

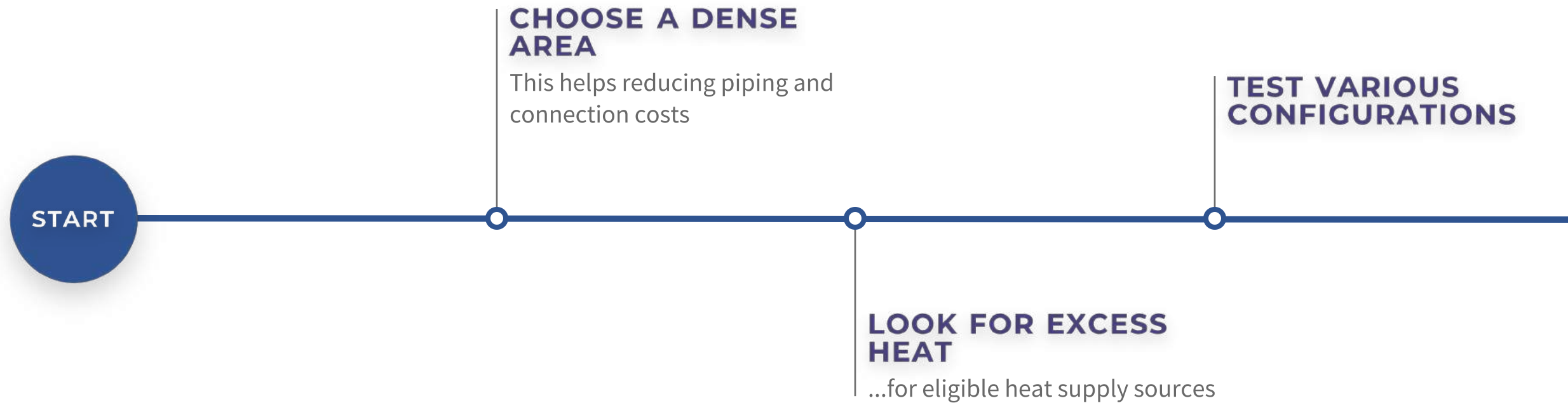


ULB - JEANNE @ BXL

A District Heating Network case study between a university and a residential area



WORKFLOW



OVERVIEW OF THE HEATING DEMAND

	No. of buildings	Heat demand (GWh/yr)	Heat peak (MWp)
University campus (whole)	19	6.27	3.53
Households at Avenue Jeanne	36	2.03	1.79
Remaining households	112	5.79	5.32

OVERVIEW OF THE AREA

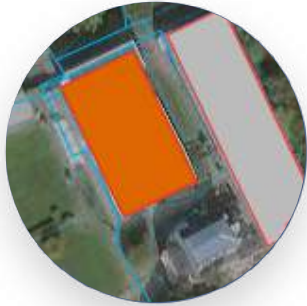


VIEW OF THE HEATING MAP



VIEW OF THE CANDIDATES OVER THE HEATING MAP

IDENTIFIED SUPPLY POINTS



ULB "K" BUILDING

- **Fuel:** biomass (wood)
- **Maximum capacity:** 5 MW
- **Capacity cost:** 420 €/kW
- **Annual cost:** 20 €/kW
- **Supply cost:** 8.5 c€/kW
- **CO2 emission factor:** 646 g/kWh



SOLVAY BRUSSELS SCHOOL OF ECONOMICS & MANAGEMENT

- **Fuel:** LPG
- **Maximum capacity:** 8 MW
- **Capacity cost:** 1000 €/kW
- **Annual cost:** 15 €/kW
- **Supply cost:** 14.0 c€/kW
- **CO2 emission factor:** 244 g/kWh



ULB "U" BUILDING

- **Fuel:** natural gas
- **Maximum capacity:** 20 MW
- **Capacity cost:** 1000 €/kW
- **Annual cost:** 0.5 €/kW
- **Supply cost:** 14.3 c€/kW
- **CO2 emission factor:** 238 g/kWh

GENERAL MODEL PARAMETERS

OBJECTIVE CHANGES WHETHER WE INCLUDE INDIVIDUAL SYSTEMS

- **Without ISs:** *Maximize network NPV.* Coupled with THERMOS' "Market" tariff, it's useful to check the advantage over individual systems
- **With ISs:** *Maximize whole-system NPV.* This way can consider the use of ISs impacting the overall cost

ACCOUNTING PERIOD IS 30 YEARS AT 2,0% DISCOUNT RATE

Data are extrapolated from the Belgian Statistical Office

EMISSION COSTS ARE ONLY FOR CO2

Values of 100, 300 and 550 Cost/ton have been evaluated for all the scenarios

COMPUTING RESOURCES LEFT AT DEFAULT VALUES

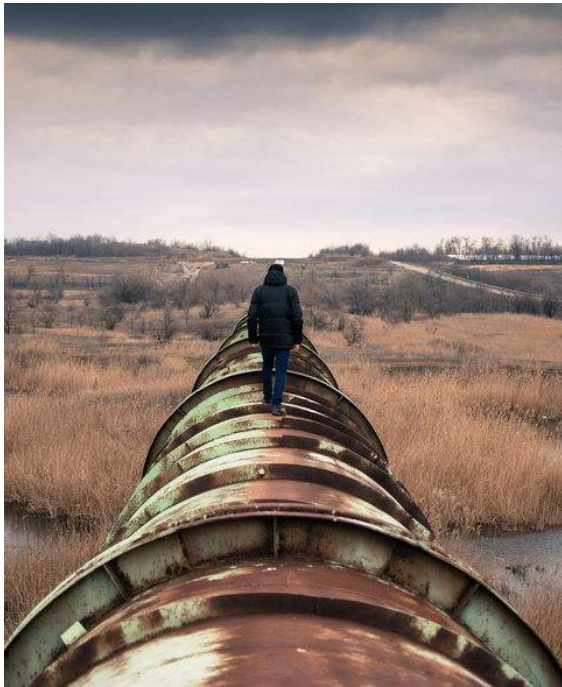
- **MIP gap:** 10%
- **Time limit:** 30 minutes

COUNTERFACTUAL IS NATURAL GAS HEATING

It's the common choice in the analyzed area

INDIVIDUAL SYSTEMS OPTIONS

Alternatives can be found [here](#).



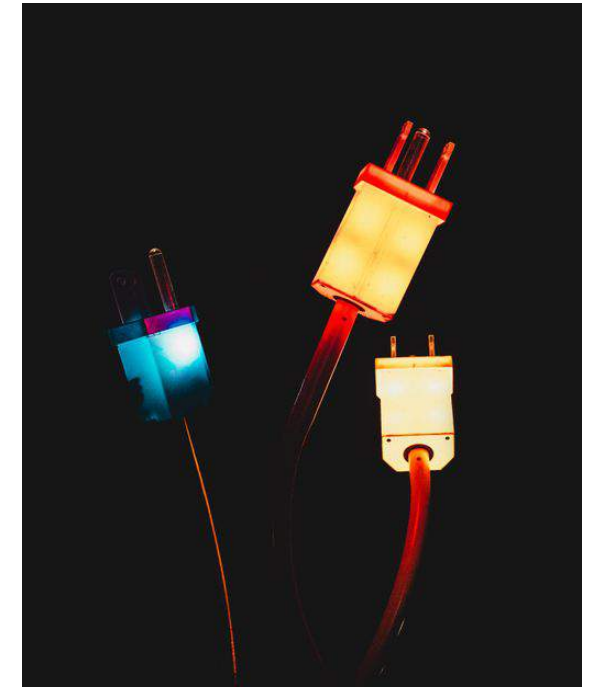
**NATURAL GAS
BOILERS**



LPG BOILERS



**WOOD (PELLET)
BOILERS**



**ELECTRIC AIR-AIR
HEAT PUMPS**

INDIVIDUAL SYSTEMS CHARACTERISTICS

Data are derived and adapted from the [Official UK 2020 Calculator](#) and commercially available data for Belgium



NATURAL GAS BOILER

- **Heat cost:** 6.9 c€/kWh
- **Variable capital cost:** 150 €/kWp
- **Operating cost:** 9 €/kWp
- **CO2 emissions:** 238 g/kWh
- **Efficiency:** 75%



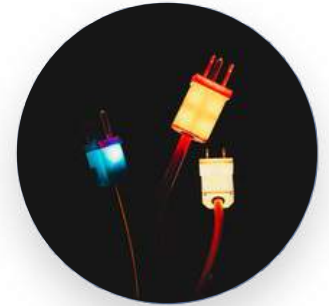
LPG BOILER

- **Heat cost:** 6.8 c€/kWh
- **Variable capital cost:** 120 €/kWp
- **Operating cost:** 10 €/kWp
- **CO2 emissions:** 244 g/kWh
- **Efficiency:** 90%



WOOD BOILER

- **Heat cost:** 4.1 c€/kWh
- **Variable capital cost:** 450 €/kWp
- **Operating cost:** 18 €/kWp
- **CO2 emissions:** 646 g/kWh
- **Efficiency:** 63%



ELECTRIC AIR-AIR HEAT PUMP

- **Heat cost:** 6.8 c€/kWh
- **Variable capital cost:** 4500 €/kWp
- **Operating cost:** 50 €/kWp
- **CO2 emissions:** 73 g/kWh
- **COP:** 4

LIST OF SCENARIOS

1

NO INDIVIDUAL SYSTEMS INSTALLED

1/A: CO2 cost at 100/year

1/B: CO2 cost at 300/year

1/C: CO2 cost at 550/year

2

ALL INDIVIDUAL SYSTEMS OPTIONED

Choice is up to the optimisation model

ELEMENTS IN SOLUTION



ONLY REQUIRED ELEMENTS APPEAR IN SOLUTION

Market rate ¹	9,1 c/kWh ¹
Base cost ¹	0 ¹
Heat demand	9,5 GWh/yr ¹
Heat peak	6,09 MWp ¹
In solution	63 network x
Coincidence	79,33 % ¹
Capacity	3,84 MW ¹
Principal v ¹	1,61 M ¹
Revenue	843,25 k€/yr ¹

SCENARIO 1/A CHARACTERISTICS

ELEMENTS IN SOLUTION



ONLY REQUIRED ELEMENTS APPEAR IN SOLUTION

Market rate ⁱ	13,38 c/kWh ⁱ
Base cost ⁱ	0 ⁱⁱ
Heat demand	9,5 GWh/yr ⁱ
Heat peak	6,09 MWp ⁱ
In solution	63 network x
Coincidence	76,33 % ⁱ
Capacity	3,41 MW ⁱ
Principal v ⁱ	3,86 M ⁱⁱ
Revenue	1,25 M ⁱⁱ /yr ⁱ

SCENARIO 1/B CHARACTERISTICS

ELEMENTS IN SOLUTION

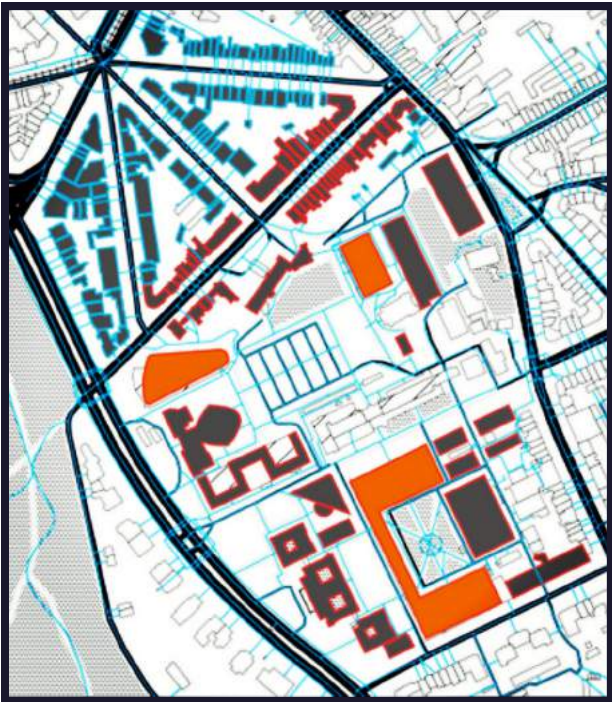


ONLY REQUIRED ELEMENTS APPEAR IN SOLUTION

Market rate ¹	18,74 c/kWh ¹
Base cost ¹	0 ¹
Heat demand	9,5 GWh/yr ¹
Heat peak	6,09 MWp ¹
In solution	63 network x
Coincidence	87,67 % ¹
Capacity	3,84 MW ¹
Principal ▾ ¹	3,84 M ¹
Revenue	1,76 M ¹ /yr ¹

SCENARIO 1/C CHARACTERISTICS

ELEMENTS IN SOLUTION



REQUIRED AND OPTIONAL ELEMENTS
APPEAR IN SOLUTION

Market rate ¹	9,28 c/kWh ¹
Base cost ¹	0 ¹
Heat demand	15,29 GWh/yr ¹
Heat peak	11,41 MWp ¹
In solution	112 Natural Gas (existing) x 63 network x
Coincidence	64,67 % ¹
Capacity	1,68 MW ¹
Principal ▾ ¹	2,96 M ¹
Revenue	843,25 k ¹ /yr ¹

SCENARIO 2 CHARACTERISTICS

NPV WHOLE SYSTEM COMPARISON

Values in Millions; higher is better

SCENARIO 1/A

-€24.78

SCENARIO 1/B

-€39.00

SCENARIO 1/C

-€38.78

SCENARIO 2

-€46.45

NPV NETWORK COMPARISON

Values in Millions; higher is better

SCENARIO 1/A

-€5.52

SCENARIO 1/B

-€10.47

SCENARIO 1/C

€1.36

SCENARIO 2

-€13.82

REVENUES COMPARISON

Values in Millions; higher is better

SCENARIO 1/A

€25.30

SCENARIO 1/B

€37.47

SCENARIO 1/C

€52.73

SCENARIO 2

€25.30

CO2 NET EMISSIONS COMPARISON

Values in ton/yr; lower is better



**THANK
YOU FOR
LISTENING!
*QUESTIONS?***



SCENARIOS

DETAILED RESULTS



SCENARIO 1/A

No individual systems installed

CO2 cost at 100/year

COST SUMMARY

Values are in *Total* costs

	Capital cost (€)	Operating cost (€)	Operating revenue (€)	NPV (€)
Pipework	2.1 M	--	--	-2.1 M
Heat supply	1.61 M	27.67 M	--	-22.68 M
Demands	0	--	25.3 M	19.26 M
Emissions	--		--	0
Network	3.71 M	27.67 M	25.3 M	-5.52 M
Whole system	3.71 M	27.67 M	n/a	-24.78 M

NETWORK DEMANDS

Values are in *Total* costs

	Count	Revenue (€)
University	19	16.6 M
Residential	36	5.52 M
Other	8	3.18 M

NETWORK SUPPLIES

Values are in *Total* costs

	Capacity (Wp)	Output (Wh/yr)	Capital (€)	Capacity (€)	Heat	Coincidence
ULB “K” Building	3.84 M	9.95 G	1.01 M	2.3 M	25.37 M	63%
Solvay Brussels School of Economics & Management	0	0	0	0	0	100%
ULB “U” Building	0	0	0	0	0	75%

EMISSIONS

Values are in *Total* costs

	CO2 (ton/yr)	CO2 (€)
Network (heat)	6.43 k	19.28 M
Counterfactual	2.26 k	6.78 M
Net	4.17 k	12.5 M

SCENARIO 1/B

No individual systems installed

CO2 cost at 300/year

COST SUMMARY

Values are in *Total* costs

	Capital cost (€)	Operating cost (€)	Operating revenue (€)	NPV (€)
Pipework	2.07 M	--	--	-2.07 M
Heat supply	3.86 M	43.43 M	--	-36.93 M
Demands	0	--	37.47 M	28.53 M
Emissions	--		--	0
Network	5.92 M	43.43 M	37.47 M	-10.47 M
Whole system	5.92 M	43.43 M	n/a	-39 M

NETWORK DEMANDS

Values are in *Total* costs

	Count	Revenue (€)
University	19	24.63 M
Residential	36	8.12 M
Other	8	4.72 M

NETWORK SUPPLIES

Values are in *Total* costs

	Capacity (Wp)	Output (Wh/yr)	Capital (€)	Capacity (€)	Heat	Coincidence
ULB “K” Building	0	0	0	0	0	100%
Solvay Brussels School of Economics & Management	448.36 k	1.04 G	448.36 k	201.76 k	4.37 M	66%
ULB “U” Building	3.41 M	9.03 G	3.41 M	51.13 k	38.81 M	63%

EMISSIONS

Values are in *Total* costs

	CO2 (ton/yr)	CO2 (€)
Network (heat)	2.4 k	21.62 M
Counterfactual	2.26 k	20.34 M
Net	141.82	1.28 M

SCENARIO 1/C

No individual systems installed

CO2 cost at 550/year

COST SUMMARY

Values are in *Total* costs

	Capital cost (€)	Operating cost (€)	Operating revenue (€)	NPV (€)
Pipework	1.99 M	--	--	-1.99 M
Heat supply	3.84 M	43.28 M	--	-36.79 M
Demands	0	--	52.72 M	40.14 M
Emissions	--		--	0
Network	5.83 M	43.28 M	52.72 M	1.36 M
Whole system	5.83 M	43.28 M	n/a	-38.78 M

NETWORK DEMANDS

Values are in *Total* costs

	Count	Revenue (€)
University	19	34.7 M
Residential	36	11.38 M
Other	8	6.65 M

NETWORK SUPPLIES

Values are in *Total* costs

	Capacity (Wp)	Output (Wh/yr)	Capital (€)	Capacity (€)	Heat	Coincidence
ULB “K” Building	0	0	0	0	0	100%
Solvay Brussels School of Economics & Management	0	0	0	0	0	100%
ULB “U” Building	3.84 M	10.05 G	3.84 M	57.55 k	43.22 M	63%

EMISSIONS

Values are in *Total* costs

	CO2 (ton/yr)	CO2 (€)
Network (heat)	2.39 k	39.48 M
Counterfactual	2.26 k	37.3 M
Net	132.3	2.18 M

SCENARIO 2

All individual systems optioned

CO2 cost at 100/year

COST SUMMARY

Values are in *Total* costs

	Capital cost (€)	Operating cost (€)	Operating revenue (€)	NPV (€)
Pipework	1.84 M	--	--	-1.84 M
Heat supply	2.96 M	37.13 M	--	-31.24 M
Demands	0	--	25.3 M	19.26 M
Emissions	--	--	--	0
Network	4.81 M	37.13 M	25.3 M	-13.82 M
Natural gas	0	13.42 M	--	-10.22 M
Emissions	--	4.13 M	--	-3.15 M
Individual systems	0	17.56 M	--	-13.37 m
Whole system	4.81 M	54.69 M	n/a	-46.45 M

NETWORK DEMANDS

Values are in *Total* costs

	Count	Revenue (€)
University	19	16.6 M
Residential	36	5.52 M
Other	8	3.18 M

NETWORK SUPPLIES

Values are in *Total* costs

	Capacity (Wp)	Output (Wh/yr)	Capital (€)	Capacity (€)	Heat	Coincidence
ULB “K” Building	1.64 M	3.68 G	688.6 k	983.17 k	9.38 M	63%
Solvay Brussels School of Economics & Management	596.11 k	1.5 G	596.11 k	268.25 k	6.31 M	66%
ULB “U” Building	1.68 M	4.69 G	1.68 M	25.19 k	20.16 M	65%

INDIVIDUAL SYSTEMS

Values are in *Total* costs

	Count	Capacity (Wp)	Output (Wh/yr)	Capacity (€)	Heat (€)
Natural gas	112	NaN	5.79 G	1.44 M	11.99 M

EMISSIONS

Values are in *Total* costs

	CO2 (ton/yr)	CO2 (€)
Network (heat)	3.86 k	11.58 M
Natural gas	1.38 k	4.13 M
Total	5.24 k	15.71 M
Counterfactual	3.64 k	10.92 M
Net	132.3	2.18 M