SDH CONFERENCE 2016 – MONITORING RESULTS FOR THE TWO FIRSTS SOLAR PLANTS ON DISTRICT HEATING IN FRANCE: BALMA GRAMONT AND JUVIGNAC

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Abstract – Balma and Juvignac are the first French solar district heating networks. They are now in full operation and first feedback of the performance, defaults and possible improvements are possible. Here below are listed details about the configuration of both installations, and global analysis regarding solar production.

1. PRESENTATION OF BOTH SOLAR DISTRICT HEATING PLANTS: BALMA-GRAMONT AND JUVIGNAC

1.1 Balma Gramont

A 1000 housings ecodistrict located next to Toulouse, with a technology of high temperature vacuum tubes solar collectors supplied by Viessmann, in a parking shade structure. Collectors surface is 458 m2.

Figure 1: solar panels on parking shade in Balma

Heating boilers associated to solar thermal on district heating network are a biomass boiler with 24 m3 storage tank and a gas boiler.

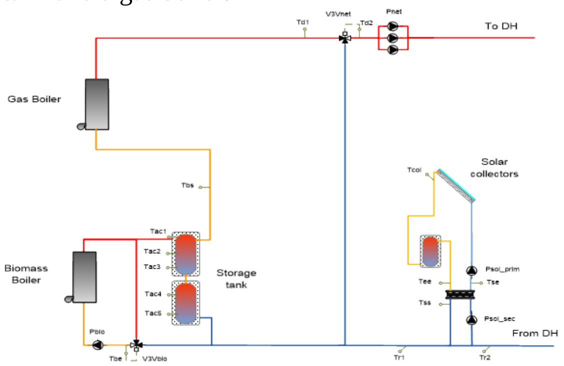

Figure 2: Hydraulic scheme of Balma installation

1.2 Juvignac

A 1400 housings ecodistrict located next to Montpellier. The technology chosen for collectors is flat plate 2-glazed collectors, installed on roof of the boiler room specifically developed for this kind of application by Clipsol. Collectors surface is 295 m2.

Figure 3: solar panels on roof of boiler room in Juvignac

A biomass boiler with a 24 m3 storage tank and 2 gas boilers are associated to solar thermal installation.

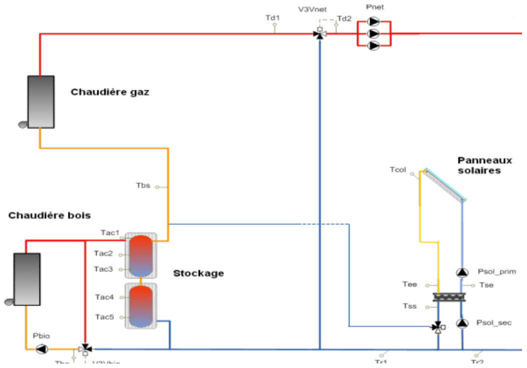

Figure 4: Hydraulic scheme of Juvignac installation

Technologies chosen are different for solar collectors, but on both plants, they are connected in “return-return” configuration so that return line is preheated by solar energy.

2. MONITORING RESULTS

This part present the monitoring results of both installations: Balma and Juvignac. The analyses are based on measurement of this year (from summer 2015 to summer 2016).

2.1Balma-Gramont

Hereafter are the monitoring results between July 2015 and June 2016 for the installation of Balma:

Indicator	Unit	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Total
Global irradiation	[MWh]	78,5	72,4	54,6	47,2	31	29,9	24	33,1	47,3	65,9	74,9	75,2	**634**
Solar energy	[MWh]	39,4	35,9	27,1	17,5	9,1	10,4	4	9,6	17,2	23,5	28,2	30,4	**252,3**
Biomass energy	[MWh]	0,2	0,3	0,14	138	494	559	624	409	123	286	301	218	**3154,9**
Gas energy	[MWh]	135	140	172	182	25,5	110	158	319	638	224	70,4	14,1	**2190,5**
Solar system efficiency	[%]	50,2	49,6	49,6	37,1	29,4	34,8	16,7	33,1	29	35,7	37,7	40,4	**39,80%**
Solar fraction	[%]	22,6	20,4	13,6	5,1	1,7	1,5	0,5	1,3	2,2	4,4	7,1	11,6	**4,50%**
Solar productivity	[kWh/m²]	86	78,4	59,2	38,2	19,9	22,7	8,7	21	37,6	51,3	61,6	66,4	**551**

Figure 5: Table of productions for Balma

Regarding the annual results (from 1st July 2015 to 30th June 2016) solar production is 252.3 MWh/year and we have reached a solar productivity of about 551 kWh/m2/year. Solar cover rate is about 4.5% on the district heating network. These values are slightly below the results of previous year (596 kWh/m2/year) but the difference could be explained by a lower amount of global irradiation in 2015-2016 than in 2014-2015.

The trend of the performance indicators with the heat balance and the solar fraction are shown in figure below:

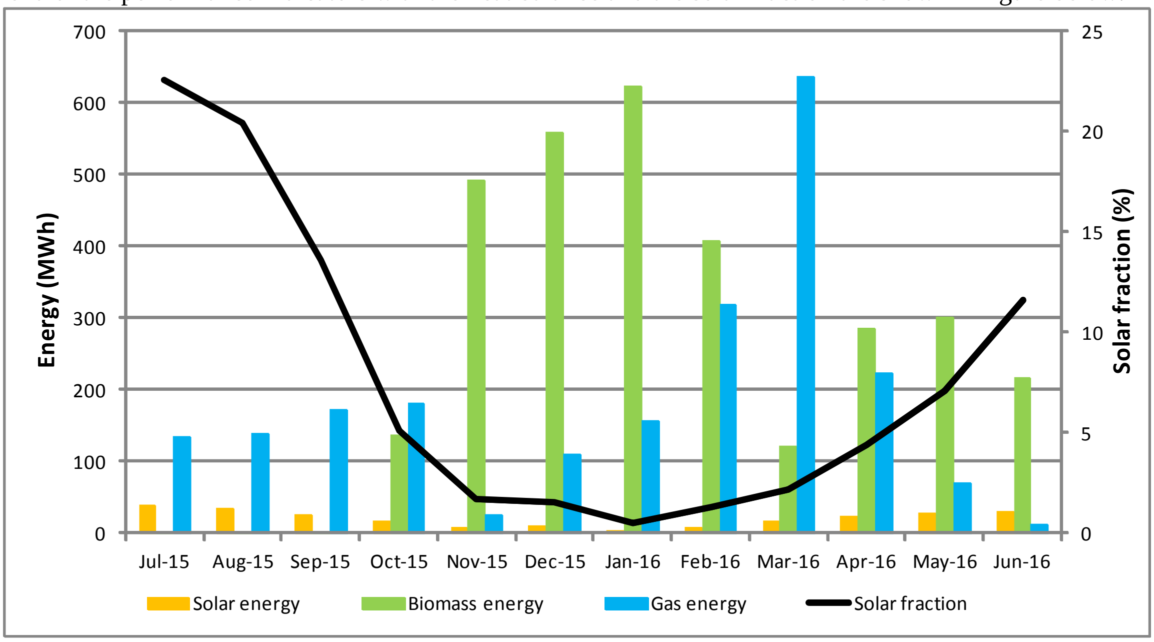

Figure 6: Performance indicators for Balma between July 2015 and June 2016

The solar fraction has reached a maximum of 22.6% for the month of July 2015. Obviously, it is much lower during winter period due to the lower global irradiation, but also because district heating demand is evolution is much higher.

During summer 2015, biomass boiler has been stopped because district heating power demand was too low considering minimum technical power limit of the biomass boiler. During this period, gas boiler has been used to complete the solar thermal production.

For the rest of the year, biomass boiler was used in parallel with solar thermal, and gas was only engaged in case of high peak of power, or technical stop of biomass boiler.

The energy performance of the solar system for June 2016 is detailed in the next figure:

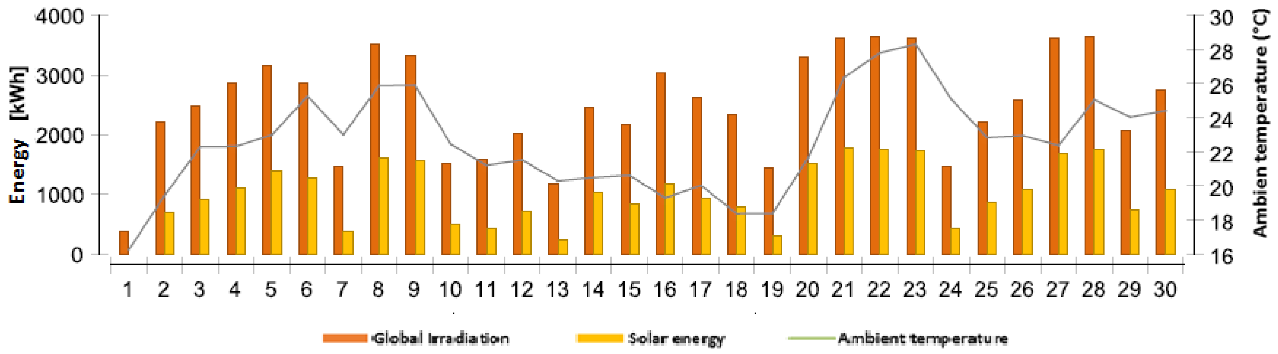

Figure 7: Energy performance of solar system for June 2016

In June 2016 the solar energy delivered into the district heating is 30,4 MWh whereas gas boiler provided only 14,1 MWh. During this month a solar fraction of 11.6% was reached.

Analysis of the solar production during one day

The maximum daily solar fraction is reached on June 28, 2016 with 24.9%. Between 2 pm and 6 pm the solar production accounts for more than 70% of the total energy delivered in the district heating. Furthermore at 3 pm the solar fraction achieves 74% as shown in the next figure. Even during summer period, solar thermal production never reaches the total heat demand on the district heating. Therefore, there is no need of storage on the solar plant.

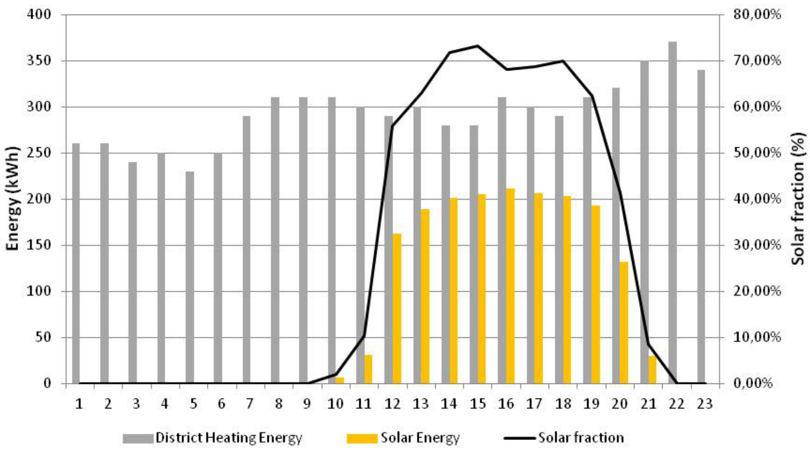

Figure 8: Solar performance June 28, 2016

The control of the solar system is based on the irradiation for the solar loop and a temperature difference for the secondary loop. The solar pump will turn on when the global irradiation reaches 150 W/m². Then when the primary hot temperature of solar loop will exceed the district return temperature thus the secondary pump will turn on. When these two conditions are met solar energy is delivered to the district heating.

To illustrate these conditions of solar production, an example of monitoring of 28/06 is given:

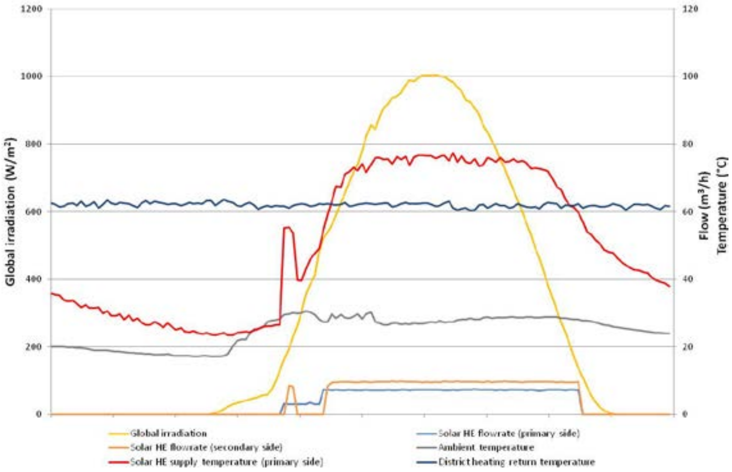

Figure 9: Analysis of solar production for June 28, 2016

During the first minutes of the operation, the primary loop is heating up in order to achieve a sufficient temperature for feeding the district heating. It depends on the capacity and the losses of the solar loop. This energy is not valorized and could be considered has lost (hatched area in next figure).

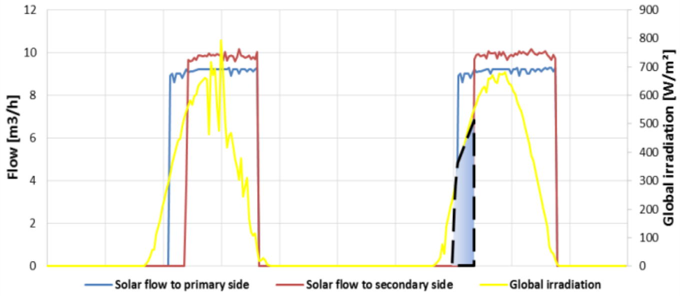

Figure 10: Global irradiation useful to heat up the primary loop

In conclusion for the installation of Balma-Gramont, the solar plant works well since July 2014. It has been realized through a R&D project with a Viessmann technology prototype. The first feedback is positive regarding the operation of the plant: the installation is well received by operators, and it is reliable. Performances of solar thermal are good but slightly below forecasts. Realisation and monitoring of this demonstrator enabled the manufacturer to make improvements on its product.

2.2 Juvignac

This plant has less than 1 year of full operation so the feedback cannot be as complete as Balma regarding solar production but here are the first results:

	Units	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16
Global irradiation	[MWh]	18.935	32	42	45	51	57.7	56.8
Solar Energy	[MWh]	3.61	11	16.3	18.2	23	29.07	32.3
Biomass Energy (MWh)	[MWh]	729	654	483.8	38.21	139.74	196.9	0
Gas Energy (MWh)	[MWh]	143	64	236.9	427.1	179.53	24.83	180.67
Solar system efficiency	[%]	19.1%	34%	39%	40%	45%	50.4%	56.9%
Solar Fraction (%)	[%]	0.4%	1.5%	2.2%	3.8%	6.7%	11.6%	15.2%
Solar productivity	[kWh/m^2]	12.2	37.7	55.32	61.56	77.9	98.5	109.5

Figure 11: Table of productions for Juvignac installation

Considering data measured from January 2016 until now, we can foresee an annual solar productivity between 700 and 750 kWh/m2/year. The estimated solar production would be 205 to 225 MWh/year and the solar cover rate 3,8 to 4,2%.

The trend of the performance indicators with the heat balance and the solar fraction for Juvignac are shown in figure below:

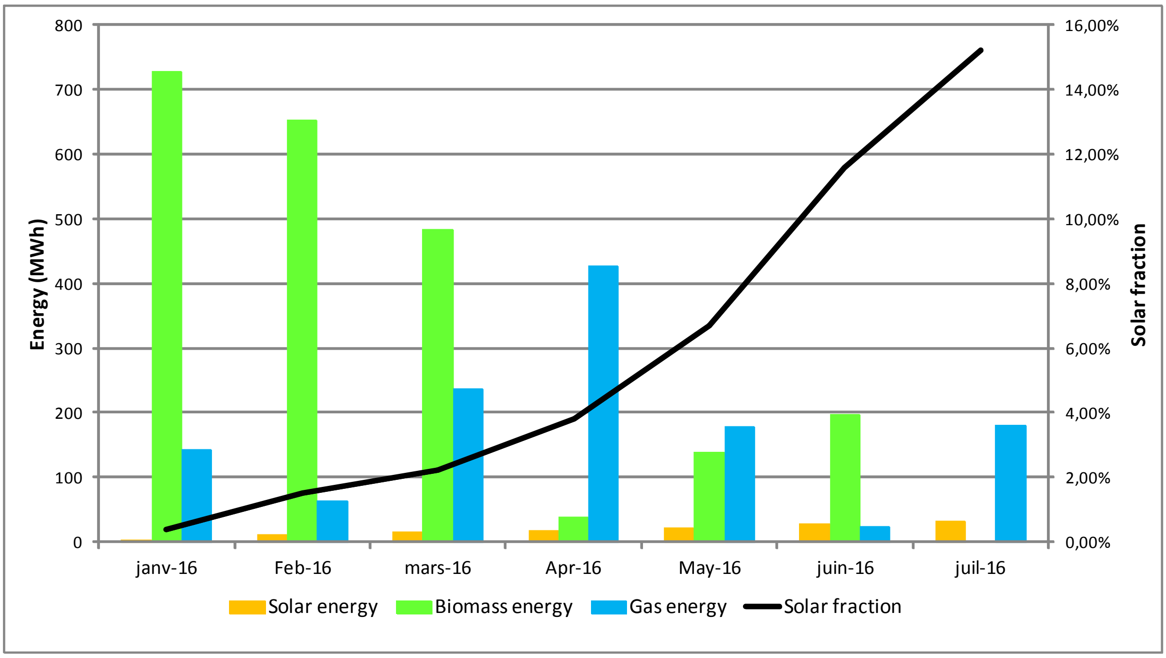

Figure 12: Performance indicators for Juvignac between January 2016 and July 2016

The solar fraction has reached a maximum of 15.2% for the month of July 2015. The biomass boiler is stopped during summer period (July 2016) because, as for Balma heat plant, district heating power demand is too low considering minimum technical power limit of the biomass boiler. During this period, gas boiler is used to complete the solar thermal production. For the rest of the year, biomass boiler is used in parallel with solar thermal, except for the month of april 2016 where technical problems on biomass boiler have reduced the biomass fraction in the energy mix of the heating network

The energy performance of the solar system of Juvignac for June 2016 is detailed in the next figure:

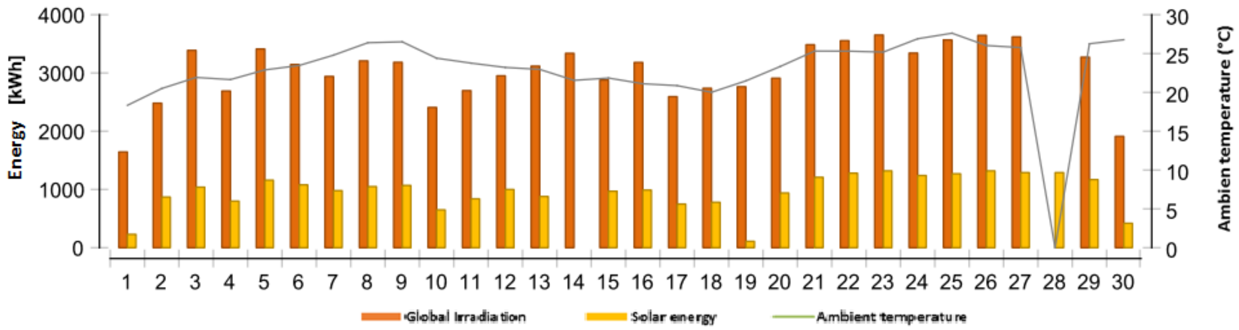

Figure 13: Energy performance of solar system during June 2016

During the month of June 2016, average solar production was about 0,95 to 1 MWh/day, so 3,3 kWh/m2/day, with 1 to 1,5 MWh produced during sunny days, and 0,5 to 1 MWh for cloudy days. The solar fraction is 11.6% for this month.

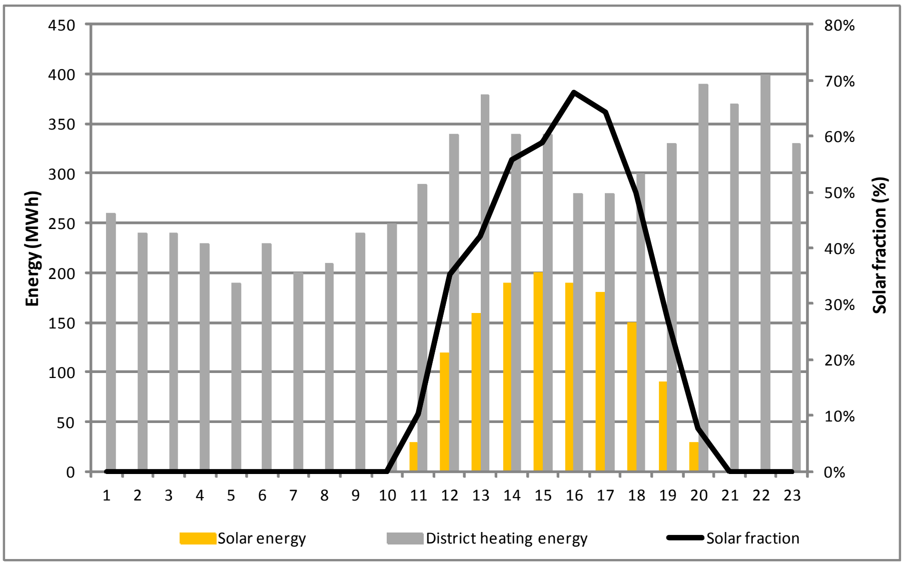

Figure 14: Solar performance June 26, 2016

During this day, 1,32MWh have been produced by solar thermal at the output of the heat exchanger. Instantaneous efficiency of solar reach values up to 68%.

The installation of Juvignac works well since the beginning of January 2016. The measured performances are in line with forecasts. The monitoring and analysis of results will continue to validate performances on a complete year of operation. The same observation for the installation of Balma: this first feedback is positive regarding the operation of the plant, the system is well received by the operators and it is reliable.

3. CONCLUSIONS

The two firsts solar district heating plant are in operation in France since 2014 for Balma plant and 2016 for Juvignac plant. Results on performances of solar installations are really good (between 550 and 750 kWh/m²/year) and show us a promising future for SDH application in France.

Both installation provide a small fraction of the district heating annual demand (less than 5%) but could achieved quite a high hourly solar fraction (up to 80%). A detailed analysis of the working operation show us that some improvements can still be done on each, to reach better solar productivity and general efficiency regarding pumps operation, temperatures, and combination of solar with others energy sources (biomass boiler and storage).

Another important conclusion of this feedback is that we did not notice specific constraints regarding the daily operation of the solar thermal installations: operating the solar thermal installations does not need heavy actions to produce solar heat in good conditions, which is a very good point for the operating teams in the district heating networks.

REFERENCES

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