

STATIONARY

Biomass to Energy Conversion



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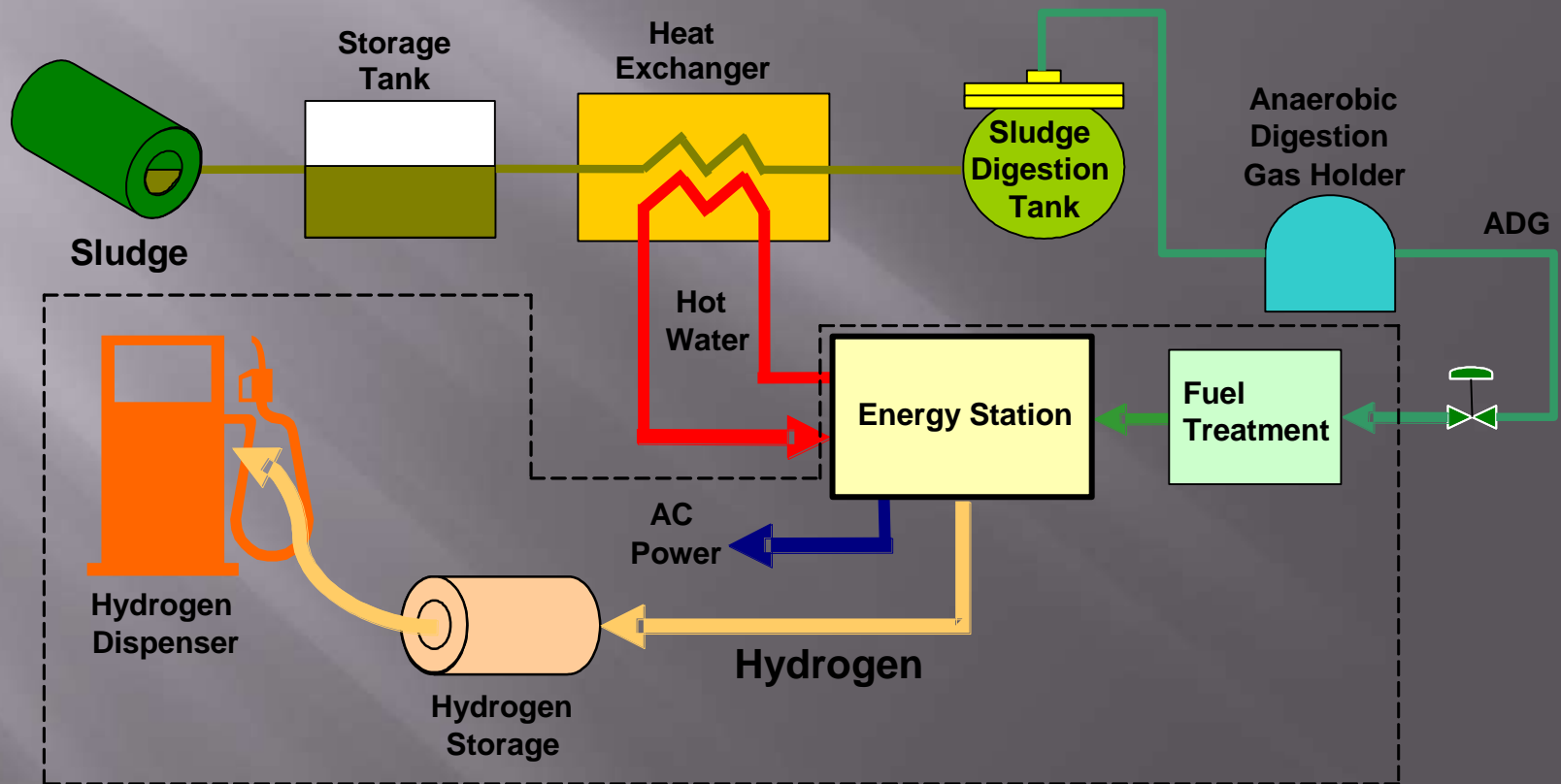
Biomass to Energy Conversion Projects

- ▣ Hydrogen Energy and Fueling Station at Orange County Sanitation District - Air Products and Chemicals
- ▣ Steam Hydro-Gasification to Produce Synthetic Natural Gas - Center for Environmental Research and Technology University of California, Riverside - CE-CERT

Hydrogen Energy and Fueling Station at Orange County Sanitation District - Air Products and Chemicals

- ▣ 100% renewable hydrogen & 100% renewable electricity produced from a molten carbonate fuel cell (MCFC)
- ▣ MCFC produces electricity, hydrogen and heat from anaerobic digester gas renewably generated from waste water
- ▣ Electric power and heat to operate the station
- ▣ Hydrogen will be dispensed from a refueling station for fuel cell powered vehicles

Overview of Production of Hydrogen from Anaerobic Digester Gas via Hydrogen Energy Station



Hydrogen Energy Station Shop Validation Test - H₂ Purification Skid



Hydrogen Energy Station Shop Validation Test – DFC[®] System

FUEL CELL MODULE

MECHANICAL BALANCE
OF PLANT



Project Status

- ▣ Completed testing of energy station equipment at the FuelCell Energy site in Connecticut
- ▣ Operated energy station on simulated digester gas by addition of carbon dioxide to the methane supply
- ▣ System performance matched predictions for power and hydrogen production.
- ▣ Completed a 7-day continuous operating test of hydrogen energy station

Project Status

- ▣ To date, operated DFC-300 and equipment for over 6,000 hours with stable performance
- ▣ Produced over 200 kw of power
- ▣ Generated 200+ lbs/day of hydrogen
- ▣ Developed operating procedures for flexible output of power plus hydrogen
- ▣ Hydrogen quality met automotive fuel cell quality requirements

OCSD Fountain Valley Site

HYDROGEN STATION
SITE



ENERGY STATION
SITE



Cost Share

Hydrogen Energy and Fueling Station Project

	Amount	Percent
AQMD	\$750 K	9%
Partners	\$7.9 M	91%
Total	\$8.7 M	100%

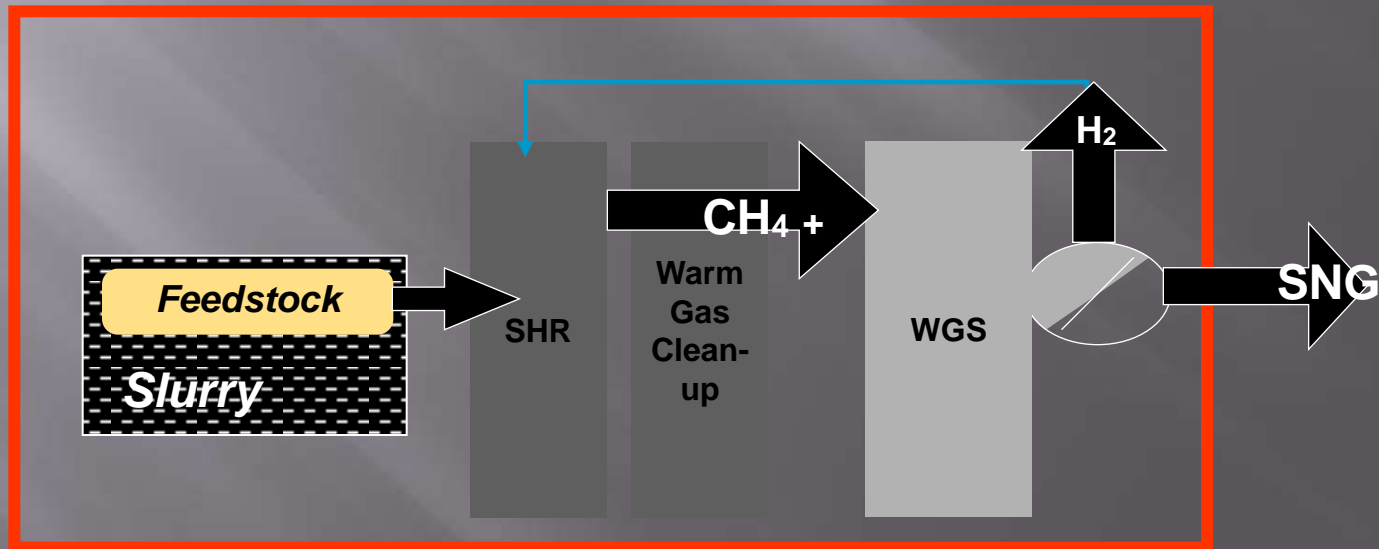
Steam Hydro-gasification to Produce Synthetic Natural Gas

- ▣ Transportation fuel from renewable feedstock's must be made clean to address criteria pollutants and greenhouse gas
- ▣ CE-CERT developed a steam hydro-gasification reaction (SHR) process that produces a product gas that contains a high methane concentration using a biomass waste and biosolids feedstock
- ▣ A bench scale demonstration using the SHR process will be conducted at CE-CERT

Project Background

- ▣ CE-CERT will modify a pressurized rotating kiln type SHR to handle the co-mingled biomass with biosolids
- ▣ A water gas shift reactor will be integrated to the SHR process to demonstrate the syngas production
- ▣ CE-CERT will further refine the process engineering and economic parameters for the development of a pilot plant and also for an eventual commercial facility

Block Diagram of Process for the Syngas Production



Bench Scale Operation of SHR Process



Cost Share

Steam Hydro-Gasification Process to Produce Synthetic Natural Gas

	Amount	Percent
AQMD	\$101 K	48%
Partners	\$111 K	52%
Total	\$212 K	100%