Energy Audit Summary Report
CRP HENRI TUDOR
Audit no. 63 – LU03

Plastic injection

Centre de Ressources des Technologies pour l'Environnement

June 2012

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AUDIT n.63

1. Data of the auditor

1.1. Contact data of the auditor

Name: Alex Bertrand and Jonathan Hervieu

Organisation: Public Research Centre Henri Tudor

Country: Luxembourg

Profession: Engineer

Number of audits performed: 6

Date of the audit: 03/2012

Duration of the audit: 2 weeks

2. Introduction

2.1. Objectives

The objectives of this audit are to assess the energy consumption of injection machines, as well as to analyse the impact of replacing the compression chillers by a cooling tower and assess the impact of heat recovery on the site's energy needs.

3. Status Quo: processes, distribution, energy supply

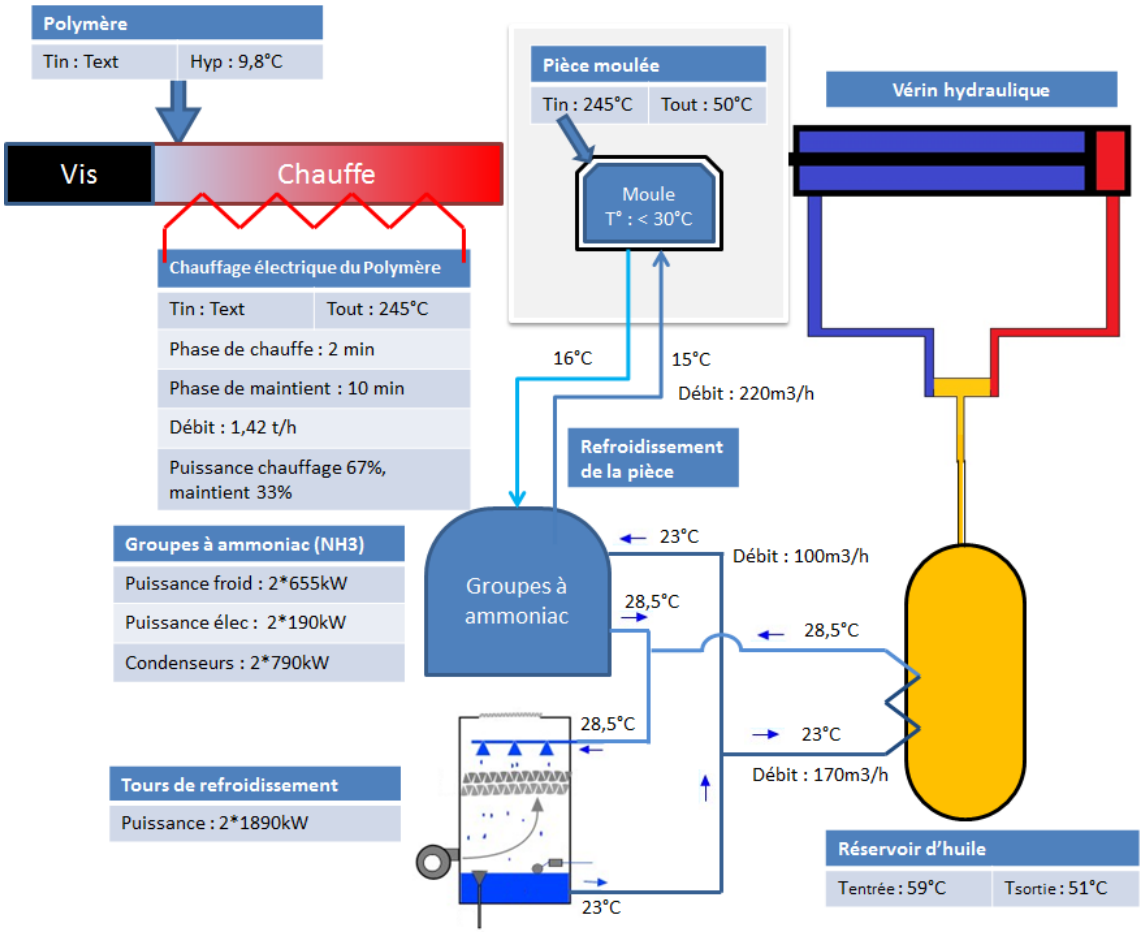
3.1. General info of company

Type: plastic injection

Location: Luxembourg

Number of employees: 280

3.2. Flow sheet of the whole manufacturing side



3.3. Description of the existing system

- *Primary energy consumption: 3 386 MWh*

- *Final energy consumption*

The systems assessed in this audit did not use natural gas.

	[MWh]	[% du total]
Natural Gas	0	0,00
Electricity	1 129	100,00
Total	**1 129**	**100,00**

- *Final energy demand thermal (FET) by equipment*

		[MWh]	[% de total]
Résistance électrique	Electricity	849	75,21
Groupes Ammoniac	Electricity	171	15,15
Tour de refroidissement	Electricity	109	9,64
Total		**1 129**	**100,00**

- *Useful supply heat (USH)*

Equipment **USH par equipment**

	[MWh]	[% del total]
Résistance électrique	840	100,00
Total	**840**	**100,00**

- *Useful supply cool (USC)*

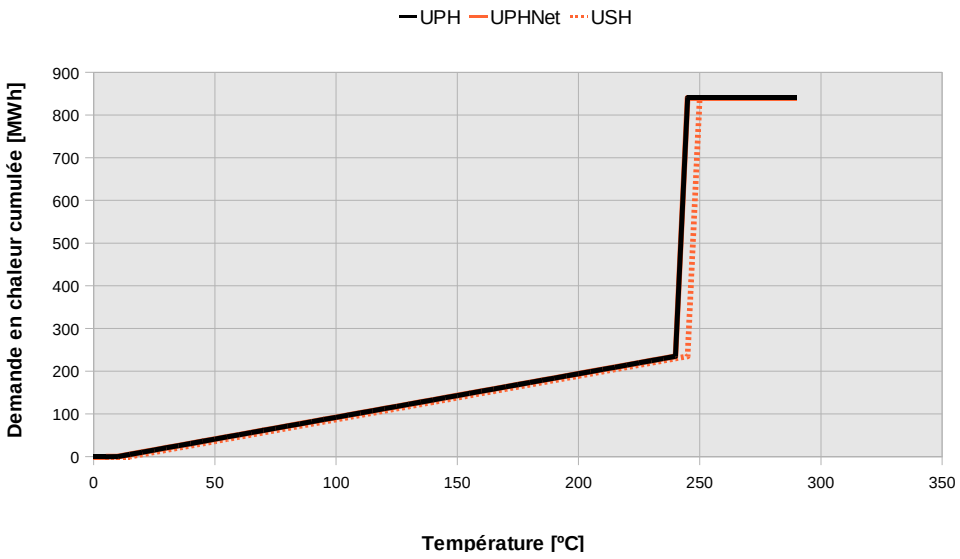
Equipment **USC par equipment**

	[MWh]	[% du total]
Groupes Ammoniac	1 001	15,03
Tour de refroidissement	5 657	84,97
Total	**6 658**	**100,00**

- *Main energy consuming energy processes (UPH)*

Processus	**Total**	**Circulation**	**Maintenance**	**Démarrage**
	[MWh]	[MWh]	[MWh]	[MWh]
Chauffage polymère	840	240	600	0
Total	**840**	**240**	**600**	**0**

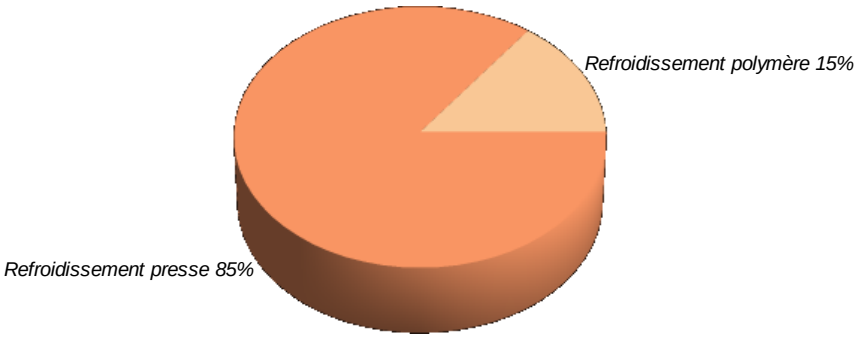
Heat demand (temp),



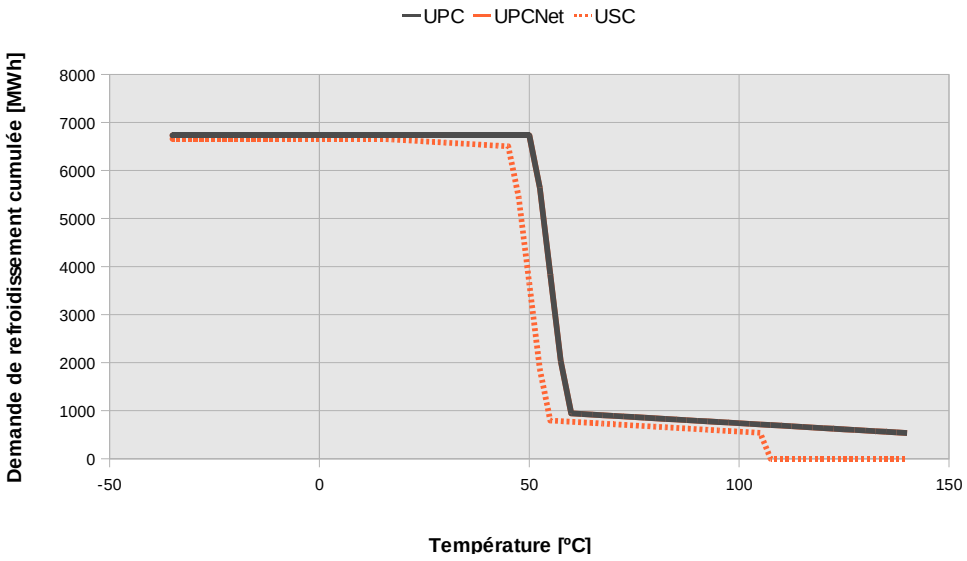
- *Main energy consuming energy processes (UPC)*

Processus	Total	Circulation	Entretien	Démarrage
	[MWh]	[MWh]	[MWh]	[MWh]
Refroidissement polymère	995	995	0	0
Refroidissement presse	5 734	5 735	0	0
Total	**6 729**	**6 729**	**0**	**0**

- *Cold demand (proc),*



- *Cold demand (temp),*



3.4. General

The company uses injection machines. For this type of systems, only 5 to 10% of the total electricity consumption is **directly** used for thermal process. The rest (more than 90%) is used for the motors (which indirectly also provide heat), electric equipment, control system, etc. The results of this audit therefore represent less than 10 % of the actual electricity consumption.

The main assumptions made for the audit were:

- In winter, the spraying circuit of the cooling towers is disconnected, therefore improving the tower's efficiency. For 4 months, it is assumed that the cooling towers have the efficiency of cooling ponds. Hence, the COP for the company's cooling towers is averaged over the year with the generic COP value of towers and cooling ponds.
- The temperature level of the hydraulic circuit was assumed to be between 51 and 59°C.

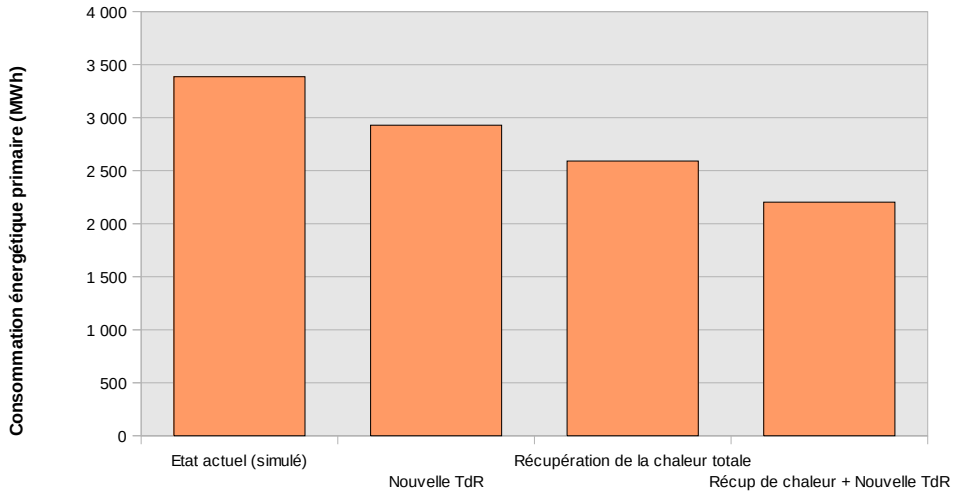
4. Comparative study

4.1. Proposed alternatives

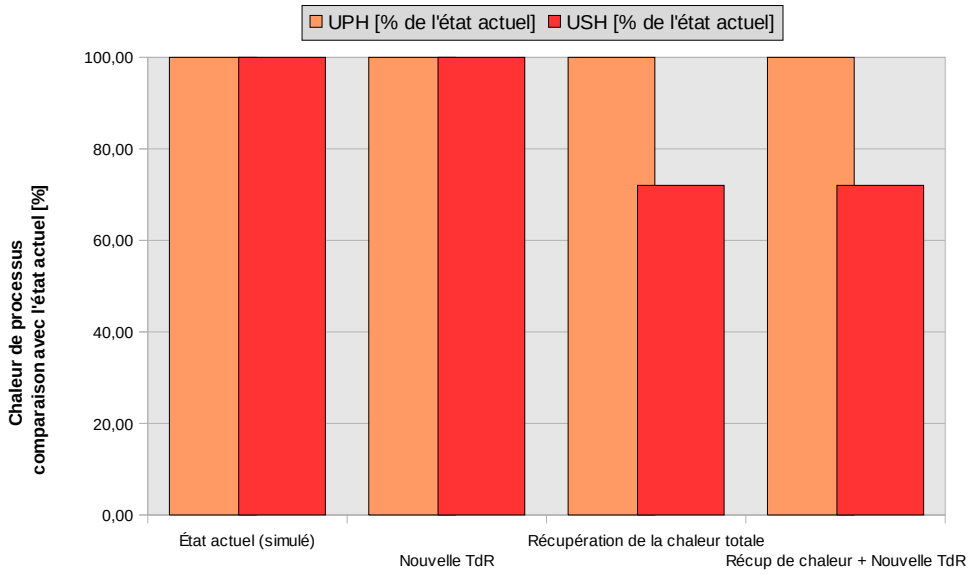
3 scenarios were considered:

1. Substitution of the compression chillers by a cooling tower.
2. Heat recovery: one heat exchanger for the cooling of the plastic part and the mould and a second for the hydraulic system, to preheat the polymer. The 2 heat exchangers are connected in series.
3. The third alternative is the combination of the two previous ones.

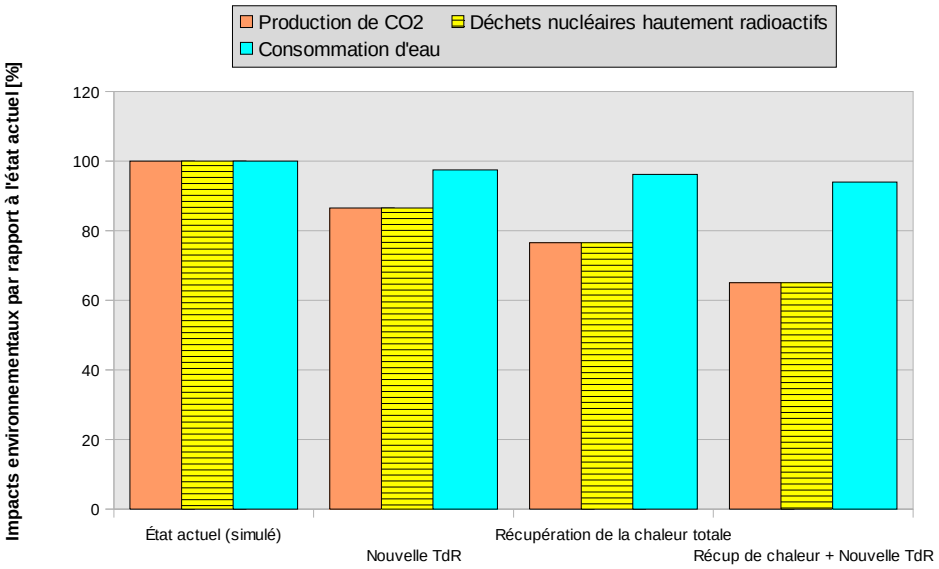
- *Primary energy demands*



- *UPH and USH*



- *Environmental assessment*



5. Selected alternative(s) and conclusions

5.1. Selected alternative

The combination of heat recovery and the replacement of the compression chillers by a cooling tower was retained as final alternative, as it was the scenario with the highest saving potential.

5.1.1. Process optimisation (written proposals)

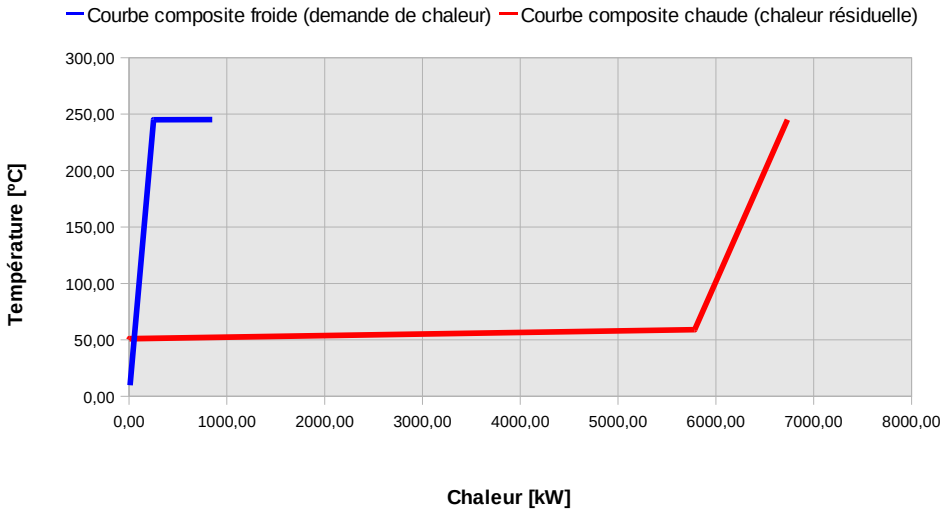
No process optimisation was proposed

5.1.2. Heat recovery

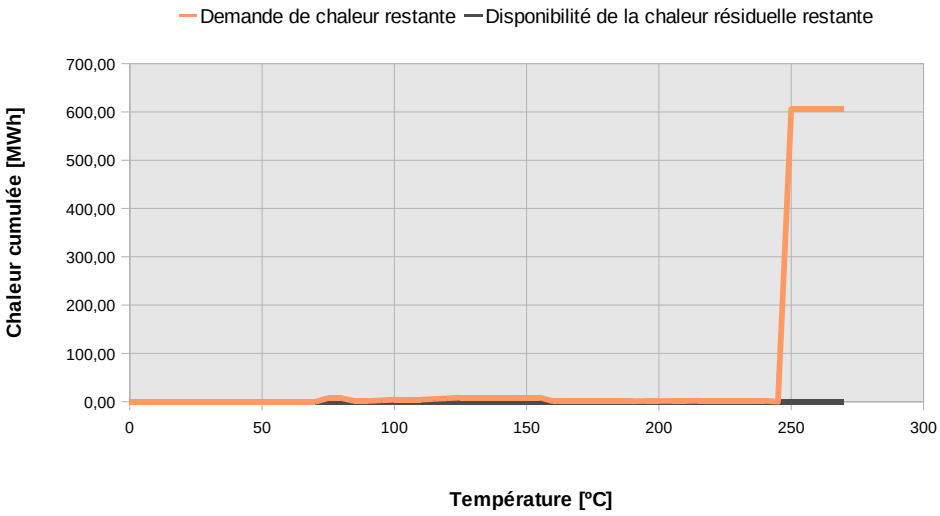
It is proposed to preheat the polymer using 2 heat exchangers in series. The first exchanger recovers the heat of the hydraulic system of the injection machines. This system needs to be maintained at a certain temperature, which is currently done using the cooling towers. The second heat exchanger recovers the heat of the polymer after its forming. This heat is currently transferred to the compression chillers.

Échangeur de chaleur	Puissance	Source de chaleur	Dissipateur de chaleur	Chaleur transférée	
	[kW]			[MWh]	[%]
Échangeur Huile	48	Refroidissement presse	Chauffage polymère	50,21	21,35
Échangeur polymère	177	Refroidissement polymère	Chauffage polymère	184,91	78,65
Total	**225**			**235,12**	**100**

- *CCC/HCC curves*



- *Remaining heat demand*



5.1.3. Heat and cold supply

It this alternative, it is proposed to replace the compression chillers by a new cooling tower.

Equipment	Type	Chaleur et refroidissement fournis dans le tuyau/conduit	Capacité nominale	Contribution à la fourniture de chaleur et de refroidissement totale	
			[kW]	[MWh]	[%]
Résistance électrique	Chauffage direct	o==Résistance==o	350	605	8,63
Tour de refroidissement	Tour de refroidissement	o==Eau tempérée==o	3 780	5 608	79,99
Nouvelle TdR	Tour de refroidissement	o==Eau glacée==o	1 310	798	11,38
Total			**5 440**	**7 010**	**100**

- *Useful supply heat (USH)*

Équipement	USH par équipement	
	[MWh]	[% del total]
Résistance électrique	605	100,00
Total	**605**	**100**

- *Useful supply cool (USC)*

Équipement	USC par équipement	
	[MWh]	[% du total]
Tour de refroidissement	5 608	87,55
Nouvelle TdR	798	12,45
Total	**6 405**	**100**

5.2. Comparative study and conclusions

No indications on investment costs due to the heat exchangers and cooling towers could be given.

		Present state	Alternative	Saving
Total primary energy consumption (1)				
- total	[MWh]	3386	2203	34.92
- fuels	[MWh]	0	0	-
- electricity	[MWh]	3386	2203	34.92
Primary energy saving due to renewable energy	[MWh]	-	-	-
CO_2 emissions	[t/a]	677.15	440.66	34.90
Annual energy system cost (2)	[EUR]	90783	59078	34.92
Total investment costs	[EUR]	-	-	-
Payback period	[years]	-	-	-

(1) including primary energy consumption for non-thermal uses

(2) including energy cost (fuel and electricity bills) and operation and maintenance costs.

5.2.1. Energy and environmental analysis

As can be seen from the figures and tables above, the third alternative presents a high primary energy saving potential compared to the present state, which is due to the combination of heat recovery and substitution of the compression chillers. This alternative also leads to reductions of around 35% of CO_2 emissions and nuclear waste, while water consumption would be reduced by 6%.

5.2.2. Economic analysis

No economic data were available for this audit.

5.2.3. Conclusions and outlook

This audit detected a certain potential for optimisation on the processes and equipment assessed. Unfortunately, due to the specificities of the injection machines, the current audit finally only covered 10% of the total electricity consumption of the site. Also, while the replacement of the compression chiller with a cooling tower is feasible, the addition of heat exchangers in the injection machines would prove to be difficult. CRP Henri Tudor will try to address this issue with the manufacturer. In order to improve the overall efficiency of the site, it is suggested to conduct additional energy audits, with a particular focus on the hydraulic part of the injection machines.