

Innovation
To
Reduce Methane Emissions
During Shale Oil Production
in
Colorado

EPA Natural Gas STAR: October
26, 2017



QUESTOR

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Questor is a leading provider of *safe, reliable, efficient Emission Control Devices (ECDs) that addresses air quality and emissions issues while reducing methane and Greenhouse Gas (GHG) emissions.*

New EPA regulations and State specific changes are resulting in improved access to oil and gas development permits while earning social license and effecting improved air quality.

COLORADO REGULATORY

- Colorado Oil and Gas Conservation Commission (COGCC)
- Department of Natural Resources (DNR)
- Colorado Department of Public Health & Environment (CDPHE)
- Colorado Division of Wildlife
- Bureau of Land Management (BLM) - Federal
- Environmental Protection Agency (EPA) - Federal



KEY RULES AND LEGISLATION

- EPA 40 CFR Part 60 Subpart 0000 (“Quad 0”)
- Colorado Regulation 7



EPA QUAD 0

- US Federal legislation controlling VOC and HAP emissions from:
 - Well Completions
 - Hydraulic Fracturing
 - Storage Tanks
 - Compressors
 - Glycol Dehydration
 - Leak Detection & Repair (LDAR)
 - Pneumatics
- Standard for testing and certifying combustion, or emissions control, devices



COLORADO REGULATION 7

- Previously the regulation for VOCs
- Amended version was effective April 14, 2014
- Now a hydrocarbon rule that includes methane
- Statewide rule – i.e. not just in non-attainment zones
- Includes Oil & Gas Exploration and Production
- Must use enclosed combustion to control emissions



DRILLING MEETS DEVELOPMENT



DJ BASIN AND POPULATION GROWTH

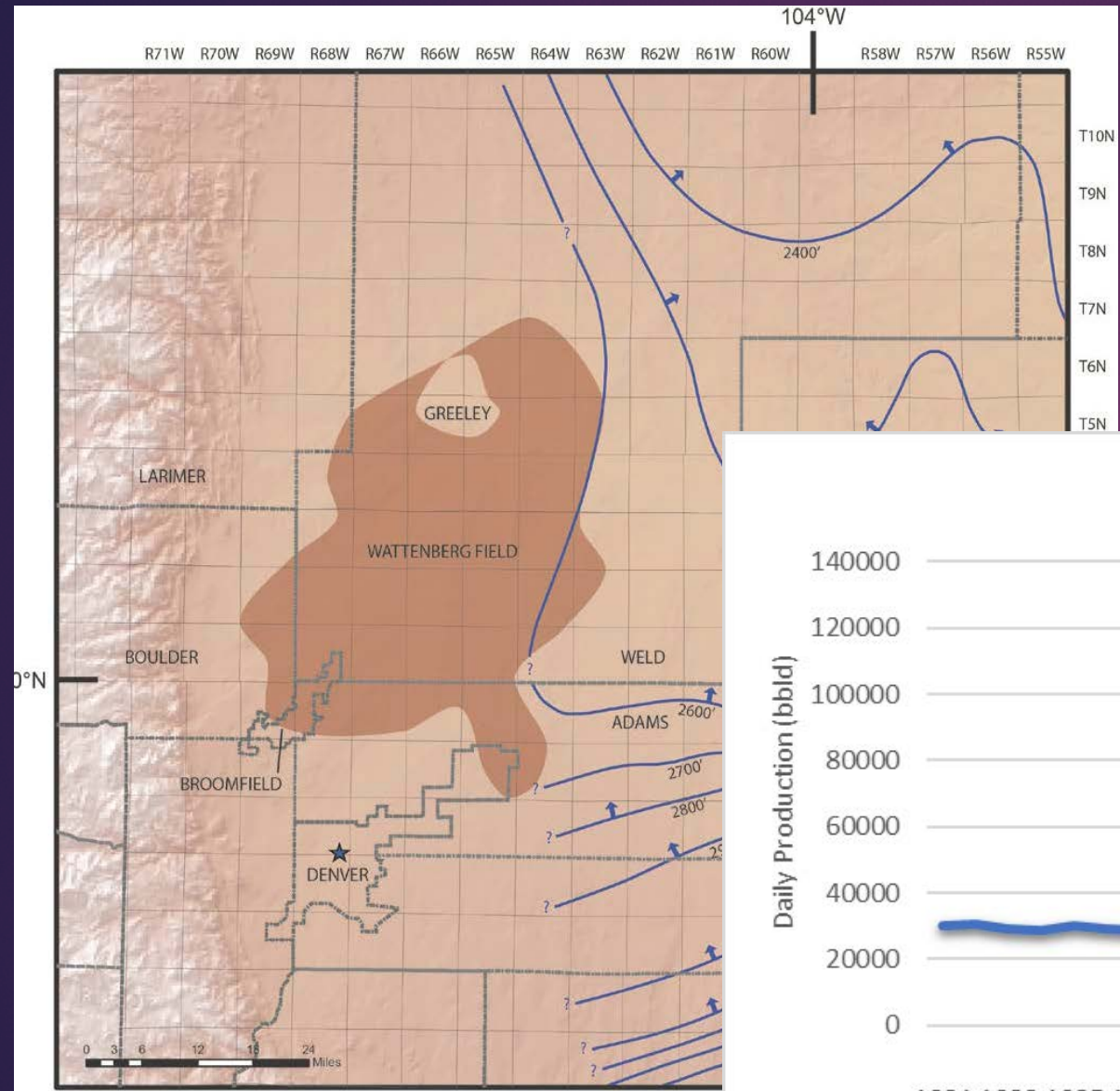
	Pop. growth rate (%) 2010-16	Drilling permits
Timnath	364	38
Johnstown	54	60
Berthoud	40	0
Frederick	39	49
Windsor	30	213
Mead	29	41
Firestone	25	57
Erie	23	34
Broomfield	18	6
Milliken	17	26
Wellington	17	1
Brighton	16	147
Lochbuie	16	167
Dacono	16	116
Eaton	16	85

ENCLOSED COMBUSTION RULES

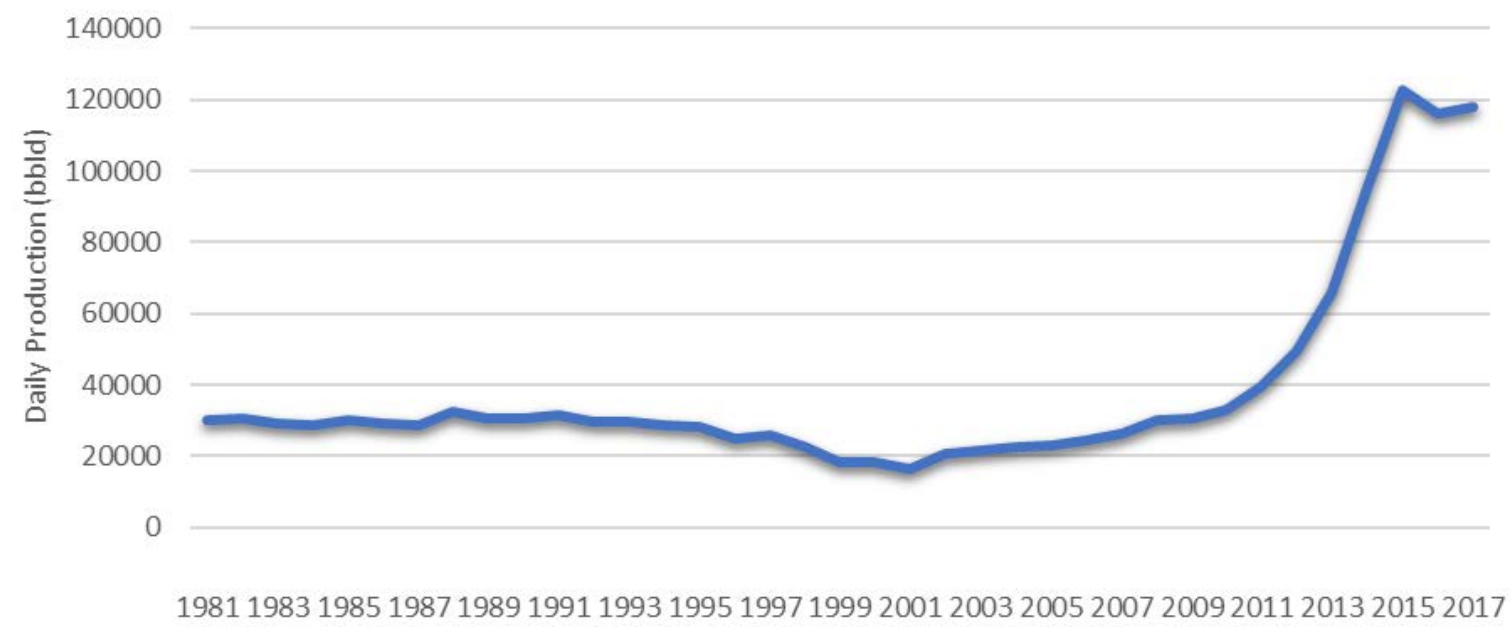
- EPA 40 CFR Part 60 Subpart 0000 (“Quad 0”)
 - Requirement to meet 95% efficiency
 - specific testing requirements using propylene
- Colorado Regulation 7 states that enclosed combustors
 - must exhibit no visible emissions
 - must be designed so can be determined if operating
 - have installed auto-igniters
 - operate at 98% efficiency



STATE OF COLORADO



Daily Production - Colorado

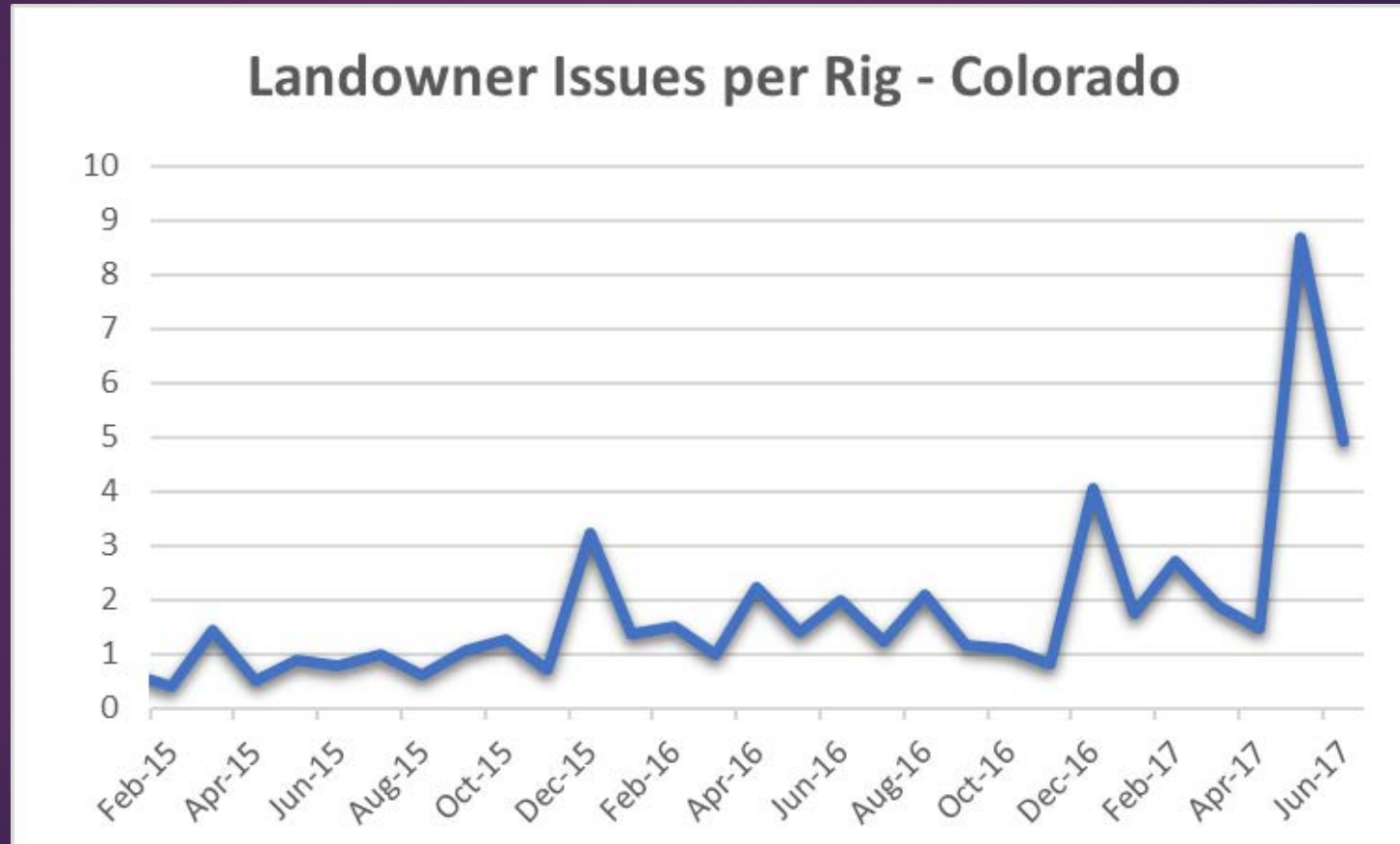




ECD HISTORY IN COLORADO

- 1-2 low capacity combustors per well
- Mostly low-pressure and lower capacity
 - Primarily tank vapors
 - <100 mscfd per combustor

INCREASED ISSUES

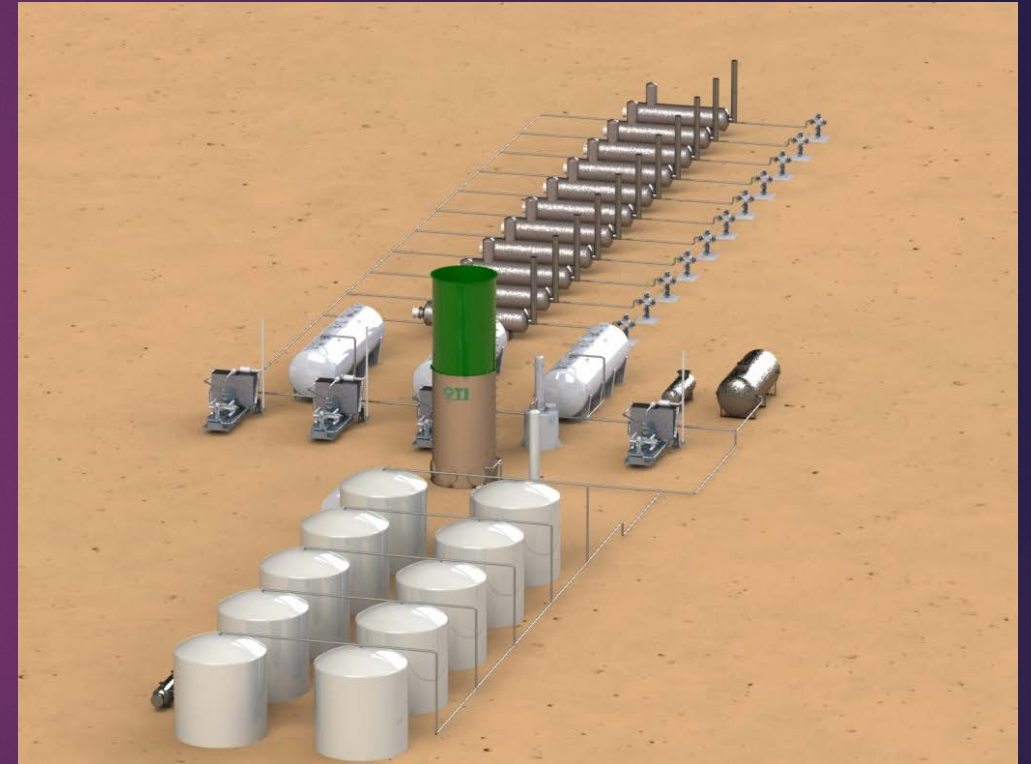


HIGHER CAPACITY ECDs

- Initially deployed in Colorado in May, 2014
- Flowback throughputs of > 3 MM scfd per stack
- 12 MM scfd of associated gas (1600 but/scf) over 8 months
- Industry activity significantly reduced into 2015
- Several projects for mid-sized producers in mid to late 2015
- ECD operations were all for flowbacks and tank vapors

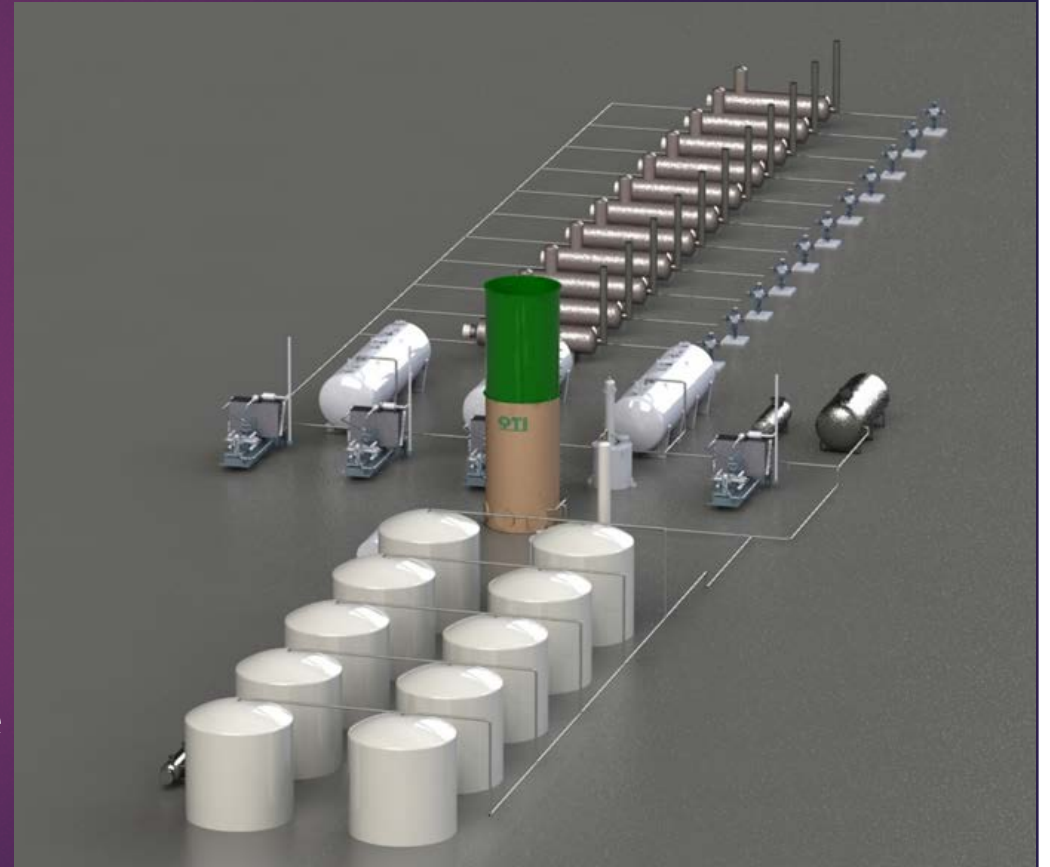
2016 - COLORADO

- Introduced high-capacity Hybrid ECD to Colorado
- Client purchases bottom 22 ft portion of ECD
- Top 18 ft portion used only for flowback
- Top removed after flowback and deployed at next site
- Bottom 22 ft for production operations
- Replaces 12-15 small capacity combustors – reduces footprint 20%



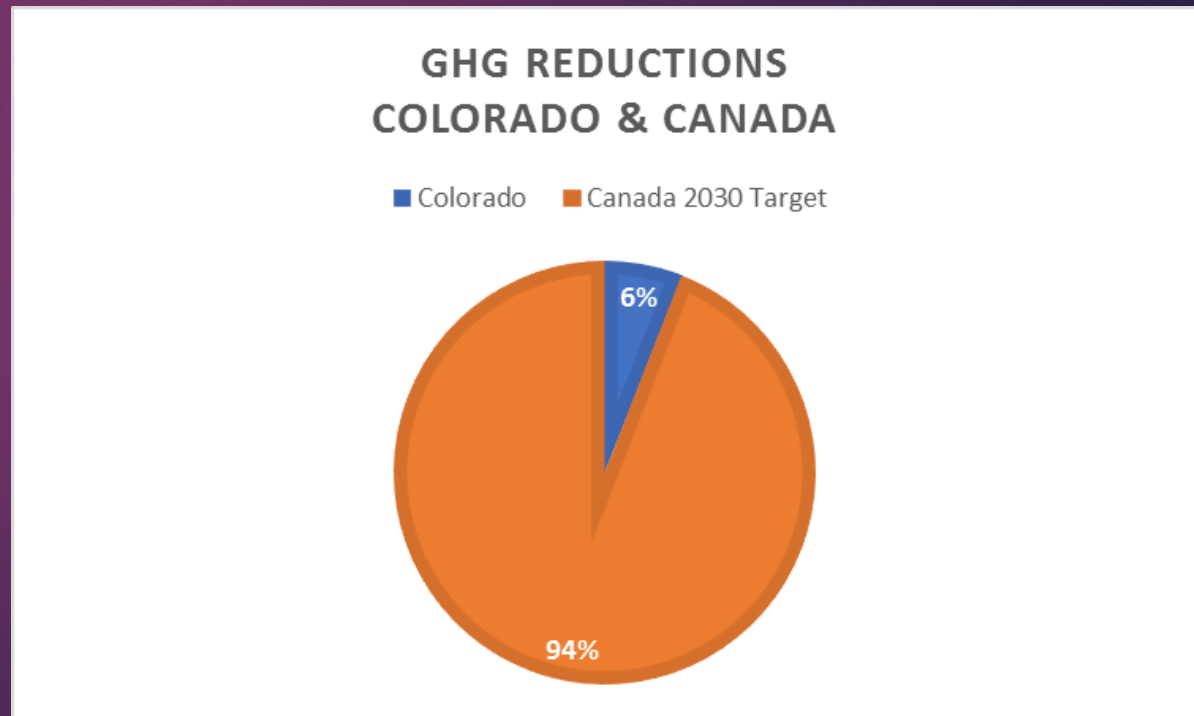
HYBRID MODEL

- Reduces footprint by 15%
- Integrated complete total system solution
- Tall unit for flow-backs & high initial production rates
- Top portion of stack removed for permanent production
- Remaining portion of ECD handles all of the production facility gas streams on site

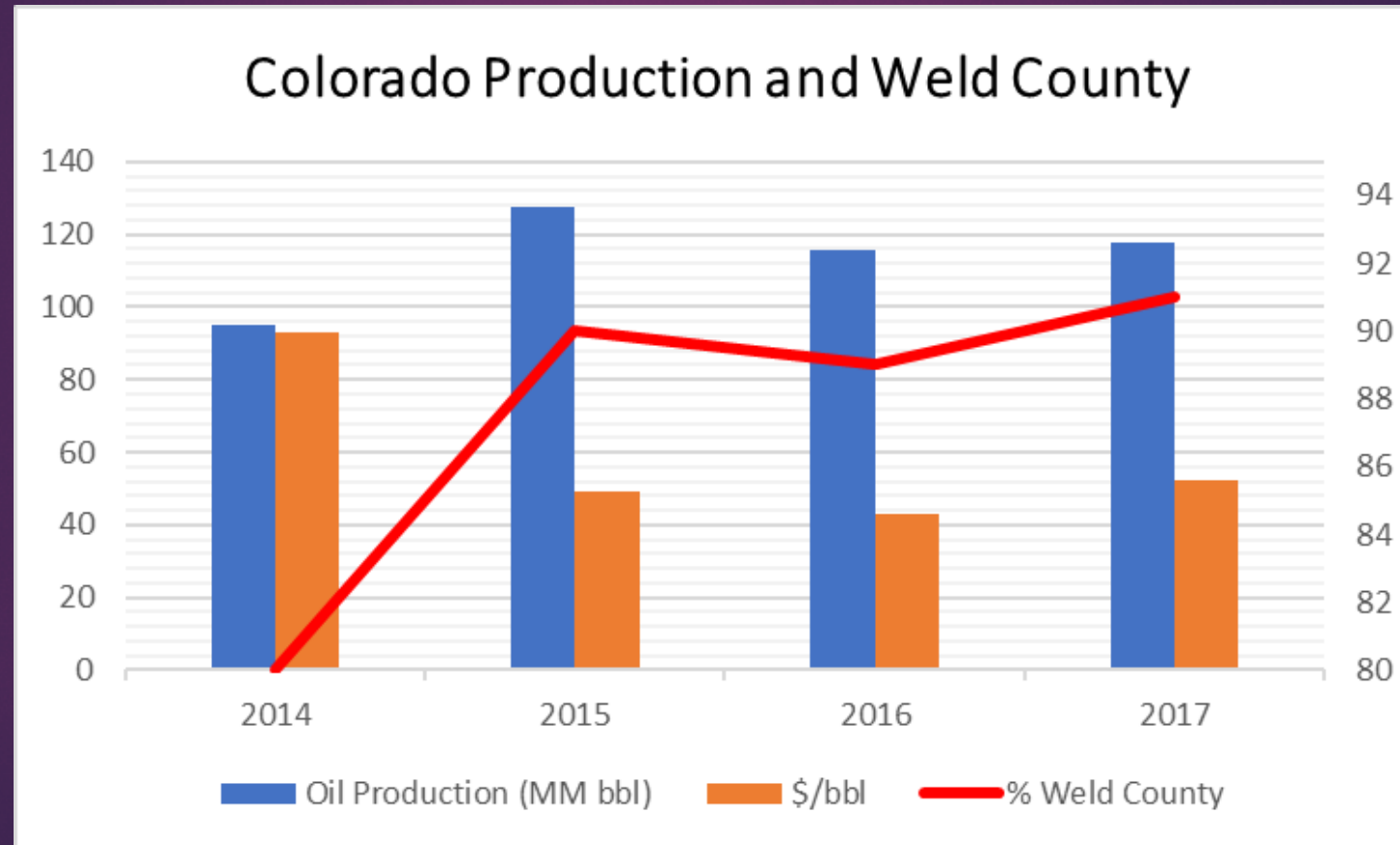


COMBUSTION AND GHGs

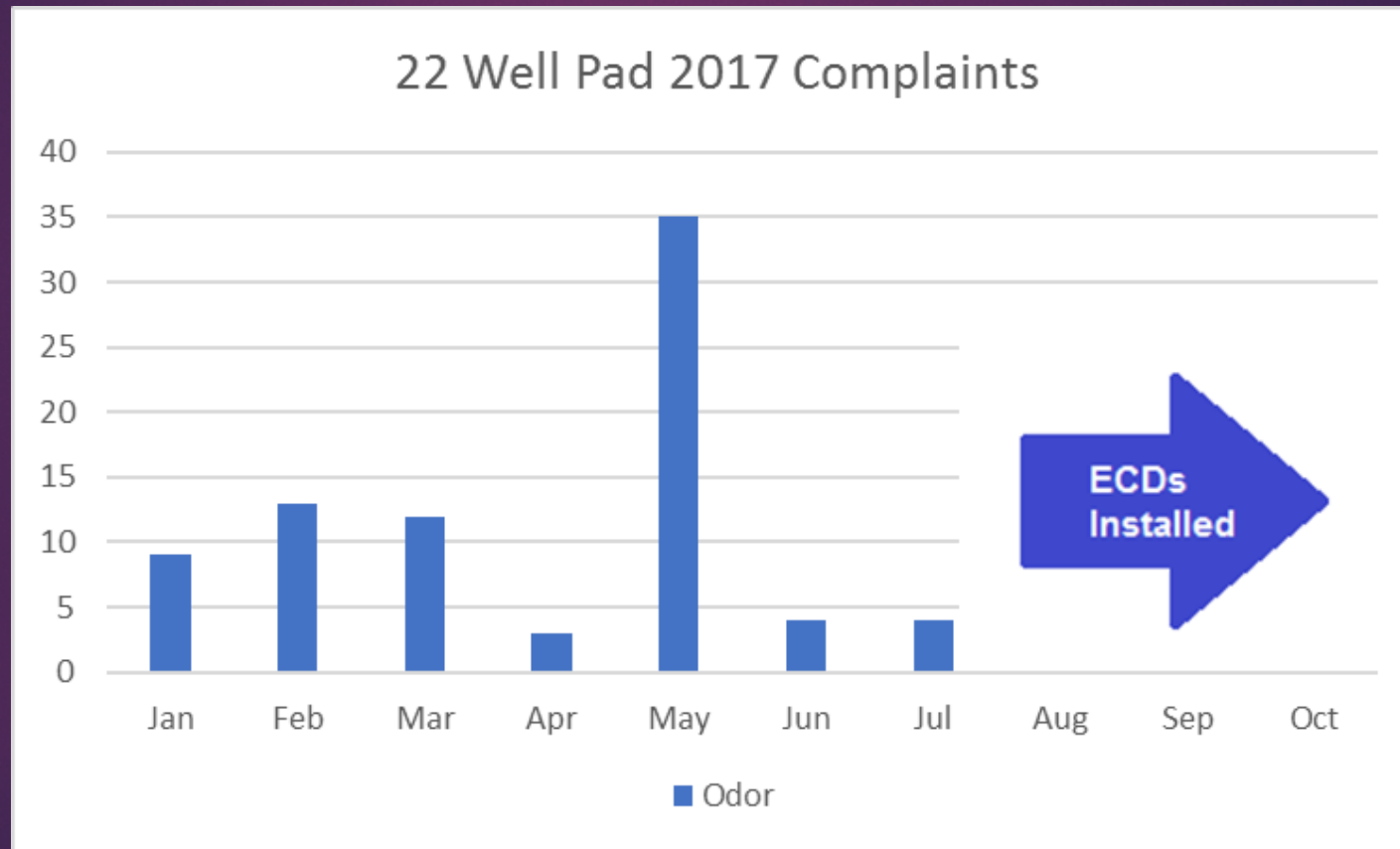
- Combusted 21 bcf of DJ Basin associated gas since Jan 2015
- CO₂e of this gas is 22 Mt (GWP CH₄ = 80 CO₂) over 20 months
 - Tank vapors
 - Flash gases
 - Upset vapors
 - Truck loading
- Operations include
 - Drilling
 - Frac cleanouts
 - Flow backs
 - Production operations



NEW ECONOMICS



ADDRESSING ISSUES



WHY IS METHANE A FOCUS?

- $GWP_{100} = 25-34^a$
- $GWP_{20} = 84-86^b$
- Stays in atmosphere much shorter period than CO_2
- Forms toxic compounds VOCs and Ozone
- Ultimately forms CO_2

^aSource: EPA and Harvard

^bSource: EDF and Harvard



GHGs QUANTIFIED

- Using a Global Warming Potential (GWP) of 80 for methane, as compared to CO₂, the following table illustrates the benefits of clean combustion
- For example: incinerating 19,000 sft³/d (mscfd) of waste methane results in the following CO₂ emissions:

Combustion Efficiency	tonne/d	tonne/yr
0% (Vented)	29.1	10,621
65%	10.8	3,942
80%	6.6	2,409
>99.99% (High Efficiency Combustion)	1.0	365

EFFICIENT SITE PLANNING



SUMMARY

- High capacity and high efficiency ECDs
- Consolidates combustion into 1-2 high capacity-high efficiency ECDs
- ECDs now used across all operations
- Significant footprint reduction
- Significant reduction in methane and VOCs
- EPA and new Colorado regulations results in methane/GHG reduction and earning social license



*Thank
you*





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