# Chapter 7
# A Massive Urban Symbiosis: A Preliminary Review of the Urban Mining Pilot Base Programme in China

**Yanyan Xue, Hans Bressers, and Zongguo Wen**

**Abstract** Waste recycling helps to establish a circular loop of resource flow between production and consumption, achieving a certain symbiosis between the industrial and urban sector. Since more and more resources are accumulated in the urban sector, urban mining as form of waste recycling in a massive way becomes an outstanding way to achieve industrial and urban symbiosis. In 2010 China initiated a national urban mining pilot base (UMPB) programme with the objective of developing the recycling industry and relieving environmental and resource constrains. This study aims to provide policy review of the programme. We find that the UMPB programme was developed from past circular economy policies and attains legacy assurance from current laws and national plans. But this did not formulate a perfect governance context for its implementation. A multi-ministerial cross-management network led to policy conflicts, and recycling-oriented legislation remained absent. These became the main barriers for the good implementation of those urban mining pilots. Comparing with the eco-town programme in Japan, it shows that both programmes share some similarities of partial policy objectives but also show variety in the scope of urban symbiosis due to the different problems they focus on and the slightly different policy objectives under the different economic and social development phases.

**Keywords** Urban mining · Urban symbiosis · China · Recycling industry

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## 7.1 Introduction

Resource supply is an international issue for many countries in the process of urbanisation and industrialisation. UNEP predicted that the global demand of in-use metal stocks would be increased by 3–9 times if the world total population were to enjoy the same levels of use as industrialised countries (UNEP 2010). China's outstanding economic growth pattern is resource intensive, having become "the world's factory". Ministry of Land and Resources (MLR) report shows that China's external dependence on imported iron, copper and aluminium is up to 51.2%, 72% and 47.9%, respectively (MLR 2016).

Recycling is regarded as one important solution to ease the resource depletion in many counties. Recycling rates of 18 metals are estimated exceeding 50% and those of glass, plastic and other packaging materials even higher than 90% (Graedel 2011). Moreover, recycling can also save energy and avoid environmental pollution compared with virgin resource exploitation. Such extraction of secondary resources from urban metabolism is named as urban mining (Krook and Baas 2013; Krook et al. 2010). Since urban theorist Jacobs noticed that the cities will become a huge, rich and diverse mine of raw materials (Jacobs 1969), urban mining has become a metaphorical term for resource recovery from the technosphere. Literature suggests that urban mining has various denotations in different contexts. A broader concept includes the landfill mining and mining the tailings, the slags, the dissipations, the hibernations and in-use stocks (Johansson et al. 2013). The urban mining potential of copper and iron will attain 8.1 and 711.6 million tons, respectively, in 2040. The substitution rate (secondary metals substituting primary metals) can increase by 25.4 and 59.9% compared to the status in 2010 (Wen et al. 2015).

In 2010, the Chinese government initiated a national programme to establish 50 national urban mining pilots base (UMPB) in China. In its official notification, urban mining is defined as recycling waste materials from the major seven waste stream, including the electronic equipment, cables, communication facilities, vehicles, household appliances, electronic products, packaging and scraps (NDRC 2010). These are obviously classified as end-of-life products of in-use stock. The so-named bases are often referring to industrial parks hosting large-scale waste-recycling plants including pretreatment, processing and products manufacturing. In this process, massive resources are recovered from waste and transited into secondary materials and even new products. In 2012, 29 bases recycled 24 million tons of waste and produced 16 million tons of secondary materials with a total market value of 247 billion RMB.[1]

Such massive waste recycling establishes a circular loop of material flow between production and consumption and between industry and urban to enable symbioses emerging in the urban sector. The urban symbiosis concept is first introduced by Van Berkel, taking the Japanese eco-town case as example (Van Berkel et al. 2009), and was followed by several more publications on the same subject (Dong et al. 2014;

[1] Equivalent to 35.9 billion USD at an exchange rate of 1 USD to 6.88 RMB on 23 May 2017

Geng et al. 2010). Contrary to the intensively studied industrial symbiosis (Chertow 2000, 2007; Golev et al. 2014; Shi et al. 2010; Van Berkel 2004), the study of urban symbiosis is still at an early stage. This paper aims to bring the Chinese urban mining base case into this rarely studied field and answer the following questions: *What are the typical features as a massive urban symbiosis policy that the Chinese urban mining base programme represents, and to what extend can it be improved?*

Data was collected and analysed by reviewing documents from government and by interviewing policy makers and the pilot base managers. The paper is organised as follows: after this introduction, Sect. 7.2 profiles recycling industry in China; Sect. 7.3 introduces the urban mining programmes including the management frameworks and the progress of its implementation. Section 7.4 presents a policy analysis including the policy evolution and governance context and analysing those with the help of the governance assessment tool (Hans Bressers et al. 2016). Section 7.5 compares the UMPB programme with the Japanese eco-town programme, and conclusions are in Sect. 7.6.

## 7.2 Development of China's Recycling Industry

Since the 1980s, some farmers began to engage in recyclable waste resources collection and recycling by establishing recycling workshops in their backyards. They traded and collaborated with each other and gradually cultivated a leading industry in the county, contributing to the local economy and employment. For example, the plastic waste-recycling industry in the Gengche town in the Jiangsu province accounted for 80% of the GDP in total (Zhao 2011). It also created jobs for the surplus rural labour force of the towns; 70% of the residents of Gengche town worked on waste collection and recycling business, and people from adjacent towns also joined in the industry; altogether 60,000 jobs were created (Zhang 2010). Table 7.1 lists some typical recycling industry township/county in China.

The spontaneously developed recycling industry in towns bears some problems. Firstly, there is no layout plan for the household workshops; the wastes are randomly

**Table 7.1** Some typical township or county recycling industry aggregations (Authors' contribution)

| Town/county | Recycling industry | Recycling amount per year ($10^4$ tons) | Workers involved ($10^4$) |
|---|---|---|---|
| Wen'an, Hebei | Plastic | 200 | 10 |
| Jieshou, Anhui | Plastic, lead acid battery | 200 | 5 |
| Dazhou, Henan | Metals | 380 | 4.5 |
| Guiyu, Guangdong | Imported WEEEs | 220 | 6 |
| Ziya, Tianjin | Imported hardware | 150 | 2 |
| Gengche, Jiangsu | Plastic | 300 | 3 |

piled up in open air and dismantled and processed with poor equipment, imposing environmental and health risk to the workers and local residents. Wen'an in Hebei province, a county 150 km from Beijing, became the largest waste plastic assembling site in the past 20 years but also turned from a bucolic agricultural region to a bustling, crowded, dirty, stinky and noisy environment (Minter 2013). Manually dismantling imported WEEEs in Guiyu of Guangdong province caused severe environmental problems and even poor health and high neonatal mortality (Song and Li 2014; Xing et al. 2009; Xu et al. 2012).

Secondly, recycling in China is mainly driven by market forces and economic profits. Waste metal and paper/cardboard have higher market value leading to high collecting and recycling rates, while waste plastic and glass have lower recycling rates, and the collecting and recycling of waste compact fluorescent lamps remain deficient due to little profits and the absence of regulations. Thirdly, because most recycling plants cannot afford advanced technology and equipment, they often only reclaim high-value metals and discard the compound metals that are difficult to be separated, resulting in the overall recycling rate staying very low. The WEEE's reclaim rate is only 30% in China, while that of European countries can be as high as 75%. These are not helpful for resource saving and circular economy development set by the central government; thus low-end recycling industry needs improvement.

## 7.3 Urban Mining Pilot Base (UMPB) Programme in China

In 2010, the China National Development and Reform Commission (NDRC) and the Ministry of Finance jointly initiated the UMPB programme. The objective stated in the official document is "to implement the Circular Economy Promotion Law, to promote the recycling industry development and help to relief the resource and environmental bottleneck constrains in China". The goal is to support 30 (later upgraded to 50) national urban mining pilot bases. Through this process, it intends to promote the key waste streams recycling at a large scale with high-value production, to develop and spread advanced recycling technology and to explore the urban mining model and policy mechanism. For this purpose, the programme prescribes seven requirements for an ideal urban mining base: systematic waste collection network, proper industrial chain, upscaled recycling of materials, advanced equipment, shared infrastructure, collective environmental facilities and a standard management and operation system (Xue et al. 2017).

The prediction of the urban mines' potential and waste stream tracing as well as the spatial distribution of the recycling plants needs in-depth research, but some studies indicate that it is very promising. The urban mining potential of copper and iron will attain 8.1 and 711.6 million tons, respectively, in 2040. The substitution rate (secondary metals substituting primary metals) can increase by 25.4% and 59.9% compared to the status in 2010.

### 7.3.1 Selection of the Pilot Bases

The pilot bases are selected from the recycling industry parks, and only those parks with annual recycling capacity above 0.3 million tons are eligible to make application. The selection process consists of four steps: (1) provincial DRCs recommend local applicants; (2) the applicants draw up and submit their national urban mining pilot base action plans according to the guideline issued by NDRC. The guideline sets a unified format for the action plans and emphasises the park's status quo analysis, the target of recycling capacity and the newly added waste-recycling facilities investment projects to achieve the target. (3) NDRC invites experts to evaluate the action plans following certain rating rules and selects the top-scoring applicants as national urban mining pilot bases. The Ministry of Finance will provide subsidies to support investment of new facilities and equipment as well as collection system. The management procedure of pilot base selection is illustrated in Fig. 7.1.

### 7.3.2 Progress at Present and Some First Observations

During 2010–2015, NDRC called for five batches of selection; in total 140 recycling industrial parks made application, and only 45 were selected as the national urban mining pilot bases. The 45 selected urban mining pilot base information are shown in Table 7.2. The overview shows that their total planning area is 275.8 $Km^2$ and total planned annual waste recycling capacity is 68.3 million tons. China in total recycled 210 million tonnes domestic and imported recyclable resources in 2012. The total recycling capacity of 45 urban mining pilot bases can account for one third of this amount, which shows some significance in terms of the scale.

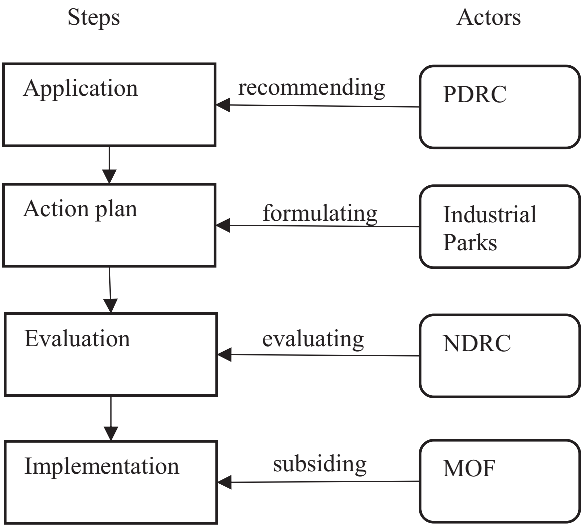


**Fig. 7.1** Selection procedure of urban mining pilot bases (*PDRC* Provincial Development Reform Commission, *NDRC* National Development Reform Commission, *MOF* Ministry of Finance). (Authors' contribution)

**Table 7.2** Profile of the 45 approved national urban mining pilot bases (Authors' contribution based on own data collection from several sources)

| Nr | Name | Planned area (km$^2$) | Total investment (billion RMB) | Recycled in 2012 (million tons) | Planning capacity (million tons) |
|---|---|---|---|---|---|
| 1 | Tianjin Ziya | 135 | 19.8 | 1.53 | 3.4 |
| 2 | Anhui Jieshou | 10 | 10 | 0.48 | 0.5 |
| 3 | Hunan Miluo | 18 | 17.8 | 1.57 | 4.0 |
| 4 | Guangdong Qingyuan | 2.7 | 0.7 | 0.49 | 1.2 |
| 5 | Sichuan Xinan | 3.3 | 0.9 | 1.03 | 1.9 |
| 6 | Qingdao Xintiandi | 5.0 | 1.0 | 0.37 | 0.9 |
| 7 | Zhejiang Ningbo | 1.4 | 5.0 | 0.4 | 0.6 |
| 8 | Shanghai Yanlongji | 0.1 | 0.8 | 0.49 | 0.8 |
| 9 | Guangxi Wuzhou | 6.7 | 15 | 1.5 | 1.8 |
| 10 | Jiangsu Pizhou | 4.3 | 2.0 | 0.4 | 0.9 |
| 11 | Shandong Linyi | 1.5 | 1.1 | 1.2 | 3.0 |
| 12 | Chongqing Yongchuan | 2.5 | 1.5 | 0.88 | 0.9 |
| 13 | Zhejiang Tonglu | 8 | 1.5 | 1 | 1.0 |
| 14 | Hubei Gucheng | 10 | 2.4 | 1.63 | 2.8 |
| 15 | Daliang Eco-park | 12 | 18 | 0.7 | 1.9 |
| 16 | Jiangxi Xinyu | 4.2 | 2.5 | 2 | 3.3 |
| 17 | Hebei Tangshan | 1.1 | 0.7 | 0.65 | 1.0 |
| 18 | Henan Dazhou | 10 | 10.6 | 2.3 | 3.5 |
| 19 | Fujian Huamin | 2.3 | 1.3 | 0.4 | 0.3 |
| 20 | Ningxia Lingwu | 6.7 | 9.0 | 1 | 2.1 |
| 21 | Beijing Lvmeng | 0.3 | 1.0 | 0.75 | 1.3 |
| 22 | Liaoning Donggang | 8.2 | 6.0 | 0.45 | 0.9 |
| 23 | Foshan Yingjia | 0.8 | 2.9 | 0.58 | 1.3 |
| 24 | Anhui Chuzhou | 3.8 | 2.5 | 0.2 | 1.0 |
| 25 | Xinjiang Nanjiang | 0.8 | 1.5 | 0.4 | 0.6 |
| 26 | Shanxi Jitianli | 2.7 | 1.5 | 0.2 | 0.5 |
| 27 | Heilongjiang Dongbu | 3.8 | 0.5 | 0.37 | 0.6 |
| 28 | Hunan Yongxing | 4.2 | 20 | 0.53 | 1.4 |
| 29 | Jilin Gaoxin | 2.0 | 1.3 | 0.5 | 0.8 |
| 30 | Hubei Gelinmei | 0.4 | 4.2 | – | 1.6 |
| 31 | Jiangxi Yingtan | 10 | 3.5 | – | 1.8 |
| 32 | Jiangsu Rudong | 16.6 | 6.5 | – | 1.5 |

(continued)

**Table 7.2** (continued)

| Nr | Name | Planned area (km$^2$) | Total investment (billion RMB) | Recycled in 2012 (million tons) | Planning capacity (million tons) |
|---|---|---|---|---|---|
| 33 | Zhejiang Taizhou | 4.4 | 10 | – | 3.0 |
| 34 | Hebei Zhonghang | 0.7 | 3.3 | – | 0.3 |
| 35 | Sichuan Baohe | 3.3 | 5.0 | – | 1.7 |
| 36 | Henan Luoyang | 5.9 | 3.5 | – | 0.3 |
| 37 | Guiyang Baiyun | 2.2 | 2.8 | – | 1.4 |
| 38 | Fujian Haixi | 0.9 | 3.4 | – | 2.0 |
| 39 | Fujian Xiamen | 0.4 | 0.4 | – | 0.4 |
| 40 | Shandong Yantai | 3.2 | 2.5 | – | 5.0 |
| 41 | Inner Mongolia Baotou | 20 | 26 | – | 0.8 |
| 42 | Gansu Lanzhou | 14.1 | 3.2 | – | 0.8 |
| 43 | Xinjiang Kelamayi | 30 | 9.0 | – | 0.5 |
| 44 | Heilongjiang Haerbin | 5.5 | 5.9 | – | 2.0 |
| 45 | Guangxi Yulin | 2.0 | 0.5 | – | 1.5 |
| | Total | 390.8 | 248.4 | 24 | 68.3 |

Further scanning of these pilot bases shows some disparities between the pilots in terms of the planned area and recycling capacity. This is related with their various historic development foundations and with future goals. The Nr. 1 Tianjin Ziya pilot was a town focused on imported hardware waste dismantling and now targets to become a comprehensive industrial park, including dismantling and recycling of WEEEs, waste vehicles, cables, plastics and cardboards, with a total processing capacity of 3.4 million tons. The planned pilot area also includes the agricultural and residential areas, in total 135 km$^2$, and a new town. The Nr. 2 Anhui Jieshou pilot is developed from an acid lead battery-recycling aggregation. It is a specifically urban mining industry park focusing on a single waste stream. Due to the national total emission control limitation policy of $SO_2$, the pilot cannot plan more than 0.5 million tons of capacity.

Figure 7.2 shows the locations of the 45 pilot bases, mainly located at the east coastal and middle region of China. Two factors explain this. First, the industrial development and population are concentrated in the eastern and central regions, leading to a high demand for waste generation and processing as well as for resources. These favour the development of the labour-intensive recycling industry, especially in the provinces of Anhui, Henan and Hebei with large population. Second, coastal areas hold many harbours, through which the waste resources get imported or smuggled in, thus favouring a growth of dismantling and recycling industry in the coastal area. Several urban mining pilots like Tianjin Ziya and Guangdong Qingyuan are developed on such importing and dismantling of wires and cables, WEEEs and waste metals.

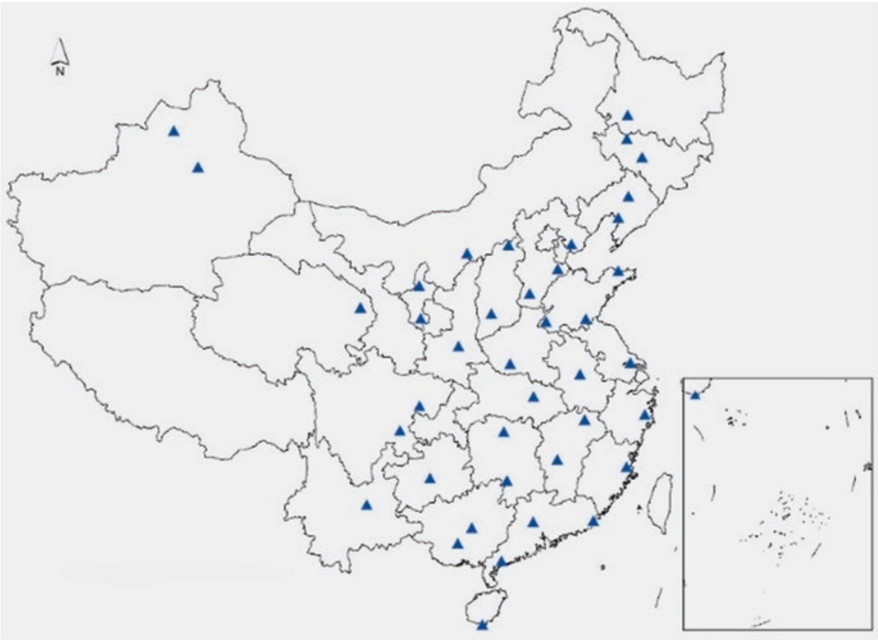


**Fig. 7.2** Location of 45 national urban mining pilots bases. (Authors' contribution)

However, the selection of the 45 urban mining pilots was only based on their industry development planning. It has not considered the location distribution issue. Because the inputs for an urban mining pilot are the recyclable waste resources from nearby cities, the waste generation and supply are much related to the local economic development level and the consumption habits of the people. Urban mining pilots cannot be located too nearby each other, to avoid waste supply competition problems. Figure 7.2 shows that there are seven pairs of pilots located nearby each other; their transportation distances are under 200 km. If they focus on similar recycling streams, there must be a potential risk of competition for waste supply. Table 7.3 compares the seven adjacent pilots' similarities and finds that three adjacent pairs of pilots bear such problems.

In summary, some first observations on the 45 urban mining pilots are:

1. The 45 urban mining pilot bases account for one third of the total collected and imported recyclable resources and thus have a high significance.
2. There are many disparities between the pilots in terms of the planned capacity and scale, some are targeting to become a comprehensive recycling industrial park and some are focused on specific waste streams.
3. The selection of the urban mining pilots has neglected the geographical distribution issue, resulting in seven pairs of pilots that are located within 200 km from each other, and some of them have a similar industry planning, thus leading to a high risk of waste resource competition in the future. The overall management of these urban mining pilots should coordinate the capacity planning among the pilots.

**Table 7.3** Mutual distances of seven pairs of pilots are less than 200 km (Authors' contribution)

| Adjacent pilots | Distance (km) | Similarity of their recycling industry |
|---|---|---|
| Xiamen and Quanzhou | 100 | Same recycling industry but different waste resources, middle similarity |
| Yongchuan and Neijiang | 112 | Both are comprehensive recycling industry parks, high similarity |
| Jingmen and Xiangyang | 124 | Different waste streams focused on, low similarity |
| Beijing, Tianjin, Tangshan | 125 | Three are comprehensive recycling industry, high similarity |
| Nantong and Shanghai | 128 | One comprehensive and the other is specific glass recycling park, low similarity |
| Taizhou and Ningbo | 174 | Middle similarity |
| Linyi and Xuzhou | 198 | Middle similarity |

## 7.4 The Policy Analysis

This section presents a policy analysis of the UMPB programme. We firstly review other relevant policies and find the policy evolution path and then profile its policy network which is featured with a multi-ministries cross-management system. Finally, we apply governance contextual analysis tool to find the supportiveness of the current governance structure for the programme.

### *7.4.1 Policy Evolution of the Urban Mining Programme*

The urban mining programme is an important initiative for developing circular economy in China. Reviewing circular economy relevant policy suggests that the urban mining initiative is not isolated but was built upon other policies. It also shows that the driving forces of waste-recycling management in China are moving from environmental and recycling angles to resource strategy concerns.

The circular economy concept was first officially introduced by the Ministry of Environmental Protection (MEP) in 2002 but soon included in the profile of NDRC authorities. Table 7.4 lists all circular economy-relevant policies since then.

In 2004, MEP initiated a circle zone management for the assembling area of imported waste-recycling workshops (mainly wastes of electric wire, cable, machinery and equipment). The objective was to improve the environmental management in the area. Nineteen pilots were selected; instruments to monitor imported waste licences and total control as well as environmental technology planning were introduced to improve in total 627 enterprises.

In 2005 and 2007, NDRC with other five ministries jointly initiated two batches of circular economy pilots, in total supporting 178 pilots to practise waste reduction, recycling and recovery projects (Jiao and Boons 2014). Among these pilots, some

**Table 7.4** Relevant national circular economy policies and programmes (Authors' contribution)

| National programmes | Year started | Ministry in charge | Policy focus | Results so far |
|---|---|---|---|---|
| Eco-industrial park | 2003 | MEP | Recognise eco-industrial parks | 26 were accomplished; 59 are in application procedure |
| Circle zone management initiative | 2004 | MEP | Improve environmental management of waste-recycling assembling area | 19 pilots were selected |
| Circular economy demonstration programme | 2005<br>2007 | NDRC | Key industries, industrial parks, province and cities | 178 demonstration projects were accomplished |
| Urban mining pilot base programme | 2010 | NDRC | Supports 50 pilots bases | 45 pilots selected |
| Industrial park circularised development programme | 2012 | NDRC | Supports 100 industrial parks to implement circular economy projects | 67 industrial parks were selected |
| Circular cities demonstration programme | 2013 | NDRC | Supports 100 cities | First batches, 40 cities were selected |

waste-recycling projects were included in the first batch such as renewable resource collection and recycling, waste metals recovery, WEEE and remanufacturing. The second batches list several renewable resource-recycling industrial parks, e.g. Tianjin Ziya and Anhui Jieshou, which were naturally selected as urban mining pilot bases in 2010.

The above two initiatives addressed different issues of recycling. The circular economy pilots explored various circular economy models at wide-ranging fields and industries. A total of 178 pilots included enterprises, industrial parks, provinces and cities, of which nine circular economy pilot parks were further selected as pilot in urban mining pilot base programme in 2010. The circle zone management initiative targeted on environmental issues of the recycling companies. There are only 19 pilots, but ten of which were also selected as urban mining pilot bases later. Sixteen UMPBs enjoyed the circle zone management policy or circular economy pilots before they were listed as urban mining pilot bases (see Table 7.5).

The urban mining programme has the dual objective of industrial development and reducing environmental and resources constrains, but its resource strategy is more obvious as it sets an annual capacity threshold of 0.3 million tons for the applicants. Figure 7.3 illustrates the policy evolution path of urban mining policy. It shows the driving forces of waste-recycling management in China moved from environmental and recycling angles to resource strategies at UMPB programme and then to an integration of three aspects in 2013 when NDRC initiated 100 circular pilot cities programme to promote comprehensive circular economy development of industrial, agricultural and society sectors in cities (NDRC 2013). Till then, China is moving forward to a more comprehensive urban symbiosis stage.

**Table 7.5** Some urban mining bases are developed from the circular economy pilot and circle zone management pilot programmes (Authors' contribution)

| Nr. | Urban mining pilot bases | Urban mining pilot base approving date | Circular economy pilots approving date | Circle zone pilots approving date |
|---|---|---|---|---|
| 1 | Tianjin Ziya | 2010 | 2007 | 2007 |
| 2 | Anhui Jieshou | 2010 | 2007 | – |
| 3 | Hunan Miluo | 2010 | 2005 | – |
| 4 | Guangdong Huayuan | 2010 | 2005 | – |
| 7 | Zhejiang Ningbo | 2010 | 2007 | – |
| 9 | Guangxi Wuzhou | 2011 | – | 2010 |
| 15 | Dalian Eco-park | 2011 | – | 2012 |
| 18 | Henan Dazhou | 2011 | 2007 | – |
| 22 | Liaoning Donggang | 2011 | – | 2010 |
| 28 | Hunan Yongxin | 2012 | 2007 | – |
| 31 | Jiangxi Yingtan | 2013 | 2005 | 2009 |
| 32 | Jiangsu Rudong | 2013 | – | 2011 |
| 33 | Zhejiang Taizhou | 2013 | – | 2008 |
| 40 | Shandong Yantai | 2014 | – | 2007 |
| 41 | Inner Mongolia Baotou | 2014 | 2005 | – |
| 45 | Guangxi Yulin | 2014 | – | 2008 |

### *7.4.2 The Governance of Implementing the UMPB Programme*

The urban mining policy has evolved from the previous relevant circular economy policies but is also supported by a more comprehensive policy framework. Together they define the policy network (see Fig. 7.4). The term policy network is here not confined to the relevant actors but also to the policies, institutions and resources that form the context of the policy implementation. This is also labelled as the "governance" context (Hans Bressers and Kuks 2004).

Firstly, at the regulation level, the Circular Economy Promotion Law promulgated in 2009, provides a regulation basis for all circular economy planning and pilot programmes including the urban mining programme (Su et al. 2013). Secondly, at the planning level, the 12th national Five-Year Plan (FYP) sets the target to increase resource productivity by 15%. This is the first time for China that a FYP sets target on resources and recycling. Following that, the NDRC has drawn up a circular economy development strategy and action plan, which lists major tasks such as the top 10 circular economy (CE) pilot projects, 100 CE pilot cities and 1000 CE pilot enterprises and parks. The urban mining pilot base programme is emphasised in the plan. There are other special plans that also support and embody the urban mining programme (see Table 7.6).

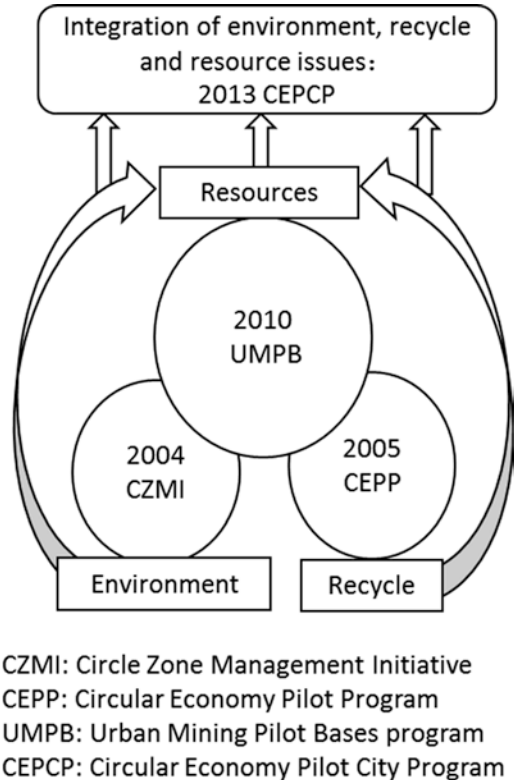


**Fig. 7.3** Policy evolution path of urban mining policy. (Authors' contribution)

Lastly, the urban mining programme also receives financial support. The Ministry of Finance established a circular economy fund, to support projects in six sectors, which include urban mining pilot base programme, food waste management, industrial park circular retrofit, remanufacture, cleaner production technology promotion and circular economy infrastructure. The fund provides 10% of the total investment ratified in the urban mining pilot base action plan as subsidy. About 4 billion RMB has been ensured for the urban mining pilot bases. Averagely, every pilot base can receive about 0.1 billion RMB for the projects construction.

However, while the current urban mining policy framework looks sufficiently supportive in terms of policy and planning context and resource allocation, there are still some issues to be improved.

The single urban mining pilot base programme covers seven major types of waste. It tries to establish a comprehensive platform for waste recycling. Comparing with the EU waste management legal framework (see Table 7.7), the EU sometimes deploys specific directives to regulate specific waste management streams. But the target of China's urban mining policy is not the waste itself but industrial park which provides a platform for large-scale and high-value recycling production. Therefore, it also needs other policy mechanisms such as pollution control, recycling licences, industry access, waste collection system, financing and industry

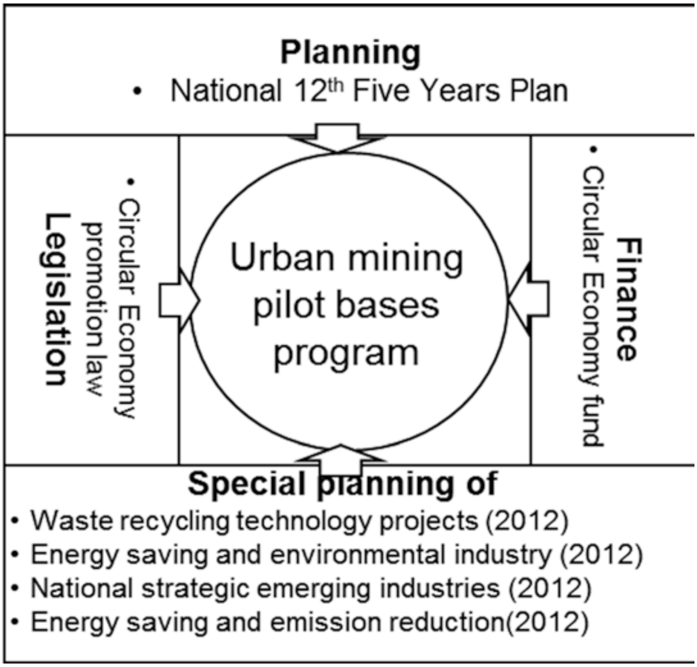


**Fig. 7.4** Legal framework of UMBP programme. (Authors' contribution)

chain cultivation. Because different wastes are under different ministries' jurisdictions, this leads to a complex urban mining policy network consisting of multiple ministries and multiple waste streams (see Figs. 7.4 and 7.5).

In this multi-ministerial cross-management network, policy conflicts occur in many cases. The collection, recycling and pollution control parts are under different ministries' jurisdictions. Some planned recycling facilities can be hindered by licence applications from other departments and even undermined due to short supply of waste resources.

The absence of a specific waste management law is another shortage in the current governance context of implementing the urban mining policy. Particularly waste collection is not supported by regulation but only relies on free market mechanisms. This leads to several problems. Waste streams can be transported more than 500 km to the highest price buyer while nearby plants are in short supply; thus eco-efficiency is not assured.

Currently the urban mining pilot base programme policy effects are not coordinated with the WEEE policy. Since 2012, the Ministry of Environmental Protection initiated a WEEE-recycling and management programme, a fair WEEE fund and management system has been established, and 106 WEEE-dismantling enterprises are listed to receive subsidies. However, only few enterprises are located in the current 45 urban mining pilot bases; therefore the two policies have little mutually supportive influence to one another.

**Table 7.6** Several 12th FYP special plans reinforce the urban mining pilot base programme (Authors' compilation from various sources)

| | Ministry in charge | Special plans | Main tasks listed in the plans relevant to urban mining and resource recycling |
|---|---|---|---|
| 2011 | State council | 12th FYP action plan for energy saving and emission reduction | 100 resource comprehensive utilisation bases |
| | | | 80 waste collection pilot cities |
| | | | 50 urban mining pilot bases |
| | | | 5 remanufactures' assemble area |
| | | | 100 food waste management pilot projects |
| 2011 | NDRC | Guidelines for comprehensive resource utilisation of 12th FYP | Increase renewable resource collection rate to 70% |
| | | | Increase secondary copper, aluminium and lead production to 40%, 30% and 40% of the total production, respectively |
| 2012 | Ministry of Science and Technology | 12th FYP special plan of waste-recycling technology projects | Priorities filed include resource recycling technologies of metals, WEEEs and polymer and electric machine remanufacturing |
| 2012 | State council | 12th FYP special plan of energy saving and environmental industry development | Support 50 urban mining pilot bases; support waste collection, recycling industrial chain, environmental pollution remediation infrastructure and platform, scaled and high-value resource recycling |
| 2012 | State council | 12th FYP special plan of national strategic emerging industries development | Support some urban mining pilot bases, and improve the recycling technology and equipment manufacture level of waste metals, rubble, tire, battery, etc. |
| 2012 | State council | 12th FYP special plan of energy saving and emission reduction | Implement key projects of resource comprehensive utilisation, waste collection, urban mining, remanufacture, food waste management, industrial park circular reform, technology spreading |
| 2013 | State council | Circular economy development strategy and short-term action plan | Top 10 pilot projects: waste collection pilots, 50 urban mining pilot bases |
| | | | 100 CE pilot cities |
| | | | 1000 CE pilot business/industrial parks |

**Table 7.7** Comparison between and EU waste management directives (Authors' contribution)

| Waste stream covered by china UMPB programme | Corresponding EU directives |
|---|---|
| Electronic equipment | Directive on WEEE (2002/96/EC) |
| Cables | Directive on WEEE (2002/96/EC) |
| Communication facilities | Directive on WEEE (2002/96/EC) |
| Household appliances | Directive on WEEE (2002/96/EC) |
| Electronic products | Directive on WEEE (2002/96/EC) |
| Packaging and scraps | Directive on packaging and packaging waste (1994/62/EC) |
| End-of-life vehicle | Directive on end-of-life vehicle (2000/53/EC) |

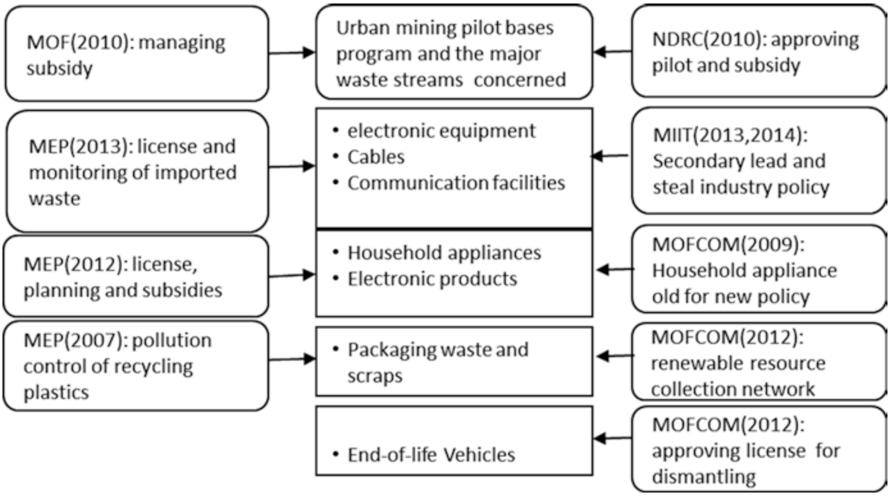


**Fig. 7.5** A complex urban mining policy network consisting of multiple ministries' cross-management (*MOF* Ministry of Finance, *MEP* Ministry of Environmental Protection, *NDRC* National Development and Reform Commission, *MIIT* Ministry of Industry and Information Technology, *MOFCOM* Ministry of Commerce). (Authors' contribution)

All in all, the current urban mining governance context only provides a platform for the urban mining recycling activities, some policy conflicts still occur and special regulations are absent, so inter-ministerial coordination and policy integration are needed to develop an overall institutional design for urban mining in China. Consequently, specific recycling-oriented regulations are in need to assure sufficient waste supply for the urban mining industry development. Lastly, coordination between ministries and policy integration is needed to implement the urban mining pilot base policy goal of resolving resource bottleneck constraints.

### *7.4.3 Analysing the Supportiveness of the Governance Context*

Above we have shown that the urban mining policy in fact originates from many policies and with many governmental stakeholders. It attempts to harmonise those in an overall platform. Hans Bressers and Kuks (2004) state that under these conditions, two criteria determine the degree to which the governance context, including the network context, is supportive for the implementation. The criteria are defined by the questions that they pose to the five dimensions of governance (administrative levels and geographical scales, actors and networks, problem perspectives and goal ambitions, strategies and instruments and responsibilities and resources for implementation):

1. *Extent*: are all elements in the five dimensions that are relevant for the policy or project that is focused on taken into account? Or are essential ones lacking?
2. *Coherence*: are the elements in the dimensions of governance reinforcing rather than contradicting each other?

Sufficient extent and coherence together form genuine policy integration. Just having sufficient extent, being complete, is not enough. However, lack of extent can be one of the sources of lack of coherence.

In later theoretical development and empirical studies, two extra criteria were added:

3. *Flexibility*: are multiple roads to the goals, depending on opportunities and threats as they arise, permitted and supported?

4. *Intensity*: how strongly do the elements in the dimensions of governance urge changes in the status quo or in current developments?

For each of the five dimensions of governance, the four criteria mentioned above can be applied, which forms a matrix. This matrix forms the core of the *Governance Assessment Tool* (GAT) (Hans Bressers et al. 2016). Together, the questions in each cell shed light on the degree of supportiveness or restrictiveness of the governance context towards the implementation of policies and projects. Note that not the implementation and success of the programme itself is evaluated, but the degree to with the governance context is supportive for such success.

While the early assessment of the governance context as described in the sections above does not provide detailed information on all the 20 separate cells, it is possible to systematically analyse the governance context for the implementation of the urban mining pilot base programme with the criteria of the governance assessment tool.

**Extent: High Level of Involvement, but Some Elements Are Still Lacking**
The selection process involved both upper and lower levels in a sort of top-down bottom-up interaction. Also the potential bases themselves were involved. This selection process has however not resulted in an optimal geographical spread of pilot sites. Among the problem perspectives, obviously such geographical scope has been missing.

Absence of a specific waste management law is another shortage in the current policy governance context. Particularly waste collection is not supported by regulation but only relies on free market mechanisms. This leads to several problems, as waste can be transported more than 500 km to the highest price buyer while nearby plants are in short supply; thus eco-efficiency is not assured, and extra unnecessary pollution is likely. While reducing these was an important purpose of the national programme, these shortages affect the core of the policy.

**Coherence: Both Reinforcing and Contradicting Forces**
On the positive side, the urban mining pilot base programme is very well embedded in the general circular economy policies, laws and plans of China. Equally positive is that the development of those policies and plans goes consistently into the

direction of more comprehensive strategies, for instance, with the recent 100 circular city pilot programmes.

On the other hand, the broad scope of the programme, involving various waste streams and stages of processing, also creates coherence issues. It requires a multi-ministerial cross-management network while the collection, recycling and pollution control parts are under different ministries' jurisdictions. They are not always geared towards mutual cooperation. As a consequence, in many cases policy conflicts occur.

While the geographical distribution of the pilots is not optimised, it is possible that in some cases completion for waste streams occurs, leading to transports and pollution hazards.

While the WEEE's policy is not coordinated with the urban mining pilot base programme, only few enterprises are located in the current 45 urban mining pilot bases. Thus the potential for reinforcing the two programmes is underused.

**Flexibility: Test Is Yet to Come**

The criterion of flexibility is an important governance asset in situations in which the field develops in a dynamic way, and thus adaptive responses to these changes are required to keep the original goals feasible. It can be predicted that such developments are bound to occur in the future. One might think of technological developments in waste separation and processing or of developments in supply of waste stream and demands for materials due to technological and economic forces like the gradual transition towards a service-oriented economy. As the implementation of the programme is still under development, the test whether it is capable of allowing and supporting a sufficient degree of flexibility to the bases to cope with such changes while keeping the objectives up is yet to come.

**Intensity: High Level of Policy Support**

While the urban mining pilot base programme is one of the spearheads of the circular economy policy turn that China is pursuing, even supported by the 12th FYP, it has a high level of policy support that makes it difficult to ignore. The sheer size of the effort to create a nationwide innovative system testifies this. Whether the level of finance (10% subsidy) is sufficient to enable the pilots to flourish remains to be seen. Probably solving the issues mentioned under extent and coherence is as important as that and will also require continuously strong high-level policy support.

**Highlights**

The systematic analysis of the governance context above confirms the picture of the previous section. While intensity of the programme is quite high, the institutional organisation created a medium level of extent and coherence. Whether flexibility will prove sufficient is too early to tell. Actually this picture is not uncommon for an innovative programme. By its nature it has to obtain a position among many existing and more established policies and government organisations. Only an open eye for its remaining inconsistencies and a continuation of its high-level support can make the situation develop into an even more supportive governance context, for instance, by taking the measure mentioned at the end of the previous section.

An open mind includes a desire to learn from previous examples. Therefore, the next section will compare the Chinese programme with a programme that Japan started already in the late 1990s.

## 7.5 Comparison with the Eco-town Programme in Japan

Facing a similar waste and resources problem as China did later when developing economically, Japan initiated its eco-town programme in 1997 with two aims: to extend landfill site life and to revitalise local industry. Local governments formulated eco-town plans and submitted them to the ministries for approval and endorsement. Ministries provided grants to local authorities to execute the town planning, community recycling and outreach activities and subsidies to private companies to invest in the recycling projects (Van Berkel et al. 2009). During 10 years of operation, 26 eco-towns are endorsed, and 205 projects were invested in and started in operation. The eco-towns are classified into three types: promotion of environmental industries, treatment of wastes and community development. The projects are mainly focused on plastic recycling as the largest waste stream and food and electronic waste recycling (Ohnishi et al. 2012). The programme has been proven successful. It not only contributed to diversification and sophistication of recycling technologies such as metal recovery and high-grade recycling options for plastics but also had a broader impact as eco-towns are regarded as industrial recycling clusters with extensive cooperation among different companies in Japan's Second Fundamental Plan for Establishing a Sound Material-Cycle Society (OECD 2011). Table 7.8 summaries comparative information between Japan's eco-towns programme and the urban mining base programme in China.

Although the eco-town programme targets at the city level, while the urban mining programme is targeting at industrial park level, it is still worthwhile to compare the pair, as both programmes support the same category of recycling projects: recycling waste from urban life. This makes them sharing a similarity in terms of urban symbiosis. The total capacity of eco-towns' recycling projects is almost 2 million tons per year, and China's urban mining bases' planned capacity is 66 million tons per year. Other similarities include that both programmes share the same objective to bloom the recycling industry development and share the same national policy background of striving for a circular society.

Still, both programmes also present diversities of the urban symbiosis, these include:

1. Recycling projects in the eco-town programme are mainly focused on the municipal waste recycling such as plastics, food waste and electric waste, while China's urban mining base programme supports the recycling plants of electronic equipment and products, cables, vehicles and tires, packaging, etc. Municipally gener-

**Table 7.8** Comparison between Japan's eco-town programme and China's urban mining programme

| | Japan eco-town programme | China urban mining programme |
|---|---|---|
| Time | 1997–2006 | 2010–2015 |
| Policy objectives | Stimulating new industrial development | Stimulating new industrial development |
| | Addressing waste management issues | Help relief environmental and resource bottleneck |
| Ministries in charge | Ministry of Environment (MoE), | National Development and Reform Commission (NDRC) |
| | Ministry of Economy | |
| | Trade and Industry (METI) | |
| Legal bases | Basic Law for Establishing the Recycling Society | Circular Economy Promotion Law as general law |
| | National planning | 12th FYP and specific plans |
| | Specific laws (2002–2003) | Absence of specific laws |
| Result | 26 eco-towns endorsed | Target to support 50 bases; 45 are already recognised and 5 more to come |
| | 205 projects (170 were recycling and recovery projects in operation, of which 61 received subsidies) | |
| Investment and subsidies | Grants to local government for planning execution activities, 50% of project costs in the range of 3–5 million JPY/year (30–50,000 USD/year) for a 3–5-year period. | No grants to local authorities |
| | Subsidy to companies for recycling plants at averagely 36% of the investment (total investment 1.65 billion USD), total subsidy 59 billion JPY (approximately 590 million USD) spent | Total projects investment is 192.3 billion RMB (approximately 32 billion USD). Subsidy is 10% of total investment in every urban mining base, 4 billion RBM (approximately 666 million USD) ratified for 45 bases |
| Project types | Software projects of the community and outreach activates | Software projects include waste collection system and waste information platform projects |
| | Plants' projects include plastic-recycling projects, as the largest group, and food and electronic waste-recycling projects | Other major projects include recycling plants of waste metals, electronics, vehicles and tires, plastics etc.; no food waste stream |
| Effects and impacts | It contributed to recycling technology development | It is still early to do programme evaluation, but some effects already occur. The programme helps to upgrade recycling technology and equipment and integrate waste collection systems and the industrial chains in some bases. Assembling and upscaling waste recycling also generate environment impacts |
| | Eco-towns are recognised as industrial recycling clusters with extensive cooperation among different companies in the Second Fundamental Plan for Establishing a Sound Material-Cycle Society | |

Eco-town programme information is adapted from Fujita (2008), GEF (2005), Sato et al. (2004) and Van Berkel et al. (2009)

ated food wastes are not included but covered by another national initiative. This is related to the different policy objectives between two programmes. The eco-town programme is to extend the service life of landfilling site and to cultivate local industry, while the urban mining programme is to promote the recycling industry development for resource and environmental concerns.

2. The slight difference of policy background and policy objectives also causes that the scope of urban symbiosis in both programmes is different. Recycling projects in the eco-town programme are mainly processing waste from local and nearby cities. The recycling boundaries of China's urban mining bases can extend to provinces at 500 km away. Moreover, some recycling plants in Japan are facing a shortage of waste supply because of exporting to Chinese plants. The scope of urban symbiosis in China has a larger scope than Japan. But eco-efficiency of both large- and small-scope urban symbiosis needs further study.
3. Several factors contribute to the success of the eco-town programme, but the recycling-oriented legislation is conceived as an most important one to assure sufficient supply of waste to the recycling plants (Van Berkel et al. 2009). The Waste Management Law (2003) sets aims and objectives for waste management. The Law for Promotion of Effective Utilisation of Resources (2001) designated key products and industries for resource saving. Besides, the Law for Promotion of Sorting, Collection and Recycling of Containers and Packaging (2000), the Law for Recycling of Specific Kinds of Home Appliances (2001), the Construction Materials Recycling Act (2002), the Food Recycling Law (2003) and the Domestic Automobile Recycling Law (2003) all set very specific recycling goals (Morioka et al. 2005). These recycling-oriented legislations are still absent in China's legal framework.

In summary, the similarity between the eco-town programme and the urban mining programme is based on their joint focus on urban symbiosis. The differences between both programmes indicate their different background and different policy objectives. Industry development for resources is the core feature of China's urban mining programme, and waste management is attached to the eco-town programme. This leads to different results of small scope urban symbiosis in Japan and large scope urban symbiosis in China. And it is too early to conclude which one is more eco-efficient.

The eco-town programme is a proven success, contributing to recycling technology diversification and sophistication while being recognised in the later Japan Second Fundamental Plan for Establishing a Sound Material-Cycle Society. While it is too early to evaluate the urban mining programme, already some obvious effects are appearing. Firstly, it helps technology and equipment upgrading. Jieshou, a specialised waste lead acid battery-recycling park, discarded hand-dismantling equipment and deploys the most advanced automatic production line, vastly improving the efficiency and reducing environmental and health risks. Secondly, it promotes extending of industrial recycling chains. Many bases planned facilities for new production by using recycled materials. Also some bases expand the waste resource collection systems to ensure waste supply for the recycling plants. All these improvements are attributed to the urban mining programme that provides a platform and subsidies for massive resource recycling. Last but not least, the environment effect is obvious when the technology and equipment are upgraded and when waste-recycling quantities are increased.

## 7.6 Conclusion

Urban symbiosis taking recycling as main activity links efficient material flows between production and consumption the industry sector and urban sector. China's urban mining pilot base programme promotes the recycling industry developing towards large-scale, advanced technology and high-value recycling practise to help in relieving environmental and resource bottleneck constraints. The current 45 pilot bases with planned 6.6 billion tons per year capacity indicate that a massive urban symbiosis effort is taking place in China.

This paper provides a preliminary review of the urban mining pilot base profile by analysing its policy evolution pass and the policies in which it is located. It finds that China's urban mining base programme is developed from past circular economy policies, including the circular economy pilot programme and circular zone management programme. It shows that the driving forces of waste recycling management in China are moving from an environmental and recycling angle to resource strategies. The programme attains legal assurance from the Circular Economy Promotion Law and support from the national 12th FYP and specific plans, as well as subsidies from the circular economy fund. But this does not yet create a perfect governance context for its implementation. On the contrary, a multi-ministerial cross-management network is currently implementing the urban mining pilot base programme. In this network, incoherencies create, policy conflicts occur, and recycling-oriented legislation is absent, thus becoming main barriers for the urban mining programme and especially its waste collection requirements.

Comparing with the eco-town programme in Japan, the urban mining programme shares the partial policy objective to promote industry development. But waste management and environmental amenity is another driving force for the eco-town programme, while optimising the resource strategy is for the urban mining programme. This leads to the differently focused recycling projects and recycling area boundaries between the two programmes. Therefore, China's urban mining programme is regarded as a large scope urban symbiosis programme and Japan's eco-town as a local scope urban symbiosis. Such difference is attributed to the different problems they attack and the slightly different policy objectives under different economic development phases. The resulting eco-efficiency of both forms is a future study subject.

It is too early to evaluate the urban mining programme; still some obvious effects are already appearing. The recycling technology and equipment improved, industrial recycling chains extended up to collection part and down to production part, and environmental effects are observed. As it stimulates massive recycling activities, the urban mining pilot programme will help with environmental and resource constraints. However more inter-ministerial coordination and policy integration are needed to develop the governance context into an institutional top design for a sustainable urban mining in China.

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