TIMES-Europe: Exploring the Future of Energy

Steven Sergij Salim | Amsterdam

TIMES-Europe

European energy & climate pathways

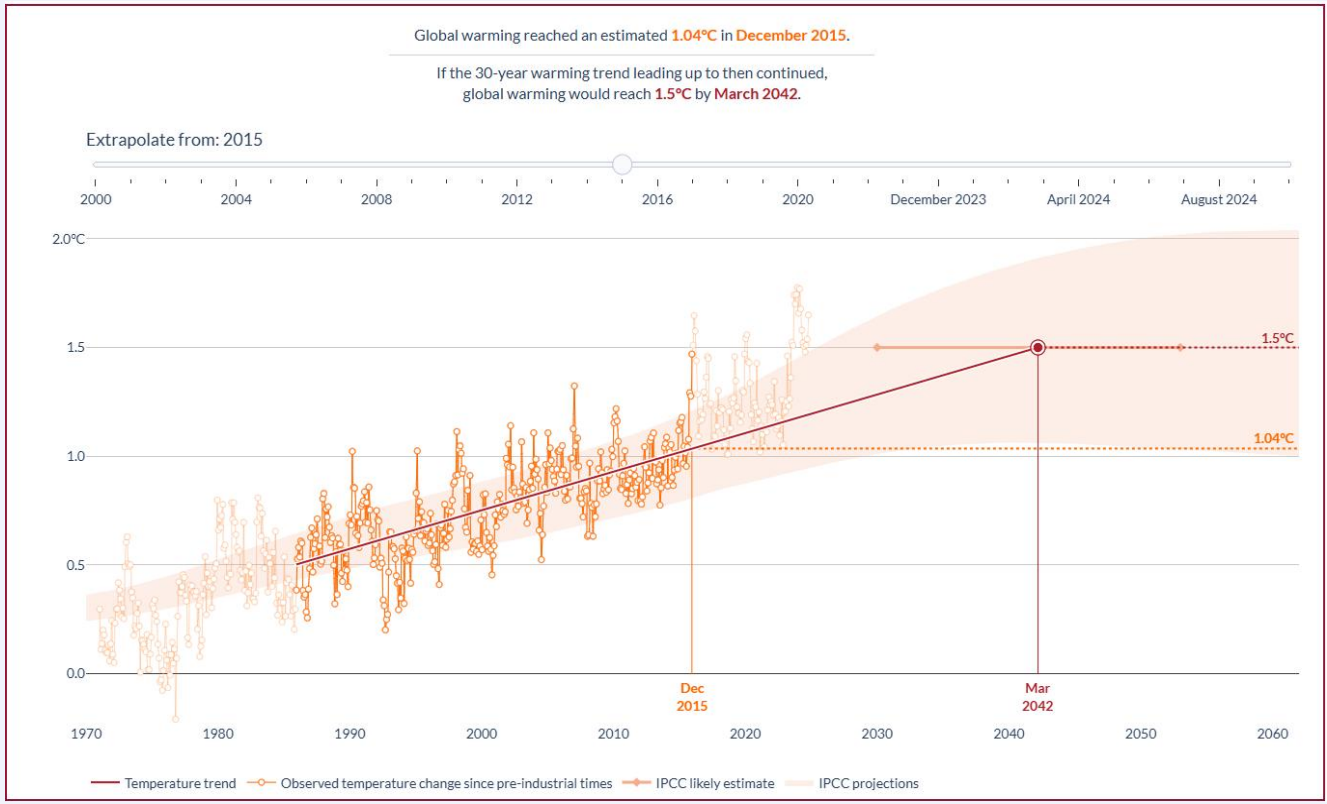
TNO innovation for life

University of Amsterdam



Throwback to 2015





Its overarching **goal:**

"Hold the increase in the global average temperature to well below 2°C above pre-industrial levels"

and pursue efforts to:

"Limit the temperature increase to 1.5°C above pre-industrial levels."

Climate Change in 2025

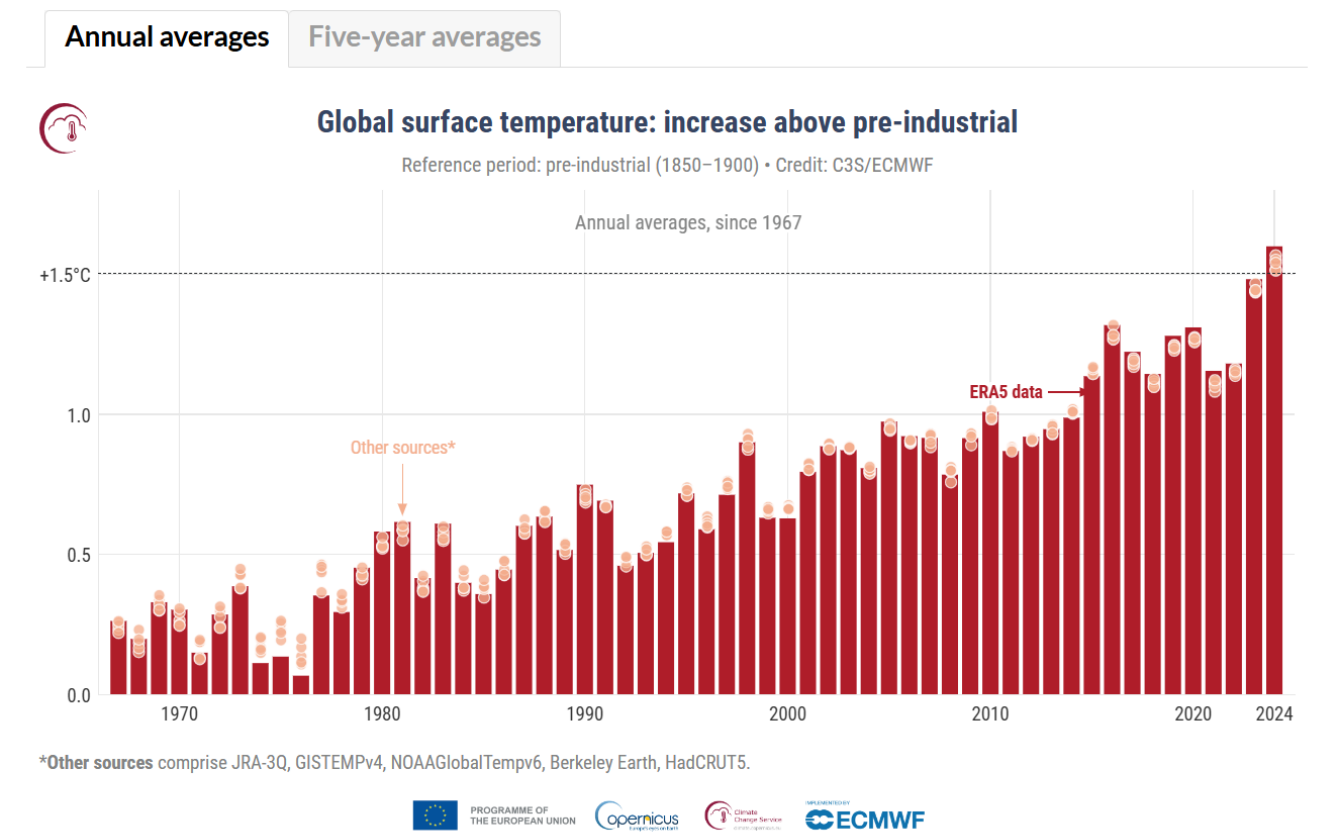
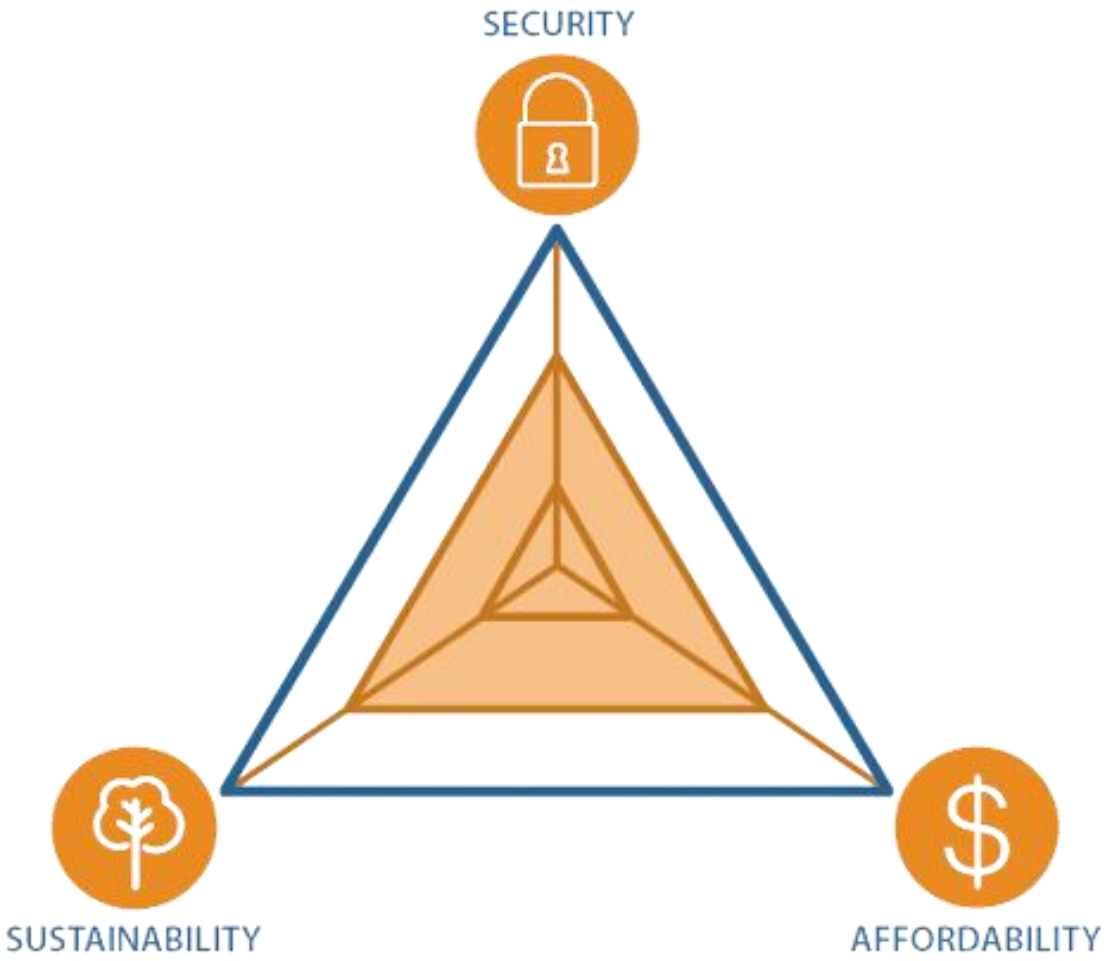


Figure 2a. Global surface air temperature (°C) increase above the average for the 1850–1900 designated pre-industrial reference period, based on several global temperature datasets, shown as annual averages since 1967. Credit: C3S/ECMWF.

2024 was 1.60°C warmer than the pre-industrial level, making it ***the first calendar year to exceed 1.5°C*** above that level.

Energy Trilemma



Policy Questions

Are these ambitions enough to reach climate neutrality by mid-century?

What will our energy system look like in 2050? 2100?

How’s the interaction between these policies?

Any Economic sectors missing?

What does it mean for the Netherlands?

How about burden sharing?

Etc.

Scenario Studies

Scenarios:

Describe **possible future developments**.

An **exploratory** manner for a scientific assessment to understand the functioning of an investigated system.

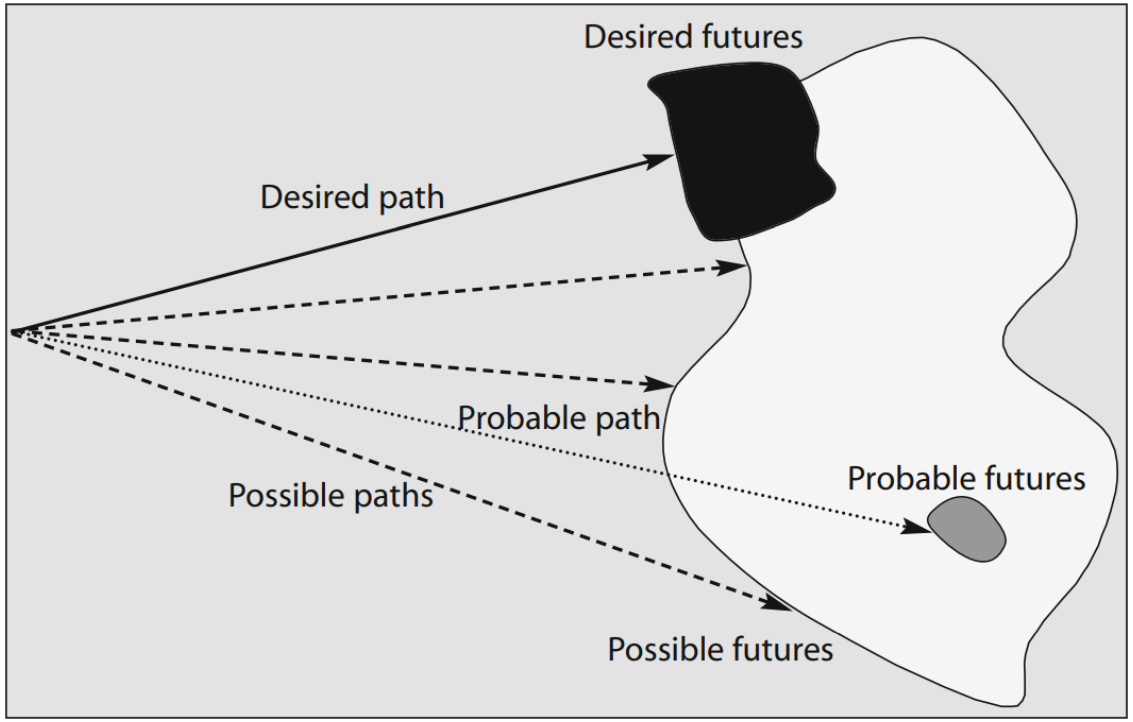
It is not a prediction, also not a forecast.

It is a projection

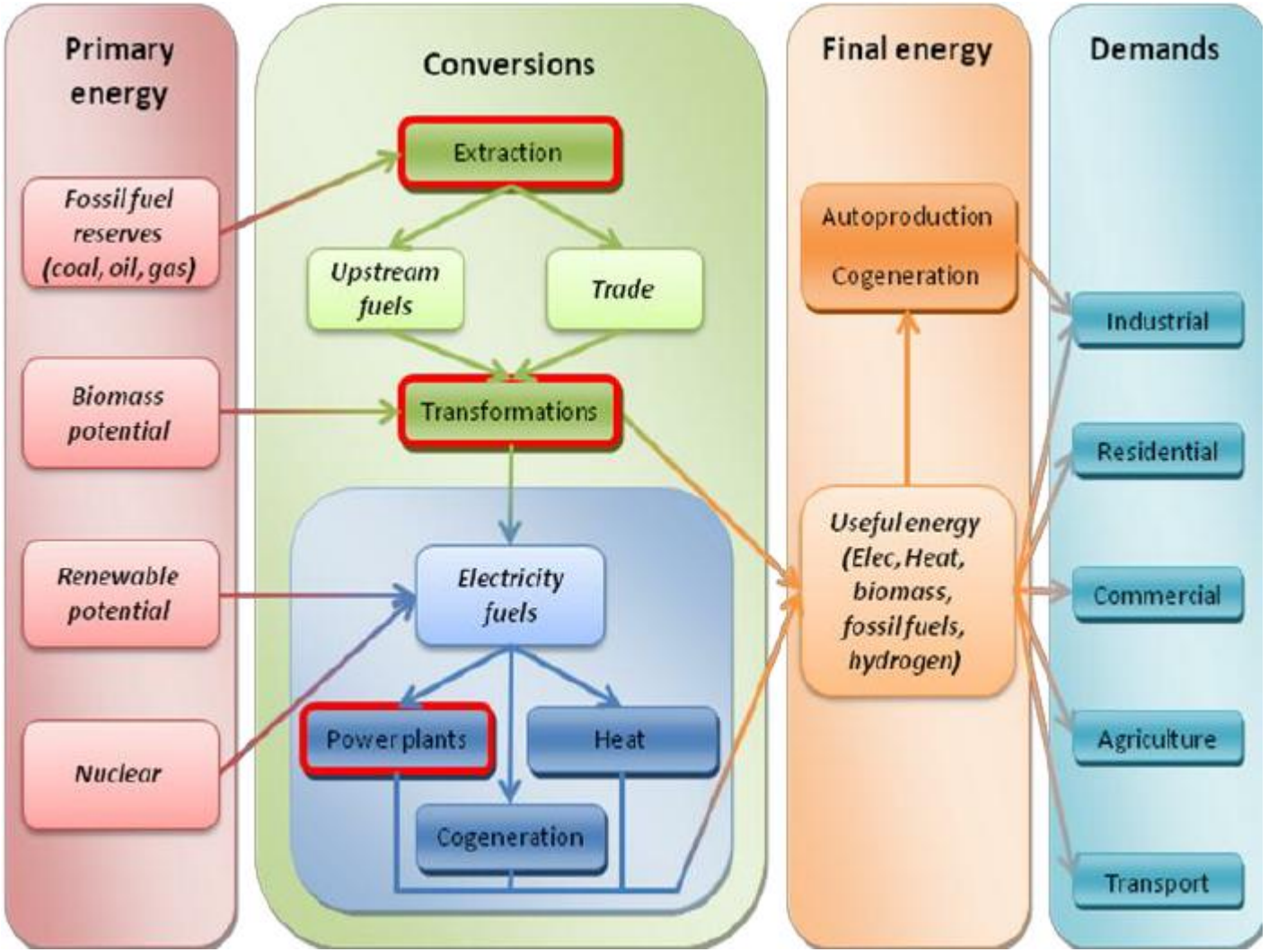
The Idea of using scenario studies:

- Exploring possible future.
- What is their main underlying driving forces?
- How these might be affected by policy interventions?

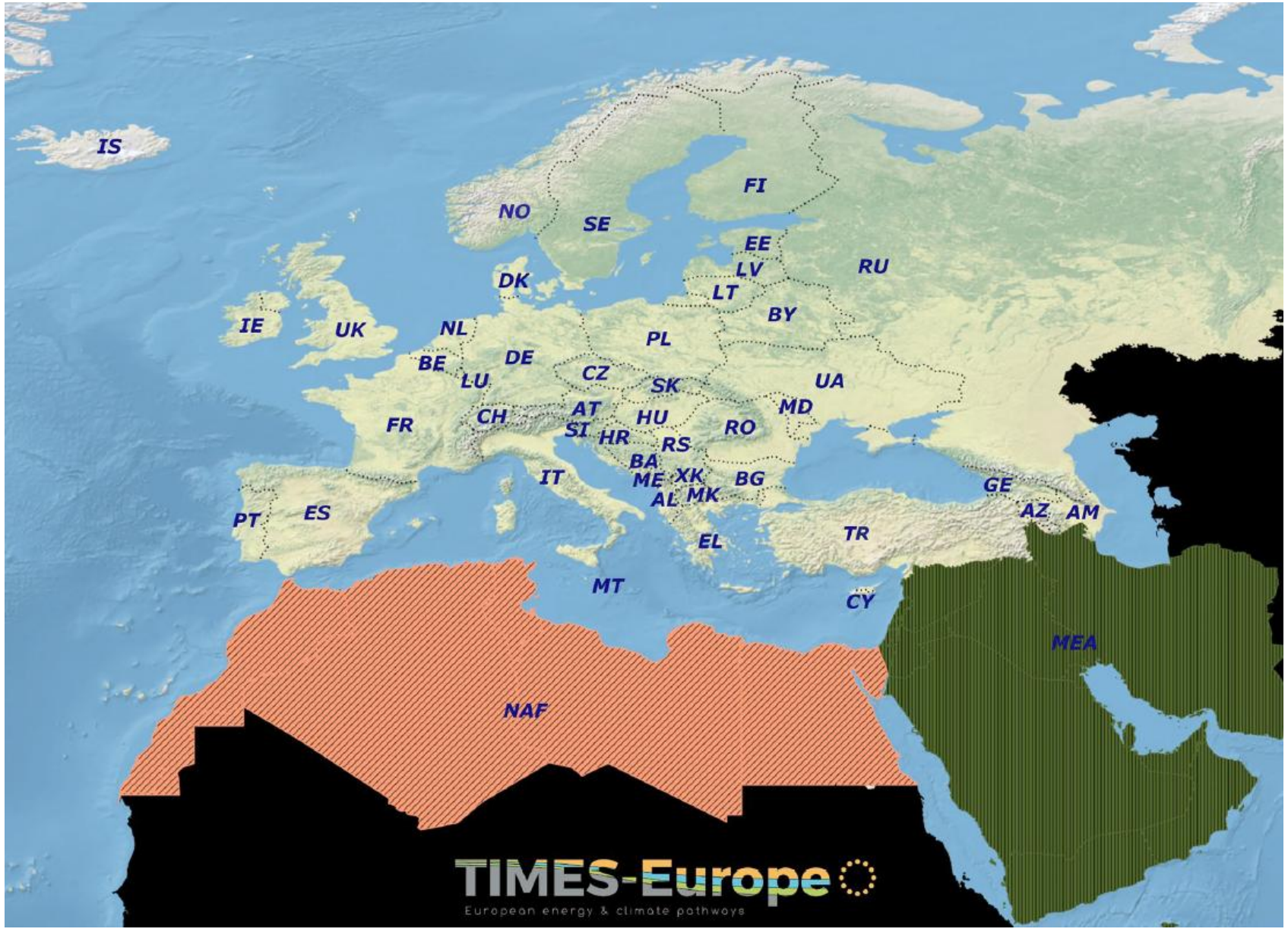
What system?



What is an Energy System?

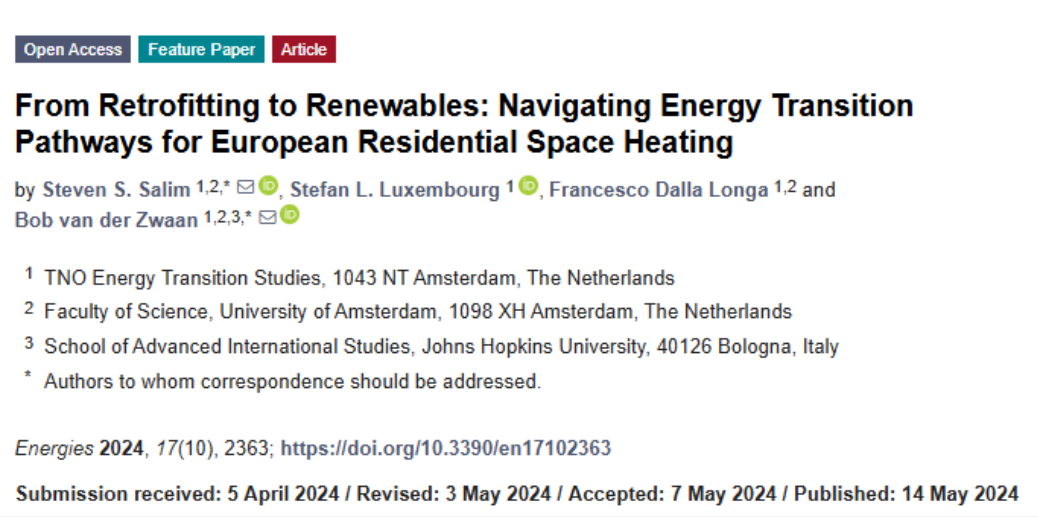


TIMES-Europe Geographical Scope



Research Overview

- European level
  - Pathways to Climate Neutrality: Europe's Energy Transition under the Green Deal
- Sectoral focus
  - Decarbonisation Scenarios for the European Residential Sector
- Specific demand
  - From Retrofitting to Renewables: Navigating Energy Transition Pathways for European Residential Space Heating
- Country level
  - From National Asset to Regional Balancer: Norwegian Hydropower in Europe's Energy System



Open Access Feature Paper Article

From Retrofitting to Renewables: Navigating Energy Transition Pathways for European Residential Space Heating

by Steven S. Salim [1,2,*], Stefan L. Luxembourg [1], Francesco Dalla Longa [1,2] and Bob van der Zwaan [1,2,3,*]

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Decarbonisation scenarios for the European residential sector

Steven S. Salim [a b], Stefan L. Luxembourg [a], Francesco Dalla Longa [a b], Bob van der Zwaan [a b c]

Show more

Pathways to Climate Neutrality

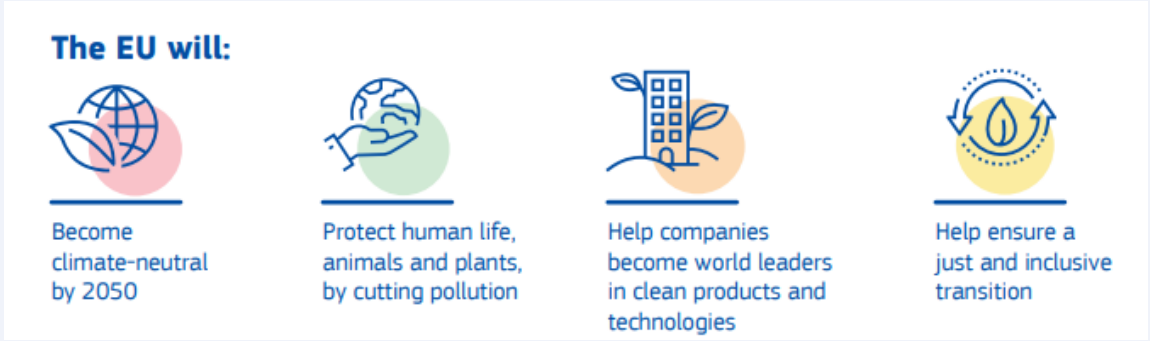
Europe’s Energy Transition under the Green Deal

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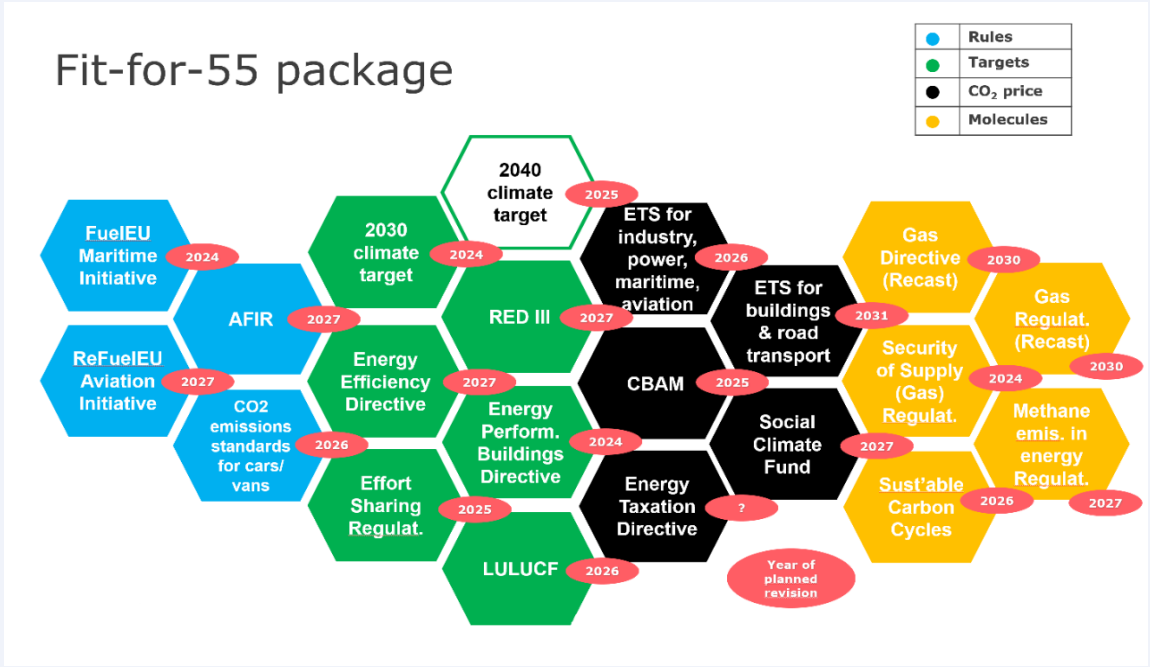


Background

The goals are:



How?



Research gap today:

- *Geographical scope*
  - *EU level only or National level only*
- *Sector coverage*
- *Individual policy examination*

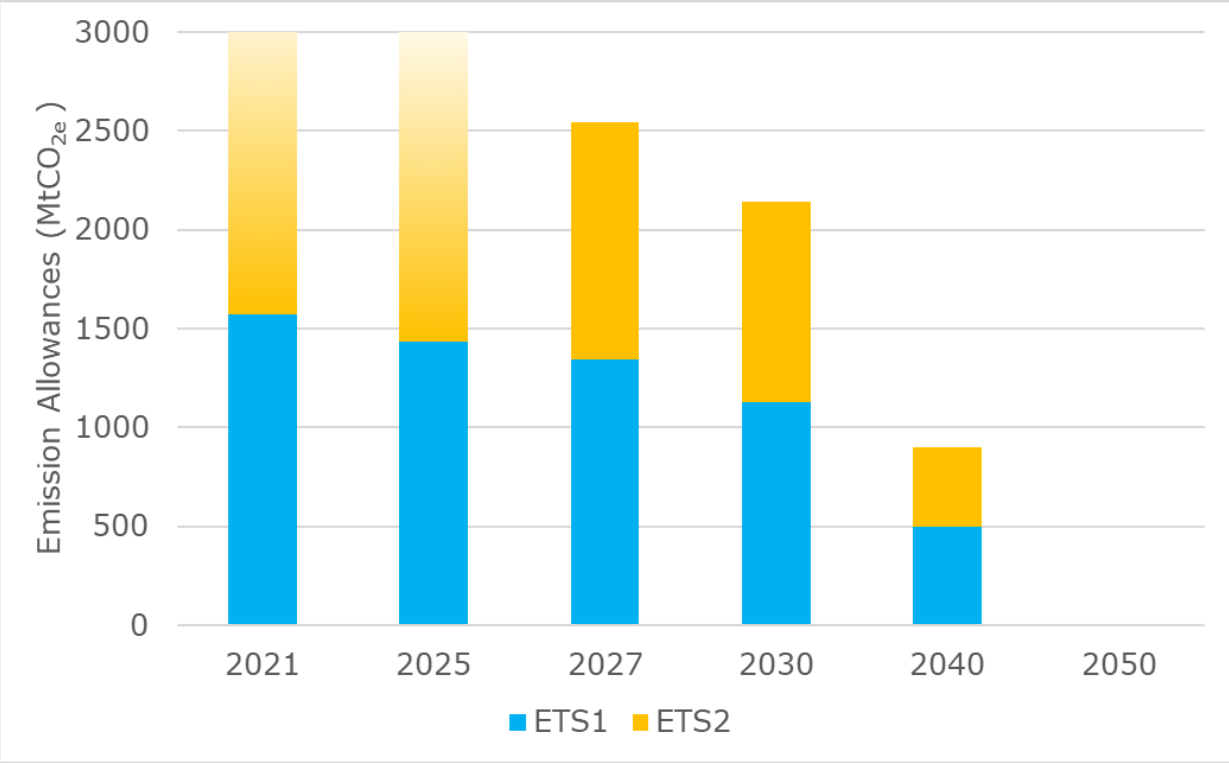
What do we need to cover?

- *Synergies between national and Europe level*
- *Integration of all sector*
- *Interaction between various energy policies*

Interpretation of EU policies



Top of Pyramid: Emission Cap via EU ETS



	Sector	Inclusion
ETS 1	Power & Heat generation	All processes
	Industry	All processes
	Aviation	Intra-Europe flights only
	Maritime	All emissions for all Intra EU voyages; 50% emission of extra EU voyages
ETS 2	Buildings	All processes
	Road transport	All processes

Middle of Pyramid: Principle and Ambition

Policy	Target
Energy Efficiency Directive (EED)	Primary energy cap: 49.1 EJ by 2030 Europe-wide
	Final energy cap: 38.1 EJ by 2030 Europe-wide
2040 Climate Target	CO_2 emissions cap: ~0.42 $GtCO_2e$ by 2040 (reflecting a 90% reduction from 1990 levels)

Bottom of Pyramid: Sectoral Policies

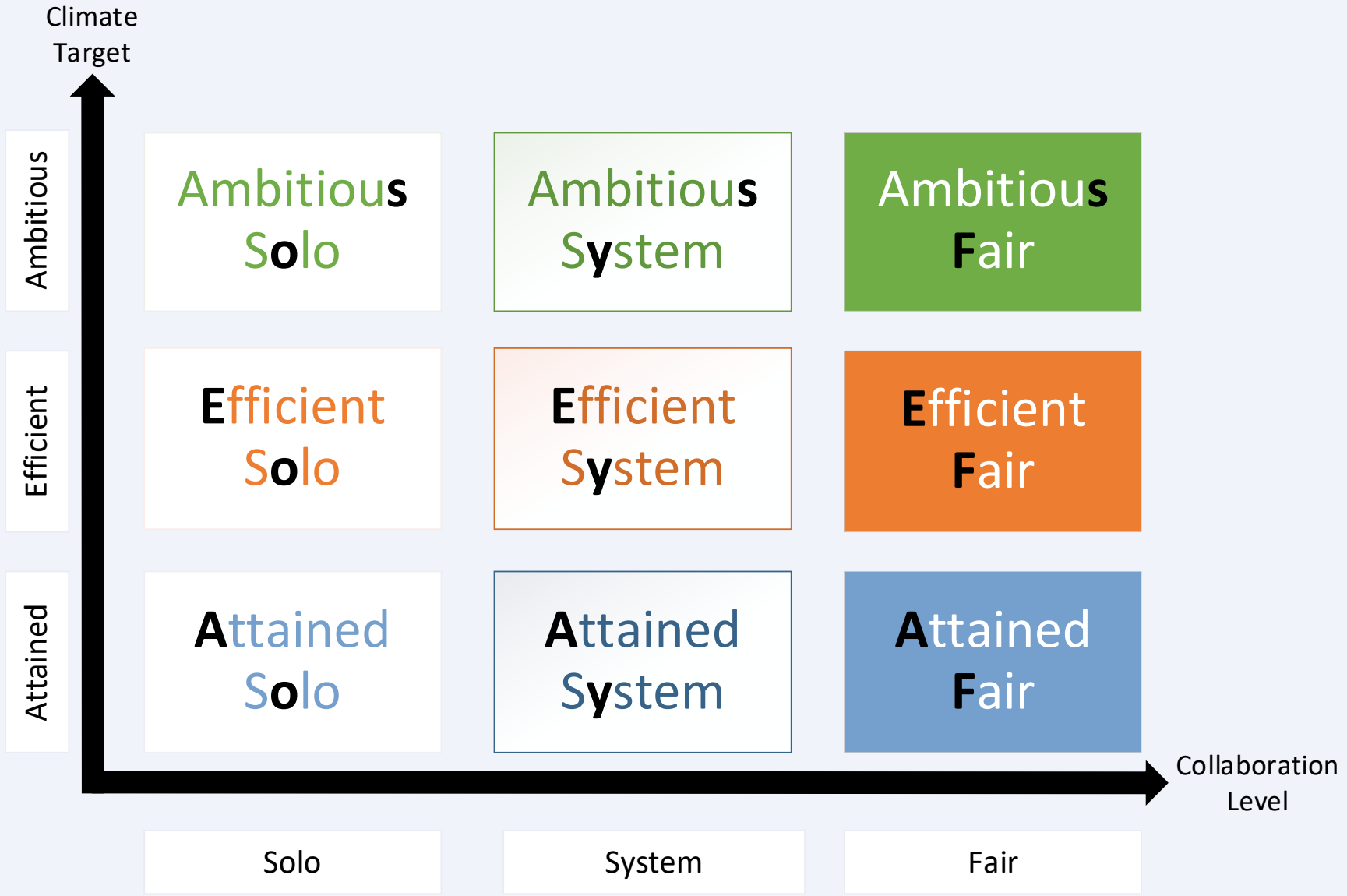
Policy	Target
Renewable Energy Directive (RED I & II)	Renewable electricity share Europe-wide target: ≥42.5% by 2030
Part of RED: Offshore energy strategy	Offshore wind capacity: 60 GW (2030), 300 GW (2050)
	Ocean energy capacity: 300 GW by 2050
Part of RED: Hydrogen strategy	Electrolyzer capacity: 6 GW (2024), 40 GW (2030)
	Green hydrogen production: 120 PJ (2024), 1200 PJ (2030)
Alternative Fuels & Transport Decarbonization	Sustainable aviation fuel: ≥2% (2025), 70% (2050)
	All new vehicles zero-emission by 2035
	Emission reductions: 55% by 2030 for passenger cars (PC) and light commercial vehicles (LCV), and 90% by 2040 for heavy-duty vehicles (HDV).
Energy Performance of Buildings Directive (EPBD)	30 million additional heat pumps by 2030
	Retrofitting rate: 3% dwelling stock per year Europe-wide
	All new buildings must be zero-emission
Carbon Management & Net-Zero Industry	CO_2 injection capacity: 50 $MtCO_2$/year (2030), 280 $MtCO_2$/year (2050)

From Policies to Scenario

	Climate Target	Sectoral Policies	ETS	EED	2040 Climate Target
A	Attained	✓	✓		
E	Efficient	✓	✓	✓	
S	Ambitious	✓	✓	✓	✓

	Collaboration Framework	**Optimization Description**
O	Solo	Equal reduction rate and final allowances per country.
Y	System	Reduction rate and final allowances at the European level as a whole.
F	Fair	Emission reductions and allowances are allocated per country based on an equal cumulative per capita principle.

From Policies to Scenario



Conclusion and Policy Messages

- Primary Energy Consumption Trends
  - Electrification
  - Increased reliance on fossil fuel imports.
  - A tripartite challenge for Europe
- Collaboration Frameworks:
  - The Solo (O) and Fair (F):
    - More evenly distributed emissions
    - Less cost-effective due to limited optimization.
  - System (Y):
    - Optimizes cost efficiency by leveraging resource-sharing and maximizing emission reductions across Europe.
    - Demands strong political coordination and compensation mechanisms due to regional disparities in cost burdens.

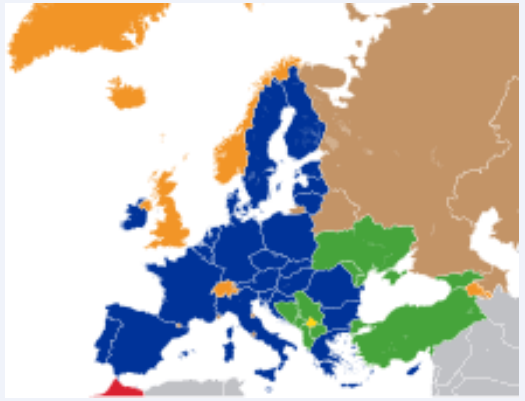


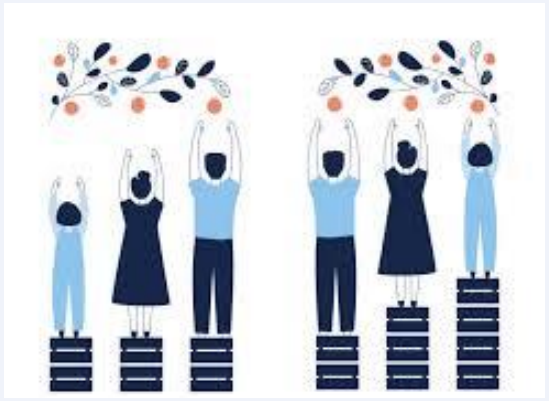


What we want to do next?

- Targeted Studies for Key Sectors
- Expanding Geographical Scope
- Alternative Fairness Frameworks
- Implication to the national level









TIMES-Europe Takeaways

- TIMES-Europe: A tool for climate policy analysis through scenario studies
  - Highly adaptable across:
    - Geographical, Sectoral, and Temporal dimensions
  - Rich technological representation
  - Addresses the energy trilemma: Affordability, Clean Energy, and Security
- Limitations:
  - Bottom-up; all linear equations
  - Cost-optimal solution
  - Limited representation of social aspects