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The Materialities of Energy Transition in Mountain Territories: Towards a Critical Approach

Marie Forget, Vincent Bos et Silvina Cecilia Carrizo

- 1 Both a paradigm and a process, energy transition promotes the transition from a stock energy system to a flow energy system, presented as more sustainable. Associated with a desire for energy sobriety, efficiency and renewable energies find their place at different scales and according to different consumption patterns by making regulatory frameworks evolve. In addition, they provoke a socio-technical re-organization of networks and they cause actors to renew their strategies (Geels *et al.* 2016). Following theories of the Anthropocene (Bonneuil, 2015; Crutzen, 2007; Steffen *et al.*, 2018), and the Capitalocene (Malm, 2017; Moore, 2017a, 2017b), global energy transition becomes a “vital” response to the urgency of global change and environmental concerns.
- 2 The dynamic of energy transition reconfigures both the energy and extractive sectors, their networks and services (Addison, 2018, Ali *et al.*, 2017). New energy frontiers then emerge in marginal places and territories (Forget *et al.*, 2021; Forget, Bos, forthcoming). Energy consumption has never been higher (Fressoz, 2014, 2020). Nevertheless, energy tends to be invisible to those with constant access to modern services (Bridge, 2018). Thinking about energy, therefore, leads to a consideration of its materiality.
- 3 A materialist approach to energy transition proposes to investigate: (1) the materials necessary for the development of the technologies on which the transition is based, (2) the socio-technical mechanisms of resource construction, and (3) the energy infrastructures necessary for the production and transportation of energy (networks, power plants, etc.). The notion of materiality thus refers to the complex linkages between the material dimensions of socio-economic systems and the socio-environmental system (Balmaceda *et al.*, 2019; Bridge, 2009; Bridge *et al.*, 2018).
- 4 The critical dimension makes it possible to question the ethics of energy and to think about the availability of materials and resources, but also about modes of action and new organizations in a world where environmental concerns make these issues

prevalent (High, Smith, 2019; Servigne, Stevens, 2015). As an object of multiform power relations, the question of the materiality of energy transition replaces mountain territories in a new centrality.

- 5 In mountain territories, which are both particularly sensitive or even vulnerable to the effects of global change and idealized areas of “nature” to be preserved, energy transition initiatives are numerous. The relations of inhabitants to mountain environments condition, support or hinder the implementation of energy projects, beyond economic gains, opening to motivations of a more ideological nature. The development of these territories, constrained by their relief and their geographical configurations, brings about a reexamination of the logic of network deployment, by promoting initiatives in isolated sites — veritable pilot territories of new ways of consuming and producing energy.
- 6 It is interesting to wonder if these territories could allow adaptable autonomous solutions, beyond the mountain environment, and generate wider interest for rural territories or unconnected urban territories. Moreover, mountain territories possess important non-conventional energy resources (water, solar radiation and geothermal energy, among others) which make them both potential providers of renewable energies and ideal territories of transition. The exploitation of these resources *de facto* induces positive and/or negative territorial impacts.
- 7 At the same time, mountain territories are potentially rich in minerals, metallic and rare earth resources, which are necessary for new energy technologies (solar panels, wind turbines, smart grids, batteries, etc.). The exploitation of some of these territories (mainly in the South) often benefits other so-called “in transition” territories. This exploitation is often presented as a lever for development due to the income generated by extractive activities, but the reality shows processes of social decohesion and “denaturation” of indigenous landscapes associated with irreversible environmental damage. The environment of mountain territories makes them a reserve of commodities that support energy transition dynamics.
- 8 Mountain territories participate in transitions materially through the exploitation of the renewable energy sources they harbor and the raw materials they provide. Territorial transformations give rise to a diversity of situations for which the stakes differ according to context (geographical configurations, marginal situations, forms of development, population density, isolation, connections, etc.).
- 9 In the South and in the North, transformations are taking place because of the effects of energy transition, visible locally and in distant territories. In the mountains of the southern hemisphere, the transition is transforming the territories which, through the development of new projects, are seeking to increase their energy production and to make up for the shortfall. Various energy projects are materially taking shape to meet the needs of local populations as well as national and Global North demands.
- 10 Resistance movements, more or less coordinated, are emerging in the face of the materialization of numerous projects driven by energy transition, both in the North and the South. In these tensions, which usually lead to conflict, protestors frequently defend claims about landscapes, traditional activities and access to transversal resources (land, water, etc.). These movements invite us to consider materiality through the lens of different ontologies associated with matter and infrastructures, that is, to recognize how matter and infrastructures inform the organization of space and social relations and that they are a form of political address (Larkin, 2013). Thus,

analyzing energy through the lens of materiality, in distinct contexts, sheds light on its forms and values, and even its agentivity (Graham, Thrift, 2007).

- 11 Through the interplay of divergences and convergences between the Global North and the Global South, and at different scales, energy transition is encouraging diverse, often innovative projects with material implications. The decision to focus on mountain territories has two main reasons. On the one hand, mountain territories have historically been built as providers of resources and as places exploited to serve the centers. On the other hand, they constitute idealized spaces of nature to be preserved, particularly vulnerable to the effects of climate change.
- 12 Mountain territories thus appear at the heart of a double tension of transition. Our aim is to analyze dialectically what energy transition is doing to mountain territories and what mountain territories are doing to transition through the prism of the materials and infrastructures mobilized.
- 13 This special issue seeks to document and study the mutations underway, along three main axes:
 1. **The role, access and construction of the material resources of transition.** New technologies make it possible to fuel so-called “green” economic growth, which can itself be perceived as a contradiction. On the environmental, social and political levels, the use of technologies that can be polluting and require extractive resources re-enacts and reinforces unequal power relations. Moreover, this “green growth” reinforces the capitalist paradigm based on the increased consumption of “high-tech” goods and services, inducing an increased need for raw materials (Bridge *et al.* 2012, Child *et al.* 2018). These goods and services are then presented as part of the solutions to the current socio-environmental problems, but they generate a restructuring and an increase in extractive activities (Addison, 2018). This phenomenon is illustrated by the development of energy storage devices such as batteries, which require many materials (lithium, cobalt, nickel, etc.) but which change networks (Carrizo, Forget, 2017; Forget *et al.*, 2021) and services, such as mobility (Ali *et al.* 2017; Cranois, 2017; Martin *et al.*, 2021, Vikström *et al.*, 2013).
 2. **Mountains as places of energy production.** Places take on a new value associated with the priority of an *in situ* energy production. In mountain areas, the historical development of hydroelectric power and wood energy has now been joined by solar parks, geothermal installations and methanization (Droulers, 2019; Flaminio, 2016; Sanjuan, Béreau, 2001). Renewable energies, in their multiple forms, remind us that if resources are social constructions, matter and the territories where they are found are central to energy production. This situation allows us to understand the phenomenon of “place dependence” in the energy sector (Aykut *et al.*, 2017; Chabrol, 2016; Chailleux, Hourcade, 2021).
 3. **The permanence and evolution of energy production and transport infrastructures.** Infrastructures are considered both as a possibility to re-organize territories of transition and as an inherited, pre-existing asset that strongly influences the configuration of new projects. Thus, planners and managers will seek to reuse existing infrastructures in order to reduce their operating costs. The materiality of infrastructures, their capacity to structure a territory, the perception of inhabitants, and the impacts linked to their (non-)integration into the landscape are among the questions raised in the new ways of designing energy projects.
- 14 The seven articles in this dossier address these three questions of materiality from different perspectives and in different places. Several articles are based on case studies in the South, with a particular focus on the Andes (notably Peru and Argentina) or in the North (the French Alps, the Mediterranean mountains, the Massif Central). In spite

of the various territorial anchors, for all the authors gathered here, the energy changes linked to global processes of transition place the States at the center, as promoters of the strategies and policies that give rise and form—or not—to the materiality of the projects. The transition—direct or indirect—is in all cases an opportunity for the mobilization of energy resources, renewable or not, and/or for the satisfaction of local or external demands.

In the South: Expansion of Energy Services, Political, Socio-economic and Environmental Issues

- 15 In the mountain territories of the South, where conventional and non-conventional energy deposits are located, populations generally suffer from service deficits due to their distance from consumption centers and infrastructures. In this part of the world, perhaps more than anywhere else, social, environmental and energy dimensions are combined, requiring us to think about a fairer development model.
- 16 The article **“Energy modernisation and regional reorganisation of the Southern Andes: the unexpected materialities of the Southern Peruvian Gas Pipeline.”** by Nina Montes de Oca and Sébastien Velut illustrates the difficulties that Southern countries have in completing large infrastructures. This article presents how the (non-) materialization of projects transforms territories. Even large, unfinished projects bring about many changes in the socio-technical systems, for the populations and the country. With them, representations change as well as local ways of life. The exploitation of the CAMISEA gas field (2004) in the Andean foothills has upset the Peruvian energy system, which until then had depended largely on water resources in the high mountains. The gas infrastructure leads to a considerable increase in energy services in Peru and the export of liquefied natural gas to international markets, which are in great demand and whose prices are constantly rising. Construction work on the Southern Peruvian Gas Pipeline, launched in 2014 to facilitate access to energy through an abundant, cheap, and low-polluting national resource, remains unfinished. Nevertheless, the project is having an impact on energy access and practices in the regions that should eventually be served by it, guiding a possible energy transition in Southern Peru.
- 17 The article **“Andean energy resources. Non conventional projects in San Juan and Neuquén, Argentina”** by Sofía Villalba, Alejandra Ise and Luciana Clementi, presents the exploitation of gas, wind and solar resources in the Argentinian Andes. Three major extractive projects illustrate their development: the exploitation of unconventional gas in Vaca Muerta (Neuquén) promoted by the Argentinian company YPF S.A.; the Iglesia Guañizuil photovoltaic park in San Juan, awarded to the Chinese company Jinko Solar; and the Veladero mine wind park in San Juan, owned by the Canadian mining company Barrick Gold. The development of local resources, the construction of infrastructures and the places energized/vitalized by the activities, respond to extra-territorial logics. The changes seek, among other things, a replacement of sources, rather than an integral transformation of the energy model. However, these projects also facilitate the momentum of new local projects because of the rents generated, the infrastructures built and the groups of actors involved.

- 18 The final article on spaces in the South, **“Northern Argentinian Andes: a factory of energy territories”** by Silvina Cecilia Carrizo and Guillermina Jacinto, shows the coevolution of diverse experiences. The transition is revealed, in the territories of Jujuy, as a wide spectrum of opportunities that open up projects — extractive, productive and / or service-based. The province becomes a factory of energy territories with variable geometry. Several initiatives aimed at satisfying the basic needs of low-income populations and reducing energy poverty are being implemented. At the same time, the territory is marked by the presence of photovoltaic mega-parks on the high mountain plains, and lithium mines are exploited in the salt flats. The materialization of energy, mining and industrial infrastructures and equipment, as well as the services that the works and operations require, have a profound impact on local communities, socio-spatial dynamics and landscapes of great cultural and natural value. These phenomena lead to the emergence of processes of (re)territorialization that redefine the trajectories and identities of mountain environments.

In the North: The Dilemmas of Territorialization of Renewable Energies in Network or Isolated

- 19 Northern mountain sites are often presented as laboratories of technical and institutional innovation. The return of energy infrastructures, that were previously located in dedicated or remote sites that made them invisible to the consumer territories, provokes a new visibility of energy materiality. The infrastructures linked to energy transition, particularly those for the production of renewable energies and energy transport, are generating a social resistance that invites us to rethink the strategies of acceptability. This raises the question of their territorialization. In contrast, in the mountain territories of the North, energy development models are questioned in favor of more autonomous models, or by apprehending the changing physicality¹ of infrastructures, that is, the shifting of networks of actors and the stakes they hold, and the materialities of which remain more or less identical.
- 20 Through a multiscalar approach, the article **“(Dis)Connected. Energy Materialities of Isolated Sites in Mountain Areas”** by Marie Forget and Kilian Ayroles, shows the particularities of transitions in sites sensitive to climate change. They analyze materialities, understood as the modalities and motivations of autonomous energy solutions, from an individual building to an integrated approach of valleys. These spaces catalyze innovations for a transition to a sober, efficient and decentralized system. However, the place and path (sociotechnical) dependence, based on electrical networks, is present. Experimentation and socio-technical creativity are poorly reproducible because of the cost and the technical and institutional complexity of implementing these autonomous systems. The result is a large number of “cobbled-together” solutions that often push the limits of legality.
- 21 In their text **“Physicalities in transition: the case of hydroelectric dams in the French Alpine valleys,”** through the study of the Sautet dam, Emmanuelle Santoire, Jean Desroche and Romain Garcier, analyze how energy transition affects the materiality of infrastructures. They take up the distinction made by Philippe Descola between materiality and physicality. The former answers the question “what is a body made of?” while the latter answers “what can a body do?” i.e., what it is compared to how it is supposed to function. The authors observe that in Europe, energy transition is

advancing with the liberalization of a single market, in which the competitive renewal of dam concessions modifies the physicality of plants and dams while their materiality remains the same. The role of dams in river regulation, their territorial dimension, and their financial and fiscal mediating role change according to competitive values and interests. Thus, the same materiality is both relational and interpretive and can support diverse physicalities.

- 22 Jimmy Grimault, in his article **“Towards an ecological modernization: conflictual territorialization and government of the criticism of new energy infrastructures in medium-sized mountain areas”**, evokes the obvious resistance to energy transition, linked more to its materiality than to its physicality, as shown in the article by Santoire *et al.* Mid-mountain areas present environmental, landscape and tourist challenges. They are also territories conducive to the development of renewable energy productive infrastructures. The development of new energy infrastructures in the name of transition tends to be a source of socio-environmental conflicts. The territorialization of infrastructures forces a repositioning of energy producing actors. In this context, these territories appear to be laboratories for the “government of criticism” (Topçu, 2013) in which new social acceptability mechanisms such as local investment and door-to-door canvassing are tested. Nonetheless, these mechanisms are far away from containing all contestations, leading to a repositioning of actors. Even so, the new energy infrastructures are also presented as an opportunity to overcome the historical marginalization of these territories.
- 23 Finally, in **“Energy transition in mountain areas: the cases of Greece and Cyprus. Participatory planning with the support of 3D Representations: examples of applications in the Eastern Mediterranean”** Dimitrios Goussios, Ioannis Faraslis and Prodromos Mardakis show the integration of functions and territorial resources in these processes of change, and the need for local authorities to participate in their planning. Interactive participatory planning, based on 3D representations, repositions the authorities as managers of territorial resources and sources of a “territorial” information system. In this way, the authors seek to move away from the restrictive geometric approach of the integration of renewable energies, conceived in a centralized manner, and to enter through the landscape to incorporate places and relationships that local communities include in the dynamics of territorialization.

Conclusion: Materialities and the New Construction of Territories

- 24 Concerns about climate change and the evolution of technologies have contributed to the development of renewable energies, which are largely supported by current policies. The exploitation of these energy sources invites us to question their materialities in terms of the raw materials needed, infrastructure and governance. The return and deployment of energy or raw materials production sites for transition, in the South and in the North, provokes resistance movements. The development of large-sized production infrastructures, linked by networks, is being met by systems of production that want to be autonomous, which require a redefinition of modes of consumption and an integration of sobriety into energy practices. This sobriety, while sometimes elected in the North, is often imposed in the South, where populations do

not have access to energy services and have to live with endemic energy poverty on a daily basis.

- 25 Generally speaking, energy transition provokes an energy productive function in new territories, with the spatial extension of energy production devices. In these territories, mechanisms of negotiation and/or co-construction are necessary for their territorialization, as their populations do not necessarily support it. Thus, the processes associated with energy transition not only renew the socio-technical systems of supply, energy services and the development of local resources, but also modify their territorialization dynamics and, as a result, the relationships between actors at different scales.
- 26 Nevertheless, energy transition constitutes an opportunity for mountain territories to propose a model that will allow them to reduce their marginalization within their national territory. Indeed, these areas are particularly well endowed with energy resources, which, when used in a reasonable way, can allow innovative services and organizations. However, this requires reflecting on a transition that respects the environment, their heritage, identities and landscapes. In the South and in the North alike, mountain territories are becoming laboratories of energy transition, presenting both constraints and geographical opportunities.

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NOTES

1. “The physicality (of a being) consists of all the visible and tangible dispositions (i.e., courses of action) that arise from its morphological and physiological (material) characteristics” (Santoire et al. in this volume).

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