POTENTIAL OF CO_2-BASED DISTRICT HEATING AND COOLING NETWORKS - SWITZERLAND

Potentiel des réseaux de chaud et froid fonctionnant au CO_2

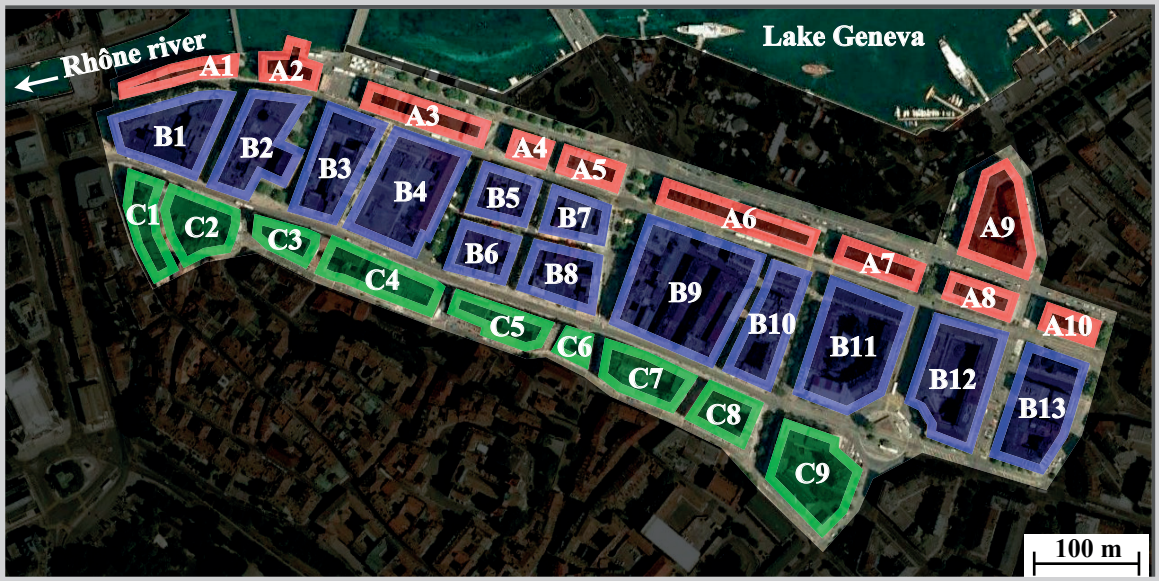

Fig 1: Map of the test case area of « Rues-Basses » showing the subdivision used for the various groups of buildings.

Summary of the project

As a major gas responsible for the greenhouse effect, CO_2 can also contribute to limit climate change. CO_2 reveals itself to be an efficient energy carrier for heating and cooling buildings. Already used as a refrigerant in the industry, carbon dioxide (CO_2) could also transport heat and cold efficiently and economically in urban areas. That's what researchers from the École Polytechnique Fédérale de Lausanne (EPFL) are demonstrating. A prototype in the lab and simulations in the neighbourhood Rues-Basses in Geneva will reveal its feasibility.

Expected results

A district heating and cooling system, using a two-pipe network with a pressurized refrigerant as a fluid, could possibly bring an economic viable solution to substitute fossil fuels in urban areas and thus to mitigate CO_2-emissions. Samuel Henchoz, from the engineering Group of industrial processes and energy systems, together with the Centre of Energy, tackled this problem. In his thesis, he studied a new concept which relies on the circulation of a saturated refrigerant, CO_2 under pressure between the buildings. Like in a domestic fridge, liquid CO_2 evaporates in a heat exchanger to produce cold. The heat is produced with the inverse reaction, when CO_2 is at vapour state.

> ” RESEARCH AND TESTS ON DISTRICT HEATING NETWORKS WITH CO_2 AS A MEDIUM ”

Waste heat recovery

In the proposed system, CO_2 circulates at a temperature of about 15 °C, close to the saturation point between liquid and vapour state. Being comparable with the underground temperature, there is no need for insulation. Not being able to freeze, the pipes could even be layed under the sidewalks. Furthermore, gas under pressure has a higher energetic density; the pipes can be dimensioned much smaller than for the water networks. Last but not least, the refrigerant recovers waste heat from cooling processes on his way, reducing so considerably the amount of heat required by the central plant.

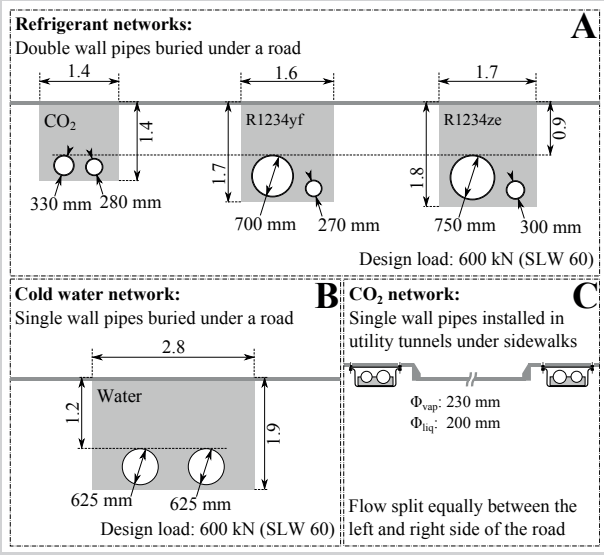

Fig 2: Scale representation of the cross-section of the different networks discussed in this study.

The researcher has focused his analysis on a test case area in Geneva's city centre. Five options of refrigerant based district heating and cooling networks, one cold water network and a mix of technologies currently in use were compared on the basis of their energy, exergy performances and on the economic profitability. Considerations on economic uncertainty, safety and technical issues were also included in the analysis.

Profitable after four to six years

Results: the current system composed of boiler and cooling units shows to be the less attractive system. All the other options of network can potentially reduce the final energy consumption of over 80 % compared to the current situation. The most profitable option uses CO_2 as a transfer fluid and an open cycle CO_2 heat pump at the central plant. It costs initially between 27 and 35 millions reaches break-even in 4 to 6 years. A cold water network is the second best option, although more expensive initially and thus less profitable, it has several advantages in terms of safety and availability of components. The CO_2 option shows a much better compactness than the cold water network. "Unlike synthetical refrigerants, CO_2 is natural, cheap, non-flammable and non-toxic" reminds Samuel Henchoz. "However, it must circulate under pressure of 50 bars, which is new and needs an adaptation of the official norms."

FACTS ABOUT THIS PROJECT

Building type: Commercial (shops and restaurants), offices and residential

Heated floor area [m²]: 687 843 m²

Installed heat capacity [kW]: 20 MW

Heat source: Lake Geneva and heat pumps

Investment cost: 35 millions CHF

Participating countries: Switzerland

Time frame: 2016

Project organisation:

Project leader: École Polytechnique Fédérale de Lausanne (EPFL)

Project partners:

- Financial partner: Commission for Technology and Innovation CTI
- Industrial services: Services industriels de Genève SIG
- Engineering office: Amstein + Walthert AG

Link to web page or report: https://infoscience.epfl.ch/record/217013/files/EPFL_TH6935.pdf (in English)

Thanks to the financial support of the Commission for Technology and Innovation (CTI) and the collaboration with the Services Industriels de Genève (SIG) and the engineering office Amstein + Walthert AG, the researcher has realized and tested a network with a fluid refrigerant at smaller scale in the lab. The tests focused on the feasibility proof of concept. They confirm the well behaviour of the installation and validate the concept of automatic control.

Contact information

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