2013 Seven Year Electricity Planning Statement
(2014-2020)

Power Network Development Department
Asset Management Directorate
June 2013
Forward

I have the pleasure in releasing the 2013 Seven Year Electricity Planning Statement (7YPS) for transmission within the Emirate of Abu Dhabi and, where appropriate, our network outside of the authorized area in the period 2014-2020. In producing this document, we have endeavored to ensure that our customers, both existing and future, are presented with an opportunity to understand the scale and type of transmission network operated by us. We have sought to ensure that customers and other stakeholders are able to identify areas of the network where additional investment is proposed in order to increase available capacity or otherwise ensure that network performance continues to attain the targets expected from such a critical infrastructure provider.

This is the fourth 7YPS released in response to Condition 15 of the Transmission and Despatch Licence that provides detailed short to medium-term plans for the transmission network. The plans included in the 7YPS are linked to the needs and investment requirements and are based on the network development strategy covering the period 2010-2030 that places much greater emphasis on the trends and drivers which provides a long-term vision for taking the transmission system forward consistent with Government’s 2030 vision.

Feedback on this 7YPS is most welcome in order that TRANSCO is able to continue to adjust its planning and development strategies to meet the regulatory, customer and stakeholder requirements and expectations.

Copies of the approved 7YPS can be downloaded from our website www.transco.ae.

Dr. Najib H Dandachi
Asset Management Director
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### Abbreviations

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<tr>
<td>7YPS:</td>
<td>Seven Year Planning Statement</td>
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<tr>
<td>AC:</td>
<td>Alternating Current</td>
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<td>AED:</td>
<td>UAE Dhirams</td>
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<td>AAPS:</td>
<td>Al-Ain Power Station</td>
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<td>AADC:</td>
<td>Al-Ain Distribution Company</td>
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<td>ADDC:</td>
<td>Abu Dhabi Distribution Company</td>
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<td>ADNOC:</td>
<td>Abu Dhabi National Oil Company</td>
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<td>ADWEA:</td>
<td>Abu Dhabi Water and Electricity Authority</td>
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<td>ADWEC:</td>
<td>Abu Dhabi Water and Electricity Company</td>
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<tr>
<td>ACCC:</td>
<td>Aluminum Conductor Composite Core</td>
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<td>ACSR:</td>
<td>Aluminum Conductor Steel Reinforced</td>
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<td>CSP:</td>
<td>Concentrated Solar Power</td>
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<td>CAPEX:</td>
<td>Capital expenditure</td>
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<td>DEWA:</td>
<td>Dubai Electricity and Water Authority</td>
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<td>DISCOs:</td>
<td>Distribution Companies</td>
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<td>DSM:</td>
<td>Demand Side Management</td>
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<td>EMAL:</td>
<td>Emirates Aluminum Smelter Plant</td>
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<td>ENG:</td>
<td>Emirates National Grid</td>
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<td>FEWA:</td>
<td>Federal Electricity and Water Authority</td>
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<td>GCC:</td>
<td>Gulf Cooperation Council</td>
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<td>GDP:</td>
<td>Gross Domestic Product</td>
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<td>GENCOs:</td>
<td>Generation and Desalination Companies (Producers)</td>
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<td>GTACSR:</td>
<td>Gap-type Aluminum Conductor Steel Reinforced</td>
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<td>GW:</td>
<td>Giggawatt</td>
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<td>HVAC:</td>
<td>High Voltage Alternating Current</td>
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<td>HVDC:</td>
<td>High Voltage Direct Current</td>
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<tr>
<td>Acronym</td>
<td>Description</td>
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<tr>
<td>HVDC LCC</td>
<td>High Voltage Direct Current Line Commuted Converter</td>
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<td>ICAD</td>
<td>Industrial City of Abu Dhabi</td>
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<td>kV</td>
<td>Kilovolt</td>
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<td>KIZAD</td>
<td>Khalifa Industrial Zone Abu Dhabi</td>
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<td>KSA</td>
<td>Kingdom of Saudi Arabia</td>
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<td>MEAV</td>
<td>Modern Equivalent Asset Value</td>
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<td>MW</td>
<td>Megawatt</td>
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<td>MVA</td>
<td>Megavoltampere</td>
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<td>NPV</td>
<td>Net Present Value</td>
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<td>OPEX</td>
<td>Operational expenditure</td>
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<td>PAS55</td>
<td>55th Publicly Available Specification</td>
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<td>PV</td>
<td>Photovoltaic</td>
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<td>RO</td>
<td>Reverse Osmosis</td>
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<td>RSB</td>
<td>Regulation and Supervision Bureau</td>
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<td>SASN</td>
<td>Sas Al Nakheel</td>
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<td>SEWA</td>
<td>Sharjah Electricity and Water Authority</td>
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<td>STATCOM</td>
<td>Static Synchronous Compensator</td>
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<td>SVC</td>
<td>Static VAr Compensator</td>
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<td>TRANSCO</td>
<td>Abu Dhabi Transmission and Despatch Company</td>
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<td>UPC</td>
<td>Abu Dhabi Urban Planning Council</td>
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<td>USERS</td>
<td>DISCOs, GENCOs, ADNOC, Non-embedded customers, interconnected utilities</td>
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<tr>
<td>UAE</td>
<td>United Arab Emirates</td>
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<td>VAr</td>
<td>Volt Ampere</td>
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<td>VSC</td>
<td>Voltage Sourced Converters</td>
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<td>WLCC</td>
<td>Whole Life Cycle Cost</td>
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<td>XLPE</td>
<td>Cross Linked Polyethylene Insulated</td>
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Substations acronyms are included in the Attachment of 7YPS.

*Planned transfer* is the planned power flows across the identified boundary/lines.

*Transfer capability* is the maximum power flow across the identified transmission boundary without causing any unacceptable conditions as a result of secured events.

*Secured event* is the event that relates to a fault outage of a single transmission circuit under Intact System conditions at time of peak demand; or the fault outage of a single transmission circuit with planned outage of another transmission circuit, a generating unit or reactive element during maintenance period.

*Identified generation capacity* is the total gross electricity generation capacity available from all existing power plants, power plants which are under construction and committed power plants less the off-set capacity available due to life-time capacity retirements.

*Required generation capacity* is the total gross electricity generation capacity required to satisfy the generation security of supply standard that takes into account the generation planning criteria and other factors such as forced outage rate, demand forecast error, spinning reserve.
Executive Summary

E1 Introduction

Condition 15 of the Transmission Licence requires the Abu Dhabi Transmission and Despatch Company (TRANSCO) to prepare a Seven Year Planning Statement (7YPS) annually in a form approved by the Regulation and Supervision Bureau (RSB or Bureau). In relation to the electricity transmission system, the requirement is to contain the following information in each of the seven succeeding financial years:

a) Capacity, forecast power flows and loading on each part of the transmission system, and fault levels for each electricity transmission node.

b) Plans for capital expenditure necessary to ensure the relevant transmission system meets the security and performance standards and future demands.

The 7YPS has been developed in the context of the TRANSCO’s network development strategy for the period to 2030 that sets out a long-term vision for taking the transmission system forward. The network development strategy includes consideration of the trends and drivers which provides a long-term vision for taking the transmission system forward consistent with Government’s 2030 vision. The 7YPS describes more detailed short to medium-term plans for the transmission system and is linked to the needs and investment requirements in the period 2014-2020.

The main purpose of the 7YPS is to enable the Users seeking the use of the transmission system, to identify and evaluate the opportunities available when connecting to and making use of such system. It also gives a forward view on the proposed transmission infrastructure expansion plans to meet the forecast demand growth and planned new generation capacity that will be of benefit to other stakeholders. However, we recommend prospective Users of the system and other stakeholders to contact TRANSCO directly if they want to fully understand the opportunities available to them.

This is the fourth 7YPS which contains the latest updated information and replaces all Statements released earlier. This 7YPS covers the planning period 2014-2020. The 2013 7YPS (2014-2020) is based on the best available updated information from ADWEC and Users; updated project scope and status. The cutoff date for the input data used in compiling this 7YPS is 30 April 2013.
The 7YPS presents a wide range of information relating to the planning and development of 400kV, 220kV and 132kV transmission system within the Emirate of Abu Dhabi and, where appropriate, TRANSCO’s network outside of the authorized area.

**E2 Network Development Strategy**

TRANSCO’s network development strategy is to continue to develop a flexible, reliable, secure, accessible, robust, economical, efficient, environmentally friendly and safe transmission system that meets the needs of its customers in a manner consistent with its License obligations.

This is achieved through:

- Implementing a structured asset management process that takes cognizance of best practice asset management principles for the development and stewardship of the transmission network and requirements for capital assurance governance.

- Continuing with the development of 400kV main bulk transmission system. Given the uncertainty in the demand and generation background, the possible need to migrate to 765kV or HVDC as the main overlay transmission system option across the West-East corridor is to be kept under review, particularly if significant level of additional generation capacity beyond the committed Shuweihat S3, Mirfa and Barakah nuclear plant are contracted in the Western region, and that there is increased requirement to provide power to Northern Emirates.

- Replacement of assets whose condition is approaching the end of useful life in a manner that avoids adversely affecting network security and exploits any synergies with capacity related asset creation.

- Incremental deployment and integration of new technologies and best available practice.

It is intended that the development of the transmission network will be done in such a manner to:

- Have minimum negative side-effects on the environment and society.

- Accommodate large central and decentralized generation and storage.

- Enable active participation of consumers including demand response.

- Provide high quality of supply and reliable power that satisfy the expectation and needs of the customer and comply with international best practice and standards.
- Optimize asset utilization and operate efficiently through integrated outage management, risk assessment, improved process, resource management and use of technology and decision support tools.

- Anticipate and respond to system disturbances.

- Operate resiliently under unforeseen events.

- Enable participation in the Gulf Cooperation Council Interconnector Authority (GCCIA) and the benefits and obligations thereof.

### E3 Demand-Generation Background

Global peak electricity demand (including supplies to Abu Dhabi Emirate and Northern Emirates) is forecast to increase to between 17.6GW-21.7GW by 2020 according to ADWEC’s 2013 forecast update. This represents an average growth rate of about 6.5% (low forecast scenario) and 9.4% (high forecast scenario) per annum respectively for the period 2012-2020. An intermediate demand level based on “ADWEC’s project based demand forecast scenario” is about 20.4GW by 2020. This together with the generation background described below is used for establishing “best-view” transfers for the development of the transmission network.

The principle demand drivers are industrial, residential and commercial development expansions; and export supplies to Northern Emirates. The proportion of industrial demand relative to peak demand is forecast to increase as the U.A.E diversifies its economy and there is the potential for variations of the locational development of demand.

Figure E-1 shows the region-wise demand forecast based on “ADWEC’s project based demand forecast scenario”.
To meet these demands, the existing power generation plants contribute about 13.8GW (in 2012) of capacity. New committed generation projects identified to date which are expected to be integrated into the main bulk transmission grid in the period 2013-2020 are:

- Shams-1 concentrated solar power (CSP) plant with a maximum installed capacity of 100MW at a facility located south of Madinat Zayed in the Western region. The plant was synchronized to the grid in end 2012 and achieved commercial operation in February 2013.

- Shuweihat S3 (1.65GW) combined cycle fossil fuel plant located adjacent to the existing Shuweihat S1/S2 site in the Western region.

The first phase of Shuweihat S3 is planned to be operational (about 0.5GW capacity) in 2013 and fully operational (about 1.65GW) in 2014.
- New Mirfa (1.6GW) combined cycle fossil fuel plant to be located adjacent to the existing Mirfa site in the Western region.

  The first phase of New Mirfa plant is planned to be operational (about 0.85GW capacity) in 2015 and fully operational (about 1.6GW) in 2016.

- The Barakah site in the Western region has been identified to promote nuclear generation of total capacity 5.56GW by 2020. Generator units of 1.39GWe each are expected to be integrated to the transmission system through 2017-2020.

- Nour-1 photovoltaic solar power plant (PV) with a maximum installed capacity of 100MW at a facility located near Sanaiya in Al-Ain region. The plant is likely to be integrated after Summer 2015.

- Taqa’s waste to energy plants expected to be integrated to the transmission system in the period 2017-2020 with total installed capacity of about 200MW in ICAD area.

The total additional generation capacity due to above new committed generation projects contributes about 8.9GW by 2020.

Some of the existing generation plants are expected to retire in the period 2013-2020. These are located at Mirfa (186MW) in the Western region and Umn Al Nar (778MW) in the Eastern region. The available capacity off-set due to the closure of above existing generation will be about 1.0GW by 2020.

Figure E-2 shows the expected demand-supply gap for the ADWEC’s high, project based and low demand forecast scenarios. Certain of the demand forecasts indicate a need for additional generation capacity from 2015 to satisfy the emerging gap between the demand and generation outlook, and ensure sufficient generation reserve margin is available, particularly to meet the project based and high demand forecast scenarios.
A degree of uncertainty will continue in the realization of the volume, location and timing of new additional generation capacity in the period 2015-2020. The uncertainty levels in the demand forecast increases (as evident from the spread between the low and high demand forecast scenario) particularly from 2015. It should be recognized that the actual commitment to the new conventional generation capacity takes place on a shorter time scale (about 4 years) to close any emerging gap between the supply and demand. Options are maintained such that the associated transmission reinforcement works are established in a phased manner to ensure minimum cost and provide a least regret solution.
E4  Regional and International Grid Interconnections

To support the Government of Abu Dhabi initiative to bolster the domestic energy security, TRANSCO’s transmission system is increasingly integrated with Emirates National Grid (ENG) and Gulf Cooperation Council (GCC). Figure E-3 shows the simplified high-level grid interconnection arrangement (existing and current plans) with ENG/GCC grids.

Figure E-3  Simplified high-level grid interconnection arrangement with ENG/GCC grids (As on April 2013).

Potential maximum transfers between TRANSCO and regional/international grids under “Secured Event” conditions could include:

- ±1GW through the current existing Northern GCC 400kV interconnector between UAE-KSA.
±170MW through the current existing Southern GCC 220kV interconnector between UAE-Oman. This is to be increased to ±1GW following the commissioning of the planned 400kV UAE-Oman interconnection.

±2GW through the current existing ENG interconnections to Northern Emirates (i.e. through 400kV interconnector between Taweela-Warsan, and 400kV interconnector between Fujairah Qidfa-Sweihan) with possible range of exports.

These interconnections not only enhance the security of supply but also reduce the spinning reserve requirements and facilitate power exchange among member utilities and states. It also reduces power plant procurement cost through achieving higher efficiency and plant load factors apart from reducing the global operating costs of the integrated electricity market.

**E5 Planned Transfers**

The requirements for the transmission system development and its associated investments are primarily driven by the demand and generation backgrounds identified above and the resulting power transfers on the transmission system. There are uncertainties associated with the demand and generation backgrounds as with any forecasts and plans. These uncertainties will affect future planned power transfers on the transmission system and hence the way the transmission system develops. Using scenarios analysis, the planned power transfers on the transmission system are established for the most probable demand-generation scenarios envisaged in the period 2012-2020. Envelopes of possible transfers are established and the most likely (best-view) planned power transfers are identified across each of the transmission corridors that is used as a basis to inform how best to develop the transmission system. In establishing the envelope of possible transfers and planned transfers, consideration has been given to ADWEC’s three demand forecast scenarios (low, project-based and high demand forecast scenario) and the required generation (in terms of location and volume) to meet the demand.

Figure E-4 shows the envelope of possible transfers and the best-view planned transfers across the five identified boundary corridors for the peak demand-generation background in the period 2012-2020.
**Figure E-4** Envelope of possible transfers and best-view planned transfers in the period 2012-2020.

### E6 Evolution of Transmission Network

Major committed 400kV transmission system expansion projects are expected to be completed in the period 2013-2016 to meet the system needs and to accommodate committed new generation projects.

Figure E-5 shows the existing main bulk 400kV transmission network (as on 2012) spread across the five regions (Western region, Eastern region, Abu Dhabi islands’, Al-Ain region and Northern Emirates).
A network development plan has been produced based on the best view planned transfers across the identified boundaries up to 2020.

To evacuate power from the Shuweihat S3 generation (about 1.65GW), a new 400kV grid station (S3PS) and related 400kV overhead line transmission facilities are planned to be completed in 2013 to evacuate power from the Shuweihat S3 generation.

New 400kV grid stations and related 400kV overhead line works are expected to be integrated to the transmission network in the period 2013-2014 to meet the respective regions’ demand requirements. These are 400/220kV grid stations in Ruwais (RWSG) and Baab (BABG) in Western region; 400/132kV grid stations in Bahia (BHYG), Mahawi (MHWG) and Shamkha (SMKG) in Eastern region; and 400/132kV grid station in Ajman (WSTG) in Northern Emirates.
Restrictions are placed by the Government and the developers for building new 400kV overhead lines and/or replacing existing overhead lines within Abu Dhabi island, along Abu Dhabi island-Sadiyat-Bahia (ADST-SDYT-BHYG) and Sas Al Nakheel-Mahawi-Mussafah (SASN-MHWG-MOSG) corridors in the Eastern region. Hence, TRANSCO has been required to increasingly underground transmission infrastructure serving these areas. The 400kV underground cables’ projects along the ADST-SDYT-BHYG corridor and SASN-MHWG-MOSG corridors have been staged through 2013-2016. This is to ensure security of supplies to Abu Dhabi island will be maintained, and that the performance of 400kV XLPE cables will be demonstrated satisfactorily and thereby enable the policy decision to dismantle the 400kV overhead lines along the said corridors thereafter. The 400kV overhead line reconfiguration works between BHYG and TANE/TWPS are staged through 2015-2016 to enable dismantling the existing 400kV overhead line circuits along ADST-SDYT-BHYG corridor. A new 400/220kV grid station in Wasit (Oman) and related 400kV overhead lines are planned in 2015 to facilitate increased power exchange between the U.A.E and Oman.

New 400kV grid station (MRPS) and related 400kV overhead line transmission facilities are planned in 2015 to evacuate power from the new Mirfa generation plant (1.6GW). New 400kV grid station (Barakah switchyard-1&2) and related 400kV overhead line transmission facilities are planned in the period 2015-2017 to facilitate the start-up operations of Barakah nuclear power plant and enable the phased integration of the nuclear power generation at Barakah from 2017.

Major 400kV transmission reinforcement’s works are required in Western region and across West-East region corridor to evacuate power from the Barakah nuclear power plants in the period 2017-2020. There is a need to establish two new intermediate 400kV grid stations in the Eastern region namely Hameem (HMEM) and Al Faya (FAYA) to facilitate large volumes of power transfers across West-East corridor; strengthen the overall 400kV transmission system and improve the dynamic performance of the transmission network. This is achieved through 400kV overhead line reinforcement works between Barakah (BNPP)-Madinat Zayed (WMZD)/Baab (BABG) grid stations; Ruwais (RWSG)-Baab (BABG) grid stations in the Western region. The 400kV West-East corridor reinforcements ensure an integrated approach for evacuating power from Shuweihat S3, Mirfa and Barakah power plants while meeting the demands in the Western region and further oilfields.

Figure E-6 shows the main bulk 400kV transmission to meet ADWEC’s project based forecast scenario in 2020.
**Figure E-6** Main bulk 400kV transmission topology in 2020.

### E7 Asset Replacement Works

In addition to enhancing network capacity there is a need to replace certain assets.

The requirement to replace aging assets affecting network security include:

- Transformers replacement works (132/11kV transformers at JZRH/SLTC substation; and 220/33kV transformer at Al-Ain Power Station).
- Indoor transformer cooling system upgrade (132/11kV transformers at GLFA, CPGR, PORT, MKT1, FLAH and CLNS substations in Abu Dhabi Island).
- Protection (busbar, line and transformer protection upgrade at various sites).
- Batteries and chargers at various sites (e.g. DHMG-220, AAPS-220, AHYG-220 etc.).
LV switchgear replacement at Jabel Hafeet 33kV substation.
- Underground cables (replacement of oil filled to XLPE between ADST-FDRS)
- Overhead lines (220kV Ruwais-Sila line OPGW rehabilitation works).
- Others (SCMS, FMS upgrade).

The requirement to replace/decommission aging assets affecting network security and exploit the synergies with capacity related asset creation include:
- 220/33kV grid stations at Mirfa, Zakher and Al Wagon.
- 132kV cable circuit between Mushrif-Mussafah/Mussafah-Umn Al Nar.

In addition to the above, there is also a need to procure new 400/220kV 500MVA transformer at Mussafah 400/220kV grid station (MOSG) to replace the failed transformer.

The economic treatment of the assets that are expected to be decommissioned will be treated in accordance with TRANSCO’s asset policy and shall be written off from the regulatory asset base when disposed of after due approval from RSB.

**E8 Network Operation and Despatch**

The power and water demand is met by despatching production facilities in accordance with a unit commitment model. Given the power and water system characteristics, together with the changing characteristics particularly associated with production facilities used to meet this demand, there is a need to ensure both power and water requirements will be securely met in an efficient manner. Figure E-7 shows the current generation mix making up the annual load duration curve. For the 2012, the average winter/summer demand ratio is assumed 32% and the average load factor of the system demand about 65%.

In the period to 2020 the peak demand on the transmission network will increase from about 10.6GW (in 2012) to between 17.6GW-21.7GW in 2020. This will be accompanied by a corresponding increase in the generation portfolio. The evolution of the transmission network, expected changes in the generation portfolio and the export requirements will significantly influence the network operation and despatch in the period to 2020.
The generation mix along with the expected increase in the industrial demand and export requirements will alter the average winter/summer demand ratio to about 35% and the average load factor of the system demand about 70%. The impact of these changes and the need to take into account the inter-relationship between power and water production has been the subject of a detailed economic despatch study reported in 2013. Given the uncertainty associated with the future evolution of power and water systems, three contrasted scenarios have been built by combining the system parameters to embrace the envelope of all possible operational situations.

On the basis of the results obtained by analyzing the power and water despatch in each of the three scenarios and by carrying out sensitivity analyses on influent parameters, the study results are broadly consistent with the above-mentioned observations. The study recommends the following:

- Revising the minimum deployment time of the secondary reserve specified in the Electricity Transmission Code.
- Implementing additional capacity in CCGT and GT on the system in order to be able to meet the summer peak load situations from 2017 to 2020.

Figure E-7  Generation mix making up the annual load duration curve (in 2012).
• Introducing a degree of flexibility into the despatch of certain power plant units including the nuclear plant.
• Introduction of greater penetrations of RO and/or exports particularly to meet the off-peak power-water demand combined.
• Managing maintenance and refueling of the nuclear plant to times of minimum demand.

The main changes to the transmission network operation that TRANSCO will experience as a result of this include fault level and reactive power management, and increased awareness of the effects of the regional and international interconnections on the system and Users.

E9 Capital Programme and Delivery

The transmission system development requirements and associated investments are largely driven by the demand-generation backgrounds and the resulting power transfers on the transmission system. As there will continue to be a degree of uncertainty in the realization of the volume, location and timing of demand-generation backgrounds in any given area, particularly in the period 2015-2020, the potential transmission reinforcement plans shall be established in a phased manner and that the options are maintained at minimum cost to provide a least regret solution.

In view of the greater uncertainty in the development requirements; some project proposals and schemes are evaluated with intent of optimizing the assets’ utilization taking into account the potential risks. The risks could be if the demand does not materialize as expected or if the demand comes early, project delays and its impact on network performance and security of supply could result. Risk mitigation measures through various scenario/optioneering approaches are built into the planning proposals by engaging relevant Stakeholders and Users in order to achieve a consensus on the optimum balance of overall benefits/savings and risk trade-off. Hence, there is a likelihood of potential deviations of some project proposals and schemes included in this 7YPS.

Chapter-10 provides a high-level summary of capital and replacement projects; and a brief description of their needs/drivers. These include the major on-going, currently under tendering stage and new planned power projects to meet the future demands and security standard for the period 2013-2020. Whilst some of these identified seven year capital projects shall be initiated depending on their priority level and subject to the receipt of approvals from relevant authorities,
for others it is proposed to continue monitor the developments of the market and update the plans accordingly.

The detailed capital delivery and capital forecast for the on-going and planned power projects to meet the future demands and performance standards including the replacement projects are reported separately and released only to the RSB. In that report TRANSCO have taken the opportunity to maintain the capital delivery transparency by presenting for regulatory review a year-on-year view of planned and delivered capital performance.
1.0 Introduction

Condition 15 of the Transmission Licence requires Abu Dhabi Transmission and Despatch Company (TRANSCO) to prepare a Seven Year Planning Statement (7YPS) annually in a form approved by the Regulation and Supervision Bureau (RSB or Bureau). In relation to the electricity transmission system, the requirement is to contain the following information in each of the seven succeeding financial years:

a) Capacity, forecast power flows and loading on each part of the transmission system, and fault levels for each electricity transmission node.

b) Plans for capital expenditure necessary to ensure the relevant transmission system meets the security and performance standards and future demands.

The Sector Law requires the Abu Dhabi Water and Electricity Company (ADWEC) to prepare a demand forecast and accordingly secure the future generation capacity to meet the short and long-term requirements of the Sector.

The 7YPS has been developed in the context of the TRANSCO’s network development strategy for the period to 2030 that sets out a long-term vision for taking the transmission system forward. The network development strategy includes consideration of the trends and drivers which provides a long-term vision for taking the transmission system forward consistent with Government’s 2030 vision. The 7YPS describes more detailed short to medium-term plans for the transmission system and is linked to the needs and investment requirements for the period 2014-2020.

The main purpose of the 7YPS is to enable the Users seeking the use of the transmission system, to identify and evaluate the opportunities available when connecting to and making use of such system. It also gives a forward view on the proposed transmission infrastructure expansion plans to meet the forecast demand growth and planned new generation capacity that will be of benefit to other stakeholders. However, we recommend prospective Users of the system and other stakeholders to contact TRANSCO directly if they want to fully understand the opportunities available to them.

This is the fourth 7YPS which contains the latest updated information and replaces all Statements released earlier. This 7YPS covers the planning period 2014-2020. 2013 7YPS (2014-2020) is
based on the best available updated information from ADWEC and Users; updated project scope and status. The cutoff date for input data used in compiling this 7YPS is 30 April 2013.

The 7YPS presents a wide range of information relating to the planning and development of 400kV, 220kV and 132kV transmission system within the Emirate of Abu Dhabi and, where appropriate, TRANSCO network outside of the authorized area.

The 7YPS update contains the following chapters:

a) Network development strategy

The network development strategy for the period to 2030 sets a long-term vision for taking the transmission system forward. It places much greater emphasis on the trends and drivers which provides a long-term vision for taking the transmission system forward consistent with Government’s 2030 vision.

b) Demand-generation background

The requirement for the transmission system development and its associated investments is primarily driven by the demand and generation backgrounds. The demand-generation trends and the choice of the key assumptions are summarized. Based on the electrical connectivity and geographical dispersion, the capacity and demand forecast at each part of the transmission network are presented.

c) Planned transfers

In this chapter the envelope of possible transfers and the best-view planned transfers based on the demand-generation backgrounds are summarized. These planned transfers determine the requirements for the transmission system developments and its associated investment plans.

d) Evolution of transmission network

The evolution of 400kV, 220kV and 132kV transmission system within the Emirate of Abu Dhabi and, where appropriate, the TRANSCO network outside of the authorized area up to 2020 are presented. The evolution of the transmission network is based on the best-view planned transfers.
e) Asset replacement works

The requirements to replace aging assets affecting network security is included. While identifying these requirements considerations have been given to exploit the synergies with capacity related asset creation.

f) Network operation and despatch

The evolution of the transmission network to meet the demand-generation background and the expected changes in the generation portfolio and export requirements will significantly influence the network operation and despatch in the period to 2020. In this chapter, the changes to the generation portfolio and its impact on the despatch; and the potential changes to the transmission system operational requirements is briefly described.

g) Transmission system capabilities and constraints

This chapter describes the main bulk transmission system capabilities which give an indication of the extent to which the system can accommodate the circumstances outside the chosen likely best view planned transfers. It also provides an insight into some of the major constraints in the transmission network and at the Users interfaces, so that the Users can evaluate its impact on their network.

h) Opportunities

The potential generation and transmission connection opportunities are presented. The ability to connect new connections that requires the least electricity transmission reinforcement works is the main consideration given for the purpose of identifying the opportunities.

i) Capital programme and delivery

The chapter summarizes the on-going projects and planned proposals to meet the future demands and comply with security standard. It also includes a brief description of the needs/drivers for the identified projects/proposals among other information.
2.0 Network Development Strategy

TRANSCO has over the years developed a modern and reliable transmission system making use of best available technology to provide a high degree of energy security. TRANSCO aims to continue to develop, operate and maintain a safe, flexible, accessible, robust, reliable, and efficient transmission system that meets the needs of its customers in a manner consistent with its License obligations. This is to be achieved through a structured asset management process that takes cognizance of best practice asset management principles for the development and stewardship of the transmission network and requirements for capital assurance governance.

TRANSCO’s power network development strategy for the period to 2030 provides a long-term vision for taking the transmission system forward and provides direction to the 7YPS and its associated investment plans. The strategy places much greater emphasis on the trends and drivers which provides a long-term vision for taking the transmission system forward consistent with Government’s 2030 vision. The 7YPS describes more detailed short to medium-term plans for the transmission system and is linked to the needs/investment requirements in the period 2014-2020.

2.1 Objectives

The long-term network development strategy for the period to 2030 (20 years) aims to provide an optimized vision for taking the transmission system forward that takes into account the government objectives and policies, particularly those associated with the United Arab Emirates (UAE) future social, environmental and economic requirements. The Abu Dhabi Economic Vision 2030 envisaged a real Gross Domestic Product (GDP) average target growth rate of about 6.4% per annum for the period 2010-2030. The Abu Dhabi Urban Planning Council (UPC) developed the “Plan Abu Dhabi 2030-Urban Structure Framework Plan” calibrated to achieve the target population growth rate at about 4.8% for the period 2010-2030. The electricity transmission infrastructure continues to be developed consistent with the above set policy targets among others to support the future economic development of the Abu Dhabi Emirate.

The adopted transmission network development strategy along with the application of relevant novel technologies will ensure achieving the following objectives:

- Fulfill the expectations of society.
- Facilitate sufficient energy resources to meet the current and future demand within the Emirate and to allow Abu Dhabi’s continued contribution to the energy requirements of the UAE.
Secure the domestic energy supplies to minimize vulnerabilities associated with unplanned domestic system disruptions, import disruptions, and other crises.

Provide accessibility in granting connection access to all network users and benefits to customers at the earliest opportunity, particularly for renewable power sources and high efficiency local generation with zero or low carbon emissions.

Reliable in assuring and improving the security of supply standards, transmission code and quality of supply to accommodate the customer requirements having different technical characteristics.

Economical by providing the best value through innovation and efficient energy management while supporting economic competitiveness and diversification by facilitating supply of reasonably priced energy and tariff regulations.

Facilitate implementation of Abu Dhabi Water and Electricity Authority (ADWEA) Demand Side Management (DSM) program. This program presents policies, means and techniques to achieve a scale of possible reduction of electricity demand keeping high standards of living and customer satisfaction.

Flexible in fulfilling the customers’ needs and broader spectrum of stakeholders whilst responding to the changes and challenges ahead.

Environmentally friendly and safe. Protect the environment by facilitating renewable and alternative energy technologies, mitigating the negative effects of traditional energy production, and achieving increased energy efficiency among consumers within the Emirate. The target renewable energy share is set at 7% by 2020.

Reduce uncertainty and risk to investment decisions.

Ensure end of life renewal of assets for sustainable operation of the grid.

Enable participation in the Gulf Cooperation Council Interconnector Authority (GCCIA) and the benefits and obligations thereof.

2.2 Principle Long-Term Drivers and Trends

The principle drivers and trends which will shape the long-term development of the power transmission system and the investment plans and thereby achieve the above objectives with improved transmission performance are:
a) Electricity demand

Electricity is the critical enabler for the economic and social development of the UAE. Peak electricity demand (including supplies to Abu Dhabi Emirate and Northern Emirates) is forecast to increase from 10.6GW (in 2012) to about 32.8GW by 2030 according to ADWEC’s 2013 forecast update. Figure 2-1 shows the historical and long-term electricity demand forecast up to 2030.

ADWEC 2013 forecast update produced other possible demand forecast scenarios up to 2020 to capture the uncertainty in the forecast variables and economic environment. The long-term network development strategy and 7YPS is based on “ADWEC project based demand forecast scenario” which is considered to be their best-view demand forecast trajectory.

The principle demand drivers are industrial expansion; new mega residential and commercial developments; and export supplies to Northern Emirates. The proportion of industrial demand relative to peak demand is forecast to increase as the Abu Dhabi diversifies its economy.

![Figure 2-1  Historical and long-term demand forecast.](source)

b) Regional and international grid interconnections

To support the Government of Abu Dhabi initiative to bolster the domestic energy security, TRANSCO’s transmission system will increasingly integrate with Emirates National Grid (ENG) and Gulf Cooperation Council (GCC) transmission system. Figure 2-2 shows the simplified high-level grid interconnection arrangement (existing and current plans) with ENG/GCC grids. Potential maximum transfers between TRANSCO and regional/international grids under “Secured Event” conditions could include:

- ±1GW through the existing Northern GCC 400kV interconnector between UAE-KSA.

- ±170MW through the existing Southern GCC 220kV interconnector between UAE-Oman. This is to be increased to ±1GW following the commissioning of the planned 400kV UAE-Oman interconnection.

- ±2GW through the existing ENG interconnections to Northern Emirates (i.e. through 400kV interconnector between Taweela-Warsan, and 400kV interconnector between Fujairah Qidfa-Sweihan) with possible range of exports.

*Figure 2-2  Simplified high-level grid interconnection arrangement with ENG/GCC grids (As on April 2013).*
These interconnections will not only enhance the security of supply but also reduce the spinning reserve requirements and facilitate power exchange among member utilities. It will also reduce plant procurement cost through achieving higher efficiency and plant load factors apart from reducing the global operating costs of the integrated electricity market.

c) Generation capacity trend

The production of electricity and the desalinated water are dominated by large-scale operators using conventional technologies such as gas turbines and thermal desalination. Figure 2-3 shows the historical and future demand-generation trend upto 2030. A degree of uncertainty will continue in the realization of the volume, location and timing of new generation plants beyond 2015. The actual commitment and completion of new generation plants and related transmission reinforcement works take place on a shorter time scale (about 4 years) to close the emerging gap in the capacity deficit and based on the year-on-year updated short-term best-view demand forecast trajectory.

Figure 2-3  Demand-generation trend in the period 2000-2030.
To support the Government objectives of achieving energy sufficiency, energy security, economic diversification, and reduce the negative environmental impact of fossil fuel generation within the Emirate, connection of essential new generation such as nuclear and renewable are planned which have different technical characteristics to the current generation portfolio.

The target of the Government’s objective is not to displace the existing or future fossil fuel plants, but to supplement them with a diverse mix of technologies and fuel sources that make the electricity sector less vulnerable to supply interruptions, market swings, and other crises while creating the commercial impetus for the emergence of new technology-based clusters within the local economy. This has required consideration of:

- Committed new generation expansion projects.
- ADWEC’s view on the future potential capacity and their potential site locations as outlined in their 2012 Statement of Future Capacity Requirements.
- Closures of some existing generating plants due to various legislation and age profile.
- Policy drivers on renewable energy targets (objective is to drive towards establishing a 7% share of renewable energy by 2020) and demand side management initiatives.
- Adequate generation resources to maintain sufficient reserve margin.

d) Technological developments

Technologies such as higher rating overhead line conductors for increased power transfers, increased use of XLPE cables in areas of high amenity value at voltages up to 400kV, adoption of 765kV or HVDC transmission voltage levels and the application of static and dynamic reactive power compensators, while not necessarily new technologies require consideration in the transmission system development.

Elsewhere in the world, considerable attention is being paid to so-called “smart grids” to aid in integrating renewable, changing customer requirements and renewing life expired assets. Whilst not necessarily directly applicable to the UAE, some potential technologies such as the application of smart meters in the selective areas of the distribution network within the Abu Dhabi Emirate have been considered.
e) **System operation and despatch**

The generation mix and demand side technologies along with the changes expected in the load duration curve due to high industrial demand growth and export requirements will required to be considered. These are likely to alter the summer-winter peak demand ratio to about 35% and the average load factor of the system demand about 70% by 2020. The impact of these changes, particularly the need to take into account the inter-relationship between power and water production, could lead to the need to introduce other methods of water production such as reverse osmosis (RO) and opportunities for energy storage. As a result of the intermittency and non-despatchable plant characteristics of wind and solar generation, and plans to despatch nuclear plant as base load and/or introduce degree of flexibility in their operation needs to be considered.

f) **Asset replacement**

While the transmission network is comparatively young, there will be requirements for assets approaching the end of their useful lives to be managed and replaced at an appropriate time. Asset Management process improvements will be required to capture the “knowledge to build only what is needed”. Integrated outage management and risk assessment need to be considered for improved operational efficiency. Maintenance practices and resource management processes shall be programmed and managed innovatively to better position the transmission network for next 20 years of operation and maintenance; particularly noting that the system demand develops from about 10.6GW (in 2012) to about 32.8GW (in 2030). Certain of these can be managed by technologies mentioned above. All these improvements will enable reduction in the utility costs (CAPEX and OPEX) resulting in optimized asset utilization and efficient operation.

g) **Standards and procedures**

The evolution of bulk transmission network over the period to 2030 requires review of standards and procedures related to the network planning, operation and despatch that needs to address:

- System complexity as the network develops to meet the demand requirements of 2030.
- Operational connection topology to manage fault levels within acceptable limits.
- Levels of security (infeed risk), power factor, reactive power management, stability including fault ride through and frequency response, and spinning reserve issues.
- Power quality requirements of customers and sensitive loads.
2.3 Approach to Developing the Main Bulk Transmission System

The requirements for the transmission system development and its associated investments are primarily driven by the demand and generation backgrounds and the resulting power transfers on the transmission system. There are uncertainties associated with the demand and generation backgrounds as with any forecasts and plans. These uncertainties will affect future planned power transfers on the transmission system and hence the way the transmission system develops.

To manage the uncertainties, the approach adopted in this strategy is based on the “scenario analysis” taking into account the sensitivities, constraints and risks through considering:

- Different demand forecast scenarios.
- Considering different locational development of demand including different levels of transfers to the Northern Emirates.
- Different locational development of generation to meet the demand scenario.

Using the scenarios developed, the planned power transfers on the transmission system are established for various demand-generation scenarios. Given the differences in scenarios, envelopes of possible transfers are established. The scenario analysis establishes the most likely (best-view) planned power transfers across each of the identified transmission corridors that is used as a basis to inform how best to develop the transmission system. Figure 2-4 shows a representative example of how the envelope of power transfers and the most likely (best view) planned transfers is established across the West (Gharbia)-East boundary corridor.
Figure 2-4 Representative example of most likely boundary transfers across West-East corridor.

Figure 2-5 shows the envelope of possible transfers and the best-view planned transfers across the five identified boundary corridors for the peak demand-generation background during the period 2010-2030. It also shows the transfer capability (represented in blue text) across the identified boundary corridors for the peak demand-generation background in 2010.
Bulk transmission system options centred on 400kV, 765kV and HVDC technologies have been explored to meet the system needs for the range of planned transfer requirements. Analysis was performed for the transmission system options for various demand generation backgrounds in order to identify the most efficient long-term transmission system option.

400kV is chosen as the most likely transmission system option to ensure that the investments are economical and efficient and that those Users connecting to the system can reasonably identify and evaluate opportunities. As there will continue to be a degree of uncertainty in the realization of the volume, location and timing of demand and generation backgrounds in any given area, it is

Figure 2-5  Envelope of possible transfers and best-view planned transfers by 2030.
proposed to continue to monitor the developments of the market and update the scenarios accordingly. Hence, the potential transmission reinforcement plans shall be established in a phased manner and that the options are maintained at minimum cost to provide a least regret solution.

It should be noted that the 400kV transmission reinforcements associated with the Barakah nuclear units are able to exploit the synergies with the committed transmission network associated with Shuweihat S3 and Mirfa generation integration. Migration to 765kV AC or HVDC as the main overlay transmission system option over the existing 400kV network across the West-East corridor is convincing only if significant future generation is introduced in the Western region and that the Abu Dhabi has increased obligations to meet the demand requirements in Northern Emirates to achieve transmission distance of about 400km or more. In developing the transmission system, considerations have also been given to the increasing requirements for renewal of existing assets in the period to 2030.

2.4 Summary

TRANSCO’s network development strategy is to continue to develop a flexible, reliable, secure, accessible, robust, economical, efficient, environmentally friendly and safe transmission system that meets the needs of its customers in a manner consistent with its Licence obligations.

This is achieved through:

- Implementing a structured asset management process that takes cognizance of best practice asset management principles for the development and stewardship of the transmission network and requirements for capital assurance governance.

- Continuing with the development of 400kV main bulk transmission system. Given the uncertainty in the demand and generation background, the possible need to migrate to 765kV or HVDC as the main overlay transmission system option across the West-East corridor is to be kept under review, particularly if significant levels of additional generation capacity are contracted in the Western region, and that there is increased requirement to provide power to Northern Emirates.

- Replacement of assets whose condition is approaching end of useful life in a manner that avoids adversely affecting network security and exploits any synergies with capacity related asset creation.

- Incremental deployment and integration of new technologies and best available practice.
It is intended that the development of the transmission network will be done in such a manner to:

- Have minimum negative side-effects on the environment and society.
- Accommodate large central and decentralized generation.
- Enable active participation of consumers including demand response.
- Provide high quality of supply and reliable power that satisfy the expectation and needs of the customer and comply with international best practice and standards.
- Optimize asset utilization and operate efficiently through integrated outage management, risk assessment, improved process, resource management and use of technology and decision support tools.
- Anticipate and respond to system disturbances.
- Operate resiliently under unforeseen events.
- Enable participation in the Gulf Cooperation Council Interconnector Authority (GCCIA) and the benefits and obligations thereof.
3.0 Demand-Generation Background

The Sector Law requires ADWEC to prepare a demand forecast and accordingly secure the future generation capacity to meet the short and long-term requirements of the Sector. The requirement for the transmission system development and its associated investments is primarily driven by the demand and generation backgrounds. In this chapter, the demand-generation trends and the choice of the key assumptions are summarized. Based on the electrical connectivity and geographical dispersion, the capacity and demand forecast at each part of the transmission network are highlighted.

3.1 Demand Background

In 2012 the total global system peak demand recorded was about 10.6GW, which included supplies to the Abu Dhabi Emirate (AD) and the Northern Emirates (NE). The recorded peak demand of Abu Dhabi Emirate (AD) was about 8.5GW.

Historically, the electricity global peak demand (AD+NE) has sustained an average growth of 10.2% for the period 2000-2012. The average peak demand growth for the Abu Dhabi Emirate was 8.2% for the same period. In 2006 TRANSCO established interconnection with Emirates National Grid (ENG) with the intention of supporting the member utilities of the U.A.E.

ADWEC’s 2013 forecast update produced three demand forecast scenarios (low, project based and high forecast scenarios) up to 2020 to capture the uncertainty and market volatility in the economic environment. This 7YPS is based on “ADWEC project based demand forecast scenario” which is considered to be their best-view demand forecast.

The ADWEC project based forecast scenario is intended to cater for the generation plant capacity building and for guiding the expansion of the power transmission system. This is with maintaining the flexibility to accommodate among the other scenarios as necessary (as per the ensuing changes in the economic environment).

Figure 3-1 shows ADWEC demand forecast up to 2020.
Global peak electricity demand (include supplies to Abu Dhabi Emirate and Northern Emirates) is forecast to increase between 17.6GW-21.7GW by 2020 according to ADWEC’s 2013 forecast update. This represents an average growth rate of about 6.5% (low forecast scenario) and 9.4% (high forecast scenario) per annum respectively for the period 2012-2020.

For the project based forecast scenario, the global peak electricity demand is forecast to increase from about 10.6GW (in 2012) to about 20.4GW by 2020. This represents an average growth rate of about 8.5% per annum for the period 2012-2020.

In developing the demand forecast, the updated Users demand forecast data, demand notifications from mega residential/ commercial project developers, bulk industrial consumers demand data, population growth, economic activity and export requirements are captured based on ADWEC’s analysis.

The principle demand drivers are industrial, residential and commercial development expansions; and export supplies to the Northern Emirates. The proportion of industrial demand relative to peak demand is forecast to increase as the Abu Dhabi diversifies its economy and there is the potential for variations of the locational development of demand within the outlier demand scenario.

Figure 3-1 ADWEC demand forecast upto 2020.
Figure 3-2 shows the region-wise forecast for the project based demand forecast scenario for the period 2012-2020.

The Attachment-A contains the full details of the region-wise forecast (project based forecast scenario) showing the existing and future capacity; and peak demand forecast at the exit demand supply points for the period 2013-2020.

Further details relating to the demand forecast are included in the Attachment-A as follows:

Table A2 includes a summary of the region-wise peak demand forecast for the project based forecast scenario.

Table A3 includes the capacity, power factor and peak demand forecast at the exit demand supply points in Abu Dhabi Emirate. It also includes the expected utilization (w.r.t N-1) at the exit demand supply points in 2013 and 2020.

Table A4 includes the capacity and assumed peak demand forecast at the 400kV grid supply points corresponding to the export commitments to Northern Emirates.
a) Residential/Commercial developments in Abu Dhabi islands’ and Eastern region

New residential and commercial developments in Abu Dhabi islands’ are mainly concentrated in Abu Dhabi island, Reem, Suwa and Sadiyat islands. The cumulative demand requirement of Abu Dhabi islands’ is expected to reach about 3.0GW, which represents about 15% of the global electricity demand in 2020.

The residential and commercial developments in Eastern region are concentrated in Khalifa, Al Falah, Yas island, Raha Beach, Bahia, Mahawi, and Shamkha regions. The cumulative demand requirement of the Eastern region (only residential and commercial category) is expected to reach about 3.5GW, which represents about 17% of the global electricity demand in 2020.

b) Industrial developments

Development of light and heavy industrial zones (excluding oil and gas developments) is another important driver contributing to the significant demand growth. The major developments include Emirates Steel-Phase 3 Extension and Industrial City of Abu Dhabi (ICAD) in Eastern region; Khalifa Port and Industrial Zone in Taweela area; ChemaWyeet and other light industries in the Western region. The cumulative demand requirements of these light and heavy industrial zones is expected to reach about 1.8GW, which represents about 9% of the global electricity demand in 2020.

c) Oil and gas developments

Expansion of the oil and gas sector and their increasing reliance upon the utility grid for its electricity requirements has directly attributed to the significant demand growth in the Western region. The growth of the oil and gas sector has a significant long-term macro-economic impact on the economy of Abu Dhabi Emirate. The supply requirements of all Abu Dhabi National Oil Company (ADNOC) group projects located in the Western region (mainly in Ruwais, Baab/Habshan, Buhasa, Asab, Shah, Quashwira areas) is expected to reach about 2.5GW, which represents about 12% of the global electricity demand in 2020.

d) Residential/Commercial developments in Al-Ain region

The new developments in Al-Ain region are mainly concentrated in the Zakher, Dahma/Towayya, Salamat, Al-Ain city centre, Ain Al Fydra, Mazyad and Al Foah areas. The cumulative demand requirements of the residential/commercial developments in the Al-Ain region is expected to reach about 2.8GW, which represents about 14% of the global electricity demand in 2020.
e) Export commitments to Northern Emirates

The total exports to the Northern Emirate (mainly FEWA and SEWA) is expected to reach about 3.8GW, which represents about 19% of the global electricity demand in 2020.

Abu Dhabi’s continued support to the energy requirements of the Northern Emirates and ADWEA’s development plans in Northern Emirates will significantly improve the overall security of the ENG grid and reduce the risk to the TRANSCO of shortages and/or network security issues in the Northern Emirates.

3.2 Generation Background

The existing available installed generation capacity is about 13.8GW (in 2012). The following are the major new committed generation projects identified to date which are expected to be integrated into the main bulk transmission grid in the period 2013-2020:

- Shams-1 concentrated solar power (CSP) plant with a maximum installed capacity of 100MW at a facility located south of Madinat Zayed in the Western region. The plant was synchronized to the grid in end 2012 and achieved commercial operation in February 2013.

- Shuweihat S3 (1.65GW) combined cycle fossil fuel plant located adjacent to the existing Shuweihat S1/S2 site in the Western region.
  
  The first phase of Shuweihat S3 is planned to be operational (about 0.5GW capacity) in 2013 and fully operational (about 1.65GW) in 2014.

- New Mirfa (1.6GW) combined cycle fossil fuel plant to be located adjacent to the existing Mirfa site in the Western region.
  
  The first phase of New Mirfa plant is planned to be operational (about 0.85GW capacity) in 2015 and fully operational (about 1.6GW) in 2016.

- The Barakah site in the Western region has been identified to promote nuclear generation of total capacity 5.56GW by 2020. Generator units of 1.39GWe each are expected to be integrated to the transmission system through 2017-2020.

- Nour-1 photovoltaic solar power plant (PV) with a maximum installed capacity of 100MW at a facility located near Sanaiya in Al-Ain region. The plant is likely to be integrated after Summer 2015.
• Taqa’s waste to energy plants expected to be integrated to the transmission system in the period 2017-2020 with total installed capacity of about 200MW in ICAD area.

The total additional generation capacity due to above new committed generation projects contributes about 8.9GW by 2020.

Some of the existing generation plants are expected to retire in the period 2013-2020. These are located at Mirfa (186MW) in the Western region and Umn Al Nar (778MW) in the Eastern region. The available capacity off-set due to the closure of above existing generation will be about 1.0GW by 2020.

Table A1 in Attachment-A includes a detailed summary of generation capacity expansion plan that shows the existing and committed generation projects in the period 2013-2020.

Figure 3-3 shows the expected demand-supply gap for the ADWEC high, project based and low demand forecast scenarios. Certain of the demand forecasts indicate a need for additional generation capacity from 2015 to satisfy the emerging gap between the demand and generation outlook, and ensure sufficient generation reserve margin is available, particularly to meet the project based and high demand forecast scenario.

A degree of uncertainty will continue in the realization of the volume, location and timing of new additional generation capacity in the period 2015-2020. The uncertainty levels in the demand forecast increases (as evident from the spread between the low and high demand forecast scenario) particularly from 2015. It should be recognized that the actual commitment to the new conventional generation capacity takes place on a shorter time scale (about 4 years) to close any emerging gap between supply and demand. Options are maintained such that the associated transmission reinforcement works are established in a phased manner to ensure minimum cost and provide a least regret solution.
In this 7YPS, the following assumptions have been considered to produce a valid study cases and achieve demand-generation balance to meet the ADWEC’s project based demand forecast scenario. This is in line with ADWEC 2012 Statement of Future Capacity Requirements released on 31 December 2012 (refer Executive Summary-page 19 and 20).

- Umn Al Nar Plant (778MW) capacity lifetime extended up to 2017. It is likely that it could be de-commissioned earlier given that the current Umn Al Nar Plant PWPA expires in end 2015.

- Al-Ain Power Station (256MW) in Al-Ain region; and Madinat Zayed Power Station (109MW) in Western region assumed their capacity lifetime extended up to 2020. However, these are used only as peaking units and despatched last in the merit order, if required.

- One new IWPP/IPP in Northern Emirates (e.g. Fujairah F3-assumed 1.2GW) by 2016 and one new IPP in Al-Ain region (e.g. Sweihan-assumed 1.0 GW) by 2017. The generation volume, time line and location to be confirmed by ADWEA Privatization Directorate/ADWEC.

Attachment-G includes a brief description of existing major generation plants and major planned committed generation projects up to 2020.
4.0 Planned Transfers

The requirements for the transmission system development and its associated investments are primarily driven by the demand and generation backgrounds and the resulting power transfers on the transmission system. There are uncertainties associated with the demand and generation backgrounds as with any forecasts and plans. These uncertainties will affect future planned power transfers on the transmission system and hence the way the transmission system develops. Using the scenarios developed, the planned power transfers on the transmission system are established for the most probable demand-generation scenario envisaged in the period 2012-2020 and ensure consistency with the long-term approach. Envelopes of possible transfers are established and the most likely (best-view) planned power transfers are identified across each of the transmission corridors that is used as a basis to inform how best to develop the transmission system.

The most likely (best-view) planned power transfers are based on ADWEC’s project based demand forecast scenario. An envelope of possible transfers is established for the ADWEC’s low and high demand forecast scenarios.

The scenario analysis establishes the most likely power transfers across each of the identified transmission corridors. These corridors are:

- From Western region to other regions.
- From Northern Emirates to other regions.
- From Eastern region to other regions.
- To Abu Dhabi islands’ from Eastern region.
- To Al-Ain region from other regions.

Figure 4-1 shows the envelope of possible transfers and the best-view planned transfers across the five identified boundary corridors for the peak demand-generation background during the period 2012-2020.
The main features of the fan diagrams across the five identified boundary corridors are:

a) The transfers across the Western-Eastern region corridor are the sum of the transfers from the Western region to the Eastern region and from the Western region to Al-Ain region. In the period 2012-2020, the most likely demand in the Western region is expected to increase from 1.3GW to about 3.9GW mainly attributed to the growth related to oil and gas sector. The scheduled generation in the region is assumed to rise significantly from 2.5GW to about 10.9GW due to high volumes of new generation seeking connection in the area. Consequently, the best-view planned transfer across this boundary (i.e. export from the Western region) is expected to reach about 6.85GW by 2020.

Figure 4-1 Envelope of possible transfers and best-view planned transfers for period 2012-2020.
b) The transfers across the Northern Emirates-other regions corridor are the sum of the transfers from the Northern Emirates to the Eastern region and from the Northern Emirates to Al-Ain region. In the period 2012-2020, the most likely demand in the Northern Emirates is expected to increase from 2.2GW to about 4.2GW. The scheduled generation in the region is assumed to rise from 2.4GW to about 3.4GW. Consequently, the best-view planned transfer across this boundary (i.e. import to the Northern Emirates) is expected to reach about 0.89GW by 2020.

c) The transfers across the Eastern region-other regions include transfers from the Eastern region to Abu Dhabi islands’, plus Eastern region to Al-Ain region, minus Western region to Eastern region, minus Northern Emirates to Eastern region. In the period 2012-2020, the most likely demand in the Eastern region is expected to increase from 2.9GW to about 5.9GW. The scheduled generation in the region assumed 5.5GW and 5.2GW. The net best-view planned transfer to the Eastern region is expected to reach about 0.92GW in 2020.

d) The transfers to the Abu Dhabi islands’ are from the Eastern region. The Abu Dhabi islands’ region constitutes Abu Dhabi island, Reem, Suwa and Sadiyat islands. In the period 2012-2020, the most likely demand in the Abu Dhabi islands’ is expected to increase from 1.9GW to about 2.9GW. There is no generation in this region. Hence, the best-view planned transfer across this boundary is the demands in the islands’.

e) The transfers to the Al-Ain region are from other regions namely from the Eastern, Western regions and Northern Emirates. In the period 2012-2020, the most likely demand in the Al-Ain region is expected to increase from 1.9GW to about 2.9GW. The scheduled generation in the region is expected to contribute about 0.9GW by 2020. Consequently, the best-view planned transfer across this boundary is expected to be about 2.0GW in 2020.
5.0 Evolution of Transmission Network

The Electricity Transmission System Security Standard, Issue 1, Rev (0) dated March 2005 sets out the criteria and methodology, which TRANSCO shall use in the planning, development, operation and maintenance of the electricity transmission system. The Electricity Transmission Code (Ver.1, Rev.4, issued in January 2012) contains additional criteria and other aspects of quality of supply standards that shall be considered for planning the transmission network. For details refer to the above-mentioned standard and code available in our website www.transco.ae. The Electricity Transmission System Security Standard is undergoing a review. The terms of references for the review were agreed with all the stakeholders and the project kicked off in July 2013.

This chapter presents the evolution of the 400kV, 220kV and 132kV transmission system within the Emirate of Abu Dhabi and, where appropriate, TRANSCO network outside of the authorized area up to 2020.

It should be noted that some of the transmission schemes included in this 7YPS are still in the early planning stage and options are kept open due to significant uncertainty in the demand-generation backgrounds particularly from 2015 and beyond. Hence, a significant amount of work is still required to be performed for those schemes. The requirements will be kept under review taking into account any updates on the demand-generation background and network developments before committing capital expenditure on those works. All options are maintained for possible optimization and based on the chosen scheme option and updated requirements, the timing of the related reinforcement works may be altered to ensure no regret solution.

Figure 5-1 shows the existing main bulk 400kV transmission network (as on 2012) spread across the five regions (Western region, Eastern region, Abu Dhabi Islands’, Al-Ain region and Northern Emirates).

Attachment-B includes detailed topology diagrams of the electrical power transmission system for the period 2013-2020. It should be noted that the reference date for inclusion of any new asset shown in the transmission network topology is the summer peak of the respective year. However, if any asset is expected to be commissioned after the summer peak of that year, the same is shown in the transmission network topology of the following year.
Figure 5-1 Existing main bulk 400kV transmission topology (as on 2012).

2013-2014

Major committed 400kV transmission system expansion projects are expected to be completed in the period 2013-2014 to meet the system needs and to accommodate committed new generation projects.

The 400kV transmission facilities from the existing Shuweihat Power Station (SHPS/S2PS) is capable of evacuating power from both Shuweihat S1 & S2 generation (total about 3.2GW) to meet the system demand requirements. To evacuate power from the Shuweihat S3 generation (about 1.65GW), a new 400kV grid station (S3PS) and related 400kV overhead line transmission facilities are planned to be completed in 2013.
New 400kV grid stations and related 400kV overhead line works are expected to be integrated to the transmission network in the period 2013-2014 to meet the respective regions’ demand requirements. These are 400/220kV grid stations in Ruwais (RWSG) and BABG (in Western region); 400/132kV grid stations in Bahia (BHYG), Mahawi (MHWG) and Shamkha (SMKG) (in Eastern region); and 400/132kV grid stations in Ajman (WSTG) in Northern Emirates.

Restrictions are placed by Government and developers for building new 400kV overhead lines and/or replacing existing overhead lines within Abu Dhabi island, along Abu Dhabi island-Sadiyat-Bahia (ADST-SDYT-BHYG) and Sas Al Nakheel-Mahawi-Mussafah (SASN-MHWG-MOSG) corridors in the Eastern region. Hence, TRANSCO has been required to increasingly underground transmission infrastructure serving these areas. The 400kV underground cables’ projects along the ADST-SDYT-BHYG corridor and SASN-MHWG-MOSG corridors have been staged through 2013-2016. This is to ensure that the security of supplies to Abu Dhabi island will be maintained; and the performance of 400kV XLPE cables will be demonstrated satisfactorily and thereby enable the policy decision to dismantle the 400kV overhead lines along the said corridors thereafter.

There are number of 220kV and 132kV works currently being executed either to meet customer requirements or comply with network security. These are expected to be completed in the period 2013-2014. A brief description of these works and their high-level need/drivers for initiating the projects among other information are detailed in Table 10-1, Chapter-10.

Figure 5-2 shows the main bulk 400kV transmission network topology in 2014.

The following details are included in the Attachment-B related to the developments in the electrical power transmission system in the period 2013-2014:

- Figure B1 and B2 shows the 400kV and 220kV electrical power transmission system in Abu Dhabi Emirate for year 2013 and 2014 respectively.
- Figure B9 and B10 shows the 132kV electrical power transmission system in Abu Dhabi Emirate for year 2013 and 2014 respectively.
- Figure B17 and B18 shows the 132kV electrical power transmission system in Northern Emirates for year 2013 and 2014 respectively.
Figure 5-2 Main bulk 400kV transmission network topology in 2014.

2015-2016

A new 400kV grid station (MRPS) and related 400kV overhead line transmission facilities are planned in 2015 to evacuate power from the new Mirfa generation plant (1.6GW).

A new 400kV grid station (Barakah switchyard-1) and related 400kV overhead line transmission facilities are planned in 2015 to facilitate the start-up operations of Barakah nuclear power plant and enable the phased integration of the nuclear power generation at Barakah.
The 400kV West-East corridor reinforcements ensure an integrated approach for evacuating power from Shuweihat S3, Mirfa and Barakah power plants while meeting the demands in the Western region.

The 400kV overhead line reconfiguration works between BHYG and TANE/TWPS are staged through 2015-2016 to enable dismantling the existing 400kV overhead line circuits along ADST-SDYT-BHYG corridor.

A new 400/220kV grid station in Wasit (Oman) and related 400kV overhead lines are planned in 2015 to facilitate increased power exchange between the U.A.E and Oman.

There are number of 220kV and 132kV works currently in the planning stage either to meet the customer requirements or comply with network security, whilst a few of these works are currently in tendering/execution stage. All these works are expected to be completed in the period 2015-2016. A brief description of these works and their high-level need/drivers for initiating the projects among other information are detailed in Table 10-1, Chapter-10.

Figure 5-3 shows the main bulk 400kV transmission network topology in 2016.

The following details are included in the Attachment-B related to the developments in the electrical power transmission system in the period 2015-2016:

- Figure B3 and B4 shows the 400kV and 220kV electrical power transmission system in Abu Dhabi Emirate for year 2015 and 2016 respectively.
- Figure B11 and B12 shows the 132kV electrical power transmission system in Abu Dhabi Emirate for year 2015 and 2016 respectively.
- Figure B19 and B20 shows the 132kV electrical power transmission system in Northern Emirates for year 2015 and 2016-2020 respectively.

As highlighted in Chapter-3, Section 3.2 two new power plants (one at Fujairah F3 of 1.2GW and other at Sweihan of 1GW) are assumed to be integrated to the main bulk 400kV transmission network by 2016/2017. This is to ensure a valid study cases are produced and achieve demand-generation balance to meet the ADWEC’s project based demand forecast scenario. Whilst the time line, location and volume of these assumed new power plants needs to be confirmed by ADWEA Privatization Directorate/ADWEC, the associated 400kV grid station and related 400kV OHL schemes are kept under review for possible optimization. The timing of the related 400kV reinforcement may also be altered to ensure no regret solution.
Figure 5-3  Main bulk 400kV transmission network topology in 2016.

2017-2018

A new 400kV grid station (Barakah switchyard-2) and related 400kV overhead line transmission facilities are planned to integrate the third and fourth reactor units of the nuclear power generation at Barakah.

There is a need to establish a new intermediate 400kV grid station in the Eastern region at Hameem (HMEM) near Mussafah area to facilitate large volumes of power transfers across West-East corridor; strengthen the overall 400kV transmission system and improve the dynamic performance of the transmission network. This is achieved through 400kV overhead line
reinforcement works between Barakah (BNPP)-Madinat Zayed (WMZD) grid stations; Barakah (BNPP)-Baab (BABG) grid stations in the Western region; and Baab(BABG)-Hameem (HMEM) grid stations in the West-East corridor.

A fourth 400/132kV 500MVA transformer at Mahawi 400/132kV grid station (in Eastern region) is planned during this period to meet the demand growth in the region.

20137YPS assumes Umn Al Nar Plant (778MW) lifetime capacity extended upto 2017 per ADWEC 2012 Statement of Future Capacity Requirements released on 31 December 2012. It is likely that it could be de-commissioned earlier given that the current Umn Al Nar Plant PWPA expires in end 2015. In line with the assumed Umn Al Nar Plant decommission timeline, the following transmission works are required by Q2 2017.

- 3rd 400/132kV 500MVA transformer at Sas Al Nakheel grid station.
- 3rd 400kV cable between ADST-SDYT grid stations.

As stated above, the timing of the above 400kV reinforcement works may be altered/advanced to ensure that the new assets are in place by Q2 2016.

The 400kV overhead line reconfiguration works between TANE and TWPS are planned to be completed during this period thereby removing the current generation constraint at TANE 400kV grid station.

132kV cable interconnection works are planned by Q2 2017 to transfer loads from the expected heavy loaded 400/132kV grid stations in Abu Dhabi island (BECH and QURM) requiring reinforcement to lightly loaded 400/132kV grid station in Reem (REEM).

The following details are included in the Attachment-B related to the developments in the electrical power transmission system in the period 2017-2018:

- Figure B5 and B6 shows the 400kV and 220kV electrical power transmission system in Abu Dhabi Emirate for year 2017 and 2018 respectively.
- Figure B13 and B14 shows the 132kV electrical power transmission system in Abu Dhabi Emirate for year 2017 and 2018 respectively.

Figure 5-5 shows the main 400kV transmission network topology in 2018.
Figure 5-5  Main bulk 400kV transmission network topology in 2018.

2019-2020

Major 400kV overhead line reinforcement works between Hameem (HMEM)-ASWG; and 400kV overhead line loop-in and out works between Shahama-Sweihan into Shamkha in the Eastern region is planned during this period to strengthen the overall 400kV transmission system and improve the dynamic performance of the transmission network.
Taking into consideration the potential increase in exports to systems outside of TRANSCO’s authorized area; it will be likely that the 400kV overhead line corridor across Hameem-Faya-Shamkha-Sweihan may require additional reinforcements to meet requirements over and above ADWEC’s project based demand forecast scenario. These will not only enable additional transmission corridor across Eastern region, but also meets the system requirements in 2020 and beyond.

Figure 5-6 shows the main 400kV transmission network topology in 2020.
The following details are included in the Attachment-B related to the developments in the electrical power transmission system in the period 2019-2020:

- Figure B7 and B8 shows the 400kV and 220kV electrical power transmission system in Abu Dhabi Emirate for year 2019 and 2020 respectively.
- Figure B15 and B16 shows the 132kV electrical power transmission system in Abu Dhabi Emirate for year 2019 and 2020 respectively.

TRANSCO has historically used 400kV double circuit overhead lines rated at 1400MVA per circuit based on a quad bundle Dove conductor arrangement, as standard. Based on power system planning studies, there is a need to increase the 400kV overhead line circuit rating to 2000MVA for certain circuits taking into account the developments in the grid. The quad cardinal bundle arrangement (ACSR/AS) provides the most attractive solution and planned to be adopted on relevant 400kV overhead line circuits (RWSG-BABG; BABG-HMEM; MRPS-FAYA) in the West-East transmission corridor.

Attachment-C includes detailed forecast power flows on the transmission system in PSS/E format for the valid peak load conditions. Attachment-D includes the three-phase and single-phase fault levels for each electricity transmission node for valid network conditions. The forecast power flows and the fault levels are computed to meet ADWEC project based demand forecast scenario.
6.0 Asset Replacement Works

In addition to enhancing network capacity there is a need to replace certain assets.

The requirement to replace aging assets affecting network security include:

- Transformers replacement works (132/11kV transformers at JZRH/SLTC substation; and 220/33kV transformer at Al-Ain Power Station).
- Indoor transformer cooling system upgrade (132/11kV transformers at GLFA, CPGR, PORT, MKT1, FLAH and CLNS substations in Abu Dhabi Island).
- Protection (busbar, line and transformer protection upgrade at various sites).
- Batteries and chargers at various sites (e.g. DHMG-220, AAPS-220, AHYG-220 etc).
- LV switchgear replacement at Jabel Hafeet 33kV substation.
- Underground cables (replacement of oil filled to XLPE between ADST-FDRS).
- Overhead lines (220kV Ruwais-Sila line OPGW rehabilitation works).
- Others (SCMS, FMS upgrade).

The requirement to replace/decommission aging assets affecting network security and exploit the synergies with capacity related asset creation include:

- 220/33kV grid stations at Mirfa, Zakher and Al Wagon.
- 132kV cable circuit between Mushrif-Mussafah/Mussafah-Umn Al Nar.

In addition to the above, there is also a need to procure new 400/220kV 500MVA transformer at Mussafah 400/220kV grid station (MOSG) to replace the failed transformer.

The economic treatment of the assets that are expected to be decommissioned will be treated in accordance with TRANSCO’s asset policy and shall be written off from the regulatory asset base when disposed of after due approval from RSB.

Further details on the asset replacement works for the period 2013-2020 is summarized in Table 10-1, Chapter-10.
7.0 Network Operation and Despatch

The committed new generation expansion projects, the retirement plans of some existing generation plants, and the potential new capacity additions to meet the “ADWEC’s project based forecast” is fully described in Chapter-3, Section 3.2 of 7YPS.

The Abu Dhabi power transmission system has been connected to systems outside of its authorized area to the Northern Emirates through the regional grid interconnection (Emirates National Grid - ENG). In the period to 2020 ADWEA’s transmission development plans in Northern Emirates will continue to grow considerably in order to support the increasing energy requirements of the neighboring Emirates. International grid interconnections through the Gulf Cooperation Council Interconnection Authority (GCCIA) network have been established.

In this Chapter, the changes to the generation portfolio and its impact on the despatch; and the potential changes to the transmission system operational requirements will be described.

7.1 Generation Despatch

The existing available installed generation capacity is about 13.8GW (in 2012). Figure 7-1 shows the existing electricity generation portfolio.

![Figure 7-1 Existing electricity generation portfolio (in 2012).](image)
The net available installed generation capacity is forecast to reach about 22.1GW by 2020 taking into account the committed generation expansion plan and generation capacity retirement plan (data as on April 2013). The installed generation capacity could potentially reach about 24.3GW by 2020 noting that the additional generation capacity is required to meet the ADWEC’s project based demand forecast scenario.

Figure 7-2 shows the expected electricity generation mix in 2020 to achieve 22.1GW (committed plan) and 24.3GW (plan to meet ADWEC’s project based demand forecast scenario). The contribution of nuclear and others(solar/waste to energy) generation mix is expected to reach about 28% of the total generation portfolio.

![Figure 7-2 Forecast electricity generation portfolio (in 2020).](image-url)
The power and water demand is met by despatching production facilities in accordance with a Unit Commitment model. Given the power and water system characteristics, together with the changing characteristics particularly associated with production facilities used to meet this demand, there is a need to ensure both power and water requirements will be securely met in an efficient manner. Figure 7-3 shows the current generation mix making up the annual load duration curve. For the 2012, the average winter/summer demand ratio is assumed 32% and the average load factor of the system demand about 65%.

Figure 7-3  Generation mix making up the annual load duration curve (in 2012).

The generation mix along with the expected increase in the industrial demand and export requirements will alter the average winter/summer demand ratio to about 35% and the average load factor of the system demand about 70%. The impact of these changes and the need to take into account the inter-relationship between power and water production has been the subject of a detailed economic despatch study reported in 2013. Given the uncertainty associated with the future evolution of power and water systems, three contrasted scenarios have been built by combining the system parameters to embrace the envelope of all possible operational situations. On the basis of the results obtained by analyzing the power and water despatch in each of the three scenarios and by carrying out sensitivity analyses on influent parameters, the study results are broadly consistent with the above-mentioned observations. The study recommends the following:
- Revising the minimum deployment time of the secondary reserve specified in the Electricity Transmission Code.

- Implementing additional capacity in CCGT and GT on the system in order to be able to meet the summer peak load situations from 2017 to 2020.

- Introducing a degree of flexibility into the despatch of certain power plant units including the nuclear plant.

- Introduction of greater penetrations of RO and/or exports particularly to meet the off-peak power-water demand combined.

- Managing maintenance and refueling of the nuclear plant to times of minimum demand.

7.2 Network Operation

In the period to 2020 the peak demand on the transmission network will increase from about 10.6GW (in 2012) to between 17.6GW-21.7GW in 2020. As indicated in the previous section, this is accompanied by a corresponding increase in the generation. The main changes to the transmission network operation that TRANSCO will experience as a result of this include:

- Fault level management:
  Fault levels on the network are increasing dramatically. TRANSCO has taken necessary operational measures to manage high fault levels at certain nodes in the transmission system; and wherever appropriate development projects have already been initiated and/or planned to ensure fault levels are managed within reasonable limits.

- Increased use of cables:
  Restrictions are placed by Government and developers for building new overhead lines and/or replacing existing overhead lines within Abu Dhabi island, along Abu Dhabi island-Reem-Sadiyat-Bahia and Sas Al Nakheel-Mahawi-Mussafah corridors in the Eastern region, and in Al-Ain region. In view of the above, TRANSCO has been required to increasingly underground transmission infrastructure serving these areas.

Figure 7-4 shows the 400kV cable developments projects expected to be commissioned in the vicinity of Abu Dhabi island and Eastern region in the period to 2020.
Figure 7-4 400kV cable development projects in Abu Dhabi region in the period to 2020.

Figure 7-5 shows the expected increase in the 400kV and 220kV cable circuit lengths in the Abu Dhabi Emirate in the period to 2020.

Figure 7-5  Expected increase in 400kV and 220kV cable circuit lengths in Abu Dhabi Emirate in the period to 2020.
The safe operation of the 400kV cable network is highly related to the operation of the 400kV shunt reactors. In view of the extensive use of 400kV cables and shunt reactors, TRANSCO has completed the required studies to optimize the allocation of 400kV shunt reactors in order to minimize the operational restriction and gain better understanding of the controlled switching requirements for the 400kV circuit breakers.

- Reactive power management:

The location of generation relative to demand is also changing such that the inherent capability of generation to provide both static and dynamic reactive support is not necessarily located optimally particularly to aid post fault voltage recovery associated with air conditioning type demands that are widespread over the country and industrial demand. Static and dynamic compensation will therefore be required and need to be managed to ensure consumers are provided with an appropriate quality of supply. Initial analysis has been undertaken to consider reactive compensation requirements and these will be fully developed in 2013/2014.
8.0 Transmission System Capabilities and Constraints

The network development plans and schemes discussed in the previous sections of the report satisfies the likely best-view power transfers to meet the ADWEC’s project based demand forecast scenario in different regions across the transmission system. An assessment of the bulk transmission system capabilities gives an indication the extent to which the system can accommodate the circumstances outside the chosen likely best view planned transfers. It also provides an appreciation of opportunities available in the transmission system to accommodate new generation and demand in different regions across the system.

The transfer capability across the boundary provides a broad appreciation of the overall capability of the bulk transmission network to transport power. The transfer capability across a particular boundary is the power flow across that boundary without causing any unacceptable conditions as a result of Secured Event. Two types of system limitation relating to the transfer of power across a boundary have been considered. The first relates to thermal limitation and the second voltage limitation. The overall transfer capability across the boundary is the lower of the thermal (MW) and voltage limitations. The transfer capability gives an indication of the maximum transfer across the identified boundary that can be supported without contravening any of the unacceptable conditions following a “Secured Event”.

Figures 8-1 to Figures 8-5 shows the transfer capabilities, envelope of likely transfers range and the best-view planned transfers across the five identified boundary corridors. These capabilities are computed for specific generation pattern (assuming new IWPP at Fujairah F3 in Northern Emirates and new peaking plant at Sweihan in Al-Ain region as the next potential generation sites after new Mirfa generation).

**Western region**

Figure 8-1 shows the planned transfers and transfer capability across West-East corridor. The Western region is considered to be the source, and other regions act as sink. In the period to 2020 major 400kV transmission reinforcements are required to cater for the committed generation and demand connections in the Western region. The introduction of nuclear generation in the period 2017-2020 mandates major 400kV transmission reinforcements across the West-East corridor thereby increasing the planned transfers and capabilities across the corridor.
Figure 8-1  Planned transfers and transfer capability across West-East corridor.

The proposed 400kV transmission reinforcements are sufficient to meet the planned transfers upto 2020. At this stage, there is a lot of uncertainty on the system demand-generation background, realization of major bulk industrial demands, and/or due to potential need to provide additional exports to the Northern Emirates beyond 2015. As these uncertainties become clearer in 2015-2016 further investments may be required to reinforce the system outside the Western region; and thereby ensure that the capability satisfies the planned transfers across West-East corridor in 2020.

Northern Emirates

Figure 8-2 shows the planned transfers and transfer capability across Northern Emirate-Abu Dhabi Emirate corridor. The Northern Emirates is considered to be the source, and Abu Dhabi Emirate act as sink. In the period to 2020, the transmission infrastructure across Northern Emirates-Abu Dhabi Emirate corridor is sufficient to meet the committed export requirements to the region. Further investments may be required to meet any potential additional exports to systems outside of its authorized area.
Figure 8-2 Planned transfers and transfer capability across Northern Emirates-Abu Dhabi Emirate corridor.

Abu Dhabi islands’

Figure 8-3 shows the planned transfers and transfer capability across Eastern region-Abu Dhabi islands’ corridor.

New 400/132kV grid stations in Bahia (BHYG) and Mahawi (MHWG) are expected to be commissioned by 2014. As part of these 400/132kV grid stations, major 400kV overhead line/cable transmission reinforcement works are carried out across Abu Dhabi island-Sadiyat-Bahia (ADST-SDYT-BHYG) and Sas Al Nakheel-Mahawi-Mussafah (SASN-MHWG-MOSG) corridors. The 400kV underground cables’ projects along the ADST-SDYT-BHYG corridor and SASN-MHWG-MOSG corridors have been staged through 2013-2016. This is to ensure that security of supplies to Abu Dhabi island will be maintained; and the performance of 400kV cables will be demonstrated satisfactorily and thereby enable the policy decision to dismantle the 400kV overhead lines along the said corridors thereafter.
In 2014 Abu Dhabi islands’ are supplied by both 400kV overhead line circuits and 400kV cable circuits from ADST-SDYT-BHYG corridor side. In 2017 Abu Dhabi islands’ are supplied by only 400kV cable circuits. The proposed 400kV transmission reinforcements are sufficient to meet the planned transfers upto 2020.

Figure 8-3  Planned transfers and transfer capability across Eastern region-Abu Dhabi islands’ corridor.

Al-Ain region

Figure 8-4 shows the planned transfers and transfer capability across Al-Ain region.

By 2020 utilization of all three existing 400kV grid supply points (Sweihan-SWHN; Dahma-DHMG, and Al-Ain South West-ASWG) in Al-Ain region is expected to reach about 100%. The existing 220kV mesh network in Al-Ain region have enough flexibility and capability to ensure that the utilization of 400/132kV grid station capacities are optimized. Consideration needs to be given to establish a new 400kV grid supply node in Al-Ain region in order to alleviate the expected capacity shortfall and meet the increasing demand requirements in the region after 2020. The new 400kV grid supply node will thereby enable additional transmission corridor across Al-Ain region and hence enhance the transfer capability to the region. However, given this is at the end of the planning period and there are a number of uncertainties no provisions have been made in this plan.
Figure 8-4  Planned transfers and transfer capability across Al-Ain region.

**Eastern region**

Figure 8-5 shows the planned transfers and transfer capability across Eastern-Other regions corridor. Sufficient capability exists to meet the planned transfers upto 2020.

Figure 8-5  Planned transfers and transfer capability across Eastern-other region corridor.
8.1 Constraints and Constraint Volumes

A transmission system constraint is an event or a system condition which has a potential to cause an increase in the delivery cost of energy to customers. These constraints arise mainly when a circuit is planned for an outage and the requirement to secure the system against the event that may result in an unacceptable system conditions (e.g. equipment overload, unacceptable voltage or frequency condition).

Constraint measures provide an approximate quantification of risk for the identified known constraints. Some of these constraints are imposed on the transmission system by the Users plant/equipment design at the interfaces necessitating TRANSCO to take certain measures (e.g. constraint generation or network re-arrangement) to ensure integrity of the power system is maintained. It should be noted that only some of these constraints are non-compliant with the security of supply standard and only those are potential candidates for the derogations.

Constraints and constraint volumes are quantified so that the Users can evaluate its impact on themselves. It also informs the Users of current known constraints in the system and the development plans to eliminate some of those constraints in the period to 2020. Constraints/risks are grouped into three main categories namely:

- Generation constraints.
- Main interconnected transmission system constraints.
- Demand supply exit points constraints.

Generation Constraints

Table-F1 enclosed in Attachment-F provides full list of existing constraints at the generation entry points. It summarizes constraints/risks, quantifies constraint volume and mitigation measures. In total there are six major constraints.

Only one constraint at TANE 400kV grid station is non-compliant with the current Transmission System Security Standard (TSSS). This constraint will be removed after reinforcing TANE 400kV grid station with additional 400kV overhead line circuits planned to be completed by 30 June 2017. All other constraints/risks are attributed to the User network design.
Main Interconnected Transmission System Constraints

Table-F2 enclosed in Attachment-F provides full list of existing constraints at the Main Interconnected Transmission System (MITS). It summarizes constraints/risks, operational measures to manage those constraints and mitigation plans wherever applicable.

In total there are fourteen 220kV sites spread across Western, Eastern and Al-Ain regions wherein the supplies are currently supplied by two 220kV overhead line circuits. The 220kV supplies to these sites are not fully secured for the N-maintenance-1 condition. Under such network condition, there is a need for Users to manage by transferring loads to other demand groups. The case for reinforcing some of these sites with additional 220kV overhead line circuits will be considered after the TSSS review is complete.

There are other existing 220kV sites (ASGS, ONGS, WAHA, RMTH and DBYA) and future 220kV sites (ADAS, HBSN, HBAA, New Dabiya and New Rumaithy) providing supply source for oil & gas fields in the Western region wherein the 220kV supplies are fed by two 220kV overhead line transformer feeders. The redundancy and security levels provided at these 220kV sites is per customer requirements.

Demand Supply Exit Point Constraints

There are a number of existing sites at TRANSCO/DISCOs interfaces which are non-compliant with the TSSS. These have developed due to rapid demand growth/historical design. Table-F3 enclosed in Attachment-F provides full list of existing non-compliant sites/substations identified to date wherein loss of supply is expected and supply restoration takes greater than 5 minutes for N-1 at the demand supply exit points. Also, it includes quantification of the maximum demand at risk of continued non-compliance and summarizes mitigation plan and resolution period.

The demand supply exit point constraints are grouped into two categories.

“Constraint category-single circuit arrangement” are those imposed on demand exit points wherein the supplies are affected for N-1 which are fed by single-circuit arrangements. These constraints are located at Shamkha-1&2, Mafraq, Mussafah M12 and Faya in the Eastern region; Liwa, Hameem (Qasr Al Sarab) and Qusahwira area in the Western region. In total there are eight such sites.
“Constraint category- historical design wherein one or more transformers operated in independent mode” are those imposed on demand exit points wherein the supplies are affected for N-1 attributed to the legacy design restrictions at the interfaces. TRANSCO has identified that a number of presently energized sub-stations cannot be operated, during times of peak demand, in a parallel arrangement. This limitation creates risk of demand loss greater than 5 minutes during the peak time when the transformers at such sites are operated in independent mode. This operating arrangement has arisen due to a mix of issues (high demand growth and/or downstream fault level restrictions). In total there are 32 sites spread across Abu Dhabi island, Eastern and Western regions and Al-Ain region.

TRANSCO is currently working with stakeholders to address these non-compliant sites.

Risk management and/or operational measures are in place to secure some of these supplies through the ADDC/AADC distribution network back feed arrangements at these demand exit points during the contingency scenario. The extent of network at risk post N-1 is deemed to be medium to group demand but would be classed as low if reflected onto overall network demand.
9.0 Opportunities

One of the main purposes of the 7YPS is to enable the Users or any other entity seeking the use of the transmission system, to identify and evaluate the most suitable opportunities available for connection.

As a pre-requisite of identifying opportunities, there is a need to understand the transmission system capabilities. An assessment of the main bulk 400kV transmission system capabilities gives an indication the extent to which the system can accommodate the circumstances outside the chosen likely best view planned transfers. The best view planned transfers are based on ADWEC’s project-based demand forecast scenario. The planned transfers and capabilities across the identified transmission boundaries is fully described in Chapter-4 and Chapter-8 respectively.

The generation capacity expansion plans and identification of potential new generation sites are carried out by ADWEC/ADWEA Privatization Directorate. The ability to connect new potential generation connections that requires the least electricity transmission reinforcement is the main consideration given for the purpose of identifying the opportunities of this category. However, other aspects such as technical, economic, environmental and the need for water production and transmission among other policy directives are to be given due weighting in the selection of the optimum generation site location.

9.1 Generation Connection Opportunities

The details of the existing and committed generation plants are presented in Chapter-3.

Figure 9-1 shows the existing and committed generation sites, and future potential site opportunities for the new generation connections up to 2020.
Figure 9-1  Potential new generation connection opportunities.

9.2 Transmission Connection Opportunities

The 400kV main transmission system interconnects all major electrical power stations and serves various load centres (demand supply points) through 400/220kV and 400/132kV grid stations (grid supply points). The main electricity transmission system is essentially spread across five regions namely Abu Dhabi islands’, Eastern region, Western region, Al-Ain region and Northern Emirates.

In Abu Dhabi city and neighboring islands, the principal sub-transmission voltage is 132kV. Both 220kV and 132kV sub-transmission voltage levels are available in the Eastern region, whilst 220kV sub-transmission voltage level is predominant in the Western and Al-Ain regions. In high load density area of Abu Dhabi city, direct transformation from 132kV to 11kV already exists. The
132kV to 22kV voltage level is recently introduced for the new mega project developments in the neighboring islands and Eastern region within the vicinity of Abu Dhabi island. The 132/11kV and 132/22kV substation capacity are configured with 4x40MVA and 4x80MVA respectively. In the medium and low load density areas of Eastern/Al-Ain regions and Western region respectively, transformation from 220kV to 33kV exists. Most of the existing 220/33kV grid station capacity is either 2x140MVA or 3x140MVA.

Figure 9-2 shows the expected increase in the net quantities of 400kV grid supply points and demand supply exit points (220kV and 132kV) by 2020 to meet the ADWEC’s project based demand forecast scenario, after taking into account decommissioned assets in the planning period.

![Figure 9-2: Expected quantities of 400kV, 220kV and 132kV supply points by 2020.](image)

The 400kV grid stations (i.e. 400kV generation entry points, 400/220kV and 400/132kV grid stations) expected to be integrated to the main bulk transmission network in the period 2013-2020 are: S3PS, Mirfa, Fujairah F3, Barakah-1&2, Ruwais, Baab, Hameem, Faya, Bahia, Mahawi, Shamkha, Ajman and Wasit (Oman).
The 220/33kV grid stations expected to be integrated to the 220kV transmission network in the period 2013-2020 are: Ghantoot, New Baab, Asab, Shah, Habshan, Towayya, New AAPS and Ain Al Fydha. It is be noted that some 220kV assets (i.e. 220/132kV and 220/33kV grid stations) are expected to be decommissioned either due to assets reaching their end of useful life or replace as part of non-compliance mitigation plan. These are located at Umn Al Nar, Mahawi, Watbha, Shamkha, Mafraq and Al Faya.

A significant number of 132kV substations (i.e. 132/33kV, 132/22kV and 132/11kV) are expected to be integrated to the 132kV transmission network in the period 2013-2020.

New 132/33kV substations expected to be commissioned are located at Taweela, Mahawi, Watbha, Nadha, Shamkha and Al Faya areas in Eastern region; and Sudah Port, Al Hayl, Kalba, Tawyeen and Khorfakkan in the Northern Emirates.

New 132/22kV substations expected to be commissioned are located at Airport, Al Falah, Capital District, Mafraq and South Shamkha areas in the Eastern region.

New 132/11kV substations expected to be commissioned are located at Presidential palace, Capital centre of Abu Dhabi, E25/02, E04/02 and E12 sectors in Abu Dhabi island, Madinat Khalifa and Khalifa area, Mohamed Bin Zayed City and M12 areas in Eastern region; and Sir Baniyas Island in Western region.

Figure 9-3 and Figure 9-4 shows the utilization on the 400kV grid supply points (with respect to N-1 capacity) in 2012 and 2020 respectively.

Users have good opportunities to connect their potential new loads into the demand groups at the following 400kV grid supply points (whose utilization is forecast to be less than 75% by 2020) which do not require any major transmission reinforcement works:

- Reem (REEM), Sadiyat (SDYT) and QURM 400/132kV grid stations in Abu Dhabi islands’ region.

  The utilization at REEM and QURM 400/132kV grid stations is optimized after the establishment of 132kV interconnection to transfer loads from expected heavily loaded 400/132kV grid station in Abu Dhabi island (i.e. QURM 400/132kV grid station) requiring reinforcement to lightly loaded REEM 400/132kV grid station by 2017.

- Bahia (BHYG) 400/132kV; Shahama (SHME), Mussafah (MOSG) and ICAD 400/220kV grid stations in Eastern region.

- Ajman (WSTG) 400/132kV grid station in Northern Emirates.
Figure 9-3 Utilization of 400kV grid supply points in 2012 (Actual recorded in peak 2012).
In the period to 2018-2020 utilization of following 400kV grid supply points expected to reach about 100%:

- BECH grid station in Abu Dhabi island region.

Hence, an opportunity exists which will improve the utilization of both REEM and SDYT 400/132kV grid stations through additional 132kV interconnection transfer schemes to Abu Dhabi island. These 132kV interconnection transfer schemes will permit load transfers of about 1GW from Abu Dhabi island to REEM/SDYT 400/132kV grid station. Hence, the need for a new 400/132kV grid station and related 400kV cables in Abu Dhabi island that require significant capital investment be delayed for atleast next 10 years, which otherwise required by 2018/2020.
- Sweihan (SWHN), Dahma (DHMG), Al-Ain South West (ASWG) 400/220kV grid stations in Al-Ain region.

Hence, an opportunity exists to establish a new 400kV grid supply node in Al-Ain region and/or 220kV interconnection schemes between the said 400/220kV grid stations by 2020.

- Ruwais (RWSG) and Baab (BABG) 400/220kV grid stations in Western region.

400kV switching stations at Hameem (HMEM) and Al Faya (FAYA) are planned in the Eastern region by 2020. These 400kV switching stations are required to enable additional transmission corridors across West-East corridor to facilitate power evacuation from Barakah nuclear power plants, Shuweihat and Mirfa power plants; and improve the dynamic performance of the overall transmission network. Also, HMEM and FAYA 400kV switching stations provide good opportunities to connect potential new demands of Mussafah/ICAD region and Shamkha/Al Faya regions respectively.

The total export commitments to the Northern Emirate (mainly FEWA and SEWA) are expected to grow from about 2GW (in 2012) to reach about 3.8GW (in 2020). These export commitments are satisfied by the existing 400kV grid supply points at Dhaid (DHID), Fujairah-Qidfa (QDFA), Ras Al Khaimah (FILA), New Fujairah City (FJCT); and Ajman (WSTG) 400kV grid supply point planned after summer 2013.

In the period 2020 good opportunities exists for additional new 400kV grid supply nodes to enable Abu Dhabi’s continued support to the energy requirements of the Northern Emirates and meet any potential additional exports to systems outside of its authorized area.

Attachment-A contains the electricity demand forecast at the demand supply exit points for 2013-2020 to meet ADWEC’s project based demand forecast scenario.

Attachment-B shows the electricity transmission network topology (400kV, 220kV and 132kV system) for 2013-2020.

These Attachments gives full details of the opportunities available (in terms of location and timeline) at the demand supply exit points for the Users or any other entity seeking the use of the transmission system.
10.0 Capital Programme and Delivery

Table 10-1 provides a high level summary of capital projects to meet the future demand growth (load category) and replacement requirements (non-load category). These include the major ongoing, currently under tendering process and new planned power projects for the period 2013-2020. It also includes a brief description of their needs/drivers for the identified projects/proposals among other information.

It should be noted that some of the transmission schemes included in this 7YPS are still in the early planning stage and options are kept open due to significant uncertainty in the demand-generation backgrounds particularly from 2015 and beyond. Significant amount of work is still required to be performed for those schemes. Hence, the requirements will be kept under review taking into account any updates on the demand-generation background and network developments before committing capital expenditure on those works. All options are maintained for possible optimization and based on the chosen scheme option and updated requirements, the timing of the related reinforcement works may be altered to ensure no regret solution.
<table>
<thead>
<tr>
<th>S.N.</th>
<th>Budget Code/Contract No.</th>
<th>Project Status</th>
<th>Project Name</th>
<th>Voltage level (kV)</th>
<th>Connection Category</th>
<th>Initiative Category</th>
<th>River</th>
<th>Location</th>
<th>Drivers/Needs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>N7081</td>
<td>R</td>
<td>400kV OHL works for integrating Shuwaihat 53 generation.</td>
<td>400</td>
<td>Entry Point.</td>
<td>Strategic expansion.</td>
<td>ADPCO.</td>
<td>Western region.</td>
<td>For S3 NWP generation integration.</td>
</tr>
<tr>
<td>2</td>
<td>N7080, N7081</td>
<td>R</td>
<td>400kV grid station at Ruwais, and related 400kV OHL works.</td>
<td>400</td>
<td>Exit Point.</td>
<td>4 &amp; gas.</td>
<td>TAMER.</td>
<td>Western region.</td>
<td>To meet Takreer demand requirements in Ruwais Industrial Area.</td>
</tr>
<tr>
<td>3</td>
<td>N9410, NS999 A/B</td>
<td>R</td>
<td>400kV cable works (2nd circuit) between ADResearch-Sadiyat.</td>
<td>400</td>
<td>MRTS.</td>
<td>Government initiative.</td>
<td>TRANSCO. Abu Dhabi island.</td>
<td>To enable dismantling of 400kV OHL along the Abu Dhabi Island-Sadiyat-Bahia corridor.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>N7137</td>
<td>R</td>
<td>400kV 2nd interconnection cable works between TANE-EMAL Smelter.</td>
<td>400</td>
<td>Exit Point.</td>
<td>Strategic expansion.</td>
<td>EMAL.</td>
<td>yawell.</td>
<td>To secure the back-up supplies during &quot;Secured Events&quot; conditions in EMAL Smelter.</td>
</tr>
<tr>
<td>5</td>
<td>N7026, N7026-1A, N7071-01</td>
<td>R</td>
<td>400/110kV grid station in New Fujairah City (EKC) and related 400kV OHL works.</td>
<td>400</td>
<td>Exit Point.</td>
<td>Northern Emirates &amp; Exports.</td>
<td>FEWA.</td>
<td>Fujairah.</td>
<td>To meet the demand requirements of Northern Emirates and meet the statutory obligations of ADWEA-FEWA Agreement.</td>
</tr>
<tr>
<td>6</td>
<td>N67218, NS424-V01</td>
<td>R</td>
<td>400kV OHL works between Fujairah Qal’a and Ras Al Khaimah.</td>
<td>400</td>
<td>MRTS.</td>
<td>Network security.</td>
<td>TRANSCO.</td>
<td>Fujairah.</td>
<td></td>
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<tr>
<td>7</td>
<td>N7026</td>
<td>R</td>
<td>220kV GIS modification works at Maktar Zayed 400/220kV grid station.</td>
<td>220</td>
<td>Exit Point.</td>
<td>Strategic expansion.</td>
<td>MAXDAR.</td>
<td>Western region.</td>
<td>To integrate Masdar CSP Shams-1 Solar Plant.</td>
</tr>
<tr>
<td>8</td>
<td>N7015</td>
<td>R</td>
<td>220kV cable works between Bahar - Zakheer grid stations.</td>
<td>220</td>
<td>MRTS.</td>
<td>Network security.</td>
<td>TRANSCO. Al Ain region.</td>
<td>To comply with network security.</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>N7109</td>
<td>R</td>
<td>220kV OHL works for 1.8MMBD Project in Qushairat (ADQW).</td>
<td>220</td>
<td>Exit Point.</td>
<td>Oil &amp; gas.</td>
<td>ADCC.</td>
<td>Western region.</td>
<td>To meet demand requirements of ADCC’s 1.8MMBD Project in Qushairat.</td>
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<tr>
<td>10</td>
<td>N7107-01, N7148</td>
<td>R</td>
<td>120/33kV grid station at Ghantoot (JTTW) and related 220kV OHL works.</td>
<td>220</td>
<td>Exit Point.</td>
<td>Growth.</td>
<td>ADCC.</td>
<td>Eastern region.</td>
<td>To meet demand requirements in Ghantoot/Sah Al Sedaira (Al Ghadeer).</td>
</tr>
<tr>
<td>11</td>
<td>N7026-1A (B), NS771-02</td>
<td>R</td>
<td>132/33kV substation in Sudah Port (SUDAP) and related 132kV OHL works.</td>
<td>132</td>
<td>Exit Point.</td>
<td>FEWA.</td>
<td>Fujairah.</td>
<td></td>
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</tr>
<tr>
<td>12</td>
<td>N7026-1E, NS771</td>
<td>R</td>
<td>132/33kV substation in Al Hayl (AV3) and related 132kV OHL works.</td>
<td>132</td>
<td>Exit Point.</td>
<td>Northern Emirates &amp; Exports.</td>
<td>FEWA.</td>
<td>Fujairah.</td>
<td>To meet the demand requirements in the mentioned areas and support the export commitments agreed between ADWEA and FEWA.</td>
</tr>
<tr>
<td>13</td>
<td>N8051, N11380</td>
<td>R</td>
<td>New 132/132kV substation at Kalba (KLAB) and related 132kV OHL works.</td>
<td>132</td>
<td>Exit Point.</td>
<td>FEWA.</td>
<td>Fujairah.</td>
<td></td>
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</tr>
<tr>
<td>14</td>
<td>N7169, NS754</td>
<td>R</td>
<td>New 132/33kV substation at Khor Fakkan (PKYN) and related 330kV OHL works.</td>
<td>132</td>
<td>Exit Point.</td>
<td>FEWA.</td>
<td>Fujairah.</td>
<td></td>
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</tr>
<tr>
<td>15</td>
<td>N7133, N7009</td>
<td>R</td>
<td>132/11kV substation in Sir Banjus Island (SBIF) and related 11kV cable works.</td>
<td>132</td>
<td>Exit &amp; Exit Point.</td>
<td>Strategic expansion.</td>
<td>ADCC.</td>
<td>Western region.</td>
<td>To meet demand growth in Sir Banjus Island and facilitate integration of Masdar Wind Farm.</td>
</tr>
<tr>
<td>16</td>
<td>N6166-1 Lot A, N6773</td>
<td>R</td>
<td>132/11kV substation at ADREC (CCAD) and related 132kV cable works.</td>
<td>132</td>
<td>Exit Point.</td>
<td>Growth.</td>
<td>ADCC.</td>
<td>Abu Dhabi Island.</td>
<td>To meet ADNEC development demands and release loading on the existing 132/11kV substations within the vicinity (EMBS &amp; GUFA).</td>
</tr>
<tr>
<td>17</td>
<td>N6166-1 Lot B, N6773</td>
<td>R</td>
<td>122kV substation at New Airport (ADIF) and related 11kV cable works.</td>
<td>132</td>
<td>Exit Point.</td>
<td>Growth.</td>
<td>ADCC.</td>
<td>Eastern region.</td>
<td>To meet Airport demand requirements.</td>
</tr>
<tr>
<td>18</td>
<td>N7156-1 Lot C, N7156, N7144 R</td>
<td>R</td>
<td>132/11kV substation at Khalfia (MKAYH) and related 11kV cable works.</td>
<td>132</td>
<td>Exit Point.</td>
<td>Growth.</td>
<td>ADCC.</td>
<td>Eastern region.</td>
<td>To meet demand requirements related to Al Falah Community development and in the vicinity area of Shamkha.</td>
</tr>
<tr>
<td>19</td>
<td>N6155-1 Lot C, N6775, N7144 E</td>
<td>R</td>
<td>132/11kV substation in Khalfa (MKAYH) and related 11kV cable works.</td>
<td>132</td>
<td>Exit Point.</td>
<td>Growth.</td>
<td>ADCC.</td>
<td>Eastern region.</td>
<td>To meet demand requirements in Khalfa and vicinity area related to Watani, golf club, golf gardens and Abu Dhabi shooting club developments.</td>
</tr>
<tr>
<td>20</td>
<td>N61022/N7144-A, N7155</td>
<td>R</td>
<td>132/11kV temporary substation in Musaffeih M12.</td>
<td>132</td>
<td>Exit Point.</td>
<td>Growth.</td>
<td>ADCC.</td>
<td>Eastern region.</td>
<td>To meet high demand in Mussafah M12 area and relieve loading on ADCC 33/11kV substations in the area until a permanent 132/11kV supply source is established in the area.</td>
</tr>
</tbody>
</table>

**Commission in Year 2014 - by End Q2 2014**

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Budget Code/Contract No.</th>
<th>Project Status</th>
<th>Project Name</th>
<th>Voltage level (kV)</th>
<th>Connection Category</th>
<th>Initiative Category</th>
<th>River</th>
<th>Location</th>
<th>Drivers/Needs</th>
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<tr>
<td>1</td>
<td>N6449, N6445</td>
<td>R</td>
<td>400/132kV grid station in Ajman (WSTA) and related 400kV OHL works.</td>
<td>400</td>
<td>Exit Point.</td>
<td>Northern Emirates &amp; Exports.</td>
<td>FEWA/SEWA.</td>
<td>Ajman.</td>
<td>To meet the demand requirements for FEWA &amp; SEWA (in Ajman area and vicinity) and meet the statutory obligations of ADWEA-FEWA Agreement.</td>
</tr>
<tr>
<td>2</td>
<td>N6411-1A-B, N6411-1A-V01, N6420, N6480-1V4</td>
<td>R</td>
<td>400/110kV grid station at Bahia (BYSHG) and related 400kV OHL works.</td>
<td>400</td>
<td>Exit Point.</td>
<td>MRTS.</td>
<td>TRANSCO.</td>
<td>Eastern region.</td>
<td>Provide 33/11kV supply source to the existing substations in Bahia, Yas Island and Raha Beach (Raha A &amp; Raha B) and planned substations in Al Falah and Airport areas; enabling ganging of 400kV OHL cable circuits across Taweelah-TANE-Bahia-Sadiyat corridor and facilitate power evacuation from TANE generation.</td>
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<td>L.N.</td>
<td>Project Name</td>
<td>Connection Category Drive</td>
<td>Initiative Category</td>
<td>Driver/Needs</td>
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<tr>
<td>4</td>
<td>912920</td>
<td>R</td>
<td>400kV shunt reactors at Babah and Sabiyat. Work stage programme through 2014-2015.</td>
<td>400 MRTS. Network security. TRANSCO. Eastern region. a) Required for MVAr compensation due to long and isolated 400kV cable circuits in TRANSCO network b) For stabilization and voltage control under light load conditions c) Achieve lower line losses.</td>
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<tr>
<td>5</td>
<td>96462.3A</td>
<td>R</td>
<td>400/123kV grid station in Mahawi (NHFWG).</td>
<td>400 MRTS. Growth. TRANSCO. Eastern region. a) Provide 132kV supply source to the planned substations in Mohamed Bin Zayed City, Musafah M12, Mahraj, Nahda and Capital District. b) Facilitate transfer of existing Musafah substation N1156 to Mahawi region. c) Provide 132kV supply to Mahawi. d) Enable dismantling of existing 120/33kV grid stations in Mahawi and Waldba and conversion of the same to 112/33kV substations. e) Enable dismantling of 400kV and 220/33kV OHL along Sabah Al Nahki-Mahawi-Musafah corridor.</td>
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<tr>
<td>6</td>
<td>96462.4, N6462-6, N6462-C</td>
<td>R</td>
<td>400/123kV cable works between Sas Al Nahkiel &amp; Mahawi (2 circuits) and between Mahawi and Musafah (3 circuits) - Work programme staged through 2014-2016.</td>
<td>400 MRTS. Government initiative. TRANSCO. Western region. Provide 400kV source to meet ADNOC group demand growth in Babah, BuHusa, ASAB and SHAI area; and enhance 220kV overhead line transfer capability in the region.</td>
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<tr>
<td>7</td>
<td>N77110, N75710</td>
<td>R</td>
<td>400/123kV grid station at Shambha (SAEG) and related 400kV OHL works.</td>
<td>400 MRTS. Growth. TRANSCO. Eastern region. a) Provide 132kV supply source to the planned substations in Shambha, South Shambha and Al Mays. b) Provide 132/33kV back-up supply source to Fahah 400kV substations. c) Avoid short term investments that would have been required to reinforce the existing 220kV network to alleviate the current network arrangement that is non-compliant with TRANSCO’s security of supply license obligations and its associated loss of supply risk as a result of supplying loads by non-secure single circuit 220/33kV substations. d) Strenghens 400kV system backbone and enable additional transmission corridors across West East.</td>
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<tr>
<td>8</td>
<td>912447, N11443, N11446</td>
<td>R</td>
<td>400/220/33kV grid station at Babah (BABG) and related 400kV OHL and 220kV OHL works.</td>
<td>400, 220 MRTS. Oil &amp; gas. TRANSCO. Western region. Provide 400kV source to meet ADNOC group demand growth in BAAB, BUHUSA, ASAB and SHAI area; and enhance 220kV overhead line transfer capability in the region.</td>
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<tr>
<td>9</td>
<td>N77149</td>
<td>R</td>
<td>Bypass one 400kV OHL circuit between SASN and MOSS to form SAAN-ICAO-400kV OHL circuit.</td>
<td>400 MRTS. Network security. TRANSCO. Eastern region. To facilitate connection of 2 nos of 400kV cable circuits from MOSS to Mahawi; and thereby ensuring secure supplies to Mahawi-400/132kV grid station.</td>
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<td>10</td>
<td>912448, N11446</td>
<td>R</td>
<td>New 220kV switching station at ASAB and related 220kV OHL works.</td>
<td>220 MRTS. Oil &amp; gas. AL Hoon Gas/RCCD. Western region. To meet Al Hoon Gas/ADCC demand growth requirements in SHAI and ASAB area.</td>
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<tr>
<td>11</td>
<td>912448, N11443, N11446</td>
<td>R</td>
<td>220kV switching station in Arab and related 220kV OHL works (400kV design) between Babah, Arab switching station and Al Hoon.</td>
<td>220 MRTS. Oil &amp; gas. ADCC &amp; Al Hoon Gas. Western region. Enhance 220kV overhead line transfer capability to ASAB area and meet demand growth in SHAI and ASAB area.</td>
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<tr>
<td>12</td>
<td>N6612.2A</td>
<td>R</td>
<td>220/33kV temporary station at Al Faya (300kW).</td>
<td>220 MRTS. Growth. ADDC. Al Ain region. To meet initial demand requirements in Shamka/Al Faya area until the establishment of permanent supply source in the area.</td>
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</tr>
<tr>
<td>13</td>
<td>N11762</td>
<td>R</td>
<td>220kV GIS extension works and 3rd 220/33/11kV transformer at Bkeiyad 220/33kV grid station.</td>
<td>220 MRTS. Growth. ADDC. Al Ain region. To alleviate capacity shortfall in Maqayd 220/33kV grid station and meet the increasing demand requirements in the area.</td>
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<tr>
<td>14</td>
<td>N6734</td>
<td>R</td>
<td>132kV OHL works from 400/132kV QDfa grid station to 132/33kV substation in Dibba (via Al Khumer and Suwai).</td>
<td>132 MRTS. Network security. PWWA/SEWA. Fujairah. To provide 132kV OHL transfer capability and secure the supplies to Al Khumer, Dibba, Dhatuma and Tarayeb 132/33kV substations.</td>
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<tr>
<td>15</td>
<td>97204 LadC, N7144-A</td>
<td>R</td>
<td>132/11kV substation at ERID (QIZ/D) and related 1320kV cable works.</td>
<td>132 MRTS. Growth. ADDC. Abu Dhabi Island. a) To meet demand growth in EZ1 Sector and vicinity area. b) Relieve the loading on the existing EZ1-132/11kV substation (HTCO).</td>
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<tr>
<td>16</td>
<td>97204 LadC, N7144-A</td>
<td>R</td>
<td>132/11kV substation for Presidential Palace (PRPD) and related 1320kV cable works.</td>
<td>132 MRTS. Growth. ADDC. Abu Dhabi Island. To meet Presidential palace demand requirements.</td>
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<td>17</td>
<td>N7022</td>
<td>R</td>
<td>1320kV cable interconnection works between 132kV substations in TAMUR (Reem Island) and SOWK (Suwai Island).</td>
<td>132 MRTS. Network security. TRANSCO. Reem and Suwai Islands. To comply with network security.</td>
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<td>18</td>
<td>96887-A, N6525, N6755, N6632 YC1</td>
<td>R</td>
<td>132kV cable interconnection works between Babah 400/132kV grid station and 132kV substations in Abu Dhabi Group.</td>
<td>132 MRTS. Growth. TRANSCO. Eastern region. To secure supplies to 132kV substations in Babah Demand Group.</td>
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<td>19</td>
<td>96884-18, N6685-1</td>
<td>R</td>
<td>132/11kV substation at Mohamed Bin Zayed City (NACAA-28/05) and related 132kV cable works.</td>
<td>132 MRTS. Growth. ADDC. Eastern region. To meet demand growth in Mohamed Bin Zayed City.</td>
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<td>Project Name</td>
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<td>Connection Category</td>
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<tr>
<td>1</td>
<td>C/13-0311</td>
<td>P</td>
<td>400kV OHL - Shuaibat /S'wa Turn-in works into Braika Switchyard-1 and related remote end works.</td>
<td>400 Entry Point</td>
<td>Strategic expansion.</td>
<td>ENEC.</td>
<td>Western region.</td>
<td>To facilitate start-up operations of Barakah nuclear power plant and integrate phased nuclear power generation at Braika from 2017-2020.</td>
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<td>2</td>
<td>C/13-03014</td>
<td>P</td>
<td>400kV OHL - recollection works between Bhalu TANE-TWPS. Works programme staged through 2015-2017.</td>
<td>400 ARTS.</td>
<td>Government initiative.</td>
<td>TRANSCO.</td>
<td>Eastern region.</td>
<td>a) Facilitate freeing of 400kV bays at TANE to enable planned 400kV OHL connection to TWPS/Shuwaikh (in 2017) and thereby eliminate the current generation constraint at TANE. b) Enable diverting 400kV OHL along the ADST-Saddayi-Bahira corridor.</td>
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<tr>
<td>3</td>
<td>C/13037</td>
<td>R</td>
<td>400kV OHL - works between Ruways (PRWSG) and Baab (BABS) grid stations.</td>
<td>400 ARTS.</td>
<td>Strategic expansion.</td>
<td>TRANSCO.</td>
<td>Western region.</td>
<td>To facilitate power evacuation from Shuaibat S3 generation and enhance the transfer capability across West-East corridor.</td>
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<tr>
<td>4</td>
<td>C/13-03223</td>
<td>P</td>
<td>400kV reactors at Sae Al Nahbeh (GASN).</td>
<td>400 ARTS.</td>
<td>Network security.</td>
<td>TRANSCO.</td>
<td>Eastern region.</td>
<td>a) Required for MIV compensation due to long and increased 400kV cables circuits in TRANSCO network b) For stabilisation and voltage control under light load conditions c) Achieve lower line losses.</td>
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<td>5</td>
<td>C/13034</td>
<td>R</td>
<td>400/220/11kV grid station at Mifra.</td>
<td>400 Entry Point</td>
<td>Strategic expansion.</td>
<td>TBA.</td>
<td>Western region.</td>
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<td>6</td>
<td>C/13035-A (i.e. LOT-1A)</td>
<td>R</td>
<td>400kV OHL works between Mifra-Ruways.</td>
<td>400 ARTS.</td>
<td>Strategic expansion.</td>
<td>TRANSCO.</td>
<td>Western region.</td>
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<td>7</td>
<td>C/13035-B (i.e. LOT-2A)</td>
<td>T</td>
<td>400/220kV Dual OHL works between Mifra and (IP-A near Central 220kV grid station.</td>
<td>400 &amp; 220 ARTS.</td>
<td>Strategic expansion.</td>
<td>TRANSCO.</td>
<td>Western region.</td>
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<td>8</td>
<td>C/13035-B (i.e. LOT-2C)</td>
<td>T</td>
<td>400kV double circuit OHL between (IP-B near Central 220kV grid station to Al Faya junction point.</td>
<td>400 ARTS.</td>
<td>Strategic expansion.</td>
<td>TRANSCO.</td>
<td>Eastern region.</td>
<td></td>
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<tr>
<td>9</td>
<td>C/13035-B (i.e. LOT-2D)</td>
<td>T</td>
<td>400kV double circuit OHL between from Al Faya junction point to New 400/220kV Shamal grid station.</td>
<td>400 ARTS.</td>
<td>Strategic expansion.</td>
<td>TRANSCO.</td>
<td>Eastern region.</td>
<td></td>
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<tr>
<td>10</td>
<td>C/13035-C (i.e. LOT-1B)</td>
<td>R</td>
<td>Diversen works of existing 220kV OHL into the new Mifra 400/220/11kV grid station (Elfin, Bash and Buhasa (later Madnat Zayed) 220kV OHL circuits.</td>
<td>220 ARTS.</td>
<td>Strategic expansion.</td>
<td>TRANSCO.</td>
<td>Western region.</td>
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<tr>
<td>11</td>
<td>C/13035-C (i.e. LOT-2B)</td>
<td>R</td>
<td>220kV double circuit OHL works from (IP-A near Central 220kV grid station to Central 220/33kV grid station.</td>
<td>220 ARTS.</td>
<td>Strategic expansion.</td>
<td>TRANSCO.</td>
<td>Western region.</td>
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<tr>
<td>12</td>
<td>C/13042</td>
<td>T</td>
<td>220(11kV) OHL works - from ASAB Switching Station to ADCC facilities (ASAF).</td>
<td>220 ARTS.</td>
<td>OIL &amp; gas.</td>
<td>ADCC.</td>
<td>Western region.</td>
<td>To provide 220kV supplies to feed a new 220/33kV ADCC facility near ASAB.</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>N/A</td>
<td></td>
<td>11kV grid station and related 220kV OHL turn-in works at Habshan 2 (OGSU).</td>
<td>220 Entry Point</td>
<td>OIL &amp; gas.</td>
<td>GASCO.</td>
<td>Western region.</td>
<td>To meet demand requirements of nitrogen re-rejection unit in Habshan-2 area.</td>
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</tbody>
</table>

**Table 10-1 High-Level Summary of Year-Wise Major Capital Power Projects (Load and Non-Load Requirements) - Planning Period 2013-2020**
<table>
<thead>
<tr>
<th>L.N.</th>
<th>Project Status</th>
<th>Project Name</th>
<th>Voltage Level (kV)</th>
<th>Connection Category</th>
<th>Initiative Category</th>
<th>Driver/Location</th>
<th>Drivers/Needs</th>
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<tr>
<td>14</td>
<td>P</td>
<td>3rd 220/33kV transformer and extension works at Ruwais 220/33kV grid station</td>
<td>220</td>
<td>Exit Point. Growth</td>
<td>ADDC. Western region.</td>
<td>To meet demand growth in Ruwais area.</td>
<td></td>
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<tr>
<td>15</td>
<td>R</td>
<td>120/33kV grid station at Al Ain Al Fatha (AAIF) and related 220kV OHL/cable works.</td>
<td>220</td>
<td>Exit Point. Growth</td>
<td>ADDC. Al Ain region.</td>
<td>To meet demand requirements in Al Ain Al Fatha region (Shaab Al Ashkari Housing, Jabel Hafeet Cluster and Numa (1287 Shalabia).</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>R</td>
<td>220/33kV grid stations at Towayya (TWA) and related 220kV cable works.</td>
<td>220</td>
<td>Exit Point. Growth</td>
<td>ADDC. Al Ain region.</td>
<td>a) To meet demand growth in Dahma and Towayya area. b) Major developments are Aero structure composite manufacturing plant - phase 1. Shalabiya, Mohammed Bin Rashid Commercial Complex, Al Ain water distribution network. c) Provide additional capacity to Dahma area from 2016.</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>R</td>
<td>220/33kV grid station at Al Ain Power House (AAPH) and related 220kV cable works.</td>
<td>220</td>
<td>Exit Point. Growth</td>
<td>ADDC. Al Ain region.</td>
<td>a) To meet demand growth in Al Ain Power House/City Centre area. b) Provide additional capacity to offset decommissioning of existing generation at Al Ain Power Station after 2015. c) Minimize risk of loss of supply due to operational restrictions. Existing 220/33kV grid station design is not fully compliant with the current security of supply standard.</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>R</td>
<td>New 220/33kV grid station at Zakher (replacement of existing 220/33kV grid station and related 220kV cable works.</td>
<td>220</td>
<td>Exit Point. Growth</td>
<td>ADDC. Al Ain region.</td>
<td>a) To meet demand growth in Zakher area. b) Minimize risk of loss of supply due to operational restrictions. Existing 220/33kV grid station design is not fully compliant with the current security of supply standard.</td>
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<tr>
<td>19</td>
<td>T</td>
<td>3rd 220/33kV transformer and extension works at Al Ishfah 220/33kV grid station.</td>
<td>220</td>
<td>Exit Point. Growth &amp; Network Security</td>
<td>ADDC. Al Ain region.</td>
<td>a) To meet demand growth in Al Ishfah area. b) Reduce single-phase 33kV fault level.</td>
<td></td>
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<tr>
<td>20</td>
<td>P</td>
<td>Sharika 1 (15MV) and Sharika 2 (25MV) 220/13kV mobile stations - De-commission, dismantle, packing and re-locate to other potential TRANSCO site.</td>
<td>220</td>
<td>Exit Point. Asset management</td>
<td>FEWA. Fujairah.</td>
<td>a) To meet Sharikian demand after the retirement of SEWA generation. b) Facilitate retirement of existing SEWA inefficient generation at Khorfakkan.</td>
<td></td>
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<tr>
<td>21</td>
<td>P</td>
<td>3rd 132/33kV transformer and 132kV transformer bay at Khorkifan.</td>
<td>132</td>
<td>Exit Point. Growth</td>
<td>FEWA. Fujairah.</td>
<td>To meet FEWA demand requirements in Fujairah area.</td>
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<tr>
<td>22</td>
<td>R</td>
<td>132/33kV substation at Tianweep.</td>
<td>132</td>
<td>Exit Point. Growth</td>
<td>FEWA. Fujairah.</td>
<td>To meet FEWA demand requirements in Tianweep area.</td>
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<tr>
<td>23</td>
<td>R</td>
<td>132/33kV substation at Corniche Hospital (CHRHO) and related 132kV cable works.</td>
<td>132</td>
<td>Exit Point. Growth</td>
<td>ADDC. Abu Dhabi Island.</td>
<td>a) To meet demand growth in east of Abu Dhabi Island and Tourist Club redevelopment. b) Facilitate transfer of loads from the existing CHP (15/11kV) substation to the proposed CHRHO 132/11kV substation and thereby enabling ADDC plans to phaseout CHP 33/11kV substation.</td>
<td></td>
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<tr>
<td>24</td>
<td>R</td>
<td>132/33kV cable interconnection works between existing MOSS 132/11kV substation and planned 132/11kV substations in M12 (BAICT) and Mohd Bin Zayed City (MCA-20/05).</td>
<td>132</td>
<td>MHTS. Network security</td>
<td>TRANSCO. Eastern region</td>
<td>To comply with network security and secure 132kV supplies at existing MOSS 132/11kV substation and planned 132/11kV substations in M12 (BAICT) and Mohd Bin Zayed City (MCA-20/05).</td>
<td></td>
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<tr>
<td>26</td>
<td>T, R</td>
<td>132/220 kV substation works at Mafraq (MAF2) and related 132kV cable works.</td>
<td>132</td>
<td>Exit Point. Growth</td>
<td>ADDC. Eastern region.</td>
<td>To meet demand growth in Mafraq and vicinity area. Demand drivers are Al Mafraq hotel, Mafraq staff accommodation, Mafraq hospital and Banias developments.</td>
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<tr>
<td>27</td>
<td>R</td>
<td>132/220 kV substation works at Nahda (NAHOD) and related 132kV cable works.</td>
<td>132</td>
<td>Exit Point. Growth</td>
<td>ADDC. Eastern region.</td>
<td>a) To meet demand growth in Nahda and vicinity area (ADSSC sewage treatment plant projects). b) Eliminate the current network arrangement at Mafraq (132/11kV single circuit station) that is non-compliant with TRANSCO’s security of supply license obligations and its associated loss of supply risk.</td>
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<tr>
<td>28</td>
<td>R, R</td>
<td>132/33kV substation works at South Sharikia (SMA2) and related 132kV cable works.</td>
<td>132</td>
<td>Exit Point. Growth</td>
<td>ADDC. Eastern region.</td>
<td>a) To meet demand growth in South Sharikia and vicinity area b) Eliminate the current network arrangement at Sharikia (132MV &amp; 25MV: 220/33kV single circuit stations) that is non-compliant with TRANSCO’s security of supply license obligations and its associated loss of supply risk.</td>
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<tr>
<td>29</td>
<td>P</td>
<td>132kV cable interconnection works between Sharikia and Falah 132kV substations.</td>
<td>132</td>
<td>MHTS. Network security</td>
<td>TRANSCO. Eastern region</td>
<td>Comply with network security.</td>
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<tr>
<td>30</td>
<td>P</td>
<td>132kV cable reconfiguration between SLTC and (33MV 112/11kV substations) decommission 132kV cable circuits between Old Mushrif (MSKO) Mushrif and Old Mushrif (MSKH) Linx. Al Nah.</td>
<td>132</td>
<td>MHTS. Network security</td>
<td>TRANSCO. Eastern region</td>
<td>To facilitate use of existing 132kV bays at MOSS 132/11kV substation for connecting planned 132kV cable circuits from 132kV substations (MCT and MCA2) i.e. enable completion of 132kV cable works related to contracts N67/5, N6485.1.</td>
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<td>Project Name</td>
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<td>Initiative Category</td>
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<td>31</td>
<td>DB 2014 P</td>
<td>240kv OHL to 220kv substations</td>
<td>Bus bar Protection (RNO2 &amp; SK105) Upgrade at various sites</td>
<td>220 &amp; 132</td>
<td>Exit Point</td>
<td>Network security</td>
<td>ADCC &amp; ADDC</td>
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<tr>
<td>32</td>
<td>DB 2014 P</td>
<td>240kv OHL to 220kv substations</td>
<td>Feeder protection upgrade at various sites: 220-WATH-SHAME, WATH-BKH, TBLA-ADGP, SHAME &amp; WPS</td>
<td>400, 220 &amp; 132</td>
<td>WRTS</td>
<td>Network security</td>
<td>TRANSCO</td>
</tr>
<tr>
<td>33</td>
<td>DB 2014 P</td>
<td>220kv OHL to 220kv substations</td>
<td>220kv OHL to 220kv substations</td>
<td>220</td>
<td>WRTS</td>
<td>Network security</td>
<td>TRANSCO</td>
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<tr>
<td>34</td>
<td>DB 2014 P</td>
<td>220kv OHL to 220kv substations</td>
<td>Indoor 132/11kv transformer cooling system upgrade at GLEFA, CPGR, FORT, MRTS, FLAK; CLMS</td>
<td>132</td>
<td>Exit Point</td>
<td>Network security</td>
<td>ADDC</td>
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<tr>
<td>35</td>
<td>DB 2014 P</td>
<td>220kv OHL to 220kv substations</td>
<td>220kv OHL to 220kv substations</td>
<td>220</td>
<td>Exit Point</td>
<td>Network security</td>
<td>TRANSCO</td>
</tr>
</tbody>
</table>

**Commission in Year 2016 - By End Q2 2016**

1. **DB 2014 P**
   - 400kv OHL works between Barakah Switchyard-1 and Ruwais grid station.
   - 400kv OHL to 220kv substations | 400 | Entry Point | Strategic expansion | PNEC | Western region | To facilitate power evacuation from 400kv OHL works between Barakah Switchyard-1 and Ruwais grid station |
2. **DB 2014 P**
   - 400kv OHL to 220kv substations | 400 | Entry Point | Strategic expansion | TBA | Northern Emirates | To facilitate power evacuation from 400kv OHL to 220kv substations |
3. **DB 2014 P**
   - 400kv OHL to 220kv substations | 400 | Exit Point | Strategic expansion | ADDC | Eastern region | To facilitate power evacuation from 400kv OHL to 220kv substations |
4. **DB 2014 P**
   - 400kv OHL to 220kv substations | 220 | Exit Point | Strategic expansion | TRANSCO | Eastern region | To facilitate power evacuation from 400kv OHL to 220kv substations |

**Other**

1. **N/P-13-0015**
   - Conversion of 220kv OHL to 132/11kv transformers at Al Wagan.
   - 220 | Exit Point | Replacement | ADDC | Al Ain region | To facilitate power evacuation from Conversion of 220kv OHL to 132/11kv transformers at Al Wagan |
2. **DB 2014 P**
   - 132 | Exit Point | Replacement | ADDC | Al Ain region | To facilitate power evacuation from 132/11kv OHL to 132/11kv transformers at Al Ain South West |
3. **DB 2014 P**
   - 132/11kv OHL to 132/11kv transformers at Al Ain West.
   - 132 | Exit Point | Replacement | ADDC | Al Ain region | To facilitate power evacuation from 132/11kv OHL to 132/11kv transformers at Al Ain West |
4. **DB 2014 P**
   - 132/11kv OHL to 132/11kv transformers at Al Ain South East.
   - 132 | Exit Point | Replacement | ADDC | Al Ain region | To facilitate power evacuation from 132/11kv OHL to 132/11kv transformers at Al Ain South East |
5. **DB 2014 P**
   - 132/11kv OHL to 132/11kv transformers at Al Ain North.
   - 132 | Exit Point | Replacement | ADDC | Al Ain region | To facilitate power evacuation from 132/11kv OHL to 132/11kv transformers at Al Ain North |
6. **N/P-13-0016**
   - 132/11kv OHL to 132/11kv transformers at Al Ain North East.
   - 132 | Exit Point | Replacement | ADDC | Al Ain region | To facilitate power evacuation from 132/11kv OHL to 132/11kv transformers at Al Ain North East |
7. **DB 2014 P**
   - 132/11kv OHL to 132/11kv transformers at Al Ain South East.
   - 132 | Exit Point | Replacement | ADDC | Al Ain region | To facilitate power evacuation from 132/11kv OHL to 132/11kv transformers at Al Ain South East |
8. **DB 2014 P**
   - 132 | Exit Point | Replacement | ADDC | Al Ain region | To facilitate power evacuation from 132/11kv OHL to 132/11kv transformers at Al Ain South West |
9. **DB 2014 P**
   - 132/11kv OHL to 132/11kv transformers at Al Ain South East.
   - 132 | Exit Point | Replacement | ADDC | Al Ain region | To facilitate power evacuation from 132/11kv OHL to 132/11kv transformers at Al Ain South East |
10. **DB 2014 P**
    - 132 | Exit Point | Replacement | ADDC | Al Ain region | To facilitate power evacuation from 132/11kv OHL to 132/11kv transformers at Al Ain South West |
11. **N/P-13-0017**
    - 132/11kv OHL to 132/11kv transformers at Al Ain South East.
    - 132 | Exit Point | Replacement | ADDC | Al Ain region | To facilitate power evacuation from 132/11kv OHL to 132/11kv transformers at Al Ain South East |
12. **DB 2014 P**
    - 132/11kv OHL to 132/11kv transformers at Al Ain South East.
    - 132 | Exit Point | Replacement | ADDC | Al Ain region | To facilitate power evacuation from 132/11kv OHL to 132/11kv transformers at Al Ain South East |
13. **N/P-13-0018**
    - 132/11kv OHL to 132/11kv transformers at Al Ain South East.
    - 132 | Exit Point | Replacement | ADDC | Al Ain region | To facilitate power evacuation from 132/11kv OHL to 132/11kv transformers at Al Ain South East |
14. **DB 2014 P**
    - 132/11kv OHL to 132/11kv transformers at Al Ain South East.
    - 132 | Exit Point | Replacement | ADDC | Al Ain region | To facilitate power evacuation from 132/11kv OHL to 132/11kv transformers at Al Ain South East |
15. **DB 2014 P**
    - 132/11kv OHL to 132/11kv transformers at Al Ain South East.
    - 132 | Exit Point | Replacement | ADDC | Al Ain region | To facilitate power evacuation from 132/11kv OHL to 132/11kv transformers at Al Ain South East |
16. **N/P-13-0019**
    - 132/11kv OHL to 132/11kv transformers at Al Ain South East.
    - 132 | Exit Point | Replacement | ADDC | Al Ain region | To facilitate power evacuation from 132/11kv OHL to 132/11kv transformers at Al Ain South East |
<table>
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<tr>
<th>L.N.</th>
<th>Budget Code/Contract No</th>
<th>Project Status</th>
<th>Project Name</th>
<th>Voltage level (kV)</th>
<th>Connection Category/Driver</th>
<th>Initiative Category</th>
<th>Liver</th>
<th>Location</th>
<th>Driven/Needs</th>
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<tr>
<td>1</td>
<td>2014</td>
<td>P</td>
<td>400kV OHL turn-in works of GCC Sila circuits into Barakah Switchyard-2 and related remote end works.</td>
<td>400</td>
<td>Entry Point</td>
<td>Strategic Expansion</td>
<td>ENEC</td>
<td>Western region</td>
<td>To integrate nuclear power generation at Barakah in phases (from 2017-2020).</td>
</tr>
<tr>
<td>2</td>
<td>2014</td>
<td>P</td>
<td>400kV interconnection works between Barakah Switchyard-1 &amp; 2 and related remote end works.</td>
<td>400</td>
<td>Entry Point</td>
<td>Strategic Expansion</td>
<td>ENEC</td>
<td>Western region</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>2014</td>
<td>P</td>
<td>400kV OHL works between Barakah Switchyard-2 and Madinat Zayed and related remote end works; 400kV extension works at Madinat Zayed.</td>
<td>400</td>
<td>Entry Point</td>
<td>Strategic Expansion</td>
<td>ENEC</td>
<td>Western region</td>
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<td>4</td>
<td>2014</td>
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<td>400kV GIS extension works at Sweihan.</td>
<td>400</td>
<td>Entry Point</td>
<td>Strategic Expansion</td>
<td>TBA</td>
<td>Al-Ain region</td>
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<td>5</td>
<td>2014</td>
<td>P</td>
<td>400kV cable works (3rd circuit) between ADST and Sudayt grid stations.</td>
<td>400</td>
<td>ARTS</td>
<td>Government Initiative</td>
<td>TRANSCO</td>
<td>Eastern region</td>
<td></td>
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<td>6</td>
<td>2014</td>
<td>T</td>
<td>2nd 400/132kV 500MVA transformer, 400kV and 132kV bay extension works at Saf Al Nahda.</td>
<td>400</td>
<td>ARTS</td>
<td>Strategic Expansion</td>
<td>TRANSCO</td>
<td>Eastern region</td>
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<td>7</td>
<td>2015</td>
<td>P</td>
<td>Retranslate SACH-ICAD-400kV OHL circuit to its original ICAD-MOSG circuit configuration.</td>
<td>400</td>
<td>ARTS</td>
<td>Network Security</td>
<td>TRANSCO</td>
<td>Eastern region</td>
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<td>8</td>
<td>2014</td>
<td>P</td>
<td>400kV OHL circuits between ADST-SDIY-400kV extension and ADST-MOH-supergrid.</td>
<td>399</td>
<td>ARTS</td>
<td>Asset management</td>
<td>TRANSCO</td>
<td>AD island &amp; Eastern region</td>
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<tr>
<td>9</td>
<td>2015</td>
<td>P</td>
<td>400kV OHL circuits between SACH-MOH-MOSG corridor-De-commission and dismantle.</td>
<td>400</td>
<td>ARTS</td>
<td>Asset management</td>
<td>TRANSCO</td>
<td>Eastern region</td>
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<tr>
<td>10</td>
<td>2014</td>
<td>P</td>
<td>220kV OHL works to New Dabiba facilities.</td>
<td>220</td>
<td>Exit Point</td>
<td>Oil &amp; Gas</td>
<td>ADCO</td>
<td>Western region</td>
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<tr>
<td>11</td>
<td>2014</td>
<td>P</td>
<td>220kV capacitor banks at New Zahid 220/132kV grid station.</td>
<td>220</td>
<td>ARTS</td>
<td>Network Security</td>
<td>TRANSCO</td>
<td>Al-Ain region</td>
<td>To provide steady state reactive power support.</td>
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<tr>
<td>12</td>
<td>2015</td>
<td>R</td>
<td>Welatiba 220/33kV grid station equipment - Decommission, dismantle and transport to stores.</td>
<td>220</td>
<td>Exit Point</td>
<td>Project management</td>
<td>ADDC</td>
<td>Eastern region</td>
<td></td>
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<tr>
<td>13</td>
<td>2014</td>
<td>P</td>
<td>Mahaw 220/33kV grid station equipment; and related 220kV OHL towers in Mahaw/Welatiba area.</td>
<td>220</td>
<td>Exit Point</td>
<td>Project management</td>
<td>ADDC</td>
<td>Eastern region</td>
<td>To loads transferred and secured through new Welatiba 132/33kV substation commissioned in 2014.</td>
</tr>
<tr>
<td>14</td>
<td>2014</td>
<td>P</td>
<td>Mafraaj (LCMD) 220/33kV mobile station - Decommission, dismantle, packing and re-locate to other potential TRANSCO site.</td>
<td>220</td>
<td>Exit Point</td>
<td>Project management</td>
<td>ADDC</td>
<td>Eastern region</td>
<td>Loads transferred and secured through new Mahaw 132/33kV substation commissioned in 2014.</td>
</tr>
<tr>
<td>15</td>
<td>2014</td>
<td>P</td>
<td>220kV works for integrating Taqiy’s Waste to Energy Plant integration.</td>
<td>220</td>
<td>Entry Point</td>
<td>Strategic expansion</td>
<td>Taqiy</td>
<td>Eastern region</td>
<td>To integrate Taqiy’s Waste to Energy Plant integration at ICAD.</td>
</tr>
<tr>
<td>16</td>
<td>2014</td>
<td>P</td>
<td>132/33kV substation at Al Faya and related 132kV cable works.</td>
<td>132</td>
<td>Exit Point</td>
<td>Growth &amp; Network security</td>
<td>ADDC</td>
<td>Eastern region</td>
<td>a) To meet demand requirements in Al Faya area. b) To eliminate the network arrangement that is non-compliant with TRANSCO’s security of supply license obligations and its associated loss of supply risk as a result of supplying loads by non-secure single circuit. 220/33kV mobile station at Faya (135kS).</td>
</tr>
<tr>
<td>17</td>
<td>2014</td>
<td>P</td>
<td>132/11kV substation at Khafji-8 and related 11kV cable works.</td>
<td>132</td>
<td>Exit Point</td>
<td>Growth</td>
<td>ADDC</td>
<td>Eastern region</td>
<td>To meet ADDC demand requirements in Khafji-8 area.</td>
</tr>
<tr>
<td>18</td>
<td>2014</td>
<td>P</td>
<td>4k-1k-11kV transformer at Welatiba.</td>
<td>132</td>
<td>Exit Point</td>
<td>Growth</td>
<td>ADDC</td>
<td>Eastern region</td>
<td>Alleviate capacity shortfall and meet ADDC demand requirements in Welatiba area.</td>
</tr>
<tr>
<td>19</td>
<td>2014</td>
<td>P</td>
<td>220kV cable interconnection works between Reem Island and Abu Dhabi Island (QUHM Zone).</td>
<td>132</td>
<td>ARTS</td>
<td>Growth &amp; Network security</td>
<td>TRANSCO</td>
<td>AD Island</td>
<td>a) Alleviate capacity shortfall in QUHM/RECH Zone beyond 2018. b) Need for additional 400kV cable-circuits with RO/Island (ADST-QUHM or QUHM-RECH) could be delayed. c) Need for a new 400/132kV grid station in AD Island could be delayed. d) Utilisation of RECM-400/132kV grid station could be improved significantly in the medium to long-term.</td>
</tr>
<tr>
<td>20</td>
<td>2014</td>
<td>P</td>
<td>500kV (connected at 132kV switchgear) at Beach 400/132kV grid station.</td>
<td>132</td>
<td>ARTS</td>
<td>Network security</td>
<td>TRANSCO</td>
<td>AD Island</td>
<td>To provide dynamic reactive power support capability to the transmission grid and aid in the post fault voltage recovery.</td>
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</tbody>
</table>
## High-Level Summary

<table>
<thead>
<tr>
<th>L.N</th>
<th>Budget Code/Contract No</th>
<th>Project Status</th>
<th>Project Name</th>
<th>Voltage level (kV)</th>
<th>Connection Category</th>
<th>Initiative Category</th>
<th>User</th>
<th>Location</th>
<th>Drivers/Needs</th>
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<tbody>
<tr>
<td>22</td>
<td>DB 2014</td>
<td>P</td>
<td>FMS upgrade at various sites in Al Ain region.</td>
<td>400 kVTS</td>
<td>Strategic Expansion</td>
<td>TRANSCO Eastern region</td>
<td>Network security</td>
<td>Asset replacement due to ageing.</td>
<td></td>
</tr>
</tbody>
</table>

### Commission in Year 2018 - by End Q2 2018

1. **DB 2015**
   - 400kV switching station at Hamweel; related 400kV CHL turn-in and remote end works.
   - 400 kVTS Strategic Expansion TRANSCO Eastern region
   - A) Enable additional transmission corridors across West-East to facilitate power evacuation from Braka nuclear power plants, Shuwaikh and Mefta power plants. B) Strengthen 400kV network across West-East and East-Al Ain corridors. C) Improve the dynamic performance of the network.

2. **DB 2015**
   - 400kV CHL works between Al Ain Switchyard 2 and Boab (BAIBG) and related remote end works.
   - 400 kVTS Strategic Expansion TRANSCO Western region
   - To facilitate power evacuation from Braka nuclear power plants.

3. **DB 2015**
   - 400kV CHL works between New Boab 400/220kV grid station (BAIBG) to Hamweel 400kV switching station.
   - 400 kVTS Strategic Expansion TRANSCO Western & Eastern region
   - To facilitate power evacuation from Braka nuclear power plants and strengthen West-East 400kV corridor.

4. **DB 2015**
   - 400 400/132kV (500MVA) transformer and related extension works at Mahawi grid station.
   - 400 kVTS Growth TRANSCO Eastern region
   - To meet demand growth in Mahawi zone.

5. **DB 2015**
   - Al Faya (33kV) 220/33kV mobile station - De-commission, dismantle, packing and re-locate to other potential TRANSCO site.
   - 220 kVTS Exit Point Asset management ADDC Eastern region
   - Loads transferred to New 132/33kV substation at Al Faya as part of non-compliance mitigation plan in Faya area.

6. **DB 2015**
   - 220kV CHL circuits between Umm Al Nar and Mussafah - De-commission and dismantle; Re-configures 220kV CHL circuits between MOSG-MMSC.
   - 220 kVTS Asset management TRANSCO Eastern region
   - Umm Al Nar Power Plant decommissioned.

7. **DB 2015**
   - Capacitor banks at Al Ain-400/132kV grid station (WSTG), Salamit 220/132kV grid station (NAIBG) and Nahita 112/33kV substation (NAISC).
   - 220 & 132 kVTS Network security TRANSCO Northern Emirates, Eastern and Al Ain regions
   - To provide steady state reactive power support.

8. **DB 2015**
   - SVCs (connected at 132kV switchgear) at Mahawi-400/132kV grid station.
   - 132 kVTS Network security TRANSCO Eastern region
   - To provide dynamic reactive power support capability to the transmission grid and aid in the post fault voltage recovery.

9. **DB 2015**
   - 132/33kV substation at Rawdah and related 132kV cable works.
   - 132 kVTS Exit Point Growth ADDC AD Island
   - To meet demand growth in Rawdah and vicinity area.

10. **DB 2015**
    - 132/11kV T101 & T202 transformer replacement at Embassy substation (WSTG).
    - 132 kVTS Exit Point Network Security ADDC Abu Dhabi Island
    - Asset replacement due to ageing.

### Commission in Year 2019 - by End Q2 2019

1. **DB 2016**
   - 400kV CHL turn-in works between Shahama and Saeihan into Shamka-400/132kV grid station; and related remote end works.
   - 400 kVTS Strategic Expansion TRANSCO Eastern region
   - Facilitate power evacuation from West to East Corridor.

2. **DB 2016**
   - 400kV CHL works between Hamweel and Al Ain South junction; and related remote end works.
   - 400 kVTS Strategic Expansion TRANSCO Eastern/Al Ain region
   - A) Enable additional transmission corridors across West-East to facilitate power evacuation from Braka nuclear power plants, Shuwaikh and Mefta power plants. B) Strengthen 400kV network across West-East and East-Al Ain corridors. C) Improve the dynamic performance of the network.

3. **DB 2016**
   - SVCs (connected at 220kV switchgear) at New 220/132kV grid station in Al Ain Power House (AAPS).
   - 220 kVTS Network security TRANSCO Al Ain region
   - To provide dynamic reactive power support capability to the transmission grid and aid in the post fault voltage recovery.

4. **DB 2016**
   - SVCs (connected at 132kV switchgear) at QIAFM 400/132kV grid station.
   - 132 kVTS Network security TRANSCO AD Island
   - To provide dynamic reactive power support capability to the transmission grid and aid in the post fault voltage recovery.

### Commission in Year 2020 - by End Q2 2020

1. **DB 2017**
   - 400kV switching station at Al Faya; related 400kV CHL Turn-in and remote end works.
   - 400 kVTS Strategic Expansion TRANSCO Eastern region
   - A) Enable additional transmission corridors across West-East to facilitate power evacuation from Braka nuclear power plants, Shuwaikh and Mefta power plants. B) Strengthen 400kV network across West-East and East-Al Ain corridors. C) Improve the dynamic performance of the network.