# Measurements from marginally producing oil and gas wells indicate they are a disproportionate source of methane relative to production

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**Measurements show that marginal wells are a disproportionate source of methane relative to production**

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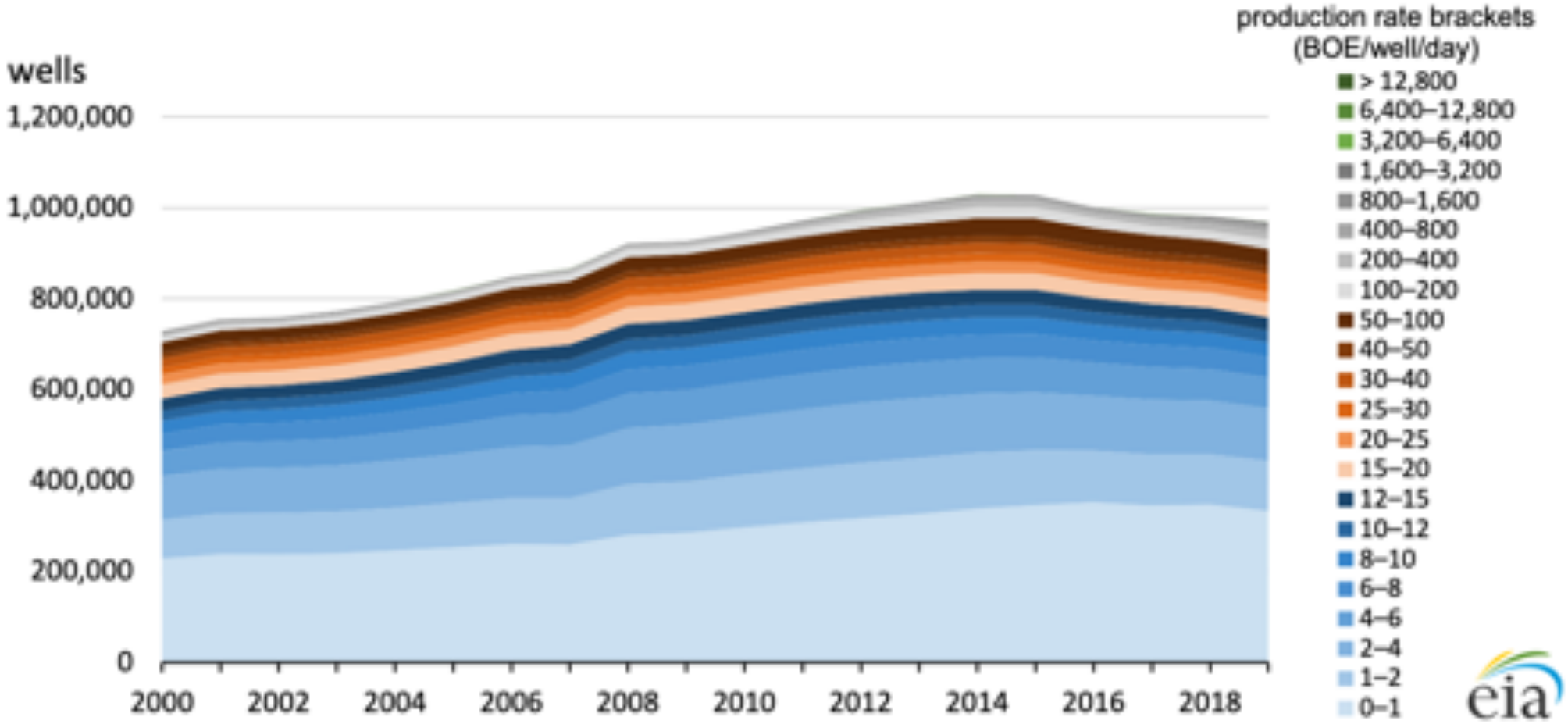
# What is a marginal or “stripper” well?

- Defined by Internal Revenue Service as a well that produces less than 15 barrels of oil or equivalent, or less than 90,000 cubic feet (90 MCF) of natural gas per day.
  - Why does IRS define a marginal well? Because there are federal (and some state) tax advantages for marginal well operators designed to help keep these wells in production, particularly when prices drop below a certain threshold
- Before the onset of hydraulic fracturing, marginal wells were the dominant source of domestic oil in some regions of the US
  - Far from my area of expertise but I refer you to “Tax credits and incentives for oil & gas producers in a low-price environment” in the *Journal of Multistate Taxation and Incentives*

# Marginal wells are the dominant type of well in the US, by far




79% of oil wells are marginal but only account for 7% of national oil production

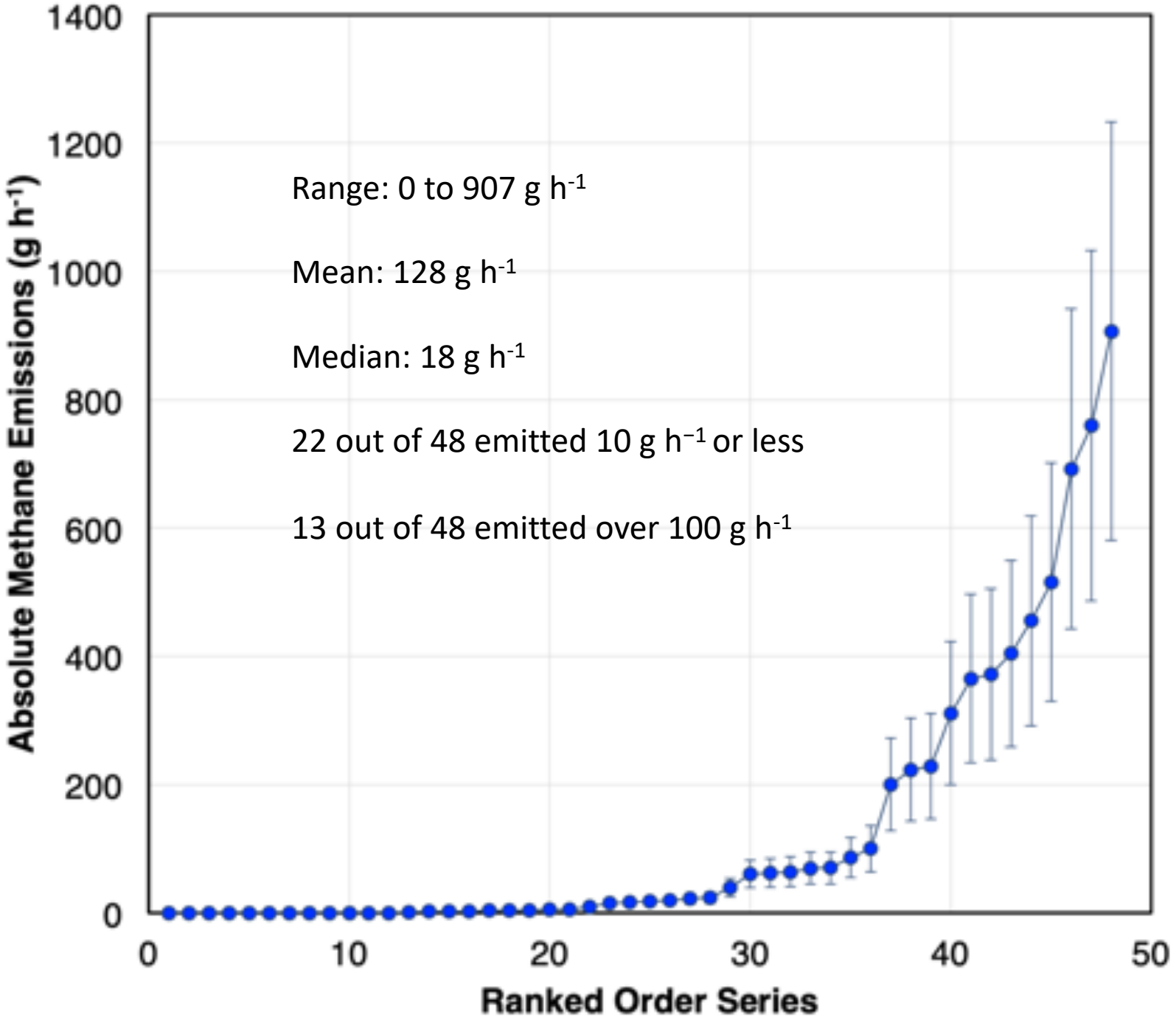
78% of gas wells are marginal, accounting for 7.5% of gas production

Source: U.S. Energy Information Administration
Note: BOE = barrel of oil equivalent.

https://www.eia.gov/petroleum/wells/

# Our study area: Appalachian Basin, Ohio

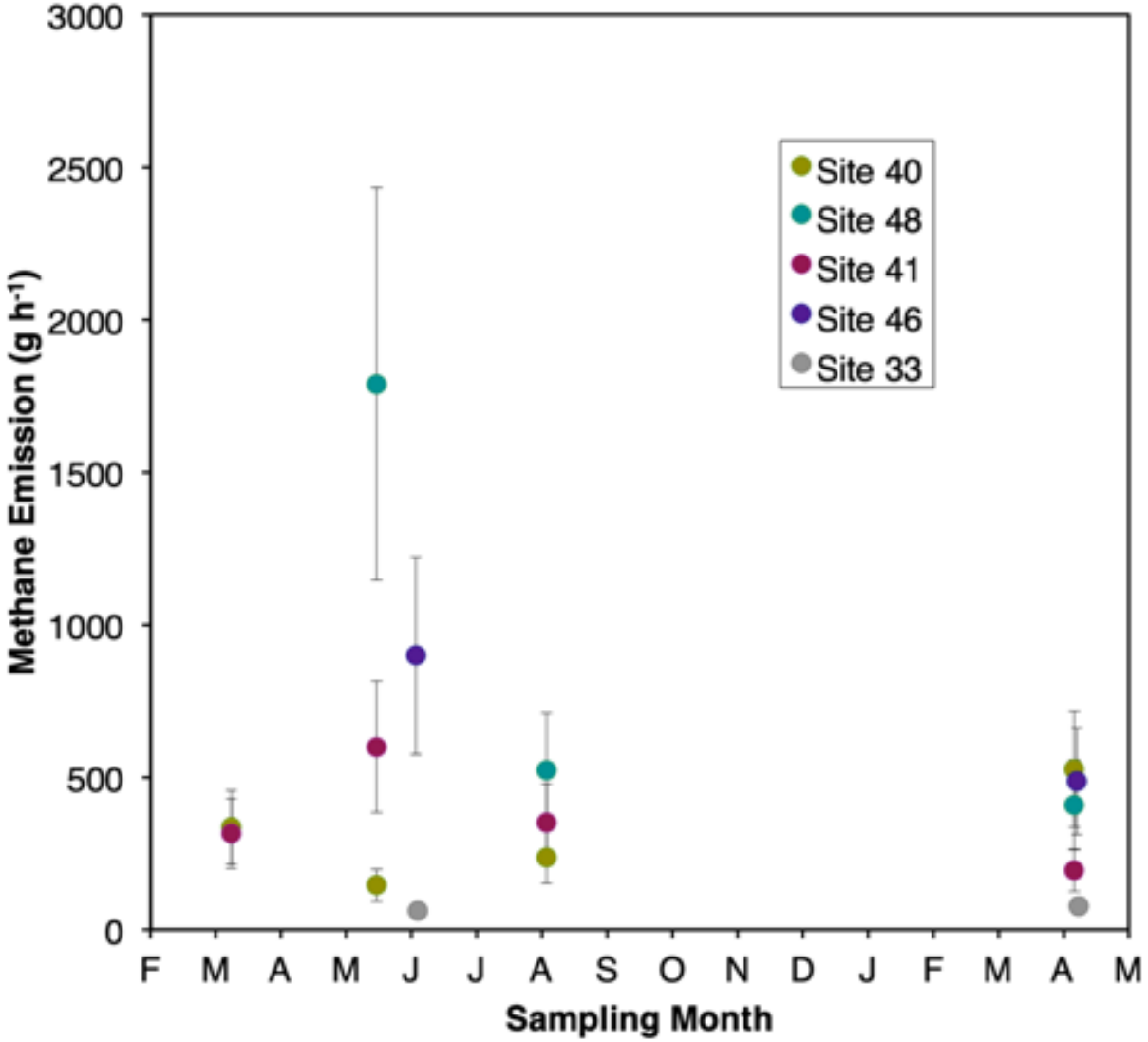
- In Ohio, 99% of oil wells are marginal, but they produce only 15% of annual oil production. 91% of gas wells are marginal but they produce 1.4% of annual gas production in the state.
- We made measurements of methane emissions at the component level (high flow sampler) from 48 oil and gas wells on public land. All were marginal wells producing 0-1 barrels of oil equivalent per day. This is the largest category of marginal wells in the state and in the country.




- Some gas wells are venting more than 100% production (indicating production numbers are wrong or less than what is being lost)
- All oil wells are venting all produced gas

- If we apply this emission factor to all wells in the US **JUST** in the 0-1 BOE category, it equates to 10% of $CH_4$ from O&G production in the EPA inventory (they produce less than 0.5% of US oil and gas)

# Are these emissions episodic?  Appears not




Measurements over two years at five of our highest emitting sites indicate that these emissions are not episodic, although there is some variability

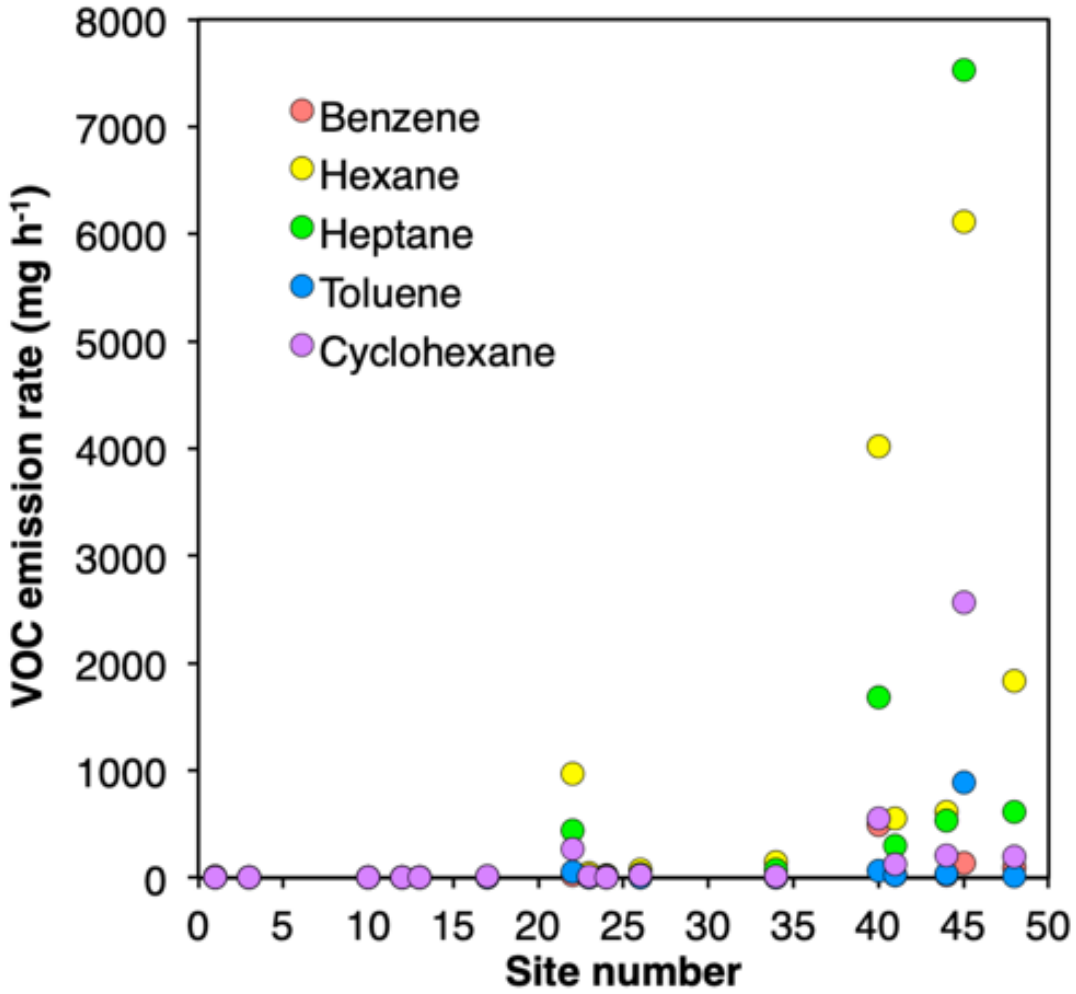
# Omara et al, 2016

- Pennsylvania and West Virginia
- Reported gas production only, but all wells were marginal (less than 90 thousand scf per day)
- Average emissions 820 g/hr
- Percent loss ranged from 0.35 to 91%

# How do marginal well emissions (~128 g/h) compare to high producing sites?

- Hard to compare, because most measurements are from sites that are producing gas to pipelines, not venting.  A few examples:
- Omara et al. 2016, Marcellus, downwind tracer
  - 18,800 g/hr
- Rella et al. 2015, Barnett, flux plane
  - 630 g/hr
- Brantley et al. 2014, OTM 33A
  - Barnett: 1,200 g/hr
  - Denver-Julesburg: 504 g/hr
  - Pinedale: 2,124 g/hr
- Unplugged abandoned wells
  - Nationwide: 10 g/hr
  - Appalachia: 28 g/hr

# Marginal wells are a small but consistent source of air toxics




Heptane and hexane were the dominant VOCs emitted

Stripper wells are famously located in urban Los Angeles, where VOCs and $CH_4$ contribute to ozone formation

If these wells are located in residential areas, they can contribute to poor health outcomes

Also high risk for workers if wells are venting

- Stripper well emissions measured in this study, in the 0-1 BOE production category, did not correlate with production rate
- We used the average emission rate (128 g $hr^{-1}$) and the national activity factor (336,012) to estimate national emissions for wells in this category (0.4 Tg $yr^{-1}$). (for 2018)
- This is about 11% of $CH_4$ emissions from oil and gas in the EPA GHG inventory
  - Remember these wells produce less than 0.5% of our national oil and gas

# Thanks so much!

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