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CT SEI

GENCo- An Energy Management Dashboard

Executive summary

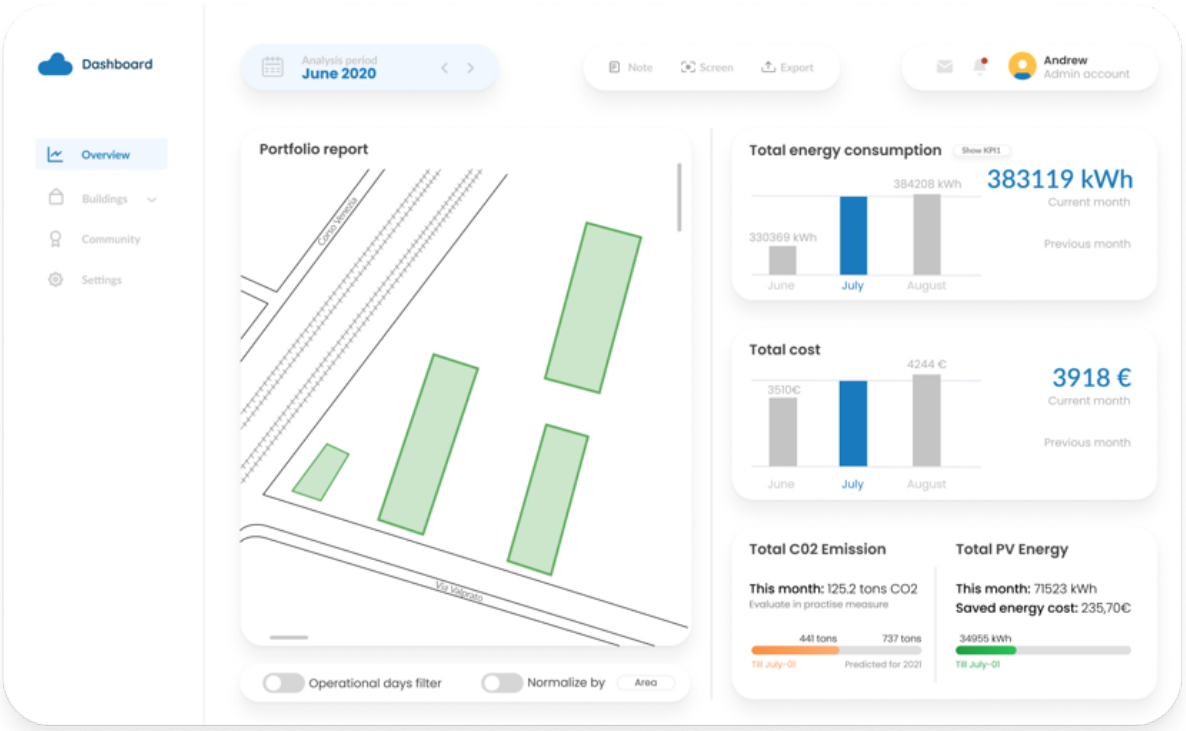
The Building Energy Management (BEMS) sector is a developing sector, whose market is expanding mainly due to the interest of companies in optimizing their use of energy. Moreover, better energy management helps companies to achieve **money savings** and, on the other hand, contributes to **reducing CO2 emissions** related to building operations, which amounts to **35% of the global emissions**. The existing solutions on the market provide basic tools for data analysis, but the lack of effective visualization of results makes knowledge extraction and application cumbersome. Furthermore, the limited possibilities of selection of methods for Data Analytics and representation of results limit the application of the energy manager's skills.
The project aims to develop an efficient **energy management dashboard** for three different stakeholders: Energy Managers, Companies or Building Owners, and Building Occupant**s**. The solution (**GENCo**) combines advanced **data analytics** techniques with **visual analytics** improvement, maintaining the features of accessibility, customization, and ease of communication. It is a complete and integrated system, which provides different dashboards depending on whether the user is the **Energy Manager**, the **Company**, or the **Building Occupants**, to allow all users to know the status of the building in terms of the energy consumption and the building emissions, each according to their needs. It introduces:

- Innovative section to control **comfort** parameters (RH and T).
- Effective **visualization** of the information generated from data analysis
- The concept for "**community**" section, where energy managers can share models and results to foster the exchange of ideas and knowledge
- Informative **communication strategy for employees** so they can contribute to more sustainable energy management.

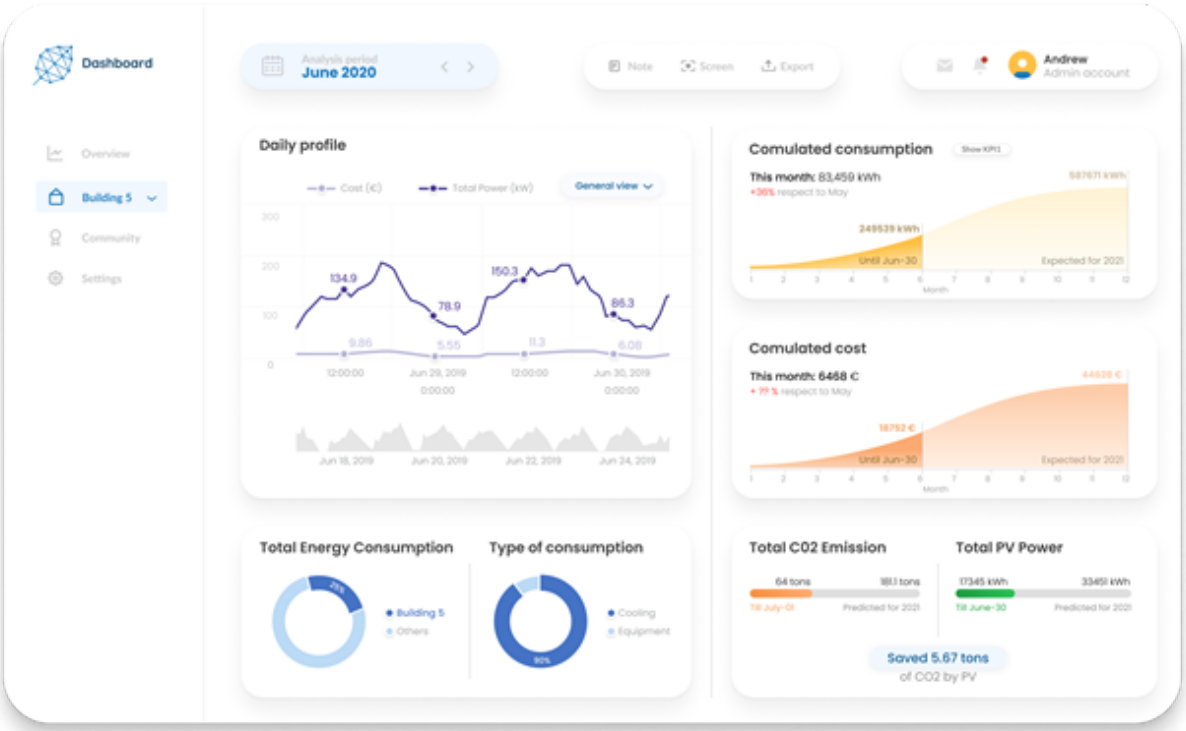
Key Words

Building's energy management system (BEMS), Data analytics, Visual analytics, Energy Managers, Occupants

Energy manager and data analysis



GENCo homepage



GENCo overview of single building

Project description written by the Principal Academic Tutor

Enhancing energy management in buildings is becoming a crucial objective to face the challenges posed by the progressive introduction of renewable energy sources, multi-energy systems and bidirectionality of energy exchange between prosumers. Internet of Things (IoT) and advanced Information Communication Technologies (ICT) are leading a profound transformation of the energy management paradigm in buildings, enabling the collection and analysis of large amount of building related data. In this framework, Energy Management and Information Systems (EMIS) provide great opportunities to building owners and energy managers to optimise building operation, leveraging on advanced data analytics-based technologies for extracting knowledge from building-related data. EMIS include Energy Information Systems (EIS) and Fault Detection and Diagnosis (FDD) intended as software tools aimed respectively, to analyze and effectively display building related data and to detect faults or suboptimal performance of building systems and to diagnose their potential causes. Considering that both EIS and FDD are tools aimed at supporting the decisions with the aim of reduce energy wastes during building operation, it becomes crucial the development of robust, engaging end interactive tool, which can really enable actions from energy managers and building owners to translate the information provided into ready-to-implement strategies for optimizing the building performance. In this context the SEI Pioneer project aims to conceptualize an energy dashboard to get insight on data related to both energy performance and indoor environmental quality of buildings at different scales (from single building to district of buildings). The dashboard was conceived based on interviews with experts in the energy sector and specifically designed for different type of users, form the energy manager to the occupant. This tool informs on energy utilization both through effective visualization and the introduction of specific KPIs to track energy consumption, costs, quality of the built environment and environmental impact. The project required a high level of multi- and interdisciplinary and forced the team members to continuously challenge themselves to propose and implement solutions which can really address the needs of the smart energy dashboard market.

Team description by skill

Our team is composed of:

Davide Ricci, Materials and Nanotechnology Engineering student, is the spokesman and planner of the team. He has taken on the task of managing the project and, thanks to his engineering background, he has mainly dealt with the work on data analysis and dataset training.

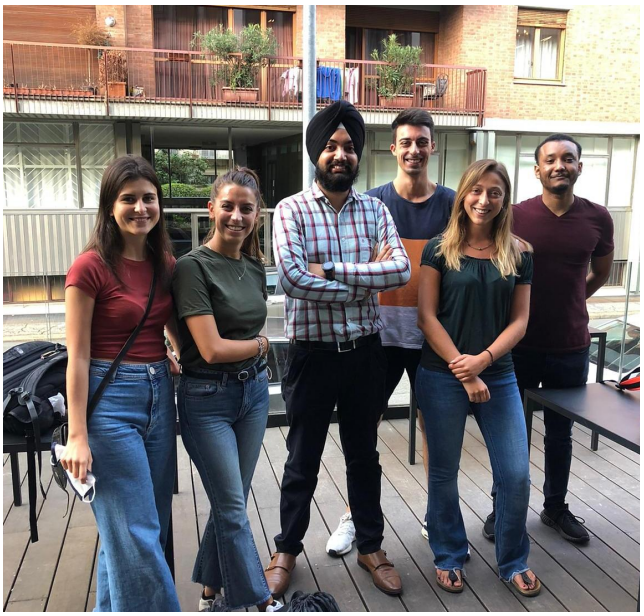
Lovepreet Singh, Energy and Nuclear Engineering student, is the coordinator between the team, ASP and tutors. He is the humorous member of the group, always ready to break the tension in the moments of decisions. He initially dealt with data analysis, and then devoted himself to the study of the energy costs of non-residential buildings and to the in-depth study of building comfort.

Mohamed Elfaki, Engineering and Management student, is the peaceful member of the team, whose last word was always expected as it was always objective. He mainly dealt with data analysis and dataset training together with Davide.

Lucia Marrocco, Electrical Engineering student, with his positive attitude is the motivator of the team. She dedicated herself to the coordination between the scientific and the artistic part of the project, helping characterize the features of the solution, and contributed to the cost and comfort analysis part together with Lovepreet.

Camilla Nicolini, Architecture for Sustainable Development student, with her proactivity adapted to carry out different tasks within the group. She took care of characterizing the solution with added values, maintaining a constant dialogue with the scientific part to arrive at a shared and feasible concept. Together with Beatrice she took care of the creative part, taking care of the graphics of the presentations. Thanks to her background, she was in charge of the study of the GIS tool and its integration in the dashboard.
Beatrice Riva, Design Engineering student, is the creative mind of the project. She is responsible for the design of the dashboard, which was conceived following an in-depth study of data representation and coordinating with Lucia and Camilla to characterize the solution with new features.

The project integrates the different backgrounds of each member, so that value can be derived from the contribution of different expertise while providing value to each one.



Goal

The project aims to develop an **efficient energy management dashboard** for three different stakeholders: Energy Managers, Companies or Building Owners, and Building Occupants. The project stems from the challenge issued by a management software house, SAP, whose request was to develop an energy management dashboard for their offices, using their data analysis platform SAC (SAP Analytics Cloud). This led the team to first study a dashboard concept on the **SAC platform**, and then to develop a general and **independent** idea of an energy management dashboard for tertiary buildings. The second phase of the project involved the study of advanced data analytics techniques combined with visual analytics, to design a demonstrator and mock-up of an innovative and functional dashboard, able to create reliable forecasts and predictions to extract useful knowledge for a better energy planning and insights from them.

Understanding the problem

Buildings use 35% of energy in the world and are directly **responsible for 35% of global emissions**. Moreover, barely designed and poorly managed buildings use more energy, increasing the demand for energy production and contributing, again, to global warming. The range of direct and indirect impacts that buildings have on the environment makes it easy to understand that the fight against climate change must start by reducing the CO2 production of the building sector.

In this context, the increasing development of Energy Management Systems (EMS) technologies in buildings have made a huge amount of building data available, which has enabled greater **interoperability** between the building and the energy manager. Energy managers have to manage the building's energy consumption. They are responsible for analyzing the energy state of the building and for detecting malfunctions and misreporting, in order to optimize consumption and find opportunities for energy savings.

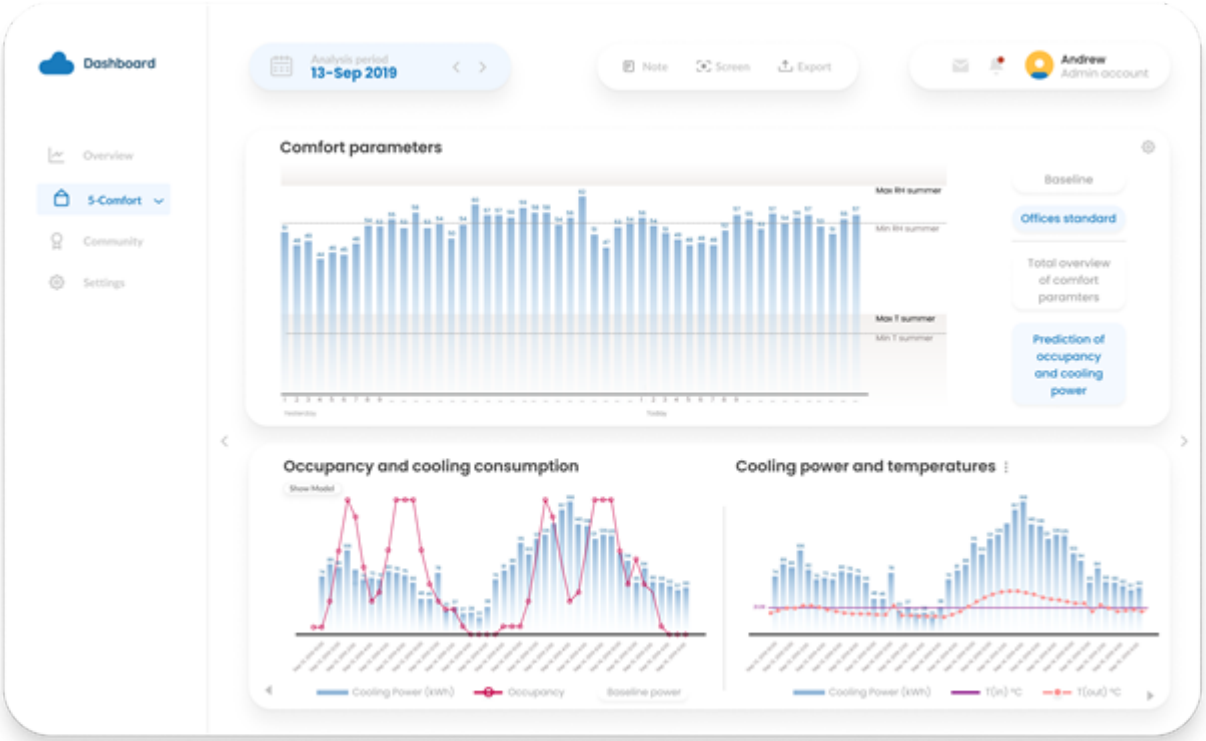
From a holistic point of view, overcoming the limits of current methods, tools and technologies for data analysis with an adequate energy monitoring dashboard is therefore essential to reduce the impact of buildings on climate change. This will help the energy managers to effectively manage the energy status of the building to **save energy consumption and costs** for the company, obtaining a **better reputation** for the company and, last but not least, **improving the working environment.**

Exploring the opportunities

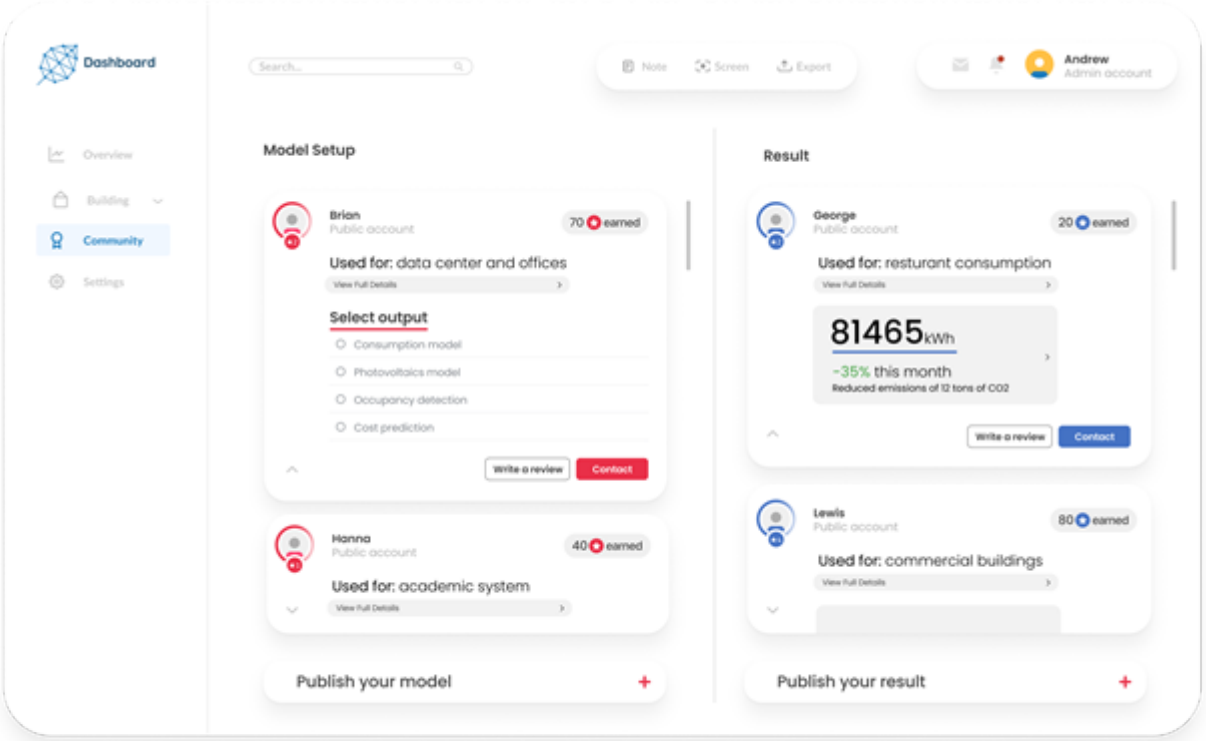
Currently, the most utilized tool to manage the energy consumption and the CO2 emissions by an energy manager is Excel. The reason for this choice is related to the high level of customization offered by the Excel environment along with the possibilities to analyze a large amount of data. However, the data analysis activity with Excel requires huge computational resources and time. In addition, in Excel the **data visualization is not effective**. As a consequence, one of the major benefits would come from designing a platform that is highly customizable and can handle a large amount of data in a reasonable time frame exploiting the data pre processing techniques.

There are energy platforms that offer data visualization and analysis services, nevertheless, in the market there is a lack of a platform which **involves different stakeholders** of an energy management system. Moreover, the services provided by these dashboards do not cover all the needs of an energy manager. These untapped opportunities underline the importance of addressing all the stakeholders involved in the decision making process of a building energy consumption and emissions and the need of a unique platform which covers all the features wanted by the energy managers.

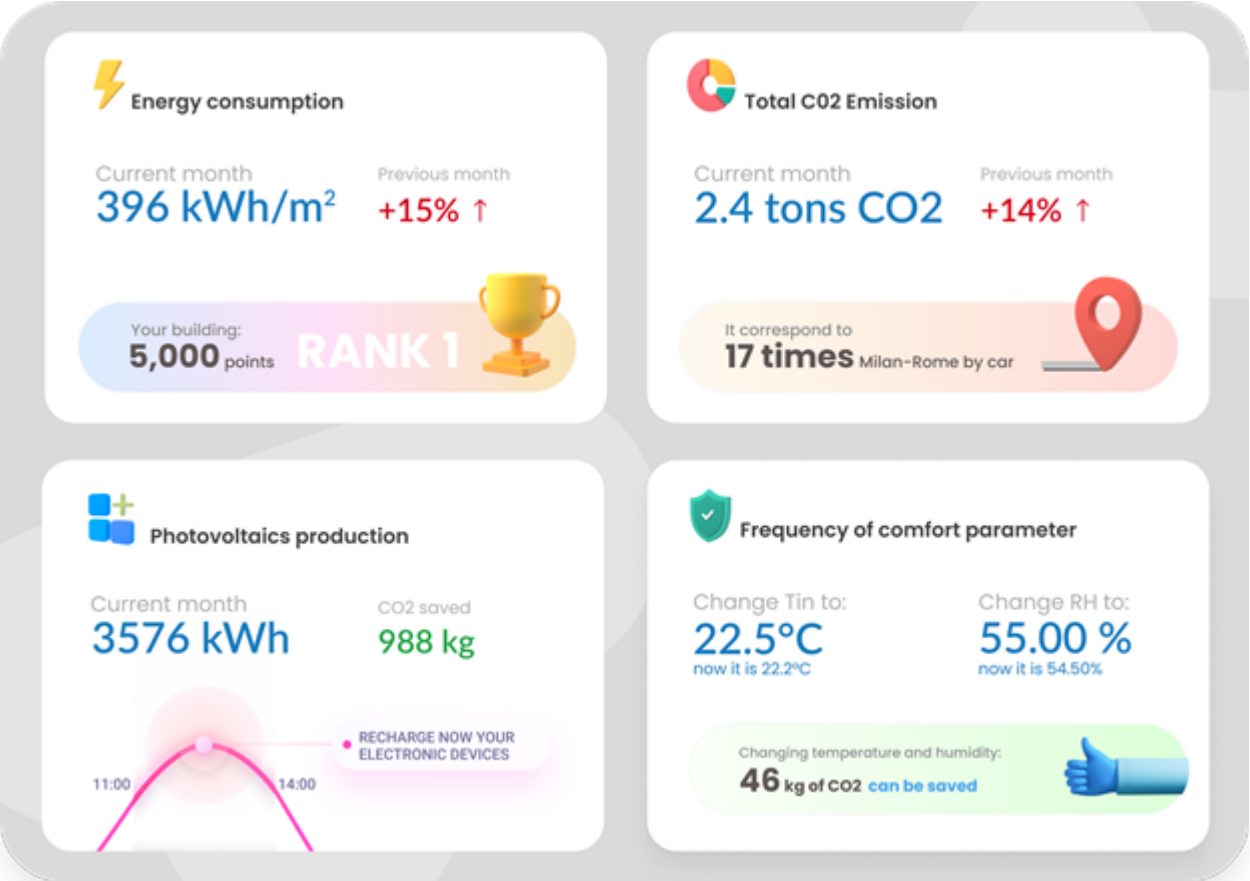
Finally, an additional opportunity is offered by the implementation of a service that addresses the lack of **communication between the energy managers** of different buildings. This would lead to optimizing the data analytics models reducing the computational resources required for a particular task.



GENCo comfort section



GENCo community section



GENCo occupants engagement section

Generating a solution

After an in-depth analysis of users' requirements, as well as of the strengths and limitations of existing energy management systems and dashboards, **GENCo** was born: the concept represents the starting point for the development of an innovative dashboard for energy management. We have managed to arrive to a solution that combines advanced data analytics techniques with visual analytics improvement, maintaining the features of accessibility, customization, and ease of communication thanks to hierarchical and spatial organization. It is a **complete and integrated system**, which provides different dashboards depending on whether the user is the Energy Manager, the Company, or the Building Occupants, to allow all users to know the status of the building in terms of the energy consumption and the building emissions, each according to their needs. It introduces:

- Innovative section to **control comfort parameters** (RH and T) combined with consumption and occupancy
- **Effective visualization** of the information generated from data analysis, with the division of dashboard and thanks to the use of **GIS** spatial representation
- The concept for "**community**" section, where energy managers can share models and results to foster the exchange of ideas and knowledge
- Informative communication strategy for **employees** so they can **contribute** to more sustainable energy management.

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