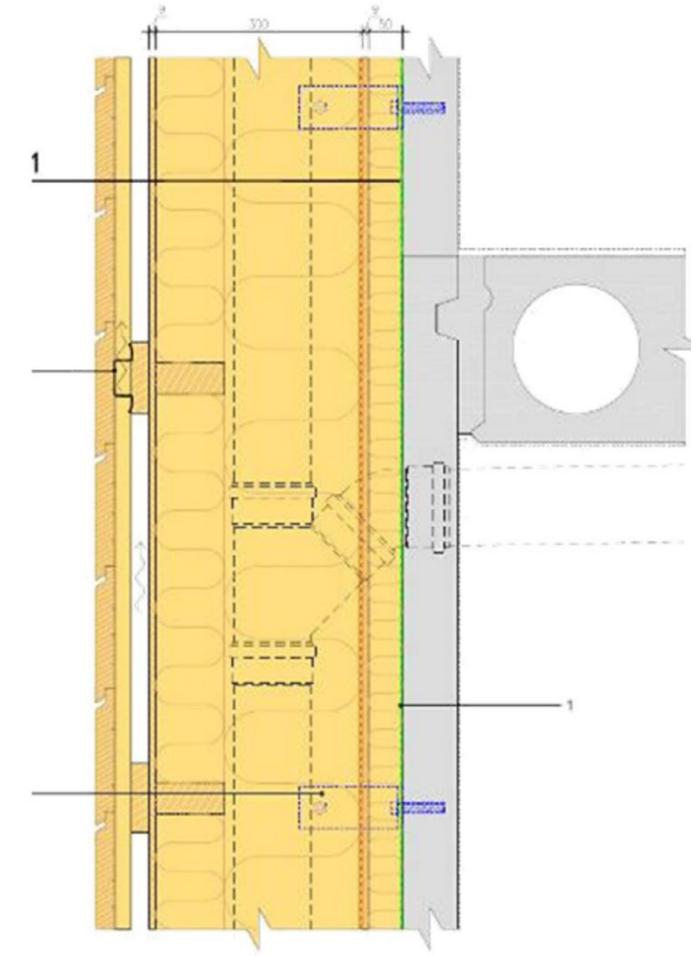
# CONNECT



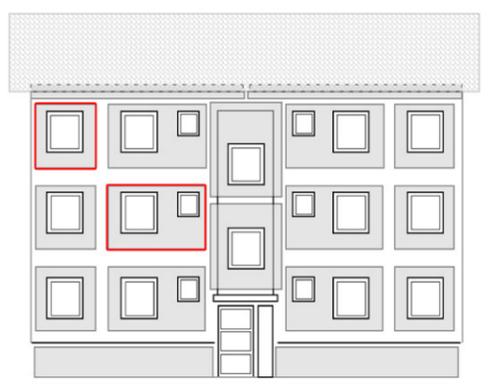
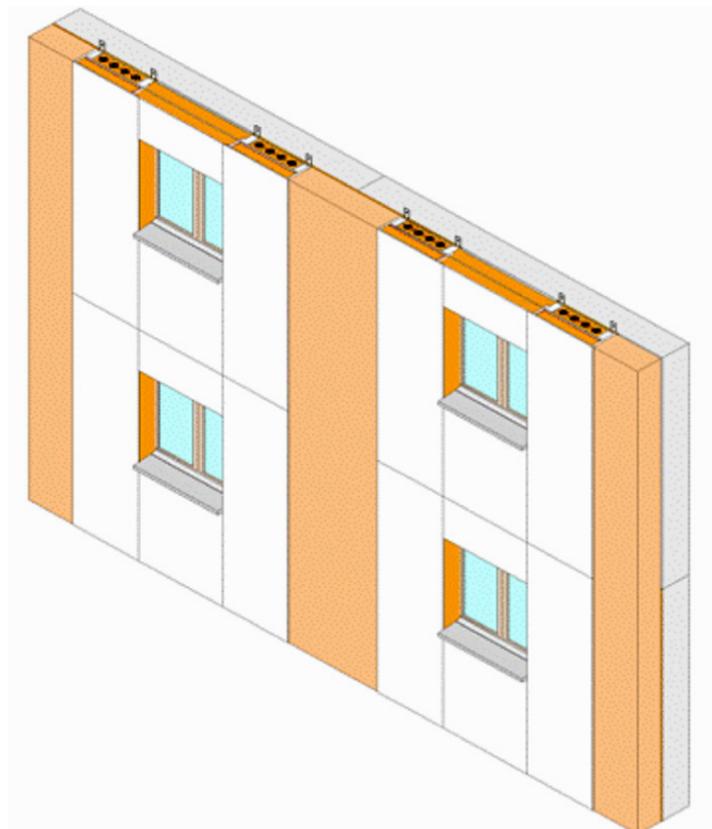
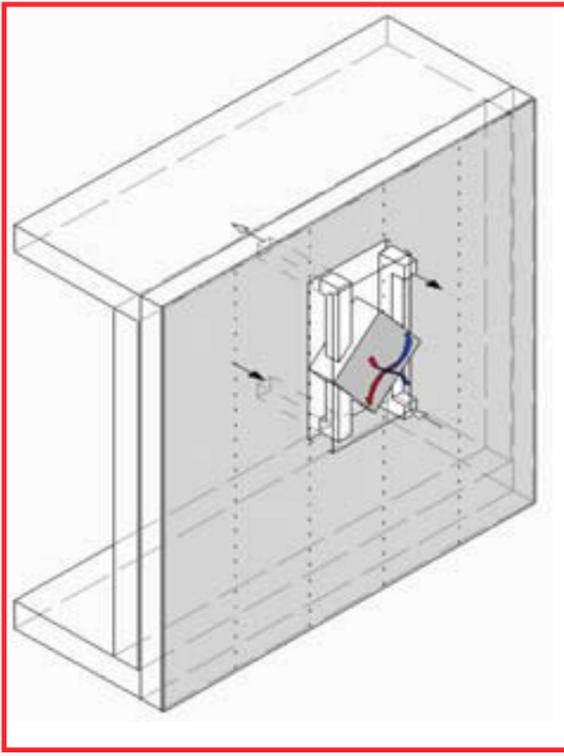
- SPECIAL CRANE
- EXCEPTIONEL TRANSPORT OR MOUNTED TOGETHER ON BUILDING SITE--> SEMI PREFABRICATED



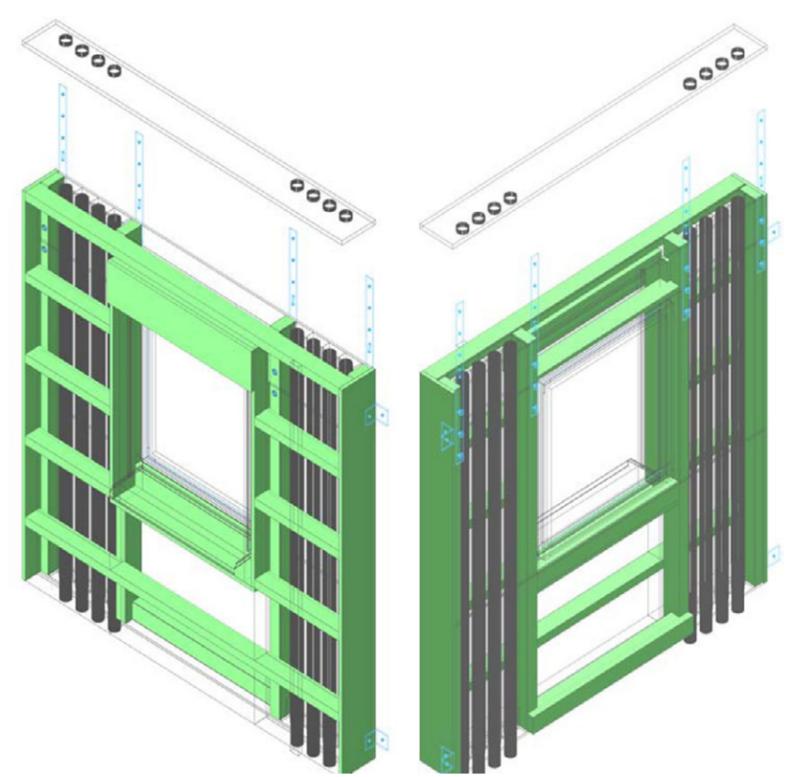
smartTes, 2014



# INTEGRATE

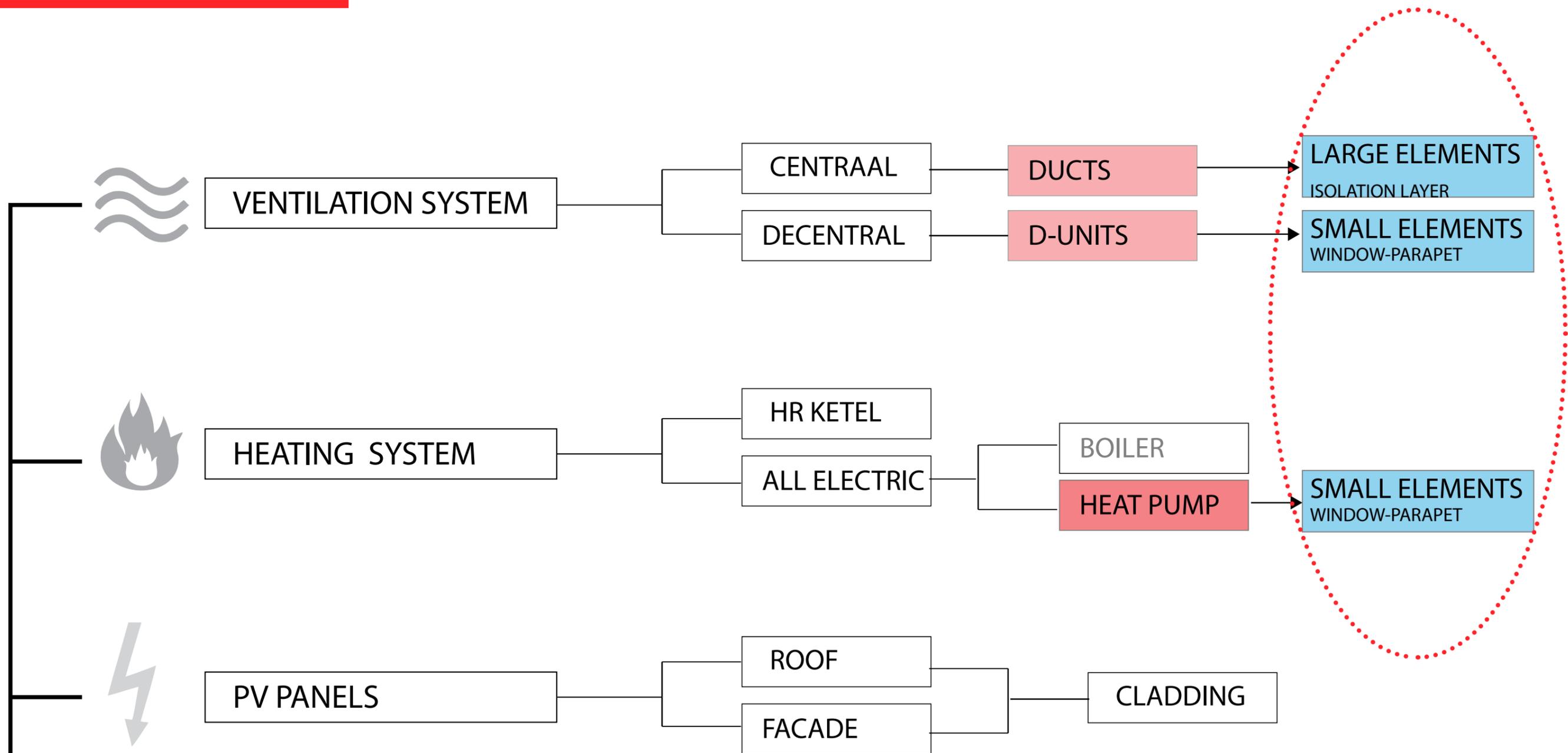


- TRADITIONAL ASSEMBLAGE WITH NEW TECHNOLOGY
- FLEXIBEL IMPLEMENTATION



Annex 51, 2013

# CONCLUSION



SUNSCREENS-SENSORS-LIGHTING-CONTROL SYSTEMS

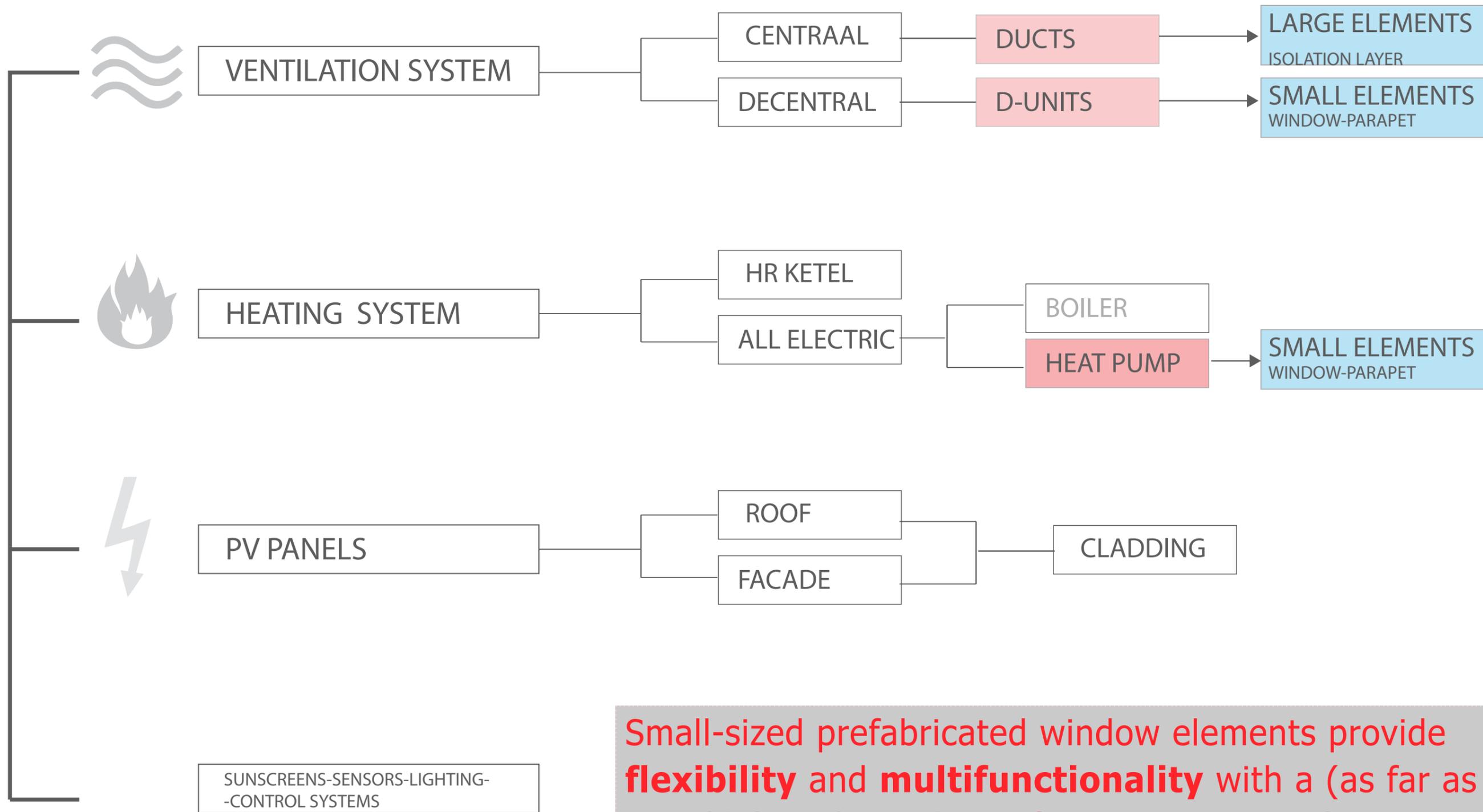


Growing Green project, Delft



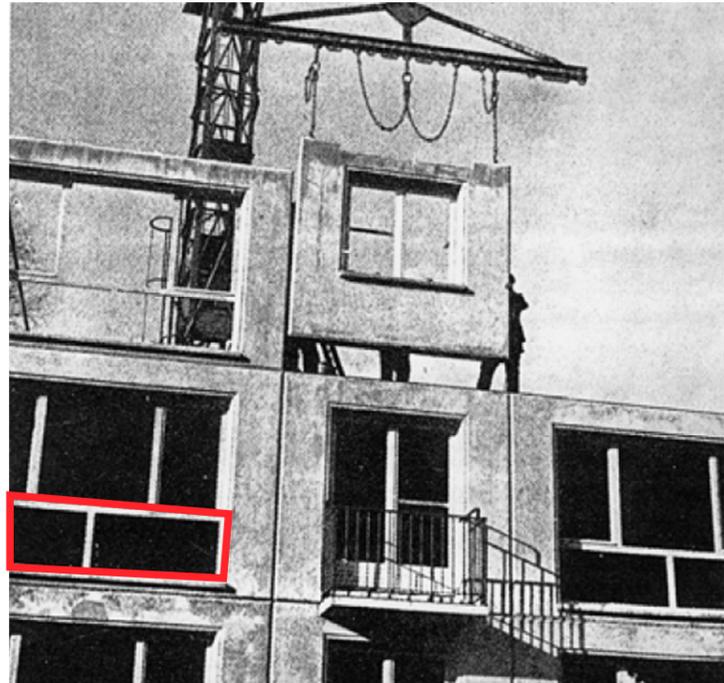
DHS Hydrotop binnen- en buitenunit  
DHS roof unit

# CONCLUSION

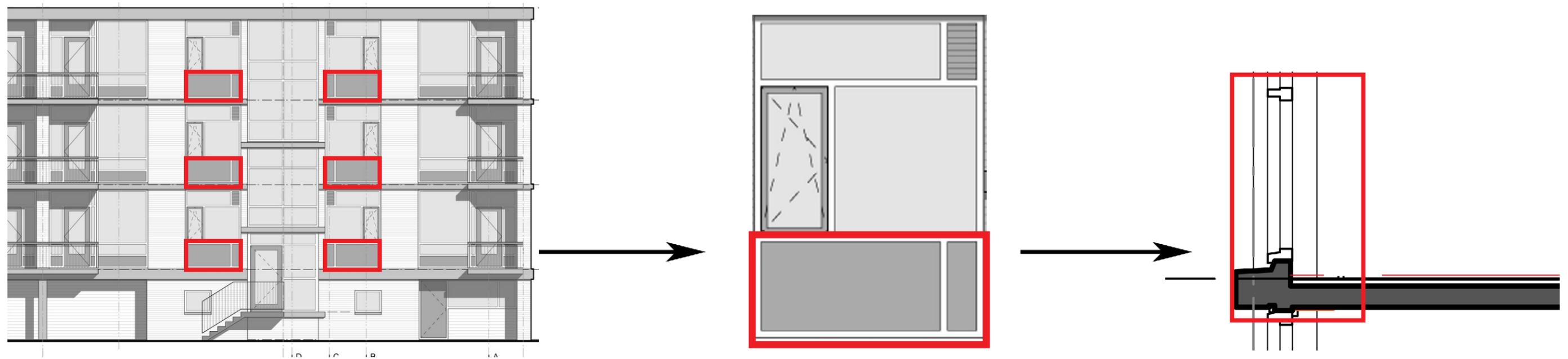


Small-sized prefabricated window elements provide **flexibility** and **multifunctionality** with a (as far as possible) traditional retrofitting process at the same time (Fraunhofer IRP, 2013)

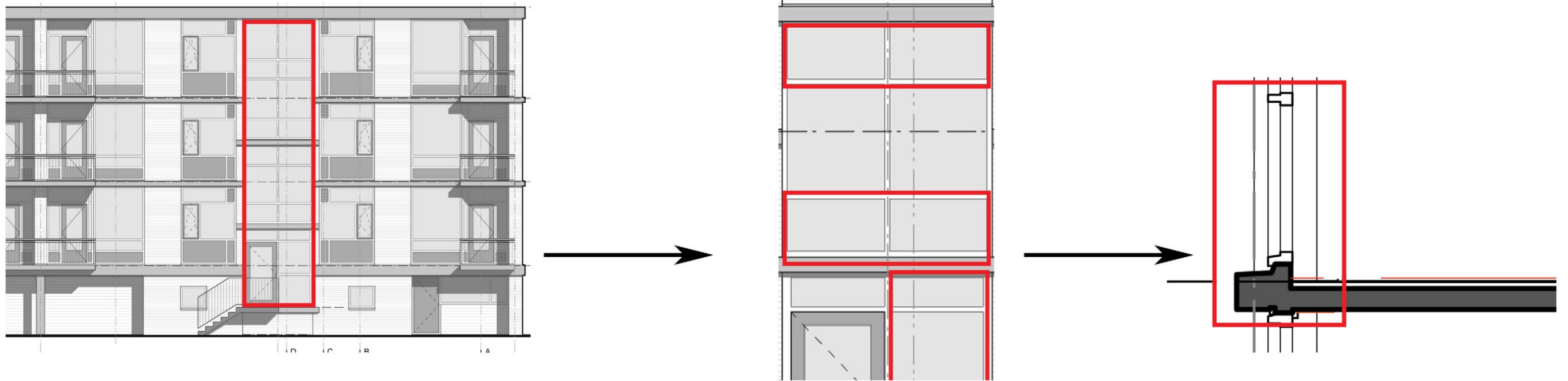
# NON-TRADITIONAL BUILDING METHODE



		121.000
1	<b>Muwi</b>	37.831
2	<b>RBM</b>	32.292
3	<b>Coignet</b>	31.378
4	<b>BMB (o.a. HeBoMa)</b>	29.369
5	<b>EBA</b>	19.291
6	<b>Pronto</b>	17.836
7	<b>Rottinghuis/IBC</b>	17.000
8	<b>Korrelbeton</b>	15.394
9	<b>VAM</b>	14.000
10	<b>BBB: Bredero</b>	13.118
11	Wilma	12.579
12	Pege	12.000
13	Smit	10.000
14	Airey	9.975
15	ERA	9.810
16	Elementum, later PLN	8.574
17	Vaneg	7.000
18	Bakker	5.643
19	welschen	5.602
20	B-G	5.581
21	Tramonta	4.845
22	EBO	4.586
23	Nijhuis	4.059
24	Schokbeton	4.000
25	Simplex	3.800
26	Houten woningen	2.500
27	Bitcon	2.245
28	K & G	1.900
29	Sanders	1.883
30	Bouwvliet	1.616

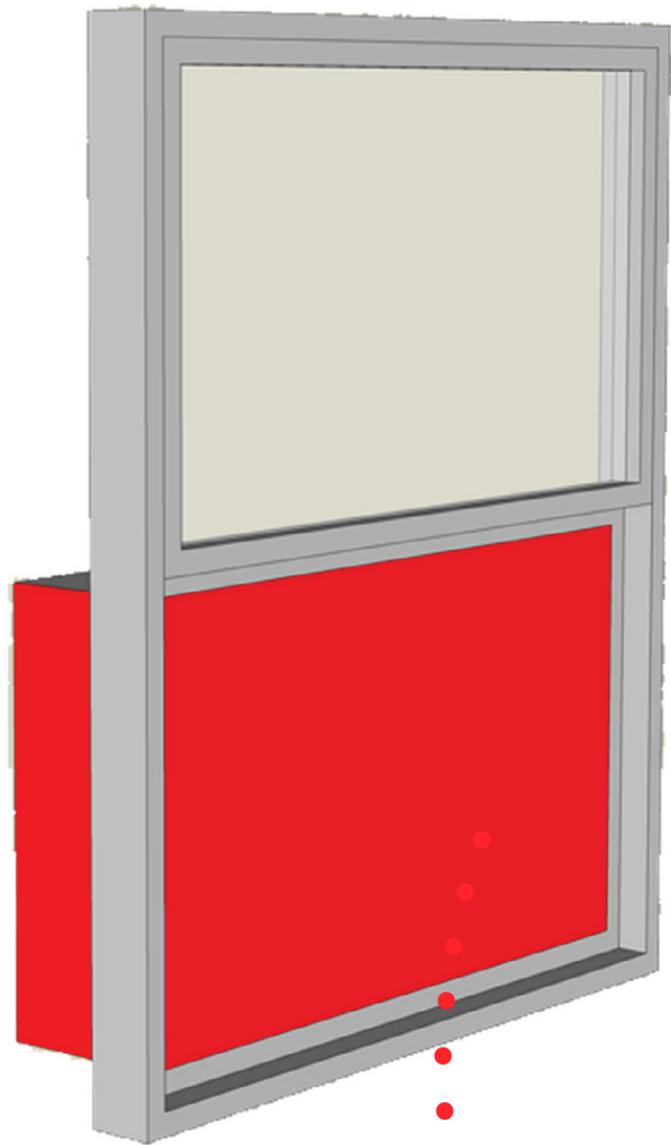


- **Near the existing waterpipes-->plug'n play**
- **Kitchen is near the installation room**
- **Kitchen is not a living spaces -> Less Disturbancing**
- **Maintaince from outside is possible**

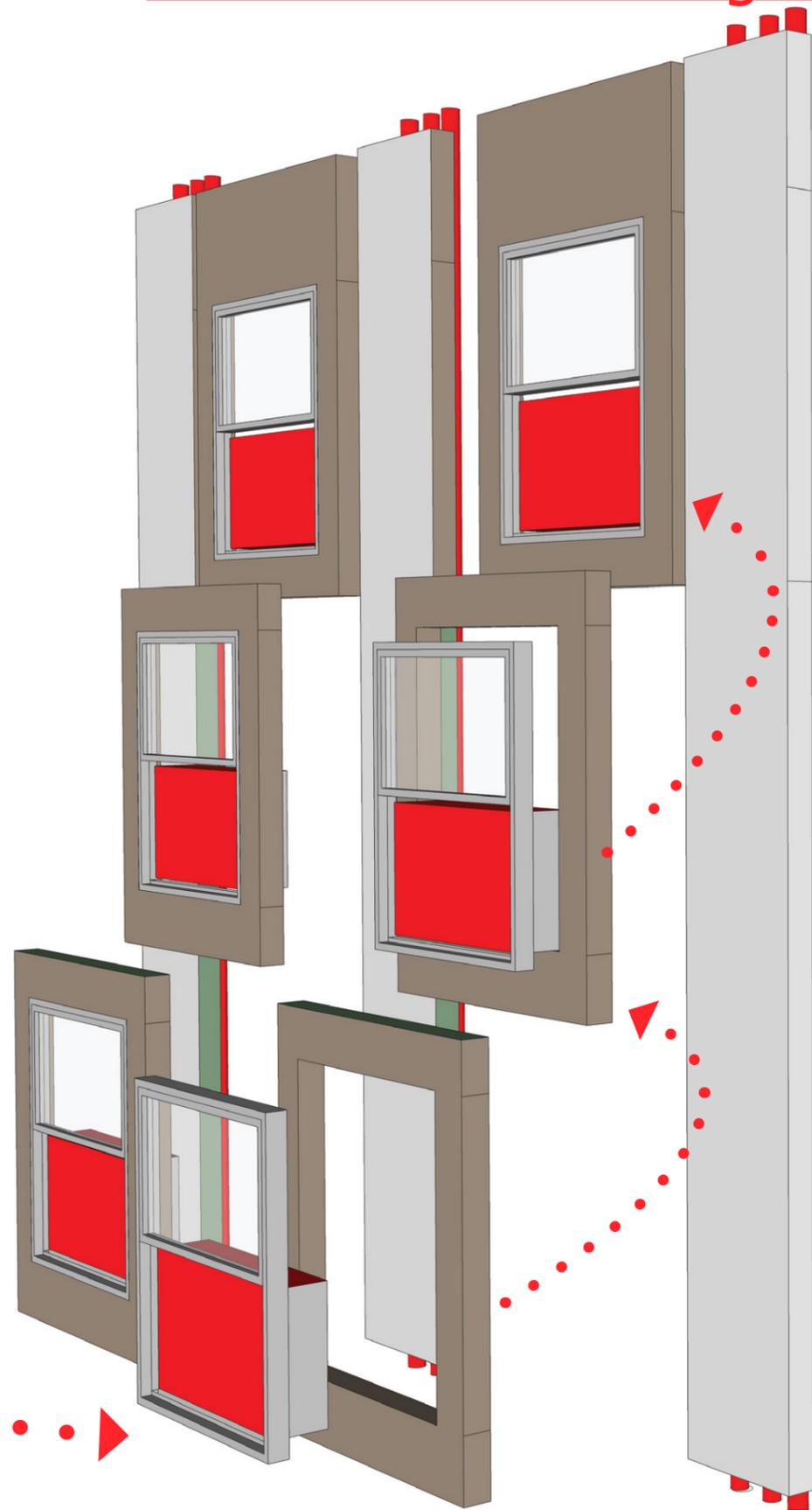


- **Need new water infra**
- **Less disturbance**
- **Maintaince is possible throw staircase**
- **One central zone--> Design freedom**

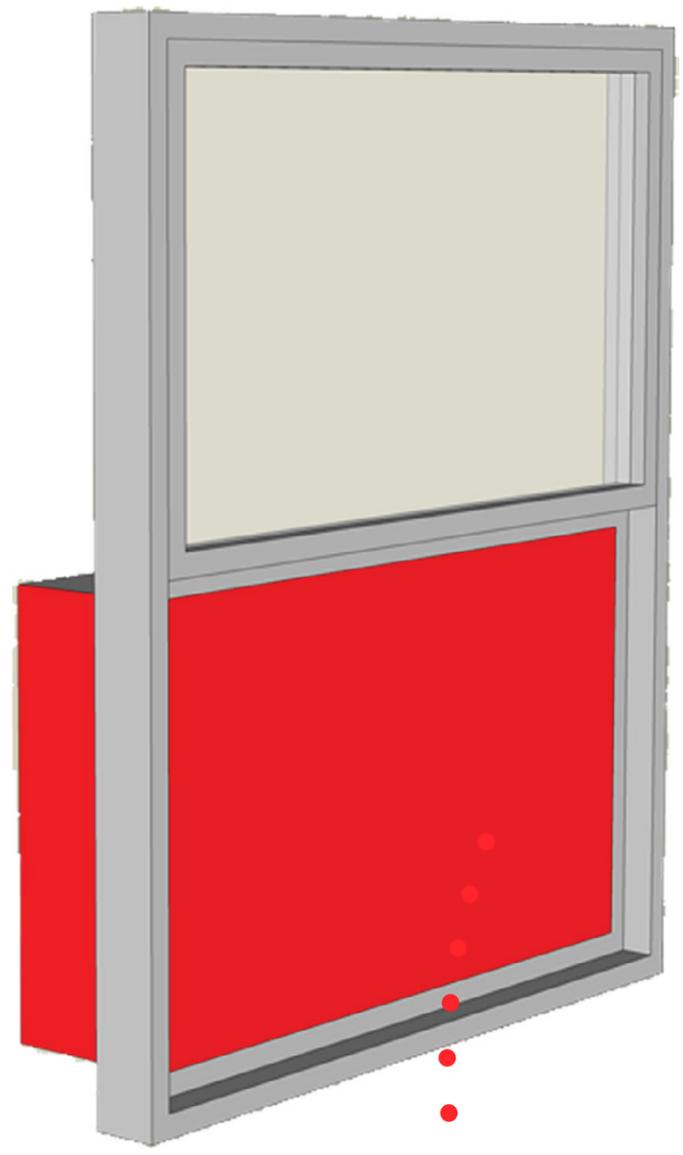
Design



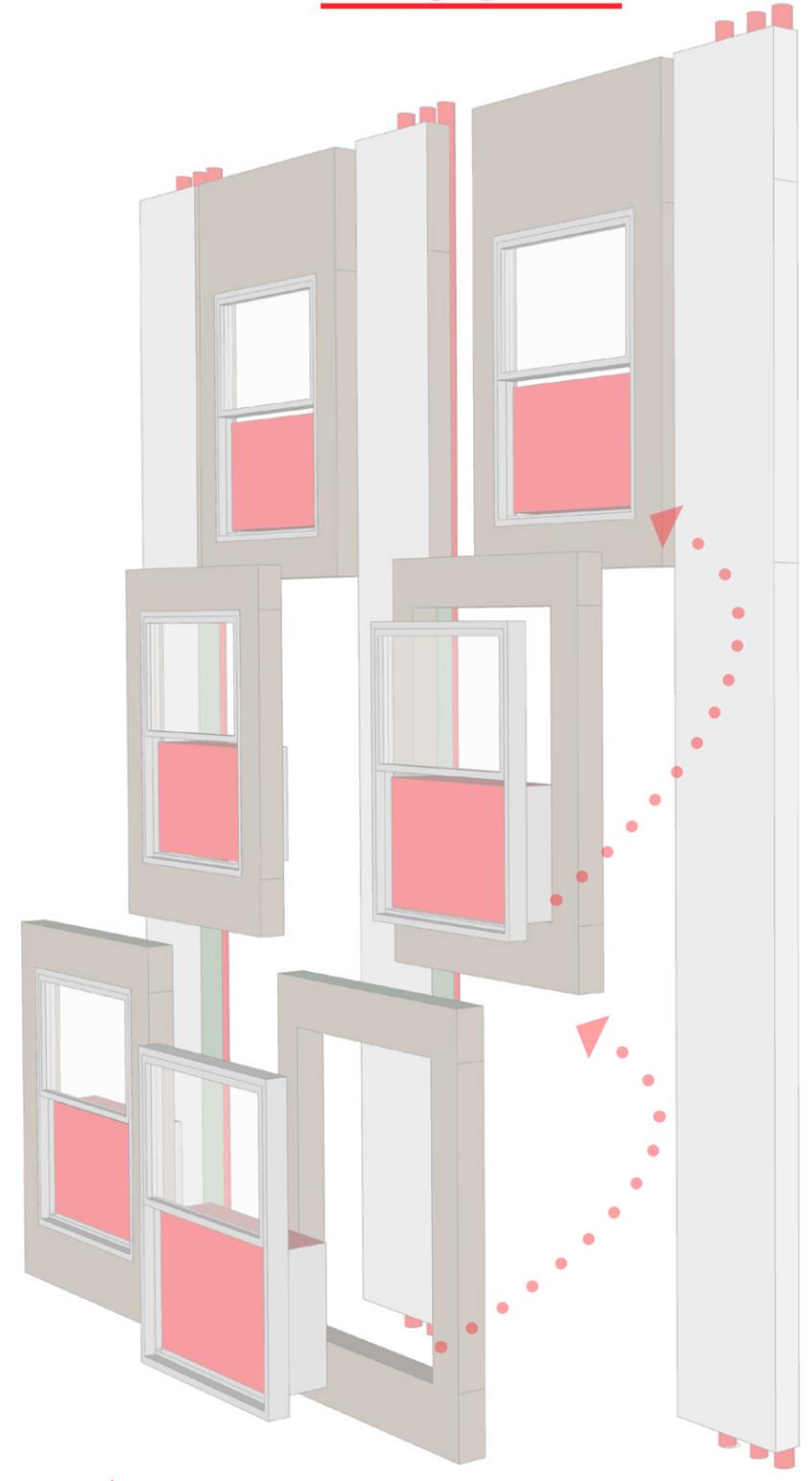
2ndSkin F-Assemblage



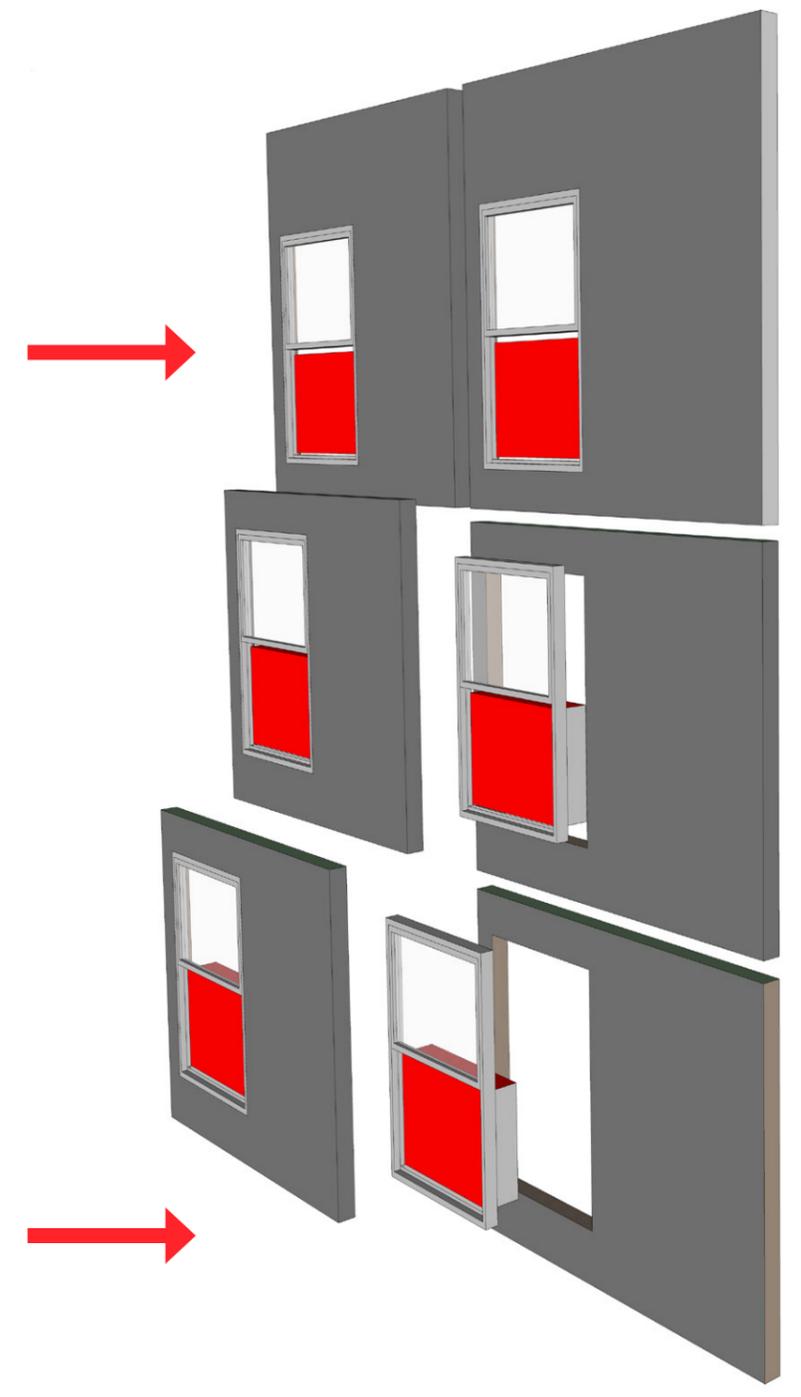
Design



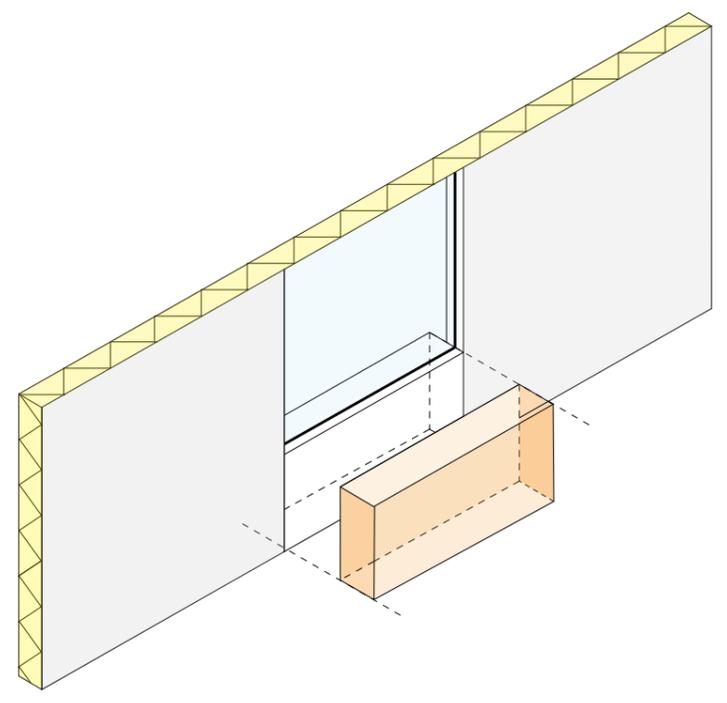
2ndSkin



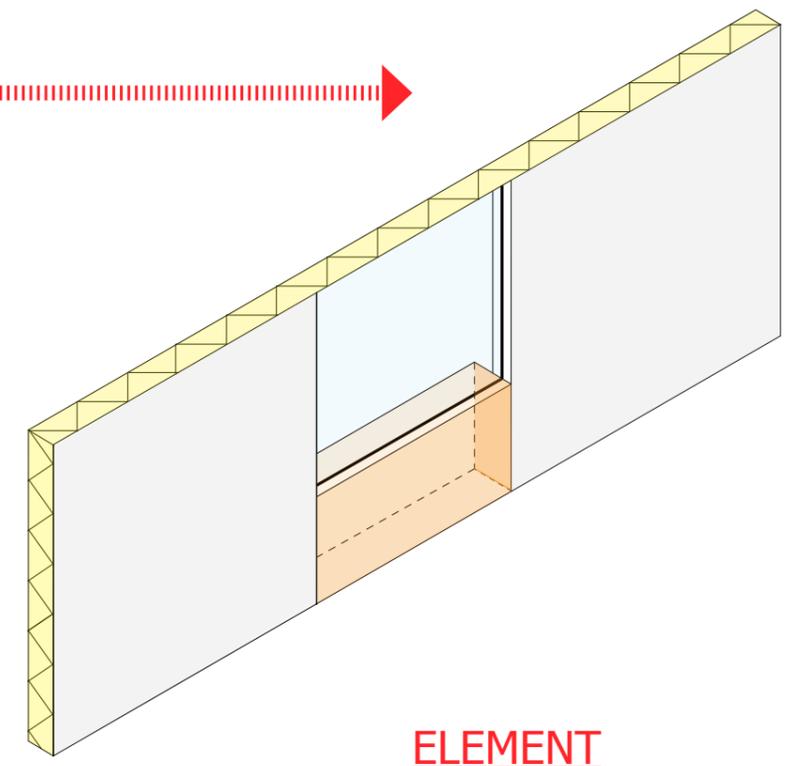
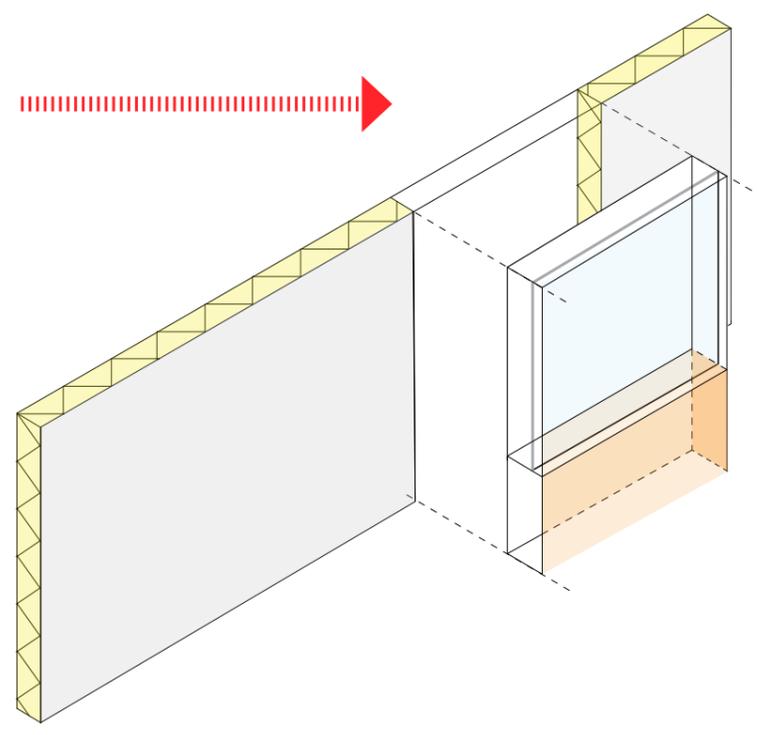
FLEX



# DESIGN DEVELOPMENT

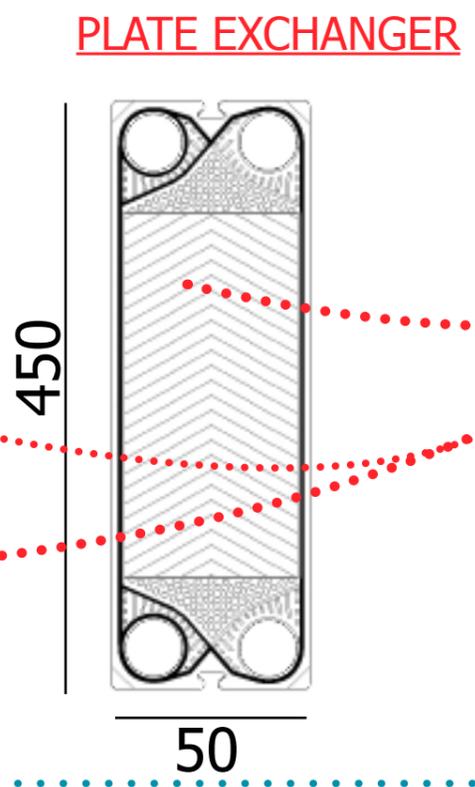
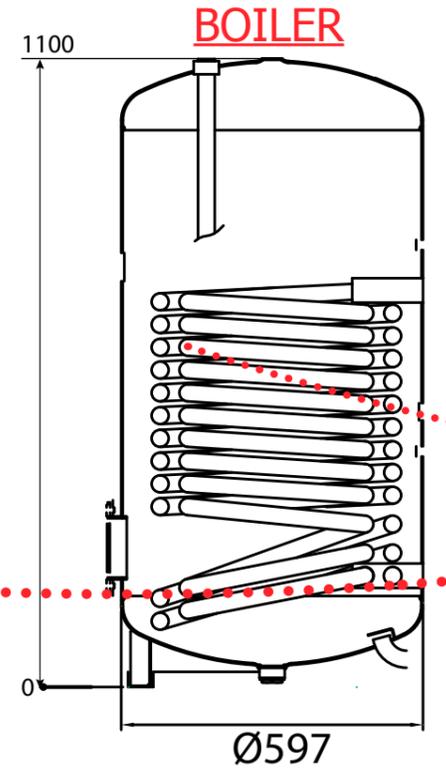
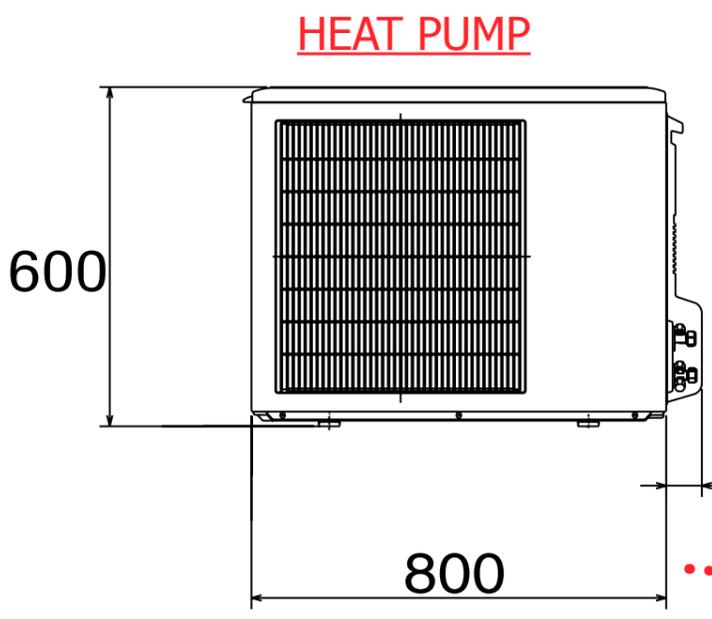
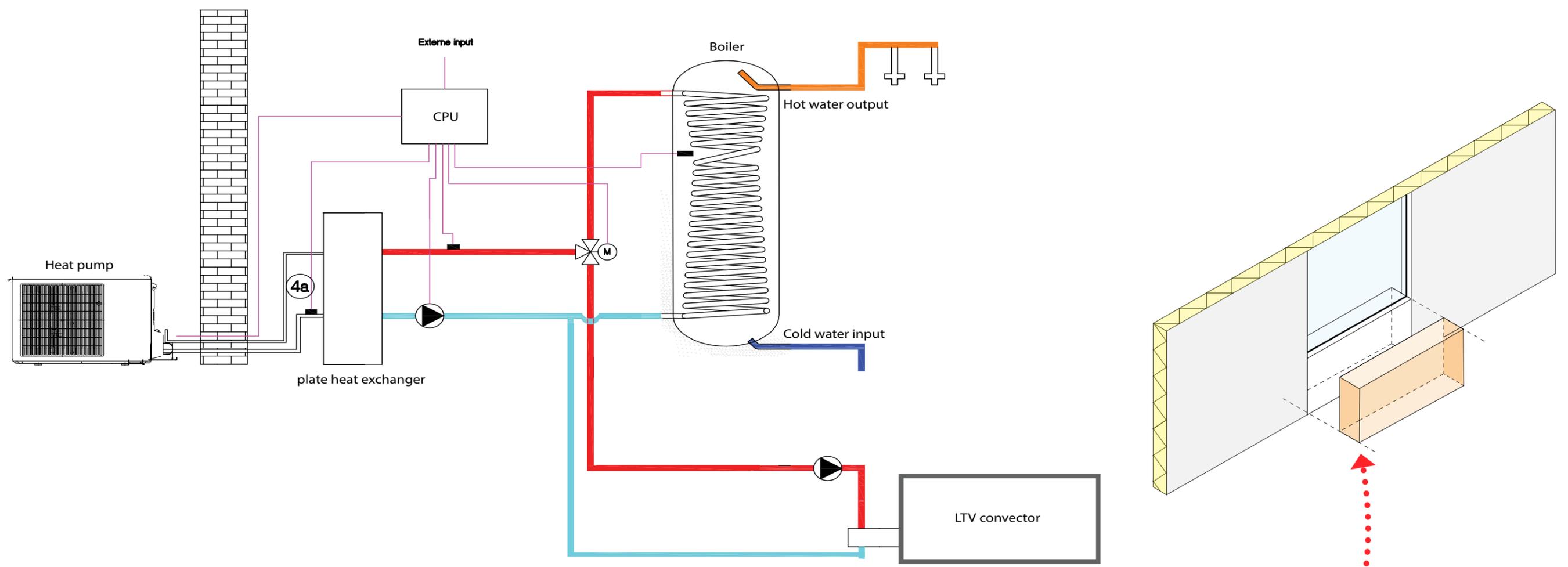


BOX

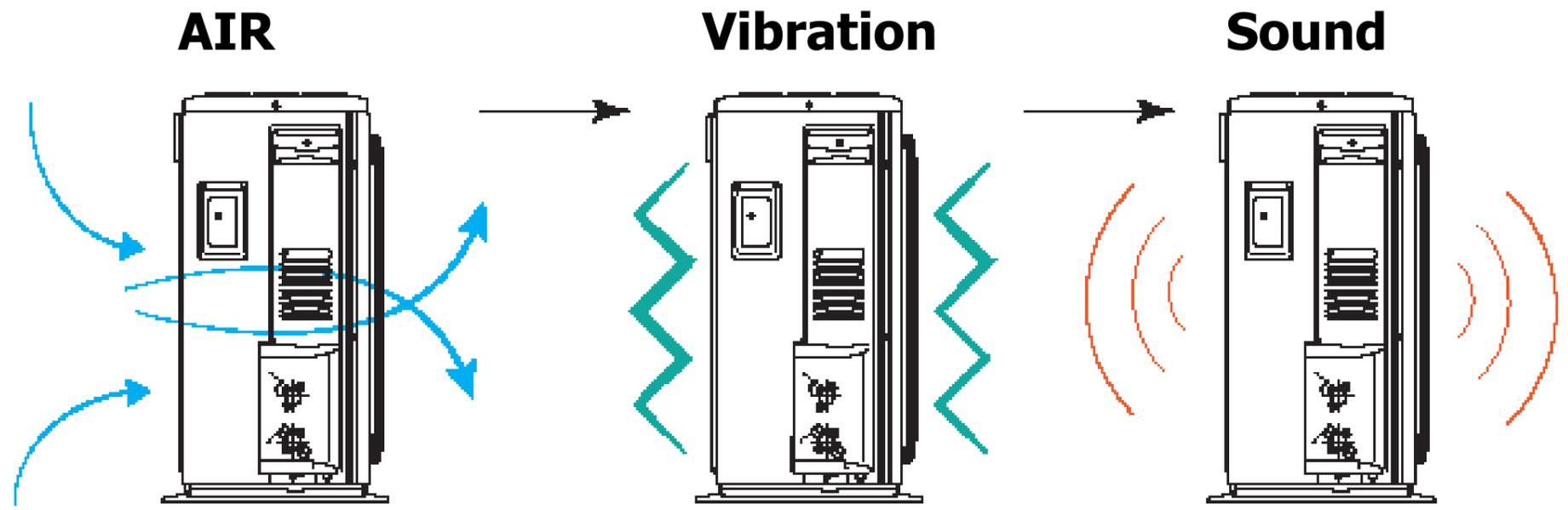


ELEMENT

# WHAT TO INTEGRATE??



# CHALLENGE HEAT PUMP



- 2100 M<sup>3</sup>/h
- in-out air separate

- vibration of compressor

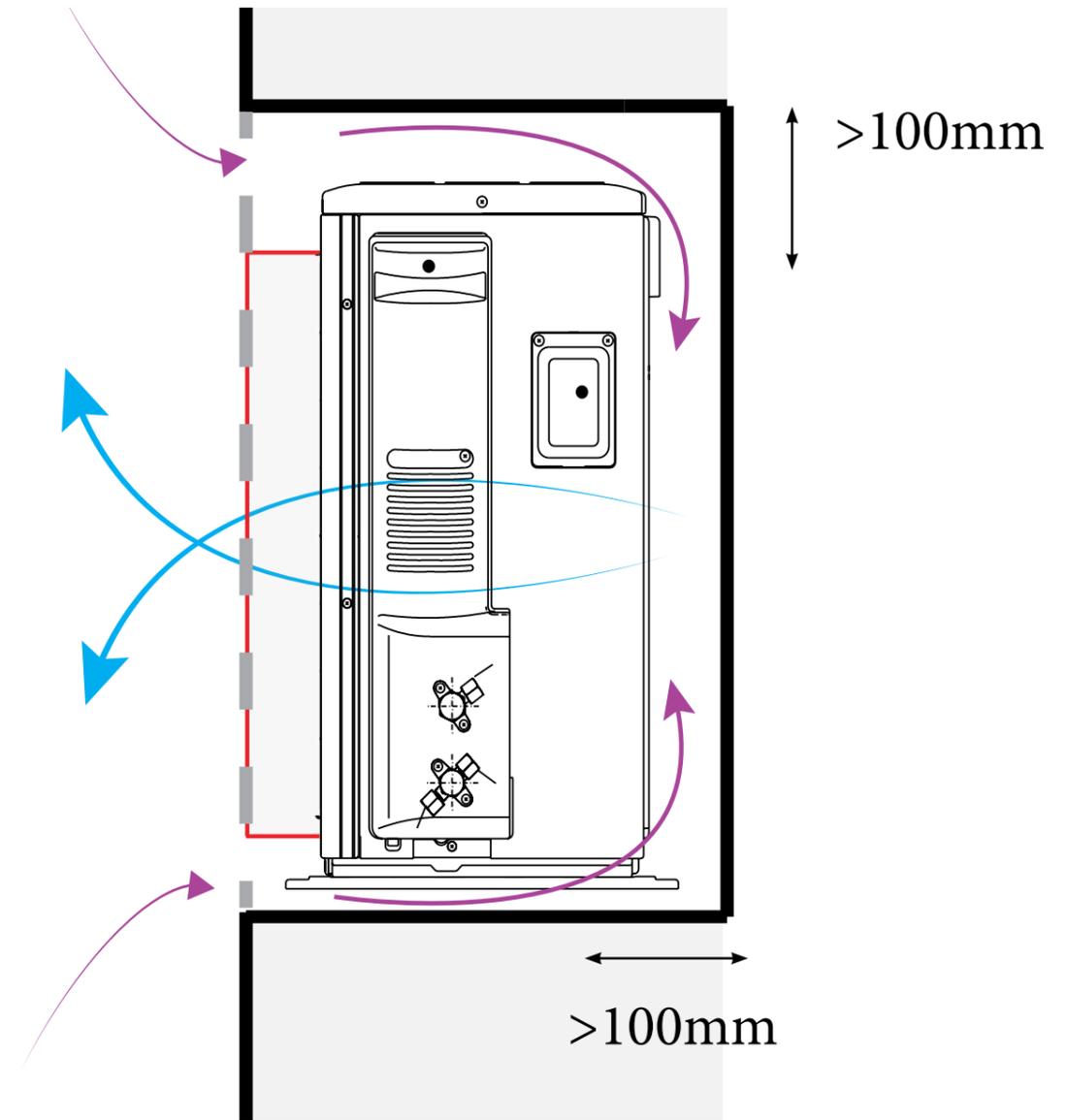
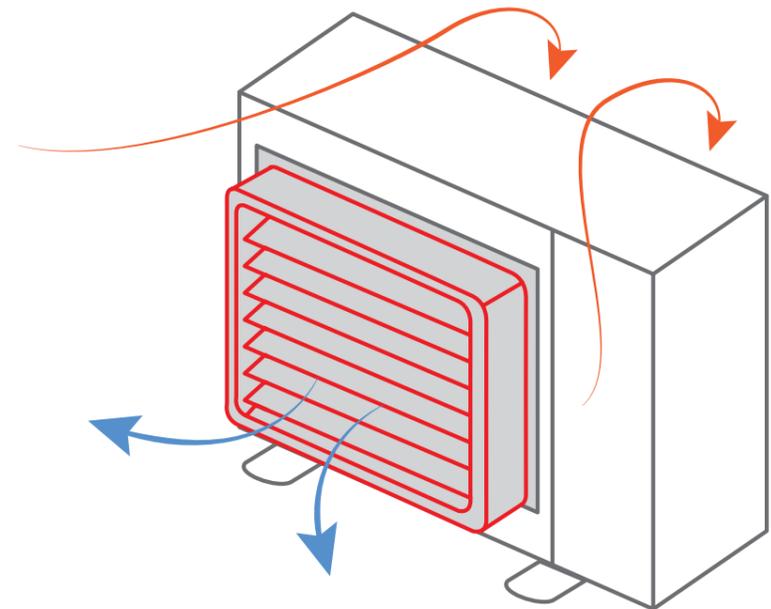
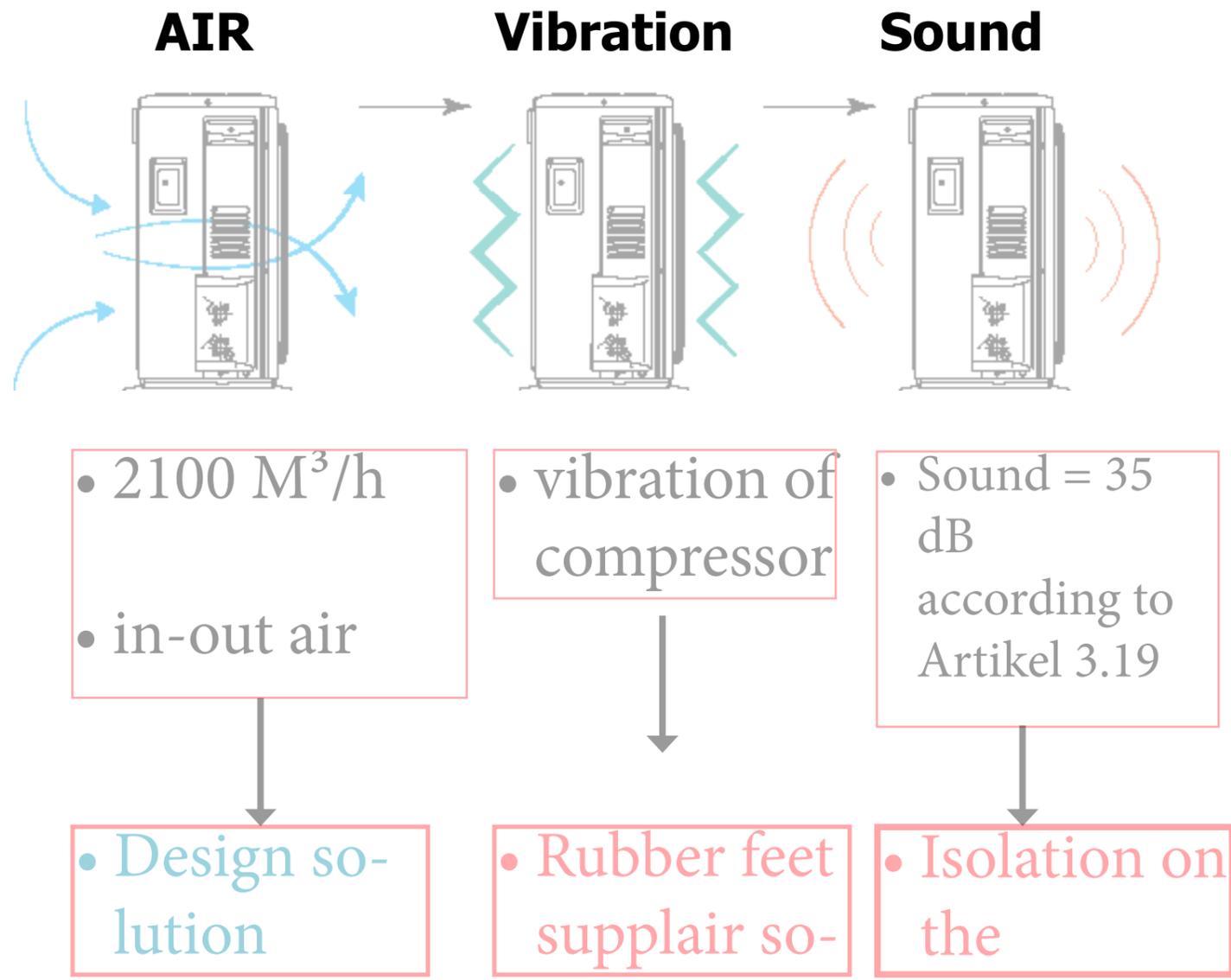
- Sound = 35 dB according to Artikel 3.19 5 db to much

- Design solution

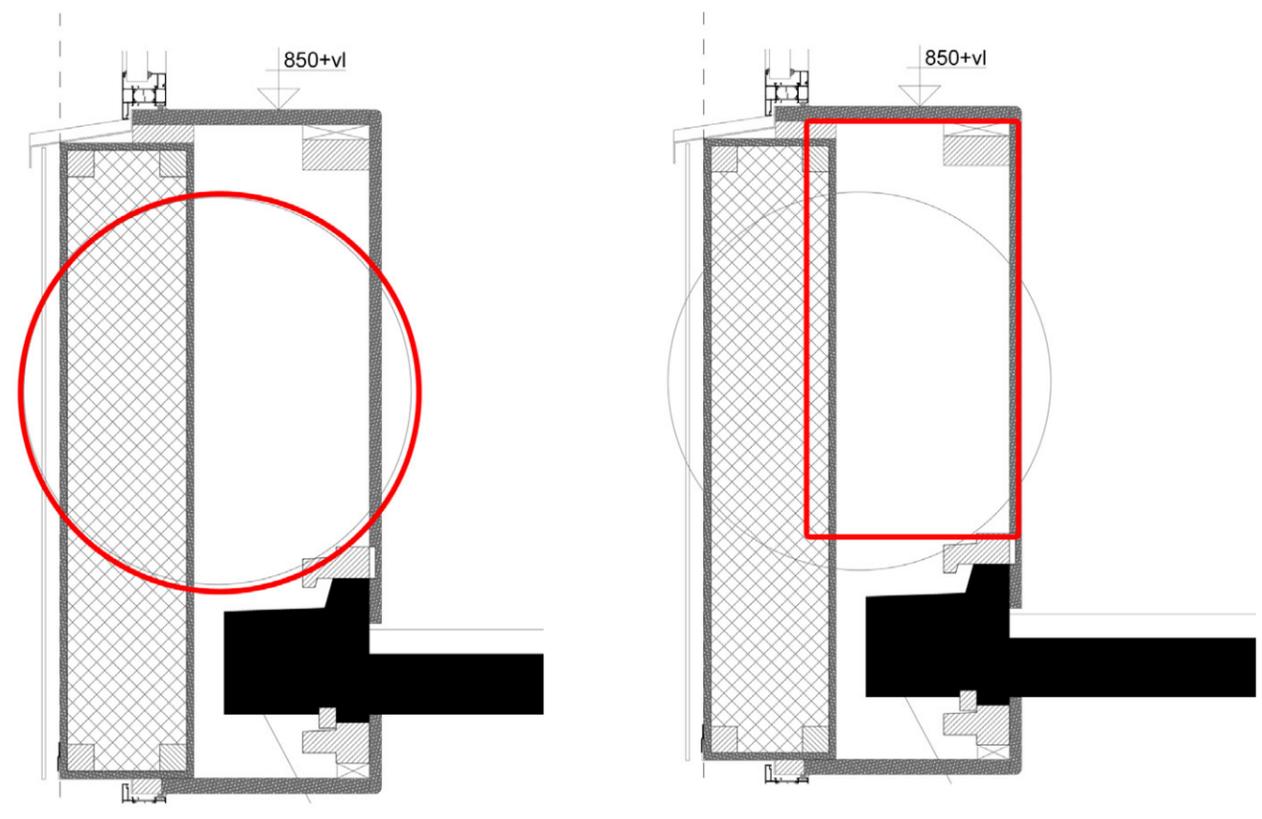
- Rubber feet supplair solution

- Isolation on the compressor

# CHALLENGE HEAT PUMP

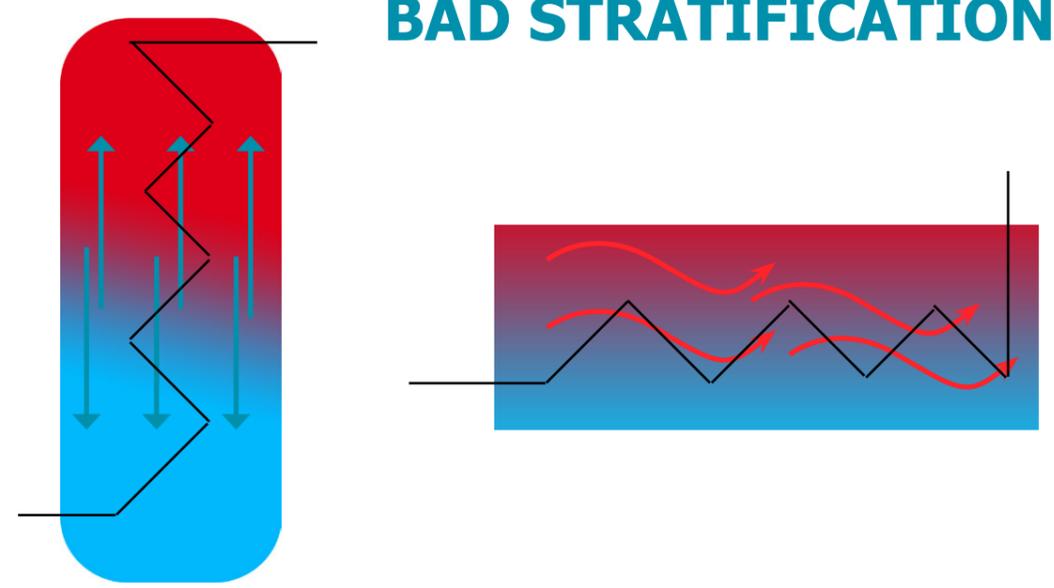


# CHALLENGE BOILER

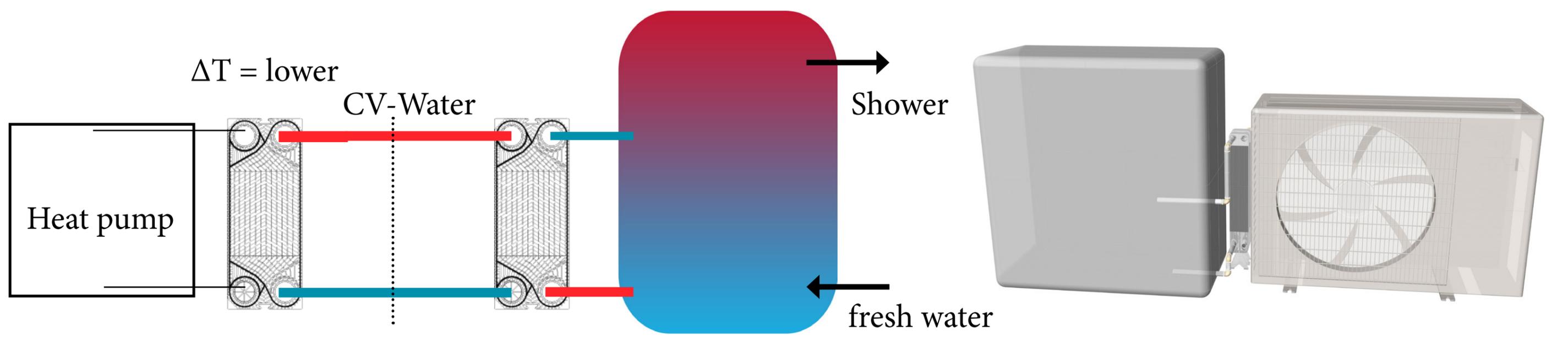
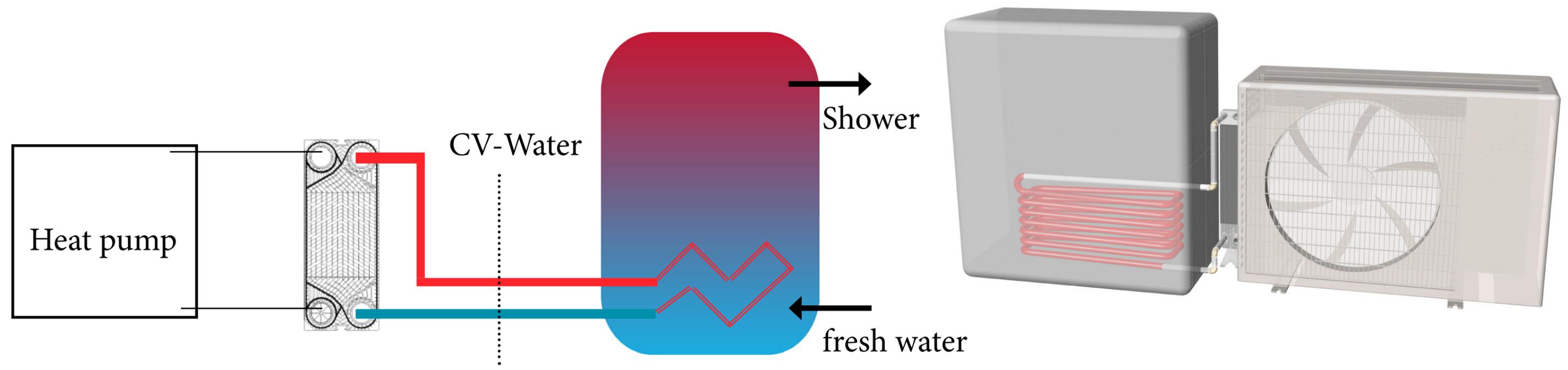


- **CHANGE GEOMETRY LEADS TO:**
- **BAD STRATIFICATION** (Temperature)
- **STIFFNESS OF THE VESSEL**

## BAD STRATIFICATION

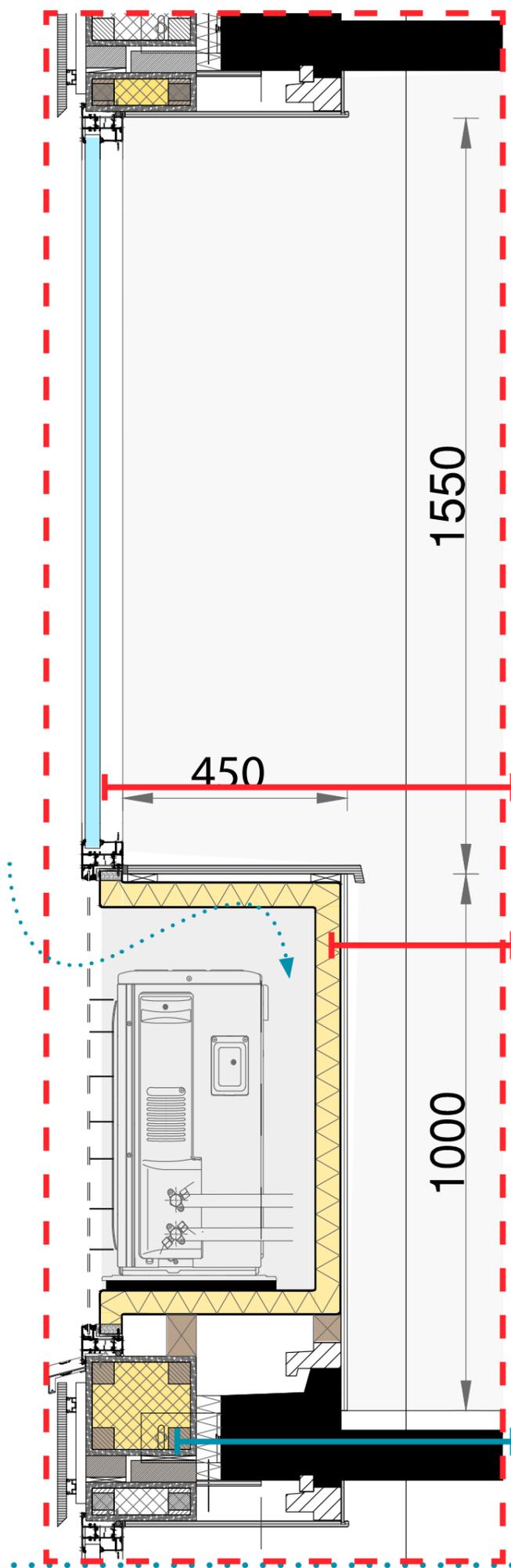
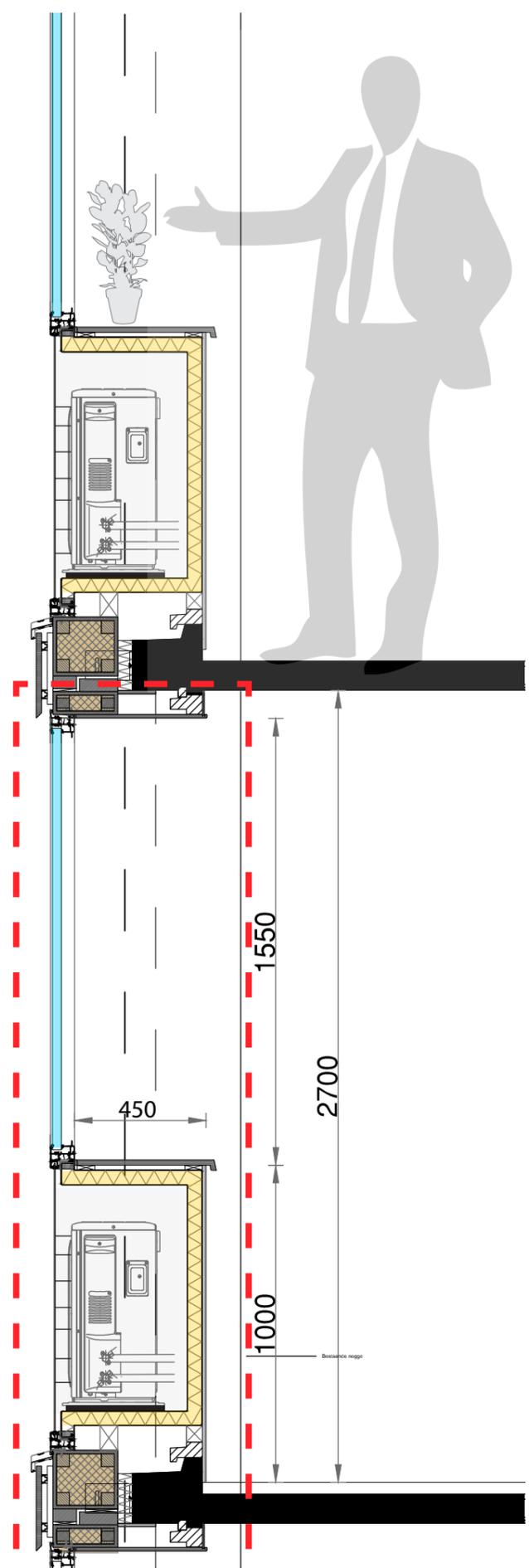


# CHALLENGE BOILER





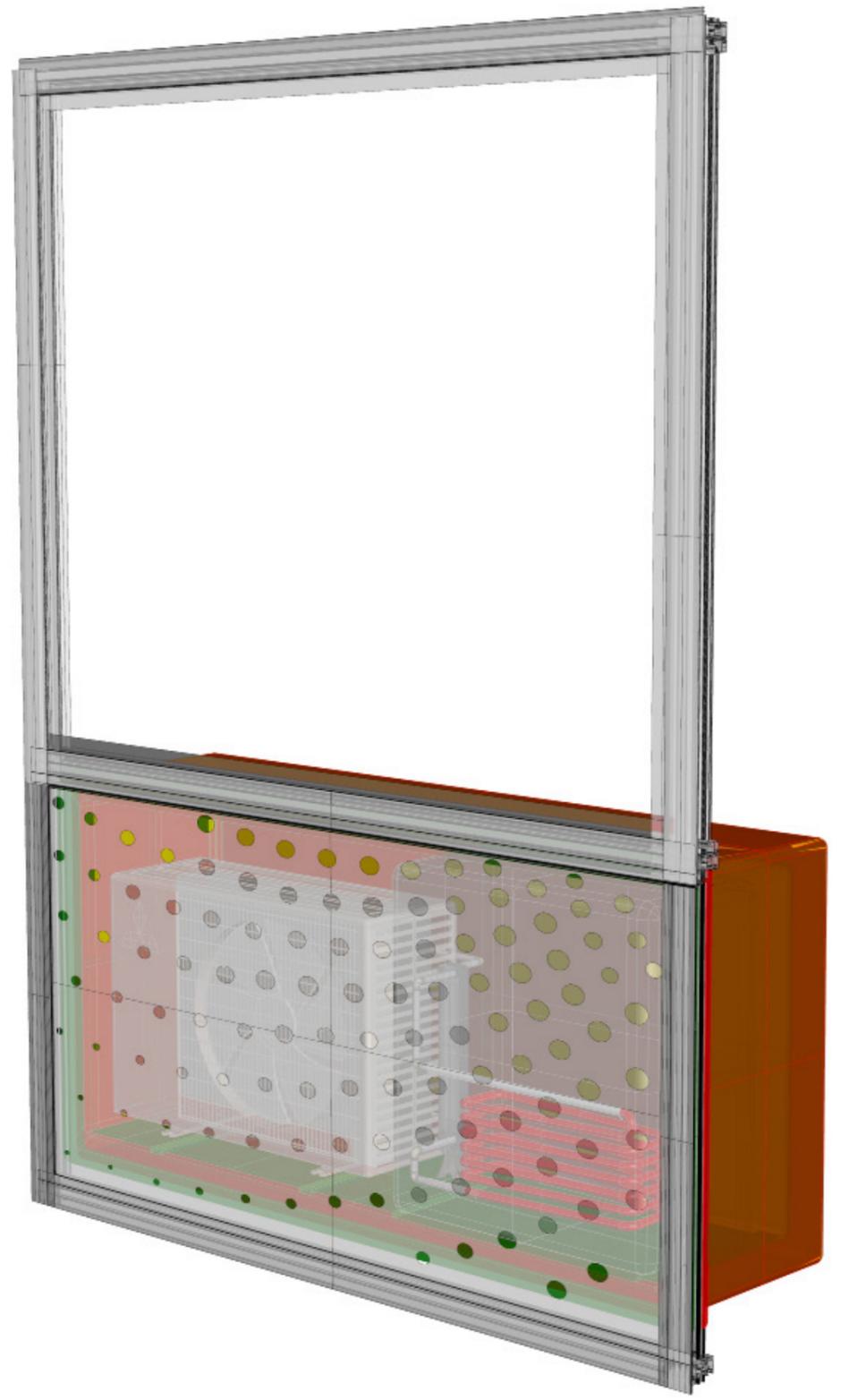
# FINAL DESIGN



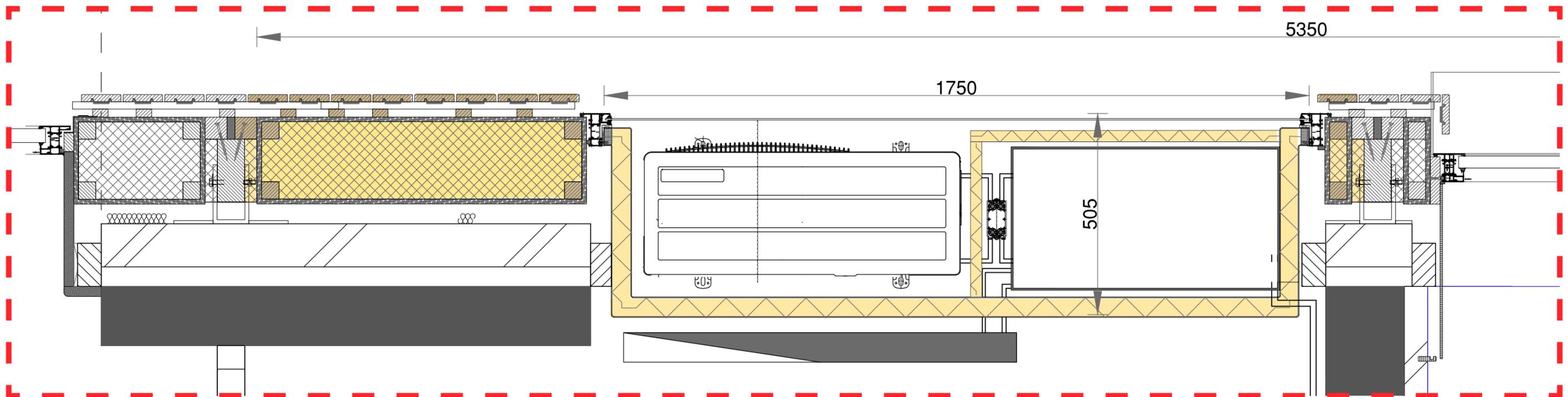
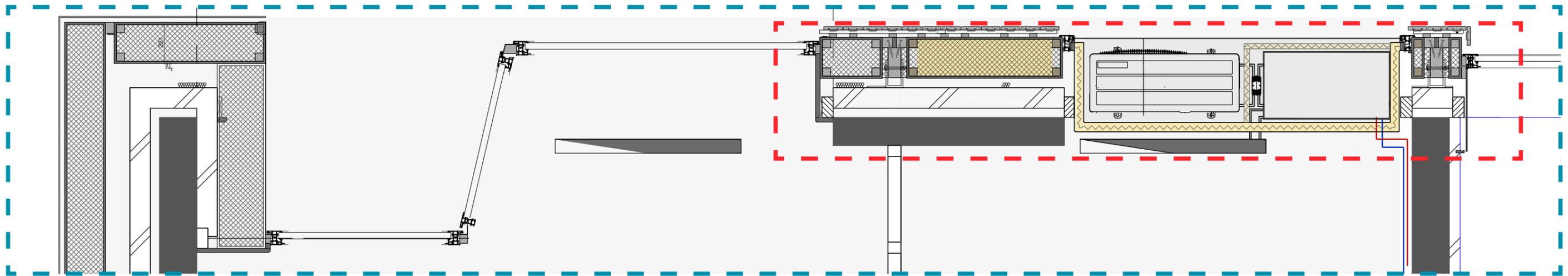
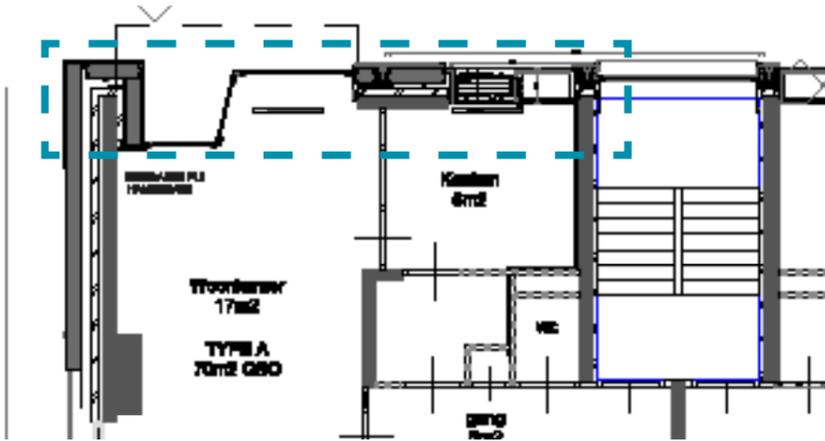
Aluminium-frame

Composite box  
800x1750x450;  
Vacuum insulation  
rc=5,0

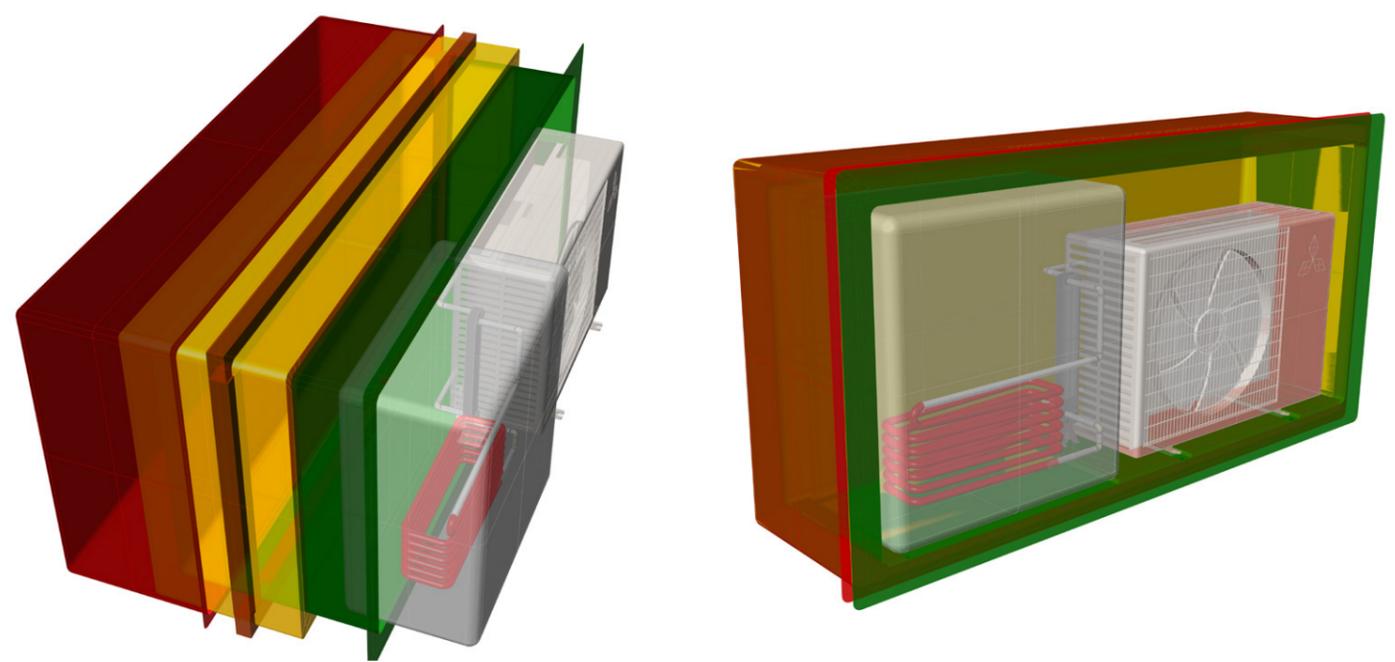
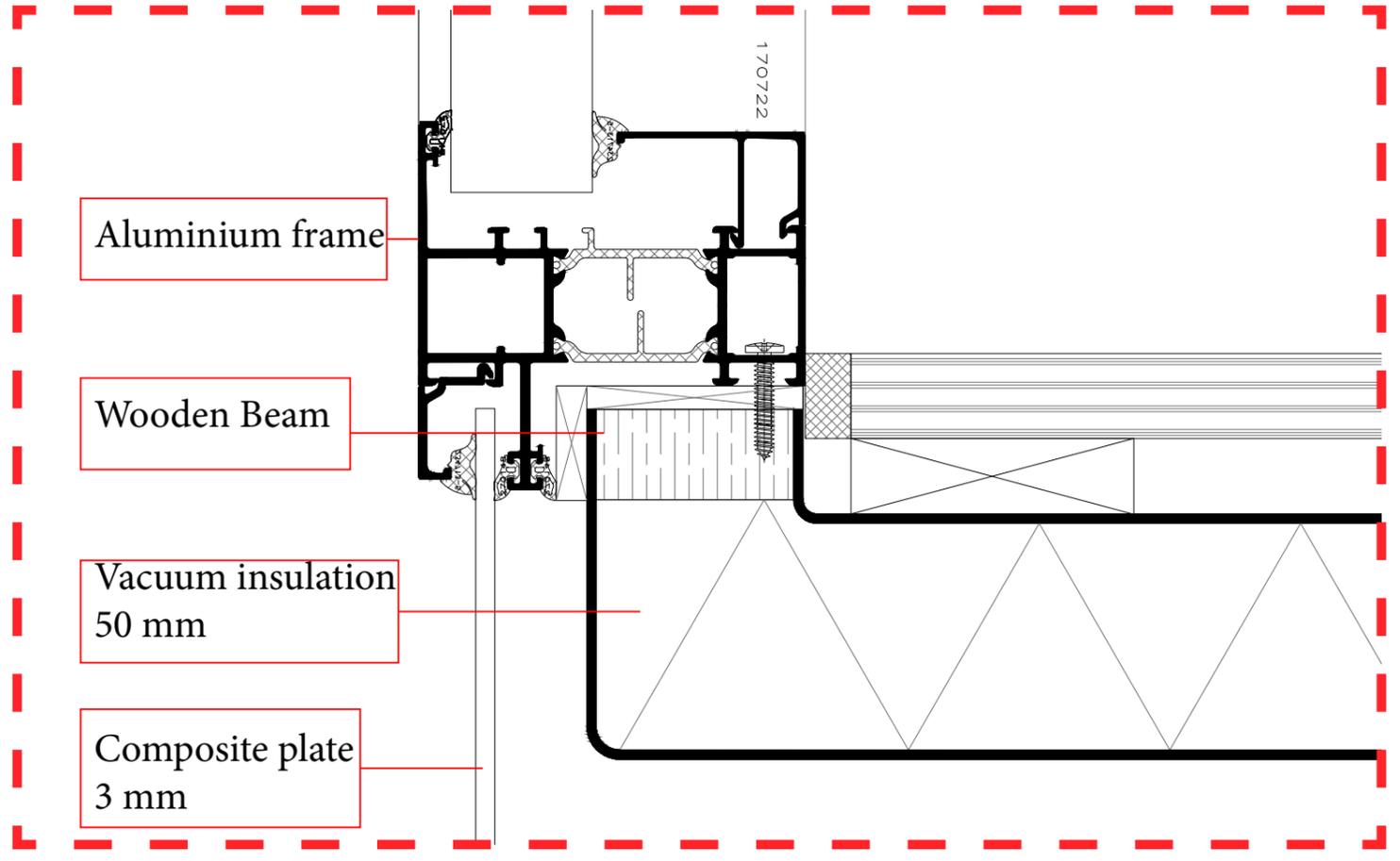
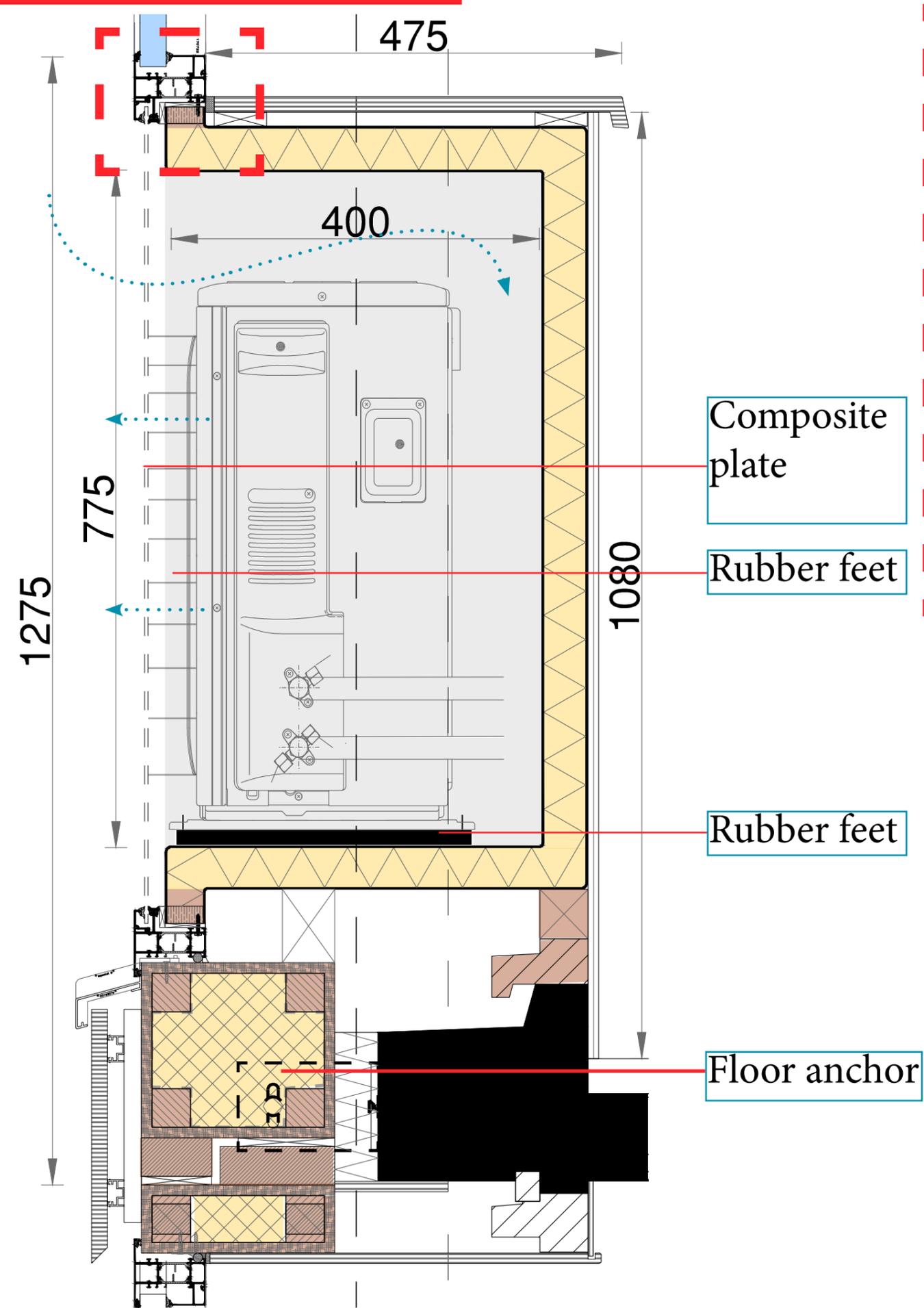
SIPS -  
wood panel



# FINAL DESIGN



# FINAL DESIGN





## Design evaluation:

- Design requirements, according 2ndSkin

- Interviews

- Supplair --> Mitsubishi
- Constructor --> BAM (nieuwegein)
- Architect --> Bart spee architecten

- Design requirements, according 2ndSkin

Aspect	Description	Grade +/-
Structural adjustments	adding structural elements? changing structural elements Level of demolition.	+
Facade assemblage	Component or element facade? Assemblage technique complex? Prefabricated level?	+
Residents	Level of disturbance?	+/-
Integrate installation	level of prefabricate installation level of assemblage technique	+
Scaleability	level of customized design or Industrialised solution? Fit other typologies?	+



-No structural adjust,  
-Some typology--> remove parapet (brick)

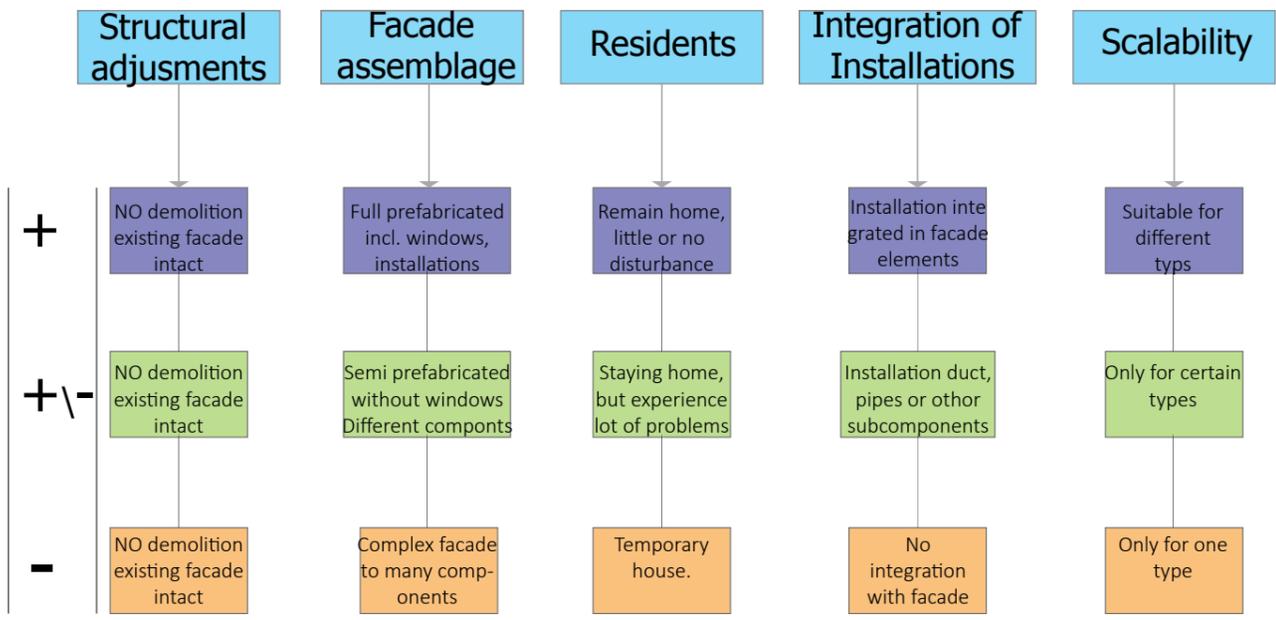
-Traditional assemblage methode  
-Flexibel --> component or element

-Install waterpipes/elektra from inside  
-Maintenance from inside--> staircase?

-Full prefabricated but, Transport --> box

- High Scaleability--> according the dimensions of the box

### Design requirements



- Interviews

## **ir. Linda van Leeuwen (Bam/stroomversnelling)**

- Integrating heat pump in facade is potential --> Roof is not always best option- slope/pv-panels
- Maintenance from outside --> Expensive -> Staircase is very good option
- Integrate boiler in facade --> Interesting topic --> needs investigation according installation time with current methode
- Install from inside --> Bam research indicate work in kitchen is not disturbing

## **ir. Hugo Jansen (Mitsubishi/Growing green/stroomversnelling)**

- Integrating heat pump in facade --> Refurbishment & new building, wanted product Airflow--> testing/monitoring
- Maintenance from outside --> Needs to be easier designed
- Integrating boiler in facade --> Needs investigation on costs and time

**Architect --> Not yet interviewed**

## • ALL ELECTRIC SYSTEM

- Testing/monitor heatpump --> Mitsubishi Lab
- Production technique Boiler, Stiffness --> Tema Techniek
- Boiler facade, staircase or inside --> Cost study -> Markt related
- Install from inside 2hr --> Inhabitants study

## • Facade Module

- Transport full or semi --> Efficiency study --> design study
- Composite frame --> Design study --> constructive
- Box development --> P5 --> Material, Mounting, form
- Esthetically --> P5 --> Design option parapet

*"How can all electric equipements get integrated in a prefabricated facade module, to upgrade the building envelope for Dutch post-war apartments to make them Zero energy?"*

## ***How can we integrate 200L boiler, without changing the façade geometry?***

- Use "open source" all electric system, with plate heat exchanger
- Design the boiler without
- The window/parapet are suitable area's in post war appartements

## ***Is the heat pump suitable to integrate in the façade?***

- According --> airflow of the HP vs Facade, still unknow. Reference project showed it is possible
- According to weight and size the heat pump is not a obstacle,
- Maintenance is once year, low cost reachable from outside.
- Leads to a industriliased design, fits in refurbishment

# “Towards Industrialized Zero Energy Retrofit” by a prefabricated FacadeModule

**THANK YOU!**

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- 3<sup>de</sup> Dr. ir. P. van den Engel
- ext Dr.ir. Olindo Caso,