hybrid GEOTABS

Controlling the power of the ground by integration

INNOVATIVE PROCEDURES FOR THE OPTIMIZED DESIGN OF HYBRIDGEOTABS BUILDINGS

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The data source construction: Prof dr ir-arch Jelle Laverge, Ghent university

Goal

Develop easy-to-use guidelines for HVAC engineers, with the ultimate goal to develop design tools that will help the designer team (architects, HVAC engineers, structural/mechanical engineers, control engineers and acoustical engineers**) to set-up the building HVAC systems with the hybridGEOTABS, in order to make the predesign phase short and easy, comparable to the predesign phase of traditional technologies**

This task is translated into :

- **Guidebook** easy-to-use guidelines + describing the additional tool [book Rehva]

- **Decision making tool for concept selection**
  - read: to hybrid geotabs or not to hybrid geotabs
  - without the need of a tailor made load duration curve as input => extrapolated from basic geometry and technical parameters

Why?

Usually done with simplified or static approaches, and with a qualitative storyline.

The hybridGEOTABS concept does not fit in to this approach, since it relies on storage (hours and months) that relies on the dynamic behaviour and integrates other advantages as grid flexibility and low carbon energy supply. The behaviour is extremely dependent on the control.

Assessing this to compare and quantify the hybridGEOTABS advantages is crucial to remove the barriers that developers and designers face to correctly adopt the concept as a suitable scenario in the early concept comparison.

Give hybridGEOTABS with optimized control a fair level playing field
in the early project design stage, the stage where the concept is chosen.

Main Idea *"Every building deserves a share of Tabs"*

I have a project

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I want to apply GEOTABS
(disregarding the limitations of the building envelope performance limitations)

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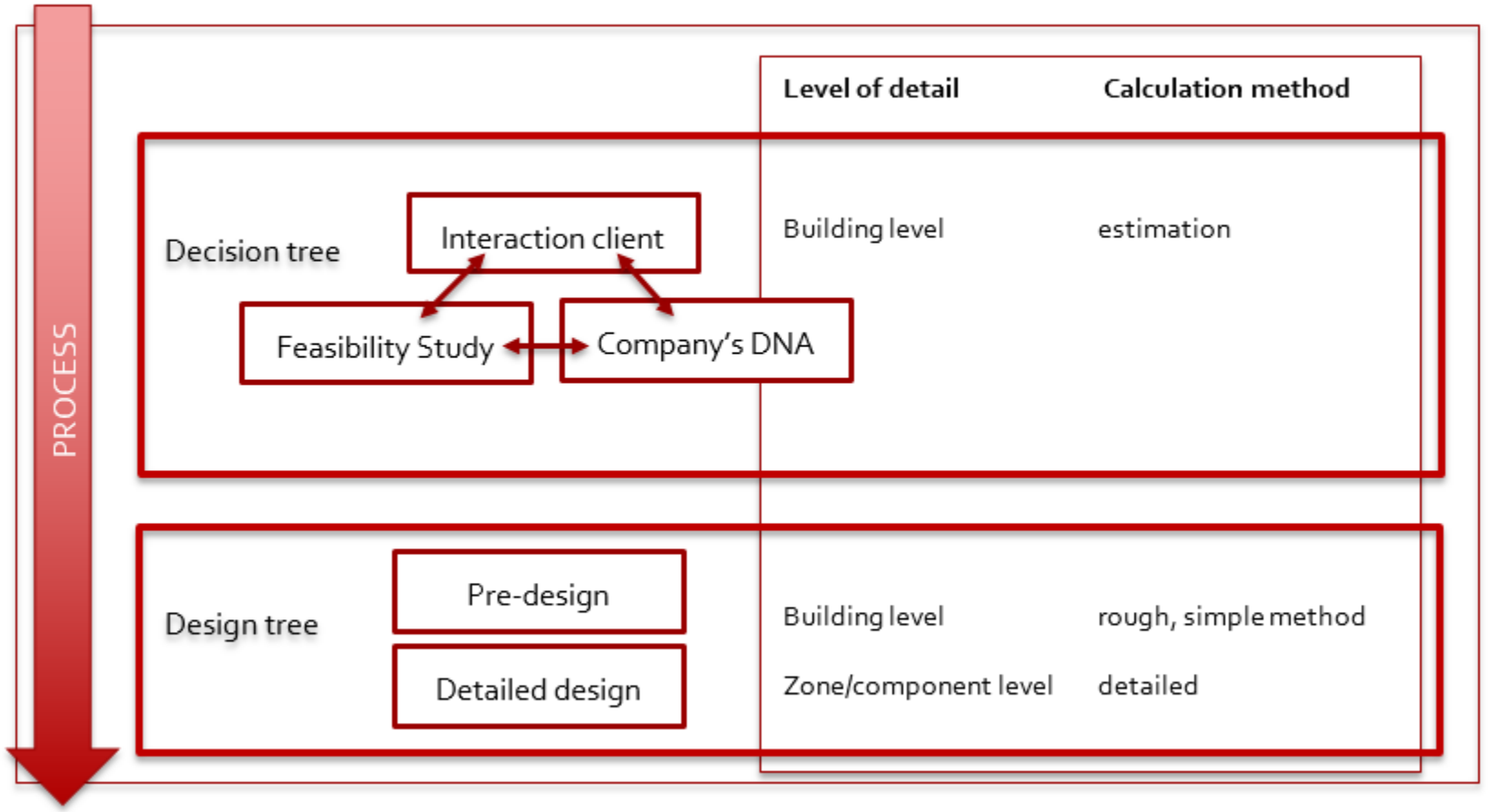
I want to apply GEOTABS

Question:
How far can we use GEOTABS?
To what extend it make sense for the project?
= Hybridity
And quantify the advantages

Feasibility and pre-design process



Feasibility and pre-design

Feasibility study: one part of this decision phase
In addition :

- Prospect with client: What is the need of the client?
- Concept study/brainstorming: integrate companies DNA (“a sustainable, energy efficient concept”)

Feasibility study

- ✓ not only a calculation process
- ⊗ helps in the interaction with the client, to show the impact of a concept on energy use, cost, payback time, CO2-emission…

Feasibility

STEP 1: What are possible concepts for the building?
Constraints in Boundary conditions?

Internal constraints: *function (office, theater…), indoor environmental quality (acoustics…), timing, financial resources…*
External constraints: *climate, geography, geology, legal frame…*

Hybrid-Geotabs | Concept 2 | …

STEP 2: Estimate heating and cooling load

Building concept: *internal heat gains, thermal mass*
Building heating and cooling load: *estimate heating and cooling capacity*
based on (local) standards (e.g. ISO 11855-4, EN ISO 13790), benchmarking numbers, experience, previous projects

STEP 3: Apply estimated heating and cooling load on the chosen concepts

Concept of hybridGEOTABS
Estimate Type of the GHEX: : *available ground area => open or closed*
Capacity of the GHEX: *available ground area, drilling into artesian water…*
=> Rule of thumb, map with ground data
System Concept:
GHEX sufficient or additional heating/cooling on demand side?
TABS sufficient or additional heating and cooling on emission side?

STEP 4: Is the Concept of hybridGEOTABS feasible?

Estimate performance of system: *energy use, CO_2*
Cost estimate: *investment cost, operation cost, maintenance cost*

Feasibility

How far can we use GEOTABS?
To what extend it make sense for the project ?
= Hybridity

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hybridGEOTABS | Concept 2 | …

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Feasibility and pre-design

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In addition :

- Prospect with client: What is the need of the client?
- Concept study/brainstorming: integrate companies DNA (“a durable, energy efficient concept”)

Feasibility study

- ✓ not only a calculation process
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➡ Guidelines + Tool:

- Necessary to help to see the impact of the hybridity on cost , durability, ….
- Allows to give for every building the best option (now some buildings excluded based on experience,…)

TOOL: 3 big parts

BUILDING:
DEFINING BUILDING AND BOUNDARY CONDITIONS

Important to keep in mind that:

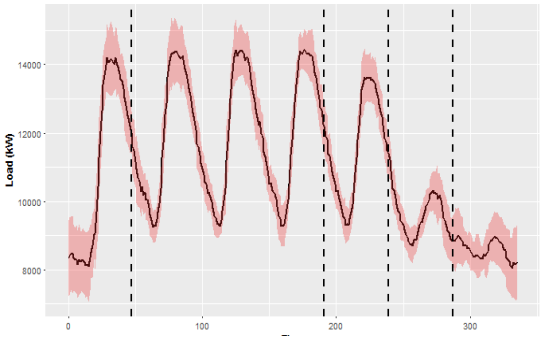
Target Public = whole designer team:
i.e.: architects, HVAC engineers, structural/ mechanical engineers, control engineers and acoustical engineers

- ⇨ Well-known general inputs
- ⇨ Freedom to overwrite some "default" values (experience and client)

Phase in the project: Early Design
- ⇨ Not many parameters known
- ⇨ Parameters derived from building stock

RESULTS:
DEMANDS AND PEAKS

3 Typical Weeks: winter –summer – intermediate season



Monthly Demand Prim and Sec. Heating and Cooling
+
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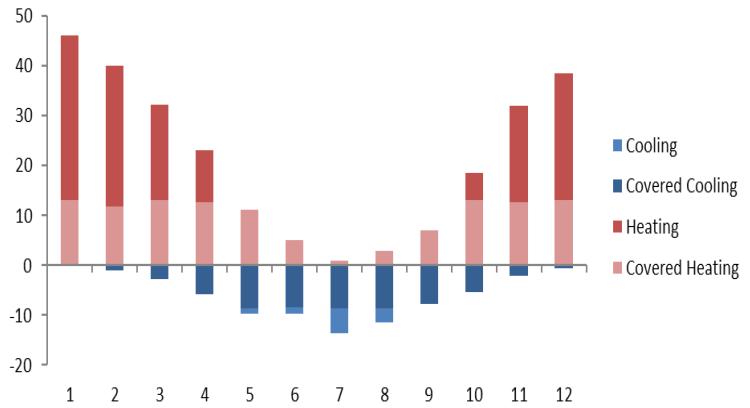
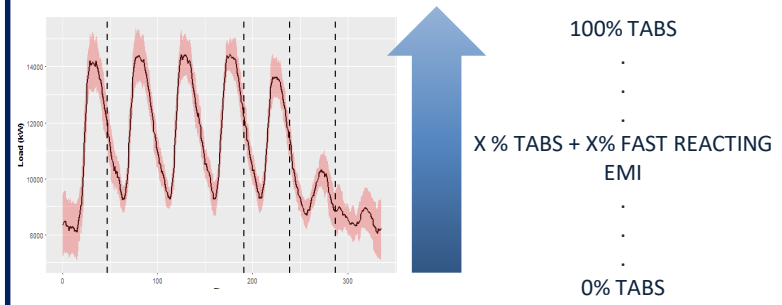


POST-PROCESSING:
COST AND DURABILITY

1. EARLY DESIGN:

3 Typical Weeks: winter –summer – intermediate season
⇨ hybridity of the concept for heating and cooling

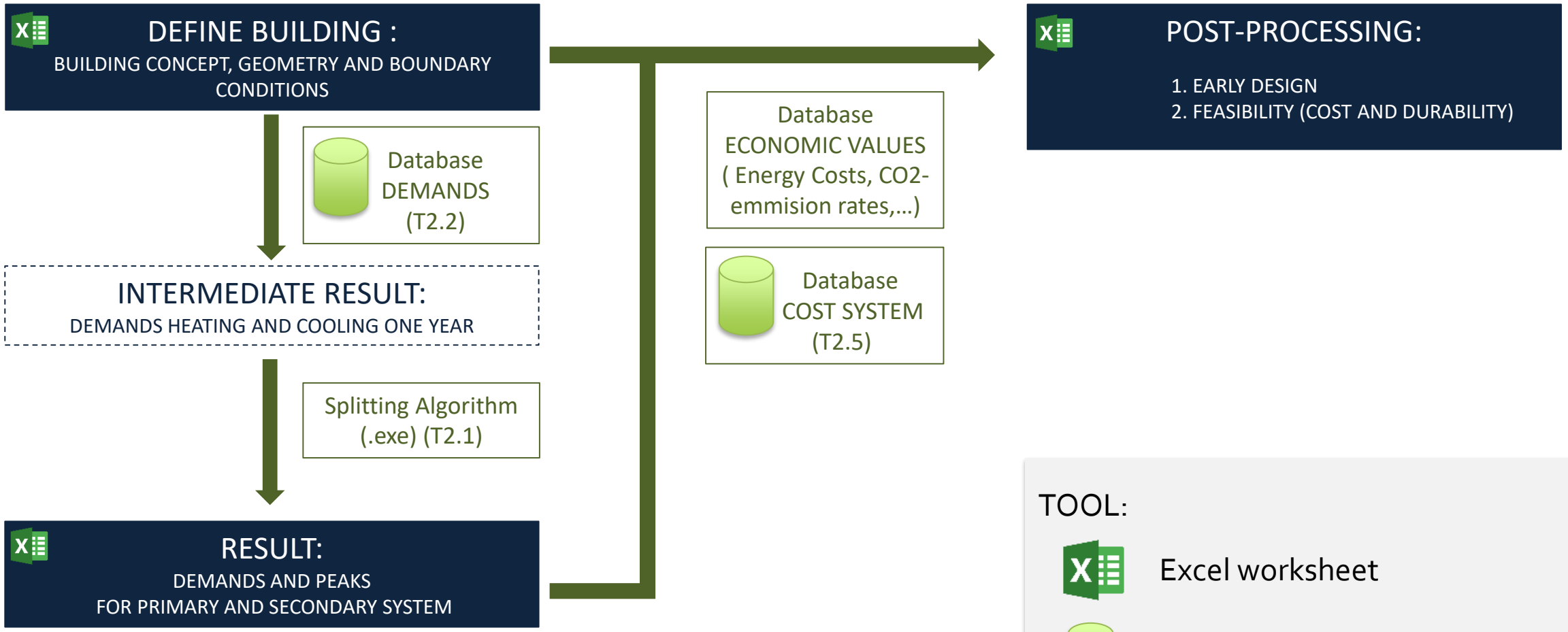


2. FEASIBILITY:

Monthly Demand Prim and Sec. Heating and Cooling
+
Monthly Demand Prim and Sec. Heating and Cooling
⇨ Investment + Operational + Maintenance
⇨ Payback?
⇨ Durability?

Invested cases	Paybacktime	CO2 Reduction	Comfort
Base Case: non-geothermal	-	-	
Hybrid variant 1	N/A	N/A	
Hybrid variant 2	**6**	**15%**	
~~Hybrid variant 3~~	~~5~~	~~8%~~	-
Hybrid variant 4	**12**	**32%**	
~~Hybrid variant 5~~	~~13~~	~~5%~~	-
~~100% geothermal~~	~~10~~	~~-15%~~	-

TOOL: 3 big parts

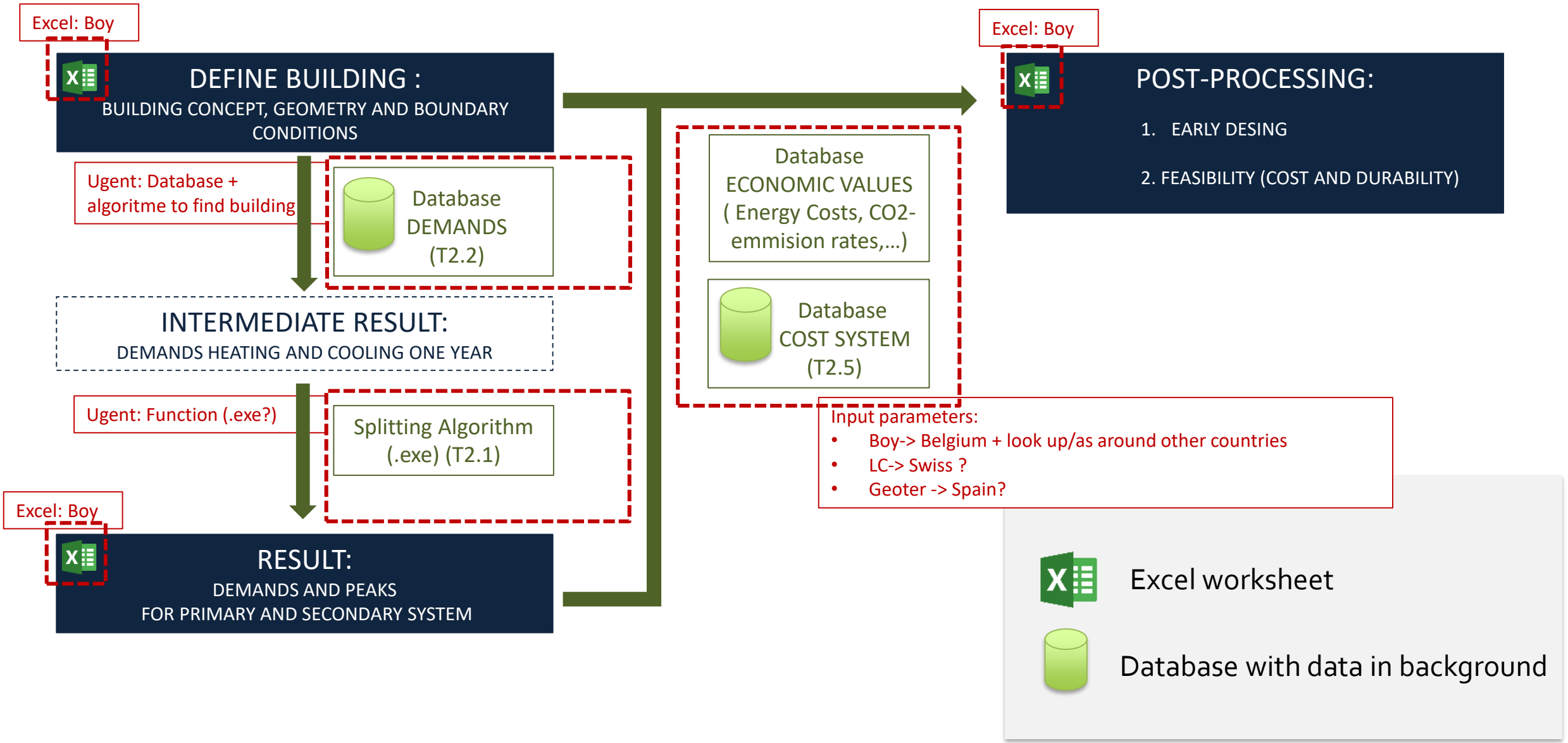


TOOL:

Excel worksheet

Database with data in background

TOOL: 3 big parts



TOOL: 3 big parts

BACKGROUND

Database BUILDING GEOMETRIC DATA
(building stock - T2.2)

Database HEATING &COOLING DEMANDS
(Dynamic simT2.2)

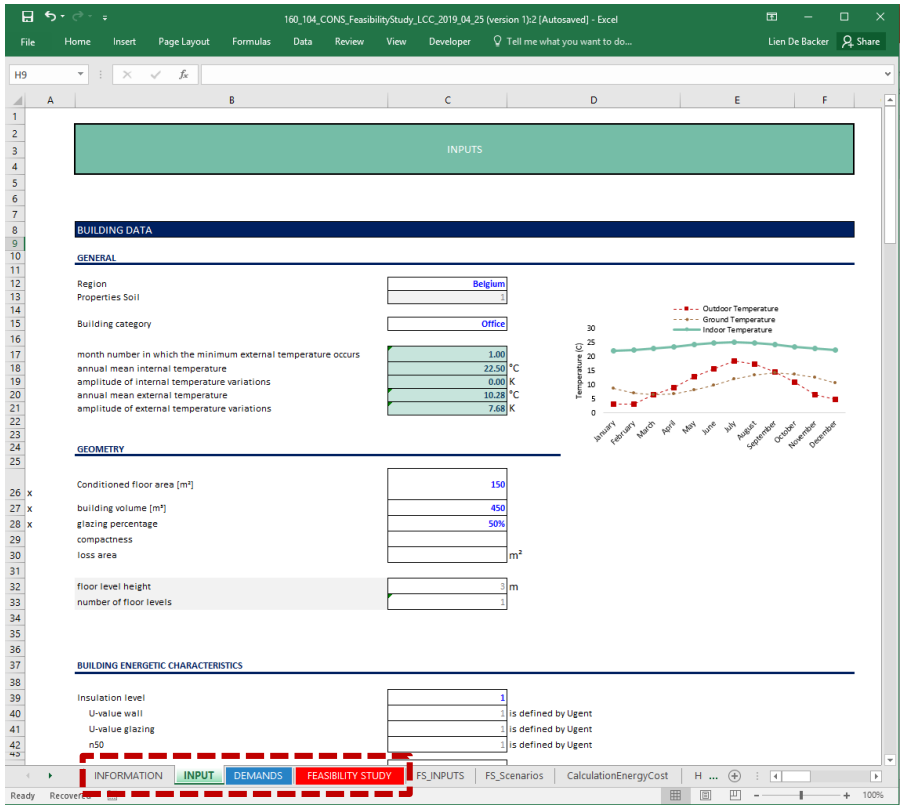
Database ECONOMIC VALUES
(T2.5: Lead Boy – helped by partners)

Database COSTS SYSTEM
(T2.5: Lead Boy – helped by partners)

SQL Server (online):

- Boy: Lead
- Ugent: writing access or own SQL database that will be later integrated into SQLserver

USER: EXCEL FRONT-END = TOOL



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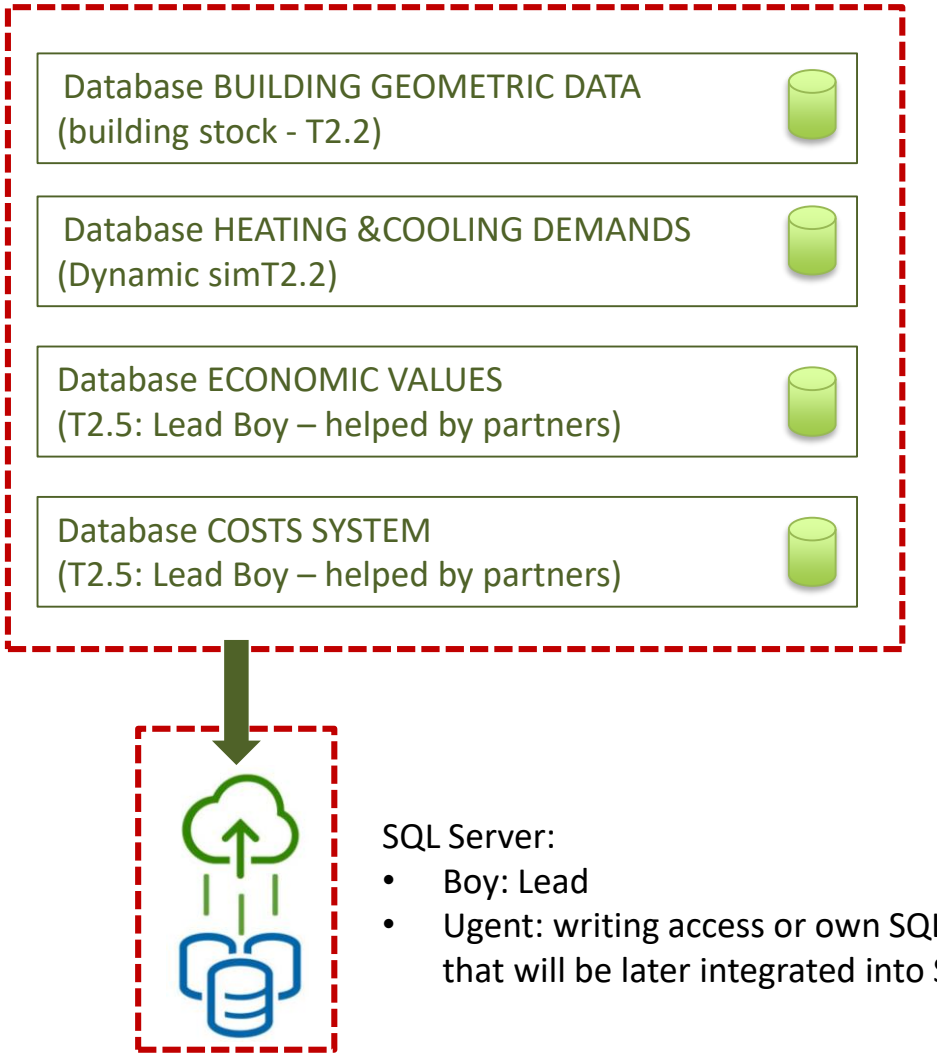

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TOOL: 3 big parts

INPUT

Algorithm (Ugent): f(building type, geometric parameters)

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TOOL: 3 big parts

INPUT

Algorithm (Ugent): f(building type, geometric parameters)

DATABASE TABLE

Building ID (prim. Key)	Volume	Floor Area	Glazing percentage	
1				
2				
…				
n				

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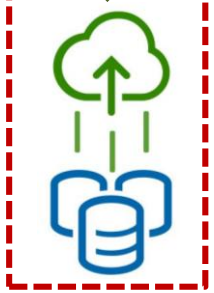

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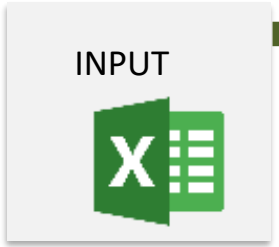

Algorithm (Ugent): f(building type, geometric parameters)

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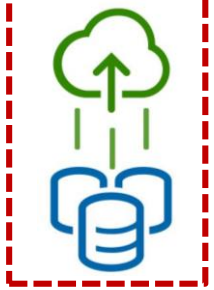

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TOOL: 3 big parts

For each building (**Unique ID**): TABLE with heating and cooling demands

TimeStep [h]	Qheat	Qcool	Qheat,prim, baseload	Qheat,sec, baseload	Qcool,prim, baseload	Qcool,sec, baseload
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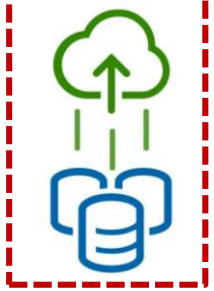

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Baseload Splitting Algorithm (.exe)
= BEST SPLIT from energetic point of view

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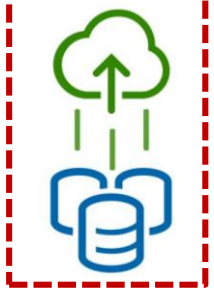

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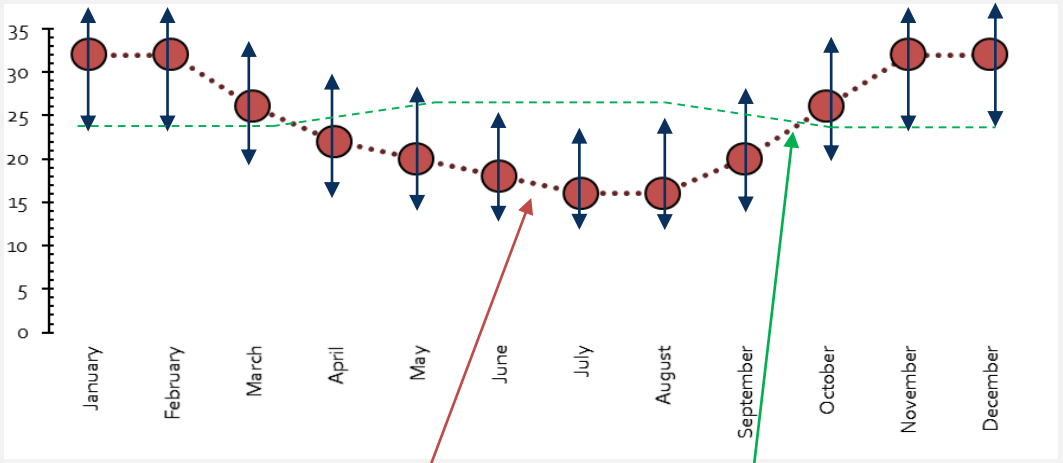
Equalizer: Set Floor/Ceiling water temperature (TABS)



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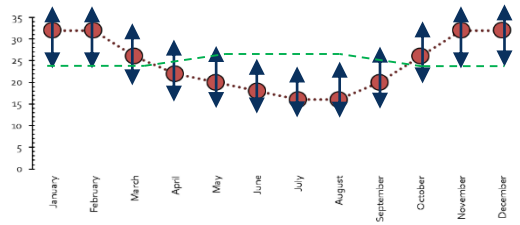
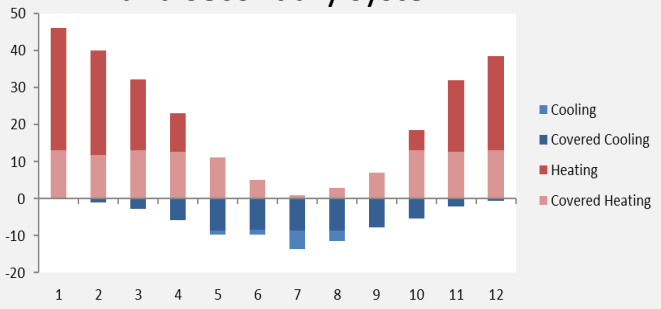


AdaptedBaseload Splitting Algorithm (.exe) → 1

Energy use
+ peak for heating/cooling for primary and secondary system



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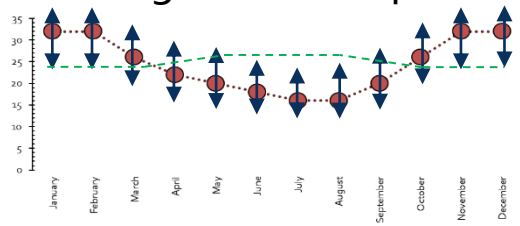

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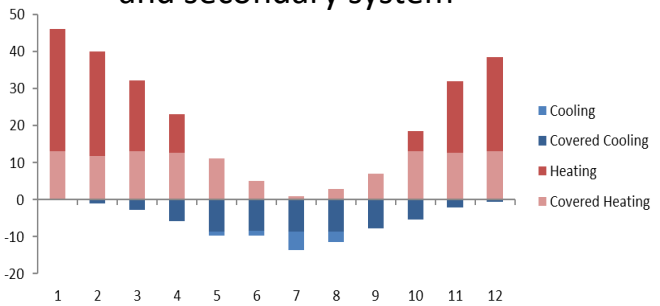

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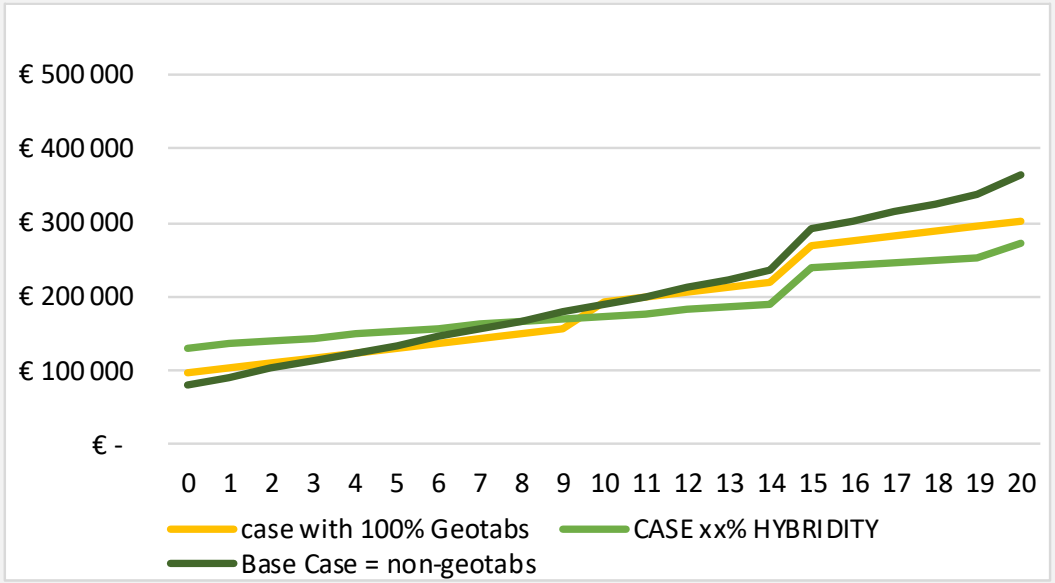

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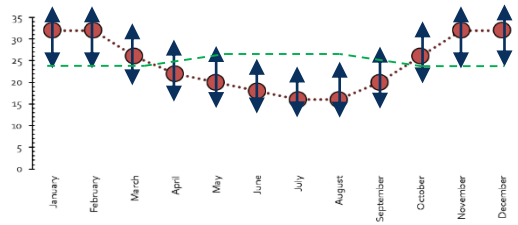
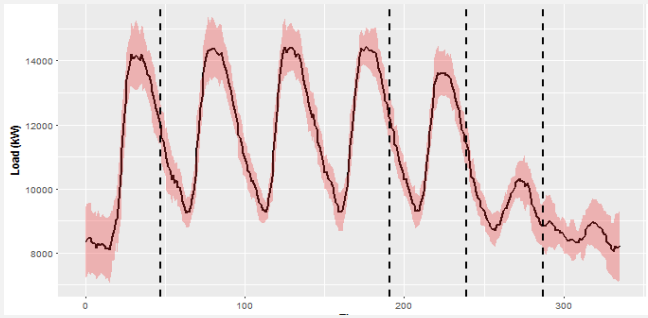


AdaptedBaseload Splitting Algorithm (.exe) 2

3 Typical weeks



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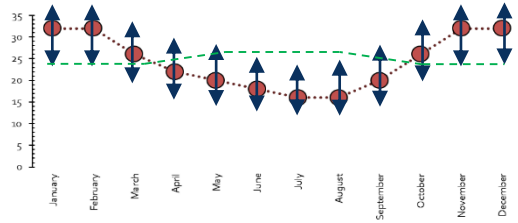

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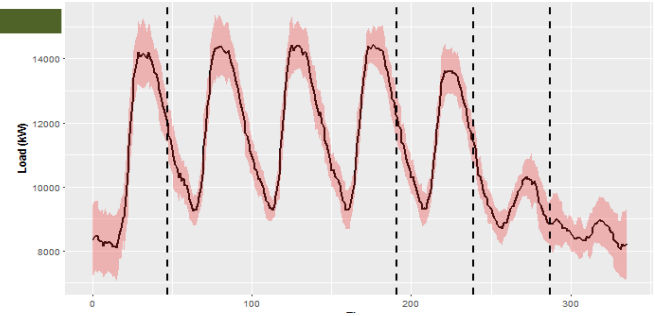

PREDESIGN

Case 1 : flat curve $Q_{dot}h < x$	Answer Non hybrid (TABS suffices) e.g. well insulated MFH in moderate climate
Case 2 : moderate amplitude curve $X < Q_{dot}h < y$	Answer «Hybrid» with dominant share of TABS (still peak load must be covers by secondary to guarantee comfort)
Case 3 : high amplitude curve $Q_{dot}h > y$	Answer «very Hybrid» alternation of heating and cooling on a weekly basis (and high peaks)

that will be later integrated into SQLserver