An experimental design to evaluate satellite ALD in local distribution

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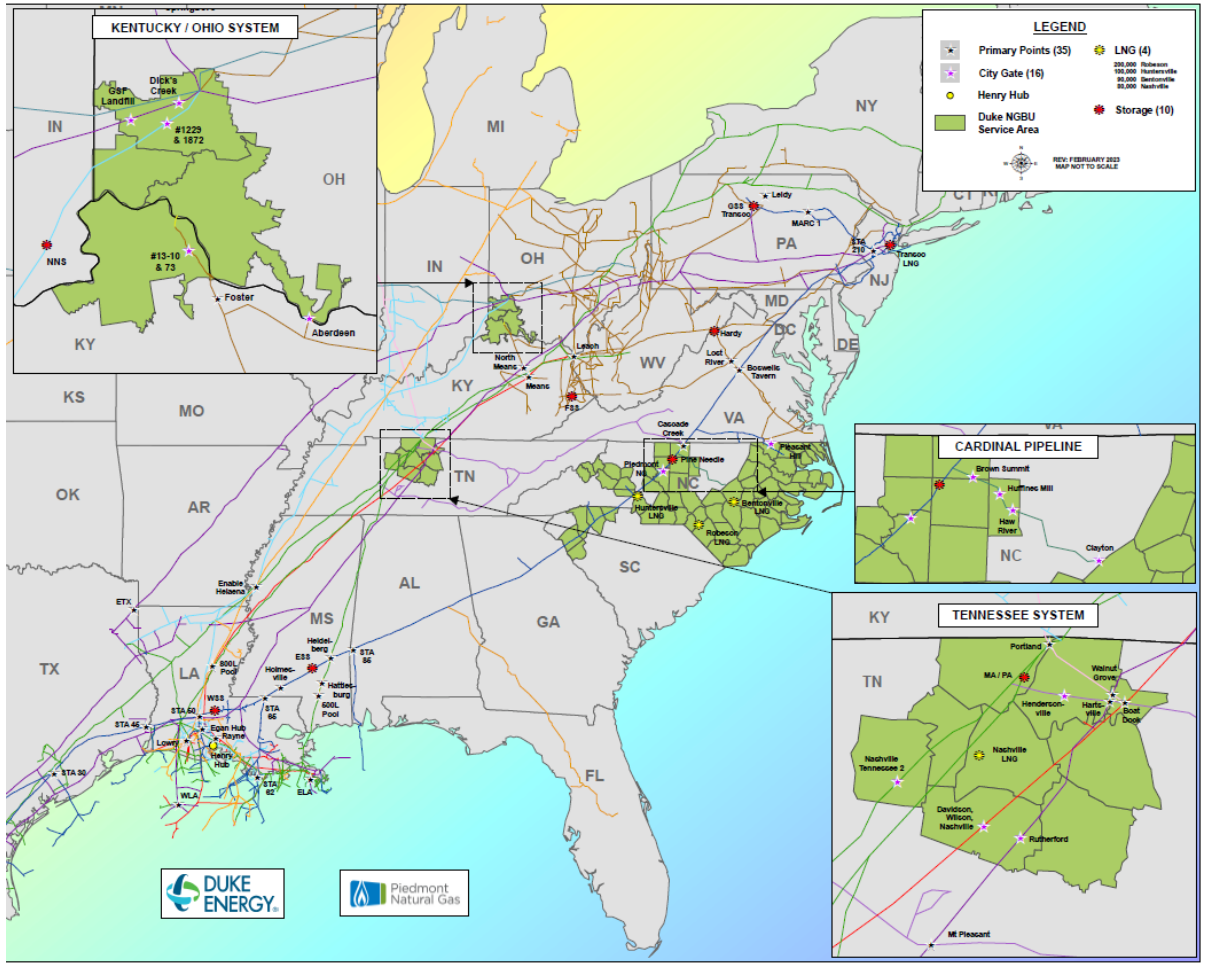
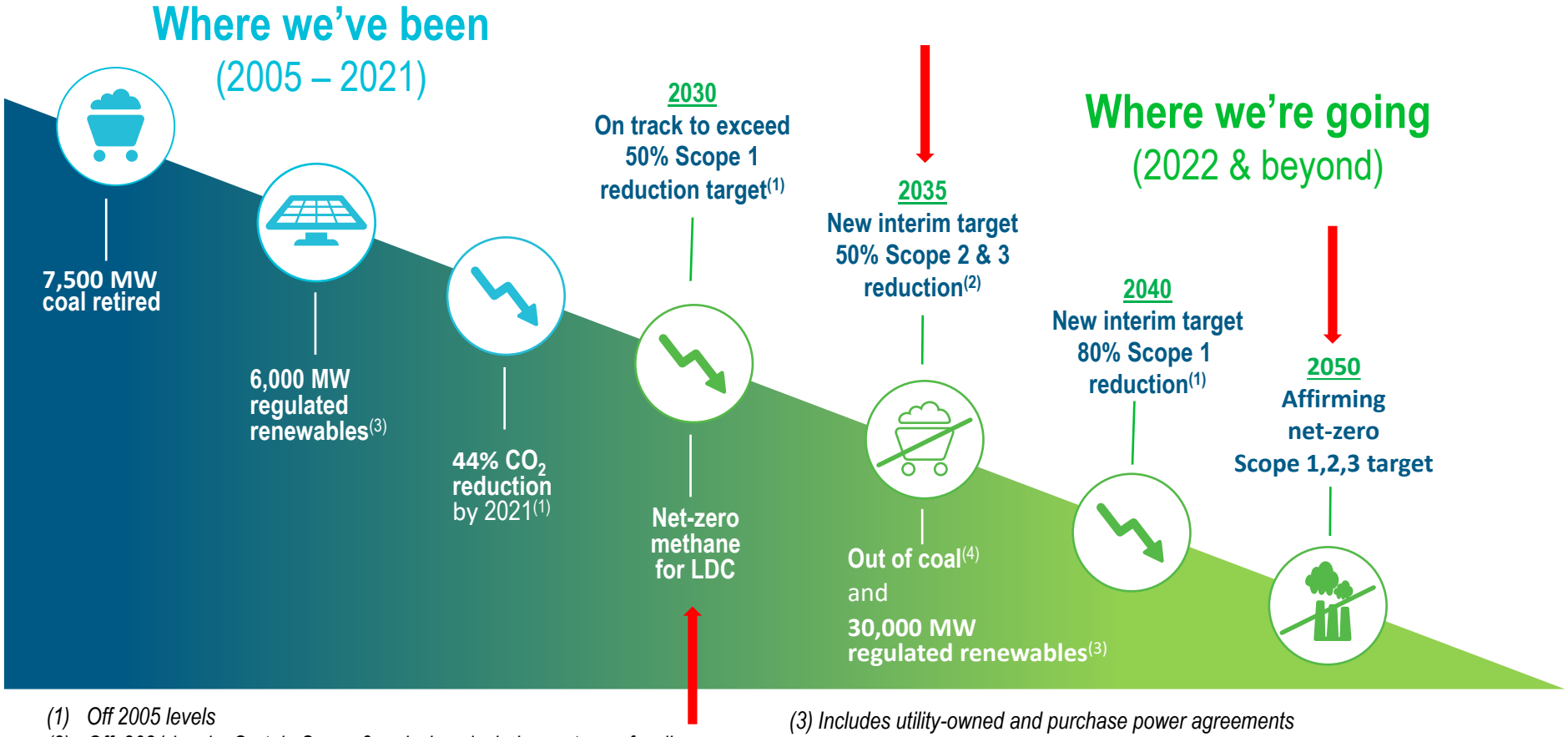
Duke Energy/Piedmont Natural Gas Utility Business



- 1.7 M customers in 5 states
- ~32,000 miles distribution main
- ~2,900 miles intrastate transmission main
- 5 compression stations
- 4 Liquified Natural Gas (LNG) sites
- 2,000+ employees in NGBU

Duke's Commitment: The Road to Net-Zero

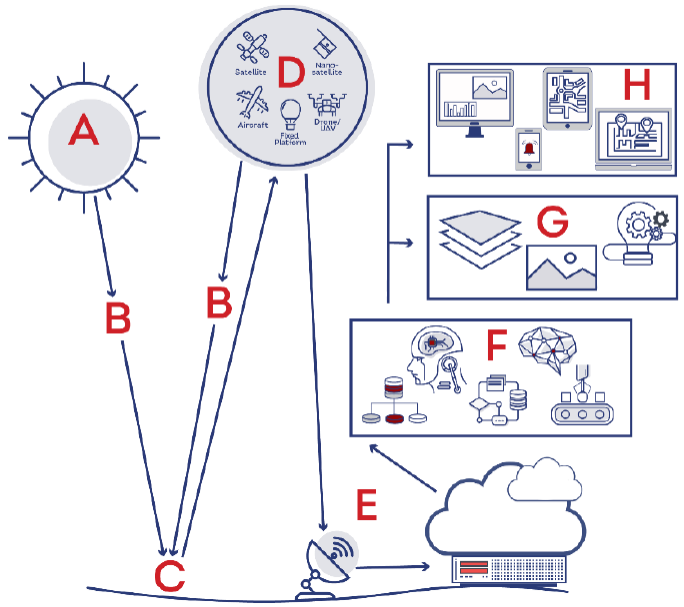


(1) *Off 2005 levels*
(2) *Off 2021 levels. Certain Scope 3 emissions include: upstream fossil fuel procurement, production of power purchased for resale, and downstream use of sold products in our natural gas LDCs*

(3) Includes utility-owned and purchase power agreements
(4) Subject to regulatory approvals. Contemplates retiring Edwardsport coal gasifiers by 2035 or adding carbon capture utilization and storage to reduce carbon emissions

Pilot Study:

Satellite for local distribution companies (LDCs)



Operational experience indicated the presence of a leak within 150-feet of a satellite-identified indication ***approximately 74-93%*** *of the time, depending on tuning of imagery processing*

Duke Energy Natural Gas Business Unit (NGBU) began piloting **satellite advanced leak detection (ALD)** in early 2020.

Pilot process steps:

1. Satellite with appropriate SWIR bands takes capture
2. Satelytics processes imagery and delivers data to NGBU
3. Field technician is deployed to identified methane indications
   - If leak is identified, field technician follows appropriate company procedure for documentation and repair

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Potential strengths & weaknesses of satellite-ALD

Potential strengths

- Ability to capture large areas quickly
- Ability to observe in areas that are hard to reach
- Could be cost effective
- Could estimate leak sizes
- Not all satellites have resolution fine enough for precise leak location

Potential weaknesses

- Use in local distribution segment needs additional evaluation
- It is not clear which satellites have the needed systems & algorithms to be effective in an LDC
- May miss intermittent sources
- Leak flow rate detection limits need to be evaluated
- Regulatory landscape for acceptable technologies would need to address satellite use

Gas technician viewing satellite-captured methane plumes on a tablet

Duke Energy NGBU engaged with Colorado State University to complete an independent study of satellite-ALD

Results of the study are being finalized for release

This presentation details elements of experimental design for evaluating satellite ALD

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Selecting an experimental area of interest

Consider these factors in selecting a location

Gas technician utilizing a combustible gas indicator on a meter set

- Wide-range of asset ages and materials
- Diverse geographic landscape
- Various end-users or customer types
- Variety of asset types, including pipelines and stations
- Existence of non-natural gas methane sources (e.g., landfills)

Conducting controlled releases

Blind, measured gas releases help test identification and quantification

- Natural gas or methane release at a known flow rate
- Conducted in locations where leaks might actually happen (e.g., service line, meter set assembly)
- Wide range of leak release rates
- Consider timing of release before satellite flyover

Satellite-captured methane plumes from controlled releases

Comparing with other standard methods

Collect congruent data from other methods to compare results, utilizing the same time and location

Gas technician walking with equipment

Traditional walking survey

- Usually conducted for safety compliance purposes
- Hand-held combustible gas indicator
- Walking examination of every LDC field asset, especially service lines & meters

Directed survey

- Technician dispatched to an individual customer address
- Analogous to technician-response for an odor call
- Typically, the same equipment as traditional walking survey
- Can be more time on-site than during walking survey

Survey positive and negative sites

Positive Site:

- Satellite-identified leak indication present

Negative Site:

- Site similar in characteristics to positive site
- At least 500’ from positive site
- No satellite-identified leak indication present

Expectation:

> Leaks found more often at satellite-identified leak indication locations

< Leaks found less often when satellite identifies no indications

Gas technician working with gas detection equipment

Additional experimental considerations

Satellite-identified methane plumes in a residential neighborhood

Area of interest:

- Select an area of interest with higher abundance of leak-prone pipe

Controlled release:

- Determine amount of time for release prior to satellite capture

Directed survey:

- Encourage technicians to survey and record any customer-side (after the meter) emissions

Data Analysis Questions

Reproducibility:

- What is the rate of repeated observation of leak indications across data captures and methods?

Method Comparisons:

- Is there agreement between positive and negative sites across methods?
- How does the rate of leak identification compare between positive and negative sites?

Controlled releases:

- Was the controlled release detected?
- How the indication flow rate vary from measurement?


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