

USING REMOTE CONTROL SYSTEMS FOR THE RE-COMMISSIONING OF HEATING PLANTS OF SCHOOL BUILDINGS

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Summary. The objective of this work is to develop a semi-automatic commissioning tool that can be implemented in Remote Control Systems to help building operators test the performance of heating plants in school buildings. The work was carried out with the city of Paris and the tool was adapted to the requirements of end-users who are operating more than 700 schools. This semi-automatic commissioning tool could help to reduce costs and time for commissioning tasks of a large number of buildings. It also helps to improve the commissioning process, to have a whole building functional testing approach and make the commissioning procedure available for different users with different skills.

This work was carried out as part of an IEA Annex 40 research project, an international research group focused on energy saving technologies and activities that support their application in practice.

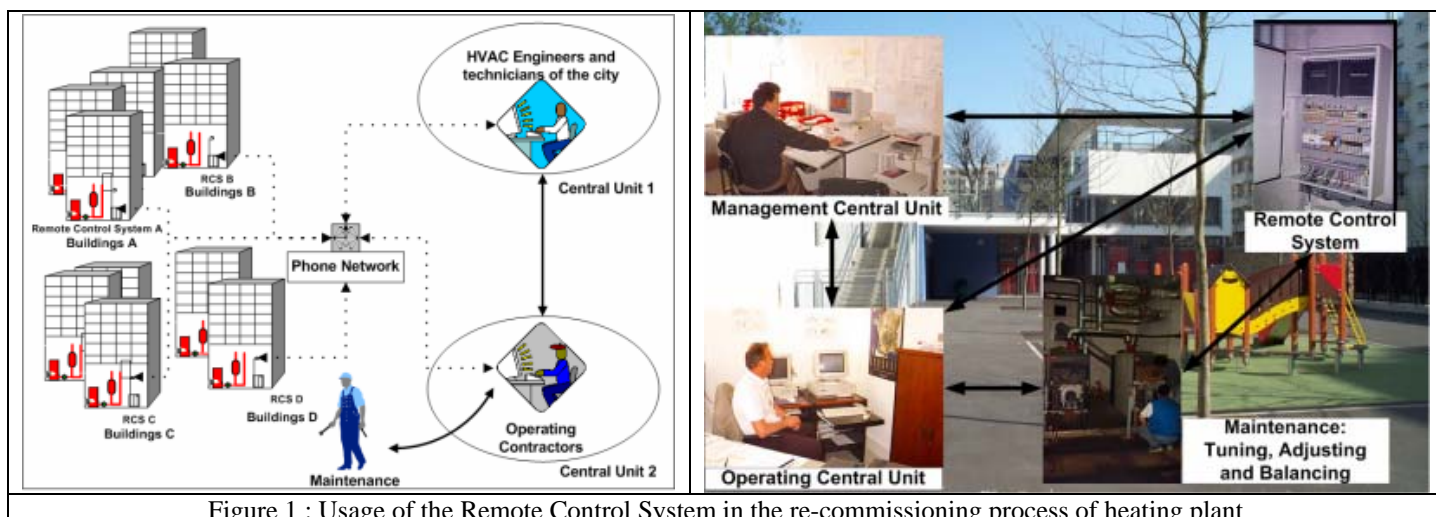
Keywords: automated commissioning, school building, remote control systems, graph technology, performance index

INTRODUCTION

The improvement of the performance of school heating plants in the city of Paris started in the mid- 1980s. At this time the city started to modernize heating plants and to install Remote Control Systems (RCS). The RCS help the HVAC engineers and technicians of the city of Paris to supervise heating facilities from central units (installed in the office of the HVAC engineers and technicians of the city) and via the phone network [2]. Today one third of the 700 educational establishments are equipped with RCS and connected to the central units. The city of Paris uses the RCS mainly for detecting failures of heating equipment (boilers, pumps, district heating systems, etc.) that are transmitted to the central units (Alarm Function of RCS). They are generally not using the available measurements of the RCS to analyse the performance of the heating facilities.

The aim of our project is to develop, validate and document a semi-automatic re-commissioning tool that uses the RCS measurement capabilities for analysing the performance of large numbers of heating plants and assisting the operator in diagnosing the defects that cause the faulty process operation. The term "semi-automatic" instead of "automatic" tool is used in this paper because the tool only provides graphical information that requires additional analysis and action on the part of the user of the tool. This tool can help the engineers and technicians of the municipality to select the buildings with low performance and to start the improvement process (Figure 1):

- Tune and adjust the control parameters
- Send maintenance team to verify, adjust, repair and balance equipment
- Develop refurbishment program for heating plants



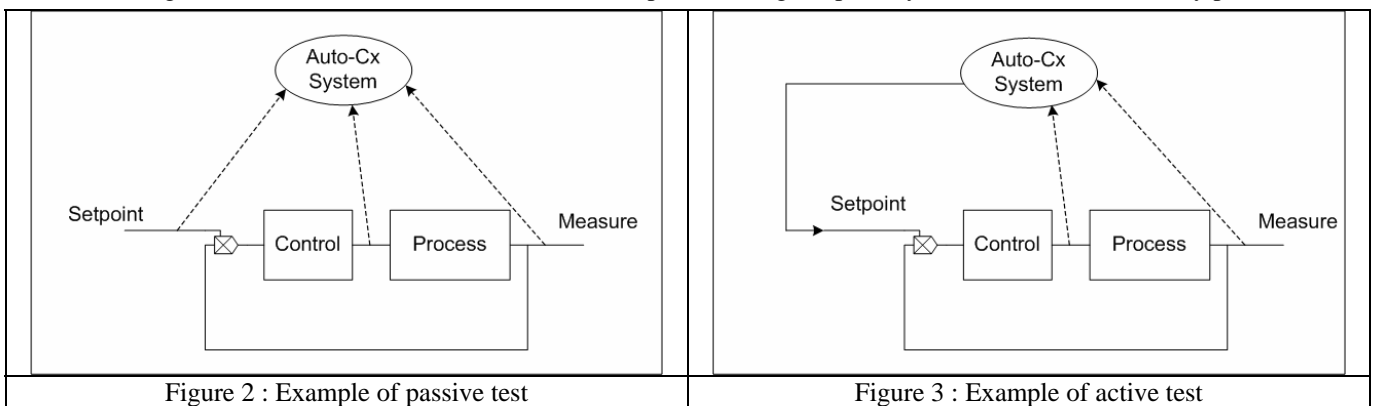
DESCRIPTION OF THE APPROACH

Our approach for the development of the semi-automatic commissioning tool was guided by the answers to the main questions and the definition of the main criteria that are present in the following.

- o Who is going to use the tool: the HVAC engineers and technicians of the city of Paris?

They usually have a good knowledge of heating plants, but they have little time to devote to the analysis of heating plants performance. They usually prefer graphical presentations that help them to analyse phenomena and decide by themselves about the need for specific actions.

- What are the main difficulties of end-users in the field of commissioning?
 The main difficulty encountered by the HVAC engineers and technicians of the city of Paris is linked to the number of buildings they must manage. The number of data that can be collected daily is huge. The main difficulty is to find a good balance between the time spent to examine these data and the improvement in energy consumption and comfort which can be achieved from this examination.
- For what type of commissioning approach (initial, re or ongoing commissioning) will the automatic tool be designed?
 The tool is mainly designed for re-commissioning, but it could be used during ongoing-commissioning or initial commissioning.
- For what type of building and HVAC systems is the automatic tool designed?
 The tool is designed for medium sized buildings with simple HVAC systems, specifically for school buildings with hydronic heating systems. The buildings are equipped with Remote Control Systems. We have access to a limited number of measurements (number of variables and sampling period are both limited) for the commissioning tests, so detailed diagnostic information can not be expected.
- Are we going to use passive or active commissioning tests?
 The tool uses only passive tests (only observation of the heating plant data without any action, Figure 2) to evaluate the performance of the facilities. The end-users did not want to use any active tests (action on heating plant and observation of the results, Figure 3) that could create disturbances in occupied buildings, especially when actions are remotely performed.



- The implementation level of the automatic commissioning tool and the communication mode with the control system
 The tool is implemented at the Remote Management Level (see Figure 4) and uses data logging files of the RCS.

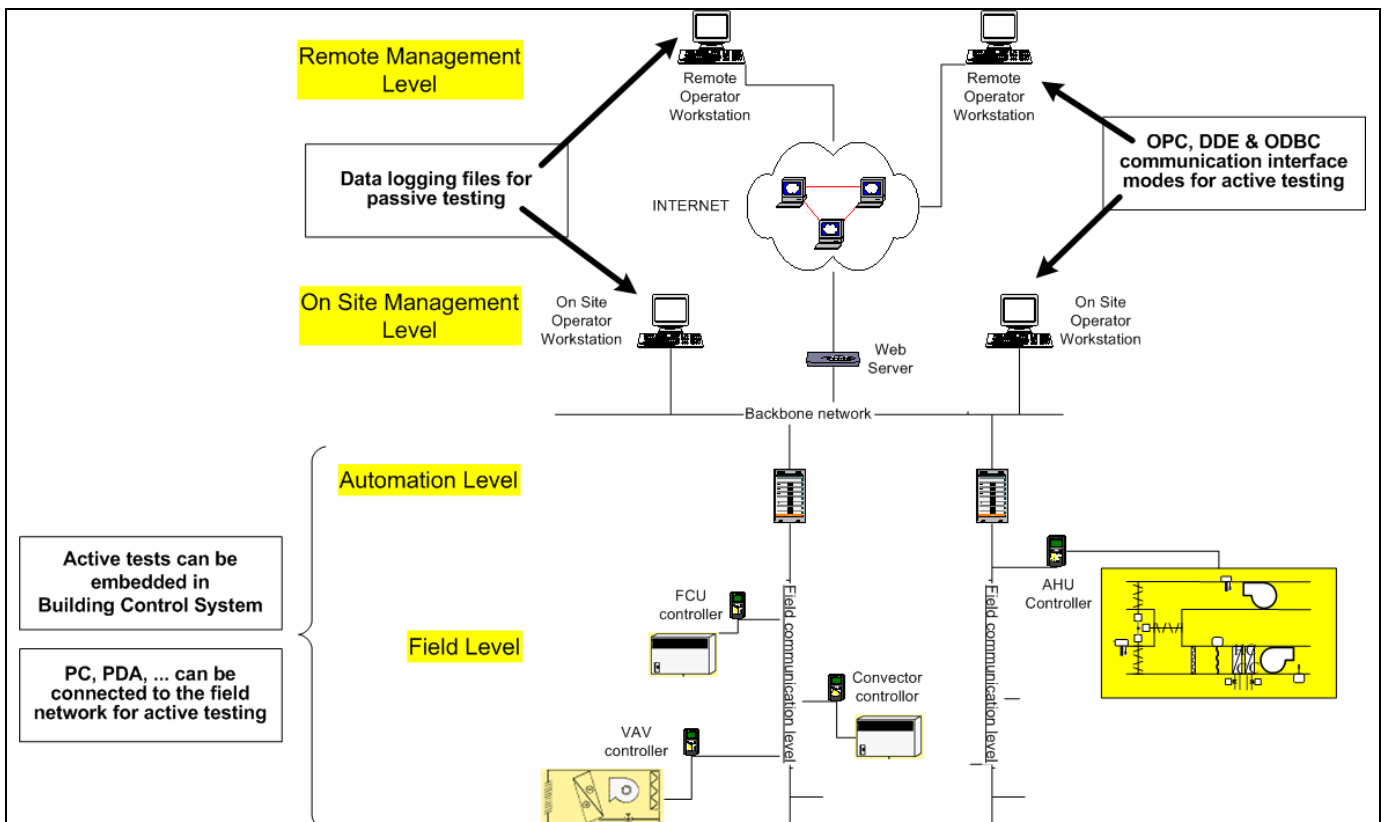


Figure 4 : Architecture of BEMS (Building Energy Management System) with the possible level of implementation of automatic commissioning tools and mode of communication with the control system

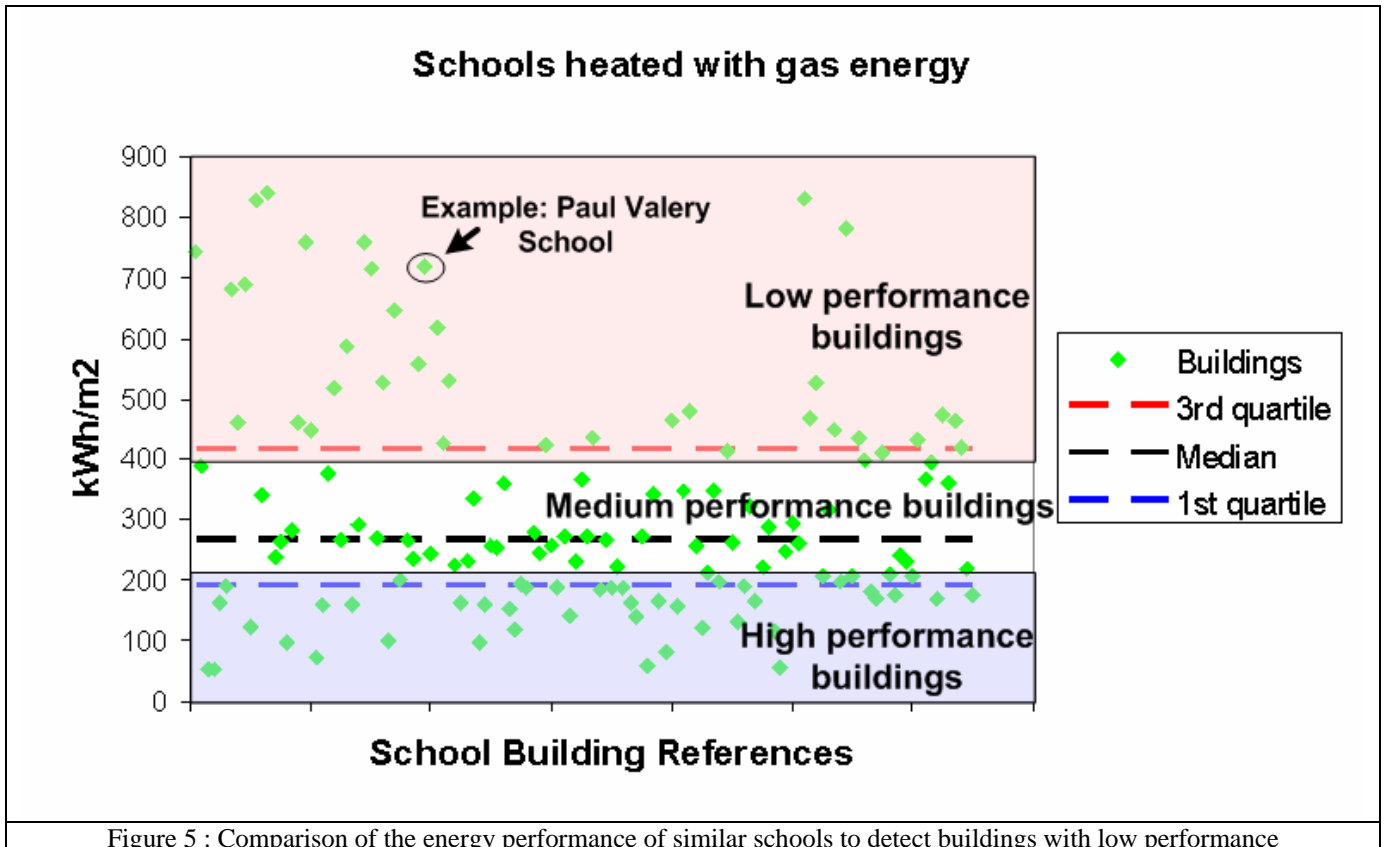
- o The method for detecting equipment with poor performance and for commissioning heating plant

Various types of methods have been considered in Annex 40, including: model-based, expert rules, graph technology, functional test sequences, and performance index. Some of the methods were also evaluated as part of IEA Annexes 25 and 34 [1, 3 & 5]. We mainly used in our re-commissioning tool the graph technology [4] and performance index in order to meet the requirements of end-users who are usually HVAC experts and who only need a tool that can assist them in their own diagnostics.

DESCRIPTION OF THE TOOL

Ecole-Cx is the software developed to help validate the methods for re-commissioning heating plants of school buildings. The software imports the data logging files of the RCS for analysing the performance of school buildings. It also needs characteristic parameters of the school: annual energy consumption, schools size, etc.

A first module helps the user screen for schools with abnormal energy consumption, for which a detailed investigation of the heating plant is justified. This module [6] compares the energy consumption per square meter of similar schools and separates the schools into groups with low, medium and high energy use. This is shown graphically in Figure 5.



The next phase will be to carry out detailed investigations of the “low performing” schools in order to detect and diagnose faults, and to attempt to improve the performance of the heating plants. The software gives the users access to three main groups of tests:

- Energy Consumption and Comfort
- Sizing and Balancing
- Control and Automation

In each main group of tests, adapted graphs or tables help users assess the building performance in terms of the comfort or energy consumption, the sizing and balancing of the heating plant, and the adjustment and tuning of control and automation systems (Figure 6).

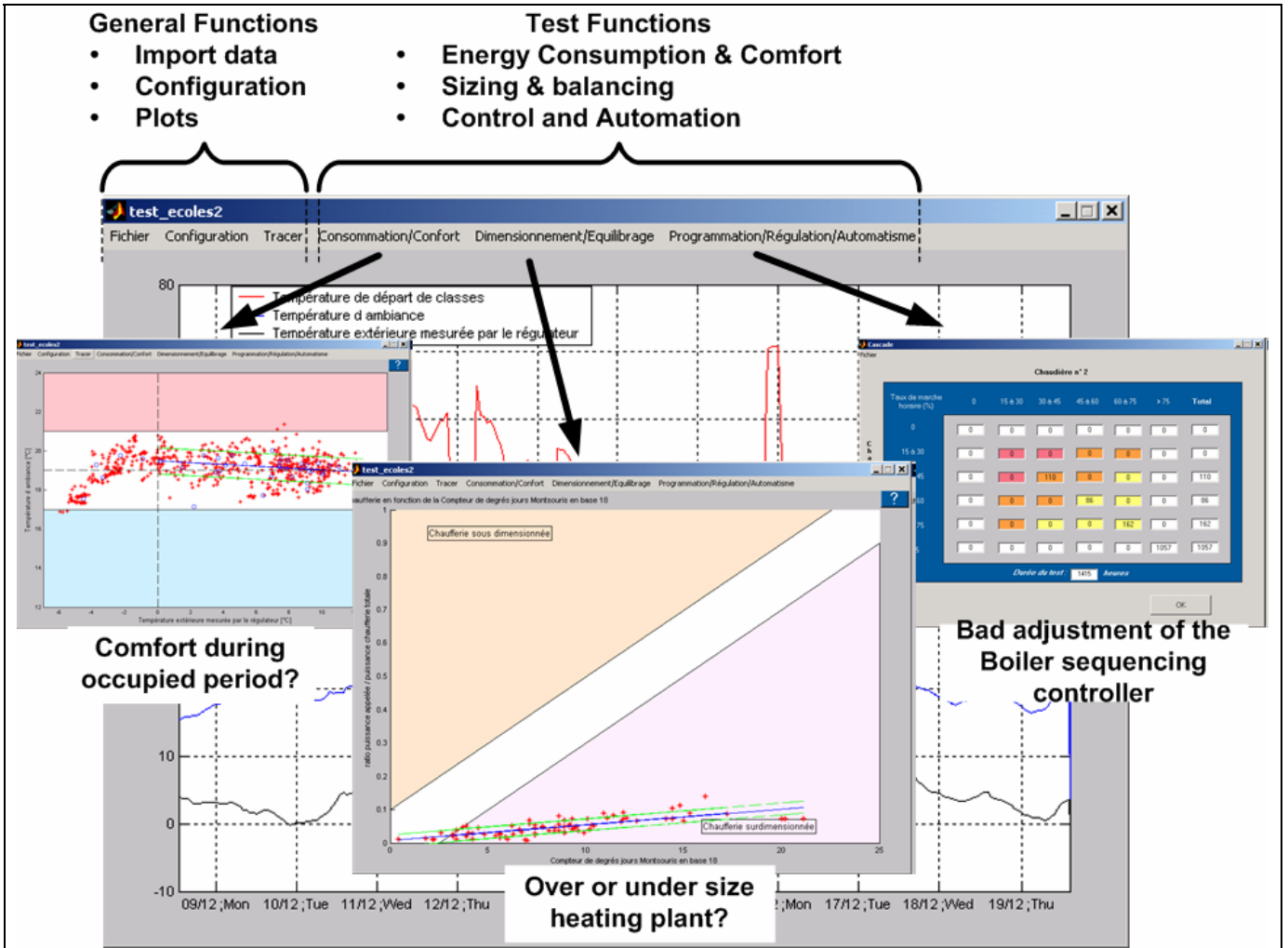


Figure 6 : The re-commissioning software contains different test modules to help the users to decide about the performance of comfort, energy consumption, sizing, balancing and control systems

We also tried to develop modules that assist the users in the adjustment of control systems: proposition for the adjustment of heating curve. First, the tool helps to visualise and to estimate the heating curve characteristic (Figure 7) and then a second function calculate the optimal heating curve for the building according to the inside and outside measured temperatures (Figure 8).

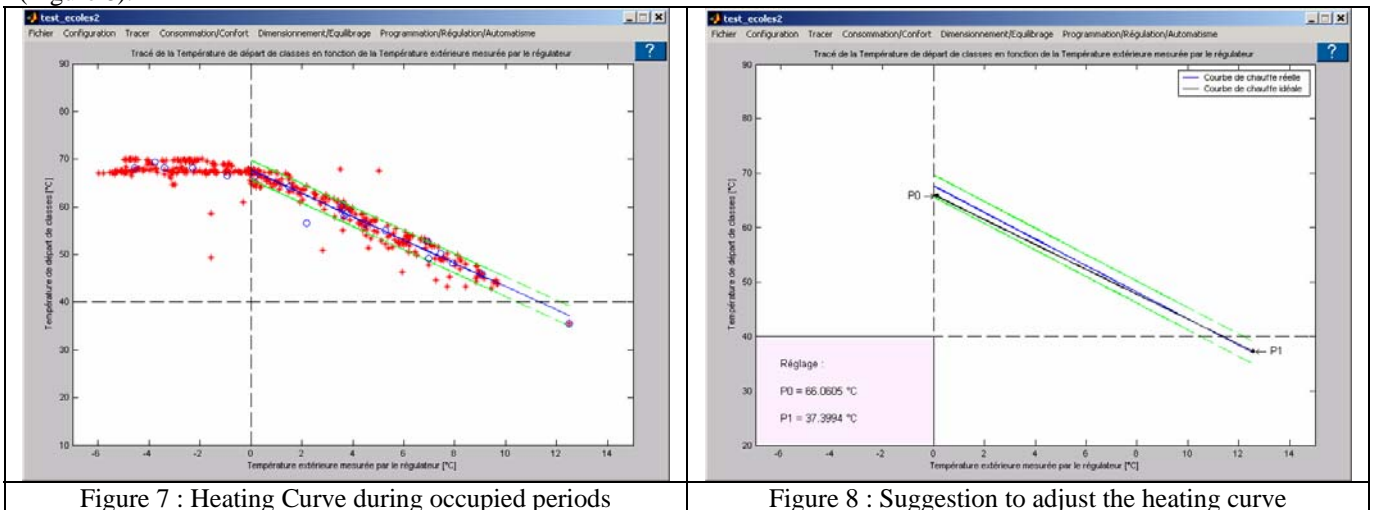


Figure 7 : Heating Curve during occupied periods

Figure 8 : Suggestion to adjust the heating curve

CONCLUSIONS AND DISCUSSIONS

A semi-automatic re-commissioning tool that can help users improve the performance of heating plants of school buildings has been developed in collaboration with, and for, the city of Paris. The first reason to develop an automatic commissioning tool was to fulfill the requirement of professionals in this field to reduce costs and time necessary for commissioning. But in the process of developing the re-commissioning tool, other important reasons to develop such tools were identified:

- To improve the quality of the commissioning process with the help of automatic and systematic procedures.
- To do commissioning of systems or whole buildings (and not only specific equipment) that needs to take account of important number of parameters.
- To make commissioning procedures available for different users with different skills.

The semi-automatic tool that we have developed for the HVAC engineers and technicians of the city of Paris has the following main advantages:

- It is adapted to the commissioning of a large fraction of the buildings managed by the city, specifically schools heated with gas-fired boilers
- It could assist in the re-commissioning of a large number of buildings with low investment
- The implementation and use of the commissioning tool is relatively easy and is adapted to the skill and requirements of end-users

Its main disadvantages are that:

- Detailed diagnostic is difficult with this approach because with the RCS we have access to a limited number of measurements (number of variables and sampling period are both limited) for the commissioning tests
- The commissioning process with the help of RCS increases the telecommunication data flow rate

The next steps to make the tool easier to use and facilitate its dissemination would be to integrate it with the supervision software of the RCS. This task could comfort the end-users who are used to working with the RCS supervisor and are reluctant to learn new software.

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