



THE PEOPLE'S REPUBLIC OF CHINA'S MUNICIPAL WASTE-TO-ENERGY PROJECT

A Model Approach to Financing a State-of-the-art Technology

Suzhou waste-to-energy plant
in Jiangsu Province

- In the People's Republic of China, higher income growth in urban and rural areas resulted in higher demand for energy and generation of more waste.
- One viable solution is waste-to-energy (WTE) technology, which increases electricity generating capacity without increasing greenhouse gas emissions.
- The high cost of WTE technology and lack of interest by international commercial banks hinder the installation of new WTE power plants.
- Using the Asian Development Bank innovative financing approach, a private company developed six WTE plants that process 6,200 tons of municipal solid waste, generating an additional 132 megawatts of power capacity and delivering 630 gigawatt-hours of electricity annually.

CONTEXT

The People's Republic of China (PRC) is the world's largest producer and consumer of energy and coal, and the fourth largest producer and second largest consumer of oil.^{1,2}

Consequently, pollution, air degradation, and global warming will continue to be one of the PRC's primary concerns.

The PRC also generates the second largest quantity of municipal solid waste (MSW). MSW generally refers to household and commercial garbage and trash within a municipality. Estimates suggest that the PRC produces around 220 million tons of garbage each year. The volume of MSW increases every year as the population increases and the economy grows. Thus, solid waste management is a major expense and continuing challenge.³

In 2009, not all MSW were properly collected, segregated, recycled, and disposed. Almost 50% of wastes in the PRC's secondary municipalities ended up in unengineered landfills and waterways.⁴ Failure to prevent such disposal practices and to properly manage MSW could cause local, regional, and global environmental problems such as air pollution, soil and groundwater contamination, and greenhouse gas (GHG) emissions.

In the 1980s, the Government of the PRC started to study and address the challenges of energy security and environmental degradation, and urged the pursuit of scientific development, energy conservation, and environmental protection. Waste-to-energy (WTE) technology was viewed as an effective measure against environmental degradation. However, combining good WTE infrastructure with sustainable financing and timely delivery of public services challenged the capacity of local governments. Projections suggest that the market for WTE will increase fourfold, to 47 million tons by 2020, requiring an estimated investment of \$10 billion. The PRC's existing 67 WTE plants, which process 11 million tons of MSW annually, cannot meet this increase.

In addition, current WTE technology contributes to urban air pollution. Most WTE plants use locally produced fluidized-bed incinerators that require supplemental fuel (e.g., coal) to burn MSW. Without clean technologies for new WTE plants, environmental degradation will worsen.

¹ Asian Development Bank (ADB). 2013. *Energy Outlook for Asia and the Pacific*. Manila.

² United States Energy Information Administration. 2014. China Produces and Consumes Almost as Much Coal as the Rest of the World. *Today In Energy*. 14 May. <http://www.eia.gov/todayinenergy/detail.cfm?id=16271>

³ Solid waste management aims to treat MSW in an environmentally and socially acceptable manner with appropriate clean technologies.

⁴ ADB. 2009. *Report and Recommendations of the President to the Board of Directors: Proposed Loan and Technical Assistance to the People's Republic of China for the Municipal Waste to Energy Project*. May. Manila. <http://www.adb.org/sites/default/files/project-document/65075/43901-prc-rrp.pdf>

PROJECT SNAPSHOT

LOAN APPROVAL DATE:

May 2009

LOAN AMOUNT:

\$100 million

BORROWER:

China Everbright Environmental Energy Limited (CEEEL)

EXECUTING AGENCY:

China Everbright International Limited

GEOGRAPHICAL LOCATION:

Jinan, Zhenjiang, Pizhou, Sanya, Suzhou and Jiangyin, PRC

TYPE OF ENERGY PROJECT:

Waste-to-energy

PROJECT COMPLETION DATE:

December 2013

The government alone cannot continue as the main funding source for WTE with clean technologies. It needs the private sector to develop more WTE plants. Despite policies and incentives favorable to WTE and increased interest by municipal governments, private investors have difficulty getting support from financial institutions, partly because many institutions do not understand WTE and its associated risks. Frequently, banks cannot justify the higher total investment requirement because they lack know-how in quantifying WTE's health and environmental benefits. Higher due diligence costs also hinder financing.

SOLUTIONS

Encouraging private sector participation. The government has encouraged private sector participation through its program for public-private partnerships. A series of laws and regulations, including the Law on the Prevention and Control of Environmental Pollution from Solid Wastes (2004) and the Urban Domestic Waste Management Regulations (2007), provide incentives for investors. The Renewable Energy Law (2005) identified WTE as a key source of renewable energy. The government has also passed regulations that mandate power grid companies to purchase WTE-generated electricity within their area of operation at a premium price. Combined with financial assistance from the Asian Development Bank (ADB) in 2009, these policies paved the way for a WTE project initiated by the PRC's leading private company for environmental protection, China Everbright International Limited (CEIL).⁵

Innovative financing approach for WTE. When CEIL approached ADB for support, ADB recognized the growing potential and strong financial benefits of WTE. CEIL planned to build and operate four MSW-powered WTE plants to achieve an aggregate generating capacity totaling 84 megawatts (MW), and expand two existing WTE plants for an additional 48 MW capacity.

The project size and capital requirement of each project were small relative to transactional costs and the minimum amount ADB usually lends to borrowers. Therefore, ADB used a Portfolio Approach to bundle the individual WTE projects into a single project, enabling CEIL to meet ADB's minimum loan amount and reducing transaction costs.⁶ With a single holding company and borrower, ADB is assured payment even if one project defaults. The scheme also requires a guarantee from a creditworthy sponsor, reducing ADB's overall credit risk.

China Everbright Environmental Energy Limited (CEEEL), a special purpose company established to hold CEIL's WTE operations, secured a \$100 million A-loan funded by ADB and a \$100 million B-loan funded by international banks. The CEEEL loan is covered by a full and irrevocable guarantee from CEIL.

Using advanced WTE technology. In 2006, CEIL commenced the commercial operation of the PRC's first WTE plant that adopted advanced clean technologies, including grate incinerator technology, a reliable state-of-the-art technology used in the United States and Europe. Grate incineration technology does not require supplemental fuel and uses advanced flue gas⁷ emission control to comply with the high standards of European Union II.⁸

⁵ CEIL's project investments, operations, technology developments, and equipment manufacturing focus on environmental protection and alternative energy businesses.

⁶ The Innovative Portfolio Approach for WTE projects was developed by the Private Sector Operations Department, ADB.

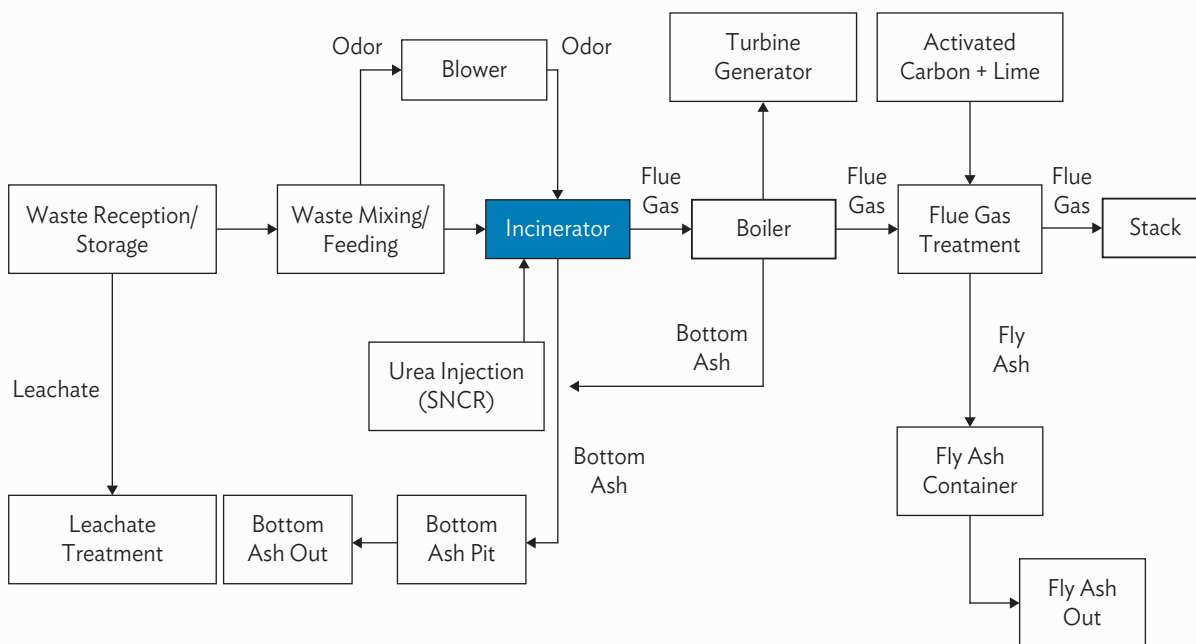
⁷ Flue gas refers to combustion-product gas resulting from the burning of fossil fuels.

⁸ These are technical specifications based on consensus among all interested parties (industries, consumers, trade unions, environmental nongovernment organizations, public authorities, etc.). It is carried out by independent standards bodies, acting at national, European, and international levels.



The PRC is the second-largest generator of municipal wastes in the world.

Figure 2.4.1: Waste-to-Energy Conversion Process



SNCR = selective non-catalytic reduction.
Source: CEIL.

Figure 2.4.1 illustrates CEIL’s WTE technology and process. During waste incineration, heat produced is recovered from the waste-heat boiler which produces steam to run the turbine generators and generate electricity.⁹ Any burnt-out waste residue and/or noncombustible materials exit at the bottom of the incineration system as incinerator bottom ash. This ash is subsequently cooled, mechanically sorted, and stored before disposal or sold to interested companies as reusable raw material (e.g., for brick making).

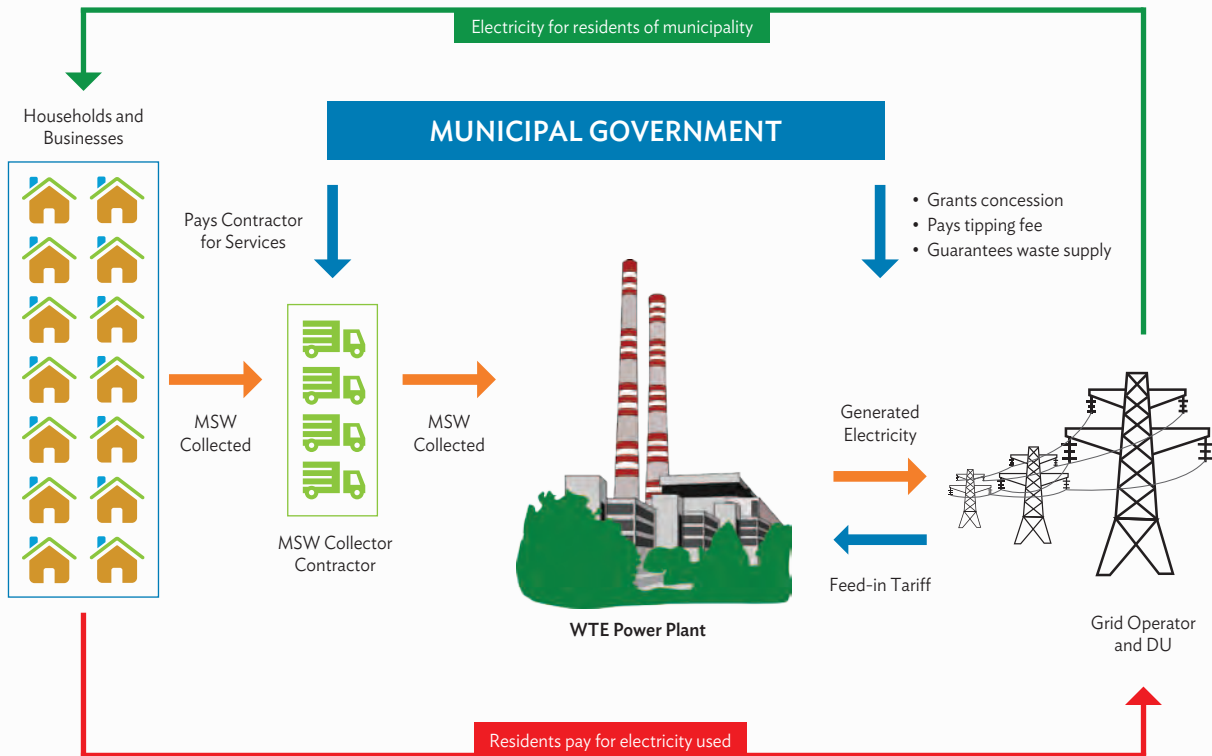
Flue gas generated from the incineration is first treated to remove nitrogen oxides. To prevent the formation of dioxins, waste is incinerated at temperatures exceeding 850°C for more than 2 seconds with sufficient air to allow complete combustion.¹⁰ After the flue gas cools from its heat transfer to the waste-heat boiler, it is treated by a desulfurization unit using lime slurry and activated carbon to neutralize the acid gas and remove organic compounds and bag dust filters to remove dust particulates. The treated flue gas is then discharged into the atmosphere through a stack.

Operation using a waste-to-energy concession model. The WTE project had five major stakeholders: (i) CEIL, (ii) the constituents of the municipality, (iii) the contractor, (iv) the government, and (iv) the power grid operator. To ensure the viability and sustainability of the WTE plant, CEIL needed to address several risks associated with three stakeholders.

⁹ Incineration is a widely accepted waste treatment process that burns organic substances at high temperatures to dispose the waste that is brought to their plant. Incineration converts waste into ash, flue gas, and heat.

¹⁰ Dioxins refer to a group of toxic chemical compounds that share certain chemical structures and biological characteristics.

Figure 2.4.2: WTE Concession Model



DU = distribution utility, MSW = municipal solid waste, WTE = waste-to-energy.
 Source: RETA 8392 task team.

Under the WTE Concession Model, the municipal government hires a contractor to collect MSW from residents and establishments and delivers it to the WTE plant. CEIL treats and processes the MSW using grate incinerators and advanced clean technologies to produce energy that it sells to the power grid operator. The power grid operator supplies power, partly supplied by the WTE plant, to the distribution utility that serves the municipality (Figure 2.4.2).

In this concession model, the WTE project can earn revenues from two sources: waste tipping fees¹¹ collected from the municipal governments, and a feed-in tariff (FIT) from the power grid operator.¹² Based on available information, an average a third of WTE revenue derives from waste tipping fees and two thirds come from FIT.

¹¹ The owner or operator of a landfill charges a tipping fee, also known as a gate fee, for accepting a unit weight or volume of solid waste for disposal, usually by the truckload. Tipping fees rise as the volume of available landfill space depletes, or as it becomes harder to open new landfills due to public opposition and stricter environmental regulations.

¹² Feed-in tariffs are an economic policy created to promote active investment in and production of renewable energy sources. These tariffs typically use long-term agreements and pricing tied to costs of production for renewable energy producers. Long-term contracts and guaranteed pricing shelter producers from some of the inherent risks in renewable energy production, thus allowing more diversity in energy technologies.

Community acceptance through participatory consultation and transparency. Energy projects often encounter resistance or opposition to the installation of power plants due to the wastes and health hazards resulting from the power generation process. To ensure smooth implementation of its WTE projects, CEIL closely coordinated with the municipal government and community leaders, and conducted public consultations in each municipality to explain the project and its benefits to the community. It also shared the project's mitigating and monitoring measures and their results.

Government participation and commitment. Three items in the concession agreement are very important for CEIL: (i) the exclusivity and tenure of the agreement, (ii) the guarantee for MSW supply, and (iii) the tipping fee. CEIL's concession agreement with the municipal government is exclusive, with a tenure of not less than 25 years. The agreement gave CEIL sole access to MSW and provided ample time to recover its investments. It also covered, or warrantied, CEIL against the municipality's failure to deliver the minimum amount of MSW for the WTE. It offsets similar warranties that CEIL would provide to the power grid operator and distribution utility. The municipal government paid CEIL a waste tipping fee for the treatment and disposal of the waste collected and delivered by the contractor.

RESULTS

Less waste, more energy. CEIL's WTE project is ADB's first private sector WTE project. With the financial support of ADB and the absence of any opposition from the hosting communities, CEIL was able to build and operate four new WTE plants in Jinan, Zhenjiang, Pizhou, and Sanya and expand the capacities of the Suzhou and Jiangyin WTE plants. The six plants, most in eastern PRC, have different power capacities, but collectively they increased CEIL's capacity to process MSW by 6,200 tons, yielding an additional 132 MW of power and 630 gigawatt-hours (GWh) of energy per year.

The Jinan WTE plant in the Shandong province is the largest of the new plants covered by the ADB loan. It produces 190 GWh of electricity from its 36 MW power plant, which runs on 2,000 tons of MSW. However, the largest of all CEIL-operated plants is the Suzhou plant, which almost doubled its capacity with the help of the ADB loan. Along with nine other WTE plants, they help address the PRC's waste management and energy supply concerns.

Less emissions. Emissions from these facilities have been strictly controlled, complying with the Chinese national standard (GB18485-2001) and comparable to the European Union II standards (i.e., Directive 2000/76/EC and relevant Annexes/Amendments). Hence, the project helped improve energy security without using fossil fuels that increase greenhouse gas emissions.

More benefits for communities. The efficient collection and processing of MSW using cleaner technology will benefit the urban population, particularly the urban poor who are most vulnerable to environment-induced diseases and least capable of paying for adequate medical attention. Construction and operation of WTE plants also created jobs in the local communities.

Model project. The WTE project is a strong model for private sector participation in public-private partnerships for multiple projects in medium-sized municipalities. The success of the project encourages private investors to invest in WTE with clean technology versus cheaper technologies that still require supplemental fuel.

By mobilizing domestic funds, ADB created awareness among commercial banks about the financial benefits and risks of WTE with clean technologies. The CEIL and ADB partnership taught commercial banks how to package and finance additional WTE projects. On a broader perspective, the project demonstrated a new mechanism for a long-term, reliable solution to address MSW problems, which are common to all municipalities.

LESSONS

Establish a long lasting harmonious relationship with the host community. To avoid opposition, proponents should always be truthful in communicating the scope, benefits, and risks of the project. CEIL has been successful in implementing both WTE and industrial solid and harmful waste landfill projects because they engage the communities. Consequently, CEIL has established a credible brand by continuously working with and helping the communities before, during, and long after project construction.

A financially viable solution to address energy supply requirements, disposal of municipal solid waste, and environmental protection. Some financial risks can discourage investors from venturing into the WTE business, but these risks are manageable. Using the ADB-CEIL-government business model, other investors can successfully venture into the WTE business.

The government and CEIL showed that a strong public-private partnership can mitigate risks and make the WTE industry a profitable and mutually beneficial undertaking. The government did its part by providing an opportunity for the private sector to venture into WTE and granting a sound concession agreement that included a 20-year concession period and a reasonable tipping fee and FIT. CEIL responded to the government's invitation by addressing all WTE-related concerns, including acceptance and approval by the community, the sourcing of funds, and compliance with environmental and safety standards and requirements.

Keywords

Waste to energy, energy, clean energy, clean technology, municipal waste, energy financing scheme, WTE concession model, WTE model, PRC

For further reading

- <http://www.adb.org/news/adb-supports-clean-waste-energy-project>
- <http://www.adb.org/sites/default/files/project-document/65075/43901-prc-rrp.pdf>

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