Annexes

Annex I

Associated gas cross-references to the UN Sustainable Development Goals

SUSTAINABLE DEVELOPMENT GOAL	UN TARGETS THAT ARE RELEVANT TO IMPROVING THE UTILIZATION OF ASSOCIATED GAS	OIL AND GAS INDUSTRY ACTIONS THAT CAN LEAD TO THE REDUCTION OF ASSOCIATED GAS FLARING
7 AFFORDABLE AND CLEAN ENERGY	7.1 By 2030, ensure universal access to affordable, reliable and modern energy services. 7.2 By 2030, increase substantially the share of renewable energy in the global energy mix. 7.3 By 2030, double the global rate of improvement in energy efficiency. 7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries and Small Island Developing States, and land-locked developing countries, in accordance with their respective programs of support.	• Improve access to energy services through shared infrastructure. • Grow the share of natural gas in the energy mix. • Increase the share of alternative energies and technologies in the global energy mix. • Improve energy efficiency in operations and production activities.
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all. 9.2 Promote inclusive and sustainable industrialization and, by 2030, significantly raise industry's share of employment and gross domestic product, in line with national circumstances, and double its share in least developed countries. 9.4 By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities. 9.b Support domestic technology development, research and innovation in developing countries, including by ensuring a conducive policy environment for, inter alia, industrial diversification and value addition to commodities.	• Upgrade infrastructure and technology to make them sustainable. • Evaluate potential opportunities for shared use infrastructure. • Enhance technological capabilities and knowledge transfer. • Expand off-grid energy access.

continued ...

SUSTAINABLE DEVELOPMENT GOAL	UN TARGETS THAT ARE RELEVANT TO IMPROVING THE UTILIZATION OF ASSOCIATED GAS	OIL AND GAS INDUSTRY ACTIONS THAT CAN LEAD TO THE REDUCTION OF ASSOCIATED GAS FLARING
12 RESPONSIBLE CONSUMPTION AND PRODUCTION	12.2 By 2030, achieve the sustainable management and efficient use of natural resources. 12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle. 12.a Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production. 12.c Rationalize inefficient fossil fuel subsidies that encourage wasteful consumption by removing market distortions, in accordance with national circumstances, including by restructuring taxation and phasing out those harmful subsidies, where they exist, to reflect their environmental impacts, taking fully into account the specific needs and conditions of developing countries, and minimizing the possible adverse impacts on their development in a manner that protects the poor and the affected communities.	• Increase energy efficiency, particularly in less-accessible and more energy-intensive operations. • Understand and address the full environmental and social footprint of oil and gas products. • Incorporate sustainability objectives into operations and encourage the same into the activities of suppliers, distributors and customers. • Work with stakeholders (including governments and NGOs) to achieve consensus-based pathways to improve patterns of oil and gas consumption, inform regulatory standards, and coordinate approaches to address issues related to fuel-sustainable mobility and future fuel consumption options and their impacts.
13 CLIMATE ACTION	13.2 Integrate climate change measures into national policies, strategies and planning. 13.3 Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning. 13.a Implement the commitment undertaken by developed-country parties to the United Nations Framework Convention on Climate Change to a goal of mobilizing jointly USD 100 billion annually by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation, and fully operationalize the Green Climate Fund through its capitalization as soon as possible.	• Plan strategically for a net-zero emissions future. • Self-assess carbon resiliency. • Strengthen resilience and adaptive capacity with regard to climate change impacts. • Mitigate emissions within oil and gas operations. • Partner in research and development and education outreach. • Support effective policy measures. • Help consumers lower their emissions.

continued ...

SUSTAINABLE DEVELOPMENT GOAL	UN TARGETS THAT ARE RELEVANT TO IMPROVING THE UTILIZATION OF ASSOCIATED GAS	OIL AND GAS INDUSTRY ACTIONS THAT CAN LEAD TO THE REDUCTION OF ASSOCIATED GAS FLARING
17 PARTNERSHIPS FOR THE GOALS	17.1 Strengthen domestic resource mobilization, including through international support to developing countries, to improve domestic capacity for tax and other revenue collection. 17.3 Mobilize additional financial resources for developing countries from multiple sources. 17.7 Promote the development, transfer, dissemination and diffusion of environmentally sound technologies to developing countries on favorable terms, including on concessional and preferential terms, as mutually agreed. 17.16 Enhance the global partnership for sustainable development, complemented by multi-stakeholder partnerships that mobilize and share knowledge, expertise, technology and financial resources, to support the achievement of the sustainable development goals in all countries, in particular developing countries. 17.17 Encourage and promote effective public, public-private and civil society partnerships, building on the experience and resourcing strategies of partnerships.	• Help build government capacity. • Develop and disseminate sustainable energy technologies. • Partner with other stakeholders to leverage core competencies and promote investment, job creation, skills development, infrastructure expansion and technological innovation. • Participate in dialogues with stakeholders, governments and NGOs to identify shared goals. • Incorporate SDGs into company policies and practices.

Annex II

Flare flow measurement techniques supplement

METER TYPE	ORIFICE PLATE	V-CONE	PITOT TUBES AND ANNUBARS	ULTRASONIC	THERMAL MASS ANEMOMETER	CORIOLIS
Installation type[a]	In-line	In-line	Insertion	Insertion or clamp-on	Insertion or in-line	In-line
Measurement principle	Differential pressure	Differential pressure	Differential pressure	Ultrasonic pulse	Thermal conductivity	Coriolis effect
Accuracy range	± 2–4%	± 0.5%	± 1–3%	± 2–5%	± 1–3%	± 0.2–0.4%
Turndown ratio[b]	3–10:1	10:1	3–30:1	2,750:1	100–1,000:1	100:1
Straight line pipe requirements[c]	Up: 6–20 D Down: 2–40 D	Up: 0–3 D Down: 0–1 D	Up: 10–25 D Down: 5–10 D	Up: 10–30 D Down: 5–10 D	Up: 8–10 D Down: 3D	Up: none Down: none
Calibration frequency	Dependent on service type	None after initial	Annual	Annual	Annual	When out of tolerance
Line pressure loss[d]	High	Moderate	Low	Low	Low	Moderate
Composition dependent[e]	Yes	Yes	Yes	No	Yes	No
Suitability for wet/dirty gas	High	High	Low/moderate	Moderate	None	Low
Mainline power required	No	No	No	Yes	Yes	Yes
Obstructs flow to flare header	Yes	Yes	No	No	No	Not suitable for flare
Per meter cost (USD)	500–2,000	--	500–2,000	20,000–90,000	2,000–5,000	5,000–20,000
Example vendors	Emerson, Spirax Sarco	McCrometer	Emerson, Dwyer Instruments	GE, Fluenta	FCI, Sierra Instruments	Micromotion, Siemens

Notes:

[a] 'In-line flow meters' refers to those that are installed in the line of fluid flow, and have the potential to impede flow and reduce stream pressure downstream of the meter. 'Insertion flow meters' refers to those that are inserted into existing ports and/or pipes that do not impede flow above marginal rates. 'Clamp-on flow meters' are portable metering devices that clamp onto the outside of a pipe.

[b] Turndown ratio is the ratio of maximum and minimum flows where accuracy is certified to be maintained. For example, a meter guaranteed to remain accurate to ±1.5 % from 400 scf/hour to 100 scf/hour would have a turndown range of 4:1.

[c] 'D' refers to the pipe diameter; 'Up' refers to pipe length upstream from the flow meter; and 'Down' refers to pipe length downstream from the flow meter.

[d] Line pressure loss is the expected magnitude of pressure drop in the fluid downstream of the installed meter.

[e] 'Compositional dependence' represents the impact that fluid composition will have on meter performance. For example, thermal mass anemometers require the thermal conductivity of a fluid to accurately calculate flow rates. If the fluid composition changes, so will the thermal conductivity. Hence, accurate compositional data are necessary. Composition dependence in this context refers to the meter's need for compositional data (e.g. gas density, thermal conductivity, etc.) in order to calculate mass flow rates.

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Annex III

'Zero Routine Flaring by 2030' initiative — example checklist for 'OpCo'

What activities at existing fields are outside the scope of the commitment?

In existing fields that OpCo operates, all gas flaring must be reported. OpCo is not obligated to install equipment to end flaring by 31 December 2030, if OpCo:

(i) does not own the gas;
(ii) does not have exclusive control of capital decisions;
(iii) is a service company (de facto operator); or
(iv) if the gas owner or joint venture/working interest partner does not choose to implement such projects.

In existing fields where OpCo is an owner but not the operator, OpCo has no responsibility for reducing flaring under the commitment and, accordingly, there is no requirement for tracking the volume of gas flared.

What is a 'new' oilfield?

A 'new' oilfield is a development project in a field where there is no existing OpCo-operated oil production. The following are not considered 'new' oilfields:

(i) Adding new wells or increasing production in existing fields.
(ii) New hydraulic fracturing programs in existing fields.
(iii) Adding new tank batteries or other facilities in existing fields.
(iv) Acquisition of other ongoing production operations.

What does 'according to plans that incorporate sustainable utilization or conservation of the field's associated gas' mean?

Such plans can include any beneficial use of the associated gas, such as sales, reinjection, use as an injectant for EOR, use as an on-site fuel source, etc. The sustainable utilization or conservation solution must be implemented within 90 days from first oil.

What does 'economically viable' mean?

OpCo will implement projects to end routine flaring at existing operations (those commissioned prior to 1 January 2022) only when the investment meets OpCo's normal capital expenditure financial criteria. For operations where partners are not willing to invest in projects, OpCo is not required to fund the flare reduction project.

How long can 'safety' flaring continue before being considered as 'routine' flaring?

For all safety flaring scenarios, flaring can continue for as long as necessary to maintain safe operations, i.e. there is no point at which legitimate 'safety' flaring must be reclassified as routine flaring.

continued ...

How long can 'non-routine' flaring continue before being considered as 'routine' flaring?

The acceptable duration of 'non-routine' flaring extends from the time an issue causing 'non-routine' flaring begins until a determination is made that the issue is completely resolved. A documented justification is necessary for any 'non-routine' flaring that extends beyond one year.

Are flaring activities that are authorized by a government agency (e.g. by permit or regulation) exempt from the initiative?

No. Regardless of how flaring is regulated, administered or controlled by government authorities, all flared gas volumes are covered by the initiative and must be reported according to the definitions described therein.

Does the initiative include portable flares?

Yes. The initiative covers all flares, whether permanent, temporary or portable.

Does the commitment require measurement of flared gas volumes, or are estimates sufficient?

Measurements are preferred, but engineering estimates (e.g. mass balance calculations) are acceptable.

Does the initiative require reporting of gas flared by OpCo (as the operator) that OpCo does not own?

Yes. In existing fields where OpCo operates but does not own the gas, or fields where OpCo is a service company (de facto operator), all flared gas must be reported.

Can routine flaring continue beyond 31 December 2030?

Yes. For circumstances where there is no flare elimination project that can meet OpCo's normal economic justification criteria (such as the capture of low-pressure, low-volume gas streams), flaring can continue.

What reporting obligations will exist after 31 December 2030?

Flaring beyond 31 December 2030 must be reported and classified as routine, safety or non-routine flaring.

What are the potential consequences if OpCo does not fulfill its commitment?

The commitment has high visibility among certain stakeholders, including investors. Failure to demonstrate progress against the commitment may create a significant reputational or credibility issue.

Is OpCo's commitment to eliminate routine flaring by 31 December 2030 consistent with the World Bank's 'Zero Routine Flaring by 2030' initiative?

The program goal, approach and definitions are consistent with the initiative.

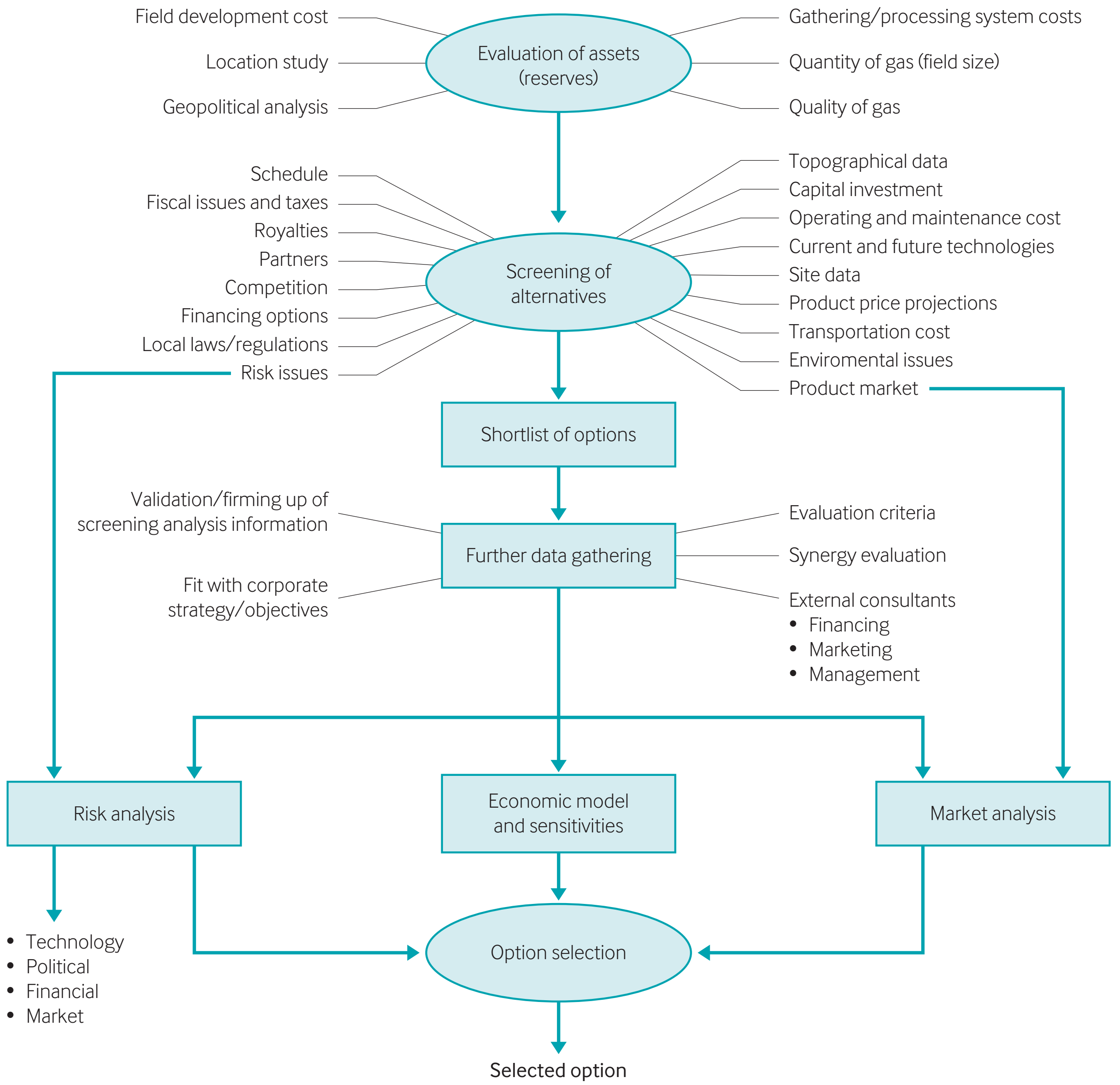
Annex IV

Criteria, project screening and bankability

The evaluation of gas monetization options is best done using a systematic approach to define the optimal technique. In addition to the technical considerations discussed in this document, commercial issues and market conditions also play a key role in the evaluation process.

The option screening process includes the key steps shown in Figure A10.

Figure A10 Evaluation of gas monetization options [193]



Once options are identified, a screening process is undertaken to reduce the number of options to a shortlist for more in-depth analysis. The screening process to shortlist, or grade, the alternative options should identify the most important criteria to be considered when selecting the optimal solution. Typical decision criteria for screening alternatives may include, but not be limited to:

- technical feasibility and project complexity;
- capital and operating cost estimates for the specified technology solution;
- alternative uses of investment capital and the producer's cost of capital;
- market demand and logistics for the gas or other products;
- natural gas pricing (or other product prices) and price risk;
- lease/concession terms;
- regulatory constraints and other factors governing access to gas utilization and export facilities;
- proximity and capacities of regional and national pipelines;
- additional operating costs associated with natural gas production and gas processing for each of the utilization options;
- cost of land acquisition and the cost and timing to obtain right-of-way approvals;
- environmental and community impact analysis;
- likelihood of legal challenges and concerns raised by stakeholder groups; and
- regulations that define allowable flaring and the likelihood of future changes.

After the shortlisted options are determined, further economic, market and risk analysis will be required. Ultimately, after a thorough evaluation of the alternatives, the goal is to select a project that makes use of all (or most) of the associated gas production.

For large projects, where the required investment cannot be funded solely by the producer or the resource owner, the proponents will need external financing (typically a loan) to initiate construction. Generally, lenders have taken the view that, compared to other sectors, loans to oil and gas projects carry greater exposure to higher and more complex risks. In addition, given the high debt levels associated with project finance, lenders normally adopt a more conservative stance towards industry risks compared to project sponsors.[194] Sources of external finance (for large projects in developing countries, this may be a multilateral development bank) will perform a due diligence review of the project to determine whether or not it meets the institution's project finance criteria.

For a commercial bank, loan underwriting focuses on financial metrics which demonstrate that the project proponents will repay the loan principal with interest in accordance with the terms of the proposed lending agreement. For MDB project finance, the due diligence process looks at other factors. Factors that are of particular importance are listed below:[195,196,197,198]

- The project location should be suitable for the activities to be carried out. There should be assurances that the sponsors of the project have unrestricted ownership and/or access to the land. The land procurement process must be performed with integrity, following documented procedures, preferably with a high degree of transparency. This includes management of any relocation issues that can affect local communities.
- The project should be of strategic importance to the relevant host government and there should be the political will to support the project through the whole project life cycle. It is critical that the government is invested in, and committed to, the project and has the institutional capacity to satisfy its obligations under its guarantees. Political risks should be mitigated by appropriate investment treaties, and by changes in legal provisions and/or investment guarantees that protect investments against non-commercial risks.
- There should be strict adherence to the regulatory and policy regimes for equity funding, finance structures and operational practices, financial controls and risk management. Since uncertain legal frameworks, weak internal controls, and delayed tender processes and/or bid rounds can directly affect project bankability and dampen the interest of other investors and stakeholders, monitoring and management protocols should be established. Regulations for the issuance of equity (if any) and mandatory local content requirements must be followed.

- There should be a clear allocation of risk among the parties. This can be an especially intricate arrangement as the size, technical complexity and number of project participants grows. Interdependent financing, senior and subordinated loans to sponsors, joint ventures or other parties, and the use of special-purpose vehicles/entities complicate the management of risk. It is essential that the risks associated with each part of the value chain are fully understood and allocated appropriately between the various stakeholders, including: the host government; project developers; suppliers and contractors; other consortia; and project lenders. Project finance lenders will likely require detailed assurances from project sponsors that all technical and operational interface issues between the various project components have been addressed, such as construction completion, testing, commissioning and acceptance.
- A robust stakeholder engagement process should have been undertaken, ensuring that the most appropriate stakeholders have been selected, especially those representing local communities. Mechanisms should have been established to ensure follow-through on delivery of the project's economic and social benefits (such as training programs, technology transfer and payment of dividends or royalties) to ensure that those communities who are affected by the project receive a sustainable economic benefit from the project. These efforts mitigate potential security and political risks.

Annex V

Associated gas CDM projects[199]

PROJECT	GHG REDUCTIONS (t CO_2e/year)
6008: Recovery and utilization of associated gas at Pondok Tengah LPG plant — PT. Yudistira Energy (Indonesia) https://cdm.unfccc.int/Projects/DB/LRQA%20Ltd1333528065.88/view Project activities include the establishment and operation of a new LPG plant to recover and utilize the associated gas previously flared at Tambun and Pondok Tengah Gas Collection stations, and the installation of a new pipeline to connect the Pondok Tengah-Pertamina EP Station with Yudistira's LPG Plant. The recovered gas is processed into LPG, condensate and lean gas.	143,428
6808: Recovery and utilization of associated gas at the Tugu Barat plant (Indonesia) https://cdm.unfccc.int/Projects/DB/BVQI1343111376.1/view The project involves the construction of facilities for the recovery and processing of associated gas previously flared at the Tugu Barat oilfields. The project also involves the transportation and processing of sour gas into sweet gas, and further processing into lean gas, LPG and condensate. Investments include a gas delivery pipeline, two gas compressors and an MDEA (methyldiethanolamine) gas treatment plant for the removal of CO_2.	52,628
6817: Associated gas recovery and utilization at Block 9 in the Safa oilfield (Sultanate of Oman) https://cdm.unfccc.int/Projects/DB/BVQI1343120764.64/view The project involves the recovery and utilization of natural gas found in association with oil at Block 9 in the Safah oilfield. The gas recovery process comprises three main stages, including the separation, compression and processing to meet pipeline conditions for transportation to end users. The main equipment necessary for the proposed project activity comprises electric motor-driven reciprocating and screw compressors, and the pipelines for gas transportation.	775,250
8276: Oil Search Limited flare and vent gas conservation project (Papua New Guinea) https://cdm.unfccc.int/Projects/DB/DNV-CUK1353303667.77/view The project involves recovery of associated gas from Oil Search Limited's operations in the Southern Highlands and Gulf Provinces, through the installation of a compression and blower system to collect gas from each low-pressure flare at the crude oil storage tanks and from the produced water system at the central processing facility (CPF), to deliver the gas to an existing booster compressor. A flow line will be installed from the refinery high pressure separator to deliver associated gas to an existing CPF booster compressor. The existing fuel gas blanketing system will be replaced with an inert gas system. Recovered associated gas will be compressed and transported to a sales gas pipeline.	57,438
8286: Gas flaring reduction at the Neelam and Heera asset (offshore Mumbai, India) https://cdm.unfccc.int/Projects/DB/SGS-UKL1353319809.68/view The Neelam and Heera process complexes comprise developed infrastructure including well head platforms, process platforms and interconnected pipelines. The project activity includes the installation of oil-flooded gas compressor packages at the processing complexes to increase the pressure of low-pressure gas for conversion into marketable products, e.g. LPG, C_2, C_3 and NGLs.	65,811

PROJECT	GHG REDUCTIONS ($t\ CO_2e$/year)
8598: Nanba associated gas processing plant and the auxiliary engineering (China) https://cdm.unfccc.int/Projects/DB/BVQI1354796911.2/view Activities include the recovery and utilization of associated gas from oil wells in the Second Oil Production Plant of the Sanan Oilfield, to be processed into dry gas and condensate. The project will involve construction of the associated gas recovery system, and processing and transportation infrastructure including gas collection facilities, a booster station, processing plant and pipelines.	301,731
8788: Tarim oil wells associated gas recovery and utilization project (CNG) (China) https://cdm.unfccc.int/Projects/DB/ERM-CVS1355492331.84/view Two skid-mounted associated gas recovery stations (movable) will be installed to recover the associated gas from remote and scattered oil wells. After low pressure separation, compression, dehydration and condensate separation, the dry gas will be compressed into CNG, transported to a decompressing plant and transported by pipeline to end users. Condensate will be transported to a processing plant.	57,904
8896: Jubilee oilfield associated gas recovery and utilization project (Republic of Ghana) https://cdm.unfccc.int/Projects/DB/DNV-CUK1355897092.73/view The project involves recovery of the associated gas that would otherwise have to be flared at the floating production, storage and offloading (FPSO) vessel in the Jubilee oilfield located within the Deepwater Tano and West Cape Three Points blocks in the Republic of Ghana, and to deliver it to shore where the wet gas will be processed. The project activity comprises gas recovery and pretreatment, all transportation pipelines, all compression facilities and a gas processing plant that will separate out the dry gas, LPG and condensate.	2,603,226
9023: Sukowati-Mudi (Tuban) LPG associated gas recovery and utilization project (Indonesia) https://cdm.unfccc.int/Projects/DB/JCI1356078464.98/view The project involves construction of a new facility to recover and utilize the flared associated gas located at the Mudi-Sukowati oilfields, East Java, Indonesia, to produce saleable lean gas, condensate and LPG. The project requires construction of a compressor, condensate recovery plant, amine plant, regenerative thermal oxidizers and gas processing plant.	41,463
9163: Recovery and utilization of associated gas from the Obodugwa and neighboring oilfields in Nigeria https://cdm.unfccc.int/Projects/DB/RINA1356376663.73/view Project activities include the provision of infrastructure to allow for the utilization of the associated gas that is currently flared from two oilfields in OML56 in Delta State, Nigeria. The infrastructure for the project activity consists of the compression and transport of the gas from the Obodugwa site to the domestic gas network.	288,147

continued ...

PROJECT	GHG REDUCTIONS (t CO_2e/year)
9193: Sao Thian-A oilfield flare gas recovery and utilization project, Sukhothai, Thailand https://cdm.unfccc.int/Projects/DB/BVQI1356466744.97/view The project aims to recover and utilize the associated gas, by use of a separator at the STN-A permanent facility, and then use the recovered gas for internal demand and sale to another utility. The proposed project will include a fuel gas skid system and sale gas metering system.	26,163
9400: Flare gas reduction through the use of a spiking compressor at the Shah oilfield (Abu Dhabi) https://cdm.unfccc.int/Projects/DB/TUEV-RHEIN1356771209.26/view The project involves recovery and utilization of associated gas that is currently flared in the ADCO Shah oilfield. The recovered associated gases will be compressed in a spiking compressor. After dehydration, the gas will be sent to processing facilities where it will be converted into dry gas, NGL and condensate.	109,142
10108: Gas flaring reduction project at GGS, Chariali, Sibasagar, ONGC, Assam (India) https://cdm.unfccc.int/Projects/DB/KBS_Cert1422689659.16/view Oil and Natural Gas Corporation (ONGC) Limited of India will install gas compressors to recover associated gas for distribution and sale to customers or for on-site consumption in gas-based generator sets.	15,172
10584: Associated gas recovery and utilization at Khamilah oilfield area, at Block-27 in Wilayat Ibri of the Sultanate of Oman https://cdm.unfccc.int/Projects/DB/CTI1596441167.27/view Project activities include the recovery and utilization of natural gas from the Khamilah oilfield area at Block-27 in Wilayat Ibri. The gas recovery process comprises three main stages, including the separation, compression and processing to meet pipeline conditions for transportation to end users. The main equipment necessary for the proposed project activity comprises electric motor-driven reciprocating and screw compressors, and the pipelines for gas transportation.	432,416
0152 : Rang Dong oilfield associated gas recovery and utilization project (Vietnam) https://cdm.unfccc.int/Projects/DB/DNV-CUK1133472308.56 Activities will include the recovery and utilization of gases produced as a by-product of oil production activities at the Rang Dong oilfield, located off the south-eastern coast of Vietnam. The project includes construction of a gas pipeline and compressor facilities. Recovered gas is processed into dry gas and condensate. Dry gas is supplied to nearby power plants and a local fertilizer plant, LPG is utilized as home cooking fuel, and condensate is used to produce gasoline.	675,858

Annex VI

Typical non-routine flare sources[200]

FACILITY TYPE	PROCESS/EQUIPMENT	NON-ROUTINE FLARE SOURCES
Oil battery	Inlet separator	Pressure relief valve
	Treater	Pressure relief valve
	Process vessel liquid drains	Level control valve, blowdown valve
	Vapor recovery compressor	Pressure relief valve
	Equipment isolation: maintenance	Blowdown valve
	Gas pipeline pigging	Blowdown valve
Gas battery	Inlet piping	Emergency shutdown valve
	Inlet separator	Pressure relief valve
	Process vessels containing vapor	Pressure relief valve
	Process vessel liquid drains	Level control valve, blowdown valve
	Compressor suction scrubber	Pressure relief valve
	Fuel gas scrubber	Pressure relief valve
	Compressor discharge	Pressure relief valve
	Compressor valve seals	Vent
	Fired line heaters	Pressure relief valve
	Equipment isolation: maintenance	Blowdown valve
	Gas pipeline pigging	Blowdown valve
Gas plant	Inlet piping	Emergency shutdown valve
	Inlet separator	Pressure relief valve
	Process vessels containing vapor	Pressure relief valve
	Process vessel liquid drains	Level control valve, blowdown valve
	Compressor suction scrubber	Pressure relief valve
	Fuel gas scrubber	Pressure relief valve
	Compressor discharge	Pressure relief valve
	Compressor valve seals	Vent
	Fired line heaters	Pressure relief valve
	Equipment isolation: maintenance	Blowdown valve
	Gas pipeline pigging	Blowdown valve
	LPG storage vessels	Pressure relief valve
	Gas sweetening: off-spec product	Flow control valve
	Amine flash tank or vessel	Pressure relief valve

Annex VII

Good practice considerations for operational design and control[200]

SYSTEM	GOOD DESIGN PRACTICE
Piping	Add piping to divert blowdown gas from maintenance activities to fuel, low pressure source or gas recycle/recovery.
	Add piping to divert non-emergency flare gas to low-pressure source such as compressor suction or gas recycle/recovery.
	Add piping (compression as necessary) to allow recycling of off-specification sales gas.
	Use hot tap procedure for making new piping connections versus depressurizing and flaring.
Valves	Any valves on a high pressure source that discharges to a low pressure source should be double blocked and bled.
	Install a rupture disk (and pressure sensor) upstream of pressure relief valves (PRVs) that have chronic seat leakage to flare, or install spare PRVs and isolation valves to permit frequent servicing without shutdown.
	Where the failure of a check valve could create pressures that exceed equipment design pressures, a secondary device should be installed to prevent flow reversal.
	Any manually operated valve that can discharge from a high-pressure source to a lower-pressure source should be tagged and car-sealed closed.
Flare system	Avoid overloading the flare knock-out drum with condensable hydrocarbons; instead, send to stream to a liquid recycle/recovery system.
Fire protection	Install flame resistant insulation and metal cladding (to 8 m above grade) on hydrocarbon vessels that could be exposed to flame impingement. Install a depressurizing system to isolate and transfer hydrocarbon liquid and vapor from vessels exposed to external fire.
Redundancy	Provide spare or redundant equipment in critical services in order to enable continuous operation (and avoid flaring) when equipment failure occurs.
Instrument air	Provide spare air compressor and sufficient air receiver/reservoir capacity in order to cycle all isolation valves at least three times.
Condensers	For fractionation towers in series, size condensers large enough to handle the vapor load from upstream towers should loss of heat input from a preceding tower occur.
Vapor recovery	Size the compressor and system according to individual stream compositions and process parameters.
Heat exchangers	Design the shell and tube side of exchangers to the highest-pressure design specification, and provide pressure alarms and automatic isolation valves.
Gas dehydration	Consider replacing glycol dehydrators with desiccant dehydrators.

continued ...

SYSTEM	GOOD DESIGN PRACTICE
Compressors	Replace wet seals on compressors with dry seals.
	Keep compressors pressurized when taken off-line for operational reasons or put on temporary standby.
Shutdown controls	Provide dedicated block valves for process or equipment isolation instead of relying on fail-closed control valves.
	For emergency shutdown valves, the fail-safe condition must ensure that overpressure risk is addressed in the event of electrical power or instrument air failure.
	Provide control logic and valves to allow for a controlled facility (or individual process) shutdown.
	Where possible, use a strategy of relieve-and-hold versus total release-to-flare for controlled shutdowns.
	For scenarios where there is localized equipment or control failure, the facility control logic should adjust process control parameters to the safe standby mode to prevent overpressure in related processes.
	Provide high-temperature alarm and heat input shutdown where vapor overpressure is possible.
	For engines and rotating equipment, install instrumentation to avoid run-to-failure scenarios.
	Provide process alarms and automatic isolation in situations where operating temperatures or pressures outside intended process limits could cause runaway reactions and/or equipment overpressure/failure.
	Install automated flow control at gas batteries to prevent/reduce flaring during upsets.
	To prevent overpressure on a blocked-in pipe, valve or pump, install an automatic bypass to another process unit.
	Install a high-pressure alarm on the flare knock-out drum liquid drain to detect gas flow/blow-by.
	For facilities subject to power failures, provide auxiliary or self-generated emergency power for the process control computer, critical plant controls and safety-critical equipment.

Annex VIII

Example calculations for absolute, rate-based and intensity targets

ABSOLUTE TARGET			
PARAMETER	UNITS	EXPRESSION	DESCRIPTION
Forecasted volume of associated gas produced	m^3	FGV_A	This value will change each year to reflect estimated production rates for the wells or facilities related to the flare point.
Design reliability of flare gas recovery system	%	DR	This value is fixed, but should be updated if equipment in the flare gas recovery system is replaced.
Expected flaring volume due to design basis	m^3	$DBFV_A = FGV_A * (1 - DR/100)$	This is a calculated value.
Flaring days due to planned production system outages (i.e. shutdowns and maintenance) that contribute to flaring	days	POF	This value will change each year to reflect planned outages for the wells or facilities related to the flare point.
Flaring days due to unplanned production system outages (i.e. process upsets and unplanned shutdowns and maintenance) that contribute to flaring	days	UPOF	This value will change each year to reflect the target for unplanned outages for the wells or facilities related to the flare point.
Flaring volume due to operational outages	m^3	$OOFV_A = FGV_A * (POF + UPOF)/365$	This is a calculated value.
Flaring target (absolute)	m^3	$FT_A = DBFV_A + OOFV_A$	This is a calculated value.

ABSOLUTE TARGET IN TERMS OF A DAILY RATE			
PARAMETER	UNITS	EXPRESSION	DESCRIPTION
Forecasted rate of production of associated gas volumes	m^3/day	$FGV_R = FGV_A/365$	This value will change each year to reflect estimated production rates for the wells or facilities related to the flare point.
Design reliability of flare gas recovery system	%	DR	This value is fixed, but should be updated if equipment in the flare gas recovery system is replaced.
Expected daily flaring volume due to design basis	m^3/day	$DBFV_R = FGV_R * (1 - DR/100)$	This is a calculated value.
Flaring days due to planned production system outages (i.e. shutdowns and maintenance) that contribute to flaring	days	POF	This value will change each year to reflect planned outages for the wells or facilities related to the flare point.
Flaring days due to unplanned production system outages (i.e. process upsets and unplanned shutdowns and maintenance) that contribute to flaring	days	UPOF	This value will change each year to reflect the target for unplanned outages for the wells or facilities related to the flare point.
Daily flaring volume due to operational outages	m^3/day	$OOFV_R = FGV_R * (POF + UPOF)/365$	This is a calculated value.
Daily flaring target (rate)	m^3/day	$FT_R = DBFV_R + OOFV_R$	This is a calculated value.

INTENSITY TARGET			
PARAMETER	UNITS	EXPRESSION	DESCRIPTION
Design reliability of flare gas recovery system	%	DR	This value is fixed, but should be updated if equipment in the flare gas recovery system is replaced.
Percentage of associated gas volume flared due to design basis	%	DBFP = 100 - DR	This is a calculated value.
Flaring days due to planned production system outages (i.e. shutdowns and maintenance) that contribute to flaring	days	POF	This value will change each year to reflect planned outages for the wells or facilities related to the flare point.
Flaring days due to unplanned production system outages (i.e. process upsets and unplanned shutdowns and maintenance) that contribute to flaring	days	UPOF	This value will change each year to reflect the target for unplanned outages for the wells or facilities related to the flare point.
Percentage of associated gas volume flared due to operational outages	%	OOPV = 100 * (POF + UPOF)/365	This is a calculated value.
Flaring target (intensity)	%	FT_I = DBFP + OOPV	This is a calculated value.

Annex IX
UNDP-identified functional capacities for government ministerial agencies[201]

CAPACITY TO ENGAGE STAKEHOLDERS

- Identify, motivate and mobilize stakeholders.
- Create partnerships and networks.
- Promote engagement of civil society and the private sector.
- Manage large group processes and open dialogue.
- Mediate divergent interests.
- Establish collaborative mechanisms.

CAPACITY TO ASSESS A SITUATION, AND DEFINE A VISION AND MANDATE

- Access, gather and disaggregate data and information.
- Analyze and synthesize data and information.
- Articulate capacity assets and needs.
- Translate information into a vision and/or a mandate.

CAPACITY TO FORMULATE POLICIES AND STRATEGIES

- Explore different perspectives.
- Set objectives.
- Elaborate sectoral and cross-sectoral policies.
- Manage priority-setting mechanisms.

CAPACITY TO BUDGET, MANAGE AND IMPLEMENT

- Formulate, plan, manage and implement projects and programs; includes the capacity to prepare a budget and to estimate capacity development costs.
- Manage human and financial resources and procurement.
- Set indicators for monitoring and monitor progress.

CAPACITY TO EVALUATE

- Measure results and collect feedback to adjust policies.
- Codify lessons and promote learning.
- Ensure accountability to all relevant stakeholders.

Annex X
EU Fuel Quality Directive

The fuels used for road transport throughout the EU need to meet strict quality requirements that help in protecting human health and the environment, and make sure that vehicles can operate safely when traveling from one country to another. Having common fuel quality rules helps to reduce GHG and air pollutant emissions, and to establish a single fuel market while ensuring that vehicles can operate anywhere in the EU on the basis of compatible fuels. The EU Fuel Quality Directive (FQD) requires a reduction in the GHG intensity of transport fuels by a minimum of 6% by 2020 (compared to a 2010 baseline). In addition, the Directive states that suppliers should respect the 6% target beyond 2020, and that the monitoring and reporting obligations relating to GHG emissions intensity also remain applicable after this date.[202]

The GHG intensity of fuels is calculated on a life-cycle basis, covering emissions from extraction, processing and distribution. These emission reductions are calculated against a 2010 baseline of 94.1 g CO_2e/megajoule (MJ). The 6% reduction target is likely to be achieved primarily through the use of biofuels, electricity, less carbon-intense fossil fuels and renewable fuels of non-biological origin.[202]

To incentivize further reductions in GHG emissions, the savings claimed from upstream emission reductions (UERs), including from flaring and venting, are included in the calculation of suppliers' life-cycle GHG emissions[203] which were adopted on 20 April 2015 under the FQD Implementing Directive (Directive EU 2015/652).

The Directive states that, in order for the UERs of fossil fuels to be eligible for the purposes of the reporting and calculation methodology, suppliers shall report the following information to the authority designated by the Member States:[203]

a) The starting date of the project, which must be after 1 January 2011.
b) The annual emission reductions in grams CO_2e.
c) The duration for which the claimed reductions occurred.
d) The project location closest to the source of the emissions in latitude and longitude coordinates in degrees to the fourth decimal place.
e) The baseline annual emissions prior to installation of reduction measures and annual emissions after the reduction measures have been implemented in grams CO_2e/MJ of feedstock produced.
f) The non-reusable certificate number uniquely identifying the scheme and the claimed GHG reductions.
g) The non-reusable number uniquely identifying the calculation method and the associated scheme.
h) Where the project relates to oil extraction, the average annual historical and reporting year GOR in solution, the reservoir pressure and depth, and the well production rate of the crude oil.

On 9 September 2015, Directive EU 2015/1513,[204] often referred to as the 'ILUC Directive,' was adopted. Some of the key elements of this Directive include:[205]

- tackling indirect land-use change emissions through a 7% cap on conventional biofuels, including biofuels produced from energy crops, to count towards the Renewable Energy Directive (RED) targets regarding final consumption of energy in transport in 2020. Member States have the possibility to set a lower cap;
- setting an indicative 0.5% target for advanced biofuels as a reference for national targets which will be set by EU countries in 2017;
- harmonizing the list of feedstocks for biofuels across the EU that would count double towards the 2020 target of 10% for renewable energy in transport (RED Annex IX);
- requiring that biofuels produced in new installations emit at least 60% fewer GHGs than fossil fuels;
- introducing stronger incentives for the use of renewable electricity in transport (by counting it more towards the 2020 target of 10% for renewable energy use in transport: 5x for renewable electricity in road transport and 2.5x for renewable electricity in rail);
- a number of additional reporting obligations for the fuel providers, EU countries and the European Commission; and
- a requirement for Member States to enact the legislation by 2017.