

# WASTEWATER PROJECT OPPORTUNITY

## Household-Scale Biogas Digesters: Opportunities for Methane Emissions Reductions from Latrines in Rural Areas of China

### OVERVIEW OF WASTEWATER PROJECT:

Household biogas digesters are on-site treatment technologies for the disposal of human waste, as well as manure and kitchen waste. Digesters can replace pit latrines, which are major methane sources, as the dominant treatment technology for human waste in rural areas of developing and middle-income countries. The anaerobic decomposition of organic waste in these digesters produces biogas, which is captured and used as a renewable energy source for cooking and lighting. China has been a leader in household biogas technology, deploying approximately **38 million digesters** in rural areas of the country as of 2010.<sup>1</sup> The motivation for digester construction has traditionally been rural energy supply.

Previous analyses of greenhouse gas emissions reductions from the use of household digesters have focused on the impact of fuel substitution away from biomass or coal burning to biogas. Here we extend that analysis to include reductions in methane emissions achieved by diverting human waste from pit latrines to household digesters, and subsequently capturing the produced methane as a renewable energy source.

**ESTIMATED ANNUAL EMISSION REDUCTIONS: 9 MMTCO<sub>2</sub>E (Range: 4 – 14 MMTCO<sub>2</sub>E)**



*Photo Credit: China Development Gateway*



*Photo Credit: Trade Plus Aid Biogas program*

## BIOGAS IN RURAL CHINA

- **Renewable Energy Supply:**
  - 8 m<sup>3</sup> digester reliably supplies 80% of rural household's energy demands<sup>2</sup>
  - Used for cooking and in biogas-powered lanterns and other appliances
  - Animal manure is the largest source of gas production
- **Strong Growth Potential:**
  - 139 million rural households identified as suitable for household biogas, but only 38 million currently in place<sup>1,2</sup>
  - Many of the existing digesters (~50%) are old and in need of refurbishment or replacement
- **Local Environmental Quality:**
  - Reduces burning of other fuel sources, including crop residue, coal, and firewood
  - Improvements to indoor air quality and reductions in deforestation and subsequent soil erosion

## COST & REVENUE INFORMATION

- **The cost** of installing an 8 m<sup>3</sup> household-scale digester is ~US\$500, of which the Chinese government subsidizes ~US\$300
- **Direct benefits** per digester have been estimated to be ~US\$58/yr through biogas and fertilizer production,<sup>4</sup> indicating a **payback period** of ~5 yr for the subsidized cost
- **Indirect benefits per digester** include emissions reductions of ~1.5 t CO<sub>2</sub>E/yr and avoidance of ~1.4 t of firewood, which can be time-consuming to collect. These benefits are not included in the calculation of direct benefits

## CALCULATION OF METHANE EMISSIONS REDUCTIONS

Methane emissions reductions were calculated by assuming that human waste in household digesters is diverted from disposal in pit latrines. The avoided CH<sub>4</sub> emissions were then computed using the IPCC Guidelines for National Greenhouse Gas Inventories with default emissions factors for latrines and regional values for BOD production.<sup>5</sup>

$$R = N \cdot E \cdot F \cdot BOD \cdot EF_{latrine}$$

R = Reduction in CH<sub>4</sub> emissions [kg yr<sup>-1</sup>]; N = Number of household biogas digesters in China [38 million]<sup>1</sup>, E = Operational Efficiency of Digesters [60%]<sup>3</sup>; F = Average Rural Family Size [3.61]<sup>6</sup>; BOD = per capita BOD production [14.6 kg BOD person<sup>-1</sup> yr<sup>-1</sup>]<sup>5</sup>; EF = Emission Factor for Pit Latrines [0.3 kg CH<sub>4</sub> kg BOD<sup>-1</sup>]<sup>5</sup>.

The range of values is based on uncertainty ranges for emissions factors suggested in the IPCC Guidelines.

***This is a conservative estimate because it only accounts for CH<sub>4</sub> emissions reductions from diverting human waste from latrines,*** and does not account for methane emissions reductions from managing animal waste or food waste, or reductions in CO<sub>2</sub> emissions due to substitution away from less efficient fuel sources.

## CO-BENEFITS

- **Renewable energy** supply in rural areas
- Improvements to **indoor air quality** due to reduced biomass burning indoors
- Improvement in **regional air quality** due to reduced coal burning
- Sludge from digesters can be used as **fertilizer**

## OPPORTUNITIES FOR COOPERATION

- **Research to accurately quantify CH<sub>4</sub> emissions reductions** from household digester construction and include these low-cost reductions as certified emissions reductions available in voluntary carbon markets.
- **Enhanced cooperation between voluntary carbon markets and rural communities** to incentivize construction and maintenance of household biogas digesters under existing carbon credit protocols.
- **South-south development cooperation** to leverage China's expertise in household biogas technology in other nations with large rural populations and a need for renewable rural energy sources.

## SOURCES:

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## FOR MORE INFORMATION

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