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Building energy democracy to mend ecological and epistemic rifts: An environmental sociological examination of Seoul's One Less Nuclear Power Plant initiative

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ABSTRACT

This paper brings together metabolic rift theory and discussions surrounding energy democracy. Energy democracy is interpreted as a political program and social movement to alter the social order in ways that mend the ecological, knowledge, and epistemic rifts of energy systems. The *ecological rifts* of conventional energy systems refer to material separations between sites of energy production, refinement, generation, consumption, and disposal that rupture natural cycles, accumulate waste (e.g., nuclear waste, CO_2), and cause other ecological and social problems. Spaces between nodes of energy systems are also partly responsible for *energy-knowledge rifts* among energy users, or, gaps in knowledge about energy issues, as well as a more general rupture in thinking and conceptualization that divorces questions related to energy from everyday concerns and political discourse – an *energy-epistemic rift*. Seoul, South Korea's One Less Nuclear Power Plant initiative is as an energy-democratic transition plan that begins to mend the ecological, knowledge, and epistemic rifts of energy systems. Along with programs that close ecological rifts, the initiative begins to mend energy-knowledge and -epistemic rifts via citizens' recurrent interaction with nearby renewable systems ("proximate praxis"), energy education programs, and civic participation in decision-making and energy production.

1. Introduction

Beginning in Denmark and Germany, "energy democracy" describes a model of energy transition that puts the development of renewables "largely in the hands of citizens" ([1]: x). "In the hands of citizens" typically means some form of public ownership of energy systems and/or and increased citizen participation in energy policy (see section 2). Thus, the concept of energy democracy is closely related to that of "energy citizenship," which refers to a recognition "that citizens have a right to enjoy the essential energy services required for a meaningful quality of life, but also must take responsibility for the social and environmental consequences created by the production, distribution, and consumption of energy" ([2]: 80; see [3]). This paper is an environmental sociological analysis of Seoul, South Korea's One Less Nuclear Power Plant (OLNPP) initiative, a case study of energy democracy in practice at a city-level. The practical goal is to highlight the achievements of the OLNPP initiative and what other city-level energy democracy programs can learn from the initiative's success, as well as identify areas for improvement. The theoretical goal is to augment conceptualizations of energy democracy through an application and expansion of metabolic rift theory.

A metabolic or ecological rift refers to a rupture in a natural cycle caused by geographic-material spaces ("rifts") between sources of production and consumption, accelerated withdrawals of a resource at the site of production, and the accumulation of waste at another node in the system, often the site of consumption (for review, see [4]). We draw from metabolic rift theory [4,5] and the related notion of epistemic rift [6], to make the case that the conventional energy system is characterized by multiple ecological rifts. Metabolic rift is not yet a dominant analytical framework in energy social science (for meta-review, see [7]: 14ff). However, we think it has much to offer (cf. [8,9]). By identifying the ecological impacts of spatial gaps between nodes in systems, as well as the forces that drive the system in question, the concept of metabolic rift is helpful for explaining the environmental harms of the conventional energy systems. As a movement that strives to localize and socialize control of energy systems and challenge the socioeconomic

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system that drives excess energy use, energy democracy is conceptualized as a movement to close ecological rifts in energy systems as well as mend gaps in knowledge about energy and energy issues ("energy-knowledge rifts") and patterns of thinking that exclude questions of energy from everyday concerns and political discourse (an "energy-epistemic rift"). Metabolic rift theory not only helps describe the environmental political aims of energy democracy, but also illuminates the social barriers it faces.

The OLNPP initiative is a fitting case for examining avenues for mending the ecological, knowledge, and epistemic rifts of conventional energy systems because Seoul is almost completely reliant on energy produced outside of the city [10] and is heavily dependent on fossil fuels and nuclear energy [2]. There are international-level ecological rifts in South Korea's conventional energy system. Further, Seoul's energy transition plan, one example of city-level climate policies that are more ambitious than national-level policies [11,12], is used as a case study because its strategies and guiding values resonate with those of energy democracy and demonstrates the importance of closing the ecological, knowledge, and epistemic rifts of energy systems for actualizing energy democracy. The OLNPP initiative is notable because, along with meeting ambitious energy reduction goals (see section 4.1), there is strong and frequent citizen participation at multiple levels [2] and municipal financial and educational support for community-driven energy transition [13].

Our environmental sociological analysis of the social and technological conditions that are conducive to energy democracy makes three contributions to the literature. First, being the first project to analyze energy democracy from the perspective of metabolic rift theory, we advance the conceptualization of energy democracy. While one co-author of this manuscript was a participant observer as a member of the executive committee of the OLNPP initiative (see [2]), the aim is primarily conceptual, not empirical. Analyzing the OLNPP's goals and programs along with past research on ONLPP outcomes through an environmental-sociological lens, the underlying argument is that democratically controlled and decentralized renewable energy systems increase opportunities to close the ecological rifts of conventional energy systems as well as mend gaps in knowledge about energy issues among energy users (energy-knowledge rifts), and the tendency of modern thought to exclude energy issues or view energy concerns as a special issue rather than integral to everything (the energy-epistemic rift). Second, in addition to developing Schneider and McMichael's [6] notions of "knowledge rift" and "epistemic rift," we identify processes and programs energy-democratic transitions can implement to mend gaps in knowledge and thinking about energy and energy issues. Third, the manuscript makes recommendations for future improvements to the OLNPP.

In what follows, we first review the concept of energy democracy (section 2). Following, we sketch the multiple ecological rifts produced by conventional energy systems, conceptualize "energy-knowledge rifts" and the "energy-epistemic rift," as well as identify routes to address these rifts (section 3). Section 4 summarizes the OLNPP initiative and explains how it begins to mend the ecological, knowledge, and epistemic rifts of energy systems. We conclude by identifying areas for improvement for the OLNPP as well as social barriers that may be faced by other energy-democratic transitions.

2. Energy democracy

Instead of framing energy systems as socially-disembedded and assuming that climate change is merely a technical problem, energy democracy explicitly raises social and political-economic questions about energy governance, fairness in distribution, and the unsustainability of capitalism's growth-dependency [14]. Most fundamentally, energy democracy is a movement to reformulate social structures and consciousness in ways that allow energy to be treated as a commons instead of a commodity [15].

Bringing together common conceptions of energy democracy, Szulecki [16] defines energy democracy as a three-prong project: (1) *popular sovereignty*, where citizens are the "recipients of energy policy," both producers and consumers of energy (energy "prosumers"), and accountholders ([16]: 36); (2) *participatory governance*, which is characterized by inclusiveness, transparency, information access, and education and awareness raising related to energy and energy issues; and (3) *civic ownership*, or some form of collective ownership of power generation/energy converters and/or the energy distributive infrastructure. Similarly, Becker and Naumann [17] typologize energy democracy into three overarching projects: (1) *decentralized energy provision*, where the goal is to take advantage of the distributed nature of solar, wind, and biomass to localize and democratize decision-making in energy policy; (2) *collective ownership of energy systems*, where the goal is to cooperatively or publicly own local- to national-level energy systems; and (3) *energy sovereignty*, a more top-down approach to energy democracy, where the state plays a central role, including the nationalization of the fossil fuel sector.

Energy democracy can also be discussed as political goals, which Burke and Stephens [18] summarize as follows: (1) *resist the dominant energy agenda* (e.g., ending fossil fuel subsidies, halting privatization of energy systems, halting fossil fuel expansion); (2) *reclaim the energy sector* (e.g., local ownership and democratic control of energy companies, returning formally privatized systems back to public control); and (3) *restructure the energy sector* (e.g., guaranteeing energy access for all, sharing energy assets, a shift from focus on growth to a focus on wellbeing).

Energy democracy takes on different forms at different scales, from local-level energy cooperatives (e.g., [19]) and the remunicipalization of utilities at the city-level (e.g., [20]), to proposals to nationalize and phase-out fossil fuel companies (for helpful typology, see [21]; cf. section 5). At the individual level, the key actor of energy democracy is the "energy citizen" [3]. Energy citizenship may include becoming renewable energy producers and taking part in collective energy conservation actions and programs. Szulecki's ([16]: 32) notion of an energy "prosumer" is similar, referring to those who:

> are informed and conscious both of the way the energy system functions, the impacts it has, and their own role in it. They are involved, in the way the participatory democratic imagination envisages, translating their action into political engagement, both direct (political action in prosumer associations and political parties) and indirect (by becoming part of the energy system). The prosumer gains political power through ownership of means of production (of energy).

Energy democracy should be understood in relation to the physical and technical dimensions of the energy converters and systems. Solar and wind especially are energy forms that have a "distributed character" [16]. A long-known issue with, or, perhaps, unresolvable contradiction of, industrial society is how to reconcile the ideal of democracy with the complexity, scale, and rapid innovation of large-scale technological systems. Modern technology is often said to run "out-of-control" [22] and dominate subjects (e.g., [23]). While we do not have room here to discuss the proposed causes of technology-related alienation—for example, whether it is due to the material features of technology itself, social power that shapes and is embedded in technology, and/or the ownership and control of technology—one physical reason the democratization of energy systems becomes easier with renewables is their distributed character. To be clear, decentralization does not guarantee collective ownership and control. In fact, many renewable systems are centralized and/or privately owned and controlled by corporations ([14]: 12ff; [21]). Energy systems are *socio*technical systems (e.g., [24]) – energy infrastructure co-evolves with social-economic systems [25] and social organization shapes what kinds of effects energy systems will have [26]. However, because renewable energy systems are socio*technical* systems that *can* be physically decentralized, unlike conventional energy systems, they *allow for* forms of civic ownership and direct control.

To summarize, the organizing aims of the energy democracy movement are to destabilize, resist, and move beyond conventional energy systems and transition to renewable and just systems democratically controlled by informed energy citizens who control and own the means of energy production. The following section argues that energy democracy is a response to, and attempt to mend, ecological, knowledge, and epistemic rifts in conventional energy systems.

3. The ecological, knowledge, and epistemic rifts of conventional energy systems

The term "metabolic rift" was introduced by Foster [5] in a reconstruction of Marx's social-ecological analysis of the loss of soil fertility. Unlike traditional agriculture that recycled nutrients, capitalist agricultural methods coupled with urbanization and proletarianization created a "rift" between agricultural production and consumption, leading to soil nutrient loss at sites of production (agricultural land) and accumulation of waste at sites of consumption (cities). Foster [27,28] shows how the analysis is part of a broader ecological critique of capitalism's "social metabolic order" (cf. [29]).

The concept has since been more generally applied to examine any "rupture or interruption of a natural system" ([8]: 400). We use the term "ecological rift" [30] to denote more general ruptures in ecological processes [4]. The framework has been applied to understand the disruptions in ecological cycles due to capitalist social organization in a number of diverse arenas, including marine ecology [31], fisheries [32], industrial agriculture [33], and mountaintop removal [34] (for bibliography, see [35]).

Two expansions of the metabolic rift framework are most important for our analysis. First are Clark and York's [8,9] analyses of climate change and the tendency of capitalism to "shift" rather than solve ecological disruptions, including those created by conventional energy systems. The second expansion of the metabolic rift framework important for our analysis is Schneider and McMichael's [6] argument that the separation of humans from agricultural land analyzed by Marx also led to ruptures in knowledge about more sustainable farming ("knowledge rift") and an overall "epistemic rift" that hollows out the natural world from the conceptualization of social issues.

Section 3.1 further expands on work that conceptualizes conventional energy systems as a series of ecological disruptions. Section 3.2 revises the notions knowledge and epistemic rifts in the context of conventional energy systems, arguing that the ecological rifts of energy systems produce a lack of knowledge about energy, energy systems, and energy impacts ("energy-knowledge rifts") and a broader "energy-epistemic rift" characterized by the exclusion of energy issues from everyday patterns of thinking and political discourse.

3.1. *The ecological rifts of conventional energy systems*

By "conventional" energy systems we mean "fossil-nuclear" energy systems [36]. We focus on power generation systems, though our analysis could be extended to other energy-intensive systems such as transportation. We do not go into detail about the specifics of conventional energy systems and their effects here because we assume most readers of this journal will be familiar with these topics. Further, we hope to keep the discussion general enough to be applicable to future research on diverse energy systems. Our goals here are conceptual and explanatory: (1) to depict the conventional energy system as a series of ecological rifts and (2) explain the underlying driver of increasing energy extraction, generation, and use.

Conventional energy systems consist of major nodes, often including extraction/mining, refinement, generation (power stations), consumption (industrial, commercial, residential and public), and waste disposal. These major nodes are connected by links, including pipelines, trains, and trucks between extraction sites and refinement and generation sites; transmission and distribution lines and substations between power plants and sites of consumption; and, at times, transport systems between generation and waste disposal (e.g., Japanese coal companies exporting coal ash to South Korea).

The entire conventional energy system is a massive ecological rift and each link between nodes are smaller rifts within this larger rift. These rifts are physically structured via energy infrastructure, including "the physical infrastructure required for producing, transforming, transmitting, distributing, and storing energy" ([25]: 135). For fossil fuel-based systems, the rift is in the carbon cycle, where "the dynamics of capitalism disrupt the global carbon cycle by greatly increasing fossil-fuel use, which adds long-stored carbon to the atmosphere and oceans" ([4]: 220; see [8]). In nuclear-based energy systems, the rift is formed by overmining uranium and accumulating nuclear waste, often with a rift between mining sites and generation, and between generation and waste storage (e.g., Taiwan exporting nuclear waste to Orchid Island). In both systems, there are the typical characteristics of ecological rifts: shortages in reserves that can lead to more risky forms of extraction (e.g., deepwater drilling, hydraulic fracturing) and, on the other, accumulation of CO_2 and nuclear waste, not to mention other forms of air, water, and land pollution. The discussion here is purposefully general because each specific energy system varies and has diverse impacts and forms of ecological rifts. For example, Austin and Clark [34] show how mountaintop removal creates metabolic rifts in carbon as well as nutrient and water cycles.

Brockway et al.'s [37] comparison of primary and final energy-return-on-investment (EROI) ratios of fossil-fuel energy sources serves as a helpful illustration.[1] EROI calculates "the ratio between the energy delivered by a particular fuel to society and the energy invested in the capture and delivery of this energy" ([38]: 142). Past research reports higher (better) fossil fuel EROI ratios relative to renewables (e.g., [38]). Brockway et al. [37] show that relatively high fossil fuel EROI ratios are based on estimates of the inputs and outputs for energy in its "primary" stage—getting oil and gas to the "well head" and coal to the "mine mouth"—rather than "final" or "carrier" stage (e.g., as electricity or petrol). When direct and indirect energy inputs are considered in bringing fossil fuels to their carrier form—including, for example, energy needed for oil refining, coal gasification, supply chains, and trade—, global fossil fuel EROI ratios drop from ~30:1 (primary energy stage) to ~6:1 (final energy stage). The dramatic reduction in EROI when models account for the energy demands of more nodes in the fossil fuel system, as well as energy inputs required for distribution and transportation between nodes, demonstrates the importance of conceptualizing the energy sector as a system of spatially-dispersed, interconnected, and energy-dependent nodes.

The second dimension of conventional energy systems metabolic rift theory can illuminate is the underlying driver for constant increases in extraction, generation, and consumption. Building on Marx's use of the term "social metabolism," Mészáros ([29]: 39) makes the case that contemporary ecological issues are driven by "capital's order of social metabolic reproduction." "Social metabolic reproduction" refers to the reproductive demands of society and ecosystems. Capital's "order" is unable to recognize absolute boundaries like natural limits due to its need to constantly expand and accelerate (cf. [39]). In relation to energy systems, capitalist processes require a constant expansion of energy throughput, even before the industrial revolution, and creates ecological rifts that are *displaced*—rather than addressed—through relocating after an energy resource is exhausted or shifting fuels (e.g., coal to nuclear, or nuclear back to biomass) (see [9]: 20ff). Capital's social metabolic order is also the fundamental driver of CO_2 emissions associated with conventional energy systems [8].

[1] We would like to thank Dan Kasper for bringing this article to our attention.

Past research explores case studies of local- to national-level projects to mend metabolic rifts, especially those related to agriculture [40,41]. We explore the successes and limitations of a city-level energy democracy project in mending the ecological rifts of energy systems (sections 4.1 and 5). Examined in light of the argument that the conventional energy system is characterized by multiple ecological rifts and driven by a destructive social metabolic order, achieving energy democracy means mending the multiple ecological rifts in energy systems by transforming the social metabolic order.

3.2. The knowledge and epistemic rifts of conventional energy systems

An ecological rift not only physically structures society's material and energy use, it also structures human cognition and knowledge. In a critique and expansion of Marx's analysis of the metabolic rift of English high farming,[2] Schneider and McMichael ([6]: 477) argue that, as proletarianization and urbanization proceeded,

> people physically moved from the country to towns, they took with them not only their ability to recycle soil nutrients (as in Marx's argument), but they also took culturally, historically, and geographically specific knowledges about farming practices and local ecosystems (among other things). … [T]he capitalist division of labour creates a rift in the production and reproduction of embodied knowledge of local ecosystems and potentially sustainable agricultural practices.

This *knowledge rift* emerges with the metabolic rift and is sustained by the town-country antithesis. They also conceptualize a deeper rupture they term an *epistemic rift* or the tendency of thought in capitalist societies to ignore natural variables: "rendering ecological relations and processes extrinsic to social existence" ([6]: 479).[3]

There are homologous knowledge rifts and an overall epistemic rift related to conventional energy systems that emerge with the ecological rifts of conventional energy systems. We use the term "energy-knowledge rifts" to refer to ruptures in knowledge about the energy system and its effects, ruptures that are physically constituted by the ecological rifts discussed in section 3.1. The term "energy-epistemic rift" refers to an overall pattern of thinking that divorces energy issues from everyday life concerns and practices as well as typical discourses surrounding social, political, and economic issues. For example, the energy-epistemic rift even carries over into social theory where few frameworks concern themselves with energy issues. This section expands upon these concepts in relation to residential users of energy supplied by conventional energy systems. To be clear, we do not assume that carbon emissions and other problems related to conventional energy systems are primarily driven by an information deficit among energy users (see below). The causes are mostly systemic, stemming from the very structure of the social metabolic order (see section 3.1). However, as explained below, closing energy-knowledge and -epistemic rifts is a necessary if insufficient condition to challenge the social reproduction of this order.

Energy-knowledge and -epistemic rifts are partially caused by the geographic-material rifts between energy users, on the one hand, and the nodes and links of the energy system, on the other (see section 3.1). Akin to our relationship to the corporate food system where we experience "food from nowhere" [42], the energy that heats homes, cooks food, powers computers, etc. is experienced as "energy from nowhere." In everyday life, there is little knowledge or thinking about energy extraction, transportation, refinement, generation, and disposal or the social and environmental costs of conventional energy systems. One aspect of this lack of knowledge and thinking is the typical person's remoteness from the major nodes of energy systems (e.g., [39]: ch. 3; cf. [43]). Few have precise knowledge about where their energy comes from or the ecological and social consequences of energy systems because they are separated from the centralized facilities, pipelines, extraction sites, etc. This may reduce one's responsiveness to the impact energy-related activities have on the environment and communities.

Yet a lack of visibility of energy infrastructure cannot fully explain energy-knowledge and -epistemic rifts. In fact, familiarity, rather than increasing attention, is often an "obstacle to knowledge" ([44]: 46). For example, just because one has a furnace in one's laundry room—and sees it, though does not *know* it, when one does laundry—does not mean one has the slightest idea about how it works or the effects it has, beyond heating one's house (see [45]). Also, the direct and recurrent use of the laundry machine itself does not necessarily translate into any meaningful knowledge about its energy demands or ecological effects. One often stops thinking about and, instead, merely lives with the proximate and familiar [46].

Along with a lack of proximity, energy-knowledge and -epistemic rifts are caused by a lack of *information* about energy systems. Unless one is interested enough to look for it (see below), there is a dearth of energy-related information readily available to the general public in some countries (e.g., the United States), aside from occasional junk mail from energy companies and perhaps memories of a high school science unit on energy. However, it is important to clarify that "increased knowledge alone does not lead to people taking measures to reduce their energy consumption" ([47]: 455; e.g., [48]). This is why top-down energy-education campaigns, rooted in the information "deficit model" of public understanding [49,50], have had limited impacts on energy-relevant behavior (e.g., [51]; for review, see [47]: 456f). Other factors mediate energy information translating into behavioral changes, such as an interest in and capacity to act on new information [48] and whether the content of information is specific and contextual rather than general [47,52]. However, information is still a necessary if insufficient condition for energy-behavioral changes, or, "knowledge is *one* important part of the package of elements required for action" ([47]: 456).

In addition to a lack of proximity and information, energy-knowledge and -epistemic rifts are caused by a lack of *interest* in, or *motivation* to know about, energy systems, along with a capacity to act on new information [48]. Unless a theme is imposed on consciousness (e.g., when something goes wrong), one typically only pays attention to what one is interested in [46]. One cause, though certainly not the only cause, of a lack of motivation to know or think about conventional energy systems, and the ability to act on knowledge, is little or no *participation* or power in governing energy systems. Decisions are made remotely by engineers and bureaucrats and most people who enjoy the benefits of energy use do so with little responsibility for problems associated with energy use. These social arrangements do not provide any motivation to enhance knowledge about energy use and its effects.

If a lack of proximity, information, and participation together produce energy-knowledge and -epistemic rifts, there are a least three broad processes by which these rifts can be mended, all of which involve increasing understanding, awareness, and knowledge about formerly elusive systems:

- *Proximate praxis*: "Proximate praxis" not only entails increased proximity to energy systems, but also direct and recurrent operation of multiple processes in an energy system (i.e., not just the consumption of goods and services produced by the system). Proximate praxis mends energy-knowledge and -epistemic rifts by enhancing perception, experience, visibility, and "know-how."
- *Education*: Increases in the amount and/or quality of information about the processes, effects, etc. of energy systems. Education mends

[2] Schneider and McMichael [6] develop this notion through a critique of Marx, who is said to suffer from this epistemic rift himself in formulating a critique of English high farming and his value theory (for reply, see [78]). The correctness of Marx's agricultural analysis does not concern us here.

[3] Moore [79] and Hess [80] develop distinct notions of epistemic rift. Moore uses the term to refer to an "epistemological dualism" between Society and Nature and Hess to refer to ruptures in the public's and the state's support for and trust in scientific expertise.

energy-knowledge and -epistemic rifts through enhanced awareness and understanding of energy and energy issues.

- *Participation*: Participation in the decisions that govern energy systems. Participation mends the energy-knowledge and -epistemic rifts because *discourse* generates enhanced information and *power* motivates one to understand the system.
    - o Like participation, responsibility through *ownership* can play an important role in mending energy-knowledge and -epistemic rifts.
    - o Participation may also play a role in altering the social causes of ecological rifts.

No one of the above processes alone can mend the energy-knowledge and -epistemic rifts. For example, while proximate praxis does increase familiarity with artifacts, it does not necessarily enhance perception, and one will not be motivated to really engage with energy education if they are not motivated to increase energy knowledge through more control of energy systems. Indeed, the latter connection between power and education differentiates energy-democratic educational campaigns from the educational materials of utility companies. Only in concert can proximate praxis, education, and participation contribute to mending energy-knowledge rifts of energy systems and, perhaps with time and given new social conditions, the energy-epistemic rift.

We conclude this section with a final qualification. By emphasizing the importance of increasing knowledge and thinking about energy systems among energy users, we are not implying that a realistic counterfactual is a hypothetical society in which most people have extensive and detailed specialized knowledge of all the technological systems that mediate modern life. In reality, modern technological systems are black boxes for the vast majority of the population [53] and out of the control of any one person or group [22], not only because many artifacts and processes are geographically remote, but also because they are extremely complex and rapidly changing. Even if one possessed a comprehensive understanding of many technologies, it is cognitively impossible to attend to all the sociotechnical systems that condition everyday life.

While the drivers of energy overuse and carbon emissions are structural and it is likely impossible for humans to possess precise technical knowledge of the many sociotechnical systems that constantly mediate experience and action, there is a reason that a successful energy-democratic transition requires mending energy-knowledge and -epistemic rifts: the *social reproduction* of the system that drives the ecological rifts of the energy system requires that most people do *not* think or know about these issues. Put differently, to create a movement that strives to put the development of renewables "largely in the hands of citizens" [1]: x) requires a mass of citizens who have heightened awareness about, and control over, energy systems. Increases in proximate praxis, education, and participation are necessary though insufficient conditions for an energy-democratic transition.

Solving energy-related issues presupposes the mending of energy-knowledge and -epistemic rifts. Because energy-knowledge and -epistemic rifts are partially caused by the ecological rifts of conventional energy systems, mending energy-knowledge and -epistemic rifts depend on mending these ecological rifts. The following section examines a case study that attempts to actualize energy democracy at the city-level by mending the ecological, knowledge, and epistemic rifts of energy systems.

4. Mending rifts in Seoul: the One Less Nuclear Power Plant initiative

Following the Fukushima nuclear disaster, climate change-related impacts (e.g., temperature rise and extreme weather events), a blackout in 2011 caused by a power supply shortage, and social resistance over the construction of controversial transmission lines [2], the first phase of Seoul, South Korea's One Less Nuclear Power Plant (OLNPP) initiative was launched in 2012, and formally announced by Mayor Park Won-soon six months after his election. The ONLPP initiative emerged out of, and alongside, grassroots environmental movements and initiatives, such as community energy projects [54]. The name of the initiative was a "symbolic call to arms to reduce conventional energy use and increase renewable energy production to the extent that it can replace the energy production of one nuclear reactor" ([55]: 493). The goal of the first phase was to reduce 2 million TOE (tons of oil equivalent) of energy in around two years by the end of 2014, roughly what is produced by a nuclear power plant. Energy conservation, renewable energy production, and energy efficiency were pursued through strategies such as the construction of the development of an energy self-sufficient village (see below), building retrofits, a program to replace all lights in public areas (e.g., subways) with LED lights, a car sharing program, and nearly half of Seoul participating in a UN Public Service Award-winning Eco-Mileage System [56], which incentivizes citizens to save energy through contests, home-specific information, and other means [57] (see below). The plan succeeded in reducing 2 million TOE of energy 6 months ahead of schedule.

The first phase of the OLNPP initiative was democratic, based on 20 participatory opinion-gathering sessions and then sustained by a citizens committee as well as public discussion sessions and workshops throughout. The emphasis on energy democracy in planning, implementation, and strategy was sustained and heightened in the more ambitious second phase, launched in August 2014, with 2020 set as a target year [2]. Seeking to reduce conventional energy use by 4 million TOE through energy conservation, efficiency improvements, and renewable energy production, reduce greenhouse gas (GHG) emissions by 10 million tons, and achieve a more self-reliant city energy system, the guiding values of the initiative all reflect the normative dimensions of energy democracy: energy self-reliance, energy sharing, and energy participation [57].[4] The more tangible policy goals, which explicitly attempt to produce social-structural change ([57]: pp. 30f; [58]: 105) and bring social and moral questions of energy to the fore [2], also resonate with the notion of energy democracy: decentralized energy production, a low-energy consumption and energy efficient social structure, the creation of green jobs through innovation, and promoting energy sharing.

A core feature of these policy goals is for citizens to become energy citizens [2]. For example, energy self-sufficiency is not only discussed in terms of the ratio of energy produced within the city, but also in terms of citizens becoming energy producers [59]. As explained above, energy citizenship also includes rights to energy. This is seen in the ONLPP initiative in its emphasis on energy sharing, where profits made from citizen investments in renewable projects are donated to energy funds for low-income residents, or, the energy poor: those who use more than 10 percent of their income on energy and suffer the most from winter cold and summer heat.

Energy democracy is core to the organizing promotional strategies as well: to turn 10 million citizens into energy prosumers, rather than just energy consumers; for citizens to internalize the values of renewable energy and energy efficiency; to create high-quality jobs that support sustainable energy development; and for energy participants to use profit from, and donate to charity with profits from, returns on financial investments in renewable cooperatives. Most importantly, many of the programs are deeply democratic, including around 10,000 citizens participating in hundreds of energy cooperatives ([10]: 278ff).

Focusing on the second phase of the OLNPP program (OLNPP 2), the goal of this section is to show how renewable-based decentralized energy systems increase opportunities to mend both the ecological, knowledge, and epistemic rifts of conventional energy systems. Section 4.1 focuses on OLNPP policies that begin to mend the ecological rifts of

[4] These goals were upgraded in 2019 based on a new estimation of Seoul's capacity. The energy target was enhanced into 450 MTOE from 400 MTOE and the GHG reduction target was also increased to 11 Mtons from 10 Mtons.

the energy system. Sections 4.2–4.4 describe how energy-knowledge and -epistemic rifts are addressed through OLNPP programs that increase proximate praxis, education, and participation.

4.1. Beginning to mend the ecological rifts of the energy system

South Korea's dependency on imported energy was about 94.0 percent in 2017—slightly decreased from 96.4 percent in 2011 due to a slight increase of renewable energy use) [60]—due to little domestic extraction of fossil fuel and uranium and relatively low use of renewable energy. The country is a case study in the ecological rifts of conventional energy systems in general, including its electricity system. In 2011, right before the OLNPP was initiated, the electricity self-sufficiency rate of Seoul was just 2.95 percent. This means that over 97 percent of electricity consumed in Seoul was produced in other places and transmitted through other areas. Ecological rifts have caused social conflicts concerning the siting of large-scale centralized power plants and constructing transmission lines and towers. There were severe social conflicts over the construction of 765 kV transmission lines connecting Miryang, South Gyeongsang Province (southeastern Korea) to the Metropolitan area (northwestern Korea). Thus, OLNPP 2 set the goal of 20 percent power independence. 2020 is the last year of OLNPP 2. Seoul's power independence rate increased to 14.0 percent in 2019 [61].

It is not easy to increase the power independence rates of Seoul, where almost 10 million people (around 20 percent of total population) live in a region that is 0.6 percent of the total land size. Also, the amount of solar radiation of Seoul is comparatively lower than other areas because of its higher latitude and relatively less space in a megacity with lots of skyline buildings. In terms of sectoral energy consumption, the share of the industrial sector in Seoul is much lower than the rest of South Korea. Instead, the majority of energy consumption in Seoul is residential and commercial (55.9 percent in 2011 and 54.8 percent in 2017). Shares of city gas and electricity consumption in particular are relatively higher than other parts of South Korea. This means more effort needs to be given to the residential and commercial sectors as well as city gas and electricity consumption (see section 5).

While there are roadblocks to energy independence and closing the ecological rifts of the current energy system, the ONLPP initiative is successful in terms of ecological indicators, the most important being reducing energy consumption from 2011 levels by 5.18 MTOE through renewable energy production, efficiency improvements, and energy conservation by 2019 [62]. It is too early to tell if Seoul will meet the goal of cutting GHG emissions by 20 percent by the end of 2020, though it is worth noting that Seoul reduced carbon emissions by over 9 Mtons between July 2014 and December 2019 [63]. There is good reason to believe that Seoul's achievements in energy reduction and GHG emissions reductions were due to the OLNPP initiative, especially since Seoul reduced GHG emissions and power consumption despite national increases in both ([12,58]: 103f). Further, Seoul was the only major South Korean city to reduce energy consumption and GHG emissions during the first phase of OLNPP. Regarding final energy consumption growth, Seoul has shown negative growth, unlike other big South Korean cities. Its share of final energy consumption has decreased from 13.4 percent in 2011 to 6.4 percent in 2017. In terms of per capita final energy consumption including petroleum, electricity, and total final energy, Seoul shows the lowest level among 17 metropolitan and provincial governments. This is due both to a comparatively lower share of industrial sector energy use and the effect of the OLNPP initiative.

4.2. Mending knowledge and epistemic rifts through proximate praxis

Because proximity is achieved through reductions in geographic space between the subject and the thing in question, closing ecological rifts is a perquisite for closing knowledge and epistemic rifts. In Seoul, more than 40 percent of households live in apartments [64], many skyscraper-based. This means there is only a little space to install solar PVs on rooftops. For this reason, the OLNPP initiated the mini PV program. Mini PVs or micro PVs refer to PV systems that are easily installable in apartment or townhouse verandas that typically produce from 50 W up to 1 kW per unit (usually 250 W per unit).[5] Veranda-type PVs were fitting for Seoul due to the high density of apartments. The city government subsidizes mini PV installation up to 50 percent and most systems are installed by energy cooperatives [10]. Mini PVs help close ecological rifts by matching consumption sites and production sites, even though the amount of electricity generated by mini PVs is not enough.

The success of the mini PV program varied at the district-level based on factors such as institutional capacity, diffusion, public awareness, and political context, especially district mayoral support [65,66]. Early on, the mini PV program suffered considerable obstacles, including the fact that a 250 W mini PV does not produce a large amount of electricity—around enough to power a typical refrigerator—and rumors that the PVs would reduce apartment prices and expose residents to electromagnetic waves [10]. However, the program gained steam in 2016 due to soaring energy bills in response to an extremely hot summer. Also, the peak time of the hottest summer 2018 was pushed from 2:00 pm to 4:00 pm due to shaving effect of mini PVs. At the end of 2019, 284,700 households installed mini PVs with 152.1 MW in total.

The notion of proximate praxis ties together the relation between the ecological and knowledge/epistemic dimensions of what it means to mend the rift of conventional energy systems. In terms of closing the ecological rift, improvements in electricity independence rates are key, meaning more production occurs at the place of consumption. Currently, the target for electricity independence rates of OLNPP 2, 20 percent by 2020, is not enough. However, it still contributes to mending ecological rifts. Actors involved in OLNPP 2 criticized low electricity self-sufficiency rates of Seoul, resulting in shifting ecological burden to other local areas where electricity is produced and transmitted.

In terms of closing energy-knowledge and -epistemic rifts, the explicit goals of the mini PV initiative include "transforming citizens from energy consumers to energy producers and raising their awareness of eco-friendly energy" ([57]: 41). Becoming energy prosumers through mini PVs contributes to mending energy-knowledge and -epistemic rifts. Mini PV installation provides a chance to become energy producers while stimulating people to think about their life associated with energy. Mini PVs became the first renewable facility lay people experienced at their residence. Because of their proximity and visibility, such a small facility can stimulate people to think about energy in their daily life, consider their responsibility for energy use, and, consequently, push them to be aware of the energy system as a whole. Despite the small scale of impact, those who install mini PVs become proud of themselves [2,67] because they feel that they have done something for self-production of energy they consume. While we disagree with some of their ontological claims, Ryghaug et al. ([68]: 294f) provide further evidence that energy citizenship is "co-produced" *with* interaction with PVs. In short, citizens who installed mini PVs can become energy citizens through interaction with mini PVs because they are visible at their residence.

4.3. Mending knowledge and epistemic rifts with energy education

Assuming that an information deficit among residential energy users is *the* cause of energy overuse is misleading (see section 3.2). However, it is still the case that the vast majority of lay people living in industrial societies on a typical day do not think about the origins and delivery of energy. In everyday life, few are concerned about the ecological and human impacts of energy production, distribution, and consumption (cf. [43]). There are multiple social reasons for a lack of knowledge about

[5] It should be noted that larger mini PVs have been available for residential and other buildings since 2015 [10]. We focus on veranda-type PVs here.

and interest in energy and energy issues, coupled with the invisibility of energy itself (e.g., [48]; see section 3.2). Energy systems are not easily understood by lay people because comprehension involves relatively complicated concepts and cognizing energy-related facilities and activities that are not always visible. Further, cheap electricity has been taken for granted in the everyday lives of South Korean citizens for a long time. In South Korea, the government keeps electricity prices low, citing industrial competitiveness as justification. Indeed, Korean energy development has, since the 1970s, prioritized economic growth, not social equity and environmental concerns [69]. In this social context, few wonder where electricity is produced and how it is transmitted. Thus, education is important to help citizens not only recognize that it is their basic right to use energy for their livelihood, but also to raise awareness about the responsibility they must take in using energy. In addition, education can stimulate citizens to participate in the energy decision-making process and facility installation and operation, as well as improve energy practices in their daily life.

As discussed in Section 3.2, new information about energy does not translate into new behavior unless other factors are present, including a motivation to learn. Some residents in Seoul, like residents of Seongdaegol, who are concerned about energy-relevant issues after the Fukushima nuclear accident in Japan in 2011, showed keen interest in gaining more information and knowledge about energy systems. They invited experts for lectures and created opportunities to learn and discuss themselves. In other words, the OLNPP initiative's educational programs were in part successful because of the interest of energy citizens. The Seoul Metropolitan Government (SMG) supported environmental and energy NGOs in education projects, which organized educational programs for residents and mediate experts and lay people in order to enhance knowledge about the importance of energy and self-practice in daily life. Energy self-sufficient villages could enroll in energy education programs supported by the SMG (see below). The educational programs were not limited to lay people, but extended to interior designers, university facility managers, the self-employed, apartment managers, children, students, and more.

It is sometimes said that energy education is a prerequisite to energy practice, or a precondition for energy citizenship. However, an inverted relationship was discovered in the case of the OLNPP initiative. Energy practices adopted through many projects of the OLNPP initiative stimulated energy citizens to feel the need to learn more [70]. The eco-mileage program under the OLNPP initiative is a signature energy-saving program based on voluntary participation of Seoul citizens [56] (see section 3). A participant can receive monthly monitoring reports about his/her energy consumption and how he/she can save electricity, water, town gas, and district heating at home and/or in buildings. "Eco-miles," convertible into eco-products, coupons for more ecological forms of transportation (e.g., public transportation card charging and a bike sharing program), and energy donation credits, are given as incentives. Those eco-mileage participants sometimes came to be concerned about energy issues, beyond economic incentives. In the case of energy self-sufficient villages, some participants make efforts to save energy individually and/or collectively, stimulated or encouraged by other participants without sufficient energy knowledge. Through these practices to save energy, some participants wanted to learn about energy issues. These people also come to acquire the identity of energy citizens through a process, improved practices inspiring the desire to learn more, that inverts normal expectations, learning more to improve practices.

4.4. Mending knowledge and epistemic rifts through participation

Energy education may be unsuccessful without the public's motivation and capacity to learn, and participation is one route to raise motivation and capacity (section 3.2). There are multiple examples of how the OLNPP initiative increased public participation to mend energy-knowledge and -epistemic rifts, two of which we highlight here: the energy self-sufficient village project and support for energy cooperatives. A key program of the OLNPP initiative in place since Phase 1 helps establish energy self-sufficient villages, which are "communities that create profits through energy efficiency and green energy production and implement sharing in connection with energy welfare" ([57]: 60). There are 100 energy self-sufficient villages in Seoul established through the OLNPP initiative. The project is composed of three steps taking place over three years: energy conservation in the first year, energy efficiency improvement in the second year, and energy production in the third year. Participants in this project during these three years are involved in daily energy practices with community members based on information sharing, communications, and community activities, leading to energy awareness improvement [2,58,71]. After the project, community members' networks still work and their perspective on energy improves.

One of the qualitative achievements of energy self-sufficient villages is raising public awareness of energy-related issues, including climate change [13]. This is a key component in closing the knowledge and epistemic rifts of conventional energy systems. The energy self-sufficient village program's success is in part due to the enabling conditions established by the SMG. For example, 4825 households in 45 energy self-reliant villages attended 523 meetings and classes organized by the SMG [13].

Participation in citizens' cooperatives also enhances participants' knowledge about energy policies and institutions as well as energy itself, and contributes to the recognition and acceptance of energy issues as real problems. For example, in order to achieve the goals of the OLNPP initiative, the SMG subsidizes small-scale energy cooperatives under 100 kW through Seoul–type FITs (feed-in-tariffs) and provides public space with lower rental fees and loans with lower interest rates for project financing. This approach has driven the establishment of citizens' energy cooperatives, more than 25 by the end of 2019. By participating in citizens' energy cooperatives, energy systems at large become one of the key issues they must tackle.

To summarize, Seoul's OLNPP initiative demonstrates how closing the ecological, knowledge, and epistemic rifts of conventional energy systems are interdependent goals of energy democracy. The programs discussed above—mini PVs, the eco-mileage program, educational programs, energy self-reliant villages, and energy cooperatives—all contribute to mending ecological rifts through, for example, conservation and renewable energy production and self-sufficiency, as well as mending knowledge and epistemic rifts by increasing awareness of the energy system through proximate praxis, education, and participation (see Table 1). All three processes make the energy system a vivid object of concern that must be attended to rather than a remote, abstract, or indifferent issue.

5. Conclusion: areas for improvement

This paper brings together metabolic rift theory and discussions surrounding energy democracy. Energy democracy is a social movement and political program to alter the social order in ways that mend the ecological, knowledge, and epistemic rifts of energy systems. The ecological rifts of conventional energy systems are material separations between sites of energy production, refinement, generation, consumption, and disposal that rupture natural cycles, accumulate waste (e.g., nuclear waste, CO_2), and cause other ecological and social problems.

Table 1
Mending energy-knowledge and -epistemic rifts.

Processes	OLNPP program illustrations
Proximate praxis	Mini PV program
Education	Eco-milage program; citizen-invited expert lectures; NGO-led educational projects
Participation	Energy self-sufficient villages; energy cooperatives

These ecological rifts are also partly responsible for "energy-knowledge rifts," or, gaps in knowledge about energy issues among energy users, as well as a more general rupture in thinking and conceptualization that divorces energy and energy issues from everyday concerns and political discourse – an "energy-epistemic rift." Seoul, South Korea's One Less Nuclear Power Plant (OLNPP) initiative is an energy-democratic transition plan that begins to mend the ecological, knowledge, and epistemic rifts of energy systems. Along with programs that close ecological rifts, the initiative begins to mend energy-knowledge and -epistemic rifts via citizens' recurrent interaction with nearby renewable systems ("proximate praxis"), energy education programs, and civic participation in decision-making and energy production.

The application and elaboration of metabolic rift theory and the notions of "knowledge rift" and "epistemic rift" in the context of a concrete energy democracy program are our two primary contributions to the literature. This conclusion identifies areas for improvement that can inform future phases of the OLNPP initiative as well as energy democracy initiatives in other regions, which is our third contribution.

Despite its benefits and potentials, the OLNPP initiative faces challenges and can be improved. Ahn ([58]: 117f) identifies three considerations moving forward: (1) the possibility that future Seoul administrations will undermine the structures built by the OLNPP initiative; (2) a need to deepen the initiative to continue to promote energy citizenship; and (3) the importance of expanding from a "stand-alone" policy approach to a "permeation" strategy that alters the entire energy system (e.g., urban planning, transportation). We focus on the third point here, providing the following recommendations to achieve a permeation strategy: the implementation of policies that (1) transform the service sector and (2) reduce fossil fuel use. We discuss each recommendation in turn, highlighting larger political-economic barriers involved in mending ecological rifts (cf. [41]).

First, regarding the need to transform the service sector, it is important to point out that the service sector consumes most of the Seoul's electricity [59]. The OLNPP initiative should consider more transformative programs to alter Seoul's service sector. A successful energy transition is dependent on transforming the economy away from growth-oriented capitalism. A viable energy-democratic transition must democratize the social arenas in which energy systems are embedded, including the economy [21,26]. This also means addressing some of the social barriers to energy democracy, including media misinformation, resistance from stakeholders of conventional energy systems, and institutional barriers from the price system. If energy democracy remains confined to the local-level or even city-level, it risks producing a new epistemic rift, whereby participants think that ecological and social issues related to conventional energy systems have been solved when, in reality, this will only be achieved by transforming the entire social-metabolic order.

Second, policies that directly reduce fossil fuel use are necessary because merely developing renewables does not necessarily reduce fossil fuel development [72–75]. Similarly, as its name implies, the OLNPP initiative should implement policies to directly reduce nuclear development instead of assuming that developing renewables and conserving energy will necessarily displace nuclear energy development. This brings us back to the question of how the physical characteristics of energy converters, distribution systems, etc. influence prospects for democratization and collective ownership. Work on energy democracy tends to assume that all centralization is bad and all decentralization is good [21]. One problem with this assumption is the fact that decentralization does not guarantee democratic control (see section 2). Energy democracy advocates should strive to ensure that decentralized systems are under public control. Another issue is that some energy systems cannot be decentralized yet still must be dealt with. Centralized systems, like fossil fuel and nuclear systems, cannot be assumed away. To phase out centralized systems, the energy-democratic transition movement and governmental initiatives must develop governance and ownership structures that approximate democratic control. One route is the nationalization of fossil fuel companies with high levels of public accountability [21,76].

There are other areas for improvement for future phases of the OLNPP initiative as well as future energy democracy models. For example, most of the renewable energy production achieved by the OLNPP initiative came from bioenergy and waste incineration [59], which are obviously much less desirable than solar and wind development. Another limitation of the OLNPP initiative is it includes efficiency gains as part of TOE energy reductions, which, in comparison to energy conservation and renewable energy expansion, is an approach that notoriously suffers from rebound effects (e.g., [77]). Despite its limitations, the OLNPP initiative should serve as a revisable model for other city-level transition plans, not only for its considerable success in meeting energy goals and develop renewables, but also for its explicit aim to create social institutions supported by municipal policy and funding that conserve energy, create energy citizens, democratize energy governance, share energy surpluses with the energy poor, and socialize energy ownership. These are the seeds that, if spread and scaled-up, have the potential to mend the ecological, knowledge, and epistemic rifts of energy systems.

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