# ALIVE - Assessing Indoor Environmental Quality (IEQ) and Energy Efficiency In a range of Naturally-Ventilated Buildings: A Multi-Disciplinary Approach (RDD537)

This project has been funded by the Sustainable Energy Authority Ireland under the SEAI National Energy Research, Development and Demonstration Funding Programme 2019

Miriam Byrne
James O'Donnell
James McGrath
Ibrahim Alhindawi
**Divyanshu Sood**

# Longitudinal IEQ and Energy Consumption Monitoring Campaign

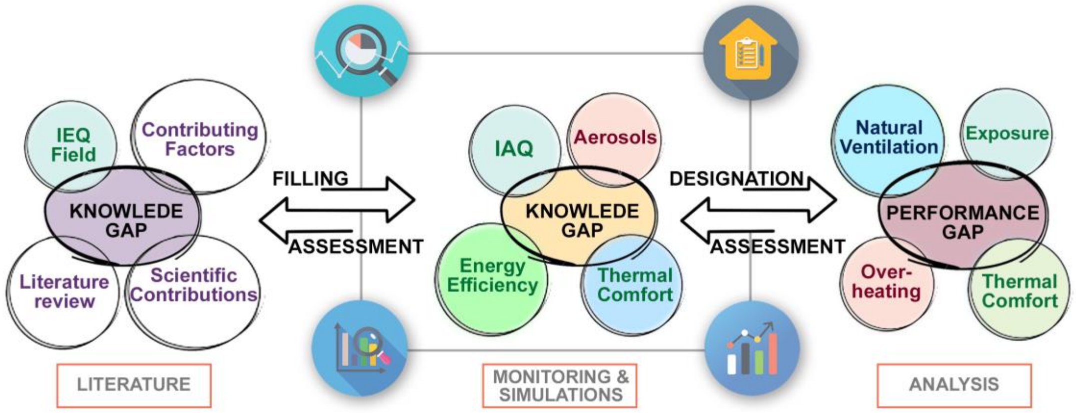


Figure 1 – Concept Diagram

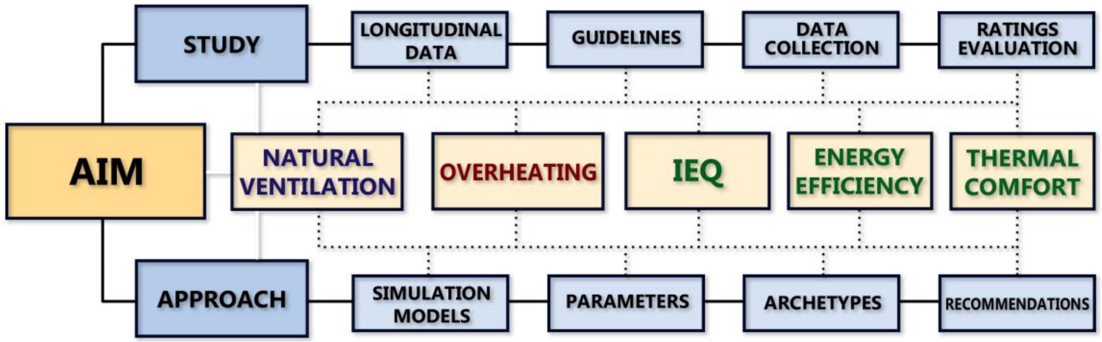


Figure 2 – Workflow Diagram

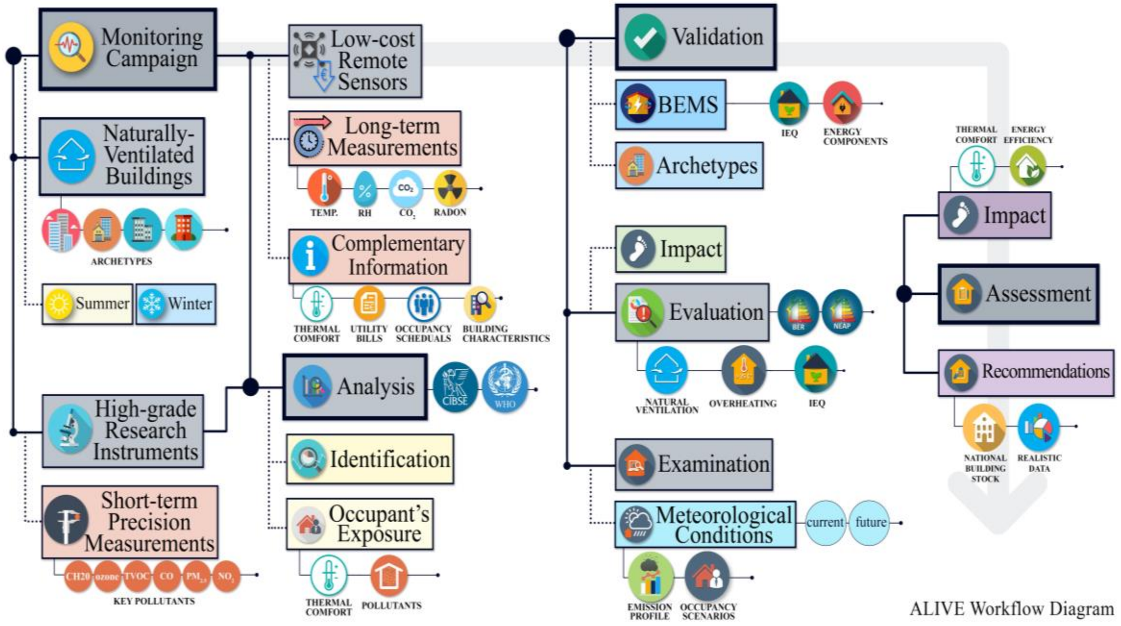


Figure 3 – Overarching methodology

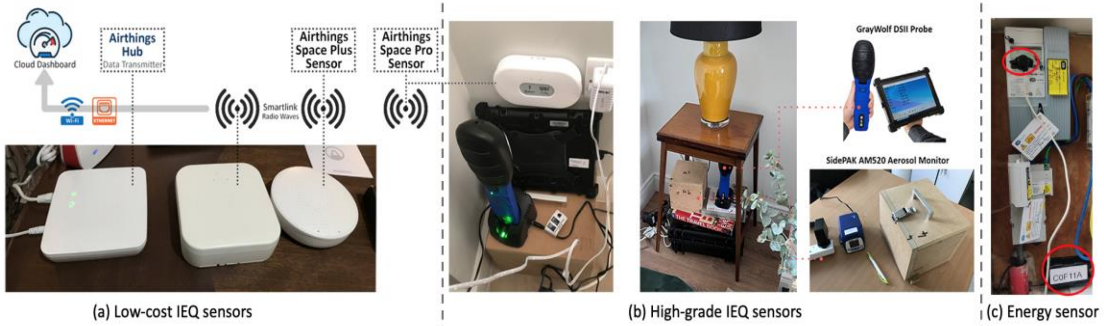


Figure 4 - Sensor Devices Setup

# Research Outcomes/Learnings – IEQ analysis

- A novel methodology allows for an accurate, longer-term representation of IEQ, capturing a combined **40 million** datapoints.
- IEQ levels are governed by occupant behaviour and habits.
- $CO_2$ data illustrates occupancy patterns: adaptive approach needed for ventilation operation.
- Natural ventilation provides inconsistent air change rates: Large variation between summer and winter. Improved IAQ during the summer period.
- Variation in IEQ concentration between days reinforces the need for longer-term monitoring.
- Cooking a large source of indoor PM and insufficient ventilation to remove it.

# Research Outcomes/Learnings – combined Energy-IEQ analysis

1. Developed **deterministic** and **probabilistic occupancy models** for multi-scale energy analysis using residential building archetypes.

2. **Enhanced** the energy prediction accuracy of **computationally less-expensive residential building archetypes** for multi-scale energy analysis at different spatial and temporal scales.

3. Developed a **customised framework** based on the metamodel approach for **rapid prediction and optimisation** of heating energy consumption, thermal discomfort, and $CO_2$ concentration in energy-efficient naturally ventilated homes.

4. Achieved an **80%** reduction in optimisation completion time with a high correlation coefficient of **0.98** compared to traditional physics-based approach.

# Informed policy and decision making

1. The integration of realistic occupancy behaviour and the energy-IEQ relationship into building energy models represents a significant advancement in multi-scale energy analysis.
2. This research focused on the development of sustainable building policies that priorities both energy efficiency and occupant comfort.
3. The metamodel-based enhanced predictive accuracy and reduced optimisation time facilitate the adoption of more efficient building management systems and retrofitting practices.
4. The insights gained from this research support the development of robust energy policies and standards that ensure buildings are both sustainable and conducive to occupant well-being, aligning with long-term environmental and societal goals.

# Vision for 2050

1. **Integration of Renewable Energy:** Strengthening the interaction between buildings and the power grid is essential. Research should aim to optimise energy use and facilitate the seamless integration of renewable energy sources.

2. **Scalable and Interoperable Technologies:** Research should prioritise the development of scalable and interoperable building technologies. For example, cloud-based BIM (Building Information Modelling) technologies.

3. **Data-Driven Decision Support Tools:** The creation of advanced decision support tools, incorporating machine learning and data mining techniques, is critical. These tools will help stakeholders make informed decisions about energy efficiency and sustainability, contributing to Ireland's net-zero goals.

4. **Community-Focused Energy Solutions:** Research should also emphasise the importance of community-focused energy solutions, encouraging sustainable practices at the grassroots level.

# Thank you

Any questions?

BuildingEnergyInformaticsGroup

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*This research was supported by a grant from the Sustainable Energy Authority of Ireland (SEAI) under the ALIVE Project: Assessing Indoor Environmental Quality and Energy Efficiency In a Range of Naturally-Ventilated Buildings: A Multi-Disciplinary Approach (19/RDD/537).*

# *Operational, stability, and network-related strategies for large-scale deployment of solar PV generation on the Irish power system*

Phurailatpam Chitaranjan Sharma (Lead researcher)

Assoc Prof. Damian Flynn (Project mentor)

*School of Electrical and Electronic Engineering,*

*University College Dublin, Dublin, Ireland*

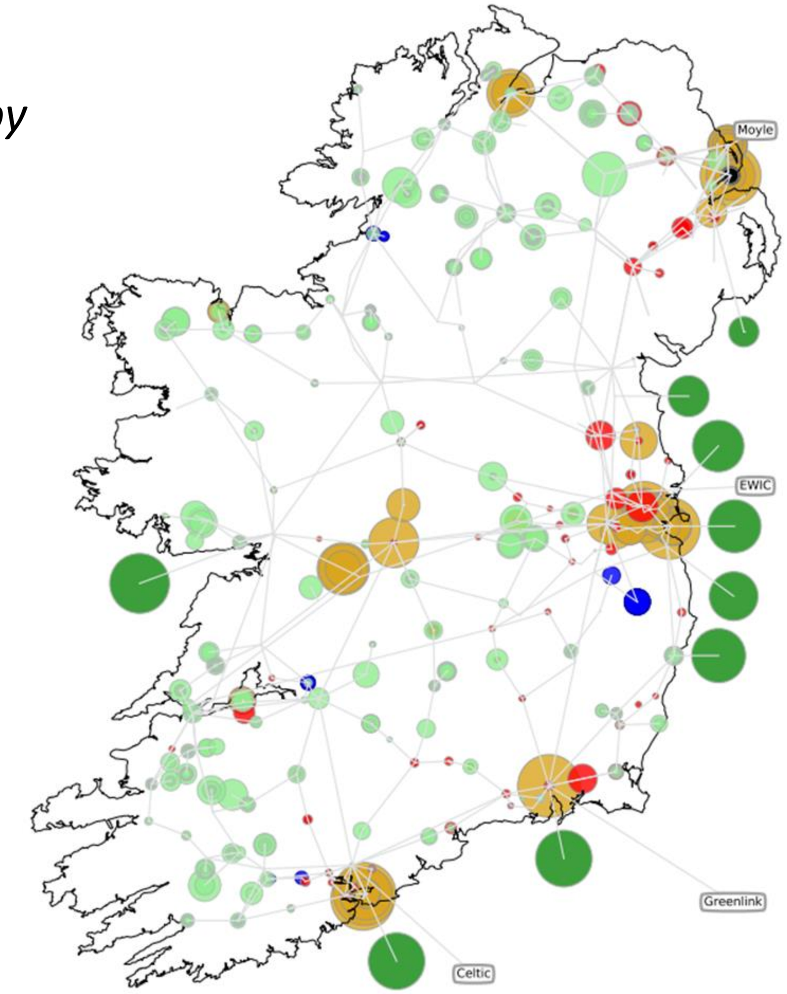
**SEAI RD&D Academic Fellowship - Grant 23/RDD/991 (OSN-Solar)**

SEAI 2024 National Energy Research and Policy Conference, *12th Sept 2024*

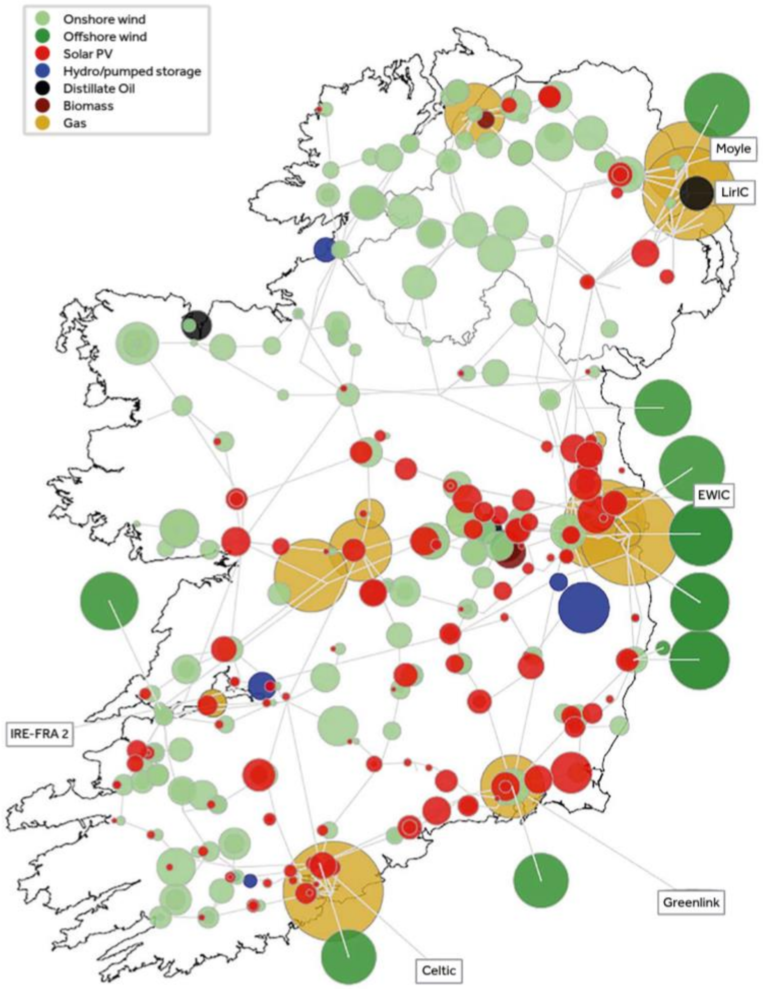
# Solar PV targets - 2030 and beyond

- *New target* – 5 GW by 2025 and *8 GW by 2030**
- Significant jump from *1.5 GW* defined *previously* for *2030*
- Accounting - *22 GW* of *all renewables*
- Rapid integration of PV – wide range of *new challenges* for System Operators
- PV systems - considerable *differences* in *variability of output* and the underlying *technology*

*2030 (Old targets)*

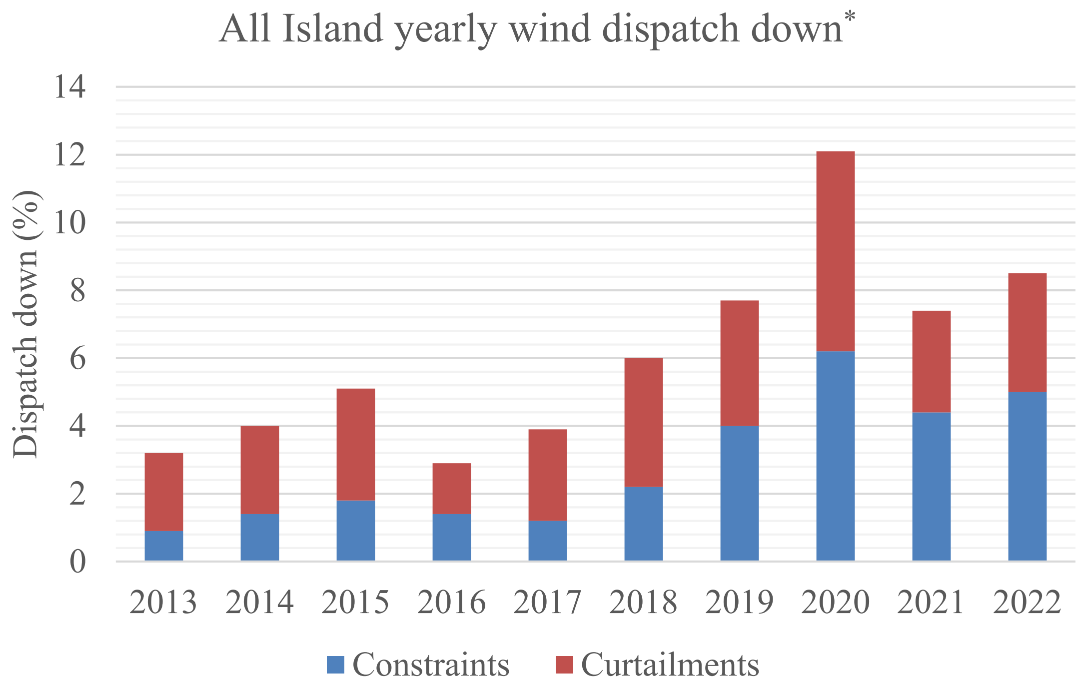


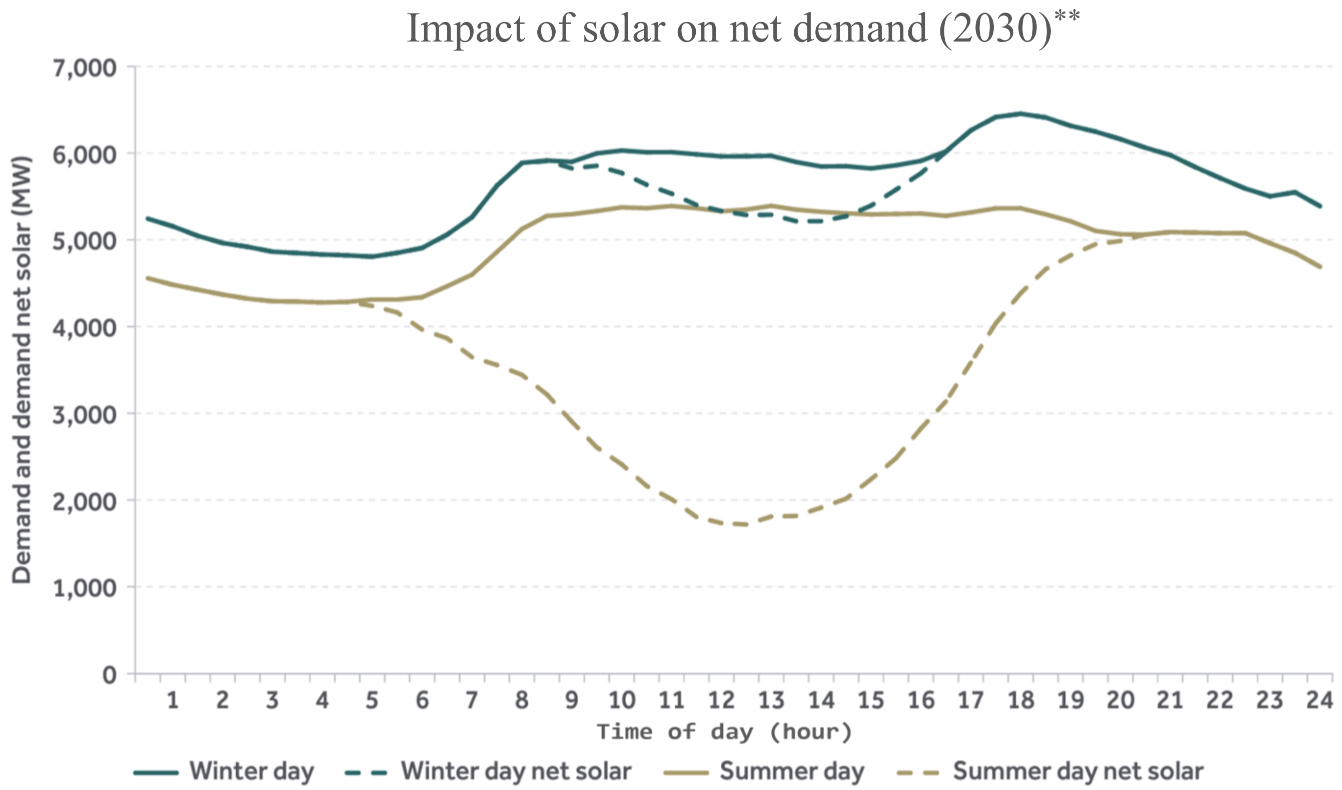

*2030 (New targets)***




*Government of Ireland, Climate Action Plan (CAP 23): Changing Ireland for the Better
**Shaping Our Electricity Future Roadmap – Version 1.1 (EirGrid and SONI, 2023)

# Challenges for Irish power system



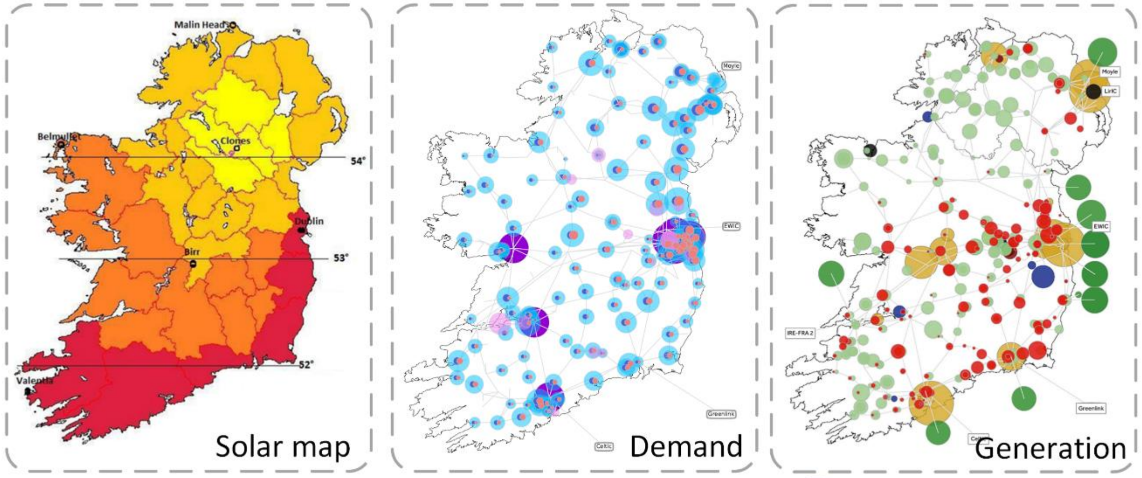




- *System-level challenges* – balancing, frequency control, stability, dispatch-down of RES, reduced system services provision, spatio-temporal variation in PV output, ramping effects, dunkelflaute
- *Local/regional-network challenges* – local over-voltage, over-loading, regional hotspots, power quality issues, reduced RES hosting capacity

*Annual Renewable Energy Constraint and Curtailment Report 2022 (EirGrid and SONI, 2023)
**Ten-Year Generation Capacity Statement 2023–2032 (EirGrid and SONI, 2024)

# Project Methodology

***Inputs*** PV/Wind – Resource & locations | Load data | Network data | Generation data




***Impact of high shares of PV in the Irish grid***

- Spatial and temporal distribution of PV
- Development of network models
- Identification of regional networks and system-wide issues

***System services from PV relevant to Irish Grid***

Grid-forming capability | Fast frequency response | Voltage/reactive power support | System strength | Inertial response | Congestion management | Black-start | Fault current

EMT Simulations

Performance analysis

***Challenges & solutions at regional level***

*Increasing PV share*

- Over-voltage & overloading issues
- Regional PV hotspots
- Grid hosting capacity
- Power quality
- Congestion
- Smart metering - coordinated control

RMS/average simulation- regional networks

EMT real-time simulation using Opal-RT

*TSO-DSO coordination*

***Challenges & solutions at system level***

*Increasing PV share*

- Maintain dispatch down below levels
- Coordination with other VRES
- Stability and reliability issues
- Spatiotemporal variation of output

Stability analysis

Optimal mix of service providers

Average/EMT simulations

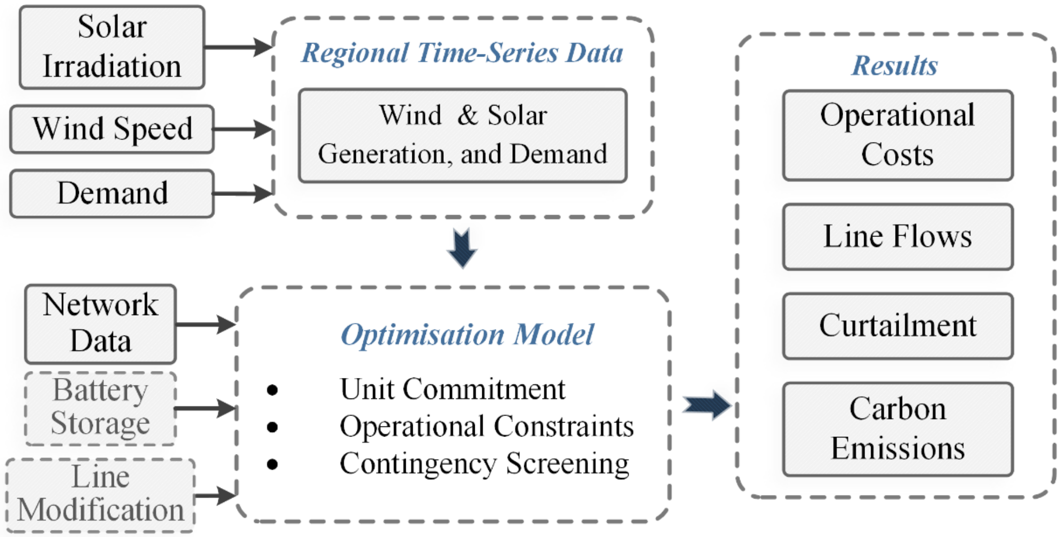
Optimisation studies – Irish grid scenarios

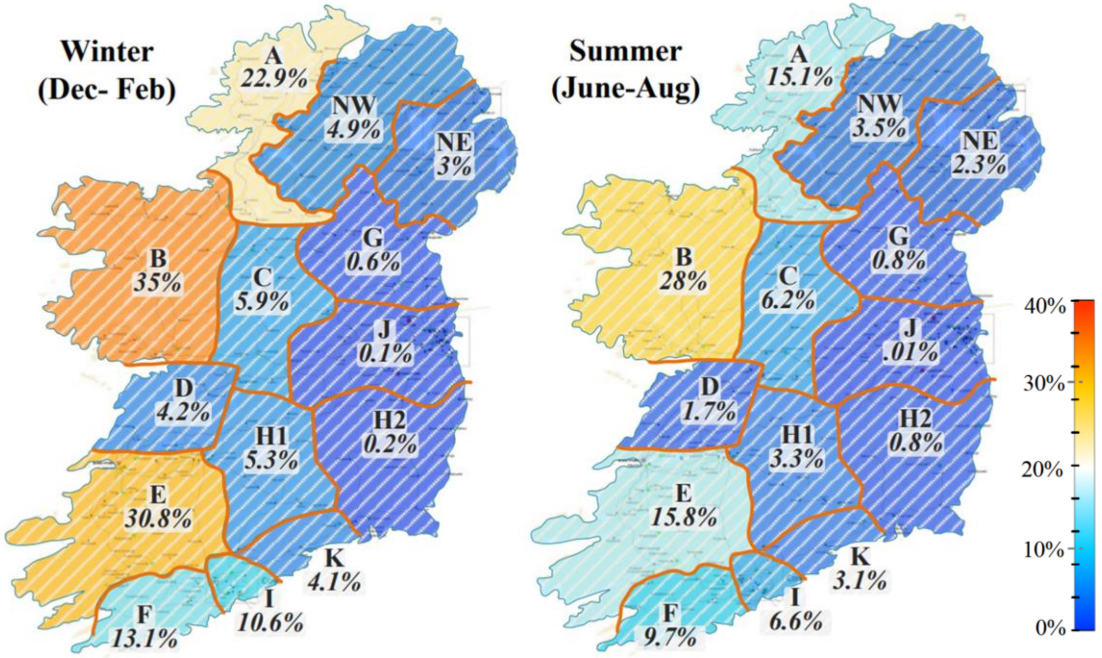
***Study Outcomes***

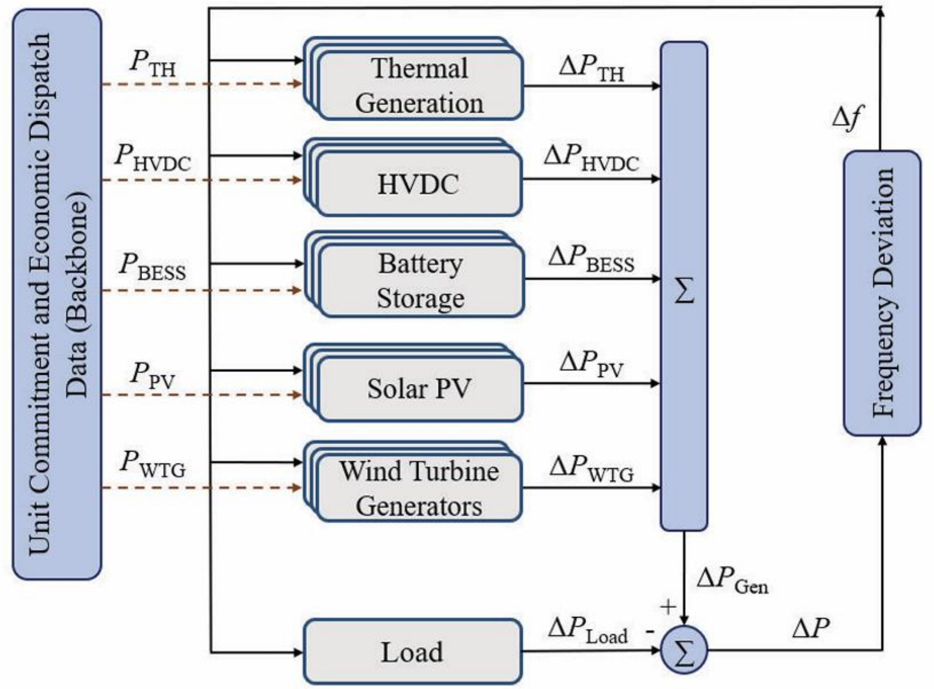
- Solutions for regional & transmission operators
- Grid code modifications
- Policy changes

End users - ESB & EirGrid

# Optimisation & Simulation




*Dynamic system model (All Island)*

# Conclusions

## *Project Objectives:*

- Comprehensive approach for identifying Ireland specific problems and solutions (2030/2050 targets/scenarios)
- At system level
  - Stability, dispatch-down, and optimised/economic solutions
  - Unit commitment – optimal power flow studies for multiple weather years
  - Frequency, voltage and transient stability issues, with various mitigation measures
- At regional level
  - Maintaining headroom and rapid/continuous uptake of PV
  - Distribution network overloading and over-voltage issues to identify potential PV hotspots
  - Power quality issues - proposing solution options
- Solutions looking ahead to 2050
  - Advanced options for system service, such as grid-forming capability
  - Provide services - system strength, black start capability, fault current injection
  - EMT simulation (average, detailed & HIL – PowerFactory & Opal-RT) of networks and components
  - Rooftop PV (uncontrollable, unobservable, single-phase) VS grid-scale PV (controllable, observable)

# *Operational, stability, and network-related strategies for large-scale deployment of solar PV generation on the Irish power system*

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*University College Dublin, Dublin, Ireland*

**SEAI RD&D Academic Fellowship - Grant 23/RDD/991 (OSN-Solar)**

SEAI 2024 National Energy Research and Policy Conference, *12th Sept 2024*

# Test, Validate, Innovate

## Atlantic Marine Energy Test Site AMETS

Belmullet, County Mayo

- Full scale open ocean test site
- High energy wave resource onsite - 70kW/m
- Historical and real-time metocean data available

## SmartBay Test Site

Galway Bay

- Offshore test facility for trial and demonstration of wave & floating wind prototypes
- Suitable for ocean energy devices at Technology Readiness Level (TRL) 4-6
- Historical and real-time metocean data available
- High speed comms & data delivery

## Lir National Ocean Test Facility

Ringaskiddy, County Cork

- Laboratory based test & validation facilities for offshore renewable energy technologies
- Physical (Wave tank) testing
- Electrical testing
- Numerical Modelling

**Ireland** Ocean Energy Expertise

www.oceanenergyireland.com

For more information contact

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SMARTBAY

LIR National Ocean Test Facility

Supported by

Marine Institute Foras na Mara

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Department of Communications, Climate Action & Environment

European Union European Regional Development Fund

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ATLANTIC FLOAT

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# National Energy Research & Policy Conference

**Event date:** Thursday 12th September, 2024
**Venue:** Online
**Presenter:** Jimmy Murphy, UCC-MaREI

# AtlanticFloat Project - Floating Offshore Wind for the Atlantic Frontier

## Objectives

- Understand the behaviour and dynamics of floating wind turbines in Atlantic environments
- Development of innovative Irish floating wind technologies
- Determine the impact of platform motions on O&M activities

## Project Partners

UCC University College Cork, Ireland Coláiste na hOllscoile Corcaigh | MaREI Energy · Climate · Marine

Rockall Research Limited

WIND ENERGY IRELAND

Dublin Offshore

MTU Ollscoil Teicneolaíochta na Mumhan Munster Technological University | HALPIN Centre for Research & Innovation at NMCI

ATLANTIC FLOAT

## Funded by

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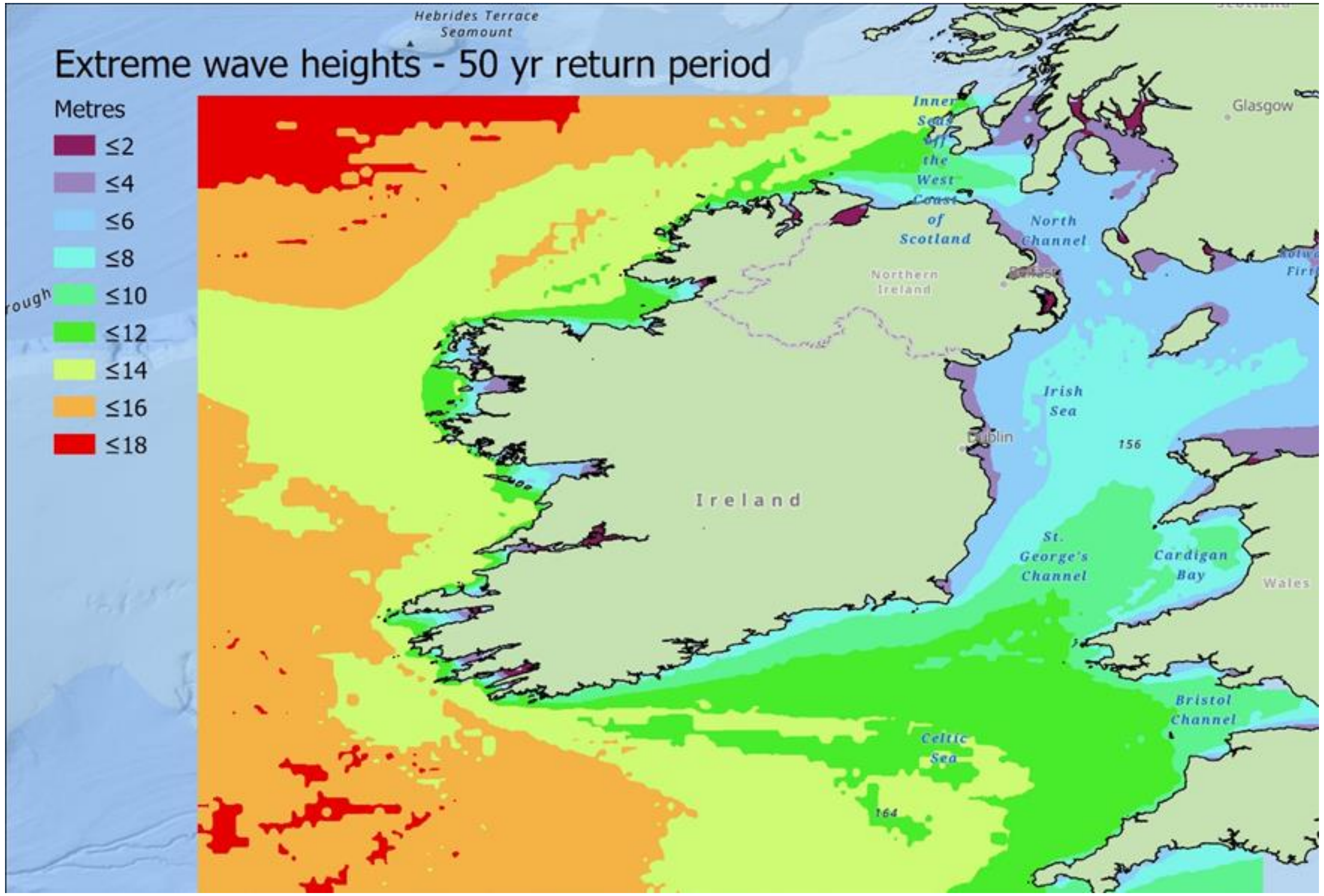
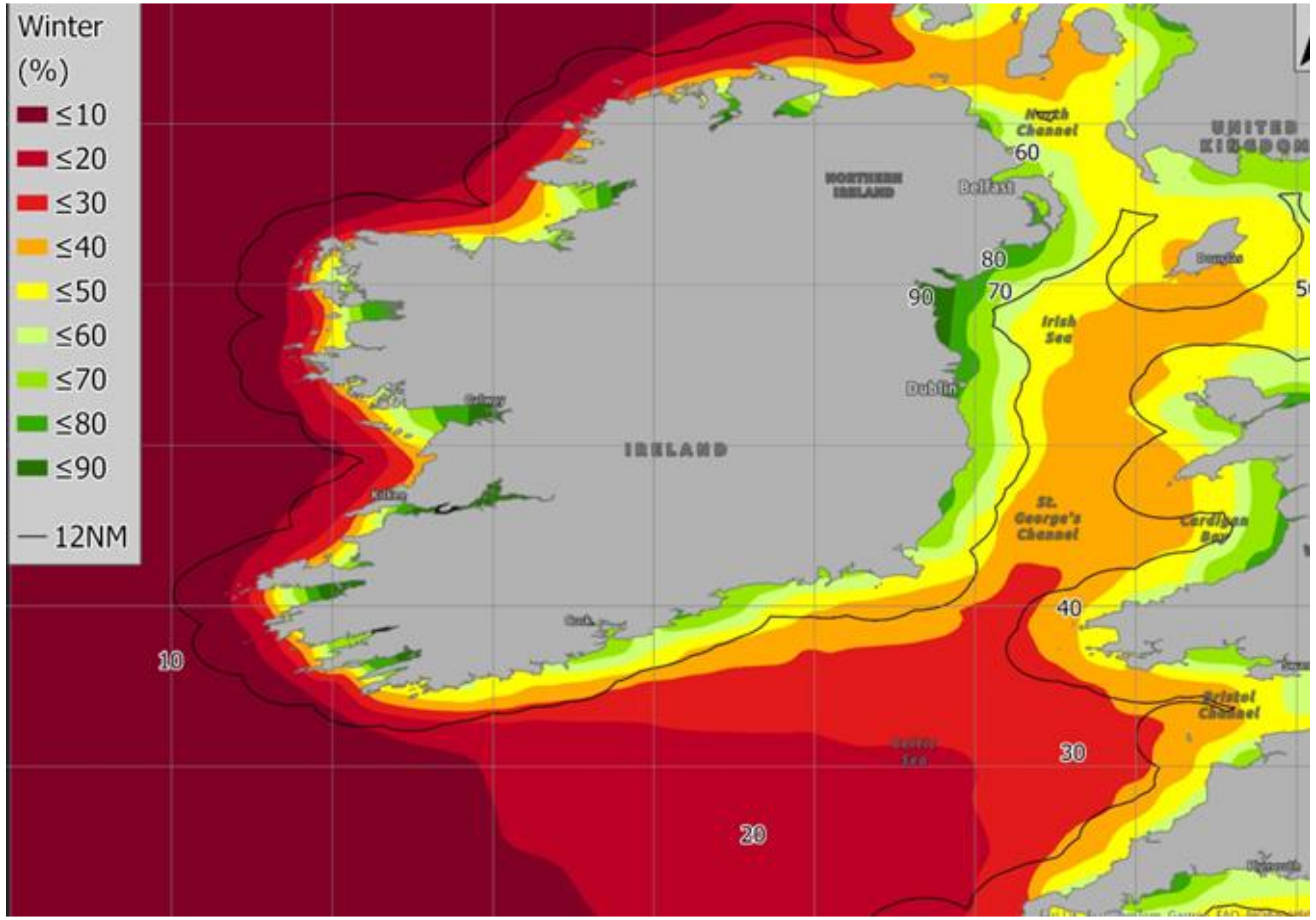
**This project has been supported with financial contribution from Sustainable Energy Authority of Ireland under the SEAI Research, Development & Demonstration Funding Programme 2023, Grant number 23/RDD/955**

# AtlanticFloat Project - Floating Offshore Wind for the Atlantic Frontier

## The Atlantic Challenge




Winter Weather Windows (6hr) – Hs < 2.5m and Wind Speed <10m/s

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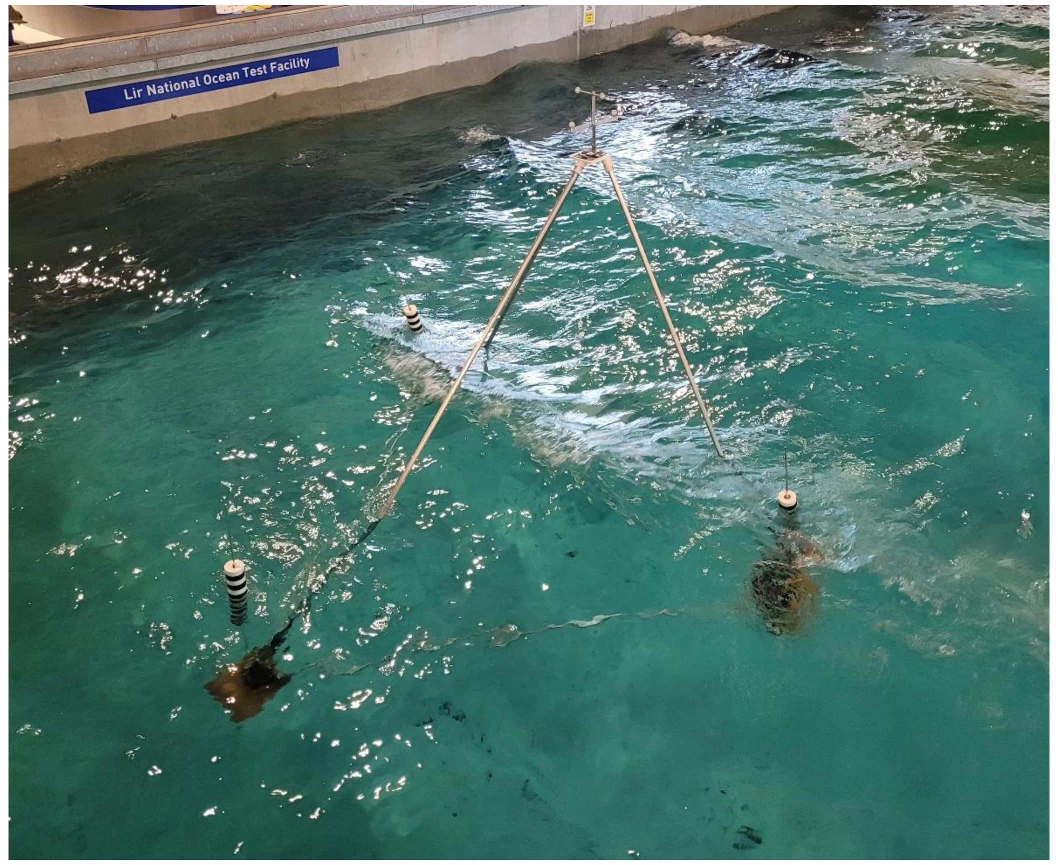
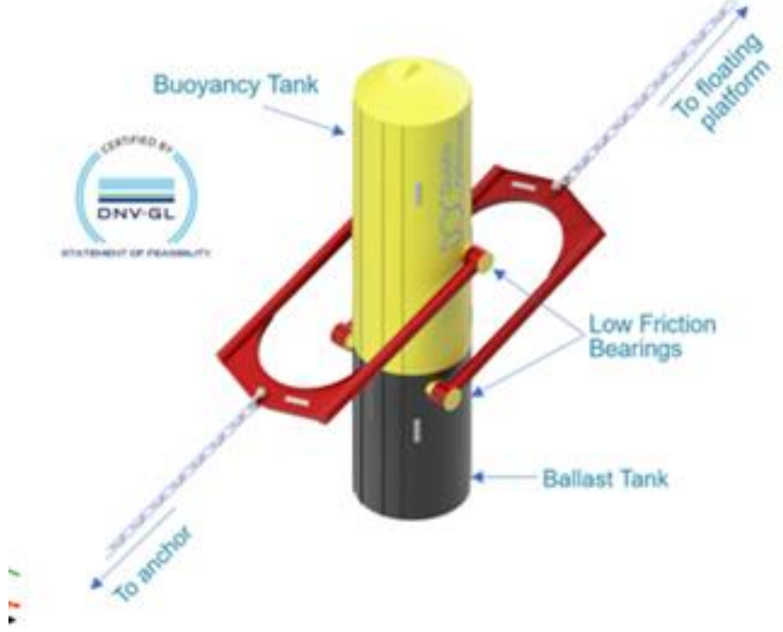
# AtlanticFloat Project - Floating Offshore Wind for the Atlantic Frontier

## Research Outcomes and Learnings

- Physical and Numerical Modelling of 3 floating platform technologies (semi-sub, TLP, novel design) for Atlantic site conditions.
- Understand the suitability of each platform type in terms of loading/fatigue and limiting conditions for O&M
- Advance the development of two Irish technologies
  - Stable Offshore Floating Wind (SOFWind) platform
  - Expand the use of the LRD to other platform types
- Open access to project data and output

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# AtlanticFloat Project - Floating Offshore Wind for the Atlantic Frontier

## Informing Policy

- Identification of readiness and challenges related to the development of floating windfarms on Atlantic sites. This may influence timeline and site locations of first floating windfarms in Ireland
- Providing output and data that allow for more reliable estimates of LCoE
- Contributing to the development of the Irish supply chain and enabling a higher indigenous content
- Provision of data and knowledge

Volturn Platform (University of Maine)

ATLANTIC FLOAT

# AtlanticFloat Project - Floating Offshore Wind for the Atlantic Frontier

## Research required for innovative solutions 2050

- Understanding technology performance and operational limits and designing innovation solutions.
- Logistics and operations optimisation through simulation and field applications
- More offshore testing capacity for testing technologies and methodologies (FLOWT–EOB, SmartBay, AMETS)
- Improved collaboration and sharing of information and data between research, industry and government
- Fast tracking of a floating wind demonstrator project with linked research/innovation and data sharing.

*Ref: offshoreWIND.biz*
https://www.offshorewind.biz/2024/08/12/worlds-largest-single-capacity-floating-wind-platform-en-route-to-installation-site/
*Accessed: 02-Sep-2024*

ATLANTIC FLOAT

# District heating feasibility studies

## Researching the key parameters and approach

National Energy Research and Policy Conference 12/09/24

Dr. Niamh O’Sullivan



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# 90%

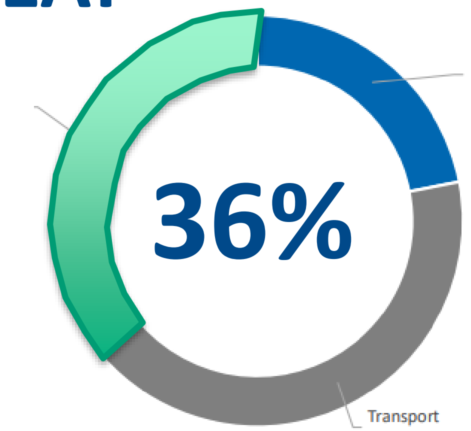
# 21%

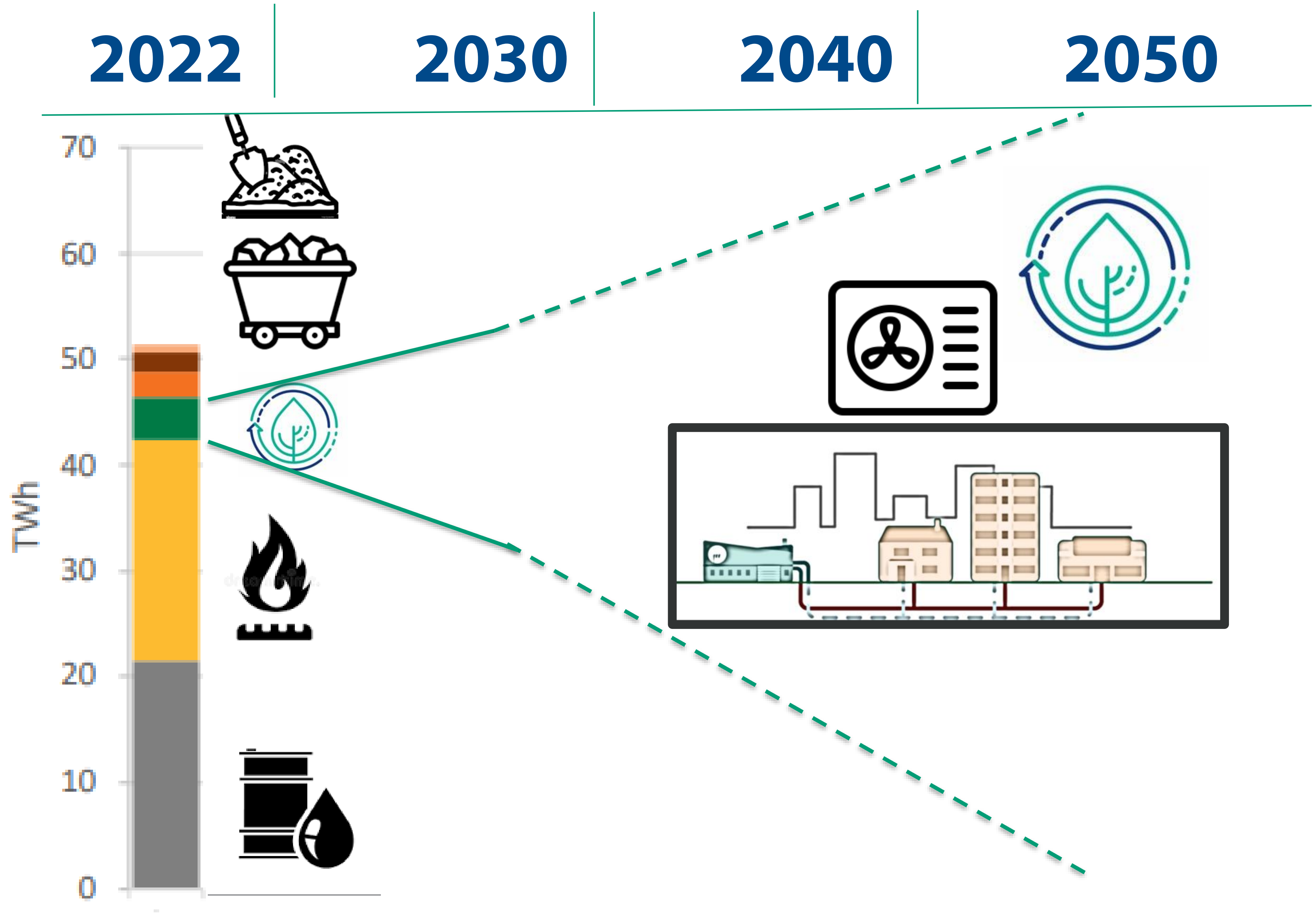
# Last

# Decarbonising Heat

## The Challenge

## HEAT



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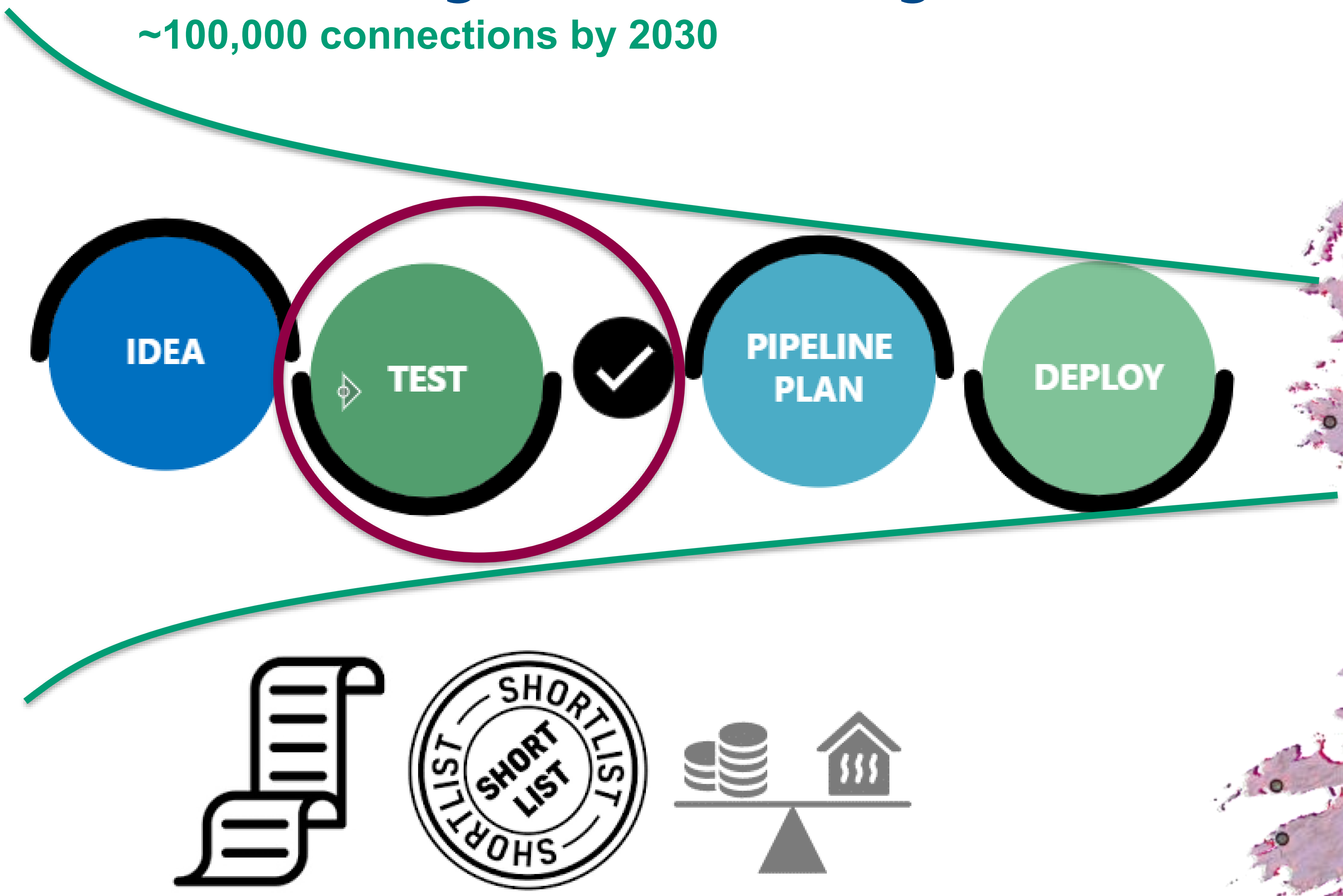
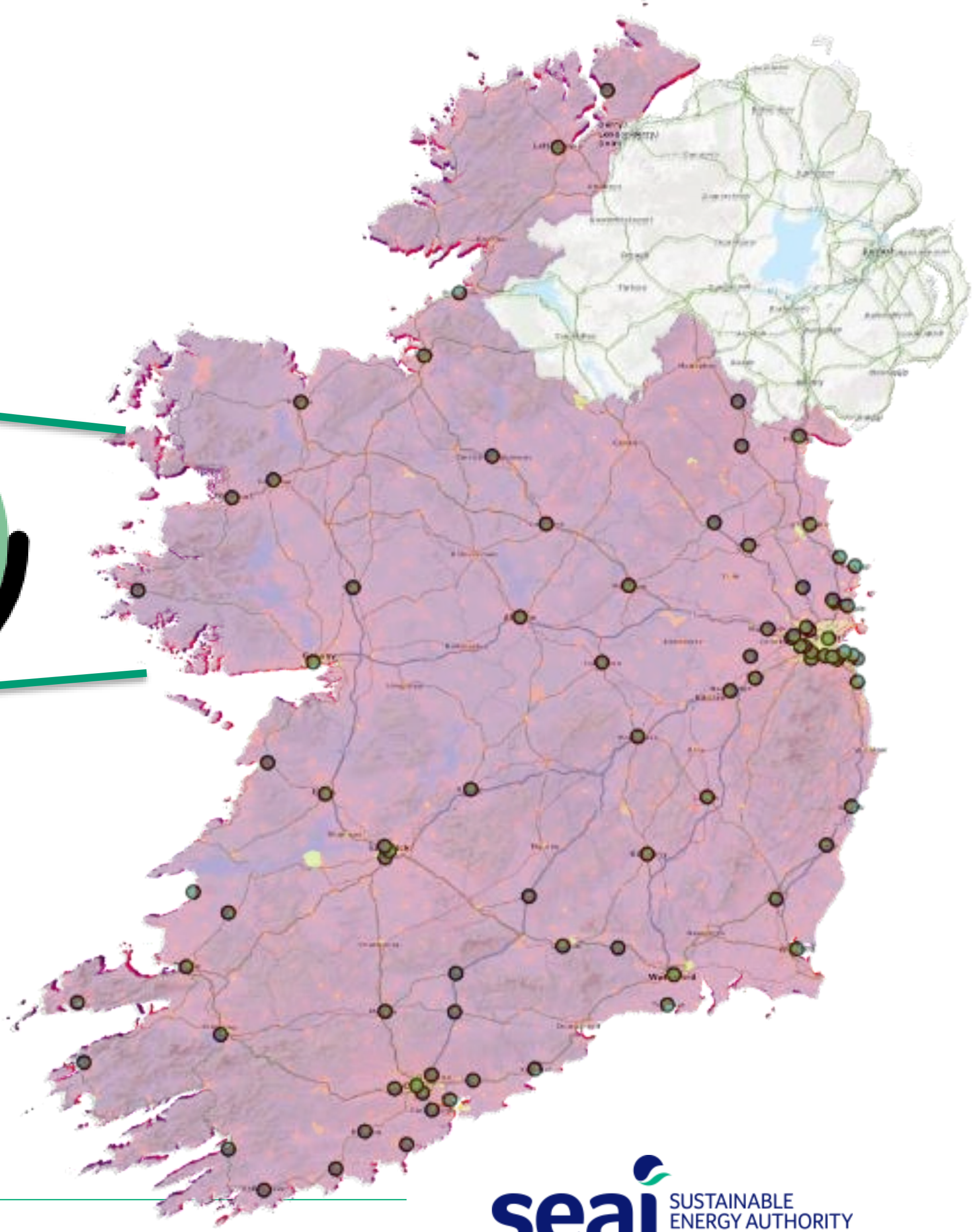
# Accelerating District Heating

## ~100,000 connections by 2030

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# Thank you for listening

For more information visit **seai.ie**

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# Integration of anaerobic co-digestion of grass silage and cattle slurry within a livestock farming system in Ireland

**Sofia Tisocco**
**University of Galway & Teagasc**

Co-authors: Dr. Ciara Beausang, JJ Lenehan, Prof. Xinmin Zhan and Dr Paul Crosson

OLLSCOIL NA GAILLIMHE
UNIVERSITY OF GALWAY

Teagasc
AGRICULTURE AND FOOD DEVELOPMENT AUTHORITY

## Opportunity

- Pasture-based beef farms can provide cattle slurry and grass silage for anaerobic digestion (AD)

## Challenges

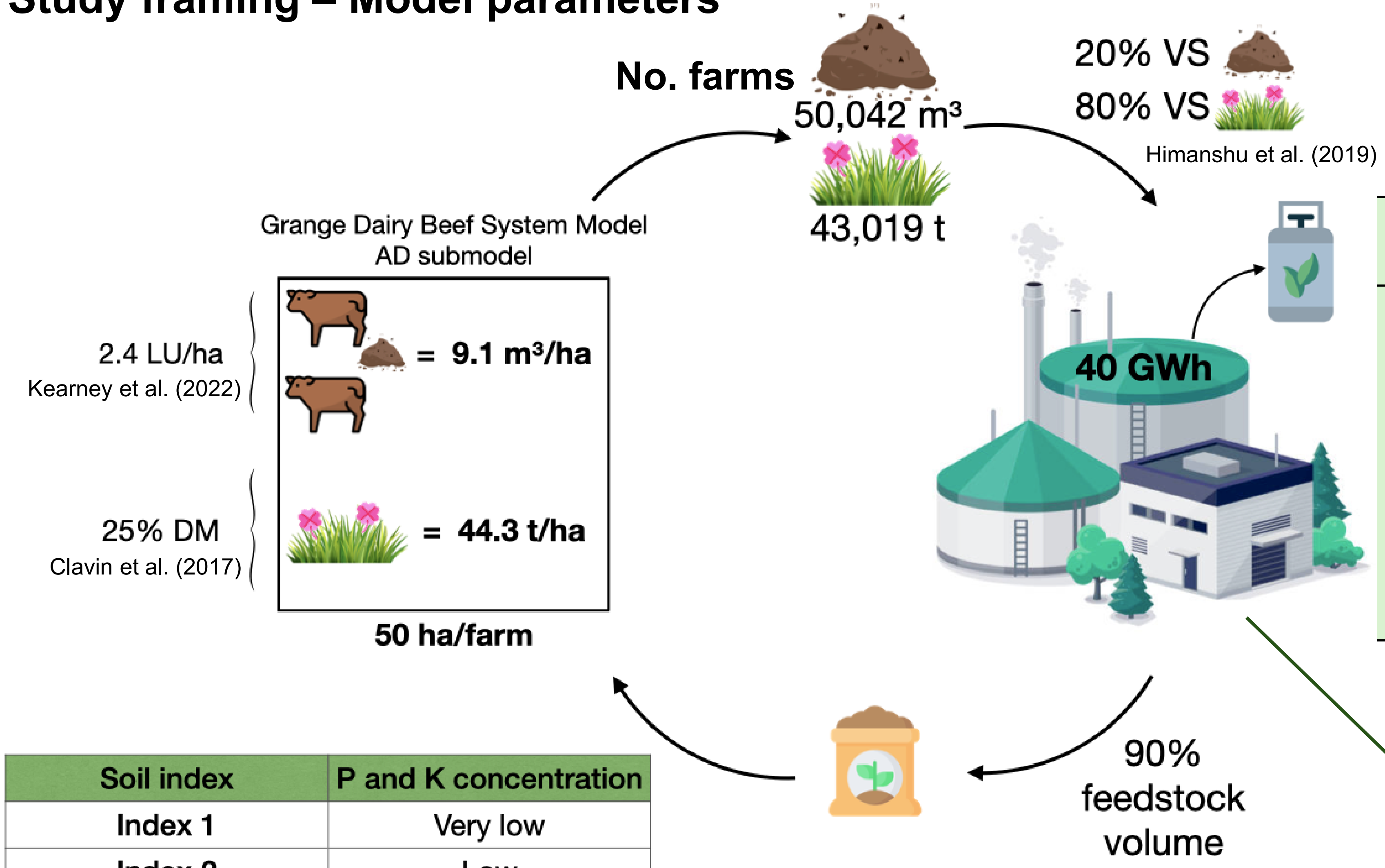
- Sustainable production of grass silage
- Feedstock provision into a full-scale AD plant
- Financial viability at a farm and supply chain scale

## Research objectives

- Assess farmland area required to provide slurry and grass silage for a 40 GWh biomethane plant
- Quantify greenhouse gas (GHG) emissions
- Analyze digestate management
- Economic analysis of biomethane production at a farm and supply chain scale

# Methodology

## Study framing – Model parameters




| Soil index | P and K concentration |
|---|---|
| Index 1 | Very low |
| Index 2 | Low |
| Index 3 (Baseline) | Medium |
| Index 4 | Excess |

Wall and Plunkett (2021)

## Financial analysis

| Financial support | Baseline | Grants |
|---|---|---|
| Biomethane certificate | €0.098/kWh | €0.098/kWh |
| CAPEX grant | - | 20% |
| Gas grid connection grant | - | 30% |
| AD silage subsidy | - | €60/ha/year |

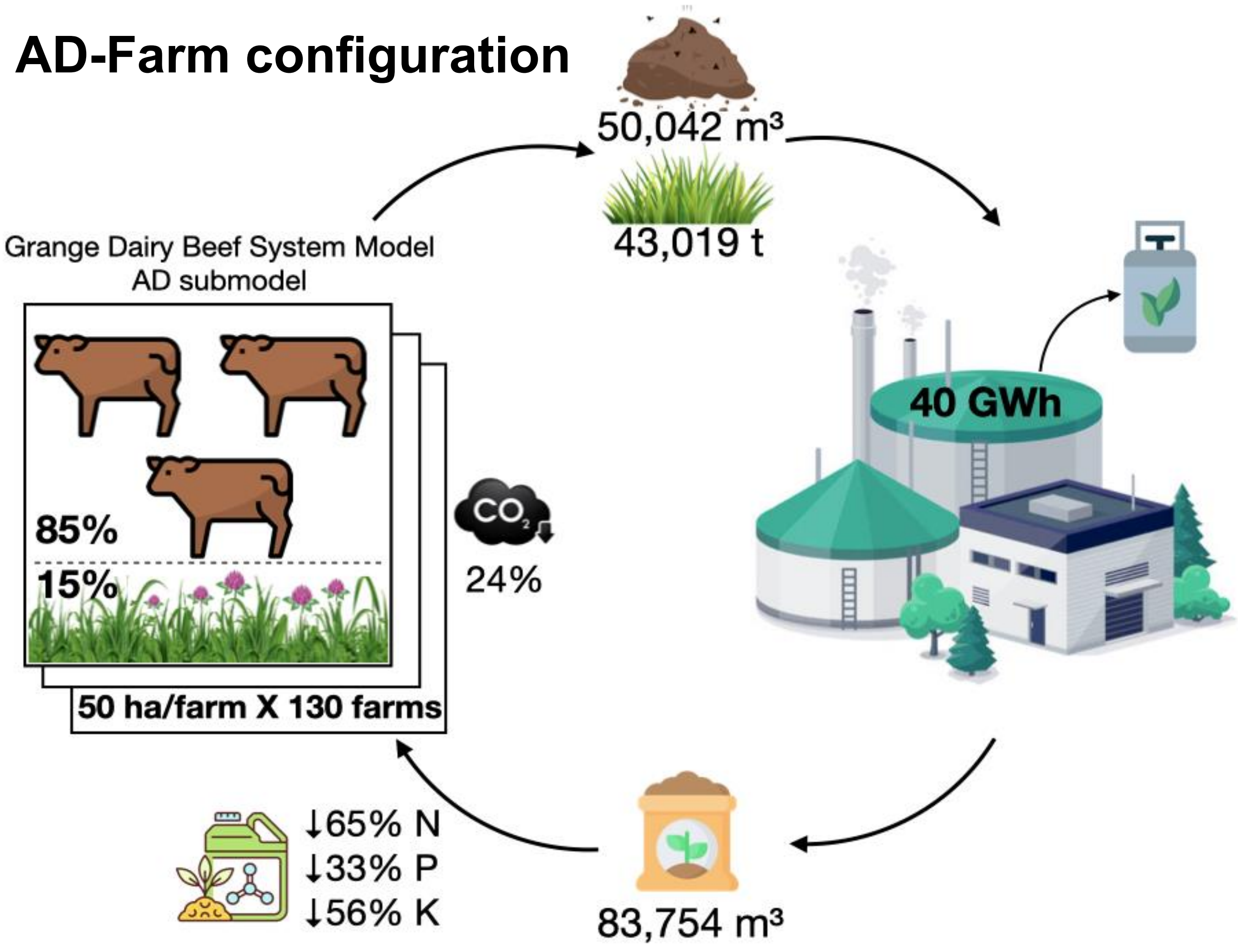
CAPEX & OPEX calculation

Net present value (20 years)

$$\text{NPV}\ (€) = -C_{op} + \sum_{t=1}^{n} \frac{R_t - C_t}{(1+r)^t}$$

# Results

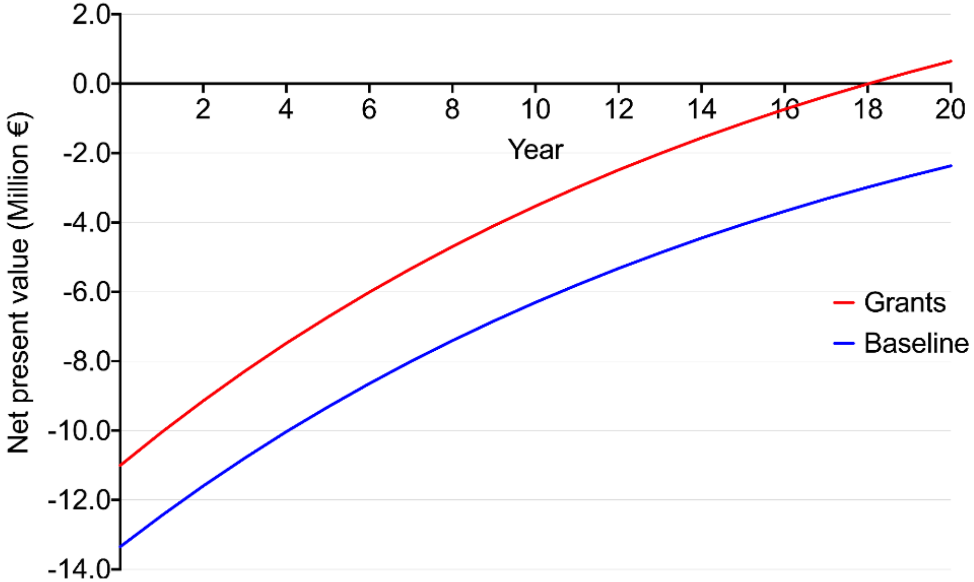
## AD-Farm configuration

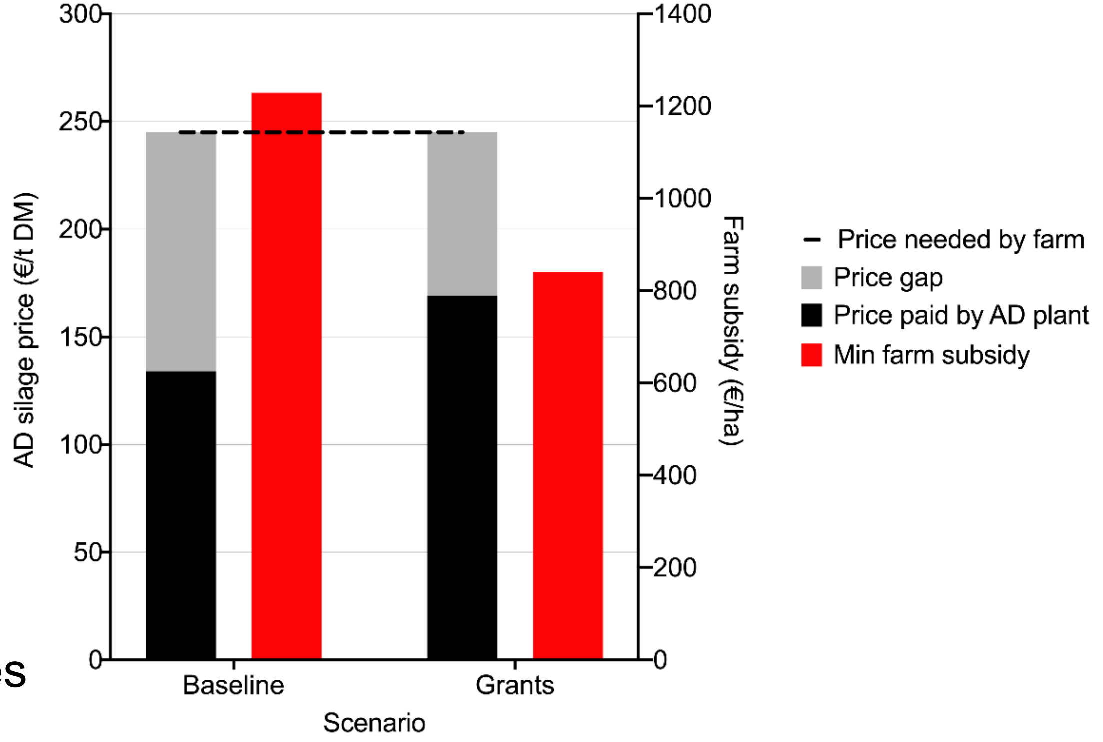



Outcomes and learnings

- Farmland area
- GHG emissions
- Grass silage and biomethane prices

## Financial analysis



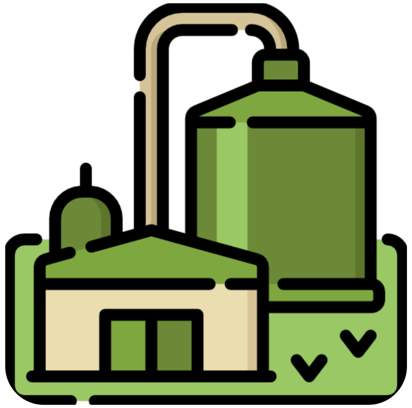



Ollscoil na Gaillimhe
University of Galway

Teagasc
Agriculture and Food Development Authority

# Impact of research on policy making and energy future

**Farm**
Grass silage price
Diversificaion

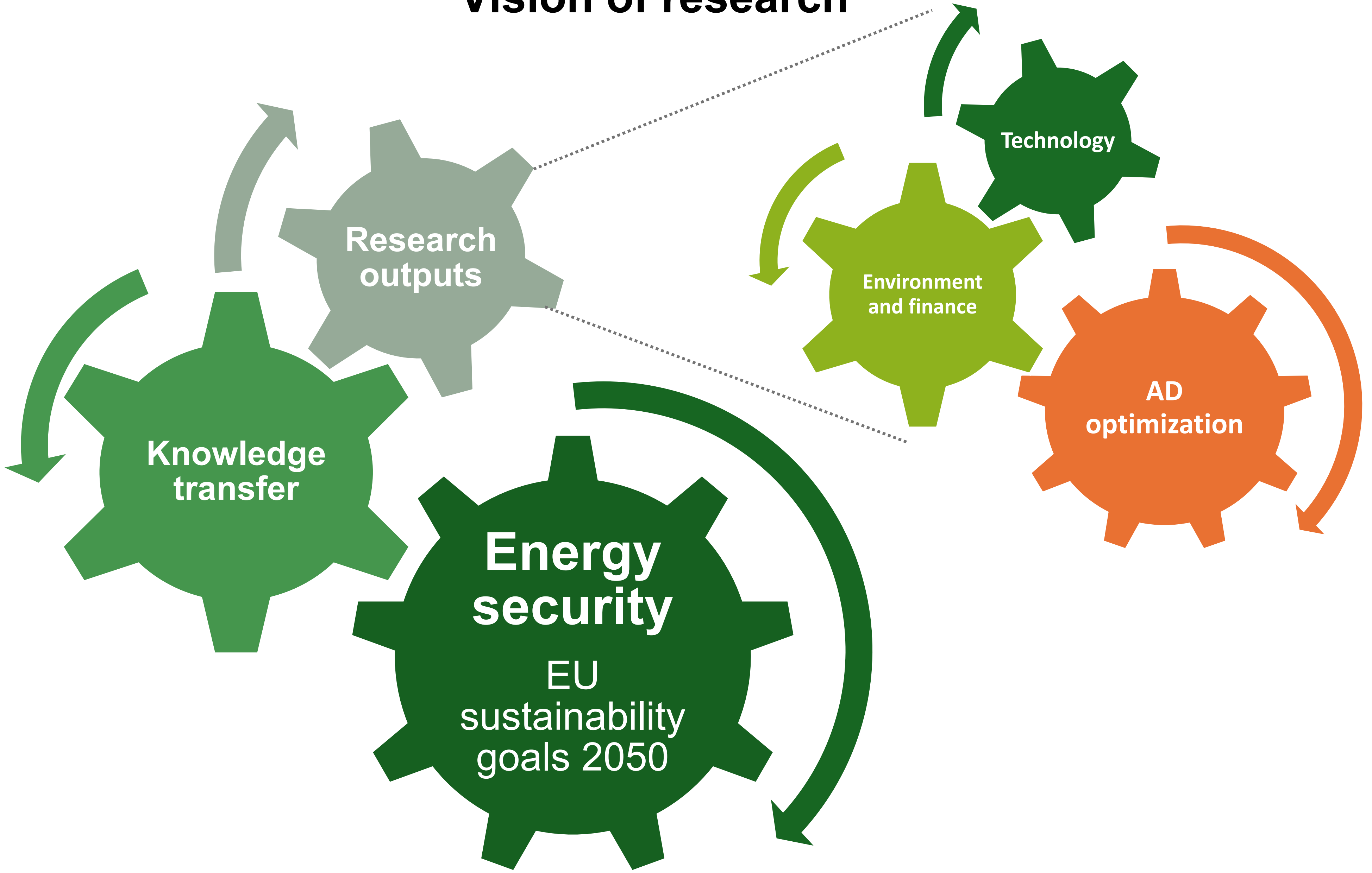


**Industry**
Biomethane
certificate prices

**Policy**
Incentives and
support mechanisms

**Ireland**
Sustainable, low-carbon agricultural sector and Irish energy future

# Vision of research



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University of Galway

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# Thank you for your attention

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*This research was financed by the Teagasc Walsh Scholarship Programme (Ref: 2021010)*

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# Tackling Energy Poverty Through Retrofit Analytics

**SEAI 2024**

*National Energy Research and Policy Conference*

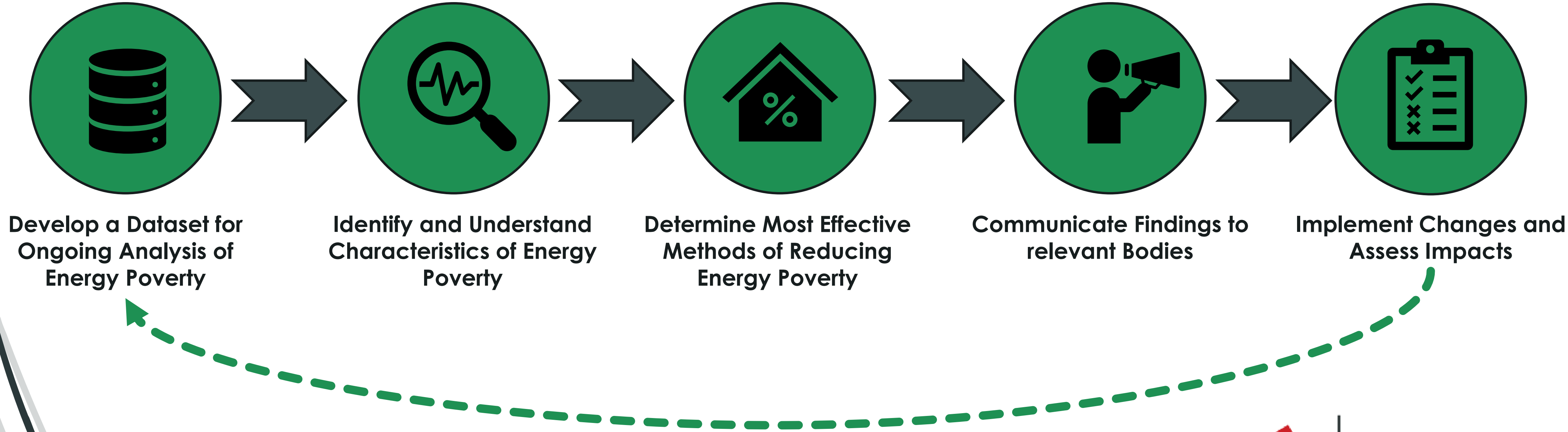
David Shiel
James Clarke
David Baker

# Project Overview

## Introduction

- This research aims to identify strategies to reduce energy poverty rates in Ireland
- This will be done by identifying and characterising energy poverty and then developing tailored solutions to improve the energy efficiency of the residential housing portfolio

### Project Structure

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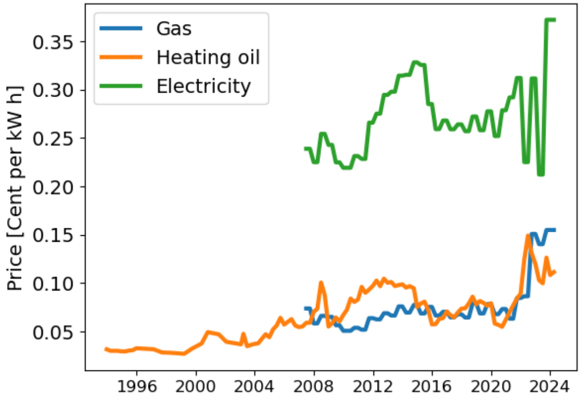
# Motivations for this Research

## Overview

There are 2 main motivations that underpin this research project:

### Helping Households to Escape Energy Poverty

- Recent years have seen huge **volatility in energy prices** due to external forces on the energy market




- Understanding the profile of those in energy poverty can **help to identify who is at risk** from these fluctuations
- Developing tailored solutions for households can help to **protect from future risk of energy poverty**

### Supporting Ireland in achieving sustainability targets

- The Irish Climate Action plan sets out targets to Ireland to achieve by 2030. In particular:
  - 500,000 Homes to be **retrofitted to a B2 or higher**
  - 600,000 **Heat Pumps** to be installed
  - Develop a model for aggregation where **home retrofits are grouped together**
- This analysis will provide an ability to view the country from a "Retrofit perspective" to see what measures will have the most effect where

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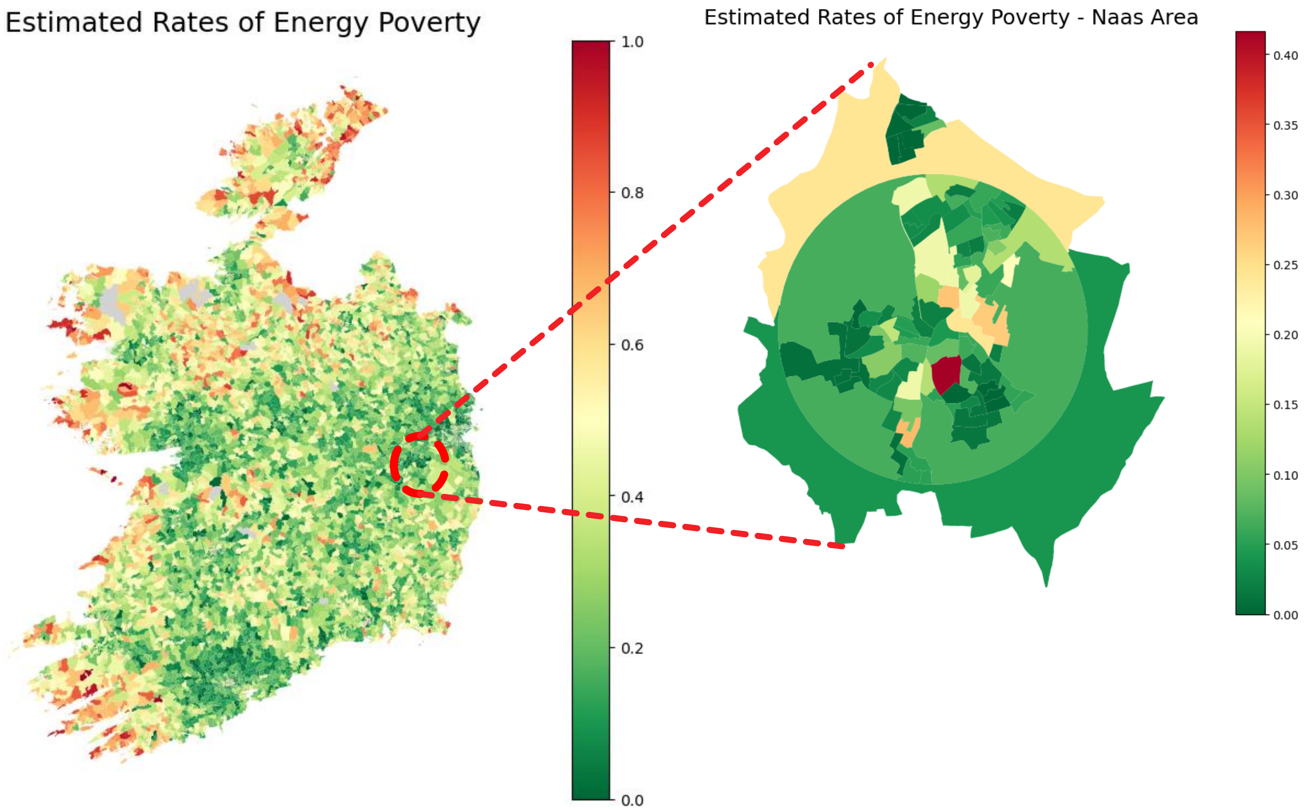
# Learnings so far…

## Overview

- A toolset has been developed that allows energy poverty to be examined at a Small Area level
- This uses an objective **Expenditure Definition of Energy Poverty** [10% of Income spent on Energy Bills]
- The example below shows how a deep-dive can then be applied to a small area to understand its **energy poverty profile** and **retrofit requirements**




**Naas: At a glance**

| Metric | Value |
|---|---|
| **Total Small Areas** | 96 |
| **Number of Homes** | 10,005 |
| **Homes with BER** | 5,522 |
| **Median Household Income** | €83,565.46 |
| **Average BER** | C2 [178.3 kWh/m2/year] |
| **Heat Pump Ready Homes** | 1,627 |
| **Average Heating System Efficiency** | 90.3% |

# Impact on Policy Making

## Overview

- This research is designed to help inform policy making decisions in relation to the National Retrofit Plan and Energy Master Plans
- There are steps throughout the research process to engage with different stakeholders to ensure that results are being communicated

**Residential Households**

- Qualitative Surveying of Households
- Information Campaigns to communicate results

**Local Authorities and Approved Housing Bodies**

- Questionnaires to understand Issues
- Sharing results and insight tools for implementation

**SEAI**

- Regular Communication for guidance and feedback

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# Future Work

## Overview

- This project applies analytics to the BER housing data to identify areas of energy poverty and the optimal routes for mitigating poverty through Retrofitting
- In the future, with BER data for more houses it will be possible to be **proactive in tackling energy poverty**

### Current Position

- BER Coverage Approximately 1.1 m of 2.1 m total homes
- Average BER C2-C3
- Energy Poverty c22%

### 2030 Action Plan

- More homes with BER values
- Average BER increased
- Energy Bills reduced

### Future Approach

- Active Monitoring of homes' BERs
- Proposing bespoke solutions as needed
- Eradicating Energy Poverty

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# Thank You

SEAI National Energy Research and Policy Conference Ireland
*2050, our innovative energy future*

September 12th, 2024

# SMART-LEM Supporting Ireland's Energy Transition

## A Clean Energy Transition Partnership project

Research Sprint session

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# An international collaborative effort

**SMART-LEM is a project aimed at accelerating the energy transition.**

Project start: May 2024
Expected completion: 2027

- Four Universities
- Two Grid Operators
- Two SMEs
- Two City Halls

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**SMART-LEM**

PROJECT

# SMART-LEM: goals and anticipated impact

## Primary objective:

Develop a digital platform for Local Electricity Markets (LEM) to support renewable energy integration within partner countries.

# Anticipated outcomes

- Empowered local stakeholders in energy trading
- Enhanced grid flexibility and resilience
- Actionable insights for policymakers

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# How SMART-LEM can inform energy policy

## Policy contribution

Providing data and insights to support the development of harmonised energy policies within and across partner countries.

## Innovative solutions

Using project findings to recommend policies encouraging decentralised energy systems. The framework could inform future discussions on enhancing the resilience of interconnected grids.

## Long-term impact

Aiming to inform national and EU-level energy policies by demonstrating the viability and benefits of Local Electricity Markets (LEM).

# Envisioning the future of energy transition by 2050

## Technological innovation

- Advanced AI and machine learning technologies will optimise energy management systems, predict demand, and automate real-time trading.
- Innovation in energy storage solutions, such as next-generation batteries and hydrogen storage, will ensure stability and reliability in a renewables-dominated grid.

## Decentralisation as the norm

- By 2050, energy systems will likely be highly decentralised, with Local Electricity Markets (LEM) crucial to balancing supply and demand at the community level.
- This shift will empower consumers to participate actively in energy markets, driving greater adoption of renewable energy sources.

## Cross-border energy collaboration

While SMART-LEM focuses on local markets, the broader future vision sees increased energy market integration across borders, supported by policies that encourage collaboration between nations to optimise energy flows and reduce carbon emissions.

# Envisioning the future of energy transition by 2050 (continued)

## Policy and Regulation

- Policymakers will need to adapt rapidly to technological advancements, developing flexible regulations that support innovation while ensuring the security and reliability of the energy grid.
- Greater emphasis will be placed on policies incentivising hard-to-abate sectors' decarbonisation, such as heavy industry and transportation.

## Sustainability and climate goals

- Achieving climate neutrality by 2050 will require a concerted effort from all sectors, with energy research playing a pivotal role in developing the solutions needed to meet this challenge.
- The future of energy research will focus on creating systems that are not only sustainable but also equitable, ensuring access to clean energy for all communities.

# Thank You

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National Energy Research and Policy Conference

*Ireland 2050, our innovative energy future*

# Does tailored information on potential cost savings and emission reductions impact the likelihood of switching to an EV?

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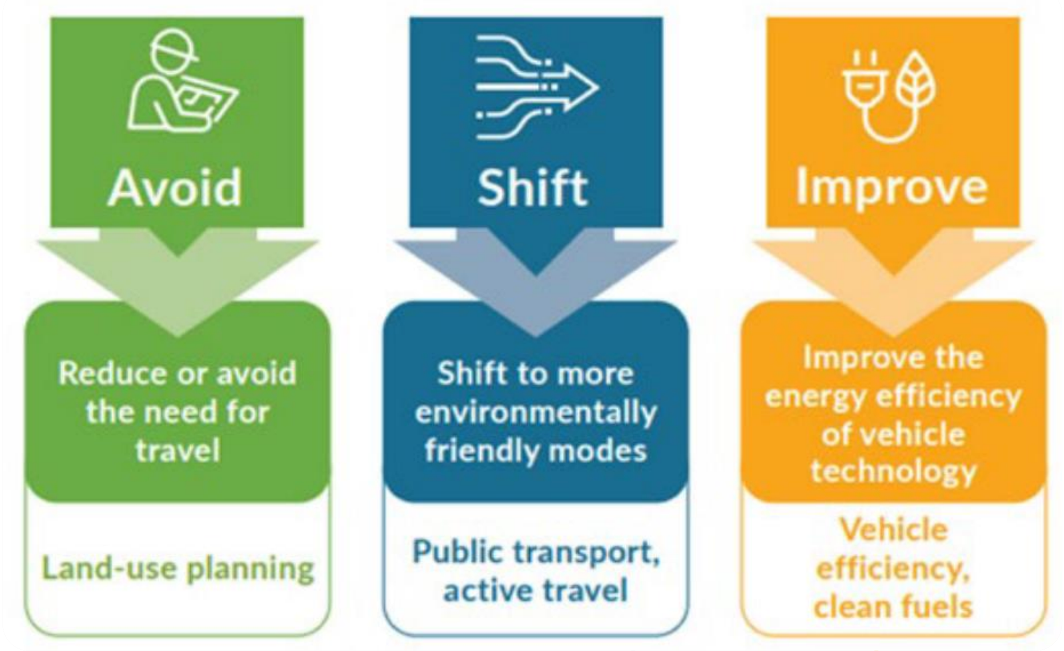
# TRAnsport Behaviour Change Trials: Project Overview




*Source: Climate Action Plan (CAP, 2022)*

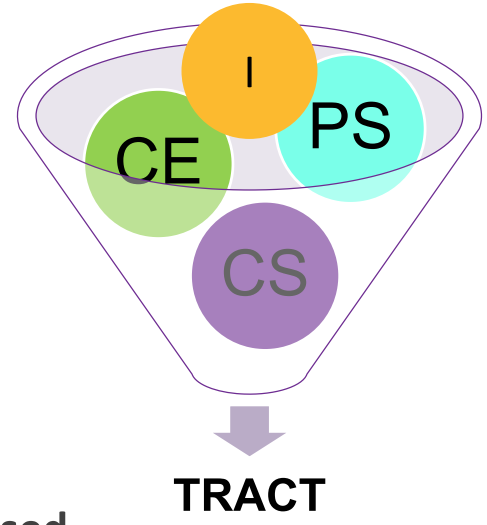
**e-mobility trial**: Shift and Improve strategies that will nudge people to shift to EVs

*Overarching goal*:

**Decarbonisation** in the **Transport** sector

*Policies Addressed*:

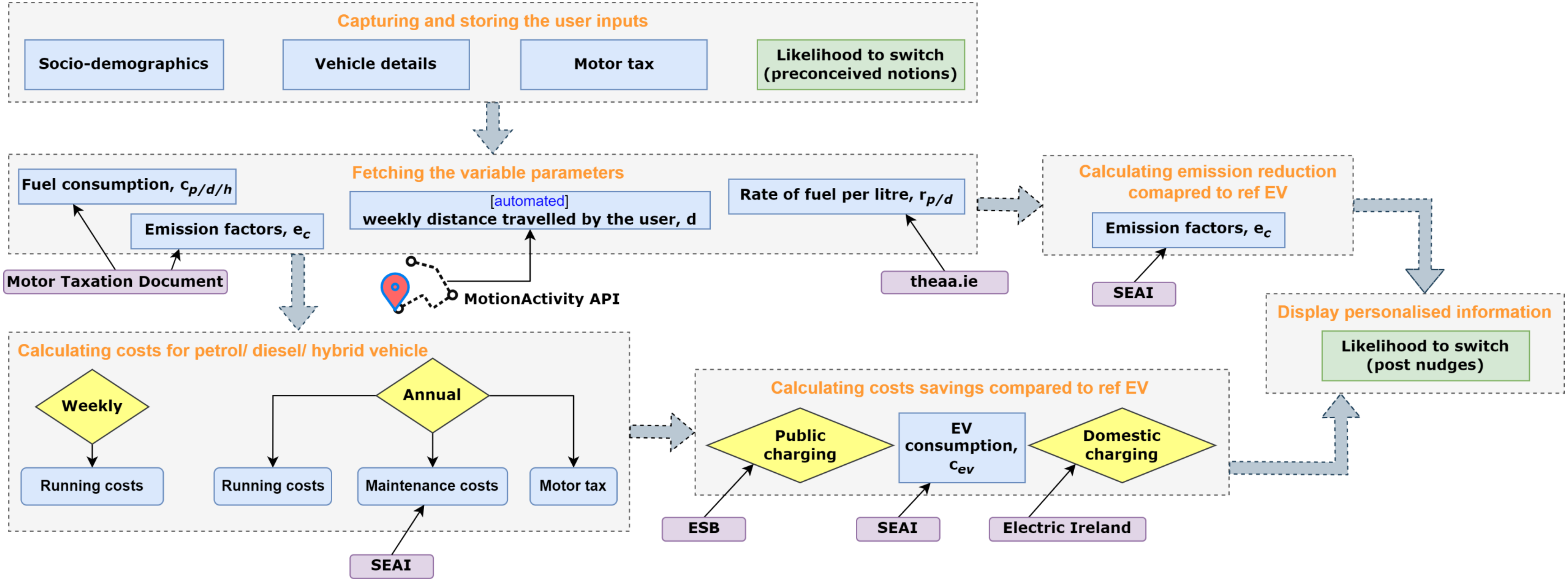
**Climate Action Plan**




*Theme (1 of 2)*: **Electric Mobility**

*Objective*: Analyse whether **personalised information** can lead to **behavioural changes** toward adopting EVs through trials.

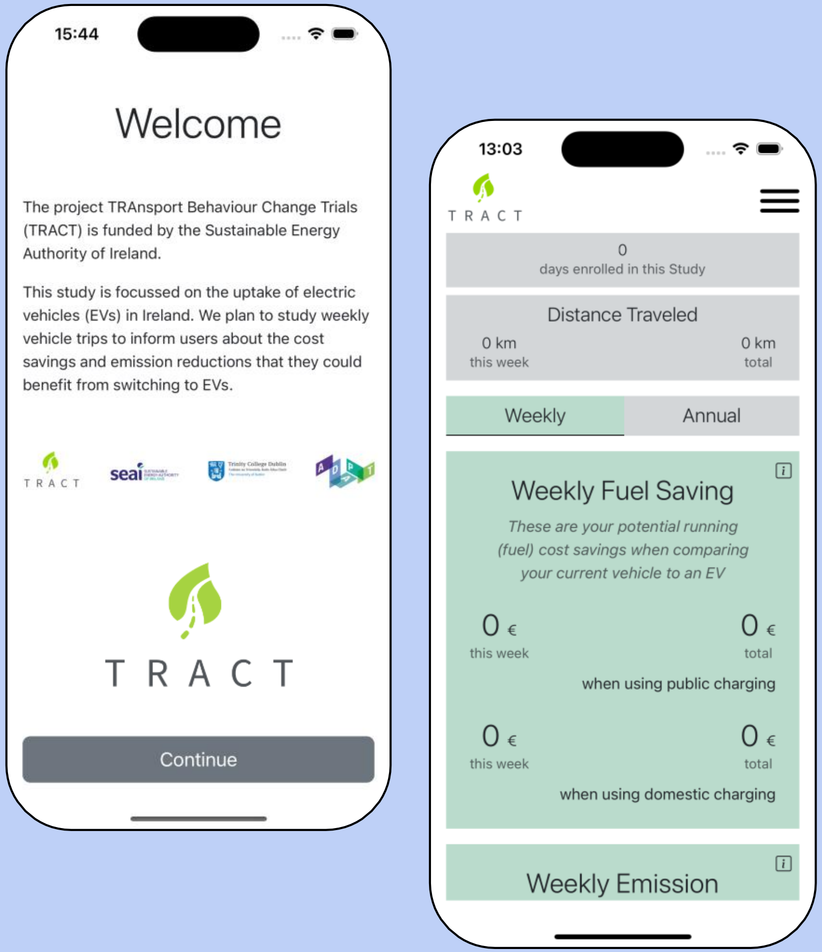
# TRACT EV app structure



# TRACT EV app features

- **First-of-its-kind** study to collect **one of the largest datasets** on **Electric Vehicle** usage potential in Ireland
- **Holistic** and **interdisciplinary** approach for **emission mitigation** and **decarbonisation** of transportation sector
- Provide evidence from meticulously chosen **five use-cases**


- **Personalised** tracking and **information nudges**
- Weekly and annual **cost** and **emissions comparison**
- **Interactive** dashboard
- Tailored **range recommendations**
- Minimum **user-intervention**



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TRACT

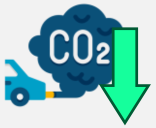
# Insights so far

1090 +

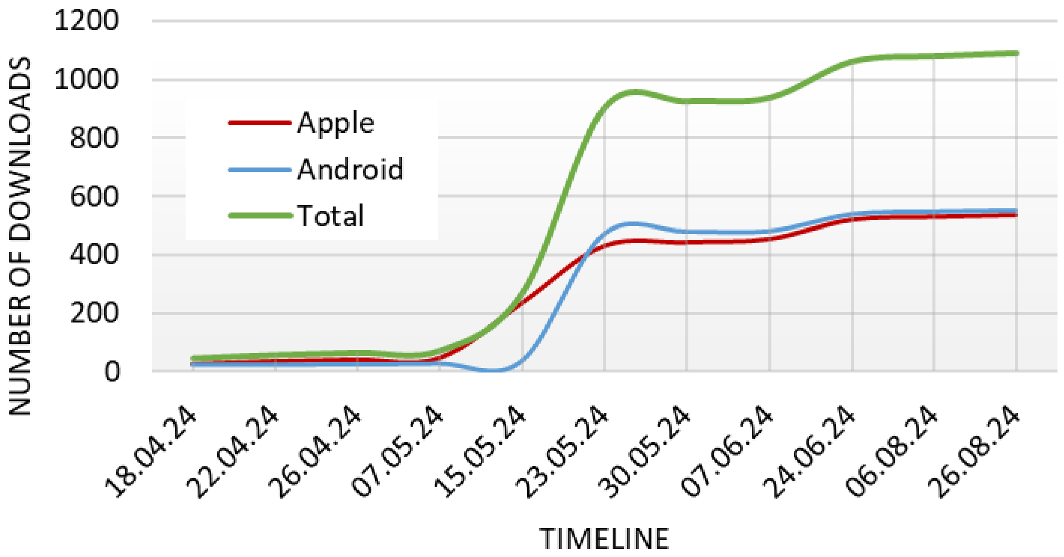
1.47 + million km

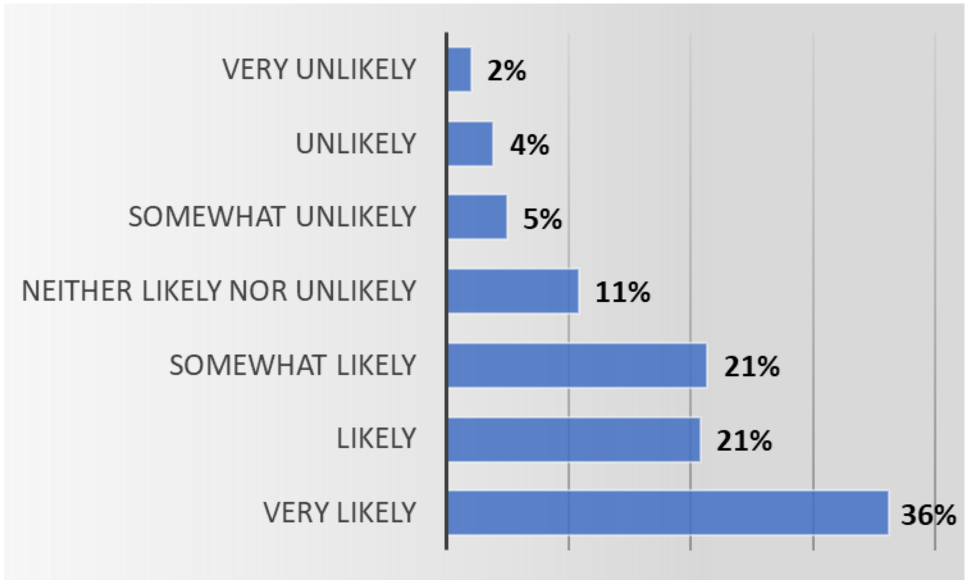
€14,300 +

€62,500 +




84231 + tonnes




User willingness to switch to an EV (last response)

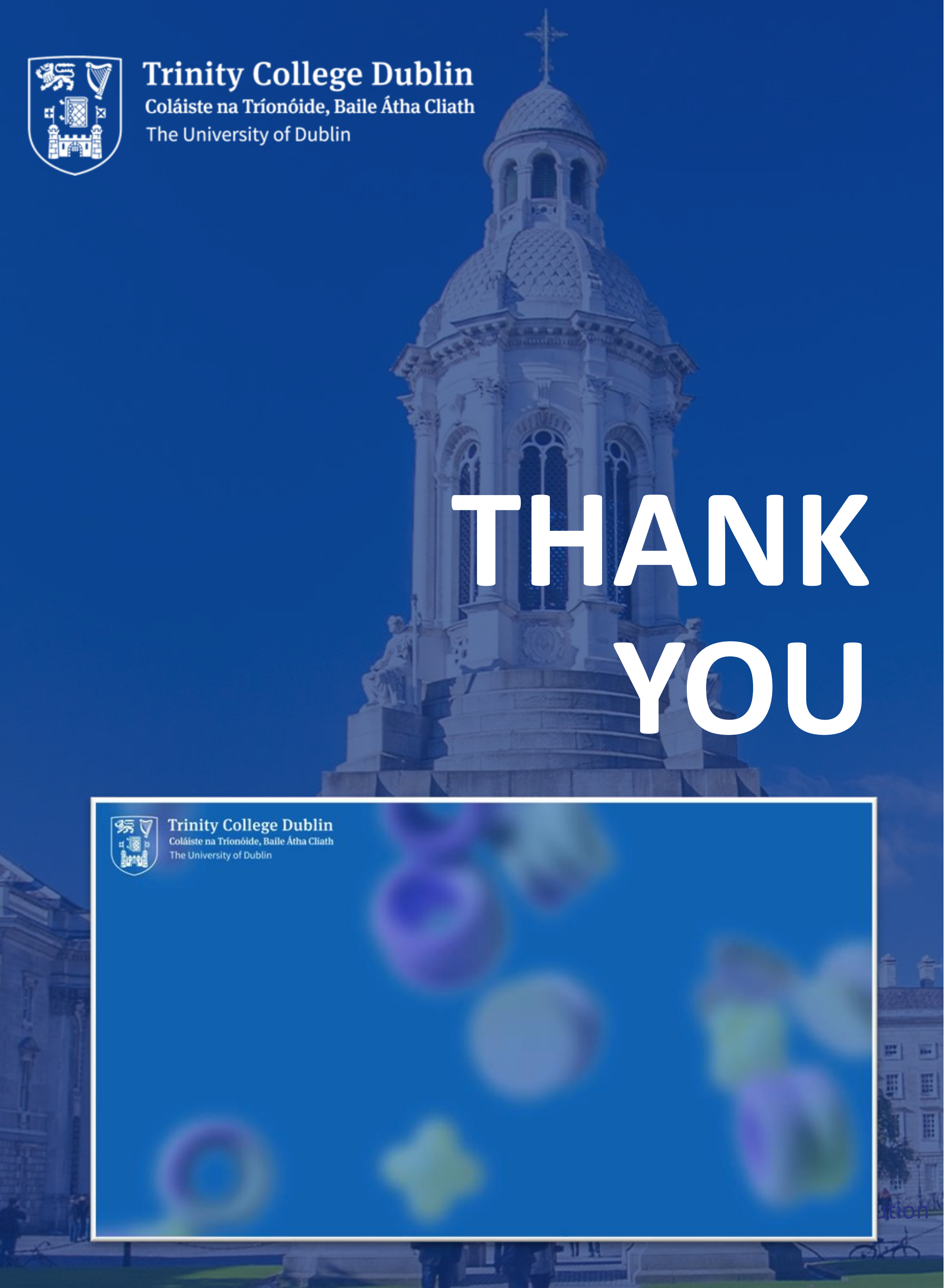
# Policy Perspective

## Expected Outcomes

- *Provide **evidence** from five use cases **where the EV uptake has been slow.***
- *Estimate **emissions reductions** and determine the potential of **national impact** by analysing designed scenarios.*
- *Identifying and exploring the **perceived barriers** beyond those related to upfront costs towards EV adoption and possible solutions thereof to tackle them.*
- *Provide insights on the importance of the **second-hand** EV market that has little to no evidence.*

## Vision: Future Research Directions

- ***Optimise EV adoption** through evidence-based solutions*
- *Encourage users to **shift** towards cleaner transportation systems*
- *Test policies that encourage **intermodal solutions** by integrating EVs with public transit, shared mobility services, cycling, and walking*
- *Conduct pilots to capture public response towards **smart charging** and **advanced EV infrastructure***
- *Push uptake of **sustainable energy** and **sustainable transport** and determine potential of upscaling it*




# So, are you ready to switch to an EV?

TRACT

**Scan to download the TRACT EV App**


## Acknowledgments

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