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Energy Integration and Regional Development: A Comparative Analysis

By Serafettin Yilmaz [1], Chaoying Zhang [2]

ABSTRACT
This study presents a cross-regional analysis with the aim of understanding the dynamics between energy-integration and regional development. It draws on the premise that cooperative relationship in energy has a positive impact on the regionalization process. For this end, the paper examines renewable energy-based electricity grid interconnectivity in Europe, Southeast Asia and Northeast Asia through a study on their level of energy interconnection, platform sharing, market and policy integration, and institutionalization and formalization. The aim of this study is to illuminate the nexus between energy integration and regional development.

Keywords: Energy Interconnectivity; Electricity Grid; Regional Development; Europe; Southeast Asia: Northeast Asia

1. Introduction

This study draws on the premise that cooperative relationship in energy has a positive impact on the regionalization process (Kim 2004; Pempel 2004). It suggests that energy-related legislative, technical, logistical, and financial linkages established between (cross-border) and among (cross-borders) states require the regional actors (both state and non-state) to maintain viable and sustained communication and to ensure compatibility at different levels, including policy, technology and markets. When the stakeholders begin to take steps toward energy integration, socialization process begins, generating paths for deeper interaction, involving learning, role-modeling and norm diffusion. Thus, through such stages as inception, construction, maintenance and innovation, communication in energy creates conditions for better connectivity, assisting regional development. A stronger socialization in energy, we hold, translates into a more comprehensive regionalization.

In this paper, we present a cross-regional comparative analysis with the aim of understanding the dynamics between energy-integration and regional development. We examine renewable energy (RE)-based electricity grid interconnectivity in three major regions, the European Union (EU), ASEAN and Northeast Asia (NEA), through a study on their level of energy interconnectivity, platform sharing, market and policy integration, and institutionalization and formalization. The main objective of this research is to illuminate the nexus between energy socialization and the regional development. For this end, we compare the scope of energy interconnectivity and regional integration in the three

[1] Associate Professor, School of Political Science and Public Administration, Shandong University, Qingdao, China
[2] Ph.D. Candidate, School of Political Science and Public Administration, Shandong University, Qingdao, China

sub-regions based on three variables (agency and structure) and four indicators (capacity, willingness, institutions and connectivity).

2. RE-Based Socialization in Regional Context

Socialization is a critical concept with broad applications in a number of disciplines (Tannenbaum & McLeod 1967; Zürn & Checkel 2005). In general terms, at the national and international level, socialization involves participation into and acceptance and adaptation of rules and norms in a new environment -- be it political, economic or cultural. The notion indicates the presence of a certain capacity for rational choice in which the participating agent seeks what is rewarding and avoids what is costly. Socialization, however, is not seen as entirely systemic or uniform across the board, but rather, as context-based, that is, varying in density and direction depending on the actor (or group of actors). The way actors behave in different social contexts reflects both their perception of self within the larger unit and of how they believe they are treated (Rosecrance 1976). Socialization is essentially an institutionalized realm. For Johnston, states' behavior preferences are impacted by exogenous (reward and punishment) and indigenous (internal political structure) factors. The question regarding what happens within the institutional context after participation and how bilateral and multilateral interactions play out within the more formalized settings invokes an agent-structure dimension in the process of socialization (Johnston 2001). On this, Gheciu underlies normative mechanisms that involve persuasion and teaching, and are reflected in a number of ways such as compatibility of the members' particular interests with the newly promoted ideas and the consistency of behavior (Gheciu 2005) . In the same vein, Bearce and Bondanella highlight the socializing attributes of institutions for endogenously-informed actors, especially, in the long term (Bearce & Bondanella 2007). Nevertheless, change in belief, perception and, eventually, attitude and behavior is not seen as deterministic or universal since the actors are not uniform entities (Peck 1979). Within an institution, agents may be positioned according to their capabilities to shape and lead their environment or to undermine and eventually defect from it. Scholars such as Johnston and Checkel find that the choices made based on realistic calculations are eventually normalized through a process of internalization, which indicates a cycle made up of rational and normative mechanisms (Checkel 2005; Johnston 2003, 2008). All in all, agent-related variables within the construct of a regional or international system, and structural variables informed by the nature of institutions and availability of incentives determine the content, direction and prospects of socialization (Checkel 2001; Feldman 1976; Ikenberry & Kupchan 1990; Johnston 2001). Integration through energy connectivity, in this regard, is an outcome of a complex actor-structure dynamic interaction that plays out both on the national and regional planes. As an integral aspect of energy-driven socialization, renewable energy-based electricity interconnectivity indicates the engagement of multiple state and non-state actors in time and effort-demanding negotiations involving broad issue areas such as finance, infrastructure, trade, and regulation. In the regional context, therefore, we highlight electricity interconnection as a strong socializing element, reflecting, on the one hand, actors' willingness and capacity, and, on the other, the nature of the structure in which the actors interact. As we operationalize in the ensuing pages, by means of a willing and

capable actor and connected and institutionalized structure, energy functions as a socializing agent, leading to deeper regional integration and, hence, development.

In the table below, we present an actor and structure-based representation of energy-driven socialization. We identify willingness and capacity as the main variables indicating the role of the actors in the process of integration. For any socialization to occur, first and foremost, the actors must want it. However, willingness is only one of the aspects in the equation because to will does not always equate to a capacity to do what is willed. In regards to energy integration, which requires the mobilization of financial, technological, industrial and regulatory resources, capacity is also of great importance. As an aspect of structure, institutions reinforce capacity. If a region achieves higher institutionalization, mechanisms such as rules making, confidence building and dispute resolution encourage the stakeholders to participate in good faith and avoid cheating or defection. In a sense, institutions equip stakeholders with agential power in which each actor capitalizes on their particular strength and claim certain benefits.

Structure represents the realm in which actors interact with each other. High institutionalization and connectivity are anticipated to lead to less negative competition whereas low institutionalization and connectivity may result in more negative competition. If there is enough economic, political and social determination and capacity, on the one hand, and physical and institutional capacity to reinforce it, on the other, the existence of informal regional hierarchy would not deter smaller regional actors from participation due to the existence of formal regulatory frameworks. Structure, therefore, could affect the nature of relationship between the stakeholders. High physical and regulatory interconnectivity might lead to a better facilitated regional interaction in which actors would be more willing to take part in difficult integration regimes such as energy. Once commitments were made and structural linkages were established, it would be rather costly to cheat or defect -- even though the likelihood of which could not be ruled out entirely. Consequently, the nature of relationship would be more cooperative and less competitive.

Table 1: Energy socialization: Two Variables and Four Indicators

Agent	Capacity
	Willingness
Structure	Institutions
	Connectivity

3. Energy Integration: Cross-Regional Comparison

3.1 Europe (The European Union)

Historically, energy has been integral in the European regional integration. The establishment of the European Coal and Steel Community (ECSC) in 1951 played a significant role as a model for the subsequent integration in the region with energy acting as a key instrument in the early stages of functional regionalization (Alter & Steinberg 2007; Moravcsik 1998). However, national energy policies in member states remained non-aligned until a more streamlined energy policy took shape in the 1980s (Andersen, 2000). In 2009, the Lisbon Treaty and coming into effect of the Treaty on the Functioning of the European Union (TFEU) helped strengthen the EU institutions and associated regulations,

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including those related to energy. Over time, the EU has created interest convergence in institutionalized frameworks on wide variety of issues such as construction and modernization of national energy systems, production quotas, market access and pricing (Maltby 2013).

The EU's RE policy identifies a number of objectives related to supply security, global competitiveness, and environmental sustainability (Sandoval & Morata, 2012). Policy directives require the member states to include the EU Road Map in Renewable Energy into their national legislation and achieve the nationally-stated goals through legally-binding provisions that provide support, monitor infringements and regulate non-compliance in energy-related issues (Cross et al., 2015). What is noteworthy in all these policy initiatives is that they are formal, binding, and incorporate sanctions in case of non-compliance.[1] Thus, in spite of the existing challenges associated with "communicative, organizational and procedural processes and tools," over time, several institutions have been established under the oversight of the European Commission (EC) and the European Parliament (EP) (Knudsen 2012).These institutions, which are composed of both public and non-public stakeholders, cover all major aspects of RE, including generation, storage, grid networking, transmission and distribution.

Europe (EU-28) is not among the top energy producing regions in the world. In 2015, it had a 5.6% share in global energy production and ranked behind all major countries such as China, the US and Russia. Historically, energy production decreased from 967 Mtoe (Million Tons of Oil Equivalent) in 2005 to 771Mtoe in 2015. In the same period, the share of final energy consumption declined, accounting for 11.9% of the global consumption, trailing behind China and the US. However, thanks, in large part, to the strong policy impetus by the EU, renewables represented 26.6% of the total energy production (second highest after nuclear and higher than the global average of 13.1%), achieving higher percentage than solid fuels and natural gas in 2015. Similarly, the share of renewables in the region's gross inland consumption saw an increase from 5% to 13% in the period from 2005 to 2015 (close to the global average of 13.4%). The EU's import dependency, in the meantime, increased from 43.1% to 54% of total energy consumption with Russia as the main import destination in natural gas, crude oil, and solid fuels(European Commission Directorate-General for Energy, 2023).

[1] Among the ongoing RE-related (including hydro) trans-European integration projects are Norway-Great Britain North Sea Link, Norway-Germany Nord Link, Britain-France IFA2, Italy-Montenegro Power Line (renewables), and Belgium-Germany ALEGrO.

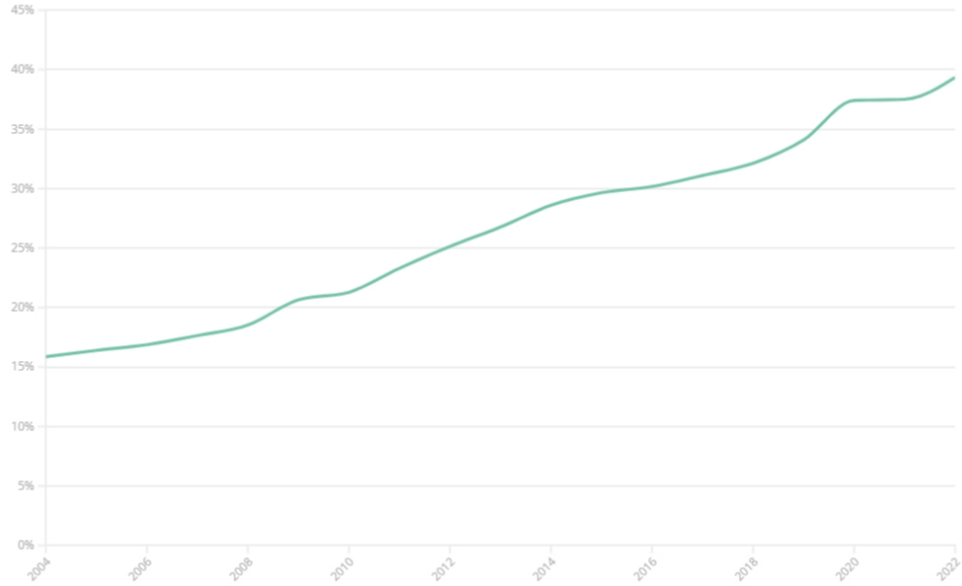

Figure 1. Share of renewables in electricity generation in the EU (2004-2022). Source: European Council - Eurostat

In electricity, too, the EU remains dependent on imports. In 2015, over 35% of the region's total electricity came from external sources, indicating a major increase from 17% in 2005. Still, installed electricity capacity grew considerably over the years with renewables (excluding hydro at 16%) taking up 19% of the overall net electricity generation in 2017, while fossil fuels stood at 41%. In the meantime, the share of RE in the overall consumption reached 34.1% of the total -- 19.1 % without hydro (ENTSOE, 2017). In 2015, among the renewable resources, hydro, wind and solar took the top spots with 15.5%, 14.4% and 9.7% share, respectively (Ortega-Izquierdo & del Río, 2016). Ever since, electricity from wind, solar, and biomass has risen the most whereas hydro remained mostly stable. Generally speaking, generation from renewable sources grew strongly whereas energy from solid fuels, petroleum products, and nuclear all decreased. According to estimations, the EU can reach its 2030 targets of 50% RE-based electricity generation capacity "with renewables supplying 27% of the continent's fuels as well as electricity" (Neslen 2015). Among the RE sources, the share of wind (particularly offshore) is projected to increase to account for 23% of the EU's energy mix by 2027, followed by biomass at 20% and solar at about 7%.

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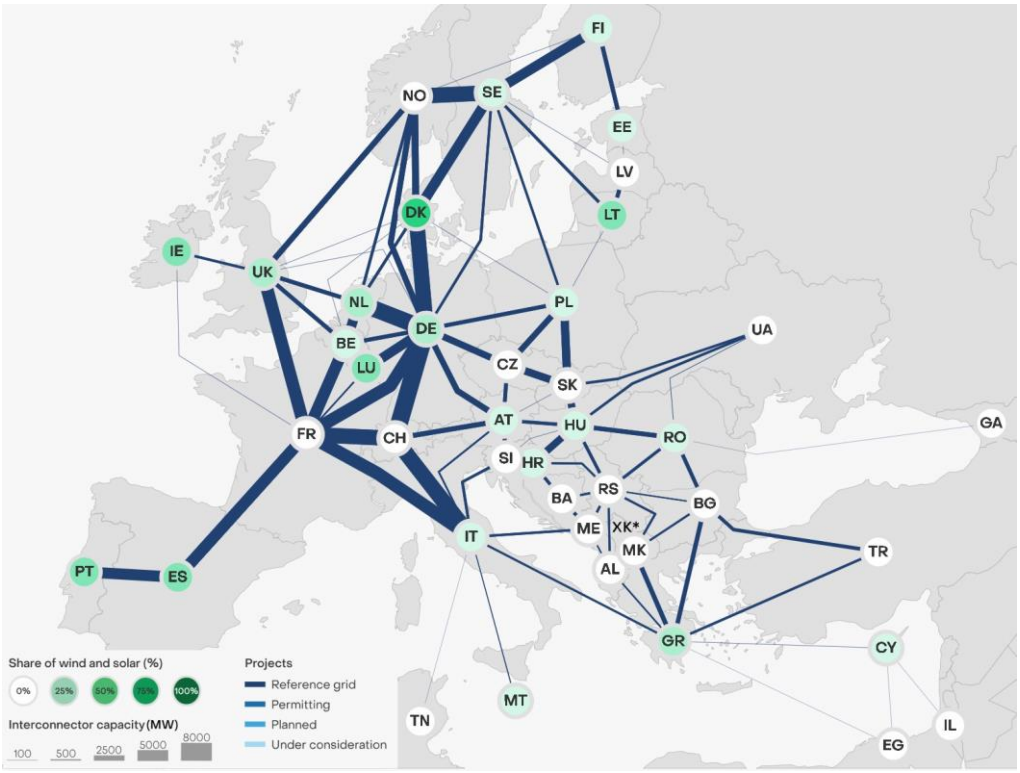
Map 1: Electricity interconnection in Europe.



Source: Ember

Connectivity and integration of RE-based electricity in Europe has for long been a topic for discussion. The challenges include initial costs, building high voltage transmission lines over long distances, disparate energy market regulations and procurement rules, aging of the cross-border interconnection networks, slow pace of the construction of new grid lines, integration of the geographically dispersed RE sources, and harmonization of energy trade to ensure that power supply always matches the demand based on individual annual load curves (Battaglini et al. 2012; Gallo Cassarino et al. 2018; House of Commons Energy and Climate Change Committee, 2011; Ortega-Izquierdo & del Río 2016). Drivers for a region-wide supergrid in Europe, on the other hand, include better utilization of existing RE capacity, the potential to link Europe to the African and Middle Eastern solar power, avoiding regional RE generation fluctuations, and promoting energy trade and ensuring price reductions. Thus, the primary objective of the European Electricity Grid (EEG) is the construction of a pan-European network that integrates both national and sub-regional power grids and archives inter-regional connectivity by linking the North African solar and wind energy into the EU network via High Voltage Direct Current (HVDC) cables under the Desertec framework (Colthorpe 2016; Lilliestam & Ellenbeck 2011).

At the moment, however, the European electricity grid is a loosely connected system, composed of a number of sub-regional clusters, which includes continental Europe, the

Nordic and Baltic regions, the UK and Ireland. A full connectivity is still non-existent among sub-regions despite attempts for a common electricity market of which pan-European electricity grid is an essential part. The construction of long-distance networks has not been fully realized due to regulatory, technological and financial challenges. Accordingly, although Europe has made significant progress in institutionalizing into a well-connected and open region, "energy policy remains a deeply national domain" and "the current transformation process varies strongly between individual member states" (Egerer et al. 2016; Ortega-Izquierdo & del Río 2016).

Several agencies such as the Agency for Cooperation of Energy Regulators (ACER) and the European Transmission System Operators (ETSO) work to create a more institutionalized environment to encourage energy integration. The Third Energy Package, which was adopted in 2009 by the European Parliament, stipulates a more interconnected energy network between member states and identifies a number of priority corridors, including North-South electricity interconnections in Western, Central Eastern and South Eastern Europe, and the Baltics. Although most of the existing interconnections in Europe are state owned or controlled, private institutions, too, have introduced their own projects (Probert, 2009). National grid systems are well-developed in Europe, especially in the Western part of the region. There are over 40 interconnection schemes between European states which oversee a large number of planned or ongoing cross-border(s) grid projects.[2] Hence, albeit marred with controversies and competing visions between the stakeholders, a pan-European RE-based electricity grid is a work in progress (Lilliestam & Hanger 2016). Under the EC-led energy union framework, electricity grid is viewed as a significant element in the overall regionalization process (European Commission, 2018). By laying out a timetable and identifying clear objectives, the EU aims to overcome challenges associated with policy and systems integration and costs related to generation, storage, networking and transaction, and to further reinforce energy governance and ensure deeper regional community build-up. Regulatory issues, rather than financial or technical, remain the single biggest barrier to grid integration in Europe. The persistence of challenges related to energy governance such as insufficient regulations, inadequate implementation, "the primacy of national over European concerns," and slow and complex decision-making procedures underscore the primary role of cross-borders electricity interconnection in the European regional development (Battaglini et al. 2012).

3.2. Southeast Asia (ASEAN)

Over the past few decades, ASEAN has taken important steps toward establishing a formal economic community. However, the region is still dominated by disparity in economic development. Both geographically and culturally, ASEAN is one of the most diverse regions in the world. One characteristic that is more or less universal across the region, however, is the strong sense of sovereignty embodied in what is popularly known as the ASEAN Way. Owing to the legacy of the twin historical traumas that the region

[2] Among the ongoing RE-related (including hydro) trans-European integration projects are Norway-Great Britain North Sea Link, Norway-Germany Nord Link, Britain-France IFA2, Italy-Montenegro Power Line (renewables), and Belgium-Germany ALEGrO.

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experienced in the form of colonialism and the Cold War confrontation, the state actors in Southeast Asia (SEA) have been cautious toward proposals (including a regional legal framework designed to regulate energy markets) which they see as potentially impinging upon their economic and political sovereignty (Navarro & Sambodo 2013).

Thus, demographic, economic, political and geographical questions in SEA are the major obstacles for the overall regionalization process, including for the more specific question of energy interconnectivity. Demographically, low urbanization and the existence of small pockets of people scattered along the region, especially, in maritime states such as Indonesia and the Philippines that are made up of thousands of islands, pose serious technological and infra-structure related challenges for a viable intra-regional electricity grid build-up. Considering that most ASEAN members are still in the early stages of development, economically, too, it is difficult for the states to be able to indigenously meet all the costs associated with expensive systems required to ensure a viable connectivity. This situation is further exacerbated by the division of ASEAN into continental and maritime areas, which requires cross-strait interconnection.

Major disparities between the countries with respect to their share in total regional energy consumption notwithstanding, energy utilization is increasing in SEA. According to International Energy Agency (IEA), the use of energy has increased 70% over the past two decades, accounting for 5% of the global demand. Fossil fuels still dominate the total energy mix, with oil, natural gas and coal taking up 34%, 22%, and 17%, respectively, in 2017 (IEA, 2017). In spite of the existing RE potential, the rate of utilization is still low in SEA. In 2015, natural gas accounted for 41% of power generation, followed by coal (33%) and hydropower (16%) whereas RE resources took up 17%, with hydro power comprising three-fourth of it (IRENA, 2018). Major challenges for RE development include issues related to financing, profitability, and governance (Koh, 2017). Nevertheless, the proportion of RE in ASEAN's final energy consumption grew to 17% in 2017 and is projected to reach 30% by 2050 (Enerdata, 2018).

The positive economic implications of region-wide grid connectivity in SEA are analyzed in various studies. Among others, interconnectivity could help "reduce the cost of the power supply" by allowing power transactions between countries with disparate peak demand, "lower tariffs for countries that have high tariffs and are dependent on high-cost generation," and lead to reductions in carbon emissions by encouraging "power generation from renewable sources" (Chang & Li 2013; Matsuo et al. 2015; Navarro & Sambodo 2013). Furthermore, drawing on the complementarities in energy resources and supply and demand patterns, grid networking could provide incentives to participate, reinforcing, in turn, political rapprochement on contentious issues such as territorial disputes.

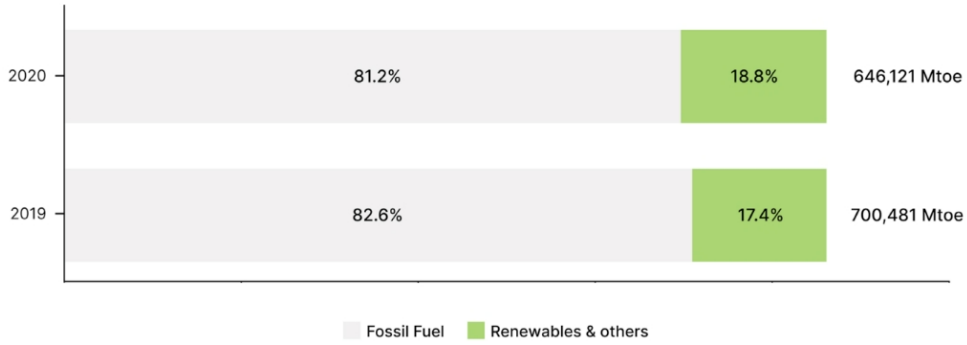

Figure 2. ASEAN primary energy supply by type of fuel (2019-2020). Source: ASEAN Centre for Energy

As of August 2017, there are 16 electricity interconnection projects involving all ASEAN member states. Although the schemes experience setbacks and will likely fall behind their schedule for completion, 15 interconnections are currently in operation (Andrews-Speed 2016; ASEAN Centre for Energy, 2018). However, the existing power network does not qualify as regional since it "is a collection of interconnected national grids offering bilateral exchanges of electricity… [but] not a unified regional grid" (International Energy Agency, 2015). ASEAN's initial plan, for that matter, is first to strengthen the sub-regional connectivity concentrations in the region, and then build a pan-ASEAN unified network. The current power system appears to be more advanced in the Greater Mekong Subregion (GMS) since the area is rich in hydropower potential. GMS also serves as the only point of cross-border connectivity with Mainland China, which is significant for the proposed East Asia power grid.

Map 2. The ASEAN power grid, 2020.

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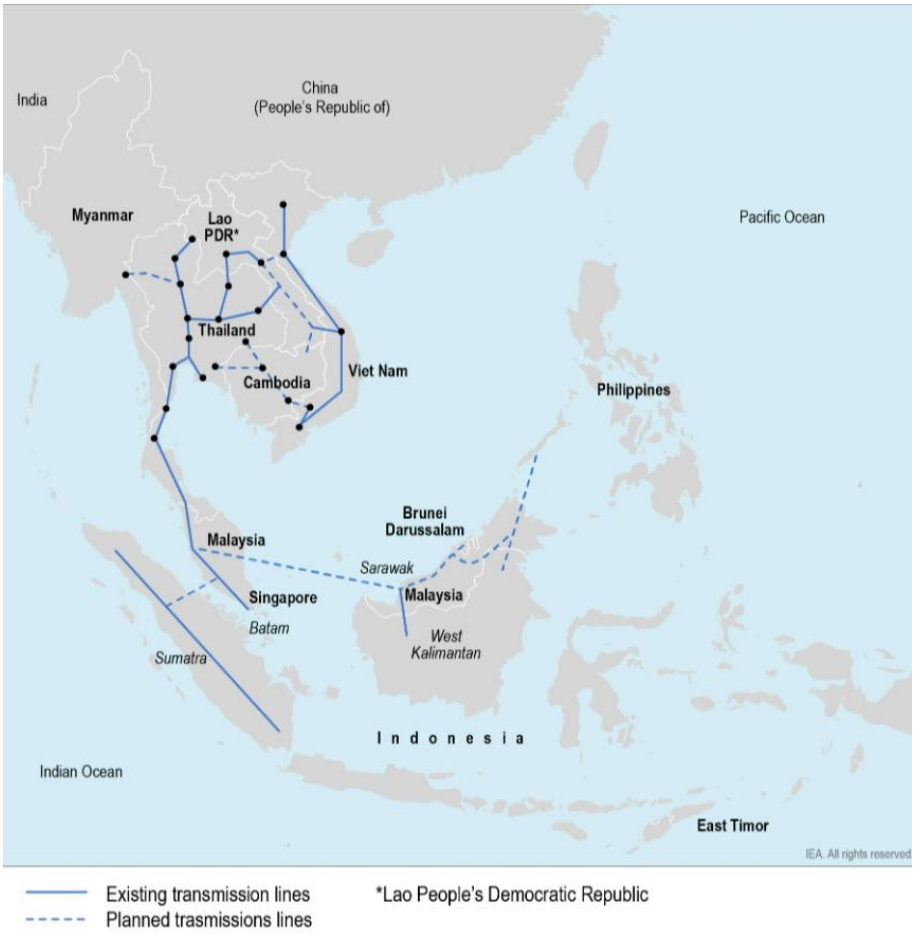

Source: IEA

Clearly, the pace and depth of formalization in ASEAN's regional energy integration has generated dynamism over time (Doshi 2012). In terms of institutional development, the Heads of ASEAN Power Utilities/Authorities (HAPUA) is one of the earliest organizations that seek to promote energy cooperation among the member states and private actors. The institution holds annual ASEAN Ministers on Energy Meeting (AMEM) to encourage policy mobilization and create a sustained discourse on energy cooperation. Under the framework of the HAPUA as a working group, the ASEAN Power Grid (APG) initiative stands as the main framework for regional power connectivity. Integrated in the Master Plan of the ASEAN Connectivity in 2010, the initiative envisions a region-wide grid development as part of the ASEAN Vision 2020. Established in 1999, ASEAN Centre for Energy (ACE) is an intergovernmental organization that serves as a think tank for the ASEAN member states. Being one of the early institutions, it conducts extensive analysis and produces comprehensive reports on connectivity, including in its scope both traditional and new energy resources as well as grid networking. Similarly, the ASEAN

Energy Market Integration (AEMI) initiative (2013) functions as an epistemic organization to facilitate research on issues related to connectivity and energy market integration.
Clustered around numerous institutions, ASEAN is working to build a governance framework for electricity grid interconnectivity. The regional energy model under construction is reinforced by a number of multilateral documents. For example, since the mid-1980s, ASEAN states have signed Agreement on ASEAN Energy Cooperation (1986), ASEAN Vision 2020 (1997), which adopted the APG plan, ASEAN Plan of Action for Energy Cooperation (APAEC) in 1999 and 2004, the ASEAN Interconnection Master Plan Study (AIMS) in 2003, and Vientiane Action Programme (VAP) 2004-2010 in 2004. Although those documents still reflect ASEAN characteristics which do not enforce top-down or highly formalized rules and regulations, they nonetheless help sustain a regional discourse on energy interconnection, helping facilitate regional development.[3]
All in all, energy interconnectivity is an indispensable aspect of Southeast Asia's socialization into a community of states (Shi, 2014). Granted, in spite of the progress made, SEA is not free from internal challenges such as protracted maritime entitlement and border disputes. ASEAN regionalization has been relatively incremental and its ability to solve problems is inadequate. Economic and political diversity, (an aspect of ASEAN accomplishment in view of the absence of major conflicts in the region) still posits governance-related challenges for the region. Externally, too, SEA comes under pressure from multiple directions which at times force individual actors to take positions that may be in conflict with others. Nevertheless, ASEAN regionalization continues to progress and a growing degree of actor empowerment and structural interconnectivity in renewable energy remains an essential factor in its development.

3.3. Northeast Asia (NEA)

In spite of numerous complementarities in terms of RE generation capacity and distribution of financial and technological resources, energy-related institutions are weak and physical connectivity networks are loosely integrated in NEA (Yilmaz & Li, 2018). The region lacks an overarching mechanism monitoring and regulating a common energy policy whereas the existing public and private initiatives often function as part of larger multilateral settings such as ASEAN, the Asian Infrastructure Investment Bank (AIIB), and the Asian Development Bank (ADB). However, this does not mean that, individually, NEA states are disinterested toward the idea of a NEA supergrid. In fact, with the exception of North Korea, each of the five NEA states (China, Japan, South Korea, Russia and Mongolia) over the past three decades, taken steps for higher cross-border connectivity and introduced several proposals for a region-wide energy interconnection.
NEA has a number of peculiarities that would potentially facilitate a pan-regional electricity network. With respect to geographic distribution of RE sources and energy production and consumption patterns, each country in the region has certain advantages and disadvantages that encourage complementary energy communication. Russia is one of

[3] As a matter of fact, the ASEAN Way of energy interconnectivity is not one of a kind. The Nordic power market has also deviated from the more formalized and top-down approach as associated with the EU; instead, it grew incrementally, allowing market forces and societal actors to voluntarily participate in the multilateral scheme which is now known as the Nord Pool.

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the world's largest producers in traditional energy, notably, natural gas and crude oil. Its energy generation capacity is spread across the vast landmass which contains diverse resources. Although the share of RE in total primary energy supply is still low (3% of the total in 2012), the country's RE potential in hydro, solar, wind and biomass is high (ERIRAS & ACRF, 2014). The country's current energy generation surpasses its consumption (EIA, 2023b). Similar to Russia, Mongolia, too, is rich in potential wind, solar end hydro energy capacity although the current electricity generation is heavily coal-based. In 2013, the share of RE in total electricity generation was only 1.96% and its total primary energy supply (TPES) stood at 3.77%, suggesting that potential resources are underutilized (Asia Pacific Energy Portal, n.d.-b). It is projected that, if fully utilized, Mongolia's total energy potential is big enough to meet China's national energy demand by 2030 (Chen et al. 2016).

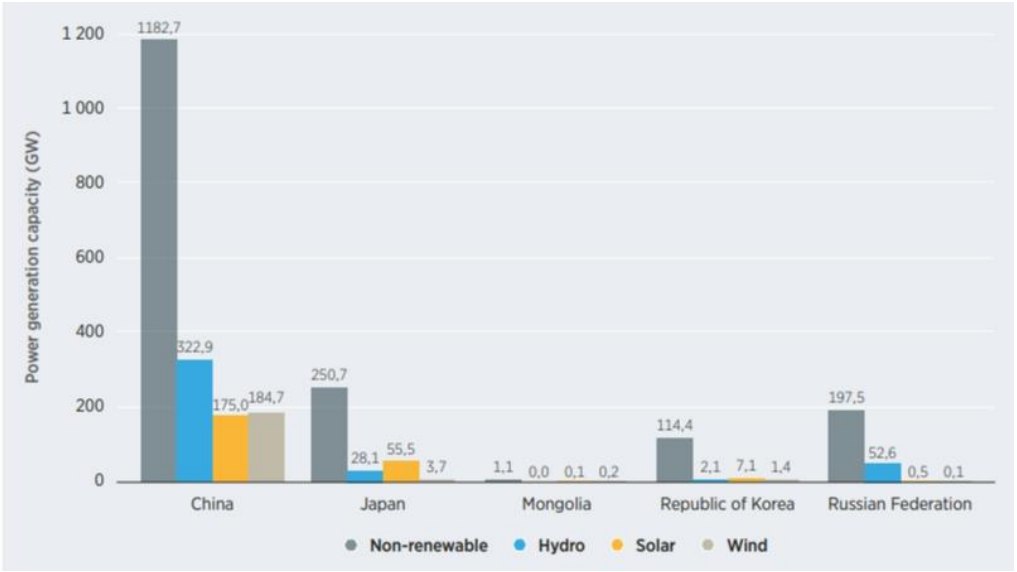


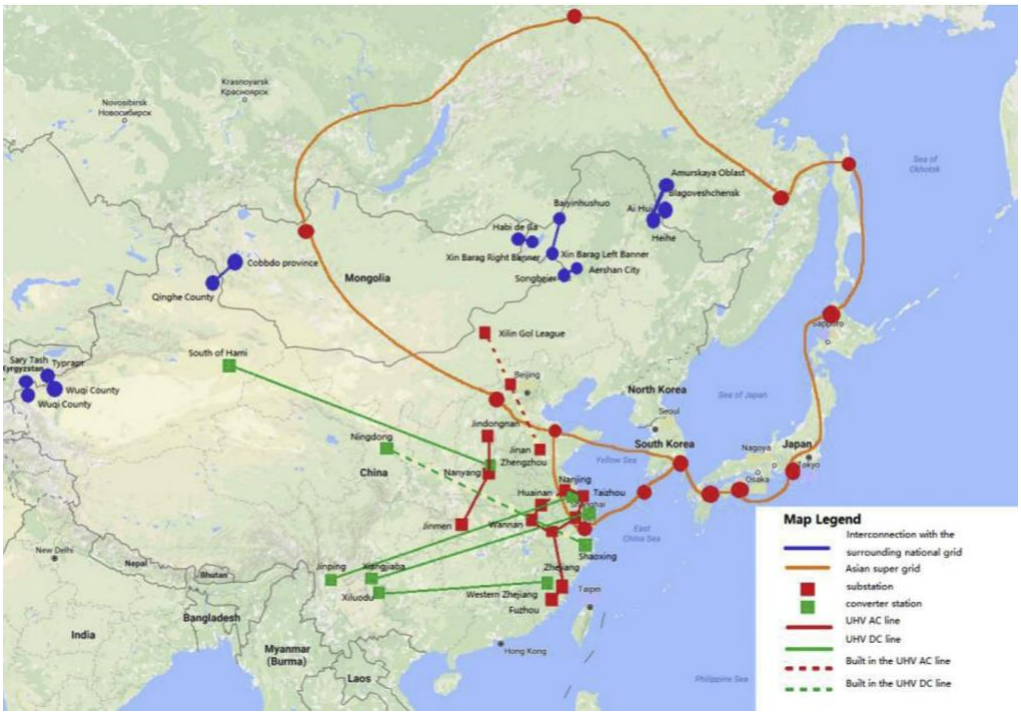
Figure 3. Installed power generation capacity by country (2018). Source: IRENA

As the most advanced economies in NEA, Japan and South Korea are considered resource poor although they are both major energy consumers. Japan is self-reliant in electricity which is heavily based on nuclear-generated power (EIA, 2023a). The share of renewable energy has gradually increased to 16.9% of the total in 2015, with hydro, solid biofuel and wind accounting for most of it (IEA, 2016). South Korea, too, is self-sufficient in electricity production and consumption. The share of RE resources in total energy mix, however, is still low. In 2019, clean energy, including hydro, accounted for 6% of the total electric generation (EIA, 2023c). China, on the other hand, surpassed the US in 2011 to become the world's largest producer and consumer of energy. Since the country consumes more energy than its current production, it is a net importer. Hydrocarbons, especially coal, dominate the country's electricity generation although the share of RE resources has grown over the past decade to account for nearly one fourth of its total production (Asia

Pacific Energy Portal, n.d.-a). China leads the world in both installed RE capacity and generation. Yet, since the country's consumption is rather big, the share of individual RE categories is relatively small with hydro representing about 20% of the total electricity generation, followed by wind (3.3%), biomass (0.9%) and solar (0.7%) (Mathews & Huang 2018).

Grid networking in NEA is underdeveloped and is based on bilateral interconnections. The primary reason is the absence of an institutionalized regional energy governance framework to introduce road maps for regional connectivity, regulate energy markets and prices, and provide formal dispute management mechanisms. At the state level, Russia and Mongolia lack in technologies and finance to ensure reliable RE generation and national smart grid. Therefore, in spite of their natural endowments, the two countries are still unable to position themselves as optimal sources for RE. Underdeveloped national grid systems in both countries also pose a challenge for viable cross-borders interconnectivity since huge investments are needed to develop existing lines or build new ones (Ferris 2014).

Map 3. Existing and proposed power grid interconnection in Northeast Asia.



Source: Yilmaz and Li, 2018.

Japanese grid, too, is inadequate to encourage sustainable RE development. The wind energy generated in rural areas cannot efficiently be transmitted into urban areas in which consumption is high. Another challenge for the country is that connectivity with continental NEA requires challenging and expensive underwater transmission systems. South Korea's national grid, on the other hand, is one of the most developed and efficient

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among industrialized countries. The country has invested heavily in electricity networks and aims to establish a nationwide smart grid by 2030. The major regional connectivity challenge for the country is geopolitical due to division on the Korean Peninsula. Finally, in China, in spite of explosive growth in investment in RE generation systems, the existing grid network is inadequate to store, transmit and distribute the generated electricity, which leads to loss and waste (Luo et al. 2012).

That said, a number of electricity grid proposals have been put forward by various organizations from Russia, China, Japan, Korea and Mongolia since the 1990s, each with varying geographical scope. In a sign of the emergence of a regional discourse on energy connectivity, power companies from China, Japan, South Korea and Russia joined together to sign a Northeast Asia Power Network Cooperation Memorandum in 2016 (Hanley, 2016). Still, electricity interconnectivity in NEA remains largely bilateral and the region lacks a unified network. Existing cross-country grids only cover China, Russia and Mongolia whereas Japan and South Korea remain isolated. Although major investment is required in RE technologies, UHV AC/DC lines and smart grid systems, there has been little progress due to the political actors' unwillingness to take decisive steps.

Analyzed from the perspective of regional governance, the major characteristic of energy integration in NEA is the lack of strong overarching institutional mechanisms and the related prevalence of bilateralism. The ongoing debate on the topic is dominated by academic and business actors in their private capacity, which encourages little political commitment and action (Asia International Grid Connection Study Group, 2018; Lee & Lee 2015). The obstacles to grid development in the region is first political and then technical: First, a multilateral regional institutional framework with certain regulatory powers over national decision-making needs to be build and, second, existing cross-border connections need to be transformed into multilateral arrangements with the aim of, eventually, having a pan-Northeast Asian supergrid. Although the chances for progress in regional energy interconnectivity has recently been higher thanks to technological advances, the growing share of RE in individual states' energy mix and a certain level of political normalization between actors, as compared to both the EU and ASEAN, institutionalization and formalization of a regional energy strategy remains a distant goal in NEA.

4. Energy Interconnection and Regional Development

Due to formal and technical complexities such as "the alignment of regulations, policy instruments and market design at all system levels and between (national) electricity systems," once achieved, electricity grid interconnectivity acts as a strong socializing agent in regional development (De Vries & Verzijlbergh 2018). Generally speaking, institutionalized, highly-formalized and well-developed interconnectivity leads to deeper integration and more comprehensive and rules-based governance, thereby reinforcing regionalization. The three-case study on Europe, SEA and NEA above, in this respect, illustrates diverse levels of energy socialization which result in disparate regional community characteristics and development prospects. An analysis on the state of energy integration in the three major regions from an agent-structure perspective suggests a causal

relationship between RE-based electricity grid-driven integration and regional development.

Energy has traditionally been one of the core components in European regionalization. As a highly formalized region, numerous institutions function as governing units to coordinate and monitor energy policies of each member state by means of legally-binding provisions. In fact, the EU's agential capacity as a compliance demanding institution singles it out from the rest studied in this research. Participation in energy-related integration in Europe covers both state and private actors with considerable feedback from civil society and business groups. At the structural level, on the other hand, RE-based electricity interconnectivity in Europe remains mostly bilateral due to challenges related to policy coordination, financing, and development disparities. Hence, in spite of high institutionalization achieved, the lack of a pan-European RE-based grid network indicates structural weaknesses in energy socialization, which reflects the challenges ahead for European regionalization in the years to come.

A region diverse in geography, politics and culture, ASEAN has made meaningful progress in energy-driven socialization, especially in terms of institutionalization. Yet, although rich in potential RE resources, SEA faces challenges related to technology, finance, and governance. At the level of agency, over the years, a sustained dialogue and consensus on energy connectivity have emerged in the region. Agential power seems to be increasing as a number of institutions with capacity to bring together various societal actors have been built over time. Several documents on RE-based grid interconnectivity have been signed by the members under the established institutions. It can be said that while actor willingness is currently being formed in the ASEAN, formalization, problem-solving and discourse making potential of the institutions remain weak as they are still not capable of formulating binding rules (Do & Burke 2023). Besides, actor interaction is limited to the elite with little civil participation in energy-interconnectivity debate. Therefore, structurally, RE governance remains bilateral and within the sovereign power of each state while ASEAN is far from building even a partially integrated energy network.

Of the three regions, Northeast Asia is the weakest in terms of the degree of comprehensive integration in energy. In spite of the existence of complementarities in the region in RE generation and consumption patterns, technological advancement, and financial capabilities, regulatory capacity to build viable institutions remains quite weak due to reluctance on part of the state agents to place themselves within binding institutional frameworks. In fact, lack of viable institutions remains the major characteristics of Northeast Asian regionalism. Thus, energy-related intuitional build-up, too, is lackluster and does not move beyond often-inconclusive statements and visions. The ongoing debate on interconnectivity is primarily done by non-state actors in their private capacity and NEA has yet to formulate a common policy toward the issue. As a result of weak agency, structurally, too, NEA energy integration remains bilateral even though there have been numerous proposals for a region-wide integration since the 1990s.

Table 2: Energy socialization: Two Variables and Four Indicators

		Europe (EU)	**SEA (ASEAN)**	**NEA**
Agent	***Capacity***	High	Medium	High
	Willingness	Medium	Medium	Low

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Structure	***Institutions***	High	Medium	Low
	Connectivity	Medium	Low	Low

We find that, of the three regions, both agentially and structurally, Europe has the most advanced energy socialization. Institutional capacity and the associated political willingness are high in the EU as compared to both SEA and NEA. Although connectivity remains bilateral, due to strong institutional backing, energy-driven regionalization continues to improve quantitatively and qualitatively. In SEA, over the years, a number of steps have been taken to empower ASEAN's formal capacity. However, state sovereignty remains a dominant force on the political scene. The agential power of the institutions, including those related to energy, is not as strong as that of the EU. Structurally, too, much as the EU, interconnectivity remains bilateral even though there has been advances to designate energy grid networking as one of the constituent elements of the ongoing ASEAN economic community build-up process. Hence, within their capacity, numerous ASEAN-related institutions play instrumental role in preventing destructive competition and formulating a sustainable energy governance model for the region.

Finally, lack of sustainable institutions remains the defining characteristic of NEA, including those related to energy governance, thereby, leading to a major agential weakness. Structurally, existing energy interconnectivity is bilateral and lacks cooperative frameworks. Energy socialization in NEA reflects the pace and scope of its regionalization process as characterized by a lack of an institutional core which results in a shallow, fragmented, and idealess region. Its major weakness appears to be actor-related, which leads to structural deficiencies. Indeed, at the level of agency, NEA is devoid of a formal platform to create and sustain regional discourse on significant issues, including energy interconnectivity. Without the framework of a viable institution, NEA actors are unable to maintain sustained and binding interaction, manage differences and disputes, and avoid unconstructive competition. Geopolitical fault lines in the region and its periphery such as Russia's invasion of Ukraine and the US-China competition further complicate the organization of an energy framework conducive to regional dialogue and integration (Lin & Reilly 2023). Accordingly, regardless of the existing material potential in terms of technology and finance, both on the agential and structural level, energy socialization in NEA remains weak.

To further reinforce energy interconnectivity, the three regions are required to capitalize on their strengths and take steps to address existing weaknesses. The European Union may draw on its institutional strength to generate a regionwide interest and common action on the question of physical connectivity, which includes regulations, infrastructure and technology. As for SEA, the region under the ASEAN's institutional leadership is in the process of integration, which appears to be incremental but steady. In this respect, what is missing in terms of capacity and, to a greater degree, existing physical connectivity can be compensated by its strengths in institutions and a healthy regionwide interest in creating a close-knitted economic community, including in energy. NEA, on the other hand, is required to address multiple challenges due to the low agential willingness and almost non-existent physical connectivity. As noticed from the analysis above, a political action needs to spearhead interconnectivity with a view on greater regional integration and common

prosperity. Since energy interconnection requires considerable human and capital resources as well as political will, without a top-down involvement, bottom-up action is bound to be rather slow and inadequate.

5. Conclusion

As a key factor in regional integration, energy provides a critical nexus between socialization and development. Actors' socialization through energy interconnectivity contributes to regional community build-up. Renewable energy-based cross-borders electricity grid interconnection is a powerful socializing agent through a complex and challenging process of regulatory and technical integration. In this study, we constructed a three-case cross-regional analysis to highlight the relative positioning of Europe, SEA and NEA in terms of their degree of energy integration to eventually illuminate the dynamics between socialization in energy and regional development.

It should be stressed that, against the backdrop of recent developments in the European theater with respect to the Russian invasion of Ukraine and the ensuing energy crisis, the nexus of energy and regionalization gains further politico-analytical importance. Since the crisis has generated accessibility and affordability (prices) challenges for Europe, energy stands at the juncture of the course of European integration and regional development for the years to come. Of particular significance is the question whether European policy response will be predominantly nationally focused or it will manage to devise an integrated strategy. In the related literature, one cannot find a clear agreement on this issue. Whereas some analysts suggest that the initial signs are less than encouraging, others stress the incremental progress being made at the institutional level. If the optimist view is to be considered, then, the formal basis of the European regionalism is expected to eventually lay out a common plan in which all stakeholders take part (Osička & Černoch 2022; Nicoli et al. 2023; Kuzemko et al. 2022). Then, the present crisis may be said to contain a certain opportunity to further expand and solidify European regionalism through energy socialization.

As a matter of fact, policy-related developments over the past year indicate that the EU has already taken some concrete steps toward reinforcing the bloc's energy resiliency and security, "includ[ing] "diversifying import routes, developing energy networks and improving cross-border interconnections" (EPRS, 2023). For example, "just 20 days after the [Russian] invasion started, the Ukrainian and Moldovan power grids were synchronized to the Continental European power grid…" (Bottcher et al. 2023). Thus, the invasion of Ukraine has created further incentive to pursue more aggressively the 2015 Energy Union goals, which set regionwide targets on a broad spectrum related to energy security, efficiency, integration and competitiveness. More specifically, adopted in May 2022 in the aftermath of the Ukraine War, the REPower EU Plan aims to further diversify the European energy mix with emphasis on the renewables and reach the 2030 target of each member state to "have electricity networks allowing for 15 % of the electricity produced on its territory to be transported cross-border to neighbouring countries" (EPRS, 2023).

Granted, given that regional development involves a greater number of variables, the agent and structure-based conceptualization introduced in this study is not exhaustive. In our

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study, we have provided preliminary analysis with data on renewable energy resources and electricity integration. Further research could expand the scope of the comparative data, by adding into the analysis integration in other energy resources. This way, it may be found that prior regional cross-borders experience in connectivity in traditional energy resources provides certain paths for cooperation in new energy resources. Such a finding would be valuable especially for regions which are in the very early stages on energy integration. Nevertheless, we believe that an analysis on RE-driven interconnectivity helps introduce valuable insights into the relationship between the processes of energy socialization and regional development. By introducing new attributes and indicators, future studies could further illuminate in a comparative fashion the role of energy interconnectivity in state actors' socialization into a community in regions with disparate characteristics and conditions.

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