



# Sustainable Energy Authority of Ireland

National Energy Research,  
Development & Demonstration  
Funding Programme

## FINAL REPORT TEMPLATE

### SECTION 1: PROJECT DETAILS – FOR PUBLICATION

<b>Project Title</b>	sECUre: eStablishing Energy Community Utilities for Remote Energy grids
<b>Lead Grantee (Organisation)</b>	IES R&D
<b>Lead Grantee (Name)</b>	Ruth Kerrigan
<b>Final Report Prepared By</b>	Niall Buckley
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	<b>Name</b>	<b>Organisation</b>
<b>Project Partner(s)</b>	Mladen Antolic	Smart MPOWER (MPOWER)
	Dudley Stewart	MEGA Association (MEGA)
	Dara Ó Maoildhia, Avril Ní Shearcaigh, Helena Concannon	Comharchumann Fuinnimh Oileáin Árann Teoranta (CFOAT)
<b>Collaborators</b>	Jonathan Sandham	ESB Networks (ESBN)

	Gregg Allen	Templederry Renewable energy Supply Limited. T/A Community Renewable energy supply (CRES)
	Rory Mullan	Mullan Grid Consultancy
	Hugh Mullany	Mullany Engineering Consultancy
	Sandy Dunlop	Alexander Dunlop Ltd

### Project Summary (max 500 words)

The sECUre project has now been restructured, due to external factors, which has resulted in a change of scope. A virtual peer-to-peer (P2P) network will be established using the Aran island pilot site as a case study for the application of P2P microgrid in an Irish context. This is a significant change from a real-world fully functional P2P microgrid which has been shelved due to unfortunate timing which coincided with a global pandemic and was then further exacerbated by supply chain issues. The new proposed project will leverage all the groundwork accomplished by project partners to date and will depend on a key project partner, MPower, delivering on Smart Link Unit (SLU, smart-meters) instalment and operation. SLU instalment will be carried out during Q1 of 2023 and will be fully operational before March 2023. With a 12-month non-cost extension and a relocation of project funding from stabiliser equipment to personnel budget, the sECUre project can generate a calendar year of prosumer data subtitle for testing the cost benefit of implementing a P2P microgrid on the pilot site. The findings will be published and disseminated in support of grid decarbonisation and the potential proliferation

### Keywords (min 3 and max 10)

Energy communities, disturbance neutrality, distributed generation, grid capacity, user interfaces, storage, DSM

***NB – Both Section 1 and Section 2 of this Final Report will be made publicly available in a Final Technical Report uploaded online to the [National Energy Research Database](#).***

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## **SECTION 2: FINAL TECHNICAL REPORT – FOR PUBLICATION**

(max 10 pages)

### **2.1 Executive Summary**

Net zero islands have been a long-time goal of CFOAT (Comharchumann Fuinnimh Oileáin Árann, The Aran Islands Energy Co-op) as they endeavour to transition from a fossil fuel-dependent rural community to a more sustainable means of living.

Moreover, these island inhabitants are eager to foster resilience, particularly concerning the local grid, to become more independent from dependence on the mainland. Often, energy policy is targeted at urban centres where they understandably have a heavier impact on national carbon budgets; however, rural communities make up over 30% of the country's inhabitants and will need innovative solutions to help them transition towards more sustainable energy communities needed for national net-zero aspirations. To this end, the SECURE project will test a digital peer-to-peer (P2P) microgrid system with the ambition of incentivising the island inhabitants in partaking in localised energy generation and distribution. These P2P systems may be ideally suited for more remote communities that are susceptible to power outages due to disruptive events as well as energy losses over long-distance transportation from generation sources.

This project will support the islands' future goals of net-zero energy and energy resilience using Inishmore, the largest of the three Aran islands, as the pilot site. By testing the cost-benefit of applying these localised microgrids, the project hopes to develop a roadmap for decarbonisation for rural communities in Ireland and abroad. The SECURE project aims to support sustainable and energy-efficient community on Inishmore island through innovative energy trading testing via digital twin simulations. This report outlines the project's objectives, methodology, challenges, and findings. The project partners are IES, CFOAT, and MPOWER each contributing to different aspects of the initiative.

- **IES:** Developed a digital twin of Inishmore, conducted P2P trading impact analysis, and generated net-zero scenarios.
- **CFOAT:** Facilitated public engagement, managed communication between stakeholders, and assisted with data collection and participant recruitment
- **MPOWER:** Responsible for designing, manufacturing, and installing 10 SLUs, establishing a virtual P2P trading network, and preparing a report on microgrid challenges.

## **2.2 Introduction to Project**

### **Summary of the sECUre Project**

The sECUre project, titled "Establishing Energy Community Utilities for Remote Energy Grids," is a pilot initiative focused on deploying an Energy Community in the Aran Islands. This project serves as a practical demonstration of community grids while ensuring no adverse impact on national grid stability. Led by IES R&D and involving multiple partners including CFOAT and MPOWER, the project aims to optimize distributed energy generation and flexibility assets through advanced planning and management technologies.

### **Project Overview and Objectives**

The project was originally planned to be completed in 36 months, but ultimately transitioned to being a 48-month project that involved engaging local prosumers (residential, public, and commercial) to assess the feasibility of a Community Grid. Utilizing software developed by IES, scenarios for local energy generation and storage to be analysed before installation of the MPOWER community grid to ensure both technical and cost efficiency. Key aspects that needed to be established for a successful real-world energy community were:

- Real-time management of energy production, storage, and flexibility through the Community Grid System and online MPOWER platform.

- Evaluation of future trading potential within the community and the wholesale market.
- Alignment with ESB Networks to ensure compliance with national grid regulations.
- Development of regulatory frameworks and business models for widespread adoption of the Energy Community Utility (ECU) concept.

### **Key Challenges and Adjustments**

The project faced several challenges due to its unfortunate timing coinciding with a disruptive global pandemic, notably logistics, staff turnover, and supply chain delays impacting MPOWER's ability to deliver the Community Grid, which hindered the installation of key physical assets. To mitigate these setbacks, contingency measures were implemented, including:

- Mapping probable energy production and consumption profiles in Inishmore.
- Conducting site surveys to simulate energy demand.
- Establishing a virtual microgrid to test scenarios.
- Engaging with other local projects such as REACT<sup>1</sup> to share resources and expertise.

Due to these challenges, certain objectives and timelines were revised, impacting original aspects of the project such as the implementation of a grid stabilizer installation and real-world peer-to-peer (P2P) energy trading, which were removed due to the aforementioned challenges.

### **Digital Twin and Data Management**

One of the major innovations in the sECUre project is the use of Digital Twin (DT) technology implemented by IES. Delays in Smart Link Unit (SLU) installation

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<sup>1</sup> <https://react2020.eu/>

required the project partners to find alternative metered data to calibrate the DT model.

- The DT serves as a virtual representation of the demand side loads, allowing for detailed analysis of energy consumption and potential efficiency measures.
- It enabled the application of Energy Conservation Measures (ECM) and scenario testing towards net-zero aspirations for the Aran Islands.
- The DT formed the foundation in forecasting energy demand scenarios and evaluating the transition to electric heating systems.

### **Implementation of SLU Smart Meters**

SLU installations facilitated energy metering at building scale that supported digital twin calibration for residential buildings on Inishmore. These data underpinned demand side management strategies tested using the DT of the island. The SLU deployment underwent several changes from the original project plans such as:

- **SLU Development:** Originally designed with Raspberry Pi components, the SLUs were redesigned using Arduino due to semiconductor shortages. This enabled the energy trading mechanics needed for real-time energy trades if there was potential for initiating energy trading on the island.
- **Communication Network Testing:** GSM and LoRa helium was used instead of local LoraWAN network due to poor coverage of the LoRaWAN network.

### **Stakeholder Engagement and Regulatory Considerations**

Community participation was a cornerstone of the sECUre project. The project community engagement was led by CFOAT. They supported with the following:

- Conducted in-person presentations to educate the community on digital twin technology and the benefits of energy trading.
- Facilitated GDPR-compliant data-sharing agreements to integrate metered data from existing projects.
- Engaged regulatory bodies to explore pathways for ECU recognition and licensing within Ireland.

- Supported project partners on workshops, personations, face to face meetings and general interaction with the public as well as supported operations on the ground

In summary, the updated goals for SECURE included:

- Recruit project participants to help generate data towards supporting virtual P2P grid scenarios
- Installing Smart Link Units (SLUs) in each participant building for real world data and potential for real-time energy trades
- Developing a digital twin roadmap renewable energy strategies for a net-zero transition incorporating P2P into these scenarios
- Create a virtual P2P network to test the cost benefit of applying novel renewable technologies

### **2.3 Project Objectives**

The amended project set out to 1) support the transition towards decarbonized energy systems by integrating digital twins (DTs) to optimize renewable energy sources (RES) and demand-side management (DSM) strategies. 2) leverage data-driven and predictive digital twins towards P2P trading that enhances local consumption of excess renewable energy. 3) Use digital twin models to simulate current and future energy consumption, forecast potential impacts of P2P trading and examined how digital twins can support better integration of RES, especially in communities with limited energy storage. 4) identify challenges related to infrastructure limitations, regulatory constraints, and technical feasibility. Finally, 5) leverage community participation by implementing SLUs that capture local energy usage data into digital twin models to create realistic and implementable energy trading scenarios and support local participants with live dashboards to better understand energy consumption.

**In order to execute the above objectives, the following case studies were conducted:**

- **Seven Building P2P Case Study:** SLUs were deployed in ten residential buildings to analyse P2P trading effects.
- **Island-wide Digital Twin Scaling:** The digital twin model was extended to simulate the impact of large-scale P2P trading and net-zero scenarios.

The case studies explored various scenarios:

- **Business as Usual (BaU):** Examined the effects of continued adoption of PV panels, EVs, and heat pumps.
- **Climate Action Plan (CAP):** Simulated aggressive decarbonization efforts aligned with EU Green Deal targets.
- **With vs. Without P2P Trading:** Energy efficiency improvements were assessed, with P2P trading.

**Data Collection and Infrastructure Development** Mapping of energy clusters on the island was conducted using ESB grid data. The SLU system was developed to monitor three primary energy sources: photovoltaic (PV) panels, electric vehicles (EVs), and household consumption. The IoT architecture involved data transmission from SLUs to MPOWER servers, where it was processed and shared via an API with IES dashboards for further analysis.

**Data Processing and Interpolation** Data gaps were identified in metered data due to sensor issues, connectivity, and some environmental disruptive events. Interpolation techniques using data analytics software were employed to fill missing values by IES. Energy consumption and production were calculated on an hourly basis to create accurate baseline comparisons

**Digital Twin Modelling** the Inishmore digital twin was developed using:

- **Building performance data (Tabula IE, CSO data, ICL UK Template)**
- **Site visits and surveys**
- **Energy consumption metrics (lighting, HVAC, EV charging)**

Simulations accounted for seasonal variations, which are significant due to the island's fluctuating population. Validation was conducted by cross-referencing modelled data with actual metered electricity usage.

## **2.4 Summary of Key Findings/Outcomes**

**Net-Zero Strategy and Decarbonization Roadmap** Decarbonization strategies were modelled for 2030, 2040, and 2050 under Business as Usual (BaU) and Climate Action Plan (CAP) scenarios. Key interventions included:

- **Building retrofits (insulation, window replacements, HVAC upgrades)**
- **Electrification of heating systems**
- **Expansion of renewable energy installations**

Simulation results indicated that a CAP-driven approach could significantly accelerate the island's transition to net-zero but current trends will fall significantly below the 2050 net-zero targets.

**Public Engagement and Challenges** CFOAT led community engagement efforts, including surveys, public meetings, and workshops. Challenges included:

- **Limited internet connectivity affecting data transmission**
- **Low engagement with online workshops**
- **Difficulties in interpreting dashboard data**

Efforts were made to enhance engagement through in-person meetings and local events

The SECURE project has successfully demonstrated the feasibility of integrating P2P trading and digital twin technology for rural energy transition. Key achievements include:

- **Deployment of smart metering infrastructure**
- **Development of a validated digital twin**
- **Simulation of net-zero scenarios including P2P**

## 2.5 Project Impact

The sECUre project demonstrated the challenges of establishing sophisticated P2P technology in Ireland with many policy, infrastructure, hardware, and software challenges on the Island of Inishmore, which reflects challenges associated with other locations on the Island of Ireland. Moreover, the digital twin technology was successful at testing strategies that illustrated the importance of storage in making optimal use of P2P energy trading methodologies in the future. Furthermore, the DT technology, highlighted shortfalls in the current trajectory for CAP2023 performance in a rural setting with projected targets to fall well below the goals set out by the 2030 and 2050 targets. This methodology is now being rolled out on other European funded projects and pilot sites to investigate current trends in decarbonization to test the potency of current decarbonization policy and methods across Ireland and the EU.

With regards to the impacts and findings of the sECUre project on the Irish energy sector, deliverables WP3-D4, and WP4-D4 have discussed the limitations and opportunities associated with P2P in Ireland and the following challenges are listed below as the key barriers to establishing P2P energy trading in the Irish context:

1. For the entire duration of the project there was no tangible policy or framework that would have enabled the application and operation of grid technology needed to facilitate P2P trading at a local scale
2. Network connectivity was poor at the pilot site with many SLUs suffering from data gaps and latency making it prohibitive for quick reliable energy trades assuming a P2P network was established
3. During the project, hardware and software necessary for real-time energy trades that was implemented by the project was bespoke and not readily available for public procurement

Ultimately, for the adoption of P2P technology in Ireland, policy needs to support the adoption of P2P technologies so that energy communities can leverage existing Renewable Energy Sources (RES) by adopting novel technologies towards energy trading network. Both the CRU and ESB Networks could begin by trialling P2P by clustering pilot sites that have both the appropriate network connections (buildings that are ideally situated on a network for energy trading) coupled with strong network

connectively (buildings that have broadband or 5G signal strength for fast connectivity) underpinned by nascent technology (smart-meters with building automated control functionality regulating PV and Storage operations). If an appropriate pilot site(s) is identified that meet the above criteria, then the probability of establishing a P2P network, or at least a trial run for energy trading would be more likely than without the support of stakeholders, technology, and infrastructure.

## **2.6 Recommendations**

The following themes are summaries from WP4 D4 and are suggestions on what could support the proliferation of P2P energy schemes on the Irish grid:

### **1. Facilitate the proliferation of P2P Energy Trading Schemes**

- Establish a licensing process for community energy trading platforms, ensuring compliance with grid stability, cybersecurity standards and other standards relating to the safe operation of hardware and software components of the grid.
- Introduce policies that encourage local energy communities (LECs) to engage in P2P energy trading.
- Provide incentives for prosumers (energy-producing consumers) to participate in localized energy sharing, reducing dependency on selling surplus to the national grid.

### **3. Enhance Digital Infrastructure for Smart Grids that can facilitate P2P**

- Expand high-speed internet and 5G networks to rural and island communities to support real-time energy trading.
- Develop national standards for smart metering and energy tracking to enable efficient P2P transactions.

### **4. Promote Energy Storage Integration**

- Provide financial incentives (grants, tax rebates) for residential and commercial battery storage to optimize energy use and encourage the proliferation of P2P
- Encourage vehicle-to-grid (V2G) uptake, allowing electric vehicle owners to sell excess energy back to the local community or consume during disruptive events.

## **5. Modernize Grid towards Demand Side Management for Decentralized Energy**

- Invest in grid infrastructure improvements that support bidirectional energy flows from distributed energy resources (DERs).
- Reinforce grid infrastructure to enable greater load capacity for surplus energy to be utilized across the wider network

## **7. Support Digital Twin Applications for Grid Optimization**

- Embrace the proliferation of digital twin technologies towards compliance with EU digitisation aspirations<sup>2</sup>, specifically technologies that optimize energy use scenarios, reducing waste and enhancing grid stability.
- Leverage digital twins for predictive maintenance and energy master planning in energy infrastructure development.

### **2.7 Conclusions and Next Steps**

The sECUre project has successfully demonstrated the feasibility of integrating peer-to-peer (P2P) energy trading and digital twin technology to support rural energy transitions. Despite challenges such as supply chain disruptions, regulatory barriers, and network connectivity issues, the project has provided valuable insights into the future of community-led energy solutions. The use of digital twins enabled in-depth

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<sup>2</sup> [https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age\\_en](https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age_en)

analysis of energy consumption patterns, the potential benefits of P2P trading, and the necessity of energy storage solutions for optimizing distributed energy systems.

While the project did not achieve a fully operational P2P microgrid, it laid critical groundwork for future implementations. The findings highlight the need for regulatory frameworks, enhanced digital infrastructure, and stronger stakeholder engagement to enable energy communities to participate effectively in decentralized energy trading.

## **Next Steps**

1. **Regulatory Advocacy** – Work with policymakers, ESB Networks, and the Commission for Regulation of Utilities (CRU) to establish guidelines that facilitate P2P energy trading.
2. **Infrastructure Development** – Expand high-speed internet and smart grid technologies to support real-time energy trading and reliable data transmission.
3. **Further Pilot Projects** – Identify and develop new pilot sites with improved network connectivity and regulatory backing to test real-world applications of P2P energy trading.
4. **Technology Enhancement** – Refine digital twin models in tandem with emerging technologies such as AI, block chain, and Smart Meters for more effective monitoring and trading.
5. **Community Engagement** – Continue educating and involving local communities in energy transition projects, leveraging lessons learned from the Aran Islands pilot.

By addressing these next steps, the insights gained from sECUre can help drive Ireland's transition to a decentralized, sustainable energy system, supporting both rural and urban communities in achieving net-zero goals.