MULTI – OBJECTIVE, INTEGRATED, REGIONAL ENERGY SYSTEM OPTIMISATION

Bertrand Alex[1,2], Aggoune Riad[1], Maréchal François[2]

[1] *Luxembourg Institute of Science and Technology (LIST), Grand-Duchy of Luxembourg*

[2] *Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland*

Objective: Development of an integrated optimisation method focusing on regional industrial waste heat valorisation and heating and cooling utility selection, aiming at minimising investment and operational costs as well as CO_2 emissions.

A. Development of generic models for heating and cooling demands of buildings and industrial processes (using regression analysis and data from literature reviews).

		before 1919	1919-1945	1946-1960	1961-1980	1981-1995	1996-2010	> 2010
Type 1	Single family building	189	176	184	164	187	150	150
	Multi-family building	177	198	176	175	165	169	169
Type 2	Single family building	179	187	216	175	184	143	143
	Multi-family building	177	198	176	201	190	172	172
Type 3	Single family building	195	197	210	203	205	155	155
	Multi-family building	177	198	176	201	190	150	150

Table 1: Specific heating demand of private buildings in Luxembourg, adapted from STATEC, in kWh/m²*a

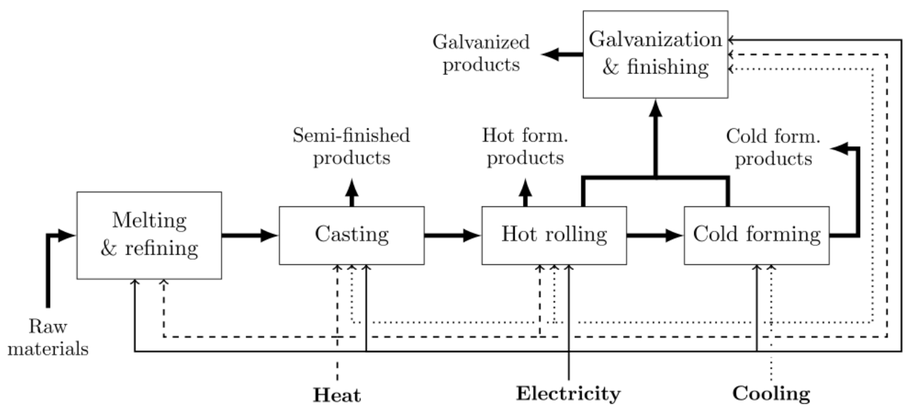

Figure 1: Process flow diagram of a steel plant [1]

B. Geolocalisation and characterisation of heating and cooling demands of case-study (Luxembourg) based on Geographical Information System (GIS) databases.

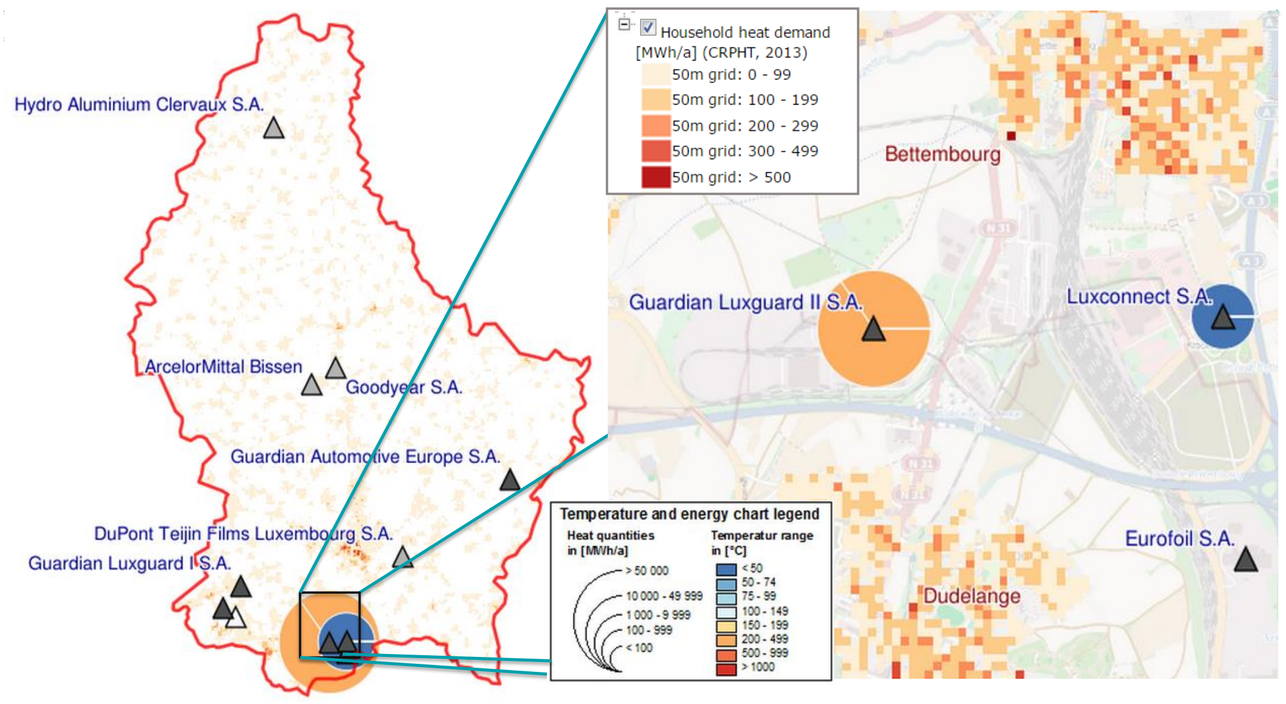

Figure 2: Heat map of Luxembourg (www.heatmap.lu)

C. Industrial excess heat potential characterisation. Calculation of rate of return on investment (RoRoI) for internal excess heat recovery. For RoRoI > 1 year: excess heat considered for regional valorisation.

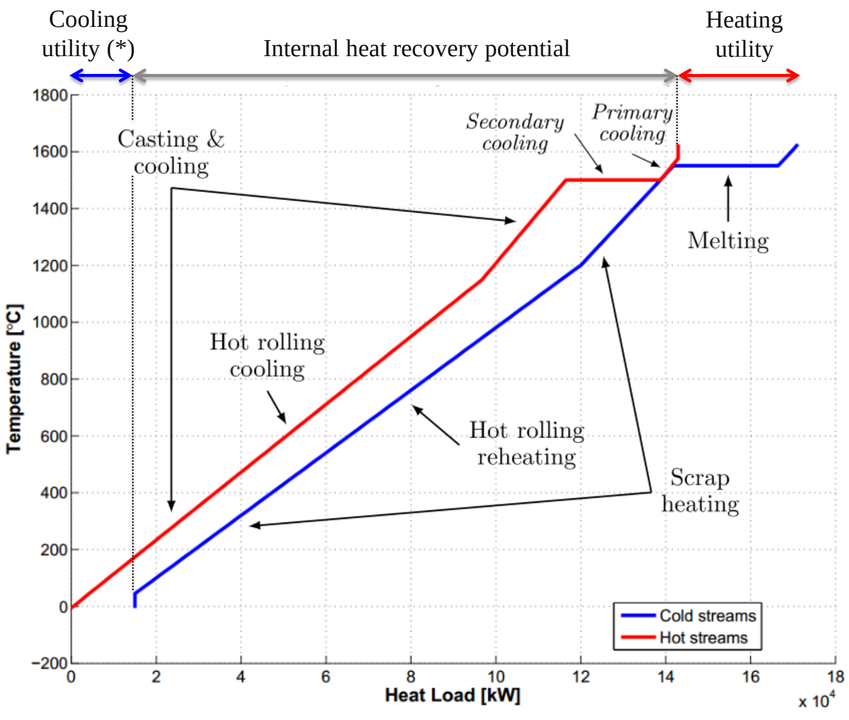

Figure 3: Hot and Cold Composite Curves (HCC, CCC) of a steel plant, per 1 kg of final product [1].
Cooling utility load (*) available for external valorisation

D. Generation of regional composite curves. Use of multi-objective optimisation generating solutions with minimised total costs and CO_2 emissions, combined with Mixed Integer Linear Programming (MILP) for optimal process integration and energy conversion selection and sizing.

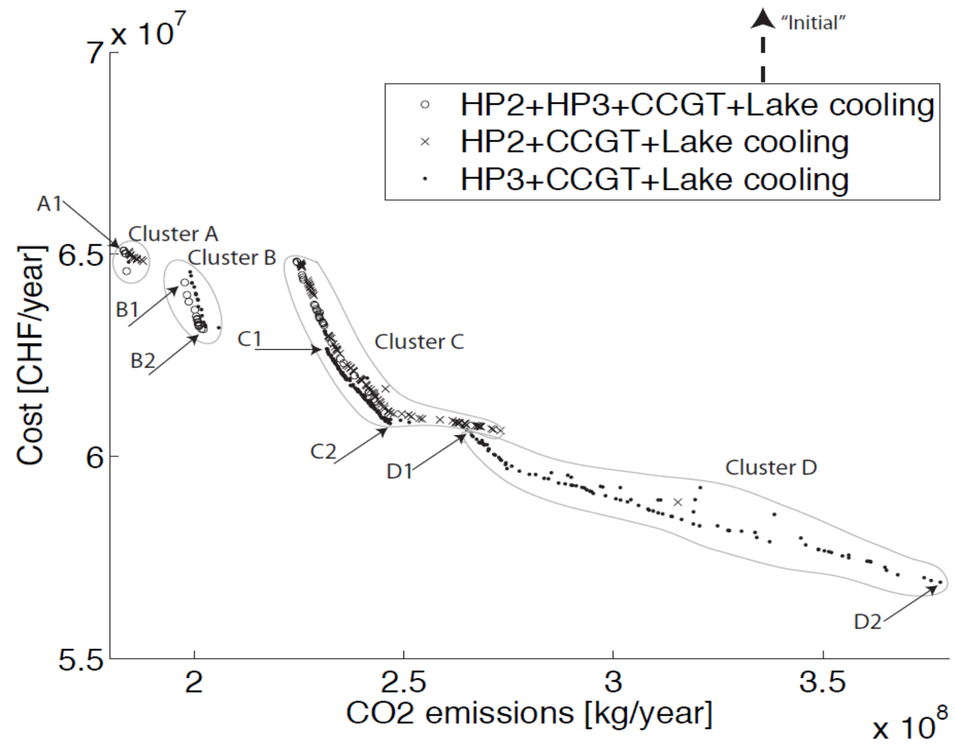

Figure 4: Example of Pareto front curve [2]

[1] Stadler P., 2014, Assessment of energy requirements of commercial and industrial facilities in Luxembourg, Master thesis, LIST, Belvaux, Luxembourg
[2] Weber C., 2008, Multi-objective design and optimization of district energy systems including polygeneration energy conversion technologies, PhD thesis, EPFL, Lausanne, Switzerland

Luxembourg Institute of Science and Technology | 5, avenue des Hauts-Fourneaux L-4362 Esch/Alzette | phone: (+352) 275 888 - 1 fax: (+352) 275 885 | alexandre.bertrand@list.lu LIST.lu

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