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Taking Control of the Energy Crisis: Proposing a community-owned solar panel system in Beirut, Lebanon

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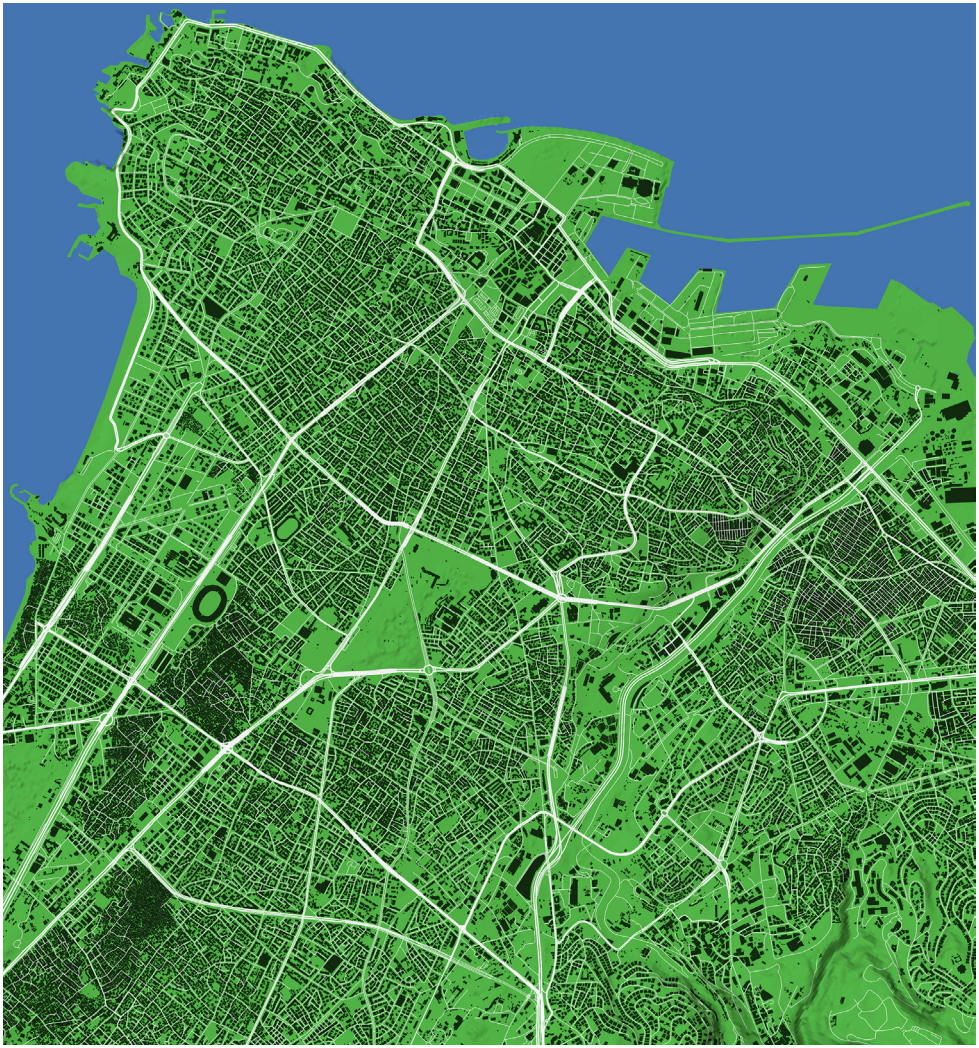

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Cover: map of Beirut, Lebanon - Chris Craig-Neil

Contents

Foreword

Dr. Antonis Vradis

There has never been a more pressing need for community-stemming solutions to the great environmental, social and political challenges of our time – and the Middle East at the current conjuncture is living proof of this, and of the great tragedies that can unfold if authorities act in defiance of, and against the interests of their people. It is for this reason that Seema Machaca's intervention is crucial as much as it is timely: a hands on, practice-oriented proposal that promises to offer a tangible solution to a pressing challenge that plays out at the everyday level. What is most enticing with the proposal that you will find in the pages that follow, is that it masterfully combines a strong grasp of the historical context of the Sabra neighbourhood with a detailed and actionable plan for a community-owned and shared de-centralised solar (PV) system that – crucially – will involve all key actors and stakeholders in the neighbourhood, thereby ensuring both its feasibility and longevity. At a time in history when the news cycle is (rightly) dominated by horrific news, this plan, realistic in its huge ambition, offers a glimmer of hope and a snapshot of what our collective future might look like, if communities seize the moment and come to the fore.

Introduction

Beirut, the capital of Lebanon is home to diverse communities and has a rich and lively culture. Spending the majority of my summers in Beirut since I was a child, has given me insights into the love people have for the city, but also the daily struggles of Beirut citizens since the 15-year civil war started in 1975. More recently, Lebanon has simultaneously been dealing with five crises which are heavily centred around governmental mismanagement (Moore, 2023). These include the Syrian refugee, economic meltdown, and post-covid crises; as well as dealing with the aftermath of the August 2020 Beirut port explosion and the continual effects of climate change. In fact, the World Bank (2021) listed Lebanon as one of the top 3 countries experiencing the most severe crises since the mid-1900s. These crises combined, specifically, the lack of effective governance and severe economic crisis have resulted in an almost complete loss of electricity in the city. I do not pretend to understand the full extent to which the communities in Beirut have been affected by my short yearly stays in Lebanon, however, I will attempt to provide community-led alternative solutions to the energy crisis that move away from government involvement, the root cause of the current conditions in Lebanon.

The Community

The Sabra neighbourhood, defined by the UN-Habitat (2019) as a 'disadvantaged neighbourhood in Beirut' is a diverse bubble of about 6,215 inhabitants. Made up of about 50% Lebanese citizens it also hosts Syrian and Palestinian refugees, and it acts as an extension of the Shatila refugee camp found in the neighbouring community (UN Habitat, 2019). The struggles faced by this community are deeply rooted in its horrifying historical context. In 1982, during the Lebanese civil war, the Shatila refugee camp and neighbouring community of Sabra were attacked by a Christian militia group (Phalange), who were aided by the Israeli army which was occupying Lebanon at the time (Al Jazeera, 2022). The Israeli army surrounded the district to allow the Phalange militia to enter and attack civilians for over 2 days. Around 3,500 lives were taken, and this massacre was deemed an "act of genocide" by the UN General Assembly, however, neither party was ever held accountable for the tragedy (Al Jazeera, 2022). To this day, the people of Sabra are still dealing with the effects of this massacre. Currently, most of the

Sabra residents are in the low-income bracket and do not have access to adequate living conditions, most importantly a reliable source of energy.

The Challenge

Environmental justice is heavily discussed in the literature tackling 'sustainable cities'. According to Pearsall and Pierce (2010), environmental justice, a theoretical concept focuses on (1) how environmental burdens are divided among groups of people, and (2) the rights of the people to take part in the environmental decision-making process. (1) was defined as distributional justice and (2) as procedural justice. Sabra provides a clear example of this theoretical concept of distributional injustice in a tangible setting as lower energy poverty is correlated with households that have higher degrees in education (Dagher et al., 2023). Thus, this community which is comprised of a majority of low-income residents and refugees, have less accessibility to good education, in turn leading to disproportionate effects on energy justice. Furthermore, only 10% of the residents have fully functional electricity grids supplied by the government (UN-Habitat, 2019). After the 2020 port explosion, the technical problems with the electrical grid increased because the power grid infrastructure was heavily damaged throughout the city (Tarnini et al., 2023). So, with an average household receiving only 2 hours of electricity a day, private diesel generator (DG) systems have become the new electricity market in Lebanon (Simet et al., 2023). The DG systems are only accessible to higher-income households, which clearly represents procedural injustice as the Sabra community did not have control over this DG energy transition (Simet et al., 2023).

This energy crisis affecting all of Lebanon has roots in Moore's (2023) '5 crises' discussed above. To provide some context, the economic crisis began in 2019, when the Lebanese Lira inflated by 8580%, a jump from 1 USD = LBP 1,515 to 130,000 in 2023 (Tarini et al., 2023). Not only does the Human Capital Index show that citizens are underperforming because they don't have access to basic public service rights but, Beirut is a coastal low-lying city, so the climate change crisis is becoming increasingly apparent (Moore, 2023). The term 'crisis' acknowledges the different challenges faced by this community, however, Sirri (2021) indicates that

this term crisis is typically associated with a short-term or recent problem. The corruption and mismanagement of the post-war Lebanese government is directly correlated with the collapse of public industries like the energy sector (Simet et al., 2023). These 5 crises come from a long history of political turmoil that has led to deeply rooted social, environmental, and economic, inequalities. Thus, the importance of multi-stakeholder involvement and long-term strategies like the community-led energy approach suggested below becomes increasingly more valuable in addressing these problems.

Community Response So Far

Most communities in Beirut have relied on DGs, which was a practical solution in the past when the government subsidised diesel. However, this led to smuggling and illegal activities which then led to a shortage of this energy source, and consequently, the subsidies were removed (Dagher et al., 2023). DGs heavily contribute to climate change, but more importantly, their use is increasingly expensive with the subsidy block. For households, the market value of DG systems is at 2 billion USD, a large waste of money in providing energy (Adbdelnour et al., 2023). For low-income households this option, puts an unsustainable financial burden on families attempting to gain access to basic public services. On a more positive note, Zahle, the third largest city in Lebanon, has implemented hydropower and has seen a decrease in energy poverty and reliance on DGs (Dagher et al., 2023). Considering that so many of the country's problems are rooted in the instability and corruption of the government, it is not always possible for communities like Sabra to depend on the municipality for real change, as seen in Zahle. Thus, several higher-income households have opted to install their own photovoltaic (PV) systems. How can we make this more accessible to low-income communities like Sabra?

Suggestions Moving Forward

Overview

Lebanon receives about 300 days of sun per year and experiences 7 months of a

dry season (Moore, 2023). With renewable energies becoming increasingly more affordable, there has been a steep increase in solar panel usage (81%) in Lebanon from 2010-2020 (Adbdelnour et al., 2023). In fact, diesel energy is about 45 cents per kWh versus solar energy at 9-10 cents per kWh. Hence, the PV systems are becoming more appealing to Lebanese communities. Other renewable energies like hydropower and wind energy could be successful, however, this would likely need involvement from the municipalities and government. Similarly in the past, the idea of solar farms in Lebanon has generated ambition but has been unsuccessful for urban communities as they are less accessible (Moore, 2023). Whereas solar panels can be placed directly on the buildings in Sabra, especially considering that 85% of its buildings are mixed-use and/or residential and are suited for community sharing (UN-Habitat, 2019). Thus, this community briefing suggests the implementation of a community-owned and shared de-centralised solar (PV) system.

At this stage, most consumers buy private PV grids that are used interchangeably with a few hours of government-provided energy in a day. However, Adbdelnour et al. (2023) explain that these two systems are used in conjunction because the few solar panels purchased by each household do not supply enough reliable energy for the household's daily requirements. Thus, as suggested by several other scholars in the literature, Adbdelnour et al. (2023) propose a Peer-to-Peer (P2P) energy trading system. Essentially, it is a bottom-up (community-led) energy exchange platform that makes the energy consumer a 'prosumer' and allows them to sell and buy energy based on their household needs (Trivedi et al., 2022). Therefore, excess energy will not be wasted, instead, it is shared around the community. In this suggestion, Adbdelnour et al. (2023) propose that the initial significant investment to purchase solar panels will come from community members. Unfortunately, in the case of the Sabra, this is not an achievable option. Thus, further funding opportunities will be discussed below.

A PV system for the size of the Sabra community can be defined as a micro-grid system. The development of microgrids is becoming increasingly popular in Lebanon and all over the world as it localises and decentralises renewable energy sources. Two somewhat well-known microgrid set-ups in Lebanon have inspired

the Sabra initiative, the Baaloul project and the Menjez project. Baaloul, a town in the Bekaa Valley of Lebanon received funding from USAID, and support from CARITAS (a catholic-relief organisation) to develop community-owned PV micro-grids (Social Impact Inc., 2020). This initiative was extremely successful and reduced household and municipal energy bills by 25% (National News Agency, 2018). However, Chaplain (2022) notes that although this was community-led in partnership with third-party organizations, the Syrian refugee population was not included in decision-making and consequently did not gain much from the initiative. This once again depicts procedural injustice as they now only receive energy when it is in excess, which is rare. The Menjez project, on the other hand, was not as successful. This project also received funding from USAID, however, this micro-grid is supported by the René Moawad Foundation (RMF) instead of CARITAS. The RMF is a political relief organisation, that now use this initiative to control the region. Furthermore, this initiative is owned by the local municipality, meaning that they take tariffs on the energy and the community does not receive any profits. For these reasons, the suggested Sabra initiative will not involve the government or local municipalities and will aim to find alternative approaches over an involvement with political actors.

A Decentralised On-Grid System

As highlighted above, a decentralised community-based microgrid (C-MG) solution has been chosen. Trivedi et al. (2023) lays out various C-MG strategies based on the existing literature including centralised, distributed, and decentralised approaches. A decentralised structure is best suited for the Sabra because it has comparatively moderately high levels of community engagement, a high possibility for scalability in the future, and is relatively less complex.
Let us break this down further. The American University of Beirut (AUB) and SOAS University of London held a workshop in 2021, that analysed 'models for tackling Lebanon's electricity crisis'. They explained that the increased use of renewable energy in Lebanon has occurred out of necessity and has been particularly successful when the private or community sector is involved (either from an investment or managerial standpoint) (ACE, 2021). This urges the need for a decentralised approach. ACE (2021) agree with Trivedi et al. (2023) in that this system would make a consistent energy supply more accessible to different

community members and reduce the energy monopoly based on DGs. Gaining access to reliable energy sources for Sabra could have significant positive impacts specifically around daily life. Giving access to these basic human rights allows for stronger development of the community and an 'urban citizen' thus giving ownership of the city to the people (Moore, pg. 170, 2023) (UCL, 2020).

ACE (2021) do pose the challenge of the large initial investment for the PV systems. As discussed in more depth below, taking a loan could be a possible approach to alleviate the financial burden. However, this approach implies that the initial instalment of the solar panels in Sabra is used in combination with the existing DGs. The Beirut Arab University's (BAU) transition to renewable energy inspired this mixed approach for the initial phase of the Sabra C-MG system (Tarnini et al., 2023). Before implementing any changes on the campus, BAU scholars used HOMER, a platform that runs simulations of various energy systems. They simulated off-grid solar, on-grid solar, and DG systems. Tarnini et al. (2023) found that the DG system was impractical from a financial standpoint in the long run and was environmentally unsafe. The off-grid system was the most sustainable and environmentally friendly, however, the high investment costs, lack of available land, and 'system reliability' issues made it unsuitable for this institution. The on-grid PV system in combination with DG, when necessary (in winter months), had the best return on investment and allowed for the DG's to be used less, also lowering their maintenance and operational costs. The on-grid PV system was successfully implemented at the BAU university campus. The strategy and implementation will be different in Sabra as this is a bottom-up approach compared to the institutionally driven project at BAU. However, this initiative provides concrete evidence that a C-MG strategy is a practical approach to reducing energy poverty at a localised level.

Implementation

Stakeholders

This initiative would be a multi-stakeholder approach involving local and international actors. In both the Menjez and Baaloul projects, sustainable change was implemented with the involvement of various parties. The Sabra neighbourhood has worked with the UN before to improve the living conditions

on El Jazzar Street in Sabra (United Nations, 2021). The organisers put community engagement at the forefront of the project, allowing women and men from various nationalities and ages to decide on infrastructural changes that would lead to a better quality of life. Although a small initiative, it gives an insight into the possibilities of collaborating with the Sabra community in achieving a sustainable and reliable energy system.

Alongside an international organisation like the UN, it could be beneficial to include a solar NGO with a high level of expertise in setting up on-grid PV systems. Some possible NGOs that were investigated include but are not limited to SolarAid, Solar Village Project, and SELF (Solar Electric Light Fund). Environmental justice, which is necessary in Sabra has become a core value for several NGOs. This is important to ensure that the goals of the Sabra community stay at the forefront of the stakeholders' motivations. These NGOs have not worked in the Levantine region in the past, but they could be incentivized to do so in the future. The choice of the specific NGO(s) will be dependent on the funding source as well.

As the BAU institution did with its academic scholars, it would be valuable to partner with a research group that can aid in running the technical aspects of this initiative (Tarnini et al., 2023). At BAU, the academics used the HOMER system to fully simulate the financial and environmental effects of different energy systems. This briefing advocates for a similar approach in Sabra. The Sabra community could partner with the Beirut Urban Lab, an urban studies research group, who would be suited for this project, considering they have previous experience in urban recovery projects and simulation mapping (Beirut Urban Lab, 2023).

Funding

Between the 5 crises Lebanon is facing it has one of the largest public debts in the world. From 1992-2017, $36 billion of this debt has come from the electricity sector (UCL, 2020). Sabra faces energy poverty even more so since the government subsidies on diesel have ended (UCL, 2020). Thus, the initial hesitation to implement renewables has declined, and solar panels are becoming a necessity to achieve reliable energy. PV systems have a high initial capital, but they have the

best return on investment compared to fossil fuels (Tarnini et al., 2023).

Funding could come from various sources. The first source could be a grant like that of the Baaloul and Menjez projects from USAID. Another opportunity could be crowdfunding in combination with a loan that would pay itself over time from the trading (buying and selling) of energy. Lastly, several of the NGOs discussed above provide these systems for disadvantaged areas at a significantly lower cost. Thus, a partnership with an NGO could be extremely appealing to this community. What remains most important in whichever way funding is received, is guaranteeing that the community has ownership over their neighbourhood solar systems.

Layout of the System

The recommended structural design of the system will have 5 'layers' as outlined by Trivedi et al.'s (2022) thorough literature review of community-based microgrids. (1) physical, (2) information communication and transmission, (3) market and business, (4) regulation, and (5) control layer. The structural design here needs to have an overarching goal of educating and collaborating with the community at each step. Discussions at the UCL (2020) energy workshop stressed the need for community awareness and engagement campaigns, arguing that regardless of whether the municipalities were involved, this was a necessary factor. For instance, the community in the Akkar region of Lebanon heavily resisted the construction of a wind farm because they assumed the turbines were unsafe in that they could fall off the motors and injure people (UCL, 2020). Once this issue was addressed, the community was eager to see the installations. Once again, this social factor needs to be acknowledged for the issues with procedural and distributional environmental justice to be addressed in Sabra.

Physical Layer

The physical layer covers the actual equipment involved in constructing the microgrids. As mentioned in the funding portion, these community-owned photovoltaic systems will be purchased through grants and subsidies so that this low-income community does not take a strong financial burden.

Market and business layer

The market and business layer is separate from the implementation actors (NGOs, Beirut Urban Lab, UN). Instead, the focus here is the Peer-to-Peer (P2P) energy trading system discussed above (Adbdelnour et al., 2023). This strategy is associated with a decentralised structure because the consumer can become the producer (making them a 'prosumer'). Essentially, each building or household will have a smart meter and app system. This will then allow the prosumer to give/sell their excess energy to other households, ensuring that not only is energy not wasted, but also that households have a more reliable source of energy (Adbdelnour et al., 2023). Trivedi et al. (2022) support this suggestion and add that it leads to a micro-balanced market.

Information, communication, and transmission layer

Interoperability is key to understanding this layer. Interoperability is the ability of a computer or technical system to work in conjunction with other systems (Trivedi et al., 2022). The interoperability system plays an important role in ensuring that energy sharing between various households is possible. Thus, this briefing suggests the installation of a smart meter and app system that work together. The Brooklyn Micro Grid (BMG) (2019) is a clear example of a successful initiative. Essentially BMG is an energy marketplace managed by the prosumers at a local level (BMG, 2019). When energy is created in excess at a certain household, it is detected by a smart meter and can be sold to another household on the app through the detection of a smart meter (UCL, 2020, pg. 18).

Regulation layer

In order to ensure that such systems become a long-term solution and run smoothly, Trivedi et al. (2022) suggest that a policy document be put into place. This would include the rules and regulations for the system. Ideally, this is agreed upon by the community members who will benefit the most from this micro-grid solution. The Beirut Urban Lab would be the perfect collaborator on such a legal document because they have done similar work in the past (Al-Harithy & Yassine, 2023).

Control layer

The control layer simply explains the need for maintenance of the PV systems.

Once again, this highlights the need for community and social awareness to run the system and deal with technical errors and long-term maintenance. The trading platform described above could also pay for the upkeep. Teaching the community these skills will also allow for independence in running the PV panels. However, if the initiative is operated by an NGO that provides the PV panels, it could also be involved in the control layer.

Conclusion

The suggested solution aims to provide hope and functionality to the Sabra community while simultaneously outlining several technical factors that need to be considered for implementation. It does not aim to suggest that this is a perfect solution for the Sabra community that has been faced with political corruption for years on end. Possible limitations could include ensuring the various stakeholders involved are able to collaborate smoothly to succeed in this energy transition. This report reviews the current literature and available opportunities to make a significant change for the Sabra community's energy needs. Boone and Fragkias (2013) offer hope as they argue that when sustainable practices like the micro-grid solution are implemented, it leads to environmental justice. This begs several questions moving forward: what domino effects could this movement have in showing the government the success of an independent community initiative? Could this be replicated in other communities around Beirut?

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