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Supplement of

Impacts of coal burning on ambient $PM_{2.5}$ pollution in China

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Table S1 Summary of the major assumptions of the energy scenario.

	2010	2013
GDP (2005 price)/billion CHY [a]	31165	39486
Population/billion	1.34	1.36
Urbanization rate/%	49.7	53.7
Power generation/TWh	4205	5398
Share of coal-fired power generation/%	75.3	66.4
Crude steel yield/Mt	627	779
Cement yield/Mt	1880	2417
Urban residential building area per capita/m^2	23	23
Rural residential building area per capita/m^2	34.1	37
Vehicle population per 1000 persons	58.2	93.6
Share of new and renewable energy/% [b]	7.5	8.3

a CHY, Chinese Yuan.

b Including hydro power, solar energy, wind energy, ocean energy, and nuclear energy; excluding biomass.

Table S2. Penetrations of major control technologies in power sector in China (%).

Energy technology	Control technology	2010	2013
Grate boilers	CYC (PM)	12	10
	WET (PM)	88	90
Pulverized coal combustion	WET (PM)	0	0
	ESP (PM)	93	85
	HED (PM)	7	15
	FGD (SO_2)	88	93
	LNB (NO_X)	75	38
	LNB+SNCR (NO_X)	1	2
	LNB+SCR (NO_X)	12	54

Fluidized bed combustion	WET (PM)	0	0
	ESP (PM)	100	85
	HED (PM)	0	15
	CFB-FGD (SO_2)	53	53
	SNCR (NO_X)	0	0
	SCR (NO_X)	0	0
Natural gas power	LNB (NO_X)	74	70
	LNB+SNCR (NO_X)	1	0
	LNB+SCR (NO_X)	5	15

Notes: CYC, cyclone dust collector; WET, wet scrubber; ESP, electrostatic precipitator; HED, high efficiency deduster; FGD, flue gas desulfurization; CFB-FGD, flue gas desulfurization for circulated fluidized bed; LNB, low NOX combustion technology; SCR, selective catalytic reduction; SNCR, selective non-catalytic reduction. The table gives the national average penetrations of major control technologies. However, the penetrations vary with provinces. The penetration of the "key region" is usually larger than that of other regions.

Table S3. Penetrations of major control technologies in industrial and domestic combustion sources in China (%).

Energy technology	Control technology	2010	2013
Industrial grate boilers	CYC (PM)	0	0
	WET (PM)	95	85
	ESP (PM)	0	10
	HED (PM)	5	5
	WET (SO2)	95	70
	FGD (SO2)	1	30
	LNB (NOX)	0	18
	LNB+SCR (NOX)	0	5
Domestic boilers	CYC (PM)	14	15
	WET (PM)	78	85
	DC (SO2)	0	5
Coal stoves	STV_ADV_C	0	0
Biomass stoves	STV_ADV_B	0	0
	STV_PELL	0	0

Notes: DC, application of (low-sulfur) derived coal; STV_ADV_C, replacement of advanced coal stove; STV_ADV_B, replacement of advanced biomass stove (e.g. better combustion condition, catalytic stove); STV_PELL, biomass pellet stove.

Table S4. Penetrations of major control technologies for selected industrial process in China (%).

(1) SO_2

Industrial process	Control technology	2010	2013
Sintering	FGD	10	30
Coke oven	FGD for coal filling process	0	5
	FGD for coke oven gas	0	5
	Combination of the technologies above	0	0
Glass production (float process)	FGD	0	8
Sulfuric acid production	Ammonia acid desulfurization method	0	10

(2) NOx

Industrial process	Control technology	2010	2013
Sintering	SCR	0	7
	SNCR	0	0
Precalcined cement kiln	LNB+SCR	0	0
	LNB+SNCR	0	1
	LNB	35	47
Glass production (float process)	OXFL	0	16
	SCR	0	8
Nitric acid (dual pressure process)	ABSP	12	16
	SCR	18	30
	ABSP+SCR	0	0
Nitric acid (other process)	ABSP	63	65
	SCR	32	33
	ABSP+SCR	0	5

Notes: ABSP, absorption method; OXFL, oxy-fuel combustion technology.

(3) PM

Industrial process	Control technology	2010	2013
Sintering (flue gas)	CYC	0	0
	WET	5	0
	ESP	75	75
	HED	20	25
Blast furnace (flue gas)	WET	100	100
	ESP	100	100
Basic oxygen furnace	ESP	30	25
	HED	70	75
Electric arc furnace	WET	30	20
	ESP	50	50
	HED	20	30
Coke oven	WET	100	100
	HED	0	0
Precalcined cement kiln	WET	0	0
	ESP	40	35
	HED	60	65
Glass production	CYC	0	0
	WET	20	20
	ESP	75	75
	HED	5	5
Brick production	CYC	30	30
	WET	20	20
	ESP	20	20
	HED	0	0

(4) NMVOC

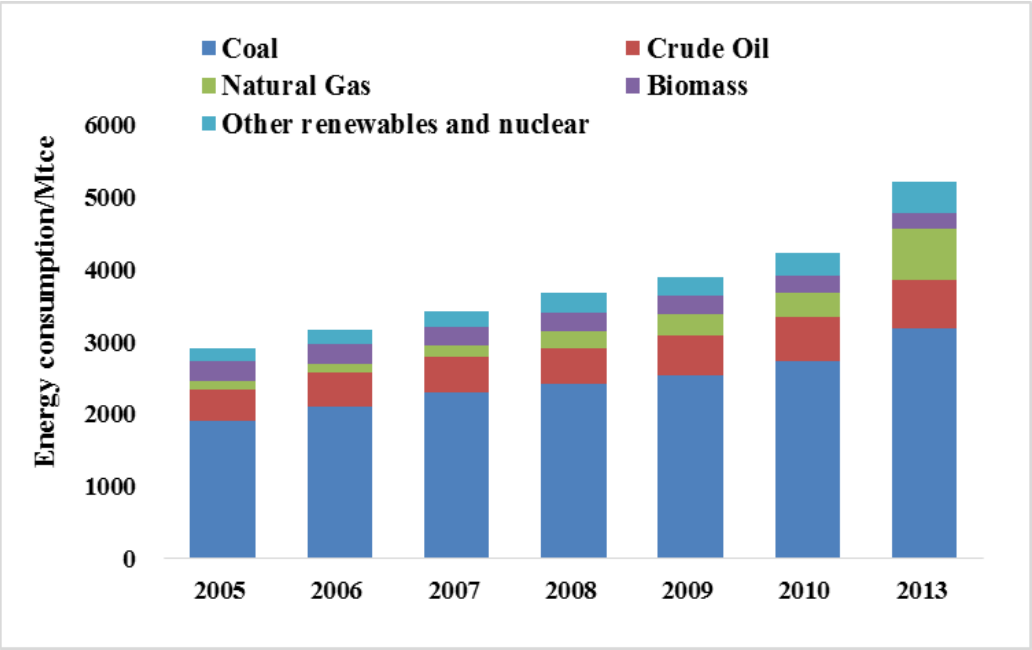
Industrial process	Control technology	2010	2013
Coke oven	No control	100	100
	End of pipe control measures	0	0
Refinery	No control	100	93
	Leak detection and repair program	0	5
	Covers on oil and water separators	0	2
	Combination of the above options	0	0
Plant oil extraction	No control	90	87
	Activated carbon adsorption	10	12

	Schumacher type DTDC and activated carbon adsorption	0	1
	Schumacher type DTDC and new recovery section	0	0
Pharmacy	No control	100	95
	Primary measures and low-level end-of-pipe measures	0	5
	Primary measures and high-level end-of-pipe measures	0	0
Gasoline storage	No control	95	90
	IFC (Internal floating covers or secondary seals)	5	10
Gasoline loading and unloading	No control	85	80
	Stage IA (Vapor recovery systems and modified loading techniques)	15	20
Service station	No control	85	80
	Stage IB + Stage II (Improvement in service station tank and vapor balancing system between a vehicle and service station tank)	15	20
Crude oil storage and distribution	No control	100	100
	IFC + Stage IA + Stage IB + Storage II	0	0

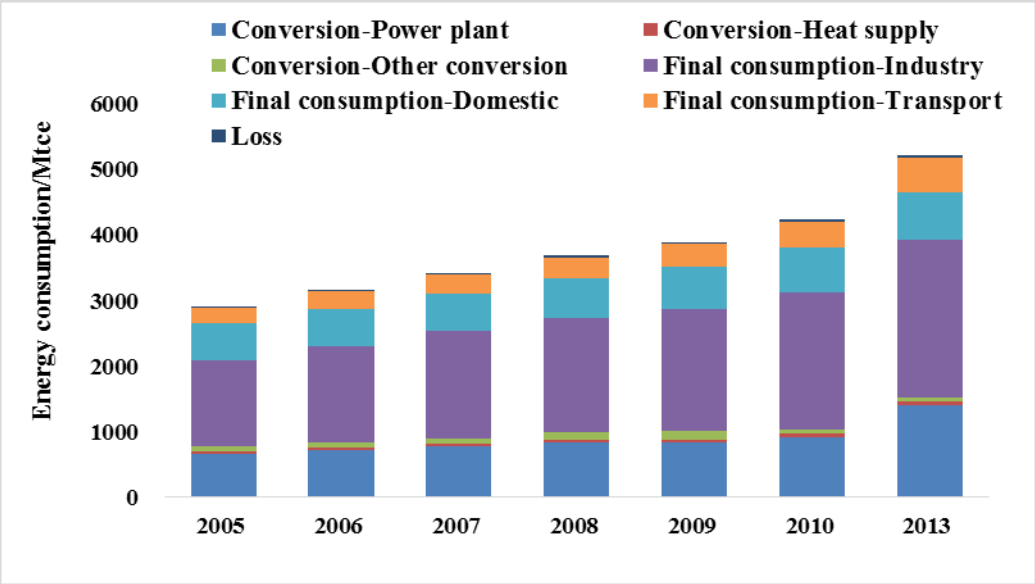
Table S5. Penetrations of major control technologies for NMVOC emissions from selected solvent use types in China (%).

Solvent use type	Control technology	2010	2013
Paint use in interior wall of buildings	No control (GB18582-2001)	0	0
	Decrease of solvent content--GB18582-2008	100	97
	Decrease of solvent content--2004/42/EC stage 1	0	3
	Decrease of solvent content--2004/42/EC stage 2	0	0
Paint use in external wall of buildings	No control (solvent-based paint)	78	75
	Substitution with water-based paint	22	25
Paint use in vehicle manufacturing	No control (water-based primer, solvent-based paint for other parts)	97	94
	Substitution with water-based paint	2	3

	Adsorption, incineration	1	3
	Substitution + adsorption, incineration	0	0
Paint use in vehicle refinishing	No control (solvent-based paint)	93	90
	Sustitution with high solids or water-based paint	8	10
Paint use in wood coating	No control (solvent-based paint)	89	84
	Incineration	0	1
	Substitution with high solids paint	4	6
	Substitution with water-based or UV paint	7	9
Offset printing	No control (solvent-based ink)	90	88
	Substitution with water-based or UV ink	10	13
	Add-on control technology	0	0
Flexography and rotogravure printing (for packaging)	No control (solvent-based ink)	64	60
	Substitution with low solvent or water-based ink	35	38
	Add-on control technology	1	3
	Substitution + add-on control technology	0	0
Flexography and rotogravure printing (for publication)	No control (solvent-based ink)	85	83
	Substitution with low solvent or water-based ink	15	18
	Add-on control technology	0	0
	Substitution + add-on control technology	0	0
Screen printing	No control (solvent-based ink)	85	83
	Substitution with low solvent or water-based ink	15	18
	Add-on control technology	0	0
	Substitution + add-on control technology	0	0
Adhesive use in wood processing	No control	98	95
	Add-on control technology	3	5
Adhesive use in manufacturing of shoes	No control (solvent-based adhesive)	87	85
	Substitution with low solvent adhesive	13	15
	Add-on control technology	0	0



(a) Energy consumption by fuel



(b) Energy consumption by sector

Figure S1 Energy consumption in China from 2005-2013

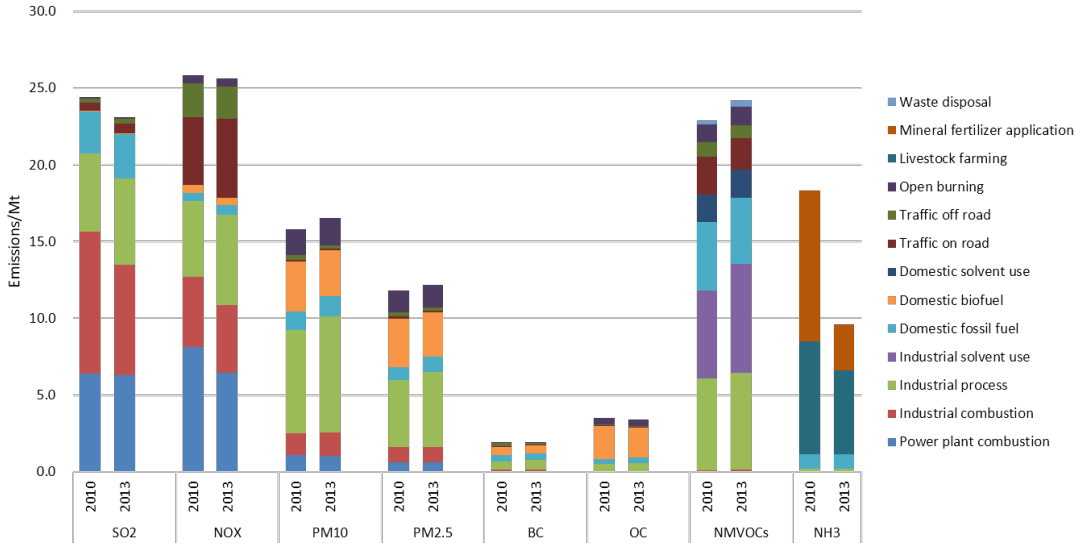


Figure S2 Comparison of emissions for year 2010 and 2013 in China