CSTB
le futur en construction

A simulation tool for the analysis of energy concepts based on renewables and heat recovery for buildings and districts

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SEBT – Systèmes Energétiques du Bâtiment au Territoire

SUSTAINABLE PLACES

WHAT IS DIMOSIM ?

> Transient, bottom-up energy simulation platform for buildings and communities, developed at CSTB since 2014.

DEVELOPMENT AND USE IN NATIONAL AND EUROPEAN PROJECTS:

RESILIENT

ECODISTR-ICT

E²District

THERMOSS

SmartMEDParks
ENERGY EFFICIENCY | RENEWABLE ENERGIES

Sinfonia
Low Carbon cities for better living

efficacity

REUSEHEAT

OBJECTIVE: ASSIST THE KEY ACTORS IN URBAN PLANNING AND EXPLOITATION

> On a district level, help the operators to achieve better energy management

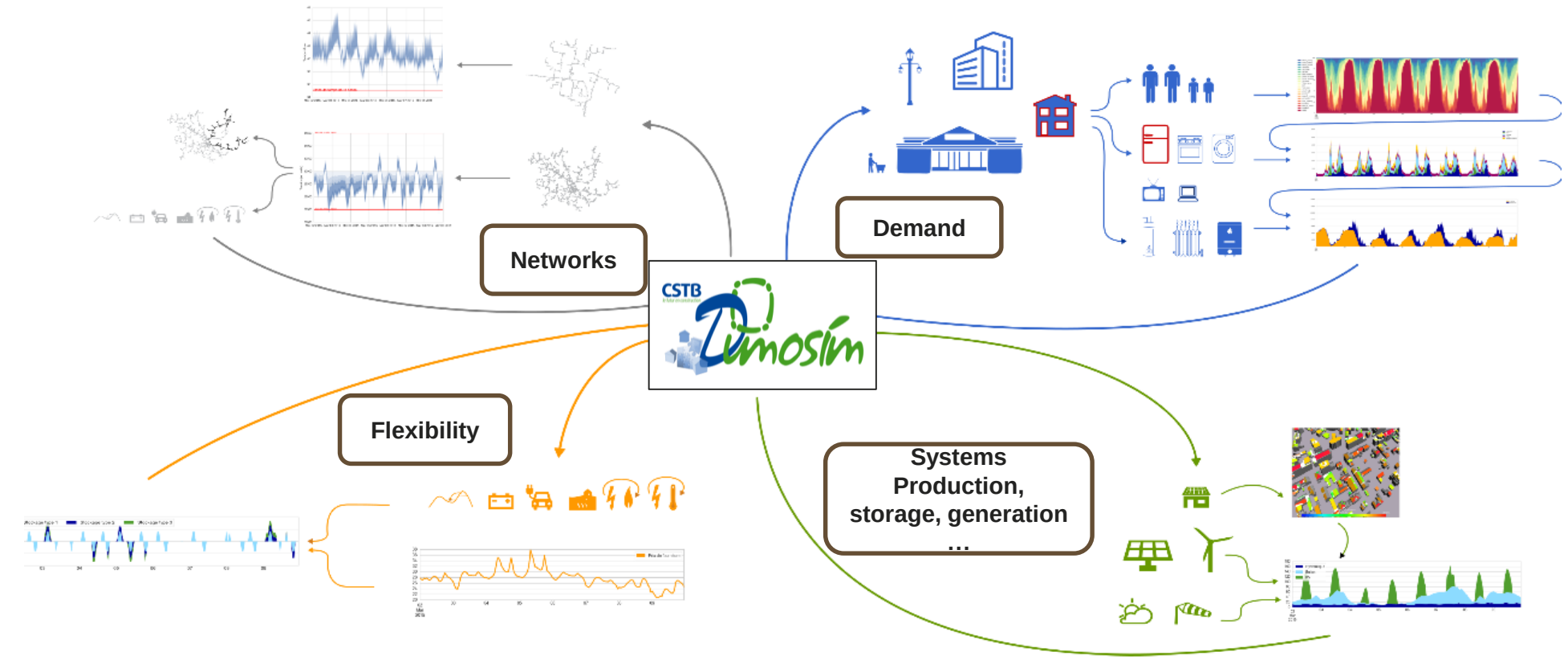
> In the case of urban planning, analyse different energy concepts in terms of KPI's related to energy, economical, environmental or other criteria (multicriteria analysis)

CSTB Dimosim

THERMOSS

REUSEHEAT

Domains, phenomena and systems



→ Integration of multi-energy systems in buildings (thermal and electrical vectors)
→ Coupling with non-deterministic modelling (occupation and equipment)

MULTI-SCALE OBJECTIVE

- ✓ Bottom-up district energy simulation platform
- ✓ Use for urban planning and/or the « improvement » of energy management

Building

District

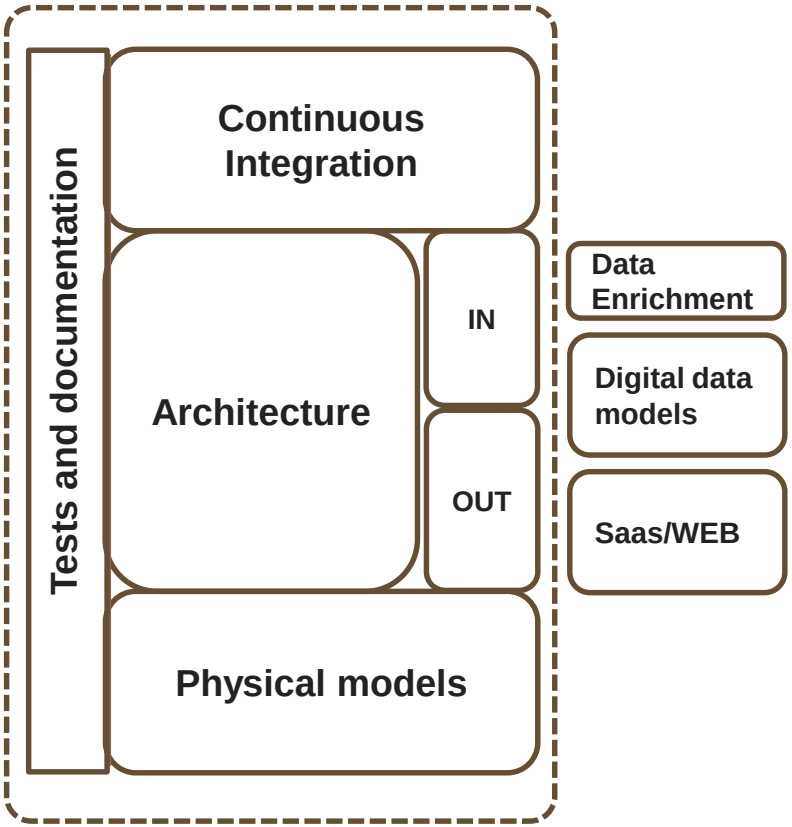
Territory

> Based on <u>one</u> single simulation kernel (Dimosim) that allows to plug other tools (fmu etc.)

Software approach

GENERAL CHARACTERISTICS

- Development in Python 3.6
- GITLAB with continuous integration (CI)
- Use of the platform as web service
- Connection to digital data models



Dimosim Architecture

Output data and postprocessing

DIMOSIM RAW OUTPUTS

States

- States in networks (temperature and pressure, Voltages)
- Building temperatures
- States of generators (temperatures, commands…) – central/local

Energy flows

- Detailed consumptions (gas, fuel, electricity) and productions (heat/elec)
- Detailed losses (generators, distribution, buildings) - heat and electricity
- REN Production (heat and electricity)

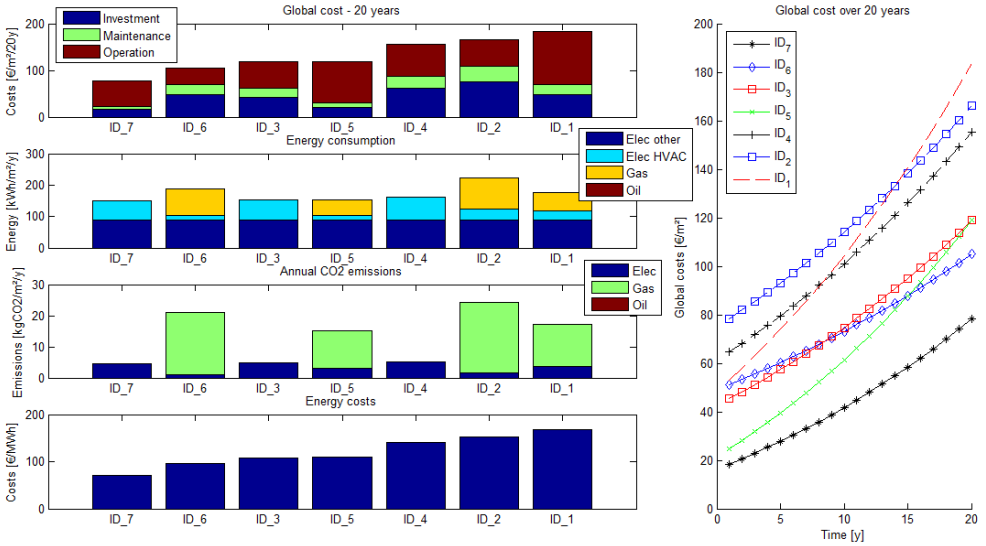
DIMOSIM POSTPROCESSED OUTPUTS (assessment)

Efficiencies

- Thermal and electrical generator(s), thermal and electrical distribution, storage etc.

Emissions and economics

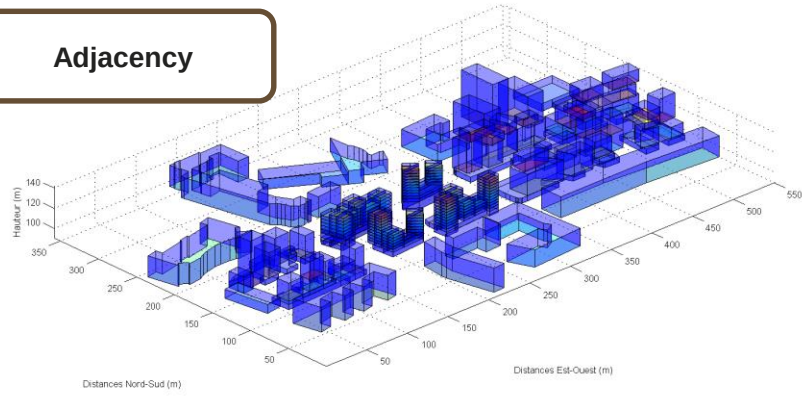
- CO2 emissions
- Global costs (CAPEX/OPEX, TRI, NPV,…)



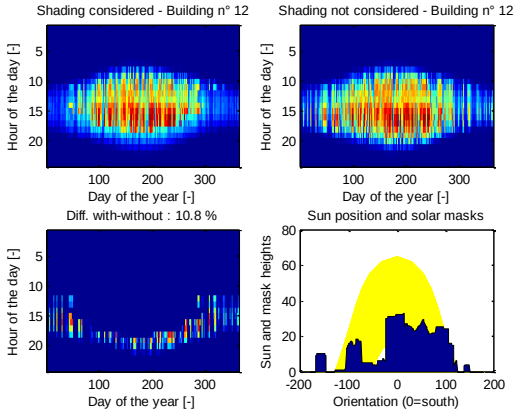
	Climate : NICE			
Small district	Nice	Energy price	Primary energy	CO2 emissions
	Variants	€/MWh	kWhPE/m²/y	kgCO2/m²/y
	ID1	197	48	9,3
	ID2	204	68	12,3
	ID3	133	36	3,9
	ID4	171	42	4,1
	ID5	118	36	8,0
	ID6	129	49	10,4
	ID7	69	31	3,8

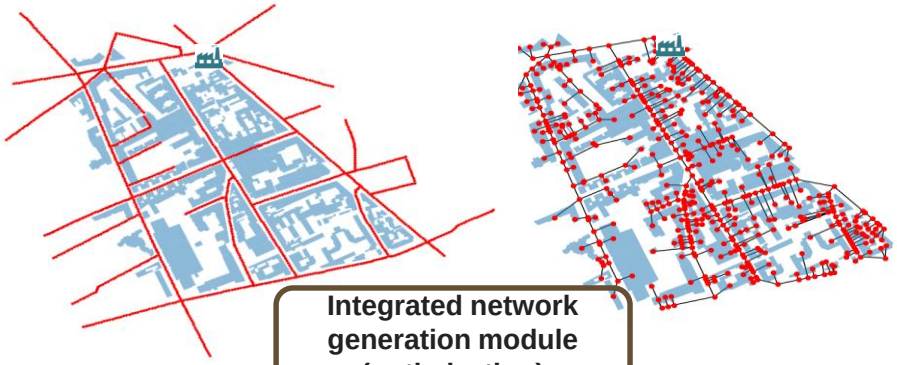
Some examples of functionalities and usages

Adjacency

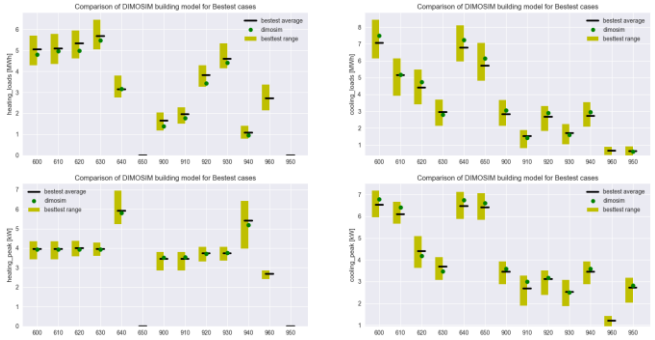


Solar masks from other buildings





Integrated network generation module (optimization)

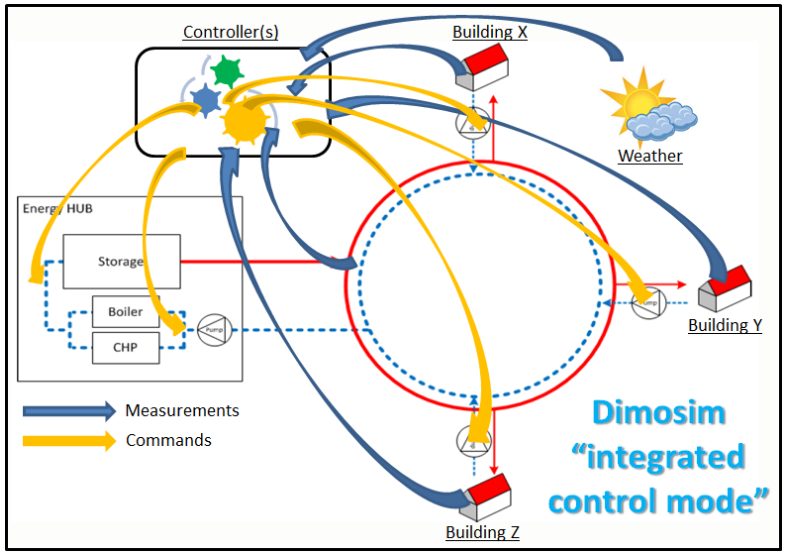


Besttest validation examples

2 modes of usage: Stand-alone simulation / with external controller plugin

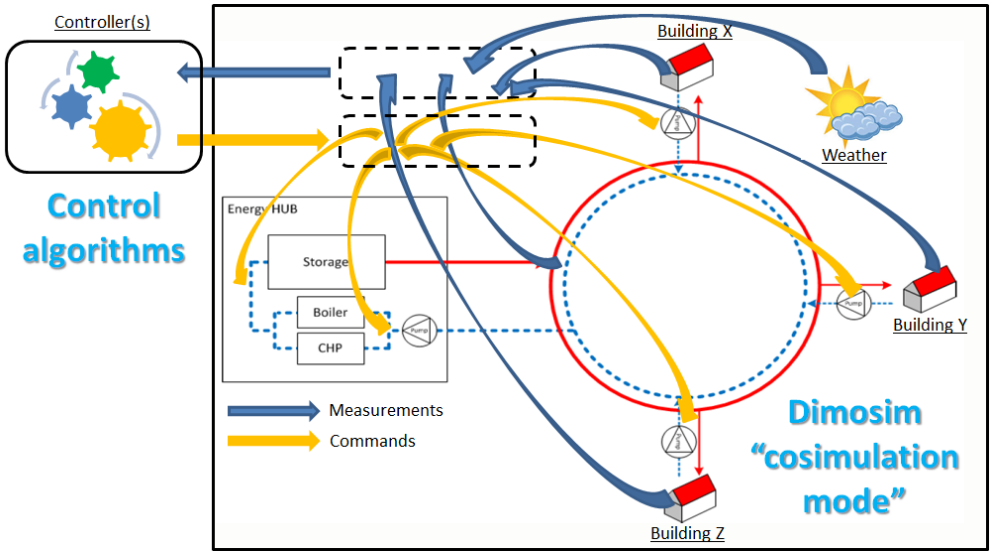
Internal control mode – simulator

Example: Used for « standard » simulations
Project examples: ReUseHeat and THERMOSS



External control mode – Emulator

Example: Testing controllers and optimizers
Project example: THERMOSS



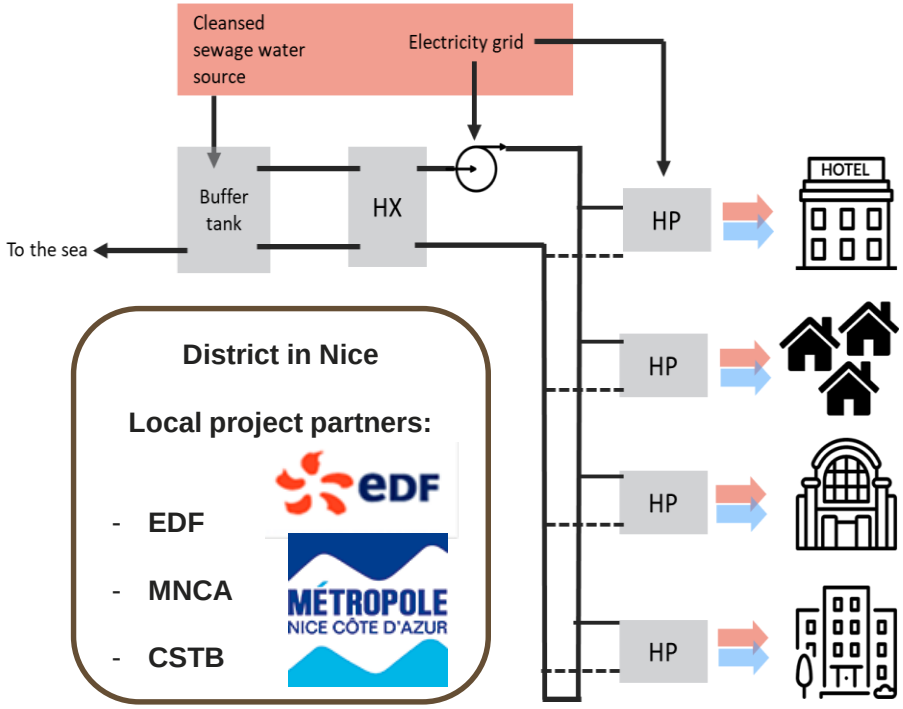
Use for the improvement of energy concepts and sizing example: ReUseHeat project (1)

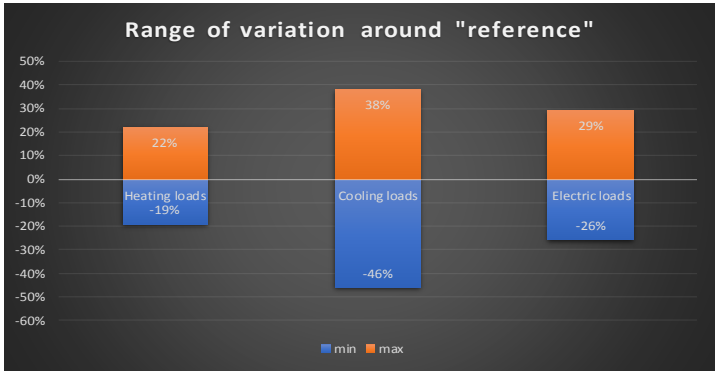
The energy system of the Grand Arena district:

- Waste water as heat source (seasonal temperature variation).
- Very low-temperature network (heat-sharing network),
- Thermo-refrigerating heat pump substations (heating and cooling is possible, the network acts as buffer)

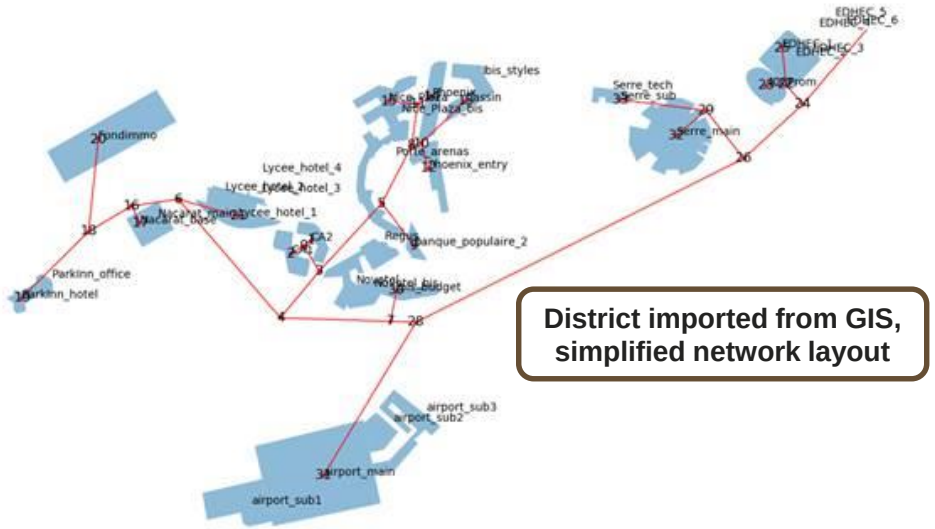
Sensitivity analysis parameters:

- Internal gains from -25% to +25%
- U-values of envelope (-20% to +20%)
- Window area ratio (-10% to +10%)
- 2 different blind control strategies in summer

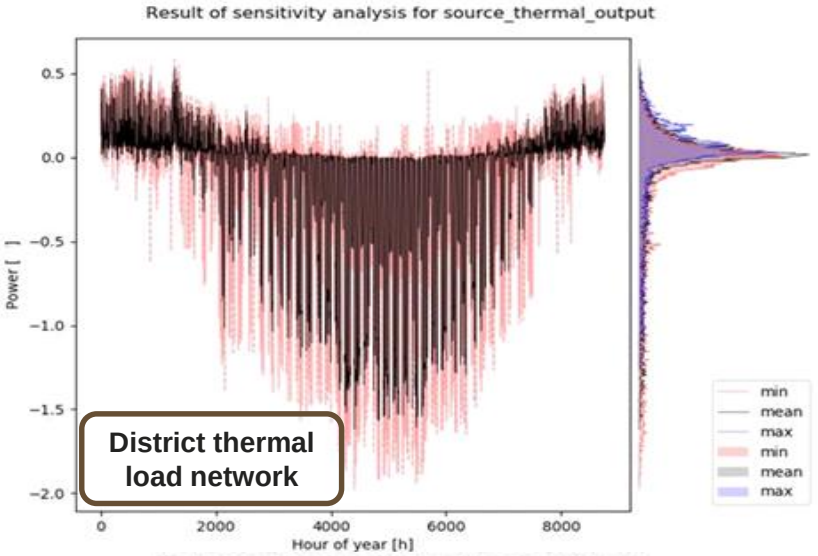




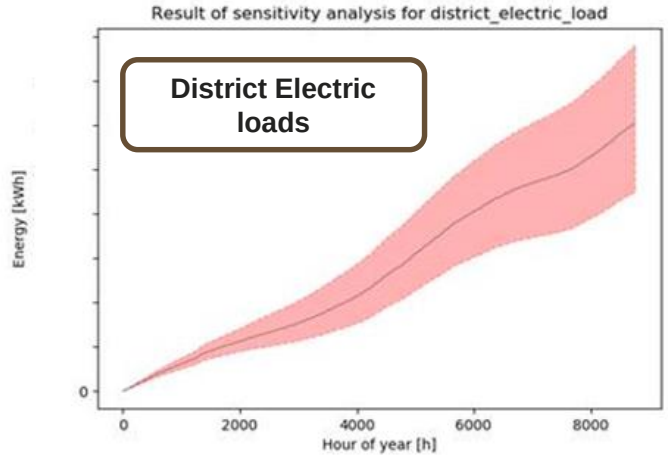
Use for the improvement of energy concepts and sizing example: ReUseHeat project (2)



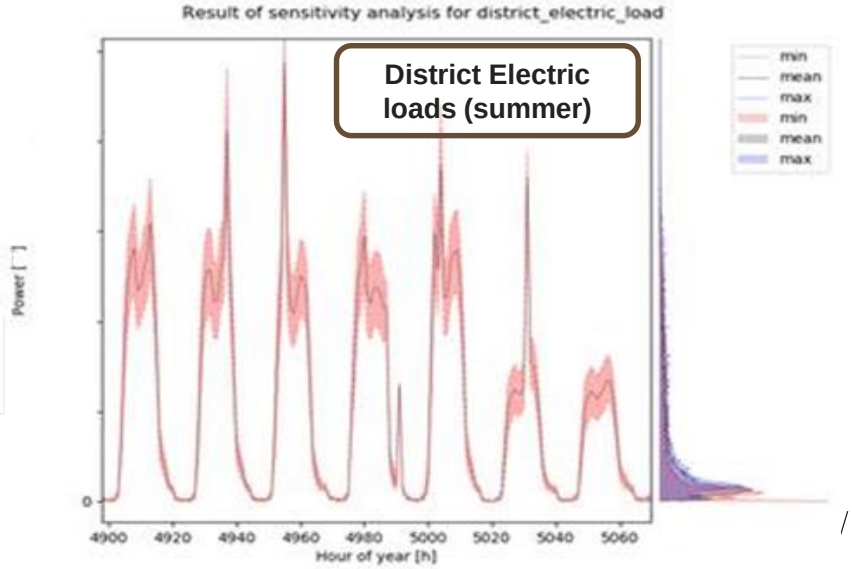
District imported from GIS, simplified network layout



District thermal load network



District Electric loads

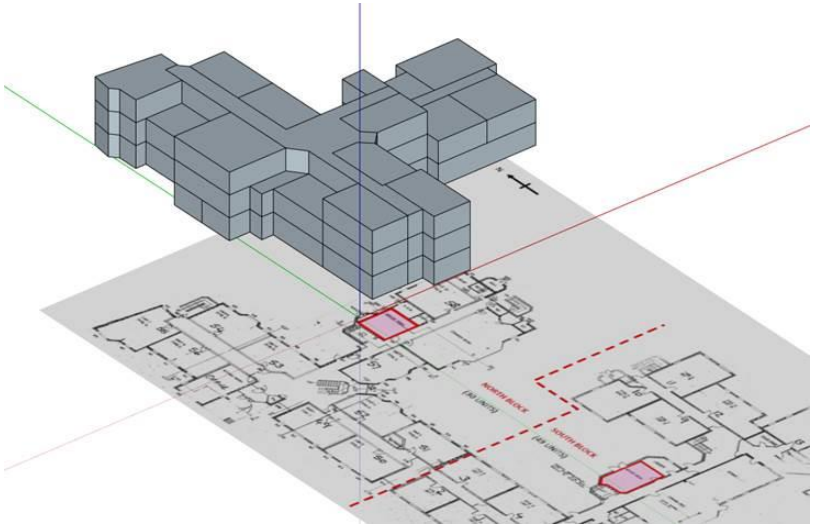


District Electric loads (summer)

Use for the improvement of energy concepts and sizing example THERMOSS project – Hale Court district

Hale Court, UK

Google maps



«BIM» data generated in Sketchup

More detailed presentation of the study: BS2019 Rome (Grivon et al.:)

Use for the improvement of energy concepts and sizing example THERMOSS prject – Urberoa district (1)

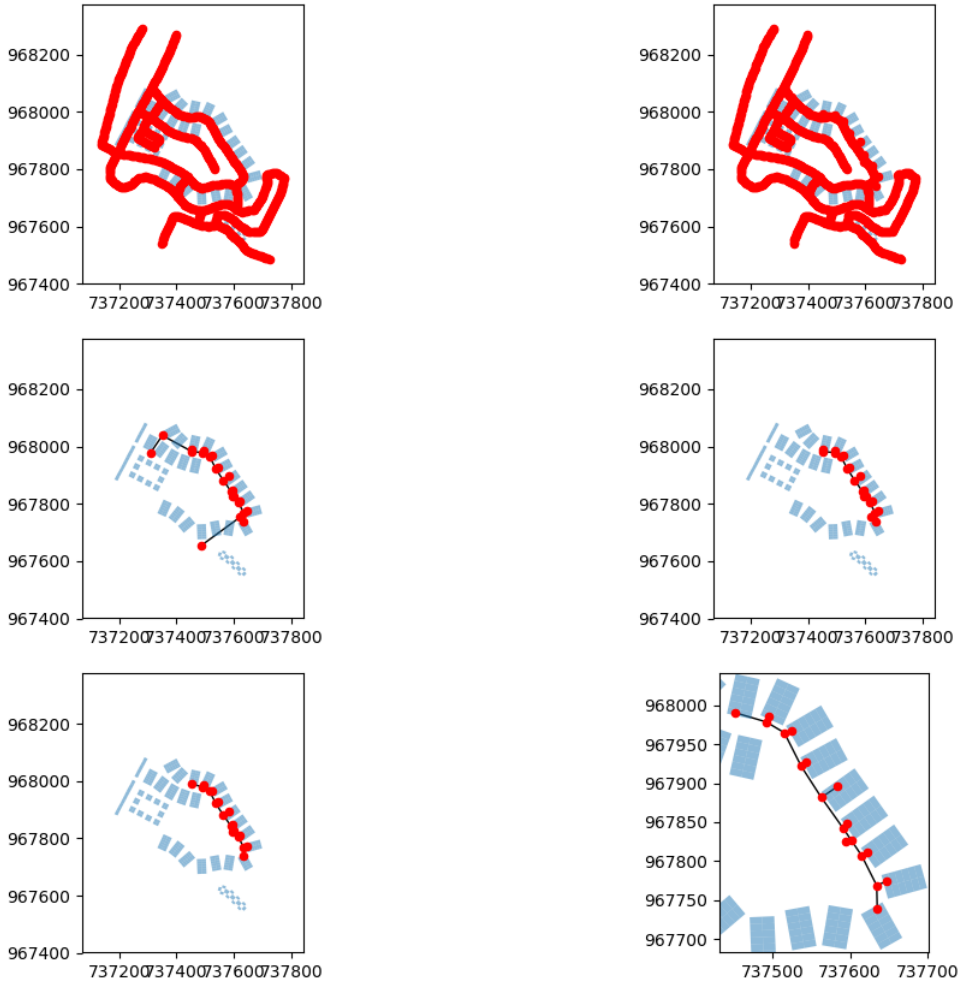
Urberoa, San Sebastian, Spain

Google maps

«BIM» data generated (Qgis display)

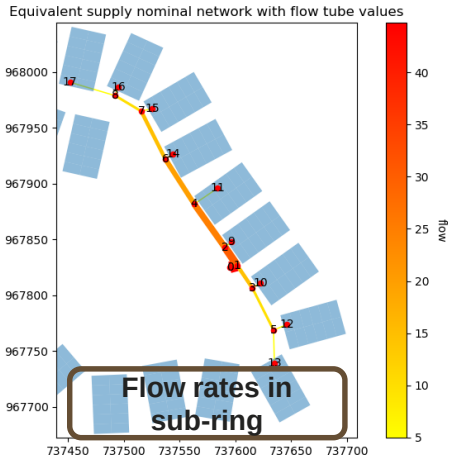
- Stand-alone simulation of pilot for the study of conception and sizing issues
- Study on the optimial operation of district generation and substations (CEA)

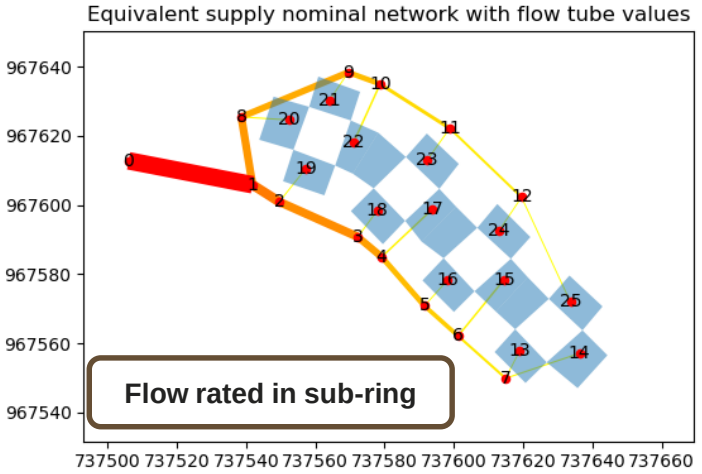
Use for the improvement of energy concepts and sizing example THERMOSS project – Urberoa district (2)

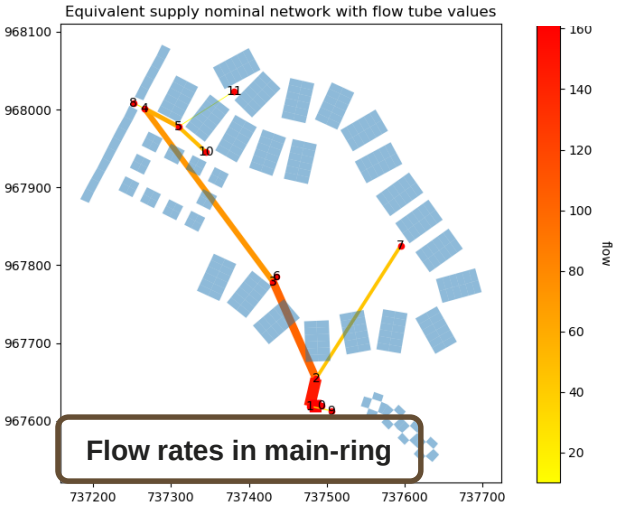


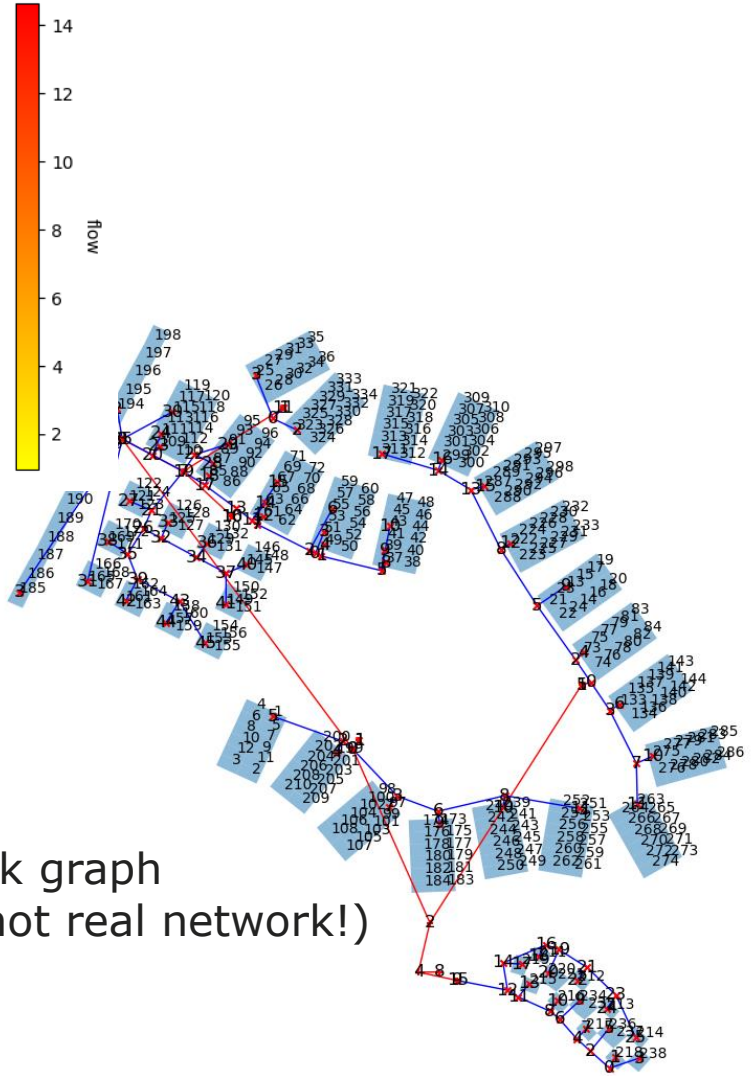
"Optimal" network generation module:
- Steps of generation from possible network paths (roads)

Use for the improvement of energy concepts and sizing example THERMOSS project – Urberoa district (3)









Complete network graph
(graph plot and not real network!)

Other ongoing work based on DIMOSIM

Other research topics with external partners:

- Online-Coupling of DIMOSIM with ENVIBATE, a microclimatic simulation tool

  → common PHD with University of La Rochelle (LASIE)

  G. Kyriakodis, E. Bozonnet, P. Riederer. Quantifying the Impact of Urban Microclimate in Detailed Urban Building Energy Simulations, Proceedings of the Building simulation 2019 conference, Rome, Italy 2019.

- Online-Coupling of DIMOSIM with OMEGALPES (MILP optimisation tool) for district energy management optimisation

  → common PHD with University of Grenoble (G2ELAB)

  M. Brugeron, F. Wurtz, Y. Marechal, P. Riederer. The presentation of a model-based predictive controller architecture through the interfacing of a dynamic simulation platform DIMOSIM and an optimization modeller OMEGAlpes. Proceedings of the Building simulation 2019 conference, Rome, Italy 2019.

- Parsomonious modelling in DIMOSIM

  → common PHD with Mines ParisTech (PSL Research university)

  E. Garreau, T. Berthou, B. Duplessis, V. Partenay, D. Marchio. Urban-Scale Energy Building Simulation: A Development Of A Novel Method For Parsimonious Modelling – The Example Of Solar Irradiation Calculation, Proceedings of the Building simulation 2019 conference, Rome, Italy 2019.

- Use of DIMOSIM in POWERDIS, a district simulation platform developed by the French EFFICACITY institute

Conclusions

- DIMOSIM has now successfully passed from an internal prototype to a serious tool (Gitlab, continuous integration etc.)

- Use and improvement in several national and European projects

- Strong partnerships have been created around DIMOSIM with external partners

- In the frame of the EFFICACITY institute*, Powerdis (with Dimosim as simulation kernel) is supposed to get a reference platform for district simulation

** EFFICACITY is a national research institute with 30 partners from public and private partners and more than 100 researchers - https://www.efficacity.com/*

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European Union’s Horizon 2020 research and innovation programme under grant agreement No 723562

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