

# Local Energy Transition and Technical Knowledge in the Southern Cone: A Sociological Approach\*

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**ABSTRACT** | Social research on the transition to renewable energies has focused on understanding public policies and social movements. Energy knowledge plays an important practical, normative, and social role that influences actors’ approaches to this transition, which has been scarcely studied at local or community levels, let alone in the Global South. A comparative methodology is used to study cases of communes in Argentina and Chile. The results are presented using a variety of data sources to explore the frameworks of the energy matrix and energy projects, revealing the role of technical knowledge in building local agency. This article presents a theoretical discussion and conclusions that include proposals for the future development of a more local, inclusive, committed and deliberative transition process, based on local technical expertise in renewable energies.

**KEYWORDS** | Acceptability of renewable energies; local energy transition; renewable energies; socio-technical knowledge; South America

## Conocimiento técnico y transición energética en el Cono Sur: un enfoque sociológico

**RESUMEN** | La investigación social sobre la transición hacia las energías renovables se ha enfocado en conocer las políticas públicas y los movimientos sociales relacionados. El conocimiento energético tiene un importante papel práctico, normativo y social que influye en la manera en que los actores asumen esta transición, lo que ha sido escasamente estudiado a nivel de localidades o comunas, y aún menos en el Sur Global. A través de una metodología comparativa, se estudian casos de comunas en Argentina y Chile. La presentación de los resultados utiliza una variedad de fuentes de datos para explorar los enmarques de la matriz energética y de los proyectos energéticos, y así revela el papel del conocimiento técnico en la construcción de la agencia local. Este artículo presenta una discusión teórica y conclusiones que incluyen propuestas para el desarrollo futuro de un proceso de transición más local, inclusivo, comprometido y deliberativo, que se basa en la experiencia técnica local en energías renovables.

**PALABRAS CLAVE** | Aceptabilidad de energías renovables; América del Sur; conocimiento socio-técnico; energías renovables; transición local de energía

## Conhecimento técnico e transição energética no Cone Sul: uma abordagem sociológica

**RESUMO** | A pesquisa social sobre a transição para as energias renováveis concentrou-se em conhecer políticas públicas e movimentos sociais relacionados. O conhecimento energético tem um importante papel prático, normativo e social que influencia a maneira pela qual os atores assumem essa transição, que pouco foi estudada no nível das localidades ou comunas e menos no Sul Global. Seguindo uma metodologia comparativa, são estudados

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casos de comunas na Argentina e no Chile. A apresentação dos resultados usando uma variedade de fontes de dados para explorar os limites da matriz energética e dos projetos energéticos revela o papel do conhecimento técnico na construção da agência local. Este artigo apresenta uma discussão teórica e conclusões que incluem propostas para o desenvolvimento futuro de um processo de transição mais local, inclusivo, comprometido e deliberativo, baseado na experiência técnica local em energia renovável.

**PALAVRAS-CHAVE** | Aceitabilidade de energia renovável; América do Sul; conhecimento sociotécnico; energia renovável; transição energética local

## Introduction

Transition to renewable energies (RE) and clean technologies occupies a central position in the efforts to address the threat of climate change (Stolten and Scherer 2013; Petit 2017; IEA 2017). Argentina and Chile, in the southern cone of America, are increasingly active in terms of changes involving the energy systems with the two countries coming 9<sup>th</sup> and 11<sup>th</sup> in the world respectively, on the Renewable Energy Country Attractiveness Index of April 2019 (EY Power & Utilities 2019).

Energy transitions (ET) are complex, multidimensional, and long-term processes, although in sociohistorical terms they take place in localities and can occur much more quickly than commonly believed (Sovacool 2016). However, Local Energy Transitions (LET) –a subject very close to energy communities– in developing countries have not enjoyed much attention from academia (Devine-Wright 2005; Turcu, Rydin, and Pilkey 2014; Smith *et al.* 2016; Ahlborg 2017).

The main goal of this paper is to deliver the results of a comparative sociological research in the Southern Cone of the Americas (Argentina and Chile). The main questions are: what is the role of technical knowledge in LET in the Global South? And how does it contribute to encouraging the participation of local actors? Based on empirical research on the framing of acceptance of RE conducted in three communes in Chile and a province in Argentina, this paper delivers the main results and plausible interpretations. Finally, we advance some analytical discussion around the key issue of energy transitions **from below** and from southern countries, highlighting the role of technical knowledge in those processes, a perspective scarcely developed in the social science literature on energy in South America.

## Energy Transition in the Global South

### Local Energy Transition in the Southern Cone of the Americas

Local level energy transitions in southern countries involve a challenging mobilization of local populations. Local communities that support energy changes will

increase the likelihood of energy transition towards renewables being successful. Indeed local transitions renders relevant the localism/centralism debate. Subjects discussed in developed countries like the United Kingdom concerning self-reliant communities facing the interventionist state (Catney *et al.* 2014), in South America are discussed in terms of the participation and initiative of local citizens having to tackle centralism and renewable extractivism (Baigorrotegui and Parker 2018). It is also a known fact that REs can be introduced in a centralized or decentralized manner, but in Argentina and Chile the number of projects designed, installed and managed by local actors is very limited.

The main characteristic of the current energy transition in the southern cone is that investments and technology transfer come from large transnational companies or from the central State, sometimes by the initiative of small and medium enterprises and therefore, they usually constitute an exogenous intervention in the locality. This sheds light on the reasons for which many local processes are linked to protests against large megaprojects including renewable projects, as shown in the map of environmental conflicts in Argentina (62) and in Chile (53) (Temper, del Bene, and Martinez-Alier 2015).

Thus, from a bottom-up perspective, the critical acceptability of REs sheds light on the role of the local actors in LET processes in these countries. Acceptability has been studied mainly in terms of wind technologies in North America and Europe (Cowell, Bristow, and Munday 2011; Toke 2011; Rand and Hoen 2017) and focuses on specific energy technologies and sources, either for particular localities or for the general population. Here, we will focus on the acceptability dimension for different renewable technologies in the energy matrix and analyze local capabilities to assess local actors' agency in mid- and long-term energy transitions.

In the context of the above arguments, our hypothesis is that the highest incidence of local actors' agency is introduced by technical knowledge. Energy knowledge has an impact on both the acceptability of renewable energy and the mobilization of the agency. Beyond the organizational capabilities of the geographic and demographic conditions, and of the socio-political and institutional frameworks, beyond the conditioning factors of landscapes and regimes (socio-ecological, technological,

or energy regimes) (Smith, Voß, and Grin 2010), local agents' technical knowledge appears as the trigger for active support of local level non-conventional renewable energy (NCRE).

### About the Technical Knowledge Concept and Local Energy Transition

Following our hypothesis, technical knowledge would be a key factor that would make it possible to overcome the gap between acceptability and the possibility of implementing projects at local level.

We understand technical knowledge as specialized knowledge in matters that are linked to the implementation of technological devices that employ or adopt clean, mainly renewable, energy. It is not a question of high-level technical knowledge (Ciapuscio 1996), or of competencies of the energy industry, or expert engineering knowledge, or management knowledge of renewable energy systems. That is, what we are referring to here is the knowledge about technologies that are associated with renewable energies within the framework of energy transition, which for operational purposes, we associate with the following indicators: an understanding of the basics about a) renewable energy; b) the country's energy matrix; and c) polluting energy sources, clean energy, energy efficiency, photovoltaic sources, solar energy and wind energy. A lack of basic knowledge of such concepts, is a limited or complete absence of energy transition-related knowledge.

When we refer here to *technical knowledge*, we are concerned with a concept with social and political connotations, going beyond a merely technocratic point of view. We are not using, however, the socio-technical paradigm (Ropohl 1999; Ulli-Beer 2013) to talk about knowledge because its systemic orientation tends to ignore the social conflicts in which local actors are submerged.

### Local Energy Transition in the South: Global Process and Local Actors

In general terms, energy transition can be better understood as a global issue, often on a large scale and over a long time span (Petit 2017; Froestad and Shearing 2017). But LET that are taking place are also subjected to specific and small-scale dynamics (Berkhout, Marcotullio, and Hanaoka 2012). LET can only be understood within particular and multidimensional changes in the field. As acknowledged by a number of experts, there are different ways to decarbonize energy systems. Views are influenced by the current stage of development, by different regional perspectives, and "by the part of the energy sector being discussed" (REN21 2017, 10). In any case, we understand LET as the complex social

and technical processes of introducing clean energy systems (whatever the scale) and the replacement of contaminating sources in a given and defined territory (communes in this research).

The accepted theory of ET, which has connections with technological transition theory, has been produced from the experience of highly developed OCDE countries from the northern hemisphere. Much of this transition literature "is explicitly technology oriented" (Fuchs and Hinderer 2016). The analysis focuses mostly on institutional elements linked to technological innovation systems. For countries in early stages of the transition –mostly developing countries in the Global South— elements of local and original innovations are scarce, while investments and technological dependence on developed transnational centers are the norm.

Nevertheless, progress in energy technologies and advances in renewables reaching grid parity is changing the role of consumers, making them both the producers and consumers of the energy they use; in other words, prosumers (Schleicher-Tappeser 2012). At the same time, politics and the private sector have discovered the consumer as a market player –either as co-producer, as self-consumer, or as investor— whose acceptance of RE installations and new technologies like smart meters is crucial.

Meanwhile local initiatives such as the energy communities, the experience of local prosumers, and (co-)ownership of RE systems that have gained importance in European countries, are still scarcely implemented across South America. Therefore, a main trait of local ET in the southern cone countries is that they do not challenge the traditional control logic of traditional power supply. With local innovations and initiatives being scarce, and governmental policies offering normative and institutional support but not solid finance and investment, foreign capital continues to play a critical role in South America in the emerging markets for clean energy (FGV Energía 2016). A relevant part of these solutions contains models that are not decentralized. They are not small scale, and do not involve local communities. This means that local actors' agency will be the result of the way in which renewables are framed and ultimately energy technology negotiated (Smith 2005) in the context of local territories.

We are interested in elucidating how local actors code and decode RE and what factors affect the performativity of their speeches. By the term *local actor* we refer to socio-ecological agencies (Navarrete, Christine, and Buzinde 2010) that operate in a bounded territory (administrative communes or districts cases studied in Chile and Argentina). It includes a large category of actors from the local government sector, local businesses and enterprises, to a wide range of organizations of the local civil society, whether they are or not directly linked with the energy sector.



In this study, we identified and surveyed different local actors (Baigorrotegui and Parker 2018) such as front line local leaders, social leaders of different areas (commerce, transport, services) and neighborhoods. The interviewed actors were local leaders with some decision power in the field. A central strategy of our study was to analyze the discourses of the local actors in an attempt to uncover the main semantic nuclei of their renewable interpretative framing.

We borrow the framing concept from the theory of social movements (Benford and Snow 2000), since they tell us how collective action is socially constructed in a referential context where the emphasis is placed in situations, and the socio-historical dynamism is large. We call these collective action frames *interpretive frames*, as they define diagnoses and strategies, and channel the individual or collective courses of action. Other types of action frames—to which the structuralist or systemic literature refers but places in different conceptual frameworks—are linked to regimes, lock-ins, or landscapes (Smith, Voß, and Grin 2010). All these frames can open or close opportunities to undertake collective action, which activates abilities of their agency (Giddens 1984).

We define the LET as the set of social interaction processes by means of which multiple socio-ecological actors grounded in a local territory, as well as from the upper levels (regional, national, multinational), code and decode the existing action frames concerning the energy settings, assuming agency to provoke an integral social change (socio-technical-ecological) that might transform energy systems, referential action frames, power relations, and community lifestyles.

## Our Analysis

Our analysis is based mainly on the responses of local actors given in surveys or interviews, or through the documents they produce. In the case of the survey, we carried out a qualitative secondary analysis of the quantitative primary data in order to reproduce the rationale of the interpretive frames of the actors in terms of their approach to ET, whether it be explicit or implicit. Many discursive segments analyzed have been considered and they guide the interpretations that follow but are not referenced in detail for reasons of space.

Research on environmental movements has suggested that cultural beliefs or value orientations are a vital part of how people think about their relationship with the natural environment and their environmental concern (Deng, Walker, and Swinnerton 2006; Leiserowitz, Kates, and Parris 2006), their relationship with energy and energy systems (Poortinga, Steg, and Vlek 2004) and with technological changes (Smith 2005).

Our analysis seeks to shed light on the subjacent cultural model in the local actors' discourse. The central point is to understand that we are dealing with a vision embedded in a precise time-space cultural model (Bajoit 2015). It is a *social construction* (Berger and Luckmann 1966) of the problem that inspires the change and a specific *social construction* of the solution to that problem, which in fact, unchains the purpose and orientation of that very change.

## Research and Methodology

Small- and large-scale renewables projects are being implemented in the studied localities: short term visible solutions such as house heating systems and top roof photovoltaic (PV) panels; and large-scale ones such as hydroelectric, solar plants, and wind farms. The local actors under study inhabit very diverse communes, in three different parts of Chile and in one Argentine province.

The communes studied were chosen because they have recently been subjected to systematic, above average introduction of renewable energies. Three communes chosen in Chile were compared to cases in the province of Mendoza (latitude 32°53'S, longitude 68°49'W) (subsamples in the districts of Godoy Cruz, Lavalle, San Martín, and General Alvear). The communes of Coyhaique (latitude 45°31'S, longitude 71°33'W) and San José de Maipo (latitude 33°39'S, longitude 70°20'W) are two cases in which hydroelectric megaprojects have been strongly resisted by the local community. Coyhaique marked by dendroenergy is the most polluted commune of Chile because of bad use of firewood. In contrast, Copiapó, (latitude 27°30'S, longitude 70°20'W), and Mendoza, Argentina, are experiencing an energy transition to solar energy systems.

Argentina and Chile were chosen because among South American countries, they rate very highly in terms of development and RE potential. Indeed, they are both leaders in final energy consumption per capita in South America (UN DESA 2015). Both have climate change and energy policies. Mendoza is home to one of the largest wind turbine manufacturers in South America, which also makes turbines for the country's Nuclear Reactors. Chile—considered the “Solar Saudi Arabia” by the Washington Post—is one of the first markets to enable economically viable renewable projects (Miroff 2017).

The main methodology was a comparative one involving multiple case studies (Yin 2003), which involved quantitative and qualitative techniques (Del Canto and Silva 2013) in the framework of a comprehensive and constructivist approach (Berger and Luckmann 1966), and it employed different techniques for each selected case: a) semi-structured interviews of local elites, leaders from governmental and private spheres, including some influential local civil society members; b) a survey

answered by local intermediate level grassroots leaders; c) non-participant observation in the field; d) available official government and business reports and documents about the energy sector of each locality, and e) analysis reports and media reports about each case under study. For both interviews and surveys, we used theoretical quota sampling (Marshall 1996). Heterogeneity and logistics of the field work induced a mixture of convenient and snowball sampling. Our analysis must be mostly considered in qualitative terms, as the results are derived from non-probability sampling (Baker *et al.* 2013).

We conducted our field work in the different localities of Chile and Argentina during 2016 and at the beginning of 2017. In Chile, the field work was supported by Universidad de Santiago de Chile, and in Argentina by Universidad Nacional de Cuyo (Mendoza). The interviewing followed the standard qualitative norms and ethical protocols (Noreña *et al.* 2012). The individuals on the ground involved were citizens not stakeholders of energy enterprises, nor did they share a long-term project. A total of 69 people were interviewed: 16 from the commune of San José de Maipo, 19 from Coyhaique, 17 from Copiapó and 17 from Mendoza. We surveyed a total of 1029 people in all these localities (see Table 1).

**Table 1.** Surveyed Local Leaders and Citizens

Samples and subsamples	Absolute frequency	Relative frequency
Total sample Mendoza (MAR)	295	100,0
Subsamples:		
Lavalle	79	26,8
San Martín	63	21,4
Mendoza GC	72	24,4
Gral. Alvear	81	27,5
Total added sample Chile (MCL)	734	100,0
Copiapó sample	218	29,7
Coyhaique sample	252	34,3
San José de Maipo sample	264	36,0

Source: Our team based on FONDECYT N°1150607 Project database.

Triangulation in our study assured validity, intersubjectivity, consistency, and reliance (Noreña *et al.* 2012) complementing systematic comparisons of various types of evidence obtained from the results of the instruments and the local field work with comparisons of available information, including previous research.

## Results

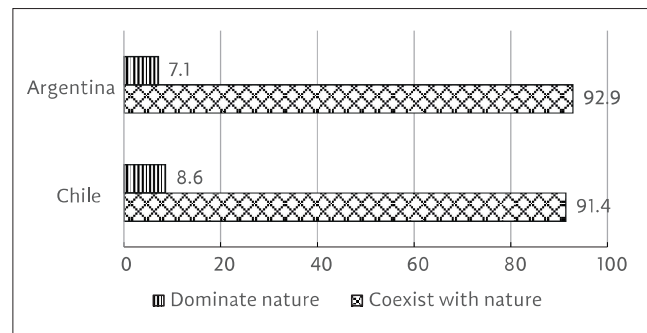
### The Social Construction of the Energy Problem

The vision of the local actors on climate change (CC) and on the energy situation in each commune allowed us to reconstruct the main elements of the interpretive frame about “the problem”.

Climate change is considered a global and planetary fact, its impacts are manifested and experienced at local level and in different ways. Communes such as Copiapó and the province of Mendoza are affected by water scarcity and increasing desertification, while communes like San José del Maipo and Coyhaique are affected by melting glaciers and the loss of biodiversity.

Although both Argentina and Chile signed the international consensus on the Paris Agreement, there seems to be no universally clear awareness that a decisive step towards the implementation of ET must be taken. In this context, local actors were asked about energy and the need to advance to RE. The point of departure of all social representations of environment and energy are the cosmovision of nature (Leff 2000), and this topic was explored based on a general question, used extensively in the World Value Survey (WVS 2014), on the appropriate relationship between man and nature. A substantial majority of responses from both Argentina and Chile affirm that humankind must coexist with nature rather than attempt to “dominate it” (see Figure 1). The trend is clear in both countries, reaffirming a post-enlightened vision that rejects the utilitarian idea that humanity must exploit nature as it wishes without considering natural rhythms and ecological processes.

**Figure 1.** Must Human Beings Dominate or Coexist with Nature?



N: AR=295, CL=734

Source: FONDECYT N°1150607 Project database.

Consistently, a very large majority of those surveyed answered that the energy problem in the country is *serious* (41% in Chile, 37% in Argentina) or *very serious* (51% in both countries) (see Table 2).

**Table 2.** Concern for Climate Change and Energy Issues

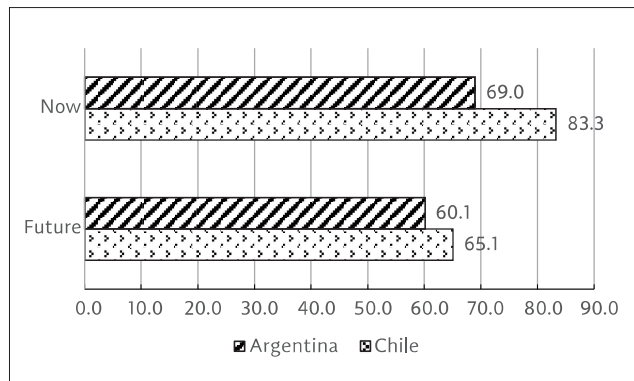
	Concern for:	
	1 is no concern and 10 is much concern	
	Energy problem	Climate change
Sample Chile (CL)	7.67	8.09
Sample Argentina (AR)	7.79	8.05

Source: Our team based on FONDECYT N°1150607 Project database.

The analysis shows that it is educational level that influences the social construction of this problem and not gender, income, occupation, or political orientation as commonly thought. The higher the educational level, the clearer the tendency to perceive a greater impact of climate change at all levels. Elementary schools in the case of Argentina have greater incidence than other variables.

Another question referred to personal perceptions of the country’s levels of environmental pollution. In an idea connected with the generalized perception of the impact of CC, there is a broad perception of the country’s environmental contamination, as seen in Figure 2.

**Figure 2.** Pollution in the Country (Percentage): Responses to Perception of the Country’s Environment Pollution in the Present and Expectation of Pollution in the Future



N: AR=295, CL=734

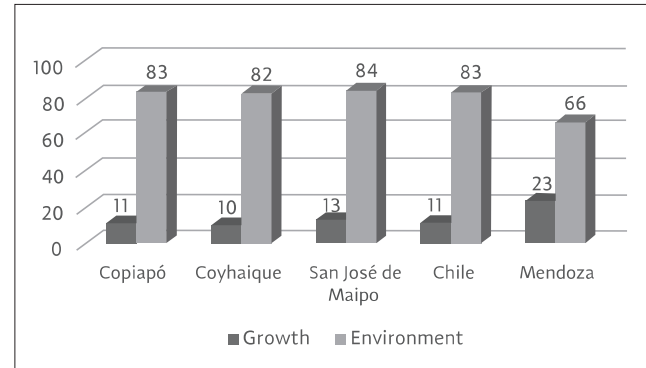
Source: FONDECYT N°1150607 Project database.

The data in Figure 2 reveals that for those surveyed in Chile, the pollution problem is perceived more acutely; however, there is some optimism in both countries because of a perception that in the future there will be less pollution than today, as the percentages go down a little. In any case, for more than two thirds of the local leaders, environmental pollution is quite a serious problem.

**The Social Construction of the Solution**

The critical vision of the environment generates an alternative perspective in local leaders. The following question was asked: Which of the following alternatives would you prefer to be implemented for a sustainable development: greater economic growth, improving the environment, another alternative? The answers, disaggregated by communes, clearly reveal that the environmental option is preferred (see Figure 3):

**Figure 3.** Alternatives for Sustainable Development (Percentage)



N: AR=295, CL=734

Source: FONDECYT N°1150607 Project database.

As shown in Figure 3, there are practically no differences between the Chilean communes whose average percentage is slightly greater than that of Mendoza (83% vs. 66%) with respect to the preference for the environment over economic growth. The pro-environmental conception of the respondents is evident.

These orientations must be understood in the context of a Latin American public opinion whose environmental consensus towards climate change can be considered a response to their experience of a depredation of ecosystems. Latinobarómetro 2017 public opinion survey reveals that national surveys in Argentina and Chile agree in classifying the fight against global warming as a priority. Of those surveyed, 78% in Chile and 71% in Argentina state that “priority must be given to the fight against climate change, regardless of its negative consequences on economic growth” (Latinobarómetro 2017; see also DESUC 2018).

The ideas about ET and its acceptability are a good example of what we have called the *interpretative framing* of the local actors. A battery of questions was drafted around the ET, and the results are shown in Table 3.

**Table 3.** Visions of ET in Communes of Both Countries (Percentages)

	Argentina (AR, N=295)		Chile (CL, N=734)			
	Clearly affirmative	Affirmative	Total	Clearly affirmative	Affirmative	Total
1	44.5	49.3	100	52.3	43.8	100
2	73.9	24.7	100	76.0	21.6	100
3	20.5	56.0	100	37.8	52.0	100
4	52.4	37.2	100	59.6	29.5	100
5	28.2	44.3	100	32.7	29.5	100
6	30.2	50.2	100	26.1	43.4	100
7	2.7	3.4	100	8.3	8.0	100
<b>Questions:</b>						
1	A clear reduction of fossil fuel burning is required.					
2	Greater sustainable consumption requires the introduction of RE.					
3	It is necessary to introduce clean energy in companies and institutions.					
4	It is imperative to reduce the carbon footprint in companies and institutions.					
5	I have considered reducing my own carbon footprint.					
6	Willingness to pay more taxes to subsidize RE.					
7	Use of solar technology for electricity or heating.*					
* The choices were “always” and “almost always”.						

**Note.** Only affirmative responses are considered here. Percentages will not add up to one hundred.

Source: FONDECYT N°1150607 Project database.

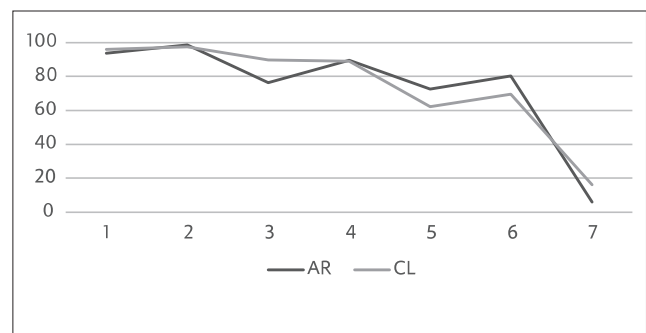
The first four questions refer to the vision of ET in general, while the last three refer to the personal commitment of the people surveyed to ET, either because they have considered reducing their own carbon footprint, because they are willing to assume the cost, even if it means paying more taxes, or because in fact they are already using solar technology by means of solar panels in their homes. It should be stressed that one of the dimensions on which the analysts of ET agree is that the wider adoption of rooftop PV panels will contribute decisively to changing the whole power system (Petit 2017).

A more detailed analysis of the aggregate results reveals that the tendencies are very similar in the different surveyed communes, with no significant statistical differences. Similarly, the aggregate trends in the two countries are very similar (see Figure 4), with slight differences:

There seems to be a generalized consensus (in all the communes and in both countries) on the need to reduce fossil fuel burning and on the introduction of RE.

In Chile, there is a slightly greater inclination to support the introduction of clean energy in companies and institutions. In Argentina, on the other hand, there

is a slight option for a greater personal inclination to decreasing the personal carbon footprint and pay taxes to subsidize the introduction of RE. This last question generated a fictitious case, because in both countries the laws subsidize RE and there are no additional taxes affecting it. Finally, in Chile, where energy transition is more developed, there are more cases of surveyed persons (16.3% vs. 6.1%) who use solar energy for heating or for supplying electric power to their homes in a permanent or habitual manner.

**Figure 4.** Visions on ET: Similar Trends in Argentina and Chile

N: AR=295, CL=734

Source: FONDECYT N°1150607 Project database.



Now, what do we mean when we talk about RE? Those surveyed show a clear preference for NCRE, and especially those coming from solar and wind sources. The question was: Which energy sources do you prefer in promoting energy efficiency and diversification?

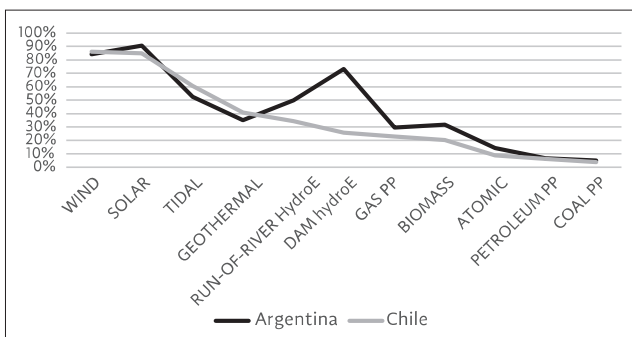
**Table 4.** Preference for Alternative Energies (Relative Frequency)

	Copiapó	Coyhaique	San José de Maipo	Mendoza
Wind	84.5%	89.9%	84.1%	84.1%
Solar	86.8%	87.4%	79.9%	90.5%
Tidal	61.2%	55.0%	65.3%	52.6%
Geothermal	36.9%	42.8%	42.8%	35.0%
Run-of-River HydroE	32.1%	40.1%	30.8%	49.8%
Dam HydroE	37.2%	16.5%	23.5%	73.2%
Gas PP.	16.7%	21.3%	30.7%	29.5%
Biomass	16.1%	24.0%	20.3%	31.5%
Atomic	10.8%	5.4%	10.7%	14.3%
Petroleum PP.	6.6%	2.9%	8.3%	6.7%
Coal PP.	4.5%	2.9%	3.7%	5.1%
N=	218	252	264	295

Source: FONDECYT N°1150607 Project database.

The table shows that the energy sources derived from fossil fuels (coal or oil thermoelectric plants) are the least preferred. The preference of Gas PP is above other sources of fossil fuels (oil and coal). The combined cycles fed by gas are preferred in a similar way to biomass. Conventional renewable sources like hydroelectric dams occupy an intermediate place together with NCRE Run-of-River Hydro and geothermal. The most preferred NCRE are tidal sources, but solar and wind energy clearly take the lead. Figure 5 shows that the trends in the Argentine and Chilean samples are quite similar.

**Figure 5.** Preferences for Alternative Energy Sources



N: Ar=295, CL=734

Source: FONDECYT N°1150607 Project database.

The differences regarding preferences for hydroelectric sources in Mendoza are clearly due to the type of energy regime in place in the province. In contrast, although Argentina has thermonuclear power plants and has plans to continue investing in them, supported by Russia and China (“La energía nuclear” 2017), it is significant to note that this is not reflected in the preferences of Argentinians. Indeed, in this respect, it is important to mention the population’s rejection of the new nuclear plant project in Rio Negro (Kidd 2017), in view of the Fukushima accident and ecological awareness.

### The Relevance of Technical Knowledge in the Construction of the Solution

Local leaders are aware of climate and energy challenges and their discourse is aimed at finding solutions. The interviewees make it very clear that all of them know about RE and many of them –the majority– are in favor of its introduction. This consensus in advancing a less carbonized economy, however, must be analyzed in greater details.

The inquiry here is about the factors that affect the favorable support of RE. The survey data was subjected to a multinomial logistic regression (see Table 5) especially suited for non-representative samples specific for case studies. The analysis focused on those variables that indicate practices and commitment to renewables. We used multinomial regression procedure of the SPSS packet, but for reasons of space, only the most significant results are presented.

The variables subjected to the nominal regression non-parametric test were the questions related to:

- Introducing RE as a measure to promote sustainable energy consumption.
- One’s own willingness to decrease the carbon footprint.
- The willingness to pay more taxes to subsidize RE.
- Personal use of solar technology (electricity or thermal).

The results are the following:



**Table 5.** Multinomial Logistic Regression Models (Only Likelihood Ratio Tests Shown)

Introducing renewable energies								
Likelihood ratio contrast	Chile				Argentina			
Effect	-2 log reduced likelihood	$\chi^2$	df	Sig.	-2 log reduced likelihood	$\chi^2$	df	Sig.
Intersection	451.80	0.00	0	.	223.05	0.00	0	.
Sex	455.58	3.78	2	0.15	226.79	3.74	2	0.15
Age	454.28	2.48	4	0.65	224.84	1.79	4	0.77
Occupation	465.61	13.80	12	0.31	236.50	13.45	14	0.49
Participates in social orgs.	456.81	5.01	2	0.08	224.57	1.53	2	0.47
Political orientation	455.61	3.81	4	0.43	229.74	6.69	4	0.15
Education	457.51	5.71	4	0.22	229.86	6.82	4	0.15
Energy matrix knowledge	466.60	14.79	4	0.01	232.31	9.27	4	0.05
NCRE knowledge	453.95	2.15	2	0.34	230.37	7.33	2	0.03
Final fit	451.80	66.64	34	0.00	223.05	57.107	36	0.01
Decrease own carbon footprint								
Likelihood ratio contrast	Chile				Argentina			
Effect	-2 log reduced likelihood	$\chi^2$	df	Sig.	-2 log reduced likelihood	$\chi^2$	df	Sig.
Intersection	920.48	0.00	0	.	515.64	0.00	0	.
Sex	921.63	1.15	3	0.76	517.20	1.56	3	0.67
Age	930.01	9.53	6	0.15	518.49	2.85	6	0.83
Occupation	947.24	26.76	18	0.08	544.71	29.07	21	0.11
Participates in social orgs.	922.87	2.39	3	0.50	517.23	1.59	3	0.66
Political orientation	930.96	10.48	6	0.11	522.89	7.25	6	0.30
Education	926.50	6.02	6	0.42	520.00	4.35	6	0.63
Energy matrix knowledge	948.11	27.63	6	0.00	525.20	9.55	6	0.14
NCRE knowledge	949.23	28.75	3	0.00	544.80	29.16	3	0.00
Final fit	920.48	146.99	51	0.00	515.64	96.4039	54	0.00
Pay more taxes for renewable energy								
Likelihood ratio contrast	Chile				Argentina			
Effect	-2 log reduced likelihood	$\chi^2$	df	Sig.	-2 log reduced likelihood	$\chi^2$	df	Sig.
Intersection	973.77	0.00	0	.	491.65	0.00	0	.
Sex	975.07	1.30	3	0.73	500.40	8.75	3	0.03
Age	984.07	10.29	6	0.11	497.94	6.30	6	0.39
Occupation	1001.79	28.02	18	0.06	511.26	19.61	21	0.55
Participates in social orgs.	973.99	0.22	3	0.98	493.61	1.97	3	0.58
Political orientation	984.16	10.38	6	0.11	496.72	5.08	6	0.53
Education	980.96	7.19	6	0.30	499.85	8.21	6	0.22
Energy matrix knowledge	994.81	21.04	6	0.00	492.84	1.19	6	0.98
NCRE knowledge	989.95	16.18	3	0.00	509.72	18.08	3	0.00
Final fit	973.77	108.49	51	0.00	491.65	67.6046	54	0.10

Home use of solar energy*								
Likelihood ratio contrast	Chile				Argentina			
	-2 log reduced likelihood	$\chi^2$	df	Sig.	-2 log reduced likelihood	$\chi^2$	df	Sig.
Intersection	1072.24	0.00	0	.	536.25	0.00	0	.
Sex	1074.51	2.26	4	0.69	548.92	12.67	4	0.01
Age	1080.81	8.57	8	0.38	600.73	64.48	8	0.00
Occupation	1095.91	23.67	24	0.48	2581.33	2045.08	28	0.00
Participates in social orgs.	1073.42	1.17	4	0.88	524.97	.	4	.
Political orientation	1077.90	5.65	8	0.69	546.11	9.86	8	0.28
Education	1080.16	7.92	8	0.44	389.47	.	8	.
Energy matrix knowledge	1074.72	2.47	8	0.96	520.40	.	8	.
NCRE knowledge	1086.72	14.48	4	0.01	706.81	170.56	4	0.00
Final fit	1072.24	77.34	68	0.21	536.25	.	72	.

\* AR case without estimation of max. likelihood because of a low N.

Source: FONDECYT N°1150607 Project database.

The regression models show that the social and demographic variables such as sex, age, occupation, participation in social organizations, and even the educational level, as nonparametric variables, have no incidence on the configuration of a favorable performative posture towards the RE, and nor does the political orientation of those surveyed. In the Argentinian case, sex, age and occupation have an incidental effect only for home use of solar energy but the data is doubtful because of a low N.

However, knowledge of the energy matrix and detailed knowledge about various kinds of NCRE, key elements of what we consider *technical knowledge* in this paper, appear as incidental variables associated with those pro-ET postures. We asked participants whether they had in-depth knowledge of what solar, wind, geothermal, and biomass energies dealt with. Finally, we asked them whether they were aware of the energy matrix and whether they knew what it meant.

In short, as shown in Table 6, there are associations between variables that indicate acceptability of the ET towards RE, and variables related to technical knowledge.

This set of factors is multivariate, so we are not postulating simple causality, but the associations reflect that greater technical knowledge leads to greater acceptability of and commitment to ET and RE. Differences such as the use or not of solar technologies must be noted, as these seem to be more directly related to greater

**Table 6.** Factors Associated with RE Acceptability

	Chile		Argentina	
	Energy Matrix Knowledge	NCRE Knowledge	Energy Matrix Knowledge	NCRE Knowledge
Introducing RE	As	No	As	As
Decrease own carbon footprints	As	As	No	As
Pay more taxes for NCRE	As	As	No	As
Home use of solar energy	No	As	InD	As

NB: As=Associated; No=No Associated; InD=Insufficient data.

Source: FONDECYT N°1150607 Project database.

knowledge of renewable technologies. Knowledge of the energy matrix seems to be a factor that has a greater effect in the Chilean cases than it does in Mendoza, possibly due to Chile’s more advanced status in ET. Finally, proper knowledge of what the NCRE and technologies are seems to have a greater effect than any other variable on ET acceptability in all the cases studied.

Quantitative data can be complemented here with the analyzed discourse (see Table 7).

**Table 7.** Vision of Technical Knowledge among Those Interviewed

		Copiapó	Coyhaique	San José de Maipo	Mendoza
Vision of technical knowledge	Relevance of knowledge in the transition towards RE.	All the actors see the task of knowledge as a middle-term one, linked with socio-environmental education. The term illiteracy in energy topics is mentioned. It is a cultural issue that must be dealt with when thinking about new generations.	The knowledge is found in specialized persons, there is no knowledge at a general level. It belongs to specialized persons linked with both energy and tourist enterprises.	It is essential for the conservation of the Cajón del Maipo, and this implies the creation of a culture of commitment to the environment that must first be generated in schools, creating awareness in those who live in and visit the place.	It is relevant to develop NCRE projects in the region to increase energy offer for the local housing and industrial demand. This requires knowledge that must be developed by specialists at universities.
	Relevance of knowledge.	Very important. Notwithstanding, it is only mentioned in formal education with pupils.	The actors point out that there are different kinds and levels of knowledge. For example, educating in energy efficiency at the home, which is a fundamental issue (thermal insulation of houses), but also in the generation of residential energy. A potential is seen in the use of water courses for small power plants and in wind energy.	It is vital to generate knowledge. All the actors point out that there is much ignorance with respect to the NCRE and their scope, as well as on their efficiency and costs. They believe that this must start with children in school.	Generating knowledge is vital for all the interviewees. It must start at school, without leaving aside the development of technical and professional studies on this matter.
	Critical vision of technocracy.	They identify technocracy with bureaucracy. Consequently there is a negative vision in that respect. Obstacles by central agencies for solving legal matters of the projects are mentioned.	A technocratic vision is seen in State agencies. Negative characteristics are attributed to them linked with the State's bureaucracy.	Technocracy is identified with the State and the engineers of large companies. It is seen negatively, and in order to deal with it, people have to generate their own knowledge.	There is a predominant vision that technocracy delays the development of a clean energy matrix. It is identified with State agencies.
	Democratization of energy knowledge.	It is necessary and basic for the development of the awareness of NCRE, and it is associated with formal education.	It is seen as urgent. It must begin in the formal education system, since that implies a mid-range effort. All the actors see that there is much ignorance and incorrect knowledge with respect to the NCRE.	Generating and transferring knowledge is vital for carrying out NCRE projects. The State must support these initiatives in the Maipo basin so to preserve it.	The development of knowledge is key for the installation of NCRE. Without that knowledge it is impossible to think of a good reception for those energies, so we must start with schools. There is energy illiteracy that must be reduced.

Source: Interviews FONDECYT N°1150607 Project database, project 2015–2016.

In general, the discourse values knowledge as a main factor that affects the vision of environmental and energy issues. However, different emphases are noted, because in Copiapó and San José de Maipo they talk about an “environmental culture” that should include energy issues, but the technical expertise and the knowledge divide involved in decarbonization is not recognized. In contrast, in Coyhaique and Mendoza they give relevance to the knowledge produced and reproduced by specialists.

In all cases, the importance of environmental education at school is highlighted, but in Coyhaique and Mendoza the levels and specializations of technical knowledge are mentioned. In San José de Maipo technical knowledge is noted by its absence in the population. In general, technocracy is identified with the technopolitical elites (state bureaucracy) and they are regarded negatively.

The survey allowed us to clarify where technical knowledge comes from and which vectors increase it. Most of the interviews and the field observations in the various localities, both in Chile and Mendoza, deliver background information that sheds light on at least three instances by means of which the local actors acquire greater technical knowledge on RE and can improve their negotiating capability:

- a. Environmental education, and in particular by means of training courses dealing explicitly with climate change and the energy issue. Environmental education about conservation matters, recycling or sustainable consumption is not enough, because it does not deliver specific information on the NCRE and does not refer to their management, and implementation.
- b. Specific training promoted by the authorities or by ecological NGOs on the energy issue, and in particular on NCRE.
- c. Demonstration effects generated by local projects and enterprises that introduce solar panels, solar water heating plants or wind power plants promoted by public policies, local or foreign companies, or NGOs concerned with the energy problem, provided those pilot experiments have been conducted with the active participation of the local citizens.

It was mentioned in several interviews, and processes experienced in communes such as Coyhaique and San José de Maipo, reveal that a greater technical knowledge may be associated with the resistance movements against megaprojects. But it is not proven that movements such as *Patagonia sin Represas* (Patagonia without Dams) against dams like the Hidroaysén project in Coyhaique or the movement against the Alto Maipo hydroelectric project in San José de Maipo (Parker 2017), have had some impact on technical energy

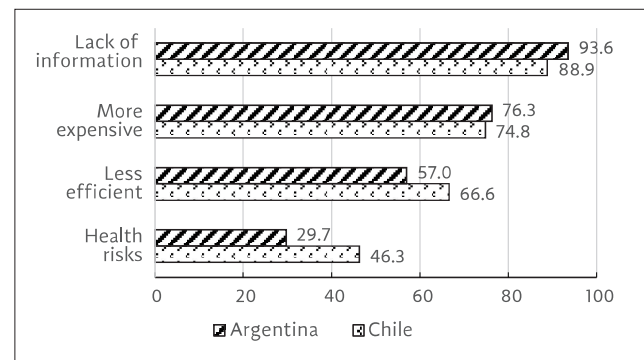
knowledge. Generally, these resistance movements are motivated by multiple issues, defense of the ecosystem, scenery, water rights, protest against the companies’ monopolies, impact on tourism and other businesses, opposition to energy policies, and not by the existence of alternative RE sources (Schaeffer and Smits 2015; Hernando and Blanco 2016; Agostini, Silva, and Nasirov 2017; Watkins *et al.* 2017; Baigorrotegui 2019).

Environmental movements that resist energy megaprojects and give rise to environmental awareness, do not necessarily contribute with the information and technical knowledge needed to promote and accept RE (Mendoza and Pérez 2010), something that must be further studied.

Finally, corroborating the importance of the knowledge factor, those surveyed explicitly admit—in response to explicit questions—the need for more technical information on the matter when dealing with RE and energy transition.

The following figures reveal information regarding the obstacles that the local leaders face with respect to the introduction of RE, and especially NCRE in their communes (see Figure 6).

**Figure 6.** Main Obstacles to Promoting Renewable Energies (Argentina and Chile)



N: AR=295, CL=734

Source: FONDECYT N°1150607 Project database.

A very similar trend with slight variations is clearly seen: In both countries the main obstacle or difficulty for promoting the RE in the communes is the lack of available information. In Argentina, the levels are a little higher (94% vs. 89%), and this is coherent with the fact that at the time of the interview there was a slightly delayed transition towards decarbonization in the country. Costs and market reasons seem to be equally pertinent. Fear that RE will be more expensive than conventional fossil fuel sources is a concern of three out of four of those surveyed. The fear that they may not be sufficiently efficient is somewhat greater in



Chile (67%) than in Argentina (57%), and in Chile there is greater concern for the possible health impacts of these new energy technologies (46% vs. 30% in AR).

As a matter of fact, the lack of knowledge and awareness is one of the obstacles to implementing a full RE supply, especially among Latin American policy makers, as mentioned in the 2016 GFR REN21world survey on renewables (REN21 2017, 21).

Indeed, the common sense of the local leaders surveyed is perceiving lack of information on renewables as a main obstacle for encouraging and empowering people to take part in LET. Coherently, those surveyed declare that there is a need for broad environmental education about global warming and energy transition. An average of 84% of those surveyed in the samples in Chile and 81% in the Mendoza sample (AR) fully agree with that idea.

There is consensus among those interviewed in the three Chilean communes and in Mendoza that the role of environmental education is important, and this implicates the new generations. Also mentioned as important is the training of energy technicians in local schools who can install and maintain the new technology and also developing professional training and research in RE technologies at local universities.

The need to democratize energy information is reflected in the fact that a majority rejects the idea that they are exclusively technical matters. To the question that “Only technicians, experts, and those who are directly involved must make decisions on electricity, fuels, and energy issues because they are technical matters,” 67% of the samples in Chile and 63% of those in Argentina disagree.

Environmental and energy issues require citizen participation so LET is supposed to involve even ordinary citizens. Seventy-nine percent of those surveyed in Chile and 74% in Argentina declare that they completely agree with promoting citizen participation. Local leaders’ discourse supports participation in energy policies and investments in RE in the communes.

Citizen participation in environmental evaluation is mentioned by many of those interviewed in various communes, especially in relation to megaprojects. In several cases, working with local communities for energy or mining projects requires different stages of participation. This has implied the formation—for example, in Copiapó— of specialized teams by the companies and consultants that work directly with local communities, experiences that in general are well evaluated, but the evidence compiled in the field shows that participation in consultation processes in environmental evaluations is restricted to top-down initiatives. They do not promote local initiatives and local innovation and are not geared towards general training on LET.

## Analysis and Comments. The Relevance of Socio-Technical Knowledge

The analysis of the data gathered in the different communes studied in both countries show that similarities are evident: they obey to the same trends that go in favor of the introduction of renewables. The differences seen in terms of the social construction of the *problem* are minor. In defining the solution, local actors establish an interpretative frame that installs a common sense favorable to RE and ET, this tendency is clear and shared on both sides of the Andes.

The discourse of the local actors interviewed and surveyed recognizes that the information and knowledge factor is a powerful element that can turn into a coadjutant of actions empowering the introduction and development of NCRE in their communes. The survey, which we have examined extensively by regression analysis, indicates that technical knowledge is an important support for the local actors in their effort for decarbonization. Precisely, it is mentioned that the obstacles for the NCRE are preceded by the lack of information, more than by market related matters (prices) or efficiency, even though these latter factors are quite indicative. Literature has shown that the recent speeding up of the introduction of RE, both in Argentina and in Chile, is due substantially to technological advances, making them more efficient, and that the prices of the renewables are now much more competitive and even more attractive to both investors and consumers (IEA 2017; EY Power & Utilities 2017). Finally, environmental education and citizen’s participation are widely supported as ways of ensuring that the citizens are empowered and fulfil a more active role in this transition.

However, what should be subject to further research is the apparent lower impact of the territorial variables over the framing of renewable energies by local actors.

The consensus of the respondents in all the communes in both countries about the diagnosis of climate change and the energy solution is remarkable. We recognize here the fact that public concern for the environment is not a monopoly of affluent and industrialized countries, as the classical thesis of post-materialism has anticipated (Dunlap and York 2008; Martínez Alier 2009; Running 2012). A significant number of those interviewed in different positions and communes are aware that the environment is linked with energy problems and that environmental justice is also related to the democratization of energy.

The vision of the local actors studied in our four cases is clearly differing to that of the economist and extractivist national elites in these countries (REN21 2017; Ryan 2017). This trend reveals the plausibility of the introduction of an alternative paradigm, the NEP (New Ecological Paradigm) in Dunlap’s terms (Dunlap

and Mertig 1997). This perspective focuses on energy system changes favoring decentralized and renewable forms of energy production and distribution as well as local control over energy issues (Fairchild and Weinrub 2017), and rejects centralized, mainly fossil driven, structures with large-scale power plants.

The analysis of the results reveals that technical knowledge is a key factor of transition transforming the theoretical discourse into a performative one. This means that knowledge might transform potential actors' agency into a functioning agency. In this sense, we can now speak of *socio-technical knowledge* because it is not an aseptic knowledge, but rather, it is full of social and political connotations, including those that have an impact on public energy policy.

In all the cases studied the "bottom up" initiatives have not been duly stimulated and even less so, supported, although there is, as we have seen, a favorable interpretive frame of local action. Asymmetries of knowledge and power (Fuchs, Hofkirchner, and Klauninger 2002) must be addressed to increase local empowerment and negotiating capacities. Traditionally, environmental planning and energy projects have been the domain of highly trained experts. Several failures have occurred, as these experts rarely had the benefit of detailed local knowledge and failed to generate community support for policy changes.

From a theoretical framework the results of our research highlight the need to advance into new perspectives that must consider a multiplicity of local, regional and global variables and complement the techno-economic, socio-technical and political global perspectives for analyzing national energy transitions (Cherp *et al.* 2018).

## Conclusion

The results of our research on the selected communes in Argentine and Chile have evidenced that the interpretive frame of the local actors is highly favorable to the LET. Not only is there good acceptability of NCRE, but also a general idea in the direction in which an energy-sustainable and decarbonized society must advance.

The mixed and comparative methodology used has shown us that the *socio-technical knowledge* variable affects acceptability and the promotion of RE. Indeed, one of the factors that emerge as decisive and supports our initial hypothesis is that socio-technical knowledge has an effect in activating the agency of local actors. We have not found any literature that reaches these same conclusions. They are indeed relevant to enhance our understanding of the interplay between local actors and national and transnational actors in energy megaprojects of the transitional processes in the Southern Cone.

Our research suggests that within a knowledge democratization perspective, exogenous socio-technical knowledge might be transformed into endogenous local community knowledge on energy. The attempts for a rapid energy transition in the local milieu in developing countries coming from an exclusive top-down dynamic can even have negative consequences. The recognition of local actors, local knowledge and the knowledge dialectic that must be reproduced on-site might improve the chances of a successful long term LET. Local level energy transitions and the democratization of the power system (Thompson and Bazilian 2014; Szulecki 2017) must consider the challenges of socio-technical knowledge and asymmetries of power. The democratization of socio-technical knowledge begins with the overcoming of energy illiteracy at local level which implies the need for great local level efforts in informational, educational and knowledge transfer, including communities' self-induced empowerment. Citizen participation with open deliberation, and inclusionary governance structures must accompany these processes.

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