Utilization of a Deep Lake Water Direct Cooling Network (DLWDC) for cooling of a large administrative district. Energy and Environmental demonstration and follow-up

Pierre-Alain VIQUERAT, Bernard LACHAL, Willi WEBER, André MERMOUD, Eric PAMPALONI
CUEPE, University of Geneva, Switzerland

Abstract
The GLN-DLWDC (Deep Lake Water Direct Cooling Network) facility will cool administrative buildings in the district of Sécheron. The GLN facility will draw water from deep in Léman Little Lake (depth of 35 m) and circulate it through heat exchange facilities (HEFs) that will be located inside each connected buildings. Heat exchangers in the HEFs will remove heat from each buildings “chilled” water in a separate closed-loop, and it will transfer this heat to the circulating lake water. The warmed water will be returned to the upper waters (depth of 4.5 m) of the lake via a diffuser, located about 150 m offshore.

The GLN-project is composed of three sub-systems: the lake, the hydraulic network itself and the buildings that are connected to the network. The GLN-network will be partially operative for the 2009 cooling season (April to October 2009). Our objectives are to demonstrate the efficiency of the GLN-project with respect to energy, environmental and economical aspects, and to raise awareness about the promotion the use of certified renewable electricity among the buildings participating in the GLN project.

The GLN-project "Genève Lac Nations" has been undertaken by the State of Geneva, the City of Geneva, the SIG (Services Industriels de Genève, fluid management) and the FIPOI (Building Foundation for International Organizations). This project is supported by the Europe in the framework of the TetraEner project, which includes another urban energy management project of the San Sebastian City, and the city of Frankfurt as an observer. The TetraEner project matches the "Concerto" programme criteria.

1. “Genève-Lac-Nations” (GLN), a European Project
The Geneva project, which is called “*Genève-Lac-Nations*” (GLN-project) is a Low Temperature Exchange Network. Lake Geneva can be seen as a virtually unlimited source of perfectly renewable and non-polluting energy that can be used to provide heating, cooling and water services. Water is drawn from a depth of 34.7 meters and is distributed through a hydraulic network at a temperature lower than or equal to 10 °C, to heat or cool buildings in the area. The network also serves as a thermal exchange medium and as a source of non-potable water.

TetraEner is a European integrated project, which is included in the sixth framework Priority 6.1 “*Sustainable energy systems*”. These European projects are based on the premise of creating residential and administrative communities where external energy dependency is reduced by optimising the supply/demand balance through an improvement in energy efficiency and the use of renewable energy sources, together with demand monitoring and control applications.

TetraEner encompasses two new urban developments in the cities of San Sebastian (Spain) and Geneva (Switzerland). These communities can offer a series of synergies with regard to the priorities set out in the CONCERTO initiative: Large-scale integration of renewable energy sources, Eco-buildings, polygeneration, energy storage and supply assurance.

1.1. Energy objectives
The project aims to save energy compared with non-influenced constructions that respect the regulations in force:

- Fuel: ~ 1,500 tons/year of ultra-light oil fuel (~ 20 % of the heating capacity), or around 4’800 tons/year of CO_2,
- Electricity: ~ not influenced. The savings on consumption for cooling (in summer) are offset by the consumption of the heat pumps (in winter),
- Drinking Water: non consumption of ~ 400’000 m³/year.

These objective do not concern the Serono-Merck-sub-network: however, this sub-network will be taken into consideration for the follow-up of the lake, because both GLN and Serono-Merck sub-networks share intake and outlet structures.

1.2. Activities of the CUEPE – University of Geneva

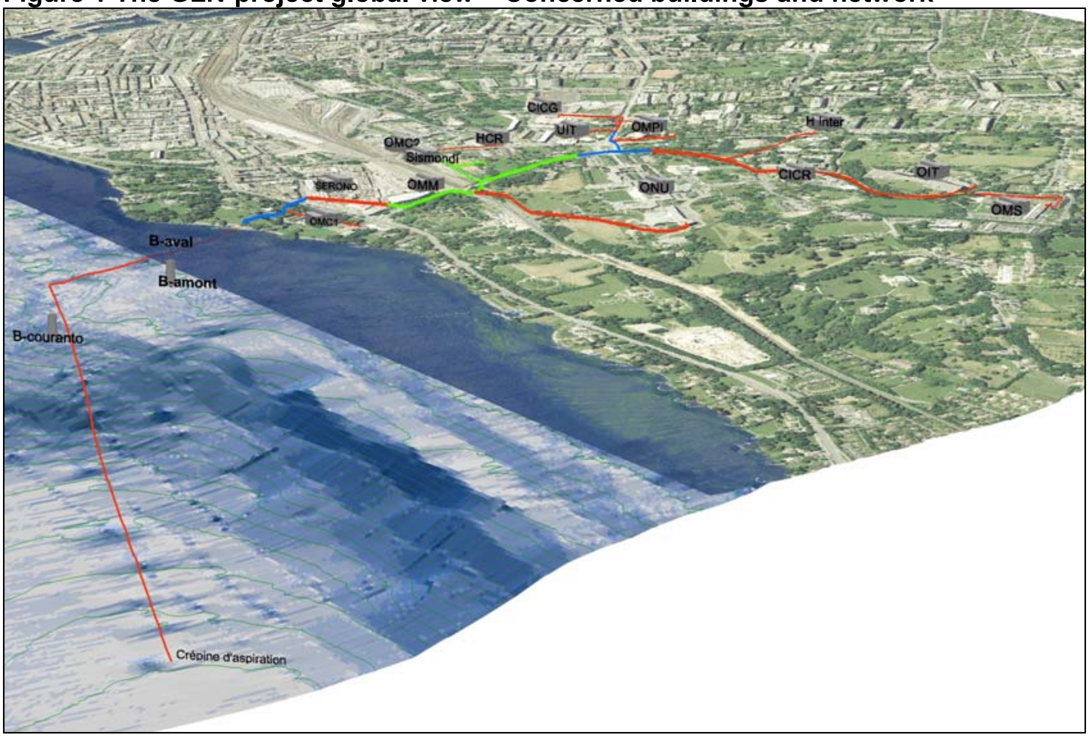
Our first objectives are to demonstrate the efficiency of the GLN-project with respect to energy, environmental and economical aspects, and to raise awareness about the promotion the use of certified renewable electricity among the buildings participating in the GLN project

Our second objectives are to develop an auditing method of the existing buildings to be connected to a Deep Lake Water Direct Cooling Network (DLWDC), and its application on two existing large administrative buildings (International Organizations). This method is aimed at a "medium size" (about 2-3 working weeks) evaluation of building cooling needs and air conditioning installations, and especially to the study of the "connectivity" of the buildings to the network. In particular, this should evaluate the ability of the air-conditioning installations to increase the chilled loop operating temperature to values which are as high as possible; which is a very important challenge for optimizing the energy transfer from the DLWDC network.

2. Description of a Deep Lake Water Direct Cooling (DLWDC) network

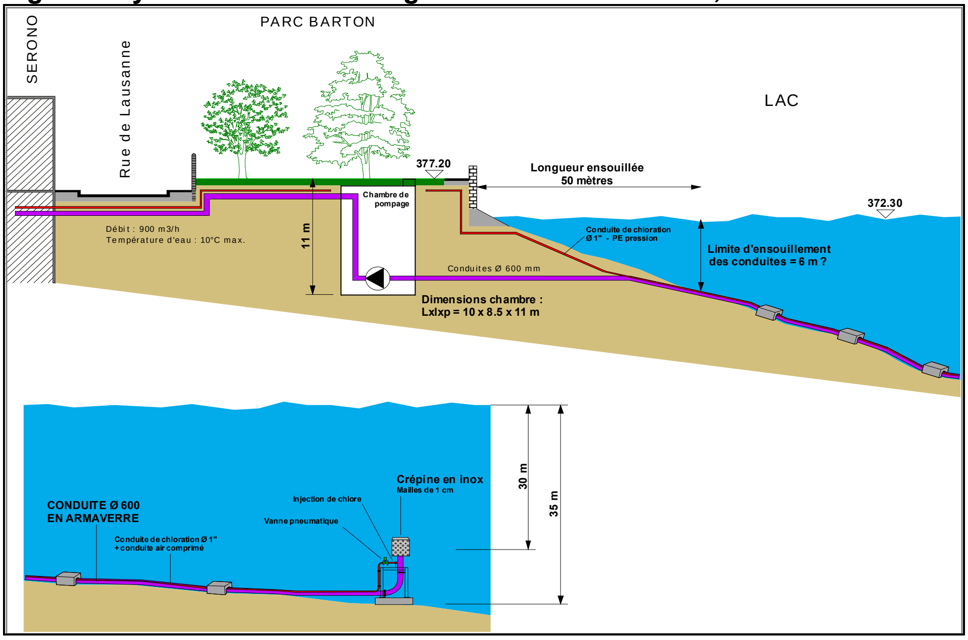
The project consists of creating a hydraulic bus serving as a thermal source (*figure 1*) for anyone needing to discharge or extract heat, and as a source of water for the watering of the Botanical Garden and other green areas.

Figure 1 The GLN-project global view – Concerned buildings and network



It uses a renewable source at a temperature sufficiently low as to permit direct cooling; DLWDC involves drawing cold water from 34.7 m depth in Lake Léman through an intake pipeline (*figures 1,2,3*), and circulating this water to the building's heat exchange facility (HEF) through a primary hydraulic network. Noncontact heat exchangers remove heat from water in a separate closed-loop pipeline which extends from each connected building to its HEF, and transfers this heat to the circulating lake water (*figure 1*). The warmed (or cooled) water is returned to the upper water (about 4.5 m depth) of Lake Léman via a discharge pipeline with diffuser assembly.

Figure 2 System of heat exchange with the GLN DLWDC; details of intake installations



Source *(SIG, 2005*)

Contrary to a central chilled water cooling system based on electrically driven chillers to meet the administrative buildings air conditioning needs, the resulting savings in electricity by the GLN cooling system are used to pump water and to substitute the fuel burning installations in the zone (heat pumps in winter). This reduces the demand for non-renewable fuels and, as a consequence, CO_2 and NO_x emissions, also relieving a zone that often exceeds the allowed limits.

The water from the Lake also replaces the treated water otherwise used for watering green areas and supplying large fountains. The water returned to the Lake Léman drives turbines (*figure 4*) in order to recover any potential energy still available.

Figure 3 Water intake structure (left); Figure 4 Details of pumping station (Serono part) (right)

Sources (*SIG, 2005*)

2.1. Technical specifications

- Approximate hydraulic network length: 6 km (*figure 1*),
- Maximum authorised flow rate for GLN-sub-network: 2'700 m^3/h (in addition to 1'800 m^3/h for Serono-Merck-sub-network, total pumping 4'500 m^3/h),
- Capacity: 23.5 MW cooling (at ΔT = 7.5°C) and 3 MW heating,
- Cost estimate ~ 22 Million €.

2.2. Existing DLWDC plants around the World –differences from the GLN-network

Very few existing Deep Lake Water Cooling networks could be found in the literature, and none of them presents the same characteristics as those of the GLN project. These specificities are:

- Direct cooling: no cooling devices included in the network to guarantee the temperature level,
- Not dedicated system: the cooling energy is for sale to a number of customers within a geographic area, and the provider has to make profit,
- The majority of the buildings to be connected already exist, and all are already equipped with their own cooling system.

For example, Cornell University (USA) (*NYSDEC, 1998*), or EPFL (Switzerland) (*EPFL, 2003*) use a deep lake water cooling system, but only for their own buildings. In Lugano (Switzerland) (*Lugano, 2006*), an "industrial" water network feeds the condenser part of the cooling system of each building. The Deep Lake Cooling System of Toronto (Canada) (*Toronto, 2006*) presents the closest characteristics: its main concept involves a heat exchanger on the potable water distribution, feeding a cooling network, but also equipped with a big cooling machine which ensures complementary needs.

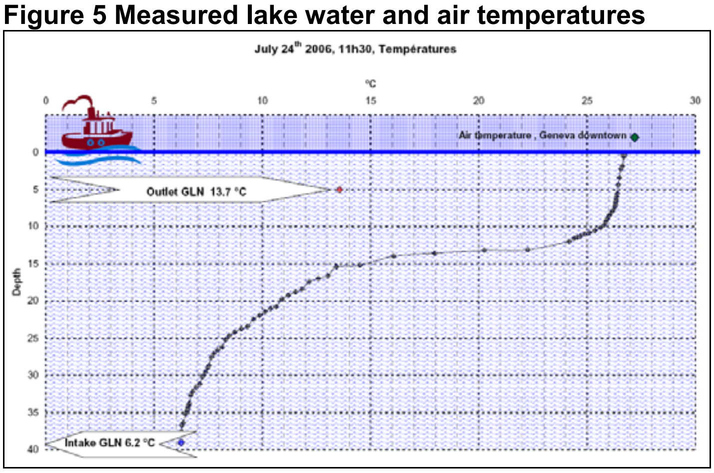
3. Renewable energy resource

3.1. Hypolimnetic water as a Renewable Resource

Lake Léman, as with all deep northern hemisphere lakes, is stratified by temperature during the warm month of the year. Water at the deeper depths (hypolimnion) is consistently cold year round: at 34.7 m depth, Lake Léman waters remain at approximately 5-8 °C, regardless of the season. The design concept of using the deep water resource of Lake Leman for cooling is based on the long-term availability of sufficient water volume at the appropriate temperature. What makes this proposal viable is that heat added to the lake from the GLN-system will be returned to the atmosphere each year. As the surface of the lake cools to 4° C in the winter, the surface water sinks because it is at its highest density. In the summer, surface water is warmed, and remains on the surface because it is less dense. Deep Lake Water remains cold throughout the summer. Over the years, this cycle has created a permanent reservoir of cold water that lies at the bottom of the lake.

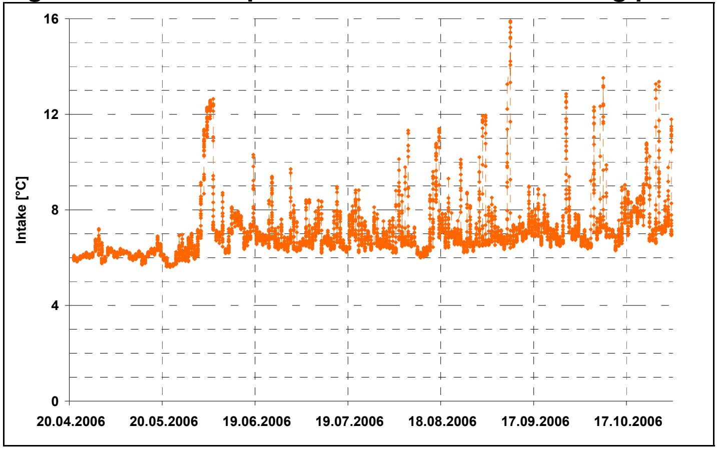
For example, *figure 5* shows a vertical lake temperature profile measured at the pumping intake point of the GLN-project during a hot day of July 2006. At 11h30, the air temperature in central Geneva City is 27.2 °C, reaching 33 °C during the afternoon. The Lake temperature is exceptionally high in the upper layer (10 m thick): more than 26 °C; but a strong decrease is observed at a depth of 13 m, with a sharp cooling of more than 10 °C. At 30 m, the temperature falls below 7 °C. At 34.7 m, the GLN-pumping intake could pump lake water around 6.2 °C (*Lachal, 2006*).

Figure 5 Measured lake water and air temperatures



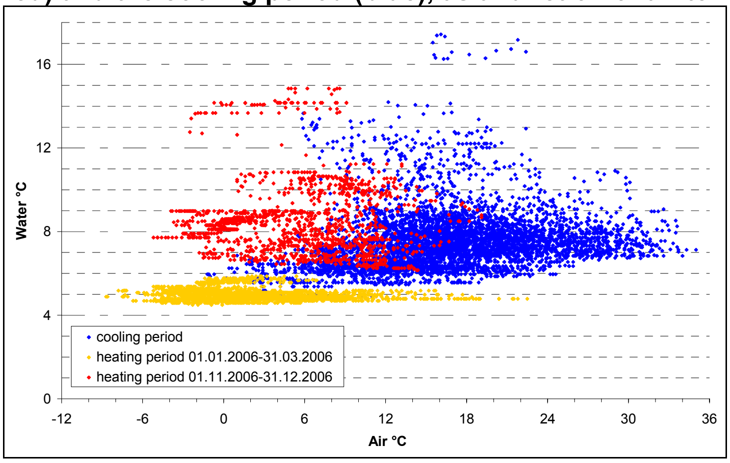
The temperature of the resource, at 35 m depth (GLN-intake) is quite homogeneous, and the majority of temperature measurements ranges between 5 and 9 °C (*figure 6*). Sometimes the temperature exceeds 9 °C (*figure 6*): in this case, the resource becomes less effective, because the usable ΔT decreases. These punctual increases of resource temperature penalises the project and has to be accounted for, and are due to a particular natural phenomenon (*Viquerat et al., 2007*).

Figure 6 Intake temperatures for the 2006 cooling period (21.04.2006-31.10.2006), (data by hour)



The three typical distributions of resource temperatures that occur are explained by the annual dynamic of temperatures within the water column (*figure 7*): during the first part of the heating period (from 1st November to 31st December), the lake is very dynamic: air temperature decreases sharply, which induces the cooling of surface layers, and thus increasing their density; water body movements that are dependant on wind strength, induce the mixing of surface layers with deeper layer. At 35 m depth, the resource temperature is thus modified by the downwards movement of upper layers that are higher in temperature.

Figure 7 Temperature of the resource for the year 2006, for the two heating periods (yellow and red) and the cooling period (blue), as a function of air temperature (data by hour)



During the second part of heating period (1st January to 31st of March), the lake is totally unstratified, throughout its entire water column. The lake is not dynamic, and the temperature is uniform throughout the whole water column. At 35 m depth, the resource temperature remains very constant, with an average value of 5 °C. During the cooling period (1st April to 31st of October), the lake temperature is very dynamic: it starts to stratify from early spring, remains well stratified during the summer and starts to unstratify in autumn. In spring, air temperature increases, which induces the warming of surface layers, and thus creates a temperature gradient throughout the water column according to water density; in autumn, the dynamic is exactly opposite to that of spring. For these two periods, air temperature can deeply vary very rapidly: this induces the mixing of surface layers with the deeper layer, when sudden decreases of air temperatures occur. These water body movements are reinforced by the wind's effect on the surface layer. In these conditions, the resource temperature (35 m depth) is thus modified by the downwards movement of upper layers that are only slightly higher in temperature than deeper layers (*Viquerat, 2007*). During the summer period, the lake remains very well stratified, with a clear separation of upper layers from deeper layers according to water temperature. In addition, sudden decreases of air temperatures do not occur during this period, which prevents downwards movements of upper layers, as these layers remain higher in temperature than deeper layers.

3.2. Critical events

A fine analysis has been conducted, to determine all the events during which the resource temperature exceeds 9 °C. Natural conditions have also been studied, as air temperature, surface water temperatures and wind speed. 21 events have been isolated, from 20th May 2006 to 15th November 2006. For each event, a general pattern can be determined. If the resource temperature suddenly rises up to 9 °C, it means that hotter water initially located in surface layer can descend under specific conditions. It has been observed that two parameters induce this phenomenon: a decrease of air temperature coupled with an increase in wind speed (*Viquerat, 2007*). A decrease of air temperature provokes a parallel decrease of surface water temperature, and the increase of wind speed induces water body movements. These two parameters induce the descent of upper layers to deeper layers.

Depending on temperature difference between surface waters and 35 m depth waters, surface layers descend more or less deeply, thus influencing the temperature at 35 m depth for a more or less long while (*Viquerat, 2007*). In spite of the resource temperature increases during these 21 critical events (*table 1*), air temperature remains very low in such cases, thus cooling needs are also weaker.

Table 1 21 critical events for the year 2006 and determining factors linked to these events

Events 2006	Date 2006	T_{AIR} (daily) °C	$T_{AIR\ max}$ (hourly) °C	T_{max} PCREP °C	ΔT_{min} (T_{PCREP}-$T_{surface}$) °C	Time T> 9 °C hours
1	03.06.2006	13.4	17.8	12.64	0.8	60
2	18.06.2006	20.2	27.2	10.41	8.4	5
3	24.06.2006	22.2	29.3	9.44	8.8	7
4	30.06.2006	22.4	28.7	9.76	13.9	2
5	04.08.2006	14.4	16.2	10.23	8	3
6	07.08.2006	18	23.2	11.49	10	5
7	16.08.2006	17.9	23	11.42	2.75	33
8	20.08.2006	18.8	23.4	9.91	9.6	1
9	24.08.2006	17.3	20.8	10.26	9.5	6
10	01.09.2006	14.4	25.5	11.99	6.4	21
11	09.09.2006	18.7	22.4	16.35	10.2	20
12	27.09.2006	15.5	19.8	13.19	8	19
13	06.10.2006	13.7	18.8	12.33	4.6	18
14	09.10.2006	12	18.4	13.52	5.9	14
15	16.10.2006	13	14.9	9.13	8.9	1
16	23.10.2006	14.3	14.9	10.87	6.4	28
17	27.10.2006	14.8	23.4	13.38	5.8	18
18	31.10.2006	11.8	17	11.86	7.2	10
19	03/04.11.2006	4	9.1	14.99	-1.2	69
20	07.11.2006	4.5	11.3	9.79	5.8	2
21	11.11.2006	7.3	13.2	11.1	2.8	40

4. Energy potential of the GLN-system

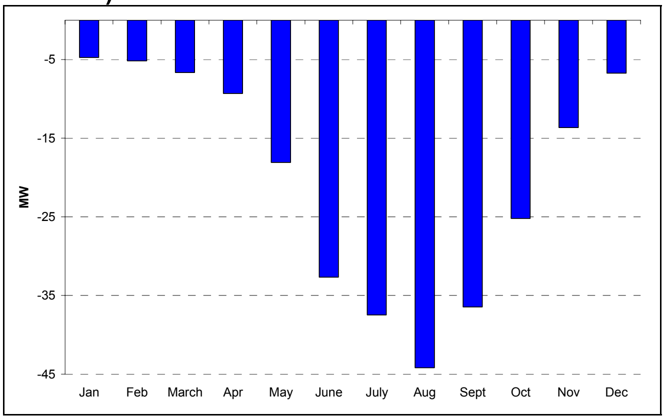
The potential of the GLN-system can be expressed in two general ways:

- Taking into account only the environmental characteristics,
- Taking into account cooling and heating needs of buildings, and technical installations for heating and cooling.

4.1. Energy potential for legal environmental requirements

The maximum allowable temperature increase is fixed at 3.0 °C, taking into account the temperatures upstream and downstream from the heated effluents (*OEaux, 1998*). It is reduced to 1.5 °C if the area concerned by the hydrothermal discharge is a body of water classified as trout habitat (*OEaux, 1998*). This indicates that the thermal impact on the lacustrine environment that is induced by the GLN-system should be as low as possible, without changing the natural dynamic of water temperatures and without damaging natural biological conditions in the area of the GLN-discharge. The area of the GLN-discharge is classified as a trout habitat: it means that the allowable temperature increase is reduced to 1.5 °C.

Figure 8 Monthly potential cooling power delivered, when $T_{discharge} < T_{lake} + 1.5$ °C (GLN-sub-network)



The maximum cooling potential also occurs in August, but with a higher cooling power of about 44 MW (*figure 8*). For the sake of comparison, a maximum allowable temperature increased to 3.0 °C enables to sustain a maximum cooling demand slightly higher.

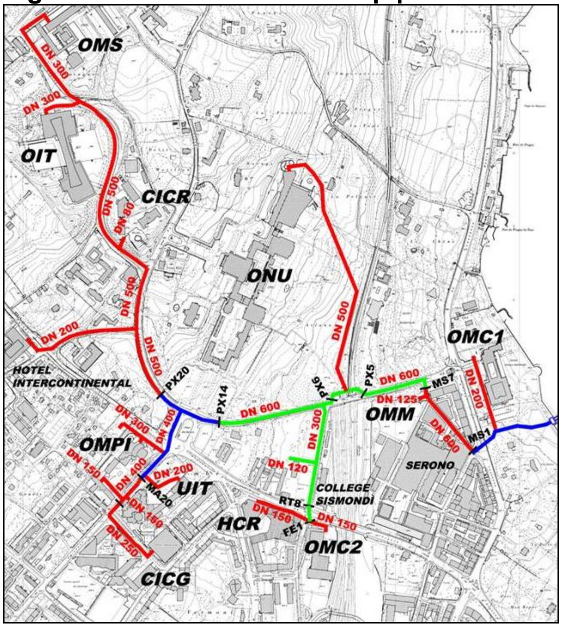
5. Network and Buildings

5.1. Pipeline corridor

The hydraulic network is composed of a terrestrial pipeline corridor and an aquatic pipeline corridor (*Viquerat, 2007*). The entire system is divided into two sub-network: the GLN-sub-network and the Serono-Merck sub-network: they share the aquatic pipeline corridor for pumping and discharge waters, and the pumping station building: 4 pumps are dedicated to the Serono-Meck sub-system, which is operating since June 2007, and 4 other pumps are dedicated to the GLN-sub-network, which should be operative in spring 2009.

The terrestrial pipelines will be located primarily underground and will not entail any permanent change in land use. The existing land uses along the terrestrial pipeline route are a combination of public and institutional green areas, as well as public utilities, but the majority of underground pipelines will follow existing roadways and road shoulders. The pipelines in blue on the map below are already built (*figure 9*). The primary network will measure about 6 km; it consists of a principal branch line, which is composed of big diameter pipes (500 and 600 mm), and of several branch lines, which consist of smaller diameter pipes (400, 300, 250, 200, 150, 125, 120 and 80 mm) (*figure 9*).

Figure 9 Details of terrestrial pipeline corridor (primary network)



Source (*SIG, 2007*)

The terrestrial pipelines will not be thermally insulated, as the warming of the circulating lake water is insignificant (*Lachal, 2007*).

5.2. Buildings

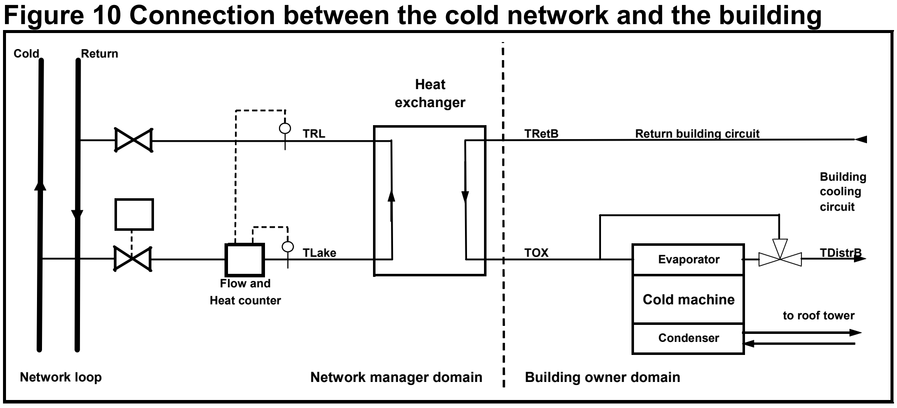
SIG selected 19 buildings that are potentially connectable in the concerned district, according to two main criteria: they should be part of a restricted area hinged around the "Place des Nations", so that the network to be built would not be too long (construction problems, head losses, cost of the infrastructure, etc.), and the prospected buildings are the biggest energy consumers in the defined area, in terms of cooling and heating needs. These 19 buildings are composed of 13 International Organization buildings, 4 commercial buildings, 1 school and one hotel. Serono1 (which is not strictly part of the GLN-network: Serono-Merck-sub-network) is the only "new building" which is already built, 6 others are only planned. All the others (12 buildings) are "existing buildings": 3 were built before the 1960's, 7 during 1960's and 1970's, and 4 others are more recent.

The United Nations Commission for Sustainable Development has decided to implement the "Sustainable Development" concept. The GLN-project enables these International Organizations to follow sustainable imperatives: with a 100 % renewable energy (lake water) and the replacement of oil by gas for heating needs, this project is in accordance with the Kyoto protocol, which has been signed by a large number of members countries of the United Nations.

5.3. Connection mode

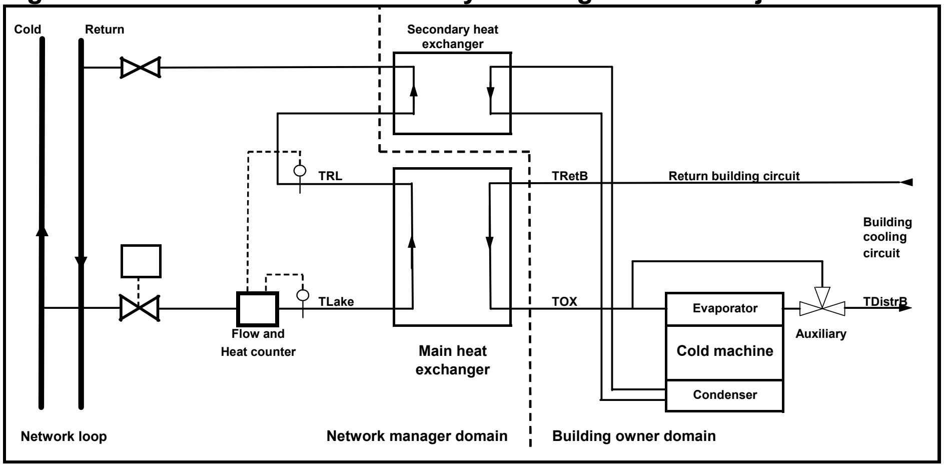
The cold transfer from the lake network to the chilled loop of the building will be done through a heat exchanger, managed by the network's owner (SIG). A typical configuration is illustrated on *figure 10*.

Figure 10 Connection between the cold network and the building



The SIG domain of responsibility will extend up to the output of the secondary loop's pipes, and will of course include the flow and heat transfer counters for the invoicing. In reality, the SIG's flow-meter and heat counting will take place in the secondary building loop, with simultaneous recording of the return temperature level for invoicing (as the price of kWh will be indexed on the return temperature level).

Figure 11 Connection with secondary exchanger for heat rejection



Moreover, the SIG proposes a secondary exchanger for the rejection of the condenser heat of the cooling machines. This will be connected to the output of the exchanger, and will therefore benefit from the flow used for the primary exchanger of this building (*figure 11*). As the GLN-sub-network works in open loop mode, there is no additional cost for SIG: the temperature of the output circuit has no implications on the loop's performance (for other customers), except that the global rejected waste water into the lake should not exceed a given legal temperature of 30 °C.

Therefore, SIG propose this heat rejection for free, the investment for the secondary exchanger paid for by the building owner. For the air-conditioning system global performance, this has two considerable advantages. First, it avoids the use of roofs towers, including their maintenance. Moreover, it will operate at very low temperature (around 20 °C instead of 45 °C), which will drastically improve the COP of the cooling machine. The size of this exchanger may be relatively small, as the temperature drop in the condensing circuit is not crucial.

This configuration makes the customer captive of his use of cold energy from the lake network. As the flow in the secondary exchanger is related to the flow of the "bought heat", the cooling machine will not work unless a minimum amount of lake energy is bought.

5.4. Building point of view versus network point of view

The building owner point of view is quite different from that of the network system. The network has to be optimized as a whole, the total pumped volume is limited and there is no way to decrease the inlet temperature. From the building point of view, it is interesting mainly to have cool water at the lowest price possible.

In the case of an existing building, two problems will occur:

- A very bad estimate of the cooling service price by the building owner. As noted by the Toronto project (*Toronto, 2006*): "*the maintenance cost of on-site cooling equipment should include parts, labour and refrigerants. Apart from routine maintenance and annual overhaul, an annualized cost of major repairs should also be included. A building owner usually has a limited knowledge of the exact cost for the cooling equipment because the specific costs for cooling can be difficult to identify and also because there is typically a limited interest in activities outside the main business of the building"*,
- The misleading between the interest for the system owner to adapt the existing building cooling plant to the DLWDC network and the fact that the investment is to be made in the building part.

As noted in the Auditac project (*AUDITAC, 2006*): *"It is well known that in order to generate financial savings, industrialists invest in priority on their "core business". To spend money to improve "utilities" is* *often judged less rewarding and that is the most important barrier to Energy-Efficiency. In comparison to industry, the difficulty is that there can be several persons linked to a building with diverging interests: the building-owner(s), the occupant(s) and the operator(s) of technical installations included".*

6. GLN monitoring

The GLN-project is composed of three sub-systems that must be evaluated and studied (*Viquerat, 2007*): the lake, the hydraulic network itself and the buildings that are connected to the network. The GLN-network will start to be constructed in 2008, and it will be partially operative for the 2009 cooling season (April to October 2009): for the moment, the monitoring activities are focused on the existing buildings and on the lake.

6.1. Monitoring of the Lake sub-system

The monitoring of the lake is based on physical and chemical measurements. Several energy and environmental aspects has to be considered to characterize the Lake subsystem as precisely as possible: physical-chemistry, biology, hydrology, microbiology, heat flows, sedimentology and meteorology. Depending on parameters, three types of data acquisition will be used: continuous, monthly or bi-monthly and punctual measurements.

The lake is a natural entity which is central to the GLN-project: lake water is the natural resource that is used to supply energy, thus some potential impacts on this natural ecosystem are possible. Three main potential impacts have been identified:

1. Impacts on natural heat flows: impact of the thermal discharge from the GLN facility on the temperature and aspects of water quality in the downstream portion of the GLN-discharge area,
2. Impacts linked to Phosphorus mobilization: long-term record of trophic state indicators (phosphorus and water clarity) on the affected area,
3. Impact linked to chlorination.

These three potential impacts are organized through a balance of the following points: a heat flows monitoring of the concerned Lake area, physical-chemical monitoring of water quality linked to the lake biological dynamics and hydrological network chlorination.

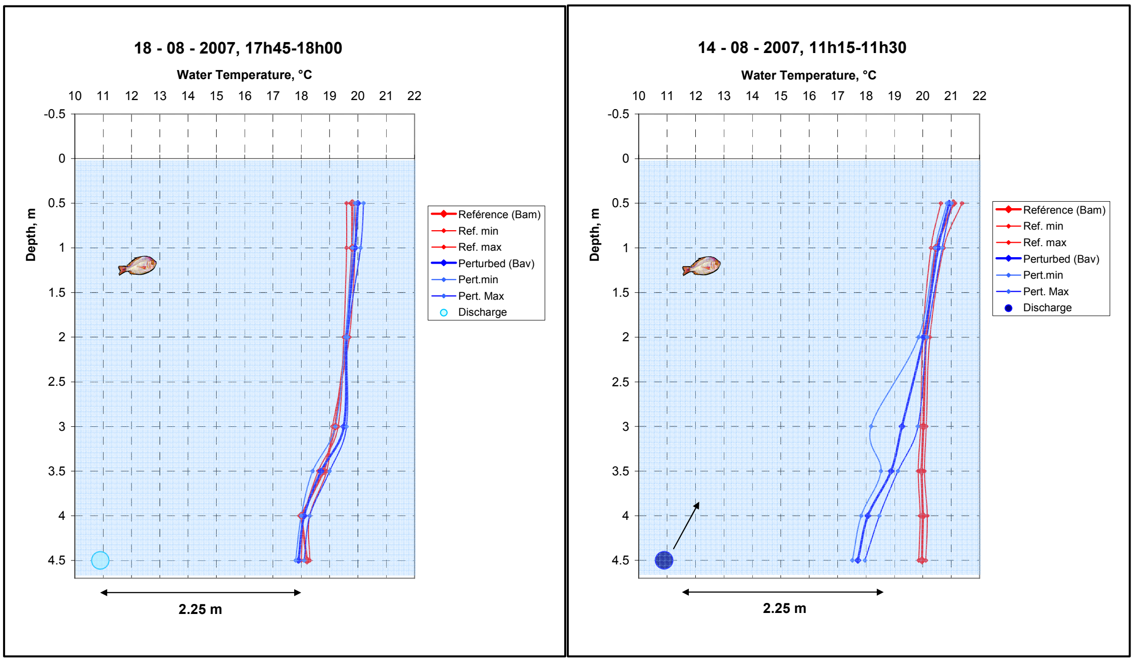
6.2. Thermal impact: first results

This thermal impact is related with the Serono_Merck-sub-network, which is already in operation, and that uses the same discharge utility as the GLN sub-network.

For the thermal analysis of the discharge area, which is affected by the SeronoMerck-sub-network discharge, the analysis is conducted both on two points: a reference point (upstream buoy), which is located 300 m upstream from the Serono-discharge and an "affected" point, which is located about 2.25 m downstream from the discharge: these two measurements locations enable to have a first idea of the impact that could be observable close to the network discharge ("affected" point).

During summertime, the lake is clearly stratified and water temperatures are less dynamic in comparison with the early spring period. When there is no discharge, the water temperatures in the area of the network discharge ("affected" point) and in the "reference" point are very close (*figure 13*); when there is a network-discharge, the water temperatures in the area of the network discharge ("affected" point) and in the "reference" point show differences (*figure 13*): close to the network-discharge and at 3 m depth ("affected" point), temperatures are cooled by the cooler network-discharge waters.

Figure 12 Water temperatures in function of depth, for the "affected" area (2.25 m from the GLN-discharge, in blue) and the "reference" area (in red), when the system is not in operation (18th August 2007) (left); Figure 13 When the system is in operation (14th August 2007) (right)



In a general manner, unaffected (”reference”) water temperatures are higher than “affected” water temperatures (*figures 12, 13*). It indicates that the area of the system discharge (affected area) is cooler than the non-affected area (reference). In the area of the system discharge, the discharge waters are therefore most of the time cooler than the water of surface layers.

In the affected area, the difference of water temperatures is less important in surface layers (less than 1 °C) in comparison with the difference of water temperature in deeper layers (between 1 and 3 °C). This confirms the impact of the discharge waters : the system discharge diffuser is located at a depth of 4.5 m, where deeper layers are highly affected. The mixing of the discharge waters is therefore not complete at about 2.25 m from the system discharge (*figure 14, 15*).

Figure 14 Evolution of Δ of water temperature between “reference” area and “affected” area from 7th April to 12th May 2007 (T1 to T8 is 0.1, 0.5, 1, 2, 3, 3.5, 4 and 4.5 m depth)

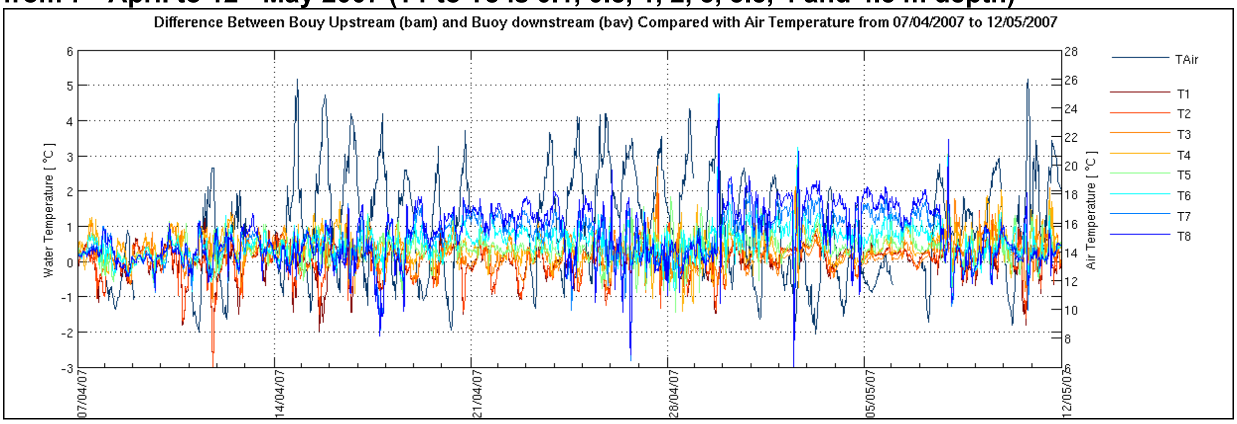
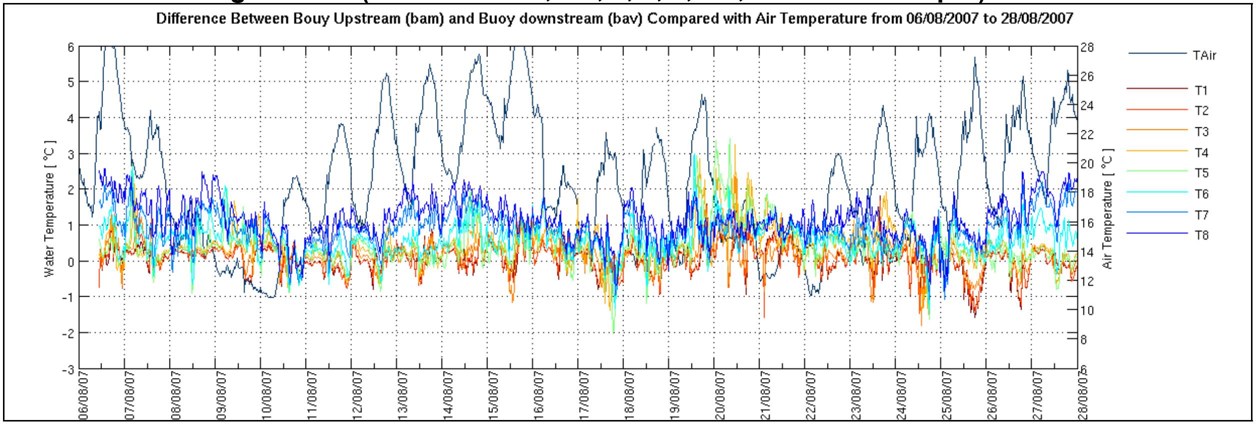


Figure 15 Evolution of Δ of water temperature between "reference" area and "affected" area from 6th to 27th August 2007 (T1 to T8 is 0.1, 0.5, 1, 2, 3, 3.5, 4 and 4.5 m depth)



Three characteristics periods can be distinguished (*Viquerat, 2007*):

- Winter: the deeper layers of "affected" area are a little cooled by the system discharge; water temperatures and air temperatures are low and not very dynamic. There is no cooling demand during this period,
- Spring: deeper layers of the "affected" area are also clearly cooled by the system discharge (*figure 15*); for this period, the maximum air temperatures (data by 30 min) range between 14 and 20 °C (representative of a typical spring period). The lake is stratifying: in term of thermal impact by the network, the lake is fragile. The cooling demand starts, but it remains weak,
- Summer: deeper layers of the "affected" area are also clearly cooled by the system discharge (*figure 15*); water temperatures and air temperatures are high. The lake is clearly stratified and less dynamic, in comparison with spring period. The cooling demand is therefore strong.

The results above explained should therefore be firstly considered as indicative. A further analysis will be carried out in more details during a further cooling season, when the GLN sub-network will be also operative, during which all the necessary parameters for determining with insurance a quantitative thermal impact will be available.

6. Conclusion

For the moment, the GLN-sub-network is not yet built: it will start to be constructed in 2008, and it will be partially operative for the 2009 cooling season (April to October 2009). It is composed of three sub-systems that must be evaluated and studied: the lake, the hydraulic network itself and the buildings that are connected to the network (existing buildings and new buildings).

Concerning the monitoring of the lake, the measured impact are linked only with Serono-Merck-sub-network; a more comprehensive analysis will be carried out during the 2009 cooling season, when the GLN sub-network will be also operative, when all the necessary parameters for determining with insurance a quantitative thermal impact will be available.

The follow-up methodology of this large cooling and heating installation has been precisely established: the monitoring will be conducted during 5 years, in accordance with CONCERTO European projects: it will enable to study a lot of environmental aspects on the lake sub-system, and the energy benefits for the buildings, from a "building level" to a district level.

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