



# Preparing effective flare management plans

Guidance document for the oil and gas industry

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change  
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The global oil and gas industry association for environmental and social issues

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# Preparing effective flare management plans

Guidance document for the oil and gas industry

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## Background

The combustion of natural gas produced as a by-product of petroleum production operations is a global challenge. Worldwide it is estimated that about 150 billion cubic metres are 'flared' in this manner each year, contributing hundreds of millions of tonnes of carbon dioxide to the atmosphere.

Significant barriers impede progress in bringing this valuable natural gas to more effective use, including: distance to markets; lack of local infrastructure; gas ownership; local security issues; and availability of capital, regional resources and skilled manpower, among other factors. The key to addressing gas flaring is the identification of project activities that can successfully bring the gas to more productive use, and the expansion of potential solutions from those attainable by individual oil field operators to solutions that fully employ the capabilities of operators and governments working together.

Recognition of the importance of cooperation among governments and operators to address the flaring of natural gas led to the creation of the World Bank-led Global Gas Flaring Reduction Public-Private Partnership (GGFR) in 2002. Among the first efforts of this partnership was the creation of an international (voluntary) standard, the Voluntary Standard for Global Gas Flaring and Venting Reduction (the GGFR Standard), which calls for operator and government planning to identify and execute flare reduction projects. GGFR has gathered considerable experience in the generation and execution of these plans, and in the facilitation of government-operator collaboration to maximize success. In parallel, the petroleum industry has recognized the importance of creating guidance for its membership to support climate risk reduction and lower greenhouse gas emissions. This has led to the formation of the Greenhouse

Gas Emissions Task Force (GET) through a joint effort of the two leading industry bodies active in international issues—IPIECA and the International Association of Oil and Gas Producers (OGP). A series of international standards, such as the ISO Standards, also promotes effective environmental management through a cycle of planning, tracking and review.

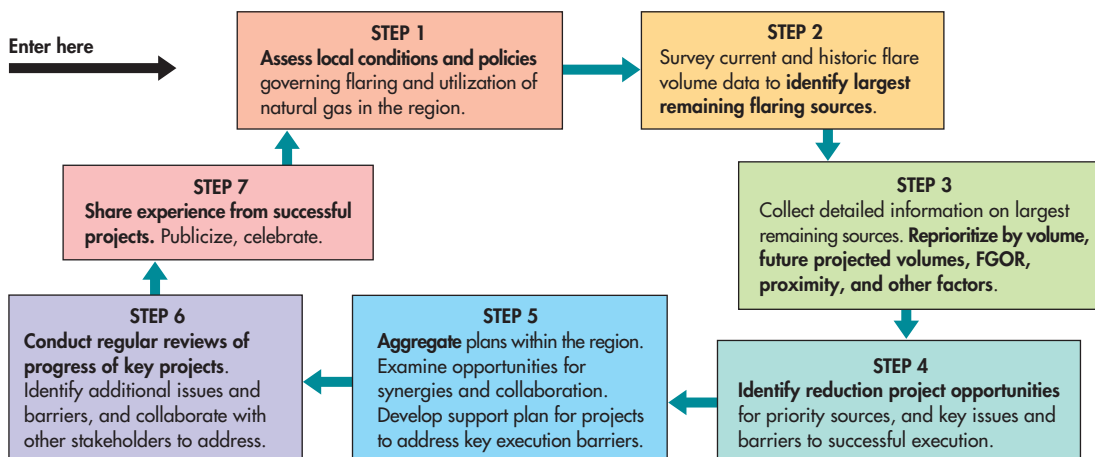
This publication draws on the experience and expertise of the above-mentioned international efforts, and is the product of a cooperative effort between GET and GGFR to create a guidance document to support flare reduction efforts by petroleum producers and governments worldwide.

There are a range of circumstances that lead to the flaring of natural gas from oil production operations, including startups and shutdowns, emergency and safety gas management, and the continuous combustion of unused by-product gas. These circumstances can call for very different types of actions from improved maintenance, to application of production operation effectiveness practices, to the design and implementation of new facilities to utilize gas. GGFR's research has shown that the overwhelming majority of the volume of gas burned (and thus the largest contribution to greenhouse gas emissions from flaring) results from continuous flaring<sup>1</sup> operations wherein large amounts of unused by-product gas are combusted as part of the regular operation of a production facility. Controlling this source of flaring also typically involves the greatest degree of effort on the part of operators, often requiring major capital investments in new equipment to manage, process or export the gas. Because of the relative importance of these 'continuous flaring' sources, the focus of this document is on the management of these flares.

<sup>1</sup> Defined as long-term flaring of gas that is associated with crude oil production and not utilized for on- or off-site energy needs, recovered for local or international gas markets, or re-injected.

## Guidance on the preparation of effective flare management plans

Figure 1 Flare reduction planning cycle



As with other environmental management processes, the recommended approach to flare management involves a multi-step iterative process designed to identify opportunities to reduce flaring, and track and support the activities that deliver real and lasting emissions reductions from these opportunities.

Drawing upon the experience of GGFR and the IPIECA and OGP membership, this guidance document provides recommended steps for operators and governments in focusing efforts to improve the success of flare reduction activities. Along the way, a hypothetical example is used to illustrate the processes of collecting and reviewing critical information and data, and creating priorities and focus to enhance the effectiveness of flare reduction programmes in companies and governments. The document also highlights supporting tools and capabilities that have emerged within GGFR to assist operators and governments in flare management.

It is important to emphasize that the process and steps outlined in this document are offered as guidance. Individual situations may require changes in the order of steps, skipping of steps, or the introduction of additional steps and rigor not described in this document. It is therefore expected, and desired, that users of this guidance document modify the processes outlined, in accordance with

their specific needs. GGFR staff can often assist by suggesting modifications to suit specific circumstances (for instance, operators or countries having few remaining flares may choose to skip prioritization steps and focus on identification of reduction options and supporting project execution). GGFR staff can often assist in suggesting modifications to suit specific circumstances.

The steps outlined in this document include:

- Step 1:** Assess/understand local conditions and policies governing flaring activities and the utilization of natural gas in the region.
- Step 2:** Survey current and historic information to identify the most important flaring sources ('bright spots').
- Step 3:** Collect and analyse detailed information on priority flaring sources; reprioritize.
- Step 4:** Identify reduction options and develop plans for priority sources ('project list').
- Step 5:** Aggregate plans within a region; organize support for priority reduction projects.
- Step 6:** Periodic progress reviews and reassessment of ongoing needs for project support.
- Step 7:** Celebrating success and sharing experience ('success stories').

## Step 1: Assess/understand local conditions and policies governing flaring activities and the utilization of natural gas in the region

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This activity forms the essential foundational work of any flare management plan. It is a given that compliance with local and regional policies is essential for any flare reduction plan. In addition, the local and regional regulatory structures and commercial conditions, e.g. gas infrastructure ownership, will affect access to natural gas and power infrastructure, and can significantly impact the choice of flare reduction project activities. Local stakeholders and non-governmental organizations, and public expectations also form an important context into which flare reduction activities must fit. For governments, understanding the commercial environment affecting oil production and gas utilization can also prove invaluable in assessing reduction options and supporting the successful execution of reduction projects.

Within any operating area, the expectations and requirements set by governments and other stakeholders must be respected; these will have an important impact on production operations. Flare management expectations can take many forms, ranging from compliance requirements such as formal reduction requirements mandated by local law, to less formal, stated aspirations or government targets that call for the utilization of a higher percentage of

produced gas, to pressures by local stakeholders to provide gas. The extent of appropriate flaring planning will often be the result of the sum of such forces.

Creating a thorough understanding of this context for flare reduction in a region will lead to better choices in flare reduction activities and better prospects for successful execution. In addition, this activity offers an important opportunity to form or strengthen relationships with key partners that will be needed to assure success. Building an understanding of issues, and creating a climate of shared objectives, can be instrumental in creating successful flare-reduction programmes.

### GGFR assistance

GGFR has considerable experience in flare management and gas/power regulation and utilization activities in many diverse regions of the world; it also benefits from its contacts and experience working with a range of stakeholders involved in flare management. A variety of supporting services, ranging from reviews of regulatory conditions and limitations, to assessment of policy options, to facilitation of government-operator and other stakeholder dialogues, is available through GGFR.

## Step 2: Survey current and historic information to identify the most important flaring sources ('bright spots')

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Knowing where to focus the activities of a flare reduction programme is key to achieving the greatest progress in flare reduction for any magnitude of effort. It is therefore important to gain a broad perspective of the numbers and sizes of different flaring sources in the region. For many operators and regions, this step will prove highly informative, and can have its own challenges.

For both operators and governments, this step involves the assembly of available information on the locations and magnitudes of existing flaring sources. Utilizing the existing reporting systems of governments and operators can often facilitate this process. Many operators have internal reporting systems that collect information on flaring volumes, and many governments have a variety of

information systems that include basic data on production operations in the region. These existing reporting systems can be an essential source of data for assembling a flaring source list showing all sources and the volumes flared. Table 1 provides

an example source list for a hypothetical region and group of operators.

As illustrated in the Table, a wide range of sources of differing sizes and histories may be present for a

**Table 1** Historic data collection (example source list for a hypothetical region and group of operators)

Operator	Field name	Annual average gas flared (million scf/d)						
		2004	2005	2006	2007	2008	2009	2010
Beta International	Scorpion	177	138	135	141	144	141	147
Delta Oil	Cane	108	129	130	127	71	75	73
Alpha Petrol	Orion	320	270	178	130	56	56	42
Delta Oil	Julia	52	40	43	57	41	40	22
Gamma Production	Cetus	122	123	131	128	13	12	22
Gamma Production	Cyrus	0	0	0	8	9	12	18
Gamma Production	Jordan	23	21	21	21	16	14	15
Delta Oil	Ursa 2	0	2	5	1	6	8	19
Alpha Petrol	Antara	0	0	0	2	3	3	3
Epsilon Petroleum	Shula	0	0	0	3	3	3	3
Delta Oil	Hercules	8	6	4	4	2	2	2
Epsilon Petroleum	Sag A	9	32	102	75	0	2	1
Beta International	Phoenix	83	54	4	0	0	1	1
Epsilon Petroleum	Hadar	0	0	0	1	1	1	1
Alpha Petrol	Gemini	18	17	17	17	0	1	0
Beta International	Sirius	3	3	2	2	0	1	0
Gamma Production	Aldeb	3	2	1	1	0	1	0
Gamma Production	Delphi	51	31	15	17	0	0	0
Alpha Petrol	Capri	30	36	29	0	0	0	0
Delta Oil	Virgenes	11	6	31	2	0	0	0
Beta International	Lynx	14	9	17	0	0	0	0
Alpha Petrol	Pegasus	13	16	8	3	0	0	0
Alpha Petrol	Boot	3	2	5	4	0	0	0
Delta Oil	Ursa 1	3	3	9	0	0	0	0
Gamma Production	Perseus	0	5	1	7	0	0	0
Alpha Petrol	Cass	10	3	1	0	0	0	0
Beta International	Drake	8	1	2	0	0	0	0
Epsilon Petroleum	Sag B	4	2	2	0	0	0	0
Epsilon Petroleum	Rigel	7	0	0	0	0	0	0
Gamma Production	Cruz	2	0	0	0	0	0	0
	<b>Totals</b>	<b>1081</b>	<b>951</b>	<b>893</b>	<b>750</b>	<b>364</b>	<b>373</b>	<b>369</b>

given operator or region. Often, a more limited set of priority flaring sources ('bright spots') may dominate the overall picture. In this example, the historic data are sorted so that the largest sources from the most recent years are listed highest in the table. Of the 30 sources in the example, a group of approximately 8 sources dominate the picture. Focusing flare reduction efforts on these most important sources would be the preferred approach, rather than diluting efforts on sources of lesser impact.

Some additional processing of the historic data can help to refine the picture and to determine which sources are most deserving of further examination. Table 2 (*Computation of averages, ranks, prior reductions*) on page 6 provides an example. The average flaring volume for each source over the available history, and over the two most recent years, provides a means of judging the more recent importance of a source, compared to its historic importance. Calculating the contribution of a given source to the national or company total also adds perspective on the relative importance of a source. It can also be informative to examine the amount of reduction that has occurred by comparing flaring volumes for each source in the early years with the volumes in more recent years. In the example, we see some sources that continue to flare at close to their historic peak levels, while the current volumes of other sources are a small fraction of their prior peak levels.

A logical next step in the examination of current and historical data is to assign preliminary priorities to flaring sites for further analysis. Table 3 on page 7 provides an example of such prioritization. In this example, flaring sources with low 2010 volumes (in this case a figure of less than 10 million scf/d<sup>2</sup> was used) and declining profiles from 2004 through 2010 were assigned a green colour on the table, indicating a source of lower priority for further work.



In the example, 19 sources (out of a total of 30) fit into this category. Of the other sources listed, those with the highest remaining volumes and least prior reduction history are highlighted in red, and categorized as most deserving of further review. Finally, a middle category involving significant remaining volumes but also significant prior reduction successes, is highlighted in yellow as a secondary priority for further examination. Using this type of identification process enables a large number of sources to be quickly and effectively broken down into a smaller number of distinct categories, so that focus can be more easily placed on the most important sources. In the absence of other priorities, e.g. government requirements, the most important sources are typically the largest remaining flares.

The degree to which this prioritization will reduce the number of sources for further evaluation will be dependent on the individual region or operator but will almost always serve to create improved focus for the flare reduction effort.

### **Data availability and accuracy**

While government and operator data on individual flares is generally available, it is also fair to note that the absolute accuracy of such

<sup>2</sup> scf/d = standard cubic feet per day ('scf' is a US expression of gas volume, typically measured at 60°F and 1 atmosphere).

**Table 2** Computation of averages, ranks, prior reductions

Operator	Field name	Annual average gas flared (million scf/d)								Average volume flared (million scf/d)			Percentage of national total			Cumulative percentage of:			Ranks		Remaining percentage 2010/ avg.(04-05)	Volume reduced (million scf/d) avg.04-06 - 2010
		2004	2005	2006	2007	2008	2009	2010	2010	04-10	09-10	04-10	09-10	04-10	09-10	04-10	09-10	04-10	09-10			
Beta International	Scorpion	177	138	135	141	144	141	147	146	144	21	39	21	39	2	1	93	3				
Delta Oil	Cane	108	129	130	127	71	75	73	102	74	15	20	36	59	3	2	62	49				
Alpha Petrol	Orion	320	270	178	130	56	56	42	150	49	22	13	58	72	1	3	14	214				
Delta Oil	Julia	52	40	43	57	41	40	22	42	31	6	8	64	80	5	4	48	23				
Gamma Production	Cetus	122	123	131	128	13	12	22	79	17	12	5	76	85	4	5	18	103				
Gamma Production	Cyrus	0	0	0	8	9	12	18	7	15	1	4	77	89	13	6	Increasing	-18				
Gamma Production	Jordan	23	21	21	21	16	14	15	19	15	3	4	80	93	8	7	68	7				
Delta Oil	Ursa 2	0	2	5	1	6	8	19	6	14	1	4	81	96	14	8	Increasing	-17				
Alpha Petrol	Antara	0	0	0	2	3	3	3	2	3	0	1	81	97	22	9	Increasing	-3				
Epsilon Petroleum	Shula	0	0	0	3	3	3	3	2	3	0	1	81	98	24	10	Increasing	-3				
Delta Oil	Hercules	8	6	4	4	2	2	2	4	2	1	1	82	99	17	11	29	4				
Epsilon Petroleum	Sag A	9	32	102	75	0	2	1	32	2	5	0	86	99	6	12	5	47				
Beta International	Phoenix	83	54	4	0	0	1	1	20	1	3	0	89	99	7	13	1	46				
Epsilon Petroleum	Hadar	0	0	0	1	1	1	1	1	1	0	0	89	100	29	14	Increasing	-1				
Alpha Petrol	Gemini	18	17	17	17	0	1	0	10	1	1	0	91	100	11	15	0	17				
Beta International	Sirius	3	3	2	2	0	1	0	2	1	0	0	91	100	25	16	0	3				
Gamma Production	Aldeb	3	2	1	1	0	1	0	1	1	0	0	91	100	27	17	0	2				
Gamma Production	Delphi	51	31	15	17	0	0	0	16	0	2	0	94	100	9	18	0	33				
Alpha Petrol	Capri	30	36	29	0	0	0	0	13	0	2	0	96	100	10	19	0	31				
Delta Oil	Virgenes	11	6	31	2	0	0	0	7	0	1	0	97	100	12	20	0	16				
Beta International	Lynx	14	9	17	0	0	0	0	6	0	1	0	97	100	15	21	0	13				
Alpha Petrol	Pegasus	13	16	8	3	0	0	0	6	0	1	0	98	100	16	22	0	12				
Alpha Petrol	Boot	3	2	5	4	0	0	0	2	0	0	0	99	100	18	23	0	4				
Delta Oil	Ursa 1	3	3	9	0	0	0	0	2	0	0	0	99	100	19	24	0	5				
Gamma Production	Perseus	0	5	1	7	0	0	0	2	0	0	0	99	100	20	25	0	2				
Alpha Petrol	Cass	10	3	1	0	0	0	0	2	0	0	0	99	100	21	26	0	4				
Beta International	Drake	8	1	2	0	0	0	0	2	0	0	0	100	100	23	27	0	4				
Epsilon Petroleum	Sag B	4	2	2	0	0	0	0	1	0	0	0	100	100	26	28	0	3				
Epsilon Petroleum	Rigel	7	0	0	0	0	0	0	1	0	0	0	100	100	28	29	0	2				
Gamma Production	Crux	2	0	0	0	0	0	0	0	0	0	0	100	100	30	30	0	1				
<b>Totals</b>		<b>1081</b>	<b>951</b>	<b>893</b>	<b>750</b>	<b>364</b>	<b>373</b>	<b>369</b>	<b>683</b>	<b>371</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>0</b>	<b>1</b>				

Table 3 Prioritization of sites based on volumes and history

Operator	Field name	Annual average gas flared (million scf/d)								Average volume flared (million scf/d)			Percentage of national total			Cumulative percentage of:			Ranks	Remaining percentage 2010/ avg.(04-05)	Volume reduced (million scf/d) avg.04-06 - 2010
		2004	2005	2006	2007	2008	2009	2010	2010	04-10	09-10	04-10	09-10	04-10	09-10	04-10	09-10	04-10			
Beta International	Scorpion	177	138	135	141	144	141	147	146	144	21	39	21	39	2	1	93	3			
Delta Oil	Cane	108	129	130	127	71	75	73	102	74	15	20	36	59	3	2	62	49			
Alpha Petrol	Orion	320	270	178	130	56	56	42	150	49	22	13	58	72	1	3	14	214			
Delta Oil	Julia	52	40	43	57	41	40	22	42	31	6	8	64	80	5	4	48	23			
Gamma Production	Cetus	122	123	131	128	13	12	22	79	17	12	5	76	85	4	5	18	103			
Gamma Production	Cyrus	0	0	0	8	9	12	18	7	15	1	4	77	89	13	6	Increasing	-18			
Gamma Production	Jordan	23	21	21	21	16	14	15	19	15	3	4	80	93	8	7	68	7			
Delta Oil	Ursa 2	0	2	5	1	6	8	19	6	14	1	4	81	96	14	8	Increasing	-17			
Alpha Petrol	Antara	0	0	0	2	3	3	3	2	3	0	1	81	97	22	9	Increasing	-3			
Epsilon Petroleum	Shula	0	0	0	3	3	3	3	2	3	0	1	81	98	24	10	Increasing	-3			
Delta Oil	Hercules	8	6	4	4	2	2	2	4	2	1	1	82	99	17	11	29	4			
Epsilon Petroleum	Sag A	9	32	102	75	0	2	1	32	2	5	0	86	99	6	12	5	47			
Beta International	Phoenix	83	54	4	0	0	1	1	20	1	3	0	89	99	7	13	1	46			
Epsilon Petroleum	Hadar	0	0	0	1	1	1	1	1	1	0	0	89	100	29	14	Increasing	-1			
Alpha Petrol	Gemini	18	17	17	17	0	1	0	10	1	1	0	91	100	11	15	0	17			
Beta International	Sirius	3	3	2	2	0	1	0	2	1	0	0	91	100	25	16	0	3			
Gamma Production	Aldeb	3	2	1	1	0	1	0	1	1	0	0	91	100	27	17	0	2			
Gamma Production	Delphi	51	31	15	17	0	0	0	16	0	2	0	94	100	9	18	0	33			
Alpha Petrol	Capri	30	36	29	0	0	0	0	13	0	2	0	96	100	10	19	0	31			
Delta Oil	Virgenes	11	6	31	2	0	0	0	7	0	1	0	97	100	12	20	0	16			
Beta International	Lynx	14	9	17	0	0	0	0	6	0	1	0	97	100	15	21	0	13			
Alpha Petrol	Pegasus	13	16	8	3	0	0	0	6	0	1	0	98	100	16	22	0	12			
Alpha Petrol	Boot	3	2	5	4	0	0	0	2	0	0	0	99	100	18	23	0	4			
Delta Oil	Ursa 1	3	3	9	0	0	0	0	2	0	0	0	99	100	19	24	0	5			
Gamma Production	Perseus	0	5	1	7	0	0	0	2	0	0	0	99	100	20	25	0	2			
Alpha Petrol	Cass	10	3	1	0	0	0	0	2	0	0	0	99	100	21	26	0	4			
Beta International	Drake	8	1	2	0	0	0	0	2	0	0	0	100	100	23	27	0	4			
Epsilon Petroleum	Sag B	4	2	2	0	0	0	0	1	0	0	0	100	100	26	28	0	3			
Epsilon Petroleum	Rigel	7	0	0	0	0	0	0	1	0	0	0	100	100	28	29	0	2			
Gamma Production	Crux	2	0	0	0	0	0	0	0	0	0	0	100	100	30	30	0	1			
<b>Totals</b>		<b>1081</b>	<b>951</b>	<b>893</b>	<b>750</b>	<b>364</b>	<b>373</b>	<b>369</b>	<b>683</b>	<b>371</b>	<b>100</b>	<b>100</b>	<b>683</b>	<b>371</b>	<b>100</b>	<b>100</b>					

2010 volumes less than 10 and declining profiles from 2004 through 2010  
 2010 volumes greater than 10 but less than 20% of the 2004-06 average, **OR** increasing volumes from 2004 to 2010  
 2010 volumes greater than 10 and greater than 20% of the 2004-06 average

information has often proven to be challenged. Very few production operations have direct measurement facilities for flares (e.g. flow meters). More typically, flaring volumes are estimated using data on the total production of gas and oil, and on the amount of gas used for other purposes. In some situations, no data may exist for certain

operations or the data available may be incomplete (e.g. not including all sources, or years of operation). In all of these cases, it may often be appropriate to utilize remote sensing information to either gain an initial perspective on where the largest sources are, or to confirm the accuracy or completeness of the available information.

**Table 4** Identifying success story candidates from historic reduction data

Operator	Field name	Average volume flared (million scf/d)		Remaining percentage	Reduced volume (million scf/d)	Success story candidate?
		04–10	09–10	2010/avg. (04–05)	2010 vs. 04–06	
Beta International	Scorpion	146	144	93	3	
Delta Oil	Cane	102	74	62	49	yes
Alpha Petrol	Orion	150	49	14	214	yes
Delta Oil	Julia	42	31	48	23	yes
Gamma Production	Cetus	79	17	18	103	yes
Gamma Production	Cyrus	7	15	Increasing	-18	
Gamma Production	Jordan	19	15	68	7	
Delta Oil	Ursa 2	6	14	Increasing	-17	
Alpha Petrol	Antara	2	3	Increasing	-3	
Epsilon Petroleum	Shula	2	3	Increasing	-3	
Delta Oil	Hercules	4	2	29	4	
Epsilon Petroleum	Sag A	32	2	5	47	yes
Beta International	Phoenix	20	1	1	46	yes
Epsilon Petroleum	Hadar	1	1	Increasing	-1	
Alpha Petrol	Gemini	10	1	0	17	yes
Beta International	Sirius	2	1	0	3	
Gamma Production	Aldeb	1	1	0	2	
Gamma Production	Delphi	16	0	0	33	yes
Alpha Petrol	Capri	13	0	0	31	yes
Delta Oil	Virgenes	7	0	0	16	yes
Beta International	Lynx	6	0	0	13	yes
Alpha Petrol	Pegasus	6	0	0	12	yes
Alpha Petrol	Boot	2	0	0	4	
Delta Oil	Ursa 1	2	0	0	5	
Gamma Production	Perseus	2	0	0	2	
Alpha Petrol	Cass	2	0	0	4	
Beta International	Drake	2	0	0	4	
Epsilon Petroleum	Sag B	1	0	0	3	
Epsilon Petroleum	Rigel	1	0	0	2	
Gamma Production	Crux	0	0	0	1	
	<b>Totals</b>	<b>683</b>	<b>371</b>			



GGFR has done considerable work in concert with the US National Oceanic and Atmospheric Administration (NOAA) to utilize night-time satellite imagery to assess flaring volumes throughout the world. While the historic use of this data has been to assess changes in global and national flaring totals, GGFR is also using this information to identify the most important past and remaining sources (referred to as 'Project Bright Spot'). While flare volumes estimated by this methodology are not as reliable as ground-level estimates, the assessment of regional sources using satellite monitoring can be either a useful initial source of data or can be valuable in confirming that no major sources have been overlooked in surveys based on other data sources.

An additional value to this review of flaring history is the identification of locations in which successful flaring reduction has already been accomplished. Table 4 (*Identifying success story candidates from historic reduction data*) provides an example. Comparing flaring data from early years with data from more recent years and calculating the percentage and volume reductions shows multiple sources that have achieved success in reduction. These sources can be important examples of the types of flare reduction activities that can be successful in a given region; they can serve as

sources of information on how to overcome significant hurdles, and can provide a meaningful response to public or media inquiries on progress in flaring reduction. GGFR has a programme of collecting and promoting such 'success stories' in the interest of propagating knowledge that will lead to increased success in reducing the volume of gas flared (discussed further in Step 7).

The final result of this step can be a 'short list' of priority sites for further examination (see Table 5, *Focus on priority sites for further reduction planning*, overleaf). The creation of such a short list creates a focus for further planning without unduly burdening operators or governments with the collection of greater detail on a large number of sources of lesser importance.

### **GGFR assistance**

GGFR has staff members who have been involved in assembling and reviewing flare volume data from many regions, worldwide. Along with this expertise, GGFR also has access to operator source data, production location data and satellite data for major flares around the world. This expertise and data can be used to support individual operators or governments in identifying their principal flares.

Table 5 Focus on priority sites for further reduction planning

Operator	Field name	Annual average gas flared (million scf/d)							Average volume flared (million scf/d)	Percentage of national total		Cumulative percentage of:	Ranks			Remaining percentage 2010/ avg.(04-05)	Volume reduced (million scf/d) avg.04-06 - 2010			
		2004	2005	2006	2007	2008	2009	2010		04-10	09-10		04-10	09-10	04-10			09-10	04-10	09-10
		2010								04-10	09-10		04-10	09-10	04-10			09-10		
<b>Top priority</b>																				
Beta International	Scorpion	177	138	135	141	144	141	147	146	144	21	39	21	39	2	1	93	3		
Delta Oil	Cane	108	129	130	127	71	75	73	102	74	15	20	36	59	3	2	62	49		
Delta Oil	Julia	52	40	43	57	41	40	22	42	31	6	8	64	80	5	4	48	23		
Gamma Production	Cyrus	0	0	0	8	9	12	18	7	15	1	4	77	89	13	6	Increasing	-18		
Gamma Production	Jordan	23	21	21	21	16	14	15	19	15	3	4	80	93	8	7	68	7		
Delta Oil	Ursa 2	0	2	5	1	6	8	19	6	14	1	4	81	96	14	8	Increasing	-17		
	<b>Totals:</b>	<b>360</b>	<b>331</b>	<b>335</b>	<b>287</b>	<b>290</b>	<b>294</b>	<b>292</b>	<b>322</b>	<b>292</b>	<b>47</b>	<b>79</b>								
<b>Second tier</b>																				
Alpha Petrol	Orion	320	270	178	130	56	56	42	150	49	22	13	58	72	1	3	14	214		
Gamma Production	Cetus	122	123	131	128	13	12	22	79	17	12	5	76	85	4	5	18	103		
Alpha Petrol	Antara	0	0	0	2	3	3	3	2	3	0	1	81	97	22	9	Increasing	-3		
Epsilon Petroleum	Shula	0	0	0	3	3	3	3	2	3	0	1	81	98	24	10	Increasing	-3		
Epsilon Petroleum	Hadar	0	0	0	1	1	1	1	1	1	0	0	89	100	29	14	Increasing	-1		
	<b>Totals:</b>	<b>442</b>	<b>393</b>	<b>309</b>	<b>264</b>	<b>75</b>	<b>75</b>	<b>71</b>	<b>233</b>	<b>73</b>	<b>34</b>	<b>20</b>								
<b>National totals:</b>		<b>1081</b>	<b>951</b>	<b>893</b>	<b>750</b>	<b>364</b>	<b>373</b>	<b>369</b>	<b>683</b>	<b>371</b>	<b>100</b>	<b>100</b>								
<b>Red + Yellow:</b>		<b>802</b>	<b>724</b>	<b>644</b>	<b>618</b>	<b>362</b>	<b>365</b>	<b>365</b>												
<b>Total others:</b>		<b>279</b>	<b>227</b>	<b>249</b>	<b>131</b>	<b>2</b>	<b>8</b>	<b>4</b>												

2010 volumes greater than 10 but less than 20% of the 2004-06 average, OR increasing volumes from 2004 to 2010

2010 volumes greater than 10 and greater than 20% of the 2004-06 average

### Step 3: Collect and analyse detailed information on priority flaring sources; reprioritize

While flare volumes alone can help to identify which sources most deserve further assessment and support, consideration of the additional factors listed below can help to determine the feasibility of addressing individual flaring sources. This may lead to a reprioritization based on the specific circumstances and opportunities surrounding individual sites.

Examples of additional factors recommended for consideration as part of the detailed evaluation of priority sites include:

- flared gas-to-oil evaluation (FGOR);
- examination of past and future flaring levels;
- proximity evaluation;
- reprioritization based on FGOR, future flaring levels and community proximity;
- examination of field management options; and
- technical evaluation of continuous flaring elimination/gas utilization options.

#### FGOR (flared gas to oil ratio)

One valuable step involves the assessment of the relative value of the produced oil from a given operation compared to the amount of gas flared—a type of benefit-cost review often used in environmental management—referred to as ‘flared gas-to-oil evaluation’. (See Table 6, overleaf.) This assessment examines the more detailed production data for the priority flaring sources and the amount of gas and oil produced. Considerable variations in the relative amounts of flared gas to produced oil can occur in different operations, as illustrated in this example. For some fields, the volume of produced oil can be very large in proportion to the volume of gas flared, while in other cases relatively little oil is produced with relatively large volumes of flared gas. In the example, the Cyrus, Shula, Orion and Ursa 2 fields have a high FGOR, indicating that they may be higher priority for further reduction planning focus.

An additional value of the FGOR analysis is that it permits the examination of the relative monetary value of the gas and oil produced at each field by calculating the value of the produced oil per unit of gas flared. Table 6 (overleaf) provides an example of the range of values often encountered in different fields. In this example, the Ursa 2 field, due to relatively high gas volumes relative to oil volumes, shows a very low value of produced oil per 1000 scf of gas (US\$7.21). This indicates a field with the potential for considerable added production value if the gas can be marketed (or, conversely, a field in which relatively low penalties from loss of production value would occur per volume of flaring reduced if production was curtailed). At the other end of the spectrum, the low FGOR of the Jordan field means that, if production in this field was curtailed, there would be a very large sacrifice in the production value of oil (US\$118 of oil value per 1000 scf of flared gas) for a relatively minor reduction in the amount of gas flared.

#### Future flaring levels

A second evaluation criterion involves the expectations for future flaring levels if no further reduction occurs (see Table 7, *Future flaring profiles without reduction*, overleaf). As shown in this example, multiple scenarios occur for individual fields, ranging from relatively constant expected levels of future flaring, to slow declines, to substantial increases (due to increased production from new wells or enhanced production operations, or changes in gas yields due to reservoir conditions) or substantial decreases (due to planned ‘shut-ins’ or normal production declines). The example shows expected increases and decreases in the future, as well as evidence of prior reductions. The Orion and Cetus fields show significant prior declines in flaring levels and may thus be reduced in priority for further examination.

**Table 6 Flared gas-to-oil evaluation**

Production site name	Most recent production data						FGOR (gas flared per bbl oil produced) (scf/bbl)	Value of produced oil (USD million/d)	Value of oil per mscf flared (USD/1000 scf)
	Oil produced (thousand bbl/d)	Gas produced (million scf/d)	Gas used on site (million scf/d)	Gas reinjected (million scf/d)	Gas sold/exported (million scf/d)	Gas flared (million scf/d)			
Scorpion	232.9	155.2	8.2	0.0	0.0	147.0	631	11.64	\$79.21
Cane	137.0	140.1	16.4	50.7	0.0	73.0	533	6.85	\$93.83
Julia	30.1	78.2	17.8	0.0	38.4	22.0	730	1.51	\$68.49
Cyrus	8.2	52.2	12.3	0.0	21.9	18.0	<b>2190</b>	0.41	<b>\$22.83</b>
Jordan	35.6	61.6	5.5	41.1	0.0	15.0	421	1.78	\$118.72
Ursa 2	2.7	54.6	2.7	0.0	32.9	19.0	<b>6935</b>	0.14	<b>\$7.21</b>
Orion	11.0	46.1	4.1	0.0	0.0	42.0	<b>3833</b>	0.55	<b>\$13.05</b>
Cetus	43.8	124.7	6.8	95.9	0.0	22.0	502	2.19	\$99.63
Antara	4.1	3.8	0.8	0.0	0.0	3.0	730	0.21	\$68.49
Shula	0.8	3.8	0.8	0.0	0.0	3.0	<b>3650</b>	0.04	<b>\$13.70</b>
Hadar	0.7	2.4	1.4	0.0	0.0	1.0	1460	0.03	\$34.25

**Table 7 Future flaring profiles without abatement: history and expectation for future flared gas levels with no intentional flare reduction activities**

Scorpion field detail	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Scorpion											
Flared gas volume (million scf/d)	136.99	134.25	142.47	145.21	142.47	147.95	139.73	134.25	131.51	128.77	128.77
Oil Produced (thousand bbl/d)	301.37	287.67	273.97	260.27	246.58	232.88	219.18	191.78	178.08	136.99	95.89
Value of oil revenue (USD million/d)	15.07	14.38	13.70	13.01	12.33	11.64	10.96	9.59	8.90	6.85	4.79
FGOR (scf/bbl)	455	467	520	558	578	635	638	700	738	940	1343
\$ oil revenue per mscf flared	\$110.00	\$107.14	\$96.15	\$89.62	\$86.54	\$78.70	\$78.43	\$71.43	\$67.71	\$53.19	\$37.23
<b>Essential data for other priority fields</b>											
Flared gas volume (million scf/d)	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Cane	128.77	128.77	126.03	68.49	73.97	73.97	68.49	68.49	60.27	54.79	54.79
Julia	41.10	43.84	57.53	41.10	41.10	22.00	21.92	19.18	19.18	19.18	19.18
Cyrus	0.00	0.00	8.22	8.22	10.96	19.18	16.44	13.70	2.74	0.00	0.00
Jordan	21.92	21.92	21.92	16.44	13.70	13.70	13.70	13.70	13.70	13.70	10.96
Ursa 2	2.74	5.48	0.00	5.48	8.22	19.00	27.40	43.84	43.84	41.10	41.10
Orion	270.00	177.60	129.50	55.50	56.00	42.00	38.36	35.62	32.88	32.88	27.40
Cetus	123.00	131.35	128.39	12.91	12.00	22.00	21.92	19.18	19.18	19.18	19.18
Antara	0.00	0.30	1.96	3.37	3.00	3.00	2.74	2.74	2.74	2.74	2.74
Shula	0.00	0.00	2.63	2.55	3.00	3.00	8.22	21.92	41.10	41.10	41.10
Hadar	0.00	0.00	1.07	0.63	1.00	1.00	0.82	0.82	0.82	0.82	0.82

Note significant prior flaring management activities of Orion and Cetus. Note anticipated increases in flaring from Ursa 2 and Shula. Note anticipated elimination of flaring at Cyrus due to production phase-out.

The Ursa 2 and Shula fields show significant anticipated increases in flaring, while the Cyrus field shows elimination of continuous flaring accompanying a production phase-out. Such conditions create reason to either raise or lower the priority of a given location for further management planning.

**Proximity evaluation**

The importance of local community forces on flaring is reflected in this analysis. Table 8 provides an example of an analysis which examines where the production operation exists, and its potential for affecting local communities. In this example, the sites are first identified by whether they are onshore or offshore, reflecting the greater sensitivity of onshore operations to community impacts. The distance and direction from the nearest community, the prevailing plume direction and the size of the night-time visible plume (typically estimated from satellite monitoring) are further indicators used in this examination. The results are often qualitative but informative. In this example, the Julia, Ursa 2, Shula and Orion fields are all onshore and in close proximity to communities, providing justification to increase their priority for further reduction planning.

**Reprioritization**

Utilizing factors such as FGOR, future flaring levels and proximity evaluation allows for a reprioritization of the sites identified in the examination of current and future flaring levels from Step 2. Table 9 (overleaf) illustrates such a prioritization. In this example, the Ursa 2 and Shula fields were both raised into the top priority category on the basis of high FGOR, expected future increases in flaring levels, and close proximity to communities. The Jordan field is dropped from the highest priority to secondary priority on the basis of low FGOR (high oil revenue per amount of gas flared), low future flaring levels, and remote location. Cyrus is also reduced in priority due to the expected flare-out in three years. The Orion field, while large enough in current volumes to justify inclusion in the higher priority flaring sites, is left in the lower priority category due to its history of having accomplished considerable reduction in flaring volumes in the past (reduced from 270 million scf/d in 2005 to 42 in 2010 and 27 anticipated in 2015).

**Table 8** Proximity evaluation

Production site name	Offshore/onshore	Nearest distance (km)	Community direction	Dominant direction of plume travel	Size of visible plume at night (km)
Scorpion	offshore	35	nw	wnw	8
Cane	onshore	8	se	wnw	6
Julia	<b>onshore</b>	<b>2</b>	<b>e</b>	<b>w</b>	<b>2</b>
Cyrus	offshore	14	n	wnw	2
Jordan	offshore	21	ne	nw	2
Ursa 2	<b>onshore</b>	<b>1</b>	<b>nw</b>	<b>w</b>	<b>2</b>
Orion	<b>onshore</b>	<b>4</b>	<b>n</b>	<b>nnw</b>	<b>4</b>
Cetus	offshore	36	ne	sw	2
Antara	offshore	16	nne	nw	1
Shula	<b>onshore</b>	<b>4</b>	<b>se</b>	<b>w</b>	<b>1</b>
Hadar	<b>onshore</b>	<b>8</b>	<b>ssw</b>	<b>w</b>	<b>1</b>

Note relatively high proximity of Julia, Ursa 2, Shula and Orion.

Sites with low FGOR, strong future declines and low proximity to communities may be reduced in priority. Sites with high FGOR, continued high or increasing projected future flaring levels and close proximity to communities may be raised in priority.

**Table 9** Reprioritization based on FGOR, projections, proximity

Production site name	FGOR Gas flared per bbl oil produced (scf/bbl)	FLARE VOLUMES (million scf/d)			LOCATION Offshore/onshore	DISTANCE Distance to nearest community (km)
		2005	2010	Expected 2015		
Scorpion	631	136.99	147.95	128.77	offshore	35
Cane	533	128.77	73.97	54.79	onshore	8
Ursa 2	6935	2.74	19.00	41.10	onshore	1
Shula	3650	0.00	3.00	41.10	onshore	4
Julia	730	41.10	22.00	19.18	onshore	2
Orion	3833	270.00	42.00	27.40	onshore	4
Cetus	502	123.00	22.00	19.18	offshore	36
Jordan	421	21.92	13.70	10.96	offshore	21
Cyrus	2190	0.00	19.18	0.00	offshore	14
Antara	730	0.00	3.00	2.74	offshore	16
Hadar	1460	0.00	1.00	0.82	onshore	8

Notes: Ursa 2 and Shula raised in priority—high FGOR, expected future increases in flaring levels and close proximity to communities.  
Orion remains second level due to prior successful flare management record.  
Jordan reduced in priority due to low FGOR, low future flaring levels, remote location.  
Cyrus reduced in relative priority due to expected flare out in three years.

## Field management options

The refined list of priority sites described above enables the identification of possible options for flaring reduction based on the potential for flaring reductions at each site. Often, the least expensive options for flaring reduction are choices that can be conducted within the operations of a given field. Such choices include changing production operations in a manner that utilizes or reinjects more produced gas, or the focusing of production at individual wells or groups of wells that have relatively greater oil productivity. A highly abbreviated example of such an assessment for the Scorpion field is shown in Box 1 (right). While a real assessment would go into greater detail, the example illustrates some of the types of options examined in in-field management, and also provides an example of prospects to manage flaring in collaboration with nearby fields (in this case the potential export of gas to support gas lift operations of an adjacent operation).

### Box 1 Assessment of in-field management options

#### Scorpion field example

- Offshore location does not easily lend itself to increased gas utilization options in-field.
- Potential to use more gas in neighbouring production site for gas lift, but would increase flaring load in that field.
- High cost to increase on-platform power generation from excess gas, and little prospect to export power.
- Detailed well examination reveals single well with exceptionally high FGOR (3800) relative to field average:
  - 10% reduction in production could eliminate 20% of flaring volume.
  - Suggests prospect of temporary shut-in of high GOR well while awaiting utilization plan to be completed for all field gas.

## Technical evaluation of options

As cited in the GGFR Standard, the ultimate objective of flare management is the complete cessation of continuous flaring operations unless there are no feasible alternatives. An example describing some of the evaluation steps used in identifying options for ending continuous flaring is illustrated for the Scorpion field in Box 2. Among the options typically considered are:

- examination of the viability of reinjection of gas;
- examination of local, regional and international gas markets;
- distance to gas processing facilities, pipelines, power plants, major export facilities;
- regulatory environment and other factors governing access to gas utilization and export facilities;
- evaluation of best technical and commercial approach to utilize gas and key barriers to success;
- examination of prospects for carbon finance; and
- collaboration with other operators and local government in improving viability of best commercial options.

### Box 2 Examination of continuous flare elimination options

#### Scorpion field example

- Examination of viability of reinjection:
  - Complex field with multiple producing horizons. Models suggest significant concerns of gas breakthrough to producing wells.
  - Reservoir models show significant risk of gas breakthrough to production wells with reinjection.
  - High acid-gas content of produced gas will require significant processing prior to reinjection.
  - Inadequate capacity of existing production platform to hold gas processing and compression equipment—would require costly construction of separate gas processing platform.
- Examination of local, regional and international gas markets:
  - Local markets have some room for expansion, but not sufficient to accommodate the full volume of gas from Scorpion.
  - Regional markets dominated by a single export pipeline controlled by another operator.
  - International markets require access to LNG export facility operated by another operator.
- Distance to gas processing facilities, pipelines, power plants and major export facilities; regulatory environment and other factors governing access to gas utilization and export facilities:
  - Closest facility is LNG export facility, 35 km away (20 km subsea).
  - Gas processing facility and export pipeline at a distance of 75 km.
  - Power plants within acceptable distance have long-term contracts for supply in place.
- Evaluation of best technical and commercial approach to utilize gas, and key barriers to success:
  - Best commercial option appears to be export to LNG facility through expansion of existing facility.
  - Negotiations with LNG plant owner required.
- Examination of prospects for carbon finance:
  - No project has yet been approved for carbon finance involving use of flared gas for LNG. Significant barrier to carbon finance.
  - Examining prospect of developing new CDM methodology with GGFR Carbon Finance Network.
- Collaboration with other operators and local government in improving viability of best technical options:
  - Utilizing regional Flare Reduction Network to facilitate preliminary discussions of expansion in LNG export facility.
  - Utilizing GGFR to catalyse discussions with government on means to improve expansion project economics.

As with the 'In-field' option assessment illustrated in Box 1, the example given in Box 2 is less detailed than would likely occur in practice, but is illustrative of the types of analyses that may be carried out, and of the issues that can arise.

Potential additional information that can support this further assessment includes:

- typical gas composition, including liquid/LPG content, inert gases and contaminants (assists in assessing potential technical solutions to utilize the gas);
- operatorship and equity ownership of the production facility and nearby infrastructure (can determine key stakeholders in supporting reduction project activity);
- estimated capital costs of gas utilization (assists in determining flare management costs and identifying risks of complications in acquiring needed capital to execute projects); and
- proximity to other flares (can reveal opportunities for combining flare reduction efforts to improve feasibility).

### **GGFR assistance**

Drawing from experience in many regions, and with a large number of operators, GGFR can provide a global view on how to prioritize sources for reduction.

## **Step 4: Identify reduction options and develop plans for priority sources ('project list')**

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Conducting the analyses illustrated in Step 3 for each priority site leads to the identification of commercial project activities designed to address the priority flares. This important stage is the transition from considering what can be done to putting in place the actions needed to reduce flaring.

GGFR has had experience in examining the detailed information on flaring operations, and in the assessment of reduction opportunities for many operators and governments. This experience can be valuable in refining priorities and identifying reduction options for other operators or regions. Satellite information can be useful in identifying neighbouring sites.

GGFR has access through the World Bank Group to substantial information on local infrastructure, regulatory systems and ownership, as well as experience in commercial partnerships and conditions to enhance viability of reduction projects.

GGFR has developed tools for assessing the most viable technical and economic options to match individual sources with regional facilities and conditions.

GGFR has a Carbon Finance Network skilled in supporting efforts of flare reduction activities in obtaining additional support for projects.

An example of a project list for priority flaring sites is provided in Table 10. The list provides essential information needed to identify the type of project, its magnitude (gas volume utilized and capital cost), expected timing of key project execution steps and the critical factors affecting successful completion of the project. In the

Table 10 Reduction project list for priority flaring sites

PROJECT PLAN: January 2010 Flare Reduction Plan										
Production site name	Project name	Flare volumes (million scf/d)		Estimated flare reduction volume (million scf/d)	Total investment cost (USD million)	Estimated project completion dates			Critical factors affecting success	
		2010	Expected without abatement 2015			Design	Investment	Startup		
<b>Top priority</b>										
Scorpion	LNG Expansion	147.9	128.8	120	5000	2Q2011	2Q2012	1Q2014	Funding, national and partner approvals, gas markets.	
Cane	Independent Power Project	74.0	54.8	70	1000	3Q2008	3Q2010	2Q2012	Labour availability. Local security issues.	
Ursa 2	Gas Processing and Reinjection Facility	19.0	41.1	40	1500	4Q2010	4Q2011	4Q2013	Government approvals, fiscal terms. Partner funding.	
Shula	Gas Pipeline	3.0	41.1	40	3000	1Q2010	1Q2012	1Q2013	Labour availability. Security. Gas markets.	
Julia	Condensate Recovery Project	22.0	19.2	15	2500	1Q2008	1Q2009	2Q2011	Tie-ins to production facility.	
<b>Second tier</b>										
Orion	Gas Reinjection Expansion	42.0	27.4	40	150	3Q2009	2Q2010	4Q2011	Labour availability. Local security conditions.	
Cetus	Sour Gas Project	22.0	19.2	15	200	1Q2008	4Q2009	3Q2011	Safety and operating clearances. Startup issues.	
Jordan	Gas Export Project	13.7	11.0	10	50	2Q2010	2Q2011	2Q2013	Negotiations for export facility access.	
Cyrus	Production Phase out	19.2	0.0	20	5	3Q2009	2Q2010	4Q2012	Local security.	
Antara	None yet planned	3.0	2.7							
Hadar	None yet planned	1.0	0.8							

Project colour coding:

- Green: investment decision made; startup within three years
- Yellow: investment still pending but startup expected within three years
- Red: no project planned, or startup date beyond three years

Completion dates colour coding:

- Green: completed
- Yellow: scheduled for completion within the next three years
- Red: scheduled for completion beyond the three-year horizon

example, a range of project types from LNG plant expansions, to pipelines, to reinjection projects is illustrated. Three principle execution dates are provided for each project, being markers of the essential steps to completion in each case (i.e. date of design completion; date of financial investment decision; and date of project startup). As with the earlier prioritization, the example uses colour coding to identify key areas of concern. In this case, the planner chose to identify as green those projects for which the investment is already committed, and for which the project startup dates are projected to be within three years from the date of the reduction plan (highest probability of success). The red category was chosen for fields where no project has yet been identified or where the project startup date is beyond three years from the present, signalling a need to track these activities more closely. Colour coding was also used for the project execution dates, to indicate those successfully completed (green), those nearing completion in the next three years (yellow) and those for which completion is projected to be beyond the three-year horizon (red)—again reflecting some indication of the probability of completion of the overall activity.

An important benefit of having such a project list and schedule is the ability to prepare a more meaningful schedule of future flaring reduction expectations based on reduction project completions. These future flaring profiles are illustrated for the priority fields in Table 11. A profile of substantial overall reductions is shown, with the important distinction of being based on actual project execution schedules. Whilst it is possible that schedules might slip (see illustrations in Step 6), this approach nevertheless provides a far more realistic basis for projecting future gas utilization than projections lacking a link to the reduction project activities.

Another important benefit of the project list is the identification of key factors affecting successful execution and the ability to garner collaborative support. Many regions have established flare reduction collaborations between governments and operators to facilitate reduction project identification and execution. As many of the key barriers affecting project success are not under the sole influence or control of field operators, this collaboration can be essential in improving prospects of success.

### GGFR assistance

GGFR plays an important facilitation role in bringing operators and governments together to enable the successful identification and completion of flare management projects. GGFR’s facilitation of dialogue has also helped to improve the interaction between different stakeholders, and reduce tensions and misperceptions. GGFR can facilitate access to World Bank Group capabilities in providing tools and mechanisms to support investments in flare reduction infrastructure (as an example, the World Bank provided a Partial Risk Guarantee for gas infrastructure investors in Nigeria in 2009).

**Table 11** Future flaring profile based on reduction plans

PROJECT PLAN: January 2010 Flare Reduction Plan					
Production site name	Flaring volume (million scf/d)				
	2011	2012	2013	2014	2015
Scorpion	150	150	150	50	30
Cane	70	35	0	0	0
Ursa 2	27	44	35	10	0
Shula	8	22	10	0	0
Julia	10	0	0	0	0
Orion	35	10	0	0	0
Cetus	15	0	0	0	0
Jordan	13	12	5	2	1
Cyrus	16	14	3	0	0
Antara	3	3	3	3	3
Hadar	1	1	1	1	1
<b>Totals:</b>	<b>348</b>	<b>291</b>	<b>207</b>	<b>66</b>	<b>35</b>

## Step 5: Aggregate plans within a region; organize support for priority reduction projects

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In many cases, the planning activities described in Steps 1–4 will be accomplished by individual operators assessing their best commercial options (or less penalizing options) for utilizing the gas from the priority flare sites (following a process referred to in the GGFR Standard as the Associated Gas Recovery Plan, or AGRP). Governments will often want to assemble more comprehensive pictures of the priorities and plans for flare elimination in a given region (a process referred to in the GGFR Standard as Country Implementation Plans, or CIPs).

It is a logical extension of the operator AGRP process to be a principle contributor to the creation of a CIP. A recommended practice for the assembly of a CIP takes a logical approach whereby the CIP is created from an amalgamation of the AGRPs of the operators having flaring operations within the country. This aggregation process allows the government to establish priorities for supporting reduction project activities and contributing to collaborative efforts, or enabling commercial investments needed to complete the projects. It also enables governments to have meaningful predictions of flaring volumes for the future, and to place policy efforts where they can produce the most beneficial outcomes.

To ensure that plans are best integrated to meet the overall objectives of operators and governments, it is of value to establish a national- or regional-level organization to serve as a facilitating and reviewing body for flare reduction plans. In addition to supporting the creation and regular review of region-wide plans, such organizations may take the role of facilitators of flare reduction activities, supporting project success, addressing key barriers and supporting continuous progress toward meeting operator and government objectives.

The result of this step is a regional flare management plan based on the combined capabilities of operators and governments, with appropriate focus on the most important sources and a means of continuously addressing barriers to success. Clear expectations can be created based on realistic project execution schedules, and problem areas may be addressed using the broadest possible set of capabilities.

### GGFR assistance

GGFR has experience in facilitation of operator-operator and operator-government dialogues on prioritization of sites, reduction options and feasibility evaluations, and in resolving project execution barriers.

## Step 6: Periodic progress reviews and reassessment of ongoing needs for project support (regular reviews/iteration)

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With the creation of a consolidated national or regional plan with clearly identified projects and timetables, and with governments and operators collaborating to facilitate successful project execution, the focus turns to monitoring progress and the facilitation of ongoing success.

Regular reviews of project activities focus on:

- assessment of progress and slippage;
- identification of key barriers affecting project success;
- focusing regional partnerships on addressing barriers through cooperation; and

- decisions to create new reduction plans for sources not yet addressed.

Key products of this step are a regularly updated plan, providing accurate tracking of success toward meeting government and operator reduction objectives, and providing a current view of key remaining projects, execution dates and expected flare reduction schedules. These reviews can also produce tangible steps toward addressing key execution barriers, incorporating the maximum combined capabilities of government and operators.

An example review process is illustrated in Tables 12 to 14 and Figure 2. Table 12 illustrates the annual tracking of reduction project progress. This example shows a second year of project reporting after the initial year discussed earlier in Table 10. During this second year, both the current project execution dates and those provided in the prior year are listed. This allows the clear and easy identification of projects that are encountering difficulties during execution, and allows one to easily examine which of the milestones that were expected to have been achieved in the prior year were accomplished. The example in Table 12 shows that, for the Cane Independent Power Project (second row in the table), the prior year plan indicated that the investment decision was expected in the third quarter of 2010. The current plan shows that this was accomplished in 2010 (but during the fourth quarter) and that the expected date of startup of this project has changed from the second quarter of 2012 to the fourth quarter of 2012. The 'milestone progress' columns show the project as being delayed two quarters and provide the reason for the change (local labour competition). Similarly, changes in project execution schedules, and the reasons for such changes, are shown for the other projects. Colour coding is again employed to illustrate the most critical changes. In this case, red coding shows prior year expected milestones not delivered, and significant milestone changes affecting dates of flare volume reductions.



Such information can be of great value to regional collaboration organizations seeking to support flare reduction project success. The identification of slippage points and reasons creates a focus for supportive activity to assist projects encountering difficulty. The revised project schedule information enables a revision of regional and national flaring projections. Such a revision is illustrated in Tables 13 and 14, and Figure 2. Table 13 provides the revision to Table 11 from the prior year plan illustrating the expected flaring levels from the priority fields based on the latest projected execution schedules. Table 14 then combines the estimates of regional flaring total volumes for the latest plan and compares them to the flaring volume profiles obtained from prior consolidated plans from the same region. The same data are plotted in Figure 2, showing how the expectations from the 2005 flare reduction plan (that anticipated complete continuous flare elimination by 2009) have shifted to one that anticipates a flaring volume plateau between 300 and 400 million scf/d from 2008 to 2012 and some remaining flaring in 2015 to accommodate the completion of remaining project activities without interrupting petroleum production and revenues.

### GGFR assistance

GGFR is able to provide:

- continued facilitation of operator-government collaborations; and
- guidance on management of project execution barriers from experience in other regions.

**Table 12. Annual tracking of progress on reduction projects**

Production site name	Project name	Expected flare reduction volume (million scf/d)	Estimated project execution dates								Completed 2010 milestones	Milestone progress	
			January 2010 Flare Reduction Plan				January 2011 Flare Reduction Plan					Milestone changes	Reason for changes
			Design	Investment decision	Startup	Design	Investment decision	Startup	Design	Investment decision			
<b>Top priority</b>													
Scorpion	LNG Expansion	120	2Q2011	2Q2012	1Q2014	3Q2011	4Q2012	4Q2014	-	-	Project delayed 2-3Q	Overseas LNG market availability, Partner negotiations.	
Cane	Independent Power Project	70	3Q2008	3Q2010	2Q2012	3Q2008	4Q2010	4Q2012	Yes	Project delayed 2Q	Local labour competition.		
Ursa 2	Gas Processing and Reinjection Facility	40-20	4Q2010	4Q2011	4Q2013	1Q2011	4Q2011	4Q2013	No	Resized from 40 to 20	High cost of remote tie-ins		
Shula	Shula Gas Pipeline		1Q2010	1Q2012	1Q2013	1Q2010	1Q2012	1Q2013	Yes				
Julia	Condensate Recovery Project	15	1Q2008	1Q2009	2Q2011	1Q2008	1Q2009	3Q2011	-	S/U delayed 1Q			
<b>Second tier</b>													
Orion	Gas Reinjection Expansion	40	3Q2009	2Q2010	4Q2011	3Q2009	1Q2011	4Q2012	No	S/U delayed 2Q	Local labour competition. Local security.		
Cetus	Sour Gas Project	15	1Q2008	4Q2009	3Q2011	1Q2008	4Q2009	3Q2011	-				
Jordan	Gas Export Project		2Q2010	2Q2011	2Q2013				No	Project cancelled	Project determined infeasible.		
Cyrus	Production Phase out	20	3Q2009	2Q2010	4Q2012	3Q2009	3Q2010	4Q2012	Yes				
Antara	None yet planned												
Hadar	None yet planned												

Project colour coding:

- Green: prior year expected milestones achieved
- Yellow: prior year milestones on target
- Red: prior year expected milestones not delivered; significant milestone changes affecting dates of flare volume reductions

**Table 13** Future flaring profile based on reduction plans

PROJECT PLAN: January 2011 Flare Reduction Plan					
Production site name	Flaring volume (million scf/d)				
	2011	2012	2013	2014	2015
Scorpion	150	150	150	120	50
Cane	70	60	20	0	0
Ursa 2	27	44	35	25	20
Shula	8	22	10	0	0
Julia	12	2	0	0	0
Orion	35	30	5	0	0
Cetus	15	0	0	0	0
Jordan	14	14	14	14	14
Cyrus	16	14	3	0	0
Antara	3	3	3	3	3
Hadar	1	1	1	1	1
<b>Totals:</b>	<b>351</b>	<b>340</b>	<b>241</b>	<b>163</b>	<b>88</b>

**Table 14** Tracking changes in flare reduction expectations

Plan year	Annual average gas flared (million scf/d)											
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
2005	<b>1081</b>	850	700	500	100	0						
2006	<b>1081</b>	<b>951</b>	750	650	200	100	0					
2007	<b>1081</b>	<b>951</b>	<b>893</b>	700	300	200	100	50				
2008	<b>1081</b>	<b>951</b>	<b>893</b>	<b>750</b>	350	250	150	100	0			
2009	<b>1081</b>	<b>951</b>	<b>893</b>	<b>750</b>	<b>364</b>	350	300	280	150	100		
2010	<b>1081</b>	<b>951</b>	<b>893</b>	<b>750</b>	<b>364</b>	<b>373</b>	350	348	291	207	66	
2011	<b>1081</b>	<b>951</b>	<b>893</b>	<b>750</b>	<b>364</b>	<b>373</b>	<b>369</b>	347	336	237	159	84

Bold figures indicate actual reported results. Other figures (not bold) are future estimates based on flare reduction plans.

**Figure 2** Comparing flaring reduction progress over time

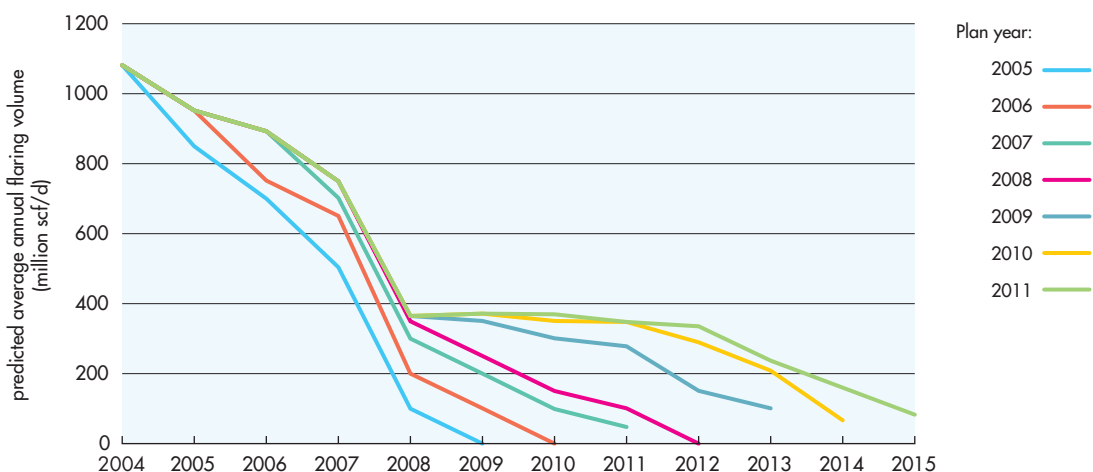


Figure 2 shows changes in predicted flaring volumes with annual revisions to the flare reduction plans. Anticipated reductions are based on annual flare reduction plans from 2005 through 2011.

## Step 7: Celebrating success and sharing experience ('success stories')

The final step in flare reduction involves the recording of success, and sharing this experience both publicly and within the flare reduction community. This activity includes the tracking and reporting of successful reduction project activities, and the preparation and dissemination of communication materials for public and media, as well as more detailed technical organizational information on key barriers to project execution and successful approaches to address them. An agreed communication plan among regional partners, and mechanisms for sharing relevant information, can facilitate the maximum benefit being achieved from each successful reduction project.

Operators and governments alike can share the benefits of collecting and reporting success stories. A growing library of international experience in flare management can result from this activity, assisting all in identifying solutions and in

resolving barriers impeding project success. Appropriate use of these experiences can also enhance the engagement of the oil and gas production community with the public and other stakeholder groups.

### GGFR assistance

GGFR can provide recommendations for the formatting and structuring of 'success stories', and can facilitate publication through GGFR communication channels (e.g. website, media access). GGFR has established a communications network which can help to coordinate and facilitate the dissemination of success stories on flaring reduction and associated gas utilization. GGFR also works to create and disseminate a body of knowledge concerning key project execution barriers and ways to overcome them.



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IPIECA is the global oil and gas industry association for environmental and social issues. It develops, shares and promotes good practices and knowledge to help the industry improve its environmental and social performance, and is the industry's principal channel of communication with the United Nations. Through its member-led working groups and executive leadership, IPIECA brings together the collective expertise of oil and gas companies and associations. Its unique position within the industry enables its members to respond effectively to key environmental and social issues.

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OGP represents the upstream oil and gas industry before international organizations including the International Maritime Organization, the United Nations Environment Programme (UNEP) Regional Seas Conventions and other groups under the UN umbrella. At the regional level, OGP is the industry representative to the European Commission and Parliament and the OSPAR Commission for the North East Atlantic. Equally important is OGP's role in promulgating best practices, particularly in the areas of health, safety, the environment and social responsibility.

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Launched at the World Summit on Sustainable Development in August 2002, GGFR is a World Bank-led public-private partnership that brings around the table representatives of governments of oil-producing countries and international and state-owned oil companies, so that together they can overcome the barriers to reducing gas flaring by sharing global best practices and implementing region-/country-specific programmes. GGFR's main objective is to play a catalytic role in facilitating cooperation between public and private stakeholders in order to reduce routine gas flaring to minimum levels.

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