Renewable energy as a clean energy source to operate water and wastewater facilities in light of the extreme deficit in electricity availability in Gaza:

Towards Green Economy Cooperation

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Overview

The Gaza Strip suffers from an extreme deficit of electricity supply. Current average demand outstrips average supply by 300 MW. Gazans spend 8 to 16 hours a day without electricity in their homes. As the population in Gaza grows and average temperatures rise, demand will only increase. Without a parallel increase in supply, life in Gaza will become more unbearable and add to the political volatility in the region.

The two main current sources for electricity supply in the Gaza Strip are the *Gaza Power Station* with an installed capacity of about 140 MW, and ten radial connections to Israel with a total capacity of 121 MW, supplying power at a 22 kV level. Current peak demand in Gaza, according to the Palestinian Energy Authority is about 748 MW

The Gaza Strip has suffered a chronic energy crisis with a total average power supply of 208 MW compared with an average electricity demand of more than 500 MW anticipated to exceed 700 MW very soon. Gaza is characterized by high population density of more than 5,200 inhabitants/km2, representing the third largest population density in the world; challenges of closure and siege imposed by Israel and Egypt; internal political division; scarcity of natural resources; and high rates of unemployment. Electricity supply is one of the main challenges facing Gaza which has resulted in underdevelopment, especially in the economic sector. If the economy can be revived, it could lower unemployment rates, and give hope to Gazan youth, 70% of whom are unemployed though many have university degrees. New electricity sources are under discussion both with the Israeli authorities, and internally by Palestinian authorities, including Gas for Gaza (G4G) and the 161 KV line. Recently, some progress has been made through negotiations between Egypt, Israel, and the PA on the development of natural gas from off the coast of Gaza, but the process of practical implementation and utilization will be lengthy.

One energy consuming sector adversely influenced by this energy deficit is the operation of water and wastewater facilities, leading to additional secondary economic, environmental, and humanitarian consequences. A feasible option that is a technically viable solution to this nexus of issues is the dedication of large scale solar photovoltaic (PV) fields to electrify water and wastewater facilities through a separate grid system. This option will also maximize the efficient utilization of conventional energy during the night.

The Gaza Strip has an average solar radiation of 5.46kWh/m²/day which varies seasonally, with as low as 2.63 kWh/m2/day in December and as high as 8.4 kWh/m2/day in June. The mean–daily hours of sunshine are 2,861 hours per year.

Despite limited open space in Gaza, there is a restricted access zone on the eastern border of Gaza with Israel, which is not utilized. 100 meters west of the border fence inside the Gaza Strip access is prohibited, while for the next 200 meters access is limited and cannot be productively utilized now. This article makes a case for joint negotiations to utilize this zone for a green economy initiative, to serve as an example of cooperation, led by the private sector.

The energy situation in the Gaza Strip

As stated in the overview, the current two main sources of electricity in Gaza are the Gaza Power Station (installed capacity of about 140 MW), and the ten radial connections to Israel (total capacity of 121 MW).

The Gaza Power Plant is a dual fuel power station with four 24 MW combustion turbines and two 22 MW steam turbines, making the full load capacity of the plant 140 MW. To operate the plant at full load, a supply of about 4.9 million liters of fuel per week (700 m^3/d) would be needed. This would incur operational costs of more than 20 cents/KWh; very high compared with international standards.

Actual energy production from those sources has not met installed capacity since 2006 due to many factors including limited fuel availability, damage to feeders outside of Gaza, and damage to the electricity transmission lines in Gaza due to military operations. In addition, the electrical grid is not totally interconnected so that the possibilities to transfer electricity across the Gaza Strip are limited.

While a feasibility study for natural gas supply from Israel to Gaza (G4G) has been conducted, the detailed design has not progressed as planned. More importantly, governance issues to manage purchase and operate in Gaza are dependent on complex and lengthy bureaucratic and legal processes. The feasibility study looks at increasing the Gaza Power Station capacity by 130 MW in the first phase.

The second proposed large-scale project in Gaza is the supply of electricity through the 161 KV line from Israel which has been under discussions with Israel for many years. But even with the most optimistic projections of both a new gas supply and the 161 KV line operational, Gaza would still face a shortage in electricity supply.

Due to the currently insufficient power supply, electricity to the Gaza Strip is cut off for several hours a day, ranging between 8-16 hours. These planned power cuts are distributed between different areas in regular intervals. This requires frequent switching on and off of the electricity in the Gaza power supply grid.

Fuel Supplies

The total monthly consumption of diesel fuel in Gaza is approximately 108 thousand tons, representing 40% of total fuel needs. Diesel fuel is used for electricity generation in the Gaza Power Plant, as well as in the commercial and industrial sectors. Widespread use of small-scale diesel electricity generators in the public and private sectors in the Gaza Strip increase the pressure on its consumption. The insecurity of diesel fuel supply and its high prices due to taxation make it an unacceptable short-term solution for the Gaza energy crisis. Long power supply interruptions result in long operation times of the diesel engines, leading to their fast deterioration, high maintenance needs, greater environmental and safety threats, and an increased stress on the economy. Qatar has been supplying fuel to the Gaza Power Station to enable the generation of 60 MW for the last few years. At more than 20cents/kWh, the current high costs of operating the Gaza Power Station are not economical. If natural gas becomes available and the modifications on the electricity supply system to operate on natural gas are implemented, the cost of electricity production would drop considerably.

Potential for Solar Energy

The Gaza Strip has the potential to generate solar energy year-round, with an average daily solar radiation of 5.46 kWh/m² according to the Meteonorm solar data base. The average daily solar radiation varies seasonally from as low as 2.63 kWh/m^2 in December to as high as 8.4 kWh/m^2 in June. The installation of rooftop solar water heaters in Gaza is widespread and represent an equivalent of an electricity generation of 600 GWh. In addition, to mitigate the unreliable electric grid, more and more residents of Gaza have installed rooftop photovoltaic (PV) in their homes.

Palestine has a specific renewable energy target for the near future. According to the 'General Renewable Energy Strategy' by the Palestinian Energy Authority (PENRA), 10% of total domestic electricity production and 5% of the total expected electricity consumption is to be generated using renewable sources. The Palestinian renewable energy target and policy place a priority on solar PV and concentrated solar power (CSP) with an expected contribution rate of 50%, in part reflecting the high-level of solar energy resources in Palestine and decreasing technology costs.

One of the main challenges to solar energy production in the Gaza Strip, with only 365 KM^2 area, land available to build solar energy fields is limited. Several sites along the eastern border of Gaza with Israel could make it easier to install separate connections of the different zones in Gaza with the grid creating a distributed system of generation.The area needed to generate a peak power supply of 75 MWp is 600 dunam. The technology selected should be a simple installation of conventional crystalline photovoltaic panels fixed to the ground. Most of the land in the restricted access area along the eastern border of Gaza with Israel is private, however no commercial use is permitted. Due to a lack of alternatives, it can be assumed that long-term rent at low rates could be negotiated. It could be an opportunity for both Palestinian and Israeli private sector to develop shared solar fields on both sides of the border fence in eastern Gaza and on the Israeli side in the Gaza envelope, to feed electricity grids and transfer electricity where and when needed at both sides of the fence, applying net metering principles. By doing so, the contested zone east of Gaza will go from a conflict zone to become a Green Energy Zone for Cooperation.

Regional Perspective

Cooperation on developing water supplies, including desalination, and development and integration of energy systems, including renewable energy, are explicitly stated objectives of both the Palestinian-Israeli Oslo Accords and the Jordanian-Israeli Peace Agreement. The envisioned water-energy exchanges could promote such objectives, as well as a diverse range of national governmental objectives, including water and energy security, diversification of resource supplies, regional integration, and environmental protection. If successful, it could also serve as an inspiration and basis for wider regional cooperation in other fields.

With respect to energy resources, all three jurisdictions are highly dependent on imported fossil fuels. This dependency is a serious drain on foreign currency reserves as well as a strategic threat, and a source of both local air pollution and

global greenhouse gases (GHGs). The region has high potential for renewable energy, and all three countries have signed the Paris Climate Accords of 2015 and committed to reducing GHGs and all three have stated goals for increasing the share of energy supplied by renewable sources.

All three parties have potential for developing renewable energy domestically, including solar, wind, biomass, and other sources. Due to their large tracts of deserts, Jordan and Egypt could supply additional renewable energy to the region. Actions in this direction can be envisioned as complementary to, and not in place of, conservation measures and local sustainability policies.

Initiatives to address electricity supply in Gaza

The private sector has established standby diesel engine generators at the neighbourhood level, and supplies electricity through a separate network with a cost of approximately 4 NIS/kWh, which is almost 8 times the tariff paid to the Gaza Electricity Distribution Company (GEDCO), the company responsible for supplying electricity to residences and businesses in Gaza. This approach is very expensive and while the trend had strong momentum in the beginning, it has started to decline due to costs.

A lot of households in Gaza have begun to install rooftop PV systems that can cover some of their electricity demand. Investment cost is relatively high but when calculated over the long-term and compared with fees paid to the private sector for electricity supplied by neighbourhood generators, it is more economical. PV rooftop systems also have very low operation costs, except for the replacement of storage batteries, which is necessary every two years to three years. The disposal of the 80,000 to 100,000 batteries a year from rooftop solar arrays has created its own environmental challenge since there is no hazardous waste site in Gaza to appropriately dispose of them.

Examples of current larger scale renewable energy initiatives in Gaza are desalination plants, water wells, and some industrial buildings. About 600 KWp PV capacity has been installed on the three low-volume desalination plants in Khan Younis, Deir Al Balah, and North Gaza. In addition, ongoing projects target to install additional plants at about 7 MWp PV capacity at both North Gaza and Khan Younis wastewater treatment plants (WWTPs).

The capacity of solar panels supplied to Gaza over the past 12 years, with a considerable increase in the last two years, is estimated by experts to be in the order of 40 MW. It is important to note that such additional power capacity does not mean a reduction in the demand on the grid capacity by 40 MW. The 40 MW is the peak PV capacity that can be obtained at certain times in the year, and generally covers around 12-14 MW of the average energy demand over the year. Unless stored or connected to the grid for net metering, Gaza's electricity demand does not fully benefit from the installed capacity as energy production. Net metering with the grid has its own challenges according to periods of electricity availability in the area where a PV system is connected, and the capacity of the grid to accommodate additional electricity.

Economic aspects of PV systems

The electricity purchased from Israel is taken at a rate of 0.35 NIS/KWh which should be the basis for economic comparison. Energy generated from fuel supplies either at the Gaza Power Plant or from community generators is almost double that of the cost of energy purchased from Israel due to "the blue tax" (a tax imposed by the PA on industrial diesel brought into Gaza) and, therefore, low efficiency.

The cost of a Solar Power Plant depends mainly on the cost of PV panels. Costs may differ greatly depending on the design integration mode selected, the structure (fixed or mobile), the connection to the grid, and the size of the installation.

Solar PV has already become a low-cost renewable energy technology and competitive with conventional fossil alternatives. A breakthrough in costs was observed in the last decade following a massive investment in research and deployment. Those recent substantial cost reductions are attributed to advancements in technology, production processes and industry development, as well as governmental involvement in a global industry that is subject to significant international competition. The international renewable energy agency (IRENA) reported in 2021 that solar PV total installed cost of a kW dropped by 82% between 2010 and 2021.

Financing

Several options exist for financing the Green Energy Zone for Cooperation. The Palestinian Authority is eligible for financial assistance on favorable terms from development banks. In addition, various carbon finance instruments may also be available, both through development banks, and various private carbon markets.

The private sector should be part of financing such a venture with significant international and national subsidies to offset political risks. Build, Operate and Transfer (BOT) project finance models, for example, have the advantage of deferring upfront costs to the private sector and deflect much of the risk from the government. This also galvanizes private sector knowledge and experience. Finally, private sector led projects face less political resistance than government led ones, which is particularly important in the context of cooperation between Israeli and Palestinian authorities. Critical for the success of a Green Energy Zone for Cooperation are guarantees provided by the international community on the one hand, and the commitment by the Palestinian Authority to implement proper governance and ensure that electricity fees are collected.

Way forward

As proposed by the Harvard Business School for capacity building in developing countries, the ‘triple A’ framework of authority, acceptance, and ability should be a basis for success. Without the commitment of PA stakeholders none of the international donors or the private sector will take the risk.

A public-private partnership needs to be developed, including financial and legal aspects in consultation with the Palestinian Energy and Natural Resources Authority

(PENRA), relevant respective government organizations (such as ministries of finance, and land authorities in Israel and the PA) and the private sector. An international environmental steering and monitoring committee should be established to assess all environmental mitigation actions needed. This committee, which should have executive power, would include representatives of all stakeholders who take part in the financing, construction, and operation of the project, and local supervisory authorities. The committee should operate in total transparency, explaining the strategic interest of the plan, and all socio-economic public benefits to mobilize the land at a reasonable cost.

The concept should be discussed with the Israeli Authorities about proposed sites and the possible connection to electricity supply sources in Israel. Generated electricity would be supplied, first to the Israeli grid and then transferred to the Palestinian grid in Gaza, after the necessary upgrades of the main feeders to increase their capacity in supplying more electricity.

Technical complications associated with the Green Energy Zone for Cooperation are not insignificant since the existing feeders in Gaza can only accommodate a limited amount of additional energy. Supplying the total energy generated in the project, to the Israeli grid then swapping for an equivalent amount of electricity from Israel to Gaza may be possible, but may not be an easy task.

Energy demand of water and sanitation facilities is significant. It is estimated that once the implementation of Gaza's strategic water plan is completed, which will increase all the supply of all qualities of water in Gaza, including wastewater treatment plants, sea water desalination plants, recovery, and reuse schemes of treated effluents, pumping and booster stations, etc., the installed power dedicated to water, and wastewater facilities will be approximately 128.3 MW. This is a significant increase in demand compared to domestic needs and compared to amounts of energy currently supplied and planned to be supplied even when the 161 kV line and the G4G project are implemented.

A Green Energy Zone for Cooperation could make a significant and possibly quicker contribution to lowering the energy deficit in Gaza, improving the socio-economic situation of millions of Gazans, while creating a shared Palestinian Israeli interest in stability along the Gaza Israel border and boosting security to hundreds of thousands of Israelis in the Gaza Envelope.

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