شركة أبوظبي للماء والكهرباء
Abu Dhabi Water & Electricity Company

ADWEC 2008

Statement of Future Capacity Requirements

2008 – 2030

Law Number Two (2)

Law No (2) of 1998 with Amendment of 2007 Concerning the Regulation of the Water and Electricity Sector in the Emirate of Abu Dhabi, places a number of legal obligations on the Abu Dhabi Water and Electricity Company. The key Articles are reproduced below.

Article 30

Duty to Match Capacity to Demand

It shall be the duty of the Abu Dhabi Water and Electricity Company to ensure that there is provided sufficient production capacity to ensure that, at all times, all reasonable demands for water and electricity in the Emirate are satisfied.

Article 32

Capacity Planning Duty

The Abu Dhabi Water and Electricity Company shall, for the purpose of ensuring the long term security of the supply of water and electricity in the Emirate, determine annually in respect of each year and the next five years, the requirement for the provision of:

(1) new or additional capacity for water desalination
(2) new or additional electricity generation capacity
(3) new or additional water storage capacity.

In order to perform its obligations in Article 30 of this Law and in any case where such requirement exists, the Abu Dhabi Water and Electricity Company shall contract for the provision of such new or additional production capacity with those persons operating existing production facilities or persons wishing to provide new such facilities.

In order to meet the above legal requirements ADWEC prepares the following items annually:

(1) A Long Term Electricity and Water Demand Forecast
(2) A Statement of Future Capacity Requirements.

This *ADWEC Statement of Future Capacity Requirements* replaces all previous *ADWEC Statements of Future Capacity Requirements*.

ADWEC's latest demand forecast, *ADWEC's Electricity & Water Demand Forecasts 2008 – 2030*, (for the Emirate of Abu Dhabi only) is available on request or via ADWEC's website www.adwec.ae

ADWEC Licence Conditions 18.1 & 18.2
Statement of Future Capacity Requirements

18.1. The Licensee shall once every year (and not later than such date as the Bureau shall specify), and after consultation with other licensed operators, prepare and publish, in accordance with such requirements as the Bureau shall from time to time specify, a statement (in a form approved by the Bureau) showing in respect of each of the seven succeeding financial years:

(i) its projections of the amount of demand for relevant capacity in the Emirate of Abu Dhabi in that year;

(ii) the amount and nature of relevant capacity available to it that it expects will be taken out of service permanently in those years;

(iii) the amount and nature of relevant capacity it expects it shall require to be available to it in order to ensure that the desalination and generation security planning standards shall be met; and

(iv) in respect of the first five financial years only, general details of its then current plans for securing that additional relevant capacity shall be so available to it,

together with:

- such further information as shall be reasonably necessary to enable any person seeking opportunities to provide any such additional relevant capacity to identify and evaluate such opportunities;
- a commentary prepared by the Licensee indicating its views as to those parts of the Emirate of Abu Dhabi where such additional relevant capacity would be most appropriately located and the nature of the relevant capacity required in such places; and
- such other matters as shall be specified in directions issued by the Bureau from time to time for the purposes of this Condition.

18.2. The Licensee may with the prior consent of the Bureau omit from any such statement any details as to its current plans for securing additional relevant capacity disclosure of which would, in the view of the Bureau, seriously and prejudicially affect the commercial interests of the Licensee or any third party.

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Preface

Article 32 of Law Number 2 of 1998 places a general obligation on ADWEC to determine annually the requirements during the next five years for additional electricity generation capacity and water desalination capacity. Condition 18 of ADWEC's License essentially extends Law Number 2's requirement to seven years, but with more detailed requirements for the first five years. These more detailed requirements include ADWEC's views on where additional capacity should be located and additional information that potential bidders may require.

This *ADWEC Statement of Future Capacity Requirements* is designed to fulfil the requirements of Law Number 2 of 1998 (including any related amendments from Law Number 19 of 2007) and Condition 18 of ADWEC's License.

ADWEC's obligation to prepare each year an electricity and water demand forecast for the Emirate of Abu Dhabi was met via *ADWEC's Electricity & Water Demand Forecasts 2008 – 2030* presented to the MEED Middle East Power & Water Conference in Abu Dhabi on 17-18 March 2008. It was through the MEED Middle East Power & Water Conference that ADWEC's latest demand forecasts for the Emirate of Abu Dhabi were initially released into the public domain. A copy of ADWEC's demand forecast presentation (for the Emirate of Abu Dhabi only) to the MEED conference can be found on ADWEC's website www.adwec.ae.

Copies of ADWEC's demand forecasts presentations and ADWEC's *Statement of Future Capacity Requirements* are also available on request from

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1. Introduction

The purpose of this ADWEC *2008 Statement of Future Capacity Requirements* (*Statement*) is to identify how much additional capacity will be required (unplanned capacity additions) after taking into account the existing planned capacity additions / retirements and ADWEC's latest demand forecasts.

Scope

In keeping with the requirements of Law Number 2 and ADWEC's License, previous versions of this *Statement* only considered the capacity requirements for the Emirate of Abu Dhabi. Starting with the 2008 *Statement* however, it has become necessary to consider ADWEC's long-term firm export contracts when calculating future capacity requirements. Since these export contracts are firm (i.e. not interruptible) and for the entire year they will require dedicated firm capacity, in addition to the Emirate of Abu Dhabi's capacity requirements. These exports contracts cannot be supplied with electricity on a firm basis from Abu Dhabi's Generation Security Standard reserve capacity, as to do so would violate the GSS of LOLE 0.1 for the Emirate of Abu Dhabi.

At the end of May 2008 ADWEC had long-term supply firm contracts with Fujairah Energy Company (FEC) and the Federal Electricity and Water Authority (FEWA). The FEC contract's maximum firm exports are 450 MW and this maximum is attained in 2012. After 2012 ADWEC's exports to FEC remain capped at 450 MW.

The FEWA's contract's maximum firm exports are 600 MW in 2008. This maximum gradually increases such that the 2,500 MW maximum commitment is attained in 2015. After 2015 ADWEC's exports to FEWA remain capped at 2,500 MW.

Both of the above contracted export quantities exclude transmission losses and auxiliaries. Consequently when estimating future capacity requirements transmission losses and auxiliaries must be added onto the above contracted quantities. In 2010 ADWEC's firm export contracts with FEC and FEWA will have a combined export of 1250 MW, and rise to 2950 MW by 2015. FEC will use the electricity supplied by ADWEC under contract to supply mainly industrial consumers, whereas FEWA will use the electricity supplied by ADWEC under contract to supply smaller customers, mainly residential. In 2007 the Federal Court sent letters to all Emirates supplied by FEWA asking the Emirates to take responsibility for power projects relating to all commercial buildings. As a result FEWA is now only responsible for residential power supply.[1]

Thus although Law Number 2 and ADWEC's License only requires that this *Statement* consider the capacity requirements for the Emirate of Abu Dhabi, it is now certain that ADWEC will be exporting some electricity and water outside of the Emirate of Abu Dhabi to the Northern Emirates on a firm basis via existing signed export contracts.

[1] The National, Wednesday June 11, 2008.

For 2008 only, ADWEC has a short-term electricity export contract to supply up to 200 MW to SEWA. At the time of writing however, this electricity export contract with SEWA did not extend beyond 2008, consequently no further exports to SEWA have been assumed after the end of 2008. Based on ADWEC's experience with the Emirates National Grid since it went live in May 2006, it is considered likely by ADWEC that further as yet unidentified exports to the other UAE utilities will occur in future years. Since no firm export contracts existed at the time of writing however, other than the FEC / FEWA firm export contracts discussed previously, it has been agreed with the RSB that for the purposes of preparing the ADWEC 2008 *Statement* these likely but as yet unidentified electricity exports to the other UAE utilities should be excluded from the analysis. As with all assumptions, ADWEC will carefully review this assumption during the preparation of future ADWEC *Statements of Future Capacity Requirements*.

By 2015 ADWEC's firm contracted electricity exports to the Northern Emirates will be 2,950 MW (FEC + FEWA contracts, but excluding network losses, auxiliaries and F1 / F2 water pumping requirements etc). Further details can be found in Annex A.

Since the indicative supply of electricity to the Northern Emirates must be met on a firm basis, additional generation capacity will need to be procured by ADWEC in order to ensure that the Generation Security Standard (GSS) for the Emirate of Abu Dhabi is not violated. The capacity requirements associated with the firm export supply contracts have been calculated using the same Generation Security Standard (GSS) of LOLE 0.1 as for the Emirate of Abu Dhabi. This assumption has been used to ensure that the Emirate of Abu Dhabi's GSS is not violated.

Note that zero firm electricity exports via the GCC Grid, due to come into operation in 2010, have been assumed when preparing this *Statement*. Note that this assumption does not exclude the possibility of future exports to the other five GCC countries, it simply implies that these exports must be supplied on an interruptible basis during off peak hours or utilise spare capacity (if any) over and above that necessary to ensure the Emirate of Abu Dhabi's GSS is not violated. In 2007 ADWEC exported electricity to DEWA, FEWA and SEWA in order to utilise spare capacity and lower the sector's units costs via better fuel efficiency and higher capacity load factors etc.

In the case of ADWEC's firm water exports, the indicative peak supply of water to the Northern Emirates ranges from 20 MGD in 2008 / 2009 to 30 MGD from 2010 onwards. The only possible source of water supply for the Northern Emirates' exports is from the Fujairah F1 and F2 stations. Further details can be found in Annex A.

Note that unlike water, electricity can be supplied to the Northern Emirates from any station via the Emirates National Grid (ENG). The ENG, along with the associated transmission facilities, became fully operational in April 2008. The indicative supply of electricity to the Northern Emirates (+ transmission losses), the auxiliary electricity consumption of the Fujairah F1 and F2 IWPPs and the electricity consumed for water pumping purposes combine to reduce the total amount of generation capacity available to meet the Emirate of Abu Dhabi's required capacity, as calculated via the GSS.

Time Horizon

The time horizon of this *Statement* is 2008 – 2030 inclusive. ADWEC's license only requires ADWEC to prepare a *Statement* for the next seven years, given however rapidly rising demand and the need for sector participants to plan accordingly this *Statement* covers the longer period 2008 – 2030 inclusive. The publication of the Urban Planning Council's *Plan Abu Dhabi 2030* in September 2007 led ADWEC to extend the time horizon of the *Statement* from 2020 to 2030 so that an integrated plan for the Emirate of Abu Dhabi could be developed. Note however that the analysis for the period 2016 – 2030 is primarily for illustrative purposes, and so should not be given the same weight as the analysis for the period before 2015.

Particular emphasis is given to the immediate planning horizon of 2012 – 2013. New IWPPs typically take around 16 months from the issue of the RFP to financial close. Once financial close has been achieved, it takes a further 2 – 3 years to complete the construction and testing of the new IWPP station, approximately 4 years in total for a gas fired station. In the case of crude oil / coal fired stations, it is estimated that it would take around 5 – 6 years to bring new capacity into production from the time an RFP was issued. The current tight supply market means that it now takes longer to procure and install all types of new capacity than at the start of this decade. Consequently the earliest new IWPP capacity can be added to the Abu Dhabi system is 2012, assuming an RFP was issued during the Summer of 2008.

Demand

New Abu Dhabi land ownership laws were announced during the Summer of 2005. These changes in land ownership laws, and the releasing of surplus oil revenues for major infrastructure developments, are expected to result in a construction boom that will likely last for several years.

The Abu Dhabi Government has also announced the creation of Special Economic Zones that will focus on the industrial sector. These special economic zones will be run by the Higher Corporation for Special Economic Zones (Zonescorp). Zonescorp will be setting up 30 industrial clusters and special economic zones, whose purpose is to diversify the economy and to create better opportunities for entrepreneurship. The clusters will take the form of industry specific zones where upstream, downstream and service providers from the same industry will operate. For example, it is planned to create a cluster to service the oil industry.

Besides the Special Economic Zones, the development of Khalifa Port and Industrial Zone (KPIZ) has also been announced. The Abu Dhabi Ports Company (ADPC) has been mandated to oversee the development of the KPIZ. KPIZ will be one of the world's biggest industrial estates and will include a container handling terminal and piers for handling raw and bulk cargoes. The project also offers an industrial estate along with ancillary commercial and residential developments. The industrial estates will be free zones, offering 100 per cent foreign ownership to companies and individuals.

KPIZ will cater to a number of industrial clusters, including base metals, heavy machinery, transport vehicle assembly, chemicals, shipyards, building materials, processed foods and beverages, light manufacturing and assembly, small and medium enterprises, trade and logistics, information and communication technology, alternative energy and others. The first phase will cover an area of 100 square kilometers and replace Abu Dhabi island's existing port, Mina Zayed by 2010. Mina Zayed port will then be redeveloped into a residential and commercial area. KPIZ will be a world class industrial service and logistics hub. It will also support the development of new industries and trade within the port and industrial zones.

The resulting mega demand projects from the above announcements (e.g. Al Raha Beach, Saadiyat Island, Al Reem Island, Abu Dhabi Airport, Special Economic Zones and KPIZ etc) will not only result in a construction boom, but are expected to substantially increase the Emirate of Abu Dhabi's electricity and water demands over and above the *'normal'* rate of developments assumed in the Winter 2004 / 2005 ADWEC demand forecast, the last ADWEC demand forecast prepared before the mega projects were announced. These substantially higher demands will require significant additional quantities of electricity and water capacity.

ADWEC's demand forecasts for the Emirate of Abu Dhabi, presented initially to the MEED Middle East Power & Water Conference in Abu Dhabi on 17 – 18th March 2008 are available on ADWEC's website www.adwec.ae

Capacity

All capacity information shown in this *Statement* refers to **gross capacities** at Reference Site Conditions (typical values for IWPP projects are 46 degrees Celsius ambient temperature, 42% relative humidity and a sea water temperature of 35 degrees Celsius, although the exact values may vary slightly from IWPP) at the time of **system peak demand**.

The capacity additions envisaged in the early planning years are based on the assumption that adequate natural gas supplies will be available, however other fuels may also need to be used in place of gas. The UAE Government's document 'P*olicy of the United Arab Emirates on the Evaluation and Potential Development of Peaceful Nuclear Energy*' noted that '*the known volumes of natural gas that could be made available to the nation's (UAE) electricity sector would be insufficient to meet future demand, providing adequate fuel for only 20,000 - 25,000 MW*'. Since the UAE's 2020 electricity peak demand forecast is 40,858 MW the known volumes of gas are only sufficient to generate 49% - 61% of this total.

The capacity assumptions used in this *Statement* have been prepared on the basis of discussions at the Generation Expansion Planning Committee (GEPC) meetings of the 19th March 2008 and 9th April 2008. The GEPC comprises representatives from ADWEC, TRANSCO and the ADWEA Privatization Directorate.

Planned near term capacity expansion is based on:

(1) The official bidding process statement for the Shuweihat S2 IWPP
(2) ADWEA's press briefing on the ADWEA Strategic Plan 2008 – 2012 held on May 14, 2008 at which it was announced that the next IWPP

would be Shuweihat S3, with net capacities of about 1500 MW and 100 MIGD, and that S3 would start production in either 2012 or 2013 [2]

As a result of firm long-term contracted electricity exports to the Northern Emirates being included in the ADWEC 2008 *Statement* for the first time, it was concluded that additional electricity generation capacity may be required in 2011 and 2012 (in addition to Shuweihat S2 in 2011 and Shuweihat S3 in 2012) in order to satisfy the Generation Security Standard (GSS). Following consultations between ADWEC and the Regulation and Supervision Bureau (RSB)[3], it was agreed that Al Ain station's 256 MW (gross) of capacity should have its retirement date further extended from end-2009 until end-2012.

It was also agreed that the 778 MW (gross) of capacity at Umm Al Nar that was scheduled to be retired before the of end-2010 should also have its retirement date further extended to end-2012. These agreed extended retirement dates of end-2012 have been fully incorporated into this *Statement's* available capacity assumptions. TRANSCO and ADWEC's fuel suppliers etc will need to separately confirm that they can accommodate these lifetime extensions.

ADWEC will make a final decision on whether or not to extend the lifetimes of the above capacities once work on the ADWEC Winter 2008 / 2009 demand forecast has been completed at the end of 2008.

In the case of the 50 MGD of desalination capacity associated with Umm Al Nar's 778 MW of deferred retirement generation capacity, the RSB requested ADWEC to provide some separate analysis on the advantages and disadvantage of retaining this capacity. Since this 50 MGD of capacity is not required in 2011 / 2012 to satisfy the Desalination Security Standard, ADWEC will submit this analysis separately to the RSB after work on the ADWEC 2008 Statement has been concluded.

Demand Forecasts

The Emirate of Abu Dhabi's peak gross electricity demand increased from 2868 MW in 1998 to 5286 MW in 2007, an increase of 84% or 7% per annum. During the same period the Emirate of Abu Dhabi's peak water supply increased from 206.8 MGD in 1998 to about 559 MGD in 2007 an increase of 170% or 12% per annum. For the projection period 2008 - 2030, ADWEC has prepared High, Base / Most-Likely and Low demand forecasts. This increase in water supply, however, is not necessarily representative of the growth in demand due to the network constraints. Al Ain supply, for example increased from less than 40 MIGD in 1998 to over 170 MIGD in 2007; a more than 400% increase. This rapid growth reflects improvements in the water network supplying Al Ain and not the growth in water demand itself.

As with previous *ADWEC Statements of Future Capacity Requirements*, the Base Demand Forecast continues to be the most probable forecast. There are still however a number of unavoidable uncertainties surrounding the latest demand forecast, such as changes in the Abu Dhabi Government's development and infrastructure policy, the

[2] The National, May 14, 2008.
[3] For example, ADWEC's meeting with the RSB of 3rd July 2008 and the RSB's subsequent letter of 7th July 2008 to ADWEC.

size and phasing of the known mega demand projects, the size and timing of as yet unknown mega projects' demands, the potential impact of tariff reforms and other changes in policy (e.g. agriculture, forestry and greenery). In order to meet its License requirements ADWEC updates its demand forecasts at the end of every year, so that new information and policy changes are included in the latest demand forecast.

Because of the above uncertainties, this *Statement* concentrates on the results from the Base Electricity / Most Likely Water Demand Forecast that comprises the Emirate of Abu Dhabi's peak demand plus ADWEC's indicative exports to the Northern Emirates.

The results from the High and Low Electricity and Water Demand forecasts can be found in **Annex A**. Note that that the High and Low electricity demand forecasts only consider the requirements for the Emirate of Abu Dhabi.

2. Statement Timetable

Along with the other monopoly companies in the sector, ADWEC is subject to a rigorous Price Control regime that is enforced by the Regulatory and Supervision Bureau. Under the terms of the current Price Control regime (PC3) one of ADWEC's performance indicators is the delivery of this *Statement of Future Capacity Requirements* to the RSB by 30th June 2008.

The preparation of the 2008 *Statement* was delayed because of the need to incorporate the Urban Planning Council's *Plan Abu Dhabi 2030* into ADWEC's Winter 2008 – 2030 demand forecasts. In this respect ADWEC was 100% dependent on the UPC to provide the necessary additional information needed to complete the demand forecasts, over and above the simple aggregates reported in the UPC's published report *Plan Abu Dhabi 2030*. The preparation of the 2008 *Statement* was also somewhat delayed because of the Emirate of Abu Dhabi Government's desire to provide some basic electricity and water support to the people of the Northern Emirates. Details of these exports of electricity and water to the Northern Emirates can be found in Annex A.

The various mega projects developers were also asked to ensure that their previous electricity and water demand forecasts were still consistent with the UPC's Plan. This requirement for the mega projects' developers to resubmit their demand forecasts inevitably extended the preparation period for this *Statement*. This delay was unavoidable however in order to ensure that the UPC's Plan and the mega projects' demand forecasts were as consistent as possible. Furthermore, the requirement to include the high profile and fast-track KPIZ project necessitated ADWEC delaying finalising the demand forecast until the KPIZ Masterplan became fully available and ADWEC's questions had been satisfactorily answered. The Regulation and Supervision Bureau were formally informed in writing of the delays to the preparation of the demand forecast in late 2007.

The final ADWEC Winter 2007 / 2008 demand forecasts were widely circulated throughout the ADWEA Group of Companies on 25th March 2008, as per the electricity and water Transmission Codes requirements[4].

The Master Agreement between ADWEA (on behalf of ADWEC) and FEWA was signed on May 29th 2008. The Master Agreement is the document governing ADWEC's exports of electricity to FEWA. These exports will reach a maximum of 2,500 MW by 2015. Only once the Master Agreement had been signed could ADWEC begin the analysis required to prepare this *Statement*.

Despite the above delays being outside of ADWEC's control, ADWEC continued its endeavours to complete this *Statement* by the original June 30th 2008 RSB deadline or as soon as practically possible thereafter. The adopted timetable is shown below:

[4] ADWEC Winter 2007/2008 Demand Forecasts Memorandum, March 25th 2008, Reference ADWEC/DPSD/GroupLtr/004/3.08, addressed to the Chairmen of the Electricity and Water Transmission Codes.

ADWEC Statement Timetable

Milestones	Delivery Dates	Status
Electricity & Water Demand Forecast Preparation	01/9/2007 – 09/03/2008	√
Adoption of ADWEC's Electricity and Water Demand Forecast and Demand Forecast Cutoff Date	10/03/2008	√
Electricity & Water Demand Forecast Presentation to MEED Middle East Power and Water Conference in Abu Dhabi	18/03/2008	√
Generation Expansion Planning Committee (GEPC) meeting	19/03/2008	√
Circulation of Final ADWEC Electricity and Water Demand Forecasts to Transmission Code Users	25/03/2008	√
Generation Expansion Planning Committee (GEPC) meeting	9/04/2008	√
Signing of ADWEA and FEWA Master Agreement	29/5/2008	√
Information cutoff date for this Statement	31/5/2008	√
Submission of Statement to RSB	29/06/2008	√

Note that the main purpose of the ADWEC presentation to the MEED Middle East Power and Water Conference in Abu Dhabi on 18th March 2008 was to release ADWEC's latest demand forecasts simultaneously to all potential IWPP developers / lenders / EPC contractors etc in the interests of transparency. The presentation also provided a forum for ADWEC to outline its likely future capacity requirements, based on the latest demand forecasts.

The cutoff date for information to be included in this *Statement* was **31st May 2008**. All information received after this date will be used in the preparation of the next *ADWEC Statement of Future Capacity Requirements* and the Winter 2008 / 2009 Demand Forecast.

3. Recent Capacity Developments

Capacity Definitions

In this *Statement* the following capacity definitions are used:

- **Required Capacity**
  (the amount of capacity required to satisfy either the GSS or DSS)

- **Existing Capacity**
  (after adjusting for planned retirements)

- **Under Construction Capacity**
  (e.g. Taweelah B IWPP, Taweelah A10, Fujairah F1 and Fujairah F2)

- **Committed Capacity**
  (RFP issued, and bids possibly received, but construction not yet started, e.g. Shuweihat S2 IWPP)

- **Planned Capacity**
  (announced but RFP has not been issued, e.g. Shuweihat S3 IWPP)

- **Available Capacity**
  = Existing + Under Construction + Committed + Planned

- **Unplanned Capacity**
  (Required Capacity – Available Capacity)

The above capacity definitions avoid the use of meaningless generic terms such as ‘*new*’ capacity.

Demand Definitions

In addition to the above capacity definitions, the following demand definitions are used to compare total demand with capacity:

- **System Demand**
  (total demand within the Emirate of Abu Dhabi only, i.e. excluding exports)

- **Global Demand**
  (System Demand + exports to the Northern Emirates, including associated auxiliaries, network losses and electricity used for F1 / F2 water pumping and water production etc).

- **Constrained Demand**
  (Total Demand minus Network Constraints)

3.1. Retirement Plans

Abu Dhabi Power Station (ADPS)

Abu Dhabi Power Station was fully retired effective the 31st December 2007.

Al Ain Power Station (AAPS)

Part of Al Ain Power Station consisting of all diesel generators and gas turbines GT01- GT06 was retired as from April 1st 2007.

The remaining part of Al Ain Power Station with ten gas turbines GT07 - GT16 of total gross **256 MW** power capacity, equivalent to a net of 253.2 MW, was originally scheduled to have its retirement extended until at least the end of 2009. As a result of firm long-term contracted electricity exports to the Northern Emirates being included in the ADWEC 2008 *Statement* for the first time, it was concluded that additional electricity generation capacity may be required in 2011 and 2012 (in addition to Shuweihat S2 in 2011 and Shuweihat S3 in 2012) in order to satisfy the Generation Security Standard (GSS). Following consultations between ADWEC and the Regulation and Supervision Bureau (RSB)[5], it was agreed that Al Ain station's 256 MW (gross) of capacity should have its retirement date further extended from end-2009 until end-2012. This agreed extended retirement date of end-2012 has been fully incorporated into the ADWEC 2008 *Statement's* available capacity assumptions. TRANSCO and ADWEC's fuel suppliers etc will need to separately confirm that they can accommodate this lifetime extension.

ADWEC will make a final decision on whether or not to extend the lifetime of the above capacity once work on the ADWEC Winter 2008 / 2009 demand forecast has been completed at the end of 2008.

Madinat Zayed Station

Once Al Ain station has been retired the only remaining single (open) cycle station will be Madinat Zayed. It is currently planned that the Madinat Zayed station will be retired after the 2017 peak, however ADWEC is constantly reviewing the future of all non-IWPP capacity in order to ensure that ADWEC's economic procurement costs are minimised and all reasonable demands can be met.

Umm Al Nar IWPP (Arabian Power Company)

The Umm Al Nar IWPP finished its capacity expansion phase on 21 July 2007 (Project Commercial Operation Date), as detailed in the PWPA with later amendments. Originally part of the existing old capacities were planned to be retired, as per the PWPA.

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[5] For example, ADWEC's meeting with the RSB of 3rd July 2008 and the RSB's subsequent letter of 7th July 2008 to ADWEC.

One potential option for minimising ADWEC's economic purchase costs is to defer the retirement of capacity scheduled for closure. The *ADWEC 2005 Statement of Future Capacity Requirements* concluded that deferring the retirement of capacity at the Arabian Power Company's Umm Al Nar (UAN) IWPP site, originally scheduled for retirement in June 2008, was the most economic way in which to enhance capacity during the period 2008 - 2010. Based on that recommendation, an updated PWPA was signed between ADWEC and APC implementing the deferred retirement. Accordingly, this *Statement* has incorporated the delayed retirement of some UAN capacity in order to meet the short term capacity requirements of 2008 - 2010.

Note that the above deferment in the retirement dates for some Umm Al Nar capacity was the result of higher forecasted electricity demands in 2008 – 2010 (than previously forecasted) primarily because of the announcement of several mega projects in the residential and industrial sectors. At least some of this Umm Al Nar capacity can also burn crude oil as a backup fuel, and so in times of constrained gas supplies this ability to burn crude oil enhances security of supply.

Details of the Umm Al Nar IWPP electricity and water capacities that have had their retirements deferred until the end of 2010 are shown below:

a)	UAN East A	(118 MW)
b)	UAN West 1-6	(360 MW)
c)	UAN West 7-8	(300 MW)
d)	UAN East B	(20 MGD)
e)	UAN West 1-6	(24 MGD)
f)	UAN West 7.1	(6 MGD)

The above Umm Al Nar capacities were originally scheduled to be retired in June 2008.

After the water peak demand of 2006 some 19 MIGD capacity of Umm al Nar East A was retired, along with 17 MIGD at UAN West 7-8 and 3 MIGD at UAN East B. These water capacity retirements decreased the water capacity of Umm Al Nar station from 184 MIGD in 2006 to 145 MIGD from 2007.

Umm Al Nar IWPP 2011 - 2012

As a result of firm long-term contracted electricity exports to the Northern Emirates being included in the ADWEC 2008 *Statement* for the first time, it was concluded that additional electricity generation capacity may be required in 2011 and 2012 (in addition to Shuweihat S2 in 2011 and Shuweihat S3 in 2012) in order to satisfy the Generation Security Standard (GSS). Following consultations between ADWEC and the Regulation and Supervision Bureau (RSB)[6], it was agreed that the 778 MW (gross) of capacity at Umm Al Nar that was scheduled to be retired at the of end-2010 should have its retirement date further extended to end-2012. This agreed extended retirement date of end-2012 has been fully incorporated into the ADWEC 2008 *Statement's* available capacity assumptions.

[6] For example, ADWEC's meeting with the RSB of 3rd July 2008 and the RSB's subsequent letter of 7th July 2008 to ADWEC.

TRANSCO and ADWEC's fuel suppliers etc will need to separately confirm that they can accommodate the Umm Al Nar 2011-2012 lifetime extensions.

ADWEC will make a final decision on whether or not to extend the lifetime of the above capacity once work on the ADWEC Winter 2008 / 2009 demand forecast has been completed at the end of 2008.

In the case of the 50 MGD of desalination capacity associated with Umm Al Nar's 778 MW of deferred retirement generation capacity, the RSB requested ADWEC to provide some separate analysis on the advantages and disadvantage of retaining this capacity. Since this 50 MGD of capacity is not required in 2011 / 2012 to satisfy the Desalination Security Standard, ADWEC will submit this analysis separately to the RSB after work on the ADWEC 2008 Statement has been concluded.

3.2. New Capacity

3.2.1. Taweelah B IWPP (TAPCO)

The Taweelah B IWPP additional capacity consisting of three gas turbines with adjacent heat recovery steam generators, one backpressure steam turbine and four MSF water desalination units, being part of the TAPCO IWPP, is currently under construction. Project commissioning was planned before the electricity and water peak demands of 2008, with gross electricity and water capacities to be added in 2008 about 1037 MW and 69 MIGD. Due to technical problems part of the capacity, around 567 MW and 35 MIGD, may not be available until October 2008. It has been assumed that this capacity will not be available in time for the 2008 annual peak in demand.

3.2.2. Taweelah A10 IWPP (GTTPC)

The Taweelah A10 Project, part of the GTTPC Taweelah A1 IWPP, is currently under construction. The planned date of the Taweelah A10 Project commissioning is 1st May 2009 and the added gross power capacity will be about 257 MW, and comprises 213 MW from two new gas turbines and an additional 44 MW from upgrading of existing capacity.

3.2.3. **Fujairah F1 IWPP** (SembCorp)

In July 2006 a PWPA for the Fujairah F1 IWPP was signed between ADWEC and the Sembcorp Gulf Holding Company Limited.

The gross electricity capacity of the existing F1 IWPP station will be increased by 219.5 MW to 861 MW from February 2009. Water capacity will remain unchanged i.e. 102 MIGD (gross).

Before April 2008 the net output from F1 was exclusively supplied to the Northern Emirates (FEWA). In April 2008 the Emirates National Grid (ENG), with associated transmission facilities, was fully completed and so it became possible for the first time to export electricity from the Fujairah F1 IWPP to the Emirate of Abu Dhabi.

In 2007 about 12 MIGD water from F1 station was consumed locally in the Northern Emirates and the rest was sent to the Al Ain region.

At the time of preparation of this document it was expected that the **Northern Emirates** would consume up to 20 MIGD of water from the Fujairah IWPPs in the years 2008 – 2009 and up to 30 MIGD between 2010 – 2030. The rest would be available to ADWEC, supplying mainly the Al Ain region. The *indicative* water supply to the Northern Emirate is shown below:

Indicative[7] Water Supply to the Northern Emirates

Year	2008	2009	2010	2011	2012	2013	2014	2015
MIGD	20	20	30	30	30	30	30	30

3.2.4. **Fujairah F2 IWPP** (FAPCO)

In July 2007 a PWPA for the Fujairah F2 IWPP station was signed between ADWEC and FAPCO.

The Fujairah F2 IWPP will have a net capacity of 2000 MW and 130 MIGD. This equates to a gross capacity of approximately 2114 MW and 132 MIGD.

It is anticipated that some of F2's capacity will meet Abu Dhabi demands and that the remainder will meet demands in the Northern Emirates.

After completion of the F2 station in 2010 the gross capacities of both Fujairah IWPP stations will be about 2975 MW (F2 2114 MW + F1 861 MW).

Electricity will be exported from the Fujairah IWPPs to the Emirate of Abu Dhabi via the ENG (Emirates National Grid) and a new transmission line currently under construction connecting the Qidfa and Sweihan 400 kV substations.

The gas pipeline supply for F2 was initiated by ADWEC in April 2006 to meet the F2 implementation in late 2009 / early 2010. At the time of writing Dolphin energy have

[7] Indicative Supply is a term used in this *Statement* to reflect the uncertainty surrounding supply to the Northern Emirates and is ADWEC's own internal estimation based upon network projects etc.

proposed but not firmly committed to achieving the gas supply to F1 / F2 by the same schedule dates

Some of the net capacity available for export from the Fujairah IWPP stations will be used to meet the supply contracts that ADWEC has with FEWA and FEC.

An indicative electricity supply to the Northern Emirates is shown below.

Indicative Electricity Supply to the Northern Emirates [8]

Year	2008	2009	2010	2011	2012	2013	2014	2015
MW	800	720	1,250	1,600	2,516	2,651	2,796	2,950

3.2.5. Shuweihat S2 IWPP

In response to a Request for Proposals (RFP) for **Shuweihat S2 IWPP** three bids were submitted on 14th May 2008. The RFP stated that the net electricity capacity of Shuweihat S2 must lie in the range 1500 - 1600 MW and that the net water capacity must be 100 MIGD. At the time that this *Statement* was being prepared the S2 bids received were still being evaluated and so the assumed gross capacity of the S2 IWPP may differ slightly from the winning bid's actual capacity when it is announced.

The full gross electricity and water capacity of Shuweihat S2 is scheduled to be available before the peak of 2011.

3.2.6. Storage Capacity

Article 32 of Law Number 2 (3) requires ADWEC to determine requirements for the provision of water storage capacity.

It is planned that all new IWPP water production facilities will be built with 24 hours of water storage reservoirs, as per the requirements of the Water Transmission Code.

One exception to the Water Transmission Code's requirements for water storage reservoirs is Fujairah F2. Due to Fujairah F2's site constraints, 50 MIGD of F2's water storage of 132 MIGD will be constructed outside of the F2 site, specifically at Al Ain. This change in F2's water storage location contradicts the Water Transmission Code's requirements for onsite storage. ADWEC has expressed its concerns that this change in the location of F2's water storage reservoirs could jeopardize F2's ability to continue production if the pipeline between F2 and Al Ain was not operational.

[8] This indicative supply does not include transmission losses and own consumption of power plant etc. See Annex A for further details.

3.2.7. Emirates National Grid

The **Emirates National Grid** (ENG) began operating in May 2006, via the interconnection between Abu Dhabi and Dubai.

Recent Summer peak ADWEC export contracts with DEWA, FEWA and SEWA are shown below for information purposes:

ADWEC's Peak Export Contracts (MW)

	Summer 2006	Summer 2007
DEWA	400	700
FEWA	500	500
SEWA	-	200
sub-total	**900**	**1400**

From June 2006 onwards the ENG was used to export approximately 400 MW from Abu Dhabi to Dubai. The total capacity of the ENG between Abu Dhabi and Dubai is approximately 1150 MW. Connection of the SEWA system to the ENG occurred in May 2007. Connection to the remaining Northern Emirates transmission networks via the Dhaid 400 kV sub-station was completed in April 2008.

3.2.9. GCC Grid

From 2010 onwards the TRANSCO network will be a key part of the Gulf Cooperation Council (GCC) Grid. ADWEC will then have the optimal location with which to trade electricity via the following interconnections :

- 900 MW between Abu Dhabi and Saudi Arabia (GCC Grid)
- 1150 MW between Abu Dhabi and Dubai (ENG)
- 400 MW between Abu Dhabi and Oman (GCC Grid).

So ADWEC could export up to 2450 MW via the GCC / ENG grids.

Note that the above interconnections estimates are maximum potential trades based on the various agreements and not expected trades. Note also that the interconnector capacities may exceed the values shown above providing further opportunities for trade. The GCC Grid and ENG will therefore present ADWEC with good opportunities for trading electricity with its neighbouring utilities and thereby lowering ADWEC's economic procurement costs through higher efficiency and higher load factors etc.

3.3. Planned Capacity

3.3.1. Relocation of Al Zawra Gas Turbines

Four of the six gas turbines originally planned to be installed at the FEWA Al Zawra station in the Emirate of Ajman, each with a capacity of around 100 MW, will be relocated to the Emirate of Abu Dhabi. These four gas turbines were originally scheduled to contribute to FEWA's production at the new Al Zawra station, however under the terms of the Master Agreement signed between ADWEA and FEWA on 29th May 2008 these gas turbines are to be transferred to ADWEA. The relocated gas turbines are expected to operate in simple (open) cycle mode before the peak of 2011. The new location of these four gas turbines had not yet been finally decided, however the expectation at the time of writing was that they would be located at the Al Mirfa site.

3.3.2. MASDAR Solar Plants

MASDAR's first solar capacity of around 100 MW is the first step in the MASDAR initiative to embrace renewable and sustainable energy technologies, and thereby promote clean energy.

MASDAR's first five solar plants will use Concentrating Solar Power (CSP) technology and be located in the Madinat Zayed area. This location will allow these plants to benefit from TRANSCO's well developed transmission infrastructure and they will also be well placed to meet ADNOC's rising electricity demand, part of which will be supplied by ADWEC. The solar plants nominal capacity and expected commissioning dates are shown below.

Plants	Installed Capacity	MASDAR's Firm Capacity Estimate	Commercial Operation Date	Capacity used in LOLE calculations
Shams 1	100 MW	50 MW	April 2011	40 MW
Shams 2	100 MW	50 MW (possible to change to 100 MW)	April 2012	40 MW
Shams 3	100 MW	50 MW (possible to change to 100 MW)	April 2013	40 MW
Shams 4	100 MW	100 MW	April 2014	100 MW
Shams 5	100 MW	100 MW	April 2015	100 MW

The first three solar plants are unlikely to be equipped with heat storage facilities, and so their output will depend mainly on the amount of solar radiation. After 3:00 p.m. the amount of solar radiation declines significantly and at 6:00 p.m. it reaches a level so low that it is no longer possible to generate electricity from solar radiation alone.

During the Summer months, the Emirate of Abu Dhabi's daily peak electricity demand typically occurs around 16:50 hours each day when split shift offices / shop etc reopen and the heating effect on buildings (delayed by around 2 hours because of insulation from walls) combines with high humidity levels to produce a peak.

It is planned that supporting back-up fuel (natural gas) will be used by MASDAR to increase the solar plants' output during the afternoon hours, when electricity demand is at its highest. It is expected however that amount of gas that will be available to MASDAR to utilise as back-up fuel will be insufficient to produce electricity during all of the afternoon hours in the three key peak summer months.

ADWEC's analysis shows that there are more than 60 Summer days in the year when demand is greater than 92% of annual peak demand. Of these 60 Summer days there are six hours between 2 PM[9] and 8 PM when demand is greater than 95% of these daily peak demands. Thus there are 360 hours (60 x 6 hours) after 2 PM when demand is higher than 87.4% (95% x 92%) of the annual peak demand. These 360 hours can be thought of as 360 peak hours or near-peak hours.

When considering the contribution burning back-up fuel can make to enhancing the solar plants' output between 2 PM and 8 PM, it should be noted that while there are 360 hours when demand is greater than 87.4% of annual peak demand after 2 PM, the quantity of gas to MASDAR will likely be supply constrained. Without burning gas the solar plants can produce a minimum of 30–35 MW before 6 PM from solar radiation alone. Taking into account the likely constrained gas supply to MASDAR and the 360 hours when demand is greater than 87.4% of annual peak demand, it is estimated that the solar plants could be safely relied up to produce approximately 40 MW during these 360 hours. Thus in the LOLE calculations the solar plants Shams 1, 2 and 3 are assumed to produce 40 MW during the annual peak. This 40 MW compares with the installed capacity of 100 MW for each of Shams 1, 2 and 3.

3.3.3. MASDAR Hydrogen Plant

MASDAR's hydrogen plant is the second part of MASDAR's clean energy initiative. An integrated hydrogen power generation project will enable clean electricity generation along with carbon dioxide sequestration. The MASDAR hydrogen plant will have a net capacity 390 MW and is planned to start commercial operation at the end of 2012 / start of 2013. The plant will be located to the east of the existing Shuweihat site. It is intended that the carbon dioxide produced by the hydrogen plant will be used for oil reservoir reinjection purposes instead of natural gas. This will free up additional natural gas for other uses, particularly power generation.

The hydrogen plant will be supplied with natural gas, which will then be split via the air blown thermal reforming process into hydrogen and carbon monoxide. The synthetic gas, being a mixture of hydrogen and nitrogen from the air will be used as a fuel for combined cycle power plant feeding mainly two gas turbines but also supplementary firing burners of heat recovery steam generators. Firing of synthetic gas ensures that no carbon dioxide will be produced during electricity generation. The carbon monoxide will be turned into carbon dioxide and further compressed and sent to oil fields for enhanced oil recovery. This process will free some natural gas currently used for oil reservoir reinjection.

[9] 2 PM was chosen since between 10 AM and 2 / 3 PM inclusive the CSPs can produce 100% output \ from solar radiation alone.

A related MASDAR initiative is a project for developing a national network of Carbon Capture and Storage (CCS) from existing power / water stations etc. It is intended that the captured CO_2 will also be used in oil reservoirs for enhanced oil recovery.

3.3.4. Shuweihat S3 IWPP

Based on ADWEA's press briefing on the ADWEA Strategic Plan 2008 – 2012 of the 14th May 2008,[10] the Shuweihat S3 IWPP station is expected to enter into service during 2012 / 2013. Due to high peak electricity demand in 2012 (including ADWEC's exports to FEC / FEWA) it is assumed in this *Statement* that S3 will be fully commissioned before the peak of 2012. The gross power capacity of S3 is assumed to be 1700 MW and water capacity around 101 MGD in order to fully utilise the potential capacity of the Shuweihat site.

Note that the primary fuel for S3 will be gas.

[10] The National, May 14, 2008.

4. Security Standards

The forecast electricity capacity requirements presented in this *Statement* have been calculated using the current **Generation Security Standard** (GSS). The 2008 GSS uses a loss of load expectation (LOLE) of 1 day in 10 years, and has been calculated using generation forced outage rates of 5% for non-IWPP stations and the PWPA specified forced outage rates for the IWPP stations.

In practice the actual reserve margin tends to higher than the GSS due to:

- The need to commission new stations before old stations can be decommissioned
- The lumpiness associated with capacity additions.

ADWEC had previously proposed to the RSB that the GSS LOLE of 1 day in 10 years be revisited. This proposal was made in view of the impending (at that time) interconnection with the other UAE Emirates, via the ENG, and the GCC Interconnection Grid (scheduled for 2010). At that time the RSB did not accept ADWEC's proposal and so the GSS LOLE of 1 day in 10 years was retained and has also been used in this *Statement*. The RSB did however ask ADWEC to further investigate this issue in due course.

Since ADWEC's original proposal to revisit the GSS, the demand forecast has increased significantly as a result of several residential and industrial mega projects being announced, culminating with the publication of the UPC's *Plan Abu Dhabi 2030* in September 2007. In recent years therefore the overwhelming majority of the uncertainty surrounding the future level of required capacity has been demand forecast related and not GSS definition related. The publication of the UPC's *Plan Abu Dhabi 2030* in September 2007 significantly reduced the uncertainty surrounding the future level of demand (and associated required capacity).

In 2008 the RSB and ADWEC again revisited the issue of the GSS. The RSB have asked ADWEC to investigate the potential for capacity savings arising from the enhanced availability of IWPP generation capacity since 1999. ADWEC agreed to investigate this issue in time for inclusion in the 2008 *Statement*.

For post-2008 *Statements* the following work program was agreed:

- ADWEC to provide the RSB with a list of potential software replacements for the existing GeneRel and GAMS software packages, along with ADWEC's recommended software solution

- ADWEC to work with the RSB to investigate how the ENG and GCC interconnections might be incorporated in the GSS and included in future ADWEC *Statements of Future Capacity Requirements*.

4.1 Assumed Generation Outage Rates

The *ADWEC 2007 Statement of Future Capacity Requirements* and earlier *Statements*' LOLE calculations were prepared using pre-1999 sector operating experience and international data. The following table reproduces the assumptions used in pre-2008 *ADWEC Statements*.

Pre-2008 Statement's Assumed Generation Outage Rates

Company	Plants	Reliability Data			
		FOR (%)	MOR (days)	MOR (%)	Availability (%)
BPC	Al AIN	5.0%	40	11.0%	84.0%
APC	UNE-A	5.0%	55	15.11%	79.9%
	UNW-1-6	5.0%	25	6.8%	88.2%
	UNW-7-8	5.0%	50	13.7%	81.3%
	SAN	3.6%	20	5.5%	90.9%
TAPCO	TAW B1	5.0%	30	8.2%	86.8%
	TAW B2	5.0%	30	8.2%	86.8%
	TANE	3.5%	20	5.5%	91.0%
AMPC	MRF	5.0%	40	11.0%	84.0%
	MZD	5.0%	10	2.7%	92.3%
ECPC	TAW A2	3%	20	5.5%	91.5%
GTTPC	TAW A1	3.5%	20	5.5%	91.0%
SCIPCO	SHT 1	3.3%	20	5.5%	91.0%
SembCorp	FUJ-1	3.6%	20	5.5%	90.9%
FAPCO	FUJ-2	3.6%	20	5.5%	90.9%

FOR = Forced Outage Rate MOR = Maintenance Outage Rate

Since 1999 when the sector was restructured, and IWPP capacity started being introduced from 2000 onwards, the reliability of the generation capacity stock has improved significantly. This improvement in availability is primarily the result of IWPPs receiving hourly based capacity payments that account for 90%+ of the total PWPA payments made by ADWEC to the IWPPs. The improvement in availability is also the result of international power and water companies bringing world class operating expertise to the Emirate of Abu Dhabi for the first time.

In 2008 ADWEC and the RSB revisited the issue of the outage rates to be used in the LOLE calculations and agreed that the post-1999 improved availabilities should be reflected in the LOLE input assumptions starting from the 2008 *Statement*. *Ceterius paribus* better generation capacity availabilities will reduce the required capacity at any given level of peak demand because the capacity is now more reliable. This will reduce the sector's costs without in any way damaging the Emirate of Abu Dhabi's GSS of LOLE 0.1.

From the 2008 *Statement* onwards the LOLE calculations are based on the outage rates shown in the PWPAs for IWPP stations. For non-IWPP stations more conservative outage rates have been used as these stations pre-date the restructuring of the sector in 1999 and are not operated by international power and water companies. The outage rates that are now used in the LOLE calculations are shown below:

2008 Statement's Assumed Generation Outage Rates

Company	Stations	Reliability Data			
		FOR (%)	MOR (days)	MOR (%)	Availability (%)
BPC	Al AIN	5.0%	40	11.0%	84.0%
APC IWPP	UNE-A UNW-1-6 UNW-7-8 SAN	3.6%	10	2.7%	93.7%
TAPCO IWPP	TAW B1 TAW B2 TANE	2.5%	10	2.7%	94.8%
AMPC	MRF	5.0%	40	11.0%	84.0%
	MZD	5.0%	10	2.7%	92.3%
ECPC IWPP	TAW A2	2.0%	12	3.3%	94.7%
GTTPC IWPP	TAW A1	3.3%	10	2.7%	94.0%
SCIPCO IWPP	SHT 1	3.3%	9	2.5%	94.2%
SembCorp IWPP	FUJ-1	1.4%	14	3.8%	94.8%
FAPCO IWPP	FUJ-2	3.3%	13	3.6%	93.1%

FOR = Forced Outage Rate MOR = Maintenance Outage Rate

4.2 Assumed Desalination Outage Rates

For water, the required capacity is calculated according to a **Desalination Security Standard** (DSS) methodology specified by the RSB. This is a risk based methodology restricting the risk of loss of water supply to the Abu Dhabi consumers to 2% (once in 50 years), in contrast to the previous methodology, in which a constant margin (5% of demand) was added to the water demand to calculate the required capacity.

4.3 Reserve Capacity

Different countries have adopted different generation security standards. The GSS adopted by ADWEC, and approved by the RSB, of LOLE 0.1 is amongst the most stringent security standards. Most other GCC utilities either do not have a generation security standard or adhere to an inferior standard. This is why ADWEC continues to be (probably) the only utility in the GCC never to have suffered capacity shortages since 1999, when the sector was restructured and ADWEC became responsible for implementing the GSS. This good security of supply is not costless however, as it requires installing additional capacity that will only be used in times of emergency.

No GSS however can ever entirely eliminate the probability of a full or partial blackout, particularly when a large number of improbable events occur close to each other. A good example of the latter occurred in the UK on the 27th May 2008. Despite the UK having relatively high reserve capacity requirements (around 20%) and live interconnections with France and Ireland, the loss of two power stations within minutes of one another, along with nine other smaller stations on the same day, resulted in thousands of customers suffering blackouts. Further details can be found in Annex C.

The general point to note is that a GSS can only reduce the likelihood of a generation interruption to an acceptable level (in Abu Dhabi's case the GSS is set by the RSB at 1 day in 10 years), as the risk of interruption can never be 100% eliminated. The costs of meeting the GSS increase exponentially if it becomes overly strict (e.g. reserve capacity of 100%+).

Within the Emirate of Abu Dhabi there has also been a series of recent events that could potentially have resulted in an interruption to supply, but thanks to the GSS used by ADWEC, the actions of other sector participants and importing emergency power via the ENG, an interruption in customers' supply did not occur. On Friday 6th June 2008 the Taweelah A1 station lost 10 turbines one after the other (not simultaneously) because of auxiliary load rejection problems resulting in the loss of over 1000 MW of capacity within a very short period of time. Fortunately ADWEC's good demand forecasting, GSS based planning and TRANSCO's prompt action combined together to ensure that the people of the Emirate of Abu Dhabi continued to receive an uninterrupted supply of electricity.

The above examples highlight the need for the reserve capacity / required capacity as calculated by the GSS. The above examples also highlight the role that interconnections play in mitigating the effects of suddenly losing large amounts of generation capacity.

4.4 Demand Scope

Prior to the 2008 *Statement*, the GSS / DSS calculations did not consider the impact of electricity and water exports to the other Emirates on the required capacity calculations as exports were either temporary and utilised spare capacity, or in the case of electricity exports to FEWA they were isolated from the Abu Dhabi electricity transmission system.

With the ENG fully completed in April 2008 and ADWEC having firm electricity and water export supply contracts with:

- Fujairah Energy Company (FEC)
- Federal Electricity and Water Authority (FEWA)

along with a water only firm export contract with

- Sharjah Electricity and Water Authority (SEWA)

it became necessary to include these demands in the GSS / DSS calculations for the first time. Full details of the demand forecasts and exports can be found in Annex A.

In 2010 alone ADWEC has total firm electricity export contracts of 1,250 MW (FEC 250 MW and FEWA 1000 MW) rising to 2,950 MW (FEC 450 MW and FEWA 2,500 MW) in 2015.

The above firm contracted export electricity quantities have been added to Abu Dhabi's peak demand (after including transmission losses, associated auxiliary consumption and an assumed diversity factor) in order to calculate the required capacity using a GSS of LOLE 0.1. Thus the Northern Emirates exports are assumed to have the same GSS as applied to the Emirate of Abu Dhabi.

Note that an interesting feature of the LOLE calculation is that the required capacity does not increase at the same rate as peak demand. So the higher the level of peak demand the smaller the percentage of reserve capacity. Thus adding the Northern Emirates' supply exports to the GSS calculation significantly reduces the percentage of reserve capacity. By 2030 the percentage of reserve capacity will be just 11% of annual peak demand, or less than half of the percentage of reserve capacity in 2008.

It is clear from press reports[11] that the Northern Emirates currently have a significant shortage of electricity and water production capacity, and that this shortage could possibly last for several years until new capacity is added by the relevant utilities. This shortage of Northern Emirates' capacity and the start of the GCC Grid in 2010 will provide ADWEC with good alternative markets for any surplus electricity generation capacity that may arise because of delays to the Emirate of Abu Dhabi's mega projects. The consequences of surplus electricity generation capacity are now much less severe than in the past when alternative export markets did not exist.

[11] See for example The National newspaper, Wednesday June 11, 2008, www.thenational.ae, *Energy Crisis Slows Northern Growth*.

5. Available Electricity Capacity

The existing, under construction, committed and planned capacities are shown in the table below.

Existing, Under Construction, Committed and Planned Capacities Gross Electricity Capacity (MW)

Station	2008	2009	2010	2011	2012	2013
Al Ain Power Station	256	256	256	256	256	
BPC	**256**	**256**	**256**	**256**	**256**	
Umm al Nar East A	118	118	118	118	118	
Umm al Nar East B						
Umm al Nar West 1-6	360	360	360	360	360	
Umm al Nar West 7-8	300	300	300	300	300	
Umm al Nar West 9-10						
UAN-new (Sas Al Nakhl)	1,657	1,655	1,652	1,652	1,652	1,652
APC	**2,435**	**2,433**	**2,430**	**2,430**	**2,430**	**1,652**
Al Mirfa Power	186	186	186	186	186	186
Madinat Zayed	109	109	109	109	109	109
AMPC	**295**	**295**	**295**	**295**	**295**	**295**
Taweelah B1	825	825	825	825	825	825
Taweelah B2	358	358	358	358	358	358
Taweelah B New	470	1,037	1,037	1,037	1,037	1,037
TAPCO	**1,653**	**2,220**	**2,220**	**2,220**	**2,220**	**2,220**
Taweelah A1	1,414	1,458	1,458	1,458	1,457	1,457
Taweelah A10		213	213	213	213	213
GTTPC	**1,414**	**1,671**	**1,671**	**1,671**	**1,670**	**1,670**
ECPC	**760**	**759**	**760**	**760**	**758**	**765**
SCIPCO S1	**1,615**	**1,615**	**1,615**	**1,615**	**1,615**	**1,615**
Shuweihat S2				**1,730**	**1,730**	**1,730**
Fujairah Existing F1	641	641	641	641	641	641
Fujairah F1 Extension		220	220	220	220	220
ESWPC Fujairah F1	**641**	**861**	**861**	**861**	**861**	**861**
FAPCO Fujairah F2			**2114**	**2114**	**2114**	**2114**
Al Zawra Relocation				**400**	**400**	**400**
Masdar CSP Shams 1				**40**	**40**	**40**
Masdar CSP Shams 2					**40**	**40**
Masdar CSP Shams 3						**40**
Masdar Hydrogen Plant (net)						**390**
Shuweihat S3					**1,700**	**1,700**
Available Capacity	**9,069**	**10,110**	**12,222**	**14,392**	**16,129**	**15,532**

Assumed capacity lifetime extensions are shown in green.

6. Available Water Capacity

The existing, under construction, committed and planned capacities are shown in the table below.

Existing, Under Construction, Committed and Planned Capacities
Gross Water Capacity (MIGD)

Station	2008	2009	2010	2011	2012	2013
Umm al Nar East A						
Umm al Nar East B	20	20	20			
Umm al Nar West 1-6	24	24	24			
Umm al Nar West 7-8	6	6	6			
UAN - New (Sas Al Nakhl)	95	95	95	95	95	95
APC	**145**	**145**	**145**	**95**	**95**	**95**
AMPC	**39**	**39**	**39**	**39**	**39**	**39**
Taweelah B1	70	70	70	70	70	70
Taweelah B2	23	23	23	23	23	23
Taweelah B New	35	69	69	69	69	69
TAPCO	**128**	**162**	**162**	**162**	**162**	**162**
GTTPC	**85**	**85**	**85**	**85**	**85**	**85**
ECPC	**51**	**51**	**51**	**51**	**51**	**51**
SCIPCO S1	**101**	**101**	**101**	**101**	**101**	**101**
Shuweihat S2				**101**	**101**	**101**
ESWPC Fujairah F1	**102**	**102**	**102**	**102**	**102**	**102**
Fujairah F2			**132**	**132**	**132**	**132**
Shuweihat S3					**101**	**101**
Available Capacity	**651**	**685**	**817**	**868**	**969**	**969**

Assumed capacity lifetime extensions are shown in green.

7. Site Location Commentary

The primary purpose of this *Statement* is to identify the currently unplanned additional capacity requirements, as required under Articles 30 and 32 of Law Number 2 (1998), along with Article 34 of Law Number 2 (1998). These Articles also require ADWEC to purchase capacity by adopting the economic purchase method.

In addition to the above well known ADWEC license requirements, ADWEC's license also requires it to provide a site location commentary. This section fulfils that obligation.

Existing Sites

Some further potential for expanding capacity may exist at or close to the existing Fujairah, Umm Al Nar and Al Mirfa sites.

Al Mirfa

Of the five existing coastal generation / desalination locations (Shuweihat, Al Mirfa, Umm Al Nar, Taweelah and Fujairah) only one location (Al Mirfa) can definitively be further developed without any site constraints.

It must be remembered that the existing Al Mirfa station would require some re-configuration in order to make it better approximate the other cogeneration stations' power to water ratios. Currently Al Mirfa has a small power to water capacity ratio. The possibility of expanding Al Mirfa, via adding just electricity capacity, has been examined by ADWEC in the past and an Request For Proposal (RFP) issued. Al Mirfa remains a good potential candidate on which to locate future capacity additions, given the current limited number of alternative locations. It is expected that the four open cycle gas turbines that are to be moved from the previously owned FEWA Al Zawra station will be relocated at the Al Mirfa station. This will increase the existing capacity at Al Mirfa by around 400 MW.

Taweelah and Fujairah

Two of the other existing coastal generation / desalination locations (Taweelah and Fujairah) are considered likely sites for additional capacity expansion, but further studies would be required to confirm this potential.

In the case of the Taweelah site, ADWEC has reservations about further expansion of this site because of security of supply concerns. The Taweelah site already comprises capacity from the Taweelah A1, Taweelah A2, Taweelah B (TAPCO) IWPP stations and will soon be joined by the Taweelah A10 extension of Taweelah A1. Accordingly further large capacity expansions at Taweelah are considered imprudent by ADWEC. Despite these reservations, the projected large increase in demand may require that additional capacity be installed on this site.

Further expansion of the Taweelah site, e.g. Taweelah C, would require additional study because of the high proportion of the sector's capacity at this site and possible environmental constraints. It is considered probable that a new cooling intake / outfall sea water system would be required. The potential site extension limit is considered as 1350-1500 MW/100 MIGD.

The existing FEWA Fujairah site, located between the ADWEA Fujairah F1 and F2 stations, will be transferred to ADWEA at the end of May 2009 under the terms of the ADWEA / FEWA Master Agreement of May 29th 2008. This transferred site may be considered as suitable for further development, via a Fujairah F3 station. The Fujairah F3's potential capacity is not expected to exceed 1,000 MW / 70 MIGD due to the limited size of the site and water transmission constraints.

Umm Al Nar

The existing Umm Al Nar site's current water capacity temporarily exceeds its maximum long-term potential because of the deferred retirement of some older capacity. In the long-term this site might be further redeveloped to include some peaking capacity (about 800 MW). Due to the site's close location to Abu Dhabi island and the future mega projects' onshore and islands demands, Umm Al Nar would be an ideal site on which to locate peaking capacity. The ready availability of an existing transmission infrastructure also favours this site. TRANSCO would need to advise on any additional transmission infrastructure that might be required to support generation capacity expansion on this site.

Further adding combined cycle plant at Umm Al Nar with / without desalination capacity would result in large amounts of heat being rejected into the surrounding sea water. Since this additional heat would cause environmental problems a combined cycle expansion is considered imprudent. Consequently the Umm Al Nar site is only like to have open cycle peaking capacity installed in future, and then only after the existing deferred retirement capacity of 778 MW has been removed.

Shuweihat

Assuming Shuweihat S3 is developed in 2012 / 2013 with a capacity of 1700 MW / 100 MGD the Shuweihat site is expected to reach its maximum capacity, thereby eliminating the possibility of future expansion at this site.

The estimated site potential for existing sites is shown below.

Existing Sites' Estimated Potential (Gross)

Electricity (MW)	Taweelah	Umm Al Nar	Mirfa	Fujairah	Shuweihat
Maximum Potential	6,000	2,450	2,250	4,000	5,000
Utilised Capacity	4,650	1,680+780[12]	190	2,975	5,000
Unused	**1,350**	**800**	**2,060**	**1,000**	**0**
Water (MGD)	**Taweelah**	**Umm Al Nar**	**Mirfa**	**Fujairah**	**Shuweihat**
Maximum Potential	400	95 + 50[13]	150	330	300
Utilised Capacity	298	95	39	234	300
Unused	**100**	0	**110**	**100**	**0**

Utilised Capacity = Existing + Under Construction + Committed + Planned.

[12] This 780 MW is deferred retirement capacity that is scheduled to be retired at the end of 2012.
[13] This 50 MGD is deferred retirement capacity that is scheduled to be retired at the end of 2010.

New Sites

In addition to the above existing estimated site potentials, there are a number of new sites at which additional capacity could possibly be located. This section describes some of the potential sites that may warrant further investigation, note that this list is not exhaustive as other potential sites almost certainly exist.

As noted earlier, the MASDAR hydrogen plant will be located to the east of the existing Shuweihat site. It was also noted that MASDAR's CSP capacity will be located in the Madinat Zayed area. Both of these MASDAR sites are considered to have a site potential approximately double that required for MASDAR's announced hydrogen / CSP projects.

In the case of electricity only capacity, new stations could be located inland near suitable gas and electricity transmission networks. One such location would be between Sweihan and the Dubai border, as Dolphin's Taweelah – Fujairah gas pipeline will pass through this area and the electricity transmission system is also well developed. This desert station (D1) would likely be situated close to the existing Sweihan 400 kV substation.

Other potential desert stations might also include new capacity on or near the existing Madinat Zayed and Al Ain stations. The main benefits of these desert sites (D2 and D3 respectively) are close vicinity to demand centers and existing transmission facilities.

Given that ADWEC will be required to generate in excess of 3 GW by 2015, in order to meet its export supply contracts etc in the Northern Emirates, it may be prudent to consider locating some additional capacity in the Northern Emirates, as future site expansion at or near the existing Fujairah site is limited. For example, a new combined cycle station (producing electricity and water) in the Emirate of Ras Al Khaimah might be an option, although other potential locations also no doubt exist. Ideally the station should be located on the coast, near deep water and not too far from TRANSCO's existing 400 kV infrastructure. Such a station would enable the Northern Emirates' demand to be better served. TRANSCO is currently constructing a 400 kV transmission line extension to Khowr Khawer from current 400 kV transmission facilities in Ras Al Khaimah.

It has been assumed that a Northern Emirates' located station would have a capacity not less than 2500 MW and 150 MGD. The exact capacity would obviously be site specific and would require detailed studies.

New Sites' Estimated Potential (Gross)

Electricity (MW)	Masdar Hydrogen Site	Masdar Solar Site	Desert Station (D1) Sweihan	Desert Station (D2) Madinat Zayed	Desert Station (D3) Al Ain	Northern Emirates Station
Maximum Potential	800	1,000	1,000	600	600	2,500
Utilised Capacity	400	500	0	0	0	0
Unused	**400**	**500**	**1,000**	**600**	**600**	**2,500**
Water (MGD)	**Masdar Hydrogen Site**	**Masdar Solar Site**	**Desert Station (D1) Sweihan**	**Desert Station (D2) Madinat Zayed**	**Desert Station (D3) Al Ain**	**Northern Emirates Station**
Maximum Potential	0	0	0	0	0	150
Utilised Capacity	0	0	0	0	0	0
Unused	**0**	0	**0**	**0**	**0**	**150**

Utilised Capacity = Existing + Under Construction + Committed + Planned.

In general, new sites should ideally be located such that different fuels can be delivered there, e.g. gas, crude oil and diesel etc, in order to provide maximum fuel supply flexibility. These new sites would also need to be located some distance from urban and environmentally protected areas, but also relatively close to the main conurbations so that their demands can be easily satisfied.

Summary

It is clear from the above discussion that finding new coastal site locations post-Shuweihat S3 may prove challenging. ADWEC raised this issue at the 2008 ADWEC Board Meeting with its 100% shareholder, namely ADWEA. ADWEA agreed to take full responsibility for identifying new sites for future capacity expansion, primarily because in addition to the usual economic / technical considerations there are also qualitative public policy considerations. ADWEC has offered to assist ADWEA with its analysis. The issue of potential sites for future capacity expansion was also discussed extensively at the 2008 Generation Expansion Plan Committee meetings.

One strong conclusion from the above analysis is that there is an urgent need for new site locations from 2013 onwards, and that ADWEA, as agreed at the ADWEC Board meeting, should immediately take action to identify and develop new sites.

7.1. Technology Choice

7.1.1 Fuel Considerations

Traditionally the primary fuel for the Emirate of Abu Dhabi's electricity and water production has been natural gas. The petrochemicals, electricity and water sectors have historically been the biggest consumers of natural gas in the GCC, however in recent years the upstream oil sector has had a growing demand for oil reservoir re-injection purposes in order to maintain oil production at mature fields. For example, the General Manager of the Abu Dhabi Onshore Oil Company (ADCO), Abdul Munim Al-Khindy, has stated that "*The demand for gas in the UAE as a fuel for power stations, water desalination, and other industrial uses is rising faster than can be met by internal supply, partly because gas is used to sustain the oil reserves. In the short term the country will have to look at meeting this demand from other sources. This it has already done through the importation of gas through the Dolphin pipeline and facilities from Qatar, and plans are underway to satisfy longer-term gas demand by developing new reservoirs, and improving the management of existing supplies*".[14]

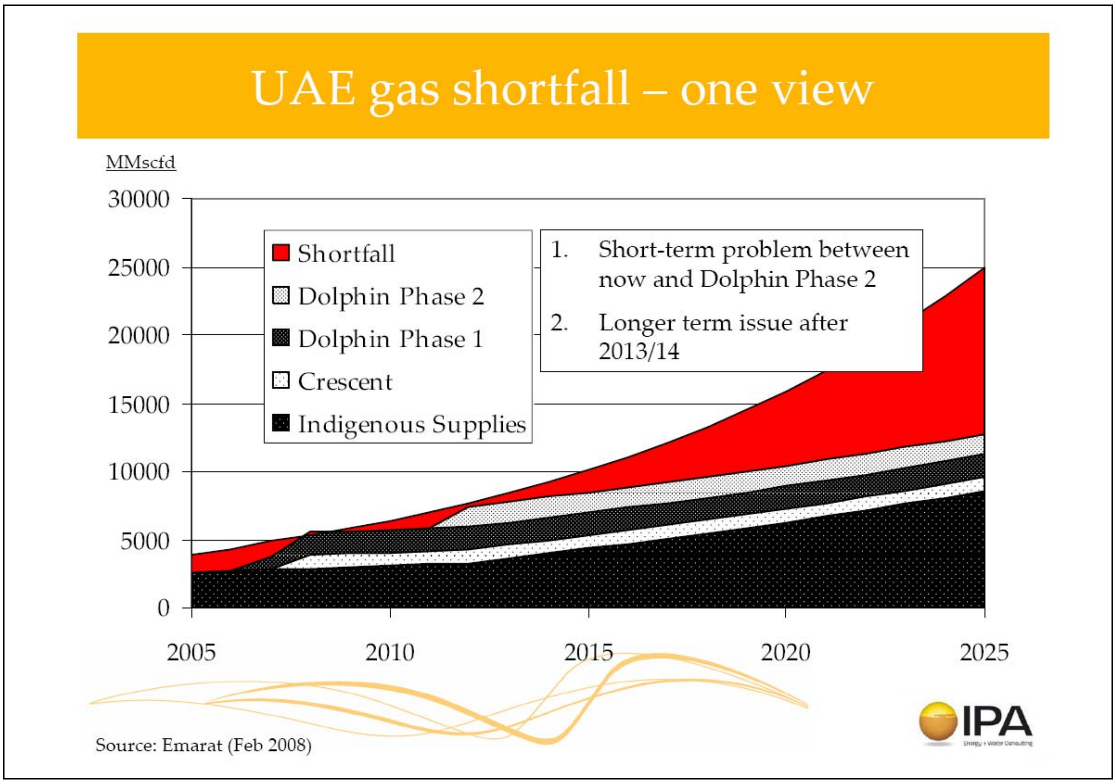
Natural gas demand is forecast to continue to rise rapidly and so the electricity and water sectors must consider alternative fuel mix options for future capacity, such as the crude oil stations used in Saudi Arabia.

If natural gas were to remain the main fuel burnt in new capacity, then combined cycle technology is usually considered to be the most cost effective technology choice when operating at relatively high power to water ratios. At lower power to water ratios however, the advantages of combined cycle technology are less pronounced, and so conventional power plants with state of the art technology and supercritical steam cycles may be a viable option for cogeneration plants. Power only stations would be expected to achieve net efficiencies of approximately 52% at Abu Dhabi's reference site conditions. At the time of system peak demand Abu Dhabi's reference site conditions are for IWPP projects 46 degrees Celsius ambient temperature, 42% relative humidity and a sea water temperature of 35 degrees Celsius, although the exact values may vary from IWPP.

According to an IPA Presentation to the MEED Middle East Power and Water Conference in Abu Dhabi on 17th-18th March 2008[15], a gas supply shortfall is expected in the UAE in 2014 - 2015, even if Dolphin Phase 2 proceeds. See the below chart for further details.

[14] See the Shell in the Middle East magazine, issue 42 July 2008.

[15] Regional Gas Availability: Issues, Outlook and Options, Douglas Caskie and Robert Bryniak.



The 2008 UAE Government's paper '*Policy of the United Arab Emirates on the Evaluation and Potential Development of Peaceful Nuclear Energy*' stated that:

> "Annual peak demand for electricity is likely to rise to more than 40,000 MW, but the known volumes of natural gas that could be made available to the nation's electricity sector would be insufficient to meet this future demand, providing adequate fuel for only 20,000 - 25,000 MW of power generation capacity by 2020.
>
> While the burning of liquids (e.g., crude oil and/or diesel) was found to be logistically viable, evaluation of this option revealed that a heavy future reliance on liquids would entail extremely high economic costs, as well as a significant degradation in the environmental performance of the UAE's electricity sector. While the evaluation of coal-fired power generation established its lower relative price compared to liquids-fired power generation, its widespread use within the UAE would have an even more severe detrimental effect on environmental performance, while also raising thorny issues related to security of supply. Evaluation of alternative energies, including solar and wind suggested that, while these options could be deployed within the UAE, even aggressive development could only supply 6-7% of peak electricity demand by 2020.
>
> Stacked against the above options, nuclear power-generation emerged as a proven, environmentally promising and commercially competitive option which could make a significant base-load contribution to the UAE's economy and future energy security."

The above policy document clearly states that known volumes of natural gas are insufficient to meet the UAE's future electricity demand. Since the peak electricity demands that ADWEC is planning for in 2020 alone exceed 20 GW it is clear that the known volumes of natural gas are also insufficient to meet Abu Dhabi's future electricity demands. Alternate fuel supplies in addition to known natural gas supplies will therefore be required and this is discussed later in this *Statement*.

To solve the problem of insufficient gas supply, imports of natural gas in the form of LNG (liquefied natural gas) is an option being considered by some GCC utilities. According to the Gulf News of April 21st 2008, Dubai will develop a floating liquefied natural gas storage and regasification facility at the Jebel Ali port. The regasification capacity will be 3 million tonnes per annum, equivalent to 400 mmscf/d of natural gas and will be used for supplementary supplies of natural gas during the summer peak demand period. LNG ships will moor alongside the storage facility to offload their cargo. The Dubai Supply Authority (DUSUP) will develop the floating LNG regasification facility at the DP World Jebel Ali Terminal in Dubai. DUSUP has selected Shell as adviser and project manager for the development phase. Shell will also be the main LNG supplier and will continue to provide advice to DUSUP once the facility is completed. The first gas is expected during 2010, primarily from Qatar.[16]

Other GCC countries, such as Saudi Arabia, plan to use crude oil as the main fuel for their power stations that will be located on the coast line. In April 2006, Saudi Arabia decided that all future coastal power and desalination capacity would use heavy fuel oil or crude oil rather than gas feedstock.[17]

Some GCC utilities are also considering importing coal to satisfy their fuel needs. MEED has reported that the first coal fired power plant in the Gulf could come on line as early as 2012, following a decision by Muscat to approve proposals for a plant at Duqm. Oman had previously rejected a series of plans to develop a coal fired plant, but with concerns growing over future energy sources, it has decided to implement the scheme. Plans for the Independent Water and Power Producer (IWPP) project, include a power capacity of 1,000 - 1,200 MW, however the desalination capacity has yet to be finalised. Coal for the plant will likely either be mined in Oman or imported from Australia and Indonesia. Oman Power & Water Procurement (OPWP), will issue an open tender for the project.

MEED also notes that according to OPWP's current seven year plan, OPWP estimates that if Oman were to rely solely on gas for power generation, it would require 1.7 - 1.9 trillion cubic feet of gas between 2008 and 2014. Difficulties with regional gas supplies mean that Oman, like the UAE, is likely to face problems in securing sufficient gas supplies, particularly if Oman goes ahead with plans to divert some gas

[16] Qatargas and Shell announced on 20 April 2008 that signed a Sales and Purchase Agreement to supply Liquefied Natural Gas (LNG) to Dubai for approximately fifteen years. The LNG will be supplied into the DP World Jebel Ali, Dubai LNG terminal that will be capable of receiving the cargoes using the new Q-Flex class of vessels via a Floating Storage and Regasification Unit. The LNG will be provided from the Qatargas 4 project in Qatar and shipped to Dubai LNG receiving terminal upon the start-up of commercial operations of these facilities. The supplies are expected to start around the end of the decade from Qatargas 4 and will be delivered during the regional summer period for the duration of the contract. Note that the Qatargas 4 project, currently under construction in Qatar, is a joint venture between wholly-owned affiliates of Qatar Petroleum (70%) and Royal Dutch Shell plc (30%).

[17] MEED Magazine 21-27 March 2008, page 27.

supplies to more profitable industrial purposes. Abu Dhabi and the UAE more generally are therefore not alone in needing to consider alternate fuels to known natural gas supplies.

7.1.2 Technologies

Oil Stations

GCC oil fired stations are typically built using the conventional configuration of steam boilers with steam turbines, however some of Saudi Arabia's crude oil fired stations will be equipped with gas turbines adjusted to the firing of crude oil. The main reason for constructing oil fired stations is insufficient gas supplies. On the Red Sea coast in Saudi Arabia almost all existing and new power plants will be fired with crude oil.

Kuwait is also planning that part of its new capacity will be fuelled with crude oil. Since GCC crude oil closely approximates light oil it can easily be used in power generation. When crude oil is used as the main fuel, it is possible to construct cogeneration power plants (electricity and water) with a fuel utilisation factor close to 90%, i.e. the same as natural gas. The main disadvantage of crude oil is its very high spot price. A crude oil price of 100 US$/barrel is equivalent to about $17.6 - $18 MBTU[18] depending on the crude oil specification. This is about 70% - 80% higher than the recent high North American market price of gas ($10 per MMBTU[19]) and approximately five times higher than price of coal ($3 per GJ = ~$3.2/MMBTU).

Oil fired stations are also somewhat more unreliable than gas fired stations, thereby reducing the reliability of the entire system via an increased system forced outage rate. Furthermore oil fired stations also tend to have higher operation and maintenance costs than gas fired stations.

In economic terms it is perhaps better to consider the opportunity cost of burning oil, i.e. the revenue forgone by not exporting the oil. As long as more revenue can be earned by exporting the oil than the total costs (including environmental, security of supply and infrastructure etc) associated with burning alternate fuels in place of oil, then the oil should be exported and not burnt in domestic power stations.

[18] There are approximately 6 GJ per barrel of oil, 1 GJ = 0.9478 MMBTU or 1 MMBTU = 1.055 GJ, and so $100 per barrel / 6 GJ = $16.67 per GJ / 0.9478 = $17.6 per MMBTU.

[19] According to the MEED magazine of 16 May 2008, Qatar sold LNG to the Korean Gas Company in 2007 at about $11 per MMBTU, and to Japanese buyers in early 2008 up to $12 per MMBTU.

Coal Stations

Coal fired capacity currently exists in the majority of developed and developing countries, but coal fired capacity has not yet been implemented in the GCC countries. As noted earlier, the first GCC conventional coal fired station could happen as early as 2012 in Oman.[20]

Dubai is also reported to be considering a coal fired power station that would be situated outside of the Emirate of Dubai[21].

Another Dubai option is a plant based on Integrated Gasification Combined Cycle (IGCC) technology. According to Khaleej Times of the 25th February 2008, DEWA is considering a power station running on synthetic gas (syngas) and capable of producing 2,000 MW of electricity. DEWA is reported to have signed a memorandum of understanding with a foreign consortium that will make a feasibility study on the project with an initial budget of AED 22 billion ($6 billion).

More generally, modern coal fired power plants have become more environmentally friendly, have relatively high efficiencies and their construction times have been shortened. Modern coal fired power plants also have good performance characteristics when run in co-generation mode (power and heat). Although coal is less environmentally friendly than natural gas, some small European countries that are renowned from their very strict environmental regulations and do not have significant domestic primary fuel supplies, such as Denmark or Finland, generate about 60% - 70% of their electricity from coal fired power plants. Furthermore these plants usually operate in cogeneration mode for district heating purposes. In Denmark, which is about half the size of the UAE, coal fired power plants with peak capacity of more than 10,000 MW generated around 38,000 GWh in 2003[22].

Nuclear Stations

"*In order to combat (the) predicted shortage in natural gas*" the UAE Foreign Minister Sheikh Abdullah Bin Zayed Al Nahyan (Gulf News, 9th May 2008) announced that the "*UAE (will) embark on nuclear power generation initiative*". As a result the UAE signed memorandum of understandings on the peaceful use of nuclear energy with France in January 2008, the USA in April 2008 and the UK in May 2008. According to Shaikha Lubna, UAE Minister of Foreign Trade (Gulf News, 16th May, 2008) the Memorandum of Understanding with the UK will enable the UAE to benefit from the UK's advanced capabilities and expertise in peaceful nuclear power.

The forecasted growth in electricity demand will, according to Sheikh Abdullah Bin Zayed Al Nahyan (Gulf News, 21st April 2008), require continued access to affordable energy, and for this reason the UAE has begun to evaluate the potential contribution of peaceful nuclear energy in meeting its future domestic energy requirements. Sheikh Abdullah said that assessments by government entities have shown that electricity produced from nuclear stations will cost less than a third of that from crude oil fired stations.

[20] According to Power Engineering Magazine from 28th April 2008 the Oman coal fired power plant could come on line as early as 2012, following a decision by the Omani government to approve proposals for a plant at Duqm.
[21] http://www.uaeinteract.com/docs/UAE_turns_to_coal_for_its_energy_needs_/29933.htm
[22] EWEA, Large Scale Integration of Wind Energy in the European Power Supply, December 2005

Alternative Technologies

As noted earlier, alternative technologies are currently being considered by the Abu Dhabi Government, most notably by the Abu Dhabi Future Energy Company via MASDAR. The currently planned MASDAR solar and hydrogen plants were discussed earlier.

According to press reports[23] *"MASDAR's proposed solar PV Project includes a world scale polysilicon factory in Abu Dhabi, which will provide the feedstock for additional activities such as PV cell and module manufacturing. Photovoltaics allow the direct conversion of sunlight into electricity - this is one of the most promising technologies in renewable energy. The global PV industry was estimated at 2 gigawatts (GW) in 2006 and is growing at 30% annually, making it one of the most attractive and high-growth international industries".*

7.2. Construction and Operating Costs

Construction and operating costs for new privately funded projects (IWPPs) are reflected in the contracted PWPA rates between ADWEC and the IWPP. Since these contracted PWPA rates are unknown until after they have been negotiated, it is assumed that all new cogeneration capacity has the same PWPA rates as the existing Shuweihat S1 IWPP. Separate costs assumptions have been used for standalone capacities such as RO and single (open) cycle gas turbines.

The PWPA rates and fuel costs will also vary for different configurations and power to water ratios. They will also vary for condensing, coal fired and mixed fuel fired stations.

Non-PWPA costs such as the

- cost of connection to the electricity and water transmission systems
- site development costs for new locations
- cost of fuel delivery.

will also vary by site.

7.3. Strategic Issues

Strategic issues may include location concerns or limitations (e.g. environmental, land availability and transmission network corridors) or other risk issues from new plants development such as placing a large proportion of the sector's capacity at a single site.

[23] http://www.ameinfo.com/109358.html, AME info from January 31, 2007

7.4. Transmission Costs

Transmission costs are not explicitly considered in this *Statement* as TRANSCO is responsible for advising on the preferred options for locating new capacity from a transmission perspective. Transmission costs can influence the most economic choice of locating plant capacity, particularly where transmission infrastructure already exists e.g. in Shuweihat.

7.5 Commissioning Times

Another consideration is that the total commissioning time for new IWPP stations, should not take longer than two years from the date of the commissioning of the first unit to PCOD. Difficulties with installing and testing new capacity over more than two years and the reluctance of contractors to remain onsite for longer than absolutely necessary, because of other commitments etc, means that it has been assumed in this *Statement* that the time period between early power / water and full capacity (PCOD) will not exceed two years.

7.6 Power / Water Ratio

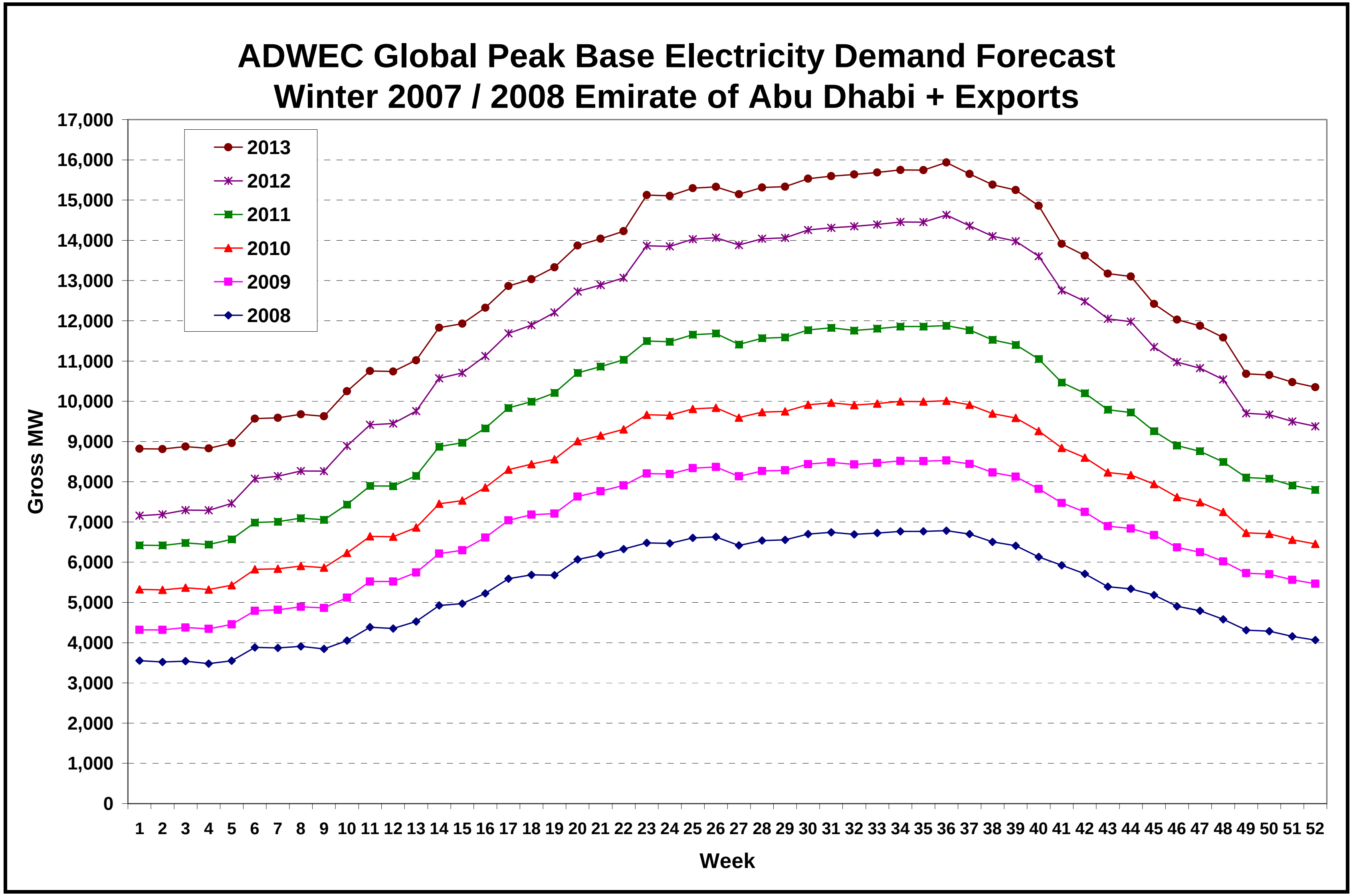
An important technology choice result arising from ADWEC's latest demand forecast is that the ratio of power / water demand is expected to increase significantly. Under the Base / Most-Likely demand forecast (including exports) the ratio of electricity to water demands will increase from around 10 in 2008 to approximately 22 by 2030.

In other words electricity demand is forecast to grow much more rapidly than water demand. One important consequence of these differing growth rates is that electricity only stations, e.g. open cycle (OCGT) or combined cycle (CCGT), will be required. An electricity only station (e.g. peaking station) widens the possible sites at which this capacity might be located, since unlike a co-generation station (electricity and water) it does not have to be located on the coast near a sea water intake. Alternatively nuclear and renewable capacities, because they typically only produce electricity, might be expected to contribute to this need for generation only capacity.

7.7 Technology Choice and Load Profile

During the Winter months when electricity demand is low, perhaps 30% - 35% of the annual peak, TRANSCO sometimes encounters problems with producing enough water to satisfy demand. This problem arises because electricity generation (from gas turbines) is too low to produce all of the hot exhaust gases needed by the Heat Recovery Steam Generators (HRSGs) as a heat input. The HRSGs convert the heat of the hot exhaust gases from the gas turbines into the steam needed by the water distillers. Thus low levels of electricity generation can result in reduced water production. Essentially this problem is a function of the current technologies used at existing IWPP stations.

In future this problem may improve as rising industrial demand (which has a flatter annual demand than the residential / commercial sectors that currently dominate demand) and exports to the Northern Emirates will flatten the annual demand curve. However some baseload electricity only capacities such as CSP, nuclear and hydrogen may offset this improvement. These baseload technologies reduce the amount of electricity that can be generated in the Winter from the existing type of stations that cogenerate electricity and water. Different technologies may therefore needed to be considered / utilised in future. ADWEC's weekly peak demand forecast for the period 2008 – 2013 is shown overleaf.


ADWEC Global Peak Base Electricity Demand Forecast
Winter 2007 / 2008 Emirate of Abu Dhabi + Exports
Gross MW
Week
2013
2012
2011
2010
2009
2008
17,000
16,000
15,000
14,000
13,000
12,000
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8. Electricity Demand Forecast

This report has been prepared on the basis of ADWEC's latest demand forecast, *ADWEC's Electricity & Water Demand Forecasts 2008 – 2030*, and is available on request or via ADWEC's website www.adwec.ae

Increasingly the ADWEA network is supplying electricity and water to the oil industry. ADWEC has included the following total Abu Dhabi National Oil Company (ADNOC) electricity demands in its latest demand forecast:

ADWEC Peak Electricity Supplies to ADNOC (MW)

	2008	2009	2010	2011	2012	2013	2014	2015
Total	**221**	**674**	**678**	**740**	**1096**	**1514**	**1490**	**1554**
	2016	2017	2018	2019	2020	2021	2022	2023
Total	**1581**	**1592**	**1596**	**1613**	**1677**	**1744**	**1771**	**1781**
	2024	2025	2026	2027	2028	2029	2030	
Total	**1804**	**1863**	**1863**	**1863**	**1863**	**1863**	**1863**	

At the time of writing, ADNOC had not supplied ADWEC with a comprehensive list of projects, as requested by ADWEC, for which ADNOC would like electricity and water supplies. It is hoped that ADNOC will provide the requested list to ADWEC in time for the Winter 2008 / 2009 demand forecasts and inclusion in the next *Statement*.

The increased supply of electricity and water to ADNOC is considered by ADWEC to be a potential long term source of additional demand, over and above the demand identified elsewhere in this *Statement*, which would in turn necessitate further capacity additions and create more opportunities for IWPP investors.

Northern Emirates

Peak electricity demand has been growing rapidly in the UAE in recent years and ADWEC has assisted the other utilities in meeting their peaks demands via exports.

UAE Peak Electricity Demands (MW)

Utility	**2003**	**2004**	**2005**	**2006**	**2007**
ADWEA	4,116	4,320	4,455	4,790	5,286
DEWA	2,874	3,228	3,571	4,113	4,736
SEWA	1,217	1,294	1,406	1,436	1,557
FEWA	1,043	1,114	1,200	1,410	1,680
Total*	**9,250**	**9,956**	**10,632**	**11,749**	**13,259**

* Excludes own generation by ADNOC (approximately 1000 MW) and own DUBAL industrial generation in Dubai (approximately 1600 MW; http://www.dubal.ae/mediacentre/Article.aspx?id=339). Also note that the total has been obtained by simple summation, as the peak times / dates are not available for any of the utilities except Abu Dhabi.

ADWEC's Recent Peak Electricity Export Contracts (MW)

Utility	Summer 2006	Summer 2007
DEWA	400	700
FEWA	500	500
SEWA	-	200
sub-total	**900**	**1400**

As noted earlier, the inclusion of contracted exports to the Northern Emirates has significantly increased the required capacity forecasts. Full details can be found in Annex A. The short-term supply forecasts are reproduced below.

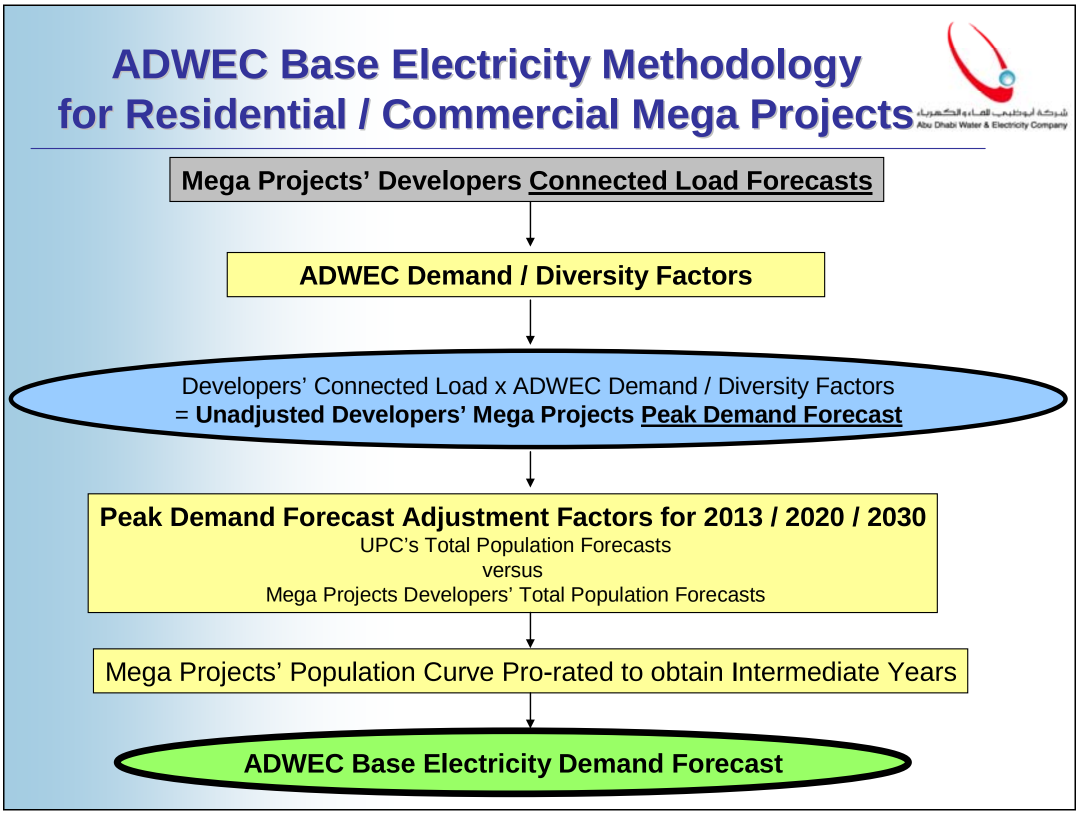
ADWEC's Forecast Electricity Supplies to the Northern Emirates

Peak MW	2008	2009	2010	2011	2012	2013
FEC Contract	0	120	250	300	450	450
FEWA Contract	600	600	1,000	1,300	2,066	2,201
DEWA	0	0	0	0	0	0
SEWA 2008 only	200	0	0	0	0	0
Total *(excluding losses)*	**800**	**720**	**1,250**	**1,600**	**2,516**	**2,651**
Transmission Losses 2%	*16*	*14*	*25*	*32*	*50*	*53*
sub-total	816	734	1,275	1,632	2,566	2,704
Associated Electricity Auxiliaries	*16*	*15*	*26*	*33*	*51*	*108*
Water Pumping etc Auxiliaries for F1/F2	*121*	*123*	*210*	*210*	*210*	*210*
Total Northern Emirates Supply	**953**	**872**	**1,511**	**1,875**	**2,828**	**3,022**

Mega Projects' Demand

In the case of the mega projects, some of the assumptions and uncertainties for these projects are summarised below. Note that the starting point for the mega projects' electricity demand forecasts are the connected load forecasts provided to ADWEC by the developers. Demand and Diversity factor assumptions are then used to convert the developers' connected load forecasts into unadjusted developers mega projects peak demands. These unadjusted developers mega projects peak demands are then calibrated to be consistent with the UPC's population forecast for the Abu Dhabi Region. For the Al Ain and Western Regions the demand forecasts are prepared using information provided by the developers, since at the time of writing the UPC's plans for these two regions had not yet been published.

The following slides have been taken from ADWEC (Winter 2007 / 2008) Electricity & Water Demand Forecasts 2008 – 2030 presentation for the Emirate of Abu Dhabi, available on ADWEC's website www.adwec.ae.



Mega Projects Forecasting Uncertainties

1) **Timing / Size** of Mega Projects.
   - Implementation needs to be **synchronized** with the development of utility capacity and vice versa.
   - **Shortage** of contractors / labour could result in delays.
   - **Mega Projects' Developers timing estimates** are usually optimistic, actual timing is likely to be delayed by at least **1 – 2 years**.

2) **Population**
   - **Population / Number of new expatriates** living in Mega Projects.

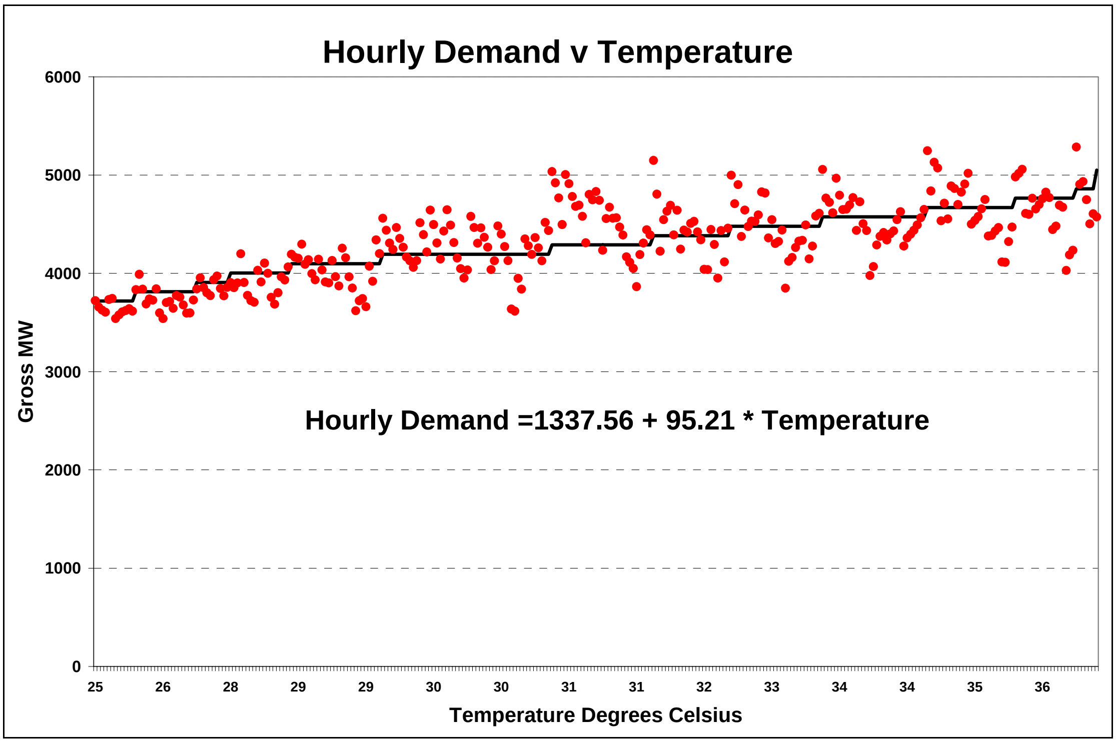
3) **Developers' Demand Forecasts** provided to ADWEC.
   - Relationship between Electricity Peak Demand and Electricity Connected Load depends on **Demand & Diversity Factors**.
   - **Peak Demand will likely lag** Connected Load because of lag associated with *moving in* etc.

4) **Unannounced** Mega Projects - less important now that UPC in place.
5) **District Cooling:** use in place of Conventional Air Conditioning.
6) **Waste Water:** Desalinated water use in Irrigation / District Cooling etc.
7) **Industry:** Zonescorp (Special Economic Zones / clusters /worker cities), Khalifa Port Industrial Zone (KPIZ), ADBIC and ADNOC etc.

Source: ADWEC *Electricity Demand Forecast 2008 – 2030* presentation, www.adwec.ae.

Stochastic Demand Factors

A number of stochastic (random) demand factors can result in the demand forecast deviating from the actual value. Apart from unexpected delays etc, the main stochastic factor is temperature. For example, during June 2008 the daily peak load declined from 5100 – 5300 MW at the start of the month, when the temperature was 35 – 37 degrees Celsius, to around 4500 MW when the temperature fell to 32 degrees Celsius (excluding Fridays / Saturdays). An analysis of all of the hourly data between the 4th June 2008 and the start of 17th June 2008 suggested that each 1 degree Celsius change in the temperature changes the hourly load by around 100 MW.



It can be seen that in June 2008 variations in temperature resulted in the hourly gross MW demand varying by up to 10%. This estimate is obviously based on the composition of demand in June 2008. In future this response to temperature may alter as a result of industrialisation and the use of district cooling. During the August peak month the variation in temperature is also likely to be smaller than observed in June, however this reduced variation in temperature makes accurate regression analysis very difficult because of the limited unique information in the existing August data set. This is why June 2008 data has been used to estimate the relationship, since the drop in temperature was most unusual and provides a rare opportunity to estimate the relationship between hourly demand and temperature in a summer month.

In summary, ADWEC's electricity annual peak demand forecasts can be expected to lie within a range of + / - 10% around the peak forecast due to temperature variations.

ADWEC Annual Peak Forecast + / - 10%

ADWEC will be undertaking further analysis to improve upon the above multiple regression to include other explanatory variables.

9. Water Demand Forecast

Water Supply Forecast

All of ADWEC demand forecasts are assumed to be unconstrained, i.e. network constraints do not limit what can be demanded. For the purposes of this *Statement of Future Capacity Requirements*, however, ADWEC is aware that the network operators TRANSCO, AADC and ADDC are not able to deliver all of the water that consumers are forecasted to demand. Rather than procuring additional IWPP capacity to meet the demand forecast and the network operators not be able to deliver all of the additional water, ADWEC has prepared an expected water supply forecast. This expected water supply forecast takes account of water network constraints etc and is lower than ADWEC's water demand forecast for the years 2007 – 2011 inclusive.

Since all three network operators (TRANSCO, AADC and ADDC) plan on the basis of a five year planning horizon, as per the requirements of the Transmission Codes etc, ADWEC has assumed that from year 2012 onwards the network operators will have upgraded their networks sufficiently to be able to deliver all of the quantities of water shown in ADWEC's water demand forecast to consumers. Thus for the system water peaks of 2008, 2009, 2010 and 2011 the expected water supply forecast has been used for the purposes of preparing this *Statement*, but from 2012 onwards the ADWEC water demand forecast has been used to prepare this *Statement*.

All the demand forecasts have been prepared on the basis of announced or anticipated Government policies. In the event, however that Government policies were to alter, for example a decision to supply some of the farms in the Western Region that currently use well water with desalinated water, then the future capacity requirements would need to be re-examined.

In the case of water, during the forecast horizon 2008 – 2015, the demand for water, excluding the mega demand projects, is expected to moderate when compared to the past. This is despite some areas currently under restricted supply (e.g. parts of Al Ain) switching to continuous 24 hours supply.

It should be noted that water demand is forecast to grow somewhat more moderately than electricity demand. The main reasons for the more moderate growth in water demand relative to electricity demand are listed below

- The mega projects' demands are forecast to be substantially more electricity intensive than water intensive, based on the data provided to ADWEC by the developers. For example, the total sum of the mega projects' forecast electricity demand is equivalent to more than 100% of the 2008 peak electricity demand, whereas for water it is less than 30%. This percentage would have been larger if the mega projects used potable water instead of recycled water for irrigation purposes, and so greater use of recycled water is an important factor in moderating the growth in water demand. The main reason for the disparity between the water and electricity mega projects demands is because of industrial projects, e.g.; ICAD and KPIZ. These projects are far more electricity intensive than water intensive.

- The water demand forecast assumes continuous improvements in per capita rates of consumption and private landscaping from the current high levels, primarily due to demand-side management implementation.

- Occupancy delays (e.g. residential towers) have a larger influence on water demand than the electricity demand. Unlike water, electricity would still be required in largely unoccupied residential towers, e.g. to meeting air conditioning demand.

Note that one consequence of occupancy delays is that less recycled water is available and this can result in a temporary increase in desalinated water to offset less recycled water being available. Once full occupancy is attained, sufficient recycled water becomes available and the temporary increase in desalinated water is removed.

ADWEC has built into the demand forecast an additional uncertainty margin for unexpected demands. Some farms currently supplied with well water may switch to desalinated water. This is to reflect the uncertainty in the government policy towards this sector.

ADWEC's water demand forecast has been prepared using a probabilistic (rather than a deterministic) approach. This approach was originally proposed by the RSB and was adopted for the first time in ADWEC's *Electricity & Water Demand Forecast 2006 – 2020* and the ADWEC *2006 Statement of Future Capacity Requirements*.

The new water demand forecasting methodology attempts to capture both actual data and the uncertainties affecting the demand forecast. The uncertainties, similar to those mentioned in the above electricity demand forecast section, generally increase with time as less actual data is available and more assumptions are adopted in the forecast.

Many factors affecting the forecast are continuously changing throughout the forecast. For example, rates of consumption can be altered by such factors as demand-side management and tariffs etc. These factors are therefore estimated for every year of the forecast.

The size of each of the categories is also changing throughout the forecast. Immigration, population growth, and government spending on development are all important factors that influence the size of many categories, and consequently water demand itself. A change in government policy towards agriculture, for example, would have a significant impact on total water demand as agriculture is one of the largest consumers of water and currently the main supply to agriculture is from underground sources.

The water demand forecast uses statistical software to represent these uncertainties via a probability distribution curve. Each uncertainty, whether rate of consumption, growth rate, occupancy rate etc, is represented with a probability distribution curve. The most likely; i.e. mean, is the value used for desalination capacity expansion planning. When used with a Normal Distribution probability curve, the most likely value within the range of the upper and lower limits is the "mean" value. This is the value used for desalination capacity expansion planning.

ADWEC's demand forecast must not be directly used however for sizing the transmission and distribution networks. Other factors must be considered when designing these networks, particularly their service lives. It is simply not practical or economical to upgrade the transmission and distribution networks regularly, every five years or so. This is another reason ADWEC prepares very long-term demand forecasts. It is however up to the transmission and distribution companies to decide upon what year of the forecast to target and what additional factors must be considered in their network planning.

Northern Emirates

ADWEC's committed water exports to the Northern Emirates are shown below.

ADWEC's Contracted Water Supplies to the Northern Emirates

Peak MGD	2008	2009	2010 - 2030
FEWA Contract	10	10	10
FEC Contract	0	0	10
SEWA Contract	5	5	5
Other	5	5	5
Total	**20**	**20**	**30**

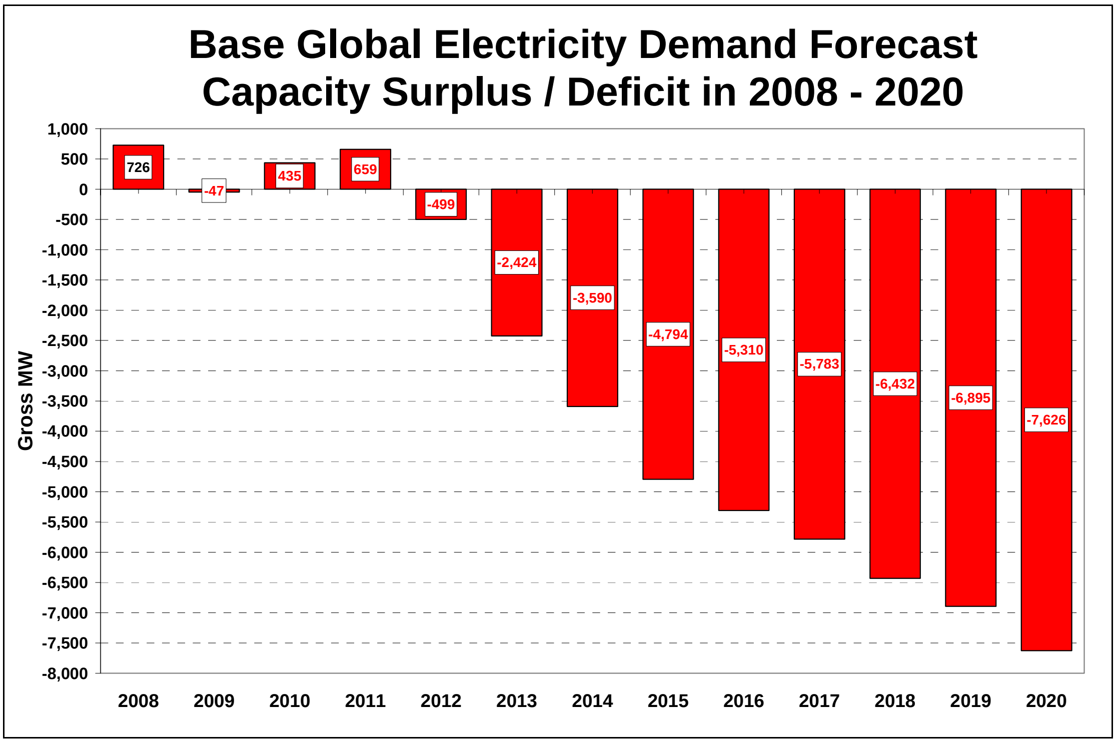
10. Unplanned Capacity Requirements

The Fujairah F2 (2010) and Shuweihat S2 (2011) IWPPs, along with the May 14th 2008 ADWEA announcement that Shuweihat S3 (2012 / 2013) will be the next IWPP, are not expected to fully satisfy the additional capacity requirements for the years 2010 – 2012 inclusive, even if Shuweihat S3 comes in 2012 as is assumed in this *Statement*. The new FEC / FEWA export contracts will require additional capacity to be procured by ADWEC over and above that shown in the 2007 *Statement* (the last ADWEC *Statement* before the unplanned for FEC / FEWA exports were announced). In keeping with ADWEC's license requirements, the 2007 ADWEC *Statement* and earlier *Statements* only considered the Emirate of Abu Dhabi's capacity requirements,.

This section details the unplanned capacity requirements based on the Base / Most Likely Global demand forecast. The Emirate of Abu Dhabi's unplanned capacity requirements for the High and Low demand forecasts can be found in Annex B.

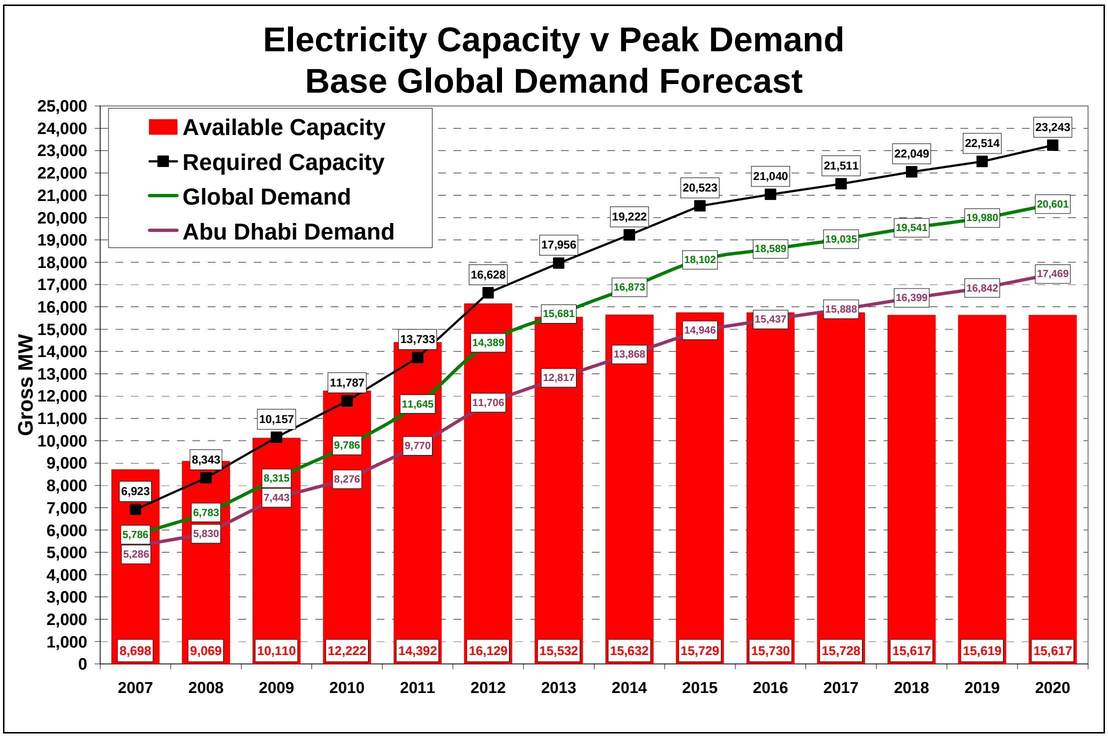
Unplanned Electricity Capacity Requirements

The following chart summarises the unplanned electricity capacity requirements under the Base Global Electricity Demand Forecast. See Annex B for further details.



Surplus / Deficit = Available Capacity - Required Capacity.

From above chart it can be seen that under the Base Global Electricity Demand forecast the system will essentially be in balance throughout the short-term planning horizon of 2009-2011 inclusive (including Al Ain and Umm Al Nar lifetime extensions to end-2012). Additional capacity will however be required in 2012 of approximately 500 MW. By 2013 the additional capacity requirements will be around 2400 MW.



The above conclusions assume the following major capacity expansions achieve PCOD before the annual peak demand in the years listed below:

- Fujairah F2 IWPP (2010)
- Shuweihat S2 IWPP (2011)
- Shuweihat S3 IWPP (2012)
- Al Zawra relocation capacity (2011)
- MASDAR stations shown in Annex B (2011 onwards).

The above conclusions are also based on the following lifetime extensions:

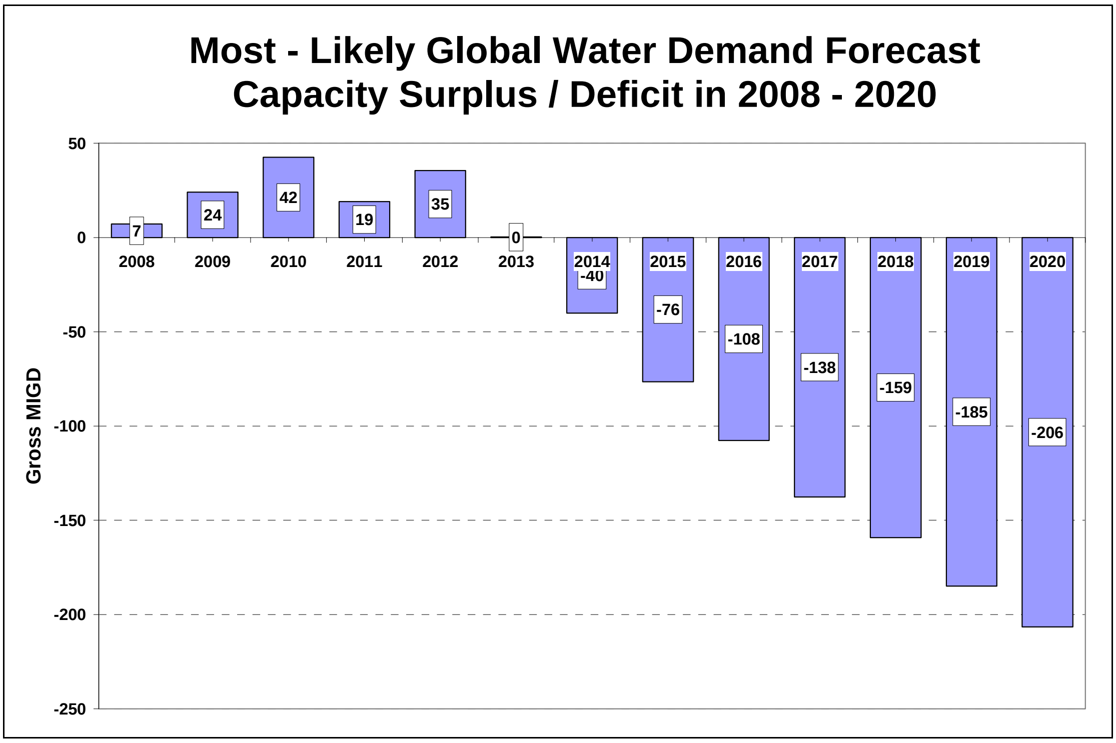
- Umm Al Nar IWPP 778 MW(end-2012)
- Al Ain 256 MW (end-2012).

ADWEC will make a final decision on whether or not to extend the lifetimes of the above capacitiess once work on the ADWEC Winter 2008 / 2009 demand forecast has been completed at the end of 2008.

In summary, sufficient electricity generation capacity will exist until year 2011 inclusive, after which additional capacity will be required.

Unplanned Water Capacity Requirements

The following chart summarises the unplanned water capacity requirements under the Most-Likely Global Water Demand Forecast, full details are provided in Annex B. Note that Global Water Demand Forecast includes up to 30 MGD of contracted exports to the Northern Emirates.



Surplus / Deficit = Available Capacity - Required Capacity.

From the above charts it can be seen that under the Most-Likely Global Water Demand Forecast about 76 MGD of additional water capacity will be required by 2015. This conclusion assumes that the following IWPPs achieve PCOD before the relevant annual peak in water demand:

- Fujairah F2 (2010) 132 MGD.
- Shuweihat S2 (2011) 101 MGD.
- Shuweihat S3 (2012) 101 MGD.

The above analysis also assumes that the Umm Al Nar capacity scheduled for retirement in June 2008 is retained until after the 2010 peak.

Until 2014 no water production capacity deficits are expected. Until 2011 inclusive water transmission constraints will limit the quantity of water that consumers can be supplied with, i.e. water demand will exceed water transmission capacity. TRANSCO plans to remove its remaining water network supply constraints before end-2011, essentially:

- a spur off the Fujairah–Al Ain pipeline (2010)
- construction of the Mussafah–Al Ain pipeline (2011).

Consequently after 2011 no water transmission constraints are expected or assumed.

Assuming Shuweihat S3 enters into service in 2012, then a small temporary surplus in capacity will exist in 2012. This surplus will however have been completely removed by 2013 leaving the system in balance. This temporary surplus in 2012 is therefore the result of the '*lumpiness*' of capacity additions, and is unavoidable.

It should be noted that it takes around 3 years for major new water transmission projects to be realised, 6 months from tendering to award and 2.5 years for construction, so completing new water transmission projects before 2011 (2008 + 3 years) would be difficult.

Similarly, it takes about 4 years to bring new IWPP stations into service from the date of the RFP and so installing new desalination capacity before 2012 (2008 + 4 years) would also be very difficult.

11 Summary

The main conclusions obtained from the Base Global Electricity / Most-Likely Water demand forecasts are shown below.

- The inclusion of the contracted Northern Emirates electricity exports into this *Statement* for the first time has significantly increased the required electricity generation capacity from previous *Statements*.

- Only firm contracted electricity exports to the Northern Emirates have been considered when preparing this *Statement* (long-term contracts with FEC and FEWA, and a short-term contract with SEWA for 2008).

- The required electricity generation and water desalination capacities have been calculated using the same GSS / DSS as applied for the Emirate of Abu Dhabi in order to ensure Emirate's security of supply is not reduced by ADWEC's exports to the Northern Emirates.

- The inclusion of ADWEC's electricity exports to the Northern Emirates has significantly increased the total required capacity that ADWEC must procure and thereby enhanced future IWPP investment opportunities in the sector.

- The analysis suggests that Shuweihat S3 will be required in 2012, and accordingly it has been assumed in this *Statement* that S3 will enter into full service in 2012.

- Some Umm Al Nar capacity (778 MW) that was originally scheduled to be retired at the end of 2010 has been assumed to be further extended in this *Statement* until end-2012. ADWEC will however make a final decision on whether or not to extend the lifetime of this capacity once work on the ADWEC Winter 2008 / 2009 demand forecast has been completed at the end of 2008.

- Similarly, Al Ain station (256 MW) has had its lifetime extended from end-2009 until end-2012 in this *Statement*. ADWEC will also make a final decision on whether or not to extend the lifetime of this capacity once work on the ADWEC Winter 2008 / 2009 demand forecast has been completed at the end of 2008.

- The total additional capacities obtained from the lifetime extensions at Al Ain and Umm Al Nar are shown below.

Station Capacity (MW)	**2010**	**2011**	**2012**
Al Ain Lifetime Extension	256	256	256
UAN Lifetime Extension	-	778	778
sub-total	**256**	**1034**	**1034**

- Available electricity generation capacity is sufficient to meet electricity demand until 2011, additional capacity will however be required from 2012 onwards.

- Available water desalination capacity is sufficient to meet water demand until 2013 year inclusive, assuming S2 enters into service in 2011 and S3 in 2012. From 2014 onwards new desalination capacity will be required in order to satisfy the DSS.

- To cover the 2012 generation capacity deficit of around 500 MW, a peaking station may be required (IPP), which because it will not include water, would comprise open cycle gas turbines that could be procured and installed more quickly than the typical 4 years for IWPP stations.

- A final decision on procuring peaking capacity for 2012, and other capacity additions from 2013 onwards, does not need to be made until after completion of the ADWEC Winter 2008 / 2009 Global Demand forecast.

- Some uncertainty surrounds the mega projects' demand forecasts and consequently this *Statement's* conclusions. ADWEC will be updating its demand forecasts at the end of 2008 and this could inevitably change some of this *Statement's* conclusions.

- There is an urgent need for new site locations from 2013 onwards.

- Further developing the Al Mirfa site would provide additional opportunities for meeting the rapid growth in demand during the period 2013 – 2015.

- Extension of existing sites and construction of new capacity Fujairah F3 and Taweelah C might be possible, but this would require additional study, e.g. cooling water / sea water recirculation, fuel supply and transmission network.

- The Umm Al Nar site could potentially be used to locate some power only capacity, particularly peaking capacity, and possibly also some combined cycle capacity (i.e. excluding water desalination capacity).

- Future capacity expansions may burn other fuels than gas, e.g. crude oil or coal.

- In the longer-term some nuclear capacity is also likely, although not probably before 2017.

- Renewable technologies, such as solar, are currently under consideration by the Abu Dhabi Future Energy Company via MASDAR. Greater use of renewable technologies and hydrogen power generation would reduce the scope for traditional IWPP capacity.

- Nuclear, renewable and hydrogen plants etc all tend to produce electricity with little or no water production, i.e. they have a very high Power / Water ratio. When combined with some peaking OCGT / CCGT capacity, these types of capacity can be expected to contribute to meeting the large increase in the Power / Water ratio expected between now and 2030.

- Nuclear, renewable and hydrogen plants because they must operate at baseload could cause problems during the Winter months when there may not be sufficient electricity generation at co-generation stations to maintain water production. This could result in changes to the current water production technologies, e.g. greater use of Reverse Osmosis etc.

Glossary

Abbreviation	Definition
A1	GTTPC - Taweelah A1 IWPP
A10	Taweelah A10 IWPP (part of GTTPC - Taweelah A1 IWPP)
A2	ECPC - Taweelah A2 IWPP
AADC	Al Ain Distribution Company
AAPS	Al Ain Power Station – part of Bainounah Power Company
ADNOC	Abu Dhabi National Oil Company
ADPC	Abu Dhabi Port Company
ADPS	Abu Dhabi Power Station
ADWEA	Abu Dhabi Water and Electricity Authority
ADWEC	Abu Dhabi Water and Electricity Company
AMPC	Al Mirfa Power Company
APC	Arabian Power Company (Umm Al Nar IWPP)
BPC	Bainounah Power Company
Btu	British Thermal Unit
CCGT	Combined Cycle Gas Turbine Station
CCS	Carbon Capture and Storage
CSP	Concentrating Solar Plant
DEWA	Dubai Electricity and Water Authority
DSS	Desalination Security Standard
ECPC	Emirates CMS Power Company - Taweelah A2 IWPP
ENG	Emirates National Grid
ESWPC	Emirates SembCorp Water and Power Company-F1 IWPP
F1	Fujairah F1 IWPP - ESWPC
F2	Fujairah F2 IWPP - FAPCO
FAPCO	Fujairah Asian Power Company – F2 IWPP
FEC	Fujairah Energy Company
FEWA	Federal Electricity and Water Authority
FOR	Forced Outage rate
GCC	Gulf Co-operation Council
GEPC	Generation Expansion Planning Committee
GJ	Gigajoule
GSS	Generation Security Standard
GT	Gas Turbine
GTTPC	Gulf Total Tractebel Power Company (Taweelah A1 IWPP)
IGCC	Integrated Gasification Combined Cycle Plant
IWPP	Independent Water and Power Producers
KPIZ	Khalifa Port Industrial Zone
kW	Kilowatt
kWh	Kilowatt Hour
LNG	Liquefied Natural Gas
LOLE	Loss of Load Expectation
MEED	Middle East Economic Digest
MGD	Millions of (Imperial) Gallons per Day
MIGD	Millions of Imperial Gallons per Day
MMBtu	Million British Thermal Unit
MOR	Maintenance Outage rate
MW	Megawatt
OCGT	Open Cycle Gas Turbine, also called Simple Cycle Power Plant

Glossary (continued)

Abbreviation	Definition
OPWP	Oman Power and Water Procurement
PCOD	Plant Commercial Operation Date
PWPA	Power and Water Purchase Agreement
RFP	Request for Proposals
RO	Reverse Osmosis
RSB	Regulatory and Supervision Bureau
S1	Shuweihat Phase 1 IWPP - SCIPCO
S2	Shuweihat Phase 2 IWPP
S3	Shuweihat Phase 3 IWPP
SCIPCO	Shuweihat CMS International Power Company – S1 Plant
SEWA	Sharjah Electricity and Water Authority
SCGT	Simple Cycle Power Plant, also called Open Cycle Gas Turbine
ST	Steam Turbine
Statement	Statement of Future Capacity
TAPCO	Taweelah Asia Power Company (Taweelah B IWPP)
TRANSCO	Transmission and Despatch Company
UAN	Umm Al Nar (also known as Sas Al Nakhl)
UPC	Urban Planning Committee

Annex A

Demand Forecast

Winter 2007 / 2008 - ADWEC Electricity Peak System Demand Forecast (Gross MW)

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
High Demand Forecast														
Abu Dhabi	3,241	3,539	4,673	6,790	8,016	8,954	9,866	11,245	12,483	13,171	13,626	14,101	14,616	15,140
Al Ain	1,516	1,637	1,750	1,828	2,076	2,228	2,345	2,419	2,609	2,626	2,687	2,644	2,720	2,785
Western Region	572	757	1,602	2,059	3,734	4,621	5,490	8,040	8,466	8,585	8,686	8,770	8,886	9,047
Abu Dhabi System Demand	**5,286**	**5,830**	**7,886**	**10,492**	**13,588**	**15,529**	**17,395**	**21,329**	**23,150**	**23,961**	**24,567**	**25,074**	**25,768**	**26,505**
Base Demand Forecast														
Abu Dhabi	3,241	3,539	4,516	5,330	6,367	7,687	8,194	9,104	9,925	10,285	10,669	11,079	11,517	11,969
Al Ain	1,516	1,637	1,781	1,814	2,075	2,251	2,333	2,441	2,572	2,619	2,623	2,673	2,615	2,677
Western Region	572	757	1,277	1,277	1,500	1,975	2,516	2,567	2,712	2,805	2,875	2,935	3,007	3,132
Abu Dhabi System Demand	**5,286**	**5,830**	**7,443**	**8,276**	**9,770**	**11,706**	**12,817**	**13,868**	**14,946**	**15,437**	**15,888**	**16,399**	**16,842**	**17,469**
Northern Emirates Supply	500	953	872	1,511	1,875	2,828	3,022	3,176	3,339	3,339	3,339	3,339	3,339	3,339
Global System Demand	**5,786**	**6,783**	**8,315**	**9,786**	**11,645**	**14,389**	**15,681**	**16,873**	**18,102**	**18,589**	**19,035**	**19,541**	**19,980**	**20,601**
Low Demand Forecast														
Abu Dhabi	3,241	3,539	3,448	3,493	4,020	4,867	5,840	7,011	7,466	8,350	9,140	9,471	9,807	10,192
Al Ain	1,516	1,637	1,783	1,844	1,885	2,183	2,291	2,367	2,457	2,581	2,612	2,602	2,642	2,563
Western Region	572	757	1,261	1,254	1,392	1,429	1,552	2,012	2,543	2,576	2,698	2,780	2,831	2,876
Abu Dhabi System Demand	**5,286**	**5,830**	**6,380**	**6,477**	**7,171**	**8,333**	**9,516**	**11,192**	**12,251**	**13,273**	**14,200**	**14,596**	**15,016**	**15,360**

2007 - 2020 Average Annual Growth Rates

	High	Base	Low
Abu Dhabi	12.6%	10.6%	9.2%
Al Ain	4.8%	4.5%	4.1%
Western Region	23.7%	14.0%	13.2%
Abu Dhabi Emirate	13.2%	9.6%	8.6%
Global Demand		10.3%	

2007 - 2030 Average Annual Growth Rates

	High	Base	Low
Abu Dhabi	8.3%	7.3%	6.7%
Al Ain	3.9%	3.4%	3.0%
Western Region	13.3%	9.0%	8.5%
Abu Dhabi Emirate	8.4%	6.7%	6.1%
Global Demand		6.9%	

Winter 2007 / 2008 - ADWEC Water Peak System Demand Forecast (Gross MIGD)

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
High Forecast	Supply													
Abu Dhabi	334	359	375	392	414	430	448	474	502	525	543	560	573	592
Al Ain	168	266	292	318	336	358	375	393	396	407	425	423	432	437
Western Region	57	83	88	97	100	107	109	112	114	119	122	125	128	131
Abu Dhabi Emirate	**560**	**706**	**753**	**805**	**849**	**894**	**931**	**978**	**1010**	**1049**	**1088**	**1106**	**1131**	**1159**
Northern Emirates Supply	12	20	20	30	30	30	30	30	30	30	30	30	30	30
Global Demand	**572**	**726**	**773**	**835**	**879**	**924**	**961**	**1008**	**1040**	**1079**	**1118**	**1136**	**1161**	**1189**
Most Likely Forecast														
Abu Dhabi	334	358	371	386	406	421	438	458	480	497	512	528	542	555
Al Ain	168	248	268	287	301	315	328	341	351	358	365	371	378	381
Western Region	57	82	86	90	92	98	100	103	106	109	113	115	119	122
Abu Dhabi Emirate	**560**	**685**	**722**	**761**	**798**	**831**	**864**	**900**	**934**	**962**	**986**	**1011**	**1035**	**1054**
Northern Emirates Supply	12	20	20	30	30	30	30	30	30	30	30	30	30	30
Global Demand	**572**	**705**	**742**	**791**	**828**	**861**	**894**	**930**	**964**	**992**	**1016**	**1041**	**1065**	**1084**
Low Forecast														
Abu Dhabi	334	355	366	380	398	410	424	437	451	460	469	486	498	507
Al Ain	168	237	257	272	286	299	309	321	329	335	338	347	345	351
Western Region	57	80	82	79	78	85	87	89	92	96	98	102	106	108
Abu Dhabi Emirate	**560**	**670**	**702**	**728**	**760**	**791**	**817**	**843**	**868**	**888**	**902**	**932**	**944**	**962**
Northern Emirates Supply	12	20	20	30	30	30	30	30	30	30	30	30	30	30
Global Demand	**572**	**690**	**722**	**758**	**790**	**821**	**847**	**873**	**898**	**918**	**932**	**962**	**974**	**992**

The demand forecast years shown in grey are when water transmission constraints are expected to constrain water supply to be less than water demand. Network constraints mean that Abu Dhabi Emirate's water demand may exceed water supply. So for the purposes of forecasting water capacity requirements and auxiliary electricity consumption the following Abu Dhabi Emirate water supply quantities have been assumed. From 2012 onwards the water demand forecast have been used to forecast water capacity requirements and electricity consumption.

	Constrained Supply (MGD)			
	2008	**2009**	**2010**	**2011**
System	**593**	**610**	**708**	**779**

2007 - 2030 Average Annual Growth Rates

	High	Base	Low
Abu Dhabi	3.3%	3.0%	2.6%
Al Ain	4.7%	4.1%	3.5%
Western Region	4.2%	3.9%	3.5%
Abu Dhabi Emirate	**3.8%**	**3.4%**	**3.0%**

Winter 2007 / 2008 - ADWEC Electricity Peak System Demand Forecast (Gross MW)

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
High Demand Forecast										
Abu Dhabi	15,586	16,056	16,545	17,057	17,593	18,153	18,744	19,361	19,878	20,419
Al Ain	2,854	2,938	3,019	3,108	3,204	3,295	3,374	3,454	3,540	3,632
Western Region	9,176	9,272	9,346	9,438	9,577	9,684	9,791	9,910	10,030	10,146
Abu Dhabi System Demand	**27,138**	**27,777**	**28,410**	**29,091**	**29,848**	**30,594**	**31,357**	**32,159**	**32,868**	**33,606**
Base Demand Forecast										
Abu Dhabi	12,358	12,766	13,193	13,638	14,107	14,596	15,107	15,645	16,089	16,560
Al Ain	2,720	2,775	2,843	2,908	2,979	3,054	3,122	3,178	3,237	3,300
Western Region	3,260	3,344	3,409	3,488	3,606	3,701	3,802	3,901	4,001	4,108
Abu Dhabi System Demand	**18,020**	**18,558**	**19,109**	**19,687**	**20,334**	**20,982**	**21,650**	**22,331**	**22,924**	**23,554**
Northern Emirates Supply	3,339	3,339	3,339	3,339	3,339	3,339	3,339	3,339	3,339	3,339
Global System Demand	**21,146**	**21,679**	**22,223**	**22,796**	**23,437**	**24,078**	**24,739**	**25,413**	**26,000**	**26,624**
Low Demand Forecast										
Abu Dhabi	10,629	11,047	11,385	11,753	12,130	12,518	12,927	13,354	13,809	14,280
Al Ain	2,600	2,626	2,675	2,719	2,774	2,823	2,877	2,931	2,967	3,004
Western Region	2,943	3,054	3,172	3,245	3,294	3,356	3,454	3,542	3,630	3,727
Abu Dhabi System Demand	**15,892**	**16,438**	**16,933**	**17,411**	**17,883**	**18,373**	**18,925**	**19,484**	**20,053**	**20,649**

Winter 2007 / 2008 - ADWEC Water Peak System Demand Forecast (Gross MIGD)

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
High Forecast										
Abu Dhabi	602	615	630	641	648	656	667	677	686	702
Al Ain	439	452	447	460	456	449	460	456	480	481
Western Region	133	138	141	141	142	145	146	148	150	149
Abu Dhabi Emirate	**1173**	**1204**	**1217**	**1241**	**1245**	**1247**	**1271**	**1279**	**1313**	**1329**
Northern Emirates Supply	30	30	30	30	30	30	30	30	30	30
Global Demand	**1203**	**1234**	**1247**	**1271**	**1275**	**1277**	**1301**	**1309**	**1343**	**1359**
Most Likely Forecast										
Abu Dhabi	567	579	591	600	609	618	628	637	645	659
Al Ain	386	391	396	401	405	406	409	414	417	420
Western Region	125	127	130	132	133	135	136	138	139	140
Abu Dhabi Emirate	**1074**	**1094**	**1113**	**1130**	**1144**	**1156**	**1170**	**1185**	**1196**	**1215**
Northern Emirates Supply	30	30	30	30	30	30	30	30	30	30
Global Demand	**1104**	**1124**	**1143**	**1160**	**1174**	**1186**	**1200**	**1215**	**1226**	**1245**
Low Forecast										
Abu Dhabi	521	531	537	550	560	565	571	581	588	602
Al Ain	356	360	361	370	369	366	365	365	372	373
Western Region	111	113	116	117	119	120	123	125	125	126
Abu Dhabi Emirate	**983**	**999**	**1010**	**1033**	**1042**	**1045**	**1054**	**1065**	**1079**	**1096**
Northern Emirates Supply	30	30	30	30	30	30	30	30	30	30
Global Demand	**1013**	**1029**	**1040**	**1063**	**1072**	**1075**	**1084**	**1095**	**1109**	**1126**

Winter 2007 / 2008 - ADWEC Electricity Peak System Base Demand Forecast Details (Gross MW)

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Base Demand Forecast														
Abu Dhabi	3,241	3,539	4,516	5,330	6,367	7,687	8,194	9,104	9,925	10,285	10,669	11,079	11,517	11,969
Al Ain	1,516	1,637	1,781	1,814	2,075	2,251	2,333	2,441	2,572	2,619	2,623	2,673	2,615	2,677
Western Region	572	757	1,277	1,277	1,500	1,975	2,516	2,567	2,712	2,805	2,875	2,935	3,007	3,132
System Demand	**5,286**	**5,830**	**7,443**	**8,276**	**9,770**	**11,706**	**12,817**	**13,868**	**14,946**	**15,437**	**15,888**	**16,399**	**16,842**	**17,469**
ADWEC Supplies to the Northern Emirates														
FEC		0	120	250	300	450	450	450	450	450	450	450	450	450
FEWA	500	600	600	1,000	1,300	2,066	2,201	2,346	2,500	2,500	2,500	2,500	2,500	2,500
DEWA		0	0	0	0	0	0	0	0	0	0	0	0	0
SEWA *2008 only*		200	0	0	0	0	0	0	0	0	0	0	0	0
Total Northern Emirates Supply *Excluding Auxiliaries and Transmission Losses*	**500**	**800**	**720**	**1,250**	**1,600**	**2,516**	**2,651**	**2,796**	**2,950**	**2,950**	**2,950**	**2,950**	**2,950**	**2,950**
Total Northern Emirates Transmission Losses 2%		*16*	*14*	*25*	*32*	*50*	*53*	*56*	*59*	*59*	*59*	*59*	*59*	*59*
Total Northern Emirates Supplies + Transmission Losses		816	734	1,275	1,632	2,566	2,704	2,852	3,009	3,009	3,009	3,009	3,009	3,009
Power Auxiliaries for Northern Emirates Supplies		*16*	*15*	*26*	*33*	*51*	*108*	*114*	*120*	*120*	*120*	*120*	*120*	*120*
Auxiliaries for water pumping from F1 and F2 to Abu Dhabi		*121*	*123*	*210*	*210*	*210*	*210*	*210*	*210*	*210*	*210*	*210*	*210*	*210*
Total Northern Emirates Supply Including Auxiliaries for Abu Dhabi Water Demand	**500**	**953**	**872**	**1,511**	**1,875**	**2,828**	**3,022**	**3,176**	**3,339**	**3,339**	**3,339**	**3,339**	**3,339**	**3,339**
Total Abu Dhabi Emirate + Northern Emirates Supplies *(Undiversified)*	**5,786**	**6,783**	**8,315**	**9,786**	**11,645**	**14,534**	**15,839**	**17,044**	**18,285**	**18,777**	**19,227**	**19,739**	**20,182**	**20,809**
*Diversity Factor**		*100%*	*100%*	*100%*	*100%*	*99%*	*99%*	*99%*	*99%*	*99%*	*99%*	*99%*	*99%*	*99%*
Global Demand	**5,786**	**6,783**	**8,315**	**9,786**	**11,645**	**14,389**	**15,681**	**16,873**	**18,102**	**18,589**	**19,035**	**19,541**	**19,980**	**20,601**

***) Diversity Factor**
Before 2012 ADWEC will likely supply a fixed hourly quantity of electricity to FEWA during the peak Summer period and the variation in demand is likely to be met by the more expensive FEWA generation.
Therefore since the amount supplied to FEWA is assumed to remain the same during every hour of the summers in 2008 - 2011 there is a very high probability
that ADWEC will be supplying to FEWA the fixed hourly quantity during the time of the Abu Dhabi system peak - hence a 100% diversity factor has been used.
Thus a 100% diversifty factor has been used for the period 2008 - 2011.
For the period 2012 onwards there is no FEWA generation and thus the amount supplied by ADWEC to FEWA varies by hour.
Thus there is no longer a very high probability that ADWEC will be supplying the maximum amount to FEWA during the time of the Abu Dhabi system peak.
Accordingly a 99% diversity factor has been applied from 2012 onwards.

Winter 2007 / 2008 - ADWEC Electricity Peak System Base Demand Forecast Details (Gross MW)

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Base Demand Forecast										
Abu Dhabi	12,358	12,766	13,193	13,638	14,107	14,596	15,107	15,645	16,089	16,560
Al Ain	2,720	2,775	2,843	2,908	2,979	3,054	3,122	3,178	3,237	3,300
Western Region	3,260	3,344	3,409	3,488	3,606	3,701	3,802	3,901	4,001	4,108
System Demand	**18,020**	**18,558**	**19,109**	**19,687**	**20,334**	**20,982**	**21,650**	**22,331**	**22,924**	**23,554**
ADWEC Supplies to the Northern Emirates										
FEC	450	450	450	450	450	450	450	450	450	450
FEWA	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500
DEWA										
SEWA *2008 only*										
Total Northern Emirates Supply *Excluding Auxiliaries and Transmission Losses*	**2,950**	**2,950**	**2,950**	**2,950**	**2,950**	**2,950**	**2,950**	**2,950**	**2,950**	**2,950**
Total Northern Emirates Transmission Losses 2%	*59*	*59*	*59*	*59*	*59*	*59*	*59*	*59*	*59*	*59*
Total Northern Emirates Supplies + Transmission Losses	3,009	3,009	3,009	3,009	3,009	3,009	3,009	3,009	3,009	3,009
Power Auxiliaries for Northern Emirates Supplies	*120*	*120*	*120*	*120*	*120*	*120*	*120*	*120*	*120*	*120*
Auxiliaries for water pumping from F1 and F2 to Abu Dhabi	*210*	*210*	*210*	*210*	*210*	*210*	*210*	*210*	*210*	*210*
Total Northern Emirates Supply Incl. Auxiliaries for Abu Dhabi Water Demand	**3,339**	**3,339**	**3,339**	**3,339**	**3,339**	**3,339**	**3,339**	**3,339**	**3,339**	**3,339**
Total Abu Dhabi Emirate + Northern Emirates Supplies *(Undiversified)*	**21,359**	**21,898**	**22,448**	**23,026**	**23,674**	**24,321**	**24,989**	**25,670**	**26,263**	**26,893**
*Diversity Factor**	*99%*	*99%*	*99%*	*99%*	*99%*	*99%*	*99%*	*99%*	*99%*	*99%*
Global Demand	**21,146**	**21,679**	**22,223**	**22,796**	**23,437**	**24,078**	**24,739**	**25,413**	**26,000**	**26,624**

Annex B

Capacity Requirements

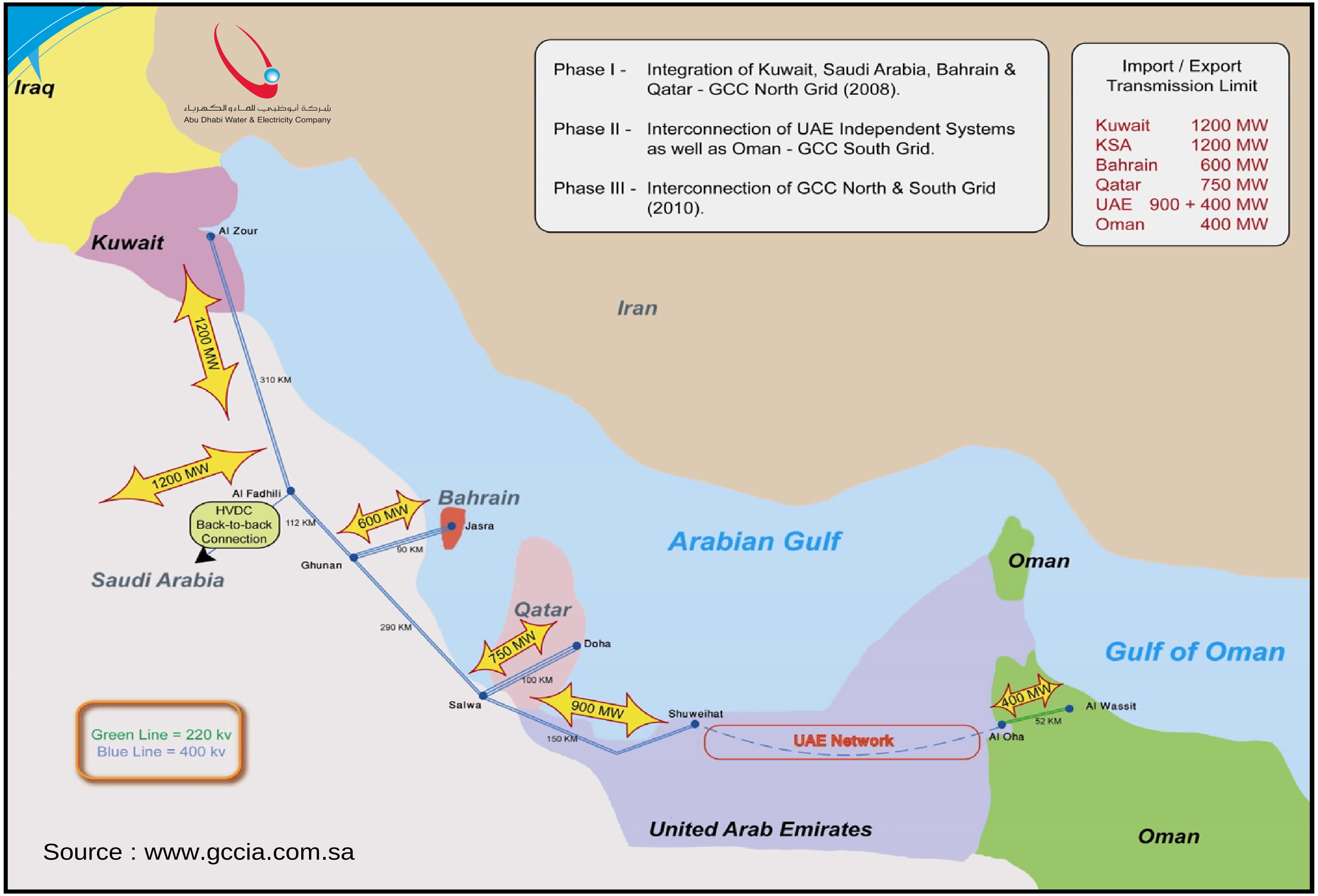
Electricity Gross Capacities by Station (MW) for 2008

Al Ain Power Station	256
BPC	**256**
Umm al Nar East A	118
Umm al Nar West 1-6	360
Umm al Nar West 7-8	300
UAN-new	1,657
APC	**2,435**
Al Mirfa	186
Madinat Zayed	109
AMPC	**295**
Taweelah B1	825
Taweelah B2	358
Taweelah B New	470
TAPCO	**1,653**
GTTPC	**1,414**
ECPC	**760**
SCIPCO S1	**1,615**
ESWPC Fujairah F1	**641**
Available Capacity	**9,069**

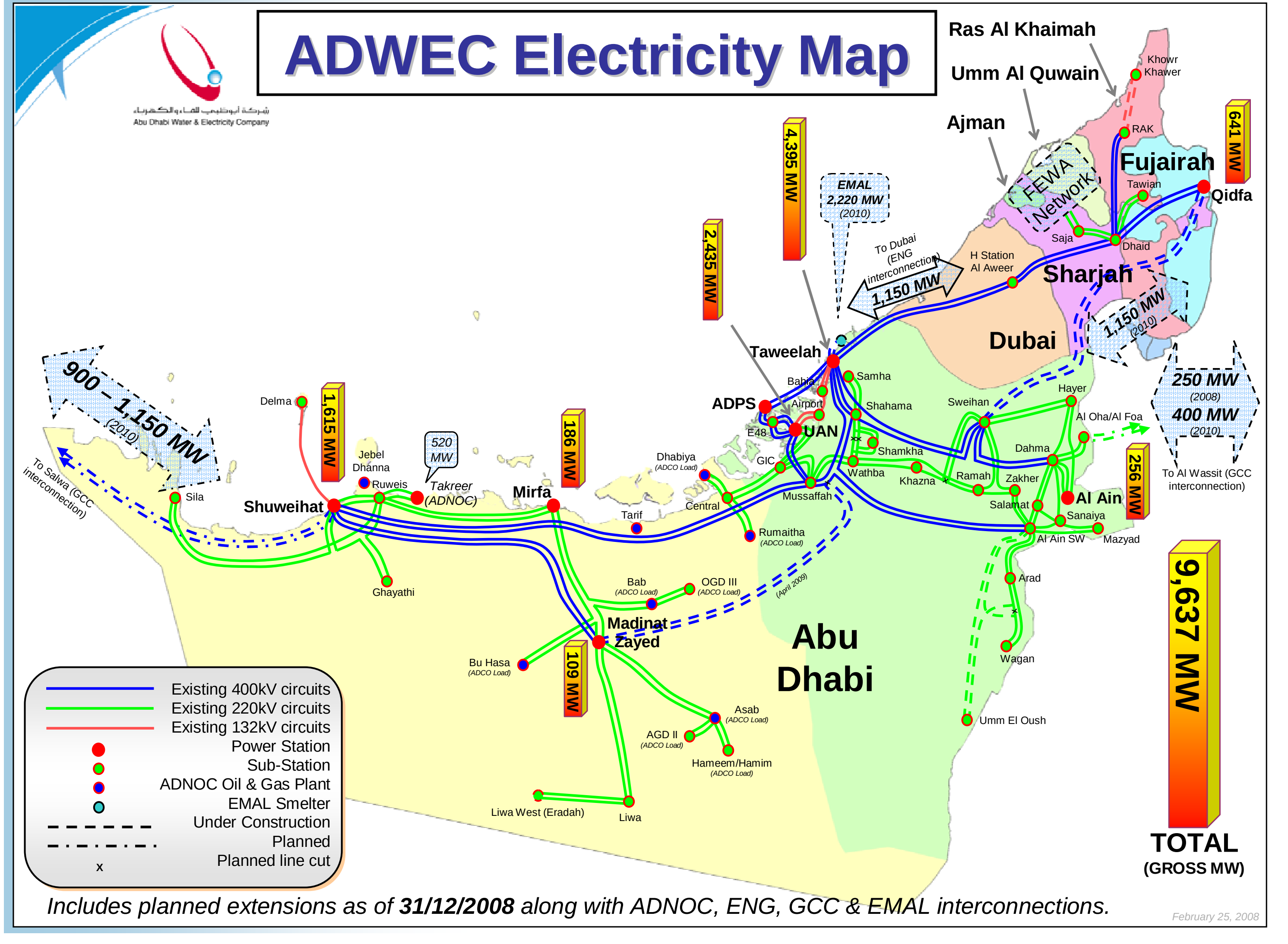
Water Gross Capacities by Station (MIGD) for 2008

Umm al Nar East B	20
Umm al Nar West 1-6	24
Umm al Nar West 7-8	6
UAN - New	95
APC	**145**
AMPC	**39**
Taweelah B1	70
Taweelah B2	23
Taweelah B New	35
TAPCO	**128**
GTTPC	**85**
ECPC	**51**
SCIPCO S1	**101**
ESWPC Fujairah F1*	**102**
Available Capacity	**651**

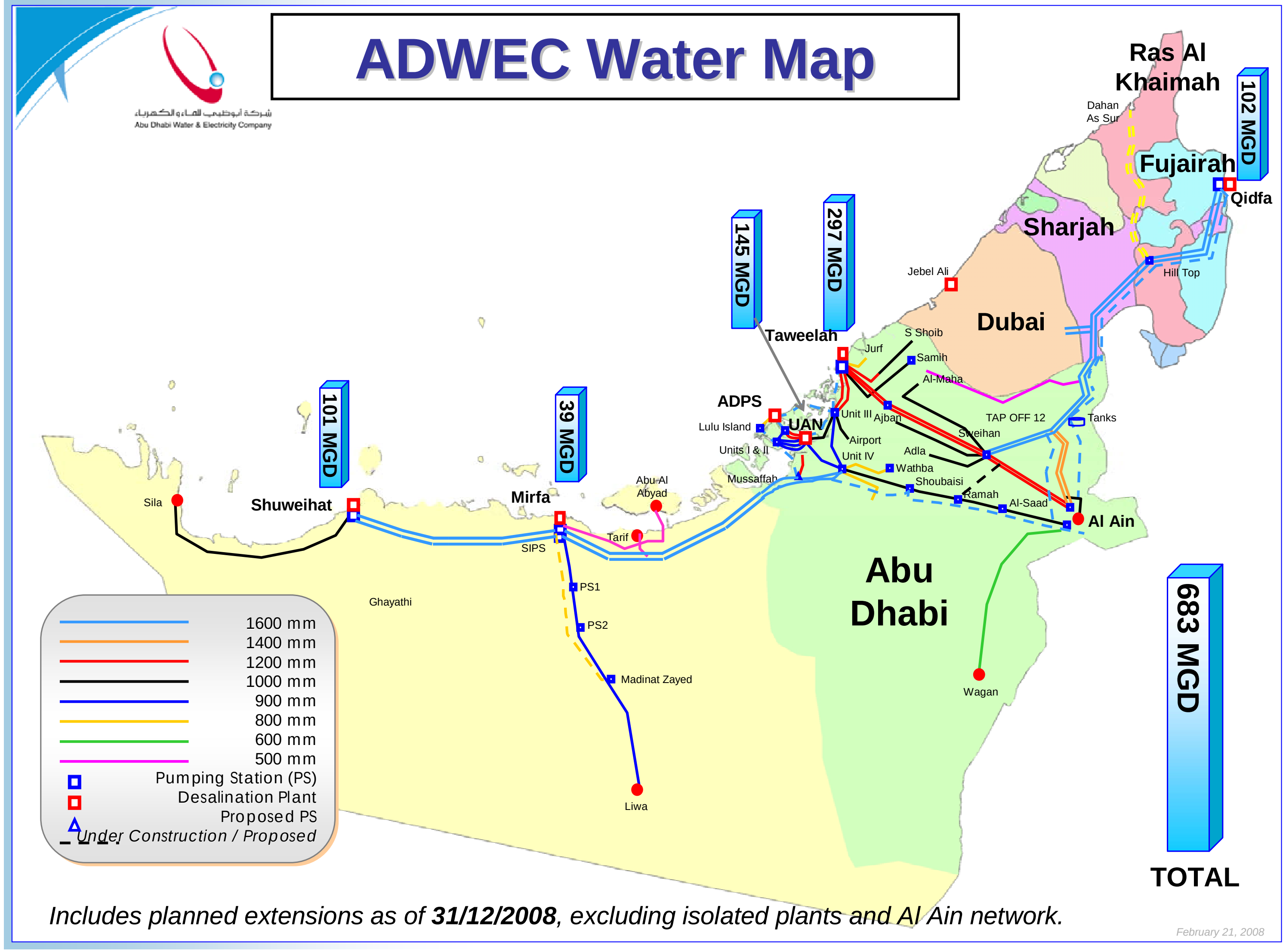
ENG / GCC Interconnections



Location of Electricity Capacities in 2008



Location of Water Capacities in 2008



Available Electricity Capacity (Gross MW)

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Abu Dhabi Gas Turbines														
Abu Dhabi Steam Turbines	76													
Al Ain Power Station	256	256	256	256	256	256								
BPC	**332**	**256**	**256**	**256**	**256**	**256**								
Umm al Nar East A	118	118	118	118	118	118								
Umm al Nar East B														
Umm al Nar West 1-6	360	360	360	360	360	360								
Umm al Nar West 7-8	300	300	300	300	300	300								
Umm al Nar West 9-10														
UAN-new (Sas Al Nakhl)	1,666	1,657	1,655	1,652	1,652	1,652	1,652	1,652	1,652	1,652	1,652	1,652	1,652	1,652
APC	**2,444**	**2,435**	**2,433**	**2,430**	**2,430**	**2,430**	**1,652**	**1,652**	**1,652**	**1,652**	**1,652**	**1,652**	**1,652**	**1,652**
Al Mirfa Power	186	186	186	186	186	186	186	186	186	186	186	186	186	186
Madinat Zayed	109	109	109	109	109	109	109	109	109	109	109			
AMPC	**295**	**295**	**295**	**295**	**295**	**295**	**295**	**295**	**295**	**295**	**295**	**186**	**186**	**186**
Taweelah B1	881	825	825	825	825	825	825	825	825	825	825	825	825	825
Taweelah B2	351	358	358	358	358	358	358	358	358	358	358	358	358	358
Taweelah B New		470	1,037	1,037	1,037	1,037	1,037	1,037	1,037	1,037	1,037	1,037	1,037	1,037
TAPCO	**1,232**	**1,653**	**2,220**	**2,220**	**2,220**	**2,220**	**2,220**	**2,220**	**2,220**	**2,220**	**2,220**	**2,220**	**2,220**	**2,220**
Taweelah A1	1,414	1,414	1,458	1,458	1,458	1,457	1,457	1,457	1,457	1,457	1,457	1,457	1,457	1,457
Taweelah A10			213	213	213	213	213	213	213	213	213	213	213	213
GTTPC	**1,414**	**1,414**	**1,671**	**1,671**	**1,671**	**1,670**	**1,670**	**1,670**	**1,670**	**1,670**	**1,670**	**1,670**	**1,670**	**1,670**
ECPC	**763**	**760**	**759**	**760**	**760**	**758**	**765**	**765**	**762**	**763**	**761**	**759**	**761**	**759**
SCIPCO S1	**1,577**	**1,615**	**1,615**	**1,615**	**1,615**	**1,615**	**1,615**	**1615**	**1,615**	**1,615**	**1,615**	**1,615**	**1,615**	**1,615**
Shuweihat S2					**1,730**	**1,730**	**1,730**	**1,730**	**1,730**	**1,730**	**1,730**	**1,730**	**1,730**	**1,730**
Fujairah Existing F1	641	641	641	641	641	641	641	641	641	641	641	641	641	641
Fujairah F1 Extension			220	220	220	220	220	220	220	220	220	220	220	220
ESWPC Fujairah F1	**641**	**641**	**861**	**861**	**861**	**861**	**861**	**861**	**861**	**861**	**861**	**861**	**861**	**861**
FAPCO Fujairah F2				**2114**	**2114**	**2114**	**2114**	**2114**	**2114**	**2,114**	**2114**	**2114**	**2114**	**2114**
Al Zawra Relocation					**400**	**400**	**400**	**400**	**400**	**400**	**400**	**400**	**400**	**400**
Masdar CSP Shams 1					**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**
Masdar CSP Shams 2						**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**
Masdar CSP Shams 3							**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**
Masdar CSP Shams 4								**100**	**100**	**100**	**100**	**100**	**100**	**100**
Masdar CSP Shams 5									**100**	**100**	**100**	**100**	**100**	**100**
Masdar Hydrogen Power (net cap.)							**390**	**390**	**390**	**390**	**390**	**390**	**390**	**390**
Shuweihat S3						**1,700**	**1,700**	**1,700**	**1,700**	**1,700**	**1,700**	**1,700**	**1,700**	**1,700**
Available Capacity	**8,698**	**9,069**	**10,110**	**12,222**	**14,392**	**16,129**	**15,532**	**15,632**	**15,729**	**15,730**	**15,728**	**15,617**	**15,619**	**15,617**

Available Water Capacity (Gross MIGD)

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Abu Dhabi Steam Turbines	15													
BPC	**15**													
Umm al Nar East A														
Umm al Nar East B	20	20	20	20										
Umm al Nar West 1-6	24	24	24	24										
Umm al Nar West 7-8	6	6	6	6										
UAN - new (Sas Al Nakhl)	95	95	95	95	95	95	95	95	95	95	95	95	95	95
APC	**145**	**145**	**145**	**145**	**95**	**95**	**95**	**95**	**95**	**95**	**95**	**95**	**95**	**95**
AMPC	**39**	**39**	**39**	**39**	**39**	**39**	**39**	**39**	**39**	**39**	**39**	**39**	**39**	**39**
Taweelah B1	70	70	70	70	70	70	70	70	70	70	70	70	70	70
Taweelah B2	23	23	23	23	23	23	23	23	23	23	23	23	23	23
Taweelah B New		35	69	69	69	69	69	69	69	69	69	69	69	69
TAPCO	**93**	**128**	**162**	**162**	**162**	**162**	**162**	**162**	**162**	**162**	**162**	**162**	**162**	**162**
GTTPC	**85**	**85**	**85**	**85**	**85**	**85**	**85**	**85**	**85**	**85**	**85**	**85**	**85**	**85**
ECPC	**51**	**51**	**51**	**51**	**51**	**51**	**51**	**51**	**51**	**51**	**51**	**51**	**51**	**51**
SCIPCO S1	**101**	**101**	**101**	**101**	**101**	**101**	**101**	**101**	**101**	**101**	**101**	**101**	**101**	**101**
Shuweihat S2					**101**	**101**	**101**	**101**	**101**	**101**	**101**	**101**	**101**	**101**
ESWPC Fujairah F1	**102**	**102**	**102**	**102**	**102**	**102**	**102**	**102**	**102**	**102**	**102**	**102**	**102**	**102**
FAPCO Fujairah F2				**132**	**132**	**132**	**132**	**132**	**132**	**132**	**132**	**132**	**132**	**132**
Shuweihat S3						**101**	**101**	**101**	**101**	**101**	**101**	**101**	**101**	**101**
Available Capacity	**631**	**651**	**685**	**817**	**868**	**969**	**969**	**969**	**969**	**969**	**969**	**969**	**969**	**969**

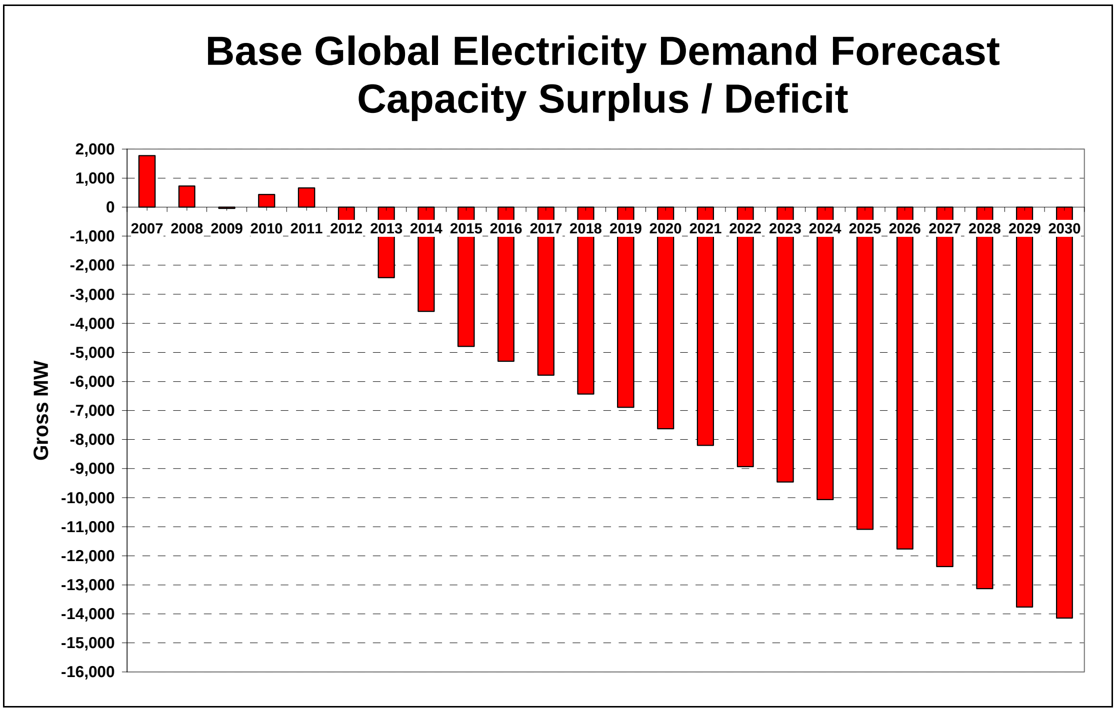
Available Electricity Capacity (Gross MW)

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Abu Dhabi Gas Turbines										
Abu Dhabi Steam Turbines										
Al Ain Power Station										
BPC										
Umm al Nar East A										
Umm al Nar East B										
Umm al Nar West 1-6										
Umm al Nar West 7-8										
Umm al Nar West 9-10										
UAN-new (Sas Al Nakhl)	1,652	1,652	1,652	1,652	1,652	1,652	1,652	1,652	1,652	1,652
APC	**1,652**	**1,652**	**1,652**	**1,652**	**1,652**	**1,652**	**1,652**	**1,652**	**1,652**	**1,652**
Al Mirfa Power	186									
Madinat Zayed										
AMPC	**186**									
Taweelah B1	825	825	825	825	825	825	825	825	825	825
Taweelah B2	358	358	358	358	358	358	358	358	358	358
Taweelah B New	1037	1,037	1,037	1,037	1,037	1,037	1,037	1,037	1,037	1,037
TAPCO	**2,220**	**2,220**	**2,220**	**2,220**	**2,220**	**2,220**	**2,220**	**2,220**	**2,220**	**2,220**
Taweelah A1	1,457	1,457	1,457	1,457	1,457	1,457	1,457	1,457	1,457	1,457
Taweelah A10	213	213	213	213	213	213	213	213	213	213
GTTPC	**1,670**	**1,670**	**1,670**	**1,670**	**1,670**	**1,670**	**1,670**	**1,670**	**1,670**	**1,670**
ECPC	**759**	**759**	**759**	**759**	**759**	**759**	**759**	**759**	**759**	**759**
SCIPCO S1	**1,615**	**1,615**	**1,615**	**1,615**	**1,615**	**1,615**	**1,615**	**1,615**	**1,615**	**1,615**
Shuweihat S2	**1730**	**1,730**	**1,730**	**1,730**	**1,730**	**1,730**	**1,730**	**1,730**	**1,730**	**1,730**
Fujairah Existing F1	641	641	641	641	641	641	641	641	641	641
Fujairah F1 Extension	220	220	220	220	220	220	220	220	220	220
ESWPC Fujairah F1	**861**	**861**	**861**	**861**	**861**	**861**	**861**	**861**	**861**	**861**
FAPCO Fujairah F2	**2114**	**2114**	**2114**	**2114**	**2114**	**2114**	**2114**	**2114**	**2114**	**2114**
Al Zawra Relocation	**400**	**400**	**400**	**400**	**400**	**400**	**400**	**400**	**400**	**400**
Masdar CSP Shams 1	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**
Masdar CSP Shams 2	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**
Masdar CSP Shams 3	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**
Masdar CSP Shams 4	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Masdar CSP Shams 5	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Masdar Hydrogen Power (net cap.)	**390**	**390**	**390**	**390**	**390**	**390**	**390**	**390**	**390**	**390**
Shuweihat S3	**1700**	**1,700**	**1,700**	**1,700**	**1,700**	**1,700**	**1,700**	**1,700**	**1,700**	**1,700**
Available Capacity	**15,617**	**15,431**	**15,431**	**15,431**	**15,431**	**15,431**	**15,431**	**15,431**	**15,431**	**15,431**

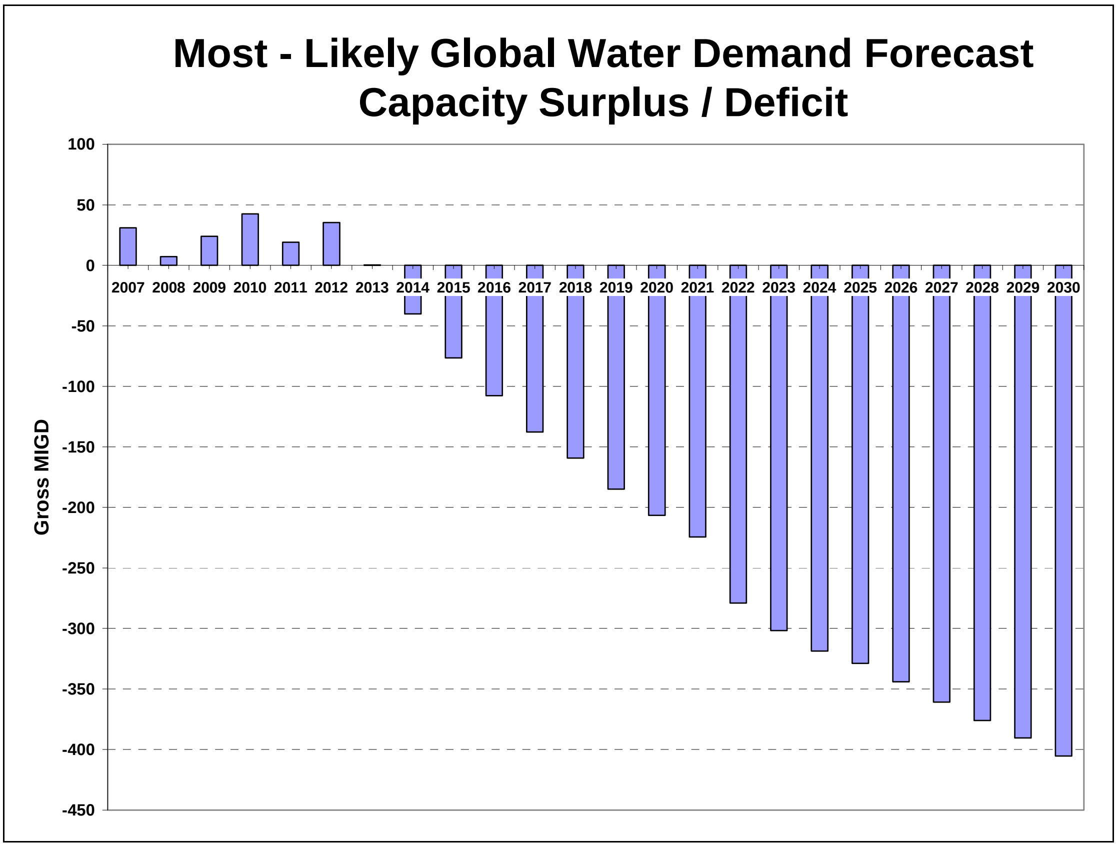
Available Water Capacity (Gross MIGD)

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Abu Dhabi Steam Turbines										
BPC										
Umm al Nar East A										
Umm al Nar East B										
Umm al Nar West 1-6										
Umm al Nar West 7-8										
UAN - new (Sas Al Nakhl)	95	95	95	95	95	95	95	95	95	95
APC	**95**	**95**	**95**	**95**	**95**	**95**	**95**	**95**	**95**	**95**
AMPC	**39**									
Taweelah B1	70	70	70	70	70	70	70	70	70	70
Taweelah B2	23	23	23	23	23	23	23	23	23	23
Taweelah B New	69	69	69	69	69	69	69	69	69	69
TAPCO	**162**	**162**	**162**	**162**	**162**	**162**	**162**	**162**	**162**	**162**
GTTPC	**85**	**85**	**85**	**85**	**85**	**85**	**85**	**85**	**85**	**85**
ECPC	**51**	**51**	**51**	**51**	**51**	**51**	**51**	**51**	**51**	**51**
SCIPCO S1	**101**	**101**	**101**	**101**	**101**	**101**	**101**	**101**	**101**	**101**
Shuweihat S2	**101**	**101**	**101**	**101**	**101**	**101**	**101**	**101**	**101**	**101**
ESWPC Fujairah F1	**102**	**102**	**102**	**102**	**102**	**102**	**102**	**102**	**102**	**102**
FAPCO Fujairah F2	**132**	**132**	**132**	**132**	**132**	**132**	**132**	**132**	**132**	**132**
Shuweihat S3	**101**	**101**	**101**	**101**	**101**	**101**	**101**	**101**	**101**	**101**
Available Capacity	**969**	**930**	**930**	**930**	**930**	**930**	**930**	**930**	**930**	**930**

Base / Most Likely Demand Forecast
Capacity Surplus / Deficit

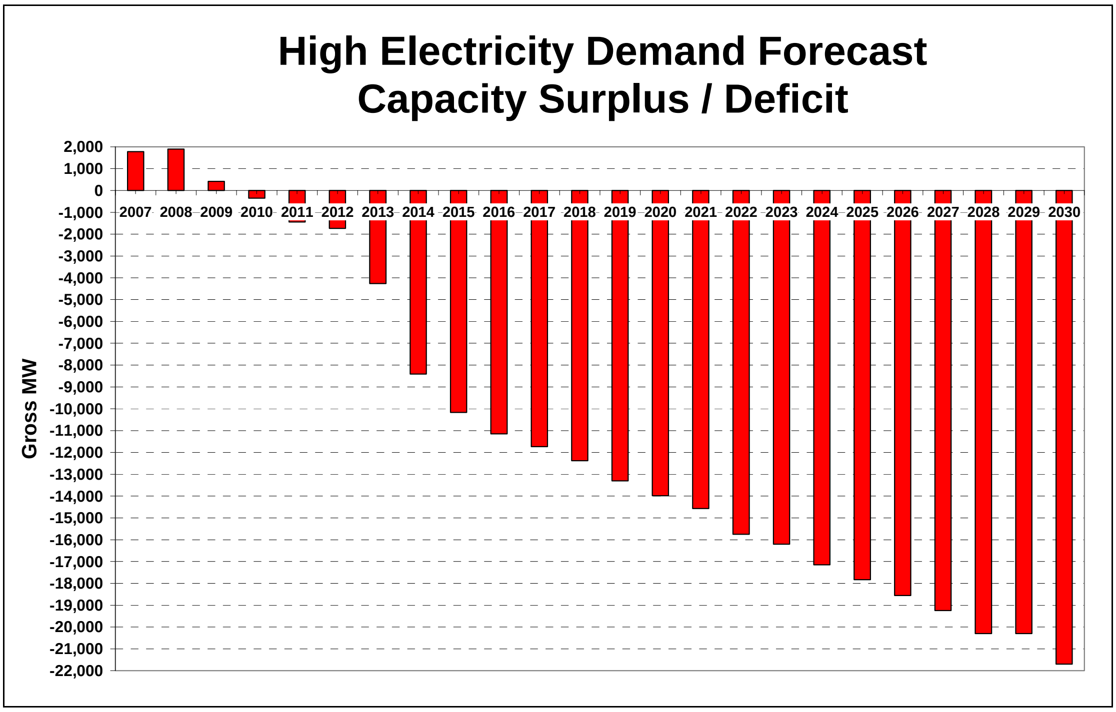


Surplus / Deficit = Available Capacity - Required Capacity

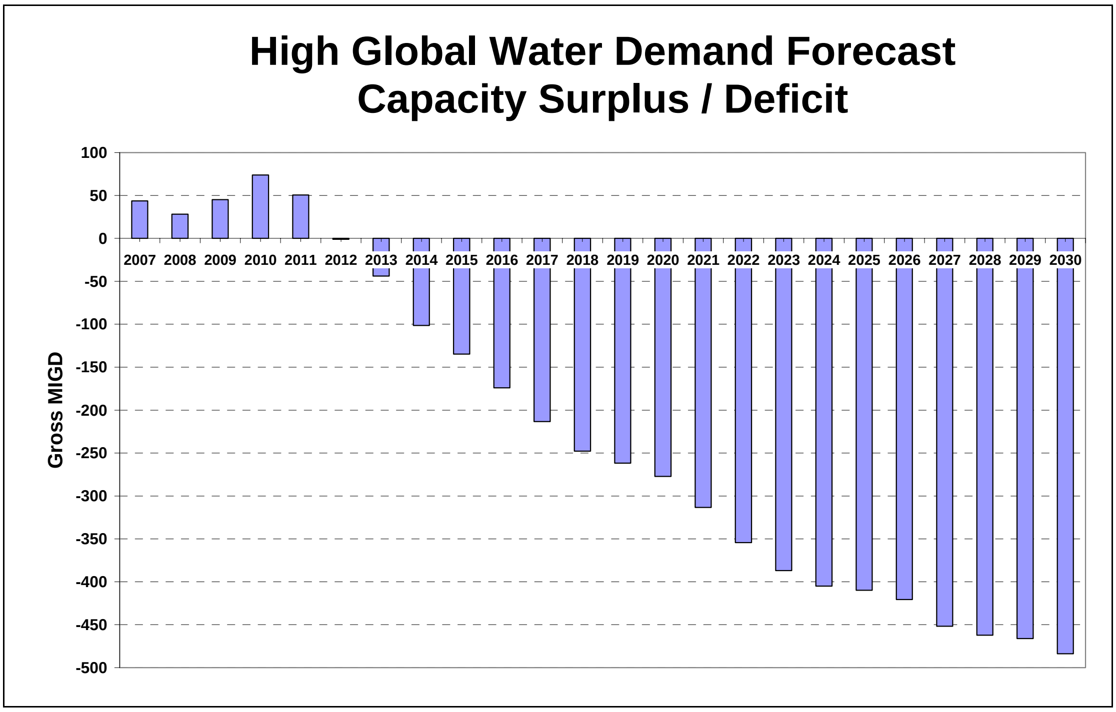


Surplus / Deficit = Available Capacity - Required Capacity

High Demand Forecast
Capacity Surplus / Deficit

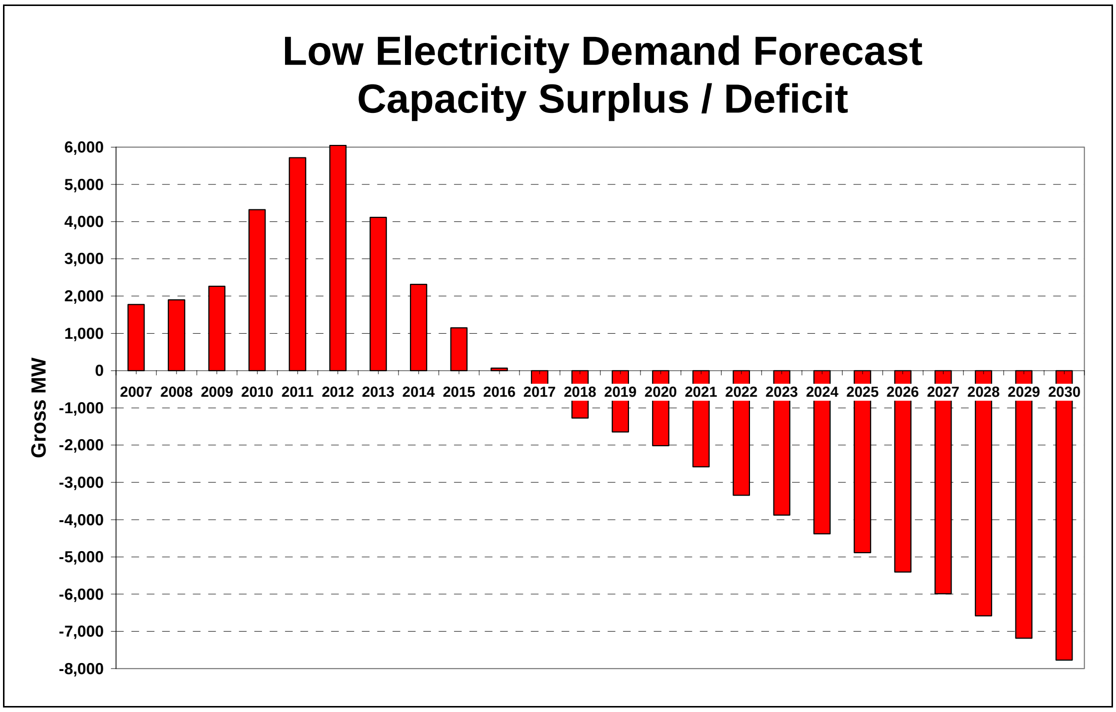


Surplus / Deficit = Available Capacity - Required Capacity

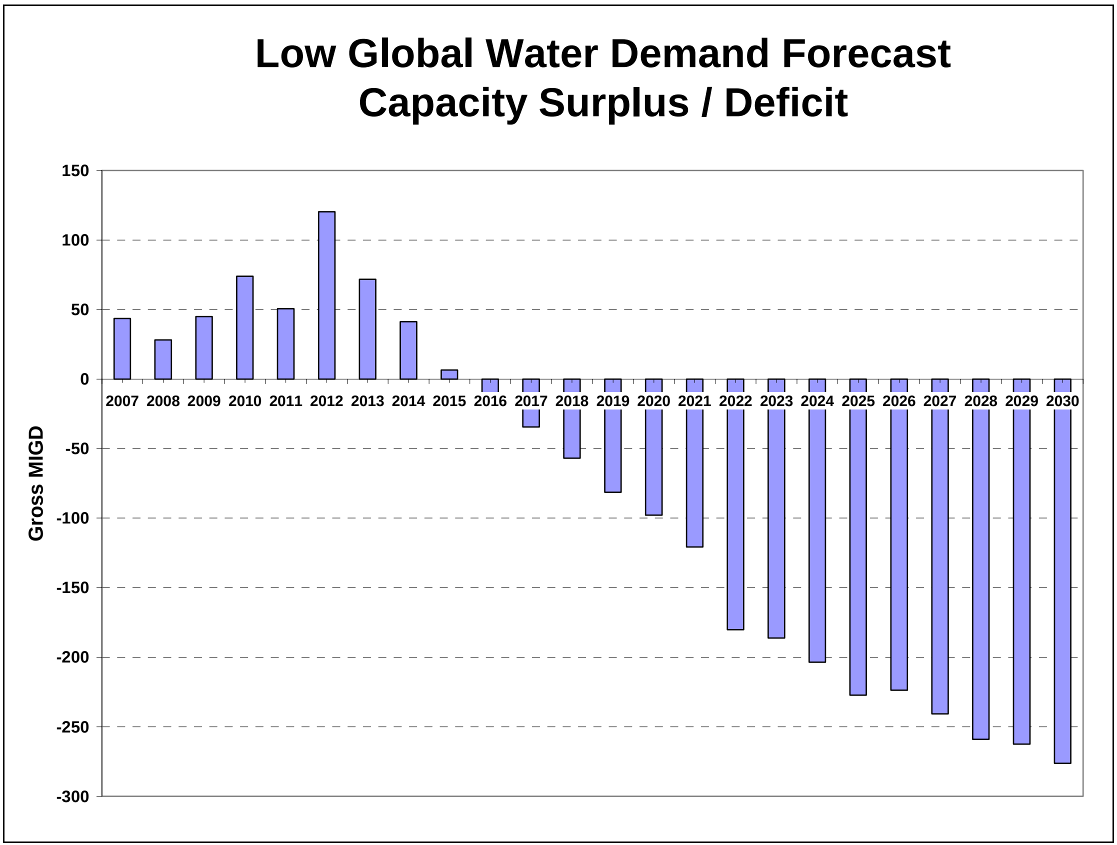


Surplus / Deficit = Available Capacity - Required Capacity

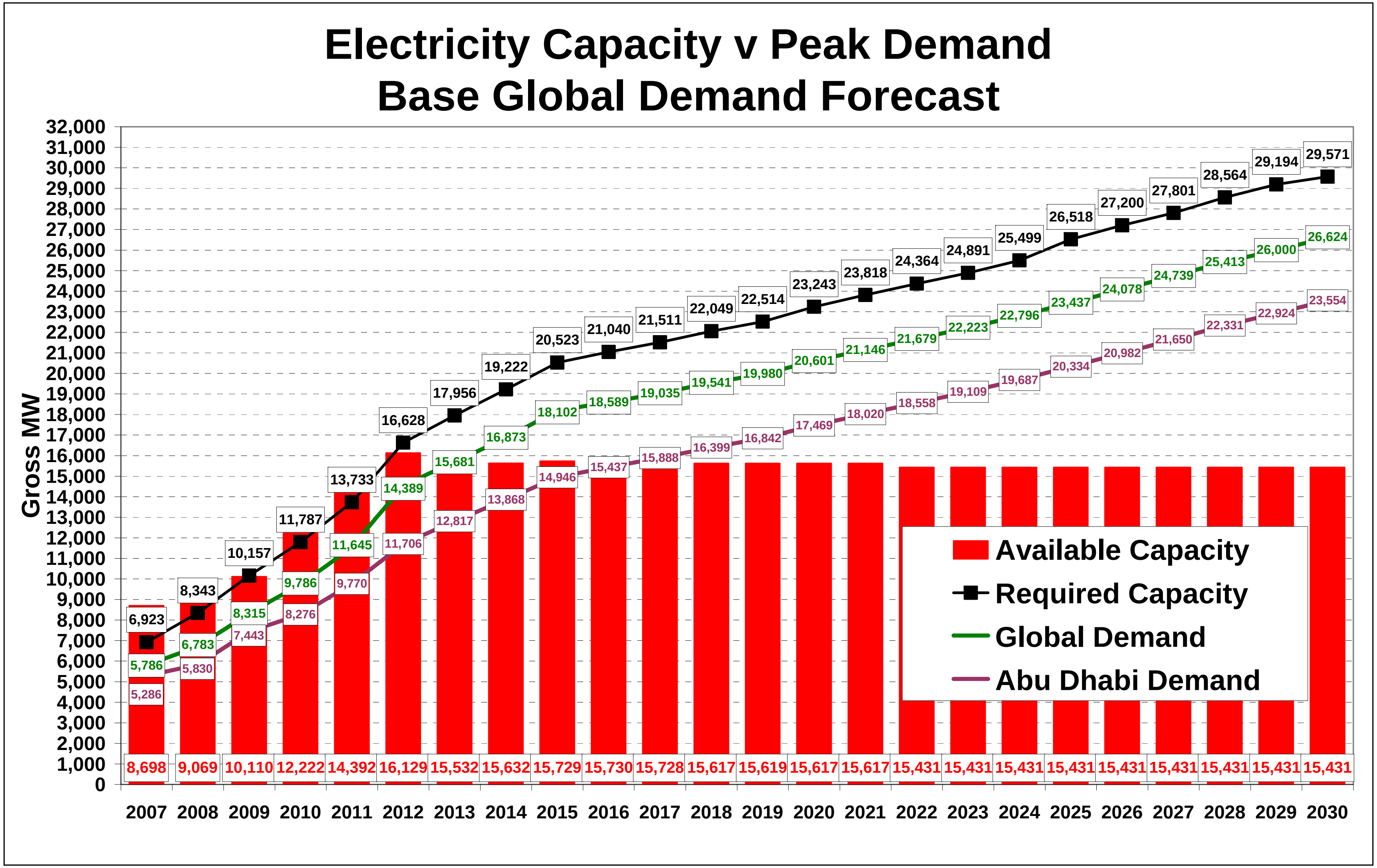
Low Demand Forecast
Capacity Surplus / Deficit

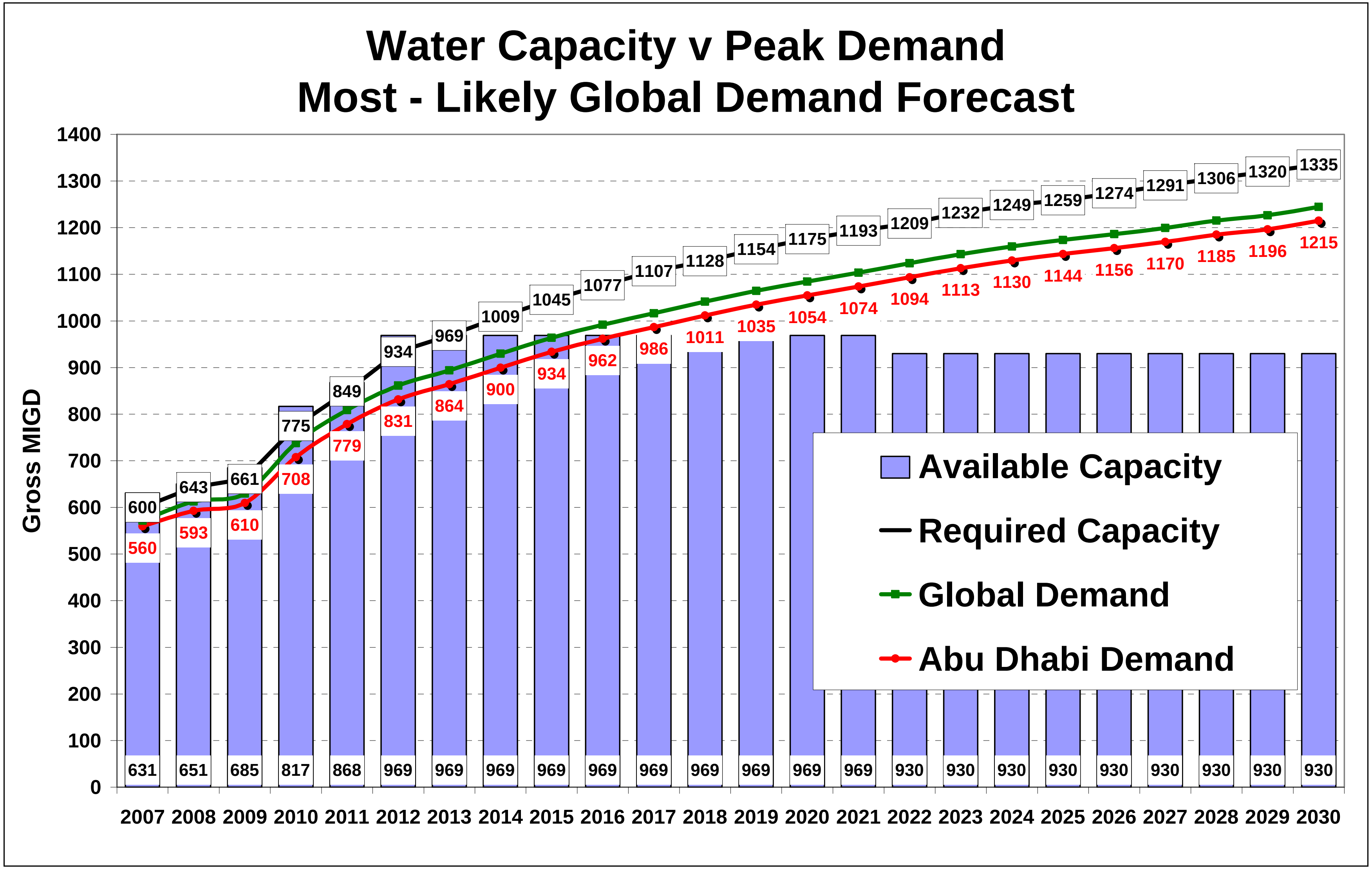


Surplus / Deficit = Available Capacity - Required Capacity



Surplus / Deficit = Available Capacity - Required Capacity


Electricity Capacity v Peak Demand
Base Global Demand Forecast
Gross MW
32,000
31,000
30,000
29,000
28,000
27,000
26,000
25,000
24,000
23,000
22,000
21,000
20,000
19,000
18,000
17,000
16,000
15,000
14,000
13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030
6,923 8,343 10,157 11,787 13,733 16,628 17,956 19,222 20,523 21,040 21,511 22,049 22,514 23,243 23,818 24,364 24,891 25,499 26,518 27,200 27,801 28,564 29,194 29,571
5,786 6,783 8,315 9,786 11,645 14,389 15,681 16,873 18,102 18,589 19,035 19,541 19,980 20,601 21,146 21,679 22,223 22,796 23,437 24,078 24,739 25,413 26,000 26,624
5,286 5,830 7,443 8,276 9,770 11,706 12,817 13,868 14,946 15,437 15,888 16,399 16,842 17,469 18,020 18,558 19,109 19,687 20,334 20,982 21,650 22,331 22,924 23,554
8,698 9,069 10,110 12,222 14,392 16,129 15,532 15,632 15,729 15,730 15,728 15,617 15,619 15,617 15,617 15,431 15,431 15,431 15,431 15,431 15,431 15,431 15,431 15,431
Available Capacity
Required Capacity
Global Demand
Abu Dhabi Demand


Water Capacity v Peak Demand
Most - Likely Global Demand Forecast
Gross MIGD
Available Capacity
Required Capacity
Global Demand
Abu Dhabi Demand
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030
631 651 685 817 868 969 969 969 969 969 969 969 969 969 969 930 930 930 930 930 930 930 930 930
600 643 661 775 849 934 969 1009 1045 1077 1107 1128 1154 1175 1193 1209 1232 1249 1259 1274 1291 1306 1320 1335
560 593 610 708 779 831 864 900 934 962 986 1011 1035 1054 1074 1094 1113 1130 1144 1156 1170 1185 1196 1215

Winter 2007/2008 Electricity Generation Capacity Requirements (Gross MW)
High, Base and Low Electricity Demand Forecasts

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Available Capacity	**8,698**	**9,069**	**10,110**	**12,222**	**14,392**	**16,129**	**15,532**	**15,632**	**15,729**	**15,730**	**15,728**	**15,617**	**15,619**	**15,617**
High Electricity Forecast Requirements														
Abu Dhabi Demand Forecast	5,286	5,830	7,886	10,492	13,588	15,529	17,395	21,329	23,150	23,961	24,567	25,074	25,768	26,505
Required Capacity	6,923	7,171	9,700	12,572	15,831	17,865	19,799	24,040	25,896	26,878	27,463	28,002	28,919	29,599
Ratio of Required Capacity to Demand	*1.31*	*1.23*	*1.23*	*1.20*	*1.17*	*1.15*	*1.14*	*1.13*	*1.12*	*1.12*	*1.12*	*1.12*	*1.12*	*1.12*
Surplus / Deficit	**1,775**	**1,898**	**410**	**-350**	**-1,439**	**-1,736**	**-4,267**	**-8,408**	**-10,167**	**-11,148**	**-11,735**	**-12,385**	**-13,300**	**-13,982**
Base Electricity Forecast Requirements														
Abu Dhabi Demand Forecast	5,286	5,830	7,443	8,276	9,770	11,706	12,817	13,868	14,946	15,437	15,888	16,399	16,842	17,469
Northern Emirates Supply	500	953	872	1,511	1,875	2,828	3,022	3,176	3,339	3,339	3,339	3,339	3,339	3,339
Global Demand Forecast	5,786	6,783	8,315	9,786	11,645	14,389	15,681	16,873	18,102	18,589	19,035	19,541	19,980	20,601
Required Capacity	6,923	8,343	10,157	11,787	13,733	16,628	17,956	19,222	20,523	21,040	21,511	22,049	22,514	23,243
Ratio of Required Capacity to Demand	*1.20*	*1.23*	*1.22*	*1.20*	*1.18*	*1.16*	*1.15*	*1.14*	*1.13*	*1.13*	*1.13*	*1.13*	*1.13*	*1.13*
Surplus / Deficit	**1,775**	**726**	**-47**	**435**	**659**	**-499**	**-2,424**	**-3,590**	**-4,794**	**-5,310**	**-5,783**	**-6,432**	**-6,895**	**-7,626**
Low Electricity Forecast Requirements														
Abu Dhabi Demand Forecast	5,286	5,830	6,380	6,477	7,171	8,333	9,516	11,192	12,251	13,273	14,200	14,596	15,016	15,360
Required Capacity	6,923	7,171	7,847	7,902	8,677	10,083	11,419	13,318	14,579	15,662	16,464	16,887	17,266	17,632
Ratio of Required Capacity to Demand	*1.31*	*1.23*	*1.23*	*1.22*	*1.21*	*1.21*	*1.20*	*1.19*	*1.19*	*1.18*	*1.16*	*1.16*	*1.15*	*1.15*
Surplus / Deficit	**1,775**	**1,898**	**2263**	**4,320**	**5,715**	**6,046**	**4,113**	**2,314**	**1,150**	**68**	**-736**	**-1,270**	**-1,647**	**-2,015**

Winter 2007 / 2008 Water Capacity Requirements (Gross MIGD)
High, Most - Likely and Low Water Demand Forecasts

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Available Capacity	**631**	**651**	**685**	**817**	**868**	**969**	**969**	**969**	**969**	**969**	**969**	**969**	**969**	**969**
High Water Forecast Requirements														
Abu Dhabi Demand Forecast	560	593	610	708	779	894	931	978	1010	1049	1088	1106	1131	1159
Northern Emirates Supply	12	20	20	30	30	30	30	30	30	30	30	30	30	30
Global Demand Forecast	572	613	630	738	809	924	961	1008	1040	1079	1118	1136	1161	1189
Total Required Capacity	587	622	640	743	817	970	1013	1070	1104	1143	1182	1217	1231	1246
Surplus / Deficit	**44**	**28**	**45**	**74**	**51**	**-1**	**-44**	**-101**	**-135**	**-174**	**-213**	**-248**	**-262**	**-277**
Most Likely Forecast Requirements														
Abu Dhabi Demand Forecast	560	593	610	708	779	831	864	900	934	962	986	1011	1035	1054
Northern Emirates Supply	12	20	20	30	30	30	30	30	30	30	30	30	30	30
Global Demand Forecast	572	613	630	738	809	861	894	930	964	992	1016	1041	1065	1084
Total Required Capacity	600	643	661	775	849	934	969	1009	1045	1077	1107	1128	1154	1175
Surplus / Deficit	**31**	**7**	**24**	**42**	**19**	**35**	**0**	**-40**	**-76**	**-108**	**-138**	**-159**	**-185**	**-206**
Low Water Forecast Requirements														
Abu Dhabi Demand Forecast	560	593	610	708	760	791	817	843	868	888	902	932	944	962
Northern Emirates Supply	12	20	20	30	30	30	30	30	30	30	30	30	30	30
Global Demand Forecast	572	613	630	738	790	821	847	873	898	918	932	962	974	992
Total Required Capacity	587	622	640	743	817	849	897	928	962	981	1003	1026	1050	1067
Surplus / Deficit	**44**	**28**	**45**	**74**	**51**	**120**	**72**	**41**	**7**	**-12**	**-34**	**-57**	**-81**	**-98**

The demand forecast years shown in grey are when the water transmission constraints are expected to constrain water supply to be less than water demand.

Winter 2007/2008 Electricity Generation Capacity Requirements (Gross MW)
High, Base and Low Electricity Demand Forecasts

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Available Capacity	**15,617**	**15,431**	**15,431**	**15,431**	**15,431**	**15,431**	**15,431**	**15,431**	**15,431**	**15,431**
High Electricity Forecast Requirements										
Abu Dhabi Demand Forecast	27,138	27,777	28,410	29,091	29,848	30,594	31,357	32,159	32,868	33,606
Required Capacity	30,184	31,181	31,638	32,581	33,266	33,981	34,681	35,731	35,731	37,131
Ratio of Required Capacity to Demand	*1.11*	*1.12*	*1.11*	*1.12*	*1.11*	*1.11*	*1.11*	*1.11*	*1.09*	*1.10*
Surplus / Deficit	**-14,567**	**-15,750**	**-16,207**	**-17,150**	**-17,835**	**-18,550**	**-19,250**	**-20,300**	**-20,300**	**-21,700**
Base Electricity Forecast Requirements										
Abu Dhabi Demand Forecast	18,020	18,558	19,109	19,687	20,334	20,982	21,650	22,331	22,924	23,554
Northern Emirates Supply	3,339	3,339	3,339	3,339	3,339	3,339	3,339	3,339	3,339	3,339
Global Demand Forecast	21,146	21,679	22,223	22,796	23,437	24,078	24,739	25,413	26,000	26,624
Required Capacity	23,818	24,364	24,891	25,499	26,518	27,200	27,801	28,564	29,194	29,571
Ratio of Required Capacity to Demand	*1.13*	*1.12*	*1.12*	*1.12*	*1.13*	*1.13*	*1.12*	*1.12*	*1.12*	*1.11*
Surplus / Deficit	**-8,201**	**-8,933**	**-9,460**	**-10,068**	**-11,087**	**-11,769**	**-12,370**	**-13,133**	**-13,763**	**-14,140**
Low Electricity Forecast Requirements										
Abu Dhabi Demand Forecast	15,892	16,438	16,933	17,411	17,883	18,373	18,925	19,484	20,053	20,649
Required Capacity	18,197	18,779	19,307	19,812	20,316	20,834	21,421	22,013	22,614	23,202
Ratio of Required Capacity to Demand	*1.15*	*1.14*	*1.14*	*1.14*	*1.14*	*1.13*	*1.13*	*1.13*	*1.13*	*1.12*
Surplus / Deficit	**-2,580**	**-3,348**	**-3,876**	**-4,381**	**-4,885**	**-5,403**	**-5,990**	**-6,582**	**-7,183**	**-7,771**

Winter 2007 / 2008 Water Capacity Requirements (Gross MIGD)
High, Most - Likely and Low Water Demand Forecasts

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Available Capacity	**969**	**930**	**930**	**930**	**930**	**930**	**930**	**930**	**930**	**930**
High Water Forecast Requirements										
Abu Dhabi Demand Forecast	1173	1204	1217	1241	1245	1247	1271	1279	1313	1329
Northern Emirates Supply	30	30	30	30	30	30	30	30	30	30
Global Demand Forecast	1203	1234	1247	1271	1275	1277	1301	1309	1343	1359
Total Required Capacity	1282	1284	1317	1335	1340	1351	1382	1392	1396	1414
Surplus / Deficit	**-313**	**-354**	**-387**	**-405**	**-410**	**-421**	**-452**	**-462**	**-466**	**-484**
Most Likely Forecast Requirements										
Abu Dhabi Demand Forecast	1074	1094	1113	1130	1144	1156	1170	1185	1196	1215
Northern Emirates Supply	30	30	30	30	30	30	30	30	30	30
Global Demand Forecast	1104	1124	1143	1160	1174	1186	1200	1215	1226	1245
Total Required Capacity	1193	1209	1232	1249	1259	1274	1291	1306	1320	1335
Surplus / Deficit	**-224**	**-279**	**-302**	**-319**	**-329**	**-344**	**-361**	**-376**	**-390**	**-405**
Low Water Forecast Requirements										
Abu Dhabi Demand Forecast	983	999	1010	1033	1042	1045	1054	1065	1079	1096
Northern Emirates Supply	30	30	30	30	30	30	30	30	30	30
Global Demand Forecast	1013	1029	1040	1063	1072	1075	1084	1095	1109	1126
Total Required Capacity	1090	1110	1116	1134	1157	1154	1171	1189	1192	1206
Surplus / Deficit	**-121**	**-180**	**-186**	**-204**	**-227**	**-224**	**-241**	**-259**	**-262**	**-276**

Annex C

Review of UK May 2008

Electricity Supply Interruption

May 2008 UK Partial Blackout

Introduction

ADWEC places the highest possible priority on ensuring that the Generation Security Standard (GSS) of LOLE 0.1 agreed with the Regulation and Supervision Bureau (RSB) is maintained throughout the forecast horizon. A good example of why it is important to maintain an adequate reserve of capacity to deal with rare contemporaneous events occurred in the UK when customers suffered a partial blackout on Tuesday 27th of May 2008 at 11.30 a.m.

A summary and discussion of the problems faced by the UK is provided below, along with the potential lessons for ADWEC.

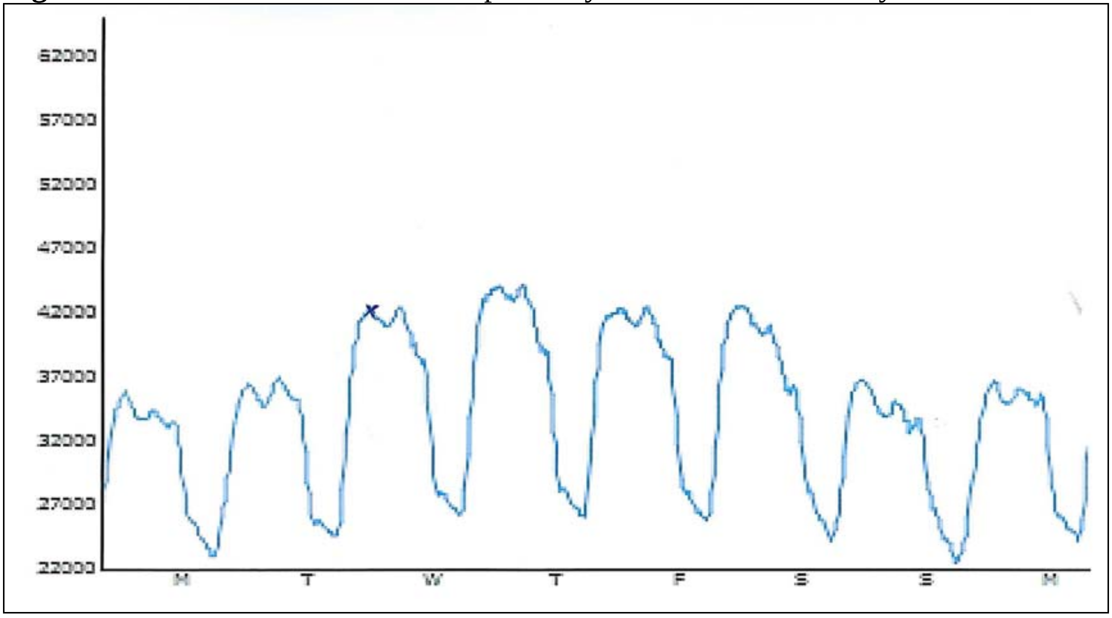
Summary

In chronological order the problems faced by the UK on 27th May are listed below.

- Longannet and Sizewell B stations trip.
- The resulting frequency drop caused the generation to be smaller than the load and National Grid were forced to disconnect some areas / customers at around 11.30 AM.
- Areas / customers had their supply restored up to 40 minutes later due to increased generation.
- After supply was restored to consumers, generation units at nine power stations unexpectedly shutdown.
- As a result of the unexpected shutdowns at nine stations, the distribution companies were instructed by National Grid to decrease the voltage to customers in order to decrease total demand and bring it into balance with the available generation capacity.
- At the same National Grid instructed some power stations to start generating in order to increase the total amount of generation.
- These combined actions prevented a second blackout occurring in the evening hours.
- Later in the evening the system was able to return to normal as the result of National Grid's actions and the normal natural decline in demand that occurs in the late evening.

The capacity of the UK power system, comprising systems in England, Wales and Scotland is about 78,000 MW and in 2007 the peak demand was around 60,700 MW. The system is connected by the 2,000 MW DC link to the UCPTE System in France and by a 450 MW DC link to Ireland. At the time of the partial blackout the system load was around 42,300 MW and the daily peak demand reached 42,500 MW (http://www.nationalgrid.com/uk/Electricity/Data/). The load distribution curve of UK power system in the week when the partial blackout occurred is shown in Figure 1.

Figure 1: Demand on the UK's power system at the end of May 2008.



Note the blackout took place on Tuesday at 11.30.

At the time of the partial blackout electricity demand was close to its annual average, i.e. the blackout did not occur during the time of annual peak demand.

Shortly after the first daily peak of 11.30 AM electricity demand started to decline slightly, as per the normal daily curve. Accordingly the network operator National Grid was forced to deactivate some local stations in order to maintain the required 50 Hz frequency. At this time two relatively large power stations suffered trips within a few minutes of each other. The frequency of the national grid dropped unacceptably low, as the gap between supply and demand widened. Automatic systems cut in, disconnecting some areas so as to preserve stable electricity supplies for other areas. About 500,000 people were affected by the power supply cut. The power cuts affected parts of London, Cleveland, Merseyside, Cheshire, Lincolnshire and East Kent.

The first incident happened in a coal fired power station, Longannet in Scotland, which has a total capacity close of approximately 2,400 MW, consisting of four 600 MW generation units, each featuring a single boiler feeding two 300 MW turbines. This station had been operational since 1970 and for a time was the largest power station in Europe. On the day of the partial blackout the station was running at reduced capacity because of maintenance, however even the capacity that was available was operating at a low load factor. Of Longannet's four power generation units, two were under long-term maintenance (sulphur emissions reduction related) and two were down as part of their summer maintenance program. A Scottish Power spokesman confirmed that one unit was powered up before it tripped, but it had only been producing 350 megawatts of power when it was shut by a minor technical fault.

Two minutes later Sizewell B, a nuclear power station located in Suffolk to the north east of London, with a 1,180-megawatt power generation unit went offline. Sizewell B is the UK's only pressurized water reactor station and consists of one power reactor running off two around 600 MW steam turbines / generators. The reactor was shut down due to instrument problems (a false reading on an instrument panel) which caused the plant to automatically shut down resulting in the two operating steam turbines tripping.

The system lost a total of 1,510 MW, causing the frequency to fall. The loss of power was more than the system was designed to handle and as a result parts of the network were shut down automatically to protect the overall system, in the process cutting off several hundred thousand customers. The system was not able to respond fast enough to cope with the loss of two plants in such a short space of time. The National Grid described the coincidental shutdowns as a *"freak event"* and pointed out that power had been restored to almost all customers within 40 minutes.

After National Grid had restored the normal frequency level, after Longannet and Sizewell B's problems, a number of other medium size power generation units in other plants started going offline for unknown reasons. A total of nine power stations were shut down for various reasons. Generating units in the stations Grain in Kent (oil fired, consisting of two 690 MW steam turbines), Ratcliffe in Nottinghamshire (coal fired, consisting of four 500 MW steam turbines), EDF Station in Cottam (coal fired, 2,000 MW), Centrica in South Humber (gas fired, combined cycle 1,285 MW) and International Power in Deeside (gas fired, combined cycle 500 MW) suffered shutdowns. Multiple power station shutdowns in one day is far from unknown for the National Grid, but nine station shutdowns in one day was deemed very unusual.

It was unclear why the power stations failed. As the cuts escalated, the National Grid was forced to issue the most serious possible warning *"demand control imminent"* and urged suppliers to provide lower voltage electricity to meet demand. The National Grid warned about possible voltage reductions and asked for more units to be made available. The *"demand control imminence"* notice is rare and is sent out about once every four years. It was issued after it became clear that the UK's electricity supply could fall short by about 400 megawatts, equivalent to just under 1 per cent of national demand. Shortly after that notice the *"demand control"* went into effect and the distribution companies reduced the voltage in their supplies. The effect of this voltage reduction on most electrically powered equipment is to reduce the amount of energy used, in most cases without causing damage or loss of function, there generally being a built in tolerance to variations in supply. The disruption continued throughout most of the afternoon.

Because the shutdown of the nine electricity generation units took place over a long period of time the frequency fall did not recur, as National Grid was able to bring in other generation. According to press information it seems that all the spare capacity available was only just enough to compensate for the trip of the first two units, leaving nothing ready to deal with the evening demand surge, despite National Grid's appeals to the market. The problems could have been worse had it not been for imports of French nuclear power. A cable under the Channel that carries 2,000 megawatts of electricity was working at full capacity during this time and the following two days.

According to National Grid this partial blackout was a huge coincidence. It is unclear why so many power stations shut down at the same time. Maintenance work is often scheduled for that time of year, as electricity demand for heating and air conditioning is relatively low. It was said that the extent of the disruption, with so many different sites going offline at the same time, had not been seen for at least 10 years. Note the similarity between the rare UK event of once in 10 years, and the GSS LOLE 0.1 of 1 day in 10 years maintained by ADWEC.

National Grid is supposed to operate with a 20% margin, meaning that if electricity supplies drop it can immediately call up new capacity, starting with the units that are already switched on. National Grid did not issue any "notice of insufficient margin" until the power cuts had already happened. At any one time, a fair number of UK power plants lie idle but ready to start up. Some types of generation take a long time to come on line, but others such as gas turbines are faster. Within forty minutes, according to National Grid, sufficient new generation was able to come online to deal with the then level of demand.

There was speculation among energy traders that the highly unusual shutdown of so many plants at once was caused by some companies trying to cash in on the rising wholesale price of electricity by taking supply out of the market. The wholesale price jumped by 13 per cent as the margin between supply and demand tightened. However, others experts said this was unlikely because any generator that closed down a plant had to buy the power to cover its commitments.

According to the Mail Online of June 3rd 2008 [1)], Britain faces a danger of repeated blackouts as old and crumbling power stations suffer a series of failures. The problems continued on 2nd of June when the Hunterston nuclear power reactor in Scotland failed. That meant ten of British Energy's 16 nuclear generation units were out of service either for maintenance or through faults.

Conclusions

The UK's experience highlights the need to maintain an adequate operating margin, which in turn can only be achieved if adequate capacity is installed in the first place by the relevant market participant i.e. ADWEC.

The UK's experience also highlights the need to ensure that sufficient spare generation capacity exists to deal with the sudden loss capacity of 1500 MW. Since several existing and future IWPP stations procured by ADWEC have capacities of 1500 MW or more, it is important that the Generation Security Standard of LOLE 0.1 is always maintained throughout the year in order to guarantee security of supply to the consumer. It should be noted that it is unlikely that the full output of a single IWPP station will ever be lost simultaneously, as the generation units will be attached to different busbars. The main danger therefore is the loss of several large turbines simultaneously.

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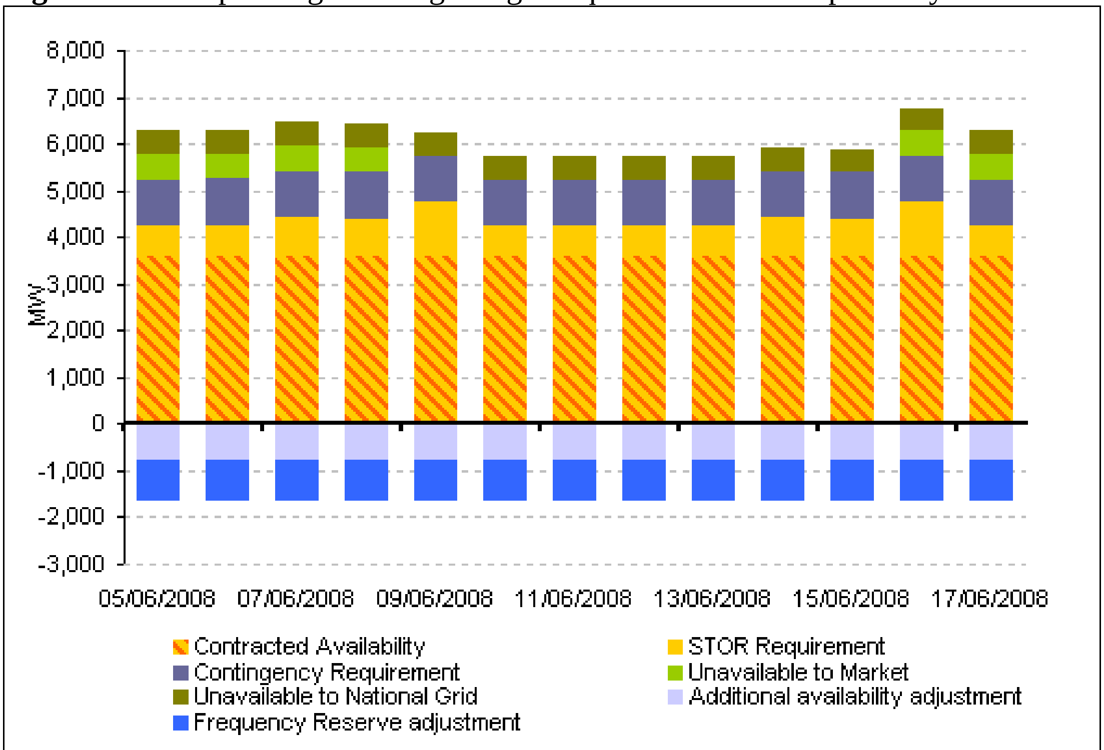
UK Reserve Margin Details

The UK's 20% reserve capacity margin refers to system peak load. At any time the National Grid keeps the Operating Margin as is defined in the Balancing Mechanism Reporting System (BMRS) [15)]. The real capacity margin, called the "Plant Margin", and being the surplus of plants capacity over peak demand was in recent years about 27% - 28%, including wind farms that are not always available at time of peak demand.

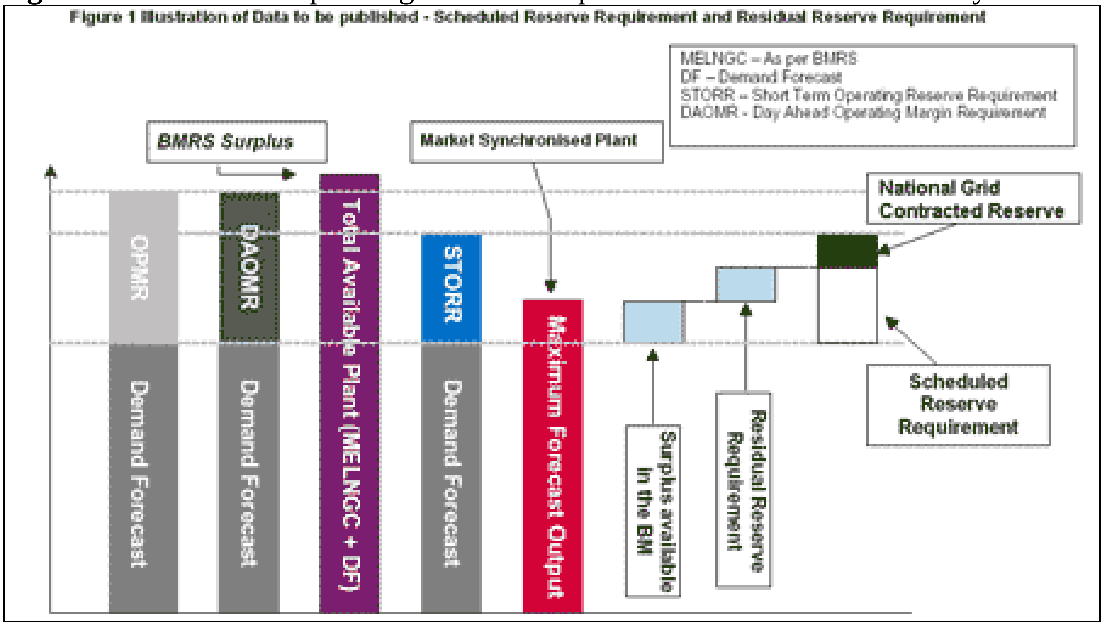
The National Grid presents on its website the Operating Planning Margin Requirements (OPMR) with its various components. It may be noted, from the below Figure 2, that Short Term Operating Reserve (STOR) and Frequency reserve adjustment totally achieve about 1600 - 1800 MW, and so are very close to the lost generation capacity at the time of blackout. The OPMR is the amount of generation, in excess of demand forecast, that is required to meet the National Grid's Day Ahead Reserve requirement. Some components of OPMR are not available in a very short time after and immediate loss of generation capacity, so they do not play important role when very fast system response is required.

Figure 2: Operating Planning Margin requirement in UK's power system.



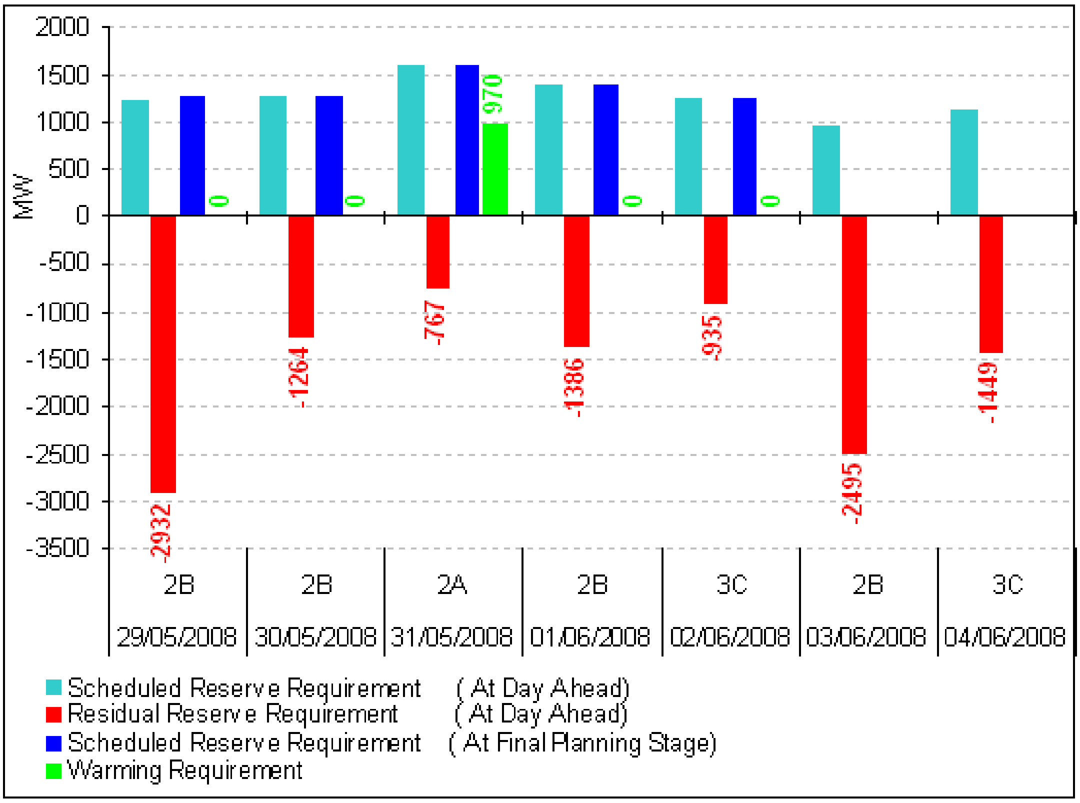
The below Figure 3 shows (red column) that Market Synchronized Plants refer to Maximum Forecast Output. Other components such as the Residual Reserve Requirement and Scheduled Reserve Requirement may achieve totally about 1500 - 2000 MW (Figure 4) but it is not clear how quickly this reserve can be used. It is also not clear how fast the response time is from the connected power grids e.g. the DC link with France. The UCPTE (European) System requires that in case of disturbances every producer is to be able to generate additionally 5% of is nominal generation capacity within 30 seconds. For UK's power system this is equivalent to around 2,000 - 2,200 MW of generation capacity without the necessity to start additional power plants.

Figure 3: Short Term Operating Reserve Requirement in the UK's Power System.



This UK example demonstrates the influence big generation unit sizes can have on the stability of system and the need to maintain a higher operating reserve when big units are installed, particularly during the at time of low and medium power demand. It seems that Short Term Operating Reserve Margin (http://www.nationalgrid.com/uk/ Electricity/Data/) kept by UK's National Grid was insufficient to withstand the immediately drop of around 1500 MW in available capacity.

Figure 4: Scheduled and Residual Reserve Requirement in the UK's Power System



ISO 9001:2000 Quality Assurance Review

In accordance with ADWEC's ISO 9001:2000 Quality Management System (QMS) this *ADWEC 2008 – 2030 Statement of Future Capacity Requirement* has undergone the following quality review process.

Main Activities	Prepared By	Signature
Water Demand Forecast and Desalination Capacity Requirements.	Mohammed Al Hajjiri	
Electricity Demand Forecast Preparation	Ahmed Al Nassay	
Generation Capacity Requirements and LOLE calculations	Salahuddin Khan	
Generation Capacity Requirements and LOLE calculations. Main drafting of Statement and preparation of tables and annexes etc.	Jerzy Roszkowski	
Review of all of the above activities and final quality check of the Statement in order to ensure that it complies with ADWEC's ISO QMS and also satisfies ADWEC's License requirements under Law Number 2 of 1998.	Keith Miller (Director)	