



**The Global Energy Transition Toward Decarbonization:**  
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# Transformative mechanisms in decarbonization policies: a structured approach

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# Motivation & Objective

- The transition to a low-carbon society should accelerate to avoid an increase in the temperatures above 1.5° to 2°C, and this is unlikely to occur without public policy intervention (IPCC, 2022).
- Need to adopt a new, broader view on policy intervention (Weber & Rohracher, 2012; Hekkert et al., 2020), moving beyond a single focus on economic competitiveness and growth towards a focus on societal problems or “grand challenges”.
- Emergence of the concept of transformative innovation policy (Schot & Steinmueller 2018; Dierks et al., 2019), which implies the consideration of a much broader range of policy objectives, targets and instruments, as well as the notion that a mix of policies needs to be deployed to achieve the desired goals (Rogge & Reichardt, 2016).
- While this policy rationale has started to enter innovation policy agendas (European Parliament, 2022), it remains to be seen to what extent it is reflected in the actual policies being implemented (Casula, 2022; Rohracher et al., 2023).
- Existing research investigates individual policies, not enabling to capture the extent to which transformative policies are being used.
- This research addresses this gap by proposing literature derived mechanisms that are expected to introduce transformative effects in policies and investigating their presence in a broad set of decarbonization policies, from different world regions.

# Conceptual Framework (1)

- Innovation policy literature discusses new perspectives to policy intervention, based on the awareness that existing policy approaches were insufficient to tackle major contemporary societal problems, such as climate change, that are complex, systemic and urgent (Mowery et al., 2010; Mazzucato, 2018; Schot & Steinmueller, 2018).
- Several lines of research proposed different approaches, supported by diverse (e.g., narrower or broader) views on innovation and change (Dierks et al., 2019), ranging from the re-adoption and reconfiguration of “mission-oriented policies” (Mazzucato, 2018) to more open-ended approaches generally labelled “transformative innovation policies” (Schot & Steinmueller, 2018).
- Scholars propose several dimensions along which policy could act in order to induce transformative effects (Weber & Rohracher, 2012; Schot & Steinmueller, 2018; Kuhlmann & Rip, 2018; Dierks et al., 2019), departing from more “traditional” policies (Haddad et al. 2022; Dierks, et al., 2019).

# Conceptual Framework (2)

- The paper selects several policy features as indicative of potential for inducing transformative effects are proposed as “transformative mechanisms”:
  - to encourage experimentation;
  - to engage a diversity of actors;
  - to encompass activities of a variety of sectors;
  - to involve multiscale coordination;
  - to enable reflexivity.
- In addition, it was also considered that a mix of instruments may be required to implement transformative policies.
- This selection had into account the scope of this research – which intends to move beyond specific policy cases to a broad set of decarbonization policies – thus taking into consideration the fact that the presence of these mechanisms had to be empirically assessed from the generic descriptions of each individual policy.

# Data collection (1)

- Data on decarbonization policies compiled from **public databases**:
  - Data from European countries was obtained from the European Environment Agency (EEA) database on greenhouse gas policies and measures. Data was obtained on 2292 policies for 30 European countries, of which 26 are European Union members.
  - Data for the three other world regions included in the analysis was obtained from the International Energy Agency (IEA) Policies and Measures Database: 562 policies for the USA, 279 for China and 153 for Japan.
- The database with **3286 policies** was built, containing information about: Title of policy, Description, Year, Implementation Status, Sectors affected, Decarbonization focus, Geographical coverage, Type of policy instruments.
- The instruments listed in the source databases were organized in four types:
  - Economic (market-based) instruments
  - Regulation (command-and-control) instruments
  - Soft instruments
  - Planning policy instruments

# Data collection (2)

- Assessment of the transformative potential of decarbonization policies → operationalization of transformative mechanisms suggested by the literature through content analysis of the policy description

<b>Mechanism</b>	<b>Criteria</b>
Experimentation	Policies refer to any form of experimental activity, from test and demonstration of technologies to various types of social experiments.
Multi-actor  Type of actors	Policies target /involve and/or refer to the creation of partnerships or other modes of cooperation between different types of actors. An additional variable is created to distinguish between policies targeting the “traditional” type of actors (industry, academia, government) from those also engaging “new” types of actors (civil society)
Multisector	Policies target / involve more than one sector of activity
Multiscale	Policies encompass more than one spatial scale: supra-national, national, sub-national (different possible levels)
Reflexivity	Policies refer to the monitoring and assessment of the progress towards goals; and/or explicitly refer to the incorporation of learning from such assessment
Instrument mix	Policies use more than one type of policy instrument.

# Data analysis

- Mix method
- Quantitative – descriptive analysis of the 3286 policies to understand the incidence and distribution (by region and sector) of policies displaying individual mechanisms and/or their combinations
- Qualitative – content analysis of policy descriptions to understand the mode of organization of policies displaying more extensive combinations of mechanisms. 17 policies were selected to include:
  - i. all regions and, in the case of Europe, countries that stand out in terms of TP;
  - ii. the most frequent target sectors (and their combinations);
  - iii. different decarbonization focuses;
  - iv. different mixes of instruments.

# Results (1) – Transformative mechanisms

## Policies with transformative mechanisms

<b>Mechanism</b>	<b>Number of policies</b>	<b>% total</b>
Reflexivity	89	2.7
Experimental	174	5.3
Multi-actor (all)	214	6.5
Of which involve new actors	138	2.3
Of which only involve traditional actors	76	4.2
Multi-sectoral	109	3.3
Multi-scale	108	3.3
Policies with at least one mechanism*	510	15.5
Policies with two mechanisms*	118	3.6
Policies with three or more mechanisms*	33	1.0

\*Using multi-actor (all)



# Results (2) – sectoral differences

Sectoral distribution of TP

	<b>All policies</b>	<b>Policies with TP mechanisms</b>	<b>% with TP</b>
One sector	2313	244	10.5
Energy	677	144	21.3
Transport	486	40	8.2
Buildings	36	4	11.1
Industry	144	20	13.9
AFOLU*	383	28	7.3
Waste	152	5	3.3
Mineral resources	15	3	20.0
Cross-sectorial (Transversal)	237	94	39.7
Sector mixes			
Energy & Buildings	647	94	14.5
Energy & Transport	217	38	17.5
Energy & Industry	212	42	19.8
Energy & AFOLU*	52	5	9.6
Buildings & Transport	24	7	29.2

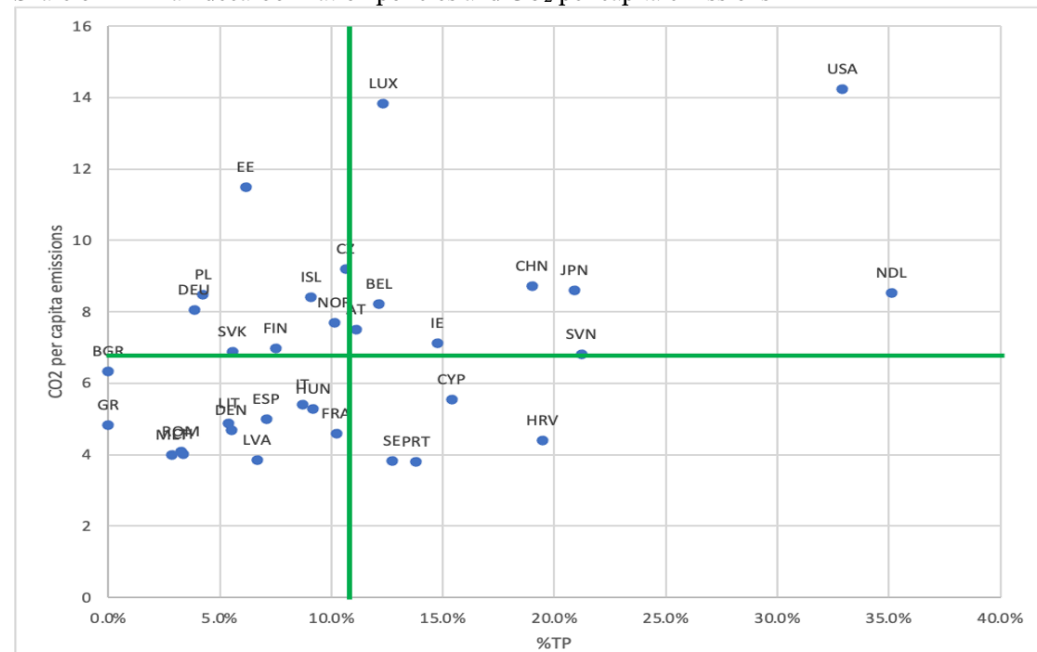
\*Agriculture, Forestry and Land Use

# Results (3) – regional differences

Policies with transformative mechanism, by region

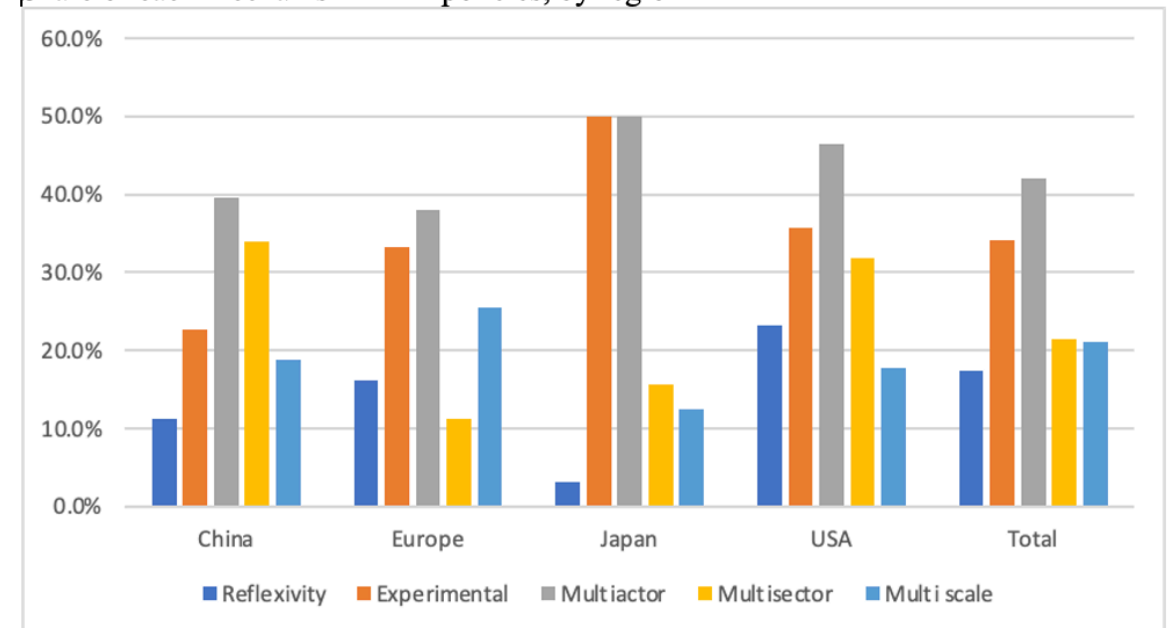
Region/Country	Share of TP in decarbonization policies in the country/region (%)	Share of country/region in all TP (%)
China	19.0	10.4
Europe	10.5	47.1
Japan	20.9	6.3
USA	32.9	36.3
Total	15.5	100.0

Share of TP in all decarbonization policies and CO<sub>2</sub> per capita emissions\*



\*2021 data retrieved from IEA-EDGAR CO<sub>2</sub>, a component of the EDGAR (Emissions Database for Global Atmospheric Research) Community GHG database version 7.0 (2022)

Share of each mechanism in TP policies, by region\*



\* Since policies can combine several mechanisms, the sum may be greater than 100%

# Results (4) – forms of transformative mechanisms

- **Multi-actor.** The involvement of a variety of actors was the most frequent mechanism. Although in some cases the focus was on the “traditional” actors (industry/academia), an already substantial number included non-traditional actors, from the civil society.
- **Muti-sector.** Multi-sector was usually combined with multi-actor, as the different actors involved might come from different sectors of economic activity or society domains. Policies including this mechanism often entailed establishment of connections / creation of interactions between sectors usually not related, aiming at a common goal (ex: energy savings; efficient use of resources / circular economy).
- **Experimentation.** Experimentation is also a frequent mechanisms. Policies including it could be divided into two types: i) policies focused on technology development which included different modes of test and demonstration as a route towards technology diffusion; ii) policies that included different types of societal experimentation, aiming at changing social practices (e.g., in terms of energy use, transportation, urban living conditions) involving a wider variety of actors, and sometimes expected to be driven or coordinated by local communities (including an important role for municipalities) or other social groups.

- **Multi-scale.** Policies encompassing and involving coordination between different spatial levels, were mostly of two types: i) formulated at a higher level (usually national) and then implemented at other levels (regional and/or local), the higher level usually assuming coordination; ii) originated at lower levels and act as pilot actions that were a learning setting that based dissemination to higher levels.
- **Reflexivity.** Some policies mentioned monitoring and assessment and their use to inform subsequent decisions, namely extension or reformulation of the policy, or the launch of subsequent policies.
- **Instruments.** Several of the policies analyzed make use of a mix of different types of instruments. When a combination of instruments is absent there is either the use of economic stimuli (for instance to mitigate negative effects of transition or to support disadvantaged communities), or the use of various soft instruments, associated to changing people's behavior.

# Conclusions (1)

#1 - Policies including transformative mechanisms – thus having a transformative potential – are still a **minority** in the four world regions analyzed.

#2 - **Regional differences** in the incidence of policies displaying transformative mechanisms:

- The highest incidence of policies with transformative potential was in the USA, followed by China.
- While Europe was the region with the greater number of decarbonization policies, it was also the one with a lower incidence of policies with transformative potential.
- Two possible explanations for this result: i) the urgency to tackle decarbonization problems may be higher in the USA and China given their higher level of CO<sub>2</sub> emissions; ii) these countries started formulating decarbonization policies relatively later than Europe, which may mean that they have a higher proportion of more recent policies, which are more likely to already incorporate the new policy rationales.

# Conclusions (2)

# 3 – **Sectoral differences** in the incidence of policies displaying transformative mechanisms, which was higher in:

- policies with a **transversal focus**, which have a greater capacity to bring together different sectors and actors aiming at a common goal
- policies targeting the **energy sector** also included more frequently transformative mechanisms → centrality of energy in decarbonization processes
- policies targeting a combination of **buildings and transport** → expansion of the electric charging infrastructure and/or of policies aiming at changes in the organization of cities

# 4 – Regarding the **transformative mechanisms**:

- involvement of a **variety of actors** and the growing policy focus on civil society actors and local communities
- relevance of **experimentation**, which is increasingly moving from supporting technology diffusion towards a broader focus on changing social practices, through a diversity of social experiments

# Limitations & further research

- One important contribution of this research was to go beyond case studies and assess the incidence of transformative mechanisms in a wide range of policies. However, this more encompassing approach also was found to have some limitations. In fact, as some policy descriptions (albeit still a minority) were insufficient to reach a conclusion about an eventual presence of the transformative mechanisms defined, the incidence of policies with transformative potential reported may be undervalued.
- Overall, the results suggest that there are already, across different world regions, efforts towards the inclusion of different types of transformative mechanisms in policies, which are promising to accelerate decarbonization. The definition of these mechanisms and their analysis is a first step towards assessing decarbonization policies' ability to produce co-benefits for the economy, but further research is needed in order to go into greater depth into the nature and effects of these policies.