LEBANON

APRIL 2020

World Bank – EDL – MEW

LEAST COST GENERATION PLAN

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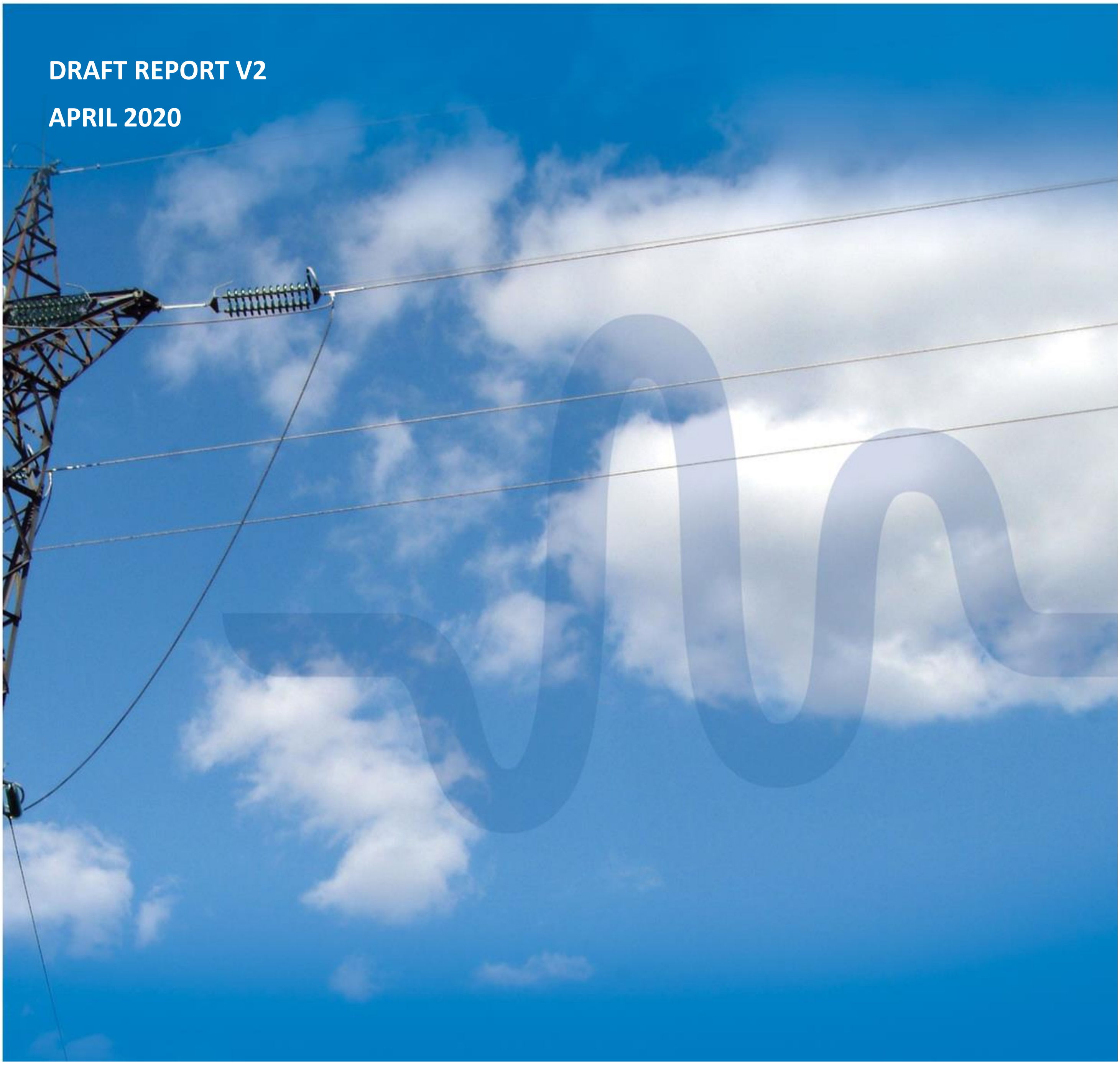

REFERENCE MAP

Source: Lebanon Crisis Response Plan 2017- 2020 (2019 update)

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1. EXECUTIVE SUMMARY

As part of the "Least cost generation plan for 2020 - 2030" project mandated by the World Bank (WB) to Electricité de France (EDF) on behalf of the Ministry of Energy and Water (MEW) and Electricité du Liban (EDL), this report details the optimal techno-economic investment plans for 2020 – 2030 under various scenarios.

A base case least cost generation plan has been developed under the assumption of a demand growth of 3% per year and an exceptional 8% decrease in 2022. Brent price is set to 40 $/barrel for 2020 with a 1.5% increase each year. The main points of this plan are as follows:

- Before 2022, fast-track solutions can be implemented to lower unserved energy;
- By 2022, energy demand can be fully met;
- At first, ICEs can be used to increase generation capacity, due to short lead time;
- Later on, the ICEs would become peaker plants to ensure flexibility, reserve and capacity margin;
- The overall renewable energy share would be around 40% of generation by 2030;
- The system would transition to Natural Gas, with minor Fuel Oil usage;
- The CO_2 emission intensity would be divided by a factor of 3 over the course of 10 years;
- LCOE ($/MWh) would be decreased by 26% in order to meet future demand and meet system reliability standards (reserve and margins).

In response to MEW's query concerning the "Class E vs Class F" generation, a comparison of the 2 models has been carried out. Under the assumptions made for this study, no significant difference between the 2 classes has been identified.

2. OBJECTIVE

The current Lebanese electrical system suffers from a lack of generation capacity to ensure balance between supply and demand. It is necessary to develop new generation plants to compensate for this gap and continue to follow a potential increase in electricity demand. In this perspective, the Ministry of Energy and Water (MEW) has fixed a Renewable Energy (RE) target of 30% of the consumed energy by 2030.

Increasing generation capacity and integrating renewable energy in the electricity mix incurs multiple challenges for the coming years. Seeing as Lebanon's power plants are getting old and require replacement by any measure, one must seize the opportunity to rethink the generation mix so that it could accommodate a high RE penetration, diversify its energy sources, improve its quality of service, and achieve self-sufficiency while reducing the cost to the final consumer.

The objective of this study is to determine and compare least cost generation plans for Lebanon, under multiple scenarios, for the target year of 2030. Another important objective is to advise on the size of the largest generation unit (class E vs class F).

3. ASSUMPTIONS AND EXPANSION SCENARIOS

The following assumptions define the main constraints of the study's base case scenario:

3.1. DEMAND & GROWTH

As long as the public supply has not reached a 24-hour continuous service and the consumers have not adapted their behavior accordingly, no accurate estimation of the demand may be achieved.

Demand for the year 2019 reached ~24 247 GWh with a peak load of ~3 844 MW. The demand for 2020 is estimated around 24 339 GWh with a peak load of 3 773 MW. For this study, the demand is projected to grow by about 3% annually between 2020 and 2030 with a dip of 8% for the year 2022, following an increase in supply hours and a substantial tariff raise. However, due to the uncertainty surrounding the demand in Lebanon, these numbers must be subjected to a dynamic revision on a yearly or bi-yearly basis, thus correcting the forecast.

3.2. POWER PLANT PORTFOLIO

The current Lebanese generation mix is split between HFO-fired steam turbines and ICEs, as well as gas oil-fired open/combined cycle gas turbines (OC/CCGT). This mix is heavy on carbon emissions.
In order to diversify, reduce dependency on fuel oil and reduce CO_2 emissions, the government is exploring Natural Gas alternatives. An advantage of such alternatives is that, once NG extraction starts on Lebanese territory, the country can source its own supply for electricity production.

Today, the government has expressed its interest in renting FSRUs to be docked in any/all of the three possible sites: Baddawi, Selaata and Zahrani. Intra-territorial pipeline projects are being evaluated as well.
Note that, in general, NG contracts are based on a long term take-or-pay framework with a pre-specified annual volume. Such a framework makes the use of NG appropriate for providing the base load.

Integrating variable renewable energy sources in the mix (Wind and Solar) will lead to a greater need for flexibility in the system due to RE variability and forecast uncertainty. Fuel oil is the de facto source for this flexibility, due to its ease of procurement and storage. As such, ICE units of ~18 MW each are appropriate for the role of peaker plants (fast ramp reserve capacity). In the optimization portfolio, ICEs running on NG are considered where gas can be supplied and FO fired ICEs are grouped under the tag "N_ADDITIONAL_ICE_FO". These FO fired ICEs have to be distributed over the remaining sites taking into account the grid capacity. In addition to the advantages listed above, ICEs can be deployed on short notice and may be key for a fast increase in generation capacity.

Solar photovoltaic, wind and battery storage systems are also considered in the optimization portfolio. Expansion rate is limited to 500 MW per year for PV and wind and 50 MW/year for storage. Today, this kind of projects is still new for the Lebanese electricity sector. For this reason we have considered conservative build costs compared to what can be found in the neighboring countries. PV build cost is set to 650 $/kW, 1200 $/kW for wind and Li-Ion storage system cost is calculated based on the following:

- Capital Cost – Energy Capacity = 189 $/kWh
- Power Conversion System (PCS) = 211 $/kW
- Balance of Plant (BOP) = 95 $/kW
- Construction and Commissioning = 96 $/kWh

3.3. NATURAL GAS

The Floating Storage Regasification Units (FSRU) may dock near the following locations:

- Baddawi (Deir Ammar);
- Selaata;
- Zahrani.

The following pipelines may be erected as needed:

- Baddawi – Selaata;
- Selaata – Zouk;
- Jieh – Zahrani;
- Zahrani – Sour.

If a gas power plant is to be commissioned in one of the aforementioned spots, it must be connected to an FSRU, either directly, or through a pipeline. This being said, the same commodity charge ($/MMBTU) applies to all gas fired power plants. The only disparity in prices stems from the capacity charge ($/year) for the supplying gas infrastructure.

The greater part of the country's electricity consumption is located in the Beirut area. In order to balance the base load generation on both sides of Beirut and reasonably limit the transmission network reinforcement, it is recommended to split combined cycle capacity between the north and the south.

3.4. SHADOW PRICE OF CARBON

Carbon tax, or Shadow Price of Carbon (SPC) has been adopted in numerous countries around the world as a means of incentivizing energy-efficiency and renewable energies. Under current regulations, the Lebanese government does not impose any SPC. It is most likely that this will remain the case for the foreseeable future. Therefore, the base case examined in this study will not take into account any such SPC. Nevertheless, a variant scenario with SPC (40$/t in 2020 going up to 50$/t in 2030) is considered.

3.5. BRENT PRICE

For the base case scenario, Brent price starts at 40$/barrel in 2020 with an escalation factor of 1.5%/year. This amounts, in 2020, to 279.80 $/t for HFO, 389.40 $/t for GO and 6.50 $/MMBTU for NG.

3.6. MAXIMUM SITE CAPACITY

When considering reasonable development and reinforcement of the electrical network, and restricting available development surface area to acceptable levels, the base case scenario must specify maximum energy limits on a per-region basis. Thus Deir Ammar will have a maximum reachable capacity of 1 500 MW while Selaata will be limited to 1200 MW, Zouk 800 MW, Jieh 600 MW, Zahrani 1000 MW and finally Sour will have a maximum reachable capacity of 300 MW.

In this study, we should keep in mind that, usually, obtaining the rights of way for new transmission lines is tedious and time-consuming. An alternative solution is to increase the power transfer capacity of existing assets. Thus, using existing rights of way may lead to a cheaper and smoother alternative to new-builds.

3.7. FAST-TRACK SOLUTIONS

Permanent large-scale power plant solutions present considerable lead-time. Therefore, quickly deployable solutions (power barges and small scale ICEs) will be considered in the scenarios in order to meet the near future demand, as requested by MEW.

3.8. GENERATION CAPACITY, SYSTEM RESERVE AND CAPACITY MARGIN

The low tariffs of electricity are the main cause for EDL's deficit. These tariffs were set circa 1996, when oil prices were much lower. Today, oil prices are much higher, but EDL's tariffs remain unchanged. Any increase in these tariffs is conditioned by increasing the generation capacity with the aim of reaching 24 hours supply. Therefore, the model will first optimize for an increase in generation capacity (VoLL = 310 $/MWh ~ tariffs of private diesel generators of 2019). The second optimization goal will be increasing the system reserve provision (VoRS = 280 $/MW), thus building immunity against (N-1) events, as well as building a firm capacity margin of 10%. These goals will be fulfilled by the optimization while searching for the least cost generation plan.

3.9. SYSTEM INERTIA

Since the Lebanese network is islanded, i.e not synchronously interconnected with any of its neighbors, system stability constitutes a main concern in the model. In case of a generation N-1 event, reserve is not the only factor that comes into play. An adequate system inertia is to be maintained if we are to prevent a system frequency collapse. In order to guarantee non-exceedance of an acceptable value of RoCoF (max 2 Hz/s) a minimum kinetic energy is required at all times. This consideration is factored into the model's computation.

3.10. SCENARIOS

Base case scenario: ***This scenario is our baseline for comparison. It describes the optimal generation mix, from a cost perspective, without any additional constraints or conditions (other than what has been listed above);***

The following scenarios are variations on the base case:

- ***CLASS_E:*** ***Only class E CCGT units are allowed;***
- ***LOW_BRENT:*** ***Brent cost is set to 30$/barrel with 1.5% increase per year;***
- ***HIGH_BRENT:*** ***Brent cost is set to 50 $/barrel with 1.5% increase per year;***
- ***NO_GAS_CAPACITY_CHARGE:*** ***Capacity charge for natural gas infrastructure (FSRUs and Pipelines) is excluded from the optimization (Assumes it's paid for a by third party);***
- ***ALL_THERMAL:*** ***No additional RE projects are suggested (committed RE projects are maintained);***
- ***WITH_SPC:*** ***Shadow price of carbon is applied (40 $/t in 2020 going up to 50 $/t in 2030).***

4. CLASS E & F COMPARISON

The MEW is considering using Class E and class F combined cycle gas turbines. A typical Class E CCPP is composed of a ~190 MW gas turbine and a ~88 MW steam unit. A Class F unit belongs to the range above, with ~330 MW GT and ~146 MW steam unit.

Class F can present several advantages compared to class E. In fact, F units are cheaper (832 $/kW vs 865 $/kW) and more efficient. Nevertheless, in a small islanded system, the size of the largest unit should not exceed capacity margin (usually 10% of the peak load) otherwise generation can become insufficient in case of a forced outage of this unit during peak demand. In addition, the required reserve provision and system inertia that prevents frequency from collapsing in an N-1 event increases with the size of the largest unit.

In order to advise on the suitability of Class F vs E units for the Lebanese system, a class E & F optimal generation plan will be compared with a class E-only optimal generation plan. In both scenarios, system stability, reserve provisions and capacity margins are secured.

The total system cost (CAPEX & OPEX) over the ten years period amounts to 20 495 M$ (4 938 M$ CAPEX and 15 557 M$ OPEX incl. fuel) for the mix using F units. The total system cost for the mix using only E class units is 290 M$ greater (5 153 M$ CAPEX and 15 632 M$ OPEX incl. fuel).

In conclusion, with the demand forecast used for this study, the simulations have shown that the optimal mix including class F units is slightly cheaper than the one limited to smaller units. However, this difference remains under 2% which is within the modelling confidence interval, meaning that both mixes are equivalent.

5. BASE CASE SCENARIO

The following tables provide the details for the least cost base case. It is inevitable that real life situations would differ from the modelled suggestions, in which case a best effort implementation should be sought. This applies particularly to the duration of contracts (e.g Bint Jbeil, Jib Jannine, ...).

Section 5.1 discusses the end result, i.e. the target year of 2030. Section 5.2 details the roadmap to achieve the 2030 target results. The prefix E stands for "Existing unit" and N stands for "New unit".

		BASE_CASE										
		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Total installed capacity by technology (MW)												
	CCGT	918	918	918	1 576	1 722	1 722	2 672	2 672	2 672	2 672	2 672
	OCGT	120	120	120	120	120	120	120	120	120	120	120
	ST	620	620	620	40	40	40	40	40	40	40	40
	ICE	657	823	1 308	1 092	1 092	1 092	1 258	1 258	1 258	1 258	1 258
	HYDRO	283	283	341	395	395	395	435	475	515	555	595
	SOLAR (PV + CSP)		180	680	1 180	1 680	2 230	2 510	2 840	2 970	3 280	3 280
	WIND			226	726	1 226	1 716	1 736	1 736	1 736	1 736	1 736
	BESS 1MW 0.5H				50	100	150	200	237	240	253	253
Total (excl. storage) (MW)		2 597	2 944	4 213	5 129	6 275	7 315	8 771	9 141	9 311	9 661	9 701
Peak demand (MW)		3 773	3 717	3 393	3 477	3 544	3 650	3 760	3 872	3 989	4 108	4 232
Demand (GWh)		24 339	23 979	21 890	22 429	22 861	23 547	24 254	24 981	25 731	26 503	27 298
Unserved Energy (GWh)		4 520	2 856	0	0	0	0	0	0	0	0	0
SYSTEM LCOE ($/MWh)		99.03	99.69	86.12	74.39	70.58	69.76	76.95	74.49	74.33	74.04	73.83
RE energy share (%)		2%	4%	10%	20%	29%	37%	38%	40%	40%	40%	40%
LOLP (%)		100.000	99.485	74.428	75.997	55.605	45.211	0.002	0.014	0.048	0.119	0.349
Firm capacity margin* (%)		-41%	-36%	-16%	-17%	-10%	-7%	24%	19%	16%	13%	10%
CO2 emission intensity* (g/kWh)		696	689	535	413	327	284	253	234	235	232	236
Average capacity factor by technology (%)												
	CCGT	100%	100%	96%	76%	73%	69%	56%	61%	63%	63%	66%
	OCGT	92%	80%	13%	6%	0%	0%	0%	0%	0%	0%	0%
	ST	97%	93%	31%	4%	0%	0%	0%	0%	0%	0%	0%
	ICE	100%	98%	93%	80%	60%	50%	20%	10%	11%	12%	13%
	HYDRO	19%	19%	18%	14%	14%	14%	14%	15%	15%	14%	15%
	SOLAR (PV + CSP)		20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	WIND			30%	34%	32%	31%	31%	31%	31%	31%	31%
Average LCOE for new-builds by technology ($/MWh)												
	CCGT				73.90	64.28	64.93	67.14	67.45	67.90	68.70	68.93
	ICE		113.43	80.33	76.14	81.25	84.64	156.15	170.67	163.88	153.73	146.48
	HYDRO			128.28	67.67	67.30	67.67	78.60	86.17	91.19	99.40	99.33
	SOLAR (PV + CSP)		70.00	52.76	50.60	49.81	48.71	48.65	48.60	48.50	48.68	48.68
	WIND			104.50	66.27	64.91	64.54	64.64	64.64	64.44	64.64	64.64
Total Fuel Cost ($000)		1 466 135	1 543 144	1 225 968	1 008 554	833 473	757 360	732 936	724 946	758 505	778 556	824 933
VO&M Cost ($000)		494 050	560 187	466 321	247 695	223 111	202 070	199 606	171 861	178 433	182 005	188 752
Emissions Cost ($000)		0	0	0	0	0	0	0	0	0	0	0
Annualized Build Cost ($000)		0	0	105 195	296 141	423 965	534 859	677 347	705 246	715 390	740 008	740 008
FO&M Cost ($000)		2 407	2 400	87 703	116 142	132 925	148 362	256 461	258 811	260 332	261 611	261 611
Total Cost ($000)		1 962 592	2 105 731	1 885 187	1 668 532	1 613 474	1 642 650	1 866 351	1 860 864	1 912 660	1 962 180	2 015 304

*Firm capacity margin: 20% of wind, 10% of hydro, 96% of batteries and 100% of CSP are considered available on peak load.

5.1. TARGET YEAR 2030

The base case least cost generation mix amounts to about 9.7 GW of installed capacity (vs 2.5 GW current capacity). 2.6 GW of combined cycle power plants are required to provide the base load (cf capacity factor at 66 %[1]).

An open cycle power plant, as well as a steam turbine are kept, to contribute to the capacity margin. However, they are not dispatched in a normal situation due to their high variable cost.

[1] Including 3% random forced outages.

A solar capacity of 3.2 GW and a wind capacity of 1.7 GW are installed, and have a capacity factor of 31% and 20% respectively. A 253 MW 2C capacity rate "Battery Energy Storage System" BESS is proposed in this plan, to participate in the system reserve and act as a minor "capacity firming" for renewable sources. BESS contribution to reserve allows efficient plants to operate at higher capacity factor, hence reducing fuel consumption and generation cost.

The target mix in this plan contains 1.2 GW of ICEs. Owing to their small deployment time and low CAPEX, they are used to rapidly increase the production capacity of the system in the early phase of the plan (starting 2022). They will be used as main production assets during the installation phase of the permanent base load plants (CCGT). In later stages, the fuel oil ICEs will mainly serve as peaker power plants, while NG fired ICEs will be used to fine-balance the system (fast-ramping). Such usage is well suited for a "Build, Operate & Transfer" (BOT) contract framework that guarantees the investors' business plan for the operation period. The transfer phase should be synchronized with the beginning of operation of NG base power plants.

Note that new Hydro-electric RoR plants are committed and are taken as they are in the hydro development plan of the MEW.

The renewable energy share reaches 40% of the demand in 2030. The LCOE is estimated around 48.68 $/MWh for solar PV and 64.64 $/MWh for wind energy.

The base case system LCOE drops by 26%, from ~99.03 $/MWh (at 40$/barrel) in 2020 to ~73.83 $/MWh in 2030 (+1.5% barrel price/year). The CO2 emission intensity will be divided by a factor of 3 over the course of 10 years.

5.2. ROADMAP 2020 - 2030

As mentioned earlier, the first priority of this plan is to build generation capacity as fast as possible. To this extent, demand is expected to be fully met by 2022, following the installation of 1 616 MW of solar, wind and ICEs. Until then, Jbeil and Jib Jinnine small ICEs in addition to the existing Zouk and Jieh power barges are used as fast-track solutions. Starting 2026, additional installations will contribute to the firm capacity margin, reaching 10% by 2030. The table below details the roadmap by energy type as well as location:

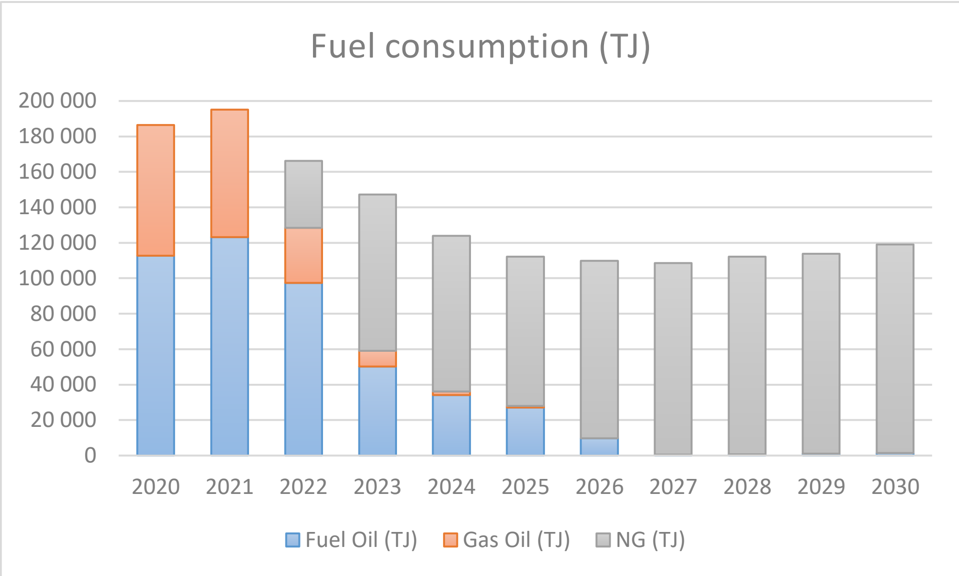
[cf. table in the next page]

Sites/technologies	Power plant installed capacity (MW) / 1 for installed FSRU or pipeline	BASE_CASE										
		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
BINT_JBEIL	N ICE FO		83	83								
JIB_JANNINE	N ICE FO		83	83								
DEIR_AMMAR	E CCGT GO	459	459									
	E CCGT RUNNING ON NG			459	459	459	459	459	459	459	459	459
	N FSRU			1	1	1	1	1	1	1	1	1
	N CCGT - GT				658	658	658	658	658	658	658	658
	N CCGT - ST					146	146	146	146	146	146	146
	N ICE NG			166	166	166	166	166	166	166	166	166
	N ICE BARGE											
HRAYCHE	E ST	40	40	40	40	40	40	40	40	40	40	40
SELAATA	N PIPELINE DEIR AMMAR TO SELAATA											
	N CCGT - GT											
	N CCGT - ST											
ZOUK	E ICE BARGE	198	198	198								
	E ICE FO	180	180	180	180	180	180	180	180	180	180	180
	E ICE CONVERSION TO NG											
	E ST	410	410	410								
	N PIPELINE SELAATA TO ZOUK											
	N CCGT - GT											
	N CCGT - ST											
ZAHRANI	E CCGT GO	459	459	459	459	459	459	459				
	E CCGT RUNNING ON NG								459	459	459	459
	N FSRU							1	1	1	1	1
	N CCGT - GT							329	329	329	329	329
	N CCGT - ST							146	146	146	146	146
	N ICE NG											
	N ICE BARGE											
BAALBACK	E OCGT	60	60	60	60	60	60	60	60	60	60	60
JIEH	E ICE BARGE	198	198	18								
	E ICE FO	72	72	72	72	72	72	72	72	72	72	72
	E ICE CONVERSION TO NG											
	E ST	170	170	170								
	N PIPELINE ZAHRANI TO JIEH							1	1	1	1	1
	N CCGT - GT							329	329	329	329	329
	N CCGT - ST							146	146	146	146	146
SOUR	E OCGT	60	60	60	60	60	60	60	60	60	60	60
	N PIPELINE ZAHRANI TO SOUR											
	N CCGT - GT											
	N CCGT - ST											
	N ICE NG											
HYDRO	KADISHA	21	21	21	21	21	21	21	21	21	21	21
	LITANI	199	199	199	199	199	199	199	199	199	199	199
	NAHR BARED	17	17	17	17	17	17	17	17	17	17	17
	NAHR IBRAHIM	32	32	32	32	32	32	32	32	32	32	32
	SAFA	13	13	13	13	13	13	13	13	13	13	13
	DARAYA, CHAMRA, YAMOUNEH & BLA			58	58	58	58	58	58	58	58	58
	JANNEH				54	54	54	54	54	54	54	54
	REMAP BALANCE							40	80	120	160	200
SOLAR PV	MEW_COMMITTED_2021_PV_180MW		180	180	180	180	180	180	180	180	180	180
	MEW_PV_1300MW_(CF 20% Power/16											
	MEW_PV_300MW_210MWH_STORAGE											
	MEW_PV_360MW_(CF 20% Power/160											
	MEW_PV_360MW_(CF 20% Power/160											
	N_SOLAR_PV_CF_17P3_MAX_30											
	N_SOLAR_PV_CF_18_MAX_452											
	N_SOLAR_PV_CF_19_MAX_669										310	310
	N_SOLAR_PV_CF_20P1_MAX_2229				480	980	1 480	1 760	2 090	2 220	2 220	2 220
	N_SOLAR_PV_CF_20P8_MAX_524			500	520	520	520	520	520	520	520	520
CSP	N_CSP_STORAGE_7.5H_CF_27_MAX_1						50	50	50	50	50	50
WIND	MEW_COMMITTED_2022_WIND_226M			226	226	226	226	226	226	226	226	226
	MEW_WIND_400MW_(CF 40% Power/											
	MEW_WIND_400MW_(CF 40% Power/											
	N_WIND_CF_22_MAX_2355											
	N_WIND_CF_25_MAX_1500							10	10	10	10	10
	N_WIND_CF_28_MAX_743					210	700	710	710	710	710	710
	N_WIND_CF_31_MAX_384				90	380	380	380	380	380	380	380
	N_WIND_CF_34_MAX_199				190	190	190	190	190	190	190	190
	N_WIND_CF_38_MAX_102				100	100	100	100	100	100	100	100
	N_WIND_CF_42_MAX_125				120	120	120	120	120	120	120	120
BIOGAS	E_BIOGAS_NAAMEH	9	9	9	9	9	9	9	9	9	9	9
N_ADDITIONAL_ICE_FO				499	665	665	665	831	831	831	831	831
Battery Energy Storage	N_BESS_1MW_0.5H				50	100	150	200	237	240	253	253

The remaining scenario roadmaps are provided in Appendix.

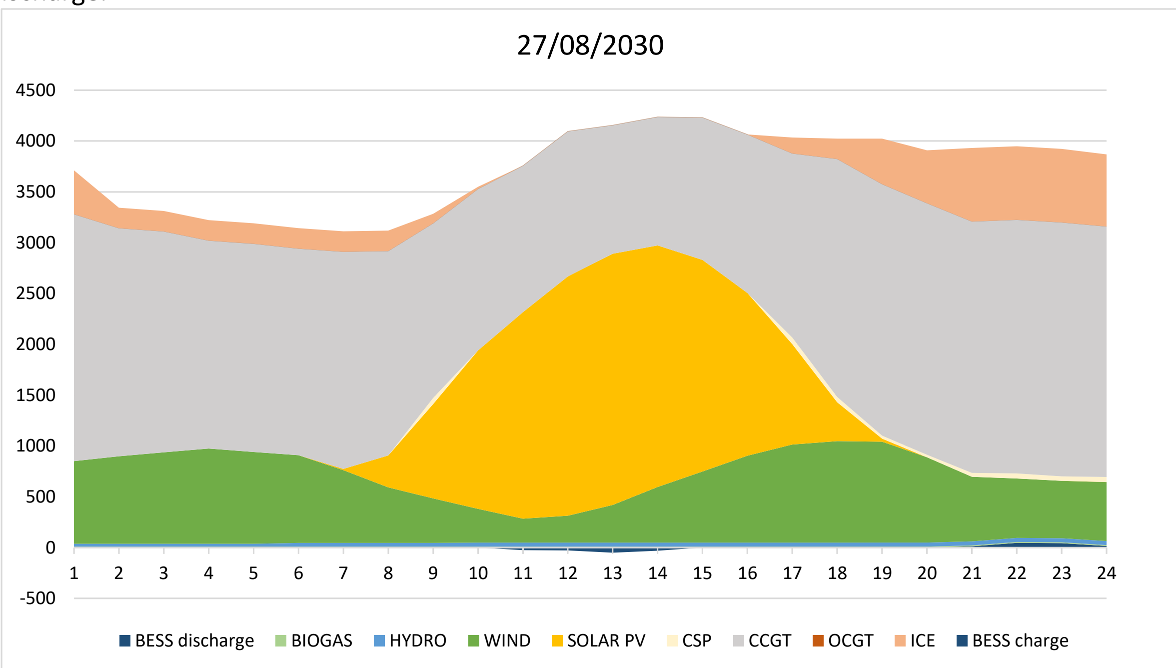
5.3. FUEL TRANSITION

The current generation mix is predominantly Fuel Oil based. As depicted in the graph below, the system will transition to a NG dominated base load production, with smaller quantities of fuel oil catering to flexible demand (marginal production). Thanks to the high share of renewable energy in the proposed plan, fuel consumption will decrease to 117 000 TJ (~2.13 MMT) in 2030 all the while providing 24/7 electricity for the whole country.



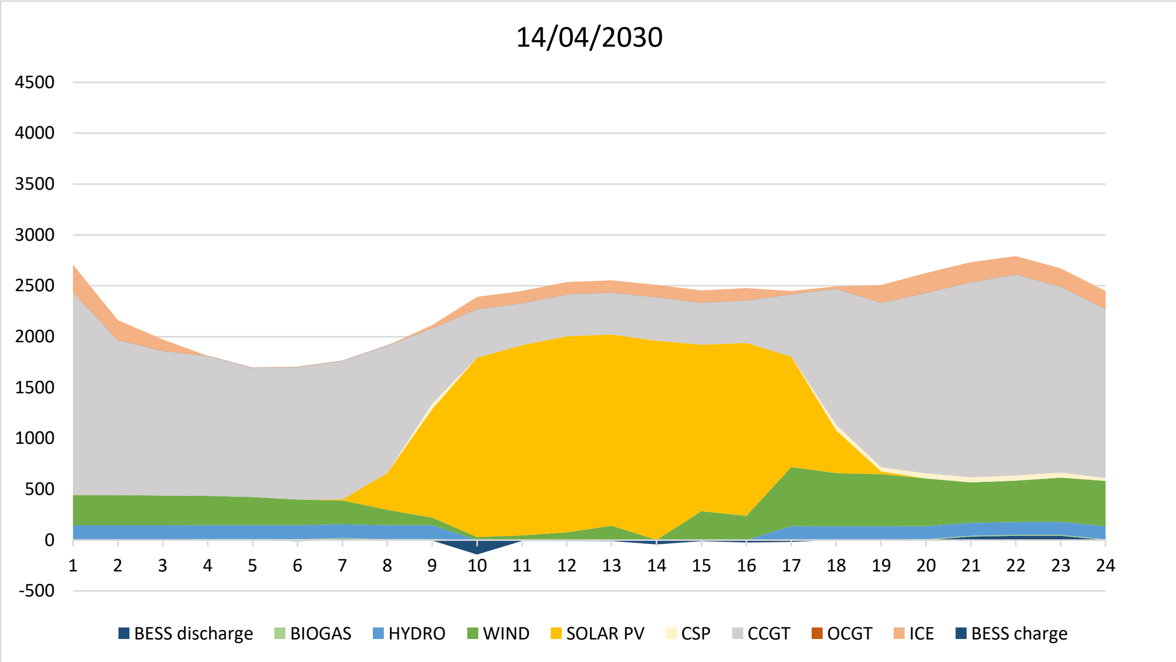
5.4. PEAK LOAD DISPATCH

The following figure shows the hourly dispatch of the generation during the annual peak load 27/08/2030. CCGT remains the base load power plant throughout the day. Hydro wind and solar power are used when available. When solar PV energy is available, CSP charges its storage and CCGT power production is reduced without the need to switch off the plants. ICEs are used to complement the production to meet demand throughout the rest of the day. During the evening, CSP and BESS discharge.



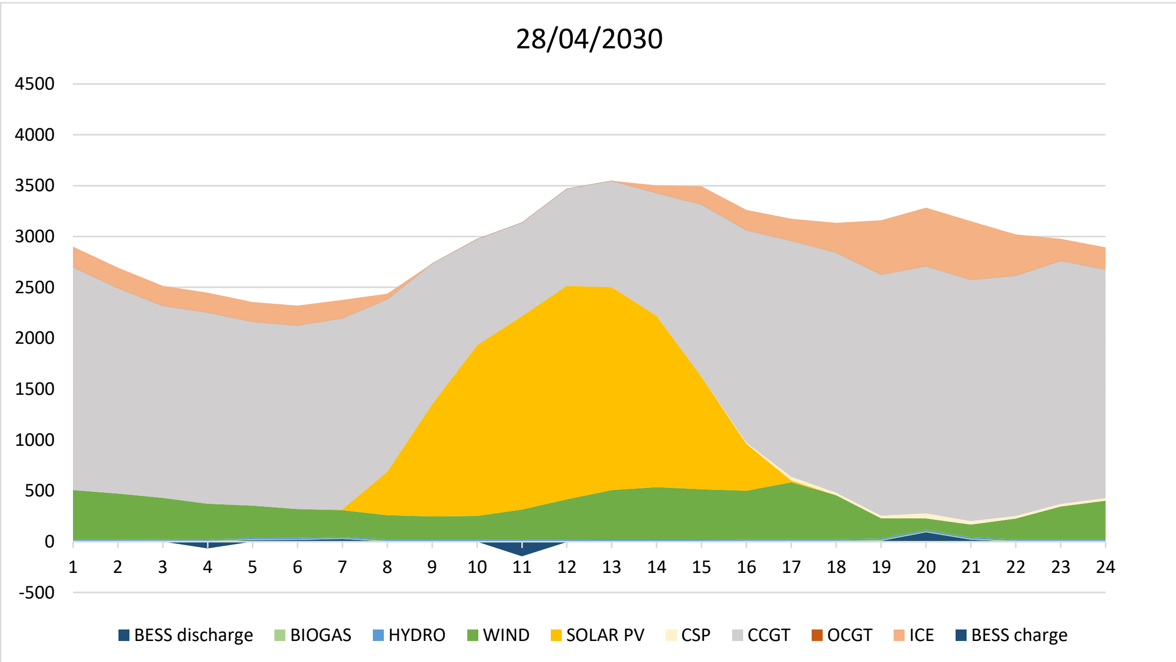
5.5. OFF-PEAK LOAD DISPATCH

During off-peak days, the same analysis remains applicable, with the particularity that renewable energy is curtailed during high solar production periods. In order to guarantee enough system inertia and reserve provision necessary for system stability, thermal units, at said time, will be run at minimum technical level.



5.6. MEDIUM LOAD DISPATCH

For an average day, renewable energy is not curtailed and system stability is ensured.



6. SCENARIO COMPARISON

This section will compare the generation mix of the target year 2030 for each of the considered scenarios.

Class_E: This scenario favors renewable sources slightly more than the base case (44% vs 40%), but amounts to a higher overall system LCOE (75.95 $/MWh).
Low_Brent: This scenario favors thermal generation at the expense of renewable energy (29% vs 40%). System LCOE is lower (68.20 $/MWh), but due to uncontrollable external factors.
High_Brent: This scenario favors renewable sources (42% vs 40%), but system LCOE still climbs to 79.04 $/MWh.
No_Gas_Capacity_Charge: It is remarkable that this scenario does not cut severely into renewables, even though the Gas infrastructure is free. This highlights the favorability of renewable energy.
All_Thermal: The LCOE for this scenario (77.34 $/MWh) is higher than the base case. The 5% renewable share belongs to committed projects (Hydro, solar and wind).
With_SPC: The addition of a carbon tax increases the renewable share to 46%. However the LCOE does increase to 85.19 $/MWh, about 15% more than the base case LCOE.

		SCENARIOS 2030						
		BASE_CASE	CLASS_E	LOW_BRENT	HIGH_BRENT	NO_GAS_CAPACITY_CHARGE	ALL_THERMAL	WITH_SPC
Total installed capacity by technology (MW)								
	CCGT	2 672	2 579	2 605	2 818	2 818	3 622	2 672
	OCGT	120	120	120	120	60		
	ST	40	40	40	40	40	40	40
	ICE	1 258	1 358	1 590	1 059	1 308	903	1 175
	HYDRO	595	595	595	595	595	595	595
	SOLAR (PV + CSP)	3 280	3 950	2 970	3 630	3 600	50	3 640
	WIND	1 736	1 756	726	1 796	1 016	226	2 286
	BESS 1MW 0.5H	253	294	250	348	261	193	350
Total (excl. storage) (MW)		9 701	10 398	8 646	10 057	9 437	5 436	10 408
Peak demand (MW)		4 232	4 232	4 232	4 232	4 232	4 232	4 232
Demand (GWh)		27 298	27 298	27 298	27 298	27 298	27 298	27 298
SYSTEM LCOE ($/MWh)		73.83	75.95	68.20	79.04	67.77	77.34	85.19
RE energy share (%)		40%	44%	29%	42%	35%	5%	46%
LOLP (%)		0.349	0.087	0.193	0.352	0.364	0.363	0.341
Firm capacity margin* (%)		10%	10%	10%	10%	10%	12%	10%
CO2 emission intensity* (g/kWh)		236	236	314	224	253	369	210
Average capacity factor by technology (%)								
	CCGT	66%	62%	67%	63%	65%	78%	62%
	OCGT	0%	0%	0%	0%	0%		
	ST	0%	0%	0%	0%	0%	0%	0%
	ICE	13%	10%	29%	6%	10%	17%	6%
	HYDRO	15%	15%	15%	14%	15%	15%	14%
	SOLAR (PV + CSP)	20%	19%	20%	20%	20%	27%	19%
	WIND	31%	31%	34%	30%	33%	30%	29%
Average LCOE for new-builds by technology ($/MWh)								
	CCGT	68.93	75.31	59.37	78.90	68.85	67.64	89.13
	ICE	146.48	143.01	87.75	246.86	125.59	113.91	245.90
	HYDRO	99.33	99.33	99.33	102.41	99.33	99.33	105.40
	SOLAR (PV + CSP)	48.68	49.14	48.58	48.78	48.77	23.36	48.81
	WIND	64.64	64.60	63.93	64.79	63.00	96.00	66.97
Total Fuel Cost ($000)		824 933	823 750	830 675	942 273	882 649	1 285 778	737 628
VO&M Cost ($000)		188 752	186 055	190 743	176 586	191 490	216 094	176 289
Emissions Cost ($000)		0	0	0	0	0	0	293 736
Annualized Build Cost ($000)		740 008	798 332	599 159	772 599	683 856	349 133	845 326
FO&M Cost ($000)		261 611	265 115	241 204	266 114	92 067	260 230	272 452
Total Cost ($000)		2 015 304	2 073 251	1 861 780	2 157 572	1 850 062	2 111 234	2 325 430

*Firm capacity margin: 20% of wind, 10% of hydro, 96% of batteries and 100% of CSP are considered available on peak load.

7. CONCLUSIONS

As noted in the introduction, we have detailed a least cost generation plan. Under the conditions and constraints set in the study, the plan includes 40% renewable energy, and reduces LCOE by around 26% by 2030.

Another conclusion from this study is that the Class E and Class F models are equivalent, with very little price difference in favor of class F, over a 10 year period.

8. APPENDICES

8.1. PROBLEM FORMULATION (LONG-TERM EXPANSION PLANNING)

Ref. energyexemplar.com

Long-term (LT) Capacity Expansion determines optimal investment decisions over long periods of time, usually up to 30 years. The PLEXOS LT-PLAN module accomplishes this by minimizing the Net Present Value of forward-looking investment costs and the portfolio production cost. Therefore, the portfolio cost minimization problem is expanded to include the investment cost and the investment-related constraints as follows:

Minimize (Portfolio Production Cost + Investment Cost) subject to

- portfolio operation constraints
- and investment Constraints.

Here, Investment Cost may include costs of: new generator builds, transmission expansion, and/or generator retirements. The Investment Constraints may include regional capacity reserve margins, resource addition and retirement candidates (i.e. maximum units built / retired), technical and financial life spans, technology / fuel mix rules, Renewable Portfolio Standard (RPS), etc. The build and retirement candidates might include thermal, geothermal, wind or solar generators, transaction and demand side participation, transmission augmentations, or generator retrofits.

This optimization problem is formulated in PLEXOS as a Mixed Integer Linear Program. The following **simplified formulation aims to illustrate the minimization problem**:

$Minimize: \sum_y (BuildCost_g * GenBuild_{g,y} + RetireCost_g * GenRetire_{g,y}) + (1+D)^y * \sum_{t\in y}\left[\sum_g (SRMC_g * L_t * GenLoad_{g,t} + SPC_{g,t}) + VoLL * USE_t\right]$	Minimize sum of net present value of build, retirement, generation costs, SPC, VoLL and etc.

With respect to: $GenBuild_{g,y}$, $GenRetire_{g,y}$, $GenLoad_{g,t}$, USE_t and $CapShort_y$

subject to:

• $\sum_g (P_{gmax} * Units_g) + \sum_y [(GenBuild_{g,y} - GenRetire_{g,y})P_{gmax} + CapShort_y] \geq PeakLoad_y + ReserveMargin_y \quad \forall y$	Capacity is sufficient to meet peak load plus required margin (incl. primary, secondary and tertiary reserve provision)
• $\sum_g GenLoad_{g,t} + USE_t = Demand_t \quad \forall t$	Energy demand is met
• $GenLoad_{g,t} \leq P_{gmax} * \left(Units_g + \sum_{i\leq y} GenBuild_{g,i} - GenRetire_{g,i}\right) \quad \forall g,t$	Dispatch is feasible
• $Kinetic\ Energy \geq Kinetic\ Energy_{min}$	Sufficient kinetic energy to cop with generation's N-1 event

where:

Variable / Parameter	**Description**	**Type / Unit**
$GenBuild_{g,y}$	Number of generating units built in year y for Generator g	integer
$GenRetire_{g,y}$	Number of generating units retired in year y for Generator g	integer
$GenLoad_{g,t}$	Dispatch level of generating unit g in period t	MW, continuous
SPC_t	Shadow Price of Carbon emitted by generating unit g in period t	\$/ton of CO_2
USE_t	Unserved energy in dispatch period t	MWh, continuous
$CapShort_y$	Capacity shortfall in year y	MW, continuous
D	Discount rate	%
L_t	Number of hours in dispatch period t	hours
$BuildCost_g$	Build cost for generator g	$
$RetireCost_g$	Cost of retirement for generator g	$
Pmax	Maximum generating capacity of generator g	MW
$Units_g$	Existing number of generating units g	integer
$PeakLoad_y$	Maximum power demand in year y	MW
ReserveMarginy	Margin required over maximum power demand in year y *(incl. primary, secondary and tertiary reserve provisions)*	MW
CapShortPrice	Capacity shortage price	$/MW
VoLL	Value of lost load	$/MWh
$SRMC_g$	Marginal cost of generation g	$/MWh
$Demand_t$	Power demand in dispatch period t	MW

8.2. INPUT DATASET

8.2.1. GENERATORS

Category (Property)	Generator	Units -	Commission Date -	Max Capacity MW	Firm Capacity MW	Min Capacity Factor Year %	Heat Rate GJ/MWh	Boiler Efficiency %	Min Stable Factor %	Start Cost $	Start Cost Time h	Min Up Time h	Min Down Time h	Max Ramp Down MW/min	Max Ramp Up MW/min	Forced Outage Rate %	Mean Time to Repair h	Project Start Date -	Lead Time yr	Build Cost $/kW	Build Set Size -	Economic Life yr	Technical Life yr	Equity Charge $/kW/yr	VO&M Charge $/MWh	FO&M Charge $/kW/yr	Max Units Built -	Max Units Built in Year -	Max Units Retired -	Min Units Retired -	Retirement Cost 0	WACC %
Class E and F CCPP	N_1x1_SGT5-2000E_GT	0		187			10.16771		40	4862	0.6	4	2	30	30	3	10	01/01/2021	2	832	1	20			3	20			0			10
	N_1x1_SGT5-2000E_ST	0		88			17.14918	80	40	0	0.66	0	0	10	10	3	10	01/01/2021	3	935	1	20			3	20			0			10
	N_1x1_SGT5-4000F_GT	0		329			9.02065		40	8554	0.6	4	2	30	30	3	10	01/01/2021	2	800	1	20			3	20			0			10
	N_1x1_SGT5-4000F_ST	0		146			15.40172	80	40	0	0.66	0	0	10	10	3	10	01/01/2021	3	905	1	20			3	20			0			10
	N_2x1_SGT5-2000E_GT	0		187			10.16771		40	4862	0.6	4	2	30	30	3	10	01/01/2021	2	832	2	20			3	20			0			10
	N_2x1_SGT5-2000E_ST	0		176			17.14918	80	40	0	0.66	0	0	10	10	3	10	01/01/2021	3	935	1	20			3	20			0			10
	N_2x1_SGT5-4000F_GT	0		329			9.02065		40	8554	0.6	4	2	30	30	3	10	01/01/2021	2	800	2	20			3	20			0			10
	N_2x1_SGT5-4000F_ST	0		292			15.40172	80	40	0	0.66	0	0	10	10	3	10	01/01/2021	3	905	1	20			3	20			0			10
BINT_JBEIL	N_BINT_JBEIL_ICE_FO	0		16.62		70	10.3717		10	49.86	0.09			200	200	3	10	01/01/2021	0		1		20		41	0	5		1000	0		
JIB_JANNINE	N_JIB_JANNINE_ICE_FO	0		16.62		70	10.3717		10	49.86	0.09			200	200	3	10	01/01/2021	0		1		20		41	0	5		1000	0		
DEIR_AMMAR	E_CCGT_DEIR_AMMAR_GO	3	01/01/2002	153			7.6338		40	3978	1	4	2	15	15	3	10								15.4	0			1000		0	
	E_CCGT_DEIR_AMMAR_NG	0		153			6.90401		40	3978	1	4	2	15	15	3	10	01/01/2021	0	0.5	3	5	12		15.4	0	3		0			10
	Class E and F CCPP																															
	N_DEIR_AMMAR_ICE_NG	0		16.62		0	7.69899		10	49.86	0.09			200	200	3	10	01/01/2021	1	850	1	20	20		8.4	10.7	10		0	0		
	N_FSRU_DEIR_AMMAR	0		0.001	0													31/12/2021	0	0	1	20	20			75190000	1		0			10
	N_ICE_BARGE_BADAWI	0		18		90	8.64308		10	54	0.09			200	200	3	10	01/01/2021	0		11		10		53	0	11		1000	11		
HRAYCHE	E_ST_HRAYCHE_IPP	1	01/01/1984	40			13.0321		40	1200	1	4	2	5	15	3	10						38		53.9	0			1000			
SELAATA	N_PIPELINE_DEIR_AMMAR_SELAATA	0		0.001	0													31/12/2021	0	0	1	20	50	980000		16425000	1		0			10
	Class E and F CCPP																															
ZOUK	E_ICE_BARGE_ZOUK	11	01/01/2012	18		90	8.62432		10	54	0.09			200	200	3	10						10		49	0			1000	11		
	E_ICE_ZOUK_FO	10	01/01/2017	18			7.97937		10	54	0.09			200	200	3	10								20.4	0			1000		0	
	E_ICE_ZOUK_NG	0		18			7.64264		10	54	0.09			200	200	3	10	01/01/2021	0	142	10	5	10		20.4	0	10		1000			10
	E_ST_ZOUK	4	01/01/1987	102.5			11.49876		40	3075	1	4	2	15	15	3	10						36		20.5	0			1000	4		
	N_PIPELINE_SELAATA_ZOUK	0		0.001	0													31/12/2021	0	0	1	20	50			18250000	1		0			10
	Class E and F CCPP																															
	N_ZOUK_ICE_NG	0		16.62		0	7.69899		10	432.12	0.09			200	200	3	10	01/01/2021	1	850	1	20	20		8.4	10.7	0		0	0		
ZAHRANI	E_CCGT_ZAHRANI_GO	3	01/01/2001	153			7.71758		40	3978	1	4	2	15	15	3	10								16	0			1000		0	
	E_CCGT_ZAHRANI_NG	0		153			6.97978		40	459	1	4	2	15	15	3	10	01/01/2021	0	0.5	3	5	13		16	0	3		1000			10
	N_FSRU_ZAHRANI	0		0.001	0													31/12/2021	0	0	1	20	20			75190000	1		0			10
	N_ICE_BARGE_ZAHRANI	0		18		90	8.64308		10	54	0.09			200	200	3	10	01/01/2021	0		11		10		53	0	11		1000	11		
	Class E and F CCPP																															
	N_ZAHRANI_ICE_NG	0		16.62		0	7.69899		10	49.86	0.09			200	200	3	10	01/01/2021	1	850	1	20	20		8.4	10.7	10		1000	0		
BAALBACK	E_OCGT_BAALBACK	2	01/01/1996	30			11.77619		40	720	0.6	4	2	15	15	3	10						34		9.5	20			1000			
JIEH	E_ICE_BARGE_JIEH	11	01/01/2016	18		90	8.66185		10	54	0.09			200	200	3	10						10		49	0			1000	11		
	E_ICE_JIEH_FO	4	01/01/2017	18			8.09535		10	54	0.09			200	200	3	10								24.5	0			1000		0	
	E_ICE_JIEH_NG	0		18			7.75372		10	54	0.09			200	200	3	10	01/01/2021	0	142	4	5	10		24.5	0	4		1000			10
	E_ST_JIEH	5	01/01/1981	34			14.45962		40	1020	1	4	2	15	15	3	10						42		23.8	0			1000	5		
	N_PIPELINE_ZAHRANI_JIEH	0		0.001	0													31/12/2021	0	0	1	20	50			9017647	1		0			10
	Class E and F CCPP																															
	N_JIEH_ICE_NG	0		16.62		0	7.69899		10	49.86	0.09			200	200	3	10	01/01/2021	1	850	1	20	20		8.4	10.7	6		0	0		

Category	Generator	Property																														
		Units -	Commission Date -	Max Capacity MW	Firm Capacity MW	Min Capacity Factor Year %	Heat Rate GJ/MWh	Boiler Efficiency %	Min Stable Factor %	Start Cost $	Start Cost Time h	Min Up Time h	Min Down Time h	Max Ramp Down MW/min	Max Ramp Up MW/min	Forced Outage Rate %	Mean Time to Repair h	Project Start Date -	Lead Time yr	Build Cost $/kW	Build Set Size -	Economic Life yr	Technical Life yr	Equity Charge $/kW/yr	VO&M Charge $/MWh	FO&M Charge $/kW/yr	Max Units Built -	Max Units Built in Year -	Max Units Retired -	Min Units Retired -	Retirement Cost 0	WACC %
SOUR	E_OCGT_SOUR	2	01/01/1996	30			12.53886		40	720	0.6	4	2	15	15	3	10						34		9.4	20			1000			
	N_PIPELINE_ZAHRANI_SOUR	0		0.001	0													31/12/2021	0	0	1	20	50			12882353	1		0			10
	Class E and F CCPP																															
	N_SOUR_ICE_NG	0		16.62		0	7.69899		10	49.86	0.09			200	200	3	10	01/01/2021	1	850	1	20	20		8.4	10.7	4		0	0		
HYDRO	E_HYDRO_KADISHA_IPP	1	01/01/1961	20.6	2.06											3	10						50		26.5	0						
	E_HYDRO_LITANI_IPP	1	01/01/1967	199	19.9											3	10						50		39.7	0						
	E_HYDRO_NAHR_BARED_IPP	1	01/01/1936	17.2	1.72											3	10						50		26.5	0						
	E_HYDRO_NAHR_IBRAHIM_IPP	1	01/01/1961	32.48	3.248											3	10						50		26.5	0						
	E_HYDRO_SAFA	1	01/01/1931	13.4	1.34											3	10						50		97.7	0						
	N_HYDRO_DARAYA_CHAMRA_YAMOUNEH_BLAT	1		58.2	5.82											3	10	31/12/2021	0	1834		30	50		7	0	0					10
	N_HYDRO_JANNEH	1		54	5.4											3	10	31/12/2022	0	1095		30	50		7	0	0					10
	N_HYDRO_REMAP_BALANCE	1		40	4											3	10	31/12/2025	0	1834		30	50		7	0	0	0				10
SOLAR_PV	N_SOLAR_PV_1300MW_(CF 20% Power/1600 kWh/kWp/y)	0		1300	0	18										3	10	31/12/2029	0	0		20	20		70	0	1		0			10
	N_SOLAR_PV_180MW_(CF 20% Power/1600 kWh/kWp/y)	0		180	0	18										3	10	31/12/2020	0	0		20	20		70	0	1		0			10
	N_SOLAR_PV_300MW_210MWH_STORAGE	0		300	0	18										3	10	31/12/2023	0	0		20	20		70	0	1		0			10
	N_SOLAR_PV_360MW_(CF 20% Power/1600 kWh/kWp/y)_1	0		360	0	18										3	10	31/12/2023	0	0		20	20		70	0	1		0			10
	N_SOLAR_PV_360MW_(CF 20% Power/1600 kWh/kWp/y)_2	0		360	0	18										3	10	31/12/2026	0	0		20	20		70	0	1		0			10
	N_SOLAR_PV_CF_17P3_MAX_30	0		1	0											3	10	01/01/2021	1	650	10	20	20		0	6	30		0			10
	N_SOLAR_PV_CF_18_MAX_452	0		1	0											3	10	01/01/2021	1	650	10	20	20		0	6	452		0			10
	N_SOLAR_PV_CF_19_MAX_669	0		1	0											3	10	01/01/2021	1	650	10	20	20		0	6	669		0			10
	N_SOLAR_PV_CF_20P1_MAX_2229	0		1	0											3	10	01/01/2021	1	650	10	20	20		0	6	2229		0			10
	N_SOLAR_PV_CF_20P8_MAX_524	0		1	0											3	10	01/01/2021	1	650	10	20	20		0	6	524		0			10
CSP	N_CSP_STORAGE_7.5H_CF_27_MAX_1187	1		50	0				25			0.66	0.66	3	2.5	3	8	31/12/2024	2	4500		25	30		2	50	23		0			10
WIND	COMMITTED_2022_WIND_226MW	1	31/12/2021	226	45.2	30										3	10						20		104.5	0			0			
																									96							
	N_WIND_400MW_(CF 40% Power/30% Energy)_1	0		400	80	30										3	10	31/12/2023	0	0		20	20		96	0	1		0			10
	N_WIND_400MW_(CF 40% Power/30% Energy)_2	0		400	80	30										3	10	31/12/2026	0	0		20	20		96	0	1		0			10
	N_WIND_CF_22_MAX_2355	0		1	0.2											3	10	01/01/2021	2	1200	10	20	20		0	20	2355		0			10
	N_WIND_CF_25_MAX_1500	0		1	0.2											3	10	01/01/2021	2	1200	10	20	20		0	20	1500		0			10
	N_WIND_CF_28_MAX_743	0		1	0.2											3	10	01/01/2021	2	1200	10	20	20		0	20	743		0			10
	N_WIND_CF_31_MAX_384	0		1	0.2											3	10	01/01/2021	2	1200	10	20	20		0	20	384		0			10
	N_WIND_CF_34_MAX_199	0		1	0.2											3	10	01/01/2021	2	1200	10	20	20		0	20	199		0			10
	N_WIND_CF_38_MAX_102	0		1	0.2											3	10	01/01/2021	2	1200	10	20	20		0	20	102		0			10
	N_WIND_CF_42_MAX_125	0		1	0.2											3	10	01/01/2021	2	1200	10	20	20		0	20	125		0			10
BIOGAS	E_BIOGAS_NAAMEH	7	01/01/2017	1.25			0		10	0	0.09			200	200	3	10						10		26.7	0			0			
N_ADDITIONAL_ICE_FO		0		16.62		0	8.12		10	49.86	0.09			200	200	3	10	01/01/2021	1	860	1	20	20		5	10.7	1000	30	0	0		

8.2.2. STORAGE

		Property																			
		Units -	Build Cost $/kW	Max Power MW	Capacity MWh	Firm Capacity MW	Capacity Degradation %	Charge Efficiency %	Discharge Efficiency %	Max Ramp Down MW/min	Max Ramp Up MW/min	Economic Life yr	Technical Life yr	Project Start Date -	Lead Time yr	Maintenance Frequency -	Max Units Built -	Mean Time to Repair h	FO&M Charge $/kW/yr	VO&M Charge $/MWh	WACC %
Storage	N_BESS_1MW_0.5H	0	449	1	0.5	0.96	6.8493E-05	93	93			10	10	31/12/2021	1	1	10000	5	10	0.3	10
	N_BESS_1MW_1H	0	591	1	1	0.96	6.8493E-05	93	93			10	10	31/12/2021	1	1	10000	5	10	0.3	10
	N_BESS_1MW_2H	0	876	1	2	0.96	6.8493E-05	93	93			10	10	31/12/2021	1	1	10000	5	10	0.3	10
	N_BESS_1MW_4H	0	1446	1	4	0.96	6.8493E-05	93	93			10	10	31/12/2021	1	1	10000	5	10	0.3	10
	N_CSP_STORAGE_7.5H	1	712.5	50	375	50	0	100	100	3	2.5	25	30	31/12/2024	2		23		0	0	10

8.2.3. FUELS

			2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
	Brent price yearly escalation factor (%)	1.5%											
LOW_BRENT	Brent Crude Forecast ($/barrel)		30.00	30.45	30.91	31.37	31.84	32.32	32.80	33.30	33.79	34.30	34.82
	Fuel Oil ($/GJ)		5.36	5.43	5.50	5.57	5.64	5.71	5.79	5.86	5.94	6.02	6.10
	Gas Oil ($/GJ)		7.27	7.36	7.46	7.55	7.65	7.75	7.85	7.96	8.06	8.17	8.28
	NG ($/GJ)		4.97	5.03	5.08	5.13	5.19	5.25	5.30	5.36	5.42	5.48	5.54
BASE_CASE	Brent Crude Forecast ($/barrel)		40.00	40.60	41.21	41.83	42.45	43.09	43.74	44.39	45.06	45.74	46.42
	Fuel Oil ($/GJ)		6.89	6.98	7.08	7.17	7.27	7.37	7.46	7.56	7.67	7.77	7.88
	Gas Oil ($/GJ)		9.36	9.49	9.61	9.74	9.87	10.01	10.14	10.28	10.42	10.56	10.71
	NG ($/GJ)		6.16	6.23	6.30	6.37	6.45	6.52	6.60	6.68	6.76	6.84	6.92
HIGH_BRENT	Brent Crude Forecast ($/barrel)		50.00	50.75	51.51	52.28	53.07	53.86	54.67	55.49	56.32	57.17	58.03
	Fuel Oil ($/GJ)		8.42	8.54	8.66	8.77	8.89	9.02	9.14	9.27	9.39	9.52	9.65
	Gas Oil ($/GJ)		11.45	11.61	11.77	11.93	12.10	12.26	12.43	12.60	12.78	12.96	13.13
	NG ($/GJ)		7.34	7.43	7.52	7.61	7.70	7.80	7.89	7.99	8.09	8.19	8.29

8.3. SCENARIO COMPARATIVE TABLE

Sites/technologies	Power plant installed capacity (MW) / 1 for installed FSRU or pipeline	SCENARIOS 2030 BASE_CASE	CLASS_E	LOW_BRENT	HIGH_BRENT	NO_GAS_CAPACITY_CHARGE	ALL_THERMAL	WITH_SPC
DEIR_AMMAR	E CCGT GO							
	E CCGT RUNNING ON NG	459	459	459	459	459	459	459
	N FSRU	1	1	1	1	1	1	1
	N CCGT - GT	658	561	561	658	658	658	658
	N CCGT - ST	146	176	176	292	292	146	146
	N ICE NG	166	166	100	83	66	166	100
	N ICE BARGE							
HRAYCHE	E ST	40	40	40	40	40	40	40
SELAATA	N PIPELINE DEIR AMMAR TO SELAATA					1	1	
	N CCGT - GT						329	
	N CCGT - ST						146	
ZOUK	E ICE BARGE							
	E ICE FO	180	180	180	180	180	180	180
	E ICE CONVERSION TO NG							
	E ST							
	N PIPELINE SELAATA TO ZOUK					1	1	
	N CCGT - GT					329	329	
	N CCGT - ST					146	146	
ZAHRANI	E CCGT GO							
	E CCGT RUNNING ON NG	459	459	459	459	459	459	459
	N FSRU	1	1	1	1	1	1	1
	N CCGT - GT	329	374	329	329		329	329
	N CCGT - ST	146	88	146	146		146	146
	N ICE NG		66	50		166	50	33
	N ICE BARGE							
BAALBACK	E OCGT	60	60	60	60			
JIEH	E ICE BARGE							
	E ICE FO	72	72	72	72	72		72
	E ICE CONVERSION TO NG							
	E ST							
	N PIPELINE ZAHRANI TO JIEH	1	1	1	1	1	1	1
	N CCGT - GT	329	374	329	329	329	329	329
	N CCGT - ST	146	88	146	146	146	146	146
SOUR	E OCGT	60	60	60	60	60		
	N PIPELINE ZAHRANI TO SOUR					1		
	N CCGT - GT							
	N CCGT - ST							
	N ICE NG					66		
HYDRO	KADISHA	21	21	21	21	21	21	21
	LITANI	199	199	199	199	199	199	199
	NAHR BARED	17	17	17	17	17	17	17
	NAHR IBRAHIM	32	32	32	32	32	32	32
	SAFA	13	13	13	13	13	13	13
	DARAYA, CHAMRA, YAMOUNEH & BLAT	58	58	58	58	58	58	58
	JANNEH	54	54	54	54	54	54	54
	REMAP BALANCE	200	200	200	200	200	200	200
SOLAR PV	MEW_COMMITTED_2021_PV_180MW_(CF 2	180	180	180	180	180		180
	MEW_PV_1300MW_(CF 20% Power/1600 kW							
	MEW_PV_300MW_210MWH_STORAGE							
	MEW_PV_360MW_(CF 20% Power/1600 kWh							
	MEW_PV_360MW_(CF 20% Power/1600 kWh							
	N_SOLAR_PV_CF_17P3_MAX_30							
	N_SOLAR_PV_CF_18_MAX_452		320					10
	N_SOLAR_PV_CF_19_MAX_669	310	660		660	630		660
	N_SOLAR_PV_CF_20P1_MAX_2229	2 220	2 220	2 220	2 220	2 220		2 220
	N_SOLAR_PV_CF_20P8_MAX_524	520	520	520	520	520		520
CSP	N_CSP_STORAGE_7.5H_CF_27_MAX_1187	50	50	50	50	50	50	50
WIND	MEW_COMMITTED_2022_WIND_226MW	226	226	226	226	226	226	226
	MEW_WIND_400MW_(CF 40% Power/30% E							
	MEW_WIND_400MW_(CF 40% Power/30% E							
	N_WIND_CF_22_MAX_2355							
	N_WIND_CF_25_MAX_1500	10			40			530
	N_WIND_CF_28_MAX_743	710	740		740			740
	N_WIND_CF_31_MAX_384	380	380	90	380	380		380
	N_WIND_CF_34_MAX_199	190	190	190	190	190		190
	N_WIND_CF_38_MAX_102	100	100	100	100	100		100
	N_WIND_CF_42_MAX_125	120	120	120	120	120		120
BIOGAS	E_BIOGAS_NAAMEH	9	9	9	9	9	9	9
N_ADDITIONAL_ICE_FO		831	864	1 180	715	748	499	781
Battery Energy Storage	N_BESS_1MW_0.5H	253	294	250	348	261	193	350

8.4. CLASS_E DETAILED TABLE

Sites/technologies	Power plant installed capacity (MW) / 1 for installed FSRU or pipeline	CLASS_E 2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
BINT_JBEIL	N ICE FO		83	83								
JIB_JANNINE	N ICE FO		83	83								
DEIR_AMMAR	E CCGT GO	459	459									
	E CCGT RUNNING ON NG			459	459	459	459	459	459	459	459	459
	N FSRU			1	1	1	1	1	1	1	1	1
	N CCGT - GT				561	561	561	561	561	561	561	561
	N CCGT - ST					176	176	176	176	176	176	176
	N ICE NG			166	166	166	166	166	166	166	166	166
	N ICE BARGE											
HRAYCHE	E ST	40	40	40	40	40	40	40	40	40	40	40
SELAATA	N PIPELINE DEIR AMMAR TO SELAATA											
	N CCGT - GT											
	N CCGT - ST											
ZOUK	E ICE BARGE	198	198	198								
	E ICE FO	180	180	180	180	180	180	180	180	180	180	180
	E ICE CONVERSION TO NG											
	E ST	410	410	410								
	N PIPELINE SELAATA TO ZOUK											
	N CCGT - GT											
	N CCGT - ST											
ZAHRANI	E CCGT GO	459	459	459	459	459	459	459				
	E CCGT RUNNING ON NG								459	459	459	459
	N FSRU							1	1	1	1	1
	N CCGT - GT							374	374	374	374	374
	N CCGT - ST							88	88	88	88	88
	N ICE NG											66
	N ICE BARGE											
BAALBACK	E OCGT	60	60	60	60	60	60	60	60	60	60	60
JIEH	E ICE BARGE	198	198	18								
	E ICE FO	72	72	72	72	72	72	72	72	72	72	72
	E ICE CONVERSION TO NG											
	E ST	170	170	170								
	N PIPELINE ZAHRANI TO JIEH							1	1	1	1	1
	N CCGT - GT							374	374	374	374	374
	N CCGT - ST							88	88	88	88	88
SOUR	E OCGT	60	60	60	60	60	60	60	60	60	60	60
	N PIPELINE ZAHRANI TO SOUR											
	N CCGT - GT											
	N CCGT - ST											
	N ICE NG											
HYDRO	KADISHA	21	21	21	21	21	21	21	21	21	21	21
	LITANI	199	199	199	199	199	199	199	199	199	199	199
	NAHR BARED	17	17	17	17	17	17	17	17	17	17	17
	NAHR IBRAHIM	32	32	32	32	32	32	32	32	32	32	32
	SAFA	13	13	13	13	13	13	13	13	13	13	13
	DARAYA, CHAMRA, YAMOUNEH & BLA			58	58	58	58	58	58	58	58	58
	JANNEH				54	54	54	54	54	54	54	54
	REMAP BALANCE							40	80	120	160	200
SOLAR PV	MEW_COMMITTED_2021_PV_180MW_		180	180	180	180	180	180	180	180	180	180
	MEW_PV_1300MW_(CF 20% Power/16											
	MEW_PV_300MW_210MWH_STORAGE											
	MEW_PV_360MW_(CF 20% Power/160											
	MEW_PV_360MW_(CF 20% Power/160											
	N_SOLAR_PV_CF_17P3_MAX_30											
	N_SOLAR_PV_CF_18_MAX_452										320	320
	N_SOLAR_PV_CF_19_MAX_669								260	660	660	660
	N_SOLAR_PV_CF_20P1_MAX_2229				480	980	1 480	1 980	2 220	2 220	2 220	2 220
	N_SOLAR_PV_CF_20P8_MAX_524			500	520	520	520	520	520	520	520	520
CSP	N_CSP_STORAGE_7.5H_CF_27_MAX_11						50	50	50	50	50	50
WIND	MEW_COMMITTED_2022_WIND_226M			226	226	226	226	226	226	226	226	226
	MEW_WIND_400MW_(CF 40% Power/											
	MEW_WIND_400MW_(CF 40% Power/											
	N_WIND_CF_22_MAX_2355											
	N_WIND_CF_25_MAX_1500											
	N_WIND_CF_28_MAX_743					210	710	740	740	740	740	740
	N_WIND_CF_31_MAX_384				90	380	380	380	380	380	380	380
	N_WIND_CF_34_MAX_199				190	190	190	190	190	190	190	190
	N_WIND_CF_38_MAX_102				100	100	100	100	100	100	100	100
	N_WIND_CF_42_MAX_125				120	120	120	120	120	120	120	120
BIOGAS	E_BIOGAS_NAAMEH	9	9	9	9	9	9	9	9	9	9	9
N_ADDITIONAL_ICE_FO				499	765	765	765	864	864	864	864	864
Battery Energy Storage	N_BESS_1MW_0.5H				50	100	150	200	200	244	294	294

		CLASS_E 2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Total installed capacity by technology (MW)												
	CCGT	918	918	918	1 479	1 655	1 655	2 579	2 579	2 579	2 579	2 579
	OCGT	120	120	120	120	120	120	120	120	120	120	120
	ST	620	620	620	40	40	40	40	40	40	40	40
	ICE	657	823	1 308	1 191	1 191	1 191	1 291	1 291	1 291	1 291	1 358
	HYDRO	283	283	341	395	395	395	435	475	515	555	595
	SOLAR (PV + CSP)		180	680	1 180	1 680	2 230	2 730	3 230	3 630	3 950	3 950
	WIND			226	726	1 226	1 726	1 756	1 756	1 756	1 756	1 756
	BESS 1MW 0.5H				50	100	150	200	200	244	294	294
Total (excl. storage) (MW)		2 597	2 944	4 213	5 131	6 307	7 357	8 951	9 491	9 931	10 291	10 398
Peak demand (MW)		3 773	3 717	3 393	3 477	3 544	3 650	3 760	3 872	3 989	4 108	4 232
Demand (GWh)		24 339	23 979	21 890	22 429	22 861	23 547	24 254	24 981	25 731	26 503	27 298
Unserved Energy (GWh)		4 520	2 856	0	0	0	0	0	0	0	0	0
SYSTEM LCOE ($/MWh)		99.03	99.69	86.12	76.02	71.83	71.00	76.85	76.24	76.12	75.95	75.95
RE energy share (%)		2%	4%	10%	20%	29%	37%	40%	43%	44%	45%	44%
LOLP (%)		100.000	99.485	74.428	76.057	51.766	42.567	0.001	0.007	0.019	0.045	0.087
Firm capacity margin* (%)		-41%	-36%	-16%	-16%	-9%	-7%	18%	15%	13%	12%	10%
CO2 emission intensity* (g/kWh)		696	689	535	433	339	295	258	240	234	231	236
Average capacity factor by technology (%)												
	CCGT	100%	100%	96%	71%	71%	68%	59%	61%	61%	61%	62%
	OCGT	92%	80%	13%	6%	0%	0%	0%	0%	0%	0%	0%
	ST	97%	93%	31%	4%	0%	0%	0%	0%	0%	0%	0%
	ICE	100%	98%	93%	87%	60%	51%	14%	9%	10%	10%	10%
	HYDRO	19%	19%	18%	14%	14%	14%	14%	15%	15%	14%	15%
	SOLAR (PV + CSP)		20%	20%	20%	20%	20%	20%	20%	20%	19%	19%
	WIND			30%	34%	32%	31%	31%	31%	31%	31%	31%
Average LCOE for new-builds by technology ($/MWh)												
	CCGT				83.40	67.42	68.04	71.58	73.50	74.43	75.14	75.31
	ICE		113.43	80.33	75.32	81.26	84.40	138.12	186.71	175.60	167.55	143.01
	HYDRO			128.28	67.67	67.30	67.67	78.60	86.17	91.19	98.06	99.33
	SOLAR (PV + CSP)		70.00	52.76	50.60	49.81	48.71	48.62	48.67	48.69	49.14	49.14
	WIND			104.50	66.27	64.91	64.56	64.60	64.60	64.40	64.60	64.60
Total Fuel Cost ($000)		1 466 135	1 543 144	1 225 968	1 040 192	856 228	780 768	756 359	741 613	754 970	775 895	823 750
VO&M Cost ($000)		494 050	560 187	466 321	250 358	222 388	199 743	159 638	173 959	177 316	180 767	186 055
Emissions Cost ($000)		0	0	0	0	0	0	0	0	0	0	0
Annualized Build Cost ($000)		0	0	105 195	299 185	430 818	543 122	691 680	729 854	763 609	791 694	798 332
FO&M Cost ($000)		2 407	2 400	87 703	115 269	132 651	148 289	256 143	259 143	262 701	264 403	265 115
Total Cost ($000)		1 962 592	2 105 731	1 885 187	1 705 004	1 642 085	1 671 921	1 863 820	1 904 569	1 958 596	2 012 760	2 073 251

*Firm capacity margin: 20% of wind, 10% of hydro, 96% of batteries and 100% of CSP are considered available on peak load.

8.1. LOW_BRENT DETAILED TABLE

Sites/technologies	Power plant installed capacity (MW) / 1 for installed FSRU or pipeline	LOW_BRENT										
		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
BINT_JBEIL	N ICE FO		83	83								
JIB_JANNINE	N ICE FO		83	83								
DEIR_AMMAR	E CCGT GO	459	459									
	E CCGT RUNNING ON NG			459	459	459	459	459	459	459	459	459
	N FSRU			1	1	1	1	1	1	1	1	1
	N CCGT - GT				561	561	561	561	561	561	561	561
	N CCGT - ST					176	176	176	176	176	176	176
	N ICE NG			100	100	100	100	100	100	100	100	100
	N ICE BARGE											
HRAYCHE	E ST	40	40	40	40	40	40	40	40	40	40	40
SELAATA	N PIPELINE DEIR AMMAR TO SELAATA											
	N CCGT - GT											
	N CCGT - ST											
ZOUK	E ICE BARGE	198	198	198								
	E ICE FO	180	180	180	180	180	180	180	180	180	180	180
	E ICE CONVERSION TO NG											
	E ST	410	410	410								
	N PIPELINE SELAATA TO ZOUK											
	N CCGT - GT											
	N CCGT - ST											
ZAHRANI	E CCGT GO	459	459	459	459	459	459	459				
	E CCGT RUNNING ON NG								459	459	459	459
	N FSRU							1	1	1	1	1
	N CCGT - GT									329	329	329
	N CCGT - ST							146	146	146	146	146
	N ICE NG							50	50	50	50	50
	N ICE BARGE											
BAALBACK	E OCGT	60	60	60	60	60	60	60	60	60	60	60
JIEH	E ICE BARGE	198	198	72								
	E ICE FO	72	72	72	72	72	72	72	72	72	72	72
	E ICE CONVERSION TO NG											
	E ST	170	170	170								
	N PIPELINE ZAHRANI TO JIEH							1	1	1	1	1
	N CCGT - GT								329	329	329	329
	N CCGT - ST							146	146	146	146	146
SOUR	E OCGT	60	60	60	60	60	60	60	60	60	60	60
	N PIPELINE ZAHRANI TO SOUR											
	N CCGT - GT											
	N CCGT - ST											
	N ICE NG											
HYDRO	KADISHA	21	21	21	21	21	21	21	21	21	21	21
	LITANI	199	199	199	199	199	199	199	199	199	199	199
	NAHR BARED	17	17	17	17	17	17	17	17	17	17	17
	NAHR IBRAHIM	32	32	32	32	32	32	32	32	32	32	32
	SAFA	13	13	13	13	13	13	13	13	13	13	13
	DARAYA, CHAMRA, YAMOUNEH & BLA			58	58	58	58	58	58	58	58	58
	JANNEH				54	54	54	54	54	54	54	54
	REMAP BALANCE							40	80	120	160	200
SOLAR PV	MEW_COMMITTED_2021_PV_180MW_		180	180	180	180	180	180	180	180	180	180
	MEW_PV_1300MW_(CF 20% Power/16											
	MEW_PV_300MW_210MWH_STORAGE											
	MEW_PV_360MW_(CF 20% Power/160											
	MEW_PV_360MW_(CF 20% Power/160											
	N_SOLAR_PV_CF_17P3_MAX_30											
	N_SOLAR_PV_CF_18_MAX_452											
	N_SOLAR_PV_CF_19_MAX_669											
	N_SOLAR_PV_CF_20P1_MAX_2229				480	980	1 480	1 940	1 940	1 940	2 220	2 220
	N_SOLAR_PV_CF_20P8_MAX_524			500	520	520	520	520	520	520	520	520
CSP	N_CSP_STORAGE_7.5H_CF_27_MAX_11						50	50	50	50	50	50
WIND	MEW_COMMITTED_2022_WIND_226M			226	226	226	226	226	226	226	226	226
	MEW_WIND_400MW_(CF 40% Power/3											
	MEW_WIND_400MW_(CF 40% Power/3											
	N_WIND_CF_22_MAX_2355											
	N_WIND_CF_25_MAX_1500											
	N_WIND_CF_28_MAX_743											
	N_WIND_CF_31_MAX_384				90	90	90	90	90	90	90	90
	N_WIND_CF_34_MAX_199				190	190	190	190	190	190	190	190
	N_WIND_CF_38_MAX_102				100	100	100	100	100	100	100	100
	N_WIND_CF_42_MAX_125				120	120	120	120	120	120	120	120
BIOGAS	E_BIOGAS_NAAMEH	9	9	9	9	9	9	9	9	9	9	9
N_ADDITIONAL_ICE_FO				499	831	831	831	1 180	1 180	1 180	1 180	1 180
Battery Energy Storage	N_BESS_1MW_0.5H				50	100	150	200	200	200	250	250

		LOW_BRENT										
		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Total installed capacity by technology (MW)												
	CCGT	918	918	918	1 479	1 655	1 655	1 947	2 276	2 605	2 605	2 605
	OCGT	120	120	120	120	120	120	120	120	120	120	120
	ST	620	620	620	40	40	40	40	40	40	40	40
	ICE	657	823	1 295	1 191	1 191	1 191	1 590	1 590	1 590	1 590	1 590
	HYDRO	283	283	341	395	395	395	435	475	515	555	595
	SOLAR (PV + CSP)		180	680	1 180	1 680	2 230	2 690	2 690	2 690	2 970	2 970
	WIND			226	726	726	726	726	726	726	726	726
	BESS 1MW 0.5H				50	100	150	200	200	200	250	250
Total (excl. storage) (MW)		2 597	2 944	4 200	5 131	5 807	6 357	7 548	7 917	8 286	8 606	8 646
Peak demand (MW)		3 773	3 717	3 393	3 477	3 544	3 650	3 760	3 872	3 989	4 108	4 232
Demand (GWh)		24 339	23 979	21 890	22 429	22 861	23 547	24 254	24 981	25 731	26 503	27 298
Unserved Energy (GWh)		4 520	2 856	0	0	0	0	0	0	0	0	0
SYSTEM LCOE ($/MWh)		82.53	83.37	74.76	66.38	64.00	63.67	75.90	68.88	68.73	68.43	68.20
RE energy share (%)		2%	4%	10%	20%	24%	27%	30%	29%	28%	30%	29%
LOLP (%)		100.000	99.485	75.162	76.057	66.689	66.093	0.289	0.796	0.027	0.055	0.193
Firm capacity margin* (%)		-41%	-36%	-16%	-16%	-12%	-12%	15%	10%	15%	13%	10%
CO2 emission intensity* (g/kWh)		696	688	541	439	392	374	374	330	314	309	314
Average capacity factor by technology (%)												
	CCGT	100%	100%	97%	71%	65%	65%	46%	62%	65%	66%	67%
	OCGT	98%	91%	18%	6%	0%	0%	0%	0%	0%	0%	0%
	ST	96%	92%	31%	4%	0%	0%	0%	0%	0%	0%	0%
	ICE	100%	97%	93%	86%	81%	79%	66%	38%	26%	26%	29%
	HYDRO	19%	18%	18%	14%	14%	14%	14%	15%	15%	15%	15%
	SOLAR (PV + CSP)		20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	WIND			30%	34%	34%	34%	34%	34%	34%	34%	34%
Average LCOE for new-builds by technology ($/MWh)												
	CCGT				70.76	57.64	58.11	64.87	60.34	58.65	59.00	59.37
	ICE		97.30	68.36	63.11	64.20	65.31	75.28	78.61	90.93	91.14	87.75
	HYDRO			128.28	67.67	67.30	67.67	78.60	86.17	91.19	95.97	99.33
	SOLAR (PV + CSP)		70.00	52.76	50.60	49.81	48.71	48.62	48.62	48.54	48.58	48.58
	WIND			104.50	66.27	66.12	63.93	63.93	63.93	63.78	63.93	63.93
Total Fuel Cost ($000)		1 140 664	1 200 919	966 636	826 128	760 325	755 344	765 830	751 637	771 778	788 602	830 675
VO&M Cost ($000)		492 609	557 788	484 374	248 234	219 859	213 359	336 746	193 350	182 822	184 733	190 743
Emissions Cost ($000)		0	0	0	0	0	0	0	0	0	0	0
Annualized Build Cost ($000)		0	0	98 557	299 263	360 420	402 248	512 297	543 212	574 127	599 159	599 159
FO&M Cost ($000)		2 407	2 400	86 992	115 269	122 624	128 289	225 864	232 444	239 679	241 204	241 204
Total Cost ($000)		1 635 679	1 761 106	1 636 559	1 488 894	1 463 228	1 499 240	1 840 737	1 720 643	1 768 407	1 813 697	1 861 780

*Firm capacity margin: 20% of wind, 10% of hydro, 96% of batteries and 100% of CSP are considered available on peak load.

8.1. HIGH_BRENT DETAILED TABLE

Sites/technologies	Power plant installed capacity (MW) / 1 for installed FSRU or pipeline	HIGH_BRENT 2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
BINT_JBEIL	N ICE FO		83	33	17							
JIB_JANNINE	N ICE FO		83	17	17							
DEIR_AMMAR	E CCGT GO	459	459									
	E CCGT RUNNING ON NG			459	459	459	459	459	459	459	459	459
	N FSRU			1	1	1	1	1	1	1	1	1
	N CCGT - GT				658	658	658	658	658	658	658	658
	N CCGT - ST					292	292	292	292	292	292	292
	N ICE NG			83	83	83	83	83	83	83	83	83
	N ICE BARGE											
HRAYCHE	E ST	40	40	40	40	40	40	40	40	40	40	40
SELAATA	N PIPELINE DEIR AMMAR TO SELAATA											
	N CCGT - GT											
	N CCGT - ST											
ZOUK	E ICE BARGE	198	198	198								
	E ICE FO	180	180	180	180	180	180	180	180	180	180	180
	E ICE CONVERSION TO NG											
	E ST	410	410	410								
	N PIPELINE SELAATA TO ZOUK											
	N CCGT - GT											
	N CCGT - ST											
ZAHRANI	E CCGT GO	459	459	459	459	459	459	459				
	E CCGT RUNNING ON NG								459	459	459	459
	N FSRU							1	1	1	1	1
	N CCGT - GT							329	329	329	329	329
	N CCGT - ST							146	146	146	146	146
	N ICE NG											
	N ICE BARGE											
BAALBACK	E OCGT	60	60	60	60	60	60	60	60	60	60	60
JIEH	E ICE BARGE	198	198	198								
	E ICE FO	72	72	72	72	72	72	72	72	72	72	72
	E ICE CONVERSION TO NG											
	E ST	170	170	170								
	N PIPELINE ZAHRANI TO JIEH							1	1	1	1	1
	N CCGT - GT							329	329	329	329	329
	N CCGT - ST							146	146	146	146	146
SOUR	E OCGT	60	60	60	60	60	60	60	60	60	60	60
	N PIPELINE ZAHRANI TO SOUR											
	N CCGT - GT											
	N CCGT - ST											
	N ICE NG											
HYDRO	KADISHA	21	21	21	21	21	21	21	21	21	21	21
	LITANI	199	199	199	199	199	199	199	199	199	199	199
	NAHR BARED	17	17	17	17	17	17	17	17	17	17	17
	NAHR IBRAHIM	32	32	32	32	32	32	32	32	32	32	32
	SAFA	13	13	13	13	13	13	13	13	13	13	13
	DARAYA, CHAMRA, YAMOUNEH & BLA			58	58	58	58	58	58	58	58	58
	JANNEH				54	54	54	54	54	54	54	54
	REMAP BALANCE							40	80	120	160	200
SOLAR PV	MEW_COMMITTED_2021_PV_180MW_		180	180	180	180	180	180	180	180	180	180
	MEW_PV_1300MW_(CF 20% Power/16											
	MEW_PV_300MW_210MWH_STORAGE											
	MEW_PV_360MW_(CF 20% Power/160											
	MEW_PV_360MW_(CF 20% Power/160											
	N_SOLAR_PV_CF_17P3_MAX_30											
	N_SOLAR_PV_CF_18_MAX_452											
	N_SOLAR_PV_CF_19_MAX_669								30	300	660	660
	N_SOLAR_PV_CF_20P1_MAX_2229				480	980	1 480	1 940	2 220	2 220	2 220	2 220
	N_SOLAR_PV_CF_20P8_MAX_524			500	520	520	520	520	520	520	520	520
CSP	N_CSP_STORAGE_7.5H_CF_27_MAX_11						50	50	50	50	50	50
WIND	MEW_COMMITTED_2022_WIND_226M			226	226	226	226	226	226	226	226	226
	MEW_WIND_400MW_(CF 40% Power/											
	MEW_WIND_400MW_(CF 40% Power/											
	N_WIND_CF_22_MAX_2355											
	N_WIND_CF_25_MAX_1500						10	40	40	40	40	40
	N_WIND_CF_28_MAX_743					210	700	740	740	740	740	740
	N_WIND_CF_31_MAX_384				90	380	380	380	380	380	380	380
	N_WIND_CF_34_MAX_199				190	190	190	190	190	190	190	190
	N_WIND_CF_38_MAX_102				100	100	100	100	100	100	100	100
	N_WIND_CF_42_MAX_125				120	120	120	120	120	120	120	120
BIOGAS	E_BIOGAS_NAAMEH	9	9	9	9	9	9	9	9	9	9	9
N_ADDITIONAL_ICE_FO				499	715	715	715	715	715	715	715	715
Battery Energy Storage	N_BESS_1MW_0.5H				50	100	150	200	250	298	348	348

		HIGH_BRENT 2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Total installed capacity by technology (MW)												
	CCGT	918	918	918	1 576	1 868	1 868	2 818	2 818	2 818	2 818	2 818
	OCGT	120	120	120	120	120	120	120	120	120	120	120
	ST	620	620	620	40	40	40	40	40	40	40	40
	ICE	657	823	1 288	1 092	1 059	1 059	1 059	1 059	1 059	1 059	1 059
	HYDRO	283	283	341	395	395	395	435	475	515	555	595
	SOLAR (PV + CSP)		180	680	1 180	1 680	2 230	2 690	3 000	3 270	3 630	3 630
	WIND			226	726	1 226	1 726	1 796	1 796	1 796	1 796	1 796
	BESS 1MW 0.5H				50	100	150	200	250	298	348	348
Total (excl. storage) (MW)		2 597	2 944	4 193	5 129	6 387	7 437	8 957	9 307	9 617	10 017	10 057
Peak demand (MW)		3 773	3 717	3 393	3 477	3 544	3 650	3 760	3 872	3 989	4 108	4 232
Demand (GWh)		24 339	23 979	21 890	22 429	22 861	23 547	24 254	24 981	25 731	26 503	27 298
Unserved Energy (GWh)		4 520	2 856	0	0	0	0	0	0	0	0	0
SYSTEM LCOE ($/MWh)		115.52	116.00	99.59	84.34	77.85	76.17	80.03	79.45	79.39	79.13	79.04
RE energy share (%)		2%	4%	11%	20%	29%	37%	40%	41%	42%	43%	42%
LOLP (%)		100.000	99.485	75.321	75.997	44.566	28.110	0.020	0.037	0.069	0.120	0.352
Firm capacity margin* (%)		-41%	-36%	-17%	-17%	-7%	-4%	19%	17%	15%	13%	10%
CO2 emission intensity* (g/kWh)		696	689	534	421	324	281	238	228	225	221	224
Average capacity factor by technology (%)												
	CCGT	100%	100%	92%	76%	69%	66%	56%	59%	60%	61%	63%
	OCGT	92%	80%	14%	6%	0%	0%	0%	0%	0%	0%	0%
	ST	97%	93%	32%	4%	0%	0%	0%	0%	0%	0%	0%
	ICE	100%	98%	94%	80%	58%	47%	12%	5%	5%	6%	6%
	HYDRO	19%	19%	18%	14%	14%	14%	14%	14%	14%	14%	14%
	SOLAR (PV + CSP)		20%	20%	20%	20%	20%	20%	20%	20%	19%	20%
	WIND			42%	34%	32%	31%	30%	30%	30%	30%	30%
Average LCOE for new-builds by technology ($/MWh)												
	CCGT				85.06	72.80	73.58	76.91	77.17	77.65	78.46	78.90
	ICE		129.56	89.67	90.63	95.39	99.78	162.05	299.57	286.42	271.30	246.86
	HYDRO			128.28	67.67	67.30	67.67	82.16	91.28	96.80	101.85	102.41
	SOLAR (PV + CSP)		70.00	52.76	50.83	49.81	48.71	48.62	48.59	48.59	48.82	48.78
	WIND			104.50	66.27	64.91	64.59	64.79	64.79	64.59	64.98	64.79
Total Fuel Cost ($000)		1 793 008	1 887 679	1 473 761	1 228 811	989 031	896 929	836 511	844 294	872 020	890 367	942 273
VO&M Cost ($000)		494 050	560 187	522 448	254 216	219 134	196 954	155 417	161 780	165 201	168 165	176 586
Emissions Cost ($000)		0	0	0	0	0	0	0	0	0	0	0
Annualized Build Cost ($000)		0	0	96 898	292 858	436 201	548 505	690 017	717 338	741 460	772 599	772 599
FO&M Cost ($000)		2 407	2 400	86 814	115 786	135 496	151 126	258 994	261 354	264 175	266 114	266 114
Total Cost ($000)		2 289 465	2 450 266	2 179 921	1 891 671	1 779 863	1 793 515	1 940 938	1 984 766	2 042 857	2 097 246	2 157 572

*Firm capacity margin: 20% of wind, 10% of hydro, 96% of batteries and 100% of CSP are considered available on peak load.

8.1. NO_GAS_CAPACITY_CHARGE DETAILED TABLE

Sites/technologies	Power plant installed capacity (MW) / 1 for installed FSRU or pipeline	NO_GAS_CAPACITY_CHARGE 2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
BINT_JBEIL	N ICE FO		83	83								
JIB_JANNINE	N ICE FO		83	83								
DEIR_AMMAR	E CCGT GO	459	459									
	E CCGT RUNNING ON NG			459	459	459	459	459	459	459	459	459
	N FSRU			1	1	1	1	1	1	1	1	1
	N CCGT - GT				658	658	658	658	658	658	658	658
	N CCGT - ST					292	292	292	292	292	292	292
	N ICE NG			66	66	66	66	66	66	66	66	66
	N ICE BARGE											
HRAYCHE	E ST	40	40	40	40	40	40	40	40	40	40	40
SELAATA	N PIPELINE DEIR AMMAR TO SELAATA			1	1	1	1	1	1	1	1	1
	N CCGT - GT											
	N CCGT - ST											
ZOUK	E ICE BARGE	198	198	36								
	E ICE FO	180	180	180	180	180	180	180	180	180	180	180
	E ICE CONVERSION TO NG											
	E ST	410	410	410								
	N PIPELINE SELAATA TO ZOUK			1	1	1	1	1	1	1	1	1
	N CCGT - GT							329	329	329	329	329
	N CCGT - ST							146	146	146	146	146
ZAHRANI	E CCGT GO	459	459									
	E CCGT RUNNING ON NG			459	459	459	459	459	459	459	459	459
	N FSRU			1	1	1	1	1	1	1	1	1
	N CCGT - GT											
	N CCGT - ST											
	N ICE NG			166	166	166	166	166	166	166	166	166
	N ICE BARGE											
BAALBACK	E OCGT	60	60	60	60	60	60	60				
JIEH	E ICE BARGE	198	198									
	E ICE FO	72	72	72	72	72	72	72	72	72	72	72
	E ICE CONVERSION TO NG											
	E ST	170	170	170								
	N PIPELINE ZAHRANI TO JIEH			1	1	1	1	1	1	1	1	1
	N CCGT - GT							329	329	329	329	329
	N CCGT - ST							146	146	146	146	146
SOUR	E OCGT	60	60	60	60	60	60	60	60	60	60	60
	N PIPELINE ZAHRANI TO SOUR			1	1	1	1	1	1	1	1	1
	N CCGT - GT											
	N CCGT - ST											
	N ICE NG			66	66	66	66	66	66	66	66	66
HYDRO	KADISHA	21	21	21	21	21	21	21	21	21	21	21
	LITANI	199	199	199	199	199	199	199	199	199	199	199
	NAHR BARED	17	17	17	17	17	17	17	17	17	17	17
	NAHR IBRAHIM	32	32	32	32	32	32	32	32	32	32	32
	SAFA	13	13	13	13	13	13	13	13	13	13	13
	DARAYA, CHAMRA, YAMOUNEH & BLA			58	58	58	58	58	58	58	58	58
	JANNEH				54	54	54	54	54	54	54	54
	REMAP BALANCE							40	80	120	160	200
SOLAR PV	MEW_COMMITTED_2021_PV_180MW_		180	180	180	180	180	180	180	180	180	180
	MEW_PV_1300MW_(CF 20% Power/16											
	MEW_PV_300MW_210MWH_STORAGE											
	MEW_PV_360MW_(CF 20% Power/160											
	MEW_PV_360MW_(CF 20% Power/160											
	N_SOLAR_PV_CF_17P3_MAX_30											
	N_SOLAR_PV_CF_18_MAX_452											
	N_SOLAR_PV_CF_19_MAX_669								140	260	630	630
	N_SOLAR_PV_CF_20P1_MAX_2229				480	980	1 480	1 980	2 220	2 220	2 220	2 220
	N_SOLAR_PV_CF_20P8_MAX_524			500	520	520	520	520	520	520	520	520
CSP	N_CSP_STORAGE_7.5H_CF_27_MAX_11						50	50	50	50	50	50
WIND	MEW_COMMITTED_2022_WIND_226M			226	226	226	226	226	226	226	226	226
	MEW_WIND_400MW_(CF 40% Power/											
	MEW_WIND_400MW_(CF 40% Power/											
	N_WIND_CF_22_MAX_2355											
	N_WIND_CF_25_MAX_1500											
	N_WIND_CF_28_MAX_743											
	N_WIND_CF_31_MAX_384				90	380	380	380	380	380	380	380
	N_WIND_CF_34_MAX_199				190	190	190	190	190	190	190	190
	N_WIND_CF_38_MAX_102				100	100	100	100	100	100	100	100
	N_WIND_CF_42_MAX_125				120	120	120	120	120	120	120	120
BIOGAS	E_BIOGAS_NAAMEH	9	9	9	9	9	9	9	9	9	9	9
N_ADDITIONAL_ICE_FO				499	499	499	499	748	748	748	748	748
Battery Energy Storage	N_BESS_1MW_0.5H				50	100	150	200	237	238	261	261

		NO_GAS_CAPACITY_CHARGE 2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Total installed capacity by technology (MW)												
	CCGT	918	918	918	1 576	1 868	1 868	2 818	2 818	2 818	2 818	2 818
	OCGT	120	120	120	120	120	120	120	60	60	60	60
	ST	620	620	620	40	40	40	40	40	40	40	40
	ICE	657	823	1 261	1 059	1 059	1 059	1 308	1 308	1 308	1 308	1 308
	HYDRO	283	283	341	395	395	395	435	475	515	555	595
	SOLAR (PV + CSP)		180	680	1 180	1 680	2 230	2 730	3 110	3 230	3 600	3 600
	WIND			226	726	1 016	1 016	1 016	1 016	1 016	1 016	1 016
	BESS 1MW 0.5H				50	100	150	200	237	238	261	261
Total (excl. storage) (MW)		2 597	2 944	4 166	5 095	6 177	6 727	8 467	8 827	8 987	9 397	9 437
Peak demand (MW)		3 773	3 717	3 393	3 477	3 544	3 650	3 760	3 872	3 989	4 108	4 232
Demand (GWh)		24 339	23 979	21 890	22 429	22 861	23 547	24 254	24 981	25 731	26 503	27 298
Unserved Energy (GWh)		4 520	2 856	0	0	0	0	0	0	0	0	0
SYSTEM LCOE ($/MWh)		99.03	99.69	74.80	68.50	65.71	65.23	72.17	67.79	67.86	67.78	67.77
RE energy share (%)		2%	4%	10%	20%	27%	30%	33%	35%	35%	36%	35%
LOLP (%)		100.000	99.485	74.378	74.927	44.124	43.529	0.000	0.017	0.055	0.124	0.364
Firm capacity margin* (%)		-41%	-36%	-16%	-16%	-7%	-7%	28%	19%	16%	13%	10%
CO2 emission intensity* (g/kWh)		696	689	485	361	299	287	280	254	254	249	253
Average capacity factor by technology (%)												
	CCGT	100%	100%	97%	94%	78%	77%	56%	61%	63%	63%	65%
	OCGT	92%	80%	14%	6%	0%	0%	0%	0%	0%	0%	0%
	ST	97%	93%	33%	4%	0%	0%	0%	0%	0%	0%	0%
	ICE	100%	98%	82%	42%	32%	32%	20%	8%	8%	9%	10%
	HYDRO	19%	19%	18%	14%	14%	14%	14%	15%	15%	14%	15%
	SOLAR (PV + CSP)		20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	WIND			30%	34%	33%	33%	33%	33%	33%	33%	33%
Average LCOE for new-builds by technology ($/MWh)												
	CCGT				75.14	63.95	64.52	67.32	67.32	67.75	68.60	68.85
	ICE		113.43	78.36	79.15	82.20	83.48	175.18	137.29	136.26	132.39	125.59
	HYDRO			128.28	67.67	67.30	67.67	78.60	86.17	91.19	97.57	99.33
	SOLAR (PV + CSP)		70.00	52.76	50.60	49.81	48.71	48.62	48.63	48.58	48.77	48.77
	WIND			104.50	66.27	64.56	63.00	63.00	63.00	62.83	63.00	63.00
Total Fuel Cost ($000)		1 466 135	1 543 144	1 093 147	923 570	800 220	795 792	804 269	786 029	821 044	836 440	882 649
VO&M Cost ($000)		494 050	560 187	406 169	273 973	234 174	224 607	245 482	173 816	181 274	184 070	191 490
Emissions Cost ($000)		0	0	0	0	0	0	0	0	0	0	0
Annualized Build Cost ($000)		0	0	123 508	297 643	411 386	453 214	613 096	644 691	653 926	683 856	683 856
FO&M Cost ($000)		2 407	2 400	14 470	41 130	56 424	62 270	87 437	88 887	89 863	92 067	92 067
Total Cost ($000)		1 962 592	2 105 731	1 637 294	1 536 315	1 502 203	1 535 882	1 750 285	1 693 423	1 746 106	1 796 434	1 850 062

*Firm capacity margin: 20% of wind, 10% of hydro, 96% of batteries and 100% of CSP are considered available on peak load.

8.1. ALL_THERMAL DETAILED TABLE

Sites/technologies	Power plant installed capacity (MW) / 1 for installed FSRU or pipeline	ALL_THERMAL 2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
BINT_JBEIL	N ICE FO		83	83	33							
JIB_JANNINE	N ICE FO		83	83								
DEIR_AMMAR	E CCGT GO	459	459									
	E CCGT RUNNING ON NG			459	459	459	459	459	459	459	459	459
	N FSRU			1	1	1	1	1	1	1	1	1
	N CCGT - GT				658	658	658	658	658	658	658	658
	N CCGT - ST					146	146	146	146	146	146	146
	N ICE NG			166	166	166	166	166	166	166	166	166
	N ICE BARGE											
HRAYCHE	E ST	40	40	40	40	40	40	40	40	40	40	40
SELAATA	N PIPELINE DEIR AMMAR TO SELAATA							1	1	1	1	1
	N CCGT - GT							329	329	329	329	329
	N CCGT - ST							146	146	146	146	146
ZOUK	E ICE BARGE	198	198	198								
	E ICE FO	180	180	180	180	180	180	180	180	180	180	180
	E ICE CONVERSION TO NG											
	E ST	410	410	410								
	N PIPELINE SELAATA TO ZOUK							1	1	1	1	1
	N CCGT - GT							329	329	329	329	329
	N CCGT - ST							146	146	146	146	146
ZAHRANI	E CCGT GO	459	459									
	E CCGT RUNNING ON NG			459	459	459	459	459	459	459	459	459
	N FSRU			1	1	1	1	1	1	1	1	1
	N CCGT - GT				329	329	329	329	329	329	329	329
	N CCGT - ST					146	146	146	146	146	146	146
	N ICE NG			50	50	50	50	50	50	50	50	50
	N ICE BARGE											
BAALBACK	E OCGT	60	60	60	60	60	60	60				
JIEH	E ICE BARGE	198	198	36								
	E ICE FO	72	72	72	72	72	72	72	72	72		
	E ICE CONVERSION TO NG											
	E ST	170	170	170								
	N PIPELINE ZAHRANI TO JIEH							1	1	1	1	1
	N CCGT - GT							329	329	329	329	329
	N CCGT - ST							146	146	146	146	146
SOUR	E OCGT	60	60	60	60	60	60	60				
	N PIPELINE ZAHRANI TO SOUR											
	N CCGT - GT											
	N CCGT - ST											
	N ICE NG											
HYDRO	KADISHA	21	21	21	21	21	21	21	21	21	21	21
	LITANI	199	199	199	199	199	199	199	199	199	199	199
	NAHR BARED	17	17	17	17	17	17	17	17	17	17	17
	NAHR IBRAHIM	32	32	32	32	32	32	32	32	32	32	32
	SAFA	13	13	13	13	13	13	13	13	13	13	13
	DARAYA, CHAMRA, YAMOUNEH & BLA			58	58	58	58	58	58	58	58	58
	JANNEH				54	54	54	54	54	54	54	54
	REMAP BALANCE							40	80	120	160	200
SOLAR PV	MEW_COMMITTED_2021_PV_180MW_											
	MEW_PV_1300MW_(CF 20% Power/16											
	MEW_PV_300MW_210MWH_STORAGE											
	MEW_PV_360MW_(CF 20% Power/160											
	MEW_PV_360MW_(CF 20% Power/160											
	N_SOLAR_PV_CF_17P3_MAX_30											
	N_SOLAR_PV_CF_18_MAX_452											
	N_SOLAR_PV_CF_19_MAX_669											
	N_SOLAR_PV_CF_20P1_MAX_2229											
	N_SOLAR_PV_CF_20P8_MAX_524											
CSP	N_CSP_STORAGE_7.5H_CF_27_MAX_11						50	50	50	50	50	50
WIND	MEW_COMMITTED_2022_WIND_226M			226	226	226	226	226	226	226	226	226
	MEW_WIND_400MW_(CF 40% Power/											
	MEW_WIND_400MW_(CF 40% Power/											
	N_WIND_CF_22_MAX_2355											
	N_WIND_CF_25_MAX_1500											
	N_WIND_CF_28_MAX_743											
	N_WIND_CF_31_MAX_384											
	N_WIND_CF_34_MAX_199											
	N_WIND_CF_38_MAX_102											
	N_WIND_CF_42_MAX_125											
BIOGAS	E_BIOGAS_NAAMEH	9	9	9	9	9	9	9	9	9	9	9
N_ADDITIONAL_ICE_FO				499	499	499	499	499	499	499	499	499
Battery Energy Storage	N_BESS_1MW_0.5H				43	93	143	193	193	193	193	193

		ALL_THERMAL 2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Total installed capacity by technology (MW)												
	CCGT	918	918	918	1 905	2 197	2 197	3 622	3 622	3 622	3 622	3 622
	OCGT	120	120	120	120	120	120	120				
	ST	620	620	620	40	40	40	40	40	40	40	40
	ICE	657	823	1 376	1 009	975	975	975	975	975	903	903
	HYDRO	283	283	341	395	395	395	435	475	515	555	595
	SOLAR (PV + CSP)						50	50	50	50	50	50
	WIND			226	226	226	226	226	226	226	226	226
	BESS 1MW 0.5H				43	93	143	193	193	193	193	193
Total (excl. storage) (MW)		2 597	2 764	3 600	3 695	3 953	4 003	5 468	5 388	5 428	5 396	5 436
Peak demand (MW)		3 773	3 717	3 393	3 477	3 544	3 650	3 760	3 872	3 989	4 108	4 232
Demand (GWh)		24 339	23 979	21 890	22 429	22 861	23 547	24 254	24 981	25 731	26 503	27 298
Unserved Energy (GWh)		4 520	3 133	0	0	0	0	0	0	0	0	0
SYSTEM LCOE ($/MWh)		99.03	100.17	86.39	78.84	74.67	74.58	78.59	77.38	77.49	77.31	77.34
RE energy share (%)		2%	2%	5%	5%	5%	5%	5%	5%	5%	5%	5%
LOLP (%)		100.000	99.485	72.137	68.667	39.914	38.202	0.000	0.009	0.027	0.140	0.363
Firm capacity margin* (%)		-41%	-36%	-14%	-13%	-6%	-6%	30%	23%	19%	15%	12%
CO2 emission intensity* (g/kWh)		696	699	539	454	402	404	372	367	367	368	369
Average capacity factor by technology (%)												
	CCGT	100%	100%	97%	96%	92%	93%	69%	72%	74%	76%	78%
	OCGT	92%	81%	17%	13%	0%	0%	0%				
	ST	97%	93%	42%	3%	0%	0%	0%	0%	0%	0%	0%
	ICE	100%	98%	89%	59%	49%	53%	15%	12%	13%	15%	17%
	HYDRO	19%	19%	18%	14%	14%	14%	14%	15%	15%	15%	15%
	SOLAR (PV + CSP)						27%	27%	27%	27%	27%	27%
	WIND			30%	30%	30%	30%	30%	30%	30%	30%	30%
Average LCOE for new-builds by technology ($/MWh)												
	CCGT				74.14	64.22	64.77	65.57	66.07	66.55	67.11	67.64
	ICE		113.43	79.71	79.01	80.17	79.83	134.31	124.04	120.75	118.03	113.91
	HYDRO			128.28	67.67	67.30	67.67	78.60	86.17	91.19	95.97	99.33
	SOLAR (PV + CSP)						23.36	23.36	23.36	23.36	23.36	23.36
	WIND			104.50	104.50	104.50	96.00	96.00	96.00	96.00	96.00	96.00
Total Fuel Cost ($000)		1 466 135	1 546 005	1 191 338	1 147 543	1 061 234	1 104 374	1 099 514	1 136 520	1 186 770	1 233 064	1 285 778
VO&M Cost ($000)		494 050	539 701	467 231	272 333	255 658	255 485	194 683	187 212	197 047	206 599	216 094
Emissions Cost ($000)		0	0	0	0	0	0	0	0	0	0	0
Annualized Build Cost ($000)		0	0	72 059	167 947	202 641	206 294	349 254	349 133	349 133	349 133	349 133
FO&M Cost ($000)		2 407	2 400	160 427	180 597	187 449	189 937	262 630	260 230	260 942	260 230	260 230
Total Cost ($000)		1 962 592	2 088 107	1 891 055	1 768 420	1 706 981	1 756 091	1 906 080	1 933 094	1 993 893	2 049 026	2 111 234

*Firm capacity margin: 20% of wind, 10% of hydro, 96% of batteries and 100% of CSP are considered available on peak load.

8.1. WITH_SPC DETAILED TABLE

Sites/technologies	Power plant installed capacity (MW) / 1 for installed FSRU or pipeline	WITH_SPC 2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
BINT_JBEIL	N ICE FO		83									
JIB_JANNINE	N ICE FO		83									
DEIR_AMMAR	E CCGT GO	459	459									
	E CCGT RUNNING ON NG			459	459	459	459	459	459	459	459	459
	N FSRU			1	1	1	1	1	1	1	1	1
	N CCGT - GT				658	658	658	658	658	658	658	658
	N CCGT - ST					146	146	146	146	146	146	146
	N ICE NG			100	100	100	100	100	100	100	100	100
	N ICE BARGE											
HRAYCHE	E ST	40	40	40	40	40	40	40	40	40	40	40
SELAATA	N PIPELINE DEIR AMMAR TO SELAATA											
	N CCGT - GT											
	N CCGT - ST											
ZOUK	E ICE BARGE	198	198	198								
	E ICE FO	180	180	180	180	180	180	180	180	180	180	180
	E ICE CONVERSION TO NG											
	E ST	410	410	410								
	N PIPELINE SELAATA TO ZOUK											
	N CCGT - GT											
	N CCGT - ST											
ZAHRANI	E CCGT GO	459	459									
	E CCGT RUNNING ON NG			459	459	459	459	459	459	459	459	459
	N FSRU			1	1	1	1	1	1	1	1	1
	N CCGT - GT				329	329	329	329	329	329	329	329
	N CCGT - ST					146	146	146	146	146	146	146
	N ICE NG			50	50	50	50	33	33	33	33	33
	N ICE BARGE											
BAALBACK	E OCGT	60	60	60	60	60	60	60				
JIEH	E ICE BARGE	198	198	198								
	E ICE FO	72	72	72	72	72	72	72	72	72	72	72
	E ICE CONVERSION TO NG											
	E ST	170	170	170								
	N PIPELINE ZAHRANI TO JIEH							1	1	1	1	1
	N CCGT - GT							329	329	329	329	329
	N CCGT - ST							146	146	146	146	146
SOUR	E OCGT	60	60	60	60	60	60	60				
	N PIPELINE ZAHRANI TO SOUR											
	N CCGT - GT											
	N CCGT - ST											
	N ICE NG											
HYDRO	KADISHA	21	21	21	21	21	21	21	21	21	21	21
	LITANI	199	199	199	199	199	199	199	199	199	199	199
	NAHR BARED	17	17	17	17	17	17	17	17	17	17	17
	NAHR IBRAHIM	32	32	32	32	32	32	32	32	32	32	32
	SAFA	13	13	13	13	13	13	13	13	13	13	13
	DARAYA, CHAMRA, YAMOUNEH & BLA			58	58	58	58	58	58	58	58	58
	JANNEH				54	54	54	54	54	54	54	54
	REMAP BALANCE							40	80	120	160	200
SOLAR PV	MEW_COMMITTED_2021_PV_180MW_		180	180	180	180	180	180	180	180	180	180
	MEW_PV_1300MW_(CF 20% Power/16											
	MEW_PV_300MW_210MWH_STORAGE											
	MEW_PV_360MW_(CF 20% Power/160											
	MEW_PV_360MW_(CF 20% Power/160											
	N_SOLAR_PV_CF_17P3_MAX_30											
	N_SOLAR_PV_CF_18_MAX_452										10	10
	N_SOLAR_PV_CF_19_MAX_669								40	410	660	660
	N_SOLAR_PV_CF_20P1_MAX_2229				480	980	1 480	1 910	2 220	2 220	2 220	2 220
	N_SOLAR_PV_CF_20P8_MAX_524			500	520	520	520	520	520	520	520	520
CSP	N_CSP_STORAGE_7.5H_CF_27_MAX_11						50	50	50	50	50	50
WIND	MEW_COMMITTED_2022_WIND_226M			226	226	226	226	226	226	226	226	226
	MEW_WIND_400MW_(CF 40% Power/											
	MEW_WIND_400MW_(CF 40% Power/											
	N_WIND_CF_22_MAX_2355											
	N_WIND_CF_25_MAX_1500				10	10	10	470	470	470	530	530
	N_WIND_CF_28_MAX_743					210	710	740	740	740	740	740
	N_WIND_CF_31_MAX_384				90	380	380	380	380	380	380	380
	N_WIND_CF_34_MAX_199				190	190	190	190	190	190	190	190
	N_WIND_CF_38_MAX_102				100	100	100	100	100	100	100	100
	N_WIND_CF_42_MAX_125				110	110	110	120	120	120	120	120
BIOGAS	E_BIOGAS_NAAMEH	9	9	9	9	9	9	9	9	9	9	9
N_ADDITIONAL_ICE_FO				499	499	499	499	781	781	781	781	781
Battery Energy Storage	N_BESS_1MW_0.5H				50	100	150	200	250	300	350	350

		WITH_SPC 2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Total installed capacity by technology (MW)												
	CCGT	918	918	918	1 905	2 197	2 197	2 672	2 672	2 672	2 672	2 672
	OCGT	120	120	120	120	120	120	120				
	ST	620	620	620	40	40	40	40	40	40	40	40
	ICE	657	823	1 305	909	909	909	1 175	1 175	1 175	1 175	1 175
	HYDRO	283	283	341	395	395	395	435	475	515	555	595
	SOLAR (PV + CSP)		180	680	1 180	1 680	2 230	2 660	3 010	3 380	3 640	3 640
	WIND			226	726	1 226	1 726	2 226	2 226	2 226	2 286	2 286
	BESS 1MW 0.5H				50	100	150	200	250	300	350	350
Total (excl. storage) (MW)		2 597	2 944	4 210	5 275	6 567	7 617	9 328	9 598	10 008	10 368	10 408
Peak demand (MW)		3 773	3 717	3 393	3 477	3 544	3 650	3 760	3 872	3 989	4 108	4 232
Demand (GWh)		24 339	23 979	21 890	22 429	22 861	23 547	24 254	24 981	25 731	26 503	27 298
Unserved Energy (GWh)		4 520	2 856	0	0	0	0	0	0	0	0	0
SYSTEM LCOE ($/MWh)		127.82	128.75	106.26	91.67	84.82	83.11	89.34	85.39	85.35	85.15	85.19
RE energy share (%)		2%	4%	10%	20%	29%	37%	43%	44%	46%	47%	46%
LOLP (%)		100.000	99.485	74.468	68.022	17.382	8.921	0.001	0.041	0.073	0.115	0.341
Firm capacity margin* (%)		-41%	-36%	-16%	-13%	-2%	0%	25%	16%	15%	13%	10%
CO2 emission intensity* (g/kWh)		695	688	498	362	280	245	233	215	210	207	210
Average capacity factor by technology (%)												
	CCGT	100%	100%	97%	91%	79%	74%	52%	58%	58%	59%	62%
	OCGT	96%	87%	18%	1%	0%	0%	0%				
	ST	96%	92%	31%	0%	0%	0%	0%	0%	0%	0%	0%
	ICE	100%	98%	88%	34%	14%	9%	17%	6%	6%	6%	6%
	HYDRO	19%	19%	18%	14%	14%	14%	13%	13%	13%	13%	14%
	SOLAR (PV + CSP)		20%	20%	20%	20%	20%	20%	20%	20%	19%	19%
	WIND			30%	34%	32%	30%	29%	29%	29%	29%	29%
Average LCOE for new-builds by technology ($/MWh)												
	CCGT				97.15	81.62	82.79	86.64	86.45	87.42	88.60	89.13
	ICE		147.03	99.12	109.39	134.66	162.90	270.15	246.37	253.91	253.34	245.90
	HYDRO			128.28	67.67	67.30	67.67	83.45	95.94	101.36	104.60	105.40
	SOLAR (PV + CSP)		70.00	52.76	50.83	49.97	48.71	48.67	48.67	48.65	48.82	48.81
	WIND			104.50	66.72	65.19	64.76	66.73	66.93	67.10	67.36	66.97
Total Fuel Cost ($000)		1 466 879	1 544 401	1 102 584	933 110	762 426	698 244	672 919	665 906	681 377	695 560	737 628
VO&M Cost ($000)		493 446	559 180	485 785	261 488	220 147	197 100	210 077	161 019	164 697	168 729	176 289
Emissions Cost ($000)		570 581	613 717	471 341	356 777	288 637	266 008	266 454	258 279	266 699	274 642	293 736
Annualized Build Cost ($000)		0	0	103 596	308 646	451 989	564 293	751 207	781 461	813 364	845 326	845 326
FO&M Cost ($000)		2 407	2 400	162 716	195 956	215 885	231 296	266 272	266 472	269 930	272 452	272 452
Total Cost ($000)		2 533 313	2 719 698	2 326 022	2 055 975	1 939 085	1 956 941	2 166 928	2 133 137	2 196 066	2 256 708	2 325 430

*Firm capacity margin: 20% of wind, 10% of hydro, 96% of batteries and 100% of CSP are considered available on peak load.