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*Supplement of*

## **The effects of energy paths and emission controls and standards on future trends in China's emissions of primary air pollutants**

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# SUPPLEMENT

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**Title:** The effects of energy paths and emission controls and standards on future trends in China's emissions of primary air pollutants

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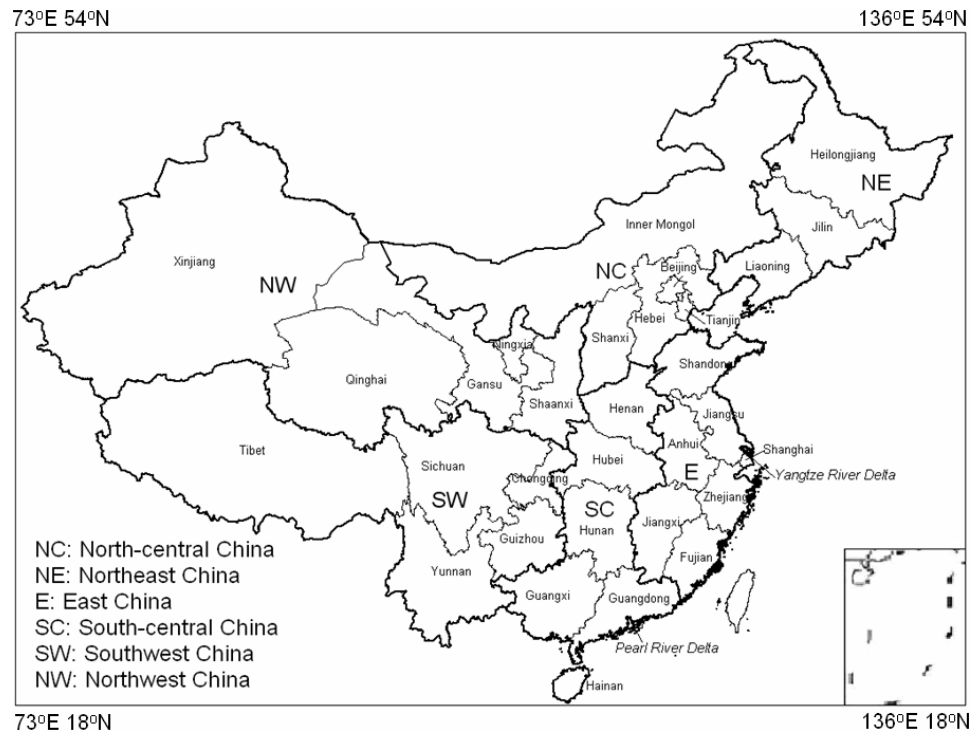
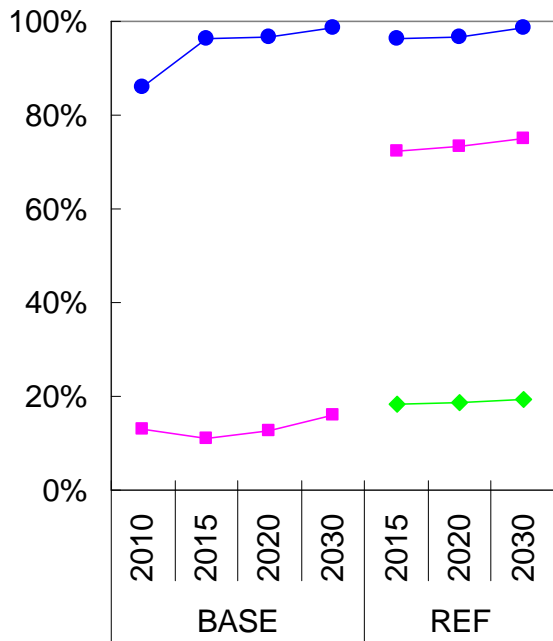
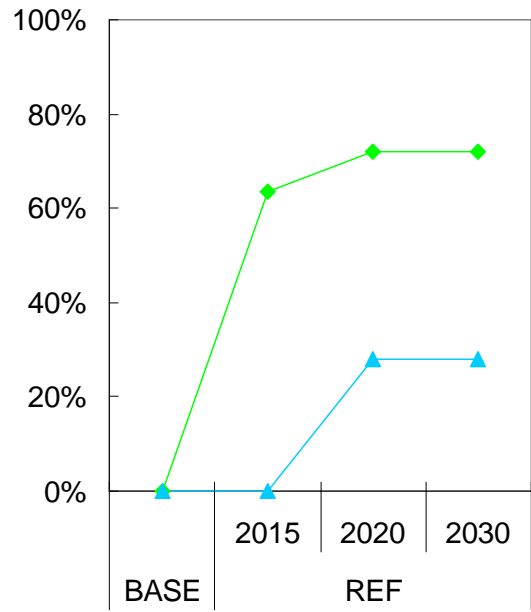


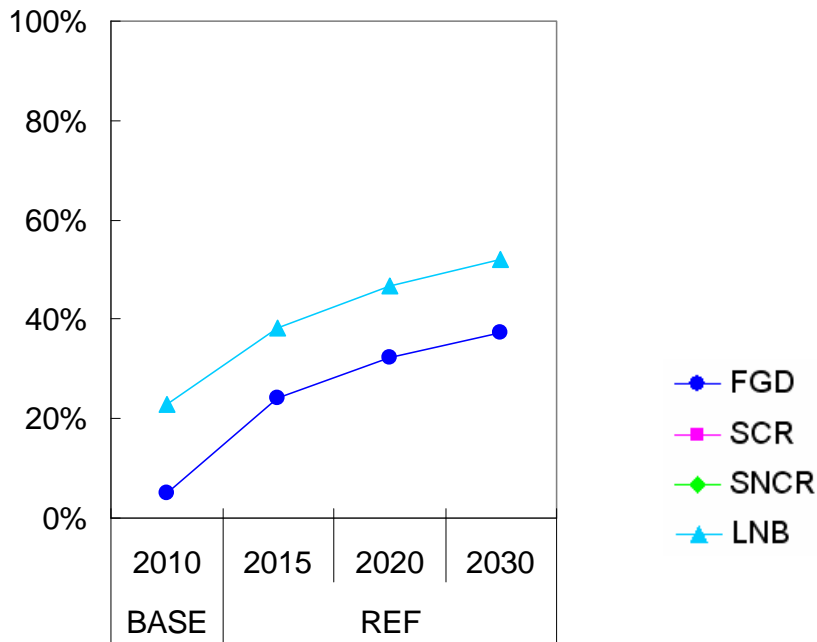
Figure S2.



(a) Coal-fired power plants

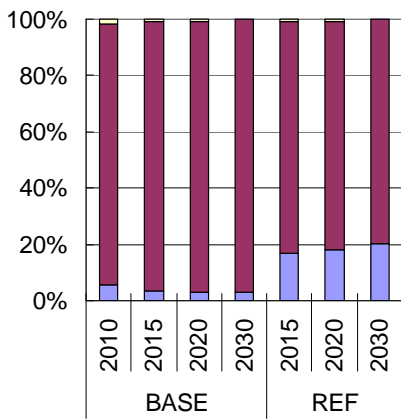


(b) Cement production (precalciner)

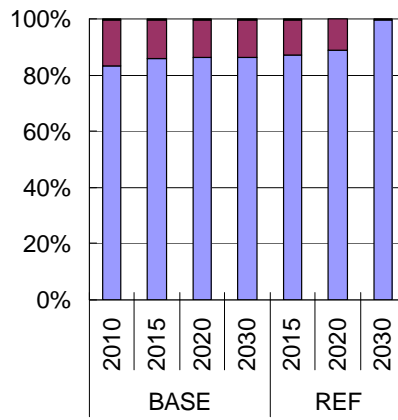


(c) Other industrial coal-fired boilers

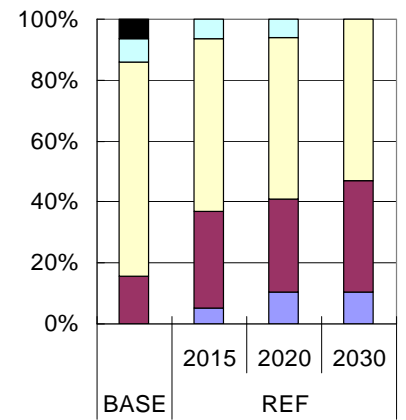
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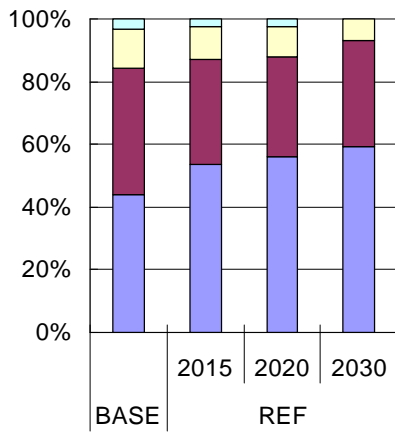
(a) Coal-fired power plants



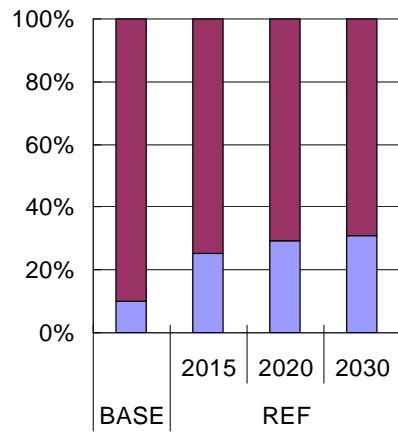
(b) Cement production (precalciner)



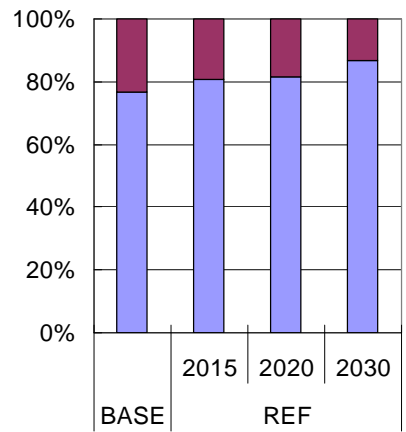
(c) Machinery coking plants



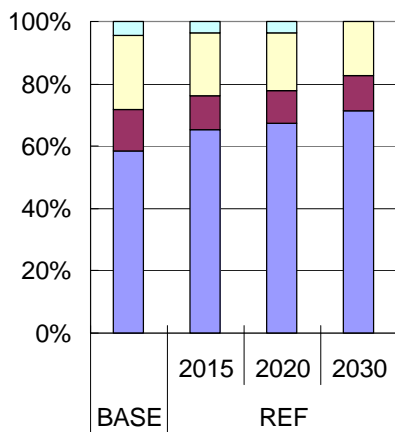
(d) Sintering



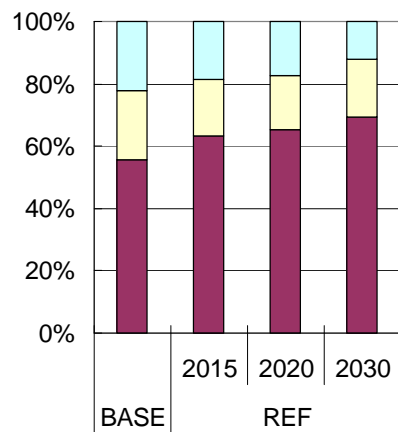
(e) Blast furnaces (iron production)



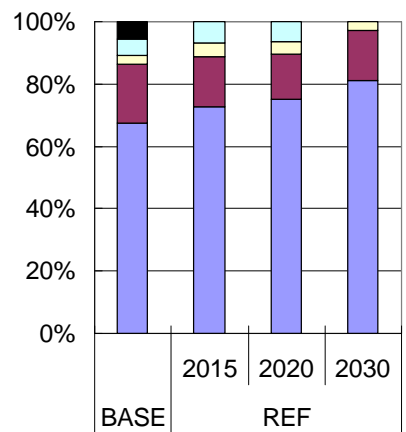
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(g) Electric furnaces (steel making)

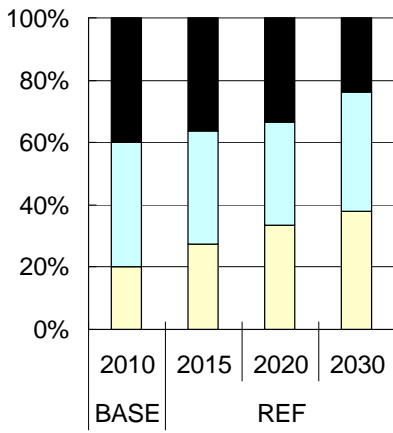


(h) Casting

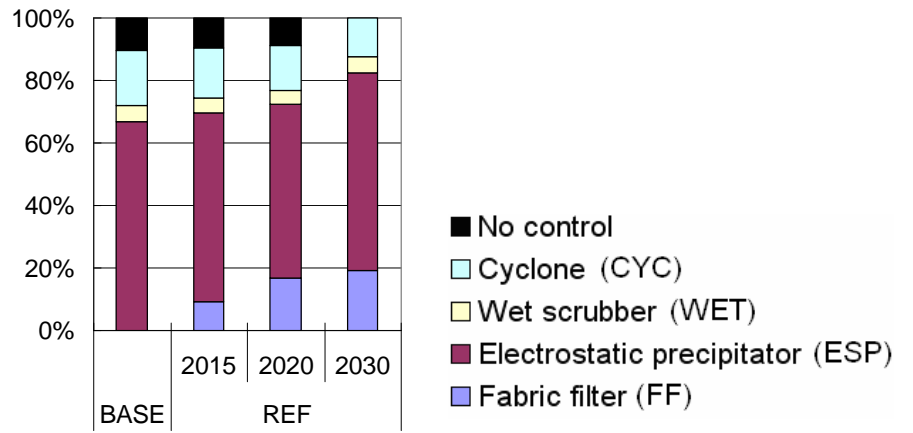


(i) Nonferrous metal (Cu, Zn and Pb)

Figure S3 (continued).

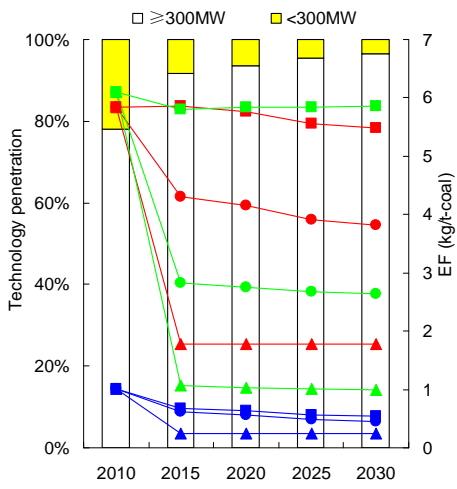


(j) Brick production

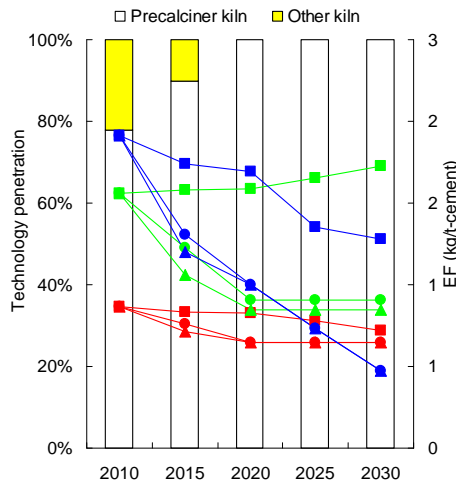


(k) Lime production

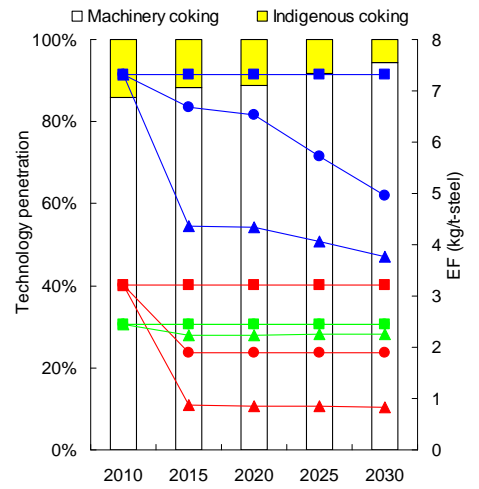
Figure S4



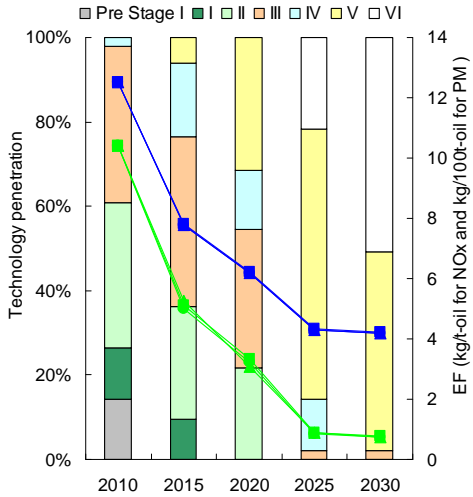
(a) Coal-fired power plants



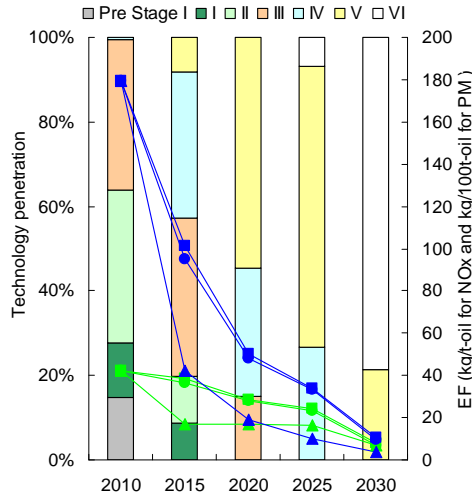
(b) Cement production



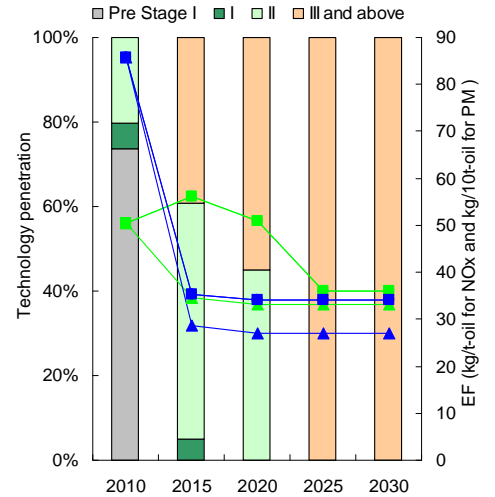
(c) Iron & steel production



(d) Light-duty gasoline vehicles



(e) Heavy-duty diesel vehicles

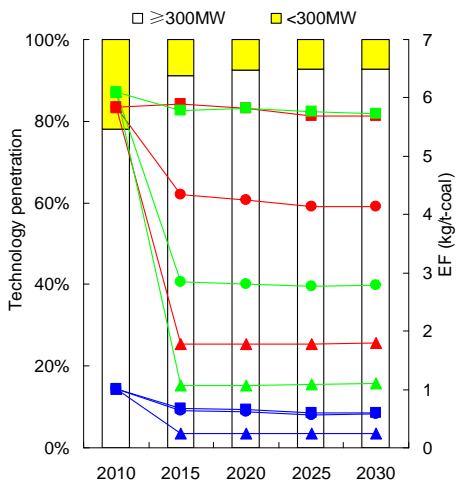


(f) Rural vehicles

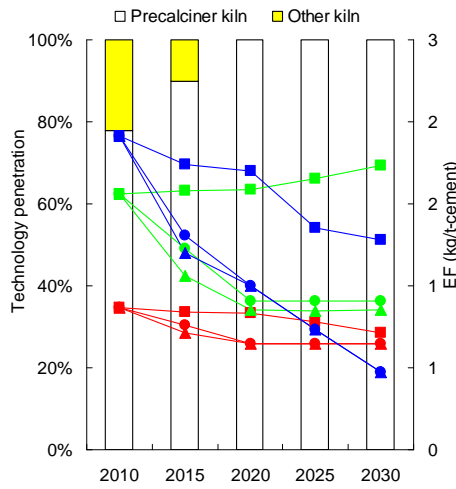
■ BAS ● REF ▲ STD ■ SO<sub>2</sub> ■ NO<sub>x</sub> ■ PM



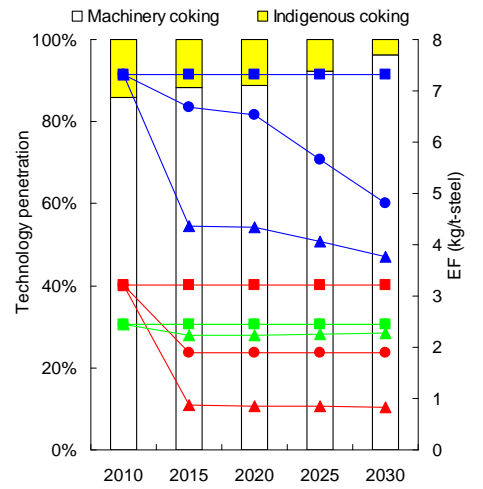
Figure S5



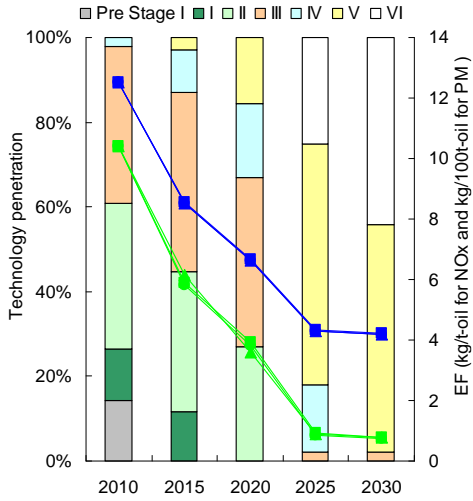
(a) Coal-fired power plants



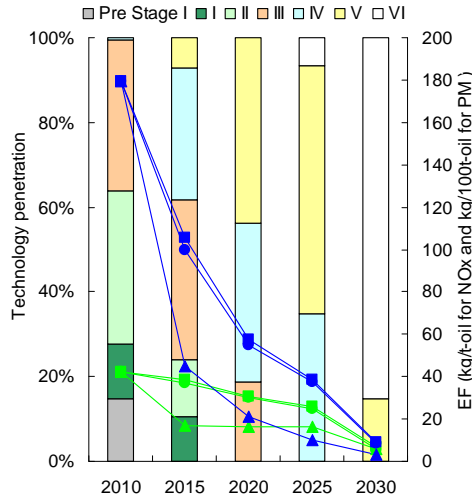
(b) Cement production



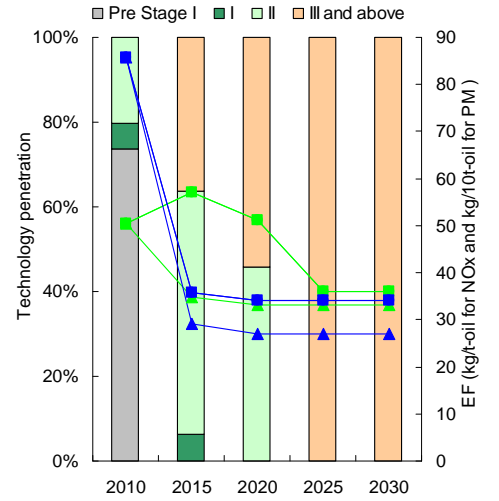
(c) Iron & steel production



(d) Light-duty gasoline vehicles



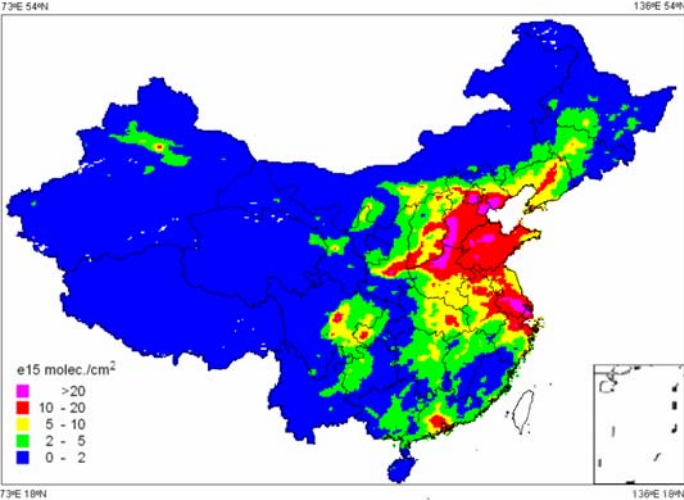
(e) Heavy-duty diesel vehicles



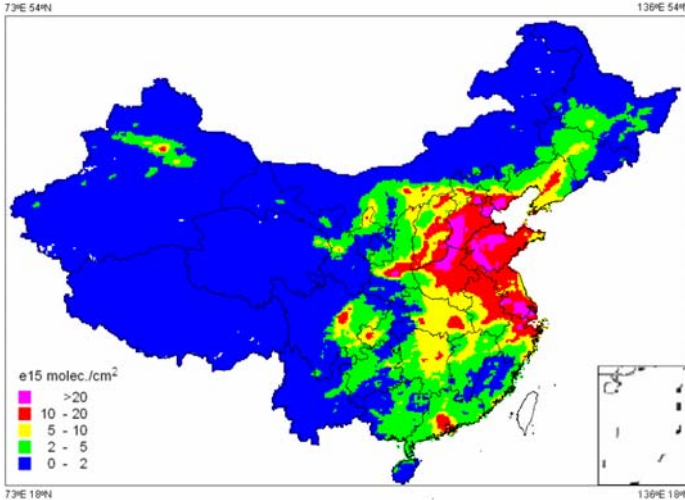
(f) Rural vehicles

■ BAS ● REF ▲ STD ■ SO<sub>2</sub> ■ NO<sub>x</sub> ■ PM

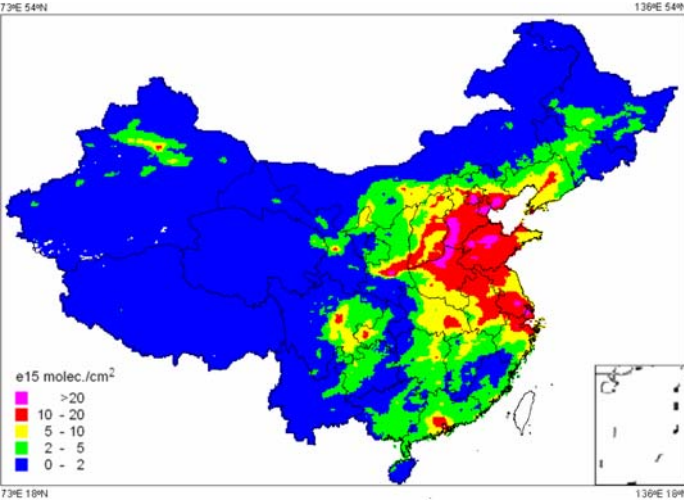
Figure S6



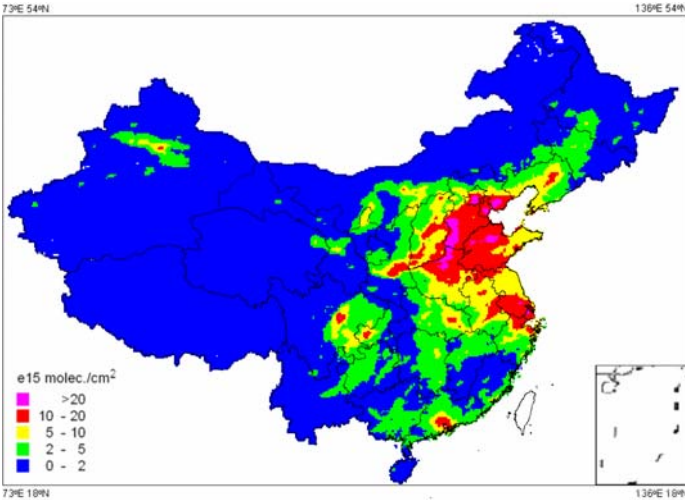
(a) 2010



(b) 2011



(c) 2012



(d) 2013 (averages of January-October)

## Tables

Table S1. The summary of emission standards for stationary sources included in this work.

Sector	Standard	Issued time	Title
Power	GB 13223-2011	July, 2011	Emission standard of air pollutants for thermal power plants
Iron & steel production	GB 16171-2012	June, 2012	Emission standard of air pollutants for coking chemical industry
	GB 28662-2012	June, 2012	Emission standard of air pollutants for sintering and pelletizing of iron and steel industry
	GB 28663-2012	June, 2012	Emission standard of air pollutants for iron smelt industry
	GB 28664-2012	June, 2012	Emission standard of air pollutants for steel smelt industry
Non ferrous metal smelting	GB 25465-2010	Sep, 2010	Emission standard of pollutants for aluminum industry
	GB 25466-2010	Sep, 2010	Emission standard of pollutants for lead and zinc industry
	GB 25467-2010	Sep, 2010	Emission standard of pollutants for copper, nickel, cobalt industry
Brick production	N/A <sup>a</sup>	Nov, 2009 <sup>b</sup>	Emission standard of air pollutants for brick industry
Cement production	N/A <sup>a</sup>	-	Emission standard of air pollutants for cement industry

<sup>a</sup> Proposed standard, not officially issued yet; <sup>b</sup> Proposed time.

Table S2. Average removal efficiencies of various air pollutant control devices (APCD) used in this work. Values are in percent.

	SO <sub>2</sub>	NO <sub>x</sub>	PM <sub>2.5</sub>	PM <sub>2.5-10</sub>	PM <sub>&gt;10</sub>	Data sources
Wet-FGD	80 <sup>a</sup>	-	53.74	81.21	92.63	Field survey (unpublished); filed tests and data integration (Zhao et al., 2010; 2011)
	70 <sup>b</sup>	-	53.74	81.21	92.63	MEP (2010); filed tests and data integration (Zhao et al., 2010; 2011)
	50 <sup>c</sup>	-	-	-	-	Field survey (unpublished); conservatively assumed
Other-FGD	30	-	-	-	-	Field tests (Zhao et al., 2010; 2011)
LNB	-	30	-	-	-	Field tests (Zhao et al., 2010; 2011)
SCR	-	60	-	-	-	Field survey (unpublished); personal communication with China Electricity Council director
SNCR	-	50	-	-	-	Field survey (unpublished); Zhao et al. (2013); conservatively assumed
FF	-	-	99.30	99.70	99.95	Field tests (Zhao et al., 2010; 2011)
ESP	-	-	92.31	96.97	99.46	Field tests and data integration (Zhao et al., 2010; 2011)
WET	20	-	67.40 <sup>d</sup>	85.74 <sup>d</sup>	96.51 <sup>d</sup>	Field tests (Zhao et al., 2010; 2011)
	20	-	56.96 <sup>e</sup>	84.01 <sup>e</sup>	96.49 <sup>e</sup>	Lei et al. (2011); Zhao et al. (2011)
CYC	-	-	13	75	90	Lei et al. (2011); Zhao et al. (2011)

<sup>a</sup> For CPP in REF scenarios; <sup>b</sup> For CPP in BAS scenarios and other industrial sources (except for sintering); <sup>c</sup> For sintering process in REF scenarios; <sup>d</sup> For CPP; and <sup>e</sup> For sources other than CPP.

Table S3. The national time schedule of implementation of emission standards for transportation sector assumed in this work.

	Stage I	II	III	IV	V	VI
On-road vehicle <sup>a</sup>	2000	2005	2008	2013	2016	2026
On-road vehicle <sup>b</sup>	1999	2003	2005	2008	2013	2016
On-road vehicle <sup>c</sup>	2000	2005	2008	2011	2014	2021
RV <sup>a</sup>	2000	2005	2008	2013	2016	2026
RV <sup>b, c</sup>	2000	2005	2008	2011	2014	2021
Motorcycle	2003	2005	2010	-	-	-
Tractor	2006	2007	2014	-	-	-
Machine	2011	2014	2016	-	-	-
Train and inland ship	2011	2014	-	-	-	-

<sup>a</sup> For BAS scenarios; <sup>b</sup> For REF scenarios in Beijing; <sup>c</sup> For REF scenarios in Tianjin, Shanghai, Jiangsu, Zhejiang and Guangdong.

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