Methane Emissions Measurement Techniques for Orphaned Wells

IOGCC Annual Business Meeting

May 14-17, 2022

NE TL NATIONAL ENERGY TECHNOLOGY LABORATORY

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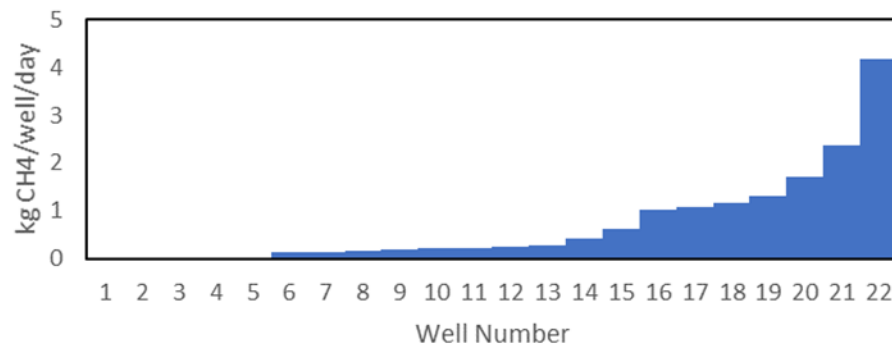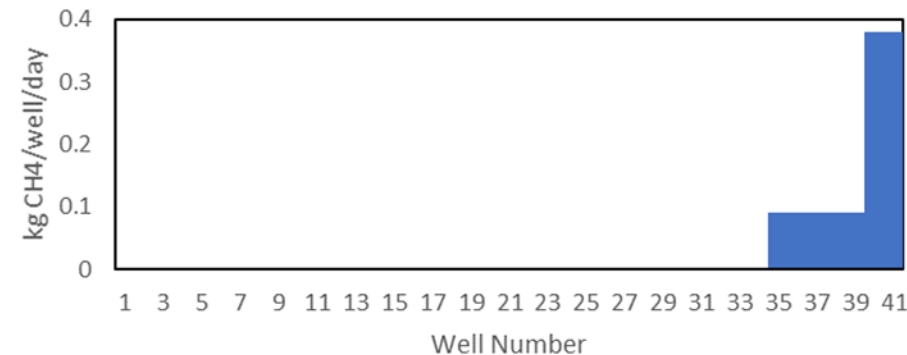
Estimating GHG Footprint of Orphaned Wells

Abandoned Well Methane Emission Factors: Fat-tailed Distribution Characterized by "Super Emitters"
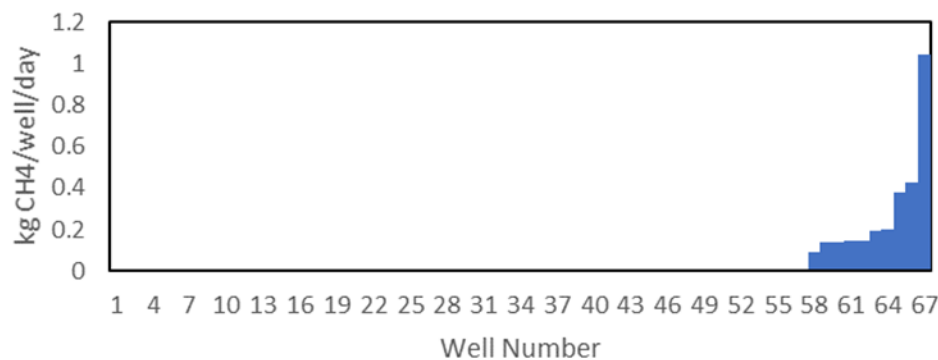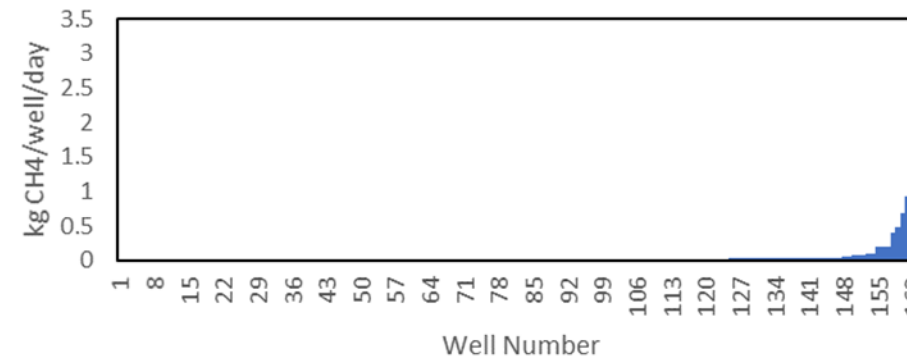
UNPLUGGED WELLS
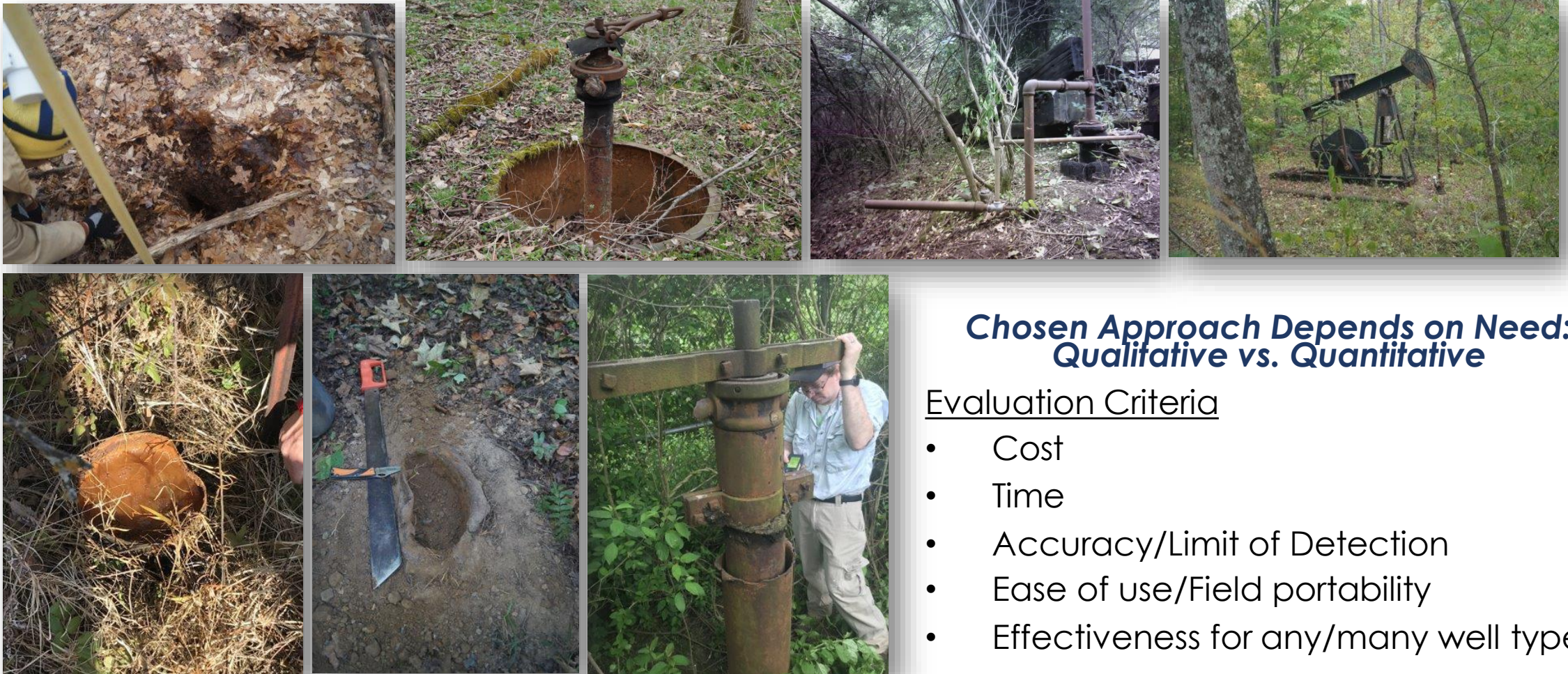
Detection and Measurement of Methane Emissions from Orphaned Wells

Variety of Well Configurations Makes Measurement a Challenge: One Approach Does Not Work at All Wells

Chosen Approach Depends on Need: Qualitative vs. Quantitative

Evaluation Criteria

- Cost
- Time
- Accuracy/Limit of Detection
- Ease of use/Field portability
- Effectiveness for any/many well types

High Flow Sampling

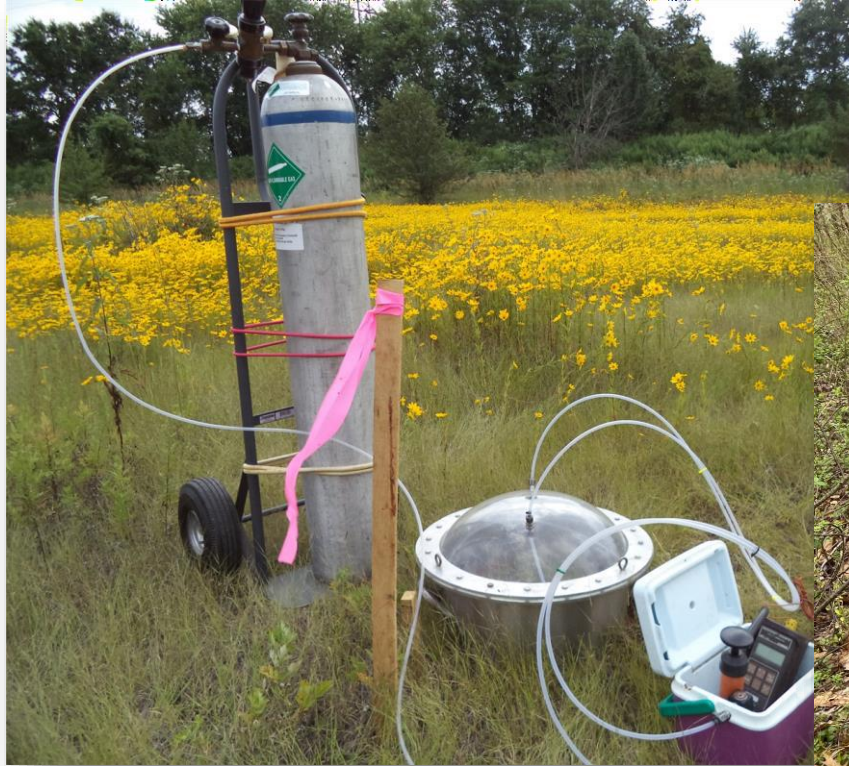**Bacharach; Sensors, Inc.; HETEK Solutions; Add Globe, LLC; Home-built**

Flux Chambers (Dynamic/Static)

Rigid Chamber or Bag

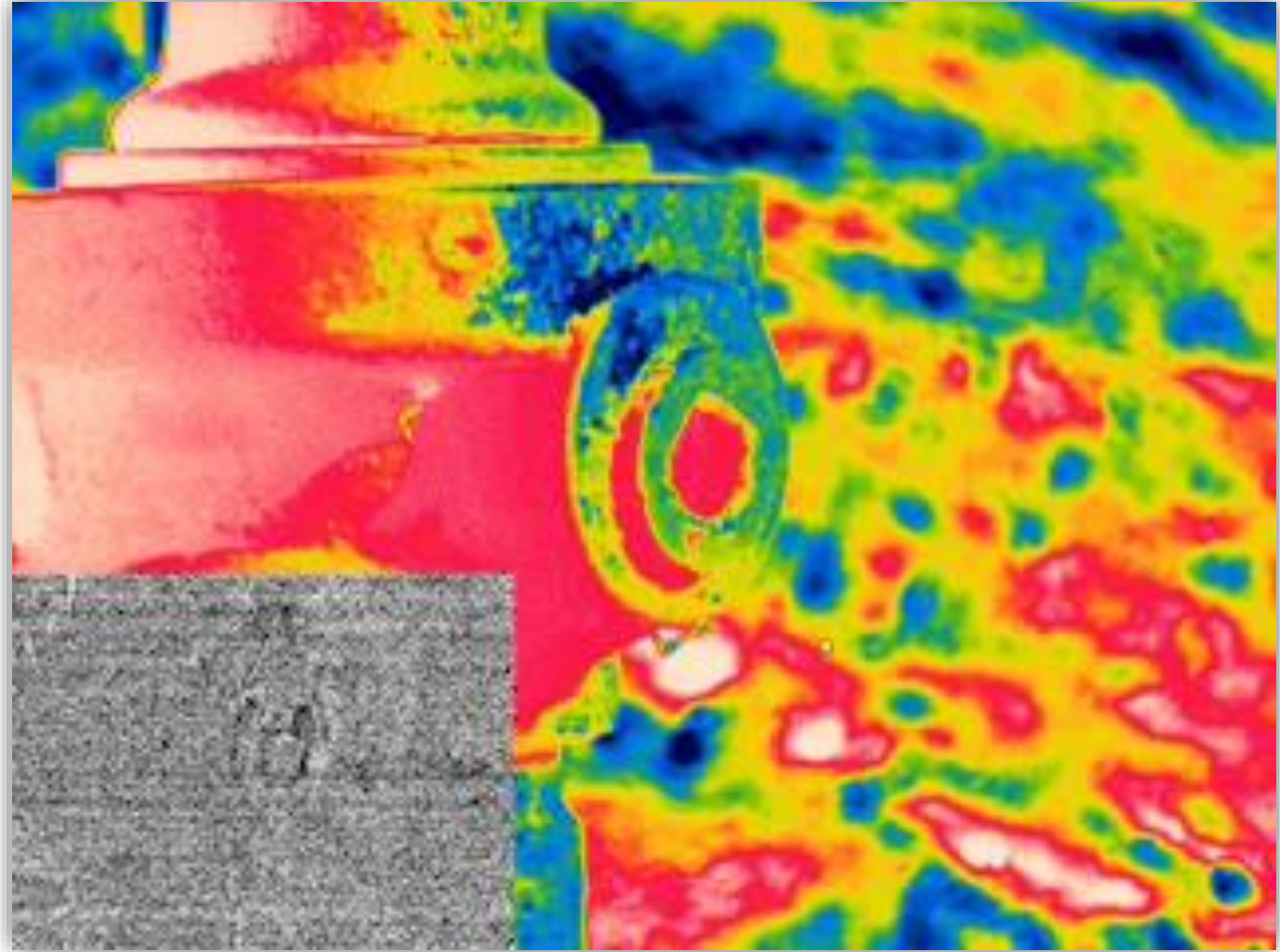Dynamic Chamber: Flux = Flow Rate * (C_{out} – C_{in})/Area

Bag: Emission Rate = Flow Rate * (C_{out} – C_{in})

Static Chamber: Emission Rate (mass/time) = dC/dt * Volume of chamber

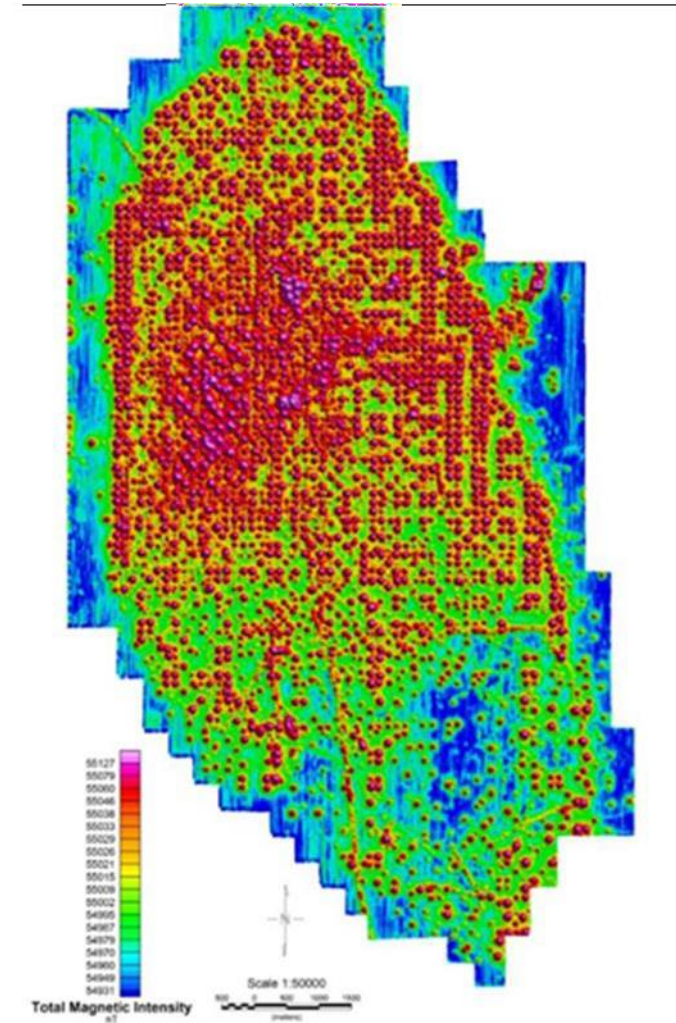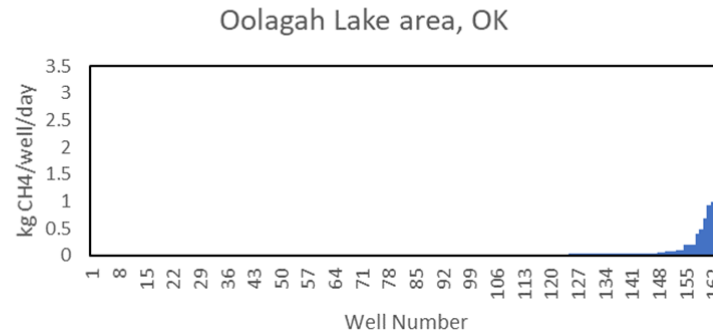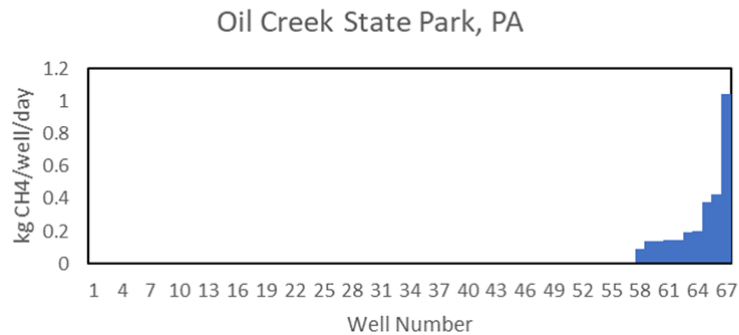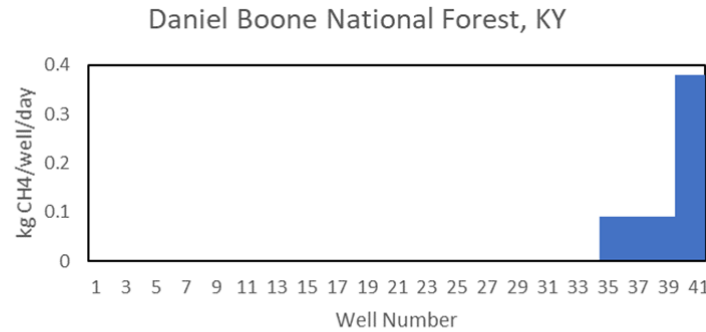# Qualitative Approaches

Optical Gas Imaging, Handheld Methane Sensors: Leak or no Leak?

Remote Sensing

Satellite, Manned Aircraft, Unmanned Aerial Systems, Ground-based surveys
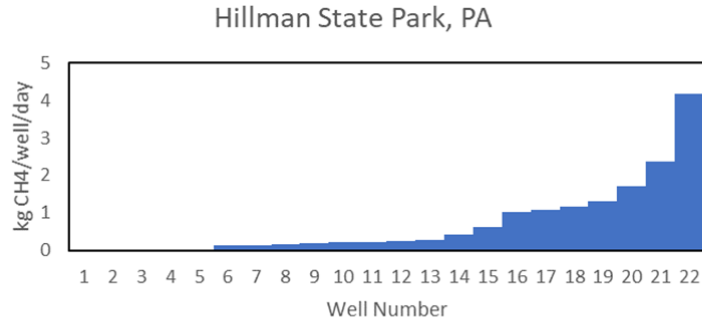
Detection is an issue of Spatial Resolution and Sensitivity!

Abandoned Well Methane Emission Factors

Sample Size and Distribution Across the US

Townsend-Small, et al. 2016
6 plugged wells
6 unplugged wells (OH)

Townsend-Small, et al. 2016
10 plugged wells (WY)

Kang, et al. 2014
5 plugged wells
14 unplugged wells (PA)

Townsend-Small, et al. 2016
87 plugged wells
2 unplugged wells (UT)

Kang, et al. 2016
35 plugged wells
53 unplugged wells (PA)*

Townsend-Small, et al. 2016
16 plugged wells
11 unplugged wells (CO)
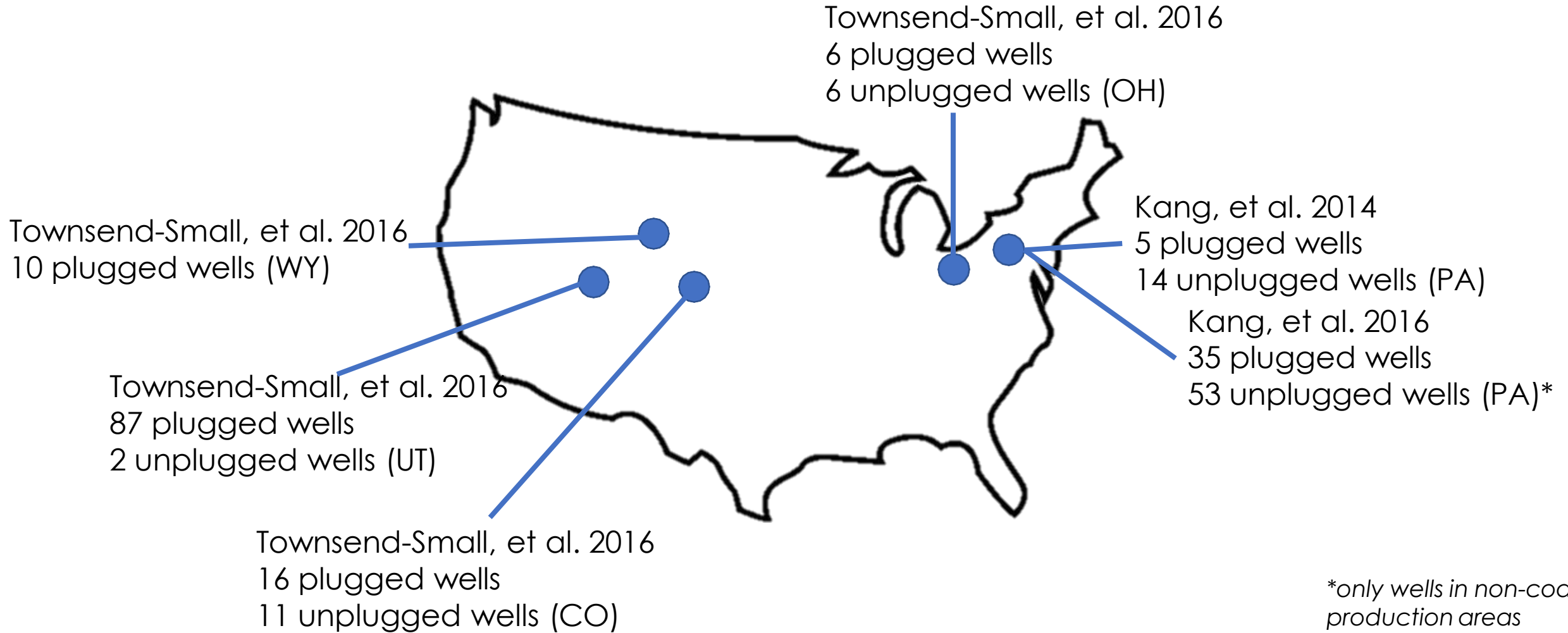
*only wells in non-coal production areas included in the EFs

NETL Abandoned Well Emissions Measurements

Completed and In-progress Study Areas

Private Property near Olean, NY
Approx. 77 wells (21 unplugged/56 plugged)

Oil Creek State Park, PA
138 wells (67 unplugged/71 plugged)

Hillman State Park, PA
31 wells, all unplugged

Daniel Boone National Forest, KY
54 wells (53 unplugged/1 plugged)

Oollagah Lake area, OK
179 wells (159 unplugged/20 plugged)

Private Property near Midland, TX
Approx. 100-200 wells, most plugged
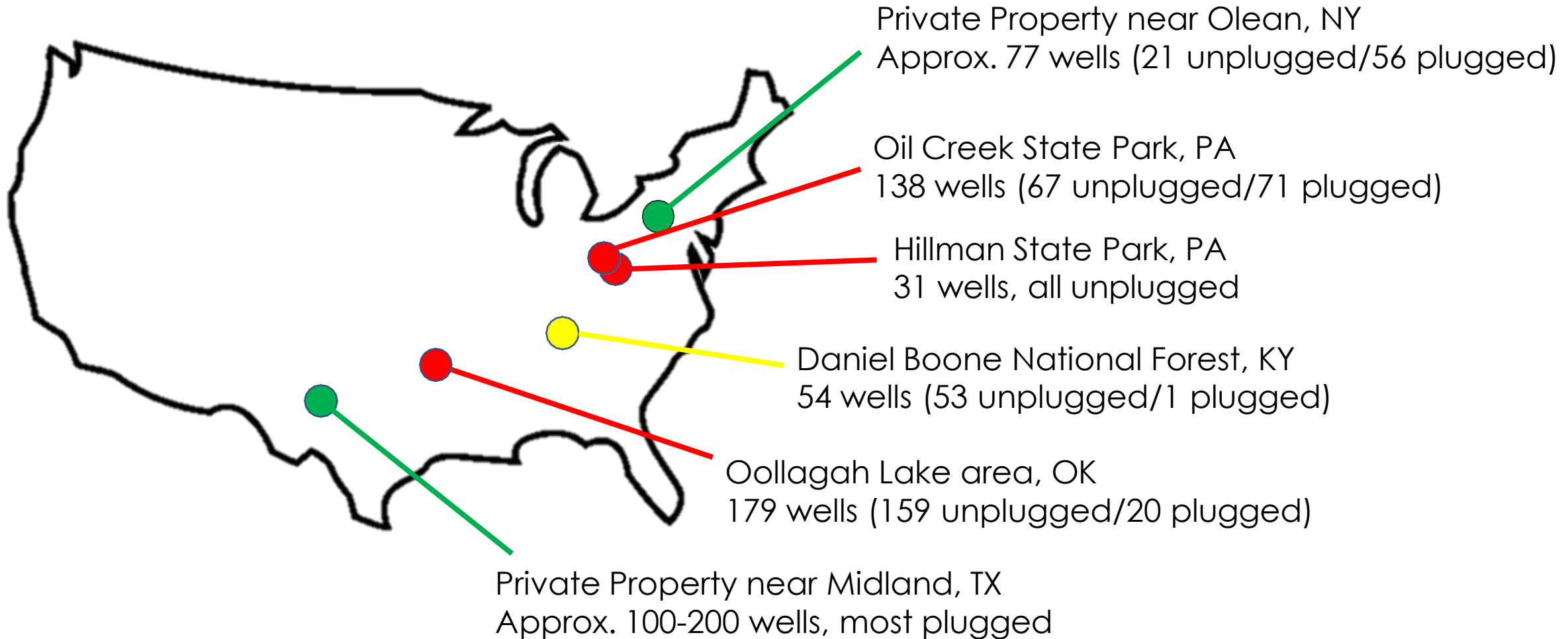
Emission Factors – Methane Emissions per Well

Using EFs Based on Field-based Measurements in the Literature

- Sources of Data:
  - Kang M, *et al.* (2014) Direct measurements of methane emissions from abandoned oil and gas wells in Pennsylvania. *Proc Natl Acad Sci USA* 111(51):18173-18177.
  - Kang M, et al. (2016) Identification and characterization of high methane-emitting abandoned oil and gas wells. *Proc Natl Acad Sci USA* 113 (48) 13636-13641.
  - Townsend-Small *et al.* (2016)   Emissions of coalbed and natural gas methane from abandoned oil and gas wells in the United States. *Geophys Res Lett* https://doi.org/10.1002/2015GL067623.

- Limited emissions data are available to support potentially stratifying EFs based on producing formation or production type.