IEA SHC Task 53 6th meeting

New Generation Solar Cooling & Heating systems (PV or solar thermally driven systems)

Latest results from French SAC projects : SERM

Daniel MUGNIER – Palma de Mallorca, 10/10/2016

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INTERNATIONAL ENERGY AGENCY

www.tecsol.fr

Targeted building description

Montpellier Heating and System net utilities
=> System owner

TECSOL : engineering company

AXIMA GDF SUEZ : Company in charge of the works

Building A view

Existing Building block in ZAC Jacques Coeur in Port Marianne area (Montpellier, France, built in 2010)

2 parts : building A & B (mini district)

Building A : 11 000 m² for offices and shops

Building B : 10 600 m² with 167 dwellings

Buildings situation

Load & system strategy

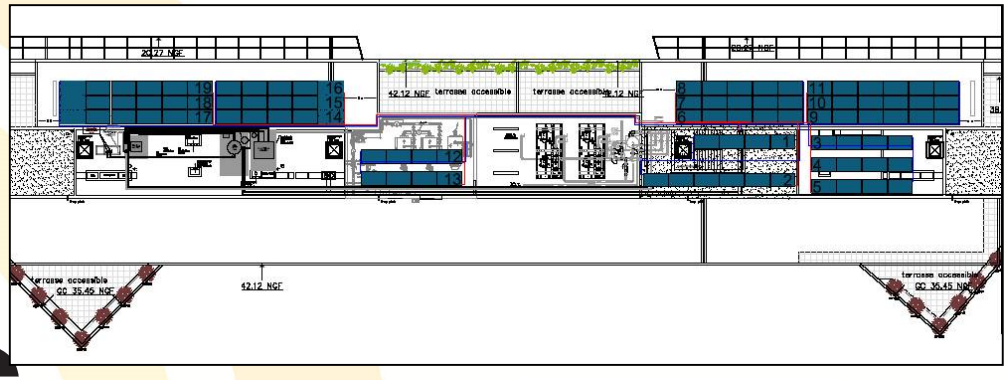
Picture of the collector field

Sizing strategy :

- available place on the roof
- simplicity & maximum yield

⇒ nearly 500 m² available on different locations on the Block A roof => 240 m² solar collector

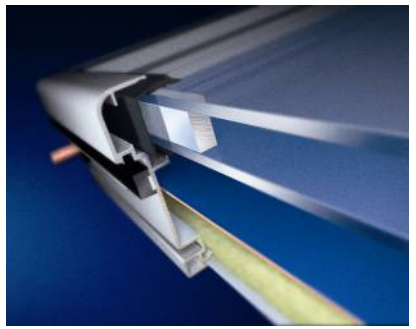
- DHW only in Winter + cooling (if possible +DHW) in Summer



Solar collector position on the roof

System description

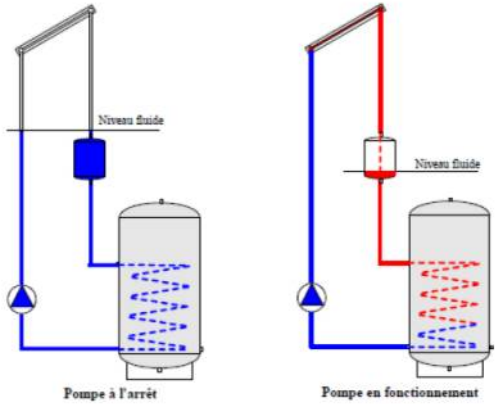
- **240 m² double glazed flat plate collectors**
- **one 35 kW absorption chiller**



Double glazed solar collector

- solar circuit in drainback mode (with water glycol + HX)

Solar collector fields in drainback mode

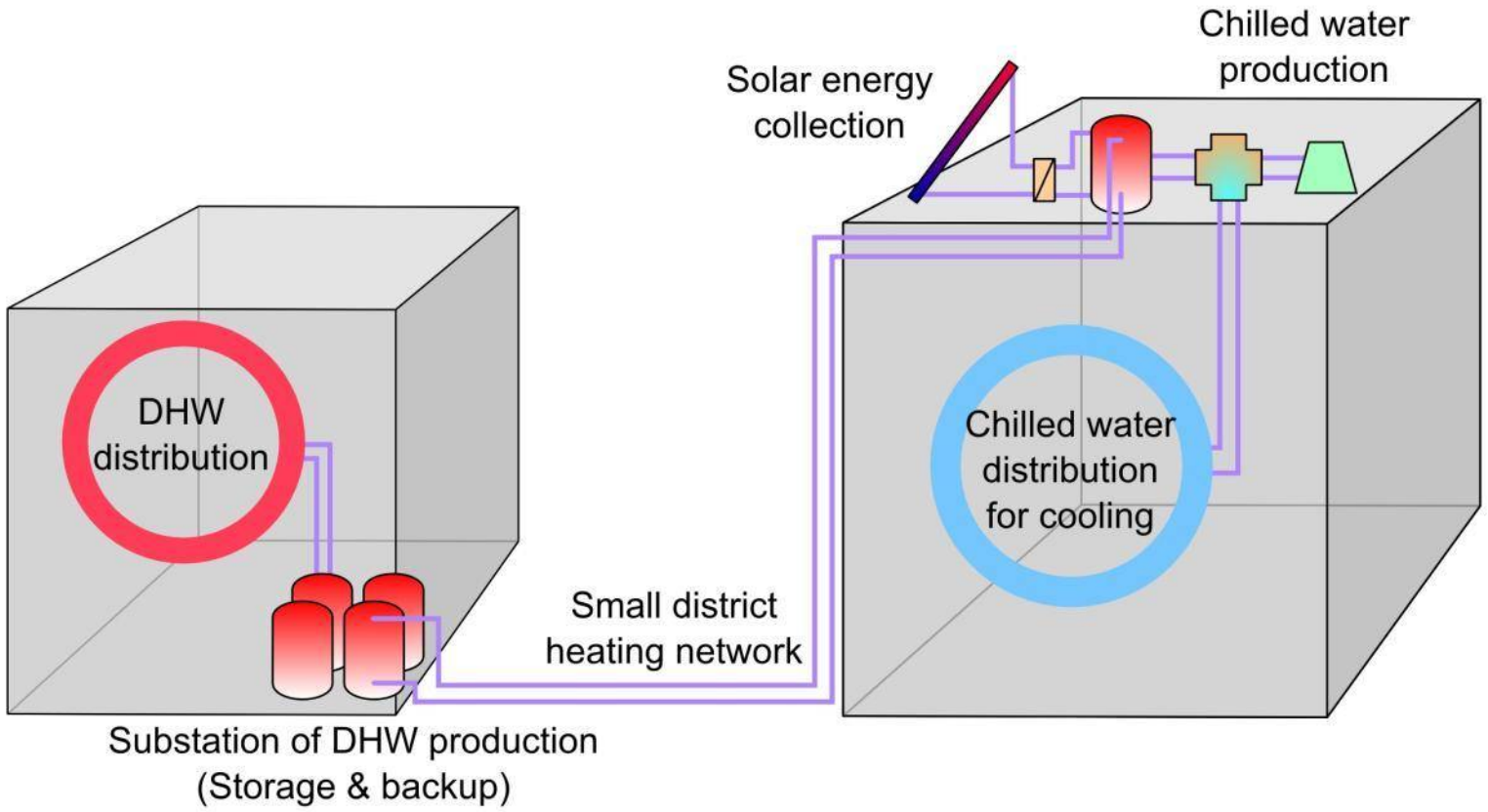


Drainback principle

- one **1500 liter hot buffer storage tank**
- DHW preheating

(+ 10 m3 DHW additional storage capacity in Building B for dwellings)

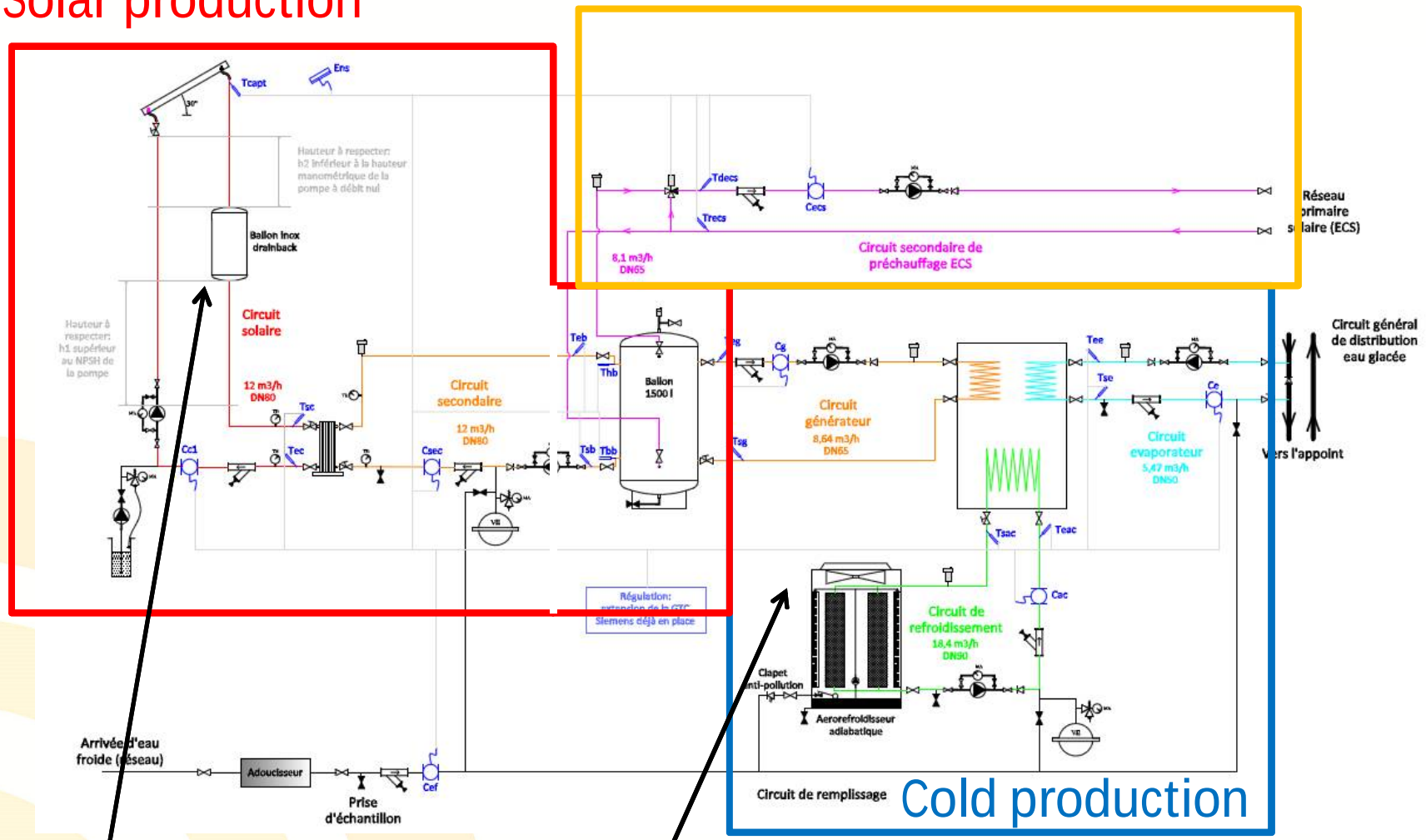
Hydraulic principle



Hydraulic scheme

DHW distribution

Solar production



Drainback system

Anti legionnella adiabatique cooling tower

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Expected results

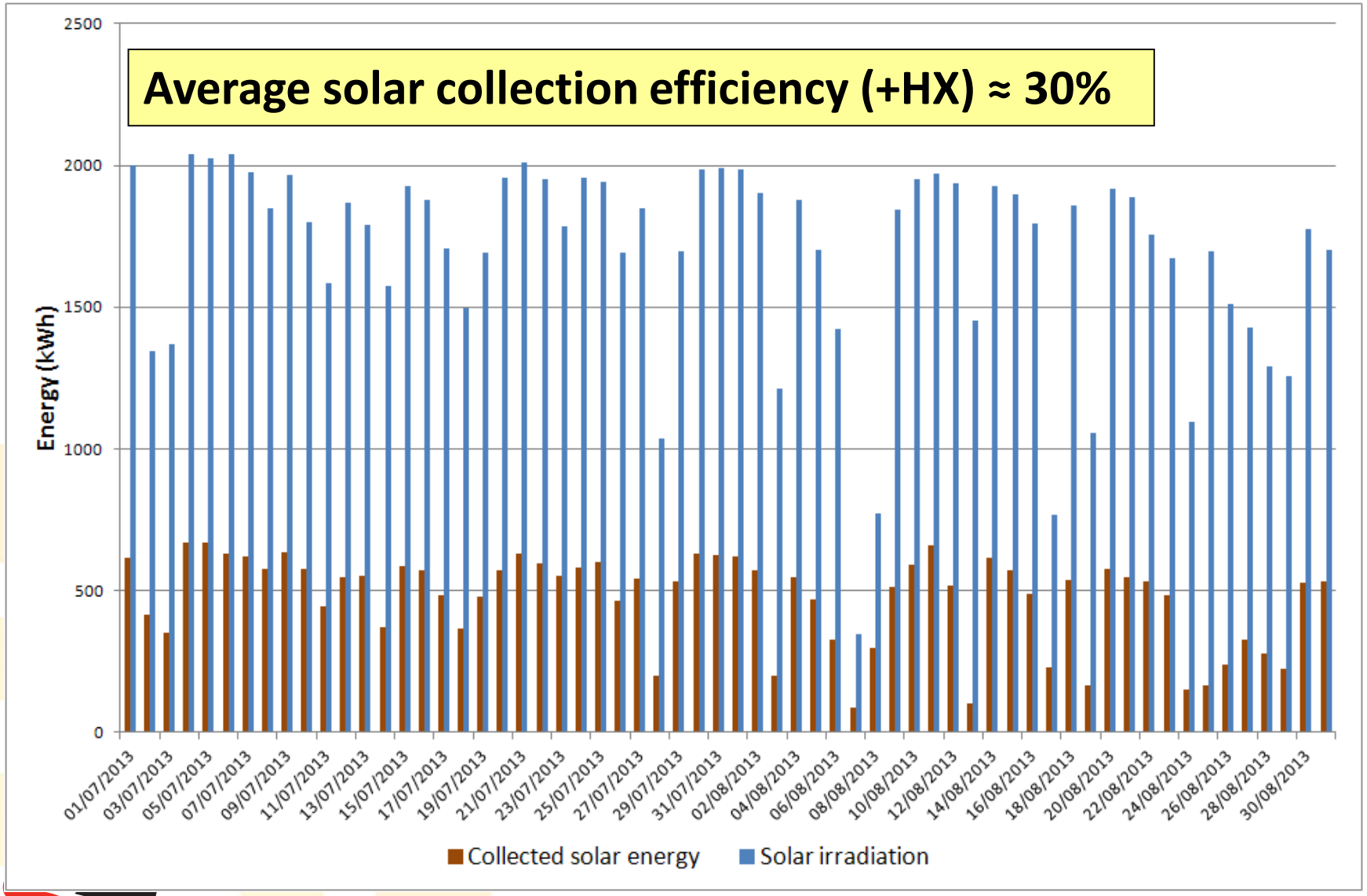
	DHW production (kWh)	Cooling production (kWh)	Electric consumption (kWh)	Solar productivity* (kWh/m²)	Electrical COP (-)	Solar fraction (%)
January	2 476	0	256	10,3	9,7	7,7 %
February	4 694	0	371	19,6	12,7	19,1 %
March	11 073	0	566	46,1	19,6	22,2 %
April	16 252	228	723	68,7	22,8	17,3 %
May	18 556	1 843	892	85,0	22,9	18,7 %
June	14 002	3 033	938	71,0	18,2	16,8 %
July	12 083	7 348	1329	81,0	14,6	9,8 %
August	11 583	6 281	1207	74,4	14,8	11,6 %
September	7 939	1 340	661	38,7	14,0	9,2 %
October	8 896	0	547	37,1	16,3	25,6 %
November	3 450	0	293	14,4	11,8	12,7 %
December	2 077	0	234	8,7	8,9	6,6 %
TOTAL	**113 080**	**20 073**	**8 017**	**554,8**	**16,6**	**13,9 %**

** Solar productivity: Calculated in winter as the distributed hot energy divided by the collector surface, and in summer the distributed cold energy is divided by the collector surface but also by the thermal COP of the chiller.*

Emergence program : mini annual thermal performance levels to reach

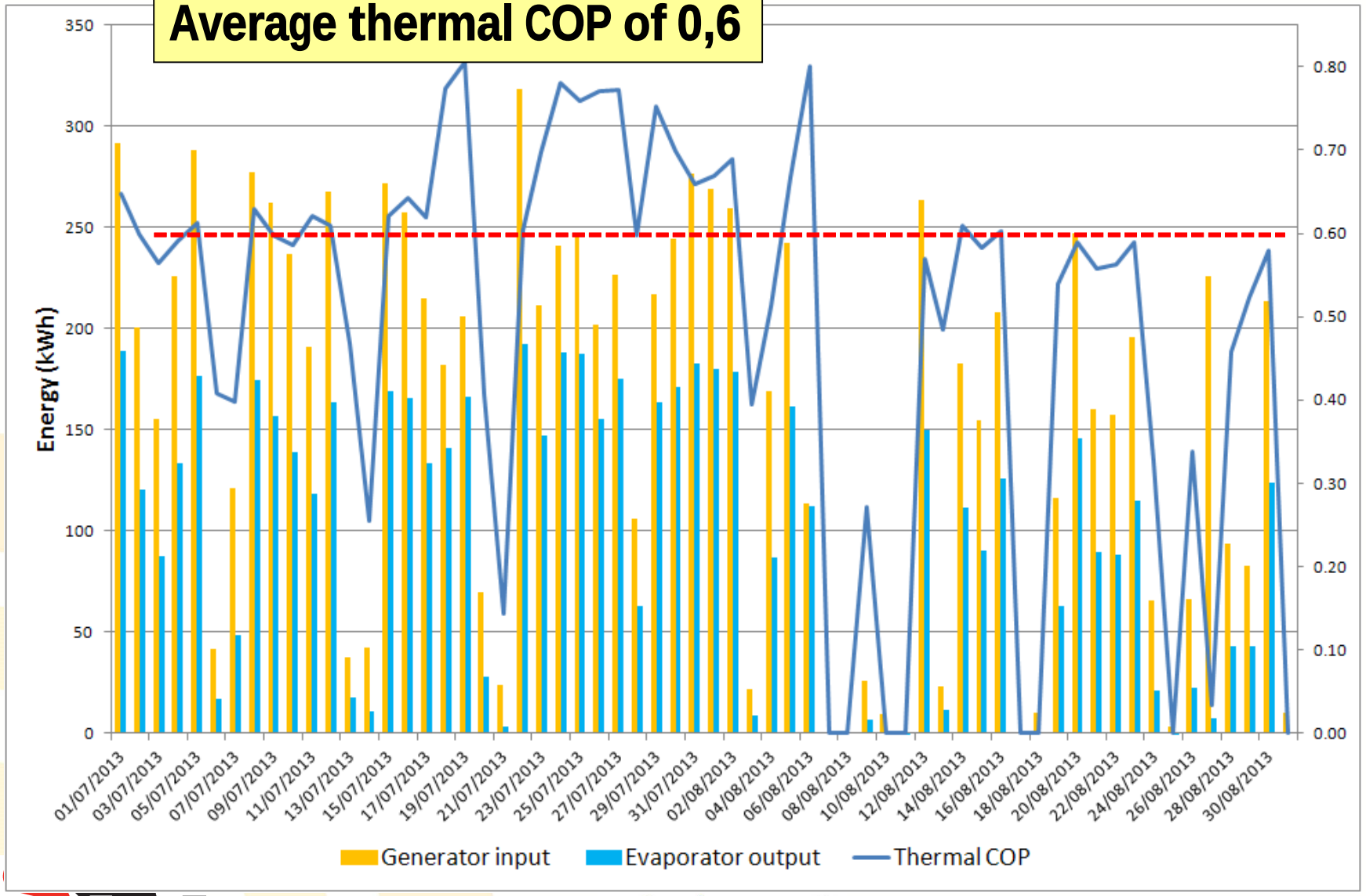
- Solar yield is estimated to 554,8 kWh/m².year **>> 350 kWh/m².year**
- **Electrical COP** is estimated to **16,6 >> 5**

Monitoring results for Summer 2013



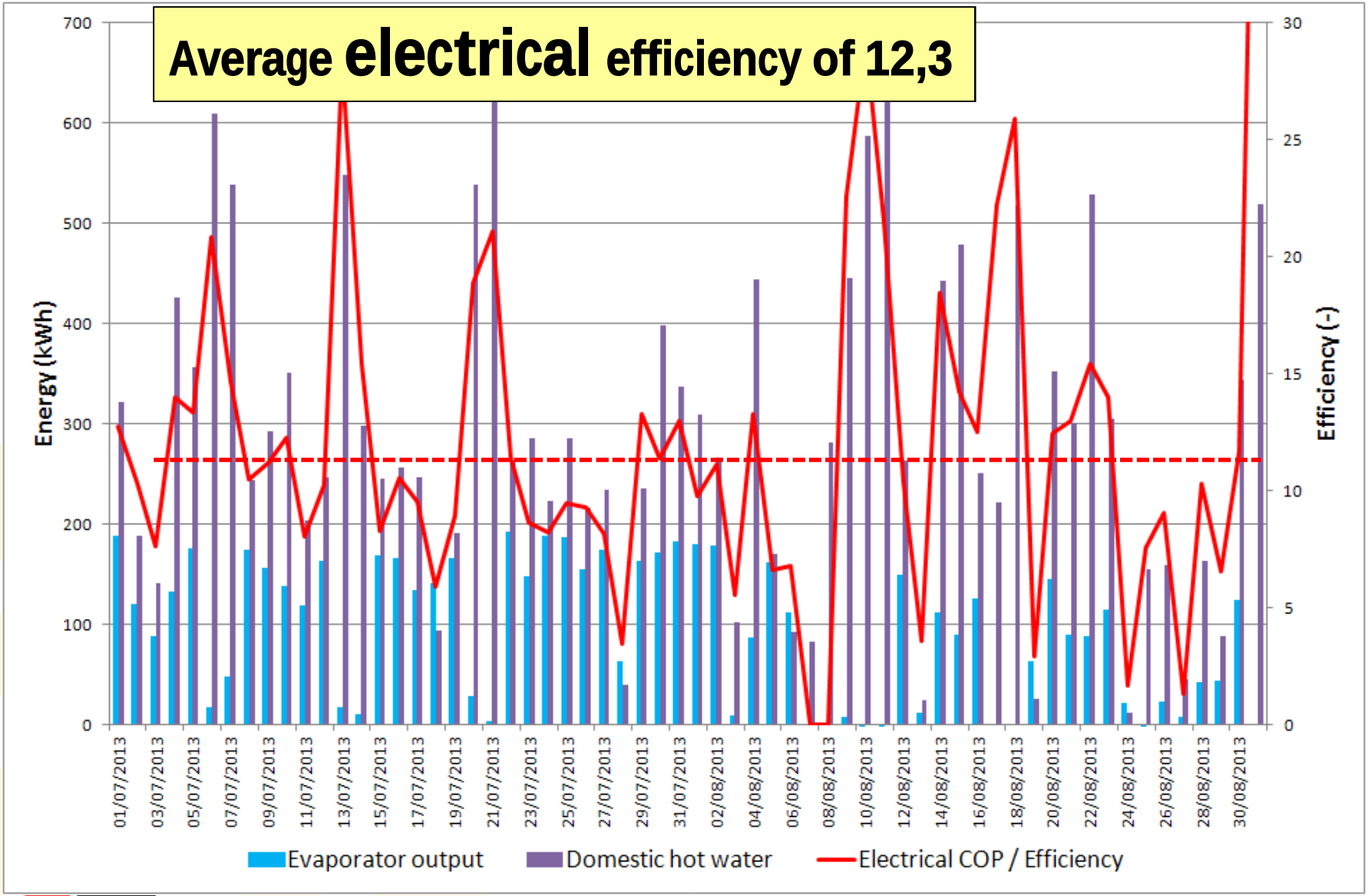
Monitoring results for Summer 2013

Average thermal COP of 0,6



Monitoring results for Summer 2013

Average electrical efficiency of 12,3



Summary of results for Summer 2013

	Unit	Value
Irradiation	kWh	104 000
Useful solar energy	kWh	30 000
Absorption generator	kWh	9 800
Absorption evaporator	kWh	6 000
DHW energy	kWh	18 000
Electrical energy	kWh	2 000
Thermal COP	**(-)**	**0.60**
Electrical Efficiency	**(-)**	**12.2**
Water Consumption	m3	60

System important advantage :

=> full complementarity between solar cooling and solar DHW

Simplicity of functionning :

=> No control issue (easy interaction Cooling <-> DHW)

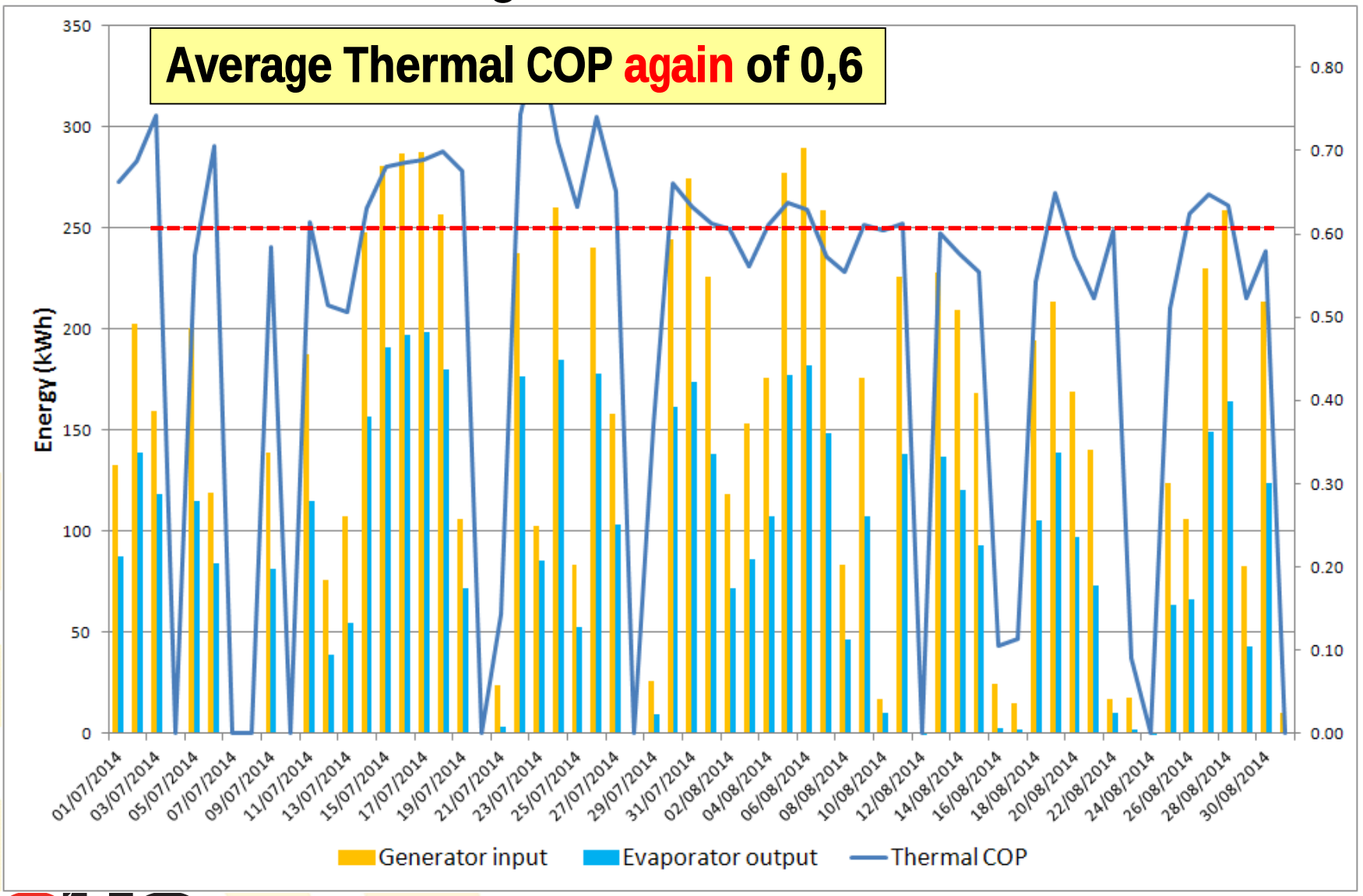
Full year balance (march 2013/ mars 2014)

	DHW Production (kWh)	Cooling Production (kWh)	Parasitic elec. Consumption (kWh)	Useful Solar Yield (kWh/m2)	Overal elec efficiency (-)
from 18/03/2013	4 654	0	110	19.4	42.3
april 2013	11 588	0	290	48.3	40.0
may 2013	16 478	0	380	68.7	43.4
june 2013	7 497	2 765	902	42.8	13.4
july 2013	9 482	3 983	1 190	56.1	13.5
august 2013	8 628	1 970	840	44.2	14.2
september 2013	9 316	676	554	41.6	18.9
october 2013	7 843	0	240	32.7	32.7
november 2013	4 789	0	220	20.0	21.8
december 2013	3 851	0	157	16.0	24.6
january 2014	3 734	0	190	15.6	19.7
february 2014	6 435	0	218	26.8	29.5
march 2014	12 860	0	348	53.6	30.9
april 2014	14 085	0	360	58.7	39.1
may 2014	12 633	281	326	54.0	40.2
june 2014	8 847	944	685	39.7	15.2
july 2014	5 586	2 959	851	26.8	12.4
TOTAL	148 308	13 578	7 861	**674.5**	**20.6**

** elec consumption linked to the solar useful production (pumps solar, DHW, generator, evaporator, condensor circuits) without measuring back up elec consumption.*

Global Electrical efficiency of **nearly 21** in average for a full year and a **solar yield of 465 kWh/m².year**

Monitoring results for Summer 2014



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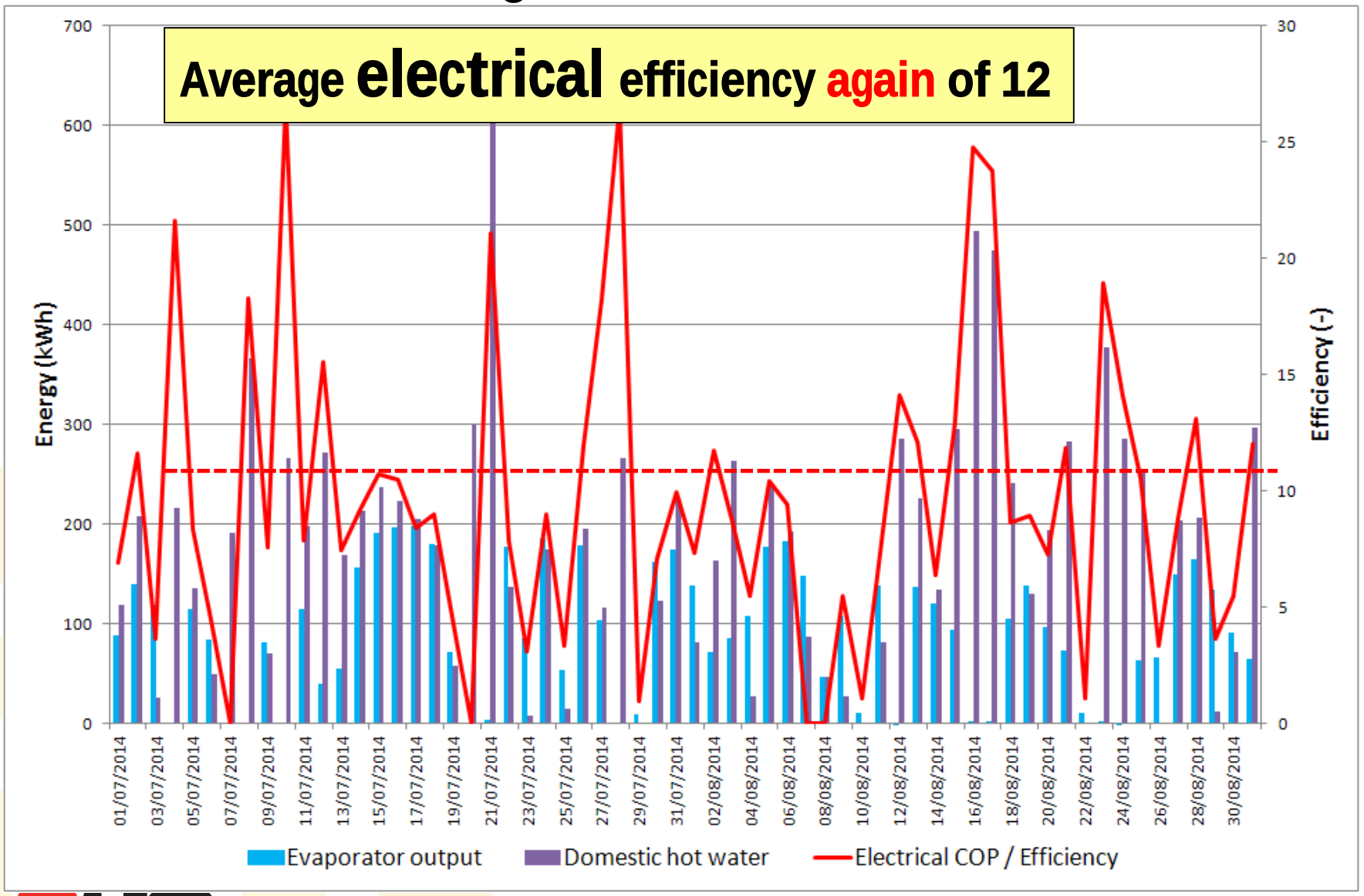
Monitoring results for Summer 2014



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Summary of the cooling season 2014

	Unit	Value 2014	*Value 2013*
Irradiation	kWh	97 400	*104 000*
Useful solar energy	kWh	24 500	*29 000*
Absorption generator	kWh	9 000	*9 800*
Absorption evaporator	kWh	5 700	*6 000*
DHW energy	kWh	11 300	*18 000*
Thermal COP	**(-)**	**0.60**	***0.60***
Electrical Efficiency	**(-)**	**12**	***12.2***
Water consumption	m3	35	*60*

Irradiation in 2014 15% less than in 2013 (bad Summer weather !!)

Electrical efficiency still so high (12)

IMPROVEMENT : division by nearly 2 of the water consumption

Robustness of the installation (no damage from 2013)

Summary of the cooling season 2015

	Unit	Value 2015	*Value 2014*
Irradiation	kWh	83 000	97 400
Useful solar energy	kWh	20 700	24 500
Absorption generator	kWh	4 800	9 000
Absorption evaporator	kWh	2 800	5 700
DHW energy	kWh	7 500	11 300
Thermal COP	**(-)**	**0.58**	**0.60**
Electrical Efficiency	**(-)**	**7**	**12**
Water consumption	m3	200	35

Irradiation in 2015 15% less than in 2014 (VERY bad Summer weather !!)

Electrical efficiency not so high (7)

Summary of the cooling season 2015

Date		juillet 2015	août 2015	Bilan	Ecart/2014
Energies					
Energie solaire incidente	kWh	32 571	50 800	83 371	-14%
Energie circuit secondaire	kWh	8 786	11 986	20 772	-15%
Energie circuit générateur	kWh	2 902	1 878	4 780	-47%
Energie circuit évaporateur	kWh	1 733	1 040	2 774	-51%
Energie circuit tour de refroidissement	kWh	5 006	3 382	8 389	-48%
Energie circuit ECS en toiture	kWh	4 416	7 526	11 942	6%
Energie sortie ballon solaire en sous-station -1	kWh	0	377	377	-64%
Energie appoint en sous-station -1	kWh	2 763	-40 919	-38 156	-302%
Energie sortie ballon solaire en sous-station -4	kWh	8 666	14 356	23 022	2064%
Energie appoint en sous-station -4	kWh	13 339	-675 561	-662 222	-4633%
Energie électrique consommée	kWh	17 735	685	18 420	966%
Energie électrique consommée (mode chaud uniquement)	kWh	254	357	612	-21%
Ratios et calculs					
Rendement de captation (capteur & échangeur)	%	27.0	23.6	25.3	0%
Rendement du ballon tampon	%	85.6	70.4	78.0	-4%
COP thermique de la machine	-	0.60	0.55	0.58	-8%
Energie solaire utile au départ de la toiture	kWh	7 305	9 259	16 564	-20%
Rendement de l'installation en toiture	%	22.43	18.23	20.33	-4%
COP électrique (toiture)	-	0.41	13.52	6.97	-42%
COP électrique (toiture) RECALCULÉ	-	calcul inutile	calcul inutile		
Energie solaire utile au départ des sous-stations	kWh	11 555	16 467	28 022	142%
COP électrique (au départ sous-stations)	-	0.65	24.04	12.35	84%
Consommation d'eau	m3	207.35	5.40	212.75	501%

Pas de données avant le 13/07

Fuite d'eau sur le refroidisseur

Summary of the cooling season 2016

	Unit	Value 2016	*Value 2015*
Irradiation	kWh	106 700	83 000
Useful solar energy	kWh	28 700	20 700
Absorption generator	kWh	13 750	4 800
Absorption evaporator	kWh	8 450	2 800
DHW energy	kWh	12 300	7 500
Thermal COP	**(-)**	**0.61**	**0.58**
Electrical Efficiency	**(-)**	**11,9**	**7**
Water consumption	m3	32,3	200

Irradiation in 2014 20% more than in 2015 (very sunny Summer weather !!)

Electrical efficiency still so high (12)

Robustness of the installation (no damage from 2013 except in 2015)

Summary of the cooling season 2016

Date		juin 2016	juillet 2016	août 2016	Bilan été 2016	Bilan juillet/août	Ecart juillet août /2015
Energies							
Energie solaire incidente	kWh	51 778	53 530	53 193	158 501	106 724	28%
Energie circuit secondaire	kWh	15 299	14 149	14 555	44 003	28 704	38%
Energie circuit générateur	kWh	3 583	7 004	6 754	17 340	13 758	188%
Energie circuit évaporateur	kWh	2 172	4 301	4 139	**10 611**	**8 439**	204%
Energie circuit tour de refroidissement	kWh	6 000	11 819	11 370	29 189	23 189	176%
Energie circuit ECS en toiture	kWh	10 548	5 808	6 479	**22 834**	**12 287**	3%
Energie sortie ballon solaire en sous-station -1	kWh	800	628	0	1 428	628	67%
Energie appoint en sous-station -1	kWh	6 178	8 833	12 428	27 439	21 261	-156%
Energie sortie ballon solaire en sous-station -4	kWh	2 623	1 230	1 315	5 168	2 546	-89%
Energie appoint en sous-station -4	kWh	8 419	8 808	8 637	25 864	17 446	-103%
Energie électrique consommée	kWh	737	1 146	1 076	2 958	2 221	-88%
Energie électrique consommée (mode chaud uniquement)	kWh	408	415	398	1 222	813	33%
Ratios et calculs							
Rendement de captation (capteur & échangeur)	%	29.5	26.4	27.4	27.8	26.9	6%
Rendement du ballon tampon	%	90.6	89.5	92.4	90.8	90.9	17%
COP thermique de la machine	-	0.61	0.61	0.61	0.6	0.61	7%
Energie solaire utile au départ de la toiture	kWh	14 168	12 975	13 377	40 520	26 352	59%
Rendement de l'installation en toiture	%	27.36	24.24	25.15	25.6	24.69	21%
COP électrique (toiture)	-	19.23	11.33	12.44	**14.3**	**11.88**	71%
COP électrique (toiture) RECALCULÉ	-	calcul inutile	calcul inutile	calcul inutile			
Energie solaire utile au départ des sous-stations	kWh	7 042	9 026	8 214	24 282	17 240	-38%
COP électrique (au départ sous-stations)	-	9.56	7.88	7.64	8.4	7.76	-37%
Consommation d'eau	m3	**43.48**	16.92	15.35	76	32.27	-85%

Conclusion

- Project **functionning very well since Spring 2012**
- **Full monitoring system** permetting a detailed feedback on energy performances
- **Very interesting concept for solar cooling and DHW** :
  - **Maxi usability** of the solar ressource and **system simplicity**
  - **Economical Optimum** (gains for DHW + cooling production)
  - **No overheating risks** because a load everytimer
  - **Drainback strategy** in case of failure/ damage
  - **First application** of Emergence Programe

Thanks for your attention !

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