RYSTAD ENERGY

PERMIAN BASIN FLARING OUTLOOK

CONDENSED REPORT

JANUARY 2021

EDF ENVIRONMENTAL DEFENSE FUND®
Finding the ways that work

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Project parameters and purpose

Mandate and purpose

- The Environmental Defense Fund has hired Rystad Energy to assess upstream flaring in the Permian basin, focusing on the state of Texas.
- The purpose of the project is to understand the effect of regulatory policies seeking to reduce overall flaring.
- Rystad Energy conducted this analysis during July and August 2020.
- The project is divided into three pieces:
    - Evaluating the historic flaring taking place in the Permian in order to understand the underlying drivers of flaring.
    - Evaluate the effect of policies (provided by EDF) on flaring intensities and total flared volumes towards 2025.
    - Evaluate the economic impact of the aforementioned policy alternatives as it pertains to stakeholders (companies, royalty owners, and governments).

Methodology and data

- Rystad Energy has built a comprehensive database on global upstream production and flaring.
- For most US states, this database is based on operator reported data, published by regulatory agencies (RRC in the case of Texas).
- Rystad Energy quality checks this data, e.g. by comparing them to other sources (satellite data), mathematical quality checks and consistency checks. In addition, we adjust data for reporting delays and lack of reporting.
- Flaring from gathering, processing and transport (midstream) facilities is not included in this report.
- Analysis in this report is based on the resulting dataset, provided on a lease level with a monthly resolution.
- We have excluded year-to-date 2020 from our analysis as we believe shut-ins and extraordinary circumstances have created noise in the data set.
- This report focuses on the Permian Basin in Texas, but some references are made to the entire basin (including the New Mexico portion).

Source: Rystad Energy research and analysis

Event-driven and temporary routine are flaring key drivers

Findings – Drivers of flaring

- Flaring of gas in the Permian is not distributed equally across leases but concentrated on a subset of leases with high flaring intensities[1]. More than half of Permian oil-producing leases had a flaring intensity below 2% over the period 2015 to 2019.
- To identify the drivers of flaring in the basin, we have classified flaring among four groups:
  - The level proven possible by the best leases ("Top performers operational flaring"), defined as the average of leases with less than 2% cumulative flaring intensity.
  - Event-driven flaring: Events resulting in temporary increases in flaring intensity.
  - Long-term routine flaring: Flaring consistently higher than the Top performers.
  - Short-term routine flaring: Wells where flaring converges to Top performers levels within 12 months.
- Of these four groups, event-driven flaring makes up 56% of total flaring, temporary routine flaring 26%, long-term routine flaring 11%, and top performers the remaining 7%[2].
- Consequently, most flaring stems from wellsite or midstream issues. These events were naturally exaggerated when overall gas infrastructure was running at or near maximum capacity (Q3'18 – Q3'19).
- Large events (e.g. midstream outages in Martin and Howard county in 2018) had outsized impact on the basin's overall flaring intensity in recent years.
- Small events are seen regularly for certain operators where gathering infrastructure is unreliable or takeaway capacity is not secured.
- Temporary routine flaring tends to follow completion activity, as even the best wells tend to flare more in the initial months' production. Temporary routine flaring has fluctuated in line with changes in activity. The Midland basin particularly has seen growth in temporary routine flaring intensity over the last few years.
- Most of the long-term routine flaring in the Permian is taking place on a small subset of leases. 60 leases make up about 50% of long-term routine flaring.

1: Flared gas as a percentage of gross gas production 2: For calendar year 2019
Source: Rystad Energy research and analysis

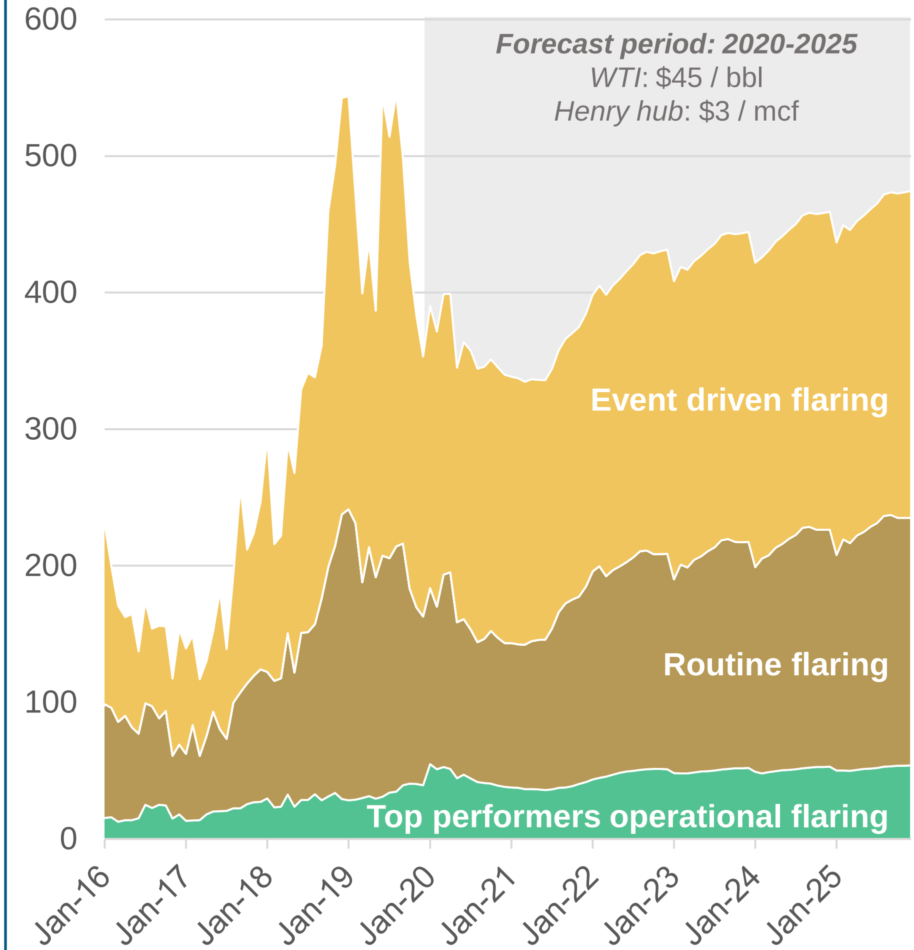
Flaring expected to increase towards 2025 in a $45/bbl scenario

Baseline flaring outlook[1]

- An oil price (WTI) of $45/bbl and gas price (Henry Hub) of $3/MMBtu is forecast to result in about 340 wells started in the Texas Permian per month. This compares to a 2019 average of about 420 wells per month.
- This activity level is sufficient for rich gas production to increase from a 2019 average of 11.4 Bcf/d to a 2025 average of 13.7 Bcf/d.
- Under a no-policy change assumption, total flaring is forecast to revert to 2019 volumes by 2025 (yearly average of about 460 MMcf/d). 2020 flaring volumes are down significantly from 2019 volumes due to impact of shut-ins and reduced activity catalyzed by a global supply-demand imbalance that was exacerbated by the COVID-19 pandemic.
- The lower activity means that the average well age will increase towards 2025. This results in a slight decline in flaring intensity, from 4.1% on average in 2019 to 3.4% on average in 2025.
- Top performers flaring volume remains at around 50 MMcf/d through the period, implying that it is likely feasible to reduce Permian Texas flaring from the baseline outlook by some 90%[2].

Texas Permian flared gas by category

Million cubic feet per day



1: Represents business as usual scenario; 2: A 90% reduction in flaring assumes all leases meet top performers operational flaring benchmark, which results in a long-term basin intensity of 0.3%-0.4% (2025 baseline 3.4%). Source: Rystad Energy research and analysis

Flaring has dropped significantly in 2020, driven by global supply-demand shocks

Baseline flaring outlook[1]

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Texas Permian flared gas by category
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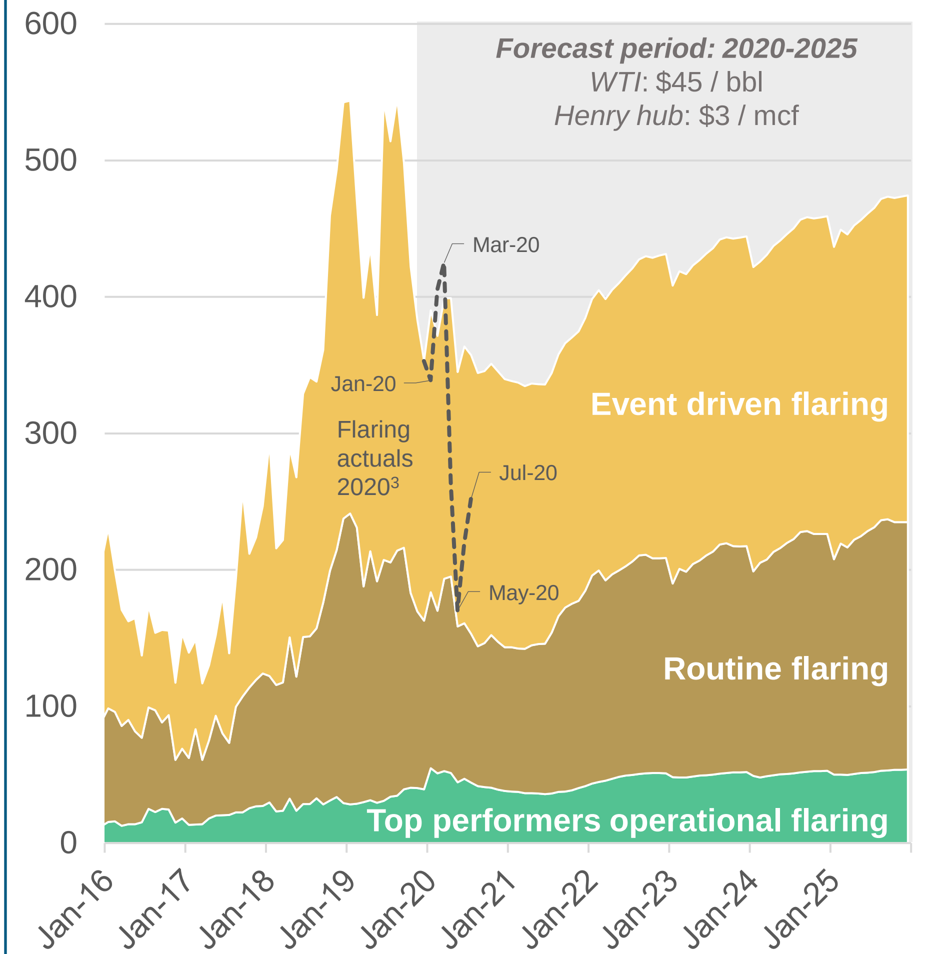
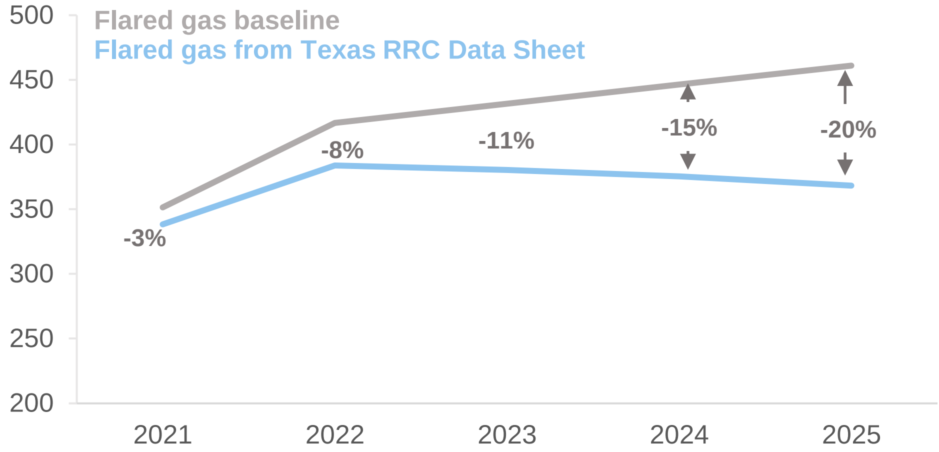


1: Represents business as usual scenario; 2: A 90% reduction in flaring assumes all leases meet top performers operational flaring benchmark, which results in a long-term basin intensity of 0.3%-0.4% (2025 baseline 3.4%). 3: Through July 2020. Source: Rystad Energy research and analysis

A gas capture rule would significantly reduce flaring, with limited cost

Effect of Policy 1: RRC Data Sheet

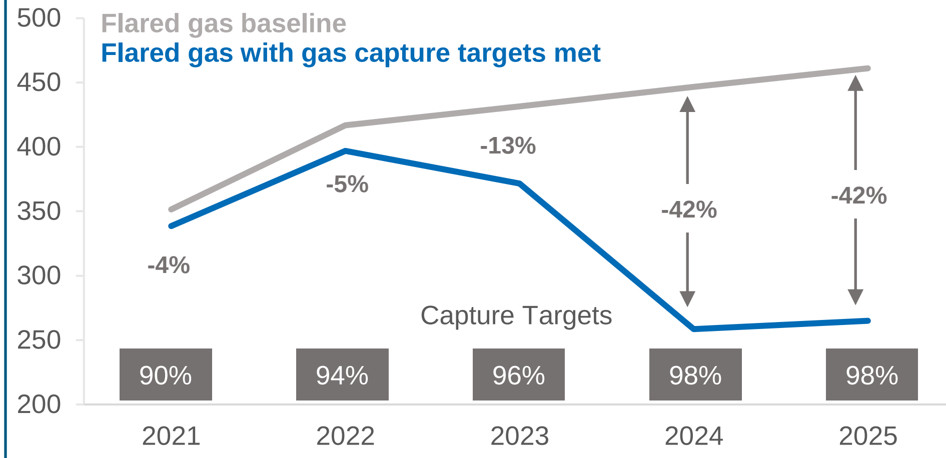
Flared gas with and without Policy 1 Texas RRC proposal
Million cubic feet per day



- On Nov. 4th, 2020 the Texas Railroad Commission enacted a new reporting form ("Statewide Rule 32 Exception Data Sheet"), seeking to address flaring. The form potentially shortens the time exclusion period in some instances and requires operators to provide more details and analysis on their reasons for flaring.
- The new form is not prescriptive, and as such its effect is expected to stem from changes in operator choices and actions. These changes are driven by an increased availability of information and analysis, as required by the form. The soft nature of this proposal also means that there is considerable uncertainty as to its effect over time.
- If operators move to capture the assumed zero-cost flaring reductions (and realizing 50% of this potential) we expect 2025 flaring intensity to be 2.7%, 0.7% lower than baseline, approximately 92 million cubic feet per day less than expected baseline volumes.
- Reductions are limited by factors including higher levels of routine flaring in the early months of a well's life and the soft nature of the policy.

Effect of Policy 2: Gas Capture Targets

Flared gas with and without Policy 2 Gas Capture Regulations
Million cubic feet per day



- In addition to the baseline estimates and the changes to the form implemented by the RRC, we have evaluated the effect of a potential gas capture statute. The policy assumes a gradual implementation, culminating in a 98% gas capture requirement from 2024 onwards.
- The policy would have greatest effect from 2023 onwards, reducing flaring in 2023, 2024 and 2025 compared to our baseline outlook by 13%, 42% and 42%, respectively.
- Assuming a strict adoption of the policy, this is likely a conservative estimate. Most companies would likely prefer to have a buffer between the requirement and their measured flaring intensity.
- A gas capture requirement of 98% will largely eliminate routine flaring and cut event-driven flaring by about a quarter.
- Overall, the gas capture plan achieves a basin-wide 1.8% flaring intensity, realizing approximately half of the reduction potential between the business-as-usual outlook flaring intensity (3.4%) and the forecasted top performers benchmark intensity (0.4%).

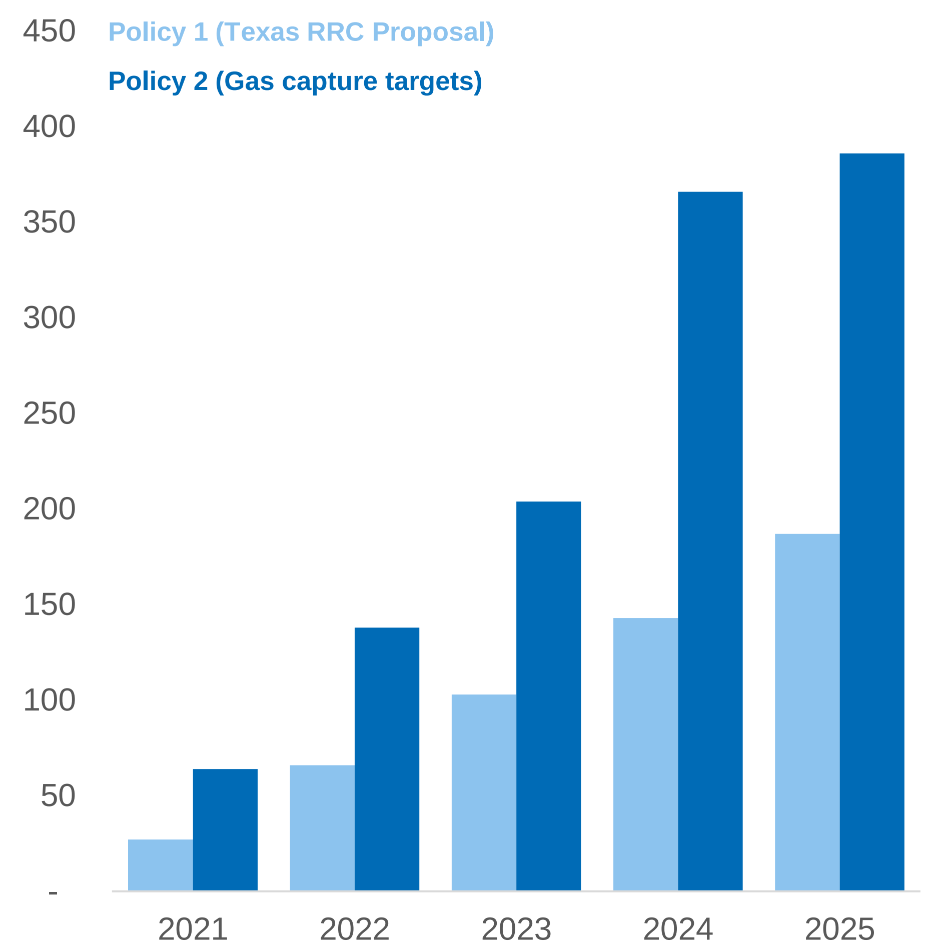
Source: Rystad Energy research and analysis

Policy 2 offers more than double the potential value as Policy 1 by 2025

Economic impact of regulation

- Soft policies will inherently not result in significant costs for the operator. The volume potential for Policy 1 assumes zero abatement cost.
- For Policy 2, the picture is more complicated. A significant part of flaring is assumed zero-cost to avoid, while the remaining part is assumed to cost $3/MMBtu to avoid. This abatement cost is considered a representative average, with the purpose of providing a reasonable policy cost estimate. More detailed economic impact assessment is outside the scope of this report.
- Such a cost level would result in considerable value creation relative to the baseline with the 98% capture rule: About 440 MUSD of wellhead revenue from increased production, at a cost of about 50 MUSD totaling approximately $390 MUSD of value creation captured in 2025.
- This cost would not be equally distributed amongst operators. Most of the companies incurring costs are smaller operators.
- In 2025, fewer than 20% of the affected operators would incur costs above $100,000 per year.

Annual wellhead value creation by policy relative to baseline
Million USD



Source: Rystad Energy research and analysis

Rystad Energy comments: Solving the interface issue key enabler of lower flaring

Interpretation of findings

- The finding that most of oil production in the Permian has a low (sub-2%) flaring intensity indicates that considerable cuts are possible. Top performers' flaring intensity (~0.4%) is achievable long-term with the right set of policies, incentives and collaboration across the value chain. Note that neither of the policy alternatives analyzed in this report achieve a basin-wide level in line with top performers (0.4%).
- The high pace of development seen in 2019 resulted in high levels of flaring, as operators and midstream providers were not been able to keep up with the growth in gas production.
- A slower pace of development and increased focus on flaring has had an effect, but the 2020 drop is likely temporary.
- Event-driven flaring is an issue with many underlying drivers. It is our understanding that interface issues between operators and midstream companies is a key issue along with more tangible examples such as equipment reliability, system design and robustness. This also means that addressing it would require additional investments.
- The relatively ease at which routine flaring can be reduced means that event-driven flaring is not pushed lower to the same extent. This does not imply that event-driven flaring is not addressable. Stricter operator policies and regulations could further reduce event-driven flaring with minimal investment.
- Hub-prices and the fundamental cost of gathering and processing implies that gas at the wellhead is valuable (around $2/MMBtu). Operators may see much lower prices over the short term. We assume over the long-term that operators will be able to close this gap.
- This implies that gas is fundamentally valuable, and operators are incentivized to increase capture.
- Despite being valuable per unit of gas, the value of flared gas is still often immaterial relative to the overall hydrocarbon stream including liquids. Without additional external incentives or regulation, some operators may choose to continue to flare despite the potential for value creation through gas capture simply because it is not a large value driver.
- Negative effects of prescriptive regulations relate primarily to smaller operators. Given the number of companies involved and the limited overall effect on the larger system, this should be a solvable problem.
- The forecast outlines a scenario with moderate production growth, which is significantly easier to manage compared to historical growth rates. The impact on flaring if oil prices go higher is a key concern. Also given the large share of event-driven flaring, the system would likely benefit from some buffer capacity to compensate for unforeseen events or developments.

Source: Rystad Energy research and analysis

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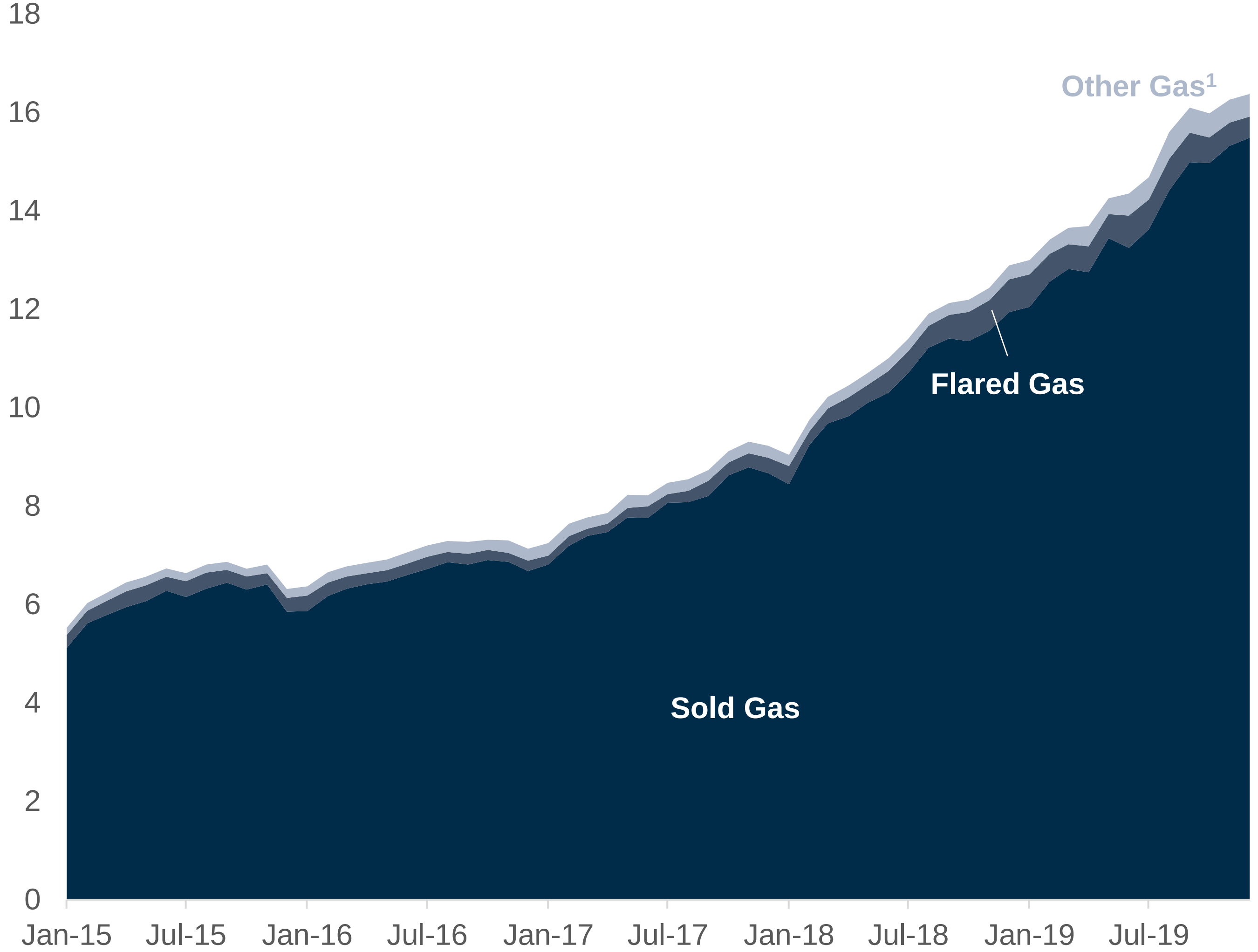
Permian has experienced tremendous growth in production of associated gas

Permian gross wellhead gas volumes by end-use
Billion cubic feet per day



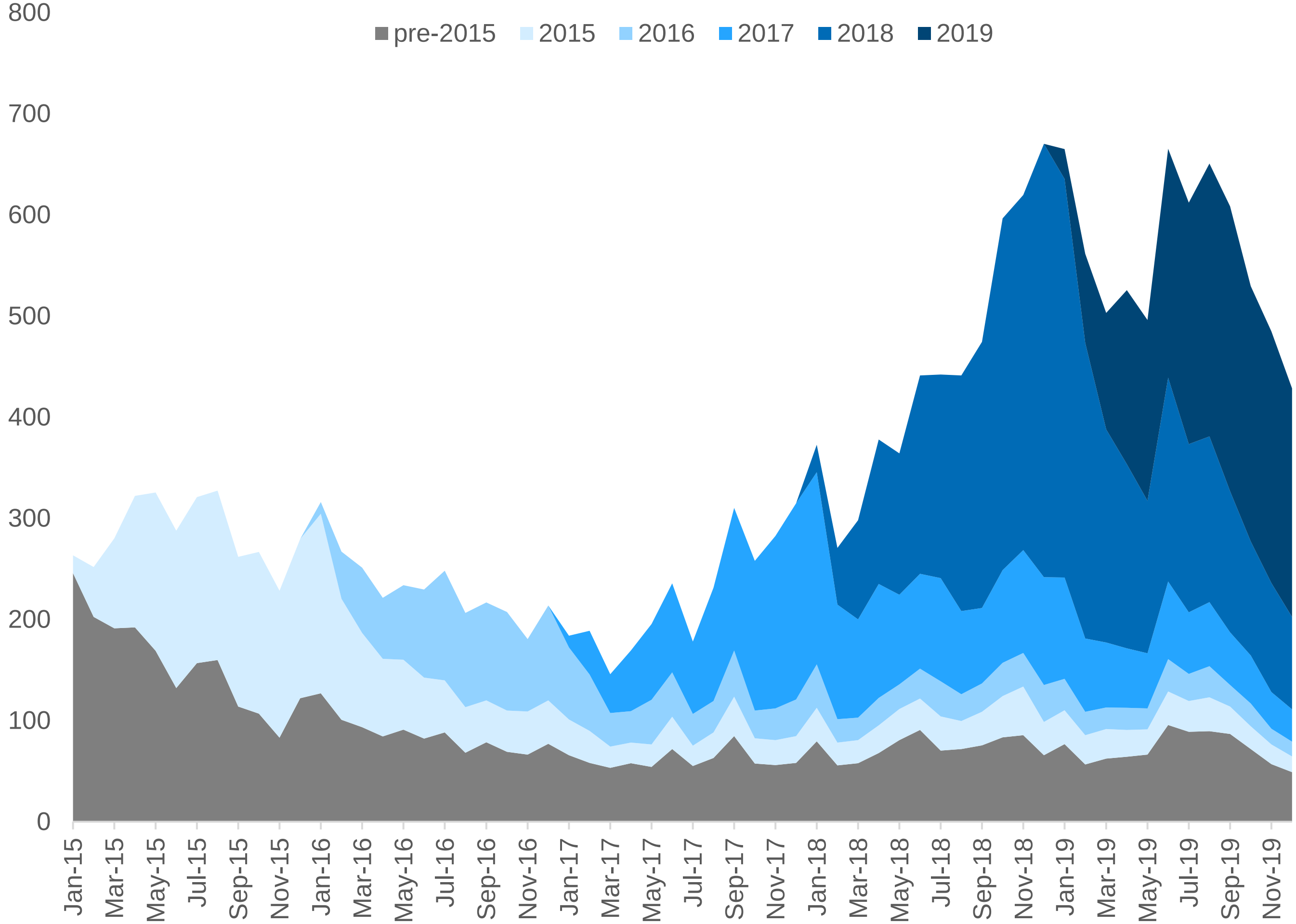
- Permian gas production grew significantly during the last 5 years, with volumes of rich gas produced rising from approximately 5.5 bcf per day in early 2015 to over 16 bcf per day by the end of 2019, growing 3-fold over the 5-year period.
- Volumes of flared gas have varied over the period. In the last 5 years, flared gas peaked at ~670 mmcfd in December 2018, nearly double the period average.
- The variations in flaring have been driven by a number of factors including but not limited to operator economic considerations, insufficient midstream infrastructure, macro-environmental effects on prices, and varying regulations.

1: Other Gas includes volumetric loss at wellhead due to lease condensate separation and removal of non-hydrocarbon components, gas consumed at the wellsite, and some reinjected volumes.
Source: Rystad Energy ShaleWellCube

Recent vintages account for the majority of flared volumes

Entire Permian

Flared volumes by well vintage[1] (production start year)
Million cubic feet per day



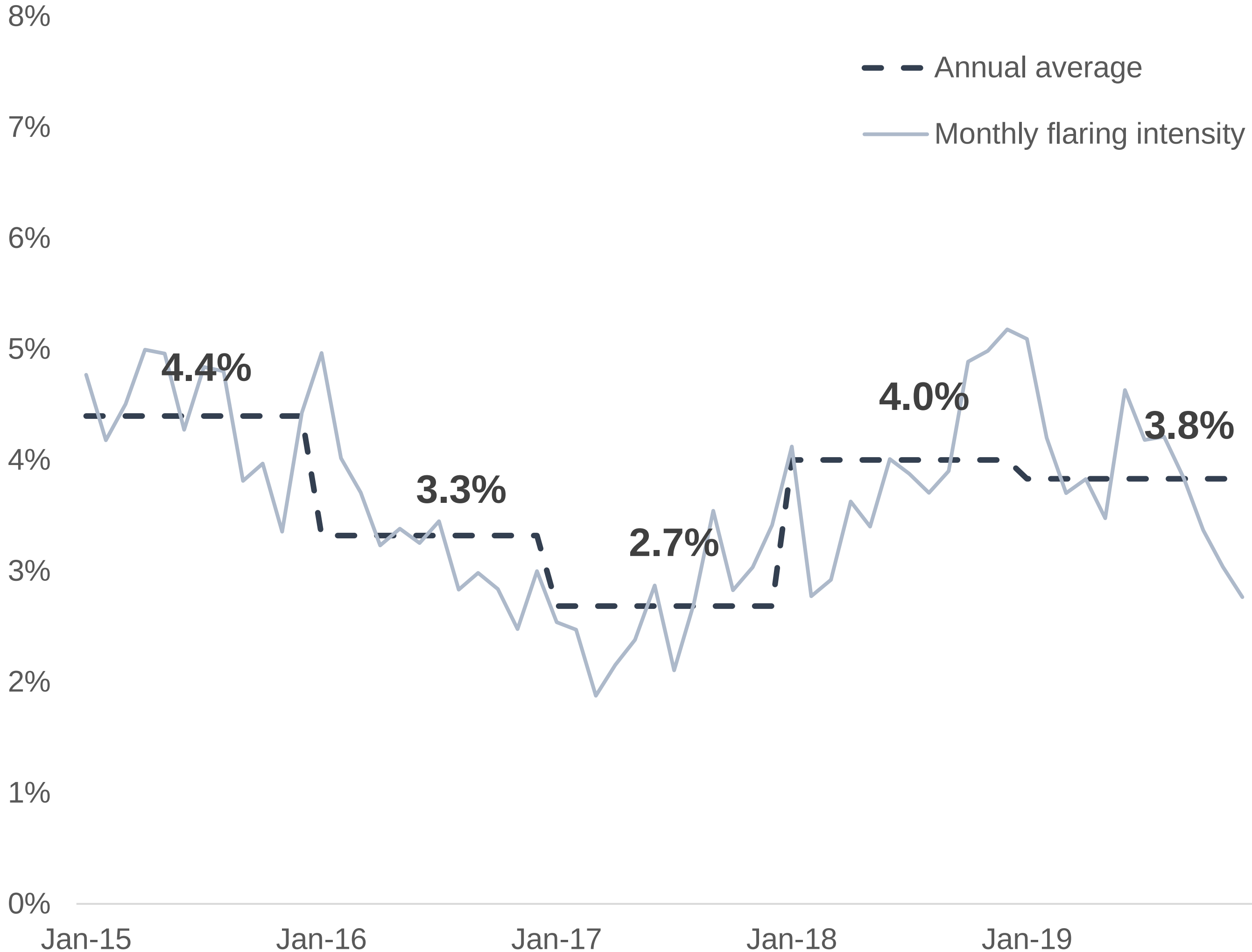
- Overall gas volumes flared increased dramatically starting in 2018 and extending into 2019; however, flared volumes has declined since mid-2019.
- The 2018 and 2019 well vintages account for a large majority of flared volumes, totaling in excess of 400 MMcfd of flared volumes in certain months in 2019.
- Generally, across the last six years, the most recent vintages flare the largest volumes, meaning that new production flares a significant amount.

1: Flared gas is grouped by the year of each well's completion to show flaring contributions by year of activity.
Source: Rystad Energy research analysis, ShaleWellCube

Permian flaring intensity on the decline after spikes in 2018 -2019

Entire Permian

Permian flaring intensity, 2015 - 2019
Ratio of flared gas to gross wellhead gas production



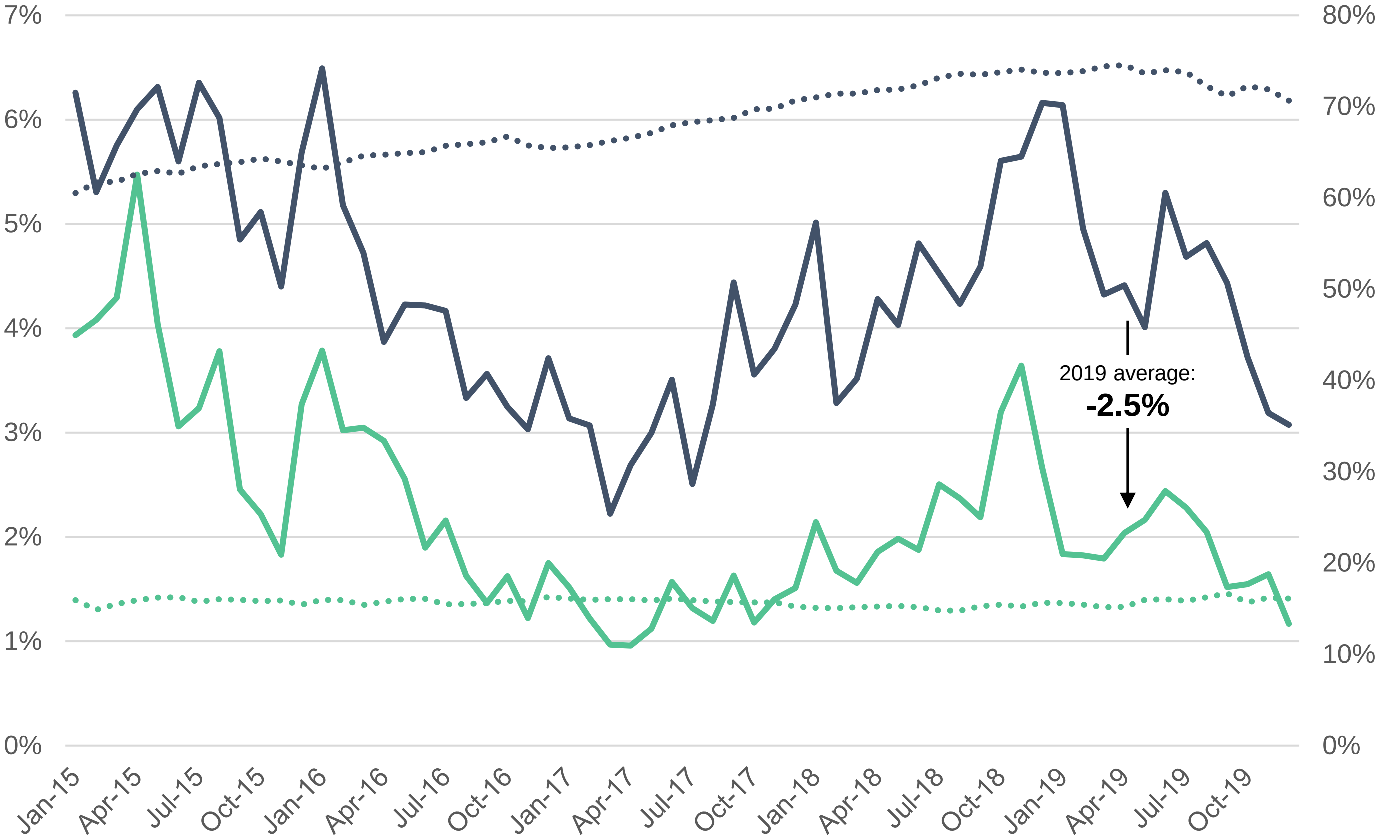
- Flaring intensity is calculated as the ratio of flared gas volumes to gross gas produced.
- After falling below 2% in 2017, flaring intensity went on to surpass the 5% threshold for the first time in approximately 3 years.
- Average flaring intensity in the Permian fell to 2.8% at the end of 2019, a year after peaking at 5.2%.
- The increase in flaring intensity was largely driven by insufficient gas gathering and takeaway infrastructure for the rising production levels within the Permian.

Source: Rystad Energy ShaleWellCube

Operators with integrated gas gathering had ~2.5% lower flaring intensity in 2019

Entire Permian

Flaring intensity and share of production by reported gas gatherer
Flaring intensity (LHS); share of total production[1] (RHS)



Flaring Intensity (**LHS**)	Operator	Third Party
Share of gas production (**RHS**)	Operator	Third Party

- The chart shows flaring intensity as a percentage of gross gas production, split between reported gatherer (operator versus third party), after some consolidation and scrubbing of operator-gatherer subsidiaries.
- On average, if the operator is the reported gas gatherer the average flaring intensity is less than 2%, ahead of the overall average in the Permian.
- Operator-owned infrastructure is only present in around 15% of wells operating in the Permian, whereas third party infrastructure is present in over 60% of wells.

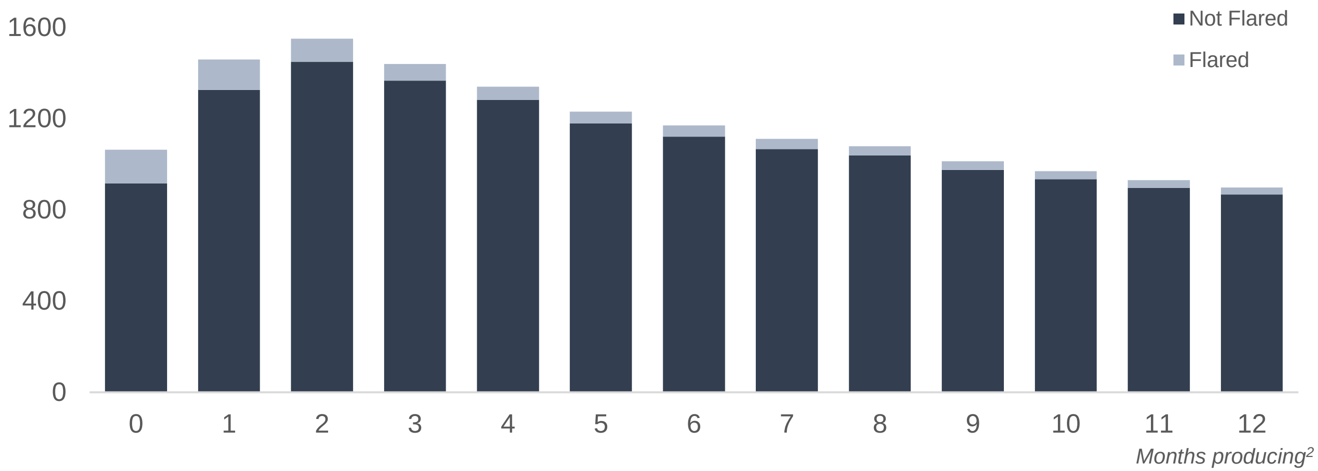
1: Limited by data availability; typically, 10-15% of Permian production lacks a reported gas gatherer.
Source: Rystad Energy ShaleWellCube

Flaring intensity tends to decrease over a well's lifetime

Entire Permian

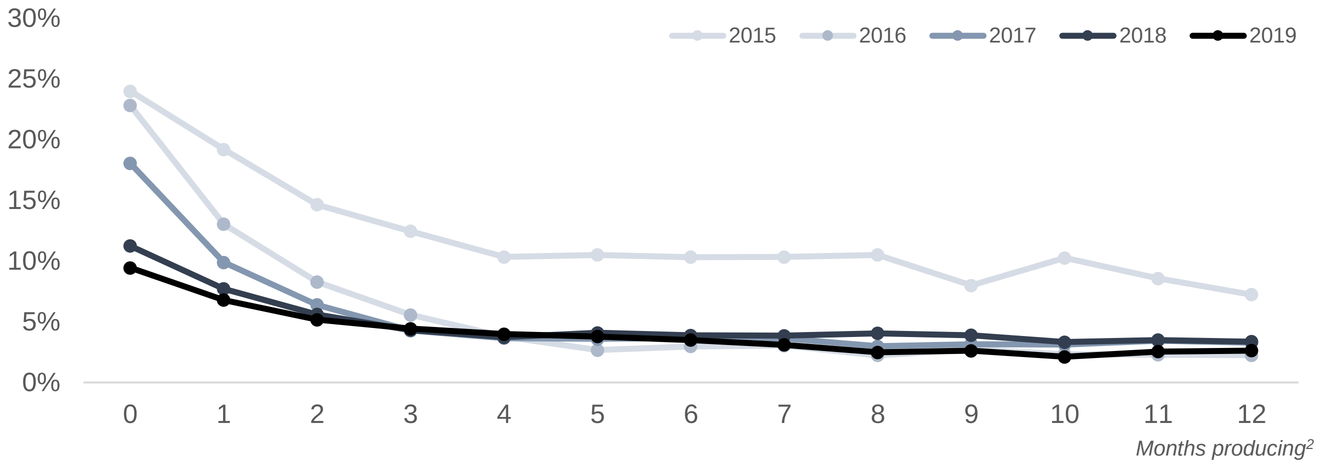
Average gas production by end use, average for completions 2015-2019
Thousand cubic feet per day

Single well leases only[1]



Average flaring intensity per production month by completion year
Percentage

Single well leases only[1]



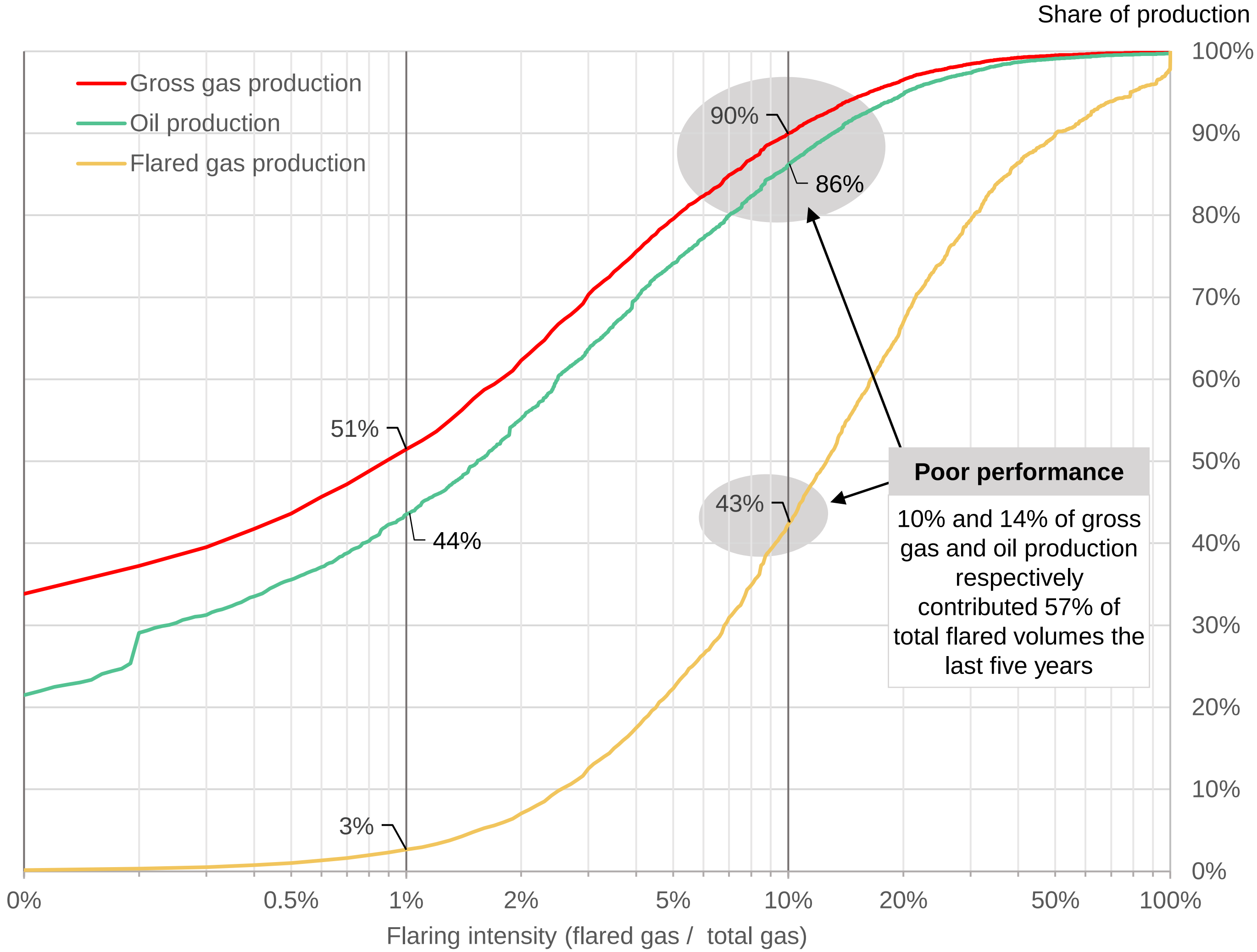
- Average total gas production tends to peak in the second cumulative month. Average non-flared gas production also peaks in the second cumulative month while average flared gas volumes tends to peak in month 0[2].
- In general, after six months the average amount of flared gas begins to flatten as total gas production continues to gradually decrease.

- Across the last five years average flaring intensity in cumulative month zero has decreased substantially from a high of 25% in 2015 to 10% in 2019. This is remarkable given that single-well leases often lack nearby infrastructure.
- Other than in 2015, average flaring intensity across years converged about 5% by month four and stayed around the same intensity with a few fluctuations for the next eight cumulative months.

1: Data shown based on leases with one well has been drilled to date, indicative of well-level flaring and flaring intensity. 2: Month 1 is the first full month of production
Source: Rystad Energy ShaleWellCube

10% of gross gas production accounted for 57% of flaring the past five years

Lease production and flaring ranked by flaring intensity[1]
Flaring intensity (x-axis) versus cumulative share of production and flaring (y-axis)



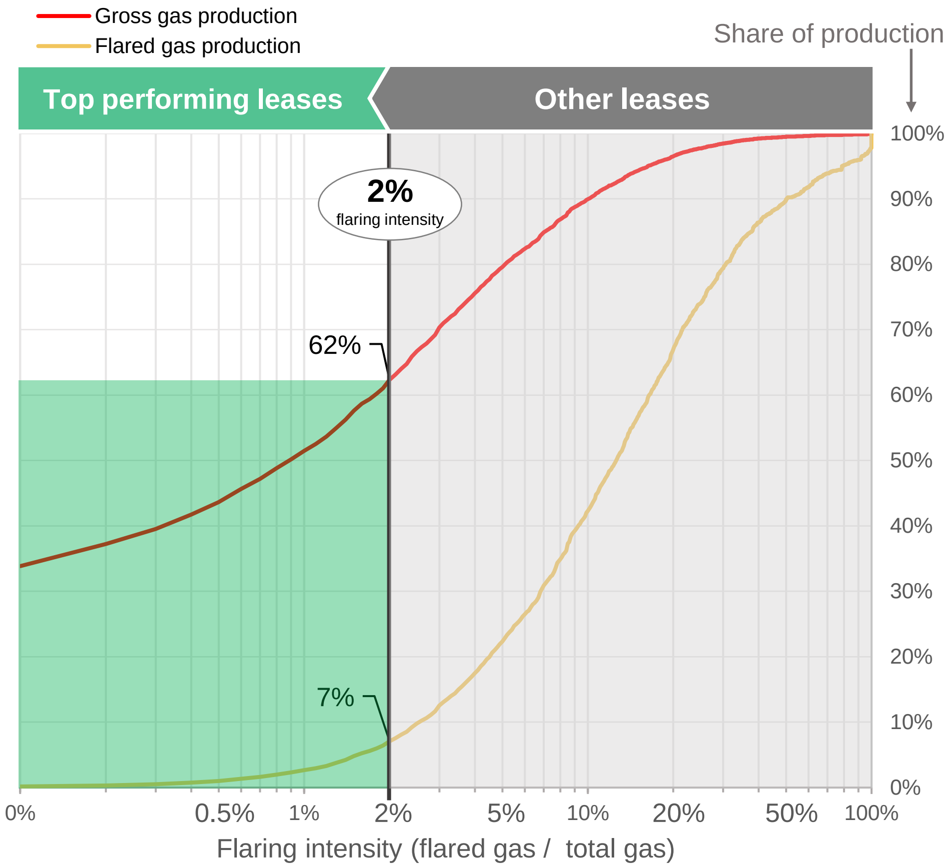
- The plot shows flaring intensity (flared gas divided by gross gas production) against cumulative production (gas, oil, and flared volumes broken out separately), calculated over the period 2015-2019.
- 51% of produced gross gas came from leases with flaring intensity below 1% on average over the period, accounting for only 3% of total flaring in the basin.
- Conversely, the last 10% of gas production and 14% of oil production accounted for approximately 57% of flared gas during the period.
- This indicates that the majority of flaring comes from a relatively small number of leases, generally flaring over 10% of produced gas.
- 3% of leases flared 100% of produced gas during the period.

1: Each point represents a lease
Source: Rystad Energy research and analysis; ShaleWellCube

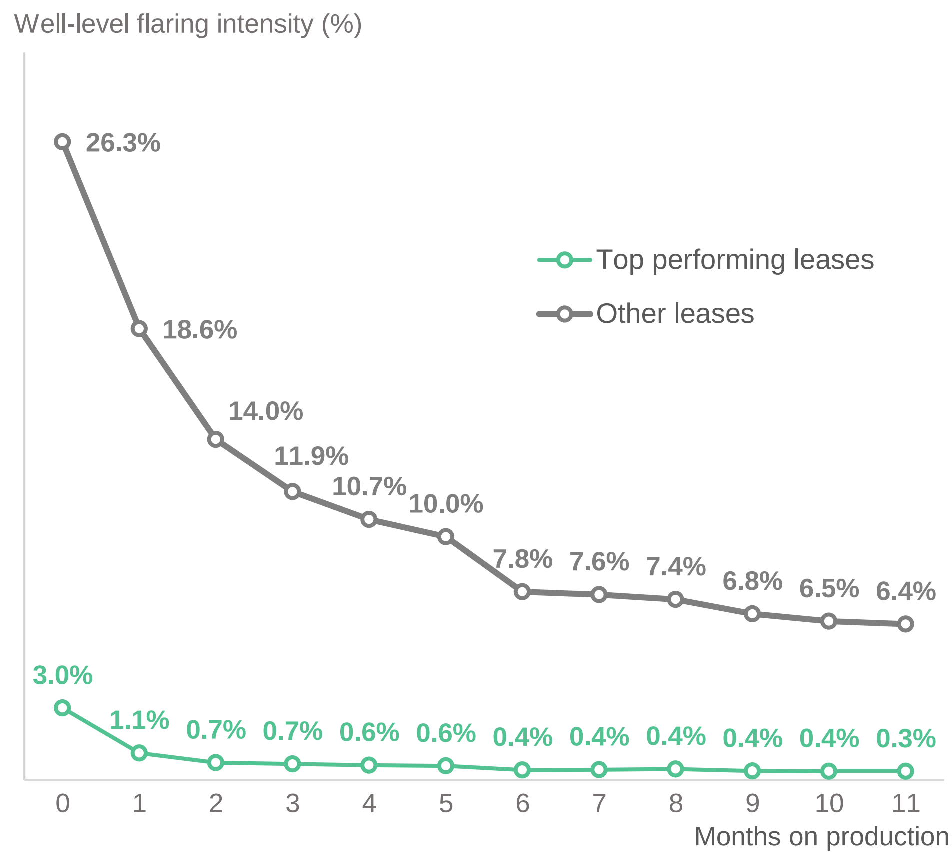
Leases with low flaring used as a benchmark for top performers' operational flaring

Entire Permian

Lease production and flaring ranked by flaring intensity[1]
Flaring intensity (x-axis) versus cumulative share of production and flaring (y-axis)



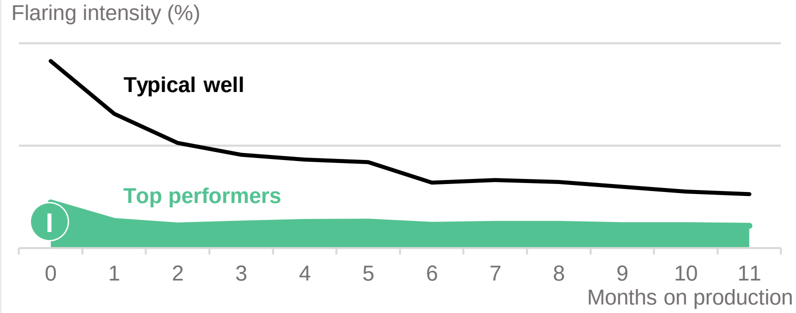
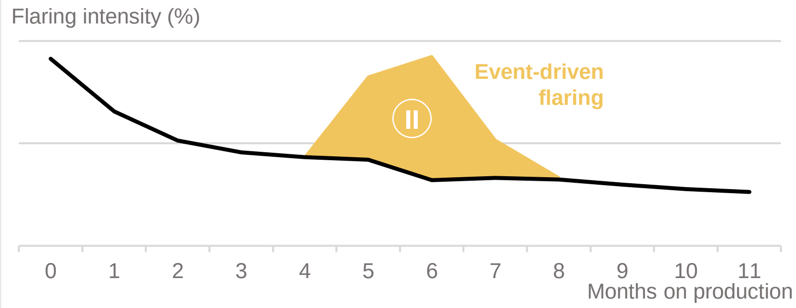
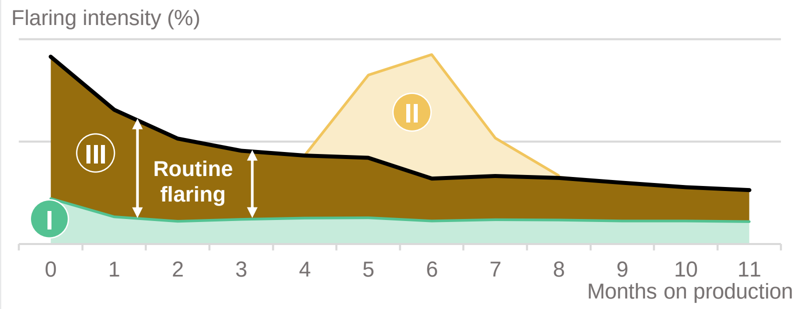
Average flaring intensity per well[2]
Months from production start, flaring intensity (percent)



Using leases that have flared less than 2% cumulatively the past five years, we establish a 'top performers' benchmark. We further use this benchmark to compare observed flaring against what could be achieved if all wells in the basin performed in line with these top performers.

1: Each point represents a lease
2: Average well level monthly flaring intensity. Includes wells completed during 2015-2019
Source: Rystad Energy research and analysis

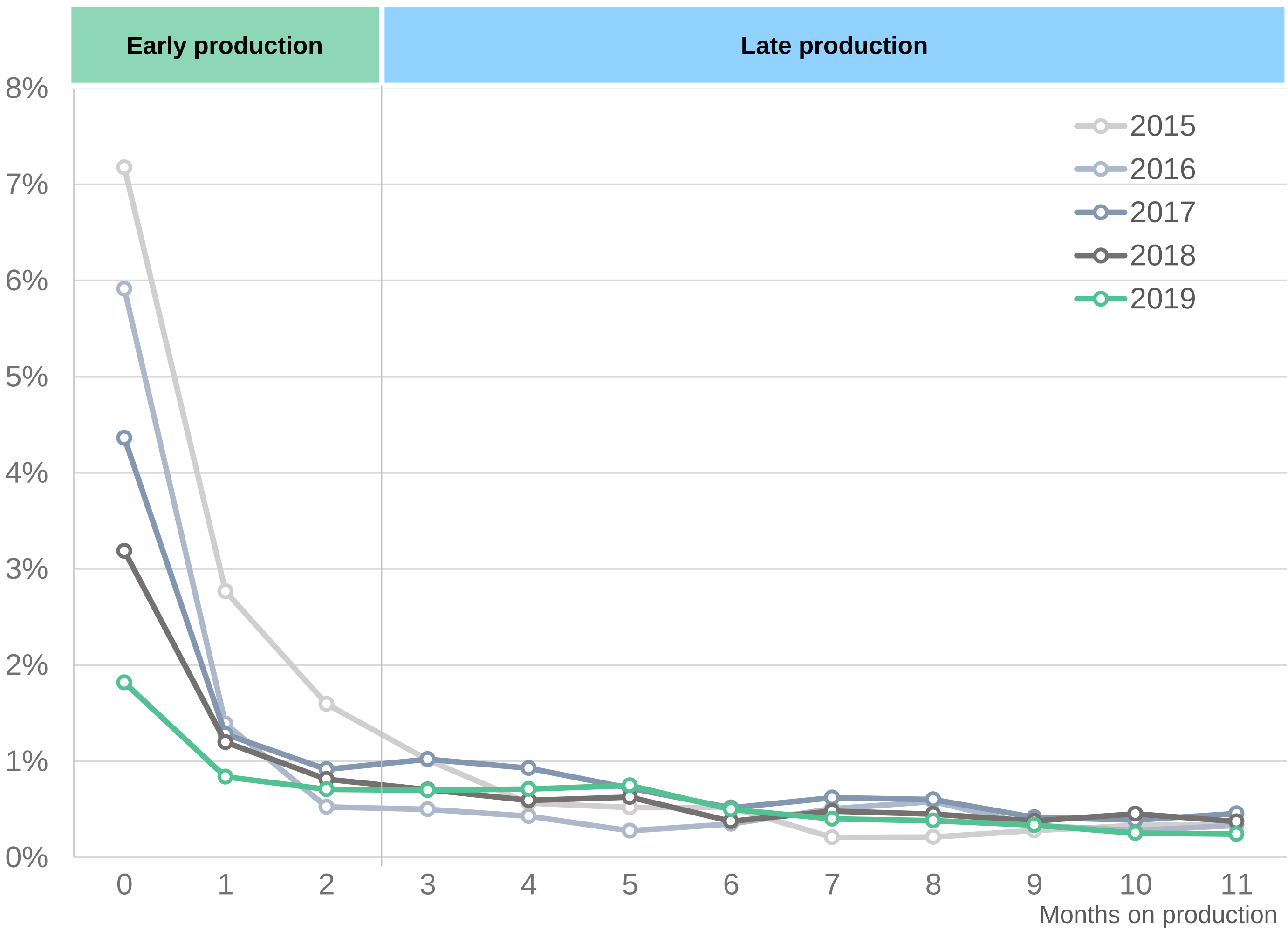
Flared volumes are categorized on three levels based on their typical cause

Categorization of flaring types		*Well level flaring categorization (indicative)*
I **Top performers operational flaring**	• Top performers flaring level is applied to each well across the basin to establish an achievable flaring intensity if all wells reduced their flaring to levels seen among the best leases (those with <2% flaring). • This establishes a baseline flaring level achievable today given regulatory and technological status quo, with only high-grading of operational performance. • The top performers flaring level could also be reduced further from current levels, mainly by reducing flaring intensity in initial months of production.	
II **Event-driven flaring**	• Event-driven flaring occurs when flaring intensity increases on a well level compared to previous periods. These increases are attributable to well-, lease-, or infrastructure-level events which necessitate higher flaring for a period. • Smaller events are localized geographically (only impact one lease/operator and temporally (~0.5-2 months) and typically result in small increases is in flaring intensity. • Larger events like basin- or county-wide midstream outages can have a significant impact on many wells across operators and time.	
III **Routine flaring**	• Routine flaring represents all flaring above the top performers' operational flaring benchmark that is not attributable to non-routine (event) flaring. • Main reasons for this routine element of flaring is mis-timing or lack of gathering or midstream capacity and low/negative expected value of gas commercialization. • Most wells with routine flaring eventually reduce flaring intensity to top performers' level, meaning the routine element is mostly driven by new well startups with high initial flaring.	

Source: Rystad Energy research and analysis

Among top performers, there has been improvement in initial flaring intensity

Top performer[1] well level flaring intensity per month, by well vintage
Flaring intensity (percent)

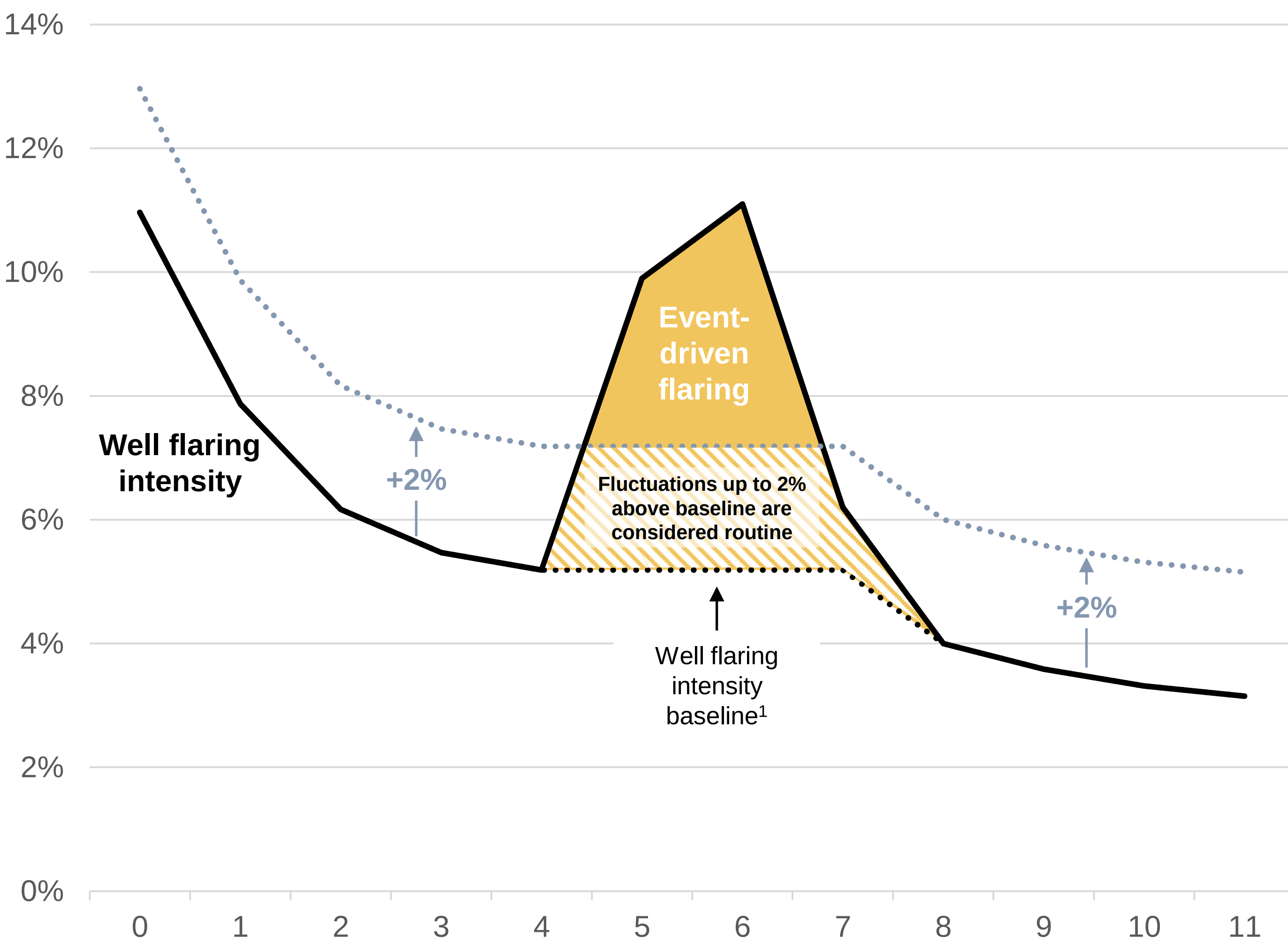


- The chart shows the average monthly flaring intensity per well for the leases with cumulative flaring intensity below 2% (the 'top performers').
- From 2015 to 2016, flaring intensity has come down by ~75% in the initial month of production.
- During late life (after months 0-2), there has been limited improvement in flaring intensity, possibly indicating a baseline level of flaring that can be expected in the normal course of operations in the current environment absent additional regulations.
- Top performers operational flaring can be further reduced both in early and late production from current levels.

1: Wells drilled on leases with cumulative flaring intensity less than 2% over the period 2015-2019.
Source: Rystad Energy research and analysis

Event-driven flaring is detected after accounting for ‘routine’ variations in flaring intensity

Flaring intensity by month from first production month, illustrative profile
Percent of gross production

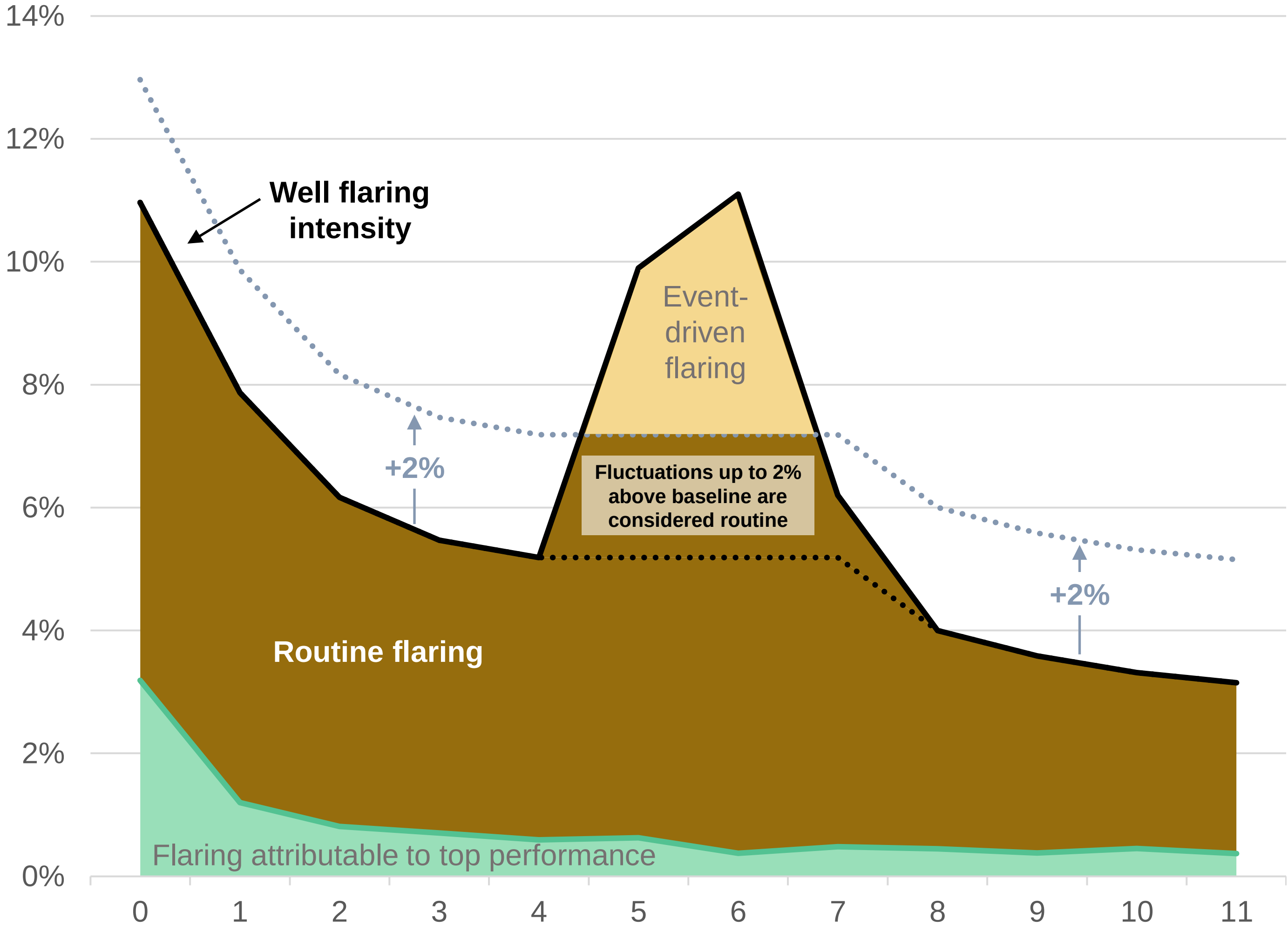


- Event-driven flaring is calculated after first establishing each well’s baseline flaring intensity. Baseline flaring intensity is calculated in each month as the minimum intensity achieved in all months up to and including the current month.
- Variations of up to 2% above baseline are considered routine and not categorized as event-driven flaring.
- The size of these events vary significantly, consequently the changes are analyzed separately based on their magnitude. Large occurrences of non-routine flaring are tied back to known events where possible to understand the typical root causes (localized versus systemic).

1: Baseline calculated monthly for each well as the minimum intensity achieved in all months up to and including the current month. Variations up to 2% above baseline are considered routine
Source: Rystad Energy research and analysis

III Routine flaring is the residual after accounting for events and top performance baseline

Flaring intensity by month from first production month, illustrative profile
Percent of gross production

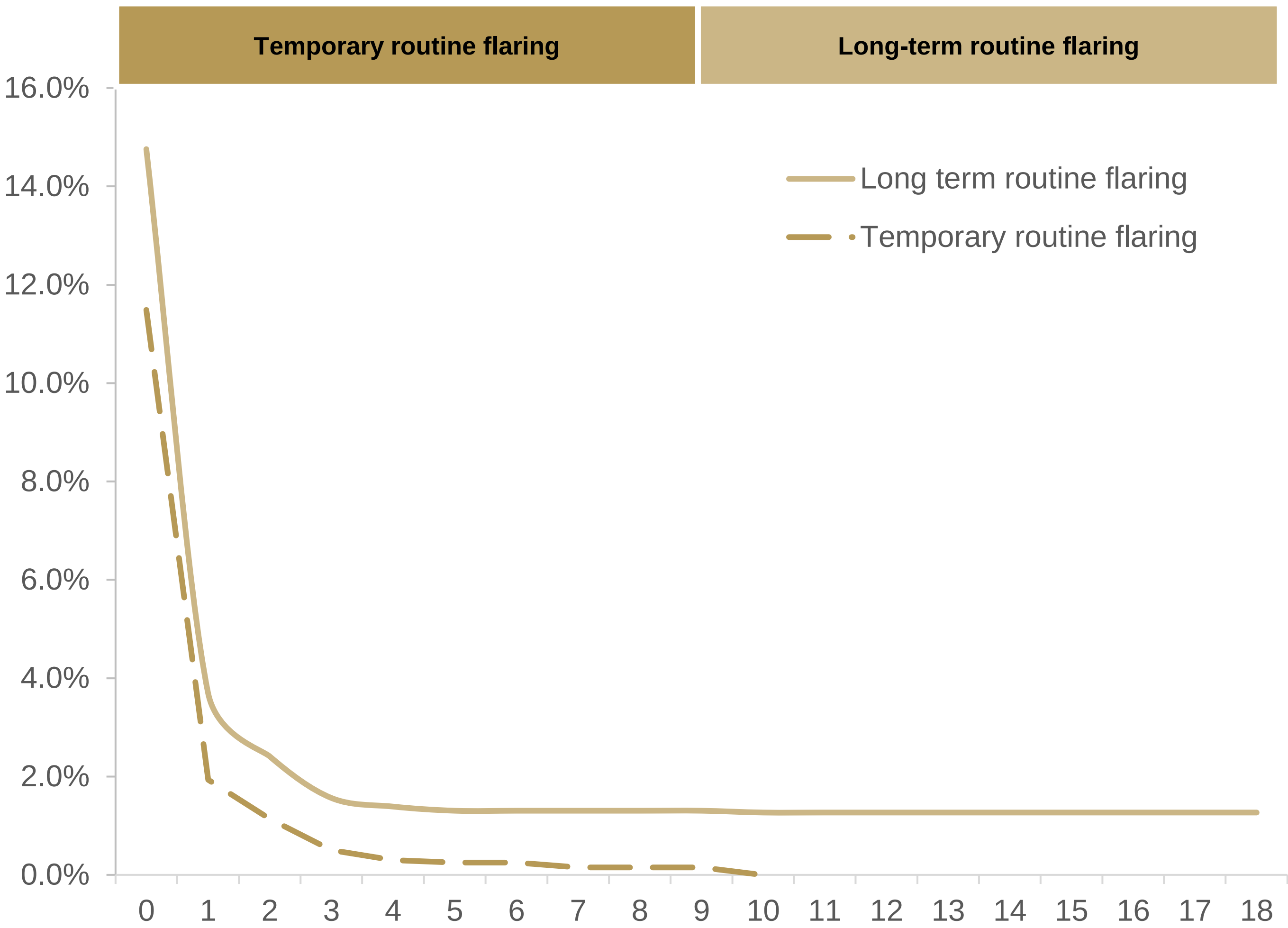


- After categorizing event-driven and top operational performance baseline flaring, the remainder is categorized as routine– that is, flaring above the 'best performers' category that is not attributable to events.
- Routine flaring varies widely across operators, geographies and over time. This portion is likely due in part to decisions taken by operators from an operational and economic standpoint to flare instead of commercializing gas.
- Understanding the persistence of routine flaring throughout a well's lifetime (temporary versus long term routine flaring) is key in understanding the underlying drivers.

1: Baseline calculated monthly for each well as the minimum intensity achieved in all months up to and including the current month. Variations up to 2% above baseline are considered routine
Source: Rystad Energy research and analysis

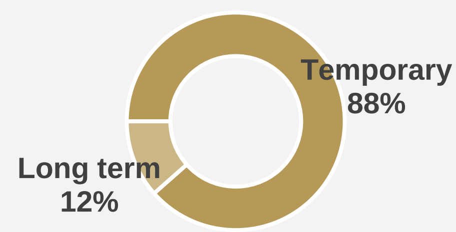
Wells are categorized on whether the routine flaring converges to zero or not

Routine flaring intensity by month from first production month, illustrative profile
Percent of gross production



- In order to understand the different impact from wells where routine flaring varies over time, we have categorized wells based on whether routine flaring intensity converges to zero within the first 12 months (temporary) or persists beyond this time frame (long-term).
- For the wells where we find long-term routine flaring, it is more likely that the flaring is a result of economic decisions or a persistent lack of infrastructure.

Share of wells per category[1]



1: Wells in the 2018 completion vintage shown
Source: Rystad Energy research and analysis

Event-driven and temporary routine are the largest contributors to flaring

Permian Texas

Main drivers of flaring 2019

I Top performers operational flaring

34 million cubic feet per day

0.3% of gross gas production

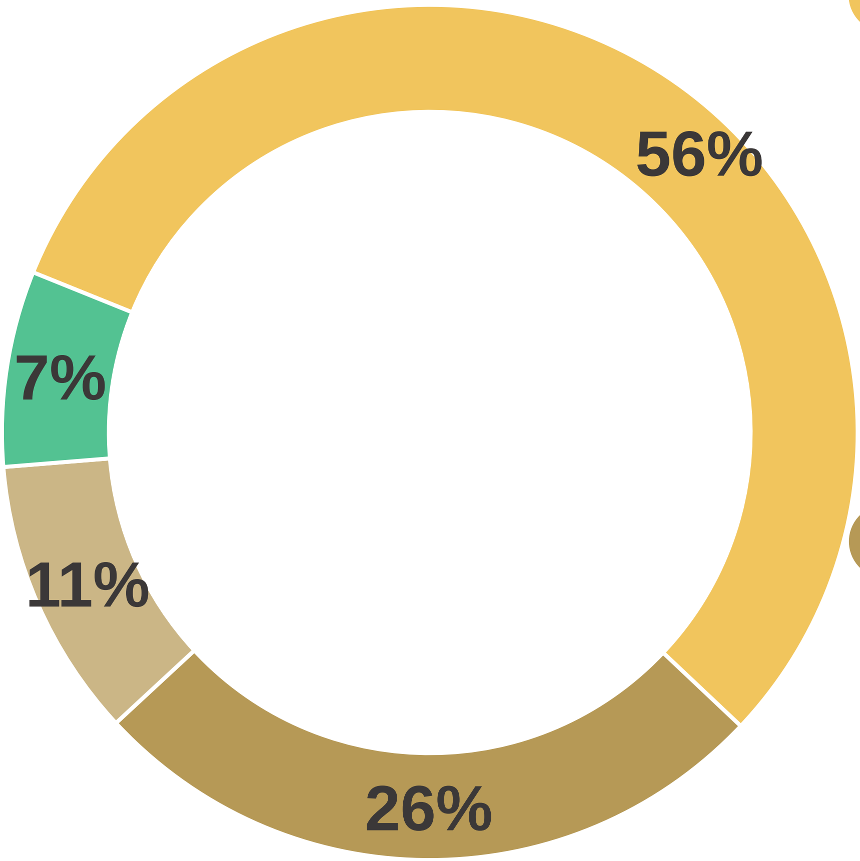
The expected flaring level if all leases were to flare at the level of the best leases today, given current technology and regulatory regime.

III Long term routine flaring

48 million cubic feet per day

0.4% Share of gross gas production

Long term routine flaring comes from wells that do not reduce flaring intensity to top performers' levels of flaring within the first 12 months of production.



II Event-driven flaring

256 million cubic feet per day

2.3% of gross gas production

Event-driven flaring is the estimated amount of flaring resulting directly from events which cause large increases in percentage of gas flared compared with historical periods.

III Temporary routine flaring

119 million cubic feet per day

1.1% Share of gross gas production

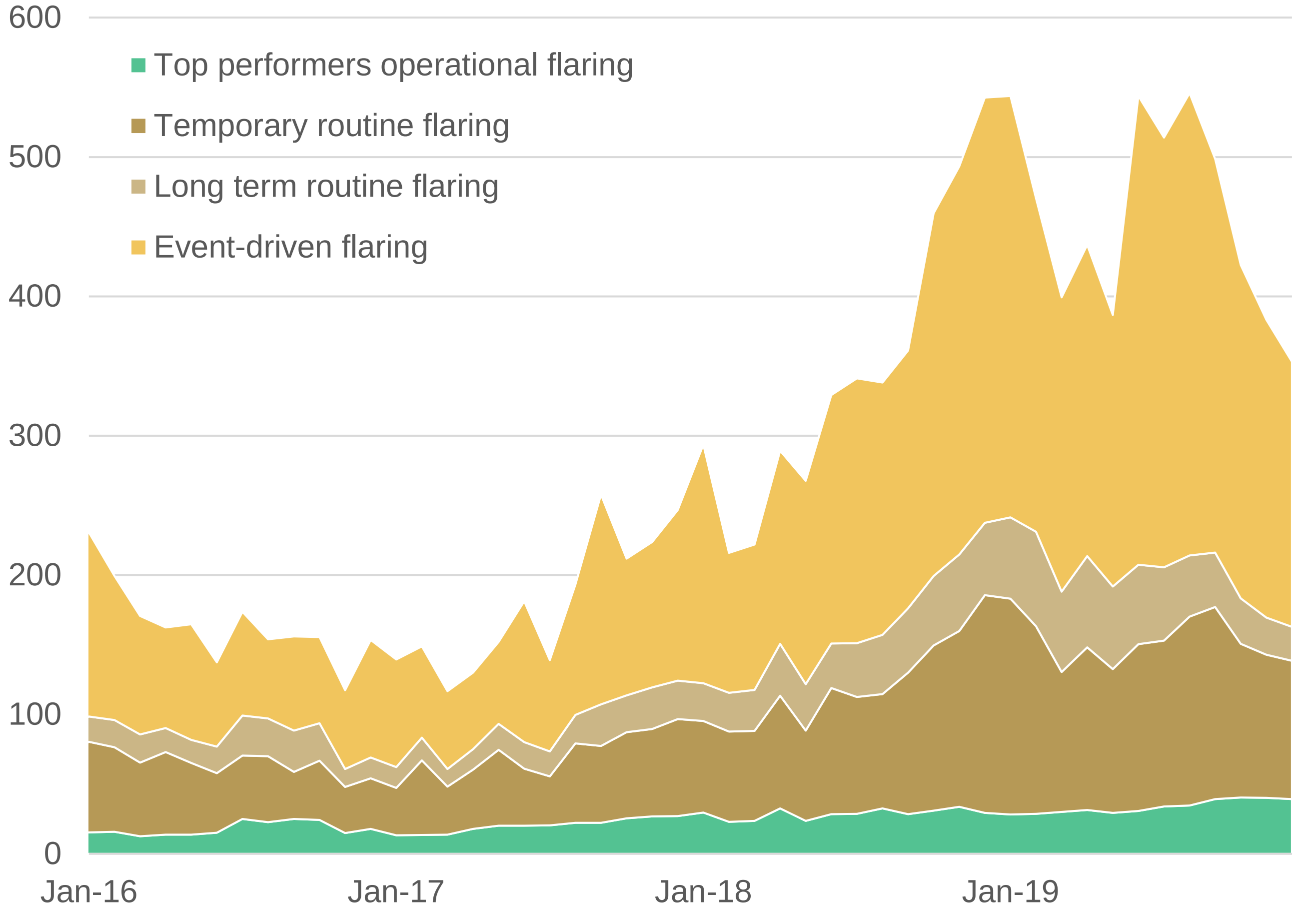
Temporary routine flaring is extraneous flaring that is temporary during the first 12 months of a well's life.

Source: Rystad Energy research and analysis

Over time, event-driven spiked as systems neared capacity and outages occurred

Permian Texas

Flared gas by flaring category
Million cubic feet per day



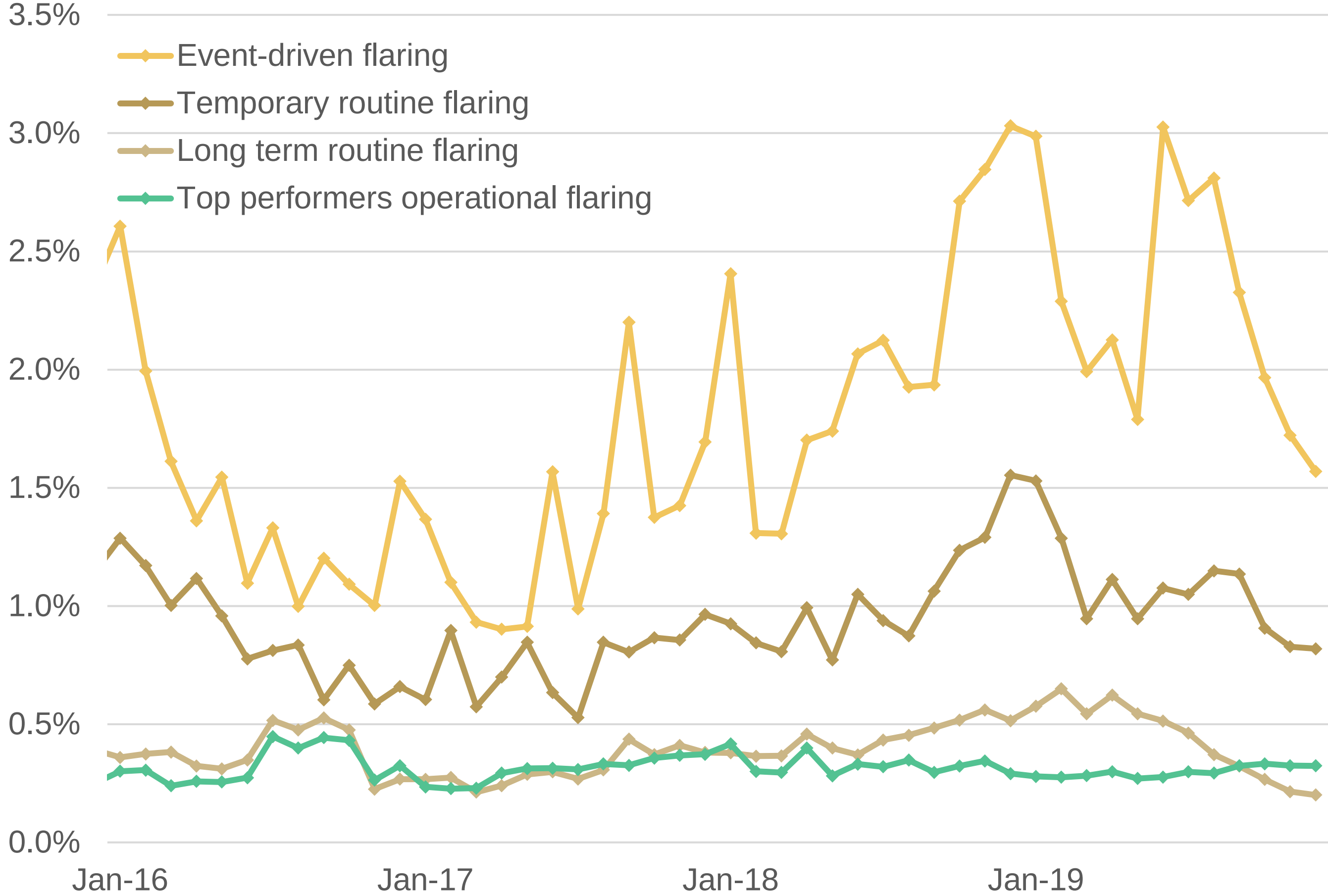
- The chart shows each flaring driver's contribution to total flaring for the Texas portion of the Permian basin.
- All types of flaring increased during the recovery in activity experienced during 2017-2018, with significant spikes in routine and event-driven flaring.
- Long term routine flaring has increased gradually as the share of wells flaring for more than 12 months increased.
- All types of flaring stabilized or declined during the second half of 2019 as activity pace slowed and various midstream outages / bottlenecks were resolved.

Source: Rystad Energy research and analysis, ShaleWellCube

Event-driven flaring segment has highest intensity within Texas-Permian

Permian Texas

Flaring intensity by flaring category
Percent of gross production



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Source: Rystad Energy research and analysis, ShaleWellCube

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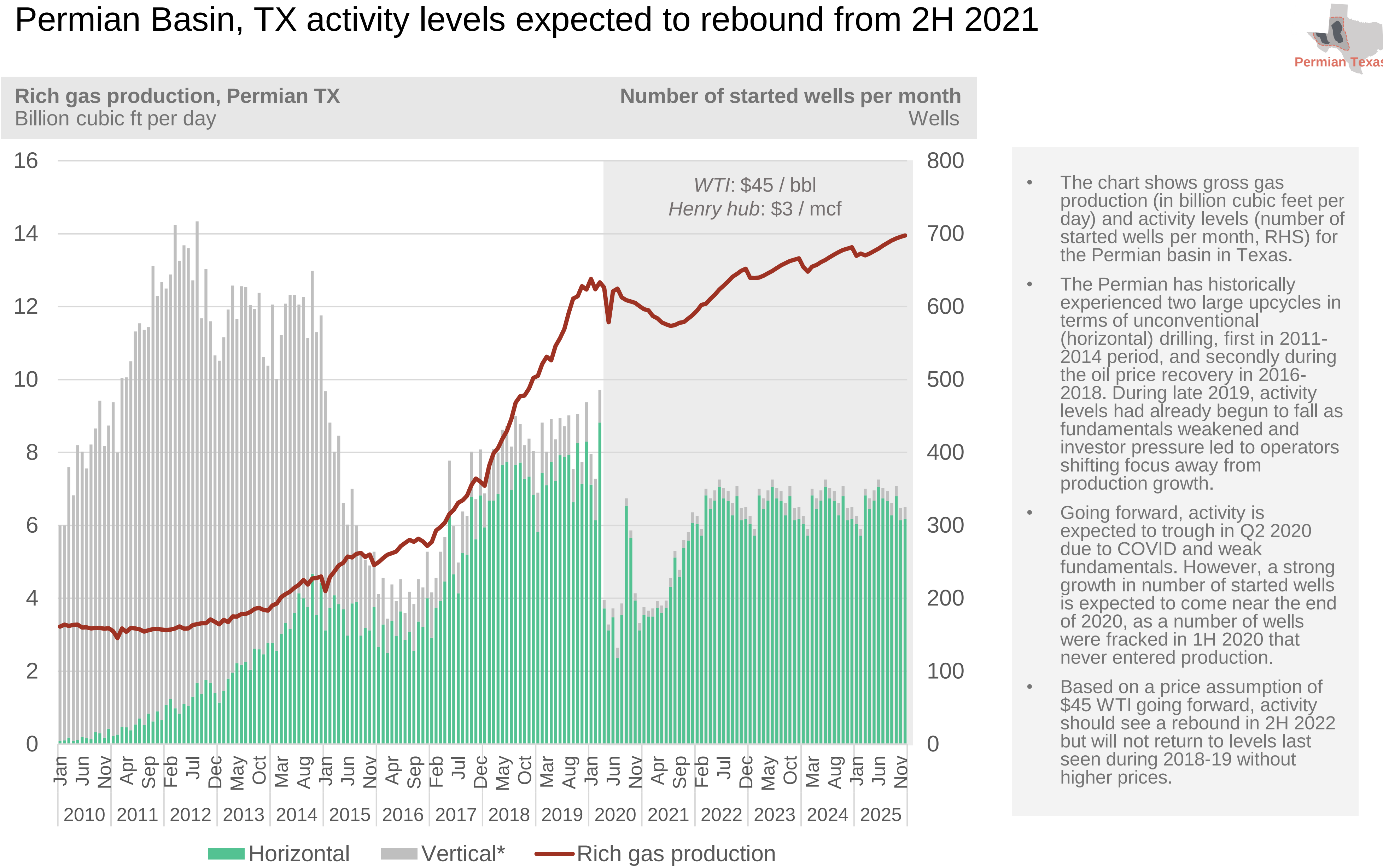
I. Summary of findings

II. Review of historic flaring trends and drivers

III. Base case outlook to 2025

IV. Evaluation of alternative policy scenarios

Permian Basin, TX activity levels expected to rebound from 2H 2021



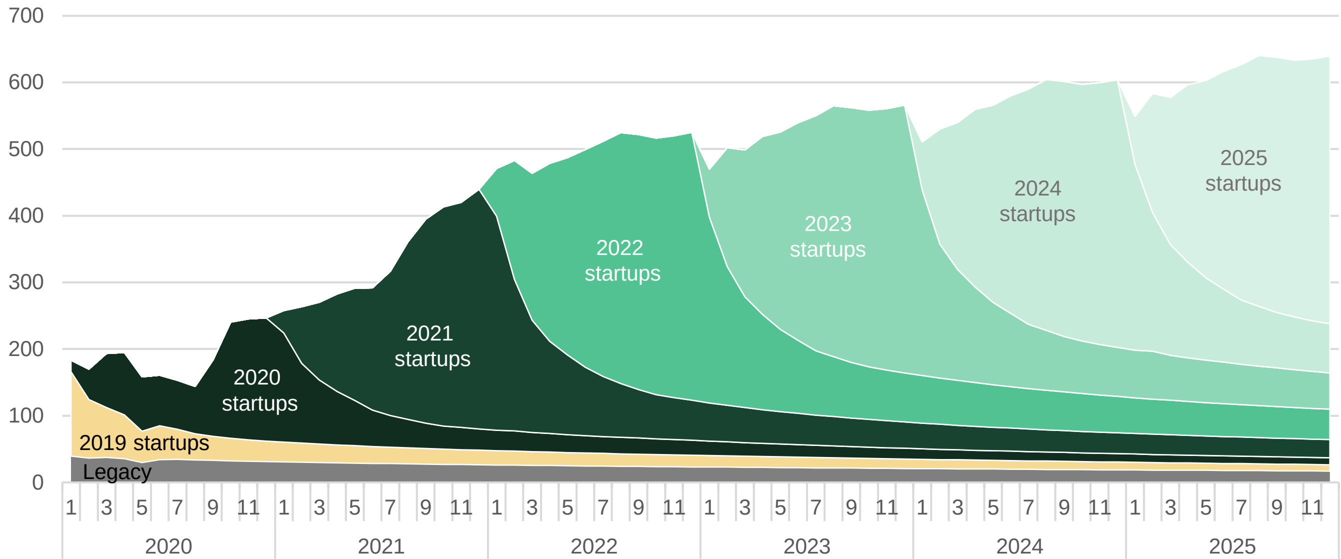
- The chart shows gross gas production (in billion cubic feet per day) and activity levels (number of started wells per month, RHS) for the Permian basin in Texas.
- The Permian has historically experienced two large upcycles in terms of unconventional (horizontal) drilling, first in 2011-2014 period, and secondly during the oil price recovery in 2016-2018. During late 2019, activity levels had already begun to fall as fundamentals weakened and investor pressure led to operators shifting focus away from production growth.
- Going forward, activity is expected to trough in Q2 2020 due to COVID and weak fundamentals. However, a strong growth in number of started wells is expected to come near the end of 2020, as a number of wells were fracked in 1H 2020 that never entered production.
- Based on a price assumption of $45 WTI going forward, activity should see a rebound in 2H 2022 but will not return to levels last seen during 2018-19 without higher prices.

*Including vertical and directional wells
Source: Rystad Energy research and analysis, ShaleWellCube

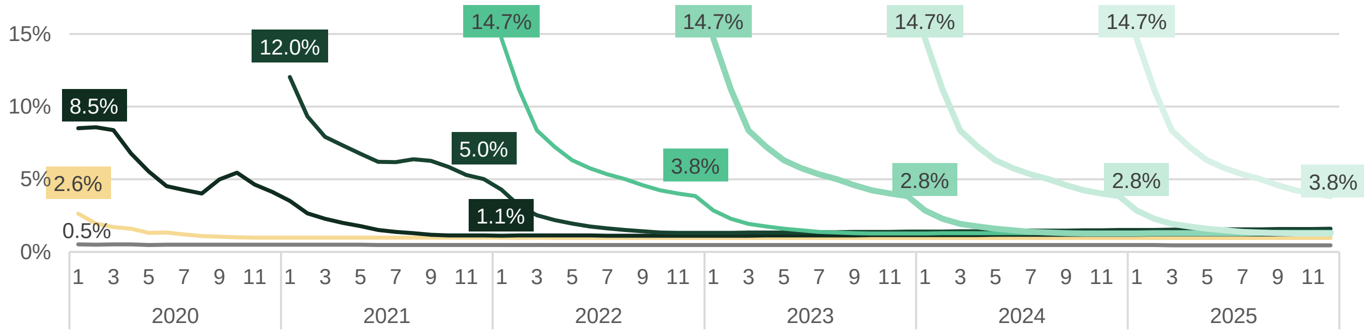
Routine flaring is driven by production from new wells in early production months

Permian Texas

Permian Texas routine flared gas by well vintage, including top performers
Million cubic feet per day



Permian Texas flaring intensity by well vintage
Percent of gross gas production



- The upper chart shows forecasted routine flaring by well vintage. For the oldest wells (more than 12 months old at January 2020), routine flaring intensity has reached a low level relative to what is typically observed historically. Future routine flaring from these wells is estimated at the operator-county level and assumes constant routine flaring intensity going forward
- For future and newer wells, the forecast applies historic trends on the well level to estimate how routine flaring develops as wells mature- typically declining as production matures, resulting in lower flaring intensity for a given vintage over time. Future flaring intensity is forecast at an operator-county-vintage level using historic flaring intensity profiles observed from wells completed from 2018 to present.

Source: Rystad Energy research and analysis; ShaleWellCube

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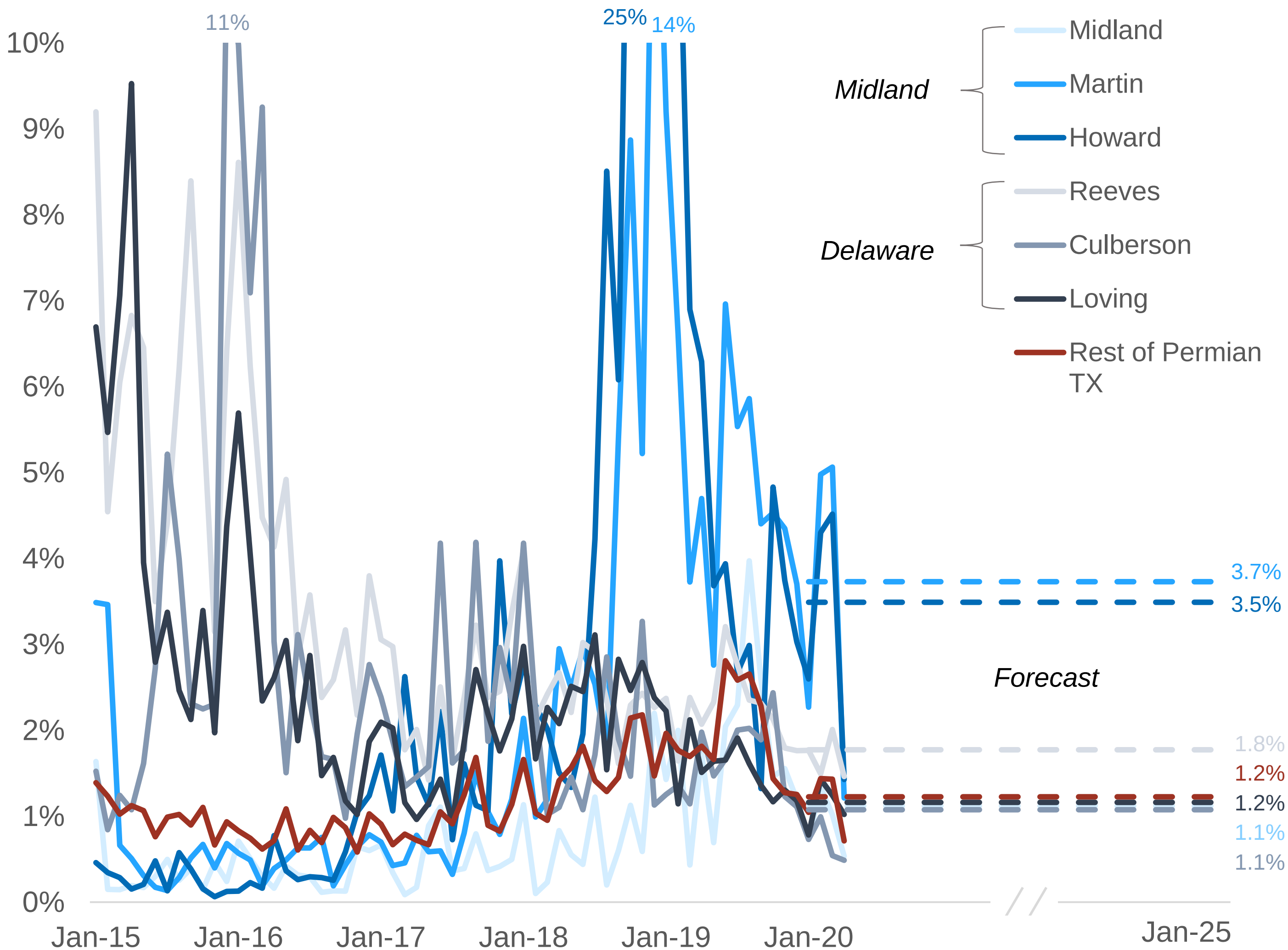
Event-driven flaring assumes continuation of trends seen on the past 7 months[1]

Permian Texas

Permian Texas event-driven flaring intensity
Percentage

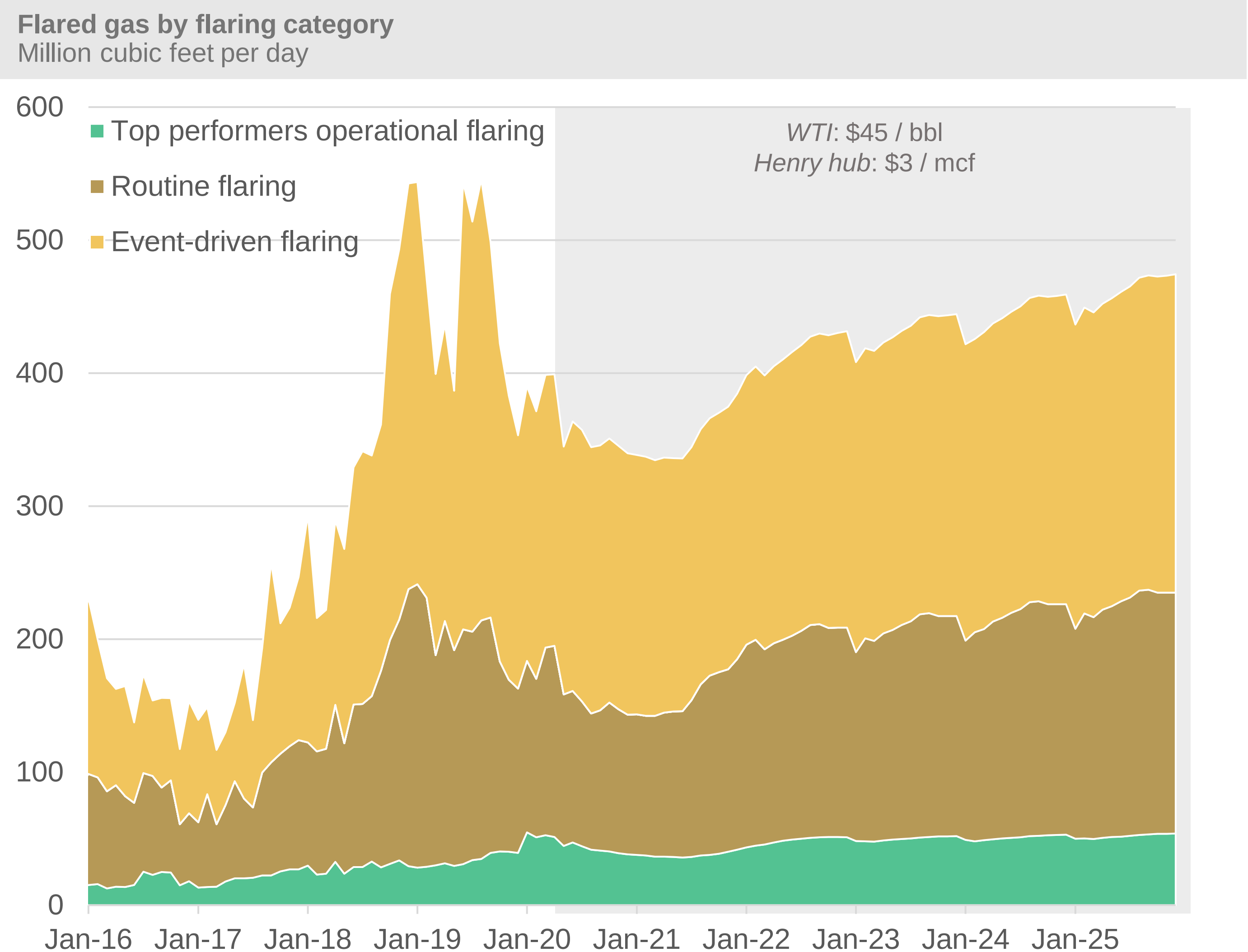


- The forecast for event-driven flaring intensity is done at the county level to capture the localized infrastructure challenges present in each county.
- Outages or infrastructure constraints affect each county in the short term, resulting in increased levels of the event-driven flaring. In the long term, however, these issues are resolved.
- It is important, then, to forecast event-driven flaring based upon recent flaring levels to better capture the current infrastructure situation and dilute one-off outages.
- Consequently, the forecast is based upon the average of the previous seven months of non-routine flaring intensity, pre-COVID-19.

1: October 2019 through April 2020
Source: Rystad Energy research and analysis

Baseline flared gas to reach ~475 mmcfd by year end 2025

Permian Texas



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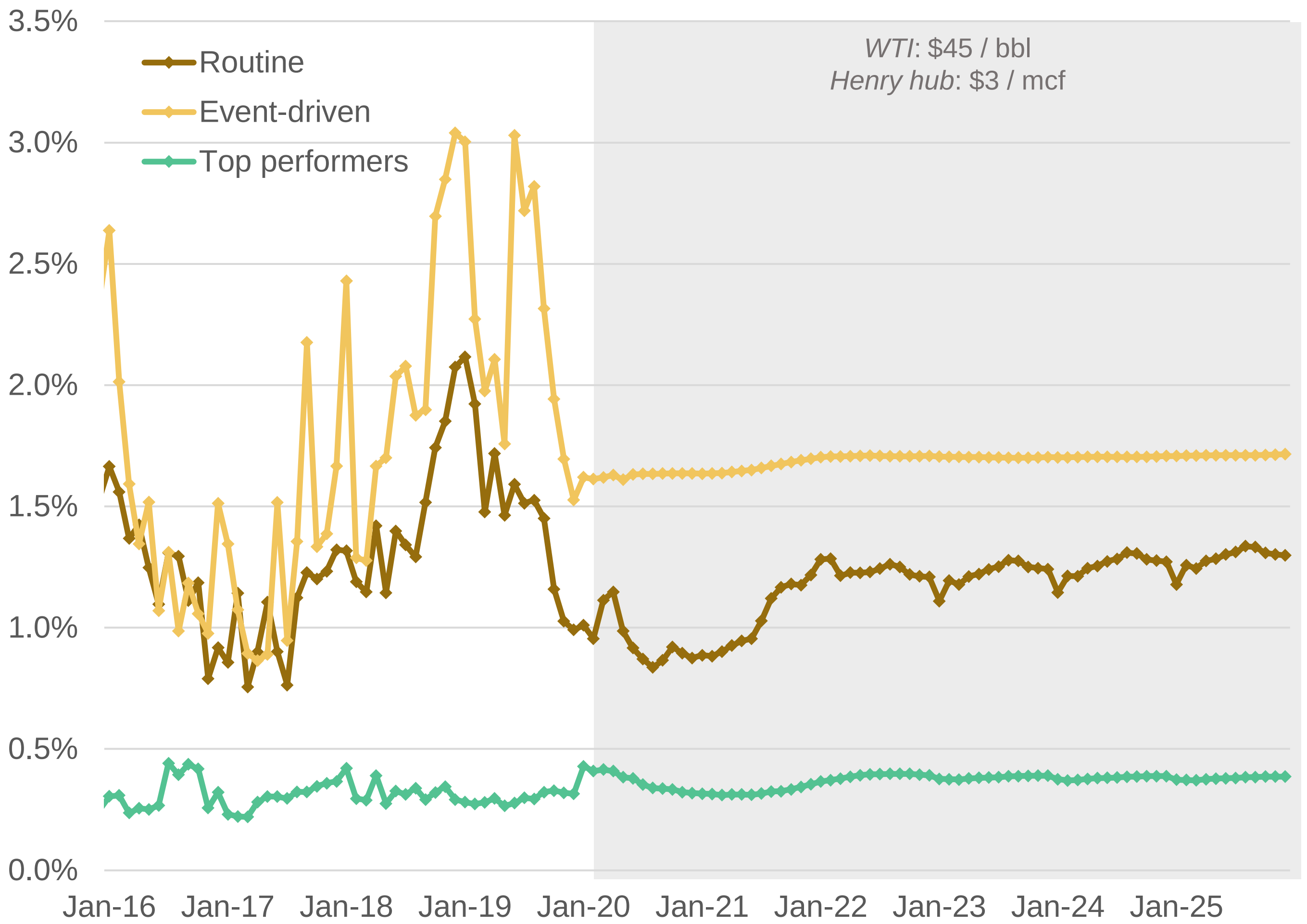
Source: Rystad Energy research and analysis, ShaleWellCube

Baseline flaring intensity naturally stabilizes as commodity price, activity stabilizes

Permian Texas

Flaring intensity by flaring category
Percent of gross production



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Source: Rystad Energy research and analysis, ShaleWellCube

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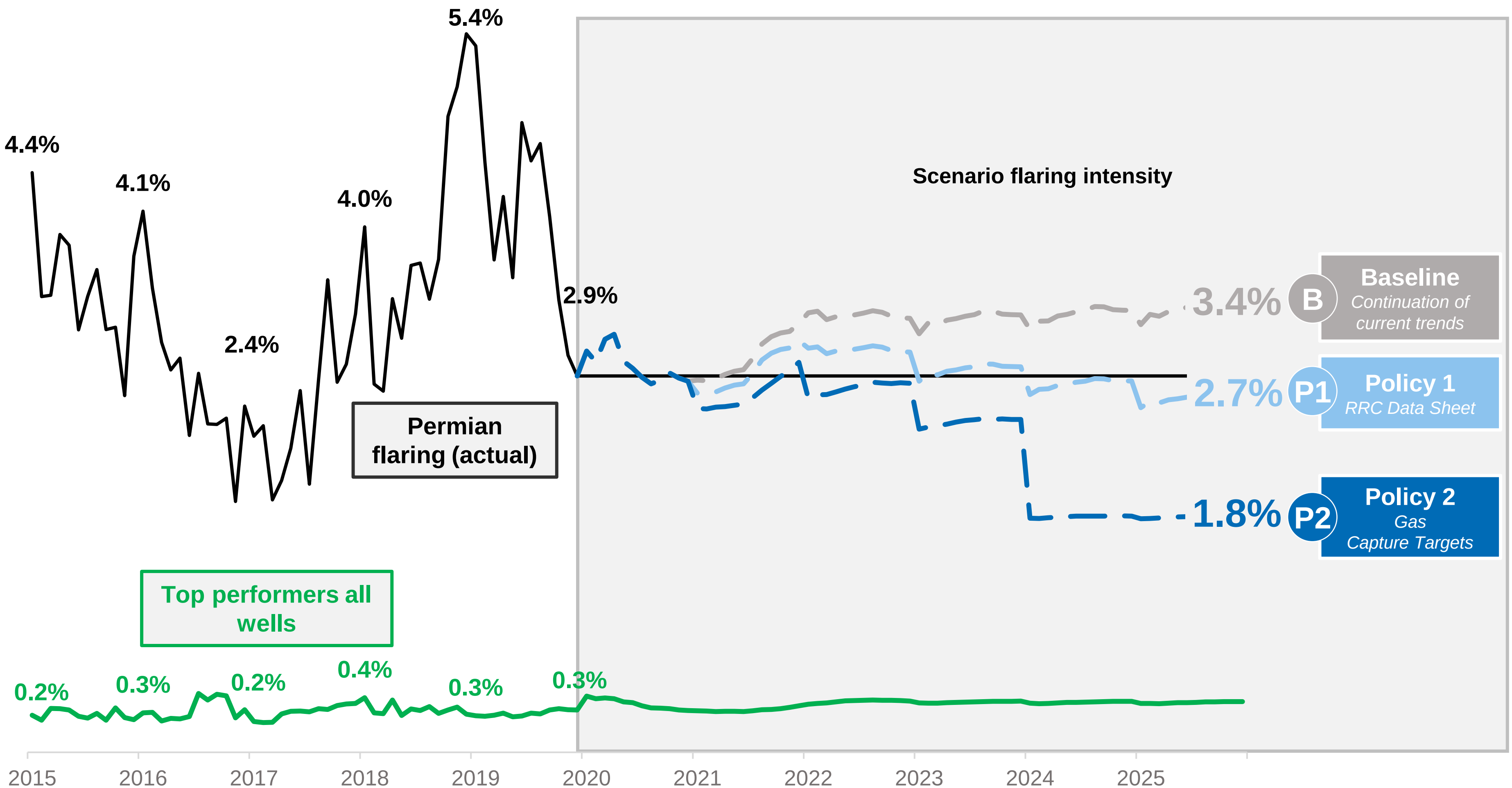
Flaring dynamics are analyzed for three potential future policy environments

	Policy Proposals	*Forecast approach*
B — Baseline: **Continuation of current trends**	In this scenario no new policy proposals are introduced; consequently, the previously detailed operator and geographic trends continue in the Permian. The level of routine flaring in the Permian will not be influenced by regulation and the only reductions in flaring will be the result of operator choice.	• Routine flaring intensity forecasted using latest trends for each operator-county combination; varies over life of each well • Event-driven flaring intensity forecasted using latest county level trends while adjusting for extraordinary outages where necessary. Actual event-driven flaring likely to be more volatile than forecasted
P1 — Policy alternative 1: **RRC Data Sheet**	As of Nov 4th 2020, the Texas Railroad Commission (RRC) enacted a new rule which requires more detailed disclosures by operators around flaring exception requests. According to the RRC, this form "greatly enhances collection of critical data points and in some cases significantly reduces flare duration", without giving specific targets or requirements for the supposed reductions.	• The new data sheet has potential to reduce flaring primarily through increased availability of information and voluntary operator changes. • We base our outlook on potential flaring reductions on the potential for zero- and negative-cost flaring that is occurring, assuming operators will aim to capture this economic activity over time.
P2 — Policy alternative 2: **Gas Capture Targets**	The key component of this proposal is escalating gas capture targets starting in 2021. Under this plan, flaring of gas above the respective thresholds would not be allowed, regardless of cause. The gas capture target would be 90% in 2021 and increase each year through 2024 when it would reach a target of 98%.	• Assumes basin-wide compliance with gas capture requirements that escalate towards 2025. • Gas capture compliance is ringfenced to the operator level, does not include additional gas production (and possibly flaring) coming from other areas in Texas.

Source: Rystad Energy research and analysis, Environmental Defense Fund

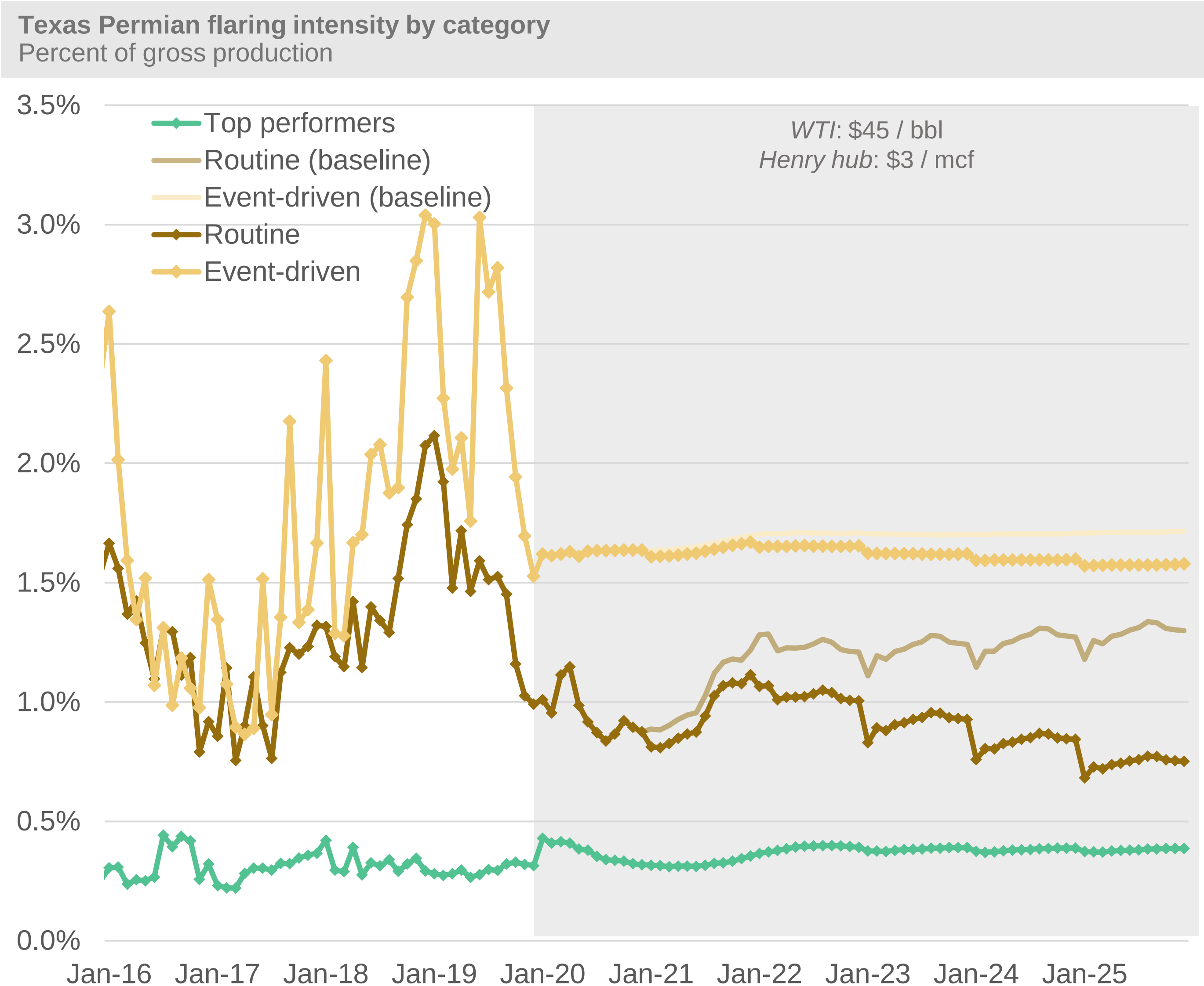
Changes in the production mix, in addition to new policies will influence flaring

Flaring intensity, Permian Texas
Million cubic feet per day



*As flaring intensity on a well level declines over time, a shift in the share of legacy production will change the flaring intensity over time, as will a shift in operator mix
Source: Rystad Energy research and analysis

RRC's new Data Sheet expected to primarily impact routine flaring

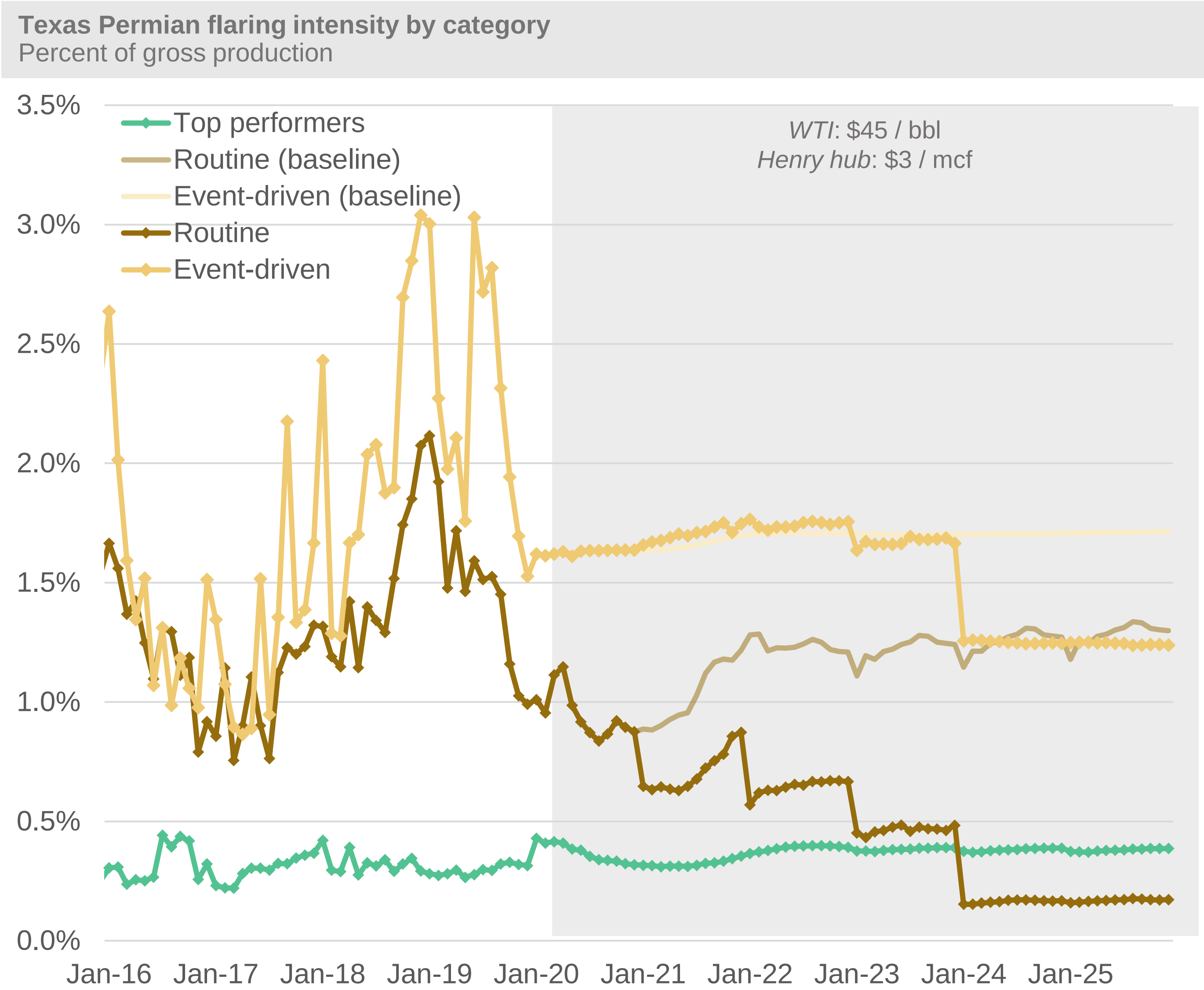


- As part of the new RRC Data Sheet implemented in November 2020, we base our forecast on the assumption that zero- or negative-cost flaring is gradually reduced through changes in operator behavior over time.
- This manifests through reductions in routine flaring, as operators aim to capture more gas that is flared typically in the early life of a well.
- This type of behavior change has already been seen in the largest operators, who have reduced routine flaring significantly in the past 12-36 months.

Source: Rystad Energy research and analysis, ShaleWellCube

P2 Gas capture requirements would largely remove routine, reduce event-driven flaring

Permian Texas

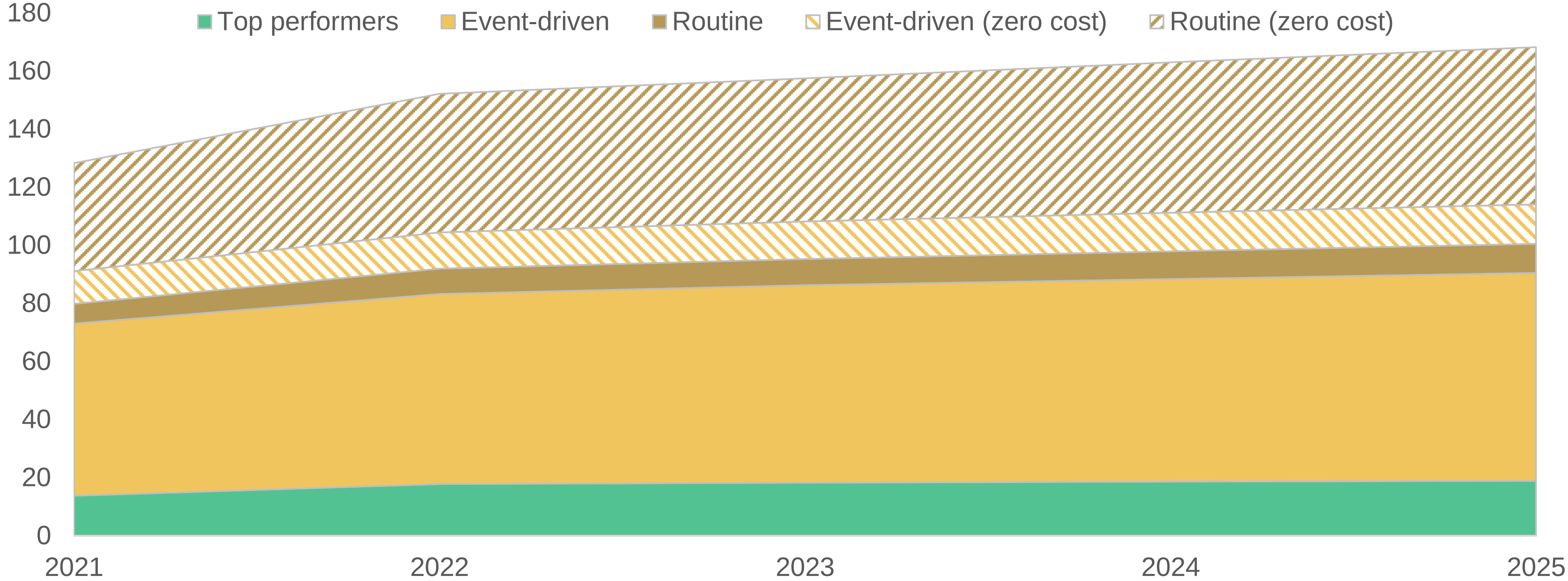


- The gas capture targets scenario sees annual decreases in flaring intensity among routine and eventually event-driven flaring.
- Routine flaring intensity starts to decline relative to the baseline rate in 2021 and at each successive gas capture target. At a 98% gas capture requirement, routine flaring would account for only 0.2% relative to gross production, down from over 2% in late 2018.
- Key in achieving the gas capture targets is a reduction in event-driven flaring, which would begin to occur from 2024 onwards. Portions of event-driven flaring will likely occur abatement costs as the up- and mid-stream industry will require additional investments in local and regional infrastructure to reduce event-driven flaring.

Source: Rystad Energy research and analysis, ShaleWellCube

Approximately 40% of flaring in 2025 is avoidable at no cost to operators

Baseline flaring forecast by flaring type and abatement cost category, 2021 - 2025
Billion cubic feet



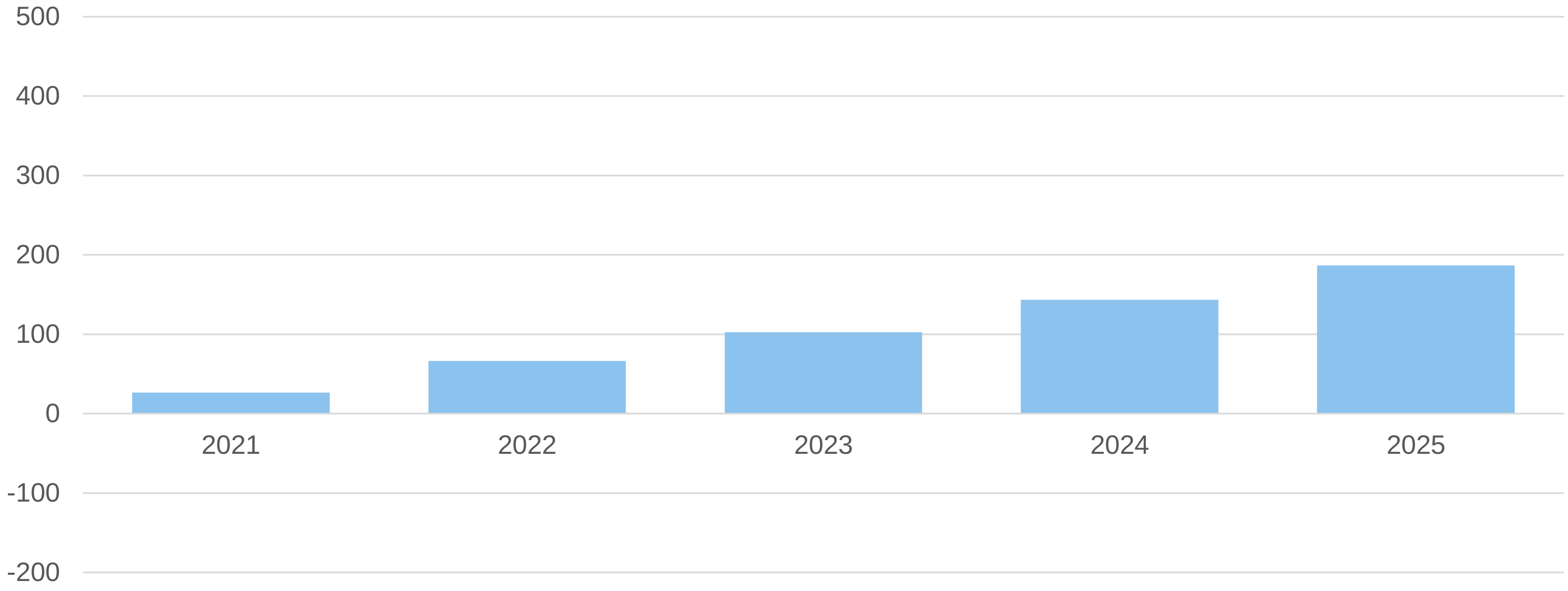
- Total baseline flared volumes are expected to rise 7% per year on average from approximately 130 bcf in 2021 to approximately 170 bcf in 2025.
- We estimate approximately 16% of event-driven flaring and 84% of routine flaring[1] can be abated at zero cost.
- If this potential is fully captured each year, approximately 50% of total flared volumes would be mitigated.
- Most of the zero-cost potential falls under routine flaring. Given this category is largely driven by issues around planning, communication, and other operational circumstances within the control of the operator. Most volumes that are avoidable with an abatement cost are considered event-driven, as this segment is naturally unpredictable and would require additional investments to improve reliability of infrastructure.
- Flaring volumes that can be abated at zero-cost would result in a economic windfall to operators through increased gas sales revenue.

1: Adjusted metric to reflect combined abatement potential of temporary and long-term routine flaring
Source: Rystad Energy research and analysis

Capturing volumes with no abatement costs results in increased sales gas revenues

P1

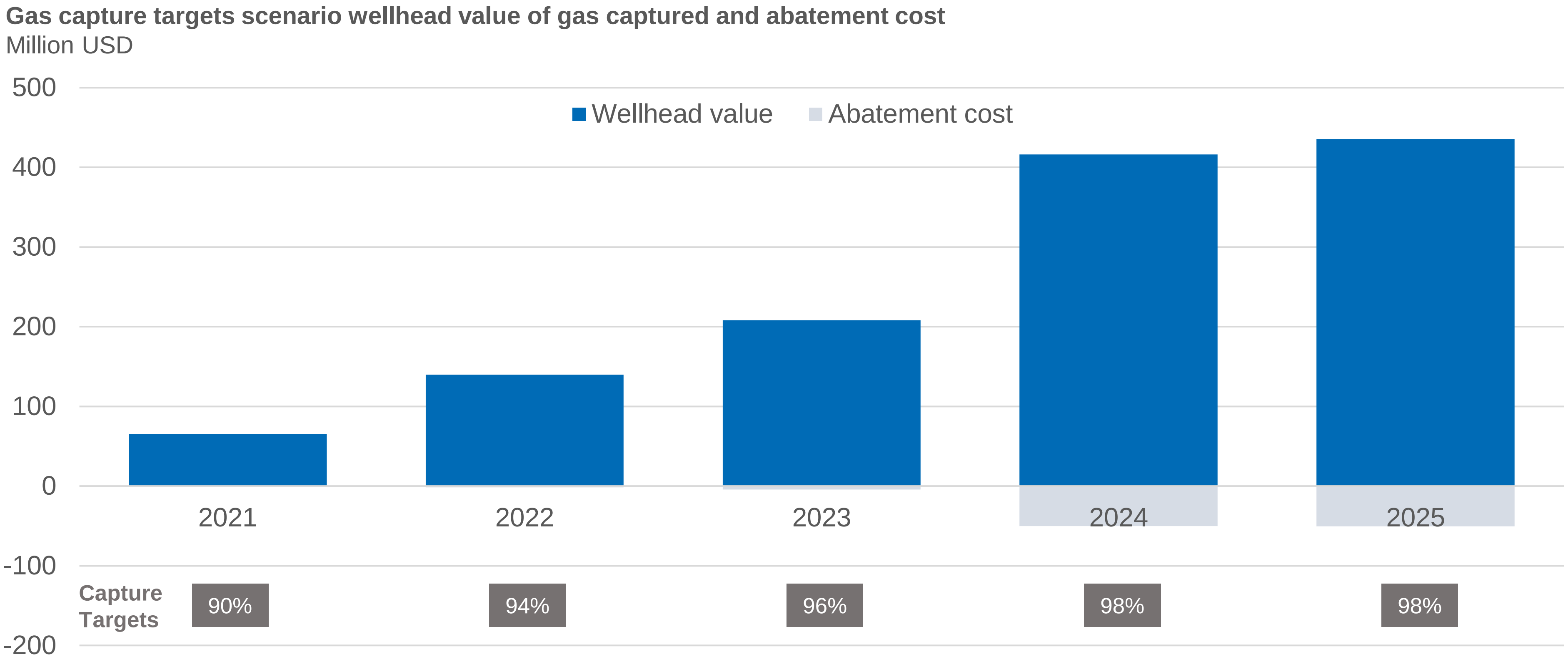
RRC Data Sheet scenario wellhead value of gas captured[1]
Million USD



- Under Policy 1, operators may limit flaring reductions to those achievable with zero abatement cost— volumes that can largely be avoided with improved communication and planning that would require no additional capital investments to achieve.
- In this scenario it is assumed that routine flaring is reduced by 42% and event-driven flaring is reduced by 8% by 2025. Operators are expected to increase abatement gradually over the period achieving 10% of zero cost potential per year.
- If issues of timing and communication are effectively mitigated, Policy 1 reductions would likely result in millions of dollars in value capture per year by commercializing gas that would otherwise have been flared under a business-as-usual scenario.

1: Zero abatement costs expected under Policy 1 scenario
Source: Rystad Energy research and analysis

P2 Wellhead value of avoided flaring under Policy 2 greater than expected cost of reductions

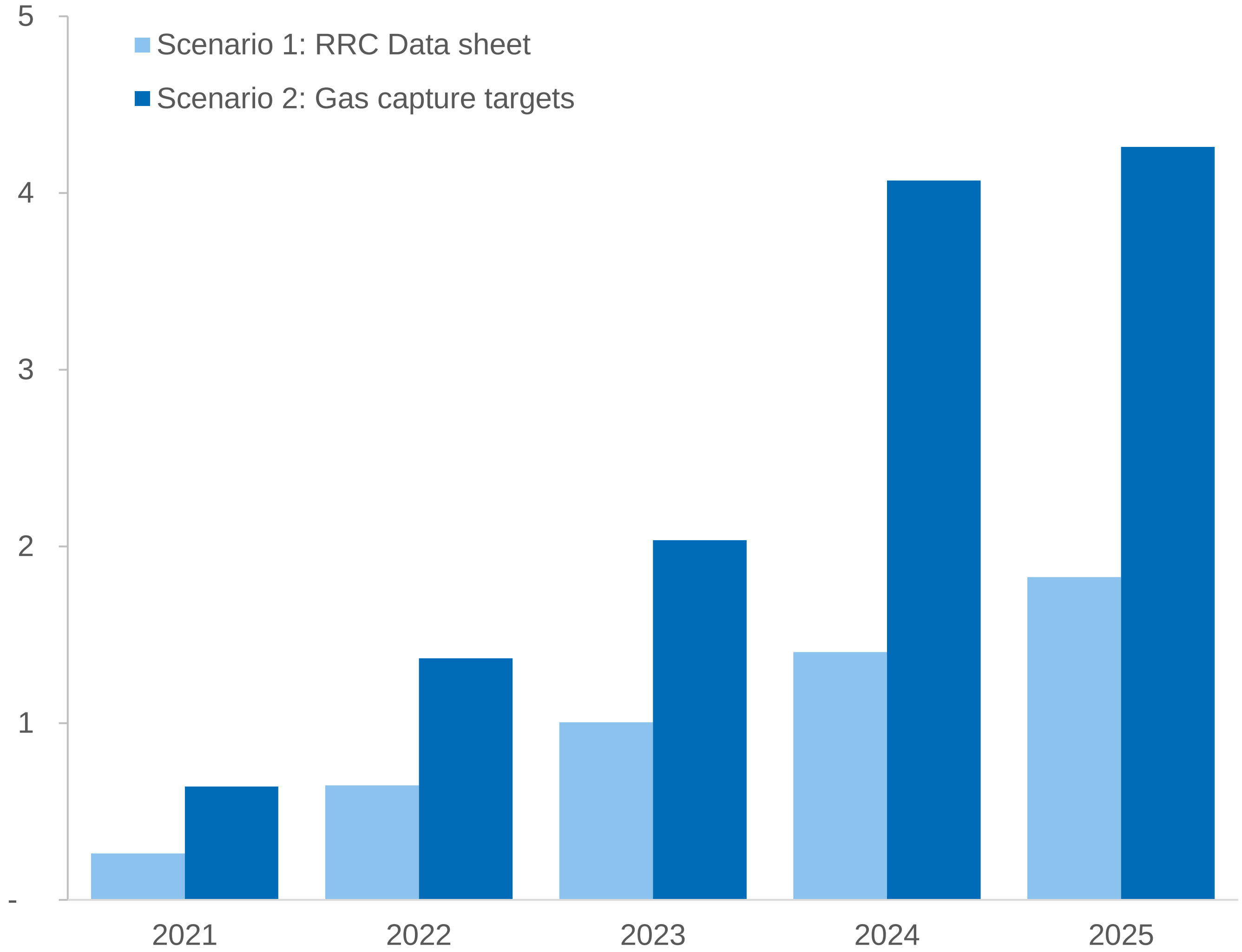


- The wellhead value of the gas requiring capture under the gas capture targets scenario is expected to exceed the costs to abate said volumes, suggesting that even with more stringent regulations, most operators are still likely to gain from improved flaring procedures.
- Policy 2 wellhead value includes all volumes requiring abatement to reach gas capture rules— this includes both volumes that have zero abatement costs and volumes with an expected cost to abate.
- In this scenario, a capture target of 98% would be the first threshold where significant abatement costs would likely be incurred by the industry, as there would then be a need to capture a larger portion of event-driven flaring to meet this target.

Source: Rystad Energy research and analysis

Policy 2 expected to bring larger emissions reductions than Policy 1 per year

Annual emissions reductions by policy
Million tonnes CO_2

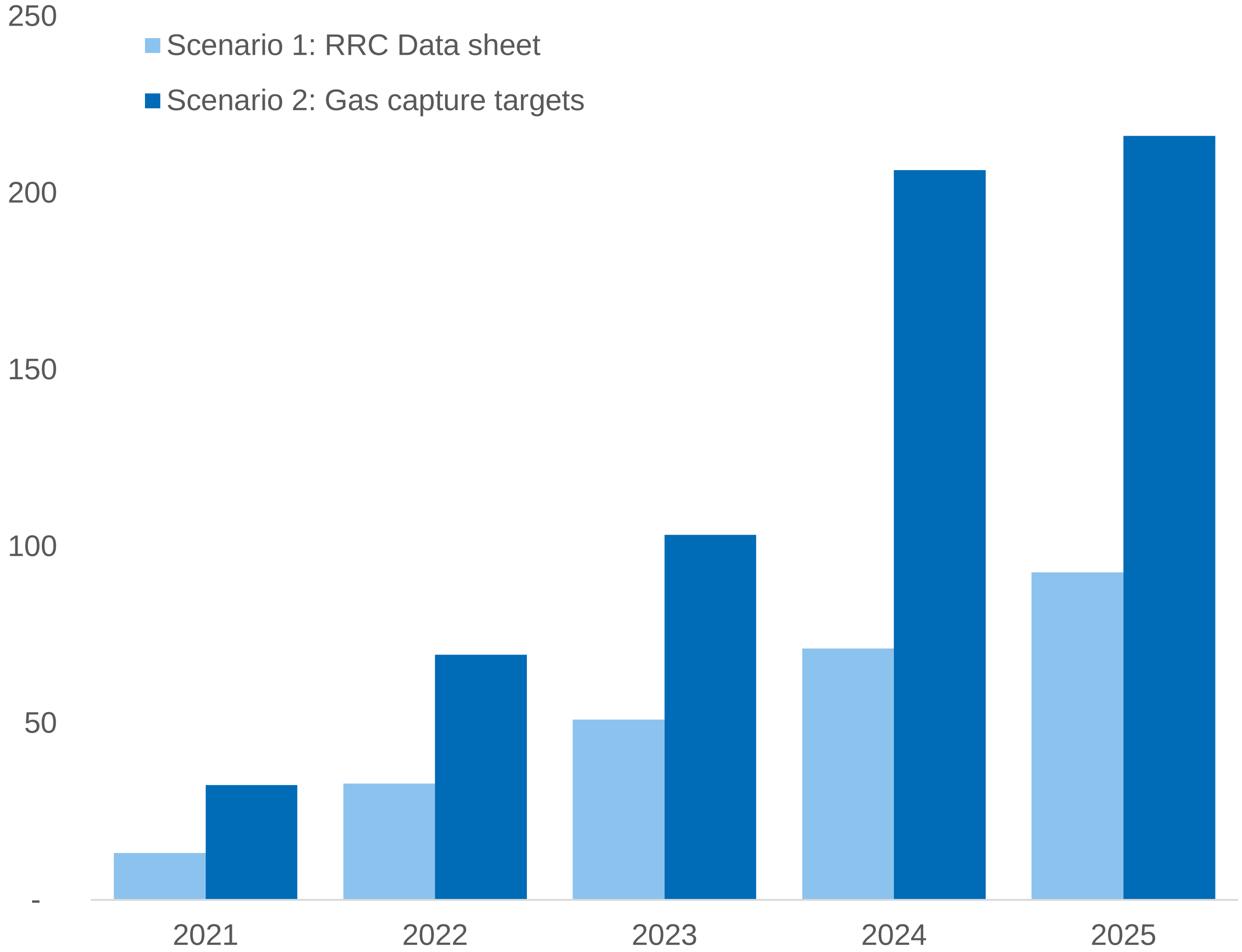


- Emissions are measured in kg CO_2. Final numbers are calculated using a conversion factor of 54 kg CO_2 per mcf.
- Policy 2 is expected to decrease gross emissions substantially more than Policy 1.
- When the 98% gas capture policy is adopted in 2024, more than 4 million tonnes of CO_2 will be eliminated.
- Forecasted US upstream CO_2 emissions in 2025 total 196 million tonnes. Policy 2 would decrease these emissions by slightly more than 2%.

Source: Rystad Energy research and analysis, UCube, EPA

Policy 2 expected to result in annual reduction of more than 200 MMcf/d flared gas by 2024

Annual flared volumes reduction by policy
Million cubic feet per day



- Policy 2 is expected to decrease flared gas volumes substantially more than Policy 1 through 2025.
- When the 98% gas capture policy is adopted in 2024, more than 200 million cubic feet per day of flared gas will be avoided due to Policy 2 targets versus the baseline forecast.

Source: Rystad Energy research and analysis