

PARCHED POWER

Energy Finance Conference - India

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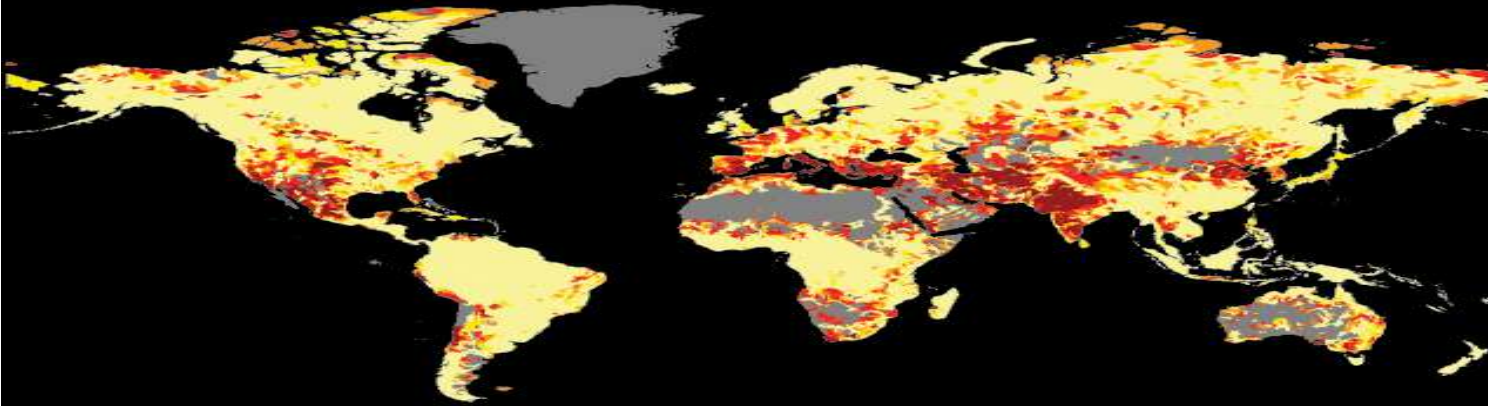
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SOME STARK REMINDERS

17 COUNTRIES FACE EXTREMELY HIGH WATER STRESS

BASELINE WATER STRESS



Source: wri.org/aqueduct

 AQUEDUCT™

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BUILDING BLOCKS OF THIS PRESENTATION

Water Use in India's Power Generation: Impact of Renewables and Cooling Technologies To 2030
(issue brief and methodology)

IRENA - Rabia Ferroukhi, Divyam Nagpal, Verena Ommer, Celia Garcia-Banos,

WRI - Tianyi Luo, Deepak Krishnan, Ashok Thanikonda

Parched Power: Water Demands, Risks And Opportunities for India's Power Sector

Tianyi Luo, Deepak Krishnan, Shreyan Sen

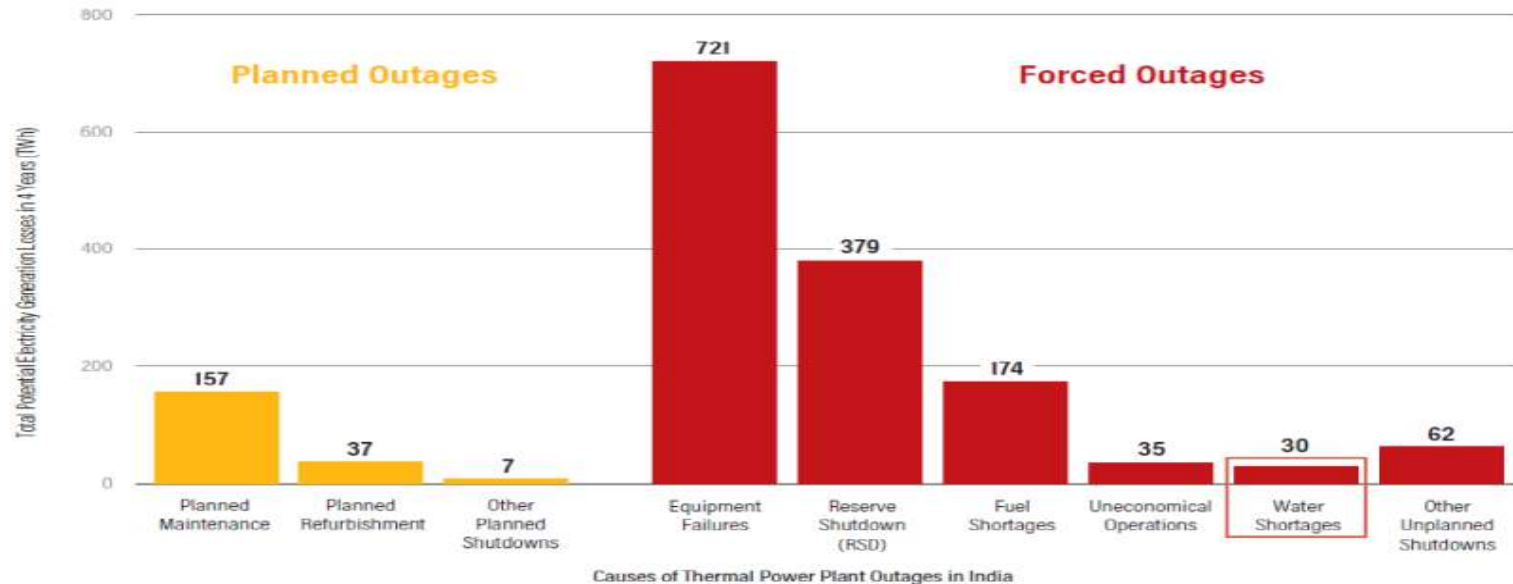
A Methodology to Estimate Water Demand for Thermal Power Plants in Data Scarce Regions Using Satellite Images

Tianyi Luo, Arjun Krishnaswami, Xinyue Li

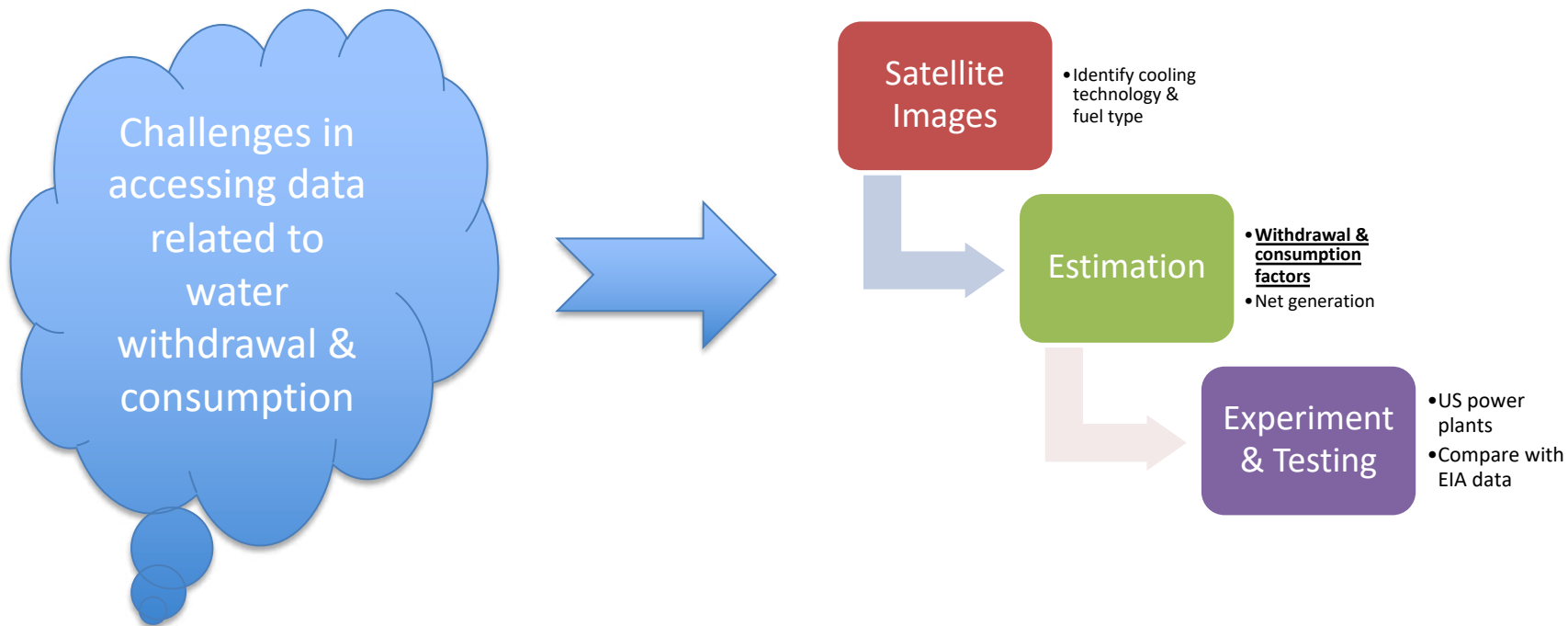
WATER SHORTAGE – A PROBLEM FOR THE FUTURE

Figure 9 | A Breakdown of Planned and Forced Outages of India's Thermal Power Sector by Outage Cause between 2013 and 2016

Water shortage is the fifth most frequent reason for forced outages of Indian thermal power plants, accounting for 2% of all outages between 2013 and 2016



UNDERLYING METHODOLOGY



SAMPLE IMAGES – ONCE THROUGH, DRY

Figure 2 | **Satellite Images of a Once-Through System**



Figure 7 | **Satellite Image of a Dry Cooling System**



Source: 2017 Google

SIMILARLY FOR FUEL TYPE – COAL, BIOMASS

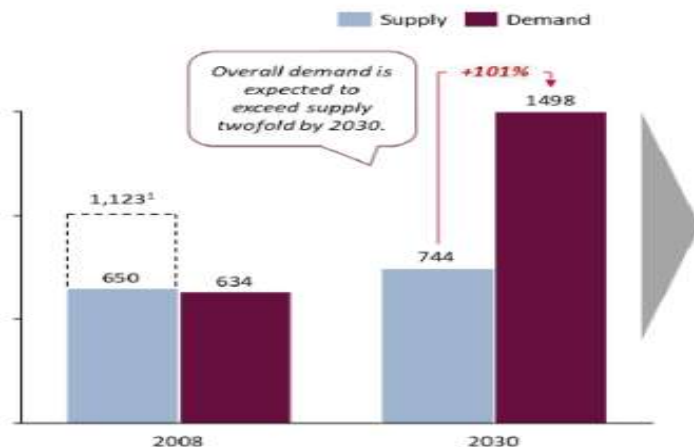
Figure 8 | Satellite Images of a Coal-Fired Power Plant (Left) and a Biomass Power Plant (Right)






Source: 2017 Google

SOME FIGURES TO KEEP IN MIND

Figure 7: Demand and supply of water in India (forecast)^{20,21}
In BCM (2008, 2030)



Facts: Scarcity is on the horizon

-  **40%** of the population will have no access to drinking water by 2030.
-  **21** cities, including New Delhi, Bengaluru, Chennai, and Hyderabad, will run out of groundwater by 2020, affecting **100 million** people.
-  **6%** of GDP will be lost by 2050 due to water crisis (under business-as-usual).

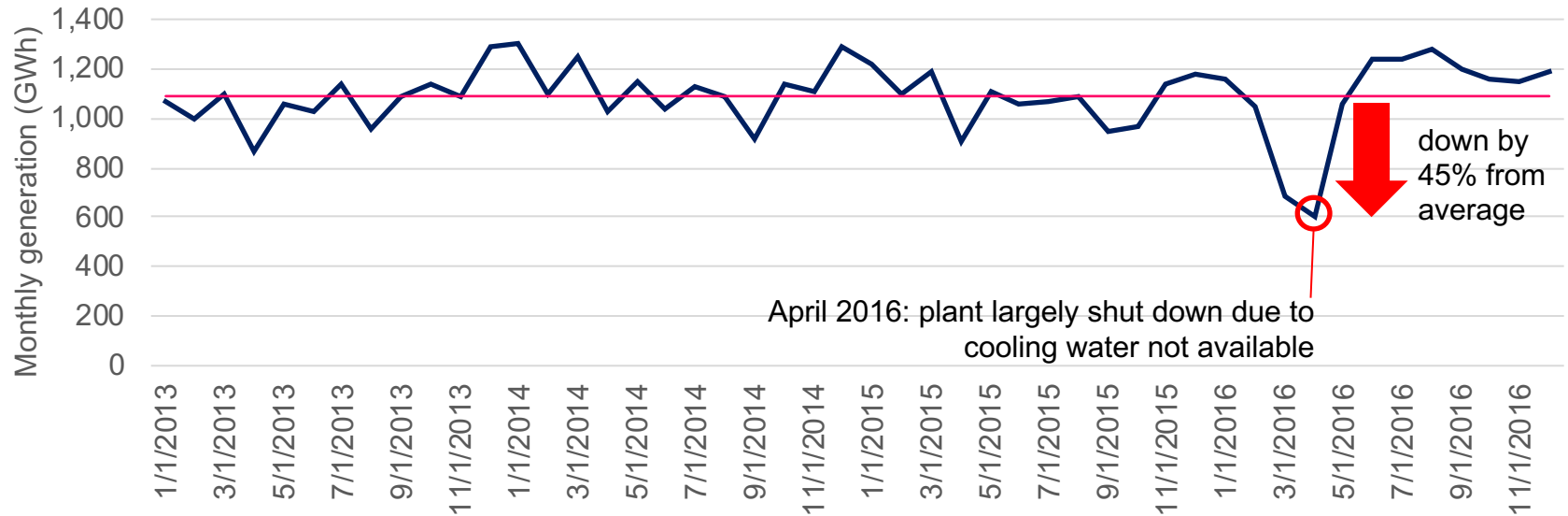
Notes: 1. Water supply for 2008 is Narsimhan's estimate of 650, while the planning commission estimate is 1,123, as represented by the dashed portion of the graph 2. Demand for 2008 is based on the planning commission's estimates 3. Supply and demand for 2030 are projections by McKinsey and Water Resources Group (WRG)
Source: Dalberg analysis; CWC Water & Related Statistics 2013; FAO & UNICEF, Water In India, 2013; McKinsey & WRG, 'Charting our water future', 2009; World Bank; Times of India

Power plants shut down due to water shortages

- India's demand for water will grow despite being a water stressed nation
- 90% of India's thermal power generation depends on fresh-water for cooling



Water shortage shut down Farakka, costing 45% its generation in April 2016



INCREASED CONSUMPTION MEANS LESS WATER FOR OTHER SECTORS

Figure ES-2 | India's Annual Thermal Utility Generation, Freshwater Consumption, and Withdrawal between 2011 and 2016

Thermal utility generation grew by 40% between 2011 and 2016



Freshwater consumption increased by 43% between 2011 and 2016

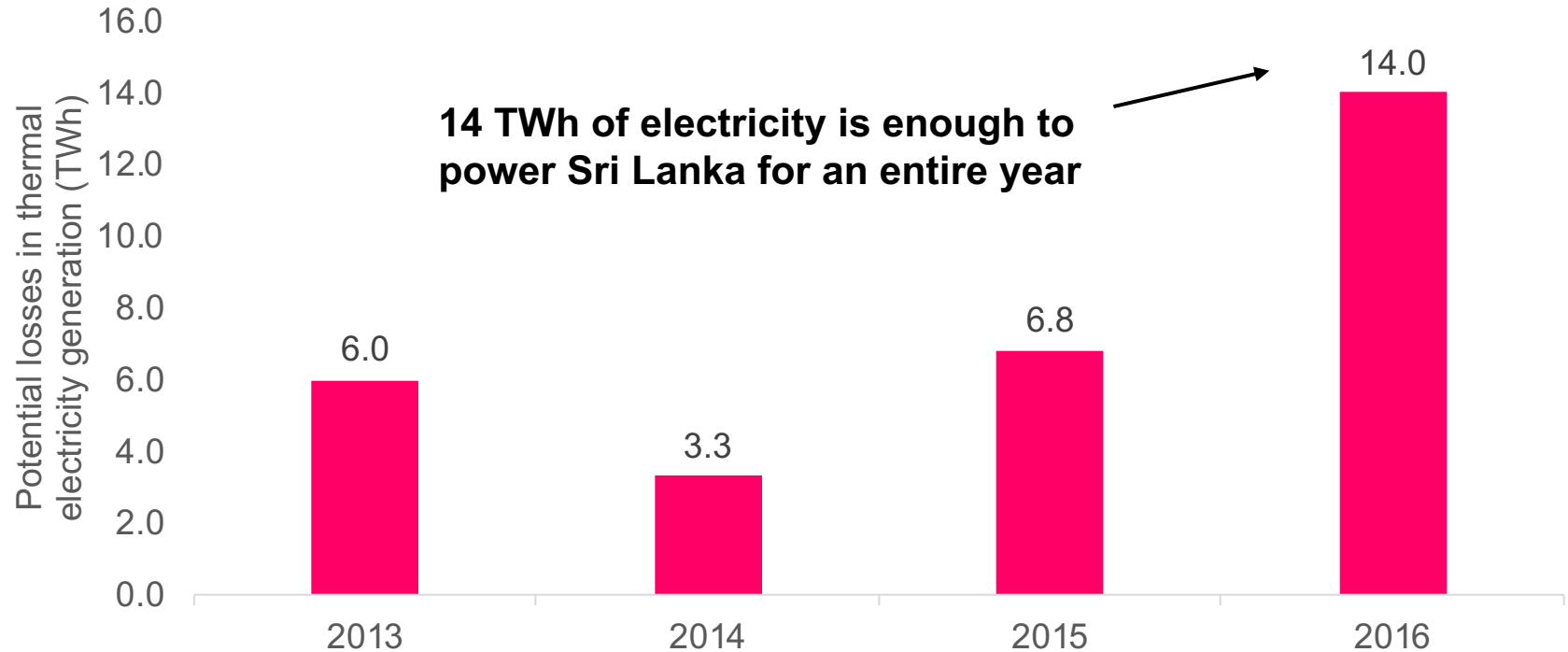


Freshwater withdrawal stayed relatively stable between 2011 and 2016

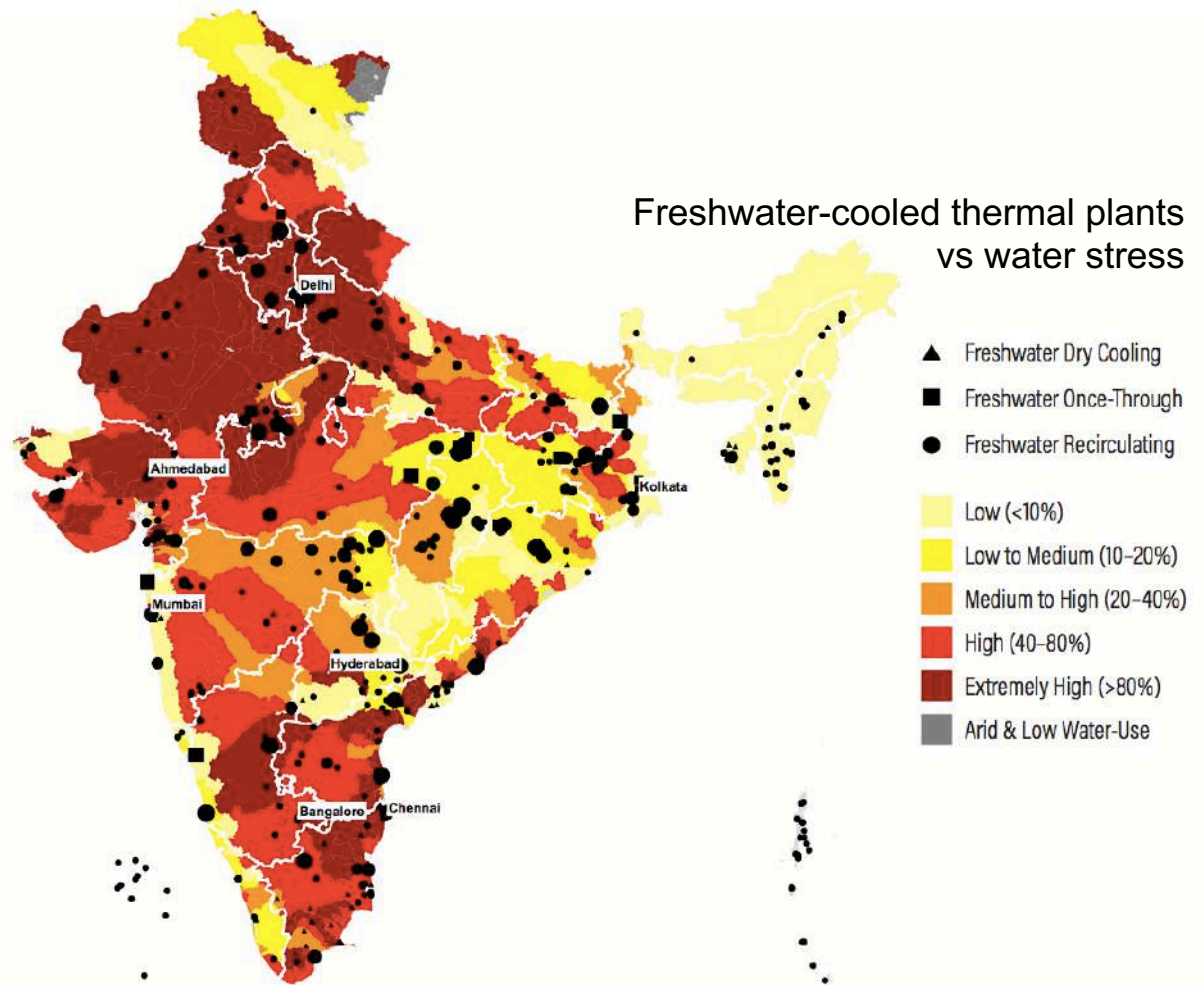


Sources: WRI authors; CEA (2017)

More than 30 TWh of generation lost due to unavailability of water



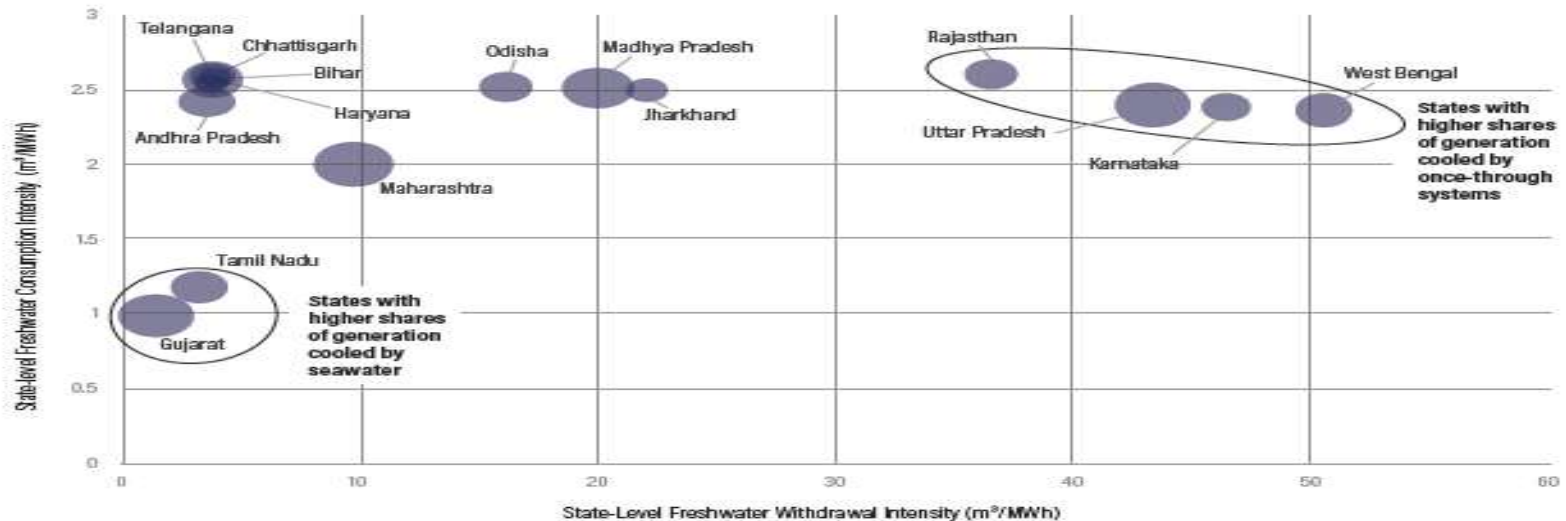
Almost 40% of India's freshwater-cooled thermal capacity is in high water-stress areas



Some states are more freshwater efficient when generating thermal electricity

Figure 7 | Statewide Average Freshwater Withdrawal Intensity vs. Consumption Intensity of the 15 Largest Thermal Electricity Producing States

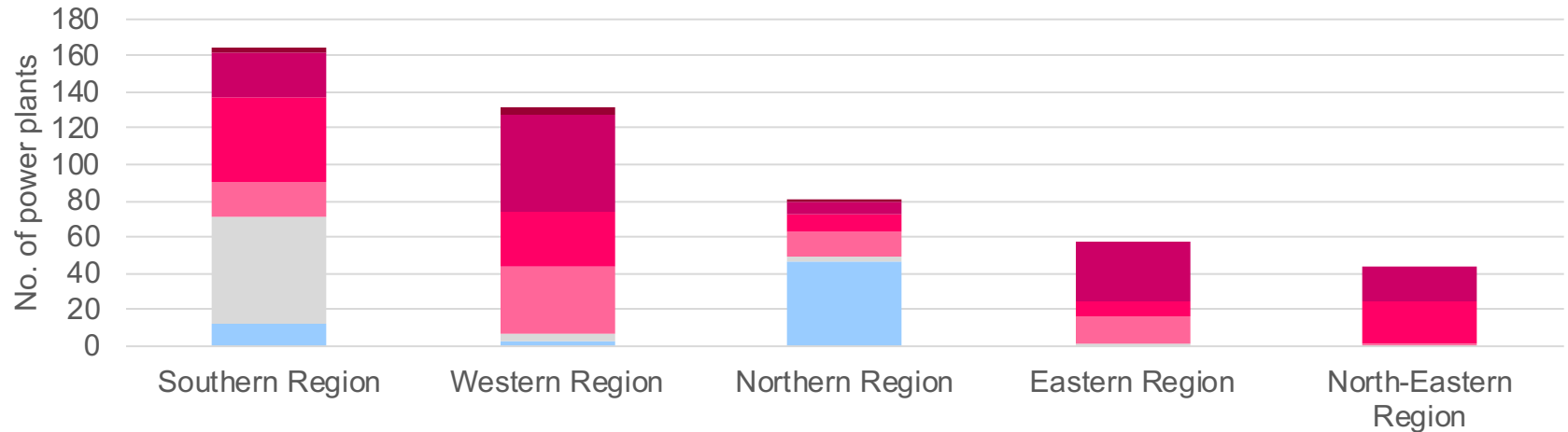
Some states are much more freshwater efficient than others when generating thermal electricity



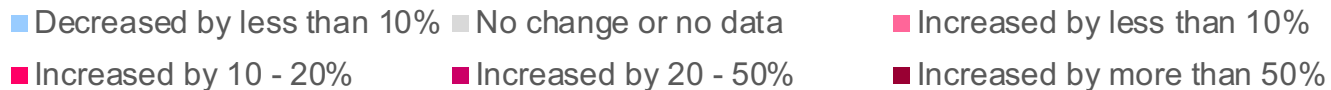
Note: Bubble size denotes thermal generation for each state relative to others in 2016.

Source: Data from CEA and Platts, analyzed by WRI authors.

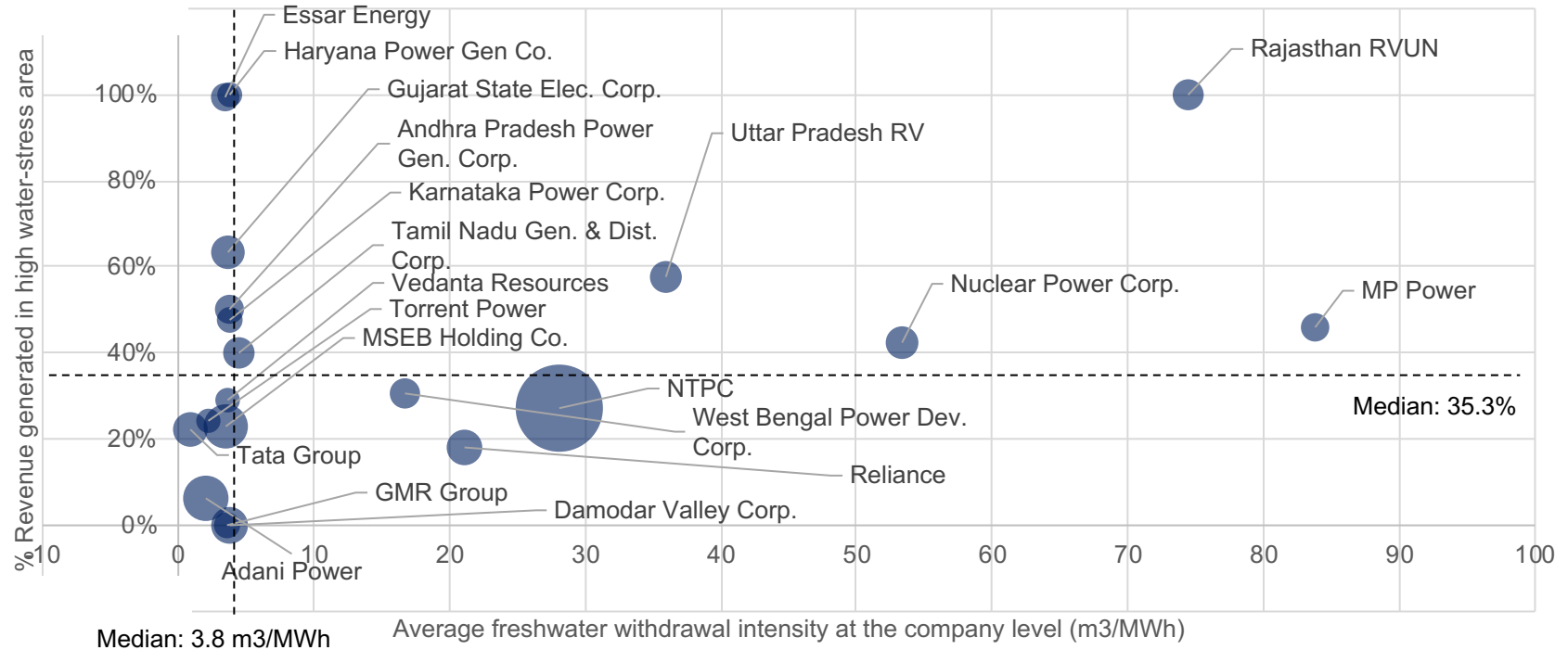
More than 70% of India's existing thermal plants are likely to experience an increased level of water competition by 2030



Distributions of no. of plants by projected changes in 2030 in local water competition by region



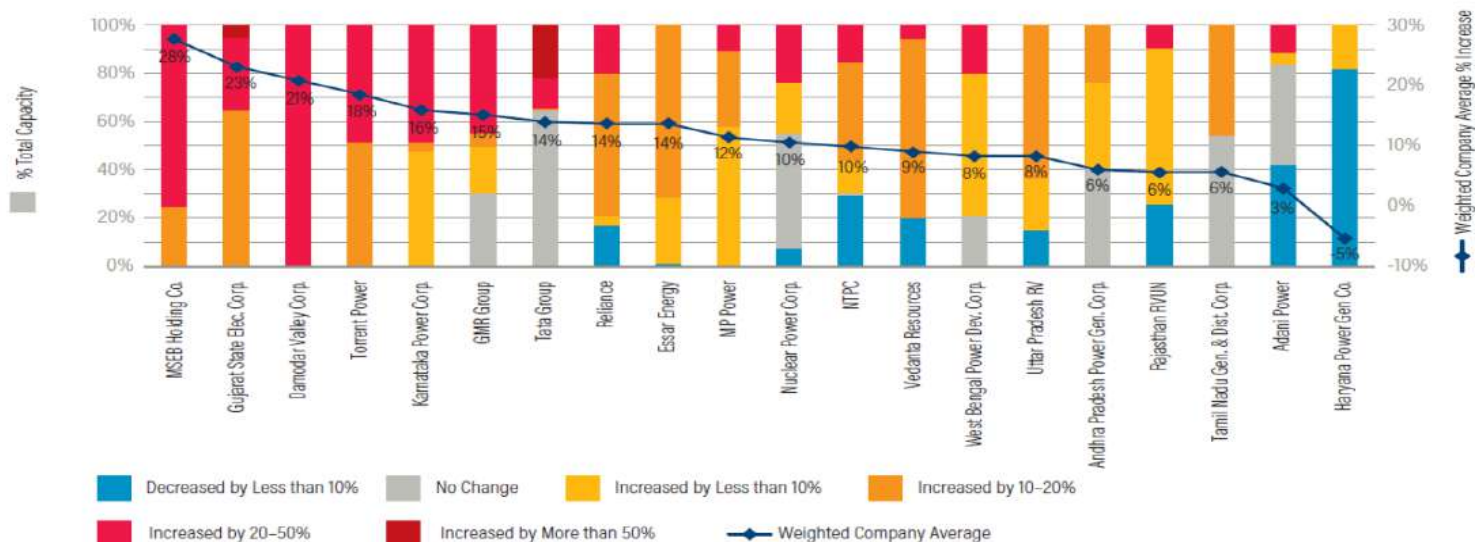
Some companies are more freshwater efficient and less exposed to water stress



NINETEEN OUT OF THE 20 COMPANIES ARE LIKELY TO SEE AN AVERAGE INCREASE IN WATER-USE COMPETITION BETWEEN 3% AND 28%

Figure 16 | The Level of Increase in Water-Use Competition in Capacity and Weighted Portfolio-Level Average Increase for the Top 20 Largest Indian Thermal Utility Owners

By 2030, almost all companies will see an increase in water-use competition between their utility assets and other water users in their shared watershed



WAY FORWARD

- Upgrading cooling systems – MoEF directive of 2015
 - But, these norms are already diluted from that originally proposed
- Improving plant efficiency
- Accelerate the transition to renewables

KEY RECOMMENDATIONS

- MoP to mandate monitoring & disclosure of water withdrawal & discharge
- Standardize reporting on water data monitoring and disclosure
- Set benchmarks and develop guidelines to incentivise better performers
- Regular company and investor level risk analysis
- Integrate energy and water planning

DISCUSSION ON DEVELOPMENTS

- CEA has released format for TPPs to disclose information about their water consumption FY-wise
 - Annual actual water consumption (metered and un-metered)
 - Type of water (river, canal, sea)
 - % of deviation from water norms with reasons and corrective measures
- Previous FY data also essential to establish baseline
- These reporting requirements need to be taken beyond Excel sheets and be part of a law/regulation
- Verifiable evidence needed – bills, third party audit reports etc
- Transparency – all this information to be publicly accessible

THANK YOU.

DATA SOURCES

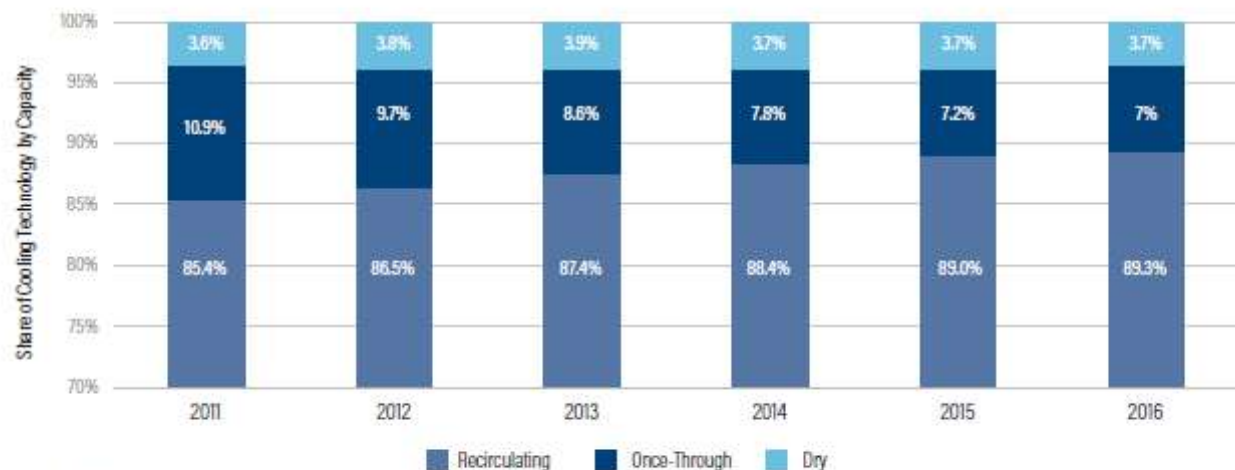
Table 1 | A List of Source Data Used in the Study

| DATA | TIME FRAME | AVAILABILITY | SOURCES |
|--|----------------------------|--------------|--|
| Plant and regional-level daily generation data | January 2013–December 2016 | Public | CEA data compiled by WRI authors |
| Plant-level monthly generation and capacity data | January 2008–December 2016 | Public | CEA data compiled by WRI authors |
| Unit-level rate of sale of power data | Fiscal year 2015 | Public | CEA data compiled by WRI authors |
| Unit-level daily outage data | January 2013–December 2016 | Public | CEA data compiled by WRI authors |
| Country-specific water withdrawal and consumption factors by fuel and cooling type | Not applicable | Public | Chaturvedi et al. (2017); CWR/IRENA (2016); Bhattacharya and Mitra (2013); NREL (2011) |
| Unit-level capacity, built year, operating status, fuel, business type, and ownership data | Calendar year 2016 | Proprietary | The Platts World Electric Power Plants Database |
| Catchment-level current water supply, demand, and stress data | Calendar year 2010 | Public | Gassert et al. (2014) |
| Catchment-level projected future water supply, demand, and stress data | Calendar year 2030 | Public | Luck et al. (2015) |
| National-level entire power sector generation and capacity data | Calendar year 2014 | Public | Courtesy of IRENA (International Renewable Energy Agency) |
| National-level projected future power mix, generation, and capacity | Calendar year 2027 | Public | Courtesy of CEA |

APPENDIX 1 – INCREASE IN SHARE OF RECIRCULATING TECHNOLOGY

Figure 6 | Share of Cooling Technology of Freshwater-Cooled Thermal Utilities by Installed Capacity from 2011 through 2016

Share of recirculating cooling among freshwater-cooled thermal utilities has increased 5% between 2011 and 2016



Source: WRI authors.