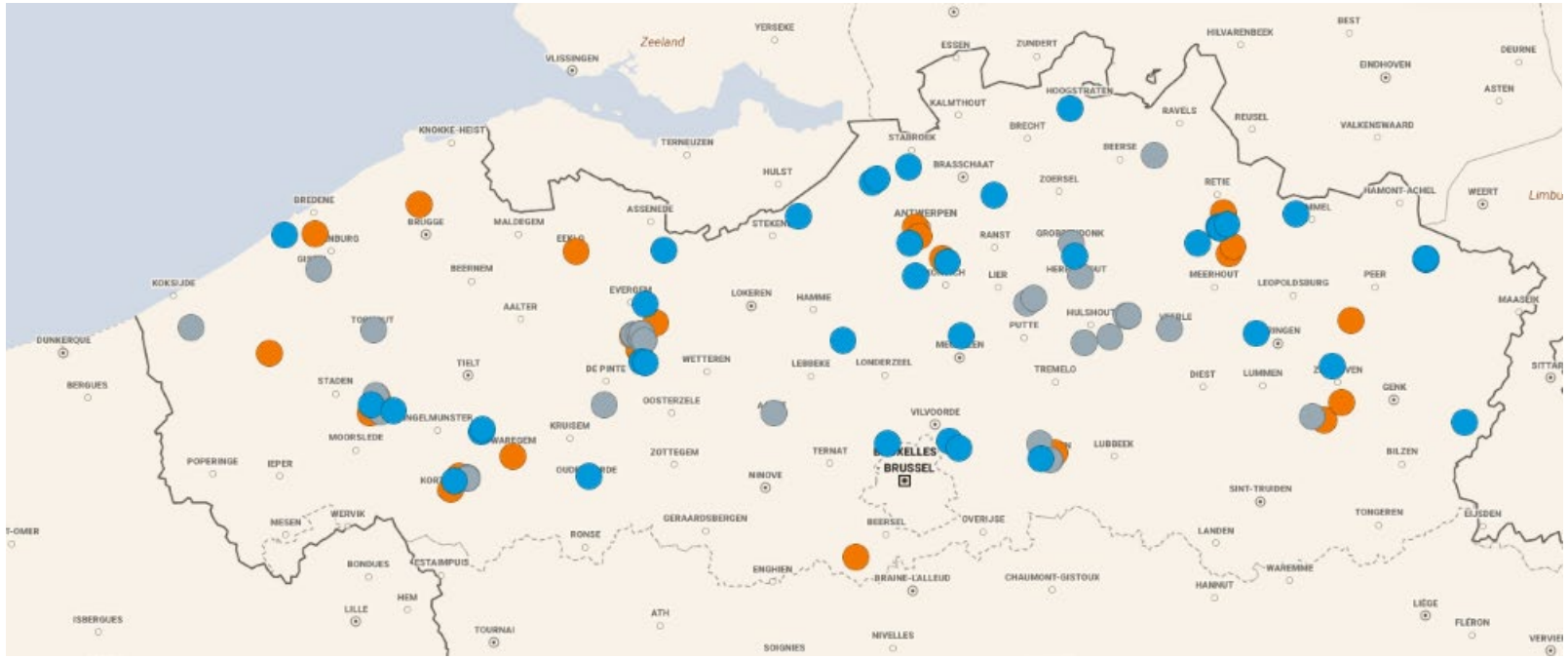
Near optimal design and operation of clustered buildings in cities, a top-down ready bottom-up approach

Workshop District Heating
28/11/2023

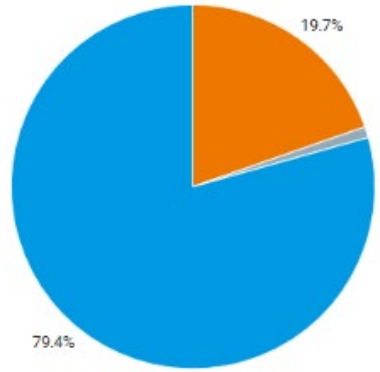
District heating networks in Flanders

SWECO

DHN's in Flanders – the current state



- Mixed DHN
- Domestic DHN
- Non-domestic DHN



Share of heat use per DH type

→ Only a small number of households is served by a DHN

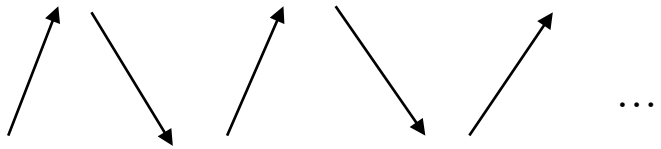
https://dashboard.vreg.be/report/Warmtenetkaart.html

Although…

Eerder lage kans voor collectieve warmte
Lage kans voor collectieve warmte

Key actors are waiting for each other

Production & distribution
Uncertainty about connection rate



Consumers
Uncertainty about heat supply

Inputs from multiple collaborations and real projects in practice and research

Integrated fossil free design of building and building services

..**hybrid** costoptimal design **and operation** (control)

..**clusters & clear hybrids**

Costoptimal in

Design and operation

Fossil-free

System integration and system approach

GEOTABS

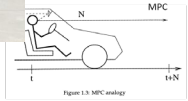
Building level

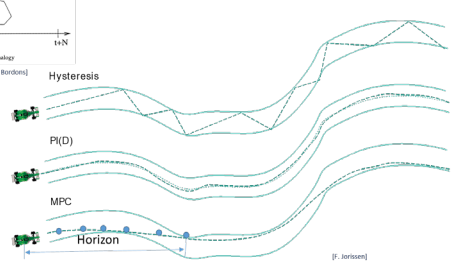
Province house Antwerp
Boydens engineering part of sweco

hybrid GEOTABS (MPC) EU Horizon 2020

Building level

modelgebaseerde predictieve regeling (MPC)



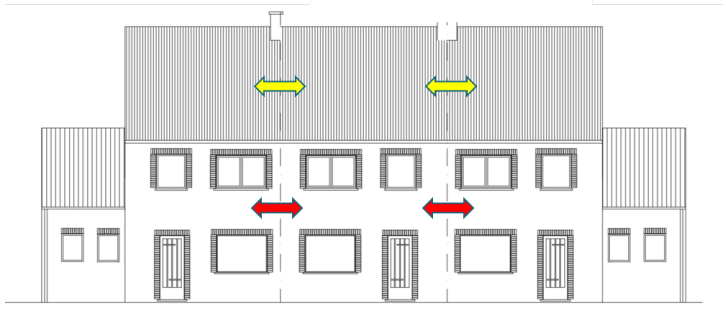


Source: builtwins
MPC company
Spinoff KU Leuven

Tiny cluster approach de **Schipjes** social housing district

HeriTACE & SEEDS

Collectivelevel



bron: duurzame drieluik, Ugent Gommers, 2021

From building to district

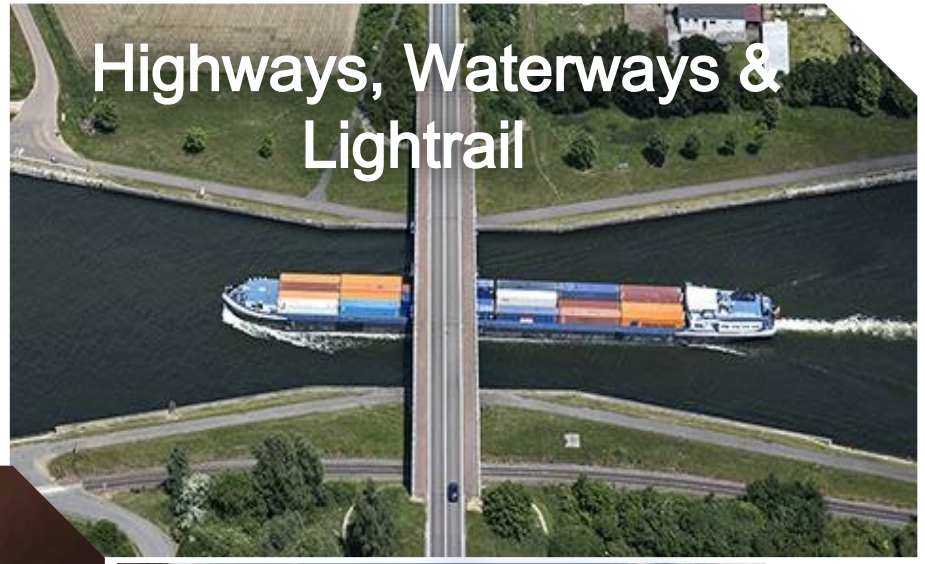
Collective level

Kasteel en nieuwbouwontwikkeling Blauwpoorte Izegem
Urbes
boydens engineering part of sweco
KU Leuven (Hermans-Helsen)

Sweco in Belgium

- 2 600 experts in Belgium

SWECO

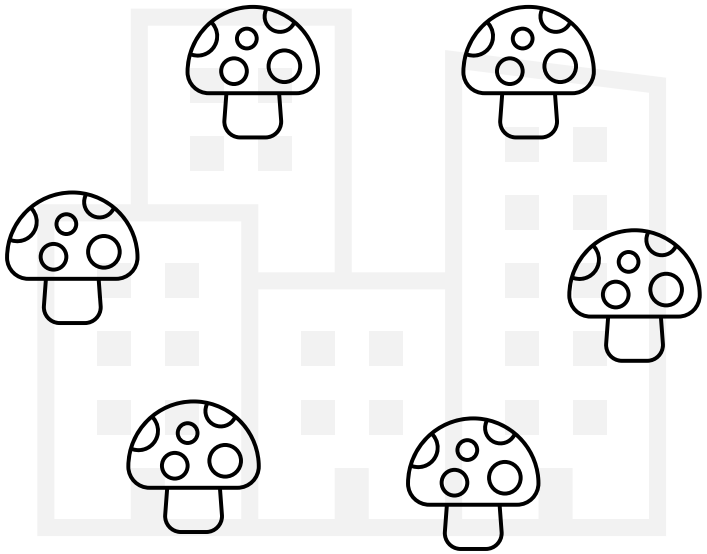


Risk mitigation using technical solutions

Near optimal design and operation of **clustered buildings in cities**, a top-down ready bottom-up approach

Divide the challenge at the demand side into smaller sub-assignments

District-level, group of households (when possible clustered with other functionalities in the neighborhood)



SWECO

Near optimal c
cities, a

50 households

KU LEUVEN

Optimization of design and operat

- Design: combination of heat so
  Ground, water, air, residual hea
- Operation: smart control (KULeuve
  RBC, MPC

Maintaining flexibility for optimizatio
Plug 'n play

What is de the perfect size of a cluste

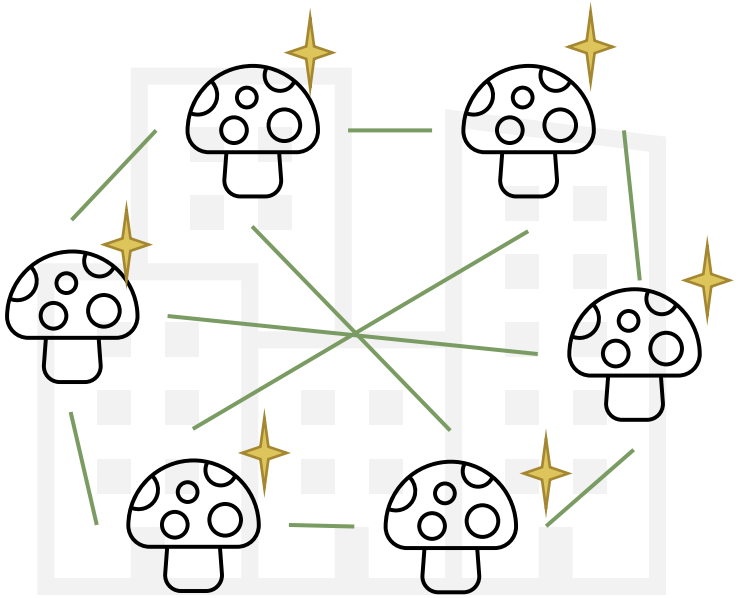
Source: Haesen & Hermans: Department Mechanical Engineering, Thermal Systems Simulation (The SySi) Team

bron: duurzame drieluik, Ugent Gommers, 2021

Near optimal design and operation of clustered buildings in cities, a top-down ready bottom-up approach

Connection of optimized clusters instead of separate households

- ✓ Risk mitigation
- ✓ No need to wait:
  - Ready for **starting today**
  - Smooth **integration in a future** larger (city scale) thermal grid
- ✓ Optimal use of available heat sources for the city

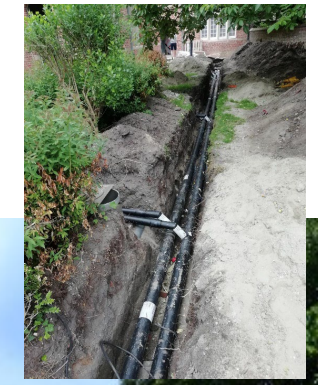


Cluster optimization test case: “De Schipjes”

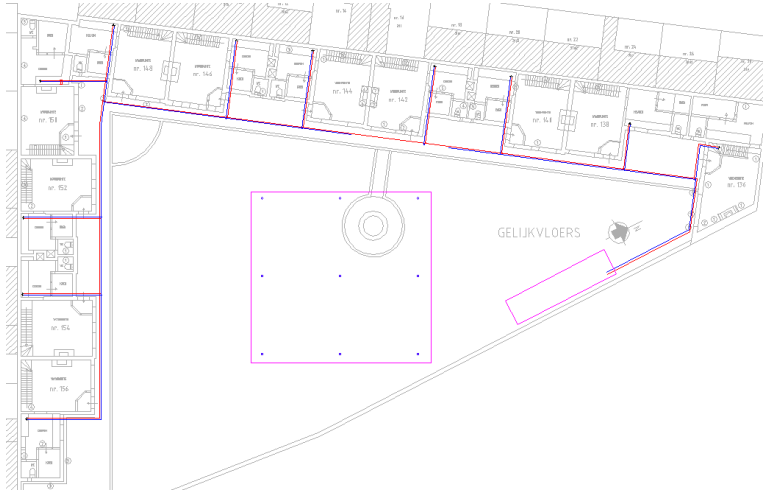
The historiœcentermedieval Bruges

Almshouses ‘the Schipjes’

VLAIO “proeftuin” living lab 20142019



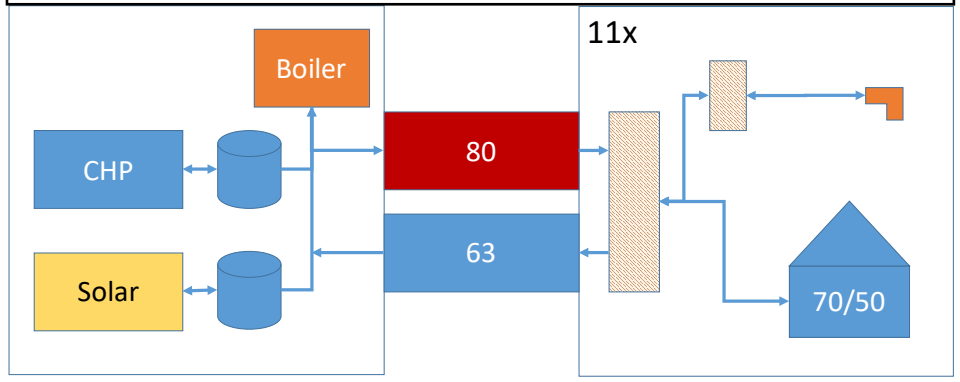
- 11 small houses (1907) in the historic city center of Bruges (BE)
- Energetical upgrade & retrofit of the historical site (building & technical performance) without a gas boiler using simulations



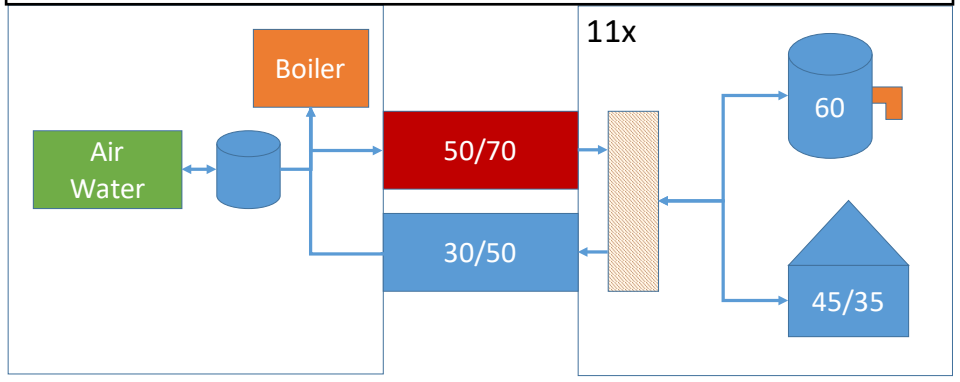
VLAIO · UNIVERSITEIT GENT · boydens engineering · KU LEUVEN · Energy Ville · HPT · mintus zorg met een plus · SWECO

Thermal network – scenario analysis

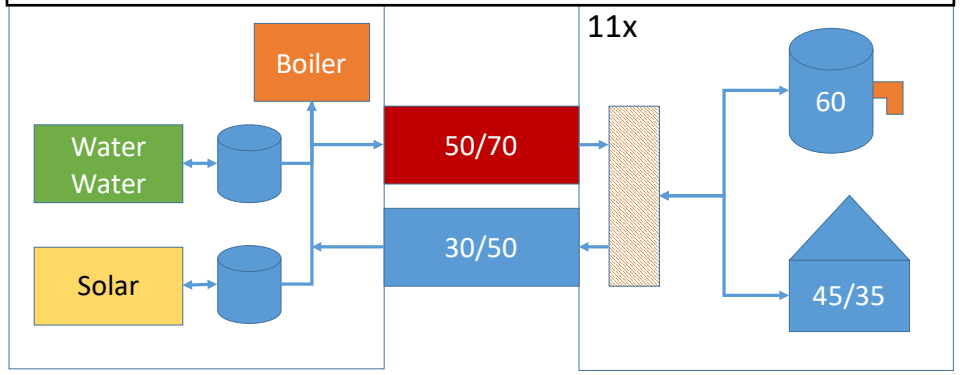
Scenario 1 (S1): high temperature



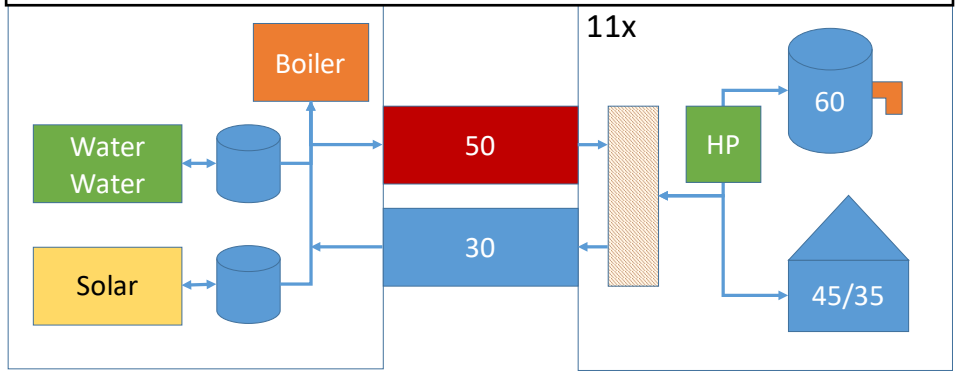
Scenario 2 (S2): intermittent temperature



Scenario 3 (S3): intermittent temperature



Scenario 4 (S4): low temperature



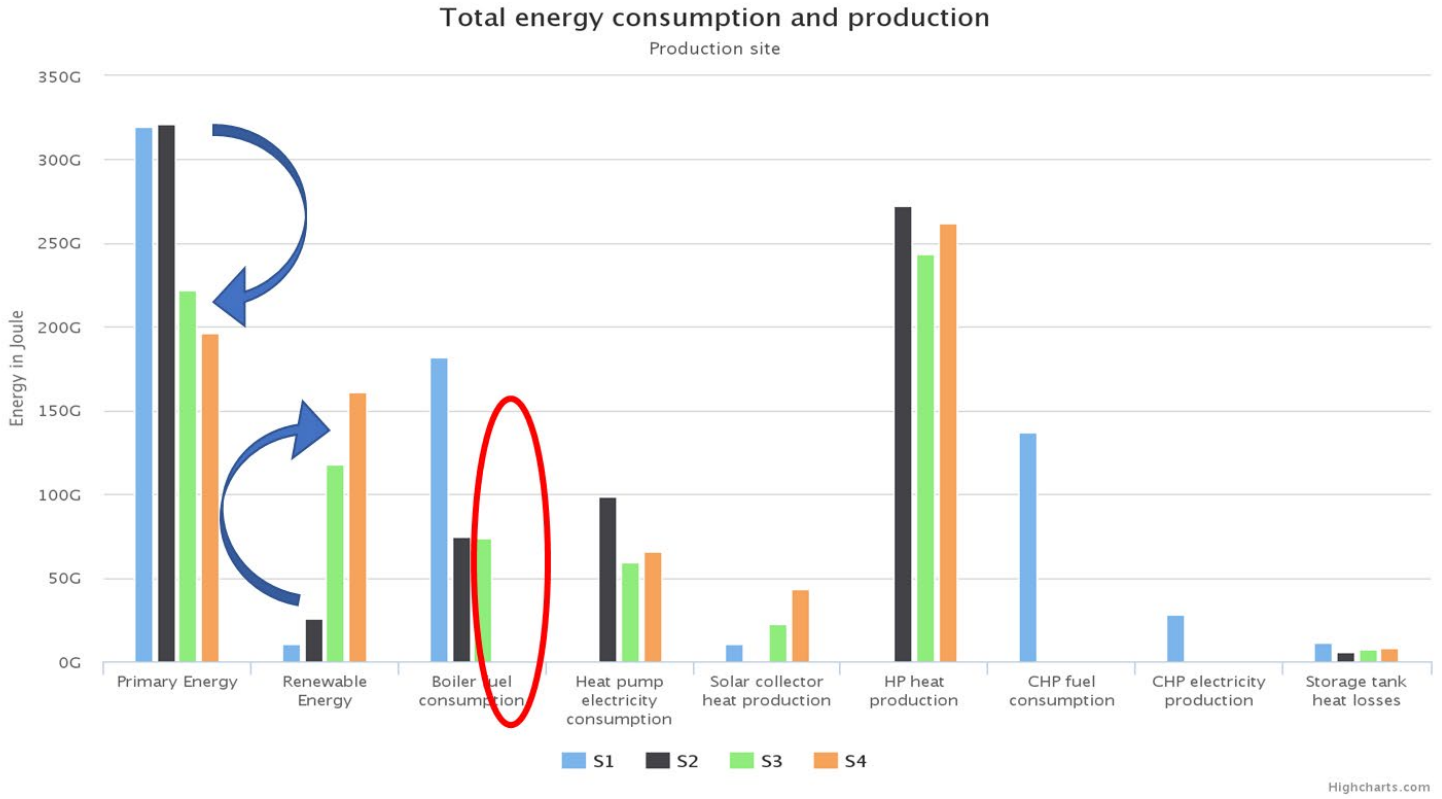
Performance based configuration of hybrid systems

From scenario analysis & based on simulations:

- Centralized GSHP
- Centralized solar collector
- Individual boosters
- Later: air source heat pump

→ System integrated design

Hybrid (multiple renewable technologies) **collective systems** make decarbonisation feasible and affordable



Way forward

- HeriTACE
- SEEDS

The horizon SEEDS project: towards an optimized residential cluster

1. Optimized sizing of hybrid systems

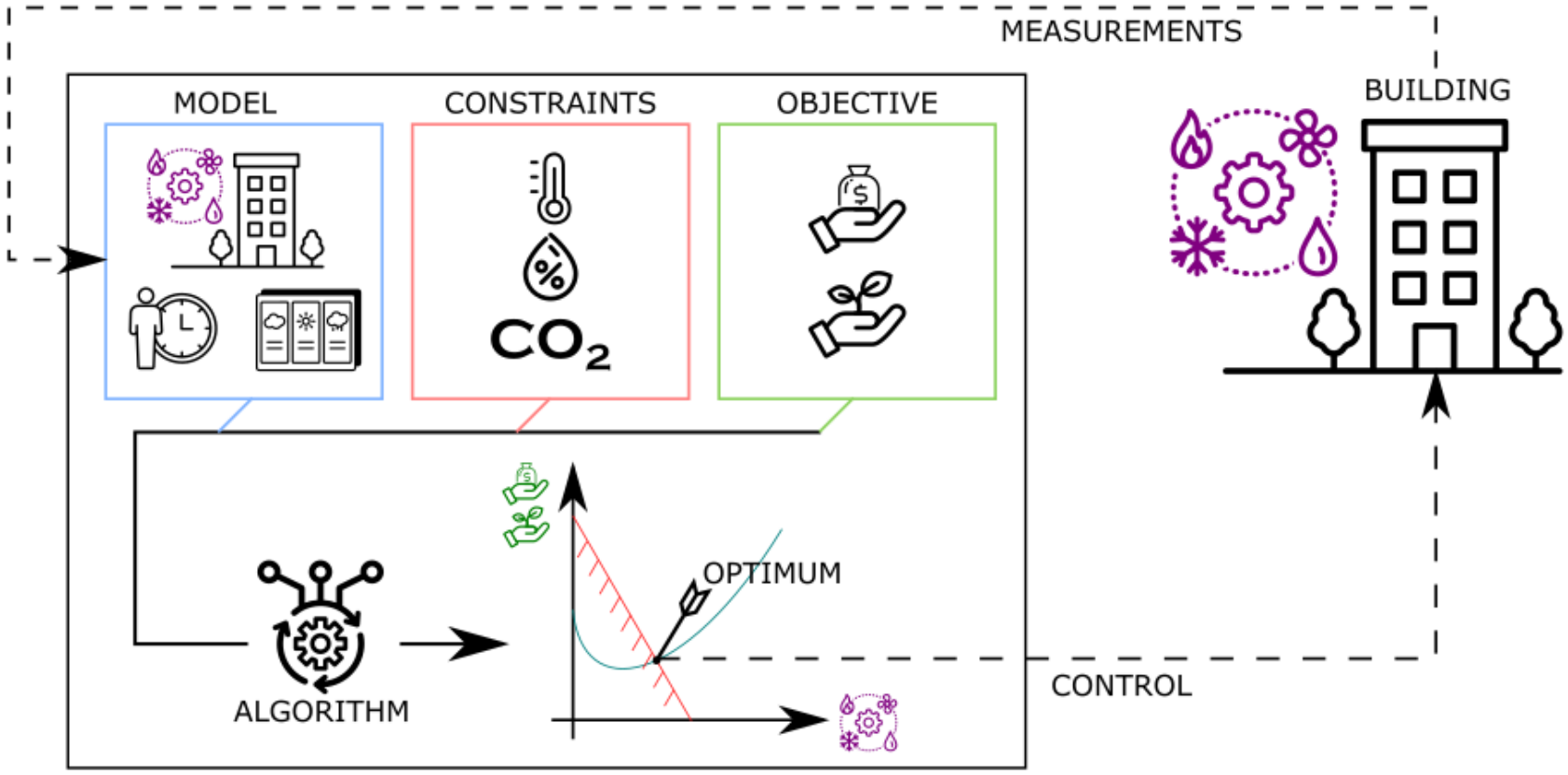
2. Optimized system integration through model predictive control (MPC)

3. Hydronic scheme switch frame to further optimize operation and performance

→ joint research and methodology development approach by partners KU Leuven & SwecoBE

KU LEUVEN SWECO

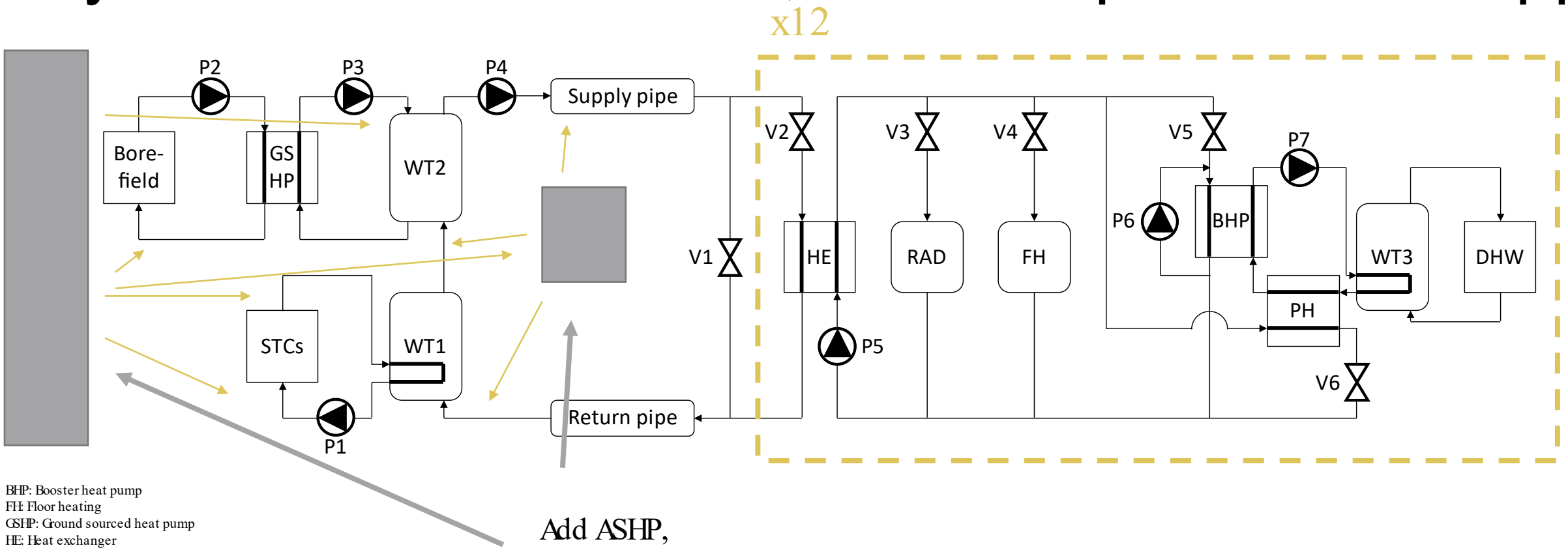
Optimized system integration through model predictiv control (MPC)



Source: D. Picard & F. Jorissen 2021, Builtwins

KU LEUVEN SWECO

Hydronic scheme switch, flexible operation of supply



BHP: Booster heat pump
FH: Floor heating
GSHP: Ground sourced heat pump
HE: Heat exchanger
PH: Preheater
RAD: Radiators
STC: Solar thermal collector
WT: Water tank

Add ASHP,
Make multiple connections for different seasons in backbone scheme switch, enrich variations and scenarios
Dynamic hydronics, feedback to models, …
Explore MPC as scheme switcher

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Extrapolation opportunities

Replication of De Schipjes concept to other residential districts in Europe

Demonstrated solution for historic buildings

- Highly replicable in historic city centers all over Europe
- Highly replicable when the energy mix is strongly dependent on Russian fossil fuel supplies
- Highly replicable in whatever district (since proven for the most difficult case)

Thanks for listening!

More information?

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anouk.robbeets@swecobelgium.be

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