Iraq and Kurdistan Electricity Masterplan – summary and recommendations

Jeff Larkin, Director - Power & Water, Middle East and North Africa, Parsons Brinckerhoff
IRAQ’S ELECTRICITY
MASTER PLANS

Jeff Larkin
Parsons Brinckerhoff
Timeline

- Mobilisation 5 January 2009
- 4 Data / Discussion Visits
- Presentations April
- Load / Gen Planning Data Freeze April
- Draft Final Report issued 30th June
- Final Report after incorporation of feedback – November 2009
- A very challenging programme!
Introduction to Master Plan

Structure of Plan

– Load Forecast
– Generation
– Transmission
– Sub-Transmission & Distribution
– Tariffs
– Organisational Challenges
Presentation Overview

• Introduction
• Load Forecast
• Generation
• Transmission
• Sub-Transmission & Distribution
• Tariffs
• Organisational Challenges
• Discussions
Challenges

• Suppressed Demand
• Only Two Years Historic Data
  – No of Consumers V
  – Sales ?
• Expected Many Fold Price Increase
• Losses by Voltage Level not known
• Load Factor not known
Comparison of Load Forecasts

- Base Case
- High Case
- Low Case

MW

Years: 2009 to 2020
Presentation Overview

- Introduction
- Load Forecast
- **Generation**
- Transmission
- Sub-Transmission & Distribution
- Tariffs
- Organisational Challenges
- Discussions
Generation Planning Methodology

- Planning Parameters
- Existing and Committed Plant
- Fuels / Renewables
- Candidate Thermal Plant
- Hydro Plant Candidate Ranking
- Hydro Energy Modelling
- Screening Curves
- Least Cost Planning using WASP program
  - Base and High Load Forecasts
- Investment
- Priority Projects
## Existing Plant

<table>
<thead>
<tr>
<th>Power Plant</th>
<th>Type</th>
<th>Max. Capacity MW</th>
<th>Maximum Available Capacity - MW</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Existing Plant and Imports</strong></td>
<td>Total</td>
<td>2009 2010 2011 2012 2013 2014 2015 2020 2025 2030</td>
<td></td>
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<tr>
<td>Dokan Hydro</td>
<td>400</td>
<td>400 400 400 400 400 400 400 400 400 400</td>
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<tr>
<td>Derbandikhan Hydro</td>
<td>249</td>
<td>166 166 249 249 249 249 249 249 249 249</td>
<td></td>
</tr>
<tr>
<td>Erbil IPP GT</td>
<td>500</td>
<td>500 500 500 500 500 500 500 500 500 500</td>
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<tr>
<td>Import from Iraq Import</td>
<td>200</td>
<td>100 100 100 100 100 100 100 100 100 100</td>
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<tr>
<td>Import from Turkey Import</td>
<td>155</td>
<td>155 155</td>
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<td>Import from Iran Import</td>
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<tr>
<td>Tasluja Diesel</td>
<td>50</td>
<td>50 50 50 50 50 50 50 50 50 50</td>
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<tr>
<td>Erbil 29 MW Diesel</td>
<td>24</td>
<td>12 12 12 12 24 24 24 24 24 24</td>
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<tr>
<td>Sulamaniya 29 MW Diesel</td>
<td>24</td>
<td>12 12 12 12 24 24 24 24 24 24</td>
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<tr>
<td>Dohuk 29 MW Diesel</td>
<td>24</td>
<td>18 18 18 18 24 24 24 24 24 24</td>
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<tr>
<td>Erbil 10 MW Diesel</td>
<td>10</td>
<td>8 8 8 8 8 8 8 8 8 8</td>
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<td>Sulamaniya 15 MW Diesel</td>
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<td>12 12 12 12 12 12 12 12 12 12</td>
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<td>Agra 10 MW Diesel</td>
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<td>Sulamaniya (Sakr) Diesel</td>
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<td>81 81 81 81 81 81 81 81 81 81</td>
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<tr>
<td><strong>Total Existing</strong></td>
<td>1522</td>
<td>1522 1450 1480 1480 1480 1480 1480 1480 1371 1299</td>
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</table>
### Under Construction / Committed Plant

Includes Kwashi GT

<table>
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<tr>
<th>Power Plant</th>
<th>Type</th>
<th>Maximum Capacity MW</th>
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<tbody>
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<td><strong>Total Existing + Import</strong></td>
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<td>Deralok</td>
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<td>Bekal</td>
<td>Hydro</td>
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<td>Chemchemal</td>
<td>GT</td>
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<td>Baadrah</td>
<td>Diesel</td>
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<td>Khabat</td>
<td>HFO / ST</td>
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<tr>
<td>Kwashi</td>
<td>GT</td>
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<td><strong>Total Under Construction / Committed</strong></td>
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<tr>
<td><strong>Total Existing + Import + Committed</strong></td>
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Main Fuels

- Assumed to be sufficient gas for Kurdistan’s future electricity requirements
- Economic prices based on 65 US$/barrel crude and Gas: 90% of HFO price
- Financial Prices: HFO 100ID/l
- COUE (Cost of Unserved Energy) = 4.5 US$/kWh

<table>
<thead>
<tr>
<th></th>
<th>HFO US$/tonne</th>
<th>Gas US$/MMBTU</th>
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## Candidate Thermal Plant

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<th>S/O</th>
<th>Capital Costs $US/kW</th>
<th>Total Cost $US million</th>
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<td>MW</td>
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<td>80</td>
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<tr>
<td>375 MW CC</td>
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<td>122</td>
<td>110</td>
<td>1332</td>
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<tr>
<td>150 MW ST</td>
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<td>259</td>
<td>140</td>
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<tr>
<td>125 MW GT diesel</td>
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<td>52</td>
<td>80</td>
<td>932</td>
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<tr>
<td>50 MW Diesels</td>
<td>1500</td>
<td>132</td>
<td>150</td>
<td>1782</td>
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<tr>
<td>GT to CC Conversion</td>
<td>1400</td>
<td>91</td>
<td>140</td>
<td>1631</td>
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</tbody>
</table>
Overall Screening - Economic Fuel Prices

![Graph showing economic fuel prices for different power plants and load factors. The graph plots $/kW/year against Annual Plant Load Factor, with various power plants represented by different markers and colors.]
Conclusions from WASP Studies

- Conversion of Erbil GTs to CC is very economic: fuel cost savings greatly outweigh investment cost.
- Kwashi 500 MW should also be converted to CC – saving of US$ 590 million overall through life.
- Delga and Deralok Rashawa are economic.
- Gali Balinda Storage hydro not selected.
- With Kwashi, additional new thermal plants not needed for many years.
### Recommended Plan with Kwashi

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<tr>
<th>Power Plant</th>
<th>Type</th>
<th>Maximum Capacity MW</th>
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<td>Total Under Construction / Committed</td>
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<tr>
<td>New Plant</td>
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<td>Delga</td>
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<td>Total New Plant</td>
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<tr>
<td>Overall Total Capacity</td>
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</table>
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Objectives of Transmission Planning

To identify what is required to:

• strengthen the existing grid system
• satisfy transmission requirements arising from growing load demands
• connect future generating stations to the grid system
• connect isolated loads to the grid system
Summary of 2009 Results
Based on MoE data (Feb ’09)

In both load cases:
• Extra capacitors are required, mainly in Dohuk Governorate, to achieve satisfactory voltages

For the unsuppressed 1797 MW case:
• Seven transmission lines are overloaded
• Dohuk is deficient in generation so more power transfers from Iraq via Mosul Dam and Turkey were required to meet increased demand
Proposed 2012 Transmission System
Results and Recommendations for 2012

• The Stage 5 network is lightly loaded as shown
• Severe under voltages and line overloads within Dohuk.
• Bring forward planned 63 MVA transformer in Sarsink in 2015 to 2012
• Bring Bigova BSP forward from 2015 to 2012 to relieve the problems in the Zakho/Dohuk area
• New Harir should be installed as a switching station by 2012
Summary of 2015 Results

- The unsuppressed demand 2128MW (High Forecast) makes the 400kV interconnection attractive.
- The 500MW at Kwashi plays down the need for a 400kV system suggesting a possible deferment to a future year.
- Additional 30MVAr reactive compensation required.
- The results of the load flows suggest that both New Harir and Soran 2 BSPs are not required in Stage 6.
- No thermal overloads (up to 120%) under N-1 contingency though Zakho to Dohuk double circuit is heavily loaded.
- Bagera should be brought forward from Stage 7 (2020) to 2015.
Summary of 2020 – 2030 Results

• Impact of 500 MW at Kwashi is minimal so not studied.
• 7 additional transformers are necessary to reinforce the existing BSPs to meet forecast demand
• 3 additional BSPs are necessary to meet forecast demand
• Four 132 kV lines need to be upgraded
• 120 MVAr additional capacitors needed to address low voltage problems
## Estimated investment costs

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<td><strong>costs of conversion of GTs to CC</strong></td>
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<td>218</td>
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<td><strong>Subtransmission &amp; Distribution</strong></td>
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<td>160.8</td>
<td>160.8</td>
<td>160.8</td>
<td>160.8</td>
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<td><strong>Total</strong></td>
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<td>378.8</td>
<td>547.4</td>
<td>398</td>
<td>270.9</td>
<td>403.9</td>
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<td>45.9</td>
<td>156</td>
<td>5</td>
<td>77</td>
<td>2590.1</td>
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</tbody>
</table>
Iraq Electricity Master Plan

• Iraq excluding Kurdistan Region (IEK)

• Develop 20 year Least Cost plan (economic)
  • Minimise overall cost of supply
  • Least cost plan for Iraq
  • Satisfy safety, environment, social, Govt requirements

• Master plan includes:
  • Load forecast
  • Generation
  • Transmission
  • Distribution (sample)

• Capacity development for Ministry of Electricity, to continue the planning process
Organizational Structure of the Project

STEERING COMMITTEE

USG-State Department

ME Planning and Study Office (General Director)

Delivery of Reports
- Workshop on Draft Final Report
- Workshop on Final report
- Final Report

Training and Capacity Development
- Seminars and workshops
- Discussion meetings
- Training Courses
- Software upgrades
- Analysis and studies development

Project Director

UK Project Manager

Load Forecast Task Leader

Generation Planning Task Leader

Transmission Planning Task

Distribution Planning Task Leader

Power Sector Economist

UK Staff

Iraq Project Manager

Data Collection Team

Iraq Load Forecast and Power Economist

Fuel and Water Resources

Generation Condition Assessment

Transmission and Distribution Network Analysis

Iraq Staff

Finance and Documentation Control

ME Master Plan Team Leader

Load Forecast Team

Generation Team

Transmission Team

Distribution Team

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Load Forecast
Load Forecast

- Unsuppressed energy and demand forecast for IEK
- Estimated 2009 demand as 11250 MW sent-out
  - Test Day Results
  - Bottom-up by consumer category
- Forecast is econometric by sales category
  - GDP by sector
  - Price and income elasticity
- Load curves by bottom up analysis
  - Typical appliances and usage
  - 2008 Iraq Socio-Economic Survey
Load Forecast Results (without Kurdistan)
## Long Term Bulk Supply Point Forecasts – 132 kV

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<th>Governorate</th>
<th>2010</th>
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<td>509</td>
<td>516</td>
<td>1136</td>
<td>1192</td>
<td>1268</td>
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<tr>
<td>Al-Najaf</td>
<td>500</td>
<td>507</td>
<td>661</td>
<td>721</td>
<td>823</td>
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<tr>
<td>Kirkuk</td>
<td>459</td>
<td>465</td>
<td>584</td>
<td>639</td>
<td>740</td>
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<tr>
<td>Al-Qadisiya</td>
<td>437</td>
<td>443</td>
<td>576</td>
<td>627</td>
<td>716</td>
</tr>
<tr>
<td>Kerbela</td>
<td>398</td>
<td>403</td>
<td>601</td>
<td>647</td>
<td>730</td>
</tr>
<tr>
<td>Missan</td>
<td>399</td>
<td>395</td>
<td>514</td>
<td>560</td>
<td>651</td>
</tr>
<tr>
<td>Wasit</td>
<td>387</td>
<td>392</td>
<td>520</td>
<td>563</td>
<td>614</td>
</tr>
<tr>
<td>Diala</td>
<td>354</td>
<td>359</td>
<td>445</td>
<td>487</td>
<td>549</td>
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<tr>
<td>Al-Muthanna</td>
<td>292</td>
<td>296</td>
<td>389</td>
<td>423</td>
<td>479</td>
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<tr>
<td>TOTAL</td>
<td>11781</td>
<td>11939</td>
<td>16111</td>
<td>17494</td>
<td>19731</td>
</tr>
</tbody>
</table>

### Base Case Demand Distribution

**Governorates**
- Baghdad
- Basrah
- Ninevah
- Salahuddin
- Babil
- Al-Anbar
- Al-Najaf
- Kirkuk
- Al-Qadisiya
- Kerbela
- Missan
- Wasit
- Diala
- Al-Muthanna

**Years**
- 2010
- 2020
- 2025
- 2030

**Demand (% of Total)**
- 0%
- 5%
- 10%
- 15%
- 20%
- 25%
- 30%
- 35%

The chart illustrates the distribution of demand for each governorate across the specified years. The bars represent the demand share as a percentage of the total demand for each year, allowing for a clear visual comparison of demand trends over time.
Generation Plan
Generation Planning Process

- **Existing Plants**
  - Assessed by on site condition assessment reports, determined retirement dates

- **Committed Plants**
  - The ME has firmly decided to build or has signed contracts for

- **Future Plants**
  - List of candidate plants developed of different sizes, technologies and fuel types
  - Screening curves used to produce a short list of plants
  - Analysis and optimisation carried out using a computer programme called WASP
Planning Parameters

- 2010 - 2030
- Economic Fuel Prices
  - Crude: 80 $/barrel
  - HFO: 747 $/tonne
  - Gas: 4.5 $/MMBTU
- Discount Rate: 10% Real
- Cost of Un-Served Energy
  - 3 $/kWh in 2010
  - 6 $/kWh by 2030
Committed Capacity (1)

- Based on ME’s Short-Term Plan (assumes fuel available)
- On schedule and delayed cases (2015 / 2016)
  - ME Fast Track Project (GTs) 600 MW
  - Hyundai Diesel clusters 360 MW
  - GE Fast Track (GTs) 660 MW
  - GE Mega Deal (GTs) 6,500 MW
  - Siemens Mega Deal (GTs) 3,190 MW
  **TOTAL** 11,310 MW

ISO

- Thermals 3,251 MW
- Other projects 642 MW
- New Interconnector 550 MW
Plant Choices 2015 Onwards

After Screening Curve exercise, short-listed plants were (45C ratings, sent-out) :

- 200 MW Gas Turbine (gas)
- 600 MW Combined Cycle (gas)
- 300 to 350 MW Thermals (steam - HFO)
  - Salah El Deen, Al Anbar, Al Shimal
- 600 MW Supercritical Thermal (steam - HFO)
Generation Planning Findings

• Total NPV of recommended plan is US$186 billion
• Un-served energy cost is huge at present ~ US$40 billion pa
• NPV Breakdown:
  • ENS = $115 bn (62%)
  • O&MF = $54 bn (29%)
  • CAPEX = $17 bn (9%)
• Delays in implementing short-term plan is therefore a huge cost to Iraq
• If gas is delayed such that new plant 2015 to 2019 cannot be converted to gas, extra cost is about US$5 billion
• Thermal plant burning HFO are even more expensive than GTs burning HFO
Overall Recommendations

- Gas is the economic fuel of choice, (Gas Turbines on Gas)
- New thermal plants are uneconomic (crude/HFO/gas)
- Convert plant burning crude to gas or HFO immediately
- Mega Deal GTs burning crude or HFO should be converted to gas ASAP
- Plant mix after Mega Deal has too many Simple Cycle GTs
- New plant after 2015 should be Combined Cycle (CC) burning gas
- Conversion of Megadeal GTs to CC produces savings, but not as much as the conversion to gas
- After 2015/16 interconnectors only provide peaking power
Recommended Generation Plan - Gas Burn MMSCF/day
Recommended Plan - Capacity Installed
Transmission Plan
Transmission Plan Objectives

- Strengthen the existing grid system to cope with rising demand
- Develop short term expansion plan to accommodate the Mega Deal projects
- Solve the Baghdad 132 kV fault level problems
- Connect future generating stations to the grid system
- Identify the future expansion and reinforcement requirements to allow for future demand and generation
- PSS/E models of the 400 and 132kV systems developed with the ME Planning Standards had to be developed and agreed
Short Term Transmission Plan 2010 - 2015
Existing 400 kV & 132 kV Network
Existing 400kV & 132kV Network – Load Centres and Directorates
Location of Committed Generation
400KV NETWORK IN 2015
Long Term Transmission Plan 2015 – 2030
MoO Planned Gas Complexes and Pipelines

Dry Natural Gas Pipelines Map

- Baiji - Mishraq Junction Gas Pipeline 18"
- Kirkuk - Taji Gas Pipeline 16"
- Strategic Gas Pipeline 24"
  Under-construction 2011
  350 MSCAF
- 42" Under-construction
- 42" Planned in 2014

1- Akkas Gas Complex 600 MSCAF/Day.
2- Bazurgan Gas Complex 500 MSCAF/Day.
3- Nassiriya Gas Complex 750 MSCAF/Day.
4- Bin-Omar Gas Complex 1500 MSCAF/Day.
5- Lehaiys Gas Complex 500 MSCAF/Day.
6- Mansuriya Gas Complex 1100 MSCAF/Day.
7- Baghdad East Gas Complex 120 MSCAF/Day.
8- Northern Fields Gas Complex 500 MSCAF/Day.
9- Gayarra Gas Complex 100 MSCAF/Day.

42"=1000 MSCAF,
Or
48"=1200 MSCAF.
Planned in 2014-2015
Long Term Transmission Plan 2015 - 2030

Gas Resources Expectation

<table>
<thead>
<tr>
<th>Location No.</th>
<th>Gas gathering Complex Name</th>
<th>Millions SCF/Day</th>
<th>% of Total</th>
<th>Location</th>
<th>Governorate</th>
<th>Region</th>
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<tbody>
<tr>
<td>1</td>
<td>Akkas</td>
<td>600</td>
<td>11</td>
<td>Al-Anbar</td>
<td>Western</td>
<td></td>
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<tr>
<td>2</td>
<td>Bazyrgan</td>
<td>500</td>
<td>9</td>
<td>Missan</td>
<td></td>
<td>Sothern</td>
</tr>
<tr>
<td>3</td>
<td>Nassiriya</td>
<td>750</td>
<td>13</td>
<td>ThiQar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Bin-Omar</td>
<td>1500</td>
<td>26</td>
<td>Basrah</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Lehaiys</td>
<td>500</td>
<td>9</td>
<td>Basrah</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Mansuriya</td>
<td>1100</td>
<td>19</td>
<td>Diala</td>
<td>North East</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Baghdad East</td>
<td>120</td>
<td>2</td>
<td>Baghdad</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Northern Fields</td>
<td>500</td>
<td>9</td>
<td>Kirkuk</td>
<td>Northern</td>
<td></td>
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<tr>
<td>9</td>
<td>Gayarra</td>
<td>100</td>
<td>2</td>
<td>Ninevah</td>
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<tr>
<td>Total</td>
<td></td>
<td>5670</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Regional locations are with respect to Baghdad
Load Centres, Zones and Gas Locations
Long Term Transmission Plan 2015 - 2030

Three Long Term Scenarios

**Scenario A**: Build Power Plants near gas resources and build EHV lines to transfer power between zones and towards Baghdad.

**Scenario B**: Move gas from the gas resources to build power plants in each zone to balance power and demand.

**Scenario C**: Utilizing the MoO gas and pipe lines development but also develop EHV lines for power transfer. This scenario is midway between A and B.

Which Scenario is the least cost solution for Iraq?
Long Term Transmission Plan 2015 - 2030

• Total Life Cycle costs of Scenarios A and B carried out

• Showed that Scenario B (gas transfer) is more economic than A (power lines)

• However, Compromise option **Scenario C is recommended** – not totally dependent on either gas pipelines or transmission lines.
Transmission Plan – Recommendations

- The Baghdad 132kV network needs to be split
- Switchgear in the Baghdad area needs to be upgraded
- An additional 38 GSPs and 175 BSPs will be required to handle the forecast Base load growth
- A new 400kV OHL specification is required for a high capacity line using Quad bundled conductor
- Reinforcement of the 400kV routes from Basrah to Baghdad is required along the eastern and western routes
- The 400kV Baghdad ring needs to be reconfigured to reduce fault levels
- The EHV network should remain at 400kV and there is no cost advantage in moving to a 765kV network at this time
- As the grid system expands there is a need for the ME to produce a protection application and setting policy, and an ASPEN database
Distribution Plan
Master Plan Goals - Distribution

- Develop systems and procedures for the ME to undertake Distribution Planning
  - Standards and Guidelines
  - Planning Tools
- Develop ME capability to conduct distribution planning
  - Data Gathering / Spatial Load Forecasting
  - Condition Assessment
  - Distribution Laboratory
  - Staff Training
  - Develop models for BSP areas in seven directorates
Sample Condition Assessment

- Sample assessment of distribution system
- Covered distribution sites in all directorates
- Looked at substations and both primary and secondary systems
- New construction generally of a good to high standard
- Significant portion of network will require rehabilitation or replacement
- Very old equipment age profile
- Maintenance standards are poor with spare parts usually unavailable
- Estimated that condition is causing high levels of energy losses, particularly at LV levels
- Require further complete network condition assessment and inventory
Loss Reduction Programme

• Should be the first priority of the distribution network
• Basic techniques and solutions will have a large impact
  • Correct design standards
  • Rebalance loads across phases
  • Correct jointing and maintenance procedure
  • Could be implemented very quickly with small team in each directorate
Investment Needs
## Long Term Generation Investment - US$ million

<table>
<thead>
<tr>
<th>Year</th>
<th>Investment Cost</th>
<th>Interest during Construction</th>
<th>Total Investment plus IDC</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Domestic</td>
<td>Foreign</td>
<td>Total</td>
</tr>
<tr>
<td>2015</td>
<td>83</td>
<td>333</td>
<td>416</td>
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<tr>
<td>2016</td>
<td>298</td>
<td>1,190</td>
<td>1,487</td>
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<tr>
<td>2017</td>
<td>338</td>
<td>1,355</td>
<td>1,693</td>
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<tr>
<td>2018</td>
<td>468</td>
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<td>2019</td>
<td>510</td>
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<tr>
<td>2020</td>
<td>340</td>
<td>1,363</td>
<td>1,703</td>
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<tr>
<td>2021</td>
<td>331</td>
<td>1,325</td>
<td>1,657</td>
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<tr>
<td>2022</td>
<td>320</td>
<td>1,282</td>
<td>1,602</td>
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<tr>
<td>2023</td>
<td>374</td>
<td>1,498</td>
<td>1,872</td>
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<td>2024</td>
<td>381</td>
<td>1,525</td>
<td>1,907</td>
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<td>2025</td>
<td>461</td>
<td>1,844</td>
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<td>2026</td>
<td>378</td>
<td>1,512</td>
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<td>2027</td>
<td>431</td>
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<td>2028</td>
<td>361</td>
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<td>1,806</td>
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<td>2029</td>
<td>204</td>
<td>817</td>
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<tr>
<td>2030</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Total 2015 - 2030</td>
<td>5,281</td>
<td>21,130</td>
<td>26,411</td>
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</table>

Notes: Money of 2009
## Transmission Plan 2010 - 2030

### Overall Costs – Short Term

<table>
<thead>
<tr>
<th>Item</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
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<tbody>
<tr>
<td>Cost of required reinforcements</td>
<td>261</td>
<td>0</td>
<td>1,362</td>
<td>0</td>
<td>152</td>
<td>351</td>
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<tr>
<td>Cost of generation connections</td>
<td>0</td>
<td>135</td>
<td>998</td>
<td>552</td>
<td>175</td>
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<tr>
<td><strong>Total Cost (Million USD)</strong></td>
<td>261</td>
<td>135</td>
<td>2,360</td>
<td>552</td>
<td>327</td>
<td>367</td>
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</table>

### Overall Costs – Long Term

<table>
<thead>
<tr>
<th>Total Cost</th>
<th>2010-15</th>
<th>2015-20</th>
<th>2020-25</th>
<th>2025-30</th>
<th>Total</th>
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<tbody>
<tr>
<td>Base Demand - Scenario C</td>
<td>4,002</td>
<td>1,380</td>
<td>1,831</td>
<td>2,615</td>
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</table>
## DIST: Short Term Investment: 2011 - 2015

<table>
<thead>
<tr>
<th>Distribution Rehabilitation Costs</th>
<th>$ millions</th>
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<tbody>
<tr>
<td>Number of existing BSPs</td>
<td>209</td>
</tr>
<tr>
<td>Cost per BSP</td>
<td>40.9</td>
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<tr>
<td>Total Cost</td>
<td>8,548</td>
</tr>
<tr>
<td>Cost per year (5yrs)</td>
<td>1,710</td>
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</table>

<table>
<thead>
<tr>
<th>Distribution from New BSPs</th>
<th>$ millions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of new BSPs</td>
<td>38</td>
</tr>
<tr>
<td>Cost per BSP</td>
<td>122.2</td>
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<td>Total Cost</td>
<td>4,644</td>
</tr>
<tr>
<td>Cost per year (5yrs)</td>
<td>929</td>
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</table>

### TOTAL COSTS

<table>
<thead>
<tr>
<th>TOTAL COSTS</th>
<th>$ millions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Cost</td>
<td>13,192</td>
</tr>
<tr>
<td>Cost per year (5yrs)</td>
<td>2,638</td>
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</table>
## DISTRIBUTION

### Long Term Investment: 2015 - 2030

<table>
<thead>
<tr>
<th>Period</th>
<th>No. of New BSPs ($122.2m ea)</th>
<th>Total Cost ($m)</th>
<th>Cost pa ($m)</th>
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<tbody>
<tr>
<td>2016 – 2020</td>
<td>32</td>
<td>3,910</td>
<td>782</td>
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<td>2021 – 2025</td>
<td>42</td>
<td>5,132</td>
<td>1,026</td>
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<tr>
<td>2025 – 2030</td>
<td>63</td>
<td>7,699</td>
<td>1,540</td>
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<tr>
<td>TOTAL</td>
<td>137</td>
<td>16,741</td>
<td>1,116</td>
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## Estimated Overall Investment Cost
(US$ millions)

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<th>Short Term</th>
<th></th>
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<th></th>
<th>Long Term</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>2011-15</td>
<td>2016-20</td>
<td>2021-25</td>
<td>2026-30</td>
<td>TOTAL</td>
</tr>
<tr>
<td>Generation</td>
<td>5,000</td>
<td>11,101</td>
<td>10,269</td>
<td>10,800</td>
<td>37,170</td>
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<td>Transmission (1)</td>
<td>4,002</td>
<td>1,387</td>
<td>1,844</td>
<td>2,633</td>
<td>9,866</td>
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<td>Distribution – Rehab</td>
<td>8,549</td>
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<td></td>
<td></td>
<td>8,549</td>
</tr>
<tr>
<td>Distribution - Expansion</td>
<td>4,644</td>
<td>3,910</td>
<td>5,132</td>
<td>7,699</td>
<td>21,385</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>22,195</strong></td>
<td><strong>16,398</strong></td>
<td><strong>17,245</strong></td>
<td><strong>21,132</strong></td>
<td><strong>76,970</strong></td>
</tr>
<tr>
<td>Per Year:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>3,849</strong></td>
</tr>
</tbody>
</table>

(1) Scenario C with Thermals – Base load forecast
Overall Recommendations

- Gas is the economic fuel of choice and Gas Turbines are the economic plant of choice – **Gas Turbines on Gas**
- New thermal plant is uneconomic (crude/HFO/gas)
- ENS @ $40 bn pa, the cost of delays in implementation is enormous
- Convert plant burning crude to gas or HFO immediately
- Mega Deal GTs burning crude or HFO should be started and then converted to gas ASAP
- New plant after 2015 should be Combined Cycle (CC) burning gas
- Significant transmission reinforcement is necessary with new high capacity lines needed
- The **CAPEX** investment required is ~ **$4 billion per year**
Iraq Electricity Master Plan

Questions?

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Email. larkinj@pbworld.com
Welcome
Power and Electricity Day