ANNEX **86**

EBC

Energy in Building and Communities Programme

D3 – Appendix 7: ST4 – Results of the survey on inspection. January 2025

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Participating countries in the EBC: Australia, Austria, Belgium, Brazil, Canada, P.R. China, Czech Republic, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Republic of Korea, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, Turkey, United Kingdom and the United States of America.

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Preface

The International Energy Agency

The International Energy Agency (IEA) was established in 1974 within the framework of the Organisation for Economic Co-operation and Development (OECD) to implement an international energy programme. A basic aim of the IEA is to foster international cooperation among the 30 IEA participating countries and to increase energy security through energy research, development and demonstration in the fields of technologies for energy efficiency and renewable energy sources.

The IEA Energy in Buildings and Communities Programme

The IEA co-ordinates international energy research and development (R&D) activities through a comprehensive portfolio of Technology Collaboration Programmes (TCPs). The mission of the IEA Energy in Buildings and Communities (IEA EBC) TCP is to support the acceleration of the transformation of the built environment towards more energy efficient and sustainable buildings and communities, by the development and dissemination of knowledge, technologies and processes and other solutions through international collaborative research and open innovation. (Until 2013, the IEA EBC Programme was known as the IEA Energy Conservation in Buildings and Community Systems Programme, ECBCS.).

The high priority research themes in the EBC Strategic Plan 2019-2024 are based on research drivers, national programmes within the EBC participating countries, the Future Buildings Forum (FBF) Think Tank Workshop held in Singapore in October 2017 and a Strategy Planning Workshop held at the EBC Executive Committee Meeting in November 2017. The research themes represent a collective input of the Executive Committee members and Operating Agents to exploit technological and other opportunities to save energy in the buildings sector, and to remove technical obstacles to market penetration of new energy technologies, systems and processes. Future EBC collaborative research and innovation work should have its focus on these themes.

At the Strategy Planning Workshop in 2017, some 40 research themes were developed. From those 40 themes, 10 themes of special high priority have been extracted, taking into consideration a score that was given to each theme at the workshop. The 10 high priority themes can be separated in two types namely ‘Objectives’ and ‘Means’. These two groups are distinguished for a better understanding of the different themes.

Objectives: The strategic objectives of the EBC TCP are as follows:

- reinforcing the technical and economic basis for refurbishment of existing buildings, including financing, engagement of stakeholders and promotion of co-benefits;
- improvement of planning, construction and management processes to reduce the performance gap between design stage assessments and real-world operation;
- the creation of ‘low tech’, robust and affordable technologies;
- the further development of energy efficient cooling in hot and humid, or dry climates, avoiding mechanical cooling if possible; the creation of holistic solution sets for district level systems taking into account energy grids, overall performance, business models, engagement of stakeholders, and transport energy system implications.

Means: The strategic objectives of the EBC TCP will be achieved by the means listed below:

- the creation of tools for supporting design and construction through to operations and maintenance, including building energy standards and life cycle analysis (LCA);
- benefitting from ‘living labs’ to provide experience of and overcome barriers to adoption of energy efficiency measures;
- improving smart control of building services technical installations, including occupant and operator interfaces;
- addressing data issues in buildings, including non-intrusive and secure data collection;
- the development of building information modelling (BIM) as a game changer, from design and construction through to operations and maintenance.

The themes in both groups can be the subject for new Annexes, but what distinguishes them is that the ‘objectives’ themes are final goals or solutions (or part of) for an energy efficient built environment, while the ‘means’ themes are instruments or enablers to reach such a goal. These themes are explained in more detail in the EBC Strategic Plan 2019-2024.

The Executive Committee

Overall control of the IEA EBC Programme is maintained by an Executive Committee, which not only monitors existing projects, but also identifies new strategic areas in which collaborative efforts may be beneficial. As the Programme is based on a contract with the IEA, the projects are legally established as Annexes to the IEA EBC Implementing Agreement. At the present time, the following projects have been initiated by the IEA EBC Executive Committee, with completed projects identified by (*) and joint projects with the IEA Solar Heating and Cooling Technology Collaboration Programme by (☼):

Annex 1: Load Energy Determination of Buildings (*)
Annex 2: Ekistics and Advanced Community Energy Systems (*)
Annex 3: Energy Conservation in Residential Buildings (*)
Annex 4: Glasgow Commercial Building Monitoring (*)
Annex 5: Air Infiltration and Ventilation Centre
Annex 6: Energy Systems and Design of Communities (*)
Annex 7: Local Government Energy Planning (*)
Annex 8: Inhabitants Behaviour with Regard to Ventilation (*)
Annex 9: Minimum Ventilation Rates (*)
Annex 10: Building HVAC System Simulation (*)
Annex 11: Energy Auditing (*)
Annex 12: Windows and Fenestration (*)
Annex 13: Energy Management in Hospitals (*)
Annex 14: Condensation and Energy (*)
Annex 15: Energy Efficiency in Schools (*)
Annex 16: BEMS 1- User Interfaces and System Integration (*)
Annex 17: BEMS 2- Evaluation and Emulation Techniques (*)
Annex 18: Demand Controlled Ventilation Systems (*)
Annex 19: Low Slope Roof Systems (*)
Annex 20: Air Flow Patterns within Buildings (*)
Annex 21: Thermal Modelling (*)
Annex 22: Energy Efficient Communities (*)
Annex 23: Multi Zone Air Flow Modelling (COMIS) (*)
Annex 24: Heat, Air and Moisture Transfer in Envelopes (*)
Annex 25: Real time HVAC Simulation (*)
Annex 26: Energy Efficient Ventilation of Large Enclosures (*)
Annex 27: Evaluation and Demonstration of Domestic Ventilation Systems (*)
Annex 28: Low Energy Cooling Systems (*)
Annex 29: ☼ Daylight in Buildings (*)
Annex 30: Bringing Simulation to Application (*)
Annex 31: Energy-Related Environmental Impact of Buildings (*)
Annex 32: Integral Building Envelope Performance Assessment (*)
Annex 33: Advanced Local Energy Planning (*)
Annex 34: Computer-Aided Evaluation of HVAC System Performance (*)
Annex 35: Design of Energy Efficient Hybrid Ventilation (HYBVENT) (*)
Annex 36: Retrofitting of Educational Buildings (*)
Annex 37: Low Exergy Systems for Heating and Cooling of Buildings (LowEx) (*)
Annex 38: ☼ Solar Sustainable Housing (*)
Annex 39: High Performance Insulation Systems (*)
Annex 40: Building Commissioning to Improve Energy Performance (*)
Annex 41: Whole Building Heat, Air and Moisture Response (MOIST-ENG) (*)
Annex 42: The Simulation of Building-Integrated Fuel Cell and Other Cogeneration Systems (FC+COGEN-SIM) (*)
Annex 43: ☼ Testing and Validation of Building Energy Simulation Tools (*)
Annex 44: Integrating Environmentally Responsive Elements in Buildings (*)
Annex 45: Energy Efficient Electric Lighting for Buildings (*)
Annex 46: Holistic Assessment Tool-kit on Energy Efficient Retrofit Measures for Government Buildings (EnERGo) (*)
Annex 47: Cost-Effective Commissioning for Existing and Low Energy Buildings (*)
Annex 48: Heat Pumping and Reversible Air Conditioning (*)
Annex 49: Low Exergy Systems for High Performance Buildings and Communities (*)
Annex 50: Prefabricated Systems for Low Energy Renovation of Residential Buildings (*)
Annex 51: Energy Efficient Communities (*)
Annex 52: ☼ Towards Net Zero Energy Solar Buildings (*)

Annex 53: Total Energy Use in Buildings: Analysis and Evaluation Methods (*)
Annex 54: Integration of Micro-Generation and Related Energy Technologies in Buildings (*)
Annex 55: Reliability of Energy Efficient Building Retrofitting - Probability Assessment of Performance and Cost (RAP-RETRO) (*)
Annex 56: Cost Effective Energy and CO_2 Emissions Optimization in Building Renovation (*)
Annex 57: Evaluation of Embodied Energy and CO_2 Equivalent Emissions for Building Construction (*)
Annex 58: Reliable Building Energy Performance Characterisation Based on Full Scale Dynamic Measurements (*)
Annex 59: High Temperature Cooling and Low Temperature Heating in Buildings (*)
Annex 60: New Generation Computational Tools for Building and Community Energy Systems (*)
Annex 61: Business and Technical Concepts for Deep Energy Retrofit of Public Buildings (*)
Annex 62: Ventilative Cooling (*)
Annex 63: Implementation of Energy Strategies in Communities (*)
Annex 64: LowEx Communities - Optimised Performance of Energy Supply Systems with Exergy Principles (*)
Annex 65: Long-Term Performance of Super-Insulating Materials in Building Components and Systems (*)
Annex 66: Definition and Simulation of Occupant Behavior in Buildings (*)
Annex 67: Energy Flexible Buildings (*)
Annex 68: Indoor Air Quality Design and Control in Low Energy Residential Buildings (*)
Annex 69: Strategy and Practice of Adaptive Thermal Comfort in Low Energy Buildings (*)
Annex 70: Energy Epidemiology: Analysis of Real Building Energy Use at Scale (*)
Annex 71: Building Energy Performance Assessment Based on In-situ Measurements (*)
Annex 72: Assessing Life Cycle Related Environmental Impacts Caused by Buildings (*)
Annex 73: Towards Net Zero Energy Resilient Public Communities (*)
Annex 74: Competition and Living Lab Platform (*)
Annex 75: Cost-effective Building Renovation at District Level Combining Energy Efficiency and Renewables (*)
Annex 76: ☼ Deep Renovation of Historic Buildings Towards Lowest Possible Energy Demand and CO_2 Emissions (*)
Annex 77: ☼ Integrated Solutions for Daylight and Electric Lighting (*)
Annex 78: Supplementing Ventilation with Gas-phase Air Cleaning, Implementation and Energy Implications (*)
Annex 79: Occupant-Centric Building Design and Operation (*)
Annex 80: Resilient Cooling (*)
Annex 81: Data-Driven Smart Buildings (*)
Annex 82: Energy Flexible Buildings Towards Resilient Low Carbon Energy Systems (*)
Annex 83: Positive Energy Districts
Annex 84: Demand Management of Buildings in Thermal Networks (*)
Annex 85: Indirect Evaporative Cooling
Annex 86: Energy Efficient Indoor Air Quality Management in Residential Buildings (*)
Annex 87: Energy and Indoor Environmental Quality Performance of Personalised Environmental Control Systems
Annex 88: Evaluation and Demonstration of Actual Energy Efficiency of Heat Pump Systems in Buildings
Annex 89: Ways to Implement Net-zero Whole Life Carbon Buildings
Annex 90: EBC Annex 90 / SHC Task 70 Low Carbon, High Comfort Integrated Lighting
Annex 91: Open BIM for Energy Efficient Buildings
Annex 92: Smart Materials for Energy-Efficient Heating, Cooling and IAQ Control in Residential Buildings
Annex 93: Energy Resilience of the Buildings in Remote Cold Regions
Annex 94: Validation and Verification of In-situ Building Energy Performance Measurement Techniques
Annex 95: Human-centric Building Design and Operation for a Changing Climate
Annex 96: Grid Integrated Control of Buildings
Annex 97: Sustainable Cooling in Cities
Annex 98: Flexibilization and Optimization of Heat Pump Systems in Existing Buildings through Secondary-Side Digitalization
Annex 99: Air Cleaning for Sustainable and Resilient Buildings

Working Group – Energy Efficiency in Educational Buildings (*)
Working Group – Indicators of Energy Efficiency in Cold Climate Buildings (*)
Working Group – Annex 36 Extension: The Energy Concept Adviser (*)
Working Group – HVAC Energy Calculation Methodologies for Non-residential Buildings (*)
Working Group – Cities and Communities (*)
Working Group – Building Energy Codes

Table of content

Results of the survey on inspection. January 2025

Results of the survey among Annex 86 participants regarding inspection of ventilation systems in residential buildings conducted in January 2025.

A.1. Questions

Question 1: To your knowledge, is there a protocol for ventilation inspection for residential buildings in your country?

- ☐ Yes - regulatory
- ☐ Yes - voluntary label
- ☐ Yes - other
- ☐ No

Question 2: If yes, do they include a part specific to smart ventilation?

- ○ Yes
- ○ No

Question 3: If yes, what is the name of the protocol text, and what part of this text concerns smart ventilation? *(example for France: Protocol ventilation RE2020, p 44-45)*

Question 4: What is checked or measured for smart ventilation systems? *(example for France: for humidity DCV, pressure measurement at each ATD)*

Question 5: Regarding your feedback and expertise:

- What should we pay attention to if we want to implement an inspection for smart ventilation?

- How should traditional inspection schemes for ventilation be adapted for smart ventilation?

- What would be the technical specifications for smart ventilation?

A.2. Answers

A.2.1. Respondents

Seven answers were obtained, from the following countries: UK, Austria, India, Belgium, Netherland (two answers) and Denmark. Five respondents belonged to an University (from UK, Austria, India, Belgium), and the other respondents (from Netherlands and France) belonged respectively to a consultancy firm, a company selling ventilation systems and a technical center.

A.2.1. Answer to question 1

Yes - regulatory	No
Yes - regulatory	No
No	No
Yes - voluntary label	No
Yes - regulatory	Yes
Yes - other	No
Yes - voluntary label	No

A.2.2. Answer to question 3

Country	Answer to question 3
UK (University)	Building Standards technical handbook 2017: domestic buildings Section 3.14 Ventilation Mandatory Standard
Netherland (consultancy firm)	
India (University)	Typically, for mechanical ventilation, the rated fan flow is used to determine the airflow rates in the room (along with air change rates). For natural ventilation, there is no protocol followed eiter.
Austria (University)	Passive House certification (measurement and adjustment of all airflow in- / outlets and balance)
Belgium (University)	Residential: Ministrial decrees in the three Belgian regions, example for Brussels (others are identical): https://document.environnement.brussels/opac_css/elecfile/Annexe1-2023-determination_des_facteurs_de_reduction_pour_ventil_a_la_demande_PER.pdf Recognised systems are included in the EPBD product database www.epbd.be (details can be found in paper presented by A. Janssens at AIVC-conference Dublin 2024. Non-residential: Ministrial decrees in the three Belgian regions, example for Brussels (others are identical) :https://environnement.brussels/sites/default/files/user_files/amb20150506_method_peb2014_annex5_fr.pdf

Denmark (University)	
Netherlands (company selling ventilation systems)	
France (technical center)	Protocol ventilation RE2020, p 44-45

A.2.3. Answer to question 4

Country	Answer to question 4
UK (University)	
Netherland (consultancy firm)	The ventilation systems (whether smart or not) have to comply with the ventilation rate requirements from the Dutch building code. In most cases this means the ventilation system will be set to the highest manual setting prior to conducting ventilation measurements. The ventilation rate in practice (under smart operation) does not have to be verified according to national law. If we investigate buildings with smart ventilation systems, we often make use of a combination of continuous (CO2 & RV) measurements in combination with an assessment of the maximum available ventilation rates.
India (University)	Not Applicable.
Austria (University)	
Belgium (University)	The EPB reporter (energy auditor) declares the performances of ventilation systems in newly constructed or deeply renovated buildings after completion of construction works based on as-built data, as needs to be done for other inputs of the energy performance calculation. For smart ventilation systems (in fact demand controlled systems) the value of f_reduc is checked, and whether the applied system is a system recognised by the authorities in the EPBD Product database. If performances don't comply with energy performance or ventilation requirements, the builder has to pay a fine. In Flanders, as in all ventilation systems, the nominal mechanical ventilation flow rates need to be measured by a competent person, and are used as input in the energy performance report of the EPB reporter, details see https://www.vlaanderen.be/epb-pedia/technieken/ventilatie/kwaliteitskader-ventilatie In case of smart systems the reporter also checks the brand of the system and visually inspects if the system is correctly used.
Denmark (University)	In Denmark there exists "The nationwide VENT scheme", which offers maintenance services, which are carried out by certified companies. Technicians from VENT certified companies are specialists with high professional knowledge acquired through further education and by passing so-called the VENT exam. The webpage is here: https://vent.dk/ The scheme includes so called VENT-Basis and VENT+ Energy Check. The scheme's guidelines are available here: https://vent.dk/kunde/. VENT-Basis and VENT+ Energy Check (focus on operation and energy optimization) are conducted according to a fixed checklist,

	ensuring that all relevant parts of the ventilation system are measured and reviewed.
Netherlands (company selling ventilation systems)	In NL, smart ventilation are dealt with in 'gelijkwaardigheidsverklaringen', this is industry association oriented info.
France (technical center)	For ventilation system unidirectional regulating with humidity, pressure measurement for extract air terminals

A.2.4. Answer to question 5

Country	Answer to question 4
UK (University)	
Netherland (consultancy firm)	It's important to first verify the design principle of the smart system: is it expected to guarantee sufficient indoor air quality? This can be verified by looking at the locations and specifications of the sensors used for indoor air quality monitoring. E.g. if a dwelling has CO2-controlled ventilation which is controlled by one sensor in the living room, sufficient ventilation in de the bedroom is not guaranteed. Next, it would be best to make use of continuous monitoring when conducting an inspection of spaces with smart ventilation. Technical specifications for smart ventilation should address sensor location, applicable control variables (CO2 & RH, not VOC), sensor accuracy (for instance RESET), calibration of sensors, impact of smart ventilation strategies on total ventilation rate calculation etc.
India (University)	Measuring the pressure drop across the fan and its power consumption can provide valuable feedback. These measurements, combined with the rated flow and power consumption, help estimate the airflow through the fan. Additionally, we have used CO2 measurements (and occupancy sensors, if available) to calculate air exchange rates after the occupancy period, providing insights into the ventilation rates of mechanical or HVAC systems.
Austria (University)	Correct installation and accuracy of sensing devices used for demand control, typically CO2 sensors. Air flow distribution in dwelling and overall balance should be checked at most likely air flow setting. Most likely the CO2 concentration is low during commissioning, and then distribution and balance measurements are done with low airflows only. Since system curve ist not linear, the adjustments should be done for nominal/most likely conditions.
Belgium (University)	In order to create an incentive for smart ventilation, it should be taken into account in regulatory requirements, such as energy performance regulations.
Denmark (University)	Regarding the smart ventilation - I mean that the incpection schemes should include not only control of the basic functionality, but also control of the correctness of the control algorithms. This would however require long-term data collection.
Netherlands (company selling ventilation systems)	Inspection of standard ventilation units is complicated enough, and not always done. So inspection of smart ventilation systems is one step ahead, and too complicated for now.
France (technical center)	Calibration of the pollutants sensors

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