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## Tackling Lebanon's Electricity Crisis: Lessons from Yemen

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### Introduction

Lebanon's electricity system is in a deep crisis. Power from Electricite du Liban (EDL)—the insolvent state-run utility—is now available for barely two hours a day, as the population has to rely on increasingly expensive diesel generators for power. In light of this crisis, it is useful to learn lessons from other countries that have faced similar circumstances. One such country is Yemen. Lebanon's situation is, fortunately, not yet as dire as that facing the people of Yemen, where war has been raging since 2015. But the very different responses to the collapse of Yemen's electricity system from the two authorities fighting for control over the country reveal some important and relevant lessons for Lebanon.

This brief outlines the Yemeni experience following the collapse of its electricity sector and derives lessons to be learnt for Lebanon. It discusses the approaches taken by the authorities controlling different parts of the country to address a near breakdown in service, notably the Houthi administration in the North, who fully liberalized the market, and the Internationally Recognized Government (IRG) in the South, who maintained a state monopoly on energy production and a highly subsidized tariff.

The discussion focuses on solar power, an alleged success story in Yemen's energy transition. It highlights that despite a short-lived boom in solar provision in areas controlled by the Houthi administration, the deployment of solar was more a symptom of the crisis rather than a solution to it. In a fully liberalized market, solar enabled some reprieve for well-off households, but failed to provide a structural mitigation of the electricity shortages, leading to negative externalities along the way. The state-led system of subsidies, on the other hand, prevented meaningful energy transition all together. While there is an urgent need for Yemen to exploit its solar resource, a resolution of Yemen's electricity crisis will not come from a single technology, but rather from addressing the deep political and governance problems that gave rise to the crisis in the first place.

The same is true in Lebanon where the sector's dysfunctional governance inhibits the deployment of solar infrastructure at scale. For solar power to unfold its potential to provide structural solutions, the sector must ensure its proper governance. The Yemeni experience provides important lessons for Lebanon. On the one hand, it shows how clinging to a corrupt, dysfunctional, state-owned model of service delivery cannot deliver the transformation needed; on the other, it highlights that the benefits of liberalization in the form of private sector engagement can only be realized within a sound governance framework. Lebanon's incoming administrations need to seize the opportunity that the current crisis presents to reform the governance of the sector to encourage large utility-scale investments, such as in renewable energy plants, as well as to make the distribution of energy to customers more efficient and cost-effective.

### Yemen's electricity system

Yemen descended into war in 2015, as the Houthis (also known as Ansar Allah) took the capital Sana'a and extended their control over large parts of the north and center of the country. The 'Internationally Recognized Government' (IRG) under President Abdrabbuh Mansur Hadi relocated to Riyadh, and has now designated the city of Aden as a temporary capital. A military campaign, led by Saudi Arabia, has supported the IRG in fighting against the Houthis. Other armed coalitions, notably the Southern Transitional Council, as well as Al Qaeda in the Arabian Peninsula (AQAP), have also been involved in the complex, fragmented, and constantly evolving political context. Sadly, the conflict continues.<sup>1</sup>

<sup>1</sup> See <https://www.wilsoncenter.org/article/yemen-2021-islam-houthis-jihadis> for a more detailed description of the main factions in Yemen. For a map showing the political and territorial divisions in Yemen as of June 2020, go to [https://www.researchgate.net/figure/This-map-shows-the-political-and-territorial-divisions-in-Yemen-as-of-June-2020-Credit\\_fig1\\_349540713](https://www.researchgate.net/figure/This-map-shows-the-political-and-territorial-divisions-in-Yemen-as-of-June-2020-Credit_fig1_349540713)

Prior to the war, Yemen's public electricity generation system was similar to that in Lebanon today. Many of its power stations were old and in a poor state of repair, with minimal levels of investment for many years. With the exception of the large, 340MW gas power plant in Marib, almost the entire electricity system was operated on diesel or Heavy Fuel Oil (HFO), at great cost. Tariffs were extremely low—far below the cost of production—leading to large subsidies which burdened the national budget. These subsidies also made it difficult for the national utility, the Public Electricity Corporation (PEC), to raise capital to invest in new plants or rehabilitate old ones, perpetuating the poor state of the infrastructure. The grid infrastructure was also relatively old and in a poor state of repair. Before the war, numerous studies by international consultancy firms proposed significant investment in both generation and upgrades in transmission and distribution systems around the country, none of which came to fruition.<sup>2</sup>

Significant parts of the generation network have been damaged or destroyed by the war, or have stopped functioning due to lack of maintenance. The same is true for major elements of the transmission system, in particular, the line connecting the Marib power station to Sana'a and the rest of the country, effectively cutting off the capital and the rest of the country from the single largest source of cheap electric power. Before the war, there were 1500MW of capacity attached to the public grid. By 2021, this had fallen to 300MW. With the exception of a small region near Aden, the public grid in Yemen has completely collapsed. Furthermore, due to shortages of parts and a lack of maintenance, the available capacity has fallen to around 1,100MW—mostly operating as standalone power plants in cities around the country.

Even this reduced capacity is barely used. Utilization rates are below 50%, due to a mixture of poor maintenance and the extreme difficulties in obtaining fuel. Previously, most fuel was imported via the Houdeidah port on the Red Sea, which is now controlled by the Houthi authority. As a response, in 2018 and 2019, the IRG passed two decrees<sup>3</sup> which had the effect of severely restricting fuel imports through the port. The consequence is that most fuel is now imported through Aden. But the dramatic escalation in fuel prices in Houthi-controlled areas means that much of this fuel does not stay in the South, but is transported north, over land, to take advantage of the higher prices created by the policy. The fragmented nature of political control over territory in the south makes this hard for the IRG to stop, particularly when there are large rents to be captured from the policy-induced price differential. Prior to the abolition of fuel subsidies in September 2021, Lebanon faced a similar challenge with the smuggling of fuel to Syria.

<sup>2</sup> See, for example, Fichtner (2010) and McKinsey (2010).

<sup>3</sup> Decree #49 of 2019 and Decree #75 of 2018.

## The response in Houthi-controlled areas

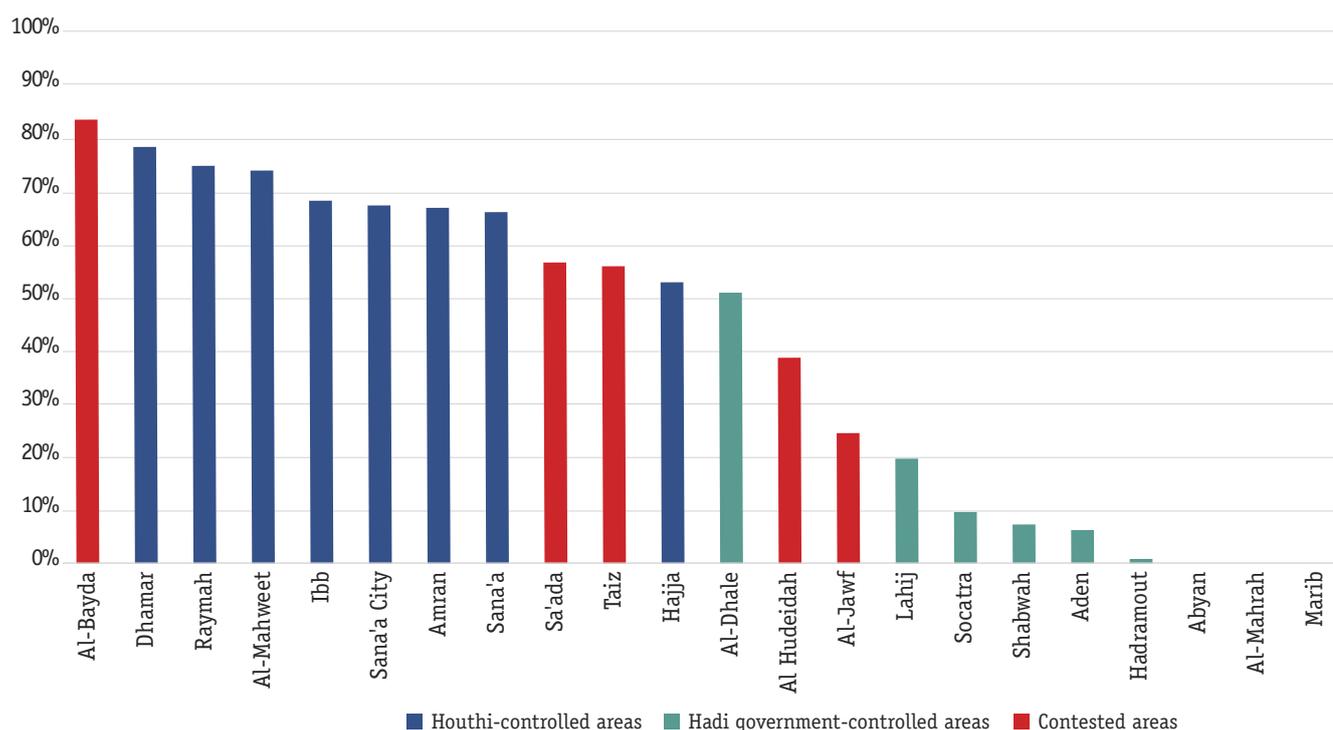
The commencement of the war in 2015 gave rise to the near total collapse of public electricity in Houthi-controlled areas. The response of the Houthi administration was a practical one. As it was initially no longer possible to obtain sufficient fuel to operate power stations and there were no resources which could possibly be used to subsidize consumers, the Houthi administration effectively permitted the complete liberalization of the sector. Electricity was treated as a private commodity to be bought and sold on the market.

The consequence of this was a remarkable boom in solar generation. Between 2015 and 2019, there was a surge in importation and sales of small-scale solar systems. Unable to obtain or to afford fuel, many households in Sana'a and elsewhere in the country switched to the use of solar to provide at least a minimal provision of electricity for lighting, charging phones, and, critically, pumping water. A phone survey conducted by the World Bank in 2019 suggests that, of those households with access to any form of electricity, three-quarters stated that their primary source of supply is from solar home systems; only 12% said that their primary supply comes from the public grid.<sup>4</sup> A previous survey in 2017 revealed that the dominance of solar home systems primarily reflects their prevalence in Houthi-controlled areas where over two-thirds of the population live (see Figure 1).

<sup>4</sup> <https://documents1.worldbank.org/curated/en/339571587498517757/pdf/Yemen-Monthly-Economic-Update-March-2020.pdf>

Figure 1

### Solar Photo Voltaic (PV) Penetration Rate by Governorate



Source [Percent Corporation for Transparency and Polling Information, 2017](#)

Note **Determination of control and contestation is as of the time of the survey in 2017 and may have changed**

In one sense, the solar boom could be seen as a success story. However, it is probably best regarded as a response to a desperate situation. While it enables large numbers of households to obtain a very basic electricity service, for the vast majority, the quality of that service is minimal, certainly when compared to the public electricity service that was available before. Similarly, solar-powered water pumps have enabled farmers in rural areas to irrigate their fields without having to incur the high fuel cost of diesel pumps. Such advancements, however, come at a great social cost: the Conflict and Environmental Observatory reports that groundwater in western Yemen<sup>5</sup> is at its lowest level since satellite records began in 2002, and the sharp recent decline in groundwater coincides with the expansion of solar water pumps.<sup>6</sup>

Anecdotally, there is evidence of widespread disillusionment with solar home systems. Without any system to enforce standards and little technical knowledge about how to safely and efficiently install such systems, the market has reportedly been swamped with sub-standard products which have had very short lifespans. In response, it would appear that the Houthi authorities are beginning to experiment with alternative non-solar mechanisms for supplying power. In particular, where the private sector has access to diesel, it is beginning to invest in neighborhood-level diesel generators, encouraging households to either subscribe to a private distribution network or piggy-back on the existing public distribution network. Thus, the electricity system in Houthi areas appears to be evolving from an atomized, household-level response providing an expensive and very basic service, to a monopolized, neighborhood-level response providing more power, but which is likely also to have high costs.

While this solution is highly non-optimal when compared to a functioning public system, it has two major advantages. First, from the perspective of the Houthi administration, electricity is a private sector commodity with a price determined by the market. There is therefore no need for any kind of public subsidy. Second, from the perspective of citizens and businesses, although electricity is expensive, supply is not rationed—it is generally possible to purchase whatever level of supply is needed if you can afford to do so.

## The response in IRG-controlled areas

The response to the electricity crisis in IRG-controlled areas has been quite different from that in Houthi-controlled areas. In large part, these differences reflect the fact that power supply from local public power stations remained intact in some cities, allowing the IRG to maintain its pre-war model of governance. As the IRG—and most of the citizens in the areas controlled by the IRG—regard the provision of electricity as one of the state's key responsibilities, electricity provision has remained under the remit of the PEC.<sup>7</sup> Yet, the PEC in Aden, as well as PEC branches in other governorates allied to the IRG,

<sup>5</sup> Their study looks at areas west of 47 degrees—home to 90 percent of the country's population.

<sup>6</sup> <https://ceobs.org/groundwater-depletion-clouds-yemens-solar-energy-revolution/>

<sup>7</sup> Although nominally one company, the PEC is in practice split between a PEC in Sana'a controlled by the Houthi administration and a PEC in Aden controlled by the IRG.

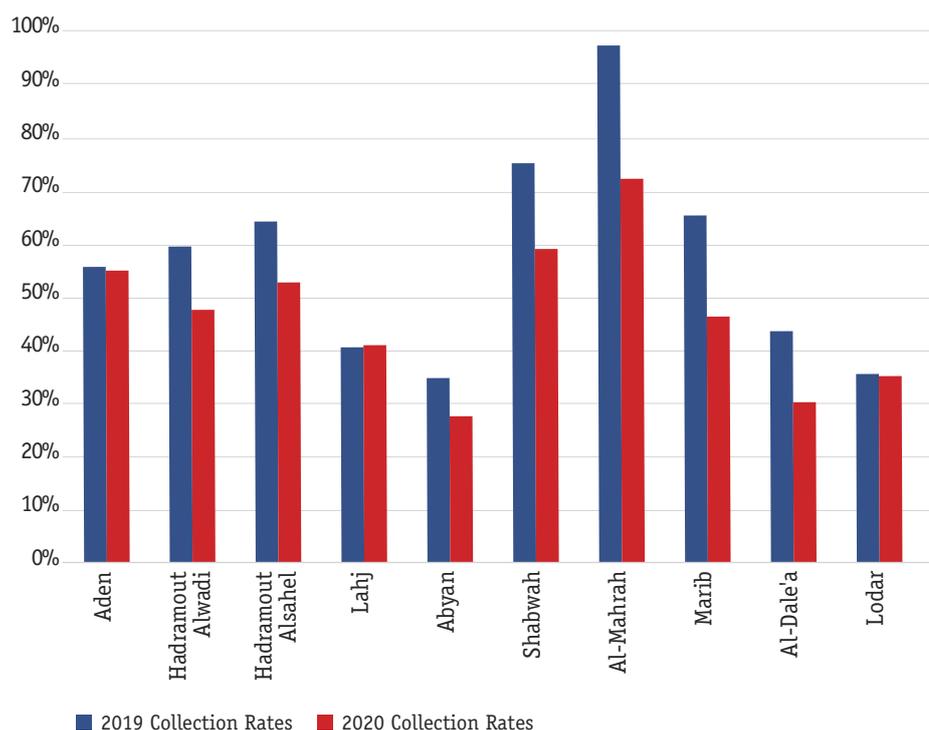
continue to supply electricity from old, primarily diesel and HFO, public power plants. Because the capacity of these plants is insufficient to meet the needs of the population, PEC also purchases almost half of all the electricity supplied from private providers, mostly diesel generators, under short-term Power Purchase Agreements (PPA). As noted above, a key challenge has been access to fuel. PEC not only has to source fuel for its own power plants, but also provides fuel to the private generators that it pays through PPAs; if it does not supply them with fuel, it is obliged to pay them anyway.

Paying for the fuel needed to provide the electricity required is a major drain on the budget of the IRG, because most tariffs have not been adjusted for years and are far below the cost of supply. Due to the age of most power plants and the use of high-cost fuels, notably diesel, it typically costs around YER 200 (around 25 US cents<sup>8</sup>) to supply 1 kWh. But the tariff paid by most households is YER 19/kWh (2.5c); even the commercial tariff is only YER 70/kWh (8.75c). Thus, the provision of electricity comes with heavy losses, even if all customers pay their bills. Unfortunately, they do not. Collection rates vary by governorate, but typically fall below 50% (see Figure 2). In Aden, it is possible to break down collection by type of payee: large businesses pay almost all their bills, households pay around two-thirds, and government institutions only pay 12%.

**8**  
The free market exchange rate was around YER 800/USD in early August 2021.

Figure 2

### Collection Rates in 2019 and 2020



Source **Public Electricity Corporation (PEC)**

The above system would be completely unsustainable were it not for the support of Saudi Arabia. Since 2018, Saudi Arabia has supported the electricity sector in Yemen through the provision of two fuel grants. In late 2018 and during 2019, Saudi granted the Yemeni electricity sector 190,391 metric tons of diesel and 86,021 metric tons of HFO.<sup>9</sup> In early 2021, Saudi Arabia pledged to support the Yemeni electricity sector with 909,591 tons of diesel and 351,304 tons of HFO.<sup>10</sup> This fuel is being distributed to more than 80 power plants in government-controlled areas.

However, the fuel grant provides only a temporary solution to the electricity problems in IRG-controlled areas. The IRG is therefore attempting to attract investment into new facilities—notably the nearly completed 263MW gas-fired power plant in Aden. It is also seriously contemplating how to reduce reliance on expensive diesel fuel and to encourage greater private sector engagement in the sector to boost supply. One element of this is solar power, where the IRG has issued tenders for utility-scale projects. However, getting investment in such projects is difficult because PEC is not a creditworthy off-taker; therefore, such projects are likely to require a partial risk guarantee by an external party.

At the household level, most people are reluctant to pay the significant cost of a solar home system when subsidized electricity is still available from the public system. Nevertheless, there is significant public anger at the dysfunctionality of the public electricity system, with major protests in Aden and other cities.<sup>11</sup> This also means that, without significant improvements in the quality of service, it is difficult for the government to raise tariffs, making it hard for them to restore the sector to financial sustainability.<sup>12</sup>

## Lessons for Lebanon from the two Yemeni approaches to the electricity crisis

The two Yemeni approaches to the collapse of the electricity sector have two important lessons for Lebanon.

1. *The collapse of the electricity provides an opportunity for radical reform... but it is important to ensure this does not lock in a worse system.*

The complete collapse of electricity in the Houthi-controlled areas of Yemen forced the authority there to accept the unsustainability of the existing system. Subsidies were abolished almost overnight and the sector was, *de facto*, liberalized. But this led to piecemeal solutions that provided a poor-quality service at a very high cost. The attempt to rebuild the public system appears to be creating the kind of local generator mafias with which most Lebanese citizens are painfully familiar. As Lebanon knows to its cost, there is no guarantee that such a system will evolve into an effective public electricity system.

9

In addition to the Saudi grants, the UAE, in September 2019, also granted 127,470 metric tons of diesel.

10

Unlike previous grants, this fuel must be purchased at the Saudi Aramco rate.

11

These protests are also linked to the conflict between the Southern Transitional Council and the IRG over control of southern areas.

12

For more on the challenges of restoring the electricity sector in Yemen, see Almohamadi et al (2021).

*2. External support can (unintentionally) facilitate the continuation of a corrupt and inefficient system.*

The IRG-controlled areas of Yemen persist with a system which can only be sustained through continual external support. Lebanon is all too painfully aware of the perils of years of failing to adjust an unsustainable electricity system. EDL's performance has gradually deteriorated for years, and is now collapsing rapidly. Failing to tackle the utility's financial unsustainability is responsible for more than half of Lebanon's enormous public debts. Its insolvency makes it nearly impossible to improve its performance; but, without improving its performance, it is difficult to raise tariffs in order to avoid bankruptcy.

The challenge for Lebanon is to find a way of recognizing reality without the disaster of complete collapse. Fortunately, there are two, complementary pathways out of its dilemma.

### **Reform 'at the margin'**

Even before the current crisis in Lebanon, EDL could not supply electricity to all areas for 24 hours a day. That is why most people had to rely on expensive private diesel generators to fill the gap. However, in the city of Zahle, citizens obtained 24/7 power from their local utility, EDZ. How did EDZ achieve this remarkable feat? Ahmad et al (2020) describe EDZ's approach as reform 'at the margin.' When EDL was generating power, EDZ simply distributed this to households. However, when EDL went offline, EDZ deployed its own 60MW of generation capacity into the same distribution grid.

Initially, at least, customers were presented with an integrated bill. For the EDL electricity they charged EDL's loss-making tariff; but for their own generation, they were able to charge a much higher tariff rate, enabling EDZ to be profitable overall. This allowed it to invest in maintenance, effective billing and collection, and good customer service (as well as in community and religious activities to build public support), creating a virtuous circle of sustainability. EDZ's model is not perfect, and some elements of the model work against the interests of the rest of the country.<sup>13</sup> But the core idea of the model is sound—a radical decentralization of power to regional private utilities could enable the provision of a professional service and align the incentives of suppliers with the needs of consumers.

But EDZ's model, like EDL has an Achilles heel: It relies on diesel. As fuel subsidies are reduced, even EDZ has had to start rationing power. An effective electricity system cannot simply rest on getting the incentives right—it must also lower the cost of supply.

**13**  
For example, until 2018, EDZ obtained electricity from EDL cheaper than other concessions, enabling it to make a profit at the expense of EDL (see Ahmad et al, 2020, for details).

## Seizing the sun

Diesel is expensive. HFO is expensive. Even gas is expensive if it has to be imported. However, the international price of sunshine is zero and does not depend on what happens to the exchange rate. Lebanon has a superb solar resource. The cost of solar generation in Lebanon is around 5.7c/kWh—far below that of diesel. Ayoub and McCulloch (2021) recently estimated that a solar power plant of similar size to that used by EDZ could save the utility over \$10 million per year. The potential savings from the country as a whole are enormous.

If this is the case, why has Lebanon not gone further in adopting solar and other renewables into its power system? Part of the answer is that it is difficult for EDZ, or even EDL, to enter into long-term contracts with the developers of utility-scale renewable power plants. All developers will require 10-to 20-year Power Purchase Agreements if they are to invest the large amounts of capital needed for such a plant. But EDZ's own contract lasts for two years, and EDL is not a creditworthy offtaker.

There may also be political reasons for the failure to make progress. Politically-connected firms make large profits through their control of the fuel distribution system—an expansion of renewables does not serve their interests. Similarly, a desire to secure rents for particular political factions may be responsible for delays in approving licenses for new utility-scale renewable plants.

Ayoub and McCulloch (2021) argue that there are four things that the government needs to do to avoid Yemen's scattered and individualistic adoption of solar power and ensure the integration of renewables into Lebanon's electricity system:

- Pass the Distributed Renewable Energy Law - to provide a legal basis for renewables development
- Grant renewable generation licenses - to show that the government is serious about facilitating large-scale renewables development
- Facilitate the emergence of private, regional concessions with long-term contracts - to allow reform 'at the margin' to happen, and
- Ensure appropriate tariff regulation across the country - for example, through the long-delayed formation of an independent Electricity Regulatory Authority (Ahmad, Mahmalat and Saghir, 2021).

## Conclusion

The experience of Yemen should be a cautionary tale for Lebanon. Yemen's public electricity system has collapsed, and this has contributed to the untold misery experienced over the last six years by the people of that country. The struggles of the Houthi administration and the IRG to restore the electricity sector show just how hard it is to rebuild a system once it has fallen apart. If Lebanon fails to make radical reforms to its public electricity system, it will collapse entirely, making the current, fragmented, monopolistic, high-cost supply of generator mafias the only source of power.

A better way is possible. The new government must recognize reality and undertake with seriousness the long overdue reforms needed in the sector. If the government is able to put aside factional politics for the benefit of the nation, then the international community may be willing to provide Lebanon with the resources to smooth the transition to a more sustainable energy future. The key blockage to progress is, and always has been, the interests of key elites. But total collapse is in the interest of virtually no one. A new elite-level bargain is needed to move from the current disastrous equilibrium to a better one. If you want to know what will happen if a new approach is not found, talk to someone from Yemen.

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