ECBCS Annex 47: Cost-Effective Commissioning Research

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ABSTRACT

In 2005, the Executive Committee of the International Energy Agency's (IEA) Energy Conservation in Buildings and Community Systems (ECBCS) program approved the start of a new four-year research project on building commissioning. Annex 47, on "Cost-Effective Commissioning for Existing and Low Energy Buildings" is an international research project involving twelve countries.

Early results include 1) the detailed workplan, 2) guidance documents for performing functional tests of advanced systems and conventional systems and 3) a standardized cost-benefit methodology. This paper presents an overview of the international research plan for 2006-2008, based on the participant work plan, and presents the important research effort to obtain and document the energy savings and non-energy benefits of commissioning new and existing buildings using international projects. Project managers, building owners and researchers are invited to contribute to this study.

KEYWORDS

Annex 47, Cost-effective, commissioning, methodology, low energy buildings

BACKGROUND

Energy consumption in residential, commercial, and public buildings presents a major demand on energy resources, representing approximately one-third of end-use energy consumption in IEA member countries[1]. This energy demand creates congestion in distribution systems, and is a significant component of total emissions.

In an effort to address this growing problem, the ECBCS program of the IEA has supported projects to improve the energy efficiency of buildings. The first IEA ECBCS commissioning project, Annex 40 on "Commissioning of Building HVAC Systems for Improved Energy Performance", developed methods and tools to ensure that heating, ventilating and air conditioning (HVAC) components/systems reach their design potential and operate energy-efficiently. Visier et al. (2005) clarified the commissioning process on an international basis and developed tools that focused on functional testing and end use.

[1] IEA member countries: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Luxembourg, The Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, and the United States.

Currently, documented commissioning methods are limited to conventional HVAC systems and do not address the advanced systems and system combinations that are important for low energy buildings. There are significant technological and market barriers that must be overcome. These systems, including integrated control of lighting, blinds and HVAC, and cooling techniques such as evaporative cooling and natural ventilation, will likely have reduced performance in the field unless suitable methods and tools are available to ensure the correct interactions. This is the focus of the second ECBCS commissioning annex, a four-year, international research project on "Cost-Effective Commissioning for Existing and Low Energy Buildings".

THE ANNEX 47 PROJECT

The goal of Annex 47 is to enable the effective commissioning of existing and future buildings in order to improve their operating performance. The commissioning techniques under development through this research will push industry's transition from the intuitive approach for building operation to more systematic operation that focuses on achieving significant energy savings. This work builds on other on-going private and public sector efforts to make this transition. The Annex will also collect the scattered data on the cost and benefits of commissioning that is needed to make the case for commissioning, exchange information on commissioning (quality assurance) practices in different countries, and disseminate relevant information to national practitioners. The workplan objectives and scope, which are summarized below, are described in more detail at the Annex 47 website http://www.iea-annex47.org/.

Annex 47's objectives are to:

- Extend methods and tools to address advanced/low energy buildings systems,
- Automate the commissioning process to the extent practicable,
- Develop methodologies and tools to improve operation of buildings in use, and
- Quantify and improve the costs and benefits of commissioning.

Table 1 presents the workplan to apply engineering principles to the operation of buildings with the specific energy-saving goals, rather than as a possible side effect.

Table 1
Annex 47 Structure (from workplan)

Scope of Annex	**Research Areas**
1) What can be done for future buildings to enable cost-effective commissioning?	**Initial Commissioning of Advanced & Low Energy Building Systems**
	•Develop information flowchart and information model •Develop general commissioning methodology for advanced & low energy buildings –Functional test procedures –Case studies –Control strategies for advanced systems
2) What can be done for existing buildings?	**Commissioning and Optimization of Existing Buildings**
	•Develop data visualization, field optimization, commissioning tools •Perform and disseminate documented case studies
3) How can the cost-benefit situation of commissioning be represented?	**Commissioning Cost-Benefits and Persistence**
	•Develop cost-benefit methodology •Develop methodology & tools to enhance persistence •Develop international databases on Commissioning cost-benefit & Persistence

Twelve countries have been active in the Annex 47 project since its beginning, and national interest groups have also been established in several countries (*): Belgium, Canada*, the Czech Republic, Finland, France*, Germany, Hungary, Japan*, the Netherlands, Norway*, Sweden, and the USA*.

In these countries, the market for commissioning is at various stages of development. For several countries, the Annex 40 project was one of the first exposures to the commissioning process, and international methods for quality assurance had to be combined to form the international definition of commissioning. This is defined internationally as:

> *Commissioning: Clarifying Owner's Project Requirements (OPR) from viewpoints of environment, energy and facility usage, and auditing and verifying different judgments, actions and documentations in the Commissioning Process (CxP) in order to realize a performance of building system requested in the OPR through the life of the building.*

Although most countries have established mechanisms for quality assurance, it is universally recognized that the current approaches are not adequate for ensuring that buildings operate as intended. The international efforts have accelerated in the past 3-4 years. A sample of the national efforts to advance the commissioning process is presented below. A more complete discussion was presented by Castro and Choiniere (2006) at the National Conference on Building Commissioning.

- Promoting the implementation of the whole commissioning process, establishing national guidelines/requirements (e.g., Canada, Finland, France, Germany, Japan, the Netherlands, Norway, the USA)
- Establishing demonstration projects for commissioning tools (Various)
- Establishing building certification programs as a way to promote energy efficiency and standardizing testing requirements (e.g., France, Germany, Japan, the USA)
- Advancing research in building optimization and intelligent control for low-energy buildings (e.g., the Czech Republic, Finland, Hong Kong/China)

COMMISSIONING BENEFITS AND BARRIERS

The commissioning process can be applied to new construction projects or existing buildings and systems. In new construction commissioning, the commissioning provider works with the building owner and the project team throughout the construction process to ensure the owner’s goals are met. In existing building commissioning, or “retrocommissioning,” the provider reviews operational practices, analyzes energy use, and tests building equipment and systems in order to identify cost-effective improvements.

Both commissioning and retrocommissioning result in significant benefits for building owners, occupants, operations staff and the many participants in the construction process. Energy benefits include overall reduced energy use and may include reduced energy use during peak demand periods. The financial benefits from reduced energy use can be significant and flow through the owner’s balance sheet

resulting in improved net operating income and increased asset value. The most comprehensive study of commissioning benefits to-date, Mills et al. (2005), found median total energy savings of 15 % in existing buildings.

Non-energy benefits from commissioning are diverse. In new buildings they include improved coordination among team members, a greater likelihood of meeting project deadlines, reduced change orders, and a smoother turnover process resulting from the early identification and correction of building deficiencies. In existing buildings, retrocommissioning can improve indoor air quality and comfort, extend equipment life, and increase the capabilities and expertise of operations and maintenance staff. While the non-energy benefits of commissioning are harder to quantify than the energy benefits, they are acknowledged as increasingly important. The California Commissioning Collaborative (2006), in its *Guide to Commissioning* for new and existing buildings, discusses the importance of building health and comfort in contributing to occupant productivity, tenant retention and liability reduction.

Commissioning is increasingly recognized for its contributions to low energy and "green" buildings. The U.S. Green Building Council, for example, requires commissioning in order to certify both new and existing projects under its Leadership in Energy and Environment Design (LEED) standard. As a quality assurance process, commissioning helps to ensure that a building's innovative systems will work as intended. Evidence emerging from the Torcellini et al (2004) study of LEED-certified buildings performed by the U.S. National Renewable Energy Laboratory and the Fisch and Plesser (2005) European study strongly suggests that commissioning to optimize operation based on actual occupancy and use is even more critical for these low energy buildings than for conventional buildings.

As an energy conservation measure, commissioning produces all the environmental and social benefits associated with reduced carbon emissions. In addition, the economic benefit from the widespread adoption of commissioning should not be underestimated. One study, Mills (2005), projected the potential savings to building owners could reach $18 billion per year, or more, in the USA alone.

At present, commissioning has low market penetration and faces both technological and process barriers that must be addressed. It is generally recognized that demonstrating cost-effectiveness, including the persistence of commissioning measures, will remove a major barrier to the wider market acceptance of commissioning. Annex 47 has launched a project to document the energy savings and non-energy benefits of commissioning new and existing buildings. This international data collection effort is the first of its kind, and is designed to collect detailed, building-specific information that can be used to convince owners to undertake commissioning and to assist government policy-making.

Contribute to the Commissioning Cost-Benefit Data Collection Project

The Commissioning Cost-Benefit Data Collection Project will document the energy and non-energy benefits of commissioning projects from around the world. An online survey form allows commissioning providers, building owners and researchers to easily submit their data. All information, with the exception of items designated as

confidential, will be publicly available. The project is designed to address the specific needs of commissioning providers and government policy makers, and it is expected that both parties will find this online database a useful source of information.

The goal for 2007 is to collect data on at least 30 new and existing building projects. Several countries (including the USA, Germany, Hungary, Norway, Canada, France, Japan, Czech Republic, and Sweden) have already committed to submitting project information, but more is needed to establish a useful database.

We invite you to submit your project data by filling out a survey form. There are two levels of detail that can be provided:

- *Whole-building data*: takes less than 2 h to complete
- *Measure-level data:* takes 4 h to 8 h to complete

The survey form requests detailed project information and is intended to be completed by someone familiar with the project.

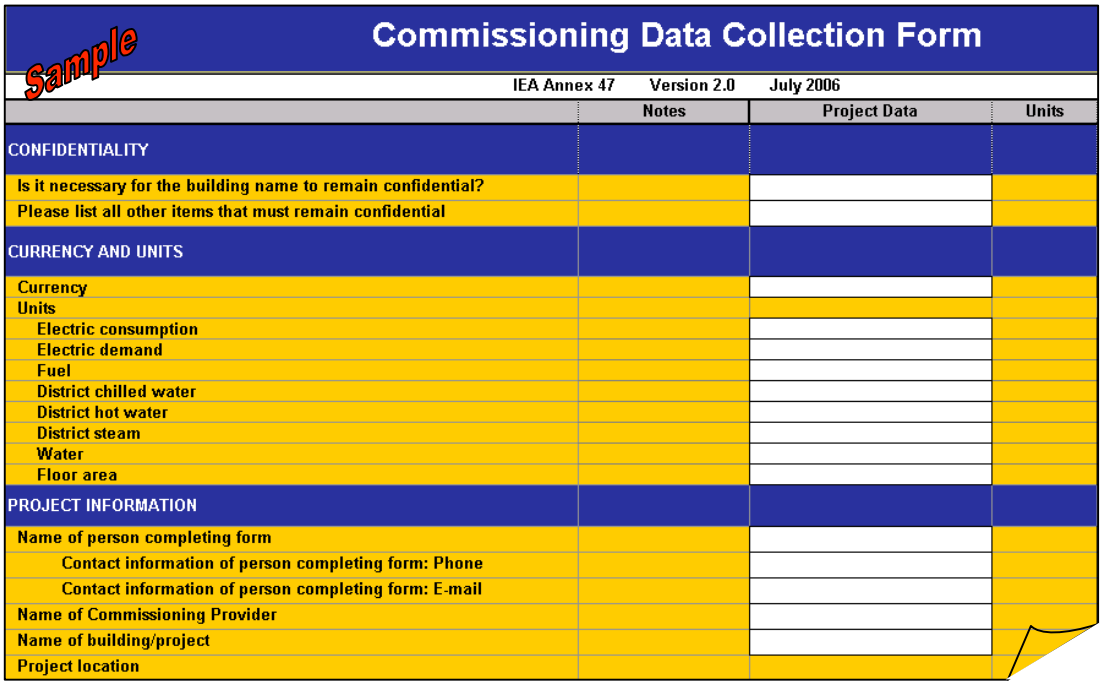

Figure 1: Sample Commissioning Data Collection Form

At the whole-building level, the survey has five sections:

- "Project Information" refers to general project information (i.e., building type, year constructed, and the phase in which commissioning began).
- "Technical Information" collects a greater level of detail about the commissioning process and the issues discovered.
- "Cost Data" asks about the various costs of the project.
- "Energy Benefits" focuses on fuel costs and energy savings from the project.
- "Non-Energy Benefits" inquires about the benefits achieved and whether they were quantified.

At the measure-level, the user is asked to supply details about the project's significant findings, defined as those whose cumulative energy savings together represent at least 80 % of the project's total energy savings. This includes 1) a short

description of the issue, 2) the system affected, 3) the recommended fix and whether it was implemented, and 4) the estimated savings and estimation approach.

More information about this project, and the survey form, are available at: http://cetc-varennes.nrcan.gc.ca/en/b_b/bi_ib/annex47/dp_pd/pd_dcp.html.

CONCLUSIONS

The Annex 47 national teams have evaluated the barriers to commissioning in their respective countries and together have developed a workplan to remove these barriers, with the goal of making building commissioning standard practice. It is recognized that this quality assurance process can improve energy efficiency in buildings and improve user comfort in any building, and that it is even more critical for buildings using innovative and low-energy systems.

In general, there is a lack of consolidated data from actual cases on the cost and benefits of commissioning to show how and when commissioning is cost-effective. This data would effect an increased market penetration and result in the realization of the energy, economic, environmental, and other benefits that are associated with the commissioning process.

The Annex 47 team has undertaken the task of collecting this information for use in a publicly available database. Commissioning providers, project managers, building owners and researchers are invited to contribute their case studies to this international database.

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