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United Nations Development Program &
United Nations Environmental Program

**Libyan Electricity Sector Stabilisation and Transition Support
(LESST)**

Final Narrative Report

January 2021 – Dec 2022

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Acronyms

BOP	Balance of Plant
CC	Combined Cycle Gas Turbine Driven Power Plant
CE	Clean Energy
CFL	Compact Fluorescent Light
CT	Combustion Turbine
DCS	Digital Control Systems
DSM	Demand Side Management
EDM	Energy Data Management System
EMS	Energy Management System
EPC	Engineer Procure Construct
EPRI	Electric Power Research Institute
ERP	Enterprise Resource Management
EU	European Union
FID	Final Investment Decision
GECOL	General Electricity Company of Libya
GNA	Government of National Accord
GoL	Government of Libya
GW	Gigawatt
GT	Gas Turbine
HFO	Heavy Fuel Oil
HMI	Human - Machine Interface
HR	Human Resources
HRD	Human Resources Department
HRSG	Heat Recovery Steam Generators
HV	High Voltage
I&C	Instrumentation and Control
IPP	Independent Power Producer
ISO	Independent System Operator
kWh	Kilowatt Hour
LED	Light-Emitting Diode
LEGSP	Libya Emergency Grid Stabilization Program
LFO	Light Fuel Oil
LLIDF	Libya Local Investment and Development Fund
LPFM	Libya Public Financial Management Project
LV	Low Voltage
LYD	Libyan Dinar 1 LYD = USD 0.64 (10/01/2016)
MENA	Middle East and North Africa
MoF	Ministry of Finance
MW	Mega Watt, 1000 Kilowatts
MWh	Megawatt-Hours
MV	Medium Voltage
NCC	National Control Centre
NOC	National Oil Company
OEM	Original Equipment Manufacturer

O&M	Operations and Maintenance
PPA	Power Purchase Agreement
PPP	Public Private Partnership
PV	Photovoltaic
RCC	Regional Control Centre
RE	Renewable Energy
RFP	Request for Proposal
SCADA	Supervisory Control and Data Acquisition System
SOE	State-Owned Enterprise
SMT	Senior Management Team
ST	Steam Turbine
T&D	Transmission and Distribution
TILs	Technical Information Letters
TOU	Time of Use
TWh	Terawatt-Hour
UN	United Nations
UNEP	United Nations Energy Programs
UNSMIL	United Nations Support Mission for Libya
USAID	United State Agency for International Development
USD	United States Dollar

Executive Summary

Since the revolution, the electricity situation has been deteriorating. This is due to breakdown in the tariff collection system which then incentivized consumption. The lack of tariff collection deprived GECOL with funds that it could use to maintain and develop its system. This, combined, with the lack of efforts to improve energy efficiency, resulted in a growing disparity between energy supplied and energy demanded by consumer. During the summer of 2018 and 2019, a nearly 50% disparity led to widespread blackouts which resulted in riots and threatened the stability of the government. If no intervention was taken the supply and demand gap would have exceeded 50% by the summer of 2021, resulting in grid wide blackouts.

Beginning in 2020, pursuant to government's requests, a coalition of organisations, including USAID, UNEP, UNDP, World Bank, and UNSMIL came together to merge their comparative capacities to support the restoration of the electricity grid and avoid its collapse. In consultation with GECOL, these organisations developed the Libya Emergency Grid Stabilisation Program which was endorsed by the GECOL Executive Committee in February 2021. This programme included nine components which if implemented would not only stabilise the grid but improve overall energy efficiency, policies and lower cost.

1. Power plant emergency turnaround programme;
2. Transmission and fuel supply repair projects;
3. Grid E- management systems;
4. Operational management load shedding;
5. Industrial energy demand management agreements;
6. LED lighting fast track replacement project;
7. Energy Efficiency Policies: Minimum Energy Performance Standards (MEPS) preparation;
8. National sustainable energy strategy - 2035;
9. Renewable energy project development.

The EU funded LESST project emanated from this program. It aimed to support the implementation of components 1, 2, 4 and 7, with other components supported by other donors.

The project successfully achieved a large part of its proposed core result or outcome: *"The stabilization, reform, and transition of the national electricity sector in Libya"*. Breaking down the components of this outcome:

- Stabilization was achieved in full, but for an indeterminate duration.
- Significant support was provided to support early reform work
- The practical transition of the electricity sector is now just starting, and the project played an overall small but not negligible role in triggering this.
- National sustainable energy strategy - 2035 has been prepared.

The project achieved the first two of its three outputs, which covered 90% of the project scope of work and all of the EU financed work. This is despite some reorganization at the activity level. The third co-financed output was not achieved, as the desired impact was not achieved despite completion of the planned activities. So, overall the project was considered successful.

The LESST project fitted within a larger framework of international support to the Libyan energy sector. These other projects ran in parallel and are continuing, so the gains secured by the LESST project are being sustained and built on.

1 Introduction

1.1 Document purpose and context

UNEP and UNDP have been cooperating on Libyan energy sector support work since 2019. The UN work in turn fed into an ongoing international and national working partnership, which is focused on both maintaining critical electricity and electrically power water supply services and commencing a national transition to more sustainable forms of electricity generation and consumption. The UN work was and is continued to be supported by multiple donors, via multiple grants with different schedules.

This is the completion report for work supported by an EU grant over the period January 2021 to December 2022. The grant was implemented via a UN Multi-Partner Trust Fund Joint Programme, with UNEP and UNDP working closely together whilst implementing specific outputs.

The JP was aligned with both the current UN national strategy and global sustainable development frameworks, contributing to SDGs 6, 7, 8, 13 and 16. It was implemented using the combination fund management modality according to the United Nations Development Group (UNDG) Guidelines on UN Joint Programming.

The key national partners and stakeholders in this JP included the Government of Libya Planning Ministry, Finance Ministry, and the State Owned Enterprises for electricity (Gecol), water supply (GMMRA) and oil production (NOC). Key international partners included the World Bank, USAID, and the European Commission.

This completion report should be read in conjunction with the original JP Document attached to the EU-MPTFO Grant countersigned in December 2020. It covers the evolving national context, the results achieved compared to the agreed results framework, the challenges noted and lessons learned.

Note that whilst this specific work is completed, the UN partnership on energy in Libya continues and so the progress and lessons learned have to a large part already been absorbed into the design, planning and implementation of other projects.

1.2 Summary results framework

Project Summary Results Framework
Outcome. The stabilization, reform, and transition of the national electricity sector in Libya
Output 1. The operational performance of the national electricity grid is stabilized in 2021 and improved in 2022 (UNEP led)
Activity 1.1. Joint development and costing of an urgent Gecol engineering repairs list and associated workplan, including facilitation of Gecol-GoL negotiations with international vendors to enable them to restart critical works.
Activity 1.2. Facilitation of GoL financing of the repair workplan and tracking of fund disbursement and procurement.
Activity 1.3. Facilitation of a Gecol-GoL owned national and subnational load shedding schedule with municipalities and other groups
Activity 1.4. Facilitation of a MMRA and Gecol project plan for improving MMR electrical self-sustainability and demand reduction
Activity 1.5 Joint analysis of interim results of all intervention options and development of a high-level national masterplan for stabilization by end 2021
Output 2: National policy and governance is advanced in the electricity sector support (transition to sustainability) (UNDP led)
Activity 2.1. Gecol operational management analysis
Activity 2.2. A progress review, update and ongoing implementation support for the Electricity Sector Reform roadmap, includes preparation a National sustainable energy strategy - 2035
Output 3: The Tripoli UNH project proposal is initiated, providing a forum for resolution of longstanding national obstacles to energy project financing and approvals (UNEP led – co financed)
Activity 3.1. Project feasibility study and consultation

2 Pre-project situational background

2.1 The Libya electricity sector

At the start of the project in January 2021 the Libyan national electrical grid was in a deepening crisis. The summer of 2020 saw extensive blackouts sometimes lasting over 12 hours. The situation affected all Libyans, causing severe hardship and triggering widespread civil unrest that damaged the legitimacy of the Libyan government.

The national-international partnership was created in October 2020 to respond to the crisis. The team studied the current situation, gathered data including conducting site visits to nearly all the power stations in Libya and developed a set of grid performance forecasts for 2021 to 2023. The forecasts are grim. Although Libya has 10,236 MW of installed capacity, it only produced an average of 5,300 MW. Due to ambient temperatures and other factors, this number drops to 3,700 MW of electricity during summer. A figure which coincides with Libya's peak demand which in August 2019 was 7,639 MW. This is a supply-demand deficit of 46%.

In the absence of immediate and large-scale intervention, grid performance was forecast to get significantly worse and collapse in stages starting in 2022. Summer 2021 would see very extensive blackouts, potentially far worse than 2020. By summer 2022-23, the national grid would no longer exist in operational terms as the grid would fragment into mini grids each focused on one or a grouping of functional power stations.

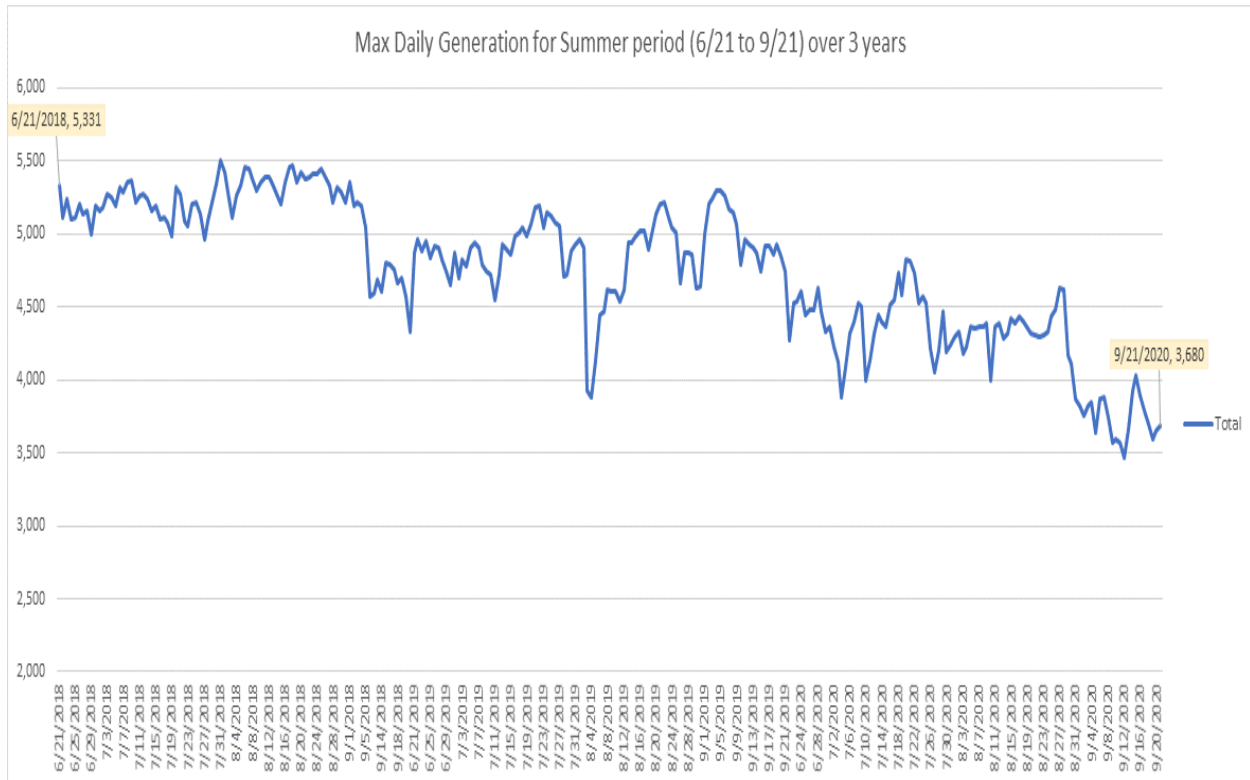
This forecast represented an existential threat to the stability of Libya and so was considered to represent a national emergency that demands a national scale emergency response. Much of what needs to be done was largely already known. However, GECOL was unable to address the current crisis on its own. In 2020 GECOL recovered approximately 10% of its operating costs and for many reasons has been unable to adequately maintain the national power generation fleet since 2012.

Addressing the current crisis requires a basket of interventions on both the supply and demand side. On supply, a \$2 billion backlog in power plant maintenance and repairs was the single most important direct cause of the increasing blackouts.

On the demand side, Libya lacked a common and transparent load shedding schedule. Large electricity consumers including cement and steel factors operated during peak demand. This needed to change. Additionally, energy efficiency offered the potential for further dramatic savings in energy demand reduction.

Finally, the situation was and remains economically non-sustainable. The country can no longer afford to consume half of its refined fuel, a cost upwards to USD 2 billion annually, for domestic electricity production. To unlock its potential, a set of legal, regulatory, and financial mechanisms needs to be developed to incentivize private sector investment in renewable energy and other energy services provisions.

Decreasing grid performance forecast during summer 2021



GECOL has detailed records for daily generation from its entire fleet. Its performance from 2018 to 2020 for the critical summer period is summarized in the graph below. In summary, peak generation has varied up to 20% daily, but the multi-year trend is very clear. From June 2018 to September 2020, peak generation dropped from 5,331MW to 3,680MW, a decrease of 1,651MW or 31%, or over 15% per calendar year.

2.2 Root Causes of Libya's Energy Crisis

In 2010 Libyan citizens benefited from very high levels of electrification and very low electricity tariffs, all of which were financed through oil exports. Nine years of conflict, instability, and economic decline, however, have undermined the electricity sector whose performance has decreased despite increasing operational costs.

The root causes of the decreasing performance and unsustainability of the electricity sector are structural and historical. Historically, Libya has maintained a heavily subsidized tariff rate at \$0.028/KWH, far below costs. Collection of revenues billed under this low tariff, however, decreased progressively after 2010 and is now about 13% of the operating cost. For example, between 2010 and 2015 revenue collection decreased while consumption demand increased from 32.5 TWh in 2010 to 40.3 TWh in 2015, making Libyan per capita consumption significantly higher than its regional comparators. Although this trend is most effectively addressed by increasing the tariff and revenue collection, doing so is difficult given the political instability and the decreased electricity quality received by consumers.

Structurally, the Libyan electricity sector is run by GECOL, a vertically integrated State monopoly. Prior to 2013, GECOL reported to the Ministry of Electricity and Renewable Energy but after this ministry became defunct, GECOL now reports directly to the General Assembly and the Presidency Council. The utility proposes its own regulations and pricing. The absence of a comprehensive energy law and policy framework has impaired the participation of the private sector, including the adoption and deployment of renewable energy sources.

The lack of a sector oversight authority capable of coordinating policy development and communications between government agencies also complicates efforts to develop a load shedding regime that effectively and reasonably shares the burden of generation capacity deficits.

To cover its operational losses, GECOL receives several subsidy streams. The Chapter Four subsidy budget line, which ranges between 820-720 million LYD annually, covers most of the 1 billion LYD of GECOL employees' salaries, a cost which has grown over the past decade due to the doubling of GECOL staff which now number 42,565. Both East and West receive Chapter 3 development spending, with the 2020 budget providing 600 million LYD versus 900 million in 2019. Fuel, which the NOC provides to GECOL without payment and represents approximately half of all natural gas produced, and refined fuel consumed in Libya, are valued at 463 million LYD at the low local price and ranges in cost from \$1.6 - 2 billion annually at international prices.

To improve governance, performance, and financial viability, in 2018, GECOL developed and approved a Libya Electricity Sector Reforms Roadmap (with the assistance of USAID) which recommended a series of short term, medium term, and long-term interventions to resolve the current Libya electricity crisis. The Roadmap outlines a series of actions needed to achieve the goal of solving Libya's current electricity crisis and transforming the electricity sector from a government subsidized sector to a commercially viable sector. The World Bank has also completed a comprehensive technical assistance and final report in 2017-18 aimed at identifying and recommended a series of actions to improve the Libya electricity sector.

The availability of reliable and affordable electricity is considered a prerequisite for driving implementation of sector reforms. In the absence of reliable electricity, many elements of the reform are difficult, if not impossible, to enact, particularly implementation of higher tariffs that are needed increase revenues. Achieving higher levels of reliability requires a power generation fleet and grid capable of producing and distributing sufficient electricity. But since the approval of the Roadmap in 2018,

electricity supplies have progressively diminished, primarily because of the lack of required generation fleet maintenance.

Engineering analysis by GECOL and its international partners (presented below) indicate that in the absence of a substantial and rapid turnaround in performance, the national electricity grid would have effectively collapsed in summer 2021. In short, the electricity situation was already in crisis and the situation would have got much worse in a short time unless immediate action and urgent corrective measures are implemented.

3 LESST Project Results

3.1 Results summary

The project successfully achieved a large part of its proposed core result or outcome: “*The stabilization, reform, and transition of the national electricity sector in Libya*”. Breaking down the components of this outcome:

- Stabilization was achieved in full, but for an indeterminate duration;
- Significant support was provided to support early reform work;
- The practical transition of the electricity sector is now just starting, and the project played an overall small but not negligible role in triggering this.

The project achieved the first two of its three outputs, which covered 90% of the project scope of work and all of the EU financed work. This is despite some reorganization at the activity level. The third co-financed output was not achieved, as the desired impact was not achieved despite completion of the planned activities. So, overall the project was considered successful.

The LESST project fitted within a larger framework of international support to the Libyan energy sector. These other projects ran in parallel and are continuing, so the gains secured by the LESST project are being sustained and built on.

The results framework table is presented again below with updates. Details on each outcome are described further in the following sections.

Project Summary Results Framework
Outcome. The stabilization, reform, and transition of the national electricity sector in Libya
Output 1. The operational performance of the national electricity grid is stabilized in 2021 and improved in 2022 (UNEP led) Achieved.
Activity 1.1. Joint development and costing of an urgent Gecol engineering repairs list and associated workplan, including facilitation of Gecol-GoL negotiations with international vendors to enable them to restart critical works. Completed Q1 2021
Activity 1.2. Facilitation of GoL financing of the repair workplan and tracking of fund disbursement and procurement. Completed Q1 2021
Activity 1.3. Facilitation of a Gecol-GoL owned national and subnational load shedding schedule with municipalities and other groups Completed Q3 2021
Activity 1.4. Facilitation of a MMRA and Gecol project plan for improving MMR electrical self-sustainability and demand reduction Completed to a basic level, work ongoing via other projects.
Activity 1.5 Joint analysis of interim results of all intervention options and development of a high-level national masterplan for stabilization by end 2021 Joint analysis conducted Q4 2022 and high level masterplan delivered via support on national policy.

Output 2: National policy and governance is advanced in the electricity sector support (transition to sustainability) (UNDP led) Achieved
Activity 2.1. Gecol operational management analysis Only basic analysis conducted and effort redirected to national policy development.
Activity 2.2. A progress review, update and ongoing implementation support for the Electricity Sector Reform roadmap Substantial detailed policy and regulatory support work delivered on general energy policy, renewables and energy efficiency.
Output 3: The Tripoli UNH project proposal is initiated, providing a forum for resolution of longstanding national obstacles to energy project financing and approvals (UNEP led – co financed) Not achieved
Activity 3.1. Project feasibility study and consultation Initial feasibility study indicated non-feasibility due to UN organizational and site technical issues and national context. The activity was therefore completed and the UNH project was not progressed any further.

3.2 Output 1 results analysis

Output 1: The operational performance of the national electricity grid is stabilized in 2021 and improved in 2022

The key steps entailed in achieving this output started in 2020, with the development of a broad partnership and the development of a jointly owned strategic document: The Libya Emergency Grid Stabilization Plan (LEGSP). The LEGSP partnership key members were Gecol, the UN (UNEP, UNDP and UNSMIL) and USAID.

The key recommendations in the LEGSP and cost estimates are reproduced in the table below and the LESST Activities were aligned to each of the plan’s priorities.

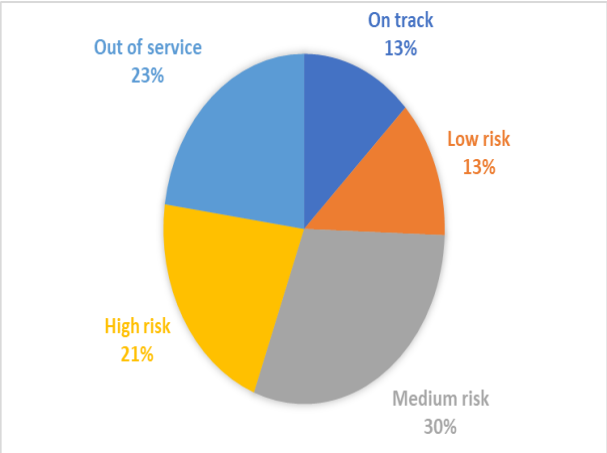
COMPONENT	BUDGET
1. Power plant emergency turnaround programme	1,300 MUSD
2. Transmission and fuel supply repair projects	100 MUSD
3. Grid E-management system	80 MUSD
4. Operational management load shedding	0
5. Industrial energy demand management agreements	0
6. LED lighting fast track replacement project	120 MUSD
7. Renewable energy project development	80 MUSD

Component 1: turning around the the power plant fleet. The UN supported this process with both reactive technical assistance and proactive development of a range analysis tools used to determine the state of the fleet and organize the turnaround.

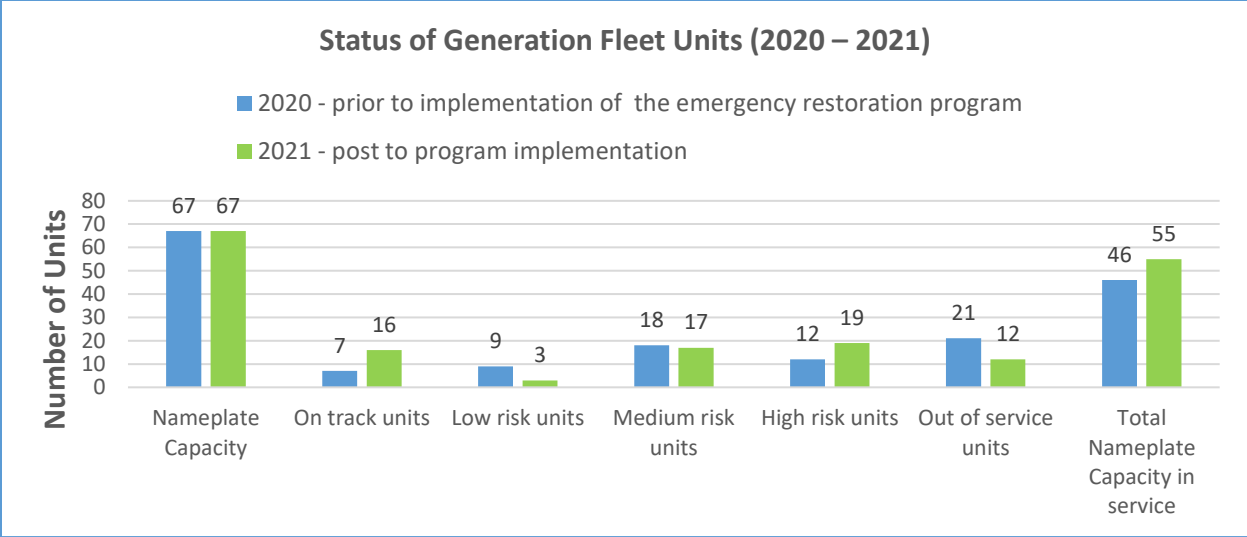
The first stage was the development of a comprehensive risk based maintenance status database for all Gecol power units. The information, terminology and overall management framework linked to this database then enabled Gecol management to better understand its priorities and reorient and accelerate its work. This reorientation started in 2020 and delivered a significant impact in 2021, as Gecol was able to best use funds finally released by the national government. Additionally, the maintenance contract procurement system employed by Gecol was greatly upgraded.

By 2021, all GECOL turbine units had been inspected and prioritized in terms of mainatanance. This maintainance schedule would roll out over the next two years progressively bringing back existing capacity onto the grid.

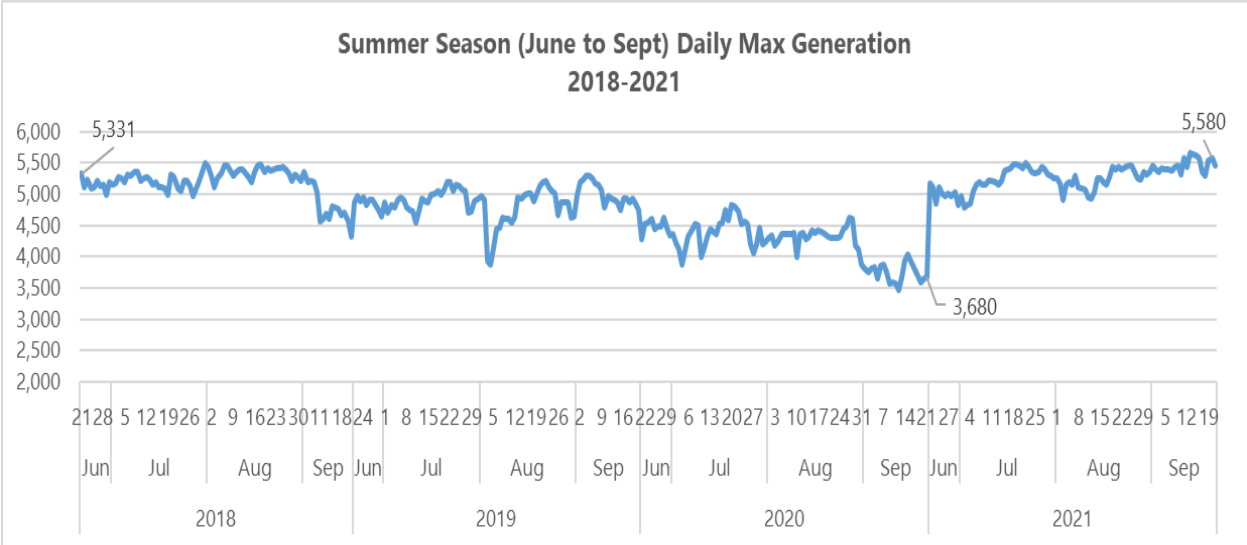
Maintenance Systems Improved to Restore Existing Capacity



As a results of these efforts, the number of in-service unit increased by 9 units, from 46 to 55. Peak generation increased from 3,680 MW to 5,5680 MW, nearly 51%.

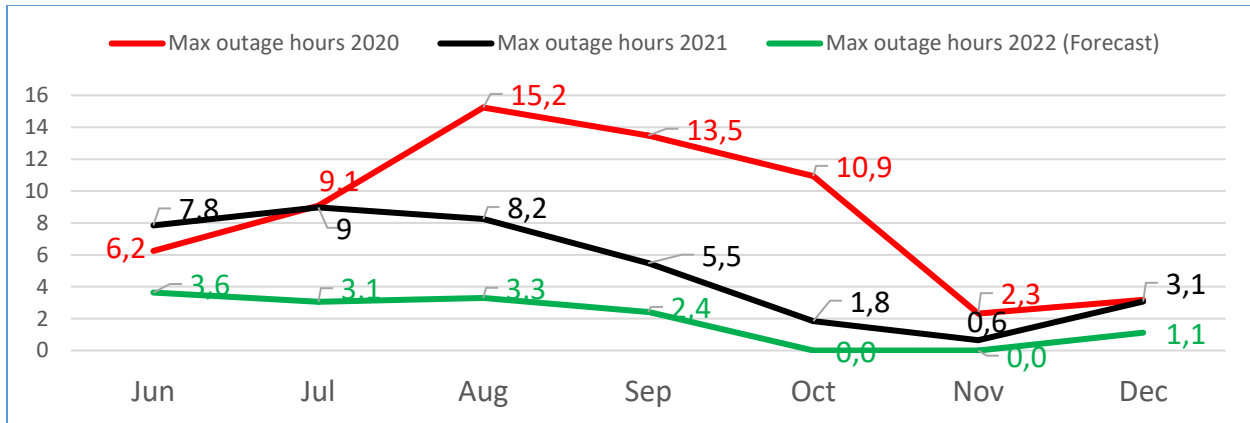


The summer heat impacts on the aging plant reduce the generation capacity of the in-service fleet by up to 35%. This is a combination of the normal impacts of heat on optimally maintained gas turbines (up to 20%) and the special precautions GECOL needs to take for protecting their older and non-maintained units (0 -15%). The practical impact of the low and reducing generation capacity only becomes apparent when it is compared to the electricity demand. Demand can exceed supply when either a) the demand grows beyond the capacity of the fleet in operation at any instant or b) generation capacity drops suddenly when a unit breaks down. When this happens, an excess load is placed on the remaining generation units.



Due to increased supply of electricity as a result of the return of existing capacity, there was a progressive improvement in service. From 2020 to 2021, the percentage of time where there were no outages increased from 46% in August to 59% in September to and 83% by October 2021. If improvements of this nature continue, it is expected that this positive trend could continue.

Forecasted vs. Actual outage hours



Component 2: The UN did not provide tailored support on this component.

Component 3: the grid E-management system. The system that maintains balance within the grid is informed by an industrial data system called Supervisory Control and Data acquisition (SCADA). SCADA provides an interfaces which enables GECOL to monitor and issue process commands to the electricity providing turbines. The system controls large-scale processes that coordinates the operation and cooperation of multiple electricity generation sites. An operating SCADA system contributes to system stability.

For the last ten years in Libya, the SCADA system was almost completely non-functional. This has led to major difficulties to control and operate the High & Low voltage Libyan Networks. These issues have made the manual load shedding scheme problematic to apply to stabilize the system during generation shortage periods. The slow and incomplete load shedding has in turn led to major frequent national blackouts. To resolve this issue, a national rehabilitation project must be urgently commenced to regain the control of the NCC and RCCs over the power stations and High, Medium, and Low voltage systems.

As a result of this project, an in-depth investigation of the SCADA system revealed that data availability is still well below the acceptable level, which is around 33%. With the support of LESST, GECOL began to rehabilitate the SCADA system and undertake effort to re-establish data communications links and real-time monitoring capabilities.

Component 4: Load shedding. This activity was led by Gecol, and USA LPFM teams and UNEP provided technical support. Severe forecasts of grid overloading for the 2021 summer season generated strong momentum to improve load shedding and communications compared to previous years. A contingency schedule was developed by Gecol and presented to many municipalities. Positive feedback from these meetings and ongoing Gecol public communications has resulted in a high level of understanding of the need for shedding and the parallel work on permanent solutions. As a result, the population is unhappy but well informed at least.

Component 5: Industrial energy demand management agreements. The UN did not provide tailored support on this component.

Component 6: LED lighting fast track replacement project. The UN working with USAID provided extensive support on this component and effectively developed a complete concept note and implementation plan, including market outreach on bulb availability and pricing. The analysis indicated

that implementation of a comprehensive plan, at a cost of US\$ 120M, could potentially reduce demand by over 300MW. The concept note was delivered to the national government, however the latter failed to act on the recommendation.

Component 7: Renewable energy project development. The UN focused its support on this component to a) continuing to progress the SouthWest Libya solar PV concept and b) engaging with the MMRA on its energy needs and potential renewable energy solutions. As of end 2022 this work continues via other projects.

3.3 Output 2 results analysis

Work on Output 2 did not advance at all in 2021 and then advanced dramatically in 2022.

In 2020, the central challenges were a) a lack of any central or authoritative government authority working on energy policy and b) poor access and results from attempts to influence the generic central authorities such as the Prime Ministers Office.

In Q1 this changed rapidly when the PM mandated the National Economic and Social Development Board (NESDB) to work on energy topics. Specifically the PM formally mandated the NESDB to develop a standing committee for electricity sector policy and another for the oil sector. The CEO of the NESDB reached out the UNDP senior consultant to lead the electricity committee. This was agreed and the consultant has played a leading role in the committee's work since Q1 2022. UNEP provided and still provides remote support.

The specific outputs and achievements included:

- Formulation the first National Sustainable Energy Strategy till 2035 in collaboration with main national stakeholders, which aims to review options for the future development of the electric power, renewable energy, and energy efficiency sector in accordance with an integrated view of the energy, through analysis and evaluation of the current situation.
- Preparation of the organizational structure for the Public Utilities Regulatory Authority. This body is the Regulator body for the public utilities and includes the following sectors: Electricity & gas, communications, and water and sanitation. The documents are sent to the government for approval and issuance of the decree.
- Preparation of the Renewable Energy Law.

The NESDB mandate and the UN contribution was expanded in Q3 2022 with a request to form an energy efficiency committee and associated policies and standards. All of this work is now ongoing via other projects.

The committee has worked on an array of detailed policies, standards and guidelines and progressed several of them through to formal approval by either decree or through the national inter-ministerial board for standards. This means in effect the developed policies are now officially in place, with government organizations such as the customs agency mandated to apply the supplied standards.

The specific outputs and achievements included:

- Establishing legal framework for energy efficiency standards;
- Setting up minimum energy efficiency standards (MEPS) for air conditioners in the first phase, followed by refrigerators, lightings and other appliances in the subsequent phases,
- Designing the types of energy efficiency indicators and rating scale to be adopted for each appliance;
- Introducing energy labelling for selected electrical appliances;
- Minimum energy performance standards and labelling were developed for non inverter type and inverter type, with a capacity until 70,000 BTU. The standard is approved and issued with number LNS 1030;
- Minimum energy performance standards and labelling were developed for LED lamps;
- Minimum energy performance standards and labelling were developed for Refrigerators;
- Minimum energy performance standards and labelling were developed for water electrical heaters.

3.4 Output 3 results analysis

This output was implemented by UNEP, using small scale co-financing (US\$ 80,000) provided by the Government of Norway, as a small part of a GoN:UNEP global partnership.

The first and core activity was conducting a feasibility study for the proposed new solar PV project at the UN central facility in Tripoli. The study however indicated the project was not feasible. The key negative issues noted included the following:

- The main UN facility in Tripoli is actually rented by UNSMIL as a fully serviced facility, including the provision of electricity and water. The UN therefore has no financial incentive and no contractual capacity to change the electricity supply solution for the site.
- The tariffs that Gecol charges the landlord for electricity are very low. In the event of a Gecol blackout, the UN provides its own emergency backup supply via generators. Hence there is no financial nor service responsibility incentive for the landlord to change the electricity supply solution for the site.
- The UN mission in Libya (UNSMIL) was the main tenant of the site. The mandate of UNSMIL has been continuously challenged, causing high uncertainty on its ongoing occupation of the site.
- The energy upgrade of individual UN sites is happening in many countries. However to date, the UN in general has been unable to create a fund or reliable central source of financing for solar PV upgrades of its operating facilities. Financing energy upgrade projects remains therefore an ad hoc process, with prioritization of sites given to those with the highest feasibility. This means that the UNSMIL managed facility in Tripoli is effectively not a priority for upgrading.

The original concept was that if the project appeared feasible, then it could serve as a useful demonstration project for Libya. However given the clear negative feasibility study result, it would have been unwise to attempt to build the project – the objective was a positive demonstration case rather than the simple construction of a solar PV facility, irrespective of utility and economics. The activity was therefore completed and the UNH project was not progressed any further.

4 Risk management and lessons identified

4.1 Risk management

The 2020 project design included a risk identification and management process, summarized in a Risk Management Table, which is reproduced below. Multiple risks actually converted to events over the 2 year implementation period. The status of each risk and the response of the project management team is appended to the table in the final column: *Implementation history and project response*.

In summary the key risks that were realised and managed were:

- Project team stability.
- COVID 19.
- Internal political issues linked to the fossil fuel economy and over-reliance.
- Key personnel changes in GoL counterpart organizations.
- National budgeting process paralysis affecting development project funding.
- National scale ongoing instability and periodic armed conflict and security incidents.

Virtually all of the risks were pre-identified, but not all could be mitigated once they were realised. For example, the national instability and security problems affected all aspects of life and recovery in Libya.

4.2 Lessons identified

The project overall succeeded in achieving its outcome despite multiple foreseen risks and challenges, so the majority of lessons identified were positive. The key lessons are described in turn below.

Design and planning flexibility

Multiple international, national and smaller scale challenges continued and/or arose immediately before and throughout the project. The project was able to mitigate the impact of these however, in large part due to its flexibility in design and planning that enabled it to redirect and tune efforts without significant damage.

To insulate itself from becoming stalled, the programme deliberately included multiple components and parallel tracks that could work in parallel to each other. While all components contribute to closing the supply-demand gaps that cause blackouts and force load shedding, the cross dependencies between components are minimized to reduce the risk of progress across the programme being blocked by issues with one component. All components started in Q1 2021, noting that the benefits and impacts of some components will not be externally visible for 18 months or more. This extended schedule also enabled resource switching between activities without much impact.

Leverage of political emergencies to enact change

Gecol was noted as both problematic and difficult to influence prior to 2020. The extremely poor electricity sector performance in 2020 however resulted in the national leadership applying severe

pressure to the Gecol leadership. This in turn improved the receptivity of Gecol to external support and advice.

Public utility transparency and communication benefits

Grid performance was very poor in 2021. In 2020 this poor performance resulted in riots, but not in 2021 or 2022. One difference was an increase in transparency and better communication by Gecol. Practical measures such as developing a load shedding schedules and developing a Gecol app for client phones helped improve trust and tolerance of the ongoing problems. This connection also help minimize blackouts, as citizens voluntarily reduced their electricity demands in peak times in response to Gecol warnings.

Focused and in depth technical assistance and capacity building

The TA and capacity building provided to the Libyan partners, whether the Gecol, the NESDB and the Libyan National Center for Standardization and Metrology, was very important technically and focused on specific issues in accordance with the requirements of the Libyan partners.

Partnerships

The LESST provided an important example of national-international partnership. It was developed and implemented by a joint national-international partnership. Capital financing was provided by the national government of Libya. The programme was implemented by GECOL and other national institutions with large scale outsourcing to national and international private sector engineering companies. Political, technical, managerial, and potentially logistical support was provided by a coalition of multilateral and bilateral organizations. Leadership was provided by a small national-international team of full-time senior personnel with oversight provided by a multi-party programme board.

The Gecol-USAID LPFM-UN partnership in particular was key to project success. This partnership was developed gradually over 2017-2020 principally by the LPFM team and then reinforced by the UN from 2020. The pre-existence of the partnership and associated trust enabled the rapid delivery, and acceptance, of more support in 2021 and 2022.

Libya LESST Project – Risk Management Table

Description	Type	Impact 1-5	Likelihood (1-5)	I*L	Status	Risk Mitigation measures & when	Implementation history and project response
1 The UNEP project team is insufficiently stable, large or skilled to deliver the project	Ops	4	3	12		Mobilize with a core team already contracted to UNEP and focus on supplementary recruitment . 2021	The project was 90% mobilized on schedule, then 2 key UNEP consultants resigned to take private sector jobs. Recruitment prospects were negative due to UN HR competitiveness issues. In response, the project team and schedule was redesigned to fit – extending duration for the remaining small team (1+ support) to deliver remaining outputs over 21 months
2 The international partnership upon which UNEP depends for political access and logistical support fades with changing partner priorities and/or key personnel	Ops	3	4	12		Establish independent direct routes to the GoL and reinforce and diversify linkages to UNSMIL and UNDP. Continue visible support to LPFM to help ensure ongoing USAID support. 2021+	The international partnership remained strong and a key project asset.
3 COVID 19 disrupts project delivery	Ops	3	4	12		Peak disruption is forecast for 2021, so focus on remote TA and mobilization. All team members to be vaccinated prior to missions. 2021+	Pandemic related disruptions were significant, with the main impacts being schedule delays and a reduction in face to face meetings with key national stakeholders. This is inferred to have reduced the impacts of the advocacy and capacity building work.
4 UN Libya security compliant accommodation space constraints block missions	Ops	4	4	16		Response is evolving. 2021+ New UNDP compound may mitigate this issue	This issue caused problems in Q2- Q4 021 but was resolved by UNDP in Q1 2022
5 Geopolitical alliances focused on fossil fuel sector and FF generation contracts derail the overarching RE and EE agenda of the GoL	Polit	5	3	15		Build and maintain strong linkages with GoL leadership and senior figures in the aid community: EC, USA, UK, Germany, Italy, WB, UN SRSG. 2021+	The results were mixed in this respect. On the negative side, Gecol maintained its historical commitment to adding more FF generation as its default solution for generation capacity shortages. No serious attempt was made to convert to RE sources. On the positive side, positive connections were made with the NOC leadership. They were also motivated for domestic electricity generation to switch to renewables, so incentives were and remain aligned. In response, the project team realigned its advocacy and outreach efforts toward the more receptive national stakeholders.
6 Priority conflicts and delays in the national budgeting process result in no RE or EE GoL financing for 2021 and potentially 2022	Polit	5	3	15		Maintain approach and progress viable and low regret activities pending top level approval – as the needs and business cases remain strong for the long term. Reschedule as needed and	The GoL 2021 budget impasse continued throughout 2021 and 2022. This particularly affected Gecol and the financing of new GoL development projects of all kinds. Hence the original risk management measures remained valid.

							then re-allocate across outputs as a last resort. 2021+	
7	Political shifts and personnel changes remove key contacts in counterparts: Min Planning, Gecol, MMRA	Pol lit	3	4	12		Build relationships at multiple levels in counterparts, including stable technical levels. Formalize relationships with an exchange of letters. 2021+	Leadership changes were seen in Gecol, REAOL and the NOC. In response, each change was managed individually. The main challenge noted was the inability to connect deeply with Gecol leadership. So this instead was left to USIAD team who had a better pre-existing relationship. REAOL also suffered from instability and personnel changes. So, instead the UN redirected efforts to NESDB and NOC.
8	Ongoing west- east political divide interferes with project support and approval	Pol lit	3	4	12		Build new relationships with eastern based counterparts. Equal focus on eastern project development. 2022.	Tensions and disruption levels remained very high. Armed conflict and security problems delayed missions and meetings throughout the project.

Annex A: Joint Programme Detailed Workplan – All donors and outputs

I D	Project Outputs & Activities	2021		2022				2023				2024				2025		
		3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	
	Project Outcome: The stabilization, reform, and transition of the national electricity sector in Libya																	
	Output A/1 Technical support provided to the GoL for grid stabilization																IMPLEMENTATION	
	EC approved funding window																NCE to Dec 2022 in process	
	1.1 Joint development and costing of an urgent Gecol engineering repairs list and associated workplan, including facilitation of Gecol-GoL negotiations with international vendors to enable them to restart critical works.																Completed Q1 2022	
	1.2 Facilitation of GoL financing of the repair workplan and tracking of fund disbursement and procurement																Completed Q4 2021	
	1.3 Facilitation of a Gecol-GoL owned national and subnational load shedding schedule with municipalities and other groups																Completed Q3 2021	
	1.4 Facilitation of a MMRA and Gecol project plan for improving MMR electrical self-sustainability and demand reduction																Ongoing TA – extended to Q4 2022	
	1.5 Joint analysis of interim results of all intervention options and development of a revised high-level national masterplan for stabilization by end 2021																UN paper planned for draft release Dec 2022	
	Output B/2. Technical support provided to GoL for the development of a national scale energy efficiency programme																IMPLEMENTATION	
	UK approved funding window																NCE in process July 2022	
	2.1 Detailed design and implementation support for the national LED lighting upgrade project																Work ongoing via NESDB support	
	2.2 Scoping, design, and approval of a national air conditioning upgrade strategy and project																Work ongoing via NESDB support	
	2.3 UNEP strategic review of broader EE and energy transition options inc gender aspects																Work ongoing on UN paper and NESDB support	
	EC CF funding window - forecast																	
	4.7 EE policy support																Follow on EC 2023 – 2025 funding	

Output C/3. Technical support provided to GoL for the early stage development of 3 Pioneer RE and emission reduction projects in Northern and Eastern Libya																				IMPLEMENTATION
UNEP Norway approved funding window	█	█	█																	Complete and reported
3.5 UN House Project Feasibility Study	█	█																		Completed early and clear neg result for feasibility study
3.6 UN House Project development support	█	█																		Cancelled due to negative feasibility study
UK approved funding window	█	█	█	█	█	█	█	█	█											NCE in process July 2022
3.1 MMRA EWF Project Feasibility Study								█	█											Rescheduled to start Q1 2023
3.3 MMRA Reservoir Project Feasibility Study								█	█											Rescheduled to start Q1 2023
3.7 NOC Flaring Reduction Project Feasibility Study										█	█	█	█							Start Q4 2022
EC CF funding window - forecast											█	█	█	█						
3.2 MMRA EWF Project development support											█	█	█	█						Rescheduled to 2023-25 for EC funding
3.4 MMRA Reservoir Project development support											█	█	█	█						Rescheduled to 2023-25 for EC funding
3.8 NOC Flaring Reduction Project development support																				Rescheduled to 2024-25 for EC funding. Other EC supported Libya methane support implemented via Global IMEO- OGMP project
Output D/4. Technical support provided to GoL post feasibility stage development of 1 Pioneer RE project in Southwest Libya																				MOBILIZATION
EC-UNDP approved funding window										█	█	█	█							DA in process
4.1 CS1 Project development Plan									█	█										Rescheduled to 2023
4.2 Supporting Gecol and UNDP in CS1 site selection									█	█										Rescheduled to 2023
4.3 Energy gender and safeguarding national guidance document									█	█										Rescheduled to 2023
4.4 CS1 site specific gender and safeguarding support											█	█								Rescheduled to 2023
4.5 Securing financing (Est.US4M) for the remaining project development activities													█	█						Rescheduled to 2023
4.6 Developing the project financing framework and securing the principal investor capital EOI															█	█				Rescheduled to 2023
EC CF funding window - forecast													█	█	█	█				
4.7 CS1 Project development support																				

