The International District Energy Awards 2011

Compagnie de Chauffage Intercommunale de l’Agglomération Grenobloise (CCIAG)

Conversion of a coal heating plant to wood energy
Villeneuve Heating plant
Application file

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Executive summary

The Grenoble urban area boasts a tremendous heating network, a local facility at the service of a sustainable energy policy, managed by the CCIAG. This urban heating network has progressed in 50 years from 0% to 54% of renewable or recovery energy (R&REn), while at the same time multiplying the heat distributed to its customers by 30.

This spectacular up-turn has been boosted by the conjunction of three factors: an intensive commercial development associated with a continuous technological innovation approach and recourse to low carbon content energies.

The recent conversion work to wood energy carried out on a boiler designed to burn coal from the mines of la Mure near the Grenoble basin is a new example of this capacity to upgrade a heating network. The flexibility of this industrial facility enabled it to meet the ever-changing needs and environmental objectives of lowering greenhouse gas emission.

For an investment of 7 million euro, transformation of the Villeneuve plant currently enables more than 39,000 tons of recycled wood of local origin to be beneficiated replacing 15,000 tons of coal imported from South Africa. 35,000 tonnes of CO2 are thus saved every year.

This project successfully illustrates sustainable development measures on a local scale by an improved energy performance, a reduction of the environmental impact and job creation spin-off.

Transformation of the Villeneuve plant highlights the usefulness of heating networks in optimisation of renewable energies at the service of a local energy policy (Local Climate Plan, Energy Scheme, factor 4, EcoCité approach) and of an attractive, united and durable urban community.
1 Introduction

1.1 – The Grenoble urban area

Situated in the heart of the French Alpine valleys, this urban community of 450,000 inhabitants enjoys an exceptional site, quality of life being one of the key features of its attractiveness. In the centre, the town of Grenoble, capital of the Alps, organised the 1968 Winter Olympic Games.

The Grenoble basin has always allied economic development, social solidarity and sustainable development. It has built up a model of solid growth with strong links between University, the research world and industrialists.

In 2005, the Grenoble urban area became the first in France to sign a local climate plan aiming to reduce energy consumption and greenhouse gases and to favour recourse to renewable energies. The town of Grenoble aims to divide greenhouse gas emissions by four by 2050.

Energy has thus always been a major issue in local development. The 19th Century witnessed the advent of Water Power and the discovery of hydroelectricity by Aristide Bergès. Today it is the new energy technologies, along with micro-nanotechnologies and biotechnologies, that constitute one of the three development sectors of the local innovation cluster.

Due to its strong creative capacity, the Grenoble urban area intends to provide its contribution to implementing original and lasting schemes, involving all the local players in the sustainable development field.

1.2 – The CCIAG

The CCIAG is a half private and public company. It operates the number one French heating network after Paris. Some 100,000 inhabitants in seven municipalities are thus supplied with heat for domestic hot water and heating.

Since 1960, the Heating Company has accompanied urban development by favouring local energies and diversifying its fuels. It currently boasts an energy pool constituted by six different fuels: household waste, recycled wood, animal flours, coal, oil and gas, enabling it to adapt permanently to the best economic and environmental conditions.

1.3 – Grenoble urban area heating network

Supplied with superheated water by six totally interconnected heating plants, the network supplies more than 900 public or private buildings all along the 160 km of underground heating ditches. A Digital Control System (DCS) enables heating requirements to be anticipated and the power to be adjusted at all times giving priority to the most suitable fuels.
1.4 - The Villeneuve heating plant

Commissioned shortly after the 1968 Winter Olympics, the Villeneuve heating plant is the most powerful heating plant connected to the network to date with 190 MW installed.

Successively equipped with heavy oil generators then with a 63 MW coal-fired plant, this heating plant has continuously adjusted to changes in energy stakes.

It enabled the anthracite from the mines of La Mure, located about forty kilometres from Grenoble, to be put to use thereby enhancing the coal-mining industry and local employment. Today the Villeneuve heating plant is contributing to converting the heating network to biofuels and "zero" carbon.

1.5 – Key figures:

- **The Heating Company (2009/2010):**
  - 50 years of experience
  - 207 employees
  - 6 thermal power plants
  - 6 different fuels
  - 156 kms of network
  - 7 municipalities supplied
  - 946 sub-stations
  - 819 MW of connected power
  - 91,000 equivalent lodgings i.e. 1/3 of the population of the Grenoble urban area
  - 781,094 MWh sold

- **The Villeneuve heating plant before transformation (2006/2007):**
  - Heat production: 122,000 MWh
  - Coal consumption: 13,800 tons
  - Heavy fuel-oil consumption: 2,000 tons
  - Wood consumption: 6,000 tons
  - CO2 emissions: 35,000 tons

2 – Transformation of the Villeneuve heating plant

2.1 - Objectives:

To achieve the objectives of reducing greenhouse gas emission, the Local Municipalities rapidly identified the heating network as the major lever to be implemented.

Conversion of the solid fuel generators appeared as being the best solution to increase the share of renewable energies. Wood, a relatively abundant local resource, was chosen as replacement fuel for imported coal.

Three major difficulties had to be overcome:
- the ability to adapt the existing generators to replace coal by wood,
- the small surface areas and volumes available to install the storage silo and transfer equipment,
- organisation of a supply chain able to cope with a large increase in requirements with constant safety and quality over time.

The internal studies carried out as from 2005 and then completed by the boiler manufacturer and design offices provided favorable responses to each of these questions.

The Villeneuve heating plant and the "G4" generator proved to be the optimum solution, enabling 10,000 tons of coal to be saved each year at the lowest cost.

2.2 – Expected results:

Three directions of progress were identified on the outcome of the techno-economic studies:
• **Reduction of the environmental impact of the heating plant:**
  - Reduction of emissions of CO\(_2\) of fossil origin by about 19,000 tons,
  - Reduction of atmospheric effluents: dusts, sulphur dioxide (SO\(_2\)), nitrogen oxides, etc.
  - Passing the threshold of 50% renewable energy for the heat supplied to the network.

• **Lowering the heat production cost**
  For identical fuel procurement costs, reduction of fossil CO\(_2\) and of the ashes produced, a factor inducing pollution and extra costs, enabled considerable savings to be made on the project.

• **Contribution to setting up a local wood energy sector**
  By committing itself to procurement contracts over several years, the Heating Company provided the different actors of the wood sector with a "visibility" enabling them to structure their activities and make the necessary investments. The project also met the expectations of the community in terms of creation of local jobs.

2.3 - Transformation work

On the basis of specifications drafted in three batches, contractor consultation started in the autumn of 2006 for work to be carried out during the summer of 2007:
- Civil engineering,
- Structural steel work, silo and transport chain,
- Boiler upgrade.

Meeting deadlines appeared to be the major priority among the project requirements. As it was impossible to operate without the "G4" generator, it was an absolute necessity for this generator to be up and running for the coldest months of the winter.

• **Project work schedule**
  - Phase 1: November 2006 to January 2007, studies and consultations
  - Phase 2: February 2007 to July 2007, building the foundations of the silo and conveyors
  - Phase 3: August 2007 to November 2007, silo erection and modifications to the generator
  - Phase 4: October 2007 to February 2008, testing and start-up of the wood installation.

2.4 – Technical features:

• **Wood storage and conveyance**

The installation was designed around a silo with a useful capacity of 3,000 m\(^3\) to provide an autonomy of three days at full power.
To enable a delivery rate of three trucks per hour, a study of the unloading area and the silo filling chain was carried out in concert with the different suppliers. The supply chain was equipped with a disc separator and a magnetic metal remover to eliminate foreign bodies which may have been transported along with the wood.
At the bottom part of the silo, a lateral-sweep endless screw performs extraction of the fuel to the boiler. A continuous residual moisture monitoring device provides the operators with constant information on the quality of the wood input to the furnace.
• **Boiler modification**

Wood could not be used without extensive modification of the fuel and combustion air circuits. Each ton of coal in fact had to be replaced by two tons of wood with very different combustion parameters.

Modification of the boiler was performed by the manufacturer on the basis of a modelling study and a test campaign. The main transformations involved:

- creation of two wood supply chutes via a rotating chamber, in parallel with the coal supply circuit,
- modification of the fluidisation and combustion air circuits,
- providing a dosing device to optimise the mixtures.

• **Renovation of the DCS**

The mechanical and thermal modifications led to a new DCS being installed. Renovation of the controllers and the main control room equipment provided the operating staff with modern facilities and improved comfort.
2.5 – Financing package:

- **DETAILED PROJECT COST BREAKDOWN**

<table>
<thead>
<tr>
<th>COMPONENTS</th>
<th>IN K€ (WITHOUT VAT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant acquisition</td>
<td>1600</td>
</tr>
<tr>
<td>Boiler technical studies</td>
<td>150</td>
</tr>
<tr>
<td>Boiler upgrade work</td>
<td>1300</td>
</tr>
<tr>
<td>Unloading, storage, handling</td>
<td>2000</td>
</tr>
<tr>
<td>Civil Engineering</td>
<td>500</td>
</tr>
<tr>
<td>Fire safety</td>
<td>500</td>
</tr>
<tr>
<td>Design offices, miscellaneous, renovation and adaptation of electrical and</td>
<td>600</td>
</tr>
<tr>
<td>instrumentation &amp; control equipment</td>
<td>800</td>
</tr>
<tr>
<td><strong>OVERALL TOTAL</strong></td>
<td><strong>7450</strong></td>
</tr>
</tbody>
</table>

Equipment origin:
- Boilers: CNIM and BABCOCK – France
- Wood storage and handling silos: TRASMEC – Italy
- Civil engineering, electricity, miscellaneous: France

3 - Results obtained:

The performances observed as from the 2009 – 2010 season were well in advance of what was forecast. Wood consumption was increased to 39,000 tons during the winter against an initial objective of 20,000 tons. This was made possible by the conjunction of several factors:
- A great flexibility of the IGNIFLUID boiler originally designed for coal,
- Strong mobilisation of the operating teams,
- Assistance in efficient tuning from the manufacturer,
- Wood suppliers who were able to cope with the new demand,
- Network interconnection for improved beneficiation of biomass heat.

### 3.1 - 09/10 season energy production

Having taken priority as far as the achieved environmental performance was concerned, the plant almost doubled its energy production: close on 220 GWh were supplied to the network compared with a quantity of 120 GWh in previous years.

This production, achieved with the old installation, would have generated an additional 35,000 tons of CO₂ and 185 tons of SO₂, as can be seen from the following table:

<table>
<thead>
<tr>
<th></th>
<th>With the new installation</th>
<th>Without transformation</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary energy production</td>
<td>220,000 MWh</td>
<td>220,000 MWh</td>
<td></td>
</tr>
<tr>
<td>Coal consumption</td>
<td>12,665 t</td>
<td>28,195 t</td>
<td>- 15,530 t</td>
</tr>
<tr>
<td>Wood consumption</td>
<td>39,000 t</td>
<td>6,000 t</td>
<td>+ 33,000 t</td>
</tr>
<tr>
<td>Oil consumption</td>
<td>3,000 t</td>
<td>3,000 t</td>
<td>-</td>
</tr>
<tr>
<td>Fossil CO₂ emission</td>
<td>40,000 t</td>
<td>75,000 t</td>
<td>- 35,000 t</td>
</tr>
<tr>
<td>SO₂ emission</td>
<td>199 t</td>
<td>384 t</td>
<td>- 185 t</td>
</tr>
</tbody>
</table>
3.2 – Evolution of environmental indicators

- Energy production breakdown between fossil fuel and biomass

(GWh supplied to the network for the whole of the urban area)

- Reduction of the CO₂ content of the heat delivered to the customer:

The heat provided to the Heating Company customers generates increasingly less greenhouse gas. The carbon content of the delivered kWh thus dropped from 234 g/kWh to 137 g/kWh of CO₂ between 2001 and 2010.

The new installation enhances the results of the Heating Company which has thus reduced its CO₂ emissions by 53% since 1990, whereas the national and local objective aims to achieve a reduction of 20% by 2020.

This innovation enabled extension of the network to new customers to be easily compensated without impairing environmental performances.
3.3 - Mastering costs

Assessment of the operation from an economic standpoint is also positive:

The investment sum spread over an installation lifetime of 20 years amounts to 10 €uros per ton of CO₂ saved.

Taking an additional operating cost of 2 €uros per ton saved into account, the financial breakeven point of the operation based on the cost of CO₂ negotiated on the carbon quotas market is situated at 15 €uros per ton.

It is moreover noteworthy that the cost price of a ton of saved carbon is ten times lower for this operation than that of a photovoltaic installation.

4 Conclusion

It took a few months and 7 millions €uros to convert the Villeneuve plant to wood energy and multiply the consumption of recycled wood on this site by six, going from 6,000 tons to 39,000 tons at present.

At the outcome, the transformed boiler consuming 75% wood and 25% coal achieves a saving of 35,000 tons of C02 per year. Combustion of wood at very high temperature (1200°C) and the presence of electro-filters furthermore considerably prevent emission of fine particles.

The work carried out on this project shows that industrial facilities initially scheduled for “all coal” can be modernised at little cost to upgrade them to match new energy issues.

Due to the success of this project, the environmental indicators of the Heating Company are in constant progress. In the energy pool of the 6 interconnected plants, the share represented by wood has increased in five years from 6.7% to 18.4% to a current figure of 64,000 tons on the Villeneuve and Poterne sites. It is moreover noteworthy that the CO₂ content dropped from 176 g/kWh to 137g/kWh between 2008 and 2010. The objective by 2050 is a zero carbon footprint.

To date, more than 50% of the heat produced is derived from renewable and recovery energies (R&REn) which means that our users benefit from a reduced VAT rate (5.5%) on the whole of their heating bill.

The company plays a leading role in structuring of the local wood sector to develop and secure procurement of fuel and ensure a competitive and stable price over time, while at the same time creating direct and indirect employment.

The good environmental performances of the Villeneuve plant highlight the interest of promoting the use of renewable energies by heating networks in the struggle against global warming.

In the future, the CCIAG will be doing its utmost to preserve the equilibrium between its public service mission and the stakes involved in sustainable development. A leading energy operator able to limit the greenhouse effect and to control consumption, it is fully committed to proposing an energy that is increasingly clean, competitive and accessible to the largest number.
Annexes :

**Annex 1 – press articles**

- *Les nouvelles de Grenoble.*
Grenoble, championne de France des énergies renouvelables

La métropole alpine se classe en tête des 250 collectivités candidates au championnat ENR.

DEPUIS LA MISSION DE SUIVIE de son volet énergétique, Grenoble, fier de son statut de ville énergie, a vu sa notoriété s'accroître dans le domaine environnemental. Après le grand prix national du développement durable reçu en 2009, Grenoble vient d'être distingué pour ses installations d'énergies renouvelables parmi les villes de plus de 100 000 habitants, lors du championnat de la ligue 1-ENR. France.


POLITIQUE ACTIVE

Pour cette qui est du solaire photovoltaïque, les 36 kW (kilo-watts-courants) reçus au réseau plafon de Grenoble en tête. Ainsi des cellules de 800 m² et 400 m², respectivement situées sur un parc immobilier de bureaux au fond du Dax et sur le bâtiment à énergie positive de l'aéroport de Bâle, étaient bientôt près de 1 010 m² de panneaux sur l'opérateur commercial de ce même quartier, dédié, si la Strasbourg est leader du solaire thermique avec 2 450 m² installés, un bâtiment grenoblois net sur deux intérêts des capteurs thermiques, soit une superficie totale de 9 956 m². Une politique active, grâce à laquelle Grenoble compte bien passer de 75 % d'énergie renouvelable et locale consommée en 2008 à 90 % d'ici à 2010.
Grenoble leader 2011 biomasse

Organisé par le Comité de Liaison des Énergies Renouvelables (CLER) qui réunit associations et professionnels spécialistes de ce domaine, ce championnat classe les collectivités territoriales participantes en fonction de leurs installations solaires (thermique et photovoltaïque) et en bois énergie.

Le classement prend en compte la puissance installée par habitant. Il a été dévoilé dans le cadre des Assises de l'énergie, en présence de Stéphane Siebert, Adjoint au Développement Durable de la Ville de Grenoble.

Pour la 2e année consécutive, la ville se maintient à la 1e place du classement biomasse avec une puissance de 200 kW et une consommation annuelle de bois recyclé de 64 000 tonnes dans la catégorie des grandes villes. Cette puissance bois-énergie provient des deux chaufferies de la Compagnie du Chauffage qui, à horizon 2014, envisage d'atteindre l'utilisation de 75 000 tonnes de bois recyclé.

Dans la catégorie solaire, Grenoble se maintient dans le peloton de tête, en 3e position, après les Communautés d'agglomération de la Réunion Est et Perpignan Méditerranée. Résultat : 592 kWc de modules photovoltaïques raccordés sur le réseau électrique.

En 2010, 7,3% de l'énergie finale consommée à Grenoble est de l'énergie renouvelable produite sur le territoire par les deux SEM d'énergie de la Ville, Gaz Electricité de Grenoble et la Compagnie de Chauffage, partenaires de "Grenoble, facteur 4" qui vise notamment à atteindre une part de 20% d'énergie renouvelable d'ici à 2020.

Version du 28/03/2011
URBANISME
Le Facteur 4 profite aux Grenoblois

Deux ans déjà ! La ville de Grenoble a joyeusement célébré l'anniversaire de son plan d'action Facteur 4, lancé en septembre 2008, par un bilan positif. Le programme vaut à présenter quatre les échéances de gaz à effet de serre de l'agglomération d'ici à 2020. Les premiers résultats. L'Observatoire de la plan climat local a ainsi évalué la baisse des consommations d'énergie de l'agglomération à 10 %, et celle des émissions de CO₂ à 17 %, entre 2005 et 2009. « Mais ces efforts sont en partie potentiellement réversibles, il faudra attendre quelques années pour les confirmer », souligne Stéphane Stirbry, adjoint en charge du développement durable à la mairie de Grenoble. Ce dernier se rejette en tout cas « des efforts déjà très concrets pour les habitants ». Ainsi, une campagne d'isolation de 657 logements a entrainé, en plus de 792 tonnes d'économies de CO₂, une réduction de près de 30 % des factures de chauffage. La compagnie de chauffage, qui alimente plus de la moitié des logements de la ville, a quant à elle, dépassé le seuil de 50 % de chaleur produite à partir d'énergies renouvelables, notamment en convertissant au bois une chaudière à charbon et au gaz un chauffe-eau solaire au fioul. Les logements concernés ont bénéficié d'une TVA réduite à 5,5 % et d'une baisse de 7 % de la facture. Dans les transports, plus de 80 km de pistes cyclables ont été aménagées, ainsi que trois zones 30 et 7 km de double sens cyclables qui ont récemment été mises en service.

http://www.grenoble.fr/74-facteur-4.htm

La Compagnie de Chauffage is certified:
Annex 2 – Technical characteristics of the Villeneuve heating plant

The heating plant comprises four superheated water generators:

- **Superheated water boiler (G1)**
  - Chaudière de secours
  - Combustible fioul lourd
  - Très basse teneur en soufre (BTS < 1 %)
  - Puissance 21 MW

- **Superheated water boilers (G2 and G3)**
  - Standby boiler
  - Heavy oil fuel
  - Very low sulphur content (LSC < 1 %)
  - Power 21 MW

- **IGNIFLUID coal boiler (G4)**
  - Direct superheated water production boiler at 180°C.
  - The generator underwent transformation in 1994 to enable co-combustion of coal and recycled wood (Decree n°94-3795 of 6 July 1994 from the Prefecture)
  - Instantaneous efficiency: 90 %
  - Useful power: 63 MW
  - Continuous analysis of combustion gases (oxygen, dust content, nitrogen oxide, sulphur dioxide, carbon monoxide)

- **Fuel storage**
  - 2000 t covered coal storage yard
  - 3000 m$^3$ ground wood silo
  - Two overhead heavy oil storage tanks, two different qualities, unitary capacity of 1085 m$^3$
  - One 40 m$^3$ overhead domestic fuel-oil tank

- **Fly ash treatment**
  - The fly ash from the coal generator is collected by a mechanical dust extractor with reinjection to the furnace, then in a two-field electrostatic dust extractor also comprising dust reinjection to the furnace.
  - The coal ash, on boiler outlet, is in the form of clinker and is beneficiated in public works.
  - The fly ash from the heavy oil generators is collected by means of cyclonic mechanical dust extractors and is then packed in paper bags.

- **Stack**
  - Once the combustion gases have been purified, they are sent to a stack formed by a single-duct concrete shaft with a height of 75 m and a diameter of 4 m with a brick lining with a thickness of 11 cm.

- **Network water circulation**
  - Four circulating pumps with a capacity of 640 t and 740 m$^3$/h each.
  - One 250 t/h circulating pump.