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Research papers for
The 19th EuroFM Research Symposium
EFMIC 2020, 3-4 June 2020
Online Conference

Editor:
Tuuli Jylhä

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PREFACE

EuroFM Research Symposium has a very special meaning to me: The EuroFM Research Symposium was my first research conference to attend and to present a co-authored scientific paper. This happened in EFMC 2008 in Manchester. It was also one of my first contacts to the other FM researchers and EuroFM community and I still remember the ability of the EuroFM to bring people together. Therefore, I was very pleased and honoured when the EuroFM board asked me to chair the 19th EuroFM Research Symposium. Thank you for this great opportunity!

Although the spring has been abnormal, intensive and halting due to the COVID-19 crisis, we have succeeded to deliver this conference proceedings including 11 papers. This year the papers include research, technical and educational papers. 70% of the submitted abstracts were developed into and finally accepted as part of the conference proceedings. All papers were double-blind peer reviewed and follow standard research paper outline.

I would like to sincerely thank all the authors, the members of the scientific committee and the best paper award committee, and the EuroFM board for their contributions and support in the process of publishing a high-quality proceedings and making the related event come true. It has been a great experience to work together with you! The process has required quick changes and responses from the members and I am grateful for the flexibility and commitment that have been provided along the way.

Due to the COVID-19 pandemic, the Research Symposium 2020 is organised online (3-4 June 2020). Although it is a lost opportunity not to meet face-to-face, the online edition provides us a new way to share ideas and discuss findings with the wider EuroFM audience. Let us be inspired to further explore the digital collaboration and new traditions to network. Meanwhile, I hope you enjoy reading the proceedings!

Dr. Tuuli Jylhä
Chair of the EuroFM Research Symposium Organising Committee
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Practical Applications of Emerging Technologies in the FM Sector

Alexander Redlein[1], Clemens Baretschneider[2] and Claudia Höhenberger[3]

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Redlein, A., Baretschneider, C., and Höhenberger, C. (2020) Practical Applications of Emerging Technologies in the FM Sector, In the Proceedings of the 19th EuroFM Research Symposium, EFMIC 2020, 3-4 June 2020, online conference.

ABSTRACT

Background and aim – Facility services largely consist of routine tasks, which makes it susceptible to automatization. Existing studies primarily focus on the macro economic effects of this radical shift. This research addresses how the facility services themselves will change, in order to gauge which tasks will be replaced and how the FS provision will alter.
Methods – A quantitative literature research of more than 720 use cases of digitization in the FS industry was conducted to define the usage of the technologies and the development of the usage. Out of the analysed use cases one most widely spread IoT use case was selected to demonstrate the benefits for the FM/FS sector and the low cost of this technology.
Results – The primary technologies driving digitization in the FS industry are IoT, AI, Big Data, and Robotics. The services most affected by this process are Maintenance and Operation (1160), Safety (2110), and Energy (1171). Based on these results an IoT use case, using temperature and humidity data, in the area of preventive maintenance was selected.
Originality – The database consists of 720 use cases. This large scope allows for comprehensive analysis of the current situation of digitization in the facility services industry. A proof of concept for easy to use and cheap IoT sensor implementation is presented.
Practical or social implications – This research gives an updated overview over the status quo of emerging technologies within facility services. The best use case developed in this this study is exemplary of wider trends in the facility services industry. The research shows how services are enabled or altered by digitization. This research can therefore serve practitioners as a guide for implementation and optimisation of processes.
Type of paper – Technical research paper.

KEYWORDS
IoT, digitization, AI, ML, automatization, facility services, evaluations of smart building technologies

INTRODUCTION

Many macro-economic studies have shown that the facility services industry will be heavily affected by digitization (Stopajnik & Redlein, The Development of the Outsourced Facility Service Industry in Europe, 2017), (Chotipanich, 2004), (Selinger, Sepulveda, & Buchan, 2013), (Čas, Rose, & Schüttler, 2017).

The impact of digitization on work processes in general has been well studied. Most studies agree that the greatest effect will be on routine tasks and that a shift in knowledge will be necessary for the workforce to keep up with these developments (Nagl, Titelbach, & Valkova, 2017), (Stopajnik & Redlein, Current Labour Market Situation and upcoming Trends in the European Facility Service Industry, 2017), (Frey & Osborne, 2013).

These existing studies primarily focus on the change that digitization will have on the FS industry and the economy as a whole. However, they pay little attention to the processes that will be changed or which new technologies will be at the forefront of these developments (Stopajnik & Redlein, Current Labour Market Situation and upcoming Trends in the European Facility Service Industry, 2017).

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Therefore, three years ago, we started a research project to better understand to which extent the digitization process is affecting facility services. Our research shows that digitization has two major impact factors:

1. The core business is changing, which demands dramatic modifications of infrastructure and services like new ways of working
2. Emerging technologies are allowing for a more efficient way of service provisioning. This means disruptive changes for the service provision itself

This paper focuses on the second factor and will show how digitization alters and optimizes service provision in the FS sector. Previously published papers from this project have focused on which technologies are important and how digitisation affects facility services. In this work, we wanted to verify some of the assumptions that have arisen in that work.

This paper focuses on the following two research questions:
1. What is an easy to use and cost-efficient use case, representing many similar use cases in the research database?
2. How is the service provision changed by the application of this use case?

For this reason, we expanded our dataset. Based on the additional use cases analysed we can validate the existing results. Based on the database a use case was selected. This use case was selected out of the technology most widely used and the services most heavily affected by digitization. Our main objective was to study the effects of digitization on particular facility services on a smaller scale. The use case we selected and developed further was cheap, easy to set up and use, and was representative of many similar use cases in our database. It was implemented and the usage was analysed to better understand the relationship of technology and changing service provisioning. This helped us to better understand the impediments and benefits of digitization of facility services.

It showed that while facility management and especially service provision are relatively slow to adapt emerging technologies, even small interventions can have huge impacts on how services are provided. Time consuming repetitive tasks can be easily relegated to technology, freeing personnel for more difficult tasks. In our example instead of routine inspection of basements cheap and easy to use IoT sensoring can be used to automatically detect problems and send information to the relevant service personnel via SMS or email. This shows that service provision will not only change for big players who can afford to spend vast sums of money, but also and especially for smaller providers of facility services. This example is also used to provide industry representatives a hands-on experience. The main purpose of this paper is to present this easy to implement digitization use case in facility services and to describe the practical impact.

RESEARCH METHODOLOGY AND METHODS

Our research consists of multiple steps. We did a preliminary literature review to find out which technologies will most likely be drivers of digitization (Schwab, 2016).

Then these results were used as the base for a database, which currently consists of 720 use cases. The publications analysed here appeared in scientific journals, companies' white papers, strategy documents of well-established consulting firms, and publications like the MIT Technology Review. The results were validated to safeguard data quality. The use cases are practical applications in the FS industry as well as other industries. Due to a detailed definition of facility services in the EN15221:4, it was possible to map non-FS use cases on facility services. As a next step the database was analysed to discover which services were most affected by digitization.

For a more detailed description of the methodology used in this first phase, please see Relationship of emerging technologies and their influence on Facility Services (Redlein & Höhenberger, 2019). The results of the first 300 use cases gathered in the years 2016 to 2018 were validated by the analyses of more than 400 use cases in 2019. The goal was not only to validate the results regarding the technologies and services affected but also to analyse the change in technologies used and services affected.

After this validation and updated assessment of the most important technologies and the services most heavily affected, we selected a use case that represents best these findings. This was done to assess in more detail how a certain service is affected by emerging technologies. In addition to being representative of the data we had previously collected, the use case had to fulfil certain requirements. It had to be cheap, easy to set up and use, scalable, and be applicable in real life situations.

Based on our research results, IoT use cases are most predominant and Maintenance and Operation, Energy, and Safety are the services most affected by digitization. Therefore, we selected an IoT use case applicable in these services. The use case monitors room parameters like temperature and humidity, in an area usually prone for mould. This allowed us to better understand how service provisioning is changed by emerging technologies, and how even simple solutions can influence service provisioning on the whole.

RESULTS

Relevant Technologies

Figure 1 shows which technologies, according to our quantitative literature review, are most widely used in the FS industry. The results are presented as a percentage of overall use cases analysed.

Technologies with less than 36 overall occurrences (equalling 5% of use cases analysed as of February 2020, n=720) were omitted from the figure. BIM was included to show that while experts state its importance as a smart building technology, the literature review does not support this claim. Software as a Service (SaaS) and Cloud Computing on the other hand were not part of the initial pre-study. These two technologies are a way to provide software and support smart building technologies, rather than tools themselves.

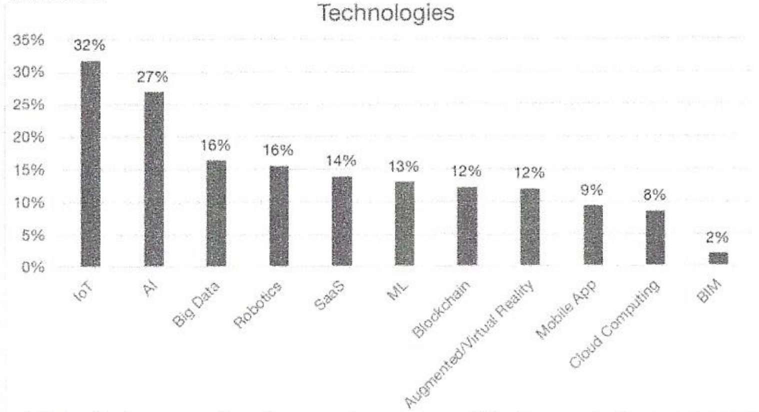

Figure 1 Technologies grouped by category and occurrence within the case studies as a percentage of 720 use cases analysed (February 2020)

The analysis of the database showed that technologies like IoT, AI, big data, and robotics are already widely used in facility services. This can be accredited to massive lowering of prices of IoT sensors and hardware in general as well as increased data processing speed over the last years. Robotics remain important in FS applications, as they mostly carry out repetitive tasks. They become more flexible and versatile, especially in combination with 5G technology.

Services affected by digitization

Figure 2 show the occurrence rate of all analysed cases as a percentage of the 720 analysed use cases. The services most affected by digitization are Maintenance and Operation (1160), Safety (2110), Energy (1171), Security (2120), and Logistics (2410, 2430, 2440). Many use cases were added which find applications in the facility services Safety (2110), Customer Experience (2000), and Healthcare.

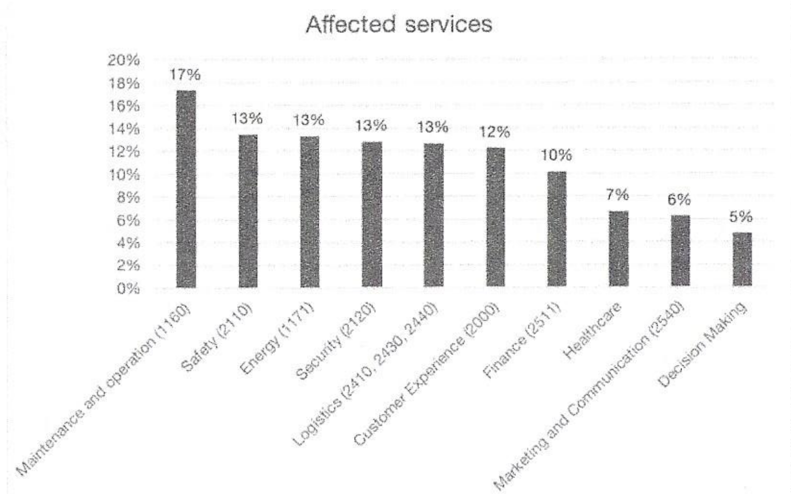

Figure 2 Affected services according to number of occurrences in publications as a percentage of the number of cases analysed (720 use cases as of February 2020).

The dominance of IoT technology in the facility services industry overall can also be observed in the individual services. To illustrate this, the service Maintenance and Operation (1160) has been analysed more closely (see Figure 3). 59% of Maintenance and Operation (1160) use cases in our current database use some form of IoT technology, mostly sensors. This is followed by Machine Learning and Big Data, with AI trailing behind a little. These technologies are often used in tandem. For example, IoT sensors constantly monitor KONE elevators and escalators. These sensors send the data to a cloud for storage. This data is then analysed by IBM Watson's AI, which identifies possible malfunctions before they occur, which allows for in-time maintenance scheduling. This transforms reactive maintenance tasks into predictive ones (KONE Corp., 2016).

Robotics also have a significant share within Maintenance and Operation (1160) use cases. This can be attributed to an improvement in robotics technology, transferring dangerous maintenance tasks from humans to robots. For example, drones are used for remote pipeline inspection (Meakin, Wong, Zikry, & Shae, 2019).

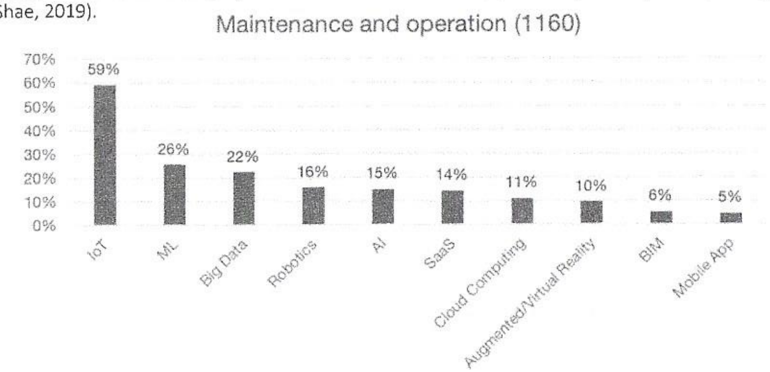

Figure 3 Used technologies according to number of occurrences in publications as a percentage of the 125 overall "Maintenance and Operation" use cases (February 2020).

Our next goal was to show how technology affects service provisioning on a micro level. As stated earlier, IoT sensoring was chosen as use case due to its dominance not only in services overall, but their importance in Maintenance and Operation (1160) especially. The low price of readily available sensors also played an important role in this decision.

We chose a scenario that is relatively wide spread and representative for the three services most affected by digitization: room inspection for mould. The most important factors with regard to mould growth are relative humidity, temperature, substrate and time (Sedlbauer & Krus, 2002). Since substrate is provided by the building material and can therefore not be changed easily, the three decisive factors for intervention are relative humidity, temperature, and time. In order to supervise whether mould has developed it is paramount to regularly check vulnerable areas. Usually, a person would check such a room visually for mould infestation on a regular basis. This takes time and effort.
Therefore, we decided to transfer this repetitive task to sensors. Instead of checking in visually, these sensors monitor temperature and humidity of the affected area constantly. By making sure that certain thresholds have not been exceeded, it can be deduced that mould will not find suitable conditions for growth. This means that instead of reacting to a situation (mould growth), this use case will prevent the growth of mould by withholding conditions susceptible for its development.

IoT Sensor Set Up
As can be seen, Maintenance and Operation (1160), Safety (2110) as well as Energy (1171) are, according to our database, highly affected by IoT technology. IoT technology itself is the most important smart technology affecting facility services overall. Using these facts as a starting point, we wanted to show in practice how technologies are changing facility service provisioning. As a result, an IoT use case was selected for further analysis that touches on the three services most affected by technology. Maintenance is simplified by IoT monitoring. Health and Safety issues like moulding are dangerous for people staying in spaces. And lastly, reduce in energy use can be achieved by better understanding temperature and humidity patterns, reacting accordingly.

In order to show how simple IoT implementation is, we developed a cheap and easy to set up use case. The sensors were installed in areas prone for mould. Since mould growth is influenced by humidity and temperature, its spread can be confined by monitoring these parameters and proactively influencing them. This problem touches on the three facility services that are, according to our research, most susceptible to digitization. This provides a good use case for easy IoT implementation. The costs for one unit were about 80€ and interested personnel were taught how to set up the sensors, program tasks, and read and interpret the data in a two-hour workshop.

The start-up procedure consists of several steps:

1. Connecting the keyboard and mouse with a Raspberry Pi (RPi) via USB
   Connecting a USB power adapter suitable for continuous operation with a Rpi USB power supply
2. Connecting a screen via HDMI (alternatively via VGA or VNC)
3. Connecting the RPi to the internet (via WLAN or LAN)
4. Connecting the sensor and preliminary testing
5. Adapting the existing lines of code for the individual purposes. For example: triggering a task when a certain level of humidity or temperature was exceeded
6. Maintain security (changing passwords, keeping software up to date, using a firewall)

All that is needed on-site is a wall socket, space and internet access. The costs are equivalent to having a technician come and monitor the desired parameters once. But with this set up it is possible to monitor the data continuously over a long period of time.

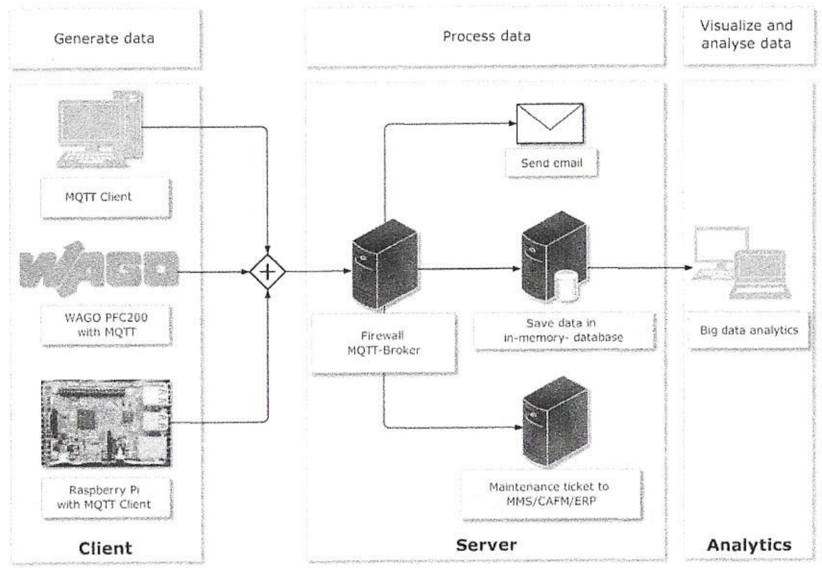

Figure 4 Set up for IoT use case.

In order to prevent mould, two parameters were measured by a sensor: The relative humidity and the temperature of the room. This allows maintenance personnel to see whether there is danger for mould or a leakage of sorts. The sensor data is processed by a RPi single board computer which triggers one of three actions, if a certain temperature or humidity threshold is exceeded:

1. An email is sent.
   This email contains the individual ID of the RPi, therefore allowing the recipient to easily identify where the incident has taken place. This email immediately alerts the personnel responsible. It also gives information about why this action has been triggered by the system, by telling the recipient whether the temperature or relative humidity are too high or too low.
2. The data is stored in a database for further Big Data analysis.
   This allows maintenance personnel to ensure that the temperature and relative humidity have never exceeded or fallen below certain thresholds. The data can also be used for further analysis over a longer period of time, greatly improving results gathered from isolated expert technician visits, which cost about the same as this whole IoT use case set up
3. Information is sent to an existing MMS/CAFM/ERP system.
   Like the email, this action informs maintenance personnel of where and what has occurred. In this case, a ticket is created. The IoT setup thereby seamlessly integrates with existing in-house or outsourced IT solutions for maintenance operations.

These simple and adaptable tasks (the thresholds for temperature and humidity can be easily changed) ensure that the system is proactively monitoring the environment. The system easily integrates into existing infrastructure, and automatically alerts responsible personnel when problems arise. The setup can be adapted for various uses, depending on the needs of the building and maintenance demands. For example, since this specific set up can be installed in areas that are prone to develop mould, in a more advanced step a dehumidifier could be activated automatically to prevent this.

Remote and regular supervision of the data ensures that physical check-ins can happen at much greater intervals, further reducing costs. This small, cheap, and simple set up illustrates that even at this scale, due to digitization, a shift from reactive towards predictive maintenance is taking place in the FS sector.

DISCUSSION AND CONCLUSIONS

Digitization heavily affects facility services, especially Maintenance and Operation (1160), Safety (2110), Energy (1171), Security (2120) and Logistics (2410, 2430, 2440). Not all technologies are equally important to this process. According to our research, IoT technology, especially with regards to sensors, is the main technology in digitization processes. IoT is followed by AI, Big Data, and Robotics. BIM on the other hand plays a minor role in this development.

Digitization in the FS industry not only means that tasks that were previously conducted by humans are now executed by technologies. The high degree of technology use has effects on how the tasks are performed, and in the process on the tasks themselves. For example, reactive maintenance is shifting towards preventive and predictive maintenance.

To illustrate this concept, we developed an easy to use and cheap IoT use case. This set up can be used to monitor humidity and temperature levels in areas susceptible to moulding. Low price IoT sensors enable a continuous monitoring of the room parameters for almost no costs. The permanent analysis makes it possible to optimise the systems continuously in contrast to one-time audits. In addition to the continuous supervision, maintenance staff is automatically informed about problematic developments. This makes it possible to react before damage happens, at a fraction of effort. As was shown by preceding research, first-line personnel tasks will change dramatically. In our example, instead of regular in-person check-ins at short intervals, the temperature and humidity are always monitored by the IoT sensor. An email or ticket is sent automatically to the personnel responsible to take care of the problem when it arises. Because of this, in-person checks can happen much less frequently.

However, a sensor is worthless if the data generated from it is not in some way analysed. To what extend IoT is dependent on other technologies to sustain a fully functioning autonomous system is the topic of further research.

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Housing Federation Hub Initiative – A Collaboration between FM and Academia

Laila Marie Bendiksen [1], Coline Senior [2], Alenka Temeljotov-Salaj [3] and Svein Bjørberg [4]

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Bendiksen, L., Senior, C., Temeljotov-Salaj, A. and Bjørberg, S. (2020) Housing Hub Initiative - A Collaboration between FM and Academia, In the Proceedings of the 19th EuroFM Research Symposium, EFMIC 2020, 3-4 June 2020, online conference.

ABSTRACT

Purpose – The objective of this paper is to present the results from one approach in the Co-operative Housing Federation of Norway (NBBL) HUB activities, which consist of eight different feasibility study projects geared towards a potential contribution to Paris Climate Agreement. NBBL is a national membership association representing 41 co-operative housing associations (building co-operatives) managing 12.700 housing co-operatives and condominiums, counting 510.000 houses representing 1.020.000 members which is approximately 25% of total housing in Norway. The Norwegian building stock consists of approximately 400 million square meters gross area. Of this housing is app 67%. In order to reach the Paris Climate Agreement goals, it is not enough to concentrate on new constructions, the biggest potential lies within the existing buildings stock. Fostering changes towards more sustainable neighborhoods, we propose in this research to tighten the collaboration between FM and Academia to create a network of universities and local FM, following the goals and strategies developed at the strategical level. "Hjernringen" is an initiative from NBBL to co-develop new solutions and research topics for more sustainable urban communities in collaboration with Norwegian Universities and local residential FM.

Methodology/approach – This paper presents one case study in detail as an example of collaboration between FM and Academia. The methodology used are both qualitative and quantitative research methods. It was organized as a student summer school for four weeks working on site. A substantial part of getting information was to listen, inform, understand people' needs and voices, ultimately creating a visual survey. Consulting with users was important to make an interactive platform with 3D models capable of collecting feedback and have a tailor-made communication of the benefits of sustainable renovation.

Results – The results of this research are showing that a tight collaboration between FM and Academia benefits both parties in the development of innovative solutions both from the academic and industrial perspective. It has also enabled to shed light on the importance of better communication between FM and users. The media coverage of the experience has also increased the attention given to the issue.

Practical implications – The research is important to increase the understanding of users' involvement in sustainable building renovation and its potential to move towards a more sustainable society. For NBBL, together with their 41 co-operative housing associations, it is an opportunity to develop a new platform for decision-making in renovation projects of urban communities.

Type of paper – Educational paper

KEYWORDS: 3D model, communication, co-creation with residents, well-being.

INTRODUCTION

As a signatory of the Paris Climate agreement, Norway had committed to reducing its overall Greenhouse gas emissions by 40% by 2030 compared to 1990 levels. In a recent statement, following the publication of the European Green Deal, the Norwegian government has increased this target to 50% and towards 55% by 2030. The country has expressed the will to take a leading role in helping to reach this goal at the EU level. In order to pave the way to success, major industry actors will have to take actions. With the building sector accounting for almost 40% of the global CO_2 emissions and 36% of the energy use, there is a big potential for these actors to make a significant contribution.

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