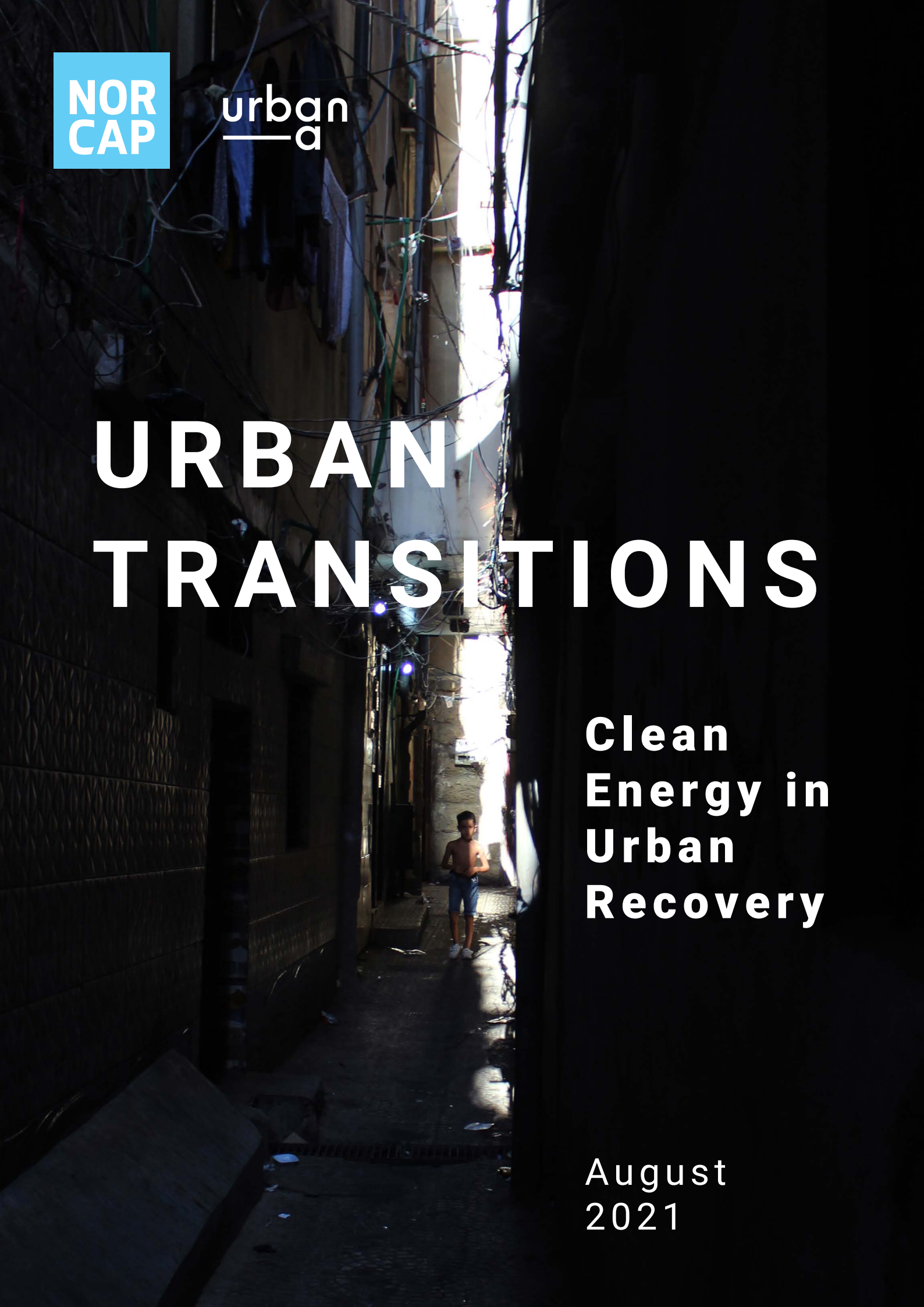

NOR CAP

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URBAN TRANSITIONS

Clean Energy in Urban Recovery

August 2021

NORCAP solves key challenges in the humanitarian, development and peacebuilding sectors, in order to better protect vulnerable people's lives and rights. NORCAP does this by:

- **Creating opportunities:** Promoting more effective ways of working at the global level and in the field, not only to reduce needs, but to create choice and opportunity for vulnerable people.
- **Working together:** Developing partnerships and projects with national and international organisations and stakeholders. Setting common goals and working together in a coordinated and sustainable manner is the best way to reduce needs, risks and vulnerability.
- **Developing capacity:** Deploying skilled experts to develop our partners' capacity. NORCAP's experts are well placed to identify and address challenges, improve collaboration and encourage new and innovative approaches.

NORCAP is part of the Norwegian Refugee Council. NORCAP was founded in 1991 and has since then have provided expertise to approximately 10,000 missions.

Urban-A is a consultancy firm based in Oslo, Norway, specialised in analysis and strategies for complex urban environments and crises settings.

The firm brings together experts with broad knowledge of the humanitarian and development fields, with work experience from the UN and (I)NGOs, public and private sectors, as well as academia. Urban-A is dedicated to improving and strengthening evidence-based, context-specific approaches to better understand and respond to crises' complex dynamics. Through collective efforts, and by increasing awareness of systems and processes, Urban-A strives to contribute to improve tools and methods to help cities prepare for, respond to and recover from emerging challenges and crises.

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COVER PHOTO
Boy walking in the narrow streets of Shatila, a Palestinian camp in Beirut, Lebanon. **Photo**: Urban-A/Synne Bergby (2021)

A warm thank you to all NORCAP colleagues who have contributed to the study.

A destroyed building from the 4 August 2020 explosion at the Beirut city port.
Photo: Synne Bergby

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Diab Abu Ali, an Iraqi IDP from Salah ad Din province, stays in an old, worn-down house in the urban area of Mamzawa. Together with his wife, six sons, four daughters and his grandchildren they had to flee their home when war broke out. Three generations of in total 30 persons live under the same roof in the urban area of Mamzawa, Erbil Kurdistan Region of Iraq. **Photo**: Karl Schembri (2016),

Scope, methodology and purpose

This study has been undertaken by Urban-A for NORCAP to support the acceleration of clean energy across the humanitarian, development, and peace sectors in complex environments and urban response settings. Rather than a technical assessment, this study was carried out to identify opportunities for and the value-add of focusing on clean energy in urban response for NORCAP. The study builds on the EmPowering Africa's most Vulnerable report published September 2020 (NORCAP and Boston Consulting Group [BCG]), which investigates the deployment of clean energy solutions in Africa in rural and camp-settings. Acknowledging that urban and rural contexts present different challenges, needs, and opportunities, this report adds an urban lens to the conversation. Specifically, the report outlines reasons for and consequences of not having access to reliable, sustainable, or adequate clean energy in urban contexts, with a focus on vulnerable groups including refugees, Internally Displaced People (IDPs), and host communities.

For this study, we have looked at the energy situation in urban settings in Kenya, Lebanon, and Syria to nuance and better understand general and place-specific conditions for deployment of clean energy solutions and potential impact on refugee, IDP, and host populations. The case-studies give insight into legal and policy environment, systems, and household vulnerabilities and needs. Further, they illustrate why energy access is important to address multi-dimensional needs in urban crises settings. Combined, this provides a foundation to identify place-specific and shared approaches to accelerate clean energy provision.

We have applied a three-tiered lens for the analysis covering national (political, legal, and regulatory environment), city (systems), and neighbourhood levels (needs and vulnerabilities) (see figure 1). While all three lenses are used to identify and understand relevant capacities, systems, and mechanisms for acceleration of clean energy solutions, the national and city levels are to a greater extent focused on central and local (city) governance, including legal and regulatory frameworks, value-chains, and service provision (or lack thereof). The neighbourhood and community level, on the other hand, focuses more on understanding the unmet and interlinked needs, vulnerabilities, and ways of accessing electricity for people living in poor, informal and underprivileged city areas. This spatial approach adds a central dimension when working on energy access in urban areas characterised by complex systems, networks, and linkages within and across scales and geographies. This require an overview of the three levels and how they are linked, regardless of the level at which a specific intervention is being implemented (e.g., the enabling environment, provision of services, or unmet needs of displaced persons in a given area of the city).

As further explained in the next section, the three-tiered structure corresponds to emerging urban crises response and recovery approaches. For this study, these approaches thus provide both an analytical tool to investigate the role of clean energy across sectors and scales and offers a way to place the work within existing and future crises response agendas.

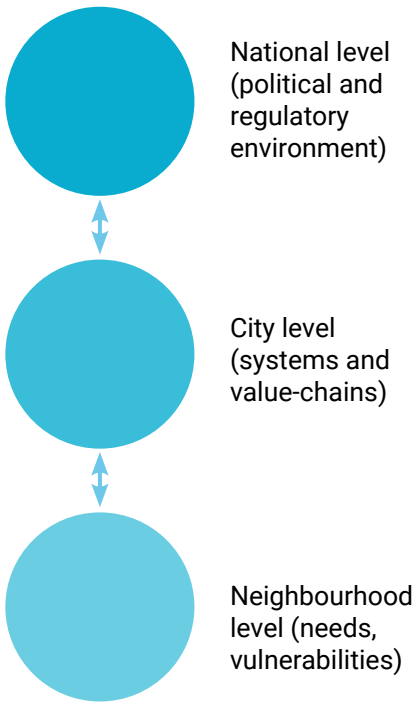


Figure 1 The three-tiered lens used for this study

Energy access, displacement and urban crises response

The scale of migration and displacement is growing. Global displacement is at a record high with more than 46 million internally displaced and 26 million refugees (UNHCR, 2019). Estimates suggest that there were 272 million international migrants globally in 2019, with more people migrating to other countries than ever before. A large share of migration takes place across borders to neighbouring countries or countries in the same region. As mixed migration[1] is increasingly taking on an urban dimension, a growing share of humanitarian crises are also unfolding in cities. Humanitarian actors are therefore increasingly working within complex urban crises settings characterised by interlinked systems and governance structures, high inequalities, and overlapping vulnerabilities.

The size and growth of urban areas is determined by a range of factors including economic activities, population (movement) patterns, community structures, and environmental conditions. Already, more than 50 per cent of the world's population live in cities. A large share of urbanisation moving forward will take place in African countries that are still predominantly rural. In contrasts, regions such as the Middle East and Europe are already largely urbanised.

Energy provision and access

An estimated 1.2 billion people worldwide remain without access to electricity. Many are amongst the most vulnerable population groups, including refugees and migrants. While urban residents have relatively better access to energy including electricity compared to rural residents, the quality of energy provision is often poor, unreliable, and inadequate. Access to publicly and privately supplied electricity is usually uneven across different areas of cities and worse in vulnerable and informal neighbourhoods. This correlates with deprivations in other areas such as lack of access to clean water and sanitation (including wastewater and solid waste management), inadequate and unaffordable housing and so on. Moreover, local power structures linked to patronage, sectarianism, nationality, and ethnicity play a role in who has access to and the quality of services such as electricity. Private providers compliment or substitute poor public provision in urban areas but cater to those with disposable income to pay for the services. In situations with competing needs, energy often takes less priority for the most vulnerable, who simply are not able to pay or are forced to prioritise other needs.

For many refugees and migrants their uncertain and controversial status means that they are treated as temporary residents, even though many stay in the same location for many years. However, in practice energy service are usually extended for many years in an ad hoc and inadequate manner. The same situation pertains to many urban poor living in neighbourhoods where local governments face budget constraints that limits infrastructure upgrading, or where redevelopment plans,[2] which may or may not be implemented, make public investments in infrastructure unattractive or unrealistic.

1 The principal characteristics of mixed migration flows include the irregular nature of and the multiplicity of factors driving such movements, and the differentiated needs and profiles of the persons involved and include both migrants and displaced persons. For more information see: (IOM, no date)

2 Urban redevelopment is a process that takes place in urban areas through rezoning of low-density (single-family housing) to higher density (mixed-use or commercial) development. The government undertakes a new development plan and delivers the necessary infrastructure. For more information see for example World Bank, Urban Redevelopment. Available at: https://urban-regeneration.worldbank.org/node/32

BOX 1: Urban systems

Urban environments comprise a range of interlinked, and interdependent systems. By applying different systems categories, the complex interrelationships between these systems can be made more apparent. This helps identify how a change will affect other aspects within or between systems. Systems can, for example, relate to the built environment, such as systems of housing, land, property rights, and housing construction, or basic services such as water, waste management, and energy. Working in urban areas requires an understanding on how these systems work at different geographical levels. This to respond to needs in an effective and efficient manner, facilitate synergies and multiplying effects, while at the same time mitigate possible negative or unintended effects. Given the population size and multitude of challenges in urban crises settings, no one organisation or governance body can respond to the needs or meet the rights of all residents. Therefore, collaboration and coordination is critical. Working with urban systems open up for innovative partnerships, including new types of partners and partnership structures.

Ramadi in Anbar, Iraq. **Photo**: Wolfgang Gressmann (2017)

Clean Energy

There is a growing recognition of clean energy as a viable alternative to more traditional forms of energy. Clean energy holds the potential to deliver cheaper and more reliant energy through flexible and scalable solutions. Furthermore, it can contribute towards reducing climate change impacts and public health concerns linked to the use of unsustainable/non-renewable energy sources, notably diesel and firewood. Clean energy solutions, particularly solar photovoltaic systems (PV), are increasingly becoming available on the market, and are increasingly being used to supplement energy from other unsustainable sources.

The supply-chain for renewables, and in particular solar products, starting from the materials needed for production (such as minerals from conflict areas) to the production process to the recycling and reuse of clean energy appliances and their parts, is often disregarded in discussions on clean energy solutions. Currently, the emphasis is largely on technology and the potential of unlocking market mechanisms, while less attention is devoted to exploring value-chains and opportunities for circular economies through holistic systems thinking.

While the cost of producing clean energy-compatible appliances has been reduced considerably in recent years and many countries have put in place laws and regulations to promote clean energy provision, key barriers to accelerating clean energy solutions persists. Existing, heavily subsidised non-renewable energy provision, high up-front costs, and strong interests in preserving the current system are among the main challenges for introducing clean energy solutions at scale. In many cases the transition from conventional to clean energy is not as much of a technical challenge or a question of reducing the production costs, but rather a question of political will.

"Urban Transition"

Humanitarian and development efforts to support the deployment of clean energy solutions have largely been focused on rural areas. This is in part due to much lower access to electricity in many rural areas compared to urban areas, the premise of access to energy as an instrument to combat poverty, and the historical focus on rural contexts for humanitarian and development actors. However, as a growing share of humanitarian crises are unfolding in cities, humanitarian and development actors are also increasingly responding in urban areas.

This urban shift presents both challenges and opportunities. Figure 2 outlines some of the key factors that changes from the national to city to neighbourhood level, and the focus for this study for the three levels. For instance, cities have limited available or affordable land. They also constitute complex systems with

a range of actors that often have different and / or conflicting interests, and a more heterogenous, fluid, and anonymous population compared to rural areas and an aggregated national level. A lack of reliable and granular data of conditions makes it more difficult to assess options and respond where needs are the greatest. Moreover, strong national interests in energy adds a political dimension to the work, both in countries where national laws and regulations are in place and in countries lacking in such. In urban areas particularly, the degree to which decentralised governments can regulate, control, and are able to provide energy, is a key factor for energy access at the local level.

Given the above, multi-scale, cross-sectorial, and context-specific approaches are needed to address issues linked to unreliable, inadequate, and inequitable access to energy in urban areas. To move towards sustainable models for clean energy provision in urban settings and at scale, using and strengthening existing market structures and value chains is key. This requires market entry and scaling-up of activities by public and private sector actors in a way that includes poor and vulnerable segments of the population.

Urban crises response approaches

With the increased number and scale of urban crises, new approaches, response tools, and ways of working are being developed and tested. For example, area-based approaches have been adopted as holistic and cross-sectoral ways of working within existing urban systems and with local governments. These approaches are complementing international policy initiatives such as the Global Compact on Refugees and the New Way of Working in support of comprehensive and effective humanitarian assistance.

While area-based approaches often focus on a sub-city or neighbourhood levels, the Urban Recovery Framework (URF)-model has emerged as a tested methodology that considers policy, regulations, and interventions across multi-level governance and urban systems. The approach has been developed by UN-Habitat and partners within country level programmes in the Middle East. The URF is responding to the needs of various population groups from local and city to national levels. These urban response approaches were conceived to fill a significant gap in the international system's ability to support countries and cities affected by urban crises. Most crises response approaches are organized along sectoral lines, without recognizing their interdependence in urban areas, and thus less flexible in application to account for local dynamics. Economic, social, cultural, environmental, and political dimensions manifest differently across cities and scales of human settlements, and recovery programmes thus require a locally tailored approach. The URF process incorporates city- and community-level approaches as well as national political, legal, and regulatory environments. This to identify and strengthen linkages, connections, and synergies in response across areas and systems. Furthermore, response approaches, such

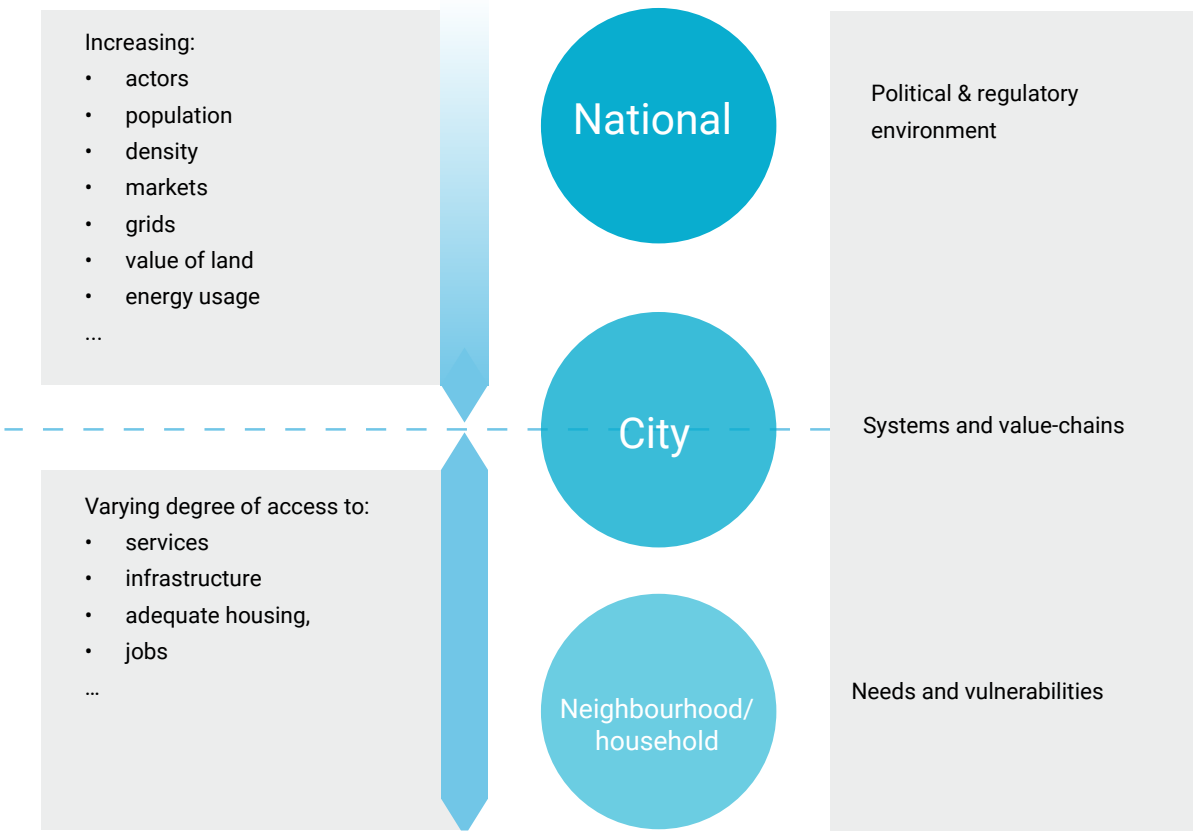
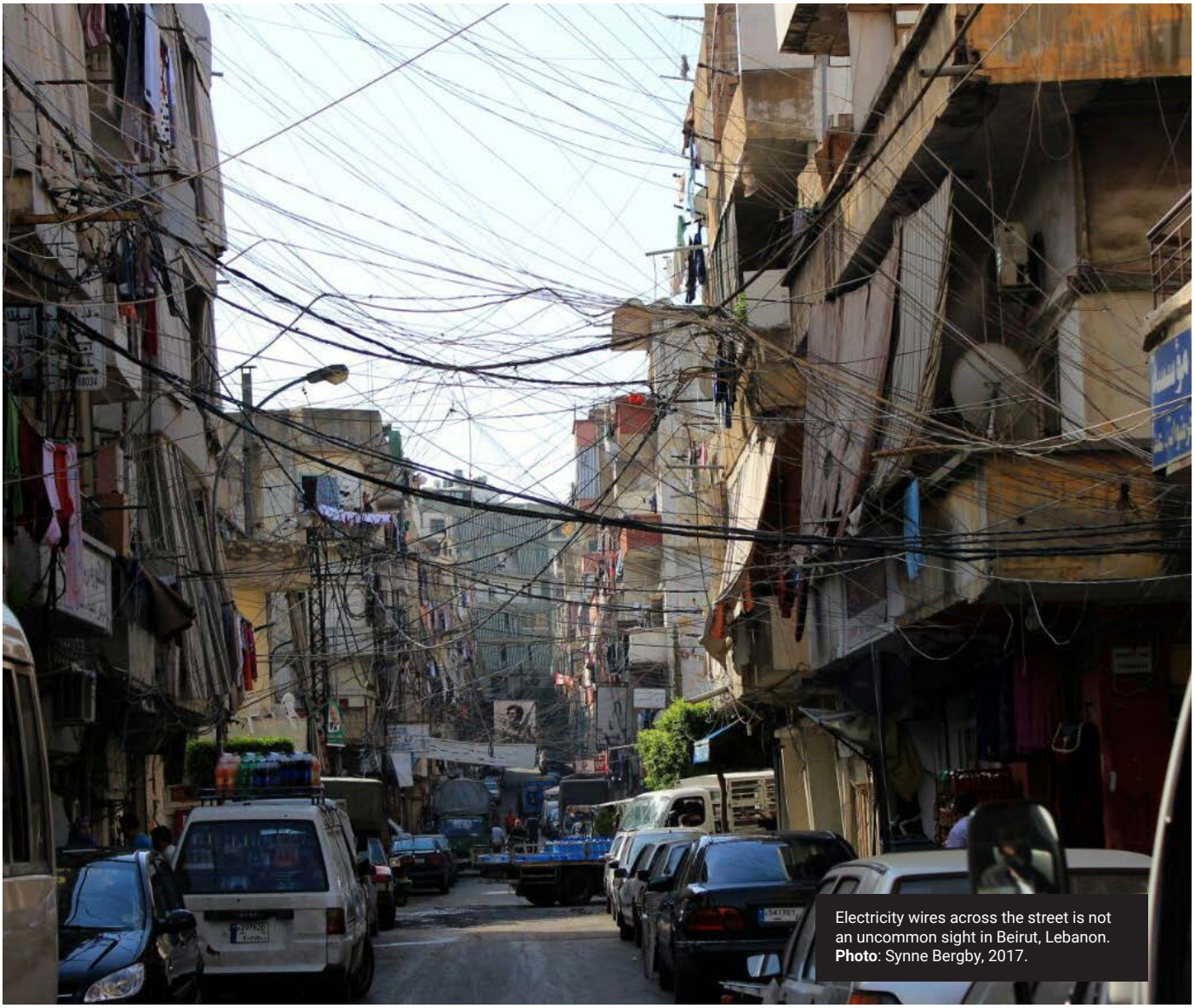


Figure 2 Key considerations for clean energy provision and access from national to local level

as the URF, accommodates a need for both immediate response and longer-term adaptive and transformative measures in cities.

Emerging urban response approaches represent an opportunity to highlight energy access as a key condition to address a range of needs and composite challenges in urban crises situations. Historically, energy has not been part of the core areas of humanitarian response or been integrated into the humanitarian cluster system. This is reflected in the slow turn-around to address energy solutions as part of immediate response interventions (beyond e.g., fuel supplies). In recent years however, energy as both a cause and consequence of conflict is increasingly recognised, as is energy access as a trigger or multiplier for food security, adequate housing, water, sanitation, health, education, and protection. Approaches such as the URF provide an analytical frame to understand how access to energy can help move beyond immediate response towards recovery and resilience by anchoring and streamlining energy in current response efforts.

This study has made use of the URF approach as a concept to analyse the intersection of energy access, displacement, and urban crises, as well as to place the discussion within current initiatives and response agendas. UN-Habitat has been developing tools to respond to urban recovery needs in Syria, while in Lebanon urban recovery planning has taken place in response to the 4 August 2020 explosion, in a context of compounding crises. Since fall 2020, NORCAP has supported the efforts of providing analysis for the shared understanding of needs and adopt the URF approach to the Beirut context. This is based on previous experiences providing support to area-based programming in Lebanon, as well as regional and global learning on urban response and engagement in the Global Alliance for Urban Crises.



Electricity wires across the street is not an uncommon sight in Beirut, Lebanon. **Photo**: Synne Bergby, 2017.

Challenges to be addressed

In urban crises situations, precarious and harsh living conditions for a high number of people, including many IDPs, refugees, returnees, and poor and vulnerable populations manifest through interlinked or competing needs, where energy plays a key role. In this section, key challenges associated with lack of or limited access to energy will be identified. The section will look at both general and context-specific needs and vulnerabilities, and energy access for people living in poor, informal and underprivileged areas of a given city. This as a foundation to identify possible approaches and entry-points to accelerate clean energy provision at the local, city, and national levels. The section will present overall challenges for accelerating access to clean energy in urban areas, drawing on the three case-studies used in this study.

Energy at neighbourhood and household level (needs and vulnerabilities)

This section provides a summary of some of the main challenges identified for clean energy deployment at a neighbourhood level, focused on access to energy, consequences of not having reliable electricity, and impediments for uptake of new technologies.

Access and usage

1. **Poor and inequitable electricity access across cities.** Regular load shedding and power cuts is common for public electricity provision, with poor and informal neighbourhoods, in particular female-headed households, often disproportionally affected. In many places, refugees and migrants are regarded as temporary residents, and the government might be reluctant to provide more permanent solutions, with services extended for years in an ad hoc, inadequate, and expensive manner.

2. **Inefficient energy use in residential buildings due to unsustainable building designs and the lack of maintenance.** Poor housing conditions contributes to increased need for fuel for heating, increased electricity bills, affect living conditions, and increase social tension between refugee and host communities. It also represents a safety and health concern, including fire hazards and health concern, where cooking inside with charcoal and poor ventilation for example can lead to respiratory illnesses.

3. **High cost and inaccessibility of clean energy options for cooking.** Many urban residents cannot access clean cooking energy solutions due to upfront cost. For instance, Liquefied Petroleum Gas (LPG) require upfront payment for equipment (cylinder and accessories, cooker, etc), and the refill gas is usually sold in large quantities. In some countries, pre-paid solutions have been tested.

Consequences of not having access to reliable energy

4. **Unsafe streets and public spaces, and dangerous power connections increases protection risks such as attacks, harassment, and injuries.** See Box 3 on the next page.

5. **Less opportunity to study.** Lack of electricity is affecting schooling, particularly for girls. Research from different contexts suggests that increased time for homework due to electrification does not reduce the total time spent on household chores, but allows for children, especially girls, to reschedule tasks (study in the evening) and mothers to help with homework (Winther et al., 2017).

BOX 2: Categories of energy access

In this study, access to energy is discussed along three broad categories of usage:[3]

- **At a household level,** access to energy is required for electricity, cooking and heating / cooling.
- **At a neighbourhood and city level,** energy is used for service provision, such as water, waste handling, transport, for public spaces, including street lighting, and for powering facilities for health, education, community and office buildings and so on.
- Energy is also applied for productive use for **"value-added" activities** by individuals, private and public entities.
  However, the availability of such technologies is still low.

3 Based on the Multi-Tier Framework developed by ESMAP, https://www.esmap.org/node/71201.

Box 3: Protection risks in urban areas

Urban populations are more heterogeneous and fluid compared to rural populations. Particularly for people on the move, social capital and community ties are often low in the places they arrive. Competition between refugees and host communities over scarce resources is seen to increase friction and insecurity locally. This is especially the case in informal and underprivileged areas that suffer from structural issues linked to limited or lacking infrastructure, inadequate housing, and a lack of safe public spaces, and high population density.

A fear of being attacked or harassed in public spaces results in (self)restricted movement for many, particularly at night, and especially among women and children. The neighbourhood profiling carried out by UN-Habitat and UNICEF in Sabra, a vulnerable neighbourhood in Beirut, shows that the presence of armed groups, criminal gangs, drug addicts, and missing or inadequate infrastructure, including street lighting, represent key risks of physical and verbal attacks, rape, kidnapping, and killings. Moreover, one of the reasons cited for frustration and conflict between host and refugees in Sabra was electricity.

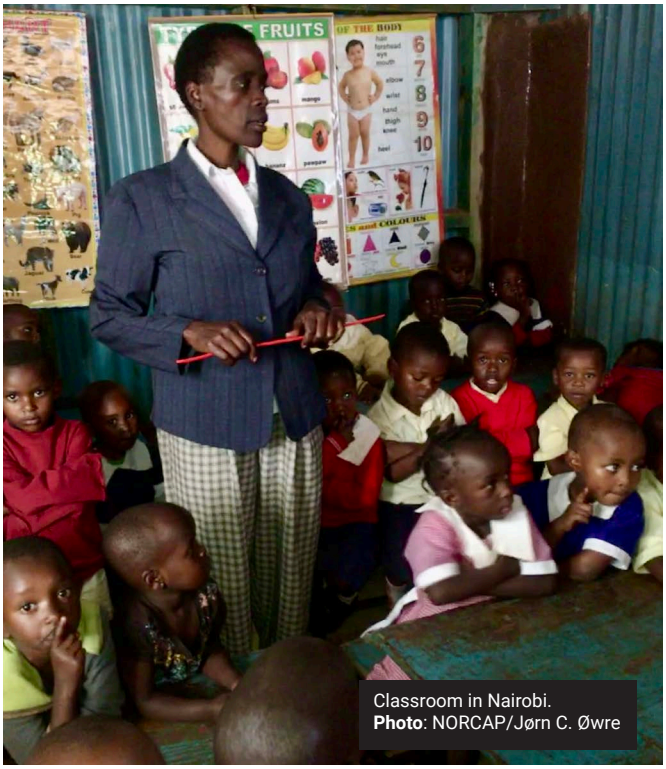
The lack of access to affordable and reliable electricity forces many to connect illegally, resulting in a prevalence of dangerous connections in some of the poorest neighbourhoods in cities. In Burj Barajneh Palestinian camp in Beirut, for example, which is suffering from poor service provision and where illegal connections are rampant, yearly cases of death by electrocution from encountering unsafe and haphazard electrical wire systems have been reported. Moreover, assessments of living conditions for Syrian refugee families, also in Beirut, shows that some use electrical wires directly into pots to heat water in lack of alternatives.

In Nairobi, our survey[4] shows that the main reason for feeling unsafe is the fear of physical attacks and robbery. Rape and attacks were cited as the primary reason for feeling unsafe by 22 per cent of female respondents.[5] Almost all respondents said that improved lighting at night would contribute to a safer neighbourhood.[6]

4 A survey was carried out in November and December 2020 in Mukuru and Pumwani, two informal/semi-informal neighbourhoods in Nairobi, on energy consumption patterns, work, income, background of the residents and area, and other questions relating to the neighbourhood, to inform this study. A full overview of findings from the survey can be found in Annex 1: Nairobi case study.

5 It should be noted that the survey did not focus on protection issues and that it was carried out by male surveyors. These findings are therefore only suggestive and would need further investigation.

6 At the same time, 68 per cent of respondents did not have lighting outside their own house, but still felt relatively safe. This could be attributed to bias in responses where respondents answered what they believed were the neighbourhood needs rather than from their own experience. It might also be due to an assumption that the answer could increase the chance of receiving assistance. Or that the respondents knew their neighbours and therefore felt safe in their sub-communities even if street lighting would increase their sense of safety on a larger scale.



Classroom in Nairobi.
Photo: NORCAP/Jørn C. Øwre

Reduced productivity and economic activities. Unreliable electricity hinders operations for small and medium sized enterprises with direct implications on productivity and income.[7] In Lebanon and Syria small and medium sized businesses are to a great extent reliant on diesel generators to maintain operations throughout the day. In Beirut, a reduction in access to electricity, from having access large parts of the day to now only a few hours have major implications for industry and commercial activities. In the beginning of September 2021, electricity was reduced to as low as one hour a day in Beirut. Coinciding with a nation-wide fuel crisis and an economic crisis, meant that households and businesses in reality neither had access to fuel to operate generators, nor the means to buy fuel, which significantly hampered activities across the city.

6. **Reduced food security and unclean cooking solutions.** A lack of electricity and cooling systems

7 It should be noted that a straightforward relationship has not been found between increased access to electricity and women's employment or income, according to studies in various location.

reduces the shelf-life of food and limits options for food transporting. The use of solid fuel for cooking is common due to costs, including costs of purchasing equipment, and/or lack of alternatives. In Kenya, solid fuels (e.g., firewood and charcoal) is the most common method for cooking. In Lebanon and Syria, where overlapping shocks is making fuel such as LPG scarce and limits purchasing power, some are forced to turn to solid fuel or resort to negative coping mechanisms such as meal-skipping or undercooking food.

7. **More time allocated to drudgery.** Lack of access to reliable electricity increases the time allocated for drudgery for both women and men. This could include time spent on household chores such as washing and cooking or reacting to and compensating for load shedding and blackouts. While increased access to electricity might not reduce the overall time spent on household tasks, it frees up time that can be put towards more productive uses. A study from Zahle in Lebanon, for example, shows the positive effect of stabile access to electricity on responsibilities and workloads, particularly for women (Ahmad, Al-Masri, et al., 2020).

Impediments to successfully introducing new energy solutions

8. **Low uptake of new technologies**. Cultural norms are important determinants for peoples' choices and behaviour. In terms of cooking, people might not want to cook using electricity, or know how. In Nairobi for example, there is a widespread cultural belief that coal is better for preparation of traditional meals.[8] This could be a consumption pattern that is hard to decarbonise. Other barriers to switching to alternative solutions include perceived risk, distrust, or lack of knowledge of the technology. Furthermore, lack of trust between providers and consumers has been seen as an impediment to introducing new solutions, even when the cost or reliability of the service is comparable to or better than the option currently used. This is furthered by often limited opportunities for residents to participate in decision-making for energy provision.

9. **Increase in demand for electricity.** When people get better access to reliable electricity their needs change, and the demand for electricity increases. Unless new electricity solutions have the capacity to meet future energy demands, it does not have the same potential for transformative change, and in worst case will make the solution obsolete when the supplied energy no longer meets the need.

10. **Solar solutions require high up-front investment, while financing options are limited and investment risks high.** Affordability and high up-front cost for solar solutions is a key barrier for people to invest in energy technology, particularly for poor and vulnerable households where other needs take priority. See Box 4.

Energy at city and systems level (integration with response, reconstruction, and development efforts)

This section provides a summary of some of the main challenges identified for clean energy deployment at a city or systems scale, focused on city governance, value-chains, and service provision.

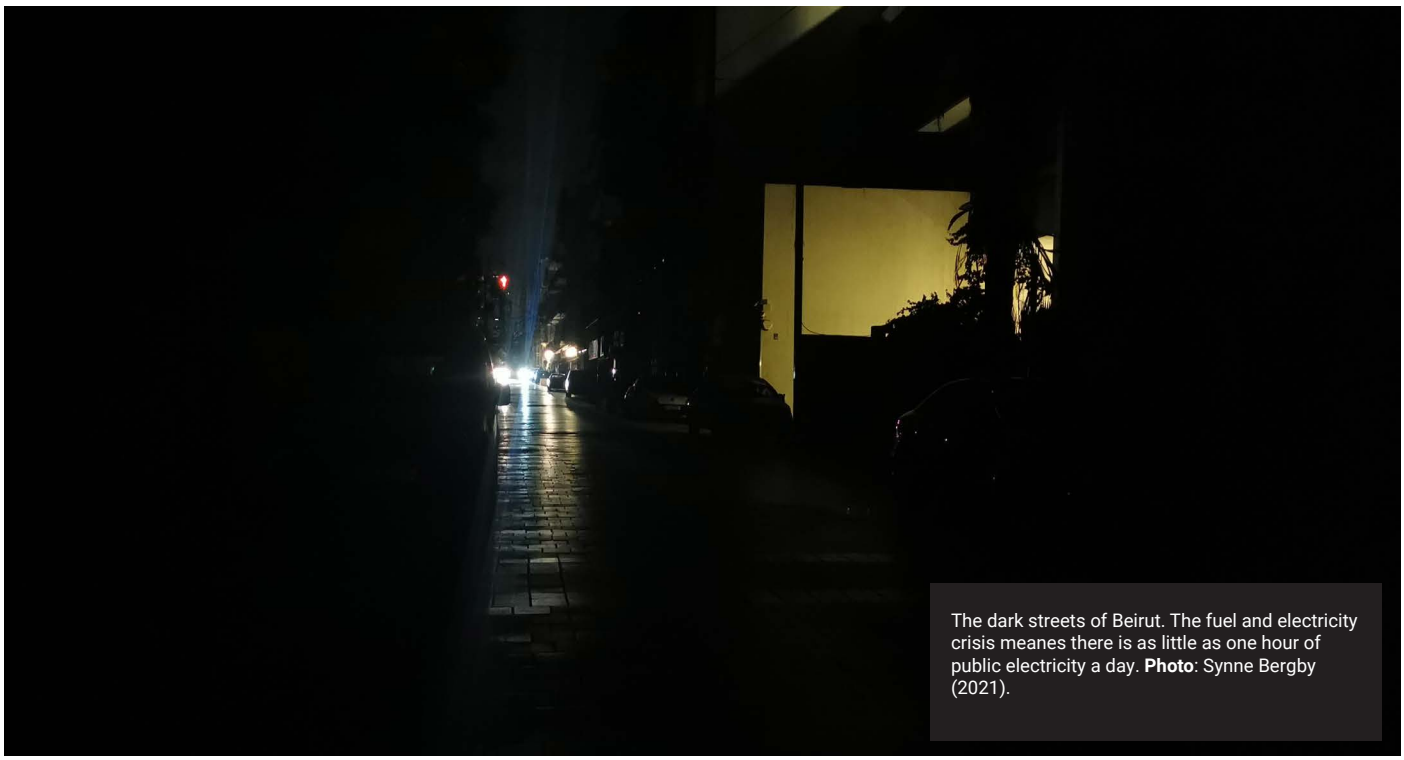
City governance

11. **Lack of shared understanding of energy access.** Access to energy holds different meanings to different stakeholders, where central and local governments, private sector, international organisations, NGOs, and residents often have diverging perceptions of what adequate energy access means, for whom the needs are greatest, and how this can be addressed. This will influence the type of information generated on needs and gaps in provision, and in turn which solutions are promoted to increase energy access. For private sector actors, for example, how energy access will reinforce, or shift, power structures is often not a consideration. Examples have shown how private companies' entry into the market has negatively affected women's role due to a lack of sensitivity of how new solutions, and the mechanisms to provide these, are designed and implemented.

12. **Multitude of actors involved and benefiting from current set-up.** Actors supplying electricity from non-renewable sources will have strong interests in preserving the existing system and their position within it. Anchoring of solutions will need to account for and/or involve these entities. This is particularly the case in places where authorities have exclusive contracts with private partners, or where informal providers have de facto monopoly and control of the local markets (as for instance the neighbourhood profiling in Lebanon has shown).

13. **Transmission and distribution networks are poor quality and overloaded.** Structural deficiencies combined with limited financial, human, and technical resources are key barriers for quality and reliable public energy supply by local and central governments. Factors such as civil unrest, conflict, lack of planning, and added demand due to population influx put additional strain on already pressured systems.

8 Confirmed in our Nairobi survey.



The dark streets of Beirut. The fuel and electricity crisis meanes there is as little as one hour of public electricity a day. **Photo**: Synne Bergby (2021).

Box 4: Cost and financing of solar solutions

The high cost of off-grid renewable devices is a consistent barrier for people to invest in solar solutions. In Kenya for example, 46 per cent nationally, and 58 per cent across high to middle income and 52 per cent of low-income neighbourhoods in Nairobi, report to be concerned with the cost of equipment (Kiprop, Matsui and Maundu, 2019). Many do not have the disposable income to prioritise high up-front investment in solar devices. At the same time, there are often limited options for loans and credit for such investments. This is in part explained by the perceived risk of late or non-payments. In the case of fixed assets, there is also the problem of redeploying the device if the borrower wants to sell or move. Moreover, for those who have access to financing, options such as lease to own and monthly payments may be unfamiliar concepts. Solar home panels systems are commonly paid for after 2-3 years, but the life span is often low. One study suggests that half of off grid solar devises are disregarded after 3-4 years (World Bank and Dalberg Advisors, 2018). This means that interests on loans are paid almost the entire time that the devise is in use. At the same time, the high up-front costs must be considered relative to the maintenance cost of equipment and use of for example generators, or the cost of establishing legal grid connections.

In places where looting is likely, there is a risk and financial disincentive to invest in off-grid and portable devices. With access to markets to re-sell products and the relative anonymity offered in cities, this is particularly a concern in urban areas. The advantage of portable solutions over fixed assets is nevertheless that they can be brought to a new location.

Box 5: Lack of urban data

There is a lack of reliable, up to date, multisectoral, and disaggregated data in many cities, particularly when a crisis hit. This reduces the ability to respond in a timely and comprehensive manner, where priorities should be made based on value for money and greatest impact. While data collection and analysis to address this gap is advancing, the context-specific understanding needed for response and recovery at scale is still not sufficient in most urban crises settings.

Box 6: Life-cycle of renewables

There is often limited understanding of the non-linear trajectories of materials and parts, and their potential integration in new value chains and circular systems. This has direct implications on which measures are taken for afterlife and reuse management. A more holistic take on how different parts are re-purposed and re-used is needed. It is worth noting that in many cases people keep their devises when they have stopped working. In Kenya for example, 65 per cent of solar products are kept or left in the home after they no longer function (Cross and Murray, 2018).

In urban areas where collection and recycling are often conducted by informal sector workers with little emission control or regards for human and environmental impact, battery and e-waste represent a serious health hazard.

14. **Low lifespan and poor afterlife management for solar solutions.** Safe disposal of used batteries and recycling of solar equipment represents a key challenge across the supply chain of solar PV (including local skills, systems maintenance, product longevity, work, and labour across sites of mining, sourcing, assembly, and manufacturing).

15. **Existing electricity grids do not have capacity to integrate new solutions.** When feed-in of electricity is permitted, the existing grid is not always adequate to receive and/or prioritise the power generated. Limited financial and technical capacities for infrastructure development on the part of central and local governments is a key barrier to upgrade the public electricity system. Illegal and dangerous connections to the electricity nets also contributes to poor quality and availability of electricity in the grid. Existing systems thus often need a complete overhaul or reinforcement to integrate new systems.

16. **Lack of/insufficient regulatory framework to encourage private sector investments in renewable electricity solutions.** In many countries, a regulatory framework to incentivise investment by the private sector is not in place, including regulations for net metering arrangements and subsidies.

Land governance

17. **Lack of available land and poor land management makes service provision in informal areas difficult.** Poor quality roofs, tight living spaces and lack of "greenfield" land can make installation of energy solutions, such as solar panels, challenging. Moreover, urban planning is often short-term

Sanaa, 15 years old, making Turkish coffee at the house where she and her family of 8 lives in Irbid, Jordan. TNRC provides financial incentives and technical support to Jordanian landlords to finish their semi-constructed housing and bring new adequate and affordable housing units onto the rental market. In return, vulnerable Syrian refugee families are provided with rent-free accommodation for a period of 12-24 months. **Photo**: Alisa Reznick (2015)

without considerations for the longer-term needs and demands, or connection to other areas.

18. **Disputed land rights, precarious tenure, and threat of redevelopment of informal areas.**[9] Uncertainty about the future gives limited incentive to implement large-scale infrastructure upgrades, or for the residents to invest in their homes. In informal areas, a large share of the population lives with precarious tenure and are not able to plan for the long-term. In Nairobi, where a significant share of residents is tenants, homeownership has been seen to be positively correlated with an interest in investing in off-grid clean energy appliances (Kiprop, Matsui and Maundu, 2019).

Energy provision

19. **Parallel systems for energy provision.** Non-state actors respond to gaps in the market: private and informal providers often sell electricity at higher prices and predominantly using diesel generators, and civil society organisations often provide financially unsustainable solutions at high costs. In addition to being costly, service provision by non-state actors may detract legitimacy of the state, and potentially fuel tension and marginalisation.

20. **A free market cannot resolve the energy need for the poorest urban populations.** While markets offer a range of opportunities for expanding clean energy, particularly in urban areas, there are financially and structural barriers to access these options for poorer and vulnerable population groups. The current market for utilities and small-scale household solutions is characterised by low quality and lack of competition, and there is generally a lack of low-cost solutions relevant to the poor. Market segmentation and the use of different vehicles targeting those who cannot afford market-based options are therefore required.

21. **Not advancing from pilot to scale.** While there are examples of successful implementation of humanitarian/development clean energy projects, these are rarely translated into replicable or scalable solutions. One challenge is that input from organisations and donors are often not designed for scale. Short-cycle funding do not respond to the up-front investments required for clean energy projects, which makes larger-scale projects difficult. Another challenge is how to account for context-specific conditions, decisive for the success or failure of a given project, when replicating or scaling up a solution. Furthermore, piloting needs to be coupled with creation of favourable conditions for the scaling up of interventions.

Consequences of unreliable energy supply for linked service provision

22. **Limited or non-operational water pumping and treatment.** Electricity is required for water pumping and treatment, where water pumping usually accounts for 70-80 per cent or more of overall electricity needed for water operations. In Beirut,

9 Redevelopment schemes often implies that the current residents within informal areas are forced to relocate and/or are assigned new areas to settle in.

Crossing electrical wires and water heaters on the roof-tops of buildings in Beirut, Lebanon. **Photo**: Synne Bergby (2017)

for example, high electricity costs and unreliable supply has rendered most wastewater treatment plants (WWTPs) non-operational.

23. **Worsened public health and provision of health care services.** Unreliable and limited access to electricity affecting hospital operations, transportation, and cooling of medicines. Moreover, fuel oil used to generate electricity at hydroelectric plants and by local diesel generators produces toxic emissions resulting in public health concerns, including respiratory diseases.

Energy provision at national level (political, legal, and regulatory environment)

This section provides a summary of some of the main challenges identified for clean energy deployment at a national scale, focused on national governance, including the political, financial, legal, and regulatory environment related to energy.

24. **Weak legal framework, regulatory hurdles and/or rapidly changing regulatory environment.** This is a considerable deterrent for investment and restricts international financing and execution. Amongst others, this makes it unclear which regulations are in effect. The situation is often worsened because of lacking technical capacity to develop new energy regulations within relevant government entities.

25. **Complex decision-making and power structures.** The energy sector is characterised by diffused decision-making processes and a lack of coordination between the various actors charged with energy provision. Often there is not a clearly identified entity that is accountable for mismanagement. In many countries, there is a strong state control over the energy sector, but with limited anchoring at the city and local level. This makes it difficult to implement regulations and can encourage clientelism and corruption along the entire supply chain.

26. **Markets not economically viable for private providers of clean energy.** In many countries the energy market is not liberalised. Factors such as a subsidised energy sector, low energy pricing and artificially low fossil fuel prices distorts the market and makes it uncompetitive. Moreover, high up-front financing costs (both for equity and debt), weak power purchase agreements (PPA) and an unstable political and economic environments make investments risky.

27. **Low collection rates and high costs of energy production**. Particularly in places where energy production is largely sourced from fossil fuel, production costs can be extremely high. At the same time, unreliable and inadequate supply reduces willingness to pay, while poorer households might be unable to pay for services. This negative expense-recovery ratio put additional pressure on already strained public service delivery, which in turn reduces the governments' ability to collect fees and invest in and maintain the infrastructure.

28. **Energy sources as a root cause and driver of crises.** Questions of who controls and benefit from energy sources, especially oil, gas, and fuel, is a root cause of conflict between and within countries. See box 7.

29. **Contradicting global, national, local-level energy agendas.** There is an inherent contradiction between the neoliberal approach to clean energy on a global level, the state-led developmentalism at national level and project-based clean energy provision on a local level (Rob Byrne and Kennedy Mbeva, 2017). A fundamental challenge is thus coordinating national and political ambitions and humanitarian and development aims. While the objective to provide clean energy to people might be shared amongst stakeholders, how and who should gain from it might not coincide between host countries, international donors, humanitarian agencies, and private actors.

Box 7: Natural resources and energy governance
Given the strong state interest in energy, the management of energy is usually highly centralised. In oil and gas producing countries, energy is an important source of revenue. In Syria for example, oil production has been relatively small in comparison to other countries in the region, yet accounted for as much as 25 per cent of government revenues pre-crises. The conflict has reduced the government's revenues and the reliability of electricity while also increased prices. Syria is also impacted by climate change and environmental hazards that include rise of temperatures (resulting in heat waves and exacerbating urban heat island effects), soil erosion and deforestation (and forest fires), water shortages, and droughts – with a severe three-year drought in the years before the conflict broke out (2007-2010) – that have exacerbated resource scarcity and displacement. Such overlapping, interconnected, and mutually reinforcing stressors and the effect they have on peoples' resilience, economic recovery, and decentralised governments' abilities to respond to needs, manifest differently in different in various regions and cities across the country, where energy access is a key factor.

Case-studies

The case studies give insight into context-specific challenges and in extension which approaches to clean energy are relevant and have the greatest potential for impact. The cases focus on different scales: the Kenya-case focuses on the local/neighbourhood level using Nairobi as an entry point,[10] and the Syria- and Lebanon-cases focus on the city and national level-systems. While this section highlights some key dimensions, a detailed overview of the Kenya and Lebanon case-studies can be found in the annex to this report.

In Kenya, the energy mix supplied through the national grid is predominantly from clean energy sources. Among the central challenges in cities such as Nairobi is how to secure reliable and equitable access to electricity, particularly in informal urban areas, and how to reduce the reliance on unclean energy for cooking and heating. To address these, an understanding of the current barriers and opportunities at the local level, working with residents to identify the best solutions on and off-grid, is key. The findings can also be extended to other rapidly expanding second-tier cities in Kenya.

In Lebanon and Syria, the energy-mix is almost exclusively based on fossil fuel. One of the main challenges facing Lebanon and Syria is thus how to shift existing production of energy towards clean energy sources. As with Kenya, another main challenge is power cuts and how to secure access to and reliable energy for all. Progress has been made to develop policies and a conducive regulatory environment, and initiate projects to promote clean energy transition. However, entrenched power-structures and a focus on fossil fuel extraction is preventing large-scale transition.

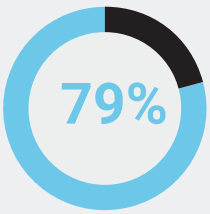
10 As explained in footnote 5, a survey was in Nairobi to inform this study. See Annex 1: Nairobi case study for details.

Kenya

Nairobi is rapidly expanding as people continue to migrate from rural areas to the city. Kenya is expected to increase its urban population from 27 per cent in 2018 to 40 per cent in 2040, with much of this growth taking place in the largest cities. Environmental shocks and the effects of climate change are likely to intensify the trend of urban migration and displacement. To accommodate this growth, large-scale investments in urban development projects are taking place outside the city, mainly in tenement developments and satellite cities. At the same time, many poor areas in the city are considered unfit for upgrading by authorities due to their informal or illegal status. While there are many plans for redevelopment projects of informal areas of the city, many are yet to materialise.

The economic growth and significant investments in Nairobi have not translated into a more equal distribution of services, infrastructure, or income. Urban disparities and pockets of poverty is, similarly to other larger cities in Kenya, on the rise. With COVID-19 this is likely to have been further exacerbated, where those in informal employment, those living in densely populated neighbourhoods, and those with limited access to services have been disproportionally affected.

See* **Annex 1 Nairobi case study *for further information, including a detailed presentation and analysis of the survey data that was collected for this study.*



Renewable energy as share of energy mix

Displacement situation

65,000 refugees in the country, 15 per cent of whom live in Nairobi.

Refugees not allowed to work, and not to settle outside of camps.Recently the government ordered the closure of Dadaab and Kakuma camps, hosting more than 400,000 people predominantly from Somalia, as well as countires such as South Sudan and Ethiopia.

Electricy access

Electricity access said to be 100%, however the reliability and quality varies. Provision in Nairobi mainly grid through legal and illegal connections.

Cooking energy

More than eight out of ten households in Kenya rely on firewood and charcoal for cooking every day.

Electricity in Kenya

Kenya is considered a leading example in Africa on electrification and the transition to renewable energy. Electrification has increased rapidly in the last decade. From 2011 to 2015, Kenya Power and Lighting Company (KPLC), the public company in charge of electricity transmission and distribution, doubled its connections to households across the country (Power Africa, 2016). The World Bank estimated that access to electricity was at 75 per cent in 2018, with 71 per cent supplied through the national grid and 29 per cent off-grid (World Bank, 2019). However, a significant share of national grid connections is made illegally. This is particularly common in informal settlements. The national electrification rate in 2019 was estimated to 84.5 per cent, with full electrification in urban areas (IEA, 2021). However, as discussed in the previously outlined key challenges, even with high share of electrification, the access is often not adequate or reliable. A significant share of connections is made illegally to the national grid.

In 2018, Kenya's president declared plans to transition the country to 100 per cent clean energy by 2020. At the time, the share of installed capacity in the national grid originating from renewable sources stood at 70 per cent, more than three times the world's average (Wood, 2018). This ambitious goal would entail tripling the number of residents connected to the national grid to 60 per cent share of the population.

Most of the existing large-scale mini-grids in Kenya are part of electricity infrastructure operated by the public sector (New Climate Institute, 2019). Off-grid solar and mini-grids are expected to contribute to 2.1 million additional connections as part of the transition to 100 per cent renewable energy (RES4Africa, 2019).

Nairobi

Nairobi is the most populated city in East Africa with a population density estimated to 6,247 persons per square km (Mixed Migration Centre, 2020). Of the city's population 62 per cent are estimated to live in informal areas. There is around 65.000 refugees living in Nairobi (15 per cent of total refugees in the country) (Omata, 2020), even with Kenya's encampment policy.

Governance
Despite a significant move towards the decentralisation of Kenya's government in recent years, it is argued that there have been limited efforts to do so in practice (Zalengera et al, 2020).There is for instance a lack of clear provisions in place for county-level decision making, and boundaries between national and sub-national responsibilities are not yet clear. This is also the case for the energy sector which is heavily centralised.

At the neighbourhood-level, Chief's camps[11] may have an important role to play in coordination with local authorities and the implementation of local policy. For instance, Chief camps have played an important role in providing sanitary packs to their communities to combat the COVID-19 pandemic. For the 2011 KPLC Transmission Line project carried out in collaboration with the World Bank, Chief's camps were part of the project's consultation process (KPLC, 2011).

Energy access
Grid quality and availability of grid connections are unevenly distributed across neighbourhoods in Nairobi. Due to issues of regular blackouts from overloading of the national grid, rationing regimes have been put in place. Wealthier areas, business districts and areas with government buildings benefit from preferential rationing regimes than low-income areas. One might expect this to increase the need for polluting off-grid back-up sources in those areas as long as residents don't have access to off-grid renewable sources. A survey conducted across 150 households in low-income and high to middle income and city centre neighbourhoods in Nairobi, shows that around 40 per cent of respondents who were interested in investing in off-grid renewable devices were motivated by the prospect of avoiding power outages. Moreover, 74 per cent in high to middle income communities and 64 per cent in low-income communities would want to sell electricity to the grid if they could. Net metering is likely to incentivise a greater acquisition of off-grid generators however the regulatory framework necessary for net metering to operate effectively has not yet been finalised (CMS, 2021).

In Mathare slum, 93 per cent of households were connected to the national grid in 2018, however half of these had been made illegally and were unmetered (Njoroge et al, 2020). The reasons for why residents connected informally included lower costs and lower monthly charges. In Kibera, Nairobi's largest informal settlement, most households with access to electricity in 2008 were found to have gained this illegally, despite being close to KPLC transmission networks (Karekezi, Kimani, and Onguru, 2008). In the survey conducted for this study, 61 per cent of electricity connections were claimed to be formal connections. It is interesting however to note that amongst the formal connections, 83 per cent used pre-paid meters, while 26 per cent of informally connected households claimed to use pre-paid meters. The remaining 17 per cent of formally connected households reported to negotiate bills through the landlord. The types of connections through landlords are not known and might be informal. The stability of informal connections was reportedly lower with more frequent surges and blackouts compared to formal connections.

An estimated 21 per cent of households in urban areas in Kenya use off-grid connections or rely on stand-alone fuel consuming generation (e.g., kerosene lamps) to

11 Chief's camp is an administrative unit in the city, and the most local contact point between residents and authorities

cope with regular supply outages from the national grid (World Bank, 2019). In our survey, 21 per cent of the respondents said they rely on alternative sources. In terms of solar solutions, 16 per cent of respondents used hand-held solar devices (87 per cent of whom used them as a back-up source and 13 per cent as a primary source) and 28 per cent knew people who used off-grid solar devices.

There seems to be a disparity in access to grid electricity between male and female headed households in urban areas in Kenya. A survey found that 16 per cent of female headed households do not have access to grid electricity, as opposed to 9 per cent of male-headed households (Ibid).

Significant efforts have been made to increase grid connections in informal settlements in Nairobi. For example, KPLC and the World Bank, have implemented the Kenya Slum Electrification Project (SEP) to provide connections at heavily subsidised rates, making use of grid lines that often run adjacent to informal settlements. KPLC were initially met with resistance from residents. While the illegal connections to the grid were unsafe and unreliable and KPLC connections would be subsidised to cost the same as the illegal ones, a lack of trust towards KPLC made uptake very slow. However, once the implementers started working with local community leaders advocating for the safety and affordability of KPLC connections, residents started transitioning to legal connections. Eventually 50,000 residents in Nairobi's slums gained connection to the grid through the project (ESMAP, 2015).

Energy usage

In the survey conducted for this study, 94 per cent of respondents used electricity in their homes, where lighting and charging were the most important power use activities. A differentiation is made here between general lighting needs and lighting specifically for homework, both of which were top two priorities among many respondents. In the workplace, a large majority of respondents (89 per cent) needed electricity for lighting purposes, followed by 40 per cent who used it to charge devices in addition to lighting. 18 per cent used electricity for food preparation (or storage) in addition to charging and lighting. This means that approximately 40 per cent used electricity for lighting only.

In Kenya, solid biomass is widely used for heating and cooking, with 82 per cent of households relying on firewood and charcoal for cooking every day (Rahnema, Felix Sanchez, and Paola Giordano, 2018). In the survey, almost all respondents (98 per cent) used open fires. This would normally be jikos (stoves for burning coal or firewood) used for heat but mainly for preparing food. In Mukuru, people tended to use the stoves indoors. In Pumwani people tended to use them outdoors as well as indoors. This could be explained by the layout of the two areas, where Pumwani in many cases caters for small courtyards between houses and streets, allowing for household activities to take place outside. The use of solid fuel has serious health implications, particularly if used indoors, while also

In informal areas such as Mukuru, solid waste managements and pollution are major health concerns. **Photo**: Urban-A/Synne Bergby (2019)

Survey Mukuru and Pumwani

NUMBERS AT-A-GLANCE

- Almost half of the respondents live in households with 4-5 people
- 47% have been living in the area for more than 10 years or were born there
- 9% are house owners
- Over 80% believe they will be able to stay in the neighbourhood, although 75% wish they could live somewhere else
- 95% of the respondents are Kenyan citizens
- 45% have a higher education (vocational training, college, or university)
- 85% are working (but 7% of these are temporarily without work due to COVID-19)
- 80% work in the informal sector
- 80% work in service related professions (shop, kiosk, market, street)
- 55% claim they do not need licenses to carry out their work
- 59% have been harassed by police or authorities because of their work
- 22% have more than one job
- 51% have been in their current job for more than 5 years
- 94% have been affected by COVID-19 in their work situation (less customers, more difficult to work, loss of work)
- 71% of respondents live in single income households
- 80% say that their neighbourhood is lit during night in some way (flood lighting, street lights, outdoor lights on houses)
- 67% say that they feel relatively safe living in their neighbourhood
- 91% report that mugging in public places is the most common criminal occurrence, 50% say that this is the crime they are most afraid of
- 85% believe that more night time lighting would improve safety
- 76% dispose of their garbage at garbage collection points where it is taken away by informal garbage collectors
- 84% use electricity at work
- 94% use electricity at home
- 58% say that electricity is the cheapest form of energy available to them
- 85% report that general lighting is the most important electricity consuming activity at home, followed by 46% reporting that lighting specifically for homework is second most important
- 60% claim their connection to electricity at home is formal, with 53% paying through a pre-paid metre
- 80% complain of blackouts or power surges at home, while 60% say they still have sufficient energy supplies for their household
- 56% say they have access to various energy sources at all times for their work
- 1% uses solar power at work (as a supplement to other sources)
- 16% use solar power at home, at least 2% rely on it as a main source of electricity. All 16% use hand held or portable solutions.
- 35% know of other people who use solar power
- 98% use open fire (coal burning jikos/stoves) for heating or food preparation. 70% use the jiko indoors

Energy consumption in Mukuru and Pumwani is relatively low yield. Lighting is by far the most common use of electricity for work purposes (89%), followed by the need to charge devices (44%). 23% of respondents use electricity in the workplace for higher yield activities, such as preparing or storing food, in addition to 12% who use electricity for production purposes for making crafts, utility items, or repairs.

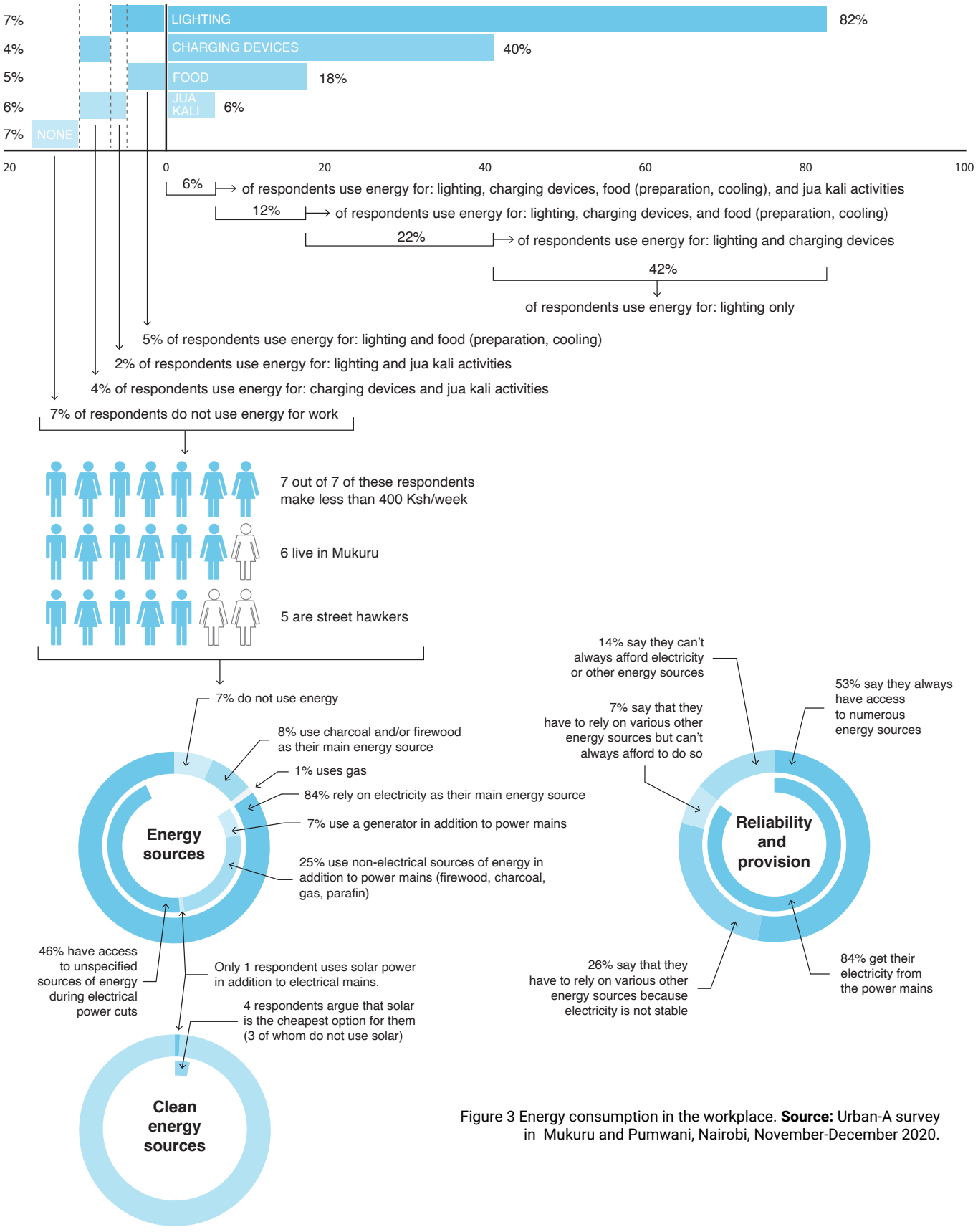
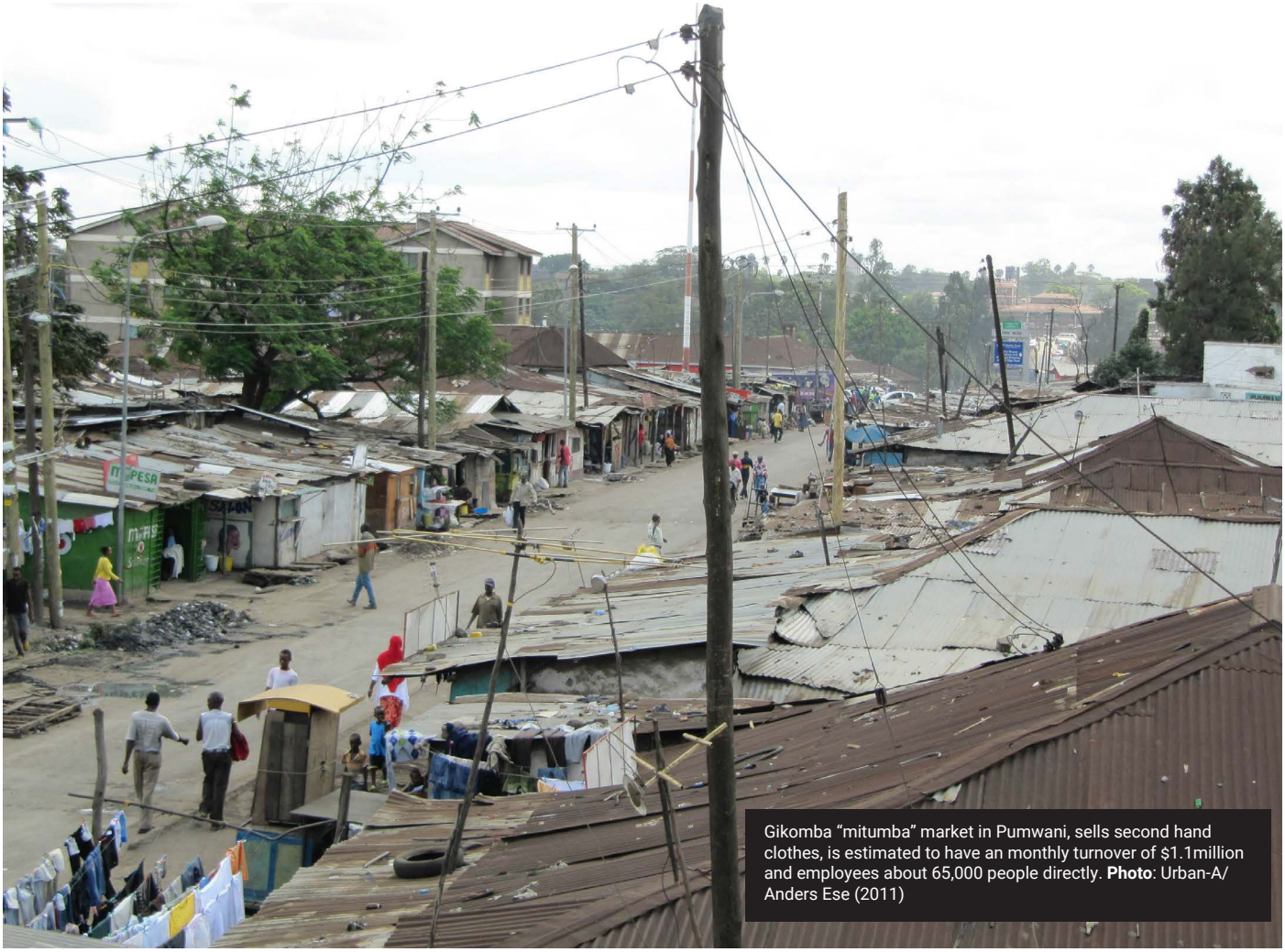


Figure 3 Energy consumption in the workplace. **Source:** Urban-A survey in Mukuru and Pumwani, Nairobi, November-December 2020.



Gikomba "mitumba" market in Pumwani, sells second hand clothes, is estimated to have an monthly turnover of $1.1million and employees about 65,000 people directly. **Photo**: Urban-A/ Anders Ese (2011)

representing a fire hazard where fires quickly spread between tight living spaces (see below).

Financial costs

The high up-front cost to acquire solar PV and the unwillingness of banks to finance investments in solar technology are key barriers to transition to solar PV in Kenya (Samoita et al, 2020). In a study, 56 per cent of high to middle income, 50 per cent of city-centre and 65 per cent of low-income residents indicate wanting government financial assistance to support the acquisition of off-grid renewable technology (Kiprop, Matsui, and Maundu, 2019). Payment flexibility is reported to be an effective tool to reduce the significant up-front costs of both grid connections and off-grid solar devices in Kenya (World Bank, 2019).

Urban planning and tenure

Land issues and precarious tenure in Nairobi's informal settlements are important factors when considering electricity provision on-grid or through stand-alone devices. In Mathare, 73 per cent of residents in 2017-2019 were tenants (Njoroge et al, 2020). In our survey, 91 per cent of respondents were tenants, of whom 17 per cent responded that they are afraid of evictions.

At the same time, the population appears to be less transient than one might expect, with 47 per cent of respondents having either lived more than 10 years or were born in Pumwani and Mukuru kwa Reuben.

In Mukuru, funds have been allocated in Government budgets for a large scale upgrading, but information on the "whats" and "hows" is scant. In Pumwani threats of demolition and redevelopment have been circulating for the last 60 years. As Pumwani's outskirts are steadily being developed there is nothing to suggest that these threats are any less potent today. The prospects are by no means unique to Mukuru and Pumwani. Through Nairobi's Metro 2030 Vision, none of the city's populous neighbourhoods will retain their current form. In the vision, these neighbourhoods are replanned and caters to a wealthier population segment than the current residents. Based on Nairobi's historical development and the lack of consideration of poorer residents in redevelopment schemes, there is an ingrained distrust between residents and city governments.

Several informal neighbourhoods are near areas of high economic activity, including neighbourhoods located between 4 to 8 km from Nairobi's Central Business

Districts. This reflects the labour demand in higher-end and business areas, either as casual workers or as domestic workers for wealthy neighbourhoods (SEforall, 2020). The importance of reliable electricity supply for economic development explains the prioritisation of the City's industrial zones in the grid rationing schemes. Informal areas with unreliable electricity provision through the grid are, in other words, located very close to some of the best serviced areas of the city.

The lack of planning was noted as a significant barrier to service provision in the conducted survey. Low availability of open spaces makes it difficult for KPLC to access interior areas of neighbourhoods in order to develop the networks (Njoroge et al., 2020). Fires due to unsafe illegal connections were also very common (as mentioned often due to open fire cooking). Several fires have rampaged areas of Mukuru over the past years. In 2019 a leak in a gas cylinder led to a fire that spread to some 600 houses, with the total damages leaving 200 families homeless and three people dead. The density in the area makes it particularly exposed for fires to rapidly spread if accidents related to gas cylinders, failures on electrical connections, or open fire accidents happen. A 2011 fire in the same neighbourhood, left about 120 people dead after a petroleum spillage in an industrial area up-river. Following the spill, people had scooped up diesel from the river, when a fire broke out in one of the houses and then spread rapidly with fatal consequences. Some residents were also trapped in flames when running down to the river to cool down, though only to light fire to diesel residues in the river. The Kenya Red Cross noted the vulnerabilities of areas such as Mukuru, both due to its exposure to fire risks, but also the difficulties in being able to respond due to poor vehicle access, and hazards such as illegal electrical wires posing risks to rescue workers (Kenya Red Cross, .n.d). In an article for africaisacountry.com (Gathanga, 2021), the author recounts his days growing up in Mathare and how illegal connections were *"rampant"*. These needed to be hid from KPLC and as such were often passing through the neighbourhood at dangerously low heights, which caused numerous fires. In his own words *"three months without a fire tragedy would be a good reason to thank the Lord."*

Pumwani, Nairobi. **Photo**: Urban-A/Anders Ese (2012)

Building in Beirut. **Photo**: Synne Bergby (2017)

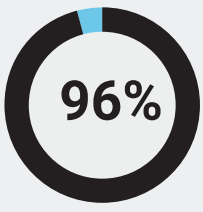
Lebanon

"In the Lebanese context, electricity is a humanitarian need, directly linked to the provision of vital services and, to a large extent, to security and social stability."

Lebanon Crisis Response Plan 2017-2020.

The explosion at the Port of Beirut 4 August 2020 was the latest of a series of overlapping and compounding crises in Lebanon. With the downward spiral in the country, Lebanon serves as an example of rapidly weakened markets and limited ability for people and local governments to pay and provide services in a time of acute need. Energy as both a contributor to and result of recent shocks is evident and suggests that the path towards recovery must include addressing energy needs at household, neighbourhood, city, and country level, as well as being made available for productive uses.

**See Annex 2 Lebanon Case Study for a more in-depth presentation of the governance system and production of energy in Lebanon.*



Fossil fuel as share of energy mix

Displacement situation

Estimated 1.7million Syrian and Palestinian refugees, 17 per cent live in Beirut (one quarter of population).

Refugees in Lebanon officially termed "guests" and are in general barred from gaining Lebanese nationality and are only able to obtain work permits in certain sectors. Palestinian refugees prohibited from owning property and accessing state-provided services, such as health and education.

Electricy access

Provision through national grid and diesel generators. Access and rate of electricity per day varies, with fuel shortages driven by economic and financial crises, electricity outages increased from around 3 hours per day to 20 hours by July 2020 in Beirut.

Cooking energy

Most of population has access to clean cooking, including LPG. However, with the lack of fuel and hyperinflation, deforestation to get firewood for cooking and heating and forest fires an increasing problem.

The protracted Syrian refugee crisis started in 2011, while more recently a deepening economic, financial, and monetary crisis have been exacerbated by COVID-19 measures, political impasse, and ongoing civil protests. The effect on energy is manifesting in multiple ways. The influx of Syrian refugees to Lebanon led to a significant increase in electricity demand, with estimated 54.8 per cent increase in demand from 2010 to 2016 (CoR, 2020). Hyperinflation and drastic reduction in purchasing power has driven up prices for imported fuel and thus energy production while also limiting people's ability to pay for energy. The same has increase illicit commerce in gasoline, where smugglers are purchasing subsidised gasoline in Lebanon and selling it on the black market in Syria. Some areas of the country used to have only 6 hours electricity a day while Beirut prior to the economic crisis had 21 hours of electricity a day. In July 2020 electricity went down to 4 hours due to fuel shortages, and with a further deterioration of the situation since electricity has been even more restricted. Moreover, the pandemic has contributed to a drop in electricity bill collections of around 20 per cent. Damages from the 4 August 2020 explosion affected Beirut's transmission network and reduced supply at the time when the need for electricity to power health institutions, business, homes, and to support reconstruction efforts was of upmost importance. As a result, national production of electricity fell significantly in 2020. The compounded crises have also heightened the effect of chronically underperforming public services and historic and structural challenges.

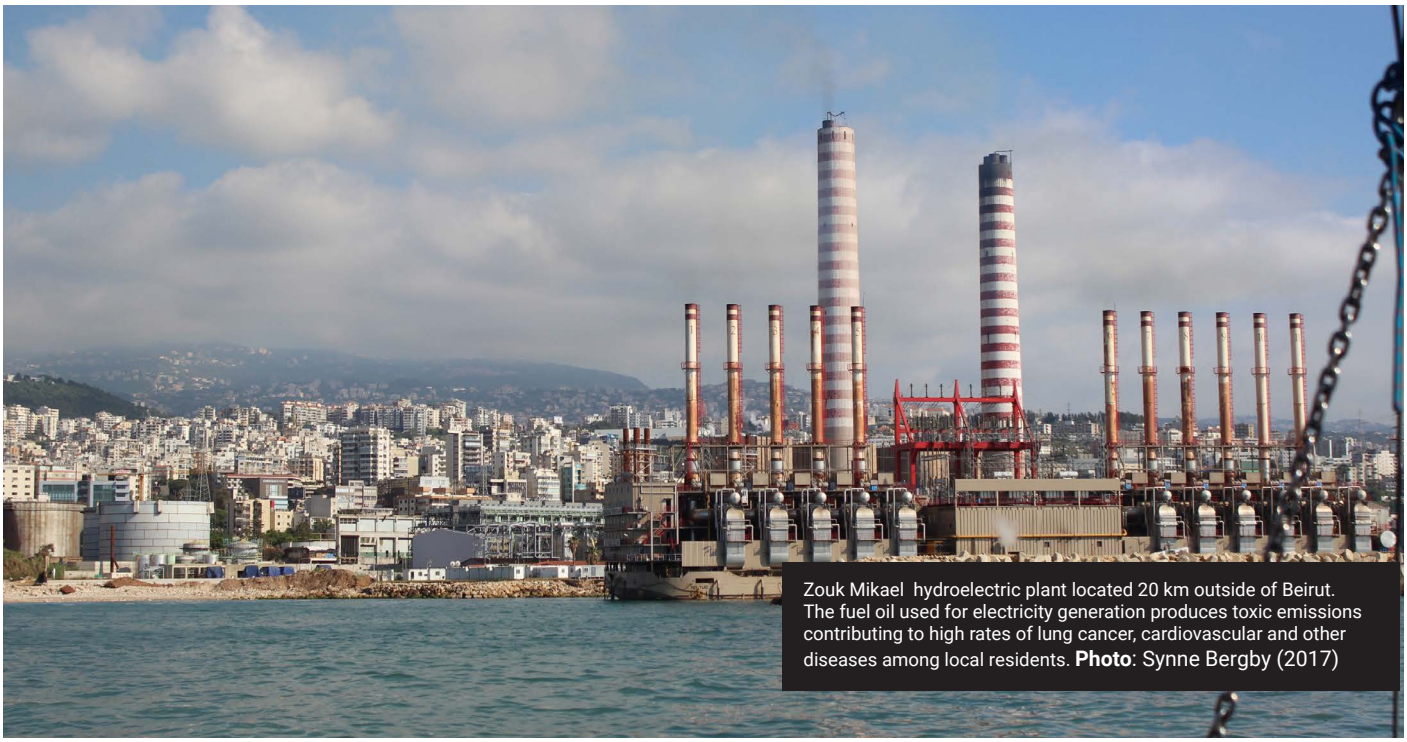
Energy provision and systems

Lebanon has a single, integrated utility company – Electricité du Liban" (EdL) – responsible for the provision of electricity for the entire country. However, only 55-64 per cent of Lebanon's electricity demand is provided by EdL. Electricity is commonly supplemented by neighbourhood suppliers, who are fully embedded in local wasta[12] systems and in some neighbourhoods also referred to as the "generator mafia", alluding to the little flexibility of residents to choose or navigate different options of energy suppliers. Estimates suggests that there are between 32,000 and 37,000 neighbourhood suppliers in Lebanon, concentrated in dense urban areas. While municipalities in theory regulates the rates charged by generator owners, this is a recent and an uncoordinated system that is often influenced by local sectarian politics. The legality of municipal provisions of energy remains in dispute. Currently, decentralised systems are not legal and cannot be connected to the grid (Zahle as an exception, see Box 8).

Energy supplies in Lebanon rely almost entirely on fossil fuel (oil and diesel). Lebanon is in the exploration phase of oil and gas, which if found can provide Lebanon with energy for domestic use as well as exports. Currently however, Lebanon is importing all its fossil fuel needs, including for power generation. In addition, it is importing small quantities of coal, electricity, and solid biofuels. For example, Lebanon imported 533.803 GWh and 11.391 GWH electricity from Syria in 2017 and 2018, respectively.

The GoL-subsidized fuel used in EDL's power-generation plants has thus caused significant deficits in the government budgets. In comparison, revenues from energy provision is minimal. Electricity tariffs are based on consumer prices that have not changed since 1996

12 Term used on patronage/clientilism in the Arab world



Zouk Mikael hydroelectric plant located 20 km outside of Beirut. The fuel oil used for electricity generation produces toxic emissions contributing to high rates of lung cancer, cardiovascular and other diseases among local residents. **Photo**: Synne Bergby (2017)

when a barrel of oil cost USD 23 (Reuters, 2019), and collection rates remain low, while the inefficiencies on the system (notably network leakage) lead to loss in efficiency and supply (World Bank, EU and United Nations, 2020). Technical and non-technical losses amount to a third of EDL's generation.

A study on willingness to pay for renewable energy in Lebanon showed that a significant amount of income (around 16 per cent) is already earmarked electricity and hot water (UNDP, 2015). Many individual and business respondents had poor knowledge of renewable energy. Amongst residents, the main reasons for not being willing to pay for renewable energy was that it was not of interest and that the government should pay. More than half of businesses were willing to pay to undergo energy efficiency measures. The highest interest in renewable energy was if it could replace diesel generators, where most business owners rent or own diesel generators currently.

LPG is used by households for cooking, using liquid cylinders and for space and water heating. It is also used in industries, commerce, and public services.

City-level energy access: Inequitable, unreliable, and lacking

The provision of energy in Lebanon is uneven and reflects socio-cultural divisions and inequity. Many poor and disenfranchised areas, such as the Palestinian camps, receive far less energy than other areas of the cities. For example, Shatila, one of the Palestinian refugee camps in Beirut, is connected to the Mount Lebanon network but has far less access to energy than neighbouring areas. Moreover, electricity provision in Beirut has been severely affected by recent shocks. From previously being without electricity for a few hours a day, this has increased to large parts of the day.

The lack of access to affordable and reliable electricity forces many to connect illegally. There is thus a prevalence of dangerous connections in some of the poorest neighbourhoods. In Burj Barajneh Palestinian camp there have been cases of death by electrocution from encountering damaged electrical wires. Assessments of living conditions for Syrian refugee families have shown that some put electrical wires directly into pots to heat water.

Box 8: Zahle city and its 24 hours electricity provision.

Zahle city has established its own service provision of electricity. In Lebanon this is a unique case. While it is a success story in terms of providing reliable electricity to the residents 24 hours a day prior to the fuel crisis, it is also a story of how rent-seeking is shifted from a central to a local level rather than being disposed of in the new system. The opportunity to set up a decentralised system for electricity generation has only been made possible as a result of specific historic and political conditions combined with successful mobilisation of residents.

How does it work?
When EDL electricity is available, Électricité de Zahlé (EDZ) is purchasing the electricity at a heavily subsidised rate and reselling it at a much higher EDL tariff. When EDL electricity is not available, private emergency power contractor EDZ-Aggreko, provides electricity. EDZ collects 100 per cent of electrical bills and provide electricity at cost that is competitive with the private generators that back up EDL supply. Unlike private generators who rely on their own low-quality grid, the EDZ-Aggreko supply is connected to the medium-quality EDL grid. The system has eliminated blackouts, and consumers are provided with an integrated billing. Access to reliable electricity 24 hours a day is benefiting households and small businesses, particularly women managing domestic affairs. In a study on Zahle, people benefiting from this access reported feeling of dignity and humanity amongst the benefits.

Clean energy
EDZ has encouraged the development of solar power and has installed significant net-metering technology. As of June 2020, EDZ had 8 MW of solar photovoltaics (PV) capacity connected to its grid, around 10% of EDZ-Aggreko's total installed capacity. While Aggreko offered to incorporate solar systems in their generation, EDZ refused because the relatively long contractual timeframe required by Aggreko was inconsistent with the highly uncertain policy and regulatory context that EDZ faced. In addition, a shift towards renewables-based power generation would impact EDZ's business with powerful local diesel fuel suppliers, creating an additional layer of resistance.

The Zahle case suggests there is market demand for higher-priced electricity if this is reliable and good quality. This would necessitate to raise the price that concessions pay to the EDL for their power to something that approaches the price at which EDL sells to costumers. However, the continued corruption and the lack of financial sustainability of this model that does not allow for scaling up of the model, even if the political will was there (Ali Ahmad et al, 2020).

Electricity generation in Beirut
There is one hydroelectric plant located 20 km outside of Beirut. The fuel oil used to generate electricity at the hydroelectric plant produces toxic emissions contributing to high rates of lung cancer, cardiovascular and other diseases among residents (Armstrong, 2015).

Solar PV
There are several large-scale solar PV projects in Beirut. The Beirut River Solar Snake is the first grid-connected pilot PV plan in Lebanon (see Box 9). The solar PV project in Bourj Hammoud is an example of a community-led upgrading project, implemented by PCPM and UN-Habitat in collaboration with the Municipality of Burj Hammoud and the Lebanese Center for Energy Conservation. 26 kWp, separated into two PV systems, have been installed with on-grid connection to a church and batteries for street lightning. In Lebanon, the solar PV sector has more than 100 competitive companies with potential for further growth (Moore and Collins., 2020). The solar water heaters are the most developed clean energy technology in the country, promoted through interest-free loans. Close to 40 per cent of the installed solar water heaters in Lebanon have been partially or completely manufactured in Lebanon (Ibid).

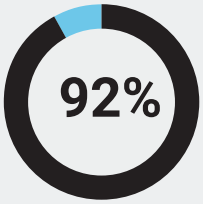
Box 9: The Lebanese Centre for Energy Conservation (LCEC).
The LCEC, Lebanon's national energy conservation agency, was initiated as a joint project between the Ministry of Energy and Water (MoEW) and UNDP in 2002. Affiliated with the MoEW but with a financially and administratively independent statute, LCEC's mandate is to "lead the efforts in Lebanon in the development of energy efficiency and renewable energy to increase energy security and de-carbonisation levels" (LCEC, n.d.). This includes setting up national action plans and strategies for sustainable energy, and the implementation of projects by MoEW. A notable pilot project is the first grid-connected PV plant in Lebanon, the Beirut River Solar Snake (BRSS) (the name given because the project is implemented on top of the Beirut river, taken advantage of the vacant "unused" space in the densely populated capital) (LCEC, 2020). The BRSS was built in 2015 by a private sector consortium. While being planned for a total output of 10MW, currently only the first stage of the project, adding 1MW to the national grid, has been implemented.

Solar PV in Burj Hammoud, Beirut, part of community upgrading project by PCPM, UN-Habitat, the municipality, and LCEC. **Photo**: LCEC (2020).

Beirut Solar Snake built over Beirut River, is the first grid-connected PV plant in Lebanon. **Photo**: Synne Bergby (2016)

Syria

The conflict in Syria has caused significant damages to high, medium, and low voltage infrastructure and key assets, including distribution grids in rural and urban areas. The energy sector has also been greatly impacted by interruptions to the country's oil production and the state's loss of control of the oilfields in the North-East. While a relatively small crude oil producer prior to the conflict, the production still accounted for 25 per cent of government revenues. Electricity access remains low in urban areas, but with large variation between neighbourhoods and cities.



Fossil fuel as share of energy mix

Displacement situation

6.6 million Syrian refugees outside the country, predominantly in neighbouring countries, as well as 6.7 million internally displaced.

Increased attention to policies and planning that will facilitate return.

Electricy access

Access and rate of electricity per day varies between cities, but typically 3-4 hours per day.

Cooking energy

N/A, however situation similar to Lebanon with deforestation and forest fires particularly North-East extending into Lebanon.

In 2010, 94 per cent of Syria's electricity was generated from national thermal power plants using oil and gas, while six per cent was generated at Tabqa Hydro-electric dam (LNA, forthcoming). This made Syria a net exporter of electricity. Energy and electricity have been severely affected by the conflict that started in 2011. Going from a net-exporter to a net-importer of oil, and with the imposed embargo in the early stages of the conflict, Syria received crude oil deliveries from Iran (Shaar, 2019). The oil deliveries have, however, been significantly reduced since 2018, with oil shortages becoming more frequent. A halt in supplies has contributed to the crippling economy in regime-held areas and is a key barrier to economic recovery and reconstruction efforts. Rising fuel costs have led to a dramatic increase in the cost of electricity production. Prior to the conflict, electricity was priced at 2.5 SYP per kilowatt hour (kWh) of electricity. The price has increased to 32.5-42.5 SYP per kWh. According to sources, fuel expenses now account for nearly one-third of all electricity generation costs (LNA, forthcoming).

Renewable energy

Prior to the conflict, renewable strategies were advanced by the Government of Syria (GoS). An initiative to improve supply-side efficiencies and conservation of energy was established already in 2002, and Law 3 / 2009 on energy conservation and Law 32 / 2010 on electricity furthered Syria's commitment to clean energy (Ibid). Recently, the Ministry of Electricity (MoE) has updated the plans for integration of renewable energy sources with a goal of adding 1,500 MW of solar PV and 900 MW of wind power by 2030 (Syrian Arab News Agency, 2019). The MoE is also guaranteeing to purchase clean energy from private vendors, covering costs of connection to the national grid, while interest free loans are provided for small solar PV systems and water heaters. However, restrictions on investment in projects less than 100kW, the government's limited ability to buy electricity and selections of who may provide large-scale projects are key barriers to the growth of the market (LNA, forthcoming).

Climate change, environmental degradation, and energy.

In Syria, it is also relevant to look at the intersection of energy with climate changes and environmental hazards and how this is impacting the country. Over the past decades the country has been increasingly exposed to climate and environmental changes that has had a negative effect on people's ability to sustain their lives and livelihoods, and increased pressure on infrastructural systems and resources. Recorded increase of average temperatures and reduced rainfall, for example, has contributed to land degradation, deforestation, and droughts. Four severe droughts spanning more than four years have occurred over the past 90 years; one around 1960, and three after 1990 (Urban Recovery Framework, forthcoming). This includes the 2007-2010 drought that resulted in loss of crops, livelihoods, and a wave of rural-to-urban migration.

BOX 10: Laws in Syria related to electricity generation and use

- Law 3/2009. The Energy Conservation Law
- Law 32/2010. The Electricity Law
- Prime Ministry Decision 16202/2011. Determined the purchase prices of electricity produced from renewable energy projects and systems
- Law 18/2008. Energy consumption of electrical equipment
- Law 17/2011. The Solar Heater Law
- Prime Ministry Decision 1113/2020. Updates the purchase prices of electricity produced from renewable energy sources and sets a lower limit to generation capacity of such sources at 100 kw.

Source: iMMAP, forthcoming.

Over the past years, there has been an increased occurrence of forest fires, mainly along the coastal mountain-belt. The same has been seen in Lebanon, which is part of the same mountain system. With a significant subtraction of green cover in Syria, forests now cover only 3 per cent of the land and the increase of forest fires is therefore an even greater concern. While rainfall is overall decreasing, heavy and very heavy rainfall resulting in floods has increased in the north-western corner. This is also observed in Lebanon and in other places in the region such as Yemen, which is particularly affected by severe flash floods. Due to limited catchment of heavy rainfall in built-up areas with high impermeability of surfaces and built structures, the contribution to recharging the ground water table is low and contributes to the propensity of severe water shortages. For coastal cities, rising sea water levels also increases salinity of the groundwater. The frequency and magnitude of these stressors have implications on the energy and resource usage and demands. It both increases the pressure on scarce natural resources and energy production for irrigation, cooling down, and heating of buildings, water pumping, etc. The reliance on fossil fuel is further a contributor to these stressors, showing the need to consider environmental aspects in recovery efforts. As such, clean energy provision, in this context represents an important opportunity to address energy gaps that would support the economic recovery of vulnerable households and small-scale business owners, while at the same time mitigating the negative consequences fossil fuel reliance.

Energy access across cities.

While the energy supply is managed centrally in Syria, through the Ministry of Electricity and its directorates,

the conflict impact on the energy sector has manifested differently across the country and between cities. This has implications on urban recovery trajectories as well as household needs. For example:

As-Sweida has remained under the control of the GoS and has therefore experienced lower degree of damage to its physical infrastructure (Urban Analysis Network Syria, 2019). The electricity infrastructure, however, is suffering from lack of maintenance starting already prior to the conflict. The daily electricity was reported to be between 6 and 12 hours in 2019 with less access in the winter due to lower temperatures. Residents are thus resorting to alternative solutions to supplement electricity, including batteries and expensive private generators. Diesel prices have increased 12-fold on the official market since the conflict started, and more than 300 per cent on the black market. The supplied electricity is 100 MW annually, less than half of the governorate's need of 250 MW (LNA, forthcoming). Between 70 and 80 percent of the electricity provided is used for residential purposes.

Gas cylinders used for heating and cooking are rationed and only available every two months by smart-cards. This lasts up to 20 days during winter and 30 days during summer. The smart-card allocation of diesel is supposedly 300 litres per year, but only 200 litres is made available, one fifth of the 1,000 litres fuel requirement for heating. Wood-fire heating is therefore common (Ibid).

In Aleppo, the pre-conflict electricity coverage was close to 100 per cent, with electricity reported to be available 23 hours a day (Urban Analysis Network Syria, 2019a). During the conflict, electricity has been used as a weapon against the communities be aggressors on all sides, and electricity infrastructure has been severely damaged. This includes damages to the thermal plant which used to meet the city's as well as nearly 20 per cent of the entire country's energy needs. While rehabilitation of the plant is critical for electricity supply, aerial imagery from 2019 suggests that despite declared intentions to restore production the actual work has not yet started.

The availability of electricity differs greatly between neighbourhoods in the city. While some neighbourhoods have 6 to 15 hours of electricity per day (mostly western Aleppo), others are disconnected (mostly eastern Aleppo). As an alternative source of electricity, many rely on private generators with high costs (Ibid).

In Ar-Raqqa, the Euphrates river and Tabqah Dam supplied the city with electricity prior to the conflict (Urban Analysis Network Syria, 2019b). The fighting has dramatically affected electricity supply, and a battle between ISIL and the coalition forces in 2017 finally damaged the generators to the point that rendered them non-operational. As a result, grid connections were still not available to any neighbourhood in May 2019. This makes people dependent on diesel generators for all electricity needs. Reportedly, around 80 per cent of the areas of the city have between 8 and 10 hours of electricity access daily using generators, while the remaining areas have between 10 and 12 hours electricity access.

Idlib Province, in the northwestern part of Syria bordering Turkey under rebel stronghold, is an example of how no government supplied electricity and very high costs of imported oil from Turkey to power diesel generators, have resulted in a transition to solar technology. According to the New York Times, one supplier of solar technology has scaled up from basic 130-watts panels selling for $38 each, to packaged for around $550 with enough energy to power a refrigerator or washing machine, lights and TV, to the largest package yet of 160 solar panels of around $20,000 to a farmer.

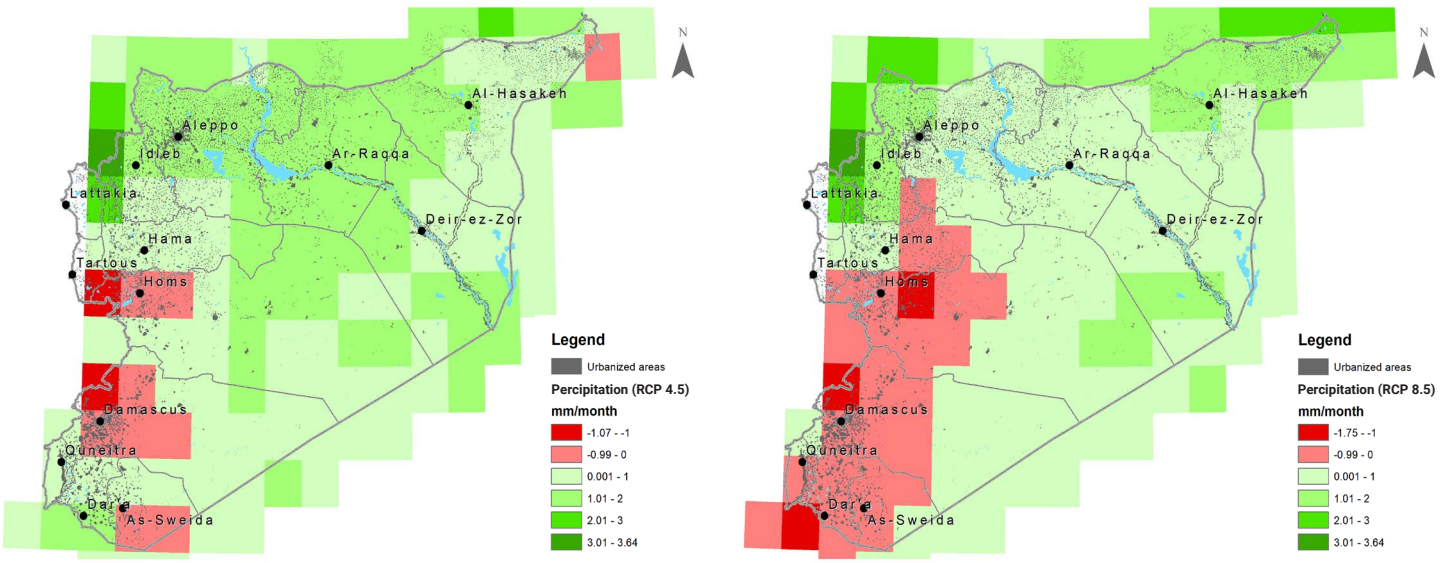


Figure 4 Moderate and extreme scenarios for precipitation in Syria in 2030 (RCP 4.5 and 8.5 respectively).
Source: Urban Recovery Framework, forthcoming

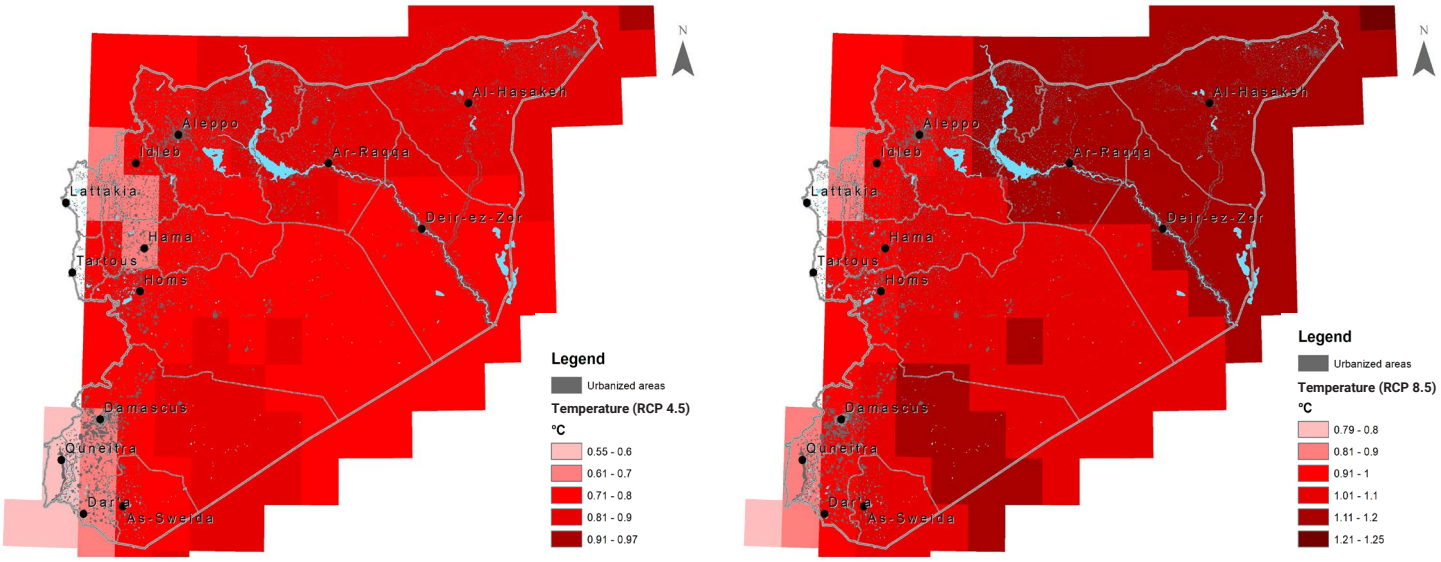


Figure 5 Moderate and extreme scenarios for temperature in Syria in 2030 (RCP 4.5 and 8.5 respectively).

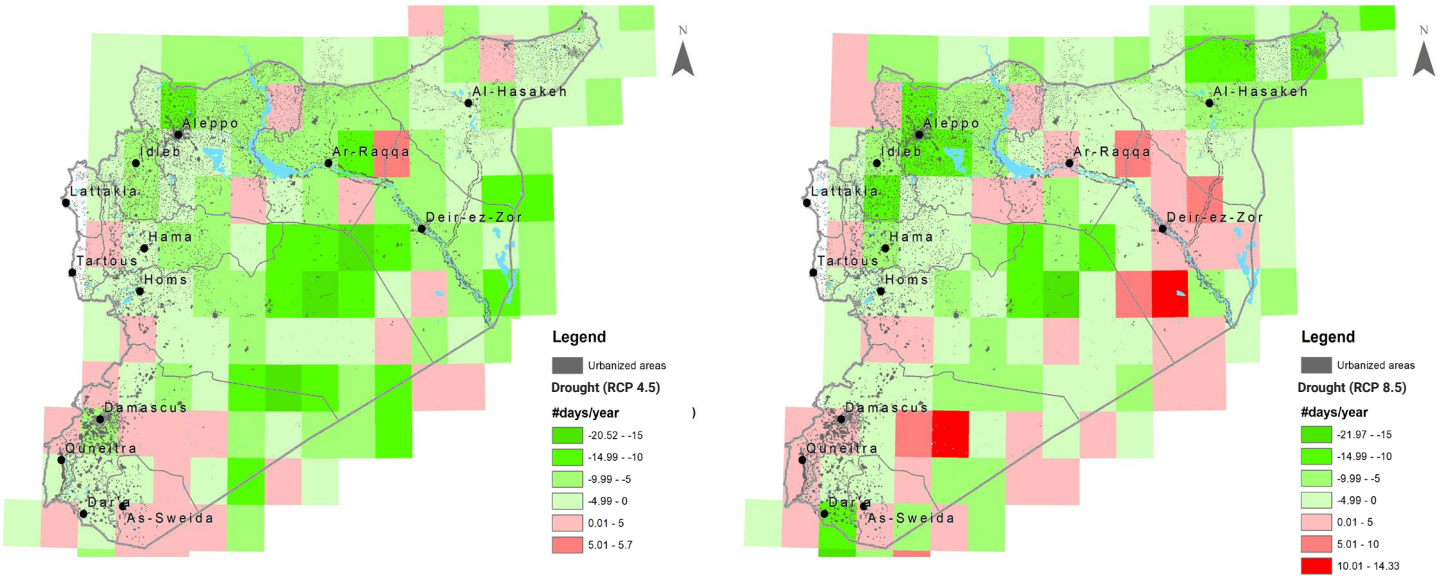


Figure 6 Moderate and extreme scenarios for drought patterns in Syria in 2030 (RCP 4.5 and 8.5 respectively).

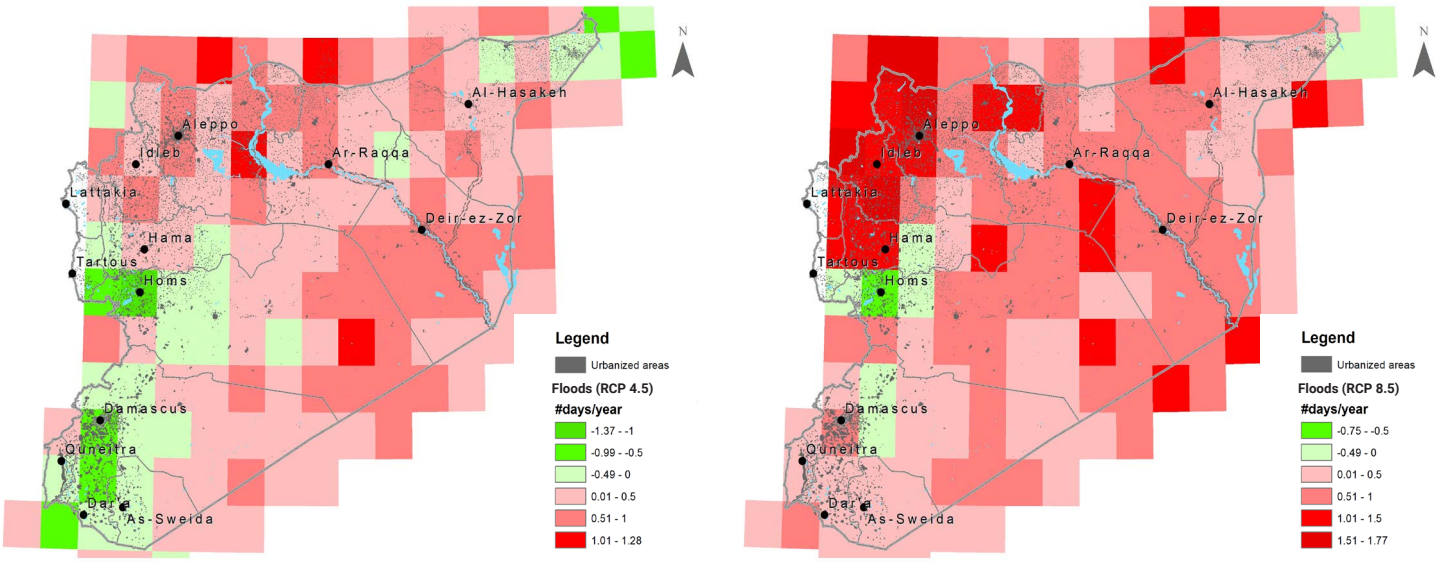


Figure 7 Moderate and extreme scenarios for floods pattern in Syria in 2030 (RCP 4.5 and 8.5 respectively).

Using the Representative Concentration Pathway (RCP) of the Intergovernmental Panel on Climate Change (IPCC), two climate change scenarios have been produced for Syria for 2021-2040, one using RCP 4.5 (representing a moderate climate scenario) and the second RCP 8.5 (representing an extreme climate scenario). RCP 8.5 can be considered a 'business as usual' scenario as it assumes little-to-no mitigation efforts globally. Source: Urban Recovery Framework, forthcoming.

Approaches to clean energy provision in urban recovery

Drawing on the outlined challenges of energy access in urban crises setting in general, and the three country cases in particular, the below section outlines some possible approaches to work with clean energy as part of urban recovery across geographies. In line with the foregoing analysis, this section is structured along the three levels for intervention: neighbourhood (community), city (systems), and national (policy and regulations). For each level, a list of considerations that should guide interventions, are outlined.

Approaches to clean energy provision at neighbourhood and household level

The three case studies show significant gaps in access to adequate, safe, reliable, and sustainable electricity in urban areas. This situation is often worse in pockets of informality and/or poverty including areas hosting internally displaced and refugees. The Kenya case shows a transition to renewable energy at the national scale, where energy access gaps in informal neighbourhoods are circumvented by connecting illegally to the grid and using alternative non-clean energy sources for cooking and heating, such as coal, firewood, and gas. In Lebanon and Syria, the compounded crises and collapse of the economies has both reduced hours of electricity per day and made alternative energy sources unaffordable and/or unavailable.

Lack of access to energy negatively impacts people in several ways. For example, lack of energy directly affects families' ability to adequately store and cook food, with associated health risks from undercooked or non-preserved food; it reduces access to water and water heating; poses a significant hindrance to operation of small and medium sized businesses during hours of power outages; reduces the time available for homework; and increases protection risks in unlit streets/open spaces. The exposure to these risks is generally highest among vulnerable groups including, displaced, children, and women.

In the below, considerations to guide interventions in urban crises settings at the neighbourhood level are presented. Here, interventions will generally centre on facilitating, incentivising, engaging, and supporting different stakeholders to understand needs and vulnerabilities, and how these can be addressed.

Considerations and principles to guide interventions at neighbourhood level

- Base the design and implementation of interventions on **evidence and contextual understanding** of interlinked needs, systems, practices and formal and informal service provision and governance using spatial mapping and needs analysis.
- **Embed energy projects and accountability at the local level.** Energy interventions must ensure transparency and accountability among local providers and implementers for the performance of energy interventions.
- **Make informed decisions on whether to target needs of vulnerable populations on a community- or household-level.** Household-level interventions in densely populated city neighbourhoods are costly and/or requires targeting certain vulnerable households (e.g., refugee families). This is especially challenging in heterogenous neighbourhoods with shared needs and is a primary reason why area-based approaches, discussed above, have been developed. Whether to target needs on a household or community level must be based on a solid understanding of the local context.
- **Apply people-centred and community-led initiatives** to respond effectively to real needs, ensure "do no harm", and increase uptake of new solutions. Involvement of residents, including representatives of vulnerable groups including refugees, migrants, and women, is central to respond to different segments of often highly heterogenous populations' needs.[13] Residents, formal and private service providers,

13 See NORCAP and BCG, 2020 report for more on the importance of engaging local stakeholders and encouraging community participation to effectively scale up off-grid solar PV in Sub-Saharan Africa's rural areas.

local power brokers, and community-based organisations should be engaged in the design and implementation of interventions. This is particularly important in places where there is low trust towards the local government, private actors, or other "external" actors.

- **Use anchor clients,** such as local business, organisations, and institutions, and explore solutions for selling excess electricity back to the city grid and expanding local provision to industries.
- **Use electricity access as leverage to address other challenges such as precarious tenure or lack of clean water.** An example from Amman highlights the potential to use solar power to improve tenure security for displaced persons.[14] In Lebanon, the Shelter Working Group has used housing upgrading schemes to secure rental agreements for refugees. This could potentially be expanded on to incorporate renewable energy systems.
- **Identify and seek to mitigate cultural barriers for clean energy solutions.** Cultural practices important for the success or failure of interventions, both on a country and regional level and between rural and urban areas, must be accounted for. Displaced persons and migrants carry with them cultural practices to the place they go that may differ from the host population. This is important to understand in order to address needs and vulnerabilities.
- **Improve and streamline assessments to capture and increase impact of interventions to understand what works and what does not**. Currently there is "no real mechanism" for incorporating the human factor in impact assessments to justify why and how clean energy transition is a good investment and will improve people's well-being.

Approaches to clean energy provision at city and systems level

Complex urban crises settings require attention to both sub-city levels and the broader city and systems levels. While the impact of shocks, such as flash floods, hurricanes, or the explosion in Beirut, is most noticeable in physically affected neighbourhoods, economic and political repercussions manifest on a city (and country) level. Broken and disrupted value chains and economic activities are not necessarily located within residential neighbourhoods targeted for assistance, using for example area-based or neighbourhood profiling to guide interventions. The halt in economic activities and loss of livelihoods has ramifications for people residing in the city at large, as well as connected rural areas. Either through the loss of activities in value-chains (e.g., food production), or as people living in rural areas commute to work in the city. To ensure that immediate response contributes towards recovery and resilience in the medium- and longer-term it is therefore necessary to think at a larger scale and with a longer horizon from the onset of the crisis.

The interconnectedness of functions and reliance on income generating activities in urban settings makes it vital to target systems in urban recovery efforts to address the needs of the most vulnerable. With limited resources to respond (both strained government budgets and limited donor funding) this requires new ways of thinking and market-based solutions. It further necessitates to balance and prioritise investments and interventions between immediate or short-term support at household and community levels and interventions with potential transformative effect on recovery and longer-term poverty reduction.

In the below, consideration to guide interventions in urban crises settings at the city level is presented. Here, interventions will generally target local governments.

Considerations and principles to guide interventions at city level

- **Promote a shared understanding of needs and opportunities** for different actors using comprehensive city level analysis and response planning in line with adopted approaches for urban crises response.
- **Anchor interventions with local governments.** Bolster municipal information systems with a focus on cross-sectoral and spatial analysis to create awareness and understanding of energy systems and solutions at the municipality level. Identify the effectiveness of local authorities and why innovations are possible in some areas of the country, and others not. Explore options for municipalities to identify, lease, or borrowing land for clean energy solutions.
- **Analyse and segregate the market** to reach different population groups through different channels. Often options are available for middle class, while the (free) market does not cater to poorer population segments.
- **Apply punctual, strategic interventions for selected value chains with growth potential and target composite needs.** Promote ways of creating job opportunities for target populations when implementing solutions such as street lighting, water, heat and cooling deficiencies, and health services.
- **Strengthening of value chains and rural-urban market linkages.** Improve transportation and storage of goods that require cooling.
- **Integrate energy solutions in redevelopment processes.** In the case of Lebanon, and Beirut specifically, the reconstruction of central areas of the city can be an opportunity to integrate clean energy. In the case of Nairobi, there is high

14 NRC implemented water heating system with rental contracts for refugees. For more information see NRC, Green energy for Syrian refugees. Available at: https://www.nrc.no/news/2016/juni/jordan-renewable-energy-project/

uncertainty for many redevelopment schemes and thus many current residents live with precarious tenure situations. With a history of housing developments targeting poor residents has tended to lead to gentrification processes favouring new, middle class residents, linking services such as clean energy to tenure rights could be a possible inroad to strengthen tenure rights.

Approaches to clean energy provision at national (policy) level

To accelerate the transition to clean energy, solutions need anchoring in national policies and regulations. In the three case studies, there are existing entry points to strengthen the policy environment and governance systems towards this end. However, when competing with established systems relying on fossil fuels in oil both in producing countries like Syria and in countries carrying out petroleum explorations like Lebanon, a clean energy transition requires modelling and business case development that is reflective of the financial interests in oil production, and the costs of building out new energy solutions compared to e.g., fuel import.

Acknowledging the importance of creating an enabling policy and regulatory environment for urban recovery more broadly, and clean energy transition specifically, interventions at the national level will seek to support ministries and departments responsible for energy. This to develop and strengthen policies and regulations, and to trigger necessary changes within key institutions, considering both national priorities and the needs at local levels.

In the below, consideration to guide interventions in urban crises settings at the national level is presented. Here, interventions will generally target the central government.

Considerations and principles to guide interventions at national level

- **Move towards a finance-oriented market** using effective finance mechanisms, including financing of small-scale investments. Consider systems for subsidies and tariffs and explore innovative funding models, and legislation on innovative finance and crypto crowdfunding with digital assets. This could include blockchain as way to fund renewable energy. Apply stress test mechanisms to allocate risks between public- and private-sector actors.
- **Strengthen connection between national and local levels to promote evidence-based solutions that responds to and informs specific policy and regulatory environment in a given context.** Scale up solutions by promoting an enabling environment and governance structure for cross-fertilisation and replication.
- **Incorporate sustainable energy access for displaced people into international, national, and local agency agendas.** Humanitarian agencies should incorporate energy considerations into core programming for each stage of a humanitarian response.
- **Encourage and, where possible, incorporate new technology and innovation through legislation and incentives.** For example, redox/vanadium flow batteries have emerged on the market for larger-scale, long-term energy storage. This is expected to revolutionise the energy storage market by providing hundreds of megawatts hours at grid scale and lasting over 20 years without loss in storage capacity. While still at an infant stage and thus expensive and unviable, it is expected that cost will reduce 50-70 per cent by 2025. Smart microgrids powered by demand-response systems also hold large potential impact. By reducing peak load and need for larger grid infrastructure, smart microgrids can optimise energy derived from solar and wind in combination with smart meters.
- **Consider the afterlife** and whole value-chain for clean energy appliances. Work towards safe disposal of used batteries from solar PV, and improved conditions for informal waste workers who are collection and recycling appliances.

ANNEX 1: NAIROBI CASE

Satellite image Nairobi. **Photo**: European Space Agency

Governance

National

Kenyan energy policy is formulated by the Ministry of Energy (MoE), previously the Ministry of Energy and Petroleum (MoEP). The body regulating the sector is the Energy and Petroleum Regulatory Authority (EPRA), previously the Energy Regulatory Committee (ERC). The Renewable Energy Advisory Committee advises the MoE's Cabinet Secretary on renewable energy including policy areas.

The principal utility companies involved in the process of electricity generation, transmission and distribution are REREC, GDC, KETRACO, KenGen (60% of national generation in the grid) and KPLC (the most significant player in transmission/distribution). KenGen and KPLC have been some of the best performing utilities in Africa - they are both listed on Nairobi's Securities Exchange and have been able to successfully raise funds on the capital markets and from commercial banks (World Bank, 2019). Eleven Independent Power Producers (IPPs) have investments in power plants across Kenya who sell electricity to KPLC through long-term Power Purchase Agreements (PPAs), generating approximately 30% of national grid electricity. The COVID-19 pandemic however led to an 8% drop in electricity demand from the grid last year which has put pressure on KPLC, even going so far as to cause the utility to consider suspending its commitments to its IPPs (The East African, 2017). Kenya is also part of the East African Power Pool, a project still under development, with the aim of connecting national grids in the East African Community. Kenya is already connected to Uganda and it is expected that the connection between Kenya and Ethiopia will be finalised in June 2021 (Pumps Africa, 2021).

Since 29 per cent of electricity connections nationally were made through off-grid devices as of February 2018 (World Bank, 2019), off-grid suppliers (REREC, private sector companies selling off-grid generators and customers acquiring them to produce their own electricity) constitute a prominent role in the national supply of electricity. Finally, informal suppliers of electricity are very present in Naiorbi's low-income areas - a study of the city's Mathare informal settlement revealed that across 2017-2019, an estimated 50 per cent of grid connections were illegal (Njoroge et al, 2020). Looking at the availability of the national grid across Kenya, the World Bank's MTF survey finds that it is lacking for 16 per cent of urban households and 27 per cent of rural households as of February 2018 which is coherent with urban and more densely populated

Government agency	Responsibilities
Kenya Power and Lighting Company (KPLC)	- Electricity transmission, distribution and retail sales - Operating PPAs with KenGen and the Independent Power Producers (IPPs) for transmission and distribution - Owned by GoK
Kenya Electricity Generating Company (KenGen)	- Producing the majority (60 per cent) of electricity consumed on Kenya (hydro, thermal, geothermal and wind) - Partly owned by GoK (with a 70 per cent controlling stake) and the public (30%)
Kenya Electricity Transmission Company (KETRACO)	- Planning, designing, constructing, operating and maintaining the national high voltage electricity grid - owned by GoK
The Rural Electrification and Renewable Energy Corporation (REREC)	- Developing rural electrification master plans - Promoting renewable energy tech (excluding only geothermal tech) - Implementing rural electrification through grid extensions and off-grid solutions - Owned by GoK - Established under the Energy Act (2019)
The Geothermal Development Company (GDC)	- Conducting geothermal resource assessments (exploration, appraisal and production) - Selling geo-termal steam to KenGen and IPPs for electricity production - Owned by GoK
The Energy and Petroleum Regulatory Authority (EPRA)	- Independent statutory body - Regulating the operation of energy and petroleum nationally - Ensuring the interests of consumers, investors and other stakeholders are protected by enforcing the Energy Act (2019)
The National Environmental and Management Authority (NEMA)	- Formulates environmental regulations that the energy sector needs to comply with (RES4Africa, 2019)
The Energy Tribunal	- Arbitrating disputes that occur between the EPRA and other stakeholders in the energy sector

Table 1 Key national agencies under the MoE and their responsibilities. Source: Ministry of Energy website (energy.go.ke)

regions being better serviced with respect to the grid (World Bank, 2019).

Sub-national
Nairobi City County "Environment, Water and Sanitation" sector's mandate is to "increase access to clean and affordable Energy to all County residents" (Nairobi County, 2021). According to county website, the sector has the mandate to regulate energy, to plan and develop gas/electricity networks, to process applications for licenses relating to energy generation and to enact Nairobi County laws, policies and regulations in the energy sector. Nairobi City is also a member of the Global Compact of Mayors for Climate and Energy, a global alliance of cities and regions for climate action.

Despite a significant move towards the decentralisation of Kenya's government in recent years, it is argued that there have been limited efforts to do so in practice (Zalengera et al, 2020). There is for instance a lack of clear provisions in place for county-level decision making, and boundaries between national and sub-national responsibilities are not yet clear.

At the neighbourhood-level, Chief's camps[15] may have an important role to play in coordination with local authorities and the implementation of local policy. For instance, Chief camps plays an important role in providing sanitary packs to their communities in the context of the COVID-19 pandemic. For the 2011 KPLC Transmission Line project carried out in collaboration with the World Bank, Chief's camps were part of the project's consultation process (KPLC, 2011).

Policies

Under the National Energy Policy of 2018 (Republic of Kenya), the government has made a commitment to providing affordable energy of high quality to all Kenyans (CMS, 2021). The GoK's medium-term plan for the years 2018-2022 is part of the "Kenya's Vision 2030", and depends on a reliable, affordable and adequate electricity supply to meet the priorities on universal healthcare, food security, manufacturing and affordable housing (World Bank, 2019).

The Energy Act of 2019 (Republic of Kenya) contains regulations related to the off-grid sector, net metering and establishes necessary legal provisions for renewable energy feed-in-tariffs (RES4Africa, 2019). National and subnational governments are expected to facilitate the entry and activities of energy infrastructure developers through the acquisition of land, and the MoE to provide an environment conducive to renewable energy investment (CMS, 2021). The act allows consumers who own an electricity generator lower or equal to 1MW capacity to sell their supply excess to a near-by distributor (e.g. KPLC). The regulations that would be necessary for its implementation however are still not defined. Consumers do not need any authorisation to generate electricity for personal usage so long as the technology's generation capacity does not exceed 1 MW (RES4Africa, 2019). The Draft Energy (Solar Photovoltaic Systems) Regulation 2020 (EPRA, 2021) developed under the provisions of Section 10 of the Energy Act, 2019, is a revision of the 2012 Energy (Solar Photovoltaic Systems) Regulations that regulates solar PV systems in Kenya.

The 2013 PPP Act (Republic of Kenya) details the legal frameworks that apply to public-private partnerships. Policies, such as tax benefits (VAT and import duties for renewable equipment and accessories), have encouraged development of the off-grid renewables sector, making Kenya's off-grid sector one of the most established in Africa (RES4Africa, 2019).

National Feed-in-Tariffs Application and Implementation Guidelines and the 2008 Feed-in-Tariff Policy set out the procedures for wind generators not exceeding 50MW, small hydro not exceeding 10 MW and biomass generation not exceeding 40 MW (CMS, 2021). The policy also specifies the parameters of a standard Power Purchase Agreement (PPA) for all renewable generation technologies connected to the grid. It is worth noting that renewable projects with a capacity larger than 10 MW must pass technical (flow and system) tests.

Energy market

Total installed capacity in electricity generation in Kenya amounted to 2,819 MW by the end of 2019, with a peak demand of 1,912 MW (The East African, 2017). The mix is estimated to be as follows:

Energy source	Production
Thermal	749 MW
Geothermal	828 MW
Hydro	826 MW
Wind	331 MW
Solar	51 MW
Biomass	28 MW

Table 2 Installed capacity in electricity generation
Source: USAID, 2021

Kenya has been investing in the exploration and development of geothermal power generation. In 2018, Kenya had the 9th largest capacity of geothermal generation (REN21, 2019). Africa's biggest wind power generation plant project, the Lake Turkana Wind Farm, with a generation capacity of 310 MW was completed in Kenya's Marsabit County in 2019.

Scaling up distributed generation of solar PV offers the benefit of reducing demand strains on the national grid. Nairobi's solar PV annual output was estimated to be at

15 Chief's camp is an administrative unit in the city, and the most local contact point between residents and authorities.

1530 kWh/kWp in 2019 (Kiprop, Matsui, and Maundu, 2019). Numerous cost reductions in distributed Solar PV in recent years make it a more economically attractive option for consumers. In a survey, 86 per cent of high to middle income, 80 per cent of low income and 72 per cent of Nairobi centre households said they would choose Solar PV, arguably due to its relative affordability and suitability compared to small wind and small hydro off-grid solutions. Wind power in Nairobi County ranges from poor to marginal across the territory whilst some areas are considered to have very favourable conditions for wind energy. Lack of available land, especially in densely populated informal settlements pose a barrier to the development of wind farms. The 25.5 MW Ngong Hills Wind Farm however is located in close proximity to the city (35 km South West).

In 2017 in Nairobi, Solar Water Heating regulations (dating from 2012) were enforced, making it obligatory for owners of buildings with a hot water consumption exceeding 100 litres a day to install a solar heating system (The East African , 2017). The law was since revoked due to multiple complaints on the unaffordability of those systems.

Energy generation from municipal waste is currently being explored in Nairobi County. KenGen and the Nairobi Metropolitan Services are partnering to build a power plant generating biogas (which can be transformed into electricity) using the 3000 tonnes of solid waste collected every day from the City in Dandora Dumpsite, 10 km outside the city's centre (CMS, 2020).

Store in Pumwani. Photo: Urban-A/Anders Ese (2012)

MUKURU KWA REUBEN AND PUMWANI SURVEY

Selection Criteria

A total of 104 respondents from Mukuru and Pumwani neighbourhoods partook in a survey about their energy consumption patterns, their work situation, income, background, and other questions relating to their neighbourhood. The survey was carried out in November and December 2020, and consisted of 68 questions. A snowballing method was used to secure respondents in each location, and the following criteria were provided when choosing respondents:

- 50% of the respondents were to live in Mukuru and 50% in Pumwani
- Around 50% of respondents in each location to be female, and 50% male
- Gender groups were ideally to be broken down into equally sized age brackets: 20-30, 31-40, 41-50, 51-60, and 61-70 years.

Finding willing participants in the two areas meant that it was not possible to strictly observe equal gender and age distribution. Hence, there is an overweight of male respondents in the survey, and an overweight of older respondents in Pumwani. This is important to consider in further analysis – particularly for findings where gender and age are of interest.

Survey Areas

Both Mukuru and Pumwani are popular settlements in Nairobi that from the outset might seem to share attributes. They are by many considered informal settlements and slums,[16] both with high levels of poverty, and lacking in suitable living conditions. These are dilapidated and insalubrious areas that also boast high densities. The two areas were however chosen because they also showcase clear differences, highlighting the diversity and non-homogenous nature of such neighbourhoods. It is important to consider and to be knowledgeable of the dehomogenisation of urban poor areas when planning interventions (e.g. clean energy infrastructure) most suitable to case areas such as Pumwani and Mukuru.

The team also has previous and ongoing research in these areas, providing the possibility of comparing the data in this survey with existing research material, giving added depth and understanding to the analysis.

Mukuru

Mukuru is situated close to an industrial area and includes Mukuru Kwa Njenga, Mukuru Kwa Reuben, Viwandani, Mukuru Kayaba, Fuata Nyayo, and Mariguini (Corburn et al., 2017). Mukuru as a whole is home to over 200,000 people, while the case area, Mukuru kwa Reuben, is home to approximately 75,000 of these.

16 Habitat III (2017) defines informal settlements as "residential areas where 1. Inhabitants have no security of tenure vis-à-vis the land or dwellings they inhabit, with modalities ranging from squatting to informal rental housing, 2. The neighbourhoods usually lack, or are cut off from, formal basic services and city infrastructure, and 3. The housing may not comply with current planning and building regulations, is often situated in geographically and environmentally hazardous areas." In 2018, UN-Habitat extended on the definition: "(N)ot all informal settlements are slums, as they can still have well-developed housing and services without being legally recognized. Meanwhile, not all slums are informal settlements, as they can be legal housing which has fallen into disrepair with poor provision of services. (…) refer to settlements characterized by at least some of the following features: a lack of formal recognition (…); the absence of secure tenure (…); inadequacies in provision for infrastructure and services; overcrowded and sub-standard dwellings; and location on land less than suitable for occupation."
United Nations Conference on Housing and Sustainable Urban Development. 2017. Habitat III Issue Papers. New York: United Nations. www.habitat3.org. p 151; United Nations Human Settlements Programme (UN-Habitat). 2019. Addressing the Most Vulnerable First – Pro-poor Climate Action in Informal Settlements. Nairobi. p 3.

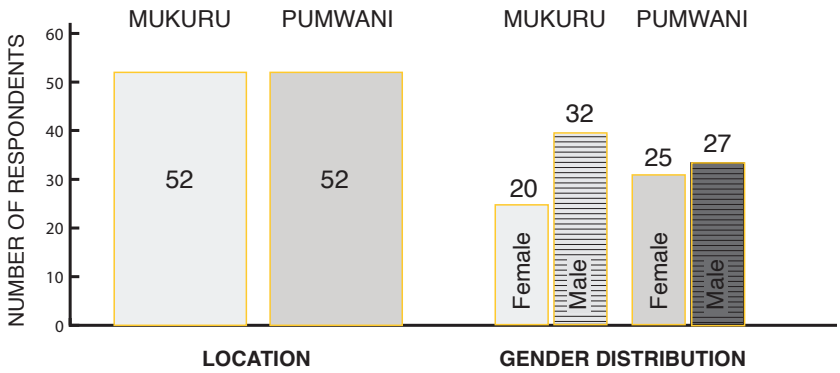


Figure 8: Respondents according to location and gender

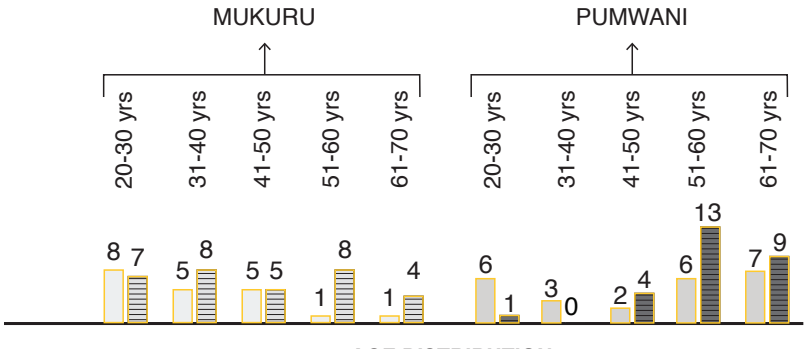


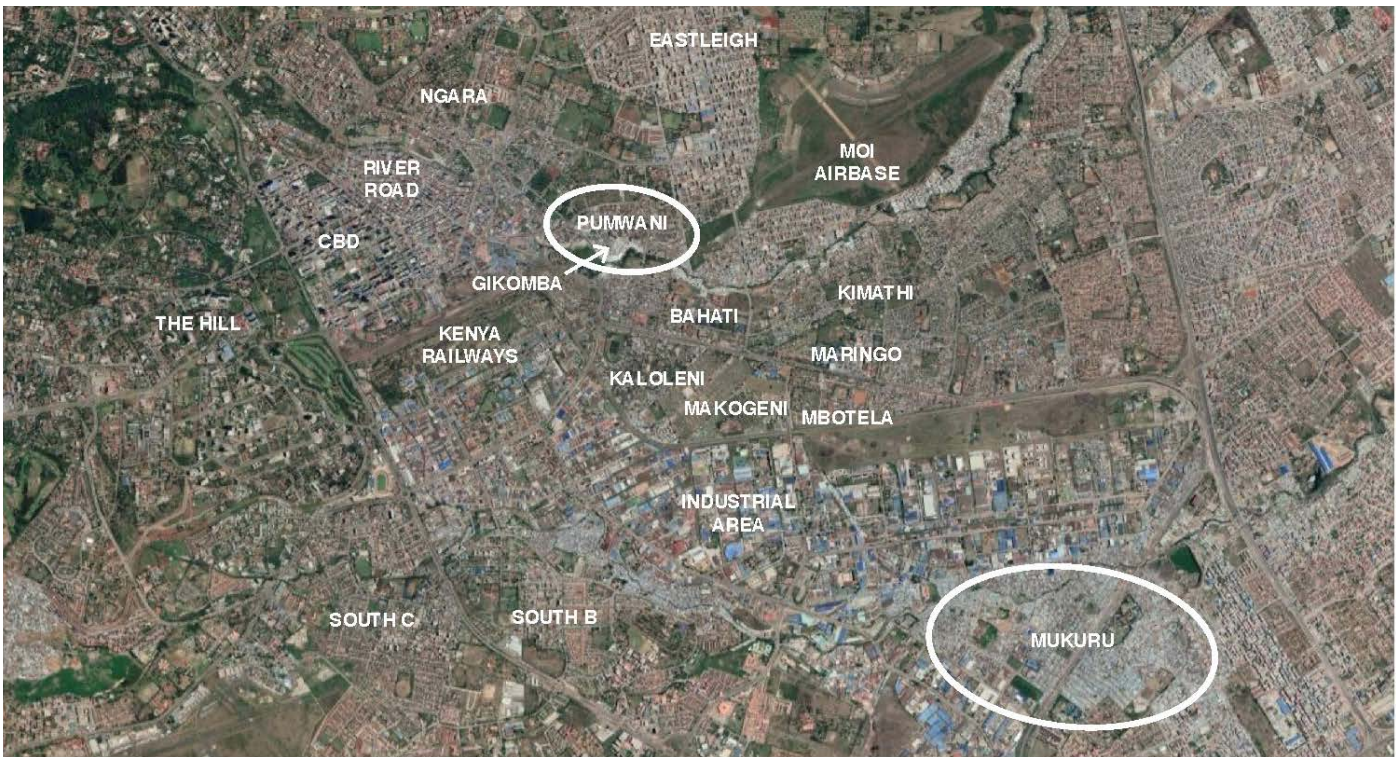
Figure 9: Age distribution respondents according to location and gender

Mukuru kwa Reuben was probably the first of the settlements, and is said to have been established from the late 1950s or early 1960s by women when the landowner Reuben left the country and the government took possession of the land and later sold it to private developers. The land remained largely undeveloped and was quickly settled upon by migrant families and industrial workers drawn to jobs in the neighbouring industrial zone and Nairobi's city centre. In 2002 only 50 per cent of the Mukuru of today was built. Mukuru has since expanded and densified dramatically and is therefore amongst the relatively new informal areas. Casual labour is very common, with much of the economy being informal and partially untaxed.

Housing in Mukuru is low-quality, primarily temporary in nature, and built with inadequate construction materials. Evictions are common. As the population of Mukuru grows, the pressure for increased density has given rise to many informal and unregulated 'permanent' multi-level structures that pose a threat to the safety of residents.

A number of organisations and NGOs work in Mukuru. One of them, Muungano wa Wanavijiji – The Kenyan Federation of Slum Dwellers (supported by SDI) mobilises residents to fight forced evictions and demolitions. According to the federation, rising land values and continued lack of tenure security means evictions are a constant threat, and has in some cases triggered mass resistance and the filing of a court case by the federation on behalf of Mukuru residents to stop evictions by powerful title holders, such as former president Moi.

Mukuru kwa Njenga, Mukuru kwa Reuben and Mukuru Kayaba was declared a special planning area by the County Government in 2017, stopping any unplanned development in the area for two years. There have been several activities aimed at upgrading the settlement. Currently there is an ongoing project for opening up and upgrading of roads in the settlement, which employs some residents. The settlement upgrading plans were initially packaged through a participatory process involving the resident community members. In the last government budget allocation, funds were set aside to specifically finance the upgrading of Mukuru. Several organisations are involved in this process: https://www.muungano.net/mukuru-spa



Map 1: Location of Pumwani and Mukuru, Nairobi.

Pumwani

Pumwani was the first legal African location in Nairobi established in 1922. Pumwani can today mean different areas. For the purpose of this research we will be looking at old Pumwani which today is called Majengo due to the old Swahili houses. It is situated 3 km east of the central business district (CBD). In the close vicinity of Majengo are several informal areas like Kitui and Kenuku/Kinyago as well as middle class areas like California (1969) and Highrise (1987 and 2007). To the west are old settlements from the colonial days Shauri Moyo (1939), Ziwani, Starehee, and Bondeni/Gorofani (1940s).

From early on Pumwani became a heterogenous community where different ethnic groups from all over East Africa were represented. In the early days it was mostly a Muslim society and still has a high percentage of Muslims living there. Many are old families having lived in Nairobi for decades. Half of the house owners live in Majengo, the other part are absentee landlords. Most house owners have one house each, as well as an allotment letter, originally provided from the 1920s to the first settlers, providing proof of ownership of structure on Municipal plots. House owners have historically had a right to a trading license. Pumwani has a high proportion of older people due to its history, and a higher percentage of women owning houses (allotment letters) than elsewhere in Nairobi (Ese and Ese, 2020). Gikomba, an open-air market, is situated adjacent to Majengo and is said to be the biggest market in Nairobi and among the biggest mitumba (second-hand clothes business) markets in East Africa. Majengo is also close to the oldest market in Nairobi, Kariokor (1926), and Burma market, Shauri Moyo market, and the Jua Kali businesses close to Shauri Moyo on the opposite side of Nairobi River.

It is assumed that Pumwani houses 30,000 people, but this includes surrounding areas like Kitui, and Kenuku/Kinyago.[17] In 1965, 10,000 people resided in Majengo. Most women in Pumwani work in the informal economy as street vendors, market women in Gikomba and Kariakor, or selling their products from their homes. Traditional beer brewing takes place in certain parts of Majengo and the rate of prostitution is high both in Majengo and the adjacent slums; Kenuku/Kinyago and Kitui. Khat is also an important commodity being sold, mostly along the main thoroughfare.

Although central parts of Pumwani are formal, the place has many qualities of a "slum"; dilapidated housing and infrastructure, poor sanitation, lacking garbage collection, etc. On the other hand, Pumwani is a well-established community. There are three important institutions in Pumwani; St John's Community Centre and school together with St Johns Church, then there is the (Riyadha) Mosque and various Muslim organisations, all with long-standing roots. The third is the Chiefs Camp. Descendants of Pumwani's once powerful landlords have secured key positions in these institutions; little happens without the consent of St John's, the Mosque leadership, or the Chief's camp.

A word on population numbers

According to the Kenya 2019 Census, there were 19,654 people living in the study area in Pumwani, and

17 Pumwani can mean Majengo, Pumwani ward or Pumwani division, and colloquially also Majengo and its surrounding slums.

65,691 people living in Mukuru kwa Reuben. There is a lot of contention surrounding the inaccuracies of population counts and statistics in popular settlements in Nairobi. To address this, two international independent studies were carried out in Kibera in 2008 and 2009 using two different and well documented methods of enumeration (Desgroppes and Taupin, 2011). The aim of both studies was to provide as accurate as possible stipulated population numbers. These arrived at numbers that were 12-15% higher than the 2009 census (reporting a total population count of 170,000) (Kenya National Bureau of Statistics (KNBS), 2009), well below stipulations of 1-1,5 million residents made by several NGOs[18] that are either unreferenced or trace back to a 2005 UN-Habitat and Research International estimate placing population figures in Kibera at anywhere between 400,000 – 700,000 (Research International, 2005) (based on average family sizes that other research has found to be too high). While enumeration studies have not been carried out specifically for Pumwani or Mukuru kwa Reuben, similar problematics are applicable. For the purpose of this study we will be using 2019 census data (Kenya National Bureau of Statistics (KNBS). 2019) + 15 per cent. This provides the following caveat with regards to the analysis of data:

- Pumwani (Majengo and Gorofani/Bondeni wards) = 22 600 (providing a statistical accuracy of around +/- 10% for this study
- Mukuru (Kwa Reuben ward) = 75 500 (providing a statistical accuracy of around +/- 10% for this study)

The high margin of error means that all calculations in this analysis should be treated as tendencies rather than as facts.

18 See e.g. The US Government's statement https://obamawhitehouse.archives.gov/blog/2010/06/08/audio-slideshow-dr-biden-sees-kibera-kenya or NGO Lunchbowl https://www.lunch-bowl.org/kibera.html

Rooftops in Pumwani. Photo: Urban-A/Anders Ese (2012)

ANALYSIS

Education

There are clear distinctions between education levels in Mukuru and Pumwani. While residents in Mukuru tended to have primary or secondary educations only, Pumwani residents were better educated with many having vocational training or college degrees. Men tended to dominate in these groups, but given the imbalance in gender among respondents, this is uncertain. Differences in education level between Mukuru and Pumwani might be skewed by younger respondents in Mukuru (who have not had the chance to reach higher education yet), and older respondents in Pumwani, but can also be attributed to the urban developments of these areas: while Mukuru is a relatively new and fast growing settlement, possibly with a more transient population, Pumwani has historical roots and connections to a 'house owner class' and an 'administrator class' going back several generations where higher education has been sought. In addition, Pumwani's proximity to Gikomba, where artisans work, and workshops are located might also boost vocational training percentages in the population. As would the presence of St John's which has provided its members with education and training schemes since the 1950s.

What this means in terms of clean energy provision

While education does not directly affect any potentials for clean energy provision or consumption, the difference in education numbers between Pumwani and Mukuru highlights the differences between these neighbourhoods; areas with different socio-economic and socio-cultural structures. They are also physically and spatially different. If any infrastructure projects were to be initiated in these two areas, one would need to be aware of these differences and seek to contextualise implementation.

Within the different age groups there were also clear differences in education levels. Not surprisingly, secondary education dominated among the youngest respondents, while vocational training dominated among the oldest. Again, this may have to do with younger respondents (20-30) not having had the chance to enroll in higher education, but could also be attributed to better distribution of education levels a few decades ago.

If we compare education levels to incomes, we see that a better education is no guarantee for better paying work. While there were indeed fewest low income

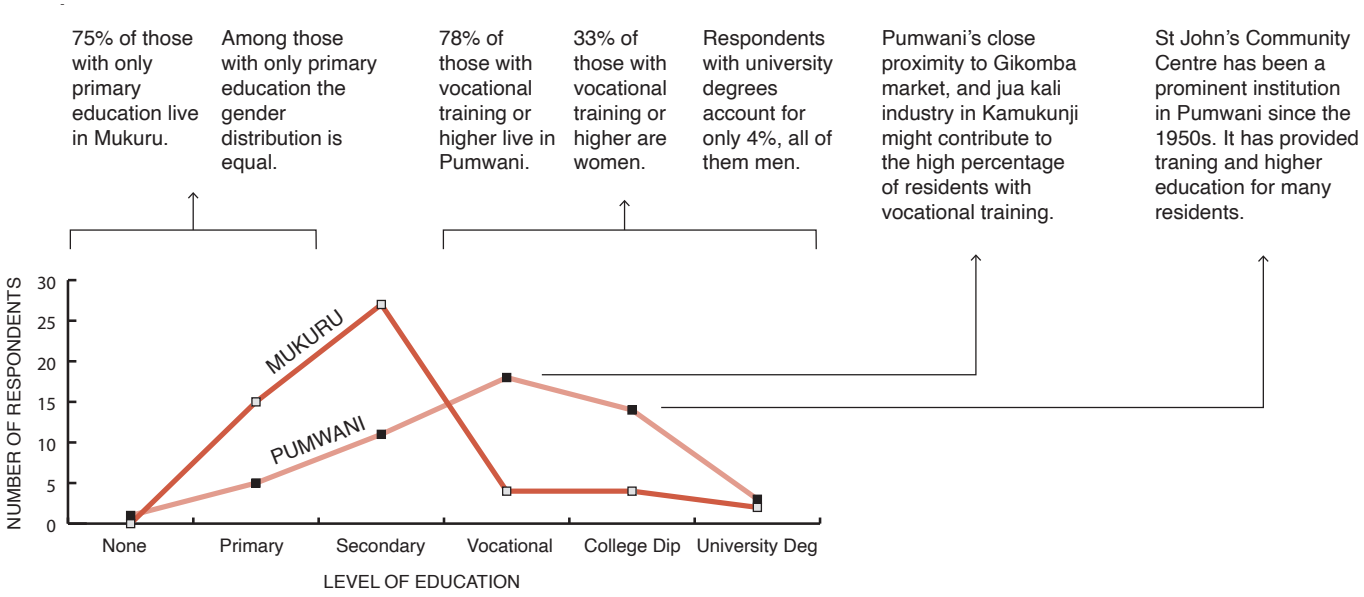


Figure 10: Comparison of education levels in Mukuru and Pumwani

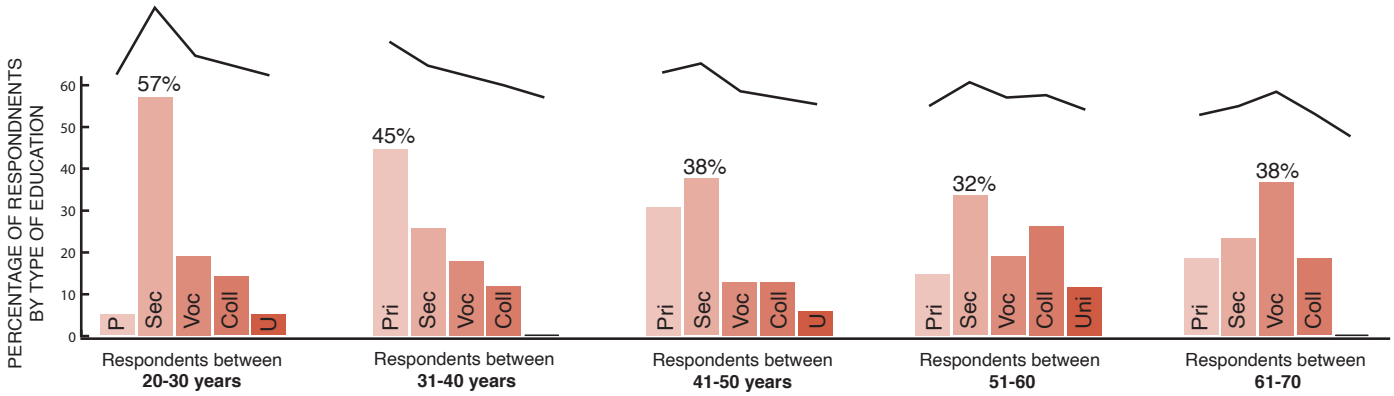


Figure 11: Education levels in Mukuru and Pumwani in relation to age groups

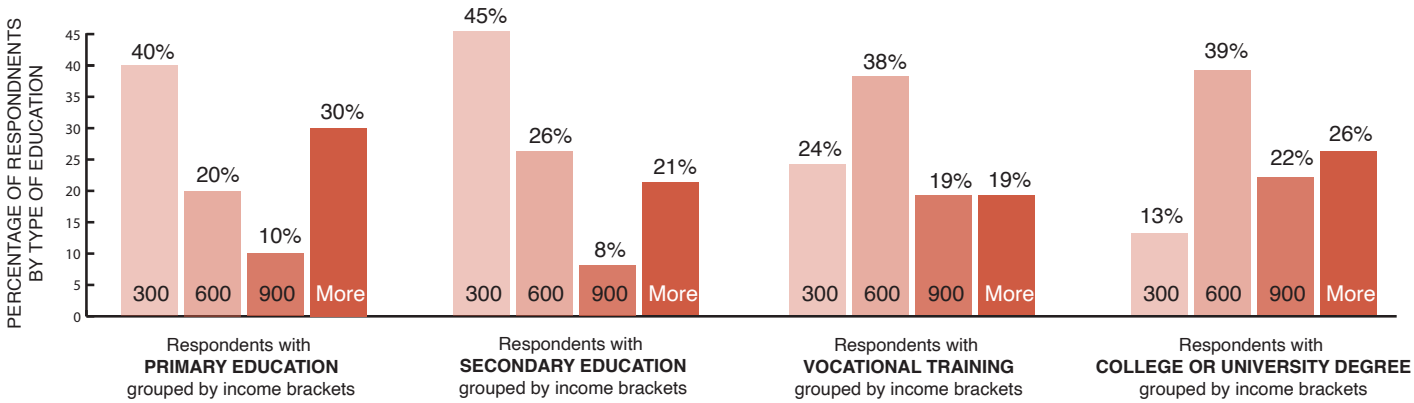


Figure 12: Education and income

earners among those with college or university degrees, most high income earners were found among those with a primary education. Pumwani and Mukuru do not offer jobs targeted at people with a higher education. And even if people residing in these areas work elsewhere in Nairobi, there tends to exist structural barriers against people from such neighbourhoods acquiring jobs, even with college or university degree requirements. Most respondents worked informally in a 'hustle economy'. These are jobs that favour work experience over education. Those that have worked longer, i.e. have not spent time getting an education, may have a better chance at acquiring the skills necessary in the entrepreneurial jobs market in Mukuru and Pumwani.

Any provision of clean energy solutions to residents in Mukuru and Pumwani should possibly try to link to the type of work carried out by residents, providing solutions that benefit and possibly ease their work load. Many in Mukuru and Pumwani work in service related vocations, often related to produce and food preparation. Food preparation especially is today coal dominated.

Migration

Although Pumwani and Gikomba are highlighted by the Mixed Migration Centre as one of several spots for migration influx in Nairobi, there were few migrants among the respondents. 4 per cent were non-Kenyan citizens from Tanzania and Uganda. This is, however, a higher percentage than the registered refugees NGOs operate with, currently at around 2 per cent of Nairobi's population. The 4 respondents of non-Kenyan origin were businessmen dealing in Mitumba (second hand) clothing in Gikomba, one of the area's major industries. In terms of income they rated among the top 23% of respondents (with two of them being among the top 4 per cent).

If we look at the respondents' internal movement in Kenya, roughly half of them had only lived in Mukuru or Pumwani since moving to Nairobi (this includes those born there). The age makeup of these residents mirrors the nature of the settlements: while approx 40 per cent of those that have only lived in Mukuru are young, approx 40 per cent of those that have only lived in Pumwani are old. This difference is indicative of how recent Mukuru is as a settlement, and underpins

the long history of Pumwani. Given the size of Mukuru and the spatial constrictions on physical development possibilities in Pumwani, it is likely easier for people moving to Nairobi to find lodgings in Mukuru than Pumwani.

What this means in terms of clean energy provision

Approximately half of the population have lived in Pumwani or Mukuru only, during their time in Nairobi. This indicates that the population in these areas tends to be more stable than what is generally considered to be the case. In terms of service provision this means that residents are potential long-term clients. However, it is worth noting that long durations of residency does not mean that people want to live there.

Tenure

9 per cent of respondents in Mukuru and Pumwani were house owners, 6 in Pumwani, 3 in Mukuru. While women were well represented amongst house owners in both settlements historically, this is no longer the case. Only one of the house owners were women. As house owners, their duration of stay was longer and their income slightly higher than other respondents. Despite their house ownership, 4 of the 9 respondents were concerned they might be evicted. All of these lived in Pumwani. By comparison, only 17 per cent of tenants (in both areas) were afraid of eviction.

What this means in terms of clean energy provision

The fear of eviction among house owners in Pumwani is indicative of the uncertainty Pumwani faces as a community. Since the 1940s plans to tear down the housing have been suggested, but with no good options to house current residents, and the area providing important lodging services, little has happened. Still, the outskirts of Pumwani are constantly changing with high-rise buildings coming up, and speculators waiting for the chance to develop the area. Investing in permanent clean energy infrastructure in such an environment, without it being part of a larger redevelopment scheme, would be risky. The same problem exists in Mukuru. The area is in constant flux, and plans for redevelopment and upgrading of Mukuru are supposedly imminent, with budget allocations made by the government. Any investments in clean energy solutions of a lasting kind would have to be part of such a process to make economic sense to investors.

Looking at the duration of residency of respondents, the areas came across as having more stable than transient populations. This is true for both Pumwani and Mukuru. However, the stability of the population masks the fact that the majority of residents, no matter how long they have lived in the neighbourhood, would like to have lived somewhere else given the chance.

Many respondents did not want to live in Mukuru or Pumwani, but they stayed because they have not been presented with better options. The areas are lacking in services and infrastructure far beyond electricity provision. This is not unique for Mukuru or Pumwani and can be said to be true for most poor communities in Nairobi. It would therefore be advisable that clean energy projects be connected to overarching redevelopment schemes targeting current residents or similar groups of low income earners. Before connecting with redevelopment schemes such

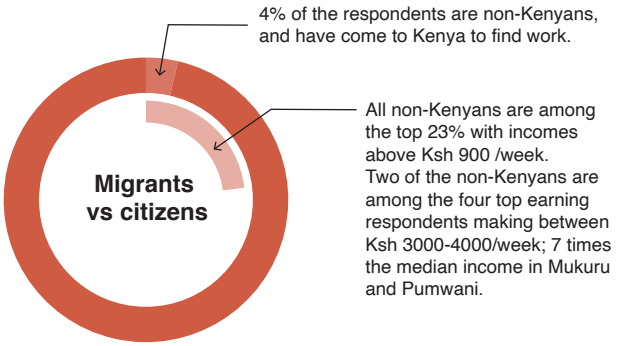


Figure 6: International migration

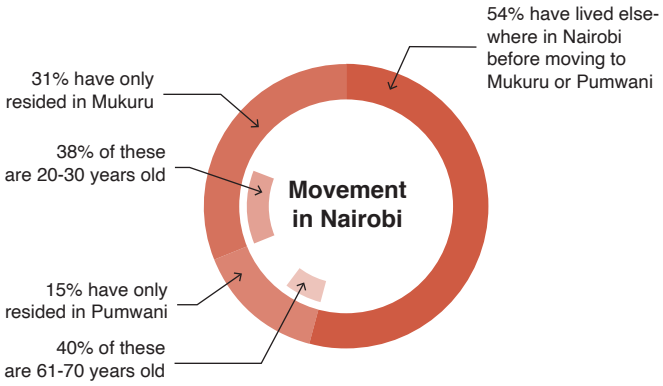


Figure 13: Migration to or within the city

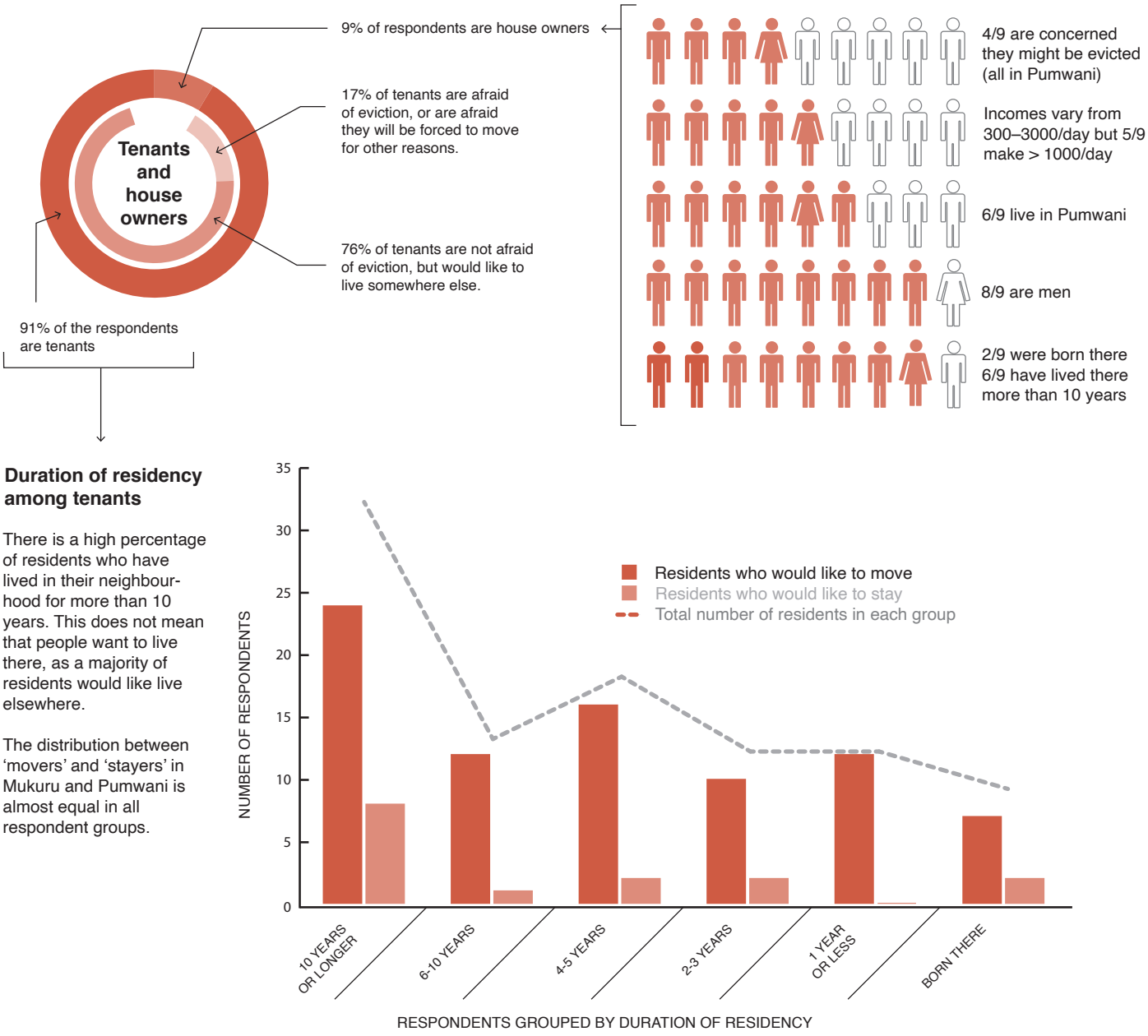


Figure 14: Tenants and house owners

as in e.g. Mukuru, it would be pertinent to assess the scheme's strategy for retaining current low income residents.

Income

If we divide income groups into four: 300 KSh/day or less, 300-600 KSh/day, 600-900 KSh/day, and above 900 Ksh/day, the two lowest income groups were equally big (31% and 32% of the respondents), while the two 'higher' income groups were smaller (14% and 23% of respondents). There were a higher probability for lower income earners to live in Mukuru, and a higher probability for 'higher' income earners to live in Pumwani, a tendency that could be connected to the potential of large scale markets such as Gikomba, next to Pumwani. Mean incomes in Mukuru and Pumwani are somewhat misleading, as a few 'high income' outliers pulled up the average considerably. Modal and median numbers are more interesting with median incomes being twice as high in Pumwani as in Mukuru (300 vs 600 Ksh) and modal numbers being 200 KSh higher in Pumwani than in Mukuru (300 vs 500 Ksh).

The data indicates that there are gender biases related to incomes, with approx 60 per cent low income earners being women. The tendency is clearer in the 'high income' brackets where around 90 per cent of respondents are men.

There were also correlations to be found between incomes and family sizes. This is possibly indicative of

the practice of supporting relatives by taking in children in times when e.g., relative's incomes are low, or ones own income is good.

What this means in terms of clean energy provision

There were a higher probability for female led households having lower incomes (given that they are the sole breadwinners). Low income earners tended to spend a greater share of their income on power (electricity, coal, paraffin – see statistics on incomes vs expenditures on energy under "energy consumption at home"). This needs to be factored in when attempting to shift women led households to e.g., solar, where electricity produced is free, but which requires startup costs.

If we organise the type of work respondents carry out into categories, two things are apparent: there were great variations in income within each category, and some categories were lower income than others. Hawking, Jua Kali work (street based panel beaters, repairs etc), and produce related shop work (not food preparation) for instance, are all rather low paying vocations. There were also some differences in where you carry out your work: if you worked in a shop or kiosk in Mukuru you make less money than if you did the same in Pumwani. In general, working in a market provides a better income, as is true for food preparation i.e. serving meals, or farming, but here net incomes might be much lower due to costs of running a business.

What this means in terms of clean energy provision

Provision of clean energy solutions to e.g. Jua Kali workers who would need access to electricity for machinery is important, but as with women in low income groups, one would need to be sensitive of potential startup costs. The food preparation market is by and large coal driven, providing not so much an economic challenge, but a cultural one: does corn on the cob or chapatis grilled on an electric stove taste as good or sell as well as those prepared on a coal grill? Still, with the amount of fires happening in markets in Nairobi (barring assumptions that they are purposefully set), changing from open fire food preparation to solar/ electric might increase safety.

Work

80 per cent of respondents worked in the informal sector. 5 per cent were formally employed, and around 14 per cent were unemployed. In addition to these 14 per cent, 7 per cent responded that they were (temporarily) without work due to the pandemic. Almost all responded that their work situation had been affected negatively in some way by the pandemic. What is most interesting however, is the longevity of work situations. Approximately 60 per cent of respondents

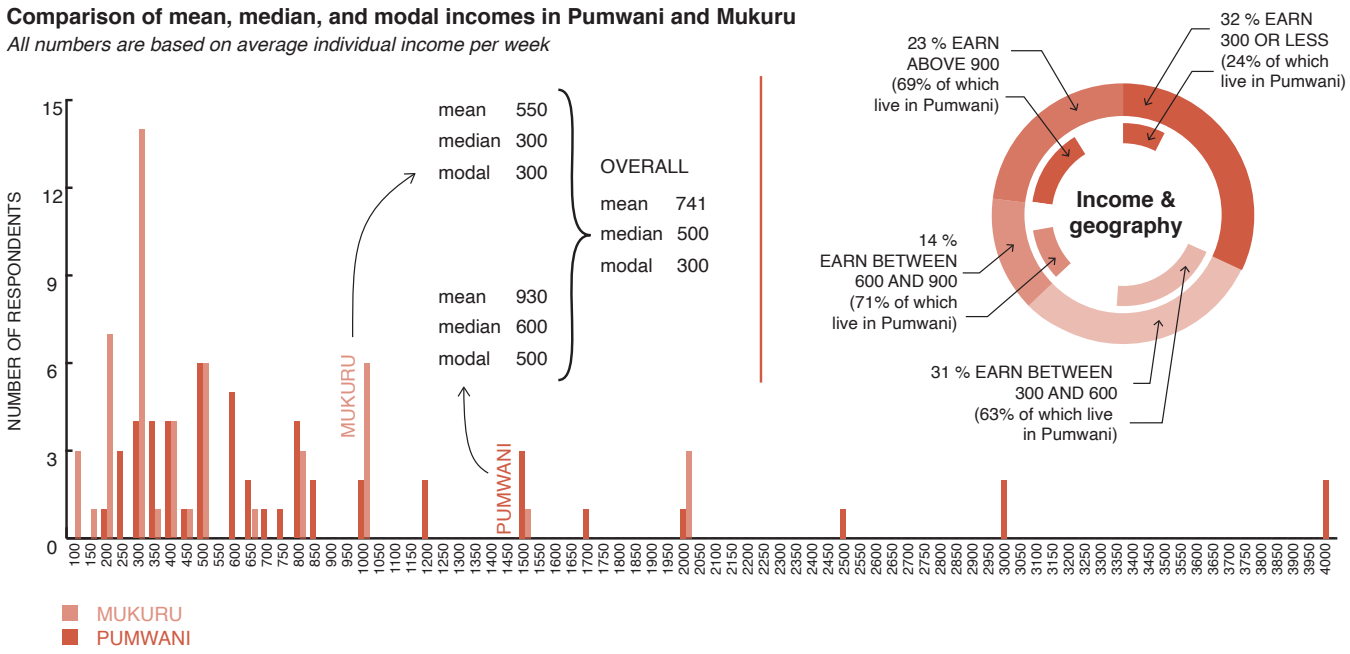


Figure 15: Income in Pumwani and Mukuru, and income, gender and household size

had been in their current job for the last 5 years or more. This is equally true in Pumwani and Mukuru.

What this means in terms of clean energy provision

Longer stints of work imply a more stable work environment, and a more predictive client situation in terms of energy provision. Coupled with long durations of residency, the market for clean energy clients in places like Mukuru and Pumwani is more stable than what is normally considered to be the case in informal settings.

Around 60 per cent of respondents claimed they had been harassed because of work by police or authorities. This included most of those who worked formally. Around half of those who had experienced harassment were women, and around half worked in a fixed location. There are indications that chances of harassment are slightly higher in Mukuru. Interestingly, 70 per cent of those harassed claimed that they did not need a license to carry out their work.

Crime

Surprisingly, most respondents felt that their neighbourhood was relatively safe. This is true of both men and women with approximately 67 per cent women saying it was safe, compared to 70 per cent men. This included those who felt that the neighbourhood was safe, but more so during daytime than nighttime. There is no assertable difference in safety perceptions between Mukuru and Pumwani residents either, with 65 per cent of Mukuru residents feeling secure vs 69 per cent in Pumwani (the difference in percentage between gender and geography is down to skewed gender distribution among respondents). Differences in perceptions of safety was rather found when compared to duration of residency: 80 per cent of those that have lived in the area less than 1 year and 80 per cent of those that were born in the area felt relatively safe. As perceptions of safety were lower in the other tenure groups, it could be speculated that those who felt it is safe had not lived long enough in the area to experience insecurity, as well as being biased responses from people who identified with the area, and had not experienced living elsewhere. Barring any speculations: 80 per cent of all those who felt safe in the area would still like to live somewhere else if given the chance.

There are correlations between what is considered to be most prevalent types of crime and what people feared the most: mugging (in the street or in a public place) was the number one concern for many respondents, followed by theft from private property. However, while people considered police and authority harassment to be quite normal, most people were not afraid of this (even though many have experienced harassment). The reason might (speculatively speaking) be down to harassment being of low

It is difficult to establish any clear links between type of work and income. Most all work types showcase great differences in income, with a few exceptions.Most low income earners are to be found in Mukuru, but also some of the “top earners” live here.

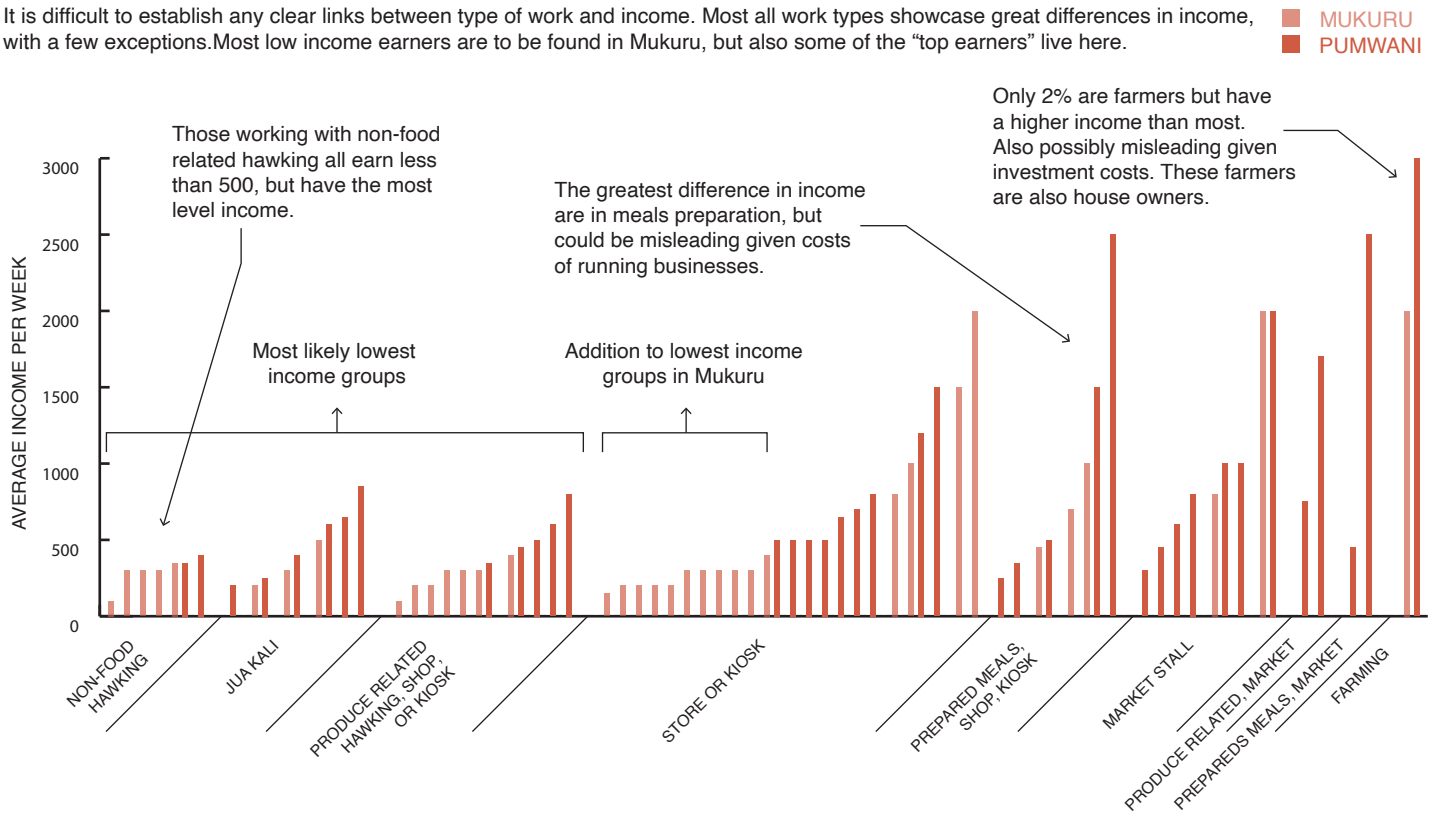


Figure 16: Income and type of work

consequence (avoidable through bribes) compared to the potentially bigger consequences of muggings and thefts. Fear of sexual assaults and violence rate was low, highlighting the material concerns of respondents. But an important caveat here is that fear of sexual assault was only raised by women respondents. If we therefore look at how big a threat sexual assaults are considered to be among women only, the percentage is much higher: 22 per cent of women feared sexual assault the most. While most of those who considered sexual assaults to be one of 5 most common crimes were women, there were also a few male respondents who highlighted this.

Some incongruities were to be found with regards to the potential of making respondents' neighbourhoods safer by way of night time lighting. While a clear majority, 94 per cent, felt that night time lighting would increase safety (regardless of current lighting situation), 68 per cent of those that do not have any form of lighting outside their house still felt relatively safe (also at night). Such incongruities might be explained by tendencies seen elsewhere, where respondents differentiate between what they personally feel, and what they believe others might feel: while a respondent may personally feel safe even though their house is in the dark at night, he or she might also be concerned his or her neighbour feels unsafe, and would therefore want to have night time lighting in their neighbourhood. It is also likely that questions about more lighting in the survey raises expectations among respondents that more lighting will in fact be provided as long as respondents say "yes".

What this means in terms of clean energy provision

Communal night time lighting is more common than not in areas like Pumwani and Mukuru. There is room for improvement: installing lighting in the few areas that are in the dark, and improving on existing lighting situations (with a caveat: what respondents believed to be necessary and actual necessity may be two different things).

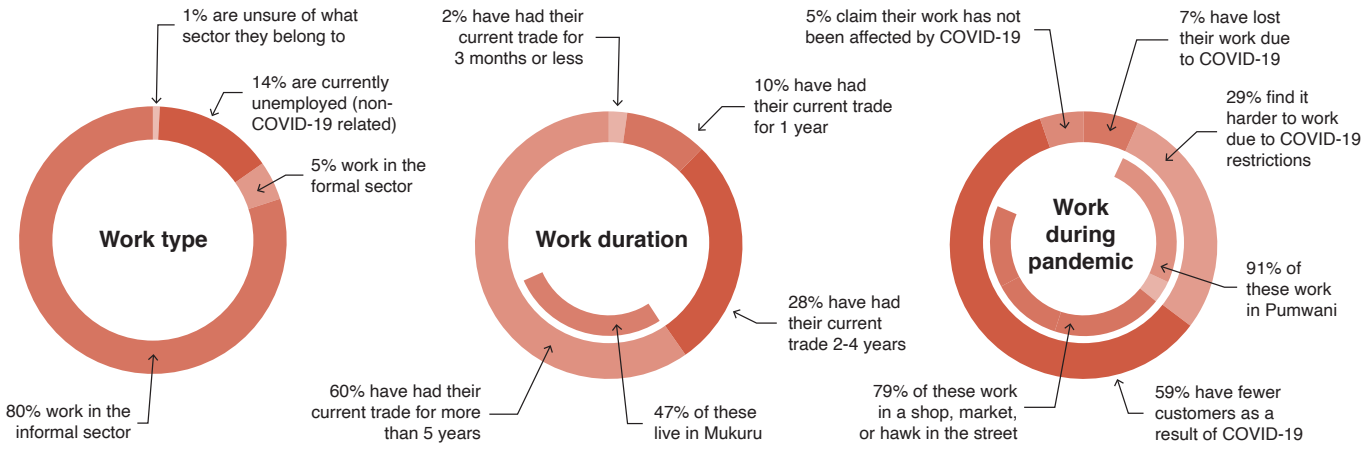
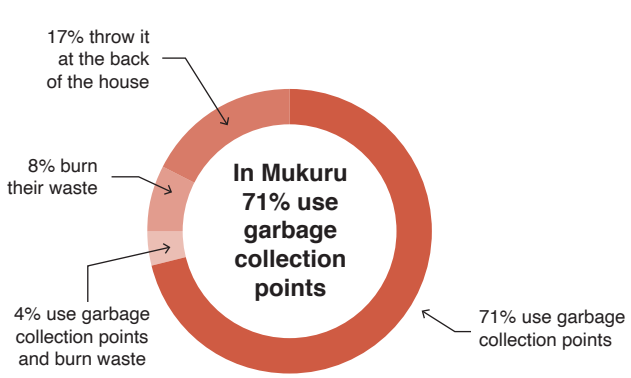


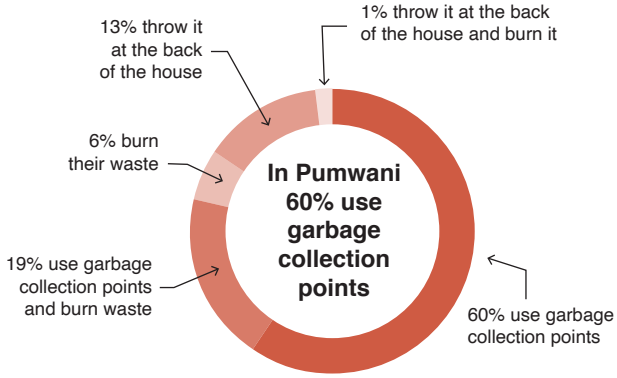
Figure 17: Work type, work duration, and work during the pandemic

Figure 18: Work and harassment



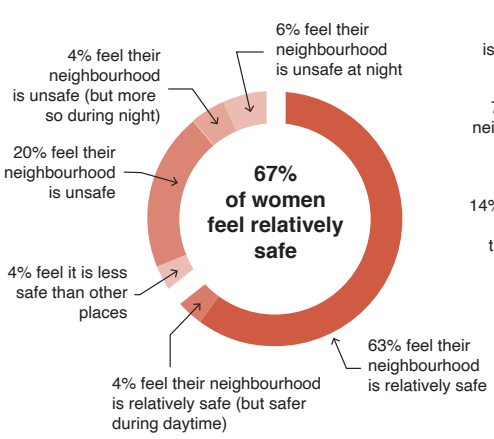
All garbage disposed of at collection points is taken away by informal garbage collectors

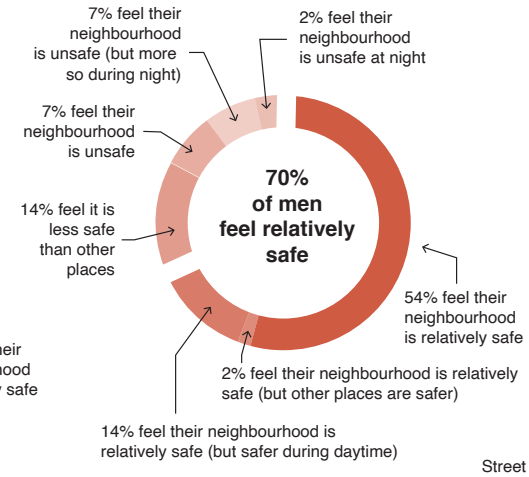
One respondent knows of informal garbage collectors that recycle some of the garbage



All garbage disposed of at collection points is taken away by informal garbage collectors

Figure 19: Waste management in Pumwani and Mukuru





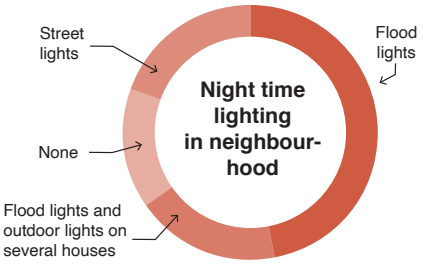
Perceptions of neighbourhood safety

80% of those that have lived in the area for 1 year or less feel that it is relatively safe

80% of those that were born in the area feel that it is relatively safe

The sense of insecurity is almost equal in Mukuru (65%) and Pumwani (69%)

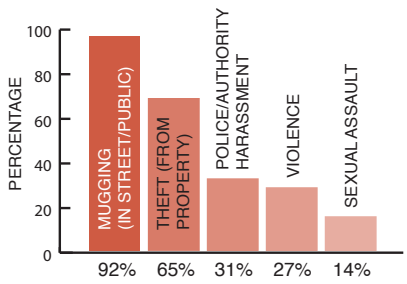
80% of those that feel their neighbourhood is relatively safe would still like to live somewhere else



68% of those without night lighting still feel their neighbourhood is relatively safe

94% believe that more outdoor lighting would make their neighbourhood safer, regardless of current lighting situation

What are considered most common crimes? (Rated 1-5)



What are people most afraid of?

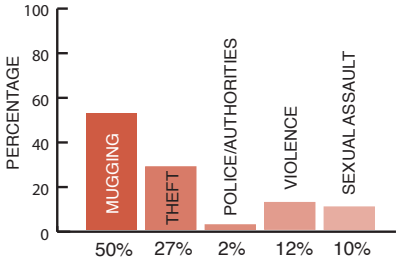


Figure 20: Perception of safety and types of crime.

Energy Access

Energy consumption at in the workplace

As people in places like Mukuru and Pumwani tend to use multiple sources of energy in their daily life, the questionnaire differentiated between various types of energy, including electricity. In the survey, questions were divided between energy consumption in the workplace and energy consumption at home. In terms of electricity usage in the workplace, large majority of respondents (89%) needed electricity for lighting purposes, followed by 40 per cent using it to charge devices *in addition to lighting*. 18 per cent used electricity for food preparation (or storage) *in addition to charging and lighting*. This means that approximately 40 per cent used electricity for *lighting only*. A lower percentage (7%) did not use electricity at all. These are low income earners, mostly street hawkers in Mukuru.

Energy sources

Most respondents used electricity as their main source of energy/power, while a large number of these had access to and used a number of other sources of energy when there were power cuts or for food preparation (see "use of open fires"). Only one respondent of 104 indicated that he used solar power in addition to electricity from the mains, while an additional 3 respondents indicated that solar would have been a cheaper option for them.

In total, 14 per cent said that they could not always afford electricity or other energy sources for work purposes. 53 per cent indicated that they always had access to various energy sources.

What this means in terms of clean energy provision

Electricity is only one of many energy sources used for work as well as at home. However, lighting and charging needs are relatively ubiquitous among residents, requiring stable energy supplies. With around half of the respondents complaining over power instability and affordability issues, there is a potential market for more durable and cheaper options, many of which could be portable solutions given the low yield electricity needs. Catering for jua kali work (welding, etc), and food preparation may require other solutions.

Energy consumption at home

As with energy use in the work place, respondents rated lighting and charging as the most important power use activities at home. A differentiation was made here between general lighting needs and lighting specifically for homework, both of which were top two priorities among many respondents. In fact 37 per cent had the same top four priorities (general lighting, lighting for homework, charging, and providing internet access), and as many as 54 per cent had the same top three priorities (general lighting, lighting for homework, and charging).

There was a higher degree of formal connections (61%) than informal connections among the respondents (39%). This was true for both Mukuru and Pumwani. But the rate of formality is questionable based on how electricity bills are stipulated. 83 per cent of formal connections have pre-paid meters, an indication that they are formal. The remaining 17 per cent negotiated bills through landlords, meaning the landlord may or may not have a formal connection. It is not clear that pre-paid meters were formal though. 26 per cent of the informal connections (approximately 10% of the total) said that they also paid through a meter, indicating that even though meters are formal, informal arrangements might be made to share a meter (jerry rigging power from it) and split costs.

If we extract monthly expenditures on electricity and compare to stipulated monthly incomes, two tendencies becomes clear: there were great variations from individual to individual with regards to electricity usage and costs, but on average there is a tendency that electrical consumption only increased slightly with increased income. In other words, low income earners are most affected by electricity costs, while these costs do not affect high income earners as much even though they spend more on electricity.

There is no evidence that increased household sizes equals more electrical usage, nor is it possible from the data to see any correlations between type of work and power usage, nor location and power usage. The only overlap seems to be between household size and probability of formal connections: the bigger the family, the higher likelihood of a formal connection. This might, however, be a coincidence.

Not surprisingly, people who claimed to have formal connections also reported that their connections were stable, strengthening the claim that they are indeed formal connections. Among informal connections the stability was much lower. If we compare informal and formal connections in terms of stability, the graphs are almost inverse of one another: the largest share of informal connections are characterised by power surges *and* blackouts, while less informal connections

Street views from Mukuru kwa Reuben and Pumwani


Mukuru kwa Reuben


Plainsview Road, Mukuru


Viwandani, Mukuru


Lamu Road, Pumwani


Lamu Road, Pumwani

Soure: Google Earth Street View (as of February 19th 2021)

Energy consumption in Mukuru and Pumwani is relatively low yield. Lighting is by far the most common use of electricity for work purposes (89%), followed by the need to charge devices (44%). 23% of respondents use electricity in the workplace for higher yield activities, such as preparing or storing food, in addition to 12% who use electricity for production purposes for making crafts, utility items, or repairs.

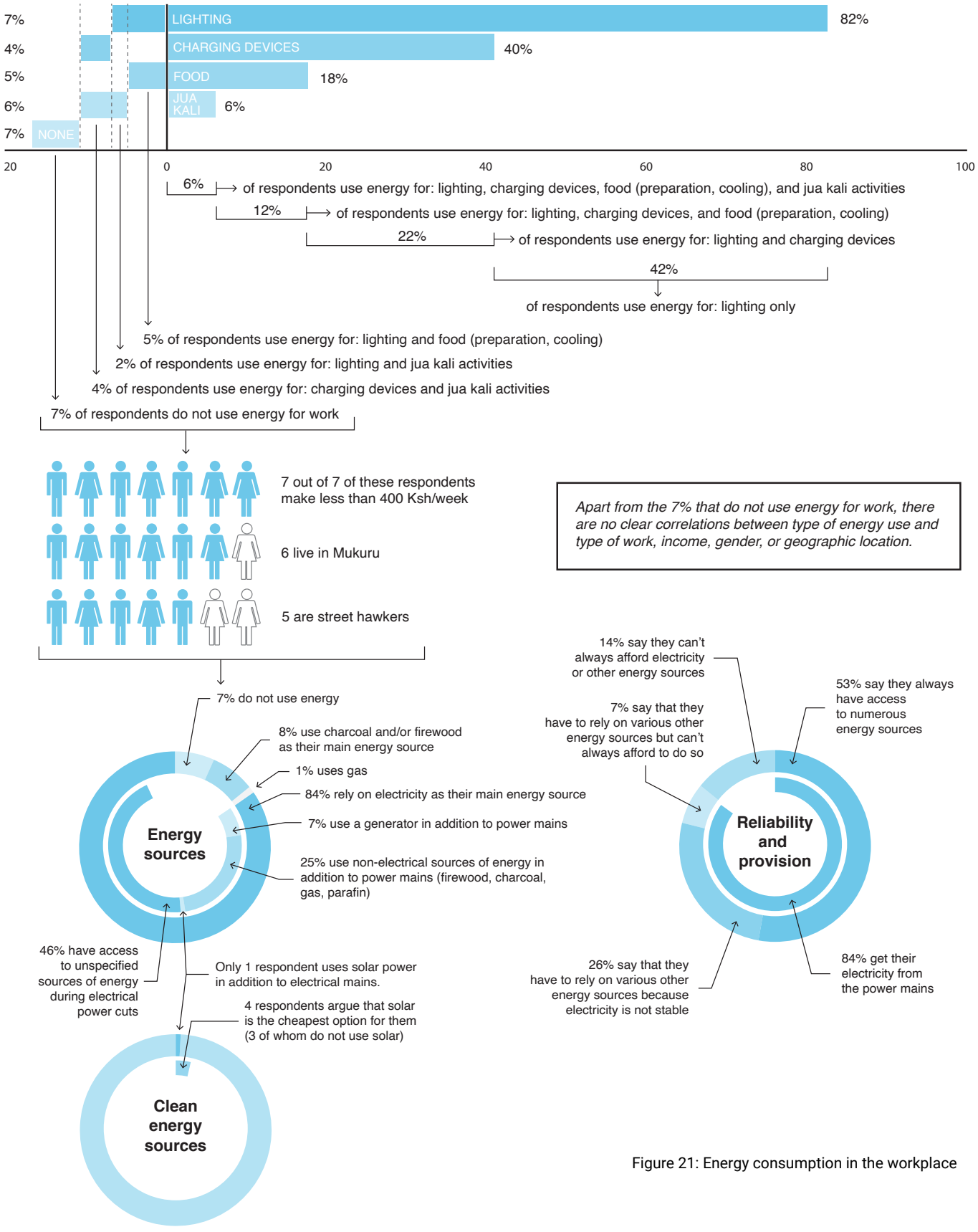
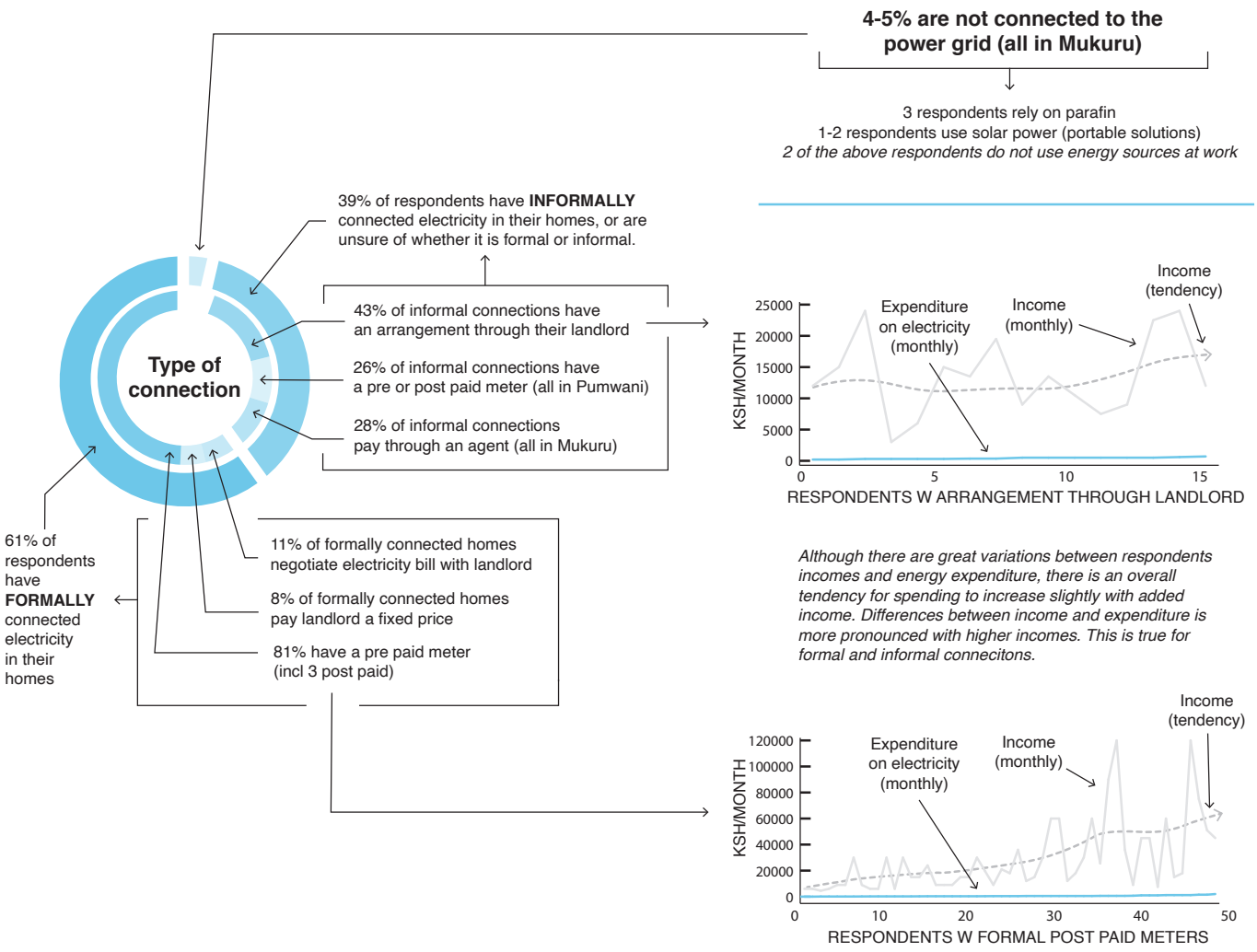


Figure 21: Energy consumption in the workplace



Prevalence of formal electrical connections and family sizes

Larger families are more likely to have formal electrical connections at home.

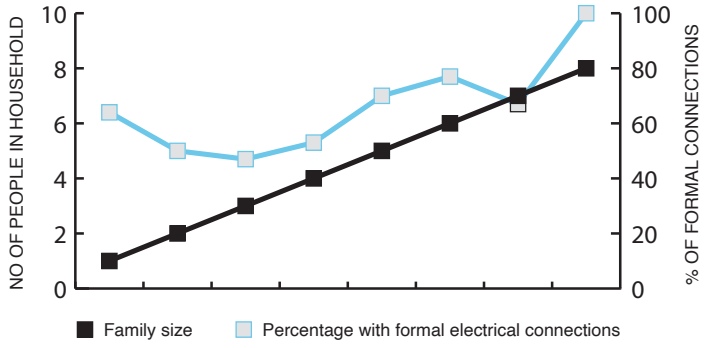
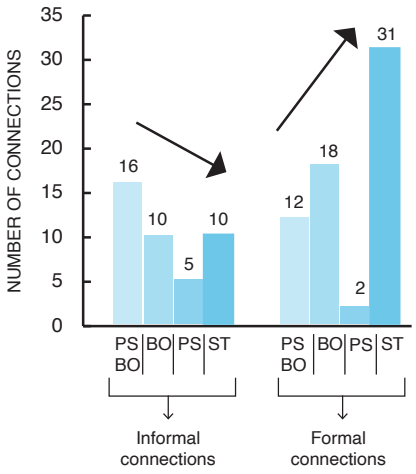


Figure 22: Energy consumption at home

Stability and type of connection

Among respondents with informal connections, 24% are satisfied with the stability of electricity

Among respondents with formal connections, 49% are satisfied with the stability of electricity



ST = Stable
PS = Powersurges
BO = Blackouts
PS/BO = Powersurges *and* blackouts

experience either power surges, blackout or stable connections. Conversely, amongst formal connections, the largest share have stable connection, and the smallest share has both power surges and blackouts.

Prevalence of solar

Of respondents 16 per cent used solar in some way. The solar power solutions they used are all hand held or portable. 2 per cent used these devices as a primary source of energy/electricity, while 14 per cent used them as a secondary source – a supplement to electricity from the power mains. 80 per cent of respondents used electricity from the power mains and used other energy sources than solar as a secondary or back up source. This means that 95 per cent of all respondents used electricity from the power mains as their primary energy source. Note that this does not include energy for food preparation where almost all respondents used charcoal or firewood (see "use of open fires"). Knowledge of solar power is relatively high across most groups; 28 per cent responded that they knew of people or friends who use solar power. In one instance there was knowledge of an organisation providing such solutions. There are some clear tendencies among the 16 per cent who used solar: most of them were men, and most of them lived in Pumwani. Most of the men had higher education. The women did not. These tendencies are clear even if correcting for skewed gender representation among respondents. Speculatively, education may be key here. That most solar power users live in Pumwani might be connected to the general higher levels of education here compared to Mukuru. Geography and spatial premises may not factor in, especially considering that the solar solutions in question are portable devices. Also, men were better represented among respondents with higher educations, and may explain the disparity between male and female solar users.

What this means in terms of clean energy provision

While prevalence of solar power usage and knowledge of usage covers one third of residents, these are portable and most likely low yield gadgets/battery packs that allow for lighting and/or charging. These kinds of solutions cover the most prominent needs of residents. Access to such solutions is probably through the private market, as only one respondent had knowledge of organisations providing assistance relating to solar power. In other words, there is an existing market, room for expansion and enhancement, and few if any existing service providers targeting urban poor settlements with the goal of improving access to power and standards of living. Based on the data, solar power is currently preferred by men with higher educations. More knowledge about why this should be collected in order to target different groups efficiently.

Use of open fires

Almost all respondents (98%) used open fires. This would normally be jikos (stoves for burning coal or firewood) used for heat, but mainly for preparing food. Distinctions are made between those that used jikos outside, those that used jikos inside, and those that used jikos both inside and outside. The respondents were equally divided among the three categories. Geographical differences can be seen in usage of jikos. In Mukuru people tended to use them indoors. In Pumwani people tended to use them outdoors as well as indoors. This could be explained by the layout of the two areas, where Pumwani in many cases caters for small courtyards between houses and streets, allowing for household activities to take place outside.

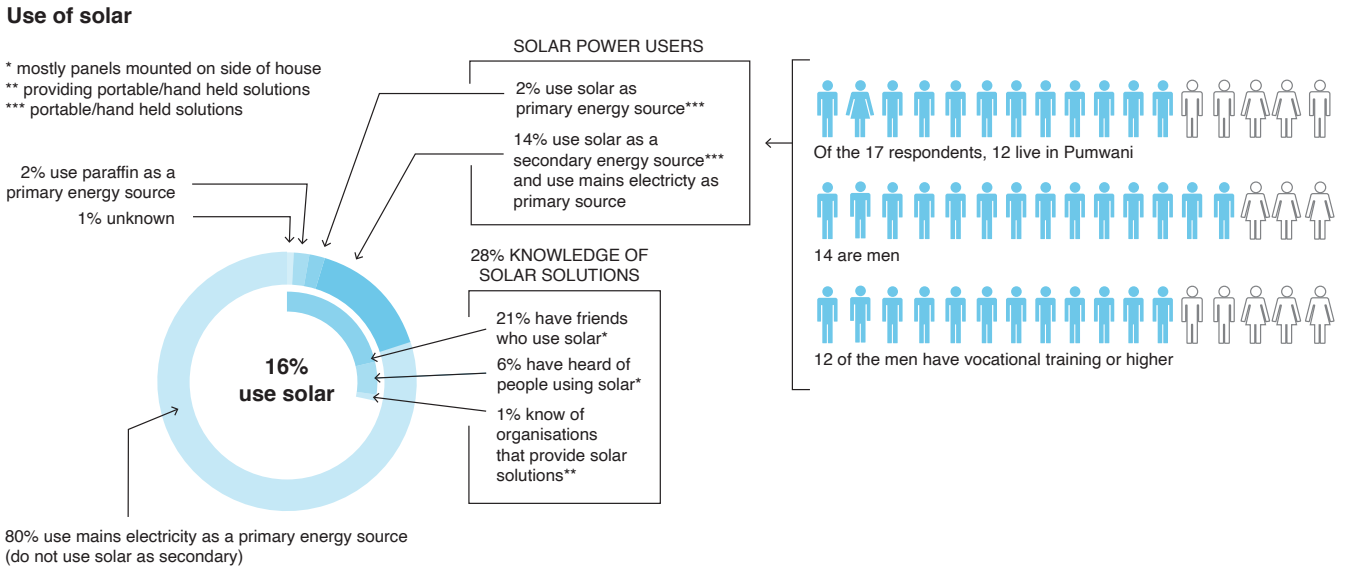


Figure 23: Use of solar

While the consequences of having accidents with fires inside would be greater than outside, this does not seem to be a great concern among respondents. That is: there is a tendency that respondents who use fires outside are concerned about safety. This might mean that many of these respondents choose to be outside for such activities in order to avoid consequences of potential accidents.

What this means in terms of clean energy provision

The ubiquitous use of coal burners for food preparation is a health and safety hazard, particularly considering that a large majority (approximately 70%) of respondents used jikos inside. There is in other words a large potential in shifting from coal and firewood to solar. But this would entail a cultural shift that could be difficult to instill even though there could be economic gains (over time) in shifting to solar. Also energy requirements for cooking are high, and may not be feasible to attain without larger and permanent solar power systems.

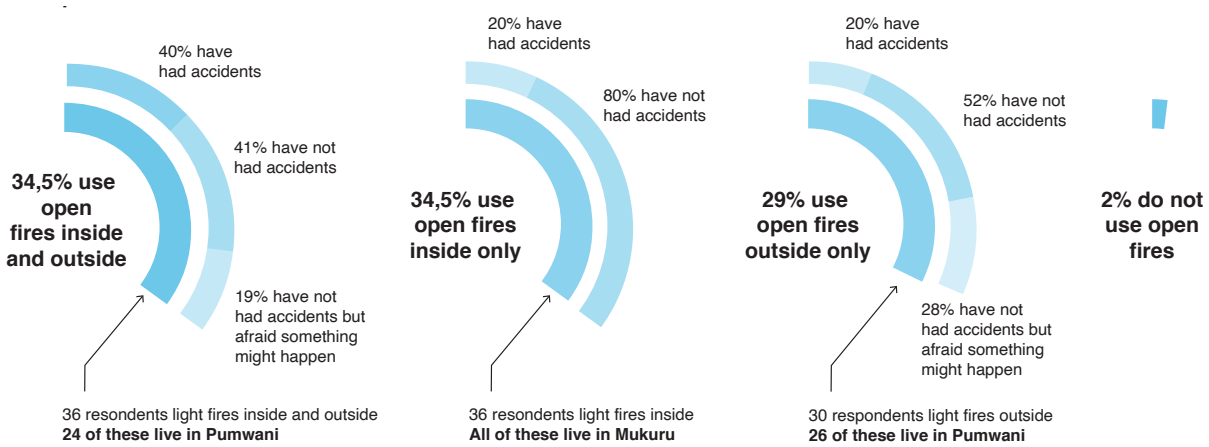
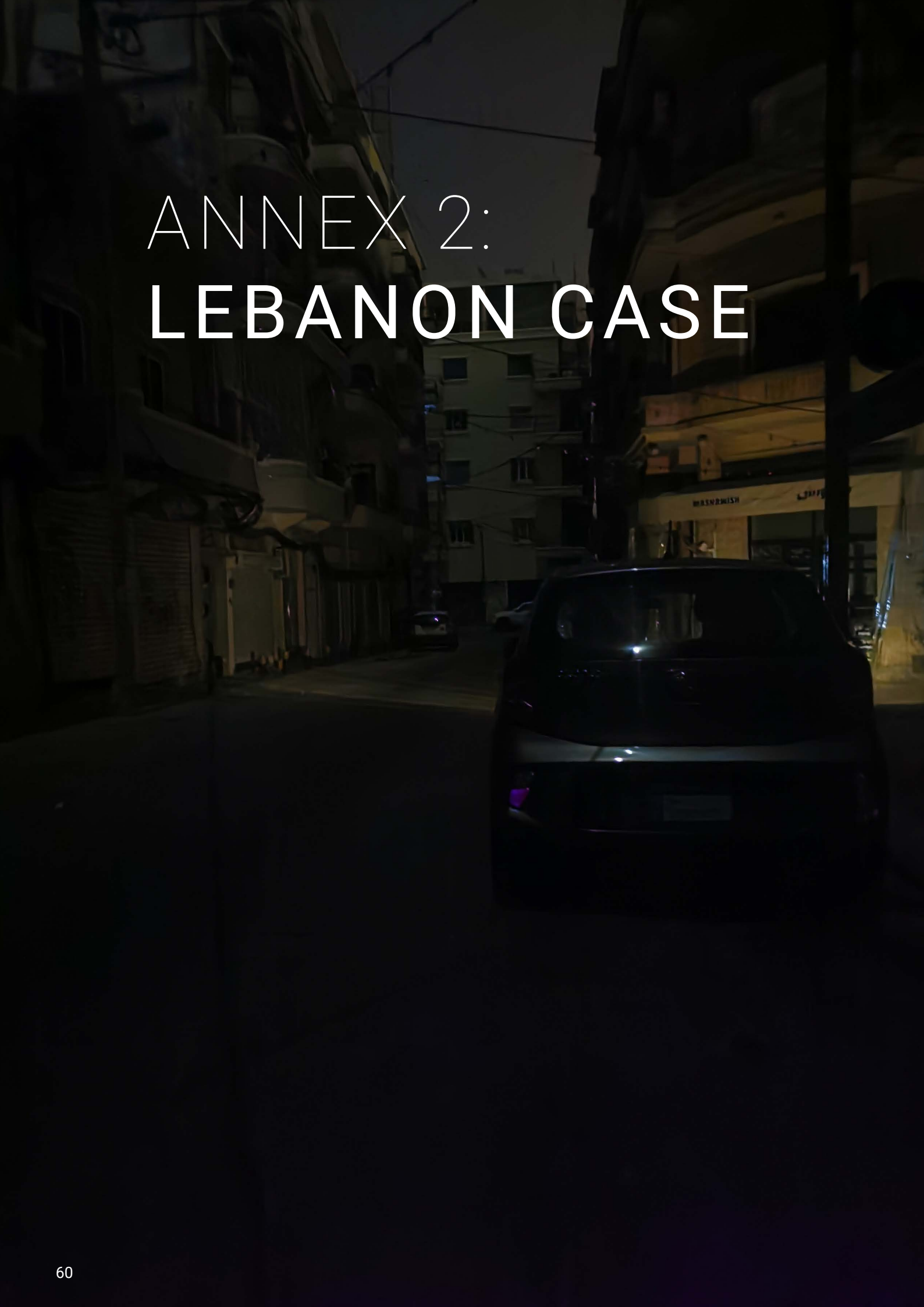


Figure 24: Use of open fires



ANNEX 2:
LEBANON CASE

Governance

The energy sector in Lebanon is principally governed by the Ministry of Energy and Water (MoEW), who is responsible for legislations and policies. The Lebanese Centre for Energy Conservation (LCEC) affiliated to the MoEW provides technical expertise on matters of energy efficiency, green buildings, and renewable energy in the context of national strategies for energy savings and the reduction of GHG emissions (IRENA, 2020).

The Central bank of Lebanon has initiated the National Energy Efficiency and Renewable Energy Action (NEERA), a public financing mechanism for clean energy projects in Lebanon. Through this financing mechanisms, clean energy projects can qualify for loans at an interest rate of 2.5 per cent. In 2016 almost half of Solar PV investments was made through NEERA, with close to 1000 clean energy projects financed by March 2019 (Ibid).

Electricité du Liban (EDL) is responsible for electricity provision for the entire country. EDL owns and manages the national grid and the distribution of power to customers through a network of Distribution Service Providers (DSP) (ESMAP, 2020). This system was introduced by the Government of Lebanon (GoL) in 2010 to allow for PPPs in the distribution of electricity. The first power purchase agreement (PPA) was signed in 2018 with a total capacity of 226MW. The take-or-pay clauses means that EDL is obliged to assume payment in cases where the grid cannot absorb the power supplied.

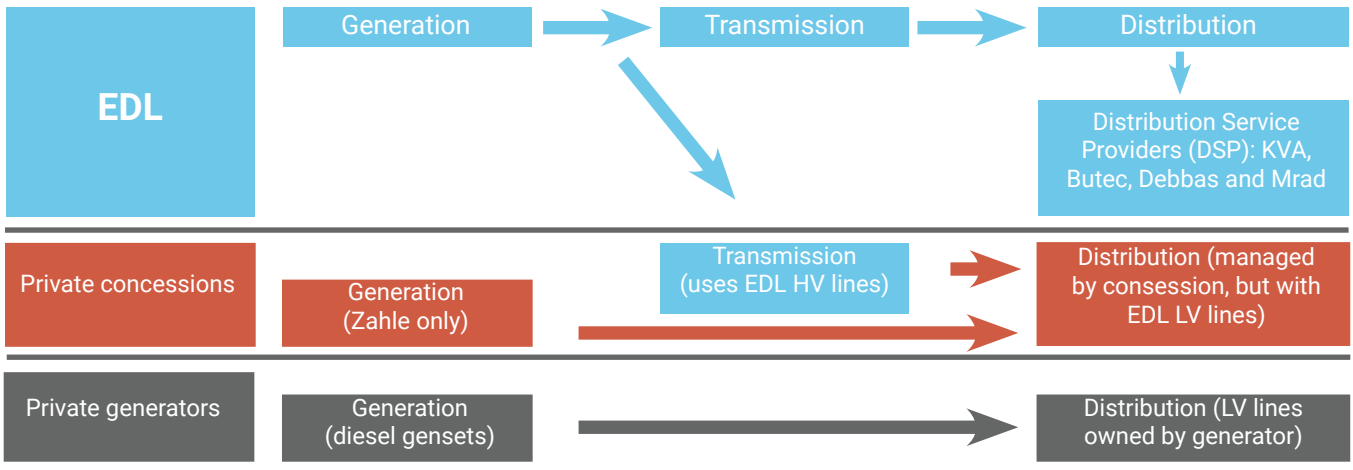
Decentralised systems are not legal and cannot be connected to the grid (one notable exception is the case of EDZ, see Box 1 p.27). Regional governments are responsible for the maintenance of energy infrastructure in their respective regions.

The energy sector is suffering from considerable governance challenges. Over the post-Civil War period (since 1990), an increasingly clientelist and corrupt public sector characterised by diffused decision making and a lack of accountability, has plagued an energy sector that was already suffering from structural deficiencies and competing interest prior to the Civil War. EDL as the sole provider of service contracts and employment opportunities, in particular, has given room for exchange of political favours and nepotism.

As a result of the government's deficiencies in supplying adequate and reliable electricity, private generators are used to supply low voltage electricity direct to local households through separate distribution networks. In 2018, the government started a campaign to regulate the operations of commercial diesel generator networks by requiring metering systems for diesel generator subscribers and to follow monthly tariffs issued by the MoEW. Prior to this, most owners of diesel generators imposed a flat tariff on subscribers. It should be noted that the real level of compliance has not been assessed (Ali Ahmad et al, 2020).

In 2017, 96 per cent of Lebanon's energy mix was produced from oil (IRENA, 2020). This makes the energy sector and national economy highly vulnerable to fluctuations in oil prices. The GoL subsidised fuel used in EdL's power generation plants has caused significant deficits in the government budgets. It is estimated that over the 2010-2020 period, the GoL transferred on average 3.8 per cent of GDP annually to the EdL, which is almost equivalent to half the total fiscal deficit (World Bank, EU, and United Nations, 2020).

The negative expense recovery ratio is further exacerbated by the low electricity tariffs. The last update of the tariff structure dates to 1996 (L'Orient-Le Jour, 2021). While electricity tariffs are fixed at around



Notes: HV = high voltage; LV = low voltage

Figure 25 The Structure of the electricity sector in Lebanon.
Source: Ali Ahmad et al, 2020.

Electricity cables in Palestinian camp Beirut. **Photo**: Synne Bergby (2017).

9.5 USD cents per kilowatt-hour (kWh) on average across consumer type and day times, the oil used to produce a kWh is generally between 16 and 22 cents. Moreover, collection rates remain low, and there has been a reported drop of around 20% in electricity bill collections due to the pandemic (Ibid). Moreover, the current hyperinflation makes cost of production and electricity prices significantly more expensive. A pricing revision will enable EDL to progressively cover its deficit and gradually dissolve the generator's market. However, there is currently not political will to implement such a policy.

Legal and Policy Framework for Renewables in Lebanon

- Law 462 for electricity sector has existed on paper since 2002 but has still not entered into force (UNDP, 2017). The law was established to allow private power generation and grid connection through independent power producers (IPPs), and to establish the National Electricity Regulatory Authority (NERA) to prepare necessary regulations such as grid codes, power purchase agreements (PPAs) and feed-in structures. The renewable energy-related grid code is necessary to create an enabling environment for IPPs to provide the rules for the electrical system and energy market operations. This should as a minimum include interconnection codes, operating codes, planning codes and market codes.
- Law 288, issued in 2014, extended the authority of the Council of Ministers for two years. In 2015, the parliament passed law 54, extending the period to 2018. Currently Lebanon lacks a regulatory authority, and no entity has the authority to grant licenses (Institute for Global Prosperity and Chatham House, 2019).
- Decision 32/2019 was issued by the Higher Council for Urban Planning to support the installation of solar photovoltaic systems on buildings' rooftops.
- Decree 167/2017 calls for a reduction of between 10 per cent and 50 per cent in customs duties for individual and legal entities importing goods to be used to avoid, reduce, or eliminate pollution.
- The National Energy Efficiency Action Plan (NEEAP) 2016-2020 (MoEW, 2016) sets out that deployment of clean energy and energy efficiency measures should satisfy 12 percent of primary energy consumption for both electricity generation and heating purposes by 2020 (Institute for Global Prosperity and Chatham House, 2019). According to NEEAP, this would be achieved by prioritising energy efficiency as well as the refurbishment, replacement and retrofitting existing power plants (Ibid). A new target has since been set to have 30 per cent of total primary energy consumption from clean energy by 2030 MoEW, 2019).

Energy production

EDL owns and runs eight heavy fuel and diesel oil generation plants and five hydropower plants. In addition, EDL contracted Karadeniz Powership in 2013 to provide 385 MW of emergency power from floating power barges (MoEW and LCEC, 2019). EDL's available installed capacity is 1,616 MW, while peak demand is up to 3,000 MW (UNDP, 2017). Currently, all the powerplants use fuel oil. Of Lebanon's GHG emissions, 53 per cent is from electricity sector. If gas is discovered in Lebanon, there are policy environment and financing requirements that must be put in place for the resources to be productive. Moreover, transitioning from fuel oil to gas will only to a degree reduce pollution (Institute for Global Prosperity and Chatham House, 2019).

The total installed renewable power capacity is 350MW. Of this, 286MW is from hydropower; 7MW from landfill; and 56.36MW from solar power (IRENA, 2020). Hydropower is the most established renewable energy resource in Lebanon and contributes to around 4.5 per cent of the energy mix with a nominal capacity of 280 MW (MoEW, 2019). There is a large potential for wind energy, particularly along the Mount Lebanon Range.

PERFORMANCE PARAMETER	VALUE
Total capacity (owned and purchased) (MW)	2512
Generation capaacity (% of peak demand capacity)	72.7
Total generation delivered (teawatt hours, TWh)	14
Total generation (% of total demand)	63
Average load factor (%)	75
Technical losses (%)	14
Non-technical losses (%)	20
Average tariff (US cents per kWH)	9
Average tariff (% of cost-recovery tariff)	27
Collection ratio (%) (2017)	66

Table 3 EDL performance in 2018
Source: Ali Ahmad et al, 2020.

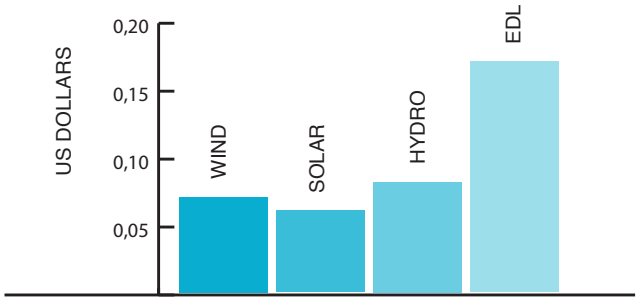
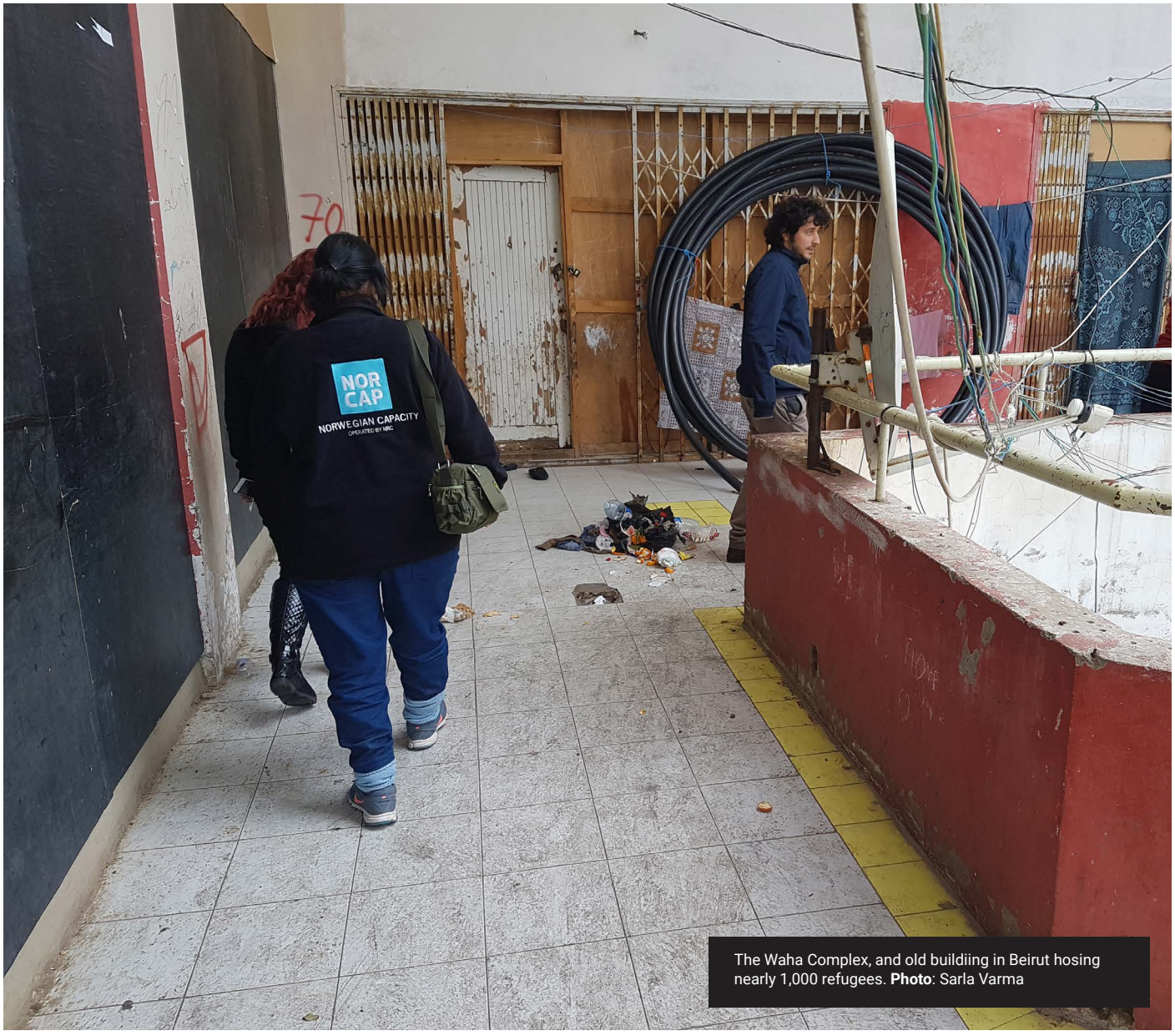


Figure 26 Cost of energy production Lebanon.
Source: Heinrich-Böll-Stiftung, 2019.



The Waha Complex, and old buildiing in Beirut hosing nearly 1,000 refugees. **Photo**: Sarla Varma

Power purchase agreements (PPAs) has been made with three wind farms in Akkar. Procurement process started in 2013 however, is still ongoing (UNDP, 2017). Solar production is also increasing. Beirut City potential for distributed rooftop solar CV capacity is estimated at between 200 and 300 MWp (average rooftop area estimated at 185m^2 with capacity between 12 and 17 kWp).

Despite the potential for clean energy production however, the extremely affordable pricing of electricity due to governmental subsidies of imported fossil fuel, renders other energy sources financially unfeasible.

Energy provision

As discussed in the Lebanon chapter, energy provision on a national scale is uneven and reflects a multitude of socio-cultural divisions and inequity within Lebanese society. The overall energy generation deficit is estimated to be around 20 per cent of total demand (Moisseron and Guesmi, 2018) with only 55 to 64 per cent of Lebanon's electricity demand being supplied by EdL in 2018 (World Bank, EU, and UN, 2020). Weak transmission networks and an overall deteriorating infrastructure is a major challenge, with technical and non-technical losses amounting to a third of EDL's generation. Moreover, there has been a significant increase in electricity demand driven by the arrival of Syrian refugees (CoR, 2020). Electricity demand is indeed estimated to have jumped 54.8 per cent from 2010 to 2016.

To compensate for the lack of public electricity provision, people rely on expensive small diesel generators, either for their household or through private neighbourhood suppliers. The commercial generator market in 2018 was estimated at USD1.1 billion, serving more than a million customers (ESMAP, 2020). The neighbourhood suppliers' influence is sustained through close relations with politicians, municipal officials, and security forces, who might for example "donate" free electricity to municipalities and religious institutions in their areas. In 2018, diesel generators emitted about 3,400 gigagram (Gg) CO2 equivalent, which represents around 40 percent of Lebanon's total emissions from electricity and 11.4 percent of the country's total emissions. This has serious environmental and health implications. In Beirut for example, operating diesel generators for only three hours per day has been found to account for 38 per cent of the daily carcinogen exposure (Ahmad et al., 2020).

Electricity at the local level: vulnerable neighbourhoods in Beirut

A profiling of vulnerable neighbourhoods in Beirut (UN-Habitat and UNICEF, 2020) shows that the share of streets connected to an electrical grid in bad condition ranges from 35 per cent to none, with an average of 15.5 per cent (see Figure 27). Figure 28 shows the share of buildings connected to the public electricity grid with critical defects. While Dauk-Ghawash (56 per cent) and Havyy Tamlis (33 per cent) have the highest share, other neighbourhoods have relatively low shares of buildings that are connected to the public grid with critical defects.

For those connected to the public grid in Dauk-Ghawash neighbourhood, electricity supply is offered 21 hours per day. Most residents in the neighbourhood, however, rely on privately owned generators with a monthly subscription charge of US $50. The generators are contributing to air and noise pollutions. Overall, more than 70 per cent of the street are connected to a power grid of poor and medium quality. Of buildings, only 6 per cent are functionally connected to a public electrical grid, while 29 per cent are connected but with minor defects (installed externally with some safety measures such as weatherproofing. 65 per cent of buildings are connected but with major defects (electrical wires externally installed with limited safety measures) or with critical defects (installed externally with no safety measures, presenting an immediate hazard).

The share of streets with functional streetlight also varies across neighbourhoods. With an average of 15.5 per cent of streets with no light, Daouk-Ghawash has the highest share with close to one third of streets without lighting, while Nabaa and Marash has the lowest share with less than 10 per cent each. It should be noted that all lights are nonfunctional when public electricity is down. The frequent power cuts are therefore rendering the streets without lightning at different times of the day and at night.

The impact of the Beirut Port explosion on electricity supply

The 4 August 2020 blast has impacted the electricity supply. Damages to Beirut's transmission network from the 4 August blast include significant damages to the 220 kV Achrafieh substation, a key electrical feeder supplying electricity to Downtown Beirut, as well as destruction to the National Control Centre controlling the power system's operations from within the EDL headquarters (World Bank, EU and United Nations, 2020). Damages to electrical distribution included the damage to substations, distribution lines (115.6 km of the 284 km of low-voltage power lines were damaged), and a data centre for electricity billing. Damages to the energy sector were estimated at around USD 40 million to USD 50 million, with losses of around USD 55 million to USD 70 million.

It is likely that projects that were to be implemented under the various government plans developed in recent years have become non-implementable or applicable due to the current crisis. This is particularly a consequence of the effect it has had on curbing investment from energy companies (L'Orient-Le Jour, 2021).

Electricity connection to streets across eight neighbourhoods in Beirut, and buildings in Dauk-Ghawash neighbourhood

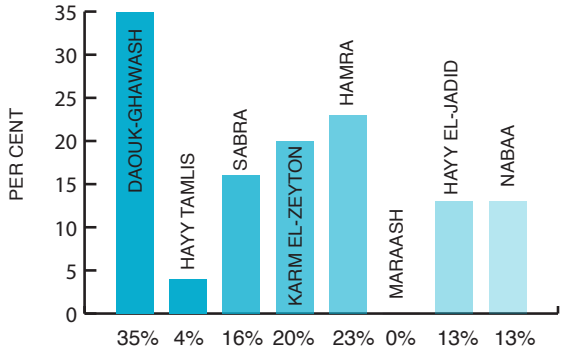


Figure 27 Streets connected to an electrical grid in bad condition across eight neighbourhoods in Beirut.

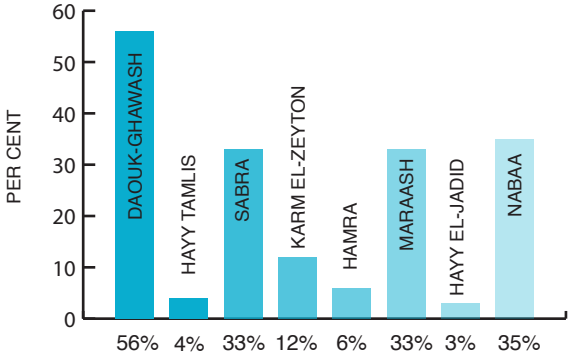


Figure 28 Buildings connected with critical defects to the public electrical grid (%) across eight neighbourhoods in Beirut.

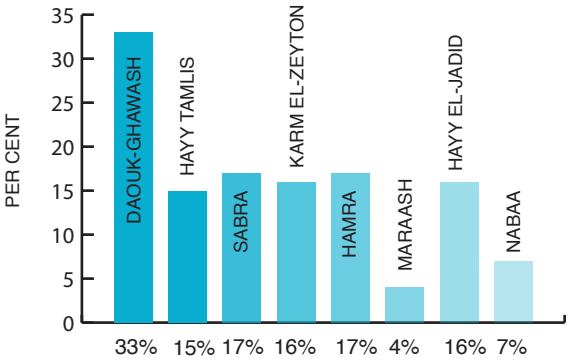


Figure 29 Streets with no street lightning (%) across eight neighbourhoods in Beirut.

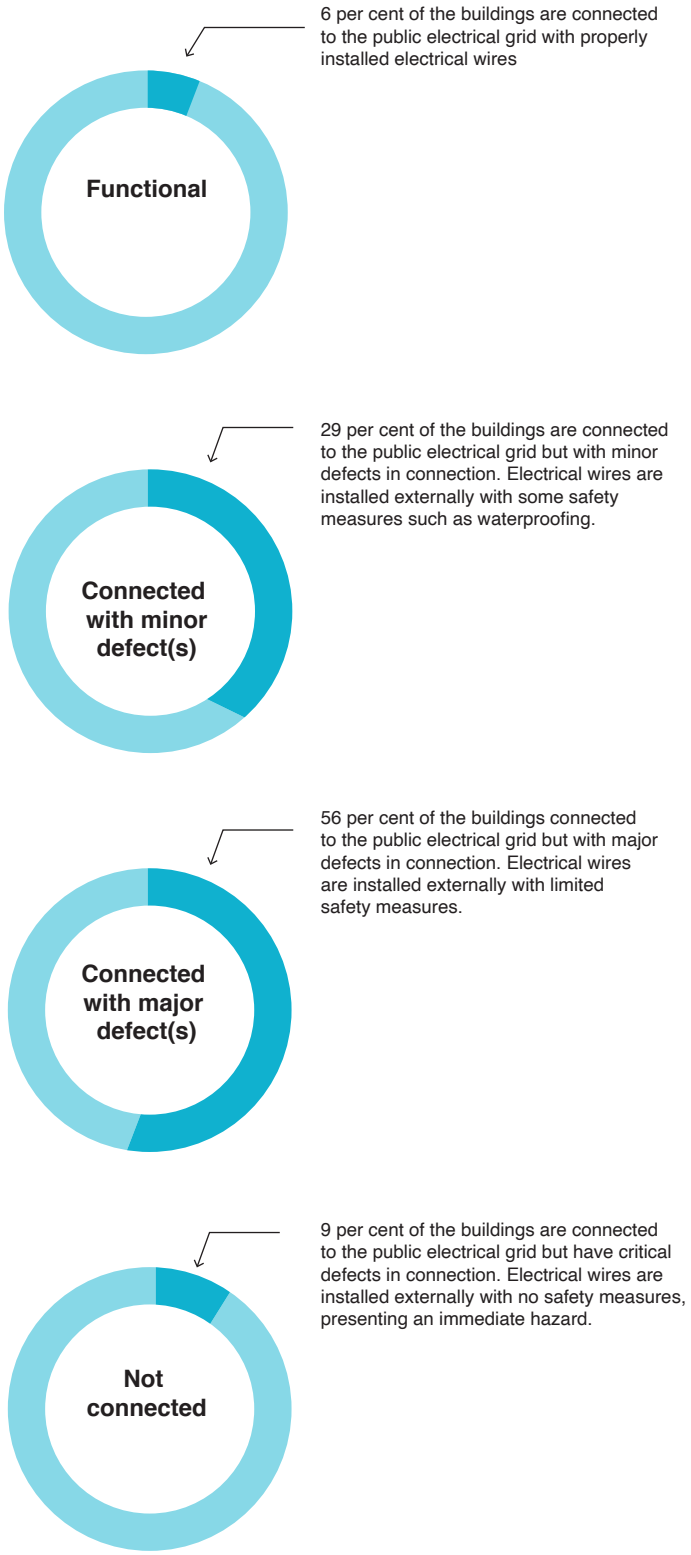


Figure 30 Electricity connections in Dauk-Ghawash neighbourhood in Beirut.

Source: UN-Habitat and UNICEF, 2017-2020; UN-Habitat and RELIEF Centre, 2020.

Photo: Synne Bergby, 2017

Bibliography

Ahmad, Ali, Muzna Al-Masri, Marc Ayoub, and Neil McCulloch. "From Dysfunctional to Functional Corruption: The Politics of Reform in Lebanon's Electricity Sector | The Policy Practice." The Policy Practice, 2020. https://www.thepolicypractice.com/dysfunctional-functional-corruption-politics-reform-lebanons-electricity-sector.

Ahmad, Ali, Neil Mcculloch, Muzna Al-Masri, and Marc Ayoub. "From Dysfunctional to Functional Corruption: The Politics of Reform in Lebanon's Electricity Sector," 2020.

Armstrong, Martin. "The 'enviromental Disaster' Lebanon Can't Afford to Fix." Near East News Agency, 2015. https://nena-news.it/the-enviromental-disaster-lebanon-cant-afford-to-fix/.

Byrne, Rob, and Kennedy Mbeva. *Energy Transformations-Kenya The Political Economy of State-Led Transformations in pro-Poor Low Carbon Energy: A Case Study of Solar PV in Kenya*. ESRC STEPS Centre, 2017. www.steps-centre.org/publications.

CMS. "Renewable Energy Law and Regulation in Kenya | CMS Expert Guides." Accessed February 2, 2021. https://cms.law/en/int/expert-guides/cms-expert-guide-to-renewable-energy/kenya.

CoR. "CoR - Lebanon Energy." 2020. Accessed December 21, 2020. https://portal.cor.europa.eu/divisionpowers/Pages/Lebanon-Energy.aspx.

Cross, Jamie, and Declan Murray. "The Afterlives of Solar Power: Waste and Repair off the Grid in Kenya." *Energy Research and Social Science* 44 (October 1, 2018): 100–109. https://doi.org/10.1016/j.erss.2018.04.034.

EPRA. "The Draft Energy (Solar Photovoltaic Systems) Regulations 2020 - Energy and Petroleum Regulatory Authority," 2021. https://www.epra.go.ke/the-draft-energy-solar-photovoltaic-systems-regulations-2020/.

ESMAP. "Bringing Global Best Practices to Transform Kenya's Slum Electrification Project," 2015.

———. "Distributed Power Generation for Lebanon: Market Assessment and Policy Pathways," May 2020. www.worldbank.org.

———. "Multi-Tier Framework (MTF) ." Accessed April 13, 2021. https://www.esmap.org/node/71201.

Hubbard, Ben. "Syria's Surprising Solar Boom: Sunlight Powers the Night in Rebel Idlib," May 15, 2021. https://www.nytimes.com/2021/05/15/world/middleeast/syria-solar-power-idlib.html.

IEA. "Access to Electricity – SDG7: Data and Projections – Analysis - IEA," 2021. https://www.iea.org/reports/sdg7-data-and-projections/access-to-electricity.

Institute for Global Prosperity, and Chatham House. "Transitions to Renewable Energy and Sustainable Prosperity in Lebanon: A People-Centered Approach to Equitable Energy Supply," 2019. www.ucl.ac.uk/bartlett/igp.

———. "Transitions to Renewable Energy and Sustainable Prosperity in Lebanon: Why Democratic Infrastructure Supports Innovative Energy Projects," 2019.

IOM. "Mixed Migration ." Accessed April 29, 2021. www.nairobi.iom.int.

IRENA. "Renewable Energy Outlook: Lebanon," 2020. www.irena.org.

———. *Renewable Energy Outlook Lebanon*, 2020.

Jean-Yves Moisseron and Khalend Guesmi. "Assessing EU-Mediterranean Policies in the Field of Energy from a Bottom-up Perspective: The Case of Lebanon," 2018.

Karekezi, Stephen, John Kimani, and Oscar Onguru. "Energy Access among the Urban Poor in Kenya." *Energy for Sustainable Development* 12, no. 4 (2008): 38–48. https://doi.org/10.1016/S0973-0826(09)60006-5.

Kenya Red Cross. "Mukuru-Sinai Fuel Spill and Fire Disaster," n.d.

Kiprop, Eliud, Kenichi Matsui, and Nicholas Maundu. "The Role of Household Consumers in Adopting Renewable Energy Technologies in Kenya," 2019. https://doi.org/10.3390/environments6080095.

KPLC. “Resettlement Action Plan for the Proposed 66kv Transmission Line from Nairboi North Substation to Westlands and Ilri (Kabete) Substations,” 2011.

L’Orient-Le Jour. “Avoiding the Collapse of the Electricity Sector in Lebanon,” February 17, 2021. https://www.lorientlejour.com/article/1252260/eviter-leffondrement-du-secteur-de-lelectricite.html.

Lahn, Glada, and Owen Grafham. “Heat, Light and Power for Refugees: Saving Lives, Reducing Costs,” 2015. www.chathamhouse.org.

LCEC. “Beirut River Solar Snake: The Dawn of the Solar Market in Lebanon,” 2020. www.scienceandink.io.

———. “Our Identity .” Accessed April 29, 2021. https://www.lcec.org.lb/our-identity.

Localised Needs Assessment (LNA). “As-Sweida Localised Needs Assessment,” forthcoming.

Ministry of Energy and Water. “Updated Policy Paper for the Electricity Sector,” 2019.

Mixed Migration Centre. “Urban Mixed Migration Nairobi Case Study,” 2020.

MoEW. “The Second National Energy Efficiency Action Plan for the Republic of Lebanon 2016-2020,” 2016.

MoEW, and LCEC. “The Evolution of the Solar Water Heaters Market in Lebanon 2012-2017,” 2019. http://lcec.org.lb/Content/uploads/LCECOther/190926084439809~Lebanese Solar Water Heater Market Study 2012-2017.pdf?fbclid=IwAR2YYdQxtcPrmvbYwhVTdb6Nuu-eDp7kEHVmU6fXG6VsWdNZyMlCVWT7QN4.

Moore, Henrietta L., and Hannah Collins. “Decentralised Renewable Energy and Prosperity for Lebanon.” *Energy Policy* 137 (February 1, 2020). https://doi.org/10.1016/j.enpol.2019.111102.

Nairobi County. “Environment Energy Water and Sanitation | Nairobi City County,” 2021. https://nairobi.go.ke/environment-energy-water-and-sanitation/.

NCR. “Green Energy for Syrian Refugees,” 2016. https://www.nrc.no/news/2016/juni/jordan-renewable-energy-project/.

NewClimate Institute. “The Role of Renewable Energy Mini-Grids in Kenya’s Electricity Sector Evidence of a Cost-Competitive Option for Rural Electrification and Sustainable Development,” 2019. www.ambitiontoaction.net/.

Njoroge, Peris, Amollo Ambole, Daniel Githira, and George Outa. “Steering Energy Transitions through Landscape Governance: Case of Mathare Informal Settlement, Nairobi, Kenya.” *Land* 9, no. 6 (2020): 1–19. https://doi.org/10.3390/land9060206.

NORCAP, and BCG. “EmPowering Africa’s Most Vulnerable,” 2020.

Omata, Naohiko. “Refugee livelihoods: a comparative analysis of Nairobi and Kakuma Camp in Kenya,” 2020.

Parker, Elizabeth, and Victoria Maynard. “Humanitarian Response to Urban Crises: A Review of Area-Based Approaches.” Human Settlements Working Paper , 2015. https://pubs.iied.org/10742iied?k=maynard&r=p.

Power Africa. “Development of Kenya’s Power Sector,” 2016.

Pumps Africa. “Kenya to Complete Grid Connection to Ethiopia by June,” 2021. https://pumps-africa.com/kenya-to-complete-grid-connection-to-ethiopia-by-june/.

Rahnema, Ahmad mname, Felix mname Sanchez, and Paola mname Giordano. “Alternative Cooking Fuels in Kenya: How Can Household Decision-Making Be Impacted?” *SSRN Electronic Journal*, February 7, 2018. https://doi.org/10.2139/ssrn.3102883.

REN21. *Renewables 2019 Global Status Report*. *Resources*. Vol. 8, 2019. http://hdl.handle.net/20.500.11822/28496.

Republic of Kenya. “National Energy Policy,” October 2018.

———. The Energy Act, 2019 , Pub. L. No. 1 (2019). https://www.epra.go.ke/download/the-energy-act-2019/.

———. The Public Private Partnership Act 2013, Pub. L. No. 27 (2013).

RES4Africa. *RE-Thinking Access to Energy Business Models* , 2019. www.gangemieditore.it.

Reuters. “Fixing Lebanon’s Ruinous Electricity Crisis,” 2019. https://www.reuters.com/article/us-lebanon-economy-electricity-idUSKCN1RA24Z.

Samoita, Dominic, Charles Nzila, Poul Alberg Østergaard, and Arne Remmen. “Barriers and Solutions for Increasing the Integration of Solar Photovoltaic in Kenya’s Electricity Mix.” *Energies* 13, no. 20 (2020). https://doi.org/10.3390/en13205502.

Samuel Gathanga. “Homelessness and (Un)Affordable Housing in Nairobi,” 2021. https://africasacountry.com/2021/02/homelessness-and-unaffordable-housing-in-nairobi.

SEforall. “Energy Safety Nets Kenya Case Study,” 2020. www.ceew.

Shaar, Karam. “The Syrian Oil Crisis: Causes, Possible Responses, and Implications,” 2019.

Syrian Arab News Agency. “Electricity Ministry Sets a Strategic Plan for Establishing Photovoltaic Plants, Wind Farms.” Energy Central, November 13, 2019. https://energycentral.com/news/electricity-ministry-sets-strategic-plan-establishing-photovoltaic-plants-wind-farms.

The East African. “Kenya’s Solar Panel Law Takes Effect - The East African,” 2017. https://www.theeastafrican.co.ke/tea/business/kenya-s-solar-panel-law-takes-effect-1365470.

UN-Habitat, and UNICEF. “Lebanon Neighbourhood Profiles.” Accessed February 4, 2021. https://lebanonportal.unhabitat.org/.

UNDP. “Blockchain-Enabled Solutions for the Update of Renewables Energy in Lebanon,” 2020. http://www.cedro-undp.org/content/uploads/publication/201127104115821~CEDROBlockchainReport.pdf.

———. “Lebanon: Derisking Renewable Energy Investment,” 2017. www.climatechange.moe.gov.lb.

———. “Willingness to Pay for Renewable Energy: The Case of the Lebanese Residential and Commercial Sectors,” 2015. www.cedro-undp.org.

UNHCR. “Global Trends 2019: Forced Displacement in 2019.” Accessed April 13, 2021. https://www.unhcr.org/globaltrends2019/.

Urban Analysis Network Syria. “Aleppo City Profile,” 2019. https://doi.org/10.1016/S0264-2751(03)00056-8.

———. “Ar-Raqqa City Profile,” 2019.

———. “As-Sweida City Profile,” 2019.

Urban Recovery Framework. “Thematic Paper: Pursuing environmental sustainability through urban recovery in Syria”, forthcoming.

Winther, Tanja, Margaret N Matinga, Kirsten Ulsrud, and Karina Standal. “Women’s Empowerment through Electricity Access: Scoping Study and and Proposal for a Framework of Analysis,” 2017. https://doi.org/10.1080/19439342.2017.1343368.

Wood, Johnny. “Kenya Is Aiming to Be Powered Entirely by Green Energy by 2020.” World Economic Forum, 2018. https://www.weforum.org/agenda/2018/12/kenya-wants-to-run-entirely-on-green-energy-by-2020/.

World Bank. “Kenya Beyond Connections: Access to Electricity and Clean Cooking in Kenya Based on the Multitier Framework Survey and Data Analysis,” 2019. www.worldbank.org.

———. “Kenya Electricity System Improvement Project (P166646),” 2019.

———. “Urban Redevelopment .” Accessed April 29, 2021. https://urban-regeneration.worldbank.org/node/32.

World Bank, EU, and UN. “Beirut RDNA Full Report Energy,” 2020.

World Bank, EU, and United Nations. “Beirut Rapid Damage and Needs Assessment,” 2020. http://documents1.worldbank.org/curated/en/650091598854062180/pdf/Beirut-Rapid-Damage-and-Needs-Assessment.pdf.

WRI. “Powering Cities in the Global South: How Energy Access for All Benefits the Economy and the Environment,” 2017. www.citiesforall.org.

Zalengera, Collen, Long Seng To, Richard Sieff, Alison Mohr, Aran Eales, Jon Cloke, Hannah Buckland, Ed Brown, Richard Blanchard, and Simon Batchelor. “Decentralization: The Key to Accelerating Access to Distributed Energy Services in Sub-Saharan Africa?” *Journal of Environmental Studies and Sciences* 10, no. 3 (September 1, 2020): 270–89. https://doi.org/10.1007/s13412-020-00608-7.

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