LFGTE – Maximizing Your LFG Returns

TETRA TECH

Region 6: SWANA 2021

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Today's Presenters

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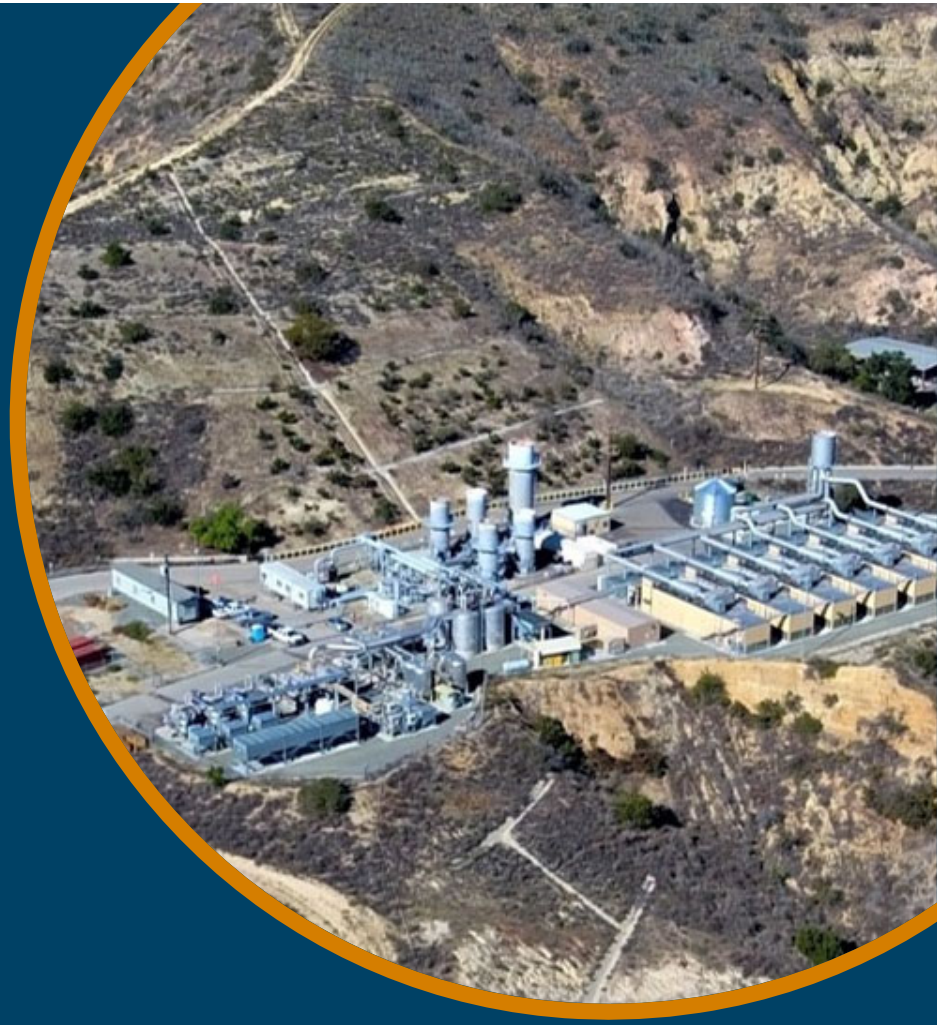
Maximizing Your LFG Returns

Getting your site ready for a beneficial use project



NSPS Operating Requirements

- Vacuum (negative gauge pressure) at each collector
- Temperature below 131°F (55°C)
- <5% O2, <20% N2 - WWW
- O2/N2 monitoring only – no actions - XXX
- Goal is to actively pull on each well but not hard enough to:
  - Introduce air,
  - Create a fire,
  - Flood your well, or
  - Create a compliance issue.

Operating Considerations for Recovery Projects

- Optimize fuel recovery – BTUs
  - More flow at existing gas quality
  - Better gas quality at existing flow rate
- Reduce air intrusion (minimize 02 and N2)
- Minimize sulfur compounds
- Increase CH4 content
- Recover more gas sooner

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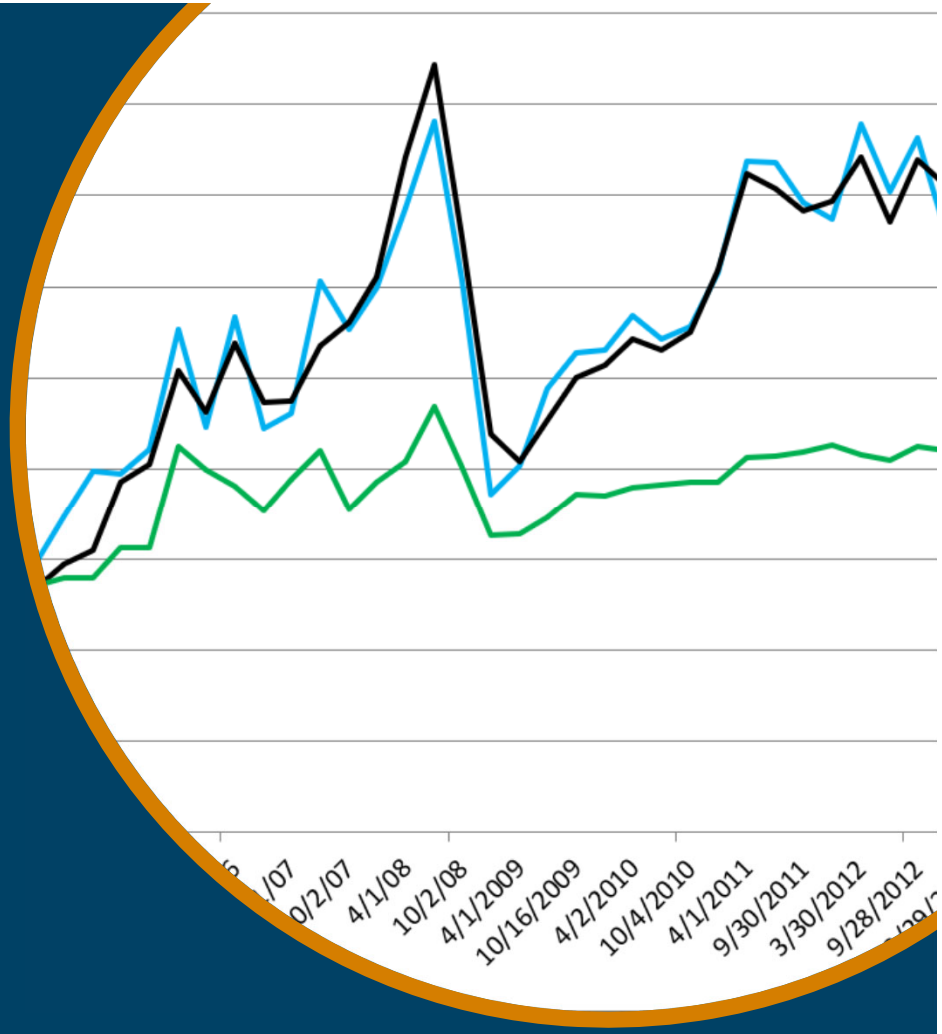
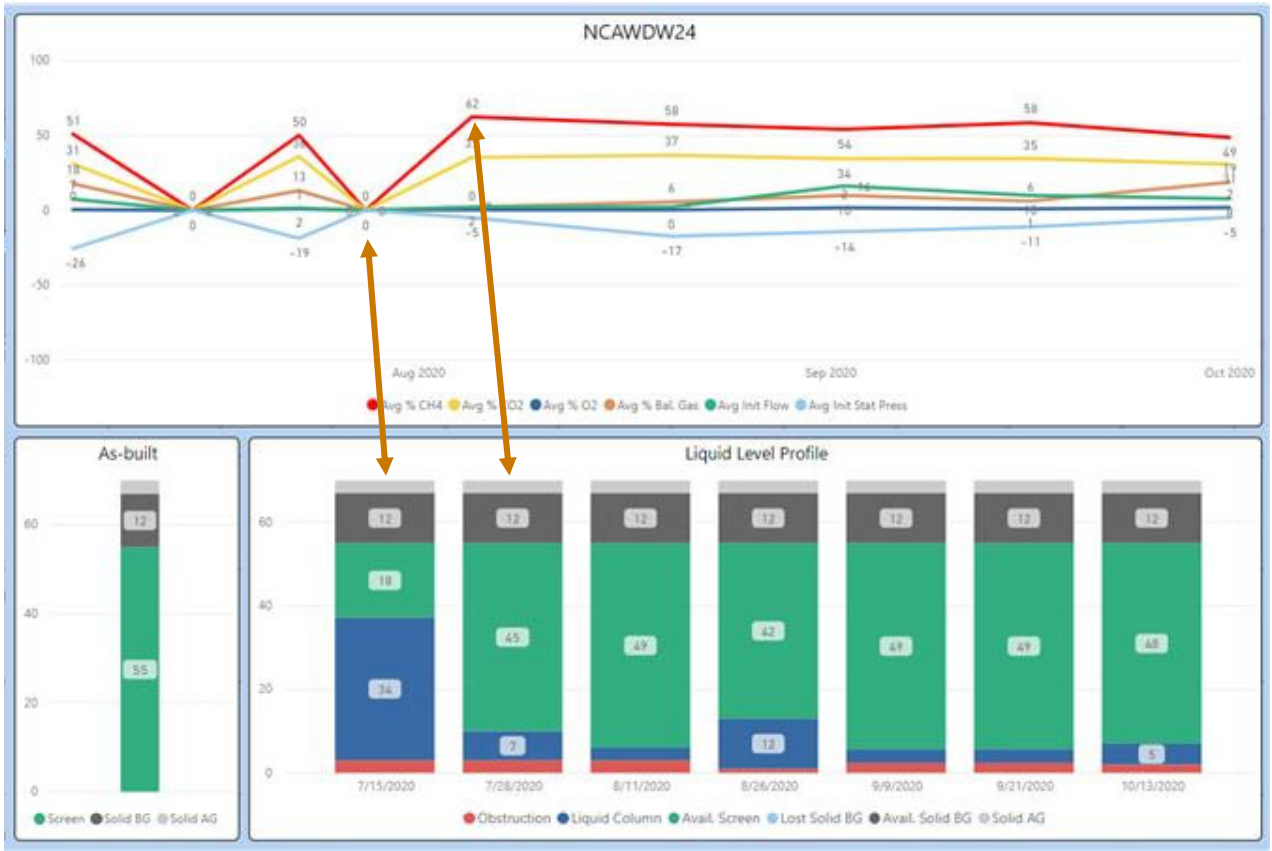
Data Management

The trend is your friend



Start Your Journey With Good Data!

- Looking at the surface is important but not enough
- Data analyses will point the way to the issues
- The data does not lie – bad is bad, but sometimes rehabilitation is possible

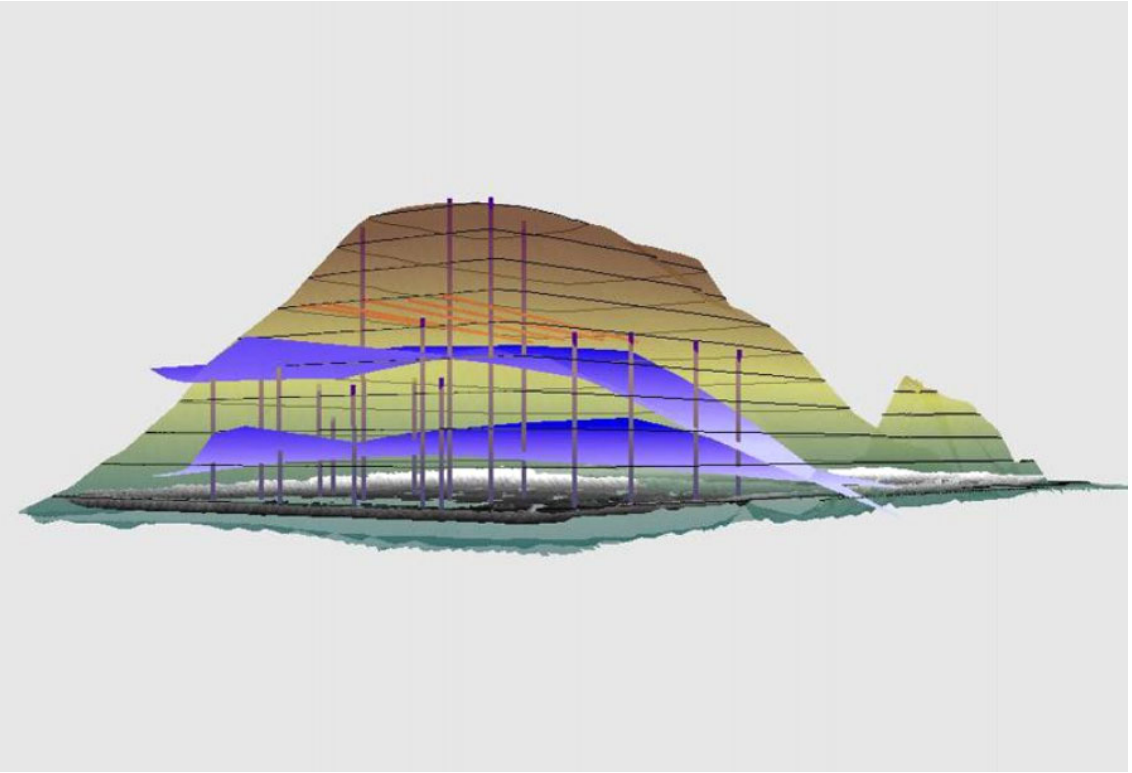


Data Analyses

- Data trending
  - Good wells vs. bad wells (or good areas vs. bad areas)
    - Are there areas that should be excluded from a recovery plan?
  - Short-term impacts – vacuum application, weather, or seasonal changes
  - Long-term impacts – development of landfill, waste consolidation, liquid levels
- Monitoring/tuning frequency
  - Monthly under NSPS
  - Weekly/daily depending upon:
    - Site characteristics
    - Delivery requirements
- Look back over the past year to account for any seasonal changes

GIS 3D Modeling for Well Management

- Tetra Tech developed 3D models of active landfills to:
  - Better visualize existing data
  - Make better, faster decisions regarding continued development of GCCS
- Can be used to generate a 3D model to:
  - Map liquid levels in vertical wells
  - Evaluate available perforations
  - Aid in the decision-making process



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Wellfield Assessment

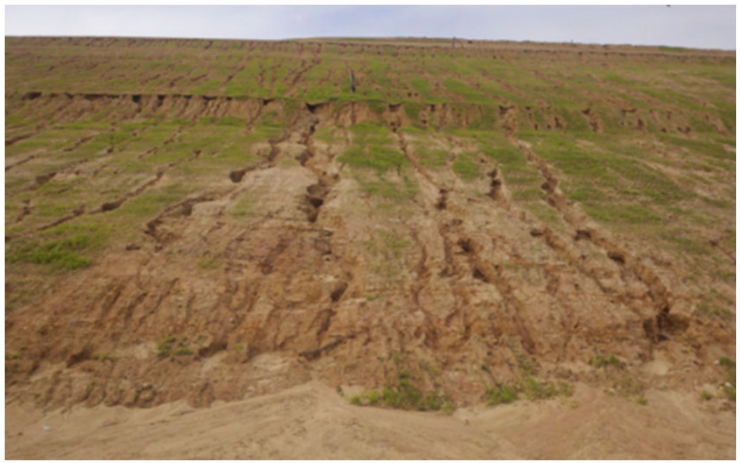
What's going on out there?

I Have Lots of Wells – Why Can't I Get More Gas?

- Visual inspection
- Surface emissions monitoring (SEM)
- Landfill gas system efficiency
- Well spacing
- Well seals
- Wellheads
- Cover integrity
- Removal of liquids

How Old Is Your LFG System?

- "Older" systems may be undersized or buried too deeply to maintain
- Evaluate the carrying capacity of the header system for both the current and peak projected flows
- More prone to settlement issues and potential condensate management problems
- Consider replacing lines that are too deep to access
- Visual inspections and SEM



Collector Spacing

- Vertical wells
  - Control purposes – typically 200-300 feet spacing
  - Utilization purposes – may see spacings of 100-200 feet
- Horizontal wells
  - Control purposes – typically 300-400 feet spacing (H) and 40-50 feet (V)
  - Utilization purposes – may see spacings of 150-200 feet (H) and 20-30 feet (V)
- Tighter spacing puts less operational stress on individual wells
- Operation at lower vacuums
- Less potential for air intrusion
- More redundancy

Mechanism for Improving Gas Quality

- Improved cover materials
  - Low-permeability soils
  - Temporary FML covers

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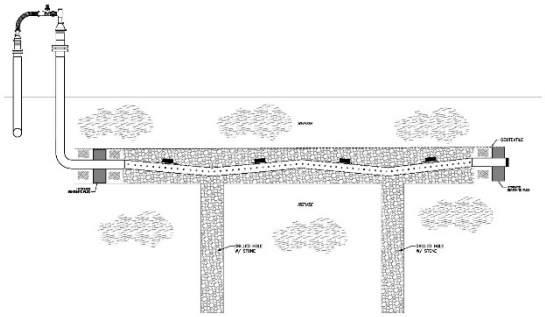
Design for Success

Increasing your ability to get high quality LFG

LFG Collectors

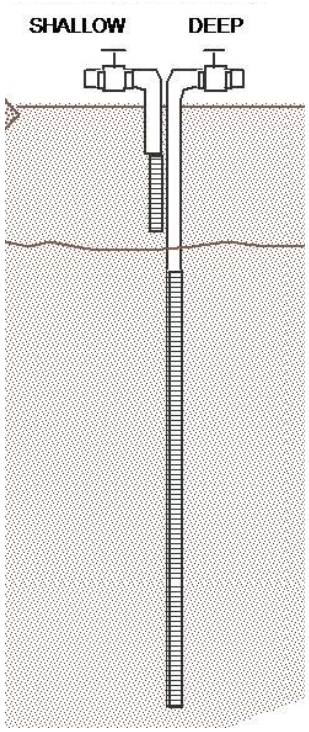
- Horizontal wells
- Vertical wells
- Caisson wells
- Belly collectors
- LCS connections
- Goals:
  - early LFG collection
  - optimization of fuel delivery



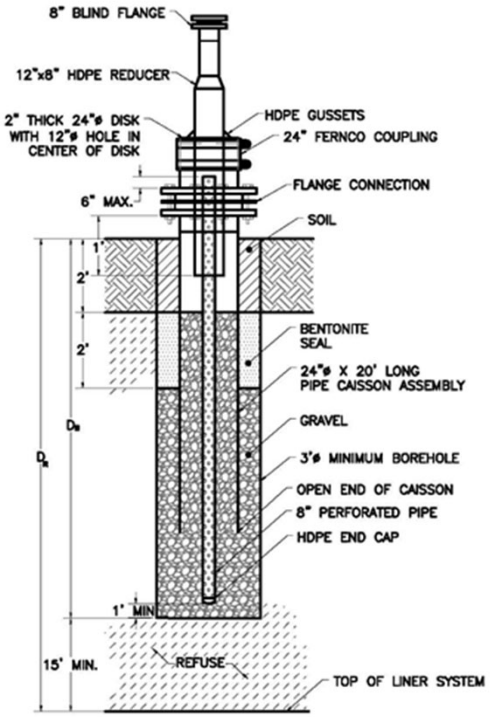
HORIZONTAL COLLECTOR DETAIL

Vertical LFG Extraction Wells

- Drilled on existing slopes or based on compliance and odors needs
- Solid pipe used to extend well
- May require re-drills or nested wells



Nested vertical wells



Caisson wells

Toe/LCS Collectors

Installed in crest of slope toe of berm (intercell)

Operate like a vertical/horizontal

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Bogey Number 1 – Fluids Management

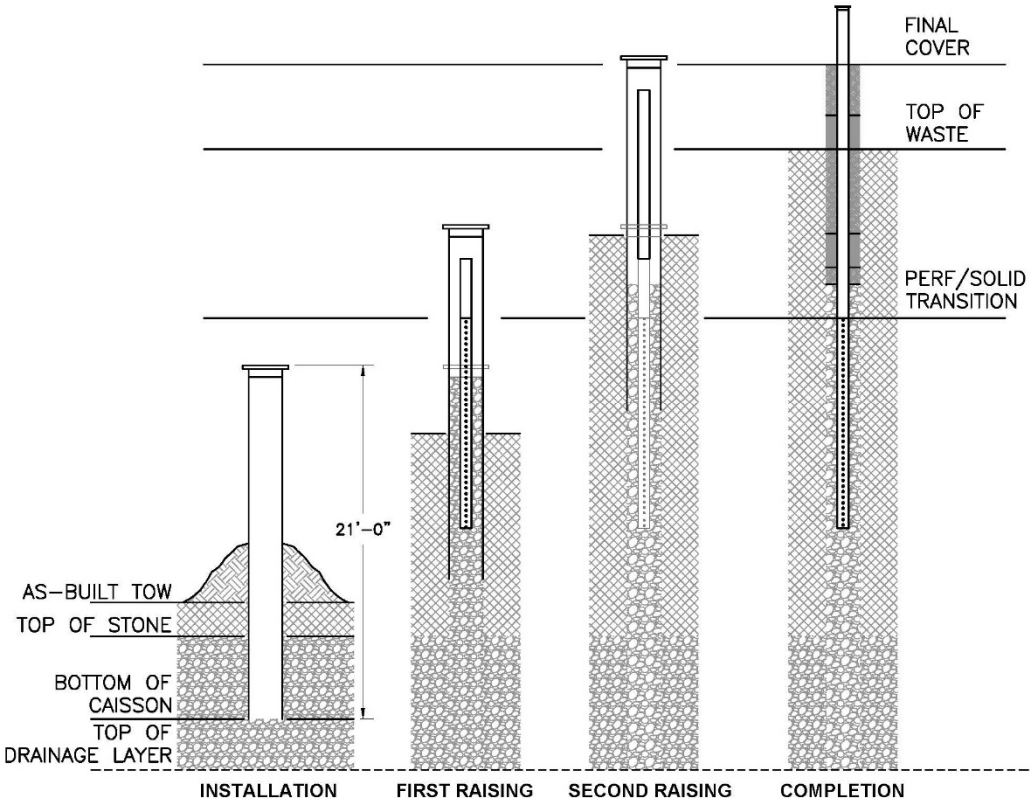
Too much water!

Water, Water Everywhere!

- Liquids management
  - LFG wells are holes in the refuse and will collect any nearby liquids
  - Some fills are “wet”
  - Reducing liquid levels can increase both quantity and quality

Design for Drainage – Caisson Installation

- Allows to drain liquids directly on to the drainage layer (continuous rock column)
- Eliminates the need for pump installation in the well along with air and force main lines



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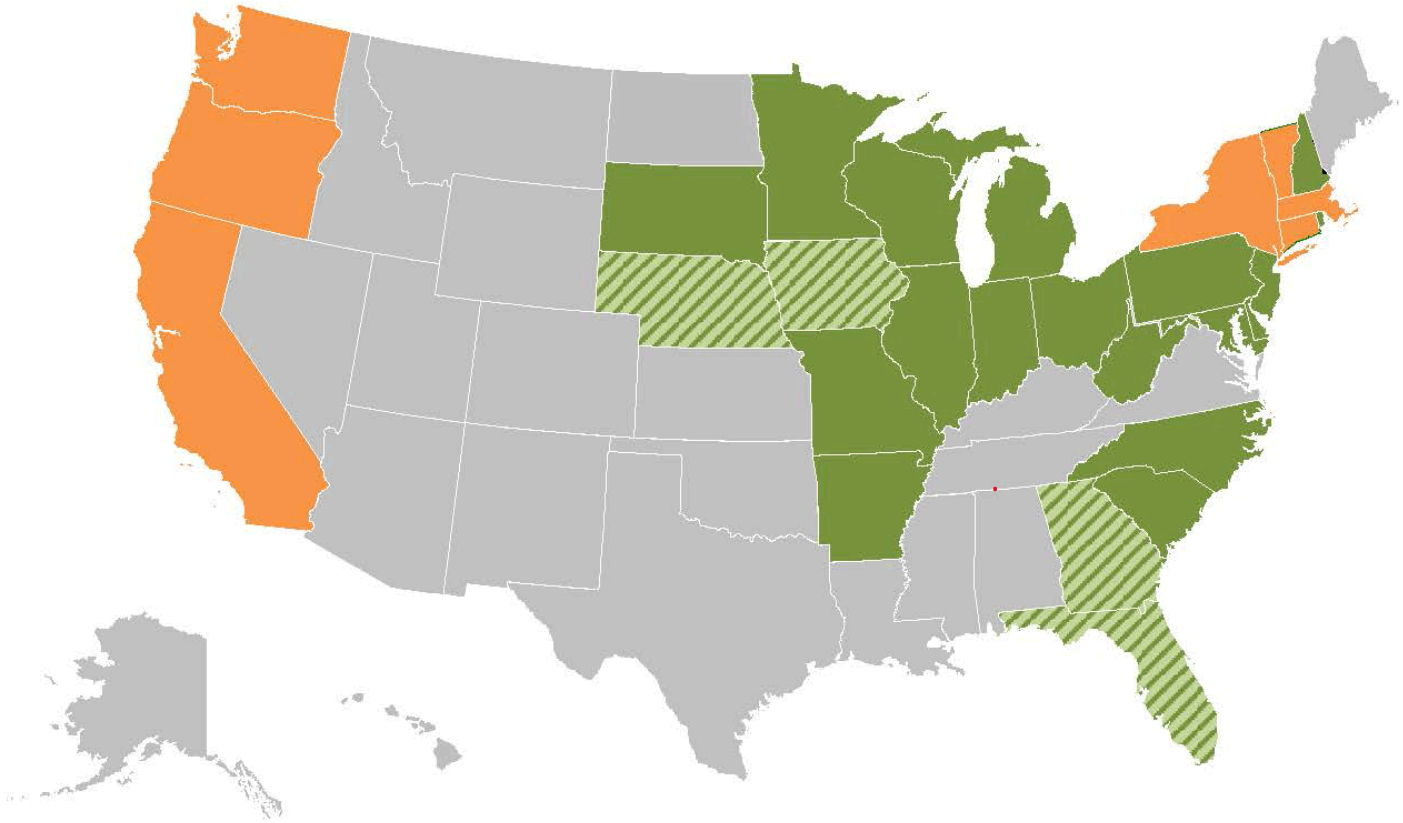
Bogey Number 2 – Organics Management

Regulatory burden or potential opportunity?

Organics Bans and Diversion Mandates

As of December 2020



Yard debris bans: Arkansas, Delaware, Illinois, Indiana, Maryland, Michigan, Minnesota, Missouri, New Hampshire, New Jersey, North Carolina, Ohio, Pennsylvania, Rhode Island, South Carolina, South Dakota, West Virginia, Wisconsin

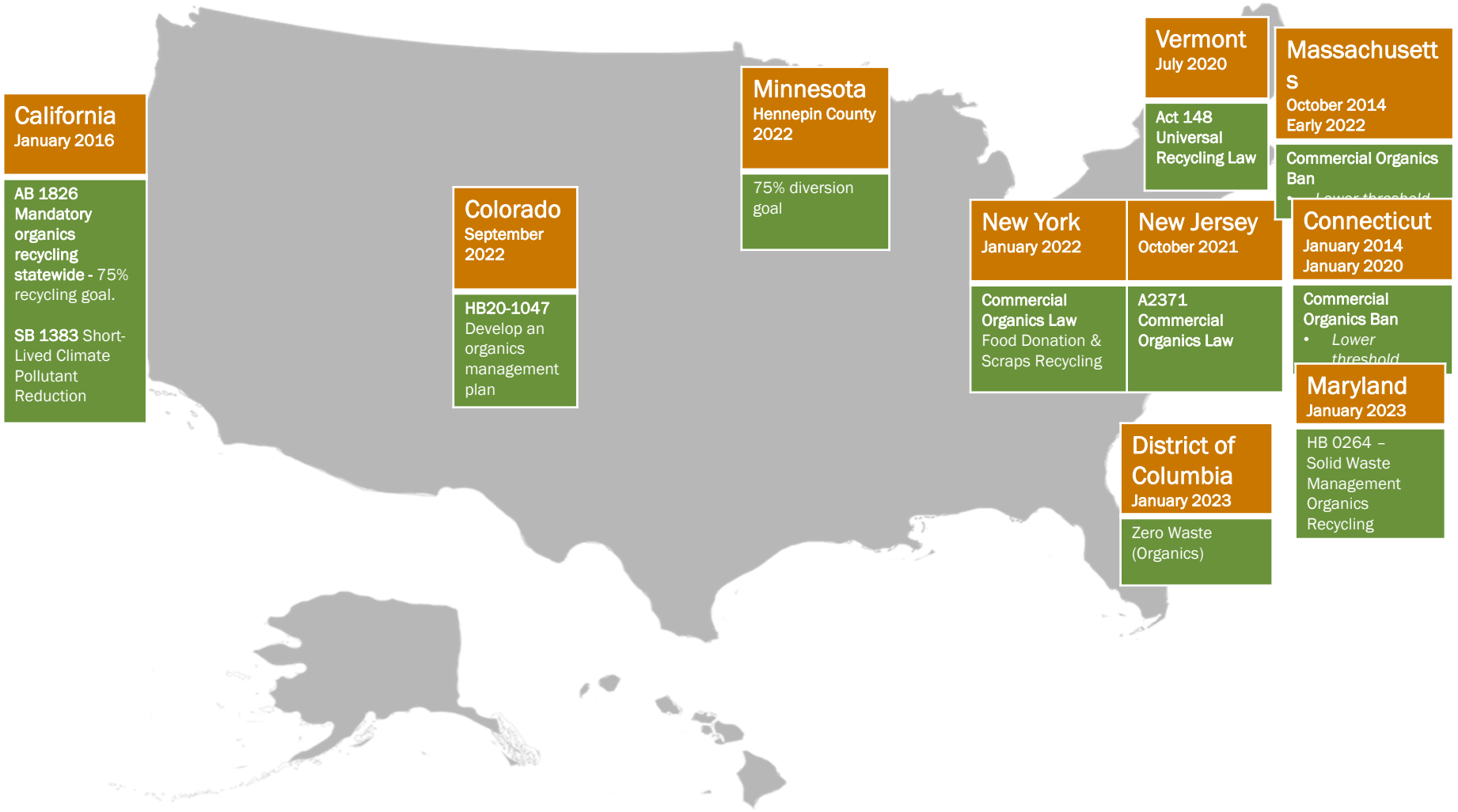
Yard debris bans with exemptions for landfills with gas collection systems: Florida, Georgia, Iowa, Nebraska

Food scrap collection mandates or aggressive legislation for keeping out of landfills: California, Connecticut, Massachusetts, Oregon, Vermont, Washington

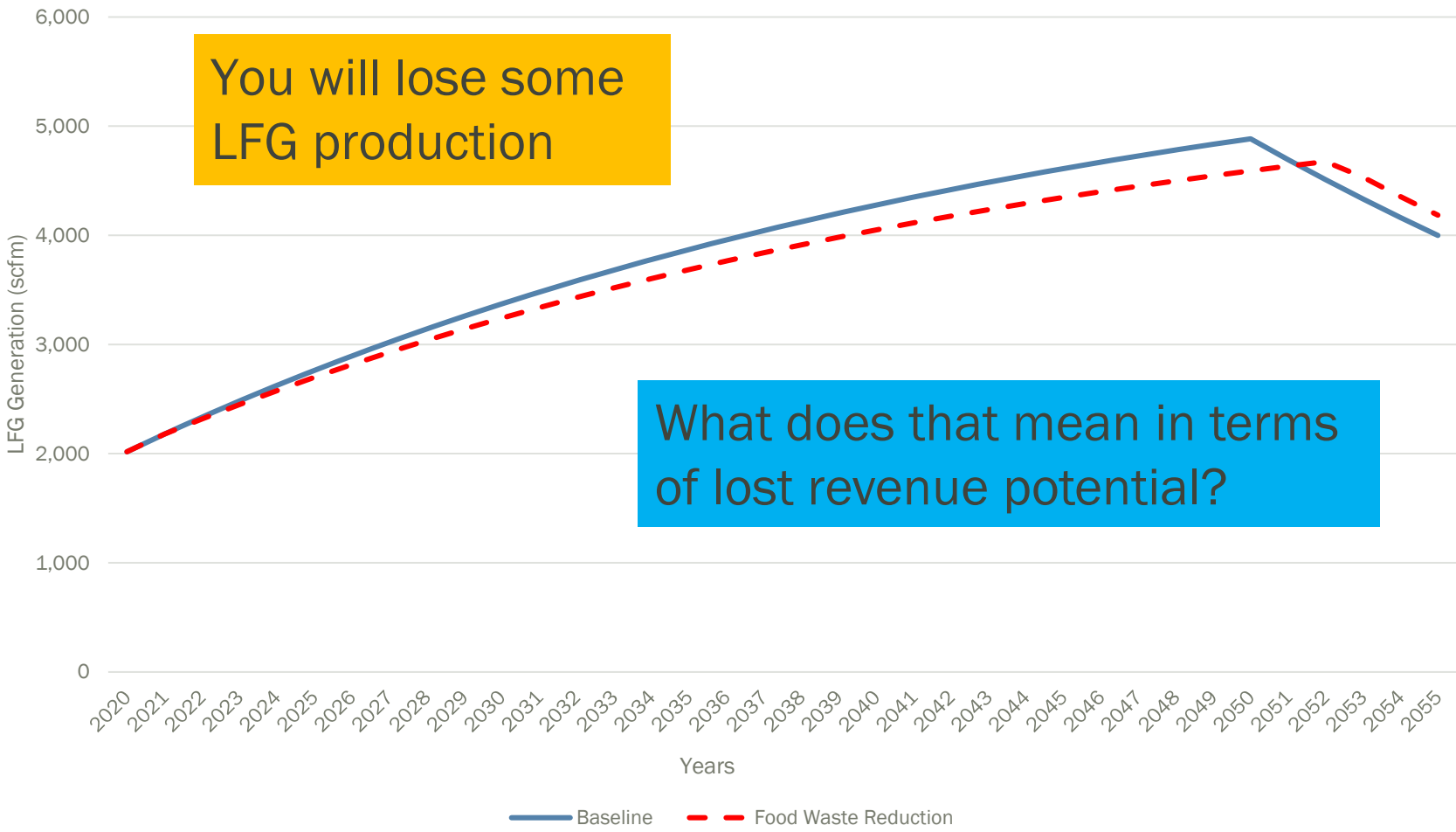
Source: US Composting Council organics bans

Organics (Food Scraps) Legislation

Coming Your Way



Cost of Not Getting the Food Waste



Compost

- Need space for windrows & handling equipment
- Create compost
- Remember Milorganite (MMSD 1926)

Aerobic Thermophilic Digester

- "High Tech" composting – smaller footprint & shorter timeframe
- Enclosed facility for process equipment
- Minimal air/liquid emissions

Anaerobic Digester

- Wet or Dry
- Residuals – landfill/compost
- Leachate
- High-quality biogas

So how could we make this work?

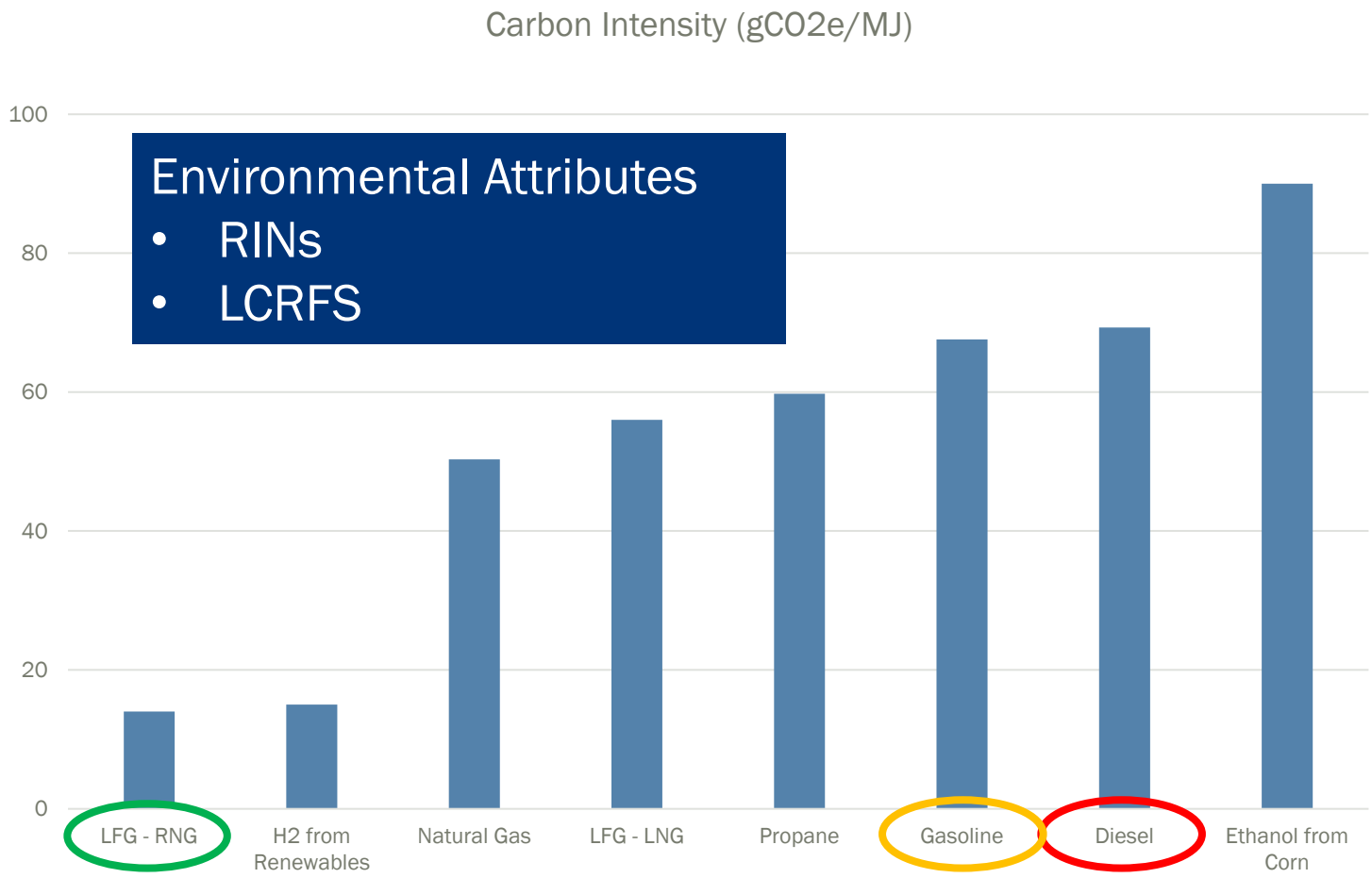
Since it looks like this is a reality coming to your neighborhood soon, what can you do to make *(or at least not lose)* capital?

If you built an AD/RNG system at your site…

- 100 TPD of food waste, Wet AD system
- $30 - 40M in capital expense
- $1.3 - 1.8M per year in operating expense
- Twenty years ~ *$81M cost*
- @ $50/ton ~ *$88M revenue*

- 350-400 scfm of biogas @ 70% CH4 and 0% O2 Develop as RNG pipeline or CNG vehicle fuel (650k DGE/Yr) - Assume fueling at the site
- $3 - 5M in CAPEX, $1/DGE in OPEX
- Diesel you're not buying @ $3.00/gallon ~ $1.95M/Yr
- RNG incentives (D5 RINs) @ $15/MMBTU (net) ~ $1.35M/Yr
- Combined VF/AD - $98M cost vs $154M revenue (20 years) – *Net $56M*

Environmentally Friendly



Ref: U.S. Energy Information Administration FAQS (https://www.eia.gov/tools/faqs/faq.php?id=73&t=11) and California Air Resources Board Current Fuel Pathways spreadsheet (https://ww2.arb.ca.gov/resources/documents/lcfs-pathway-certified-carbon-intensities)

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Bogey Number 3 – Facility Planning

Where are we going to put this thing?

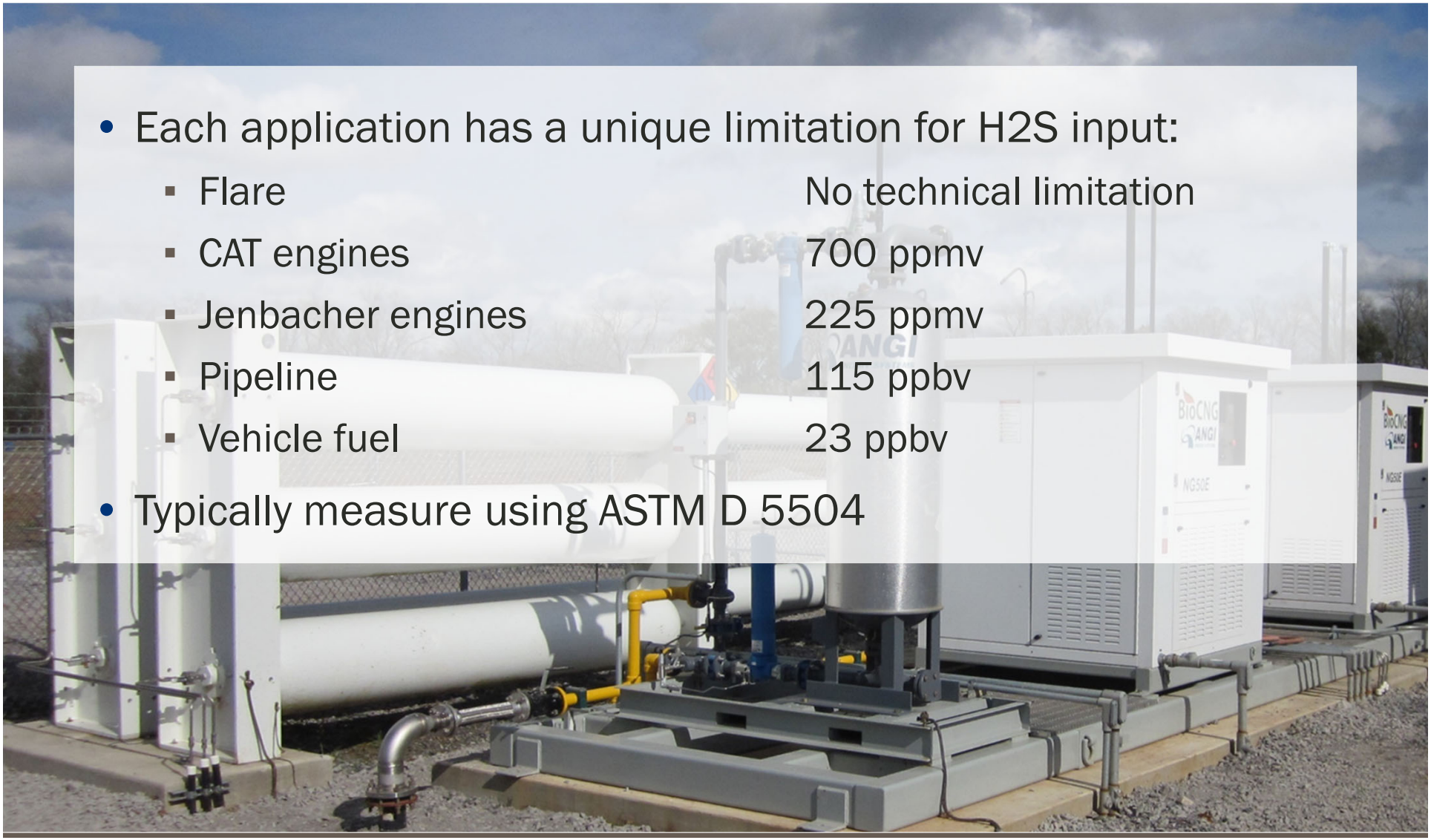
We Need Space!

- Different facilities have different footprints and utility requirements
  - Anaerobic Digester 2-7 acres
  - 400 cfm BioCNG™ Vehicle Fuel 0.25-0.5 acres
  - 8 MW Engine Facility 1-2 acres
  - 6,000 cfm RNG Facility 2-3 acres
  - Gas Treatment 1-2 acres
- This is in addition to your flare facility
- Don’t forget about site access
- Tractor-trailer access for equipment, construction, waste materials, and operating supplies

We Need Stuff To Make It Run!

- Water
- Sewer
- Waste disposal (can you dump it back into the landfill?)
- Communications
- Electrical service
  - 480V/3ø at a minimum
  - Primary for some large facilities
  - Self-generate power for your plant
- Treatment requirements
  - H2S
  - Siloxane

Treatment Requirements



- Each application has a unique limitation for H2S input:
  - Flare — No technical limitation
  - CAT engines — 700 ppmv
  - Jenbacher engines — 225 ppmv
  - Pipeline — 115 ppbv
  - Vehicle fuel — 23 ppbv
- Typically measure using ASTM D 5504

Summary

- Developing a LFGTE project is a great asset, but you need to be prepared
- Review
  - Data trends
  - Density of wellfield
  - Availability of perforations
  - Cover integrity
- Design for success
  - Proactive means to get more and better fuel earlier on the site life
  - Review spatial and utility needs
- Be aware of potential pitfalls
  - Liquids management
  - Regulations that may lead to revenue loss

Questions?

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