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Securing Energy for Development in West Bank and Gaza

June 30, 2017

WORLD BANK GROUP

ESMAP
Energy Sector Management Assistance Program

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Table of Contents

Acknowledgements

The report was prepared under the guidance of Vivien Foster (Global Lead, GEEDR, co-task team leader) and Roger Coma-Cunill (Senior Energy Specialist, GEE05, co-task team leader).

The overall report was drafted by Sara Badiei (Energy Specialist, GEE05), Vivien Foster and Roger Coma-Cunill. Several sections of the report were led by the following team members: Samuel Kwesi Ewuah Oguah (Energy Specialist, GEESO), the planning model analysis; Joeri Frederik de Wit (Energy Economist, GEESO), the demand forecast analysis; Alain Bourguignon, the renewable energy, transmission and distribution, and energy efficiency analysis; Amit Mor and Shimon Seroussi (Eco-Energy, consultants), the gas analysis and energy sector financial model; Peter Griffin (consultant), the macro-economic model analysis; Joern Huenteler (Energy Specialist, GEE05) provided valuable inputs on the Jordan and Egypt energy sectors; Jonathan Walters (Castalia, consultant) provided political economy and institutional guidance throughout the project; Carlos Alberto Lopez Quiroga (Senior Oil and Gas Specialist, GEEX2) provided advise on hydrocarbons; and Khalida Seif El Din Al-Qutob (Program Assistant, MNCGZ) contributed with valuable logistical and administration support.

The study would not have been possible without the continuous collaboration and consistent feedback from the Palestinian Energy and Natural Resources Authority (PENRA), Palestinian Electricity Regulatory Council (PERC), the Palestinian Ministry of Finance (MoF), Palestinian Electricity Transmission Company Ltd. (PETL), Palestinian Energy and Environmental Research Center (PEC), Jerusalem District Electricity Company (JDECO), Gaza Electricity Distribution Company (GEDCO), Northern Electricity Distribution Company (NEDCO), Hebron Electricity Distribution Company (HEPCO), Tubas Electricity Distribution Company (TEDCO), Southern Electricity Distribution Company (SELCO), Palestinian Investment Fund (PIF), Palestinian Central Bureau of Statistics (PCBS), and Palestinian private sector. The study also benefited from discussions with and inputs from the Israeli Electric Corporation (IEC), Coordinator of Government Activities in the Territories (COGAT), Israeli Public Utilities Authority (PUA), Israeli Ministry of Foreign Affairs and Ministry of Energy. The study also received inputs from the Jordanian Ministry of Energy.

The team would like to thank Marina Wes (current Country Director West Bank and Gaza, MNC04), Steen Jorgensen (former Country Director West Bank and Gaza, MNC04), Erik Fernstrom (MENA Energy Practice Manager, GEE05), Bjorn Philipp (Program Leader, MNC04) and Mark Eugene Ahern (Program Leader, MNC04) for their continuous guidance and support as well as peer reviewers Victor Loksha (Senior Energy Economist, GEEES), Rahul Kitchlu (Senior Energy Specialist, GEE01), Kwawu Mensan Gaba (Global Lead, GEEDR), Bjorn Philipp, as well as Rima Tadros and Thomas Berdal from the Norwegian Representative office.

The financial support by the Norwegian Government and the Energy Sector Management Assistance Program (ESMAP) is gratefully acknowledged. ESMAP—a global knowledge and technical assistance program administered by the World Bank—assists low- and middle-income countries to increase their know-how and institutional capacity to achieve environmentally sustainable energy solutions for poverty reduction and economic growth. ESMAP is funded by Australia, Austria, Denmark, the European Commission, Finland, France, Germany, Iceland, Japan, Lithuania, the Netherlands, Norway, Sweden, Switzerland, the United Kingdom, and the World Bank Group.

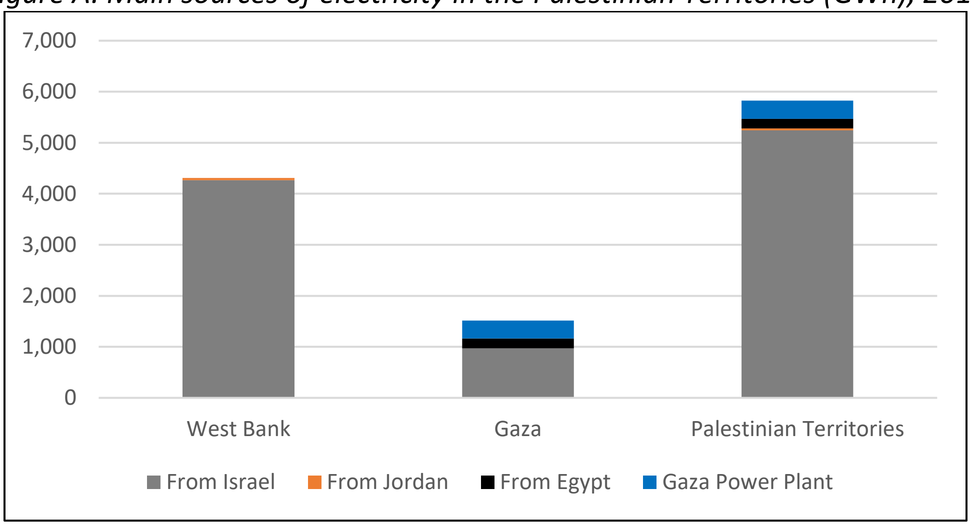
Executive Summary

What is the Current Energy Supply Situation in West Bank and Gaza?

1. **The Palestinian Territories face significant energy security challenges, already severe in Gaza, but also emerging in the West Bank.** In Gaza, the available power supply only meets half the demand leading to rolling blackouts, alternating between 8 hours on and 8 hours off. Although the West Bank generally enjoys 24-hour power supply, there have been emerging power shortages during peak winter and summer months. With Palestinian electricity demand projected to grow at an average annual rate of around 3.5 percent for the coming years – a little faster in Gaza and slower in the West Bank – energy shortages can be expected to deteriorate unless new supply options are found.

2. **The Palestinian Territories rely primarily on Israeli imports to meet its electricity needs.** As of 2015, about 90 percent of electricity to West Bank and Gaza was supplied by imports from the Israeli Electric Corporation (IEC) (Figure A). The situation differs significantly between the West Bank, where IEC imports represent 99 percent of electricity consumption, and Gaza, where they represent only 64 percent. Modest amounts of electricity are also imported from Jordan into the West Bank and from Egypt into Gaza. The Palestinian Authority has set targets of 130 MW of renewable energy by 2020, but only 18 MW have been developed to date.

Figure A: Main sources of electricity in the Palestinian Territories (GWh), 2015



Source: PCBS Energy Balance

3. **The only large scale generation capacity in the Palestinian Territories is the troubled Gaza Power Plant.** The 140 MW diesel-fired plant was developed as an Independent Power Project and has been operating since 2004 on a 20-year Power Purchase Agreement involving significant take-or-pay capacity charges. Due to the high cost of diesel, the plant is so expensive to operate – costing NIS 1.05-1.65 (US$ 0.29-0.46) per kilowatt-hour – that it can typically be run only at half capacity. It has also suffered repeated damage during armed conflict affecting its fuel storage capacity. The best prospect is to convert the plant to run on natural gas, which would

reduce its operating costs to at least a third of current levels. In parallel, considering the expected long lead time of this project, the development of renewables such as rooftop solar PV, and additional imports from IEC, both with a shorter implementation time frame, should be prioritized.

4. **The Palestinian electricity sector has undergone a number of institutional reforms, which still require further consolidation.** In 1995, the sector was reorganized to cluster most of the former municipal service providers into six local distribution utilities. The Electricity Law of 2009 created PERC, the sector regulator, with responsibility for tariff-setting, as well as PETL, a new transmission operator and wholesale power trade. While there is no Palestinian transmission infrastructure at present, PETL will take charge of four high voltage sub-stations, of which three have recently been built, to consolidate the physical flows of electricity from Israel into the West Bank as opposed to the default mechanism by which electricity is imported through hundreds of low and medium voltage connection points.

5. **The Palestinian electricity sector as a whole has yet to establish a track record as a creditworthy off-taker for wholesale power.** There are three layers to this problem. First, despite important efforts by the regulator, PERC, electricity is not priced at cost recovery levels throughout the Palestinian Territories. The gap between tariffs and costs is particularly large in the case of Gaza, where tariffs have not been adjusted over the last decade. Second, while the operational performance of the distribution utilities has been improving, they are still only able to recover revenue for 64 percent of the electricity they purchase in the West Bank (Figure B). The situation is worst in Gaza, where revenues cover only 50 percent of electricity purchases. Third, even when revenues are collected, they are sometimes diverted by municipal governments to cover other sub-national expenditures rather than being channeled to the purchase of power. As a result, implicit subsidies to the electricity sector have been estimated at close to 1 percent of GDP in the West Bank and around 4-5 percent of GDP in Gaza.

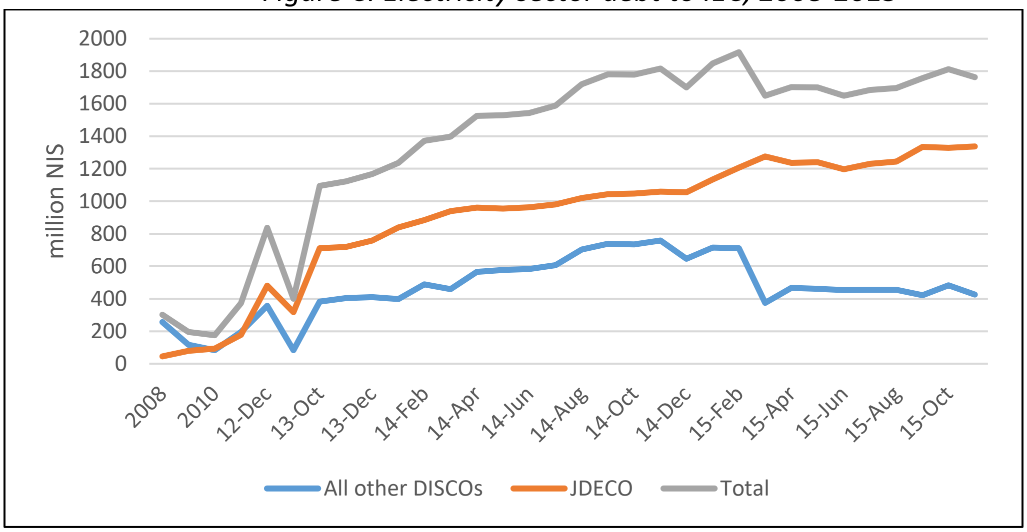
Figure B: Overview of Palestinian electricity distribution companies, 2015

	GEDCO	**Total West Bank**	**JDECO**	**NEDCO**	**HEPCO**	**SELCO**	**TEDCO**
Scale							
Customers	231,500	436,389	256,314	90,265	45,660	25,650	18,500
Purchased Electricity (mil NIS)	795	1,398	871	250	164	71	42
Billed Electricity (mil NIS)	518	1,509	949	245	193	76	46
Net Annual Income/loss (mil NIS)	n.a	-76	-82	9	9	-15	3
Performance							
Losses-Technical and non-technical (%)	26%	22%	24%	17%	20%	28%	16%
Collection ratio (%)	65%	89%	91%	98%	81%	71%	76%
O&M costs as percentage purchased electricity (%)	8%	17%	22%	5%	10%	21%	17%

Source: DISCOs

6. **The poor track record of paying Israeli power import bills has led to the so-called 'net lending' crisis and a high accumulation of outstanding debt.** Since power purchased from IEC is only partially paid for by the DISCOs who purchased and received the power, the unpaid portion is then partially covered through 'net lending' (a fiscal mechanism whereby money is deducted from clearance revenues that would otherwise be transferred from Israel to the Palestinian Authority) and partially accumulated as outstanding debt. In 2015, the Israeli Minister of Finance deducted over NIS 1 billion (US$ 275 million) from the PA's clearance revenues. By September 2016, the accumulated debt owed to IEC reached over NIS 2 billion (US$ 500 million) (Figure C). An agreement was reached in September 2016 which allowed for the settlement of past accumulated debt and laid the vision for a new Palestinian power market with imports channeled through the new high voltage substations and tariff set according to a new long term Power Purchase Agreement. According to this vision, PETL would act as the Palestinian 'single buyer' purchasing power from IEC and selling it on to the DISCOs.

Figure C: Electricity sector debt to IEC, 2008-2015



Source: Eco Energy

What Options Exist for Improving Palestinian Energy Security?

7. **Looking forward, the Palestinian Territories have a number of tangible options for expanding and diversifying its electricity supply.**

8. **Israeli electricity imports continue to be a valid option for future power supply, but would call for a significant scale-up of interconnection capacity.** Israel has a strong track record of providing reliable power supplies to the West Bank and Gaza. As long as the 'net lending' crisis can be satisfactorily resolved, there is potential to further increase Israeli power exports to West Bank and Gaza, provided the existing interconnection capacity is upgraded accordingly. West Bank and Gaza already represents IEC's largest and fastest growing electricity consumer. However, IEC is facing high levels of indebtedness and an uncertain future operating structure. Under the current Israeli power sector reform, all new Israeli generation capacity is being

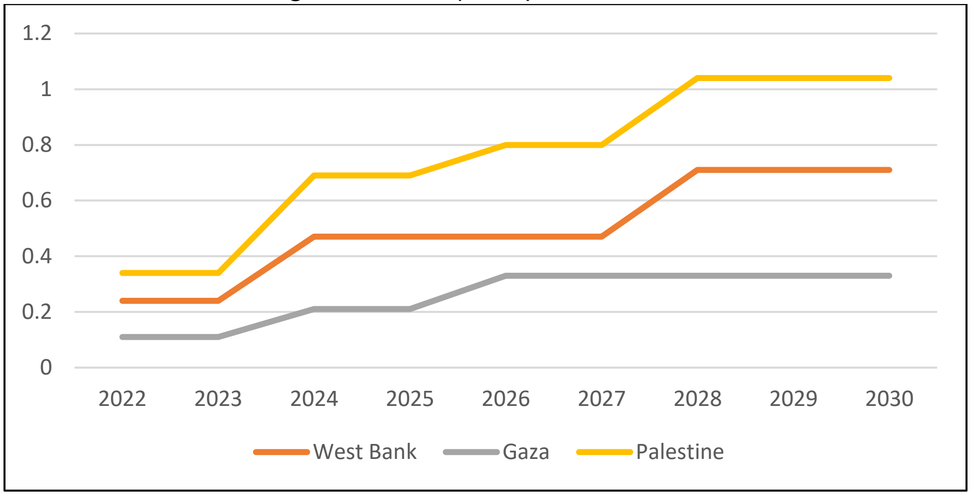
developed by Independent Power Producers, which may present an alternative and more commercially oriented Israeli power supply option for West Bank and Gaza in the future.

9. **Expanding power imports from Jordan and Egypt is also a realistic medium term option, although both sources present certain drawbacks.** Both Jordan and Egypt have recently overcome interlinked power supply crises caused by a shortage of Egyptian gas, and are now heading for significant power surpluses. In principle, existing interconnection capacity of 20 MW with Jordan and 20-30 MW with Egypt could be upgraded to support higher volumes of imports. However, Jordanian electricity is currently more expensive than Israeli power due to heavy reliance on LNG, but is expected to become cheaper as Israeli gas enters the Jordanian market and renewables increase their share in the Jordanian generation portfolio. On the other hand, the size of Jordan's power system is on par with the size of Palestinian electricity demand – meaning that the amount of power available for export may not be so large relative to Palestinian needs. Egyptian power is currently cheaper than Israeli power due to the historic low cost of natural gas; however, the size of the Egyptian power system is 30 times larger than the Palestinian demand making it relatively easy for Egypt to supply the scale of power that West Bank and Gaza might need. Nevertheless, historical imports from Egypt into Gaza (which have been managed through a local Egyptian distribution company rather than the national Egyptian transmission operator) have proved unreliable due to security issues in Sinai. In addition, Gaza has not yet established any payment record with Egypt since the cost of these imports has been covered by third party benefactors to date. Finally, neither Jordan, nor Egypt have access to the controversial 'net lending' mechanism that has so far provided Israel with an informal payment security mechanism to at least partially offset any payment risk from Palestinian consumers.

10. **Thanks to major gas discoveries in the Eastern Mediterranean, it would be feasible in the medium term to import gas to the Palestinian Territories for gas-fired power generation.** Israel became a major gas producer in 1999 with the discovery of the 10.9 TCF Tamar field. The imminent development of the much larger 21.9 TCF Leviathan field will make Israel a gas exporter. The Israeli government has already given approval for a 40 kilometer pipeline extension from the Ashkelon terminal in Israel into Gaza, to allow for the conversion of the Gaza Power Plant, and for a 15 kilometer spur from the Israeli national gas transportation network into Jenin in the north of the West Bank, to allow for the construction of a new 400 MW CCGT gas-fired plant.

11. **The Gaza Marine gas field, discovered almost two decades ago, has yet to be developed.** The eventual development of this small 1.2 TCF Palestinian gas field, could allow for the substitution of Palestinian for Israeli gas. The investment costs of developing Gaza Marine have been estimated between US$0.25-1.20 billion depending on the extent to which existing Israeli gas infrastructure is shared. However, its development would require the signature of a gas supply contract of adequate volume with a credible off-taker, and it will take some time before Palestinian gas demand builds up to the requisite levels (Figure D). Once developed, Gaza Marine has the potential to generate US$2.7 billion in fiscal revenues for the Palestinian Authority over its estimated 25-year life of production.

Figure D: Estimated natural gas demand (BCM) in the Palestinian Territories until 2030



Source: Delek Drilling.

12. **The Palestinian Territories have substantial potential for solar electricity in the West Bank, particularly in Area C** (Figure E). Solar energy is the only significant renewable resource in the Palestinian Territories. The technical potential in the West Bank is estimated to be around 530 MW of rooftop solar PV, and at least 100 MW of utility scale solar in Areas A and B. This is dwarfed by the vast solar potential of over 3,000 MW estimated in Area C, which would be suitable for both PV and CSP technologies. Nevertheless, the significant political challenges associated with securing Israeli approval for construction in Area C casts some doubt over the possibility of developing this resource. By contrast, extreme land constraints in the Gaza strip limit the available solar potential to 160 MW of rooftop solar. However, even this limited solar capacity could play a vital role in increasing energy security and acting as an electricity safety net.

Figure E: Overview of solar energy potential in West Bank and Gaza

Potential Available RE Capacity (MW)				
Utility scale PV or CSP[1]				
	Area A & B		Area C	Total
West Bank	103		3,374	3,477
Gaza				0
Palestinian Territories				3,477
Rooftop Solar[2]				
	Residential	Public	Commercial	Total
West Bank	490	13	31	534
Gaza	136	8	19	163
Palestinian Territories	626	21	50	697

Source: Own estimates

[1] Assumptions: According to PETL and PEC, 0.12 percent of Area A and B and 3 percent of Area C are available for solar installations. The land requirement is ~28m2 per KWp (includes space for control rooms etc).

[2] Assumptions: According to PCBS and PEC, in West Bank and Gaza, there are over 400,000 residential, 2500 public sector and 5000 commercial sector rooftops. The rooftop areas range from 150-300m2 and between 30-50 percent of the rooftops are available for solar installations. The rooftop space requirement is 9m2 per KWp.

13. **Measures to improve energy efficiency can also make a valuable contribution to energy security going forward.** The existing Palestinian National Energy Efficiency Action Plan aims to make savings equivalent to one percentage point of energy consumption annually through to 2020, focusing primarily on reducing electricity consumption by improving the energy efficiency of residential buildings. A much more ambitious action plan is under consideration by the Palestinian Energy and National Resources Authority for 2020-2030, and aims to save 5 percent of the energy consumption anticipated during that period. The new strategy encompasses high impact energy efficient appliances (such as heaters, fridges and air conditioners), further tightening of efficiency standards for buildings, and smart grid infrastructure to allow consumers to participate in the energy market as demand response. Investments to improve energy efficiency are proven to be much more cost-effective than expanding power generation capacity. Specifically, many of the measures included in the Government's plans cost between US$0.01-0.05 per kilowatt-hour, while new generation would cost at least US$0.10 per kilowatt-hour.

14. **As domestic Palestinian generation capacity expands, transmission infrastructure will also need to develop.** At present, there is no significant power transmission infrastructure in the Palestinian Territories as most power is simply absorbed and distributed from the Israeli grid at low and medium voltage. As the Palestinian Territories increase their domestic generation capacity, there will be an increasing need to move power from the point of generation to the centers of demand that may be located some distance away. In Gaza, this will call for a strengthening of the transmission backbone within the compact urban area. In the West Bank, this could initially be managed by wheeling power back into the Israeli grid at one location and bringing it back in at a different location. The level and structure of the associated 'wheeling charges' will have a significant effect on the cost of power supply. As the volume of wheeling rises, it will become increasingly attractive to develop a transmission backbone in the West Bank. However, since the backbone would need to traverse Area C, the issue of securing the necessary construction permits from Israel would once again present a significant challenge.

How Can the Palestinian Territories Choose Among Available Options?

15. **Choosing among the available energy options for the Palestinian Territories involves balancing technical and financial considerations.** Meeting electricity needs typically involves developing a balanced portfolio of power supply options that represent a reasonable and affordable cost.

16. **From a technical standpoint, the different energy supply options need to be sequenced and packaged into an investment plan that reliably meets electricity demand.** The different power supply options described above vary in terms of production cost, physical production characteristics, availability, and associated risks. For example, gas-fired power generation will only be feasible once gas transportation infrastructure is completed and a gas supply agreement can commence, while generating solar power from photovoltaic panels is subject to variability in solar radiation throughout the day and from one day to another. Gas-fired power generation may be vulnerable to a curtailment of gas supply, while solar power is a fully indigenous resource.

Also, the costs of gas-fired power generation are relatively well understood though susceptible to variations in the price of natural gas, while the costs of generating solar power are declining rapidly along a path that is not straightforward to predict. All of these considerations need to be carefully balanced in defining the best possible power generation investment plan. Box 1 provides an overview of alternative scenarios that were considered in a novel Robust Power System Planning Model developed uniquely for the Palestinian context.

Box 1: A Robust Power Systems Planning Model for the Palestinian Territories

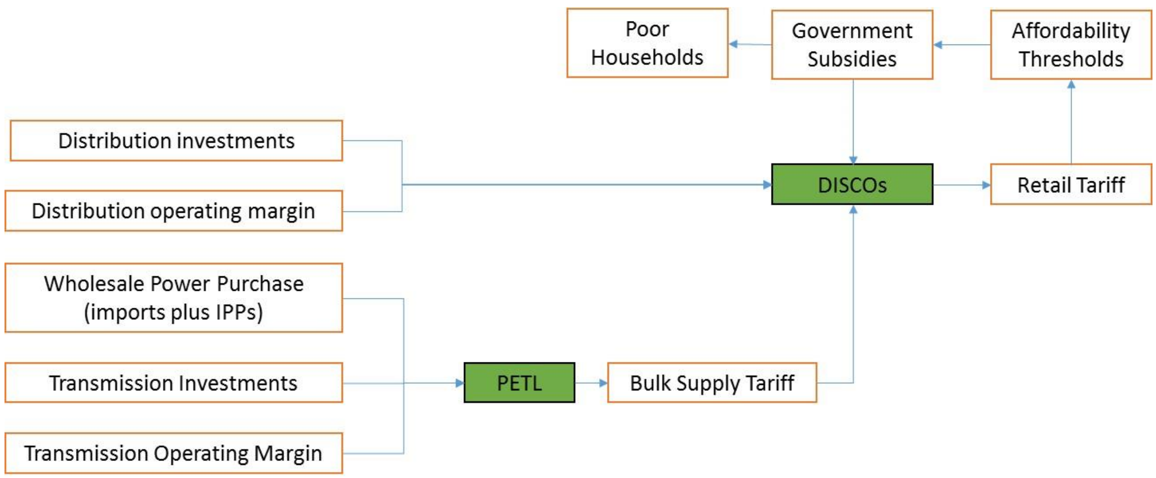
In order to select from among the various energy supply options, a traditional least cost power systems planning model is modified to account for the inherently uncertain nature of the Palestinian context, and used to identify investment plans that are as resilient as possible to alternative states of the world. Five illustrative planning scenarios for West Bank and Gaza are explored, covering the period through to 2030.

(i) '*Do nothing*' considers how rapidly energy security will deteriorate if no further investments are made.
(ii) '*Planned future*' looks at the impact of implementing all investment projects currently in the pipeline.
(iii) '*PENRA vision*' explores limiting dependence on any one source of energy to no more than 50 percent.
(iv) '*Maximum cooperation*' considers meeting demand growth primarily through increased Israeli imports.
(v) '*Maximum independence*' considers the fullest possible extent of domestic power generation.

17. **From a financial standpoint, it is important to understand the tariff implications of the preferred investment plan and whether it is affordable to the population.** The costs of providing a secure electricity service include not only the cost of power generation, but also the associated transmission and distribution infrastructure. To the extent that the sector operates inefficiently, costs will be further inflated. Given fiscal constraints, it is assumed that domestic power generation could be developed by the private sector under a Power Purchase Agreement, leaving limited public investment for transmission and distribution where private investment would be difficult to harness. At the end of the day, these costs must either be paid by the consumer through retail tariffs or by the government through subsidies. Both sources of funding are constrained, given the relatively low income of the population as well as the limited budget of government. So an important reality check for any power sector investment plan is to examine its impact on retail tariffs, whether these are affordable, and – if not – what the potential size of the associated subsidy bill would be. Due to the diverse features of the power sector in the two territories composing the Palestinian Territories, the study analyses separately the West Bank and the Gaza Strip. (For more information on the financial model of the Palestinian electricity sector developed for this study, see Box 2.)

Box 2: A Power Sector Financial Model for the Palestinian Territories

The planning model (see Box 1) feeds into a comprehensive financial model of the Palestinian power sector, so as to shed light on the financial implications of any particular investment scenario. The financial model looks at how the selected generation investment plan translates into an average cost of power generation, converts this into a wholesale power tariff by further incorporating the costs of any future transmission system, overlays a distribution margin in order to come-up with a retail tariff, and finally assesses the affordability of this tariff to the population, as well as the fiscal implications of any remaining subsidies.

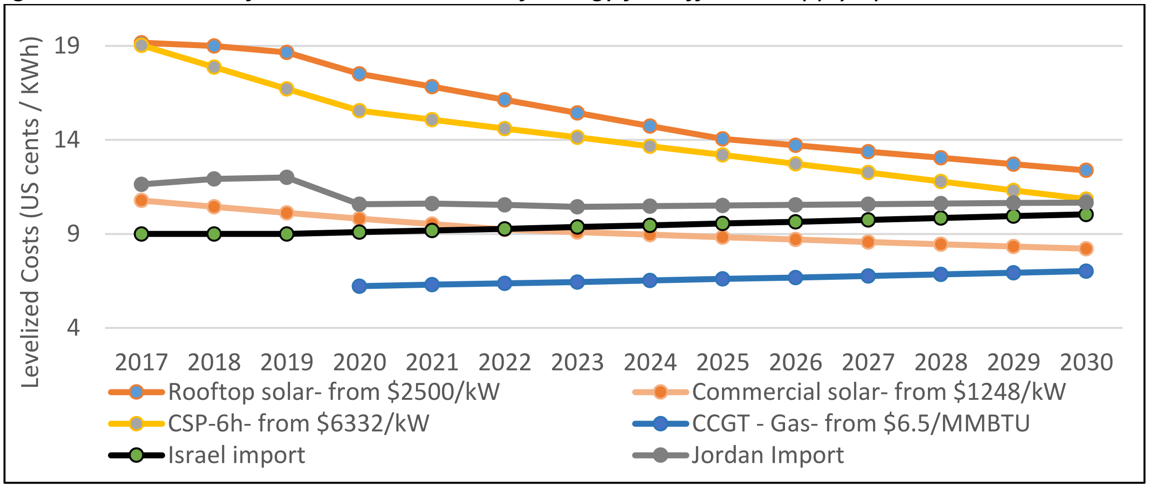


What Does West Bank's Energy Future Look Like?

18. **Failure to invest in the West Bank's power sector would lead to deepening shortages over time.** Under the 'do nothing' scenario, unserved demand rises from negligible levels today to reach 9 percent by 2030, with certain locations – such as Jenin and Nablus – having already experienced unserved demand in 2016. To avert this outcome, the West Bank must develop a number of alternative energy supply options.

19. **The development of gas-fired power generation and renewable energy should be pursued more intensively in light of the cost convergence of different energy supply options over time in the West Bank** (Figure F). As of 2017, there is a wide variation in the cost of the different energy supply options available to the West Bank, and Israeli imports carry a cost advantage over any of the alternatives. However, this changes over time. Gas-fired power generation, once available, proves to be cheaper than Israel imports. While continuing technological change in renewable energy, brings the cost of utility scale solar PV below the cost of Israeli imports before the end of the planning horizon, while rooftop solar and even Concentrated Solar Power start to look a lot more competitive. These evolving relative costs of power generation are one important driver of project selection.

Figure F: Time trends for the Levelized Cost of Energy for different supply options in the West Bank



20. **There are a number of attractive power development scenarios available to the West Bank, all of which are broadly competitive with Israeli power imports**. The performance of the five alternative scenarios presented by the planning model can be compared along a number of dimensions, with no single scenario dominating on every dimension (Figure G).

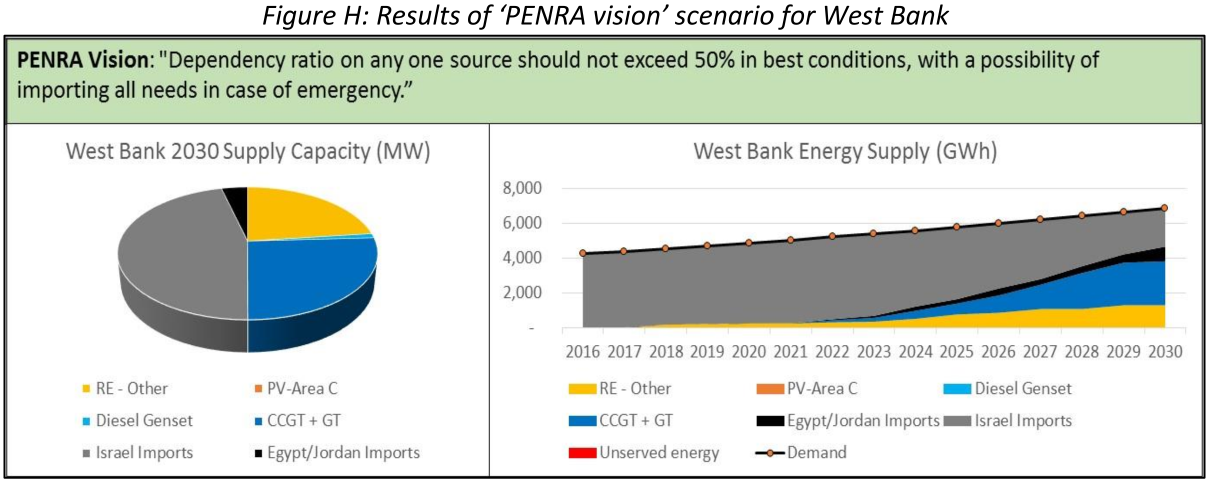
a. <u>Average cost of power generation:</u> This is a key driver of retail tariffs and varies remarkably little across the scenarios considered for the West Bank, ranging from US$0.098 to US$0.102 per kilowatt-hour. This is due to the convergence in the cost of different power generation technologies already noted above.
b. <u>Capital expenditure</u>: Scenarios contemplating continued reliance on Israeli imports require hardly any capital expenditure to be made, whereas those involving the development of domestic power generation capacity would entail private investments of between US$0.85 and US$2.28 billion.
c. <u>Unserved demand</u>: All scenarios that bring new investment into power generation ensure that all demand can be reliably met; although there a small chance of unserved demand remains when there is no diversification away from Israeli imports.
d. <u>Reliance on electricity imports:</u> The degree of reliance on Israeli imports ranges from 96 percent in the 'maximum cooperation' scenario to 36 percent in the 'maximum independence' scenario. Hence, Israel remains a significant source of electricity under any eventuality.
e. <u>Reliance on imported fuel:</u> All of the scenarios entailing significant development of Palestinian power generation capacity entail reliance on gas imports to meet between 32-37 percent of electricity needs.
f. <u>Reliance on domestic renewables:</u> Domestic renewables represent the only source of truly independent power as neither the power, nor the fuel, needs to be imported. The maximum share that can be reached for domestic renewables, even under the most optimistic scenario, is 19 percent if production is limited to Areas A and B or 30 percent if sites in Area C can be developed.

Figure G: Comparison of results across planning scenarios for the West Bank

		Average Cost of Power (US cents/ KWh)	CAPEX (mil USD)	2030 Unserved Demand (%)	2030 Electricity Imports (%)	2030 Domestic Gen – Imported Fuel (%)	2030 Domestic Gen–RE (%)
1	Do nothing	9.79	0	9%	90%	0%	0.4%
2	Planned Future	10.06	850	0%	64%	32%	4%
3	PENRA Vision	10.16	2,133	0%	45%	37%	19%
4	Maximum independence	9.88	2,284	0%	36%	34%	30%
5	Maximum cooperation	9.78	174	1%	96%	0%	4%

21. **Overall, the 'PENRA vision' scenario looks relatively attractive** (Figure H). It calls for development of gas-fired power generation capacity, along with aggressive expansion of solar energy on rooftops and in Areas A and B to attain over 500 MW of solar PV capacity by 2030; which is about 4-5 times the current target. By 2030, this scenario achieves a relatively balanced composition of domestic solar, gas-fired power generation and Israeli imports. Import capacity is nonetheless kept higher than strictly needed to provide back-up in the case of shortfalls in the other sources of energy.

Figure H: Results of 'PENRA vision' scenario for West Bank

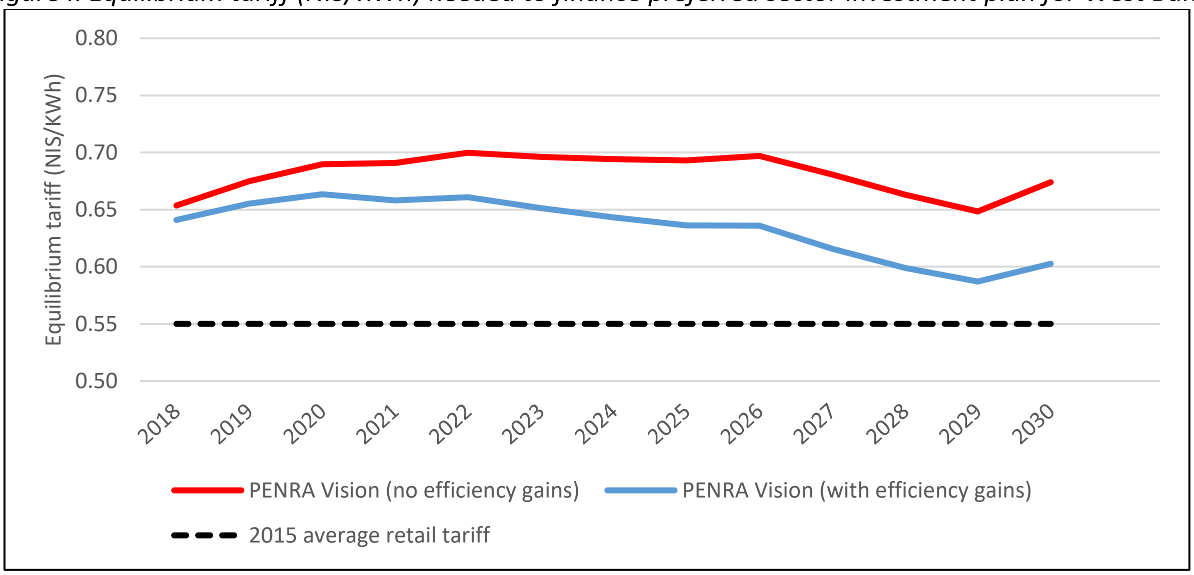


Source: Robust Power System Planning Model

22. **To implement 'PENRA's vision', electricity tariffs would need to increase significantly in the medium term, but could potentially reduce over time if efficiency targets are met.** The financial equilibrium tariff needed to sustain the envisaged investments in generation in the West

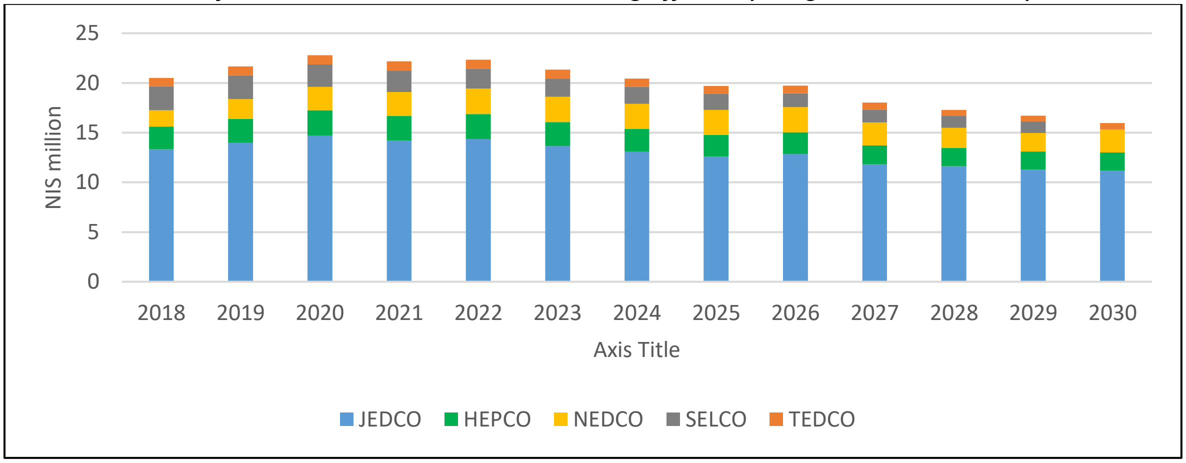
Bank, as well as the associated transmission and distribution costs, starts at approximately to NIS 0.66 (US$0.18) per kilowatt-hour in 2018, well above current retail tariff of NIS 0.55 (US$0.15) per kilowatt-hour (Figure I). However, if the operational and commercial efficiency of the distribution utilities could be improved over the same time period, the financial equilibrium tariff could drop back towards NIS 0.58 (US$0.16) per kilowatt-hour by 2030. Essentially, addressing the shortcomings of the distribution utilities can reduce the retail tariff by as much as NIS 0.07 (US$0.02) per kilowatt-hour. Failure to adjust tariffs as needed would create a financial deficit in the sector peaking at NIS 450 million (US$123 million) per year by 2022 (equivalent to 4.5 percent of the 2016 public budget for the West Bank).

Figure I: Equilibrium tariff (NIS/KWh) needed to finance preferred sector investment plan for West Bank



23. **The resulting increase in tariffs would present an affordability problem only for the poorest households in the West Bank, and this could be addressed through a modest targeted subsidy.** According to usual practice, electricity service is considered affordable if households can meet their basic needs without spending more than 5 percent of their monthly budget. In the context of the Palestinian Territories, the first block of the tariff schedule set at 160 kilowatt-hours per month, broadly allows households to meet such requirements. Based on the distribution of income in the West Bank, only the poorest 10 percent of the population would struggle to buy 160 kilowatt-hours per month at the required financial equilibrium tariff of NIS 0.66 (US$0.18) per kilowatt-hour. Assuming that these needy households could be identified using existing social registries, the cost of a targeted subsidy to safeguard their basic consumption would amount to no more than NIS 25 million (US$7 million) per year declining as tariffs come down due to efficiency gains by distribution utilities (Figure J).

Figure J: Targeted subsidy requirement to offset affordability concerns of the bottom income decile in the West Bank for PENRA Vision scenario assuming efficiency targets are reached by 2030

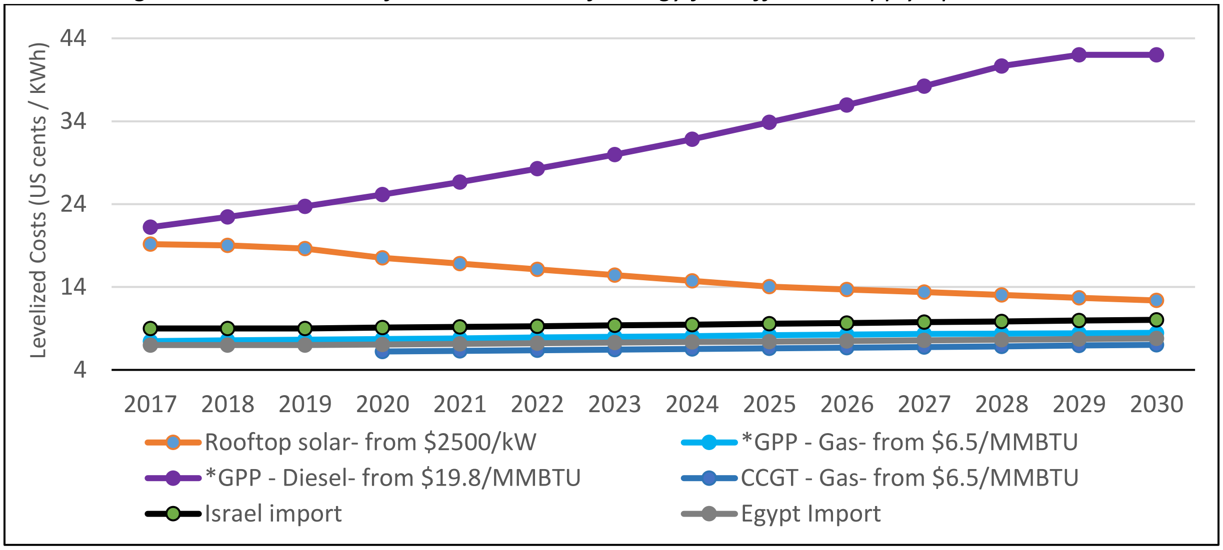


What Does Gaza's Energy Future Look Like?

24. **Failure to invest in Gaza's power sector would make an already dire situation even worse.** Gaza is already unable to meet 50 percent of its demand today. If no further power options are developed, the extent of unserved energy would further escalate to 63 percent of demand by 2030. To avert this outcome, Gaza needs to develop additional power supply options; albeit from a much more limited menu than that available to the West Bank.

25. **The cost of the diesel-fired Gaza Power Plant becomes increasingly unattractive over time relative to alternative options** (Figure K). As of 2017, the diesel-fired Gaza Power Plant is already very expensive compared to alternatives and this cost is projected to rise along with the international oil price. Israeli electricity can be imported at fraction of the cost of current domestic generation, and Egyptian imports are even cheaper though heavily restricted in supply and rather unreliable. Conversion of the Gaza Power Plant to fire on gas would make it competitive with Israeli and Egyptian imports. While rooftop solar looks relatively expensive today (though still undercutting the Gaza Power Plant), the cost is expected to fall significantly over the planning horizon converging towards Israel imports. These changing patterns of relative costs are one key driver of investment planning decisions.

Figure K: Time trends of Levelized Cost of Energy for different supply options in Gaza



26. **The alternatives for Gaza are much more constrained than for the West Bank and the premium associated with energy independence particularly high**. The key energy policy issue for Gaza is where to strike the balance between Israeli imports and domestic gas-fired power generation, while intensively developing solar rooftop PV. The performance of the five alternative scenarios presented by the planning model can be compared along a number of dimensions (Figure L).

a. Average cost of power generation: This is a key driver of retail tariffs and varies hugely across the scenarios considered for Gaza, ranging from US$0.10 per kilowatt-hour if power is entirely sourced from Israeli imports, to US$0.15 per kilowatt-hour if domestic generation is developed to the fullest extent. In marked contrast to the West Bank, the premium for energy independence in Gaza amounts to a substantial 50 percent of costs.
b. Capital expenditure: Scenarios contemplating continued reliance on Israeli imports require hardly any capital expenditure to be made, whereas those involving the development of domestic power generation capacity would entail private investments of just over US$1 billion.
c. Unserved demand: All scenarios that bring new investment into power generation ensure that all demand can be reliably met; although some chance of unserved demand remains when there is no diversification away from Israeli imports.
d. Reliance on electricity imports: The degree of reliance on Israeli imports ranges from 93 percent in the 'maximum cooperation' scenario to only 9 percent in the 'maximum independence' scenario.
e. Reliance on imported fuel: All of the scenarios entailing significant development of Palestinian power generation capacity entail reliance on gas imports to meet between 46-83 percent of electricity needs. In that sense, the 'maximum independence' scenario essentially only replaces dependence on electricity imports with dependence on gas imports.

f. Reliance on domestic renewables: Due to the fact that Gaza's renewable energy potential is limited to rooftop solar, this is not able to meet more than 6 percent of energy needs under any scenario.

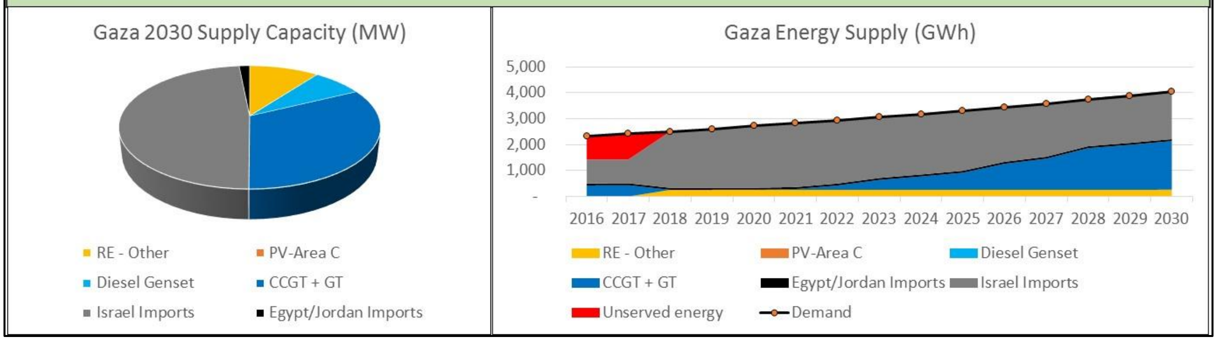
Figure L: Comparison of results across planning scenarios for Gaza

		Average Cost Power (US cents/ KWh)	CAPEX (mil USD)	2030 Unserved Demand (%)	2030 Electricity Imports (%)	2030 Domestic Generation – Imported Fuel (%)	2030 Domestic Generation – Renewable Energy (%)
1	Do nothing	14.68	0	63%	26%	11%	0%
2	Planned Future	13.39	1,035	0%	26%	68%	6%
3	PENRA Vision	12.30	1,066	0%	47%	46%	6%
4	Maximum cooperation	10.37	385	0%	93%	0%	6%
5	Maximum independence	15.15	1,185	2%	9%	83%	6%

27. **Among the energy diversification options for Gaza, 'PENRA vision' is the one offering the lowest cost premium for maximum diversification.** The differential average cost of generation between 'PENRA's vision' and the 'maximum cooperation' scenario is NIS 0.07 (US$0.02) per kilowatt-hour, or about 20 percent, still relatively high but preferable to the alternatives. The 'PENRA vision' scenario envisages a phase out of diesel-fired power generation in the short-run and increase reliance on Israeli imports (Figure M). This brings a double benefit by bringing power generation costs down to a third of current levels, while at the same time expanding supply to a point where current outages can be offset. This achievement is contingent on the commissioning of new 161 kV lines to expand import capacity from Israel. Further out, once gas becomes available, the Gaza Power Plant comes back into service and plays a growing role in meeting energy needs. By 2030, the scenario sees an almost 50:50 reliance on self-generation through gas and Israeli imports. In addition, rooftop solar provides a safety net to meet critical needs under emergency conditions.

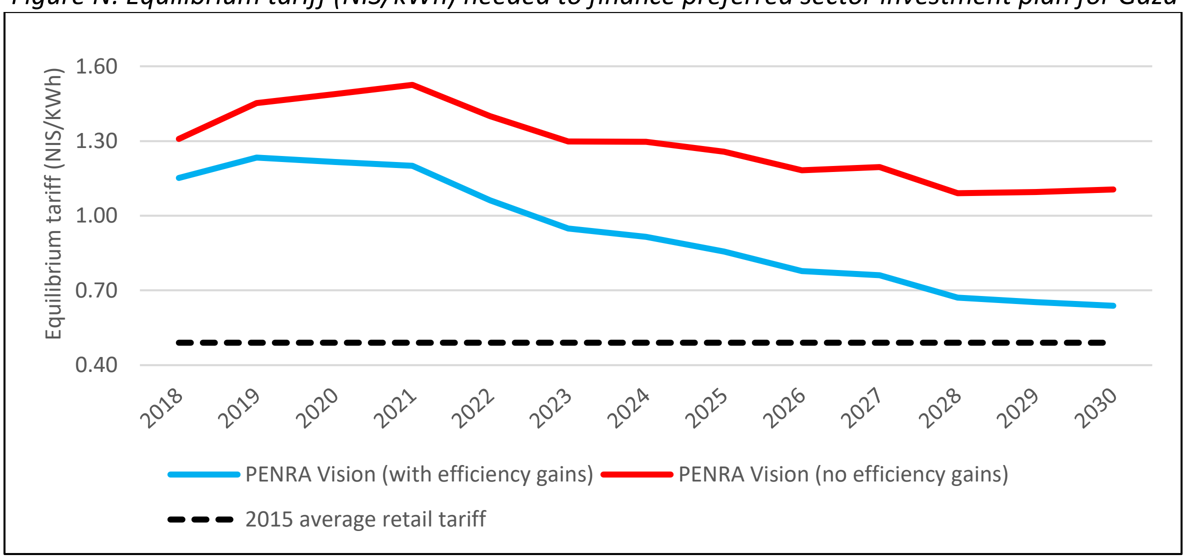
Figure M: Results of ‘PENRA’s vision’ scenario for Gaza

PENRA Vision: "Dependency ratio on any one source should not exceed 50% in best conditions, with a possibility of importing all needs in case of emergency.”



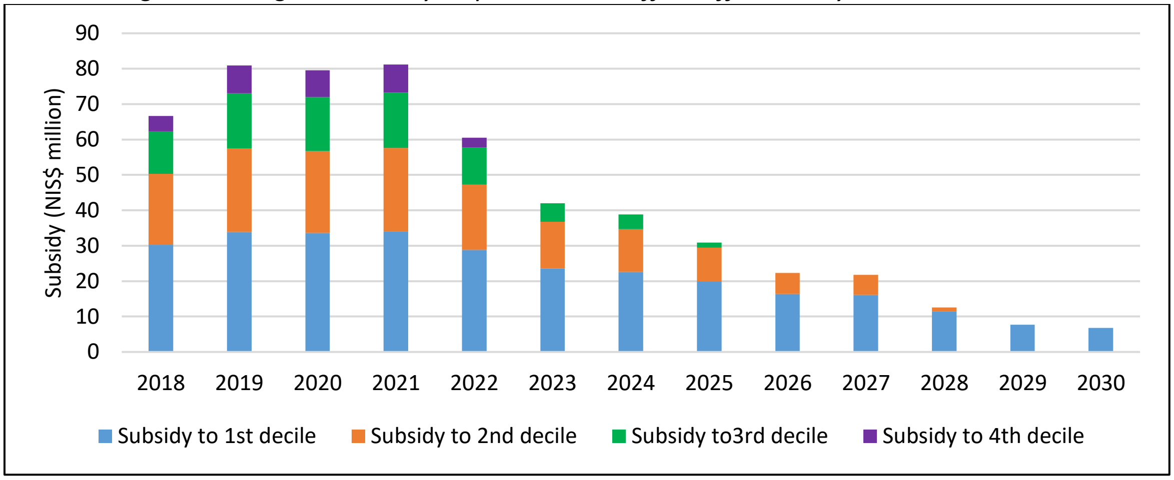
28. **The tariff impact of implementing the ‘PENRA vision’ is substantial, although can be somewhat offset by operational efficiency gains.** The ‘PENRA vision’ scenario requires a financial equilibrium tariff on the order of NIS 1.20 (US$0.33) per kilowatt-hour in the short term, well above the current retail tariff of NIS 0.50 (US$0.14) per kilowatt-hour (Figure N). This would eventually come down to around NIS 0.62 (US$0.17) per kilowatt-hour, but only as long as the Gaza utility substantially improves its operational and commercial performance in line with regional best practice, which can reduce the retail tariff by as much as NIS 0.47 (US$0.13) per kilowatt-hour by 2030. Failure to adjust tariffs would result in a financial shortfall of around NIS 1,200 million (US$330 million) per year by 2020 (equivalent to over 20 percent of the public budget for 2016).

Figure N: Equilibrium tariff (NIS/kWh) needed to finance preferred sector investment plan for Gaza



29. **Affordability is a much more serious concern in Gaza than the West Bank, given higher costs of electricity and a more impoverished population**. Based on the distribution of income in Gaza, as much as 40 percent of the population would struggle to buy 160 kilowatt-hours per month at the required financial equilibrium tariff of NIS 1.20 (US$0.33) per kilowatt-hour. Assuming that these needy households could be identified using existing social registries, the cost of a targeted subsidy to safeguard their basic consumption would amount to a maximum of NIS 80 million (US$22 million) per year in 2021. However, as tariff levels decline due to improved efficiencies by 2030, they would also become more affordable such that by the end of the planning horizon social protection would be needed only for the poorest 10 percent of the population (Figure J).

Figure O: Targeted subsidy requirement to offset affordability concerns in Gaza



What Measures Need to Be Taken by Government?

30. **To make progress on a trajectory towards greater energy security, the Palestinian Authority will need to adopt a sequenced approach to addressing the critical policy bottlenecks.** The starting point for the road map is to strengthen PETL's operational capacity and financial sustainability. While an important interim agreement has been signed in July 2017, PETL is still negotiating with IEC on: i) a Power Purchase Agreement (PPA), ii) the energization of several high voltage substations, and iii) the transfer of connection points from DISCOs and MVC's to PETL. In parallel, PETL should focus on: i) negotiating the Power Supply Agreements (PSAs) with Palestinian distributors , ii) putting in place billing and collection systems to sell power to, and collect payments from, Palestinian distributors, and iii) providing advice to PERC in the calculation of a tariff for selling power to the distributors. With these mechanisms in place, PETL could accelerate its progress towards fulfilling its role and responsibilities under the PPA and reduce its reliance on donor assistance for its operational costs. Once these immediate measures are in place, the question becomes what needs to be done next to begin to move towards the vision of improved energy security in the Palestinian Territories. The analysis suggests that there is a certain sequence in which measures will need to be taken. In particular, four distinct phases are identified (Figure P).

Phase 1: Improve Sector Creditworthiness

31. **The first phase, and absolute priority is to improve the creditworthiness of the sector without which none of the alternative supply arrangements discussed could be consummated**. Progress on all other aspects of the Palestinian energy sector depend on greater creditworthiness. Without improved creditworthiness, the sector cannot sign new power import deals or close Power Purchase Agreements with Independent Power Producers for increased domestic power generation projects, let alone import natural gas. None of these ventures can get off the ground unless the Palestinian electricity sector strengthens its creditworthiness. Financial security will bring about energy security but the reverse is not true. There are several distinct components that will need to be tackled if creditworthiness is to be improved.

i) **First, replace generation from the Gaza Power Plant with increasing electricity imports from Israel to provide considerable relief until such a time as a conversion to gas can be undertaken.** The cost of diesel-fired generation at the Gaza Power Plant is very high at approximately US$0.30 per kilowatt-hour, even at current low oil prices. This is approximately three times the cost of power imports from Israel, which also provides a much more reliable level of supply. Until such a time as the Gaza Power Plant is ready for the switch over to gas-fired generation that would slash costs to US$0.068 per kilowatt-hour, it would be desirable to substitute domestic diesel-fired power generation with Israeli power imports taking advantage of the new 161 kV line that is in an advanced stage of planning. Even taking into account the need to continue to pay capacity charges of US$0.026 per kilowatt-hour to the Gaza Power Plant, every reduction of one kilowatt-hour in diesel-fired power generation would be sufficient to buy two kilowatt-hours of Israeli imports. Such a move would simultaneously reduce costs and improve quantity and reliability of supply, and thereby increase prospects for improved recovery of costs through tariff revenues.

ii) **Second, accelerate improvements in the operational and commercial performance of Palestinian DISCOs.** Cost recovery tariffs could be substantially reduced over time if the operational and commercial performance of the Palestinian DISCOs could be improved to reasonable regional benchmark levels. For the utilities in the West Bank, improved operational performance would take US$0.03 per kilowatt-hour off the financial equilibrium tariff, while in Gaza improving operational performance is worth as much as US$0.11 per kilowatt-hour. Achieving further improvements can build on some recent successes with the introduction of prepaid and smart meters that helped to raise revenue collection rates to 85 percent on average across the utilities. Moreover, across the board, attention needs to turn toward improving network losses which remain very high despite all efforts. In this regard, it is recommended to establish a Revenue Protection Program to permanently measure and bill every kilowatt-hour sold to the largest DISCO customers with state-of-the-art technology.

iii) **Third, create securitization mechanisms to ensure that Palestinian DISCO revenues are not diverted to other municipal projects.** Due to the lack of a sub-national financing framework in the Palestinian Territories, DISCO revenues remain vulnerable to diversion into municipal budgets. The long term solution to this problem, which is to strengthen the basis of sub-national public finance is important for broader development reasons that go well beyond the energy sector; however, it will likely take some time to achieve. Hence the importance of finding interim mechanisms to securitize the revenues needed for the DISCOs to meet the costs of wholesale power purchase. This could take the form of a payment prioritization hierarchy, combined with an escrow account that requires revenues to be deposited to cover a certain advance period of wholesale power purchases before these can be supplied. The issue of securitization of revenues is particularly critical in Gaza, and would be an essential component of any moves to substitute increased Israeli power imports for domestic diesel-fired power generation.

iv) **Fourth, ensure that all Palestinian DISCOs move towards cost recovery.** Not all Palestinian DISCOs are charging cost recovery tariffs today. Only two Palestinian utilities, JEDCO and NEDCO, make formal tariff submissions to PERC. The resulting uniform tariff that is applied across all Palestinian utilities in the West Bank is estimated to under-recover costs for all but NEDCO. Moreover, PERC's practice of not passing through collection inefficiencies to the retail tariff, while defensible from the standpoint of consumers, further weakens the financial solidity of the sector. In addition, GEDCO in Gaza does not follow PERC tariff guidelines and has not adjusted its electricity tariff for a decade, currently charging a retail tariff that is US$0.03-0.05 per kilowatt-hour lower than the wholesale purchase price of electricity, without considering the costs of power distribution. The higher costs of electricity production in Gaza combined with the sensitive social context, suggest that efforts to improve cost recovery in Gaza would need to be preceded by the measures noted above to both reduce costs and improve the availability of power supply.

32. **Fifth, build the capacity of PETL to play its envisaged role in the sector.** In the new sector architecture, PETL has been assigned a dual role of Transmission System Operator and single buyer and central book keeper of the electricity sector. However, its start of operations have been delayed pending the closure of a long term Power Purchase Agreement with Israel and the energization of the high voltage sub-stations. The signature of an interim agreement with Israel to energize the Jenin high-voltage substation alone was the first step towards PETL's financial and operational sustainability and this was completed on July 10, 2017 after extensive negotiations. PETL is now able to resell the discounted power to DISCOs in the North of the West Bank at a slight markup allowing them to obtain revenues. The next step is the signing of the main long term PPA for all substations. In the meantime, PETL should make further progress towards their goal of being the single buyer, by ensuring that all wholesale power purchases are undertaken through their intermediation so as to improve transparency and discipline of the sector.

Phase 2: Advance Parallel No Regrets Measures

33. **While the absolute priority is to improve the creditworthiness of the electricity sector, there are a number of other no regrets measures that can advance in parallel during a second phase.** Even after decisive steps are taken to address the issue of creditworthiness, time will be needed for a payment record to be established and a reputation to be built. During this period of consolidation, it would be helpful to accelerate measures that will facilitate the development

of other power supply options that will become feasible, once the issue of creditworthiness has been adequately addressed.

i) **First, create the infrastructure needed to support the import of natural gas into the Palestinian Territories.** All the planning analysis confirms the strategic role that natural gas-fired power generation can play in the electricity mix for both West Bank and Gaza, as well as its relatively attractive cost. The first step in making this possible is to construct the relatively modest pipeline extensions needed to make possible the import of gas from the Israeli system. These will create the platform needed to have credible negotiations for gas supply agreements and ultimately the construction of new gas-fired plant, or the conversion to gas in the case of Gaza. The Gas-for-Gaza Project led by the Office of the Quartet has focused its efforts in removing key obstacles for the construction of a gas pipeline from Israel to the Gaza Power Plant.

ii) **Second, pursue an aggressive program to promote the uptake of rooftop solar PV.** Unlike grid-based solar power, rooftop solar PV is highly decentralized and is not contingent on progress towards sector creditworthiness and the capacity of PETL. Moreover, it has been shown that rooftop solar PV can play a valuable role as an electricity safety net to increase the resilience of the Palestinian electricity system and ensure that critical humanitarian needs can be met. This is particularly true in the case of Gaza, where efforts to pilot rooftop solar are already underway.

iii) **Third, complete the domestic transmission backbone in Gaza.** Domestic transmission constraints are already an issue in Gaza, and these will only become more severe as efforts to increase the supply of power bear fruit. It is therefore important to ensure that the modest transmission and distribution upgrades required are completed in a timely fashion, and certainly well ahead of any future expansion of the Gaza Power Plant.

iv) **Fourth, improve the enabling environment for Independent Power Projects.** While the financial creditworthiness of the sector is the single largest impediment to the implementation of Independent Power Projects, there are a number of other simple measures that could be taken to improve the quality of the enabling environment, and which could be handled through secondary legislation or executive regulations that develop broad provisions in the existing sector legislation. In particular, these include further clarifying the provisions for licensing new generators and the provisions associated with interconnection to the grid. The roles of PERC and PETL in this process also need to be further spelt out.

v) **Fifth, establish a risk mitigation mechanism to support the next generation of Palestinian Independent Power Projects.** Risk mitigation is no substitute for addressing the fundamental underlying creditworthiness issues in the sector, and it does not make sense to move ahead with risk mitigation until the Palestinian Authority has demonstrated a sustained and credible commitment to improving the financial standing of the sector. Nevertheless, once this has taken place, risk mitigation may play a valuable role in getting the next generation of Palestinian Independent Power Projects off the ground. It would therefore be valuable to work with donors to develop a suitable mechanism for risk mitigation, evaluating the relevance of a range of financial instruments such as guarantees, first loss, blended finance, and viability gap finance.

Phase 3: Implement First Wave of IPPs

34. **In a third phase, it will become possible to make progress with the first major wave of Palestinian Independent Power Projects.** These will build on the critical foundational elements already tackled under the first two phases. It makes sense to begin with those projects that look to be the most tractable from a technical and political perspective, which suggests focusing on developing CCGT capacity and utility-scale solar PV in Areas A and B.

i) **First, convert the Gaza Power Plant to CCGT gas-fired technology as the most urgent of the domestic power generation projects.** Conversion of the Gaza Power Plant to CCGT gas-fired technology once a gas pipeline comes on stream would save between US$45-62 million annually in fuel bills and provide Gaza with a cost-effective domestic source of power generation.

ii) **Second, progress with the construction of new CCGT gas-fired plant initially in Jenin, and eventually in Hebron.** Once the gas transportation infrastructure is in place, and some improvements to the sector environment have been achieved, the implementation of the Jenin CCGT plant should be relatively straightforward. Guarantees may be required to reduce the risk of non-payment by the off-taker. Two important issues need to be addressed in the project design. One is the arrangements for selling any surplus energy back into the Israeli grid. The other is to ensure that the terms of a future gas supply agreement are sufficiently flexible to allow for an eventual switch of supply from the Gaza Marine gas field should this prove to be desirable.

iii) **Third, embrace a more ambitious target for utility-scale solar PV farms in Areas A and B.** As noted in the planning analysis, it looks feasible to develop over 600 MW of solar PV capacity in the West Bank just based on potential in Areas A and B as well as rooftop. This goes far beyond the current target of 130 MW by 2020. With the improvements in the enabling environment in place, as well as the establishment of risk mitigation mechanisms, it should become feasible to scale-up and accelerate efforts to develop this solar potential.

iv) **Fourth, establish suitable wheeling arrangements with Israel.** As the volume of domestic power generation in the West Bank ramps up, there will be increasing need to move power away from generation plant towards Palestinian load centers. At present, this can only be done by wheeling power back through the Israeli grid and re-importing into the West Bank at another location. The analysis suggests that wheeling charges are relatively costly, particularly if low voltage networks need to be used. It will therefore be important to ensure that the number of sub-stations in the West Bank increases in such a way as to keep pace with the expansion of domestic supply. It would also be important to have dialogue with the Israeli regulator, PUA, regarding the charges for wheeling, and to explore any possible alternative arrangements (such as power swaps) that may help to contain costs.

v) **Fifth, engage in dialogue over the use of Area C for the development of Palestinian power infrastructure and renewable energy generation.** The planning analysis highlights the economic value of Area C, both as a location for grid-based solar generation and as the conduit for any future Palestinian electricity transmission infrastructure. While there is much that still needs to be done before the issue of Area C becomes a binding constraint, the political complexity of the issue suggests that it may be helpful to begin a dialogue process that over time can help to clarify the modalities for making use of Area C. A related question is the need to coordinate Palestinian plans to ramp-up renewable energy generation with those that also exist on the Israeli side, in order to ensure that challenges related to grid stability and the integration of intermittent sources can be adequately handled to the benefit of both sides.

Phase 4: Implement Transformational Projects

35. **The fourth and final phase would build on earlier success to tackle the more challenging, and potentially transformational, projects needed to complete the Palestinian energy vision.** These include the construction of solar generation and transmission backbone infrastructure in Area C, as well as the development of the Gaza Marine gas field.

i) **First, develop a Palestinian transmission backbone in the West Bank.** The analysis has shown that as domestic Palestinian power generation ramps up, the cost of wheeling charges back through the Israeli grid rapidly become quite significant. A more economic option in the long term would be to construct a Palestinian transmission backbone. Since such a backbone would need to cut across Area C, it would present significant technical and political challenges.

ii) **Second, develop utility-scale solar PV and CSP projects in Area C of the West Bank.** If a successful track record of solar farm development can be established on the more limited land endowments of Areas A and B, and suitable transmission backbone infrastructure can be put in place across Area C, the West Bank would be ready to benefit from larger scale solar development in Area C. This would entail both solar PV and CSP technologies.

iii) **Third, move ahead with the development of the Gaza Marine gas field.** The development of the Gaza Marine gas field is critically dependent on having a creditworthy off-taker to sign the gas purchase deal. Given the abundance of gas discoveries in the Eastern Mediterranean and the relatively small nature of the field, the development of this field will likely need to be underwritten by a significant Palestinian demand for gas. This demand will take time to develop and would only be achieved once significant gas-fired power generation was on-stream and a solid gas purchase payment record had been established in both the West Bank and Gaza. That would be a suitable juncture at which to be able to sign a bankable deal for the development of the field, allowing the Palestinian gas-fired plants to switch gradually from Israeli to Palestinian gas as the new field starts to become productive. Given the relatively small volume of Palestinian demand, it may make sense to consider the options for Gaza Marine development that require the least infrastructure development – by making use of stranded infrastructure from the Israeli Mari B field – thereby making the field economic at lower levels of throughput. The primary value of the Gaza Marine field to the Palestinian economy, lies not so much as a supply of gas –

which is in any case abundantly available in the region – nor even as a source of energy security – since Palestinian gas would likely be transported through Israeli infrastructure – but rather as an eventual source of fiscal revenues for the Palestinian authority that have been estimated at US2.7 billion over 25 years.

What Are the Costs and Benefits of Achieving Energy Security?

36. **The overall investment costs of pursuing energy security for West Bank and Gaza are estimated to amount to US$4 - 5 billion** (Figure Q). Of this total, almost all would take the form of private sector investment in domestic power generation capacity, with only US$0.3 billion taking the form of public investment in supporting infrastructure for electricity transmission and distribution, as well as gas transportation. About just over half would be needed for the West Bank and the remainder for Gaza. Significant investments would begin in Phase Two of the roadmap, peaking in Phase Three, and remaining significant in Phase 4.

Figure Q: Investment needs for the Palestinian electricity sector 2017-2030

US$ million	West Bank		Gaza		West Bank and Gaza	
	Public	Private	Public	Private	Public	Private
Phase One	-	-	-	-	-	-
Phase Two	7	800 – 1100	135	240 – 320	142	1040 - 1420
Phase Three		930		900 – 990	-	1830 - 1920
Phase Four	188	375-500	-	250 - 1,200	188	620 - 1700
Total	**195**	**2105 - 2530**	**135**	**1390 - 2510**	**330**	**3495 - 5040**

37. **Macro-economic simulations indicate that the wider development impacts of pursuing these energy investment pathways would be substantial.** According to modeling undertaken for this project, implementing the proposed investments and associated reforms would boost GDP growth by 0.3 percentage points per year in the West Bank and 0.5 percentage points per year in Gaza. Relative to the counterfactual 'do nothing' scenario, the energy subsidy bill would come down by 1.7 percentage points of GDP in the West Bank and 5.1 percentage points of GDP in Gaza. The main macro-economic benefits would come through freeing-up resources for higher levels of productive investment in these economies.

This study emphasizes the fact that financial independence in the energy sector will lead to energy independence but it is not possible to have energy independence without first achieving financial independence. In addition, the study aims to show a path towards energy security and, although the path may be fraught with financial, technical and political challenges, the study stresses that inaction is not an option.

Figure P: Summary overview of the proposed road map for Palestinian energy security

Phase 1: Improve sector creditworthiness	Phase 2: Advance parallel no regrets measures	Phase 3: Implement first wave of IPPs	Phase 4: Implement transformational projects
Substitute Israeli imports for diesel-fired generation in Gaza	**Create infrastructure for import of natural gas**	**Convert GPP to CCGT gas-fired technology**	**Develop grid-scale solar PV/CSP farms in Area C**
P: Gradually ramp down GPP and use the savings to buy additional IEC supply until GPP can be converted to gas I: Provide additional power to Gaza through 161kV	P, I: Construct natural gas pipelines for West Bank and Gaza paving the way for construction of new/upgraded power plants	P: Complete conversion and upgrade of GPP ensuring flexible gas supply agreement to allow switch to Gaza Marine I: Enter into gas supply agreement for GPP	P: Begin development of renewables in Area C only after a successful track record of renewable development in Areas A and B I: Provide permits for construction in Area C
Improve operational and commercial efficiency	**Improve enabling environment for IPPs**	**Construct new CCGT plant at Jenin then Hebron**	**Develop transmission backbone in West Bank**
P: Continue improvement of DISCO performance by reducing losses, increasing collection rates and bringing down overhead costs. One mechanism can be through a Revenue Protection Program aiming to permanently measure and bill every KWh sold largest DISCO consumers	P: Update and improve legislation and licensing provisions that would help IPPs enter the market and also clarify roles and responsibilities of PERC and PETL in this environment	P: Complete JPP and HPP construction with flexible gas supply agreement to allow switch to Gaza Marine. Build additional substations to keep pace with increased domestic generation I: Enter into gas supply agreement for JPP and HPP	P: Begin development of a transmission backbone considering also the possibility of negotiating a swap mechanism which eliminates the need for wheeling or building of infrastructure I: Provide permits for construction in Area C and/or provide swap alternatives to building a backbone
Securitize payments of wholesale electricity	**Promote uptake of rooftop solar PV**	**Develop grid-scale solar PV farms in Areas A & B**	**Develop Gaza Marine Gas Field**
P: Strengthen sub-national public finance to avoid diversion of electricity bill collections to municipal budgets and set up escrow accounts both in Gaza and West Bank to ring fence collections	P: Set aggressive targets for 160MW of rooftop PV in Gaza and 530MW in West Bank	P: Increase renewable energy targets to 600MW in West Bank and 160MW in Gaza by 2030 (includes rooftop solar) but only after the right enabling environment has been established from Phase I	P: Develop Gaza Marine with least amount of infrastructure development to keep costs low I: Allow permission to use existing Israeli infrastructure for evacuation of Gaza Marine
Adjust tariffs to better reflect cost recovery	**Develop transmission backbone in Gaza**	**Establish wheeling arrangements with IEC**	P: Palestinian measures I: Israeli measures D: Donor community measures
P: Re-examine the retail tariffs and increase rates to allow better cost recovery by DISCOs	P: Upgrade T&D network to allow increase in power supply and reduction in losses	P, I: Negotiate lower wheeling tariffs and/or swap arrangements until a transmission backbone is built	
Build the capacity of PETL to play its role	**Design a risk mitigation mechanism for IPPs**	**Engage in dialogue over use of Area C**	
P: PETL to streamline billing to, and payments from DISCOs while in parallel pushing to energize the new substations and sign the PPA with IEC I: Sign bulk supply PPA and energize new substations	P, D: After creditworthiness issues from Phase I have been improved, develop financial risk mitigation instruments such as guarantee mechanisms	P, I: Coordinate on Area C access and permitting issues as well as grid stability and regional integration for supply expansion and transmission infrastructure	

Part I – Palestinian Energy Sector Context

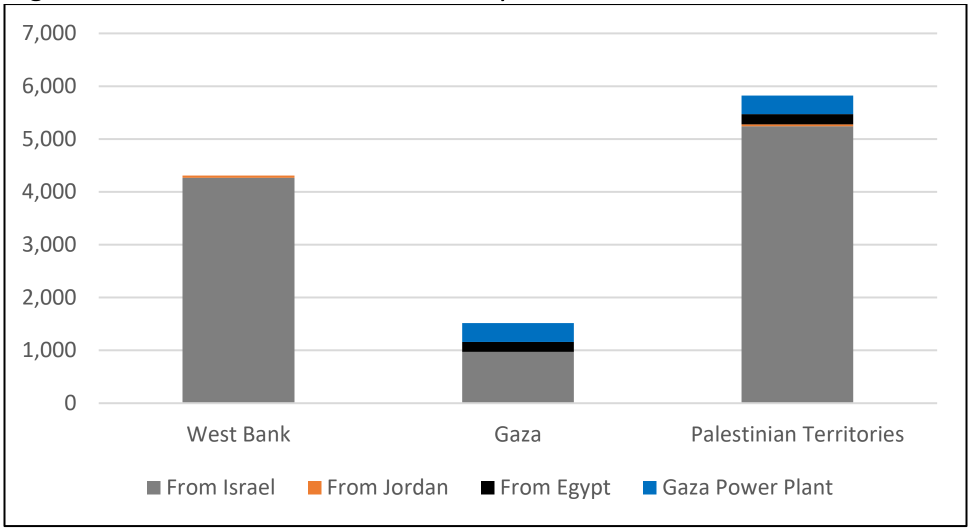
1. The Palestinian Electricity Sector:

1.1 Sector overview and challenges

38. **The Palestinian Territories face significant energy security challenges, already severe in Gaza, but also emerging in the West Bank.** Limited power supply is rationed through rolling blackouts which are increasing in frequency in the West Bank and in duration in Gaza. In Gaza, the available power supply only meets half the demand resulting in the rationing of power through rolling blackouts with 8 hours of power supply followed by 8 hours of power cuts. During peak summer and winter load conditions, the power schedule is reduced to 3-4 hours per day. Although the West Bank generally enjoys 24 hours of power supply, in recent years they have also began experiencing power shortages during peak winter and summer months. Electricity shortages in both West Bank and Gaza are often met with mass protests and demonstrations.

39. **West Bank and Gaza rely primarily on Israel for electricity imports, particularly in the West Bank.** Imports of electricity from the Israeli Electric Corporation (IEC) account for 99 percent of electricity supply in West Bank and 64 percent in Gaza but have recently been constrained as the existing power lines are becoming overloaded (see Figure I-1.1). Up to now, Israeli power has been provided through over 270 low and medium voltage connection points between Israel and the West Bank with a total contracted capacity of 890 MW. In Gaza, 10 connection points with Israel provide 120MW of capacity. Due to the low and medium voltage connection points, Palestinian consumers have historically paid higher Israeli tariff rates of NIS 0.33-0.37 ($0.09-0.10) per kilowatt-hour, and cannot benefit from the lower tariff rates available to higher voltage customers. Furthermore, the proliferation of connection points has made it difficult to monitor electricity flows across the territories. In the West Bank, four new 161 kV substations have recently been constructed with donor support, which will allow for the import of electricity from Israel through a small number of high voltage lines. While for Gaza, an additional 161 kV interconnector with Israel is planned. Refer to Part 1, Chapter 7 for more detail on the Palestinian transmission and distribution system. See Annex 1 Figures A1.1 and A1.2 for maps of the existing electricity supply options.

Figure I-1.1: Main sources of electricity in the Palestinian Territories, 2015



40. **The Palestinian Authority does not have control over most of its territory, adding layers of complexity to the implementation of infrastructure projects.** The Oslo II Accord divided the West Bank in three administrative divisions: Areas A, B and C. The distinct areas were given different statuses, according to their governance pending a final status accord. Area A comprises around 18% of the West Bank and is exclusively administered by the Palestinian Authority; Area B comprises around 22% and is administered by both the Palestinian Authority and Israel; and Area C, which contains Israeli settlements comprises 60% of the West Bank and is administered by Israel (see Figure A7.3 in Annex 7). A key Israeli actor in the Palestinian power sector is COGAT (Coordinator of Government Activities in the Territories Unit), which operates under the Israeli Ministry of Defense and is responsible, among other issues, for dealing with energy and electricity supply issues in Area C[3]. COGAT's authorization is required for regional electricity projects, such as interconnectors with neighboring counties, as well as any power generation or transmission infrastructure to be built within the West Bank. COGAT plays an important role in the monitoring and maintenance of distribution infrastructure and provides assistance in dealing with failures.

41. **In addition to the Israeli supply, modest volumes of power are imported from Jordan into the West Bank and from Egypt into Gaza.** Egypt's Al Kanal Electricity Company can supply up to 30MW of electricity through three medium voltage 33kV connections points at the southern end of the Gaza strip (see Figure A1.2 in Annex 1). The power lines from Egypt are frequently out of service delivering significantly less than the 30MW capacity. Furthermore, the available electricity is of poor quality and subject to frequent voltage and frequency deviations that damage expensive and sensitive equipment at hospitals such as MRI machines and CT scans. The majority of the power from Egypt is paid for through the Arab League as a donation relieving the obligation of payment on Gaza and the Palestinian Authority. As a result, there is no track record of payment between the Egyptian power utility that supplies electricity to Gaza and the local distribution company GEDCO. As for the West Bank, Jordan's National Electric Power

[3] For large energy projects in Areas A and B, COGAT has been requesting that their approval be obtained in advance

Company (NEPCO) can supply up to 20MW through a medium voltage connection. JDECO currently purchases power from NEPCO by arbitraging between IEC and NEPCO Time of Use (TOU) prices. NEPCO prices are on average NIS 0.11-0.15 (US$ 0.03-0.04) per kilowatt-hour higher than IEC prices, except at certain times of day during specific seasons. Refer to Part 1, Chapter 5.2 for more details on the cost of Jordanian versus Israeli power. While there are plans to upgrade the Jordanian interconnector to allow more imports, similar to the case of Egypt, the question of payment remains the main concern.

42. **The Gaza Power Plant (GPP) is the only significant domestic generation capacity in the Palestinian energy portfolio, and has been plagued with difficulties.** The Gaza Power Plant (GPP) is owned by the Gaza Power Generation Company (GPGC) which is in turn owned by the Greek-Lebanese construction company Consolidated Contractors Company (CCC). The plant entered into commercial operation on March 15, 2004 under a 20 year PPA contract which requires that the Palestinian Authority (PA) cover take-or-pay capacity charges of NIS 0.096 (US$ 0.026) for the full 140MW capacity of the plant. This capacity charge is paid to the owners of GPP regardless of the level of the plant's actual production and output. In addition, the PA must cover the cost of fuel which, depending on the level of fuel taxes and exemptions applied, can range from NIS 0.74 – 1.3 (US$ 0.20-0.40) per kilowatt-hour for the diesel fuel alone. Although the plant has a rated capacity of 140MW, it normally operates at less than 50 percent of its capability due to the inability of the Palestinian institutions to pay the high costs of diesel fuel. As international donor support to West Bank and Gaza has declined in recent years, budget constraints have resulted in the Palestinian Authority reducing exemption on fuel taxes to Gaza more than doubling the cost of fuel for GPP. The plant has also suffered repeated damage during armed conflict affecting its fuel storage capacity. Considering both the capacity charges and the fuel costs, the Gaza Power Plant is very expensive to run at approximately NIS 1.05-1.65 (US$ 0.30-0.45) per kilowatt-hour equal to more than three times the IEC power import tariff. GPP is already designed to operate on natural gas which would significantly bring down its cost of power production. This will become possible once the planned gas pipeline project linking Gaza to gas terminals at Ashkelon in Israel is completed.

43. **In the West Bank and Gaza, renewable energy generation is still in its infancy.** The Palestinian cabinet adopted a renewable energy strategy in 2012 which set a target of 130MW for domestic renewable generation by 2020 of which only 18MW has been installed as of 2017. The renewable energy laws, which laid the rules and regulations for entering the Palestinian renewable energy market, were released only in mid-2015. In terms of utility scale solar PV, many private sector entities have shown great interest and several licenses have been granted. However, by law, projects over 1MW can only sell to the single buyer, PETL, which is not currently creditworthy and lacks any kind of payment record. This high risk of non-payment, together with the possibility of significant construction delays is discouraging project developers and financiers alike. Further obstacles, are lack of access to prime land in Area C, as well as the lack of transmission infrastructure to evacuate the power. In terms of rooftop solar, the Palestinian Solar Initiative (PSI), launched in 2012 aimed to install on-grid residential rooftop solar systems in the West Bank each with a range of 1-5kw, for a total installed capacity target of 5MW by 2015. Under the plan, households purchase the solar systems themselves through 'green loans' and sell

energy back to the grid in return for a feed-in-tariff. Although initially attractive, over time the PA reduced the feed-in-tariff rates due to budgetary restrictions, making the program progressively less attractive to consumers. As of December 2016, PENRA reported that approximately 300 systems were installed under PSI. Refer to Part 1, Chapter 6 for further details on the Palestinian renewable energy sector.

44. **An unfinished power sector reform, which started over twenty years ago, consolidated the distribution segment into a handful of local distribution companies.** The Palestinian Energy and Natural Resources Authority (PENRA), established in 1995, launched key institutional reforms including the consolidation of hundreds of small municipality and village councils' (MVC) electricity services into six larger distribution companies (DISCOs) to benefit from economies of scale. These include Gaza Electricity Distribution Company (GEDCO), Hebron Electricity Distribution Company (HEPCO), Jerusalem District Electricity Distribution Company (JDECO), Northern Electricity Distribution Company (NEDCO), Southern Electricity Distribution Company (SELCO) and Tubas Electricity Distribution Company (TEDCO). Despite considerable progress, a significant number of municipalities and village councils continue to distribute power independently, rejecting the legal imperative to integrate electricity services and merge with the DISCOs. Together these independent municipalities and village councils represent up to 30 percent of total power sales in the West Bank. In the long run, the goal is to further consolidate all DISCOs and MVCs in the West Bank into one central DISCO thereby reducing overhead costs and in turn bringing down the retail sales tariff. See Annex 1 figures A1.5 to A1.16 for the financial statements provided by each DISCO from 2011-2015.

45. **JDECO is the longest standing distribution company in the Palestinian Territories and is regulated by both Israeli and Palestinian authorities due to the nature of its service area.** In contrast to the other five DISCOs that were created as part of the recent sector reform, JDECO is a longstanding utility that has been in existence since 1914. JDECO's coverage area includes: i) East Jerusalem (30%), which falls under Israeli control with tariffs and regulations set by the Israeli Public Utility Authority (PUA), and ii) the central West Bank (70%) including Ramallah and Jericho, which falls under the control of the Palestinian Authority with tariffs and regulations set by the Palestinian Electricity Regulatory Council (PERC). As noted above, JDECO purchases the bulk of its supply from IEC, supplemented by Jordanian imports when demand peaks or pricing rule differences prove advantageous.

46. **The Electricity Law 2009 created a number of new sector institutions and provided the beginnings of a legal framework for PPP in the sector.** The new legislation paved the way for a new sector regulatory entity, as well as the creation of a separate transmission company, as described further below. In addition, the law provides a basis for new generation projects to be developed in West Bank and Gaza on a PPP basis by classifying this as a licensed activity. Nevertheless, few details are provided about the detailed terms and conditions of licenses or their classification into different categories, and the law is silent about roles and responsibilities for the grid connection of new generation plants. In the absence of broader PPP framework legislation, these kinds of issues would need to be settled through secondary legislation or supporting regulations.

47. **The establishment of the Palestinian Electricity Regulatory Council (PERC) has helped provide a more solid technical basis for the determination of tariffs.** In 2009 the Palestinian Electricity Regulatory Council (PERC) was established, with support from the World Bank and the EU, with a mandate of regulating and monitoring the energy sector. A key contribution of PERC has been to adopt a clear tariff-setting methodology and set a unified end-user tariff for the Palestinian Territories (see Annex 1 figures A1.3 and A1.4 for a breakdown of PERC's tariff structure). In addition, PERC has managed to significantly improve data collection over the past few years allowing the regulator to track technical, financial and customer service key performance indicators for each DISCO on a quarterly basis.

48. **A new transmission company, PETL, has also been established as part of a move to rationalize power import arrangements with Israel.** In 2013, the Palestinian Electricity Transmission Company Ltd (PETL) was established, with support from the World Bank, with a mandate to be the single buyer and Transmission System Operator (TSO) for the Palestinian energy sector. Although the Palestinian energy sector does not yet have any transmission infrastructure, PETL will be responsible for maintaining and operating the new substations, and acting as the single buyer of wholesale power purchased from Israel, as well as from any future Palestinian IPP. In the absence of transmission infrastructure, the electricity network in the West Bank takes the form of a series of "electricity islands", all connected to the Israeli grid, rather than one interconnected Palestinian network. Refer to Part 1, Chapter 7 for further discussions on PETL and the transmission and distribution grids.

49. **The political division between the West Bank (ruled by Fatah) and Gaza (ruled by Hamas) reduces the ability of PENRA, PETL and PERC to exercise their jurisdiction in Gaza.** In principle, the new institutional structure applies across the Palestinian Territories. However, in practice, GEDCO, the Gaza utility, operates independently of this framework. For example, GEDCO does not follow the unified tariff set by PERC and adopted by all the DISCOs in the West Bank. In fact, PERC has no enforcement capability in Gaza as the board and governance structure of GEDCO do not report to the Palestinian Authority. PENRA does have a branch office on the ground in Gaza, which works very closely with GEDCO and with PENRA Ramallah to coordinate activities; but it does not have direct control over GEDCO. PENRA in Gaza supports GEDCO by facilitating materials entry for energy projects in Gaza, organizing provision of fuel for the Gaza Power Plant, and communicating and coordinating with the international community on energy projects in Gaza.

50. **Despite some improvements, the electricity sector suffers from operational and financial problems due to high losses and low collection rates.** In 2015, DISCOs in West Bank and Gaza (WBG) billed consumers for 76 percent of the power they purchased from suppliers with the other 24 percent lost and never billed due to the poor state of the infrastructure and due to illegal connections. Of the electricity billed to consumers, DISCOs collected 84 percent of invoices with 16 percent accumulating as outstanding debt from consumers to DISCOs. Overall, this means that for every 100 kilowatt-hours supplied to the DISCOs from IEC, only 64 kilowatt-hours actually generate revenue; although, there is significant variation in performance across

companies (see Figure I-1.2 below). The net annual income of JDECO has been negative year after year over the past five years, despite the company's scale advantages and relatively high collection rates arising from the successful implementation of pre-paid meters. However, the company faces challenges in terms of high distribution losses and operating expenditures. On the other hand, NEDCO is by far the most efficient DISCO in West Bank and Gaza with the lowest losses and overhead costs and the highest collection rates.

Figure I-1.2: Overview of Palestinian electricity distribution companies, 2015

	GEDCO	Total West Bank	JDECO	NEDCO	HEPCO	SELCO	TEDCO
Scale							
Customers	231,500	436,389	256,314	90,265	45,660	25,650	18,500
Purchased Electricity (mil NIS)	795	1,398	871	250	164	71	42
Billed Electricity (mil NIS)	518	1,509	949	245	193	76	46
Net Annual Income/loss (mil NIS)	n.a	-76	-82	9	9	-15	3
Performance							
Losses-Technical and non-technical (%)	26%	22%	24%	17%	20%	28%	16%
Collection ratio (%)	65%	89%	91%	98%	81%	71%	76%
O&M as percentage purchased electricity (%)	8%	17%	22%	5%	10%	21%	17%

51. **Bill collection rates are particularly low in Gaza and in refugee camps in the West Bank due to difficult living conditions and a culture of non-payment.** In Gaza, paying electricity bills is not considered a high priority, particularly given the low quality of service. This is understandable given that the population has been affected by armed conflict every 2-3 years over the past decade and faces the highest unemployment rate in the world at 42 percent. Refugee camps in the West Bank are also challenging in terms of revenue collection, as they combine high levels of per capita consumption with very low rates of bill payment. According to a recent survey, underlying reasons for non-payment of electricity bills are the high cost of electricity, low income, poor quality of service, and perceived exemption due to refugee status. Moreover, the poor security conditions in the camps make it difficult for DISCO staff to enter and enforce revenue collection or disconnect service. A recent cabinet decision enforces all DISCOs and MVC's in the West Bank to establish an escrow account for collection of electricity bills. This mechanism, which has already been adopted by over 100 local authority councils, aims to monitor, streamline and audit the flow of electricity payments preventing diversion of funds.

52. **Current electricity tariffs are low relative to the costs of service provision leading to implicit subsidies of over NIS 600 million (US$ 166 million).** The regulatory authority, PERC, has set a uniform tariff of NIS 0.53-0.56 (US$ 0.14-0.15) per kilowatt-hour for the Palestinian DISCOs. However, financial analysis of the sector suggests that the full cost of service provision – given current levels of inefficiency – ranges from about NIS 0.66-1.42 (US$ 0.18 – US$0.39) per kilowatt-hour depending on the DISCO. Even if operating and commercial efficiency could be improved to more typical levels, tariffs would still need to increase significantly to ensure the financial viability

– and hence creditworthiness – of the sector. It is estimated that the shortfall between tariffs and costs amounts to implicit subsidies over NIS 600 million (US$ 166 million) in 2015.

53. **However, it is important to recognize that there are genuine affordability issues among the poor.** A widely used international benchmark is that electricity remains affordable when households are able to meet their basic needs without spending more than 5 percent of income. Based on current practice in West Bank and Gaza, it is estimated that 160 kilowatt-hours is an adequate level of consumption to meet basic household needs. Given the current income distribution, the lowest income decile can only afford to pay a rate of NIS 0.43 (US$0.11) per kilowatt-hour. The mechanism currently used to safeguard affordability is a rising block tariff with first block of 160 kilowatt-hours per month that is currently set at NIS 0.43 (US$ 0.11) per kilowatt-hour, matching the lowest income decile's ability to pay. However, given that average residential electricity consumption in West Bank and Gaza is only 200-300 kilowatt-hours per month, this means that most consumption benefits from this subsidized rate.

54. **Beyond the challenge of collecting revenue from customers, the scarcity of sub-national fiscal resources means that power sector revenues get diverted to municipal budgets.** No regular and predictable intergovernmental fiscal transfer exists to cover the recurring expenditures of municipalities or fund basic capital investments. Thus, municipalities and Village Councils (VCs), have developed a practice of diverting revenues from service fees to meet their expenditures needs, making electricity revenues among the more important sources of municipal funds. Data for the years 2011-2013 shows that total revenues per capita for VCs in charge of electricity distribution can be up to four times higher than for those VCs without that responsibility. VCs with electricity distribution functions were able to spend each year in the 2011-2013 period over twice as much in per capita operating and development expenditures than VCs not in charge of electricity distribution. For municipalities, there is almost a difference of 100 percent between the two groups of municipalities in total revenues per capita holding on average and for every year in the 2010-2012 period. This consideration may be one of the factors discouraging the remaining municipalities from incorporating their electricity service under the umbrella of the local DISCOs. However, even in municipalities that have ceded electricity service to the Palestinian DISCOs, there is evidence that some dividend income is still being paid by the DISCOs back to the municipalities. While data on this phenomenon is sparse, it is known that at least NIS 5.1 (US$1.4) million were paid to various municipalities by three Palestinian DISCOs in 2014. Breaking this vicious circle will require (i) increasing local revenue collection; (ii) improving transparency of payment flows, including inter-agency arrears; (iii) sanctions on entities which divert funds for non-essential or unproductive use; and (iv) provide financial support to those LGUs that do not have the fiscal capacity to ensure basic service provision.

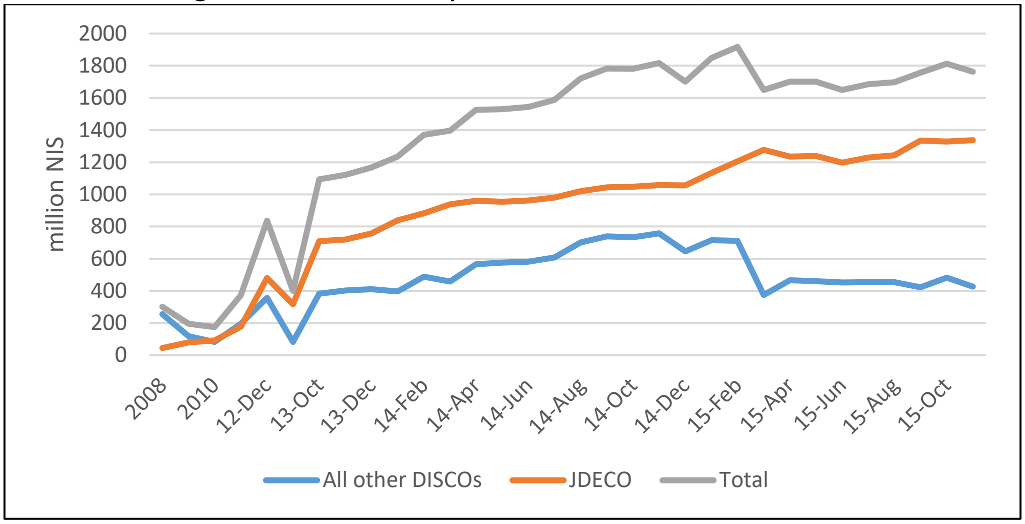
55. **As a result, the DISCOs have developed a culture of non-payment for wholesale electricity supplied by IEC, leaving the Palestinian Authority to step in through a 'net lending' mechanism.** Given the weak state of cost recovery, some DISCOs and MVCs only partially pay for electricity supplied by IEC, which amounts to 58 percent of the total cost of electricity; while others don't pay at all preferring to use the collected revenues for financing municipal activities. For years, the Palestinian Authority has indirectly paid a portion of the outstanding bills owed by

DISCOs and MVCs to IEC, through a mechanism called 'net lending'[4]. Outstanding payments owed to the IEC are either (i) deducted from the PA's clearance revenues by the Israeli Ministry of Finance and registered as "net lending" or (ii) are accumulated as debt owed to the IEC. Net lending reduced the Palestinian Authority's available revenues by an estimated NIS 1 (US$ 0.3) billion in 2012, representing 13.5 percent of the Palestinian Authority's total revenues. This mechanism sets a precedence in which service providers continue to receive electricity from suppliers, and consumers continue to receive electricity from service providers even if they don't pay their bills with an assurance that the Palestinian Authority will pay on their behalf reducing a sense of responsibility and accountability. Since Israel considers JDECO an Israeli company, the debt owed by JDECO to IEC cannot be paid through the 'net lending' mechanism making JDECO the second largest contributor, after GEDCO, to Palestinian electricity sector debt to Israel.

56. **A new electricity agreement between Government of Israel (GoI) and the PA has settled past debt and plans to pave the way for improvements in the Palestinian energy sector.** The unpaid portion of outstanding bills from IEC to Palestinian service providers started to accumulate substantially from 2011 onwards (see Figure I-1.3). The debt can be divided into two portions, the larger share that relates directly to JDECO and a smaller share owed by the Palestinian Authority relating to the remaining five Palestinian distribution companies and MVC's. In view of the situation, IEC made payment of past debt a pre-condition for energization of the four new high voltage substations as well as a pre-condition for the scale-up of the capacity of the connection points. On September 13, 2016, the PA and the Israeli government signed an agreement to settle past electricity sector debt, which stood at NIS 2.03 billion (US$ 534 million), and created joint committees to work on three key issues: i) energization of the new high voltage substations to bring more power to the West Bank, ii) signature of a long term Power Purchase Agreement (PPA) at a lower wholesale tariff rate, and iii) transfer of over 200 connection points to PETL in order to have a single point of transaction (single-buyer) between Israeli and Palestinian sides. On July 10, 2017, an interim PPA was signed for the energization of the Jenin substation alone, which was en encouraging step in the right direction until the full negotiations for the long term PPA are concluded. Overall, the success of the new electricity agreement rests on the ability of PETL to pay for 100 percent of the power purchased from IEC. In turn, DISCOs and end consumers need to follow-suit along the value chain.

[4] **'**Net lending' refers to the process by which Israel deducts a portion of unpaid electricity bills, owed by Palestinian distributors, to the Israeli Electric Company (IEC – which supplies over 95percent of the energy to WBG) from collection revenues that are collected by the Israeli Ministry of Finance on behalf of the PA. This process essentially forces the PA to indirectly pay for the outstanding bills of distribution companies through collection revenues destined for the national budget.

Figure I-1.3: Electricity sector debt to IEC, 2008-2015



Source: Eco Energy

57. **The economic burden associated with the subsidization of the electricity sector is several times higher in Gaza than for the West Bank.** Based on Computable General Equilibrium models developed for both the West Bank and Gaza, the magnitude of the subsidies associated with the electricity sector were estimated (Figure I-1.4). The implicit subsidies due to underpricing, distribution losses and under-collection of revenues amounted to between NIS 236-342 million (US$65-95 million) per year for the West Bank, which amount to no more than one percent of the West Bank's GDP for the period 2013-2015. This is equivalent to a 15-20 percent subsidization rate for the retail tariff. In the case of Gaza, the implicit subsidies are much larger, both in absolute and relative terms, amounting to NIS 487-638 million (US$125-175 million) per year which amount to as much as 4-5 percent of Gaza's GDP during the period 2013-2015. This is equivalent to a 60 percent subsidization rate of the retail tariff.

Figure I-1.4: Macroeconomic impact of electricity sector under-performance

	West Bank			Gaza		
	2013	2014	2015	2013	2014	2015
Implicit subsidy (US$m per annum)	94.8	65.9	72.6	136.0	178.1	125.4
Implicit subsidy (NISm per annum)	342.3	235.9	281.5	491.1	637.7	486.5
Implicit subsidy (As % of GDP)	1.0	0.6		4.4	5.0	
Subsidy rate (As % of tariff)		17.5		50.9	65.5	56.7

1.2 Implications for West Bank and Gaza

This sector context carries a number of important implications for the future of the Palestinian electricity sector.

a) **There is scope to diversify Palestinian electricity supply, particularly in the West Bank.** The Palestinian energy sector, and particularly the West Bank, has long relied primarily on Israel for power imports, which for the most part have been relatively reliable and cost-effective. Yet, energy security could be further enhanced by greater diversification of power sources in the West Bank, including the development of indigenous gas-fired and solar power generation options.

b) **The Gaza Power Plant provides a cautionary tale of Independent Power Projects.** Nevertheless, the experience of the Gaza Power Plant, which has proved expensive and unreliable, demonstrates that indigenous power generation does not necessarily represent an improvement on power imports. It is important to ensure that contractual terms are sufficiently attractive and adequate supplies of cost-effective fuel are available. For Gaza, a key priority is the conversion of the current plant to natural gas to reduce the cost of fuel.

c) **Palestinian's power sector reform process has made strides but remains incomplete.** Significant institutional reforms have already been undertaken in the Palestinian electricity sector, but these are still fragile and need to be sustained. Institutional strengthening is needed for all sector institutions, including PERC, PETL and the DISCOs. PETL is expected to be commercially operational and financially sustainable following the energization of the Jenin, Nablus, Hebron and Ramallah high-voltage substations and the signature of a long term Power Purchase Agreement (PPA) with IEC. In the meantime, the signature of the interim PPA for the Jenin substations allows PETL to begin operations gradually until the full PPA is signed.

d) **Distribution utilities are the Achilles' heel of the Palestinian electricity sector.** The under-performance of the DISCOs is the deepest challenge faced in the electricity sector, because the DISCOs are the foundation of the payment chain for the sector and because the difficulties faced are institutional and political in nature. Without improving the ability of the DISCOs to capture customer revenues and reliably pay for wholesale power, PETL's viability will be compromised, as will the creditworthiness of the sector as an off-taker for future Independent Power Projects in West Bank and Gaza.

e) **Addressing sub-national financing issues is key to the future of the power sector.** Even once the performance of the DISCOs is improved, their financial viability will remain vulnerable to municipal capture of revenues, until and unless the fundamental challenges of sub-national municipal finance are addressed. Indeed, without this, as DISCOs enhance their own efficiency they risk simply becoming an increasingly attractive source of municipal revenues without solving the fundamental problem of creditworthiness in the sector

f) **In Gaza, it is possible to pay for additional IEC supply by ramping down generation at GPP and using the money to buy double the power from IEC.** Referring to figure I-1.5, between 2011-2015, GPP was operating an average capacity of 45MW while IEC imports accounted for 119MW. Factoring in the capacity charge that is paid for IEC, the unit cost of power from GPP is 3 times more expensive than IEC. If the GPP take-or-pay capacity charge payments continue to be paid, for every 1MW that GPP is ramped down, 2MW can be purchased from IEC for the same cost. If GPP's take-or-pay capacity charge payments are terminated, for every 1MW that GPP is ramped down, 3MW can be purchased from IEC for the same cost. This means that if GPP, running on diesel, is turned off completely, and the money used to buy power from IEC, Gaza can have access to 30 percent more power. This does not require additional payments by the PA through clearance revenues or net lending. Later on, once GPP is converted to operating on natural gas, which is expected to have a lower cost of production on par with Israeli imports, then GPP can be turned on again. However, in the immediate term, the best solution for Gaza is to ramp down GPP operating on diesel.

g) **To ensure bill collection revenue continues to be forwarded from GEDCO to PA, it is important to set up a separate escrow account into which collections are deposited and which is monitored by an international oversight committee.** There is a legitimate concern, that if GPP is turned off, authorities in Gaza will no longer have any incentive to forward bill collections to PA who will then bear the responsibility of paying for all IEC supply through clearance revenues. Currently, fuel for GPP is procured by the PA from the money that is forwarded to the PA by GEDCO from bill collections amounting to 20-25 million NIS per month. To ensure that this forwarding of bill collections continues as GPP ramps down, an escrow account should be set up, separate from PA budgets, into which GEDCO can forward its collections. This account should be monitored by a high-level international committee which serves to ensure transparency. At 20-25 million NIS per month, the collections will be enough to pay for 30-40 percent of the total supply to Gaza which is on par with the current setup.

Figure I-1.5: Financing additional IEC power by ramping down GPP

Status Quo: 2011-2015 historical average values				
	IEC			GPP
Cost of purchased power (NIS/mo)	31,807,885		Cost of Capacity Charge (NIS/mo)	10,097,360
			Cost of diesel fuel (NIS/mo)	24,430,783
Quantity of purchased power (KWh/mo)	85,576,569		Quantity of purchased power (KWh/mo)	32,633,872
Corresponding Capacity (MW)	**119**		Corresponding Capacity (MW)	**45**
Average purchase tariff (NIS/KWh)	0.37		Average purchase tariff (NIS/KWh)	1.06
			Cost of fuel per KWh produced (NIS/KWh)	0.75
Total cost per month (NIS/mo)	**66,336,028**			
Phase 1 - Ramp down GPP by 12MW, ramp up IEC by 25 MW				
	IEC			GPP
Cost of purchased power (NIS/mo)	38,498,290		Cost of Capacity Charge (NIS/mo)	10,097,360
			Cost of diesel fuel (NIS/mo)	17,740,378
Quantity of purchased power (KWh/mo)	103,576,569		Quantity of purchased power (KWh/mo)	23,697,039
Corresponding Capacity (MW)	**144**		Corresponding Capacity (MW)	**33**
Average purchase tariff (NIS/KWh)	0.37		Average purchase tariff (NIS/KWh)	1.06
			Cost of fuel per KWh produced (NIS/KWh)	0.75
Total cost per month (NIS/mo)	**66,336,028**			
Phase 2 - Ramp down GPP by 25MW, ramp up IEC by 50 MW				
	IEC			GPP
Cost of purchased power (NIS/mo)	45,188,695		Cost of Capacity Charge (NIS/mo)	10,097,360
			Cost of diesel fuel (NIS/mo)	11,049,973
Quantity of purchased power (KWh/mo)	121,576,569		Quantity of purchased power (KWh/mo)	14,760,206
Corresponding Capacity (MW)	**169**		Corresponding Capacity (MW)	**21**
Average purchase tariff (NIS/KWh)	0.37		Average purchase tariff (NIS/KWh)	1.06
			Cost of fuel per KWh produced (NIS/KWh)	0.75
Total cost per month (NIS/mo)	**66,336,028**			
Phase 3 - ramp down GPP by 45MW, ramp up IEC by 91 MW				
	IEC			GPP
Cost of purchased power (NIS/mo)	56,160,959		Cost of Capacity Charge (NIS/mo)	10,097,360
			Cost of diesel fuel (NIS/mo)	0
Quantity of purchased power (KWh/mo)	151,096,569		Quantity of purchased power (KWh/mo)	0
Corresponding Capacity (MW)	**210**		Corresponding Capacity (MW)	**0**
Average purchase tariff (NIS/KWh)	0.37		Average purchase tariff (NIS/KWh)	1.06
			Cost of fuel per KWh produced (NIS/KWh)	0.75
Total cost per month (NIS/mo)	**66,258,319**			

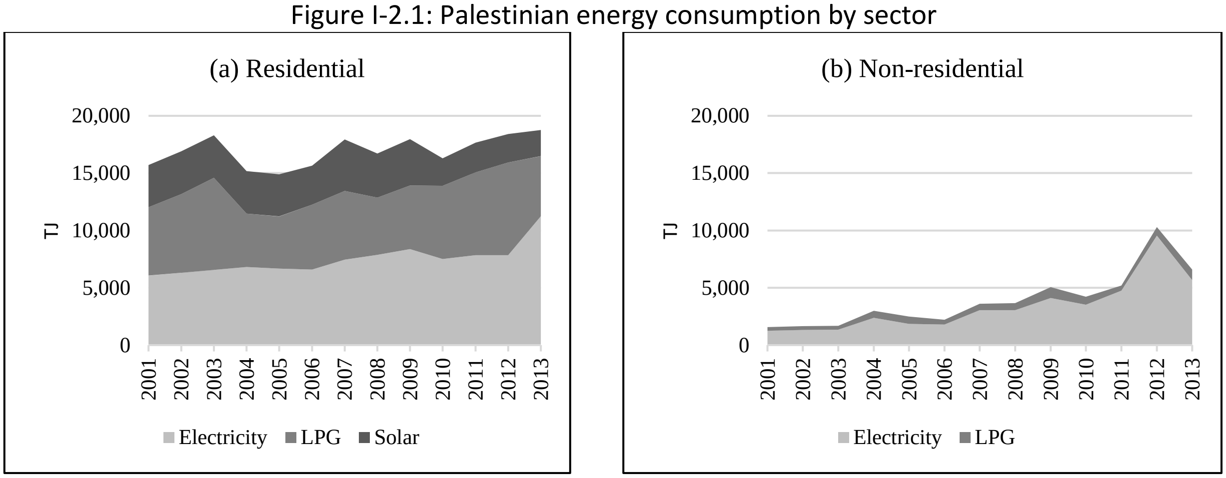
2 Electricity Demand

2.1 *The current context*

58. **Electricity accounts for 27 percent of Palestinian energy consumption and is dominated by the residential sector.** During the historical period 2001-2013, electricity demand has grown at an average annual rate of 7.2 percent. Residential electricity consumption has been growing slightly below that average at 5.3 percent, with average household electricity consumption reaching some 250 kilowatt-hours per month by 2013. This is a modest level of consumption by regional standards, at about half the levels found in the Maghreb countries. Non-residential electricity consumption was negligible in the early 2000s, and despite steep growth rates of 13.4 percent annually from 2001-2013, still only accounted for a small percent of total electricity consumption relative to the residential sector in 2013 (see Figure I-2.1). It is unusual for the share of non-residential consumption to be so low, and this illustrates the under-developed nature of the economy. It also represents a disadvantage for the utilities who typically count on large industries as anchor customers.

59. **While enjoying diversified energy sources, Palestinian households increasingly rely on electricity.** While non-residential energy consumption almost entirely takes the form of electricity, Palestinian households meet their energy needs through a mixture of electricity, LPG and solar water heaters. A long series of household energy surveys document a trend of substitution of electricity for other forms of household energy over time; particularly for baking as well as water and (to a lesser extent) space heating applications (see Annex Figures A2.1 and A2.2). Since 2009, there has also been a notable increase in the uptake of air conditioning units. Based on econometric analysis of the 2013 household energy survey, air conditioning units add over 100 kilowatt-hours per month to a household's consumption during the summer months, while electric water and space heating each add 50 kilowatt-hours per month during the winter months (see Annex Figure A2.3 and A2.4).

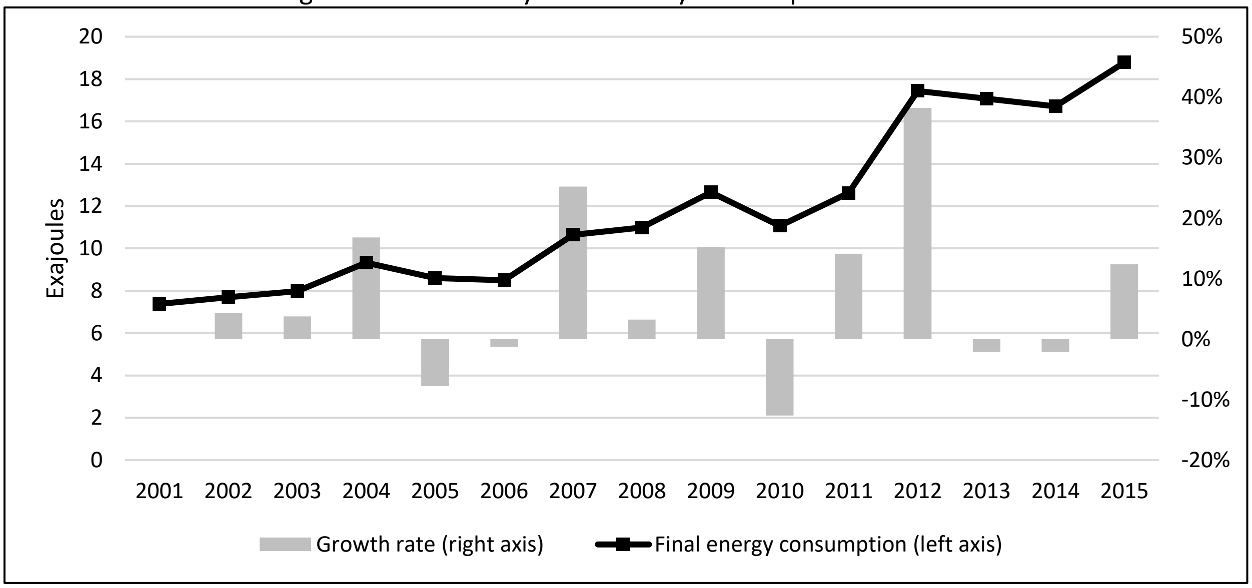
Figure I-2.1: Palestinian energy consumption by sector



Source: PCBS Energy Balances 2001-2013

60. **Electricity demand patterns in West Bank and Gaza have historically been quite volatile, making it challenging to predict the future.** For example, electricity consumption grew at 38.2 percent in 2012, shrunk by 2.1 percent in the next two years, and increased again by 12.4 percent in 2015 (see Figure I-2.2). As a result of strong swings in historic demand as well as limited data availability, Palestinian electricity demand cannot be reliably forecast using standard econometric techniques. There is some evidence, however, that electricity demand does tend to follow GDP growth trends. Indeed, for the MENA region as a whole the elasticity of electricity output to real GDP growth, based on 370 country-year observations finds a region-wide elasticity value of 1.07[5].

Figure I-2.2: Volatility of electricity consumption over time



61. **A simple and defensible approach is to base electricity demand forecasts on real GDP growth forecasts.** The most recent real GDP demand forecasts from PCBS and IMF stand at 2.63 percent for West Bank and Gaza as a whole, ranging from 2.51 percent in the West Bank to 3.02 percent in Gaza. These become the starting point for forecasting electricity demand. However, it is also important to consider the current base from which electricity demand is forecast to grow.

62. **Observed electricity consumption is not a reliable indicator of existing electricity demand.** Effective demand for electricity is the amount that would be consumed at current tariffs if all electricity were fully paid for and there were no restrictions on the available supply. Neither of these two conditions holds for West Bank and Gaza. Due to problems of network theft and under-collection of bills, a significant share of electricity consumption is supplied for free and therefore likely exceeds what would be consumed if tariffs were fully enforced. At the same time, severe supply restrictions and associated rationing – particularly in the Gaza Strip – mean that even paying consumers cannot access all the power they would like to buy. As a result, electricity

[5] Author's calculations based on 370 country-year observations of electricity output and real GDP growth rates from across the Middle East and North Africa region.

demand is partially suppressed. These two effects pull the base year demand in opposite directions and their net impact needs to be considered.

63. **Inflated consumption is observable and relatively easy to estimate.** It can quite readily be estimated from utility operational data, by calculating the absolute amount of electricity lost to theft and under-collection based on the reported rates for non-technical losses and revenue collection respectively. Based on the literature, it is assumed that this inflated demand would drop by one half if tariffs were effectively applied[6]. In West Bank and Gaza with total unpaid consumption amounted to 903 MWh and 558 MWh in 2030, implying that baseline consumption should be reduced by half of this amount, that is 452 MWh and 279 MWh respectively.

64. **Suppressed demand is unobservable and can only be estimated indirectly.** Utilities can provide some indication based on their knowledge of demand patterns. In the West Bank, PENRA reports that this is 235 MW, or 20 percent of load. For Gaza, GEDCO reports that this is somewhere between 145-245MW, or around 50 percent of the load. This 50 percent shortfall for Gaza is reasonably consistent with the results obtained by comparing average residential and total industrial electricity consumption in Gaza with that in the less constrained environment of the West Bank.

Figure I-2.3: Adjusting current electricity consumption in West Bank and Gaza to effective demand

2013 MWh	West Bank	Gaza	West Bank and Gaza
Current consumption	3,166	1,344	4,510
- Inflated consumption	452	279	731
+ Suppressed demand	655	768	1,423
= Effective demand	3,370	1,832	5,202

Source: Own elaboration based on utility data from PENRA and PERC for 2013

65. **Since estimates for suppressed demand exceed those for inflated consumption, the electricity demand forecast needs to be adjusted upwards.** For West Bank and Gaza as a whole, the amount of suppressed demand is found to exceed the magnitude of inflated consumption, indicating that current electricity consumption is lower than it would be in a normal environment. In the West Bank, suppressed demand slightly exceeds inflated consumption by a margin of about 6 percent of registered consumption. In Gaza, the suppressed demand is substantially larger than the inflated consumption by a margin of 36 percent of registered consumption. It is unrealistic to assume that suppressed demand can be eliminated overnight, but rather it would take some time for supply to catch-up. The demand forecast is therefore adjusted in such a way as to ensure that this consumption shortfall is gradually eliminated over the period 2016-2030. This entails an extra annual growth rate of 0.9 percent for West Bank and Gaza as a whole; 0.4 percent in the West Bank and 1.9 percent in Gaza (see Figures I-2.3 and I-2.4). A range of plus and minus one percent around these central growth estimates is recommended to capture the uncertainty in electricity demand growth. A full set of year by year demand forecasts are provided in Annex Figure A1.5.

[6] Peter Meier (2016) *Guidelines for Economic Analysis of Energy Projects* (forthcoming)

Figure I-2.4: Forecast electricity demand growth rates for West Bank and Gaza

AAGR %	West Bank	Gaza	West Bank and Gaza
Real GDP growth forecast	2.51	3.02	2.63
+ Adjustment for suppressed demand	0.40	1.90	0.90
= Electricity demand forecast	2.91	4.92	3.53

66. **The contrast in the electricity supply situation in the West Bank and Gaza is also evident in patterns of generator ownership among firms and households.** Owning and operating a small back-up generator in West Bank and Gaza is expensive and works out to NIS 2.77 (US$0.76) per kilowatt-hour for a diesel generator, and NIS 4 (US$1.01) per kilowatt-hour for a more common gasoline generator. According to enterprise surveys, 47 percent of firms in Gaza reported owning such a generator, and depending on it for 42 percent of their electricity supply. By contrast, only 13 percent of firms in the West Bank reported owning a generator, depending on it for only 15 percent of their supply. Throughout West Bank and Gaza, generator ownership is strongly linked to the size of the firm; and hence the available capital. Despite the high cost, as many as 20 percent of households in Gaza reported owning generators in 2013, compared to less than 1 percent in the West Bank. Nevertheless, NEDCO, a distribution company in the West Bank, has used large utility scale generators in the past to meet summer peak load energy shortages.

67. Combining all the assumptions and methods discussed so far, the low, central and high demand forecasts for West Bank and Gaza are provided in Figure I-2.5 below.

Figure I-2.5: Summary of electricity supply forecast required to meet effective demand by 2030 (GWh)

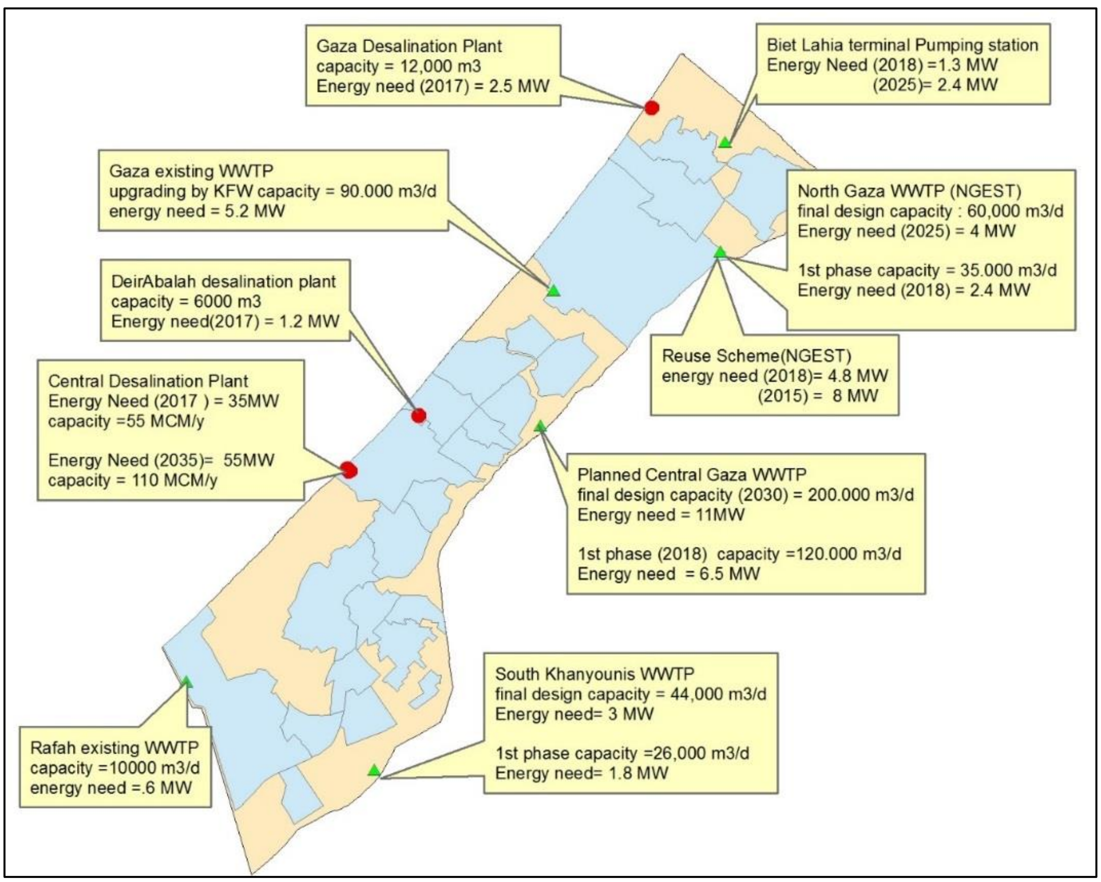
	Central case			Low case			High case		
	West Bank	Gaza	West Bank & Gaza	West Bank	Gaza	West Bank & Gaza	West Bank	Gaza	West Bank & Gaza
2013 consumption	3,166	1,344	4,510	3,166	1,344	4,510	3,166	1,344	4,510
2013 effective demand	3,370	1,832	5,202	3,370	1,832	5,202	3,370	1,832	5,202
2013 supply for eff.dem	3,938	2,141	6,079	3,938	2,141	6,079	3,938	2,141	6,079
2014	4,037	2,206	6,239	3,998	2,185	6,179	4,076	2,227	6,300
2015	4,138	2,272	6,403	4,058	2,229	6,279	4,220	2,317	6,529
2016	4,242	2,341	6,572	4,119	2,273	6,382	4,368	2,410	6,766
2017	4,349	2,412	6,745	4,182	2,319	6,485	4,521	2,507	7,011
2018	4,458	2,484	6,922	4,245	2,366	6,591	4,680	2,607	7,266
2019	4,570	2,559	7,104	4,309	2,414	6,699	4,844	2,712	7,529
2020	4,685	2,636	7,291	4,374	2,462	6,808	5,014	2,821	7,803
2021	4,803	2,716	7,482	4,440	2,512	6,919	5,190	2,934	8,086
2022	4,923	2,798	7,679	4,508	2,563	7,031	5,373	3,052	8,379
2023	5,047	2,882	7,881	4,576	2,614	7,146	5,561	3,174	8,683
2024	5,174	2,969	8,088	4,645	2,667	7,262	5,757	3,302	8,999
2025	5,304	3,059	8,301	4,715	2,721	7,381	5,959	3,435	9,325
2026	5,437	3,151	8,519	4,786	2,776	7,501	6,168	3,572	9,664
2027	5,573	3,246	8,743	4,859	2,831	7,623	6,385	3,716	10,014
2028	5,713	3,344	8,973	4,932	2,889	7,747	6,609	3,865	10,378
2029	5,857	3,445	9,209	5,007	2,947	7,874	6,841	4,020	10,755
2030	6,004	3,548	9,451	5,082	3,006	8,002	7,081	4,182	11,145

Source: Own elaboration

68. **Beyond the general demands of the population and productive sector, a number of humanitarian activities have critical energy needs.** Few detailed needs assessments have been done, but the box below provides an important illustration for the water and wastewater sector in Gaza (Figure I-2.6).

Figure I-2.6: Existing and future electricity needs for Gaza's water sector

The electricity needs of essential infrastructure, such as water and sanitation, must be incorporated into any supply expansion plan. In Gaza, the existing water and wastewater facilities required approximately 34MW of electricity as of 2014. By 2030, this is expected to increase to 127MW as additional desalination and wastewater treatment plants come online (details provided in Annex 2, Figure A2.5). Supply expansion plans must consider a holistic view taking into account the needs of critical infrastructure, such as water, sanitation and health services.



Source: Gaza Coastal Municipalities Water Utility (CMWU)

2.2. Implications for West Bank and Gaza

69. These patterns of electricity demand have important implications for energy planning in West Bank and Gaza.

a) **Palestinian energy planning should recognize the inherently uncertain nature of electricity demand.** The challenges in predicting electricity demand underscore the importance of not relying on a single estimate for planning purposes, but ensuring that the wide range of uncertainty of demand is reflected in power system planning.

b) **Electricity demand is strongly influenced by broader policies on household energy.** Given the weight of residential electricity demand and recent substitution trends, it is important to recognize that broader household energy policies will have an important impact on the demand for electricity. Historic policies to promote solar water heaters, have been successful in dampening household electricity demand, but usage appears to be in decline. Similarly, government policy needs to carefully consider the economic case for using LPG (as opposed to electricity) for space and water heating, and ensure that incentives are adequately aligned.

c) **Moderate electricity demand growth is anticipated in West Bank and Gaza.** As a result of macro-economic challenges as well as constraints faced by the productive sector, electricity demand is forecast to slow from historic levels of 7.2 percent annually to levels of around 3.5 percent annually.

d) **Electricity demand will grow more rapidly in Gaza than in the West Bank.** Due to both higher GDP growth forecasts, as well as the need to catch-up with higher levels of suppressed demand, electricity consumption in Gaza is forecast to grow substantially faster than in the West Bank, at 4.9 percent versus 2.9 percent annually. Given the much tighter supply situation in Gaza, this will represent a particular challenge going forward.

e) **Current levels of electricity consumption understate existing demand.** Observed electricity consumption does not provide a reliable demand baseline given that a significant amount of electricity is supplied free of charge, while there is also significant rationing due to supply shortages. The dampening impact of rationing on current consumption is estimated to outweigh the inflated consumption resulting from non-payment; particularly in the case of Gaza.

f) **A number of humanitarian activities have critical energy needs that need to be better documented.** The example of water and wastewater services in Gaza was provided as an illustration, but a similar case could be made for healthcare facilities.

3 Importing Electricity from Israel

70. **The Israeli and Palestinian electricity sectors are closely intertwined.** On the one hand, the Palestinian Territories depended on the Israeli Electric Corporation (IEC) for 90 percent of electricity supply in 2015, ranging from 64 percent in Gaza to 99 percent in the West Bank. On the other hand, taken as a whole, West Bank and Gaza are the IEC's single largest customer accounting for 8 percent of Israeli electricity demand in 2015 (see Annex 3 Figure A3.3). Moreover, Palestinian electricity demand has been growing historically at 7.2 percent per annum from 2001-2013 – much faster than Israeli electricity demand that expands at only 5.2 percent per annum. This is also reflected in demand forecasts (see Figure I-2.5), which project annual demand growth of 3.5 percent for West Bank and Gaza versus only 2.9 percent for Israel. This means that over time Palestinian needs will inevitably represent a growing share of the Israeli total, estimated to increase to 11 percent of Israeli electricity demand by 2030.

3.1 The current context

71. **Israel's power sector is an island system that remains largely vertically integrated and is in the midst of a shift from coal-fired to gas-fired power generation.** Due to a lack of interconnection with neighboring Arab countries, the Israeli power system operates as an island that must be fully self-sufficient and capable of fully meeting its own demand in all circumstances. The only slight exception to this are the transmission links with West Bank and Gaza, whose power systems in turn have modest interconnections with Jordan for the West Bank and Egypt for Gaza. As of end 2015, Israel had an installed generation capacity of 17.3 GW and generated 65.4 million MWh. About 45 percent of energy came from IEC's two large coal-fired plants, while the remainder came almost entirely from natural gas (see Annex 3 Figures A3.1 and A3.2). Use of natural gas for electricity generation has expanded rapidly during recent years, as a result of major Israeli gas discoveries in the eastern Mediterranean. See Annex 3, Figure A3.4 for the Israeli demand forecast.

72. **The power sector in Israel is regulated by the Public Utilities Authority (PUA) under a modern regulatory framework.** The PUA was established in 1996 and operated originally as an independent regulatory entity reporting to the public and the Knesset. In January 2016, however, the PUA scope of action was moved under the Ministry of Energy. The PUA sets electricity tariffs based on IEC's cost of service, excluding costs considered excessive or unnecessary, while providing for allowed returns on equity according to the risk profile of each activity (see Annex 3 Figure A3.6). By law, PUA is prohibited from setting tariffs that create deliberate cross-subsidies between customer classes. PUA is involved in the determination of five categories of tariffs: electricity usage tariffs (for end users); network wheeling tariffs (for use of the transmission grid); production tariffs (for electricity generated by IPPs); interconnection tariffs (to access the grid); and system management or ancillary services (to cover back-up provided by IEC to other market players). The PUA also assesses the marginal production costs of different generators as input to economic dispatch by the System Manager; which is still a department within IEC. For the largest consumers, Time of Use (TOU) tariffs are applied differentiating 9 different time blocks with

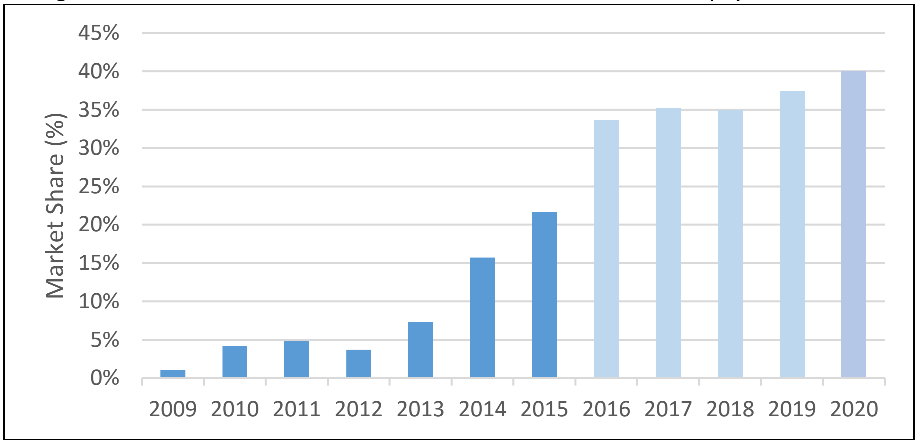
different cost characteristics. (Full particulars of the regulated power tariffs determined by PUA can be found in Annex 3 Figures A3.5-A3.10.)

73. **Israel's electricity industry has been undergoing a protracted, and still incomplete, process of sector reform.** This began with the 1996 Electricity Sector Law, and its subsequent amendments. Implementation has proved challenging with negotiations between the government and IEC management ongoing since 2002. In the meantime, a number of different blueprints of reform have been put forward. IEC itself envisions becoming a holding company with subsidiaries for generation, distribution, transmission and services, with potential privatization of at least 49 percent of the generation and distribution subsidiaries. At the same time, the recommendations of the government's Yogev Committee in 2014, envisaged divestiture of some of IEC's generation assets to cap market share at 58 percent, as well as a separate transmission system operator and the possibility of limited private sector entry into the distribution segment.

74. **During the last decade, IEC has experienced severe financial difficulties and had accumulated debts of NIS 65 billion (US$16.6 billion) as of end 2015.** A number of factors contributed to this situation, including the employee union's wage demands, the electricity regulator's unwillingness to pass-on costs deemed inefficient into consumer tariffs, as well as substantial debt service obligations. The specific debt from the Palestinian Authority that reached NIS 2 billion (US$0.5 billion) in 2016 – while substantial in absolute terms – is a relatively small share of IEC's overall debt burden (no more than 3 percent).

75. **Nevertheless, dramatic changes have already taken place as a result of strong entry of Independent Power Producers (IPPs).** Since 2009, IEC has been prohibited from building new generation plant and there has been strong entry of gas-fired IPPs that received construction and operation license from the PUA. Installed IPP capacity increased from some 100 MW in 2009 to some 5,500 MW at May 2017, with further 4,000 MW already licensed and expected to be commissioned by 2022. As a result, the market share of IPPs in the Israeli power generation has climbed steeply, spurred by abundant availability of natural gas, already rising from 1 percent in 2009 to 33 percent in 2016 and projected to rise further to reach 40 percent by 2020 (see Figure I-3.1). The rapid entry of IPPs during a period of relatively flat demand growth has helped to reduce generation costs, increase reserve margins, and pave the way for the replacement of aging coal plants.

Figure I-3.1: Market Share of Israeli IPPs Climbs Steeply Over Time



76. **A clear set of regulations governs commercial transactions between IPPs and other market participants.** To stimulate the first generation of IPPs, they were provided with a safety net that IEC would purchase up to 80 percent of their power production at normative tariffs set by PUA. As the sector has matured, these financial supports have been removed so that more recent IPPs operate as merchant plants. Only transactions between IPPs and IEC (the "essential services provider") are currently subject to price regulations, all other transactions are deemed private and prices can be freely agreed by bilateral negotiation. Sales from IPPs to IEC can either take the form of capacity and energy contracts or energy only contracts, with the former being subject to closer regulation. IPPs are required to provide demand forecasts for their customers and show how these will be reliably met by a combination of their own generation and power purchased from other private producers. They also need to provide IEC with day ahead maintenance and output schedules for each 30-minute time interval.

77. **The next wave of IPPs will include a substantial scale-up of renewable energy.** The Israeli government has introduced technology specific Feed-In Tariffs. These are designed to support scale-up of renewable energy from levels of 2 percent in 2015 to reach targets of 10 percent renewable energy by 2020 and 17 percent by 2030. This will lead to a second wave of policy-driven IPPs for renewable energy, and will raise technical challenges for the Israeli system to accommodate a much higher share of variable renewable energy.

3.1 Implications for West Bank and Gaza

78. These recent developments in the Israeli electricity sector have significant implications for the future energy plans of West Bank and Gaza.

a) **West Bank and Gaza will represent a growing share of IEC's client base.** As Palestinian electricity demand growth outpaces that in Israel, and as IEC's share of the Israeli power market continues to decline, the Palestinian Single Buyer PETL may represent an increasingly large share of IEC's client base, further intertwining the economic prospects of these two companies. This means that Palestinian energy planning decisions, as well as the financial viability of the Palestinian electricity sector, will have an increasingly large impact on IEC.

b) **West Bank and Gaza will have the option of buying power from Israeli IPPs.** With the growth of the Israeli IPP sector, the Palestinian Single Buyer would also increasingly have opportunities to purchase power directly from IPPs on negotiated commercial terms outside of the context of any inter-governmental framework. Given the relatively rapid pace of Palestinian demand growth, this may make it an increasingly attractive market for Israeli IPPs. Nonetheless, this option may be difficult to pursue until the Palestinian electricity sector re-establishes a strong payment record with IEC. Moreover, a commercial power import agreement would likely also entail harder enforcement of payment discipline given that parallel fiscal channels would not be available.

c) **West Bank and Gaza could also consider selling any future electricity surpluses into Israel.** Any future Palestinian IPP could potentially sell surplus electricity into the Israeli grid, and this would likely be a necessary backstop arrangement, if PETL is to sign take-or-pay contracts with future IPPs. The arrangements for trading surplus electricity would need to be agreed on a case by case basis and regulated in a Power Purchase Agreement.

d) **West Bank and Gaza may stand to benefit from Time of Use pricing for Israeli electricity.** The current renegotiation of the Palestinian Power Purchase Agreement with IEC, in the context of the switch to high voltage electricity imports, offers the opportunity to benefit from the Time of Use tariff structures that have been developed by the PUA in Israel. This offers potential advantages given that the Palestinian and Israeli daily and annual peaks do not coincide. Historically, only JDECO has been charged based on Time of Use, while other Palestinian imports have rather been charged based on the (less attractive) Bulk Supply Tariff (See Annex 3 Figure A3.9). On the retail side, Palestinian DISCOs could also benefit from selling electricity to their consumers on a TOU basis which would encourage demand side management and energy efficiency.

e) **West Bank and Gaza may need to purchase ancillary services from Israel.** The current renegotiation of the Palestinian Power Purchase Agreement with IEC, will also need to consider the future role for management (or ancillary) services from IEC. This is particularly relevant in the context of the planned construction of new Palestinian IPPs in the West Bank based on gas-fired and renewable energy technologies. As such new plants come on stream, the West Bank will continue to require back-up services (such as reserves and system balancing) that are most efficiently provided by IEC, and for which PUA has already established regulatory tariffs (see Annex 3 Figure A3.10).

f) **Palestinian renewable energy plans need to be coordinated with the Israeli system.** Given that the Israeli power system is already contemplating a substantial scale-up of variable renewable energy generation, additional scale-up on the Palestinian system would need to be carefully coordinated with the Israeli system operator to ensure that the additional variability is appropriately managed.

4 Importing Natural Gas for Domestic Power Generation

4.1 The current context

79. **The discovery of sizable gas resources in the Eastern Mediterranean has the potential to be game-changing for the region.** Discoveries have been made in the Levant Basin, a geological structure that straddles the territorial waters of Cyprus, Israel, the Palestinian Territories, Lebanon, and Syria, and more recently, in Egypt's Nile Delta Basin. Until then net energy importers[7], these countries are now faced with the prospect of long-term energy self-sufficiency and even energy exporting status, with the prospect of a new revenue stream for their economies. In 2010, the United States Geological Survey (USGS) estimated that there could be up to an additional 122 trillion cubic feet of undiscovered natural gas resources in the Levant Basin. As a result, the Eastern Mediterranean is now the focus of much interest on the part of major upstream investors. However, in the short to medium term, the development and monetization of these resources present stakeholders with a set of challenges over and above the standard technical difficulties relating to the development of these resources. The challenges originate in the region's complex political make-up, and include the downturn of international gas prices, rapidly falling costs of solar energy as an abundant alternative to gas, as well as the under-developed nature of their energy and gas utilization policies.

80. **West Bank and Gaza plan to use natural gas to support development of domestic gas-fired power generation capacity, leading to modest estimated demand of 1 BCM per year by 2030.** Development of gas-fired power generation capacity is one of the main options available to support diversification away from Israeli power imports (although in itself that does nothing to diversify dependency away from Israel, if the gas is imported from Israel). In the West Bank, plans are already underway to commission a 400 MW gas-fired combined-cycle power plant in the northern region of Jenin and potential subsequent addition of a second plant of a similar scale in the southern region of Hebron. The associated natural gas demand is estimated to start at 0.24 BCM per year in the early 2020s and climb to 0.71 BCM per year by 2030. In Gaza, the priority may be conversion of the Gaza Power Plant (GPP) from fuel to gas and restoration of its full production capacity. This gas conversion could save the Palestinian Authority as much as NIS 164-226 million (US$45-62 million) per year[8] in its current fuel bills (depending on the price of oil). This would create a gas demand of 0.21 BCM per year by the mid-2020s, potentially climbing to 0.33 BCM per year by 2030 if further capacity expansion takes place. Demand for natural gas in the industrial sector is not expected to be economically viable due to the absence of major industries in the Palestinian Territories (see Annex 4 Figure A4.1)[9]. Therefore, referring to Figure

[7] With the partial exception of Egypt, which has oscillated between being a net importer and a net exporter

[8] The exact magnitude of the savings is sensitive to the oil price and is estimated at current oil prices of US$50 per barrel and prevailing gas prices for IPPs in Israel. The savings could increase to NIS 226 million (US$62 million) per annum in case oil prices increase to US$100 per barrel.

[9] The existing factories could be converted to natural gas supplied in compressed form (i.e. CNG, by road tankers). But their modest consumption of diesel and LPG and current oil prices do not make it a viable option.

I-4.1, the maximum estimated gas demand for the Palestinian Territories would begin at around 0.34 BCM per year in the early 2020s and climb to a maximum of 1.04 BCM per year by 2030. (Further details of the assumptions behind this forecast can be found in Annex 4 Figure A4.2-A4.3).

Figure I-4.1 – Estimated natural gas demand in the Palestinian Territories until 2030

Year	West Bank	Gaza	West Bank and Gaza
2022	0.24	0.11	0.34
2023	0.24	0.11	0.34
2024	0.47	0.21	0.69
2025	0.47	0.21	0.69
2026	0.47	0.33	0.80
2027	0.47	0.33	0.80
2028	0.71	0.33	1.04
2029	0.71	0.33	1.04
2030	0.71	0.33	1.04

Source: Delek Drilling.

81. **Israel has become a major natural gas producer due to substantial offshore discoveries that begun in 1999**. Since then some 36 TCF of natural gas were discovered offshore Israel (equivalent to over 1,000 BCM). About 94 percent of this resource is concentrated in just two huge fields: Tamar with 10.9 TCF and Leviathan with 21.9 TCF. To backup domestic gas production, Israel connected in 2013 an FSRU to the domestic gas pipe grid. The FSRU, located 10 km offshore the Israeli city of Haedera, enables imports of modest quantities of LNG at prices that ranged during the period of 2016 to April 2017 at NIS 18-26 (US$5-7) per MMBtu (excluding the FSRU leasing cost).

82. **Tamar is the only offshore gas field active today and supplies the entirety of Israeli gas needs at prices ranging from NIS 17-24 (US$4.7-6.5) per MMBtu**. The reliance of Israel on one gas source creates a major national security risk since the entire gas supply is exposed to technical and security risks. Hence the urgent need for Israel to diversify its gas supply sources by developing additional fields. Tamar's gas production is also constrained by a serious bottleneck in the submarine pipeline that connects it to shore, since the capacity of the pipeline is lower than the demand for gas in peak hours. In February 2017, the developers of the larger Leviathan field finally reached a Final Investment Decision (FID) for the NIS 14.6 billion (US$ 4 billion) development of the field. (For further details of recent Israeli prices for natural gas, see Annex 4 Figure A4.4.).

83. **The commissioning of Leviathan is expected in December 2019.** The FID decision was delayed for three years due to domestic professional and public regulatory debates, including an anti-trust case brought against Noble Energy and Delek, the companies that hold major equity stakes in both the Tamar and the Leviathan fields. The case was eventually resolved in 2016 with the High Court authorization of the Government-led "Natural Gas Framework". According to this framework Noble Energy has agreed to partially divest its interests in the Tamar field and Delek

has agreed to divest all of its interests in the Tamar field. In addition, the two companies had to sell their Karish and Tanin assets, that were purchased in 2016 by Energian Energy of Greece. It should be noted, however, that geological reports suggest that current discoveries represent only about half of the potential available in Israeli waters, providing the basis for ongoing exploration efforts. In this regard, the Israeli Government published in late 2016 its first offshore exploration round, tendering 24 blocks in its Exclusive Economic Zone (each of 400 km^2). Proposal are expected by July 2017. Figure I-4.2 provides an overview of current Israeli natural gas discoveries and proven reserves.

Figure I-4.2 – Natural gas discoveries and proven reserves in Israeli waters

Field	**Date of Discovery**	**Operator**	**Reserve (TCF)**
Noa	1999	Noble Energy	0.3*
Mary Band	2000	Noble Energy	1.0*
Or	2000	Isramco	0.1
Dalit	2009	Noble Energy	0.5
Tamar	2009	Noble Energy	10.9
Leviathan	2010	Noble Energy	21.9
Tanin	2011	Noble Energy	1.2
Dolphin	2011	Noble Energy	0.1
Shimshon	2012	Isramco	0.5
Karish	2013	Noble Energy	1.8
Total			38.2

* These fields have already been depleted

84. **Israeli gas demand for both power generation and industry has been growing rapidly.** Since the discovery of domestic natural gas reserves, Israel has been actively promoting a switch in its power generation mix from oil-fired to gas-fired, resulting in annual savings to the economy estimated at NIS 11 billion (US$3 billion) annually, as well as important air quality benefits. Natural gas is also being taken-up for industrial use. All this is bringing important fiscal proceeds to the Israeli economy that are estimated to amount to NIS 220 billion (US$60 billion) over the next 25 years. As a result, gas demand has already growth from negligible levels in the early 2000s to 8.3 BCM per year by 2015, and is projected to expand further reaching 18 BCM per year by 2030.

85. **Israel has a regulatory regime in place to govern its natural gas sector.** Israel's Natural Gas Authority was created in 2002 and has jurisdiction over both economic and technical (safety) regulation of the sector. The Natural Gas Authority aims to create conditions suitable for private sector development of the gas sector through promoting competition wherever possible, while regulating monopoly segments of the industry. Israel operates an open third party access regime for its gas transportation network, with regulated tariffs for the national transportation company, INGL, as well as the local distributors. The prices of the natural gas itself, however, are not subject to regulation but rather determined through negotiation between the parties, although negotiated prices and resulting profitability must be publicly disclosed to create transparency in the market. According to the Natural Gas Framework for policy that was approved in 2016, gas

export prices cannot be lower than average domestic prices. The regulatory regime for gas in Israel has been subject to considerable political contention but appears to have now stabilized.

86. **Once Leviathan comes on stream, there is the possibility that Israel will become a significant natural gas exporter.** Once under production, the Leviathan field will substantially exceed projected domestic gas demand, allowing Israel to become an exporter. In 2013, the Zemach Committee established that 15 TCF of Israeli reserves could be allocated for export purposes, as the balance was more than adequate to cover domestic needs for the next 30 years. Gas Export quotas could increase, however, as additional gas reserves are established.

87. **Israel started to export gas to Jordan in 2017 by supplying 1.8BCM from the Tamar field**. The destination was two of the Jordanian Arab Potash plants that are located at the southern Dead Sea. Moreover, in September 2016 Nobel Energy (on behalf of the Leviathan partners) signed a final binding 45 BCM take-or-pay (ToP) contract with the Jordanian state-owned electric utility NEPCO for the supply of 3 BCM per annum for 15 years. It is expected that additional Jordanian IPPs[10] and industrial consumers may sign gas import contracts with Leviathan in the near future.

88. **Israeli gas may also be exported to Egypt**. An arrangement to export 5 BCM per year to the Egyptian industrial sector is under discussion with Dolphinus Holdings, possibly by reversing the flow of the idle EMG pipeline that previously supplies gas from Egypt to Israel, or by utilizing the Arab Pipeline, once gas from Leviathan reaches Jordan (expected at December 2019 or early 2020). In addition, two separate MOUs were signed in 2014, to supply 4.5 BCM per year and 7 BCM per year for 15 years, with Egyptian idle LNG export facilities of Union Fenosa Gas and ENI in Dumyat and British Gas (currently Royal Dutch Shell) at Idku. It is doubtful though whether these MOUs evolve to binding contracts as market conditions have changed significantly since 2014. The major hindering factors are the steep decrease in oil and LNG prices, on the one hand, and the very large discoveries of additional gas fields in Egypt, with the leading discovery of Zohr field by ENI in 2015, on the other.

89. **Israel's gas fields could provide an immediate source of gas for West Bank and Gaza.** Palestinian gas demand, estimated to rise toward 1 BCM per year by 2030, is tiny in relation to Israeli gas reserves already in excess of 1000 BCM. Israel has already indicated its openness to supply gas to the Palestinian Territories under commercial agreements, and a Letter of Intent for Noble Energy to supply gas to the future Jenin gas-fired power plant was signed in 2014 and later cancelled in 2015. Further discussions are reportedly underway. Meanwhile, the Israeli authorities have indicated the feasibility of interconnecting the Palestinian Territories with the Israeli gas transportation infrastructure.

90. **The West Bank could relatively easily be supplied with natural gas from Israel by constructing short spurs from the nearby Israeli gas transportation network**. In the northern

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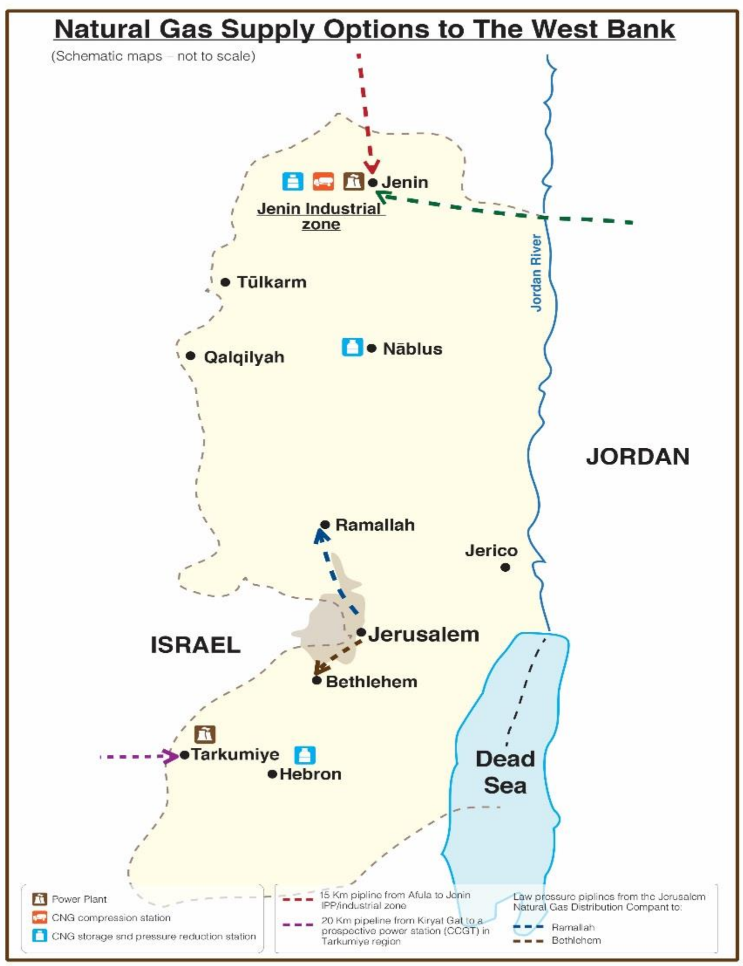
[10] It should be noted that no existing IPP in Jordan purchases its own fuel; they are all supplied with fuel by NEPCO, at NEPCO's own risk.

West Bank (see Figure I-4.3 below), the construction of only 15 km of pipeline from Afula (Israel) to the Jenin Industrial Zone, near the border with Israel, could supply high pressure gas to the planned 400 MW CCGT in Jenin. This work has received the required authorizations from the Israeli Civil Administration (COGAT) and is straightforward from a technical standpoint. It could be conducted by INGL, the Israeli high pressure gas transmission company, up to the border with the West Bank, at which point another company will need to build the pipeline all the way to the plant. The gas could flow through this pipeline within five years prior to the commissioning of the Jenin gas-fired combined cycle power plant by 2022. The pipeline could deliver gas from Israeli sources (such as Tamar, Leviathan, or Karish-Tanin) or eventually others. A similar arrangement could be envisaged in the southern West Bank. This would involve the construction of a high pressure pipeline from Kiryat Gat to the Tarkumiya area, west of Hebron, to supply gas for a proposed future second gas-fired plant for the West Bank. This option is not expected to materialize before the end of the 2020s.

Figure I-4.3 – Natural Gas Supply Options to the West Bank

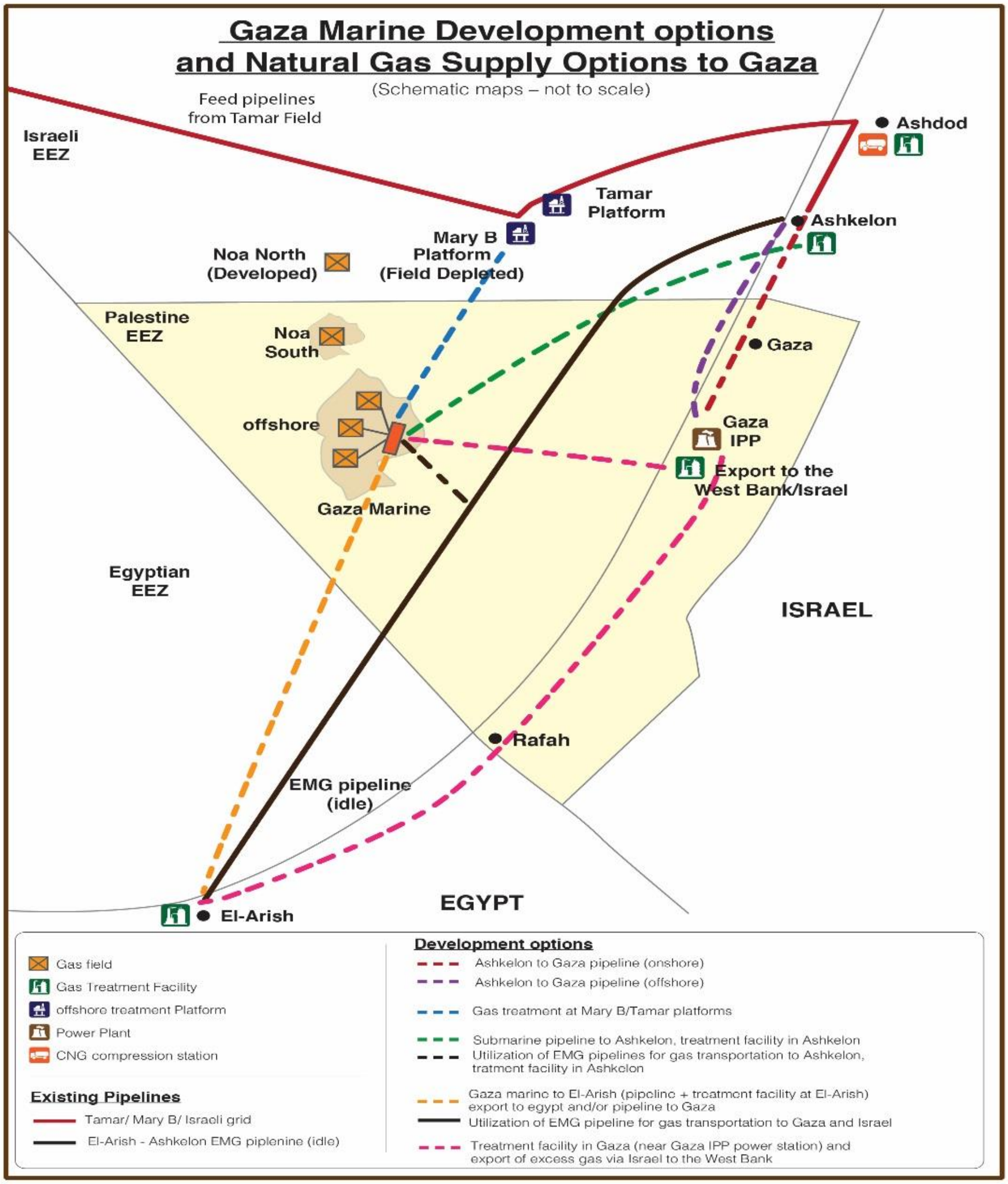


91. **An additional option that has sometimes been raised is the construction of a dedicated gas pipeline from Jordan to the northern West Bank.** This could be used to supply gas from the

Arab gas pipeline or imported LNG from Jordan (see Figure I-4.3). While this option is technically feasible, its economic viability can be called into question. Such a dedicated pipeline would need to be a relatively long 80 kilometer spur from the Jordanian grid to Jenin, over hilly terrain, and could be expected to cost more than $100 million. It would also need to cross the Jordan River, which is the border between Jordan and the PA, that is currently held by Israel. Given that a pipeline from Israel to Jordan is already planned to support the export of Israeli gas, the same infrastructure could potentially be used to transport gas from Jordan into the West Bank using the same spur from the INGL network indicated above.

92. **It is also relatively straightforward (from a technical point of view) to supply Gaza with Israeli gas through a short dedicated pipeline from the Israeli production terminal in nearby Ashkelon.** There are two main options for the supply of Israeli natural gas to Gaza. The first option is the supply of Israeli gas through a high pressure 18 km pipeline from Ashkelon in Israel to GPP that is located to the south of Gaza City. Technically it is a relatively simple project (8 km pipeline from Ashkelon to Erez, the Gaza crossing, and an additional 10 km to the station). The European Union (EU) is currently sponsoring a technical study to support the “Gas to Gaza” initiative led by the Quartet. The second option is the supply of Egyptian gas via a 60 km pipeline from El Arish to GPP.

Figure I-4.4 – Natural Gas Supply Options to Gaza



93. **In addition to the Israeli discoveries, a much smaller Palestinian gas field has been discovered offshore from Gaza.** The so-called Gaza Marine field is located 36 kilometers offshore from Gaza in relatively shallow waters, and has estimated reserves of 1.2 TCF. In November 1999, a 25-year contract for gas exploration and development of the field was signed between British Gas Group (BG Group), the Consolidated Construction Company (CCC), and the Palestinian Investment Fund (PIF), a sovereign wealth vehicle that reinvests in Palestinian projects. The

Palestinian Authority has recently renegotiated the terms of the concession agreement with British Gas (BG), to grant a 15-year extension and increase the PIF equity share from 10.0 percent to 17.5 percent, and limited BG rights to Gaza Marine only.

94. **The development of the Gaza Marine field is highly contingent on securing export markets, since the Palestinian market is too small to justify the necessary investment**. It has been estimated that the Gaza Marine field would need to be developed with a throughput of 2 BCM per year in order to provide adequate returns to the necessary investments of NIS 3.6-4.4 billion (US$1.0-1.2 billion). This is about twice the maximum levels of demand that could be reached in West Bank and Gaza by 2030. Hence, the development of the field is contingent on securing a suitable export agreement, either to Israel (and possibly Jordan) or to Egypt. The first option of export to Israel would entail construction of an offshore pipeline to Ashkelon in Israel where a new gas treatment plant could also be located. The second option of export to Egypt would be based on an offshore pipeline to El Arish in Egypt and use of the gas as feedstock in the Egyptian LNG export terminal at Idku. A third possible option would be to develop the Gaza Marine field at a lower level of throughput more compatible with domestic demand. This could be viable if existing Israeli infrastructure could be shared with the Tamar field and the soon to be depleted Mari B field, which are located relatively nearby, reducing development costs to NIS 910 million (US$250 million). The main features of the three options are summarized in Figure I-4.5 below. In all three cases, a part of the gas could be brought back by pipeline into Gaza, as already noted above. The two Israel options would also allow transportation of Palestinian gas into the West Bank through the Israeli gas transportation network, as already described above.

Figure I-4.5: Alternative options for developing the Gaza Marine gas field

	Option 1	**Option 2**	**Option 3**
Anchor client	Israel and West Bank and Gaza (possibly also Jordan)	Egypt and West Bank and Gaza	West Bank and Gaza
Gas transportation infrastructure	45km offshore pipeline to Ashkelon (Israel)	70 km offshore pipeline to El Arish (Egypt)	25 km offshore pipeline to Mari B and Tamar Platforms
Gas treatment infrastructure	New gas treatment facility in Ashkelon (Israel)	Supply to Gaza or Egyptian market or feed-gas to LNG Liquefaction plants in Egypt	Use existing offshore gas treatment facility (Israel)
Project duration	3-4 years	3-4 years	2 years
Investment costs	US$1.2-1.5 billion	US$1.2-1.5 billion	US$0.3-0.4 billion
Required throughput	2.0 BCM per year	2.0 BCM per year	0.2-0.3 BCM per year (rising in a flexible manner with demand)
Supply to Gaza	23 km pipeline from Ashkelon (Israel) to GPP	65 km pipeline from El Arish (Egypt) to GPP	23 km pipeline from Ashkelon (Israel) to GPP
Supply to West Bank	Via injection into INGL gas transportation network	None	Via injection into INGL gas transportation network

95. **The development of the Gaza Marine field would bring significant fiscal revenues to the Palestinian Authority**. Based on a typical 60 percent public sector profit sharing arrangement, it is estimated that Gaza Marine could bring fiscal proceeds of almost NIS 10 billion (US$ 2.7 billion) over its 25-year life. These would be phased as follows: NIS 146 million (US$ 40 million) per year in the first three years of operation; NIS 310 million (US$ 85 million) per annum in the rest of the first decade of operation; and NIS 475 million (US$ 130 million) per annum in the next fifteen years of operation. Out of these revenues, royalties set at 12.5 percent of sales, would amount to 26 percent of overall fiscal proceeds, with the remainder being taxes.[11] In 2005, the Palestinian Authority signed an agreement in principle to sell the natural gas to the Government of Egypt via the terminal at El Arish, however this deal did not receive Israeli approval. From 2006-2008, negotiations took place with IEC regarding possible sales of the gas to Israel via the terminal at Ashkelon. Due to the failure to reach a purchase agreement, the private companies pulled out and the development of the Gaza Marine field has subsequently been on hold.

4.2 Implications for West Bank and Gaza

96. These recent developments in the natural gas sector have significant implications for the future energy plans of West Bank and Gaza.

a. **The development of gas-fired power generation plants in the Palestinian Territories should not be contingent on development of Gaza Marine.** Given the relatively small initial levels of Palestinian gas demand, their relatively slow ramp-up, and the unproven creditworthiness of West Bank and Gaza as a purchaser of natural gas, it does not look practical to base development of Palestinian gas-fired power generation on development of Palestinian gas resources. Instead, the well-established Israeli gas market with its abundant reserves, provides a more practical immediate source of gas for West Bank and Gaza, with the ability to supply at relatively small volumes providing flexibility for demand growth (although the Palestinian creditworthiness issue still needs to be addressed).

b. **There may be strategic value in developing gas transportation links between Israel and the Palestinian Territories.** Whether gas is ultimately sourced from Israeli or Palestinian sources, interconnecting West Bank and Gaza to the Israeli gas transportation infrastructure looks to be a necessary prerequisite for accessing any gas supplies. Fortunately, the required investments to connect WBG to the Israeli high pressure gas grid are relatively small. These costs are estimated at some NIS 55 million (U$S 15 million) to connect the prospective Jenin IPP in the northern West Bank, and some NIS 73 million (US$ 20 million) to connect Gaza IPP. These connections have already been established as technically and economically viable, and seem to have some political support from both the Israeli Government and the Palestinian Authority.

[11] These results derive from the following simplistic assumptions: GM development via the Tamar Platform scheme; development costs of $250 million; gas treatment and variable costs of $1/mmbtu, gas price of $5/mmbtu, gas production quantities: 0.5BCM/yr in the first 3 years of operation, 1 BCM/yr in the next 7 years of operation, and 1.5 BCM/yr in the next 15 years of operation.

c. **The main economic benefit of the Gaza Marine project to West Bank and Gaza lies in its contribution to fiscal balance rather than to energy security.** In view of the preceding considerations, it is clear that Gaza Marine gas is not critical to the development of gas-fired generation capabilities in the Palestinian Territories. Nor does it necessarily guarantee greater energy independence to West Bank and Gaza, given that Palestinian gas would in any case need to travel through Israeli infrastructure to reach the West Bank or Gaza. It follows, therefore, that the main advantage of developing Gaza Marine may lie in its contribution to public finances rather than to energy security.

d. **There may be merit in considering the smaller scale development options for Gaza Marine.** It is unclear whether export arrangements of Gaza Marine gas to either Israel, Jordan or Egypt would prove to be feasible. Israel itself is on the brink of having a large gas surplus, once the Leviathan field comes on stream. Egypt, on the other hand, has become a significant importer of LNG (rather than an exporter as previously envisaged) although this may change with the discovery of the Zohr field. While Jordan has previously shown an interest in Palestinian gas, the recent agreement of import arrangements with Israel may limit the scope for this. Given the uncertainties surrounding all the potential export possibilities, the option of developing Gaza Marine at a slower pace that could be entirely absorbed by the Palestinian market could prove to be a practical solution for getting the project off the ground. However, it may be more feasible to get this project off the ground once some gas-fired generation capacity has been built in West Bank and Gaza, the required gas transportation infrastructure is in place, and a track record of payment has been established based on experience with Israeli gas imports.

e. **Any gas import agreement with Israel should not foreclose the eventual development of Gaza Marine.** If the ultimate goal is to anchor the development of Gaza Marine from an established base of Palestinian gas consumption, it would be important to ensure that any gas import agreements with Israel provide adequate flexibility for an eventual transition from Israeli to Palestinian gas supplies. However, it is likely that this flexibility will come at a cost premium relative to a longer term rigid take or pay arrangement for the supply of gas.

f. **Development of gas-fired power in West Bank and Gaza may in future become uneconomic.** Given the rapid pace of development of solar PV, concentrated solar power, and energy storage technologies, it should not be precluded that gas-fired power will become uneconomic in West Bank and Gaza, or simply less desirable given the energy security advantages for solar energy. Solar energy supply to West Bank and Gaza could be from Palestinian territory and/or from Jordan (which is scaling up solar energy very rapidly) and/or from Egypt (which is planning to scale up solar).

5 Importing Electricity from Jordan & Egypt

5.1 Current Context

97. **In addition to its power imports from Israel, West Bank and Gaza also have the possibility to consider further increase of current modest imports from Jordan and Egypt.** The validity of these options depends to a considerable extent on the domestic power sector context in each of these neighboring countries, as well as the relative costs of their power export tariffs compared with Israel and other domestic Palestinian options. Expanding imports from either of these countries would also entail significant upgrades to cross-border transmission infrastructure, which is currently quite modest, and would require various levels of political and governmental approvals to allow permitting for beginning construction. For both countries, the lack of payment security from Palestinian buyers is also a concern as the risk of non-payment is deemed high and unlike Israel, neither Egypt nor Jordan have access to the controversial 'net lending' mechanism to recover their costs. Finally, although Jordan is typically considered as a supplier to the West Bank and Egypt to Gaza, since Egypt and Jordan are fully interconnected it is – at least in principle – possible to envisage Jordanian power flowing to Gaza via Egypt or Egyptian power flowing to the West Bank via Jordan.

5.2 Jordan

98. **In 2008, the West Bank started importing 20 MW of power from the Jordanian grid through a 33 kV feeder to Jericho.** The Palestinian strategy was to reduce its dependence on Israeli electricity supply and access the Arab network in a moment where Israeli electricity supply to the Gaza strip was being reduced[12]. The Jericho area was disconnected from the Israeli power grid and connected to the Jordanian grid. Since then, the Jerusalem District Electricity Company (JDECO) has been managing a separate electricity supply system for the customers in the Jericho area.

99. **The upgrade of the existing interconnection inside Jericho from 33kV to 132kV would further increase power supply in the West Bank and diversify Palestinian electricity sources.** This project is backed by PENRA and JDECO and its execution would be highly desirable. Other options such as a 400 kV interconnection to the Jordanian Samra 400 kV substation have been assessed in the past but are more costly and more complex. The Jordanian substation has sufficient space for extensions by two 400 kV line bays, and there is also the possibility of extending the Samra Thermal Power Plant in Jordan, to supply additional energy if required[13].

100. **Since Palestinian power demand is not integrated into Jordanian power sector expansion plans, only surplus Jordanian power is available for export**. Given the relatively small size of the Jordanian system, total power demand in the West Bank currently represents

[12] http://www.reuters.com/article/us-palestinians-israel-electricity-idUSL2563001520080225

[13] Palestinian Energy Authority, Norconsult, Feasibility study "Interconnection of the Electrical Networks of Egypt-Gaza Strip & Jordan-West Bank", May 2008.

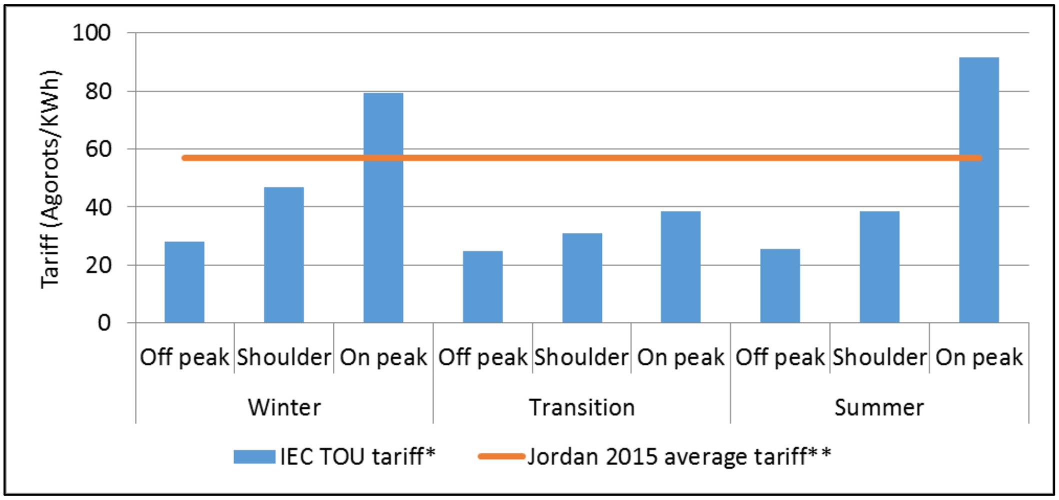
about one third of Jordanian demand. The quantities available for export are determined on an hourly basis by the available capacity in Jordan as well as the evolving Jordanian load. Nevertheless, NEPCO has been responding positively to requests for firm power export from Jordan to the West Bank. In a recent visit[14] to Amman, the Palestinian Minister of Energy agreed with the Jordanian counterparts to accelerate efforts to upgrade the existing interconnection inside Jericho from 33kV to 132kV.

101. **Jordan's successful transformation of its energy sector has increased its capability to export power to the West Bank.** As recently as 2010-2015, Jordan faced an electricity supply crisis due to a shortage of natural gas in Egypt that led to the curtailment of Egyptian fuel and power imports, and forced the country to switch its plants over to Heavy Fuel Oil with serious financial consequences. This situation has largely been turned around by the installation of an FSRU at Aqaba allowing the import of LNG so that thermal plants could revert to running on natural gas. The recent signature of a Gas Sales Agreement GSA) with the US-based Noble Energy for gas from Israel's Tamar and Leviathan fields, will allow Jordan to displace part of its LNG imports with natural gas reducing the cost of power generation. While Jordan was also interested in exploring imports of Palestinian gas from Gaza Marine, it remains unclear when such gas may become available. As a result of these measures, Jordan has restored its reserve margin to the prudent 10-15 percent range. In addition, the country has 1,300 MW of renewable energy in the pipeline, which due to their variable nature are not counting towards the reserve margin. Hence, Jordan is likely to face electricity surpluses in the medium term and would be well positioned to increase electricity exports to the West Bank.

102. **A key issue driving the decision of how much to rely on Jordanian imports is their relative cost.** Historically, the cost of electricity imports from Jordan to the West Bank, through JDECO, have been based on a special import tariff averaging NIS 0.51-0.55 (US$0.14-0.15) per kilowatt-hour, which is significantly more expensive than the Israeli import tariff averaging NIS 0.33-0.40 (US$ 0.09–0.11) per kilowatt-hour. JDECO, purchases power from IEC on a Time of Use (TOU) basis with different costs based on the time of day and season. At the same time, JDECO arbitrages IEC costs against Jordan TOU rates which are made up of a capacity charge component and a day versus night tariff rate. Typically, during fall and spring, when Palestinian loads are smaller, JDECO buys exclusively from IEC whose rates are much lower than Jordan. However, during summer and winter, when Palestinian loads are high, and IEC tariffs increase (see Figure I-5.1), JDECO may purchase power from Jordan as tariffs rates are within 10-15 percent difference. It should be noted that the Palestinian Authority pays back to JDECO the difference in price between IEC and Jordanian tariff rates as JDECO is obliged to follow PERC's unified tariff which is set using the IEC price only. A fundamental reason for the cost differential between Israeli and Jordanian power lies in the fact that Israeli power generation is increasingly based on relatively low cost domestic gas, while that in Jordan it is based on significantly more expensive imports of LNG. This differential will come down as Jordan starts to rely on Israeli imports of natural gas, although it is unlikely to disappear entirely.

[14] World Bank, Aide Memoire, May 2016.

Figure I-5.1: IEC Time Of Use High Voltage Tariff versus Jordan average annual tariff



**IEC TOU high voltage tariff set as of 13.09.2015*
***Jordan 2015 annual average tariff*
Source: IEC and PERC

103. **Increasing energy imports from Jordan is key to diversifying energy sources through regional trade**. Jordan is willing to act as a transit country for Palestinian trade with third parties, and already has a well-established wheeling tariff and associated regulations. Strengthening interconnection with the Jordanian grid would allow access to Egyptian power supply (see below), as well as the eight country Arab regional grid comprised of Egypt, Iraq, Jordan, Syria, Turkey, Libya, Lebanon, and West Bank and Gaza. In terms of natural gas, as noted above, an approximate 60 kilometer branch from the Arab Gas Pipeline from Jordan into the West Bank, would allow export of gas for the Palestinian energy sector. This would require agreement from the four nations (Egypt, Jordan, Lebanon and Syria) that are members of the Arab Gas Pipeline.

5.3 Egypt

104. **Gaza imports 20-30 MW of power from Egypt to the Gaza Strip during a limited number of hours per day.** This restricted service is frequently interrupted due to lack of maintenance of the lines, and security concerns in the Sinai Peninsula. In addition, the electricity supplied is of poor quality with voltage and frequency deviations causing damage to sensitive electronic equipment, such as MRI machines at hospitals. Egypt provides 14 percent of Gaza's energy supply through three feeder lines from the Al Arish power plant in Northern Sinai at an average tariff of NIS 0.27 (US$0.07) per kilowatt-hour, almost 40 percent lower than the Israeli import price. Unlike all other cross-border electricity transactions with Egypt, which have the Egyptian Electricity Transportation Company as the contractual party, the export of power to Gaza is managed through an agreement with the local Canal Distribution Company in Sinai. The total monthly cost of Egyptian power imports is NIS 3.7 million (US$ 1 million), which is entirely paid by the League of Arab States (LAS).

105. **Increasing interconnection capacity from Egypt into Gaza is a technically feasible option.** In addition, they would have minimal impact on the Egyptian power system because current exports only represent 0.1 percent of total current consumption in Egypt. (Indeed, total electricity demand in West Bank and Gaza is no more than 2-3 percent of Egyptian demand.) The construction of a 220 kV transmission line from Egypt into Gaza has been considered in the past. The Islamic Development Bank (IsDB) had agreed to finance two 22kV feeders from Egypt to Gaza, which would have increased the import capacity to 60MW, but the project was put on hold.

106. **Egypt has successfully turned around its recent power supply crisis and is heading for a substantial electricity surplus.** A shortage of domestic gas supply led to a serious power supply crisis in Egypt during the summer of 2014, resulting in rolling blackouts and social unrest. Since then, the government has taken decisive measures to expand electricity supply through contracting emergency plants, establishing three new floating LNG import terminals at Ain Sokhna to compensate for the shortage of domestic gas, and contracting the development of over 18 GW of new thermal generation capacity, most notably through a large bilateral deal with Siemens of Germany for the development of a new generation of efficient CCGT plants. As a result, Egypt's fossil-fuel generation capacity is expected to double between 2015 and 2021, even as some 4 GW of new renewable energy capacity also come online. Demand is unlikely to keep up with this rapid growth, so that – in the absence of major capacity retirements – the average capacity utilization of fossil power plants will fall from 54 percent in 2015 to 41 percent in 2021 (see Figure I-5.2 and Annex 5 figure A5.1 for additional detail). As a result, Egypt is moving from a 5 GW power deficit in 2014 to potentially a substantial power surplus by 2021, opening up the possibility of significantly expanding power exports and other domestic uses of electricity.

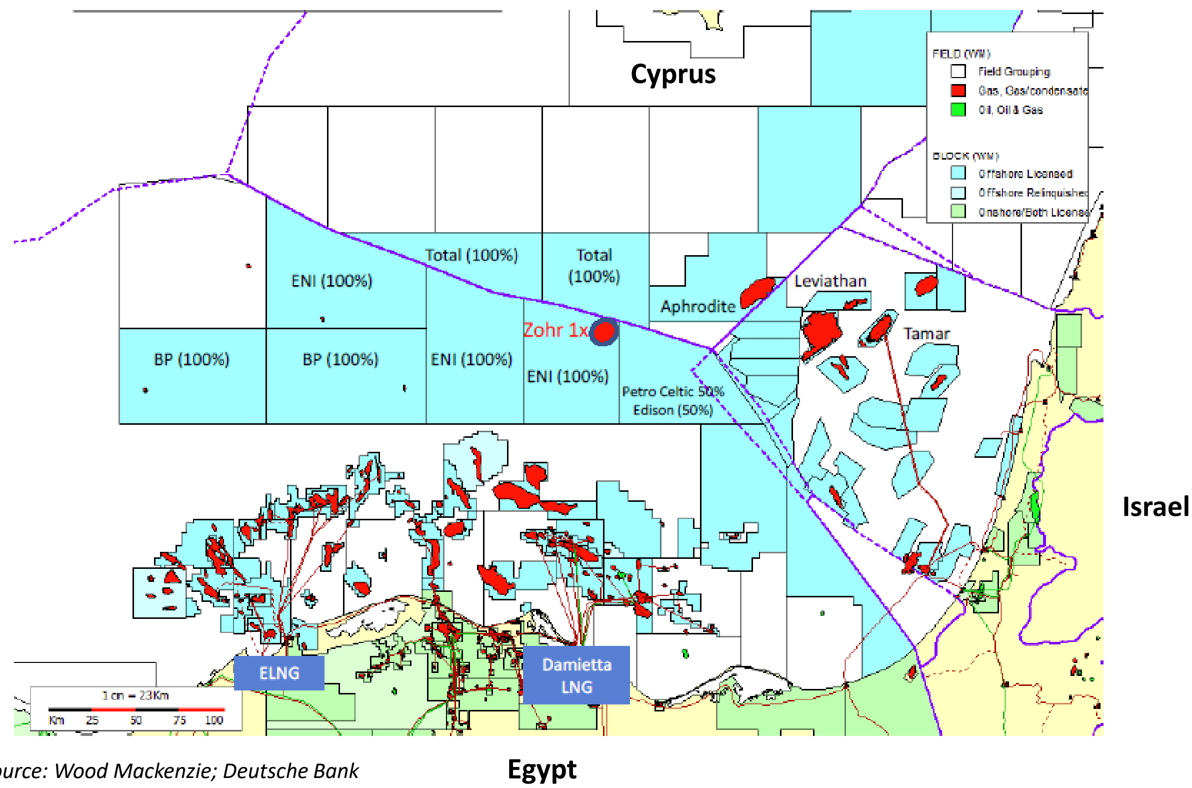
Figure I-5.2: Projected fossil fuel supply situation in the Egyptian power market

	Unit	2015	2016	2017	2018	2019	2020	2021
Capacity utilization factor	%	54%	55%	52%	44%	40%	41%	41%
Marginal economic cost	USD/kWh	0.04	0.03	0.04	0.05	0.05	0.06	0.06
Electricity Supply	'000s GWh	161.9	171.7	178.6	188.6	199.1	210.2	223.2
Generation Capacity	GW	21.3	22.3	25.9	33.6	39.6	41.2	44.8

107. **Egypt's declining domestic gas production received a boost from the discovery of the Zohr field in 2015.** The offshore deep water Zohr field could hold a potential of 30 TCF of lean gas, making it the largest gas discovery in Egypt and one of the largest globally over the last decade. Assuming that 75 percent of the gas can be recovered, the field would add around 22 TCF or 34 percent to Egypt's natural gas reserves, equivalent to about 12 years of current natural gas consumption. ENI's announced development plan envisages the start of production by the end of 2017, just two years after the discovery, with a progressive ramp up to a volume of about 2.7 billion cubic feet of gas per day by 2019. This discovery promises to

reverse the fortunes of Egypt's gas sector which had been in long term decline switching from exporting to importing status in 2015. This was due to an unfavorable energy pricing regime, mounting arrears to international oil and gas companies, and social unrest following the Arab Spring. An ambitious policy reform agenda has helped to restore private sector confidence and underpinned the current development of the Zohr field. Due to its strategic location close to the boundary of Egyptian, Cypriot and Israeli water, and the availability of stranded LNG export facilities in Egypt, the Zohr field also has the potential to become a gas hub for LNG export from the region (see Figure I-5.3).

Figure I-5.3: Zohr gas discovery and surrounding infrastructure



Source: Wood Mackenzie; Deutsche Bank

108. **The cost of Egyptian electricity imports compares favorably with those of Israel.** Domestic electricity tariffs in Egypt, at an average level of NIS 0.08 (US$0.02) per kilowatt-hour, compare favorably with Israel, although they are distorted by significant subsidies both to the power sector and the upstream fuels sector, which are currently in the process of being unraveled. The current cost recovery benchmark tariff is in the order of NIS 0.15 (US$0.04) per kilowatt-hour. Historic exports to Gaza have also been priced at a favorable rate of NIS 0.27 (US$0.07) per kilowatt-hour.

5.4 Implications for West Bank and Gaza

109. These recent developments in the electricity sectors of neighboring Jordan and Egypt have significant implications for the future energy plans of West Bank and Gaza.

a. **Both Jordan and Egypt have recently overcome major inter-related power supply crises and are well on their way to having significant power surpluses.** The recent electricity supply crisis in Egypt due to declining availability of domestic gas, triggered a second crisis in Jordan as Egyptian imports to that country had to be curtailed. Both countries have acted decisively to address their respective power supply crises and are emerging with significantly expanded power generation capacity and greatly enhanced energy security. Both countries are beginning to face the prospect of electricity surpluses, a modest surplus in Jordan of the order of 100s of MW, and a much more substantial surplus in Egypt of the order of 1,000s of MW. As a result, both countries will have power available for export during the coming years which would greatly help in the diversification efforts of West Bank and Gaza.

b. **From an economic standpoint, power imports from Egypt look more attractive than those from Jordan.** The characteristics of potential power imports from Jordan and Egypt look quite different. In particular, Egyptian power looks to be lower cost than Israeli power, while Jordanian power looks to be higher cost than Israeli power. Since all three countries are heavily dependent on natural gas, this difference largely boils down to the cost of gas. In Egypt, domestic gas has historically been low cost as the gas reserves are in shallow waters. In Israel, gas prices are higher as the gas reserves are in deeper waters. In Jordan, gas prices are the highest as they do not have domestic gas supply and rely on more expensive LNG imports.

c. **From a technical standpoint, the relative sizes of the different power systems also facilitate reliance on Egypt.** Another important difference lies in the scale of the two neighbors' power sectors. The Egyptian power sector is more than 10 times larger than the Jordanian one. As a result, Palestinian electricity demand represents more than 30 percent of Jordanian demand, but less than 3 percent of Egyptian demand. This has important implications for energy planning. Any significant increase in imports from Jordan would eventually suggest the need for closer coordination between the two countries on energy planning. While imports from Egypt could be substantially increased without any real impact on the Egyptian system.

d. **From a political and security standpoint, however, power imports from Jordan may be more feasible than those from Egypt.** Despite the technical and economic advantages of Egyptian power, cross-border power cooperation with Jordan is significantly more advanced for political reasons. For a number of reasons, ranging from political upheaval and security concerns in the Sinai to the recent curtailment of power exports to Jordan, Egypt's reputation as a reliable source of electricity has been prejudiced. At the same time, political relations between Egypt and Gaza have been increasingly strained. On the other hand, political relations with Jordan remain strong and constructive dialogue has already been established.

e. **Further upgrading of electricity imports from Jordan will require approvals from Israel over access to Area C.** Any expansion of or addition to the current cross-border power line to Jordan traverses Area C of the West Bank and as a result will require Israeli approval, even for the upgrade of the existing lines.

6 Developing Domestic Renewable Power Generation

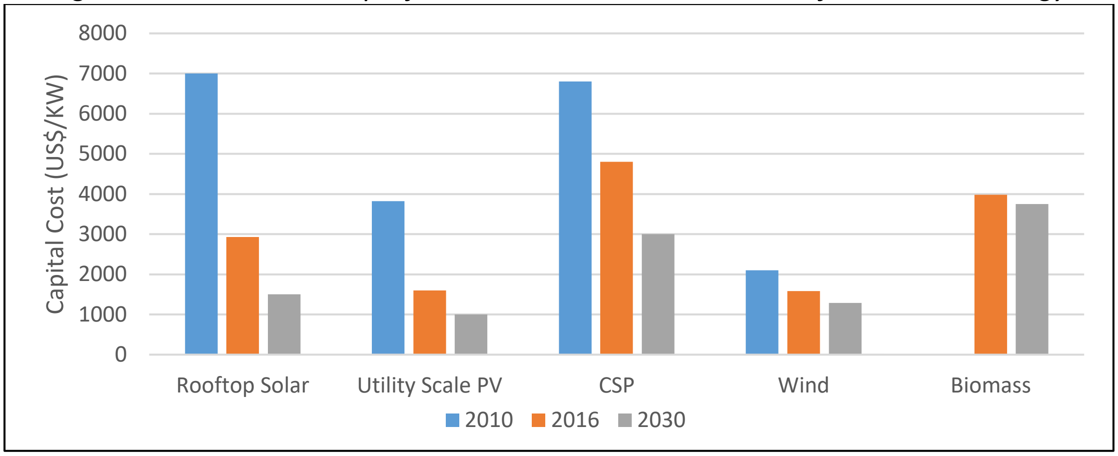
6.1 The current context

110. **Renewable energy represents the only truly independent form of power supply which does not rely on imports of electricity or fuel.** Currently, over 96 percent of Palestinian energy supply is dependent on Israel either in terms of direct electricity imports or in terms of fuel imports for the Gaza Power Plant (GPP). In the future, there are plans to increase domestic gas-fired generation capacity. However, unless the Gaza Marine field is developed – which is difficult given the complex geopolitical context – the fuel for these power plants would also have to be imported from Israel. Even if Gaza Marine were to be developed, the import of the fuel would likely still entail reliance on Israeli gas transportation infrastructure. Renewable energy, particularly solar, is the only source that can be independently produced on Palestinian soil.

111. **As the cost of solar energy continues to decline, the option looks increasingly attractive for West Bank and Gaza.** Referring to figure I-6.1 the cost of rooftop photovoltaics and utility scale solar have dropped more than 80[15] percent since 2010. In addition neighboring Jordan has received bids as low as NIS 0.22 ($0.06) per kilowatt-hour, which is almost half the price of IEC imports. Nevertheless, care should be taken in comparing simplistic unit costs between firm sources of energy, like IEC imports, and variable sources, like solar generation. In addition, the political and economic climate in Jordan are significantly better than in West Bank and Gaza making it a more conducive environment for investment and private sector involvement. Nevertheless, West Bank and Gaza are located in a region rich with the sun's energy. With 3,000 sunshine hours per year and Global Horizontal Irradiance (GHI) over 2,000 kilowatt-hours per meter squared, West Bank and Gaza rank amongst the world's top locations for construction of solar systems. Solar energy represents one of the few untapped supply options for West Bank and Gaza, in a context where negotiations with neighboring countries on increasing power supply options have proven difficult to advance.

[15] NREL 2016 annual technology baseline. Note: these figures represent the US solar sector. In West Bank and Gaza costs could be higher to compensate for the high risk environment.

Figure I-6.1: Recent and projected declines in the unit cost of renewable energy



112. **Nevertheless, it is proving challenging to kick start renewable energy investment in the Palestinian context.** PENRA's renewable energy targets, set in 2012, aim to generate 130MW of power supply from domestic renewable resources by 2020. As of March 2017, less than 15 percent of that target had been achieved (see figure I-6.2). After a slow start, interest in renewables has noticeably increased in the past 3-4 years following the cabinet adoption of the renewable energy strategy in 2012, and the promulgation of the Palestinian Renewable Energy Laws being released in 2015. This young sector has faced two main challenges to date. They include an inability to secure a Power Purchase Agreement (PPA) with a bankable off-taker, and a lack of available transmission infrastructure for power evacuation. Investors are deterred by the context which, given the current circumstances, could result in significant construction delays and high risk of payment default.

Figure I-6.2: Progress towards the achievement of PENRA's renewable energy targets

PENRA's Renewable Energy targets (set in 2012)		
	2020 Target (MW)	Achieved by 2017 (MW)
Rooftop Solar	25	1.5
Utility scale PV & CSP	40	16
Wind	44	0
Biogas (animal & landfill)	21	0.5
TOTAL	130	18

113. **If these obstacles were addressed, the potential for renewable energy development in West Bank and Gaza could go far beyond current policy targets.** In fact, based on a survey of the available potential, the existing renewable energy target could be increased by more than 30 times as highlighted in figure I-6.3 below for a total of 4,246 MW (see Annex 6, figures A6.1-A6.5 for full calculations and assumptions). However, there are a number of important points to note. First, about 96 percent of the identified potential is in the West Bank. Only 165 MW of potential have been identified for Gaza, and this is almost exclusively in the form of rooftop solar, due to extreme land constraints and vertical patterns of urbanization. Second, about 83 percent of the potential identified for the West Bank is located in Area C (see Annex 7 Figure A7.3 for map and explanation of areas A, B and C); however, obtaining construction

permits in Area C is extremely difficult with only 3.5 percent of construction permits submitted by Palestinians to the Israeli Civil Administration to build in Area C having been approved in 2015. Again due to land constraints – less severe for West Bank than Gaza but nonetheless real – the total renewable potential of Areas A and B amounts to just 707 MW, of which over 75 percent is in the form of rooftop solar. The larger prevalence of houses in West Bank, as well as the larger population, makes the rooftop potential much larger than for Gaza. Third, as much as 98 percent of renewable energy potential in West Bank and Gaza take the form of solar, due to limited suitability for wind or availability of biomass.

Figure I-6.3: Overview of renewable energy potential in West Bank and Gaza

Potential Available RE Capacity (MW)				
Utility scale PV or CSP[16]				
	Area A & B		Area C	Total
West Bank	103		3,374	3,477
Gaza	0			0
Rooftop Solar[17]				
	Residential	Public	Commercial	Total
West Bank	490	13	31	534
Gaza	136	8	19	163
Wind[18] & Biomass[19]				
	Wind Areas A/B/C	Biomass (Animals)	Biomass (Landfill)	Total
West Bank	45	7	18	70
Gaza	0	2	0	2
Total				
West Bank				4,081
Gaza				165
West Bank and Gaza				4,246

114. **Wind faces land limitations similar to utility scale PV and needs to be firmed up due to its intermittent nature.** Due to safety concerns, wind farms cannot be built in densely populated urban centers. In Gaza, this means wind production is not possible. In addition, wind speeds are not sufficient in Gaza. In the West Bank, the densely populated Area A is not suitable for wind generation. On the other hand, similar to utility scale PV, Area C is not accessible for construction. The limited sites in the West Bank with the right height, orientation and wind speed are located close to the Israeli border which presents a security concern to the Israeli side. Also,

[16] Assumptions: According to PETL and PEC, 0.12 percent of Area A and B and 3 percent of Area C are available for solar installations. The land requirement is ~28m2 per KWp (includes space for control rooms etc).
[17] Assumptions: According to PCBS and PEC, in West Bank and Gaza, there are over 400,000 residential, 2500 public sector and 5000 commercial sector rooftops. The rooftop areas range from 150-300m2 and between 30-50 percent of the rooftops are available for solar installations. The rooftop space requirement is 9m2 per KWp.
[18] Assumptions: In hilly regions of West Bank wind speeds are 4-8m/s for regions above 1000m. The land requirement is ~210 to 330m2 per KWp.
[19] Assumptions: Three landfills in the West Bank (Jenin, Ramallah, Hebron) each take in 800 tons of waste per day and produce 41,800m3 of biogas which can be converted to 251MWh/per day. For animal waste, assuming approximately 172 animal digesters making a total of 750MWh/day.

the intermittency of wind would have to be firmed up with additional supply likely having to come from Israel.

115. **Biogas plants are dispatch-able and do not face land restrictions but are limited in terms of scalability.** Small, distributed biogas digesters can be located close to the associated farms. The larger biogas power plants for landfills can be built on site. Power from biogas plants is dispatch-able because gas output is constant and an operator can choose when to generate power. This eliminates the need for firming up through backup generation. Biogas generation will decline over time but can be considered relatively constant until 2030. Although biogas is an excellent supply option, it is limited in scale and cannot be scaled up.

116. **By 2030, rooftop solar and utility-scale PV are expected to have the lowest combined capital expenditure and fixed and variable operating and maintenance costs.** The 2016 and forecasted 2030 capital costs, as well as fixed and variable operation and maintenance costs for these supply options are shown in figure I-6.4 below[20].It should be noted that these figures represent the US solar market and could be higher in West Bank and Gaza to compensate for the higher risk environment. In addition, cost comparisons between PV and CSP technologies are complicated by the fact that CSP provides some degree of storage and hence greater flexibility of use.

Figure I-6.4: Projected cost of alternative renewable energy technologies in West Bank and Gaza by 2030

	Rooftop Solar	Utility Scale PV	CSP	Wind	Biomass
	2016				
Capital Costs ($/KW)	2930	1600	4800	1580	3984
Fixed O&M ($/KW-yr)	17	15	63	51	107
Variable O&M ($/MWh)	0	0	4	0	5
	2030				
Capital Costs ($/KW)	1500	1000	3000	1290	3750
Fixed O&M ($/KW-yr)	10	8	40	49	107
Variable O&M ($/MWh)	0	0	4	0	5

117. **There is considerable potential to use rooftop solar as an electricity safety net for institutions fulfilling critical humanitarian roles, particularly in Gaza**. Figure I-6.5 describes how health facilities in Gaza are benefiting from a switch away from backup diesel to rooftop solar generation.

Figure I-6.5: Contribution of rooftop solar to meet critical energy needs in Gaza's health facilities

The UN has been delivering emergency fuel supply to a subset of critical health and WASH facilities in Gaza since 2013. The available power supply to Gaza is only enough to meet half the demand, and the available power is constantly fluctuating due to frequent unit and line outages. Between 2015 and 2016, GPP was off-line on average 23 days per year and a subset of Egyptian and Israeli import lines were down for an average of 6 and 4 days, respectively, per month. As a result, since December 2013, the UN has coordinated emergency

[20] NREL 2016 annual technology baseline.

donations of fuel supplies for generators of critical infrastructures in Gaza to ensure the population continues to have access to health, water and sanitation facilities. As of April 2017, the UN supplies this emergency fuel to 186 facilities, of which 32 are in the health sector, 124 in water and sanitation and 30 in solid waste management. OCHA takes on the role of coordination and prioritization of fuel needs with sectors in Gaza while UNRWA takes charge of purchase, delivery and distribution of fuel.

As the power situation in Gaza deteriorates, the need for additional emergency fuel donations for critical infrastructure increases, while donors are backing away from providing additional funding. In the best case scenario, where GPP is running at 60MW, health facilities need 450,000 liters of fuel per month, WASH facilities need 200,000 liters per month and solid waste collection needs 150,000 liters per month. In total, this costs over NIS 22 million (US$ 6 million) per year which includes a UN tax exemption on the cost of fuel without which the cost would be much higher. If GPP is not running, health facilities need 650,000 liters of fuel per month, WASH facilities need 400,000 liters per month and solid waste collection needs 200,000 liters per month. In total, this costs NIS 37 million (US$ 10 million) dollars per year. Traditionally, Islamic Development Bank, Qatar, Turkey, and Japan have been the biggest donors of funds for emergency fuel supplies to Gaza; however, as the situation continues to deteriorate, donors are finding it increasingly difficult to contribute to such an expensive and unsustainable solution.

Many donors are considering donation of rooftop solar systems for critical departments in hospitals as an alternative to providing fuel for generators. Since the 2014 war in Gaza, which saw extensive damage to GPP and the Egyptian and Israeli import lines, the efforts to harness the abundant energy of the sun, through distributed rooftop solar systems, have increased 10[21] fold in the Gaza strip. This is especially true for critical infrastructure such as hospitals, where donors are substituting the need to provide emergency fuels for generators with installation of sustainable solar systems for critical units/departments in hospitals at a fraction of the cost. As of May 2017, approximately 306 Kilowatts of rooftop solar systems have been, or are being installed on rooftops of health facilities in Gaza at a total cost of approximately NIS 5.5 million (US$ 1.5 million). Figure A6.6 in Annex 6 contains a full breakdown of the completed and on-going installations including the names of health facilities benefiting from the projects and the names of donors which are providing the funding.

There is significant additional need for installation of rooftop solar systems in Gaza and more donors should consider this approach as an alternative to providing fuel donations. Rooftops of hospitals in Gaza are large, flat surfaces ideal for solar installations. Although the area will not be enough to supply solar energy to the entire hospital, the existing rooftop space should be maximized through solar installations before spending extremely high sums on diesel fuel for generators. According to MoH and WHO, an additional 1MW of rooftop solar systems can be installed across 34 critical units within 10 MOH hospitals in Gaza with a total expected cost of approximately NIS 14.5 million (US$ 4 million). Figure A6.7 in Annex 6 provides a full breakdown of the hospitals and critical units in need of solar systems. A similar analysis should be carried out for the WASH sector in Gaza where a subset of energy needs could also be met through solar energy.

6.1 Implications for West Bank and Gaza

118. These recent developments in the renewable energy market have significant implications for the future energy plans of West Bank and Gaza.

a) **PETL is the key enabler of renewable energy development, particularly in the West Bank.** PETL plays two critical roles in renewable energy development: off-taker of power and provider of transmission infrastructure. At present, PETL has no track record in either of these

[21] According to PENRA Gaza, between 2012 and 2014 only 310 KWp of large scale rooftop solar systems were installed; however, post-2014, over 3,500KWp have been, or are being installed

roles. It is therefore pressing for PETL to become financially sustainable and establish a track record as a reputable off-taker. It is also important to ensure that PETL has the capability to meet the transmission requirements of renewable energy generation and/or to negotiate appropriate transmission arrangements with IEC.

b) **The financial credibility of PETL is ultimately premised on the creditworthiness of the DISCOs.** Ultimately, PETL is largely a financial middle man between generators and distributors. Providing credit enhancements for PETL cannot be seen as a reliable solution until the real underlying financial issues are resolved at the level of the DISCOs and MVC's. That involves tackling pricing and operational performance at the utility level, as well as strengthening municipal finances to avoid the diversion of revenues from the electricity sector into municipal budgets. As such, a cabinet decision has enforced DISCOs and MVC's to establish escrow accounts which ring-fence the electricity bill payments to ensure they are used only for the payment of suppliers.

c) **Land availability is a major constraint for developing utility scale solar energy production.** In Gaza, due to the small size and high population density, the potential for utility scale solar is negligible. In the West Bank, Areas A and B, which make up 40 percent of the total land area of the West Bank, contain all Palestinian towns and industries leaving little space for land intensive solar generation, but providing more rooftop space for PV than in Gaza. According to PETL and PEC, based on currently submitted projects, approximately 0.12 percent of Areas A and B are available and suitable for solar production with max potential capacity of 103 MW. Area C, which is sparsely developed, has much larger tracts of desert land potentially suitable for solar generation. However, this is outside the control of the PA and permits for construction are rarely granted there.

d) **Access to Area C would have a huge impact on the ability to develop domestic renewable energy generation for the West Bank.** If just 3 percent of the land in Area C was used for utility scale solar production over 3,000MW could be built. Area C, which makes up 60 percent of the total land area of the West Bank is made up of vast empty spaces. The lack of access to Area C is a significant lost opportunity for independence, diversification and energy security for the Palestinian energy sector.

e) **Rooftop solar systems increase resilience and energy security in a context prone to armed conflict.** Of all supply options under consideration, rooftop solar holds the greatest potential as it is least tied to the geopolitics of the region. Land restrictions are not a factor and construction permits are not required. There is no need to enter into long term Power Purchase Agreements with an off-taker or to evacuate the power generated through a transmission grid. In terms of construction time, it is the fastest and easiest to build and since there is no need for imported fuels, the system reduces import dependency. Due to their small distributed nature, rooftop solar systems are the most secure power supply option in case of armed conflict as experience has shown that large centralized generation systems have repeatedly become damaged during past conflicts. In that sense, rooftop solar can be regarded as an electricity safety net that allows the most basic needs to be met under a wide range of possible scenarios

7 Developing Transmission Infrastructure

7.1 The Current Context

119. **The West Bank and Gaza are highly dependent on energy imports from neighboring countries.** The West Bank has over 250 low and medium voltage connection points with Israel, and 1 connection point with Jordan, which provide 99 percent and 1 percent of total energy supply to the West Bank respectively. Gaza has 10 connection points with Israel, 3 with Egypt, and 1 with the Gaza Power Plant (GPP) which provide 64 percent, 13 percent and 23 percent of Gaza's energy supply respectively. Refer to Figure A7.1 in Annex 7 for a geographical representation of the connection points. All interconnection points in Gaza, and most in the West Bank are fully saturated, which lead to power cuts during peak winter and summer loads. As the electricity demand continues to grow, the situation is bound to deteriorate unless the capacity of import lines are expanded.

120. **To increase diversification of supply and relieve the pressure on the saturated interconnections, additional infrastructure needs to be built.** Plans for improved power supply for the West Bank are more advanced than for Gaza. Expansion plans for the West Bank include: i) four new high voltage substations (see Figure A7.2 in Annex 7 for location and service area of new substations) providing an additional 550MW of import capacity from IEC with expected in-service dates ranging from 2017-2019, ii) Jenin Power Plant (JPP), providing additional capacity of 200-450MW with expected in service date of 2020, and iii) Hebron Power Plant providing additional capacity of 120MW with planned in-service date 2022[22].. Expansion plans for Gaza are still in discussion phase and include: i) a high voltage 161kV power line from IEC with import capacity of 100-150MW, and ii) upgrade of GPP to operate on natural gas coupled with expansion of the capacity up to 560MW. All expansion plans, for West Bank and especially for Gaza, are heavily tied to the political economy of the context and concerns over risk of non-payment.

121. **In the West Bank, the energization of the new high-voltage substations under PETL's management will start a process of consolidation of the existing connection points.** This would streamline operations by reducing the large number of direct bilateral low and medium voltage connection points between Palestinian DISCOs and Municipalities and Village Councils (MVCs). Instead, IEC would sell power to PETL at higher voltage through the substations, and PETL would in turn sell the power to DISCOs and MVCs. This would increase billing transparency and allow PETL to improve the sector's book keeping by having better control of the billing and payment cycles. Power transmission at higher voltages would also reduce losses enabling PETL and DISCOs to bill for a larger portion of the purchased power thereby improving cost recovery. In addition, IEC's bulk supply tariff at higher voltage is at least 10 percent lower than at the low and medium voltage levels. Finally, the substations would allow desperately needed additional power to be supplied to the West Bank which would be instrumental in avoiding civil unrest and

[22] Source: PEA draft Energy Sector Strategy 2017-2022

mass protests observed during past winter and summer peak load conditions which were stemmed from power cuts due to shortages in power supply.

122. **The West Bank does not have its own transmission backbone to evacuate domestic generation.** Currently, Palestinian load centers are passive absorbers of electricity. Their power comes from several low and medium voltage distribution networks managed by Palestinian DISCOs. These Palestinian distribution networks are in turn fed by Israeli high voltage transmission networks which act as electron highways routing large volumes of power over large distances from point of generation to point of distribution.

123. **As the West Bank develops its own domestic power generation capacity, one option for moving generated power to its load centers is to wheel through the Israeli grid.** Wheeling is a mechanism by which power generated in the West Bank is evacuated out into the Israeli network and injected back into the West Bank at a different location closer to the Palestinian load centers. Wheeling charges are set by the Israeli regulator, PUA, with a full breakdown provided in figure I-7.1. This figure shows that the Time of Use (TOU) costs are lowest if only the Israeli transmission network is used and highest if both the transmission and distribution (T&D) network are used. (See Annex 3 figure A3.7 for definition of TOU periods). Figure I-7.2 provides a breakdown of the consumption patterns in the West Bank showing that the shoulder hours in spring and fall make up the largest percentage of consumption at 26 percent and on-peak hours in winter or summer make up the smallest percentage of consumption at 3 percent each. Average wheeling costs, shown in figure I-7.3, are derived by cross multiplying the costs in figure I-7.1 with the consumption patterns in figure I-7.2. Figure I-7.3 shows that, for every KWh of Palestinian energy that needs to be moved through the Israeli grid, the Palestinian side would need to pay between NIS 0.018-0.050 (US$0.005-0.013) US per kilowatt-hour, equivalent to a 5-10 percent mark-up over the IEC import tariff. In addition to these relatively high wheeling costs, the Israeli transmission network acts as the gatekeeper for the flow of Palestinian electricity which diminishes the control and flexibility of Palestinian operators.

124. **An alternative option is to construct a Palestinian backbone by connecting the new high voltage substations through a high voltage transmission line.** This would allow generated power to be routed directly to Palestinian load centers through this backbone providing greater flexibility and autonomy to Palestinian operators. Although operationally more favorable, this options faces significant obstacles as Israeli approval and permits would be required for those sizeable sections of the backbone that would need to be built cross Area C. A more detailed comparison of the financial impacts of wheeling versus building a backbone is provided in Part II.

Figure I-7.1: IEC wheeling tariffs

NIS Agorots per KWh, as of 13.09.2015				
Season	TOU block	Transmission tariff *	Transmission & Distribution tariff**	Distribution tariff***
Winter	Off peak	0.89	3.46	2.55
	Shoulder	1.10	3.89	2.78
	Peak	2.8	7.22	4.38
Spring/ Fall	Off peak	0.81	3.22	2.41
	Shoulder	1.36	4.17	2.80
	Peak	1.79	4.82	3.01
Summer	Off peak	1.42	4.20	2.77
	Shoulder	2.60	6.32	3.68
	Peak	6.12	12.13	5.90
* Ultra high voltage producer selling to ultra high voltage consumer ** Ultrave high voltage producer selling to "far away" high voltage consumer *** Ultra high voltage producer selling to "close by" high voltage consumer Ultra high voltage = 400kV and 161kV, high voltage = 22kV and 33kV				

Source: Israel PUA

Figure I-7.2: West Bank annual consumption by ToU

Winter			Spring/Fall			Summer		
Off peak	Shoulder	On peak	Off peak	Shoulder	On peak	Off peak	Shoulder	On peak
3%	16%	9%	11%	26%	20%	3%	7%	5%

Source: IEC load curve for JDECO consumption[23] – 2015

Figure I-7.3: Annual average wheeling tariffs

	Transmission tariff	Transmission & Distribution tariff	Distribution tariff
Agorots / KWh	1.8	5.0	3.1
UScents / KWh	0.5	1.3	0.8

Source: Author's calculations

125. **Building a transmission backbone in the West Bank is logistically and operationally complex.** The land in the West Bank is divided into islands, called Areas A and B, which are entirely surrounded by Area C (see map in Figure A7.3 in Annex 7). Areas A and B, which combined make up 40 percent of the West Bank, are under Palestinian or joint Palestinian and Israeli civil control respectively, so construction permits can be obtained more easily. Area C is entirely under Israeli control and construction permits are extremely difficult to obtain. Building a transmission backbone would require constructing large and contiguous infrastructure traversing Areas A, B and C which would likely face significant delays. In addition, neighboring countries would have to provide approvals for large interconnections to their system which may affect their own grid stability. Finally, if the transmission backbone is built, all sides must work together constantly to create supply-demand balance in the interconnected grids which requires

[23] The data comes from IEC and only represents sales to JDECO which equals approximately 50 percent of the West Bank but we are assuming similar consumption patterns in all West Bank

excellent cooperation at all times. For this to happen, PETL would need to develop their capacity to play the role of a proper Transmission System Operator.

126. **Many other preconditions need to be met before it makes sense to consider the development of a transmission backbone.** Before a transmission backbone is built, a series of phases must be passed to create the right environment. First, the substations must be energized which would allow PETL to become operational. Next, PETL must work with DISCOs to reduce financial leakages to create strong payment discipline along the electricity supply chain. This would improve the creditworthiness of PETL and make it possible to sign Power Purchase Agreements with Independent Power Producers, thereby increasing domestic generation capacity. As domestic generation increases, in the initial years, wheeling could be a viable option as PETL becomes financially and operational stable and capable. Only at this point, once the foundations for a financially secure energy sector have been laid, it would be time to consider the construction of a transmission backbone to enhance energy sector independence.

127. **A swap mechanism could be an interesting third option to consider.** In addition to the options of wheeling through the Israeli grid or building a transmission backbone in the West Bank, the PA could negotiate a swap mechanism with the Israeli side where power generated in the West Bank is exported to Israel, and Israel agrees to provide the same quantity of power at a different location back to the West Bank. The details need to be sorted between the two sides but this would provide a convenient middle ground to avoid having to build infrastructure in Area C or having to pay a constant per Kilowatt-hour charge to use the Israeli network.

128. **In Gaza, PA concerns over non-payment have impeded development of additional IEC supply through a 161kV transmission line from Israel.** Additional power supply to Gaza is desperately needed as the existing import feeder lines have been fully saturated for quite some time. Additional power supply from IEC through a 161kV transmission line has been on hold for over a decade but recently Israeli authorities gave the green light for its construction. Since the Palestinian Authority (PA) pays for the entirety of the power that Gaza receives from IEC through clearance revenues and the net lending process, they are concerned about how the additional power from IEC to Gaza will be paid for. This is especially true given the fact that donor contributions to the Palestinian Authority’s budget support have fallen from 32 percent of GDP in 2008 to under 6 percent in 2016.

129. **Building a transmission backbone in Gaza makes more sense than wheeling domestically generated power supply through Israel.** Given the small size of the Gaza strip, and the fact that there are no land restriction and permitting issues such as Area C in the West Bank, if domestic generation is ramped up in the future in Gaza, it makes more sense to create a domestic backbone then to export the power into the Israeli grid for wheeling and re-injection.

130. **Between West Bank and Gaza, the total investment costs for building the full domestic T&D infrastructure, including the transmission backbone but assuming no wheeling or swaps, would be given by the table below.**

Figure I-7.4: Summary of transmission and distribution investment requirements

Transmission and Distribution Investment Costs (US$ million)			
	Gaza	West Bank	West Bank and Gaza
Transmission backbone	33[24]	72[25]	105
Transmission to evacuate RE projects in Area C	-	44[26]	44
Regional interconnectors	32[27]	20[28]	52
Distribution	60[29]	52[30]	112
TOTAL	**124**	**188**	**312**

7.2 Implications for West Bank and Gaza

131. The development of transmission infrastructure in West Bank and Gaza have the following implications for the Palestinian energy sector.

a) **PETL must start operating on a commercial basis and take ownership for fixing the gaps in the revenue cycle as their first priority.** Financial independence will lead to energy independence but the reverse is not possible. Supplier concerns over non-payment undermine any potential for upgrade and expansion in the energy sector. PETL has two roles: that of a single buyer and bookkeeper and that of a transmission system operator. In order to enable the right environment for building large scale infrastructure including transmission, PETL must excel in their role as the single buyer and book keeper first before becoming a transmission system operator and they can take on this role even before the substations are energized or PPA with IEC is signed.

b) **In parallel, while PETL is negotiating with IEC on the main PPA and the energization of the substations, it can focus on strengthening its operational capacity as the energy sector's book keeper.** As the negotiations continue, PETL should focus on three issues in the short term. First, PETL should prepare and open negotiations on Power Service Agreements (PSA) with the DISCOs and MVCs to set the terms of power sales to, and collections from, electricity distributors in the West Bank. Progress can be achieved on draft PSAs while the main PPA is still being negotiated. Once the PPA is signed, the PSAs can be completed with final clauses, hence saving a significant amount of time. Second, a billing and collection system must be set up for PETL

[24] 161/33 substations: 2, overhead 161 kV line: 26 km
[25] 161/33 substations: 2, overhead 161 kV line: 117 km plus a national control center
[26] 161/33 substations: 3, overhead 161 kV line: 72 km
[27] 161/33 substations: 2, overhead 161 kV line: 20 km
[28] 161/33 substations: 1, overhead 161 kV line: 26 km
[29] For Gaza-North: rehabilitation of the distribution grid (224 km) and extension of the grid (200 km). For Gaza-South: rehabilitation of the distribution grid (74.7 km) and extension of the grid (200 km)
[30] For WB-North: adaptation of the distribution grid to support new connection points (200 km) and extensions around JPP (100 km). For WB-Central: adaptation of the distribution grid to support new connection points (200 km) and extensions for supporting Area C and extension of interconnection with Jordan(100+100 km). For WB-South: adaptation of the distribution grid to support new connection points and extensions to support the development of gas for WB-South

allowing them to receive invoices from IEC, send bills to distributors, collect payments from distributors and pay back IEC for the purchased electricity. USAID is currently supporting PETL to design the software and mechanism for billing and collections. In addition, PETL is working with IEC to ensure that the company receives the bills directly instead of through the Palestinian distributors. Finally, PETL should collaborate with PERC in the preparation of its sale tariff to the distributors. With these mechanisms in place, PETL could accelerate its progress towards fulfilling its role and responsibilities under the PPA and reducing its reliance on donor assistance for its operational costs. PETL's staffing plan needs to be adjusted according to the company's projections on revenues collected from distributors.

c) **As domestic generation develops, Israeli and Palestinian sides will have to work together to determine how best to evacuate the power.** In the short term, the two sides will need to negotiate favorable wheeling charges or swap mechanisms to ensure that power supply expansion keeps pace with demand growth. In the mid to longer term, as the Palestinian energy sector becomes more stable and bankable, the two sides can work together to build a long term vision of establishing a high voltage transmission network. Given the inherently interwoven nature of the Israeli and Palestinian energy sectors, with or without a Palestinian transmission network, both sides must cooperate closely to ensure grid stability.

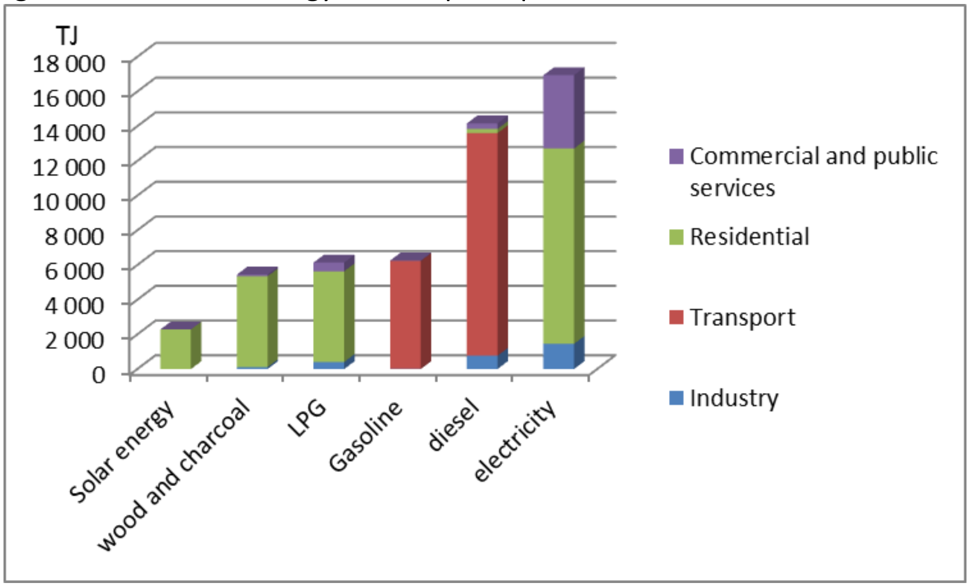
d) **If the Palestinian energy sector is to become a major client for wheeling power back through the Israeli grid, then the tariff structure for wheeling will need to be carefully considered or alternatively a swap mechanism needs to be negotiated.** At present, the wheeling charges that would appear to apply to Palestinian electricity wheeling back through the Israeli grid look to be relatively high, and represent a significant surcharge on the import tariff. The cost implications of using the Israeli grid for wheeling would need to be carefully understood and negotiated by both sides. A swap mechanism could be the most ideal solution if both sides can come to agreeable terms.

8 Integrating Energy Efficiency

8.1 The Current Context

132. **The Palestinian energy system is characterized by the complete dependence on imported energy products and the predominance of electricity in final energy consumption**. Diesel and gasoline are used primarily in the transport sector, while all other sources of energy – including electricity – are primarily used by the residential sector (see Figure II-8.1 below).

Figure II-8.1 – Final energy consumption per sector in the Palestinian Territories



Source : World Bank own elaboration based on PCBS data

133. **The Palestinian National Energy Efficiency Action Plan (NEEAP) aims to reduce 384 GWh of total energy demand by 2020, representing around 1% reduction per year**[31]. The action plan is mainly focused on electricity because this energy type has the largest share in the Palestinian final energy mix[32] (see figure II-8.2 below). The Palestinian Energy and Natural Resources Authority (PENRA), with the support of the French Development Agency ("Agence Française de Développement", AFD) and the World Bank, has been actively spurring the implementation of the three-phased NEEAP for 2012-2020. Phase I has been successfully achieved and Phase II is being implemented satisfactorily. PENRA's Energy Efficiency Unit has so far undertaken 250 energy audits[33] across different sectors of the Palestinian economy[34], which have triggered the investments required to unlock the untapped energy efficiency potential. Phase III is expected to start in 2018.

Figure II-8.2 – Energy Efficiency Targets under NEEAP 2012-2020 (GWh)

Sector	Targets			
	Phase I (2012-14)	**Phase II (2015-17)**	**Phase III (2018-2020)**	**2020**
Industrial	5	6	8	19
Buildings	38	130	195	363
Water pumping	-	1	1	2
Total (GWh)	**43**	**137**	**204**	**384**

Source : NEEAP, PENRA

[31] Compared to 2010 levels.

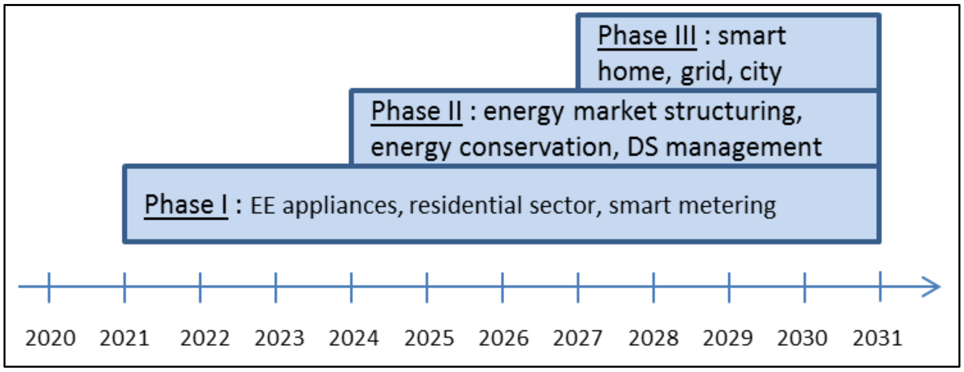
[32] Electricity represents 33% of the final consumption of energy. Savings on diesel[32], the second energy most commonly used in the Palestinian Territories, should also be considered in future assessments. Electricity is mainly used by the residential sector (more than 60%) whereas diesel is used almost exclusively in the transport sector.

[33] The AFD has financed the required energy audit equipment and staff costs.

[34] 60 in the industrial, 120 in the public, 40 in the service, 10 in the agricultural and 20 in the residential sectors

134. **To further promote energy efficiency investments, PENRA[35] has drafted a more ambitious action plan for the period 2020-2030 with the support of the World Bank**. The proposed target is to reduce 5% of the forecasted consumption during the ten-year period, or a total savings of 5,000 GWh. This represents a large increase from the 384 GWh savings of the current NEEAP 2012-2020. The future action plan is also divided in three phases:

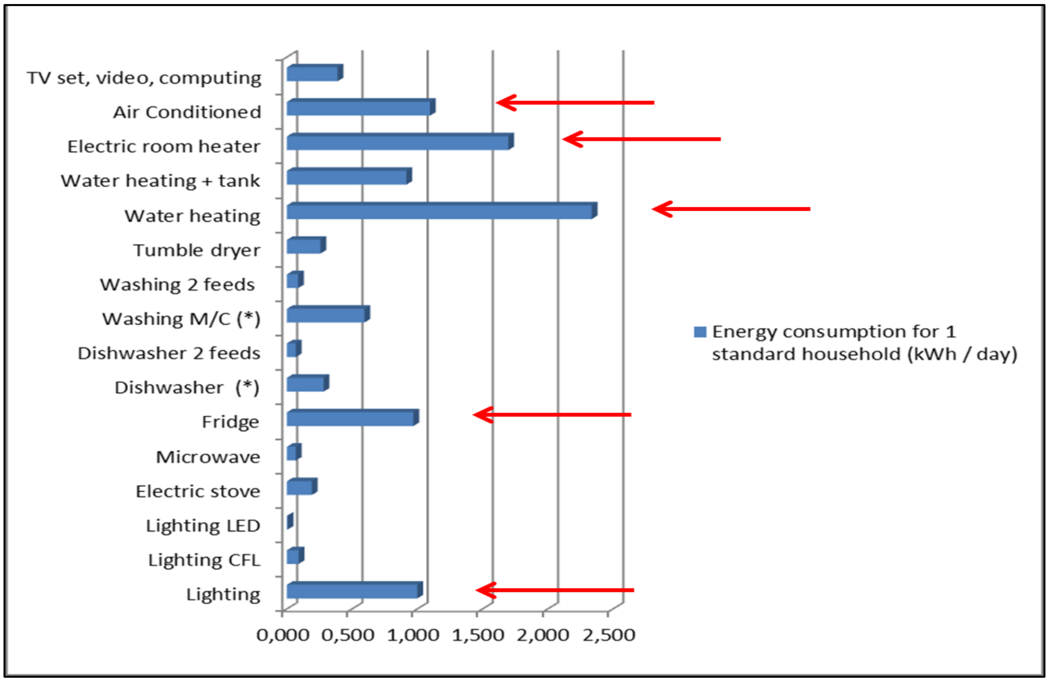
Figure II-8.3 – Draft NEEAP 2020-2030 implementation strategy



135. Phase I (2021-2030) focused on efficient appliances and industrial equipment (see Figure II-8.4 below). This phase is designed as a follow-on of the current NEEAP 2012-2020 to expand and consolidate its achievements. This phase focuses on energy audits for the industrial and commercial sectors and financial incentives. The deployment of smart-meters and related information systems will allow consumers to have real-time and accurate information on consumption and associated costs. Consumption data will be collected, stored and analysed to provide useful guidance to replace inefficient products and improve industrial processes[36]. This phase will also pave the way to Phase III to ensure that smart home appliances will be fully interoperable with metering systems.

[35] PENRA, The Palestinian national energy efficiency action plan for 2020 – 2030, draft march 2016
[36] Sub-metering and energy audits are the key tools to be used.

Figure II-8.4 – Energy Efficiency potential in the residential sector



Source: World Bank own elaboration based on PCBS data for Households energy 2015

136. Phase II (2024-2030) will focus on energy market structuring and thermal insulation of buildings. The opening of the national electricity market to competition could be considered in this phase. From an energy efficiency perspective, this reform would make new market-based services available, such as the possibility to remunerate clients reducing their consumption on demand. The roll-out of smart meters and the introduction of Time-of-Use tariffs would contribute to incentivize behaviour change and reduce consumption during peak hours. Due to the large lead times of building renovations, thermal insulation of buildings should also be a priority activity during this phase. Following the design of specific Minimum Efficiency Performance Standards (MEPS) and building codes integrating Zero Energy Building standards (nZEB)[37], these would become mandatory for all public buildings and encouraged by financial incentives for the residential sector. A building renovation strategy would also be drafted for the residential sector in order to improve thermal insulation of the existing building stock.

137. Phase III (2027-2030) will focus on smart homes, smart buildings and smart grids. The simultaneous use of market-based services and smart appliances would enable consumers to become active energy players. For instance, consumer's behaviour could adjust to changes in electricity prices. Demand response actions to shift consumer's electricity usage during peak hours in response to time-based rates would avoid building new generation capacity.

138. **The proposed energy efficiency actions have relatively modest investment costs and short paid-back periods.** The figure below summarizes the proposed energy efficiency

[37] The concept of nearly Zero Energy Building (nZEB) is an attempt to standardize the consumption of energy per m^2 per year

actions with the expected savings during the 2020-2030 timeframe, their total costs and the cost/benefit ratio. When this ratio is less than the average retail electricity price, i.e. US$ 0.13 for residential, the corresponding investment may be recovered in less than 10 years.

Figure II-8.5 – Energy Efficiency Potential during 2020-2030

Energy Efficiency actions	Benefits (GWh)	Total costs (US$ million)	C/B (US$/kWh)
Lighting: move to CFL standard	2,612	1.750	0.001
Lighting: move to LED standard	322	2.275	0.007
Introduction of more efficient fridges	127	4.375	0.035
Switch to gas for room heating	246	24.832	0.101
Electronic thermostats	222	10.177	0.046
Labelling and national campaign	1,270	3	0.002
Repairing of SWH	1,576	126	0.080
Smart metering for all households	1,587	48	0.038
Sub-metering	317	4.812	0.015
Building thermal insulation	720	345	0.479
Labelling program	881	50	0.057

Source: PENRA, **T**he Palestinian national energy efficiency action plan for 2020 – 2030, draft march 2016

8.2 Implications for West Bank and Gaza

139. The development of energy efficiency programs in West Bank and Gaza have the following implications for the Palestinian energy sector.

a) **Managing overall energy demand is a priority but managing peak hour load will become increasingly important.** Nowadays, electricity is bought from IEC at a high price but IEC is in charge of managing the flexibility of the demand. In the future, PETL acting as transmission system operator could purchase "blocs" of electricity in bulk at a lower price but would have the responsibility to make daily forecasts and balance demand and generation in real time. If PETL has to develop the role of system operator in the future, a deep knowledge of energy consumption and its patterns would be key.

b) **Among the proposed energy efficiency actions, two of them may require a complex implementation program.**

i) The first one is the generalization of the smart meters for the residential sector. This program aims at providing relevant information to the consumers so that they will be in a position to better manage their consumption. These meters are the visible part of the iceberg. A sophisticated information system is simultaneously required from DISCOs to prepare energy audits per household, compare consumption profiles to detect non-efficient usages, recommend the replacement of appliances, etc. Home displays or equivalent devices (e.g. mobile application) will help the consumers to relate their daily behaviours and the impacts on their consumption. Monthly billing information is not sufficient to create this link between usage and energy. The same program should help DISCOs to improve their quality of service (detection of failures) and reduce technical / commercial losses. Smart meters are not sufficient to do that. Internal processes have to be implemented to randomly check the consumption and detect unbalanced LV lines.

ii) The second action is to promote a switch from electricity to gas (LPG and / or natural gas) for room heating. Electricity should be reserved to usages where there are no replacements (motors, electronics …). For consumers, the main argument in favour of electricity is the low cost of appliances. However, in the long term, the operational costs are much lower for gas. This switch cannot be initiated without a national strategy for gas so that the cost of the required infrastructures (transportation and storage of gas) will be shared between all stakeholders. The repair and further penetration of solar water heaters is part of this endeavour since it would decrease the need to use non-renewable energy.

Part II – Decision Making

1. Introduction

140. **Attention now turns to the exploration of possible energy futures for West Bank and Gaza, with the accent on enhanced energy security.** However, energy security can itself be defined from a number of perspectives, each of them valid in its own way. First, there is the ability to reliably meet the entire demand for electricity, by minimizing supply interruptions and hence loss of load. Second, there is the resilience of the power system that comes from diversifying sources of power supply and including alternatives that are relatively robust in the context of different types of shocks. Third, there is the degree of independence of the power system, in terms of the extent to which electricity needs can be met from domestic production versus imports; although, only renewable energy provides full energy independence, in the sense that domestic generation with fossil fuels can be as – if not more vulnerable – to fuel supply interruptions as the import of electricity. The analysis will consider all three of these dimensions of energy security, which can usefully be described as reliability, resilience and independence, and in practice trade-offs may exist between them.

141. **Energy security cannot be considered in isolation of financial affordability.** Increasing energy security often comes with a cost premium of some sort, as additional investments will likely be needed to achieve the requisite reserve margin, diversify sources of power, and/or expand domestic production. The benefits of energy security also need to be weighed-up against the associated costs, and the affordability of these costs for the power system as a whole. Affordability can be considered from two perspectives. The first is whether the retail tariffs needed to implement the energy security plan are affordable to customers. The second is whether any government subsidies needed to support the achievement of the energy security plan are fiscally affordable to government. Both will be evaluated in the analysis that follows.

142. **There are therefore two steps involved in realizing a secure and affordable energy future for West Bank and Gaza.** The first is to conduct a power sector planning exercise to evaluate the relative attractiveness of different electricity supply options. The second step is to evaluate the feasibility of financing the preferred power sector planning choice.

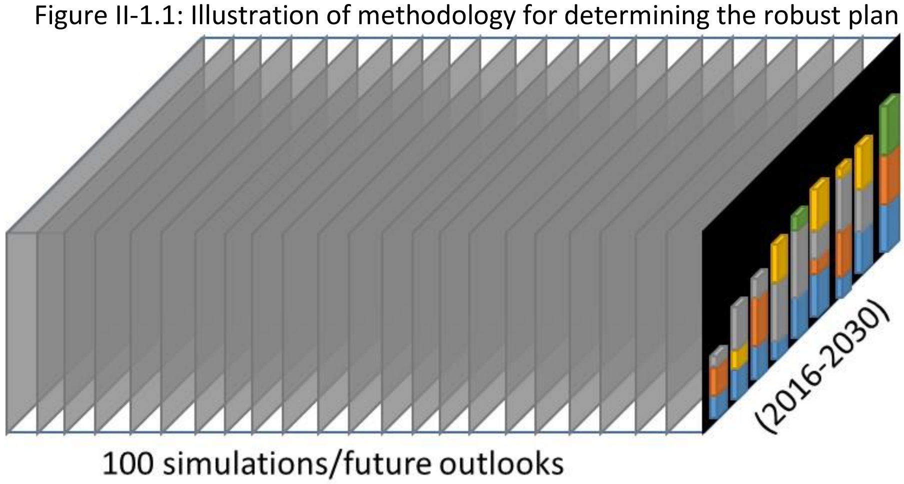
1.1 Robust Planning Model

143. **A Robust Planning Model is developed that is capable of incorporating the significant uncertainties of the Palestinian context into a traditional least cost power generation plan.** Power system planning is normally undertaken using models that select the least cost sequence of generation options needed to meet electricity demand at some specified level of reliability, based on the assumption that all parameters are known with certainty. This approach does not appear realistic in the Palestinian context where deep uncertainty is the norm. Four dimensions of uncertainty are explicitly considered for each generation option including: i) uncertainty in demand forecast, ii) uncertainty in the evolving unit cost of different technologies

over time, iii) uncertainty in how soon particular supply options (ie, gas) will become available, and iv) uncertainty due to outages and force majeure such as conflict. Based on stakeholder consultation and expert opinion, plausible ranges for the uncertainties were defined.

144. **By running the planning exercise many times in different states of the world, it becomes possible to identify the plan that is most robust over the largest number of possible futures.** The model is run 100 times and each time a different draw is made from the probability distribution of all the uncertain parameters, resulting in a slightly different optimal least cost plan (see Figure II-1.1). At the end of the process, the 100 resulting plans are put side by side and used to construct a robust plan by starting with the supply option that is most frequently selected across the 100 least cost plans, and then adding the next most frequently selected, and so on, until demand is fully met. The model provides a detailed set of information regarding each selected energy future, and can be constrained to meet certain policy objectives. Extensive details on the robust planning model and methodology, uncertainty variables and plausible ranges, and full model outcomes are provided in Annex 8.

Figure II-1.1: Illustration of methodology for determining the robust plan



145. **The Robust Planning Model is used to illustrate a number of different planning scenarios.** The model will be used to explore five different types of planning scenarios each for West Bank and Gaza (Figure II-1.2). It is important to stress that not all of the scenarios presented by the model are necessarily realistic, and some of them are used primarily to illustrate the implications of pursuing different approaches.

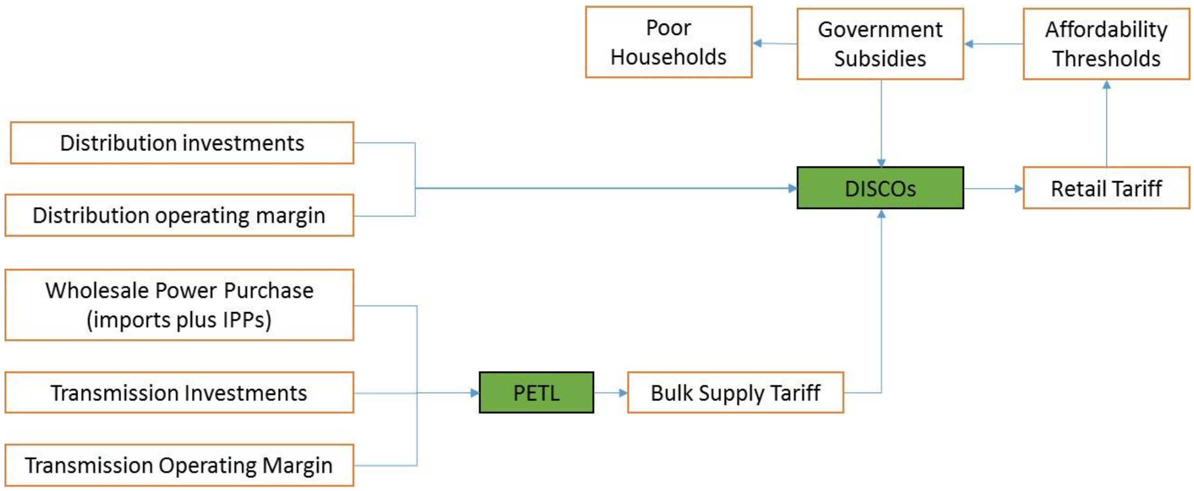
Figure II-1.2: Overview of energy planning scenarios developed with the Robust Planning Model

Scenarios	Characterization	Purpose
Do nothing	Electricity demand continues to grow without any proactive measures either to increase power imports or develop generation capacity.	The baseline against which other planning alternatives can be evaluated
Planned future	Future increases in electricity demand are met by projects that are already in the pipeline.	Evaluate the current thinking of the Palestinian Authority by analyzing the impact of: i) planned projects currently in the pipeline, and ii) PENRA's vision as stated in the most recent Palestinian National Authority Energy Sector Strategy of 2011-2013, as well as the draft Strategy for 2017-2022.
PENRA vision	Future increases in electricity demand are met in such a way that by 2030 no single generation source accounts for more than 50 percent of energy needs, while providing the capacity to import 100 percent of energy needs as back-up.	
Maximum cooperation	Future increases in electricity demand are met primarily by increasing electricity imports.	Evaluate alternative futures at the extreme opposite ends of the independence spectrum to analyze the trade offs
Maximum independence	Future increases in electricity demand are met primarily by developing domestic generation options.	

1.2 Sector Financial Model

146. **A Power Sector Financial Model was developed to cover the entire Palestinian Electricity Sector.** Referring to figure II-1.3, the model begins with PETL purchasing a "basket" of electricity from different producers at different wholesale costs under Power Purchase Agreements assuming no Palestinian public investment in generation. The pattern of purchases is determined by the output of the Robust Planning Model (see figure II-1.4) which identifies the quantity and cost of each generation source. PETL then sells this electricity to DISCOs at a 'bulk supply tariff' which will include a mark-up to cover PETL's own investment and overhead costs. DISCOs then sell this electricity to consumers at a 'retail tariff' which will include a mark-up to cover their own investment and overhead costs. The tariffs calculated in the financial model are 'equilibrium tariffs' designed to offset and compensate for losses and low collection rates. This differs from the regulator, PERC's, tariff setting methodology.

Figure II-1.3: Flowchart illustrating the different building blocks of the electricity sector financial model



147. **The retail tariff, consistent with financial equilibrium that is calculated by the model, differs somewhat from the regulatory tariff set by the regulator, PERC.** First, PERC calculates a single unified tariff for all Palestinian distributors based on averaging financial data submitted by a subset of the utilities (JDECO and NEDCO). This means that while tariffs are set to cover costs on average, individual utilities may over or under recover. The financial model instead calculates individual cost recovery tariffs for each utility each year. Second, PERC bases tariff calculations on the assumption of 100 percent revenue collection so as not to pass on commercial inefficiencies to customers. The financial model allows efficiency improvement targets for 2030 to be built into the calculations so that performance improves gradually and are reflected in tariffs as soon as they take place. However, during the transition period, collection inefficiencies are passed on to customers.

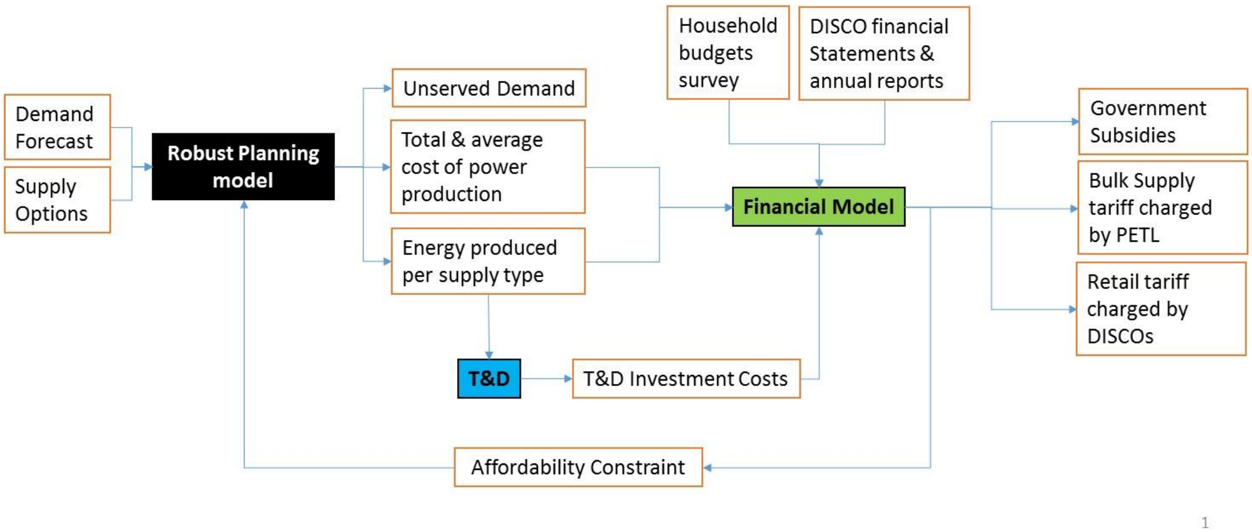
148. **Considerable efforts were made to collect the financial and operational data needed for the model.** Numerous meetings were held with the Ministry of Finance, PETL, PERC and all 6 DISCOs to support an extensive data gathering exercise. The data collected include financial statements of DISCOs, as well as operational data such as purchase and sales, losses and collection rates, payment to suppliers including through net lending, and more. In the case of the transmission system operator, PETL – a new institution with limited financial records – the company's business plan was used to estimate its anticipated cost structure.

149. **In addition, the consumer perspective was introduced into the financial model by incorporating an affordability limit on retail tariffs for the poorest households.** To determine the affordability limits, the financial model draws upon the most recent *Palestinian Expenditure and Consumption Survey (PECS)* from 2011 which provides detailed information on household budgets, including electricity expenditure. The survey was used to understand the income distribution in the Palestinian Territories, and in particular the budget available to the average household in each decile – or 10 percent – of the income distribution from poorest to richest.

150. **According to the international literature, 5 percent of budget for a basic level of 'subsistence consumption' is said to represent an affordability limit.** In the Palestinian context, the 'subsistence consumption' is set at 160 kilowatt-hours per month and corresponds to the first block of the retail tariff structure (see Annex 1, figure A1.3). Taking into account the income distribution discussed previously, and the 5 percent affordability threshold, the model identifies: i) the maximum cost for the subsistence block of consumption so that even the poorest consumers can afford basic electricity supply, and ii) the magnitude of subsidies required to make electricity services affordable to different income deciles. Such subsidies could either be channeled through distribution utilities as targeted bill reductions for poor households or through social welfare payments. In either case, a targeting mechanism would be needed to ensure that the poorest households can be identified. The West Bank and Gaza Cash Transfer Program (CTP) could potentially be used as the targeting mechanism since it contains a database of 115,000 households living under the poverty line in West Bank and Gaza. The alternative to targeted subsidies, which is to keep tariffs low for all consumers, can also be modeled. While simpler to administer, it evidently entails a much higher subsidy bill.

151. **Bringing all the pieces together, the Robust Planning Model and the Sector Financial Model are designed to work together along with a Transmission Costing Matrix as illustrated in Figure II-1.4 below.** The results of the Robust Planning Model are fed into both the Financial Model and a Transmission Costing Matrix which is used to price out the cost of building additional transmission and distribution (T&D) infrastructure for the generation mix identified by the Robust Planning Model. The T&D costs are then also fed into the Financial Model which calculates the equilibrium tariffs and, comparing to affordability thresholds, also identifies subsidies required from the government to protect the poorest consumers. If outcomes are unacceptable, further iterations of the models are run to, for example, impose upper bounds on the cost of generation to improve overall affordability. Refer to Annex 9 for further details on the Financial Model methodology. Refer to Annex 9, figures A9.1-A9.6 for full operational and financial data used in the Financial Model for each DISCO.

Figure II-1.4: Flowchart illustrating the interlinkages between the
Robust Planning Model, Sector Financial Model and the Transmission Costing Matrix



152. **Finally, the macro-fiscal impact of implementing the planned scenarios are also evaluated.** Building on a new set of Computable General Equilibrium models developed separately for the West Bank and Gaza, it is possible to examine the macro-fiscal impacts of the planning scenarios. The models are augmented to provide a more detailed characterization of the energy sector than might normally be the case, and the impact of the planning scenario is incorporated into the model simulation. This makes it possible to examine how the energy investments affect the overall GDP growth trajectory, as well as the public finances.

2. West Bank

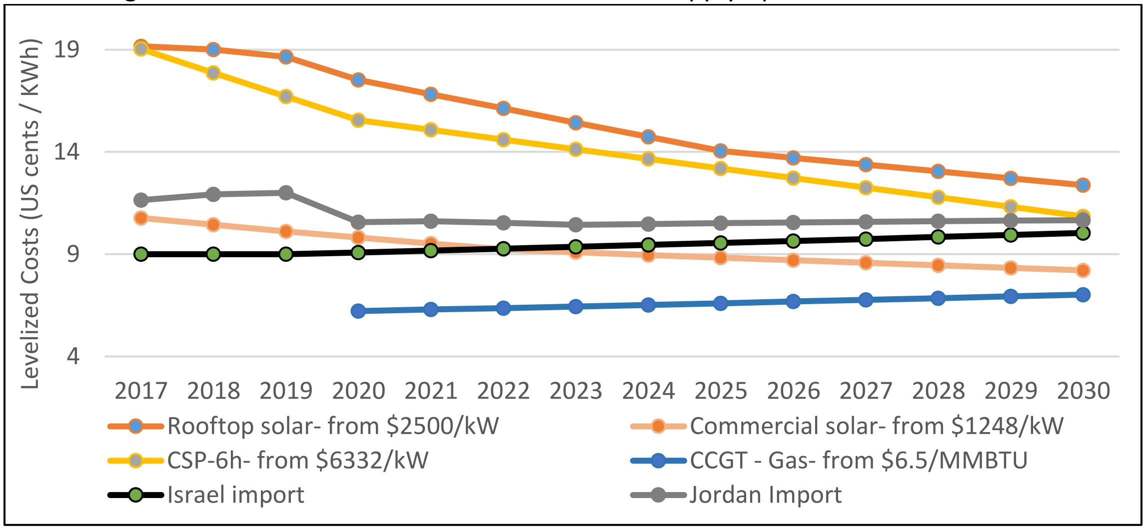
153. This section presents the results of the integrated planning and financial exercise for the West Bank.

2.1 Planning Model

154. **The two key drivers of the planning scenarios are the relative cost of power supplied through different technologies, as well as the range of uncertainties that affects each of them.** Figure II-2.1 plots the so called Levelized Cost of Energy (LCOE), defined as total capital and operating costs across the lifetime of a power project averaged over the total electricity produced. While LCOE is a convenient device for making simple relative cost comparisons, it is important to recognize that it does not capture all relevant characteristics of each power source, such as its availability for dispatch and contribution to meeting peak loads. Figure II-2.2 summarizes the different uncertainty parameters that characterize each of the power supply options, considering delays in availability, uncertainty of cost, as well as probabilities of

interruption to supply. These are inevitably somewhat subjective and based on a combination of expert judgment and stakeholder consultation.

Figure II-2.1: Time trends of LCOE for different supply options in the West Bank



155. **Domestic gas-fired power generation looks to compare favorably with Israeli imports, while projected declines in the cost of renewable energy bring these increasingly into parity.** The LCOE analysis illustrates a wide dispersion in costs across different generation technologies, although for most sources there is convergence of costs over time towards the range of NIS 0.26-0.47 (US$0.07-0.13) per kilowatt-hour by 2030. Israeli imports, currently the dominant source of energy, and priced at just under NIS 0.37 (US$0.10) per kilowatt-hour, set the relevant benchmark. At the beginning of the period, only gas-fired power generation comes in below the cost of Israel imports. While renewable energy starts out as more expensive than Israeli power imports, projected steep declines in unit costs bring solar PV into parity by the year 2022, and the cost differential for rooftop solar and CSP is substantially eroded by 2030. Nevertheless, it is important to underscore that these do not represent firm energy in the way that Israeli power imports do. Power imports from Jordan are also expected to decline with time as cheaper Israeli gas begins flowing to Jordan by 2020. This will bring the cost of Jordanian power closer to Israeli power although Jordanian power is expected to continue being offered at a premium to Israeli power unless Jordan's power generation portfolio moves away from being dominated by gas towards cheaper renewables.

156. **The modeling exercises also strives to capture some of the main features of the uncertain planning environment.** Specific uncertainty ranges associated with each of the non-renewable options are summarized in figure II-2.2. With the exception of diesel, there is considerable uncertainty of when particular capacity expansions would come online, how large they would be, and at what price they would be offered. Probabilities of supply interruptions and their effect on availability of power from different sources and potential duration of outages are also captured. Based on the historic record, Israeli power imports come across as the least risky source of electricity and diesel as the most risky.

Figure II-2.2: Overview of uncertainty parameters for West Bank planning exercise

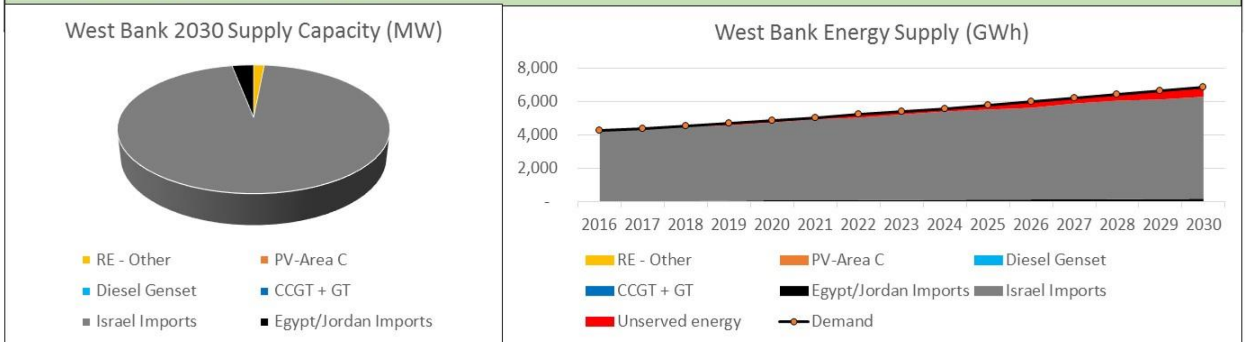
	Diesel	Gas – North	Gas – South	Israel	Jordan
Availability range					
Earliest Latest	2016 2016	2021 2035	2024 2035	2020 2030	2022 2035
Volume range					
Lowest Highest	Unlimited Unlimited	0.2 BCM 2.0 BCM	0.2 BCM 2.0 BCM	850 MW 1400-1800 MW	30 MW 100-200 MW
Price range					
Lowest Highest	Known Known	\$4.0/mmbtu \$6.5/mmbtu	\$4.0/mmbtu \$7.5/mmbtu	Current \$0.11/kWh	Indexed to oil Indexed to oil
Outage duration range					
Minimum days Maximum days	37 293	37 365	37 365	18 91	29 256
Other parameters					
Minimum availability Probability of interruption	0.30 0.40	0.40 0.06	0.40 0.10	0.80 0.02	0.70 0.05

157. **Against this backdrop, the results of five planning scenarios are considered.** As noted above, these include a ‘do nothing’ counterfactual, where not further investments are made in power infrastructure while demand continues to grow. This is compared with the impact of the current pipeline of investments, described as the ‘planned future’, as well as ‘PENRA’s vision’ for the longer term, which seeks to limit dependence on any single source of energy to 50 percent of demand while retaining the ability to import 100 percent of energy needs, if required. For the purposes of illustration, two additional – more extreme – scenarios are considered. ‘Maximum cooperation’ considers the possibility of continuing the West Bank’s historic almost exclusive dependence on Israel for imported power, while scaling up the associated infrastructure to keep pace with mounting demand. ‘Maximum independence’ looks at the fullest extent of domestic power generation that could be developed in the West Bank under the most optimistic scenario.

158. **Under the ‘do nothing’ scenario, the West Bank becomes increasingly unable to meet its electricity demand** (Figure II-2.3). With the capacity for Israeli electricity imports capped at current levels of 890 MW, and Jordanian imports capped at 20MW, and in the absence of any new domestic generation capacity, the average cost of electricity remains at current level of NIS 0.36 (US\$0.098) per kilowatt-hour. However, the percentage of unserved demand rises steeply from small levels in 2016 to reach 9 percent in 2030; and averages 4 percent of total demand over the entire period. The associated economic losses are valued at NIS 9.5 billion (US\$2.6 billion), equivalent to about 20 percent of the GDP of the West Bank in 2015. In the northern region of the West Bank, this shortage has already been felt as power shortages during the summer of 2016 resulted in rolling blackouts culminating in street protests. This clearly represents an unacceptable trajectory.

Figure II-2.3: Results of 'do nothing' scenario

Do Nothing: Demand continues to grow while power infrastructure is capped at 890 MW of interconnectors with Israel and 20 MW of interconnectors with Jordan.



Avg Cost Power (US cents/KWh)	CAPEX (mil USD)	2030 Unserved Demand (%)	2030 Electricity Imports (%)	2030 Domestic Gen – Imported Fuel (%)	2030 Domestic Gen – Renewables (%)
9.79	0	9%	90%	0%	0.4%

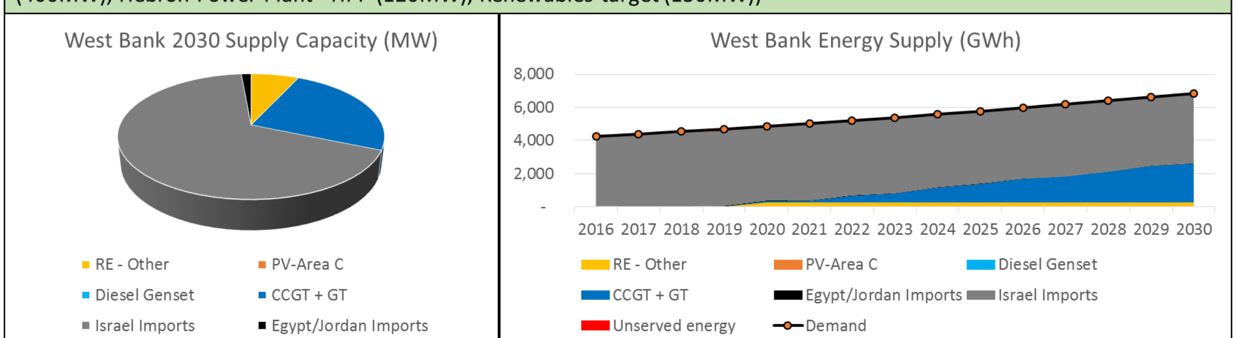
Takeaway: Currently, power supply is not diversified and there will soon be power shortage in the West Bank.

1

159. **Under the 'planned future' scenario, a significant volume of investment brings about greater supply diversification with only minimal impacts on costs** (Figure II-2.4). The development of the Jenin and Hebron gas-fired CCGT plants, as well as the expansion of the renewable energy portfolio to reach the 130 MW target, call for capital expenditure of NIS 3.1 billion (US$850 million), and lead to significant diversification of the power mix with domestic production providing 36 percent of energy needs by 2030. Relative to the 'do nothing' scenario, this eliminates supply shortages while only raising the average cost of electricity very slightly to NIS 0.37 (US$ 0.101) per kilowatt-hour. However, in terms of energy independence, little has changed since both the electricity and gas – accounting for 96 percent of energy use – are imported from Israel.

Figure II-2.4: Results of 'planned future' scenario

Planned Future: All PENRA's currently planned projects come online (4 substations (540MW), Jenin Power Plant -JPP (400MW), Hebron Power Plant - HPP (120MW), Renewables target (130MW))



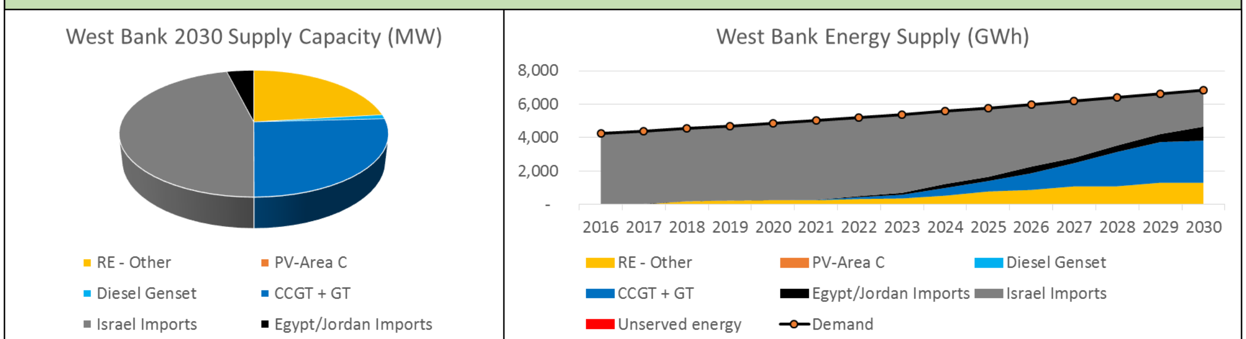
Avg Cost Power (US cents/KWh)	CAPEX (mil USD)	2030 Unserved Demand (%)	2030 Electricity Imports (%)	2030 Domestic Gen – Imported Fuel (%)	2030 Domestic Gen – Renewables (%)
10.06	850	0%	64%	32%	4%

Takeaway: There is no power shortage but still limited diversification as 96% of power and fuel is imported.

160. **But the only way to meet the full 'PENRA vision' of diversification is to invest much more heavily in solar PV, fully developing potential in Areas A and B** (Figure II-2.5). While the 'planned future' scenario represents a substantial improvement on 'do nothing', it remains dependent on Israeli electricity and fuel imports to meet 96 percent of its energy needs, and therefore does not meet PENRA's longer term diversification criterion that no source of electricity should account for more than 50 percent of demand. To meet this constraint, the model ramps up the proportion of renewable energy – essentially developing much of the potential in Areas A and B – and achieving, as a result, a much higher degree of diversification. Although these options are slightly more expensive on a per unit basis than Israeli imports, and the necessary capital expenditure more than doubles to reach NIS 7.7 billion (US$2.1 billion), the overall impact on the average cost of generation remains very modest, rising only to NIS 0.372 (US$0.102) per kilowatt-hour. This scenario shows that PENRA's strategic vision can be achieved without access to Area C, by focusing on developing solar PV potential in Areas A and B and on rooftops.

Figure II-2.5: Results of 'PENRA vision' scenario

PENRA Vision: "Dependency ratio on any one source should not exceed 50% in best conditions, with a possibility of importing all needs in case of emergency."



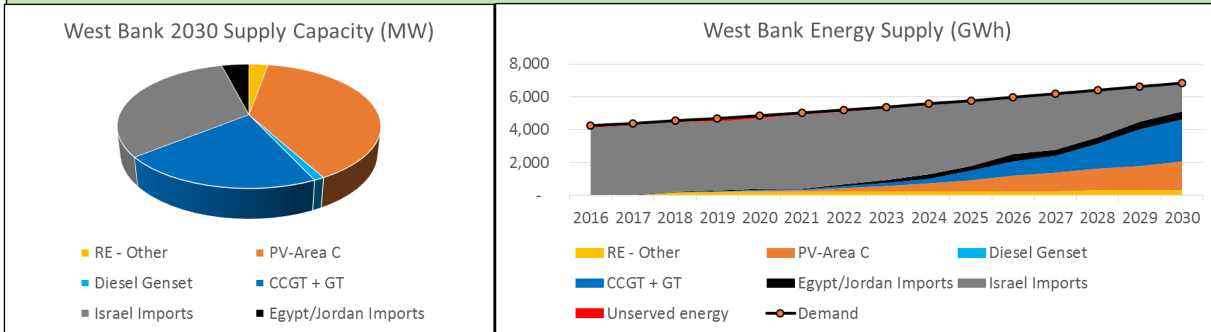
Avg Cost Power (US cents/KWh)	CAPEX (mil USD)	2030 Unserved Demand (%)	2030 Electricity Imports (%)	2030 Domestic Gen – Imported Fuel (%)	2030 Domestic Gen – Renewables (%)
10.16	2,133	0%	45%	37%	19%

Takeaway: PENRA can achieve diversification vision w/o Area C but needs large RE scale up in Areas A, B and rooftop solar.

161. **Relaxing the constraint on access to Area C, significantly reduces import dependence and improves diversification even while slightly reducing costs** (Figure II-2.6). Even in the above more diversified scenario, the West Bank would still be dependent on Israel for about 80 percent of its energy needs through electricity and fuel imports. The next scenario considers what is the 'maximum independence' that could be achievable in power generation. This is done by relaxing the constraint on access to Area C, so that the model has a much larger renewable energy potential to draw upon. Under these conditions, it becomes economical to increase the renewable energy share from 19 to 30 percent, even as the average cost of generation falls slightly relative to the 'PENRA vision' from NIS 0.372 (US$0.102) to NIS 0.361 (US$0.099), although capital expenditure requirements climb slightly to reach NIS 8 billion (US$2.2 billion).

Figure II-2.6: Results of 'maximum independence' scenario

Maximum Independence: Same goals as PENRA vision but with unlimited access to Area C.



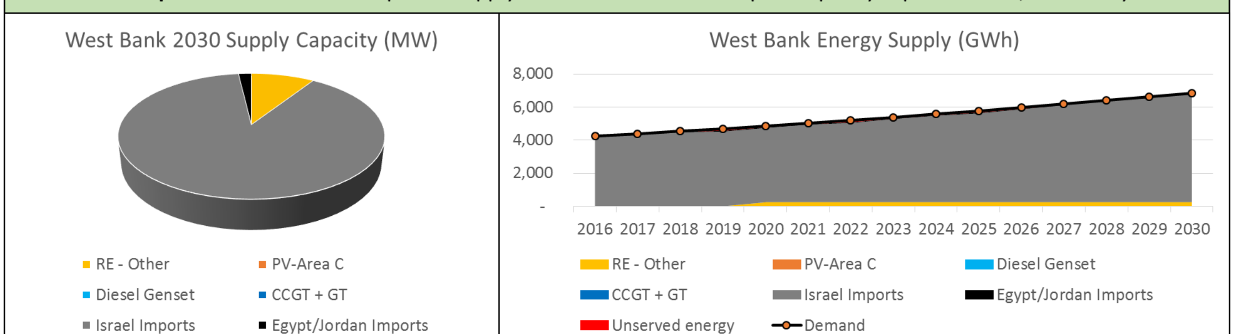
Avg Cost Power (US cents/KWh)	CAPEX (mil USD)	2030 Unserved Demand (%)	2030 Electricity Imports (%)	2030 Domestic Gen – Imported Fuel (%)	2030 Domestic Gen – Renewables (%)
9.88	2,284	0%	36%	34%	30%

Takeaway: If Area C was available, diversification would be more balanced and average cost of power would be lower

162. **Finally, it is helpful to contrast these increasingly diversified and independent scenarios with one of 'maximum cooperation'** (figure II-2.7)**.** This essentially represents a continuation of the current strategy whereby West Bank imports almost the entirety of its electricity needs from Israel, with the Israeli interconnection capacity allowed to expand in tandem with growing demand and estimated to reach 1,430 MW by 2030. At the same time, the relatively modest current targets for renewable energy are met. This approach largely avoids any major capital expenditure on the Palestinian side and results in the preservation of the current average cost of NIS 0.36 ($0.098) per kilowatt-hour. Diversification drops significantly relative to the other scenarios as 96 percent of electricity would be imported. The inclusion of this alternative helps to clarify that the cost premium for supply diversification in the context of the West Bank is relatively small at between NIS 0.004-0.015 (US$0.001-0.004) per kilowatt hour, which represents a mark-up of less than 5 percent.

Figure II-2.7: Results of 'maximum cooperation' scenario

Maximum Cooperation: All additional power supply comes from IEC with import capacity expanded to 1,430MW by 2030



Avg Cost Power (US cents/KWh)	CAPEX (mil USD)	2030 Unserved Demand (%)	2030 Electricity Imports (%)	2030 Domestic Gen – Imported Fuel (%)	2030 Domestic Gen – Renewables (%)
9.78	174	1%	96%	0%	4%

Takeaway: Premium for diversified portfolio is 0.1-0.4 US cents/KWh more expensive than importing all power from IEC

163. **No single option performs better than others on all relevant dimensions, illustrating that trade-offs must be made.** Examining the five scenarios side by side helps to clarify their relative performance. Figure II-2.8 compares various dimensions of performance including the average cost of power generation, the total capital expenditure, the level of unserved demand in 2030, the continued reliance on electricity imports or fuel imports for generation, and the share of domestically generated renewable energy in the overall mix. The darker the shade of green the better the performance on that dimension, while the darker the shade of orange the worse the performance on that dimension.

Figure II-2.8: Comparison of results across the five scenarios

		Avg Cost of Power (US cents/ KWh)	CAPEX (mil USD)	2030 Unserved Demand (%)	2030 Electricity Imports (%)	2030 Domestic Gen – Imported Fuel (%)	2030 Domestic Gen–RE (%)
1	Do nothing	9.79	0	9%	90%	0%	0.4%
2	Planned Future	10.06	850	0%	64%	32%	4%
3	PENRA Vision	10.16	2,133	0%	45%	37%	19%
4	Maximum independence	9.88	2,284	0%	36%	34%	30%
5	Maximum cooperation	9.78	174	1%	96%	0%	4%

164. **The scenarios with the highest share of domestic renewable energy look to be the most attractive, but require raising large amounts of capital from the private sector.** What is clear is that any alternative that achieves a significant shift in the level of diversification and energy independence entails raising private capital in excess of NIS 7.3 billion (US$2 billion) over the next decade. Given that private sector investment in the Palestinian power sector is very much in its infancy, this is not a minor undertaking, and would require addressing the creditworthiness of the sector which is currently the most significant constraint to attractive private capital.

165. **While access to Area C would be desirable, significant diversification can already be achieved based on use of Areas A and B alone.** The 'maximum independence' scenario is based on unrestricted access to Area C, which is far from being the current situation and would pose major political challenges. Nevertheless, in the absence of access to Area C, PENRA's strategic vision, of limiting dependency on any one supply to less than 50 percent, could still be achieved by maximizing renewable energy installations in Areas A and B and on rooftops. This would be a desirable starting point and would still represent a major increase in ambition from current targets of 130 MW by 2020 to a target of 600 MW by 2030. Given that only 18 MW of

solar PV have been achieved since the target was announced in 2012, this would be very challenging.

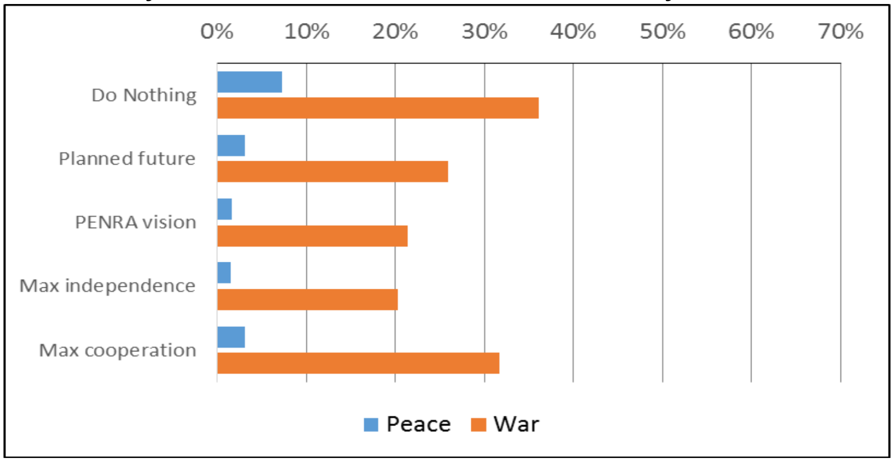
166. **Given the potential substantial scale-up in solar energy, close coordination with the Israeli grid would be critical to preserve overall stability.** Both the 'PENRA vision' and the 'maximum independence' scenarios call for increasing the share of solar PV up to 20 or 30 percent. It is important to note that any scale up in generation in the West Bank will raise significant grid stability and integration issues for the Israeli grid, which is also in the process of ramping-up its share of variable renewable energy to meet its own national targets. Close collaboration and careful planning would be a pre-requisite for any expansion plan involving an enhanced role for renewable energy. Finally, although the currently 'planned future' projects are important for ensuring power supply expansion keeps pace with demand growth, and significantly impact the reliability of supply, their impact on diversification and independence is still relatively small.

167. **To put things in perspective, the cost differentials between alternative scenarios are small and almost all of them deliver a reliable supply.** While the relative merits of the different scenarios can be debated, it is worth emphasizing that the cost differentials between them are relatively small: a difference of just 4 percent (or $0.004 per kilowatt-hour) in the average cost of generation between the highest and lowest. Moreover, all scenarios except for 'do nothing' essentially provide for a reliable supply of electricity.

168. **Another way to compare the alternative scenarios is through a stress testing process that examines how they perform under extreme conditions.** In particular, the stress test looks at how the percentage of unserved energy rises for each scenario when conflict conditions are simulated.

169. **The scenarios with a higher share of solar PV look to be the most resilient** (Figure II-2.9). As might be expected, the scenarios with higher solar PV shares have the lowest share of unserved energy at around 20 percent compared with 25-35 percent for the others. This is because they are less susceptible to supply interruption or conflict damage.

Figure II-2.9: Stress test for resilience across scenarios in terms of increase in unserved demand

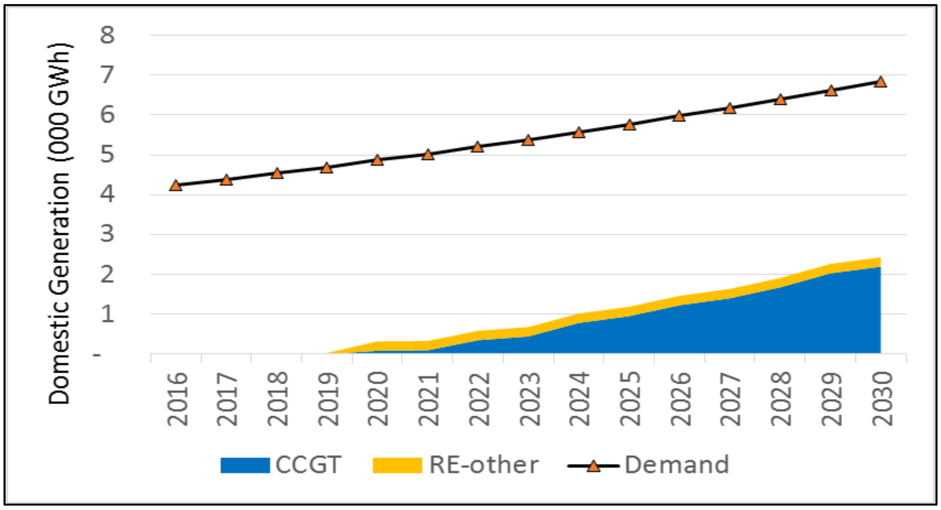


2.2 Transmission

170. **Domestic power generation in the West Bank can be moved to Palestinian load centers either by wheeling through the Israeli network or by building a Palestinian transmission backbone.** As domestic power generation in the West Bank increases, there is a need to evacuate electricity from the locations where it is produced to those where it will be consumed, as cost-effectively as possible. Two options exist. The first is to wheel the power out from the West Bank, back through the Israeli network, and inject it back into the West Bank to the load centers. The second is to build an independent Palestinian transmission backbone capable of moving power at higher voltages over long distances within the West Bank. Under both scenarios, distribution infrastructure needs to be expanded and upgraded to accommodate the additional supply. Part I, Chapter 7, provided background detail on wheeling tariffs and transmission and distribution (T&D) infrastructure capital costs.

171. **By 2030, approximately 2,400 Gigawatt-hours of domestic generation will need to be wheeled through the IEC grid if PENRA's planned projects come online** (figure II-2.10)**.** In the following analysis, the cost of wheeling is compared to the cost of building a transmission backbone for the 'Planned Future' scenario. It is expected that by 2030 up to 35 percent of demand will be met by domestic generation, in particular through renewables and thermal generation, corresponding to approximately 2,400 Gigawatt-hours per year.

Figure II-2.10: Domestic generation, as proportion of total demand, needing to be wheeled through IEC grid under 'Planned Future' scenario



172. **Due to the envisaged scale-up in the volume of domestically generated electricity, the recurring cost of wheeling charges rapidly increase year over year**Figures II-2.11 and II-2.12 below show the need for NIS 146 million (US$ 40 million) investment in the Palestinian distribution network to absorb the additional generation that would come online under the 'Planned Future' scenario. In terms of transmission, figure II-2.11 shows the scenario in which IEC's most expensive wheeling tariff is used which, at NIS 0.05 (US$ 0.013) per kilowatt-hour, allows the use of both the Israeli transmission and distribution networks. Figure II-2.12 shows the scenario in which IEC's least expensive wheeling tariff is used which, at NIS 0.02 (US$ 0.005) per kilowatt-hour, only allows the use of the Israeli transmission network. In this case, additional substations would need to be built in the West Bank, beyond the existing 4 new high voltage substations, to ensure that all power evacuated into Israel and received back into the West Bank travel only on the Israeli transmission grid. The cost for these additional substations is estimated at an additional NIS 146 million (US$ 40 million). If the higher wheeling tariff is used, by 2030 wheeling charges will reach over NIS 110 million (US$ 30 million) per year. If the lower wheeling tariff is used, by 2030 wheeling charges will be lower at approximately NIS 40 million (US$ 11 million) per year.

Figure II-2.11: Cumulative T&D and wheeling costs under 'Planned Future' scenario if highest wheeling charge is used

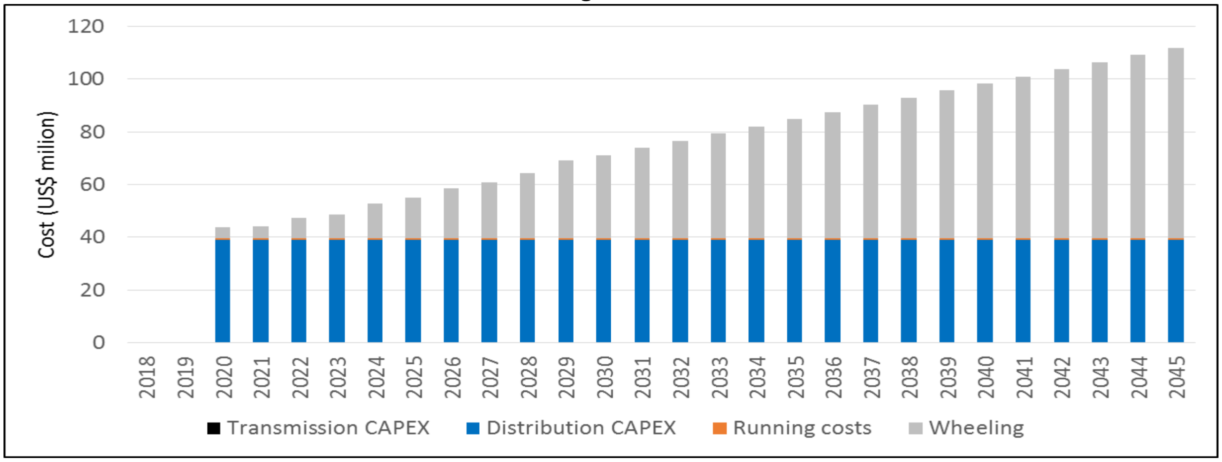
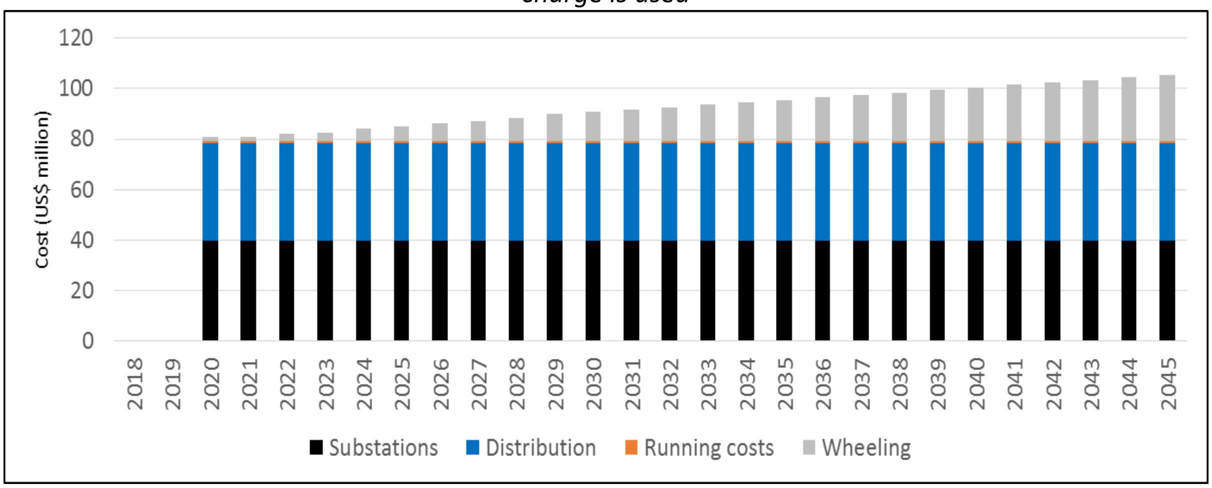


Figure II-2.12: Cumulative T&D and wheeling costs under 'Planned Future' scenario if lowest wheeling charge is used



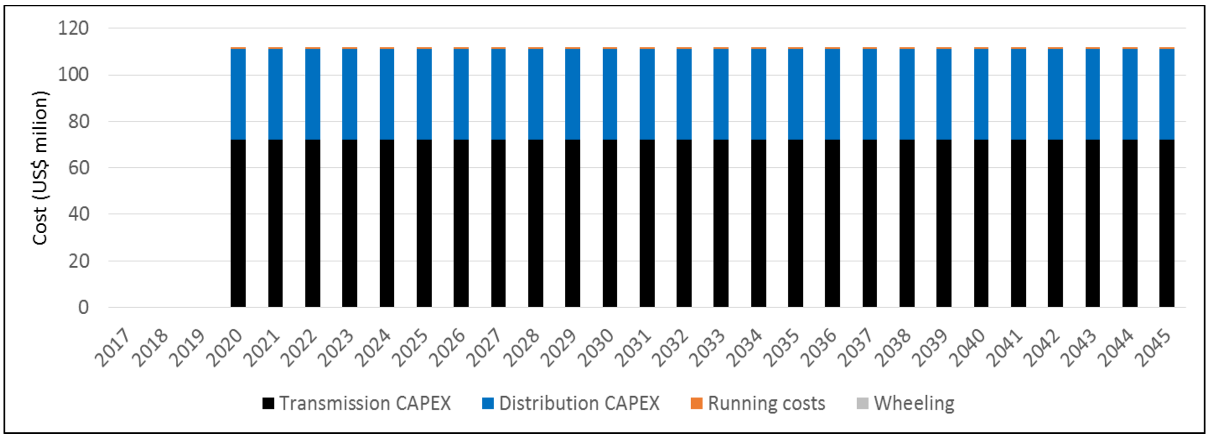
173. **Under the Palestinian backbone case, the exact investment requirements would reflect the composition of the selected investment plan** (figure II-2.13)**.** Investment needs for distribution range from NIS 95-190 million (US$26-52 million), while those from transmission range from NIS 172-500 million (US$47-137 million). The projects with the largest impact on transmission investment requirements are the Jenin Power Plant and the development of solar PV in Area C, each at around NIS 164 million (US$45 million).

Figure II-2.13: Breakdown of required transmission and distribution investments as additional supply comes online if a transmission backbone is built

(US$)		4 HV substations energized	JPP comes online	HPP comes online	Renewables allowed in Area C	Jordanian interconnector is expanded	Total
WB	T	0	47	25	44	20	137
WB	D	26	7	7	7	7	52
Total	T&D	26	54	31	51	27	188

174. **For the specific case of the 'planned future' scenario, the total required investment in transmission and distribution would be NIS 409 million (US$ 112 million).** The components in figure II-2.13, which contribute to the 'planned future' scenario, are the energization of the four new substations, plus JPP and HPP coming online. Combined, these additional supply options will need NIS 263 million (US$ 72 million) for transmission infrastructure, and NIS 146 million (US$ 40 million) for distribution infrastructure for a total investment of NIS 409 million (US$ 112 million). Regardless, it is not desirable to have variable costs that grow year after year and the transmission backbone would allow a fixed cap on expenditures. It is important to note that, whereas investments in generation would be pursued under a PPP model, investments in transmission and distribution would necessarily take the form of public investment.

Figure II-2.14: Cumulative T&D investment for the 'planned future' scenario if a transmission backbone is built



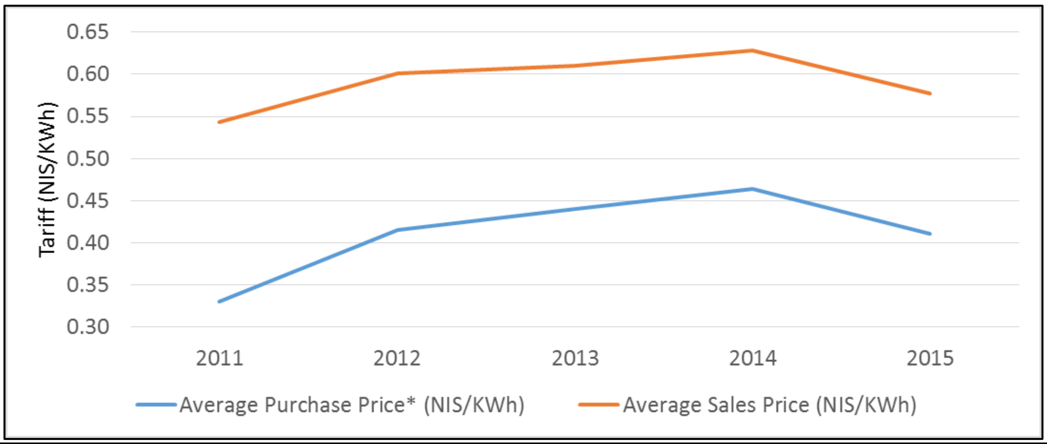
175. **In the short term, PENRA must negotiate lower wheeling tariffs with IEC, and in the mid to long term, PENRA should build a transmission backbone to reduce costs – negotiating a swap mechanism could be an attractive third option.** The cost of wheeling at the higher tariff breaks even with the cost of the backbone by 2045 and the cost of wheeling at the lower tariff breaks even with the cost of the backbone by 2052. By 2030, the transmission component of the retail tariff would be NIS 0.004 (US$ 0.001) per kilowatt-hour if a backbone is built, NIS 0.007 (US$ 0.002) per kilowatt-hour if the lower wheeling charge is used, and NIS 0.018 (US$ 0.005) per kilowatt-hour if the higher wheeling charge is used (assuming amortization of all capex to 25 years). This represents 0.7, 1.3, and 3.3 percent of the total expected retail tariff in 2030 respectively. Building a transmission backbone is more cost effective than wheeling the power through Israel simply because the costs are fixed and do not grow as domestic generation expands. If wheeling is to be used, at least in the initial years until a transmission backbone is built, the wheeling tariff should be extensively negotiated with IEC to bring down costs. A swap mechanism, in which power generated in the West Bank is evacuated to Israel, and swapped for power from Israel at a later point in time and injected back into the West Bank, can be an attractive alternative but requires extensive negotiations and collaboration on both sides.

2.3 Financial Model

176. **Attention now turns to the financial implications of implementing the planning scenarios described above.** The key focus of attention will be the financial equilibrium tariff and how it may need to evolve relative to historic practice.

177. **Historically, the retail tariff in the West Bank has included an average 45 percent mark-up over the wholesale cost of IEC power** (Figure II-2.15). Retail tariffs in the West Bank are determined by the regulator, PERC, which allows a mark-up over the wholesale price of IEC power to cover the operating margin of the DISCOs, including the significant operational inefficiencies and overheads. For the historic period 2011-2015, this mark-up has averaged 45 percent over and above the IEC tariff. (This is in contrast to Gaza, where PERC regulation has not been in force and retail tariffs have dropped below the weighted average cost of supply, which includes IEC imports and generation from GPP)

Figure II-2.15: In the West Bank, retail tariffs have followed the cost of IEC supply

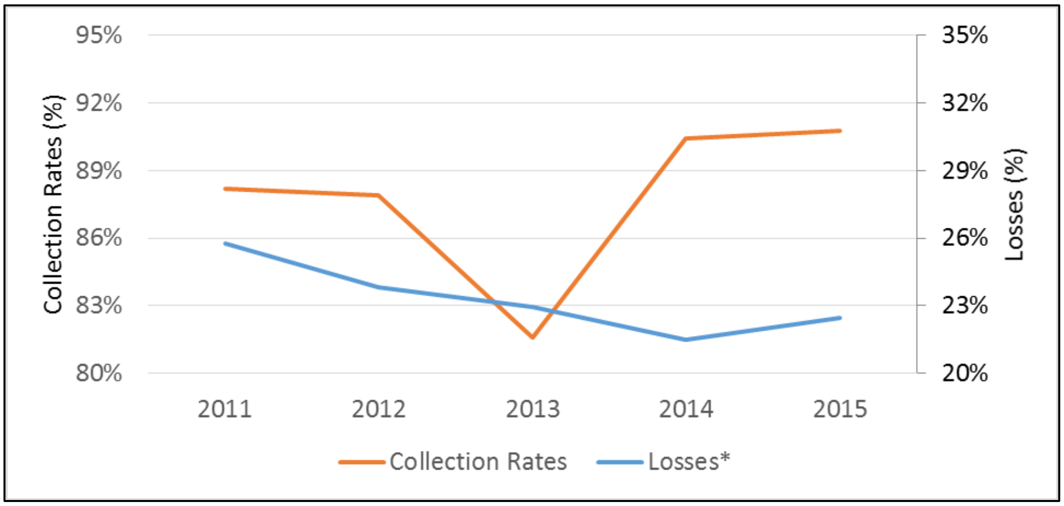


	2011	2012	2013	2014	2015
Average Purchase Price* (NIS/KWh)	0.33	0.42	0.44	0.46	0.41
Average Sales Price (NIS/KWh)	0.54	0.60	0.61	0.63	0.58
Markup	65%	45%	39%	35%	41%

* Includes IEC and Jordan

178. **While there has been some improvement in the operating efficiency of the West Bank DISCOs, substantial variations remain across companies.** In the West Bank, overall DISCO losses (including both technical and non-technical losses) have been falling from around 26 percent in 2011 to 23 percent in 2015 (Figure II-2.16). As of 2015, SELCO had the highest losses at 27 percent, followed by JDECO at 24 percent, HEPCO at 20 percent, NEDCO at 17 percent and TEDCO at 16 percent. The overall DISCO collection rates have improved from 88 percent in 2011 to 91 percent in 2015. As of 2015, NEDCO, JDECO and HEPCO, which combined make up over 92 percent of sales, had collection rates above 90 percent while SELCO and TEDCO had collection rates above 75 percent. For the purposes of financial modeling, two possibilities are considered. The first is that the regulator will set ambitious but realistic efficiency targets for the DISCOs that will be met by 2030. The second is that there is no significant improvement in DISCO inefficiency.

Figure II-2.16: Time trend for distribution losses and revenue collection rates in the West Bank

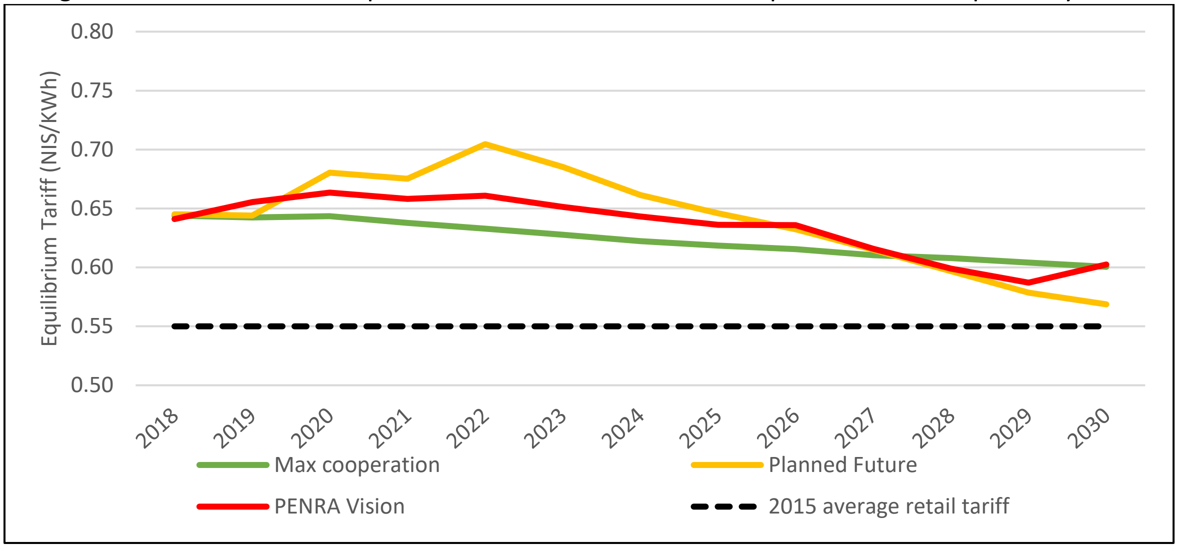


	2011	2012	2013	2014	2015
Losses*	26%	24%	23%	22%	22%
Collection Rates	88%	88%	82%	90%	91%

179. **The financial modeling exercise is pursued for three of the planning scenarios that capture the full range of potential financial implications**. In the West Bank, the 'PENRA Vision' scenario was the most expensive entailing an average generation cost of NIS 0.39 (US$0.102) per kilowatt-hour, while the 'maximum cooperation' scenario was the least expensive entailing an average generation cost of NIS 0.37 (US$0.098) per kilowatt-hour. The 'Planned Future' represents the middle ground with an average cost of NIS 0.42 (US$0.11) per kilowatt-hour.

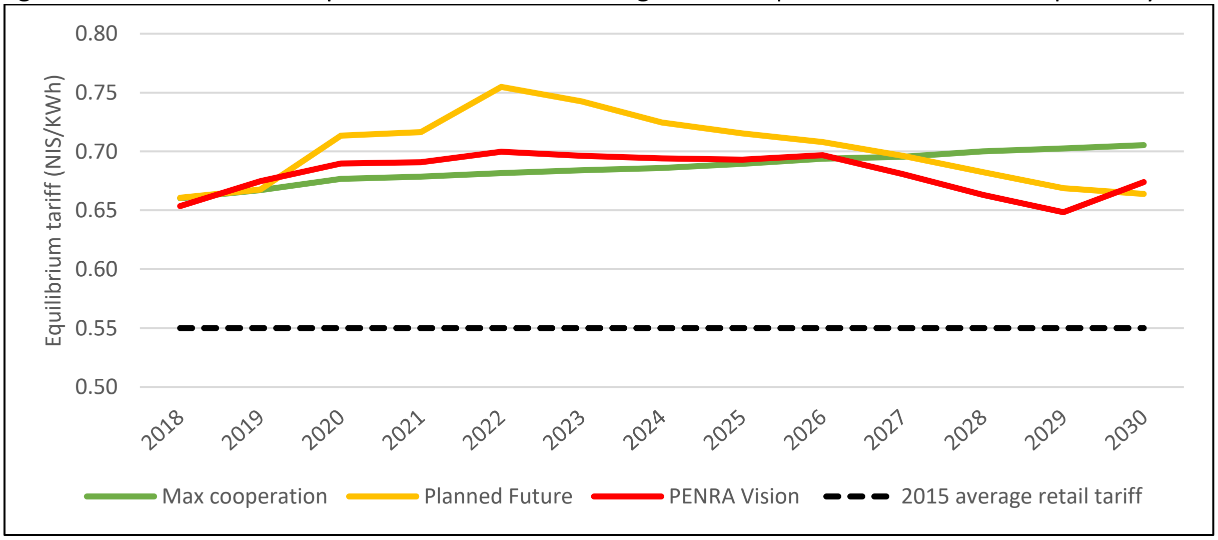
180. **In the West Bank, the financial equilibrium tariffs do not vary significantly across scenarios, but all show a declining trend.** The equilibrium tariff follows a narrow band for all three scenarios reflecting the fact that the average cost of generation does not differ significantly across different planning scenarios in the West Bank (Figure II-2.17). In all cases, the financial equilibrium tariff declines significantly by the end of the period as DISCO efficiencies improve, technology costs drop (such as PV) and gas becomes available. Although both for the 'PENRA vision' and particularly for the 'planned future', the financial equilibrium tariff rises in the medium term before an eventual decline, essentially because operational efficiency has not yet had time to improve to a point where it can more than compensate for higher generation costs. However, by 2027, it is expected that the 'Planned Future' and 'PENRA Vision' scenarios, which represent diversified portfolios with large amounts of solar and gas plants, will have lower costs than the 'maximum cooperation' scenario which represents pure imports from IEC. Despite the declining costs by 2030, the equilibrium tariff for all scenarios is higher than the 2015 retail tariff.

Figure II-2.17: West Bank equilibrium tariff decline as DISCOs performances improve by 2030



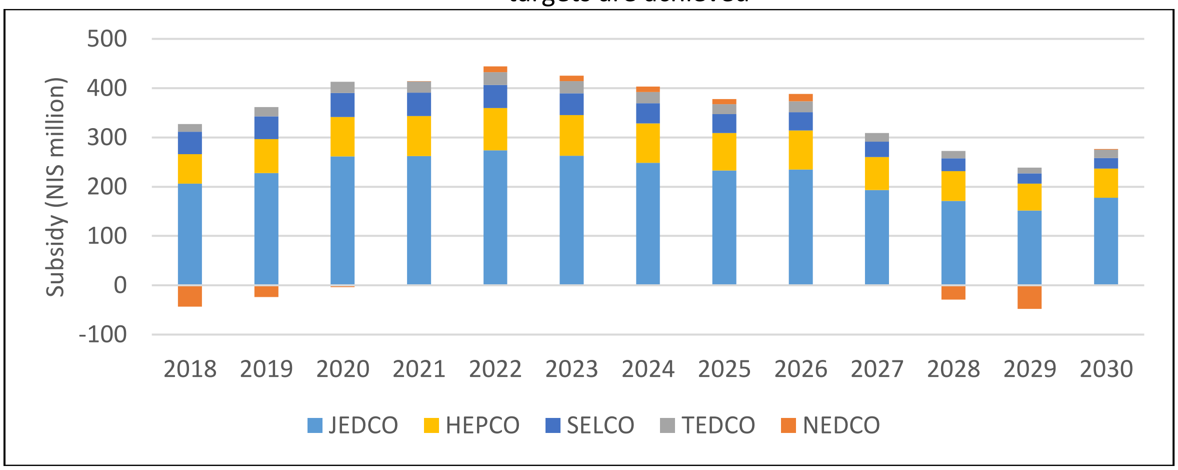
181. **If DISCO performance is not improved by 2030, equilibrium tariff for the PENRA Vision planning scenario will be NIS 0.07 (US$0.02) per kilowatt-hour higher than otherwise.** The equilibrium tariffs represented in figure II-2.17 assume that by 2030 collection rates increase from current levels of 91 percent to 97 percent, distribution grid technical and non-technical losses decline from current levels of 23 percent to 16 percent, transmission system losses are 2 percent and DISCO operation and maintenance costs improve by 2 percent per year. Based on reports from the DISCOs, it is assumed that debt is currently financed at 3.5 percent, but would need to rise towards 7 percent by 2030. If these improvements are not achieved, the equilibrium tariff in 2030 will be NIS 0.66 - 0.71 (US$ 0.17 – 0.19) per kilowatt-hour instead of NIS 0.58 – 0.61 (US$ 0.15 – 0.16) per kilowatt-hour (Figure II-2.18).

Figure II-2.18: West Bank equilibrium tariff remains high if DISCO performances fail to improve by 2030



182. **Failure to adjust the unified tariff in the West Bank would result in massive average annual subsidy requirements to keep the DISCOs afloat** (figure II-2.19)**.** If the West Bank pursues the 'PENRA Vision' scenario without making any compensating adjustments in retail tariffs, the subsidy required to keep the DISCOs afloat would begin at approximately NIS 300 (US$82) million in 2018, and increase to almost NIS 450 (US$ 123) million by 2022. In other words, in 2018, all DISCOs, except NEDCO, will lose between 0.10-0.35NIS (US$ 0.03-0.09) for every kilowatt hour they sell if the tariffs are not increased. JDECO, with the largest customer base, will require the largest subsidy from the government. NEDCO, which already has the best operational performance, does not require much in the way of subsidies and would be the only DISCO able to absorb the new generation cost without a raise in the unified tariff. These calculations are based on the assumption that all DISCOs meet efficiency targets by 2030. If they do not, the required subsidy will be significantly higher.

Figure II-2.19: Subsidy required to sustain financial equilibrium of DISCOs in the absence of any adjustment to the current unified retail tariff based on the PENRA Vision scenario assuming efficiency targets are achieved



183. **Alternatively, if subsidies are targeted purely to the poorest customers who face affordability limits, the overall subsidy bill drops substantially.** According to the affordability thresholds in the West Bank, the bottom decile of the population can afford to pay up to NIS 0.41 (US$0.114) per kilowatt-hour, while the second decile can afford to pay up to NIS 0.71 (US$0.197) per kilowatt-hour (figure II-2.20). The analysis suggests that as long as DISCOs meet their efficiency targets, tariffs should hardly rise beyond NIS 0.7 (US$0.19) per kilowatt-hour, so that subsidies need only be channeled to the poorest 10 percent of the population. The subsidy required to cover the difference between the increased retail tariff and the affordability thresholds of these families, would amount to no more than NIS 25 million (US$7 million) per year with over 60 percent going to JDECO consumers (figure II-2.21). As DISCO efficiencies improve, required subsidies are observed to decrease over time.

Figure II-2.20: Comparing the 1st and 2nd decile affordability thresholds against equilibrium tariff for the PENRA Vision scenario assuming efficiency targets are reached

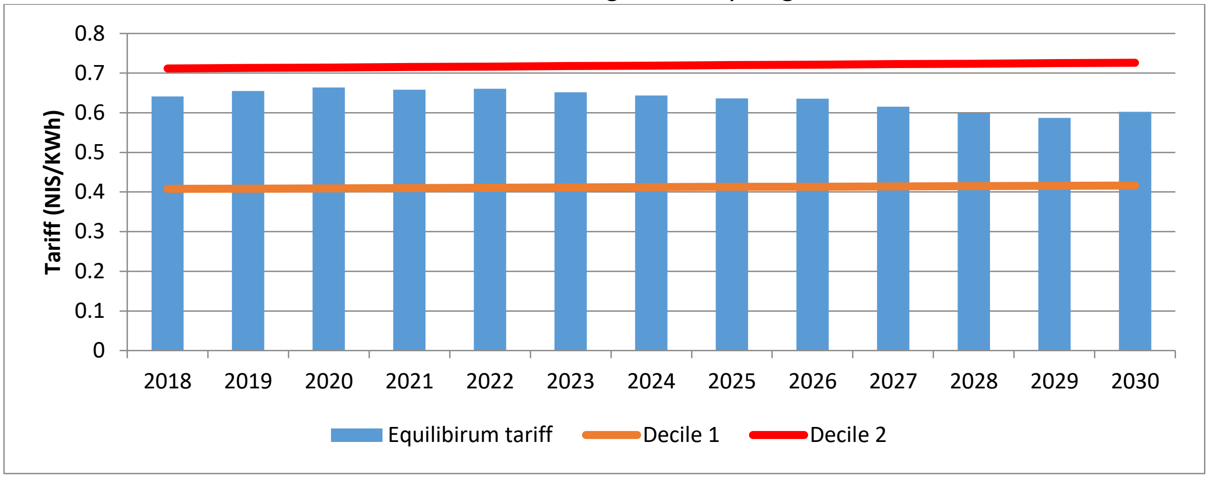
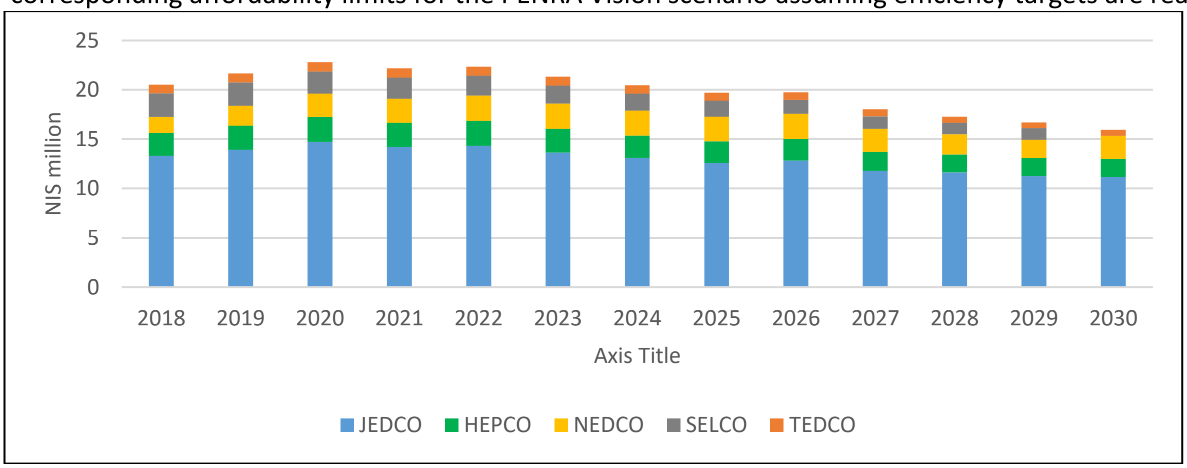


Figure II-2.21: Subsidy required to keep the bills of the bottom decile of households within the corresponding affordability limits for the PENRA Vision scenario assuming efficiency targets are reached



2.4 Macro-fiscal Model

184. **A combined energy investment and reform package produces tangible macro-fiscal benefits.** To evaluate the fiscal and macroeconomic impact of PENRA's current projects in the pipeline, a Computable General Equilibrium (CGE) model is designed for the 'Planned Future' scenario described above. For modeling purposes, this scenario is characterized by a steep expansion in domestic power generation accompanied by a fall in energy costs.

185. **The CGE model predicts that the 'planned future' scenario ensures electricity subsidies are fully eliminated and there is a boost in GDP growth and investment**. From a fiscal perspective, the 'planned future' scenario entails a dramatic reduction in electricity subsidies that are otherwise projected to escalate to 0.8 percent of GDP by 2025 under the 'do nothing'

scenario, to a net positive fiscal position of 0.9 percent of GDP by 2025 (Figure II-2.22). This makes a substantial contribution to the net government operating balance estimated to be in slight surplus under the 'planned future' versus a sizeable deficit under the 'do nothing' scenario. The 'planned future' scenario also delivers a significant boost to the growth rate of the economy, which would be 0.3 percentage points of GDP higher than otherwise for the entire decade (Figure II-2.23). The main sector to benefit from the energy turnaround is investment, which grows as much as 0.7 percentage points of GDP higher than otherwise, partly as a result of the increased fiscal space created by reducing electricity subsidies.

Figure II-2.22: Impact of planned future energy scenario on government accounts

As % of GDP	2016 Baseline	2025	
		Planned Future	Do Nothing
Revenue	28.0	26.2	27.1
Expenditure	26.6	25.9	28.3
• Of which Electricity subsidies	0.1	-0.9	0.8
Operational Balance	1.4	0.3	-1.2

Figure II-2.23: Impact of 'planned future' energy scenario on macroeconomic performance

Average annual growth 2016-2025	Planned Future	Do Nothing
GDP at market prices	2.7	2.4
Investment	2.3	1.6
Consumer Price Index	2.0	1.8

3. Gaza

186. This section presents the results of the integrated planning and financial exercise for Gaza.

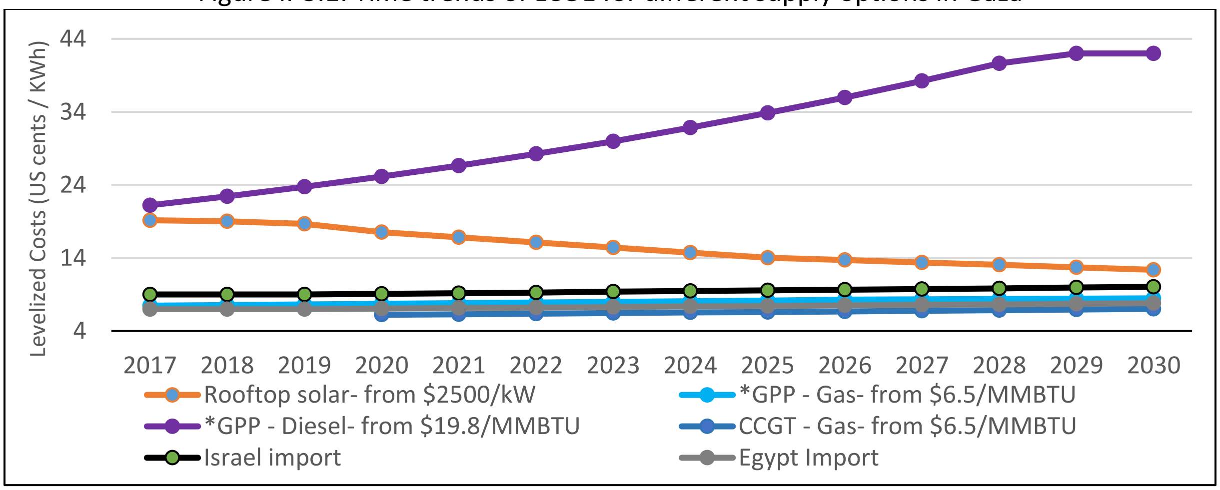
3.1 Planning Model

187. **The two key drivers of the planning scenarios are the relative cost of power supplied through different technologies, as well as the range of uncertainties that affects each of them.** Figure II-3.1 plots the so called Levelized Cost of Energy (LCOE), defined as total capital and operating costs across the lifetime of a power project averaged over the total electricity produced. While LCOE is a convenient device for making simple relative cost comparisons, it is important to recognize that it does not capture all relevant characteristics of each power source, such as its availability for dispatch and contribution to meeting peak loads. Figure II-3.2 summarizes the different uncertainty parameters that characterize each of the power supply options, considering delays in availability, uncertainty of cost, as well as probabilities of interruption to supply. These are inevitably somewhat subjective and based on a combination of expert judgment and stakeholder consultation.

188. **Domestic power generation in Gaza is extremely costly, until such a time as the Gaza Power Plant can be converted to gas and preferably to combined cycle technology** (figure II-3.1)**.** At present, the cost of diesel-fired generation at the Gaza Power Plant is over NIS 1.09

(US$0.30) per kilowatt-hour and projected to increase in line with the forecast trajectory of the global oil price. The only alternative domestic source of energy – which is rooftop solar – is also relatively expensive although projected to become cheaper over time in line with global trends to reach around NIS 0.44 (US$0.12) per kilowatt-hour by 2030. As of today, Israeli imports, at around NIS 0.37 (US$0.10) per kilowatt-hour and Egyptian imports, at around NIS 0.27 (US$ 0.07) per kilowatt-hour are by far the most cost-effective source of energy available. However, eventual conversion of the Gaza Power Plant to natural gas, as well as possible conversion to more efficiency CCGT technology, would significantly bring down the costs of domestic generation.

Figure II-3.1: Time trends of LCOE for different supply options in Gaza



189. **Due to the risky environment in Gaza, some of the lower cost power options are not necessarily the most secure** (figure II-3.2)**.** The relative cost of alternative power generation options needs to be considered alongside their relative risk. A key issue to look at is the probability of a supply interruption in any given time period. This indicates that both the diesel supplies to the Gaza Power Plant and Egyptian imports have proved to be highly unreliable sources of electricity in the past. While gas supplies are not yet available, due to their nature as fuel imports, it is envisaged that these could be subject to similar levels of risk. Electricity imports from Israel, on the other hand, based on the historic record have proved to be more reliable and are therefore assigned a lower probability of interruption

Figure II-3.2: Overview of uncertainty parameters for Gaza planning exercise

	Diesel	Gas	Israel	Egypt
Availability range				
Earliest	2016	2022	2022	2021
Latest	2016	2035	2035	2035
Volume range				
Lowest	Unlimited	0.2 BCM	120 MW	10 MW
Highest	Unlimited	2.0 BCM	270 MW	70-150 MW
Price range				
Lowest	Known	$4.0/mmbtu	Current	$0.08/kWh
Highest	Known	$7.5/mmbtu	$0.11/kWh	$0.10/kWh
Outage duration range				
Minimum days	37	37	18	29
Maximum days	365	365	91	182
Other parameters				
Minimum availability	0.30	0.30	0.80	0.60
Probability of interruption	0.15	0.15	0.02	0.20

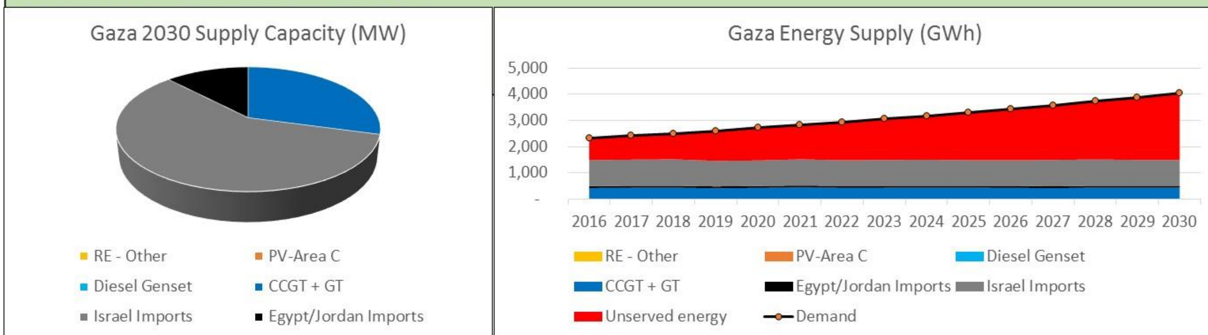
190. **Against this backdrop, the results of five planning scenarios are considered.** As noted above, these include a 'do nothing' counterfactual, where no further investments are made in power infrastructure while demand continues to grow. This is compared with the impact of the current pipeline of investments, described as the 'planned future', as well as 'PENRA's vision' for the longer term, which seeks to limit dependence on any single source of energy to 50 percent of demand while retaining the ability to import 100 percent of energy needs, if required. For the purposes of illustration, two additional – more extreme – scenarios are considered. 'Maximum cooperation' considers the possibility of Gaza following the power supply model that has so far characterized the West Bank; which is full dependence on Israeli imports to the extent of phasing out the Gaza Power Plant completely. 'Maximum independence' considers the opposite possibility of scaling-up the Gaza Power Plant to the point where it is capable of meeting the full extent of anticipated demand growth.

191. **Under the 'do nothing' scenario, Gaza's existing acute power shortages only become increasingly intolerable over time** (Figure II-3.3). The baseline for the planning exercise is a scenario in which no further power infrastructure is developed to support either increased domestic generation or expanded imports, but demand continues to grow in line with forecasts. Gaza is already unable to meet 50 percent of its demand, and under the 'do nothing' scenario, this situation continues to deteriorate dramatically so that by 2030 over 60 percent of demand cannot be met, which represents power cuts longer and more severe than those experienced today. At the same time, the cost of the limited power generation available is very high at almost NIS 0.55 (US$0.15) per kilowatt-hour – about 50 percent higher than the equivalent scenario for the West Bank – and this is due to the high cost of running the Gaza Power Plant on diesel. Neither does the Gaza Power Plant permit the achievement of energy independence. Due to the limited capacity and the constraints on diesel purchases, Gaza continues to rely on imports to meet 26 percent of its energy needs. Overall, the 'do nothing' baseline scenario for Gaza paints a dire

picture. Additional power supply is desperately needed but the high cost of energy, coupled with consumers' low ability and willingness to pay, make it difficult to bring on additional supply.

Figure II-3.3: Results of 'do nothing' planning scenario for Gaza

Do nothing: No additional power supply is brought online, and Gaza is limited to the existing: i) 120MW import capacity from IEC, ii) 30MW import capacity from Egypt, and iii) the Gaza Power Plant (GPP) running on diesel with 140MW capacity but limited to 60MW due to fuel shortages



Avg Cost Power (US cents/KWh)	CAPEX (mil USD)	2030 Unserved Demand (%)	2030 Electricity Imports (%)	2030 Domestic Gen – Imported Fuel (%)	2030 Domestic Gen – Renewables (%)
14.68	0	63%	26%	11%	0%

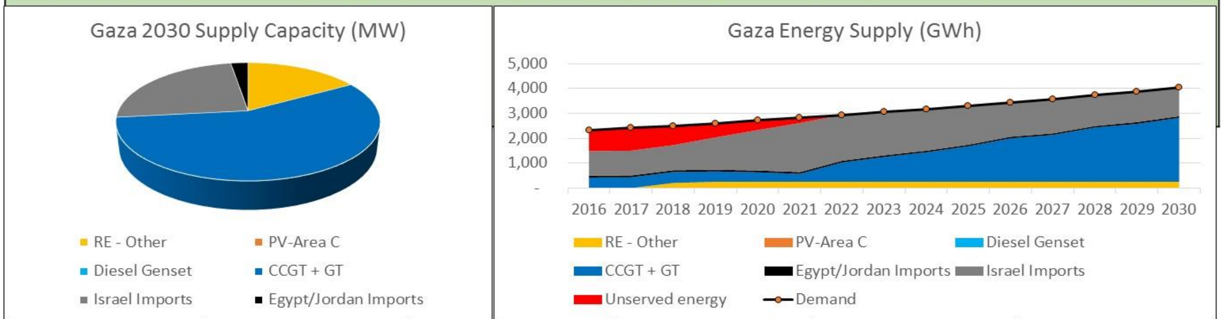
Takeaway: Under current conditions, unserved demand and power cuts will continue to increase in Gaza until 2030.

19

192. **Gaza's situation would improve significantly with the implementation of 'planned future' projects, though the cost of energy would remain relatively high** (Figure II-3.4). In addition to PENRA's plans to energize a new 161 kV line with IEC and substantially expand the capacity of the Gaza Power Plant to 560 MW while converting it to gas, this scenario incorporates the possibility of developing Gaza's full potential of 163 MW of solar PV, mainly in the form of rooftop solar systems. The inclusion of the latter is not based on cost considerations, as rooftop solar remains relatively costly even through to the end of this period, but is rather motivated by considerations of resilience. Solar capacity of this kind could help to provide an electricity safety net capable of meeting the most basic needs during times of geopolitical tension that could potentially affect fuel or electricity imports. The implementation of this package would ensure that unserved demand could be eliminated by the early 2020s. However, implementing these projects would entail raising over NIS 3.7 billion (US$1 billion) of private finance, and the cost of electricity would remain relatively high at NIS 0.50 (US$0.134) per kilowatt-hour. Gaza would only be able to meet 6 percent of its energy needs on a fully self-sufficient basis through solar; however, this is the maximum amount feasible in any case.

Figure II-3.4: Results of ‘planned future’ planning scenario for Gaza

Planned Future: All PENRA’s currently planned projects come online: i) upgrade of GPP to run on natural gas and expand capacity up to 560MW, ii) and energization of the 161kV power line to bring an additional 120MW from IEC. In addition, we assume 163MW of renewable energy (of which over 80% is rooftop solar) which is Gaza’s maximum potential capacity.



Avg Cost Power (US cents/KWh)	CAPEX (mil USD)	2030 Unserved Demand (%)	2030 Electricity Imports (%)	2030 Domestic Gen – Imported Fuel (%)	2030 Domestic Gen – Renewables (%)
13.39	1,035	0%	26%	68%	6%

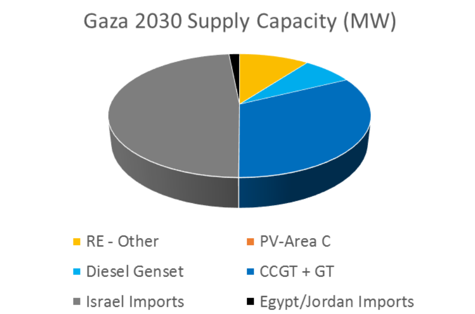
Takeaway: Planned projects will meet Gaza’s unserved demand by 2030 but 94% of fuel and power will be imported.

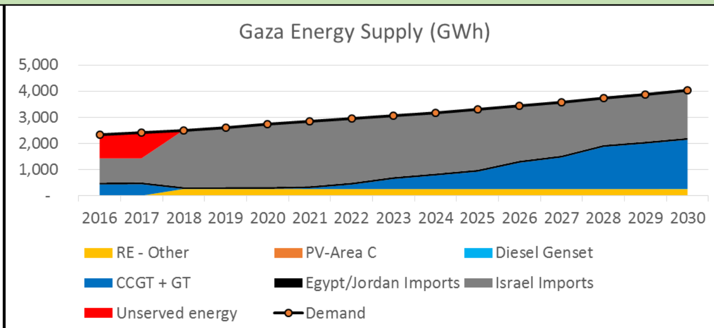
20

193. **Achieving ‘PENRA’s vision’ for the future, requires rebalancing from domestic thermal generation towards Israeli imports, thereby reducing the average cost of energy** (Figure II-3.5). The next scenario is based on the implementation of ‘PENRA’s vision’, according to which no source should contribute more than 50 percent of overall generation, while the import capacity should remain large enough to import all needed energy in case of emergency. Renewable energy potential continues to be tapped. The ‘planned future’ scenario does not meet PENRA’s strategic vision, because it relies on the Gaza Power Plant for more than 50 percent of energy needs. The only viable way to achieve the requisite rebalancing is to scale back the Gaza Power Plant’s capacity and allow the Israeli interconnection to make up a larger proportion of the overall capacity. While this still requires capital expenditure in excess of NIS 3.7 billion (US$1 billion), the average cost of energy is slightly reduced by NIS 0.04 (US$0.011) per kilowatt-hour to NIS 0.45 (US$ 0.12). Furthermore, unserved demand is more rapidly eliminated even before 2020. Both effects are due to the greater reliance of Israeli imports.

Figure II-3.5: Results of 'PENRA vision' planning scenario for Gaza

PENRA Vision: "Dependency ratio on any one source should not exceed 50% in best conditions, with a possibility of importing all needs in case of emergency."





Avg Cost Power (US cents/KWh)	CAPEX (mil USD)	2030 Unserved Demand (%)	2030 Electricity Imports (%)	2030 Domestic Gen – Imported Fuel (%)	2030 Domestic Gen – Renewables (%)
12.30	1,066	0%	47%	46%	6%

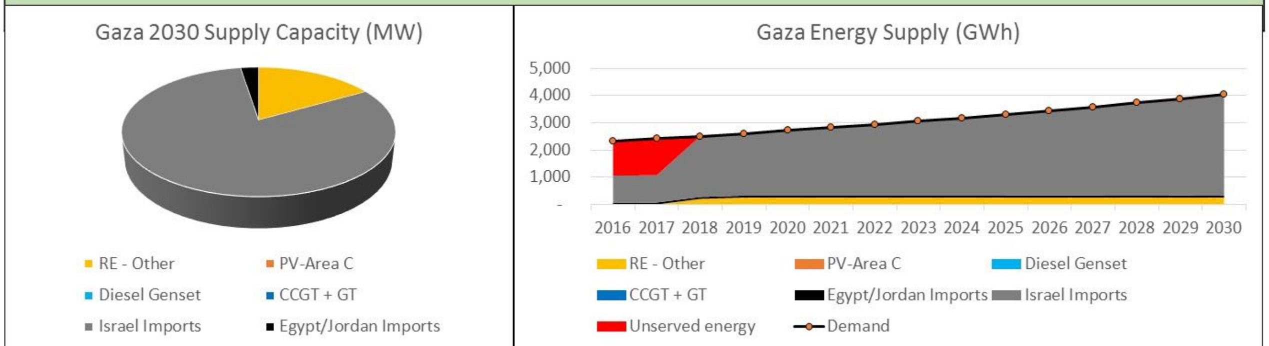
Takeaway: Better diversification, which will reduce costs, requires IEC imports beyond the planned 161kV line.

194. **As a comparison to this balanced scenario, two more extreme scenarios are also considered here for illustrative purposes.** One explores the option of 'maximizing cooperation' on electricity imports with Israel, and the other the option of further developing domestic thermal generation to achieve 'maximum independence'.

195. **Under a strategy of 'maximum cooperation', Gaza achieves the lowest possible power generation costs; comparable to those currently enjoyed by the West Bank** (Figure II-3.6). Given the cost and security advantages of Israeli power imports over domestic thermal generation, the 'maximum cooperation' scenario would call for shutting down the Gaza Power Plant and relying entirely on Israeli power imports. This entails expanding interconnection capacity with Israel from current levels of 120 MW towards 800 MW. The 163 MW of mainly rooftop solar are retained as an electricity safety net. In terms of operational installed capacity, this level of rooftop solar development would actually represent more than twice as much as what is offered by the Gaza Power Plant today, which is constrained to just 60 MW. However, in the absence of improved storage capacity, the hours of service available from solar power would be more restrictive. The capital expenditure associated with this option on the Palestinian side is much lower at NIS 1.4 billion (US$0.39 billion). Significant investments would also be required on the Israeli side to enhance interconnection capacity, although these should be covered through the power export tariff. This approach also eliminates unserved demand relatively quickly, before 2020, and results in relatively low tariffs of NIS 0.38 (US$0.104) per kilowatt-hour.

Figure II-3.6: Results of 'maximum cooperation' planning scenario for Gaza

Maximum cooperation: The Gaza Power Plant is shut down and all electricity needs are imported from IEC with expanded interconnection capacity. The full 163 MW of solar potential is developed as a safety net.



Avg Cost Power (US cents/KWh)	CAPEX (mil USD)	2030 Unserved Demand (%)	2030 Electricity Imports (%)	2030 Domestic Gen – Imported Fuel (%)	2030 Domestic Gen – Renewables (%)
10.37	385	0%	93%	0%	6%

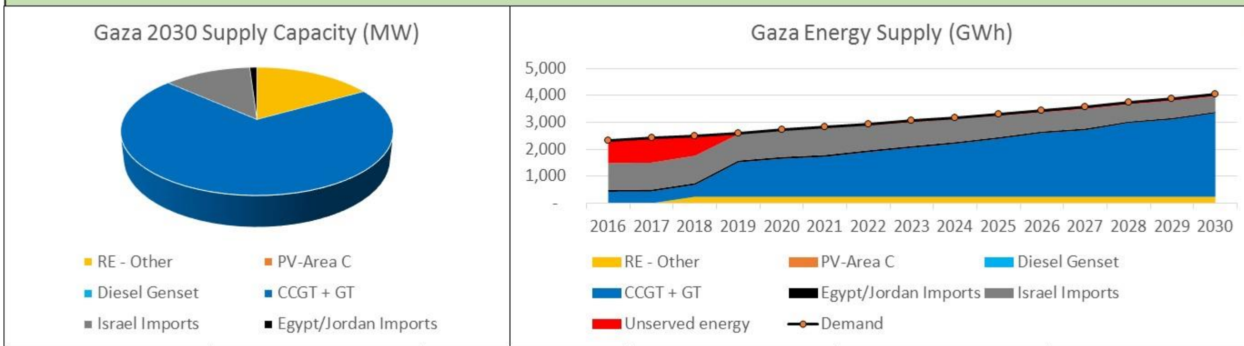
Takeaway: Cost of power is 3UScents/KWh cheaper than the planned strategy which would help improve cost recovery.

23

196. **Under a strategy of 'maximum independence', a larger scale-up of the Gaza Power Plant is called for and costs of power generation are at their highest** (figure II-3.7)**.** With Israeli imports capped at current levels of 120 MW, and renewable energy potential constrained to 163 MW, this scenarios entails further expansion of the Gaza Power Plant until it is capable of meeting the entire demand. This entails significantly higher capital expenditure than any of the other scenarios, at around NIS 4.4 billion (US$1.2 billion). While unserved demand is eliminated by 2020, the average cost of generation is also higher than under any other scenario at NIS 0.55 (US$0.152) per kilowatt-hour. The reason for this – despite the relative cost-effectiveness of CCGT technology – is that high cost diesel becomes the backup fuel for the gas plant anytime it experiences an outage; and this is relatively often given the plant's operational history. Finally, this poorly diversified scenario is so heavily dependent on imported fuel that any impression of independence is largely illusory. It is possible that the performance of this scenario could be improved, if the Gaza Power Plant were able to run on Gaza Marine gas. However, even in this case, the gas would likely need to be transported via Israel or Egypt.

Figure II-3.7: Results of 'maximum independence' planning scenario for Gaza

Maximum independence: Meet all demand growth through further expansion of Gaza Power Plant up to 677 MW, while retaining existing 120 MW interconnection with IEC, and developing full 163 MW of solar PV potential (80% rooftop).



Avg Cost Power (US cents/KWh)	CAPEX (mil USD)	2030 Unserved Demand (%)	2030 Electricity Imports (%)	2030 Domestic Gen – Imported Fuel (%)	2030 Domestic Gen – Renewables (%)
15.15	1,185	2%	9%	83%	6%

Takeaway: Relying purely on gas plants means, if gas is ever unavailable, diesel must be used, driving up costs significantly

24

197. **No single option performs better than others on all relevant dimensions, illustrating that trade-offs must be made.** Examining the five scenarios side by side helps to clarify their relative performance. The table compares various dimensions of performance including the average cost of power generation, the total capital expenditure, the level of unserved demand in 2030, the continued reliance on electricity imports or fuel imports for generation, and the share of domestically generated renewable energy in the overall mix. The darker the shade of green the better the performance on that dimension, while the darker the shade of orange the worse the performance on that dimension.

Figure II-3.8: Comparison of results across the five planning scenarios for Gaza

		Average Cost Power (US cents/ KWh)	CAPEX (mil USD)	2030 Unserved Demand (%)	2030 Electricity Imports (%)	2030 Domestic Gen – Imported Fuel (%)	2030 Domestic Gen – RE (%)
1	Do nothing	14.68	0	63%	26%	11%	0%
2	Planned Future	13.39	1,035	0%	26%	68%	6%
3	PENRA Vision	12.30	1,066	0%	47%	46%	6%
4	Maximum cooperation	10.37	385	0%	93%	0%	6%
5	Maximum independence	15.15	1,185	2%	9%	83%	6%

198. **The key energy policy issue for Gaza is where to strike the right balance between Israeli imports and domestic gas-fired power generation.** The first point to note is that the degree of true energy independence achievable in Gaza is – due to geographic circumstances –

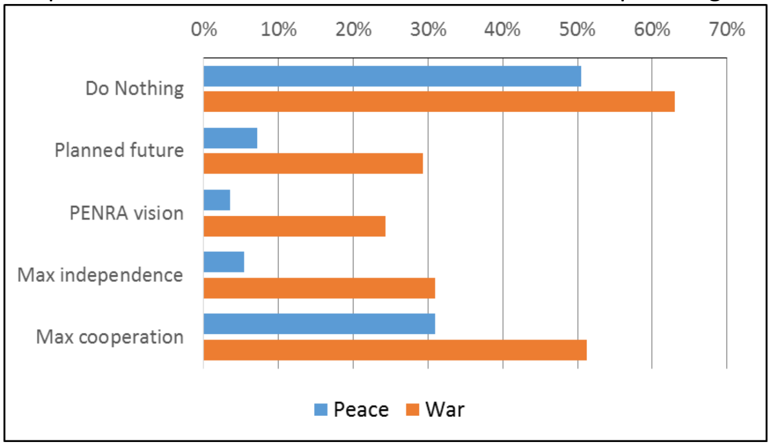
much lower than for the West Bank. Whereas the West Bank could potentially meet 20-30 percent of its energy needs from solar energy by 2030 (depending on access to Area C), Gaza is only able to meet at most 6 percent of electricity demand from solar energy by 2030, even after exploiting the full extent of its renewable energy potential. Moreover, given the low historical reliability of Egyptian power imports, Gaza's only two realistic power supply options are Israeli imports, and an expanded Gaza Power Plant suitably converted to fire on gas. Energy policy for Gaza therefore boils down to striking the right balance between these two limited options. A simple cost comparison between the two suggests a slight advantage for the Gaza Power Plant once converted to gas. However, the relative ranking of these two options changes when risk factors are taken into account. On the one hand, Israeli power imports have had a reliable historical track record. On the other hand, the Gaza Power Plant would never be able to rely on gas entirely sourced and transported within Palestinian territory, and would be forced to run on expensive diesel whenever gas supplies were to fail. Running the Gaza Power Plant on diesel, as at present, is a highly unattractive option, which should be avoided as much as possible. Indeed, the investment differential between 'maximum cooperation' and 'maximum independence' is as much as NIS 2.9 billion (US$0.8 billion) while the average cost differential is as much as NIS 0.175 (US $0.048).

199. **The recommendation is therefore not only to pursue the energization of the existing 161kV line, but also to explore the possibility of additional interconnection capacity with IEC, even as effort to import gas to Gaza continue.** Finally, the development of Gaza's limited solar potential looks to be a worthwhile investment that provides a basic electricity safety net more effectively and efficiently than is currently being achieved with the Gaza Power Plant.

200. **Another way to compare the alternative scenarios is through a stress testing process that examines how they perform under extreme conditions.** In particular, the stress test looks at how the percentage of unserved energy rises for each scenario when conflict conditions are simulated.

201. **The 'planned future' and 'PENRA vision' scenarios are the ones that perform the best under conflict conditions** (figure II-3.9)**.** Under these scenarios the unserved demand during wartime would increase to 24-29 percent, even slightly outperforming the 'maximum independence' scenario, and far outperforming the 'maximum cooperation' scenario that could lead to as much as 50 percent of unserved energy during a conflict period.

Figure II-3.9: Comparison of unserved demand in war time across planning scenarios in Gaza



3.2 Transmission

202. **The specific situation of Gaza points to the need to develop domestic transmission infrastructure as opposed to wheeling via the Israeli network.** With respect to transmission options, Gaza's situation is quite different to that of the West Bank. In particular, given Gaza's small territory and compact settlement patterns, its absence of land use restrictions, and the relatively limited existing interconnection capacity with Israel, the option of wheeling power within Gaza via the Israeli network does not appear to be relevant. Attention therefore focuses on the need to develop domestic transmission and distribution infrastructure for power transportation purposes.

203. **Capital expenditure requirements for transmission and distribution in Gaza range from NIS 292-456 million (US$80-125 million)** (Figure II-3.10). Given the need to substantially expand the amount of power flowing through the Gaza network to meet growing demands, an investment of NIS 120 million (US$ 33 million) in an internal transmission backbone and a further NIS 172 million (US$ 47 million) for supporting distribution network enforcements would be needed in any case, whether the additional power was coming from IEC, the Gaza Power Plant, or some combination of the two. Although the planning scenarios described above did not end-up including increased imports from Egypt, it is important to note that the pursuit of this option would entail a different set of investments in transmission and distribution amounting to a total of NIS 164 million (US$45 million). It is important to note that, whereas investments in generation would be pursued under a PPP model, investments in transmission and distribution would necessarily take the form of public investment.

Figure II-3.10: Overview of transmission and distribution investment requirements for Gaza

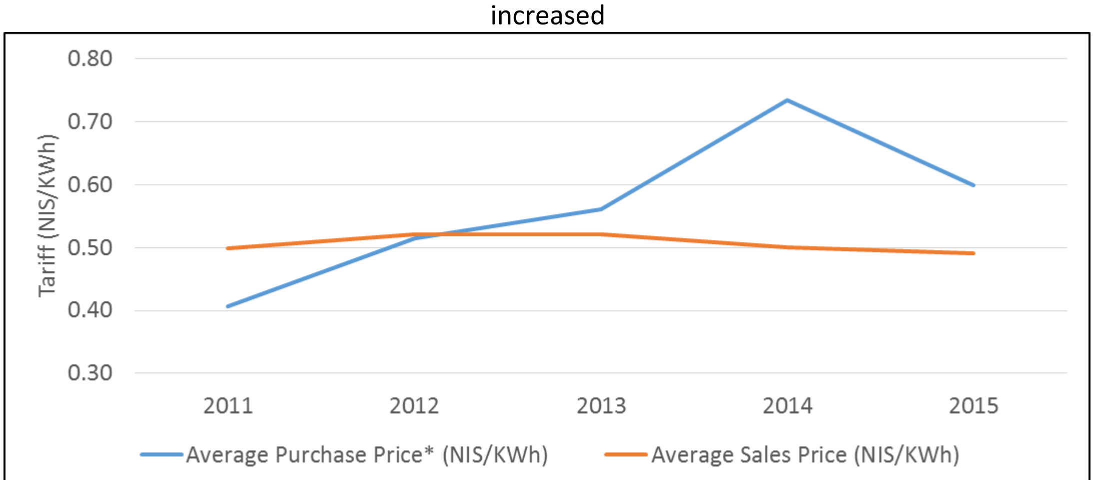
(US$)		GPP upgraded and expanded or Additional supply from IEC comes to Gaza	Egyptian interconnector is expanded	Total
WB	T	33	32	65
WB	D	47	13	60
Total	T&D	80	45	125

3.3 Financial Model

204. **Attention now turns to the financial implications of implementing the planning scenarios described above.** The key focus of attention will be the financial equilibrium tariff and how it may need to evolve relative to historic practice.

205. **GEDCO currently sells power to consumers at a cost lower than its own average purchase price from IEC and GPP** (Figure II-3.11). Gaza's retail power tariffs have been fixed at NIS 0.50 (US$0.14) per kilowatt-hour for the past decade, even as the weighted average cost of purchasing power both from Israel and GPP has risen towards the range of NIS 0.60-0.70 (US$0.17-0.19) per kilowatt-hour. The implication is that GEDCO is selling power to customers at a discount over its own power purchase price and that's not even considering the utility's own distribution operating margin.

Figure II-3.11: In Gaza, retail sales tariffs have remained flat as cost of power from Israel and GPP has increased



	2011	2012	2013	2014	2015
Average Purchase Price* (NIS/KWh)	0.41	0.52	0.56	0.73	0.60
Average Sales Price (NIS/KWh)	0.50	0.52	0.52	0.50	0.49
Markup/Discount	23%	1%	-7%	-47%	-22%

* Includes IEC and GPP

206. **Moreover, GEDCO's operating performance is by far the worst of any of the Palestinian distribution utilities** (figure II-3.12)**.** While GEDCO's distribution losses (including both technical and non-technical losses) have been falling somewhat from around 30 percent in 2011 to 26 percent in 2015, they remain high relative to other Palestinian utilities and are more

than twice as high as what would be considered good practice internationally. GEDCO's collection ratio, which stands at around 65 percent (despite a recent spurt) is extremely low and represents a huge financial drain on the company. This poor performance is partly explained by high levels of unemployment and poverty in Gaza due to the conflict situation, as well as limited willingness to pay from consumers that are subject to continuous rolling blackouts.

Figure II-3.12: Time trend for distribution losses and collection efficiency in Gaza

	2011	2012	2013	2014	2015
Losses*	30%	30%	30%	26%	26%
Collection Rates	65%	68%	71%	64%	65%

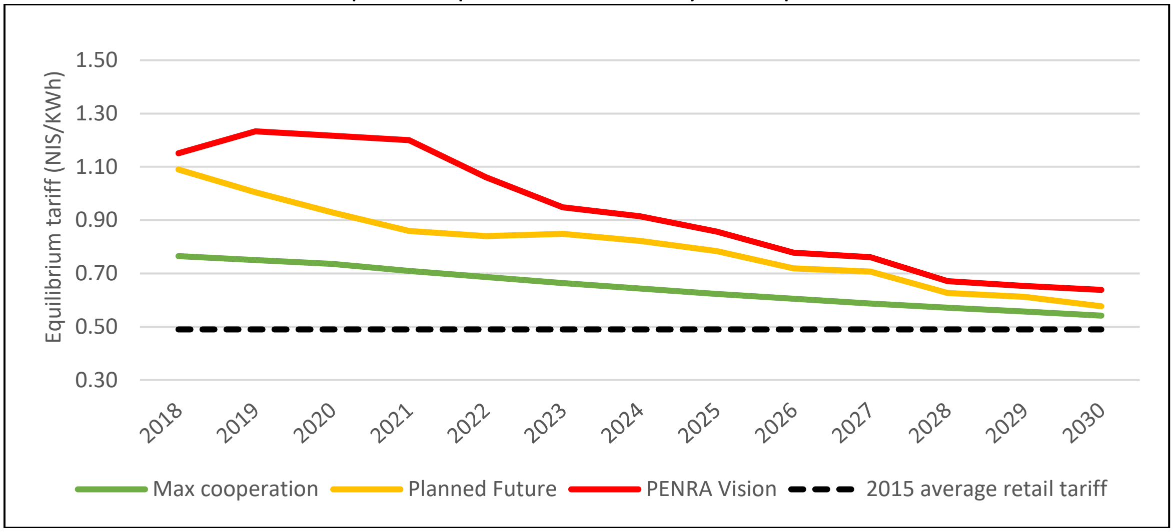
* Includes technical and non technical

207. **The financial modeling exercise is pursued for three of the planning scenarios that capture the full range of potential financial implications**. In the case of Gaza, the 'maximum independence' and 'PENRA Vision' scenarios were the most expensive entailing an average generation cost of approximately NIS 0.54 (US$0.15) per kilowatt-hour, while the 'maximum cooperation' scenario was the least expensive entailing an average generation cost of (NIS 0.36) US$0.10 per kilowatt-hour. The 'Planned Future' represents the middle ground with an average cost of just over (NIS 0.51) US$0.13 per kilowatt-hour.

208. **The financial equilibrium tariffs tend to converge across scenarios by 2030, but there are huge differences during the earlier years of the transition** (Figure II-3.13)**.** While planning scenarios were compared in terms of their average cost of generation, in practice the cost of generation varies annually throughout the planning period. In practice, across all scenarios, the cost of generation declines toward the end of the planning scenario, as GEDCO is able to switch towards lower cost technologies, such as CCGT, and benefit from declining cost trends for solar PV. The 'PENRA Vision' scenario entails a particular cost 'hump' in the early years, as GEDCO has to increase reliance on diesel to meet demands until the gas conversion for the Gaza Power Plant comes on stream. The financial equilibrium tariff converges across all scenarios towards NIS 0.50-0.60 (US$0.14-0.17) per kilowatt-hour by 2030, which is just slightly above the current tariff. However, in the early years, the tariff differences can be very large ranging

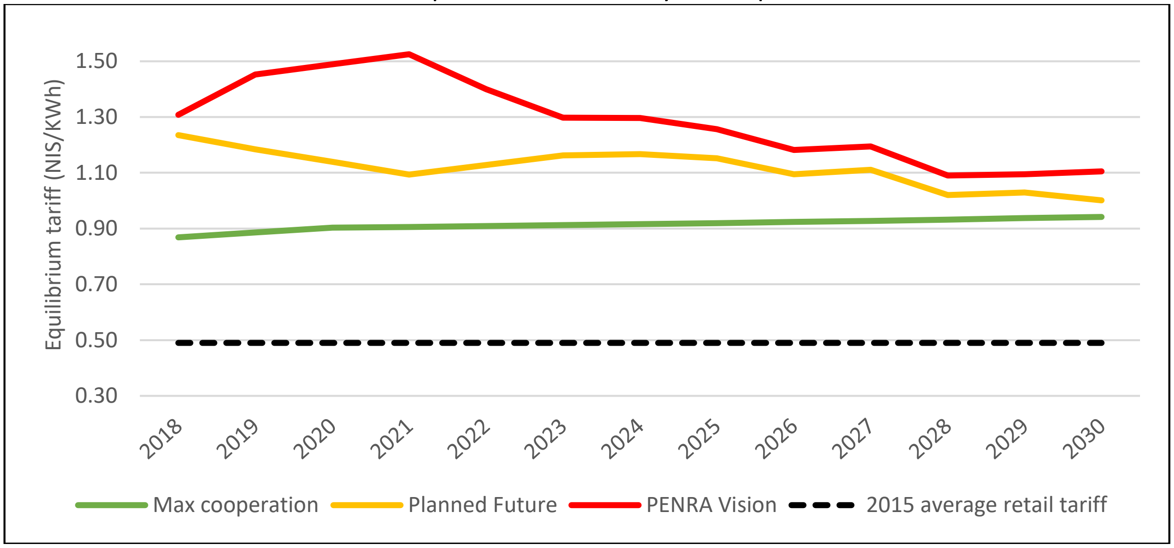
between NIS 1.20 (US$0.33) per kilowatt-hour for the 'PENRA Vision' scenario to NIS 0.70 (US$0.19) per kilowatt-hour for the 'maximum cooperation' scenario.

Figure II-3.13: Projected financial equilibrium tariff for GEDCO under different planning scenarios and improved operational efficiency assumptions



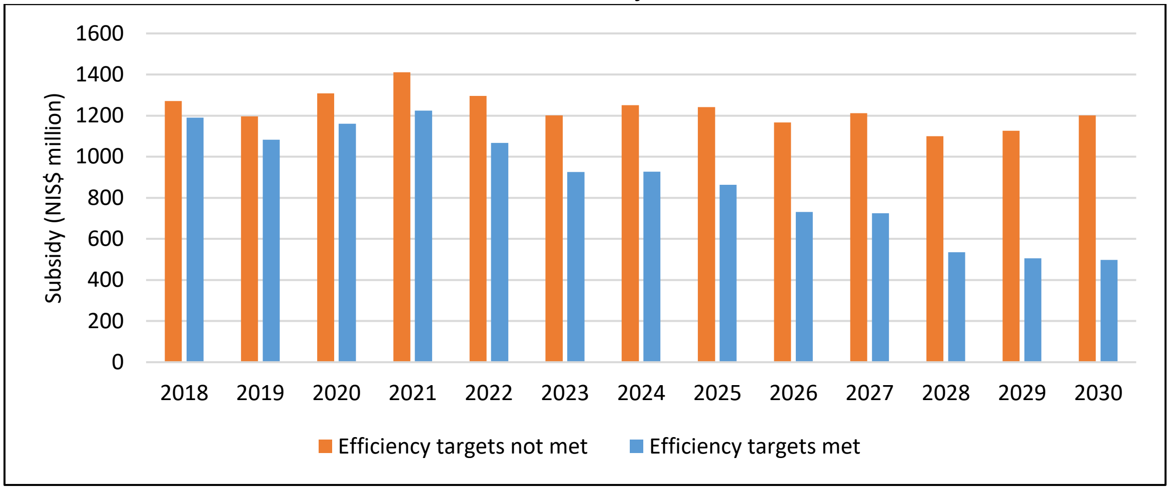
209. **The financial equilibrium tariffs for GEDCO are hugely sensitive to assumptions about improvements in operational performance, making this a critical area of action.** The financial equilibrium tariffs presented in figure II-3.14 were based on an important additional assumption that GEDCO's financial performance would improve substantially over time to meet more reasonable standards (if not yet full international best practice). In particular, it is assumed that collections can be increased from the current levels of 65 percent to 97 percent, while distribution losses fall from the current level of 26 percent to 16 percent. In addition, transmission losses are set at 2 percent, and there is an assumption that operations and maintenance costs could be trimmed by 2 percent annually. Based on reports from the DISCOs, it is assumed that debt is currently financed at 3.5 percent, but would probably need to rise towards 7 percent by 2030. Without these improvements, the financial equilibrium tariff to which all scenarios converge by 2030 rises substantially from NIS 0.50-0.70 (US$0.14-0.19) per kilowatt-hour to NIS 0.90-1.10 (US$0.25-0.30) per kilowatt-hour. Moreover, during the transition years, the financial equilibrium tariff gets as high as NIS 0.90-1.50 (US$0.25-0.42) per kilowatt-hour.

Figure II-3.14: Projected financial equilibrium tariff for GEDCO under different planning scenarios and static operational efficiency assumptions



210. **Failure to adjust GEDCO tariffs would result in massive average annual subsidy requirements to keep GEDCO afloat** (figure II-3.15)**.** For the 'PENRA Vision' scenario, the subsidy requirements are estimated at NIS 1,100-1,200 (US$ 300-330) million during the early years of the transition although they decline as efficiency targets are reached. Another way of stating this is that if new power projects are taken on without performing tariff adjustments, GEDCO could be expected to lose an average of NIS 0.47 (US$ 0.13) on every kilowatt-hour sold over the entire time horizon until 2030 with the losses in the initial 5 years being up to NIS 0.8 (US$ 0.22) per kilowatt-hour. These subsidies are based on the assumption that GEDCO meets the desired efficiency targets by 2030 2030. If this expectation is not fulfilled, then the annual subsidy requirements would increase by, on average, a further NIS 308 (US$ 81) million per year over the time horizon until 2030.

Figure II-3.15: Subsidy requirement to maintain financial equilibrium of GEDCO under planned investment scenario if retail tariffs are not adjusted under 'PENRA Vision' scenario



211. **An alternative approach is to allow GEDCO's tariffs to adjust to the evolving financial equilibrium tariff, while providing a social safety net to safeguard affordability to the poorest.** The fiscal costs of keeping GEDCO's tariffs constant would clearly be prohibitive. At the same time, increasing tariffs beyond their already relatively high level could create affordability problems among Gaza's impoverished population. The affordability analysis conducted for this study, suggests that the affordable tariff limit will be NIS 0.42 (US$ 0.11) per Kilowatt-hour in 2018 for the bottom decile of the population, NIS 0.65 (US$ 0.18) per Kilowatt-hour for the 2nd decile, NIS 0.83 (US$ 0.23) per Kilowatt-hour for the 3rd, NIS 1.0 (US$ 0.27) per Kilowatt-hour for the 4th and NIS 1.17 (US$ 0.32)per Kilowatt-hour for the 5th decile of the population (figure II-3.16). A targeted subsidy designed to keep electricity bills affordable for the poor as tariffs adjust to meet financial equilibrium would have a much lower fiscal cost estimated starting at less than NIS 70 (US$ 19) million per year, increasing to 80 (US$ 22) million per year in the subsequent years, then dropping to less than NIS 10 (US$ 3) million per year by 2030 as costs come down and target efficiencies are reached (Figure II-3.17).

Figure II-3.16: Comparing the first 5 affordability deciles against equilibrium tariff for the PENRA Vision scenario assuming efficiency targets are met by 2030

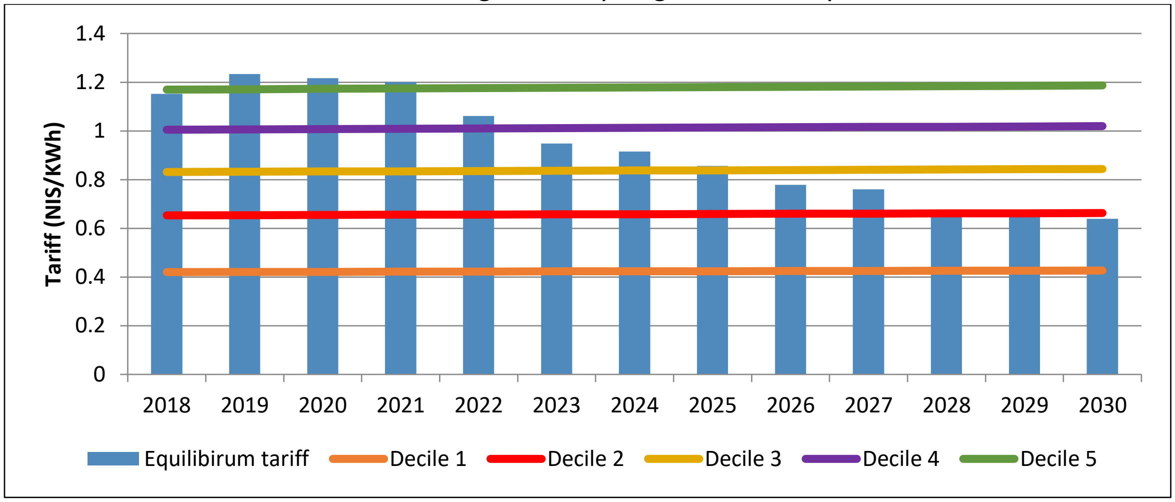
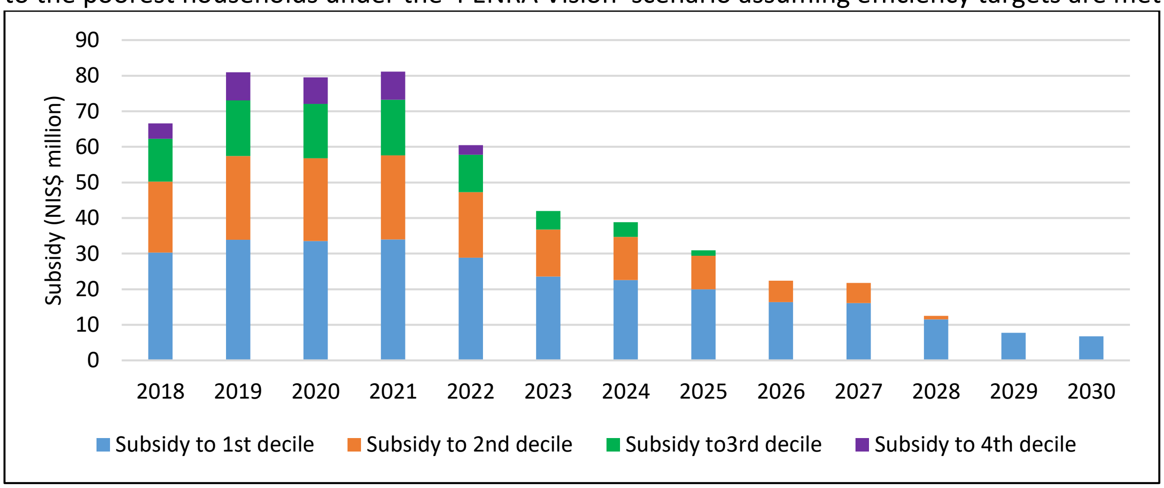


Figure II-3.17: Subsidy requirement to maintain affordability of GEDCO's tariffs to the poorest households under the 'PENRA Vision' scenario assuming efficiency targets are met



3.2 Macro-fiscal Model

212. **A combined energy investment and reform package produces tangible macro-fiscal benefits.** To evaluate the fiscal and macroeconomic impact of PENRA's current projects in the pipeline, a Computable General Equilibrium (CGE) model is designed for the 'Planned Future' scenario described above. For modeling purposes, this scenario is characterized by a steep expansion in domestic power generation accompanied by a fall in energy costs.

213. **The CGE model predicts that the 'planned future' scenario ensures electricity subsidies are fully eliminated and there is a boost in GDP growth and investment**. From a fiscal perspective, the 'planned future' scenario entails a dramatic reduction in electricity subsidies that are otherwise projected to escalate to 6.0 percent of GDP by 2025 under the 'do nothing' scenario, to a much lower level of 0.9 percent of GDP by 2025 (Figure II-3.18). This makes a

substantial contribution to the net government operating balance estimated to be in substantial surplus under the 'planned future' versus a sizeable deficit under the 'do nothing' scenario. The 'planned future' scenario also delivers a significant boost to the growth rate of the economy, which would be 0.5 percentage points of GDP higher than otherwise for the entire decade (Figure II-3.19). The main sector to benefit from the energy turnaround is investment, which grows as much as 3.7 percentage points of GDP higher than otherwise, partly as a result of the increased fiscal space created by reducing electricity subsidies.

Figure II-3.18: Impact of 'planned future' energy scenario on government accounts

As % of GDP	2016	2025	
	Baseline	Planned Future	Do Nothing
Revenue	44.1	44.4	47.3
Expenditure	47.1	40.5	48.6
• Of which Electricity subsidies	4.7	0.9	6.0
Operational Balance	-3.0	3.9	-1.3

Figure II-3.19: Impact of 'planned future' energy scenario on macroeconomic performance

Average annual growth 2016-2025	Planned Future	Do Nothing
GDP at market prices	4.6	4.1
Investment	8.9	5.2
Consumer Price Index	1.5	1.5

Part III – Conclusions and Recommendations

214. **This concluding section brings together all of the analysis in the report to define a sequenced and prioritized roadmap of recommendations for the Palestinian electricity sector.** The starting point for the road map is to strengthen PETL's operational capacity and financial sustainability. While an important interim agreement has been signed in July 2017, PETL is still negotiating with IEC on: i) a Power Purchase Agreement (PPA), ii) the energization of several high voltage substations, and iii) the transfer of connection points from DISCOs and MVC's to PETL. In parallel, PETL should focus on: i) negotiating the Power Supply Agreements (PSAs) with Palestinian distributors , ii) putting in place billing and collection systems to sell power to, and collect payments from, Palestinian distributors, and iii) providing advice to PERC in the calculation of a tariff for selling power to the distributors. With these mechanisms in place, PETL could accelerate its progress towards fulfilling its role and responsibilities under the PPA and reduce its reliance on donor assistance for its operational costs. Once these immediate measures are in place, the question becomes what needs to be done next to begin to move towards the vision of improved energy security in the Palestinian Territories. The analysis suggests that there is a certain sequence in which measures will need to be taken. In particular, four distinct phases are identified (Figure P).

1. Phase 1: Improve Sector Creditworthiness

215. **The first phase needs to focus on what is by far the highest priority issue in the Palestinian electricity sector today: namely, the issue of financial creditworthiness.** Progress on all other aspects of the Palestinian energy sector depend on greater creditworthiness. Without improved creditworthiness, the sector cannot sign new power import deals or close Power Purchase Agreements with Independent Power Producers for increased domestic power generation projects; as recent experience with renewable energy development has illustrated. Creditworthiness is equally important to allow the import of natural gas into the Palestinian Territories, whether that be gas purchase agreements with Israel or ultimately a contract to develop Palestinian gas from the Gaza Marine field. None of these ventures can get off the ground unless the Palestinian electricity sector becomes a credible off-taker.

216. **There are several distinct components that will need to be tackled if creditworthiness is to be improved.**

217. **First, replace generation from the Gaza Power Plant with increasing electricity imports from Israel to provide considerable relief until such a time as a conversion to gas can be undertaken.** The cost of diesel-fired generation at the Gaza Power Plant is exceptionally high at approximately US$0.30 per kilowatt-hour, even at current low oil prices. This is approximately three times the cost of power imports from Israel, which also provides a much more reliable level of supply. Until such a time as the Gaza Power Plant is ready for the switch over to gas-fired generation that would slash costs to US$0.068 per kilowatt-hour, it would be desirable to substitute domestic diesel-fired power generation with Israeli power imports taking advantage of the new 161 kV line that is in an advanced stage of planning. Even taking into account the need

to continue to pay capacity charges of US$0.026 per kilowatt-hour to the Gaza Power Plant, every reduction of one kilowatt-hour in diesel-fired power generation would be sufficient to buy two kilowatt-hours of Israeli imports. Such a move would simultaneously reduce costs and improve quantity and reliability of supply, and thereby increase prospects for improved recovery of costs through tariff revenues.

218. **Second, accelerate improvements in the operational and commercial performance of Palestinian DISCOs.** Cost recovery tariffs could be significantly reduced over time if the operational and commercial performance of the Palestinian DISCOs could be improved to reasonable regional benchmark levels. For the utilities in the West Bank, improved operational performance would take US$0.03 per kilowatt-hour off the financial equilibrium tariff, while in Gaza improving operational performance is worth as much as US$0.11 per kilowatt-hour. Achieving further improvements can build on some recent successes with the introduction of prepaid and smart meters that helped to raise revenue collection rates to 85 percent on average across the utilities. Further improvements in revenue collection are required, particularly for weak performers such as GEDCO and SELCO. Moreover, across the board, attention needs to turn toward improving network losses which remain abnormally high despite all efforts. In this regard, it is recommended to establish a Revenue Protection Program to permanently measure and bill every kilowatt-hour sold to the largest DISCO customers with state-of-the-art technology.

219. **Third, create securitization mechanisms to ensure that Palestinian DISCO revenues are not diverted to other municipal projects.** Due to the lack of a sub-national financing framework in West Bank and Gaza, DISCO revenues remain vulnerable to diversion into municipal budgets. The long term solution to this problem, which is to strengthen the basis of sub-national public finance is important for broader development reasons that go well beyond the energy sector; however, it will likely take some time to achieve. Hence the importance of finding interim mechanisms to securitize the revenues needed for the DISCOs to meet the costs of wholesale power purchase. This could take the form of a payment prioritization hierarchy, combined with an escrow account that requires revenues to be deposited to cover a certain advance period of wholesale power purchases before these can be supplied. The issue of securitization of revenues is particularly critical in Gaza, and would be an essential component of any moves to substitute increased Israeli power imports for domestic diesel-fired power generation.

220. **Fourth, ensure that all Palestinian DISCOs move towards cost recovery.** Not all Palestinian DISCOs are charging cost recovery tariffs today. Only two Palestinian utilities, JEDCO and NEDCO, make formal tariff submissions to PERC. The resulting uniform tariff that is applied across all Palestinian utilities in the West Bank is estimated to under-recover costs for all but NEDCO. Moreover, PERC's practice of not passing through collection inefficiencies to the retail tariff, while defensible from the standpoint of consumers, further weakens the financial solidity of the sector. In addition, GEDCO in Gaza does not follow PERC tariff guidelines and has not adjusted its electricity tariff for a decade, currently charging a retail tariff that is US$0.03-0.05 per kilowatt-hour lower than the wholesale purchase price of electricity, without considering the costs of power distribution. The higher costs of electricity production in Gaza combined with the

sensitive social context, suggest that efforts to improve cost recovery in Gaza would need to be preceded by measures to both reduce costs and improve the availability of power supply, such as the switching of diesel-fired power generation for Israeli imports.

221. **Fifth, build the capacity of PETL to play its envisaged role in the sector.** In the new sector architecture, PETL has been assigned a dual role of Transmission System Operator and single buyer and central book keeper of the electricity sector. However, its start of operations have been delayed pending the closure of a long term Power Purchase Agreement with Israel and the energization of the high voltage sub-stations. The signature of an interim agreement with Israel to energize the Jenin high-voltage substation alone was the first step towards PETL's financial and operational sustainability and this was completed on July 10, 2017 after extensive negotiations. PETL is now able to resell the discounted power to DISCOs in the North of the West Bank at a slight markup allowing them to obtain revenues. The next step is the signing of the main long term PPA for all substations. In the meantime, PETL should make further progress towards their goal of being the single buyer, by ensuring that all wholesale power purchases are undertaken through their intermediation so as to improve transparency and discipline of the sector.

2. Phase 2: Advance Parallel No Regrets Measures

222. **While the absolute priority is to improve the creditworthiness of the electricity sector, there are a number of other no regrets measures that can advance in parallel during a second phase.** Even after decisive steps are taken to address the issue of creditworthiness, time will be needed for a payment record to be established and a reputation to be built. During this period of consolidation, it would be helpful to accelerate measures that will facilitate the development of other power supply options that will become feasible, once the issue of creditworthiness has been adequately addressed.

223. **First, create the infrastructure needed to support the import of natural gas into the Palestinian Territories.** All the planning analysis confirms the strategic role that natural gas-fired power generation can play in the electricity mix for both West Bank and Gaza, as well as its relatively attractive cost. The first step in making this possible is to construct the relatively modest pipeline extensions needed to make possible the import of gas from the Israeli system. These will create the platform needed to have credible negotiations for gas supply agreements and ultimately the construction of new gas-fired plant, or the conversion to gas in the case of Gaza. The Gas-for-Gaza Project led by the Office of the Quartet has focused its efforts in removing key obstacles for the construction of a gas pipeline from Israel to the Gaza Power Plant.

224. **Second, pursue an aggressive program to promote the uptake of rooftop solar PV.** Unlike grid-based solar power, rooftop solar PV is highly decentralized and is not contingent on progress towards sector creditworthiness and the capacity of PETL. Moreover, it has been shown that rooftop solar PV can play a valuable role as an electricity safety net to increase the resilience of the Palestinian electricity system and ensure that critical humanitarian needs can be met. This is particularly true in the case of Gaza, where the World Bank will support a pilot rooftop

solar PV project to reduce the high upfront capital expenditures for the customers and test the sustainability of a revolving fund model. In parallel, the French Development Agency (AFD) is planning to launch a project based on a financial intermediary model to support the scale-up of renewable energies.

225. **Third, complete the domestic transmission backbone in Gaza.** Domestic transmission constraints are already an issue in Gaza, and these will only become more severe as efforts to increase the supply of power bear fruit. It is therefore important to ensure that the modest transmission and distribution upgrades required are completed in a timely fashion, and certainly well ahead of any future expansion of the Gaza Power Plant. The Gaza Electricity Network Rehabilitation Project (GENRP) financed by the World Bank has constructed or rehabilitated more than 250 km of transmission and distribution lines in the Gaza Strip affected by past conflicts. But more needs to the done. Additional feasibility studies for the transmission and distribution lines to deliver the power to the end-consumer will however be required.

226. **Fourth, improve the enabling environment for Independent Power Projects.** While the financial creditworthiness of the sector is the single largest impediment to the implementation of Independent Power Projects, there are a number of other simple measures that could be taken to improve the quality of the enabling environment, and which could be handled through secondary legislation or executive regulations that develop broad provisions in the existing sector legislation. In particular, these include further clarifying the provisions for licensing new generators and the provisions associated with interconnection to the grid. The roles of PERC and PETL in this process also need to be further spelt out.

227. **Fifth, establish a risk mitigation mechanism to support the next generation of Palestinian Independent Power Projects.** Risk mitigation is no substitute for addressing the fundamental underlying creditworthiness issues in the sector, and it does not make sense to move ahead with risk mitigation until the Palestinian Authority has demonstrated a sustained and credible commitment to improving the financial standing of the sector. Nevertheless, once this has taken place, risk mitigation may play a valuable role in getting the next generation of Palestinian Independent Power Projects off the ground. It would therefore be valuable to work with donors to develop a suitable mechanism for risk mitigation, evaluating the relevance of a range of financial instruments such as guarantees, first loss, blended finance, and viability gap finance.

3. Phase 3: Implement First Wave of IPPs

228. **In a third phase, it will become possible to make progress with a major wave of Palestinian Independent Power Projects.** These will build on the critical foundational elements already tackled under the first two phases. It makes sense to begin with those projects that look to be the most tractable from a technical and political perspective, which suggests focusing on developing CCGT capacity and utility-scale solar PV in Areas A and B.

229. **First, convert the Gaza Power Plant to CCGT gas-fired technology as the most urgent of the domestic power generation projects.** Conversion of the Gaza Power Plant to CCGT gas-fired technology once a gas pipeline comes on stream would save between US$45-62 million annually in fuel bills and provide Gaza with a cost-effective domestic source of power generation.

230. **Second, progress with the construction of new CCGT gas-fired plant initially in Jenin, and eventually in Hebron.** Once the gas transportation infrastructure is in place, and some improvements to the sector environment have been achieved, the implementation of the Jenin CCGT plant should be relatively straightforward. Guarantee products might be required to reduce the risk of non-payment by the off-taker. Two important issues need to be addressed in the project design. One is the arrangements for selling any surplus energy back into the Israeli grid. The other is to ensure that the terms of a future gas supply agreement are sufficiently flexible to allow for an eventual switch of supply from the Gaza Marine gas field should this prove to be desirable.

231. **Third, embrace a more ambitious target for utility-scale solar PV farms in Areas A and B.** As noted in the planning analysis, it looks feasible to develop over 600 MW of solar PV capacity in the West Bank just based on potential in Areas A and B as well as rooftop. This goes far beyond the current target of 130 MW by 2020. With the improvements in the enabling environment in place, as well as the establishment of risk mitigation mechanisms, it should become feasible to scale-up and accelerate efforts to develop this solar potential.

232. **Fourth, establish suitable wheeling arrangements with Israel.** As the volume of domestic power generation in the West Bank ramps up, there will be increasing need to move power away from generation plant towards Palestinian load centers. At present, this can only be done by wheeling power back through the Israeli grid and re-importing into the West Bank at another location. The analysis suggests that wheeling charges are relatively costly, particularly if low voltage networks need to be used. It will therefore be important to ensure that the number of sub-stations in the West Bank increases in such a way as to keep pace with the expansion of domestic supply. It would also be important to have dialogue with the Israeli regulator, PUA, regarding the charges for wheeling, and to explore any possible alternative arrangements (such as power swaps) that may help to contain costs.

233. **Fifth, engage in dialogue over the use of Area C for the development of Palestinian power infrastructure and renewable energy generation.** The planning analysis highlights the economic value of Area C, both as a location for grid-based solar generation and as the conduit for any future Palestinian electricity transmission infrastructure. While there is much that still needs to be done before the issue of Area C becomes a binding constraint, the political complexity of the issue suggests that it may be helpful to begin a dialogue process that over time can help to clarify the modalities for making use of Area C. A related question is the need to coordinate Palestinian plans to ramp-up renewable energy generation with those that also exist on the Israeli side, in order to ensure that challenges related to grid stability and the integration of intermittent sources can be adequately handled to the benefit of both sides.

4. Phase 4: Implement Transformational Projects

234. **The fourth and final phase would build on earlier success to tackle the more challenging, and potentially transformational, projects needed to complete the Palestinian energy vision.** These include the construction of solar generation and transmission backbone infrastructure in Area C, as well as the development of the Gaza Marine gas field.

235. **First, develop a Palestinian transmission backbone in the West Bank.** The analysis has shown that as domestic Palestinian power generation ramps us, the cost of wheeling charges back through the Israeli grid rapidly become quite significant. A more economic option in the long term would be to construct a Palestinian transmission backbone.

236. **Second, develop utility-scale solar PV and CSP projects in Area C of the West Bank.** If a successful track record of solar farm development can be established on the more limited land endowments of Areas A and B, and suitable transmission backbone infrastructure can be put in place across Area C, the West Bank would be ready to benefit from larger scale solar development in Area C. This would entail both solar PV and CSP technologies.

237. **Third, move ahead with the development of the Gaza Marine gas field.** As noted above, the development of the Gaza Marine gas field is critically dependent on having a creditworthy off-taker to sign the gas purchase deal. Given the abundance of gas discoveries in the Eastern Mediterranean and the relatively small nature of the field, the development of this field will likely need to be underwritten by a significant Palestinian demand for gas. For all the reasons described above, this demand will take time to develop and would only be achieved once significant gas-fired power generation was on-stream and establishing a solid gas purchase payment record in both the West Bank and Gaza. That would be a suitable juncture at which to be able to sign a bankable deal for the development of the field, allowing the Palestinian gas-fired plants to switch gradually from Israeli to Palestinian gas as the new field starts to become productive. Given the relatively small volume of Palestinian demand, it may make sense to consider the options for Gaza Marine development that require the least infrastructure development – by making use of stranded infrastructure from the Israeli Mari B field – thereby making the field economic at lower levels of throughput. Seen from this perspective, the primary value of the Gaza Marine field to the Palestinian economy, lies not so much as a supply of gas – which is in any case abundantly available in the region – nor even as a source of energy security – since Palestinian gas would inevitably need to be transported through Israeli infrastructure – but rather as an eventual source of fiscal revenues for the Palestinian authority that have been estimated at US2.7 billion over 25 years.

5. Concluding Remarks

238. **The implementation of this road map would require private investment of the order of NIS 13-18 billion (US$3.-5 billion) complemented by public investment of around NIS 1 billion (US$0.3 billion).** Figure III-5.1 clarifies the indicative investment needs that would be required during each phase of the road map in West Bank and Gaza. Of the total investment

requirements of NIS 14-20 (US$ 3.8-5.4 billion), over 90 percent correspond to the private sector, between 50 to 75 percent to the West Bank.

Figure III-5.1: Indicative investment needs associated with the Palestinian energy agenda

US$ million	West Bank		Gaza		West Bank and Gaza	
	Public	Private	Public	Private	Public	Private
Phase One	-	-	-	-	-	-
Phase Two	7[38]	800 – 1100[39]	135[40]	240 - 320[41]	142	1040 - 1420
Phase Three		930[42]		900 - 990[43]	-	1830 - 1920
Phase Four	188[44]	375-500[45]	-	250 - 1,200[46]	188	620 - 1700
Total	**195**	**2105 - 2530**	**135**	**1390 - 2510**	**330**	**3495 - 5040**

239. **Progress in many of the areas identified will require continued and even deepened cooperation with Israeli institutions** (Figure III-5.2). In every phase of the road map, progress depends on coordinated measures being taken on both the Palestinian and Israeli sides. Close coordination will be needed on both sides throughout the implementation process.

240. **In conclusion, the analysis presented in this report has allowed numerous elements of a Palestinian energy vision to come into focus**. It has also clarified what are the most immediate steps that need to be taken in support of that vision.

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[38] Includes natural gas pipeline of 15km for JPP
[39] Includes 530MW of rooftop in West Bank assuming cost of US$ 1500-2000/KWp
[40] Includes natural gas pipeline of maximum 20km (section inside Gaza only) and upgraded T&D network capable of absorbing power from expanded GPP, IEC and Egyptian supply options
[41] Includes 160MW of rooftop in West Bank assuming cost of US$ 1500-2000/KWp
[42] Includes JPP at 400MW and HPP at 120MW as well as 130MW of renewable energy in Areas A and B
[43] Includes GPP upgrade to 560MW on natural gas in Gaza
[44] Includes West Bank transmission backbone and distribution grid upgrade assuming 4 new substations as well as JPP and HPP are online, access to area C is granted and Jordanian interconnector is expanded
[45] Includes 500MW of utility scale solar in Area C, assuming cost of US$ 750-1000/KWp
[46] Estimate of costs for development of Gaza Marine gas field

Figure III-5.2: Summary overview of the proposed road map for Palestinian energy security

Phase 1: Improve sector creditworthiness	Phase 2: Advance parallel no regrets measures	Phase 3: Implement first wave of IPPs	Phase 4: Implement transformational projects
Substitute Israeli imports for diesel-fired generation in Gaza	**Create infrastructure for import of natural gas**	**Convert GPP to CCGT gas-fired technology**	**Develop grid-scale solar PV/CSP farms in Area C**
P: Gradually ramp down GPP and use the savings to buy additional IEC supply until GPP can be converted to gas I: Provide additional power to Gaza through 161kV	P, I: Construct natural gas pipelines for West Bank and Gaza paving the way for construction of new/upgraded power plants	P: Complete conversion and upgrade of GPP ensuring flexible gas supply agreement to allow switch to Gaza Marine I: Enter into gas supply agreement for GPP	P: Begin development of renewables in Area C only after a successful track record of renewable development in Areas A and B I: Provide permits for construction in Area C
Improve operational and commercial efficiency	**Improve enabling environment for IPPs**	**Construct new CCGT plant at Jenin then Hebron**	**Develop transmission backbone in West Bank**
P: Continue improvement of DISCO performance by reducing losses, increasing collection rates and bringing down overhead costs. One mechanism can be through a Revenue Protection Program aiming to permanently measure and bill every KWh sold largest DISCO consumers	P: Update and improve legislation and licensing provisions that would help IPPs enter the market and also clarify roles and responsibilities of PERC and PETL in this environment	P: Complete JPP and HPP construction with flexible gas supply agreement to allow switch to Gaza Marine. Build additional substations to keep pace with increased domestic generation I: Enter into gas supply agreement for JPP and HPP	P: Begin development of a transmission backbone considering also the possibility of negotiating a swap mechanism which eliminates the need for wheeling or building of infrastructure I: Provide permits for construction in Area C and/or provide swap alternatives to building a backbone
Securitize payments of wholesale electricity	**Promote uptake of rooftop solar PV**	**Develop grid-scale solar PV farms in Areas A & B**	**Develop Gaza Marine Gas Field**
P: Strengthen sub-national public finance to avoid diversion of electricity bill collections to municipal budgets and set up escrow accounts both in Gaza and West Bank to ring fence collections	P: Set aggressive targets for 160MW of rooftop PV in Gaza and 530MW in West Bank	P: Increase renewable energy targets to 600MW in West Bank and 160MW in Gaza by 2030 (includes rooftop solar) but only after the right enabling environment has been established from Phase I	P: Develop Gaza Marine with least amount of infrastructure development to keep costs low I: Allow permission to use existing Israeli infrastructure for evacuation of Gaza Marine
Adjust tariffs to better reflect cost recovery	**Develop transmission backbone in Gaza**	**Establish wheeling arrangements with IEC**	
P: Re-examine the retail tariffs and increase rates to allow better cost recovery by DISCOs	P: Upgrade T&D network to allow increase in power supply and reduction in losses	P, I: Negotiate lower wheeling tariffs and/or swap arrangements until a transmission backbone is built	
Build the capacity of PETL to play its role	**Design a risk mitigation mechanism for IPPs**	**Engage in dialogue over use of Area C**	
P: PETL to streamline billing to, and payments from DISCOs while in parallel pushing to energize the new substations and sign the PPA with IEC I: Sign bulk supply PPA and energize new substations	P, D: After creditworthiness issues from Phase I have been improved, develop financial risk mitigation instruments such as guarantee mechanisms	P, I: Coordinate on Area C access and permitting issues as well as grid stability and regional integration for supply expansion and transmission infrastructure	

P: Palestinian measures
I: Israeli measures
D: Donor community measures