

Week 1:

MOSS Group Project Initial Meeting – 01.11.2023 3pm

- Agree to meet in person, meeting times in the old lecture slots
- Google doc for meeting notes, overleaf for later on
- Proposed questions:
 - How does carbon from the production of renewable energy technologies compare with the carbon emissions avoided by using them?
 - § But need to make sure the model is nice to implement as an ABM
 - Lithium batteries for electric vehicles?
 - § Model individual parts of the supply chain as agents in our ABM
 - Adoption of electric vehicles inside a community, e.g., a city
- Need to decide: Do we want to write our own (probably simple) model, or use an already existing, more complex model from literature (and possibly adapt it)?
- What we'll do next: Find literature relating to our questions, refine/adapt the question and see if any models already exists.

Thursday 02.11.2023 - Lab Drop-in Session:

- Discussed two additional ideas for questions:
 1. Model an energy system of a country/community - make it agent-based by e.g. modelling individual households as agents. Example question: How does the energy supply of private households work, and how could a transition to using more sustainable energy sources work. Could do an ABM with individual households, possibly also government and energy companies, as agents. When discussing with instructors, Nigel referred to his research regarding the energy supply of households in the Orkneys, including the difficulties getting people to switch from traditional heating systems to, in the best case, heat pumps. He suggested he could put us in touch with people on Orkney working with this question, if we chose to do this.
 2. Similar: Model the energy supply of an area and investigate vulnerability questions, example: How would a drought influence hydroelectric energy generation?

Monday 11.6

Question formulation:

How can individual households in small, isolated communities (example: orkney) be motivated to transition from traditional (i.e. fossil-fuel based) to sustainable heating (i.e., heat pumps/other renewable energies)?

What motivates households in remote communities to transition from fossil-fuel heating to sustainable alternatives?

Two Possible Questions:

1. Model contains households, change policies and see the choice of households on heating options
2. Model the households with different heating options, change the proportion of different heating options and see the impact on our environments.

Factors:

1. Infrastructure
2. Government policy
3. Communication methods between households
4. Financial incentives

Outcomes:

1. Number of energy transition: one household switch to renewable energy(heat pumps)

To-Do:

Until Wednesday: review literature surrounding our topic, see if we can find a model that does what we want it to do already. If not: start formulating our own from Wednesday onwards.

MOSS Group D Project Proposal

Our group will investigate two questions: Firstly, “What motivates individual households in small, isolated communities (for example: Orkney islands) to transition from traditional (i.e. fossil-fuel based) to sustainable heating (i.e., heat pumps/other renewable energies)?” Secondly, “What strategies are efficient at motivating households to make these transitions?”

We chose the Orkney islands as our model pattern: An island community isolated from the mainland with many of the around 22,500 inhabitants living outside the two towns Stromness (10,020 inhabitants) and Kirkwall (1,790 inhabitants) scattered over the island. The islands have a fuel poverty rate of 31%¹.

With our model, we aim to explore how different factors influence the decision of individual households to change their heating energy source. These factors are infrastructure, government policy and different methods of communication between households.

Here, infrastructure refers to both material infrastructure such as power grids but also human infrastructure such as heating technicians qualified to install heat pumps. Government policy can include rules and regulations (for example, a ban on building traditional heating systems into newbuilds built after a certain date), but also positive reinforcements such as financial incentives or support. The last factor, communication between households, should both help understand the influence of communication between households on the number of transitions, and explore how different communication strategies (for example, information sessions within individual towns/villages, pamphlets) can persuade households to make the transition.

We will measure the efficiency of these methods by the number of energy transitions at the end of a simulation. An energy transition is here defined as one household switching from traditional to renewable heat energy sources. For this, we will run our model multiple times with different input parameters representing different configurations of the factors described above. Changing the factors both one at a time and in combination will help understand their influence individually and in interaction with each other.

Possible Literature:

1

<https://www.gov.scot/publications/heat-buildings-national-scheme-island-communities-impact-assessment-screening/pages/2/>

Lake example in lecture 7 (dealing with convincing people to change how their sewage system for the lake ecosystem) : The importance of transient social dynamics for restoring ecosystems beyond ecological tipping points

<https://www.pnas.org/doi/full/10.1073/pnas.1817154117>

Agent-based modeling and socio-technical energy transitions: A systematic literature review

<https://www.sciencedirect.com/science/article/abs/pii/S2214629618306418>

Agent-Based Simulations of Energy Transitions:

https://www.researchgate.net/publication/235718916_Agent-Based_Simulations_of_Energy_Transitions

Understanding the human dimensions of a sustainable energy transitions

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4469815/>

Energy transitions on European islands: Exploring the technical scenarios, markets and policy proposals in Denmark, Portugal, and the United Kingdom

<https://www.sciencedirect.com/science/article/pii/S2214629622003279>

Technical Approaches and Institutional Alignment to 100% Renewable Energy System Transition of Madeira Island -- Electrification, Smart Energy, and the Required Flexible Market Conditions

<https://www.mdpi.com/1996-1073/13/17/4434>

Modelling Renewable Energy Islands (And the benefits for energy planning) (full dissertation)

https://vbn.aau.dk/ws/portalfiles/portal/549535946/PHD_HMM_E_pdf.pdf

Summary of the above dissertation

https://vbn.aau.dk/ws/portalfiles/portal/549535943/PhD_Title_and_summary2.pdf

Modelling adoption of heat pumps in private homes considering the influences of government interventions, consumer awareness and cost of technologies using an ABM (model code publicly available):

<https://www.centrefornetzero.org/wp-content/uploads/2022/05/ABM-Report-Final.pdf>

Modelling the energy systems and supply on islands:

<https://www.sciencedirect.com/science/article/pii/S1364032121009011>

<https://github.com/centrefornetzero/domestic-heating-abm>

<https://github.com/centrefornetzero/domestic-heating-data>

Related but likely less helpful:

Politics beyond agency? Pluralizing structure(s) in sustainability transitions

<https://www.sciencedirect.com/science/article/pii/S2214629623001809>

Bottom-up energy system models applied to sustainable islands (might give insight into adaptations needed for islands vs national models)

<https://www.sciencedirect.com/science/article/pii/S1364032121009011>

Week 8 Notes

- Everyone was there.
- Discussed what we found in the literature

Feedback from David:

- Look for social science literature on household decision-making about energy systems
- Look to develop an influence diagram/diagram showing entities
- How to adapt CentreForNetZero model for Orkney
-

Next meeting:

Thu 09.11.2023, 3pm, room 19GS G.22

To-Do for next meeting:

- Read through the model description
- Try to run the model code

Questions for David and Nigel:

- Do we have to use NetLogo, or is using only python okay?
- Is it alright if we use a model that essentially does all we want already? Or is there a minimum requirement of original modelling?
- Model says that heat pumps are not efficient if a house's EPC rating is less than C - which would be 85% of houses on Orkney? -> insulation?

Thursday 9th Nov

- Constructed an influence diagram for the model
- How do we adapt the model for the small island case?
 - Change parameters
 - Maybe incorporate communication (or lack thereof due to remote house locations) into the model? In HP awareness perhaps? (more communication -> higher awareness). Or hassle factor?

- Lake model (mentioned in L7) used neighbour decisions to influence agent decisions. Perhaps we could implement that based on location? E.g., if an agent <1km apart from a different agent switches to HP, this increases the probability of one agent to switch themselves.
- Decided to stick with mainland Orkney only - not the smaller islands of Orkney

Energy efficiency north east Scotland:

<https://www.pressandjournal.co.uk/fp/politics/scottish-politics/3547053/more-than-250000-homes-in-north-and-north-east-need-upgraded-to-meet-new-government-targets/>

Monday 13th November:

FINAL REPORT LINK:

<https://www.overleaf.com/2216135239zmssdmwbtbzmh#e5839b>

Presentation link:

https://uoe-my.sharepoint.com/:p:/g/personal/s2107575_ed_ac_uk/EQvnyKs9xvVLuzlgfnS_61YBXOVkHy-GlbZrntmqGgRxnw?e=4%3A4hYI9r&fromShare=true&at=9&CID=1997618a-d7bd-703e-435d-ab3668045e04

Work to be done:

- Project Report - 5000-8000
- Sections:
 - Model, Question, Results, Limitations.
 - ODD
- Presentation
- Archive file of simulation and analysis of the model
- Evidence of collaboration

Monday, 13.11.2023 Meeting, 1-3pm

- Decided on tasks we will do over the next week:
 - Running the code (2 people), perhaps reproduce model result of the published paper (Evan and Toby)
 - Think about a plan of how to adapt the model to Orkney once we get it to run (Thomas)
 - Write the intro including lit review (Fiona)
 - Write the model ODD (Carla)

Thursday 16.11.2023 Meeting, 4-6pm

[What strategies effectively motivate households in Orkney to adopt sustainable heating?](#)

People to contact:

- Susan Krumdieck
- Paolo Cherubini

Monday 20th November:

Their Datasets:

DataSet	Size	Link
EPC	4.5GB	https://epc.opendatacommunities.org/domestic/search
Price paid data	4.3GB	https://www.gov.uk/government/statistical-data-sets/price-paid-data-downloads http://prod.publicdata.landregistry.gov.uk.s3-website-eu-west-1.amazonaws.com/pp-complete.csv
Off Gas postcodes	1.34 GB	https://geoportal.statistics.gov.uk/datasets/ons::ons-postcode-directory-august-2023/about
HousePrice Index	60 MB	https://www.gov.uk/government/statistical-data-sets/uk-house-price-index-data-downloads-september-2023

Write the intro including lit review (Fiona)

Describe the question

Describe their model, methodology and results, limitations

Write the model ODD (Carla)

Further work / limitations

Methodology & Results → blocked by model running

Other questions/ideas:

What would happen if the government gave every household below a certain property value a heat pump for free?

Results and Discussion:

Plots:

Number of heat pump installations vs. time

Email centre for net zero: Are there further advances in modelling? (especially with regard to what they said towards the end of the document, including scotland data)

Email orkney people

- EPCs for Orkney
- Heat pump installers
 - Number in early 2022
 - YoY growth rate
- Fuel prices
- House property values

Report Outline:

Introduction

- Literature review
- Our question asked
- Describe question + explain how and why we chose it
- Outline why it is relevant
- Briefly describe the model
- + FULL model description at some point

Methodology

- Recreating results from the paper
- Run model with updated data from 2023
- Our chosen input parameters, and why we chose them/how we changed the model
 - Different single parameters
 - Subtract new build contributions
 - (Change number of households, and the associated input data)
- Our investigated scenarios, like:
 - What would happen if the government gave every household below a certain property value a heat pump for free?

Results

- Plots of number of installed heat pumps w.r.t. time

Discussion

- Could we reproduce original results? I.e., do we have faith in the model?
- Compare results with literature
- Discuss limitations of the model:
 - Overall limitations of the model
 - Limitations of applying the model (at current stand) to Orkney
 - Limitation of the question itself: Are houses in Orkney efficient enough,

looking at the EPC rating -> Discuss whether the EPC rating is relevant enough

Conclusion and Outlook

- Summary
- Outlook/Other ideas
 - Add social factors (similar to lake model from lecture)
 - E.g., make spatially explicit and use neighbours
 - Change all data to make it applicable to Orkney
 - Focus on: installers, fuel prices

Appendix:

ODD

Goal finish dates:

Reproduce results by Wednesday

Once we have the output, plot and discuss

Change parameters:

- Oil and gas prices (need to be shipped over)
- Leave the number of households as it is, divide everything by 2 in the end -> gives an estimate of all of Orkney ($24,600 / 2 = 12,300$, Orkney households: ca. 10,000)
- YoY growth rate of heat pump installers, and starting value (i.e., value in Jan 2022)
-

Intro draft link:

https://docs.google.com/document/d/128QSdZA-n1EovJk1icg3CwpHe6PqRP7N7QS8iB_PsEg/edit?usp=sharing

Week 10

Change model to build a new one

1. The Policy and Industry Scenarios and their effects to the environment variables
2. The relationship between the environment attributes and the Household attributes
3. How households' communication affect their attributes
4. How households making decision based on their attributes and the environment attributes
5. Households Distribution of Orkney

Thursday, 23.22.2023

What we did:

- Discussed how we can simplify the model to further implement it in NetLogo
- Wrote up pseudocode for our new model

What we can do until the next meeting:

- Work on the discussion section:
 - What differences are there between our model and the original one?
 - How do we justify our design choices and chosen parameters

Next meeting: Monday 11am, King's Buildings, Murchison House Room LG14

Monday 27th 11-1 Meeting

Scenarios to model:

1. Loan
Decrease heat pump prices from 15,000 GSHP, 10,000 ASHP by 50%.
Loan 75% of combined cost
2. Boiler ban
2030, 2035

Work split – until Wednesday 29th:

Evan - Implement submodels, method help
Toby - write methodology
Thomas - Graph results, boiler ban thoughts
Fiona - Adapt introduction, discussion thoughts
Carla - Adapt ODD to new model

At Wednesday meeting:

- Half group work on presentation
- Half group work on discussion of results & conclusion

<https://www.which.co.uk/reviews/home-heating-systems/article/home-heating-systems/oil-central-heating-aP9gU4u5O8aQ>

<https://blog.gr8fires.co.uk/2019/05/20/comparing-the-cost-of-running-a-woodburner-with-the-price-of-oil-gas-and-electricity-in-2019/>

<https://www.britishgas.co.uk/energy/guides/average-bill.html>