Driving innovation: Successful energy use cases in Madrid and Bilbao

Society needs energy that is clean, secure and affordable. While local energy communities (LECs) are well placed to deliver on these goals in the longer term, they are inherently complex and require optimised design and operation.

To address these complexities, eNeuron focuses on improving energy management in LECs using advanced technologies and methodologies. This is accomplished through a series of use cases, where new software and hardware solutions are rigorously tested in simulations to prove their effectiveness for real-world scenarios.

Key Points

- **Effective integration of renewable energy technologies**
- **Reduction of CO_2 emissions in urban settings**
- **Enhanced energy management through smart technologies**
- **Efficient use of energy storage systems**
- **Scalable solutions for green EV charging**
- **Long-term cost savings from sustainable solutions**

Maximising use case insights through generic scenarios

In the eNeuron project, a series of use cases (UCs) were identified, requiring a careful selection of suitable scenarios. This involved mapping the required functionalities for each scenario to ensure successful simulations across various locations.

Some UCs have already been tested in generic scenarios, while others will be evaluated in pilot site scenarios. Testing UCs in generic scenarios ensures a controlled environment, isolating variables for reliable and repeatable results while optimising resources and validating core tools. In contrast, pilot site scenarios involve real-world data and specific conditions, demanding more resources and stakeholder engagement.

This phased strategy leveraged generic scenarios to establish a solid foundation for the more complex simulations to follow, enhancing decision-making and ensuring practical applicability in varied operational contexts.

Insights from simulations: Core tools and key use cases

After identifying and mapping generic scenarios to UCs, detailed simulations were conducted using the eNeuron tools, which support long-term investment analysis, system design, day-ahead operational analysis, and real-time optimisation. Also, the simulations drew on parameters such as economic factors (interest rates, energy prices), environmental metrics (carbon intensity), and device-specific characteristics (storage capacities, efficiency rates), all essential for ensuring accuracy and reliability.

The simulations yielded valuable insights and practical recommendations for future developments. Notably, the optimisation of local energy investments in Madrid and the enhancing of electric vehicle (EV) charging stations in Bilbao stood out with exceptional results, demonstrating the effectiveness of the proposed solutions in meeting the project's key performance indicators (KPIs).

Optimising local energy investments in Madrid

This use case focused on optimising investments in renewable energy sources (RES) in Madrid (Spain), aiming to minimise CAPEX and reduce CO_2 emissions. Set at Ciudad Universitaria, the scenario adhered to IEC standards, addressing the need for efficient energy systems to manage heating and cooling demands.

The simulation explored integrating PV generation, aerothermal heating, and energy-sharing between buildings. It also examined the use of hydrogen and electricity as energy carriers, with a focus on water electrolysis for hydrogen production.

An analysis using the eNeuron toolbox for investment evaluation found that transitioning to electric heating with heat pumps is the most cost-effective option, offering significant savings and CO_2 reduction. Adding PV plants and hydrogen technologies further enhances environmental benefits, though at a higher initial cost. Sensitivity analyses highlighted the importance of correctly sizing PV installations and considering factors like electricity prices and interest rates, which significantly impact long-term investments.

Overall, this use case underscored

the value of integrating renewable energy and hydrogen technologies in urban energy systems, providing practical insights for planning new integrated local energy communities (ILECs).

Green EV charging in Bilbao

The Zorrotzaurre district in Bilbao (Spain) was selected for testing due to its potential to become a positive energy district and fully decarbonise by 2050. The district is equipped with PV systems, energy storage, EV infrastructure, and a main grid connection, making it ideal for this use case. All buildings have smart meters and energy management systems, and the scenario is scalable for laboratory testing.

The main objective of this use case was to use surplus renewable energy to charge EVs, thereby reducing grid congestion and lowering energy costs for EV owners. This involved optimising the placement of EV charging stations and managing the charging and discharging patterns of EVs and energy storage systems (ESS) to provide flexibility services like peak shaving and demand response.

Simulation results confirmed the effectiveness of integrating surplus PV energy for green EV charging. Strategic placement of charging stations and coordination of ESSs significantly reduced grid congestion and greenhouse gas emissions. The use of the eNeuron toolbox for real-time optimisation enabled the efficient management of EV and ESS operations, leading to cost savings and enhanced use of renewable resources. The simulation also showed increased renewable energy penetration and reduced CO_2 emissions, demonstrating the technical feasibility and environmental benefits of the proposed approach. Overall, the Bilbao scenario offered a scalable solution for green EV charging.

Conclusions

The simulations carried out in Madrid and Bilbao delivered valuable insights, confirming the feasibility and robustness of the proposed solutions in real-world conditions. Both use cases met key performance targets, offering practical recommendations and demonstrating the potential for broader application in energy transition efforts.

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Learn more about eNeuron:

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References

- **Deliverable 5.2: Simulation of Energy Hub Solutions in Selected Scenarios**

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