MOBILE PIPELINE: A SOLUTION FOR TRANSPORTING BIOMETHANE (RNG)

HEXAGON

THE COALITION FOR RENEWABLE NATURAL GAS

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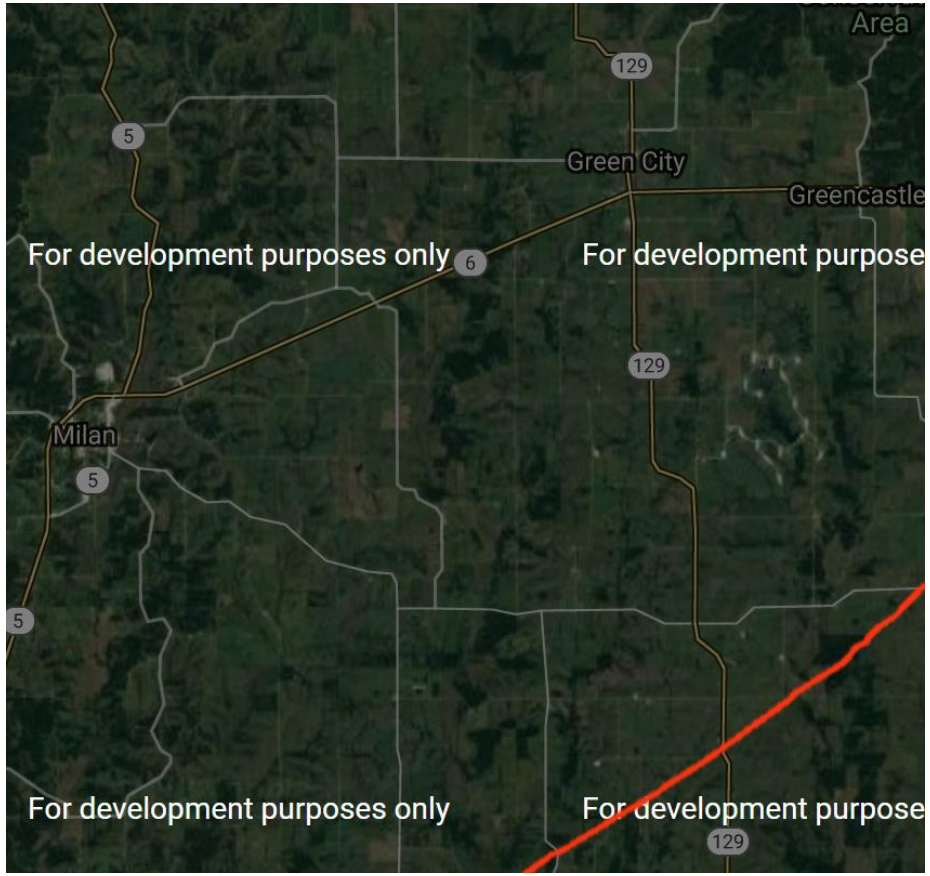
Driving energy transformation

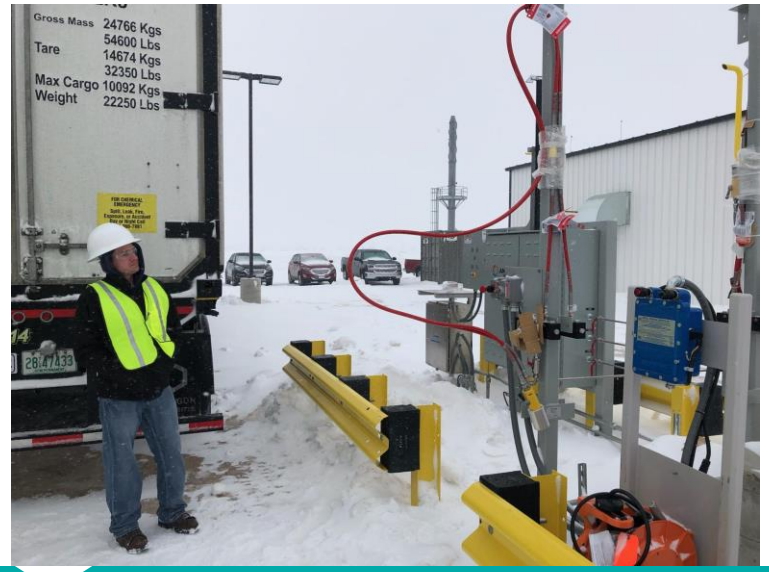
The problem: Remote production sites



Source: US National Pipeline mapping tool. Sullivan County, Missouri, USA

- Many Biogas/RNG production sites, especially those that are agricultural based, are located in remote locations
- Remote facilities likely do not have access to a natural gas distribution system. Transmission pipeline or CNG fueling stations may be many kilometers away.
- The costs for constructing a pipeline injection point may be as high as €1.5MM. In addition, the cost to construct the lateral to connect the production site and the pipeline may be as high as €0.9Miliion per mile.
- For a site 16-kilometers away from a pipeline, the cost for a direct connection to the pipeline may be as high as €12.0MM. Not every RNG project can afford an interconnect!

RNG/CNG Anywhere, Anytime



What is Mobile Pipeline®?

- Mobile Pipeline® is a method of transporting natural gas to or from facilities that lack access to pipeline infrastructure. With over 1400-modules produced in the last 10-years, this is not new technology!
- Mobile Pipeline is successfully used to transport natural gas 250-miles (400-KM) or more one way.
- Each trip can transport as much as 15,000 SM^3 of natural gas.
- Natural gas is pressurized to 250-BARG at the loading facility to obtain sufficient volume within the module to allow for truck transportation.
- Compression and decompression equipment is required to load and offload the modules.
- Regulating gas pressures at the offload site is required.
- Modules built with cylinders meeting ADR requirements for Europe and USDOT, Transport Canada, and ABS for other areas around the world.

Upper left: CNG modules in Ireland used for Biomethane. Lower left: operator at a dairy farm in Wisconsin (United States) preparing to connect module to module filling system.

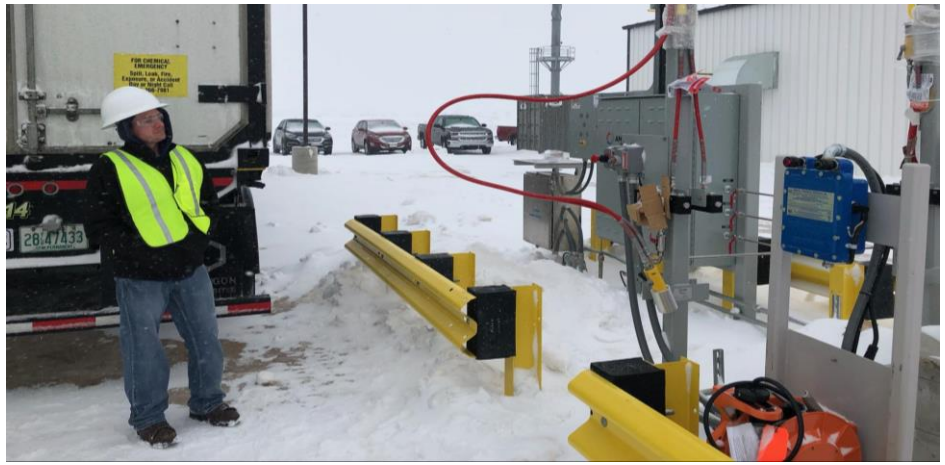
THE PRODUCTION SITES:

Covered waste lagoon at Valley View Farm, Missouri, 1.2 Hectare

Raw biogas (64% CH_4, 35% CO_2 is cleaned to >96% CH_4

Top Right: Biogas from cleanup skid utilizing membrane system to separate CH_4 and CO_2

Lower Right: Biogas from cleanup skid is compressed from 10-BARG to 250 BARG for mobile pipeline.



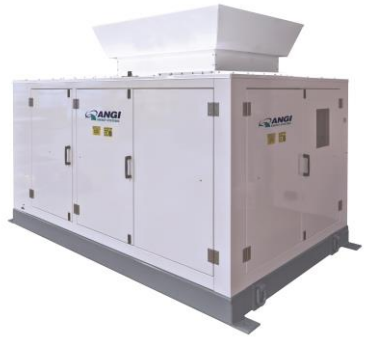
XNG Transports RNG from Pagel's Ponderosa, Wisconsin

The RNG Mobile Pipeline® – How it works

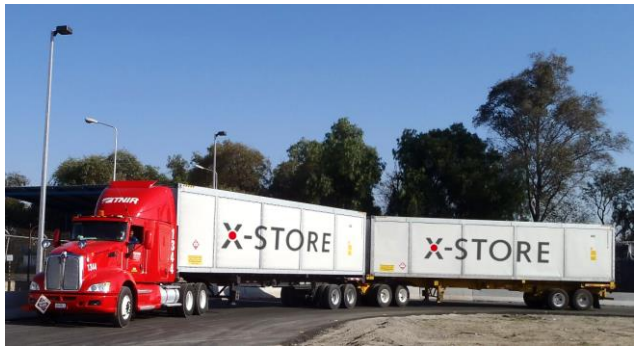
Offload site or vehicle fueling site offloads module to 10-BARG

Empty module (10-BARG) travels to production site

Module is filled to 250-BARG at production site



Full module travels to offload site @ 250-BARG



Impact on Carbon Intensity

Photo courtesy of .Roeslein Alternative Energy

Above: Stock photos from Waste Management of CNG fueled trucks

Recent calculations capturing the impact on carbon intensity of MP

- In the United States, the GREET model is the standard for determining carbon intensity of energy fuels**.**
- Agricultural animal waste carbon intensity scores are recorded as low as -253 grams CO2 equivalent per MegaJoule.
- New sites are in process of certification that may have lower carbon intensity scores.
- Mobile Pipeline adds about 3-grams CO2 equivalent per MegaJoule to carbon intensity score.
- Components considered when determining impact to CI score:
  - Added compression
  - Truck transportation of up to 100-KM
  - Venting of piping required to meet regulatory requirements.

CNG/RNG injection

What to do with Biomethane/RNG in the module?

- The Mobile Pipeline® module arrives at the offtake site with 250-BARG gas on board.
- Compressed Biomethane may be used to fill vehicles. Additional compression may be needed to reach target vehicle pressure.
- In North America, Biomethane is also injected into the gas grid system.

Above: Interstate pipeline injection site. Photo courtesy of XNG.

Left: Module with 6500 SM3 capacity and portable intensifier compressor. Phone courtesy of Compass Natural Gas.

Why Mobile Pipeline® works for RNG?

Trucking natural gas is the solution when a pipeline is too far away.

- Mobile Pipeline® is an option when there are challenges to delivering renewable natural gas:
  - Pipeline is 8-kilometers or more away from production site
  - The cost of an interconnect is prohibitive
  - Restrictions on connection to distribution system are in place.
- Mobile Pipeline® typically costs between € 4.00 and € 6.00 per GigaJoule to operate. This includes capital costs for compression, transportation equipment, and operating expenses for the electricity, trucking, and operation of offload facility.
- Each project requires multiple modules. A module will always be in the fill process, and at least one other module will be either offloading or in transit. The number of modules required for a project is a function of distance and load. Hexagon can help you determine the number of modules required.
- Credit and subsidies available for Biomethane vary by country. In the US depending on feedstock, Biomethane may receive environmental credits of up to € 75 per GigaJoule. Italy and the UK have different credits and incentives available for biomethane production.

* The actual cost will vary on each project as a function of distance, soil type, pipeline pressure, and interconnection costs

Questions?

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