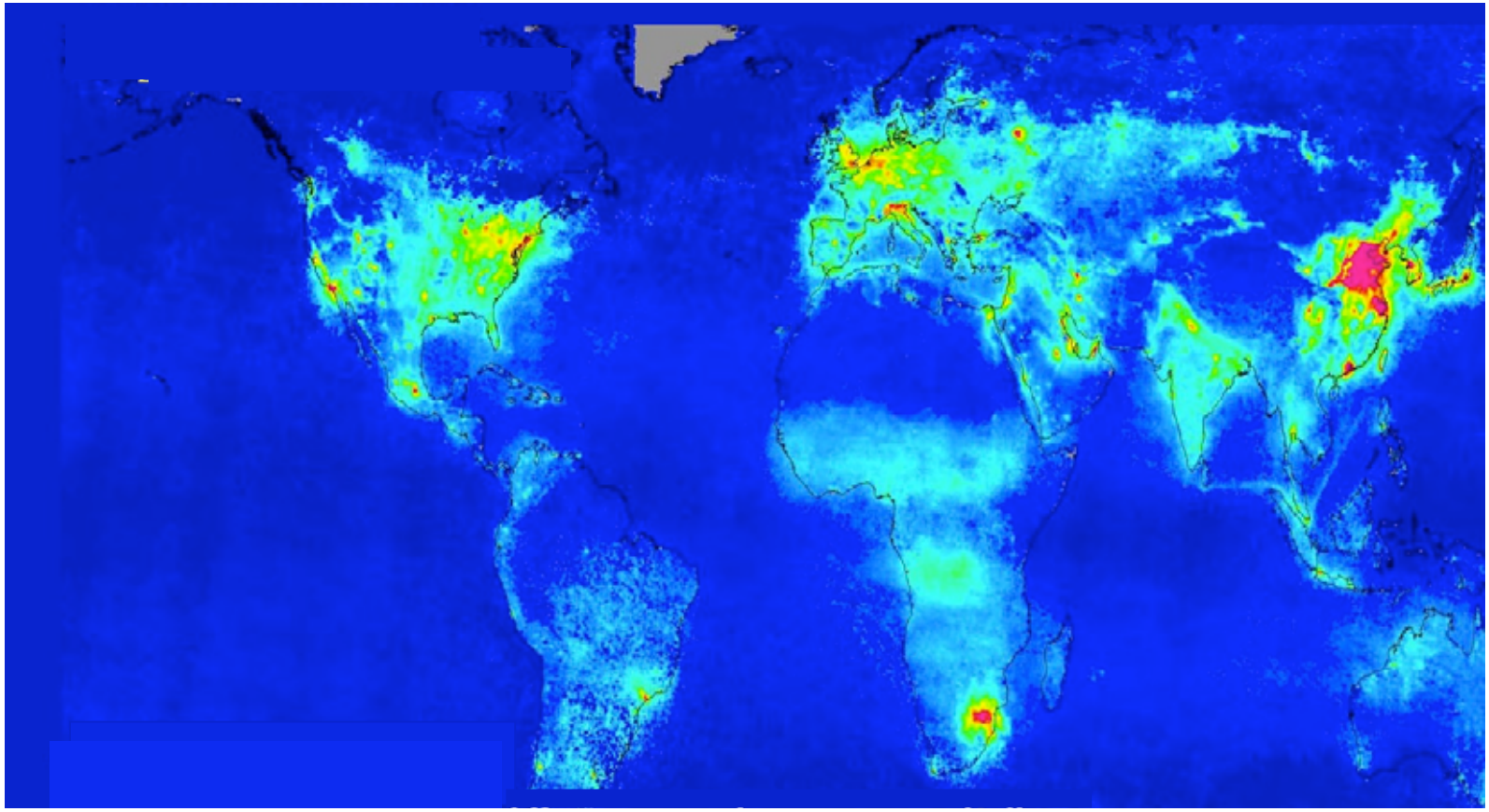
VOSTEEN Consulting GmbH

Thermal Engineering and Environmental Protection

Chinese Low Chlorine Coals Need Bromine for Co-benefit Mercury Capture

Bernhard W. Vosteen, Vosteen-Consulting GmbH

EUEC 2010: The 13th Annual Energy & Environment Conference
February 1 - 3, 2010, in Phoenix, AZ (USA)
Track C2: Mercury Control & Sorbents (#C 2.8)



Global Atmospheric NO_2 Emissions 2006

Conclusion: high dust SCR-DeNOx needed in China, as well

(Prof. Dr. Lothar Reh, ETH Zurich)

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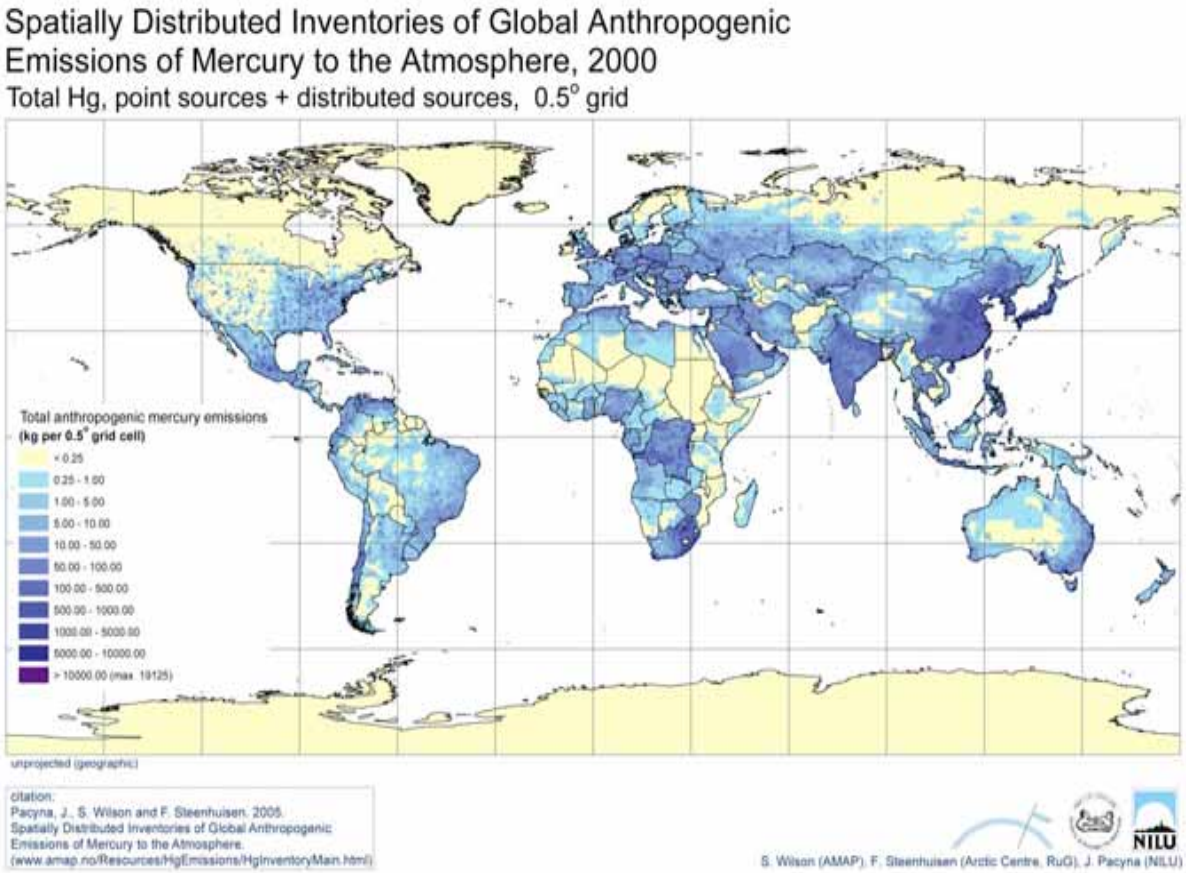
- Introduction - Global Mercury Emissions
- Coal Consumption and Mercury from Chinese Coals
- Vosteen Consulting and AE&E - Activities in China
- Low Chlorine Coals - Possible Co-benefits of BBA in China
- Legislation still open

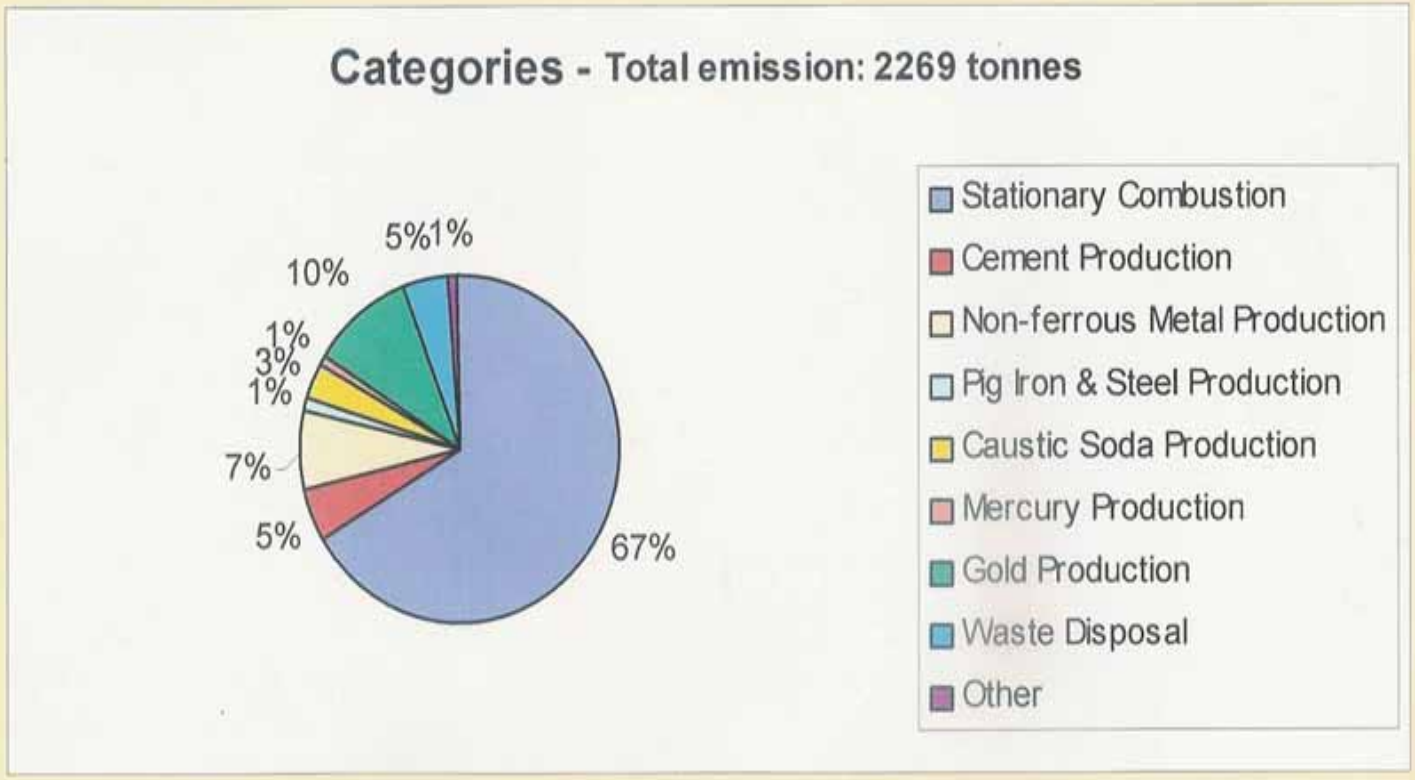
Global Anthropogenic Emissions of Mercury to the Atmosphere, 2000:

2269 tons per year (growing + 1.4 % per year)



J. M. Pacyna et al.: http://amap.no/Resources/HgEmissions/

Global emissions of total Hg from anthropogenic sources in the year 2000



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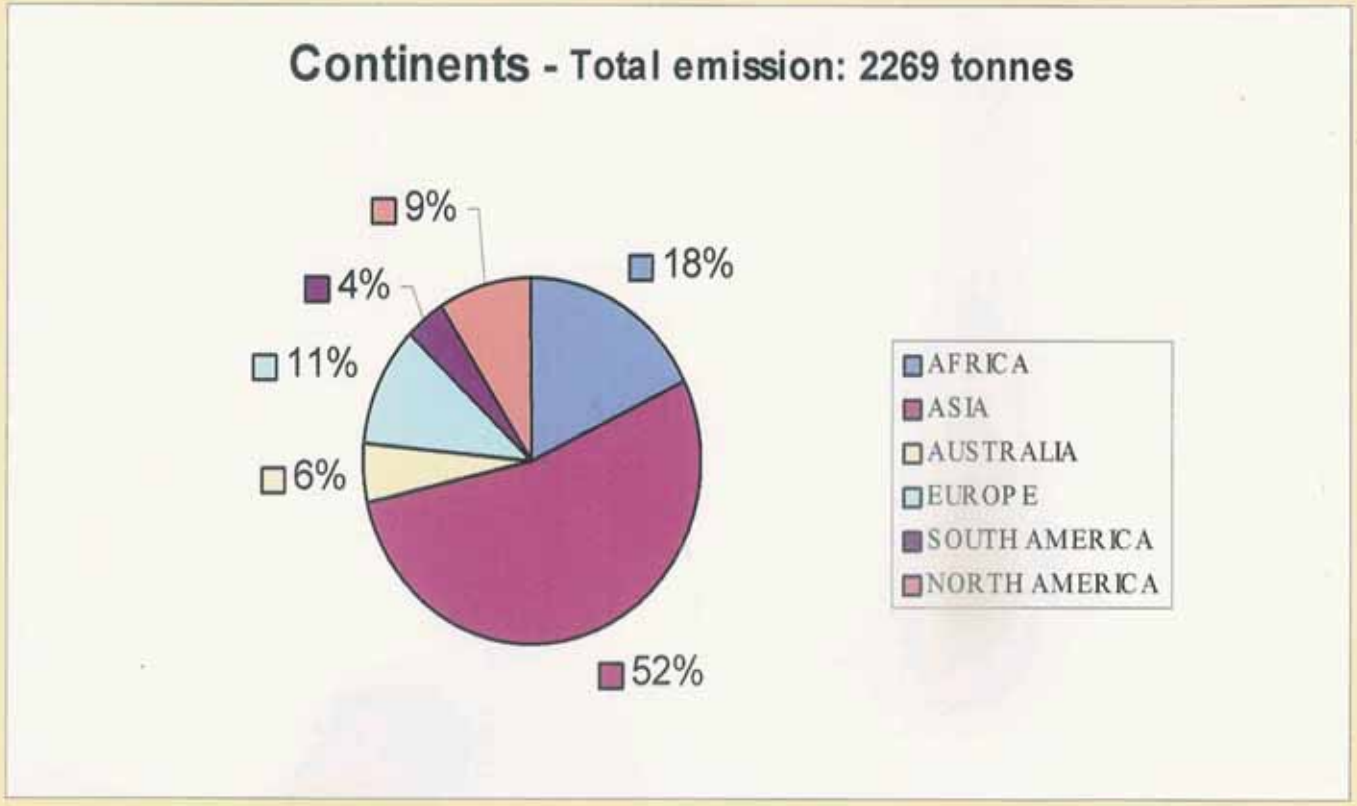

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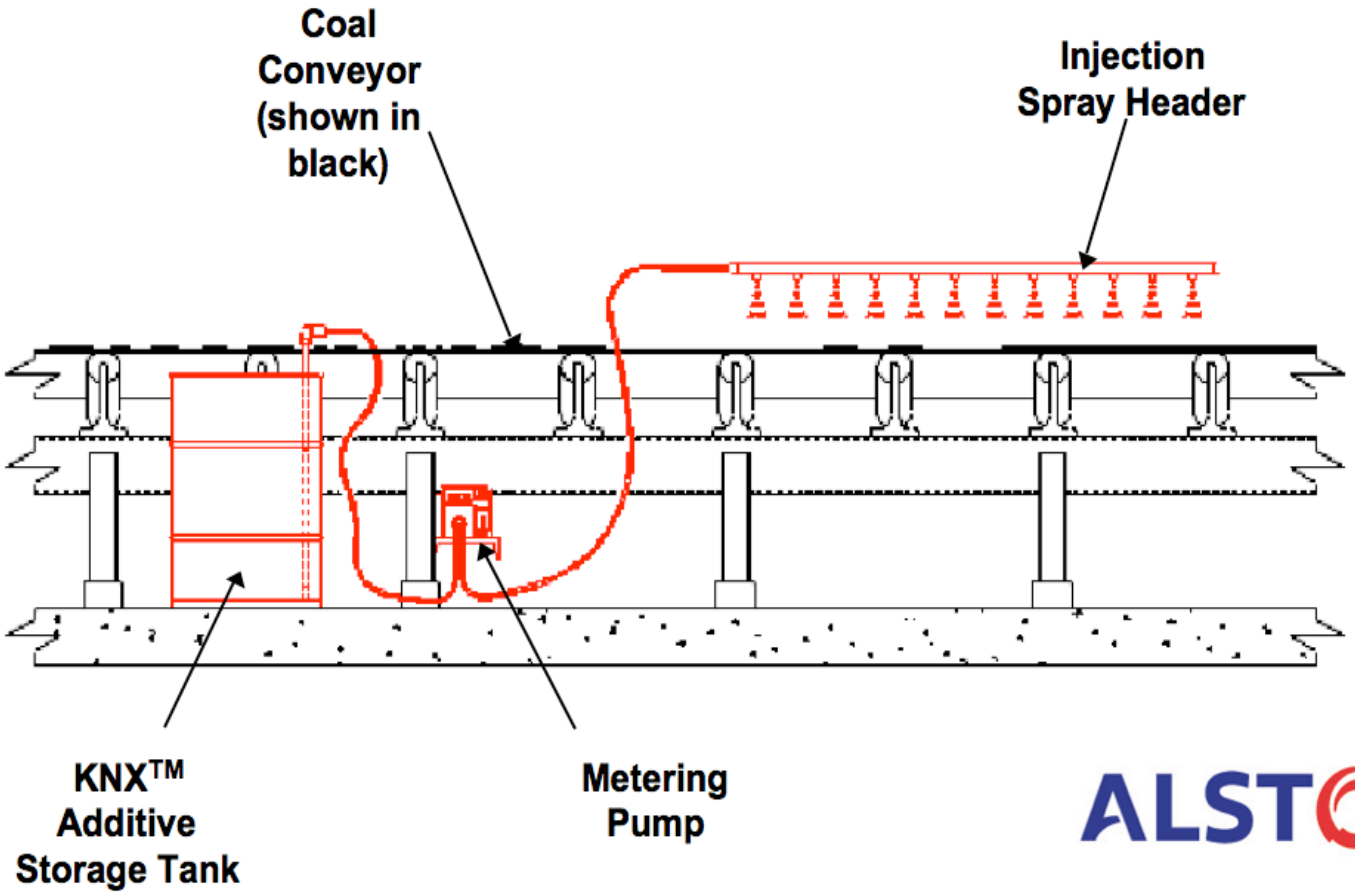
KNX™ Coal Additive – Addition on coal conveyor belt



ALSTOM

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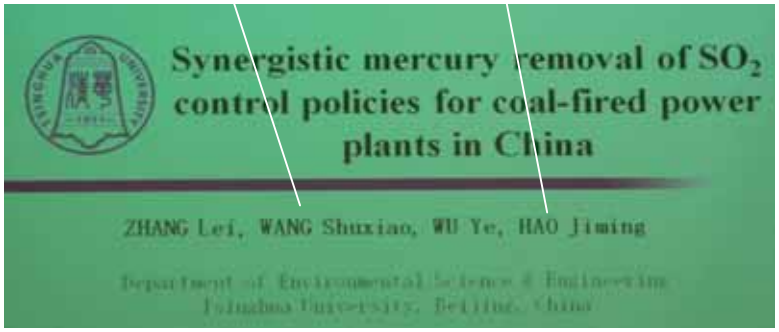
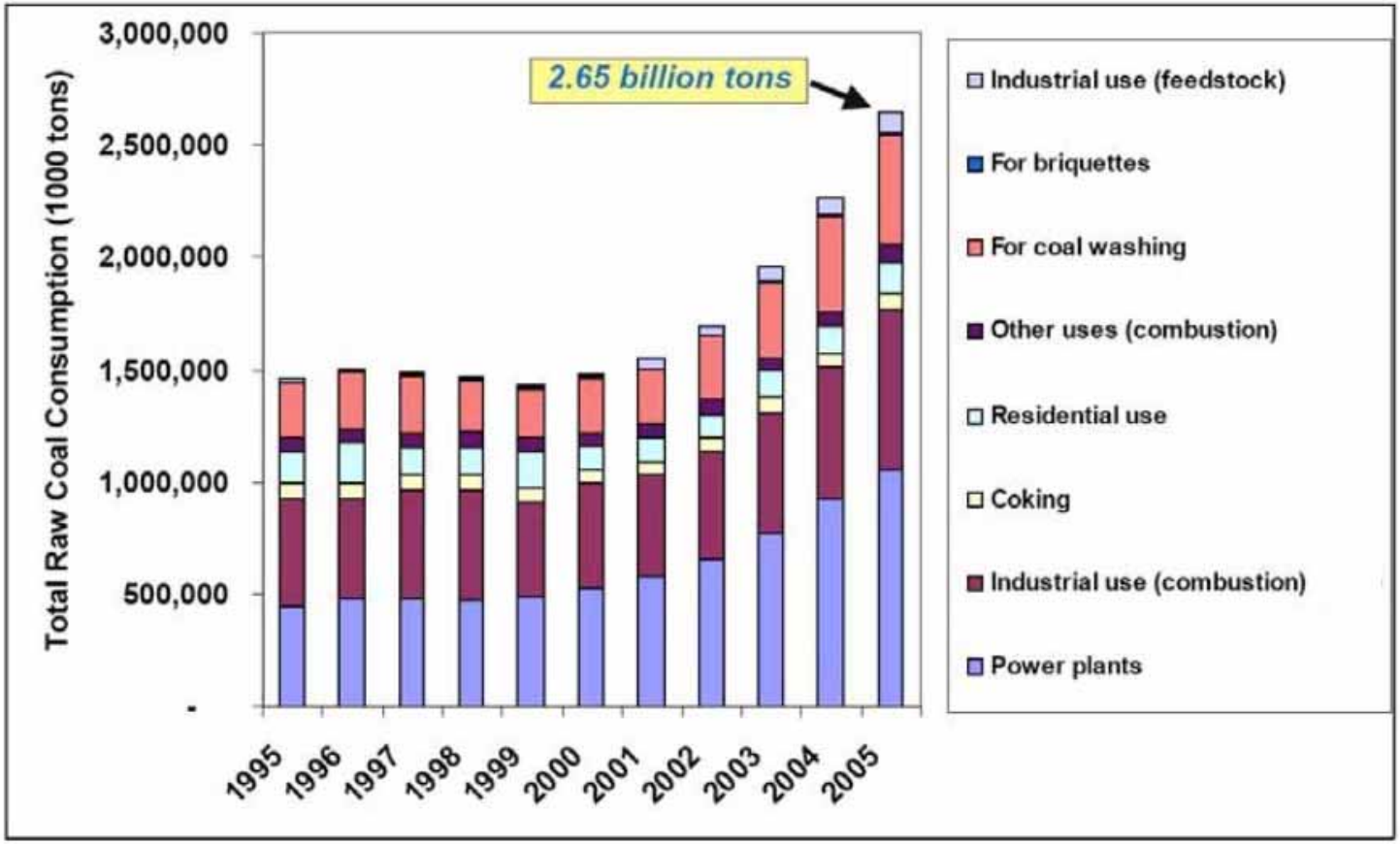
9th International Conference on Mercury as a Global Pollutant
A conference where the mercury concerns of the developed and the developing worlds will meet

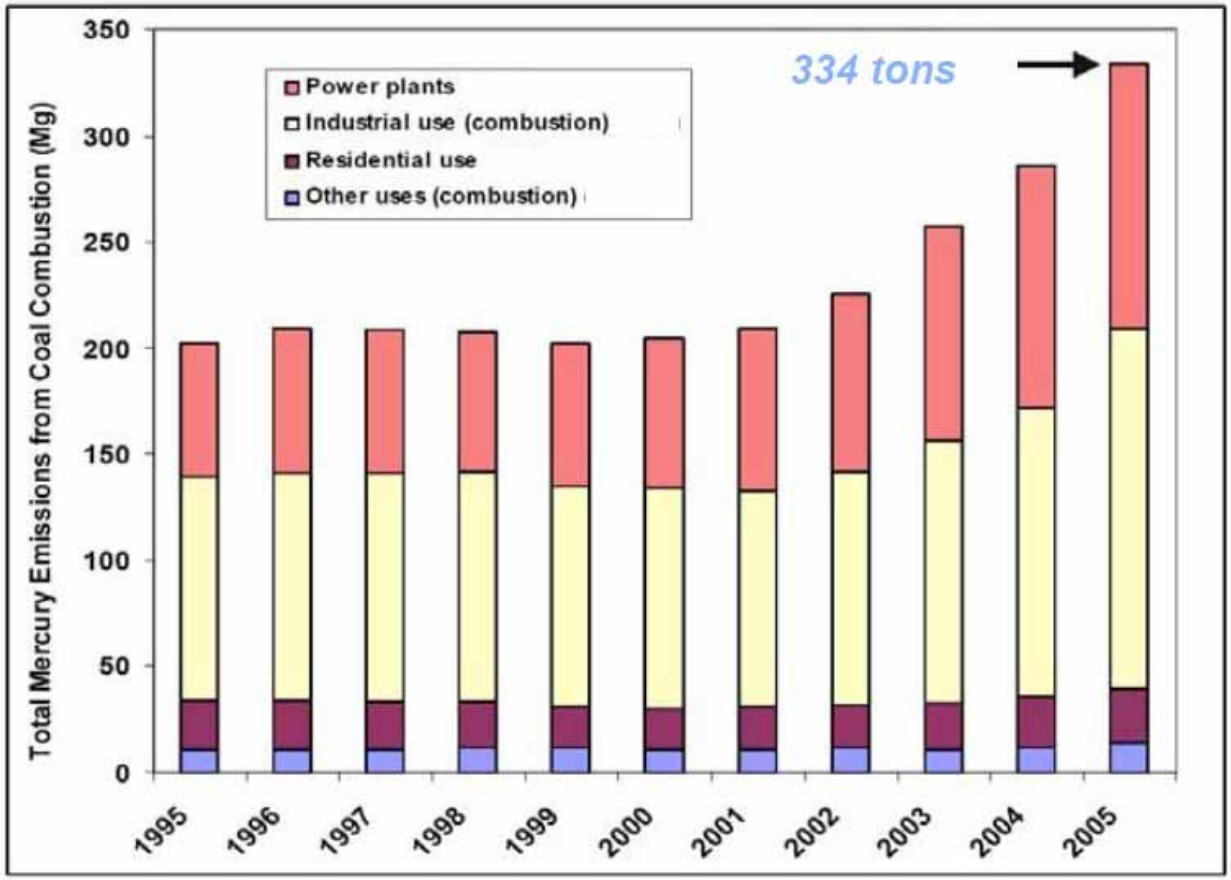

Synergistic mercury removal of SO_2 control policies for coal-fired power plants in China
ZHANG Lei, WANG Shuxiao, WU Ye, HAO Jiming

Trends in raw coal consumption in China, 1995-2005



Source: David G. Streets, Argonne National Laboratory, and Jiming Hao, Shuxiao Wang, Ye Wu, Tsinghua University, Beijing: „Mercury Emissions from Coal Combustion in China", International Conference of the UNEP, Rome, Italy, April 7-11, 2008

Trends in mercury emissions from coal combustion, 1995-2005



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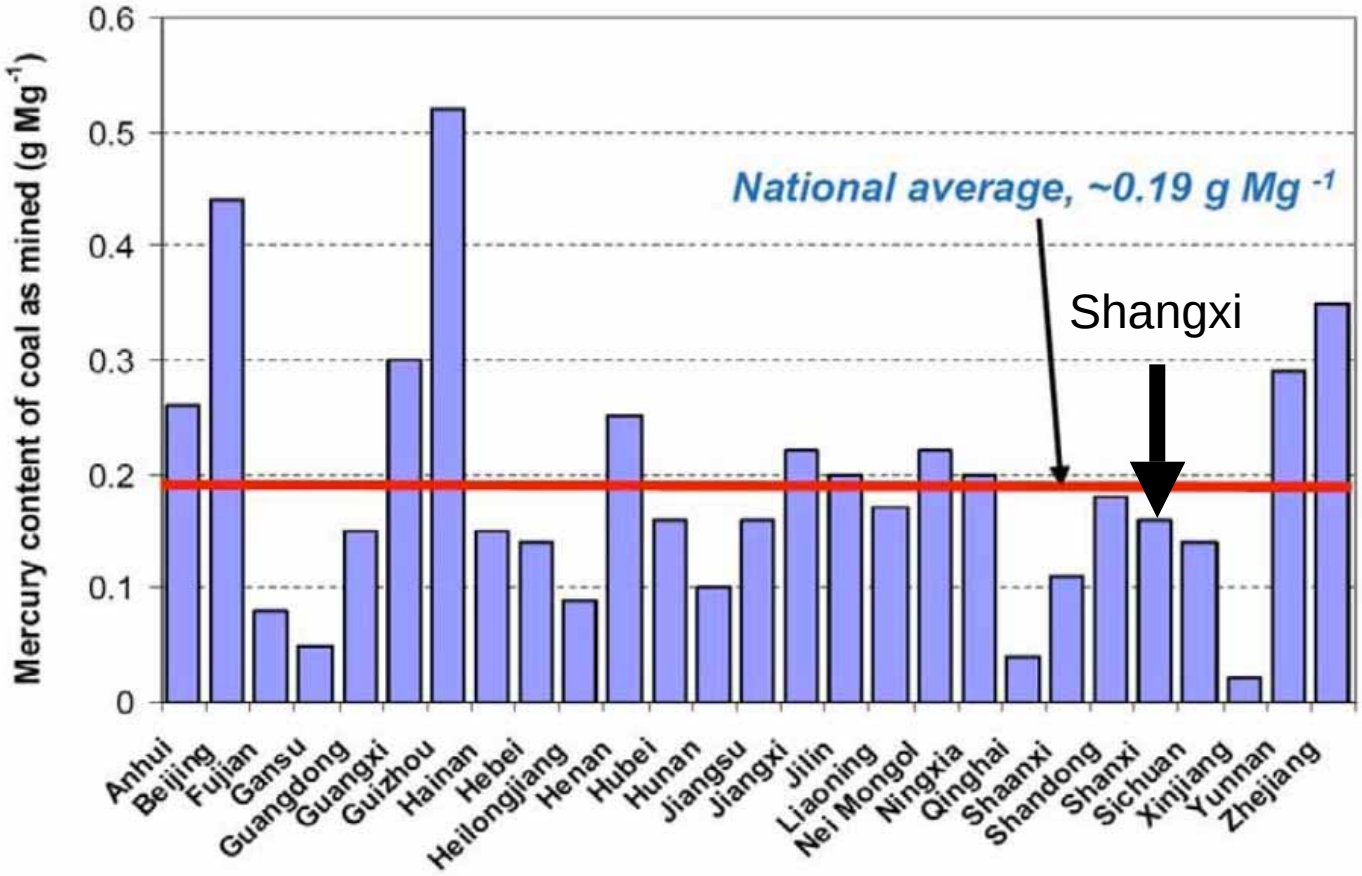
Mercury content of raw coal, as mined (g Mg^{-1})



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Annual electricity generation and installed capacity of coal fired power plants (> 200 MWe/unit) throughout 2000 - 2008

by courtesy of Wojciech Jozewicz, Arcadis US (2010)

Year	Total Electricity Generation TWh	Portion of Total Electricity Generation, %	Total Installed Capacity GW	Portion of Total Installed Capacity, %
2000[2]	1108	81.0	237.6	74.4
2001[2]	1204	81.2	253.1	74.8
2002[2]	1342	81.7	265.5	74.5
2003[2]	1905	82.9	384.5	74.0
2004[6]	2187	82.6	442.0	75.0
2005[5]	2498	82.0	517.2	75.7
2006[5]	2850	83.0	623.7	78.0
2007[4]	3264	83.0	718.2	77.6
2008[4]	3451	81.0	792.7	75.9

Data are retrieved from the reliability management statistics for years 2007 and 2008:

2007 年火电100兆瓦、水电40兆瓦及以上容量机组和核电机组运行可靠性指标
http://chinaer.cec.org.cn/news/deptnews.asp?id=2963

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http://www.cec.org.cn/news/showc.asp?id=116779

Recent Mcilvaine Forcast for China (January 28th, 2010):

Over 300 coal projects are in the planning stage.

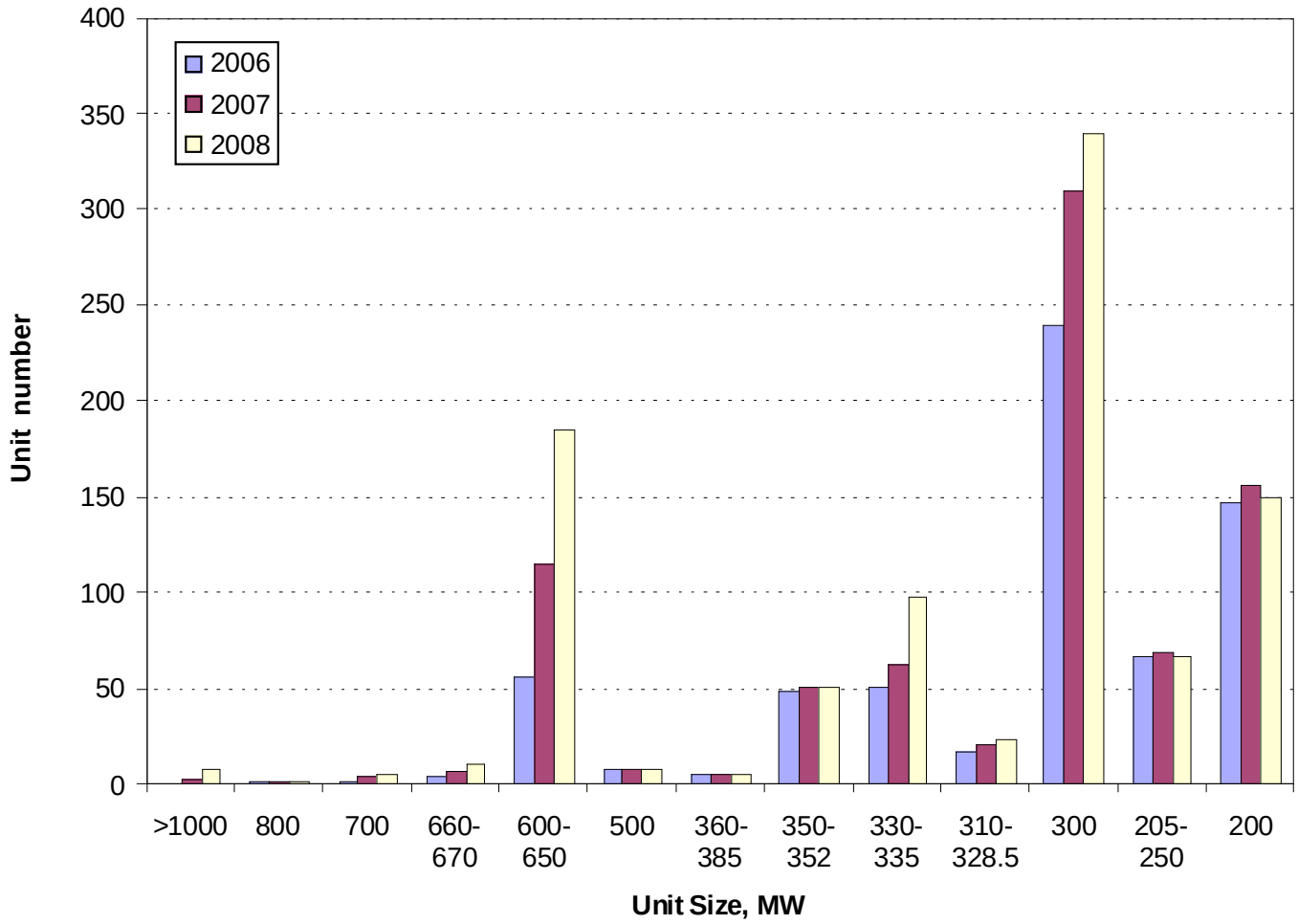
It is estimated that 75 percent of them will be constructed prior to 2020.

This results in 300,000 MW of new capacity.

Category	Nuclear	Coal	Oil and Gas	Wind	Solar	Total
Projects in Planning	100 +	300	80	140	500	1,120
MW in Planning	140,000	400,000	30,000	70,000	10,000	650,000
% Operating by 2020	43	75	80	150	200	
MW additions by 2020	60,000	300,000	24,000	100,000	20,000	504,000

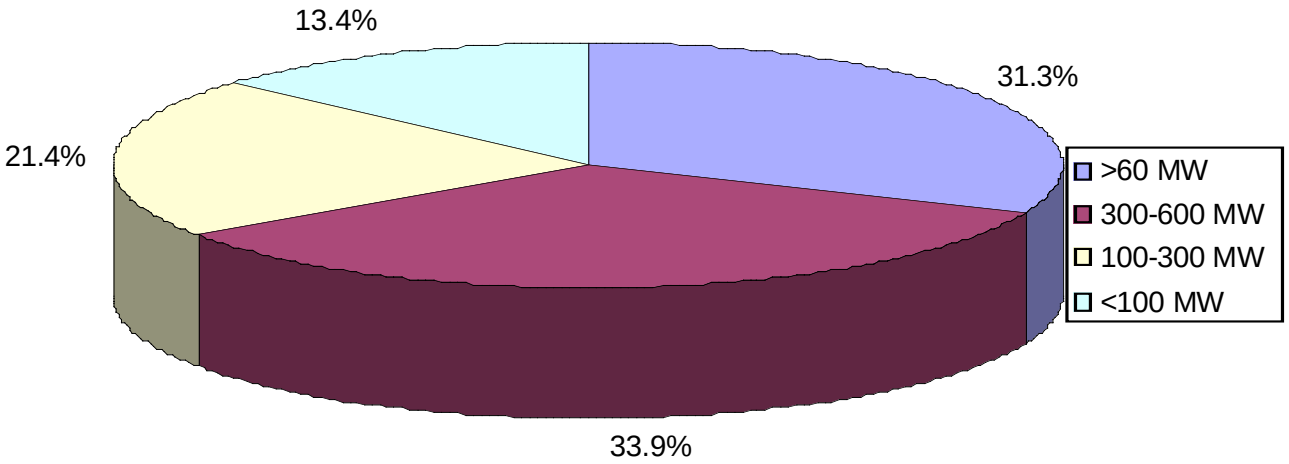
The installed units size against the number of units

by courtesy of Wojciech Jozewicz, Arcadis US (2010)



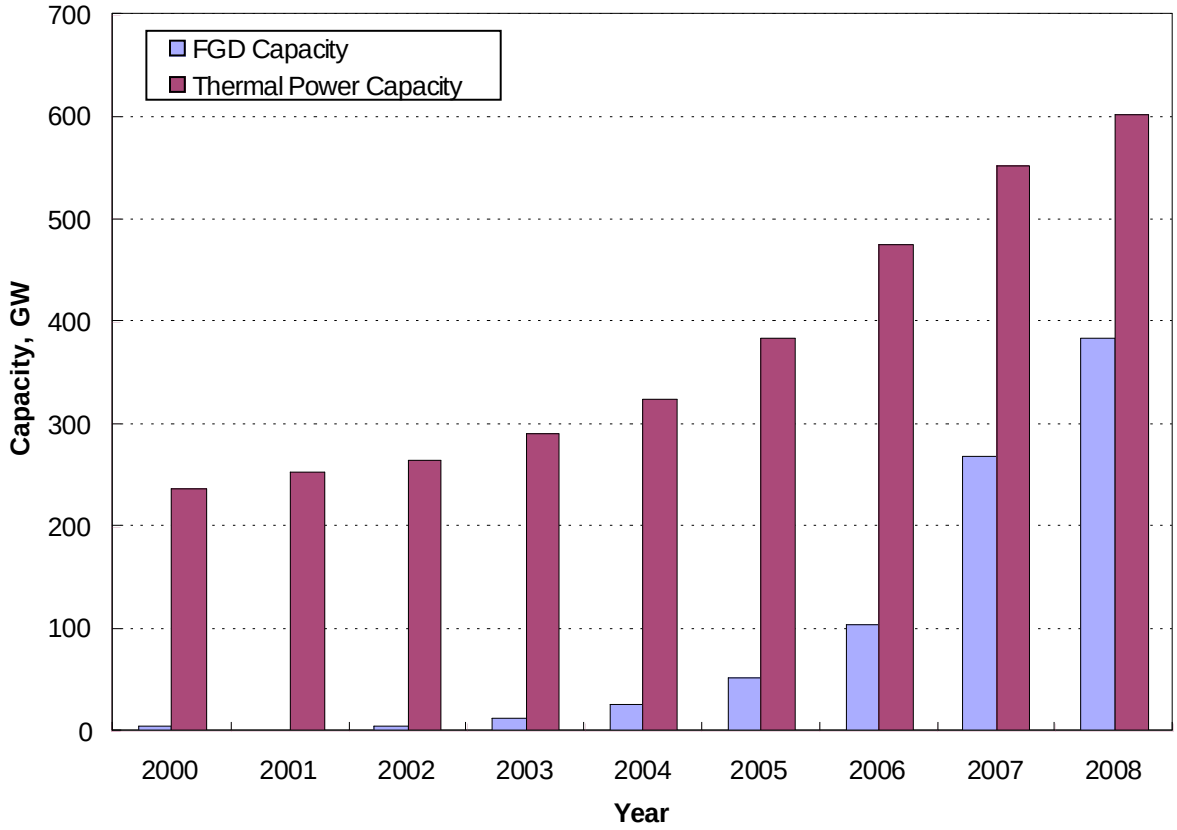
The market share of different power generation units

by courtesy of Wojciech Jozewicz, Arcadis US (2010)



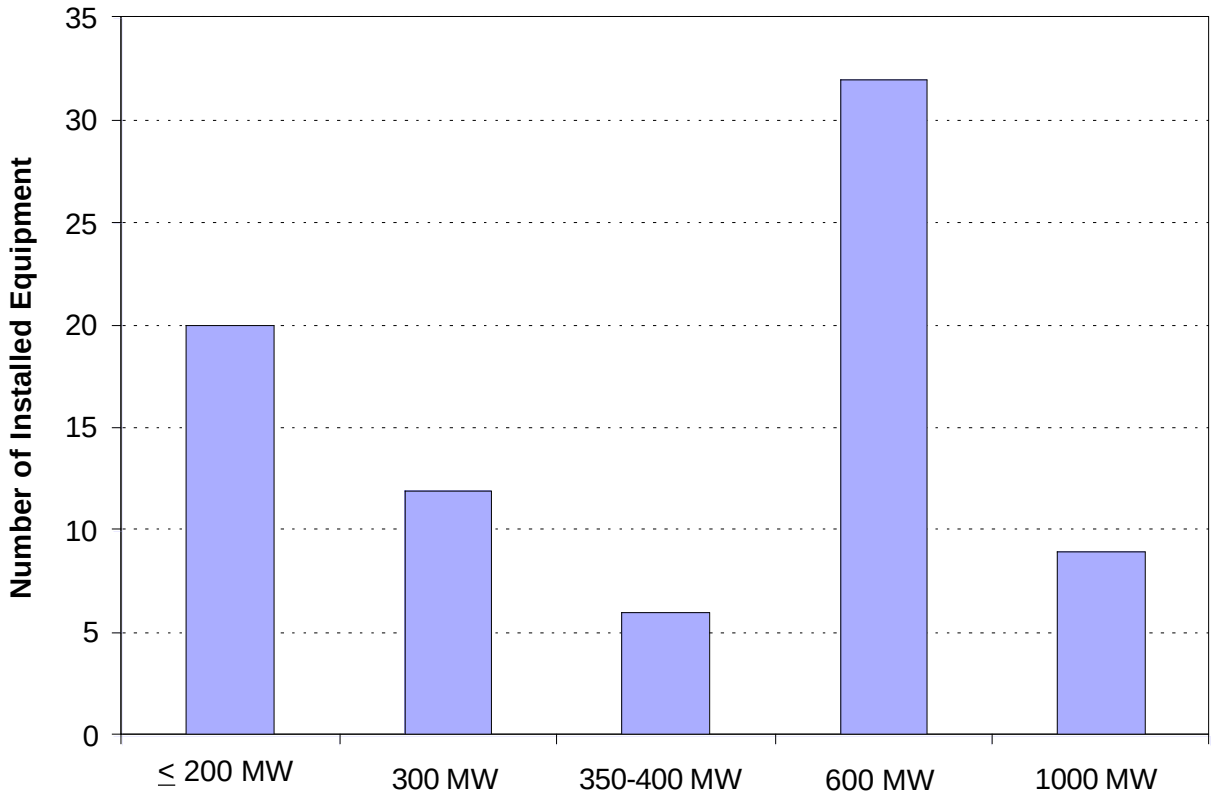
The comparison of installed FGD capacity with power generation capacity since 2000 (mainly wet limestone FGD)

by courtesy of Wojciech Jozewicz, Arcadis US (2010)



The deployment status of SCR technology against unit size

by courtesy of Wojciech Jozewicz, Arcadis US (2010)



Vosteen Consulting GmbH in China - together with

AUSTRIAN ENERGY & ENVIRONMENT

AE&E, Raaba (Austria)
and affiliates as AE&E China

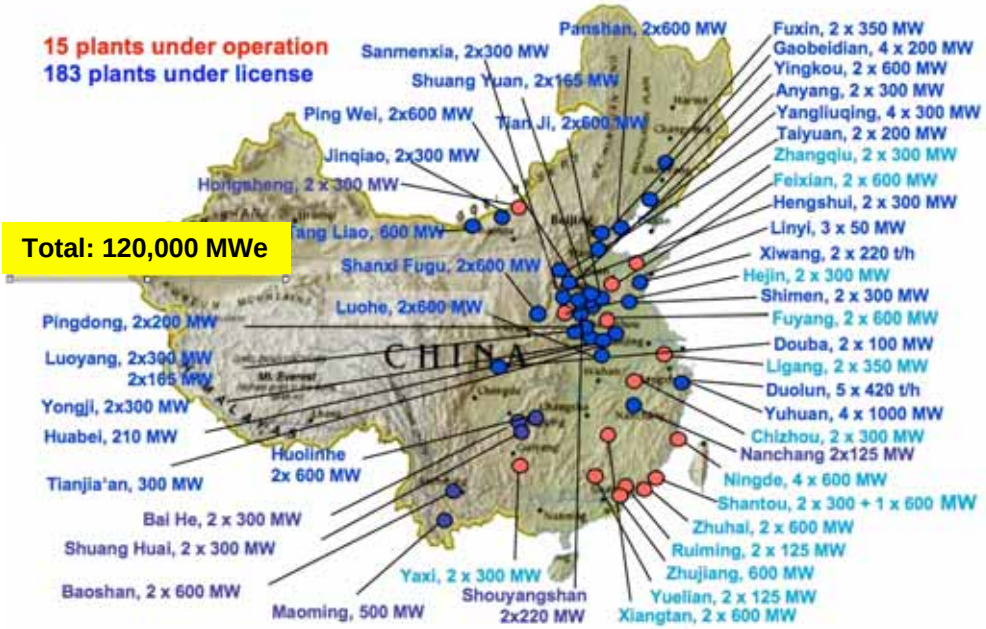
Strong Triangle – VOSTEEN+AE&E+MERQUEL™

- Combination of Simple Technology, high efficient additive and long term experience in the installation of Air Pollution Control Systems especially in China

- **AE&E Wet FGD Technology** is installed for more than **120.000 MW** of coal fired power plant capacity in China
- **AE&E's Air Pollution Control Technologies** including DeNOx-Systems, Dry Desulphurization Systems and Wet Flue Gas Desulphurization Systems is used from more than 10 Licensees in China

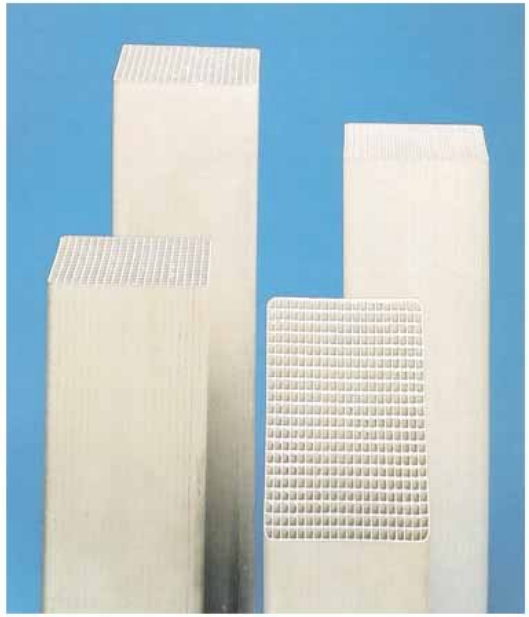
What makes the VOSTEEN Technology Unique ?

- Pre-combustion **Merquel™** addition is the most effective method to enhance mercury oxidation from coal-fired boilers and industrial processes
- **Merquel™** from **ICL-IP** is already used by the power generation industry and the waste incineration industry; The additive is cost-effective and readily available
- The **VOSTEEN** Technology is simple and inexpensive to retrofit to any boiler



SCR experience (1986 – 2009)

- Installed catalyst volume: ~ 20,000 m³
- ~ 72 % thereof in honey comb type
- 98 % high dust applications (pitch 7.3 mm)
- 2 % tail end applications (pitch 4.3 mm)
- Replacement of catalyst: ~ 1,000 m³ / year
- 50 % of replaced catalyst regenerated by washing
- Catalyst replacement for
  tangential fired boilers: every 5 to 10 years
  opposite wall fired boilers: every 3 to 5 years
- Special sieves can avoid blocking of catalyst (popcorn ash)



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Evaluation Prof. Vosteen of preliminary data from NCRDS on 305 Chinese Coal Samples - courtesy of Harvey Belkin, USGS (2010)

Coal samples originating from Anhui, Beijing, Chongqing, Fujian, Gansu, Guangdong, Guangxi, Guizhou, Hebei, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Jiangxi, Jilin, Liaoning, Nei Mongol (Inner Mongolia), Ningxia, Qinghai, Shaanxi, Shangdon, Shanxi, Sichuan, Xinjiang,Yunnan

Arrangment of these data by Prof. Vosteen with respect to the regional sources in China (number of samples, available up to now):

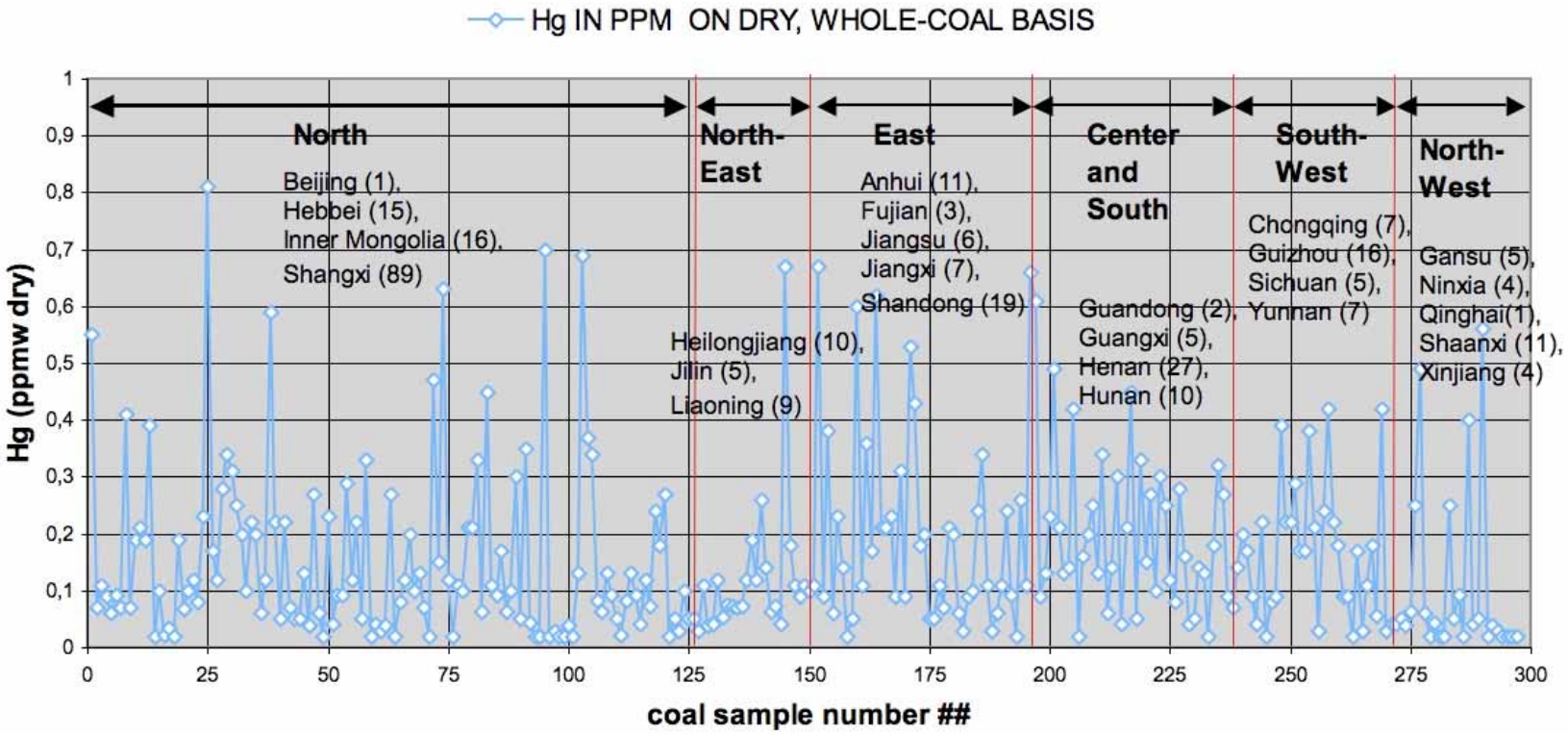
North:	Beijing (1), Hebbei (17), Inner Mongolia (16), Shangxi (89)
North-East:	Heilongjiang (10), Jilin (5), Liaoning (9)
East:	Anhui (11), Fujian (3), Jiangsu (6), Jiangxi (7),Shandong (19)
Center and South:	Guandong (2), Guangxi (5), Henan (27), Hunan (10)
South-West:	Chongqing (7), Guizhou (16), Sichuan (5), Yunnan (7)
North-West: :	Gansu (5), Ninxia (4), Qinghai(1), Shaanxi (11), Xinjiang (4)

etc.

Harvey Belkin, USGS, is analysing for bromine and iodine as well (publication intended in fall 2010)

Preliminary data from NCRDS on 305 Chinese Coal Samples - courtesy of Harvey Belkin (USGS, 2010)

Coal samples originating from Anhui, Beijing, Chongqing, Fujian, Gansu, Guangdong, Guangxi, Guizhou, Hebei, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Jiangxi, Jilin, Liaoning, Nei Mongol (Inner Mongolia), Ningxia, Qinghai, Shaanxi, Shangdon, Shanxi, Sichuan, Xinjiang,Yunnan



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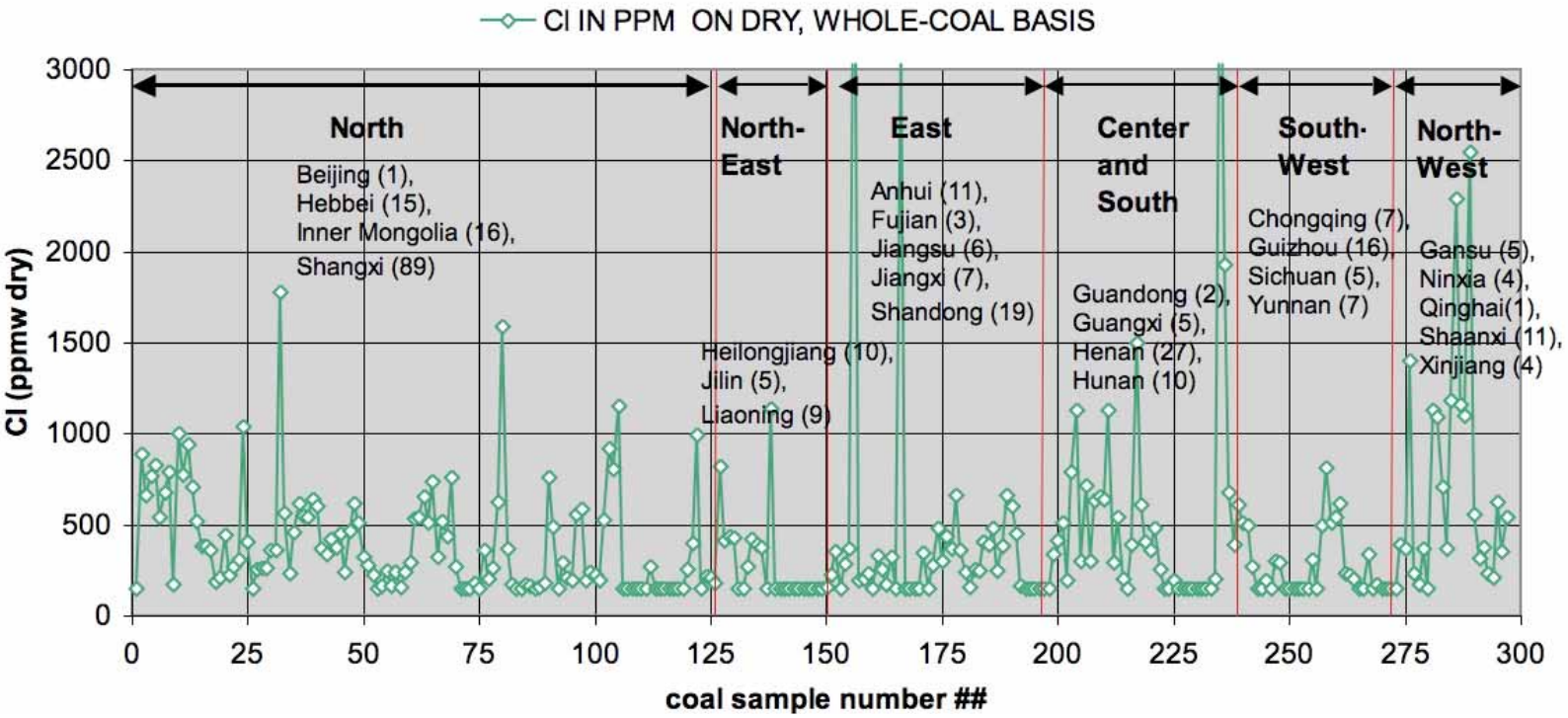

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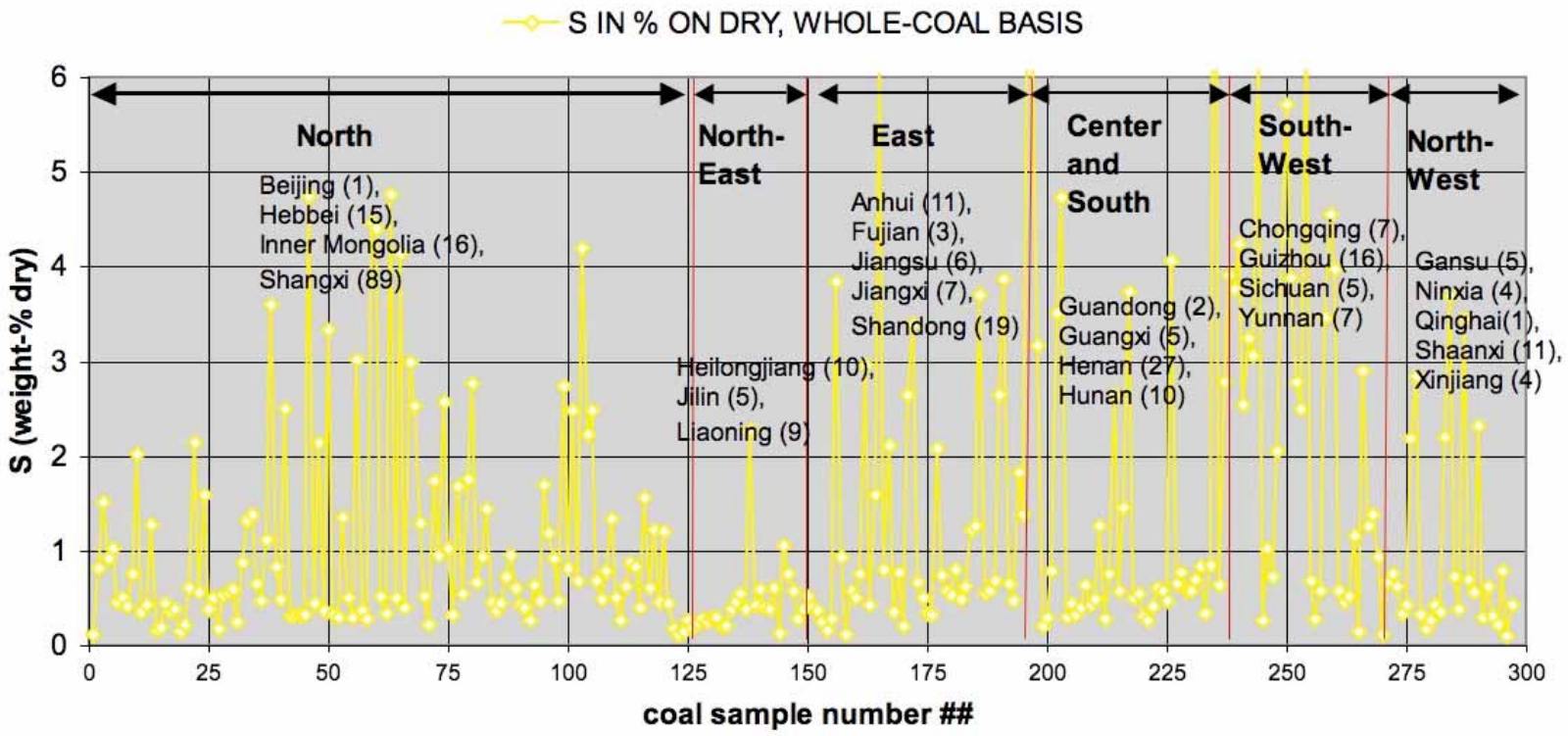

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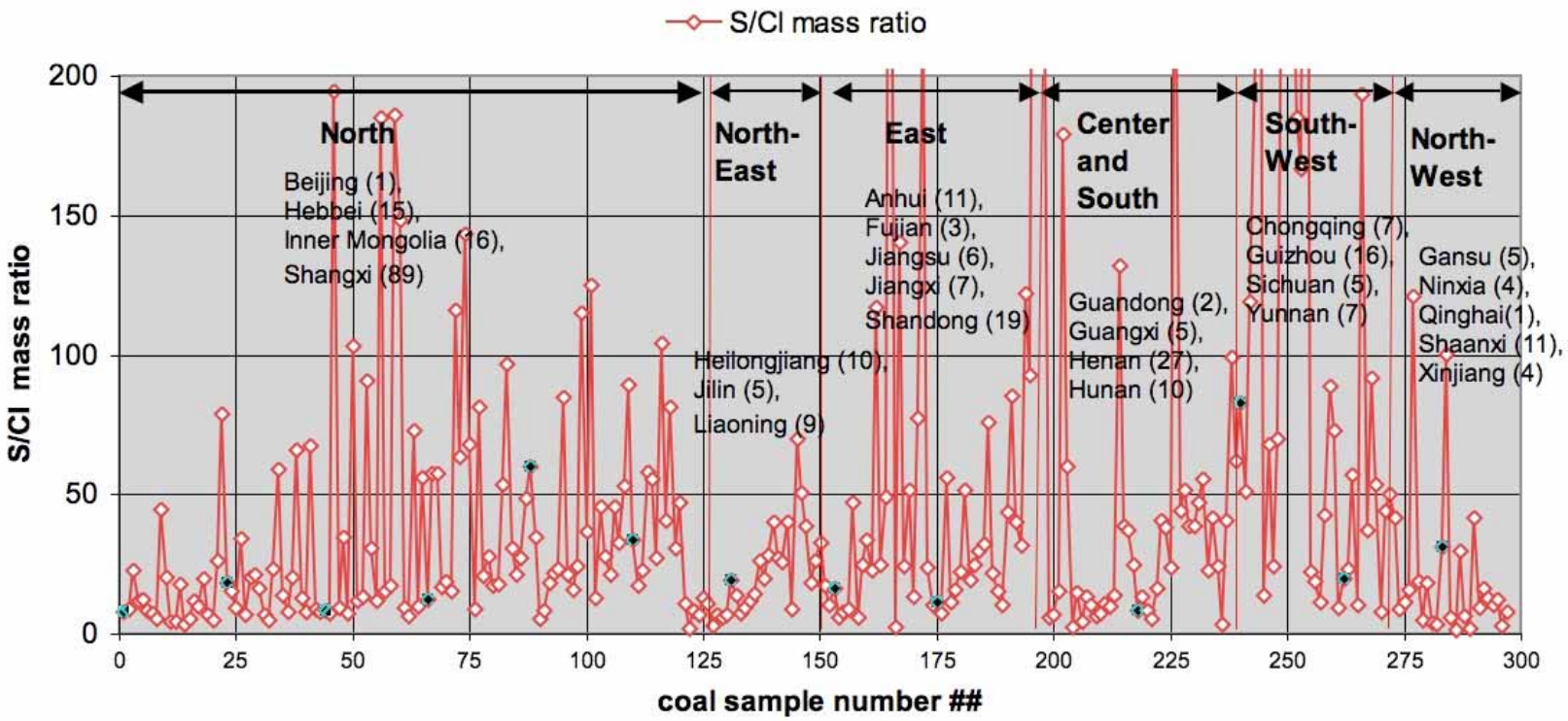

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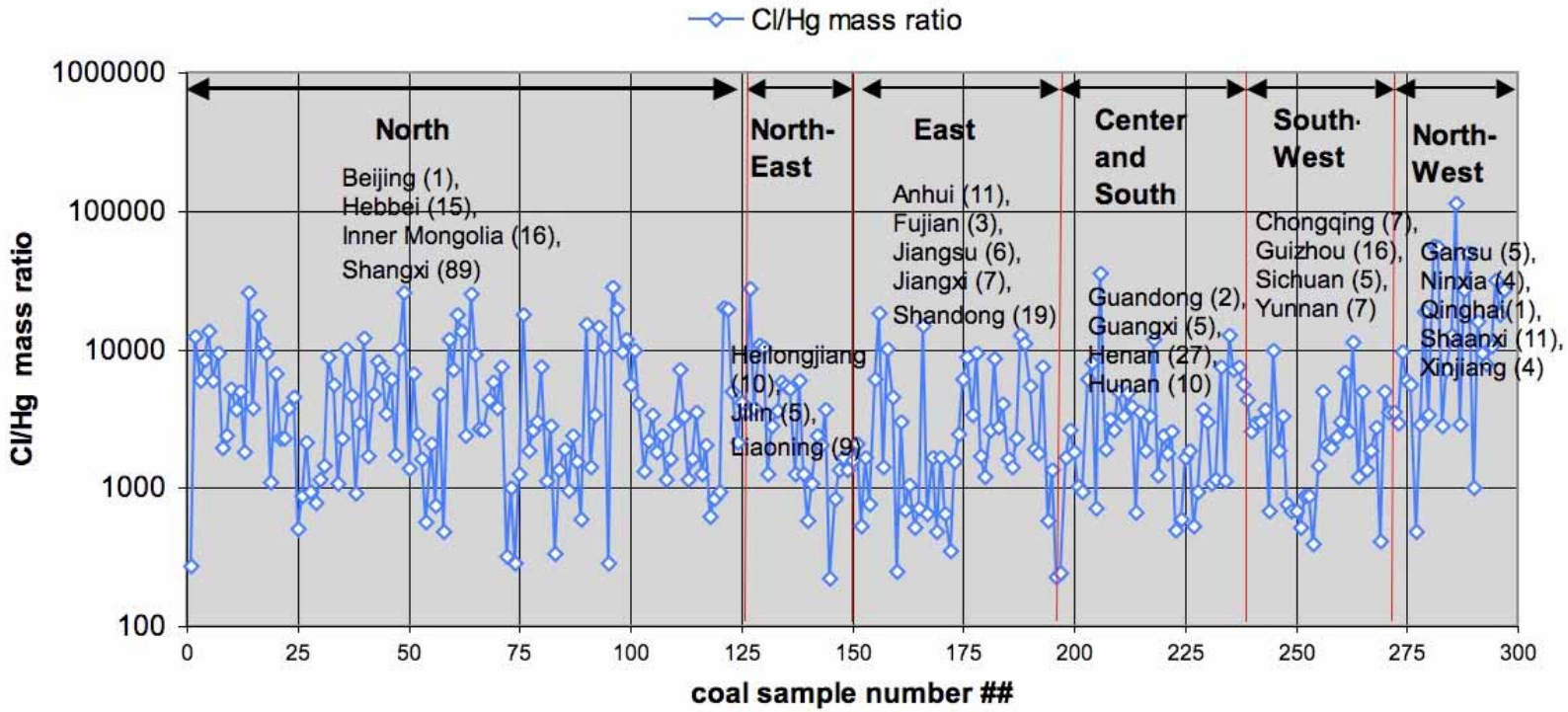

Conclusions with respect to China:

- Normal mean mercury content (0.16 ppm), but strong scatter - even within the same origin (making coal blending difficult)
- Mainly low chlorine content, but also here strong scatter
- Low up to extremely high sulfur contents, strong scatter
- Cl/Hg mass ratio small - lower than in US Ebit coals, i.e. values comparable to low chlorine coals as Columbian bituminous or Western lignite coals
- S/Cl mass ratio large - higher than in PRB coals etc.
  (limiting mercury chlorination even more)
- Harvey Belkin, USGS, is analysing Br as well (data to be published in fall 2010)

-> Precombustion/Boiler Bromide Addition (BBA) will enhance co-benefit mercury control effectively (wet and dry) in case of low chlorine coals, and has been proven the most cost effective solution, as well.

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Categories of Chinese power plants

- I

  All the plants commissioned, built, or re-constructed before Dec. 31, 1996

- II

  All the plants commissioned, built, or re-constructed between Jan. 1, 1997 to Dec. 31, 2003

- III

  All the plants commissioned, built, or re-constructed after Jan. 1, 2004

Regulations on emission of SO_2, NOx and dust given - different limits for plant categogies I, II, III

Regulations on Hg still not given - but in focus

Meeting in Beijing (October, 2008) - Prof. Vosteen presenting Boiler Bromide Addition to Yonghong Li, Having Li, Ministry of Environmental Protection, and Prof. Dr. Lei Duan from Tsinghua University

Thanks for your attention.

Questions ?