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THE LOCAL DIMENSION OF THE ENERGY TRANSITION: Systematization and Analysis of the Climate Plans of 49 Argentinean Municipalities

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Abstract: *This study examines existing energy transition efforts and their distribution by analyzing actions, instruments, and mitigation targets in the climate action plans of 49 Argentinean municipalities from 2018 to 2022. The findings reveal a focus on demand-side actions, particularly energy efficiency measures. This prioritization can be attributed to various factors, including perceived benefits, easy implementation within existing structures, and the prevailing hydrocarbon paradigm, where decentralized energy generation tends to be limited. The number of initiatives related to demand electrification remains particularly low, potentially influenced by national-level policies favoring gasification. Public investment policies are the most commonly used instruments, followed by voluntary instruments, economic instruments, governance and other municipal processes, and command and control instruments. While there is a positive and statistically significant correlation between emissions and planned reductions, the relation between emissions and the percentage of emissions targeted for reduction is not significant. This indicates that the principle of common but differentiated responsibilities is not being fulfilled in the actual distribution of efforts. Lastly, it is found that municipalities with higher emissions tend to undertake more transformative actions, which implies some alignment with the principle of common but differentiated responsibilities, as higher emitters lead transformative action. Conclusions underscore the importance of establishing a precise framework to guide and coordinate municipalities' efforts towards achieving national energy transition objectives.*

1. INTRODUCTION

The slow historical pace of global energy transitions is largely due to the magnitude of the transformations required to change energy regimes. These transformations include changes in generation, distribution and final consumption of energy. Although global energy transitions have been slow (Smil, 2010), the climate crisis makes it imperative to achieve decarbonization in just a few decades (Drewello, 2022). For this enormous task, many and varied actors are needed. The energy transition cannot be carried out solely and unidirectionally by national governments.

Municipalities are assuming an increasingly significant role within the context of the evolving decarbonized energy system. Their localized knowledge and close proximity to consumers grant them a unique position to influence energy dynamics. From the realm of energy efficiency to the optimization of consumption patterns, municipalities possess the capability to shape energy

demand. Moreover, the ascendancy of decentralized energy generation is redefining the traditional concept of energy provision from remote central production units (Krog et al., 2019). Instead, municipalities are now positioned to proactively initiate, invest in, produce, and ultimately serve as end-users of clean energy (Kata et al., 2022). Notably, decentralized energy generation helps to overcome restrictions that long distance transmission and distribution systems can pose. Municipalities also play a crucial role in facilitating a wider adoption of clean energy by promoting electrification of demand and avoiding carbon lock-in. In this capacity, local governments function as architects of policy, implementers of strategies, and vital partners in the formulation of national and provincial energy policies (IPCC, 2022).

In a highly urbanized world, where more than 50% of the world's inhabitants live in cities, up to 76% of global carbon emissions produced from final energy use proceed from urban centers (IPCC, 2022). These numbers show the importance of mitigation strategies for urban settlements and, in favor of the necessary change, the IPCC (2022) interprets this human concentration trend as an opportunity to disseminate large-scale decarbonization actions. Argentina, a middle-income Latin American country with a predominantly fossil-fueled energy matrix which is responsible for more than half of its emissions, is highly urbanized. In fact, 9 out of 10 Argentines live in urban centers.

In Argentina, there is a certain degree of coordination between the national government and the country's provinces regarding climate policy, as provinces participate in the National Climate Change Cabinet (the institutional arrangement where national climate policies are formulated) and are mandated to develop "Climate Response Plans" -i.e. climate action plans with specific requirements. However, at the national level, there are no comprehensive guidelines or minimum requirements in regards to the role of municipalities in climate action or the energy transition in particular. Therefore, these efforts are made on a voluntary basis.

Propelled by organizations such as the Argentine Network of Municipalities against Climate Change (RAMCC), there is a growing trend towards the design of municipal climate action plans. RAMCC acts as the national coordinator for the Global Covenant of Mayors for Climate and Energy (GCoM), consolidating a coalition comprising more than 270 municipalities, fostering the exchange of experiences and promoting horizontal coordination among participating entities (Mitchell et al., 2019). Furthermore, the RAMCC also offers technical assistance in the development of municipal climate action plans.

As municipal climate action is built from a bottom-up approach and should be aligned with the achievement of national goals, the multi-level energy transition challenge involves finding the right and complementary ways to enhance and align local energy transition contributions (Hooghe & Marks, 2003; Sperling et al., 2011; Westskog et al., 2017; Dobravec et al., 2021). In order to achieve alignment in municipal efforts, it is important to consider the establishment of new vertical coordination frameworks at the national level (Sperling et al., 2011), while simultaneously reinforcing existing horizontal schemes or creating new ones that foster collaboration and mutual reinforcement. Above all, the applicability and practical feasibility of the link between national objectives and local action should be sought (Dobravec et al., 2021).

To address the question of how to generate the necessary multi-level coordination for the energy transition, it is essential to begin with a comprehensive diagnosis of existing municipal efforts. In this research, the state of climate planning concerning the energy transition of municipalities

in Argentina is examined. Also, the relation between existing efforts and local emissions in the stationary energy and transport sectors is explored.

Though this summary does not include the literature review of the original research publication, it is important to point out that existing literature on climate action plans does not typically focus on specific sectors or a single transition to sustainability (Salvia et al. 2021; Reckien et al. 2018; Reckin et al., 2014; Hoff and Strobel, 2013; Tang et al., 2009). The literature that studies energy policies in the context of municipal energy planning is known as "Municipal Energy Policy" (Kostevšek et al., 2016), which does not necessarily address energy policies in the context of the energy transition. Interestingly, Wretling et al. (2018) recalls, based on the case study of Sweden, that municipal energy planning is converging towards climate change mitigation, there being a trend towards integrating climate action into local energy policy. Finally, while there are some publications that refer to the contents of climate action plans of Latin American municipalities (Lechón Sánchez, 2023; Dalla Torre and Coronel, 2020; Mitchell et al., 2019), a thorough search did not identified any document that has systematically analyzed energy transition municipal actions across multiple local climate action plans in Argentina.

The following four elements are addressed in this research. 1. The types of actions that municipalities include in their climate action plans that contribute to the energy transition, and 2. the public policy instruments that they include to operationalize these actions. 3. Whether municipalities with higher emissions from stationary energy and transportation sectors are planning greater reductions in these same sectors, and 4. whether higher emissions from these sectors are positively correlated with the planning of more transformative actions.

2. THEORETICAL FRAMEWORK

The theoretical perspective that underpins this research is the concept of multilevel governance, which recognizes that energy transitions are taking place across various levels of government. It acknowledges that different actors and stakeholders are involved in these transition processes, all of whom are essential to achieving carbon neutrality at the national level. Within this framework, municipal energy transition actions can be seen as partial contributions towards a broader and interconnected transition effort (Villamor et al., 2020). This perspective views the transition process as "relationally constructed", highlighting the interdependencies among the various actors involved in driving change, as discussed by Cowell et al. (2017).

While municipalities operate within a shared macro-context, each one has its own unique local circumstances. Consequently, their contributions to the national energy transition differ from one another (Villamor et al., 2020). These differences are influenced by various factors, including the historical context, interests, competencies, ideological orientations, availability of financial and natural resources, and technical capacities within their specific landscapes (Drewello et al., 2022). Additionally, municipalities grapple with their own distinct "stubbornly local issues" (Cumbers & Traill, 2022). The combination of these factors may imply municipalities to be, besides from capable in terms of resources, prone or not to promote this particular transition.

The principle of common but differentiated responsibilities (CBDR), as outlined in the United Nations Framework Convention on Climate Change (UNFCCC), can provide valuable guidance in determining the distribution of local energy transition efforts at the subnational level.

Specifically, this principle is useful for distributing responsibilities under the idea that each actor has different capacities, as well as a deferred duty to act due to the dissimilar contribution to the climate crisis. At the international level, its introduction sought to achieve practical equity by establishing different standards for de facto unequal countries, increasing the participation and effectiveness of international agreements (Voigt & Ferreira, 2016). Applying the principle of CBDR at the subnational level may enable a more nuanced approach to distributing responsibilities that align with the varying needs and capabilities of different municipalities. In this thesis it is interpreted that this principle is being fulfilled when the actors with the highest greenhouse gas emissions take on greater mitigation responsibilities and lead decarbonization.

The objective is to achieve the decarbonization of the energy system and, to this end, action at the municipal level is necessary, orchestrated as equitably and effectively as possible. When analyzing how energy transition efforts are distributed at the local level and whether this dispersion is consistent with existing principles such as common but differentiated responsibilities, it is important to take into consideration that not all actions generate the same contributions towards the transformation of the energy system. This is why in this thesis an analysis of whether municipalities with more greenhouse gas emissions are planning more actions with greater transformational potential is also included.

3. METHODOLOGICAL FRAMEWORK

This section presents the criteria used to classify the analyzed actions and instruments regarding the energy transition in Argentinean municipalities.

Actions are differentiated based on their focus on the supply or demand side of energy. Demand-side actions aim to modify or reduce energy consumption (Nelson, 2020; Warren, 2013) and are further classified into three sub-categories: increasing energy efficiency, increasing energy savings, and demand-side electrification. Supply-side actions impact energy production, generation, transmission, and distribution (Hoel, 2014); and are grouped into three sub-classifications: decentralized renewable energy generation, fuel substitution (UNIDO, 2009), and actions to increase the distribution and supply of electricity or alternative fuels.

Policy tools to operationalise energy transition actions are classified into five main categories according to their key characteristics.

1. Command and control instruments impose prohibitions, obligations or conditions on how to carry out an activity (IPCC, 2022).
2. Economic instruments provide a positive or negative economic incentive to modify the behavior of the regulated subjects via prices (IPCC, 2007).
3. Voluntary instruments either provide information to stimulate voluntary change or imply the generation of agreements to attain self-regulation (Aguilar et al., 2021).
4. Public investment instruments refer to the State undertaking public procurement and direct investments with criteria to achieve its proposed objectives.
5. Finally, municipalities can also carry out policies related to governance and municipal processes that do not imply concrete regulations or public investments by, for example, altering urban dynamics, carrying out logistical service optimization processes or creating institutional structures (Aguilar et al., 2021).

The transformational index used in this research is an adaptation of the one proposed by Westskog et al. (2022) and Wang et al. (2018) to suit the Argentinean context. The index categorizes actions into three transformational levels, ranging from 1 to 3, with level 1 representing the lowest transformational level and level 3 the highest.

Level 1 actions focus on reducing energy consumption in activities without necessitating structural changes or the adoption of innovative approaches. These actions typically involve the rationalization of energy use and increased efficiency while maintaining the existing sources of energy generation, means of transportation, construction techniques, and materials. They are easy to implement and have a limited degree of innovation. For example, increasing the efficiency of public lighting systems or implementing programs that encourage the responsible use of energy by turning off unused lights.

Level 2 actions aim to achieve emission reductions by introducing new ways to carry out energy-intensive activities. They imply an evolution in the way activities are carried out as new ways of doing the same tasks are adopted, which are different and better from the climatic point of view. This category is further divided into two sub-groups: 2A and 2B.

Level 2A actions involve modifying means of transportation, construction techniques, or materials to achieve energy savings or efficiency gains. Examples include promotion of the use of bicycles, public transport and carpooling over individual cars. As well as promoting bioclimatic construction techniques and highly insulated materials.

Level 2B actions focus on transitioning towards clean energy generation and creating the necessary conditions for clean energy consumption. This can involve initiatives such as the installation of decentralized renewable energy generation technologies, promoting the electrification of energy demand or establishing charging stations for electric vehicles. In order to carry out this type of actions, increasing innovation processes are needed, which could include collaboration in networks or the creation of new municipal structures.

Level 3 actions are characterized by their capacity to generate systemic changes. Societies recognize the causes of anthropogenic climate change and develop strategies aimed at preventing the generation of emissions, which implies questioning the prioritization of activities and needs. For instance, transformative shifts in urban planning and design, such as changing urban zonification to achieve the "15-minute city" model. They may also involve the application of circular economy models or prioritizing the proximity between production and consumption (e.g. local consumption models).

4. METHODOLOGY

To achieve the objectives of this research, a database was constructed by analyzing and classifying 685 transport and stationary energy actions and their respective instruments from 49 municipal climate action plans published between 2018 and 2022. All analyzed plans where developed with support from the RAMCC. The systematized elements per action are summarized in the following figure.

Figure 1: Elements systematized per action

Note: "RE" means renewable energy.

The constructed database was used for both absolute and relative analysis of actions and instruments. Absolute analysis focused on the total count of each classification, while relative analysis examined the prevalence of each classification within each municipality. In addition, observations were made regarding aspects of inclusion and resilience in systematized climate action to provide a more comprehensive understanding of the energy transition efforts. To study the relation between energy-related greenhouse gas reductions and emissions, as well as between reductions and more transformational actions, correlation analyses were performed. Statistical significance was determined using t-tests. To enhance the analysis, interviews were conducted with relevant stakeholders, providing valuable insights and perspectives. These interviews also contributed to modifying the transformational index and improving result interpretation.

It is important to note that in Argentina, the majority of municipal climate action plans are developed with support from the RAMCC, which follows a standardized planning methodology resulting in similar structured documents. This similarity between plans enables the direct comparison of documents and their actions, as they follow the same design method. At present, the RAMCC states that has assisted 70 municipalities in developing their climate action plans. However, they do not provide the plans or information on how many have been published. The 49

plans analyzed in this research had to be individually collected through internet searches. Figure 2 shows the location of the municipalities to whom the studied climate action plans correspond.

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Out of the 49 municipalities, 33 have a population of less than 50 thousand inhabitants. This means that the findings of this research predominantly pertain to small municipalities. Lastly, it should also be noted that given that all the municipalities studied in this research have climate action plans, they are probably more advanced than the rest of the municipalities in the country regarding the design of energy transition actions.

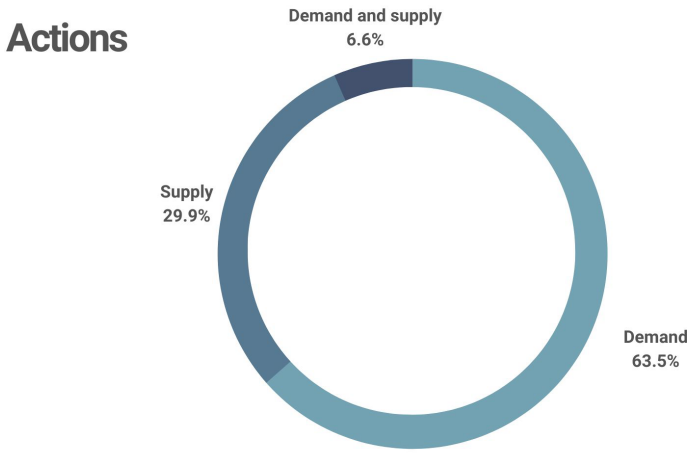
5. RESULTS AND INTERPRETATION

5.1. GENERAL RESULTS

All analyzed plans included actions related to the energy transition. Stationary energy transition actions were more prevalent, accounting for 62% of total actions, while transport actions constituted 38%. Interviews with municipal employees revealed insights into the evolving role of municipalities in these sectors. For instance, several interviewees stated that, as the energy transition develops, municipalities are recognizing the need to establish areas that specifically address energy-related issues. This highlights the growing importance of local government involvement in shaping the energy transition.

5.2. ACTIONS

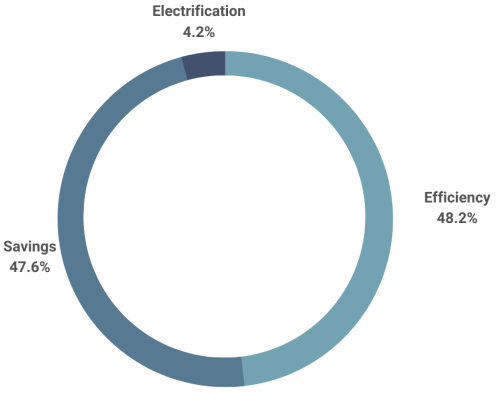
Figure 3: Percentual distribution, action classifications



In absolute terms, demand-side actions were more common, accounting for 63.5% of the total actions. Supply-side actions represented 29.9% of the actions and 6.6% affected both demand and supply. Regarding the relative analysis, in 44 out of the 49 municipalities the highest proportion of planned actions fell under the demand-side classification.

After confirming the prevalence of demand-side actions, a subsequent analysis was carried out to determine the most frequent demand-side action subcategory. In terms of absolute analysis, energy efficiency emerged as the primary subcategory (48.2%), followed closely by energy-saving actions (47.6%), while electrification actions were strongly less frequent (4.2%). The relative analysis revealed that energy efficiency actions were predominant in 31 out of the 49 municipalities. In sum, results indicate that energy efficiency measures are a shared priority among the municipalities examined.

Figure 4: Percentual distribution and examples, demand



Examples

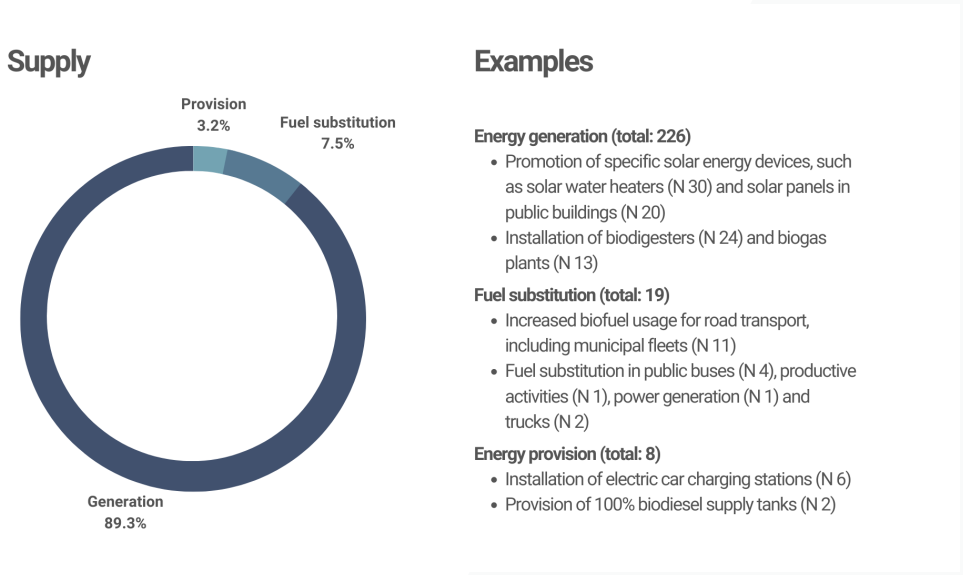
Energy efficiency (total: 251)
- Replacement of lighting luminaires (N 70) and domestic appliances (N 25)
- Incorporation of thermal insulation technologies in buildings (N 12)
- Stimulating efficient driving techniques (N 15)

Energy saving (total: 248)
- Boosting the substitution of private cars by active (N 30) and public transport (N 39)
- Stimulating bicycle use (N 75)
- Increase car sharing (N 4)

Electrification of demand (total: 22)
- Purchase of electric cars for the municipal fleet (N 4) and electric public buses (N 6)
- Electric trolleybuses powered by solar photovoltaic energy (N 1)
- Reduction of tax rates for electric vehicles (N 2)

The analysis of supply-side actions revealed that energy generation actions are widely predominant (89.3%), followed by fuel substitution (7.5%) and energy provision (3.2%). The subclassification of energy generation actions by source reveals a focus on solar photovoltaic energy (40.2%), followed by solar thermal energy (29.7%), biomass (14.1%), eolic (3.2%), and mini-hydro (1.6%). Some actions fall under an "indistinct" category, targeting clean energy generation without specifying the source.

Figure 5: Percentual distribution and examples, supply



While some municipal plans mention the alignment of their overall goal with the National Determined Contribution of Argentina (NDC), no plan states that it analyzed or assessed whether their planned actions in the stationary energy or transport sectors are sufficient to contribute effectively to achieving national energy transition targets. The lack of a clear definition of the municipal role in the process of achieving national energy transition goals may contribute to the imbalance between supply-side and demand-side actions. Without explicit guidelines or requirements for municipalities to address specific supply-side actions, they may prioritize demand-side measures, such as energy efficiency and behavioral changes, which are often perceived as more accessible or cost-effective. Additionally, municipalities may perceive their role in the energy transition as being predominantly demand-side, which may be due to the prevailing paradigm of centralized fossil fuel generation, in which energy generation near consumption centers has had less prominence. Furthermore, the mutual influence and knowledge exchange among municipalities through horizontal coordination networks may contribute to the widespread adoption of energy efficiency actions. Municipalities learn from each other's practices and success stories.

The low frequency of electrification actions is noteworthy. During the interviews, it was pointed out that there is a downward movement towards gasification and against electrification at the national level due to the availability of this resource in the country. This seems to permeate at the local level and can be related to the theoretical framework of this thesis, which characterizes energy transitions as relational processes at different levels of government, political factors, and resource availability, among other variables. The low frequency of electrification actions may indicate a potential area for further development within municipal climate action plans.

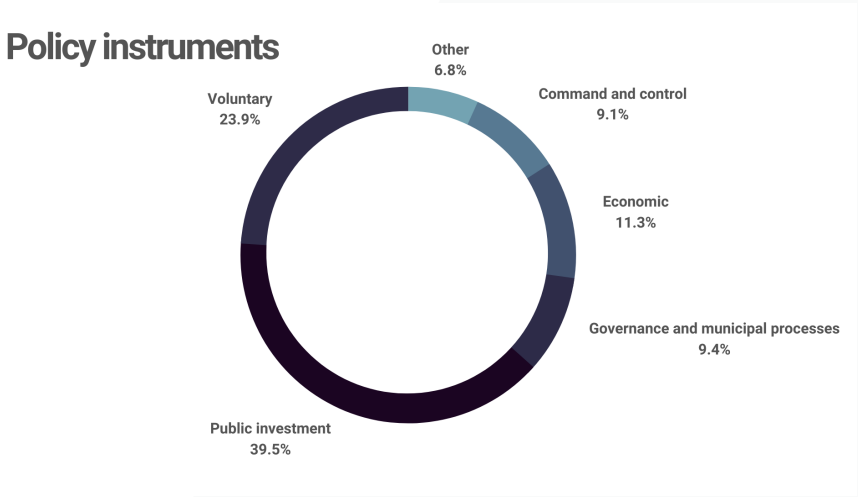
Only a limited number of actions were identified that specifically focused on enhancing resilience within the energy systems. This theme appeared scarcely in specific examples, such as the case of the municipality of San Justo (2019), which plans to install solar photovoltaic panels as a measure to mitigate outages during the summer. However, several municipalities planned actions aimed at promoting inclusivity within their energy systems. This focus may be a result of pre-existing initiatives that were incorporated into the climate planning process. Actions such as the installation of solar water heaters, improving energy efficiency in social housing, and other similar measures were prevalent.

5.3. INSTRUMENTS

The analysis revealed that public investment is the most frequent policy instrument, representing 39.5% of all instruments in absolute terms. Moreover, when examining the relative prevalence of policy instruments in each municipality, it was found that public investment instruments were the dominant category in 42 out of 49 municipalities.

The prevalence of these instruments may be related to the municipalities' capacities to make localized investments in the territory. In contrast, the literature states that the national government of Argentina tends to have more general climate action programs, centrally related to institutional and governance capacities (Dalla Torre y Coronel, 2020).

Figure 6: Percentual distribution, policy instruments classifications



Despite the prevalence of public investments, financial restrictions were frequently mentioned as a significant barrier by the interviewees. In this regard, previous research states that the RAMCC has played a crucial role in facilitating direct international financing for municipalities (Dalla Torre y Coronel, 2020). This factor may explain, to some extent, the prevalence of these instruments, as municipalities may have accessed funding facilitated by the RAMCC.

To gain more detailed insights into municipal public investments, sub-classifications were developed and used for further systematization. The results indicate that the majority of public investments are related to the acquisition of renewable energy generation technology, followed by investments in infrastructure construction, replacement of lighting fixtures, purchase of means of transportation, installation of electric charging stations, and purchases of biofuel for municipal transportation.

Figure 7: Percentual distribution, public investments classifications

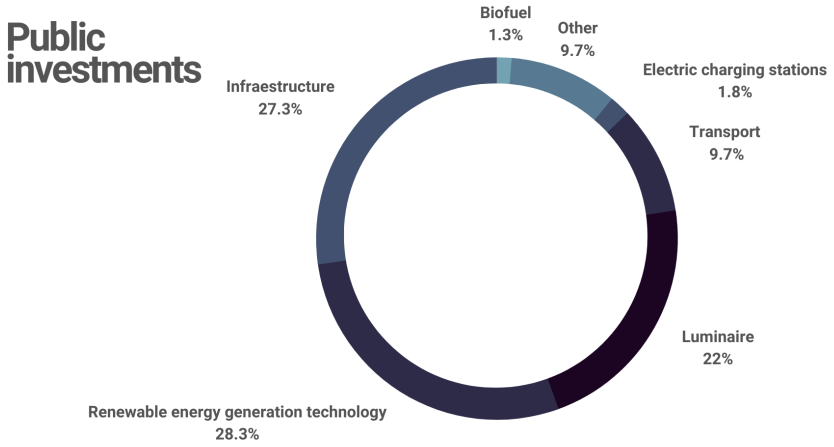


Figure 8: Examples of instruments other than public investments

Examples

Voluntary (total: 343)

- Training courses (N 60), communication campaigns (N 32) and awareness materials (N 8) about topics such as energy efficiency and decentralized renewable energy opportunities for industries, good practices on domestic energy use and sustainable mobility
- Sustainability seal programs for buildings (N 15)
- Service provision of carbon footprint for businesses (N 3)

Economic (total: 208)

- Credits and microcredits for renewable energy purchase (N 20)
- Financing plans or subsidies for renewable energy purchase (N 8)
- Tax exemptions or discounts on municipal taxes for energy-efficient buildings (N 10)
- Encourage bicycle use through subsidies or affordable acquisitions programs (N 15)

Governance and municipal processes (total: 82)

- Energy efficiency and sustainability analyses of municipal buildings (N 10)
- Improving the logistic of services such as waste collection (N 4) and public transportation (N 10)
- Monitoring transportation dynamics (N 10) and other decision-making studies (5)

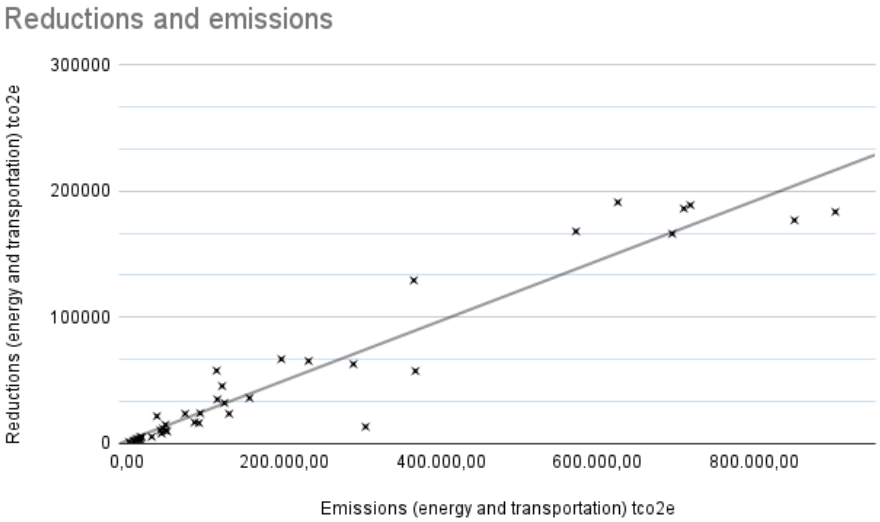
Command and control (total: 79)

- Construction codes modification to enhance energy efficiency and promote renewable energy usage (N 23)
- Exclusive corridors for public transport or prohibition of cars in specific areas (N 20)
- Energy efficiency standards for buildings (N 8)
- Mandatory biofuel cuts (N 6)

5.4. EMISSIONS AND PLANNED REDUCTIONS

The analysis of the relation between emissions from stationary energy and transportation sectors and planned reductions for the same sectors in municipalities revealed a positive and significant correlation. The correlation coefficient is 0.97 and the significance level is 0.1%. To further validate the robustness of the analysis, an outlier municipality, Comodoro Rivadavia, was excluded from the dataset. After excluding this outlier, the correlation coefficient remained positive with a magnitude of 0.95 and significant at the 0.1% level.

Figure 9: Relation between reductions and emissions



Interpretation: *The relation between the planned reductions (tco2e) corresponding to the planned stationary energy and transportation actions of each municipality and the emissions of the stationary energy and transportation sectors of each municipality (tco2e) has a positive relation. The atypical case, Comodoro Rivadavia, is not included in this graph.*

This first result on the relation between emissions and reductions can be explained by horizontal and vertical coordination mechanisms. The RAMCC suggests that municipalities reduce their emissions by at least 18% of their total emissions relative to the baseline scenario. This target aligns with the commitment that Argentina presented in its NDC (2016), which has been subsequently updated. No case was found where the total emission reduction commitment (of all sectors) is less than the reduction of greenhouse gas emissions by that percentage. The fact that municipalities define their total targets by taking a minimum threshold generates some alignment between the emission reductions.

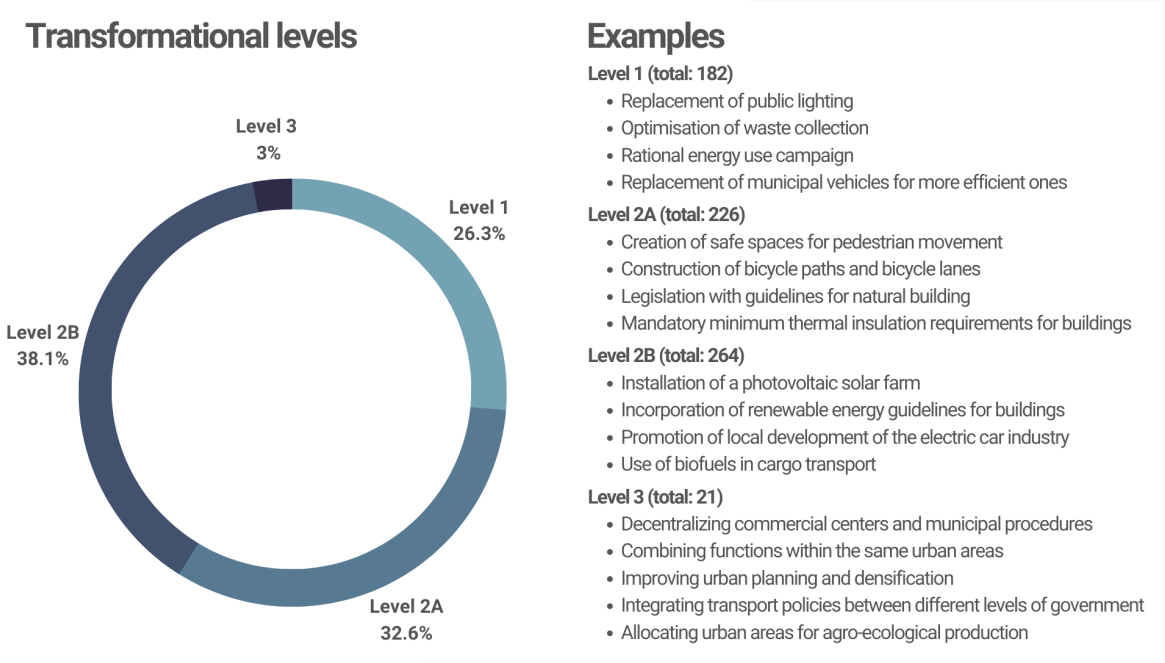
A second analysis was carried out to further explore the relation between emissions and reductions in the framework of the principle of common but differentiated responsibilities. Specifically, the relation between emissions and the percentage of emissions that each municipality plans to reduce (in both stationary energy and transport sectors) was studied. In this case, the result was positive with a magnitude of 0.0007, but not statistically significant. This means that municipalities that generate higher emissions do not necessarily make greater relative mitigation efforts and lead decarbonization. One possible extension to this first analysis could involve considering additional variables, such as the degree of economic development, to provide a more comprehensive understanding of the responsibility distribution.

The findings imply that municipalities tend to adopt percentage reduction targets irrespectively of their varying contribution to total national emissions. This suggests a lack of differentiation in responsibilities among municipalities, which contrasts with the principle of common but differentiated responsibilities. In this regard, it is important to emphasize the voluntary nature of subnational climate action and the absence of a national framework indicating how much municipalities should aim to reduce, beyond the existence of national plans and targets that are voluntarily taken as a reference.

5.5. TRANSFORMATIONAL ACTIONS

The analysis conducted to examine the relation between emissions and the planning of level 3 transformational actions revealed a positive and significant correlation coefficient at a 5% significance level, with a magnitude of 0.279. This suggests that municipalities with higher emissions in the stationary energy and transportation sectors tend to have a greater number of more transformational actions planned. These findings imply some alignment with the principle of common but differentiated responsibilities. The correlation coefficients for other action levels (level 1 and level 2) were also positive but not statistically significant.

Figure 10: Percentual distribution and examples, transformational action classifications



The low percentage (3%) of reported actions classified as level 3 suggests that such transformational actions may pose challenges or difficulties for municipalities. However, although level 3 actions have a low frequency, their impact is expected to be high. A second step is to go beyond frequency and focus on understanding the necessity and analyzing the effectiveness through time of different transformational level actions, testing the transformational index used. This has not been done in this study due to the lack of disaggregated data of the mitigation impact of the studied actions.

It should also be noted that more actions were planned at an intermediate transformational level (level 2) than at a minimum level (level 1). This could be linked to the capacity of the municipalities studied to plan actions with a certain transformational ambition. They may be able to do this by having developed a significant degree of climate action capacities, as they belong to a climate network.

5.6. FINAL REMARKS

The relevance of the present research arises within the theoretical framework of multilevel governance, which emphasizes the need for multiple actors of change at different levels of government to achieve the energy transition. Although the ability and capacity of municipalities to act are limited by the distribution of national competences and other factors such as their financial resources, it has been found that all analyzed climate action plans include energy transition actions. Therefore, it is argued that municipalities in Argentina are already participating in this transition.

This study analyzed 685 stationary energy and transport actions from 49 municipal climate action plans in Argentina. A focus on demand-side actions was found, with particular emphasis on energy efficiency measures and a very limited number of demand-electrification initiatives. The imbalance between supply and demand actions can be explained by factors such as the municipality's perception of its role in the energy transition and the prevailing centralized fossil energy generation paradigm. Furthermore, the prevalence of energy efficiency initiatives within demand actions can be attributed to factors such as their cost-effectiveness and the relatively straightforward implementation of such actions within existing structures. Lastly, the limited number of demand-electrification initiatives can be related to the influence of national-level policies favoring gasification over electrification.

Questions arise as to whether municipalities are adequately addressing the necessary actions to achieve national energy transition goals. Although some plans mention their relation to national climate action plans, there is a lack of comprehensive analysis to determine if municipal plans align with the local actions required to meet national targets. In fact, it is observed that municipalities select their actions based on their diagnosis and capacities, in a bottom-up manner (Aguilar et al., 2021). It is important to consider the voluntary nature of subnational climate action and the absence of national guidelines that specifically indicate how much effort municipalities should make according to their capacities or specific situation. This highlights the need for a more precise framework to ensure municipalities are effectively contributing to the broader energy transition objectives (Sperling et al., 2011). During interviews, municipal employees highlighted the evolving role of municipalities in the energy sector and the emergence of departments dedicated to addressing energy-related issues, indicating a changing landscape in energy planning that could be taken advantage of.

In future research, it would be highly relevant to study the correspondence between national and municipal strategies in Argentina, as previous research has done in other countries (Sperling et al., 2019). This could involve investigating how municipalities understand their role in the energy transition and whether the current municipal focus on energy demand actions is adequate to achieving national objectives.

Concerning policy instruments to operationalize actions, public investment instruments emerged as the most frequent, demonstrating the municipalities' capacity for localized investments in the energy transition. However, it is noteworthy that financial restrictions were mentioned as a significant barrier during interviews. In future research, it would be interesting to investigate the low prevalence of command and control and economic instruments, such as whether it is due to issues of political feasibility or policy design capabilities.

A positive and significant correlation has been observed between emissions and reductions in the stationary energy and transport sectors. This is because, under the suggestion of the RAMCC, municipalities use the same references for establishing their total aggregate mitigation goals, which seems to translate into their sectoral mitigation planned reductions. However, the principle of common but differentiated responsibilities does not apply to the distribution of mitigation efforts, as the results were not statistically significant when examining the relation between emissions and the percentage of emissions planned for reduction in these sectors. Future research could incorporate additional variables to further explore the subnational distribution of responsibility, such as economic development level.

Other findings include that climate action plans frequently address energy inclusion and infrequently address energy system resilience. This could be related to the fact that energy inclusion tends to be addressed separately from climate action, as a social problem. It is possible that municipalities have designed this type of action prior to their climate planning process. A possible national framework could also include the promotion of unusual actions, such as energy resilience.

Regarding transformational action, a positive and significant relation has been found between emissions and the frequency of the most transformational actions (level 3). Level 3 actions have a low frequency because they require systemic changes that can be difficult to implement (Westkog et al., 2017). However, it could be argued that, although they have a low frequency, their impact is high. Future studies could test the transformative impact of distinct actions in different municipalities, considering multiple aspects needed to achieve decarbonization. This would provide a more comprehensive understanding of the transformational action needed and its potential to generate long-term change.

This research represents a first approach to municipal energy transition planning in Argentina, and much remains to be studied in order to understand the existing and necessary local efforts, as well as the possibilities for increased coordination.

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