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Strategies of Power and the Emergence of Hybrid Mini-Grids in Lebanon

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“Developing a mini-grid based on renewable energy, and so being independent from the conventional grid and private owners of generators, it’s refusing to pay the bills of government incompetence and corruption. It’s also planning for the future of our village when we’ll have more and more power cuts and less and less subsidy on diesel.”[1]

In this interview extract, a local politician in Lebanon argues that the development of a collective small-scale grid based on renewable energies will guarantee local independence from the failing national Electricité du Liban (EDL) grid and from private generator owners. Without this kind of small-scale infrastructure, the Lebanese suffer from significant electricity rationing and variable power cuts, because of the structural deterioration of the conventional electricity sector following the Lebanese Civil War (1975–90) and the 2006 Israeli war.

Although the EDL grid actually covers almost ninety-nine percent of Lebanese territory, its persistent failures have led households, businesses, and municipalities to bypass it, adopting a range of alternative modes of access to electricity (collective or individual generators, renewable production, storage systems, etc.). As people take steps to cope with persistent shortages and to minimize disruptions to daily life, they have articulated a novel decentralized technical and organizational model.

To explore this new model, this article investigates the operation of collective electricity supply systems, particularly photovoltaic (PV) and diesel local mini-grids, and explores how these sociotechnical innovations strengthen or destabilize local and national solidarity. While this kind of local collective infrastructure has succeeded in guaranteeing energy security on a small scale, access to the technology needed to implement it is unequal, and depends on the capacity of local actors to mobilize economic and political resources.

A Wide Variety of Modes of Access to Electricity in Parallel with the Conventional Grid

The Lebanese national electric utility, Electricité du Liban, does not produce nearly enough electricity to meet Lebanese demand. In 2018, it covered just sixty-three percent of electricity demand—a shortfall of 1.5 gigawatts (GW). This is equivalent to the amount of power needed to more than 430,000 consumers in Lebanon (considering the average consumption of an EDL subscriber regardless of the sector). EDL, which operates under the supervision of the Ministry of Energy and Water (MoEW), is a near monopoly. It controls

ninety percent of electricity production, transmission, and distribution sectors in Lebanon. With the exception of two relatively small concessions, EDL is the only operator authorized to sell electricity directly to consumers in Lebanon.

Despite this monopoly, privately-owned diesel generators have been an integral component of the Lebanese cityscape since the nineties. At the end of the civil war, some households bought generators individually or collectively to compensate for power cuts. But diesel generators soon became profitable business opportunities with neighbourhood-based subscription services. Private generator owners offer monthly subscriptions to the inhabitants of the district they invest in. In 2019, diesel generators provided electricity to eighty-four percent of the population during load shedding (electricity rationing).

The supply offered by private generators is often held up as an example of the alleged individual entrepreneurship of the Lebanese in the face of policy failures and infrastructural breakdown (e.g., electricity shortages). However, scholars argue that this situation is a political artifact of particular regimes of tolerance and regulation at both the national and local levels. Though illegal, authorities tolerate these supply systems, considering them a residual and temporary palliative to power cuts. Locally, business regulations governing subscription rates and managing competition depend on the relations between municipalities and generators' owners. Despite being framed as a temporary stop-gap, these generators have been operating for so long that their owners hold local micro-monopolies. Furthermore, by offering alternatives to households with the financial means to pay a second bill, this system deepens socioeconomic and territorial inequalities. Diesel generators cost three times more per kilowatt hours (kWh) than EDL tariff. Moreover, areas outside Beirut, especially in the poor regions of the North and South of Lebanon, suffer as much as four times as many power cuts as the city.

At the same time, for over a decade distributed renewable energy systems have been blooming throughout Lebanon. Driven by the need to secure electricity supply and cut down bills, households, businesses, and municipalities have installed distributed renewable production systems like photovoltaic installations. Because renewable energies and the Lebanese grid are both intermittent, renewable systems require fallback sources of power. So, most installations are actually hybrid systems which incorporate diesel generators, photovoltaic panels and sometimes batteries. Hybrid systems have promise for both individual and collective production. In some localities where supply is insufficient, municipalities have set up hybrid PV/Diesel mini-grids ranging from 80 kilowatts peak (kWp) to almost 800 kWp. An 800 kWp mini-grid can potentially cover the average consumption of 500 to 1,300 rural households in Lebanon for basic needs (low consumption).[2]

Construction of Powers and Access to Electricity

The proliferation of mini-grids, along with the continued operation of diesel micro-monopolies and the national grid has led to a massive diversification of Lebanese energy supply configurations. The rest of the article explores four distinct mini-grids based on renewables and diesel in order to understand how and to what extent the development of renewable energies has destabilized existing sociotechnical configurations and associated local social and political systems. It argues that the configuration and regulation of these

local electricity services is primarily determined by the interests, powers, and strategies of the dominant actors in the project. Electricity provision is locally regulated by a set of technical, political, economic, social and cultural factors, which explains why access to electricity varies depending on the territory. In this context, local governance is not monolithic, but rather refers to complex plural systems of actors and resources. Consequently, mini-grids vary spatially and in terms of their effects on social, environmental and territorial justice.

Different strategies, interests, and actor systems have shaped the collective energy systems in the four municipalities the article explores. Respectively, they reflect the development of energy systems for community empowerment (1—Baaloul), the municipal electricity service as a tool for local government and political legitimacy (2—Menjez), international experimentation as an instrument of public policy and national reform (3—Qabrikha), and the lucrative entrepreneurship project for new markets and ventures (4—Jabbouleh). These four case studies highlight the essential role of municipal and national public actors, but also private players, in reconfiguring local energy territories in Lebanon.

The article focuses on small, rural municipalities (between six hundred and three thousand inhabitants) which have developed collective electricity supply systems that incorporate renewable energies in the last five years. It is based on fieldwork conducted in 2020 and 2021 in four Lebanese municipalities of different sizes and diverse communities. The research used a qualitative method including field observations, press and social media review, and semi-structured interviews with residents, local elected officials, buyers, and providers of renewable energy equipment.

The Community-led Project for the Construction of Territorial Commons

The mini-grid of Baaloul was described by the president of the municipality, Mohammed Nasser Mohieddine, as "a common good in which everyone is a partner." The local grid, which embodies a cooperative and participatory model, was financed by fundraising,[3] is owned collectively and is governed by a collective decision-making process which determines investment, fees, and hiring. The development of the mini-grid is based in the strong solidarity of a relatively homogeneous and well-off community.

Baaloul is a rural residential municipality located in the Western Bekaa which experiences six to twelve hours of daily power cuts. With six hundred inhabitants in winter and up to 1200 in summer, Baaloul is a majority Sunni and Spanish-speaking municipality. The residents have close personal and professional links with Latin America due to immigration from Lebanon to the South American continent dating from the nineteenth century. Local politics is characterized by a strong collective commitment of the inhabitants to the protection of the local environment,[4] in particular through the "Junta de Baaloul," a participatory committee which brings together volunteer residents to discuss municipal projects.

Before 2012, most of the inhabitants of Baaloul had their own individual generators, while others were connected to a private generator whose owner charged high tariffs and did not offer night-time supply. Dissatisfied with the services of the private generator's owner and

the pollution caused by individual generators, the inhabitants decided in 2012 to install their own local diesel grid funded by Baaloul families and the rich immigrant diaspora in Latin America (\$300,000 for two generators of 650 and 500 kVa,[5] as well as transmission lines and individual meters). In 2018, Baaloul received a grant of \$200,000 from the USAID-funded BALADI project to install 80 kWp of photovoltaic panels to replace some EDL and diesel consumption with solar energy.

The BALADI project, "Building Alliance for Local Advancement, Development, and Investment," is a program funded by the United States Agency for International Development (USAID) and carried out by CARITAS and the René Moawad Foundation, two foundations whose mission is to develop projects around issues of access to basic services such as education, health, or energy for the benefit of Lebanese communities and municipalities. CARITAS and USAID selected Baaloul on the condition that they also provide solar energy to the Syrian refugees living in a nearby camp. However, the refugees benefit very little from this project. They are not integrated into local decision-making processes, and do not benefit from the electricity of the generators. Syrian refugees only receive solar electricity via the EDL grid when it is available to reduce their bills (so rarely). The residents of Baaloul seized this funding opportunity for their own community by including the hybrid mini-grid as part of the local community project "Baaloul Verde," which aims to protect the living environment by reducing pollution from diesel generators.

This project is interesting because it is not owned by the municipality, but by the inhabitants, and profits are directly distributed to inhabitant-shareholders. The tariff is locally determined according to the price of diesel, the salaries of the employees who manage the municipal electricity sector, and the cost of maintaining and replacing generators. The integration of solar energy into the grid increased profit margins, making it possible to reduce the bills of all village inhabitants by fifty percent, twice, and apply tariffs lower than those proposed by the government. By mobilizing civil society in decision-making, project financing and the redistribution of profits, this project has strengthened local solidarity.

The Demonstration Project to Legitimate the Municipal Regulatory Capacity

The second mini-grid, in Menjez, was spearheaded by a local leader (the mayor), and primarily embodies his political project. Menjez, which is located in Akkar on the northern border of Lebanon, is a rural municipality created in 2012 with one thousand inhabitants, mostly Maronites. In office since the municipality was created, the mayor has worked to promote spatial development initiatives in close partnership with international actors who subsidize environmental and local projects.

Until 2013, there were few alternative sources of electricity during EDL cuts, which were about twelve hours per day in Menjez. A minority of the inhabitants were connected to a private generator, whose owner charged very high tariffs. Consequently, in 2013 the municipality funded and installed a municipal grid of generators (two generators of 180 kVa and 300 kVa, transmission lines and meters for the three hundred subscribed households). In 2018, after applying for USAID's BALADI project, the municipality got a grant of \$200,000 to install 100 kWp of solar panels.

For this young municipality with its new municipal team, the municipalization of the hybrid PV/diesel mini-grid is a tool to legitimize the local government. Unlike in Baaloul, the Menjez grid belongs to the municipality, which largely controls the energy committee and its decisions. The mayor, who chairs the energy committee, applies the Government's tariffs for generator subscriptions, and profits are not directly redistributed to the inhabitants but are included in the municipality's budget and used to finance other local projects. Thus, the supply of electricity in Menjez is becoming established as a fully-fledged municipal sector of action.

Additionally, unlike in Baaloul, BALADI's project (funded by USAID) was not implemented by CARITAS, but by the René Moawad Foundation (RMF) which is headed by Michel Moawad, a former member of the Parliament and of the World Maronite Foundation. Michel Moawad is able to use this kind of project to promote himself politically, presenting himself as the sponsor of BALADI projects and of the local, social and rural development that RMF promotes. This has helped him conquer electoral territories around Zgharta district and more broadly in northern Lebanon, and also differentiate himself and his party, the Independence Movement, from other traditional Christian parties. It is interesting to note that the mayor of Menjez won the municipal elections with an independent list against two opposition lists made up of traditional Christian parties, the Lebanese Forces and the Free Patriotic Movement.

While the Baaloul and Menjez mini-grids are technically quite similar, they have been shaped by divergent sociopolitical interests. However, both projects carry significant legal risks. Theoretically, these projects are illegal, because they involve the resale of electricity by a third party to private consumers without a license. But the EDL's position is ambiguous. In Baaloul, the EDL has tacitly recognized the legitimacy of the local grid, and even integrated it into the national grid, through the installation of "net metering" on the meter for public lighting and on the meter for the refugee camp.[6] Net metering is a technical and legal mechanism which enables electricity exchange between the conventional grid and a subscriber who produces renewable energy for their own consumption (a "prosumer"). Through a bidirectional meter, the prosumer can either take electricity from the grid or feed electricity back to the grid depending on their level of production and consumption.

Despite their potential, the Baaloul and Menjez mini-grids do not solve the fundamental problem of collective solar energy production in Lebanon: How should municipalities with substantial solar energy production use the energy when local consumption is low while the solar production is high and EDL available? To solve this problem and support small municipalities in developing local renewable generation, CEDRO,[7] a project of the United Nations Development Programme, designed a system to exchange this excess energy with the EDL grid.

International Experimentation as an Instrument of Public Policy to Reform a Monopolistic Model

In 2014, CEDRO selected the village of Qabrikha to host the first pilot project of "community-led virtual net metering." CEDRO is a project of the United Nations Development Programme

(UNDP), created in 2007 through a partnership with the MoEW within the framework of the Lebanese Recovery Fund to foster the development of renewable energy market in Lebanon (encourage demand for renewable systems and structure the offer by financing suppliers). To this end, the Qabrikha pilot project aimed to rescale the net metering mechanism at the collective and municipal levels through a European Union grant (\$300,000).

Because the main issue in residential photovoltaic production is the mismatch between production (sunshine during the day) and consumption schedules (residential consumption in the evening), devices are needed to store solar energy produced during the day for evening consumption. Net metering makes it possible to use the grid as a storage system. When solar power is not available, the household can consume electricity from the conventional grid, but when the household generates more electricity than it uses, it can feed it back to the grid and the electricity meter will work backwards. While this mechanism has existed in Lebanon since 2011 for individual consumers, CEDRO wanted to generalize it for collective production distributed across multiple meters.

Qabrikha is a suburban municipality with almost 3000 inhabitants in a hilly area with villas in the south of Lebanon. Before the beginning of the CEDRO project, the municipality bought up generators which belonged to private owners and installed meters for its 350 households. Then, in 2016, a 250-kWp photovoltaic system was connected both to the EDL and to the local diesel-generator grid, with smart meters for all subscribers. In December 2018, EDL and the energy committee of Qabrikha formalized the project, with a contract covering 124 participating households. Thanks to CEDRO's experimentation and to solar energy, the beneficiaries of the mini-grid should see a reduction not only in their generator bill, but also in their conventional EDL bill. Unlike in Baaloul and Menjez, surplus solar energy exported back to the EDL grid should be deducted from local utility bills. So, for example, if the municipal PV system produces 20,000 kWh and 100 residents participate in the project, then EDL would have to deduct 200 kWh from every individual invoice.

The main goal of this experimental project led by an international player was to encourage the EDL to reform its monopolistic model, and to foster the decentralization of collective energy systems. However, despite the formal agreement with the EDL, "community-led virtual net metering" has not yet been implemented because of a lack of EDL cooperation. EDL is not capable to provide the electricity bills after deduction of the local photovoltaic production value (lack of skills and human resources). The system's problems are not only technical but also reflect the reluctance of the national utility to risk eroding its monopoly by promoting decentralized energy systems.

So, to fill the gap created by the lack of technical and legal mechanisms negotiated with the public monopoly, several companies in other Lebanese villages have not only bypassed the public grid but are competing with it by offering consumers an autonomous energy supply with batteries.

The Lucrative Entrepreneurship Project for the Conquest of New Consumer Markets

Several Lebanese renewable energy companies have recently started marketing hybrid PV/Diesel mini-grids in order to diversify their activities and market shares. These capitalist players designed collective renewable electricity supply systems that they install in rural villages, where they provide residents with monthly subscriptions. Their goal is to use batteries not only to provide electricity during outages but to supply electricity twenty-four hours a day. Generally, these companies aim to develop an autonomous and competitive energy offer to EDL through attractive economic models and tariff structures for consumers, who are encouraged to consume more energy on the local grid than on the national one.

The mini-grid in Jabbouleh was developed in a territory with no competing private generator owner, in close partnership with a local convent of nuns. The latter signed a Build-Operate-Transfer contract which establishes that the private investor (Kenergy) and the operator (Matrix Energy) will operate the mini-grid for twelve years, after which the convent will recover the property and management of the system. The investors partnered with the convent rather than the municipality because the convent had the land necessary to install the solar farm.

With an investment of \$1.8 million, the system is made up of 800 kWp of solar panels over 15,000 square meters with 500 kWh of batteries, three generators of 330, 200 and 160 kVa, transmission lines, and prepayment meters for the 340 subscribers. The tariff structure is based on profitability and cost optimization with a variable tariff depending on the EDL rationing hours (to make the tariff more attractive than EDL when the national grid is available). Unlike the municipally and collectively-owned projects in Baaloul, Menjez, and Qabrikha, the electricity suppliers in Jabbouleh have adopted a market-driven strategy and participate in the commodification of electricity services in territories considered to be potential consumer markets.

Conclusion

These four case studies show the great diversity of strategies, powers, and interests driving the development of mini-grids. This diversity is the result of territorial differentiation, caused by different systems of actors, local governance and sociopolitical regulation. Energy change is a multiscalar, fundamentally political process, which shapes and is shaped by technical, political, and social systems in relation to one another.

This article began with the question of how renewable energy-based mini-grids destabilize existing sociopolitical configurations and solidarities. Ultimately, I found that these emerging systems do not radically reconfigure local energy territories but rather reflect structural dynamics and hybridize existing systems.

If only some socioterritorial conditions foster the development of mini-grids, their use and proliferation raises questions of social and territorial justice. The projects in Menjez, Baaloul and Qabrikha were possible because of the capacity of local and/or international actors to

mobilize external funding. In areas with limited financial, human, and technical capacities, private interest in investment could compensate for the lack of public action (like in Jabbouleh). However, substituting a private service for a public service, or leaving each municipality to chart its own path, raises questions of national solidarity. By widening inequalities between well-off communities capable of securing their electricity supply, and the most precarious communities, which are neither an attractive market for investors, nor endowed with a municipality capable of mobilizing external funds, this dynamic risks exacerbating Lebanon's socioterritorial fragmentation.

While hybrid mini-grids offer opportunities to reduce costs and dependence on fuel oil, to strengthen community capacities, and to reduce the pressure of electricity demand on the national grid, they also create the risk of social and territorial polarization between those who have access to these alternative systems and those who remain trapped by failed conventional infrastructure.

[1] Author interview with a local elected official, 14 March 2019.

[2] In Lebanon, a rural household consumes on average between 80 and 200 KWh per month. To cover this residential consumption, a rural household would require a PV system ranging from 0.6 kWp (for 80 KWh per month) to 1.5 kWp (for 200 KWh per month). However, as renewable energies are intermittent, an additional source of energy is necessary (batteries or generators in addition to the conventional grid which is not available 24/7).

[3] The mini-grid was funded by donations gathered from locals and the diaspora on a voluntary basis and now inhabitants hold shares in the collective electricity supply system.

[4] The protection of the local environment results in securing the municipal space with a video camera project and 24-hour security guards, a village beautification project with public gardens and work on roads and sidewalks as well as the development of a water and a sanitation network.

[5] On average, a 500 kVa generator is supposed to supply 312 consumers for a 5-amp subscription (Ahmad, 2020). So, a system with two generators for a total of 1150 kVa can theoretically provide 718 consumers for 5-amp subscriptions. For instance, a subscription of 5 amperes will cover at most the electrical needs for a fridge, a television, some kitchen appliances, and a washing machine. But in Baaloul the consumption of the inhabitants is higher than the Lebanese average, and subscriptions range from 5 amps to 40 amps.

[6] It must be emphasized, nonetheless, that in Baaloul the net metering mechanism only works for the municipal lighting meter, the inhabitants do not take advantage of this mechanism (which differentiates it from the following case Qabrikha).

[7] CEDRO: Country Energy Efficiency and Renewable Energy Demonstration Project for the Recovery of Lebanon.