Igniting Action to Reduce Gas Flaring: Real Opportunities. Real Projects. Real Results.

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Columbia Center on Sustainable Investment
A JOINT CENTER OF COLUMBIA LAW SCHOOL AND COLUMBIA CLIMATE SCHOOL

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The report is brought to you by CCSI and Capterio

ABOUT THE AUTHORS

Andrew Bernstein is a Senior Fellow at the Columbia Center on Sustainable Investment (CCSI) and a Senior Counsel at Cleary Gottlieb Steen & Hamilton LLP. He has represented sovereigns in oil and gas transactions for more than three decades, including completed and proposed associated gas capture projects in the Republic of Iraq.

Mark Davis is the Chief Executive Officer of Capterio, a British company specializing in flaring analytics and flaring solutions. Before founding Capterio, Mark worked in the oil and gas industry for over 25 years in a range of roles at a large international oil company, a leading management consultancy, and a leading service company.

Tom Mitro is a Senior Fellow at CCSI with over 50 years of experience in the petroleum sector, working at Chevron for 30 years in roles of director of economics and regional CFO, and the last 20 years as an advisor to governments, national oil companies and non-governmental organizations on fiscal matters, and as a university teacher.

Perrine Toledano is the Director of Research and Policy at CCSI. Perrine has conducted several research and advisory assignments on flaring and the use of associated gas.

ABOUT THE COLUMBIA CENTER ON SUSTAINABLE INVESTMENT

The Columbia Center on Sustainable Investment, a joint Center of Columbia Law School and Columbia Climate School, is an applied research center that works to develop critical understanding, practical approaches, and governance tools for governments, investors, communities, and other stakeholders to maximize the benefits and minimize the potential harms of international investment for sustainable development.

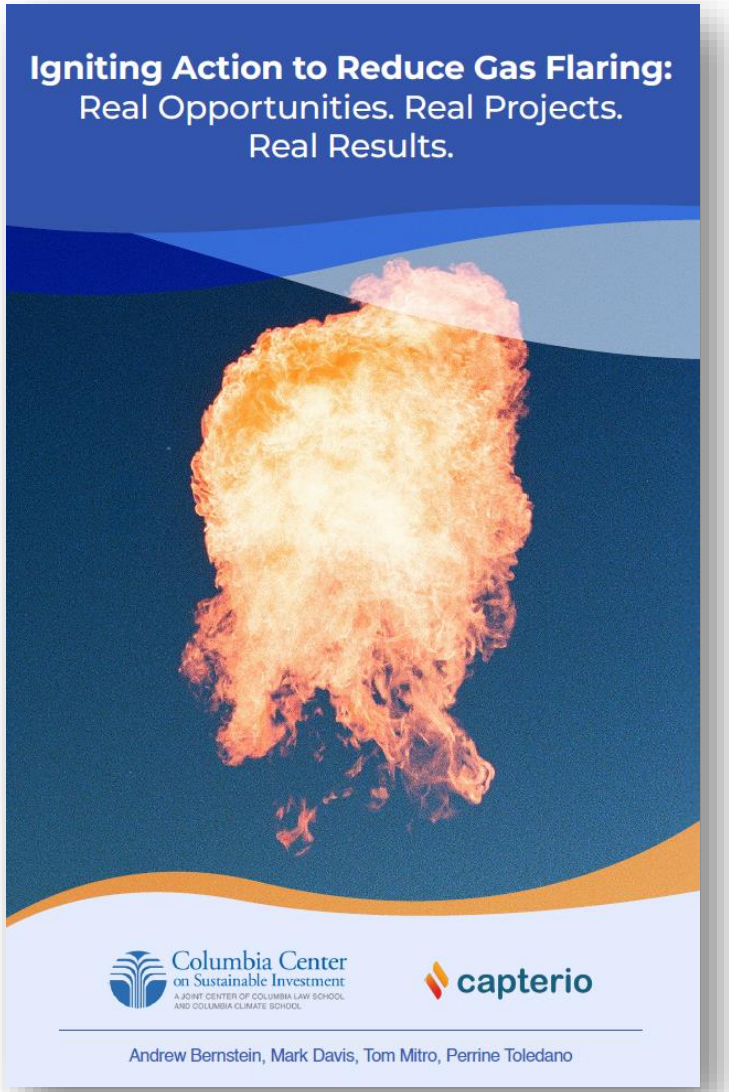
ABOUT CAPTERIO

Capterio is a British company founded in 2018 with a mission to drive real-world reductions in gas flaring. Its award-winning analytics platform, FlareIntel, uses proprietary algorithms to track every flare, for every asset, across every company and country, by satellite multiple times per day. Capterio partners with oil and gas producers, governments, regulators, service companies, and the financial sector to improve flaring transparency, enhance operational performance, and identify and prioritize projects that capture and monetize flared gas.

The authors are very grateful for the Grantham Foundation's support. The Grantham Foundation is a private foundation established in 1997 with a focus on protecting and improving the health of the global environment.

Source: CCSI; Capterio

This report goes further than most other reports on flaring reduction, incorporates insights from practitioners and is backed by rich data



Source: CCSI; Capterio

Report aims

- Build on existing reports (World Bank, IPIECA, IOGP, OGDC, etc.)
- Identify and celebrate successful flare capture projects
- Identify key factors that underpin successful projects
- Inspire actions

What makes this report different?

- Case study approach to unpick the real backstory
  - Projects: ALNG (Angola), Sarqala (Kurdistan), Los Toldos (Argentina)
  - Countries: Federal Iraq, Egypt, Algeria
- In-depth interviews with practitioners with direct experience
- Supported by rich satellite data and deep quantitative analysis
- Novel, holistic approach including *net* GHG benefits
- Targeted, with specific responsibilities for each main actor
  - Governments, NOCs, IOCs, consuming countries, and financiers

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To read the report, the 6 case studies or download this presentation, please visit the CCSI or Capterio websites

Gas flaring is a major global environmental and economic challenge/opportunity

Flaring is part of a flaring and methane ecosystem, part of scope 1 emissions

BCM

162

FLARING

CO2, some CH4

Burning of gas at oil and gas facilities

- Flaring is mostly of "associated gas", a byproduct of oil production
- Large economic and environmental opportunity, annually*:
  - 148 BCM (+14 BCM as methane)
  - up to $30 billion in revenue
  - up to 1.1 billion CO2e tonnes
- Fixing flaring reduces emissions, improves energy security, generates revenue and accelerates the transition

73

VENTING

Primarily CH4

Deliberate release of methane at tanks, valves, pumps, compressors etc.

42

LEAKING

Primarily CH4

Accidental release of methane at wells, pipelines, etc.)

* Flaring is also equivalent to powering 300 million average UK homes with electricity, taking 220 million US passenger vehicles off the road or $1000 per second in potential revenue

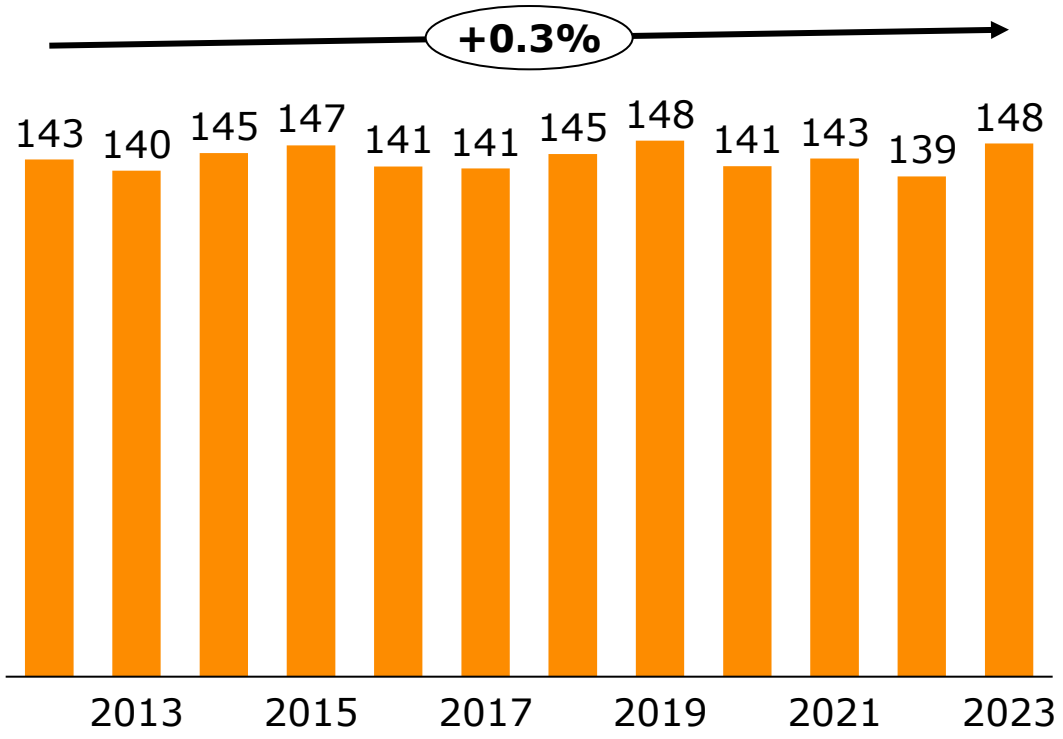
Source: CCSI; Capterio; World Bank; IEA

Gas flaring is a global challenge

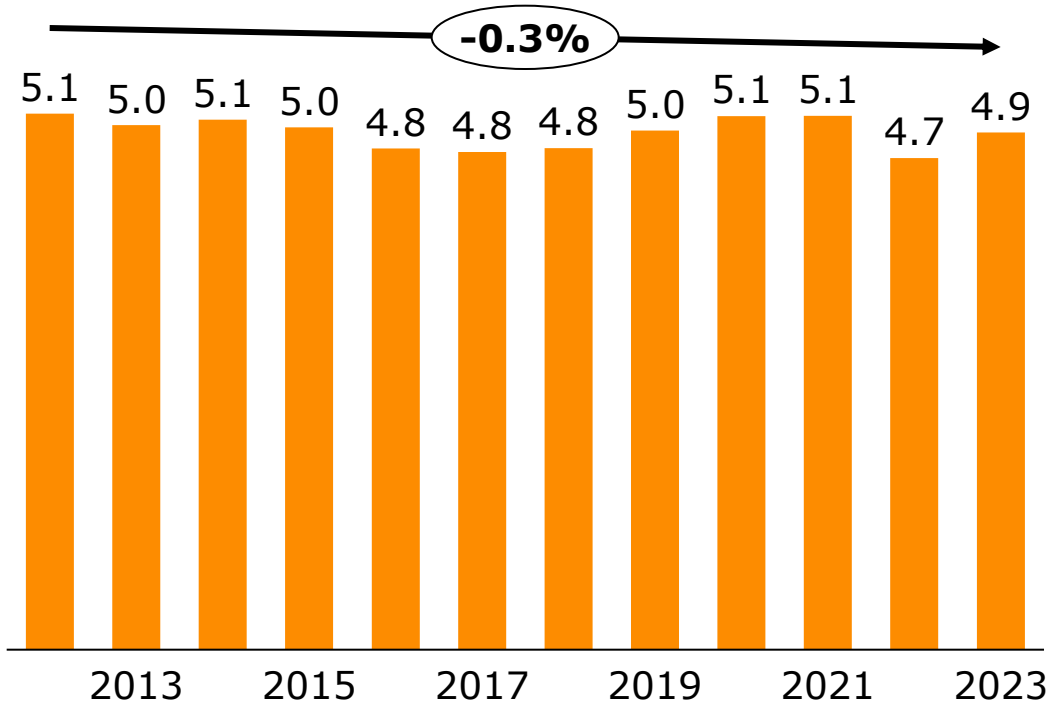
Source: Capterio FlareIntel

Despite awareness and robust pledges, flaring remains stubbornly high

Flaring
BCM per year



Flaring intensity
m3 per barrel



- Bold pledges by governments, NOCs, IOCs and others over more than two decades have increased awareness
- Flaring and flaring intensity has remained broadly flat

Source: World Bank; Capterio analysis

Beyond operational upsets, this report identifies 8 reasons why companies flare

So-called barriers that can hinder flaring progress

- **Lack of infrastructure** to process gas and send it to market
- **Lack of attractive market** to monetize the gas, no creditworthy offtaker
- **Technical complexity** as gas volumes depend on oil production levels, not gas demand, and coordination of the gas value chain is complex
- **Insufficient information and data** making it difficult to evaluate opportunities and plan investments

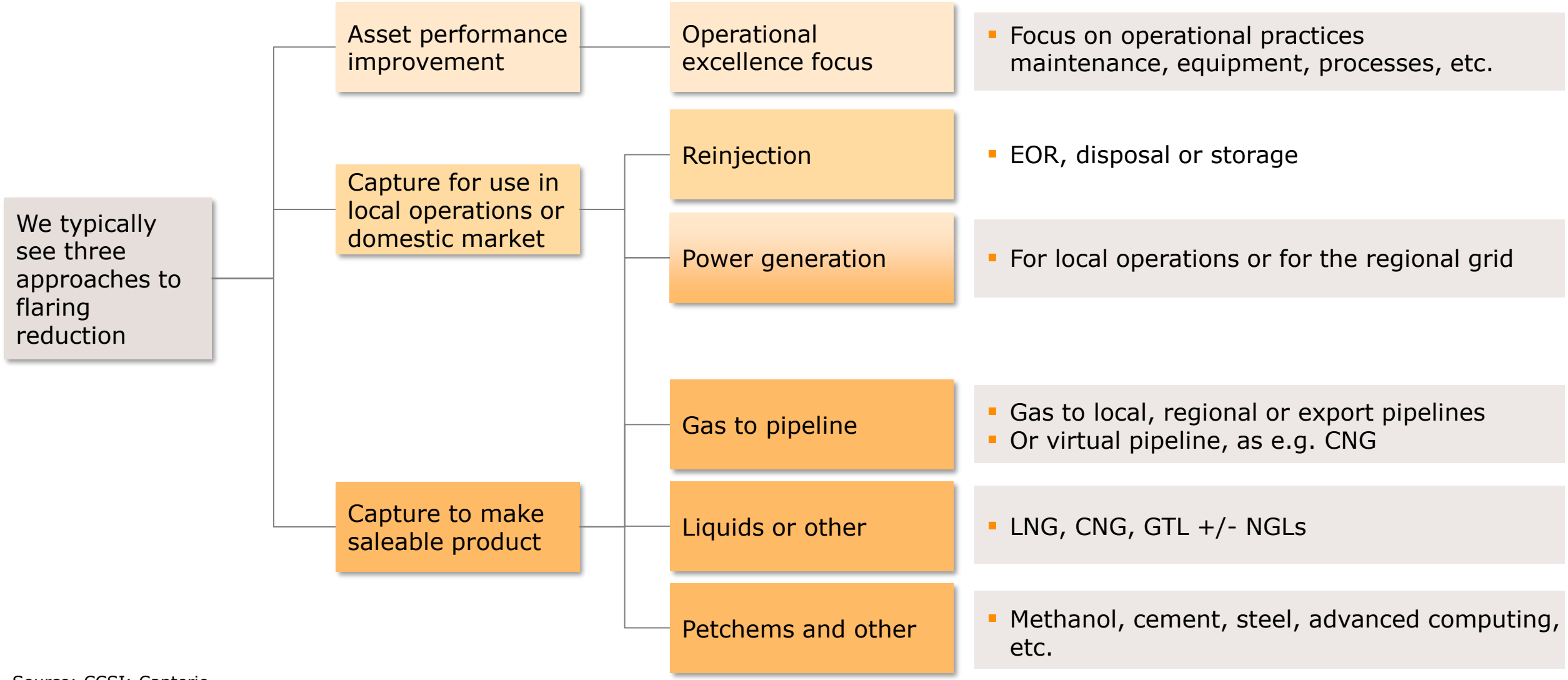
- **Lack of enforced penalties** so flaring generates zero financial cost
- **Poorly adapted fiscal regimes** with terms conceived for upstream projects, not industrial investments in associated gas value chain
- **Regulatory obstacles** that limit access to markets and infrastructure, or that create uncertainty
- **Lack of capital access or financing** particularly where flare reduction is regarded as "non-core" or low priority

These factors make flare capture more complex than oil projects, but most can be overcome

Source: CCSI; Capterio

There are typically a range of potential solutions for gas flaring

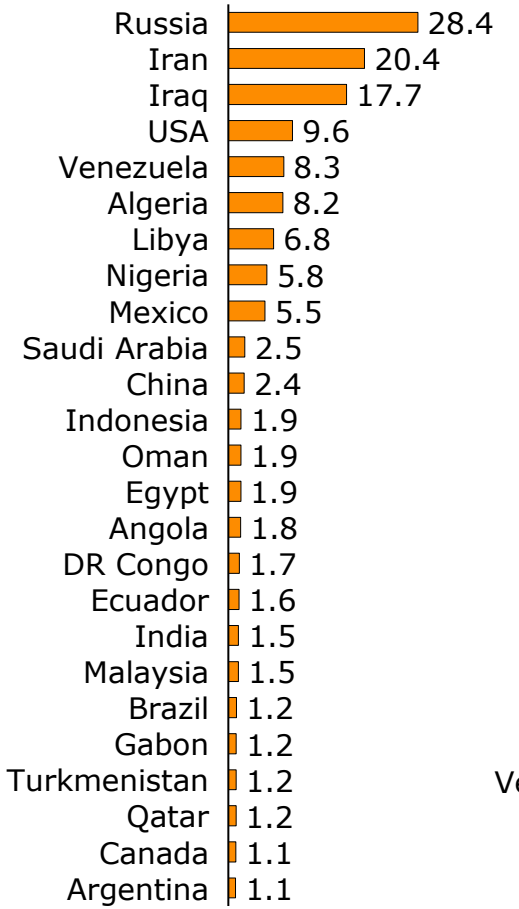
Discussed in this report



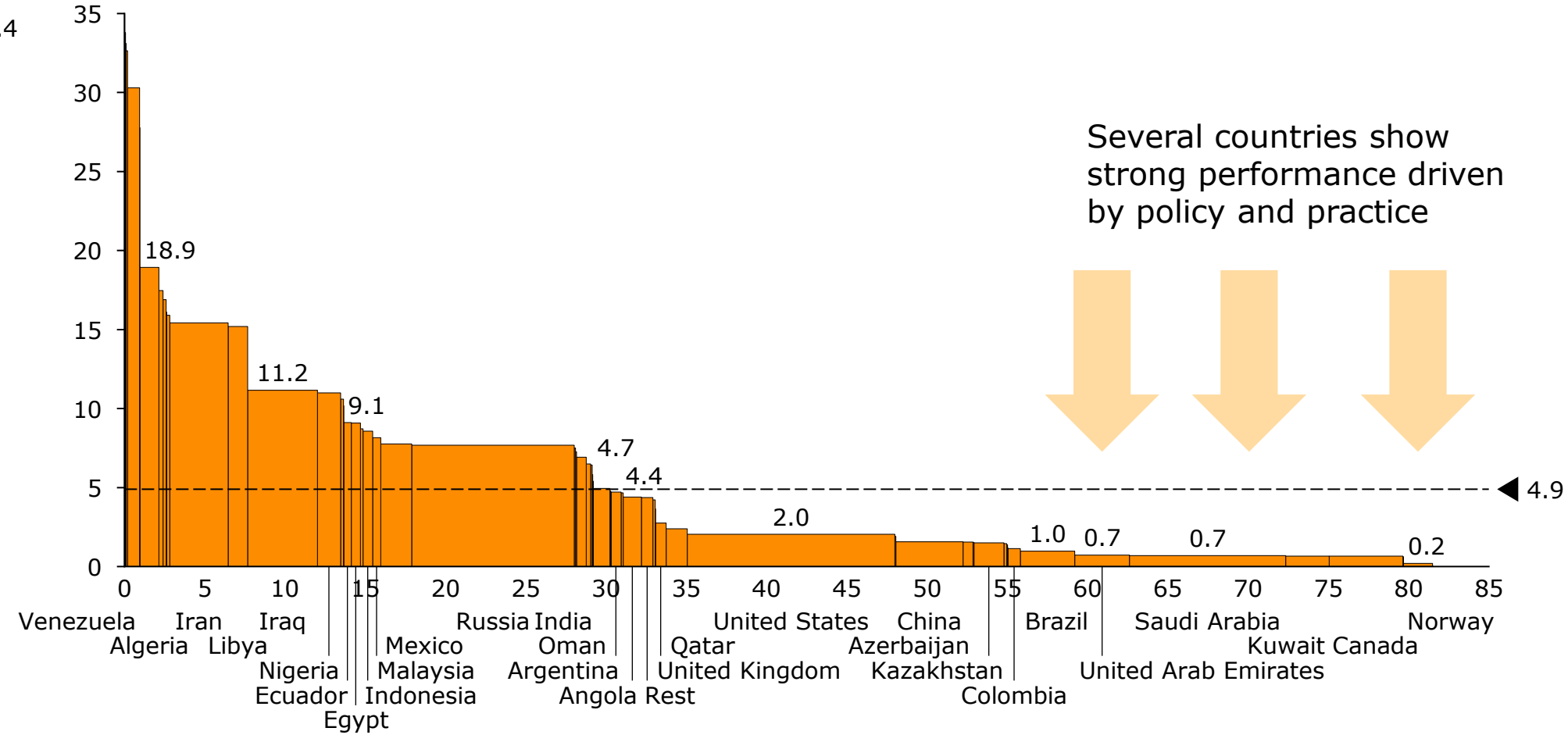
Source: CCSI; Capterio

Flaring performance varies widely, but low flaring intensity countries offer hope

Absolute gas flaring
Flaring, 2023
BCM per year



Relative flaring performance
Flaring intensity, 2023
m3 per barrel of liquids, volume in billion barrels oil & condensate per year (x-axis)



Source: World Bank; Capterio analysis

Our report is structured into 3 main groupings

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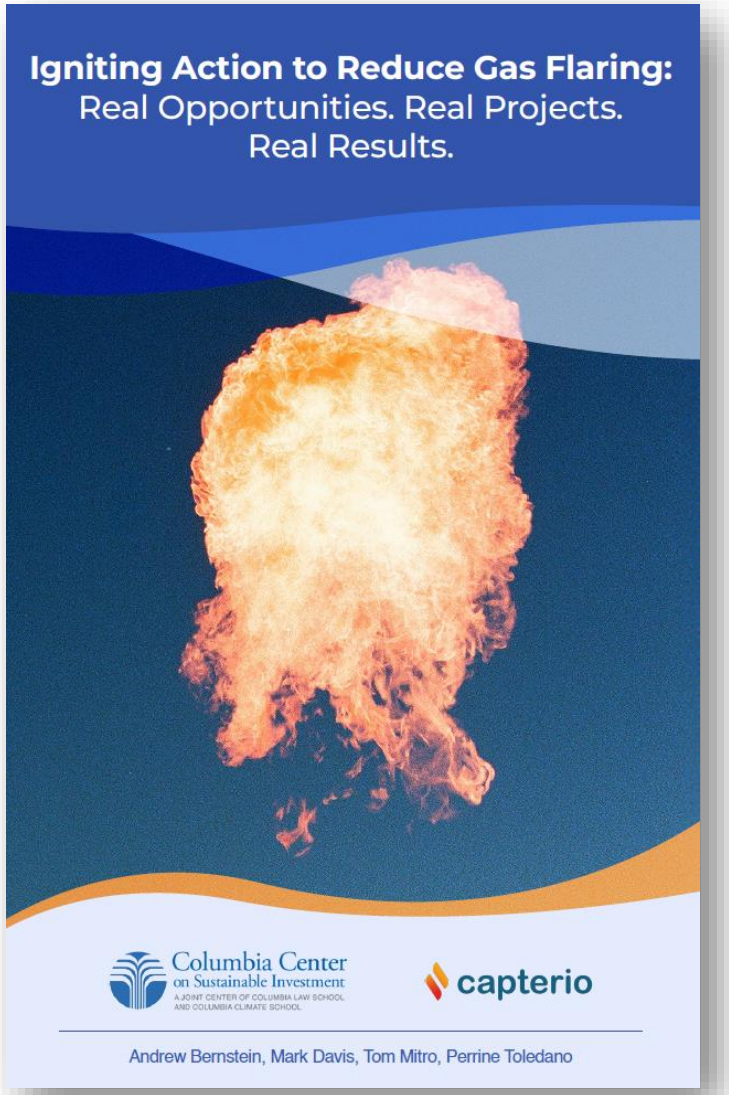


6 Case Studies

Report focused on:

- Project case studies from Argentina, Angola and Kurdistan Region of Iraq
- Country case studies from Algeria, Egypt and Federal Iraq

5 Main Success Factors

Case studies highlight 5 success factors:

- Accessible Market
- Effective flaring penalties
- Committed leadership
- Data as a game changer
- Commercial innovation and structuring

2 Actionable Recomm-endations

Actionable recommendations:

- Need for a holistic approach to GHG
- Actionable recommendations for five specific stakeholder groups

Source: CCSI; Capterio

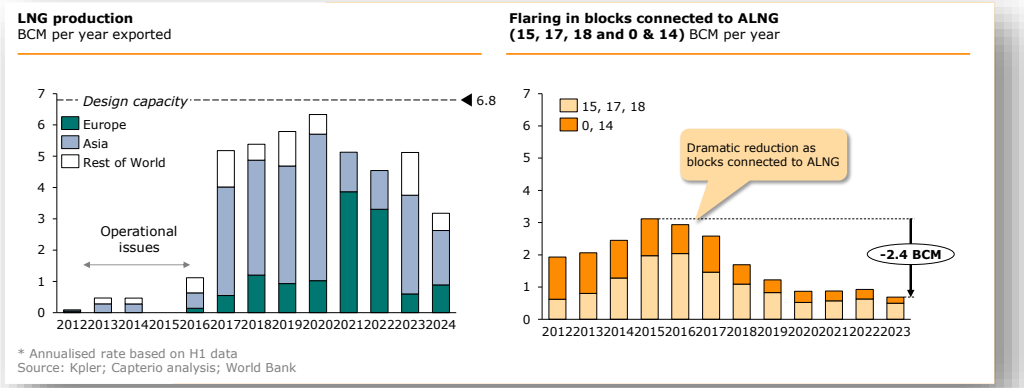
Project case study: ALNG in Angola

6 5 2

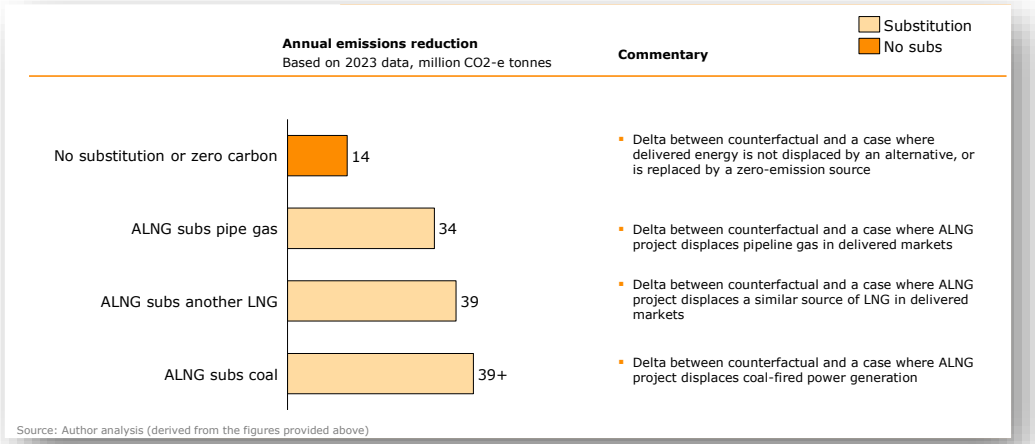
Project summary

- Complex first of a kind LNG for associated gas, although operationally challenged in early years
- Captured up to 6 BCM per year, reducing emissions by up to 39 million CO2-e tonnes

LNG production and linked flaring reduction



Assessment of life-cycle GHG impact



Key drivers and insights

- Unique integrated approach with partner alignment between upstream and downstream
- Strong government support and NOC and IOC leadership
- Creativity over fiscal structuring
- Importance of "make up" gas
- Importance of project design, execution and governance

Source: 20 page case study by CCSI and Capterio

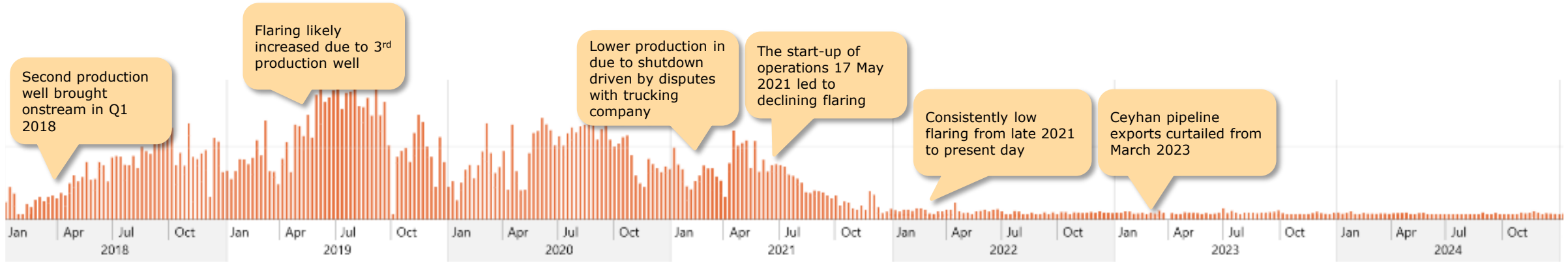
Project case study: Sarqala field in Kurdistan Region of Iraq

6 5 2

Project summary

- Modular power offtake, 200 portable gas generators installed within 7 months
- Flare capture enabled up to 165 MW of power to be delivered to previously unreliable grid

Flaring at Sarqala, million scf/week



Source: Capterio FlareIntel Pro

Key drivers and insights

- Strongly motivated by regional government need for reliable grid power
- Government consent for increased production partially linked to flare project
- Additional NGLs recovered but economics challenged by regional government payment delays

Source: 10 page case study by CCSI and Capterio; FlareIntel

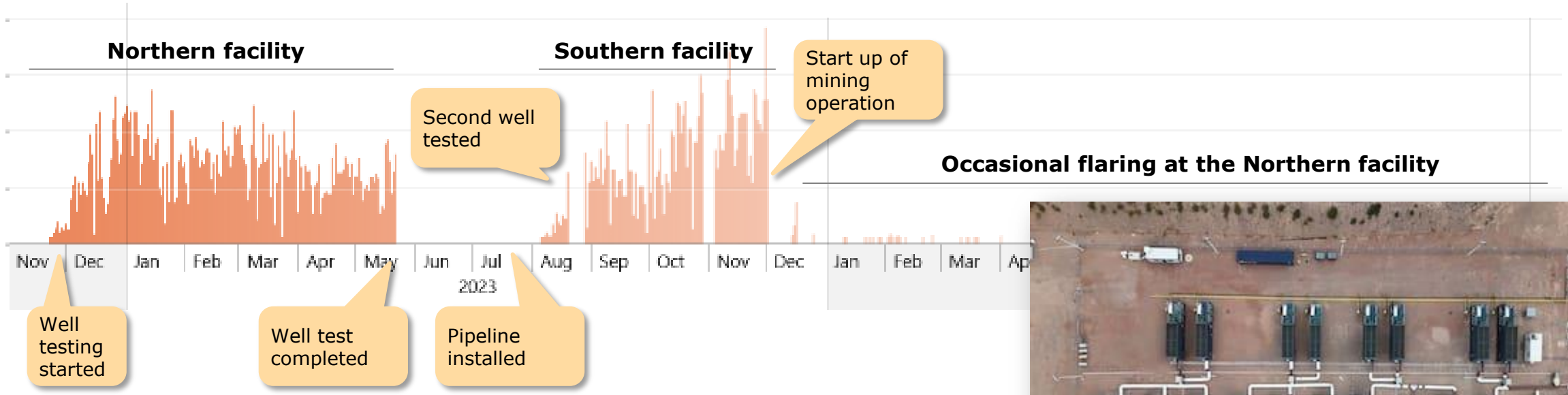
Project case study: Los Toldos Este II in Argentina

6 5 2

Project summary

- Flare capture to cryptocurrency mining in rapidly expanding Vaca Muerta shale basin
- Captured gas generates 12 MW of power and mines 82 bitcoins per year

Daily flaring at the two locations
million scf/day



Source: Capterio FlareIntel Pro

Key drivers and insights

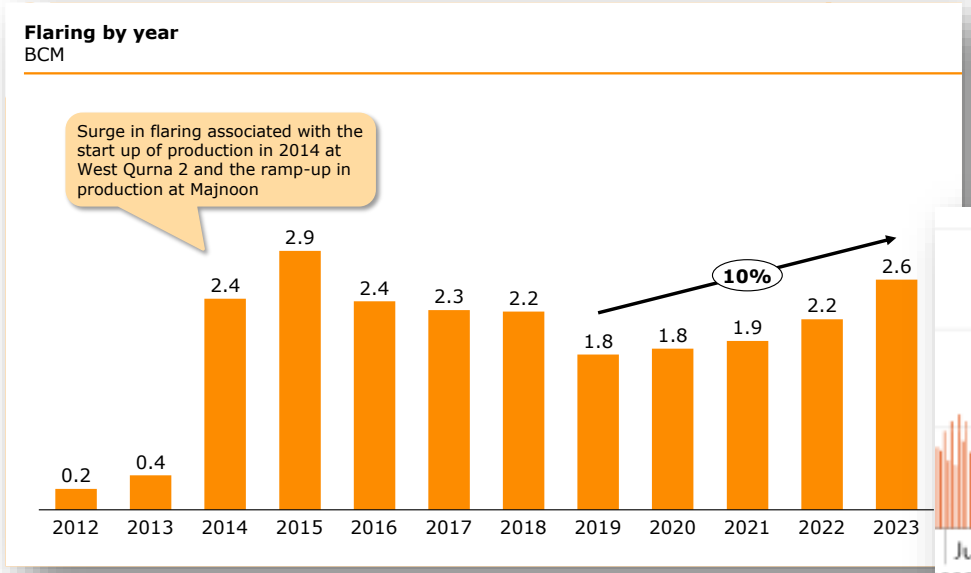
- Decarbonized operations, although/and supported increased oil production
- Delivered due to strong leadership of operator, plus national and provincial governments

Source: 10 page case study by CCSI and Capterio; FlareIntel

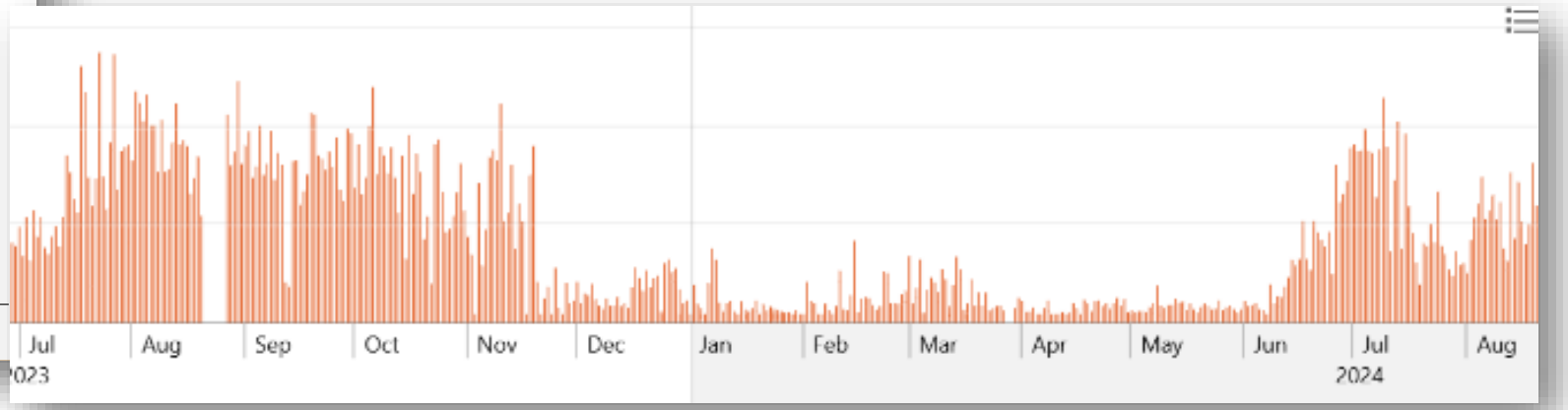
Country case study: Federal Iraq

Country summary

- Federal Iraq flared 16.3 BCM in 2023 (3rd globally), despite gas need, as power plants are run on liquids
- The 2011 world-class Basrah Gas Company project was followed by several years of indecision
- Gas Growth Integrated Project (2021) has launched robust flare reduction effort, with more projects underway
- 2028 zero routine flaring target is ambitious, but the potential is there



Daily flaring at Majnoon



Key drivers and insights

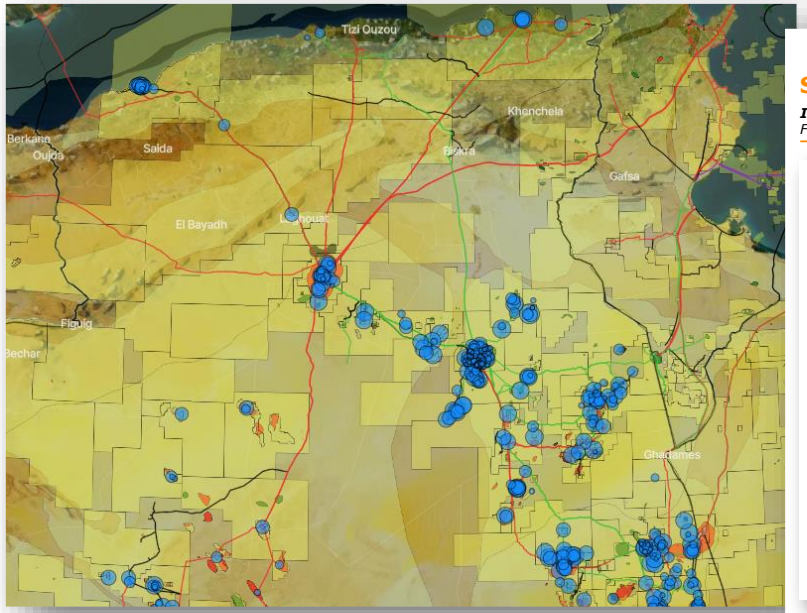
- BGC successful, but flaring initially increased due to higher oil production
- Iraq's service contracts provide few financial incentives for flare reduction
- GGIP success driven by Government/IOC commitment, integrated structure, and funding from oil revenues
- GHG from increased oil production should be offset by lower methane and substitution of gas for dirtier fuels

Source: 17 page case study by CCSI and Capterio; FlareIntel

Country case study: Algeria

Country summary

- Sixth largest gas flarer (8.2 BCM in 2023) and second highest flaring intensity at 18.9 m^3 per barrel
- Flaring broadly flat despite declining underlying oil and gas production
- Connected to Europe via 3 pipelines and 2 LNG terminals with buyers keen to increase supply diversification



Several flare capture opportunities have been identified by the Ministry of the Environment

In Amenas project as of September 2022
First proposed by Capterio in 2018

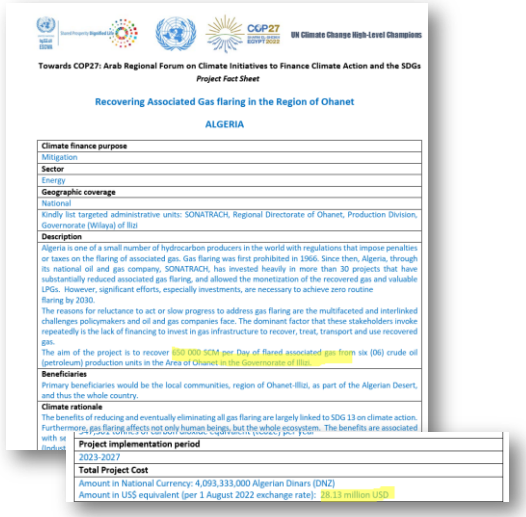
Towards COP27: Arab Regional Forum on Climate Initiatives to Finance Climate Action and the SDGs
Project Fact Sheet

Project Title: Recovering Associated Gas Flaring in Area of In Amenas

ALGERIA

Climate finance purpose
Mitigation
Sector
Energy
Geographic coverage
National
Kindly list targeted administrative units: SONATRACH Regional Directorate of In Amenas, production division, Governorate (Wilaya) Illizi, Algeria
Description
Algeria is one of a small number of hydrocarbon producers in the world with regulations that impose penalties or taxes on the flaring of associated gas. Gas flaring was first prohibited in 1966. Since then, Algeria, through its national oil and gas company, Sonatrach, has invested heavily in more than 30 projects that have substantially reduced associated gas flaring, and allowed the monetization of the recovered gas and valuable LPGs. However, significant efforts, especially investments, are necessary to achieve zero routine flaring by 2030. The reasons for reluctance to act or slow progress to address gas flaring are the multifaceted and interlinked challenges policymakers and oil and gas companies face. The dominant factor that these stakeholders invoke repeatedly is the lack of financing to invest in gas infrastructure to recover, treat, transport and use recovered gas. The aim of the project is to recover 532,000 SCM per day of flared (associated) gas from two (02) crude (petroleum) production Fields, namely the field of "Tiguentourine" with a capacity of 450 000 SCM per Day and the field of "La Reculée" for a capacity of 70 000 SCM per Day in the Area of In Amenas.
Beneficiaries
Primary beneficiaries would be the local communities, region of In Amenas in the Governorate of Illizi as part of the Algerian Desert, and thus the whole country.
Climate rationale
The global context of the project meets Algeria's commitments in terms of environmental protection and the
Total Project Cost
Amount in National Currency: 6,000,000,000 Algerian Dinars
Amount in US$ equivalent (per 1 August 2022 exchange rate): USD 41.23 million
Financing requirement

Ohanet project as of September 2022
First proposed by Capterio in 2018



Towards COP27: Arab Regional Forum on Climate Initiatives to Finance Climate Action and the SDGs
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Recovering Associated Gas flaring in the Region of Ohanet

ALGERIA

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Mitigation
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Description
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Beneficiaries
Primary beneficiaries would be the local communities, region of Ohanet-Illizi, as part of the Algerian Desert, and thus the whole country.
Climate rationale
The benefits of reducing and eventually eliminating all gas flaring are largely linked to SDG 13 on climate action. Furthermore, gas flaring affects not only human beings, but the whole ecosystem. The benefits are associated with se
Project implementation period
2023-2027
Total Project Cost
Amount in National Currency: 4,093,333,000 Algerian Dinars (DNZ)
Amount in US$ equivalent (per 1 August 2022 exchange rate): 28.13 million USD

Source: Algeria Ministry of Environment and Renewable Energy, September 2022

Key drivers and insights

- Material attractive commercial opportunities identified by Ministry, Capterio and others have strong paybacks
- Creativity likely required to innovate commercial structuring
- Proper enforcement of existing anti-flaring penalties could accelerate action
- Top down drive required, supported by a national flaring task force

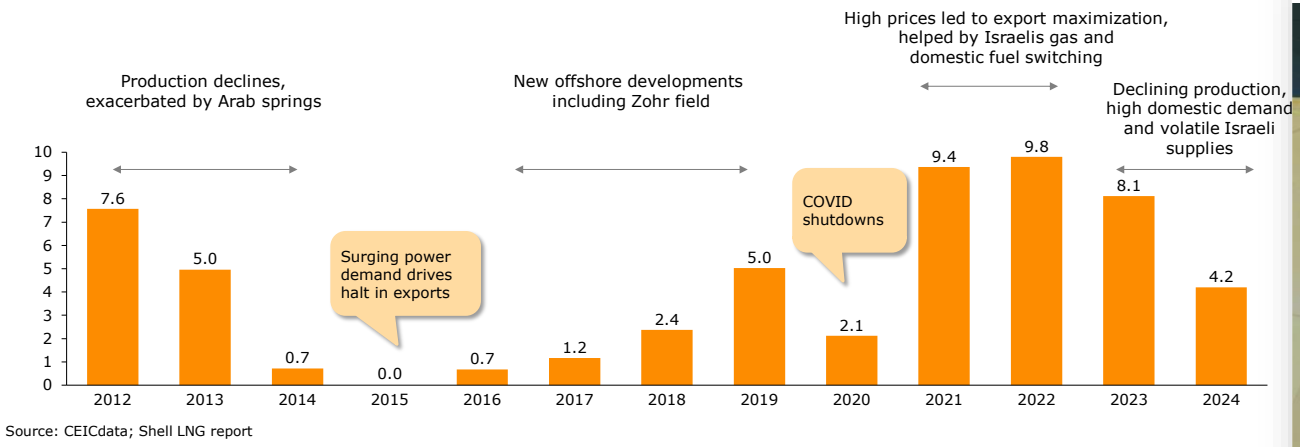
Source: 18 page case study by CCSI and Capterio; FlareIntel

Country case study: Egypt

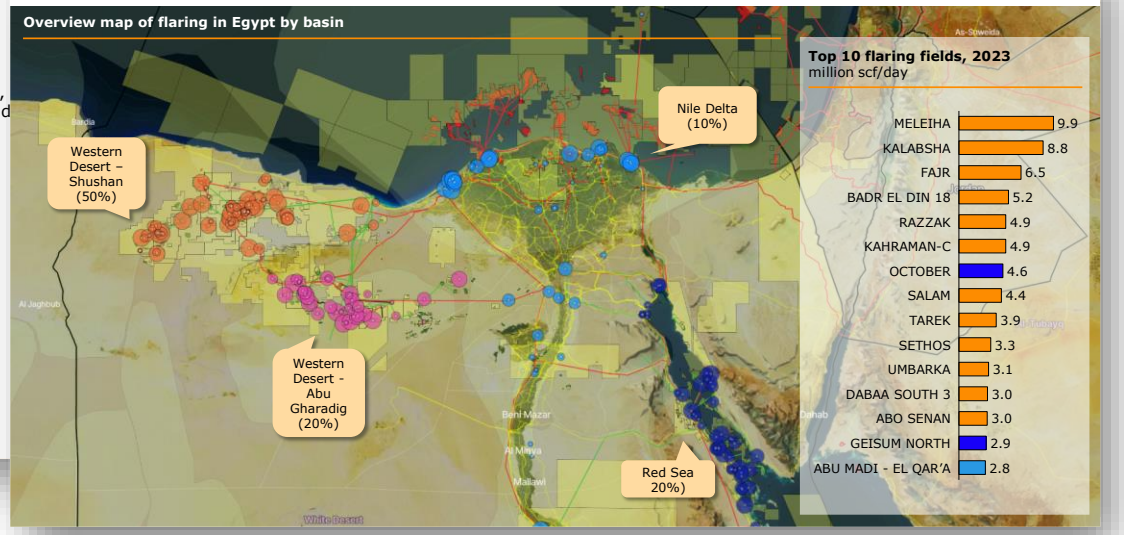
Country summary

- Egypt flares modest volumes (1.9 BCM in 2023), with high intensity (9.1 m3/bbl)
- Flare capture could be part of solution to growing gas demand, declining production, exports and blackouts
- Main obstacles: small, scattered flares, state (EGAS) purchase monopoly, low and regulated domestic prices

Egypt's LNG exports illustrate some of the structural gas supply challenges



Egypt's flaring is dominated by the Western Desert, and most flares are small



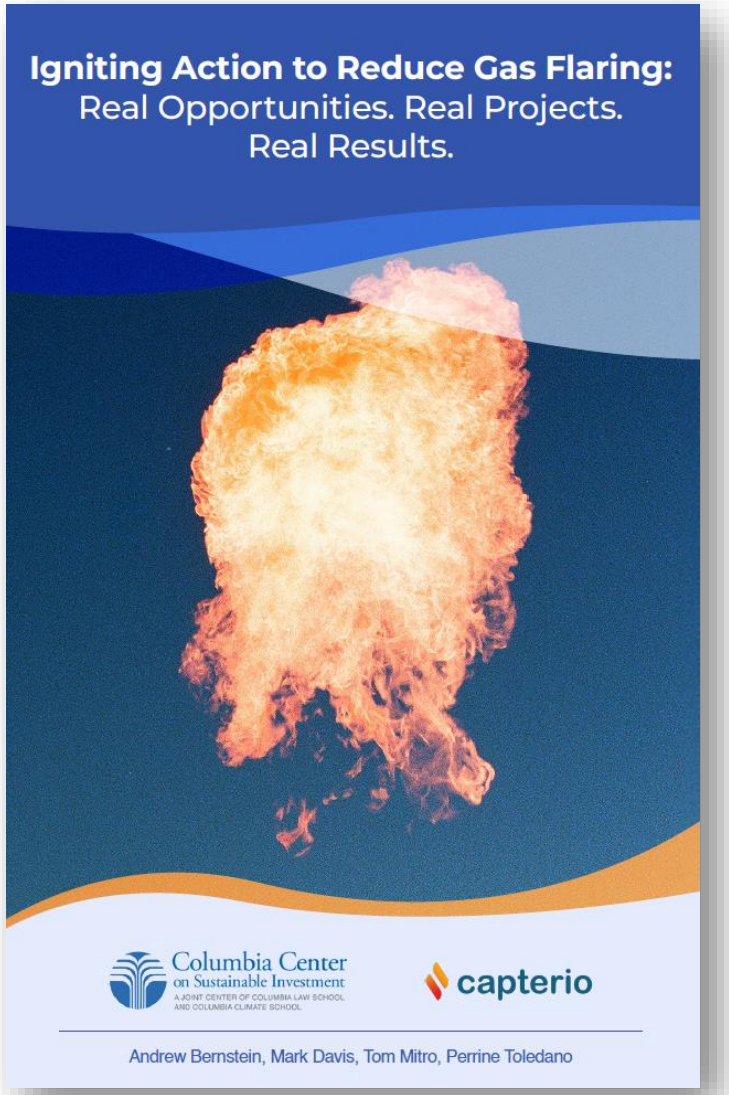
Key drivers and insights

- Egypt has made many laudable public commitments, with moderate success in practice
- Flare capture projects will require EGAS purchase commitment backed by funding (redirecting subsidies)
- "Cluster" infrastructure projects in Western Desert could generate economies of scale, should be encouraged
- Current license round strategy should be complemented by flare reduction as "quick win" solution

Source: 18 page case study by CCSI and Capterio; FlareIntel

Our report is structured into 3 main groupings

6 5 2



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Case studies highlight 5 success factors:

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2 Actionable Recomm-endations

Actionable recommendations:

- Need for a holistic approach to GHG
- Actionable recommendations for five specific stakeholder groups

Source: CCSI; Capterio

We identify 5 major insights from the case studies ….

6 5 2

Need for An Accessible Market

- Investors must be able to deliver gas to market
- State or NOC offtakers must pay reasonable prices
- Creditworthiness of offtaker is key
- Markets exist in many cases, providing opportunities

Require Effective Flaring penalties

- Flaring penalties should apply and must be credibly enforced
- Exceptions for inadequate infrastructure may remove incentives to invest in new infrastructure

Support from Committed leadership

- Leadership and commitment turn vision statements into successful actions, backed by grit
- Focus on realizing projects, with high-level support

Data as a Game Changer

- Reliable data is essential to identify and prioritize opportunities, and to structure investments
- Data key to monitoring operational performance, especially for "non-operated" assets
- Data key to the promotion of delivered success cases

Commercial and Structural Innovation

- No standard models for flares-out, innovative approaches needed
- Innovation often needed re contractual, regulatory, fiscal elements
- Inside / outside "ring-fence" fiscal structuring

Source: CCSI; Capterio

Our report is structured into 3 main groupings

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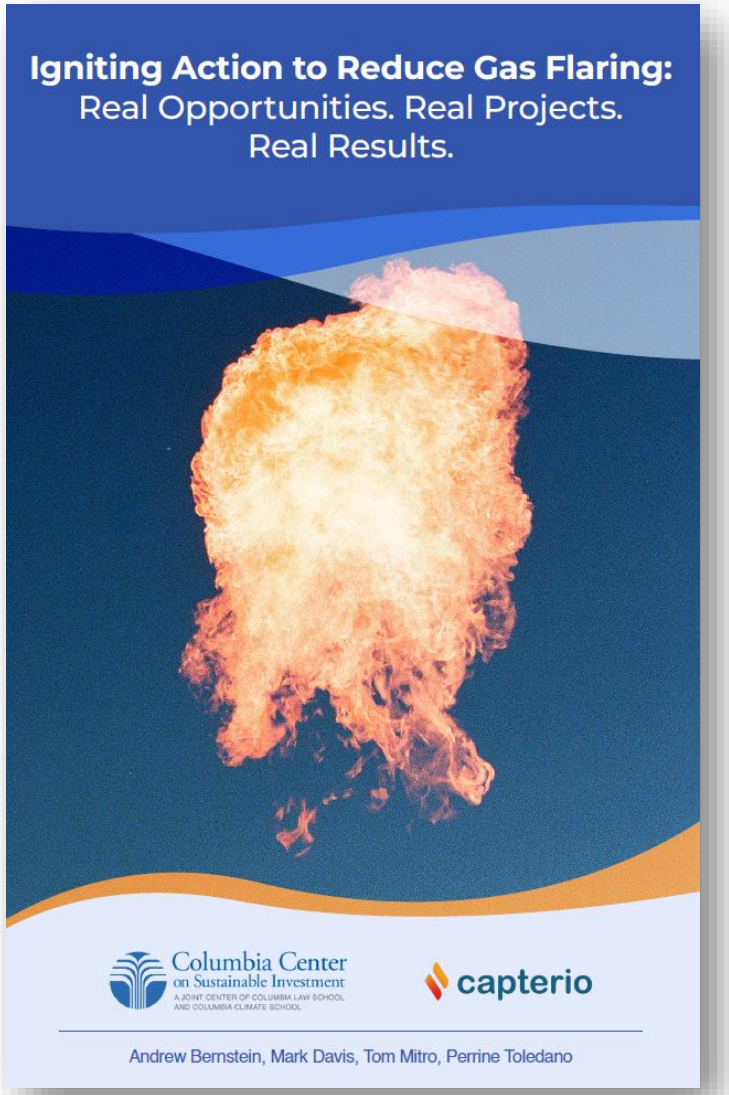

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Source: CCSI; Capterio

Recommendation 1: Flare project GHG benefits must be considered on a net basis

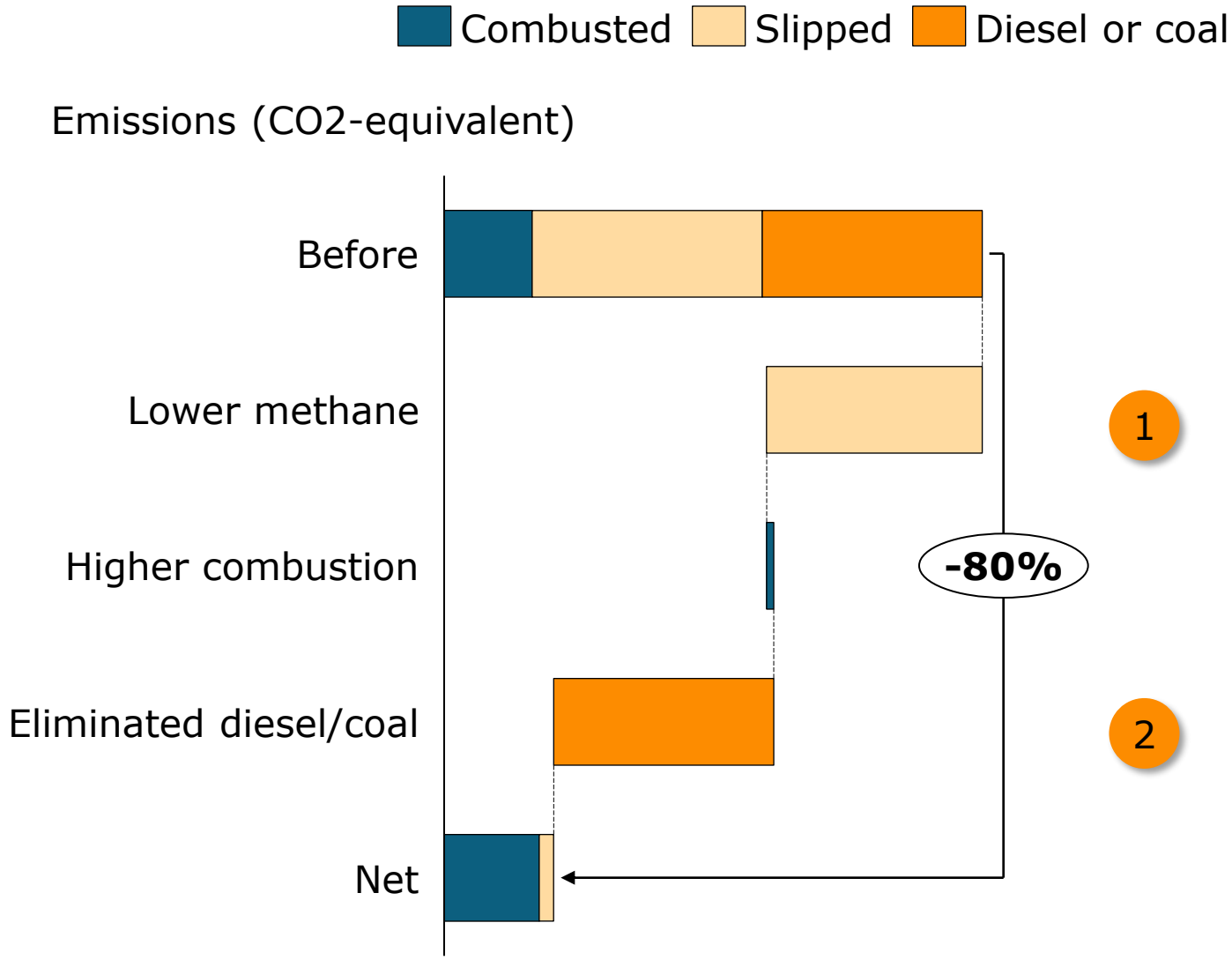
6 5 2

Flare projects need to be considered on a "life-cycle" and "net" basis to be truly effective

- Whilst most flare capture projects still burn the gas, ...
- … flare projects decarbonize, as:

1 Fixing flaring *also* addresses "methane slip"

2 And, recovered gas can be used to substitute higher carbon fuels (or reduce demand for exploration/development)



Source: Capterio analysis

Recommendation 1: Flare project GHG benefits must be considered on a net basis

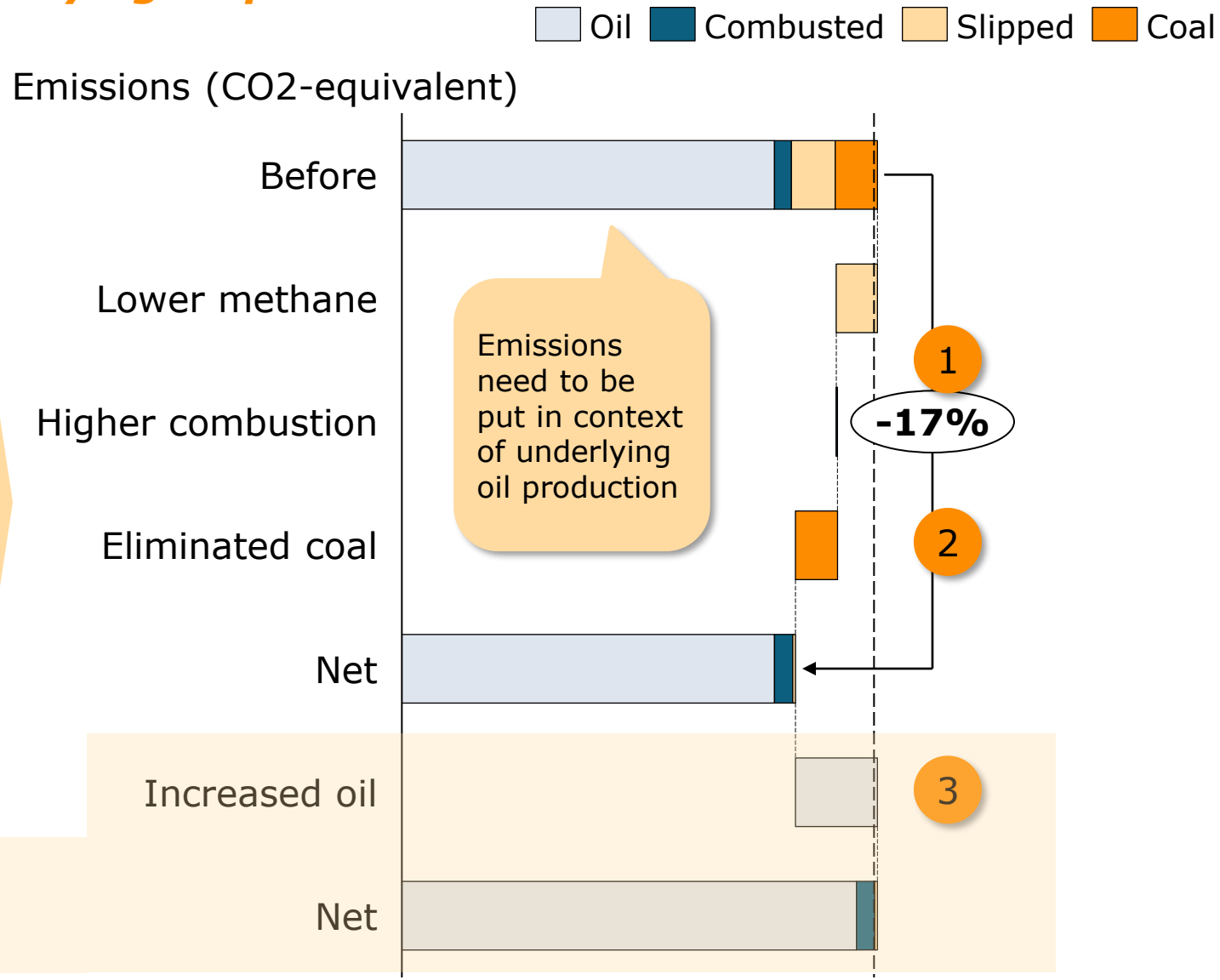
6 5 2

And account for any change in the underlying oil production

Flare projects need to be considered on a "life-cycle" and "net" basis to be truly effective

- Whilst most flare capture projects still burn the gas, ...
- … flare projects decarbonize, as:

1. Fixing flaring *also* addresses "methane slip"
2. And, recovered gas can be used to substitute higher carbon fuels (or reduce demand for exploration/development)
3. But the gains can be undermined by increased oil production



Source: Capterio analysis

Recommendation 1: Flare project GHG benefits must be considered on a net basis

6 5 2

- Flare projects can deliver *scope 1 & 2* emissions reductions

1. *Methane reduction*
2. *Fuel substitution*
3. *+/- Oil impact*

… leads to a prioritization framework for flare gas capture projects

1. Focus on flare-capture projects *where* ***oil production*** *will proceed* ***regardless of flaring***
2. Reduce upset flaring through **better operations** and use of **data as a performance tool**
3. Use existing and **underutilized gas infrastructure** to avoid lock-in
4. Substitute existing **high carbon-intensity fuels** with captured gas
5. Target reductions in **methane slip** and improve flare efficiency
6. Explore flare-to-carbon technologies that also **sequester CO_2**

Source: CCSI; Capterio

Recommendation 2: Actionable steps for each stakeholder group

6 5 2

Governments

- Create an investable environment, accessible market with creditworthy offtaker
- Support with fiscal incentives, contract flexibility, subsidy reallocation and enforced penalties
- Stand up a national task force with data-based roadmaps
- Align government "take" with objectives
- Focus on lower flaring as competitiveness lever

National Oil Companies

- Embed independent and high frequency data into management processes to identify missed opportunities and drive improved performance
- Prioritize flare reduction as an asset, not liability
- Facilitate infrastructure access for associated gas
- Collaborate with government and IOCs to drive opportunity and project implementation

Oil & Gas Producers

- Innovate with novel transaction structures and partnerships with new investor classes
- Prioritize flare reduction through better operations and delivered projects
- Drive collaboration with governments and NOCs, especially for non-operated assets
- Allocate capital and financing and demonstrate flexibility (returns, contractual rights)
- Instill transparency with real-time measurement/reporting

Importing countries and IFIs

- Fund projects and infrastructure to capture flared gas
- Deploy market incentives and penalties on imports
- Provide sovereign debt flexibility to facilitate structured financing

Source: CCSI; Capterio

In summary, this report showcases success and we hope will inspire action

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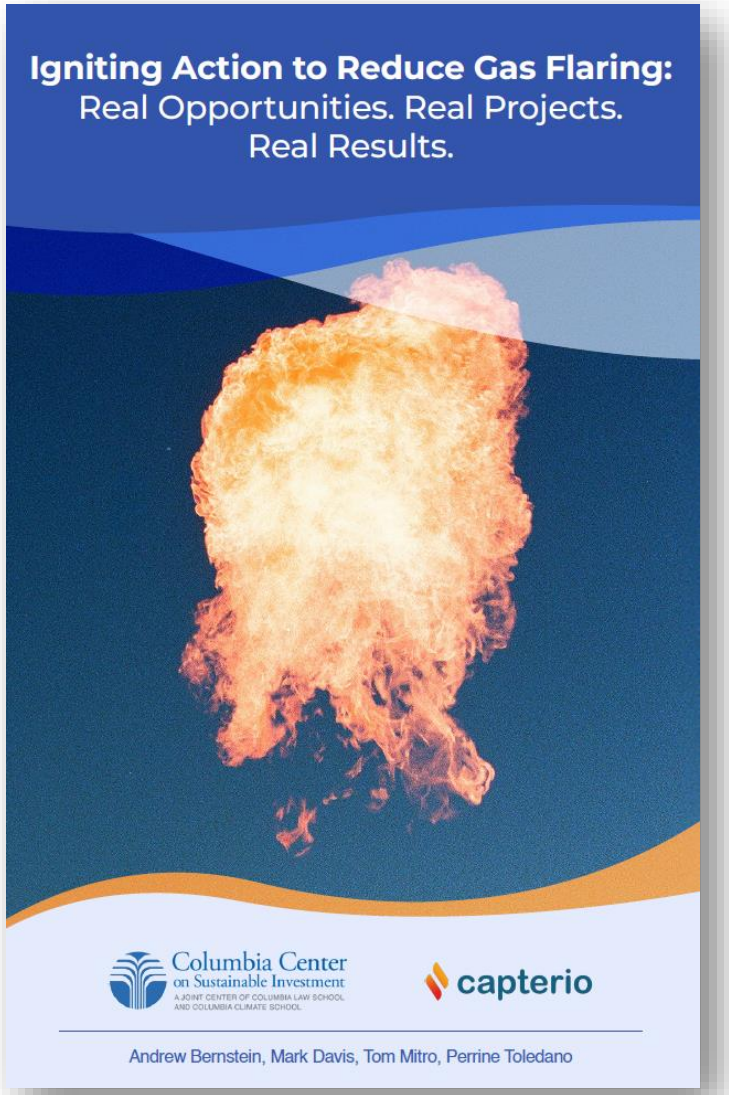

6 Case Studies

5 Main Success Factors

2 Actionable Recomm-endations

Main highlights

- Global flaring remains stubbornly high at 140–150 BCM
- Many proven technical solutions can reduce flaring, lower emissions, enhance energy security, accelerate transition
- Our analysis and six case studies (Angola, Kurdistan, Argentina, Iraq, Egypt, Algeria) show action can deliver
- **Success requires enabling conditions: investable environment, enforcement of incentives/penalties, data-driven planning, and commercial/fiscal innovation**
- We propose a new framework to prioritize flare capture projects based on their net GHG contribution
- We bring 5 actionable recommendations for stakeholder groups

Source: CCSI; Capterio

To read the report, the 6 case studies or download this presentation, please visit the CCSI or Capterio websites

Igniting Action to Reduce Gas Flaring: Real Opportunities. Real Projects. Real Results.

June 5 at 9am EST

Columbia Center on Sustainable Investment
A JOINT CENTER OF COLUMBIA LAW SCHOOL AND COLUMBIA CLIMATE SCHOOL

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