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# GETTING EVERY TON OF EMISSIONS RIGHT: AN ANALYSIS OF EMISSION FACTORS FOR PURCHASED ELECTRICITY IN CHINA

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An independent analysis of the use and calculation of emission factors (EFs) for indirect emissions from electricity purchased by corporations in China shows widespread errors that could produce inaccurate accounting results and provide distorted signals that will mislead government and corporate analyses and decisions on greenhouse gas (GHG) mitigation.

The four most common errors were:

1. Inappropriately using operating margin (OM) or combined margin (CM) emission factors derived from Baseline Emission Factors for Regional Power Grids in China, an annual report developed for Clean Development Mechanism (CDM) projects rather than for organizational accounting;

2. Attributing transmission and distribution (T&D) loss to end users;

3. Not taking into account the impact of the exchange of electricity between grids;

4. Ignoring emission allocation between electricity and heat for cogeneration plants.

Using inappropriate emission factors can ripple through the system. For example, if OM emission factors are mistakenly used to account for emissions of purchased electricity in 2010, it could lead to overestimation of GHG emissions of up to 49 percent for companies in some regions (see Figure 1).
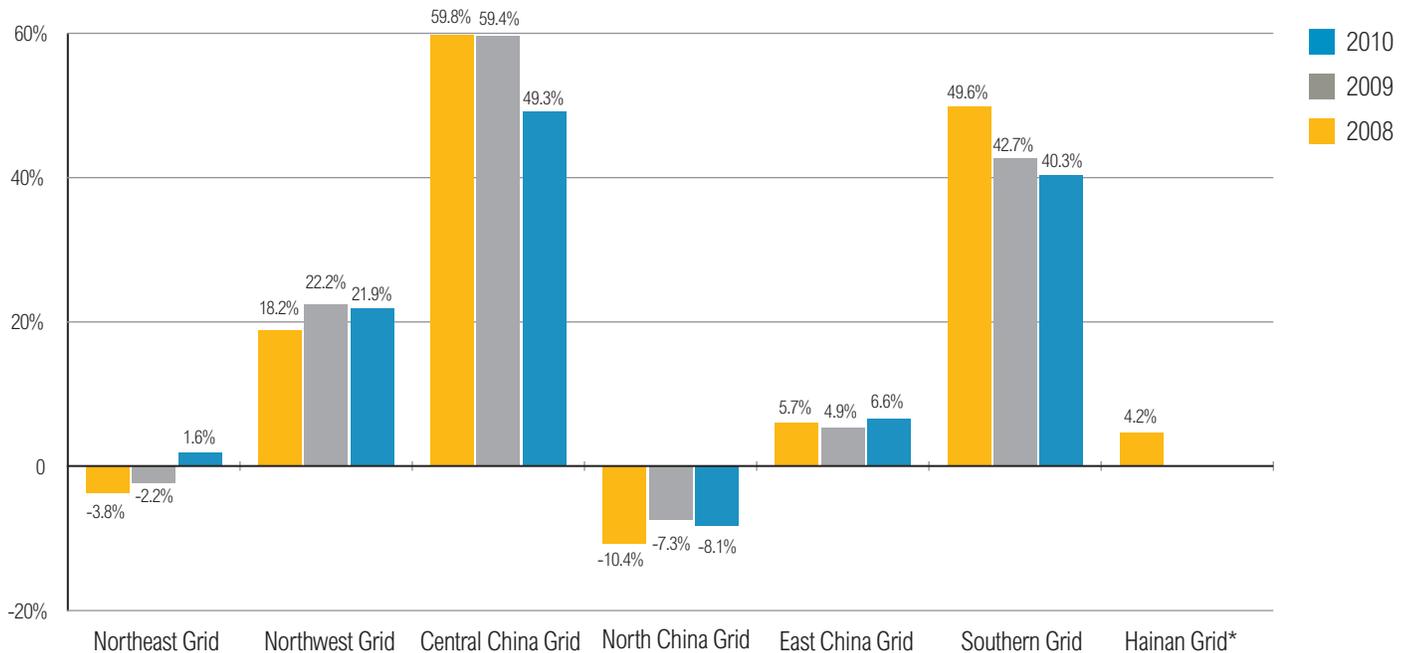
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Figure 1 | **Percentage of difference between emission factors calculated by WRI and simple operating margin emission factors (2008-2010)**



Source: World Resources Institute
Notes: Percentage of difference = (OM EF − EF calculated by this paper) / EF calculated by this paper;
    According to Baseline Emission Factors for Regional Power Grids in China, OM EFs used in the comparison are the weighted average of annual OM EFs over three years.
    Please refer to Annex 2 for detailed data.
    *Hainan has been included in the Southern Grid since 2009.

Authors of this working paper argue that using inappropriate emission factors for purchased electricity, even if they are used consistently by all companies in the same country, will produce inaccurate accounting results and provide distorted signals that will mislead analysis and decisions on GHG mitigation with the following possible consequences:

- Governments will be misled when analyzing and evaluating the GHG impacts of different industries, since different industries' demands for electricity are different.

- If inappropriate emission factors are used under end-use carbon taxes policy or emissions-trading schemes that include emissions from electricity, [1] it will create significant questions about the fairness of the policy.

- Local governments may have fewer incentives to support the development of renewable electricity because

a common error excludes electricity generated through renewable technologies. [2]

- Companies will be misled when identifying reduction hot spots and on the GHG impacts of different technologies, since inappropriate emission factors distort GHG emission profiles between direct and indirect emissions.

- Companies in regions with larger renewable energy and nuclear portfolios may be put in an unfavorable and unfair position when their clients evaluate their GHG emissions, since these emission factors tend to overestimate GHG emissions. [3]

Based on requirements and guidance from the most commonly used corporate GHG accounting and reporting standards, namely GHG Protocol A Corporate Accounting and Reporting Standard (revised edition) (GHG Protocol Corporate Standard) and ISO 14064-1:2006 Specification

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with guidance at the organizational level for quantification and reporting of greenhouse gas emissions and removals (ISO 14064-1), the authors articulate what should and should not be included in the calculation of emission factors for purchased electricity in China.

The authors also provide calculated default emission factors for six regional grids in China (Annex 1) and show the calculation process in detail (Annex 2).

This working paper argues that companies and government agencies in China should include the following items when calculating emission factors for purchased electricity:

- Use the actual supply of electricity (as opposed to electricity consumed) to calculate emission factors.

- Allocate emissions from combined heat and power (CHP) plants to heat and electricity.

- Include electricity generated from all technologies, including low-cost/must-run resources such as hydro, geothermal, wind, low-cost biomass, nuclear, and solar.

- Use cross-province regional grids or smaller geographic units as the basis to define grid boundaries. Account for GHG impact of imported electricity from outside the grid.

## RECOMMENDATIONS

For government agencies and research organizations that support policy making in China, this working paper has the following recommendations:

- The government should develop, publish, and regularly update emission factors for purchased electricity that are suitable for organizational GHG accounting purposes.

- It should develop emission factors for six regional grids or according to grid units defined by other criteria, such as smaller administrative regions (province or city) or aligned with the operation of grid companies. However the criteria are defined, they should be applied consistently.

- Base emission factors on the actual supply of electricity, including all electricity generated from all technologies, and emissions from combined heat and power

plants allocated to heat and electricity when calculating the emission factors.

- Develop a GHG reporting scheme for the power sector referencing international experiences such as the eGRID database. Using such a reference will increase data quality of the emission factors while providing a sophisticated data foundation to support GHG reduction in the power sector.

For companies that account for and report GHG emissions, consultancies, and assurance providers, as well as other organizations that provide support to corporate GHG accounting and reporting, this working paper has the following recommendations:

- For now, the operating margin emission factors, build margin emission factors, and combined margin emission factors [4] are not appropriate for GHG accounting at the organizational level. Instead, companies can use emission factors provided in Annex 1 of this working paper to account for their indirect GHG emissions from purchased electricity. To be consistent, companies should use corporate emission factors published by national or local governments when they become available.

- Companies can develop and use emission factors that are specific to them if data are available. When doing so, they should take into account the issues discussed above.

- Following the transparency principle of the GHG Protocol Corporate Standard and ISO 14064-1, companies should disclose the emission factors they use to account for indirect emissions from electricity.

The full report is available in Chinese at http://www.wri.org/publication/analysis-of-emission-factors-for-purchased-electricity-in-china.   Annex 1 is included below, as well as a link to Annex 2.

# ANNEX 1: CHINA'S REGIONAL GRID EMISSION FACTORS FOR PURCHASED ELECTRICITY, 2006–2011

## 2006

| POWER GRID | COVERAGE AREA | $CO_2$ EMISSION FACTOR t $CO_2$/10MWh | $CH_4$ EMISSION FACTOR g $CH_4$/10MWh | $N_2O$ EMISSION FACTOR g $N_2O$ /10MWh | $CO_2$ EQUIVALENT EMISSION FACTOR t $CO_2$e/10MWh |
|---|---|---|---|---|---|
| Northeast Grid | Liaoning, Jilin, and Heilongjiang Provinces | 11.9424 | 130.4796 | 184.6768 | 12.0007 |
| Northwest Grid | Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang Provinces | 8.4090 | 89.8306 | 131.4507 | 8.4504 |
| Central China Grid | Chongqing, Henan, Hubei, Hunan, Jiangxi, and Sichuan Provinces | 7.8340 | 84.1492 | 122.0859 | 7.8725 |
| North China Grid | Beijing, Tianjin, Hebei, Shanxi, Shandong, and Inner Mongolia Provinces | 10.9421 | 118.6352 | 169.7981 | 10.9956 |
| East China Grid | Shanghai, Jiangsu, Zhejiang, Anhui, and Fujian Provinces | 8.6143 | 97.7429 | 130.2607 | 8.6556 |
| Southern Grid | Guangdong, Guangxi, Yunnan, and Guizhou Provinces | 7.5167 | 94.1274 | 113.7826 | 7.5529 |
| Hainan Grid | Hainan Province | 7.7720 | 98.0973 | 96.1443 | 7.8031 |

## 2007

| POWER GRID | COVERAGE AREA | $CO_2$ EMISSION FACTOR t $CO_2$/10MWh | $CH_4$ EMISSION FACTOR g $CH_4$/10MWh | $N_2O$ EMISSION FACTOR g $N_2O$ /10MWh | $CO_2$ EQUIVALENT EMISSION FACTOR t $CO_2$e/10MWh |
|---|---|---|---|---|---|
| Northeast Grid | Liaoning, Jilin, and Heilongjiang Provinces | 11.3885 | 125.3113 | 175.0165 | 11.4438 |
| Northwest Grid | Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang Provinces | 8.6123 | 92.7833 | 133.6412 | 8.6544 |
| Central China Grid | Chongqing, Henan, Hubei, Hunan, Jiangxi, and Sichuan Provinces | 7.6449 | 82.9818 | 118.5734 | 7.6824 |
| North China Grid | Beijing, Tianjin, Hebei, Shanxi, Shandong, and Inner Mongolia Provinces | 10.6969 | 117.1162 | 164.5239 | 10.7488 |
| East China Grid | Shanghai, Jiangsu, Zhejiang, Anhui, and Fujian Provinces | 8.3635 | 93.7908 | 126.8550 | 8.4037 |
| Southern Grid | Guangdong, Guangxi, Yunnan, and Guizhou Provinces | 7.3733 | 88.3276 | 110.8124 | 7.4085 |
| Hainan Grid | Hainan Province | 7.5806 | 89.0466 | 103.9664 | 7.6138 |

## 2008

| POWER GRID | COVERAGE AREA | CO₂ EMISSION FACTOR t CO₂/10MWh | CH₄ EMISSION FACTOR g CH₄/10MWh | N₂O EMISSION FACTOR g N₂O /10MWh | CO₂ EQUIVALENT EMISSION FACTOR t CO₂e/10MWh |
|---|---|---|---|---|---|
| Northeast Grid | Liaoning, Jilin, and Heilongjiang Provinces | 11.5452 | 126.5902 | 177.9825 | 11.6014 |
| Northwest Grid | Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang Provinces | 8.4165 | 90.5728 | 130.7957 | 8.4577 |
| Central China Grid | Chongqing, Henan, Hubei, Hunan, Jiangxi, and Sichuan Provinces | 6.8040 | 73.8955 | 105.2490 | 6.8372 |
| North China Grid | Beijing, Tianjin, Hebei, Shanxi, Shandong, and Inner Mongolia Provinces | 11.0674 | 121.8201 | 169.2641 | 11.1209 |
| East China Grid | Shanghai, Jiangsu, Zhejiang, Anhui, and Fujian Provinces | 8.1278 | 90.3503 | 123.7285 | 8.1670 |
| Southern Grid | Guangdong, Guangxi, Yunnan, and Guizhou Provinces | 6.5253 | 76.9393 | 97.7720 | 6.5564 |
| Hainan Grid | Hainan Province | 7.6533 | 89.9649 | 103.9529 | 7.6865 |

## 2009

| POWER GRID | COVERAGE AREA | CO₂ EMISSION FACTOR t CO₂/10MWh | CH₄ EMISSION FACTOR g CH₄/10MWh | N₂O EMISSION FACTOR g N₂O /10MWh | CO₂ EQUIVALENT EMISSION FACTOR t CO₂e/10MWh |
|---|---|---|---|---|---|
| Northeast Grid | Liaoning, Jilin, and Heilongjiang Provinces | 11.0962 | 122.4148 | 169.8296 | 11.1499 |
| Northwest Grid | Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang Provinces | 8.1856 | 88.0316 | 127.1638 | 8.2257 |
| Central China Grid | Chongqing, Henan, Hubei, Hunan, Jiangxi, and Sichuan Provinces | 6.4595 | 70.7697 | 98.9748 | 6.4908 |
| North China Grid | Beijing, Tianjin, Hebei, Shanxi, Shandong, and Inner Mongolia Provinces | 10.5740 | 117.4268 | 160.8184 | 10.6249 |
| East China Grid | Shanghai, Jiangsu, Zhejiang, Anhui, and Fujian Provinces | 7.9759 | 88.7688 | 120.8819 | 8.0142 |
| Southern Grid | Guangdong, Guangxi, Yunnan, Guizhou, and Hainan Provinces | 6.6513 | 75.9291 | 99.9591 | 6.6830 |

## 2010

| POWER GRID | COVERAGE AREA | CO$_2$ EMISSION FACTOR t CO$_2$/10MWh | CH$_4$ EMISSION FACTOR g CH$_4$/10MWh | N$_2$O EMISSION FACTOR g N$_2$O /10MWh | CO$_2$ EQUIVALENT EMISSION FACTOR t CO$_2$e/10MWh |
|---|---|---|---|---|---|
| Northeast Grid | Liaoning, Jilin, and Heilongjiang Provinces | 10.7601 | 112.1206 | 163.2735 | 10.8115 |
| Northwest Grid | Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang Provinces | 8.1356 | 86.1619 | 126.2426 | 8.1754 |
| Central China Grid | Chongqing, Henan, Hubei, Hunan, Jiangxi, and Sichuan Provinces | 6.6604 | 69.1006 | 98.6481 | 6.6915 |
| North China Grid | Beijing, Tianjin, Hebei, Shanxi, Shandong, and Inner Mongolia Provinces | 10.9077 | 112.4693 | 161.8392 | 10.9587 |
| East China Grid | Shanghai, Jiangsu, Zhejiang, Anhui, and Fujian Provinces | 7.7357 | 81.4981 | 114.2228 | 7.7718 |
| Southern Grid | Guangdong, Guangxi, Yunnan, Guizhou, and Hainan Provinces | 6.6609 | 72.1332 | 99.3678 | 6.6923 |

## 2011

| POWER GRID | COVERAGE AREA | CO$_2$ EMISSION FACTOR t CO$_2$/10MWh | CH$_4$ EMISSION FACTOR g CH$_4$/10MWh | N$_2$O EMISSION FACTOR g N$_2$O /10MWh | CO$_2$ EQUIVALENT EMISSION FACTOR t CO$_2$e/10MWh |
|---|---|---|---|---|---|
| Northeast Grid | Liaoning, Jilin, and Heilongjiang Provinces | 11.3672 | 118.5489 | 173.5464 | 11.4218 |
| Northwest Grid | Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang Provinces | 8.1189 | 86.5064 | 126.9188 | 8.1589 |
| Central China Grid | Chongqing, Henan, Hubei, Hunan, Jiangxi, and Sichuan Provinces | 7.0300 | 72.3134 | 104.5046 | 7.0629 |
| North China Grid | Beijing, Tianjin, Hebei, Shanxi, Shandong, and Inner Mongolia Provinces | 11.2816 | 116.8759 | 169.2222 | 11.3349 |
| East China Grid | Shanghai, Jiangsu, Zhejiang, Anhui, and Fujian Provinces | 7.8427 | 85.0532 | 119.8505 | 7.8805 |
| Southern Grid | Guangdong, Guangxi, Yunnan, Guizhou, and Hainan Provinces | 6.6937 | 71.7514 | 100.4371 | 6.7254 |

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## ANNEX 2: CALCULATION SPREADSHEET OF CHINA'S REGIONAL GRID EMISSION FACTORS FOR PURCHASED ELECTRICITY

The calculation spreadsheet can be downloaded from: http://www.wri.org/publication/analysis-of-emission-factors-for-purchased-electricity-in-china

## ENDNOTES

1. For example, the emissions-trading pilot in Beijing plans to include trading of indirect emissions from electricity consumption.

2. The simple OM emission factors that are widely used for corporate accounting in China exclude hydro, geothermal, wind, low-cost biomass, nuclear, and solar generation.

3. See Figure 1.

4. Climate Change Division of National Development and Reform Commission (NDRC), 2012. "Baseline Emission Factors for Regional Power Grids in China." http://cdm.ccchina.gov.cn/WebSite/CDM/UpFile/File2975.pdf

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