Innovarpel 2025

TECHNICAL DAYS

DIGITAL TRANSFORMATION
& INDUSTRIAL CYBERSECURITY
IN THE OIL&GAS INDUSTRY

arpel 60 YEARS

JUNE, 24 & 25
Rio de Janeiro, Brazil

Digitalization of the oil and gas industry: Driving sustainability for a low-carbon energy future

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Key insights

- Most oil companies have established **definitive targets for reducing emissions from core operations** (Scope 1 & 2), fewer for Scope 3. S&P Global analysis reveals that such targets are reaching closer alignment with project development and operational decision-making.

- Digitalization-enabled solutions offers the most immediate (1-3 years) opportunities to reduce emissions, and S&P Global analysis indicates that such **digital solutions could deliver 10-30% reduction in emissions with modest incremental investment**

- <u>Key opportunity areas include</u>: energy and operational efficiency, methane leak detection & containment, management & optimization of low-carbon power systems, scenario-based asset development & operations, emissions tracking & reporting & auditing

- Leveraging digitalization capabilities to accelerate emissions reduction is **facilitated by alignment with broader efficiency & cost management goals, challenged by organizational uptake challenges**. Industry-leading case studies help to “light a path” toward effective deployment strategies.

E&P organizations are being driven to reduce the GHG intensity of their operations while maintaining growth

Energy transition

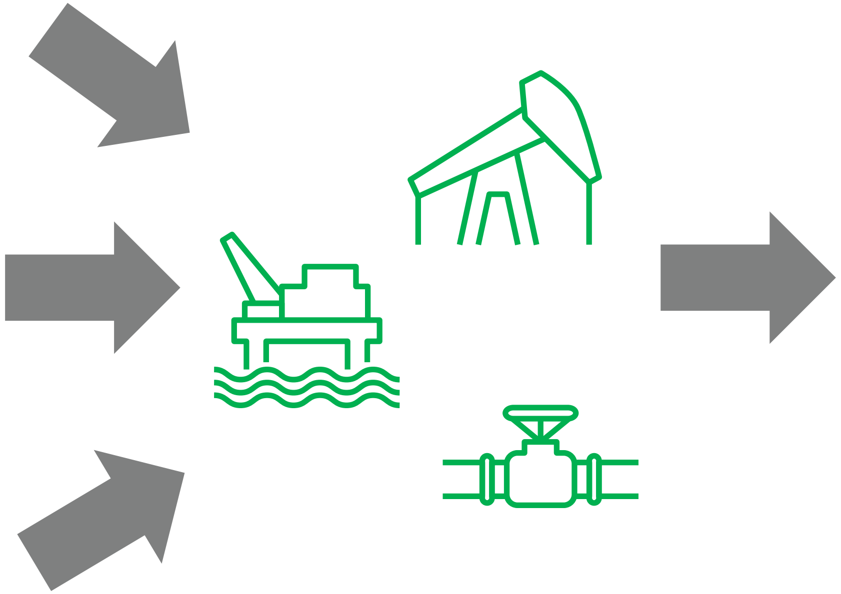
- Decarbonization of the energy system
- Long transition period where **fossil and renewable energy sources coexist**

Technology

- New low-cost technologies to precisely locate and accurately **measure greenhouse gas (GHG) emissions**
- Use of digital technologies to manage complexity of more **diverse energy supply** mix

Stakeholder concerns

- Regulatory (e.g., CNPE, Resolution 40066/2022)
- Environmental (e.g., UN Sustainable Development Goals, Global Methane Pledge)
- Financial (e.g., Task Force on Climate-related Financial Disclosure)

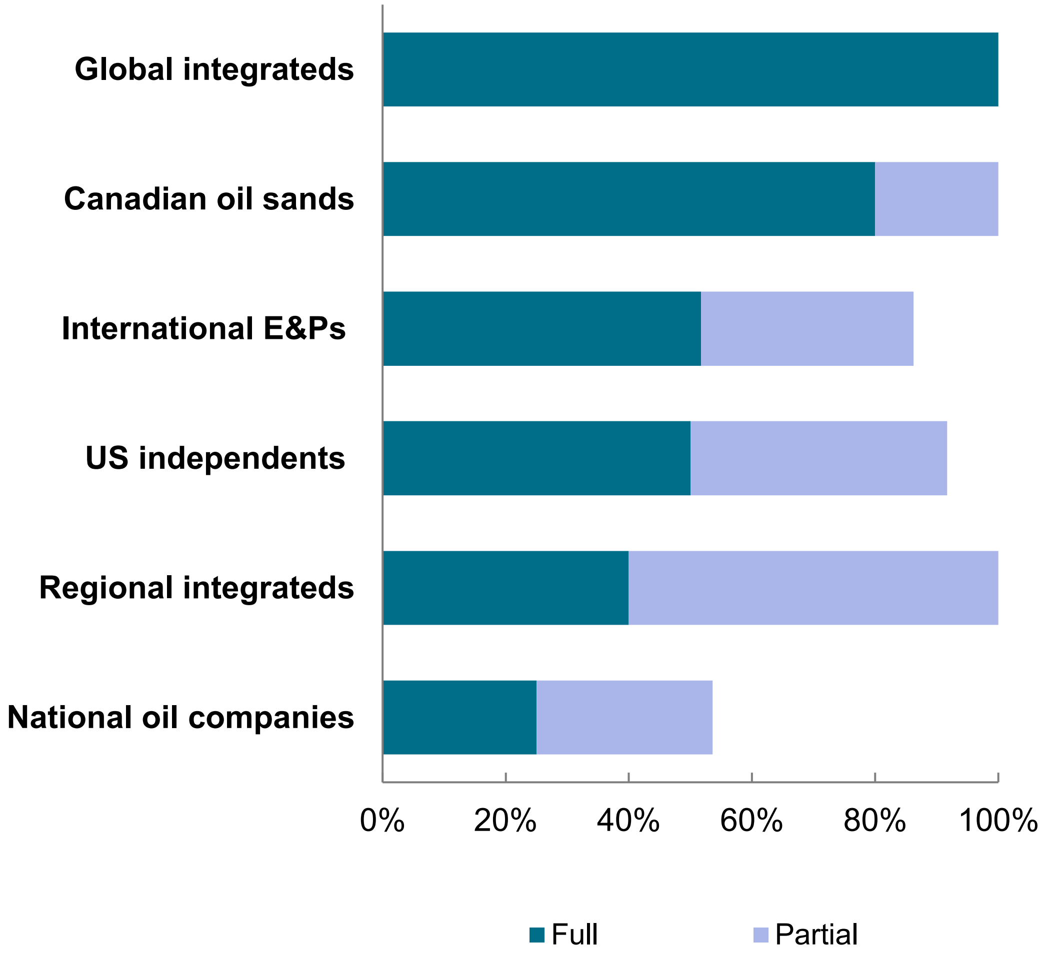


Reduced GHG-intensity of core upstream operations

- **Identify** and mitigate GHG emissions
- **Increase operational efficiency** (e.g., optimize energy usage, reduce consumables)
- **Life-cycle approach to asset management** (e.g., wells to wheels analysis, reduce end-use carbon produced)

Source: S&P Global Commodity Insights

Most oil companies are setting targets to reduce their operational (Scope 1 and 2) GHG emissions



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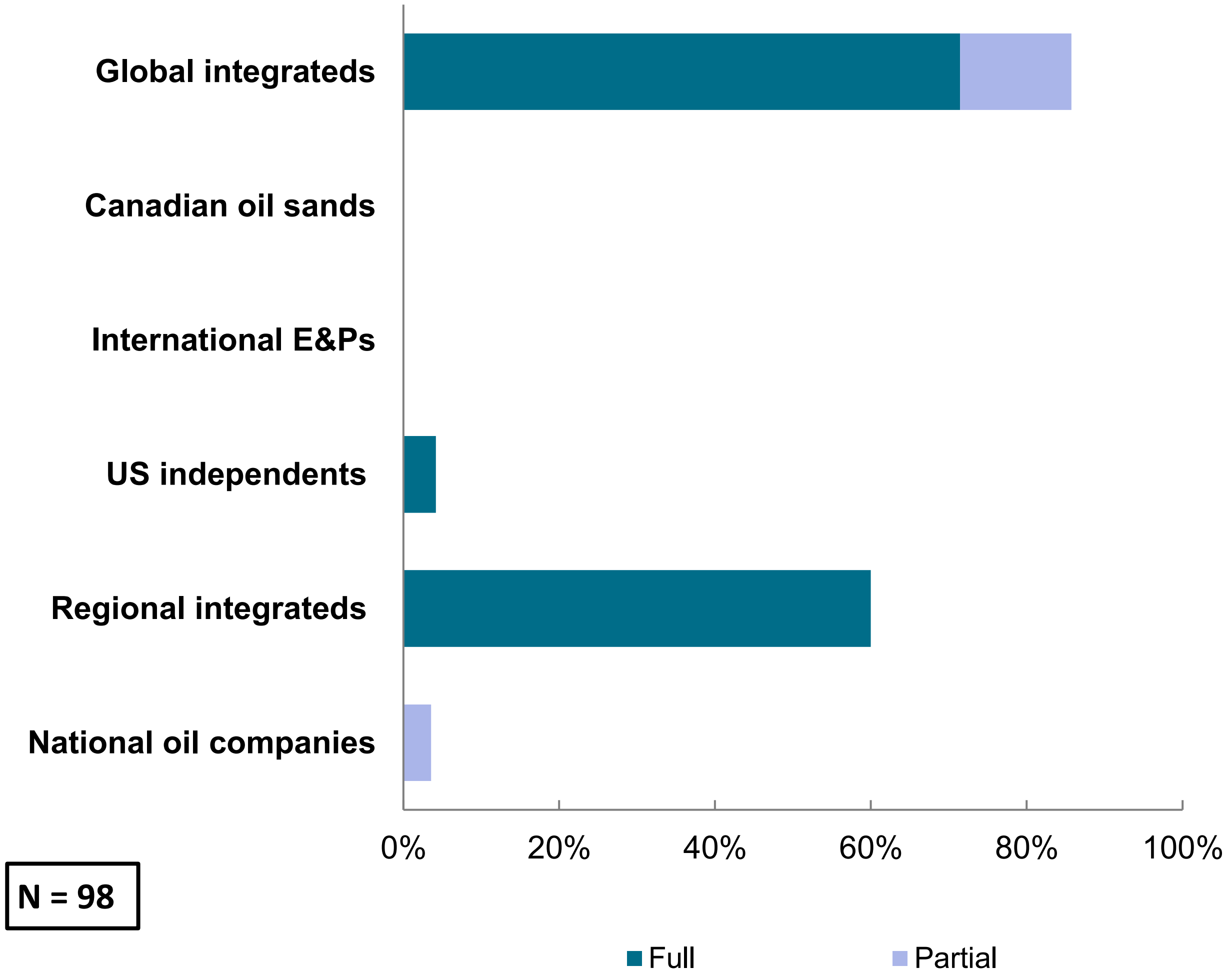
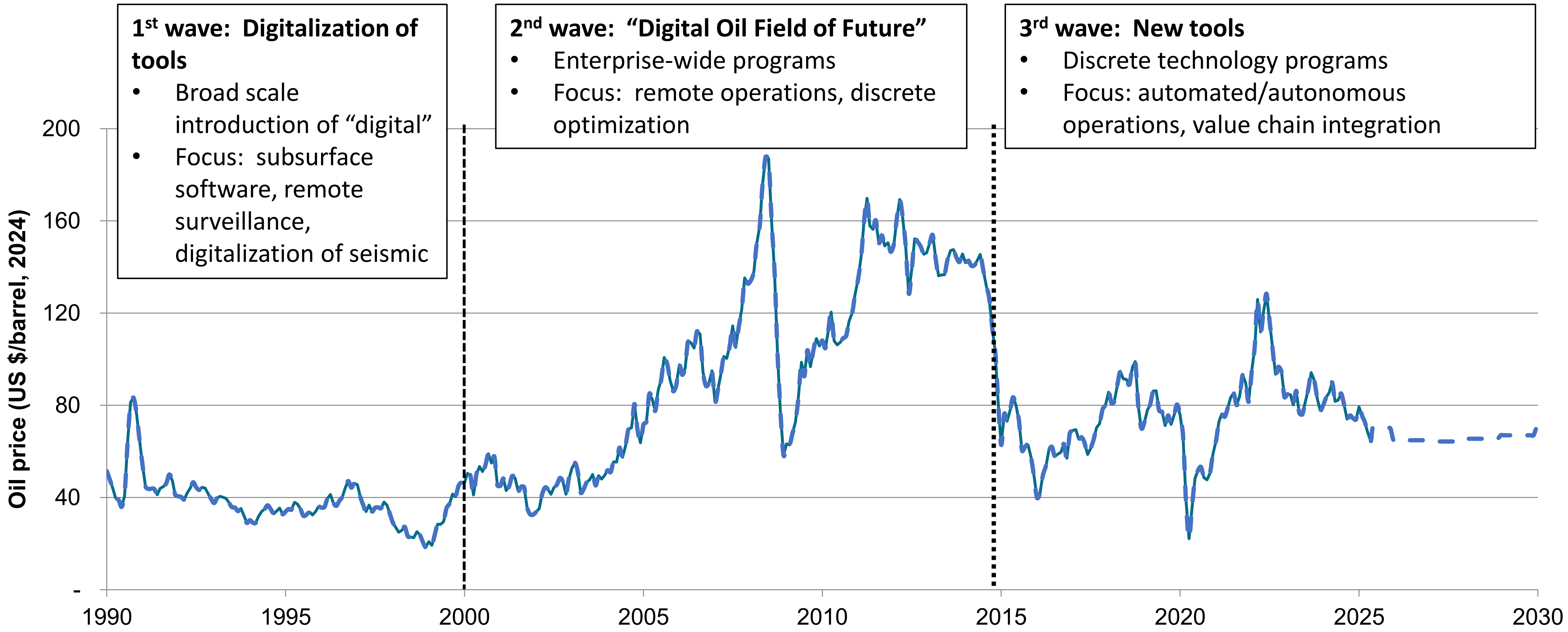


Source: S&P Global Commodity Insights

Oil and gas digitalization is now in its third wave—shifts in focus, technologies under consideration and deployment strategies



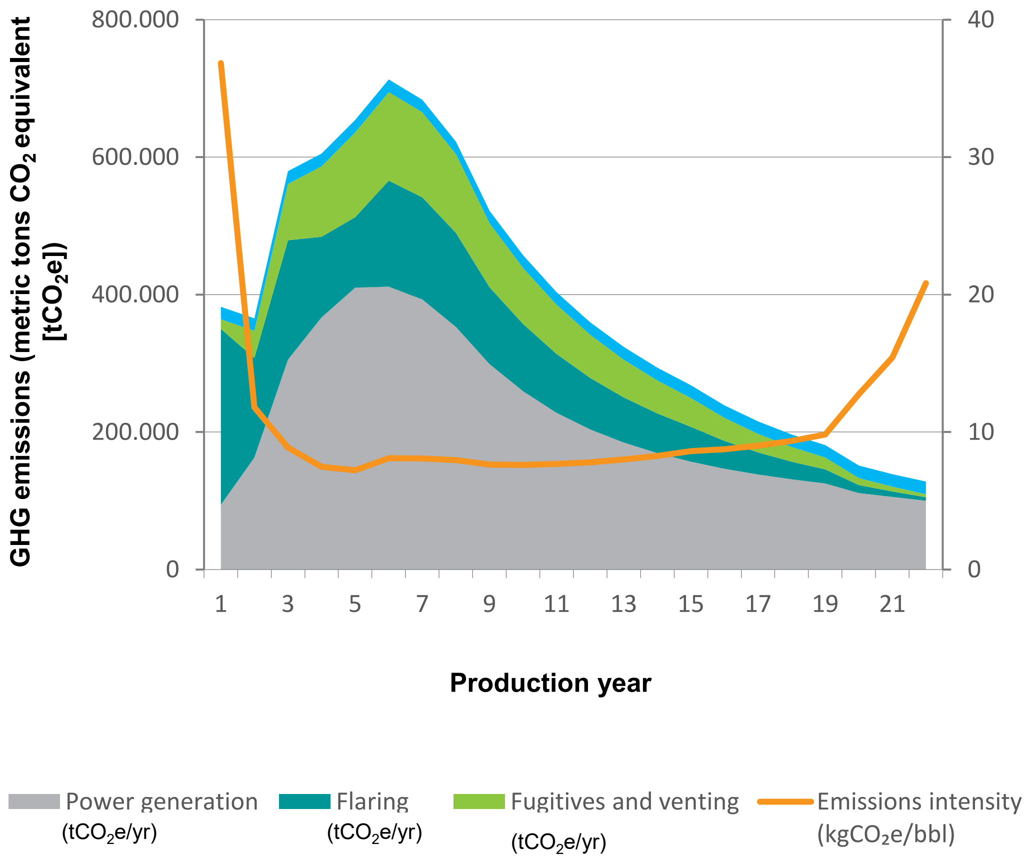
Dated Brent, FOB North Sea

Data compiled May 06, 2025.

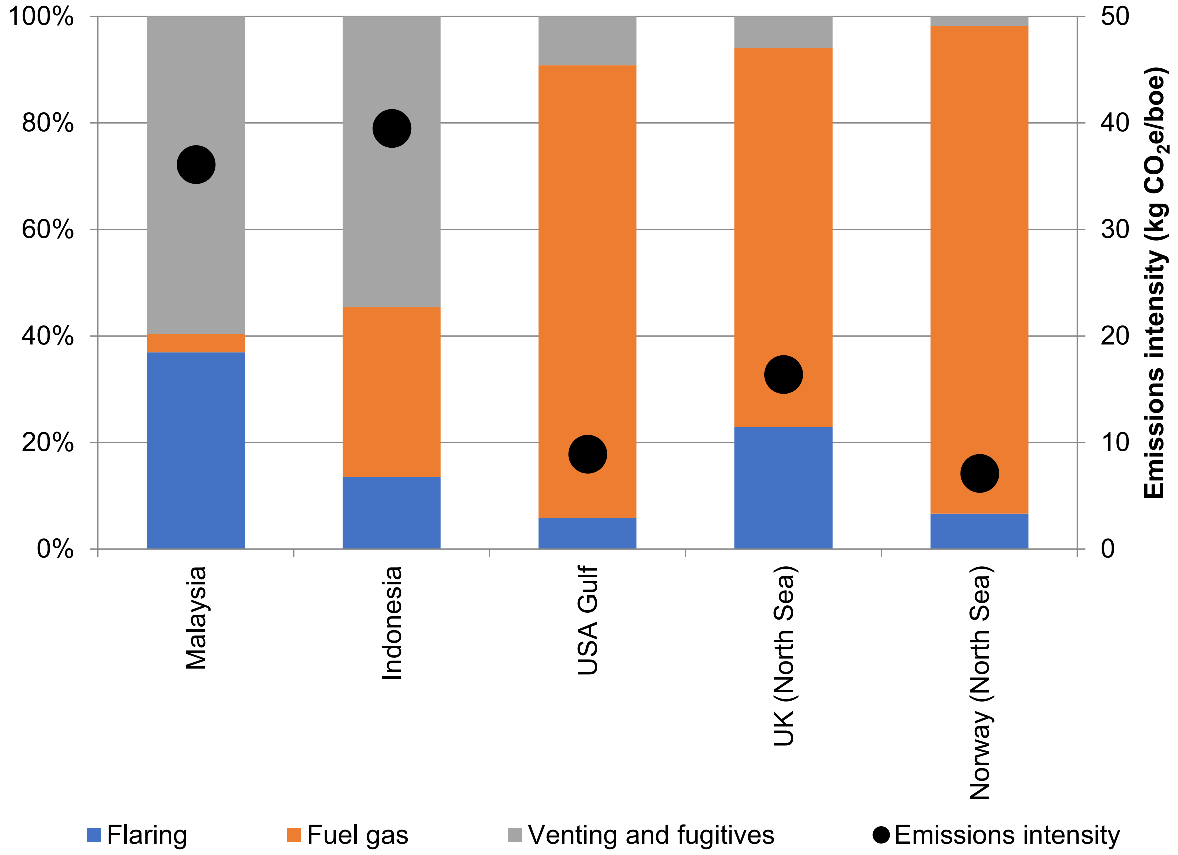
Source: S&P Global Commodity Insights.

In assessing where company GHG emissions reduction efforts for focus—understand the most significant contributors

“For-example” deepwater oil field, upstream GHG emissions



Comparison of GHG emissions by source and jurisdiction

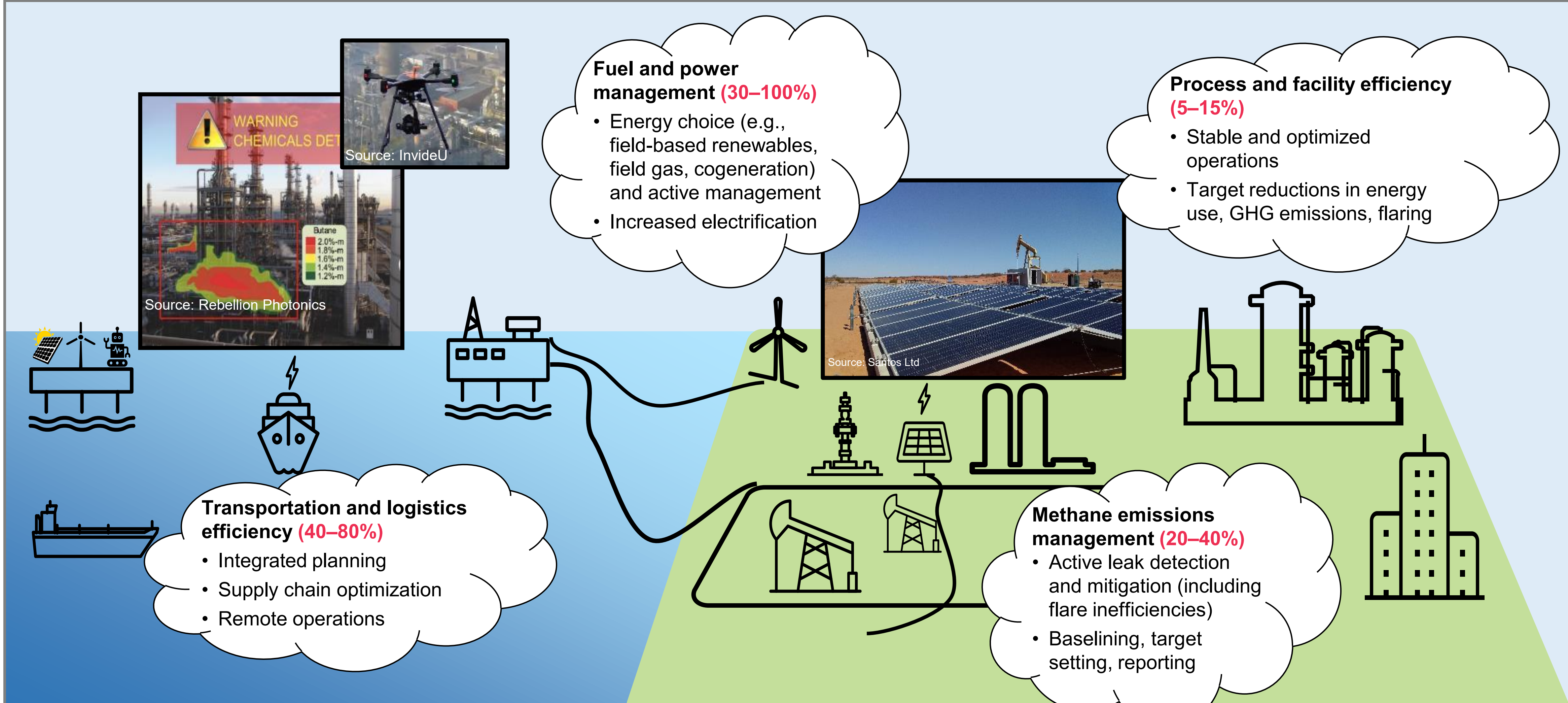


CO_2e = carbon dioxide equivalent; boe = barrels of oil equivalent
Data compiled June 17, 2025.

Source: S&P Commodity Insights, S&P Commodity Insights Upstream E&P content

Effectively applying technology can have a significant impact on the GHG emissions of oil and gas assets

Range of upstream GHG emissions-reducing activities



Source: S&P Global

Opportunities to manage emissions span the asset development and operations lifecycle—technology and innovation play a critical role

Oil & Gas GHG emissions reduction opportunity framework

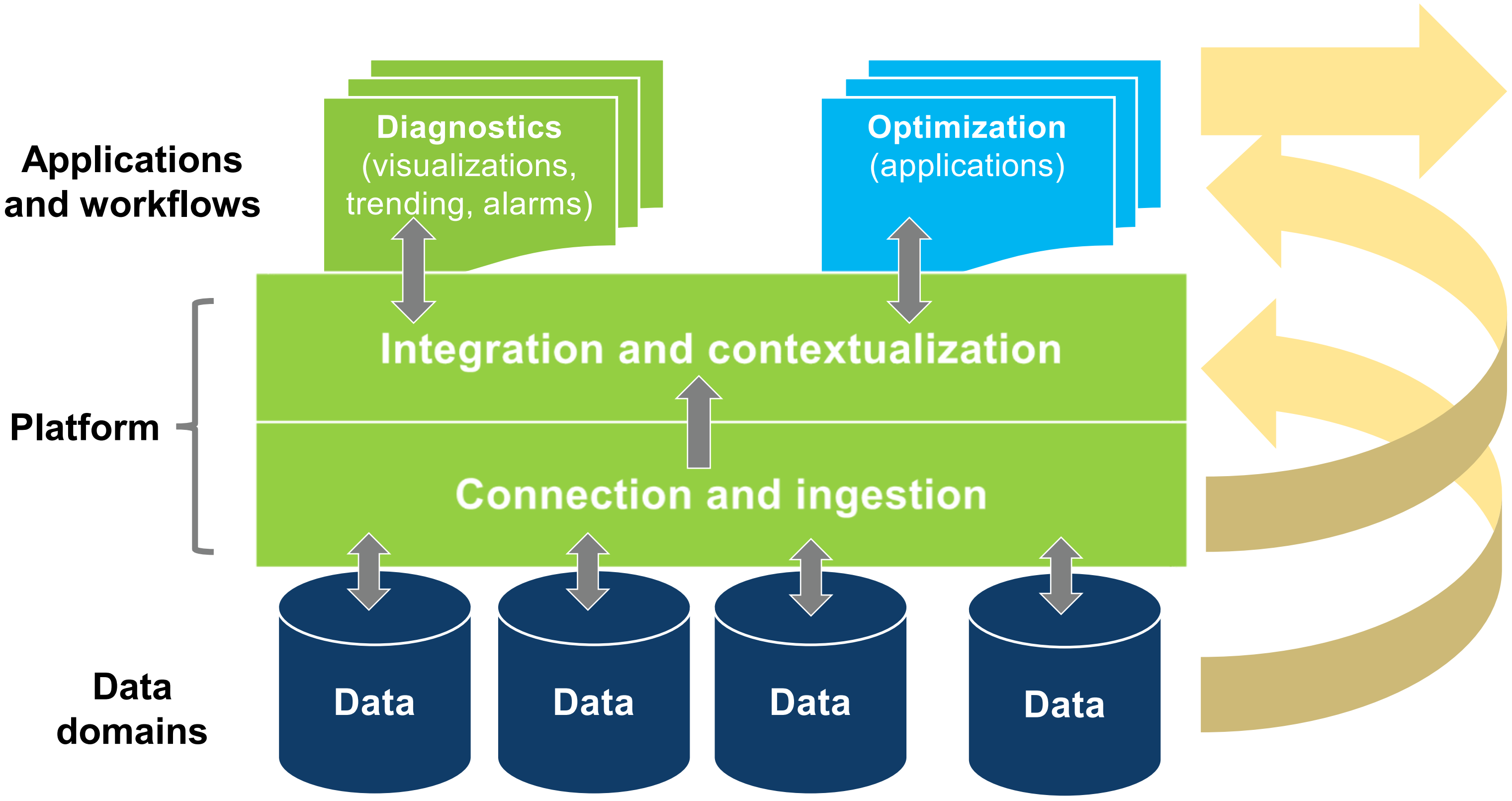
Category	Investment level	Focus (and examples)	Potential value	Time-to-value	Ease of change management
Tier 1 (10-30% reduction)	**Minimal capital investment**; emphasis on automation and digitalization	**Surveillance, management, optimization of complex systems** • Energy, power, and process control • Methane containment, flare • Transportation and logistics; remote operations	2	4	1
Tier 2 (30-60% reduction)	**Moderate capital investment**; largely proven technologies	**Upgrade and augment existing systems** • Low-carbon energy systems (e.g., onsite renewables and storage, "green" fuels, field gas) • Electrification • Upgraded equipment (e.g., higher-efficiency turbines, vapor recovery units)	3	2	3
Tier 3 (40-100% reduction)	**Major capital investment**; not-fully-proven, potentially-transformative technologies	**Build new systems or add system components** • New design concepts (e.g., unmanned, subsea facilities)	4	1	3

Low (i.e., drawback)	0 → 2 → 4	High (i.e., strength)

Source: S&P Global Commodity Insights

The same integrated digital platforms for improving operational performance are pivoting to support GHG emissions management

Schematic representation of a platform architecture



(e.g., geological attributes, completion details, production history, maintenance records, rotating equipment sensors)

Low carbon activities

- Energy and process efficiency
- Methane and other GHG containment
- Transport and logistics optimization

Links

- SCADA/DCS systems
- Maintenance management and integrated planning systems
- Methane and other GHG surveillance platforms
- Vehicular monitoring systems
- Meteorological data
- Pricing

Source: S&P Commodity Insights

NOC emphasizes energy efficiency as a key business driver—Established technology capabilities are leveraged to deliver results

Situation

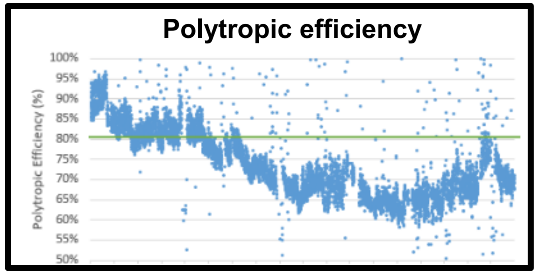
- Mature assets producing **610,000 b/d from ~8,000 wells** dispersed across 100,000 sq km; **80–95% water cut**
- **Significant & rising power demand (~2.4 GW)** associated with produced H_20 treatment, EOR, gas processing, artificial lift → **significant cost driver**
- Corporate objective = **reduce energy consumption**


Source: Shutterstock

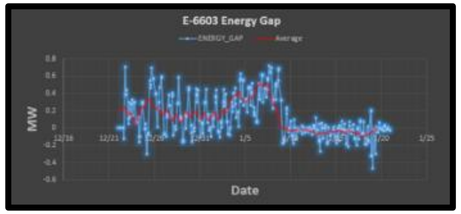
Philosophy—deliver on objective by **leveraging existing NOC resources**

- **IT platform—**internally developed solution serving as integrated surveillance platform (wells, subsurface, surface facilities); **expand to cover energy drivers** for key equipment classes (e.g., compressors, furnaces, gas turbines, high energy pumps)
- **Process optimization group**—long-standing group (1998) capable of developing the complex thermodynamic equations to **optimize individual equipment and overall system energy efficiency**

Integrate into existing workflows



Source: Oil company



Calculated MW savings opportunity

Source: Oil company

Action

Outcome

- **Rolling out across NOC:** Seven assets (2020) → complete coverage of 530+ critical equipment fleet (2022)
- **5–7% reduced energy use (56 MW)** with **no negative impact on production** (program mandate)

Source: S&P Global Commodity Insights

Oil companies are deploying a network of complimentary technologies to detect and measure GHG emissions

Overview of GHG emissions detection and measurement platforms

Near field → Far field

Comparative characteristic	Handheld detectors and cameras	Fixed and mobile sensors and cameras	Near-field aerial (drones, fixed-wing aircraft, helicopters)	Far-field aerial (satellites, high-altitude balloons)
Prevalence	• Traditional industry method; more sophisticated technology	• Industry deployments under way	• Industry pilots under way	• Industry proof of concepts and assessments under way
Advantages	• Costs • Established methodology	• Frequent, regular monitoring	• Efficiency and site accessibility • Physical measurements	• Broad, consistent coverage • Fewer operational considerations
Challenges	• Consistency and accuracy of measurement • Sampling frequency • Personnel exposure	• Cost (~$50,000 per sensor/camera) • Field of view; panning capability • Supporting IT/comms infrastructure • Longevity (heat, humidity, dust)	• Costs (drone inspection = $60–150; “operators are cheap”) • Resolution • Approval for BVLOS operation	• Cost • Resolution • Sampling frequency
Example suppliers	Heleck Solutions, Teledyne FLIR	ABB, Field GeoServices, Grandperspective, Honeywell, Infrared Cameras Inc, Kuva Systems, Longpath Technologies, mPACT2WO, MultiSensor Scientific, Project Canary, Providence Photonics, QLM, Qube, Sierra-Olympics Technologies	Avitas Systems, Ball Aerospace, Boeing, Cyberhawk, DJI, Flylogix, Insight M, PrecisionHawk, Scientific Aviation, SeekOps, Silent Falcon, Sky-Futures, SkySkopes, SkyX	Airbus, Bluefield, GHGSat, Kayrros, Maxar Technologies, MethaneSAT, Orbital Sidekick, Scepter, World View

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Integrated digital platform

- Objective: aggregate, reconcile, analyze and act on full suite of collected data
- Connected systems: SCADA, methane monitoring platforms (e.g., drones), maintenance management systems
- Example activities: SLB, Satelytics, University of Texas consortium

Source: : S&P Commodity Insights

Unconventional operator incorporated methane detection activities into its existing digitalization platforms and workflows

Situation

- Business unit of an IOC **active in several prominent North America unconventional plays**
- Field operations managed by an **analytics-driven, automated work management platform**
- Incorporated **drone readings of produced water tank levels** into work management platform, **effective but costly**

Tank methane venting event

Approach—extend drone platform to include unintended methane release detection activities

- **Investigate multiple commercially available methane detection technologies**

☐ On-equipment sensors ☑ Cameras (fixed, truck-mounted) ☑ Drones (BVLOS with a laser + optical gas imager camera payload) ☐ Satellites

- **Work with startups outside oil and gas to augment surveillance capability** (e.g., video analytics, camera technology, corrosion detection)
- **Integrate acquired data into proprietary data environment** and **methane mitigation activities into existing operator workflows** — "*It's just another task that shows up in their queue*" – BU Technology Manager

Outcome

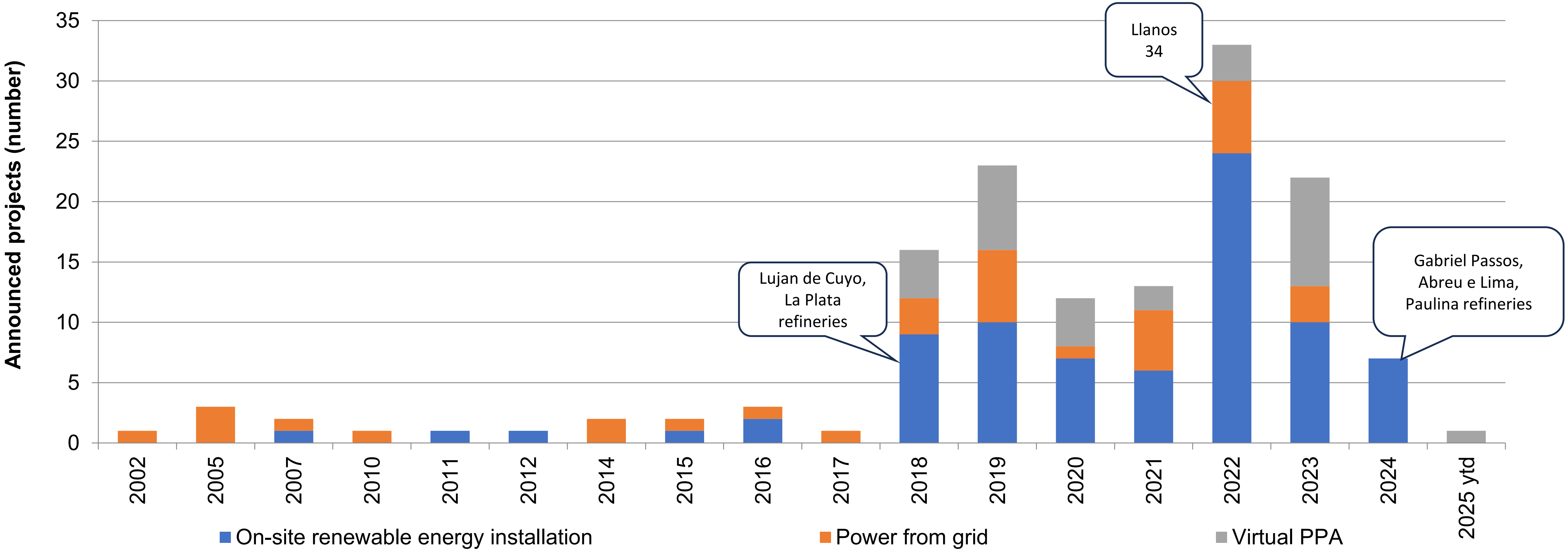
- Methane surveillance program deployed across all tight oil assets (2022)
  - **Increase daily inspections from 34–40 → 68 sites** via preprogrammed drone routes
  - **Reduce inspection costs 75%** versus handhelds (now < $80 per well)
- **Unable to quantify reduction in methane venting volumes**
- BU recognized as **company leader in methane detection via remote sensing**

What's next?

- **Investigate complementary inspection platforms** (e.g., autonomous rovers) and **new operating models**
- **Develop new remote inspection capabilities** (e.g., hydrocarbon spill detection and compositional analysis)
- **Analytics to proactively address methane releases** (e.g., releases associated with pneumatic dumps)
- Identify opportunities to **improve equipment design** (e.g., thief hatches)

Oil companies are electrifying and tapping into renewables to power core operations—reducing the most significant source of emissions

Announced oil and gas field-based renewable energy projects



Renewable energy sources include solar, wind and hydroelectric. PPA = power purchase agreement simulating deployment of new renewable energy capacity on the grid..

Data compiled June 17, 2025.

Source: S&P Global Commodity Insights.

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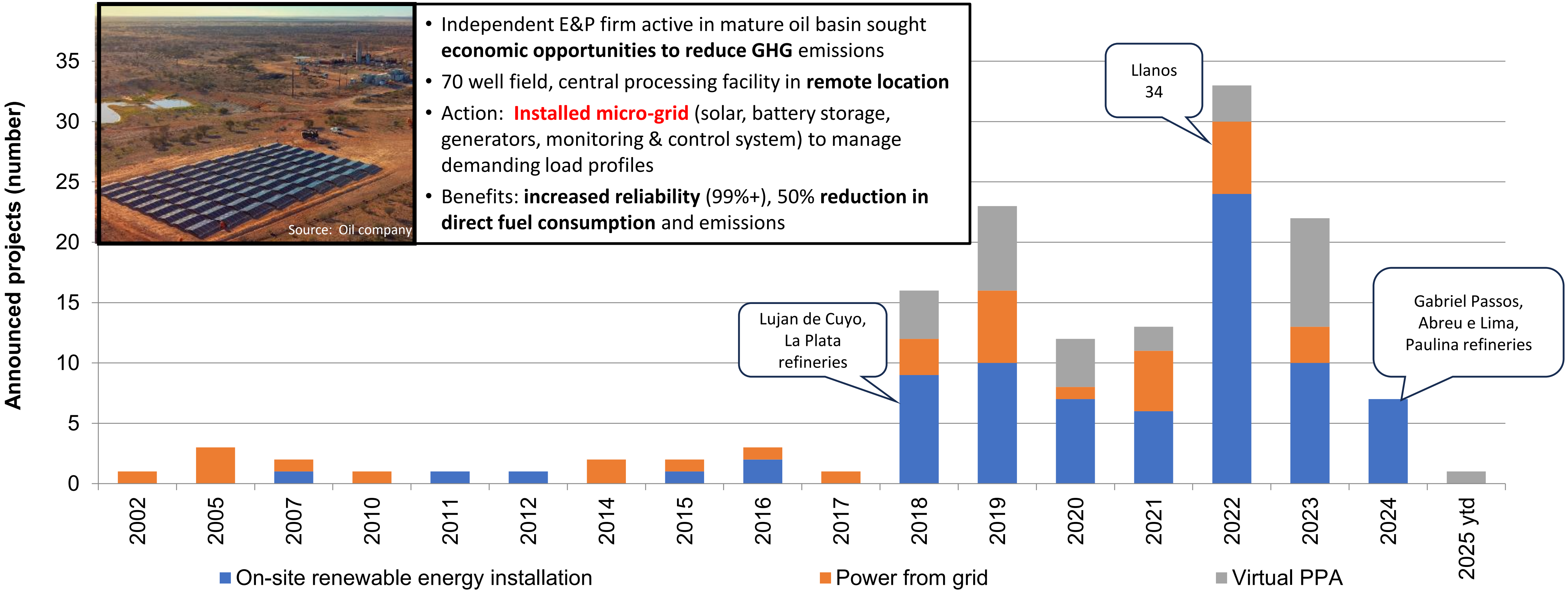


- Independent E&P firm active in mature oil basin sought **economic opportunities to reduce GHG** emissions
- 70 well field, central processing facility in **remote location**
- Action: **Installed micro-grid** (solar, battery storage, generators, monitoring & control system) to manage demanding load profiles
- Benefits: **increased reliability** (99%+), 50% **reduction in direct fuel consumption** and emissions

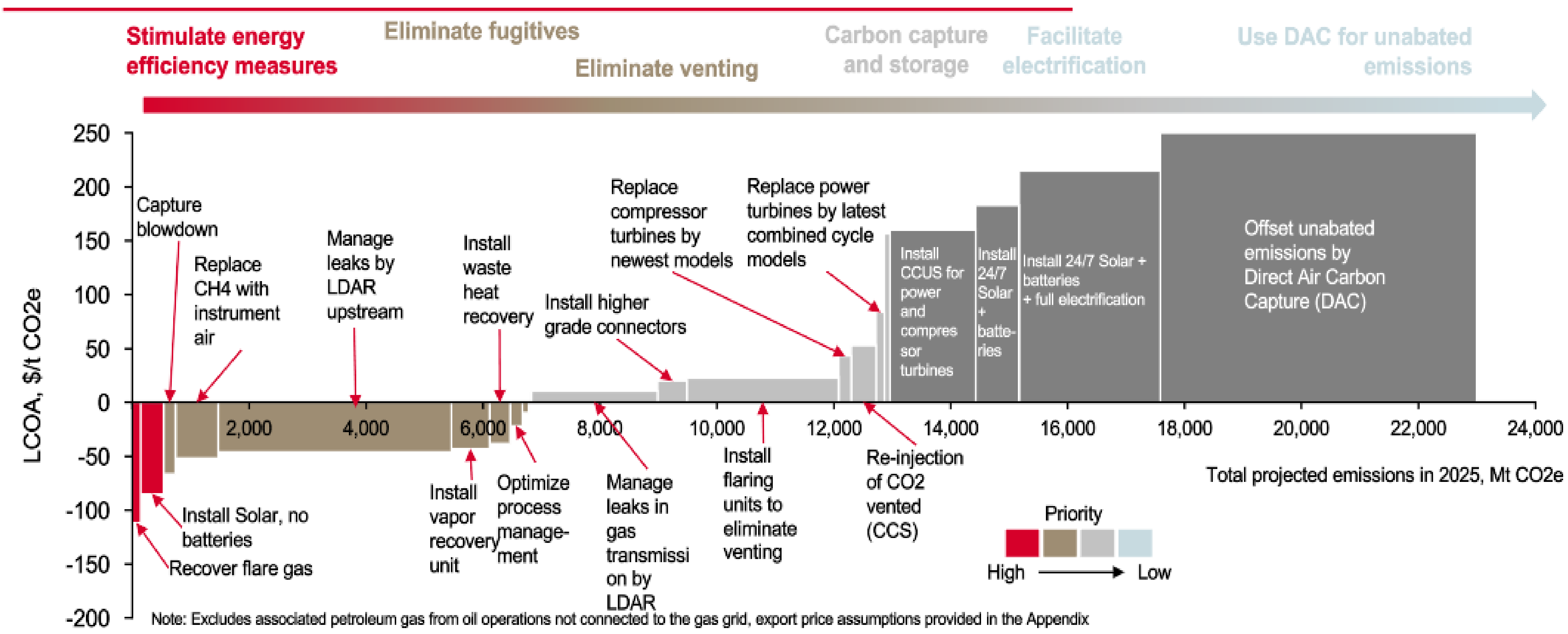
Renewable energy sources include solar, wind and hydroelectric. PPA = power purchase agreement simulating deployment of new renewable energy capacity on the grid..

Data compiled June 17, 2025.

Source: S&P Global Commodity Insights.

Prioritization is given to opportunities that offer the lowest marginal abatement cost and can have the most immediate impact

Marginal Abatement Cost Curve (generalized for gas value chain of Egypt, Israel, and Jordan, valid with specific implied conditions, incl. current EU gas price outlook)



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