TOWARD WATER RISK VALUATION
Investor Feedback on Various Methodologies Applied to 10 Energy ListCo’s

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China Water Risk (CWR) & the Water-Energy-Climate Nexus

Water increasingly is interlinked with climate issues and the Water-Energy-Climate Nexus is an integral part of CWR’s work in promoting a comprehensive view on water risks. As the largest emitter of greenhouse gases (GHG), China plays a central role in this global nexus for it needs to add significant power with limited water resources. Power generation in China is the largest contributor to GHG emissions as well as the largest user of industrial water. Not only does no water = no power, we also require power to clean and distribute water. Moreover, water resources are vulnerable to climate change from melting glaciers and unpredictable rain to droughts & floods. Balancing the right mix of power for both climate and water is thus crucial for a water secure China. As the upper riparian of many of Asia’s transboundary rivers, the future of China’s energy mix does not just impact China’s water; it has regional watershed implications and global climate ramifications. Please contact us if you would like to work with us in this nexus at info@chinawaterrisk.org

China Water Risk is grateful to our sponsor, the ADM Capital Foundation as well as our key funders, Rockefeller Brothers Fund and the RS Group.
It has been four years since we started the water and energy conversation in 2012. A lot has happened in the Water & Energy space since then. Today, China is making concerted and coordinated efforts to cut coal consumption and manage its precious water resources given its increasing vulnerability to climate change. In striving for a Beautiful China with blue skies, clean water and green land, the nation has embarked on several fronts to leapfrog towards a cleaner and greener Industry 5.0.

This fast-moving regulatory landscape has also been shifting attitudes towards water risks. We have moved from little to no awareness in the investment and financial community to now wanting to quantify the impact on valuations. The growing utility of China Water Risk’s work by these communities and continued support from our funders are testament to the urgent need to address these rising water risks.

In this report, we seek to push the water risk valuation conversation further. In this regard, we are extremely grateful to all asset owners and investment professionals who participated in providing feedback on the various approaches to water risk valuations discussed. We especially thank those who arranged meetings, conference calls and presentations to facilitate such engagement.

The dozens of meetings and discussions has helped us gain insight into the investment communities’ views and frustrations on quantifying water risks as well as expectations of the available valuation tools. These views, set out in this report, have been invaluable and we hope that they can help the community fine-tune the tools towards a consistent and useful framework for the quantification of water risks.

In addition, the valuation methodologies and results in this report largely relied on works and inputs of various institutions, including Greenpeace, the Institute of Public & Environmental Affairs (IPE), the Natural Capital Declaration coalition, Trucost and the World Resources Institute. We thank them for their tools, expert advice, inputs and collaboration. This report would not be possible without their important work.

We found throughout this exercise, significant gaps between investors’ alleged concern and their practices as well as concerns around the usefulness to tools. Challenges in disclosure and navigating regulatory risks also add complexity. However, water risks are not going away and will likely rise. With Chinese banks starting to move to quantify such risks and their impact on their portfolio, we hope that this report can help stakeholders, be they providers of capital, companies, IGOs/NGOs or stock exchanges, chart a path towards better accounting for water risk.

Debra Tan
Director, China Water Risk
EXECUTIVE SUMMARY

Over 70 investment professionals/asset owners across various asset types (“Investors”) from more than 50 financial institutions/funds provided feedback on various water risk valuation approaches. We found that although 45% of the Investors are providing feedback on an anonymous basis because they are looking for ways to embed water risks in valuation models, 61% to 90% of them had “never heard of” the tools available, be they shadow pricing, mapping, disclosure or relating to the management of water risks. That said, at the end of the exercise, almost half of them said they would use the existing tools to quantify water risks. It is worth noting here that only 23% of the Investors were SRI focused.

Three valuation approaches showcased in this report are: (1) shadow pricing’s impact on P&L; (2) balance sheet exposure to water stress; and (3) regulatory risks & compliance costs. Shadow pricing and mapping tools were thus applied to 10 listed energy majors operating in China: five in coal mining (Coal-5) and five in power generation (Power-5). Although primarily operating in China, these 10 companies are listed across four exchanges: Hong Kong, Shanghai, London and New York.

It should be noted here that the purpose of this report is not to provide stock recommendations but to serve as a base for discussion on how to incorporate water risks through various valuation methodologies. We therefore used publically available information only and did not engage directly with these companies so as not to bias the results.

The results from these three water risk valuation approaches for these two peer groups were discussed with the Investors. It turns out that regulatory risk is the #1 Investor concern. They view this risk to be tangible, material and immediate. Indeed, 73% of Investors view the cost of compliance to tighter water regulations as material with the rest saying it depends on enforcement.

Since the regulatory landscape in China is evolving, Investors recognise the risk to be high regarding (1) allocation of water; (2) tighter requirements leading to increased compliance cost in CAPEX and OPEX; and (3) fines & violations. In the end, 59% of Investors indicate they may commission/conduct more research on regulatory risks compared to 41% for physical water risks. Ultimately, this matters most as for most investors, investing in non-compliant companies is a breach of fiduciary duty.

Next, Investors were worried about physical water risks, especially the binary risk of no access to water. Here it is interesting to note that Investors rank water risks associated with water availability, such as competition for water, water scarcity, groundwater depletion and drought, higher than floods or reputational risks. Over half the Investors are “very” to “extremely concerned” over scarcity related risks.

In this regard, we mapped the 79 mines of the Coal-5 and 135 thermal power plants of the Power-5 to find that 3 of the 5 coal companies source >85% of their coal output from extremely high water stress areas, whereas Power-5 generate 34%-81% of their electricity from the same areas. Naturally, over 90% of Investors expressed varying degrees of concern over various aspects of water stress exposure for both sectors. However, we discovered granularity issues which should hopefully be now addressed with an updated China map developed by the World Resources Institute.

While broad consensus was achieved for both regulatory and physical water risks, the same could not be said for shadow pricing. We used two shadow pricing tools to estimate the impact on EBITDA margins for the Coal-5 and Power-5. Results
show wide-ranging impact on margins within & between sectors: -1% to -13% (Coal-5) & -3% to -24% (Power-5). This is mainly due to differences in the tools’ shadow price computations as well as the location & water use of each company. Although 71% & 87% of Investors acknowledge the impact margins to be “material” or “very material” for the Coal-5 & Power-5 respectively, they have serious concerns over the concept of shadow pricing & the underlying assumptions. There was enthusiastic debate over whether shadow prices fairly represent the water risk exposure for either sector. 10-13% of Investors say the approach overestimates water risk, while 14-16% believes the contrary; 13% even opine the approach is misleading as it is not a real price.

There is no doubt that of the three approaches, shadow pricing provoked the most debate & polar opinions among Investors. In the end, Investors did however appreciate the ability to estimate a range of impact by sector and 82% agree shadow pricing was a good first step, but a first step only. Shadow pricing needs complementary analysis of the exposure to physical water stress and regulatory risks. Investors also pointed out that the current shadow pricing and mapping tools ignored pollution challenges.

In short, Investors say they didn’t want to read tool manuals but rather collaborate with brokers to factor in water risks. In this regard, we recommend building scenarios into DCF models for future water needs depending on various assumptions regarding levels of water availability and regulations. Pollution violations and fines can also be tracked to gauge management’s ability to manage such risks with IPE’s pollution database.

Ultimately, the quality of corporate disclosure underpins the exercise. Water risk is location specific yet none of the 10 companies disclose any water data at a facility level. Investors remain sceptical over the current voluntary disclosure with over 90% of Investors reiterating the need for facility level disclosure of water use for both the coal and power sectors. Investors clearly feel that the stock exchanges can do more: 78% want mandatory facility-level disclosure of water use amounts. In general, 86% of Investors would like to see “mandatory disclosure required by exchanges”, while 96% want more “complete & consistent disclosure”.

In the meantime, since data disclosed for both sectors lack consistency and clarity, we recommend investors & companies use official regulations, targets, standards and quotas/norms to guarantee an ‘apples with apples’ comparison. By doing so, disclosure is immediately more decision-relevant and investors can benchmark peer group performance.

There is clearly a long road ahead. While Investors remain divided over the “real price of water” through shadow pricing, there are clear, material and more immediate regulatory and physical water risks which have to be addressed. We hope research/credit analysts and stock exchanges rise to the challenge and find ways to factor in such contingent liabilities so that they are properly reflected in company valuations.
## CONTEXT

Describes the objectives of this report and details the 10 listed energy majors and the universe of investors surveyed. Key water risks faced by the coal mining and thermal power generation sectors in China are also discussed, along with a selection of different types of tools available in the water space that help assess exposure to water risk.

## SHADOW PRICING & IMPACT ON P&L

Shows the impact of water risk valuation on the companies’ profit margins using shadow pricing methodologies adopted by some existing tools. The concept of shadow pricing in valuing water risk is explored, as are industry benchmarks like the amount of water used to produce one tonne of coal and one kWh of electricity.

## BALANCE SHEET EXPOSURE TO WATER STRESS

Maps out specific locations of 79 coal mines of the five coal majors and 135 thermal power plants of the five power generation majors against water stress maps of China. The exposure of coal output & reserves as well as electricity generated & installed capacity are considered, along with the limitations regarding the granularity of the water stress maps.

## REGULATORY RISKS & COMPLIANCE COSTS

Sets out key regulatory risks for both the coal mining and thermal power generation sectors in China pertaining to water. Various key regulations and policies are explained. Areas where additional capital and operating expenditures (CAPEX and OPEX) are needed to meet Chinese regulations specific to managing its water-energy-nexus are also set out.

## TOWARDS DECISION-RELEVANT DISCLOSURE

Explains the various levels of water disclosure by the 10 listed companies and the challenges in data consistency and calculating comparable water benchmarks. Since this affects the water risk valuations, what investors want regarding water disclosure vis-à-vis the risks they view as material are also covered in this chapter, as is the need for mandatory disclosure vs. voluntary disclosure. The importance of regulatory guidance in providing water use benchmarks is also discussed here.

Investors’ views on these different approaches and results are shown and discussed throughout the entire report.

### Shadow Pricing & Impact on P&L
- Impacts on EBITDA margins
- Shadow pricing methodology
- Water use calculations
- Needs complementary analysis

### Balance Sheet Exposure to Water Stress
- Mapping of companies’ assets
- Output in water stressed regions
- Challenges with map granularity
- Dealing with binary risks

### Regulatory Risks & Compliance Costs
- Recent regulations & enforcement
- Allocation of water & violations
- Tighter compliance & retrofitting
- #1 Investor concern

### Towards Decision-Relevant Disclosure
- Materiality to drive disclosure
- Who’s disclosing what
- Challenges in data consistency
- Role of stock exchanges
Over the last few years, much research has highlighted the growing water-related risks for many industrial sectors. Power and mining sectors are on the front line and China Water Risk, along with other organizations, has led the drive in raising awareness regarding water risks to facilitate comprehensive management of water issues.

With investors now more worried about water risks, we feel the time has come to take a step forward - from raising awareness to the quantification of exposure to water-related risks. By understanding these risks and accounting for them in financial valuations, investors and corporates can act to mitigate them, thereby resolving issues related to water pollution and scarcity.

However, despite years of research and investment by a wide range of actors, the financial valuation of such risks remains elusive. To what extent are companies’ operations exposed? What are the potential impacts of water risks to their bottom-line?

Ongoing initiatives exist that can help answer these questions. NGOs as well as corporates have developed different types of ‘tools’ to help financial institutions, investors and businesses better gauge their portfolio or company’s water risks. These tools range from disclosure and water risk management guidelines; mapping of water risk and water stress; to those that drop out dollar values for the risk exposure using the concept of ‘shadow pricing’.

While still in their infancy, these tools can collectively provide a convenient framework to screen water risks across portfolio companies. Yet, although largely designed to be used by the financial community, they remain widely unknown. Therefore, in charting a path towards an accepted framework for quantifying water risks, we need to first understand how the financial community view these existing tools. Why are they not used widely?

It came down to time. Investors did not have enough time to explore and test these tools, and so we did. As water risks vary across industries, we had to select specific sectors to cover. Power and mining sectors were chosen as they are large industrial users of water and their exposure to water risks is relatively better understood by the investment community.

We applied some of these tools to 10 listed energy majors operating in China: five in coal mining and five in power generation. Although primarily operating in China, these 10 companies are listed across four stock exchanges: the Stock Exchange of Hong Kong, the Shanghai Stock Exchange, the New York Stock Exchange and the London Stock Exchange. The results from this exercise are set out in this report which also showcases three approaches to the valuation of water risks in China’s energy sector. These include:

1. Shadow pricing
2. Exposure to water stress
3. Regulatory risks

Then, we showed these results to 70+ investment professionals/asset owners from 50+ financial institutions/funds to gauge their feedback: have they heard of the tools? How do they feel about these results? Do they consider the impact material? Are they even worried about water risks at all? If so, what type of water risk is the most worrisome? Is it floods, drought, water scarcity or competition for water in the future? Their views on the results and each of the above three approaches are also documented in this report.

Finally, please note that the tools and information used in this report are publically available. We did not directly engage with any of the 10 companies so as to provide a non-biased base to kick-start the discussion on water risk valuation methodologies. The quality of corporate disclosure underpins the entire exercise. The impact on valuation or margins is only as good as the reliability of the data used in the valuation and where data was missing, we made informed assumptions. Transparency in the amount of water use or wastewater discharge matters; especially if the impact is material. Since much of the data is voluntarily disclosed, we also obtained views from the investment community on whether they find the current disclosure framework adequate.
We received feedback from over 70 investment professionals/asset owners across various asset types (hereafter referred to individually as “Investor” and collectively as “Investors”) from more than 50 financial institutions/funds. Although feedback was possible via a questionnaire available online, a lion’s share of the Investors opted for face-to-face meetings and conference calls. We conducted these during the period 10 May to 25 July 2016.

We are pleased to see that over three quarters of the Investors hail from the “mainstream”, bucking the trend that only those who practice Socially Responsible Investment (SRI Investors) care enough about water risks to carve out time to provide feedback. Almost half of the Investors are based in Asia, mainly in our base, Hong Kong. Meanwhile, most of those who are based in the Rest of the World (ROW) are primarily located in Europe.

WHO & WHERE ARE THEY FROM?

<table>
<thead>
<tr>
<th>Surveyed investors are based in...</th>
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<tbody>
<tr>
<td>Asia</td>
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<tr>
<td>49%</td>
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<table>
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<tr>
<th>Mainstream vs. SRI</th>
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<tbody>
<tr>
<td>Mainstream</td>
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<tr>
<td>77%</td>
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<table>
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<tr>
<th>What type of investors are you?</th>
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<tbody>
<tr>
<td>Equity &amp; Equity-linked</td>
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<tr>
<td>Debt &amp; Fixed Income</td>
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<tr>
<td>Institutional Investor</td>
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<td>Pension/Sovent Fund</td>
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<td>SRI Investor</td>
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<td>Hedge Fund</td>
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<tr>
<td>Private Equity</td>
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<td>High Net Worth</td>
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<tr>
<td>Research (Debt &amp; Equity)</td>
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Note: multiple choices possible

WHY DID THEY SPEND THE TIME?

At first, we were not sure how many would respond to the call to provide feedback which was sought on an anonymous basis. We attribute the high turnout from the mainstream to that fact that they are worried about potential exposure to water risks.

Nearly half of the Investors said they were worried about water risks. Surprisingly, 45% of them even claimed they wanted to embed water risks in the valuation models.

Meanwhile, 31% are looking to embed water risks in ESG scores which is expected, as a quarter of them are SRI Investors. It was also encouraging to see that 35% were looking to use these results to engage with companies on the issue of water risks.

What’s interesting is that around quarter of them thought the process would help them identify areas of opportunity. Indeed, an Investor noted “great research and important information – makes me more bullish on renewables.”
NOT ALL WATER RISKS ARE THE SAME

Before we showed the results to Investors, it was important to gauge their understanding of and views towards water risks. Here we asked them to benchmark their concerns over water risks for India and China against global water risk. 67% and 49% of Investors respectively perceive water risks in China and India to be more of a concern than those globally. Indeed, India and China are respectively ranked by HSBC as the #1 and #2 most water-stressed countries globally. Investors express the most concern about water risks in China than India. However, this could be attributed to the fact that we are China Water Risk and not India Water Risk.

Regarding global risks, most Investors clustered around “concerned”. For China, Investors clustered around “very concerned” to “extremely concerned”, whereas for India, they were “concerned” to “very concerned”.

It is not just regional, but the type of water risk also matters. Clearly, Investors say some risks matter more than others.

Although concerned about droughts and floods, they appear to be even more worried about risks related to the availability of water. “Competition for water” ranked as the #1 concern; followed by “scarcity exposure”; then “groundwater depletion” and “droughts”. Reputational risks and floods, although important, are less of a concern.

Investors’ views towards water scarcity are discussed in further detail in BALANCE SHEET EXPOSURE TO WATER STRESS.

MUCH CONCERN, LESS ACTION

Concern does not always translate into action. Despite the Investors expressing concern over various water risks, only 37% of them said they actually conducted water risk assessments recently.

Yet, this can be viewed as positive result; after all only around a quarter of those surveyed are SRI Investors. In short, Investors have started to see water risk as a “mainstream risk.”

On a less positive note, Investors are likely not using the tools developed by various initiatives to conduct these water risk assessments. As shown on the following page, many Investors have never heard of them.
MOST HAVE “NEVER HEARD OF” THESE TOOLS

There are many tools available but we had to narrow the selection to those that are more investor-facing. We consider the nine tools listed below to be either essential, or at the forefront in valuing water risks.

Investor feedback reveals that these tools remain largely unknown. Even Bloomberg’s Water Risk Valuation Tool only garnered a nod from 39%, with 61% of Investors saying they have “never heard of” it. Still, at these low recognition rates, the Bloomberg tool fared the best, along with the CDP Water Questionnaire. The other disclosure tool, GRI Guidelines, follows closely behind. Ceres Aqua Gauge fared the worst but this is likely due to the fact that Ceres, a U.S.-centric NGO, has less presence and engagement in Asia and/or Europe where most of the Investors were based.

SRI INVESTORS LEAD & ASIA LAGS ON TOOL RECOGNITION

Not surprisingly, Investors who define themselves as “SRI investors”, as opposed to mainstream investors, are more familiar with these tools. But even then, more than half of them had “never heard of” answers.

In terms of geographical disparities, Asia-based investors lag behind their counterparts based in Europe, the U.S. and Australia.
MANY OF THESE TOOLS ARE INTERLINKED

Many of these nine tools are inter-dependent with results from some tools feeding into the other. The diagram below shows these linkages:

Linkages Between the Tools & Workflow of Different Approaches for Water Risk Valuation

AFTER SITTING DOWN WITH US ...

After completing this exercise, 49% of Investors say they will use these existing tools to quantify water risks. Considering that 61% to 90% had not heard of them before, this can be seen as a great start. What’s more, many Investors want to continue to engage with us to further the methodologies in valuating water risk. More importantly, they can see the extension of these valuation methods beyond the coal and power sectors and they even expressed willingness to pay/commission for certain aspects of these water risks assessments.
We analysed the impact on P&L and balance sheet exposure to water risks for ten listed energy companies operating in China: five coal mining companies (“Coal-5”) and five power generation companies (“Power-5”). We selected these Coal-5 and Power-5 peer groups as they are among the largest coal and power generation companies in China. The Coal-5 accounted for 14% of China’s coal output in 2014 whereas the Power-5 was responsible for 19% of the nation’s thermal electricity generated. Given China’s current focus on the environment, we also looked at regulatory pressures regarding water faced by these two sectors.

The total market capitalization of these 10 energy majors listed on four exchanges stood at more than USD110 billion as of April 2016. Altogether, they represent 1.2% of CSI300, 4.2% of Hang Seng China Enterprises Index, 11.5% of MSCI China Energy, 15.5% of SSE Energy and 24.5% of SSE Utilities. As such, these companies receive the most coverage by sell-side equity research analysts.

The purpose of this exercise is not to provide stock recommendations but a base for discussion on how to incorporate water risks through various valuation methodologies in order to properly reflect the potential impact on the P&L and asset exposure to water scarcity and availability. It should therefore be noted that we did not engage directly with these companies so as not to bias the results with additional information gleaned from engagement.

Data used in the analysis of these companies are taken from publically available sources such as annual reports, stock exchange filings, sustainability and/or CSR reports, company websites and official government data. Due to data availability at the time of initiating research, values used in this report for these companies are that of 2014. Do note that we will hereafter refer to these listed companies by a shortened version of their names (Shenhua, China Coal, Yanzhou, Yitai, Datong, Huaneng, Datang, Huadian, Guodian and CPI). These should not be mistaken with their respective parent groups which hold the same name.

Some Investors commented that they would like us to expand the Power-5 peer group to include China Resource Power (SEHK: 836). Others expressed interest in expanding these assessments to other sectors. Although these tools have only been applied to the coal and power sectors in this report, there is no reason why they cannot be used to assess water risks for listed companies and/or businesses in other sectors. The Top 3 sectors most requested by Investors are the #1 Textile, #2 Agriculture and #3 Food & Beverage sectors.

Naturally, we would be delighted to collaborate with research analysts and NGOs to deliver such analyses for these sectors. Yet, it became clear in conversations that Investors are only willing to pay for assessing certain aspects of water risks. More on which risks are more urgent for Investors in REGULATORY RISKS & COMPLIANCE COSTS.
“Coal-5” mining companies

- **China Shenhua Energy**
  SEHK: 1088, SSE: 601088
- **China Coal Energy**
  SEHK: 1898, SSE: 601898
- **Yanzhou Coal Mining**
  SEHK: 1171, SSE: 600188, NYSE: YZC
- **Inner Mongolia Yitai Coal**
  SEHK: 3948, SSE: 900948
- **Datong Coal Industry**
  SSE: 601001

“Power-5” companies

- **Huaneng Power International**
  SEHK: 0902, SSE: 600011, NYSE: HNP
- **Datang International Power Generation**
  SEHK: 991, SSE: 601991, LSE: DAT
- **Huadian Power International**
  SEHK: 1071, SSE: 600027
- **Guodian Power Development**
  SSE: 600795
- **China Power International Development**
  SEHK: 2380

**Source:** China Water Risk, projected on WRI Baseline Water Stress Map
The mining and processing of coal relate to water in many different and complex ways.

**Impacts of coal mining & operations on water resources**

Water is used in coal mining for different purposes such as dust suppression, equipment cooling and fire control. The processing of coal requires additional water, for instance during washing and screening stages. When water use levels are significant, they may alter river flow regimes and contribute to groundwater depletion. That said, such amounts of water use can be relatively modest when the mining and processing operations are properly managed and efficient/dry technologies are adopted, for instance through water recycling.

However, the impact of coal mining and processing goes beyond mere water usage. Seepage from waste rock dumps and tailings storages can contaminate soil and groundwater. In some cases, these impacts could extend beyond the closure of the mine. Contaminated water may also be discharged to local water bodies, for instance when floods, heavy rainfall or dam failures occur, or when suitable treatment facilities are lacking. The formation of pit lakes in open-pit mining and the associated evaporation can also lead to groundwater depletion.

Mine water drainage is another way through which mining operations alter local water resources. Groundwater seeping into coal mines needs to be pumped out of the mines for operational and safety reasons, thereby affecting local aquifers.

**Investors are concerned about groundwater depletion...**

Groundwater pollution is also rampant in China. Although we did not attempt to quantify pollution impact in this report, pollution issues are important.

We discuss pollution-related risks in the regulatory chapter where Investors’ views on pollution are also laid out.

**Interactions between environment, mining operations and regulatory bodies**

To manage all these water risks, operators must invest in water storage and treatment infrastructures; closed mines rehabilitation; and potentially in dry processes/storages and dewatering systems.

The impact of the coal industry on water resources has been facing growing scrutiny over the last few years and new regulations have been issued accordingly. The Chinese government has also been signaling tighter regulations to manage the water-energy nexus in the North. Tighter regulations will result in increasing costs of compliance for industries, both in terms of CAPEX and OPEX. These are considered in detail in the chapter on **REGULATORY RISKS & COMPLIANCE COSTS**. Water is clearly essential for mining and Investors express concern over binary risks: no water = no ore output. These risks are discussed in detail in the chapter on **BALANCE SHEET EXPOSURE TO WATER STRESS**.
Additional references on water & mining
CWR commissioned/ collaborative reports (2013-2015)

Recommended readings:
• Columbia Water Center, 2015 - Mining and Water Risk: Diagnosis, Benchmarking, and Quantitative Analysis of Financial Impacts
• China Academy of Engineering, 2014 - Towards Sustainable Development of Clean and Efficient Coal in China (Chinese)
• CDP, 2013 – Metals & Mining: a sector under water pressure
• UNEP FI, 2012 – Water-related Materiality Briefings for Financial Institutions – Extractives sectors
• WRI, 2010 – Mine the gap, Connecting water risks and disclosure in the mining sector
WATER & THERMAL POWER GENERATION

In thermal power generation, most of the water is used for cooling purposes, with wide-ranging water withdrawal and water consumption levels, depending on the cooling technology used. While less acute than in coal mining, there are also water pollution concerns.

Cooling makes up most of power plants' water use

Cooling represents most of water use in thermal power plants, typically 90%. The remaining 10% is used for flue gas desulfurization, boiler make-up and ash handling. As a consequence, levels of water use are mainly dependent on the type of cooling technology adopted. Set out below are three main types of technologies with wide-ranging levels of water withdrawal and water consumption.

**Different cooling technologies = different amounts of water withdrawn & consumed**

**Water use of coal-fired power plants for different cooling technologies**

<table>
<thead>
<tr>
<th>Cooling Technology</th>
<th>Water Consumption</th>
<th>Water Withdrawal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air cooling</td>
<td>0.2 m³/MWh</td>
<td>&gt;80 m³/MWh</td>
</tr>
<tr>
<td>Closed-loop cooling</td>
<td>2.0 m³/MWh</td>
<td>2.3 m³/MWh</td>
</tr>
<tr>
<td>Once-through cooling</td>
<td>0.3 m³/MWh</td>
<td>0.3 m³/MWh</td>
</tr>
</tbody>
</table>

Source: Qin, Y. et al. (2015).** Average supercritical units in China

With different cooling technologies come different types and degrees of water risk, both physical and regulatory. Power plants with once-through technologies in inland areas are the most exposed, while air cooling equipped power plants bear minimal risks on the water front. Given China’s water woes, it is not surprising that the government has stipulated air cooling to be used for power generation in water-scarce regions. The implications of this and other water-related regulations are covered in more detail in the chapter on REGULATORY RISKS & COMPLIANCE COSTS.

**Power plants are not immune to water pollution**

Water pollution concerns are often overlooked when it comes to thermal power generation. However, thermal power plants can contaminate local water resources in different ways. For instance, coal-fired power plants generate substantial quantities of coal ash that are typically stored in ponds or dump sites when not used. Water contaminated by contact with coal ash can later seep into shallow aquifers, contaminating groundwater. Separately, water used in flue gas desulfurization is another potential source of pollution, if not properly collected and treated.
Additional references on water & thermal power generation
CWR commissioned/ collaborative reports (2012-2016)

- Greenpeace, 2016 - The Great water grab
- University of Oxford, 2016 - Stranded assets and thermal coal - An analysis of environment-related risk exposure
- Zhang, C et al., 2016 - Revealing Water Stress by the Thermal Power Industry in China Based on a High Spatial Resolution Water Withdrawal and Consumption Inventory. Environmental Science & Technology
- Van Vliet, et al., 2016 - Power-generation system vulnerability and adaptation to changes in climate and water resources. Nature Climate Change
- WRI, 2015 – Opportunities to Reduce Water Use and Greenhouse Gas Emissions in the Chinese Power Sector
- BNEF, 2013 – China’s power utilities in hot water

CWR-IRENA, 2016 - Water Use in China’s Power Sector: Impact of Renewables and Cooling Technologies to 2030
CWR, 2015 - Towards a Water & Energy Secure China – Tough choices ahead in power expansion with limited water resources
HSBC, 2012 – No water, no power – Is there enough water to fuel China’s power expansion?
SHADOW PRICING & IMPACT ON P&L
SHADOW PRICING & IMPACT ON P&L

- We are aware of four tools that aim to provide a dollar valuation of water risks. We used two of these that adopt the concept of shadow pricing (CBWCRT & WRM) to estimate the impact on EBITDA margins for the Coal-5 and Power-5.

- Results show wide-ranging impact on EBITDA margins within & between sectors: -1% to -13% (Coal-5) & -3% to -24% (Power-5). This is due to differences in the tools' shadow price computations as well as the location & water use of each company.

- Although 71% & 87% of Investors acknowledge the impacts on margins to be “material” or “very material” for the Coal-5 & Power-5 respectively, they have serious concerns over the concept of shadow pricing & the underlying assumptions. Investors remain divided on whether shadow pricing was sufficient to screen out water risk.

- There was enthusiastic debate over whether shadow prices fairly represent the water risk exposure for either sector. 10-13% of Investors say the approach overestimates water risk, while 14-16% believe the contrary; 13% even say the approach is misleading as it is not a real price.

- The lack of water disclosure at a facility level also brings uncertainty. Around three-quarters of the Investors are “sceptical” or “extremely sceptical” about water use data disclosed by companies. Many stress the need for data at a facility level and more importantly: consistent, reliable and decision-relevant disclosure.

- There is no doubt that of the three approaches, shadow pricing provoked the most debate & polar opinions among Investors. When we started, >80% of Investors “never heard of” either of these two tools. In the end, Investors did appreciate the ability to estimate a range of impact by sector and 82% agree it was a good first step, but a first step only.

- Investors want complementary detailed analysis such as exposure to potential binary risks brought on by physical water stress and regulations. Investors also highlight that the tools ignored pollution challenges and the ability to pass on water price increases to end-consumers. There is clearly a long road ahead.
FOUR TOOLS PUT A $ SIGN ON WATER RISKS

There are many existing tools that aim to quantify water risks for companies and investors. However, we are only aware of four of them that ultimately provide a dollar valuation of these risks. These are set out in the table below:

<table>
<thead>
<tr>
<th>Water risk monetarization tools</th>
<th>Developers</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Corporate Bonds Water Credit Risk Tool (CBWCRT)</td>
<td>Natural Capital Declaration, GIZ &amp; VfU</td>
<td>Excel sheet</td>
</tr>
<tr>
<td>2 Water Risk Monetizer (WRM)</td>
<td>Trucost &amp; Ecolab</td>
<td>Online</td>
</tr>
<tr>
<td>3 Water Risk Valuation Tool</td>
<td>Bloomberg LP</td>
<td>Bloomberg Terminal</td>
</tr>
<tr>
<td>4 The True Cost of Water</td>
<td>Veolia</td>
<td>Veolia use only</td>
</tr>
</tbody>
</table>

All four tools adopt a shadow pricing methodology. We used the first two: (1) the Corporate Bonds Water Credit Risk Tool (CBWCRT) and (2) the Water Risk Monetizer (WRM); as these are both accessible by the public and are available to use for free.

The Water Risk Valuation Tool is accessed via a Bloomberg terminal and is only available upon subscription to the Bloomberg ESG suite. However, since the Bloomberg tool is based on the freely available CBWCRT, results should not differ, provided that water use and location of assets are properly informed.

Finally, the True Cost of Water is a tool developed by Veolia to help organizations better understand the actual and risk-based true cost of water. Using the tool, the cost of different water strategies for a corporate can be compared. However, it is currently reserved to Veolia’s clients and its need for specific data makes it more suitable for a single operation’s analysis, rather than for a whole portfolio.

THE CONCEPT OF WATER SHADOW PRICING

The two tools used in this chapter, CBWCRT and WRM, determine a “shadow price” of water to estimate the potential economic impact of water risks on a company’s bottom line. This approach, commonly known as shadow pricing, is considered a proxy for the integration of water risks into decision making. Investors’ comments, which range from “do not know how it works” to “has been a useful leading indicator for carbon, but not as familiar with water methodologies” give a good idea of where they sit on this topic.

What Investors say about shadow pricing...

<table>
<thead>
<tr>
<th></th>
<th>Carbon</th>
<th>Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never heard of</td>
<td>55%</td>
<td>27%</td>
</tr>
<tr>
<td>Know it but not tried</td>
<td>38%</td>
<td>4%</td>
</tr>
<tr>
<td>Tried but not using it regularly</td>
<td>4%</td>
<td>4%</td>
</tr>
<tr>
<td>Use it regularly</td>
<td>8%</td>
<td>3%</td>
</tr>
</tbody>
</table>

Over half the Investors have “never heard of” shadow pricing for water but more than two-thirds are familiar with the concept for pricing carbon.

However, despite higher recognition rates for carbon, only 8% use carbon shadow pricing regularly in their analysis.

As for water shadow pricing, only 3% of Investors claim to use this regularly.
With these two tools, the shadow price of water is based on the so-called Total Economic Value (TEV) of water, as recommended by the World Business Council for Sustainable Development. This TEV is supposed to capture the full economic value of water to reflect supply constraints and demand pressures. The TEV includes external benefits that water provides to society and ecology, in addition to the private benefit enjoyed by water consumers.

**Breaking down the shadow price**

While both these tools adopt the concept of TEV to compute the shadow price of water, the components they include in this computation differ.

The CBWCRT tool adds up the “use value” of water for four different “services” namely agriculture, domestic supply, human health and environmental services, resulting in an overall shadow price.

In contrast, the WRM tool adds a water risk premium to the existing water price paid by the company. This water risk premium represents the societal costs of water use that could be internalized by a business or incorporated into the market price of water in the future. It includes the “use value” of water for wildlife habitat and recreational activities, waste assimilation and groundwater recharge.

**Decomposition of the shadow price of water**

- **Human health**: 11%
- **Agriculture**: 17%
- **Environment**: 72%
- **Domestic supply**:
  - **Waste assimilation**:
    - **Wildlife habitat & recreation**:
      - CBWCRT: 72%
      - WRM: 17%
    - **Groundwater recharge**:
      - CBWCRT: 17%
      - WRM: 11%
  - **Market price**:
      - CBWCRT: 11%
      - WRM: 11%

**How each component is computed?**

These two tools associate a shadow price of water for every location, based on local water stress. In addition, CBWCRT accounts for population density, whereas WRM does not. The WRM tool does however, adjust to account for the country’s purchasing power parity (PPP). The CBWCRT tool does not adjust for this, partly explaining why the shadow price values obtained by the CBWCRT tool are often significantly higher than with the WRM tool.

However, to determine water stress levels, both these tools adopt WRI’s Aqueduct Baseline Water Stress (BWS) Map.

**Shadow price can be viewed as an ‘upper bound’**

Indeed, the shadow price can also be interpreted as an ‘upper bound’, as suggested by the CBWCRT: "The TEV framework is used to estimate the shadow price of water to provide an ‘upper bound’ with which the model is able to gauge the magnitude of direct potential exposure for a company, and test the company financials against this exposure. The market price of water might not reach the shadow price, however the costs of water constraints can be internalised through a variety of market and non-market mechanisms, including capital expenditure (capex), physical shortages leading to lower production, and asset stranding caused by loss of water rights."
FROM SHADOW PRICE TO FINANCIAL IMPACTS

Clearly, the current water pricing in China does not reflect the ‘real value of water’ should water scarcity and competition for water be taken into account. Using the CBWCRT and WRM tools can provide shadow prices of water to approximate its ‘real value’ and therefore impact on the company’s profit & loss account (P&L). Since the average shadow price of water for a company is computed as a weighted-average of their operations’ water use across various locations, we had to map each company’s assets as well as estimate the local water use for each of their operations in order to determine this shadow price (more on this later).

This shadow price of water can then be used as a proxy to reflect exposure to water risk by introducing it into the listco’s financial valuations via increased operating costs. The additional OPEX line, inserted in the P&L statement, is obtained by multiplying the amount of water used with the delta of the shadow vs actual price of water.

The impact on margins, the range of water shadow prices, as well as the water use for each of the 10 energy listed companies are discussed in this chapter in the respective sector peer groups.

SHADOW PRICING: A GOOD FIRST STEP, BUT NOT SUFFICIENT

Investors are evenly divided on whether shadow pricing is sufficient to screen out companies’ exposure to water risk, with 50% remaining neutral. That said, 4 out of 5 Investors say they either “agree” or “strongly agree” that the shadow pricing method is “a good first step but needs complementary detailed analyses”. No one disagreed with this, while 18% opt to remain “neutral”. However, 13% of Investors think that this approach is misleading, as the shadow price is not a “real price”.

Using shadow pricing for water risk valuation is...

<table>
<thead>
<tr>
<th>% of answers</th>
<th>Strongly Agree &amp; Agree</th>
<th>Agree</th>
<th>Strongly Disagree &amp; Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sufficient to screen out companies’ exposure to water risks</td>
<td>26%</td>
<td>50%</td>
<td>24%</td>
</tr>
<tr>
<td>A good first step but needs complementary detailed analyses</td>
<td>82%</td>
<td>18%</td>
<td></td>
</tr>
<tr>
<td>Misleading because it is not a real price</td>
<td>13%</td>
<td>42%</td>
<td>45%</td>
</tr>
</tbody>
</table>

82% of Investors say that shadow pricing is a good first step for water risk valuation (66% “agree” & 16% “strongly agree”)

Yet, 13% say this approach is misleading - one Investor warns “some environmental values included in the shadow price are quite arbitrary, and may never reflect the actual economic costs.”

Clearly Investors harbour concerns over the concept of shadow pricing. Many feel that they could not opine and stayed neutral. Factors driving these concerns are explored in the rest of this chapter.
Impacts on Profitability: More Material Than Not

The charts below show the potential impacts of water risk on profitability margins when using shadow pricing tools on the Coal-5 (left) and the Power-5 (right). The downside impact on EBITDA margin ranges from -1% to -13% for the Coal-5 and from -3% to -24% for the Power-5.

Key result observations for the two sectors are:

- Impact varies widely across companies in the same sector peer group – this is due to (1) the different locations of each company’s operations resulting in different shadow prices of water, as well as (2) the different amounts of water use to achieve the same unit of revenue;

- Impact on the same company varies widely across tools – this is because CBWCRT and WRM tools adopt different correlations to determine the shadow price of water. On top of this, WRM caps the shadow price of water at USD4.5/m³ whereas CBWCRT doesn’t; and

- Impact on the Power-5 is greater than the Coal-5 – this is mainly because thermal power generation uses around 2X more water per unit of revenue than coal mining (including mine water drainage). Therefore, despite lower shadow prices, the Power-5 will exhibit higher exposure than the Coal-5.

We now dive into the two factors causing these wide-ranging results (1) the shadow price of water and (2) the amount of water used in each company’s operations.

Caveat: only the core business area is considered across the valuations

We only account for the water use of each company’s core business: coal mining for Coal-5 and thermal power generation for Power-5. The potential loss of profitability is therefore only related to this core business segment. However, the current EBITDA margin (indicated in red in the above charts) refers to the company’s overall profitability from all segments like coal mining, coal to chemicals, power generation and transportation.

For example, Shenhua’s higher margin is attributable to the fact that coal sales represent only 66% of Shenhua’s revenue compared to 97% for Yanzhou and Datong. Since only the impact on water for coal is accounted for, Shenhua’s downside impact is thus underestimated relative to its peer group.

The Power-5 companies on the other hand, are more directly comparable, with power generation representing from 90% to 100% of their entire revenue.
Most Investors say these impacts are material

Most investors find these impacts on EBITDA margins either “material” or “very material”: 87% for the Power-5, and 71% for the Coal-5. The consensus on materiality is higher for the Power-5 than Coal-5. Regarding the Coal-5, some Investors only find impact on the margins to be “material” for a few of coal companies rather than the entire group, leading 21% of them to choose the “other” category.

As views vary on what is a “material” impact, Investors expand on various materiality thresholds: “more than 5% would be considered as material” while others mention that materiality would depend on the “fatness” of the margin, preferring a yardstick of “>20% delta in the margin”.

Investors put these impacts into perspective

An Investor emphasizes that many other factors should be considered, including the “company’s awareness, the commitment from the board to deal with these risks as well as the corporate culture”.

More sceptical Investors mention that “the fluctuating price of coal is actually much more impacting than the price of water”. Another one adds that the impact will only be material if water prices eventually go up. Some think that a shadow pricing approach can be “useful as long as you understand it”; another finds it helpful “from a long term perspective”.

Mainly, Investors are worried about using these tools out of context. There are indeed shortcomings in the shadow pricing approach and these are discussed in more details later. However, it is safe to say that while many regard it as a good first step, views still remain divided as to whether or not it is sufficient to screen out water risks. As one Investor notes: “worth knowing the extent of the risk to keep on the radar screen”.

The “Not material” camp

More investors regard impact in the Coal-5 as not material compared to the Power-5. Here, few have taken the view that China will do whatever it takes to get water to the coal mines and power plants due to their strategic importance to the nation.

Regardless, Investors like the sector benchmarking of water risk impact

Despite the varying views on materiality and “usefulness” of the shadow pricing valuations, Investors are keen to see the impact on the companies as a peer group, as this allowed them to compare the companies’ exposure vis-à-vis each other. The ability to compare and benchmark companies’ exposure to water risk within a sector, as well as the opportunity to cross reference exposure across sectors, are just as, if not more important than the absolute impact on profitability. Even Investors who express vociferous scepticism toward shadow pricing methodologies, welcome the ability to benchmark companies.
SHADOW WATER PRICES: WIDE-RANGING VALUES

The average shadow price of water for the 10 energy companies is shown in the charts below. Before we start, it is important to note that (1) the shadow price of water is solely dependent on the location regardless of the industrial sector and (2) prices shown per company is the average, weighted by the freshwater use at every facility rather than by the production of coal or electricity.

Key result observations for the two sectors are:

- Shadow prices of water are higher for the Coal-5 than Power-5 – this is due to the fact that a larger proportion of coal mines are located in highly or extremely highly water stress regions, compared to thermal power plants (see their spread in the chapter on BALANCE SHEET EXPOSURE TO WATER STRESS);

- Shadow prices can be >100x the actual price of water – the shadow-price can be >100x the actual water price paid by companies which is estimated to be at times less than USD0.10/m³, prompting much discussion around whether shadow pricing is realistic; and

- Shadow prices calculated using CBWCRT are higher than WRM – This holds true for both sectors. Exposure variations are reflected by the wide-ranging results: CBWCRT values range from USD2.6-12.1/m³ whilst the range for WRM is only USD1.6-4.5/m³. The main reason is that WRM caps the shadow price of water at USD4.5/m³, currently the highest water tariff observed globally. (Note: Yitai’s shadow prices are calculated correctly. Yitai has a higher shadow price with WRM than CBWCRT due to location approximation of its assets to the closest city in WRM.)

Investors like being realistic and thus the price cap …

… but more want to see the maximum downside of the water risk exposure
Are shadow prices too high & too unrealistic?

Despite the majority preferring ‘no cap’ to appreciate the potential downside, several Investors are still of the view that the shadow water prices are too high to be meaningful. One warns that “$4.50 USD is already quite high” while another opines “one can desalinate water at around USD5/m³ all year long. Shadow prices of water exceeding this value are therefore not realistic.”

The comparison with current water resource fees somehow supports this conclusion. As shown in the chart on the right, the computed shadow prices are dramatically higher than current water tariff for industries in China.

In 2015, water resource fee in coal power bases ranged from RMB0.10 to RMB0.60/m³ for surface water and from RMB0.20/m³ to RMB3.00/m³ for groundwater. In comparison, the shadow price of water ranges from RMB11 to RMB81/m³.

WRM adjusts for purchasing power parity

A word here on the PPP adjustment of the shadow prices by WRM. Shadow price correlations have been built based on U.S. values; whereas WRM adjusts for PPP when extending the correlations to other countries, CBWCRT does not. The impact of this adjustment is significant: the PPP factor between U.S. and China was 0.57 in 2014. In other words, WRM reduces the shadow price by 43% when applying correlations in China. So even without the cap, WRM shadow prices will be significantly lower than CBWCRT.

Are they a fair representation of water risks? Investors remain divided

The relatively high shadow prices of water apparently do not outright disqualify them as a measure of water risks: 34% of Investors think the shadow prices fairly represent the range of water risks for the Coal-5, whereas consensus is higher for the Power-5 at 43%. However, they remain divided

Investors are divided over whether shadow prices are over/underestimating water risks...

<table>
<thead>
<tr>
<th>Over-estimating water risks</th>
<th>Under-estimating water risks</th>
<th>Fair representation of the range of water risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>13%</td>
<td>16%</td>
<td>34%</td>
</tr>
<tr>
<td>10%</td>
<td>14%</td>
<td>38%</td>
</tr>
<tr>
<td>10-13%</td>
<td>14-16%</td>
<td>33%</td>
</tr>
</tbody>
</table>

Investors are divided about whether or not these shadow prices are a fair representation of water risks exposure.

10-13% of Investors think that these shadow prices overestimate water risk, while 14-16% believe the contrary and underestimate water risks.

Around a third of them simply confess they lack knowledge or information to answer this question for either sector.

In the “overestimating” camp – Investors note that water use is likely to diminish if water costs increase, and the shadow pricing methodology fails to account for this elasticity. The method also does not account for the ability of companies to pass on the increased costs to their clients.

In the “underestimating” camp – Investors point out that high shadow prices do not necessarily entail an overestimation of water risks, as it is important to remember that they act as a proxy to water risks that go beyond an increase in water tariffs. High prices reflect higher water scarcity and stress exposure. An Investor aptly notes “water risks can be binary: either you have it or you don’t. I will not invest if water risk is ‘live’.”
WATER FOR COAL: DATA GAPS BRINGS UNCERTAINTY

A key input of this risk assessment is the actual amount of water used in each company’s facilities. Unfortunately, none of the 10 companies disclose such information at the facility level. Such uncertainty makes it difficult to conduct proper benchmarking. As a consequence, we had to rely on some assumptions explained below.

Water use for coal mining remains a mystery

Companies in the peer group are only comparable when using the benchmark of water use per tonne of coal produced. However, only Yanzhou discloses this yardstick. Meanwhile, Shenhua is the only company disclosing both its freshwater use and its mine water drainage amounts. The other three in the coal peer group, disclose neither water use nor drainage. We therefore used disclosures made by Shenhua & Yanzhou to derive m³/tonne benchmarks for coal mining and processing.

Regarding Shenhua, since it only disclosed its total annual water use for all business segments, we had to make some assumptions. In our analysis, as Shenhua disclosed its average water use for thermal power generation, we assumed that all the water not used for thermal power generation was used for its coal segment. This resulted in an estimated 0.04m³ per tonne of coal mined and processed for 2014. More on which companies disclosed what in TOWARDS DECISION-RELEVANT DISCLOSURE.

As for China Coal, Yitai and Datong, we assumed their values to be the average of those for Shenhua and Yanzhou. The resulting ranges are represented by the black bars in the chart below. However, since there is a lack of disclosure on this front, for more colour, we show the results alongside national standards or targets. This standard is a guideline for cleaner coal production devised by the Ministry of Environmental Protection (MEP); while not strictly mandatory, this can help benchmark the Coal-5’s water performance.

Mine water drainage – to include or not to include?

Another uncertainty pertains to the type of water that should be accounted for. The most straightforward answer would be to consider only the amount of freshwater used for coal mining and processing (e.g. for cleaning equipment and dust control). However, one may also argue that the drained mine water (the water seeping into the mine that is pumped out) represents a water loss for the local competing users and hence should be accounted for as well.

Since companies are already paying a mine water drainage fee, we included mine water drainage in our computations to derive the impact on EBITDA margins. Since only Shenhua disclosed this drainage amount, we used this level across all companies and drained mine water is represented by the gray bars in the above chart. These can be compared to national benchmarks set out in the NEA-NDRC action plan - more details on the regulatory front in REGULATORY RISKS & COMPLIANCE COSTS.
Companies appear on target but Investors are sceptical over data reliability

The results show that both Shenhua and Yanzhou comply with Grade I of the MEP Cleaner Production Standard. At 0.2 m³ per tonne of coal produced, this supposedly reflects the international advanced performance level. Shenhua’s implied water use per tonne of coal produced at 0.04 m³ outperforms this standard by 5x. In addition, Shenhua outperforms the national target in mine water drainage by the same magnitude; with 0.34 m³/tonne against 1.82 m³/tonne expected nationally in 2015.

Since all values were derived from the best available data voluntarily disclosed by Shenhua and Yanzhou, we asked Investors how confident they are in these values. Most of them were either “sceptical” or “extremely sceptical”.

Water risk valuation directly relying on water use levels

Uncertainty in water use levels affects the reliability of water risk valuations that adopt shadow pricing methodologies. Indeed, the impact on profitability is directly related to the amount of water use. Were a company to use twice as much water as it is disclosing, the potential impact on profitability would be two times higher as well.

This level of sensitivity meant Investors want more reliable data. Many stress the need for better and consistent accounting for water, as well as increased transparency and disclosure. More on what Investors want to see on this front in the chapter on TOWARDS DECISION-RELEVANT DISCLOSURE.

That said, Investors did make positive acknowledgements towards the fact that Shenhua and Yanzhou were disclosing water data. Also to be fair to these two companies, around a quarter of Investors say they had no view on their water disclosure amounts and would require more details before opining. Few Investors even express confidence in Shenhua’s numbers.

Another point here was that many ROW-based Investors have an answer bias regarding data from China. Those who are sceptical, say they are so for three main reasons: (1) the data comes from China, (2) the companies are SOEs, and (3) because it’s not audited/verified.
On the power front, it’s a different story. All five companies, except Huadian, disclose the average water consumption of their thermal power generation units. These levels are shown in the chart below.

Two main factors explain the difference across companies: (1) the overall efficiency of their fleet and (2) more importantly, the use of different cooling types.

Indeed, water consumption varies significantly depending on cooling technology type. It can be as low as 0.3 m³/MWh for air cooling to 2.5 m³/MWh for closed-loop – see page 16.

Location & cooling types matter
The location of the plant also matters. Not only do water use/consumption levels vary with different cooling types, water stress (and hence shadow water prices) also vary widely depending on location. Therefore, ideally, to analyse water risk exposure, knowledge of each power plant’s water use, specific location and cooling type is required.

Using the average values across all power plants as per the chart above fails to account for such variability, thereby undermining the reliability of the results. As such, to establish a baseline, we adopted a bottom-up approach in deriving the amount of water usage for each power plant.

Bottom-up approach: fleet analysis by cooling type
In order to estimate water usage at the power plant level, we had to ascertain the cooling types across the entire fleet for each of the Power-5 companies. The cooling types of the 135 power plants of the Power-5 were derived from online databases, satellite images as well as industry data. Assumptions were also made when only partial information was available. Our estimates are shown in the chart below.

Using this bottom-up approach and the average peer group values per cooling type, we estimated Huadian’s average water consumption to be 1.4 m³/MWh. Given the time taken to complete this bottom-up exercise, it is not surprising none of the Investors attempted this.
Bottom-up approach vs. applying the company average
Since the entire bottom-up approach is time-consuming, once we had established our baseline, we looked to see if using the average disclosed by the companies gave materially different results. We found that the two approaches gave relatively similar results. Therefore, given that bottom-up data collection is time-intensive and results do not differ significantly, we can now say that using the company’s average can provide relatively accurate results as a first estimation.

However, other forms of risk analysis will still require information at the power plant level. In particular, regulations in China are very much location specific, stipulating certain cooling types for water-scarce regions.

Water risk profile varies depending on cooling type & location of the plant
As mentioned in the CONTEXT chapter of this report, different cooling technologies implies different types and degrees of water risks, both physical and regulatory. Power plants with once-through technologies in inland areas are the most exposed, while air cooling equipped power plants bear minimal risks on the water front.

From the above chart, it would appear that Guodian is most at-risk with a high proportion (32%) of electricity generated using once-through freshwater for cooling. However, this cannot be viewed on its own as location matters. In mapping the location of Guodian’s thermal fleet, we find that 34% of these lie in low water stress areas (see map on page 38). It would thus be unfair to over-penalise Guodian for its large once-through fleet. Cooling type and location therefore need to be viewed together when analysing the company’s water risk exposure. We analyse this in detail in REGULATORY RISKS & COMPLIANCE COSTS as the government indeed has stipulations for cooling types for power plants operating in water scarce regions.

Risk mitigation through selection of cooling type & trade-offs with CO₂
While it is clear that air cooling helps in mitigating water risks and once-through requires high water withdrawals, it is not clear whether closed-loop is an effective water risk mitigation technology. Many assume that it is, as the name implies that water is “recycled”. However in reality, it does require sizeable water withdrawals and water consumption.

Investors not clear on whether close-loop is adequate mitigation to water risk
Do you consider closed-loop technology adequate mitigation to water risk?

<table>
<thead>
<tr>
<th>Yes</th>
<th>10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>20%</td>
</tr>
<tr>
<td>Don't know</td>
<td>70%</td>
</tr>
</tbody>
</table>

Water use of coal-fired power plants for different cooling technologies

- Air cooling: Water consumption = 0.2 m³/MWh, Water withdrawal = 2.0 m³/MWh
- Closed-loop: Water consumption = 0.3 m³/MWh, Water withdrawal = 2.3 m³/MWh
- Once-through: Water consumption = 0.3 m³/MWh, Water withdrawal > 80 m³/MWh

Source: Qin, Y. et al. (2015). Average supercritical units in China

Finally, it is worth mentioning that air cooling increases carbon emissions as it is not as efficient as wet cooling. We asked Investors if they are concerned about the increase in carbon emissions. Interestingly, 37% are “concerned” and a further 37% are “very” to “extremely concerned”. Meanwhile, 19% are “not concerned” to “slightly concerned” and 7% remain “neutral”.

Close-loop? 70% Investors don’t know if this offers adequate water risk mitigation
3/4 Investors express concern over more CO₂ from air cooling
A GOOD FIRST STEP BUT LONG ROAD AHEAD

For most of the Investors, shadow pricing for water is a rather new approach. Indeed, over half the Investors have “never heard of” it. However, they did appreciate the ability to approximate potential impacts on profitability and to benchmark companies on water risks. Although over 71% and 87% of Investors respectively, think the impact on EBITDA margins for the Coal-5 and Power-5 to be material, they have serious concerns over the underlying assumptions. These concerns meant that most of them (82%) think that the use of shadow pricing methods to value water risk is a good first step, but a first step only.

Key limitations, usefulness and challenges of this method discussed during conversations with Investors are summarised below:

• Still much debate: theoretical shadow prices vs reality - Investors remain split on whether shadow pricing is sufficient to screen out companies’ exposure to water risk. 12% of Investors even think this approach to be misleading, questioning if China will ever raise industrial water tariffs to USD12.10/m³, the highest shadow price derived in our analysis. However, to be fair to the shadow pricing tools, their developers are not claiming that water tariffs will ultimately reach these values. Instead, such shadow prices can be seen as a proxy measurement of water risks that go beyond the potential increase of water tariffs. Shadow prices should thus be interpreted as an ‘upper bound’.

• Lacking: tools currently ignore pollution challenges - Another key concern is the lack of consideration for water pollution. Addressing water pollution in water risks assessment is crucial for many sectors given China’s ongoing ‘war on pollution’ and the recent issuance of the Water Pollution Prevention & Control Action Plan. This holds particularly true for coal mining rather than power generation. Fines, violations and regulations are explored in the chapter on REGULATORY RISKS & COMPLIANCE COSTS. Meanwhile, we are glad to hear that developers of WRM are working to solve this with a module that factors in elements of water quality.

• Use with a grain of salt: tool limitations & pervasive disclosure challenges - Investors’ comments vary from “we don’t use shadow pricing”, “need more education on it”, “difficult to judge” to “depends on tool, each has limitations”, “best we have today” and “not misleading as long as you understand it”; showing that there is a long way to go. In addition, three quarters of Investors are “sceptical” or “extremely sceptical” over the disclosure of water use and drainage numbers saying that “numbers need to be taken with a grain of salt anyway” and “sceptical about all numbers from China”. Despite this, Investors find the approach useful if applied consistently across companies as a method to benchmark sector peer groups for water risk exposure.

• Good first step but needs more analysis: Binary risks rather than cost increases - As with the calculation of the shadow price, Investors remain equally divided on whether this method under/over estimates water risks. The overestimating camp thinks prices increases can be passed on whereas the underestimating camp are thinking of binary risks rather than gradual cost increase and a dent in profitability. What happens if the access to water itself cannot be guaranteed anymore, either for ongoing operations or planned expansion? Therefore 82% say this is “a good first step but needs detailed complementary analyses” such as water stress exposure and regulatory risks. We cover these other valuation methods in the following two chapters.

There is no doubt that of the three approaches to water risk valuation covered in this report, this approach provoked the most debate and polar opinions among the Investors. There are clear challenges and a long road ahead. Perhaps, this is why there is limited shadow pricing tool recognition and usage. To recap, 87% and 80% of Investors had “never heard of” the CBWCRT and WRM tools respectively. Only 39% had heard of the Bloomberg Water Risk Valuation Tool and even then, five tried it, but only one of them ended up using it regularly. WRM fares relatively better with three Investors saying they use the tool regularly.
BALANCE SHEET EXPOSURE TO WATER STRESS
High water stress can point to over-exploitation of water resources, future competition as well as tighter regulations to ensure water availability. Indeed, over half the Investors are either “very” or “extremely concerned” over scarcity related risks, viewing them as more pressing than floods or reputational risks.

There are many different definitions of water stress. Since the CBWCRT, WRM & Bloomberg shadow pricing tools all use WRI’s Aqueduct BWS maps to determine water stress, we have followed suit so as to provide a consistent platform to view both P&L and balance sheet impacts.

We mapped the 79 mines of the Coal-5 and 135 thermal power plants of the Power-5 to find that 3 of the 5 coal companies’ source >85% of their coal output from extremely high water stress areas, whereas Power-5 generate 34%-81% of their thermal electricity from the same areas.

A deep-dive into the Kuye River catchment, which has 49% of Shenhua & 70% of Yitai’s coal output, shows extremely high water stress, contrary to WRI’s Aqueduct BWS map indications. Granularity issues explain such discrepancy. Remapping all the assets on the new high resolution China BWS map reveals significantly higher exposure across for all the Coal-5.

Over 90% of Investors express concern over various aspects of water stress exposure. Despite Power-5 assets being more spread out over less water stress areas than the Coal-5, the degree of concern is similar for both coal & power sectors. This is likely because the Power-5 needs 2x more water to generate per unit of revenue than the Coal-5.

Unlike shadow pricing, Investors achieve consensus over various types of physical water risks. Even those already conducting water risks assessments, mainly focus on water availability. At the start, 61% of Investors had never heard of Aqueduct, but after seeing the results, 41% may conduct/pay for more research on physical risks.

Investors say they didn’t want to read tool manuals but rather collaborate with brokers to factor in physical risks. We recommend building scenarios into DCF models for future water needs depending on various assumptions regarding levels of water availability. Reserves can also be valued in this manner.
MAPPING WATER STRESS

When looking at water risk exposure from an asset perspective, the availability of water locally matters. Many different indicators exist that define water stress in different ways. In this report, we adopt the commonly used Baseline Water Stress index, defined as follows by WRI: “Baseline Water Stress measures total annual water withdrawals (municipal, industrial, and agricultural) expressed as a percent of the total annual available flow”.

It is generally assumed that high water stress begins when 40% or more of the total annual available flow is withdrawn. Extremely high water stress is reached when this figure exceeds 80%. Arid areas are those with both low water resources and low water use.

WRI mapped out these Baseline Water Stress (BWS) values globally in their Aqueduct BWS Map. Although there are other water stress maps available, we used WRI’s Aqueduct BWS map to map out asset exposure to water risks, as the Aqueduct BWS map is also the underlying water stress map for CBWCRT, WRM and Bloomberg shadow pricing tools. In doing so, there is a consistent platform to view both P&L and balance sheet impacts.

WATER STRESS: PROXY FOR PHYSICAL & REGULATORY RISKS

Water stress is not a water risk per se, rather it indicates the likelihood of different water risks to materialize. For instance, access to water resources is more likely to be constrained in places where water stress is high i.e. where competition for limited water resources is intense.

In areas of extremely high water stress, over-exploitation of water resources can threaten the future availability of water resources. Such risks are physical: they pertain to the actual/physical availability of water locally. But water stress reflects more than these physical risks: enter regulations. To a large extent, physical and regulatory risks are two sides of the same coin: regulations are precisely drafted in order to prevent physical risks from materializing. Therefore, water stress can also help indicate the likelihood of regulatory risks.

In places with high water stress, regulatory bodies are more likely to issue stringent water-related regulations, be they water efficiency requirements, water tariffs or water use permits. In China, many regulations already adapt requirements to local conditions of water stress. More on this in the chapter on REGULATORY RISKS & COMPLIANCE COSTS.

Are you concerned over...

<table>
<thead>
<tr>
<th>Risk Type</th>
<th>Not concerned</th>
<th>Slightly concerned</th>
<th>Concerned</th>
<th>Very concerned</th>
<th>Extremely concerned</th>
<th>Neutral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competition for water resources</td>
<td>0%</td>
<td>6%</td>
<td>3%</td>
<td>34%</td>
<td>21%</td>
<td>8%</td>
</tr>
<tr>
<td>Scarcity exposure</td>
<td>0%</td>
<td>7%</td>
<td>36%</td>
<td>3%</td>
<td>23%</td>
<td>7%</td>
</tr>
<tr>
<td>Groundwater depletion</td>
<td>0%</td>
<td>13%</td>
<td>34%</td>
<td>37%</td>
<td>10%</td>
<td>4%</td>
</tr>
<tr>
<td>Drought</td>
<td>1%</td>
<td>13%</td>
<td>27%</td>
<td>13%</td>
<td>6%</td>
<td></td>
</tr>
<tr>
<td>Tighter regulations</td>
<td>4%</td>
<td>16%</td>
<td>23%</td>
<td>27%</td>
<td>20%</td>
<td>6%</td>
</tr>
<tr>
<td>Reputational risk</td>
<td>8%</td>
<td>23%</td>
<td>29%</td>
<td>11%</td>
<td>16%</td>
<td>7%</td>
</tr>
<tr>
<td>Floods</td>
<td>7%</td>
<td>28%</td>
<td>34%</td>
<td>11%</td>
<td>8%</td>
<td>8%</td>
</tr>
</tbody>
</table>

Over half the Investors are either “very” or “extremely concerned” about risks related to water availability.

No one is “not concerned” about competition for water resources, scarcity exposure or groundwater depletion. Only 1% say they are “not concerned” about droughts.

In turn, they are more concerned over the implications of tighter regulations to ensure water availability than reputational risk and floods.

Investors appear less concerned about reputational risk or floods as they feel that these are relatively easier to mitigate than water scarcity with good management and adequate insurance.
COAL MINING: UP TO 100% EXPOSURE TO WATER STRESS

In China, most of the coal is mined in the Northern regions, and particularly in the Yellow River basin, where water resources are limited and under pressure. The Yellow River Commission, established by the Ministry of Water Resources (MWR), estimates that the water deficit in this watershed reaches 9.5 billion m\(^3\) a year.\(^8\) The commission also estimates that this deficit will increase to 10.7 billion m\(^3\) in 2020 and to 13.8 billion m\(^3\) in 2030, mainly due to the development of coal and coal power bases.

**Up to 100% of the Coal-5’s output comes from extremely water stressed areas**

We mapped the 79 mines of the Coal-5 on WRI’s Aqueduct BWS map and found that almost all the mines are located in high to extremely-high water stressed regions.

The exposure to water stress is significant: three of the five companies source more than four-fifths of their coal from extremely-high water stressed regions: Yanzhou (87%), China Coal (90%) and Datong (100%). In turn, Shenhua and Yitai appear relatively less exposed, with only 2% and 0% located in high water stressed regions respectively.

A word of caution: mapping water stress is only as good as the granularity the map affords. As we show later in this chapter, increased granularity through a deeper dive into a specific river basin reveals greater exposure. The good news is that since conducting the analysis and collecting Investor feedback, a new and more accurate water stress map of China has been developed by WRI’s China team. The impact of this increased granularity is explored later in this chapter.

Finally, it is important to note that not all water-related risks are reflected in the map. In particular, in its current form, the map does not account for water pollution which adds further water stress. Also floods and droughts are not reflected in this map. That said, WRI Aqueduct does have separate maps that allow you to explore sensitivities to floods and droughts.

Source: China Water Risk, various companies’ disclosure, WRI Aqueduct BWS map
Inner Mongolia and Shanxi represent 83% of companies’ coal output
As can be seen from the map on the previous page, 80% of the Coal-5’s total coal output is from the Ordos-Datong-Baotou region. This region, at the border between Inner Mongolia and Shanxi, is clearly water stressed.

This pronounced geographical concentration, means provincial focus matters. Different provinces have different benchmarks for water use/drainage as well as local regulations pertaining to water use permits, resource fee and so on.

All Coal-5 companies have a high degree of exposure in Inner Mongolia and Shanxi. Collectively, 57% of their coal is extracted from Inner Mongolia and 26% from Shanxi. As a comparison, these two provinces account respectively for 26% and 24% of China’s national output.

Investors worry most about physical risks related to access to water
Obtaining water use permits may also prove more difficult in water stress regions. Facing growing tension on both environmental and economic fronts, local governments may naturally favour industries that provide the highest economic returns and employment per drop of water. As a consequence, companies may see their expansion plans constrained or more investment may be required for them to use water more efficiently and/or better clean up effluents. Social license to operate is also likely more at risk in extremely high water stressed regions.

Investors, already more sensitive to water risks associated with the availability of water, are naturally worried over the concentration of output in water stress regions. As shown below, around 90% of Investors are “concerned” to “extremely concerned” over various aspects of water stress exposure faced by the Coal-5. In particular, 2 out of 3 said they are “very concerned” to “extremely concerned” about the fact that 90% of coal output of China Coal, Yanzhou & Datong are from extremely highly water stressed regions.

Investors highlight other factors that also matter
Investors remark that it is not only water that matters; the management and internal controls of the company are also important. Others say that air pollution, quality of coal as well as safety records also weigh on the decision to close mines. Given the current overcapacity faced by the coal and coal-fired power industries, some Investors view this as the more likely reason to affect operations than water stress. Finally, there are a few who have taken the view that physical water risks will not apply to the coal sector as the government will do whatever it takes to get water to the coal mines to ensure energy security. More on the exposure of coal reserves later in this chapter.
The power sector is exposed to, and also contributes to water stress in China. This is particularly true in the Northern provinces which hold just 25% of China’s renewable water resources but account for 51% of national thermal power generation, 82% of coal production and 86% of coal reserves. The water-stressed provinces of the North are also home to nearly half of China’s farmland leading to potential conflicts between food and energy security.

China’s ambition to develop a dozen of large coal power bases – mines and power plants - in these Northern provinces further exacerbates the exposure of thermal power generation to water stress. The water stress around these bases appears to be even more severe than the provincial average.

The 135 power plants are more spread out than coal assets …

…There are also potential conflicts between food & energy security

Up to 81% of thermal power generation exposed to water stressed regions

We mapped the 135 thermal power plants of the Power-5 against the WRI’s Aqueduct BWS map. Results show various degrees of exposure to water stress: from 34% of power generation located in extremely high water stressed regions for CPI to 81% for Huadian.

It is clear that assets of the Power-5 are more spread out across low water stress regions than those of the Coal-5. This geographical spread of assets is also reflected in the lower shadow prices across the companies for this peer group.

As flagged previously on page 31, the water risk profile varies depending on cooling type and location of the plant. The water stress exposure shown below for each company should therefore be viewed together with the cooling type of their respective fleets. To recap, take the case of Guodian: although 32% of electricity generated use water intensive once-through freshwater cooling, it may not prove to be an issue, as these plants may be part of the 34% of the fleet located in low water stress areas. Cross analyses of location and cooling type are carried out for each of the Power-5 in the next chapter.

Source: China Water Risk, various companies’ disclosure, WRI Aqueduct BWS map
Investors are still concerned over fleet exposure to water stress

Despite a smaller concentration of plants in extremely water stress regions, Investors’ responses to water stress exposure of the Power-5 fleets demonstrate a similar spread to responses to Coal-5 exposure. In fact 92% of Investors express concern over water stress for the power fleet, compared to 88% for the coal mines; with 53% saying they are “very concerned” and “extremely concerned” (57% for Coal-5). Such similar levels could be due to the fact that power plants require 2x more water to generate the same amount of revenue.

Investors are particularly concerned over occasions where water availability has disrupted the production of power and asked if there were any such cases in China.

Disruptions in power generation caused by water stress

Both research and recent events suggest that limited water availability can affect the profitability of power stations, especially when it is combined with temperature rise. For instance in 2015, heatwaves in Germany and Poland forced coal-fired power plants to reduce their power generation.\(^\text{11}\) In 2003, EdF had to curtail the equivalent of four to five nuclear reactors for the same reason. A combination of factors explain temporary/partial shutdowns: warmer rivers, lower river flows and strictly enforced regulations pertaining to water discharge temperature.

In India, the coal sector has been hit by low rainfall in the last two years and droughts more recently. In the period between March and May 2016, over 4GW of coal power capacity was shut down several times due to insufficient cooling water.\(^\text{12}\) The extent to which China’s thermal power plants have so far suffered water-related shutdowns is unclear. However, a recent Nature Climate Change article anticipates warmer temperatures and decreased river flows along the Yellow River.\(^\text{13}\) The same article foresees reductions in usable capacity for 81%-86% of the thermal power plants worldwide for 2040-2069.

It should be noted that renewable energy, such as solar PV and wind turbines, are significantly less exposed to water stress given their minimal water use. A diversified power generation mix can therefore reduce exposure to water risk.

Caution! Use electricity generated not installed capacity

There is a tendency to use installed capacity to assess balance sheet exposure, but we feel it is better, when doing in-depth analysis, to use electricity generated. As can be seen from the chart below, despite a 39% and 16% water stress exposure in the installed capacity of Huaneng and CPI respectively, in extremely high water stress regions, electricity generated from these regions are much higher at 47% and 34% respectively.

In terms of installed capacity, water stress exposure to extremely high water stress across the Power-5 ranges from 16% to 74%; whereas in terms of electricity, the range is higher at 34% to 81%.

As a comparison, the national exposure of China’s entire fleet to extremely high water stress regions averages at 45%, while the global average is at 27%.\(^\text{12}\)
LIMITATIONS IN USING WATER STRESS MAPS

Baseline water stress maps are indeed a convenient way to assess and compare exposure to water stress across companies, sectors or commodities. However, in some cases, the limited accuracy of underlying data may lead to under/over-estimating the degree of water availability challenges. Such is the case in the Kuye River catchment.

Deep-dive: water availability at the Kuye River catchment

The Kuye River is the largest tributary in the middle reaches of the Yellow River. Its catchment includes Ordos, a key area for China’s coal industry. Despite its small size (only 20% larger than Shanghai), the Kuye River catchment holds almost half of Shenhua’s coal output and 70% of Yitai’s coal output.

Flowrate in the last decade was 73% lower than historical levels.

The Kuye River catchment is under threat with rising water demand and fluctuating resources. Vegetation change, coal mining and hydraulic projects have significantly affected the river flow: the average flowrate over the last decade was 73% lower than during 1956-2000, according to the Yellow River Institute of Hydraulic Research.

Water demand exceeded supply by 33%

In 2010, the actual water demand exceeded the water supply by 33% according to the same institute. Greenpeace also warns that by 2020, the coal industry alone could need more water than is available.14

70% of Yitai & 49% of Shenhua’s coal output is from the Kuye River Basin

Investors are clearly worried but this is not reflected in Aqueduct BWS map

Even Investors who are of the view that China will do whatever it takes to get water to coal are concerned about operational exposure in a specific catchment area “only to the extent that mining is changing the geology”

While the tension around water resources is clearly acute in the Kuye River basin and Investors obviously worried, WRI’s global Aqueduct BWS map only indicates a medium to high water stress. In this instance, the global map may have failed to fully grasp the intensity of the local water stress. These issues should hopefully be ironed out with the new China water stress map.
Water stress maps: global Aqueduct BWS vs. new China BWS

At the time of collecting feedback from Investors, WRI was developing a new version of this map dedicated to China with more accurate data. The global Aqueduct BWS map uses FAO AQUASTAT country-aggregated water withdrawal data and spatially disaggregates it to sub-national level. In contrast the new China version, known as the China BWS map, uses water withdrawal and consumption data of 345 administrative subdivisions nationally.

Although at a glance, no obvious differences between the two maps are visible to the eye, the China BWS map does capture the levels of water stress in the Kuye River basin. Accordingly, the water stress levels in this region, rises from “medium to high” to “high”. As a consequence, all ten companies’ exposure to water stress shift. The changes resulting from re-mapping the Coal-5 and Power-5 assets onto the new map are set out below:

**Coal-5**

<table>
<thead>
<tr>
<th>Company</th>
<th>Global Aqueduct BWS Map</th>
<th>New China BWS Map</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shenhua</td>
<td>15% Medium to high 83%</td>
<td>15% High 83%</td>
</tr>
<tr>
<td>China Coal</td>
<td>Extremely high 90%</td>
<td>Extremely high 90%</td>
</tr>
<tr>
<td>Yanzhou</td>
<td>Extremely high 87% 13%</td>
<td>Extremely high 87%</td>
</tr>
<tr>
<td>Yitai</td>
<td>Medium to high 100%</td>
<td>High 100%</td>
</tr>
<tr>
<td>Datong</td>
<td>Extremely high 100%</td>
<td>Extremely high 100%</td>
</tr>
</tbody>
</table>

**Power-5**

<table>
<thead>
<tr>
<th>Company</th>
<th>Global Aqueduct BWS Map</th>
<th>New China BWS Map</th>
</tr>
</thead>
<tbody>
<tr>
<td>Huaneng</td>
<td>48% 26% 9% 16%</td>
<td>44% 31% 8% 16%</td>
</tr>
<tr>
<td>Datang</td>
<td>54% 9% 16% 9% 10%</td>
<td>53% 29% 16%</td>
</tr>
<tr>
<td>Huadian</td>
<td>81% 18% 7% 6%</td>
<td>62% 20% 10%</td>
</tr>
<tr>
<td>Guodian</td>
<td>51% 12% 34%</td>
<td>41% 8% 12% 7% 32%</td>
</tr>
<tr>
<td>CPI</td>
<td>34% 29% 37%</td>
<td>34% 29% 37%</td>
</tr>
</tbody>
</table>

It is clear from the above that Coal-5 output is more exposed when using the China BWS map whereas the opposite could be argued for the Power-5.

**Caution! Make sure maps are comparable**

The China BWS map should only be used to compare assets within China. When comparing assets located outside China on Aqueduct BWS to assets in China mapped on China BWS, the China assets may be unfairly penalised due to increased granularity in water use data. It is also important to note here that the shadow pricing tools discussed in the previous chapter are based on the global Aqueduct BWS map and not the China BWS. Given the shift of the assets towards more water stress in the new map, shadow prices should be even higher for the Coal-5.
DEALING WITH THE BINARY RISK OF NO WATER

Investors find it easier to understand and accept water stress exposure as a method to assess water risks over shadow pricing. While there was a lot of debate over “arbitrary environmental costs included in the calculation [of shadow price] which do not reflect the economic cost”, there was noticeably less discussion over water stress. Whereas Investors remain divided on shadow price, there is consensus over the types of physical water risks they are concerned over. Key points of note here are:

- **Water risk assessments**: Most of the water risk assessments conducted by 37% of the Investors were related to availability of water. In this regard, Investors have commented they have conducted assessments for “water use & intensity”, “raw material sensitivity to drought”, “power generation’s water use” and “scarcity + type of use + pollution”. One said they mapped “asset exposure vs WRI Map” and another even performed “credit rating assignments”.

- **Management attitudes are also important**: Corporate culture and awareness matters. As one Investor aptly says materiality “depends on % of at-risk assets [and] company’s awareness and commitment from board that such risks are acknowledged and are being dealt with”.

- **Building scenario analysis for future water needs**: Future water needs can be built into DCF models depending on various assumptions regarding levels of water availability. We did not perform this analysis for the purposes of this report. However, back in 2013, HSBC did perform such hypothetical analysis and warned that if coal mining in China were severely constrained from a lack of water by say 2030, it would reduce the valuation of Shenhua by about 26% and China Coal by about 45%. As for Huaneng, the DCF-based valuation would be impacted by about 30%. Regulatory risks can also be built into these scenarios – more on the parameters for these in the next chapter.

- **Valuing reserves**: Scenario analysis can also be applied to reserves. We did not show Investors the reserves exposure of the Coal-5 to obtain feedback. However, upon request, we have now mapped their coal reserves to the new China BWS map. As per the chart, it is clear that coal reserves are also very exposed to “extremely high” and “high” water stress. We are unable to calculate China Coal’s exposure due to its limited disclosure.

We are heartened to find Investors carrying out assessments of water risks. More importantly, after seeing the results, 83% of Investors say they are more worried about water risks and 41% say they may commission/conduct more research on physical water risks. Indeed, those with their own water and E&S (environmental & social) specialists already look at specific issues prior to investment including “E&S considerations with groundwater issues, access to water for power, mining, specifically tailings for mining, droughts for hydropower deals”. Assessing Balance Sheet exposure to physical water risks exposure has indeed come a lot further than shadow pricing.

**Coal reserves - new China BWS map**

- **Shenhua**: 17% High 83%
- **China Coal**: 88% High 13%
- **Yanzhou**: 98%
- **Yitai**: 35% High 65%
- **Datong**: 87% 13%

"I will pay extra attention to the binary nature of water risk."

"We don’t want lots of words. Nobody reads tool instruction manuals. We want something practical we can use… collaborate with brokers maybe."

"Would ask broker for research."

"We have in house water and E&S specialists who look at this and may also hire additional experts."

**Water to strand coal assets?** With a high exposure of coal output to water stress, some Investors ask if water stress could strand coal assets. We are of the view that water is one among many other factors that could eventually lead to unanticipated mines closure. Indeed, in the context of weakening demand and overcapacity faced by the coal industry, the government has mentioned several criteria to decide which coal mines should be closed. These include: economic and safety records, production capacity, quality of coal reserves on top of the protection of “environmentally sensitive areas”.

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REGULATORY RISKS & COMPLIANCE COSTS
China has issued a considerable amount of regulations to enhance water management, especially in the energy sector as managing China's tight water-energy nexus in the parched North is high on China's agenda. Investors view such risks as more immediate than physical water risks.

Regulatory risk is high as China's regulatory landscape is evolving quickly. Generally, there are three key areas of regulatory risk: (1) allocation of water; (2) tighter requirements leading to increased compliance cost in CAPEX and OPEX; and (3) fines & violations.

73% of Investors see the cost of compliance to tighter water regulations as material; the rest think it depends on enforcement. Although it is unclear how tightly local regulations will be enforced, there are trends toward stricter enforcement. Huaneng Group has seen some of its projects turned down due to water allocation.

With an official war on pollution, tailings can come under the spotlight. The Yellow & Hai River basins where 82% of the Coal-5's output is derived, are far from meeting the 2020 Grade III water quality target of 70% (Yellow: 60%; Hai:39%). Given 56 tailing-related incidents reported by MEP for 2006-2014, tracking violations is prudent.

Water tariff hikes are therefore, not the only policy to impact valuation. Watch out for stricter policing of water use & water discharge permits to manage water allocation & pollution. We recommend providers of capital to factor these into DCF scenarios to test the sensitivity of valuations to these allocations & increased compliance costs.

To gauge compliance, we used official targets, standards & norms/quotas. Investors express clear concern over company disclosure. For Coal-5: Yitai & Datong do not disclose mine water recycling rates, whereas Shenhua's of 60% is far from the 2020 target of 75-95%. For Power-5, Investors have little visibility on retrofitting costs for companies that still use once-through cooling in extremely highly water stress areas.

Regulatory risk is the #1 Investor concern, in terms of tangibility, materiality and immediacy. 59% of Investors indicate they may commission/conduct more research on regulatory risk over 41% for physical water risks. For most of them, investing in non-compliant companies is a breach of fiduciary duty.
China is going through a period of re-balancing its economic growth with the degradation of its environment. In the past few years, China has issued a considerable amount of regulations, notices, standards and guidelines in a bid to enhance water resource management. More pressure is regularly added to local governments, river basin commissions, and industries to “enhance water pollution control and ensure water safety for the nation”, as mentioned in the recently issued ‘Water Pollution Prevention and Control Action Plan’ (also known as the “Water Ten Plan”).

The Water Ten Plan, released in April 2015, is part of a triage of Pollution Prevention and Control Action Plans, with the other two being the Air Ten (Dec 2013) and Soil Ten (May 2016). These three plans form the basis of China’s official ‘war on pollution’ declared in 2014 to help build a “Beautiful China” during the 13th Five Year Plan (2016-2020).

“We must work to build through tireless efforts, a Beautiful China where the sky is blue, the land is green and the water runs clear.”


Managing water: The Three Red Lines

Central to ensuring national water security is the “Three Red Lines”, a series of water policies that rein in pollution and impose national and provincial quotas on water use as well as stipulate water efficiency gains.

The energy sector, as the largest industrial user of water, plays a central role. Decisions made today to power China, do not just have implications for climate change, they impact water resources. With water and energy security being of ‘utmost importance’, managing China’s tight water-energy nexus in the North is high on the government’s agenda. We list some recent key water-related regulations for coal mining and thermal power generation below. These do not include the other specific water regulations discussed in the following pages.

The regulations and policies covered in this chapter, amongst others, have implications for the financial valuations of companies.
A regulatory risk is usually defined as “the risk that a change in laws and regulations will materially impact an industry or a business”. Such risk can manifest itself through increased expenditure; or foregone revenues through partial, temporary or permanent shutdown of the facility; or via mandatory upgrade of equipment to meet new industrial standards. By extension, regulatory risks can include cases where anticipated expansion plans of a company are impeded by new regulations.

By definition, such regulatory risks are higher when the regulatory landscape is quickly evolving, like in China, with regular issuance of additional requirements or limitations.

For the coal and thermal power industries, we identified three main ways through which water-related regulations can affect companies’ bottom line or even capacity to operate, namely:

1. **Constrained access to water use**: Foregone revenues from operational disruptions or expansion limitations;

2. **Tighter requirements**: Increased compliance costs including capital expenditure (CAPEX) and operational costs (OPEX) of upgrade or new equipment; and

3. **Fines and violations**: Potentially higher fines resulting from the updated Environmental Protection Law.

We discuss all these for both coal mining and thermal power generation in this chapter but first we asked Investors about their views regarding such regulatory risks and the related cost of compliance.

Nearly 3/4 Investors say that the cost of compliance to water regulations is “material” to valuation with only 16% remaining “neutral” and 11% as “not material”. Those with “neutral” answers added comments that materiality depended on the intention of the government to enforce the regulation.

**73% of Investors say cost of compliance is material**

Nearly 3/4 Investors say that the cost of compliance to water regulations is “material” to valuation with only 16% remaining “neutral” and 11% as “not material”. Those with “neutral” answers added comments that materiality depended on the intention of the government to enforce the regulation.

<table>
<thead>
<tr>
<th>What Investors say when we asked... Do you consider the cost of compliance to water regulations as material to valuation?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
</tr>
<tr>
<td>Not Material</td>
</tr>
<tr>
<td>Neutral</td>
</tr>
</tbody>
</table>

Investors clearly think that CAPEX/OPEX costs related to compliance are material.

Others say it's not material “when there are no obligations and penalties”.

Those in the neutral camp commented that increased CAPEX/OPEX costs only matter “if it is really enforced”.

Whether or not the cost of compliance matters is clearly tied to enforcement. So where is China on this? Is enforcement for real and are penalties significant?
ENFORCEMENT: IS IT FOR REAL?

Many Investors mention that regulations will affect industries operations only to the extent that these are enforced. At the time of writing this report, it remains unclear how tightly local governments and basin commissions will enforce new regulations. Yet, there is a trend towards increased enforcement.

Progress on the legal framework

The enforcement of regulations is high on the political agenda. While not entirely solving implementation and enforcement challenges, the revised Environment Protection Law (that came into force on 1 January 2015) definitely increases the pressure on local governments and companies. Indeed, the revised law entails tougher penalties for environmental offences, increased power to environmental protection bureaus and civil society as well as higher environmental protection standards and efforts to improve monitoring systems.18

This update to China’s legal framework regarding environmental protection is still ‘work-in-progress’ with ongoing amendments to the law to allow for effective implementation of the Air Ten, Water Ten and Soil Ten plans.

Centralised monitoring & control

In a bid to by-pass reluctant local governments, the MEP has also been given powers to send inspection teams all over the country to root out local polluters. During its pilot inspection program in Hebei, 200 factories were shut down, 123 people were taken into custody and another 366 were held accountable.19

In 1Q 2016, fines imposed by the MEP grew by 153% year-on-year and 301 operations have been either closed or suspended based on environmental concerns.20 We take a closer look at fines & violations in the coal and power sector in the following pages.

Despite enforcement uncertainty, Investors are still concerned

Despite uncertainty as to whether the government will enforce regulations, Investors are still worried about risk. “Likely to be material – still many unknowns” portrays the mood here. Another say it’s material “but doesn’t need to destroy value = companies can reprice products”.

We are of the view it’s not a matter of if, but when ...

We are of the view that the time when companies could infringe environment regulations with little or no consequence for their operations will ultimately come to an end. Therefore it is good to get ahead: conducting scenario analysis on DCF-valuation of companies with assets exposed to water risk. Simulating various regulatory parameters/targets and levels of enforcement, will help gauge the company’s maximum downside impact.

One Investor warns: “To be conservative under evolving environment (regulatory), >100% [tariff hike] is not impossible”. However, since regulation water costs do not only consist of water tariffs, but also include investment for water infrastructure and water saving technologies, or even potentially higher costs of water use permits under trading schemes, we recommend that providers of capital also take these factors into account.

We have set out some of these parameters/targets in the ensuing pages that impact the Coal-5 and Power-5 companies. However, we did not perform the DCF scenario analysis for the 10 listco’s. Instead, we hope that sell-side research and credit analysts rise to the challenge. Naturally, we would be more than happy to sit down and help work out the various scenarios to be applied.
Some studies indicate that regulatory access to water through water allocation rather than physical access to water, to be the key restriction on the development of coal industry in Northern areas. To withdraw water to operate in China, mining and power industries need to obtain a water use permit. This permit is generally issued for 5 years by a regulatory body authorized by the MWR. This regulatory body, usually a River Basin Commission, must ensure that total volume of water withdrawal issued by the permits does not exceed the quota assigned to the basin by the MWR.

Along with basin quotas, provinces are also subject to a ‘red line’ of total water withdrawal for 2015, 2020 and 2030. These provincial quotas collectively form the national water quota, which is one of the ‘Three Red Lines’. Although China stayed within the 2015 national target water quota/red line, some provinces did not. For example, in 2014, Xinjiang exceeded its water use red-line, but yet additional coal power plants are still planned for 2015-2020. It remains unclear whether these provincial red-lines will be strictly enforced; what is clear that central government wants to use these quotas to help provinces manage their water use vis-à-vis development.

Disruptions to operations due to water allocation are not unheard of. Back in 2002, a new large coal power plant belonging to China Huaneng Group saw its application for a water use permit rejected. The reason being that the total water withdrawal from the Yellow River in Inner Mongolia had already exceeded the quota issued by the State Council at that time. Other informal discussions have also inferred that some coal expansion plans in these regions have been rejected out of water availability concerns.

Besides, even after a water permit has been granted, companies are still exposed to changes in the water allocation. Examples of some instances include:

1. A new national or regional water master plan may come into place, requiring adjustments in overall water resources allocation;
2. A prospective new user may seek water from the same source which has already been allocated under the issued permit. If such new demand is prioritized by the decision maker such as the government, the existing permit may be changed; and
3. A drought or other emergency may force the government to curtail allocations under the existing permits.

In July 2014, the MWR selected seven pilot provinces to establish provincial trading markets of water use permits: Ningxia, Jiangxi, Hubei, Henan, Gansu, Guangdong and Inner Mongolia. Using trading schemes, a new power plant may "buy" water permits from irrigation districts by investing in water-saving irrigation projects and saving the equivalent amount of water. Therefore, theoretically, industrial water use could still expand without increasing the total volume of water withdrawn. Note that in most cases, the cost to save water was close to the actual water resource fee. However, these trades are still mainly government-led.

The ability to access water through water allocation and permits represents the “binary risk” that Investors fear the most. Since this can wipe out significant value, we recommend providers of capital, especially that of a long term nature, to conduct sensitivity analysis output around these allocations.

In 2013, the NDRC, MWR and MOF issued a notification requiring all provinces to increase the water resource fees by 2015. However, we estimate that even when accounting for these increases, the water resource fee would represent less than 1% of the selling price of coal or electricity. Water resource fee increases are therefore not an immediate concern for companies’ bottom line and as such not likely to be the main instrument driving water conservation in coal and power industries.
FINES & VIOLATIONS: INCIDENTS & EXCESS DISCHARGE

Coal mining and thermal power generation are prone to pollution incidents, either due to inappropriate equipment & facilities, mismanagement or even malpractices. Such pollution incidents can result in fines, production suspension and property seizure.28

Water quality targets puts polluting industries under spotlight

With China’s ‘war on pollution’, pressure is mounting on polluting industries. The Water Ten Plan has set water quality targets: 70% of water in China’s main rivers shall reach Grade III or above by 2020, 75% by 2030. The Yellow and Hai River Basins, where 82% of the Coal-5’s coal output are derived, are far from these targets.

In the Yellow River basin, which holds 58% of Coal-5 companies’ coal output, only 60% actually reached Grade III quality in 2015. The situation is even worse in the Hai River basin with only 39% of its water meeting this quality level; this catchment area holds 24% of Coal-5 output. To meet official targets, provinces and rivers basins commissions will likely enforce more stringent water pollutant discharge standards.

Watch out for water discharge standards/permits and tailings management

Proper monitoring and enforcement of water discharge standards is at the forefront of China’s efforts to clean its rivers. Companies are indeed required to obtain water discharge permits to operate. Updated and more stringent water discharge standards also set maximum pollutant concentrations in companies’ effluents.

Tailing ponds and dams are also risk-prone components of coal mines. The MEP reported 56 tailing-related pollution accidents in 2006–2014.30 Some of these risks are typical tail risks: low probability but potentially extremely costly. Recent rules strengthen the requirements on how tailings should be managed and monitored. Watch out for power plants’ ash ponds as well.

Tracking violation records

Thanks to the Institute of Public & Environment Affairs (IPE)31, it is possible to find violations and fines registered by local Environment Protection Bureaus (EPBs). We did this for the Coal-5 and Power-5 companies in 2014 and 2015. The exact list of violations is detailed in Appendix I. For Power-5, most of the referenced violations concerned air pollution while for Coal-5, violations also concerned water discharge, waste management and environment protection facilities.

As mentioned by an Investor, diligent corporate governance of environmental issues can be considered as a risk mitigation factor. In that sense, tracking violations records is an indirect way to assess pollution and reputational risks.

DO pay attention to local pollution levels

Local efforts to tackle violations will likely be influenced by how far local water quality is from its targets. In addition, industrial discharge standards for some regions are at times more stringent, due to the fact that the area is highly polluted.

DO track violations records with IPE’s database

More violations likely signal poor management, and hence higher exposure to environmental risks including tail risks. Companies’ violations records can be easily tracked by using the IPE database found on their website: www.ipe.org.cn (please see Appendix I).
TIGHTER REQUIREMENTS: COAL MINING

Additional or more stringent regulatory requirements on a company's operations can affect their expected returns. Such requirements could for instance cap water use intensity levels (water use per unit of output), reduce allowed pollutant concentrations in water discharge or require the adoption of new technologies. In this section, we review some of the recently issued water requirements that apply to the Coal-5.

Standards & benchmark for water use in coal mining & processing and drainage:
A series of standards, targets and quotas/norms exist in China that concern water use for various industries, including the MEP Cleaner Production Standard and the various provincial norms/quotas of water intake. In the charts below, we compare the relevant national standards and targets with the actual water use and mine water drainage as disclosed by companies.

As can be seen, in the chart (below-left), only Shenhua and Yanzhou voluntarily disclose water use numbers. Both companies comply with these standards. However, as previously discussed, Investors are not confident over these numbers with more than 70% of them saying they are sceptical about these values (see page 29).

As for mine water drainage, to the extent of our knowledge, there is no official standard or norm. This is probably due to the fact that mine water drainage is extremely dependent on local geological structures. That said, the NEA and NDRC did devise a 2015 national target of 1.82 m$^3$ per tonne of coal, down from 1.88 m$^3$ per tonne in 2010. In comparison, Shenhua, the only company of the Coal-5 disclosing this number fares significantly better at 0.34 m$^3$ per tonne of coal mined. These values are shown in the above-right chart.

What is “water stress”? Multiple definitions muddies outlook
In many regulations or official notices, water related requirements explicitly vary according to the local water scarcity. Usually, three categories are mentioned: water-scarce regions, regions with average water resources and water-rich regions. Unfortunately, no map is available that precisely delimits the areas concerned, leading to great regulatory uncertainty. The only official definition we found dates back from 1996 and describes these three categories (for mining areas) as follows:

- water-scarce regions: water supply capacity is lower than 60% of maximum daily water use of the area;
- regions with average water resources: water supply capacity is between 60% and 2x the maximum water use of the area; and
- water-rich regions: water supply capacity is higher than 2x the maximum daily water use of the area.

As can be seen, this definition does not match WRI’s Water Stress definitions used in the maps in the previous chapter. Highly water stressed regions in Aqueduct BWS and China BWS maps may not be officially considered as water scarce regions by the Chinese government and vice versa.
Mine water recycling rate: Are the Coal-5 meeting the 2020 target?

Very early on, China has promoted the reuse of mine water as part of its water management strategy. After proper treatment, such mine water can be reused either within the coal process itself or for local users (thermal power plants cooling, landscaping or even drinking water).

The latest recycling rate target was released in April 2015: mine water recycling rate target for 2020 should range from 75% to 95% depending on local water stress. Are the Coal-5 meeting targets for mine water recycling rate? The comparison with actual mine water recycling rates disclosed by the Coal-5 is shown in the chart on the right-hand side.

As it can be seen, only three out of five companies disclose this number. While China Coal and Yanzhou disclose recycling rates that fall within the 2020 target range, Shenhua’s disclosed mine water recycling rate is significantly lower at 60%.

We asked Investors if they were worried about this and 84% of Investors express concern over Yitai and Datong’s non-disclosure of this rate while 78% are concerned over Shenhua’s low recycling rate.

There are clear CAPEX and OPEX implications here. To this end, an Investor says this was “the most important graph” in the survey with the caveat of “depends on enforcement”. Concerns over reliability of data resurfaced with one Investor commenting that “Shenhua is probably accurate” vis-à-vis the rates disclosed by China Coal and Yanzhou.

Given the situation in the parched North, one writes “I believe the industry will move towards greater use of mine water”. He is not alone. Here, Investors, being investors see “Interesting / possible shorting opportunities”. A few also mention that entering the mine water drainage treatment and recycling market would be good hedge.

DO engage with companies regarding their compliance with existing standards and future targets.
Matching cooling types to water availability: air cooling in water-scarce regions

As discussed in previous chapters, different cooling types use different amounts of water. Matching cooling types to water availability is therefore important. Back in May 2004, the NDRC required new power plants in the water-scarce Northern regions to adopt air cooling. As a result, China’s air-cooled coal power capacity expanded rapidly. At the end of 2012, the installed capacity of air-cooled power plants reached 112 GW, accounting for 14% of China’s thermal power capacity. The figure can be as high as 51% and 61% in Inner Mongolia and Shanxi provinces respectively.

As shown in the previous chapter, a significant portion of the Power-5’s fleet is exposed to water risk as they sit in high and extremely-high water stress regions. We cross-analysed these at-risk plants vis-à-vis their cooling types so we can gauge the Power-5’s exposure to fleet retrofit in order to mitigate for water risk. The results are shown in the chart below:

It should be noted that all air-cooled power plants across the Power-5 are located in high to extremely-high water stressed regions. We consider once-through seawater cooling to be of low water risk, but once-through freshwater to be of high risk. We estimate that 6% and 2% of Datang and Huadian’s electricity generated uses the latter cooling type in high to extremely-high water stressed areas.

Once-through cooling has already been banned in some countries and provinces, there is likelihood of mandatory retrofitting/closure of such plants.

As can be seen from the feedback below, despite the low exposure rate, Investors are still concerned about these values as they have no/low visibility on the costs to retrofit these plants. In 2013, a Bloomberg New Energy Finance report warned that “China’s “Big Five” power utilities have hundreds of gigawatts of thermal power plants in water-stressed areas and face retrofit costs of up to USD20 billion to improve their resilience.”

Investor views: once-through freshwater cooling in water stressed area...

<table>
<thead>
<tr>
<th>Cooling type</th>
<th>Water Risk</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Once-through (freshwater)</td>
<td>High</td>
<td>28%</td>
</tr>
<tr>
<td>Closed-loop</td>
<td>Medium</td>
<td>20%</td>
</tr>
<tr>
<td>Once-through (seawater)</td>
<td>Low</td>
<td>14%</td>
</tr>
<tr>
<td>Air cooling</td>
<td>Low</td>
<td>10%</td>
</tr>
</tbody>
</table>

Source: China Water Risk based on annual reports, CEC and satellite images. Grey shade for Datang refers to power plants whose cooling type is unknown.

6% of Datang & 2% of Huadian’s electricity generated using once-through freshwater cooling in high & extremely high water stressed areas

Investors are clearly concerned...

NDRC: new power plants in the water-scarce Northern regions must adopt air cooling
Looking into the future: retrofitting close-loop in water stressed areas?

With development and urbanisation, water use will be on the rise. Some areas, where the power plants are located, are already using over 80% of their available water resources. The question then becomes whether close-loop cooling in these areas is sensible given the high water consumption levels of this type of technology.

Most Investors (70%) say they don’t know: “Don’t understand enough of the specific input to judge. I would have to consider relative effect of alternatives”. Of the 20% that say it was not adequate, most want to know the costs associated with retrofitting; is it even a possibility? “Interesting to know the flexibility here, e.g. close-loop retrofits”. One even states: “expect the fleet to be upgraded in the long run” but notes that “more generally, air cooling [plants] are in overcapacity areas”. At this point, few point out the opportunity to invest in wind and solar to mitigate water stress saying that “solar/ wind will increase” and feel more bullish about renewables after seeing these results.

Given future competition for water, it is important to keep an eye on the government attitudes towards water. How it views cooling norms and targets could signal tighter regulations ahead.

Setting tougher benchmarks: trends in water use in power generation by cooling types

Retrofitting cooling types is not the only way to reduce power plants’ water use. Efficiency gains could also result in more electricity generated per drop for each cooling type.

As shown in the chart on the right-hand side, the latest national water use norms released in 2012 are more stringent than the previous norms issued in 2002. Note that more stringent norms may exist at the provincial level. Water withdrawal norms have now been introduced for air cooling as well. Power plants that fail to comply with these norms may ultimately be shut down or required to invest in upgrades.

Also, it’s not just the cooling type, but the type of water used by power plants matters.

Caution! NO to groundwater use; YES to unconventional water sources for powergen

The use of groundwater for power plants in Northern regions has been prohibited by the NDRC since 2004. However, detailed listings from the China Electricity Council (CEC) showed that many power plants were still relying on groundwater for their operation in 2012, including some belonging to the Power-5.

On top of a ban on the use of groundwater for thermal power plants, China’s government has been promoting the utilization of “unconventional water sources”, such as reclaimed wastewater, mine water and seawater. Since 2013, the MWR requires new thermal power plants in Northern China to prioritize the use of reclaimed wastewater and mine water. These policies have proven quite efficient so far: in the Yellow River Basin, reclaimed water accounted for 58% of the water use quotas issued to new coal power plants from November 2009 to December 2014.24

With the recently released Water Ten Plan, China’s government is moving a step forward: no new water permits will be issued to thermal power plants that fail to fully use available recycled water.25

DO use standards, norms/quotas and targets to benchmark company performance. Scenarios estimating retrofitting costs can be built to test DCF valuation sensitivities.
Regulatory risks more tangible than physical water risks for Investors

As Investor feedback on the various approaches to water risk valuation progressed, it became clear that regulatory risks tops Investors’ concerns. The willingness to pay for services is always a good indicator of demand. When asked whether they would commission or conduct research on water risks, 59% of Investors say they would do so for regulatory water risks. The figure is significantly lower at 41% for physical water risks – see chart below.

Most Investors perceive regulatory risks as more tangible and immediate than physical water risks and are thus willing to pay for more research to assess their portfolio/investment exposure. Also, for most Investors, investing in companies that are non-compliant would be a breach of their fiduciary duty. However, uncertainty lies at many different levels when assessing regulatory risks and key areas to pay attention to are:

- **Grey areas: which regulations to factor in?** – Many different types of regulations apply to industries: mandatory vs guidelines; local vs provincial; and applicable to existing facilities vs concerning new facilities. In a perfect world, one would know exactly where each regulation sits in this grid. Instead, most lie in a grey zone: neither strictly mandatory nor purely indicative. More specifically regarding water regulations and polices, the exact locations of officially designated “water-scarce” areas still remain elusive. What’s clear is that they mostly lie in the North. In the interim, WRI’s China BWS map provides the best indicator of water stress.

- **Pollution: pervasive but difficult to assess** – Pollution is high on the central government’s agenda and enforcement could raise base operating costs of companies. Although such costs can be passed on to consumers, there are clear economic consequences. Unfortunately, tools discussed so far (shadow pricing/WRI’s maps) do not account for pollution. In the meantime, tracking violations with IPE’s database can be a good way to gauge management’s attitudes towards regulatory compliance.

- **Enforcement: not if but when?** – As many Investors say, regulatory risks can be material only to the extent that regulations are enforced. The moving regulatory landscape creates much uncertainty for industries and investors. There clearly is a trend towards better enforcement of regulations but the pace of progress remains a mystery. In such cases, it is best to conduct scenario analyses to test various enforcement outcomes against the various regulatory benchmarks identified in this chapter.

- **Estimating contingent liabilities & compliance costs** – The extent to which tightening regulations will increase the cost of compliance regarding water use or pollution is currently unknown. How much does it cost to upgrade power plants cooling systems? What about the costs for mine water treatment plants and/or switching to dry coal screening processes? How many of facilities are at-risk? Will non-compliance result in material fines? Such questions require in-depth financial and technical analyses.

Investors can decide to trust the company’s management that all future costs are already anticipated and disclosed, or test scenarios within one sector. These scenarios can show companies most likely to suffer/excel within different regulatory outcomes. As mentioned earlier, we are more than happy to work with sell/buy-side research and credit analysts to game out these scenarios.
TOWARDS DECISION-RELEVANT DISCLOSURE
TOWARDS DECISION-RELEVANT DISCLOSURE

- While Investors remain divided over the “real price of water” through shadow pricing, they view both physical and regulatory water risks as potentially having material impacts on operations. However, limited disclosure levels prevent accurate gauging of these risks.

- SOEs in China are required to publish a separate CSR report. Indeed, all 10 listco’s did disclose some GRI indicators relevant to water. However, none completed the CDP water questionnaire. That said, such guidelines which aim to provide consistency, are rarely used: >60% of Investors have “never heard of” either.

- Since data disclosed for both sectors lack consistency & clarity, we recommend investors & companies use official regulations, targets, standards & quotas/norms to guarantee an ‘apples with apples’ comparison. By doing so, disclosure is immediately more decision-relevant & investors can benchmark peer group performance.

- Investors also say better accounting for water quality risks is just as important as complete & consistent disclosure: 94% vs 96%. Yet, water quality disclosure is lagging, leaving investors blind on potentially the most material contingent financial liability in the mining sector.

- However, limited water related disclosure at both a company and facility level prevent accurate water risk assessment. Since aggregated company values are irrelevant for local water risks assessments, over 90% of Investors want facility level disclosure of water use for the Coal-5 & Power-5.

- Of the Investors who want facility level disclosure, 78% prefer mandatory assets-level disclosure of water use amounts; while 22% said voluntary disclosure will suffice. Note this was the same for both the coal and mining sectors. Investors feel that stock exchanges can do more. In general, 86% of Investors would like to see “mandatory disclosure required by exchanges.”

- The 10 companies are listed on the stock exchanges of Hong Kong, Shanghai, New York and London. These rank from #22 (London) to #39 (Shanghai) for water disclosure in a survey ranking the performance of 45 exchanges. Given rising material water risks, exchanges can play a bigger role in fostering not more, but more decision-relevant disclosure.
MATERIALITY TO DRIVE DISCLOSURE ON WATER RISKS

Consistent and complete disclosure has been high on the agenda over the last few years. Historically, measuring impact on the environment has been largely driven by NGOs, IGOs corporates and investors pushing for better environmental stewardship. This led to a discussion on valuing natural capital to assess the “true cost” of production to the corporate. The development of shadow pricing methodologies thus ensued, as well as a rise in sustainability reports and those documenting Corporate Social Responsibility (CSR). Integrated Reporting <IR> was the next step.

Changing waterscape means materiality should drive disclosure

However, things are progressively changing as environmental risks, be they physical or regulatory, are becoming more material. In a vicious cycle, it is no longer only about accounting for businesses’ impact on the environment; but the environment is also now impacting the ability of businesses to operate.

On the water front, businesses are exposed to a variety of water risks such as: floods, droughts, aquifer depletion, competition for scarce water resources and pollution-associated reputational risks. In countries where water resources are limited, like China, there are also rising regulatory risks to consider. These pertain to the allocation of water to ensure national water, energy, food and economic security as well as tighter standards with higher penalties to protect drinking water sources from industrial contamination.

These could potentially disrupt operations and therefore profitability. In some cases, the physical lack of water or regulations pertaining to allocation of water may also lead to significant write-offs. As discussed previously, the majority of Investors, be they SRI or mainstream, are clearly “very concerned” to “extremely concerned” over such risks. To a certain extent, China’s actions to manage physical water risk for the nation, has meant that regulatory & physical risks have overtaken the natural capital discussion. Indeed, Investor reaction to the results throughout the exercise confirms this.

Potential material impact means Investors are “very” to “extremely concerned”

As discussed earlier, 86% and 92% of Investors are concerned by the potential impact of water stress on coal mining and thermal power generation respectively. Also, 73% of them believe that cost of compliance to environmental regulations can be material, compared to 12% who say it was not material; the rest remain neutral. It is worth remembering here that only 23% of Investors that provided feedback identify themselves as SRI investors. In short, even mainstream Investors who are agnostic towards the environment are of the view that regulatory and physical water risks were material.

In fact, as discussed in the previous chapter, regulatory risk impact on valuation is Investors’ #1 concern: 59% of Investors even say they may commission/conduct more research on regulatory risks after looking at our analyses. Concern over exposure to physical water stress follows. Meanwhile, impact based on shadow pricing drew much heated discussion over the arbitrary nature of the assumptions and whether these are “real or not”. Many remain divided with 82% saying that this was a good first step, but required complementary detailed analyses.

Despite recognised as material, water disclosure lags

Disclosing material risks is required by regulatory bodies such as the SEC: “companies must identify and disclose known trends, events, demands, commitments and uncertainties that are reasonably likely to have a material effect on financial condition or operating performance”. Therefore disclosure standards and practices should reflect the above Investor concerns, but they do not.

Given the potential material impact of water risks, there is currently a clear lag in water disclosure by companies as well as supervision by the relevant stock exchanges. We explore in this chapter, the gaps in water disclosure and challenges encountered in using the information disclosed in this risk valuation exercise. But first, a look at who is disclosing what.
WHO IS DISCLOSING WHAT?

All ten companies of the Coal-5 and Power-5 publish a separate CSR report, as required in China for SOEs since 2006. All water-related disclosure contained in these reports is summarised in the tables on the next page. At a glance, it is obvious that the amount of information disclosed varies across companies.

With regards to water, two guidelines for water disclosure typically used globally are:

- The Global Reporting Initiative: developed guidelines for companies to disclose “generate reliable, relevant and standardized information with which to assess opportunities and risks, and enable more informed decision-making”. Most of the analysed companies mention GRI indicators in their CSR reports - indicated in the right tables as EN8, EN9 etc. However, companies do not entirely follow the guidelines, and many indicators are only partially disclosed; and
- The CDP Water Questionnaire: promotes disclosure that strives to “provide consistent performance data enabling comparisons within and between sectors”.

Disclosure takes time and is onerous for companies. Whereas all of the Coal-5 and Power-5 companies disclosed some GRI indicators, none of them completed a CDP Water Questionnaire. However, feedback from Investors reveals that only a minority of them use such information. Some attribute this to the fact that some disclosure is not relevant to their decision-making.

Challenges around disclosure of water risks
The reality is that despite these disclosure guidelines, challenges remain. Firstly, different water risks may be material to different extents in different sectors; secondly, there is no one-size-fits-all benchmark in determining the materiality of that particular risk. This is even more challenging for environmental risks where a combination of factors makes the future much more unpredictable.

For these very reasons, because Investors are worried and because environmental risks are harder to anticipate, consistent disclosure of environment-related factors is crucial. During this risk valuation exercise, we identified three main challenges around disclosure. The three challenges listed below are explored in detail the following pages.

- Uncertainty around data’s consistency: are these numbers comparable across companies? And with targets and standards stipulated by official regulations?
- Elusive disclosure of pollution risks: although pollution risks are material for mining industries, CSR reports of the Coal-5 show none/limited disclosure (see tables); and
- Lack of location specific data: water risks are extremely location-dependent but disclosed values are often aggregated.
## Coal companies water disclosure, 2014

<table>
<thead>
<tr>
<th>Companies</th>
<th>Shenhua</th>
<th>China Coal</th>
<th>Yanzhou</th>
<th>Yitai</th>
<th>Datong</th>
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<tr>
<td>Availability of CSR Report</td>
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<td>G3.1 Undeclared</td>
<td>Y</td>
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<td></td>
<td></td>
<td>Partial (no source indication)</td>
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<tr>
<td>Total water withdrawal by source</td>
<td>Y</td>
<td>N</td>
<td></td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>EN8</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Water sources significantly affected by withdrawal</td>
<td>N</td>
<td>N</td>
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</tr>
<tr>
<td>EN9</td>
<td></td>
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<td></td>
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<tr>
<td>% &amp; total of water recycled &amp; reused</td>
<td>Y</td>
<td>Partial (only mine water)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wastewater discharge by quality &amp; destination</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>EN22</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total weight of waste by type &amp; disposal method</td>
<td>Partial</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>EN23</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total amounts of overburden, rock, tailings, and sludges and their associated risks</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>MM3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total no. &amp; volume of significant spills</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>EN24</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Habitats significantly affected by discharge of water and runoff</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Partial</td>
</tr>
<tr>
<td>EN26</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fines &amp; sanctions for violations &amp; non-compliance</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>EN29</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental impact of transporting products</td>
<td>Partial (only noise)</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>EN30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental protection expenditure &amp; investment</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>EN31</td>
<td></td>
<td></td>
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</table>

Source: China Water Risk, company annual and CSR reports, GRI database

## Power generation companies water disclosure, 2014

<table>
<thead>
<tr>
<th>Companies</th>
<th>Huaneng</th>
<th>Datang</th>
<th>Guodian</th>
<th>Huadian</th>
<th>CPI</th>
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<tbody>
<tr>
<td>Availability of CSR Report</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>GRI status</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>G4 undeclared</td>
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<tr>
<td>Total water withdrawal by source</td>
<td>Partial (only water use rate)</td>
<td>Partial (only water use rate)</td>
<td>Partial (only water use rate)</td>
<td>Partial (only water use rate)</td>
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</tr>
<tr>
<td>EN8</td>
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<td></td>
<td></td>
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<td>Water sources significantly affected by withdrawal</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
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<tr>
<td>EN9</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>% &amp; total of water recycled &amp; reused</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>EN10</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Wastewater discharge by quality &amp; destination</td>
<td>N</td>
<td>Partial (only total volume)</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>EN22</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total weight of waste by type &amp; disposal method</td>
<td>N</td>
<td>Partial (only rate)</td>
<td>Partial (only SO2 discharge)</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>EN23</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total no. &amp; volume of significant spills</td>
<td>N</td>
<td>N</td>
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<td>N</td>
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<td>N</td>
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</tr>
<tr>
<td>EN26</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fines &amp; sanctions for violations &amp; non-compliance</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>EN29</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>N</td>
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<td>N</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental protection expenditure &amp; investment</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>EN31</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: China Water Risk, company annual and CSR reports, GRI database
ARE THESE DISCLOSED NUMBERS COMPAREABLE?

When extracting information from company disclosure to estimate the impact on valuation across the three different approaches for the Coal-5 and Power-5, we encountered inconsistencies in the data collected. We set out some examples of these below:

Powergen: Confusion over water consumption vs. water withdrawal

One inconsistency/uncertainty pertains to the type of water use indicated i.e. water withdrawal vs. water consumption. As discussed earlier in this report, the distinction is critical in power generation sector; depending on cooling type, differences can be significant.

GRI Guidelines explicitly define the indicator EN8 as water withdrawal. In its supplement on electric utilities, GRI recommends that companies in this sector further detail “overall water usage for processing, cooling and consumption in thermal and nuclear power plants, including use of water in ash handling and coal cleaning”.

Four of the Power-5 companies disclose average water consumption values, whereas other power companies, not included in this survey, detail instead water withdrawals. In some reports, the term water use is even used interchangeably for water withdrawal and water consumption, leading to more confusion. Note that water consumption could be approximated by deducting water discharge from water withdrawal.

Coal: scepticism over mine water recycling rate

The mine water recycling figures are also regarded with some scepticism. Investors are surprised by the low level of Shenhua’s mine water recycling rate at 60% compared to China Coal and Yanzhou’s of 84% and 93% respectively, and suspect that these values are not directly comparable.

No definition of what this rate actually means is available in companies’ reports. In the previous chapter, we compared this to the 2020 target mine water recycling rate of 75%-95% (depending on the exposure of the mine to water scarcity). But since the derivation of this rate by the company is not transparent, we do not know if this level is actually directly comparable with the regulation.

While we recognise that it would be onerous for companies to disclose everything, a good way would be to use official benchmarks make the disclosure more relevant e.g. “the mine water recycling rate is X% well within the 2020 target range of X% to X%”.

Using official benchmarks to disclose comparable values

Reference to official standards when disclosing environmental related information, is a simple and good way for companies to guarantee data consistency across companies. The information is thus made useful for investors who can use the data to easily benchmark the peer group. For instance, the water use to extract per tonne of coal can be compared to the MEP Clean Production Standards; water use could be compared to official water use quotas; and water per kWh generated to the official norm. These suggested benchmarks are covered in the chapter on REGULATORY RISKS & COMPLIANCE COSTS.

By using official benchmarks, companies would both guarantee that they adopted official accounting methodology and show that they are meeting official requirements. In turn, investors have a measure of comfort in the consistency of data across companies. More importantly, knowing whether companies are compliant is key for investors; many cannot invest if companies are non-compliant to any regulation.
WATER POLLUTION DISCLOSURE: STILL ELUSIVE

As we have seen, only two out of the Coal-5 companies disclose water use numbers. The picture is not brighter on the water quality side: only these same two companies disclose the amount of wastewater discharge. However, none of the Coal-5 disclose any kind of information on the risks their mining activities pose to local water quality, for instance through rock piles, mine water drainage or tailing dams and ponds. All these are recommended by GRI in its mining supplement of the GRI G4 guidelines. Such lack of information leaves investors blind on water pollution issues which are potentially the most material contingent financial liability in the mining sector.39

The lack of pollution data has made it difficult to measure its impact. This is evidenced by the fact that neither the shadow pricing tools nor WRI’s water stressed maps currently factor in pollution. This limited disclosure availability contrasts with the growing determination of China’s central government to tackle water pollution. Regulatory risks related to water pollution are becoming more material but disclosure has so far failed to reflect this reality.

LOCATION MATTERS: AGGREGATE VALUES MISS THE POINT

The use of aggregated figures at the company level is probably an even bigger obstacle to water risk assessments. Quantity and quality of available water resources are extremely location-specific and consequently, so are regulatory pressures and associated compliance costs. Water risks assessments are therefore heavily location-dependent.

The lack of pollution data has made it difficult to measure its impact. This is evidenced by the fact that neither the shadow pricing tools nor WRI’s water stressed maps currently factor in pollution. This limited disclosure availability contrasts with the growing determination of China’s central government to tackle water pollution. Regulatory risks related to water pollution are becoming more material but disclosure has so far failed to reflect this reality.

Investors would like to see more of...

<table>
<thead>
<tr>
<th>Investment Objective</th>
<th>China</th>
<th>Hong Kong</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete &amp; consistent voluntary disclosure from companies</td>
<td>96%</td>
<td>94%</td>
</tr>
<tr>
<td>Better accounting for water quality risks</td>
<td>94%</td>
<td>94%</td>
</tr>
<tr>
<td>Better documentation of reputational risk</td>
<td>78%</td>
<td>78%</td>
</tr>
</tbody>
</table>

When asked, 96% of Investors want complete & consistent voluntary disclosure from companies. As for water pollution, 94% of Investors want better accounting for risks associated with water quality...by extension, 78% want better documentation of reputational risk.

LOCATIONS MATTERS: AGGREGATE VALUES MISS THE POINT

The use of aggregated figures at the company level is probably an even bigger obstacle to water risk assessments. Quantity and quality of available water resources are extremely location-specific and consequently, so are regulatory pressures and associated compliance costs. Water risks assessments are therefore heavily location-dependent.

Unfortunately, none of the ten companies of the Coal-5 and Power-5 disclosed environmental information at the asset level. This deeply contrasts with Investors’ expectations: more than 90% of Investors want to see more information at the facility level. Interestingly, nobody marked “no”.

<table>
<thead>
<tr>
<th>Would you like companies to disclose water use at facility level?</th>
<th>No</th>
<th>Neutral</th>
<th>Yes</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal Mining</td>
<td>3%</td>
<td>4%</td>
<td>92%</td>
<td>91%</td>
</tr>
<tr>
<td>Power Generation</td>
<td>6%</td>
<td>4%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

When asked, 96% of Investors want complete & consistent voluntary disclosure from companies. As for water pollution, 94% of Investors want better accounting for risks associated with water quality...by extension, 78% want better documentation of reputational risk.

Some, like CLP (SEHK:0002) are disclosing such info...yet, >90% of Investors want to see facility level disclosure

Investors say stock exchanges can do more

That said, some companies do disclose such information at the asset level. For example, China Light & Power (SEHK:0002), annually discloses a wide range of information for each of its power plants: water use from different sources, water discharge, air pollutant and carbon emissions, environmental compliance as well as by-products and waste management. While voluntary disclosure guidelines can help achieve complete and consistent disclosure, Investors say stock exchanges could help foster more decision-relevant disclosure.
THE ROLE OF STOCK EXCHANGES & MANDATORY DISCLOSURE

Given their central position between investors and corporates, stock exchanges have long been widely recognized as key actors in shaping companies’ disclosure and governance.

These 10 energy majors are listed on four exchanges: (1) the Stock Exchange of Hong Kong, (2) the Shanghai Stock Exchange, (3) the New York Stock Exchange and (4) the London Stock Exchange.

Together, the 10 companies are worth more than USD110 billion as of April 2016. Moreover, altogether, they represent 1.2% of CSI300, 4.2% of Hang Seng China Enterprises Index, 11.5% of MSCI China Energy, 15.5% of SSE Energy and 24.5% of SSE Utilities.

Investors who provided feedback track some or all of these Indices.

**“Coal-5” mining companies**

<table>
<thead>
<tr>
<th>Company</th>
<th>Stock Exchange</th>
</tr>
</thead>
<tbody>
<tr>
<td>China Shenhua Energy</td>
<td>SEHK: 1088, SSE: 601088</td>
</tr>
<tr>
<td>China Coal Energy</td>
<td>SEHK: 1898, SSE: 601898</td>
</tr>
<tr>
<td>Yanzhou Coal Mining</td>
<td>SEHK: 1171, SSE: 600188, NYSE: YZC</td>
</tr>
<tr>
<td>Inner Mongolia Yitai Coal</td>
<td>SEHK: 3948, SSE: 900948</td>
</tr>
<tr>
<td>Datong Coal Industry</td>
<td>SSE: 601001</td>
</tr>
</tbody>
</table>

**“Power-5” companies**

<table>
<thead>
<tr>
<th>Company</th>
<th>Stock Exchange</th>
</tr>
</thead>
<tbody>
<tr>
<td>Huaneng Power International</td>
<td>SEHK: 0902, SSE: 600011, NYSE: HNP</td>
</tr>
<tr>
<td>Datang International Power Generation</td>
<td>SEHK: 991, SSE: 601991, LSE: DAT</td>
</tr>
<tr>
<td>Huadian Power International</td>
<td>SEHK: 1071, SSE: 600027</td>
</tr>
<tr>
<td>Guodian Power Development</td>
<td>SSE: 600795</td>
</tr>
<tr>
<td>China Power International Development</td>
<td>SEHK: 2380</td>
</tr>
</tbody>
</table>

They are also in various Indices

All 4 exchanges perform badly in terms of water disclosure: ranking from #22 to #39 out of 45

“Comply or explain” is a middle way; and has recently been adopted by the SEHK

Unfortunately, all of these four stock exchanges perform badly in terms of water disclosure, ranking from #22 to #39, out of 45 stock exchanges considered.40

The top 3 exchanges ranked by water disclosure are Helsinki (#1), Sao Paulo (#2) and Paris (#3). Hong Kong and Shanghai, where almost all the ten companies are listed, rank lower in the 30’s.

A middle way adopted by some stock exchanges is the “comply or explain” approach, where companies are required to disclose information in compliance with a reporting guide, or to give considered reasons for not doing so. In 2015, Stock Exchange of Hong Kong updated its ESG reporting requirements and adopted this ‘comply or explain’ approach.41

The impact of this remains to be seen, as amendments will come into effect at the earliest for companies’ financial years commencing on or after 1 January 2017.
Investors want decision-relevant disclosure, not more disclosure

As this report shows, water risks can be material to valuation. Each of the three disclosure limitations discussed above undermines investors and analysts’ ability to assess water risks. As summarized by an investor: “most of China’s CSR reports are not very much decision-relevant”.

To be clear, Investors do not want more disclosure; they do not have time to sift through the information. However, they do want more decision-relevant disclosure. Benchmarking companies against an official standard is a way forward, and Investors feel that exchanges can play a key role here in facilitating such disclosure. This appears to be in-line with the “comply or explain” approach but whether these official benchmarks are included in the reporting guide is not clear.

Also these benchmarks change depending on sector. In this case, is it not better to use materiality as the driver? And to require mandatory disclosure for risks that have material impact? Investors seem to think so…

Toward mandatory disclosure of material water risks

Over 90% of Investors wanted water disclosure at a facility level. Out of these, 78% wanted such disclosure to be mandatory for the Coal-5 and Power-5. As can be seen from the chart, they are spread evenly across the two sectors.

For some Investors, the distinction voluntary vs mandatory is not as important as audited vs not audited. Written comments received echo the results: “Audited by a third party”, “Likely need to be mandated by state authorities”, “Mandatory if annual”, “Voluntary but audited” and “mandatory & audited”.

Others that are more practical say: “first voluntary disclosure followed by mandatory which takes longer time to implement”.

Indeed, at the end of the questionnaire, when Investors are asked what they would like to see more of, 86% say they would like to see more “mandatory disclosure required by stock exchanges”.

As mentioned at the start of the report, the quality of corporate disclosure underpins this entire exercise. The impact on the margins or balance sheet, or DCF valuation scenarios is only as good as the reliability of the data used in the valuations. Exchanges and investors can help pave the way for more transparent, complete and consistent disclosure.
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BWS</td>
<td>Baseline Water Stress</td>
</tr>
<tr>
<td>CAPEX</td>
<td>Capital Expenditure</td>
</tr>
<tr>
<td>CBWCRT</td>
<td>Corporate Bond Water Credit Risk Tool</td>
</tr>
<tr>
<td>CDP</td>
<td>Carbon Disclosure Project</td>
</tr>
<tr>
<td>CEC</td>
<td>China Electricity Council</td>
</tr>
<tr>
<td>CNIS</td>
<td>China National Institute of Standardization</td>
</tr>
<tr>
<td>CSR</td>
<td>Corporate Social Responsibility</td>
</tr>
<tr>
<td>CWR</td>
<td>China Water Risk</td>
</tr>
<tr>
<td>DCF</td>
<td>Discounted Cash Flow</td>
</tr>
<tr>
<td>EBITDA</td>
<td>Earnings Before Interest, Taxes, Depreciation and Amortization</td>
</tr>
<tr>
<td>EPB</td>
<td>Environmental Protection Bureau</td>
</tr>
<tr>
<td>ESG</td>
<td>Environmental, Social and Governance</td>
</tr>
<tr>
<td>GIZ</td>
<td>Deutsche Gesellschaft für Internationale Zusammenarbeit</td>
</tr>
<tr>
<td>GRI</td>
<td>Global Reporting Initiative</td>
</tr>
<tr>
<td>IGO</td>
<td>Intergovernmental Organisation</td>
</tr>
<tr>
<td>IPE</td>
<td>Institute of Public and Environmental Affairs</td>
</tr>
<tr>
<td>LSE</td>
<td>London Stock Exchange</td>
</tr>
<tr>
<td>MEP</td>
<td>Ministry of Environmental Protection</td>
</tr>
<tr>
<td>MOF</td>
<td>Ministry of Finance</td>
</tr>
<tr>
<td>MWR</td>
<td>Ministry of Water Resources</td>
</tr>
<tr>
<td>NDRC</td>
<td>National Development and Reform Commission</td>
</tr>
<tr>
<td>NEA</td>
<td>National Energy Administration</td>
</tr>
<tr>
<td>NGO</td>
<td>Non-Governmental Organisation</td>
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<tr>
<td>NYSE</td>
<td>The New York Stock Exchange</td>
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<tr>
<td>OPEX</td>
<td>Operational Expenditure</td>
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<tr>
<td>P&amp;L</td>
<td>Profit &amp; Loss Account</td>
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<tr>
<td>PPP</td>
<td>Purchasing Power Parity</td>
</tr>
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<td>ROW</td>
<td>Rest of the World</td>
</tr>
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<td>SEC</td>
<td>Securities Exchange Commission</td>
</tr>
<tr>
<td>SEHK</td>
<td>The Stock Exchange of Hong Kong</td>
</tr>
<tr>
<td>SOE</td>
<td>State-Owned Enterprise</td>
</tr>
<tr>
<td>SRI</td>
<td>Social Responsible Investing</td>
</tr>
<tr>
<td>SSE</td>
<td>Shanghai Stock Exchange</td>
</tr>
<tr>
<td>TEV</td>
<td>Total Economic Value</td>
</tr>
<tr>
<td>WRI</td>
<td>World Resources Institute</td>
</tr>
<tr>
<td>WRM</td>
<td>Water Risk Monetizer</td>
</tr>
<tr>
<td>WWF</td>
<td>World Wildlife Fund for Nature</td>
</tr>
</tbody>
</table>
REFERENCES

Thanks to the Institute of Environmental and Public Affairs (IPE), it is possible to search for recent environmental violations of companies operating in China. We did the exercise for all the subsidiaries of each of the Coal-5 and Power-5 companies for the years 2014 and 2015. Results are listed in the tables below.

According to the results, most environmental violations pertain to air pollution or more generally to insufficient environment protection facilities. Some violations are directly water-related such as the excessive discharge of COD, ammonia nitrogen and phosphorus.

Please note that the IPE Pollution Database covers Key State Monitored Enterprises only. However, not all the subsidiaries housing the various assets are included in the list of Key State Monitored Enterprises. Therefore, the violations below may not be exhaustive.

That being said, tracking these violations on a regular basis and identifying trends could help Investors benchmark companies and identify those that are the most at risk. To access IPE’s Pollution Database, please visit: http://www.ipe.org.cn/En/pollution/corporation.aspx

### Coal-5 violations in 2014-2015

<table>
<thead>
<tr>
<th>Companies</th>
<th>Issue Date</th>
<th>Reason</th>
<th>Fine (RMB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shenhua</td>
<td>28/05/2014</td>
<td>Violating the “Three Simultaneities” (Design, Construction &amp; Operation)</td>
<td>50,000</td>
</tr>
<tr>
<td></td>
<td>11/12/2014</td>
<td>Desulphurization not functioning properly</td>
<td>4,0000</td>
</tr>
<tr>
<td></td>
<td>25/12/2014</td>
<td>Excessive dust emission</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>10/11/2015</td>
<td>Excessive emission of COD and Ammonia Nitrogen</td>
<td>62,974.95</td>
</tr>
<tr>
<td></td>
<td>21/01/2014</td>
<td>Start without approval</td>
<td>80,000</td>
</tr>
<tr>
<td></td>
<td>04/07/2014</td>
<td>Excess discharge of total phosphorus</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>25/11/2014</td>
<td>Excess emission of dust, SO₂ and NOx</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>03/03/2015</td>
<td>Excessive NOx emission</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>17/03/2015</td>
<td>Excess discharge, environment protection facilities need to be improved</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>11/05/2015</td>
<td>Excess dust emission</td>
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</tr>
<tr>
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<td>26/06/2015</td>
<td>Waste not disposed, environment protection facilities need to be improved</td>
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<td>Excessive waste discharge, abnormal operation of environment protection facilities</td>
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Source: China Water Risk based on IPE Pollution Database

### Power-5 violations in 2014-2015

<table>
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<th>Companies</th>
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<th>Reason</th>
<th>Fine (RMB)</th>
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<td>28/10/2014</td>
<td>Dust pollution</td>
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<td>13/03/2015</td>
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<tr>
<td></td>
<td>20/03/2015</td>
<td>Excessive emission of NOx and SO₂</td>
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<td></td>
<td>20/03/2015</td>
<td>Problems with monitoring facilities</td>
<td>--</td>
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<td>20/03/2015</td>
<td>Problems with monitoring facilities, excessive emission of SO₂</td>
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<td>Problems with monitoring facilities</td>
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<td>Companies</td>
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<td>17/03/2015</td>
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<tr>
<td>Huaneng</td>
<td>20/01/2014</td>
<td>Excessive emission of dust, NOx and SO₂</td>
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<tr>
<td></td>
<td>27/03/2015</td>
<td>Dust pollution</td>
<td>--</td>
</tr>
</tbody>
</table>

Source: China Water Risk based on IPE Pollution Database
Here are some recommendations for investors when considering water risks. This is by no means an exhaustive list.

- **DON’T only focus on water tariff hikes.** Water resource fee increases are not the only driver of water conservation in coal and power industries, there are also water use and discharge permits to consider for example.

- **DO build scenarios for water allocation.** The ability to access water represents the “binary risk” that Investors fear the most. Further water needs can be built into DCF models depending on various assumptions regarding levels of water availability. We recommend providers of capital, especially that of a long term nature, to conduct sensitivity analysis output around water allocations.

- **DO build scenarios estimating retrofitting/upgrading costs** within changing regulatory landscapes and test DCF valuation sensitivities – in each case, enforcements scenarios can also be tested.

- **DO use official standards,** norms/quotas and targets to benchmark company performance.

- **DO engage with companies** regarding their compliance with existing standards and future targets.

- **DO pay attention to local pollution levels.** Local efforts to tackle violations will likely be influenced by how far local water quality is from its official targets.

- **DO track violations records.** More violations likely signal poor management, and hence higher exposure to environmental risks including tail risks.

- **DO use existing tools** – they are free and can be applied to other sectors.

- **DO feel free to contact us or visit our website at** [http://www.chinawaterrisk.org](http://www.chinawaterrisk.org)
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China Water Risk (CWR) is a non-profit initiative dedicated to addressing business & environmental risk arising from China's limited water resources. We aim to foster efficient and responsible use of China's water resources by engaging the global business and investment communities. As such, we facilitate discussion amongst industry leaders, investors, experts & scientists on understanding & managing water risk across six industry sectors: Agriculture, Power, Mining, Food & Beverage, Textiles and Electronics. CWR also has been commissioned by financial institutions to conduct research analysing the impact of water risks on the Power, Mining, Agricultural and Textile sectors. These reports have been considered groundbreaking and instrumental in understanding China's water challenges. Join the discussion at www.chinawaterrisk.org.