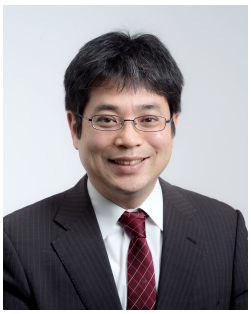
IAQVEC* NEWSLETTER

ISSUE 1 • JANUARY 2021

*ASSOCIATION FOR INDOOR AIR QUALITY, VENTILATION AND ENERGY CONSERVATION IN BUILDINGS

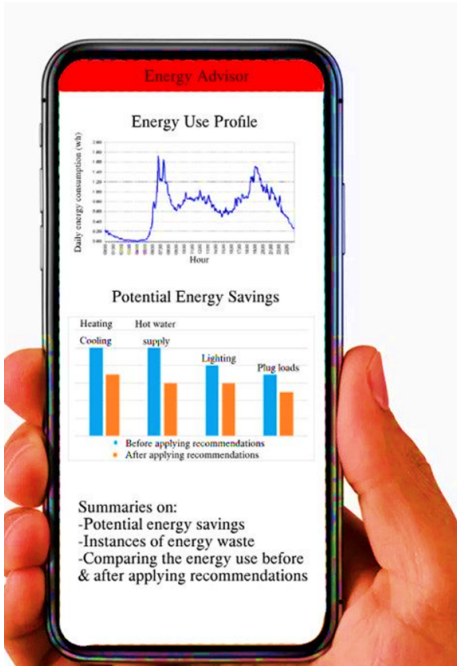
PRESIDENT'S MESSAGE



IAQVEC is the name of international conference for Indoor Air Quality, Ventilation and Energy Conservation in Buildings. Up to the present, ten conferences have been held. The first IAQVEC conference was held in Montreal, Canada in 1992 and the last one was held in Bari, Italy in 2019.

The conferences cover a wide range of key research areas with the goal of simultaneously improving indoor environmental quality (IEQ) and energy efficiency enhancing wellbeing and sustainability. To make these IAQVEC activities more systematic, constant, and vigorous, the IAQVEC association was established in 2016. After a preparatory period, the first newsletter was published here thanks to the support from the board members. Currently, the new coronavirus infection (COVID-19) is rampant. Meetings with everyone have been becoming more and more online, and new lifestyles such as working from home and teleworking have been sought. Various measures have been taken against this pandemic all over the world. On the other hand, about global environmental issues, the Paris Agreement was signed in December 2015. CO2 reduction targets were presented there. The amount of CO2 generated from buildings is more than one-third of the total amount generated, and reducing it is an urgent issue. There are many missions that the IAQVEC association, a synthetic organization related to built-environment, must undertake to address these challenges. We are planning to provide the members with more information on these issues and other services in the future. We are looking forward to the discussions with you.

Ryozo Ooka
President of IAQVEC Association



Mobile application providing energy related feedback to the users
(***see the featured article*** • *P.2*)

FEATURED ARTICLE

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ENERGY-RELATED FEEDBACK TO OCCUPANTS AND THE POSSIBLE ENERGY SAVINGS IN RESIDENTIAL BUILDINGS

BY: Panchabikesan, K., Haghighat, F., El Mankibi, M.

Preamble: Buildings are the basic need of humans, and a significant amount of energy is spent in buildings to satisfy human needs. Especially in the COVID-19 pandemic situation, people are restricted to be at their homes since March 2020, which prompted work from home culture, eLearning, shifting activities, and energy use to the residential sector. This setup has increased energy consumption in residential buildings. Therefore, in today's scenario, besides integrating renewable energy systems, understanding human building interactions is equally vital for realizing energy efficiency in buildings. Providing energy-related feedback to the users is a cost-effective solution to achieve energy efficiency and energy savings in buildings. The occupants' role in achieving energy savings is essential because the building does not need to undergo fundamental changes such as renovation or upgrading building systems or through engineering interventions. It is well agreed that modifying occupant behavior is difficult and not stable over time, but with constant monitoring and provision of energy-saving opportunities and quantification of energy savings, it becomes an achievable goal. The only effort in occupant behavior modification is reflected through changes in mind-set or lifestyle (such as shift occupant activities at certain times of the day or their presence in certain places).

Research gap

Previously, some studies have provided energy-related feedback to users. However, the main disadvantage is that most of the studies did not consider the variations in occupancy patterns (e.g., changes in occupancy status or the number of occupants) while estimating the energy savings. Indeed, without considering the dynamic occupancy patterns, it is very hard to distinguish whether the energy consumed by the appliances is caused by the actual usage or the occupants' energy inefficient behaviour. This might lead to uncertainties in identifying actual wastes and overestimation of energy-saving potentials. Though previously, the energy feedback has been reported to identify significant energy saving potentials on intervening occupant behaviour, research studies indicated that the easily interpretable feedback has not yet been transferred to the occupants as useful knowledge. There are still unclear directions for the occupants to modify and improve their energy-use behaviour (e.g., which type of behaviour needs to be modified and what actions they should take to reduce energy) in practice, which is the main barrier to enlarge occupant-related energy saving potentials.

Research opportunities

Currently, there is a boom in the concept of smart, sustainable cities, and the focus of achieving energy efficiency in buildings is shifted towards the application of the internet of things (IoT), machine learning, artificial intelligence, and big data analysis. Furthermore, the rapid increase of urban sensing, building management system data, IoT, information and communication technologies (ICT), location-based data, big data had created new opportunities to understand the occupant behaviour and energy usage patterns in buildings, especially at the urban scale. The databases mentioned above are the untapped sources of rich knowledge and could be intensively used to model occupancy, improve occupant behaviour, energy use patterns, accurate load forecasting at the urban scale.

Application of data mining frameworks to discover energy-saving opportunities in buildings

In recent years, the application of data mining (DM) techniques received increasing interests in the building sector. DM techniques can uncover previously unknown and useful information from large amounts of data and transform them into organized knowledge. In this context, we developed a systematic DM based framework to discover unusual energy use patterns in residential buildings by extracting the correlation between dynamic occupancy and building energy consumption data. More details on the developed framework can be found in this research paper1. The developed framework was applied to a dataset collected from two apartments located in Lyon, France. The developed framework aims at (1) explicitly exploring the relationship between occupancy and energy consumption patterns; (2) developing benchmarking baselines that can discover actual energy waste patterns; (3) differentiating the irregular energy use from the energy waste patterns so as to give more practical feedback. To achieve the above-said objectives, at first, a daily schedule is separated into different periods in order to approximately adapt to the routines of a given household and to represent the distinct characteristics. Then regular and irregular occupancy and energy use patterns are extracted for each period and are compared with each other to identify whether the energy consumption pattern is in accord with the occupancy level. Finally, a set of benchmarking rules is created as baselines to identify energy saving potentials in line with occupant behaviour. The proposed framework was implemented over the one-year dataset collected from two households with different occupancy and energy use behaviour.

Outcomes of the developed data mining framework

Results show that different energy waste patterns can effectively be discovered through the developed framework in both the apartments and promising energy saving potentials are possible by improving occupants' wasteful behaviour. In our research, the energy waste instances were grouped into six categories (i.e. lighting related, living room (LR) related, kitchen (KIT) related, bedroom (BR) related, bathroom (BTR) and others (OTH)). Figure 1 provides an example for different types of energy waste categories identified in apartment 1 and 2, respectively. Figure 1 (b) illustrates one example of energy waste instances associated with the refrigerator during a whole-day absence period in apartment 1. As seen in Figure 1 (b), the energy consumption pattern of the refrigerator (constantly kept at a high level during the whole day) is abnormal implying that refrigerator did not work in a normal condition. One possible reason is that the fridge door was not closed properly and resulting in changes in the operation of the refrigerator from a cyclic operation to a constantly working condition which is further verified by follow-up interviews.

As there is a high frequency to found wastes in kitchen appliances, it hints that the use of kitchen appliances deserves more attention for occupants in apartment 1 in practice. In this way, the total number of hours for which energy wastage instances identified in the selected two apartments were summarized and the obtained results are presented in Figure 2. The figure depicts the distribution of different categories of energy waste instances. For apartment 1, the inference from Figure 2 is that approximately 70% of the time, the energy wastes were found in the kitchen. The further inference from Figure 2 is that in apartment 1, the fraction of lighting waste exceeding 10% implies that occupants' wasteful behaviour would result in an unexpected increase in lighting consumption even though the building was designed as energy-efficient (one goal is to reduce lighting consumption and make the best of natural lighting). More details on the benchmarking scenarios, period classification, summary of statistics regarding the duration of abnormal energy consumption patterns and associated saving potentials can be found in the following paper.

More details on the benchmarking scenarios, period classification, summary of statistics regarding the duration of abnormal energy consumption patterns and associated saving potentials can be found HERE

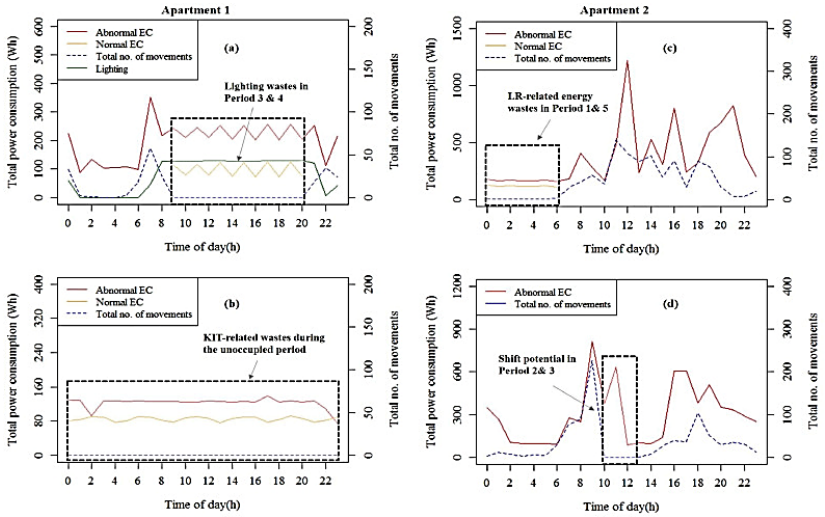

FIGURE 1. ILLUSTRATION OF DIFFERENT TYPES OF ENERGY WASTE PATTERNS DURING A SLEEPING/AWAY PATTERN EVENT IN APARTMENT 1 & 2

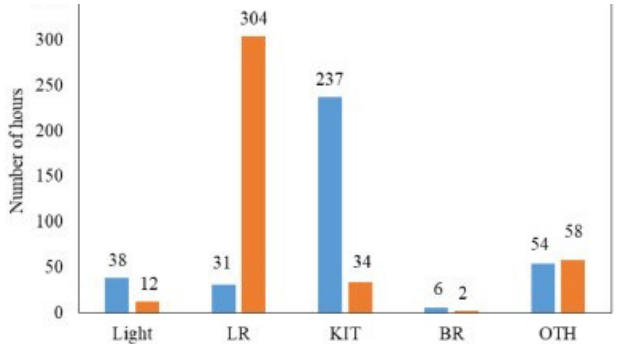

FIGURE 2. SUMMARY OF DIFFERENT CATEGORIES OF ABNORMAL ENERGY CONSUMPTION PATTERNS IN APARTMENT 1& 2.

Planned future research works

In the near future, we aim to develop more generic, systematic data-driven based frameworks that can be integrated with home energy management system (HEMS), smart energy meters and subsequently, to provide specific energy-related feedback to the user's through a mobile application as shown on the cover page. The data-driven frameworks will be developed with the self learning concept, where the user's energy use patterns/routines will be recognized and tailor-made energy saving feedbacks and peak load shifting strategies will be provided considering the occupant's energy use behaviour. One can think of Hydro-Quebec's mobile application, in which the users can review their energy consumption history and be aware of their energy usage pattern. However, what is missing in such mobile application is the feedback on how to save energy and specific energy savings tips. We want to go one step further and develop a mobile application, where the user's can know their energy efficient and inefficient behaviour. In other words, the occupants will be aware of their best and worst energy consumption profile through an analysis of their energy usage, which will motivate them to achieve the targeted energy consumption or even improve their behaviour to achieve better results. Doing so will benefit both energy consumers and suppliers. This will also make buildings more efficient as well as cost effective.

IAQVEC 2022
THE 11TH INTERNATIONAL IAQVEC CONFERENCE
JUNE, 2-5, 2022, DALIAN, CHINA

The **11th International Conference** on Indoor Air Quality, Ventilation and Energy Conservation in Buildings (IAQVEC 2022) will be held on June 2nd-5th, 2022 in Dalian, China. The Conference will be hosted by the Dalian University of Technology and co-organized by three universities - the *University of Colorado Boulder (US)*, the *Tsinghua University (China)* and the *Southwest Jiaotong University (China)*. IAQVEC is a premier international conference series, initiated in 1992 and held once every three years. It has been hosted in different countries ranging from Canada, France, China, USA, Japan to Czech Republic, Italy and South Korea.

IAQVEQ 2022 will focus on the theme "**From Macro to Micro Aspects of Efficient and Healthy Buildings**" and will provide a productive and dynamic platform for participants of diverse backgrounds and interests including scientists, researchers, designers, engineers, project managers, and policy-makers. A broad range of topics in Building Science will be covered with the following main topic streams.

IMPORTANT DATES

JULY 1, 2021

ONLINE ABSTRACT SUBMISSION OPEN

OCTOBER 31, 2021

DEADLINE FOR ABSTRACT SUBMISSION

DECEMBER 31, 2021

DEADLINE FOR FULL PAPER SUBMISSION

JANUARY 31, 2022

NOTIFICATION OF FULL PAPER REVIEW RESULTS

MARCH 31, 2022

DEADLINE FOR FINAL PAPER SUBMISSION

MAIN TOPICS

URBAN CONDITIONS AND IMPACTS

INTEGRATION OF OUTDOOR AND INDOOR

INDOOR ENVIRONMENTAL QUALITY (THERMAL COMFORT, IAQ, LIGHTING, AND ACOUSTICS)

ENERGY EFFICIENCY & IEQ STRATEGIES

SMART CONTROL AND INTELLIGENT SYSTEMS

MODELING, VALIDATION, AND OPTIMIZATION

DATA ANALYSIS AND INFORMATICS

RENEWABLES AND NET-ZERO-ENERGY BUILDINGS

PERFORMANCE MONITORING, MEASUREMENT, AND RETROFIT

ADVANCED HVAC SYSTEMS AND OPERATIONS

VENTILATION AND INFILTRATION

NOVEL ENVELOPE AND MATERIALS

CONFERENCE WEBSITE:

HTTP://IAQVEC2022.ORG

(The website will be up in the coming weeks)

COVID-19 RELATED EVENTS

- The **2nd International Conference for global Chinese Academia on Energy and built environment** will be held on 16-19th, July 2021 (Chengdu, China). About 1000 Chinese from all around the world would participate on-site or online. During the conference, there will be a section regarding the COVID-19 and its impacts. The board member Prof. Yanping Yuan will be the president of the conference.
- One of the board members, Prof. Yanping Yuan held a **UK-China workshop** on 9-11th, December 2020 (Chengdu, China). During the workshop, a section concerning the COVID-19 was conducted. About 50 experts from the UK, China, and Canada participate in the workshop. Measurements regarding reducing the risk of COVID-19 were discussed during the workshop.

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and subscription to the newsletter

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Former president of IAQVEC, Professor Hiroshi Yoshino, in 2019 Conference in Bari, Italy

ASSOCIATION'S GOALS:

- PROMOTE SCIENTIFIC, TECHNOLOGICAL AND TECHNICAL ADVANCES RELATED TO IAQVEC FIELDS AT AN INTERNATIONAL LEVEL
- DEVELOP AND DISSEMINATE KNOWLEDGE AND SPREAD INFORMATION RELATED TO IAQVEC
- PROMOTE AND ORGANIZE IAQVEC CONFERENCES

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