
FUTURE AGRICULTURE
RESILIENCE MAPPING
FARM
SHOW AND TELL
Scottish & Southern
Electricity Networks
The James
Hutton
Institute
SAOS
Working together to shape the future
of farming and food
CATAPULT
Energy Systems

HOUSEKEEPING

- Please keep your questions to the end
- Today's session will be recorded – posted onto the Engage Portal and through social media platforms
- The slide deck will be made available following the presentation

Video/webcams off
Please only turn your video on for questions at the end

Mics on mute
Please stay on mute unless you are asking a question

Technical queries
If you have any technical questions, please let us know

Slides
The presentation will be made available after the session

AGENDA

1. Introductions
2. Context: Distribution and decarbonisation.
3. The Project:
    a) Data – what do we have?
    b) Possible decarbonisation pathways
    c) What a FARM tool might look like
    d) Policy
    e) How can we support agriculture
4. What's next?

TEAM

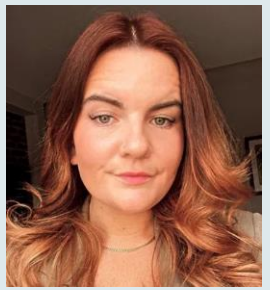
SSEN

Cori Critchlow-Watton

James Hutton Institute

Nick Roxburgh

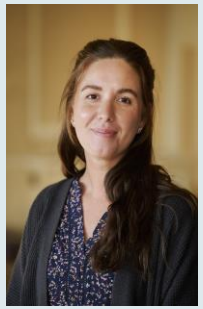
Niamh Carr



SAOS

Helen Glass

Patricia Rojas Bonzi



Alan Stevenson

Douglas Bowden-Smith

The Energy Systems Catapult

Katie Chong

Nathaniel Bottrell

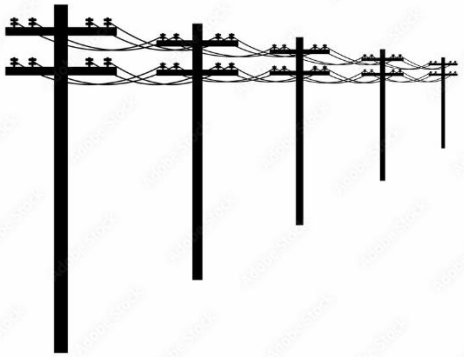
Robin Kerr

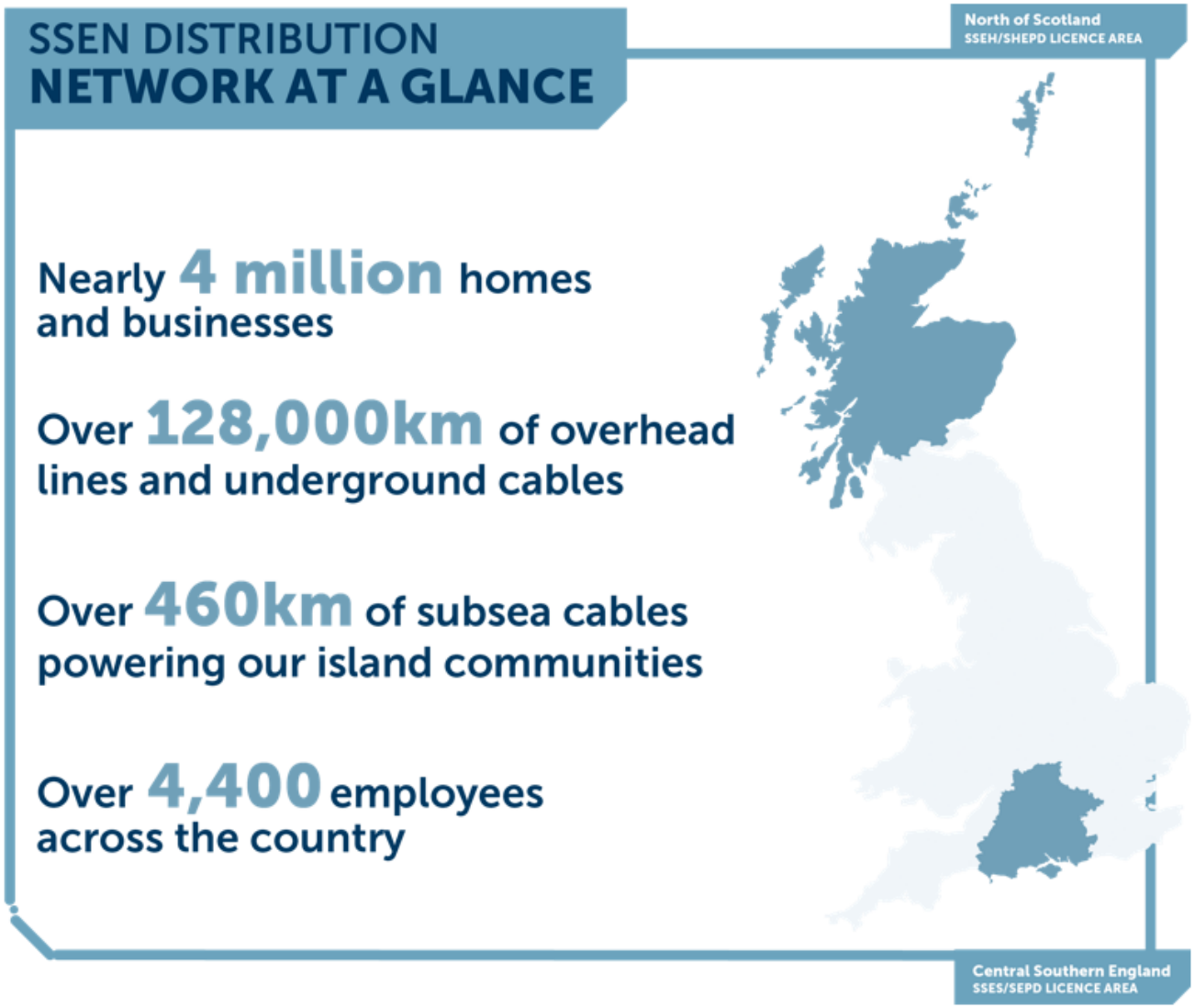
Tian Coulsting

Scottish and Southern Network DISTRIBUTION

Transmission
- Motorways of electricity
- Long distance
- High voltage (132, 220 or 400 kV)
- Bulk transfer

Distribution
- Local roads
- The last mile delivery to homes and businesses
- Lower voltages (11, 6.6kV or 400V)
- Electricity for end users





SIF FUNDING

The Strategic Innovation Fund (SIF) aims to help transform gas and electricity networks for a low-carbon future.

For energy consumers, SIF projects:

- reduce costs and increase value for money
- create innovative products and services
- provide energy security

For businesses, SIF projects:

- finance growth and scalability
- help with collaboration
- encourage more investment

This is typically done over three phases:

1. **Discovery** – A three-month feasibility study
2. **Alpha** – up to six months to provide proof of concept
3. **Beta** – a longer-term development phase

ADDRESSING THE CHALLENGE

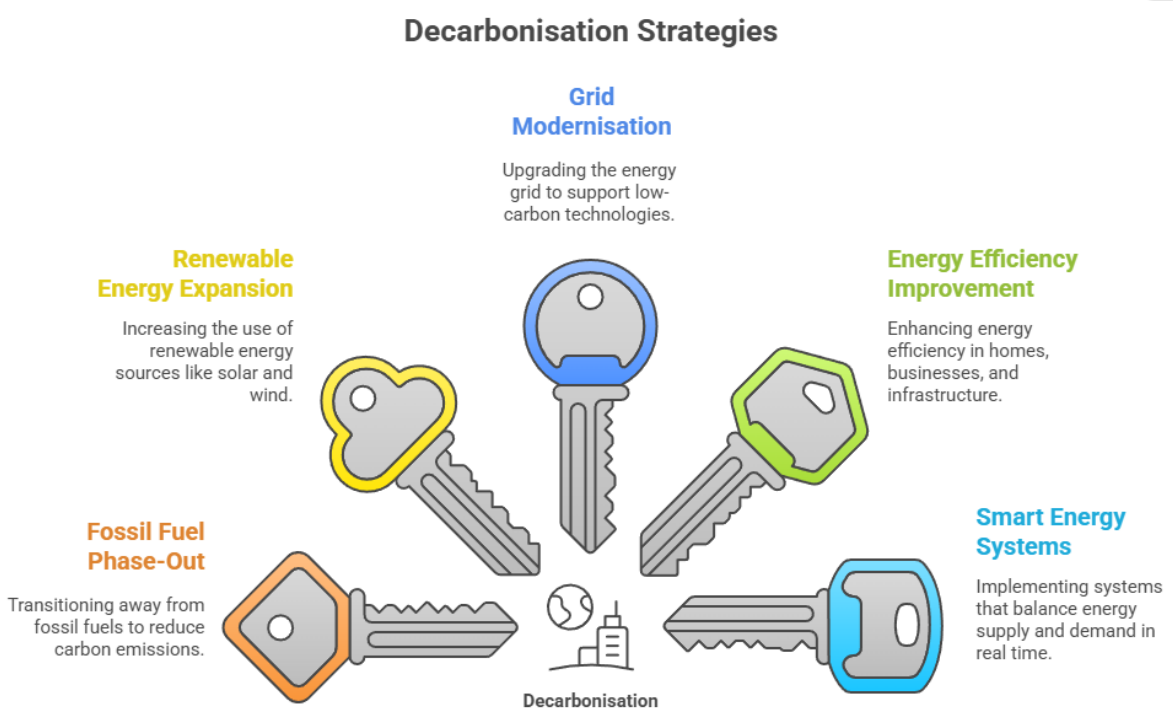
SIF entered Round 4 last year.
We worked on Innovation Challenge 3 which was to:

"Embed resilience by developing novel and replicable approaches to support rural decarbonisation in a timely, resilient and cost-effective manner."

DECARBONISATION

Decarbonisation:

1. Process of reducing and ultimately eliminating CO_2 emissions associated with the generation, transmission and use of electricity.
2. Help the UK meet its greenhouse gas targets by 2050



Future of farming and rural communities:

- Critical time of transformation requiring significant changes to farming practices
- Adoption of emerging, innovative technologies
- Reducing emissions – renewable energy generation, low emission fuels etc.

FARM – FUTURE AGRICULTURE RESILIENCE MAPPING

How much electricity will agriculture require in 2050?

FARM

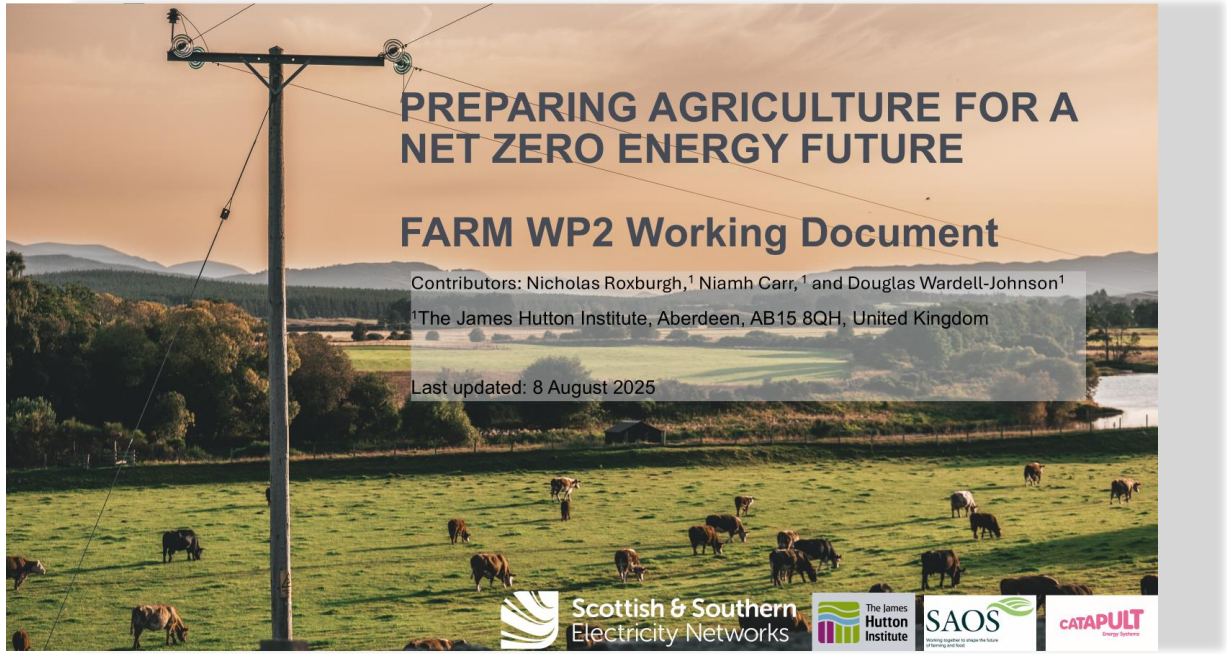
- Understand future energy needs (based on current use patterns)
- How to define such a varied sector in terms of energy need/use?
- How possible decarbonisation pathways influence carbon emissions
- How can we support rural decarbonisation – provide information or a tool?
- What are the current barriers to decarbonisation?

THE PROJECT

Scottish & Southern Electricity Networks

PREPARING AGRICULTURE FOR A NET ZERO ENERGY FUTURE

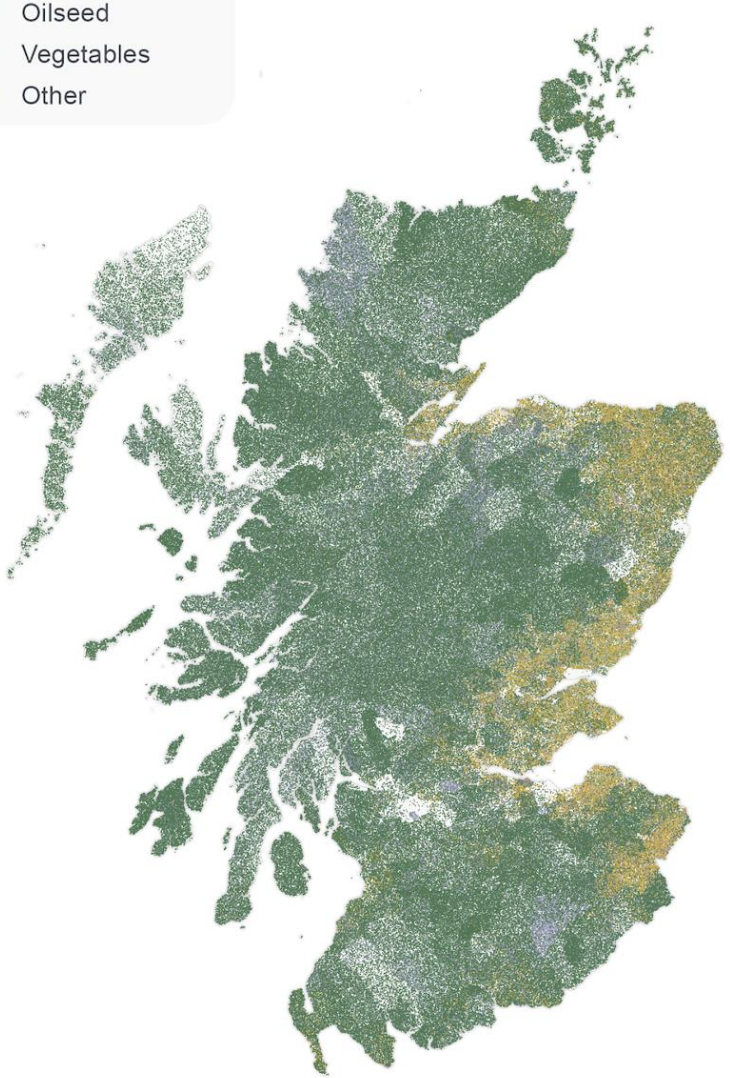
- For the Discovery Phase, Work Package 2 focused on assessing whether the data needed to carry out the wider project is currently available or could realistically be obtained. This involved:
  - Reviewing existing literature and prior work on agricultural energy use
  - Assessing the availability of detailed data on farming activities and their energy demands
  - Identifying critical data gaps and strategies to overcome them
- No single dataset gives us the full picture on its own



Agricultural Land Use

- Cereals
- Fruit
- Grass and forage
- Legumes
- Oilseed
- Vegetables
- Other

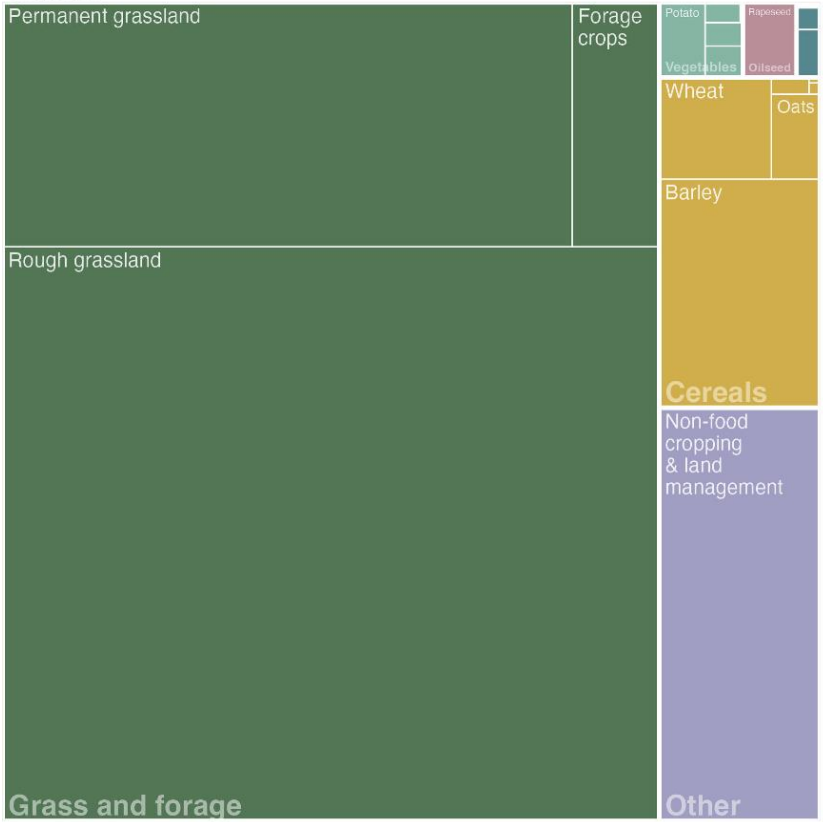
↓ Dot density map showing the distribution of reported land use across agricultural parishes in the 2020 June Agricultural Census. Each dot represents 10 hectares.



→ Number of holdings reporting each land use type in the 2020 June Agricultural Census, alongside total hectares recorded per land use.

Total agricultural land reported in JAC (ha):	Share of Scotland's total land (%):	Holdings reporting land in JAC:
5,774,759	74.12	52,326

↓ Treemap illustrating the relative area occupied by different agricultural land uses in Scotland, based on data from the 2020 June Agricultural Census.



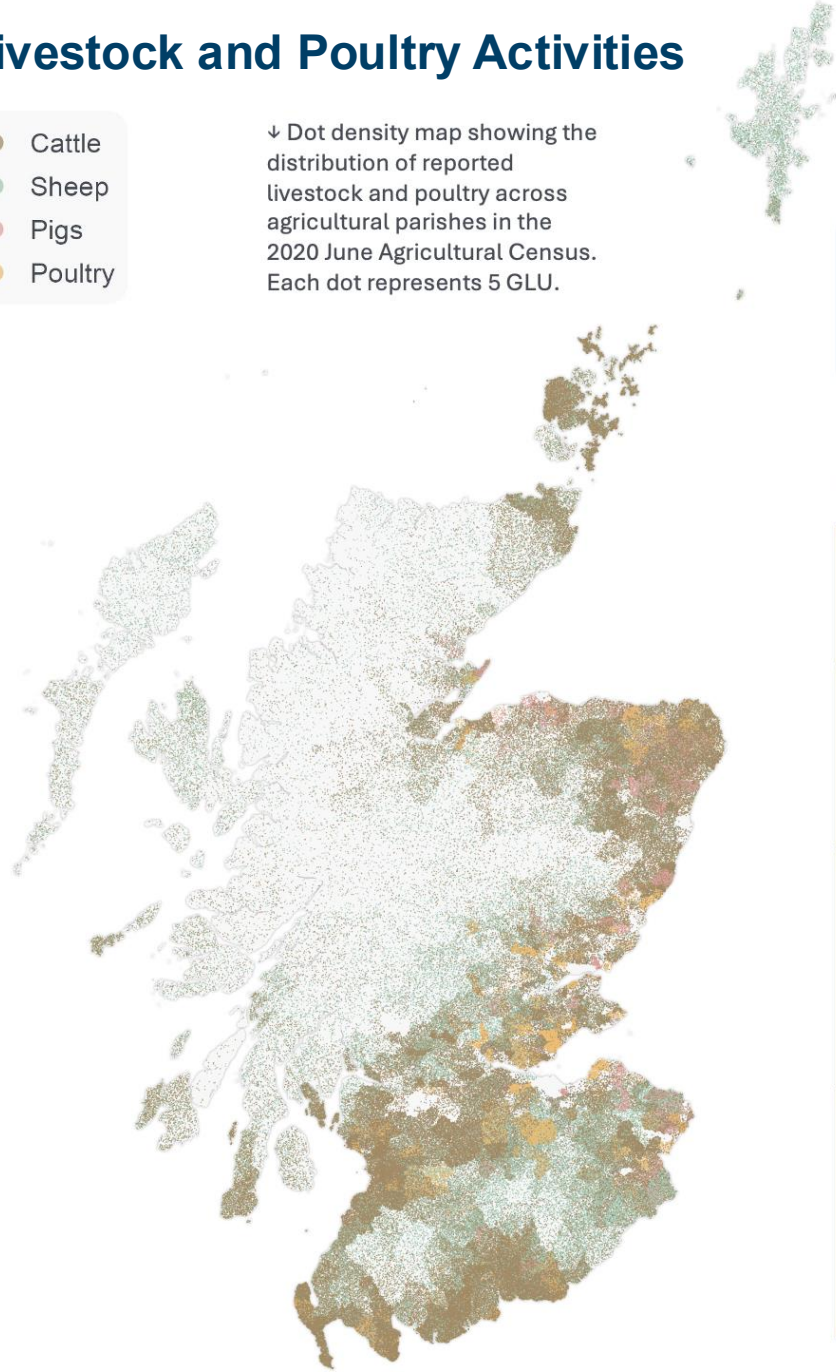
Class	Subclass	Holdings	Hectares
Cereals	Barley	8740	301792.6
	Wheat	2449	93537.7
	Oats	1772	33983.7
	Rye	175	5136.8
	Maize	58	1025.6
	Other cereal or pseudo-cereal	54	489.7
Fruit	Berry fruit	455	628.8
	Unspecified fruit	307	145.6
Grass and forage	Rough grassland	22198	3094892.3
	Permanent grassland	38007	1142251.2
	Forage crops	11551	174388.4
Legumes	Peas	636	9235.7
	Beans	338	4459.2
Oilseed	Rapeseed	1391	33085.9
	Minor oilseed	10	116.8
Vegetables	Potato	2665	28297.4
	Other root vegetable	1856	9737.9
	Unspecified vegetables	1641	7260.8
	Cruciferous vegetable	956	5835.0
	Stem vegetable	141	189.5
	Leafy vegetable	102	146.3
	Allium	86	87.7
	Fruiting vegetable	370	3.2
Other	Non-food cropping & land management	15343	545590.8

Script: 'Data/JAC/ProcessLanduse.R'. Data: Based on June Agricultural Census data obtained by permission from Scottish Government Rural and Environmental Science Analytical Services Division (RESAS).

Livestock and Poultry Activities

- Cattle
- Sheep
- Pigs
- Poultry

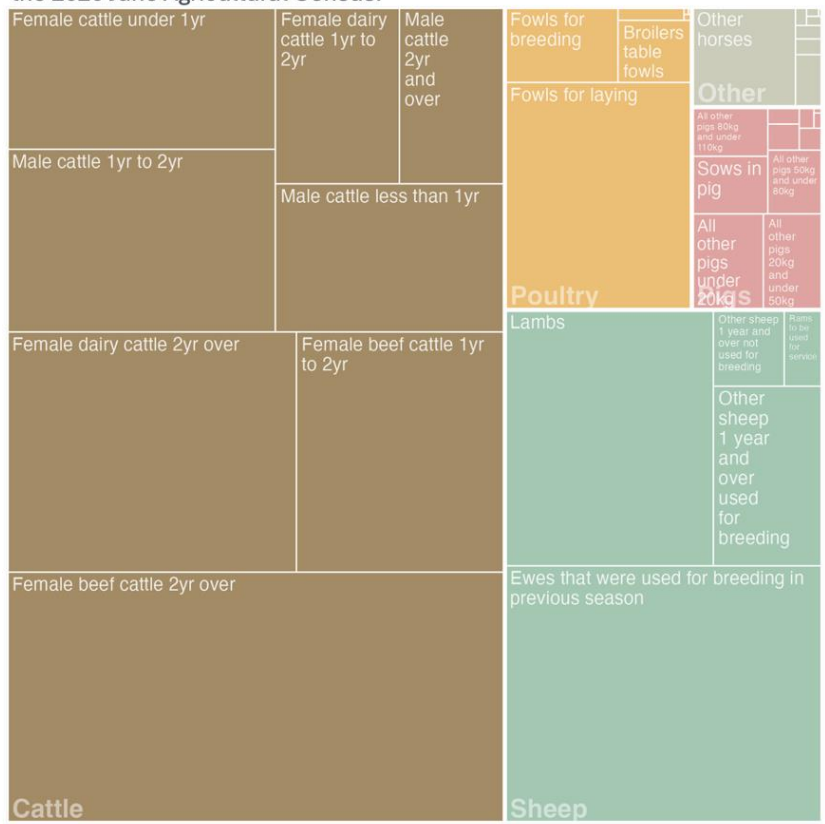
↓ Dot density map showing the distribution of reported livestock and poultry across agricultural parishes in the 2020 June Agricultural Census. Each dot represents 5 GLU.



→ Number of holdings reporting each of the main livestock or poultry types in the 2020 June Agricultural Census, alongside total Grazing Livestock Units (GLU).

Total Grazing Livestock Units reported in JAC:	Total livestock and poultry reported in JAC:	Holdings reporting GLU in JAC:
1,654,266	23,104,243	26,163

↓ Treemap illustrating the composition of Scotland's livestock and poultry populations in terms of Grazing Livestock Units (GLU), based on data from the 2020 June Agricultural Census.



Class	Detailed	Holdings	Count	Total GLU
Cattle	Female beef cattle 1yr to 2yr	7724	191490	124468
	Female beef cattle 2yr over	8489	413935	310451
	Female cattle under 1yr	8510	279308	94965
	Female dairy cattle 1yr to 2yr	974	54521	54521
	Female dairy cattle 2yr over	1580	173032	173032
	Male cattle 1yr to 2yr	6945	187613	121948
	Male cattle 2yr and over	7867	57830	46264
	Male cattle less than 1yr	8635	248534	84502
Sheep	Ewes that were used for breeding in previous season	12635	2537933	203035
	Lambs	12398	3315549	132622
	Other sheep 1 year and over not used for breeding	6938	167720	13418
	Other sheep 1 year and over used for breeding	8349	608872	48710
	Rams to be used for service	9989	90742	7259
Pigs	All other pigs 110kg liveweight and over	187	7451	1267
	All other pigs 20kg and under 50kg	331	82975	14106
	All other pigs 50kg and under 80kg	296	50952	8662
	All other pigs 80kg and under 110kg	258	54407	9249
	All other pigs under 20kg	261	100411	17070
	Barren sows for fattening	163	726	123
	Boars being used for service	308	919	322
	Gilts 50kg and over expected breeding	145	4246	764
	Gilts in pig	125	6580	1316
	Other sows for breeding	286	4619	2032
	Sows in pig	236	24715	10875
Poultry	Broilers table fowls	281	6707229	11402
	Cocks	2039	127768	2172
	Ducks	1642	15876	48
	Fowls for breeding	599	1247661	21210
	Fowls for laying	5899	6219633	105734

Script: 'Data/JAC/ProcessLivestock.R'. Data: Based on June Agricultural Census data obtained by permission from Scottish Government Rural and Environmental Science Analytical Services Division (RESAS).

CALCULATING ENERGY USE FOR TEST CASES

- After establishing the scale and location at which agricultural activities take place, we sought literature and datasets on their associated energy requirements
- Aspiration was to disaggregate energy needs by process stage and energy carrier, while also taking account of contextual conditions (e.g., grain moisture content at harvest and chosen drying method). Doing so enables:
    - Exploration of the impact of technological substitution at specific stages of production processes (e.g. diesel → hydrogen tractors)
    - Take account of differences in farming methods across holdings
    - Consider variability over time and space
- To establish the feasibility of this approach for the project, we focused on **two test cases** for the Discovery Phase: barley and pigs

Image: https://pixabay.com/photos/tractor-cultivation-field-plow-5765800/

Typical process and energy use in Scottish context

Spring & Winter Barley

	Field operations									Primary processing		
Process	Ploughing	Seedbed preparation	Drilling	Rolling	Fertiliser application	Spraying	Combining	Straw bailing	Bale carting	Cleaning	Drying	Storage
Energy carrier	Diesel	Diesel	Diesel	Diesel	Diesel	Diesel	Diesel	Diesel	Diesel	Electricity	Diesel or Electricity	Electricity
Total	95.36 – 105.36 litres of diesel per ha									Trace	Highly variable	

Pigs

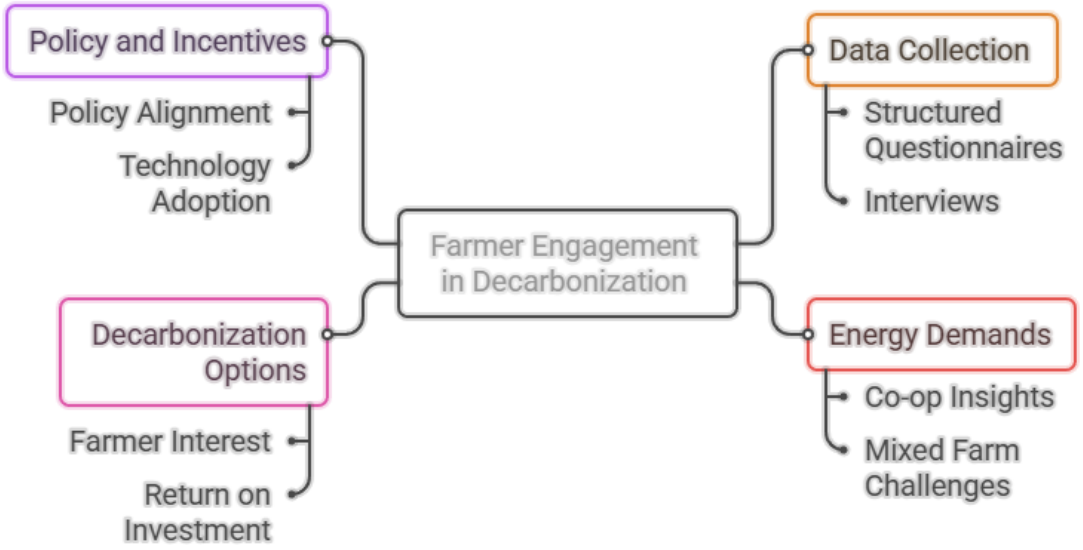
Pig type	Sow		Piglet		Slaughter-pig	
Energy carrier	Electricity	Heat	Electricity	Heat	Electricity	Heat
Total	100 kWh/place/yr	540 MJ/place/yr	27.04 kWh/place/yr	389.38 MJ/place/yr	25.35 kWh/place/yr	18.252 MJ/place/yr

Legend

- Diesel
- Electricity
- Heat

DISCOVERY: STAKEHOLDER ENGAGEMENT

WP2 farmer engagement
- 17 responses across 10 value chains



WP4 engagement raised the following decarbonisation challenges

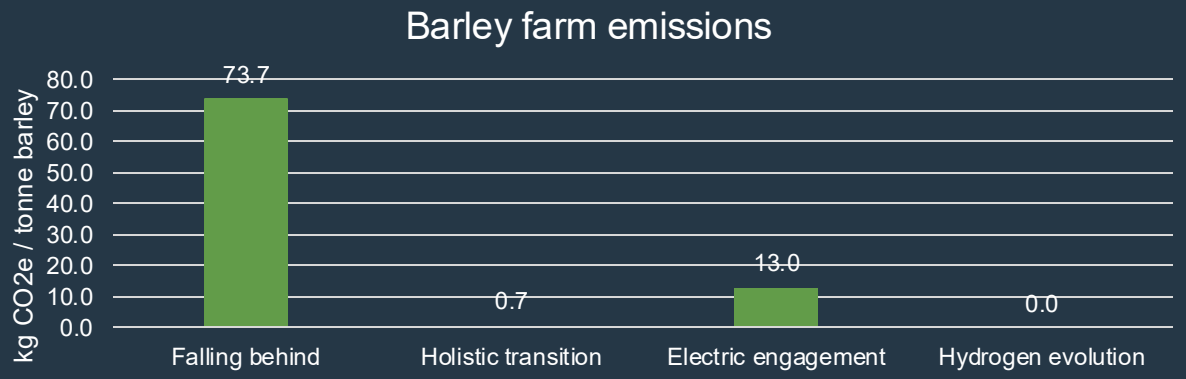
ESTABLISH BASELINE ENERGY USAGE OF ARCHETYPAL FARMS (PIGS AND BARLEY)

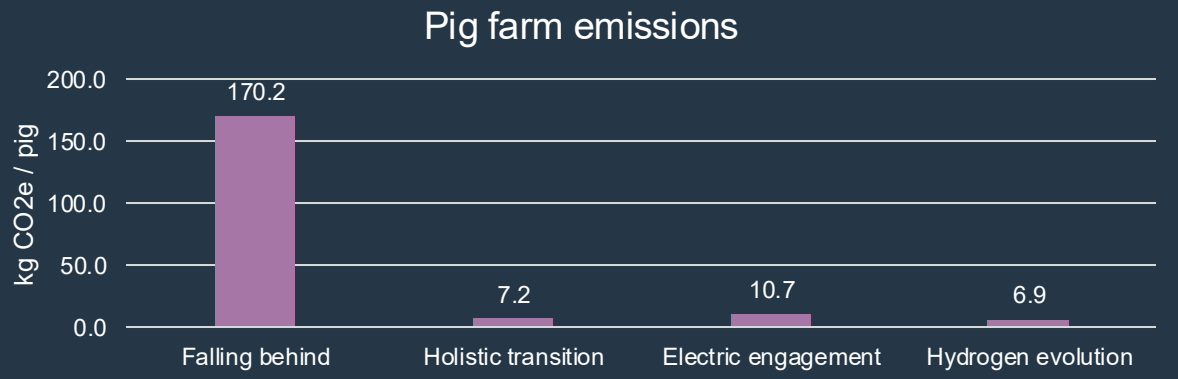
	Size	Yield	Energy Using Processes	
Spring Barley	37.4 hectares	Grain yield of 205.7 tonnes per annum	Ploughing, seedbed preparation, drilling, rolling, fertiliser application, spraying (x3), combining, straw carting, straw baling, cleaning, drying, storage	
Pig Farming		3,852 pigs (357 sows, 1523 piglets, 1972 slaughter-pigs).	Electricity and heat for sows, piglets, and slaughter-pigs.	

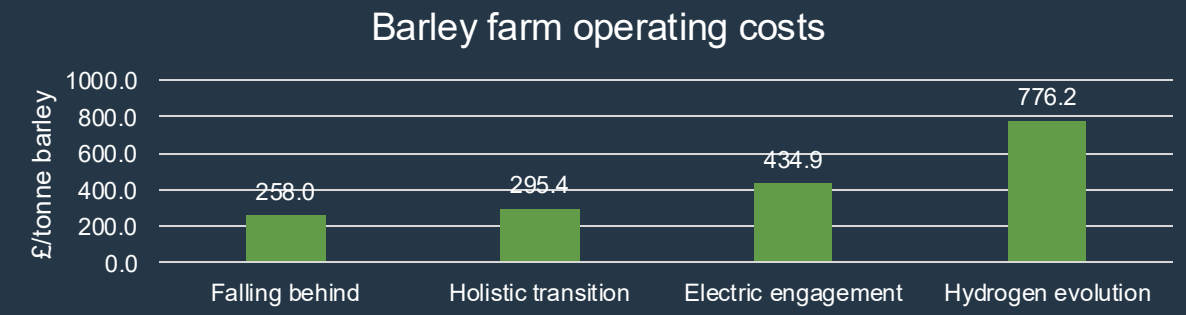
DECARBONISATION PATHWAYS

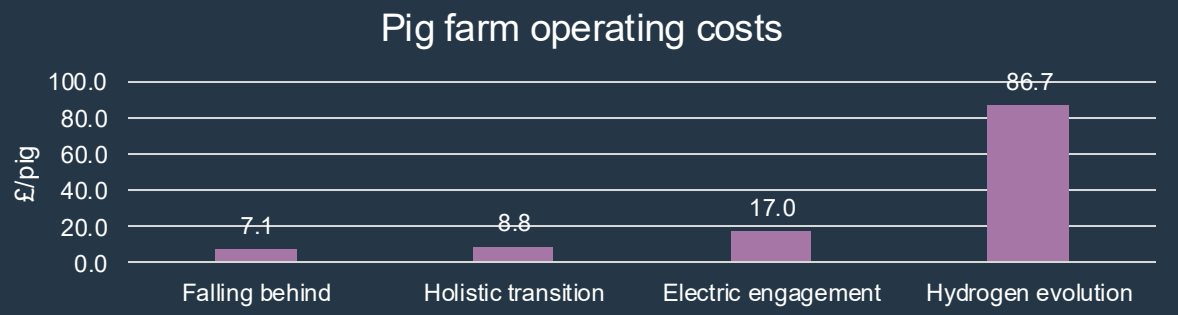
Falling Behind (Baseline)	Holistic Transition	Electric Engagement	Hydrogen Evolution
Limited progress	Balanced uptake of multiple technologies	Assumes fast electrification	Assumes H_2 becomes a widespread fuel
For barley farm:			
Diesel for tractors, heating oil for drying grain	Model is free to choose from options	Electric tractor	Hydrogen tractor, hydrogen burner for grain drying
For pig farm:			
Diesel for tractors, heating oil for heating pig sheds	Model is free to choose from options	Heat pump for heating pig sheds	Hydrogen for heating pig sheds

EMISSIONS AND COSTS









Falling behind	Holistic transition	Electric engagement	Hydrogen evolution
Diesel tractors	HVO for vehicles	Battery electric vehicles	Hydrogen fuel cell vehicles
Natural gas for drying	Biomethane for drying	Natural gas for drying	Hydrogen for drying

Falling behind	Holistic transition	Electric engagement	Hydrogen evolution
Fuel oil for heating	Biomethane for heating	Heat pump for heating	Hydrogen for heating
Electricity for lighting	Electricity for lighting	Electricity for lighting	Electricity for lighting

HOW WE DESIGNED THE FARM TOOL

Stakeholder Engagement

Workshop with 6 farming bodies and 2 interviews with National Farmers Union Scotland and the Distribution Network

Network Reinforcement Planning

Map to help inform FARM Tool Design

Systems Engineering approach

Needs Analysis

Produced through exploring interactions with the wider system and stakeholders

FARM Tool Requirements

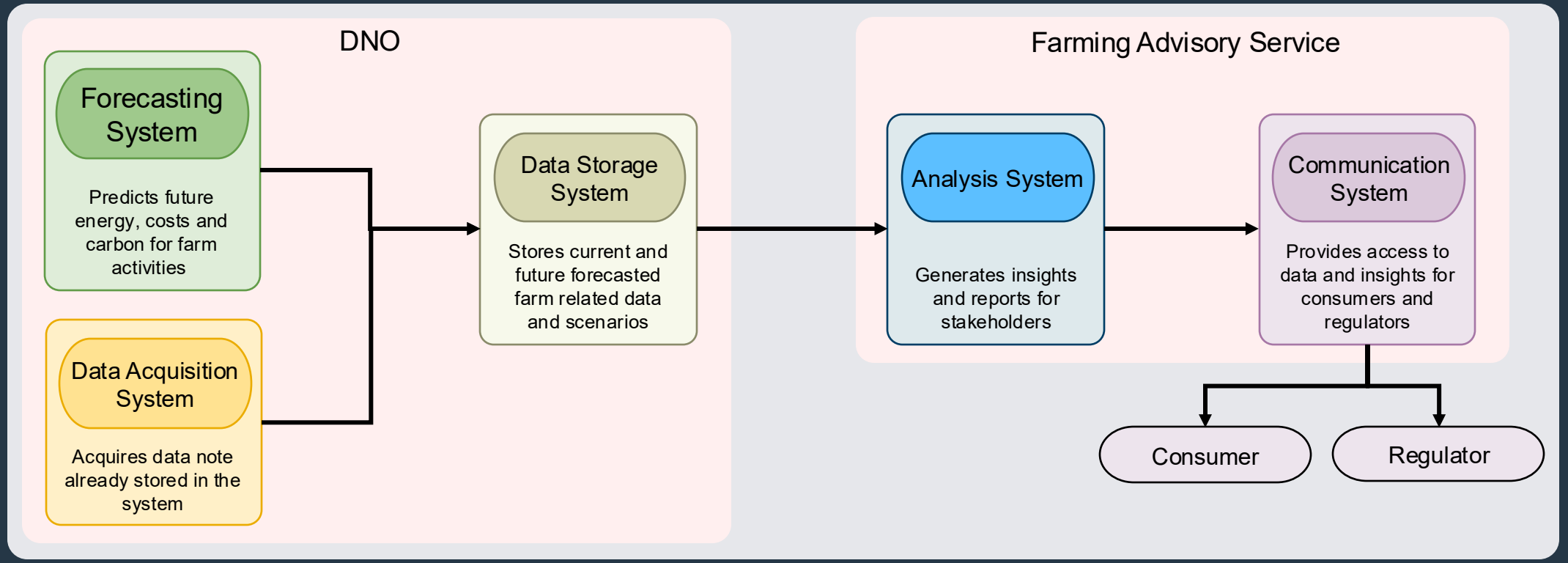
We combined all of these to design what the FARM tool should be able to do and how it interacts with the existing systems

Scottish & Southern Electricity Networks

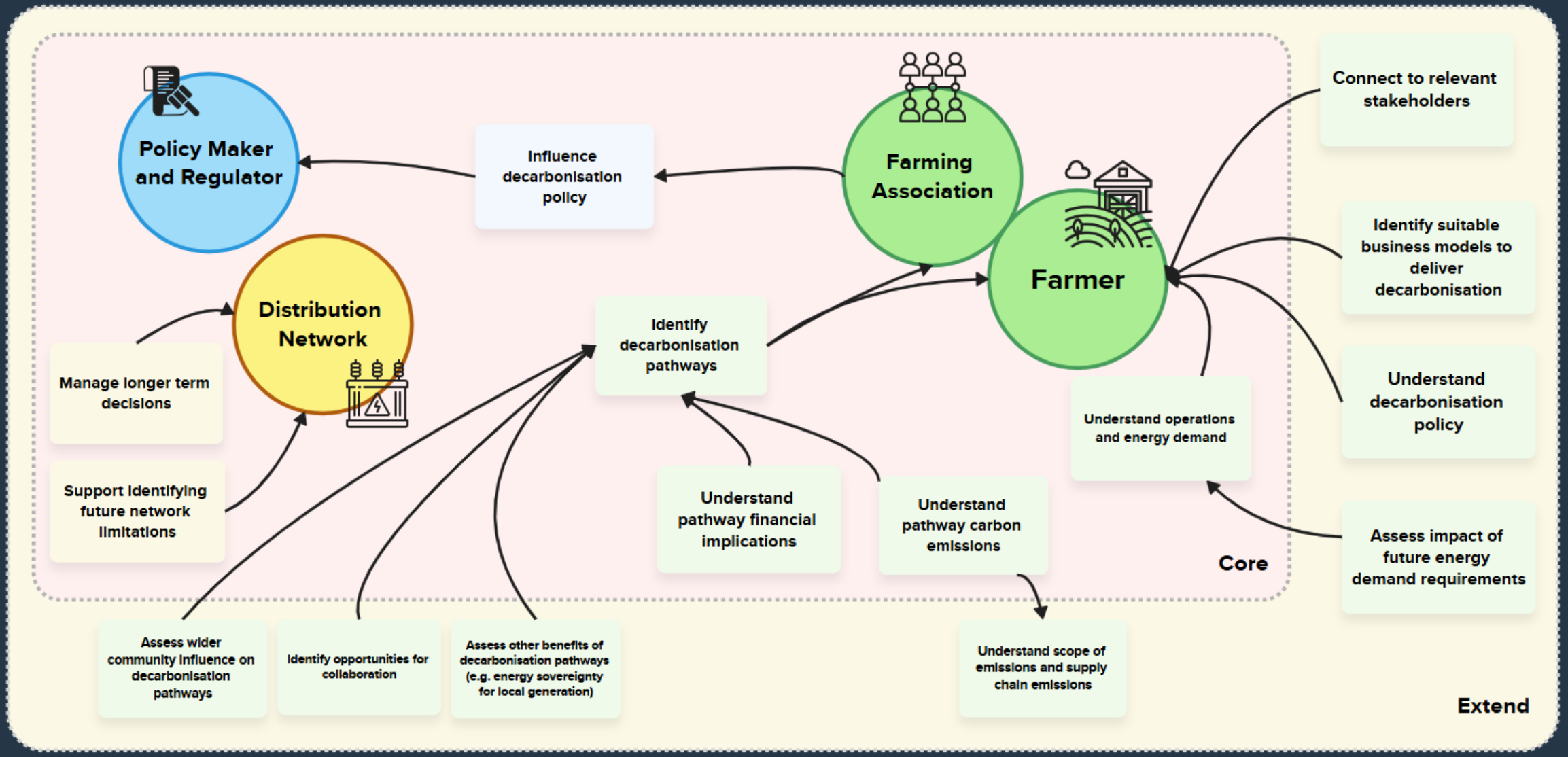
FARM TOOL DESIGN

The FARM Tool has been designed to breakdown to the structure shown below.

Possible organisations to own each part of the FARM Tool are shown with further stakeholder engagement needed to firm this up at the next stage.



FARM TOOL ENABLES



CLEAR POLICY AROUND AGRICULTURAL DECARBONISATION IS REQUIRED

Fragmentation & conditionality

Diverging UK approaches create opportunities but risk excluding smaller/mixed farms

Data as a Policy Lever

Payments increasingly tied to carbon, land-use, and practice-change data

Barriers and Stakeholder Concerns

Short policy cycles, complexity, and limited support for mixed farms restrict uptake

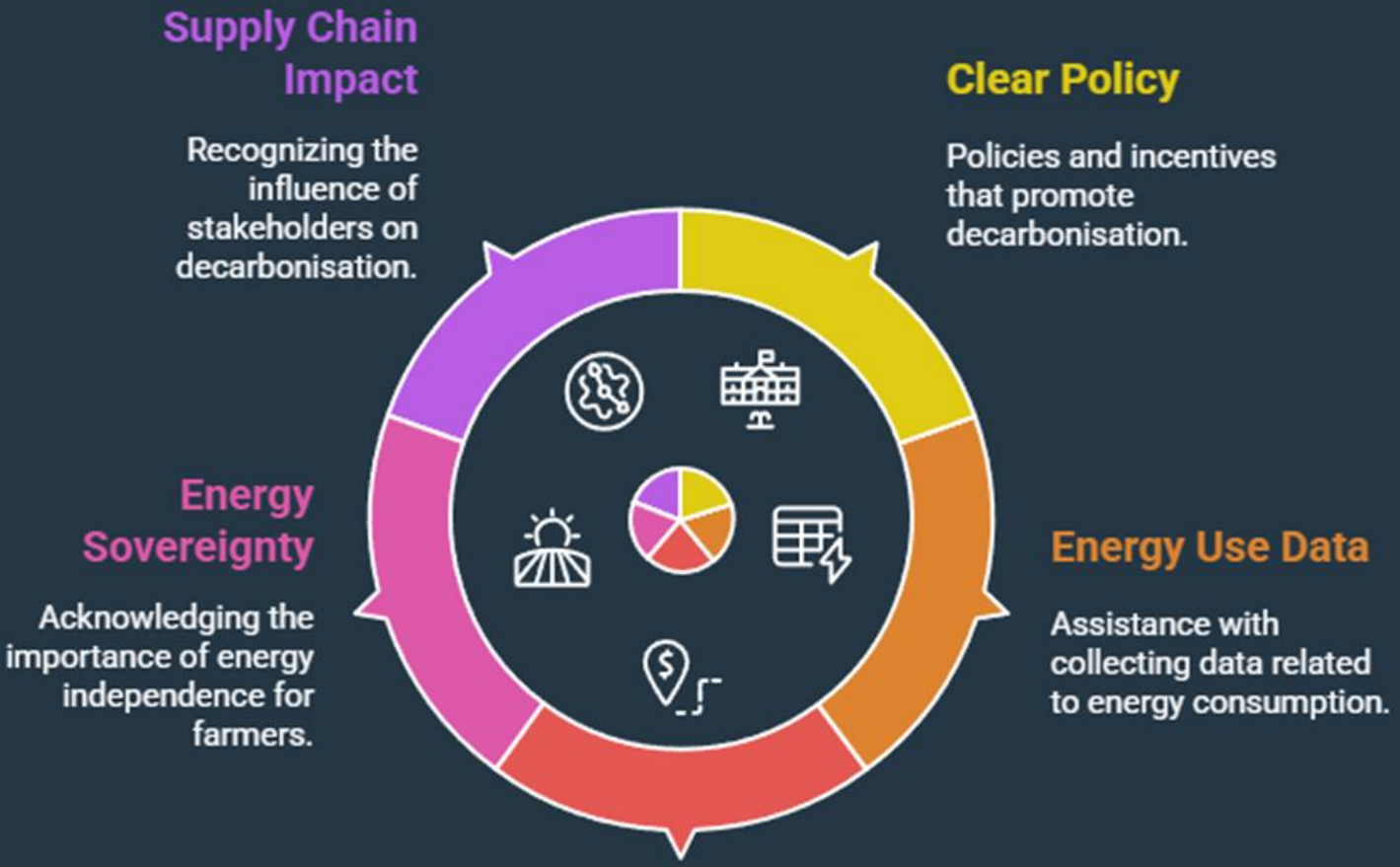
Energy-Agriculture Disconnect

Network planning overlooks farm-level energy needs

Future Policy Pathways

Scenarios from status quo to ambitious reform shape FARM's value case in terms of adoption, CAPEX, demand timing and resilience.

AGRICULTURAL DECARBONISATION SUPPORT



BRINGING IT ALL TOGETHER

1. Data – what do we have?
   - More data for arable in Scotland than for poultry and livestock
   - Validating data with farmers was difficult. Many do not collect the type of data we need to understand energy use
2. Possible decarbonisation pathways
   - Falling behind – emissions
   - Holistic transition – good balance
   - Electricity – marginally more expensive
   - Hydrogen – expensive
3. Need to have commercial confidence in decarbonisation pathways
4. What a FARM tool might look like
5. Future policy pathways
6. What support is needed

Scottish & Southern Electricity Networks

WHAT'S NEXT?

The findings and reporting from RIDES Discovery will be available on the Energy Network Association Smarter Network Portal and from partner websites.

Achieving rural decarbonisation requires more work

SSEN are reviewing their decarbonisation project portfolio to assess the best options for decarbonisation GB wide

Other SSEN SIF decarbonisation projects include:
- **SeaChange**
- **Fortress**
- **Rides**

- **Cori.Critchlow-watton@sse.com**

Further reading:

- Strategic Innovation Fund (Ofgem)
- SSEN SIF Innovations

Call to action:

If you would like to be a partner, stakeholder or subcontractor on future decarbonisation projects please email:

futurenetworks@sse.com

THANK YOU
QUESTIONS

Scottish & Southern Electricity Networks