POWER SECTOR DEVELOPMENT AND SOUTH GOBI DEVELOPMENT

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ECA has been asked to review the least-cost means of meeting electricity demand in the South Gobi region, taking into account the needs of the Central Energy System (CES)

This presentation sets out

- our base assumptions on demand growth
- the expansion plans considered
- our analysis of the costs of these plans and preliminary findings
- our estimate of the financing requirements
<table>
<thead>
<tr>
<th>DEMAND – SOUTH GOBI</th>
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<tbody>
<tr>
<td>- We expect electricity demand in the South Gobi to rise to around 600MW by 2020</td>
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<td>- We project that:</td>
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<td>- open-pit operations at Oyu Tolgoi starting in 2012 will have a demand of 200MW, increasing to 300MW by 2016 with expansion and a shift to underground mining operations</td>
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<td>- demand from Tavan Tolgoi (ERC) will reach 100MW by 2014</td>
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<td>- To this, we have added</td>
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<tr>
<td>- assumed demand growth of 100MW by 2016 and 200MW by 2018 from additional Tavan Tolgoi developments</td>
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<td>- Demand from townships is subsumed into these projections</td>
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DEMAND - CES


- Over the period to 2020, we project average electricity demand growth of 3.5% annually:
  - large tariff increases (up to 60%) can be expected to reduce demand growth;
  - ongoing work to improve distribution efficiency can be expected to reduce losses.

- Heat demand in Ulaanbaatar grew at an annual average of 2.5% from 1997-2007 and 1.7% from 2002-2007.

- Over the period to 2020 we project average heat demand growth of up to 3% annually.
SUPPLY ASSUMPTIONS

- Current installed capacity on the CES is 774MW. Net available capacity is estimated at 647MW. Up to 255MW of Russian imports are available.

- Of the existing power plants, we assume that
  - TPP#2 will be retired after 2012
  - TPP#3 will be retired after 2016

- We assume that the Newcom wind farm project, of 50MW, will commission by 2010

- We also assume that a large hydro generator (most likely Egiin) will be commissioned by 2015. A generator of this type is needed for system balancing purposes
The Mandalgovi – Tavan Tolgoi transmission line, interconnecting the CES and South Gobi region, is assumed to commission by 2010 and the CES – Mandalgovi line by 2012.

This a 640km 220kV double-circuit line. Assumed reliable capacity is around 150MW. Sustained power transfers in excess of this will require new transmission investments.

Losses on a line of this length will be significant – up to 15% at full reliable capacity.
<table>
<thead>
<tr>
<th>SUPPLY-DEMAND BALANCE</th>
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<tbody>
<tr>
<td>We expect electricity demand to exceed supply by 2012, assuming no new generating capacity is commissioned</td>
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<tr>
<td>This assumes that the full potential Russian import capacity of 255MW is utilised</td>
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<tr>
<td>These assumptions are conservative – they assume a relatively low rate of electricity demand growth on the CES</td>
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A number of possible options for new baseload power plants exist:

- TPP#5 at Ulaanbaatar
- a new thermal power plant at Oyu Tolgoi
- a new minemouth thermal power plant at Tavan Tolgoi
- a new power plant associated with a CTL export project at Baganuur
- a new export-oriented thermal power plant at Shivee Ovoo

The last two of these are both dependent on exports, and their development is outside the control of the Government of Mongolia. We do not, therefore, review them further.
<table>
<thead>
<tr>
<th><strong>OVERVIEW OF INVESTMENT OPTIONS</strong></th>
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<tbody>
<tr>
<td><strong>TPP#5</strong></td>
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<tr>
<td>- CHP using coal from Baganuur mine</td>
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<tr>
<td>- unit size of 300MW and 700Gcal/hour</td>
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<td>- investment cost of $1,240/kW</td>
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<tr>
<td>- thermal efficiency of 36%</td>
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<tr>
<td><strong>Tavan Tolgoi TPP</strong></td>
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<tr>
<td>- air-cooled sub-critical coal plant</td>
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<tr>
<td>- unit size of 300MW</td>
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<tr>
<td>- investment cost of $1,110/kW</td>
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<tr>
<td>- thermal efficiency of 33%</td>
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<tr>
<td><strong>Oyu Tolgoi TPP</strong></td>
</tr>
<tr>
<td>- air-cooled sub-critical coal plant</td>
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<tr>
<td>- unit size of 150MW</td>
</tr>
<tr>
<td>- investment cost of $1,500/kW</td>
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<tr>
<td>- thermal efficiency of 32%</td>
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TAVAN TOLGOI
COAL COSTS

- The 1995 JICA Coal Master Plan estimated the cost of production at Tavan Tolgoi at around US$20/t (at 2008 prices)

- Other estimates of production costs provided to us are around US$10-12/t

- There is also the potential for a new coal plant to use ‘middlings’ from the coal washing process
  - the opportunity cost of using middlings for power generation is zero or even negative
  - the 1995 Master Plan estimated the proportion of middlings in total production at around 9%
  - on annual production of up to 30Mt, this would represent sufficient coal for 600-750MW of baseload generating capacity

- To represent this possible range of costs, we use an assumed coal price of $20/t and a sensitivity of $0/t
We have estimated the present value (at a 10% discount rate) of total generation costs under three alternative expansion scenarios:

- **Scenario 1:** Develop TPP#5 and Tavan Tolgoi TPP simultaneously
- **Scenario 2:** Develop Tavan Tolgoi TPP followed by TPP#5
- **Scenario 3:** Develop Oyu Tolgoi TPP followed by TPP#5 and Tavan Tolgoi TOO

Our analysis takes account of:

- the need for minimum levels of generation from CHP plants to meet heating demand in the CES
- constraints on the transmission of power between the CES and South Gobi region
## EXPANSION PLANS COMPARED

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Entry dates</th>
<th>PV costs (@10% discount rate)</th>
<th>Tavan Tolgoi coal price</th>
</tr>
</thead>
<tbody>
<tr>
<td>First plant commissioned</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 TPP#5 + Tavan Tolgoi</td>
<td>2012/2018</td>
<td>2,184 $20/t 0%</td>
<td>2,029 $0/t 0%</td>
</tr>
<tr>
<td>2 Tavan Tolgoi</td>
<td>2013/2018</td>
<td>2,223 $20/t 2%</td>
<td>2,050 $0/t 1%</td>
</tr>
<tr>
<td>3 Oyu Tolgoi</td>
<td>2013/2018</td>
<td>2,202 $20/t 1%</td>
<td>2,150 $0/t 6%</td>
</tr>
</tbody>
</table>

- The least-cost expansion plan is to develop TPP#5 and Tavan Tolgoi TPP together, with the first units commissioning in 2012.
- However, the cost differences between the alternative expansion plans are minor (1-2%).
LEAST-COST EXPANSION PLAN – SCENARIO 3

MW

Imports
Egiin HPP
Oyu Tolgoi TPP
TPP#5
Tavan Tolgoi TPP
TPP#4
Erdenet TPP
Darkhan TPP
TPP#3
TPP#2
Newcom
Peak demand
20% reserve margin

As well as cost, the selection of the appropriate expansion plan needs to consider risks to the plan. Of these, the most important is the risk of delays in plant commissioning.

We do not consider there are other significant differences between the alternative expansion plans:

- All the plans involve the development of generating capacity in both Ulaanbaatar and South Gobi.
- Impacts on air pollution and export potential are therefore similar across the plans.
STATUS OF PROJECT DEVELOPMENT

- **TPP#5**
  - a tendering round is underway
  - there may be delays in evaluating submissions and negotiating final agreements due to the invitation to bidders to propose their own financing and contractual arrangements

- **Tavan Tolgoi TPP**
  - limited development activities undertaken to date

- **Oyu Tolgoi TPP**
  - the mine developers (Rio Tinto and Ivanhoe Mines) have completed design work and much of the permitting requirements
  - estimated time to completion is 30 months
ESTIMATING THE COSTS OF DELAY

- It is reasonable to assume that Oyu Tolgoi TPP can be commissioned by 2012.
- There appear to be moderate risks of delays to TPP#5 and significant risks of delays to Tavan Tolgoi TPP.
- We have estimated the costs of delays in commissioning to Mongolia, assuming that:
  - the first date that TPP#5 can be commissioned is 2013, and that Tavan Tolgoi TPP can be commissioned is 2014.
  - delays in commissioning power generation capacity result in reduced output from the Oyu Tolgoi mine.
  - the value of Oyu Tolgoi’s production to Mongolia is $0.525/lb of copper (assuming a copper price of $1.5/lb with 35% royalties and taxation).
  - this is equivalent to $380/MWh of unmet demand.
COSTS OF DELAY

- It is clear that delays would greatly increase the costs of scenarios 1 and 2
- The cost of the resulting unserved energy outweighs the minor savings relative to scenario 3
POSSIBLE EXPANSION PLAN

- These preliminary findings suggest scenario 3 should be adopted
  - Newcom is commissioned in 2010
  - Oyu Tolgoi TPP is commissioned in 2012
  - TPP#5 Unit 1 is commissioned in 2013 and Unit 2 in 2018
  - Tavan Tolgoi Unit 1 is commissioned in 2015
  - Egiin HPP is commissioned in 2015

- Although this plan is slightly higher-cost than scenario 1, it is considerably less risky
  - under scenarios 1 and 2 any delay in commissioning either TPP#5 or Tavan Tolgoi TPP beyond 2012 would result in high costs to Mongolia
  - the risks of such delays appear high, given the current status of development of these two projects
FINANCING REQUIREMENTS

- Annual investment needs under the Scenario 3 expansion plan average $500m from 2009-11, of which $250m would be financed by Ivanhoe / Rio Tinto and Newcom.

- Annual investment needs from 2012-17 average $225m.

- This excludes transmission and distribution investments, other than the CES – Tavan Tolgoi interconnector.
PROCUREMENT OF NEW CAPACITY

Financing the required generating capacity within the necessary timescale is unlikely to be possible, except on a BOT basis.

- Best practice needs to be followed to minimise the lead-times required to procure new capacity as BOTs.
  - TPP#5 will need to commission within 4-5 years.
  - Tavan Tolgoi TPP will need to commission within 6 years.
- This is discussed in the next session.