

Recent Trends in Biogas Conversion to High BTU Fuel

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New Orleans, LA • March 16-19, 2015

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Biogas Conversion to HBTU Presentation Outline

- **Trends**
- **Challenges & Opportunities**
- **Predictions for the Future**



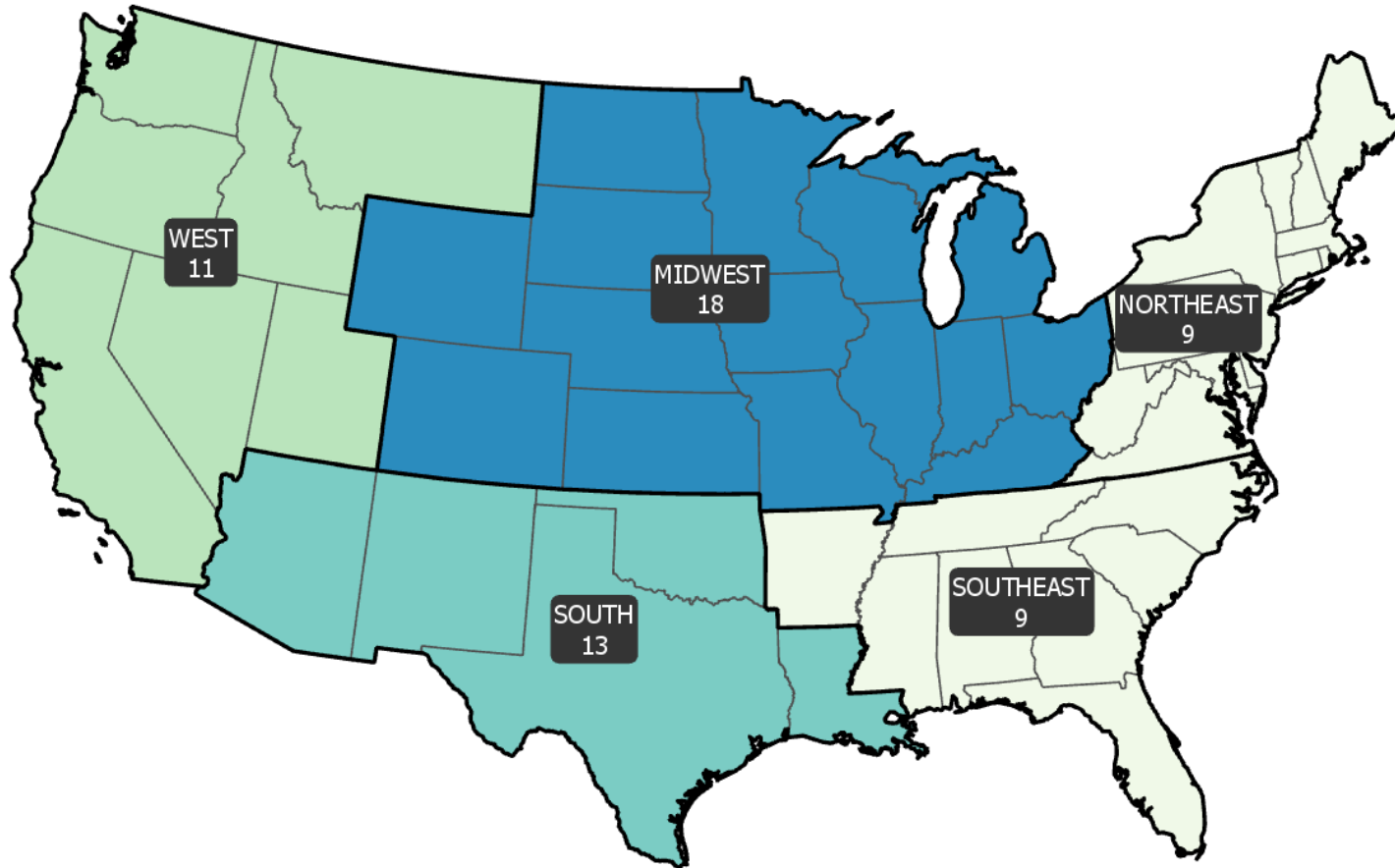
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Example High BTU Projects



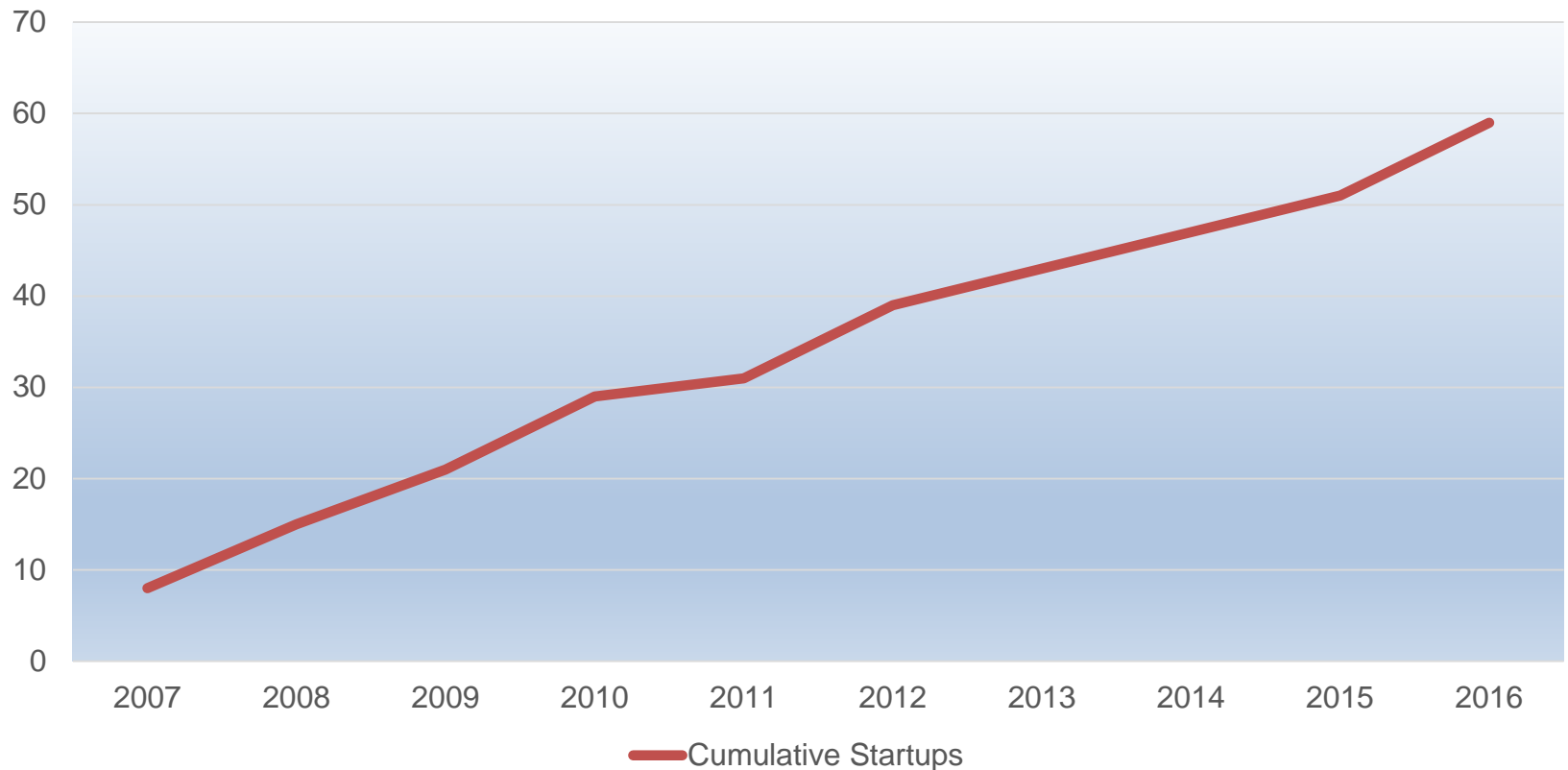
Location of Biogas to HBTU Projects (2007- 2016)



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Startups of Biogas to High BTU Projects



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HBTU Inlet Plant Capacity

- **Years 2007 to 2012 = 50 to 10,000 scfm**
- **Years 2013 to 2014 = 100 to 3,500 scfm**
- **Years 2015 to 2016 = 100 to 3,000 scfm**



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HBTU Plant Startups By Source of Biogas

- **Biogas Sources**

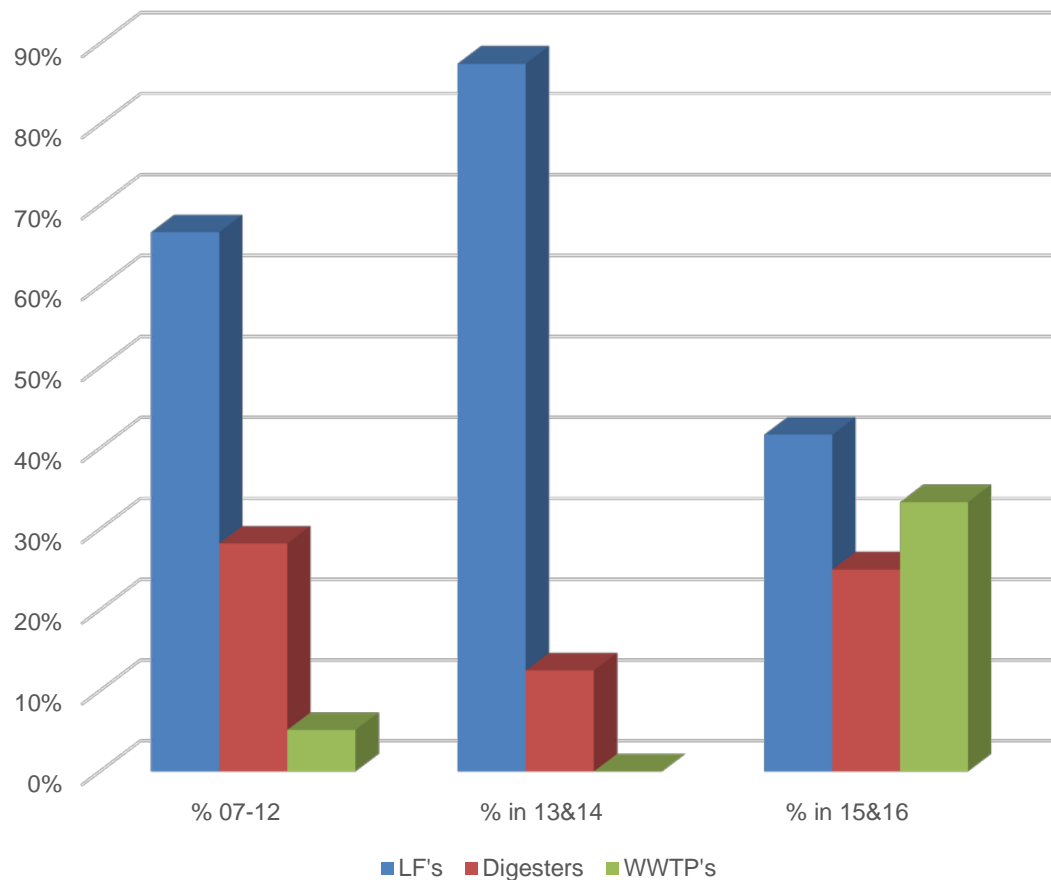
- Landfills
- Digesters
- WWTP's

- **Total Startups**

2007 - 2012 = 39

2013 & 2014 = 8

2015 & 2016 = 12



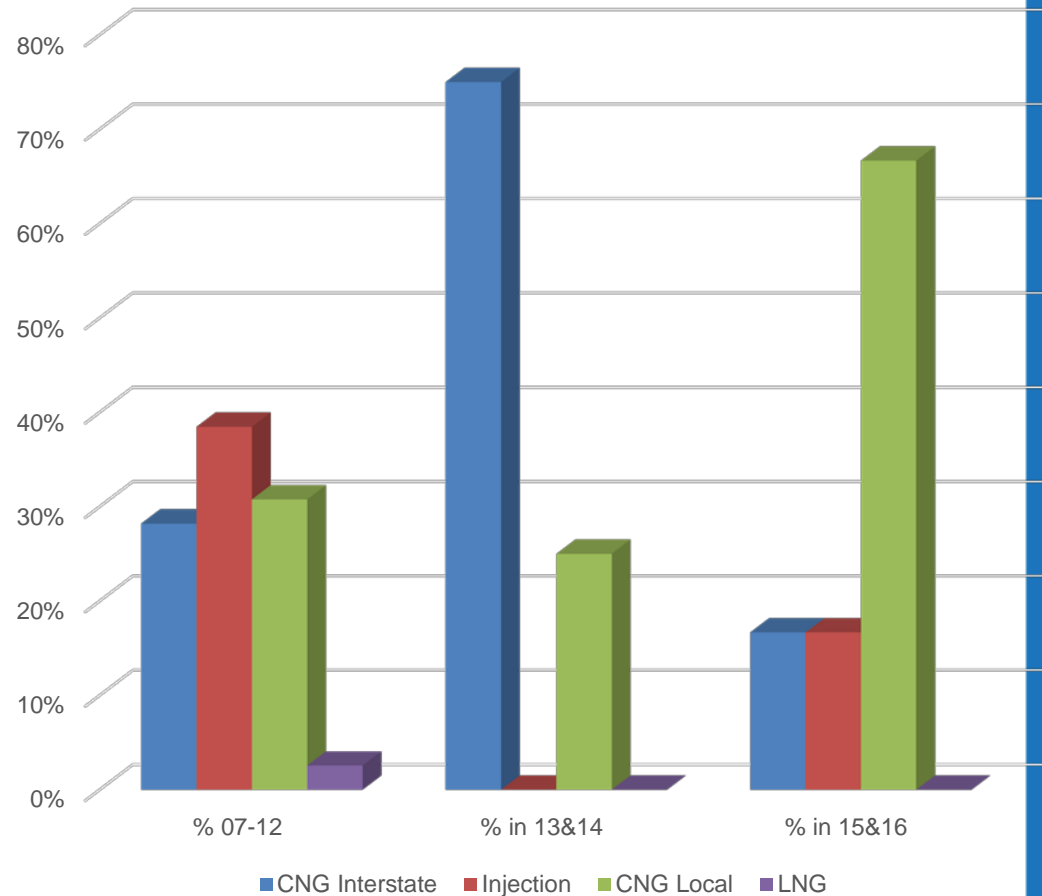
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Startups By Beneficial Use

Types of HBTU Projects

1. RNG for Pipeline Injection
2. RNG for Fuel
 - LNG
 - CNG Local
 - CNG Interstate



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Diesel & Gasoline Are Selling For About \$21.50 per MMBTU

Diesel

- 128,488 BTU's per Gallon of Diesel
- 1 DGE = 128,488 BTU's
- Equivalent Price of Diesel
 - \$2.80/gallon at the pump Chicago
 - \$21.80 per MMBTU

Gasoline

- 112,114 BTU's per Gallon of Gasoline
- 1 GGE = 112,114 BTU's
- Equivalent Price of Gasoline
 - \$2.40/gallon at the pump Chicago
 - \$21.40 per MMBTU



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Revenue From Biogas to Vehicle Fuel

- **RCNG or RLNG**

- Sell RNG for 65% of the cost at the Chicago Pump or \$14/MMBTU

+

- Sell RIN's for \$1.50/GGE or \$17/MMBTU
- Results in \$31/MMBTU

- **LCFS –California**

- Sell for \$4/MMBTU (volatile)

- **Clean Truck & Bus Program – CA**



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HBTU Project Challenges

- **High Cost of NG Interconnect**
- **Organics Diversion from Landfills**
 - Increased Recycling
 - Food Waste
- **Low NG Prices at \$3-5/MMBTU**
- **RIN's expire in 2022**
- **Gas Cleaning Technology**

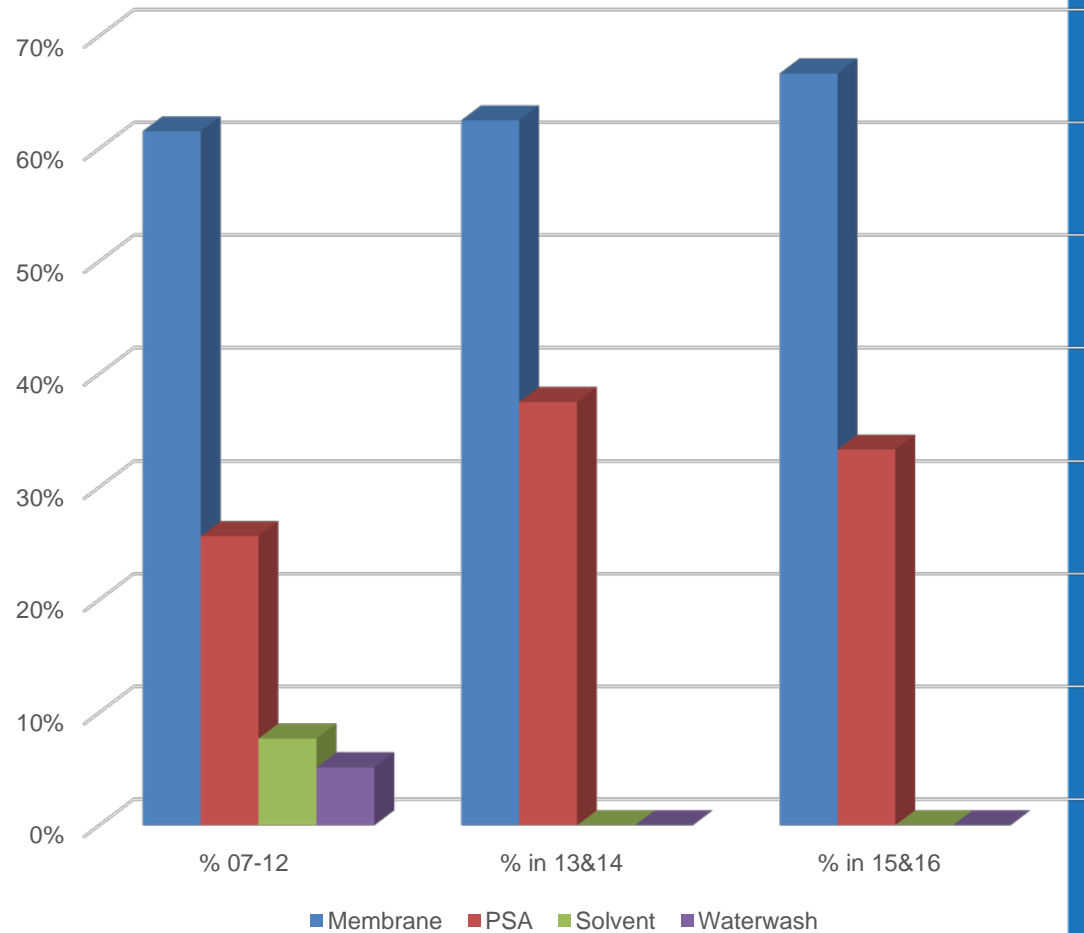


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CO2 Removal Technologies

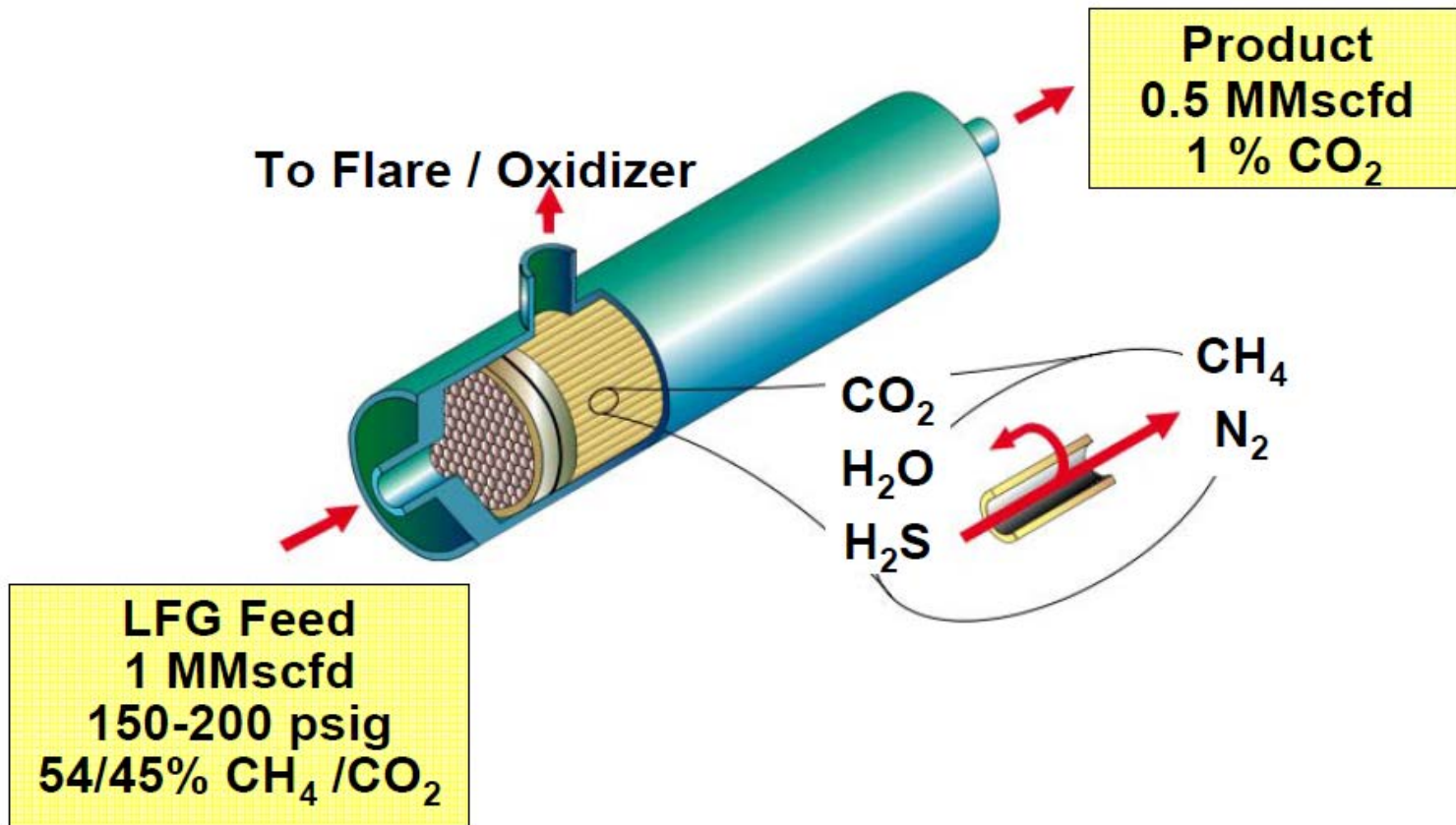
1. Membranes
2. Pressure Swing Adsorption
3. Solvent and Waterwash



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CO₂ Removal via Membrane



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Predictions - The Next 10 Years

- **Biogas to HBTU**

- CNG Fueling is Here to Stay
- Increasing # of HBTU Startups Every Year,
- More HBTU Plant Startups Than GTE Plant Startups
- Technology Will Continue to Lower CapX and OpX

- **Digesters**

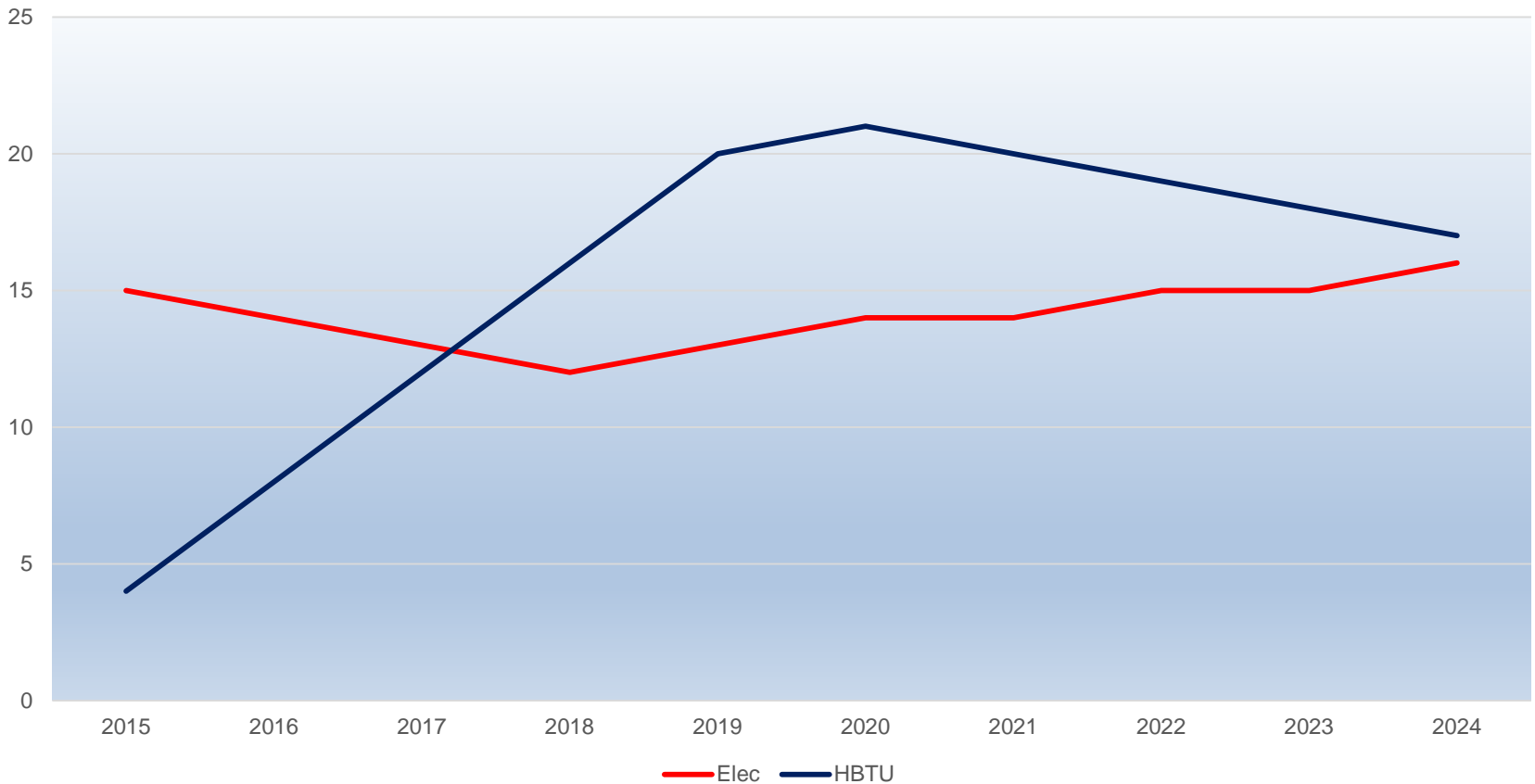
- More Food Waste Diversion & Gas From Digesters



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Prediction - Annual Startups



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