

DRAFT MEMORANDUM

Date: **July 28, 2021**

To: **Tom Moore, WESTAR-WRAP**

From: **John Grant, Rajashi Parikh and Amnon Bar-Ilan**

Subject: **O&G Activity Forecasts Developed for the Western Regional Air Partnership (WRAP) Region and Items for the Energy Information Administration (EIA) to Consider for the September National Oil and Gas (O&G) Emission Committee (NOGEC) Meeting Presentation**

WRAP O&G EMISSION INVENTORY FORECASTS FOR USE IN AIR QUALITY PLANNING

In collaboration with the Western States Air Resources Council-Western Regional Air Partnership (WESTAR-WRAP), Ramboll has prepared several future year O&G emission inventories as part of the studies listed below.

- Phase III Oil and Gas Emission Inventory Project¹
- Intermountain West Data Warehouse - Western Air Quality Study (IWDW-WAQS)²
- O&G Emissions Inventory Project: ND-SD-MT Williston and MT North Central (Great Plains) Basins^{3,4,5}
- San Juan & Permian Basins' O&G Emission Inventory Project^{6,7}
- Oil & Gas Work Group (OGWG) Future Year Emission Inventories^{8,9}

Ramboll developed O&G activity forecasts in collaboration with WESTAR-WRAP and state and tribal agencies for use in the above emission inventory and air quality studies based mainly on historical O&G activity trends. To develop historical O&G activity trends, first Ramboll obtained historical O&G activity data for several activity metrics (i.e., spud count, active well count, oil production, and gas production) by O&G basin or sub-basin from IHS Enerdeq. Then Ramboll projected O&G activity trendlines from recent historical years to a future year. The basis of the IHS Enerdeq¹⁰ database is each state's Oil and Gas Conservation Commission (OGCC), or equivalent agency. For each basin or sub-basin, Ramboll developed O&G activity forecasts based on recent historical O&G activity trends by well type (oil, gas, and coalbed methane [CBM]) and, in the recent OGWG Future Year

¹ <https://www.wrapair2.org/phaseiii.aspx>

² <https://views.cira.colostate.edu/tsdw/>

³ "Development of Baseline 2011 and Future Year 2015 Emissions from Oil and Gas Activity in the Great Plains Basin", <https://www.wrapair2.org/ND-SD-MT.aspx>

⁴ "Development of Baseline 2011 and Future Year 2015 Emissions from Oil and Gas Activity in the Williston Basin", https://www.wrapair2.org/pdf/2011_2015_Williston_Basin_14Aug2014.pdf

⁵ https://www.wrapair2.org/pdf/2011_2015_GreatPlains_Basin_14Aug2014.pdf

⁶ <https://www.wrapair2.org/SanJuanPermian.aspx>

⁷ "Future Year 2028 Emissions from Oil and Gas Activity in the Greater San Juan Basin and Permian Basin", https://www.wrapair2.org/pdf/SanJuan_Permian_Futureyear_EI_Report_21Aug2018.pdf

⁸ <https://www.wrapair2.org/ogwg.aspx>

⁹ "Revised Final Report: 2028 Future Year Oil and Gas Emission Inventory for WESTAR-WRAP States - Scenario #1: Continuation Of Historical Trends", https://www.wrapair2.org/pdf/WRAP_OGWG_2028_OTB_RevFinalReport_05March2020.pdf

¹⁰ <https://ihsmarket.com/products/oil-gas-tools-enerdeq-browser.html>

Emission Inventories, by spud type (vertical, directional, horizontal). The process by which Ramboll developed O&G activity forecasts is summarized, graphically, in Figure 1 below.

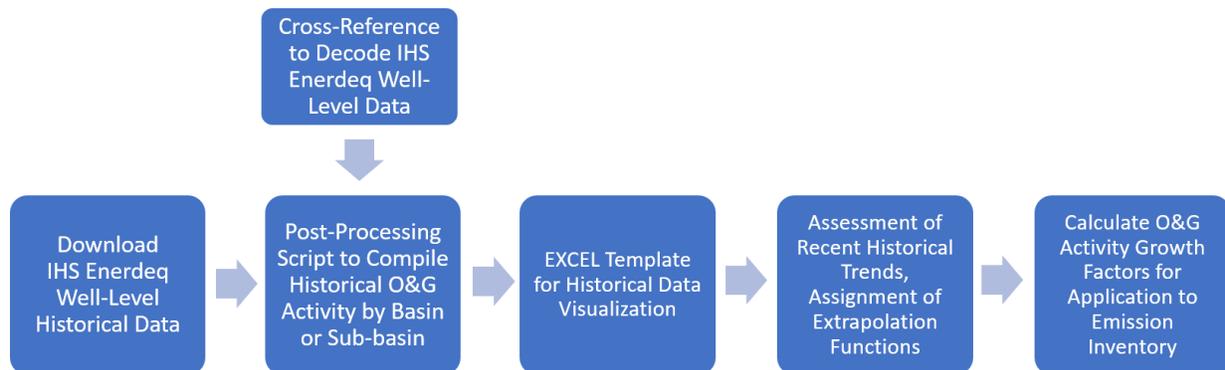


Figure 1. Process by which Ramboll develops O&G activity forecasts for WESTAR-WRAP studies.

Based on the historical trends, Ramboll forecasted O&G activity to near-term future years, approximately five years into the future. Forecasts have not been made to further future years because of the expectation that historical trends become a less reliable predictor of future activity for longer forecast periods. In the recent OGWG Future Year Emission Inventory, O&G activity data were forecast for three scenarios low (“Declined Vertical Wells” scenario), medium (“Continuation of Historical Trends” scenario) and high (“Increased Horizontal Wells” scenario) to capture a range of emissions that could reasonably be expected to occur under different O&G activity forecasts.

All wells require long term maintenance (e.g., refracturing, recompletion); data have not been readily available to estimate future changes to maintenance-related emissions. Therefore, forecasts to-date have not assessed future changes to maintenance-related emissions. Metered gas production does not include gas-phase losses upstream of the gas meter that result from the separation process, fugitive components, or other emission sources. As is typical in O&G activity forecasts, the effect of changes to gas production in gas losses upstream of the gas meter are also not considered.

Any future forecast of O&G activity is speculative. Future O&G development (i.e. drilling and midstream buildouts) and future management of existing O&G well sites and midstream facilities are dependent on the choices made by several individual operators in a given basin. In general, O&G development is dependent on both economics (e.g., cost of drilling and estimated revenue from natural gas and/or oil production) and regulatory decisions (e.g., permit issuance, National Environmental Policy Act [NEPA] approval). Wellsite and midstream facility operation decisions are similarly dependent on economics (e.g., production revenue and maintenance costs) and regulatory decisions (e.g., continued permit issuance).

To illustrate forecast methodology that Ramboll applied for WESTAR-WRAP studies, Permian Basin forecast methods (summarized below) and charts (see Figure 2) from Grant et al. (2020⁹) are included below.

- **Oil Production:** Continued steady increase in oil production from horizontal wells based on application of a 2014-2017 four-year linear forecast. Vertical and directional well oil production was assumed unchanged from estimates for the most recent historical year.
- **Condensate Production:** Continued steady increase in condensate production from horizontal wells based on application of a 2015-2017 three-year linear forecast. Vertical and directional well condensate production was assumed unchanged from estimates for the most recent historical year.
- **Associated Gas Production:** Continued increase in associated gas production from horizontal wells was estimated based on a five-year 2013-2017 linear forecast. Vertical and directional well associated gas production was assumed unchanged from estimates for the most recent historical year.
- **Primary Gas Production:** Primary gas production from horizontal wells was assumed to increase based on the linear trend over the three-year 2015-2017 period. Primary gas production from vertical and directional wells was assumed unchanged from estimates for the most historical recent year.
- **Oil Well Count:** Continued increases in horizontal oil well counts based on a five-year 2013-2017 linear forecast. Continued steady decline in vertical oil well counts based on application of a five-year 2013-2017 linear forecast. Directional oil well counts were assumed unchanged from the estimate for the most historical recent year.
- **Gas Well Count:** Continued steady decline in vertical gas well counts based on application of a five-year 2013-2017 linear forecast. Continued steady increase in horizontal gas well counts based on application of five-year 2013-2017 linear forecast. Directional gas well counts were assumed unchanged from the estimate for the most recent historical year.
- **Spud Count:** Horizontal spud count was estimated as the average spudding activity over the five-year 2013-2017 period. Vertical and directional well spud count were assumed unchanged from estimates for the most historical recent year.

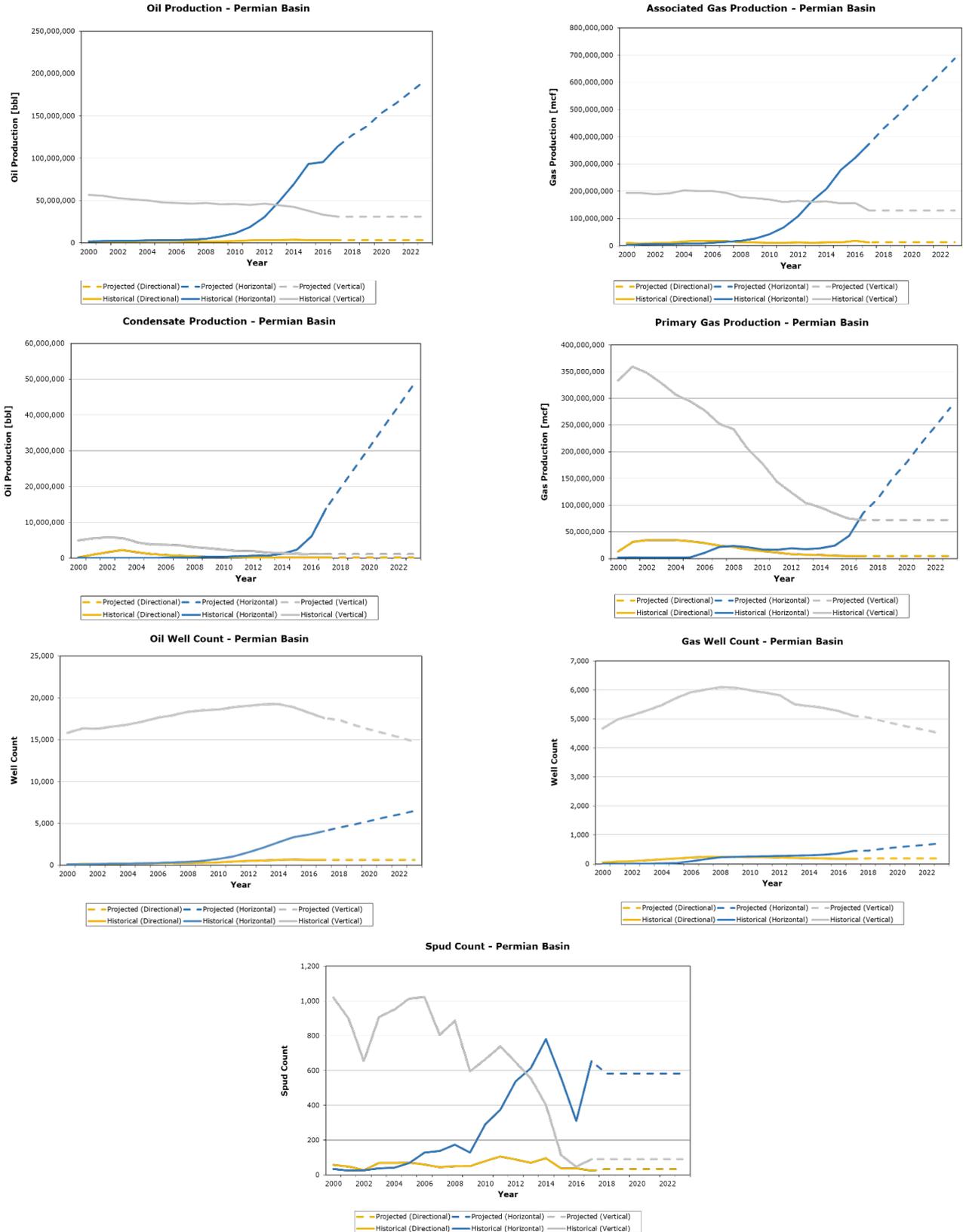
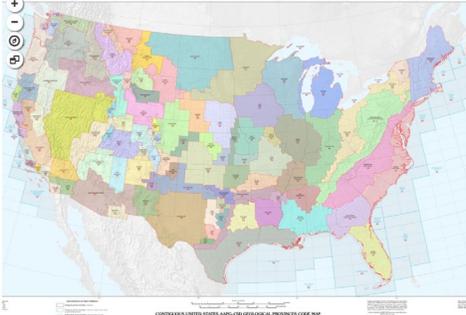


Figure 2. Permian Basin (New Mexico portion only) historical and forecast O&G activity by well type and spud type (Grant et al., 2020⁹).

EIA Annual Energy Outlook (AEO) O&G activity forecasts have also been used to develop future year regional and national O&G emission inventories. Table 1 summarizes some of the key differences between historical trends-based and EIA AEO O&G activity forecasts.

Table 1. Summary of key differences between historical trends-based and EIA AEO O&G activity forecasts.

Parameter	Historical Trends	EIA AEO
Purpose	To forecast emissions during specific time frames for use in air quality planning	"Outlook for energy markets through 2050" ¹¹
Forecast Basis	Recent historical trends	Economic evaluation and other factors ^{12,13}
Geographic region	Basin or sub-basin ¹⁴ 	Multi-state Oil and Gas Supply Module regions ¹⁵ 
Forecast Data Availability	<p>Oil Wells</p> <ul style="list-style-type: none"> Oil production* Associated gas production* Active Oil Well Count* <p>Gas Wells</p> <ul style="list-style-type: none"> Condensate production* Primary gas production* Active Gas Well Count* <p>Coalbed Methane Wells</p> <ul style="list-style-type: none"> Natural gas production* Active Gas Well Count* <p>All Wells</p> <ul style="list-style-type: none"> Spud Count* 	<ul style="list-style-type: none"> Oil production Gas production
Example Reference Documents	<ul style="list-style-type: none"> "Revised Final Report: 2028 Future Year Oil and Gas Emission Inventory for WESTAR-WRAP States - Scenario #1: Continuation Of Historical Trends"⁹ "Future Year 2028 Emissions from Oil and Gas Activity in the Greater San Juan Basin and Permian Basin"⁷ "Development of Baseline 2011 and Future Year 2015 Emissions from Oil and Gas Activity in the Williston Basin"⁴ 	<ul style="list-style-type: none"> "Assumptions to AEO2021: Oil and Gas Supply Module"¹⁶ "Oil and Gas Supply Module of the National Energy Modeling System: Model Documentation 2020"¹³

* O&G activity forecasts available with spud type detail (vertical, horizontal, directional) in recent WRAP OGWG forecasts⁹

¹¹ <https://www.eia.gov/outlooks/aeo/>

¹² EIA, 2020. "Oil and Gas Supply Module of the National Energy Modeling System: Model Documentation 2020".
[https://www.eia.gov/outlooks/aeo/nems/documentation/ogsm/pdf/m063\(2020\).pdf](https://www.eia.gov/outlooks/aeo/nems/documentation/ogsm/pdf/m063(2020).pdf)

¹³ Excerpt from EIA (2020): "The [Onshore Lower 48 Oil and Gas Supply Submodule] OLOGSS projects the annual crude oil and natural gas production from existing fields, reserves growth, and exploration. It performs economic evaluation of the projects and ranks the reserves growth and exploration projects for development in a way designed to mimic the way decisions are made by the oil and natural gas industry. Development decisions and project selection depend upon economic viability and the competition for capital, drilling, and other available development constraints. Finally, the model aggregates production and drilling statistics using geographical and resource categories."

¹⁴ Consistent with EPA GHGRP. Map excerpted from AAPG Geologic Provinces: <https://ngmdb.usgs.gov/Geolex/stratres/provinces>

¹⁵ Map Excerpted from EIA, 2021. "U.S. Energy Information Administration, Assumptions to the Annual Energy Outlook 2021: Oil and Gas Supply Module"
<https://www.eia.gov/outlooks/aeo/assumptions/pdf/oilgas.pdf>

¹⁶ EIA (2021). <https://www.eia.gov/outlooks/aeo/assumptions/pdf/oilgas.pdf>

FOR EIA CONSIDERATION

Above, we have summarized the process by which Ramboll develops O&G activity forecasts in collaboration with WESTAR-WRAP and Agency stakeholders for use in developing Intermountain West future year O&G emission inventories. If feasible, at the September, 2021 National Oil and Gas Emission Committee meeting, EIA should present one or more examples that describe basin-level O&G activity forecasts from a recent AEO. We would suggest the following basins be considered for presentation: Permian Basin, Williston Basin, and Powder River Basin. Below are several specific questions to consider answering during presentation of example forecasts.

- **Geographic resolution (general):** AEO forecasts are only available for multi-state areas (supply regions) and, if requested, for select plays. Why are forecasts not available at a more granular level such as by state/basin, consistent with Environmental Protection Agency (EPA) Greenhouse Gas Reporting Protocol (GHGRP) basin (or similar) definitions¹⁷? State-¹⁸ or basin-level forecasts are often more applicable for air quality planning and basin-level (or more granular) dynamics often have unique growth/decline patterns.
- **Geographic resolution (future additional wells):** At what level does EIA track future production; i.e., at what level of geographic resolution is new production assigned? We note that certain states track emissions from individual wells for regulatory purposes.
- **Time-scales:** Considering that annual forecasts are available through 2050 from the latest AEO, to what extent are forecasts more certain for near future years (e.g., 5 years out) and less certain for farther future years (e.g., 25 years out)?
- **Trends:** In the WRAP region, trends analysis has been a basis for estimating future O&G activity trends out to about 5 years. How do AEO forecasts differ from a trends analysis over that time frame and are AEO forecasts expected to be more/less accurate?
- **Conventional/unconventional production:** How does AEO account for O&G drilling and production for conventional and unconventional wells in their forecasts for a basin?
- **Decline curves:** How are decline curves used in AEO forecasts? What is the basis of decline curves that are used? To what extent are the decline curves specific to a given basin, well-type, and/or play?
- **O&G activity for drilling, completions, and active wells:** The AEO includes crude oil and natural gas production forecasts; however, upstream O&G emissions for several source categories are more closely related to other O&G activity metrics such as:
 - Spuds/wells drilled (e.g., drill rigs emissions)
 - Completions (e.g., hydraulic fracturing, completion venting/flaring emissions)
 - Active well counts (e.g., pneumatic controllers, fugitive components emissions)
 Does EIA have data that could be used to provide additional metrics with their O&G activity forecasts (i.e., spuds/completions, active well counts).
- **O&G production resolution:** The AEO publishes total crude oil and natural gas production forecasts. O&G production dynamics are affected by parameters such well type (oil, gas, and CBM), spud type (vertical, horizontal, or directional), and regulation regime (e.g., under tribal jurisdiction or state jurisdiction¹⁹). Each well's historical production is typically monitored by a state OGCC or equivalent. Does EIA have data

¹⁷ <https://ngmdb.usgs.gov/Geolex/stratres/provinces>

¹⁸ A basin may overlap multiple states with different regulatory regimes (e.g., Williston Basin is spreads across portions of North Dakota, Montana, and South Dakota).

¹⁹ Tribal areas regulations tend to be limited to Federal requirements.

that could be used to refine AEO O&G activity forecasts with additional levels of detail (e.g., well type, spud type, regulatory jurisdiction)?

- **Historical vs. future wells:** One source of uncertainty in O&G activity forecasts is how fast new wells will be drilled. Does EIA have information that could be used to distinguish future year O&G activity from historically-drilled wells versus future year O&G activity from wells anticipated to be drilled in the future? Such activity distinctions could allow us to identify emissions from historical wells in a given future year separate from activity from wells to be drilled in the future. This could be useful for identifying uncertainty and, if applicable, establishing different emission control regimes for historical and future wells.
- **O&G source controls:** Are AEO forecasts sensitive to upstream O&G regulations? For example, would the AEO forecast change if new regulations are promulgated in an area with substantial production (e.g., recent proposed rules in New Mexico²⁰ and recent revisions to Colorado Regulation 7²¹)?
- **National Environmental Policy Act (NEPA):** Do AEO forecasts in the Intermountain West account for impacts to future O&G activity of the NEPA process-related resource management planning decisions?

²⁰ Ozone Attainment Initiative, <https://www.env.nm.gov/air-quality/o3-initiative/>

²¹ Regulation Number 7: Control of Ozone via Ozone Precursors and Control of Hydrocarbons via Oil and Gas Emissions (Emissions of Volatile Organic Compounds and Nitrogen Oxides), https://drive.google.com/file/d/1sCtcjhhaexdE0_K-fvrFudg00vMuYis_/view?usp=sharing