



清華大學
Tsinghua University

Waste fluorescent lamps in China: generation, risk, and collection

Quanyin Tan¹, Jinhui Li^{1, 2}, Guijuan Shan¹, Lixia Zheng²

¹ School of Environment, Tsinghua University, Beijing, 100084, China

² Basel Convention Regional Centre for Asia and the Pacific, Beijing, 100084, China

June 25, 2014



- ❖ 1. Introduction.....●
- ❖ 2. Waste FLs generation prediction.....●
- ❖ 3. Project CFL.....●



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- Rapid development of the fluorescent lamp (FL) industry and growth of FL usage in the past nearly 20 years in China since the "green lighting" program. The production of FLs had risen to about 7 billion units in 2011, which was more than 28 times of it in 1994.
- Accelerated progress on phasing-out and replacement of traditional incandescent lamps (ILs) with FLs, which can reduce energy consumption by at least 65% and last up to 10 times longer than the ILs;



- Increasing public concern over the potential health risk of mercury exposure from waste FLs breakage and improper disposal.
- There is no collection or disposal system established for the waste FLs stream, and most of the waste FLs are entering to the municipal solid waste treatment facilities.



Objectives of the study

- This study intends to provide the basic information about the trends of the generation and distribution of waste FLs, as well as the potential mercury risk from waste FLs by theoretical method.
- It is expected to contribute to the planning of the collection system, distribution of relevant logistic network and disposal facilities.



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I: FLs Production and waste FLs generation prediction

Methods	Estimation Formula	Source(s)
The Modified Market Supply Method	$Q(t) = S(t - d_N)$ <p>$Q(t)$ is the estimated quantity at the year t; $S(t - d_N)$ is the quantity of products sold during the years $(t - d_N)$; t is the number of years; and d_N is the average lifetime of new products (FLs).</p>	(UNEP, 2007)
The Extended Logistic Model	$N(t) = m \times y(t) = m \times \frac{k(t)}{1 + c \times e^{-bt}} = m \times \frac{1 - d \times e^{-at}}{1 + c \times e^{-bt}}$ <p>$N(t)$ is the estimated cumulative volume for the year t; m represents the total population; $y(t)$ is the estimated saturation of specific products for the year t; $k(t)$ is the capacity fluctuating over time; a, b, c, d are the parameters determined using a regression method; and t is the number of years.</p>	(Trappey and Wu, 2007, 2008)

United Nations Environment Programme (UNEP), 2007. *E-waste Volume I: Inventory Assessment Manual*.

Trappey, C., Wu, H.-y., 2007. *An Evaluation of the Extended Logistic, Simple Logistic, and Gompertz Models for Forecasting Short Lifecycle Products and Services*, in: Loureiro, G., Curran, R. (Eds.), *Complex Systems Concurrent Engineering*. Springer London, pp. 793-800.

Trappey, C.V., Wu, H.-Y., 2008. *An evaluation of the time-varying extended logistic, simple logistic, and Gompertz models for forecasting short product lifecycles*. *Adv Eng Inform* 22, 421-430.



II: Waste fluorescent lamp generation and distribution evaluation

$$D_r = \sum_{b=1,2,3,4} S_{r,b} \times I_{r,b} \quad N_r = \sum_{l=1,2,3} N_{r,l} = \sum_{l=1,2,3} \frac{D_r}{\sum_{r=1,\dots,31} D_r} \times N_{T,l}$$

D_r is the lighting demand for a specific region (province or municipality) from all categories of buildings;

$S_{r,b}$ & $I_{r,b}$ are the floor space and relevant illuminance requirements for a category of building (b) in a region (r);

N_r & $N_{r,l}$ refer to the quantity of all FLs and the type of FL (l) used in region (r), respectively;

$N_{T,l}$ is the total quantity of FL 'l' used in mainland China.

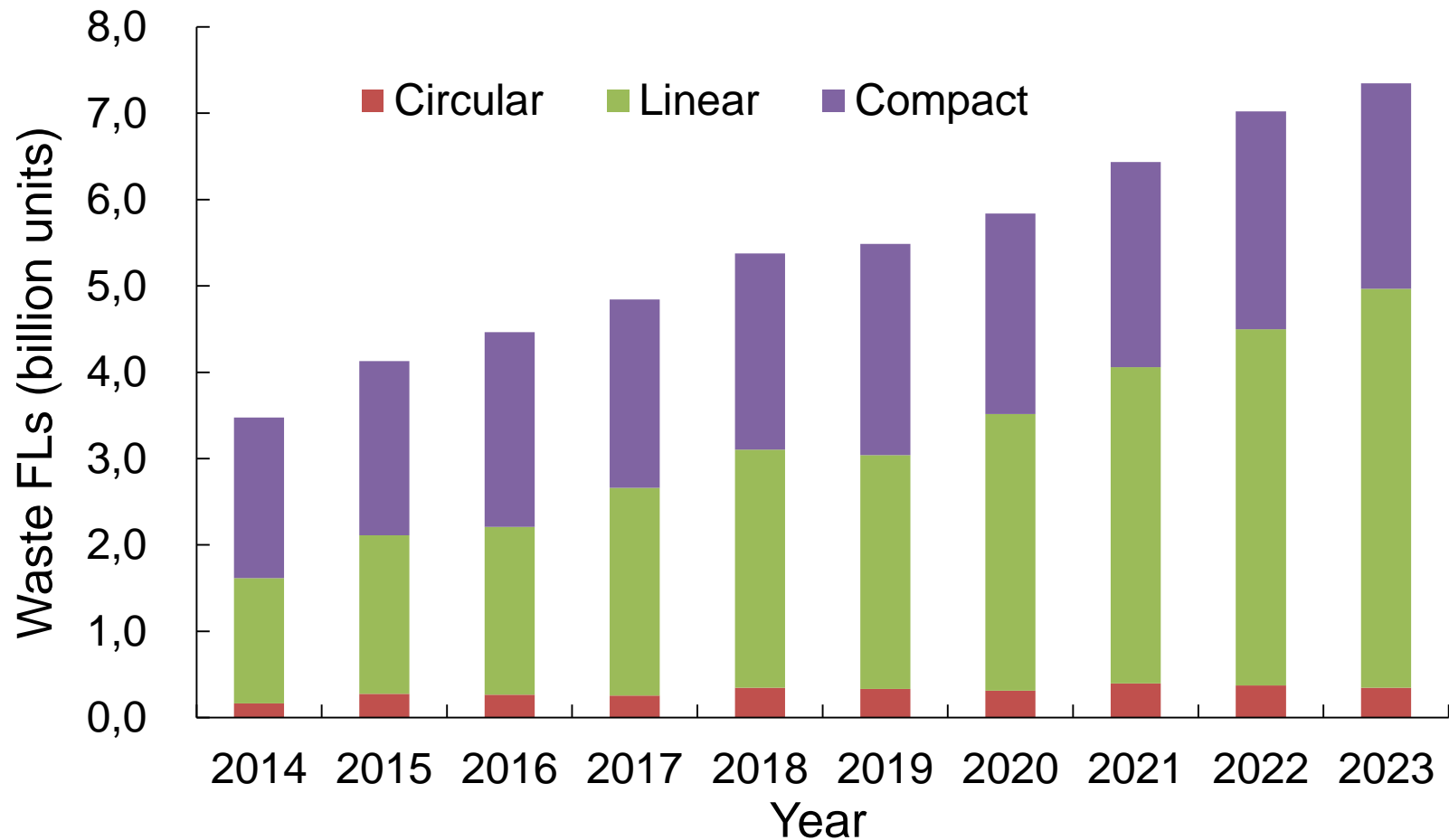


III: Data collection

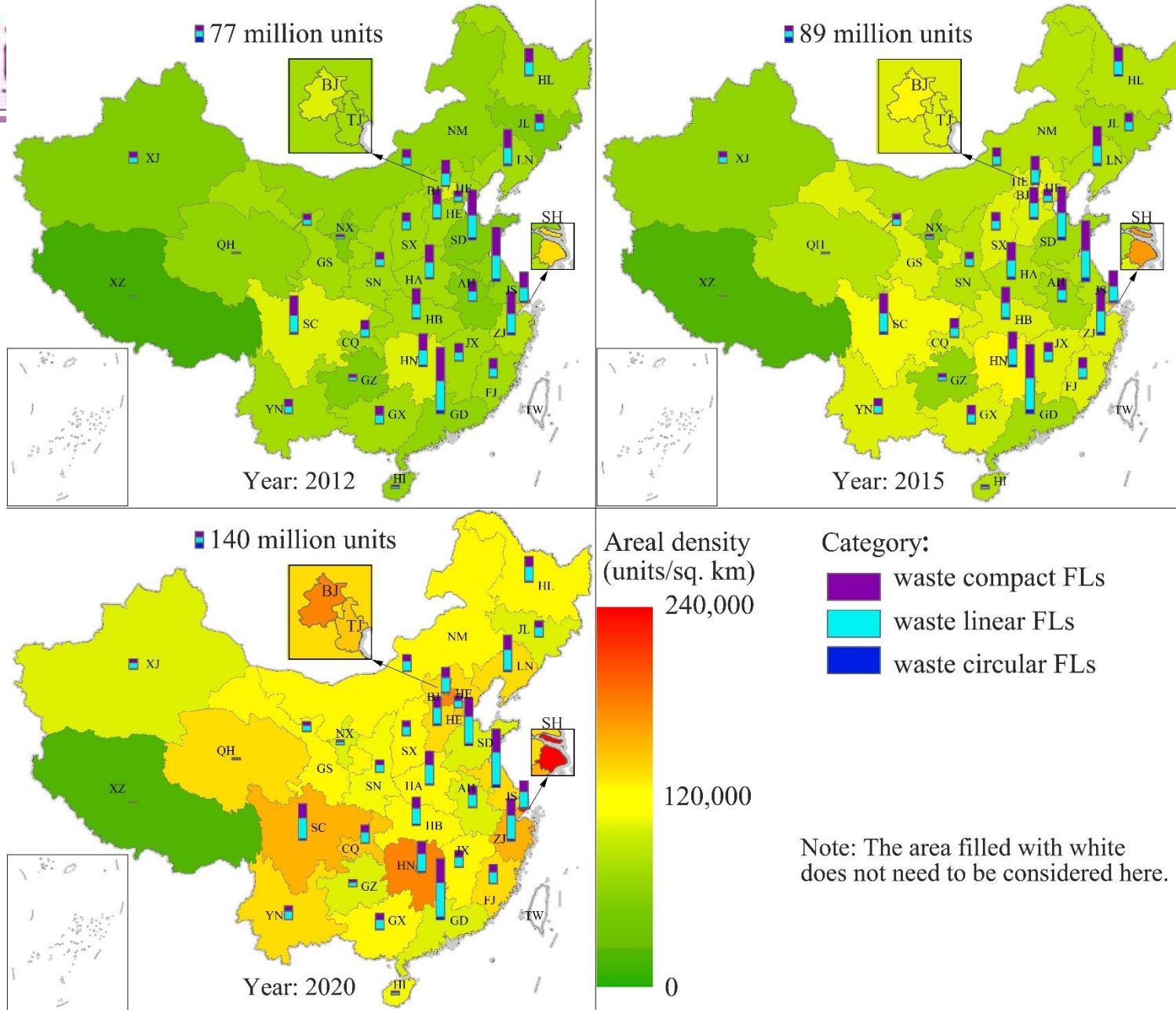
- ◆ Fluorescent lamp production in China
- ◆ Export and import quantities
- ◆ Floor space of buildings in different regions
- ◆ Average illuminance requirements for various types of buildings



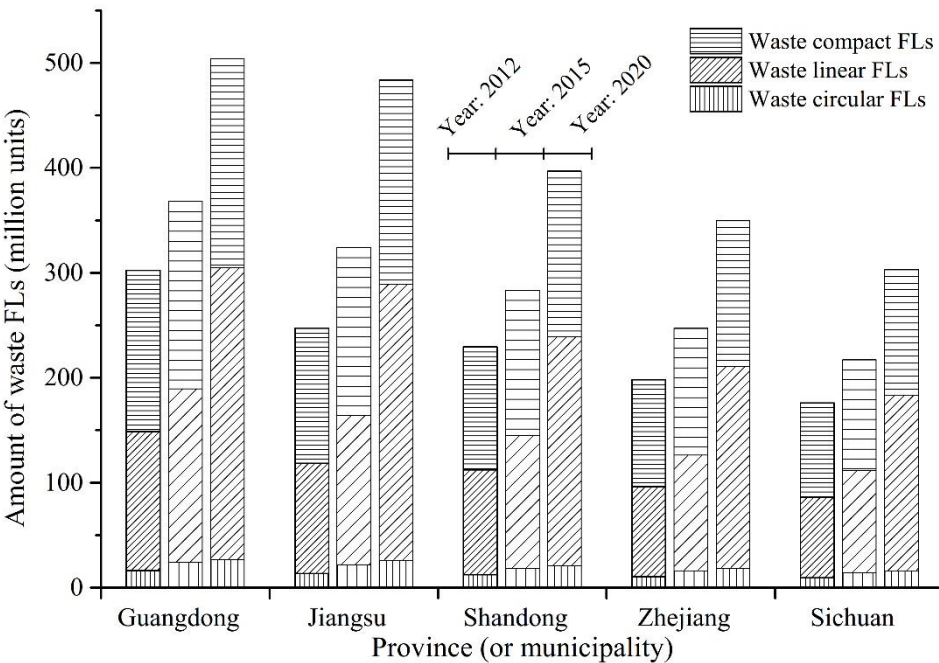
Waste FLs generation prediction



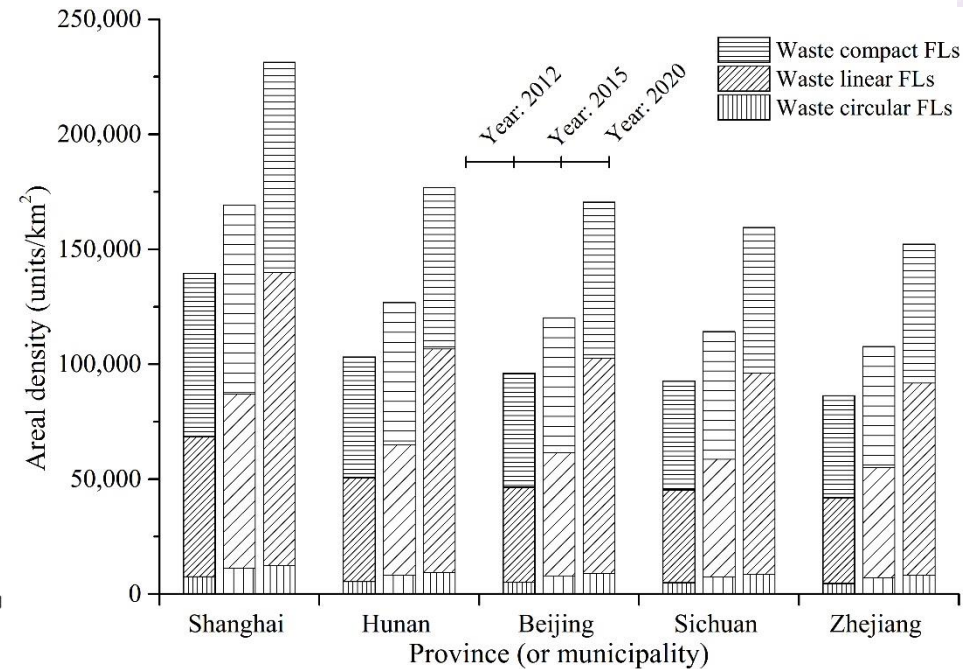
Prediction of waste FL generation in China from 2014 to 2023 (billion units)



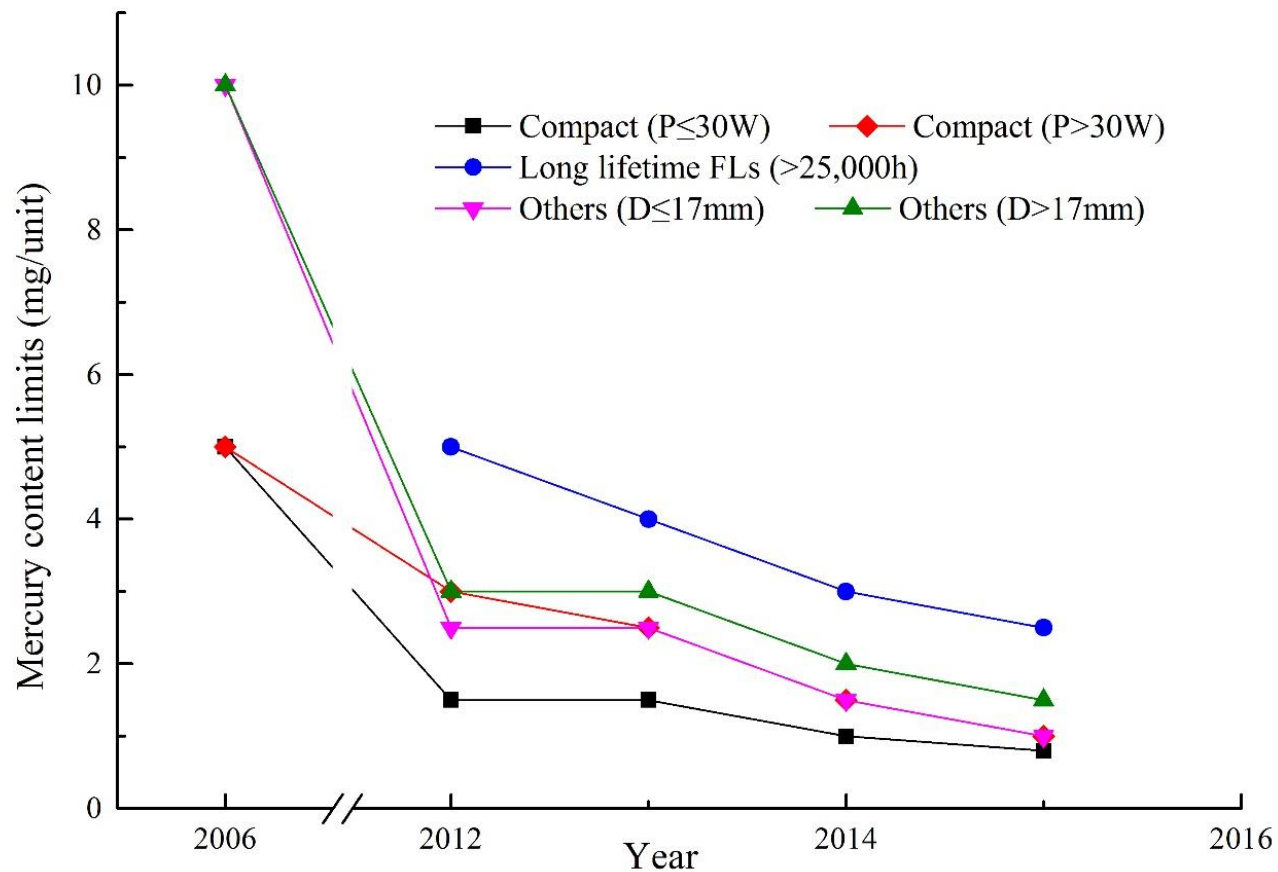
Distribution of waste FL generation in mainland of China



Amounts of waste FLs from the top 5 waste-FL-generating provinces



Areal density of waste FLs in the 5 provinces (or municipality) of the highest value



Content limits for mercury in fluorescent lamps in China

Note: “P” means the power wattage of FLs; “D” means the diameter of other types of FLs except for the compact and long lifetime FLs.

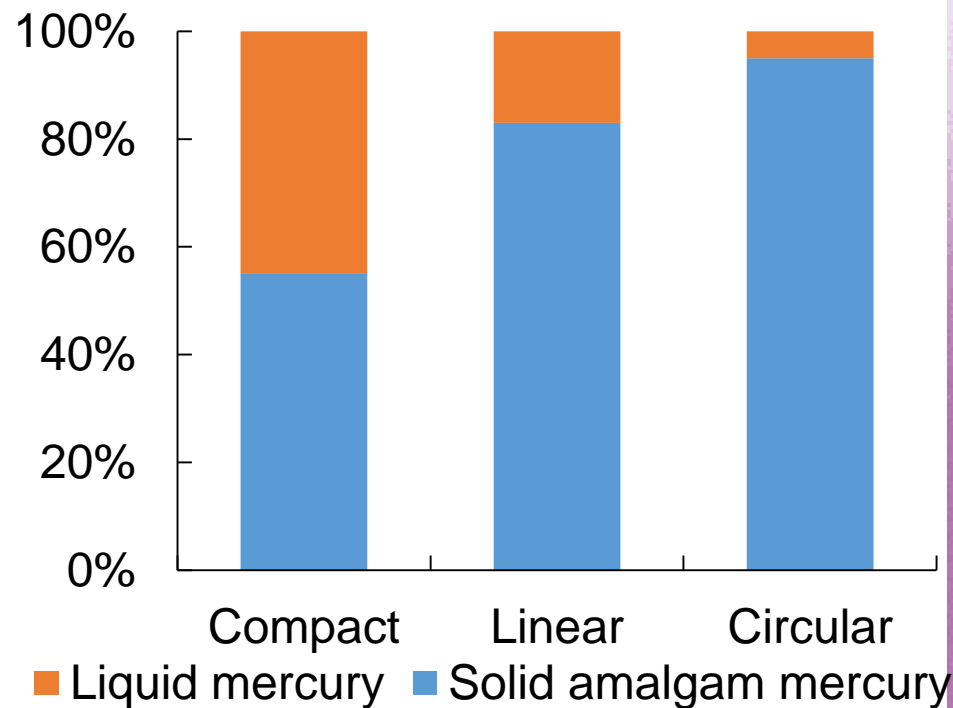


FLs production technology progress

Two different forms of mercury are being used for FLs production in China: the solid amalgam form and liquid form.

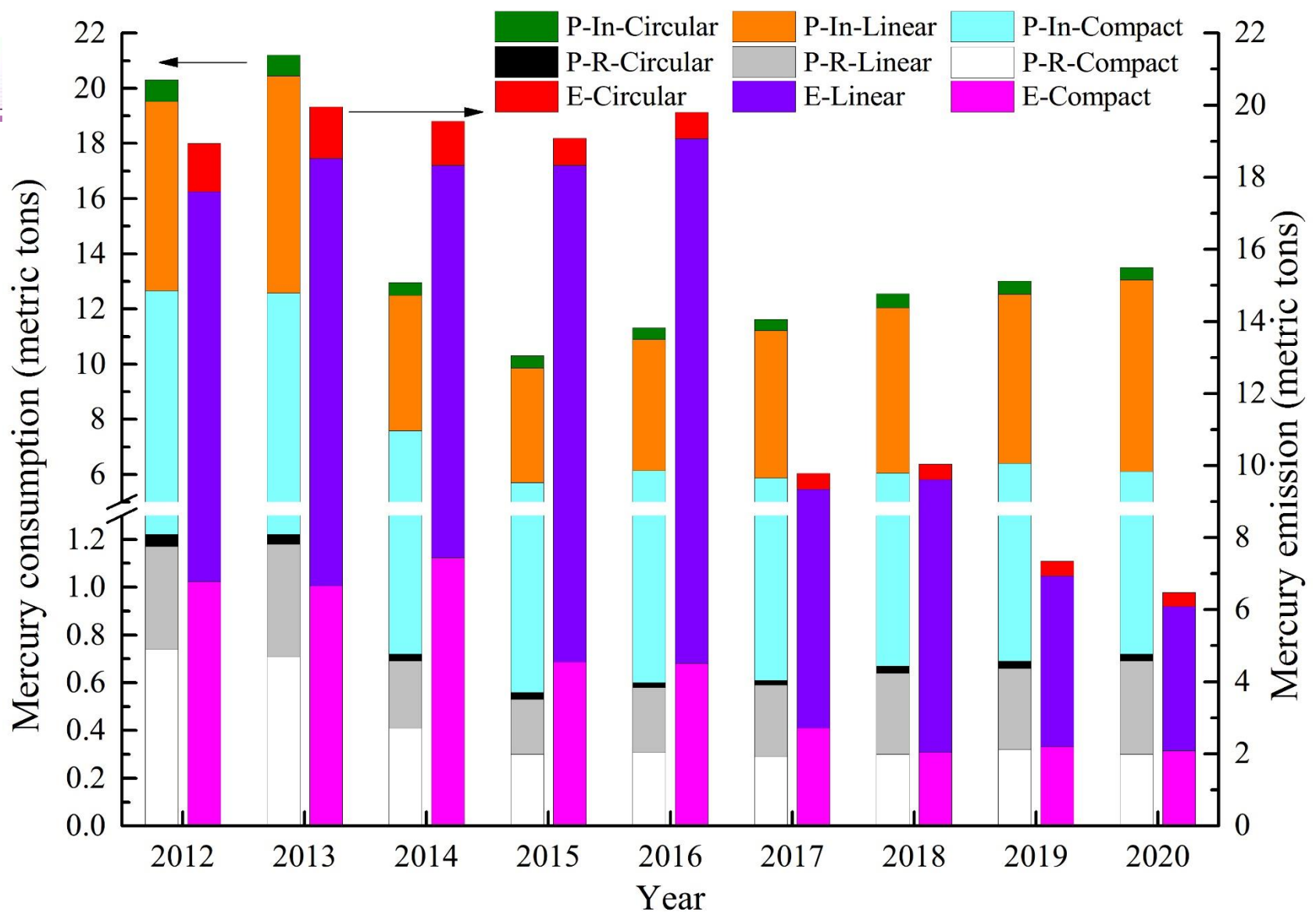
Percentage of mercury lost during dosing

Solid amalgam mercury	5.26%
Liquid mercury	9.09%



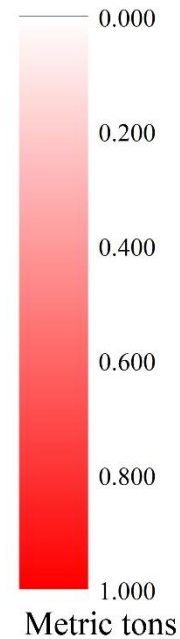
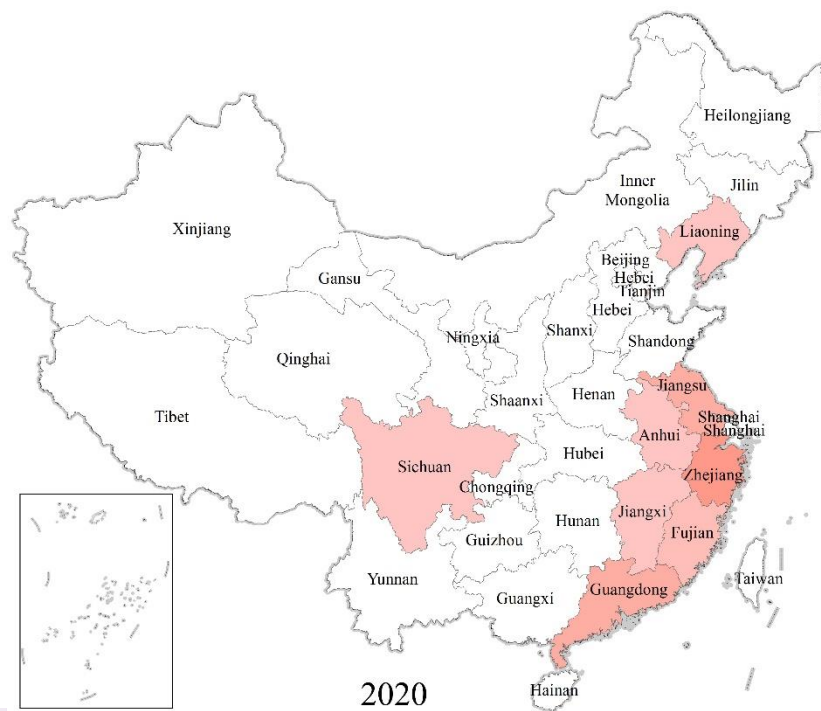
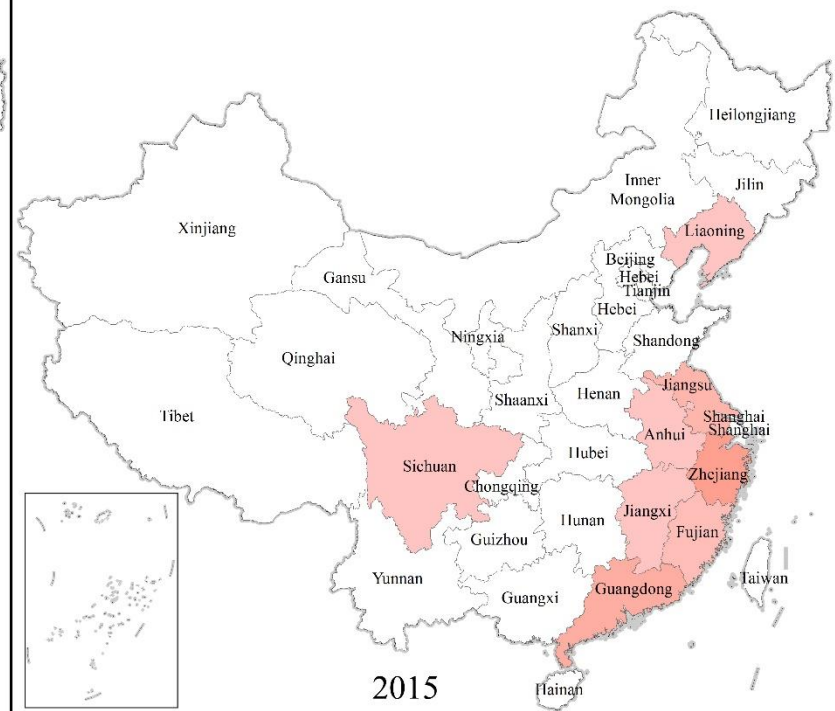
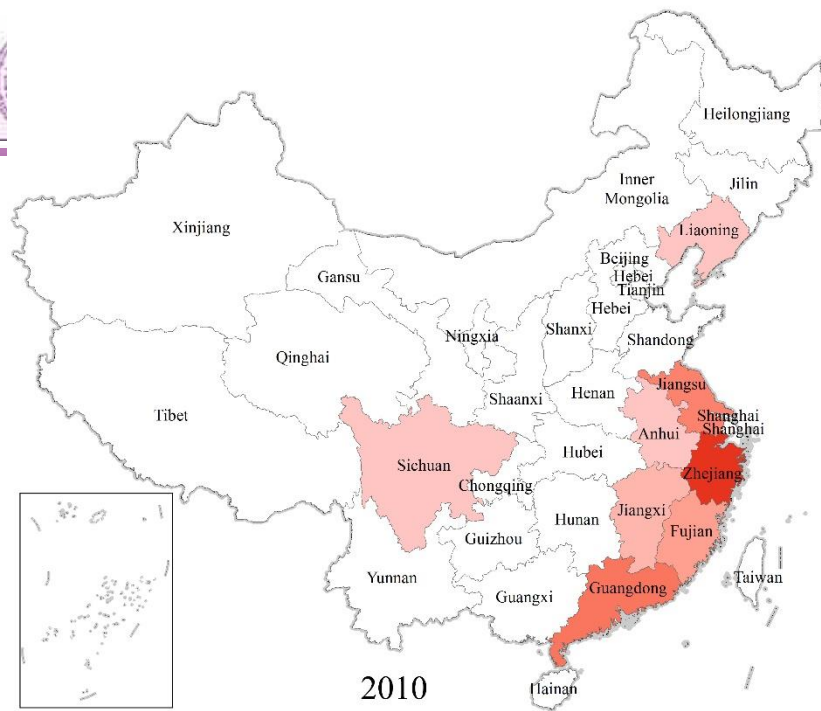
Proportion of each category of FL using the solid and liquid mercury

Li, L., et al. (2013) *Analysis on reduction trend of mercury releases from Chinese light source production industry for execution the global legally binding instrument on mercury*. China Illuminating Engineering Journal, 23-26+30.

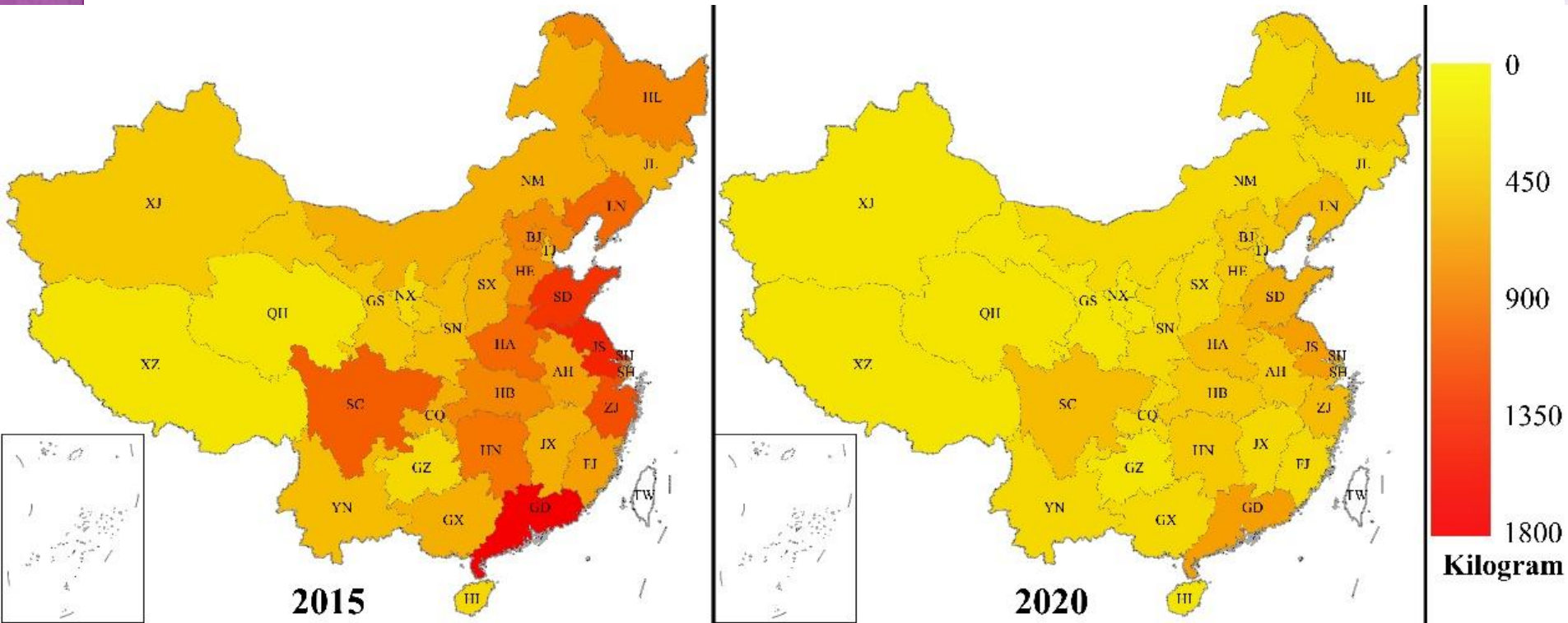


Mercury consumption during FLs production and potential emission from domestic waste FLs

Note: "P-In" mean mercury remain in the FLs during production; "P-R" mean mercury lost or released during production; "E" mean the potential emission after breakage.



**Distribution and
trends of mercury
loss during FLs
production**



Distribution and trends of mercury from waste FLs



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Current situation of waste FLs collection in China

At present, only **pilot waste FLs collection work** have been conducted out by some agencies and communities in few cities of China, such as Beijing, Tianjin, Nanning and Changsha et al.

Hazardous waste disposal facility that covers the category of mercury containing lamps

Location	Capacity (metric tons per year)	Status
Beijing City	1500	Licensed hazardous waste operation enterprise
Fujian Province	3600	
Jiangsu Province	5000	
Shanghai City	1728	In the phase of trial production
Zhejiang Province	6000	Hazardous waste operation application



Current situation of waste FLs collection in China

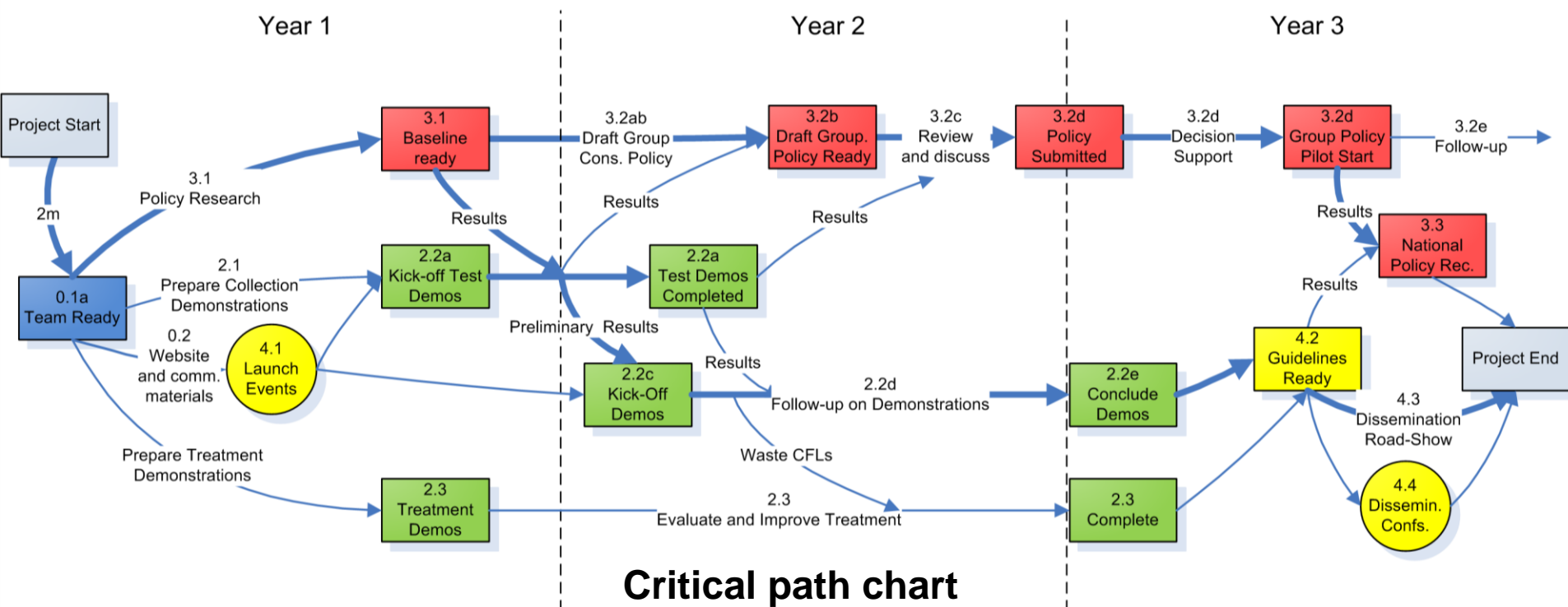
Although waste FLs are classified as a **hazardous waste** in the “China National Catalogue of Hazardous Wastes”, the practical implementation of their waste management is **far from satisfactory** due to :

- I. a general lack of detailed policies, regulations, and collection systems targeting end-users;
- II. a lack of appropriate pollution control technology, technical guidelines and/or standards on waste FLs treatment and recycling;
- III. the absence of strict supervision and enforcement.

As a result, **most waste fluorescent lamps are disposed together with municipal solid waste**, into landfills or incinerators, which causes serious pollution.



China Fluorescent Lamps collection and treatment demonstration project (Project CFL)

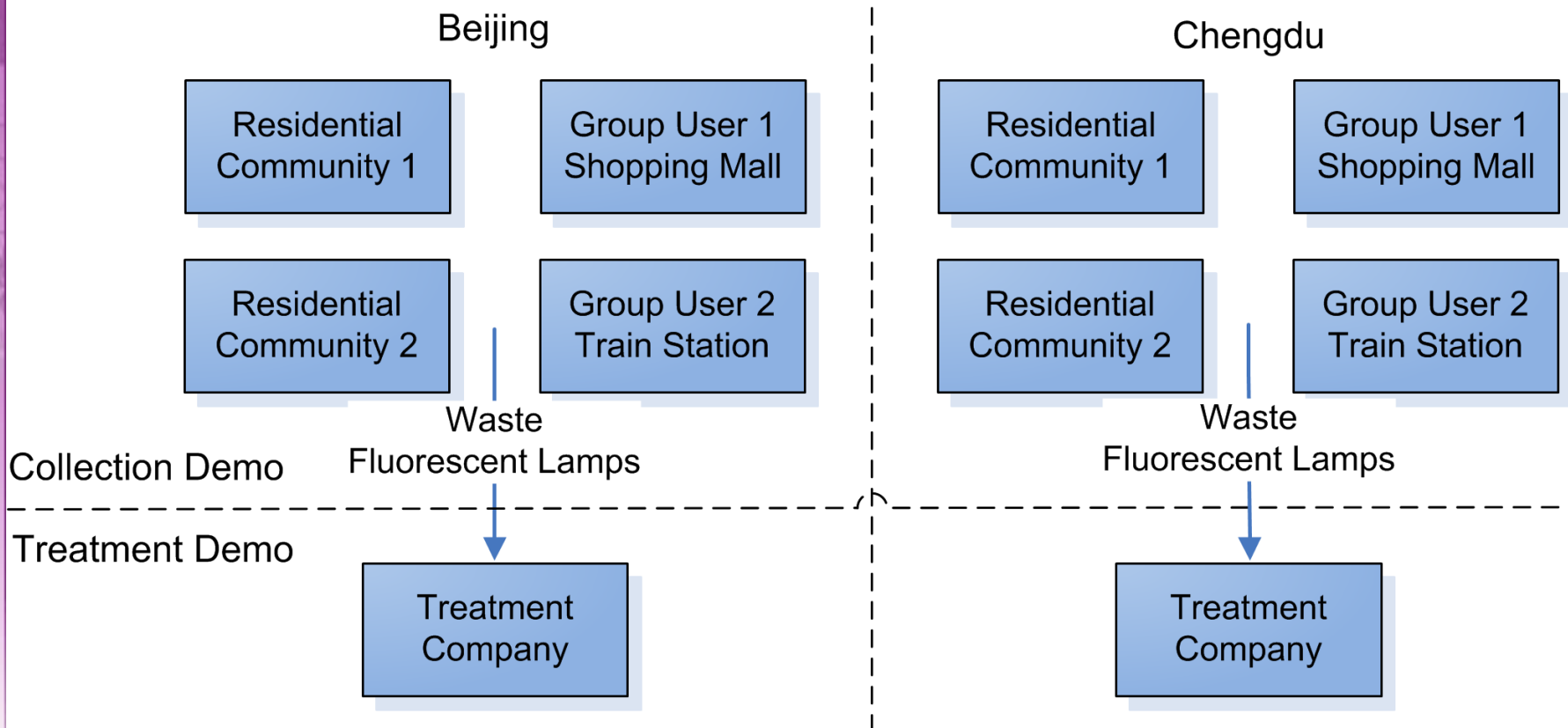


Specific objective:

To demonstrate effective approaches and improve the **policy environment** for collection and treatment of waste FLs in **Beijing and Chengdu**, and to **disseminate successful models**.



China Fluorescent Lamps collection and treatment demonstration project (Project CFL)



Overview of Collection and Treatment Demonstrations

The 9th International Conference on Waste Management and Technology

October 29-31, 2014 Beijing, China

<http://2014.icwmt.org>



Dr. Chen Yuan Ms. Wang Jiecong

*Basel Convention Regional Centre for Asia and the Pacific,
School of Environment, Tsinghua University, Beijing 100084, China,
E-mail: icwmt@tsinghua.edu.cn*

