Lessons learnt from the 1st French case study on the integration of a solar plant into an existing DH

TECSOL

cea DE LA RECHERCHE À L'INDUSTRIE

ines INSTITUT NATIONAL DE L'ENERGIE SOLAIRE

COFELY Services GDF SUEZ

SDH solar district heating

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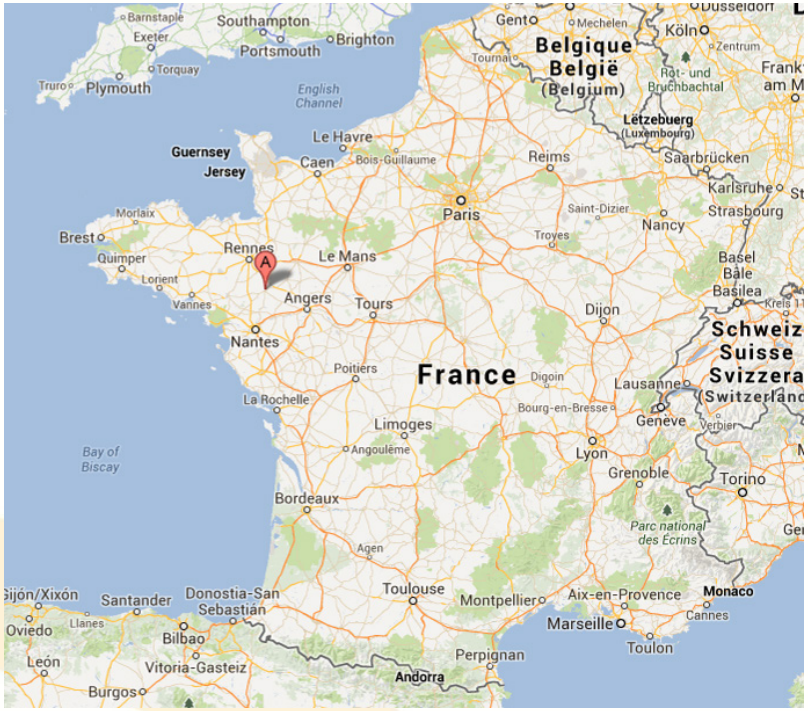
Introduction

1. The French context
2. To integrate a solar plant into Châteaubriant DH ?
3. Next step

Introduction



The city of Châteaubriant :

- 14 000 inhabitants
- Near Nantes, Rennes, Angers, Laval

Meteorological data :

- Degree Day : ~2400
- Average outside temperature : 11,3°C
- Solar irradiation : 1325 kWh/m² (South – tilt 30°)
- Minimum / Maximum outside temperature : -6.5°C / 29.8°C

Introduction

The city of Châteaubriant :

- Farming and agriculture mechanization
- Bovine cattle market and slaughterhouse
- Plastic manufacturing
- Biomass resource

Introduction

The biomass boiler and the district heating :

- 3 MW biomass boiler
- 2 x 3 MW gas boiler
- District heating 7,7 km (2014)
- Production in 2012 : 22 GWh/year, heat demand : 18,5 GWh/year, efficiency : 84%

➔ 50% grants for the biomass from the ADEME

➔ initial objective : 82% biomass / 18% gas

monitoring 2012 : 79% biomass / 21% gas

➔ the DH is operated since 2011 by COFELY

➔ heat price oct. 2011 – sept 2012 # 74 €/MWh (incl. VAT)

Introduction

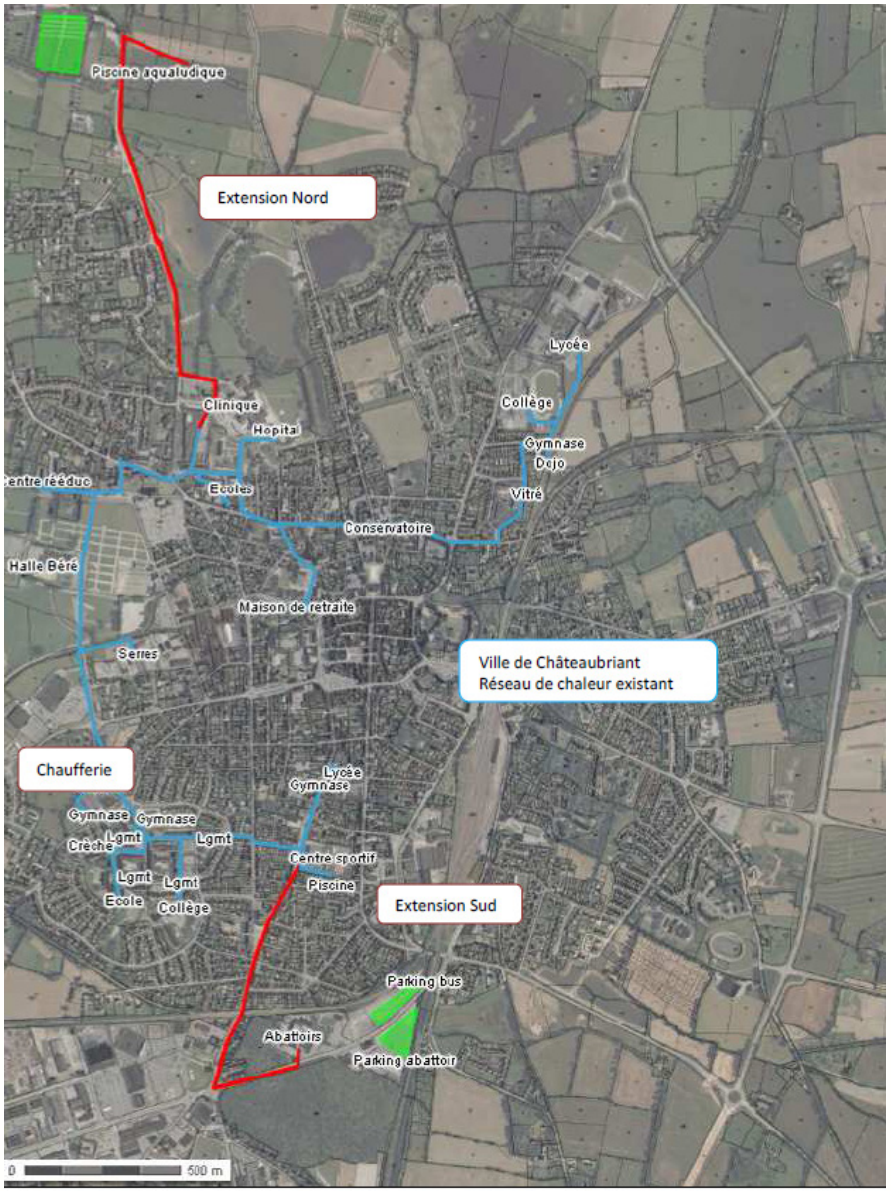
32 substations in 2013 (6,82 MW)

mainly big public consumers like :

- Social housing
- Schools
- Sport centers
- Hospital
- Town greenhouse

+ 2 new extensions planned in 2014 (+2,25 MW) :

- swimming pool (North, +1,4 km),
- slaughterhouse (South, + 1km)



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Introduction

Why integrating solar energy into the DH ?

- New substation = increase the energy demand in summer (mainly Domestic Hot Water loads)
- Solar energy is free and infinite, available everywhere in the globe, there is no inflation rate on it !

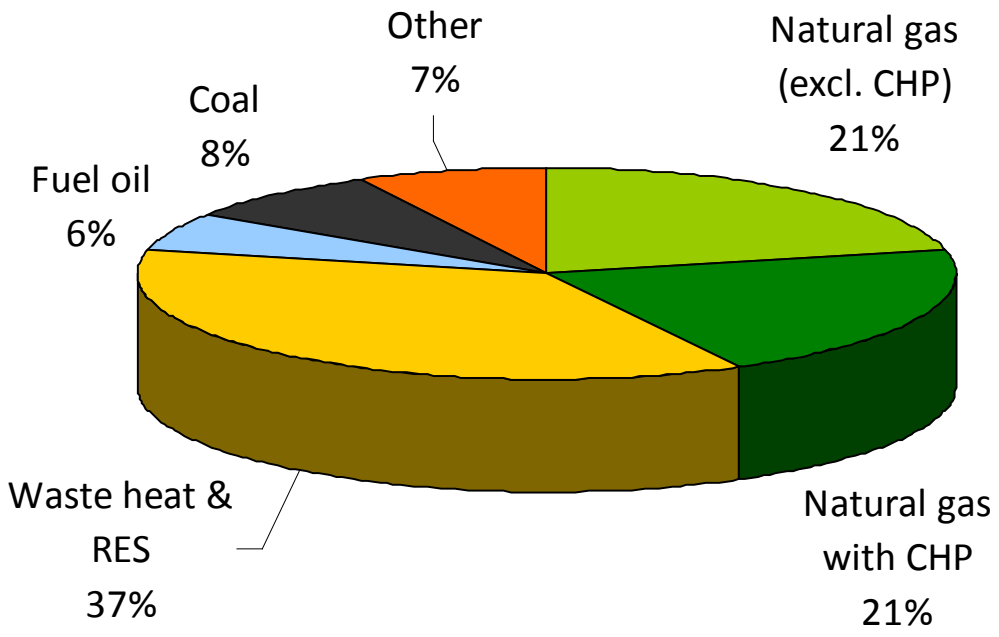
Lessons learnt…

- Important to reach the elected members of cities, especially for small cities, because they are aware about climatic issues
- Technical advisors can inform and convince the elected members in big cities ; they are interested in innovative and carbon-free solutions
- Innovative solution requires a lot of motivation and energy from all the partners

1. The French context

National Survey (SNCU, 2011)

- 400 DH > 3,5 MW + 60 DH with lower capacity
- Total production capacity 16,3 GW_{th} – Energy produced 21 807 GWh
  # 2 millions « equivalent » dwellings
- Average heat price : 68,2 € HT/MWh (6,82 c€/kWh)



2. To integrate a solar plant into a DH

1st step : SDH case studies AMORCE, CEA-INES and TECSOL (French partners of the project)

- call for interest in dec. 2012 ➔ *about 10 positive answers from local authorities and utilities*
- selection of the candidates according the following criteria : temperature of the DH lower than 100°C, heat demand all year long, waste heat does not cover all the summer loads + one place identified for solar collectors ➔ *Châteaubriant was selected*

2nd step : feasibility study about the integration of a solar plant into the existing DH of Châteaubriant.

➔ the local authority is motivated

➔ the utility is not confident with cost overspending

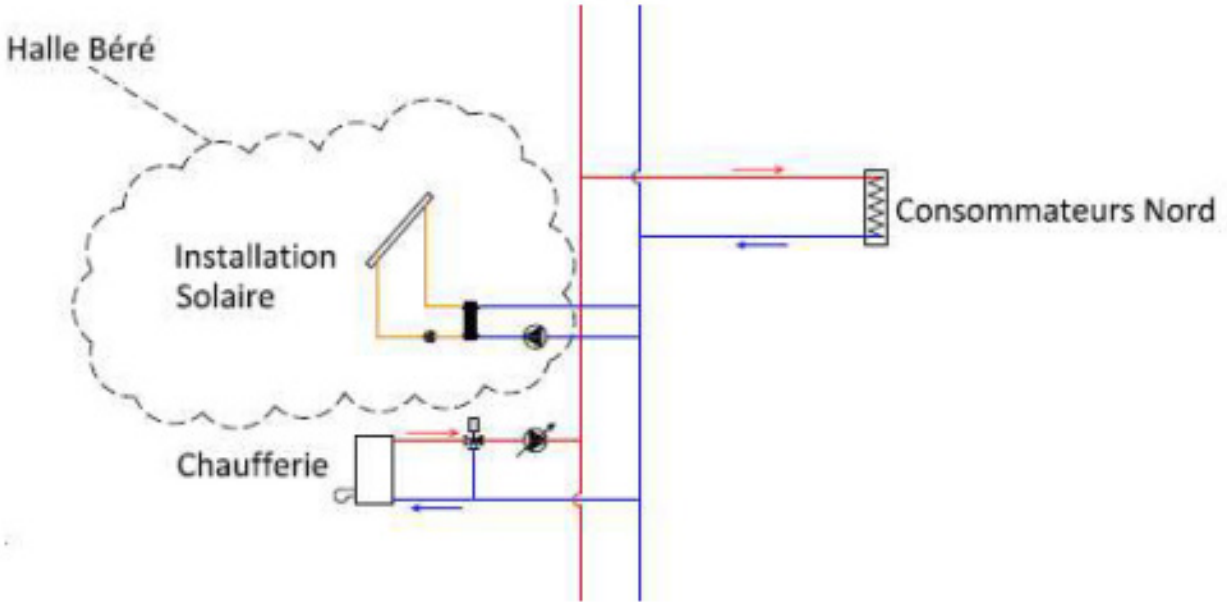
3rd step (now) : pre-project planning phase by the utility and the local authority + negotiation of the contract terms.

2. To integrate a solar plant into a DH

2.1 Major pre-design results :

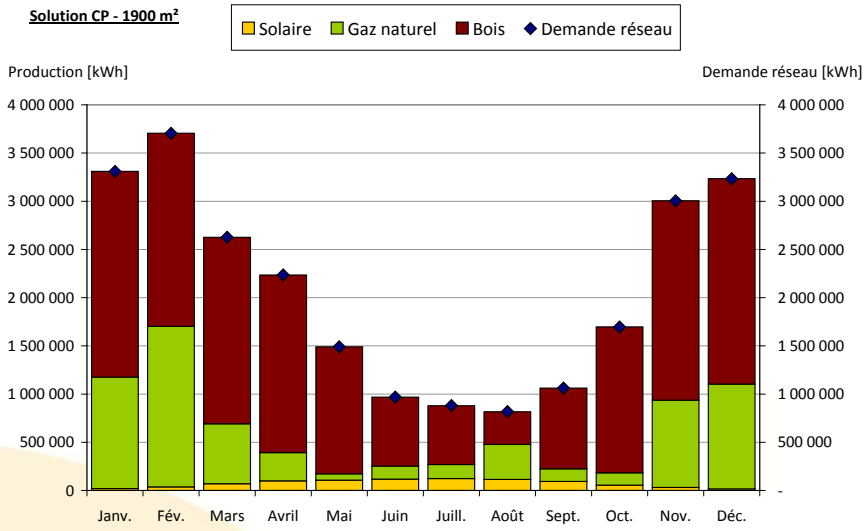
- Ground mounted solar plant, connected to the main branch of the DH
- Collector type : evacuated tubes or high temperature flat plate collectors
- between 1500 and 1900 m² according their characteristics
- No heat storage – solar connected directly in return/return to the DH

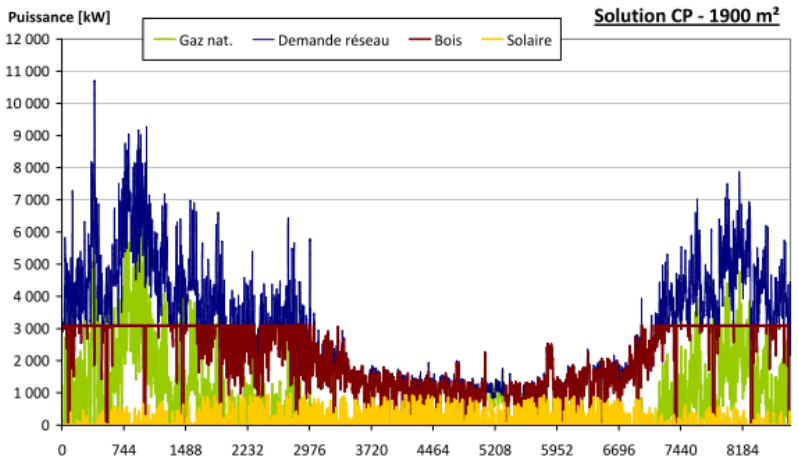
➔ solar heat production : 890 MWh/an (solar fraction 3,5%)



2. To integrate a solar plant into a DH

2.2 Major energetic results of the pre-design phase :





Heat loads (incl. Losses) [MWh/y]	CO2 emission [g/kWh]	Biomass production [MWh/y]	Natural gas production [MWh/y]	Solar production [MWh/y]
25 000	61,3	17 565 (70,2%)	6 555 (26,2%)	890 (3,5%)

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2. To integrate a solar plant into a DH

2.3 Major financial results of the pre-design phase :

LCOE = levelized heat cost over the lifespan
Hypothesis for the cost (€ without VAT)

Investment costs (CAPEX):

-solar plant……..480 €/m²
-connexion to the DH……120 000 €
-engineering……..9%

Operating costs (OPEX):

-auxiliaries electricity consumption (P1')
-monitoring, maintenance (P2)
-replacement of materials (P3)

Financial hypothesis:

-capital stock……100 000 €
-loan rate……3.75%
-loan time and installation lifespan (n)…….20 years
-actualization / update rate (a)……4%
-inflation……..2%

global cost of heat (levelized)

$$LCOE = \frac{\sum_{t=1}^{n} \frac{(CAPEX + OPEX_t)}{(1+a)^t}}{\sum_{t=1}^{n} \frac{ESU_t}{(1+a)^t}}$$

Solar heat production (levelized)

2. To integrate a solar plant into a DH

2.3 Major financial results of the pre-design phase :

Net collector area (HT FPC)	1 900 m²
Solar yield	470 kWh/m².y
Total Investment cost	1 140 k€
	600 €/m²
Operating cost	4.4 k€/y
Heat production 20 years	17.8 GWh
Global solar heat cost	1 480 k€
LCOE (excl. VAT)	**98.4 €/MWh**

The results have been confirmed by PLANENERGI in the framework of the SDH+project "WP5 **coaching" activity** :

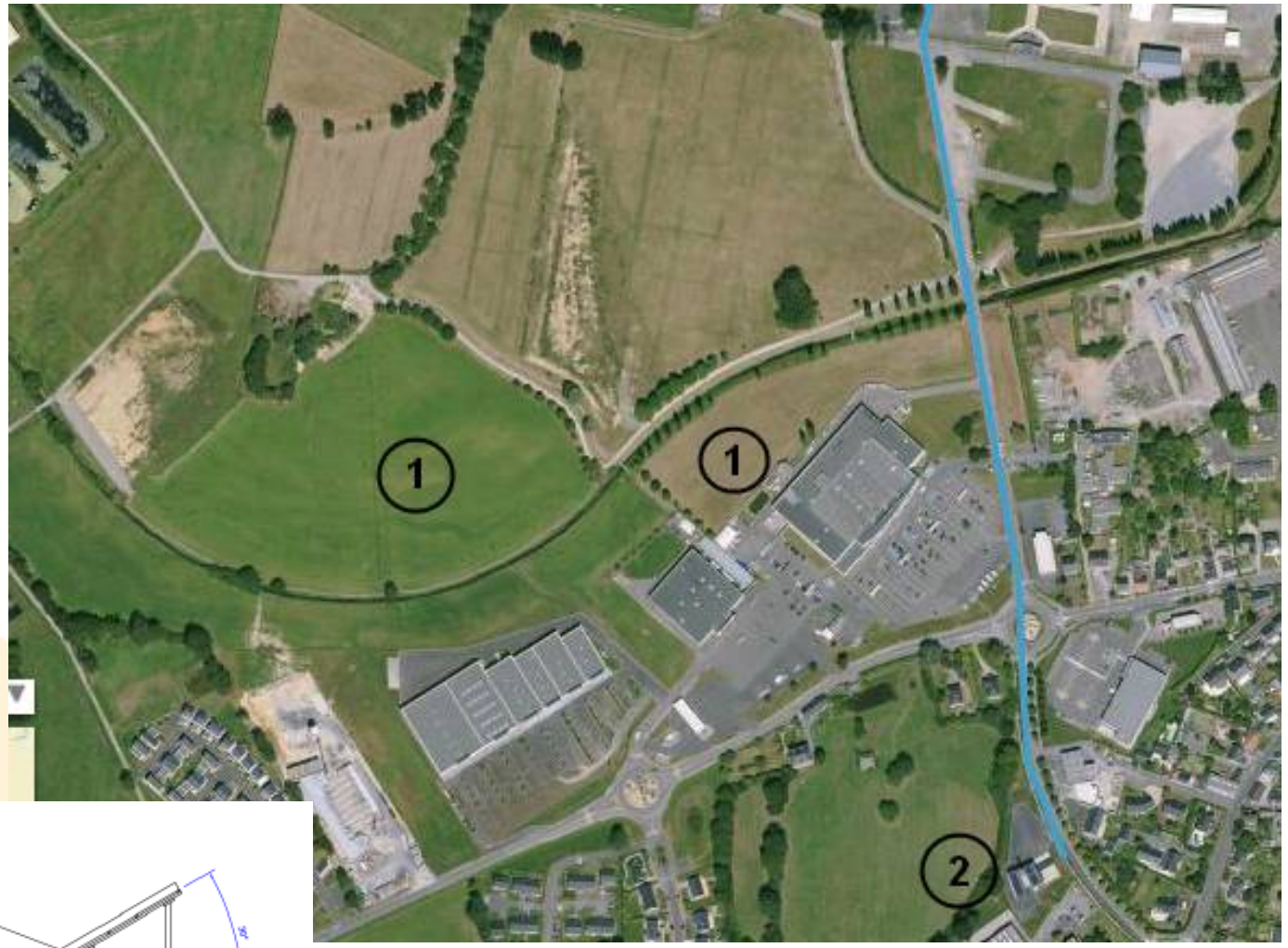
- Their conclusion showed us that an economical balance can still be achieved when increasing the collector area, with the integration of a daily storage
- For the same pre-design characteristics, they calculate o LCOE of 50€/MWh, Investment after 10% of subsidies about 600 k€ (excl. VAT)

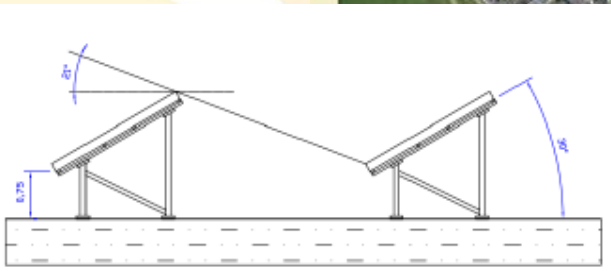
2. To integrate a solar plant into a DH

Conclusions : opportunities at Châteaubriant

- ➔ The local authority is really motivated and will make **available a ground for free**,
- ➔ The **contract between the local authority and the utility** is only 3 years old,
- ➔ Important energetic and then financial economies can be realized if the DH **operating temperatures are lowered**, which is required by the integration of solar energy,
- ➔ The DH is fully equipped with a monitoring system,
- ➔ The project would constitute a **first demonstration project** in France,
- ➔ The LCOE of the solar plant without grant is correct, compared to the heat price of innovative and granted renewable energy (geothermal for example) which is about 100 €/MWh.

Available ground





1. ground for collectors
2. boiler house

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Contract between the local authority and the utility

French model “DSP” : the DH public service is delegated by the local authority to a utility

Local authority :

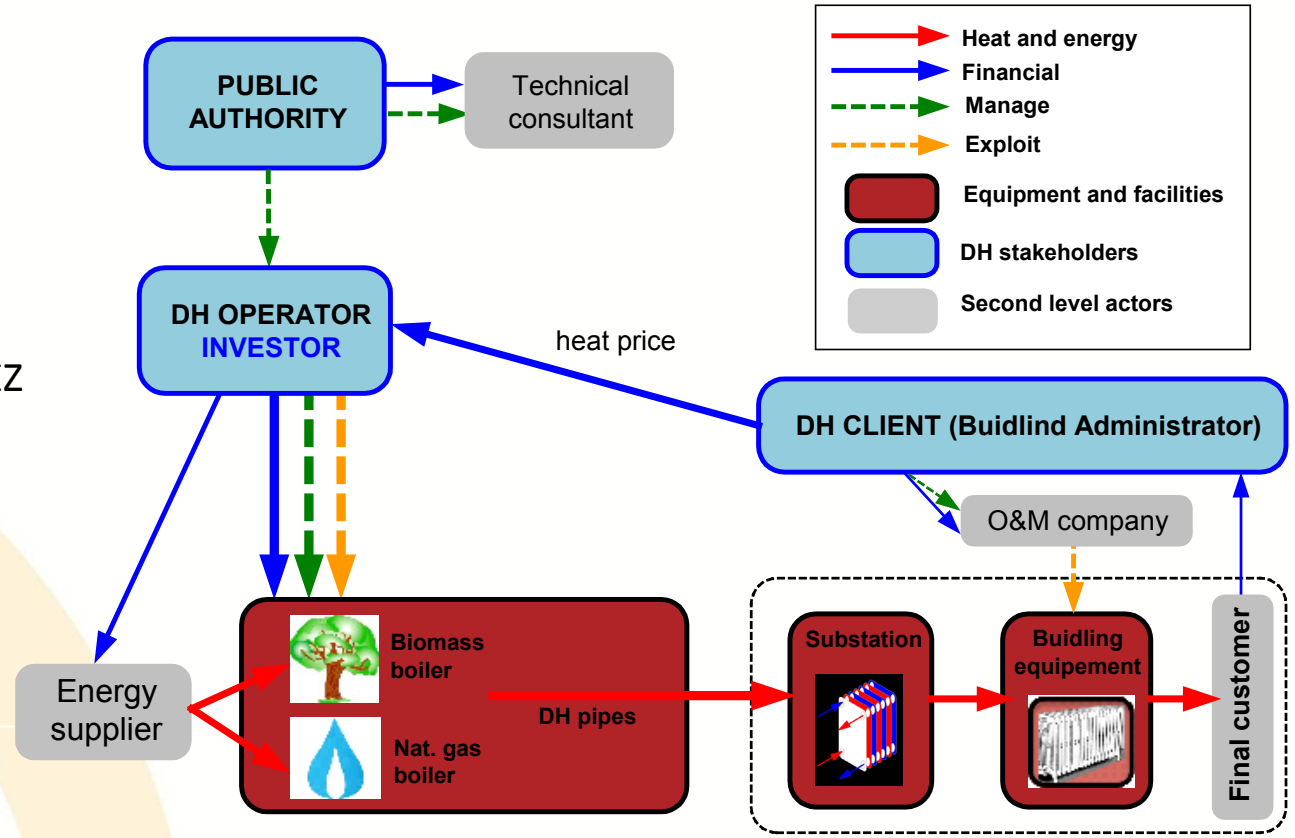
City of Châteaubriant

Utility :

COFELY Service GDF SUEZ

Time contract :

20 years



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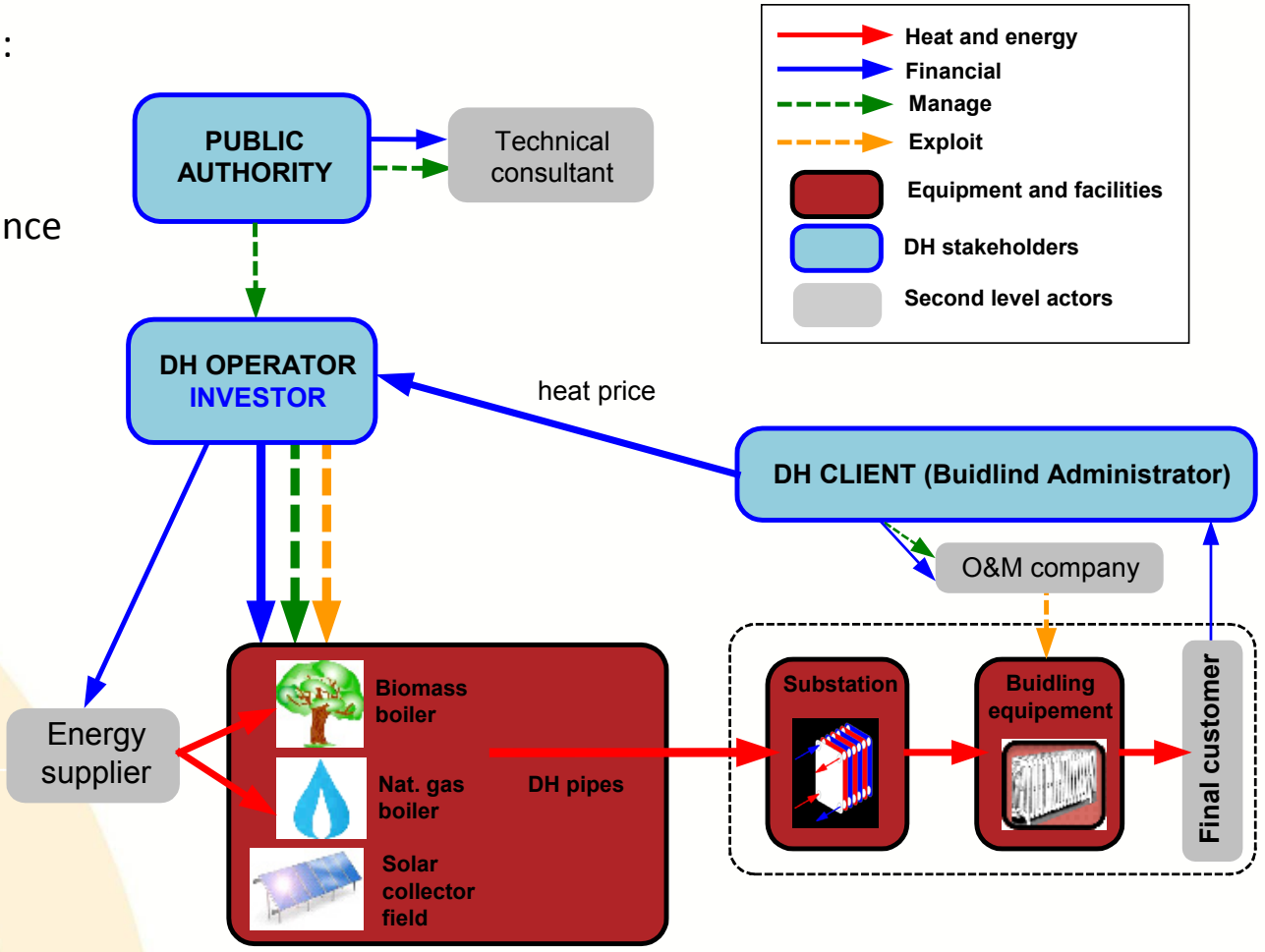
Contract between the local authority and the utility

Solution n°1 = integrate the solar plant into the DSP

COFELY is responsible for :

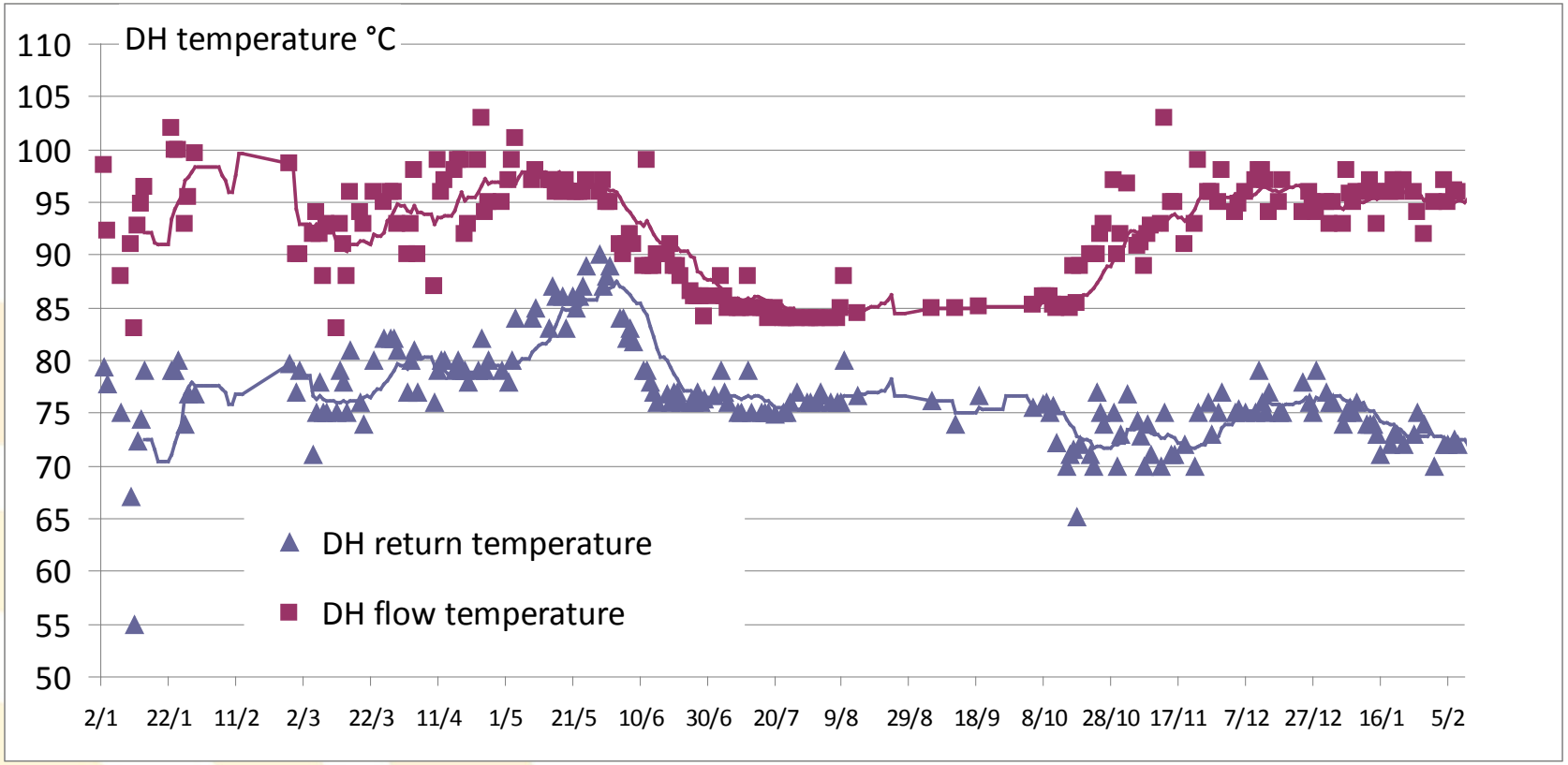
- investment
- management
- operation and maintenance



Lowering the DH operating temperature

Initial project : winter 90-70°C / summer 70-50°C

In operation : winter 99-75°C / summer 85-75°C



Lowering the DH operating temperature

Objective : Actual – 10°C ⇔ winter 90-65°C / summer 75-65°C

Results ?

- Lower the distribution losses - 13,4%
- Lower the heat production - 2,4%
- Increase the collector efficiency +15 to 20% according the collector characteristics

How to do it ?

- Analysis of the causes : the hospital requires high temperatures for DHW production to prevent legionnella development
- Solution : upgrade the DHW distribution system of the hospital OR use a local heater (aldready existing) to complete the heat production

➔ the discussion are ongoing since 1 year between the City and the hospital

3. Next steps

TO DO at Châteaubriant :

- To lower the operating temperature of the DH ➔ on going
- To Limit the investment cost of the solar plant
- To find the correct business model

3.1 To lower the investment cost ?

Public grants :

- 300 k€ NTE funds in 2013 obtained by COFELY
- Other availables grants : local ADEME agency, Fonds Chaleur, europeans grants
- Incitative : low VAT ?

Business models :

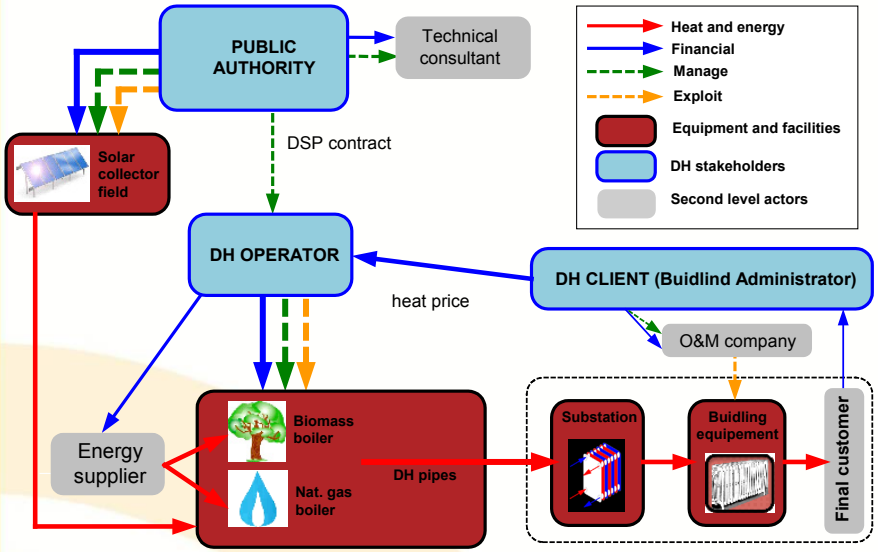
- Turn-key solar collector field (design + material + installation) ?
- Call for tender with local installers ? Direct investment on material ?

Other leads studied by COFELY :

- Lower the collector area
- Increase the DSP contract time (1 > 3 years)
- Increase the heat price (+1 to 5 €/MWh incl. VAT)

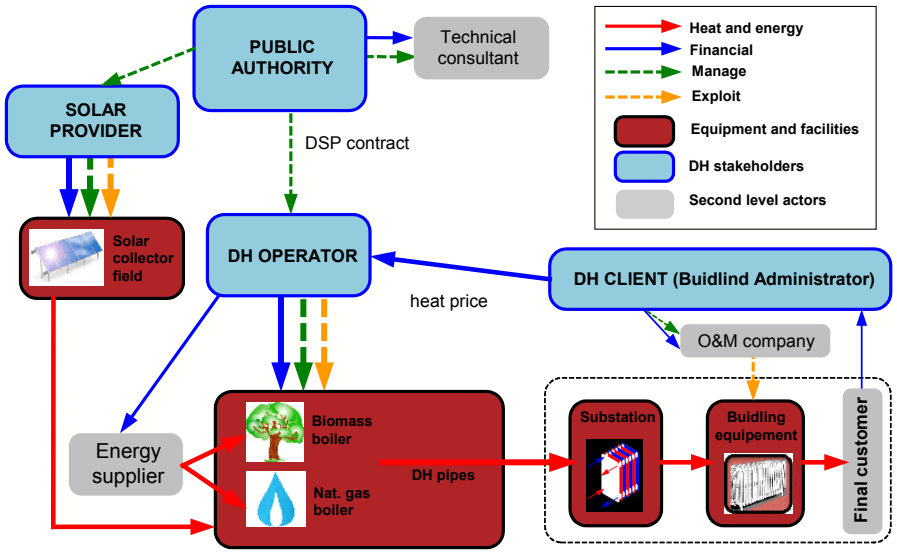
3.2 Other available business model ?

Maybe other project business model are appropriate ?



The public authority invests, manages and operates the solar plant.

Solar heat is sold to the DH.



A external company “solar provider” invests, manages and operates the solar plant.

Solar heat is sold to the DH.

Thank you for your attention

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