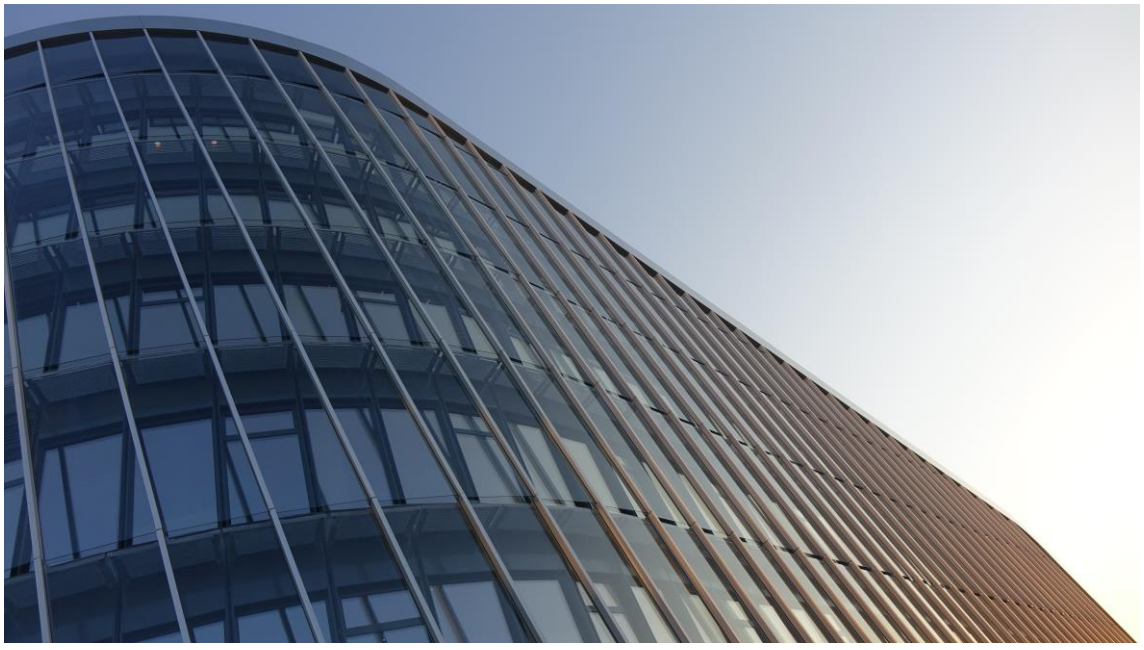
Energy Efficiency Performance - Tracking Platform for Benchmarking Savings and Investments in Buildings

D7.6 Report on academic contributions – Summary of publications for the research and policy community



This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 885395

Deliverable nº:	**D7.6**
Deliverable name:	**Report on academic contributions – summary of publications for the research and policy community**
Version:	**4.0**
Release date:	**21/02/2023**
Dissemination level:	**Public**
Status:	**Submitted**
Author:	**Smart Innovation Norway – Tuuli Veikkanen**

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 885395

Document history:

Version	Date of issue	Content and changes	Edited by
0.1	9/01/2023	First draft version	Tuuli Veikkanen (SIN)
0.2	7/02/2023	Second draft version	Tuuli Veikkanen (SIN), Josep Mayos (CIMNE)
0.3	16/02/2023	Final draft version	Tuuli Veikkanen (SIN)
0.4	21/02/2023	Final version	Tuuli Veikkanen (SIN)

Peer reviewed by:

Partner	Reviewer
CIMNE	Stoyan Danov
CIMNE (Subcontractor)	Mike Barker

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 885395

Deliverable beneficiaries:

WP / Task
WP1
WP2
WP3
WP4
WP5
WP6
WP7

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 885395

Table of contents

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 885395

Executive summary

The Horizon2020 funded EN-TRACK project is developing an online platform to support the technical and financial decision-making in the refurbishment of the existing building stock. The project and the platform address several commonly known challenges in energy efficiency projects and investments, such as data gaps and lack of data standardisation.

The EN-TRACK partners are fully committed to disseminating all non-confidential results of the project to the public. Consequently, all scientific articles and non-confidential deliverables are freely available to the public on www.zenodo.org/communities/h2020-en-track.

This report lists and summarises all EN-TRACK articles and publications published and submitted up to February 2023. The listed articles include both in-depth scientific articles targeting academic and technical audiences, as well as non-scientific articles, aimed at other key stakeholders of the project and the broader public. The up-to-date list of articles, scientific articles and public deliverables can also be found on the project website www.en-track.eu.

The report concludes with an outline of the on-going publication action plan. Plans include a publicity campaign, once the platform is launched; the publication of the story of EN-TRACK, aiming to extend the appeal of the platform to other key target groups; and articles and conference papers to disseminate the technical aspects of the platform to the science and technology communities.

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 885395

1 Introduction

The Horizon2020 funded EN-TRACK project addresses several key barriers to investments in energy efficiency in buildings. More specifically, EN-TRACK will enable massive data collection on the energy performance of buildings before and after the implementation of energy efficiency measures. The data gap and lack of data standardisation hinder decisions on investments needed to drive energy savings, reduction of carbon emissions and improvement of the well-being and/or productivity of building occupants. The EN-TRACK platform meets this challenge by enabling an interoperable ecosystem of data and tools to support the technical and financial decision-making in the refurbishment of the existing building stock.

This report provides an overview and summaries of the relevant academic and peer-reviewed publications authored by the members of the EN-TRACK consortium up to February 2023. Additionally, this deliverable lists and links to non-scientific publications produced by EN-TRACK partners, such as the most important news articles.

Following article 29 of the EN-TRACK Grant Agreement, the partners are committed to disseminating non-confidential results of the project. Consequently, all scientific publications concerning the project findings are provided with open access. Moreover, as a result of EN-TRACK's commitment to open access, all public deliverables and academic articles are published and made freely available on the Internet. The full list of articles can be found in this deliverable and on the EN-TRACK website (www.en-track.eu).

A list of the public deliverables can be found on EN-TRACK's Zenodo account at: www.zenodo.org/communities/h2020-en-track. The Zenodo repository contains a variety of educational materials, research papers, data, and reports spanning a wide range of disciplines. The facility was developed under the OpenAIRE program of the European Union and is operated by CERN.

Chapter 2 provides a listing of published and submitted scientific publications with their abstracts and links to the full articles. A number of the project's research methods and results, such as the data model, are presented in the publications. Having the publications and data freely available supports the project principles of exploitation by allowing them to be used in similar projects or other activities.

In Chapter 3, the non-scientific articles are listed in a table, with a brief description for each article. As part of EN-TRACK's communication and dissemination efforts, these articles share the project mission and results with the targeted key audiences and the general public.

In Chapter 4, a plan of action is outlined for the last year of the project concerning publications. There will be an increased focus on non-scientific articles and conference papers in the last year, intended to spread awareness of the EN-TRACK platform for building energy data management and energy efficiency investments.

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 885395

2 Scientific publications

In accordance with the Europe 2020 strategy for a smart, sustainable, and inclusive economy, EN-TRACK provides open access to its scientific outcomes, unless there are compelling reasons to restrict access.

In this report, a scientific publication refers to an article that has been academically peer-reviewed or presents a scientific method in a detailed manner. In the table below, the scientific articles published and submitted to date (February 2023) are listed and summarised.

Table 1. Scientific publications.

Paper	Title * Author(s) * Journal * DOI * Abstract
1	**Baseline Energy Use Modeling and Characterization in Tertiary Buildings Using an Interpretable Bayesian Linear Regression Methodology** Benedetto Grillone, Gerard Mor, Stoyan Danov, Jordi Cipriano, Florencia Lazzari, and Andreas Sumper. Energies 14, no. 17: 5556, 2021. https://doi.org/10.3390/en14175556 **Abstract** Interpretable and scalable data-driven methodologies providing high granularity baseline predictions of energy use in buildings are essential for the accurate measurement and verification of energy renovation projects and have the potential of unlocking considerable investments in energy efficiency worldwide. Bayesian methodologies have been demonstrated to hold great potential for energy baseline modelling, by providing richer and more valuable information using intuitive mathematics. This paper proposes a Bayesian linear regression methodology for hourly baseline energy consumption predictions in commercial buildings. The methodology also enables a detailed characterization of the analyzed buildings through the detection of typical electricity usage profiles and the estimation of the weather dependence. The effects of different Bayesian model specifications were tested, including the use of different prior distributions, predictor variables, posterior estimation techniques, and the implementation of multilevel regression. The approach was tested on an open dataset containing two years of electricity meter readings at an hourly frequency for 1578 non-residential buildings. The best performing model specifications were identified, among the ones tested. The results show that the methodology developed is able to provide accurate high granularity baseline predictions, while also being intuitive and explainable. The building consumption characterization provides actionable information

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 885395

	that can be used by energy managers to improve the performance of the analyzed facilities.
2	**The EN-TRACK Energy Efficiency Performance Tracking Platform for Benchmarking Savings and Investments in Buildings. Data Model Development** Edgar Martínez-Sarmiento, Stoyan Danov, Eloi Gabaldon, and Jordi Carbonell. Environmental Sciences Proceedings 11, no. 1: 11, 2021. https://doi.org/10.3390/environsciproc2021011011 **Abstract** This paper is related to the H2020 project EN-TRACK, dedicated to developing a platform for gathering data on the performance of energy efficiency investments in buildings. The project aims to collect and harmonize data from different sources and provide services supporting investors and building owners in decision-making and de-risking building retrofit projects. The paper focuses on the methodology and the semantic technologies used in the development of the platform's data model, which enables the interoperability of data, and supports the service functionalities for tracking building energy performance and benchmarking savings from energy efficiency investments.
3	**Data-driven methodologies for evaluation and recommendation of energy efficiency measures in buildings. Applications in a big data environment** Benedetto Grillone. PhD dissertation **Description** Benedetto Grillone (CIMNE) based his PhD thesis partly on the EN-TRACK data model, especially on the benchmarking buildings' KPIs. The PhD thesis was presented on 3rd December of 2021 in Barcelona, Spain to about 25 people. The thesis supervisors were Professor Andreas Sumper and PhD Stoyan Danov. The examining board consisted of member Clayton Miller, secretary Monica Aragues and chair Nicola Sorrentino. The objective of the thesis was to investigate how the use of novel data-driven statistical and machine learning techniques could contribute to the improvement of the energy performance of the existing built environment, specifically by quantifying energy efficiency savings and analysing energy performance.

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 885395

4

Under submission

Data collection to support energy efficiency finance in the building sector

Eddie Streng, and Telvin Kulecho.
International Conference on Energy Efficiency in Domestic & Light Sources (Eedal), 2022

The lack of empirical evidence and statistical data on the actual energy and costs savings achieved is today one of the key challenges to overcome in order to increase energy efficiency investments. Data is still hard to access because it is decentralized and in different formats. Consequently, only a small part of this can be used to produce reliable empirical evidence on the performance of the energy efficiency investment.

The goal of EN-TRACK H2020 is to create a one-stop shop platform with standardized data related to the energy efficiency performance of the public and private building stock. The platform will e.g., allow for benchmarking of the financial performance of specific energy efficiency measures (EEM). The user can analyse trends in financial performance of EEM investments by defining (ranges of) financial parameters and seeing distributions and standard deviations of various EEM types. Several filter criteria (location, building type and use, etc.) will allow a more customized analysis, ensuring a minimum number of projects to be included in the sample. The tools and platform developed through the EN-TRACK project will be based on enabling interoperability with most currently active databases and tools (e.g., DEEP and eQuad platforms) that will support more efficient building refurbishment decision making processes, putting it into practice with the financial sector. During the presentation, the speaker will present the first development of the project and practical demonstration of the platform.

5

Under submission

Making building energy efficiency investments a mainstream activity of the financial sector: The EN-TRACK project

Stoyan Danov and Josep Mayos.
7th International Conference on Energy Economics and Energy Policy (ICEEEP), 2023
Conference presentation

Buildings are responsible for 40% of the energy consumption in Europe, and 75% of the building stock is energy inefficient. Renovation of buildings for improved energy efficiency is a key priority in the European climate strategy and requires increased investments by the private sector. One of the principal challenges to this is the lack of statistical data on the actual

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 885395

energy and costs savings achieved with them. The required energy and investment data is still hard to access because it is decentralized and indifferent formats and only a small part of this can be used to produce reliable empirical evidence on the performance of the energy efficiency investments. The EN-TRACK project meets the challenge by developing an open-source big data platform enabling massive data gathering, making the data comparable and interoperable with other existing databases, analysing this data and offering relevant results to key stakeholders. This supports better (more informed, more transparent and faster) decision-making, contributes to the de-risking of energy efficiency investments in buildings and facilitates process of closing investment deals. The platform has been put into practice in two large demonstrators in Catalonia and Bulgaria and has collected energy and investment data from more than 5000 buildings and 3000 energy efficiency measures, offering building performance monitoring, savings evaluation, and benchmarking of investments' performance.The presentation will make an overview of the EN-TRACK's approach to data gathering, harmonisation, and benchmarking, and will outline its exploitation potential for increasing the energy efficiency investments in buildings.

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 885395

3 Non-scientific articles

As part of EN-TRACK's communication strategy, articles are regularly published on relevant websites and media outlets in the fields of energy, data management, green emissions, finance, and construction. Several news articles have been published on EN-TRACK's website, the websites of its partners, as well as in relevant European media outlets, including Build Up. The non-scientific articles and press releases are published to inform and engage relevant stakeholders at national, EU and global levels regarding project activities, achievements, results, and outcomes.

The articles are also intended for a wide range of stakeholder groups, including policymakers and industry representatives. An overview of the published non-scientific articles is provided in the table below, along with the authoring partner, publication dates, and links to the articles.

Table 2. Non-scientific articles.

Article	Title * Partner * Publication * Date * Link	Summary
1	**EN-TRACK Project** *CIMNE-BEE Group* Build Up 9 October 2020 https://www.buildup.eu/en/explore/links/en-track-project	Introducing the EN-TRACK project to a broad variety of stakeholder groups at an EU and international level. The main target groups of the Build Up media outlet are energy efficiency specialists.
2	**How to characterize energy use in buildings?** *CIMNE-BEE Group & Smart Innovation Norway* Build Up 8 September 2021 https://www.buildup.eu/en/practices/publications/how-characterize-energy-use-buildings	Promotion of an academic publication. Targeted at the EU and international scientific community and data management professionals in the field of building energy efficiency.

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 885395

3	**EN-TRACK: Energy Efficiency Performance-Tracking Platform for Benchmarking Savings and Investments in Buildings** *CIMNE-BEE Group* CIMNE-BEE Group website 1 November 2021 https://www.beegroup-cimne.com/portfolio/en-track-energy-efficiency-performance-tracking-platform-for-benchmarking-savings-and-investments-in-buildings/	Introducing the EN-TRACK project to the scientific community, especially experts in big data.
4	**Increasing Private Investments in Energy Efficiency Refurbishments** *CIMNE-BEE Group & Smart Innovation Norway* EN-TRACK website 25 January 2021 https://en-track.eu/increasing-private-investments-in-energy-efficiency-refurbishments/	Interview article with EN-TRACK's project coordinator Stoyan Danov, describing EN-TRACK's objective, approach and methods to all stakeholder groups at an international level.
5	**First webinar and stakeholder meeting of the EN-TRACK project** *EnEffect* EcoEnergy newsletter 13 June 2021 http://www.ecoenergy-bg.net/UserFiles/File/Publication%20May%202021.pdf	Introduction of EN-TRACK, summarising the first webinar and stakeholder meeting to Bulgarian stakeholders of Ecoenergy, a municipal energy efficiency network. The main target group consists of Bulgarian public authorities.
6	**EN-TRACK: Energy Efficiency Performance-Tracking Platform for Benchmarking Savings and Investments in Buildings** *DTES* Catalan Government website 1 April 2022 https://territori.gencat.cat/ca/06_territori_i_urbanisme/arquitectura/actuacio_internacional/projectes_europeus/en_track/	Introduction of the EN-TRACK project on the Catalan government's website. The main target group is Spanish public authorities, especially in Catalonia.

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 885395

7	**Creating systems to make energy efficiency investments a mainstream activity of the financial sector** *ep group* ep group website https://epgroup.com/case_studies/en-track/	Introduction of the EN-TRACK project to the British and international stakeholders of a consulting company ep group.
8	**EN-TRACK** *Smart Innovation Norway* Smart Innovation Norway website 20 January 2021 https://smartinnovationnorway.com/en/prosjekt/en-track/	Introduction of the EN-TRACK project to the Nordic and international stakeholders of Smart Innovation Norway
9	**Towards energy data interoperability – insights from the SPARK conference** *ep group & Smart Innovation Norway* EN-TRACK website 9 September 2022 https://en-track.eu/towards-energy-data-interoperability-insights-from-the-spark-conference/	Summary of EN-TRACK participation at the SPARK conference, including insights from energy experts across Europe on becoming part of a larger data ecosystem within Europe.
10	**EN-TRACK London Roundtable: Key Challenges for Data and Net Zero** *ep group* EN-TRACK website 9 December 2022 https://en-track.eu/en-track-london-roundtable-key-challenges-for-data-and-net-zero/	Summary of the EN-TRACK roundtable in London. Topics covered e.g. energy performance certificates and government support in the wider net zero transition.
11	**9500 households will have the chance to install photovoltaics free of charge** *EnEffect* dir.bg 17 November 2022 https://dnes.dir.bg/dir-podcast/9500-domakinstva-shte-imat-shans-bezplatno-da-poluchat-fotovoltaitsi	Interview about RES and smart metering with Stanislav Andreev from EnEffect.

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 885395

12	**The EN-TRACK project aims to increase investments in energy efficiency by collecting statistical data** *CIMNE* Eseficiencia – Grupo TecmaRed 7 October 2022 https://www.eseficiencia.es/2022/10/07/proyecto-en-track-pretende-aumentar-inversiones-eficiencia-energetica-mediante-recopilacion-datos-estadisticos	Introducing the project, its objectives, the pilots and achievements.
13	**Unveiling the Potential of Smart Meter Data: Key Learnings from the UK, Spain, and Bulgaria** *Smart Innovation Norway, EnEffect, ICAEN, ep group* BuildUp 7 February 2023 https://www.buildup.eu/en/news/unveiling-potential-smart-meter-data-key-learnings-uk-spain-and-bulgaria	The article discusses the deployment of smart meters in Spain, the United Kingdom, and Bulgaria. The article compares the different approaches and shares the recommendations and learnings from each country.

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 885395

4 Publication action plan

Once the platform is launched, a publicity campaign will be undertaken, as described in the deliverable 7.5 *Exploitation plan - plan for sustainable exploitation of the project results, presentation kits and guidelines* (confidential). For optimal visibility, press releases and non-scientific publications will be included in the campaign.

The planned non-scientific articles include a story of EN-TRACK, including its objectives, necessity and initial feedback on the platform, with the goal of introducing the platform to more key target groups. Some of the articles will provide an overview of the two pilot sites and the lessons learned from them, as well as a number of testimonials from end-users. Moreover, more articles describing the technical aspects of the platform are planned for publication, including conference papers. Relevant media outlets have been identified and selected internally within the consortium.

During the final year of the EN-TRACK project, the partners will continue to update their publications to the monitoring and reporting file in the project repository. A continuous updating of the file will enable accurate reporting of the publications in the deliverable D7.4 *Dissemination and promotion – period 2* (confidential). As the leader of the Communication and Dissemination work package, Smart Innovation Norway continues to coordinate the planning and dissemination of the upcoming articles.

The future articles and public deliverables will be shared on the EN-TRACK website (www.en-track.eu) under Deliverables and Articles.

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 885395