NEWSLETTER

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New generation of intelligent efficient District Cooling systems

Inside

INDIGO is now on the home straight, being 2019 the last year of the project.

There have been technical difficulties, but the project is progressing well and we expect to reach the expected results.

In 2018 the Consortium has had two technical meetings, one involving the participation of the External Advisory Board, who always give us excellent counsel.

This year INDIGO also organized a networking and collaborative workshop with several EU funded projects in the area of District Heating and Cooling, growing and consolidating the cluster in district energy research that we have created along the project's life.

Figure 1. Sustainable Places 2018

Figure 2. Consortium in Basurto Hospital

Activities

- INDIGO DC Planning Tool is an open source tool that supports the design of new District Cooling Systems (DCS).
- INDIGO DCOL is an open source library with parametric thermo-fluid dynamic models of DCS components.

1. Publications:
   Tools for Planning Energy Efficient District Systems. VTT. Proceedings 2018, 2(15), 1132.
2. District Energy Systems: a collaborative exchange of results on planning, operation and modelling for energy efficiency. R2M, NUIG, VTT. Proceedings 2018, 2(15), 1127.
3. Integrated Energy Modelling to Support District Cooling Optimisation: Methodological Approach. R2M, NUIG, TEK. Proceedings BSA 2017, 325.

- Organization of a workshop with EU funded projects in DHC, during the conference Sustainable Places 2018. R2M, VTT, NUIG. 28/06/18 Aix-les-Bains, France.

Project facts

Project Type: Research and Innovation Action — Start Date: March 2016

Call: H2020-EE-2015-2-RIA — Budget: €2.229.321,25 — Duration: 42 months

Results

Building Model Predictive Controller

The developed building Model Predictive Controller (MPC) aims at minimising the energy consumption at building level while maintaining thermal comfort. To do this, MPC relies on simplified models of the building and an element that calculates the optimal set-point for the building systems. This optimisation element will use a simplified model of the building to compute the control signals of heating, ventilation and air conditioning (HVAC) system that should lead to the lowest energy expenditure while maintaining comfort constrains. This process is illustrated in Figure 1. In the case of INDIGO, the control signals are the temperature and relative humidity (RH) of the air that is supplied to the various zones.

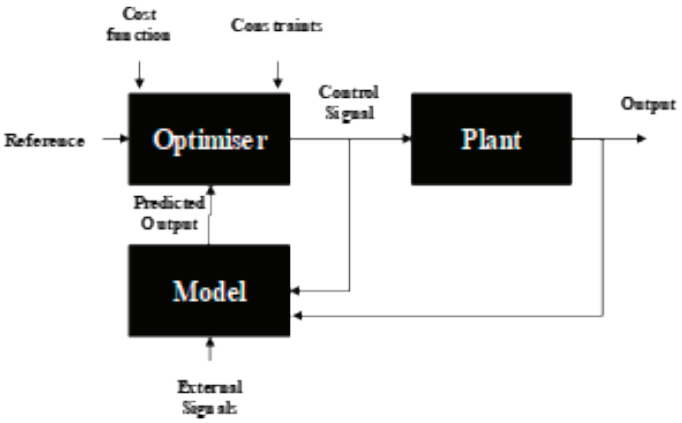

Figure 3. General Diagram of a MPC.

The MPC was developed and tested in a Matlab/Simulink environment that represents the test site. Simulations last 28 days in summer (June-July) with the constraints described in Table 1.

Table 1. Constraints imposed in the MPC problem.

Ideal room temp. (t_i)	21.5°C	Ideal room RH (rh_i)	50%
Max. room temp. (t_{max})	24°C	Max. room RH (rh_{max})	55%
Min. room temp. (t_{min})	20°C	Min. room RH (rh_{min})	45%
Max. supply temp. ($t_{t,max}$)	27°C	Max. supply RH ($x_{rh,max}$)	65%
Min. supply temp. ($t_{Xt,min}$)	21°C	Min. supply RH ($x_{rh,min}$)	45%

The MPC is compared to a standard controller (PID in this case). The MPC is evaluated using two scenarios:

- Low comfort setting: Here, the MPC is set to give priority to energy savings over to comfort constrains. This means that while the controller will strive to maintain comfort conditions it will not be too strict when small deviations over comfort conditions occur as long as the energy consumption is minimised. This configuration yields savings of around 62% in the cooling energy and 26% in the heating energy compared to the PID controller. However, notice that MPC achieves an average room temperature close to the ideal temperature but the room RH is far from the ideal.
- High comfort setting: Here the MPC give the highest priority to maintain the comfort constrains at the expense of consuming more energy. In this case the controller will first attempt to achieve control conditions and once these are met, it will attempt to minimise energy consumption. This configuration achieves room temperatures and RH close to the ideal ones at the expense of having a slightly larger energy consumption than the PID controller.

  One remark to make is that the RH has a big impact in the overall energy consumption of the building, thus, better strategies for RH control should be investigated, e.g. wider range for RH.

Table 2. MPC and PID results for 28 days between June and July

	Standard Controller	*INDIGO Controller (MPC)*	
		Low Comfort	**High Comfort**
Cooling energy (kWh)	14,227	5,286	15,063
Heating energy (kWh)	9,234	6,759	11,942
Average temperature (°C)	21.47	22.54	22.6
Standard deviation of the temperature (°C)	0.2	0.95	0.89
Average RH (%)	52.31	57.23	48.57
Standard deviation of the RH (%)	3.7	6.92	2.82

Interview to R2M

R2M Solution is an integrated and multi-disciplinary consulting company that aggressively targets filling the gap between research activities and market implementation. We excel at helping companies grow and acting as an accelerator for bringing technologies and services to the market across the fields of Innovation Management, Engineering, Energy, and ICT/Automation. We invest in opportunities, conduct research, and offer pure engineering, energy services, and ICT consulting services. We actively seek spinoff creation opportunities, showcase promising technologies and build clusters for their uptake.

https://www.r2msolution.com

- Role in the Project:

Our role in the project is both technical and non-technical.
From the technical point of view, we are developing dynamic energy models of the buildings. In particular, we are dealing with the model of the cooling demand from the point of view of the building envelope. Additionally, we are testing the district cooling planning tool developed by VTT on Italian case study.
On the other hand, R2M is the WP Leader for Communication and Dissemination activities, as well as for Exploitation activities. In order to really improve DC systems, we think it is fundamental to have a clear exploitation vision of the results of INDIGO in order to prevent these ideas to die at the end of the project. We also believe that communication and dissemination are a fundamental part of the project to make our results and ideas replicable and improved.

Andrea Costa

COO and Co-Founder of R2M Solution
Exploitation Manager in INDIGO

- Why is DC interesting for R2M?

We think that DC can be very useful and interesting in the South-European countries (where R2M has branches in Italy, Spain and France), because in these coubntries the summers are often very hot, but the DC systems are not developed completely yet. Furthermore, they are still rare.
DC systems can facilitate the integration with renewable energy sources, or through absorption chillers they can exploit the rejected heat that otherwise would be wasted.
Moreover, we think that synergies with companies that now deal with district heating could be developed.

- Expectations from INDIGO:

R2M wants to create a knowledge network with partners from other countries that work in the same fields, which are the energy efficiency and energy modeling for the building energy performance evaluation.
Moreover, we believe that there are great opportunities for the DC market and, therefore, we consider INDIGO a great opportunity for the development of the company. Additionally, Veolia is the biggest ESCO in Italy and is quite interested in assessing the results of the DC planning tool application which we are working on.

Interview to CSEM

Centre Suisse d'Electronique et Microtechnique, is a private, non-profit Swiss organisation for applied research, with its origins in research for the watch industry. CSEM has as mission supporting Swiss and European industry with research and innovation, and is a recognized RTO. CSEM's activities include technology, strategy and innovation consulting. It excels in technology transfer to small and large companies, focused on generating lasting value for a sustainable world. It also has a large experience and excellent track record in establishing successful start-ups.
https://www.csem.ch/

STAUFFER Yves

Senior R&D engineer
Yves has joined CSEM in 2010 and has worked and/or managed numerous projects linked to building and/or district heating and/or cooling optimization. In INDIGO he is in charge of managing the DC at building level.

CARRILLO Rafael

Senior R&D engineer
Rafael has joined CSEM in 2016 and has worked on numerous projects applying machine learning and optimization techniques to the development of energy management systems. In INDIGO he is in charge of developing the intelligent controllers at building level.

- Why is DC interesting for CSEM?

Cooling through district cooling (DC) networks is interesting because the problem of cooling buildings, as well as remote heating, is becoming more and more obvious in Europe. In this sense, it is important to develop methods that will reduce the energy consumption of these networks while optimizing the thermal energy consumption of buildings. CSEM wants to extend its expertise developed in building energy management to the energy management of DC systems, now that buildings are increasingly connected to these cold networks. In addition, as the energy drawn from DC will increase, such networks will face similar challenges as the electric networks. This topic is also of importance for CSEM.

- Expectations from INDIGO:

The main goal for CSEM is to extend the skills developed in the energy management of buildings, based on predictive control techniques, already extended at the level of heating networks. Additionally, the work that CSEM is going to develop will enable us to put in place a whole management system of the cold networks, making it possible to increase the efficiency of such networks with the technical systems that the other partners will implement within INDIGO.

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