Local Energy Communities – Incorporating Offshore Wind

January 2021 | Paul McKeever – Head of Electrical Research

CATAPULT Offshore Renewable Energy

Agenda

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- Summary of CLUE Project
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  - Project Objectives and Tasks
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- Conclusions

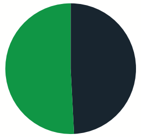
Future Energy Systems will be more decentralised, multi-vector and reliant on renewables

Current Energy System

7 GW of offshore wind

Majority of properties heated by natural gas

Fuel engine vehicles are the most popular



50% of electricity generation comes from fossil fuels

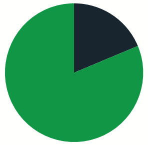
Meter reading send once every half a year

Future Energy System

At least 30 GW of offshore wind by 2030

Properties use electric heating or gas network converted to hydrogen

All new vehicles are electric, hybrid or hydrogen-powered



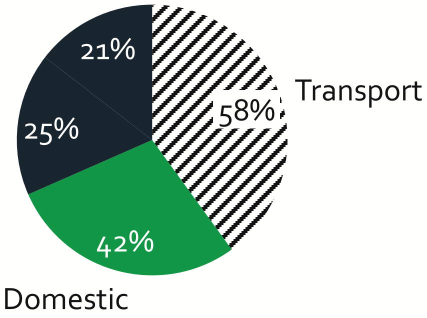
Only 20% of electricity generation comes from fossil fuels in 2030

Smart meter reading send every half an hour

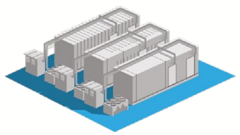
Outcomes

① Offshore wind deployment can be bigger than we anticipate now

Total primary energy consumption



② Intermittency of renewables will be largely overcome



CLUE Project Summary

Concepts, Planning, Demonstration and Replication of Local User-friendly Energy Communities (CLUE) – Project Summary

€6M project funded by ERA-Net

- CLUE is acquiring knowledge on optimized design, planning and operation of Local Energy Communities (LECs) and will develop a tool kit for planning and operation as key elements for successful replication and upscaling of LECs
- ORE Catapult is the lead partner in the Scottish CLUE consortium, providing local energy system and stakeholder knowledge as well as our 7MW turbine (LDT) for testing purposes. Our LDT will be used to show how energy produced from offshore wind could be distributed through a network architecture that offers the potential for local communities to trade energy with one another, and lead to greater generation and demand balancing at a regional and national level.

Project partners

ORE Catapult Development Services Limited

University of Strathclyde

Smarter Grid Solutions Limited

Fraunhofer Institute for Solar Energy Systems ISE

E.ON Energy Solutions GmbH

Fakt AG

Institute of Computer Technology, TU Wien

AIT Austrian Institute of Technology GmbH

Energienetze Steiermark GmbH

Energie Steiermark Kunden GmbH

Siemens AG Österreich

Malmö stad

E.ON Energidistribution Aktiebolag

E.ON Energilösningar Aktiebolag

Rise Research Institutes of Sweden AB

Lunds universitet

Fachhochschule Technikum Wien

lab10 collective eG

Klima- und Energie-Modellregion

Naturpark Almenland

Malmö kommuns parkeringsbolag

Vasakronan AB

Serneke Group AB

Funding Partners

Smart Energy Systems ERA-Net

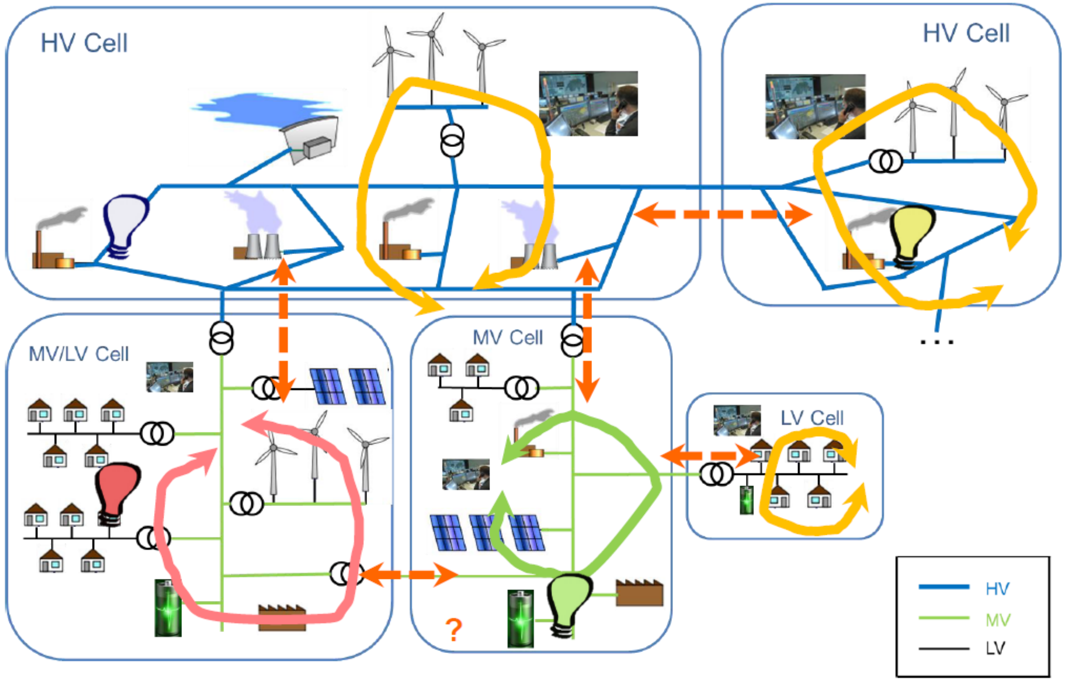
This initiative has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreements no. 646039 and no. 775970.

Web of Cells Concept

Web-of-Cells Concept

- Divide the power system (grid) in smaller entities (geographical areas) – **cells** – with local observability and control by a **cell operator** that is responsible for the real-time control of the cell
  - **Local problems are solved locally**, in a secure manner, without system-wide communication, bottom-up aggregation and central decision making
- Cells are connected with each other via tie-lines (one or multiple, radial or meshed)
  - Neighboring Cells can support each other in a autonomous distributed collaborative way (adjacent ⇔ central aggregation)
  - Neighboring cells can decide on local activation optimization (neighbor-to-neighbor ⇔ central)

Web-of-Cells Concept



Vector Integration Platform Diagram – Original Proposal

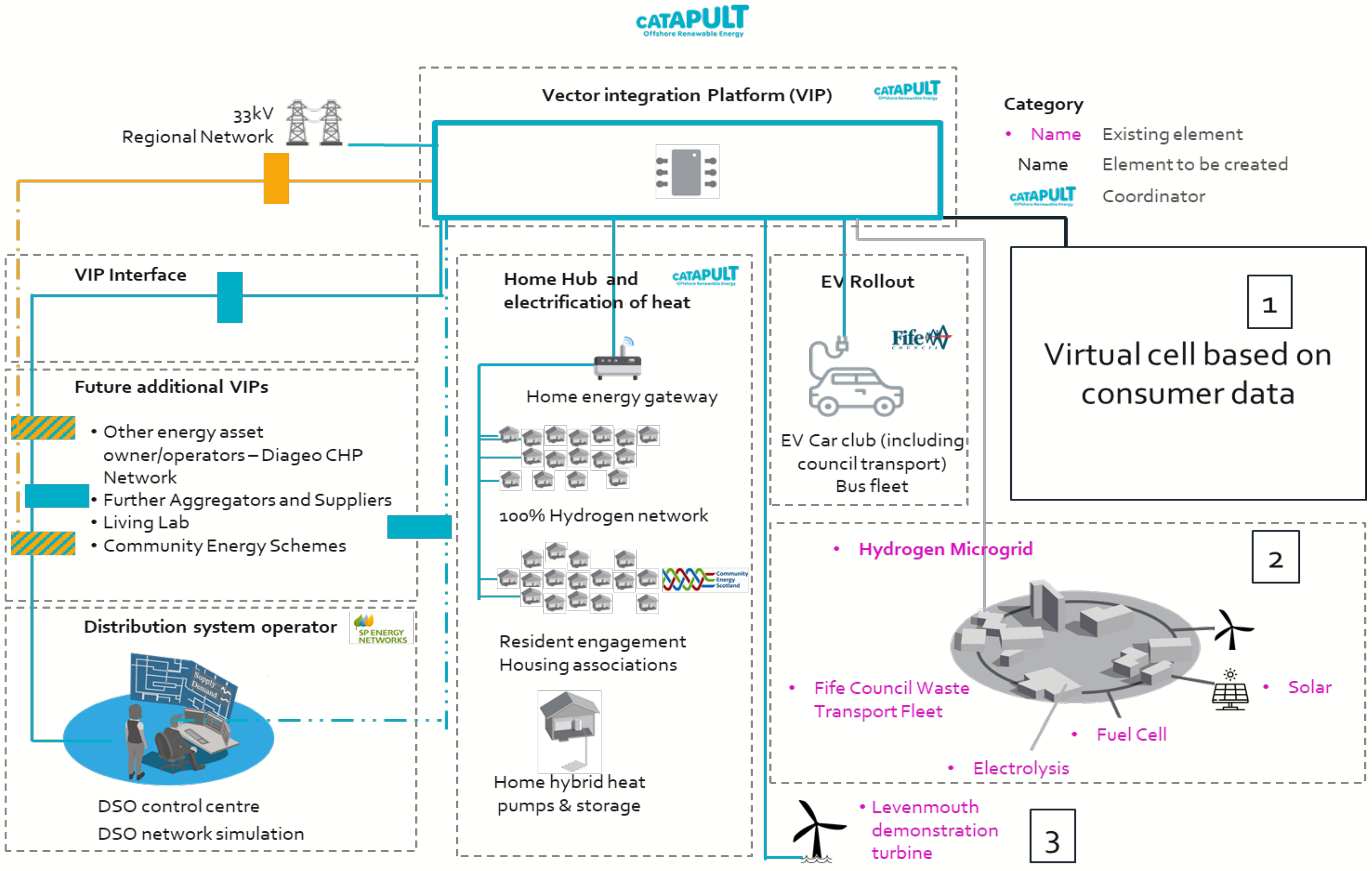
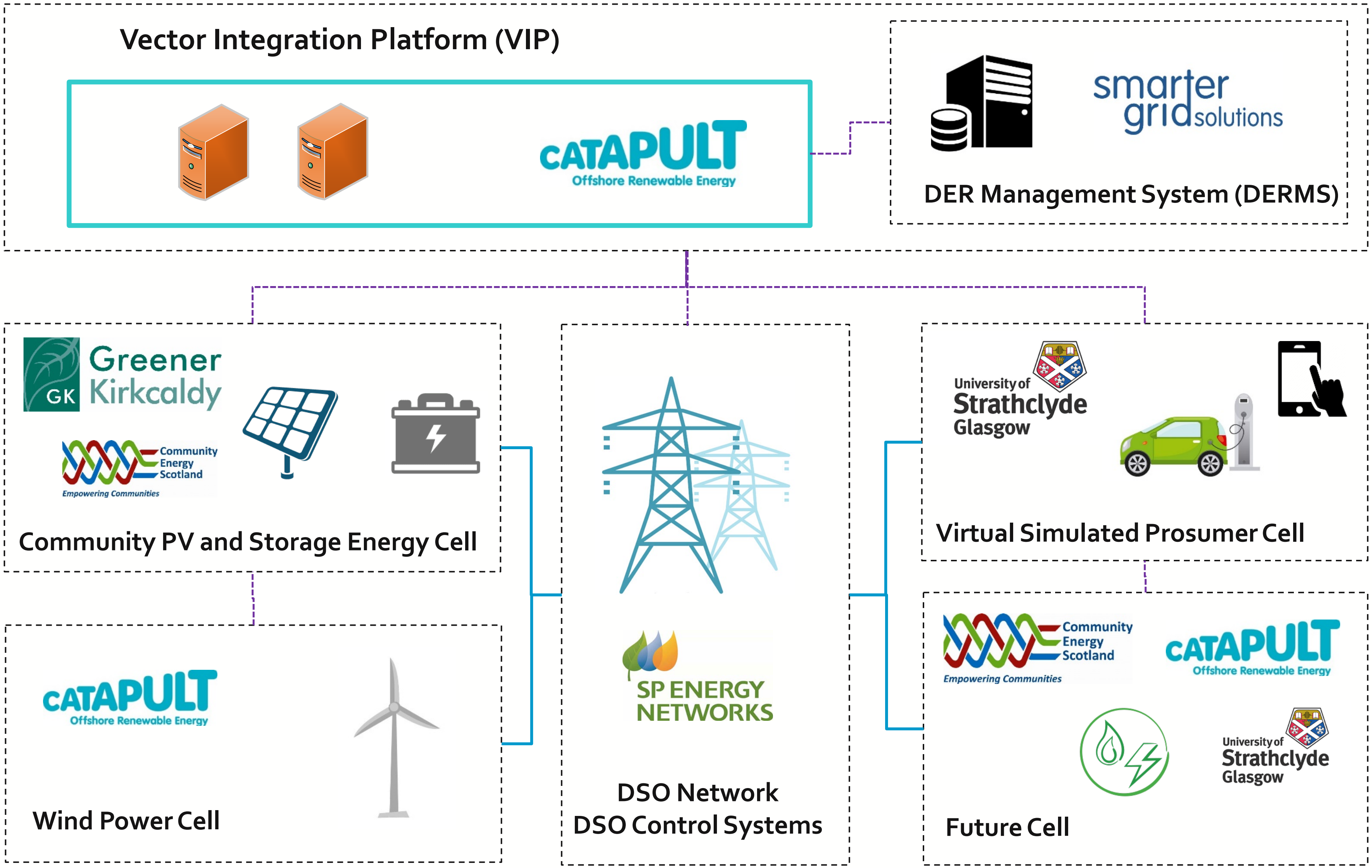


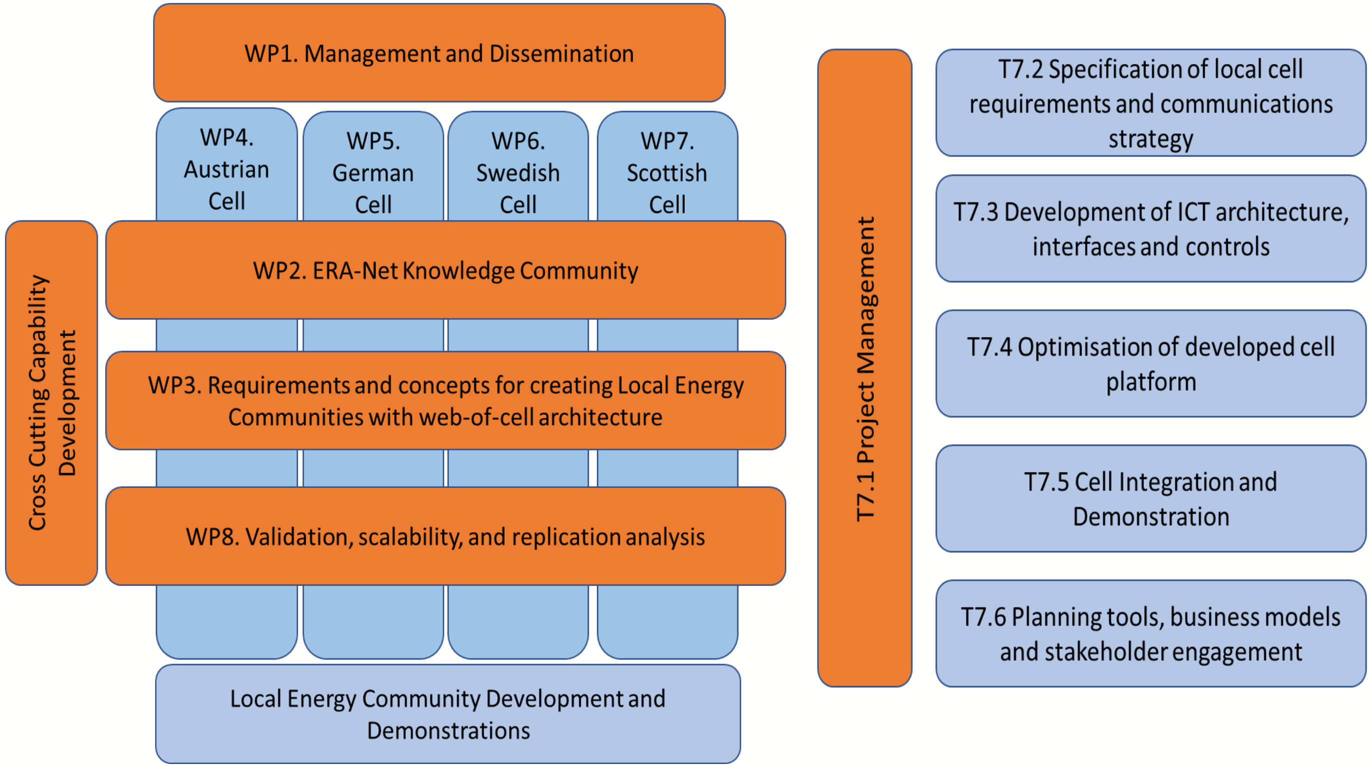
Diagram of anticipated assets to be included in VIP. Each of the cells to be included in the Web-of-cell architecture are numbered (1) Virtual Consumer Cell, (2) Hydrogen Microgrid and (3) Levenmouth Demonstration Turbine

Updated ScotCLUE Demonstrator Cell Proposal



Project Objectives and Tasks

- The ScotCLUE consortium will be involved across 4 main work packages
  - Three of these are horizontal work packages looking at the generic learning and capability building arising from the single work package focusing on each countries own "cell" demonstrator, as shown in the earlier VIP diagram



European CLUE proposal WP structure and key tasks in WP7 - Scottish Cell

Technical objectives for each key task of the Scottish CLUE Project

Task Number	T7.2 Specification of local cell requirements and communication strategy
Task Partners (Lead partner in bold)	UoS, SGS, ODSL
Objectives	(i) To define the requirements for each of the cells to be deployed as part of the web-of-cells architecture within the Levenmouth area. (ii) To define the inter cell communication requirements which will be necessary to ensure balancing of generation and demand within the local energy system.

Task Number	T7.3 – Development of ICT architecture, interfaces and controls
Task Partners (Lead partner in bold)	SGS, UoS
Objectives	(i) To define and develop the ICT architecture required to host the Web-of-cells architecture. (ii) To develop the IoT protocol for communication between multiple cells within the web of cells architecture.

Task Number	T7.4 – Optimisation of developed cell platform
Task Partners (Lead partner in bold)	SGS, UoS
Objectives	(i) To ensure the developed Web-of-cells architecture is a secure and resilient local energy system. (ii) To utilise consumer load profiles to simulate consumer demand as a virtual cell within the web of cells architecture.

Task Number	T7.5 – Cell integration and Demonstration
Task Partners (Lead partner in bold)	SGS, ODSL
Objectives	(i) To physically interface the developed control software and web of cells architecture with local assets in Levenmouth. And related areas? (ii) To demonstrate the web-of-cells architecture between the three cells of the CLUE project.

Task Number	T7.6 – Planning tools, business models and stakeholder engagement
Task Partners (Lead partner in bold)	ODSL, UoS and SGS
Objectives	(i) To develop an intensive stakeholder engagement plan to disseminate and capture feedback to inform the development of the project. (ii) To increase stakeholder acceptability of moving towards a de carbonised energy system through the utilisation of flexible renewable energy assets in a local energy system.

The 'Use' of Use Cases

Use Cases Selected

- Management of Grid Resources (incorporating Network Security)
- Energy Trading
- Capacity Sharing (Energy Storage)
- Virtual Use Case?

What are Use Cases?

use case

noun

noun: **use case**; plural noun: **use cases**

1. **a specific situation in which a product or service could potentially be used.**

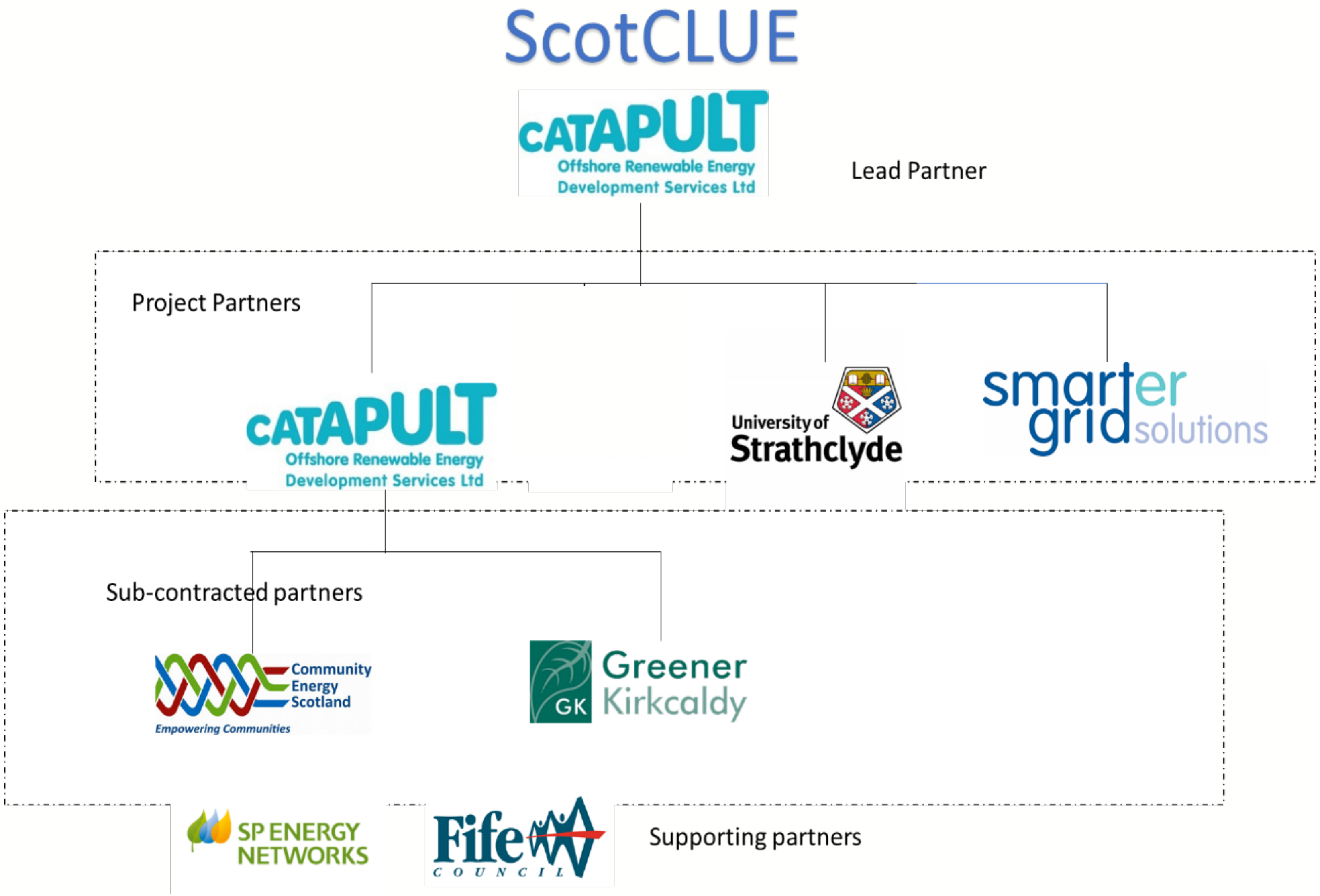
"there are lots of use cases for robotic hardware, from helping disabled users to automating factories"

CLUE: a **specific situation** in which Energy Communities could *potentially* be used.

Identified Use Cases

Use Case	Parent Use Case	Countries
P2P Trading	Energy Trading	
P2C Trading	Energy Trading	
C2C Trading	Energy Trading	
Short-term Community Storage	Capacity Sharing	
Long-term Community Storage	Capacity Sharing	
Controlled E-Mobility Charging	Demand Response	
Management of Grid Resources	Demand Response	
Emergency Supply with Battery Storage	Emergency Supply	
Network Security	Emergency Supply	

ScotCLUE Roles & Organisation Chart



ODSL – Project Coordinator of WP7. Operator and maintainer of the 7MW Levenmouth wind turbine. Provider of local energy system and local stakeholders knowledge

University of Strathclyde (UoS) – Provider of expertise in cyber security, statistical and data modelling to ensure web-of-cells architecture can be validated as a resilient energy system of the future which focuses on consumer benefit

Smarter Grid Solutions (SGS) – Provider of DERMS software, which combines grid and market optimization with real world control, to Distribution Utility, System Operators and Energy Asset Operator customers globally. SGS will utilise ScotCLUE to accelerate ANM element Hardware development for control of the electrical power network and develop an integrated control platform with their ANM Strata platform and ANM elements

ScotCLUE Project Schedule/Milestones

Delivery Month	Milestone detail
12/2019	M1 Project starts following finalising of consortium agreement.
02/2020	M2 Cell assets and intercell communication requirements defined.
08/2020	M3 ICT Architecture defined and ANM Element and Strata devices successfully communicating with one another
09/2020	M4 Third virtual cell modelled and defined based on disaggregation of consumer load data
10/2020	M5 Use cases and business models defined across CLUE consortium (characterisation of demonstration sites and infrastructure, stakeholders and barriers identified, definition of use case and business models to be investigated)
10/2021	M6 Cell optimisation delivered, and report produced
10/2021	M7 Integration of ICT control architecture with cell assets
02/2022	M8 Web-of-cells concept demonstrated
03/2022	M9 Final stakeholder engagement report delivered for ScotCLUE
09/2022	M10 Common specification for a Local Energy Community finalised
09/2022	M11 Recommendation for future LEC's reported on behalf of CLUE (considering technical, organisational and regulatory recommendations on a national level)
09/2022	M12 Project finished (all work packages and tasks successfully completed within planned schedule and comprehensive dissemination activities finished with deliverables achieved and reports available.

ScotCLUE will be running for a period of 34 months beginning December 2019 and ending September 2022. Each milestone to be delivered is aligned to a month within this 34-month period.

The Bigger Picture – The link to Hydrogen

OWIC & OREC OSW-H2 study

Background and objectives

- Report delivered as part of Sector Deal Task Group
- Goal - identifying opportunities to strengthen offshore wind's role in delivering innovative solutions to system integration

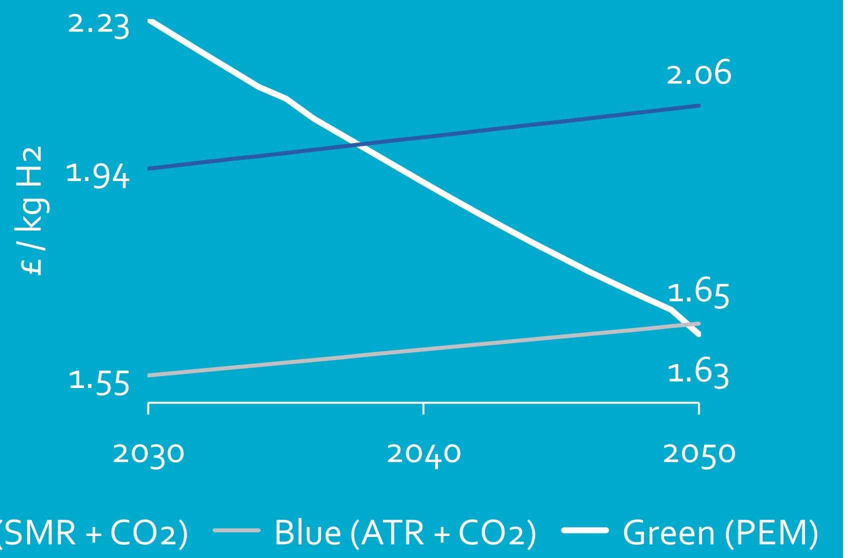
Key findings

① ENERGY SYSTEM

The UK energy system requires 130TWhr to over 200TWhr hydrogen in 2050, to integrate 75GW, or more of offshore wind.

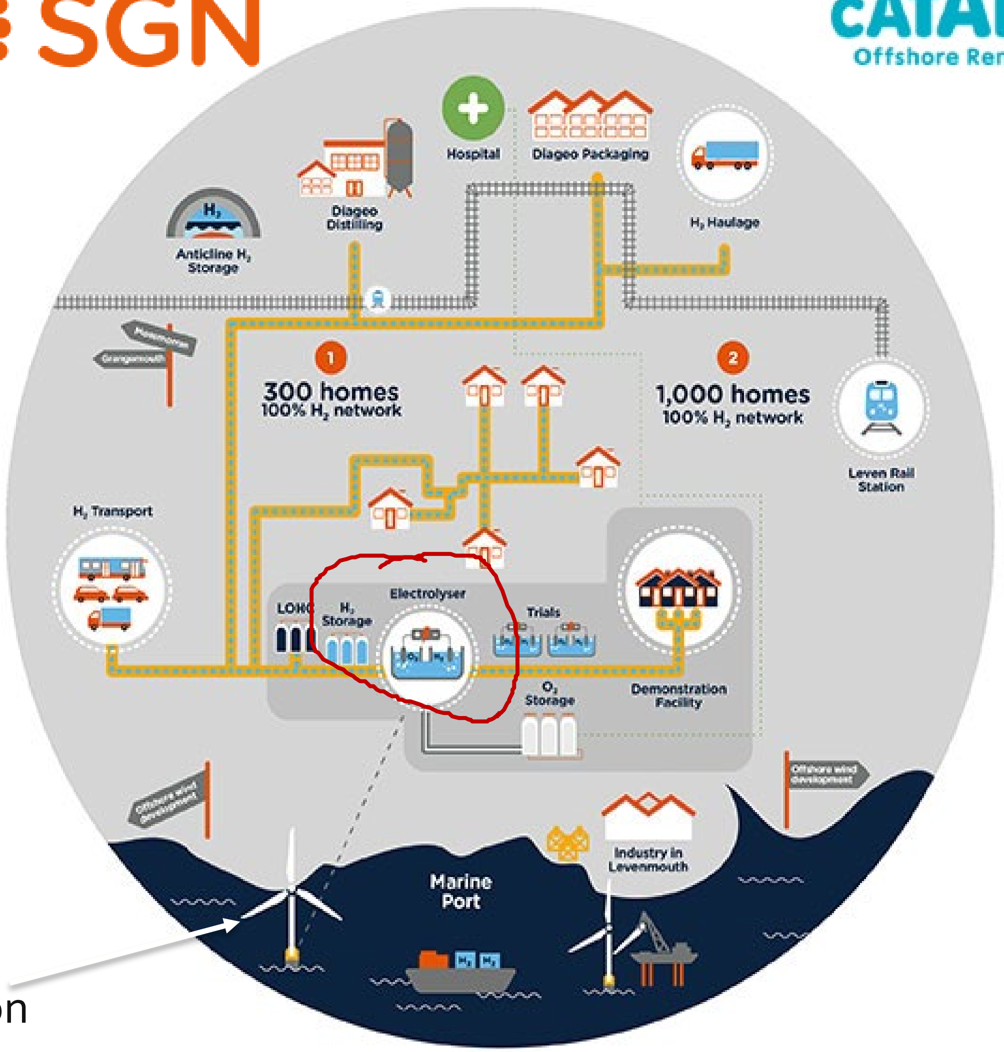
② GREEN AND BLUE HYDROGEN

- Green hydrogen from OSW costs less than blue hydrogen by 2050.
- Hydrogen production from natural gas with CCS is not essential for net-zero UK energy economy in 2050.



H100 Fife Project

The first 100% H2 to homes, zero carbon network in the world.



Levenmouth Demonstration Turbine (LDT);

- Development of a world-first hydrogen network in Levenmouth.
- In the project's first phase, the network will heat around 300 local homes using clean gas produced by an electrolysis plant, powered by ORE Catapult's Levenmouth Demonstration Turbine (LDT);
- The project will be the first of its kind to employ a direct supply of clean power to produce hydrogen for domestic heating – putting Levenmouth at the forefront of the clean energy revolution.

Milford Haven: Energy Kingdom aims to accelerate the transition to an integrated hydrogen and renewable energy system

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MH2
ENERGY KINGDOM
DEYRNAS YNNI

- Ambition - gather insight into the whole energy system around Milford Haven.
- The project is multi-faceted and will see the team investigate local renewable energy for decarbonised gas transition; diversified seed markets for hydrogen across buildings, transport and industry; consumer trials of fuel cell vehicles and hydrogen-ready heating systems.

Project partners

ARUP
riversimple
Port of Milford Haven
CATAPULT Energy Systems
CATAPULT Offshore Renewable Energy
WALES&WEST UTILITIES
Pembrokeshire County Council
Cyngor Sir Penfro
Llywodraeth Cymru
Welsh Government

Conclusions

- Energy Systems are undergoing significant transformation as we prepare for Net Zero
- The CLUE project is looking at how we can develop Local Energy Communities (LECs) from Concepts to Planning and Demonstration
- LECs are a potential solution for the connection and control of multi-vector Energy Systems incorporating offshore wind
- The integration of hydrogen into LECs will become a key link and significant future activity

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