Ex-ante Analyses of Carbon Pricing for the Diffusion of Low Carbon Technologies in China's Energy-intensive Sectors

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Contents of the presentation

- **Background and research motivation**
- **Components of the LCT policy research at IGES**
- **LCT deployment changes in response to carbon pricing**
- **Technology mitigation effect of carbon pricing at the sector level**
- **Policy implications and research outlook**

Laggard carbon pricing in major Asian economies

	Japan	China	Korea
Targets	■ To reduce its 1990 emissions by 6% from 2008-2012 **■ To reduce emissions by 26% from 2013 levels by 2030 (25.4% from 2005)** ■Improving energy efficiency at least by 30% by 2030 ■To reduce emissions by 80% from 1990 levels by 2050	■ To reduce national energy intensity by 20% by 2010 and to increase renewable energy in the national mix to 15% by 2020 **■ To cut CO_2 emissions per unit of GDP by 60-65% by 2030 compared with 2005 levels** **■ Peak at around 2030 and sooner as best efforts allow**	**■ To reduce by 37% by 2020 compared with BAU levels** ■ To achieve 46% improvement of energy efficiency by 2030 ■To increase renewable energy in the national energy mix to 11% by 2030
Major policies for industrial sector	■ Keidanren Voluntary Action Plan ■ GHG Emissions Calculation, Reporting and Disclosure System ■ Feed-in-tariff for renewable energies **■ Subsidies from NEDO, METI and MOEJ** **■ Energy-related taxes** **■ Carbon tax policy** **■ GHG ETS on trial but suspended now**	■ Energy Efficiency Standards ■ Top 10,000 energy-consuming firms program in the 12th FYP **■ Subsidies and rewards for energy-saving** **■ Differential electricity pricing system** **■ Resource-related tax** **■ Pilot GHG ETS in 5 cities and 2 provinces** **■ Carbon tax policy in discussions**	■ Target Management System (TMS) ■ Energy Use Reporting System ■ Energy Audit Requirement **■ Financial subsidies** **■ Preferable loans** **■ Tax reduction** **■ Energy-related tax** **■ GHG ETS since 2015** **■ Carbon tax policy in discussions**

High barriers for energy saving investment

	Percentage of the samples (%)							
Payback time (Years)	<0.5	0.5-1	1-2	2-3	3-5	5-10	>10	In total
China (N=127)	5.5	12.6	30.7	30.7	13.4	4.7	2.4	100.0
Korea (N=62)	3.2	12.9	48.4	33.9		1.6		100.0
Japan (N=220)	0.5	2.3	7.3	22.3	41.4	24.5	1.8	100.0

a) 1-3 years of PB expected by Chinese and Korean companies.
b) The PB expected by Japanese companies is some longer at 3-5 years.
c) High expectation to the profitability of energy saving investments
Implies the usefulness of carbon pricing policies.

Business reluctance to carbon pricing policies

Policy Type		Policy item	Policy awareness			Policy acceptability		
			China	Korea	Japan	China	Korea	Japan
MBIs	Economic incentives	Subsidies for energy saving projects	**3.75**	3.21	2.82	**4.19**	3.18	**3.60**
		Soft loan for energy saving investments		3.03	1.80		3.43	3.36
		Tax credits for energy saving projects	**3.56**	3.27	2.83	**4.21**	**3.82**	**3.79**
		Subsidies and grants for energy efficient products		3.31	**3.71**		3.54	**3.66**
	Carbon pricing tools	Carbon tax policy	2.87	2.93	2.74	3.36	**2.02**	**2.63**
		GHG emissions trading scheme	2.86	3.31	2.51	3.61	**2.09**	**2.65**
Command-and-control regulations (CCRs)		Energy saving target and responsibility system				**3.63**	**3.66**	
		Energy use and GHG emissions reporting system					**3.66**	**3.63**
Voluntary approaches (VAs)		Certification of energy efficient products				**3.85**		2.73
		Voluntary energy saving agreements				**3.85**	3.41	3.10

Note: The data is the mean of scores. For policy awareness: '1' = 'completely unknown'; '3' = 'moderate understanding'; '5' = 'very clear'. For policy acceptability: '1' = 'completely unacceptable'; '3' = 'moderate acceptance'; '5' = 'fully acceptable'.

Business low affordability of carbon prices

Country	China (N=170; Unit: Yuan/t-CO_2)			Korea (N=62; Unit: KRW/t-CO_2)		
Sector	Iron & steel (N=34)	Cement (N=17)	Chemical (N=27)	Iron & steel (N=11)	Cement (N=5)	Chemical (N=20)
MEANAFFORD	8.8%	7.7%	9.9%	2.5%	2.8%	2.6%
Affordable carbon price	42.7	38.6	83.7	3,770	2,600	3,950

Country	Japan (N=230; Unit: JPY/t-CO_2)			
Sector	Food processing (N=29)	Chemical (N=26)	Iron & steel (N=11)	Electronics (N=12)
MEANAFFORD	2.0%	3.1%	1.5%	2.6%
Affordable carbon price	683	1,062	426	801

a) Similar acceptable ratios in energy cost increases due to pricing of carbon for companies of Japan and Korea, which are much lower than Chinese companies;
b) Similar range of carbon prices affordable for companies in Japan and China (5-13 \$/t-CO_2);
c) Carbon prices affordable for Korean companies are 2.3-3.5 \$/t-CO_2;
d) The business affordability is much lower than the price level needed for realizing mitigation pledges of the three countries.

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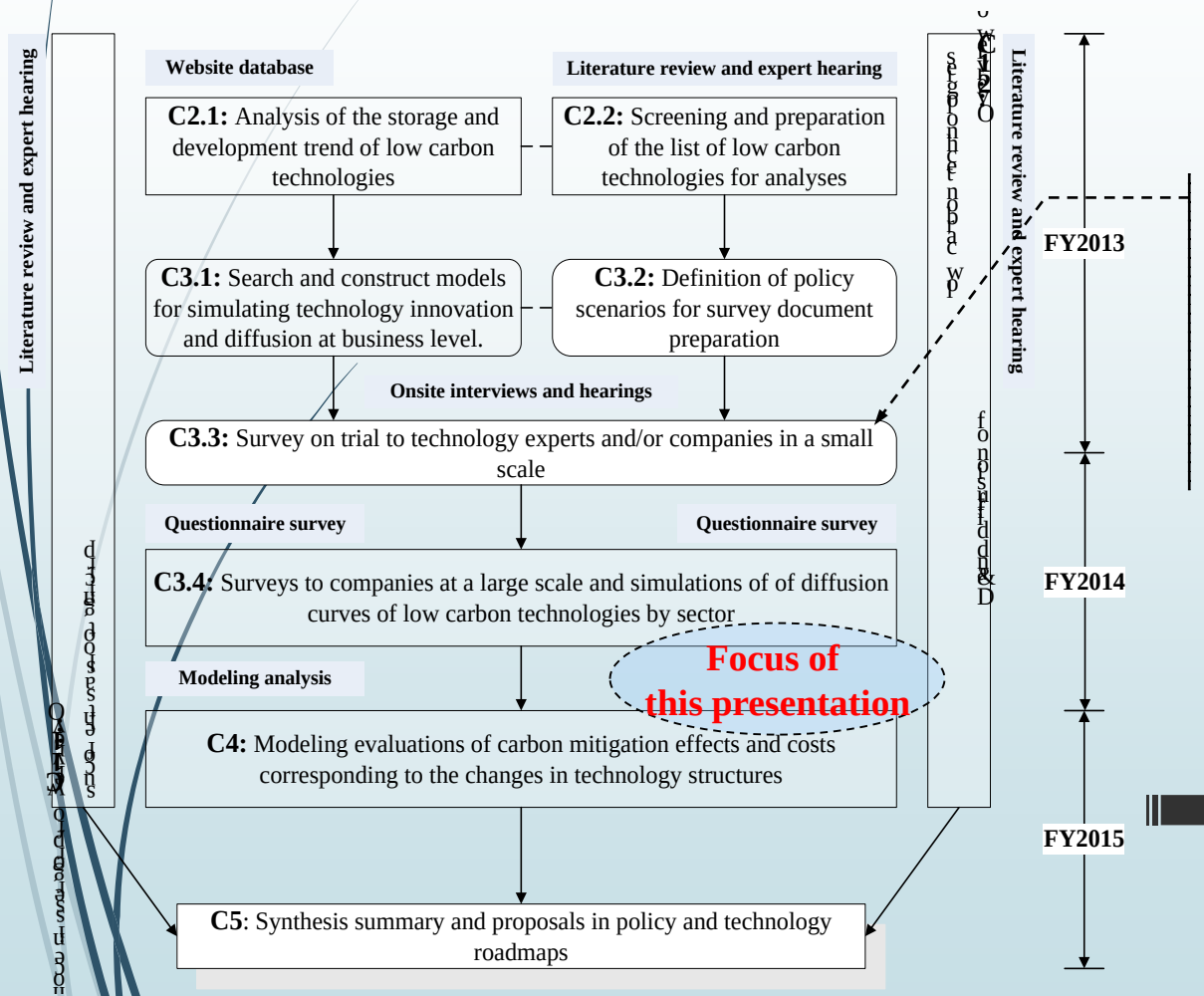
Components of LCT policy studies at IGES



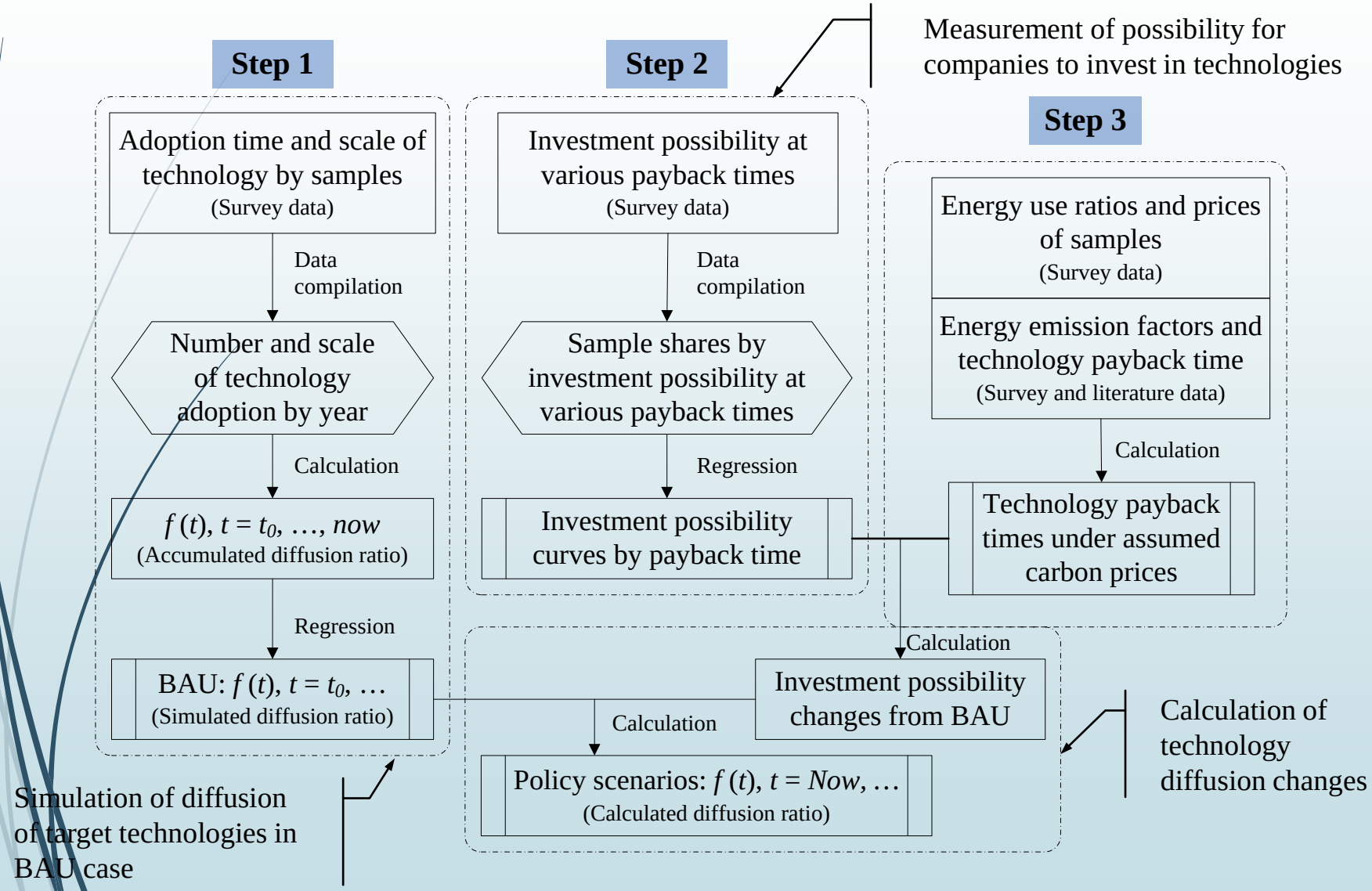
Geographical focus: Japan, China and the Republic of Korea

Policy focus: Carbon pricing tools, i.e., carbon taxes and GHG emissions trading scheme

Overall objective:

To clarify the linkage between policy and the change in technology deployment

Procedures of ex-ante analysis of LCT diffusion



Case studies: Cement and iron & steel sectors in China

- ***Questionnaire content:*** a) Company basic information; b) Energy saving management and adoption of target technologies; c) Factors determining LCT investment; d) Policies in promoting technology diffusion
- ***Implemented period:*** November, 2014 to February, 2015
- ***Coordinated by:*** China Cement Association; and, China Metallurgical Industry Planning & Research Institute

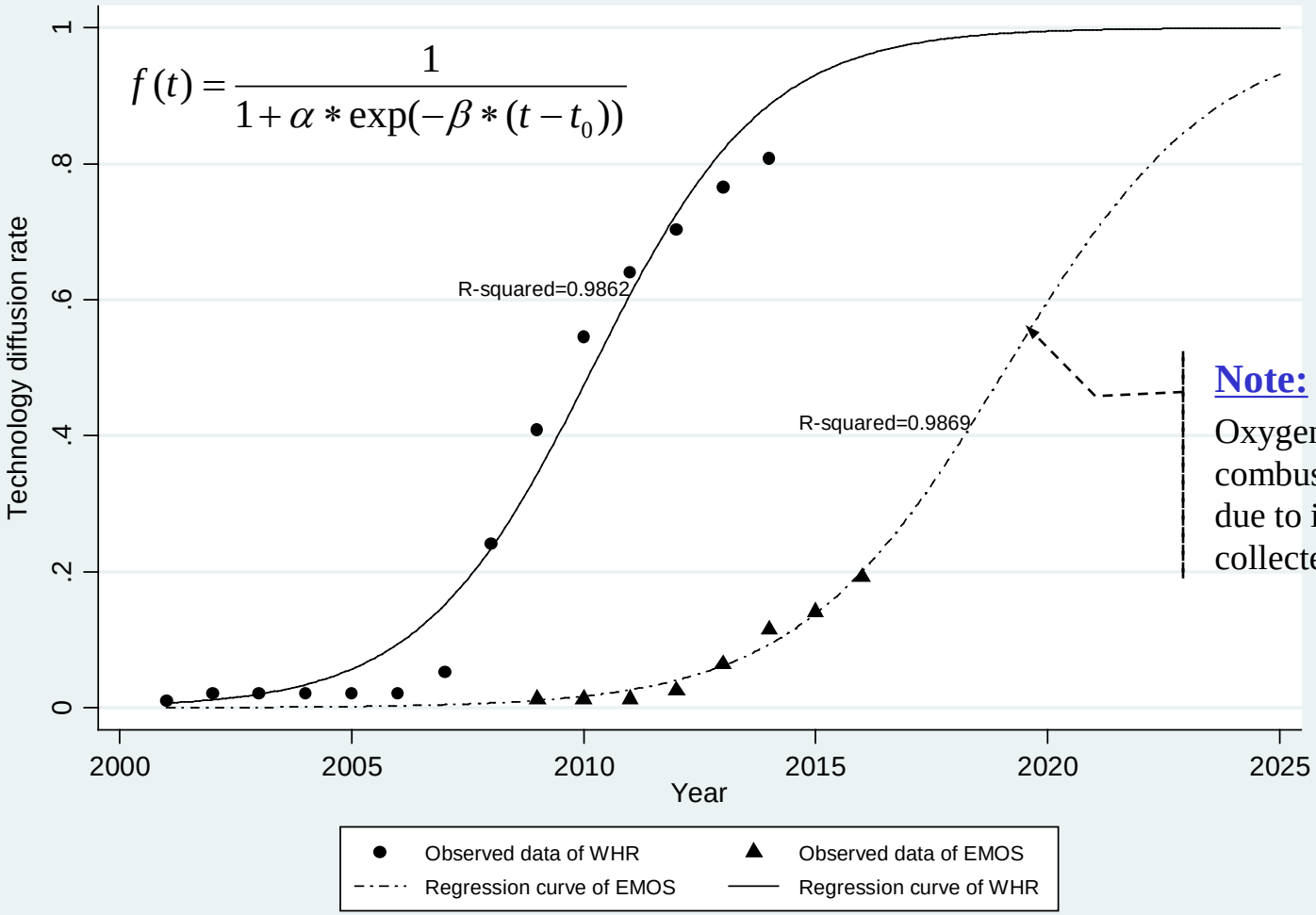
Cement

Number of employees			Ownership		
Category	No.	%	Category	No.	%
Below 100	1	1.3	State-owned	53	67.9
100-300	25	32.1	Domestically private	9	11.5
300-1,000	43	55.1	Joint-venture	13	16.7
Over 1,000	9	11.5	Fully foreign-funded	1	1.3
In total	78	100.0	Others	2	2.6
			In total	78	100.0

Iron & steel

Number of employees			Ownership		
Category	No.	%	Category	No.	%
1,000-2,000	4	6.7	State-owned	39	65.0
2,000-5,000	11	18.3	Domestically private	17	28.3
5,000-10,000	16	26.7	Joint-venture	4	6.7
Over 10,000	29	48.3	Fully foreign-funded	0	0.0
In total	60	100.0	Others	0	0.0
			In total	60	100.0

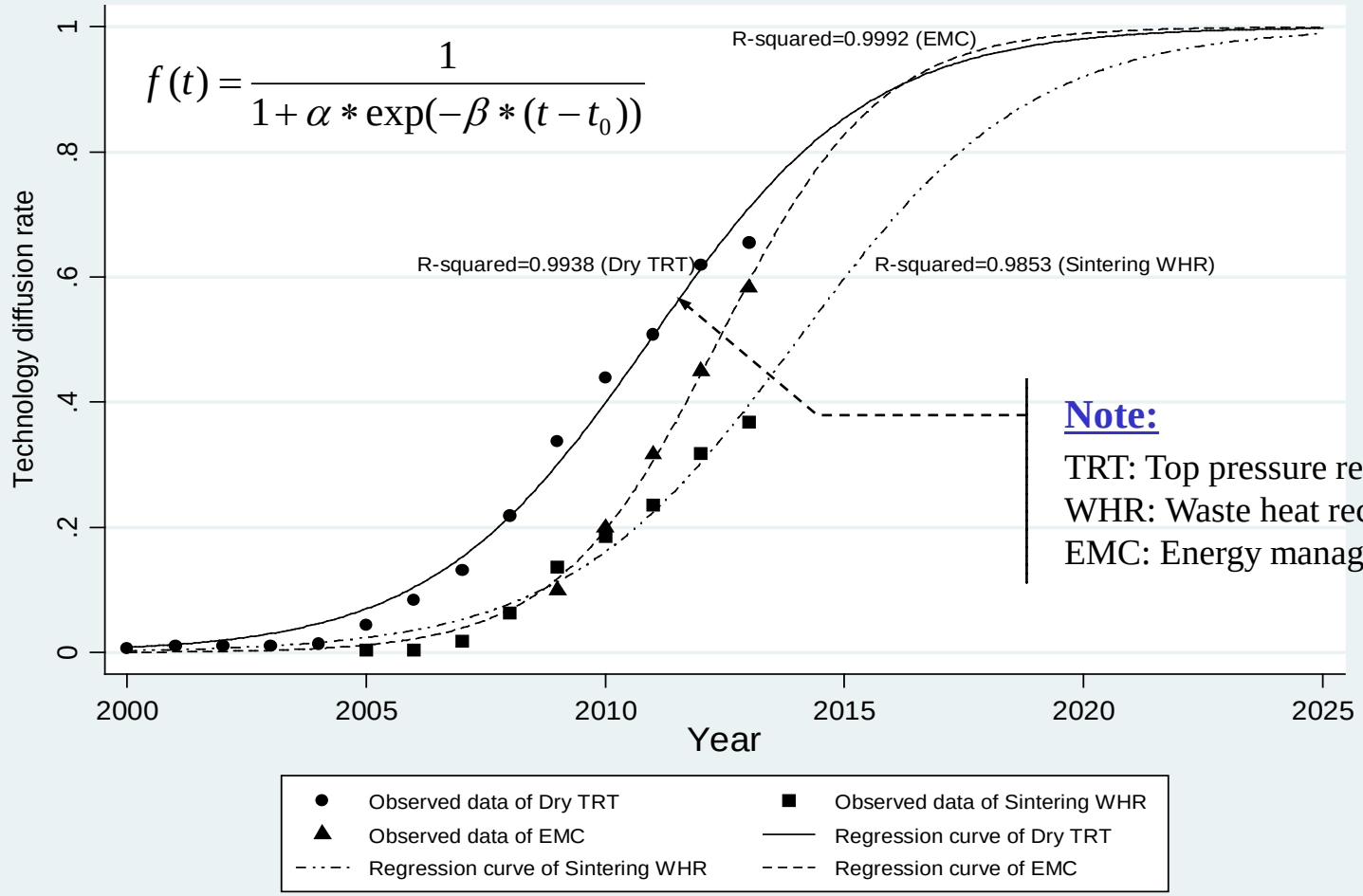
Technology diffusion curves: Cement industry



Note:

Oxygen-enriched combustion was omitted due to insufficient data collected.

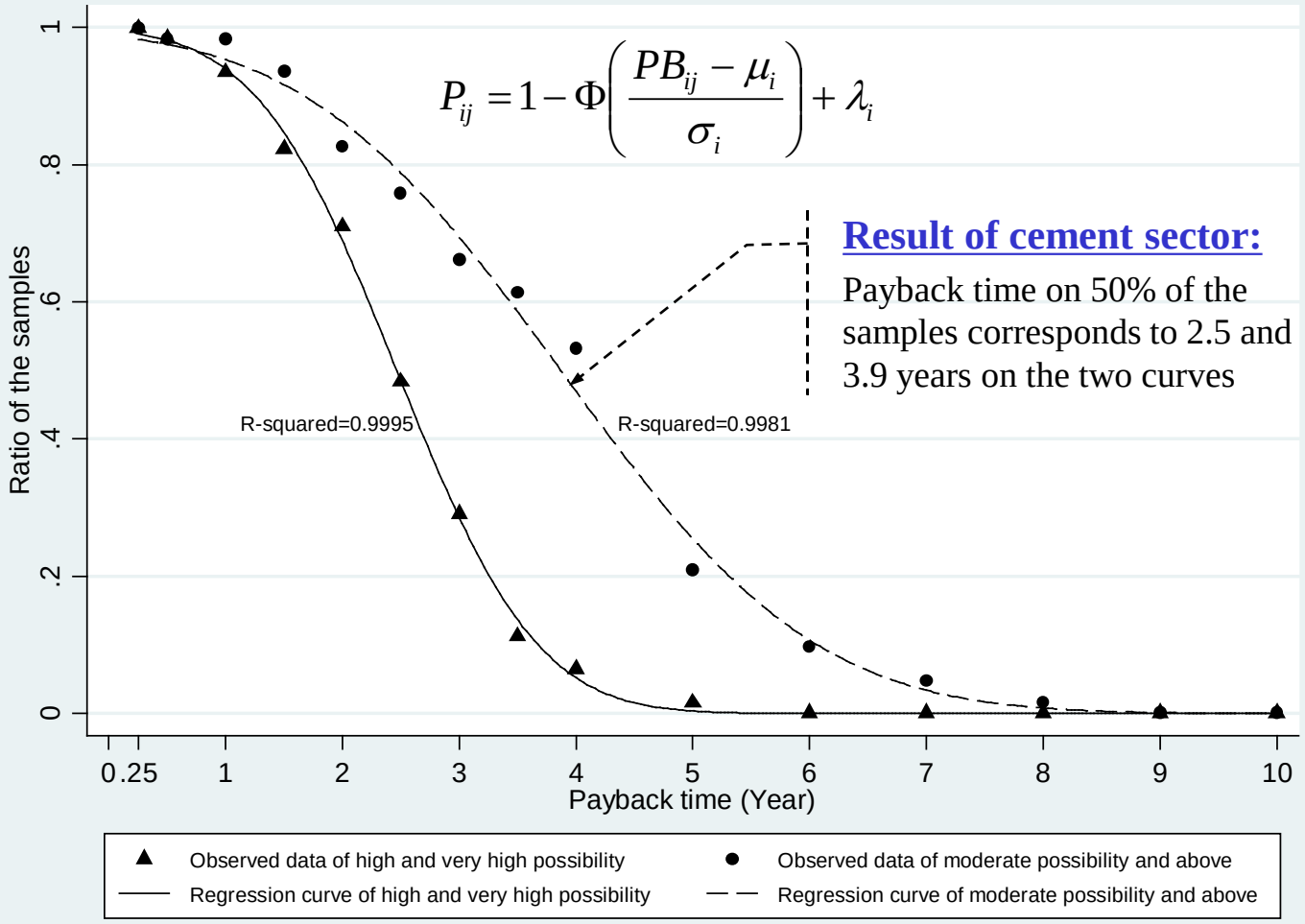
Technology diffusion curves: Iron & steel industry



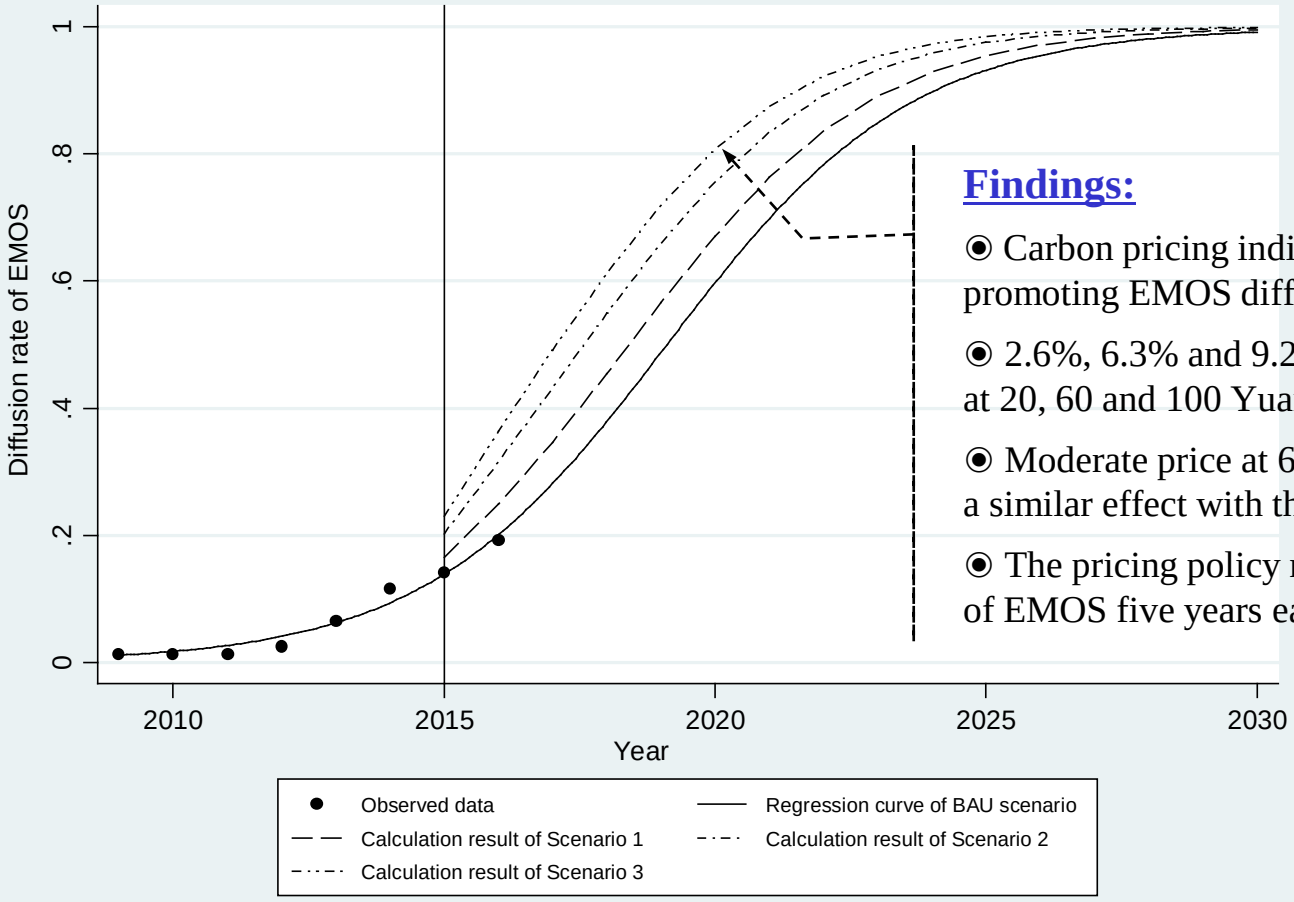
Note:

TRT: Top pressure recovery turbine
WHR: Waste heat recovery
EMC: Energy management center

Investment possibility under various payback times



An example: EMOS diffusions in various carbon prices



Findings:

- Carbon pricing indicates effectiveness in promoting EMOS diffusion.
- 2.6%, 6.3% and 9.2% increase in diffusion rate at 20, 60 and 100 Yuan/t-CO_2 From BAU in 2015.
- Moderate price at 60 Yuan/t-CO_2 may have a similar effect with the high price of 100 Yuan/t-CO_2.
- The pricing policy may realize the full diffusion of EMOS five years earlier than BAU.

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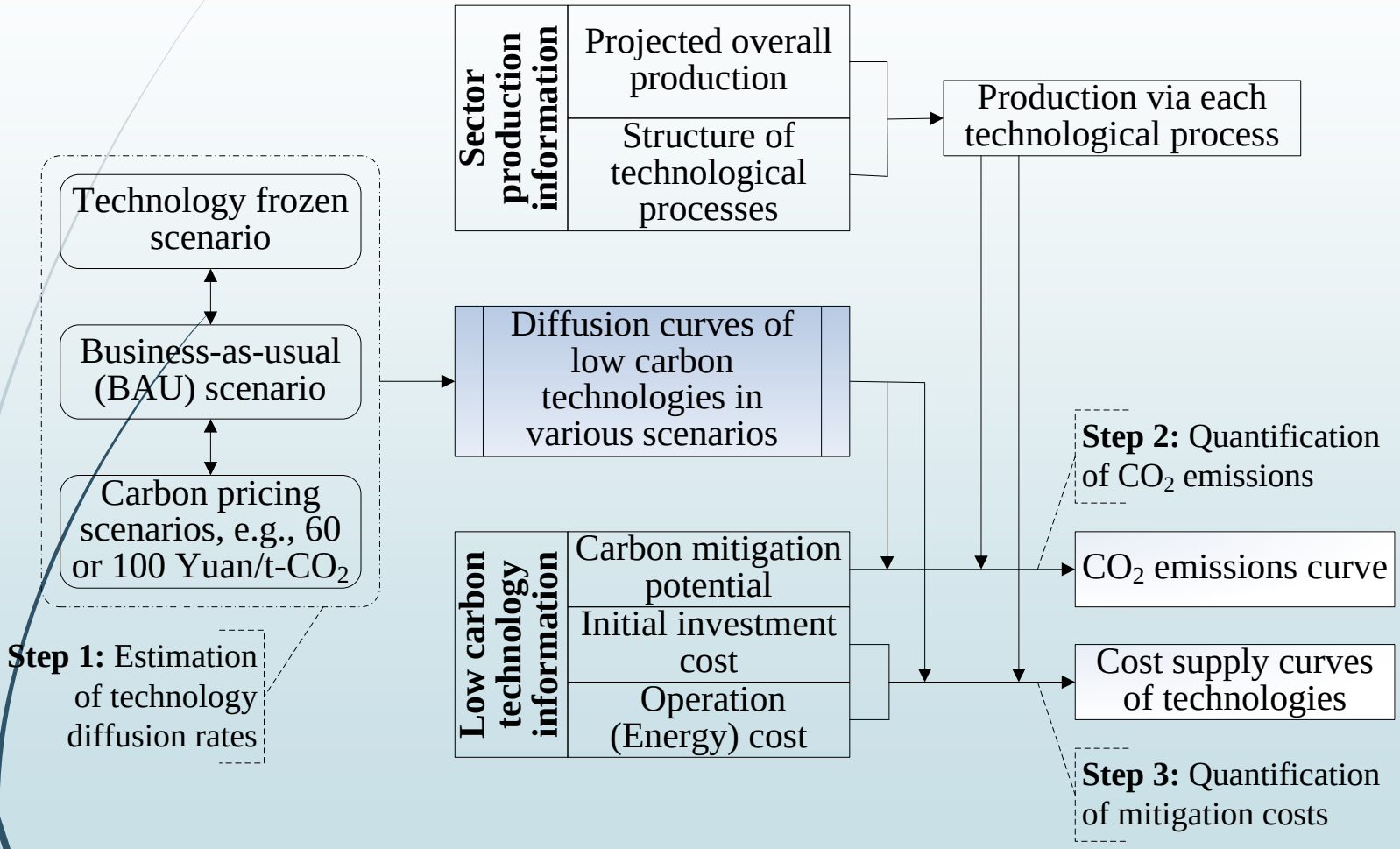
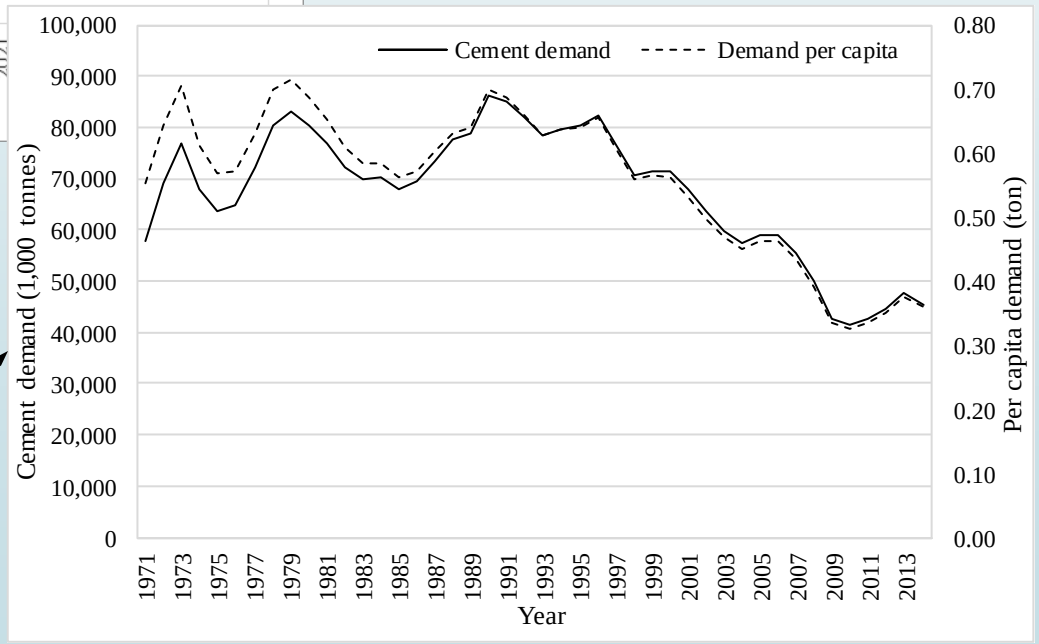
Process for estimating the mitigation at sector level



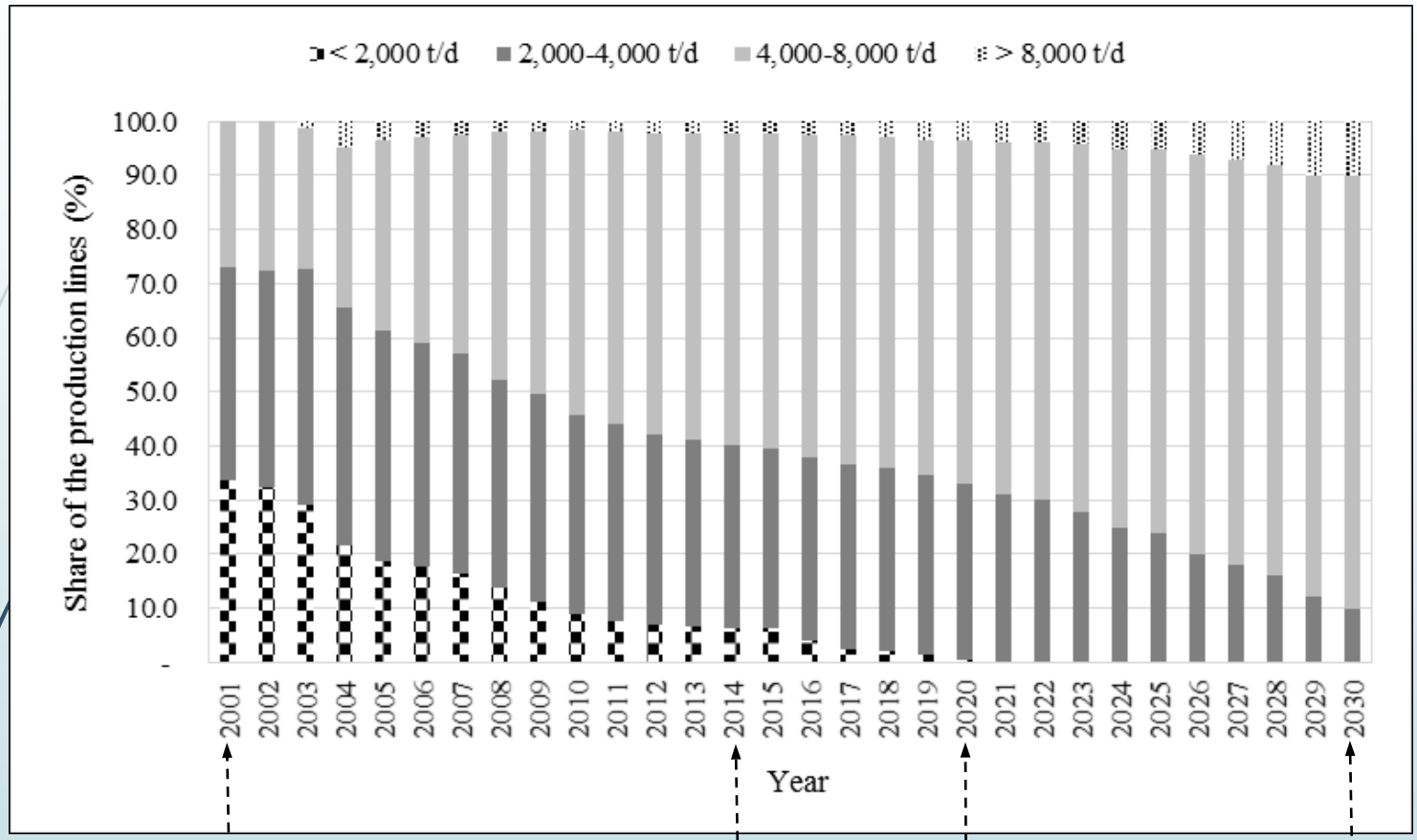
Statistics and prediction of cement production in China

Prediction result of clinker/cement production in China (by CCA)

Historical change of cement demand in Japan



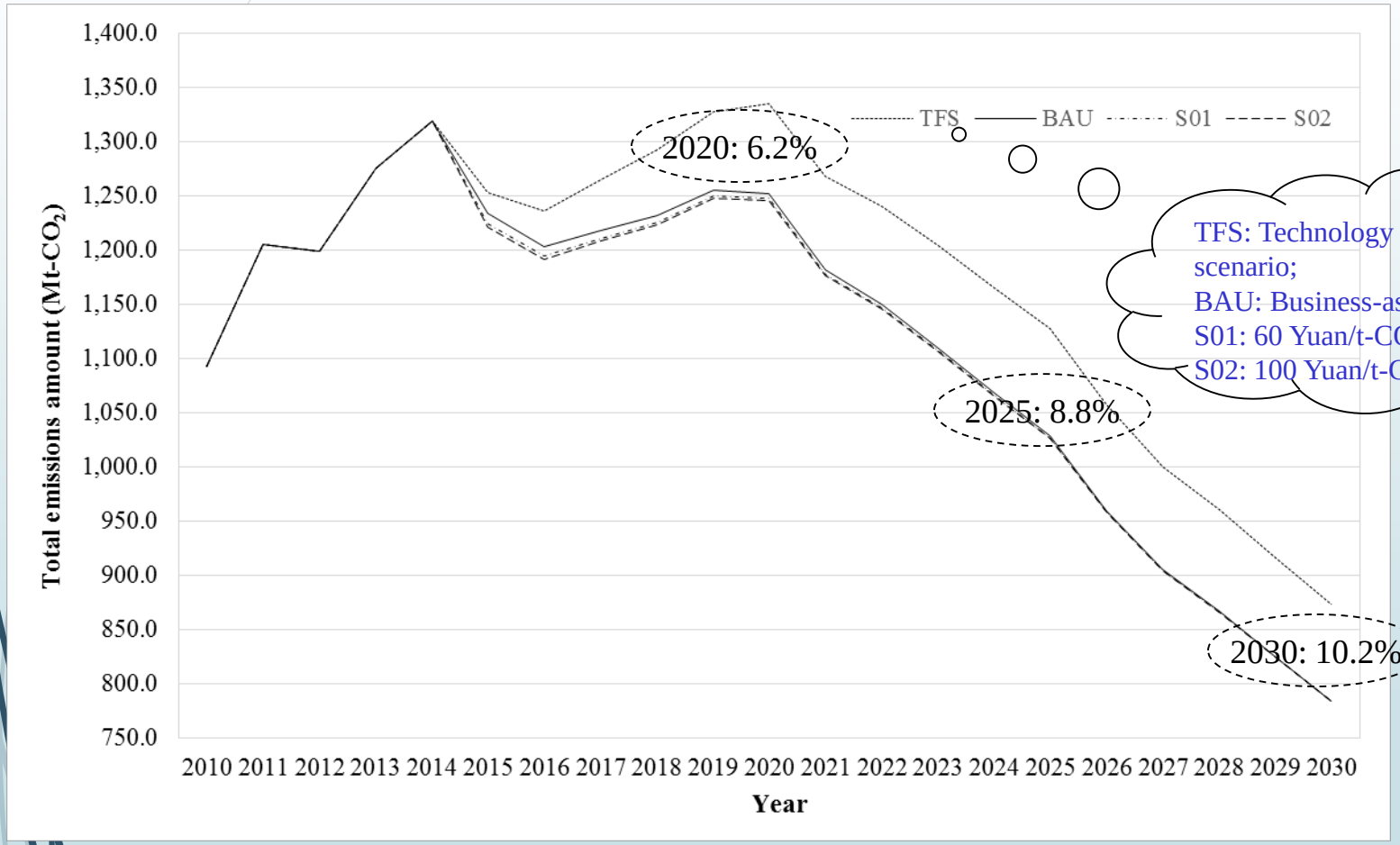
Distribution of NSP kilns by the scale



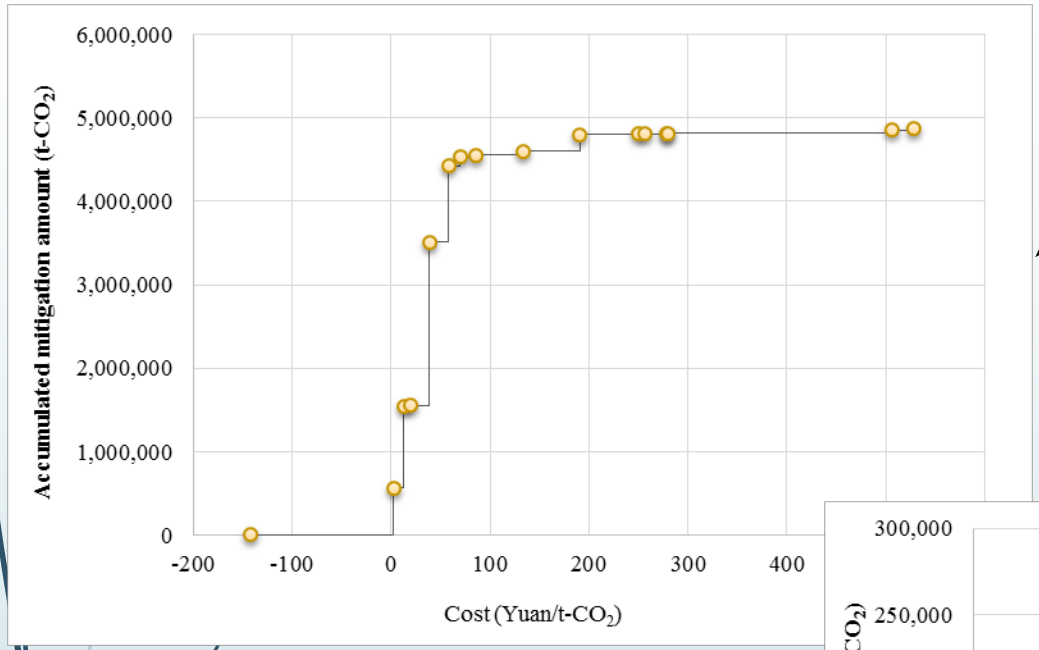
LCT of cement industry covered in the analysis

No.	Technology lever	Process	Name of technology	Code
1	Energy efficiency improvement	Raw material and fuel preparation	Vertical mill for raw materials preparation	T01
2			Roller press grinding system for raw materials preparation	T02
3			Vertical mill for coal preparation	T03
4		Clinker making	Efficient pre-heating and pre-calcination system	T04
5			Efficient pulverised coal burner	T05
6			Enriched oxygen combustion technology	T06
7			Fourth generation clinker grate cooler	T07
8			Efficient insulation materials technology	T08
9			Waste heat recovery power generation (WHR)	T09
10		Cement grinding	Ball mill and roller press grinding for cement grinding	T10
11			Vertical mill for cement grinding	T11
12			Cement grinding aids	T12
13		Whole process	Motor system frequency control retrofit	T13
14			Energy saving management and optimization system (EMOS)	T14
15	Alternative fuels and raw materials		Alternative fuels	T15
16			Alternative raw materials (carbide slag)	T16

Calculation results of emissions in various scenarios

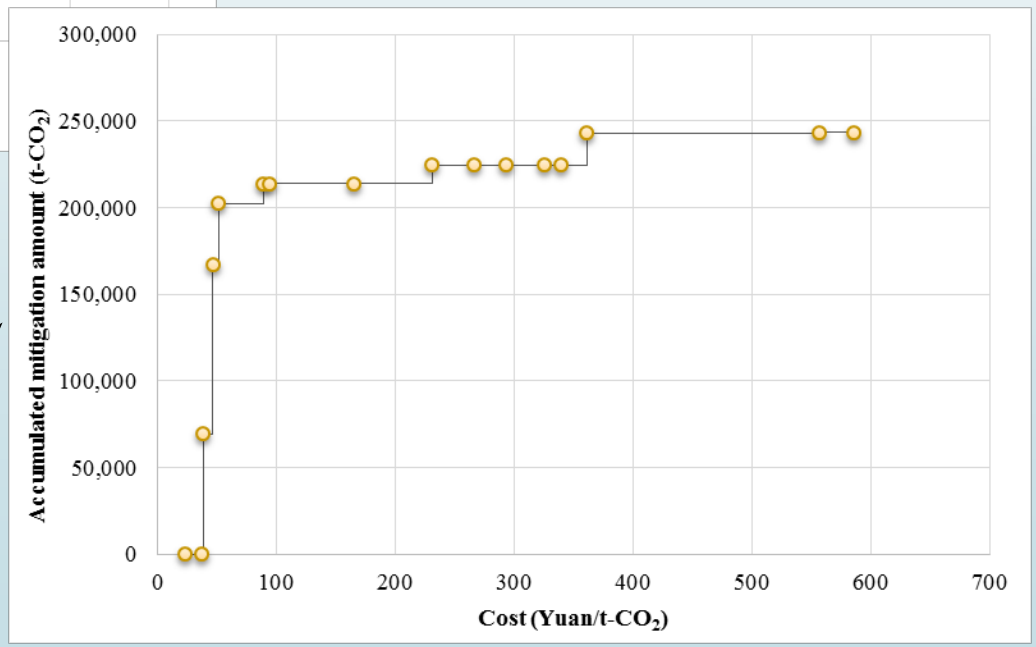


Technology abatement costs



Technology MACs under S01 in 2020

Technology MACs under S01 in 2030



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Policy implications and research outlook

- Full diffusion of energy saving technology takes 10 to 20 years after the initial commercialization.
- Certain technology mitigation potential remains in China's energy-intensive sectors.
- Effect of carbon pricing varies for the diffusion of technologies with different features.
- A moderate carbon price would generate limited effect in CO_2 mitigation;
- Most technology mitigation can be achieved at the low costs.
- Earlier carbon pricing is advised by addressing its interaction with existing policies.
- Necessary to focus on the innovative and breakthrough technologies from a longer perspective.
- The analysis of comprehensive policy mixes would be a challenge.
- To identify innovative business models is another topic with added value for low carbon transitions.

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Thank you for your attention!