



# Circular Carbon From Biosolids

Osaka City is committed to building a resource-efficient, environmentally sustainable circular society through the beneficial use of biosolids. In the past, biosolids were incinerated, and the resulting ash was disposed of in landfills. However, because of limited landfill capacity in dense urban areas such as Osaka, the City gradually transitioned to an ash vitrification process that achieves greater volume reduction. The vitrified slag produced through this process is recycled and used as backfill material for road construction.

To further expand beneficial biosolids use and address climate change, Osaka City launched a project under the Private Finance Initiative (PFI), a public-private partnership model. A private contractor is responsible for the design, construction, operation, and marketing of the end products. The facility converts biosolids into biochar through pyrolysis, producing a carbon-neutral fuel that can be co-fired with coal at power plants to help reduce greenhouse gas emissions.

 **RECOVER**

 **OSAKA, JAPAN**

 **WASTEWATER**

 **INDUSTRIAL**

## CHALLENGES FACED

Two key challenges emerged during implementation. First, the biochar had to meet strict fuel acceptance specifications for co-firing at a power plant, particularly limits on chloride content, which required sourcing biosolids only from wastewater treatment facilities with low chloride levels. Second, the pyrolysis process generated off-gases containing tar and odor-causing compounds that could adhere to the biochar. This was addressed by modifying the reactor flow configuration to reduce odor transfer and maintain product quality.

## TECHNOLOGIES & SOLUTIONS USED

Osaka City implemented a biosolids-to-biochar facility using low-temperature pyrolysis. Delivered through a PFI model, the project leverages private-sector expertise for design, construction, and operation. Biosolids from multiple wastewater treatment facilities are converted into biochar with coal-like properties and used as a coal substitute at power plants. Operating at lower pyrolysis temperatures helps limit nitrous oxide formation while reducing fossil fuel use and greenhouse gas emissions.

## IMPACT & INSIGHTS



- The system converts biosolids into biochar used as a coal substitute, supporting greenhouse gas reductions.
- Direct emissions from sludge treatment decreased from ~12,000 tCO<sub>2</sub>e/year to ~10,500 tCO<sub>2</sub>e/year.
- Using biochar to replace coal at power plants avoids an additional ~10,000 tCO<sub>2</sub>e/year in emissions.
- The total emissions benefit, including avoided emissions, is approximately 11,500 tCO<sub>2</sub>e/year.
- The PFI contract model integrated design, construction, operation, and biochar marketing into a single contract, generating cost savings of approximately JPY 1.89 billion.

## LESSONS LEARNED



- Converting biosolids into biochar produces a usable (and potentially marketable) product, and ensuring consistent product quality is essential.
- Maintaining consistent product quality requires thorough upfront characterization when accepting biosolids from multiple wastewater treatment facilities with varying characteristics.
- Securing a long-term recycling pathway (end market) and establishing a sustainable operating model are essential for successful beneficial use.
- Long-term collaboration among industry, government, and academia is essential to advance the technology.

“**Private Finance Initiative contract model enabled the project to secure private-sector financing and leverage private-sector management and technical expertise, allowing for a more efficient and cost-effective project delivery.**”