Specific Environmentally-conscious Targets for Urban Planning (SETUP)

A method for informing the decision-making process

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Context, Motivation, Objectives

Early design phase

Absence of detailed project information

Diversity of possible scenarios and performance levels

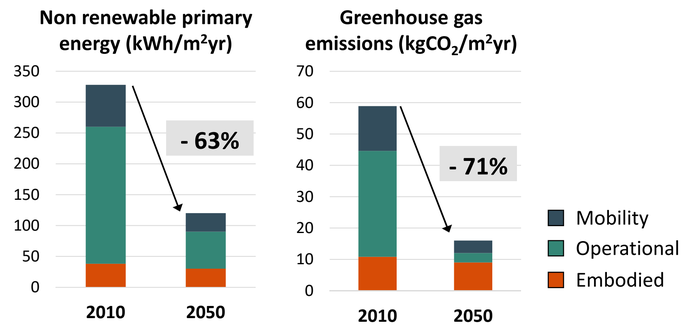
With increasing awareness around climate change and humans' ecological impact, further improvements are necessary to **minimize the environmental footprint our buildings have over their whole life**, from the construction to the operational phase and beyond.

In this context, various **building labels and norms** are setting evermore-ambitious **primary energy and greenhouse gas emissions targets**. In parallel, a growing number of **digital performance evaluation tools** integrate a **life-cycle assessment** and allow verifying if a project, based on its description, reaches these targets. However, such instruments are still largely left out of the **urban planning and design stages**, characterized by the ill-defined status of the project and the exploration and comparative assessment of multiple possible solutions.

Confronted to those conditions, existing tools often fall short given their **limited guidance and inadequacy** in dealing with the **scarce amount of available information**. We specifically observe a **lack of tools** that can allow **converting a performance objective set at the urban level** (e.g. 2000W society targets) into **specific sublevel targets** (e.g. per building or component), while taking into account the **site's characteristics** (e.g. climatic context).

*"[…] **target values cannot be reached for each building**. Some initial situations exclude or greatly complicate the achievement of the objectives."* (SIA D 0236:2011)

The **SETUP project** aims to address these issues within the Swiss context through **collaboration with practitioners** having complementary roles in a district project aiming to be low-carbon. The goal is to elaborate a **novel method for enabling decision-makers to integrate environmental performance considerations from the masterplanning stage**, and to implement it into a **prototype decision-support tool** tailored to the site under study (blueFactory, Fribourg).



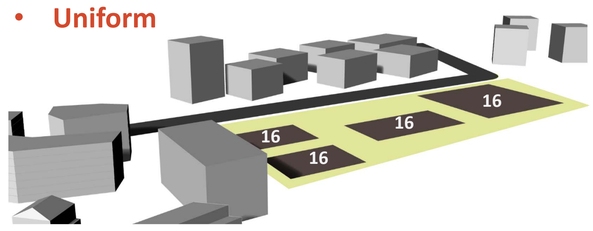
Values for residential buildings (sources: SIA 2040:2017), SIA D 0258:2018)

*"There are labels and objectives, but nothing that says **how to achieve them before the end of the project's realization phase**. I see the utility of a tool at the **very beginning** of the project, to figure out how to design my project so that it can fulfil a given label."* (project industrial partner)

Towards a zone-specific (contextualised) approach to defining performance objectives

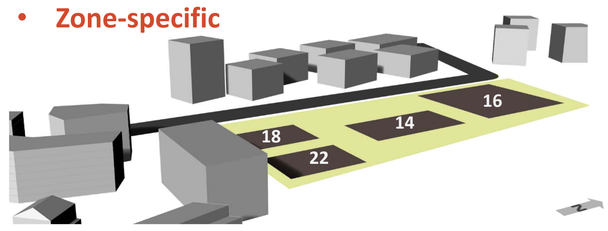
- given a performance objective set at site level of 16 $kgCO_2/m^2yr$ (SIA 2040:2017) -

- **Uniform**



- Targets applied at every level (site to zone to building) -

- **Zone-specific**



- Targets applied at subsite level -

Method, Workflow

1 Division of site in zones presenting different conditions

- Solar exposure level
- Limit in constructible building height
- Factors affecting mobility impact (SIA 2039:2016)
- …

2 Definition of variable and fixed parameters

- Variable parameters: building shape, depth, height; built context, glazing ratio and type, U-value, PV roof ratio, HVAC system, insulation material, …

3 Documentation of impacts and simulation hypotheses

- Factors related to embodied, operational, and mobility impacts (sources: KBOB database:2016, SIA 2032:2010)

4 Definition of scenarios

- Sobol sampling method for defining scenarios to evaluate (combination of variable parameter values)

5 Application to each zone

- Parametric modeling and dynamic energy simulation
- Evaluation of performance: (non-renewable) primary energy and greenhouse gas emissions

6 Data processing and analyses

- **Differentiated impact targets** at different sub-levels (e.g. per zone, per component)
- **Sensitivity** of performance indicators to different variable design parameters
- **Feasibility** of achieving given performance targets
- **Impact** of design parameters on performance indicators

Main outcomes

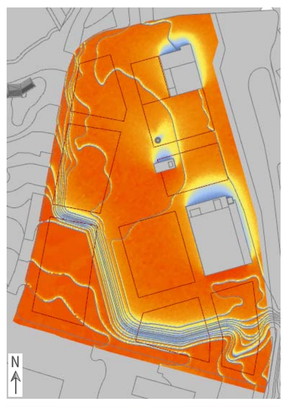
By interacting with the databases of scenarios and exploring the results of the various analyses through an Excel-based interface and dedicated web-based viewer, practitioners can **identify the most influential parameters for each zone** of the site, and **anticipate the share that a given design choice might take up in the total carbon budget** set for each zone. A feasibility assessment will indicate the difficulty in reaching a given site- or zone-level target. Such information can guide them toward **choices that do not constrain the design freedom for downstream parameters, or compromise the potential of the district for reaching its objectives**.

This research and development project notably highlights how the use of digital tools to produce, analyse and visualise data can contribute to **informing decision-making and fostering collaboration and communication** among complimentary key stakeholders.

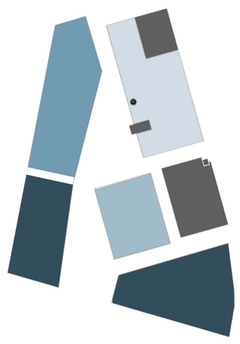
Case Study Application, Results

❑ Analysis of the **different conditions** over the site

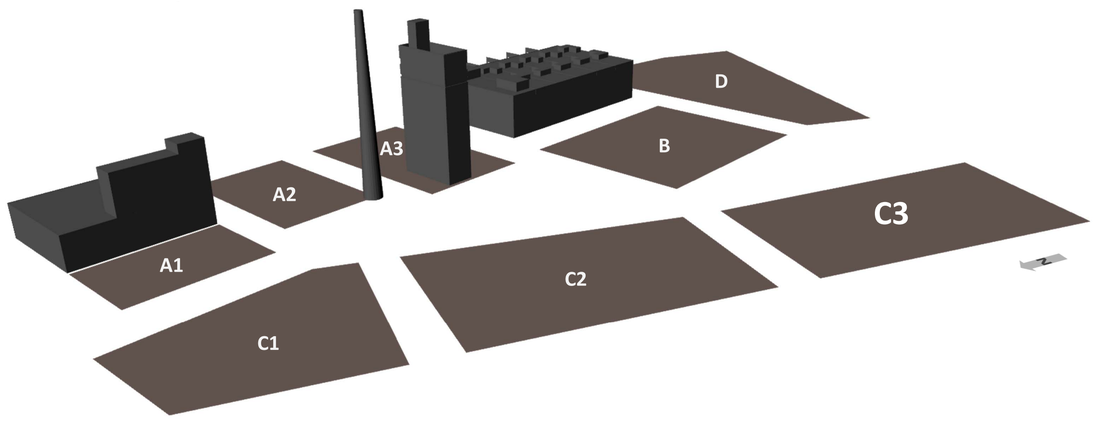
Solar **exposure** (winter)



Limit in constructible **building height**

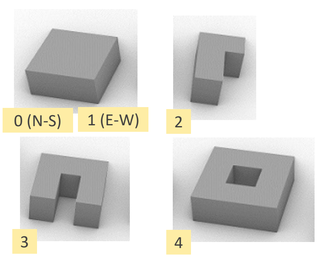


❑ blueFactory site division in 8 zones

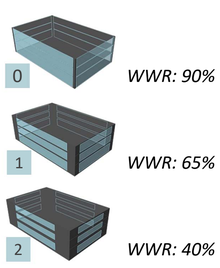


❑ Example of predefined **values** per **parameter**

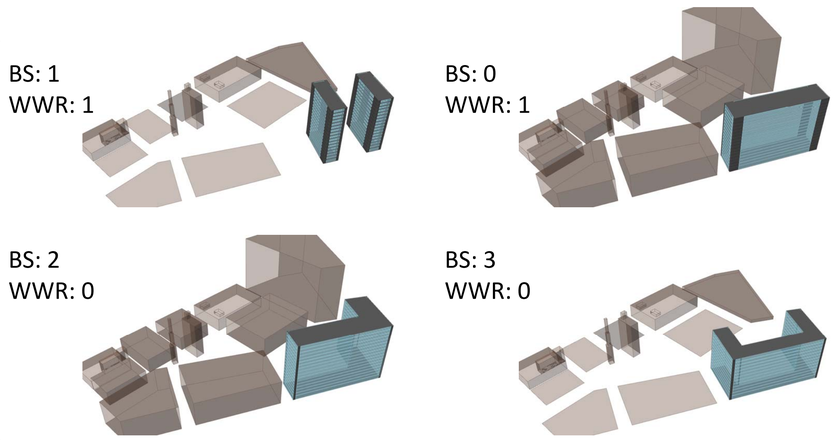
BS: Building shape



WWR: Window-to-wall ratio



Application to specific case study
- blueFactory site
- Zone C3

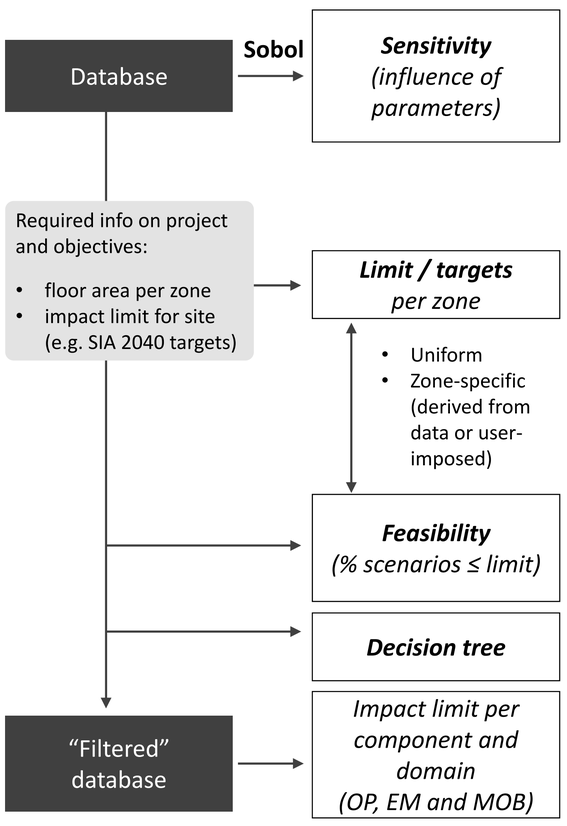


❑ "n" possible scenarios based on **Sobol matrix combination** according to predefined range of values per parameter

ID	BS	BD	BH	CONT	WWR	WIN	FRA	U	PV	HVAC	VENT	HOREL	VEREL	INS	COVS	COVW	BAL
1	1	0	1	1	1	2	0	2	2	0	0	1	1	2	1	0	0
2	3	0	1	1	2	2	0	2	2	0	0	1	1	2	1	0	0
3	1	1	1	1	1	2	0	2	2	0	0	1	1	2	1	0	0
…	…																
n	…																

BS:	*Building shape*	*HVAC:*	*Heating system*
BD:	*Building depth*	*VENT:*	*Ventilation type*
BH:	*Building height*	*HOREL:*	*Construction horizontal elements*
CONT:	*Built context*	*VEREL:*	*Construction vertical elements*
WWR:	*Window-to-wall ratio*	*INS:*	*Insulation type*
WIN:	*Glazing type*	*COVS:*	*Covering material slab*
FRA:	*Frame type*	*COVW:*	*Covering material walls*
U:	*Thermal transmittance*	*BAL:*	*Balcony*
PV:	*PV roof ratio*		

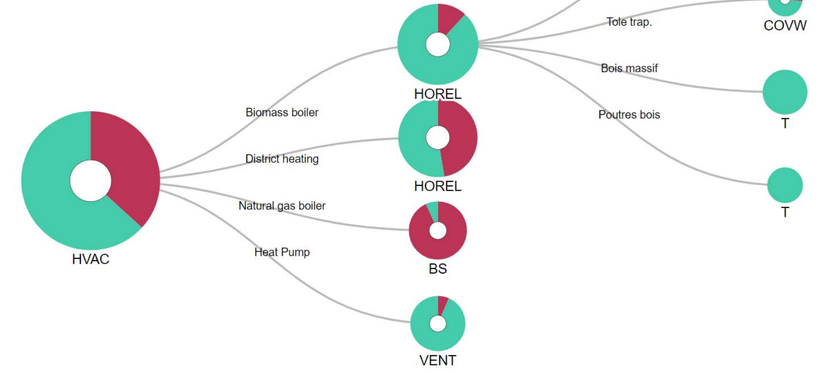
❑ **Analysis workflow**



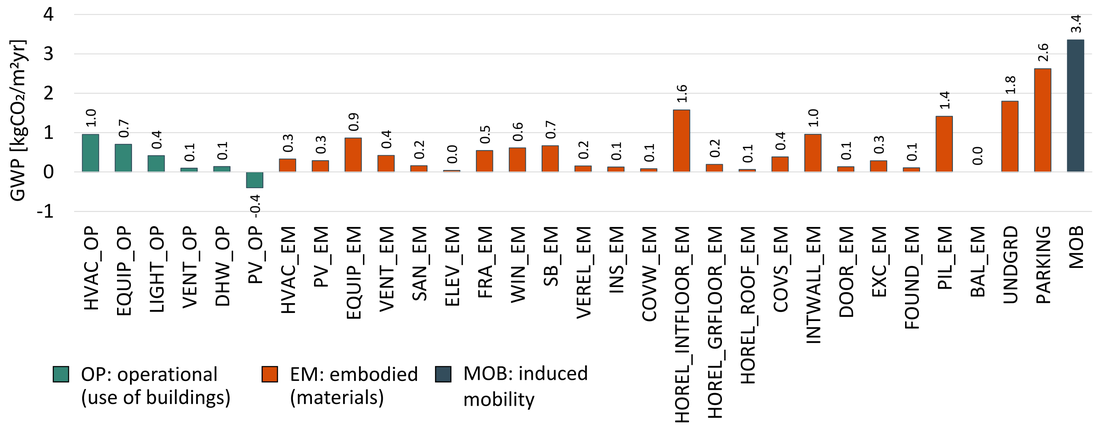
❑ **Results exploration** | Decision tree | **Dataset size**: 1'353 variants (Zone C3)

Target method: Uniform

Target Feasibility:
True (T): 63%
False (F): 37%



❑ Global Warming Potential (GWP) **impact limit** per component to achieve 2'000-watt society target



Duration of the project: Jan – Dec 2018 (1 year)

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