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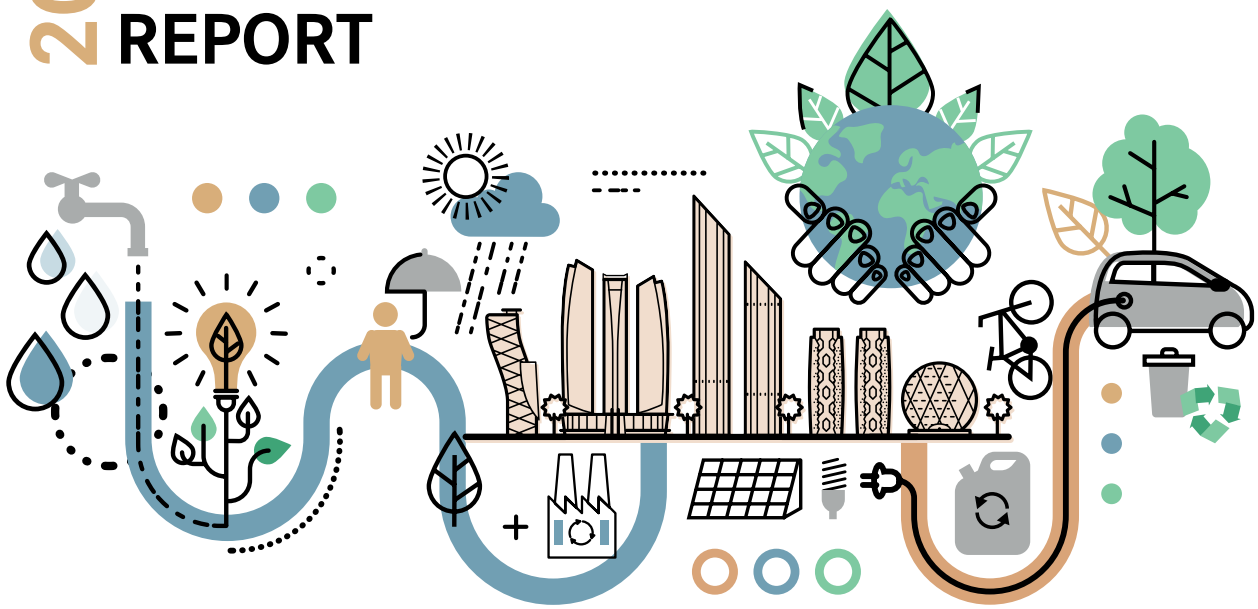
DEPARTMENT OF ENERGY

2019 Annual TECHNICAL REPORT



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

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Introduction

1 Introduction

Welcome to the Department of Energy's (DoE) new Annual Technical Report for the water, wastewater and electricity sector in the Emirate of Abu Dhabi.

Each year our licensees are required to report to the DoE a series of regulatory submissions to demonstrate their compliance with statutory requirements. These regulatory submissions intend to ensure alignment with the Emirate's strategic objectives as well as demonstrate our licensee's performance against service standards such as efficiency, sustainability and quality of service.

This report provides a general overview from a regulatory perspective of key developments and statistics in the water, wastewater and electricity sector in Abu Dhabi during the year 2019. It also provides a year on year analysis of operational performance of the network licensees (TRANSCO, ADDC, AADC and ADSSC) and highlights main operational incidents that have occurred during the year.

2 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
BOD5 (ATU)	The biochemical oxygen demand of wastewater during decomposition occurring over a 5 day period.
CFU/100ml	Colony Forming Unit per 100 milliliter
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
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
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
PCR	Price Control Returns
PCV	Prescribed Concentration or Value in accordance with Schedule 1 of the WQR
PDSRS	Production Data Submission and Reporting System
PPB	Parts Per Billion
PPM	Parts Per Million
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
SF	Sampling Frequency in accordance with Schedule 2 of the WQR
SMPs	Sector Measuring Points
STEP	Strategic Tunnel Enhancement Program
SWRO/RO	Seawater Reverse Osmosis
TA	Technical Assessor
TAPCO-B	Plant Taweelah Asia Power Company
TDIC	Tourism Development and Investment Company
TDS	Total Dissolved Solids
TEC	Trade Effluent Control
TRANSCO	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

3 Sector Highlights

Highlights

Water

System Demand

Drinking Water (Transmission Peak):
3.73 MCMD (820 MIGD)
Recycled water reuse percentage:
%61.1

Water Quality Tests

- Drinking water: 170,162
- Recycled water: 83,633
- Total testing: 253,795

Annual Production

Electricity: 85,319 GWh
Drinking Water: 1,211 MCM (266,456 MIG)
Recycled Water: 301 MCM

Installed Capacity

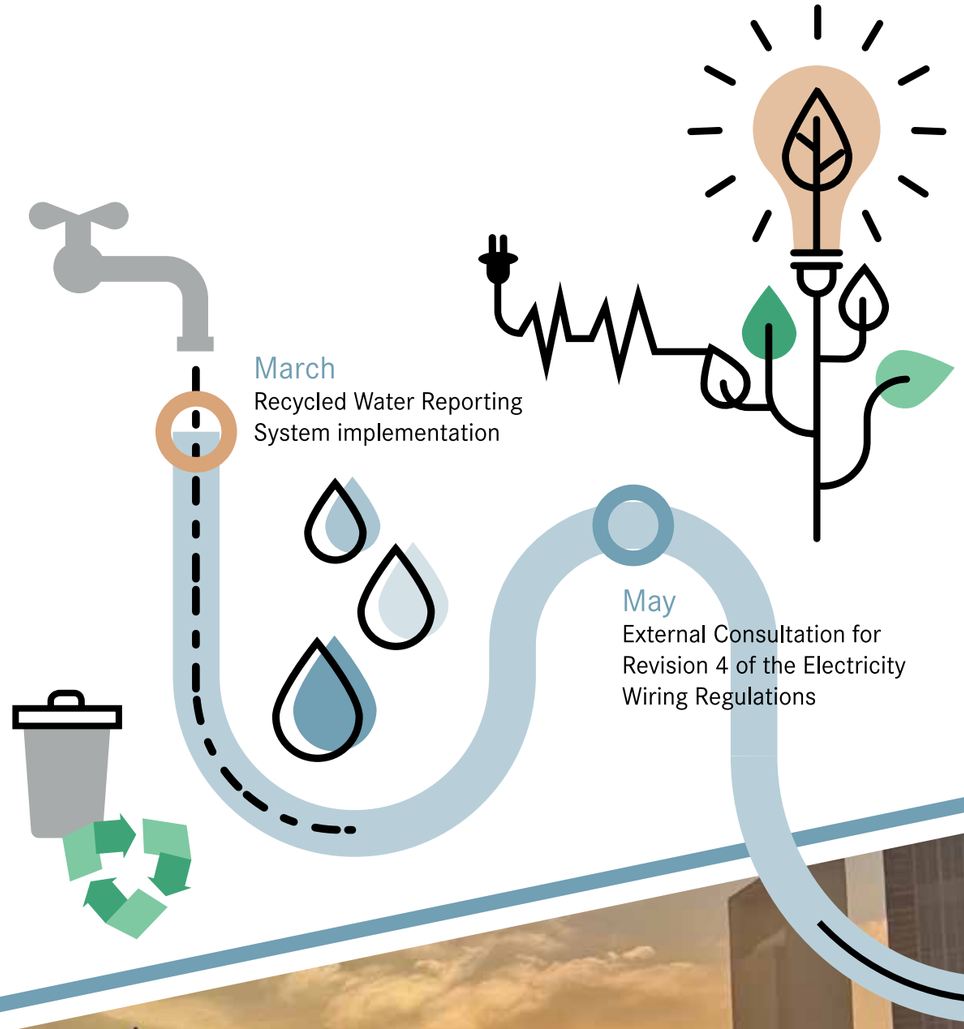
Electricity: 17,686 MW
Drinking Water: 4.14 MCMD (910 MIGD)
Wastewater: 1,330 Ml/day

Electricity

System Demand

Abu Dhabi: 11,179 MW
Northern Emirates:
4,220 MW

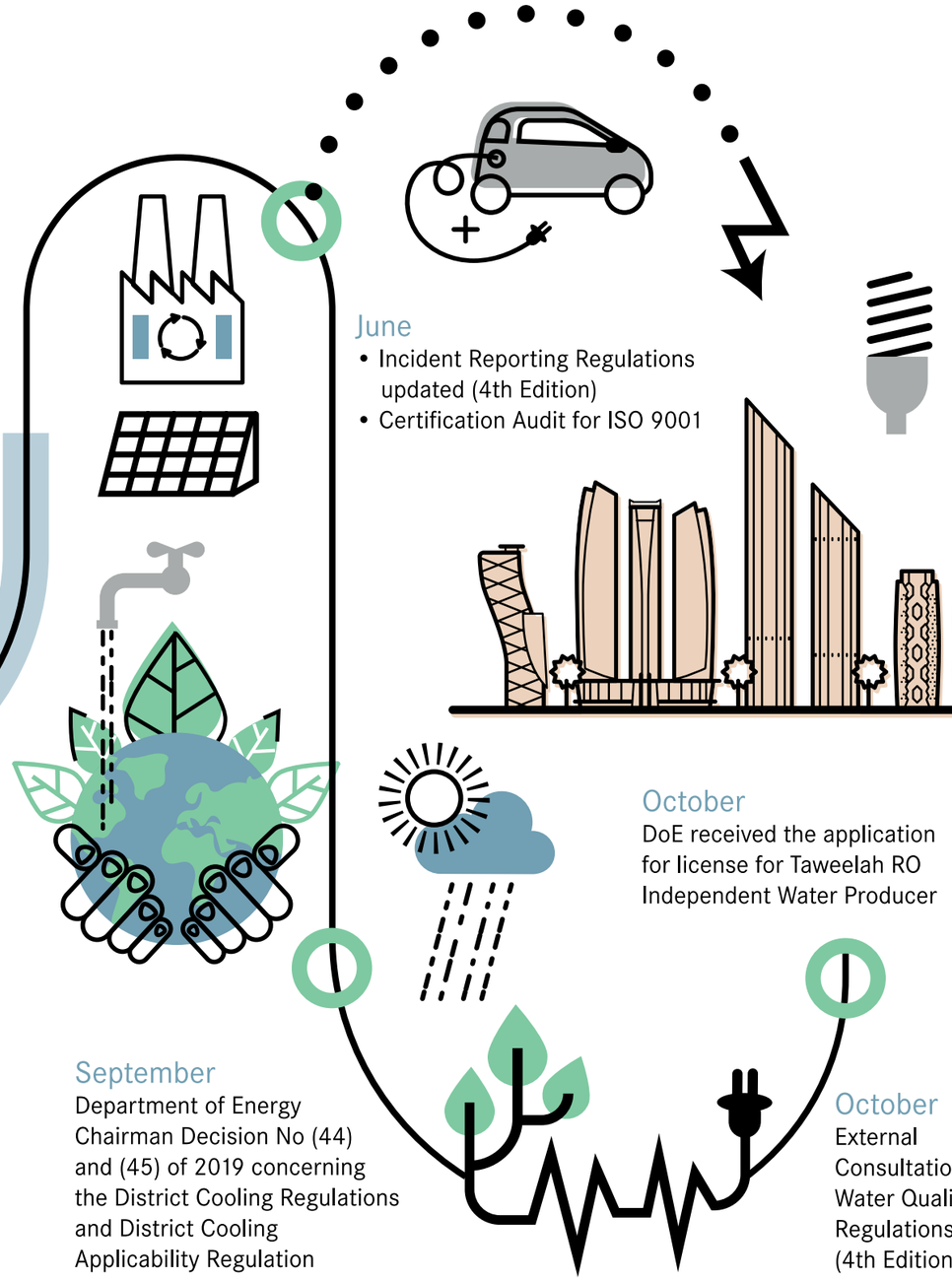
Timeline



March
Recycled Water Reporting System implementation

May
External Consultation for Revision 4 of the Electricity Wiring Regulations

4 Timeline

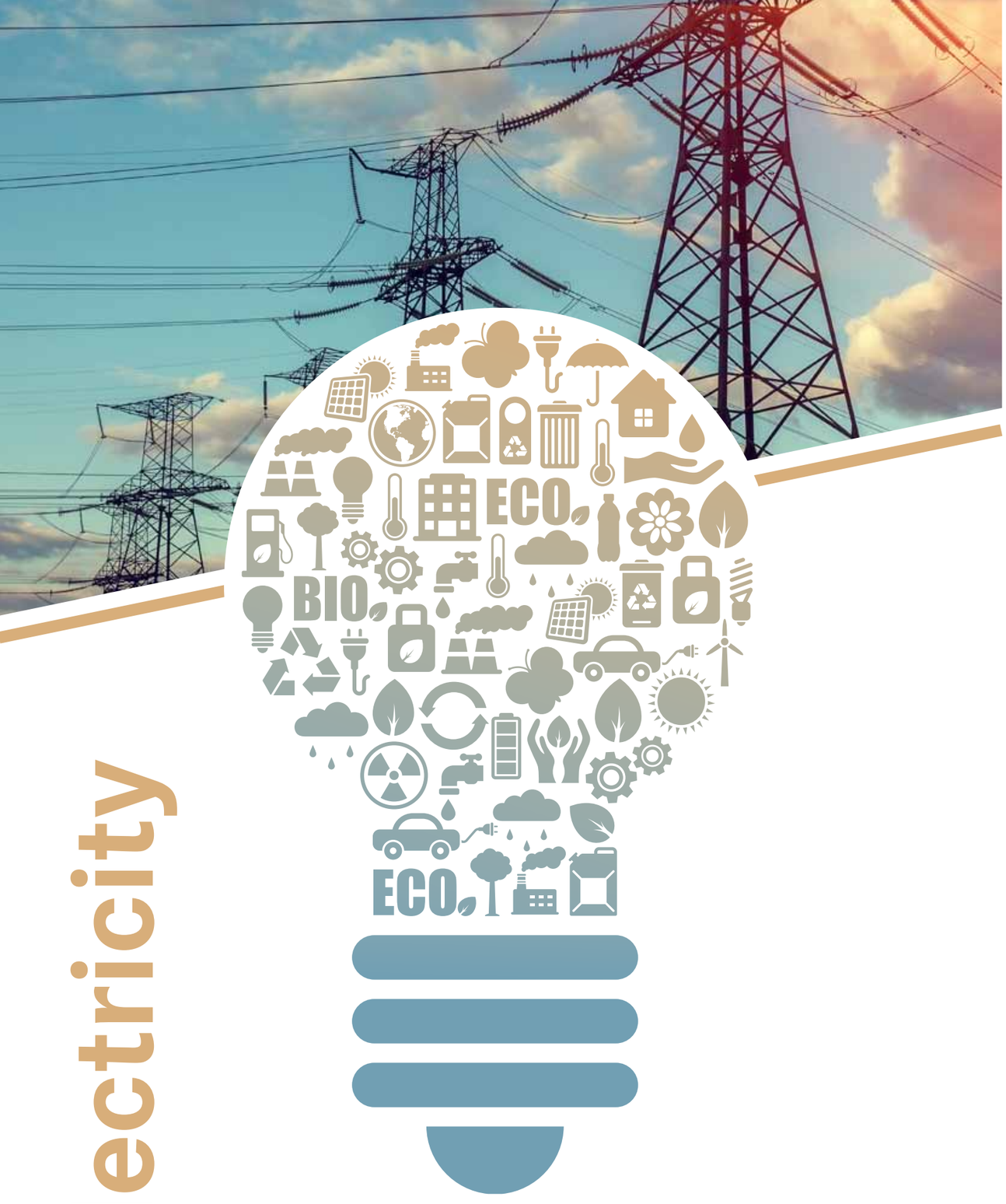


June
- Incident Reporting Regulations updated (4th Edition)
- Certification Audit for ISO 9001

October
DoE received the application for license for Taweelah RO Independent Water Producer

September
Department of Energy Chairman Decision No (44) and (45) of 2019 concerning the District Cooling Regulations and District Cooling Applicability Regulation

October
External Consultation of Water Quality Regulations (4th Edition)



Electricity

5 Electricity

Generation

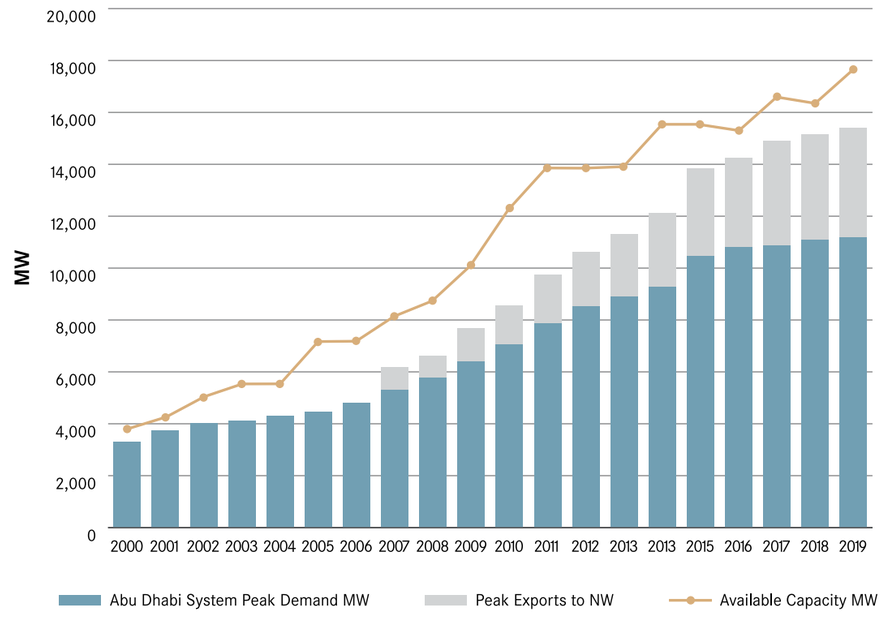
Generation overview

Electricity Demand Growth

Demand for electricity in the emirate of Abu Dhabi continued to grow during 2019 driven by a slight increase in Abu Dhabi's system demand and a higher increase demand resulting from exports to the Northern Emirates, also known as the global demand.

In 2019, the Global electricity demand in Abu Dhabi peaked at 15,223 MW on 18th June with Abu Dhabi system peak reaching 11,179 MW while exports to the Northern Emirates reaching 4,220 MW. An increase of 0.89% and 3.5% respectively from last year.

Figure 1: Electricity Demand Growth (MW)



Source: PDSRS

Global Electricity Capacity and Production

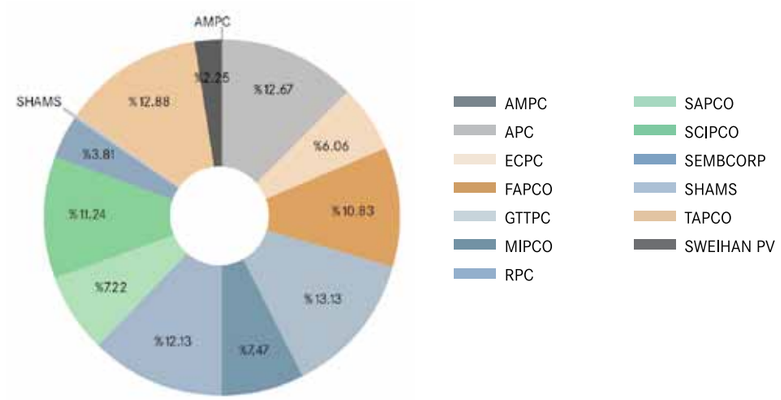
To support such demand for electricity, Abu Dhabi's energy sector has a total available electricity generation capacity of 17,686 MW. This includes an array of conventional and CCGT plants in addition renewable energy based plants as presented in Table 1 below.

Table 1 Global Electricity Capacity & Generation – 2019

	Capacity (MW)	Generation (GWh)	Technology
AMPC	365	46	OCGT
APC	2070	10,807	Co-gen
ECPC	760	5,168	Co-gen
FAPCO	2,114	9,241	Co-gen
GTTPC	1,671	11,204	Co-gen
MIPCO	1,702	6,369	Co-gen
RPC	1,627	10,350	Co-gen
SAPCO	1,647	6,158	Co-gen
SCIPCO	1,615	9,588	Co-gen
SEMBCORP	861	3,248	CCGT
SHAMS	50	230	CSP
TAPCO	2,220	10,991	Co-gen and OCGT
SWEIHAN PV	935	1,918	Solar photovoltaic
Total	**17,686**	**85,319**	

In terms of production generation markets, there are 13 power providers with electricity generation market shares ranging from 0.05 % up to 13% for 2019. TAPCO, APC and GTTPC hold the largest market share of 13% each. While AMPC is a small OCGT accounting for only 0.05% Figure 2 below shows all IWPPs generation market shares.

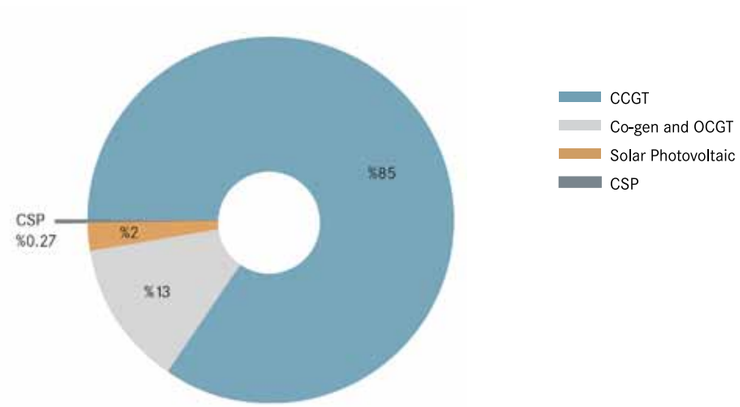
Figure 2: Electricity Generation share by Company



Source: PDSRS

As for electricity generation technologies in Abu Dhabi, the figure below represents the percentages of total generation by technologies. Renewables from SHAMS and Noor accounted for around 2% of the electricity generation mix in Abu Dhabi.

Figure 3: Electricity Generation share by technology



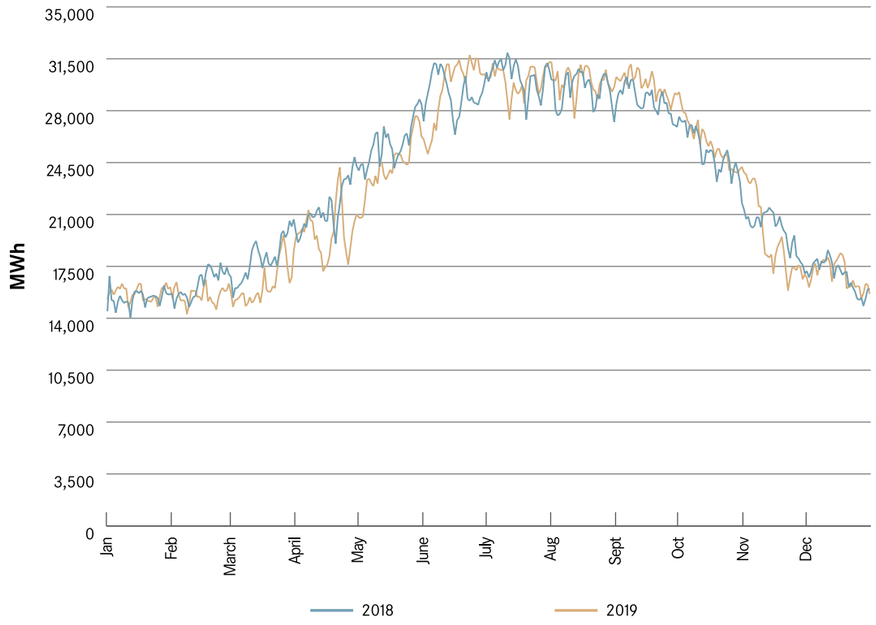
Source: PDSRS

The share of clean energy will continue to grow in the coming years. The Barakah Nuclear Energy Plant, located in Al Dhafra Region of the Emirate of Abu Dhabi, planned to be commissioned in 2021 will generate 1,400 Megawatts of electricity when unit is fully operational. The plant has four APR1400 reactors, which is one of the most technologically advanced nuclear reactor designs in the world, and meets the highest international standards for safety/ performance.

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 796,289,326 MBTU of natural gas to the sector, which is 3% less than last year (820,751,096 MBTU)

The below graph 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-June summer peak demand mentioned above.

Figure 4: Daily Energy Generation at peak (MWh)

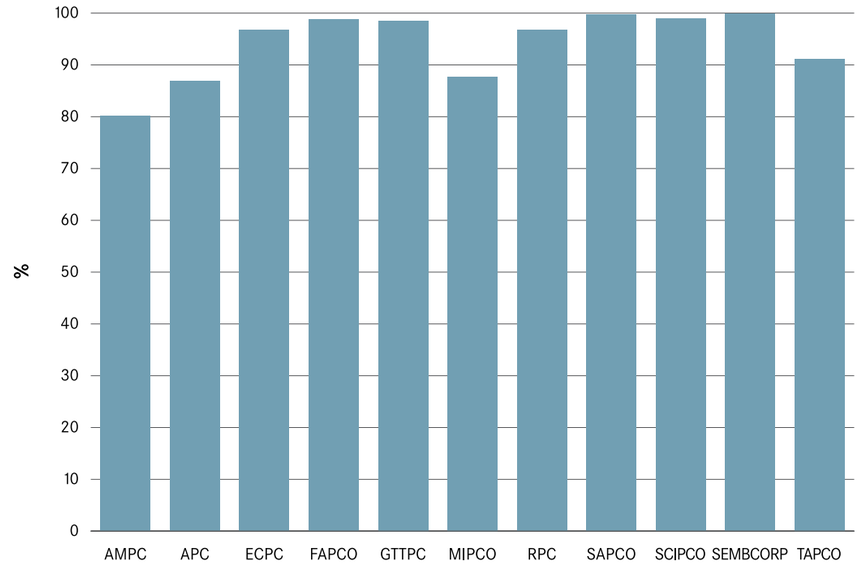


Source: PDSRS

System Performance

In terms of the performance of the generation plants, the available plant capacity was maintained with reasonable capacity margins throughout the year. The below shows the plants average reliability percentage for 2019 as reported by each plant. Overall, most of the generation plants reported high reliability index. APC results are mainly influenced by the lower performance of the aging of the assets.

Figure 5: Plant Reliability Percentage (2019)



Source: PDSRS

Transmission

Transmission Overview

TRANSCO is the sole electricity transmission licensee in the Emirate of Abu Dhabi. It 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.

The table below shows the up to date assets for TRANSCO.

Table 2: Electricity Transmission Network Assets

Grid Substations	Capacity	Underground Cables	Overhead Lines
161 (220, 400 and 132 KV)	69,605 MVA	1,051 km	8,483 km

System Performance

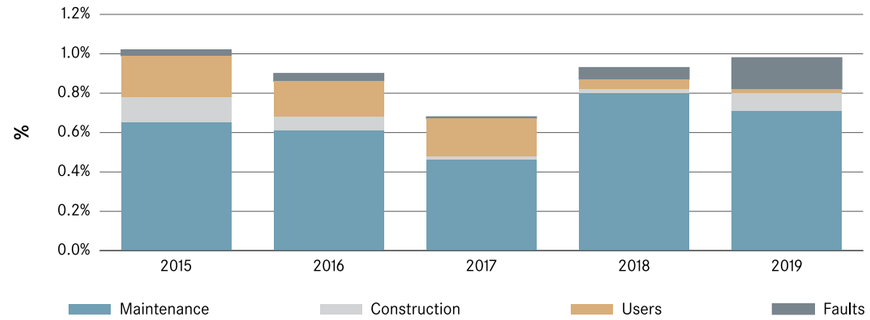
Transmission system performance is monitored through a number of Key Performance Indicators (KPIs) including:

- 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 0.92 in 2018 to 0.99 in 2019 as shown in the graph below. Analysis of the data indicates that there was an increase in fault and construction outages in 2019 compared to 2018. Overall system availability (1-unavailability) is above 99%.

Figure 6: Transmission System Unavailability

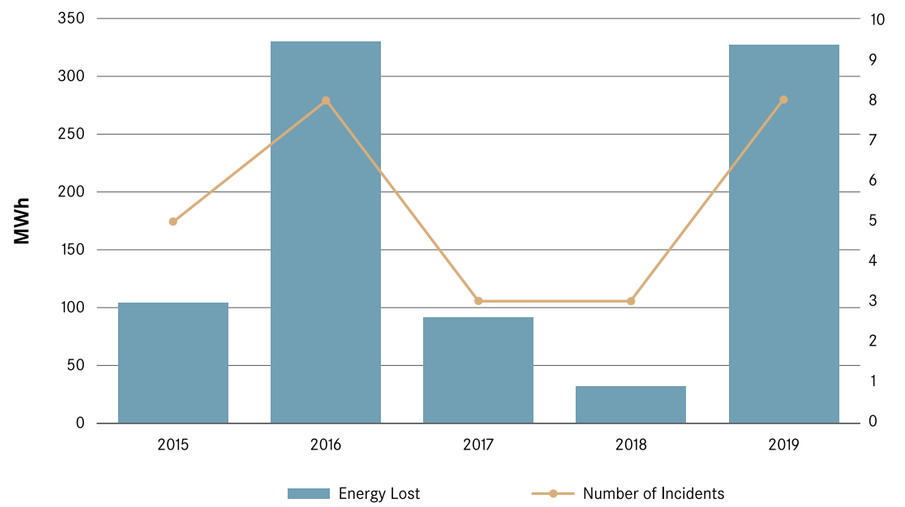


Source: TRANSCO Performance Report

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 2019, there were eight transmission incidents, which resulted in the loss of 327.2 MWh of unsupplied energy (which is a significant increase compared to 31.78 MWh in 2018). The increase in the unsupplied energy in 2019 is mainly due to two major incidents in LIWA-WMZD which resulted in the loss of 131.37 MWh and Salamat grid incident which resulted in the loss of 80.52 MWh.

Figure 7: Transmission System Incidents and Energy Lost (Unsupplied)



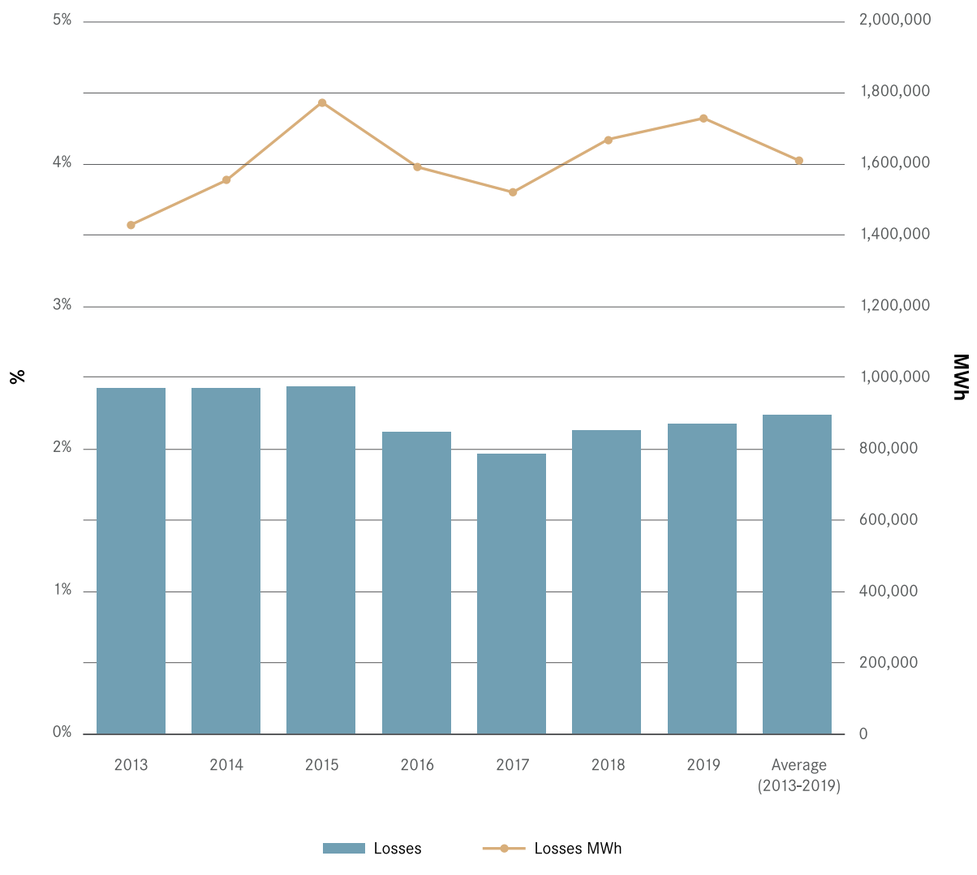
Source: TRANSCO Performance Report

Transmission system losses

Energy loss in the transmission system is mainly due 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 increased slightly from 2.13% in 2018 to 2.18% in 2019, which is below the average losses 2013-2018 (2.24%).

Figure 8: Transmission System Losses



Source: Annual Electricity Transmission Losses Reports

Distribution

Distribution Overview

ADDC and AADC own and operate the low voltage network (33 - 22- 11 KV), transporting electricity from the transmission system to homes and businesses. The table below gives an indication of the number of electricity customers and asset base of AADC and ADDC in 2019.

Table 3: Electricity Distribution Network Assets

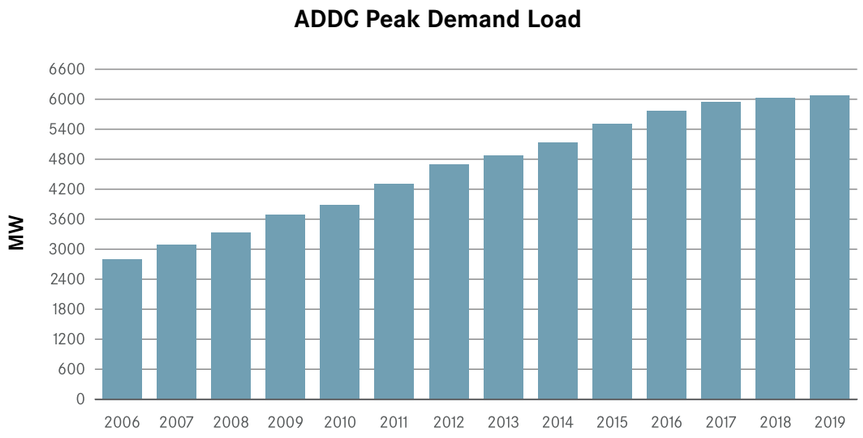
	ADDC	AADC	Total
Number of Electricity connected customers	388,543	155,407	**543,950**
Number of Primary Substations	296	172	**468**
Number of Distribution Substations	19,971	16,033	**36,004**
KM of cable/ overhead lines	43,416	28,224	**71,640**

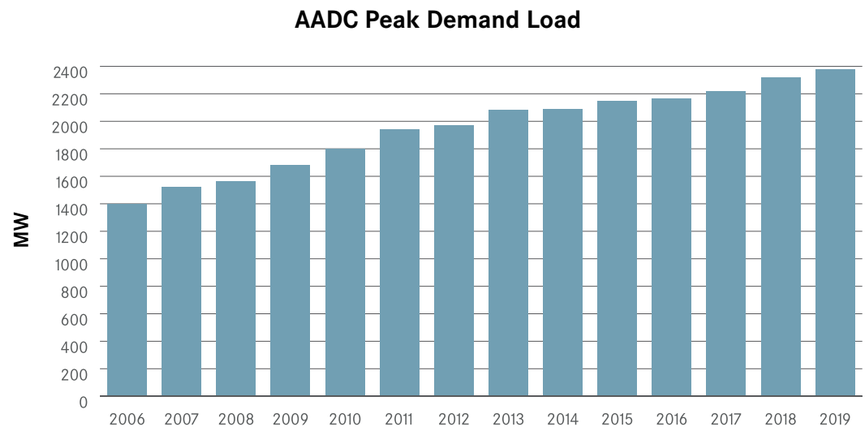
Peak Demand

The peak demand load of ADDC grew by 0.9% from 2018 to reach 6,081 MW in 2019, while that of AADC grew by 2.4% to reach 2,376 MW.

The figure below shows the peak demand growth for the last 14 years for each of the Distribution Companies.

Figure 9: Peak demand growth





Source: Electricity Distribution Planning Statements Losses Reports

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

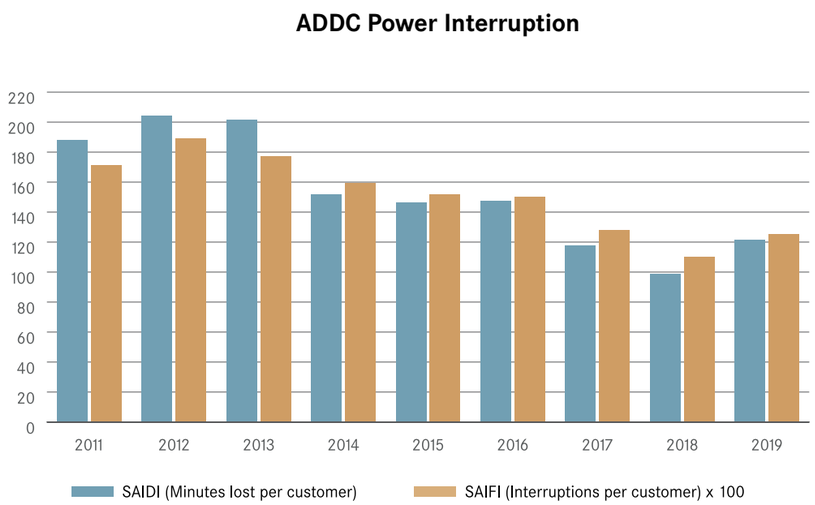
SAIDI, the System Average Interruption Duration Index is calculated as the sum of customer minutes lost experienced during the year due to interruptions in the network divided by the number of customers. It gives an indication of the average duration of interruption experienced by a customer over the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

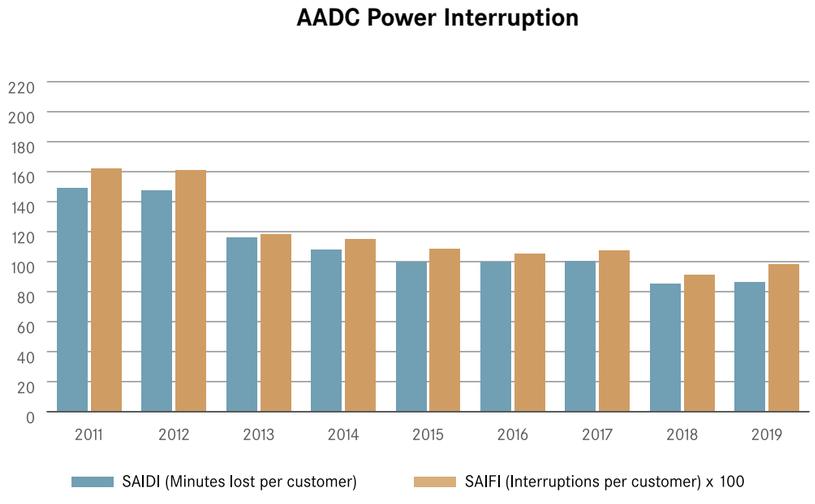
SAIFI, the System Average Interruption Frequency Index is calculated as the sum of the number of customers affected by interruptions during the year divided by the number of customers. It gives an indication of the average number of interruptions experienced by a customer over the year.

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 2019 SAIDI and SAIFI figures for both ADDC and AADC increased by between 2% and 23% from the 2018 figures. This deterioration in performance is due to ongoing schemes (requiring planned outages) to improve the distribution network mainly in Al Dhafrah Region and the Eastern Region of the Emirate.

Figure 10: Power Interruptions





Source: Annual Electricity Distribution Performance Reports

In 2018 the Council of European Energy Regulators (CEER) did 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.

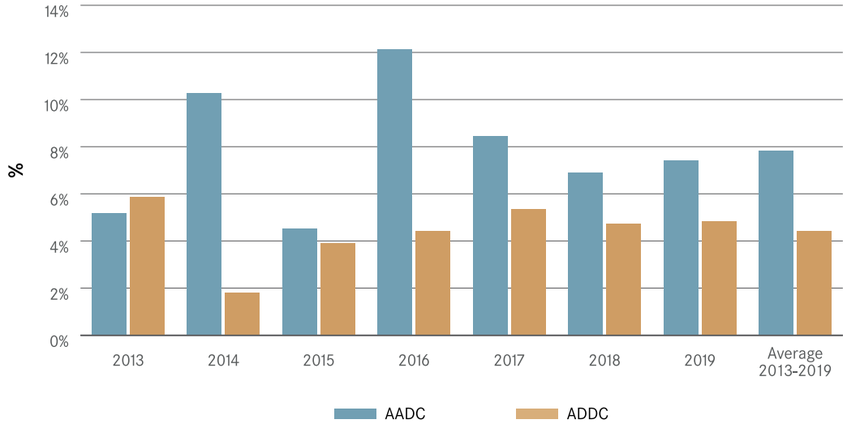
Losses

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 increase in losses in 2019 for AADC is therefore not significant, as it is within said year-on-on year variations.

The losses for ADDC, however, have improved due to improvements in the calculation methodology in terms of accuracy.

Figure 11: Distribution Losses



Source: Annual Electricity Distribution Losses Reports

Drinking Water

6 Drinking Water

Production

Production Overview

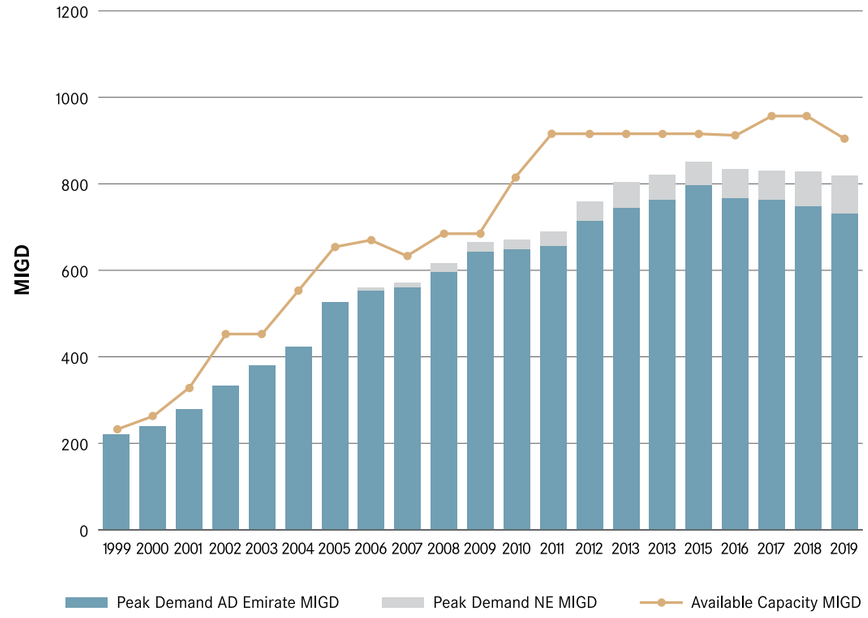
Water Demand Growth

Water demand in Abu Dhabi is generally measured by Abu Dhabi regional System demand and also the demand resulting from the exports to the Northern Emirates. Combined this is referred to as Abu Dhabi's global water demand.

In 2019, the global water demand peaked at 3.73 MCMD (820 MIGD), a negligible difference from 2018. Abu Dhabi Emirate accounted for 89% of peak demand represented by 3.32 MCMD (731 MIGD) while supply to the Northern Emirates accounted for 11% of peak demand and represented 0.4 MCMD (88 MIGD).

Abu Dhabi's global water peak demand growth has remained steady since 2016.

Figure 12: Water Demand Growth



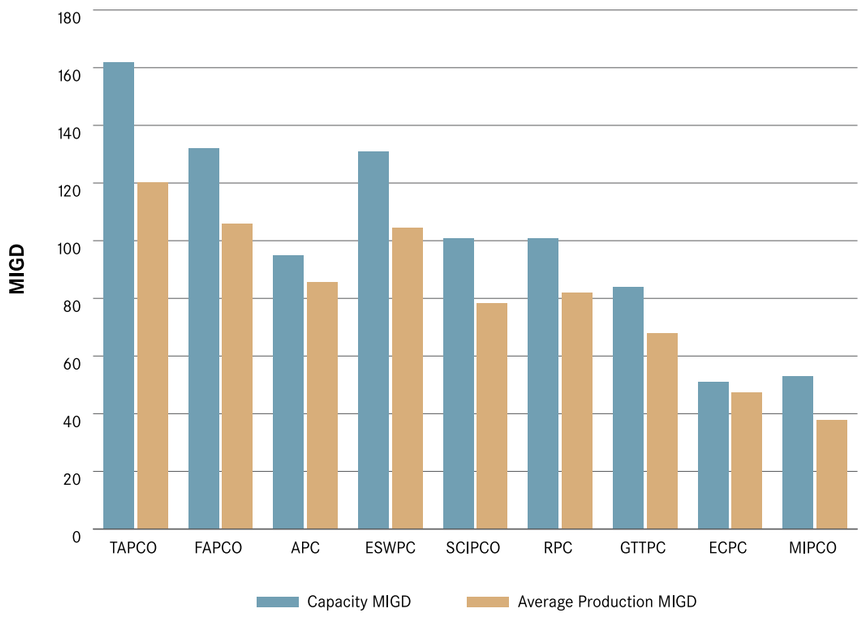
Source: 2019 EWEC Statistical Leaflet

Global Water Capacity and Production

In 2019, 1,211 MCM (266,456 MIG) of water was produced by Abu Dhabi 9 IWPPs to support Abu Dhabi's water demands. This averages to 3.32 MCMD (730 MIGD) with total available gross production capacity of 4.14 MCMD (910 MIGD) in the same year.

IWPPs capacities and average daily production are depicted in Figure 13 below. TAPCO remains to be the largest producer with daily water production capacity of 0.74 MCMD (162 MIGD).

Figure 13: IWPP Capacity vs Average Daily Production in 2019

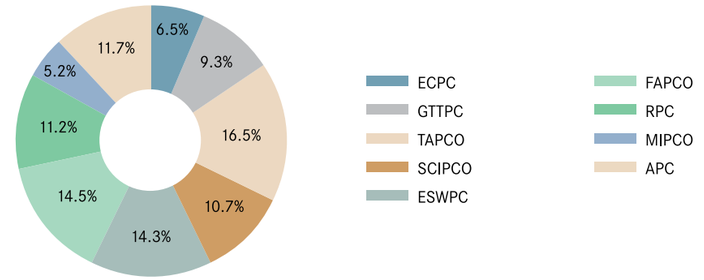


Source: 2019 EWEC Statistical Leaflet

Water Production by Company

Water production capacity share varies between the 9 IWPPs with market shares ranging between 5% and 17%. Nearly 17% of the overall water production share lies within TAPCO followed by FAPCO and ESWPC each holding around 14% of the water production market share.

Figure 14: IWPPs (%) Production Share in 2019

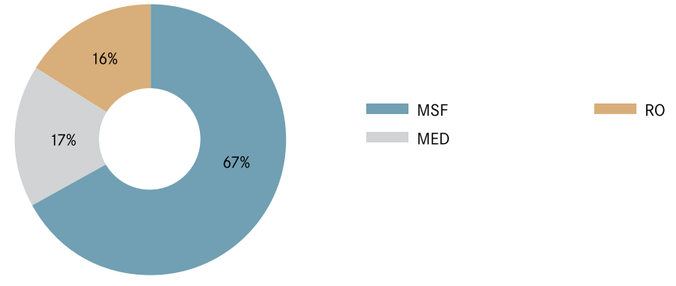


Source: 2019 EWEC Statistical Leaflets

Water Production by Technology

Thermal desalination remains to be the prevalent desalination technology accounting for 84% of water production in Abu Dhabi. Multi-Stage Flash (MSF) distillation dominates accounting for 67% of the thermal desalination and to a lesser extent Multiple Effect Distillation (MED). Furthermore, Seawater Reverse Osmosis (SWRO) accounts for almost 16% of desalination technology mix, an increase of 5% compared to 2016.

Figure 15: Production by Technology



Source: PDSRS (Monthly Performance Data)

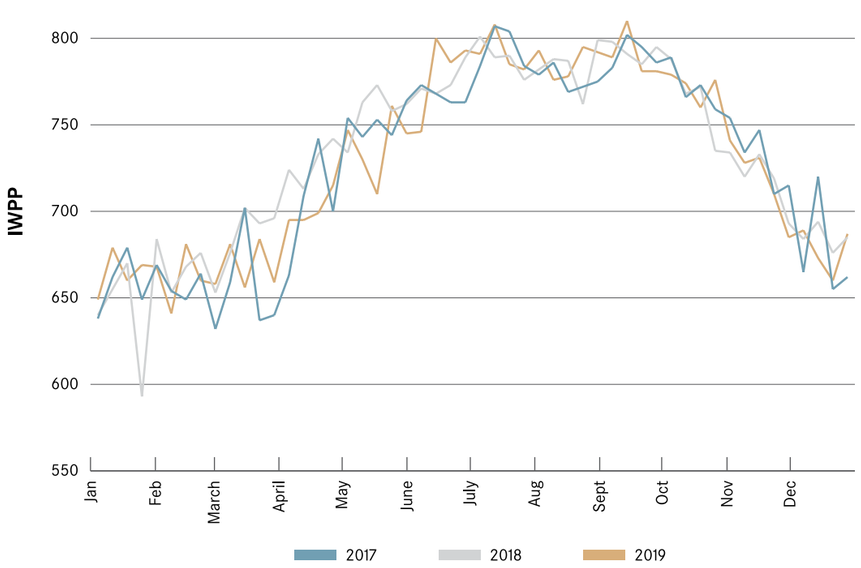
The share of RO will significantly grow over the coming years. The Taweelah RO Independent Water Plant (IWP), located in the Taweelah complex, will be the largest RO plant in the world. The plant will have a production capacity of 0.91 MCMD (200 MIGD) when completed in 2022.

Unlike electricity, water demand in the Emirate of Abu Dhabi exhibits moderate seasonal fluctuations throughout the year.

The weekly average water production in 2019 is provided in Figure 16.The global water demand reached its peak of 3.73 MCMD (820 MIGD) on July 10, 2019 , a slight decrease compared to last year's peak of 3.76 MCMD (828 MIGD) on June 9, 2018.

On the other hand, the minimum production of 2.55 MCMD (560 MIGD) occurred on March 30, 2019.

Figure 16: Average Weekly Water Supply by IWPPs (2017-2019)



Source: PDSRS (Daily Water Report)

Transmission

Transmission Overview

TRANSCO is the sole water transmission licensee in the Emirate of Abu Dhabi. It transports large volumes of water from the production companies to the distribution companies.

In 2019, the 3,504 km water transmission system carried a peak of 3.73 MCMD (820 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 drinking water transmission system comprises of 51 pumping stations with a pumping capacity of 11.74 MCMD (2,583 MIGD), and 126 reservoirs with a total capacity of 3.02 MCM (664 MIG).

The total quantity of water leaving the network amounted to 1176.71 MCM (258,840 MIG).

Table 4: Drinking Water transmission system assets

	Pumping Station	Capacity	Reservoirs	Capacity
Total	51	11.74 MCMD 2,583 (MIGD)	126	3.02 MCM (664 MIG)

System Performance

The performance of the transmission system is monitored through a number of KPIs including:

- Water Transmission losses
- Security of supply
- System availability

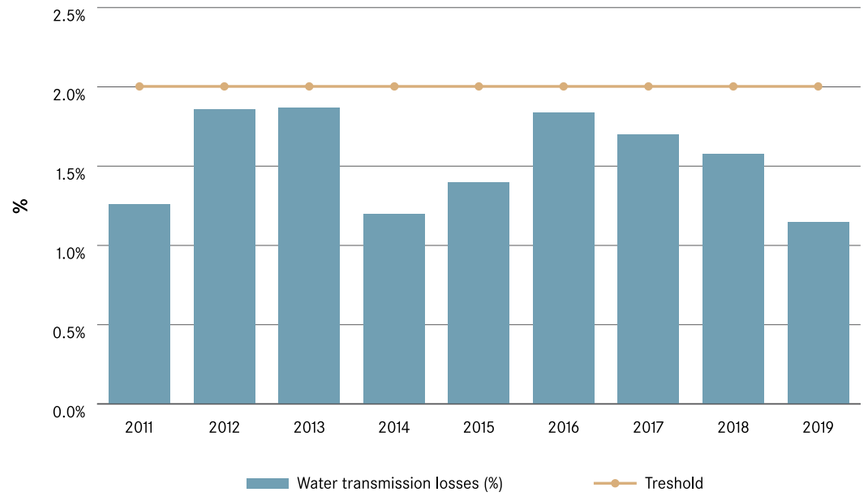
Water Transmission Losses

This indicator seeks to identify, 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, including wells, 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 17 shows the percentage of water transmission losses from 2011 to 2019, which were all below the 2% tolerance threshold.

Figure 17: Water Transmission Loss (%)



Source: TRANSCO Annual Water Performance Report 2019

Security of Supply

The security of supply indicator investigates any supply shortfalls in meeting the scheduled drinking water quantities. This indicator measures 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:

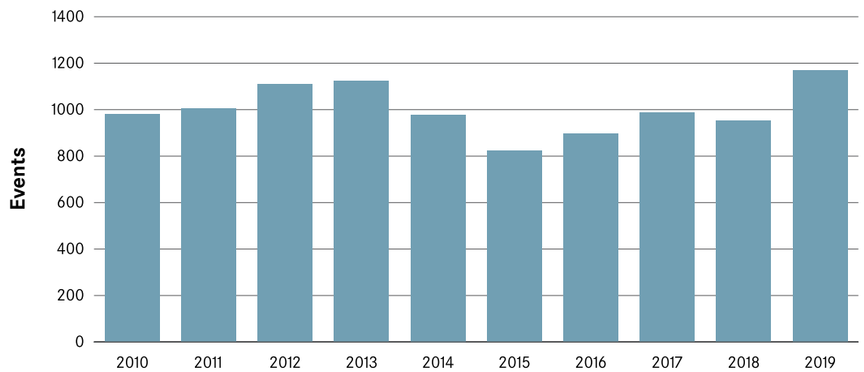
1. Unpredictable demand events.
2. Supply interruptions

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.

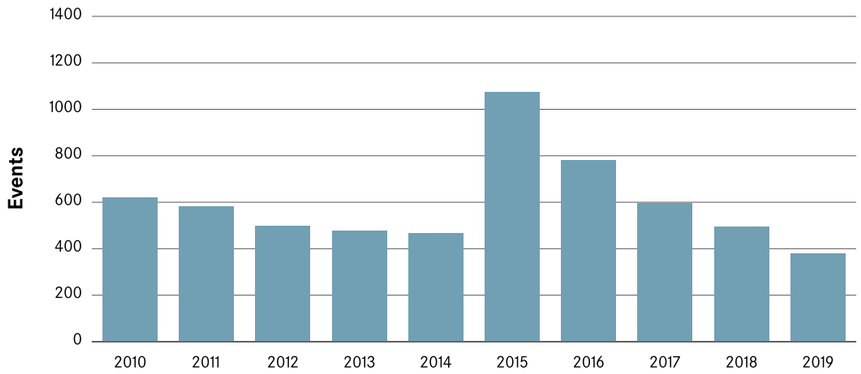
Figures 18 and 19 below show the unpredictable demand events for both ADDC and AADC respectively from 2010 to 2019. There are inherent difficulties in generating highly accurate demand forecasts, which requires further progress with data collection and validation, as well as network operational management. the number of such events is seeing a drop with AADC since 2015 while there still remains issues with ADDC which operates a larger network.

Figure 18: ADDC Unpredictable Demand Events



Source: TRANSCO Annual Performance Report 2019

Figure 19: AADC Unpredictable Demand Events

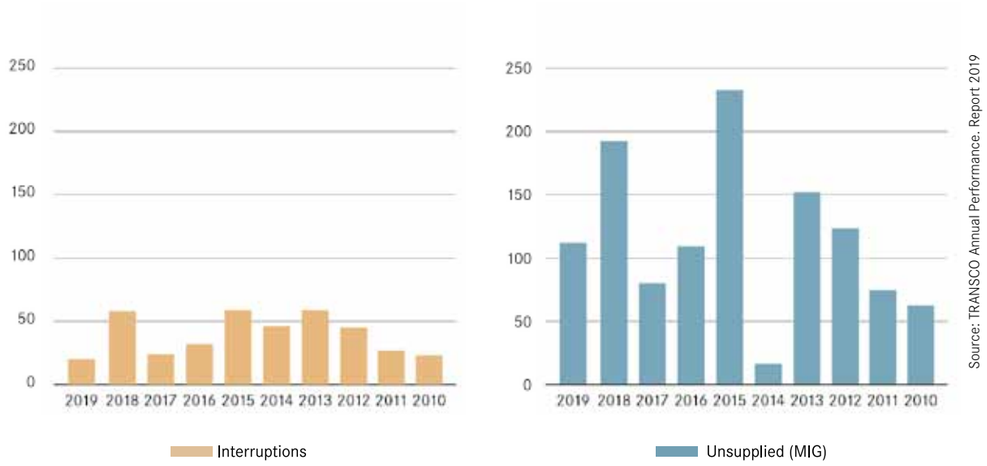


Source: TRANSCO Annual Water Performance Report 2019

Supply Interruptions

Supply interruptions result from incidents or constraints within the production; transmission; or distribution system. Figure 20 below shows the unsupplied quantities and interruptions caused by TRANSCO. 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. In 2019, both number of interruptions & unsupplied quantities showed improvement and decreased compared to 2018.

Figure 20: Unsupplied Quantities vs. Interruptions



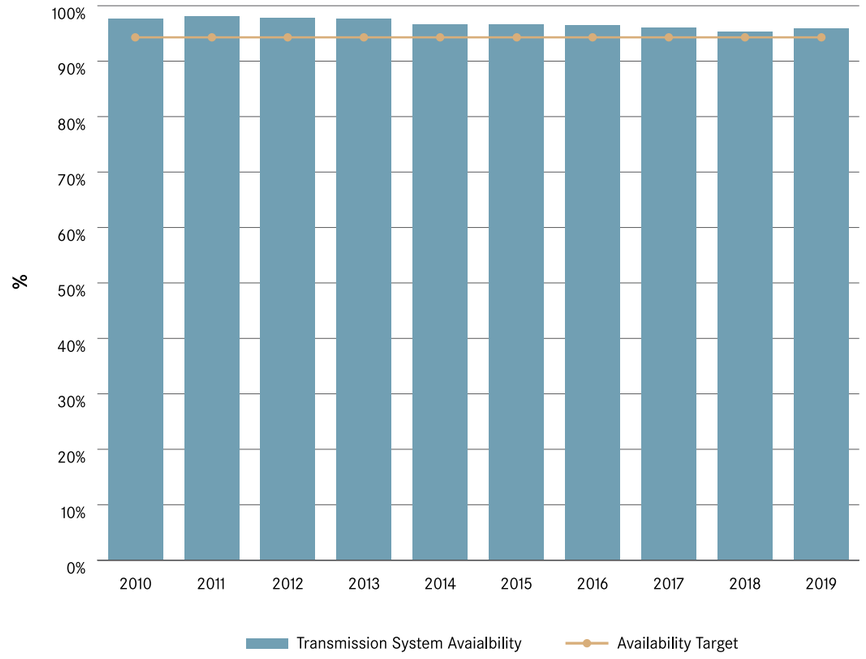
Source: TRANSCO Annual Performance. Report 2019

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 above set target since 2010; TRANSCO’s overall system availability in 2019 is 95.98%, as illustrated in Figure 21 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 21: Transmission System Availability



Source: TRANSCO Annual Performance Report 2019

Distribution

Distribution Overview

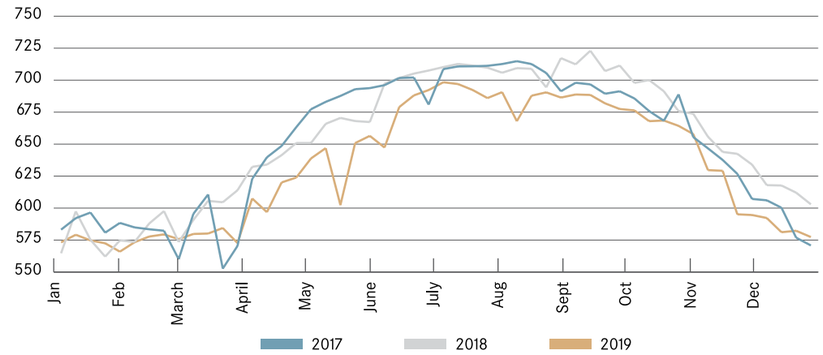
Distribution systems transport water from the transmission system to the end users. The total length of the distribution system operated by AADC and ADDC is about 14,204 km, which is predominantly composed of cement-lined DI pipelines ranging in diameter from 80 to 1,200 mm, with high density polyethylene pipe lines also increasingly being employed. The network comprises a total of 43 pumping stations with an overall capacity of 0.43 MCMD (95 MIGD) and 69 reservoirs with total capacity of 0.26 MCM (57 MIG)

Table 5: Drinking water distribution network assets

	No. of Water customers	Pumping Stations	Capacity	Pipelines (km)	Reservoirs	Capacity
AADC	313,779	8	0.29 MCMD (63 MIGD)	4,961	14	0.11 MCM (24.5 MIG)
ADDC	94,117	35	0.15 MCMD (32 MIGD)	9,243	55	0.15 MCM (32.5 MIG)
Total	**407,896**	**43**	**0.43 MCMD (95 MIGD)**	**14,204**	**69**	**0.26 MCM (57 MIGD)**

In 2019, the average daily water supplied by TRANSCO to Al Ain was 0.78 MCMD (171 MIGD) and 2.10 MCMD (462 MIGD) to Abu Dhabi, based on weekly averages, as illustrated in the graphs below. This has been consistent with the weekly water supplied in 2018.

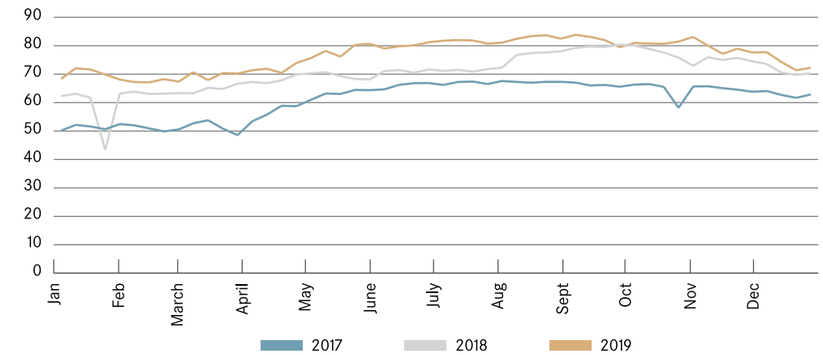
Figure 22: Water supply – Abu Dhabi Emirate



Source: PDSRS

Abu Dhabi exports to Northern Emirates reached its peak of 0.39 MCM (86 MIGD) on October 31, 2019 with an increase of 0.9% from last year. In 2019, the average daily water supplied was 0.35 MCMD (77 MIGD) to the Northern Emirates, representing an increase of 1.5% over 2018, as illustrated in the graph below.

Figure 23: Water supply – Northern Emirates



Source: PDSRS

System Performance

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

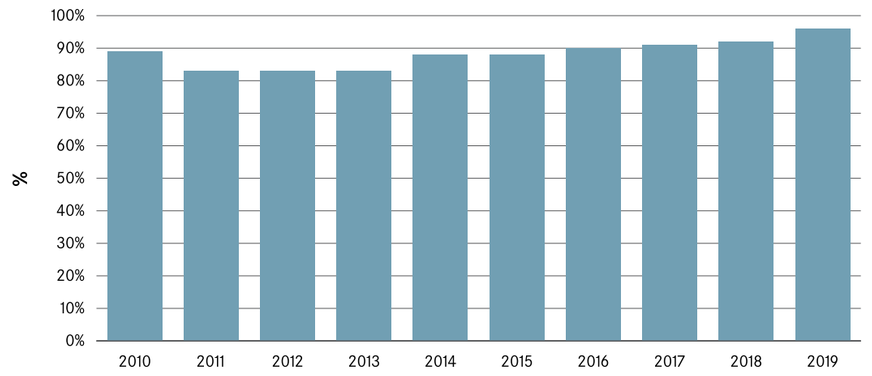
Pressure of Supply measures supply pressure with a view to achieving a standardized level sufficient to supply low-rise buildings, thereby reducing reliance on ground storage tanks and preventing infiltration by ground water contaminants.

In line with the Water Supply Regulations the minimum required pressure in the distribution network is 1.25 bar. In 2019, compliance with this requirement increased to nearly 96% in Abu Dhabi and stayed the same at 93% in Al Ain, as shown in Figures 24 and 25 below. The ultimate goal is to achieve 100% compliance.

With respect to ADDC, the majority of the noncompliant cases were in the Central Region and some in Eastern Region. As for the Central Region, ADDC restricted pressure at the interface points with TRANSCO. This is because of the aged deteriorated assets in some areas on the Abu Dhabi Island. Replacement projects are ongoing to replace these assets i.e. some Pressurized Ring Mains and Sector Mains.

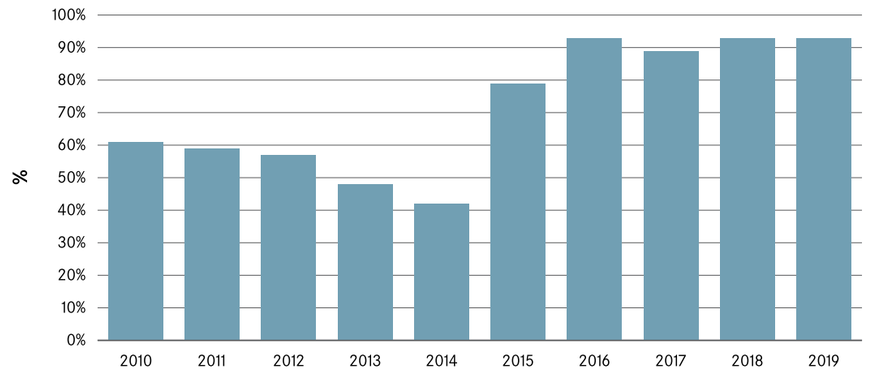
With respect to AADC, the noncompliant cases were in Abu Samra and in Al Yahar (Wahat Al Amirah) due to the pressure management/reduction required there, to avoid breakages on the aged deteriorated networks. With the completion of TRANSCO's projects in Al Ain, all transmission constraints have been lifted.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

Figure 24: Pressure of Supply ADDC



Source: ADDC Annual Performance Report 2019

Figure 25: Pressure of Supply AADC



Source: AADC Annual Performance Report 2019

Type of Supply

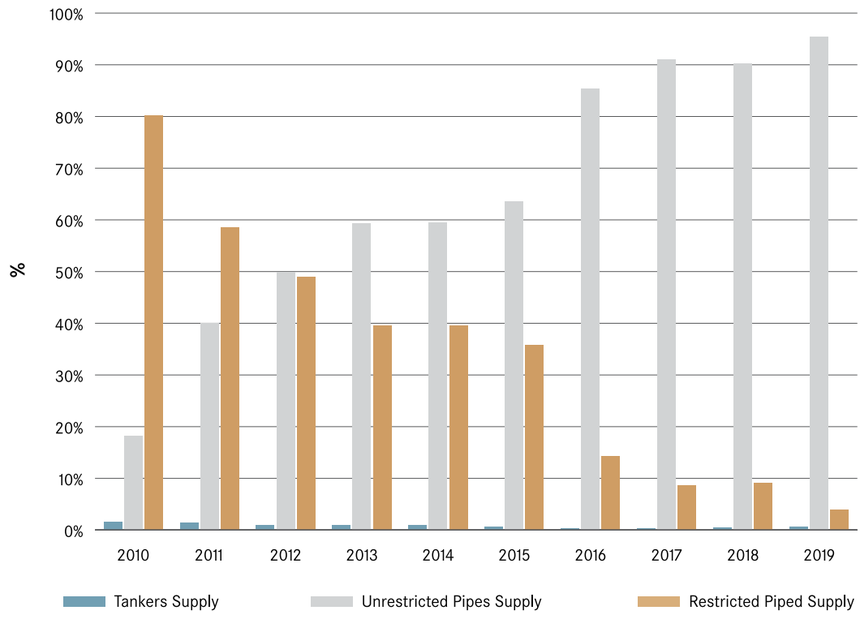
This indicator measures the progress made towards reducing the number of customers dependent on tankers and intermittent supply.

For ADDC the proportion of customers connected to the network stands at 99.60%, with 99.45% on continuous supply and 0.02% on intermittent supply, while the remaining customers (0.53 %) are supplied with drinking water by tankers.

The situation in AADC has been steadily improving and around 99.31% of AADC's customers are now connected to the network with 95.44% on continuous supply and only 3.87% on intermittent supply, a notable improvement since last year (9.13%). The remaining customers (0.69 %) are supplied with drinking water by tankers.

The Figure 26 below shows the decrease in unrestricted supply in Al Ain during 2019.

Figure 26: Unrestricted Supply in AADC

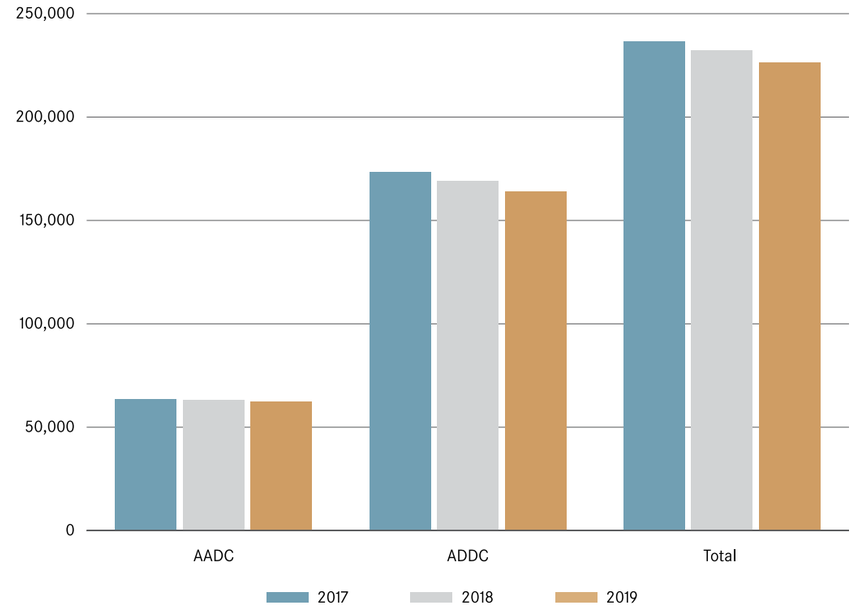


Source: 2019 PCR Report

Drinking Water Supplied by DISCOS

Water supplied by DISCO's remained steady over the years since 2017 as illustrated in the figure below. Total water supplied by DISCOs reached 1,029.43 MCM (226,443 MIG) in 2019 compared to 1,055.52 MCM (232,181 MIG) in 2018.

Figure 27: Drinking water supplied by DISCO's



Source: 2019 PCR Report

Water Quality

The Water Quality Regulations were established by the DoE to provide wholesome drinking water to consumers throughout the Emirate of Abu Dhabi and reflect the current guidance of the WHO. There are 8 Tables of Parameters outlined in the Regulations which are tested for throughout the water supply chain. The charts below illustrate the overall compliance with the Water Quality Regulations parameters.

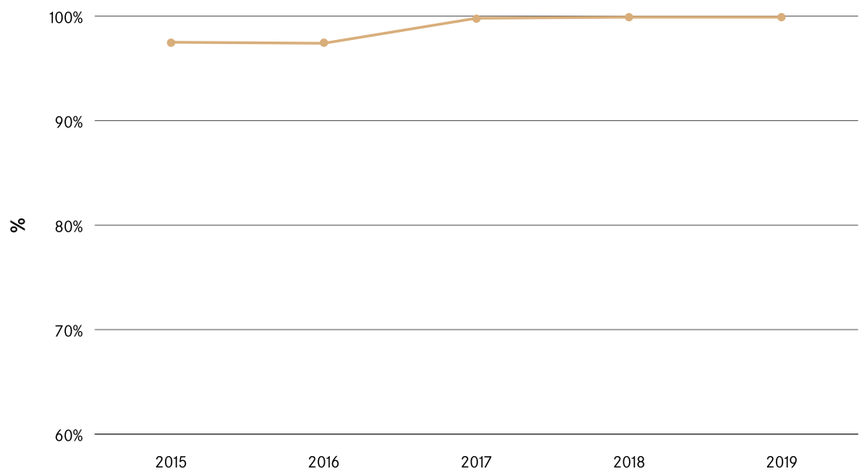
Water Quality Performance

Production

The total number of tests completed by the production companies in 2019 is 56,158, with 64 water quality parameters examined for RO and 51 water quality parameters examined for thermal desalination. The overall SF compliance (measure of the number of tests conducted against those required) for the production companies was 99.5%.

The overall PCV compliance for 2019 was 99.9%, with Physical Parameters and Microbial Parameters compliance at 99.9% and 100%, respectively. The following chart illustrates the production companies' consistent overall quality compliance from 2015 to 2019.

Figure 28: Production Water Quality Compliance



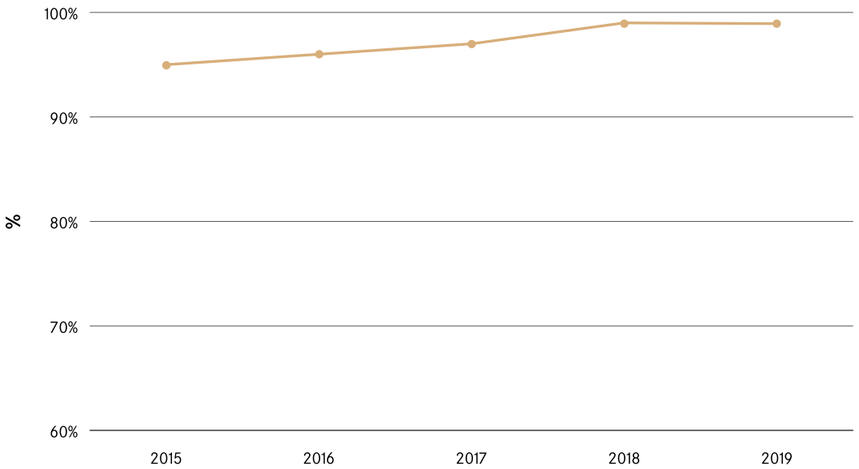
Source: WQRRS, Regulatory Annual Water Quality Report

Transmission

For TRANSCO, the total number of tests performed was 45,602, with 62 water quality parameters examined in the transmission system. TRANSCO's overall SF compliance was 99.9%.

For 2019 the overall quality compliance was 99% with Microbial Parameters at 99.9% compliance. The following chart illustrates that the overall quality compliance was greater than 95% from 2015 to 2019.

Figure 29: Transmission Water Quality Compliance



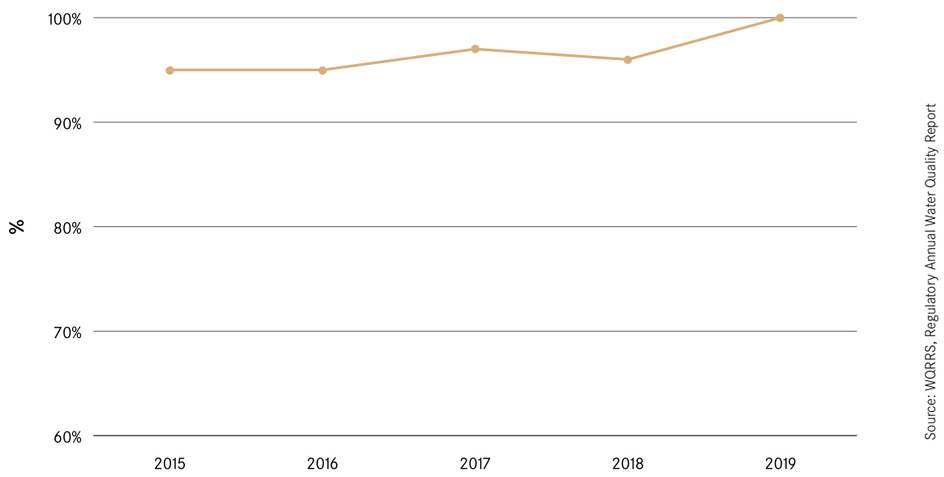
Source: WQRRS, Regulatory Annual Water Quality Report

Distribution

With respect to ADDC, the total number of tests performed was 52303 (Testing for 8 WQR's Tables), with 64 water quality parameters examined in the distribution system. ADDC's overall SF compliance for 2019 was 99.9%.

The following chart shows the overall quality compliance historical trend from 2015 to 2019.

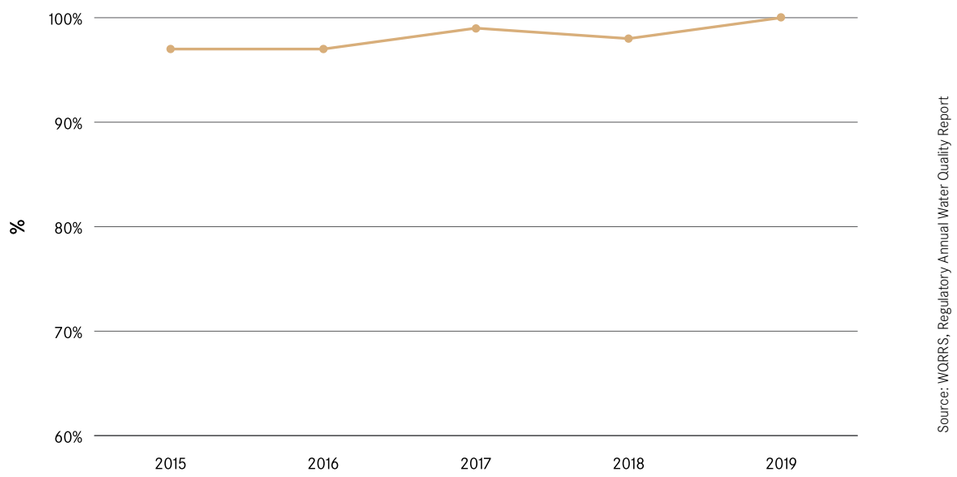
Figure 30: ADDC Water Quality Compliance



For AADC, the total number of tests performed was 16099, with 64 water quality determinants examined for the distribution system (Testing for 8 WQR's Tables) and the overall SF compliance was 100%.

The following chart manifests the overall quality compliance trends for the two mentioned tables from 2015 to 2019.

Figure 31: AADC Water Quality Compliance



7 Wastewater and Recycled Water

Collection

Collection Assets

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:

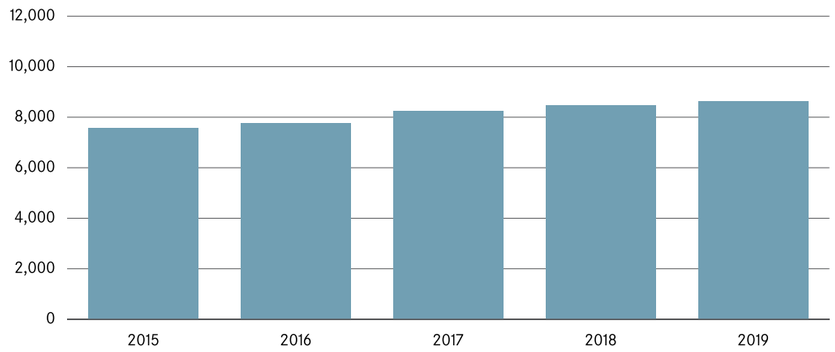
- Deep tunnel sewer;
- Conventional gravity sewers;
- Pumping stations; and
- Pumping mains.

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 MPS 1, MPS2, MPS3, MPS4, MPS 13, MPS 14, MPS6, MPS 17, MPS8N and many smaller pumping stations are diverted to the deep tunnel. Several asset enhancement and link sewer projects continued in 2019 with further enhancement projects planned through to 2024.

In 2019 ADSSC operated a total of 311 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 2019 was 8,609 km. Figure 32 illustrates the year on year change in the length of sewer network operated by ADSSC.

Figure 32: Collection network length (km)



Source: Security Standard Report 2019

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

Collection Network Performance

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.

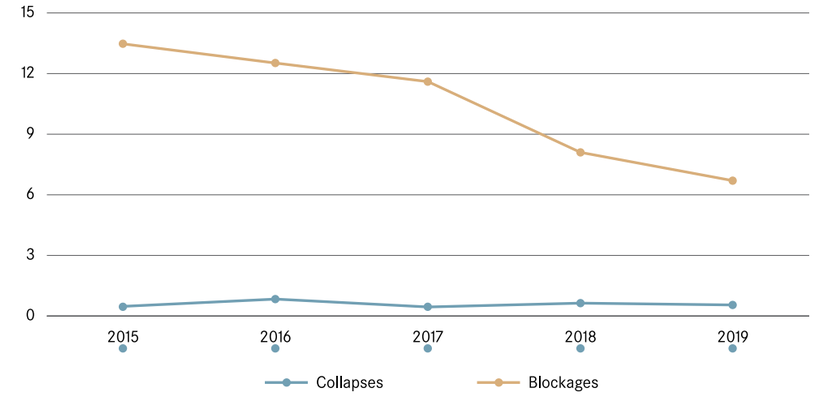
Sewer blockages per 100km

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 33 shows ADSSC's sewer collapses and blockages rate between 2015 and 2019.

Figure 33: Sewer collapses & blockages per 100km



Source: Security Standard Report 2019

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 69,838 incidents in 2019.

The rate of sewer collapses demonstrated no appreciable change from 2015 to 2019.

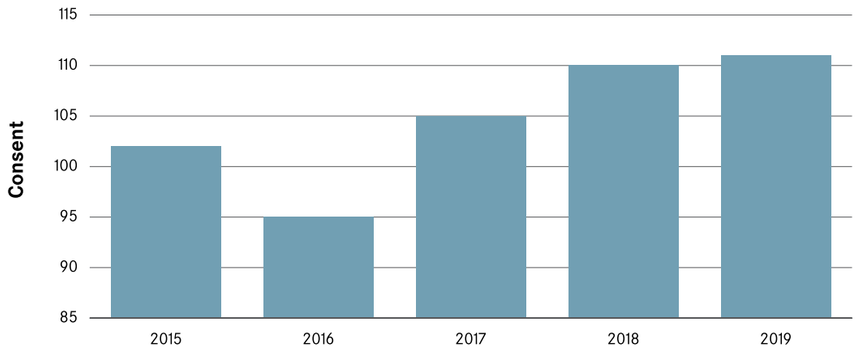
Quality Performance

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.

In 2019, ADSSC issued 13 new consents (predominantly to meat products facilities) and terminated 14 existing consents after investigations proved that the discharge was either domestic in nature or that the entities were no longer connected to the sewer network. At the close of 2019 there were 111 consented entities. Figure 34 illustrates the change in number of consented entities between 2015 and 2019.

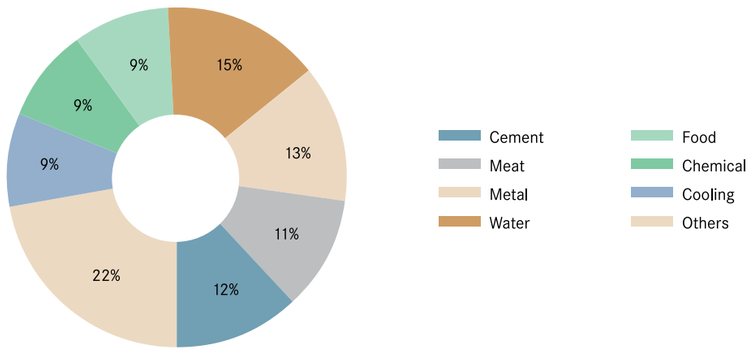
Figure 34: Number of Consented Entities



Source: 2019 Annual TEC Compliance Report

The largest contributors to the trade effluent flow were found to be the paper boarding, metal finishing and food and beverage and water industries. A breakdown of consent holders by industry type is shown in Figure 35 below.

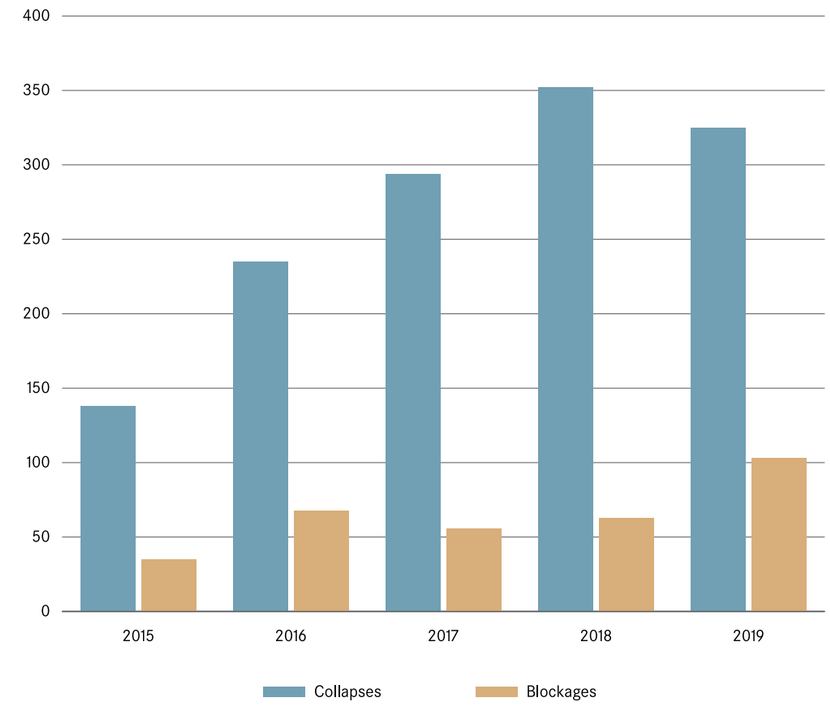
Figure 35: Percentage of Consent Holders by Industry Type



Source: 2019 2019 Annual TEC Compliance Report

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 325 sampling and inspection assessments of consent holders in 2019. Figure 36 illustrates the increased number of sampling events since 2015 and the associated decrease in sampling exceedances over the same time period. A marked increase in 2019 was attributed to a redefinition of the exceedances classification terminology to account for minor exceedances (+- 5% tolerance).

Figure 36: Number of Sampling Events



Source: 2019 2019 Annual TEC Compliance Report

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

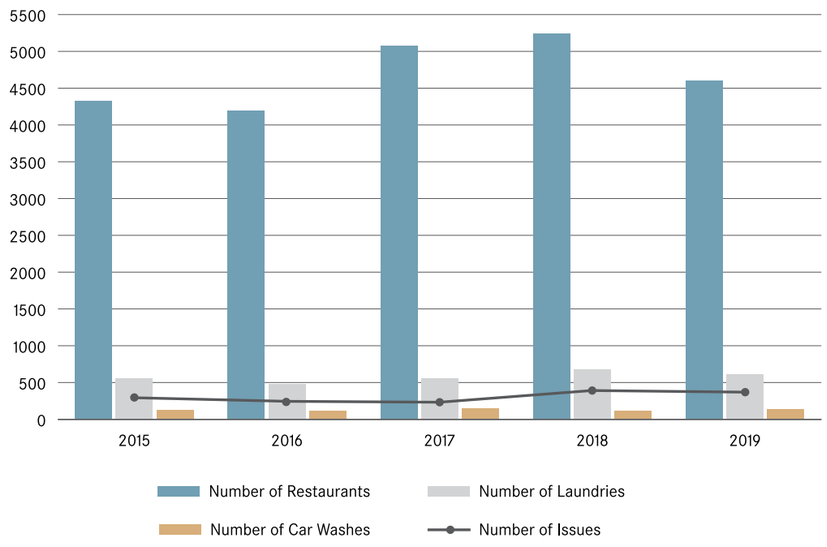
ADSSC issued 40 enforcement notices which required consent holders to address issues associated with sample failures or issues identified during inspections. Three of the enforcement actions were improvement notices.

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 37 below shows the number LRTE entities inspected from 2015 through 2019 and the corresponding number of issues encountered during the inspections.

Restaurants and cafes continue to constitute the bulk of ADSSC's inspection workload and a decrease in the number of registered restaurants and cafes was noted in 2019. The main issues encountered by ADSSC inspectors were related to grease trap maintenance.

Figure 37: Breakdown of low-risk Entities by Type of Business



Source: 2019 2019 Annual TEC Compliance Report

Treatment

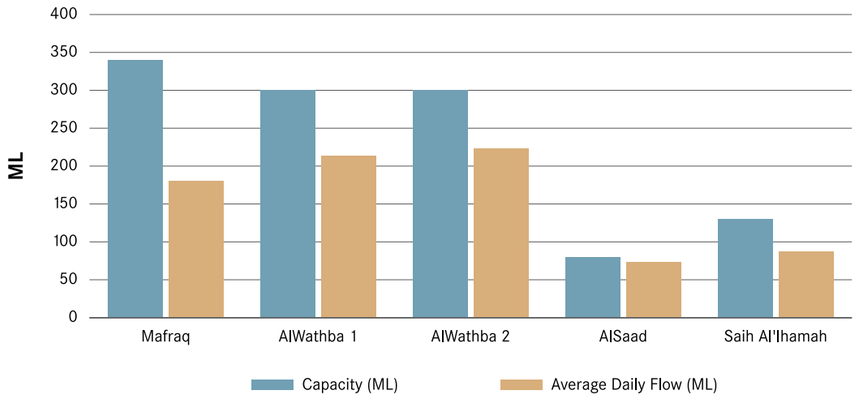
Treatment and Disposal Assets

Wastewater treatment is defined as the reception of wastewater from the collection system, the treatment of wastewater and delivery of the resulting products to the disposal system. In 2019, ADSSC operated 39 wastewater treatment plants with a total installed capacity of 1,330 ML/day. In 2018, Mirfa Canning Factory treatment plant was decommissioned and the flow diverted to the main Mirfa treatment plant, whilst the Bida Mutawa'a treatment plant was commissioned in 2019.

Over 90% of the overall 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 38 below depicts the capacities of the 5 largest plants and their average daily flows in 2019. 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 2019 flows have decreased 10% since 2016 reducing the urgency for a treatment plant upgrade.

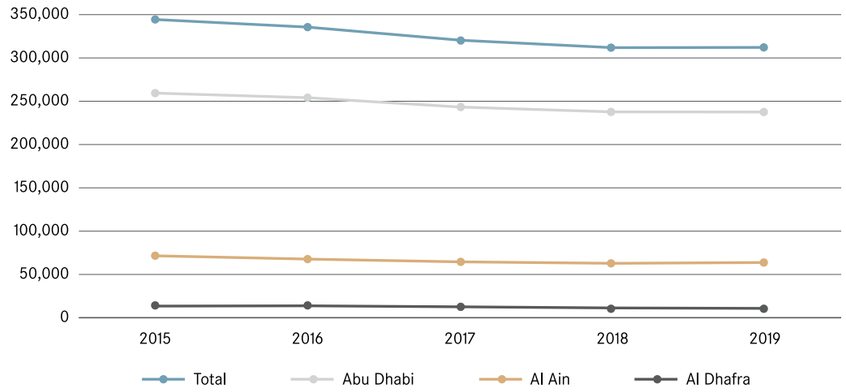
Figure 38: Production and Capacity (ML)



Source: Security Standard Report 2019

Figure 39 illustrates the total annual flow in the Emirate of Abu Dhabi, and the corresponding flows in each region from 2015 and 2019. A cumulative reduction in flow of 9% was recorded between 2015 and 2018. In 2019 the annual flow flattened out with just 0.1 % decrease noted.

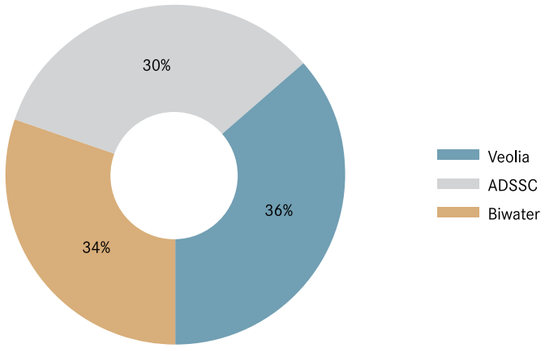
Figure 39: Annual flow data (ML)



Source: ADSSC Security Standard Report 2019

Figure 40 Illustrates the proportion of wastewater managed by each of the major licensees in 2019 and highlights the role played by the Independent Sewage Treatment Providers (ISTP) Etihad Biwater and Veolia Besix who manage approximately 70% of the total wastewater treated in the Emirate.

Figure 40: Proportion of Flow Handled by Major Licensees



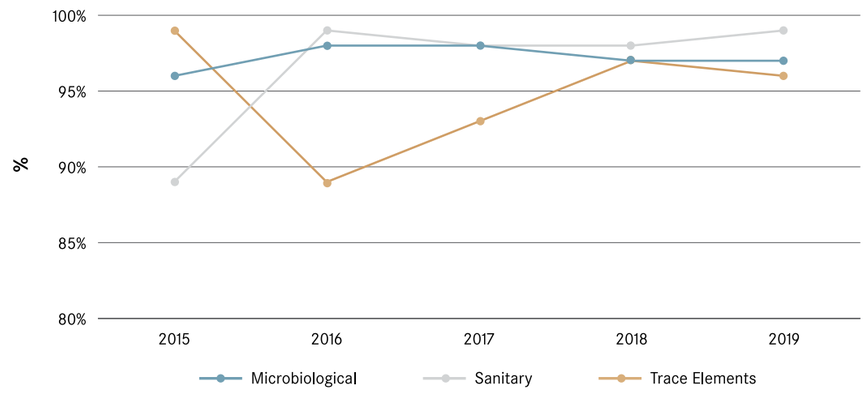
Source: Security Standards Report 2019

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 41 below summarises the recycled water quality compliance for the five major treatment plants operated by large scale licensees from 2015 to 2019 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 41: Recycled Water Quality



Source: RWRRS

The data shows significant improvements in compliance against the three key parameter over the 5 year time period, with excellent compliance reported throughout 2019 for sanitary and trace elements parameters. Occasional exceedances continue to be recorded for some microbiological parameters.

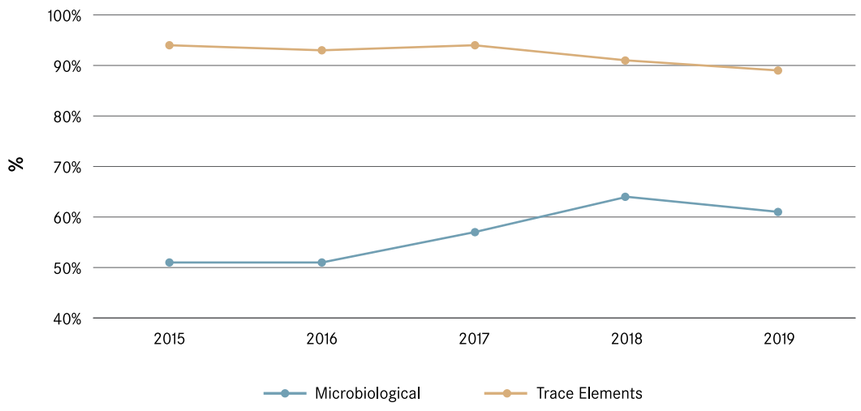
Additionally, it was noted that salinity continues to be an issue in the raw wastewater entering the Abu Dhabi treatment facilities. This is caused primarily by groundwater infiltration entering the sewerage network through defective pipes, pipe joints, connections, or manholes. Asset enhancement schemes on Abu Dhabi Island have reduced the salinity entering Mafraq treatment plant. Similar schemes have been planned for Musaffah area to decrease the infiltration affecting Wathba 1 and Wathba 2 treatment plants.

Quality of Biosolids

Figure 42 below summarises the biosolids quality compliance for the five major treatment plants operated by large scale licensees from 2015 to 2019 against the microbiological and trace elements parameters outlined in the RW&B Regulations.

A slight decrease in quality from 2018 to 2019 was noted for both sets of parameters. A temporary relaxation of the limits was granted by the DoE to investigate treatment processes and review laboratory procedures and analytical techniques. Any trace elements related issues are followed up by ADSSC as part of their trade effluent control programme.

Figure 42: Biosolids Quality



Source: RWRRS

Distribution & Supply

Recycled Water Distribution and Supply Assets

The DoE issued Licenses to both ADDC/ADDC for the distribution and supply of recycled water effective 1 January 2018. Accordingly, the entire recycled water distribution and supply network is being transferred to the DISCOs from ADSSC and the municipalities. The DISCOs are continuing with projects to enumerate the quantity of assets that were handed over, and to assess the asset condition of the transferred network.

Recycled Water Reuse

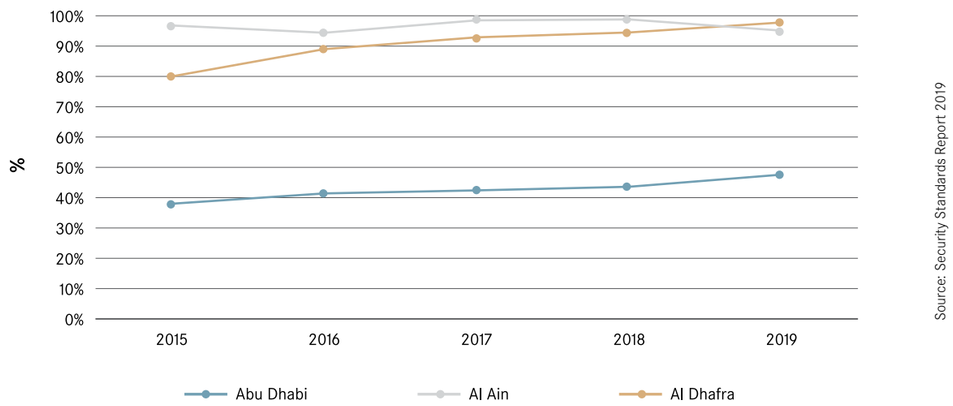
The products of wastewater treatment are a valuable source of water, nutrients and energy. The DoE believes that the wastewater sector must promote the reuse of recycled water and biosolids to support the Emirate's sustainable development goals.

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 60% of the recycled water is currently used in the Emirate of Abu Dhabi. Figure 43 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, and increase of approximately 20% has been recorded for the Abu Dhabi and Al Dhafra regions. ADDC has initiated infrastructure projects to convey the excess recycled water to farms thereby increasing the reuse percentage in Abu Dhabi.

Figure 43: Recycled water Reuse



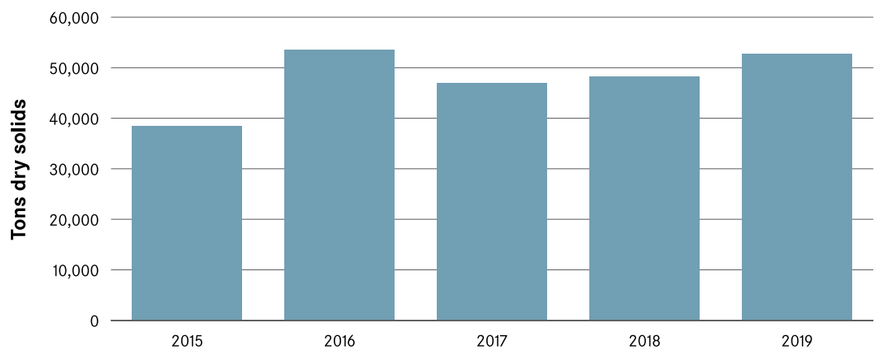
Source: Security Standards Report 2019

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.

Figure 44 shows the amount of biosolids produced from 2015 to 2019. 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 2019 was 52,815 tonnes.

Figure 44: Biosolids Production



Source: Security Standards Report 2019

Small Scale 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 43 small scale wastewater, treatment and disposal entities with licenses in 2019, 14 of which were audited to ensure compliance with the DoE's technical and health and safety requirements.

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 will be referred to the DoE's licensing and compliance department for further actions.

Health and Safety

8 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 in order to update them with any matters related to the sector, which includes the management of operational and HSE incidents.

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

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 implementation of the Abu Dhabi Occupational Health and Safety Framework.

HSE Performance

The DoE monitors the HSE performance through multiple tools including:

1. Review of incidents reported to the DoE and follow-up to ensure corrective actions are implemented.
2. Review of HSE Monthly performance reports submitted by the Licensees directly to the DoE, and Al Adaa Quarterly performance report wherein Licensees are measured against set KPIs.
3. 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; and
- Environmental.

OSH Incidents

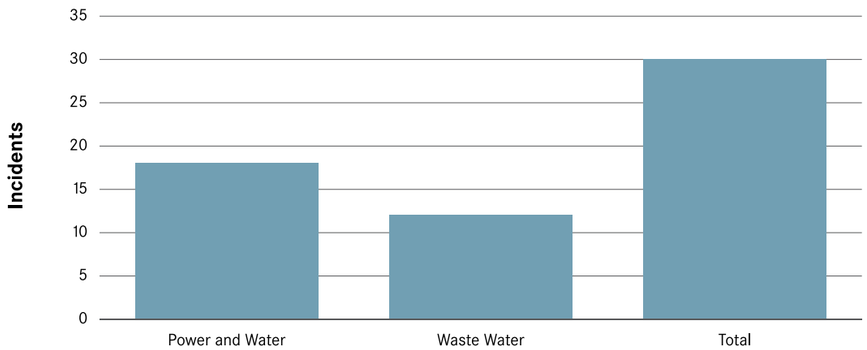
OSH incidents are defined as a single event or chain of events which has caused or has the potential to cause a fatality, injury or illness to a person, or damage to assets, or the reputation of any Entity.

The categories of these incidents include:

- Work-Related Fatality which is a death resulting from a work related injury or illness, regardless of the time intervening between injury and death.
- Lost Time Injury which is any absence from work resulting from work-related Fatalities, Permanent Total Disabilities, Permanent Partial Disabilities and Lost Workday Cases. The Lost Time Injuries were further broken down into the below:
  - Lost Time Injury Frequency Rate (LTIFR): The total number of Lost Time Injuries per million hours worked during the period. Calculation: No. of LTI's x 1,000,000 / Working Hours
  - Lost Time Injury Severity Rate (LTISR): The total number of lost work days per million hours of working. Calculation: No. of Work Days Lost x 1,000,000 / Working Hours

There were 30 total OSH incidents reported in 2019. The breakdown of these incidents by sector is shown in Figure 45 below. None of the incidents resulted in a fatality.

Figure 45: OSH Incidents by sector

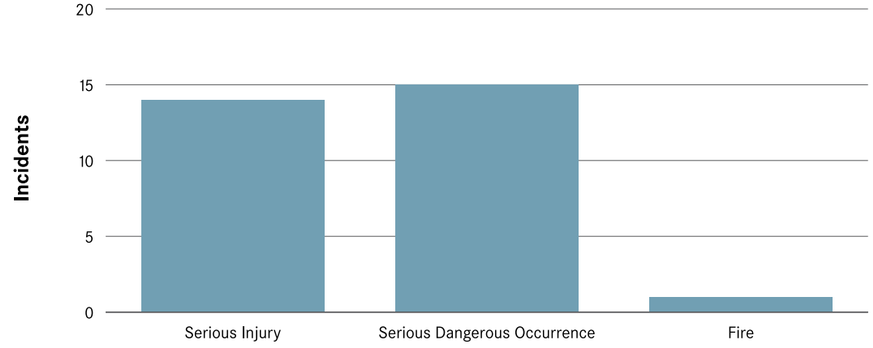


Source: IRS

The OSH incidents that occurred during 2019 were classified into 3 categories: serious injury, serious dangerous occurrence, and fire. These are shown on Figure 46 below.

One major fire incident occurred during 2019 and it resulted in property damage without injuries.

Figure 46: OSH incidents in 2019 by category



Source: IRS

Operational Incidents:

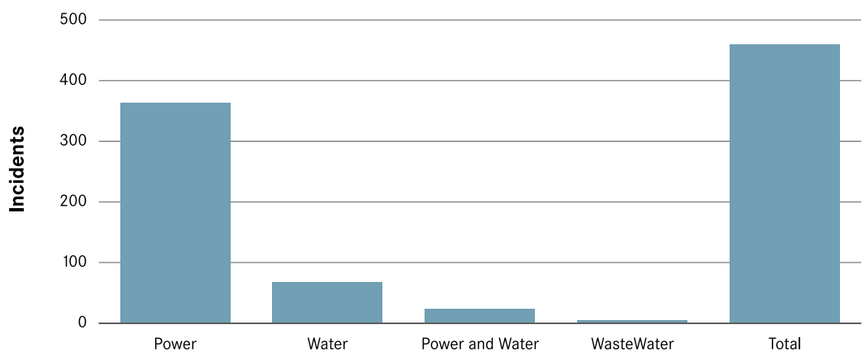
Operational incidents are defined as events that result in an interruption of service provided by the Licensee.

Operational incidents are classified based on the activities to:

- Power operational incidents (including power generation, transmission, and distribution)
- Water operational incidents (including water desalination, transmission and distribution)
- Wastewater operational incidents (including the wastewater collection, treatment, and recycled water distribution and supply)

In 2019 the DoE received and processed 459 operational incident reports; 19 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 47 below.

Figure 47: Operational Incidents in 2019



Source: IRS

Operational Power Incidents:

A total of 363 operational power incidents were reported in 2019.The 8 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) – 6 incidents reported in 2019
- Loss of grid connection / Major electrical failure exceeding 6 hours (e.g. station transformer / transmission switchgear) – 2 incidents reported in 2019

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 Drinking Water Incidents

There were 68 operational incidents reported in the production, transmission and distribution networks in 2019. None of the incidents affected the security of supply.

In 2019 vs 2018, the production water losses were reported to have reduced by 19% and the transmission and distribution losses increased by 7.6% and 11.8% respectively.

In 2019 vs 2018, the number of the transmission operational incidents have increased from 2 to 8. One of the main reasons is due the GRP pipe leakages. The number of the distribution operational incidents increased from 3 to 8 during the same time period, primarily due to operational disruptions in the network upstream (production and transmission).

Operational Wastewater Incidents

There were 5 operational incidents reported in the wastewater sector. The majority of these incidents were related to issues with the aging pipe network or accidents caused during excavation activities.

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 2019.

Environment

9 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.

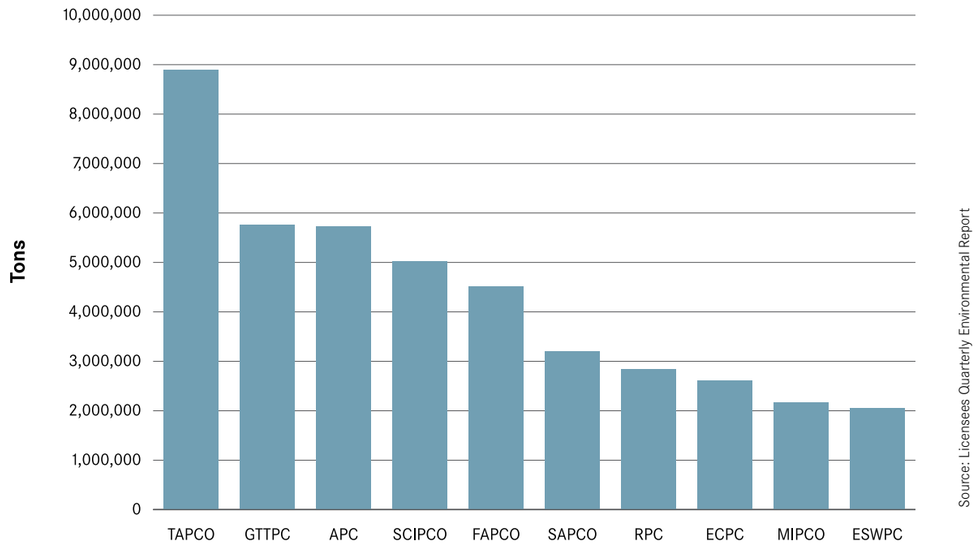
The DoE works closely with the Environment Agency- Abu Dhabi to ensure compliance with all regulations and agreed protocols for the energy sector. Also, the DoE is a part of the consultation process for all environmental matters related to the energy sector through participating in working committees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

Each quarter, 11 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 124 environment reports in 2019.

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

Additionally, the CO2 emissions in the energy sector is monitored on a regular basis. The total CO2 emissions in 2019 was 42,853,290.78 tons. The breakdown of the emissions by Licensee is shown in Figure 48 below.

Figure 48: CO2 Emissions (Tons)



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 (Emirates Water and Electricity Company)
- ADDC (Abu Dhabi Distribution Company)
- AADC (Al Ain Distribution Company)
- TRANSCO (Abu Dhabi Transmission and Despatch Company)
- ADSSC (Abu Dhabi Sewerage Services Company)
- AMPC (Al Mirfa Power Company)
- APC
- ECPC (Emirates CMS Power Company)
- FAPCO (Fujairah Asia Power Company)
- GTTPC (Gulf Total Tractebel Power Company)
- MIPCO (Mirfa International Power and Water Company)
- RPC (Ruwais Power Company)
- SAPCO (Shuweihat Asia Power Company)
- SCIPCO (Shuweihat CMS International Power Company)
- SEMBCORP
- SHAMS
- TAPCO (Taweelah B Power & Desalination Complex)
- Al Etihad Biwater Wastewater Company (EB)
- Al Wathba Veolia Besix Wastewater Company (VeBes)

2019 Annual TECHNICAL REPORT

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