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DEPARTMENT OF ENERGY

2021 Annual Technical Report

For the Water, Wastewater, Electricity and District Cooling Sector in the Emirate of Abu Dhabi

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01 Introduction

Welcome to our 2021 Annual Technical Report for the water, wastewater, electricity, and District Cooling (DC) sectors in the Emirate of Abu Dhabi.

This report is issued every year by the DoE using information and data gathered from a range of regulatory submissions provided by our licensees every year. The aim is to highlight major milestones such as our sector's role in delivering the Emirate's strategic objectives as well as providing an overview on performance metrics we use to measure how our sector is creating value for our communities, customers, investors, and the environment.

02 Glossary

AADC	Al Ain Distribution Company
ADDC	Abu Dhabi Distribution Company
ADNOC	Abu Dhabi National Oil Company
ADSSC	Abu Dhabi Sewerage and Services Company
AMPC	Al Mirfa Power Company
APC	Arabian Power Company
CS	Carbon Steel
CSP	Concentrated Solar Power
DC	District Cooling
DEL	Dolphin Energy Limited
DI	Ductile Iron
DISCOs	Distribution Companies
DMA	District Metered Area
DMP	Distribution Metering Point
DN	Nominal Diameter
DW	Drinking Water
DWSP	Drinking Water Safety Plan
EAD	Environment Agency of Abu Dhabi
EB	Al Etihad Biwater Wastewater Company
ECPC-A2	Emirates CMS Power Company
EMAL	Emirates Aluminum
ESWPC	Emirates Sembcorp Water and Power Company
EVSE	Electric Vehicle Supply Equipment
EWEC	Emirates Water and Electricity Company
FAPCO	Fujairah Asia Power Company

FEWA	Federal Electricity and Water Authority
GOR	Gained Output Ratio
GRP	Glass-fiber Reinforced Plastic
GTTPC-A1	Gulf Total Tractebel Power Company
HDPE	High-Density Polyethylene
ICAD	Industrial City of Abu Dhabi
ISTPs	Independent Sewage Treatment Plants
IWA	International Water Association
IWPP	Independent water and power producers
km	Kilometer
KPI	Key Performance Indicator
l/s	Liter per second
LDC	Load Despatch Centre
Lphd	Liters per Household per Day
LSI	Langelier Saturation Index
m	Meter
m3/day	cubic meters per day
MCM	Million Cubic Meter
MCMD	Million Cubic Meter per day
MED	Multiple Effect Distillation
mg/l	Milligrams per Liter
MIG	Million Imperial Gallons
MIGD	Million Imperial Gallons per Day
MIPCO	Mirfa International Power Company
Ml/day	Mega litre per day
MSF	Multi-Stage Flash Distillation
MWh	Mega Watt hour
NE	Northern Emirates
NRW	Non-Revenue Water
O&M	Operation and Maintenance

OPEX	Operational Expenditure
PCOD	Project Commercial Operation Date
PCR	Price Control Returns
PDSRS	Production Data Submission and Reporting System
PPB	Parts Per Billion
PPM	Parts Per Million
PR	Performance Ratio
PWPA	Power and Water Purchase Agreement
RIA	Regulatory Impact Assessment
RPC-S2	Ruwais Power Company
RW	Recycled Water
RWRRS	Recycled Water Reporting System
SCIPCO-S1	Shuweihat CMS International Power Company
SEWA	Sharjah Electricity and Water Authority
SMPs	Sector Measuring Points
STEP	Strategic Tunnel Enhancement Program
SWRO/RO	Seawater Reverse Osmosis
TA	Technical Assessor
TAPCO-B	Plant Taweelah Asia Power Company
TBT	Top Brine Temperature
TDIC	Tourism Development and Investment Company
TDS	Total Dissolved Solids
TEC	Trade Effluent Control
TRANSCO	Abu Dhabi Transmission and Dispatch Company
TSS	Total Suspended Solids
VB	Veolia Besix Waste Water Company
WHO	World Health Organization
WQR	Water Quality Regulations
WQRRS	Water Quality Regulations Reporting System
WTC	Water Transmission Code

03 Sector Highlights

Annual Production

Electricity
92,567 GWh

Water
1,236 MCM
(271,878 MIG)

Recycled water
Production
310 MCM

Installed Capacity

Electricity
17,727 MW

Water
4.14 MCM/day
(910 MIGD)

Wastewater
1,334 Ml/day

System Demand

Global electricity demand in Abu Dhabi peaked at
16,601 MW

Global water demand peaked at **3.79 MCMD (833 MIGD)**
Recycled water reuse percentage: **61%**

Water Quality Tests Conducted

Water
152,080

Recycled water
102,367

Total testing
254,447

Number of Connected Customers

Water customers
437,969

Wastewater customers
438,949

Electricity customers
579,470

04 Timeline

January

- Issuance of the Water Quality Regulations 2021
- Issuance of the Recycled Water and Biosolids Regulations 2021
- Initiation of the 2nd Regulatory Controls (RC2)

March

- Issuance of Saadiyat Cooling LLC DC integrated license
- Issuance of Saadiyat District Cooling LLC DC standalone license

April

- Full operation of Barakah Nuclear Power Plant Unit 1

August

- Issuance of Regulatory Policy for Clean Energy Certificates

November

- Issuance of Al Wajeez Development Company PJSC DC Standalone license

05 Electricity and Water

Electricity Generation and Water Production

Generation and Production Overview

Demand Growth

Demand for electricity in the Emirate of Abu Dhabi continued to grow during 2021 driven by a slight increase in Abu Dhabi's system demand and a higher increase in demand resulting from exports to the Northern Emirates, also known as the global electricity demand.

The Global electricity demand in Abu Dhabi peaked at 16,601 MW on 13th of July at 15:49 hrs. Abu Dhabi Emirate recorded a peak of 12,231MW at the same time. Exports to the Northern Emirates peaked at 4,545 MW on 8th August.

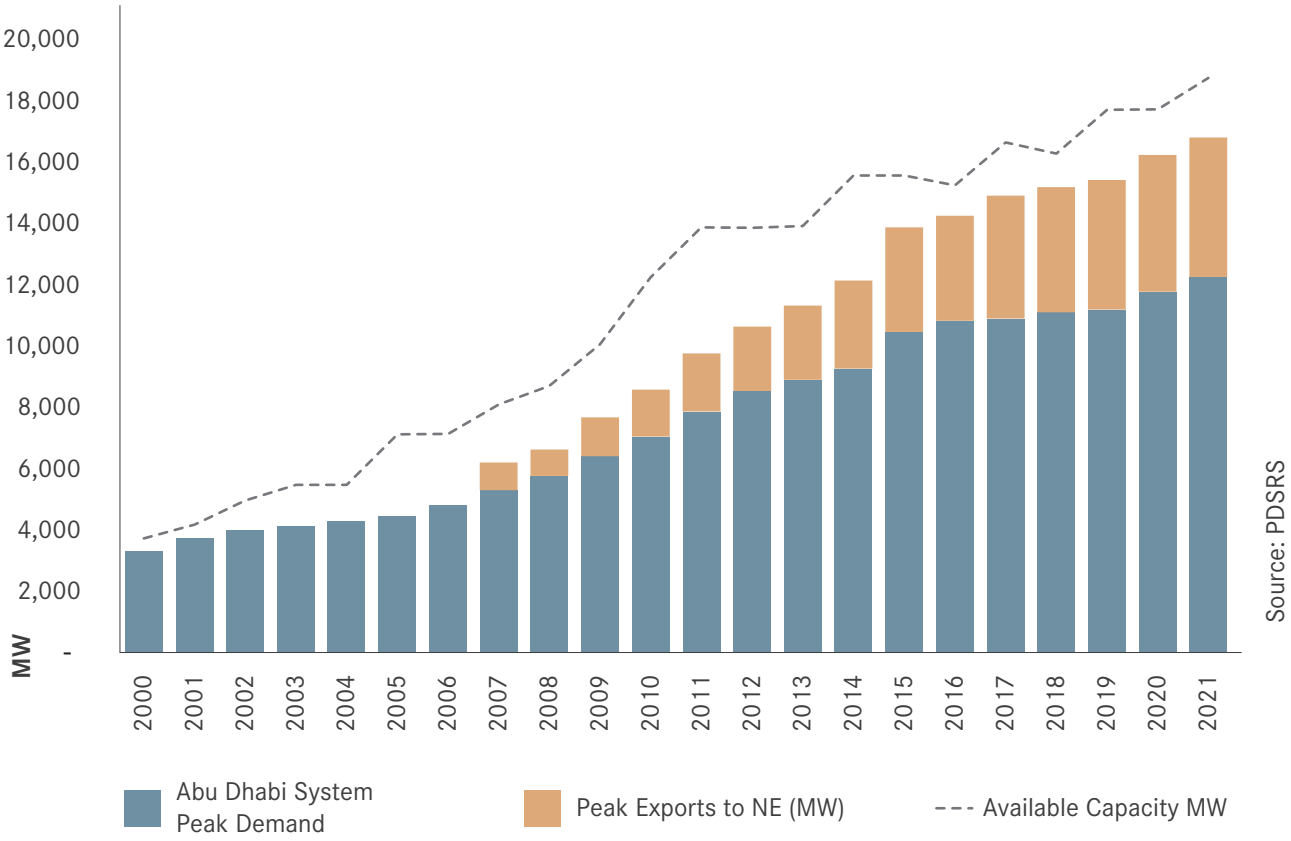


Figure 1: Electricity Demand Growth (MW)

The Global water demand in Abu Dhabi is also measured by Abu Dhabi regional system demand and the demand resulting from the exports to the Northern Emirates. In 2021, the global water demand peaked at 3.79 MCMD (833 MIGD) on 7th of September. Water global peak demand remained stable in 2021 with a minor decrease (0.35%) from 2020. Abu Dhabi Emirate accounted for 89% of peak demand represented by 3.36 MCMD (739MIGD) while supply to the Northern Emirates accounted for 11% of peak demand and represented 0.4 MCMD (94 MIGD).

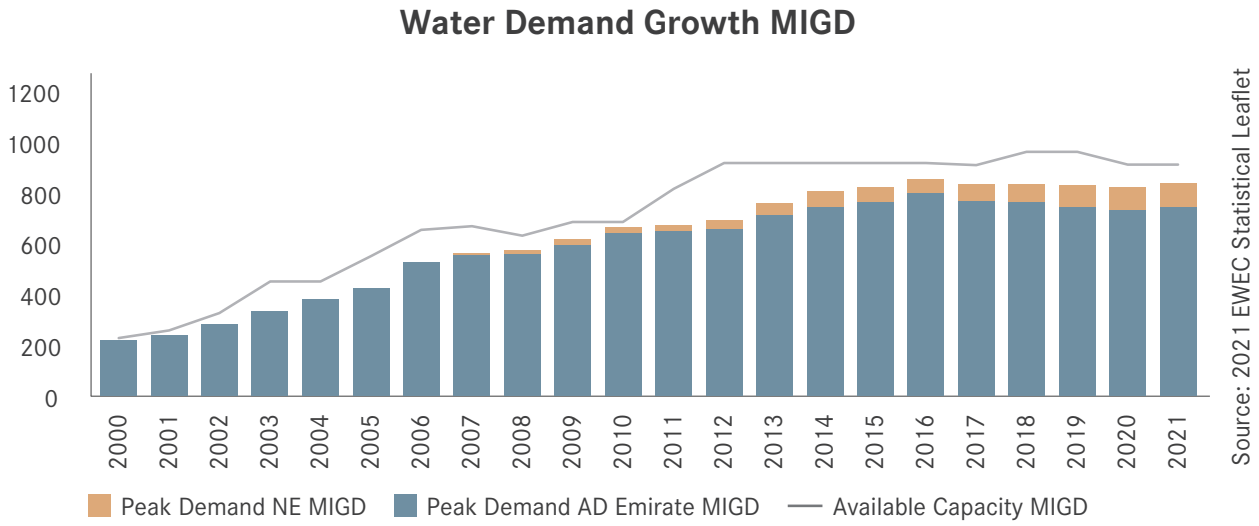


Figure 2: Water Demand Growth

Global Electricity and Water Capacity and Production

To support Abu Dhabi's demand for electricity and water, our energy sector has a total available electricity generation capacity of 17,727 MW and water production capacity of 4.14 MCMD (910 MIGD). The total electricity generated was 92,567 GWh , while the total water produced was 1,236 MCM (271,878 MIG) in 2021. This averages to 3.39 MCMD (745 MIGD) of the water produced

17,727 MW
Total available electricity generation capacity

4.14 MCMD (910 MIGD)
Total water production capacity

Electricity generation and water production capacities are depicted in Figures 3 and 4 below.

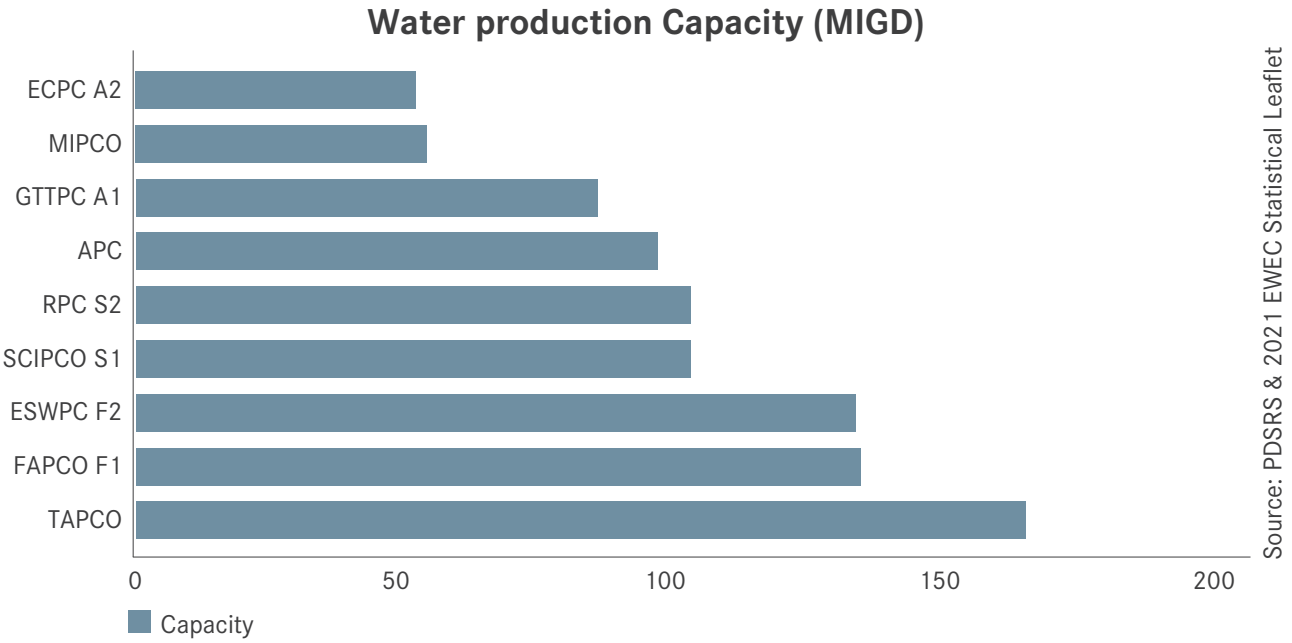


Figure 3: Water Production Capacity

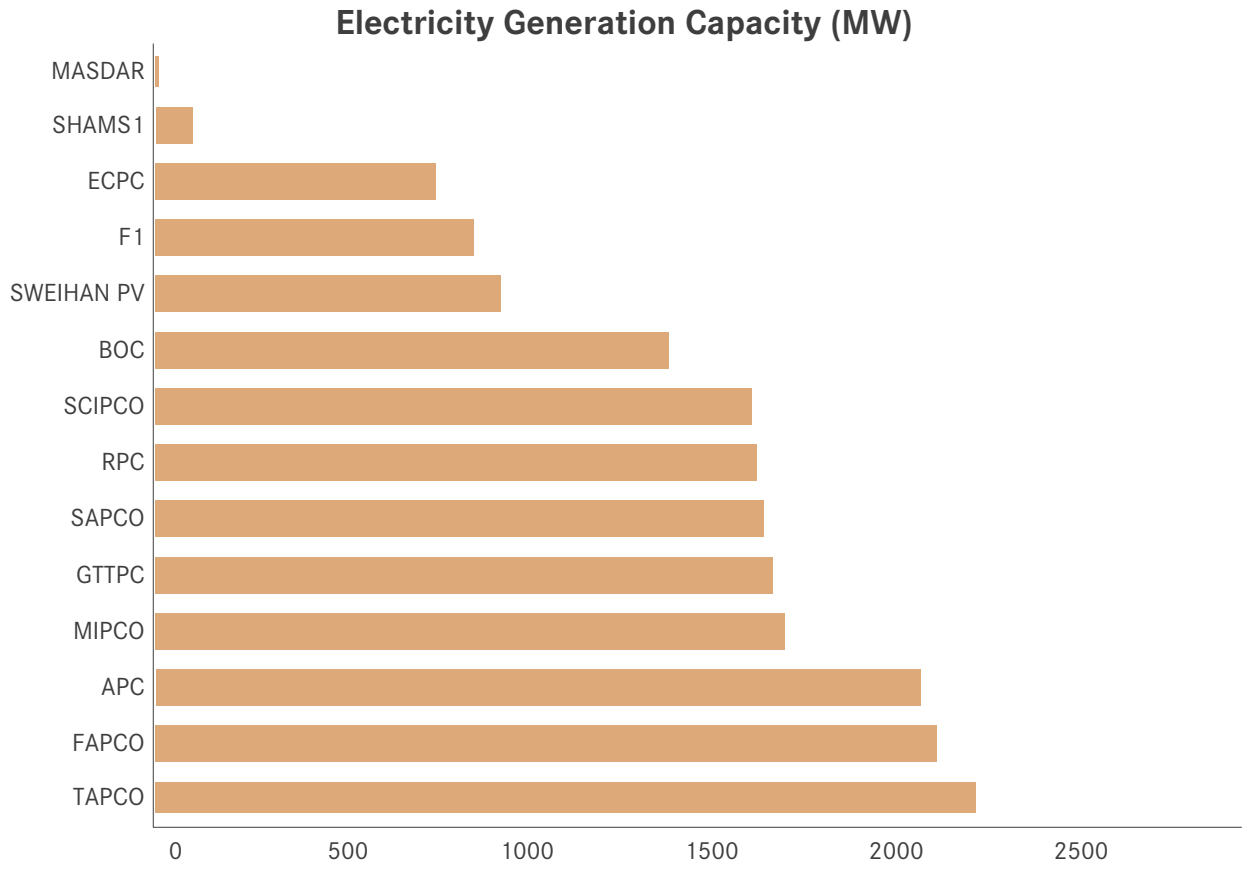


Figure 4: Electricity Generation Capacity

Electricity and Water Production by Company

In terms of electricity generation markets, there are 13 power providers with electricity generation market shares ranging from 0.3 % up to 13% during 2021. FAPCO holds the largest market share of 13%. Figure 5 below shows all IWPPs electricity generation market shares.

In terms of water production, capacity shares vary between 9 IWPPs with market shares ranging between 1% up to 17%. Nearly 17% of the overall water production share lies within TAPCO. This is followed by ESWPC and FAPCO each holding around 16 % and 14% respectively during 2021. Figure 6 below shows all IWPPs water production market shares.

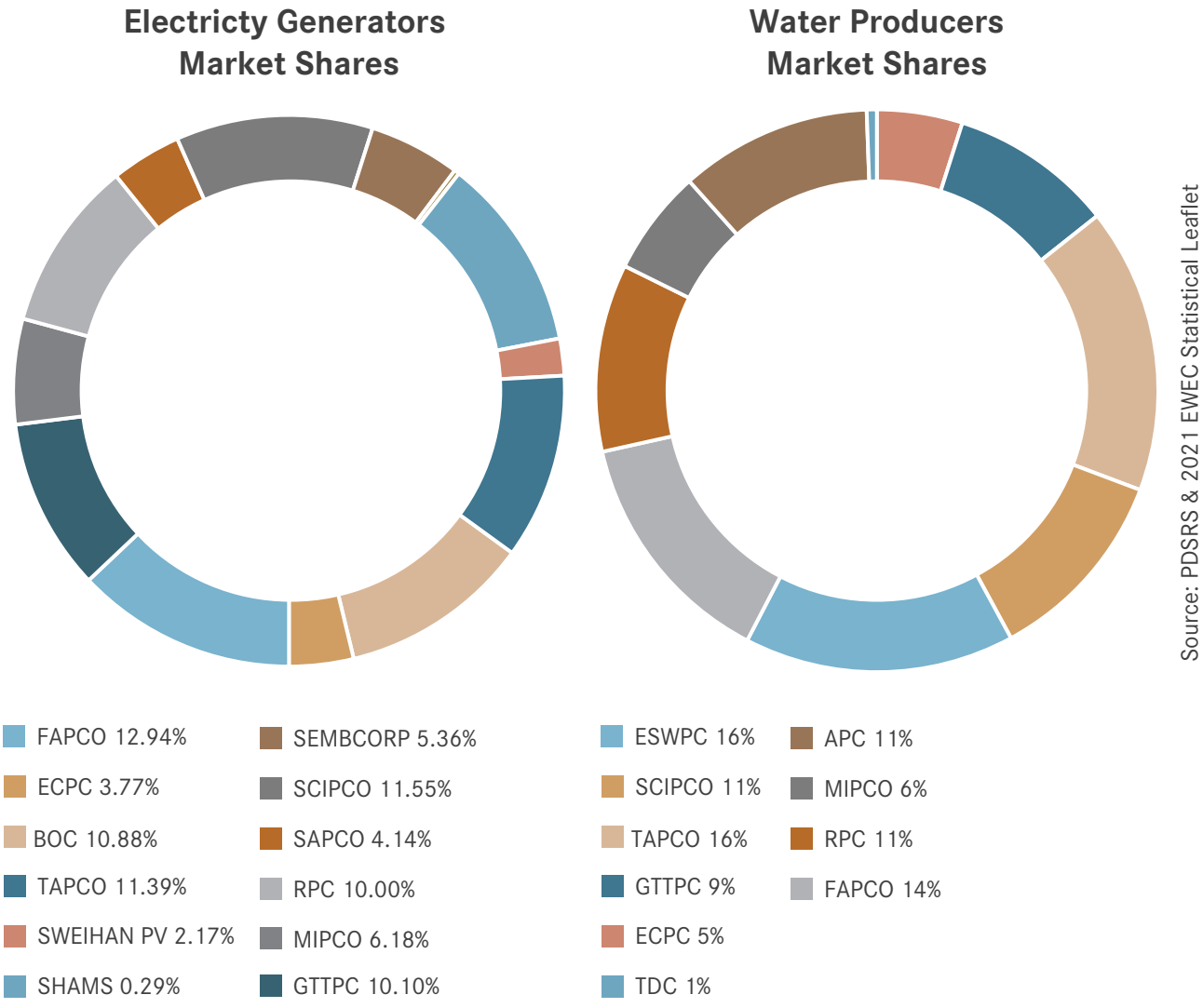


Figure 5: Electricity Generation by Company

Figure 6: Water Production by Company

Source: PDSRS & 2021 EWEC Statistical Leaflet

Electricity and Water Production Mix

As for electricity generation in Abu Dhabi, renewable energy from SHAMS and Sweihan AD accounted for around 2.3% of the electricity generation mix in Abu Dhabi, and electricity generated from Barakah Unit 1, which went into full operation in April 2021, accounted for 11%. The major share of electricity generation of 86.7% is accounted by the traditional CCGT, Co-Gen, and OCGT plants.

The share of clean energy will continue to grow in the coming years with the addition of the remaining 3 Barakah Nuclear Energy units (Barakah Unit 2 to enter full operation in 2022). The plant will have a total of 5,600 MW of renewable energy to the grid when fully operational.

As for Water production, Figure 7 demonstrates a five-year overview of the IWPPs annual production contribution percentage by technology. MSF production capacity has decreased mainly due to APC UAN East and West and ECPC water capacity retirement in 2019 and 2021 respectively. Moreover, RO desalination contribution is anticipated to significantly grow over the coming years. The Taweelah RO Independent Water Plant (IWP) will increase RO production capacity by adding 0.91 MCMD (200 MIGD) when completed by 2023.

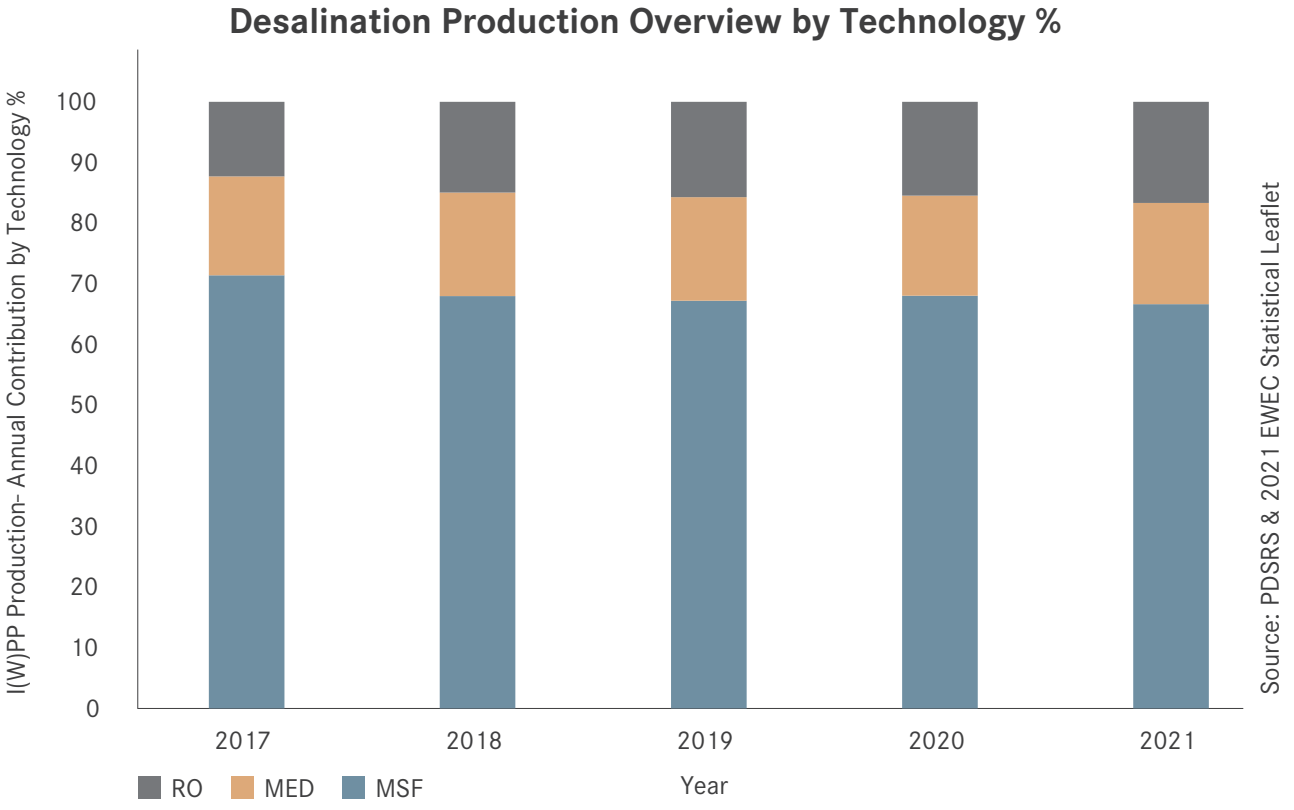


Figure 7: Water Production by Technology

Figure 8 shows the daily electricity generation at peak time in MWh for the last two years. It reflects the annual variation in demand which is seasonal in that it closely follows the weather and is consistent year on year. Certainly, the annual peak coincides with the mid-summer peak demand mentioned above.

Global demand grew by 9.2% in 2021 while Exports to the Northern Emirates grew by 12% and demand from Abu Dhabi Emirate also grew by 8.3%.

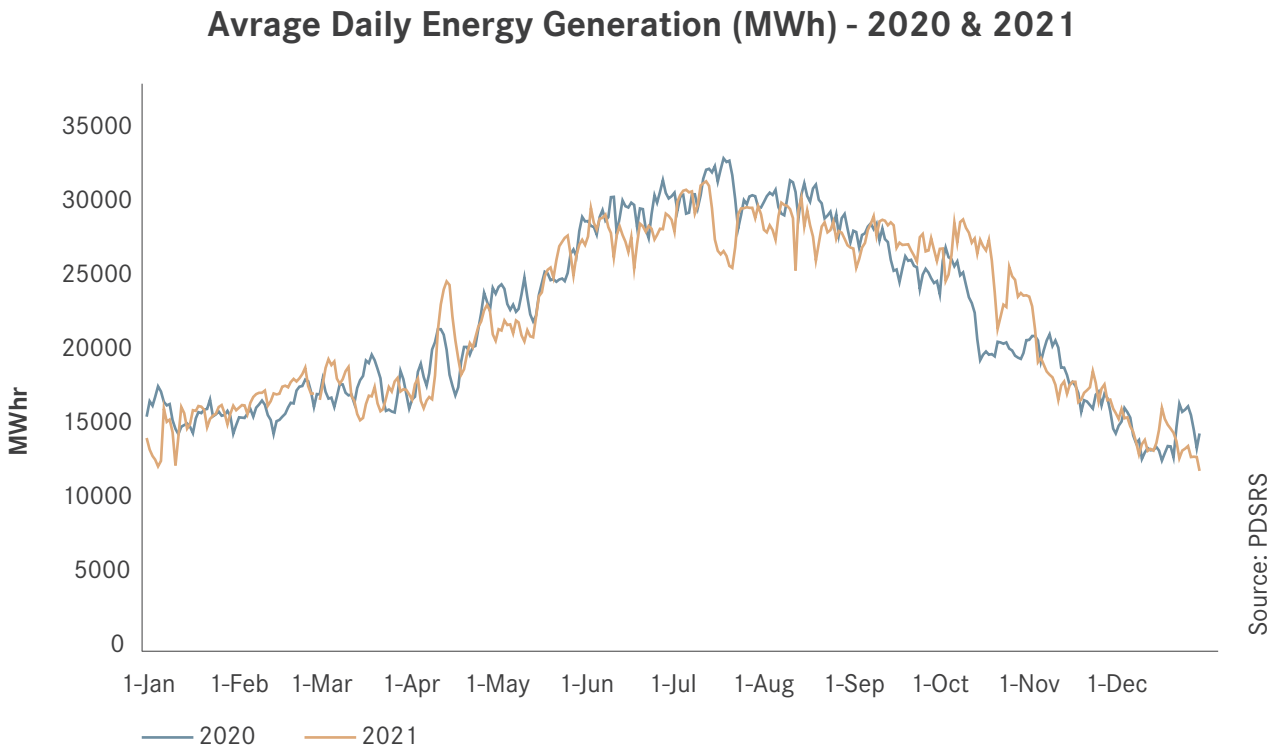


Figure 8: Daily Energy Generation

Unlike electricity, water demand in the Emirate of Abu Dhabi exhibits moderate seasonal fluctuations throughout the year. The weekly average water production in 2021 is provided in Figure 9 below. The global water demand reached its peak of 3.79 MCMD (833 MIGD) on July 09, 2021, which represents a slight decrease compared to last year's peak of 3.8 MCMD (820 MIGD) on June 07, 2020. Minimum production of 2.49 MCMD (508 MIGD) occurred on Dec 27, 2021. The production abatement in particular in the first and fourth quarters of 2021 (winter season) was mainly due to decrease in demand, planned outages, ECPC decommissioning and to a lesser extent forced outages.

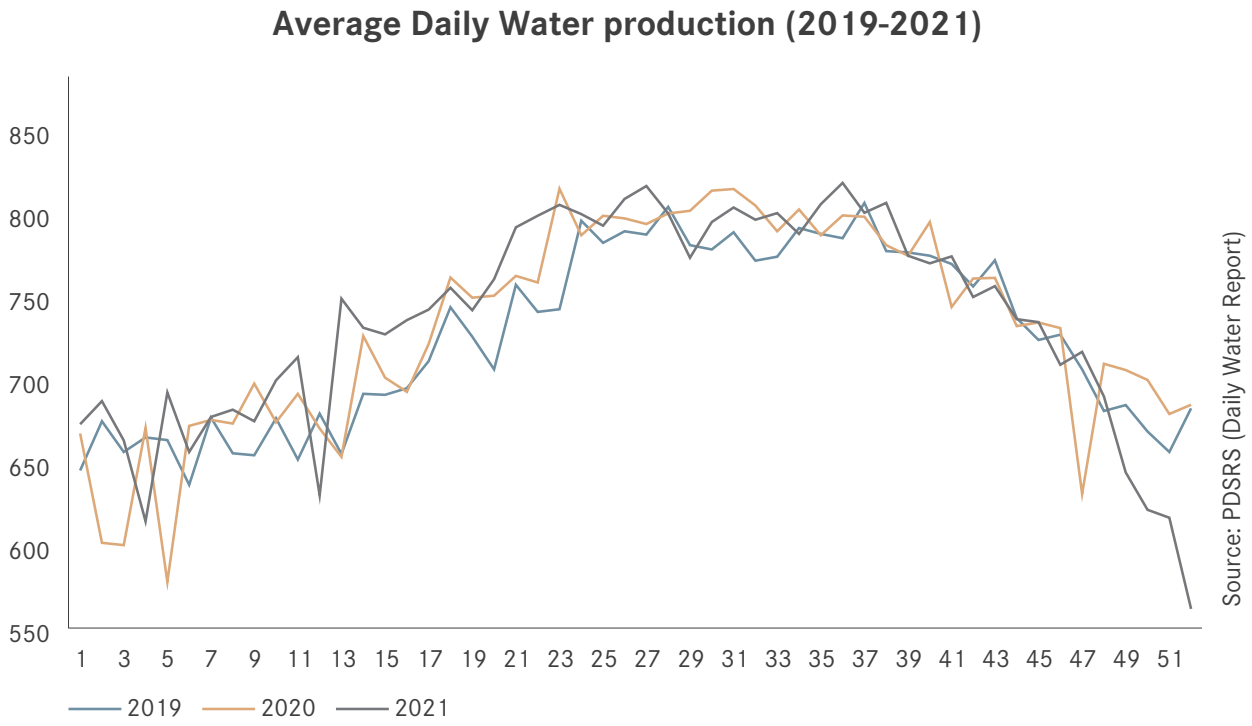


Figure 9: Average Weekly Water Supply by IWPPs (2019-2021)

Global Fuel Consumption 2021

Natural Gas remained the predominant fuel type used within the sector to generate electricity and produce water in Abu Dhabi. Both ADNOC and DEL continued supplying the sector with natural gas throughout the year without the need to burn any back-up fuel more than the regular amounts used to carry out operational tests to maintain liquid fuel supply system ready on standby if needed. It is reported that both ADNOC and DEL have delivered around 779,148,782 MBTU of natural gas to the sector, which is 0.5% less than last year (782,755,804 MBTU)

779,148,782 MBTU
This year's delivered Natural Gas to the sector

782,755,804 MBTU
Last year's delivered Natural Gas to the sector

0.5%
Less than last year

Electricity Generation System Performance

In terms of the performance of the generation plants, the available plant capacity was maintained with reasonable capacity margins throughout the year. Figure 10 shows the plants average reliability percentage for 2021 as reported by each plant. Overall, most of the generation plants reported high reliability index. APC has the lowest reliability which is mainly influenced by the lower performance aging assets.

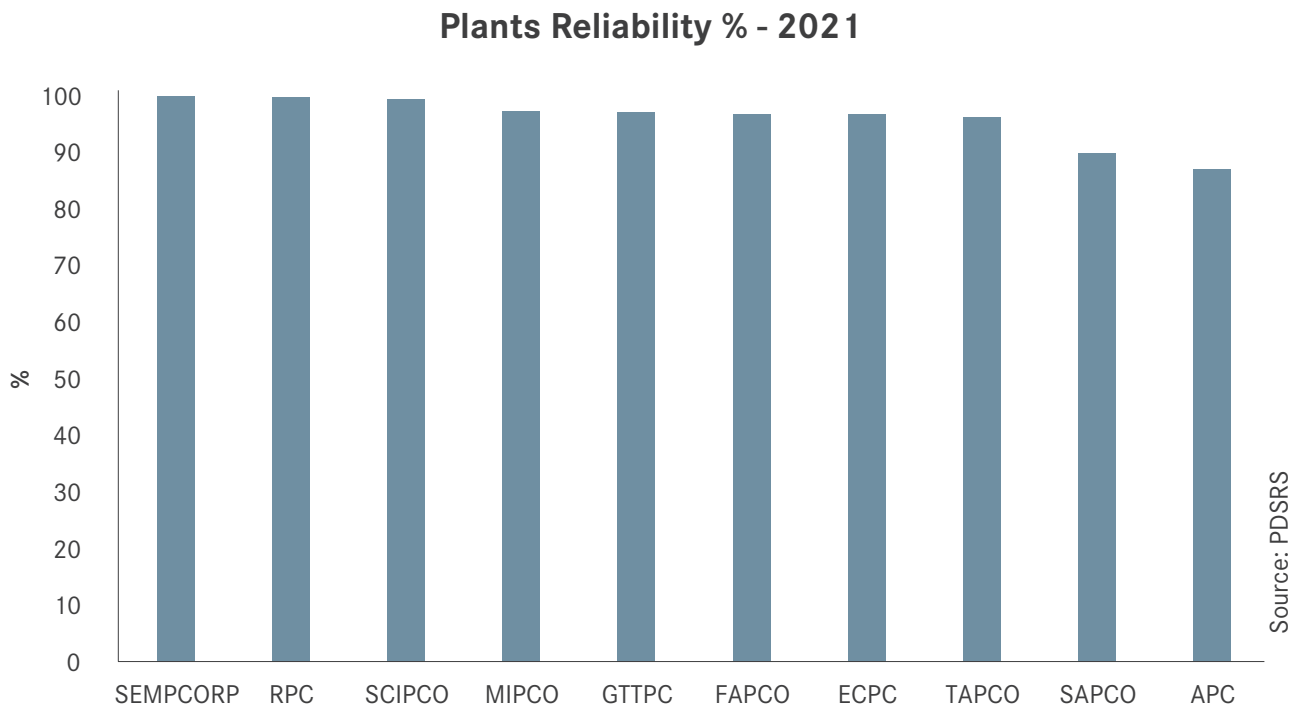


Figure 10: Plants Reliability

Water Production System Performance

In terms of the performance of the water production plants, the available plant capacity was maintained with reasonable capacity margins throughout the year. The below shows the plants average reliability percentage for 2021 as reported by each plant. Overall, most of the water production plants reported high reliability index. For thermal desalination, Taweelah B plant has the lowest reliability which is mainly influenced by the lower performance of the ageing assets and Operation and Maintenance. The average reliability for thermal and reverse osmosis plants for 2021 is 97.83 and 97.77 respectively.

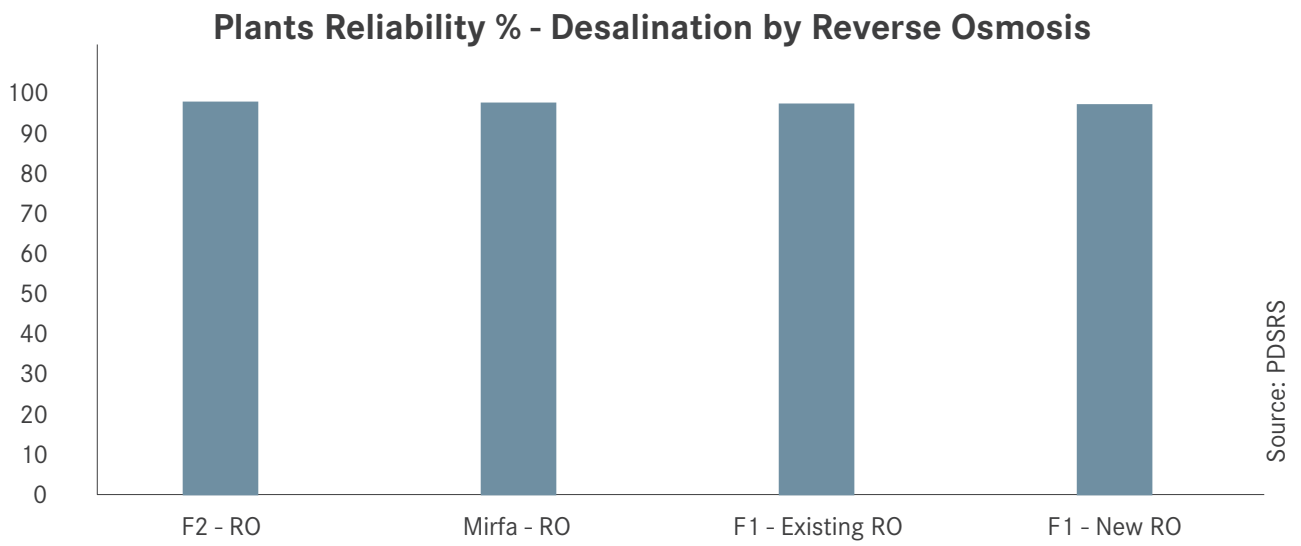


Figure 11: Plants Reliability - RO

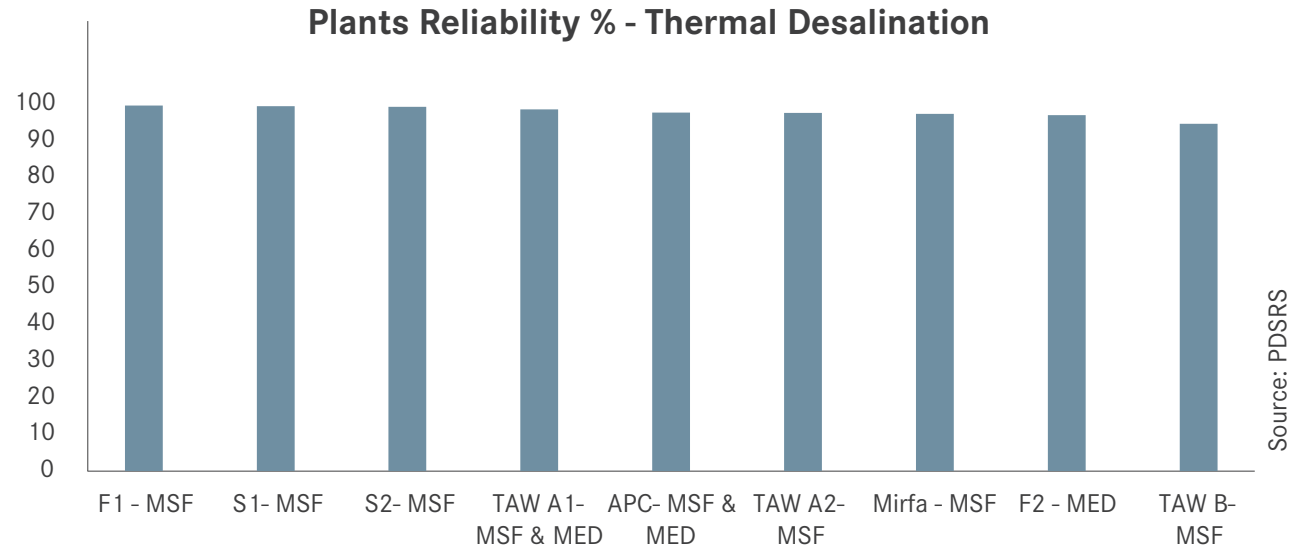


Figure 12: Plants Reliability - Thermal

Thermal water production efficiency can be measured by performance ratios. Performance ratios are stipulated in the PWPAS and defined as the mass of distillate produced per heat input.

Desalination Process - Thermal Water Production Performance

Performance ratios provides an overview of the desalination process efficiency measurement. It defines the relationship between two mass flows i.e., the distillate and the flow of the heating steam.

The sector has maintained a steady performance ratio. Its calculation is influenced by factors such as, analysers accuracy and calibration, operation and maintenance, assets ageing and chemical dosing. Figures 13 and 14 below depict five years overview of the average performance ratio for MSF and MED thermal desalination technologies for potable water production.

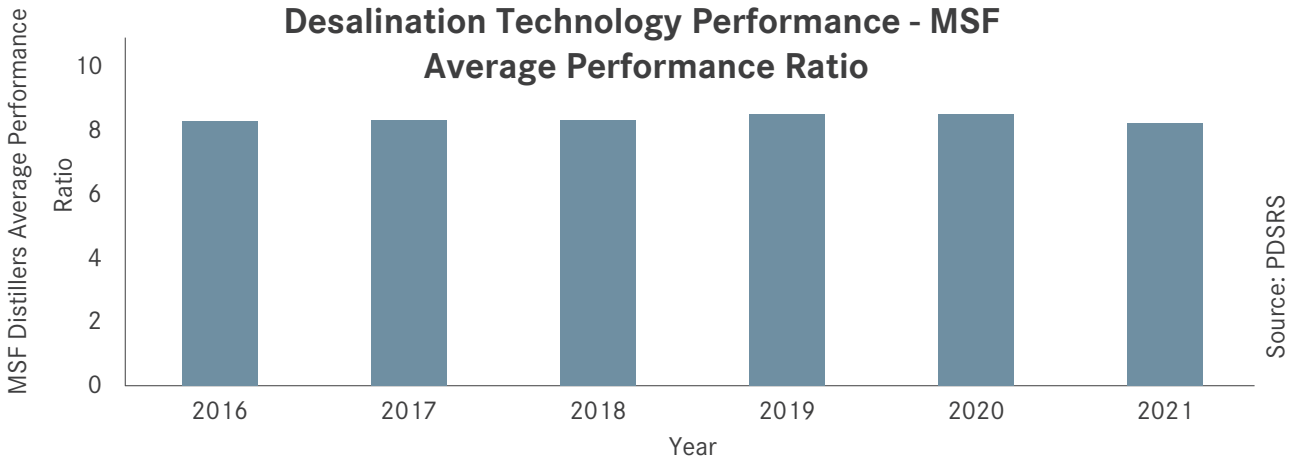


Figure 13: I(W)PPs Desalination Technology Performance - MSF Average Performance Ratio

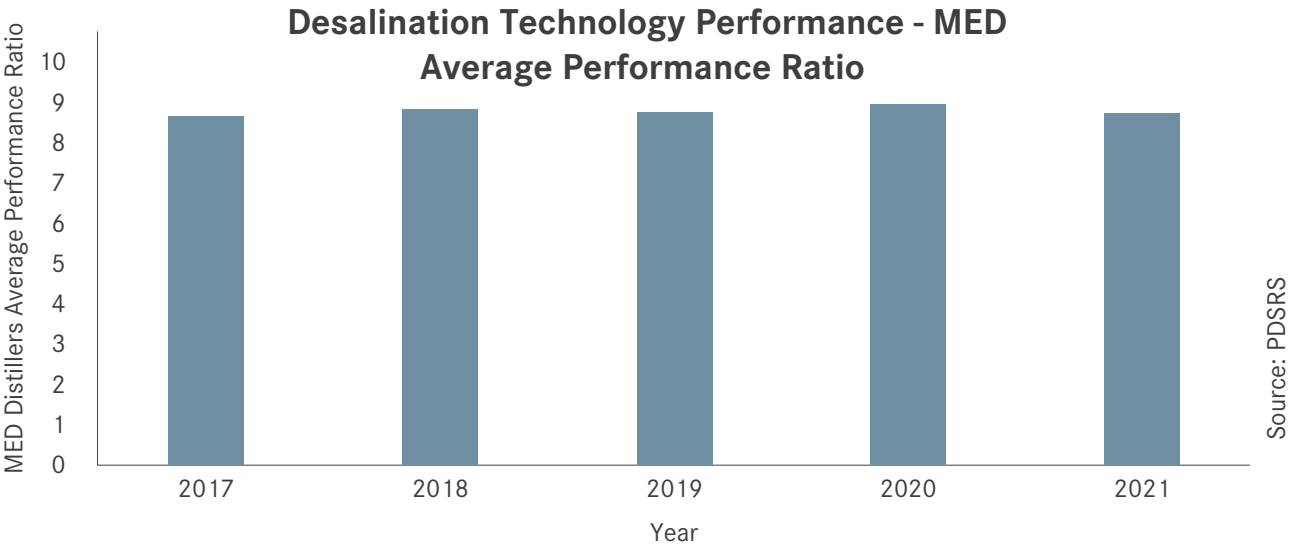


Figure 14: I(W)PPs Desalination Technology Performance - MED Average Performance Ratio

Water Quality Regulatory Performance - Production

Desalination - IWPPs

The production water quality sampling and testing is conducted as per the WQR regulatory prerequisites. The sample must be representative of the water quality at the time of sampling, its collection program is made with sampling frequency from predetermined locations at equal intervals over the year and it must be analysed as soon as practicable after it has been taken.

The total number of tests completed by the IWPPs in 2021 was 51,844, with 64 water quality parameters examined for RO and 51 water quality parameters examined for thermal desalination respectively. The overall water quality testing frequency compliance (measure of the number of tests conducted against those required) for the production companies was 99.85%.

The overall average water quality compliance for 2021 was 99.87%, with Physical Parameters and Microbial Parameters compliance at 99.68% and 100% respectively.

The figure below depicts five years overview of the IWPPs consistent overall water quality compliance

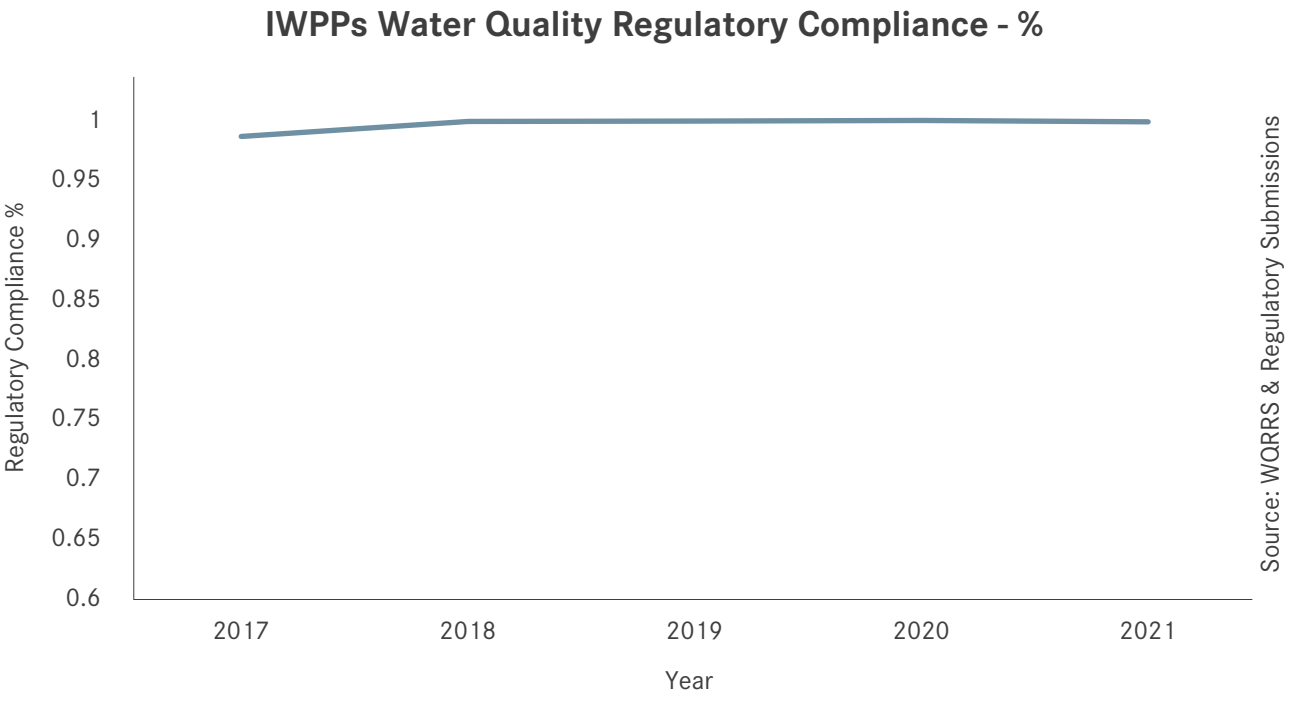


Figure 15: I(W)PPs Water Quality Regulatory Compliance - %

Desalination Process - Chemicals and Products that come in contact with Water - Regulatory Overview

To ensure regulatory compliance, maintain security of supply and optimize process operation, production licensees submit to the DoE applications to put in use chemicals in the desalination process. These chemicals are administered under the Water Quality Regulations. Chemical regulations also include the transmission and distribution networks.

Improvements in desalination chemicals like anti-scalants and using more durable and reliable material of construction are best practices that have reduced the cost of desalination in particular the investment cost and unit water cost. Performance improvements will also drive down the operating cost.

Figure 16 below depicts five years overview of the chemicals and products that come in contact with water regulatory foundation for RO, MSF and MED. The number of no objections to use new chemicals have increased steadily. Chemical trials have been conducted in thermal, RO, remineralisation and disinfection plants. The regulatory framework underpins the desalination production security of supply.

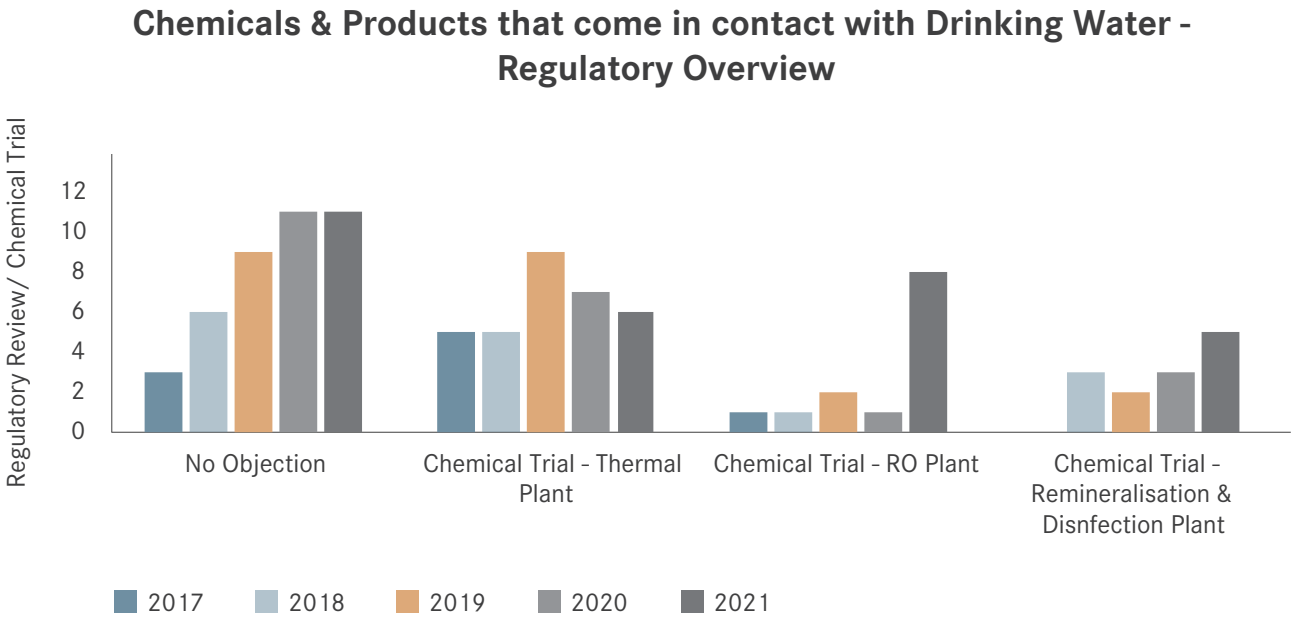


Figure 16: Five years regulatory overview of the chemicals and products that come in contact with water

Desalination Process - Thermal and Membrane Water Production Quality Performance

Figures 17 and 16 depicts five years overview of the IWPPs desalination chlorination KPI 1 and 2. The DoE has been working with its Licensees to steadily optimise the KPIs shown below towards the optimum values.

KPI 1 has been implemented to measure and optimise the efficiency of chlorine consumption. It is an indicator of the total amount of chlorine consumed by IWPPs per unit of water produced. Chlorination system efficiency performance is used to evaluate the efficiency of the chlorination system at the desalination stage, to ensure the system will use the optimum amount of chlorine at the point of dosing to deliver the desired chlorine residual. Figure 17 demonstrates a progressive course towards the optimum target value.

KPI 1 is governed by factors such as dosing regime and process, chlorine demand of the desalinated water produced by each licensee and transmission and distribution residual chlorine requirements.

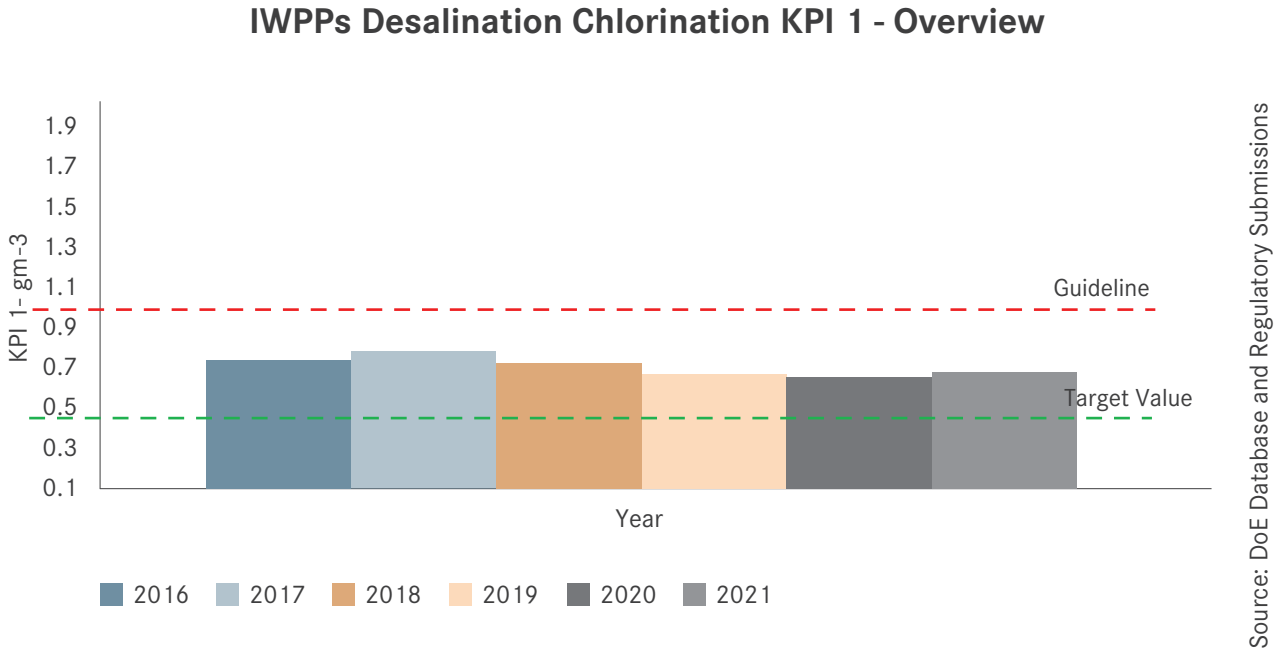


Figure 17: IWPPs Desalination Chlorination KPI 1- Overview

KPI 2 has been implemented to measure the residual chlorine regulatory compliance. KPI 2 is an indicator of the proportion of the residual chorine samples that fall outside the regulatory limit. Figure 18 demonstrates a progressive course towards the optimum target value.

KPI 2 is impacted mainly by transmission and distribution residual chlorine requirements.

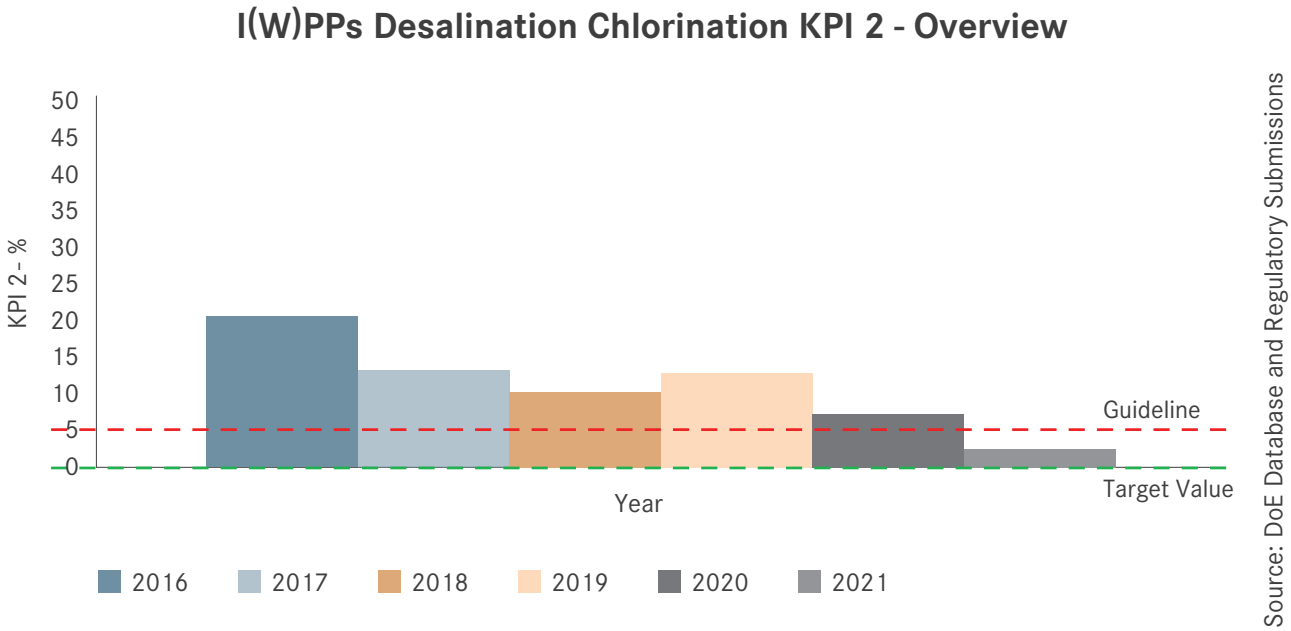


Figure 18: I(W)PPs Desalination Chlorination KPI 2 - Overview

Water Quality Regulatory Implementation – Audits and Assessments

Desalination - IWPPs

To ensure compliance with the Water Quality Regulations the DoE conducts periodic audits to assess the implementation of the Licensees DWSPs. In 2021, AMPC (Delma Island) and MIPCO have been audited.

The audit covers analytical arrangements such as, sampling processes, data quality and reporting. It may also include chemicals used in water treatment, Desalination, Transmission System, Distribution System (piped, non-piped and aquifers), transfer and storage processes for the supply of wholesome water.

Electricity and Water Transmission

Transmission Overview

TRANSCO operates the high voltage network (400 – 132 KV) transporting large volumes of electricity from production companies to DISCOs, high demand customers connected at the transmission system and to the northern emirates. TRANSCO is also interconnected with the 400 kV GCC interconnection.

On the water side, TRANSCO transports large volumes of water from the production companies to the distribution companies. In 2021 , the 3,479 km water transmission system carried a peak of 3.90 MCMD (858 MIGD) of desalinated water via mains pipelines. These pipelines range in size from 500 to 1,600 mm in diameter and are made predominantly of cement-lined ductile iron (DI) & Carbon Steel (CS) and partly Glass Reinforced Plastic (GRP). The total quantity of water leaving the network amounted to 1192.22MCM (262,252 MIG).

The Tables below provide a summary of Electricity and Water Transmission Network Assets

Grid Substations	Capacity	Underground Cables	Overhead Lines
162 (400kV, 220kV and 132kV)	70,735 MVA	1,175 km	9,081 km

Table 1: Electricity Transmission Network Assets

Pipeline length	Pumping Stations	Capacity	Reservoirs	Capacity
3,479 km	51	11.74 MCMD 2,587 (MIGD)	129	3.02 MCM (665 MIG)

Table 2: Water transmission system assets

10,256 KM

TRANSCO transports electricity/water from the production companies to the distribution companies through its transmission system

3479 km

Electricity Transmission System Performance

Transmission system performance is monitored through a number of Key Performance Indicators (KPIs) including:

Transmission network unavailability

Unsupplied energy

Transmission system losses

Transmission Network Unavailability

System unavailability is defined as the ratio of the unavailable circuit hours and the total system circuit hours. The total unavailability increased slightly from 0.98% in 2020 to 1.33% in 2021 as shown in the graph below. Analysis of the data indicates that there was a significant increase in users' outages in 2021 compared to 2020. The reason is due to COVID impact in 2020 and the backlog of those Users' outage requests are seen in 2021.

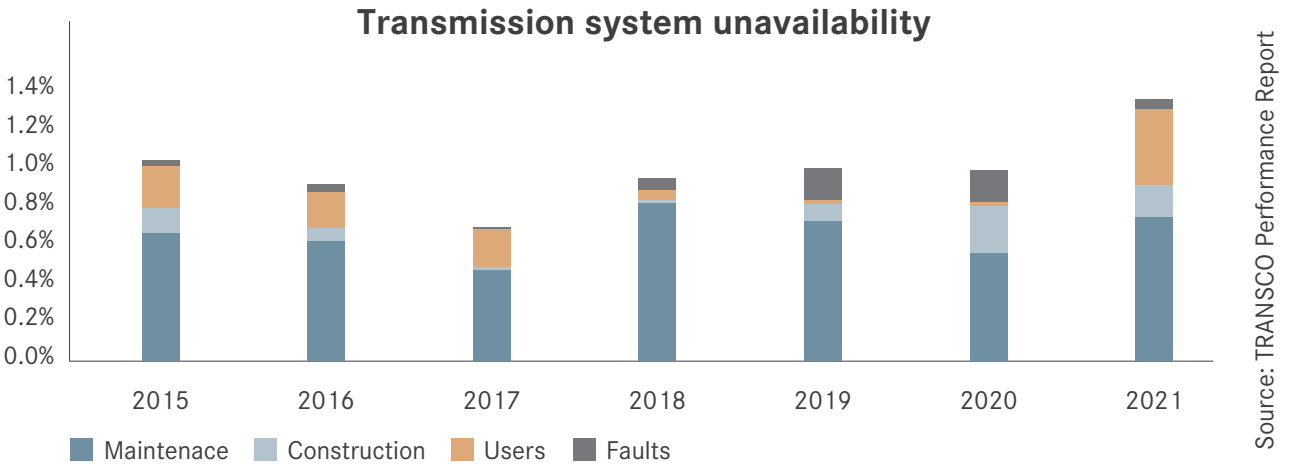


Figure 19: Transmission System Unavailability

Unsupplied Energy

The impact of loss of supply resulting from transmission incidents is quantified in terms of energy lost "unsupplied energy" which is calculated by taking into account the size and duration of the demand lost, expressed in MWh. In 2021, there were 2 transmission incidents, which resulted in the loss of 2.92 MWh of unsupplied energy (which is a significant decrease compared to 22.71 MWh in 2020).

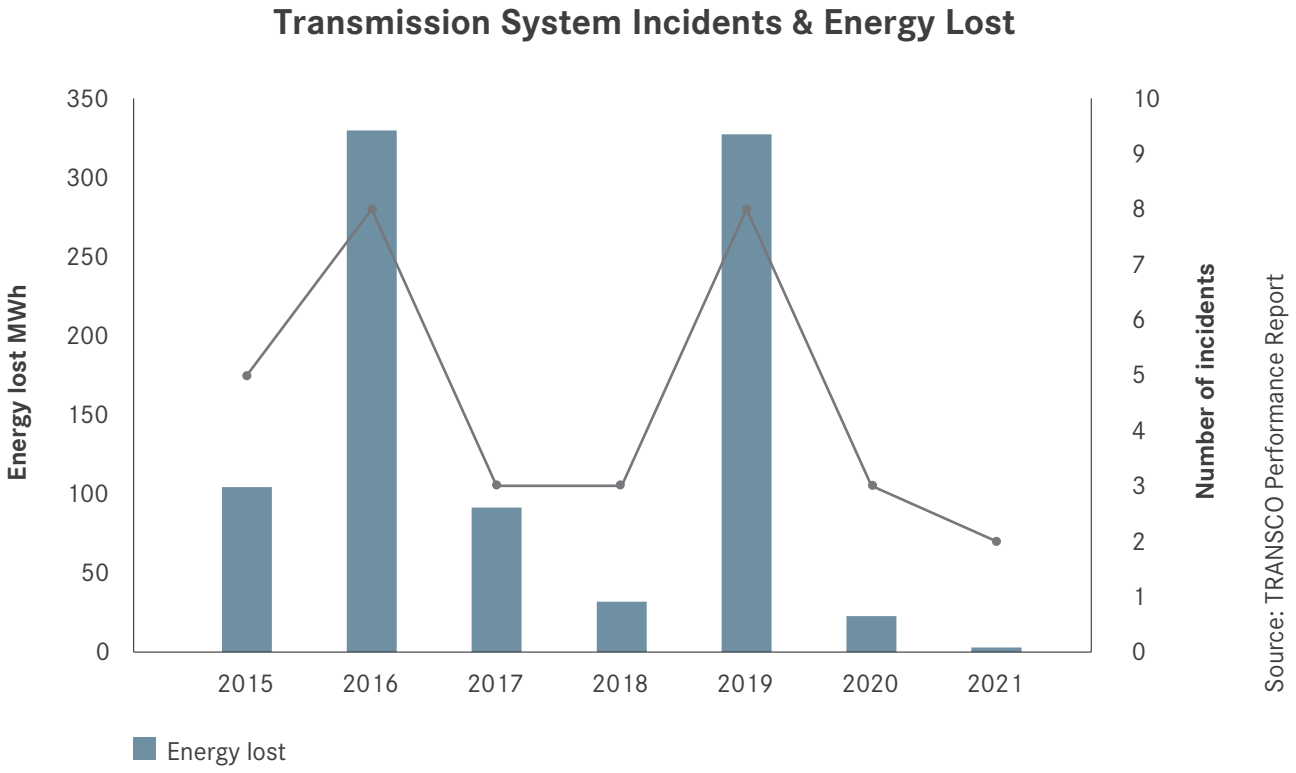


Figure 20: Transmission System Incidents and Energy Lost (Unsupplied)

2.92 MWh
Unsupplied energy in 2021

2
Transmission incidents in 2021

Transmission system losses

Energy loss in the transmission system is mainly due to heat dissipation as a result of electricity flow in the different parts of the network “overhead lines, cables and transformers”. System losses are measured as the difference between the total energy input to the transmission system and total energy output from the transmission system.

Transmission losses remained at the same percentage, increasing slightly from 2.16% in 2020 to 2.18% in 2021. It is also below the average losses of 2013-2021 (2.23%) and has been like this for the last 5 years which is a positive indication.

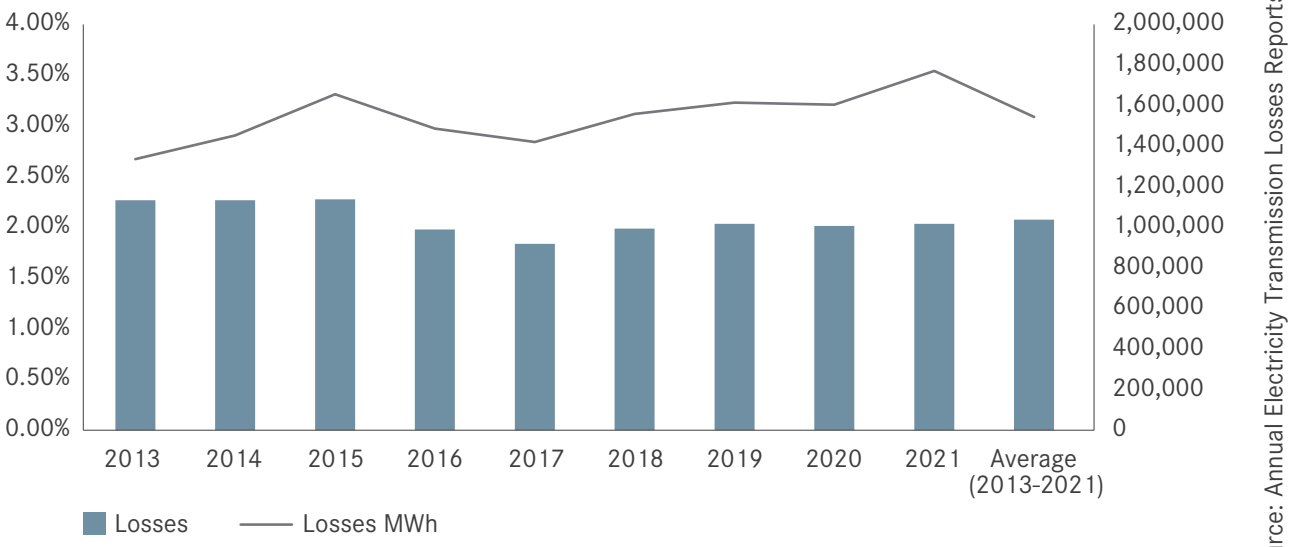


Figure 21: Transmission System Losses

Water Transmission System Performance

The performance of the water transmission system is monitored through several KPIs including:

Water Transmission losses

Security Supply

System availability

Water Transmission Losses

This indicator seeks to monitor and reduce water losses, including both “real losses (physical losses) and operational losses (metering inaccuracies).

Water transmission loss is measured as the net difference between dispatched water from all producers, at the defined entry points (Transmission System Inflow) and the water delivered to distribution at the defined exit points (Transmission System Outflow). This method also takes into consideration the change in TRANSCO’s reservoir water levels.

Figure 22 shows that the percentage of water transmission losses remained below the 2% tolerance threshold from 2011 to 2020, and slightly exceeded 2% in 2021 due to slight increase in loss/consumption within one of the pumping stations.

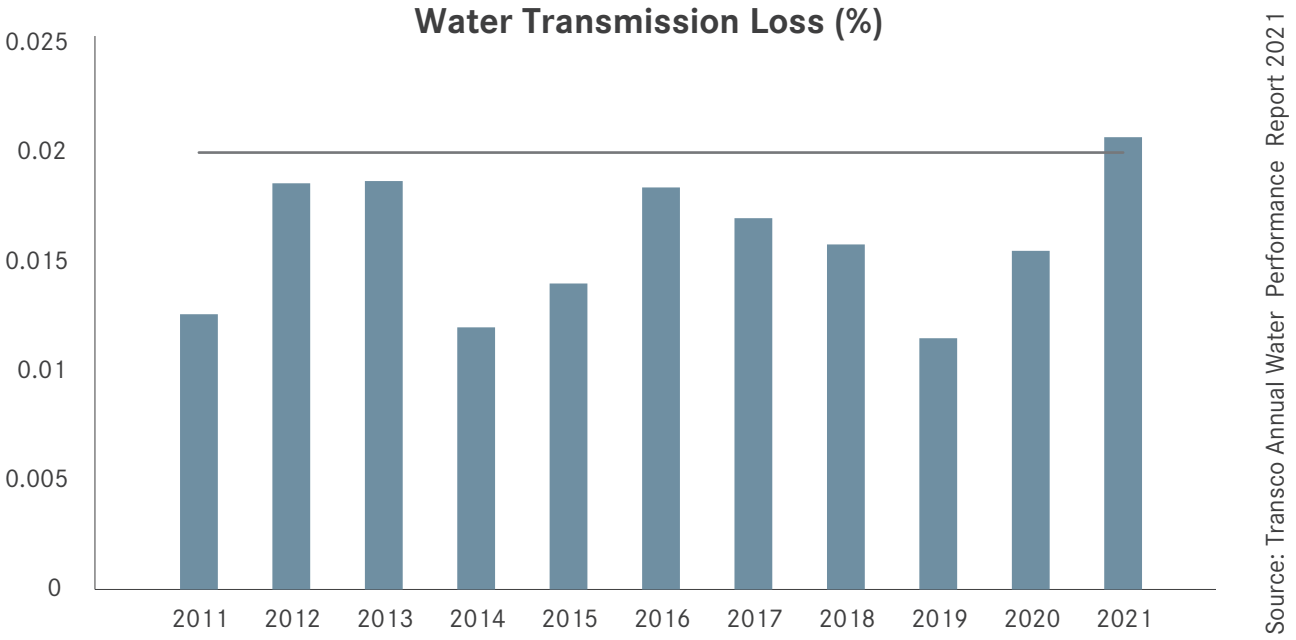


Figure 22: Water Transmission Loss (%)

Security of Supply

The security of supply indicator investigates any supply shortfalls in meeting the scheduled water quantities. This indicator measure's reliability and efficiency, as well as flexibility in reacting to unforeseen demand events. It measures TRANSCO's system ability to cope with unexpected situations that can impact water supply. Scheduled water demands by the distribution companies may not fully met by TRANSCO due to 2 main reasons:

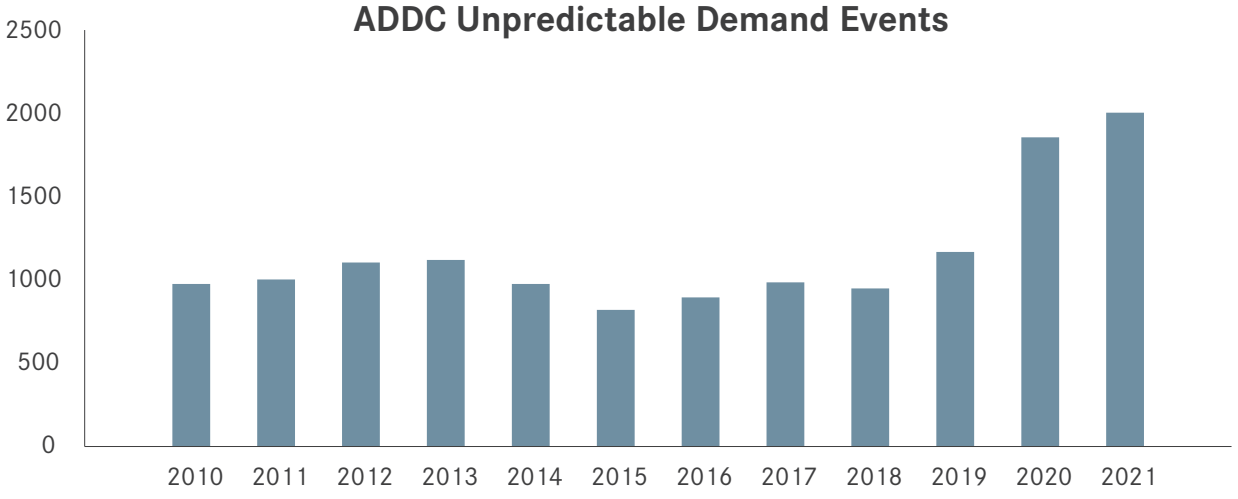
Unpredictable demand events

Supply interruptions

Unpredictable demand events

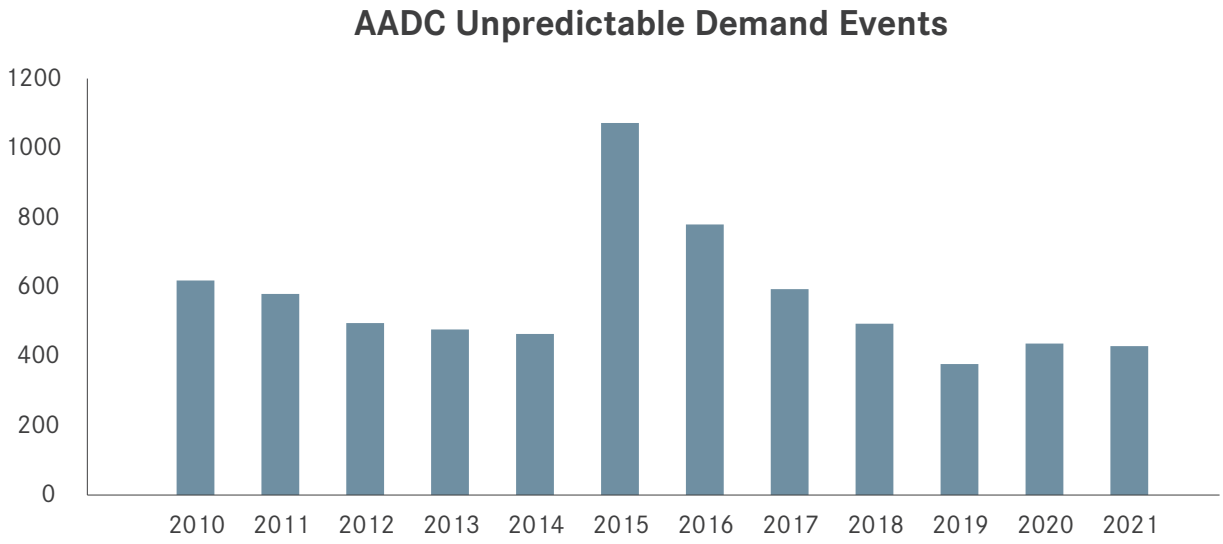
This happens when DISCO's actual demand deviated from the scheduled quantity by a certain threshold. This deviation could be attributed to DISCO's forecasting errors, non-availability of metering data at some data management platforms (DMPs), or insufficient consumption profiling.

Figures 23 and 24 below show the unpredictable demand events for both ADDC and AADC respectively from 2010 to 2021. There are inherent difficulties in generating highly accurate demand forecasts, which requires further progress with data collection and validation, as well as network operational management.



Source: Transco Annual Performance Report 2021

Figure 23: ADDC Unpredictable Demand Events

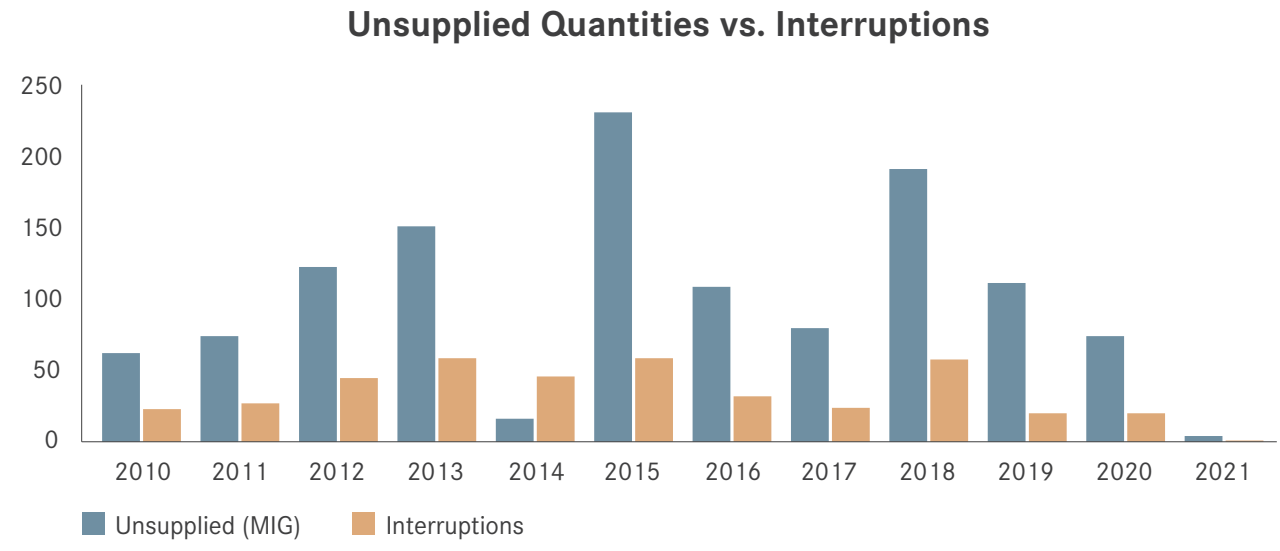


Source: Transco Annual Water Performance Report 2021

Figure 24: AADC Unpredictable Demand Events

Supply interruptions

Supply interruptions result from incidents or constraints within the production; transmission; or distribution system. Figure 23 below shows the unsupplied quantities and interruptions caused by TRANSCO from 2011 to 2021. A positive trend of significant drop in unsupplied quantities and number of interruptions were achieved after 2015 by TRANSCO. However, 2018 witnessed an increase again primarily due to operational challenges resulting from the shutdown of some pumping stations. The DoE continues to work closely with TRANSCO to enhance their operations to minimize such events and reduce the unsupplied quantities.



Source: Transco Annual Performance. Report 2021

Figure 25: Unsupplied Quantities vs. Interruptions

System availability

This indicator determines the main transmission system components/assets (pumps, transmission lines, storage tanks, or combination thereof) that are either operational or in standby mode. Components that do not meet this definition are classed as “unavailable”.

Transmission System Availability has remained relatively steady and positive since 2010; TRANSCO’s overall system availability in 2021 is 97.37%, as illustrated in Figure 26 below. The component most often found to be responsible for unavailability was pumps. The DoE works closely with TRANSCO to enhance the assets condition and performance monitoring activities.

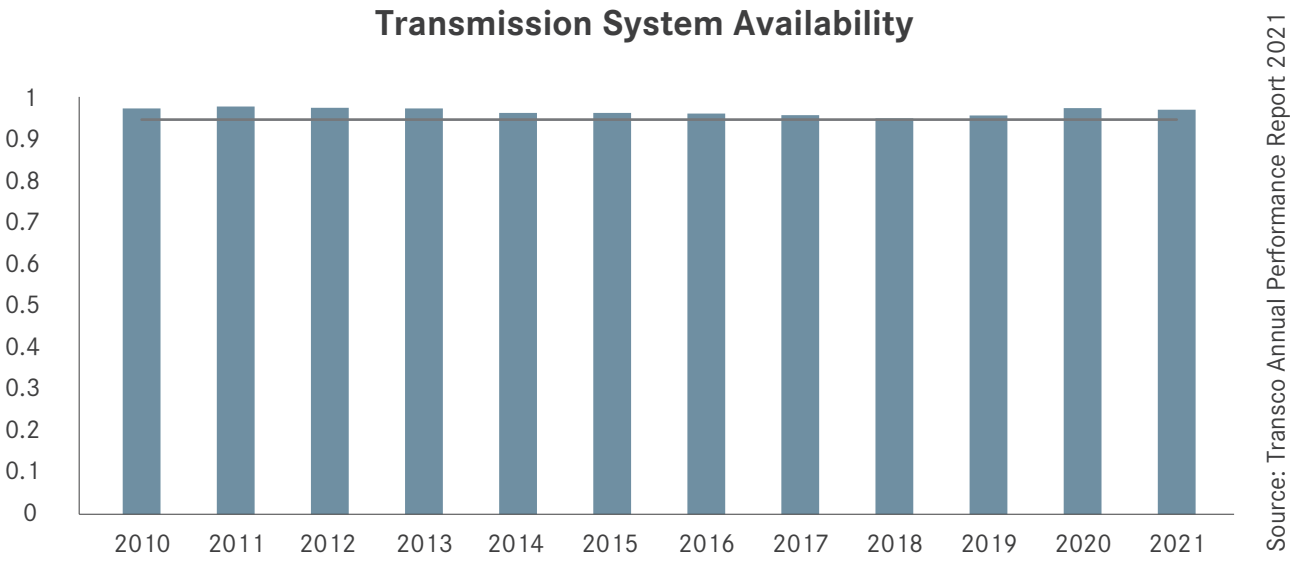
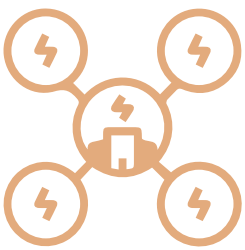


Figure 26: Transmission System Availability



97.37 %

TRANSCO’s overall system availability in 2021

Water Quality Regulatory Performance - Transmission

TRANSCO

The transmission water quality sampling and testing is conducted as per the WQR regulatory prerequisites. The sample must be representative of the water quality at the time of sampling, its collection program is made with sampling frequency from predetermined locations at equal intervals over the year and it must be analysed as soon as practicable after it has been taken.

The total number of tests completed by TRANSCO in 2021 was 41,880, with 62 water quality parameters tested in TRANSCO transmission network. The overall water quality testing frequency compliance (measure of the number of tests conducted against those required) for TRANSCO was 100%.

The overall average water quality compliance for 2021 was 96.57%, with Physical Parameters and Microbial Parameters compliance at 93.86% and 99.80% respectively.

The figure below depicts five years overview of the transmission consistent overall water quality compliance.

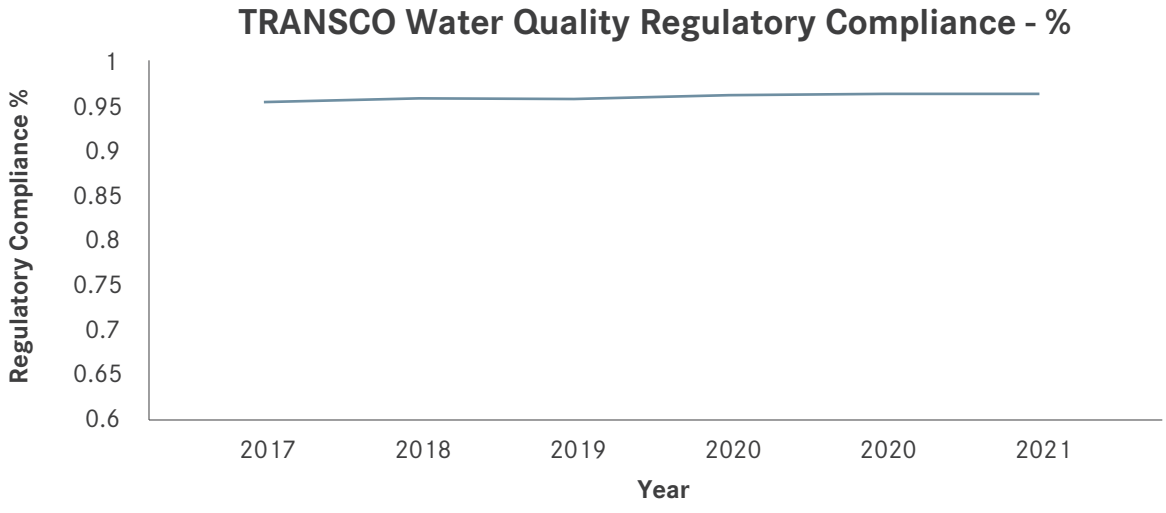


Figure 27: TRANSCO Water Quality Regulatory Compliance - %

41,880
Total number of tests completed by TRANSCO in 2021

96.57%
Overall average water quality compliance for 2021

Electricity and Water Distribution

Distribution Overview

ADDC and AADC own and operate electricity and water distribution and supply networks in their respective geographical areas. Both companies own and operate electricity networks (33 - 22 - 11 - 0.4 KV), as well as a water distribution network with a total length of 14,146 (km) transporting electricity and water from the transmission system to homes and businesses across the Emirate of Abu Dhabi.

The tables below provide an overview of the electricity and water distribution customers and asset base in 2021.

	ADDC	AADC	Total
Number of Electricity customers	418,919	160,551	579,470
Number of Water customers	341,162	96,807	437,969

Table 3: Number of Customers

	ADDC	AADC	Total
Electricity Distribution Network Assets			
Number of Primary Substations	303	177	480
Number of Distribution Substations	20,847	16,676	37,523
km of cable/overhead lines	47,833	29,251	77,084
Water Distribution Network Assets			
Water Pipelines (km)	9,434	5,088	14,522
Pumping Stations	35	7	42
Capacity	0.27 MCMD (59 MIGD)	0.23 MCMD (51.19 MIGD)	0.5 MCMD (110.19 MIGD)
Reservoirs	51	16	67
Reservoirs Capacity	0.15 MCM (33 MIG)	0.13 MCM (28.5 MIG)	0.28 MCM (61.5 MIGD)

Table 4: Electricity and Water distribution network assets

Electricity Peak Demand

The peak demand load of ADDC grew by 0.7% from 2020 to reach 6,614 MW in 2021, while that of AADC grew by 2.3% to reach 2,500 MW.

The figures below show the peak demand growth for the last 16 years for each of the Distribution Companies.

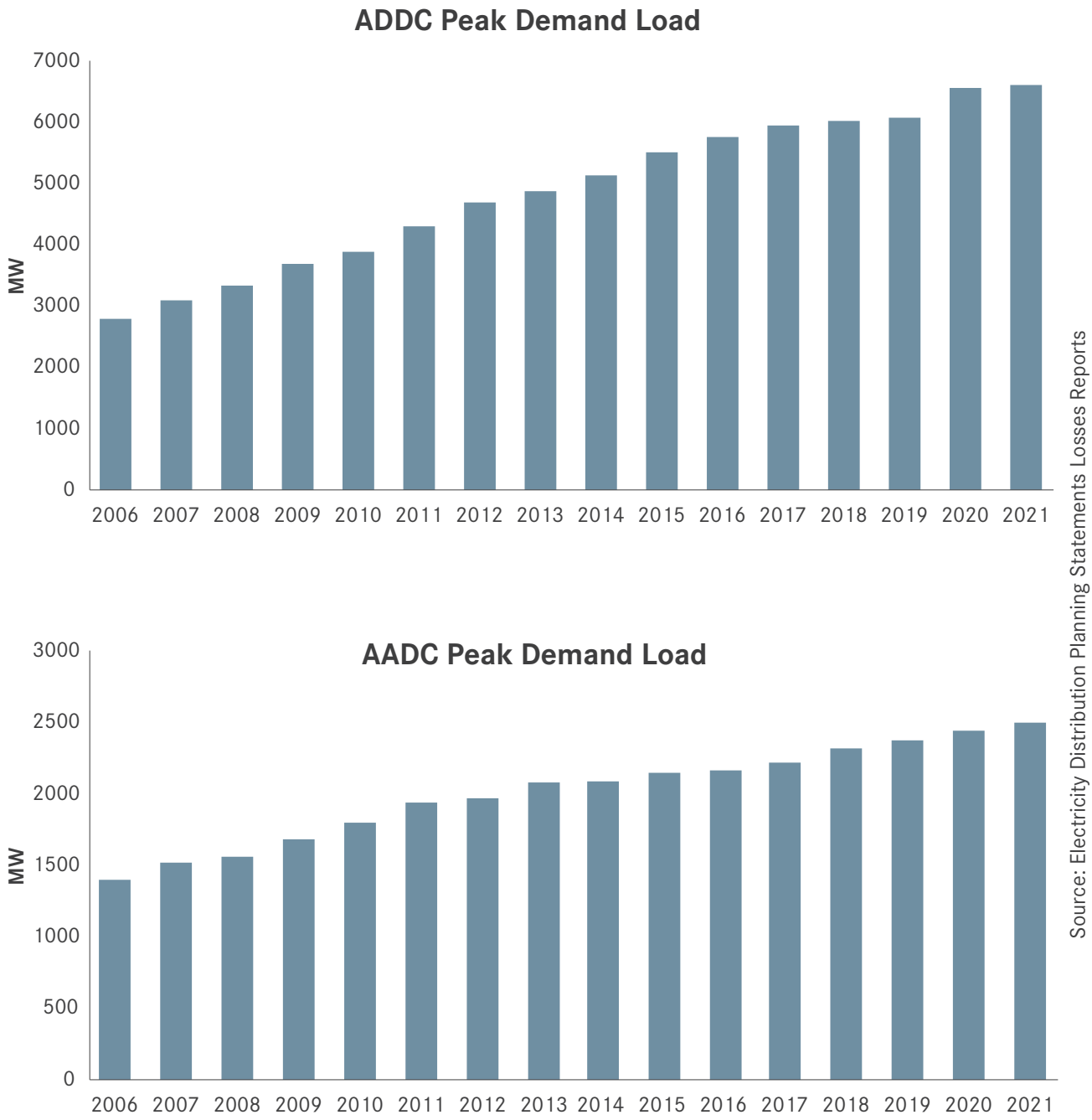


Figure 28: Peak demand growth

In 2021, the average daily water supplied by TRANSCO to Abu Dhabi was 2.14 MCMD (470 MIGD) and to Al Ain was 0.79 MCMD (173 MIGD), based on weekly averages, as illustrated in the graphs below. This has been consistent with the weekly water supplied in 2020.

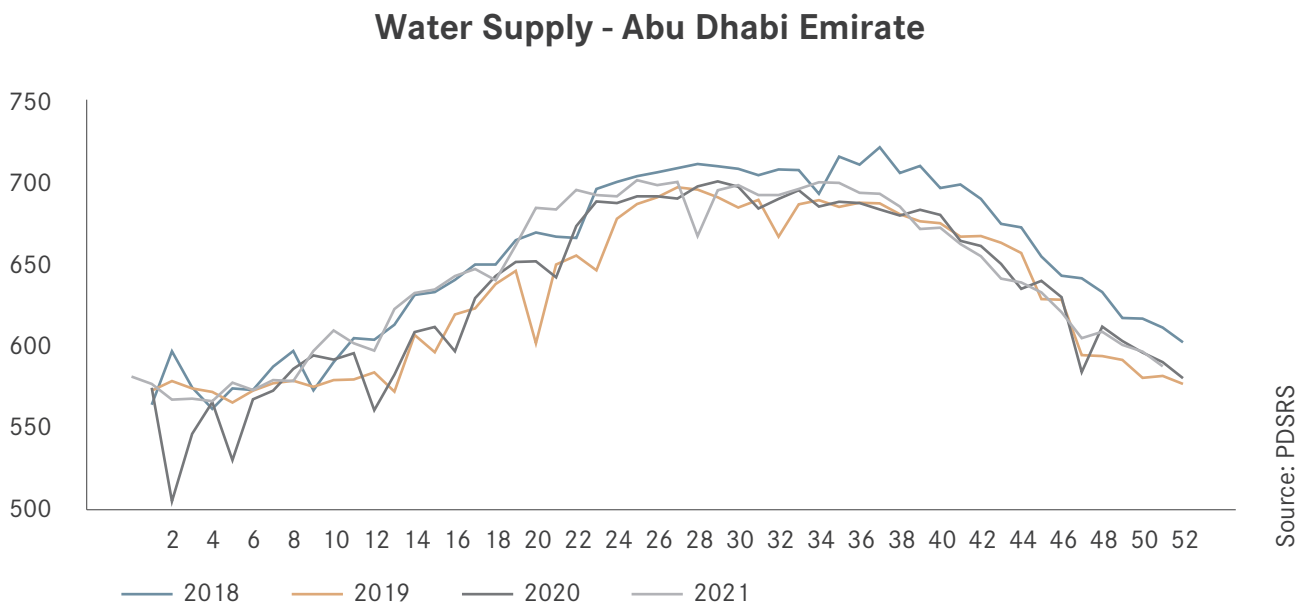


Figure 29: Water supply – Abu Dhabi Emirate

Electricity Distribution Network Performance

Similar to the transmission system, the performance of the distribution system in terms of efficiency and quality is monitored through KPIs measuring parameters such as customer interruptions and system losses.

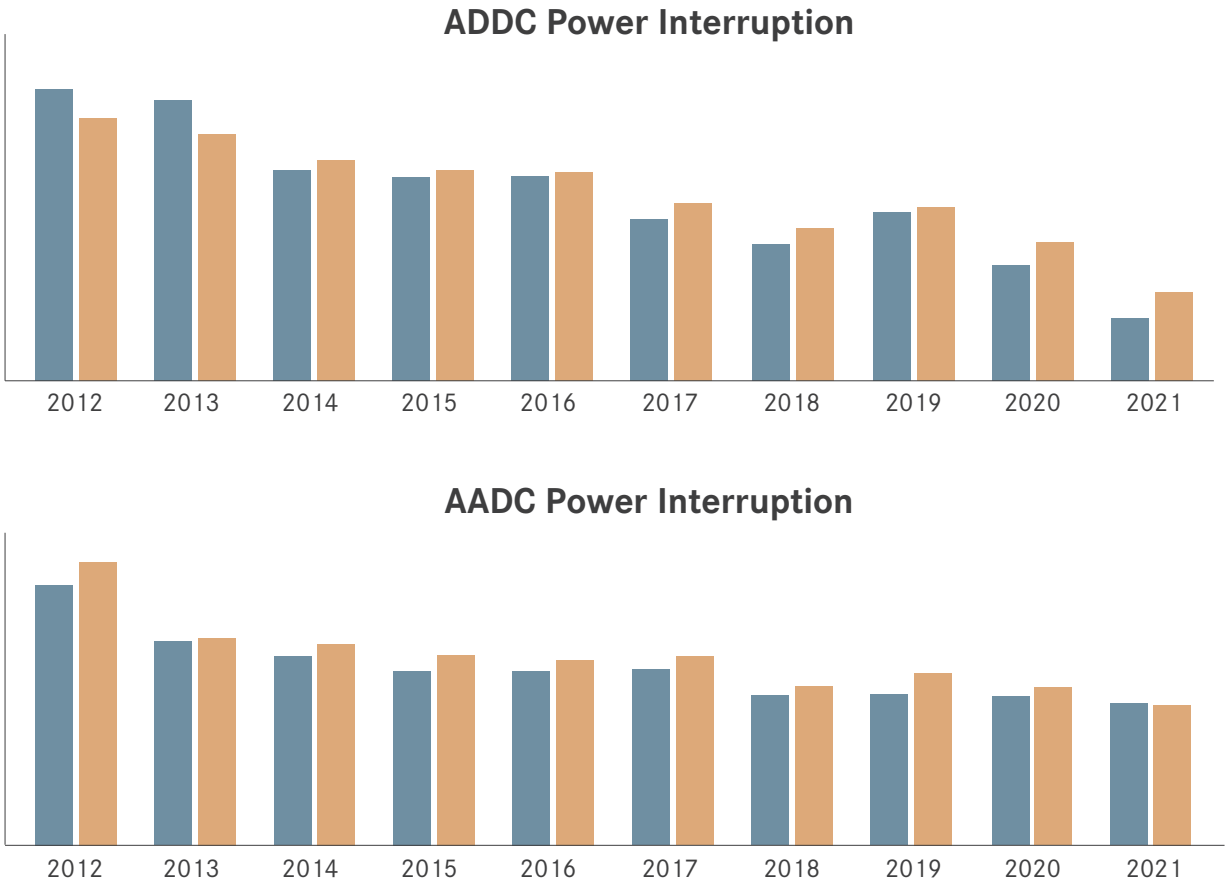
Customer Interruptions

SAIDI, the System Average Interruption Duration Index is calculated as the sum of customer minutes lost experienced during the year due to interruptions in the network divided by the number of customers. It gives an indication of the average duration of interruption experienced by a customer over the year.

SAIFI, the System Average Interruption Frequency Index is calculated as the sum of the number of customers affected by interruptions during the year divided by the number of customers. It gives an indication of the average number of interruptions experienced by a customer over the year.

While these two KPIs measure averages over the year, any major interruptions, which have a large contribution to SAIDI and SAIFI, are reportable under the Incident Reporting Regulations and investigated accordingly. These incidents, and reporting requirements, are elaborated in Chapter 5 of this report.

The 2021 ADDC SAIDI and SAIFI figures decreased significantly, in the order of 40% and 32% respectively. This is partially due to the adoption of Connectivity Model based reporting, hence a major improvement in the accuracy of reporting of the SAIDI and SAIFI figures. AADC's figures similarly decreased by 5.7% and 11% from the 2020. figures reaching the same levels as the 2018.



Source: Annual Electricity Distribution Performance Reports

Figure 30: ADDC and AADC Power Interruptions

40% **32%**

Improvement in ADDC SAIDI/SAIFI figures due to adoption of Connectivity Model based reporting

In 2018 the Council of European Energy Regulators (CEER) conducted a benchmarking study and published a report on the quality of supply for 2016 of its members, and SAIDI and SAIFI were the main indices used for electricity

It is apparent that Abu Dhabi emirate overall fairs reasonably well in comparison with the top-ranking European countries. This is due to the continuous efforts of the DISCOs over the years to improve the performance of the network in terms of capital investment and operational practices.

Losses

Electricity losses are measured by the difference between the units entering the system and those leaving it. In the case of distribution, the measurement is distorted by the billing and meter-reading cycle of both AADC/ADDC customers and therefore show significant year-on-year variations.

The slight decrease in losses in 2021 for both ADDC and the lack of change for AADC is therefore not significant, as it is within said year-on-on year variations.

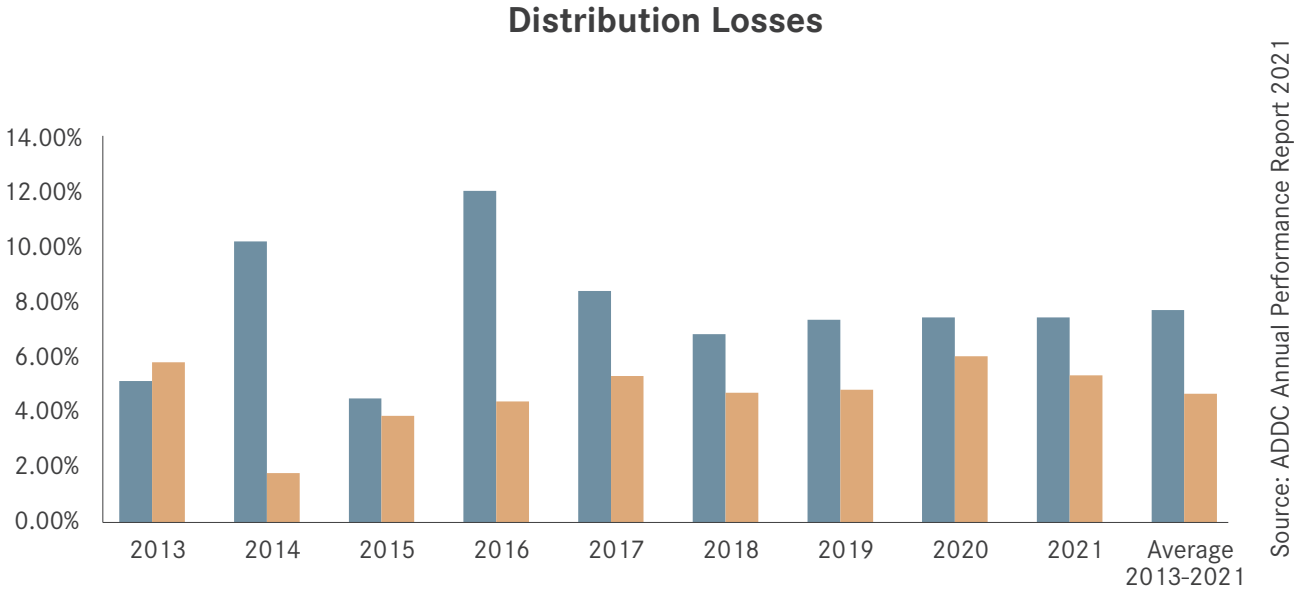
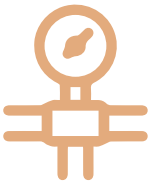


Figure 31: Distribution Losses

Water Distribution System Performance

Similarly, the performance of the water distribution system is measured using various indicators developed by the DoE, including:

Pressure of Supply



Type of supply

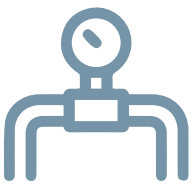
Pressure of Supply

Pressure of Supply measures supply pressure with a view to achieving a standardized level sufficient to supply low-rise buildings, thereby reducing reliance on ground storage tanks and preventing infiltration by ground water contaminants.

In line with the Water Supply Regulations the minimum required pressure in the distribution network is 1.25 bar. In 2021, compliance with this requirement increased to nearly 99% in Abu Dhabi and stayed the same at 93% in Al Ain, as shown in Figures 32 and 33 below.

With respect to ADDC, all the noncompliant cases were in the Eastern Region in remote areas of Moazes and Al Adla. The relatively good results have been achieved through pumping optimization in the transmission system and re-adjustment of control valves to optimize pressure distribution within the distribution network.

With respect to AADC, the noncompliant cases were in Abu Samra and in Al Yahar (Wahat Al Amirah) due to the pressure management/reduction required there, to avoid breakages on the aged networks. With the completion of TRANSCO's projects in Al Ain, all transmission constraints have been lifted. On the other hand, AADC are progressing well with their asset replacement scheme and the situation should improve further.



1.25 bar

Minimum required pressure in the distribution network

In 2021, compliance with this requirement increased to nearly **99% in Abu Dhabi**

In 2021, compliance with this requirement increased to nearly **93% in Al Ain**

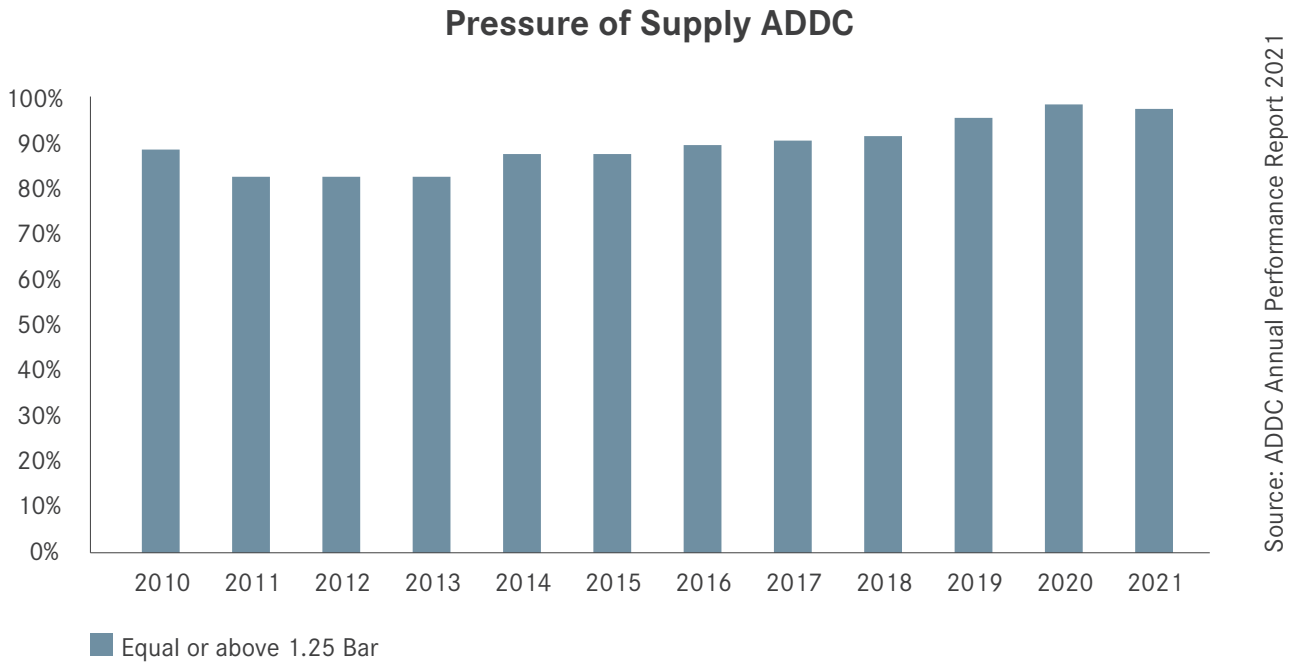


Figure 32: Pressure of Supply ADDC

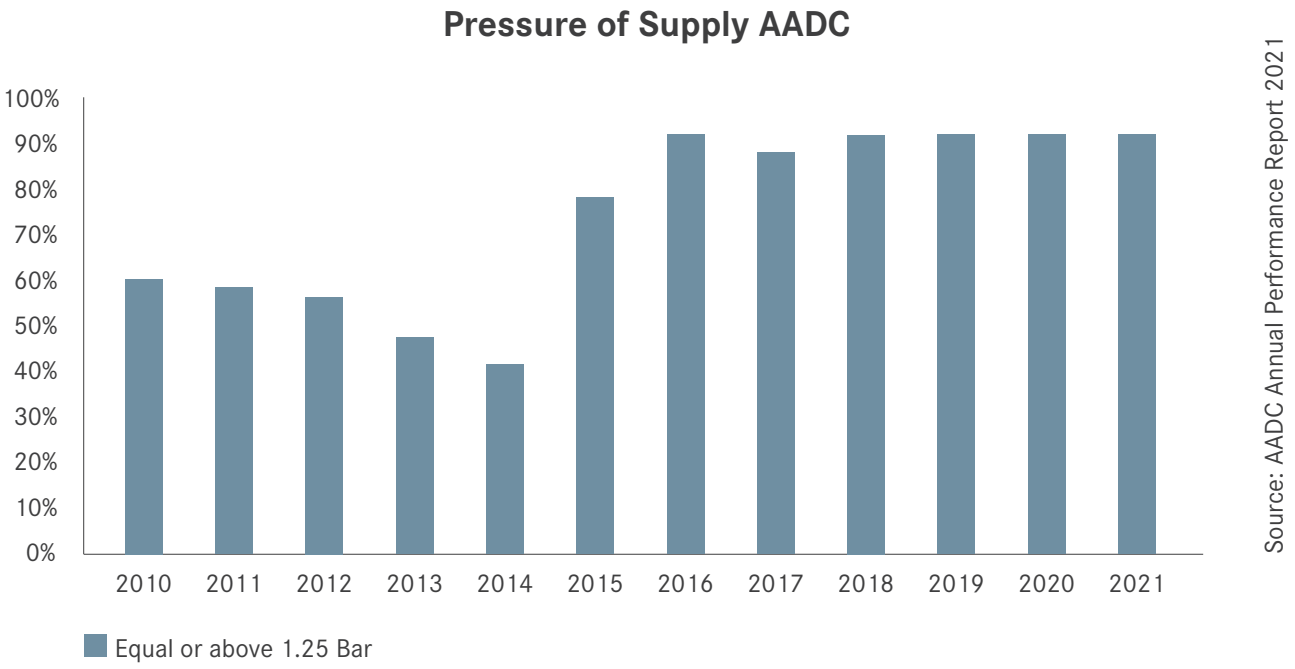


Figure 33: Pressure of Supply AADC

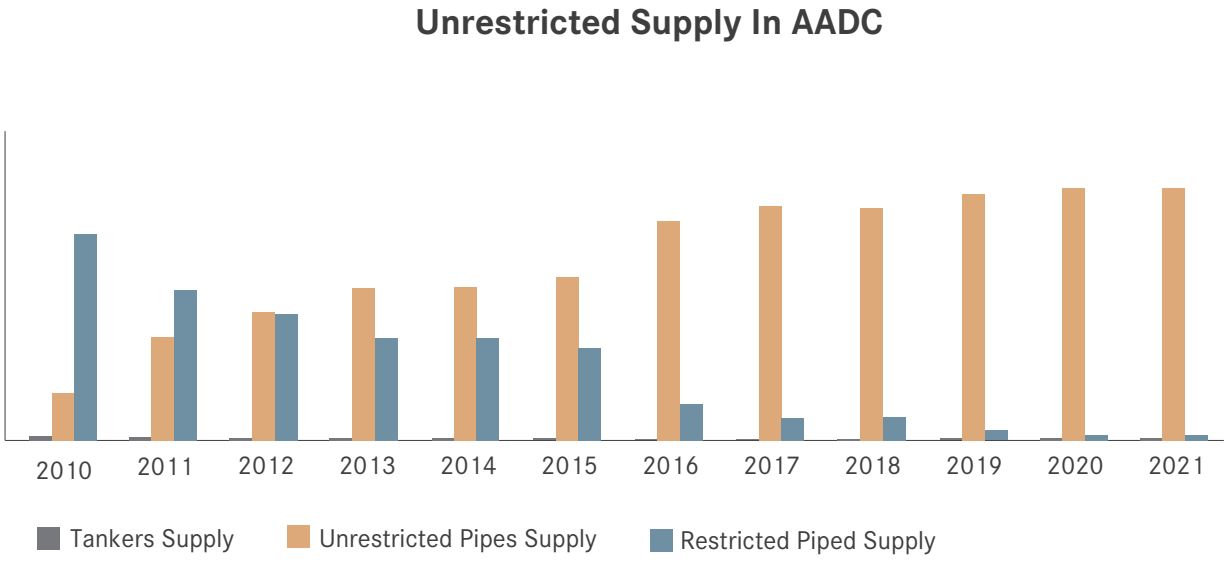
Type of Supply

This indicator measures the progress made towards reducing the number of customers dependent on tankers and intermittent supply.

For ADDC the proportion of customers connected to the network stands at 99.60%, with 100% on continuous supply, while the remaining customers (0.40 %) are supplied with water by tankers.

The situation in AADC has been steadily improving and around 99 % of AADC's customers are now connected to the network with 98% on continuous supply and only 1.98% on intermittent supply, like last year. The remaining customers (0.99%) are supplied with water by tankers.

The Figure 34 below shows the increase in unrestricted supply in Al Ain during 2021.



Source: 2021 PCR Report and 2021 Annual performance report

Figure 34: Unrestricted Supply in AADC

99 %
AADC's customers are now connected to the network

98 %
Continuous supply on last year

Water Quality Regulatory Performance - Distribution

The distribution water quality sampling and testing is conducted as per the WQR regulatory prerequisites. The sample must be representative of the water quality at the time of sampling, its collection program is made with sampling frequency from predetermined locations at equal intervals over the year and it must be analysed as soon as practicable after it has been taken.

Distribution - ADDC

The total number of tests completed by ADDC in 2021 was 43,769, with 64 water quality parameters examined for the ADDC distribution network. The overall water quality testing frequency compliance (measure of the number of tests conducted against those required) for ADDC was 100%.

The overall average water quality compliance for 2020 was 97.48%, with Physical Parameters and Microbial Parameters compliance at 97.45% and 100% respectively.

The figure below depicts five years overview of ADDC consistent overall water quality compliance.

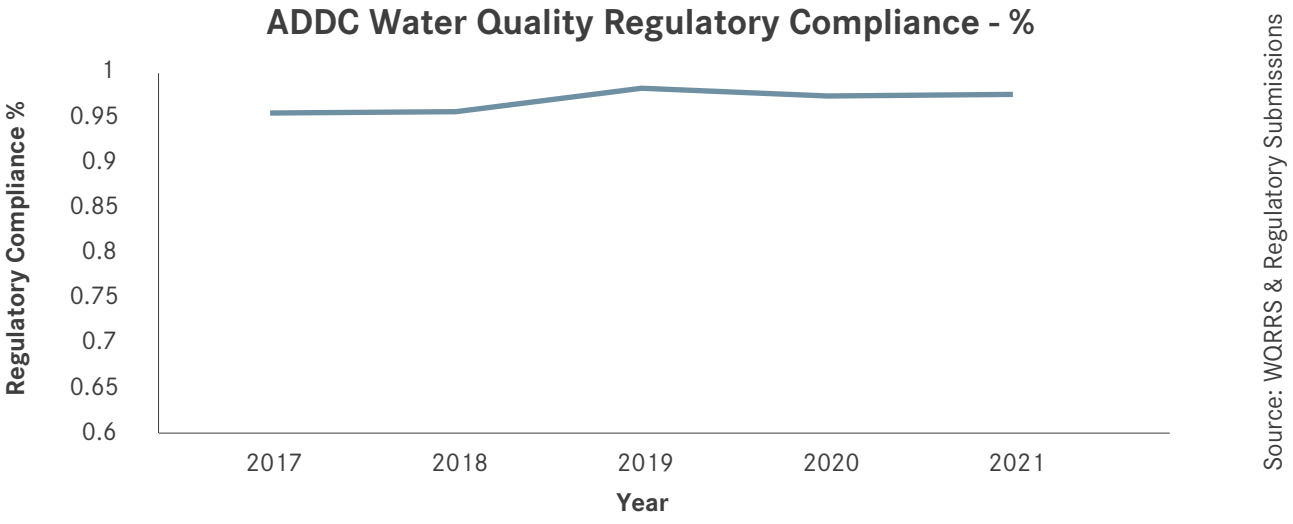


Figure 35: ADDC Water Quality Regulatory Compliance

43,769
The total number of tests completed by AADC in 2021

97.48%
The overall average water quality compliance for 2020

Distribution - AADC

The total number of tests completed by AADC in 2021 was 14,587, with 64 water quality parameters examined for the AADC distribution network. The overall water quality testing frequency compliance (measure of the number of tests conducted against those required) for AADC was 100%.

The overall average water quality compliance for 2020 was 98.57%, with Physical Parameters and Microbial Parameters compliance at 99.65% and 100% respectively.

The figure below depicts five years overview of AADC consistent overall water quality compliance.

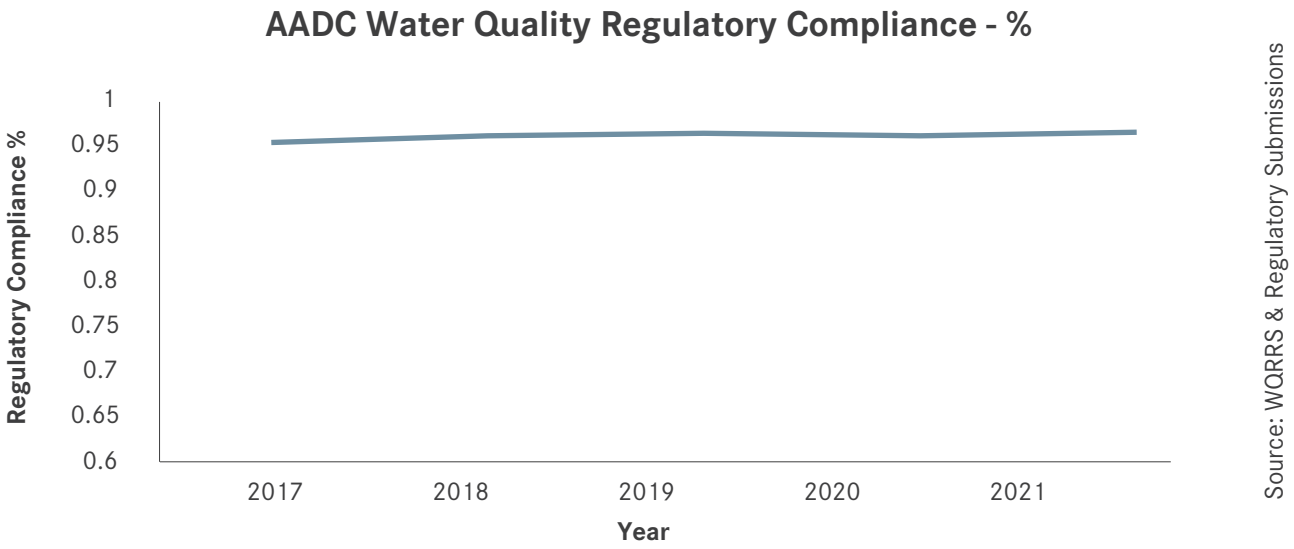
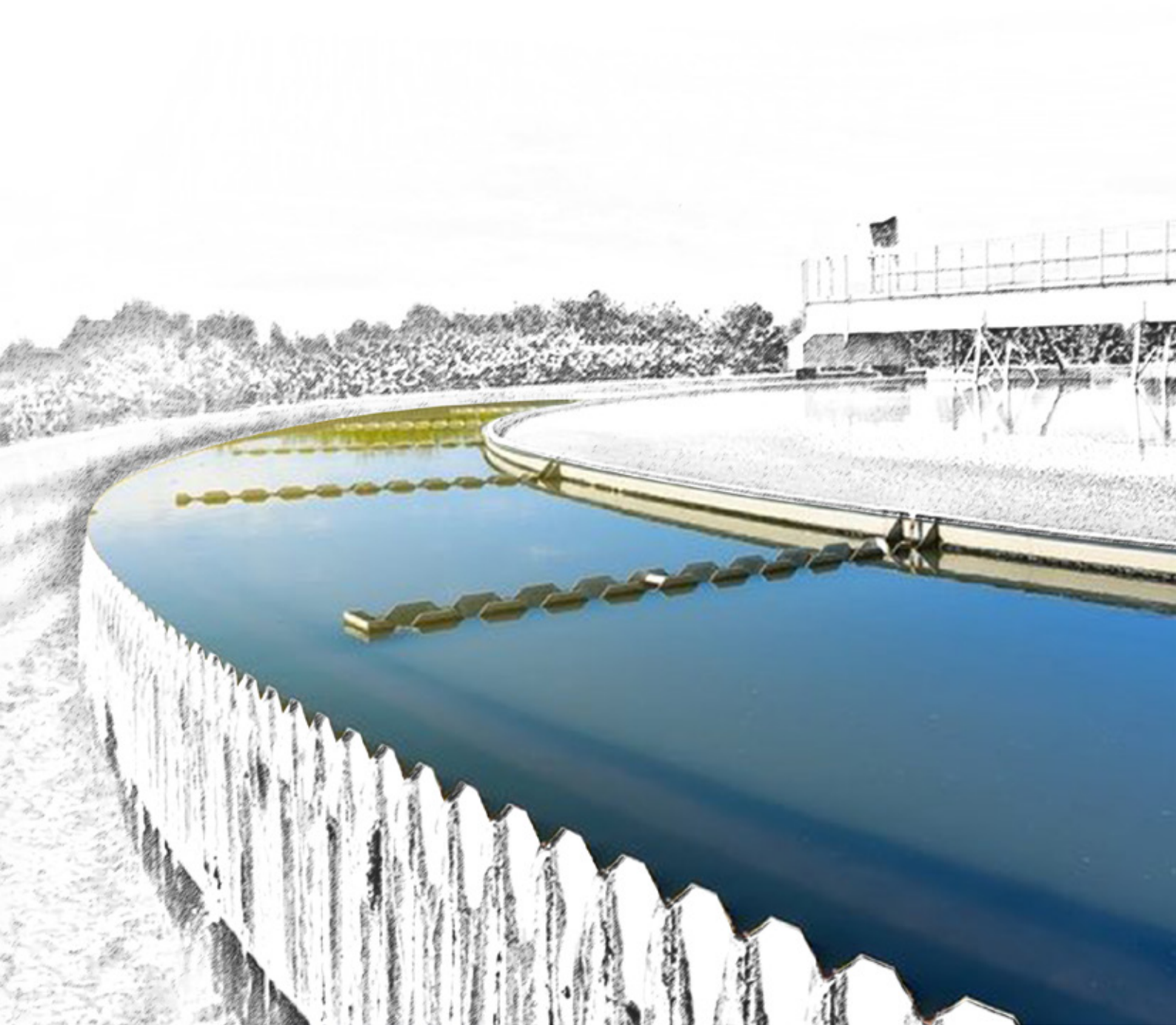


Figure 36: AADC Water Quality Regulatory Compliance - %

14,587
The total number of tests completed by AADC in 2021

98.57%
The overall average water quality compliance for 2020

06 Wastewater and Recycled Water

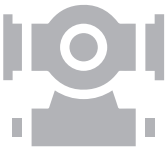


Collection

Wastewater collection is defined as the connection of premises to the sewerage system and the transportation of wastewater from premises or customers to the wastewater treatment system. The key components of the collection systems operated in the Emirate are:

Deep tunnel sewer

Conventional gravity sewers



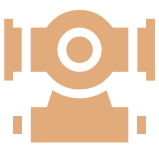
Pumping stations

Pumping mains

The Strategic Tunnel Enhancement Programme (STEP) project in 2017 enabled ADSSC to use link sewers to intercept the wastewater flows in existing gravity sewers just upstream of the existing pumping stations and transfer these flows into the Deep tunnel sewer. The wastewater is then conveyed by gravity via the Deep tunnel sewer to the Al Wathba 1 and Al Wathba 2 treatment plants.

Currently, flows from catchments of main pumping stations in Abu Dhabi MPS1, MPS2, MPS3, MPS4, MPS13, MPS14, MPS6, MPS17, MPS8N and many smaller pumping stations are diverted to the Deep tunnel. Several asset enhancement and link sewer projects continued in 2021 with further enhancement projects planned through to 2026.

In 2021 ADSSC operated a total of 280 pumping stations which ranged in size from small local stations to large terminal pumping stations rated at over 300l/s. Additionally, the total network length operated by ADSSC in 2021 was 8,942 km. Figure 37 illustrates the year-on-year change in the length of sewer network operated by ADSSC.



Year 2021

ADSSC operated a total of 280 pumping stations

8,942 km

The total network length operated by ADSSC in 2021

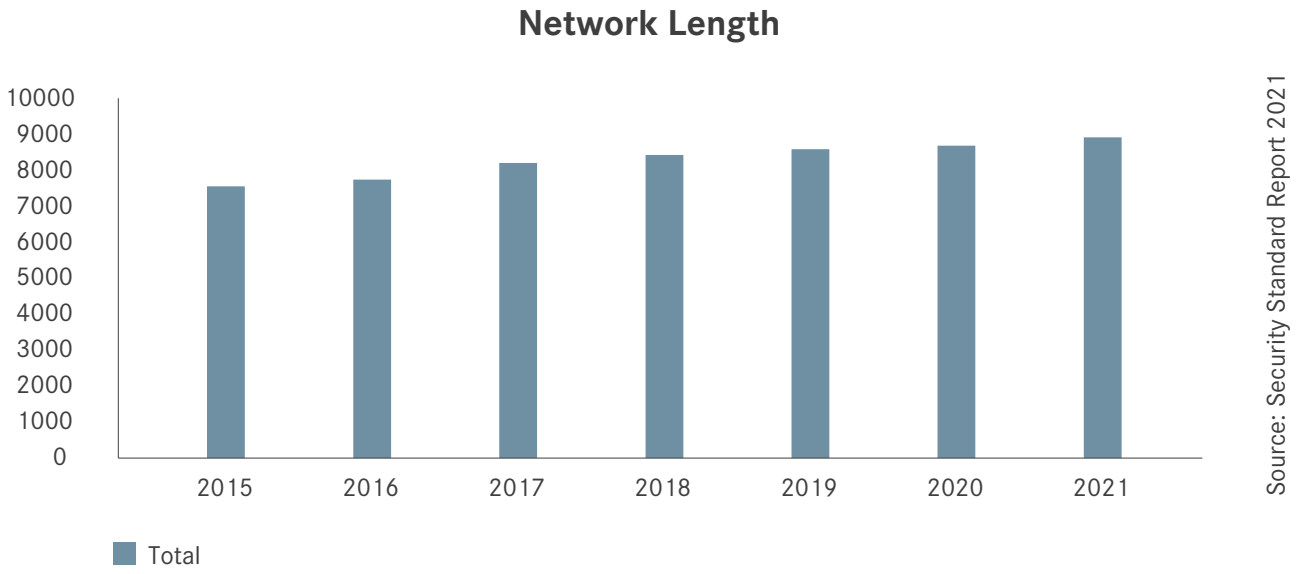


Figure 37: Collection network length (km)

The network length has increased steadily since 2015 due to new network projects and networks adoption from developers.

Collection Network Performance

ADSSC's sewerage collection network is monitored by several KPIs set by the DoE, including:

Sewer collapses per 100km

A sewer collapse is a break or collapse in any gravity sewer, pumping main or vacuum system main which forms part of the licensee's sewerage system and causes an interruption to the service.

The number of collapses per 100km of sewer is a good indicator of the effectiveness of collection system asset management activities and the performance of the operator in managing third party activities close to sewer systems.

Sewer blockages per 100km

A sewer blockage is any partial or total blockage in any gravity sewer, pumping main or vacuum system main which forms part of the licensee's sewerage system and causes an interruption to the service.

The frequency of blockages per 100km is a good indicator of the effectiveness of operation and maintenance activities in the collection system.

Figure 38 shows ADSSC's sewer collapses and blockages rate between 2015 and 2021.

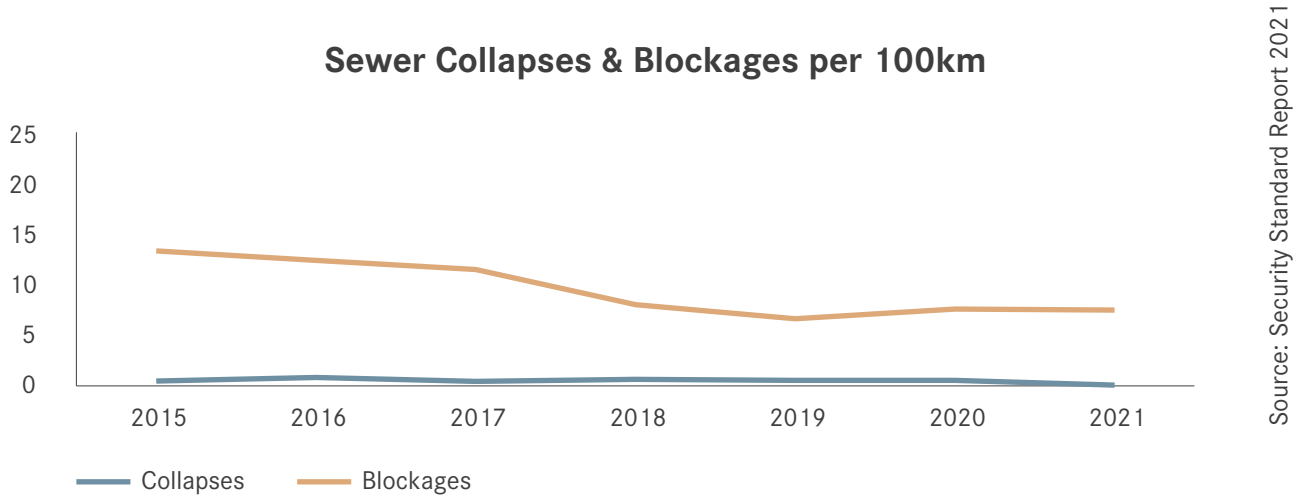


Figure 38: Sewer collapses & blockages per 100km

The primary contributor to the blockages was reported to be the fibre optic cables installed in the sewer system in Abu Dhabi City. ADSSC reported that many overloaded catchments were relieved after 2017 due to the commissioning of STEP which reduced the wastewater levels in the conventional gravity sewers. Additionally, ADSSC continued their network maintenance activities to further reduce the number of public blockages.

It should be noted that the above numbers do not include data on the blockages cleared from private sewer systems which totalled a further 76,219 incidents in 2021.

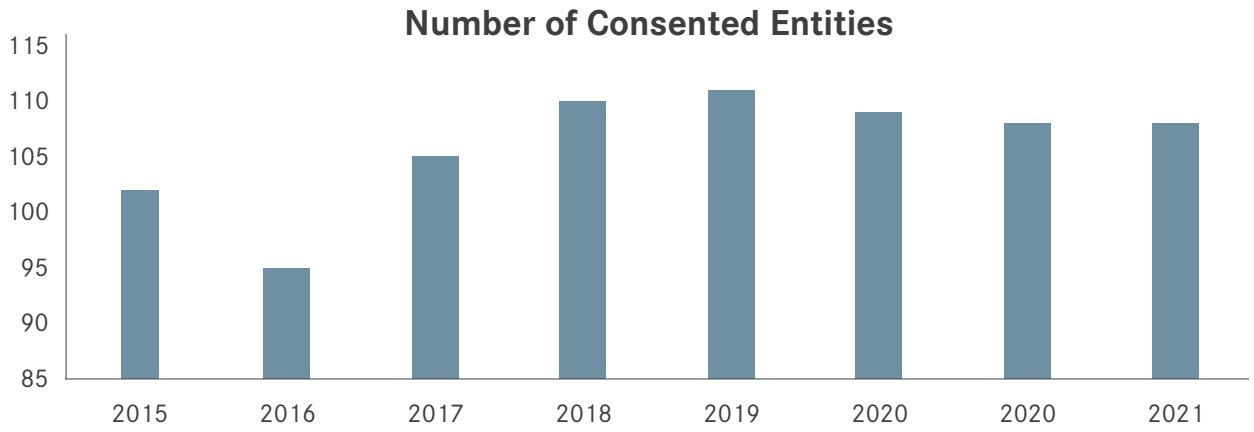
The rate of sewer collapses demonstrated no appreciable change from 2015 to 2021.

Quality Performance

Trade Effluent Control

The discharge of Trade Effluent poses a significant operational challenge to wastewater collection, treatment, and disposal systems. In order to manage these risks, ADSSC is empowered to issue and enforce consents that define the terms and conditions under which the discharge can be made.

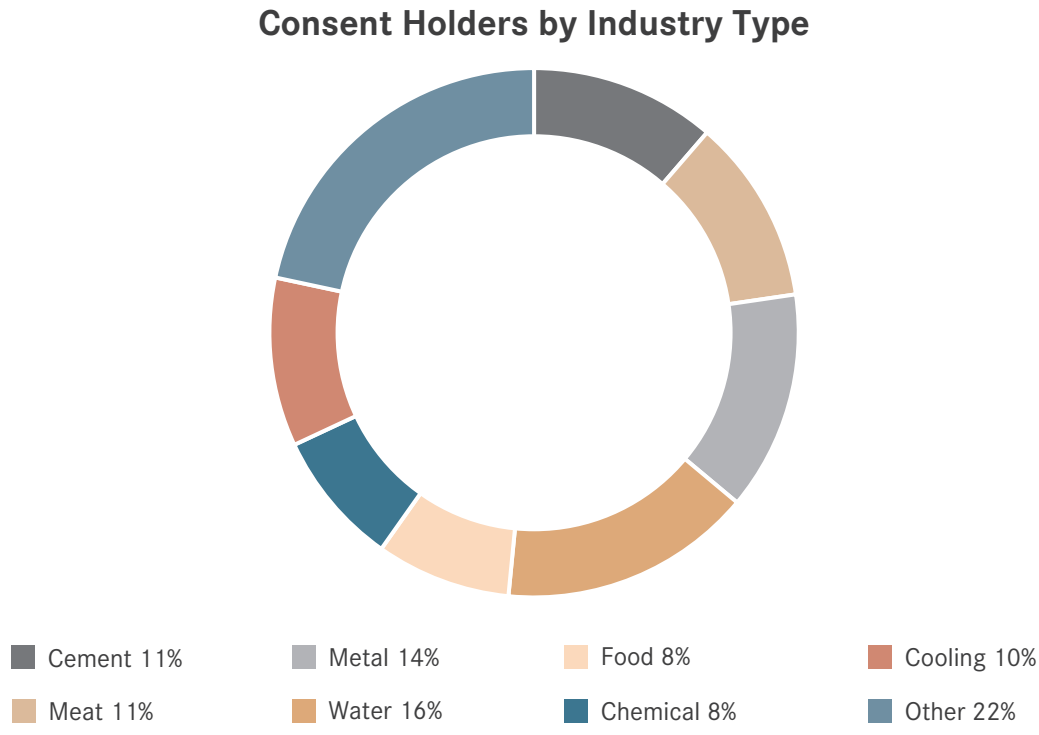
Aside from expirations, there were a number of new consents issued or terminated by ADSSC in 2021, At the close of 2021 there were 108 consented entities. Figure 39 illustrates the change in number of consented entities between 2015 and 2021.



Source: 2021 Annual TEC Compliance Report

Figure 39: Number of Consented Entities

The largest contributors to the trade effluent flow were found to be the water, metal finishing and cement industries. A breakdown of consent holders by industry type is shown in Figure 40 below.



Source: 2021 Annual TEC Compliance Report

Figure 40: Consent Holders by Industry Type

ADSSC categorises its consent holders as high, medium, or low risk according to the size, nature of discharge, and consent holder performance history. This categorisation is used to define the sampling and inspection frequencies for each consent holder. Based on this ADSSC conducted 293 sampling and inspection assessments of consent holders in 2021. Figure 4 illustrates the number of sampling events since 2015. Sampling was continued in the second quarter of 2021 following the COVID -19 outbreak and the associated health and safety concerns regarding sampling of trade effluent.

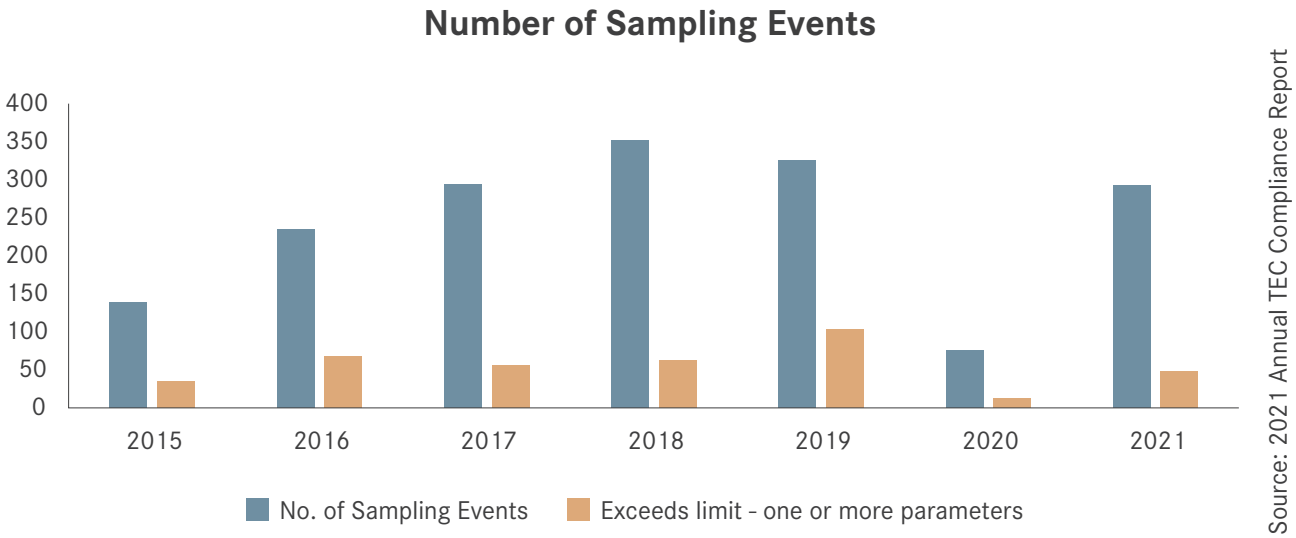


Figure 41: Number of Sampling Events

Year 2021

There were a number of new consents issued or terminated by ADSSC

Year 2021

ADSSC conducted 293 sampling and inspection assessments of consent holders

Year 2021

Restaurants and cafes continue to constitute the bulk of ADSSC's inspection

The most commonly exceeded parameters were pH, TSS and COD. These exceedances were related primarily to the slaughterhouses, cement and cooling factories.

ADSSC issued 2 improvement notices and 10 observation notices which required consent holders to address issues associated with sample failures or issues identified during inspections.

The DoE recognises that the technical and financial effort involved with issuing and monitoring Trade Effluent consents for certain types of Trade Effluent is disproportionate to the risks posed to the receiving sewerage systems. Accordingly, these discharge types are designated as Low Risk Trade Effluent (LRTE) and are managed by ADSSC through Codes of Practice.

There are currently three Codes of Practice in place covering restaurants and cafes, small-scale laundries, and vehicle washes. Figure 42 below shows the number LRTE entities inspected from 2015 through 2021 and the corresponding number of issues encountered during the inspections.

Restaurants and cafes continue to constitute the bulk of ADSSC's inspection workload and an increase in the number of the total LRTE registered was noted in 2021. The main issues encountered by ADSSC inspectors were related to grease trap maintenance.

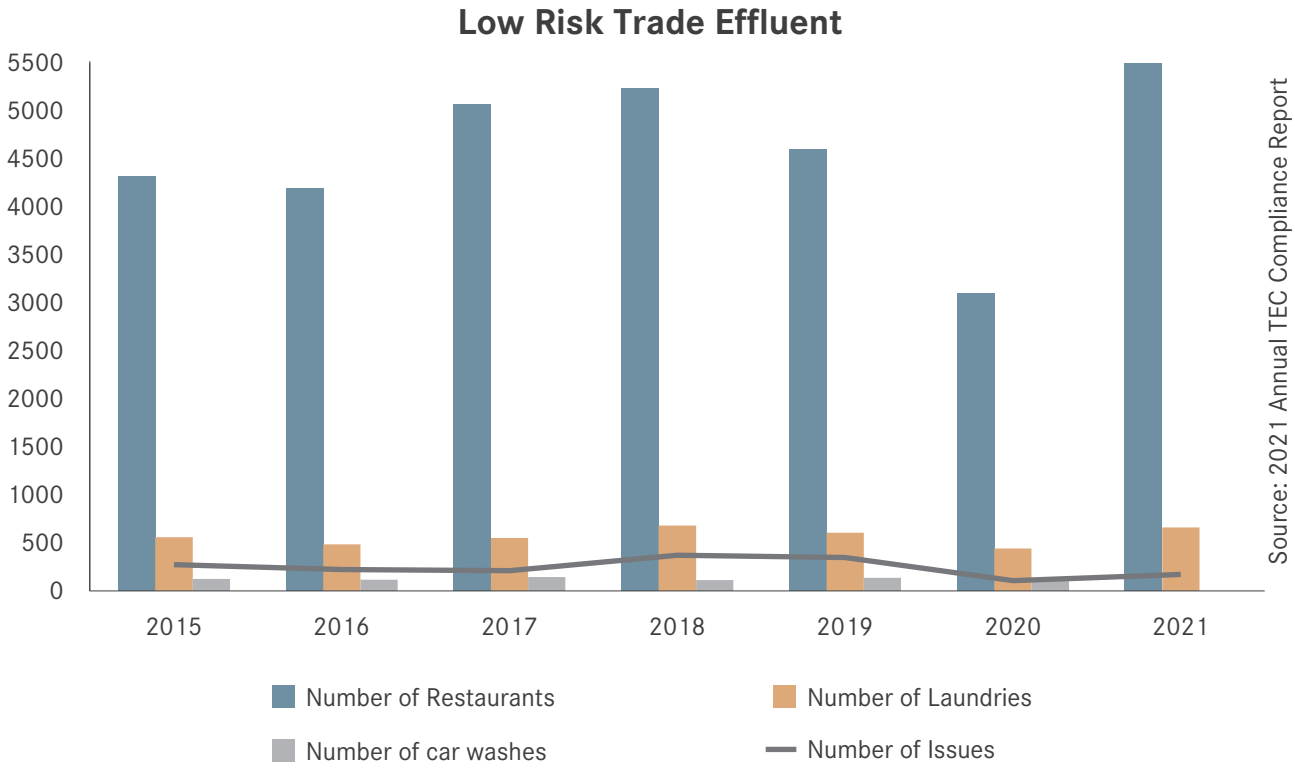


Figure 42: Breakdown of low-risk Entities by Type of Business

Treatment

Wastewater treatment is defined as the reception of wastewater from the collection system, the treatment of the wastewater and delivery of the resulting products to the disposal system. In 2021, a new treatment plant was commissioned in Qasweera bringing the total number of treatment plants operated by ADSSC to 41 with a corresponding overall installed capacity of 1,334.5 ML/day.

Over 90% of the total flow in the Emirate of Abu Dhabi continues to be handled by 5 treatment plants; Mafraq, Al Wathba 1 and Al Wathba 2 in Abu Dhabi, and Saih Al Hamah and Al Saad treatment plants in Al Ain.

Figure 43 below depicts the capacities of the 5 largest plants and their average daily flows in 2021. The figure demonstrates that the treatment plants continue to have sufficient capacity to absorb further flows. Although the average daily flow at Al Saad treatment plant is the closest to capacity, the 2021 flows have decreased 5% since 2016 reducing the urgency for a treatment plant upgrade.

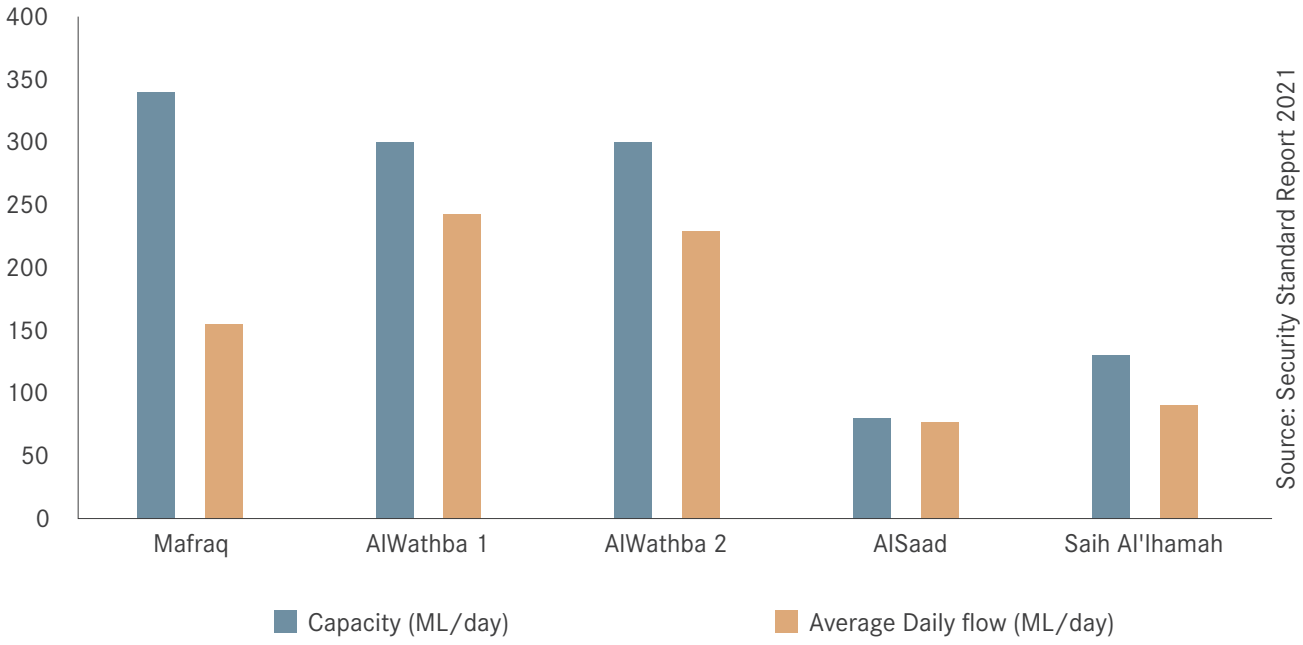


Figure 43: Average influent flow and Capacity (ML/day)

Figure 44 illustrates the total annual flow in the Emirate of Abu Dhabi, and the corresponding flows in each region from 2015 and 2021. A cumulative reduction in flow of 8% was recorded between 2015 and 2021. In 2021 the annual flow flattened out with just a 1.5% increase noted.

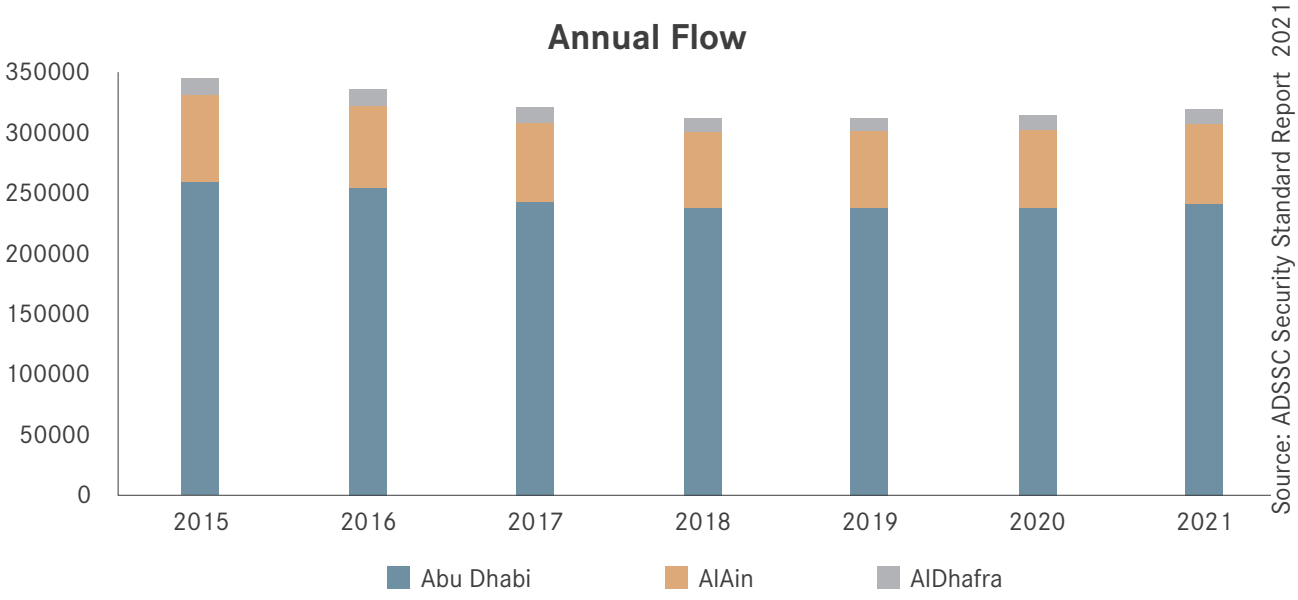


Figure 44: Annual flow data (ML)

Figure 45 Illustrates the proportion of wastewater managed by each of the major licensees in 2021 and highlights the role played by the Independent Sewage Treatment Providers (ISTP) Etihad Biwater and Veolia Besix who manage approximately 73% of the total wastewater treated in the Emirate.

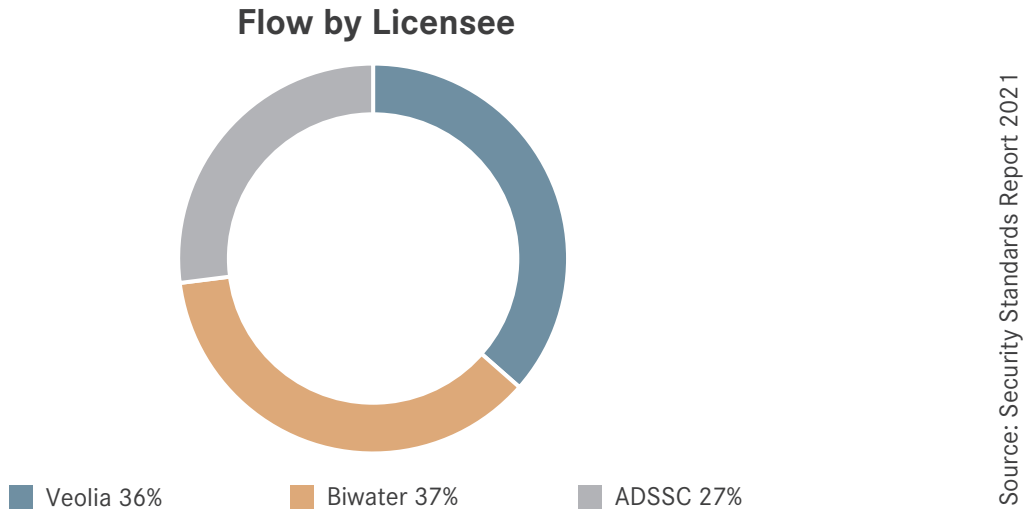


Figure 45: Proportion of Flow Handled by Major Licensees

Quality of Recycled Water at the Disposal Point

The Recycled Water and Biosolids (RW&B) Regulations establish a legal framework for the safe and economic reuse and management of recycled water and biosolids throughout the Emirate. Developing relevant information on the quality of these important products and robust, transparent reporting will highlight compliance difficulties and allow licensees to develop effective operational or project-based solutions to drive year-on-year improvements.

Figure 46 below summarises the recycled water quality compliance for the five major treatment plants operated by large scale licensees from 2015 to 2021 against the sanitary, microbiological and trace elements parameters outlined in the RW&B Regulations. Compliance was assessed by establishing the proportion of samples that passed the relevant standards for the three key parameter groups.

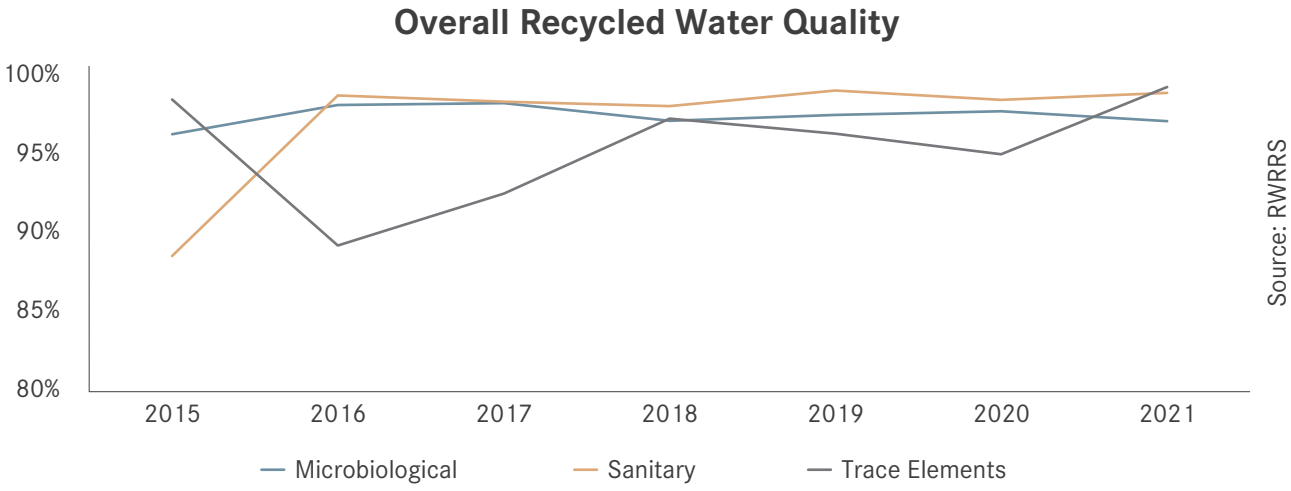


Figure 46: Recycled Water Quality

The data shows significant improvements in compliance against the three key parameter groups over the time period, with excellent compliance reported throughout 2021 for sanitary and trace elements parameters. There was a slight decrease in microbiological parameters compliance which is being investigated by ADSSC.

Additionally, it was noted that salinity continues to be an issue in the raw wastewater entering the Abu Dhabi treatment facilities. This is caused primarily by groundwater infiltration entering the sewerage network through defective pipes, pipe joints, connections, or manholes. Network rehabilitation schemes on Abu Dhabi Island, Mainland and in Musaffah are ongoing to decrease the infiltration affecting the Mafraq, Wathba 1 and Wathba 2 treatment plants.

Quality of Biosolids

Figure 47 below summarises the biosolids quality compliance for the five major treatment plants operated by large scale licensees from 2015 to 2021 against the microbiological and trace elements parameters outlined in the RW&B Regulations.

Trace elements quality was found to be consistent from 2015 to 2021, with any trace elements related issues being followed up by ADSSC as part of their trade effluent control programme. A decrease in microbiological quality from 2019 to 2021 was noted, albeit with significantly reduced sampling due to the SARS-COV-2 virus. The DoE granted a temporary relaxation of the regulatory limits whilst ADSSC investigates treatment processes and process efficiencies in removing microbiological contaminants.

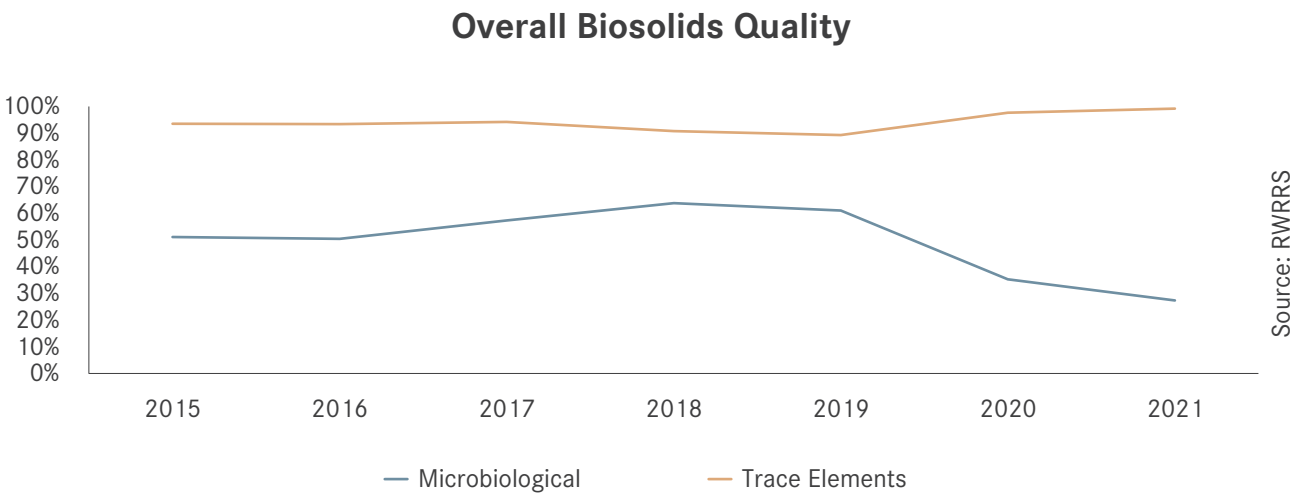


Figure 47: Biosolids Quality

Distribution & Supply

Recycled Water Distribution and Supply Assets

The DoE issued Licenses to both ADDC and ADDC for the distribution and supply of recycled water effective 1 January 2018. Accordingly, the entire recycled water distribution and supply network has been transferred to the distribution companies from ADSSC and from the municipalities. Distribution companies operate the recycled water network to transport recycled water from ADSSC to customers such as municipalities and several commercial entities. Currently recycled water is being used as a valuable source of water for landscape irrigation and beautification of the city.

Table 4 blow provides an overview of the existing recycled water asset base. ADDC and AADC are continuing with projects to enumerate the quantity of assets that were handed over, assess the asset condition of the transferred network, expand their networks, and enhance metering at the connection points with their customers.

	AADC	ADDC	Total
Total Pipeline Length (Km)	549	1,148	1,697
Number of Existing Interface Points with ADSCC	14	23	37
Number of Connections with Customer	168	677	845

Table 5: Recycled water assets

Recycled Water Reuse

The products of wastewater treatment are a valuable source of water, nutrients and energy. The DoE believes that the wastewater sector must promote the reuse of recycled water and biosolids to support the Emirate's sustainable development goals.

The Recycled Water & Biosolids Regulations have been developed to maximise the social and economic benefits associated with recycled water and biosolids reuse and to minimise the risk to public health and the environment.

The Regulations outline the prohibitions for recycled water use, and the standards to be followed depending on the level of exposure to the general public. The predominant use for recycled water currently in the Emirate of Abu Dhabi is landscape irrigation.

The DoE supports further end-use activities (e.g. industry, agriculture) whilst noting that further polishing or processing of the recycled water may be necessary and is the commercial choice and responsibility of the End-user.

A total of approximately 61% of the recycled water is currently used in the Emirate of Abu Dhabi. Figure 48 below shows the change in recycled water usage in each of the 3 regions. Whilst almost all of the recycled water produced in Al Ain is used every year. ADDC has initiated infrastructure projects to convey the excess recycled water to farms thereby increasing the reuse percentage in Abu Dhabi.

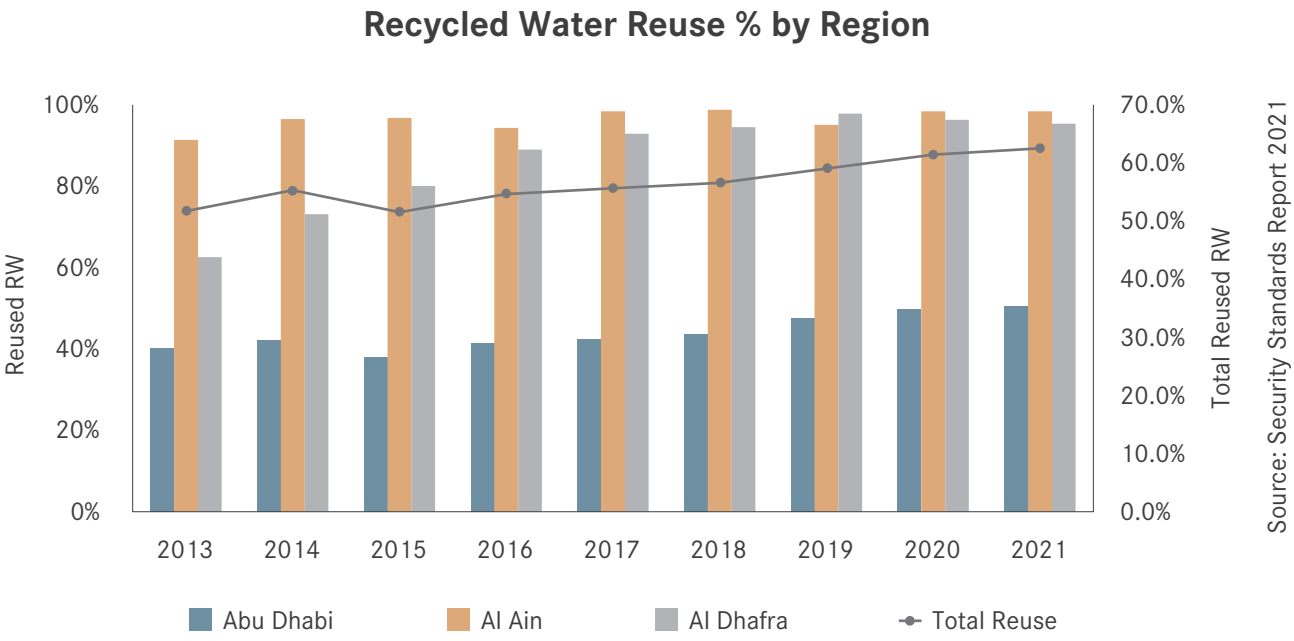


Figure 48: Recycled water Reuse

Biosolids

Only the five large treatment plants have treatment systems that can stabilise sewage sludge sufficiently for reuse as biosolids. All of the biosolids are currently being disposed to landfill subject to the regulation of the Environment Agency Abu Dhabi and the operation of The Centre of Waste Management. To divert the disposal away from landfill, ADSSC is actively seeking reuse outlets such as land application in forest preserves and potential industrial applications.

60,914 Tons
The total dry mass of biosolids produced in the Emirate in 2021

Figure 49 shows the amount of biosolids produced from 2015 to 2021. The production has remained relatively stable during the time period with annual fluctuations noted due to biosolids storage at the treatment plants. The total dry mass of biosolids produced in the Emirate in 2021 was 60,914 tons.

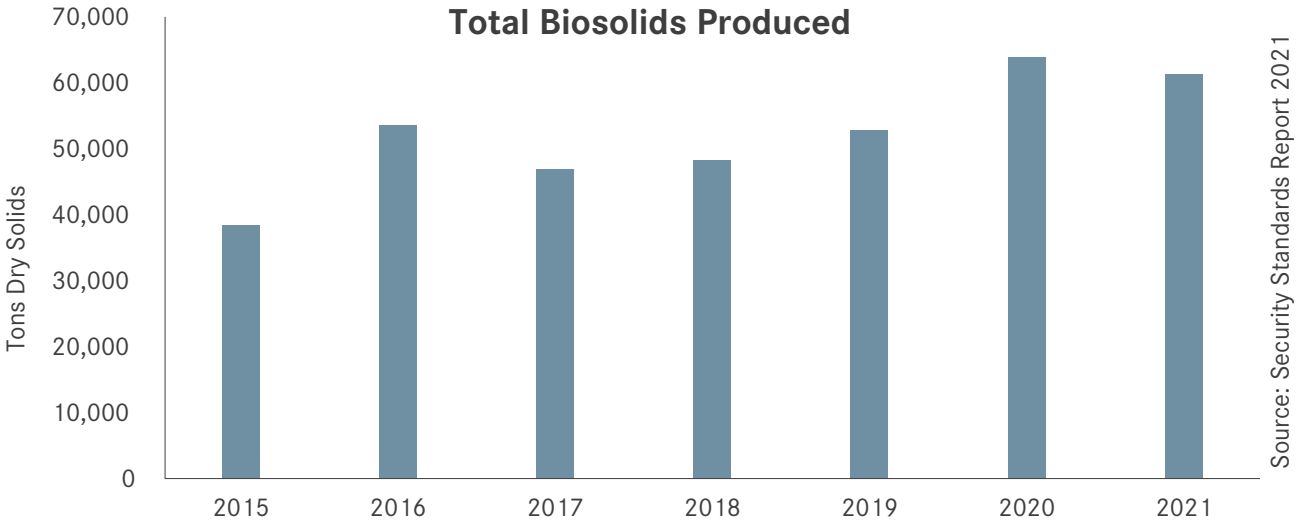


Figure 49: Biosolids Production

Self Supply Licensees

In recent years, the DoE has observed several companies operating small scale sewerage systems throughout Abu Dhabi Emirate and has managed to bring many of these companies into compliance with the DoE's regulations by issuing licences to unlicensed facilities. Treatment capacities of these small-scale sewerage systems are 10,000 m3/day and below.

There were a total of 34 small scale wastewater, treatment and disposal entities with licenses in 2021. Although none of the licensees provide recycled water quality to customers outside of their boundaries, the DoE has worked to improve compliance through organising education and awareness workshops with the licensees. Additionally, those licensees that do not provide demonstrable improvement in performance are referred to the DoE's licensing and compliance department for further actions.

10,000 m3/day
Treatment capacities of these small-scale sewerage systems

07 Health and Safety

Introduction

The DoE is the Sector Regulatory Authority (SRA) for the energy sector in the Emirate of Abu Dhabi. The DoE has been entrusted as the point of contact with the government to update them with any matters related to the sector, including the management of operational and HSE incidents.

To fulfil this mandate, the DoE is managing HSE through two workstreams:

1

License requirements:

DoE is responsible for licensing the activities of power generation, water desalination, wastewater collection, treatment and disposal, and district cooling, and HSE requirements are part of the license conditions.

2

SRA requirements:

DoE is the Sector Regulatory Authority for the Energy sector and is responsible for supervising the Abu Dhabi Occupational Health and Safety Framework implementation.

HSE Performance

The DoE monitors the licensee's HSE performance through multiple tools including:

1. Incident Reporting System (IRS), which enables DoE to monitor the operational incidents and the corrective actions taken by the Licensees to ensure that all CA are implemented, and the best practices are used to prevent the re-occurrences.
2. HSE Monthly performance reports, which designed by DoE experts to monitor 33 KPIs that related to different HSE matters related directly to the health being of the working power in the energy sector as well as those related to asset safety and environment issues. this report submitted periodically s by the Licensees to the DoE.
3. AL ADAA Soft link, which represents the reporting tool to ensure the implementation of OSHAD-SF that enables DoE to monitor the OSH Incidents and the quarterly performance of all registered Licensees in AL ADAA.
4. HSE Audit and Inspection process through site visits to test system implementation and identify improvement opportunities for the audited entities.

Incident Reporting

Incident reports are classified into three broad categories

Occupational Health & Safety (OSH)

Operational

Environmental

OSH Incidents

OSH incidents are defined as a single event or chain of events which has caused or has the potential to cause a fatality, injury or illness to a person, or damage to assets, or the reputation of any Entity.

The categories of these incidents include:

1

Work-Related Fatality

Which is a death resulting from a work-related injury or illness, regardless of the time intervening between injury and death.

2

Serious Injury

An incident causes an injured person temporarily/ permanently unable to perform any regular job or restricted work activity on a subsequent scheduled workday or shift, supported by a medical report from an approved medical practitioner. Some serious injuries could lead to fatality.

3

Serious Dangerous

Occurrence a significant incident arising out of or in the course of work that did not result in injuries and/or fatalities but had the potential to have done so.

There were 5 total OSH incidents reported in 2021. The breakdown of these incidents by sector is shown in Figure 50 below.

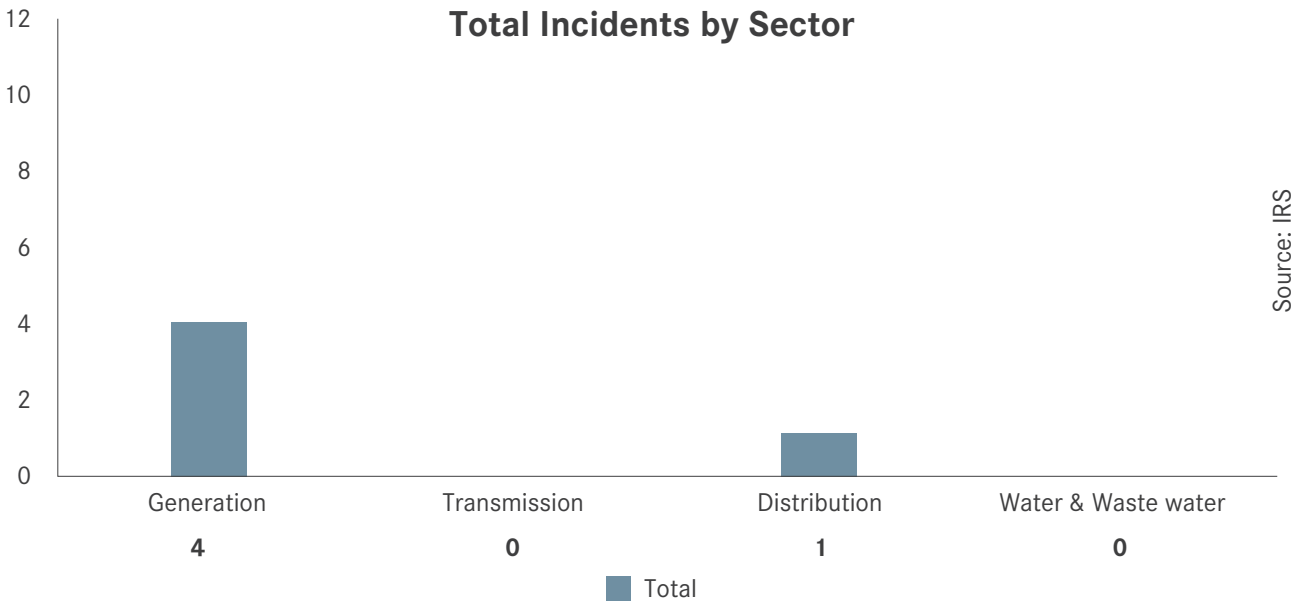


Figure 50: OSH Incidents by sector

The OSH incidents that occurred during 2021 were classified into 4 categories: serious injury, serious dangerous occurrence, occupational illness and fatality. These are shown on Figure 51 below.

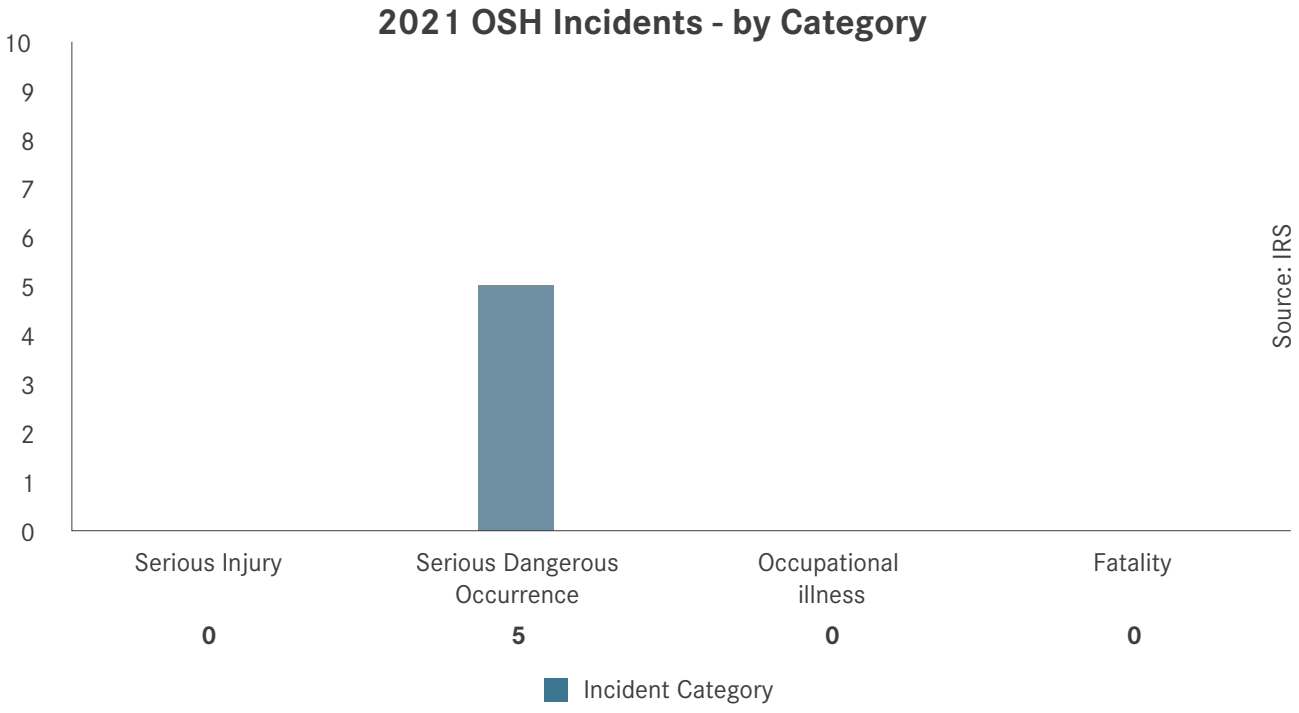


Figure 51: OSH incidents in 2021 by category

Operational Incidents:

Operational incidents are defined as events that result in an interruption of service provided by the Licensee.

Operational incidents are classified based on the activities to:

1. **Power operational** incidents (including power generation, transmission, and distribution)
2. **Water operational** incidents (including water desalination, transmission and distribution)
3. **Power, water operational** incidents (including water desalination, transmission and distribution)
4. **Wastewater operational** incidents (including the wastewater collection, treatment, and recycled water distribution and supply)

In 2021 the DoE received and processed 410 operational incident reports; 21 of which were considered critical and required reporting within 5 hours. The remaining incidents are reported under the 12 hours or 24 hours reporting category. The breakdown of the incidents by sector is shown in Figure 52 below.

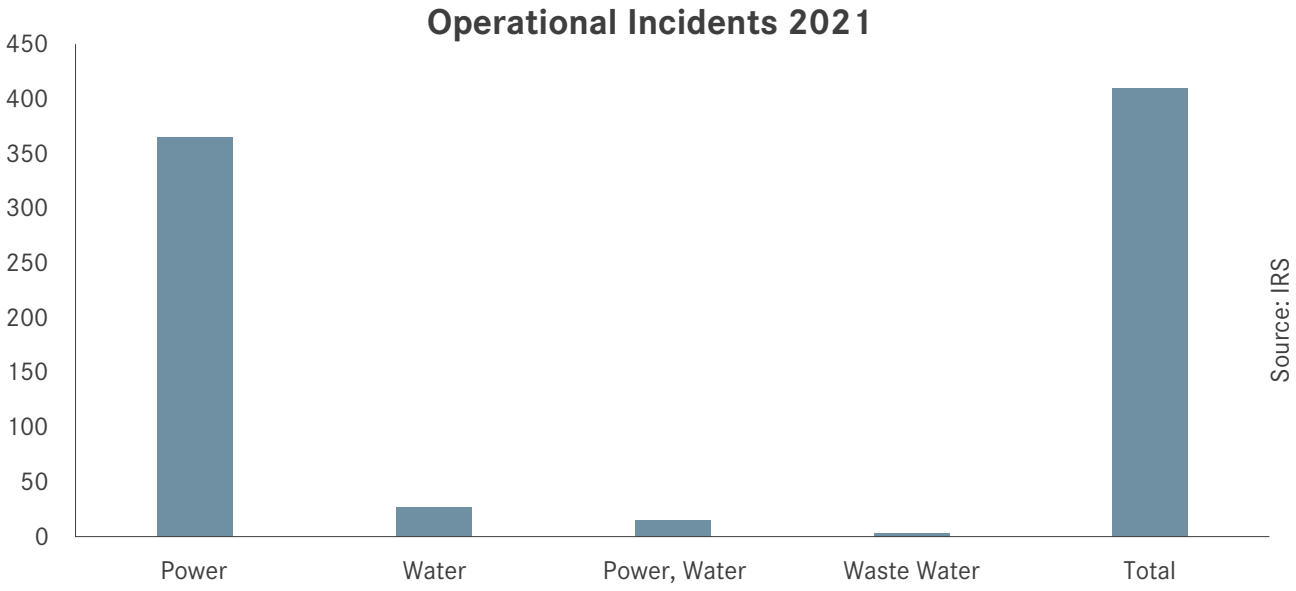


Figure 52: Operational Incidents in 2021

Operational Power Incidents

A total of 365 operational power incidents were reported in 2021. The most critical operational power related incidents fell into two specific categories:

- An interruption on any 33kV, 22kV and 11kV bus bar section at any grid station (220/33, 132/33, 132/22, 132/11kV) –
- Total Plant trips –

The DoE reviewed all the incidents, the reported root causes and ensured that the proposed action plans were fit for purpose. Furthermore, the DoE conducted an annual meeting with all of the Licensees to discuss the most serious operational incidents and the necessary actions to prevent recurrence.

Operational Water Incidents

There were 27 operational incidents reported in the production, transmission and distribution networks in 2020. None of the incidents affected the security of supply.

There were 56 Operational incidents from production side reported under the criteria of *"The simultaneous outage of any two distillers and/ or two reverse osmosis racks and/ or one reverse osmosis pass line".* , the remaining 5 Operational incidents in the Transmission network were reported under the criteria of *"A failure in the transmission system that causes a shutdown to either 50% of the desalination capacity or production loss of more than 25 MGD (113,500 m3/day) at a production plant".*

Year 2021

A total of 365 operational power incidents were reported

Year 2020

There were 27 operational incidents reported in the production, transmission and distribution networks

Operational Wastewater Incidents

There were 3 operational incidents reported in the wastewater sector. The incidents were reported under the criteria of *"Detection of any cross connection or backflow with potential to contaminate any water network (potable, recycled or storm water)"*, and *"An unplanned event or chain of unplanned events that results in the release of a prohibited waste into the wastewater or water collection, distribution or supply system"*.

In all cases no disruption was caused to the public.

Environmental Incidents

Environmental Incidents are defined as events resulting in an unplanned or uncontrolled release of a product or chemical with negative impact to the environment – water, air, soil, animals, plants, ecology and social life. There were no significant environmental incidents reported by the sector in 2021.

Year 2021

There were no significant environmental incidents reported by the sector

08 Environment

The DoE ensures that environmental protection is a priority in all operations within the energy sector. A dedicated team is assigned to oversee the environmental performance in the sector as well as to ensure all operations are aligned with the Emirate's legal requirements.

The DoE works closely with the Environment Agency- Abu Dhabi to ensure compliance with all regulations and agreed protocols for the energy sector. Also, the DoE is a part of the consultation process for all environmental matters related to the energy sector through participating in working committees and groups and reviewing environmental regulations and guidelines.

Each quarter, 16 sector companies submit their environment reports including Marine Water Quality, Air Quality and Waste management to DoE for monitoring and review. The DoE HSE team have reviewed 189 environment reports in 2021.

The DoE monitors the environmental performance of all licensees on a quarterly basis. The licensees submit an environmental report summarizing the data collected in regard to air quality emissions, sea water inlet and outfall discharge, and the waste register throughout the reporting period.

Additionally, the CO_2 emissions in the energy sector is monitored on a regular basis. The total CO_2 emissions in 2021 was 41,507,627.26 tons. The breakdown of the emissions by Licensee is shown in Figure 53 below.

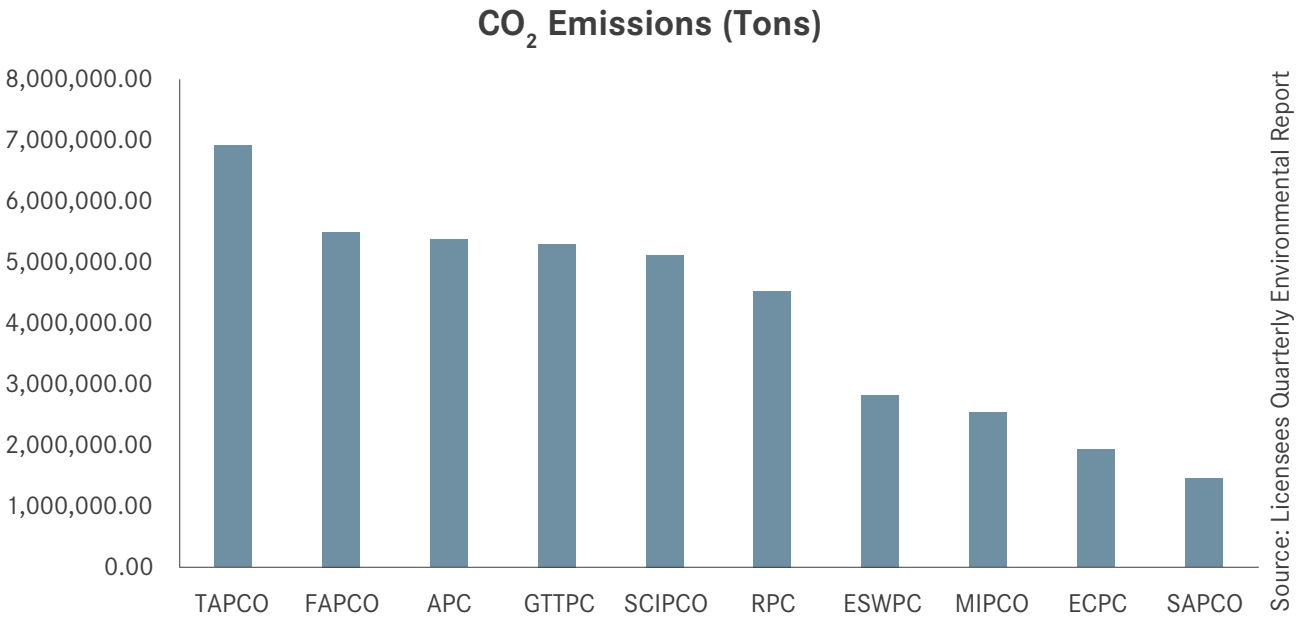


Figure 53: CO_2 Emissions

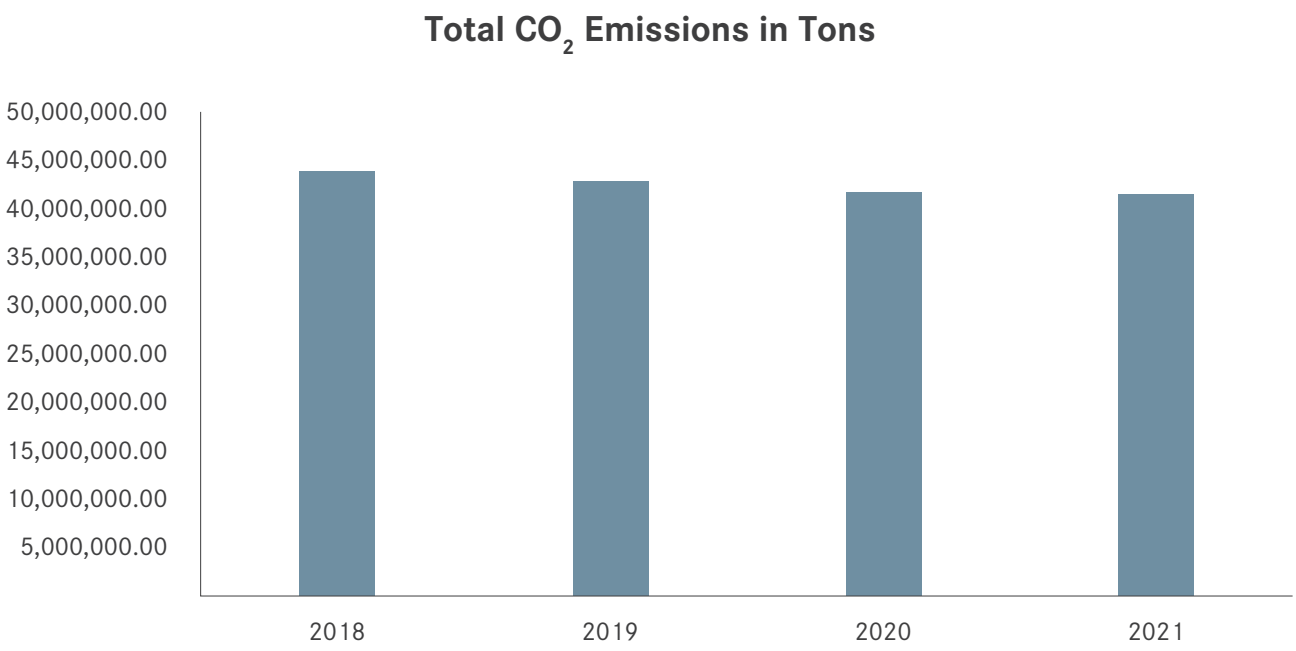


Figure 54: CO_2 emissins in Tons (2018 - 2021)

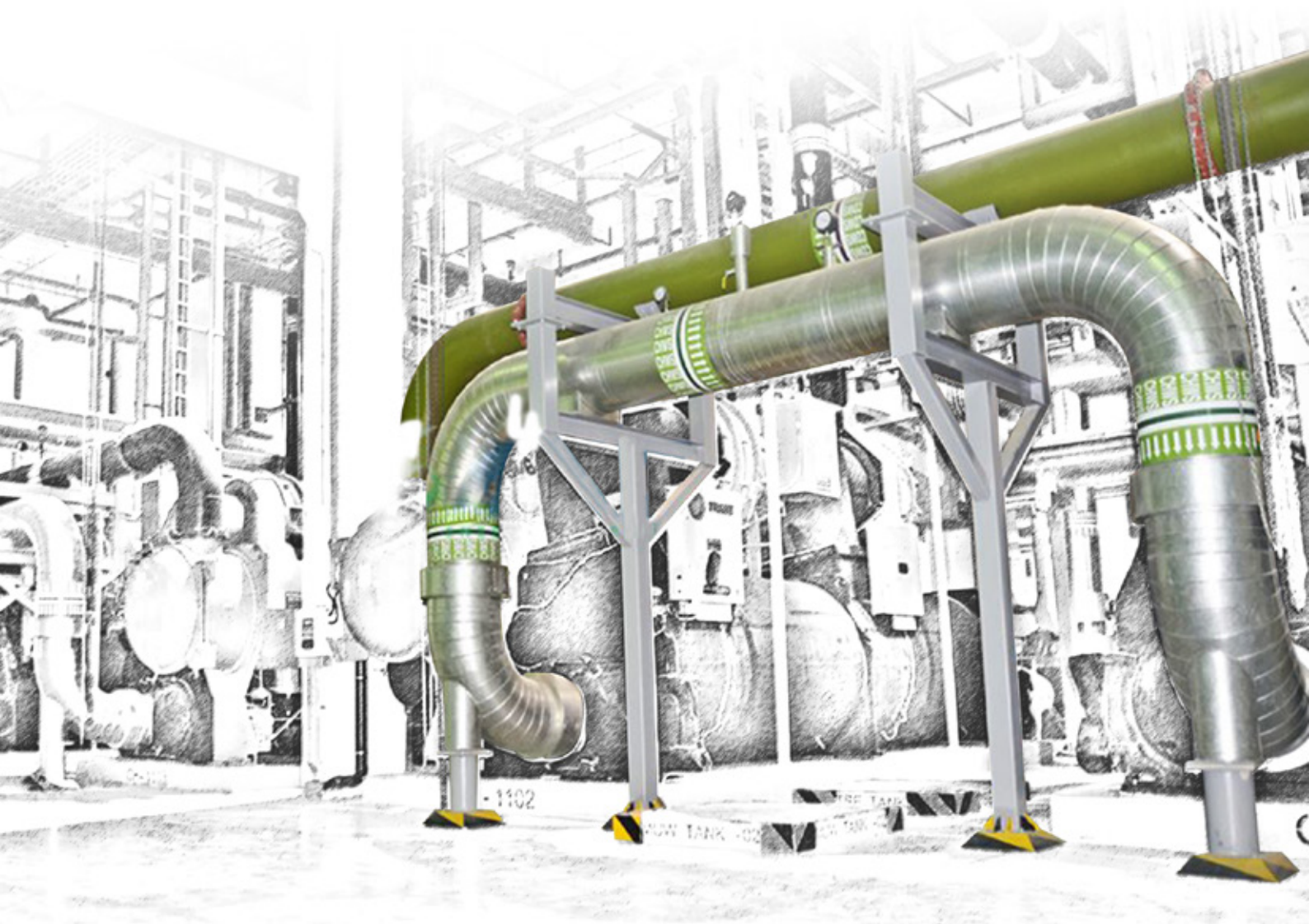
Year 2021

The DoE HSE team have reviewed
189 environment reports

41,507,627.26 Tons

The total CO2 emissions
in 2021

09 District Cooling



The Abu Dhabi Department of Energy issued the District Cooling Regulation and the District Cooling Applicability Regulation which have been in effect since September 2019.

The Abu Dhabi Government thus becomes the first administration in the Middle East and North Africa region to set up a complete integrated system for district cooling. This, reflects the DoE's commitment to taking the lead in the regional and global energy sector, highlighting its focus on developing infrastructure, ensuring energy efficiency, and promoting sustainable solutions.

The new regulations aim to unify standards, integrate efforts to regulate the sector, ensure the highest quality and competitiveness for energy services, and protect consumer rights. The regulations also include clauses to enhance energy efficiency, protect the environment, and encourage investments in the sector.

The District Cooling Regulation, and the DC Applicability Regulation, provide a regulatory framework for these activities in the Emirate of Abu Dhabi, offering investors, consumers, and the public, safe, efficient, and economical cooling services.

The District Cooling Regulation covers technical performance standards and minimum guidelines, market competition and price regulation, minimum contractual requirements, and requirements for licensing.

The District Cooling Applicability Regulation aims to ensure developers study the feasibility of district cooling at the master planning stage to ensure the optimal use of energy infrastructure, and to promote more efficient cooling systems for areas where it can be applied efficiently. In addition, it supports expanding the scope of the district cooling system in the emirate by managing demand for it and encouraging the use of this technology.

District Cooling Regulations Implementation

Licenses Issued in 2021

In 2021, DoE reviewed, engaged, and discussed with the sector companies the submitted license applications and subsequently issued three (3) licenses in Abu Dhabi as shown in table 6.

Figure 55 below shows licensed DC schemes total ultimate capacity of 129,000 TR out of Abu Dhabi's total existing District Cooling capacity undergoing grandfathering review.

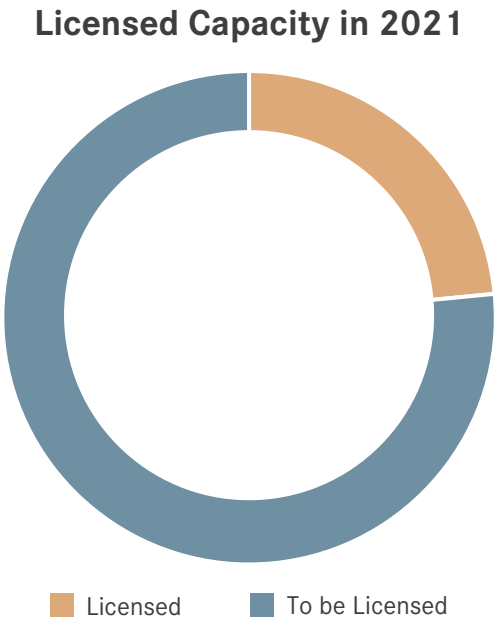


Figure 55: Licensed Capacity in 2021

#	Licensee	DC Scheme/ Serving	License Type	Installed Capacity (TR)	Ultimate Capacity (TR)
1	Al Wajeez Development CO. PJSC (AWDC)	Al Maryah Island	DC Provider Standalone	40,000 + 10,000 (TES)	40,000 + 10,000 (TES)
2	Saadiyat Cooling L.L.C (SCL)	Saadiyat Beach and Saadiyat Cultural District	DC Provider Integrated	21,250	70,000
3	Saadiyat District Cooling L.L.C (SDCL)	NYU Abu Dhabi	DC Provider Standalone	9,000 + 2500 (TES)	9,000 + 2500 (TES)

Table 6: DC Licenses Issued in 2021

129,000 TR
Total ultimate capacity of licensed DC schemes out of Abu Dhabi's total existing District Cooling capacity

Grandfathering (Licensing) Outcomes

A grandfathering review process was carried out for the mentioned DC schemes as they have existed prior to the enactment of the regulations. The grandfathering review process assesses the legal, financial, and technical compliance of the scheme against the DC Regulations and the DC Technical Codes.

DoE, in collaboration, with the licensees were able to achieve:

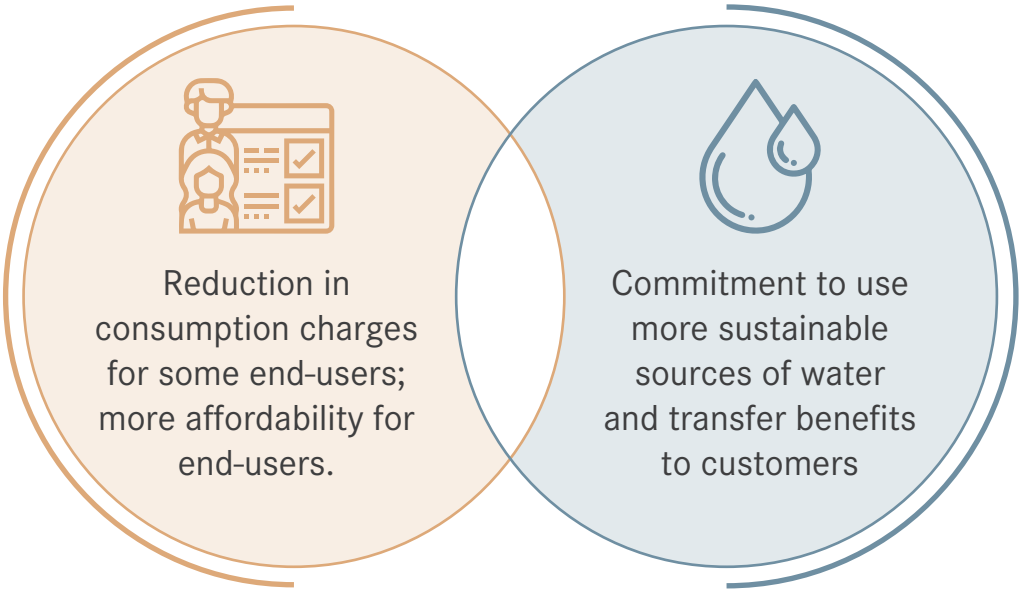


Figure 56: Grandfathering Outcomes

System Performance

As part of the ongoing monitoring of the DC licensees and in accordance with the DC Regulations, each licensee is required to submit their Annual Information Submission by the end of first quarter of each year, reporting their financial performance and their technical operational performance by providing compliance against the following KPI's as defined in the DC Technical Code:

The licensees demonstrated compliance with all KPIs and requirements of the DC codes for 2021 by achieving satisfactory limits as shown in below table:

	Unit	Limit	AWDC	SCL	SDCL
KPI 1: System Reliability	% of hours	99.5%	√	√	√
KPI 2-5: Electricity Efficiency	kWh/kWhc	0.25-0.26	√	√	√
KPI 6: Water Consumption for Condenser Cooling	liters/kWhc	2.33	√	√	√
KPI 7: Water Consumption for Chilled water make up	Max annual %	2%	√	×*	√
KPI 8: Cooling Water Circulating Quality	Legionella Colony Forming Units per ml of circulating water	100	√	√	√
KPI 9: Metering equipment Maximum Service Intervals	Years	5/10	√	√	√
KPI 10: Maximum Number of Meter Components failing achieve required accuracy level	Max % of Components Failing to Meet Accuracy Level During Periodic Testing	10%	√	√	√
KPI 11: Customer Complaint and Dispute Resolution		100%	√	√	√

Table 7: DC Licensees Compliance

* While SCL did not meet the KPI for the water consumption for chilled water make-up. The reason was due to network maintenance and connection of new energy transfer stations. SCL submitted a mitigation plan, and it is expected that this KPI will be met next year.

10 Acknowledgment

Abu Dhabi Department of Energy (DoE) has prepared this 2019 Technical Report in collaboration with Abu Dhabi energy sector's stakeholders. DoE extends its gratitude and appreciation to all participating entities for their cooperation, transparency, and integrity in submitting the required reports and data as per the applicable regulations.

Participating Entities:

- EWEC
- ADDC
- AADC
- TRANSCO
- ADSSC
- AMPC
- APC
- ECPC
- FAPCO
- GTTPC
- MIPCO
- RPC
- SAPCO
- SCIPCO
- SEMBCORP
- SHAMS
- TAPCO
- Al Etihad Biwater Wastewater Company (EB)
- Al Wathba Veolia Besix Wastewater Company (VeBes)
- National Central Cooling Company (Tabreed)

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DEPARTMENT OF ENERGY