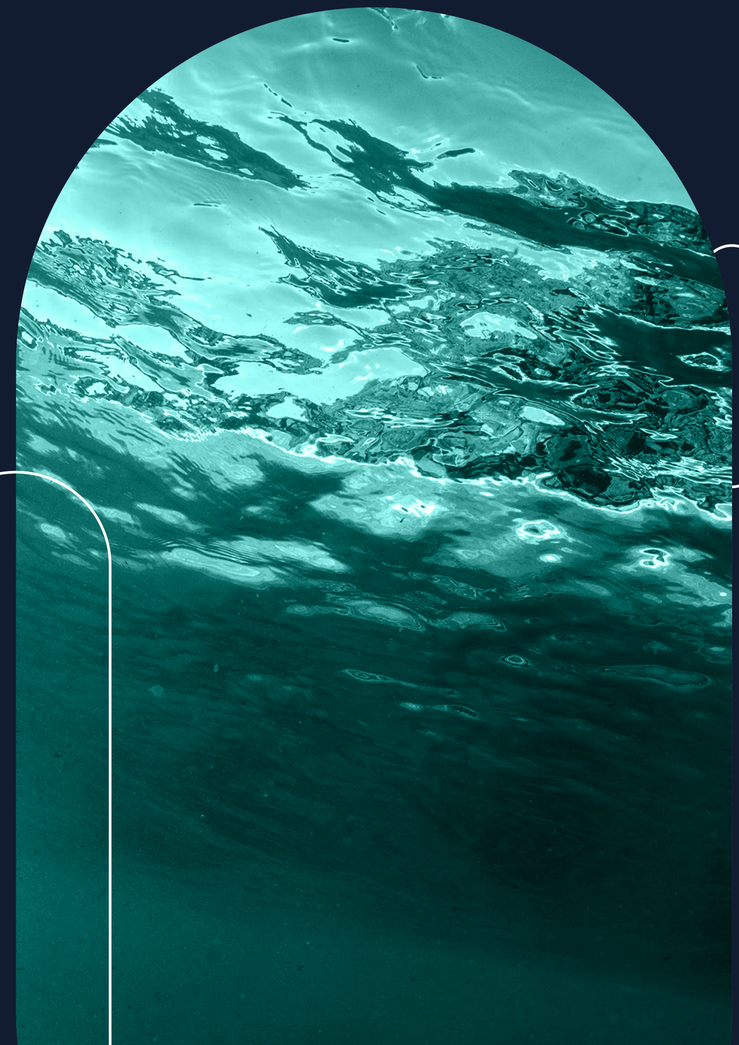
EWEC

Statement of Future Capacity Requirements

2022-2028

Summary Report

Emirates Water and Electricity Company



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Glossary

ADNOC	Abu Dhabi National Oil Company
BESS	Battery Energy Storage Systems
CCGT	Combined Cycle Gas Turbine
CO_2	Carbon Dioxide
COD	Commercial Operation Date
DoE	Department of Energy
EWE	Etihad Water and Electricity
EWEC	Emirates Water & Electricity Company
GW	Gigawatt
MIGD	Million Imperial Gallons per Day
MTPA	Million Tonnes Per Annum
PV	Photovoltaic
RO	Reverse Osmosis
SEWA	Sharjah Electricity and Water Authority
SFCR	Statement of Future Capacity Requirements
UAE	United Arab Emirates

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SUMMARY OF RECOMMENDATIONS

Based on our techno-economic modelling, we recommended in the 2021 SFCR:

- **Reverse Osmosis (RO): 200 Million Imperial Gallons per Day (MIGD) (910 m^3/d) by 2026**
  - Urgently progress the Mirfa M2 and Shuweihat S4 projects to improve system operability and achieve economic benefits as soon as possible;
  - Finalise sites for additional RO capacity on Abu Dhabi Island to reduce pumping costs and ensure timely deployment ahead of retirement of Sas Al Nakhl.
- **BESS: 100MW by 2025**
  - Procure at least 100MW x 1hr in 2025, optimised for providing operating reserves.
  - Undertake power studies to identify optimal network locations and finalise capacities to ensure secure power system operation.
- **Solar Photovolatics (PV): 1.5GW by 2027**
  - Immediately procure 1.5GW by 2027 to fully realise economic benefits through gas saving.
  - Identify and secure prospective sites for additional PV in the event that integration with bulk customers, CO_2 abatement policies or higher-than-forecast demand should occur.
- **Thermal Capacity:**
  - Secure 1.7GW by 2027 through new build, life-extension or reconfiguration of existing assets to replace portfolio capacity that reaches the end of its existing contract.
  - Enhance flexibility of existing fleet to ensure security of supply and system operability and meet projected water demand.

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INTRODUCTION

2.1 Purpose of Statement

The Emirates Water and Electricity Company (EWEC) is the single buyer and seller of water and electricity in the Emirate of Abu Dhabi. Under our licence, we are required to:

- Ensure that there is sufficient production capacity to meet all reasonable demands for water and electricity;
- Engage in the economic purchase of water and electricity production capacity; and
- Engage in the economic purchase of ancillary services and fuel.

We develop and publish a Statement of Future Capacity Requirements ("the Statement" or "SFCR") annually, which details our recommendations for achieving these obligations. This report summarises the recommendations for new capacity to be added to the system over the period 2022 to 2028. We interpret our economic purchase obligations as requiring the procurement of water and electricity (including ancillary services) in a manner which minimises the overall costs of the power and water systems for Abu Dhabi Emirate.

In minimising total system costs, we seek to optimise decisions to invest in new capacity, to reconfigure or augment existing production facilities, engage in trading opportunities with other entities both within and outside the United Arab Emirates (UAE), and retire older production facilities on contract expiry when they are no longer economical or required to maintain security of supply.

EWEC needs to adhere to two key security of supply standards: (1) Demand for power must be met, with a loss of load expectation not to exceed five hours per year, as defined in the Generation Security Standard (GSS) and approved by the DoE in its capacity of sector regulator; and (2) Demand for water must be met with a loss of load expectation not to exceed one day in 10 years, as defined in the Desalination Security Standard (DSS) and approved by the DoE in its capacity of sector regulator.

2.2 Approach to Identifying Efficient Investment

Our approach to identifying the least cost expansion plan in 2021 is based on the PLEXOS power and water system production cost model developed and refined over the past four years combined with a reserve margin requirement sufficient to meet the reliability standards required by our licence.

We have applied this modelling approach across a number of sensitivities around power and water system supply-demand fundamentals, reflecting the key uncertainties and choices facing EWEC as it plans the production capacity of the Sector. Our recommendations regarding future capacity expansions are primarily founded on a “Base Case” scenario in which we plan to meet demand growth within Abu Dhabi Emirate (consistent with the obligations in our licence), as well as the contracts for the supply of power and water that are in place today or that are in the process of being negotiated, notably ADNOC offshore and Etihad Water and Electricity (EWE).

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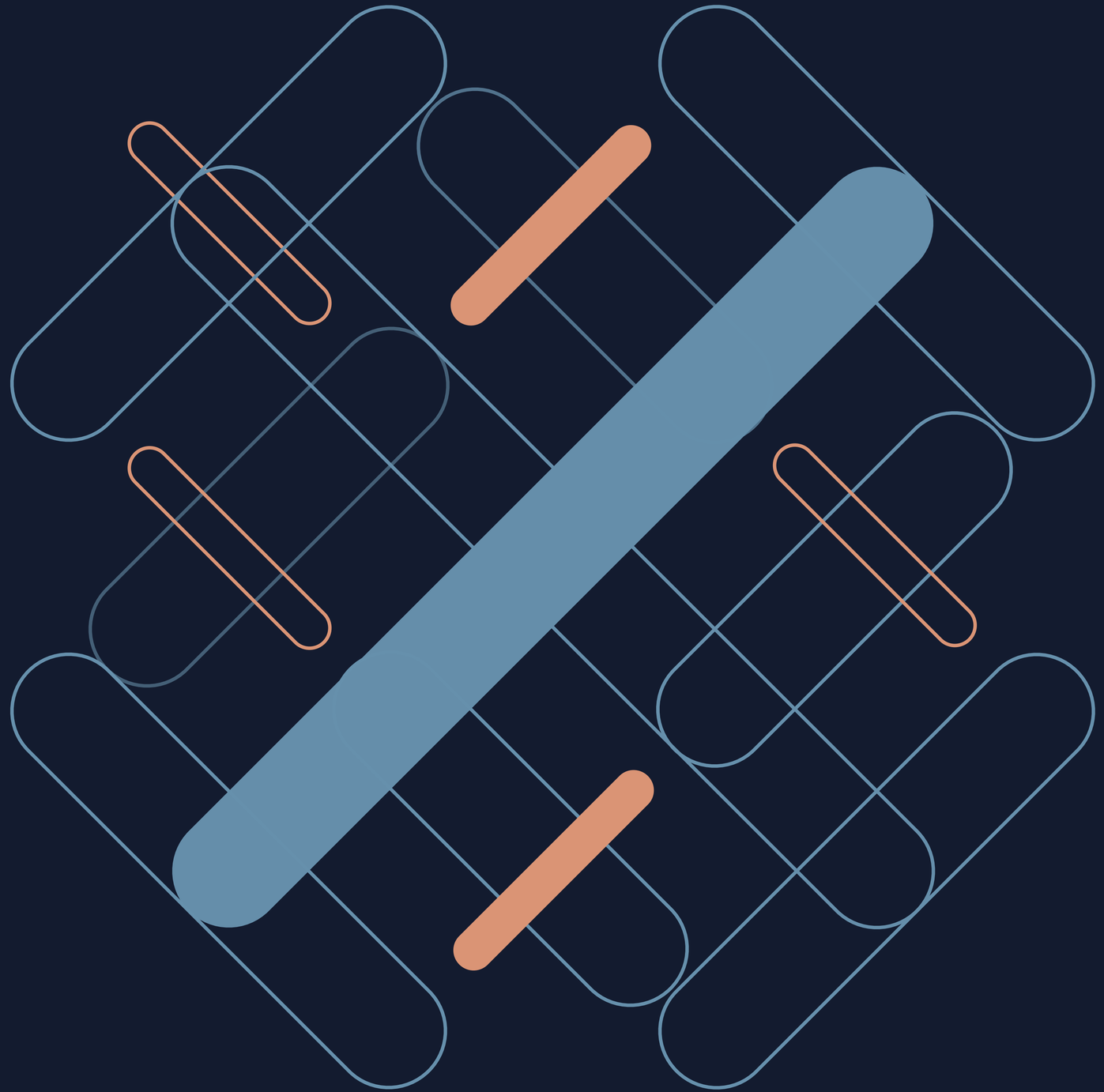
SUMMARY OF MODELLING ASSUMPTIONS



Since the 2020 Statement, the impact of COVID-19 has dominated the global economic outlook. COVID-19's effects on the power and water sector have had a material impact in terms of increasing the uncertainty of economic growth and associated short and mid-term forecasting of demand for power and water. Additionally, COVID-19 has heightened timing risk for the completion of construction and subsequent commercial operation dates for projects under construction. Finally, whilst there have been appreciable recent increases in global energy prices, our existing contracted gas position has meant that we have minimal exposure to this increase with correspondingly minor knock-on effects on short-term sector costs.

3.1 Demand Growth

We have used an August 2021 revision of our 2021 February (Week Seven) demand forecast that considers updated GDP projections provided by the Department of Finance. This indicates a faster than previously expected rebound in demand growth following the COVID-19 pandemic.

In addition to our Base Case view of demand we also assess eight demand sensitivities for their impact on our capacity expansion recommendations.

3.1.1 Power

Gross peak power demand is forecast to increase ~20% from 16.8GW in 2022 to 19.9GW in 2028.The otherwise consistent increase in peak and total energy demand from 2022 is impacted by a reduction in exports to Sharjah Electricity and Water Authority (SEWA) over 2022-2023 due to the commissioning of their new power plant and the addition of new ADNOC Offshore demand from 2026.

As Figure 3.1 illustrates, this forecast reflects an underlying increase in demand from 2022 onwards of approximately 10% compared with the 2020 forecast.

3.1.2 Water

Projected water demand has been less sensitive to uncertainties posed by COVID-19 but is nonetheless approximately 5% higher across the planning horizon than forecasted in 2020. As shown in Figure 3.2, the 2021 SFCR EWEC peak water demand is higher than the 2020 SFCR. However, in the 2021 SFCR, demand declines between 2022 and 2025 from 796MIGD to 783MIGD before rising to 803MIGD in 2028.

Figure 3.1: Base Case Global Peak Power Demand (Gross, GW), 2022-2028

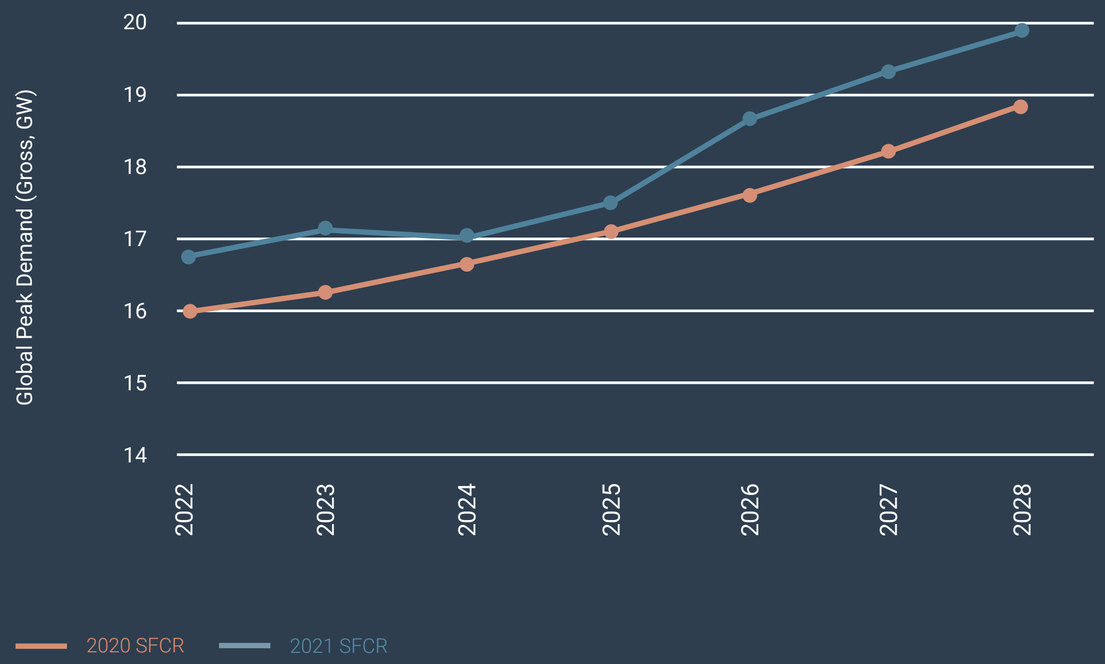
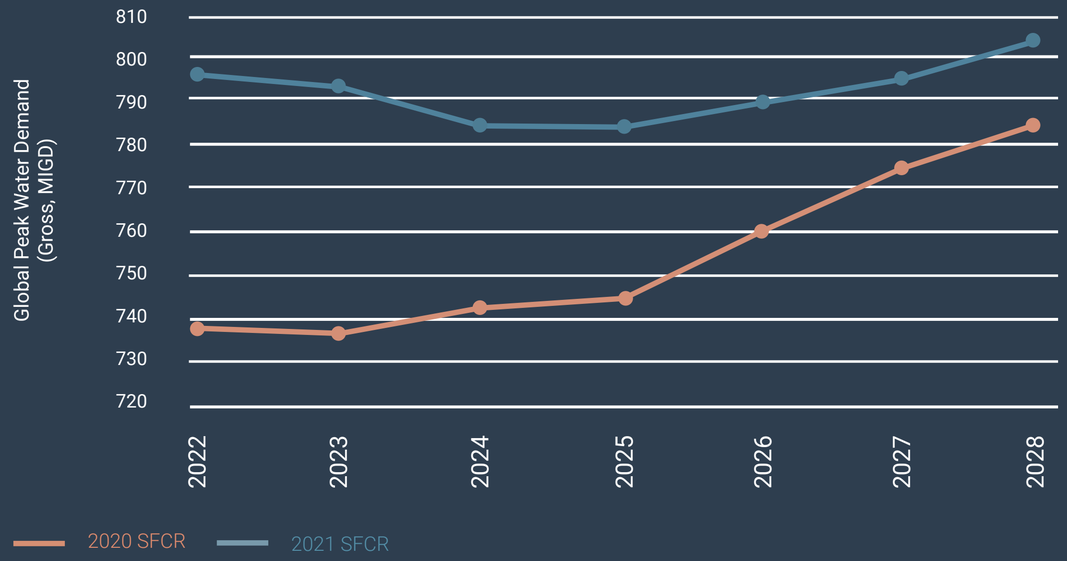


Figure 3.2: Base Case Global Peak Water Demand (Gross, MIGD), 2022-2028



3.2 Existing and Committed Supply

Since the 2020 SFCR major milestones have been realised on several projects. Barakah Unit 1 has successfully completed commissioning and achieved commercial operation on 1st April 2021, with Unit 2 under commissioning until 24th March 2022. Al Dhafra Solar PV is expected to achieve Commercial Operation Date (COD) in March 2023. Fujairah F3 has reached financial close with PCOD expected by 30th April 2023. Phase 1 of Taweelah RO has been successfully completed and has been supplying up to 100MIGD into the network from December 2021. Full PCOD is expected by the end of 2022.

As per the previous SFCR, we assume in our Base Case modelling that all existing assets will retire at the end of their contract lives.

3.3 The Costs of New Generation and Desalination Facilities

A key assumption that affects our capacity recommendations is the cost of new generation and desalination capacity. Under our base case scenario, we have taken the costs of new Combined Cycle Gas Turbine (CCGT) and solar PV from EWEC's most recent tenders for the F3 CCGT project and Al Dhafra Solar PV project respectively. We project these current costs into the future without speculating on potential future changes in technology costs.

3.4 Fuel

Our PLEXOS modelling accounts for the pricing and volumes of different tranches of gas available to the sector under current contracts.

To the extent that we need to procure gas outside of its existing contracts, we have formed an assumption through discussion with our suppliers regarding the long-term pricing of additional gas.

4

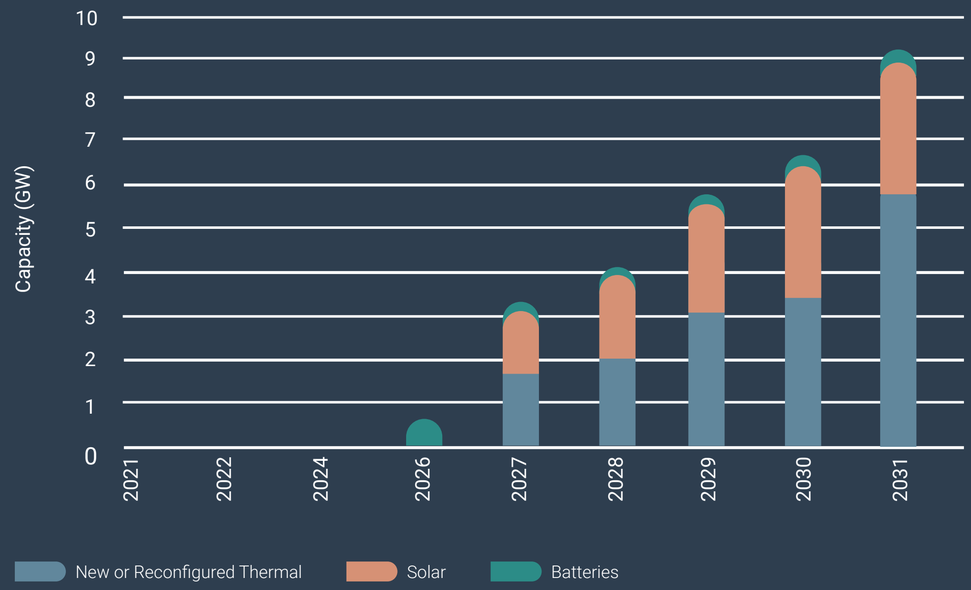
RECOMMENDATIONS

4.1 New Power Recommendations

Figure 4.1 shows our recommendation for new power capacity under the Base Case. Our modelling results indicate:

- C.1.5GW of solar PV is recommended in 2027 to offset rising fuel costs. 2027 is the earliest full year we assume is possible due to increasing asset development times.
- Significant additional thermal capacity is required in 2027 primarily to accommodate multiple retirements. This capacity has the potential to come from extension or reconfiguration of existing assets as well as new-build CCGT.
- Up to 100MW of reserve-optimised batteries (one-hour depth of storage) are recommended by 2025, increasing to 200MW by 2026 to support system operability in periods with high nuclear output and low power demand. Further studies are needed to identify optimal network locations and finalise site specific capacities to ensure secure power system operation.

Figure 4.1: Base Case Power Recommendations (GW), 2021-2031

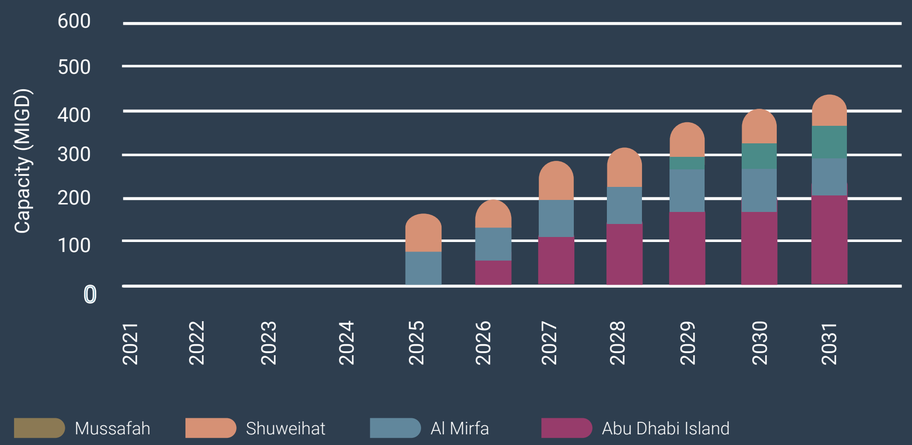


Our solar PV recommendations are reactive to a range of credible input assumptions. Sensitivities with cheaper solar PV or carbon support schemes show up to 3GW of PV by 2028 and growing rapidly thereafter. Accordingly, we must secure sites and develop business cases for materially more PV than recommended in the Base Case with a view to being able to quickly deploy additional capacity should the need arise.

4.2 New Water Recommendations

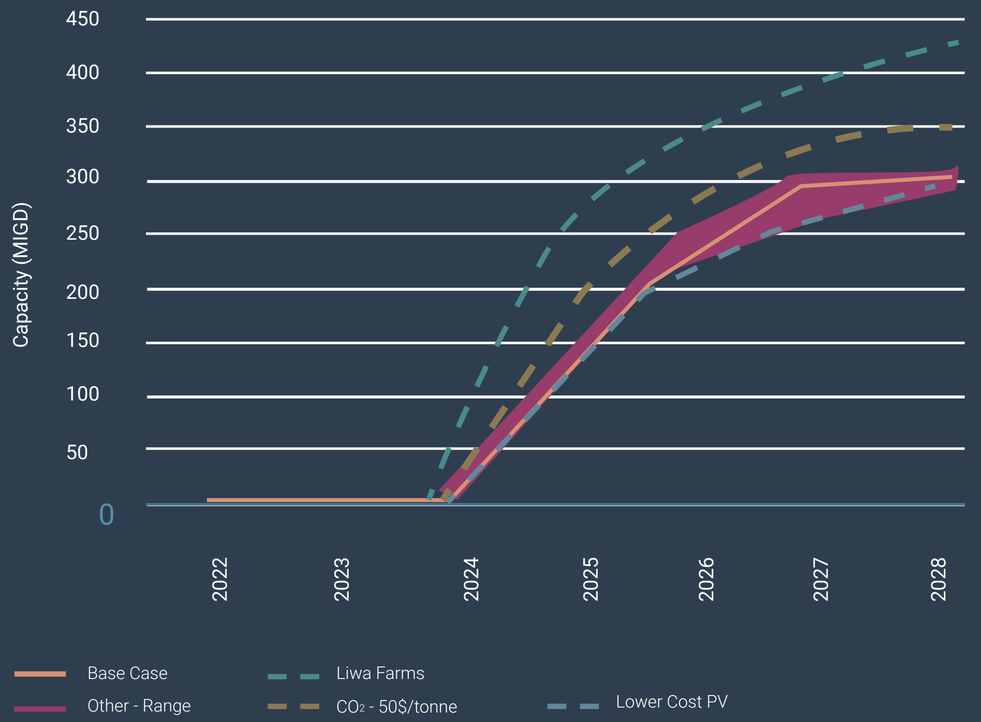
Our modelling indicates an optimal level of at least 200MIGD of new RO by 2026. With the objectives of displacing existing thermal generation and minimising pumping costs, 70MIGD of new RO capacity is recommended at Shuweihat to serve local demand. In addition, 80MIGD of capacity is recommended at Mirfa by 2025. This project may be increased to 120MIGD in size to serve new demand in Liwa. Should this occur additional sites for further capacity will be required, preferably closer to the demand centre of Abu Dhabi Island to reduce pumping costs and ensure timely deployment ahead of the retirement of Sas Al Nakhl plant by 2028.

Figure 4.2: Base Case RO Recommendations (MIGD), 2021-2031



The recommendation for at least 200MIGD by 2026 is resilient across all sensitivities tested and increases to 292MIGD if the new demand at Liwa is confirmed. The optimal level also increases somewhat with carbon pricing sensitivities.

Figure 4.3: Projected New RO Capacity by Sensitivity (MIGD), 2022-2028



4.3 Existing Fleet Recommendations

4.3.1 Focus on Flexibility

The addition of large amounts of nuclear and solar capacity introduces a number of system operability challenges, particularly in winter. We have identified opportunity to extract significant additional flexibility from the existing cogeneration fleet that could reduce winter operability challenges. The limited flexibility in the current cogeneration fleet means that providing operating reserves and water will be challenging without batteries and additional RO. As a result, we recommend the addition of more RO (200MIGD to serve demand from Abu Dhabi Island and the Western Region) and up to 200MW of batteries by 2026. These measures will help to ensure electricity and water security of supply and system operability during low power demand winter periods.

4.3.2 Life Extensions

Several plants will reach the end of their existing contracts during or shortly the 2022-2028 planning period:

- Taweelah A2 (760MW, 51MIGD) has already closed as of October 2021;
- Shuweihat S1 (1,615MW, 101MIGD) expires in June 2025;
- Sas Al Nakhl (1,670MW, 95MIGD) expires in July 2027; and
- Taweelah B (2,220MW, 162MIGD) expires in October 2028.

Recognising the resulting need for replacement capacity after the retirement of Sas Al Nakhl in 2027, EWEC is working with the operators of these plants to explore the economic viability of various extension and reconfiguration options compared with the procurement of new capacity.

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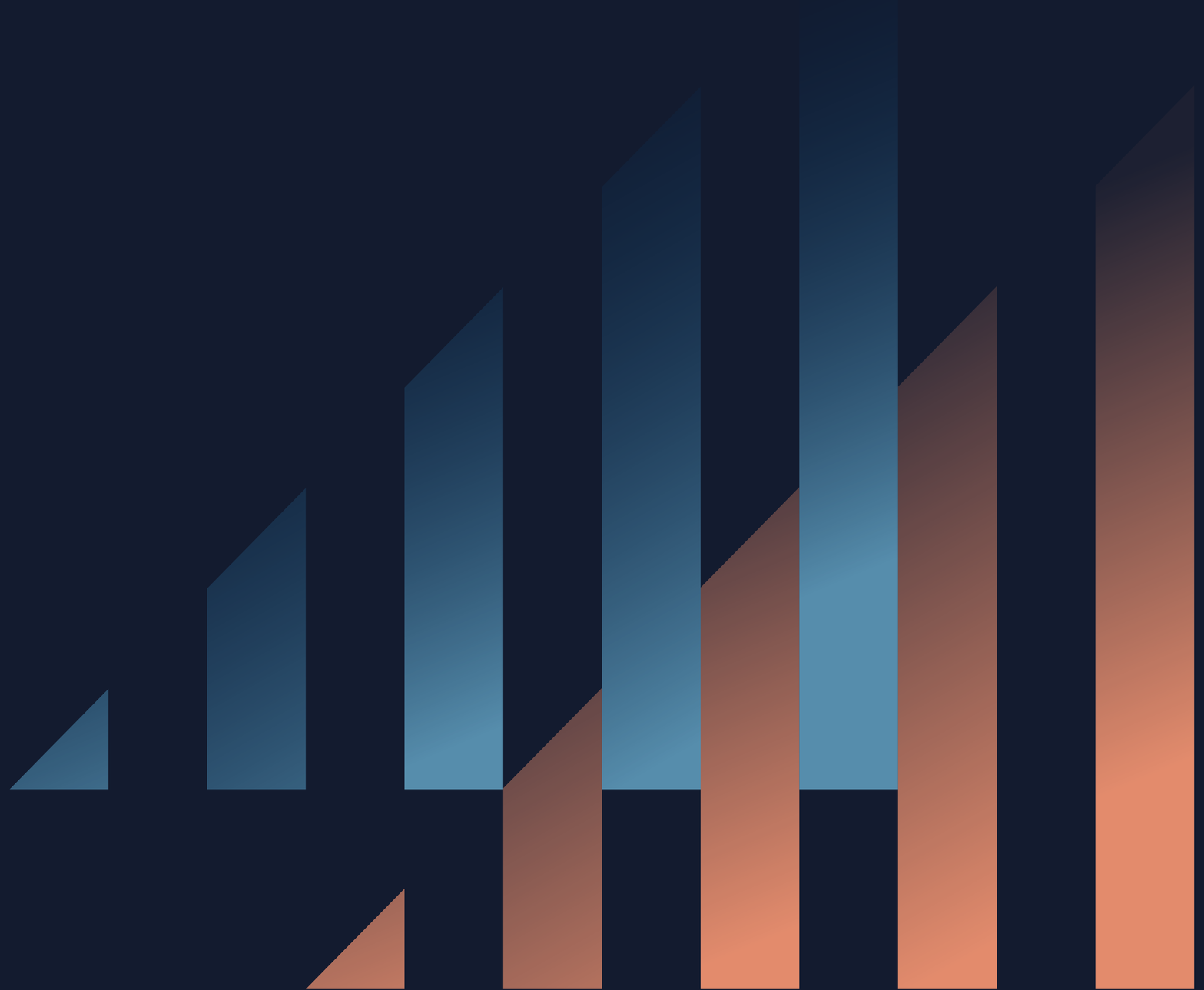
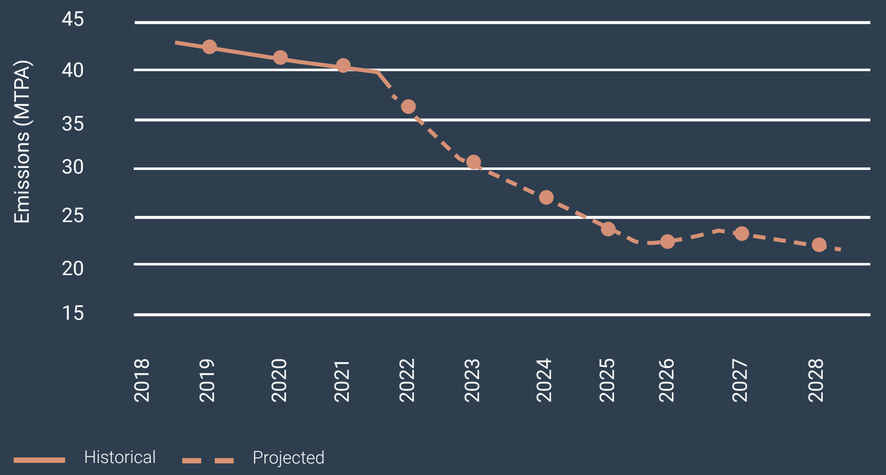
CARBON



The introduction of 5.6GW of nuclear, 200MIGD of new RO and 1.5GW of solar PV over the next several years will significantly reduce EWEC's CO_2 emissions. Compared to 2020, we project total emissions from power and water production to fall by 20MTPA or almost 50% by 2025. Carbon abatement schemes or increased trade with other entities will also allow us to further reduce emissions.

Figure 5.1: Total CO_2 Emissions: EWEC including Exports (MTPA), 2018-2028



Since the publication of the 2021 SFCR, the UAE government has announced a net-zero target for 2050. Interim clean energy targets for Abu Dhabi by 2035 will be explored in the 2023 SFCR following consultation with the DoE.

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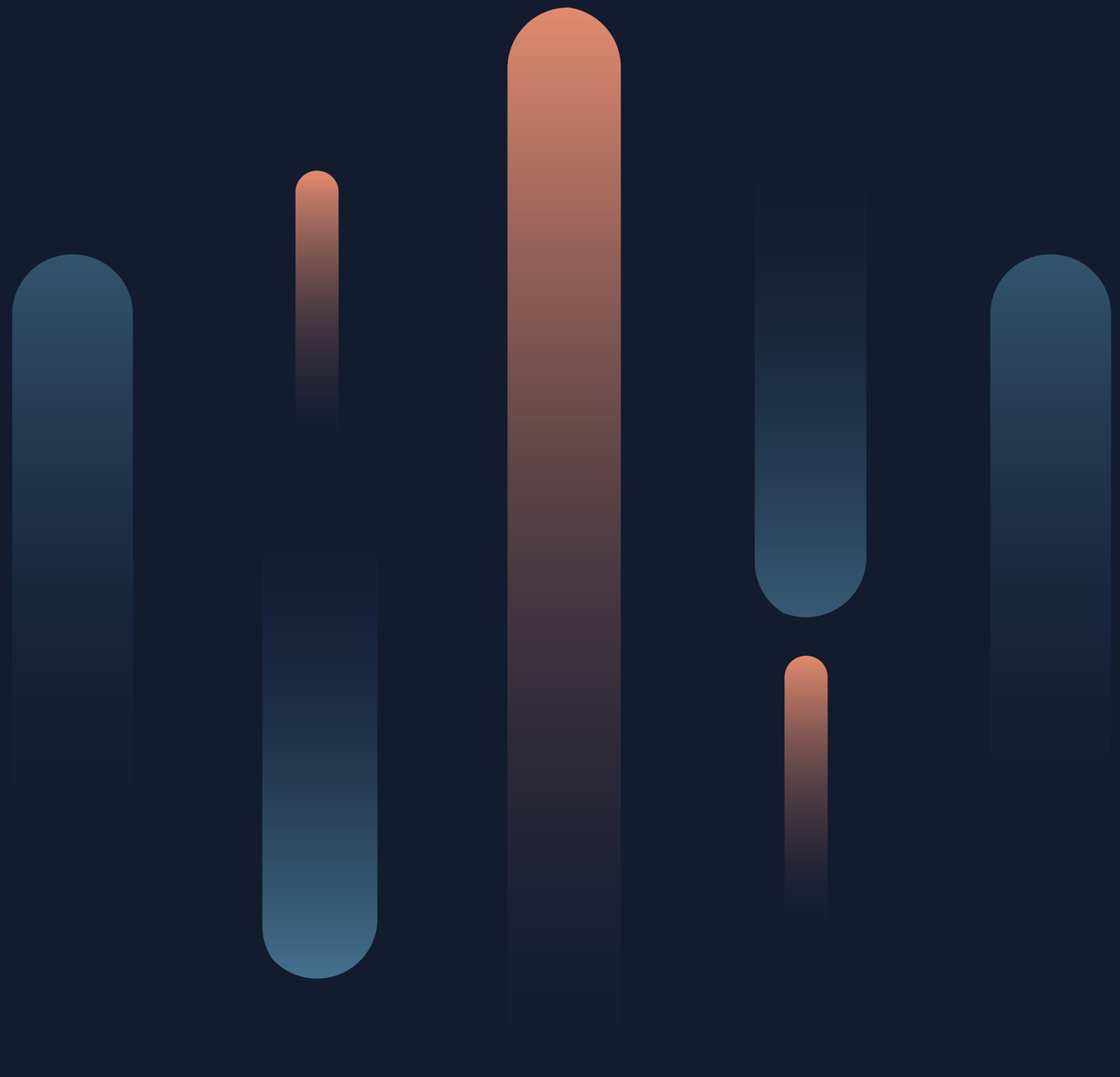
THE IMPACT OF FUTURE DEVELOPMENTS IN THE SECTOR



In the full SFCR, we have considered a wide range of modelling sensitivities reflecting possible changes within the sector to examine the effect on our planning recommendations. These are summarised below.

Introduction of an explicit carbon reduction scheme. Recognising the global impetus to reduce carbon emissions, we explored the potential impact on a least-cost portfolio of explicitly considering a range of different carbon prices. Sensitivities with even a moderate tax of US$25/$TCO_2e$ resulted in substantially more solar PV being optimal. Given the long end-to-end deployment times currently faced by the sector, this highlights the need for EWEC to develop business cases for multiple sites in tandem with a view to accelerating roll-out following the post-publication announcement of net zero targets by the UAE government.

Integration with Bulk Customers and Trade: EWEC, in conjunction with the DoE, are engaged in discussions to assess integration opportunities as well as to increase energy trading arrangements with large embedded industrial generators and consumers. Whether it is beneficial to the Sector to increase integration with any large customer is necessarily dependent on the terms that can be negotiated. However, our modelling has suggested that integration, in certain cases, can have the potential to result in material gas savings and security of supply benefits. We also identify significant benefits from increased trade with neighbouring entities.

Liwa farms: Should instruction to serve new demand at Liwa be received the requirement for additional RO capacity increases from 292MIGD by 2027 to 381MIGD. The size of the recommended Mirfa project will be either 80MIGD or 120MIGD. We will seek to develop additional production sites closer to Abu Dhabi Island to compensate for the capacity that would have been met from Mirfa that will then be directed to Liwa. The tender process has begun for the Mirfa project.