A Critical Review of Long Term Water Energy Nexus in India

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Where we are and where we are heading for?
Water and energy security are not going to be ensured in India.

**2010**

- **Water security:** Per capita water availability has dropped 1600 m$^3$ (water stressed as per Falkenmark indicator)

- **Energy security:** Nearly 288 million Indian have no access to modern form of energy (IEA, 2011)

**2050**

- **Water security:** Water demand will exceed total utilisable water (1120 BCM) by 16%

- **Energy security:** Annual growth of electricity demand will reach about 5%

**Drivers:** Rise of population, Rapid urbanization, industrialization, change of lifestyle and consumption pattern
Water and energy security are inherently inter-dependent

**Water for energy**
- extraction/production of primary energy
  - hydropower
- cooling of thermal power plant
  - clean energy generation

**Energy for water**
- water extraction
- water and wastewater treatment
  - supply of water

About 7% of total world’s energy consumption is accounted for water delivery (Hoffman, 2004)

In some developed countries energy sector accounts for about 40% of the total water withdrawn (World Economic Forum, 2011)
Long term water supply-demand gap scenario, case of India

Note: Generally, Thermal power plants use surface water for its operation.
In Madhaya Pradesh, power cuts were made to alleviate the water shortage in the region in 2006 (Source: The Hindustan Times, 2006)

Parli thermal power plant in Beed district of Maharashtra were shut down because of severe water shortage in the Marathwada region (NDTV, 2013)

In Kerala, power cuts ordered to deal with water scarcity in 2008 when monsoon rainfall was 65% less than normal (Source: Thaindian News, 2008)

In Orissa State, farmers protested the increasing rate of water allocation for thermal power and industrial use (UNEP Finance Initiative, 2010)

Opposition to Adani power projects is growing in local community due to threats to drinking water and irrigation water availability (The Times of India, 2011)
As of our knowledge there is no research work in the region which answered following research questions:

- How much water is used by electricity generation in Asian countries?
- What are the driving factors of high water footprint for electricity sector in India?
- Can current policies overcome water conflict between electricity and other users?
- What types of technology can be intervened to deal with water constraint situation?
Methodological framework of quantitative assessment of water energy nexus

Global Circulation Model

Hydrological Model (HEC-HMS)
Output: Future water availability (BCM)

Power plant survey
Output: water use intensity (m3/MWh)

Supply demand gap

MESSAGE Model
Output: Water demand for energy, Energy mix under water constraint scenarios

Water Demand

Statistical extrapolation

• Agriculture
• Industry
• Domestic

Output: projection of future water demand

Energy

Feeds into

Regional and national water management and energy development planning
The dominance of coal-based thermal power generation in the total electricity supply mix of the country is not likely to change.
Water requirement of different types of thermal power plants, India

Note: WC = Wet cooling; DC = Dry cooling

Source: Based on IGES survey of Indian power plants conducted during 2012.
State of water resources in major river basins of India

<table>
<thead>
<tr>
<th>River basin</th>
<th>Utilisable water resources (BCM)</th>
<th>Per capita water availability (m³)</th>
<th>Level of water stress</th>
<th>Water requirement in 2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ganga</td>
<td>422</td>
<td>1039</td>
<td>Stress</td>
<td>494</td>
</tr>
<tr>
<td>Indus</td>
<td>73</td>
<td>1242</td>
<td>Stress</td>
<td>77</td>
</tr>
<tr>
<td>Luni</td>
<td>26</td>
<td>486</td>
<td>Absolute scarcity</td>
<td>29</td>
</tr>
<tr>
<td>Mahanadi</td>
<td>66</td>
<td>1786</td>
<td>No stress</td>
<td>61</td>
</tr>
<tr>
<td>Brahmani and Batarni</td>
<td>22</td>
<td>2063</td>
<td>No stress</td>
<td>21</td>
</tr>
<tr>
<td>Godavri</td>
<td>116</td>
<td>1454</td>
<td>Stress</td>
<td>99</td>
</tr>
<tr>
<td>Tapi</td>
<td>22</td>
<td>714</td>
<td>Scarcity</td>
<td>18</td>
</tr>
<tr>
<td>Krishna</td>
<td>84</td>
<td>912</td>
<td>Scarcity</td>
<td>92</td>
</tr>
<tr>
<td>EFRs</td>
<td>67</td>
<td>937</td>
<td>Scarcity</td>
<td>58</td>
</tr>
<tr>
<td>WFRs</td>
<td>54</td>
<td>4879</td>
<td>No stress</td>
<td>51</td>
</tr>
<tr>
<td>Brahmaputra</td>
<td>59</td>
<td>11782</td>
<td>No stress</td>
<td>56</td>
</tr>
</tbody>
</table>

Source: ADB 2011
### Distribution of thermal power plants in river basins

<table>
<thead>
<tr>
<th>River basin</th>
<th>Thermal power capacity distribution (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ganga</td>
<td>35</td>
</tr>
<tr>
<td>Indus</td>
<td>7</td>
</tr>
<tr>
<td>Luni</td>
<td>6</td>
</tr>
<tr>
<td>Mahanadi</td>
<td>9</td>
</tr>
<tr>
<td>Brahmani and Batarni</td>
<td>3</td>
</tr>
<tr>
<td>Godavri</td>
<td>11</td>
</tr>
<tr>
<td>Tapi</td>
<td>6</td>
</tr>
<tr>
<td>Krishna</td>
<td>5</td>
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<tr>
<td>EFRs</td>
<td>7</td>
</tr>
<tr>
<td>WFRs</td>
<td>6</td>
</tr>
<tr>
<td>Brahmaputra</td>
<td>0.5</td>
</tr>
<tr>
<td>Others</td>
<td>5.5</td>
</tr>
</tbody>
</table>

Over 75% of the installed power plants is located in areas with absolutely water scarcity and water stress.
Relevant national policy to cope with water energy trade off conflict in India

- The Ministry of Environment and Forests (MoEF), Govt. of India, put a ban on using open loop wet cooling system in any inland power plants using fresh water from 1 June 1999.
- Power plant Zero Discharge Policy is promoted and encouraged.
### Projected Water Demand for Electricity Generation

<table>
<thead>
<tr>
<th>Year</th>
<th>IGES Estimate (without policy)</th>
<th>IGES Estimate (with policy)</th>
<th>NCI/WRD</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>49</td>
<td>49</td>
<td>19</td>
</tr>
<tr>
<td>2025</td>
<td>102</td>
<td>70</td>
<td>33</td>
</tr>
<tr>
<td>2050</td>
<td>227</td>
<td>143</td>
<td></td>
</tr>
</tbody>
</table>

**Water Demand (billion m3)**

Note: Estimated water demand with policy intervention basically considers the closed loop wet cooling system installed after June 1999 and without policy water demand is a reference estimate of continuation of use of open loop wet cooling system.
Can current policies overcome water conflict between electricity and other users?

By 2050, total water demand will exceed total utilisable water, even with the enforcement of existing policies.
Under water constraint situation, India needs to change electricity supply mix. India needs to reduce dependency on coal power plants and adopt low water intensive options in power sector (eg. Gas TPP with seawater cooling, renewable energy)
Key messages

• In India, water demand will surpass water availability by 60-70 BCM by 2050, meant long term energy supply might get negatively affected due to lack of water and energy sector investment can be jeopardized.

• Only putting a ban on using open loop wet cooling system cannot overcome water constraint situation for future electricity generation.

• Gradual transition to more water efficient options (Gas TPP with seawater cooling, dry cooling, wind, solar pv) will reduce both water demand as well as environmental impacts.

• Integrated assessment tools need to be developed for selection of Go and No Go areas and technologies in future power plant construction planning.
Major publications


2. Water use efficiency in thermal power plants in India. (Contribution to the World Water Development Report 5, will be launched 21 March, 2014)

3. Long Term Electricity Scenario and Water Use – A Case Study on India. (IGES policy brief, published in July 2012)

For electronic copy please visit www.iges.or.jp
Thank you very much

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