

European Energy Transition: Pathway to Net – Zero by 2050

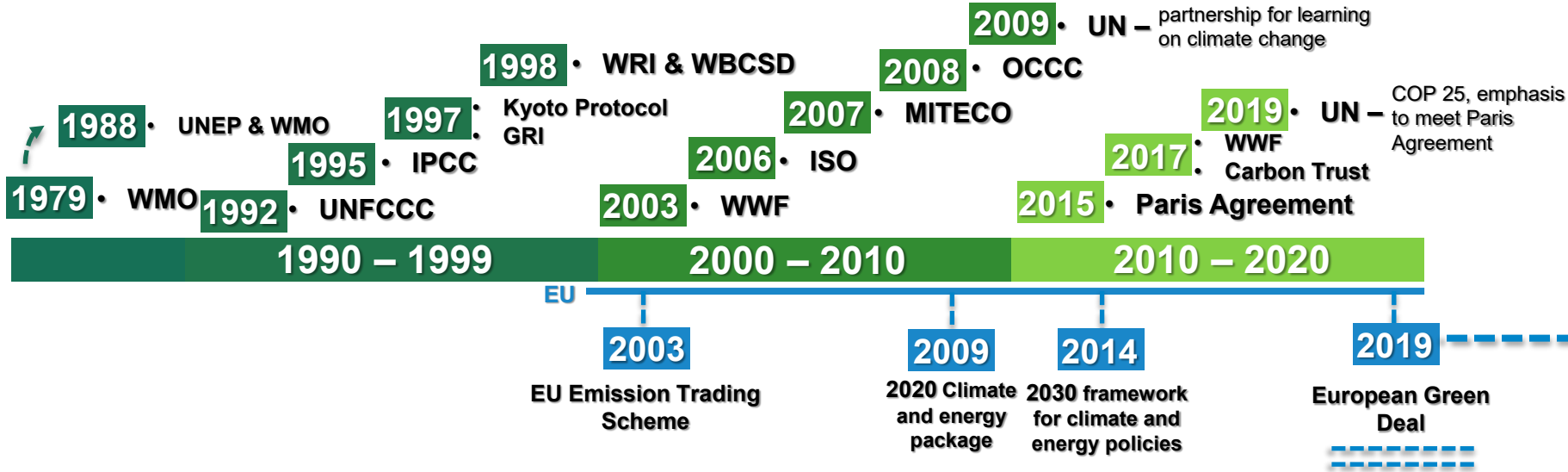
Roghayeh AlGhaithi ¹ and Niall Mac Dowell ^{1,2}

¹ *Center for Environmental Policy, Imperial College London*

² *Center for Process Systems Engineering, Imperial College London*

1

Background



1

Background

2019



A European Green Deal

Striving to be the first climate-neutral continent



- **Net-Zero Emissions by 2050**
- **Interconnected Europe**
- **2030 goal: 50% – 55% reduction compared to 1990 levels**

Key Question

How will the EU transition towards carbon neutrality by 2050?

1

Background

2009



2020 Climate and
Energy Package



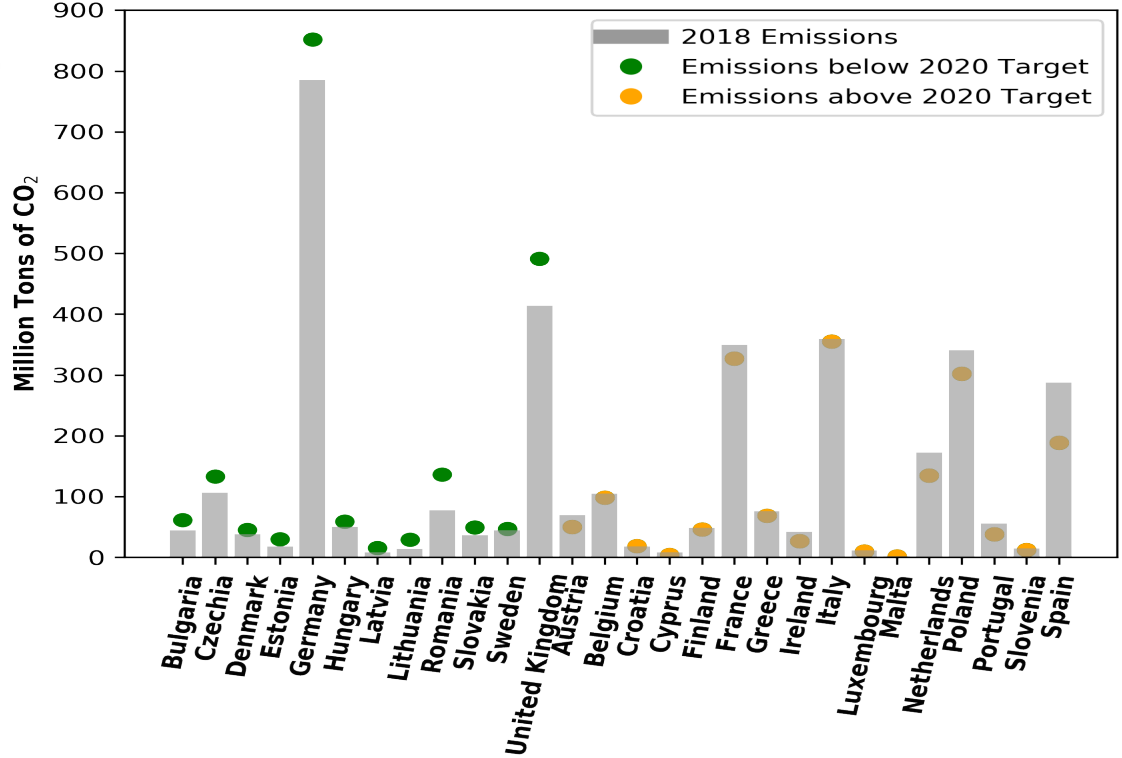
- **20% emissions reduction**
in comparison to 1990

1

Background

Current Status

emissions

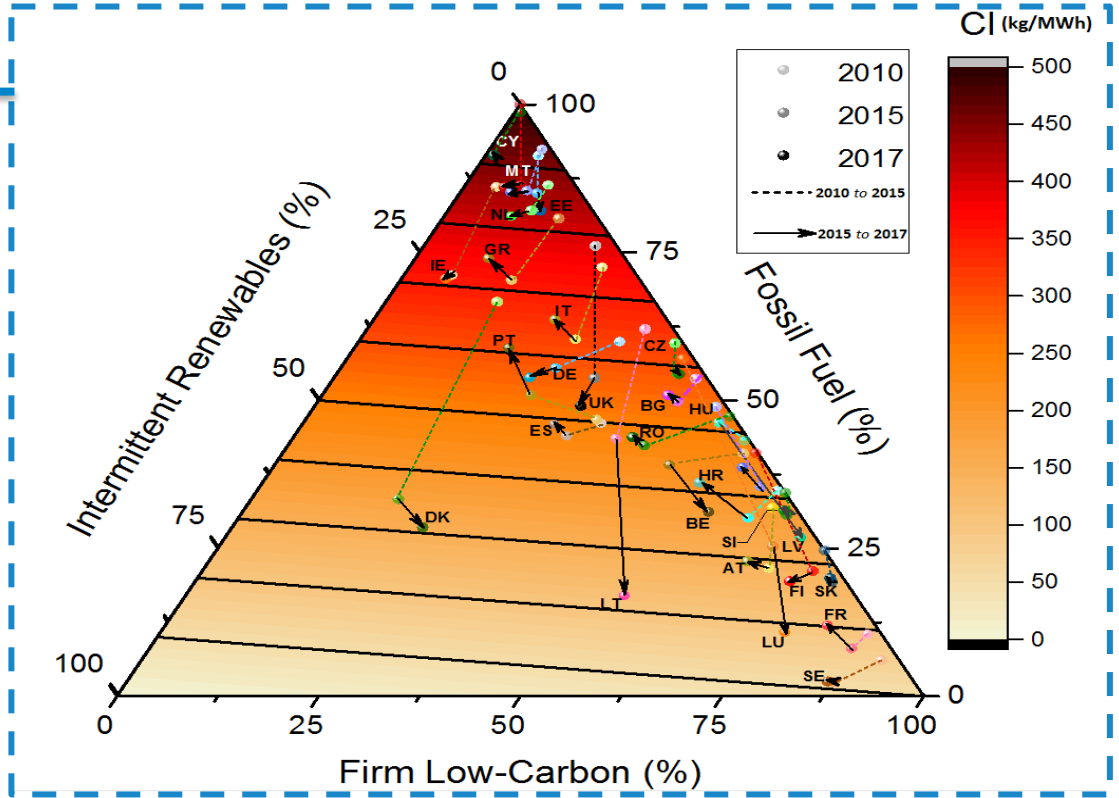


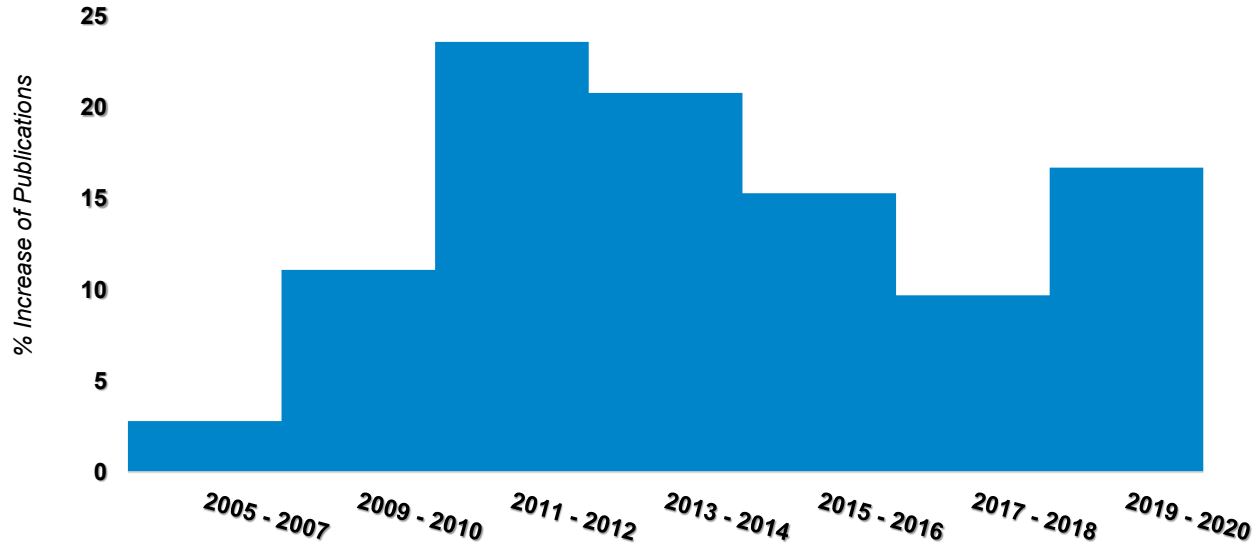
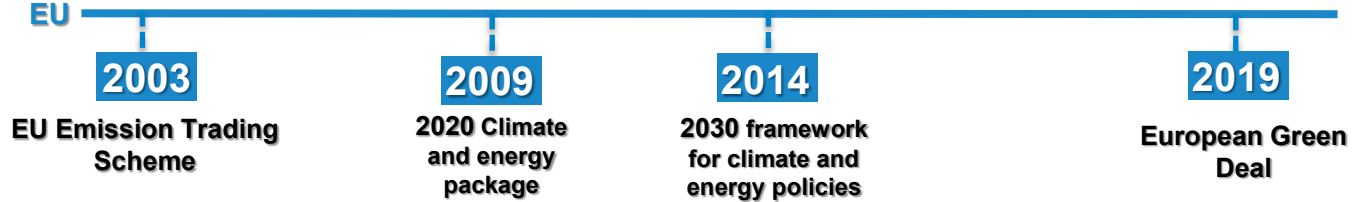
1

Background

Current Status

energy mix





Common Literature Gaps:

- **Countries are modeled individually**
- Contributions of interconnections towards the grid are not considered
- Old EU goal of 80% – 95% CO₂ reduction by 2050 is used
- Dispatchability, seasonal storage and power to gas are not considered
- Country level policies are not considered
- Models consider 2015 as a reference point
- Grid constraints are not considered
- 3rd countries are not included (EU states are connected to)

Common Literature Gaps:

- Countries are modeled individually
- **Contributions of interconnections towards the grid are not considered**
- Old EU goal of 80% – 95% CO₂ reduction by 2050 is used
- Dispatchability, seasonal storage and power to gas are not considered
- Country level policies are not considered
- Models consider 2015 as a reference point
- Grid constraints are not considered
- 3rd countries are not included (EU states are connected to)

Common Literature Gaps:

- Countries are modeled individually
- Contributions of interconnections towards the grid are not considered
- **Old EU goal of 80% – 95% CO₂ reduction by 2050 is used**
- Dispatchability, seasonal storage and power to gas are not considered
- Country level policies are not considered
- Models consider 2015 as a reference point
- Grid constraints are not considered
- 3rd countries are not included (EU states are connected to)

Common Literature Gaps:

- Countries are modeled individually
- Contributions of interconnections towards the grid are not considered
- Old EU goal of 80% – 95% CO₂ reduction by 2050 is used
- **Dispatchability, seasonal storage and power to gas are not considered**
- Country level policies are not considered
- Models consider 2015 as a reference point
- Grid constraints are not considered
- 3rd countries are not included (EU states are connected to)

Common Literature Gaps:

- Countries are modeled individually
- Contributions of interconnections towards the grid are not considered
- Old EU goal of 80% – 95% CO₂ reduction by 2050 is used
- Dispatchability, seasonal storage and power to gas are not considered
- **Country level policies are not considered**
- Models consider 2015 as a reference point
- Grid constraints are not considered
- 3rd countries are not included (EU states are connected to)

Common Literature Gaps:

- Countries are modeled individually
- Contributions of interconnections towards the grid are not considered
- Old EU goal of 80% – 95% CO₂ reduction by 2050 is used
- Dispatchability, seasonal storage and power to gas are not considered
- Country level policies are not considered
- **Models consider 2015 as a reference point**
- Grid constraints are not considered
- 3rd countries are not included (EU states are connected to)

Common Literature Gaps:

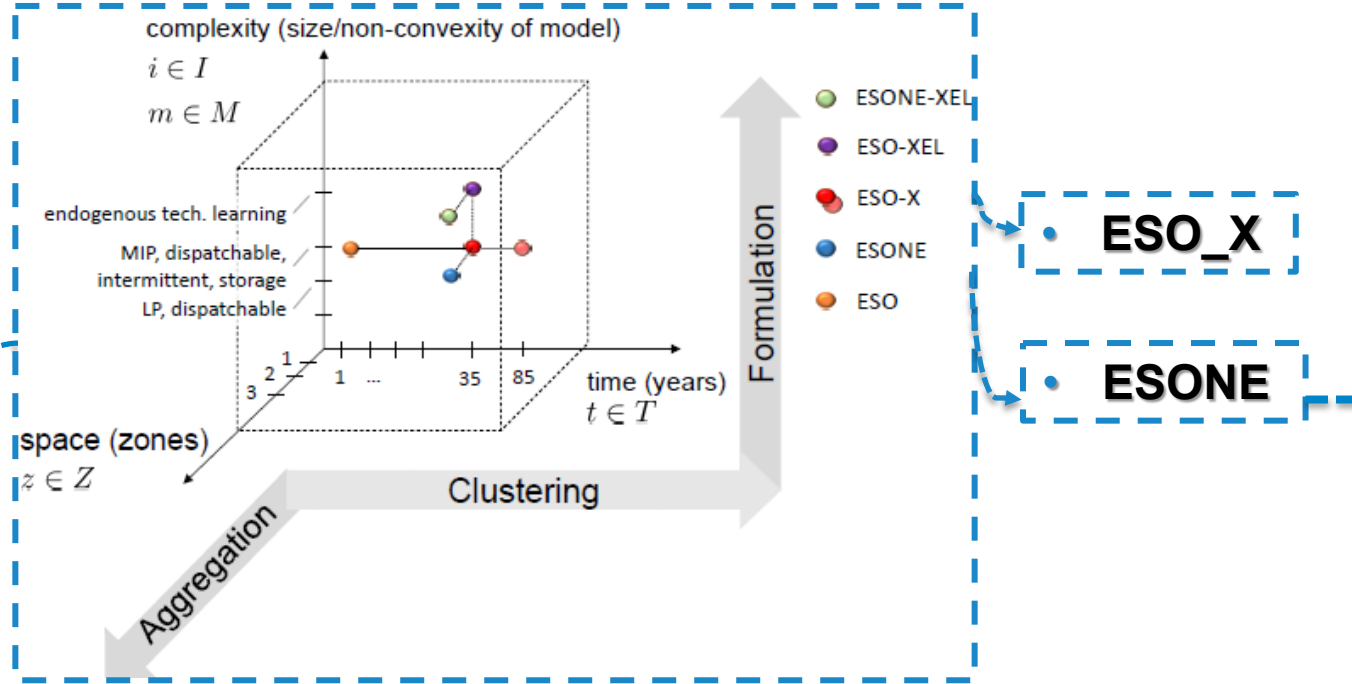
- Countries are modeled individually
- Contributions of interconnections towards the grid are not considered
- Old EU goal of 80% – 95% CO₂ reduction by 2050 is used
- Dispatchability, seasonal storage and power to gas are not considered
- Country level policies are not considered
- Models consider 2015 as a reference point
- **Grid constraints are not considered**
- 3rd countries are not included (EU states are connected to)

Common Literature Gaps:

- Countries are modeled individually
- Contributions of interconnections towards the grid are not considered
- Old EU goal of 80% – 95% CO₂ reduction by 2050 is used
- Dispatchability, seasonal storage and power to gas are not considered
- Country level policies are not considered
- Models consider 2015 as a reference point
- Grid constraints are not considered
- **3rd countries are not included that EU states are connected to**

Research Plan

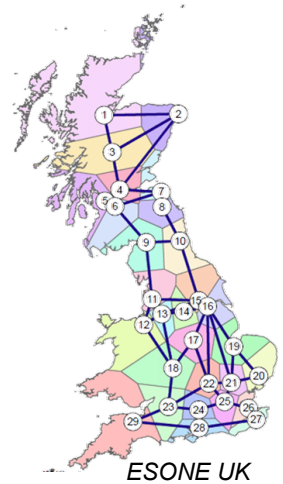
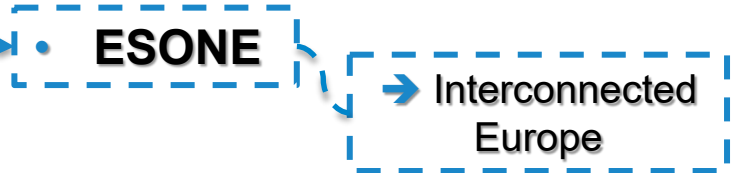
Tool



ESONE-XEL

Research Plan

Tool:



Research Plan

Tool:



• ESONE

- Interconnection cables
- Countries treated as nodes



2 Research Plan

Sectors:



- **Electricity**
- **Industry**

ESO_X:

- **Input Data:**
 - Updated hub gas prices
 - Aggregated Decommissioning
 - Grid Constraints
 - Historical Build Rates

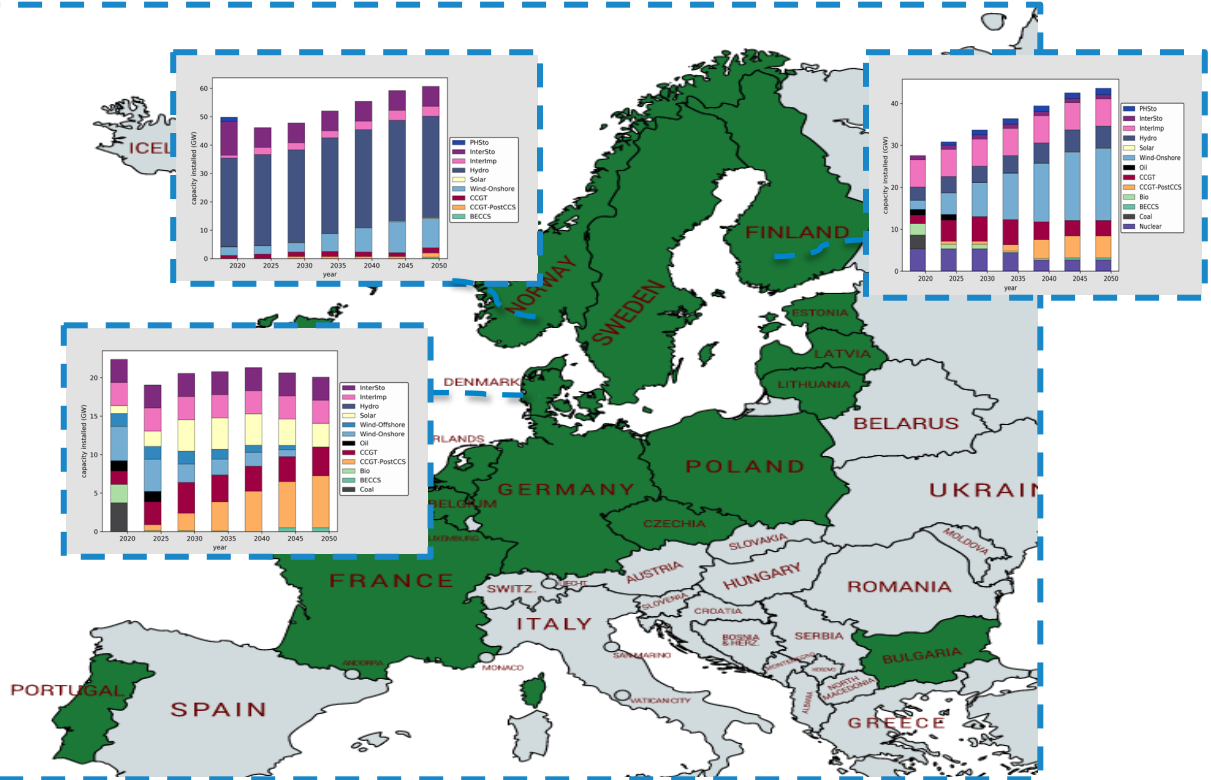


4

Current Progress & Plans

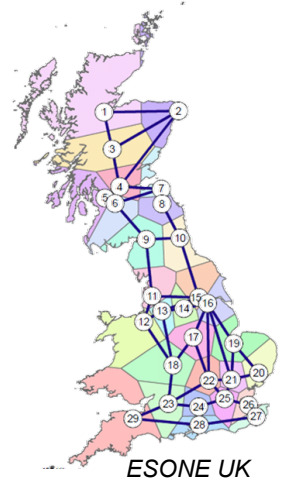
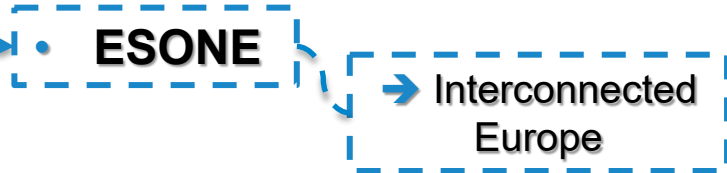
ESO_X:

- **CCS and NETs:** play an important role in most countries
- **Transition:** depends on the resources available
- **Challenge:** data collection



Research Plan

Tool:



4

Current Progress & Plans



Current Progress & Plans

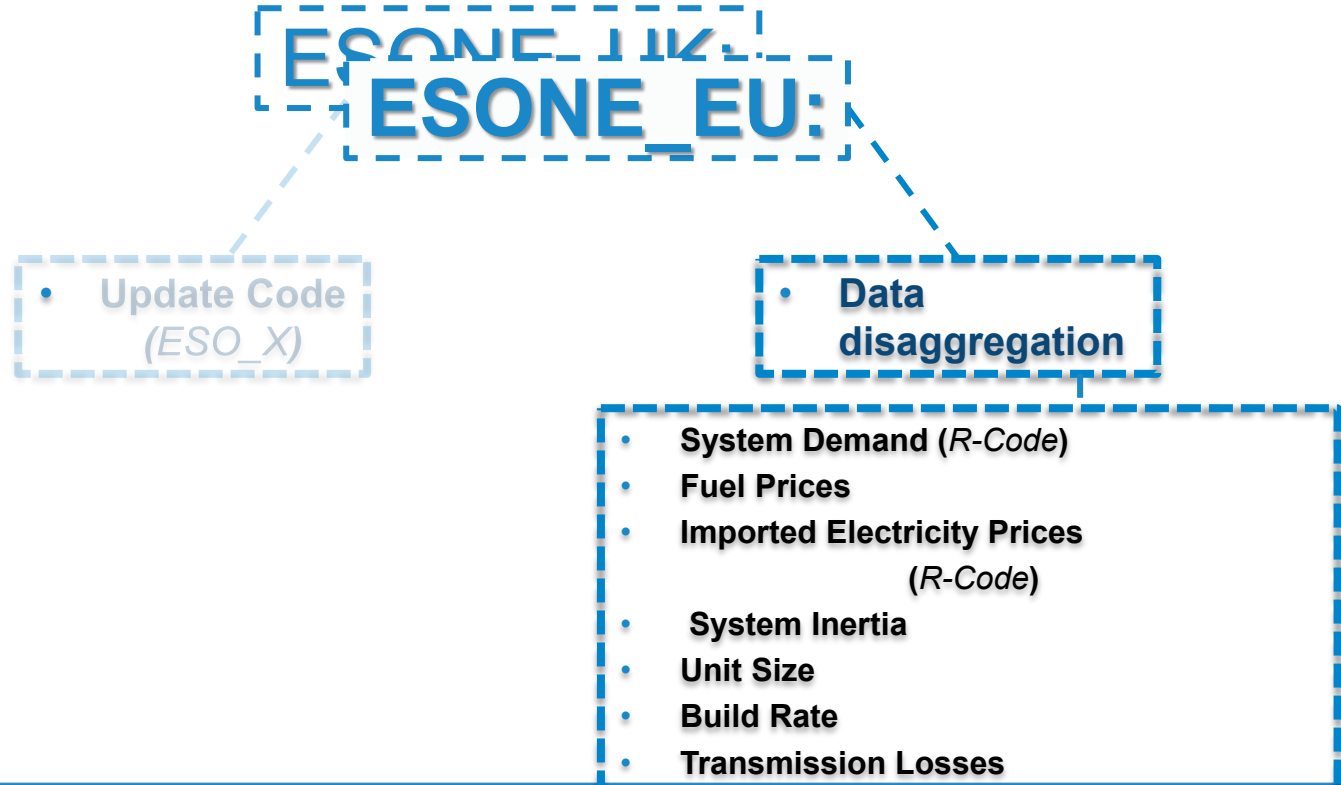
ESONE_UK
ESONE_EU

- Update Code
(ESO_X)

- Data
disaggregation

- **Decommissioning Schedule**
- **New Technologies**
- **Transmission losses** inclusion with system demand
- **Self discharge** rate for storage technologies

④ Current Progress & Plans



ESONE

- **Case Study:**
Northern Sea and
Baltic Sea countries

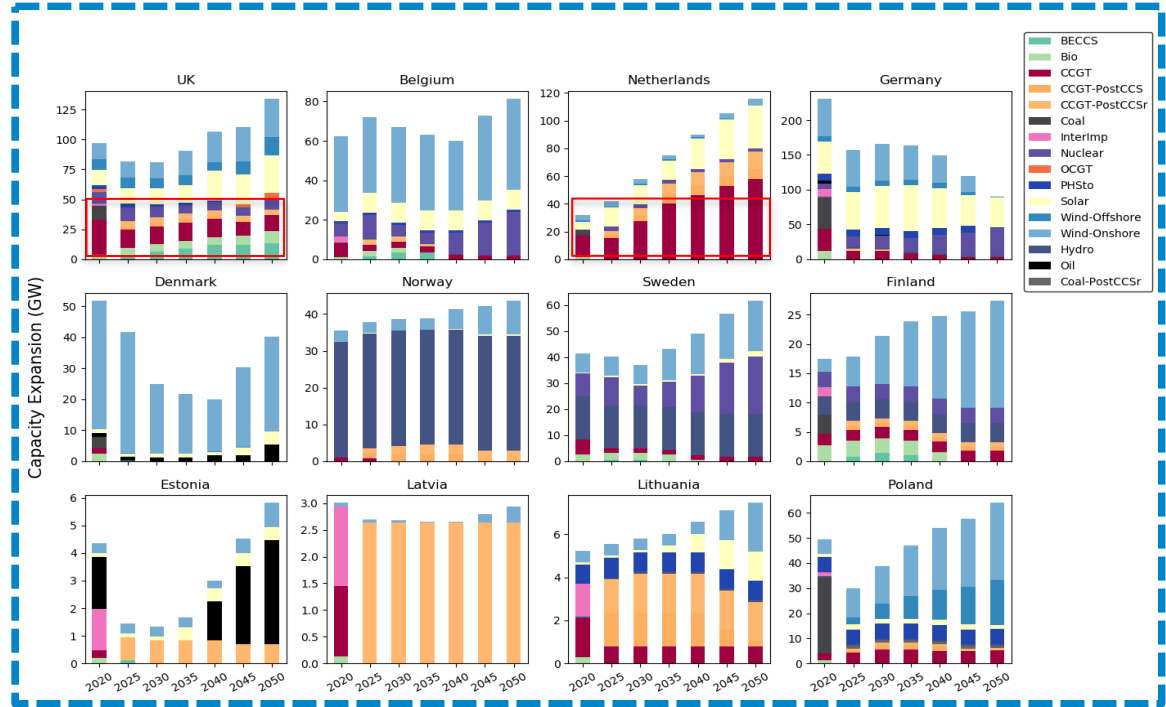


Carbon
Target

S. Inertia
National level

Observation:

- More CCS and NETs
- NL burns gas and UK offsets →
cheap NG prices in NL

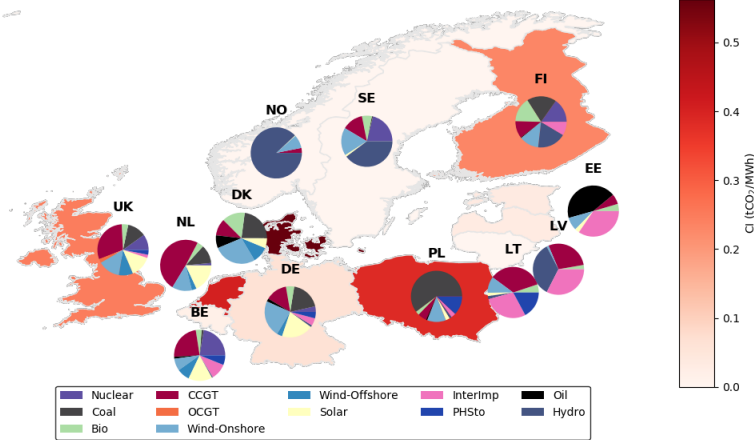


ESONE_EU.py:

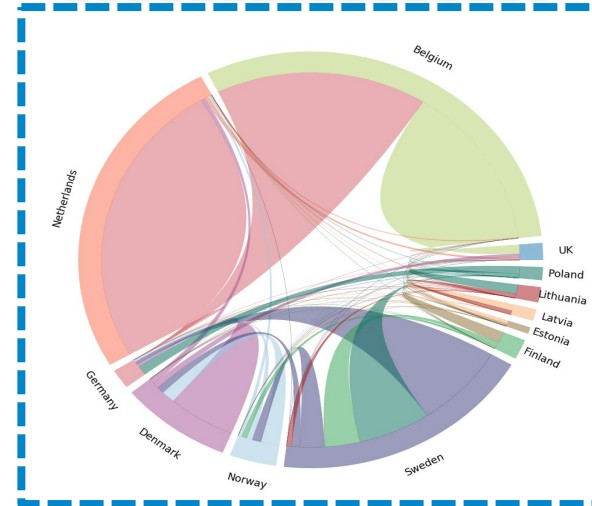
output sample

Carbon Intensity

Installed Capacity share



Imported Electricity



- European Green Deal: net-zero by 2050 → Path needs to be identified
- It is necessary to address literature gaps
- Fuel prices play a role in the introduction of CCS and NETs
- Addressing these gaps will aid in properly answering the question:
How the EU should transition towards net-zero by 2050

- Add the rest of EU member states
- Introduce national level policies
- Examine multi-objective optimization