Uinta Basin - Analyses on Emissions Data Sets to Improve 2014 Emission Inventory

US EPA 2017 International Emission Inventory Conference

8/15/17

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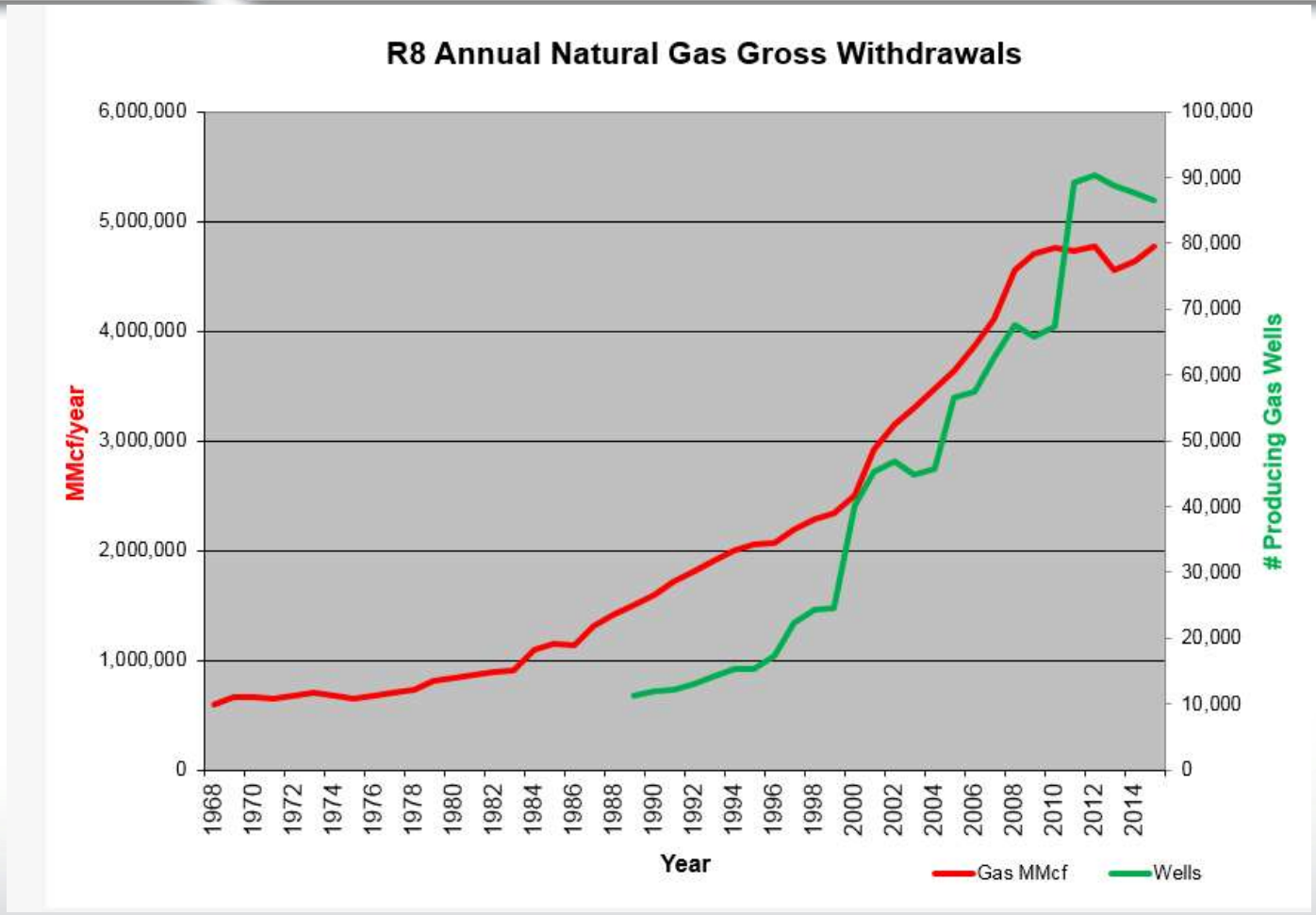
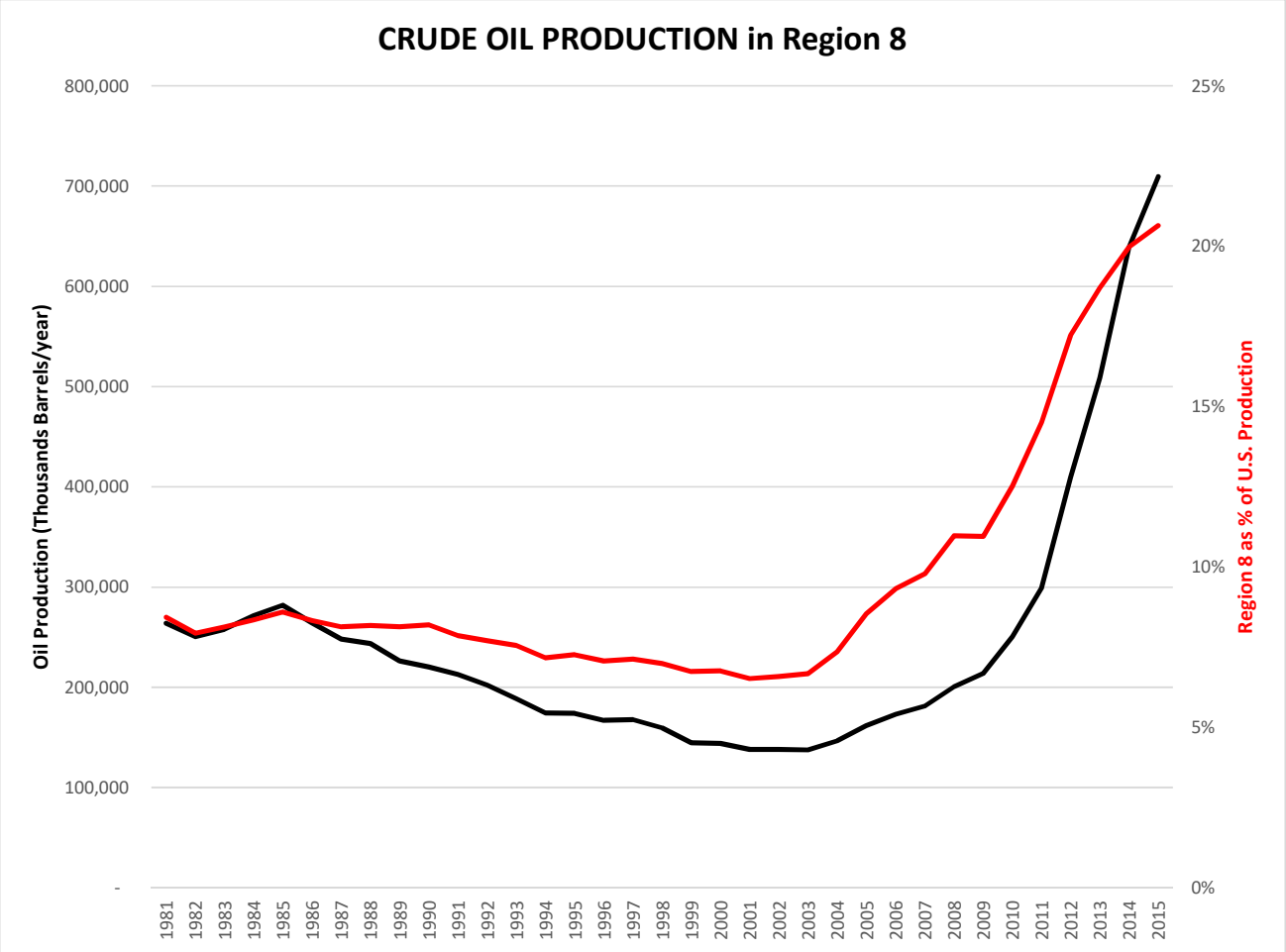
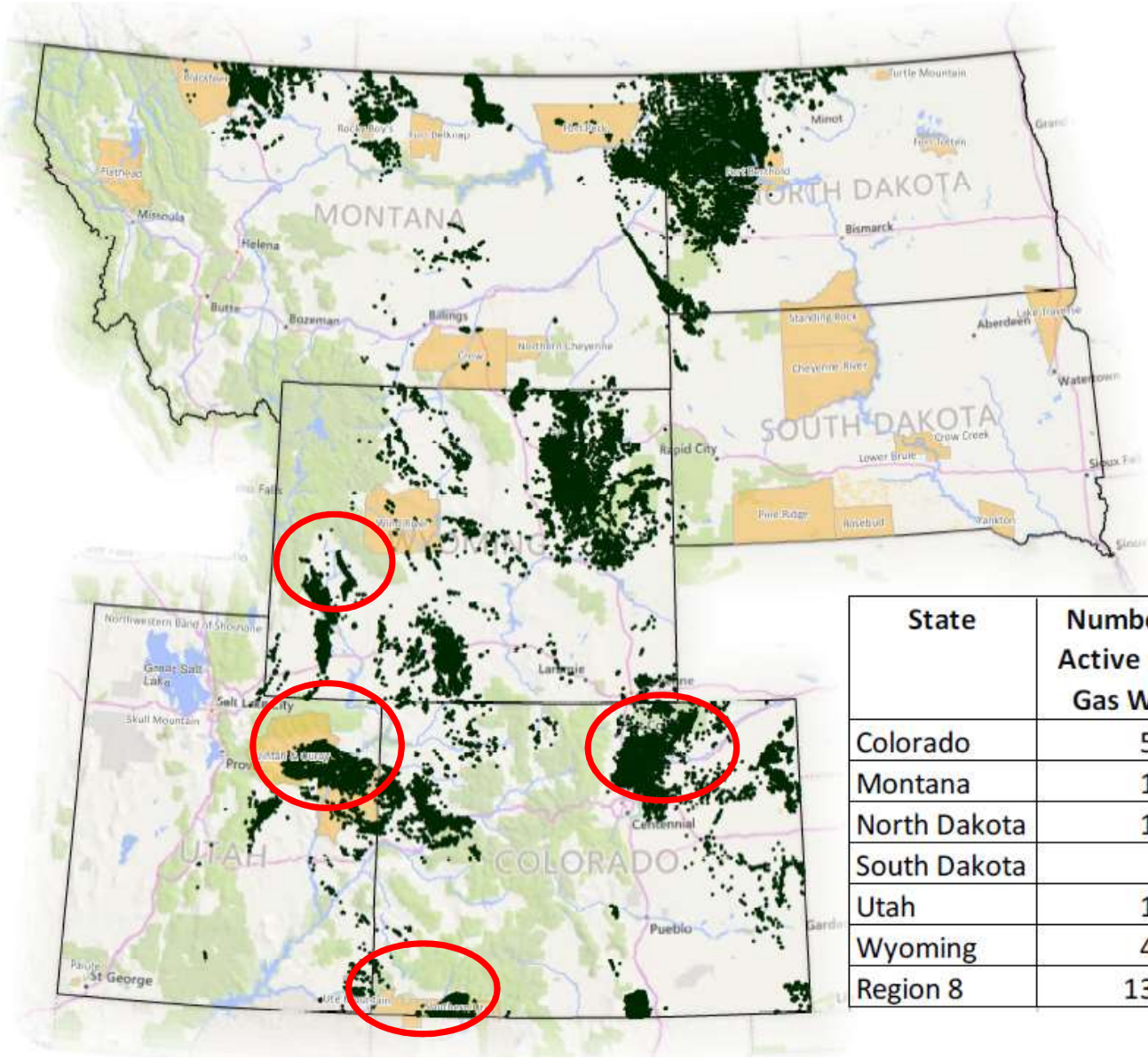
Energy Advisor

Rate of O&G Growth



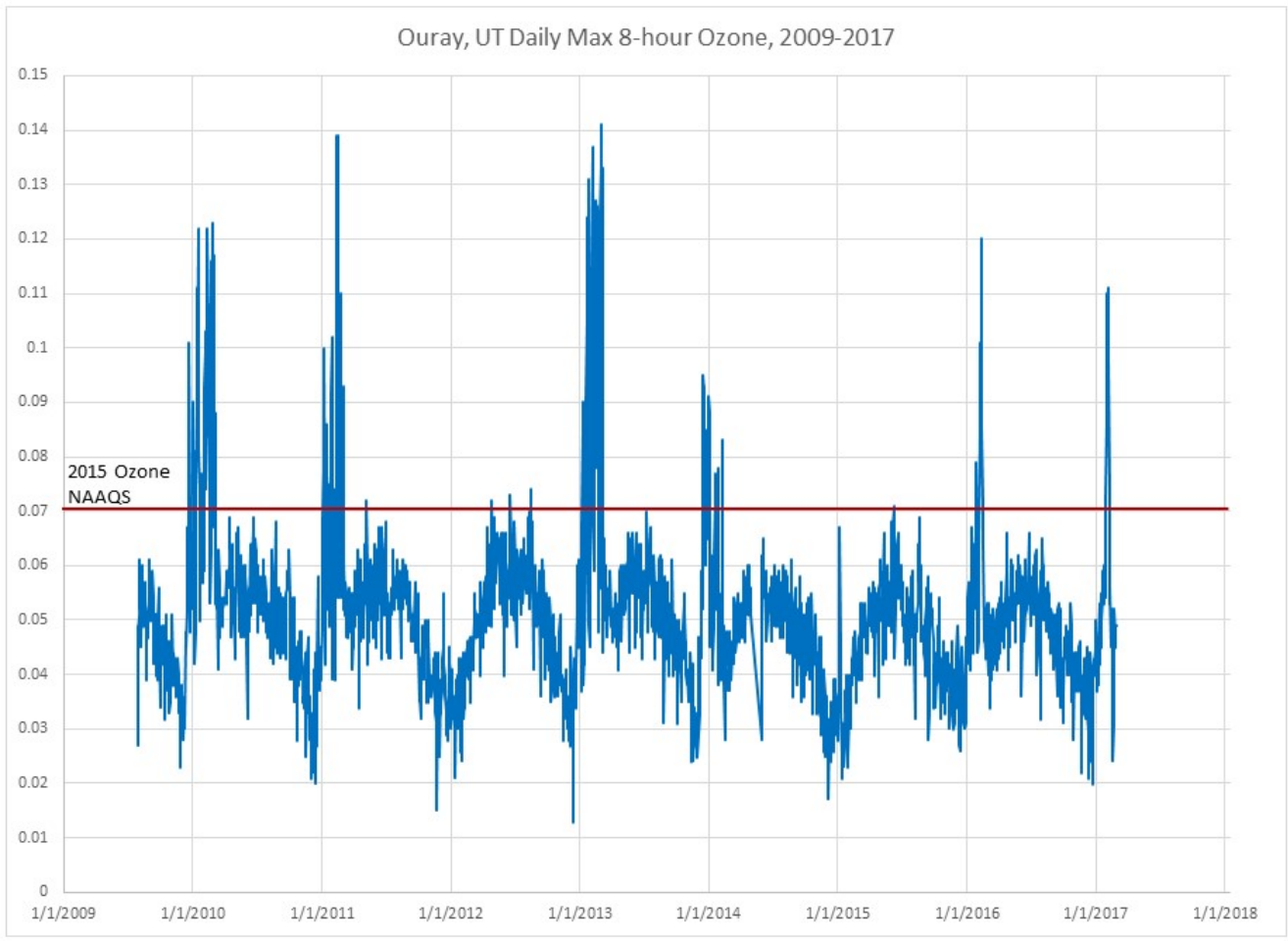
Rate of O&G Growth





State	Number of Active Oil & Gas Wells
Colorado	51,642
Montana	11,556
North Dakota	14,993
South Dakota	268
Utah	13,996
Wyoming	40,983
Region 8	133,438

Wintertime Ozone in the Uinta Basin



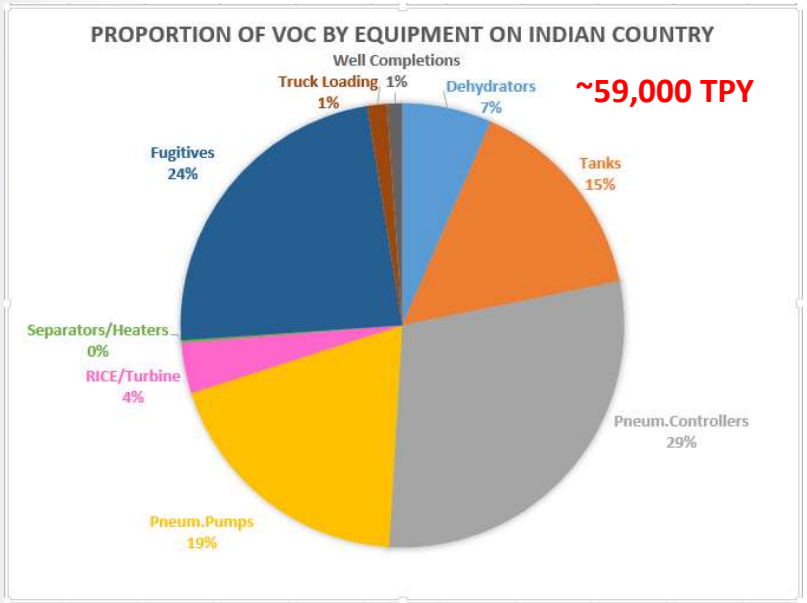
Emissions Comparative Analyses

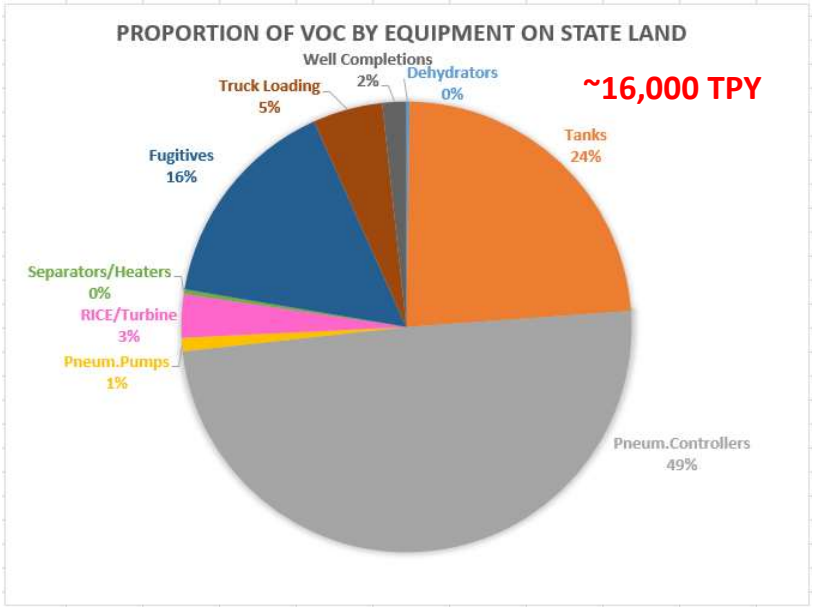
- In-depth analysis within the Uinta Basin Emission Inventory (UBEI)
  - Used R, a software environment for statistical computing and graphics
  - Compare by-operator (e.g. #PC/well, VOC lb/bbl, operating hours, glycol circ. rate, VOC wt% …)
  - Compare State land vs. Indian country
  - Screen for anomalies (e.g. negative values, zero emissions w/ oper. hours reported, etc.)

- In-depth comparative analysis between UBEI-Indian country vs. Tribal Minor Source Registrations
  - Focus on glycol dehydrators and tanks
  - UBEI 2014, Registrations 2011-2015
  - Normalized for production differences
  - Potential vs. actual – low % of dehyds/tanks controlled, operating hours

- In-depth comparative analysis between UBEI - State+Indian country vs. EPA Greenhouse Gas Reporting Program, subpart W (GHGRP-W)
  - Focus on pneumatic pumps and pneumatic controllers
  - UBEI 2014, GHGRP-W 2014

Approach - UBEI





Compare to U&O Registration data

- Dehyds
- Tanks

Compare to GHGRP-W data

- Pneum. Controllers
- Pneum. Pumps

Tribal Minor Source Registration Data

Emission Stream	Emission Source	Data Source	Data Use
"Raw" gas	• Fugitive leaks • Pneumatic controllers • Pneumatic Pumps	• Treater/separator gas • "Wet gas" stream input to GlyCALC	• Extended analyses - speciation
Tanks	• Condensate tanks • Oil tanks	• E&P TANKS output • GOR Flash Gas	• EF - lb VOC/barrel oil • EF - lb VOC/barrel cond • Extended analyses - speciation
Glycol Dehydrators	• Glycol Dehydrators – Regenerators/Still Vent	• GlyCALC output	• Extended analyses - speciation

19 Operators, 5243 Facilities, 5265 Registrations

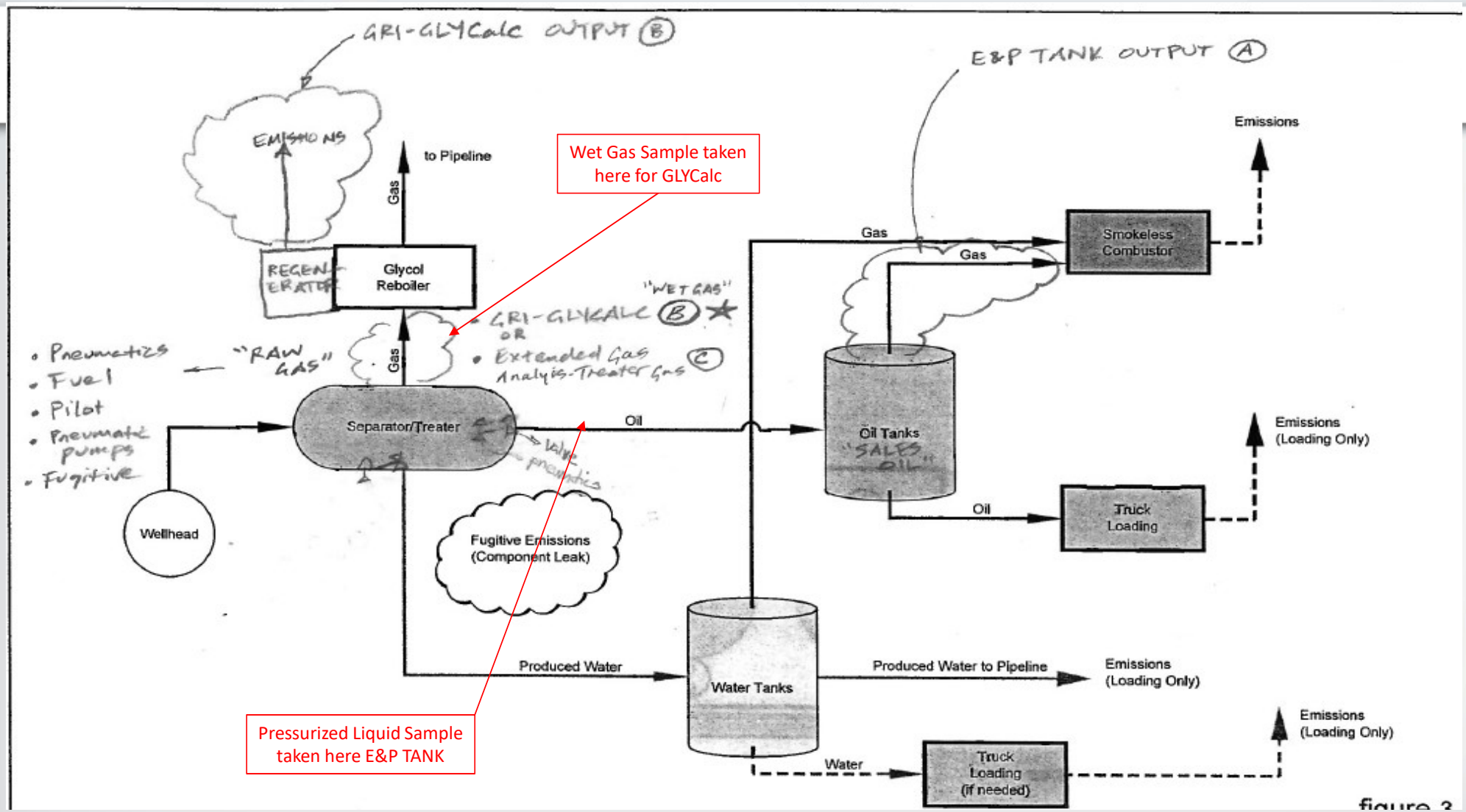

GRI-GLYCalc OUTPUT (B)
E&P TANK OUTPUT (A)
EMISSIONS
Emissions
to Pipeline
Gas
Wet Gas Sample taken here for GLYCalc
REGEN-ERATOR
Glycol Reboiler
"WET GAS"
GRI-GLYCALC (B) ★
OR
Extended Gas Analysis-Treater Gas (C)
Gas
Gas
Smokeless Combustor
Gas
• Pneumatics
• Fuel
• Pilot
• Pneumatic pumps
• Fugitive
"RAW GAS"
Separator/Treater
Oil
Oil Tanks "SALES OIL"
Emissions (Loading Only)
Oil
Truck Loading
Wellhead
Fugitive Emissions (Component Leak)
Produced Water
Water Tanks
Produced Water to Pipeline
Emissions (Loading Only)
Pressurized Liquid Sample taken here E&P TANK
Water
Truck Loading (if needed)
Emissions (Loading Only)

figure 3

TOG Condensate Tank Emission Profiles: values reported in weight %

Species	A	C	D	H	I	J	K	L	P	R
Methane	6.2997	26.4868	42.5441	13.0250	15.2277	18.8200	41.5324	15.5540	0.7173	12.5141
Ethane	11.2580	18.1956	18.1926	12.6239	24.9393	21.8901	21.2591	17.2700	5.1086	10.7620
Propane	26.8229	19.0308	11.9138	26.0258	31.2682	32.9904	17.4148	34.5372	30.5980	36.3504
Propylene	-	-	-	-	-	-	-	-	-	-
Isobutane (or 2-Methylpr	11.6633	7.7761	3.0643	9.8883	5.0718	7.8964	4.3806	9.8265	18.0008	10.1963
N-butane	18.6914	11.8718	4.0404	13.5358	11.7698	9.1849	6.2354	13.2771	22.4188	14.9828
Isopentane (or 2-Methyll	7.4490	4.7392	1.9953	7.4246	3.1223	3.7800	2.6155	3.6517	7.8238	5.0941
N-pentane	5.4619	3.7033	1.9751	5.5026	3.8963	2.4515	2.1749	2.7245	4.9544	4.0176
N-hexane	2.3255	1.3176	2.3995	4.0770	0.7668	0.4988	0.4274	0.5787	1.4481	1.2907
Isomers of pentane	-	-	-	-	-	-	-	-	-	-
Isomers of hexane	3.6207	1.8203	7.2618	1.2800	1.1982	0.9608	0.1958	0.9225	3.1309	1.6971
Isomers of heptane	3.8975	2.8853	4.5450	4.6626	1.6431	0.8830	1.6757	1.2016	3.4996	2.0047
Isomers of octane	1.5184	1.0730	0.6245	0.5906	0.2199	0.2168	1.1290	0.1425	1.3677	0.5657
Benzene	0.2076	0.2431	0.6298	0.5383	0.2493	0.1042	0.1344	0.0844	0.2276	0.2581
Toluene	0.3921	0.2763	0.5517	0.3972	0.2422	0.1524	0.4307	0.1068	0.3364	0.1565
Ethylbenzene	0.0231	0.0061	0.0040	0.0127	0.0091	-	0.0011	0.0038	0.0161	0.0000
Cumene	-	-	-	-	-	-	-	-	-	-
trimethylbenzene	-	-	-	-	-	-	-	-	-	-
M, O, & p-xylene	0.1384	0.1494	0.0444	0.1057	0.0881	0.0187	0.1602	0.0388	0.1218	0.0549
2,2,4-trimethylpentane	-	0.2	0.0	0.1	0.1	-	0.0	0.0374	0.0	-
C7	-	-	-	-	-	-	-	-	-	-
C8	-	-	-	-	-	-	-	-	-	-
C9	0.2306	0.2473	0.1583	0.1167	0.0661	0.0508	0.2268	0.0327	0.2078	0.0549
C10+	0.0000	0.0264	0.0081	0.0460	0.0071	0.0010	0.0056	0.0098	0.0201	0.0000
C-5 Cycloparaffins	-	-	-	-	-	-	-	-	-	-
C-6 Cycloparaffins	-	-	-	-	-	-	-	-	-	-
C-7 Cycloparaffins	-	-	-	-	-	-	-	-	-	-
C-8 Cycloparaffins	-	-	-	-	-	-	-	-	-	-
Unidentified	-	-	-	-	-	-	-	-	-	-
Total	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000
Total M,E	17.558	44.682	60.737	25.649	40.167	40.710	62.792	32.824	5.826	23.276
API Gravity Sales Oil	62.0	52.0	51.4	50.7	50.1	47.4	44.1	63.7	57.0	54.6

Speciation profiles for condensate tank emissions from E&P TANKS

TOG Glycol Dehydrator Profiles: values reported in weight %							
Species	D	H	J	K	L	O	Q
Methane	35.1081	70.2166	2.3921	5.1952	4.7237	7.0977	32.4064
Ethane	6.0119	4.6730	0.9287	1.0633	2.9450	2.1288	5.1459
Propane	5.5688	2.2560	1.0283	0.9727	3.9224	5.0649	6.0543
iso-butane	1.8251	1.1025	1.0107	0.4236	1.5972	1.6909	1.5343
n-butane	3.1199	1.0694	0.9905	0.6419	2.9889	5.0614	3.4084
iso-pentane	1.5603	0.7675	1.1281	0.4032	1.6175	2.0513	1.3302
n-pentane	1.5158	0.4858	0.6800	0.3854	1.4671	2.8849	1.8152
n-hexane	1.1044	0.3586	0.8094	1.0153	1.3915	2.3667	0.8794
isomers of pentane	-	-	-	-	-	-	-
isomers of hexane	1.2714	0.6131	1.4415	0.8268	1.4196	2.3253	1.4090
isomers of heptane	2.4693	0.8790	2.8676	2.8166	4.3165	5.6727	0.3634
isomers of octane	-	-	-	-	-	-	-
C-5 Compounds	-	-	-	-	-	-	-
C-6 Compounds	-	-	-	-	-	-	-
C-7 Compounds	-	-	-	-	-	-	-
C8+	7.9572	2.3245	10.6949	39.8952	16.8508	2.1291	10.5201
Benzene	4.6812	4.4616	35.7903	9.2118	8.7877	18.8657	7.7701
Isomers of propyl benzene	-	-	-	-	-	-	-
Isomers of butyl benzene	-	-	-	-	-	-	-
Toluene	12.0282	5.7070	29.1334	16.1865	22.1154	21.3574	13.2197
Cumene	-	-	-	-	-	-	-
1,2,4-trimethylbenzene	-	-	-	-	-	-	-
Ethyl-Benzene	0.5441	0.1968	0.7627	0.4152	0.7902	1.7069	2.5963
Xylenes	9.3590	3.1154	6.4650	14.1930	15.2746	6.5196	9.6954
224 Trimethylpentane	0.0928	0.0292	0.0644	0.0839	0.1378	0.2763	0.0230
C-5 cycloparaffins	-	-	-	-	-	-	-
C-6 cycloparaffins	2.0008	0.6167	1.0848	2.1937	3.9102	5.9079	0.9689
C-7 cycloparaffins	3.7817	1.1273	2.7274	4.0767	5.7438	6.8926	0.8601
Total	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000
Total M,E	41.1200	74.8896	3.3209	6.2585	7.6688	9.2265	37.5523

Speciation profiles for glycol dehydrator regenerator emissions from GRI-GLYCalc

>1800 uncontrolled glycol dehydrators!

Comparative Analysis Within UBEI

Started high-level … dug further into details to understand emissions

UDOGM vs. UBEI - 2014

	UDOGM		UBEI		GHGRP-W
	IC	State	IC	State	
#Wells	9,123	2,311	9,324	2,766	11,753
Oil Prod (MMbbls)	15.9	17.0	12.9	16.7	
Cond Prod (MMbbls)			3.0	0.1	
Gas Prod (Bcf)*	326.7	33.6	141.0	30.6	
Oil-Cond bbls/well	1,744	7,372	1,702	6,075	

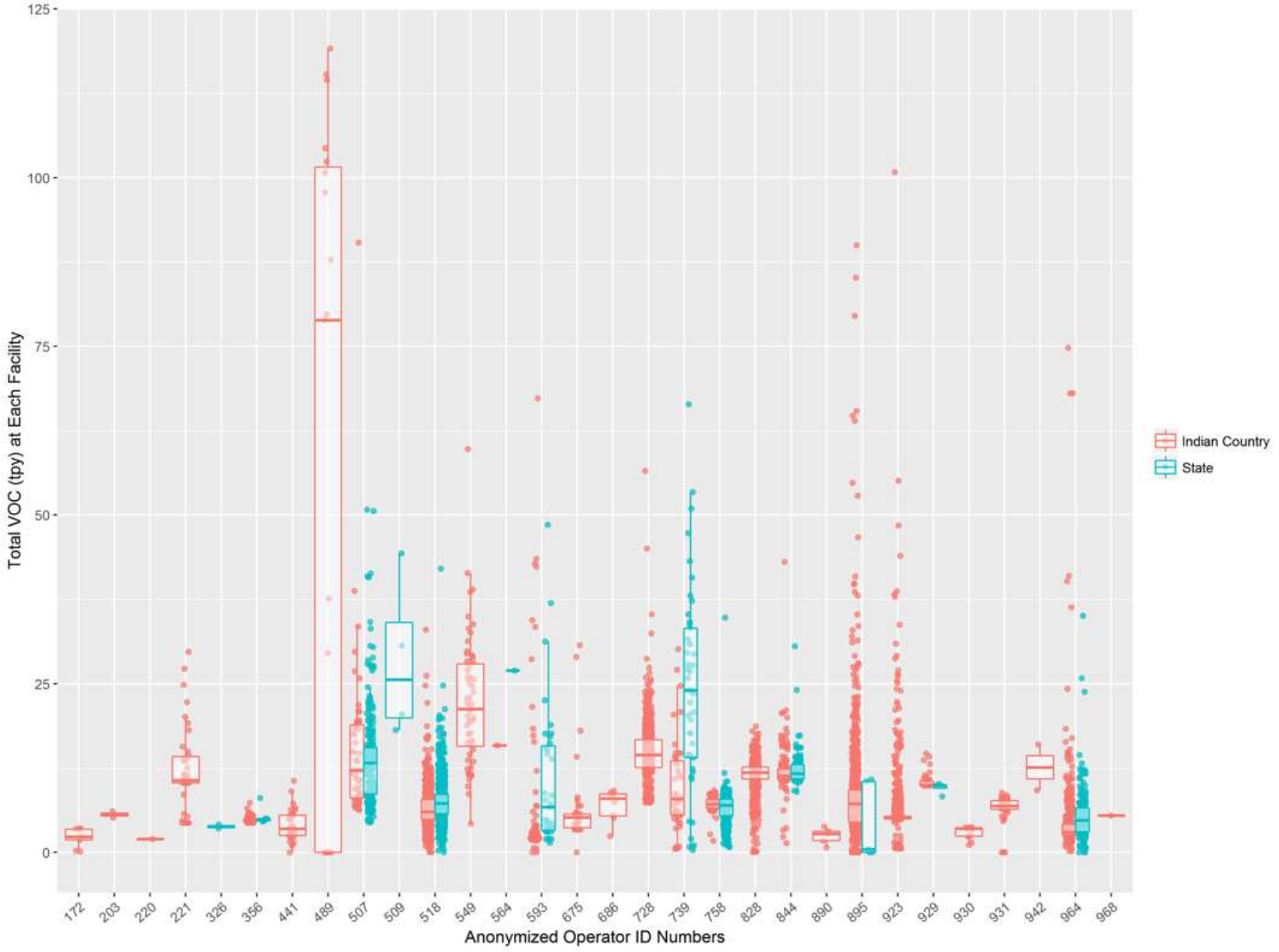
* *Utah Division of Oil, Gas & Minerals (UDOGM) data is gas produced; UBEI data is gas processed thru a dehydrator*

✓ Universe looks to be covered

Comparative Analysis Within UBEI

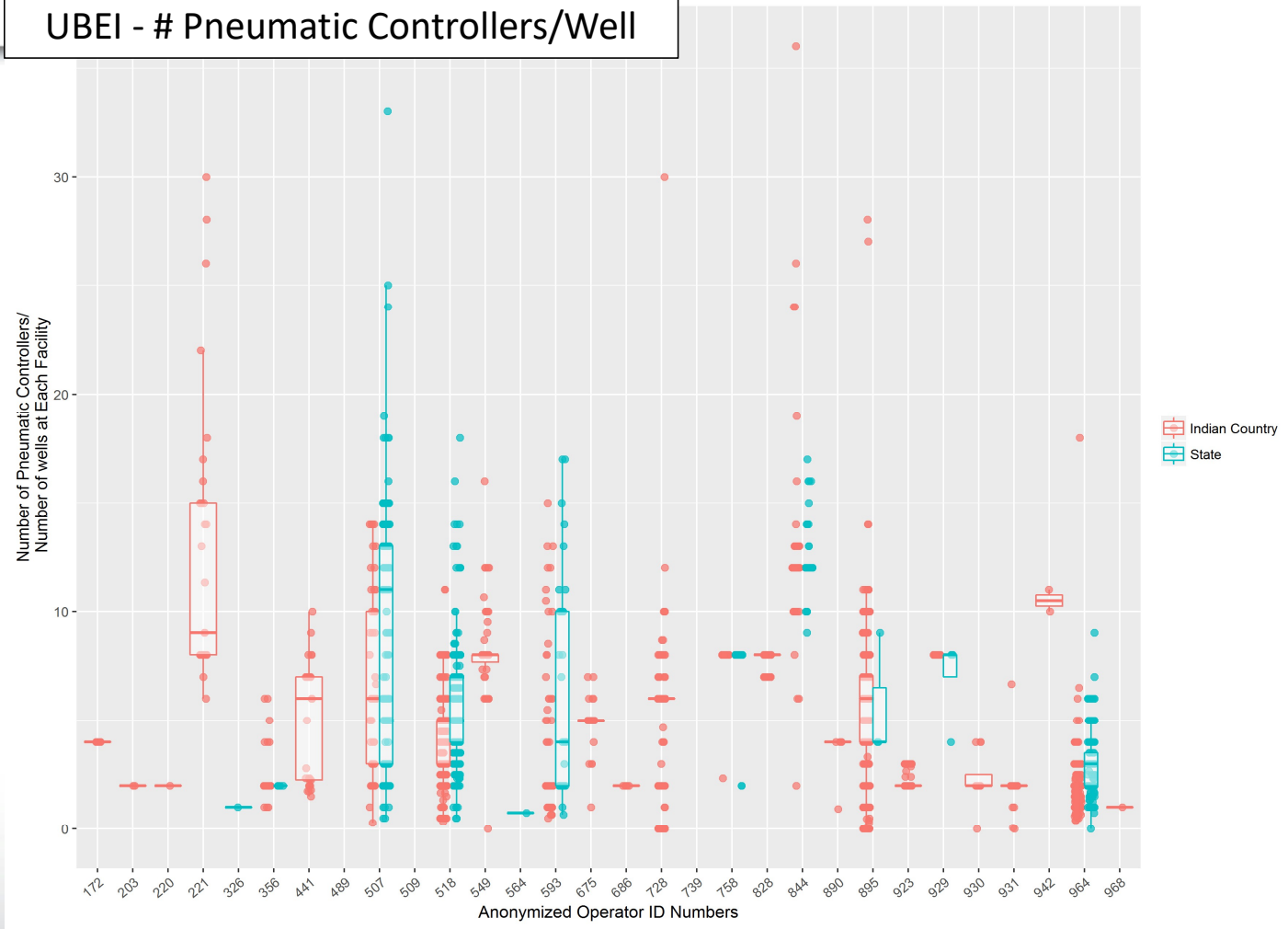
UBEI: Indian Country vs. State		
	UBEI	
	IC	State
#Wells/Facility	1.39	1.53
VOC TPY/Well Overall	6.31	5.81
#Dehydrators	1,895	8
Tanks VOC lb/bbl Overall	1.13	0.45
#PCs/Well	3.67	4.61
#Pumps/Well	0.91	0.03
#Uncontrolled Engines/Well	0.27	0.59
#Separators-Heaters/Well	1.16	1.07
Fugitive VOC TPY/Well	1.49	0.91
Truck Loading VOC TPY/Well	0.09	0.29

UBEI – VOC (TPY)/Facility



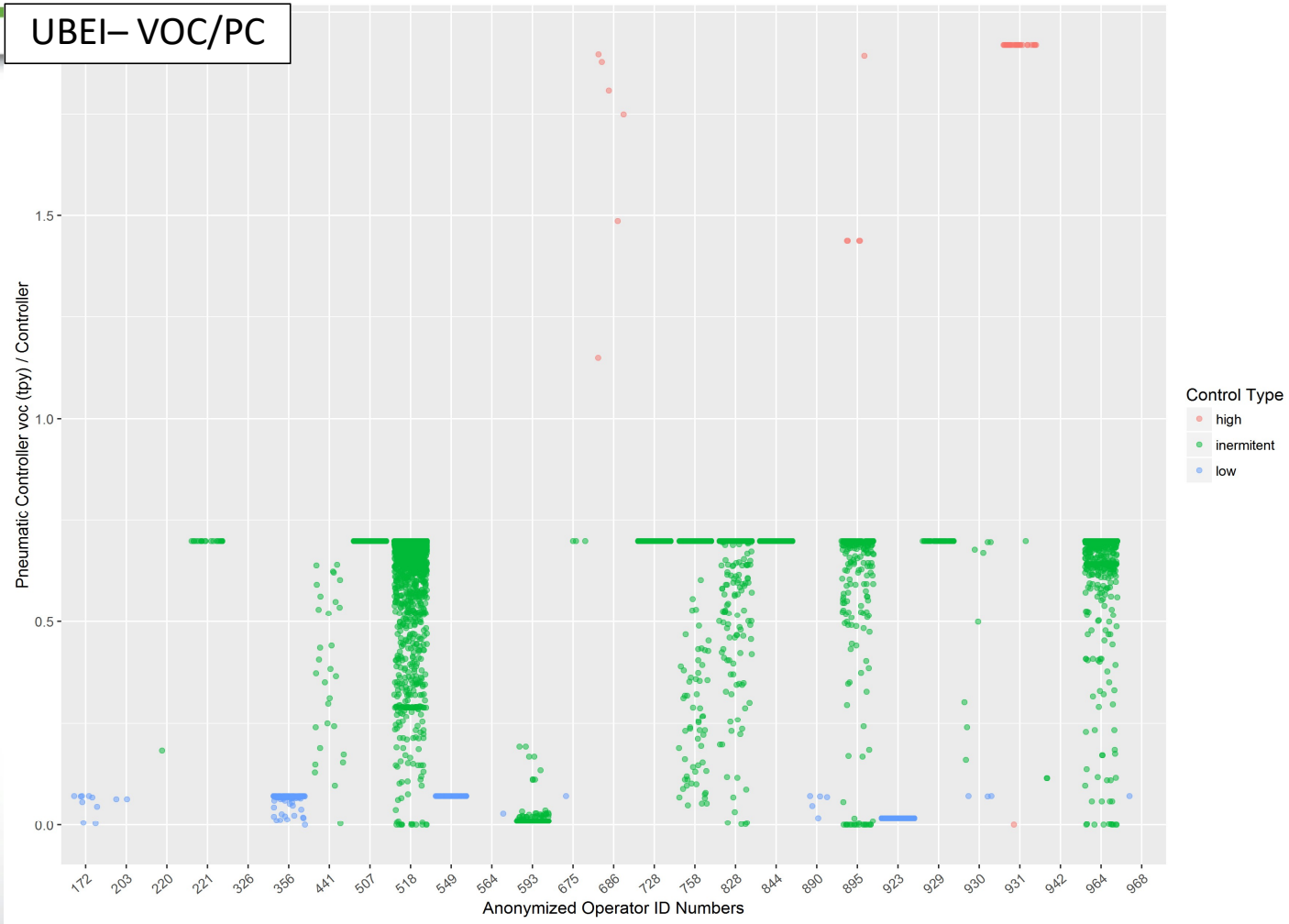
Comparative Analysis Within UBEI

UBEI - # Pneumatic Controllers/Well



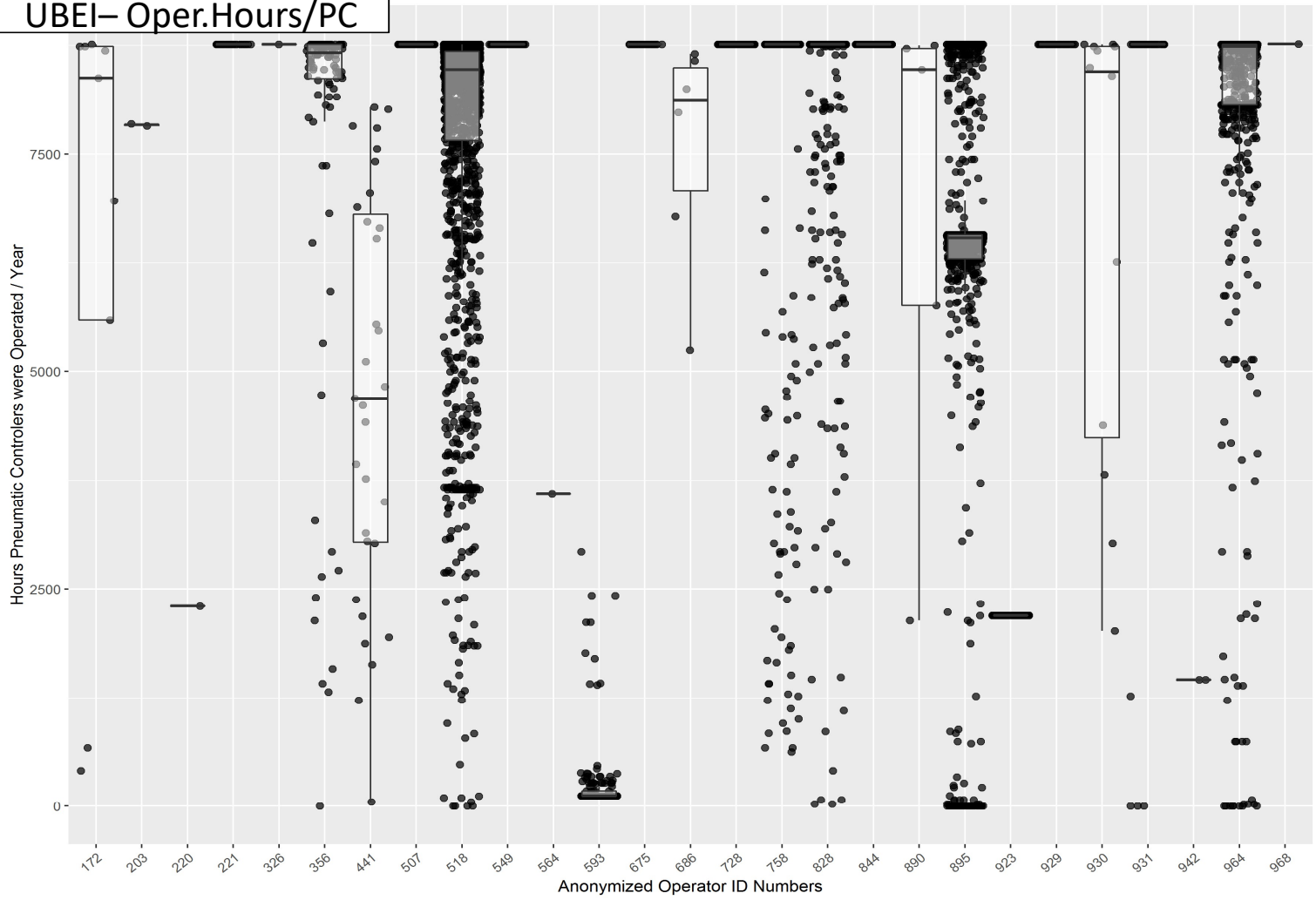
Comparative Analysis Within UBEI

UBEI– VOC/PC



Comparative Analysis Within UBEI

UBEI– Oper.Hours/PC



Comparative Analysis – Registration vs. UBEI

	U&O Registration Data	UBEI - Indian country
Number of Facilities	5,169	6,729
Avg Facility-Wide VOC (tpy)	12.25	8.74
Avg Dehyds and Tanks VOC (tpy)	8.15	1.91
# Facilities VOC (tpy) < 5	1,759	1,916

GLYCOL DEHYDRATORS

- Number of glycol dehydrators about the same
- Overall VOC emissions decreased 76%
- 97% of dehyds in UBEI uncontrolled
- 67% reported 8,760 hrs/year or close to it
- 1,137 dehyds reported glycol circulation rate of 0.102 gpm

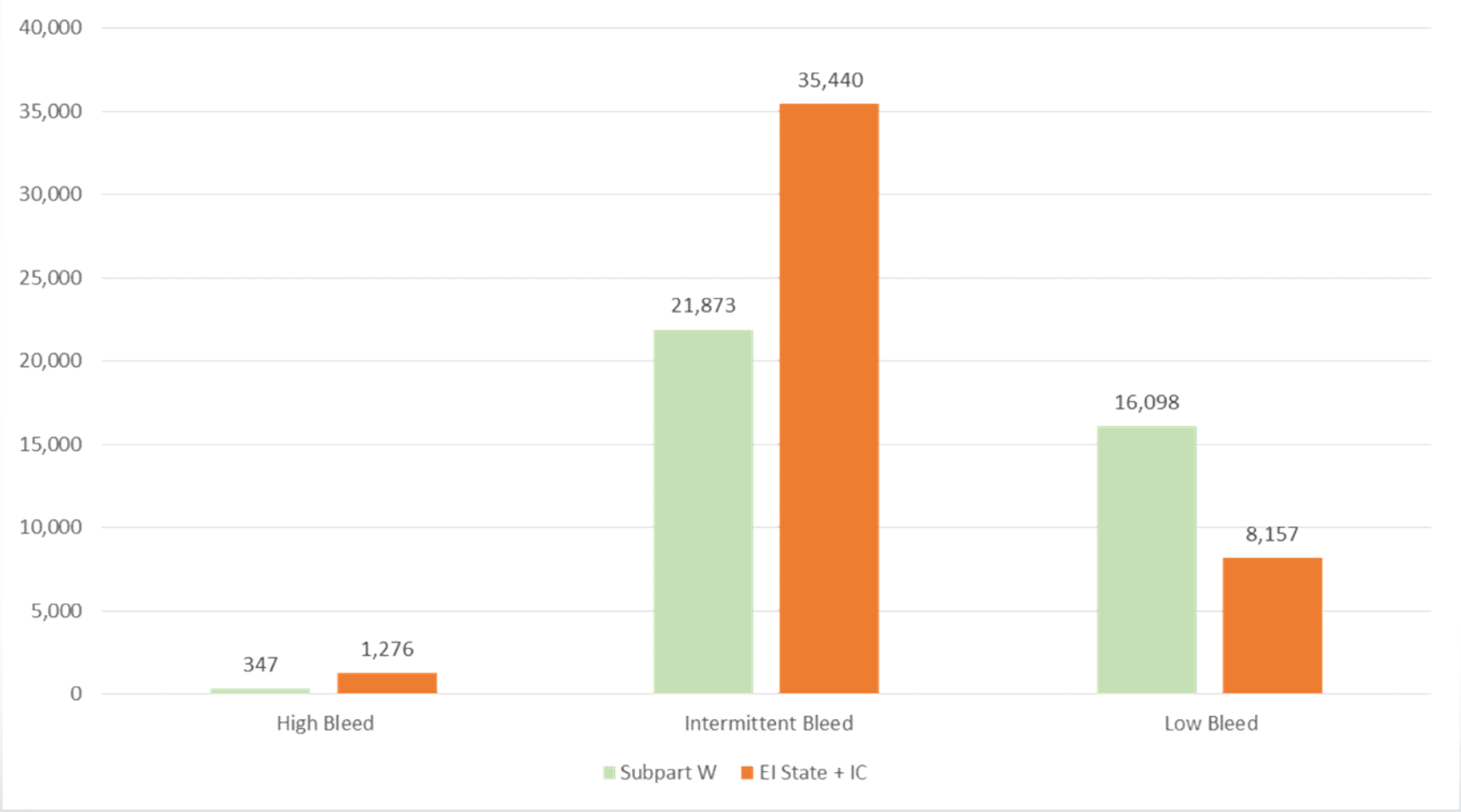
OIL/CONDENSATE TANKS

- Overall VOC lb/bbl from 1.82 to 1.13
- 88% of tanks in UBEI uncontrolled
- Variability by-Operator on UBEI > or < Registration for VOC lb/bbl
- Comparison of tank temperature and separator pressure fairly close

Comparative Analysis – GHGRP-W vs. UBEI

	GHGRP-W	UB EI	DIFF
# Wells	11,753	12,090	(337)
# Dehyds	1,860	1,903	(43)
# Pneum.Pump	11,614	8,535	3,079
# PCs	38,566	46,944	(8,378)
#Dehyds/Well	0.16	0.16	1%
#Pumps/Well	0.99	0.71	29%
#PCs/Well	3.28	3.88	-18%

Comparative Analysis – GHGRP-W vs. UBEI



Action from the Comparative Analyses

- Want the best UBEI we can get, but need to balance with resources required
- Endeavor to target and resolve the bigger issues
- Communicate with some operators individually to better understand specific UBEI emission questions
- Adjust UBEI, as appropriate

Take-Away Message …

Oil & Gas Inventory work needs DATA ANALYSTS!!

Alexas Gilbert, EPA
Access, Excel

Whitney Oswald, UDAQ
Excel, Python, SQLite

Aaron Zull, EPA
R, Excel, SQL, Access