WASTE HEAT SUPPLY STUDY

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Context : waste heat supply study

Host states are requesting to include waste heat use in the design of future CERN projects from the beginning on.
This encompasses diverse aspects such as technical, economic, and societal dimensions.

- → Identification of the opportunities and viability
- → Feasibility of the technical concept
- → Interactions with local authorities (FR) and SIG (CH)

Study carried out with **Ginger Burgeap :**

Phase 1 : Study on the consumption potentials
Phase 2 : Study of the energy recovering process and optimisation pathways
Phase 3 : Technical-economic assessment and complementary technologies (ongoing)

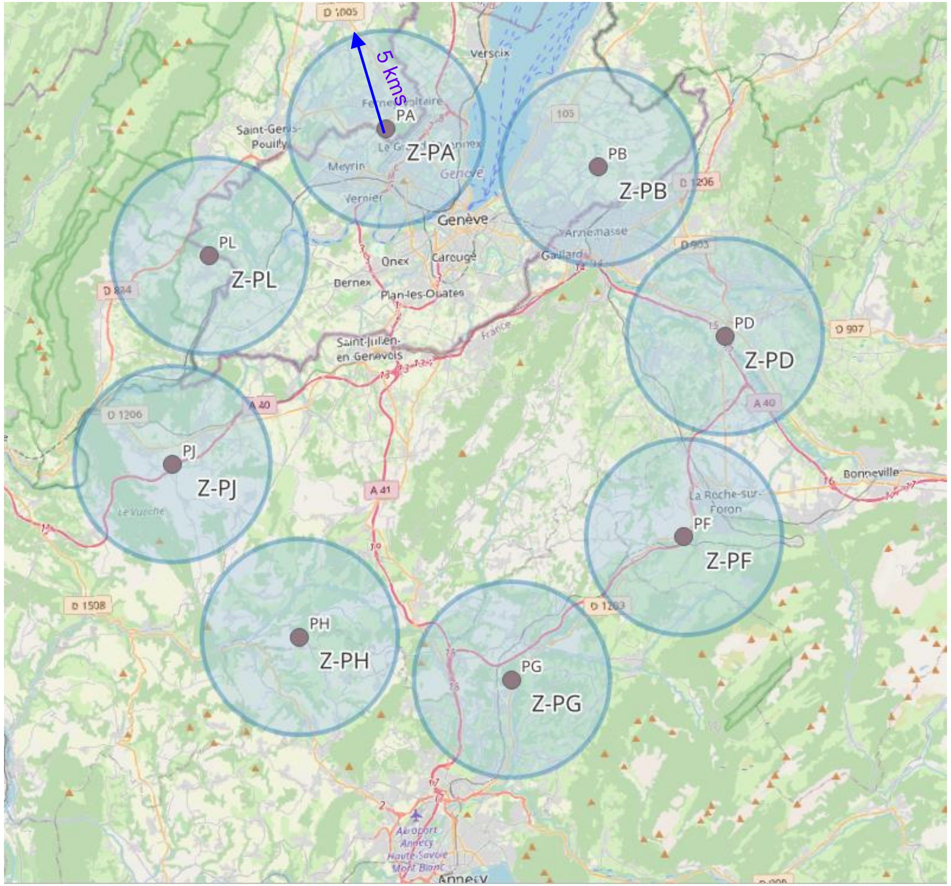
Meetings and interactions with local actors carried out, e.g. :
- SIG (CH)
- OCBA/OCEN/OFEN (CH)
- ADEME (FR)
- SYANE (FR)
- Communes (CH and FR)
- Potential consumers : e.g. cheese producers, wastewater treatment plant, aquaponics farm

FCC waste heat quantity and temperature

Emitted heat - Annual production [GWh]

Site/Mode	Z	W	H	L. S	tt
PA	138	152	172	16	225
PB	15	18	23	0	34
PD	138	152	172	16	225
PF	15	18	23	0	34
PG	138	152	172	16	225
PH	230	314	336	4	524
PJ	138	152	172	16	225
PL	25	48	56	2	109
Total per year	**836**	**1 005**	**1 128**	**68**	**1 603**

Temperature range : 40°C / 50°C (except 70°C for cryogenics)



Methodology - Residential and Tertiary sector

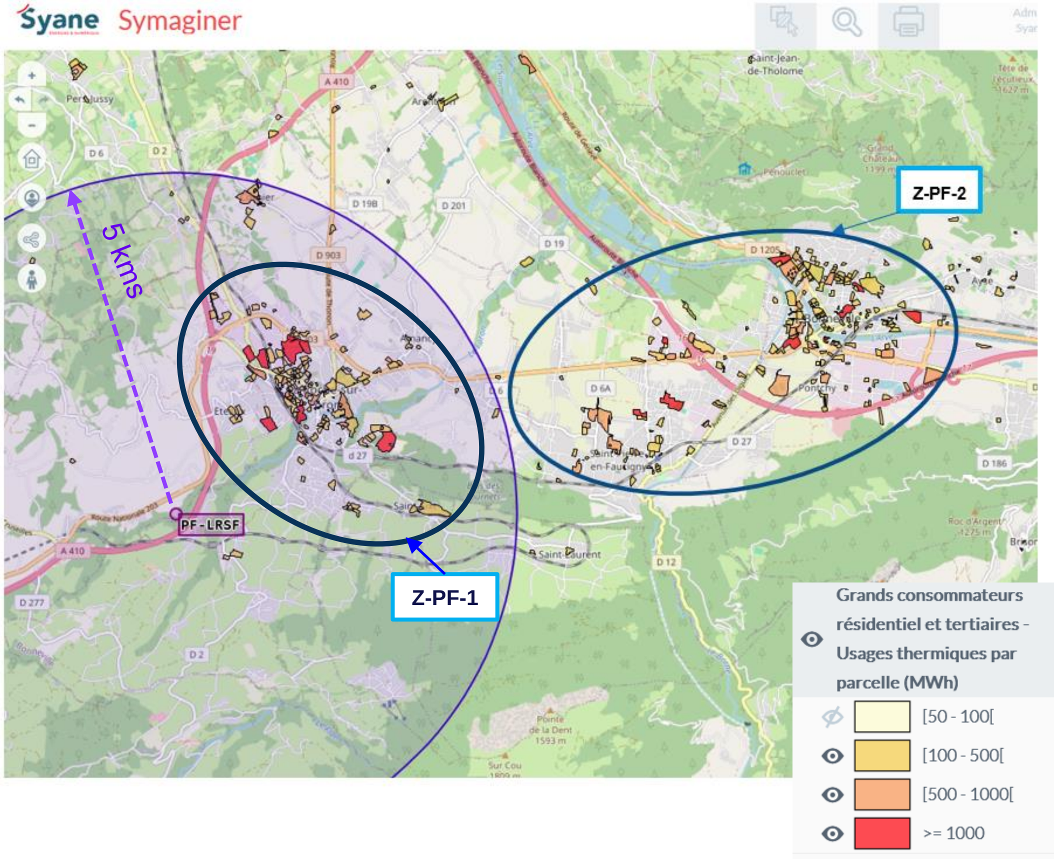
Ex. : PF – Eteaux/La Roche-sur-Foron

- **5 kms perimeter**

- **Data analysis** :
  - FR : MAJIC (private data), BD TOPO, EDIGEO, SOES, INSEE, SIRENE
  - CH : INDICE DE DEPENSE DE CHALEUR
  - Calibration
    - CH : building scale
    - FR : IRIS scale (2000 inhabitants)

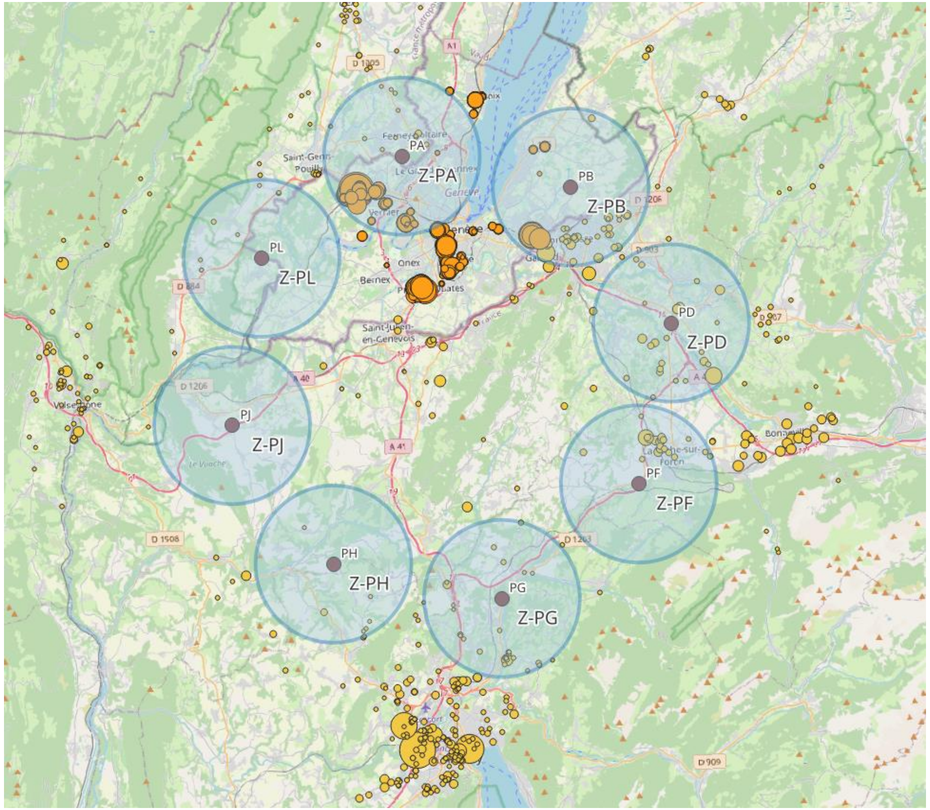
- **Large consumers > 100 MWh (0,1 GWh)**

- **Identification of different zones :**
  - Z-PF-1 : cheese producer, secondary school, exhibition center, hospital, residential
  - Z-PF-2 : schools, residential



Methodology – Industrial sector

- **Data analysis** :
  - Heating and hot water
  - Activity, size, etc.
  - Industrial process : included when necessary
    specific focus based on specific site data (e.g. cheese producer)

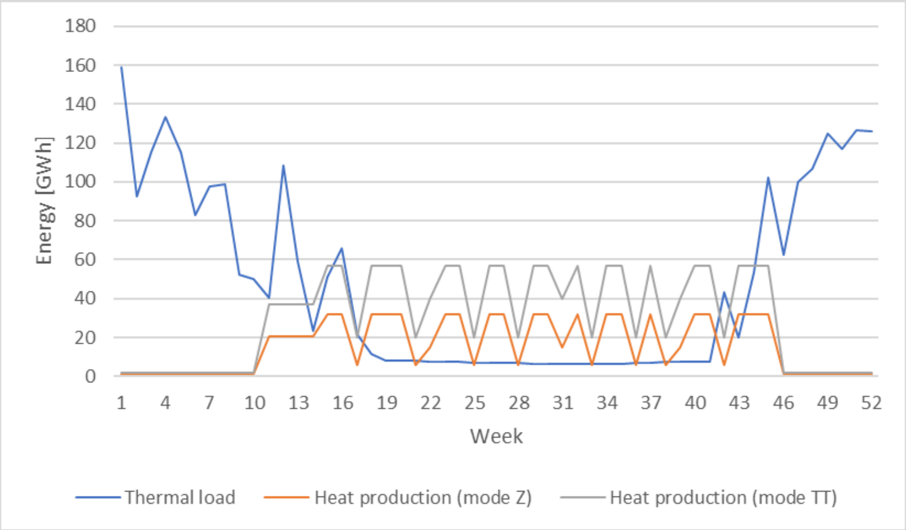


First potential estimates

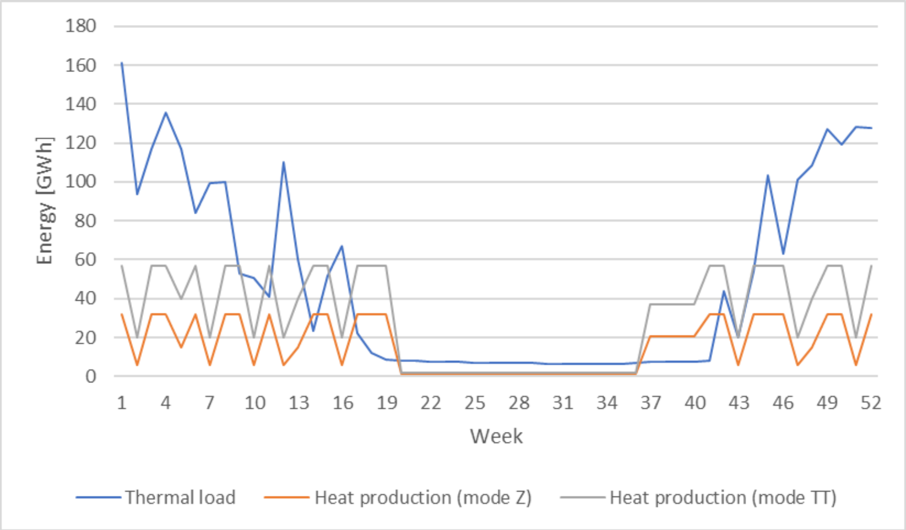
Period of time		Mode Z		15 years	
		Annual recovered heat [GWh]	Heat Recovery Rate	Mean Annual recovered heat [GWh]	Heat Recovery Rate
Base case	Target zones	223	27%	245	22%

Schedule adaptation - Dynamic thermal model

Baseline



Operation schedule adaptation



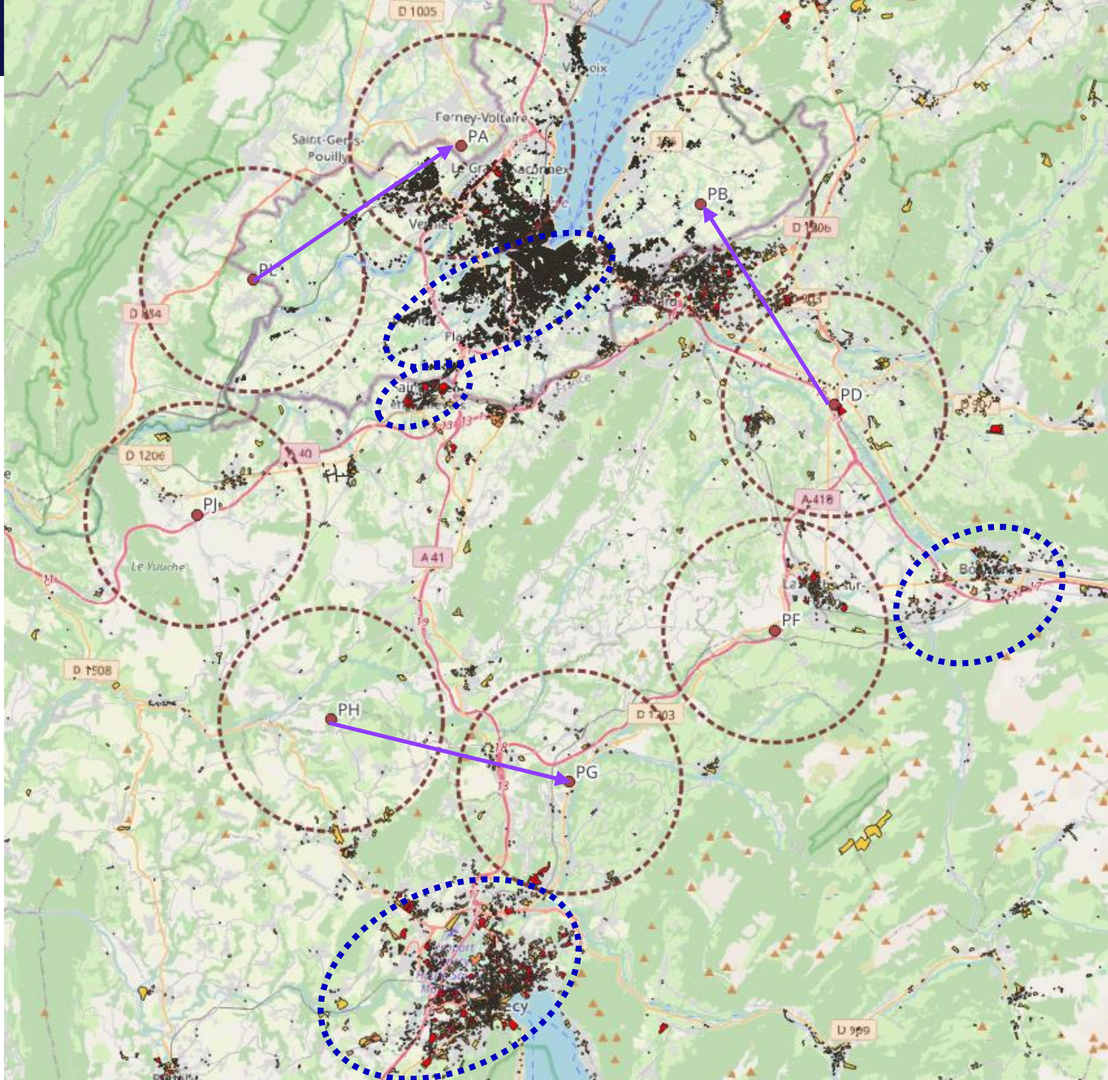
Alternatives – Full scale model

Reference case : target zones only (5 km)

Extended areas: up to 10 km

Heat distribution: site-to-site distribution
Example :

PH → PG
PD → PB
PL → PA



Results – baseline and alternatives cases

Period of time		Mode Z			15 years		
		Annual recovered heat [GWh]	HRR [1]	Efficiency	Mean Annual recovered heat [GWh]	HRR[3]	Efficiency
Base case	Target zones	223	27%	44%	245	22%	40%
	Target and extended zones	374	45%	73%	427	38%	69%
Time-shifted calendar	Target zones	308	37%	60%	353	31%	56%
	Target and extended zones	462	55%	89%	542	48%	87%
Site-to-site distribution	Target zones	278	33%	53%	315	28%	51%
	Target and extended zones	521	62% [1]	100%	618	55%[4]	100%
No integration in urban areas with existing urban networks		64	16%	26%	74	12%	22%

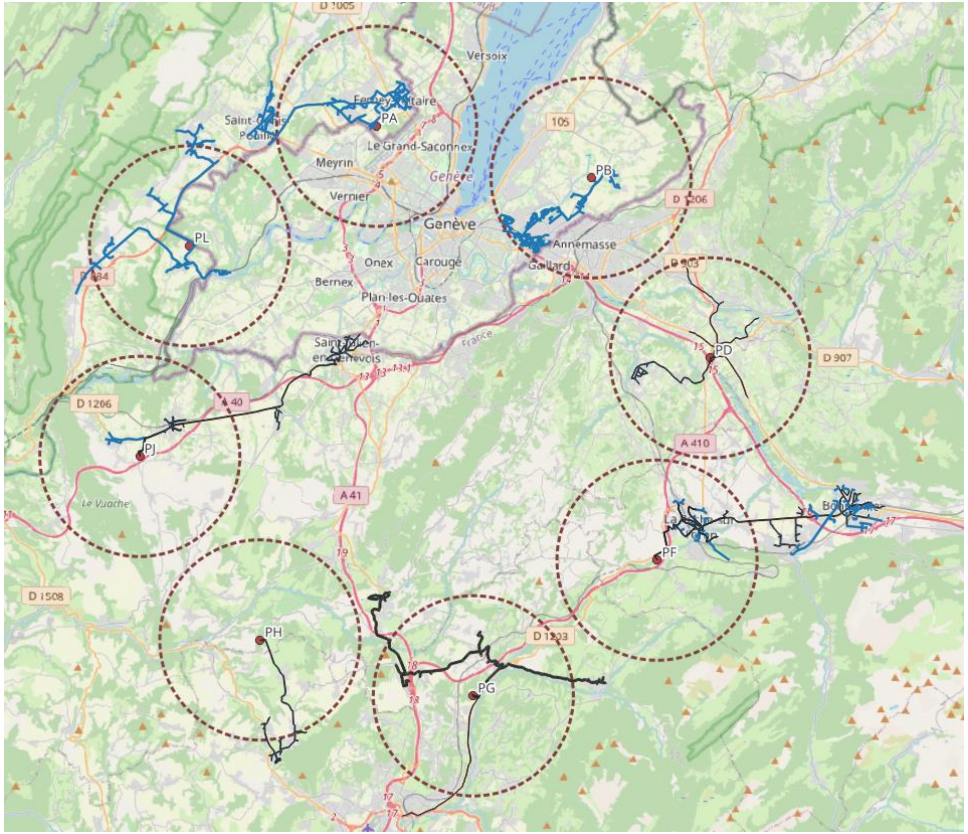
1. Reference case with the maximum HRR
2. HRR of the studied case / HRR of the reference case

3. Reference case with the maximum HRR
4. HRR of the studied case / HRR of the reference case

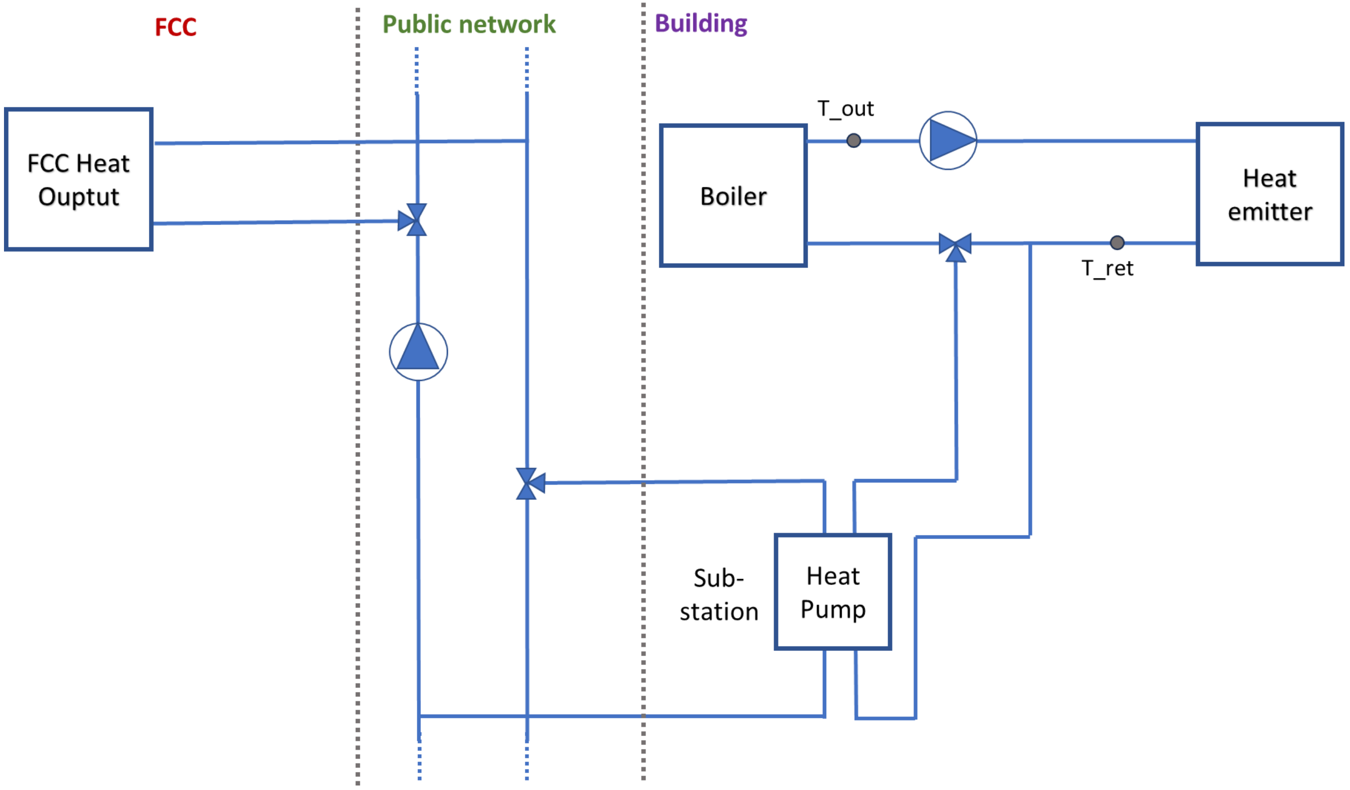
Thermal system

Geographical network drawing

Objective : estimating the technical and the economical performance of the system



Heat network

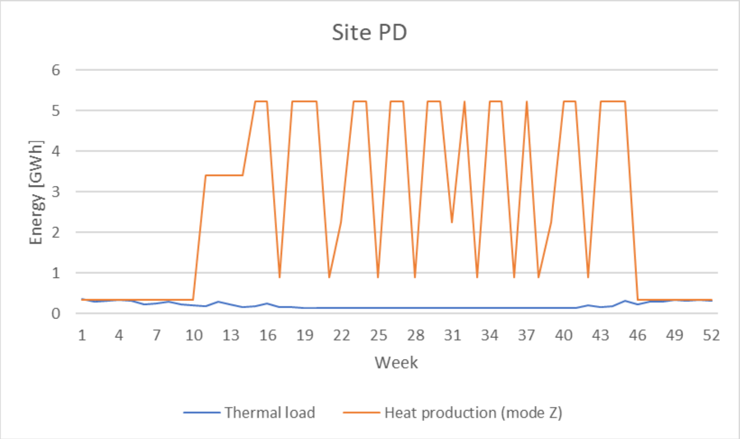


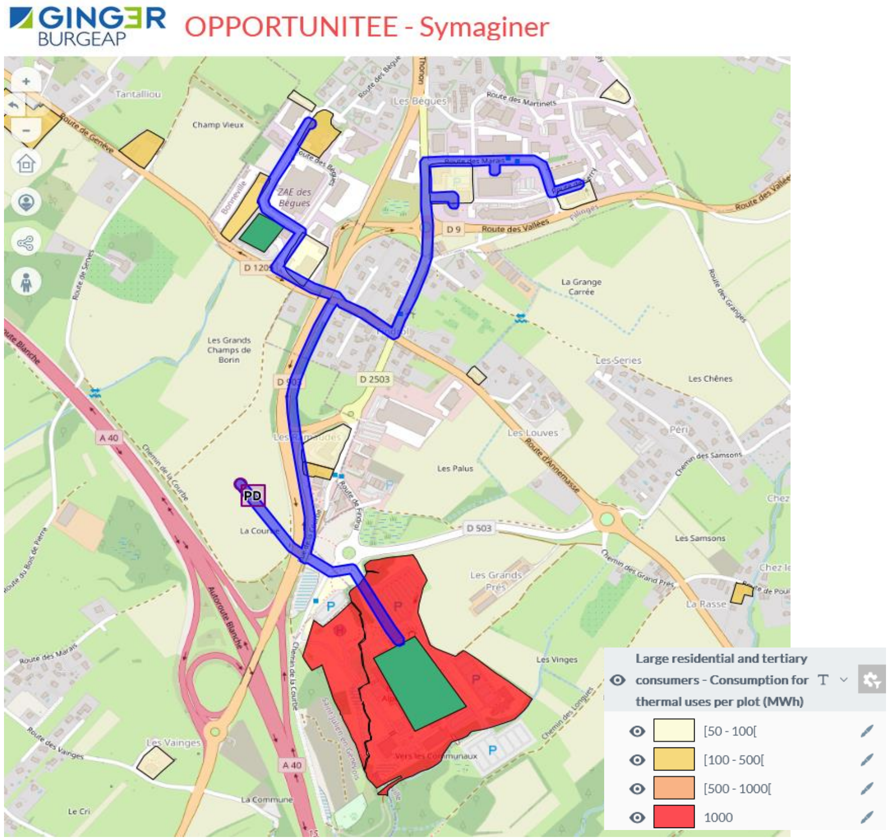
Assessing the technical and economic analysis PD Site - Nangy

Specific consumers
- Hospital
- Cheese producer

= 10 GWh

- Possibility to extend the heat network to the waste water treatment plant





Cost-Benefit analysis – PD site

Over 20 years

Costs		Benefits	
Total investment costs [k€]	5 400 – 7 700	Total avoided fossil fuel costs [k€]	10 400 – 4 800
Remaining part (subsidies) [k€]	3 530 – 5 830	Total avoided carbon footprint [tonnes]	32 000
Total operating costs [k€]	16 800 – 19 200	Total avoided carbon footprint - Economic value/shadow cost [k€]	16 800 (84 €/MWh)
		Reduced water consumption by the FCC [m3]	320 000
Total costs [k€]	**20 330 – 25 030**	**Total benefits** (avoided fossil fuel cost and carbon footprint only) **[k€]**	**27 200 – 21 600**
Cost / MWh including all costs [€/MWh]	**108 - 136**		

Conclusion and recommandations

- Significant potential in reasonable distances of surface sites for consumption of waste heat
- 30% of the total generated heat could be recovered. The variability is large from site to site
- Because of the site-dependent variability, waste heat recovery and supply is best analysed and conceived in detail in a location specific way, i.e. per site
- To achieve good heat recovery, the heat from site PH (RF) will need to be distributed elsewhere or the RF system location should be considered at PF instead
- An outlet temperature of 50 degrees Celsius matches well the needs of the cooling system and the needs of the end users
- According to a high-level and overall general heat supply analysis, the cost effectiveness is in the range of common district heat networks

Additional benefits :

- Offsetting of the FCC carbon footprint by avoiding heat generation using fossil fuels
- Heat energy supplied free of charge
- Reduction of FCC water consumption
- Incentive for an accelerated ecological transition due to the existence of a new, large-scale research infrastructure

Conclusion and recommandations

Designing and implementing the supply of waste heat relies on 3 key elements:

1. Integration of heat recovery and supply in the design of the machine, the experiments, the technical infrastructures and their sub-systems

2. Adaptation of the operation and the annual schedule to the heat consumption needs

3. Commitment of territorial stakeholders for the implementation of the heat distribution and supply to end-users

Thank you
for your attention.