



Expanding Integrated Assessment Modelling:
Comprehensive and Comprehensible Science
for Sustainable, Co-Created Climate Action



Seventeenth Annual Meeting of the
Integrated Assessment Modeling Consortium (IAMC)
November 4-6, 2024, Seoul, South Korea

Decarbonization pathways of energy citizenship: How can citizens contribute to the energy system in different ways and their impacts

Dr. Nicole van der Berg, Nikos Kleanthis, Dimitris Fotopoulos, **Dr. Vassilis Stavrakas**, Prof. Alexandros Flamos, Prof. Detlef van Vuuren

Copernicus Institute of Sustainable Development, Utrecht University (UU).
Technoeconomics of Energy Systems laboratory (TEESlab) University of Piraeus Research Center (UPRC).



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the European Union

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Scope & Objectives



Matching knowledge about energy citizenship to different decision-making contexts

- Citizens
- Practitioners
- Policymakers
- Research/Scientific community
- Industry & Business world

Integrating different scales of analysis

Machine learning clustering of energy citizenship attributes

Agent-based modeling
Demand-side management modeling
Integrated assessment modeling

Case study analysis of collective energy initiatives

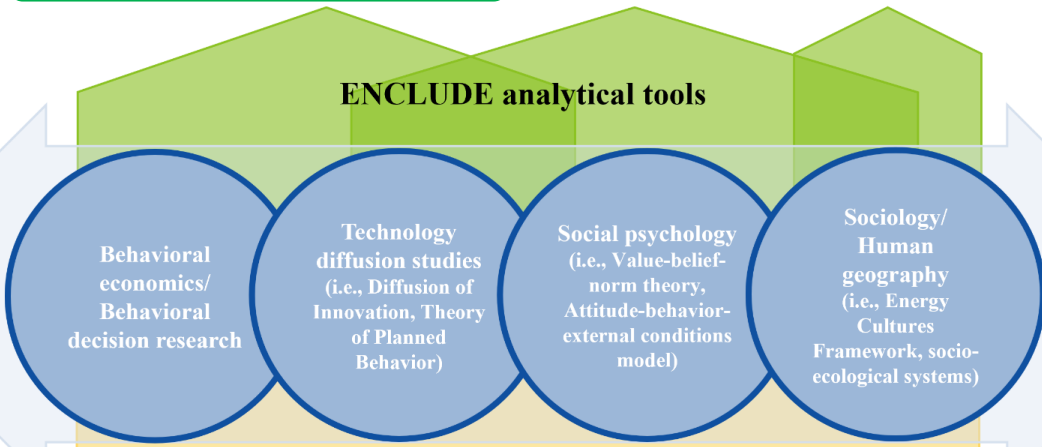
Modified Delphi method



Individual agency of energy behavior

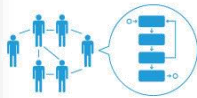
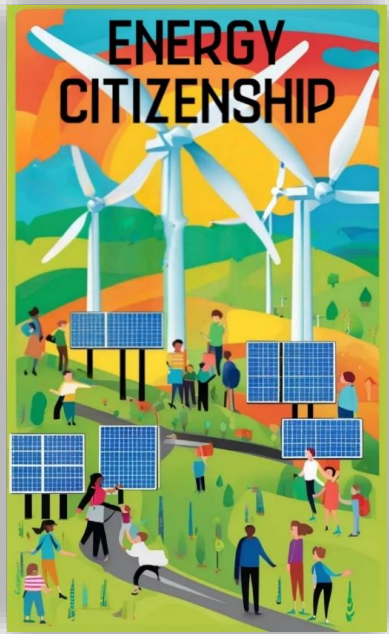


Social construction of energy behavior



Recognizing heterogeneity

Transdisciplinary modeling approach



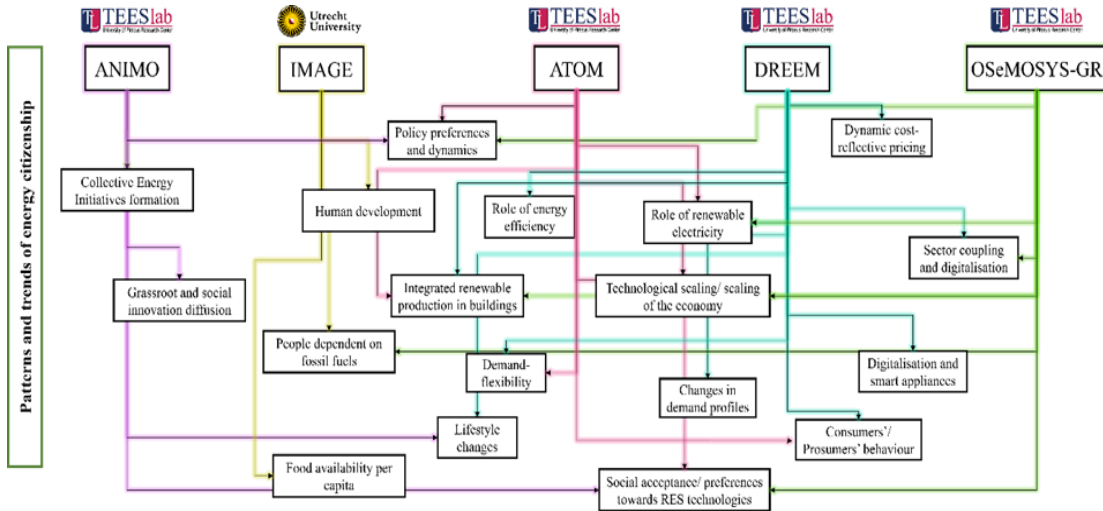
Agent-based Models



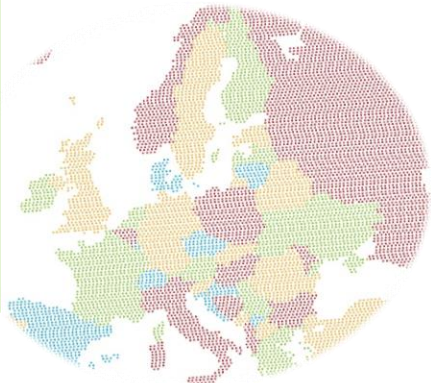
Demand-side Models



Integrated Assessment Models



- We **matched** patterns and trends of energy citizenship to our models...
- We **quantified** the impact of energy citizenship at the **local** level...
- We **quantified** the impact of energy citizenship at the **national** and the **supranational** level...



...for integration of **individual** and **collective** factors of decision-making in the context of **ENERGY CITIZENSHIP!**

"People-centered" storylines & "Future-world" narratives (1/2)



Active Participation in the Energy Market

Collective Expressions of Energy Citizenship

Actions towards Energy Efficiency

Behavioral Aspects

Political Activities



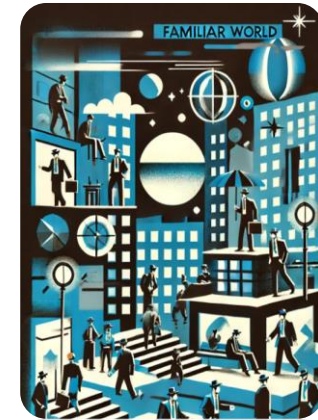
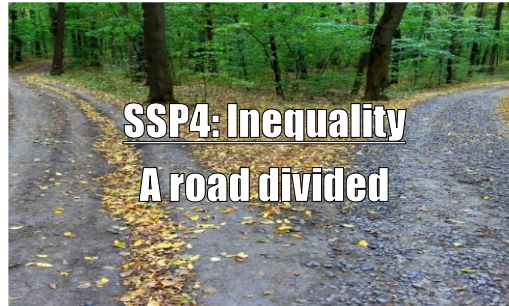
"People-centered" storylines



"People-centered" storylines & "Future-world" narratives (2/2)

A set of 3 **qualitative descriptions** of external systemic changes

"Future-world" narratives



Transformative Scenario Design & Typology

Transformative

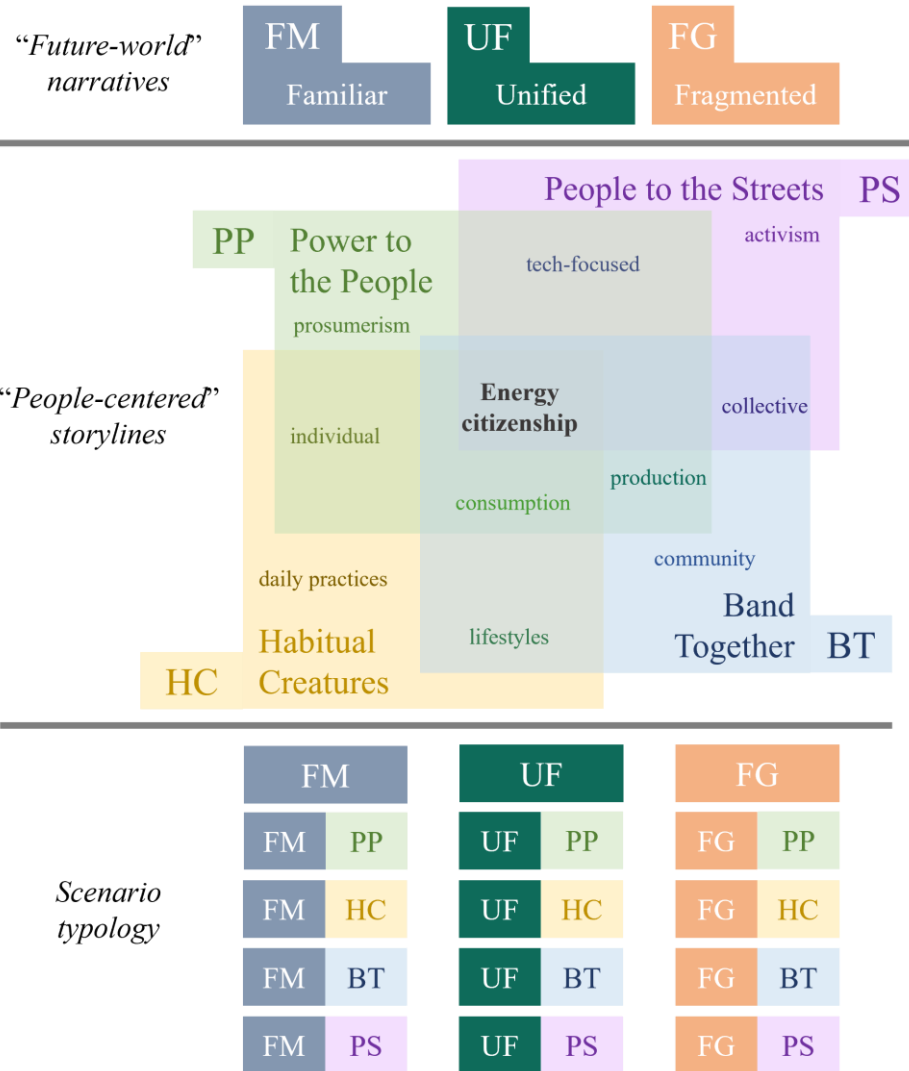


Scenario

Design



Framework



"Band Together": Further diffusion of energy communities (1/2)

Population density alone does not ensure growth!

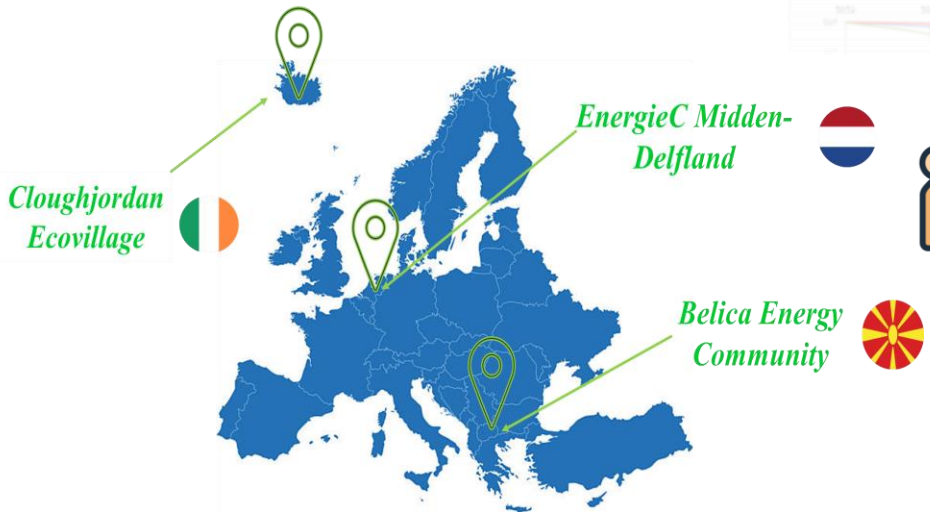
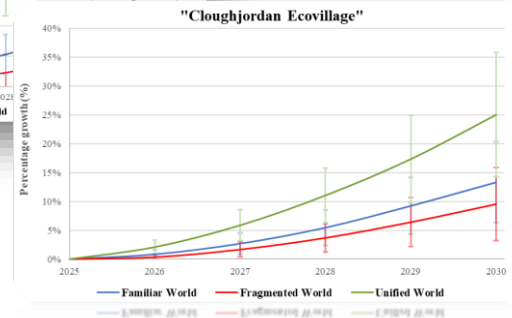
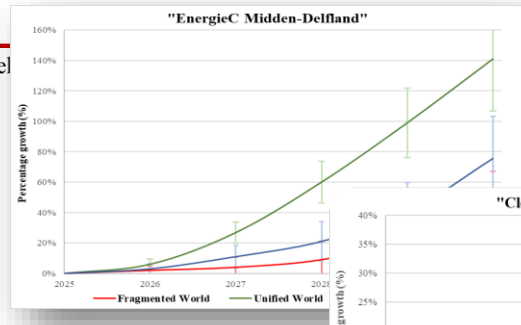
Togetherness matters!

Our work encourages the future growth of Collective Energy Initiatives (CEIs)

- Identify and prioritize CEIs with the **highest potential** of further growth and **optimize resource allocation**,
- Increase **likelihood** for citizen **participation**,
- Impact of CEIs on **reducing carbon** emissions at the **local** level,
- Optimize **infrastructure** development.

ANIMO
grassroot innovation diffusion Model

Agent-based model



"Band Together": Further diffusion of energy communities (2/2)

...about **6 different personas** outlining **potential characteristics & motivations**...

The Green Guardian



- Environmentalist
- Concerned about conventional energy sources
- Carbon footprint reducers
- Grid reliance reducers

The Eco-Collaborators



- Community-oriented
- Motivated by large environmental movements
- Appreciators of RES to reduce their environmental impact

The Self-Reliant Saver



- Self-sufficiency seekers
- Valuing energy independence
- Financial savers
- Motivated by lower energy bills

The Security-Minded Sceptic



- Attracted to financial benefits of CEIs
- Strong communal sense
- Trusting to their neighbors' positive experiences
- Encourage adoption

The Tech Trailblazer



- Technologic innovators
- Value smart home integration
- Interested in experimenting with and adopting latest technology

The Eco-Conscious Saver



- Environmentally conscious
- Carbon footprint reducers
- Money savers
- Mainly interested in CEIs' financial benefits

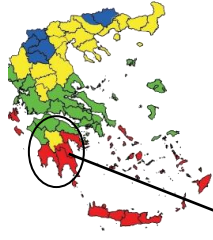
...driving citizens' **decision** to **join** a CEI, e.g., energy community, ecovillage!

"Power to the People" & "Habitual Creatures" storylines (1/2)

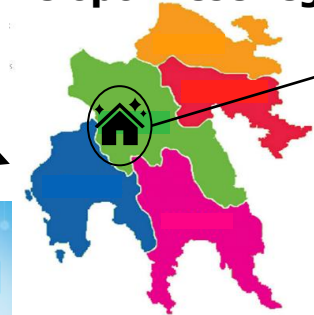


Towards a "green" rebranding of a Coal and Carbon Intensive Region into a city of the people, by the people, for the people

National scale
Greece



Regional scale
Peloponnese region



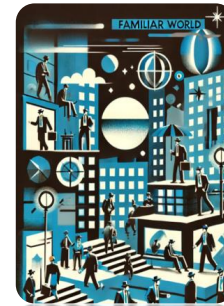
Local scale
**Municipality of
Megalopolis**



**THE JUST
TRANSITION
PLATFORM**



Familiar World



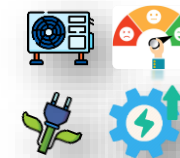
**National
Energy and Climate
Plan**

- *Current EU and NECP policies*
- *Mid-late phase out of fossil-fuels*

Fragmented World



Unified World



"Power to the People" & "Habitual Creatures" storylines (2/2)



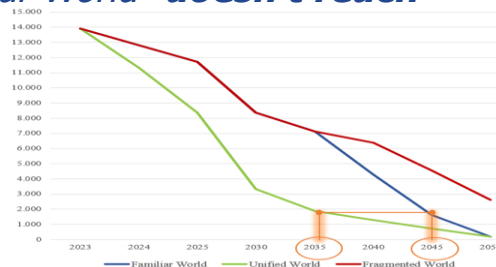
A **green** citizen-led transition in Megalopolis could not only be environmentally friendly, but also the **most financially viable** option in the long term.

A **GREEN TRANSITION** is not necessarily an **EXPENSIVE** one

Around **€300 million** could be saved at the municipality level. Downscaling to the household level, this translates to total savings of around **€60,000** by 2050 (i.e., **~3 times** the current **GDP per capita** in Greece)!



"**Unified World**" achieves **significant emission cuts** by **2030**- a milestone that "**Familiar World**" **doesn't reach until over 10 years later!**



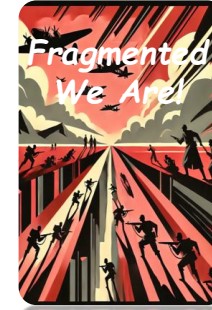
A **green** citizen-led transition could decrease households' energy **costs**, limiting the effect of **wage** reduction, and provide a significant helping hand to the **most vulnerable citizen groups**.

Coal & Carbon Intensive Regions CAN achieve BOTH sustainability and economic prosperity!

"People to the Power" storylines in different EU cities (1/2)

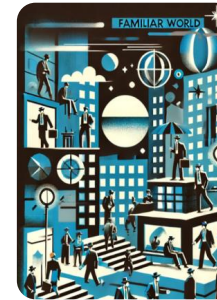
Knowledge is power & citizens seize the opportunity to harness the sun!

Unified World Fragmented World



Uncertainty & lack of trust overshadow the benefits of going green through prosumerism!

Familiar World



Citizens stick to what they already know about benefits of prosumerism!



Net metering
Feed-in-Tariff



Net metering with BESS
Net billing

- Aalborg
- Copenhagen
- Marseille
- Paris
- Athens
- Thessaloniki

- Lisbon
- Porto
- Bilbao
- Madrid
- Malaga

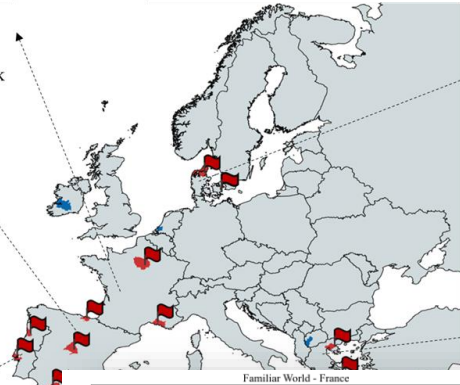


Both at the local & the national level!

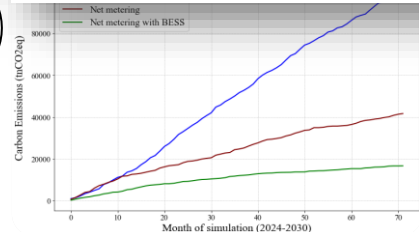
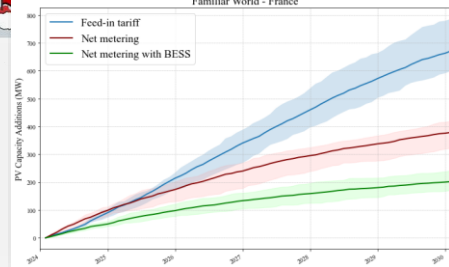
"People to the Power" storylines in different EU cities (2/2)



- **Middle** solar PV output.
 - **Lower decarbonization potential** (electricity production is mainly based on nuclear energy).
 - High profitability due to a **relatively high tariff**.
 - **Very high capital costs** results to **longer** payback periods.
-
- **High** solar PV output (especially in Malaga).
 - **High decarbonization potential** (energy mix is mostly based on natural gas).
 - **Lower profitability** (due to net billing) which results to **longer** payback periods.
-
- **High** solar PV output.
 - **Middle-low decarbonization potential** due to lower electricity consumption
 - **Lower profitability** (due to net billing) combined with lower self-consumption results to **longer** payback periods.



- **Middle-low** solar PV output.
 - **Lower decarbonization potential** (electricity production is mainly based on wind energy).
 - **Low capital costs** and **very high electricity prices** under the net metering scheme result to extremely **high profitability** and **short** payback periods.
-
- **High** solar PV output.
 - **Very high decarbonization potential** (electricity production is mainly based on fossil fuels and especially on natural gas).
 - **High profitability** (due to higher self-consumption under the net metering scheme) results in relatively short payback periods.



- **Prosumers** have the power to **influence** and **shape** the future of electricity supply, even in a **"dystopian"** world.
- **Tailored country-specific recommendations**, based on the **regulatory environment** and the different potential **evolutions** of the future, as for example:
 - ❑ **Long-term fixed prices** for FiT when short-term may have a **negative effect** on **prosumers' psychology**,
 - ❑ **More generous battery subsidies** when need to enhance **grid stability** and **flexibility**,
 - ❑ **Tipping points** in **prices** and **costs**, and **PV capacity**, in which prosumerism is **economic viable**.

Prosumerism could be a real answer towards RESILIENCE!

"Power to the People" & "People to the Streets" storylines (1/2)



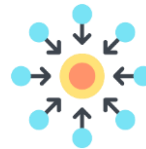
Citizen preference-led planning alternatives towards 100% renewable-based energy systems, or fossil fuel-based economies



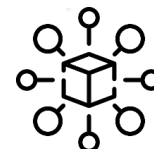
Unified World



100% renewable-based planning

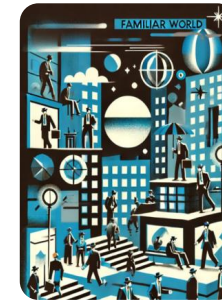


Centralized



Decentralized

Familiar World



BUSINESS AS USUAL



Fossil fuel-dependent planning



Gas



Lignite

Fragmented World



"Power to the People" & "People to the Streets" storylines (2/2)

Integrate citizens' preferences into decision-making!



A green energy system isn't just sustainable. It's also **PROFITABLE!**



Decentralization

Local renewable solutions

Transition to a 100% renewable-based national system

Prioritize people over corporations

- ✓ Electricity mix
- ✓ Capital costs and investments
- ✓ Power generation
- ✓ Carbon footprint
- ✓ Total costs of electricity supply
- ✓ Socioeconomic benefits for citizens



- **Investment timing** is a key factor for the energy transition since *the earlier citizens* start investing in solar rooftop PV the *higher* the potential **socioeconomic benefits** are going to be.
- Acknowledge that a "**Decentralized**" energy system can provide citizens with a more **democratized** and **equitable** future.
- Recognize that a "**Centralized**" energy system presents a more **individualistic** and **unfair** future in which socioeconomic benefits are distributed between a **smaller share** of people.

"People-centered" storylines & Integrated Assessment modeling (1/5)



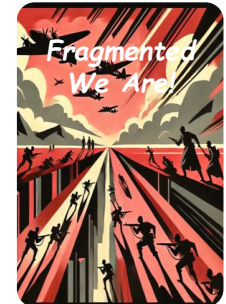
Decarbonizing the transport and the residential sectors in Western Europe under different "people-centered" storylines



Familiar World



Fragmented World



Unified World



IMAGE

Integrated Model to Assess the Global Environment

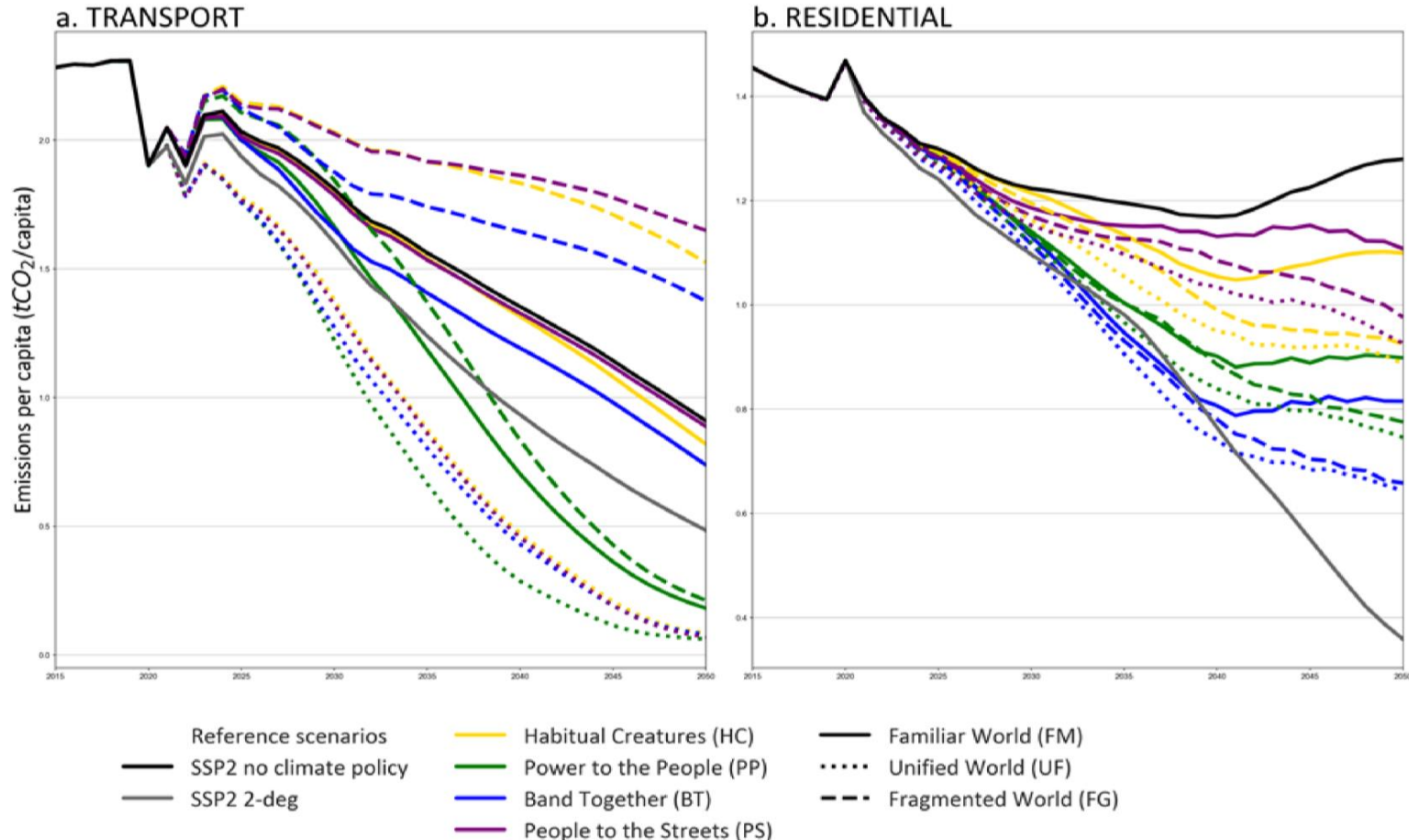


SSP2 no climate policy

SSP2 2-deg

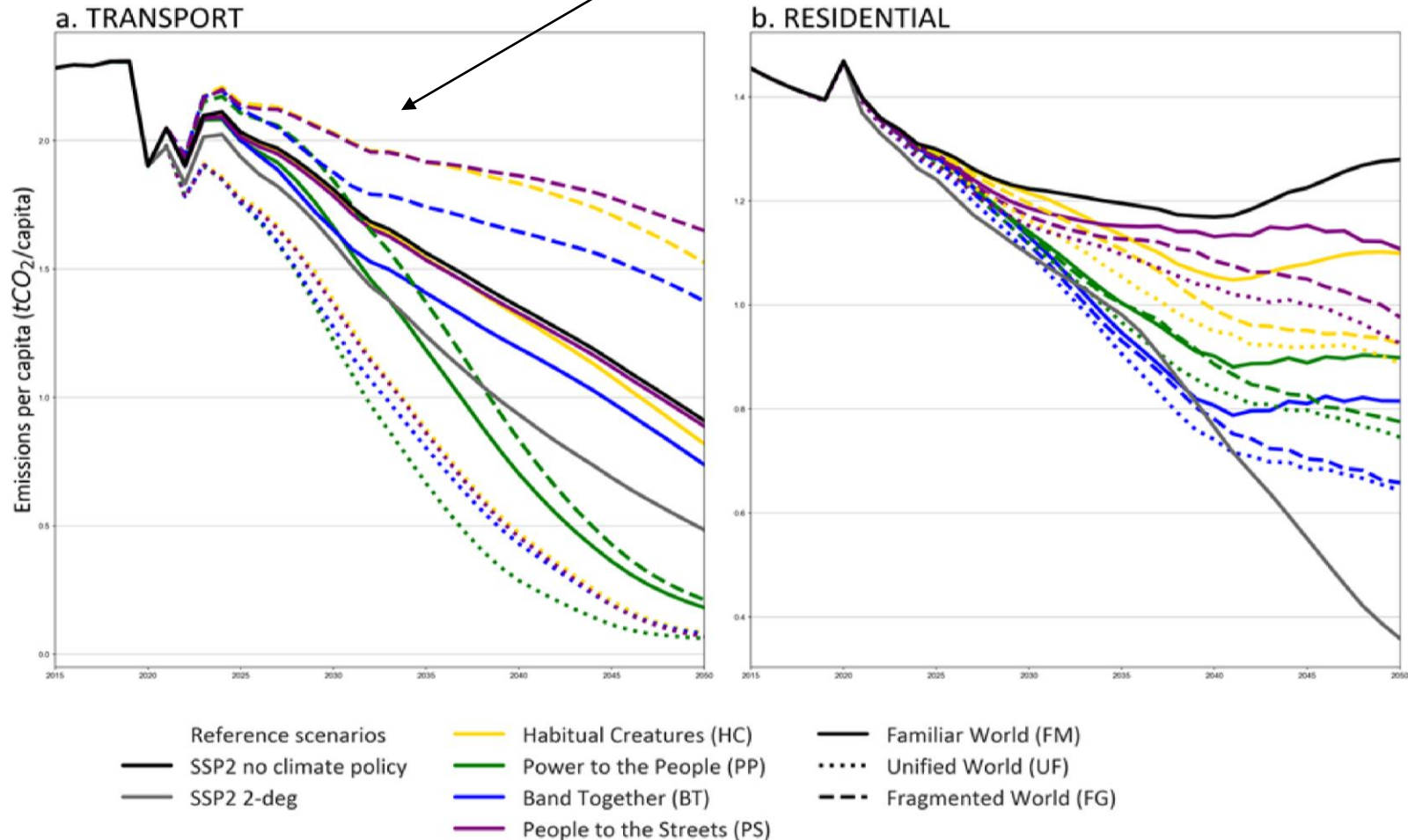
"People-centered" storylines & Integrated Assessment modeling (2/5)

Behavioral actions are more significant in the **residential** sector than in the transport sector, as all 4 "people-powered" storylines deviate substantially from the "**SSP2 no climate policy**" reference scenarios.



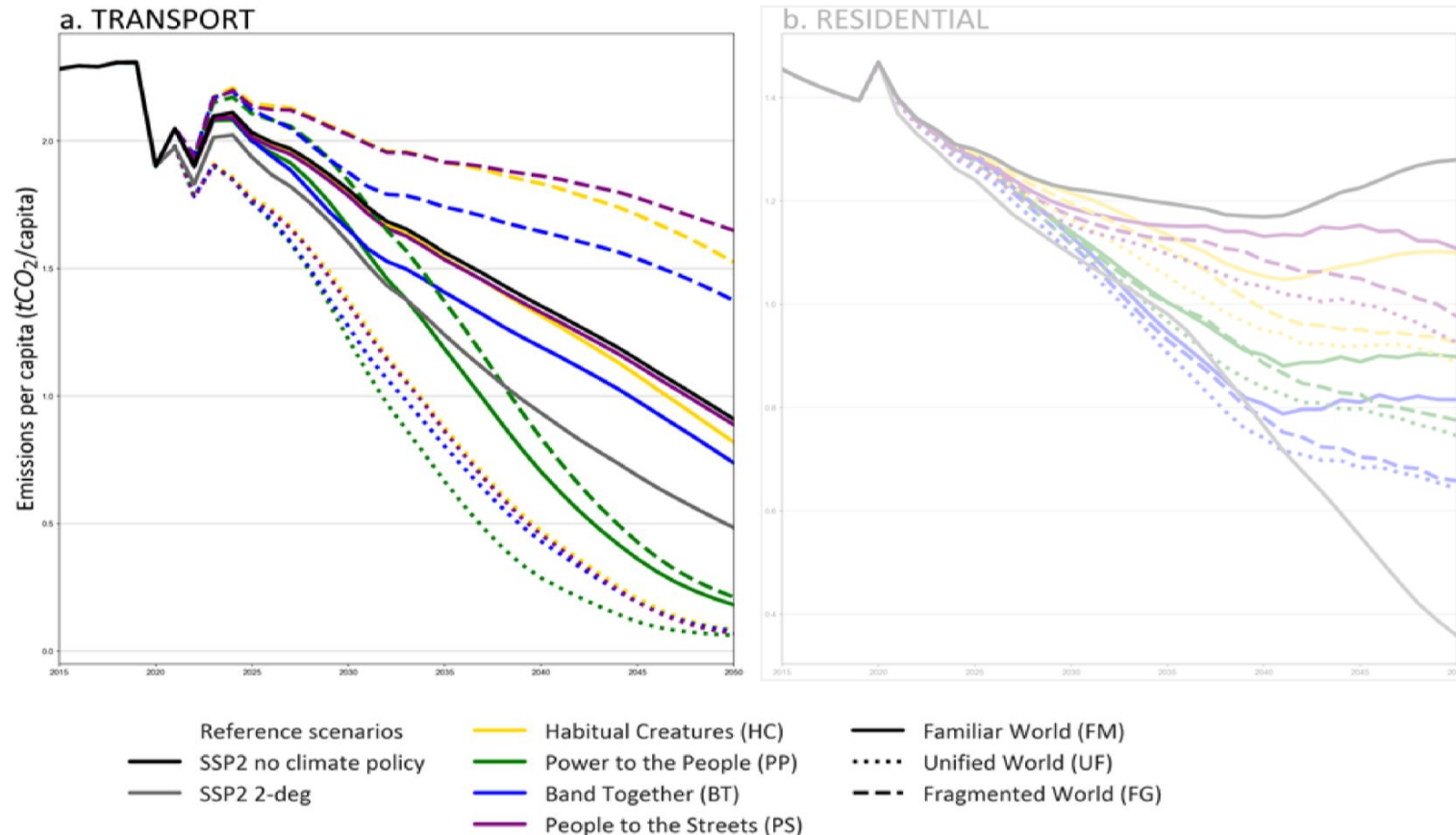
“People-centered” storylines & Integrated Assessment modeling (3/5)

However, these changes are **still far away from a 2°C reference scenario**, while in **transport**, the **“Power to the People”** storyline would go beyond the 2°C reference scenario.



"People-centered" storylines & Integrated Assessment modeling (4/5)

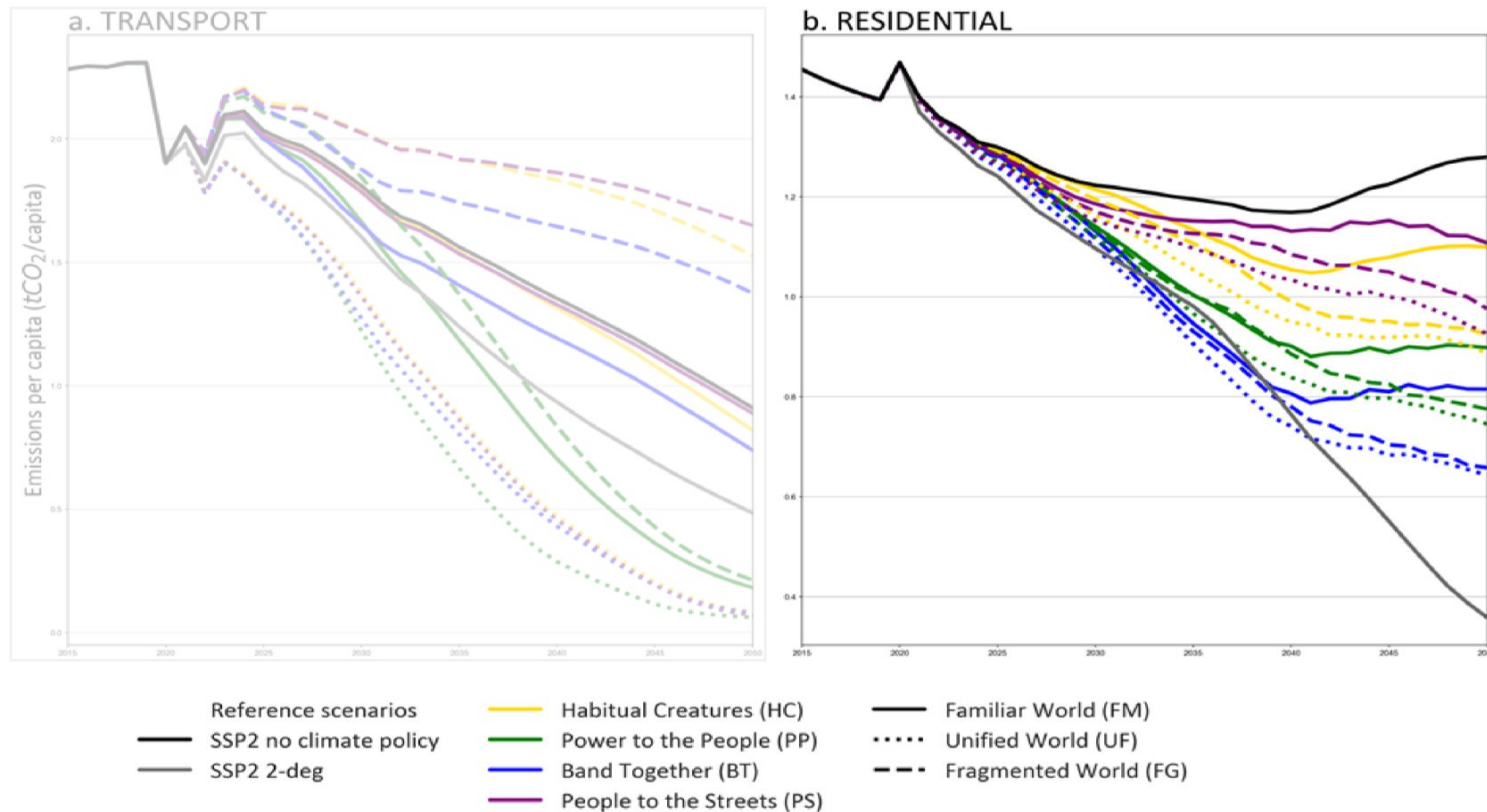
Measures under the "Power to the People" storyline (e.g., **EVs as storage**), which can be enabled by **subsidies on vehicles and storage**, etc., have the highest decarbonization potential compared to measures under the other "people-centered" storylines (carpooling, shift to public and active transport, etc.).



“People-centered” storylines & Integrated Assessment modeling (5/5)



In the **residential** sector, measures under the “*Band Together*” storyline (geothermal heat pumps for heating and cooling, communal laundry, communal dining and cooking, etc.), **enabled** by **neighborhood initiatives** and **housing cooperation**, etc., have the **highest decarbonization potential** compared to measures as insulation, air-source heat pumps for heating and cooling, thermostat adjustment, etc.).



Further research

We encourage...



...the **replication** of our work



the application of **energy system models** & **IAMs** to other geographical and socioeconomic contexts of interest, **across**, and **beyond** the national level (e.g., European Union, global).



Find more about our work !



EnergyCitizenship.eu



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Project deliverable

Report on the decarbonisation impact of energy citizenship at the local level: Deliverable 5.3 Energy Citizens for Inclusive Decarbonization (ENCLUDE)

Fotopoulos, Dimitris¹ ; Manias, Nikos¹ ; Kleanthis, Nikos¹ ; Papantonis, Dimitris¹ ; Stavrakas, Vassilis¹ ; Flamos, Alexandros¹

Hide affiliations

1. Technoeconomics Systems of Energy Laboratory (TEESlab), Department of Industrial Management & Technology, School of Maritime and Industry, University of Piraeus, Karaoli & Dimitriou 80, Piraeus, 185 34, Greece



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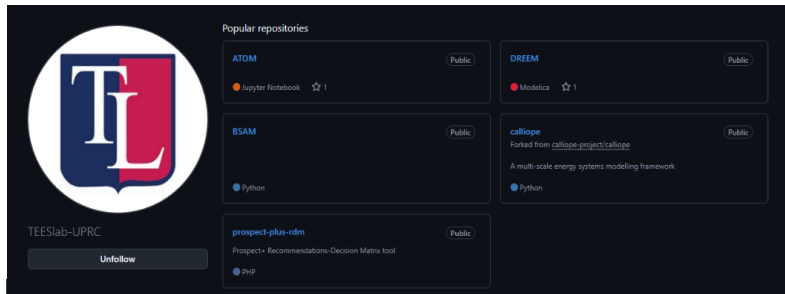
Project deliverable

Report on the decarbonization potential of energy citizenship at the national and the EU levels: Deliverable 5.4 Energy Citizens for Inclusive Decarbonization (ENCLUDE)

Manias, Nikos¹ ; van den Berg, Nicole J.² ; Kleanthis, Nikos¹ ; Fotopoulos, Dimitris¹ ; Stavrakas, Vassilis¹ ; van Vuuren, Detlef P.² ; Flamos, Alexandros¹

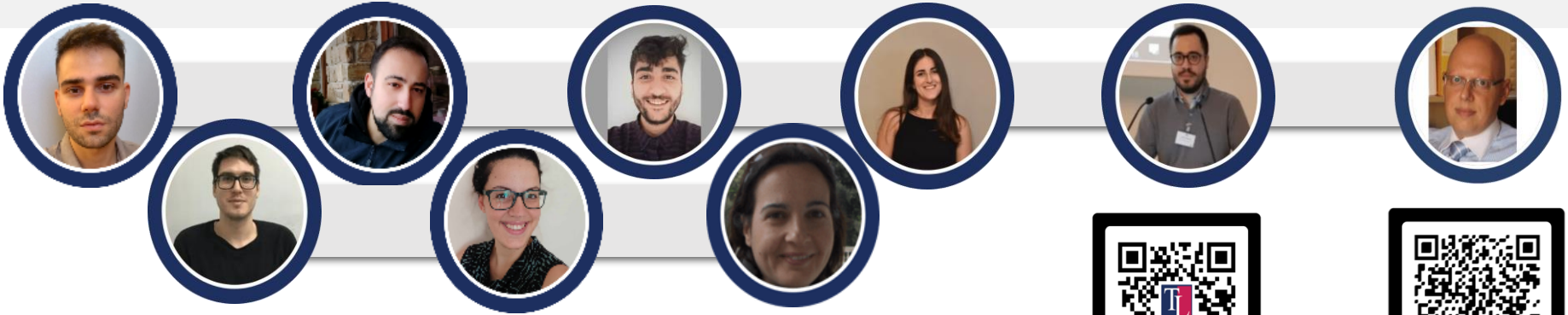
affiliations

1. Technoeconomics of Energy Systems laboratory (TEESlab), Department of Industrial Management & Technology, University of Piraeus, Karaoli & Dimitriou 80, Piraeus 18534, Greece
2. Utrecht University, Heidelberglaan 8, 3584 CS Utrecht, The Netherlands





Thank you!



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