Revision Under Consideration for the 2018 GHGI: Abandoned Wells

Stakeholder Workshop

June 22, 2017

OVERVIEW

- Available emissions data
- Available activity data
- Preliminary CH_4 emissions estimates
- Requests for stakeholder feedback

AVAILABLE EMISSIONS DATA

RECENT DIRECT MEASUREMENT STUDIES

- Kang et al. 2014
  - 19 wells in Pennsylvania
- Kang et al. 2016
  - Additional measurements of 88 wells in Pennsylvania to fill data gaps from the earlier study
- Townsend-Small et al. 2016
  - 138 wells in the Powder River Basin (WY), Denver-Julesburg Basin (CO), Uintah Basin (UT), and Appalachian Basin (OH)

KANG, ET AL. 2016

- Significantly different emissions levels observed for: well type (gas versus oil or co-producing), plugging status (plugged versus unplugged), and coal area designation

Well production type and coal area designation	Number of Measured Wells		Mean (g/hour/well)	
	Unplugged	Plugged	Unplugged	Plugged
All production types				
All	53	35	22	1.5[a]
Coal	17	12	1.2	43
Noncoal	36	23	31	0.45
Oil and combined oil and gas production				
All	34	13	0.19	0.33
Coal	13	1	0.000011	0.000012
Noncoal	21	12	0.31	0.36
Gas production				
All	19	22	60	24
Coal	4	11	5.2	47[b]
Noncoal	15	11	75	0.54

a - Corrected from value originally published in journal article, based on conversation with author.
b - The measured plugged wells in coal areas are vented as required by regulations.

TOWNSEND-SMALL, ET AL. 2016

- Significantly different emissions levels observed for: plugging status (plugged versus unplugged), and eastern vs. western U.S.

Well type	Number of Measured Wells		Mean (g/hour/well)	
	Unplugged	Plugged	Unplugged	Plugged
Entire U.S.	19	119	10.02	0.002
Eastern	6	6	28.01	0
Western	13	113	1.71	0.002

AVAILABLE ACTIVITY DATA

TOTAL ABANDONED WELLS ACTIVITY DATA

- Approach 1: Use DrillingInfo data set to count number of wells existing but no longer reporting production as of [year].
  - Analyze LAST_PROD_DATE

- Approach 2: Use EIA or other data set to count cumulative number of wells drilled; subtract active wells as of [year].
  - EIA well drilling data not maintained after 2011

TOTAL ABANDONED WELLS ACTIVTY DATA (cont.)

- For either approach (DrillingInfo- or EIA-based), data sets are not historically complete (before mid-1900s).
- *The Derrick's Handbook of Petroleum* and USGS *Mineral Resources of the United States Annual Yearbooks* provide counts of wells (oil/gas/dry) drilled and producing, by state and year from late 1800s forward.
- For the DrillingInfo approach, EPA developed a correction factor of 1.2 million wells by analyzing year 1975 data.
  - 1.93 million abandoned wells existed in the U.S. based on historical records: 2.56 million wells (oil, gas, or dry) had been drilled by 1975. 630,000 oil and gas wells were operating in 1975.
  - 764,000 wells in the DrillingInfo database would be counted as abandoned (had stopped reporting production at least one year prior to 1975, or been spud/completed at least one year prior and never reported production).

PLUGGING STATUS ACTIVITY FACTOR

- If EPA uses separate EFs for plugged vs. unplugged status, a split between the two populations is needed for the 1990–2016 time series.
  - DrillingInfo provides a snapshot of the "status" of all wells. For this example, 69% of wells are unplugged in 2016.

Status Code	Number of Wells (millions)	Percent of All Wells	Example Assigned Plugging Status
INACTIVE	1.5	42	Unplugged[a]
ACTIVE	0.9	27	n/a
P&A (plugged and abandoned)	0.7	20	Plugged
DRY	0.1	3	Unplugged[a]
ACTIVE INJ (active injection)	0.07	2	n/a
ABANDONED	0.03	1	Unplugged[a]
EXPIRED PERMIT	0.03	1	n/a
SHUT IN	0.02	1	Unplugged[a]
PLUGGED	0.02	1	Plugged
All other codes	0.1	1	-

a -EPA seeks stakeholder feedback on assigning as plugged or unplugged.

  - Assume 100% unplugged status for wells in a certain early year—e.g., 1950—based on historical literature documenting effectiveness of plugging approaches over time (NPC 2011).
  - Interpolate to develop plugged vs. unplugged split each year 1950–2016.

PRELIMINARY ACTIVITY DATA

Year	Abandoned Well Count (millions)			Plugging Status (%)	
	Total	Gas	Oil	Unplugged	Plugged
1990	2.35	0.32	2.04	81	19
1995	2.50	0.35	2.16	79	21
2000	2.65	0.37	2.28	77	23
2005	2.77	0.40	2.37	74	26
2010	2.89	0.44	2.45	72	28
2015	3.06	0.52	2.54	70	30
2016	3.12	0.55	2.57	69	31

PRELIMINARY CH_4 EMISSIONS ESTIMATES

Preliminary CH_4 Emissions Estimates

- National-level Townsend-Small EFs for plugged wells (0.002 g/hour/well) and unplugged wells (10.02 g/hour/well)
- DrillingInfo analysis for activity data (supplemented by historical data correction factor)
- Preliminary plugged/unplugged split approach
- Estimated CH_4 emissions (year 2015):

Source Category	CH_4 Emissions ($MMT\ CO_2e$)	% of Production Emissions
Natural Gas	0.8	<1%
Petroleum	3.9	10%

REQUESTS FOR STAKEHOLDER FEEDBACK

Requests for Stakeholder Feedback (Refer to EPA memo for details)

1. Are additional data sources available to estimate emission factors for abandoned wells?
2. What subcategories of abandoned wells should be represented in the GHGI (taking into account data availability and differences between emissions rates for subcategories)?
3. What additional data sources or methods are available to estimate the total population of wells abandoned prior to 1990 (considering that the production phase of many such wells likely pre-dates DrillingInfo coverage)?
4. What additional data sources are available, and what alternate methodologies might be appropriate, to estimate the total population of abandoned wells existing in each year of the time series (1990–2016)?
5. Additional data sources and methodologies to estimate the split between plugged and unplugged wells existing in each year of the time series (1990–2016)?

Requests for Stakeholder Feedback (Refer to EPA memo for details) – cont.

6. What year (e.g., 1950) might be appropriate to assume that zero percent of existing abandoned wells were effectively plugged (such an estimate would serve as a tie point for use in interpolation to develop plugged versus unplugged activity factors)?
7. Are there any additional ongoing or planned studies related to abandoned wells that could be used to refine future GHGIs?
8. Are data sources available to estimate emission factors for related derelict infrastructure (e.g., flow lines)?