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Scaling up sustainable energy in Jordan's public buildings

The case for greening schools and hospitals in refugee-hosting countries

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Summary

- Public buildings are on the front line in managing human displacement crises. With the majority of people fleeing conflict and other unliveable conditions finding accommodation in urban and peri-urban areas of developing countries, facilities such as schools and hospitals come under pressure. State resources are increasingly stretched, especially in the context of rising fuel prices. Building upgrades – retrofitting for sustainable energy, water and waste services in particular – can meet multiple local welfare and economic objectives.
- The case of Jordan offers important lessons. The country has accommodated an estimated 1.3 million people from Syria since 2012, and hosts several other refugee communities. Rapid population growth in Jordan has had a significant impact on fuel and energy use, with demand for electricity in domestic and government buildings jumping by 42 per cent between 2011 and 2017. As a result, energy bills doubled for some schools and hospitals in the northern governorates.
- Projects in Jordan have demonstrated that a coordinated, people-centred approach to adapting public buildings to harness solar energy can deliver humanitarian and public service benefits. Buildings are also an obvious starting point to boost energy security and climate resilience, in light of Jordan's high dependence on fuel imports and the country's exposure to climate-related weather extremes. Many other refugee-hosting countries are in a position to benefit through similar projects.
- Retrofitting public buildings at scale also offers multiple long-term economic gains. Existing donor-funded projects in Jordan demonstrate that efficiency measures, including passive solar and solar photovoltaic (PV), can reduce average electricity bills in schools by over 90 per cent. For hospitals, solar water heating can radically reduce fuel use, while a mix of retrofitting measures as well as rooftop and offsite PV can boost power reliability and free up resources for staff and vital equipment.
- There are a number of challenges to the implementation of sustainable energy improvements in Jordan, including a lack of data on wastage and inefficiencies; difficult collaboration between ministries and agencies; poor incentives and provision for maintenance; a lack of transparency in bill payments and savings; and the inability of ministries to borrow funds or, in most cases, to contract the private sector.

- As part of its climate resilience efforts, Jordan has the opportunity to move beyond donor-funded energy strategies, towards a system that incorporates the private sector and other local and national partnerships. Mass retrofitting, weatherproofing and solar applications have the potential to create jobs, improve public services and reduce national utility deficits.
- Jordan's national plans and targets already support investment in sustainable energy in public buildings at scale. The 2023–24 period presents a window of opportunity for relevant government ministries and experts to develop a practical strategy to achieve this. The experience of humanitarian and development partnerships in this area over the last decade could facilitate the right financing, incentive and quality assurance structures necessary for implementation.

01 Introduction

Jordan's experience shows that switching to energy efficient measures in schools and hospitals can improve outcomes for refugees and the communities in which they live.

The provision of healthcare, education and a range of public (mainly municipal) services is a vital aspect of international humanitarian work. However, the increasingly urban nature of displacement crises requires new strategies – more integrated with national development needs – to better address welfare and social cohesion. Facilities such as schools and hospitals offer a way to reach vulnerable people and support local communities. In developing countries, which host the majority of forcibly displaced people, many of these buildings are ageing and in poor repair, affecting the quality of the services they can offer.

The supply of energy and water is a case in point. In many developing refugee-hosting countries, unreliable or expensive access to power and water impedes essential requirements, such as hot water, the safe refrigeration of medicines and healthy room temperatures. Increased demand from new users can put additional strain on services and systems already under pressure. Improved sustainable energy and water access, as well as efficiency in public and community buildings, can therefore help to address the increasing challenge of urban humanitarian crises. Such developments can also bolster climate resilience, by sustainably enabling liveable temperatures and encouraging water conservation and reuse.

Jordan is highly dependent on fuel imports and ranks among the most water scarce countries in the world.[1] The country's recent experiences since the onset of the Syrian refugee crisis, and its efforts to attract aid, for both immediate needs and longer-term resilience, offer some important lessons. This paper looks at the potential gains and learnings from projects that have attempted to scale up sustainable energy use in public buildings.

1 According to the World Resources Institute rankings based on annual average withdrawals as a percentage of available renewable water supplies, Jordan was fifth in 2019, see Hofste, R., Reig, P. and Schleifer, L. (2019), '17 Countries, Home to One-Quarter of the World's Population, Face Extremely High Water Stress', https://www.wri.org/insights/17-countries-home-one-quarter-worlds-population-face-extremely-high-water-stress.

In Jordan, foreign assistance for energy upgrades has benefited schools, clinics, hospitals, ministry buildings and places of worship in the last decade. Some of this has targeted humanitarian needs and energy security objectives. Progress on energy and energy-related applications in Jordan has provided an opportunity to work on short-term relief and longer-term resilience and development, while potentially reducing reliance on foreign aid and debt.

In spite of Jordan having nationwide energy access through its electricity grid, the quality of energy services in many public buildings is suboptimal. This could potentially threaten public health as temperature extremes increase as a result of climate change. Technological fixes are often simple and improve the lives and well-being of both host and displaced populations. However, entry points for potential financiers and implementers are limited, and processes to scale up renewable energy use in public facilities are complicated.

To examine this issue further, the international Renewable Energy for Refugees (RE4R)[2] initiative (2017–22) ran both practical work in Jordan – including solar energy and efficiency upgrades for schools, implemented by the Norwegian Refugee Council (NRC) – and a policy dialogue stream to examine the feasibility of sustainable energy scale-up for hospitals (implemented by Chatham House and the West Asia-North Africa Institute).

The projects demonstrated that the use of solar photovoltaic panels and efficiency applications could reduce normal electricity bills in schools by over 90 per cent.

The projects demonstrated that the use of solar photovoltaic (PV) panels and efficiency applications could reduce normal electricity bills in schools by over 90 per cent. Hospitals could also radically decrease fuel use through solar water heating (passive solar) and solar PV, while improving reliability and safety. Dramatic reductions of electricity bills for hospitals could be achieved via wheeling projects – whereby the units of electricity generated by a renewable energy plant commissioned and owned by the customer in a different location, are subtracted from the customer's bill – as was planned through the German government-funded South Amman project for hospitals (see Table 2).

However, to maximize potential and bring about sustainable improvements, these must be accompanied by other energy efficiency and upgrading measures, which could be implemented through private sector service contracts. This is where partnerships between global or multilateral donors, humanitarian NGOs and local civil society associations with energy expertise could prove especially beneficial.

2 RE4R was a five-year project, led by Practical Action and funded by the IKEA Foundation, to implement renewable energy and efficiency in refugee settings that could demonstrate the potential for market-based scale-up. Chatham House was a partner in this project alongside Energy4Impact and UNHCR. Practical Action (undated), 'Renewable Energy for Refugees (RE4R)', https://practicalaction.org/our-work/projects/re4r.

A critical component in compiling this paper was the Inter-Ministry Committee on Scaling up Energy Efficiency and Renewable Energy for Municipal Buildings. This group included nine Jordanian ministry representatives and several stakeholders from civil society, business and multilateral organizations (listed in Box 1).

This research is based on a dynamic consultation process with the Inter-Ministry Committee, and focus group discussions with the Ministry of Health, two hospitals in Jordan as well as a wider group of financiers and humanitarian actors. The paper makes recommendations on how pioneering renewable energy projects in Jordan might be sustainably expanded, and considers the wider global experience of improving energy access for public buildings.

Box 1. Members of the Inter-Ministry Committee on Scaling up Energy Efficiency and Renewable Energy for Municipal Buildings in Jordan

The Inter-Ministry Committee was established on 27 June 2018 at a policy roundtable, at which all participants agreed on the need for an agenda to scale up sustainable energy for public buildings and greater inter-ministry coordination. Dr Omar Al-Rifa'i, then director of the West Asia-North Africa Institute (WANA), proposed the committee and that WANA host it. The committee met five times following the initial roundtable, both in person and online, not always with the same participants. The following institutions were represented at various meetings over the course of three years:

Jordanian ministries and municipalities:

- Ministry of Education
- Ministry of Energy and Mineral Resources/Jordan Renewable and Energy Efficiency Fund (JREEEF)
- Ministry of Environment
- Ministry of Finance
- Ministry of Health
- Ministry of Municipal Affairs
- Ministry of Planning and International Cooperation
- Ministry of Public Works and Housing
- Ministry of Water and Irrigation/ Water Authority of Jordan
- Greater Amman Municipality

Private sector

- Catalyst Private Equity
- Millennium Energy Industries
- PanMed energy

Civil society

- EDAMA Association for Energy, Water and Environment
- Future Pioneers for Empowering Communities
- Jordan Engineering Association
- Jordan Green Building Council
- King Hussein Foundation
- Princess Alia Foundation
- National Energy Research Council (NERC)

International institutions

- EU Delegation Jordan
- Consultants to the Energy Efficiency in Public Buildings Project (funded by German development bank, KfW)
- Norwegian Refugee Council (NRC)
- United Nations Development Programme (UNDP)

02
The impacts of regional and global turmoil on energy costs

In spite of progressive regulation, which has increased the proportion of renewable energy that supplies Jordan's electricity grid in the last decade, the country is exposed to international fuel import costs that could hike the debts of utilities.

The ongoing conflict in Syria and the resulting influx of Syrian refugees, especially between 2012 and 2015, has had a significant impact on Jordan's energy sector. As of January 2023, there were 661,670 Syrian refugees registered with UNHCR (the UN refugee agency) in Jordan, with 80 per cent residing in host communities and 20 per cent in camps.[3] This rapid growth in population in rural and urban areas has increased pressure on energy infrastructure and demand, especially in the north of the country (the governorates of Mafraq, Irbid, Jerash, Balqa, Madaba and Zarqa). Higher demand for water as a result has also ramped up electricity use, as around 15 per cent of Jordan's electricity goes to treating and pumping water.[4]

3 UNHCR (undated), 'Total registered Syrian refugees', Operational Data Portal, https://data2.unhcr.org/en/situations/syria/location/36 (accessed 12 Feb. 2023). While the number of Syrian refugees registered with UNHCR in Jordan stands at between 650,000 and 700,000 in the last decade, it is estimated that around 1.3 million Syrians have taken refuge in Jordan, including those not registered. Total refugee numbers in Jordan are higher, with over 2.2 million Palestinian refugees and around 90,000 from other countries.
4 Batool, G. (2021), 'Water pumping disrupted in Kingdom due to major power outage', Jordan Times, 22 May 2021, https://jordantimes.com/news/local/water-pumping-disrupted-kingdom-due-major-power-outage.

Vulnerability to international fuel prices and policy responses

For the past two decades, the political situation in the Arab region has also affected Jordan's energy security – limiting and at times stopping the supply of cheap oil from Iraq and gas from Egypt. In 2012, Jordan put in place a policy and regulatory environment conducive to renewable energy. This included a provision for net metering – a billing mechanism that allows consumers who generate their own electricity to use the amount of electricity they produce at any time, instead of only when it is generated – and wheeling. This regulation has enabled Jordan to attract investment in solar and wind power, which accounted for 13 per cent of the country's electricity generation in 2019, up from 0.7 per cent in 2014, and reached around 26 per cent by 2021 (surpassing an earlier target of 10 per cent).[5]

In 2018, imported fossil fuels accounted for around 93 per cent of the total primary energy supply, compared to 96 per cent in 2012.[6] In spite of introducing significant amounts of domestic renewable energy supply and passive solutions since 2012, fuel imports have continued to rise (with a dip in 2020) as Jordan decreased its oil-fired power generation in favour of gas. Gas imports, in particular, are hard to reduce due to long-term contracts, which stipulate that Jordan must pay for the agreed amount of gas even if the country imports less.[7] Coupled with domestic subsidies, this high level of dependence on imported fossil fuels has made the government budget vulnerable to international fuel price rises – such as those in 2014 and 2022.

In response, the government established new regulations and procedures aimed at increasing the revenue of the National Electric Power Company (NEPCO), which holds the largest international debts of the Jordanian state.[8] This began with restructuring electricity tariffs from 2013 to 2017, and introducing an automatic electricity tariff adjustment mechanism (which raised and lowered costs in line with international fuel prices) to better protect NEPCO from fuel price fluctuations. In turn, this raised bills for public services and buildings, including water utilities, which passed on the hike in electricity cost for pumping to consumers.[9] Furthermore, Jordan's Energy Strategy 2020–2030 strongly focuses on increasing indigenous sources of energy.[10]

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5 IRENA (2021), *Renewables Readiness Assessment: The Hashemite Kingdom of Jordan*, International Renewable Energy Agency, Abu Dhabi, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2021/Feb/IRENA_RRA_Jordan_2021.pdf?rev=a119284c631840b0882aa953f6bb0b84; Petra Jordan News Agency (2022), 'Twenty-six percent of Jordan's electricity in 2021 came from renewables', 20 July 2022, https://petra.gov.jo/Include/InnerPage.jsp?ID=43933&lang=en&name=en_news.
6 Ministry of Energy and Mineral Resources, Jordan (MEMR) (2019), *Jordan Energy Balance*, https://www.memr.gov.jo/ebv4.0/root_storage/en/eb_list_page/jordan_energy_balance.pdf.
7 Similar constraints apply to power purchase agreements for Jordan's new domestic shale-oil fired plants.
8 ECP Consult (2018), *NEPCO Restructuring Loan – Jordan: Stakeholder Engagement Plan (SEP)*, https://www.ebrd.com/documents/comms-and-bis/50034-sep.pdf.
9 The high electricity running cost of the Water Authority of Jordan, which has an annual electricity bill of around JOD 350 million ($493 million), was flagged by the Inter-Ministry Committee. In mid-2018, the electricity tariff for water increased sharply from 94 fils/kWh to 140 fils/kWh (a 48 per cent increase) then returned to 94 fils/kWh. Research interview with Inter-Ministry Committee in Jordan.
10 Ministry of Energy and Mineral Resources (2020), *Summary of Jordan Energy Strategy 2020-2030*, https://www.memr.gov.jo/EBV4.0/Root_Storage/EN/EB_Info_Page/StrategyEN2020.pdf.

The need to reduce utility deficits

While tariff reforms have helped stabilize utility deficits, accumulated national debt remains high. By the end of 2022, government debt stood at over 111 per cent of GDP as a result of constraints on business – and therefore lower tax and utilities' revenues – due to the COVID-19 pandemic and higher import bills resulting from Russia's invasion of Ukraine.[11] Government debt includes that which is held by state-owned NEPCO, the Water Authority of Jordan and water distribution companies. In 2021, NEPCO's accumulated losses were JOD 5.13 billion ($7.22 billion), while Water Authority of Jordan debt was estimated to be JOD 2.5 billion ($3.52 billion).[12] The World Bank continues to work closely with the government on electricity sector reforms and investment policy to reduce deficits.

In spite of introducing significant amounts of domestic renewable energy supply and passive solutions since 2012, fuel imports have continued to rise (with a dip in 2020) as Jordan decreased its oil-fired power generation in favour of gas.

Large public buildings are charged at high rates for much of their electricity use, and many facilities are in arrears. Buildings such as hospitals and state schools using more than 500 kilowatt hours (kWh) per month pay more than most commercial entities (see Table 1). Energy bills are substantial. For example, total energy costs for the ministries of education and health were JOD 20.3 million ($28.6 million) and JOD 10 million ($14 million), respectively, in 2018.[13] At the same time, urgent spending is required in many other areas, including on salaries, particularly in view of rising inflation. Furthermore, whereas schools were closed for periods of lockdown since 2020, hospitals faced higher diesel and electricity bills due to increased demand as they continued to provide services during the COVID-19 pandemic.[14]

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11 According to Jordan's Parliamentary Finance Committee's report on the 2023 budget, as reported in Jordan News (2023), 'Public debt interest increased 10% in 2022 to reach JD1.76b', 8 February 2023, https://www.jordannews.jo/Section-109/News/Public-debt-interest-increased-10-in-2022-to-reach-JD1-76b-26894; Asharq Al-Awsat (2022), 'Jordan's Public Debt Increases to $41 Bln', 12 September 2022, https://english.aawsat.com/home/article/3869456/jordan%E2%80%99s-public-debt-increases-41-bln.
12 Jordan Times (2022), 'NEPCO incurred accumulated losses worth JD5.13 billion in 2021 – report', 3 July 2022, https://www.jordantimes.com/news/local/nepco-incurred-accumulated-losses-worth-jd513-billion-2021-%E2%80%94-report; IMF (2023*), Jordan: IMF Country Report No. 23/49*, January 2023, https://www.imf.org/en/Publications/CR/Issues/2023/01/25/Jordan-Fifth-Review-Under-the-Extended-Arrangement-Under-the-Extended-Fund-Facility-and-528616; Dahiyat, I. (2022), 'Sustaining Jordan's Water Sector', commentary, nature middle east, 14 June 2022, https://www.natureasia.com/en/nmiddleeast/article/10.1038/nmiddleeast.2022.31.
13 Figures provided at the RE4R research and Inter-Ministry Committee meetings.
14 Ministry of Health accounts show that water bills at government hospitals totalled over JOD 1.9 million ($2.7 million) in 2019. This does not include health centres – for instance maternal clinics that are often housed separately where the bills may not be easily disaggregated from the rent paid for the facility. This is likely to have risen since 2020, due to the COVID-19 pandemic. Inter-Ministry Committee meetings and information provided by the Ministry of Health, Jordan.

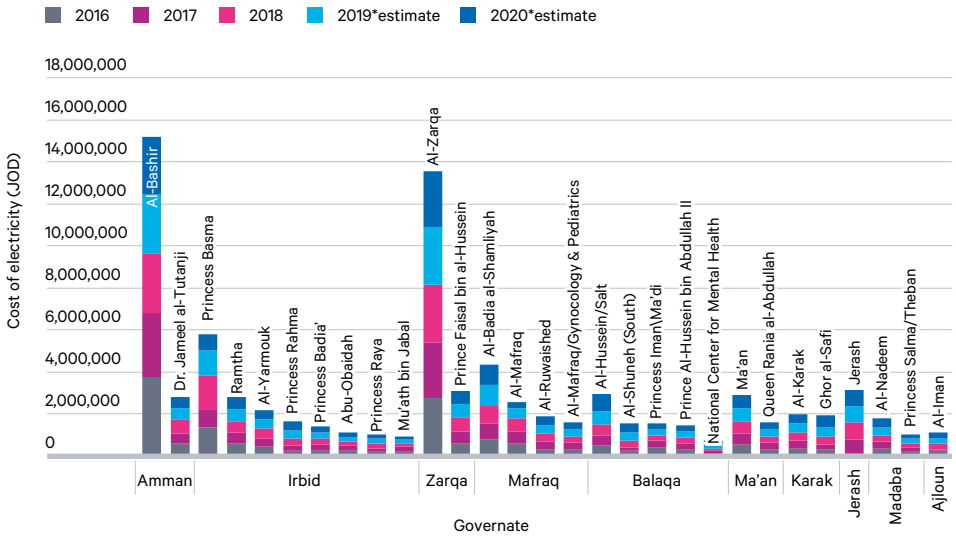
Table 1. Jordan's electricity tariff: Selected consumer comparisons

Public buildings*	**Fils/kWh**	**US cents/kWh**
1st block: from 1–160 kWh/month	42	5.9
2nd block: from 161–300 kWh/month	92	13
3rd block: from 301–500 kWh/month	109	15.4
4th block: from 501–600 kWh/month	145	20.4
5th block: from 601–750 kWh/month	169	23.8
6th block: from 751–1,000 kWh/month	190	26.8
7th block: more than 1,000 kWh/month	256	36.1
Commercial sector buildings		
1st block: from 1–2,000 kWh/month	120	16.9
2nd block: more than 2,000 kWh/month	175	24.6
Flat rate tariff for hotels (fils/kWh)**	91	12.8

* This includes ministry buildings, places of worship, government hospitals, sports clubs and educational facilities.
** Hotels of four stars or more can also choose a day and night tariff, which carries a higher charge for peak load electricity.
Sources: National Electric Power Company (NEPCO) (undated), 'Electricity Tariff in Jordan', https://www.nepco.com.jo/en/electricity_tariff_en.aspx (accessed 22 May 2022); Energy and Minerals Regulatory Commission (EMRC) (2020), *The Electricity Tariff (Arabic)*, https://emrc.gov.jo/EchoBusV3.0/SystemAssets/Electricity_Sector/pdfs/08ad1e0d-f03f-4e52-96f6-2936634dcc9c_guidea_2020.pdf.

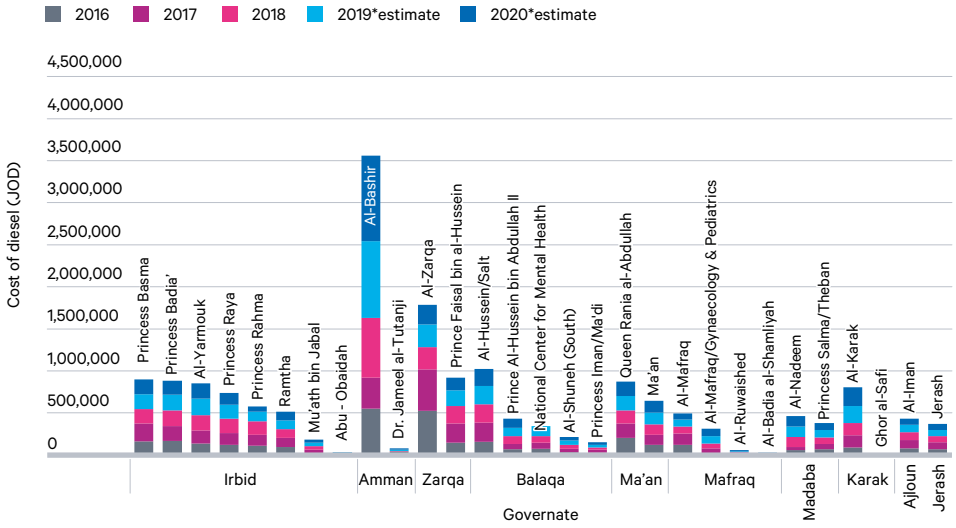
In 2020, 30 hospitals under the Ministry of Health consumed 7.5 million litres of diesel at a cost of almost JOD 4 million ($5.64 million). Figures 1 and 2 show five-year costs for most Ministry of Health hospitals.

Figure 1. Diesel cost for selected Ministry of Health hospitals (2016–20)



Source: Compiled by the authors based on data provided by the Jordanian Ministry of Health.

Figure 2. Electricity cost for selected Ministry of Health hospitals (2016–20)



Source: Compiled by the authors based on data provided by the Jordanian Ministry of Health.
Note: The Ministry of Health only provided electricity data for 29 of the 30 hospitals. Data for governmental hospital electricity costs in 2020 was not fully available during the study period but early figures suggested it was in the region of JOD 17 million ($24 million), diesel and water costs are not yet available beyond 2019.

Population, climate and infrastructure challenges

On top of these challenges, Jordan's population rose by an estimated 58 per cent between 2011 and 2021,[15] and climate change is affecting the seasons and increasing competition for already scarce freshwater. In June 2020, Jordan endured its highest temperature in 90 years, and it experiences high levels of variation in temperature and precipitation between seasons and regions, with freezing temperatures in the north in winter.[16] Flooding and landslides are also hazards in the context of urban build-up with poor drainage and exposed slopes where vegetation has been removed. Climate change is expected to further alter slope and bedrock stability.[17] Jordan's ageing public buildings are not built to weather such extremes and many facilities need structural repair. Improving infrastructure and renewable energy integration is critical to reduce future fuel needs, on both human and fiscal health grounds.

15 Department of Statistics, government of Jordan (2021), *Statistical Yearbook Of Jordan 2021*, http://dosweb.dos.gov.jo/DataBank/Population_Estimares/PopulationEstimates.pdf.
16 For more on the impacts of climate change on Jordan and the Middle East and North Africa region, see, Lahn, G. and Shapland, G. (2022), *Cascading climate risks and options for resilience and adaptation in the Middle East and North Africa*, Cascades report, https://www.cascades.eu/publication/cascading-climate-risks-and-options-for-resilience-and-adaptation-in-the-middle-east-and-north-africa.
17 ThinkHazard! (undated), 'Jordan – Landslide', https://thinkhazard.org/en/report/130-jordan/LS (accessed 5 Oct. 2021).

03
A humanitarian approach to public buildings

Health, education and social facilities provide clear points of entry for humanitarians and donors to support refugee-hosting countries.

When large numbers of refugees or internally displaced people (IDPs) rely on public facilities – including state-run hospitals, clinics, schools, community centres and even prisons – the standards of services are likely to fall for all users unless those institutions obtain more resources.

In some places, where public facilities may suffer from power outages and diesel shortages, such as in Gaza and Lebanon, energy efficiency measures and renewable sources could provide greater reliability of supply. In the case of hospitals, constant access to power is a life-or-death issue. Community services such as schools, places of worship and other support centres may be taking on additional roles in coping with refugee and IDP needs, and would therefore benefit from more reliable electricity in order to extend their hours and provisions.

These public services provide clear points of entry for humanitarians and donors wishing to support refugee-hosting countries. Clinics, hospitals and schools are an obvious focus for humanitarian agencies that prioritize health and education. Improvement of facilities can provide opportunities for greater social cohesion. Donors may be interested in protecting the level of services and support provided by relevant ministries to cope with the increased demand. That said, donors and financiers are increasingly unwilling to support anything that does not have realistic plans to sustainably scale up these services.

Jordan's experience during the refugee crisis

The government created the Jordan Response Plan (JRP) (see Box 2) to tackle the Syrian refugee crisis. The JRP introduced new approaches to support public facilities, particularly in the healthcare and education sectors, in handling increased energy and water demand. Rapid population growth in Jordan, with over a million people seeking refuge from the Syrian conflict since 2012, has had a significant impact on public services; some schools and hospitals in the north of the country have seen their energy (electricity and diesel) bills double in this period. Schools in the northern governorates have had to run two daily teaching sessions, one in the morning for Jordanian children, and one in the afternoon for Syrian children. This put tremendous pressure on already stretched resources in some northern governorates. It led donors as well as humanitarian and development organizations with a strong focus on education to consider how they could help support these schools. This tallied with the Schools Heating Program, which the King of Jordan launched in 2015 with the aim of bringing adequate thermal comfort levels to schools across Jordan. This later became the Schools Heating and Cooling Program (see Table 2).

Box 2. Jordan Response Plan for the Syria Crisis

The JRP is the Jordanian government-led (rolling) strategy formulated with international partners in response to the Syrian crisis; the plan is updated every three years and aims to address the needs and vulnerabilities of Syrian refugees and Jordanian people, communities and institutions affected by the crisis. The plan focuses on providing a comprehensive vulnerability assessment and puts forth a response plan with refugee and resilience components. Each target sector is managed by a taskforce that combines members from local and international humanitarian agencies, led by a government representative. The success of the JRP has helped the government to create partnerships with humanitarian agencies, allowing the country to benefit from their experiences and engage them to achieve the government's plans for each sector. It is the singular national document that guides and provides for international grants for the Syrian crisis. However, the plan has received no more than 50 per cent of the funding it targeted and has suffered from serious shortfalls in the wake of the COVID-19 crisis.[18]

Nevertheless, the JRP has helped encourage progress in the energy space, with its emphasis on resilience projects that serve both refugee and host community needs in line with longer-term development aims in the country. It emphasizes the importance of resilience within hosting communities from the outset and mandates that 30 per cent of support in urban areas should go to the host community and

18 Information shared at Inter-Ministry Committee meetings in 2019 and 2020.

70 per cent to the refugee community. The 2018–20 JRP sought $172 million each year for energy interventions with a focus on 'utilizing RE&EE [renewable energy and energy efficiency] technologies and solutions [in] houses, private and public building[s], including schools and hospitals, as well as to provide adequate, secure and affordable energy to refugees and host communities'.[19] In the latest JRP (2020–22), energy is part of the 'public services' category alongside local governance, municipal services, environment (especially hazardous, including medical, waste management), and transport.[20]

Health facilities were also significantly affected by the influx of Syrian refugees. Between 2011 and 2015, energy demand in hospitals and health centres in the northern and central governorates increased by between 20 per cent and 200 per cent.[21] As a result, the Ministry of Health was forced to look at how to increase efficiency and renewable energy use. A handful of pilot schemes have been conducted – two of which, to the authors' knowledge, had a humanitarian objective. Energy and water efficiency, and solar applications in the health sector are at an earlier stage compared to those in the education sector. However, the efficiency aspects have increased rapidly since 2020 with the German-funded Energy Efficiency in Public Buildings (EEPB) project (see Table 2 and Box 4), which retrofitted 17 hospitals, 23 health centres and one central storage facility.[22]

Health facilities were significantly affected by the influx of Syrian refugees. Between 2011 and 2015, energy demand in hospitals and health centres in the northern and central governorates increased by between 20 per cent and 200 per cent.

19 Ministry of Planning and International Cooperation (2018), *Jordan Response Plan for the Syria Crisis 2018–2020*, www.jrp.gov.jo/Files/JRP2018_2020.pdf.
20 Ministry of Planning and International Cooperation (2021), *Jordan Response Plan for the Syria Crisis 2020–2022*, www.jrp.gov.jo/Files/JRP%202020-2022%20web.pdf.
21 Ministry of Health billing data as provided to the RE4R project.
22 Author's communication with Eng. Ahmed Khamash, GFA Group consultant to the EEPB project.

Table 2. Summary of projects addressing energy needs in Jordan's public buildings

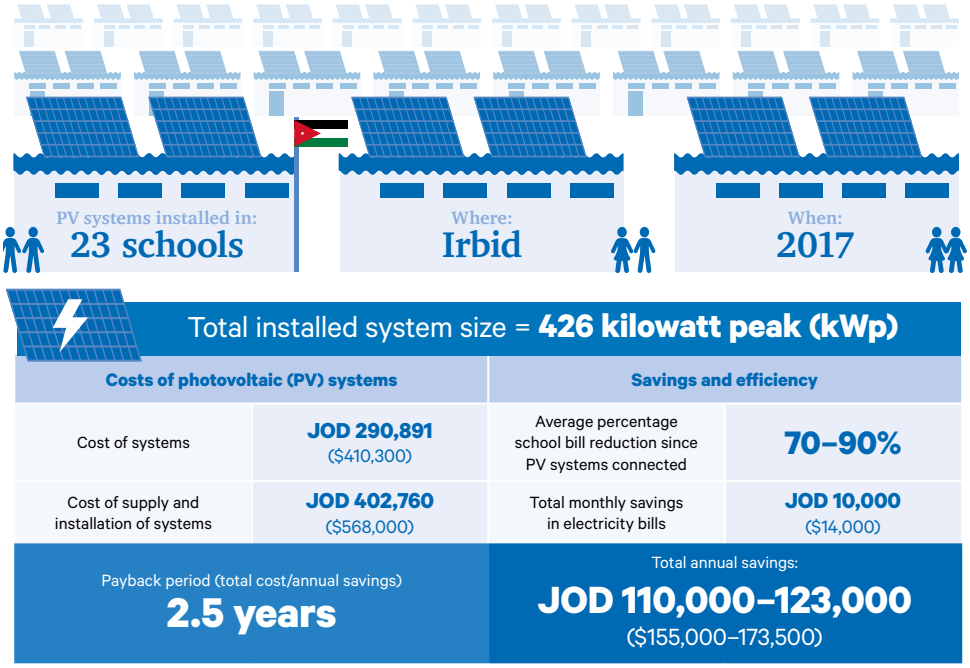
Project	Focus	Partners and funders	Additional details
Schools Heating and Cooling Program (King Abdullah II Initiative) Date: 2015–20 (Phases I and II) 2021– present (Phase III)	Multi-phased project to improve the learning environment and stimulate the green economy. A rolling umbrella programme aiming to upgrade 2,600 schools by 2025. By 2020, it had completed two phases in which 300 schools in the northern governorates had been upgraded. An additional 139 schools were completed by 2022.	Implementers: Jordan Renewable Energy and Energy Efficiency Fund (JREEEF), the National Energy Research Centre at the Royal Scientific Society (NERC/RSS). Includes projects by: Princess Alia Foundation; MercyCorps (eight schools in northern Jordan); Norwegian Refugee Council (NRC); and KfW (a development bank)-Energy Efficiency in Public Buildings (EEPB). Partners: Ministry of Education, NERC/RSS Funders: EU, CoWater (Canada)	There were discussions about completing the project (to reach 2,600 schools in total) through a private–public partnership (PPP) scheme with the European Bank of Reconstruction and Development (EBRD). However, issues pertaining to financing remain unresolved.
Implementation of Replicable Renewable Energy Pilots in Jordan 2016–17	Aimed to support 23 state schools in Irbid affected by the refugee influx, with rooftop PV solar systems to offset electricity demand.	Implementers: NRC Jordan plus private companies Partners: Ministry of Education, Ministry of Energy and Mineral Resources (MEMR) Funder: EU	Provided monitoring equipment; scoping of revolving funds with the Ministry of Education; awareness-raising sessions for pupils and staff on renewable energy; capacity-building for engineers at the assigned local directorate of the Ministry of Education on solar systems installation and maintenance.
RE4R-NRC Solar for Schools programme 2017–22	Humanitarian focus on solar and energy efficiency upgrades for 14 schools in Irbid (as part of a larger project that also retrofitted homes rented to refugees). Also aimed to improve the learning environment.	Implementers: NRC Jordan plus private companies Partners: Ministry of Education, JREEEF, Practical Action Funder: IKEA Foundation through Renewable Energy for Refugees (RE4R), led by Practical Action	Offered capacity-building for Ministry of Education engineers in preparation for regional renewable energy maintenance units; awareness-raising for pupils and staff.
Sustainable Education through Renewable Energy 2017–20	Solar PV and efficient heating and cooling systems for 120 schools. Aimed to improve learning environment and community cohesion.	Lead organization: Princess Alia Foundation Implementers: Future Pioneers for Empowering Communities (FPEC) and Horizons for Green Development Partners: Ministry of Education, JREEEF, NERC/RSS Funder: Government of the Netherlands and Princess Alia Foundation	Training for teachers, students and community leaders in energy rationalization and anti-littering; team-building activities between Syrian and Jordanian students. Jordanians and Syrians trained in installing and maintaining renewable energy systems.

Project	Focus	Partners and funders	Additional details regarding sustainability
Solar for Schools 2018–20	Educational facility improvement for eight schools. Solar PV, air-conditioning units and LED lighting.	Implementers: Mercy Corps with MASE (Modern Arabia for Solar Energy) Partner: NERC/RSS Funder: JREEEF	N/A
Large-scale solar thermal and rooftop PV for Al-Bashir Hospital, Amman 2016–18	To demonstrate the potential of solar applications for hospitals to save diesel and reduce CO_2 emissions.	Implementer: Millennium Energy Industries, supervised by NERC/RSS Partners: Ministry of Health, European Union and Millennium Energy Industries Funding shares: 80 per cent EU grant as part of Renewable Energy and Energy Efficiency Demonstration (REEED); 20 per cent Millennium Energy Industries grant.	Two years of maintenance with remote monitoring equipment operated by Millennium Energy Industries; a further study of 10 hospitals to scope the potential for a large-scale contract.
Solar thermal and rooftop PV, Al-Mafraq General Hospital, Mafraq 2017–18	Humanitarian research and demonstration project. To reduce CO_2 emissions and improve energy services for patients as part of research into humanitarian uses of energy. Boiler upgrade, solar thermal technology, four PV panels.	Implementers: The Moving Energy Initiative (Chatham House, Energy4Impact, Practical Action, UNHCR, NRC) and Millennium Energy Industries Partners: Al-Mafraq General Hospital, The Information and Research Centre, King Hussein Foundation (IRCKHF) Funder: UK DfID	Three years of maintenance; monitoring through the Ministry of Health's central computerized system requested but refused.
EEPB Pilot phase 2015–19	To demonstrate efficiency gains and institutional capacity in two hospitals, one health centre, one school and one Ministry of Public Works and Housing building	Implementers: Ministry of Public Works and Housing and GFA Group Consulting Partners: Ministry of Health, Ministry of Education Funder: KfW	Three-year maintenance warranty by the contractor, one year of direct monitoring by the consultant in order to extract operational and consumption data for feasibility analysis of each installation; training for the ministries' engineers on the operation and sustainability of the installed system.
EEPB scale-up: Retrofit and add solar PV at scale to government buildings 2019–22	Energy sustainability at scale. Project aimed to retrofit 300 buildings. It retrofitted 200 buildings (138 schools under the Ministry of Education; 41 Ministry of Health facilities; 21 Ministry of Public Works and Housing buildings).	Implementers: Ministry of Public Works and Housing and GFA Group Consulting Partners: Ministry of Planning and International Cooperation, Ministry of Finance and Ministry of Health Funder: KfW (90 per cent) and government of Jordan (10 per cent)	The project was designed to generate savings to allow a payback period of less than five years. For long-term sustainability, it aimed to: Establish an energy management unit in the related ministries that will take on the task of managing and sustaining the installed systems. And to use knowledge during the programme period to extend work to cover all the ministries' energy management related issues.

Project	Focus	Partners and funders	Additional details regarding sustainability
South Amman 46MW Solar with 2.6 MWh battery storage. Completed 2022	Humanitarian focus on 33 hospitals and health centres. The Ministry of Health is the main beneficiary, receiving net reductions to bills for hospitals and health centres in seven northern governorates. UNHCR is also able to receive further reductions to offset additional hours of electricity for Zaatari, Azraq, and for the King Abdullah Park (PAK) camps.	Implementer: Belectric Partners: MEMR, KfW, Ministry of Health, UNHCR, UNICEF Funder: KfW	Operational since January 2020. Wheeling agreement signed by the ministries and approved by EMRC end of 2020. Wheeling agreements with UNICEF and UNHCR still to be signed at the time of writing, March 2023.
Strengthening the role of places of worship in the green economy; 15 mosques, three churches February 2015–August 2016	Energy sustainability pilot to demonstrate the technical and economic feasibility of renewable energy and energy efficiency investments, it promoted the 'green worship house' concept and equipped religious leaders with knowledge and understanding of green practices.	Implementer: FPEC Partners: JREEEF, NERC/RSS and the Ministry of Awqaf Funder: EU	Promoted PPPs creating cooperation between the NERC, Ministry of Awqaf and Latin Patriarchate, private energy vendors and related engineering services. This pilot served to inform the JREEEF initiative below.
500 plus mosques in southern Jordan, 2015–present	Renewable energy scale-up	Implementer: JREEEF Partners: NERC/RSS, Ministry of Awqaf Funder: EU through JREEEF/government of Jordan/private lenders	JREEEF supports 25 per cent of the project costs; Ministry of Awqaf supports 25 per cent; places of worship support the remaining 50 per cent with funds and donations from local communities.

Source: Compiled based on research interviews and Inter-Ministry Committee meetings.
Note: Grey shading for projects with a humanitarian focus or component; the Ministry of Awqaf oversees Islamic institutions in Jordan.

Figure 3. An example of savings achieved from solar PV on 23 schools in Irbid



Source: Information provided by NRC (2022).
Note: Kilowatt peak is a measure of the size in kilowatt capacity of a solar system in bright sunshine.

The NRC's 2016–17 Implementation of Replicable Renewable Energy Pilots in Jordan to install solar panels on 23 schools was one of the first of its kind led by a humanitarian organization under the JRP (see Figure 3).

Mosques and churches have also made significant savings as a result of installing solar PV. Following the 2015–16 EU-funded project, led by Future Pioneers for Empowering Communities (FPEC) with the Ministry of Awqaf, all mosque and church committees reported a positive impact on reducing their electricity bills, with renewable energy accounting for between 50 per cent and 100 per cent of the energy used by these buildings (see Box 3). By 2019, places of worship benefiting from solar panels in Jordan had gone from zero to more than 1,000.[23] Growth in this area is due to both awareness-raising by such projects and the fact that these facilities are responsible for their own budgets and bills.

23 Publika (2019), 'Jordanian Mosques harness solar power', 2 January 2022, https://en.publika.md/jordanian-mosques-harness-solar-power_2655033.html.

Box 3. Strengthening the role of places of worship in the green economy[24]

FPEC, in partnership with NERC/RSS, was critical in promoting the benefits of solar to religious institutions. Between 2015 and 2016, FPEC deployed EU funding for its work to install solar PV on places of worship. It consulted with religious leaders and their communities in 12 governorates of Jordan, and installed solar panels on 15 mosques and three churches. Shortly after work began, the Jordanian government set a goal to add PV to all mosques in Jordan.[25]

While religious leaders expressed enthusiasm for the project, there were initially long delays in connecting the panels to the grid (and therefore in enabling net metering) due to the mosques and churches having unpaid electricity bills amounting to thousands of Jordanian dinars. The power distribution companies generally refuse to make a connection until these debts are cleared. After three months, and with an intervention from the Ministry of Awqaf (which oversees Islamic institutions in Jordan) and the Jordan Renewable Energy and Energy Efficiency Fund (JREEEF), the panels were connected on the condition that the debts were paid off in instalments. The private companies that installed the solar systems included two years of maintenance in the agreement. After that period the management committees running the places of worship allocated responsibility for maintenance to other private companies.

All participating buildings reported a reduction in electricity bills, with solar energy providing between 50 per cent and 100 per cent of power needs, depending on the system capacity.

Ownership of the solar panels was immediately transferred to the committees that ran places of worship. The committees were incentivized to continue maintaining the units because they were delivering a direct financial saving to the facility. Several participants later instructed companies to expand the systems as they decided to install air-conditioning units as a result of the new levels of affordability.

In 2019–20, FPEC led another project (Scaling up Knowledge and Awareness of the Renewable Energy and Energy Efficiency in Jordan) to increase awareness of solar power installation options through the EU. However, without the actual promise of the solar panel installation itself, engaging institutions and raising awareness proved extremely difficult.

The tangible benefits of solar systems for these public facilities supports the case for broader, large-scale investment. Most recently, the EEPB programme, which is a partnership between the Ministry of Public Works and Housing and the German development bank KfW, has targeted buildings overseen by the ministries of public works and housing, health and education. EEPB expects to begin paying back the initial investment in just five years.[26] This is the largest attempt yet

24 Based on information provided to the authors by FPEC and JREEEF.
25 O'Keefe, F. (2015), 'Jordan's 6,000 mosques to be sun-powered', green prophet, 2 March 2015, https://www.greenprophet.com/2015/03/jordans-6000-mosques-to-be-sun-powered.
26 Weldali, M. (2020), 'Pioneering project introduces measures to halve electricity bills for public buildings', Jordan Times, 10 March 2020, https://jordantimes.com/news/local/pioneering-project-introduces-measures-halve-electricity-bills-public-buildings.

in Jordan to enable scalable public–private partnerships (PPP). In the long run, the programme aims to introduce energy efficiency as an important aspect to be considered in all procurement, construction and rehabilitation measures as well as in the management and maintenance of public buildings (see Box 3).

Box 4. The Energy Efficiency in Public Buildings project[27]

The Energy Efficiency in Public Buildings (EEPB) project aimed to improve energy efficiency at scale in Jordan's public buildings and reduce the energy bills of the Ministry of Education, Ministry of Health and Ministry of Public Works and Housing – the latter acted as the executive agency for the programme.

The project lasted seven years from its initial planning phase and cost a total of €16.5 million ($18.32 million); KfW provided a loan of €15 million ($16.1 million), and the Jordan government contributed an additional €1.5 million ($1.7 million).[28] The energy saving measures mainly included improvements and replacements of electro/mechanical systems, such as lighting, hot water, heating and air-conditioning systems. The project consisted of a pilot phase and a roll-out phase.

The pilot phase (five buildings) tested the overall project approach. This provided evidence for a proper design of the roll-out phase (200 buildings) and adjustments to the project approach if necessary. The KfW project framework stipulated that the payback time for the total package of the energy saving measures had to be less than five years.

In the long run, the programme's objective was to establish energy efficiency as an important aspect in all procurement, construction and rehabilitation measures, as well as in the operation and maintenance of public buildings. The project introduced energy monitoring processes to measure the impact of its interventions. These provided timely and accurate information and supported knowledge management processes at all levels within the three ministries.

Several other initiatives and plans support this goal, including work on setting up an energy service company (ESCO) to accelerate the development of the energy services market in Jordan,[29] the incorporation of the PPP office into the Ministry of Investment, and the World Bank's ongoing work to assist with the financial sustainability of Jordanian utilities and increased government efficiency.

27 Based on communication with KfW and GFA Consulting Group experts, 2019–2022.
28 Using the exchange rate for euros to US dollars at the end of 2019 (1:1.1107).
29 USAID previously conducted these projects, and there is a current initiative under UNDP.

04 Barriers to scale-up

While the appetite for the use of sustainable energy in public buildings is encouraging, bureaucratic, technical and financial factors threaten wider uptake of these technologies.

The examples in Table 2 show the clear desire for energy efficiency and renewable energy in public facilities, but each of the pilots and projects has faced obstacles and challenges. The Inter-Ministry Committee members, project partners and implementers identified several critical interlinking barriers:

- Ministries are often unable to locate where inefficiencies and wastage occur;
- Difficult collaboration between ministries and agencies, due to the distribution of responsibilities and benefits;
- A lack of transparency in bill payments, as well as uncertainties about where savings could accrue and how they could be used;
- The inability of some ministries to access and manage finance or to contract the private sector;
- The requirement of banks for repayment guarantees in order to provide capital;
- Bureaucratic delays, particularly relating to project approvals, solar connection and maintenance needs, all of which could reduce the value of systems;
- The unwillingness of distribution companies to connect solar PV to the grid when a building has unpaid electricity bills;
- Inconsistent and ad hoc quality assurance criteria for technical applications;
- Difficulty in evaluation of performance and savings over time, due to a lack of system digitization and monitoring;
- Systems falling into disrepair when short-term (2–3 years) project maintenance contracts run out.

Some of these issues are illustrated in the following sections with regard to schools and hospitals. Overall, there are three important considerations for more financially sustainable scale-up of renewable energy: the redistribution of savings; tackling approval delays; and quality control, monitoring and maintenance.

How generated savings are used or redistributed

The Ministry of Finance allocates budgets to government ministries, which are responsible for the costs of utilities. Sometimes, these expenses go unpaid. In these instances, savings on electricity costs resulting from the use of renewable energy would first go to covering existing deficits. As a result, those managing public buildings may feel no tangible benefit of installing solar heating and PV panels. This situation may offer little initial incentive for schools and hospitals to upgrade their energy supplies, and could prevent the development of commercial models that would pay for investments through the savings generated over several years.

As one Jordanian expert put it: 'We know we can reach 100 per cent savings on electricity in schools, but who can make use of the savings? … donors [are] asking for advocacy on this issue.'[30]

Increasingly, donors are scrutinizing how their money is used to reduce aid dependence and stimulate Jordan's economy. For example, in order to finance efficiency measures and renewable energy, funders want to know how savings on electricity bills will lead to one or more of the following objectives: financially sustainable scale-up of energy efficiency and renewable energy, benefits for vulnerable people (e.g. for improved health and education outcomes), the possibility for the institution in question to enhance its infrastructure, or reduced national utility debt.

Increasingly, donors are scrutinizing how their money is used to reduce aid dependence and stimulate Jordan's economy.

There are precedents for effective use of renewable technology that offer potential solutions to incentivize those in charge of public buildings. The use of renewable energy and energy efficiency measures in mosques and churches (see Box 3) demonstrates that it is possible to encourage organic scale-up when building managers are in charge of the payment of electricity bills. These managers have an incentive to make savings, which they can allocate elsewhere, such as repaying other existing debts. This case also shows that it is possible to overcome the problem of unpaid electricity bills through coordination between government agencies. The innovative South Amman solar PV project, which was designed

30 Participant comment at expert roundtable on Scaling up Sustainable Energy for Public Buildings in Jordan, as part of the Moving Energy Initiative, held by WANA Institute and Chatham House at King Hussein Club, Amman, Jordan, 27 June 2018.

to reduce bills for Ministry of Health hospitals and humanitarian agencies, provides a template – to be tested – for how savings might be redistributed (see Table 2 and Chapter 6).

Approval delays for grid connection

Jordan's net metering regulations allow solar PV to contribute to bill savings by generating electricity that is fed into the national grid. However, approvals for connecting newly installed PV projects to the electricity grid can take time and reduce the overall value of such installations. For example, while panels were installed in October 2018 at Al-Mafraq Hospital, it took a further five months to connect them to the grid. The electricity distribution companies are responsible for connections, and have a number of requirements that must be met before they approve the connection, including grid-impact studies.

> You cannot connect if the total load [from solar] is more than 15 per cent of what is going through the local transformer [the feeder]. The installation could cover 100 per cent of demand for a building as long as [the load going through] the feeder in my neighbourhood does not [exceed] 15 per cent.
> **Participant, Inter-Ministry Committee, 14 March 2019.**

Approvals for grid connection face several conditions, most importantly the distribution companies will often demand that entities repay debts owed to electricity distribution companies before transitioning to a renewable energy system (although the rule is not hard and fast, and it can be overcome with government intervention as shown in Box 3). In the case of Jordan's drive to install PV on public buildings, if the targeted buildings have accumulated energy debts, investments for the upgrades are unlikely to be forthcoming. In an Inter-Ministry Committee meeting in 2019, it was pointed out that many solar panels installed on schools were not yet connected because the Ministry of Education had not paid outstanding bills. The same is true for some health facilities.

Quality control, monitoring and maintenance

The value of projects will be lost if equipment is low quality, poorly installed or if responsibility for maintenance is not delegated and resourced. Accountability is a frequent problem in public building projects.

As of 2019, new legislation meant that all renewable energy applications of over 20MW must be approved by the Jordan Engineering Association (JEA). This was a welcome development for ensuring standards. However, quality control checks for other elements of efficiency and energy services are still lacking. In the past, problems have occurred when renewable energy applications were performed and overseen by unqualified persons. New laws and regulations now mean that design and supervision must be separated from procurement and implementation to remove any conflict of interest. The Energy and Minerals Regulatory Commission (EMRC) approves licences for specific renewable energy projects. The developer must be a company registered with the JEA, which audits the blueprints and calculations as well as the buildings themselves. The main goal

is to have integrated, workable projects that combine efficiency aspects such as thermal insulation. The JEA is also working on the digitization of auditing, which is now compulsory to increase efficiency and effectiveness.[31] There has been little time to test this arrangement as the government temporarily suspended approvals for new renewable energy projects of over 1MW between 2019 and mid-2022, due to insufficient grid capacity, and the combination of high contracted thermal power costs and lower than expected demand – which meant the utilities were making a loss – partly due to the uptake of renewable energy in the commercial sector.[32]

Careful planning and coordination between public facilities and ministries is vital. Lack of coordination between the Ministry of Education and schools has previously hindered monitoring. For example, as part of the first project installing solar panels on schools in Jordan, in 2016–17, NRC provided schools with computer equipment to monitor the installation and send information directly to the ministry. However, when the ministry changed its IP address the monitoring was disrupted.[33]

Unlike the Al-Bashir Hospital solar project, the Al-Mafraq Hospital project did not include the option of a remote monitoring system as this function was to be carried out through the main Ministry of Health IT system, *Hakeem*. This was intended to reduce costs and to better integrate the project within the Ministry of Health system. However, the Ministry of Health did not grant the private installation company, Millennium Energy Industries, access to its system, which limited responses to faults during the maintenance warranty period. In February 2019, the project was once again disrupted when the Ministry of Health asked the installers to remove the solar water heating system in order to undertake roof repairs (the responsibility of the Ministry of Public Works and Housing). The repairs to the roof were not completed until 2021, which significantly impacted the use of the system and its value. In October 2021, with work completed, the hospital's own maintenance team reinstalled the solar system and it is now reported to be fully operational albeit without remote monitoring.[34]

Both Al-Bashir and Al-Mafraq hospitals should be generating useful data on actual diesel savings from use of the solar water heating systems. However, in Al-Mafraq's case, the hospital operations and maintenance (O&M) team did not reconnect the control system properly and, at the time of writing, the Al-Bashir Hospital system is not recording savings after the O&M team adjusted system settings.

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31 Inter-Ministry Committee meeting, King Hussein Club, Amman, 14 March 2019.
32 Bellini, E. (2019), 'Jordan suspends renewables auctions, new licenses for projects over 1 MW', PV Magazine, 29 January 2019, https://www.pv-magazine.com/2019/01/28/jordan-suspends-renewables-auctions-new-licenses-for-projects-over-1-mw.
33 Inter-Ministry Committee meeting, King Hussein Club, Amman, 2 October 2019.
34 Email communication with Eng. Hisham Mikhi, Millennium Energy Industries, 2019–22.

05 Humanitarian activities in Jordan's schools

Successful humanitarian action requires collaboration with experienced civil society organizations and businesses, as well as alignment with existing national plans and close consultation.

Renewable energy is a relatively new area for humanitarian action in Jordan that has emerged as a priority of the JRP since 2014. Jordan has received well over one million Syrians in the last 10 years. Refugees now account for over a quarter of Jordan's population, made up of 670,000 registered Syrian refugees, around 2.3 million Palestinian refugees and 90,000 refugees from other countries.[35] Jordan is at the forefront of a movement to use humanitarian funding as a way of contributing to both refugee welfare and the long-term resilience of host countries. Energy is a priority in the residential sector, as the additional population has increased the cost of providing much needed electricity and cooking fuel. Buildings such as schools, hospitals and places of worship serve mixed national and refugee communities, and these places have become a natural focus for both humanitarian and development efforts.

35 UNHCR (2022), 'Jordan issues record number of work permits to Syrian refugees', press release, 25 January 2022, https://www.unhcr.org/uk/news/press/2022/1/61effaa54/jordan-issues-record-number-work-permits-syrian-refugees.html; UNRWA (undated), 'Where We Work: Jordan', www.unrwa.org/where-we-work/jordan (accessed 28 Aug. 2022); UNHCR (2022), 'Total Registered Syrian Refugees'; Jordan's official estimated population as of 2021 was just over 11 million according to Department of Statistics, government of Jordan (2021), *Statistical Year Book Of Jordan 2021*.

As shown in Table 2, several national energy-related initiatives received support on humanitarian grounds, and these provide a solid basis for broader implementation and future scale-up. These projects chiefly focused on schools under the umbrella of the Schools Heating and Cooling Program. The more recent RE4R-NRC Solar for Schools programme has produced a model that could be replicated and adapted to humanitarian education programmes in similar refugee-hosting countries. It could also be applied to hospitals and health centres as well as courts and prisons. There are several important lessons learned from the Solar for Schools programme, which are outlined in this chapter.

Buildings such as schools, hospitals and places of worship serve mixed national and refugee communities, and these places have become a natural focus for both humanitarian and development efforts.

The RE4R-NRC Solar for Schools programme helped NRC to upgrade its existing activities within the education system and enhance the physical condition of living or learning spaces, which in turn had a direct positive impact on the lives of end-users – both Jordanians and Syrians. From a national perspective, this was in line with government strategies that focused on lowering the energy bills of public buildings such as schools, increasing the usage of renewable energy systems and lowering carbon emissions.

Lessons learned

The need for flexibility in response to setbacks

Table 3 shows the timeline for the RE4R-NRC Solar for Schools programme. It illustrates the kind of unexpected delays that can occur. In the case of this programme, COVID-19-related regulations and a teachers' strike forced schools to close and delayed some of the training and communication activities.

The timeline also shows that delays can occur where planned aspects are dependent on external entities and resources – as happened with the Ministry of Education renewable energy and energy efficiency unit, which was set up in May 2018 but did not become operational until two years later, due to a lack of funds and management capacity. As with all projects, it also took a few months to obtain the necessary grid capacity assessments and approvals from the distribution company.[36] NRC's previous experience with solar projects helped to speed up its progress with approvals.

36 The installation could cover 100 per cent of demand for a building as long as the transformer in the neighbourhood is not receiving over 15 per cent from renewable sources in total.

Table 3. Timeline of RE4R-NRC Solar for Schools interventions

Q1–2 2018	NRC holds initial consultations and focus group discussions with parent–teacher association and Ministry of Education directorates. JREEEF, Princess Alia Foundation and other partners with experience in energy upgrades for schools contribute lessons learned and inform project planning. The Ministry of Education establishes the renewable energy and energy efficiency unit in May 2018 under the buildings department of the Ministry of Education directorate in Amman.
Q2 2018	Results of focus group discussions inform the technical assessment and financial analysis; this and subsequent planning is conducted in coordination with the JEA for structural validation and safety. Request for project approval submitted to the Ministry of Planning and International Cooperation (April 2018).
Q4 2018	Final project approvals received from Ministry of Planning and International Cooperation (October 2018).
Q1 2019	Tender announced for the efficiency upgrade works.
Q2 2019	Contractor conducts energy audits for school rehabilitation and energy efficiency upgrades.
	Tender announced for school rehabilitation and energy efficiency upgrades (April 2019).
Q3 2019	Out of 20 applicants for the rehabilitation and energy efficiency upgrades, two are selected. The process takes four months – an extra two months than the total planned – due to NRC's procurement procedures and required financial and technical validation.[37] The contractor's technical proposal is revised in line with recommendations from the JEA.
	School rehabilitation and energy efficiency upgrade contracts signed in June 2019.
Q3–4 2019	Training teachers in energy conservation, renewable energy, environmental protection and water protection to enable them to deliver the relevant lessons to students of different ages and classes. Delays due to the teachers' strike, which lasts for a month (Sep–Oct 2019).
	Solar PV contractor selected, and contract signed (December 2019).
Q1 2020	Solar PV contractor applies to Irbid Distribution Electricity Company (IDECO) for approval of plans for connection to the grid for 14 schools.
	NRC coordinates with the Ministry of Education renewable energy and energy efficiency unit. This becomes functional in March 2020.
Q2 2020	COVID-19 causes the government of Jordan to announce restrictions on people's movement in March 2020 in the name of public safety, including the closure of schools, commercial markets, companies, banks and public facilities; a curfew; and movement restrictions between the governorates. In June 2020, government ends the restriction of movement between governorates and the general curfew.
Q3 2020	NRC and the contractor receive approvals for PV plans and connection from IDECO for 12 schools (two are rejected) and the Ministry of Education begins implementation in July. NRC applies instead to install solar PV on two schools in Mafraq. The construction team continues to do regular check-ups on several schools. As new extension works expanding classrooms and water, sanitation and hygiene (WASH) blocks increases the electricity consumption for three schools in Irbid, efficiency of the PV systems is reduced. NRC applies to IDECO to increase capacity of the existing PV system in these three schools in Irbid.
	IDECO rejects NRC's application for increased capacity size of two of the three Irbid schools (September 2020). NRC applies to increase the size of systems for the two schools in Mafraq instead.
Q4 2020	Contract amendment to complete work on the two additional schools (November 2020).
Q1 2021	IDECO approval received for the increase in capacity size of systems for the two schools in Mafraq. Final commissioning of efficiency measures completed. Final installation of all 14 PV systems in Irbid and Mafraq completed and all systems tested and connected to the grid by IDECO. Systems officially handed over to the relevant Ministry of Education directorate, with warranties included for the different system components (structure, PV cells and inverter).

Source: Information provided by NRC Jordan.

37 NRC logistics guidelines indicate that each tender will have a 'tender evaluation', which consists of separate technical and financial evaluations (split, technical: 60 per cent or 70 per cent; financial: 40 per cent or 30 per cent) depending on the project and tender budget. The tender is evaluated by a committee that consists of representatives from technical, finance and logistics teams, the committee works together to prepare evaluations, selection criteria and to take final decisions. Information provided by NRC Jordan, 2021.

The importance of user engagement and consultations

In order to deliver a service that meets the needs of end users, NRC consulted students, principals and parents to understand their vision for the upgrades and assess their knowledge of efficient and sustainable design. The team conducted focus group discussions at each school through parent–teacher associations. Building problems, such as draughts and leaks, were commonly cited as affecting standards and stress levels within the school. Repairing these issues prior to solar installation is important from a safety and efficiency perspective.

> We have been requesting the directorate to fix the roof that was leaking in a small part of the class, but due to delays the whole ceiling was damaged. It has been over a year now and they have yet to announce a tender since the fixings are costly and a committee from different ministries must give approval.
> **A principal in Jerash, Q4, 2018, quoted from NRC internal reporting**

The NRC team compiled the findings of the focus group discussions and interviews. The team used this information to shape new energy interventions and to develop technical assessments for public schools. Early engagement with users paid off. Despite the initial low level of support from the Ministry of Education directorates at the time of project completion, schools and students continued to show strong interest in these interventions.

Collaborating with civil society and planning for long-term sustainability

JREEEF, the Princess Alia Foundation and others worked closely with NRC and shared lessons learned. The NRC team interviewed engineers – from the buildings department at each Ministry of Education directorate and the technical department in Amman – to map knowledge gaps and brainstorm solutions and capacity-building mechanisms. This enabled NRC to prepare appropriate training for the engineers in the renewable energy and energy efficiency unit. The JEA's coordination with the NRC school construction team was also critical for the initial assessment, tender designs and ongoing supervision visits during the implementation phase.

It is too early to judge the long-term sustainability of the Solar for Schools programme, but the project made several provisions for its future upkeep. Building managers were trained in basic maintenance, and the schools tried to keep the system as clean as possible. The schools were also keen to attract financial and technical support from donors and organizations for regular maintenance and operations. NRC handed over the systems to the relevant Ministry of Education directorates in 2021, and shared the list of schools with a technical briefing for JREEEF in order to help them upscale action and build on existing infrastructure. This has enabled JREEEF to select schools with solar systems for heating and cooling unit installation, as part of the Schools Heating and Cooling Program expansion, and to increase the PV system size where necessary.

Sufficient time is needed to assess savings

Energy audits like the one shown in Table 4 informed tailored approaches for each school. Efficiency measures were chosen on the basis of greatest improvements in thermal comfort and bill savings. Based on the audit findings, these measures focused on:

- Electrical maintenance including replacing lighting with LED bulbs;
- Enhanced insulation where needed including window maintenance and double-glazed replacements, door maintenance and replacements, and roof insulation;
- Block works – erecting walls and closing openings;
- Humidity resistance painting; and
- Mechanical works mainly in WASH facilities; and introducing water-saving features to bathrooms.

The table below presents a sample of the audit results for savings to be generated through efficiency measures at one school.

Table 4. Khawla bin Al-Azwar mixed primary school energy efficiency audit results

Recommended measure	Energy saving (kWh/year)	Monetary saving (JOD/year)	Estimated cost (JOD)	Simple payback period (years)	Lifespan of energy efficiency upgrades (years)	Net present value (JOD)	Internal rate of return (%)	% of savings from total energy
Turn off plug loads when not in use	1,326.60	331.65 ($467.63)	N/A	Immediate	N/A	N/A	N/A	2.9
Improve student awareness about energy efficiency	1,008.67	252.17 ($355.56)	N/A	Immediate	N/A	N/A	N/A	2.2
Retrofit lighting	6,382.99	1,595.75 ($2,250)	618.75 ($872)	0.39	8	8,753.45 ($12,342)	261	13.95
Install a solar thermal system instead of an electric water heater	1,247.40	311.85 ($439.71)	700 ($987)	2.24	20	2,889.45 ($4,074)	48	2.73
Install A/C units instead of electric heaters inside nursery	645.15	161.29 ($227.42)	400 ($564)	2.48	10	757.17 ($1,068)	42	1.41
Retrofit A/C unit	2,141.49	535.37 ($754.87)	1,460 ($2,059)	2.73	10	2,390.87 ($3,371)	38	4.68
	Total			**Average time**				
	12,752.3 (kWh/year)	3,188.08 ($4,496.59)	3,178.75 ($4,483.43)	1.96 (year)	12 (year)			

Source: Unpublished NRC Jordan RE4R project evaluation, 2020.
Note: Net present value is a method for evaluating and comparing capital projects or financial products with cash flows spread over time, as in loans, investments, pay-outs from insurance contracts plus many other applications, accounts for the time value of money; internal rate of return is an estimate of the expected future annual rate of return; % of savings from total energy is the percentage of saved energy after applying energy efficiency upgrades.

Based on previous measures, Khawla bin Al-Azwar school's total energy consumption is 33,218 kWh/year at a cost of around JOD 4,764.4 ($6,719.88). According to the audit, energy efficiency upgrades would enable the school to cover 38 per cent of its annual energy consumption, and coupled with the solar PV system installation, it can expect total savings of around 80 per cent.[38]

An internal NRC assessment of electricity bills shows that all the schools that took part in the Solar for Schools project benefitted from savings of at least 80 per cent. However, the COVID-19 lockdown period is a factor in these figures. Due to the COVID-19 pandemic, schools were not fully staffed or occupied during this time. The assessment shows figures comparable with savings generated by earlier solar schools projects but more time will be needed for a comprehensive evaluation.

Like other projects under the nationwide Schools Heating and Cooling Program, the RE4R-NRC Solar for Schools programme sought not only to reduce bills but also to improve the learning environment for teachers and students by enhancing thermal comfort levels in the classroom. Given the feedback from consultations, it also aimed to improve safety and security measures.

The most common response to improvements expressed in the RE4R-NRC schools focus groups was that the upgraded facilities helped to create a conducive learning environment. This included bathroom and classroom upgrades as well as sealing cracks and repairing broken windows. Students commented that the school looked 'cleaner and brighter', which encouraged them to attend and learn. Principals and teachers felt more comfortable in the delivery of lessons.

> In wintertime, we used to hear the wind […] shaking the windows, we even could feel the air leaking from the windows, […] NRC repaired the windows, […] which improved the learning environment for the students and [it] feels safer.
> **Quote from one of the teachers, NRC consultation 2020**

> I used to receive warnings from the directorate when the monthly bill reached JOD 1,000 or above, and it affects my annual evaluation as a principal, comparing the electricity costs after the PV system was installed to the same period last year, over half of the consumption is covered and the bill is lower than JOD 400, it's a great thing for a school hosting over 500 students and running double shifts, operating for nine hours for six days a week.
> **Quote from one of the principals, NRC consultation 2020**

38 NRC Jordan RE4R project evaluation, unpublished, 2020.

06 Opportunities for upgrading hospitals

Renewable energy can contribute to the achievement of national healthcare priorities for both citizens and refugees. Hospital staff are in a good position to feed into the design of green improvement programmes.

Energy use in Jordan's hospitals

There is untapped potential for energy savings in Jordan's hospitals. Between 2015 and 2020, total electricity and diesal costs for government hospitals reached JOD 85.8 million ($120 million) and JOD 18 million ($25 million), respectively (see figures 1 and 2).

Across Jordan, the Ministry of Health oversees 30 hospitals and 736 healthcare centres.[39] Other government hospitals come under the authority of the Ministry of Defence (15 military hospitals) and the Ministry of Higher Education (two university hospitals). Ten hospitals and 13 medical centres are overseen by the Royal Medical Services. Beyond that number there are 69, mainly smaller, private hospitals,[40] several of which have adopted solar PV, passive solar and efficiency solutions. This chapter focuses on the potential savings on electricity and fuel bills in the hospitals administered by the Ministry of Health. These facilities provide

39 Figures for hospitals as listed on the Ministry of Health website, Ministry of Health (undated), 'Hospitals', https://moh.gov.jo/EN/List/Hospitals (accessed 23 May 2022). However, in Inter-Ministry Committee meetings, 32 was the figure given.
40 Private Hospitals Association Jordan (undated), 'An Overview of the Jordanian Health Sector', https://phajordan.org/EN-article-3809- (accessed 23 May 2022).

over one-third of hospital beds in the country and serve some of the poorest communities, including the majority of the refugee population.

The Ministry of Health is responsible for electricity, water bills and fuel for generators in all its hospitals and ministry buildings. The Hospital Expenditure Department within the Ministry of Health oversees the payment of electricity bills. The department's spending processes are monitored through the governmental financial management information system, which is directly linked to the Ministry of Finance. The Ministry of Health's annual budget in 2018 was around JOD 550–650 million ($776–917 million), but if the Jordanian government's total expenditure on health is accounted for, then that figure is closer to JOD 1 billion ($1.41 billion). Around JOD 25.5 million ($36 million) was spent on energy – JOD 20 million ($28 million) for electricity use in hospitals, JOD 2 million ($2.82 million) for ministry buildings, and about JOD 3.5 million ($4.93 million) was spent on fuel.[41]

More critical than the costs themselves, inadequate energy provision is having negative impacts on healthcare services.

> Before the solar water heating project, [Al-Bashir hospital] was paying more than JOD 1 million [$1.41 million] every year for fuel [for heating water]. It turned to gas but this became even more expensive. Sometimes eight boilers were out of action and [the hospital] could not get spare parts fast enough […] it can be very cold.
> **Participant, Inter-Ministry Committee, King Hussein Club, 14 March 2019.**

Studies in 2017 for the Moving Energy Initiative showed that in Al-Mafraq Hospital hot water was turned off in the summer months because diesel costs were too high – as a result, patients' families sometimes brought in small gas stoves to heat water in rooms.[42] In Ramtha and Jerash hospitals, power outages caused staff to revert to manual data entry and the temporary loss of patient data while the IT system was down. This increased the potential for errors to occur in the treatment of patients. Hospital officials therefore have an incentive to adopt new energy plans, but several issues at the ministerial and national levels complicate the process.

JREEEF has implemented a project that provides PV solar cells, air-conditioning systems and energy-saving lighting for several medical centres where most patients are women, for example, in Al-Ghor where temperatures reach over 40°C in summer. The work is being carried out on a 100 per cent grant basis and is implemented in cooperation with the Ministry of Health. By the end of 2020, the programme had completed five health centres in Ajloun and Deir Alla with support from the Canadian Sustainable Energy and Economic Development (SEED) project. The initiative aimed to cover a further 17 health centres by the end of 2022.[43]

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41 Information provided through Inter-Ministry Committee discussions and communication with the Ministry of Health, 2020.
42 The Moving Energy Initiative was a four-year UKAid-funded project running from 2015 to 2018 aimed at changing the way that energy was delivered in humanitarian situations towards greater access and sustainability. It was led by Energy for Impact, Chatham House and Practical Action. NRC and UNHCR were supporting partners, Chatham House (undated), 'Moving Energy Initiative: Sustainable Energy for Refugees and Displaced People', Environment and Society Programme, movingenergy.earth.
43 Information provided by email communication with Eng. Ahmad Bassam and Eng. Lina Al-Mubaideen at JREEEF, May 2022 and August 2022. See also JREEEF (2021), 'JREEEF Milestones', presentation for United Nations Economic and Social Commission for Western Asia – ESCWA, https://www.unescwa.org/sites/default/files/event/materials/1.5%20-%20Mr.%20Rasmi%20Hamze%20-%20JREEEF%20Milestones.pdf.

Potential savings and the possibility of bundling

Research on 11 military hospitals conducted by the Institute for Sustainable Technologies (AEE INTEC), alongside Millennium Energy Industries, shows that solar water heating could reduce the demand for diesel by 756,100 litres each year. This has the potential to save approximately JOD 620,000 ($870,000) per year, based on the January 2023 diesel price.[44] In these circumstances, solar water heating systems would have an average payback period of three to four years.[45]

Furthermore, a detailed study of hospitals under government control showed that solar water heating and the option of PV panels could significantly bring down energy costs. For example, the research modelled the installation of solar thermal water heating systems at Jordan University Hospital, which serves more than 500,000 people in the outpatient clinics and some 94,000 emergency cases each year. These solar systems were projected to provide all energy demand for water heating from April to October, with diesel supplementing the solar system during the winter. The return on investment over a 25-year period was estimated at over JOD 1.6 million ($2.26 million) at an average diesel price of 0.605 JOD per litre ($0.85 per litre) with a payback period of just over three years.[46]

Research on 11 military hospitals shows that solar water heating could reduce the demand for diesel by 756,100 litres each year. This has the potential to save approximately JOD 620,000 ($870,000) per year.

Such studies show the immense potential of relatively simple applications that require basic cleaning and little maintenance over their lifetimes. In addition, there remains the opportunity to bundle together a number of hospitals and medical centres for tenders to reduce transaction costs, with a repayment schedule based on projected savings.

Focus groups conducted with representatives from the Ministry of Health and two government hospitals, as part of the RE4R research that informed this paper, demonstrated the value of consultation. They showed strong interest among hospital staff and managers in energy and environmental improvement.

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44 Jordan Times (2022), 'Fuel prices see drop in January', 31 December, https://jordantimes.com/news/local/fuel-prices-see-drop-january.
45 Information provided by email by Eng. Hisham Mikhi of Millennium Energy Industries on 'Solar Potential: Government Hospitals', unpublished.
46 Millennium Energy Industries (2019), 'Solar System Proposal: Hot Water Supply for Jordan University Hospital', 26 September 2019, unpublished.

The view from the Ministry of Health

During a meeting between the authors and Ministry of Health representatives, senior officials strongly expressed their concern that the lack of alignment between national policies, utilities' incentives and ministry-level strategies may hinder future projects. One official said, 'hospitals face high levels of debt to the [district electricity] transmission companies, this negatively affects our willingness to adopt [renewable energy] projects'.

Individual hospital debt may complicate future energy ventures. Of the different public buildings involved in the KfW pilot project, hospitals had the highest levels of debt with one owing as much as JOD 620,000 ($439,580).[47] Negotiating repayment of these debts caused six- to nine-month delays in connecting solar PV to the grid and, as a result, these hospitals lost the opportunity to benefit from net metering immediately after installation. However, all issues were eventually resolved. Referring to such problems, officials stated the need for unified national energy strategies between the different ministries.

> Complementarity in strategies and action plans can grant better performance. In the Jordanian situation, national plans can have different priorities. This will hinder any potential future renewable energy initiatives.
> **Focus group participant, Ministry of Health, 15 September 2019**

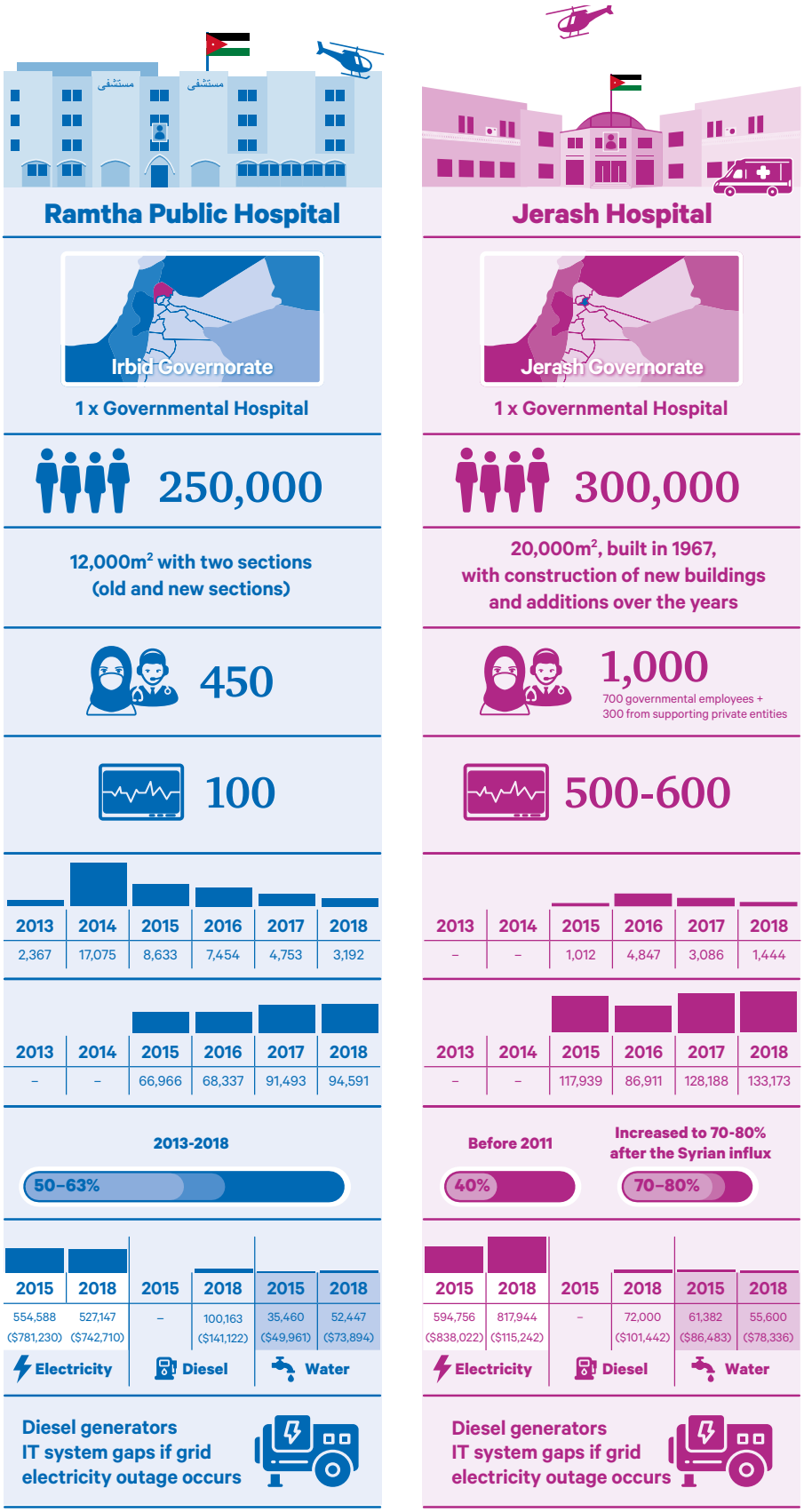
Policy and strategy complementarity is not the only challenge. Focus group participants at the Ministry of Health admitted that some behaviours in its buildings and hospitals led to significant energy waste, such as running heating and cooling systems while windows are open, or keeping the lights on when rooms or clinics are not in use. A higher, reformed electricity tariff should provide the right incentive for efficiency and solar deployment. However, access to capital, management of contracts and debt repayment remain challenging.

Hospitals themselves lack the capacity to adopt energy efficiency measures or to invest in efficient equipment or training. Spending and accounting are highly centralized. All expenditure is approved by the hospital, then sent to the Ministry of Health for payment using their allocated fuel and electricity budget. According to the Ministry of Health, the yearly budget is set by all ministry departments, in which each department head formulates budget needs, while the head of the expenditure department sets the electricity, fuel and water budget lines. Then, the budget is approved by the health minister for ratification by the Ministry of Finance and approved by the Jordanian parliament.

Based on Ministry of Health recommendations and data analysis, the Ramtha public hospital (Irbid governorate) and Jerash government hospital (Jerash governorate) were central to the RE4R focus group research that feeds into this paper. They both have high energy bills and high occupation rates; the refugee influx has tested the hospitals' responsiveness. Figure 4 demonstrates the different characteristics of each hospital.

47 Email communication with KfW.

Figure 4. Ramtha and Jerash hospital profiles



Source: RE4R Project research, 2019.

Hospital focus group findings

Ramtha and Jerash hospital focus groups contributed to RE4R project research through discussions of four key themes including energy use, energy waste, renewable energy audits or tenders, and energy awareness and capacity-building. The discussions assessed the acceptance and willingness of hospital staff to transition to a sustainable energy system. While the hospital is not responsible for paying the electricity and fuel bills, both staff and management expressed a strong interest in energy conservation and sustainable energy projects that contribute to better and efficient healthcare. Ramtha and Jerash hospitals share various similarities in their approach and perspective towards greening their energy systems, in parallel they share specific differences due to their diverse contexts.

Energy use[48]

The managerial staff at both hospitals mentioned that the Ministry of Health established a fuel committee to eliminate fuel theft onsite. For quality and quantity assurance, the ministry also has contracts in place with three certified fuel companies (Manaseer, Total and Jo Petrol), which supply the two hospitals directly.

The hospitals are not fully aware of their level of electricity consumption. Their main concern is providing safe uninterrupted services, free of power outages, for patients. Both hospitals in Ramtha and Jerash have seen occupancy rates and electricity use increase in recent years: in Ramtha public hospital, the occupancy rate increased from 50 per cent to 63 per cent (of hospital beds) in 2013–18; Jerash hospital saw occupancy rise from 40 per cent in 2011 to 70–80 per cent in 2018. The high rise in the occupancy rate at Jerash hospital is due to it being the only public hospital in Jerash governorate.

Rapid increases in the number of patients, due to the growing population, caused energy costs at Jerash hospital to jump by 37 per cent between 2015 and 2018. This influx of patients affected Ramtha prior to 2015, but thereafter patient levels have been more affected by outbreaks of conflict, border restrictions and the gradual reduction of skirmishes near the border. In addition, Médecins Sans Frontières (MSF) closed its 42-bed unit in 2018 as the number of emergency intensive care patients dropped. In order to maintain healthcare services and the efficiency of medical equipment during power outages (due to pre-announced maintenance), both hospitals have diesel generators – two at Ramtha Hospital and five at Jerash Hospital.

Energy waste

The burden of the Syrian crisis has impacted the delivery of healthcare in Jordan, where the sector had to rapidly respond to emergencies. Public hospitals lacked the space to accommodate extra inpatients, therefore new buildings and facilities were

48 Figures and quotes in this section come from focus group discussions that were part of the Inter-Ministry Commission assessments.

constructed, or old buildings upgraded and retrofitted. The increase of patients has directly affected the amount of time that air-conditioning and heating systems can be used.

To circumvent these challenges, the Ministry of Health issued summer and winter guidance to all public hospitals and primary healthcare centres to improve energy efficiency, including measures such as setting the correct temperatures on air-conditioning or heating, and closing windows while these systems are in operation. In regard to oversight, a Ramtha public hospital official stated that, 'General hospital inspections are not the most efficient, instead there is a greater need for digitized coordinated efforts.' While in Jerash hospital, staff pointed out that general energy inspections have been identified as an essential factor in changing hospital staff behaviour towards energy waste.

Renewable energy audits and tenders

The Ministry of Health is aware of the positive economic, social and health impacts renewable energy initiatives can have on Jordan's hospitals. However, there is currently no department mandated to carry out audits or issue tenders for energy efficiency and renewable energy. It is good practice for public entities to go through an energy audit before an energy tender can take place. Neither Ramtha nor Jerash hospitals have had an energy audit. Private companies that specialize in the implementation of energy systems usually face institutional impediments when looking to take part in such schemes. Conversely, a lack of understanding of existing policies and bureaucratic procedures among private sector companies often causes delays. In addition, approvals are required from the Ministry of Energy and Mineral Resources and the Ministry of Finance. These two ministries have an important role to play in facilitating any energy investments and accounting for energy cost savings and redeployment in future.

Staff at the two hospitals showed great interest in potential renewable energy installations and suggested the utilization of rooftops and parking lots. Staff at both hospitals believed that savings made from investing in renewable energy can provide a better environment for healthcare workers and patients. These savings can potentially cover some hospital needs such as investment in new medical equipment and patient beds.

The private sector can be a key partner for public entities in overcoming conventional energy challenges. This collaborative approach could provide a great learning initiative for hospital staff that would enable them to be part of the project from the beginning. The hospital staff of each location had different preferences in terms of installation and maintenance of a potential renewable energy system. Staff at the Ramtha public hospital prefer that a private company installs and maintains the renewable energy system for at least a couple of years. Conversely, staff at Jerash hospital would prefer that the hospital's O&M team is responsible for the system and is involved from the beginning.

Energy awareness and capacity-building

The shift to using renewable energy in public buildings requires the desire to change for a sustainable future. Hospitals will likely support renewable energy ventures that include and consult them, and where investments will help in the development of more sustainable and improved services. Ideally, there should be an accreditation system, which can certify the hospitals that adopt sustainable applications and practices. The lack of knowledge on the most appropriate solar technology for each hospital was evident in discussions. Hospital staff members noted that before any projects take place it would be best to launch a renewable energy awareness campaign that shares the potential positive impact of transitioning to a renewable energy system.

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Both hospital focus groups showed that the adoption of a renewable energy system would be particularly desirable from the point of view of power reliability. However, hospitals are dealing with other potentially more urgent environmental and service issues, such as medical waste disposal and water conservation through the repair of leaking taps and pipework. For a greater impact on economic, social and institutional conditions, it is clear that other essential sectors – water, sanitation facilities and waste management – should be addressed at the same time. Future investments could include the following environmental projects: water efficiency measures; solid and pharmaceutical waste management; and green infrastructure, including improved outdoor areas as part of patient-centred care.

Overcoming the challenges for public healthcare facilities

Data availability and accuracy

Any renewable energy investment in the Ministry of Health's public buildings requires comprehensive information and a set of approvals prior to implementation. The accumulation of unpaid electricity bills from prior years has made it difficult for the ministry to distinguish between power consumption and cost, which is essential for calculating potential and actual savings. Data availability on energy and total usage is sparse, and gathering it can be a complex procedure, due to technicalities associated with public buildings (these have different bill payment arrangements, with some being rented). It can also be difficult to define the energy bill for separate parts of a hospital as in most cases different units are linked to one or sometimes two meters.

Suggested approach: Comprehensive accounting of fuel use and costs is needed. For example, smart metering for different clinics and buildings would help to identify areas of highest consumption. The same approach could be taken for water use.

Since the focus groups took place, the South Amman wheeling project has come online offering an innovative model for accounting and redistribuition of savings. In 2018, the Ministry of Finance and Ministry of Health signed an agreement stating that at least 50 per cent of savings would be returned to the Ministry of Health to allow it to improve health services in the mentioned facilities. Each of the 33 hospitals and health centres in the South Amman project prepared a list of their needs to improve services for patients. Annual savings from electricity costs should cover these expenses. It has not been possible to monitor how the project has functioned to date, as the KfW project was closed once the plant became operational at the end of 2020.

Institutional challenges

Renewable energy investment in Jordan requires greater cooperation and collaboration from different respective institutions, including national bodies, such as the Ministry of Energy and Mineral Resources and the Ministry of Finance, and grid connection approvals. Improved coordination between parties (e.g. Ministry of Health, Ministry of Public Works and Housing, and Ministry of Planning and International Cooperation) could alert a project to infrastructural issues prior to implementation and before any disruptive building maintenance. For example, better coordination could have avoided the need to remove and re-install the solar water heating system in Al-Mafraq Hospital (see Chapter 4).

Suggested approach: Formalize the Inter-Ministry Committee to enable clear channels of communication between different government bodies and utility companies. Unified regulatory and policy guidelines for public buildings will be essential to pursue the development of renewable energy initiatives. For example, practical options for the repayment of electricity bill debts could be set out by the utilities regulator, Energy and Minerals Regulatory Commission (EMRC).

Patient digital information glitches

A digital information system, *Hakeem*, was rolled out in 2009 to enhance data availability and accessibility in public health entities. *Hakeem* is a national patient information system that registers inpatients and outpatients in a health sector database. This enables patient information to be accessed anywhere. Power outages affect the utilization and efficiency of *Hakeem* as during this time staff must revert to manual records, which increases the potential for inaccuracy.

Suggested approach: Transitioning to more stable renewable energy will help ensure the reliability of access to these systems.

Audits and investments

Audits for energy efficiency and solar potential are essential to ensure safety and quality control. Few comprehensive energy audits have been carried out on Ministry of Health buildings. Some hospitals and ministry buildings have recently instigated minor energy efficiency measures to minimize energy loss, where an official government expenditure policy requires equipment procurement (e.g. of lighting or air-conditioning) to be in line with energy efficiency standards.

Suggested approach: Forming a small group of individuals among hospital staff and management, who can inform and engage with the audit, will help flag issues and improve the quality of data. Comprehensive audits (ideally covering energy and water efficiency, renewable energy potential and waste) could be conducted as a package across facilities, and take into consideration the results of any previous project audits. These would reveal both behavioural and equipment-related changes that could save money and reduce payback periods. These audits could then be used in tenders for renewable energy and other types of procurement, or for the contracting of services.

Technical challenges and the condition of buildings

The Ministry of Health has expressed concern over the lack of space in hospitals for the installation of solar and PV panels as well as building structure problems, where roofs cannot withstand extra weight due to their age. Several options can be considered for future installation spaces, such as the roofs of car parks and empty rooftops that pass the audit as well as wheeling projects.

Responsibility for repair and maintenance of solar systems is also problematic. In the case of Al-Mafraq Hospital, the plumbing system was known to be outdated and prone to leaks prior to project implementation, but its repair or replacement was beyond the scope of the project funding. Many hospitals and clinics are old and in need of repair. This can have an impact on the effectiveness of upgrades, such as solar water heaters that must be connected to existing plumbing systems.

General repair of public hospital and clinic buildings (unless rented) is the responsibility of the Ministry of Health, while larger upgrade contracts may come under the responsibility of the Ministry of Housing and Public Works. Where solar projects are not part of a more holistic upgrade and responsibility for their operation is unclear, subsequent building repairs can impair or reduce the value of a project.

Suggested approach: Ideally, solar system ownership should be transferred to the Ministry of Health at project completion with clear lines of responsibility at the hospital level for maintenance – including for the hospital O&M team and the installers. If ownership is unclear, it is less likely that care will be taken to coordinate repairs and maintenance, taking into account the value of the system.

Figure 5. How energy upgrades could help meet healthcare priorities

Issues for attention and improvement	Challenges relating to energy	How energy upgrades could help	What would be needed
Financial operations and performance improvement Addressing waste in the system and increasing efficiency will free up more resources for improved care.	**Interrupted energy supplies.** **Cost of fuel and electricity** Little incentive for hospitals to address efficiency and energy within their buildings as bills are paid at the ministry level. No authority for hospital or directorate level teams to invest or contract energy services.	**Increase reliability of electricity, heating and hot water supply.** **Improve indoor temperatures.** **Reduce costs.**	**Institutional attention on efficiency combined with a budget for it – supported by financial mechanisms through the Ministry of Finance.** **Greater autonomy at the hospital management level for investments and savings, and mechanisms at the Ministry of Health level to assist hospitals to adopt efficiency improvements.** **A roadmap for complete solarization of energy sources coupled with a thorough efficiency audit and upgrade programme for hospital buildings.**
Care model innovation Hospitals require new capabilities and technologies that shift from emergency and episodic perspectives to constant care of patients health.	**Increased patient intake for many northern hospitals.** **High rate of respiratory diseases and need for additional sanitation in the wake of COVID-19.**	**Increased well-being of staff and patients through better temperature control and full access to hot water.** **Preventative approach through eliminating the need for diesel generators and thus local fumes.**	**A change in the way that the hospital building is understood – as part of the system of care. Adopt an emphasis on *'healthy buildings, healthy people'*.** **Setting targets for becoming green-hospitals with energy as one component (besides water, waste and green spaces).**
Digital transformation and interoperability Comprehensive adoption of technology can increase the accuracy and efficiency of treating patients and assist with many system functions.	**Power outages can disrupt the IT system on which *Hakeem* relies and therefore mean increased opportunities for error, and additional time taken to revert to manual records.** **Hospital data is digitized through *Hakeem* but the system is not yet adapted to receiving and passing on energy use information.**	**Increased access to on-site solar power would in some cases reduce or prevent outages that disrupt the digital data system in a hospital.**	**On-site solar PV and battery systems to displace diesel; increased robustness of the regional grid and connections.** ***Hakeem* must be adapted to allow access or send data on energy use to the correct points of contact. Regular analysis of this data should be provided to the relevant teams in the Ministry of Health so that they can monitor and address consumption patterns.**
Future of work (training, skills and sourcing)	**Maintenance is key to the sustainability of energy systems such as solar water heating and PV but at present, responsibilities can be unclear.**	**Training of engineers and building maintenance managers, and boosting the ability of ministry or hospital management to contract the private sector.** **Resourcing of local units.**	**Support for green initiatives and investments through national laws, by-laws, policies and strategies.**

Incorporating energy sustainability into healthcare priorities

Given the growth of energy projects in the health sector and the focus on public buildings in Jordan's national policies (both within the JRP and the Green Growth Plan), it is rational to see energy – and other aspects of environmental well-being and sustainability – as an integral part of healthcare priorities. This will help to institutionalize issues like efficiency and incentivize investments, maintenance and behavioural change.

Suggested approach: The Ministry of Health should target, pursue and track progress of sustainable energy improvements as part of its core mandate to achieve high-quality healthcare. Figure 5 considers the way that energy can contribute to necessary national healthcare sector improvements – as defined by Deloitte in their global study of healthcare.[49] This study defines four priorities and the above graphic demonstrates ways that energy improvement would assist in meeting those challenges.

49 Deloitte (2022), *2022 Global Health Care Outlook: Are we finally seeing the long-promised transformation?*, https://www2.deloitte.com/global/en/pages/life-sciences-and-healthcare/articles/global-health-care-sector-outlook.html.

07 Recommendations and conclusion

International humanitarian agencies can learn from Jordan's experience of adopting people-centred approaches that promote national sustainable energy and public sector welfare priorities.

Priorities

Humanitarian aid to Jordan and the inclusion of upgrades to public buildings in national strategies enable a mix of aid and concessional finance to improve local public infrastructure. If aid is harnessed to encourage sustainable financing from other sources, such as domestic and international investment banks, Jordan stands to benefit economically and create greater energy security. As energy efficiency, water and waste management in public buildings are all part of Jordan's Green Growth Plan, now is the perfect time to integrate them into economic recovery priorities and support a well-regulated energy services market.

This will require a number of concerted actions at different levels, including setting clear, high-level goals for public buildings, with all stakeholders made aware of how this may affect them, and establishing the right incentives for different agencies. The objective of solar for all schools in Jordan, as part of the Schools Heating and Cooling Program, gave impetus to the ongoing work in educational settings and boosted funding to these projects. At the same time, the JRP has taken a pioneering approach to guide and include humanitarian funders in national investment plans.

Targets, roadmaps and finance

Several cross-government actions are needed to enable and galvanize the scale-up of renewable energy projects. To achieve this, the executive and relevant ministries must work together to:

- Outline clear targets for greening public buildings that align with both Jordan's Sustainable Development Goals (SDGs) and nationally determined contributions (NDCs). In this regard, the energy sector actions (En04 and En05) in the Green Growth Action Plan 2021–2025 are a positive step in the right direction. These include publishing a National Green Building Strategy and Action Plan, with targets and projects outlined up to 2030, a roadmap and detailed budget.[50] However, this may take up to 10 years to achieve. The proposed roadmap can benefit immensely from the work of the Inter-Ministry Committee and its experience to date.
- Put the well-being of building staff and users at the heart of the roadmap. This fits with climate resilience and green city objectives already evolving in several governorates of Jordan, and could benefit from municipal, humanitarian and civil society collaboration. Guided by user needs, activity to retrofit and upgrade buildings provides opportunities to improve conditions for learning, medical treatment and patient recovery.
- Unify regulatory and policy guidelines for renewable energy installations in public buildings to streamline the financing process. These could provide clear options for accessing finance for energy, connection of solar PV in the event of unpaid bills and long-term maintenance. Where there are deficits, utilities and the Ministry of Finance will be keen to see these paid off, but if savings take years to emerge, support for these programmes may dwindle. Some considerations for incentives are set out in Box 5.

Box 5. Setting the right incentives for government agencies

In Jordan, the utilities and distribution companies currently stand to lose out when public sector entities reduce their energy use. There are several ways that mandates and incentives might be reworked in order to avoid this conflict of interest. These include:

- Exploring bold new ideas, such as merging NEPCO and the Water Authority of Jordan (especially in light of the opportunities for pumped water storage to help manage renewable power variability) or enabling distribution companies to become energy services companies (ESCOs) and thereby benefit from efficiency service contracts.

50 Ministry of Environment, Jordan (2020), *Energy Sector Green Growth National Action Plan 2021-2025*, Amman, The Hashemite Kingdom of Jordan, https://gggi.org/wp-content/uploads/2020/10/20022_Jordan_Energy_v04_HL_Web.pdf.

— Clarity from the regulator, EMRC, on how solar PV can be connected to a public building that has outstanding electricity bills would facilitate faster, more cost-effective PV implementation. The convention of distribution services companies to refuse to connect solar PV before debts are paid is up for negotiation. EMRC could usefully set out criteria explaining what is acceptable (e.g. payment of 25 per cent of debt and a future payment schedule agreed), where the installation will help bring down the costs of the user over time.

— Streamline coordination between ministries and agencies on building sustainability. The authorities should formalize the Inter-Ministry Committee to enable clear channels of communication between different government bodies and utilities companies. The Ministry of Energy and Mineral Resources could lead on proposed solutions and inform all relevant parties of the different initiatives supported by the Ministry of Finance.

— Offer clarity on sovereign risk. For example, the PPP unit within the prime minister's office and the Ministry of Investment could issue clear guidelines on lending for public buildings alongside a roadmap. The Ministry of Planning and International Cooperation could take a role in connecting pilots and grant-funded projects with larger plans and potential financiers. JREEEF would remain critical in channelling Jordanian government finance to projects. Options for enabling finance at the contract level are given in Box 6.

Box 6. Enabling finance contracts

In the short term, projects should concentrate on building efficiency, solar water heating and green upgrades to buildings that do not require grid connection. The need to manage the variability of renewable power alongside existing thermal power contracts has led to a freeze on renewable projects of over 1MW in Jordan. When the national electricity grid is fully upgraded, public facilities should be given priority for wheeling projects.

The contracts of public buildings could be bundled together to enable efficiency and green upgrade packages to be funded by larger financiers, for example, national or multilateral development banks (MDBs). This would require audits at scale that show savings potential and flag issues with infrastructure. Jordan's National Energy Research Center has amassed a body of knowledge that could underpin such plans. Bundling service contracts would allow the private sector to be involved, and ensure companies are responsible and accountable for maintenance.

Piloting the build–operate–transfer model, where a private company puts up the capital and runs the system until the ministry has paid off the capital cost, would likely cost no more than the current annual energy bill of a building. This could begin with solar water heating systems for the health sector. A separate vehicle or committee tasked with the handling and accounting of the contract would be required for this model.

- Pool the available pilot and audit data, and resource the relevant ministry capacities for information gathering and reporting. Chapter 2 suggests priorities for ministry-level actions to support performance and national targets.
- Commission green certification programmes for schools and hospitals. The Ministry of Public Works and Housing has a rating scheme for green buildings, according to the Jordan Green Building Guide. Meanwhile, the Jordan Green Building Council has also developed a rating tool for residential buildings that could be adapted to cover schools and hospitals. However, knowledge of green materials is limited, and better advocacy and support is needed to roll them out nationally. Existing schemes for schools, such as the Global Coalition for Green Schools (of which the Jordan Green Building Council is a member), could be adapted to the Jordanian context, and a similar scheme could be developed for hospitals based on international experience. Staff could be incentivized to participate if offered professional accreditation for the training received.
- Explore delegating greater authority to municipalities for energy projects and savings. Jordan's 2015 Decentralization and the Municipality Law sets the government's direction towards greater empowerment of subnational levels of the government. There is already growing experience with the Greater Amman municipality making efficiency and green investments, and the creation of sustainable energy access and climate action plans (SEACAPS) in several governorates. These suggest savings possible for buildings under direct control of the municipality, including offices, libraries and cultural centres as well as 'tertiary' buildings such as hospitals and schools.[51] Developing capacities at the municipality level including energy managers, green procurement procedures and training to apply strict green building codes would require larger resources for municipalities (which are allocated only a small fraction of the national budget) and a mechanism to enable them to reduce their debts through energy savings.

Mandates and maintenance

At the ministry level, ownership and clear responsibilities for maintenance of solar panels and PV are key to sustainability. Where it is unrealistic for an asset to be maintained by ministry staff, it makes sense to agree service contracts with private companies. This approach would still require supervision and oversight, and clear channels of reporting and authority. Where a ministry assumes ownership, teams must be adequately resourced and mandated. Those carrying out maintenance must have access to remote monitoring to enable timely repair. Recommendations for ministry preparedness include:

- Creating a permanent, centralized energy management unit (EMU) in each ministry mandated with overseeing the performance of energy installations. This could build on the collaborative work of NRC with the Ministry of Education and of the KfW EEPB project with the ministries of public works

51 See the Clima-Med website to access the Jordan SEACAPS for eight municipalities, https://www.climamed.eu/project-documents/seacaps/jordan-seacaps/.

and housing, education and health. Each ministry EMU would develop a database to collect and analyse its energy costs and consumption over time, using historical and new information.

— Assigning an energy manager at the facility or building level to meet practical targets and prepare for longer-term private sector involvement in systems upkeep. This role could be paid for through building savings, and clear responsibility would encourage maintenance and continual improvement. The energy manager can address basic matters but can also act as the focal point for each facility, ensuring better reporting and follow-up with an expert company contracted for maintenance and repair. Clear channels of communication and the ability to monitor a system in real time will facilitate this relationship.

Future energy projects in Jordan and wider humanitarian work with public buildings

With respect to lessons learned in international projects of this kind, success factors include working in inclusive, well-coordinated partnerships between government, building users and managers; being flexible to adapt to emerging realities and new facts on the ground; and institutionalizing accountability around safety, quality and maintenance. These projects also need a much longer time frame for evaluation to check if savings were achieved and reinvested, for example, or whether awareness was institutionalized and how the project affected levels of service and refugee inclusion.

Setting targets and measuring benefits

Setting targets for energy improvements and measuring their health or educational benefits is not easy given that many other factors will affect the performance and adequacy of those services. However, surveys of building staff and users, before and after implementation, can assess needs and qualitative improvements in comfort and efficiency. In addition, there are beneficial elements that projects can measure such as:

— Priority items of equipment, supplies or upgrades, agreed at the outset, which are then acquired with savings (if a savings–redistribution mechanism has been put in place) e.g. distribution of books, installation of medical equipment.

— Communal activities, e.g. building a hospital or school garden benefiting from rainwater storage.

— Training in energy efficiency and renewable energy – and ideally related issues of sanitation, water conservation and waste reuse and recycling – for pupils and staff.

— Engagement in such co-projects helps humanitarian organizations to involve staff and parents, providing opportunities to gain views and ideas, and see where the project can address particular vulnerabilities of poorer or refugee children.

Project-level considerations for work on public buildings

Humanitarian agencies are not usually well-placed to engage with energy on a national scale, but working on infrastructure in core areas, such as health and education, offers multiple gains. Improving ageing public buildings in countries that host large numbers of forcibly displaced people not only offers a way to reach vulnerable individuals, but also an opportunity to support local communities and national needs. If lessons learned from Jordan in this research are applied to urban displacement situations, planning for work on public buildings can consider:

— Using thorough assessments of a building's infrastructure, energy and water usage patterns, and costs to plan the most effective upgrade options. Energy, water and waste audits should be conducted together. It is also important to check if there are other upgrades and maintenance planned that might affect the project.

— Consultation and inclusion of building managers, staff, users and private sector companies can bring co-learning and wider engagement. These stakeholders will not only highlight what is most needed, and what level of engagement in maintenance is feasible, but can also raise local and institutional awareness of the benefits of efficiency and renewable energy.

— Addressing energy in public buildings hand-in-hand with wider upgrades. For example, in the RE4R-NRC schools project, solar panels were accompanied by renovation work to fix bathrooms and classrooms. In scoping group discussions, hospital staff expressed the urgency of addressing medical waste and water conservation.

— Standardized tools for quality assurance to assess compliance of an installed system with engineering standards, international codes and equipment vendor requirements. A customized checklist – ideally digitized and shared with clients, funders and consultants – must be introduced for each type of system installation. A qualified third party will need to check and sign off before declaring the work complete.

— Obtaining agreements and approvals from government entities and utility companies before starting project construction work to avoid delays.

— Efficiency and passive techniques, such as draught-proofing, solar water heating and painting roofs white, are under-valued and under-resourced. Raising awareness of these measures is required to gain buy-in from funders and users alike. Building repair, upgrades and green space additions can work in tandem with efficiency improvements for the well-being of users.

— A clear and workable plan for maintenance to reduce project failures. Technological applications should be simple and require minimum maintenance. It is essential that responsibilities are clear and that those responsible for maintenance are motivated. A good option is the use of service contracts with remote monitoring that allow for fast identification of errors.

Conclusion

Communal spaces are critical for integration and socialization. In displacement situations, host countries face potential economic deficits and higher unemployment, which have been exacerbated by the food and fuel price hikes following Russia's invasion of Ukraine in 2022 as well as revenue and business losses during the COVID-19 pandemic. As a result, governments of refugee-hosting countries will inevitably focus on ways to reduce waste and inefficiencies in public spending.

In line with this priority, investments in infrastructure can reduce waste and inefficiencies in public spending and increase the resilience and efficiency of vital services, while creating opportunities for business and employment in growth areas. But investors and lenders tend to avoid the public sector, due to the potential lack of return on investments. In this respect, there is an opportunity to learn from the last few years and the experience of the JRP in dealing with the Syrian crisis and other ongoing international cooperation.

Pilot schemes launched in Jordan show that local private sector and smaller NGO actors with experience in this area can be important contributors to larger projects, combining socially aware, human-centric approaches with technocratic ones. Energy is a difficult area for humanitarian agencies to engage with on a national scale. However, well-planned work with local institutions and businesses to improve the state of buildings and to foster sustainable scale-up is likely to boost humanitarian agencies' standing and relationships with local and host governments.

Successful introduction and scale-up of sustainable energy in public buildings requires a people-centred approach that focuses on improvements in education, healthcare and well-being. Only by listening to the needs of building users and managers can efficiency, renewable energy and other green upgrades be planned in a sustainable way. Incorporating consultation in efforts to improve facilities will help gain the interest and commitment of managers and users in maintaining systems. Projects can also provide an opportunity to learn about safe and sustainable energy practices, and run community cohesion activities.

Although Jordan has a specific policy and business context, the lessons from renewable energy and energy efficiency projects in the country also apply to other urban displacement situations, where authorities are looking to further energy sustainability.

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Cover image: A solar panel installation on a school in Jordan, 13 October 2016.

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