

## Commodities

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# Libyan Oil and Gas – A Primer

## A look at the past and a glimpse into the future...

- Commodities
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- **Libyan oil production should return in fits and starts from Q3'11**—with rebel forces taking over Tripoli and the possibility of the defeat of Qaddafi, the Libyan conflict may be nearing its end. This note offers a primer on Libyan oil and gas, presenting the basics of Libya oil and gas production pre-war as a benchmark for further projections.
- **The Libyan conflict had a major impact on oil markets and spreads**—Libya produces about 2% of world crude output, but its crude is particularly light and sweet. Thus, the disruption from the onset of conflict in February 2011 had a seemingly disproportionate effect on oil prices, widening sweet-sour and WTI-Brent spreads.
- **Significant proved crude reserves of 46.4 billion barrels and gas reserves of 1,600 billion cubic meters**—Libya's National Oil Corporation had previously been targeting 2.3-m b/d crude production, up from pre-crisis levels of ~1.6-m b/d. The pre-civil war fiscal regime was relatively unfavorable to IOCs, but IOCs were still attracted by its relatively predictable geology and sizable unexplored territory; Qaddafi's removal could add unforeseen production growth in the next few years. Pre-crisis gross production of gas of over 29 billion cubic meters in 2010, could be expanded over time through expansion of the Greenstream pipeline and gas liquefaction plants.
- **We could be seeing a return to Libyan crude production even sooner than markets expect**—The TNC have made it clear that IOC upstream contracts will be honored, particularly for US and European firms. There has been some talk that Brazil, China, Germany and Russia's tepid support for the UN-proposed no-fly zone in March may hurt their chances of re-entering the Libyan oil sector, although other forms of reconstruction support may negate this. However, Gazprom has publicly declared stand-offishness until what they consider a "legitimate" regime governs the country. Of the over \$150 billion of Libyan assets abroad, the European countries should be quick to unfreeze Libyan assets, although the US looks to be slower. We now see Libyan crude exports of 400-k b/d by Q1'12 and upwards of 800-k b/d by end-2012.
- **Light, sweet crude of 450-k b/d from the Sirte basin, and 45-k b/d heavy, sour crude from Pelagian shelf offshore fields could return soon**—Although damage assessments should become clearer as the security situation stabilizes and IOC foreign personnel are able to return to fields and pipelines, Agoco has suggested that southeastern fields in the Sirte basin could be ready in a matter of weeks, while the offshore fields close to Tripoli have incurred minimal damage. However, the southwestern Murzuk basin fields had output shut in after the rebels cut pipelines supplying the then-Qaddafi-controlled Azzawiya refinery close to Tripoli. Agoco's Sirte basin crude could be back on the order of 450-k b/d, while the two offshore fields of El-Bouri and Al-Jurf could each bring back around 45-k b/d of heavy, sour crude. Eni, who operates the El-Bouri field, believes it could be restarted almost straight away.

See Appendix A-1 for Analyst Certification, Important Disclosures and non-US research analyst disclosures.

## A primer on Libyan oil and gas

With rebel forces taking over Tripoli and the seemingly imminent defeat of Muammar Qaddafi, the Libyan conflict may be nearing its end, with the Transitional National Council (TNC) leading the country moving forward. There remains significant uncertainty about how rapidly political stability might emerge as well as what this means for oil markets. The end of the Qaddafi regime and of the six-month conflict would certainly be a positive step towards full-blown resumption of oil production, but market participants appear to be getting ahead of post-conflict practicalities, given the spectrum of views on this subject that have appeared this week. Undoubtedly, there are significant challenges ahead to having enough volumes in the market to do more than take the edge off Brent premiums to other crude streams, whether heavier and sourer crudes like Dubai and Urals, or over West Texas Intermediate and other light crude oils. While there are challenges on the technical side, the key challenges are political. Restoring security during the transition to elections and establishing a legitimate national government after 42 years of dictatorship will take time. Besides ensuring security, respect for rule of law and governance will be crucial in order for international oil companies and their foreign personnel to return to aid construction efforts – both in basic services, and also in energy infrastructure.

### From coup to civil conflict

By way of background, Libya had become a major oil producer by the time Colonel Qaddafi came to power in a 1969 coup. At that time, Libya's average production of 3.1-m b/d was close to on a par with Iran (3.4-m b/d), Kuwait (2.8-m b/d), and Saudi Arabia (3.3-m b/d). At the time Venezuela was OPEC's largest producer (3.6-m b/d). Libya's output peaked the next year at 3.4-m b/d, when Colonel Qaddafi orchestrated a production cut that sparked the OPEC revolution of the 1970s. Its production rapidly fell and never again achieved its previous production level again.

Libya's relationships with major oil consumers had been improving with international diplomatic efforts to strengthen ties to the country, including the lifting of sanctions in 2003-04. The process of ending sanctions included a re-opening of Libya's oil sector to foreign investment, which was targeting once again a 3-m b/d production level. The country's overall output was hovering in a range of 1.5- to 1.8-m b/d. More recently Libya's state-owned National Oil Corporation (NOC) brought its production target down to a still-ambitious 2.3-m b/d prior to the uprisings.

Many hoped that greater engagement and incentives might eventually spur Libya's return to the international community. However, armed civil conflict began early during this year's Arab Spring uprisings, beginning in February 2011 with protests in the eastern city of Benghazi, which then quickly spread. A harsh crackdown followed, but as has occurred elsewhere in the region, the use of lethal force backfired, hardening protestors' resolve and helping to consolidate the movement to overthrow Qaddafi. Clearly, the demonstration effect of regime change in Tunisia and Egypt was powerful, though the Libyan uprising has been among the longest-running and most deadly, ultimately securing support from NATO via United Nations Resolution 1973.

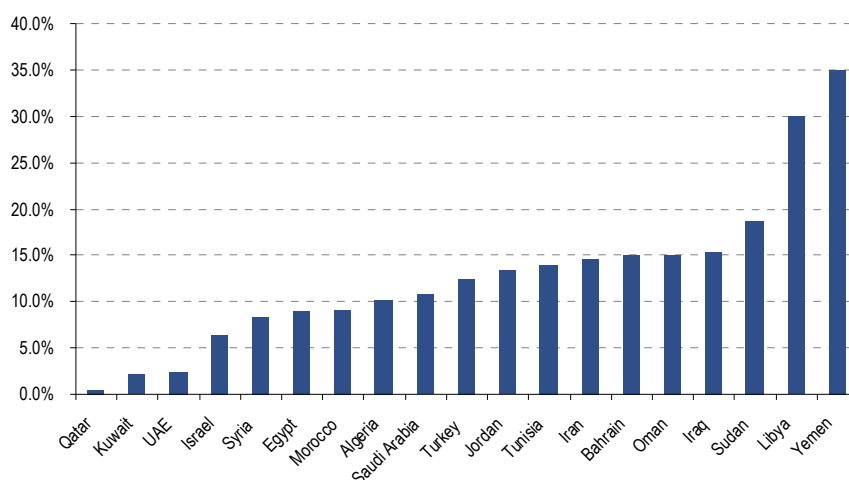
Libya is part of the “youth bulge” in the MENA region

Large-scale protests in MENA have been driven in part by demographics – in particular, young, underemployed populations. Libya has one of the largest “youth bulges” in the region, with 33% of the population between 0-14 years and unemployment at 30%. But the Libyan case was no “Facebook revolution”; the country has a comparatively small middle class (which normally leads revolutions).

Instead, Libyans from disparate regions, tribes and clans came together in armed opposition, and have continued to fight for more than six months. However, uniting in opposition to an unpopular leader may not translate into cohesion after the fact.

Divisions post-regime change are possible, and may already have played a role in the mysterious assassination of rebel commander Abdel Fatah Younes in July.

**Figure 1. Reported unemployment in MENA countries**



Source: Citi Investment Research and Analysis, Haver Analytics

**The Libyan unrest impacted Brent prices and the WTI-Brent spread...**

Libyan crude is mainly evaluated and sold against the Brent benchmark, and given the particular importance of light, sweet crude, the Libyan disruption that accompanied the unrest drove a dramatic wedge between WTI and Brent prices, which made the WTI-Brent and Brent-Dubai spreads widen. Libya was producing around 1.6-m b/d as unrest began, and output fell to under 100-k b/d, while exports effectively stopped. Later, the IEA responded with the 60 billion barrel release of strategic stocks on 23 June, which helped ease oil prices somewhat.

**...and on-looking governments increased their budgets, with impact on minimum targeted oil prices**

Oil prices were also impacted indirectly as these developments in the context of a wider Arab unrest alarmed other oil producers in the region: many governments with the means, especially in the GCC, responded by increasing spending and re-affirming energy subsidies, attempting to quell demands for reform through increased social spending. This has carried medium- to longer-term bullish connotations, raising fiscal break-even budgets and therefore minimum targeted oil prices as well as higher domestic consumption, at the expense of exports.

**The rebels are widely recognized by the international community**

Early on, one of the subsidiaries of the NOC, the Arabian Gulf Oil Co. (Agoco) affirmed support for the rebels and announced the resumption of production and export of oil from fields under their control. Qatar offered to market their oil. In mid-July, Agoco had repaired the Sarir and Misra oilfields and production inched up.

The TNC, an umbrella organization which includes some former regime elites, has already received wide diplomatic recognition from the international community. With the rebels closing in on Tripoli, the end of the Qaddafi regime seems imminent, although his whereabouts remain unknown and pockets of resistance continue.

**Challenges to restarting production are technical...**

There has been much discussion about how rapidly Libyan oil production might be restored. It appears that it could take about 12-18 months to recover Libya's full production capacity, from whenever the current crisis is resolved, depending on the scale of damage to infrastructure, international sanctions being lifted, and international oil companies and their foreign personnel feeling assured enough to return. Some analysts believe production could be restored before then; others believe it could take three years or longer.

Libya's NOC and the international oil companies operating in the country will need to work in partnership to repair infrastructure, and bring production back toward levels before the crisis. Production recovery is likely to differ basin by basin. The major Sirte basin in eastern Libya is mature and complex and may take longer – it accounted for around two-thirds of Libyan production – while the newer, less complex fields such as the Murzuk and Pelagian Shelf basins in western Libya may take less time.

Preliminary reports suggest that southeastern fields in the Sirte basin, the offshore Pelagian Shelf fields close to Tripoli and oil export terminals seem to have incurred minimal damage. On the other hand, the southwestern Murzuk basin fields had output shut in after the rebels cut pipelines which were supplying the then-Qaddafi-controlled Azzawiya refinery close to Tripoli. The condition of these pipelines is yet to be assessed.

Further, neglect of maintenance during the fighting may have caused real, physical deterioration of wells, although Eni's upstream chief, Claudio Descalzi, believes full production could be technically possible in a year.

#### ...but mainly political

The challenges now shift to restoring security and basic services and preventing score-settling between rival groups, so that a return to chaos and conflict does not prevent the political transition the TNC has announced from taking place.

Although the TNC has indicated that it does not want foreign troops remaining on Libyan soil, the presence of international security and peacekeeping forces or other personnel has not yet been ruled out, and could help ensure stability during the transition. EU members France, Germany and Italy have historically relied on Libyan oil and gas, and have oil and gas investments in Libya through domiciled companies, increasing their incentive to provide support to reconstruction efforts.

In an interview in the Italian newspaper La Repubblica on August 24, TNC Chairman Mustafa Abdel Jalil indicated that free elections would take place within 8 months. A draft interim constitution has been published which acknowledges the rights of the minority Berber population and states that Islamic jurisprudence will be the primary source of legislation, but with limits.

The move to ensure minority rights is a welcome move in the direction of national cohesion. Even so, besides the possibility of tribal and regional tensions, friction between Islamists and secular forces could also manifest themselves during the course of the transition, as groups vie for influence in the new political landscape. This has been evident in Egypt and Tunisia as well, and is proving to be an important factor in their upcoming elections this autumn.

In previous remarks Jalil has suggested that the country would respect agreements and contracts signed by the former regime, conditional on their having “nothing to do with corrupt schemes”. This could lead to scrutiny of Qaddafi-era contracts in the future.

#### Will Brazil, China, Germany and Russia receive less preferential treatment in Libya's oil and gas sector?

The TNC has also indicated that investors from countries which supported the opposition movement would be favored in the post-Qaddafi investment environment, suggesting that Brazilian, Chinese, German and Russian companies will have more work to do to gain favor than France, the UK and the US, who supported UN Resolution 1973 at the Security Council.

In terms of incentives to return to production quickly, it is in the TNC's interest to bring this about as soon as possible: they will need to pay salaries, restore public services and in many respects, build the country anew. The interim government's

Libya produces about 2% of world crude output, but its crude is very light and sweet

The disruption to Libyan crude widened WTI-Brent spreads

...but the WTI-Brent spread should not close too soon, as other factors are also at work

capacity to maintain control during the transition is yet to be seen, but these conditions would have to be present before IOCs such as Eni, Total and others would re-enter the country.

## Libyan crude and its relationship to the WTI-Brent spread

Libya was producing 1.66-m b/d in 2010, out of total world output of around 87.5-m b/d that year. However, its importance lies in the quality of its crude, which is both light and sweet. Global demand growth has been increasingly concentrated in middle distillates. Add to this the premium on middle distillate demand in emerging markets, where distillates are used not only in transportation but also as a substitute for other fuels when they are not readily available in power generation or transmission, and it is clear why Libya matters. As governments have regulated limits to sulfur content in diesel and other middle distillates, a financial premium has been placed on light, sweet (i.e. low sulfur) fuels. Of the estimated 12.5-m b/d of production of crude oil that is light and sweet, African countries produce 42%, and of the African producers, Libya, along with Nigeria and Algeria, are the largest. Thus, the disruption to Libyan crude had a disproportionate effect on oil (particularly Brent) prices, relative to its oil production prior to the uprisings.

Historically, West Texas Intermediate (a slightly higher grade crude than Brent) would trade at a \$1.50/bbl to \$1.75/bbl premium to its North Sea counterpart, as North Sea excess flow would come to the United States Gulf Coast. The transatlantic voyage added about \$1/bbl (the traditional spread of Light Louisiana Sweet, or LLS, over Brent) while the trip up to Cushing, Oklahoma, added about \$0.50/bbl - \$0.75/bbl extra. But beginning in 2007, Brent started trading through WTI due to congestion in Cushing and Canadian volumes pushing out Gulf Coast crude streams. This trend became semi-permanent during the latter half of 2010 and the growth of the spread inversion in 2011 is unprecedented.

In January of this year, the WTI discount to Brent appeared to stabilize around -\$4/bbl but has blown out in fits and starts to -\$25/bbl today, hitting a record -\$26.19/bbl last Friday. To be sure, there are a myriad of reasons to help explain the WTI-Brent blowout; inventory build-up in the US mid-continent, the "land-locked" delivery point of WTI versus waterborne Brent, declining North Sea wellhead output, disparate forward curve term structures that drive index flows into Brent as well as limited spare capacity within OPEC. This last reason is critical to why Libya matters in the oil markets and why the supply disruption was (and remains) impactful. The approximately 1.4-m b/d of lost Libyan exports has not easily been replaced. Despite roaring production from Saudi Arabia and other GCC states that more than make up for lost barrels this summer, it is the quality—not quantity—that matters. This market tightness in part affects the spread. The relative scarcity of light and sweet crude markets provided for a scenario where almost overnight, about ten percent of the world's highest quality crude for export disappeared. Excess supplies from Saudi Arabia, Kuwait and UAE were palpable, but in many cases could not be adequately utilized in Mediterranean refineries that have limited capacity to process sourer petroleum streams. Couple this with the sharp rise of Chinese and Indian imports of West African crude (an estimated 1-m b/d, which is more than double the prior five-year average), and it is no surprise that Brent rallied while WTI remained under pressure, in an isolated island of crude oil glut.

Market participants have taken note of Libya's role in the WTI-Brent "arb." As traders weighed the risks of Libya coming back online in light of the recent rebel uprising, the massive short in the WTI-Brent spread began to reverse itself sharply on Monday. Having just hit the record -\$26/bbl prior to the weekend's unfolding siege on Tripoli, traders began reversing positions to the point that the spread

narrowed in size, +\$4/bbl before cleaning up to a more modest +\$2.32/bbl on the August 22nd close. WTI even started decoupling from equities, as traders looked to position on the spread and debated whether structures on WTI-Brent were unwinding prematurely. As Libya's precocious revolution gains ground in Tripoli, and sentiment shifts towards more bullish Libyan production targets, that should weigh on the WTI-Brent spread. That said, Monday's action seemed overbought and it is unlikely that prompt-month WTI and Brent should converge sharply anytime soon because there are other significant fundamentals at play that drive the spread. To be sure, the spread has retraced itself, widening back to over -\$25/bbl at the time of this publication as new headlines emerge about when regime change in Libya should actually occur. Thus, it is a difficult arbitrage to predict in the short term and should continue to be volatile until some form of stability is reached.

## Libyan oil reserves, production and refining

**Figure 2. Libyan oil and gas reserves, production and refining capacity**

Oil reserves:	46.4 billion barrels
Gas reserves:	1,600 billion cubic meters
Oil production, 2010:	1.66 million barrels per day
Gas production, 2010:	29 billion cubic meters
Refining capacity:	380,000 barrels per day

Source: Arab Oil and Gas Directory 2011, CIRA

Libyan oil reserves were an estimated 46.4 billion barrels as of Jan 1, 2011, against 44.5 billion barrels in 2010, and 39 billion barrels in 2005. The country's reserves comprise six large sedimentary basins – Sirte, Murzuk, Ghadames, Cyrenaica, Kufra and offshore – which could yield as much as 100 billion barrels of recoverable reserves, according to Libyan authorities prior to the civil war. The Sirte basin is in eastern Libya, around the port of Brega stretching south and southeast, and has been much more extensively explored than the other basins. It also accounts for almost two-thirds of total production. The Bouri field, off the coast near Tripoli, is the largest single structure, originally containing 5 billion barrels of oil-in-place with heavy 26° API crude. The 19 of the 20 oil fields with recoverable reserves of over 1 billion barrels are located in the Sirte basin, of which two hold over 4 billion barrels – Amal (discovered in 1959) and Gialo (discovered in 1961). Three hold between 500 million to 1 billion barrels, including the El Feel (Elephant) field (discovered in 1997).

Libyan oil production was around 1.66-m b/d in 2010, 1.47-m b/d in 2009, and 1.72-m b/d in 2008, according to the Arab Oil and Gas Directory (AOGD) 2011 and the BP Statistical Review of World Energy, 2011. The fall in 2009 onwards was to bring production in line with lower production quotas issued to Libya by OPEC. With crude processing of around 350-k b/d (of which around 270-k b/d went to domestic consumption), assuming they were relatively unchanged from 2009 numbers, this meant that around 1.2-1.3-m b/d of crude was exported and supplied to the world market.

Libyan oil production capacity was estimated at 1.7-m b/d in 2010 by the IEA, down from 1.8-m b/d in 2007, although NOC former Chairman Shokri Ghanem claimed 2-m b/d of capacity in April 2010. Fields operated by the NOC accounted for around 700-750-k b/d of Libyan oil production in 2010, while those operated by foreign companies accounted for 750-850-k b/d.

In early 2011, NOC had been bringing new fields in production: NC-100 with estimated 20-k b/d within a year of its opening (but interrupted by the civil conflict), as well as the Sultan, NC-4 and NC-101 fields. No new fields came on-stream in 2009. Only the relatively small I/R field on Block NC-115 came on stream in 2008 operated by Repsol. Repsol also brought the B field on Block NC-186 into production in 2005, a few months after the A field in 2004. Eni brought the El Feel (Elephant) field on stream in 2003, with output at a plateau rate of 150-k b/d.

**Development or rehabilitation of oil and gas fields could increase production capacity by 775-k b/d by 2013...**

The NOC's development program for 2009-2013 consisted of \$10 billion investment into a five-year program to develop or rehabilitate 24 oil and gas fields, aimed to increase production capacity by 775-k b/d by 2013, with the assistance of IOCs.



Depending on the post-conflict damage and political considerations, this plan may be incorporated into reconstruction plans moving forward.

**Figure 3. The NOC's development program for 2009-2013 prior to the conflict**

Company*	Field	Reserves to be added (m bbl)	Additional output capacity (k b/d)
Waha	Gialo	851	100
	NC-98	500	80
	Gialo-Waha	175	25
	Southeast Harash (6C, %I)	65	7
	Block 31 (F, R, Q)	35	12
Agoco	Naafora/Aguila	850	130
	Messia/Saris (gas)	126	28
	NC-4	102	10
	Haram	95	10
	NC-100	90	10
	Block 80 (O field)	60	7
	Block 65 (VV.UU fields)	58	18
	NC-131 (Karim field)	49	4.5
Harouge	Amal (Phase 1)	50	8
	NC-7 (Phase 1)	37	15
	En Naga (Phase 2)	35	10
	Ghana Gir/Fasha	21	3
	Ed Dib	16	3.5
Akakus	NC-186 (I/R)	625	70
	NC-186 (B/H)	246	42
	NC-186 (J/K)	170	28
Mellitah	El Feel/Elephant	680	130
Mabruk	Garian	115	20
Zueitina	Al-Dhahab	21	4
<b>Total</b>		<b>5072</b>	<b>775</b>

\*IOC involvement as follows: Waha (Hess, ConocoPhillips, Marathon); Agoco (Occidental, OMV); Harouge (Petro-Canada), Akakus (Repsol), Mellitah (Eni), Mabruk (Total), Zueitina (Occidental)

Source: Libya National Oil Corporation (NOC), Citi Investment Research and Analysis

...which would help replace declining  
productivity of mature fields

Part of the new capacity in this program would only be replacing capacity lost through declining productivity of mature fields, which in Libya have been declining at a rate of around 5-6% per year. However, geological studies of large reservoir performance suggest that flow rates could be doubled through refurbishment and upgrade of production facilities, infill drilling, applying new production technology, and enhanced oil recovery.

**Figure 4. Production by company prior to February 2011**

Company	Crude production (k b/d)
Agoco	NOC, Occidental, OMV
Waha Oil Co.	Hess, ConocoPhillips, Marathon*
Akakus Oil Co.	Repsol
Mellitah Oil Co.	Eni
Wintershall	
Harouge Oil Co.	Petro-Canada
Sirte Oil Co.	NOC subsidiary
Zueitina Oil Co.	Occidental
Mabruk Oil Co.	Total
OMV	
	1

Source: Arab Oil and Gas Directory 2011, Citi Investment Research and Analysis

Domestic product consumption for reconstruction should not drag on exports

## Libyan refining capacity and domestic consumption

Libyan refining capacity of 380-k b/d before the conflict was more than the country's own product consumption, although output had been falling over the past two years. A new refinery close to Mellitah could boost product output and exports by 200-k b/d – particularly middle distillates – and was scheduled to complete in 2014. Further projects that would promise greater product output are upgrades and expansions to the two largest refineries in Libya, at Ras Lanuf and Azzawiya. Over and above crude distillation capacity, Libya also has over 43,000 b/d catalytic hydro treating capacity, and 3,400 b/d capacity for asphalt.

Figure 5. Libyan refining capacity

Refinery	Capacity (k b/d)	Start-up date
Brega	10	1965
Azzawiya	120	1974
Ras Lanuf	220	1985
Tobruk	20	1986
Sarir	10	1989
<b>Total</b>	<b>380</b>	

Source: Arab Oil and Gas Directory 2011, Citi Investment Research and Analysis

In 2009, Libya processed around 330-k b/d of crude, against domestic oil product consumption of 271.2-k b/d, which left a surplus of 78.8-k b/d of petroleum products that year, according to OPEC. It is reasonable to take this as a benchmark for a level of domestic product consumption that will be trended back toward, on top of which would be added the short-term boost in domestic demand for reconstruction, for new vehicles, moving of freight, construction and power generation.

In particular, Ras Lanuf provided most of the output to oil-fired power stations on the coast, as well as feedstock for nearby petrochemicals. Libyan electricity demand was growing some 8% every year until 2010, with peak demand an estimated 5,500 MW, over installed capacity of around 5,000-5,500 MW, and capacity shortages were not uncommon. Further, near-term production may help to restock inventories. However, given that Libya is a small country, with a population of 6.2 million, we do not see these factors as a major drag on estimated supply leaving the country. In fact, we expect Libya to increase product imports to support reconstruction efforts.

Figure 6. Libyan product output and consumption

Product output					Product consumption				
k b/d	2006	2007	2008	2009	k b/d	2006	2007	2008	2009
Gasoline	18.4	19.5	18.2	17.6	Gasoline	56.7	60.1	64.7	66.8
Kerosene	31.8	32.8	34.3	41.9	Kerosene	13.6	13.2	11.6	12.3
Distillates	87.7	87.8	84.4	89.4	Distillates	77	78.9	88.8	104.9
Residuals	136.1	134	141.2	131.3	Residuals	44.8	39.7	42.1	49.7
Others	194.2	222.9	84.6	69.9	Others	36.7	40.1	44.2	37.5
<b>Total</b>	<b>468.3</b>	<b>497</b>	<b>362.7</b>	<b>350</b>	<b>Total</b>	<b>228.7</b>	<b>231.9</b>	<b>251.5</b>	<b>271.2</b>

Source: OPEC, Citi Investment Research and Analysis

## Libyan crude grades are predominantly light and sweet

Prior to civil war, Libya was feeling the combined effects of OPEC quota cuts in 2009 as well as delays and disappointments in E&P. Over 30 IOCs had participated in the licensing rounds held by the National Oil Corporation (NOC) through 2005-2007, but the results were underwhelming. Having pulled back from its ambitions to expand output to 3-m b/d, even its mid-2010 target of 2.3-m b/d was questionable. Libya was producing around 1.5-m b/d in 2009-10. Nevertheless, their proved reserves of 46.4 billion barrels of crude oil provide significant potential for exploration.



Figure 7. Libyan crude streams, 2009 estimates as illustration

	API	Sulfur	2009 Output	2009 Capacity	Basin
<i>Light, sweet crudes (priced against Brent)</i>					
Abu Attifel	43.3°	0.06%	105,000	110,000	Sirte
Brega	42.4°	0.22%	80,000	80,000	Sirte
El-Sharara	42.1°	0.07%	277,000	320,000	Murzuk
Mellitah	42°	0.10%	150,000	150,000	Murzuk
Sirtica	41.1°	0.42%	75,000	75,000	Sirte
Zueitina	40.8°	0.35%	50,000	50,000	Sirte
Sarir	37.5°	0.17%	190,000	220,000	Sirte
Amna	37.1°	0.17%	180,000	180,000	Sirte
Es Sider	37°	0.39%	300,000	500,000	Sirte
<i>Medium-to-heavy crudes (priced against Urals)</i>					
Al-Jurf	30.2°	1.90%	31,000	45,000	Pelagian
Bouri	25.9°	1.86%	45,000	45,000	Pelagian
<b>Total</b>			<b>1,483,000</b>	<b>1,775,000</b>	

Source: EIG, Citi Investment Research and Analysis estimates

Libyan crude is particularly light and sweet, with an estimated 1.69-m b/d capacity with 35° API or higher; these crude streams have sulfur content of between 0.07-0.42%. Of the larger streams, some date from the late-1950s and 60s – further compounded by neglect during the years of sanctions from the West – and are facing falling pressure, water flooding and sand intrusion, and would require investment in enhanced oil recovery using methods such as gas or water injection to maintain plateau levels or even increase output. Of note is the El-Bouri field, which contains large volumes of associated gas, with the potential of 36,000 barrels of oil equivalent per day at its peak; Eni had been planning an underwater pipeline to the Mellitah plant via the Sabratha platform for treatment, which is close to Tripoli. Large streams like El-Sharara from the Murzuk basin, producing around 277-k b/d in 2010 and with capacity of 320-k b/d, could be boosted to plateau levels of production of 380-k b/d with further investment. The Zueitina stream, from the Sirte basin, could be boosted to 300-k b/d with further investment, which stood before the civil war at around 50-k b/d in 2009.

Two crude streams from the offshore Pelagian Shelf basin around Tripoli produce medium-to-heavy crudes and are priced against Urals crude. The Bouri field, operated by Eni, outputs Libya's heaviest, sourest crude with gravity of 25.9° API, while the Al-Jurf field, operated by Total and Wintershall, outputs heavy, sour crude with gravity of 30.2° API. Together, these could account for around 90-k b/d, estimated from 2009 output numbers. According to Eni, these could be among the first fields to come back online.

## Pipelines, ports and exports

Libyan exports were predominantly to Western Europe, with 875-k b/d in 2009 and 1.2-m b/d in 2008, and over 90% of total oil production in 2003 and 2004. Exports to Asia and the Far East were a distant but growing second, with 168-k b/d in 2009, 90-k b/d in 2008, and 134.1-k b/d in 2007, including an Indonesian 20-year crude oil supply contract signed between the NOC and Pertamina in February 2008.

The major coastal terminals include Azzawiya, Es Sider, Marsa el-Brega, Ras Lanuf, Tobruk and Zueitina. Getting crude oil from producing fields to these ports and refineries required over 4,000 km of crude oil pipelines. Unless there is extensive war-damage, these terminals should have adequate capacity to supply just under 1.5-m b/d, hence there should not be short-term constraints on crude exports. Reports indicate minimal damage to most pipelines, except the pipelines between the Murzuk basin fields which were cut by rebel forces to withhold supplies to the then-Qaddafi-controlled Azzawiya refinery close to Tripoli. The damage to this pipeline is yet to be assessed.

Pipelines and ports should not put short-term constraints on exports, depending on damage

**Figure 8. Libya's major coastal terminals\***

Terminal name	Berths	Tanker size accommodated	Max loading capacity
Azzawiya	5 offshore berths	175,000 dwt	6,500 tons/hour
Es Sider	3 CBMs	250,000 dwt	6,600 tons/hour
Marsa el-Brega	3 crude berths, 2 LPG/LNG berths	300,000 dwt	-
Ras Lanuf	3 CBMs, 3 inner harbors	250,000 dwt	7,000 tons/hour
Tobruk/Marsa el-Hariga	3 crude berths	120,000 dwt	8,000 tons/hour
Zueitina	3 SBMs, 2 CBMs	270,000 dwt	6,500 tons/hour

\*Figures denote situation prior to February 2011, and do not reflect any potential damage to facilities

Source: Arab Oil and Gas Directory 2011, Citi Investment Research and Analysis

**Figure 9. Libyan export terminal loading volumes**

Terminal name	Oct-10	Nov-10	Loading volumes (k b/d)	
			Dec-10	Jan-11
Western Libya:				
Azzawiya	270	226	311	199
Eastern Libya:				
Es Sider	284	314	348	447
Marsa el-Brega	58	53	90	51
Ras Lanuf	162	234	219	195
Tobruk/Marsa el-Hariga	63	20	51	51
Zueitina	117	161	175	214
<b>Total eastern Libya</b>	<b>684</b>	<b>782</b>	<b>883</b>	<b>958</b>
Unspecified:				
Other terminals	224	388	299	333
<b>Total Libya</b>	<b>1,178</b>	<b>1,396</b>	<b>1,493</b>	<b>1,491</b>

Source: IEA, Citi Investment Research and Analysis

## Overview of the Libyan gas sector

Libya has proved natural gas reserves of around 1,600 billion cubic meters as of Jan 1, 2011, of which 55% are non-associated gas, and 45% are associated gas. There were no discoveries of gas in 2010. In 2009, a Hess subsidiary, Hess Libya Exploration Limited, made a discovery in Area 54, around 56km offshore in the Sirte basin, the structure of which is around 5,000-6,000 billion cubic feet in size. Prior to the conflict, NOC former Chairman Shokri Ghanem was aiming to produce 73 billion cubic meters/year, or 200 million cubic meters/day, by 2012-13.

Gross production of natural gas was 29.3 billion cubic meters in 2009, falling from 30.3 billion cubic meters in 2008, after large gains from the completion of the 2004-06 Western Libya Gas Project (WLGP). However, the volume flared was 35.4% of the total, or 3.9 billion cubic meters in 2008, but fell to 3.3 billion cubic meters in 2009. Exports were targeted at a 45-50 billion cubic meters/year over eight to ten years, prior to the civil war.

Gas processing facilities include the Mellitah plant, which can process 10 billion cubic meters/year of raw natural gas and 95-k b/d of liquids, mainly for export and a plant at the Intisar field with capacity of 20.3 million cubic meters/day. These have been inadequately maintained and have been operating under-par for many years.

The gas transmission network is made up of 11 trunk lines with total capacity of 14 billion cubic meters/year. In particular, the Coastal Pipeline system is 1,172km long and has the capacity to transport 4.1 million cubic meters/day between Zueitina and Benghazi in eastern Libya, via Marsa el-Brega, to Tripoli, Azzawiya and Mellitah in western Libya.

**Figure 10. Libyan natural gas production, 2005-2009**

<i>billion cubic meters</i>	2005	2006	2007	2008	2009
<b>Gross production</b>	<b>21.84</b>	<b>27.06</b>	<b>29.22</b>	<b>30.31</b>	<b>29.29</b>
<i>of which:</i>					
Marketed	11.3	13.16	15.29	15.9	15.9
Flared	2.58	2.98	2.91	3.94	3.26
Re-injected	3.54	3.63	3.37	3.53	3.57
Shrinkage	4.42	7.26	7.66	6.94	6.56

Source: OPEC, Citi Investment Research and Analysis

**Development to expand the Greenstream pipeline and build gas liquefaction plants could double Libyan gas exports**

Libyan gas exports around 8 billion cubic meters/year via the Greenstream pipeline. The Greenstream pipeline is 520km long, 32 inches in diameter, and runs from Mellitah in western Libya to Gela, Sicily. The 8 billion cubic meters/year out of Libya continues on to Edison Gas (4 bcm/year), Energia Gas (2 bcm/year) – both of Italy – and Gaz de France (2 bcm/year), under 24-year take-or-pay contracts.

Royal Dutch Shell had previously signed an agreement with the NOC in 2005 to rehabilitate the gas liquefaction plant at the port of Marsa el-Brega to its planned capacity of 3.2 million tons/year. Operated previously by NOC subsidiary Sirte Oil Company, it was producing and exporting around 700-k tons/year of liquefied natural gas (LNG), which was lifted by Enagas of Spain.

Eni had previously signed an agreement with the NOC to expand the Greenstream pipeline by 3 billion cubic meters/year and to build a gas liquefaction plant with capacity of 5 billion cubic meters/year. This would double Libya's pre-civil war gas export capacity to around 16 billion cubic meters/year.

## Factors behind post-conflict oil output

**The damage to infrastructure will need to be assessed...**

Average annual production had fallen from 1.72-m b/d to 1.55-m b/d in 2009; after the cut in Libya's OPEC quota to 1.47-m b/d; it remained at that level in early-2010. The timing for restarting production will differ for various reasons. First, the level of damage is as yet unclear. Those areas more damaged or sabotaged may take longer to restart, and the return and repair process will be fraught with difficulties. Adequate security measures will need to be taken, staffing will need to be brought back, supply lines built up again, damaged infrastructure assessed and repaired and vehicles imported. Offshore fields should be mainly intact, and landlocked fields and infrastructure need to be assessed for damage.

**...but reports suggest damage to southeastern and offshore fields are limited...**

Reports suggest that southeastern fields in the Sirte basin, the offshore fields close to Tripoli and oil export terminals seem to have incurred minimal damage. However, the southwestern Murzuk basin fields had output shut in after the rebels cut pipelines supplying the then-Qaddafi-controlled Azzawiya refinery close to Tripoli.

Neglect of maintenance during the fighting may have caused physical deterioration of wells, although Eni's Claudio Descalzi believes full production could be technically possible in a year.

**...although some of the earliest crude likely to return online is heavy and sour, and priced off Urals**

Although Libyan crude is typically light and sweet, the two offshore fields of El-Bouri and Al-Jurf produce ~90-k b/d of heavy, sour crude, and are priced against Urals crude. These are operated by Eni, and Total/Wintershall, respectively, and could be among the first fields to come back online. This has implications for sweet-sour and WTI-Brent spreads.

**The Murzuk basin fields are less mature and complex, but still shut in from pipeline damage**

Second, the Murzuk, Pelagian Shelf and Sirte basins are at different levels of maturity, complexity and vary by just the sheer number of wells. The Murzuk and Pelagian Shelf comprise of only a few major fields which were operated by a small number of companies. The Murzuk basin is relatively new and composed of productive sandstone reservoirs which offer the possibility of a faster return to peak rates. Technically, these could return within 1-3 months of a stable political situation taking hold. However, these have been shut in following the rebels' cutting of pipelines supplying crude from the Murzuk basin to the then-Qaddafi-controlled Azzawiya refinery near Tripoli. The condition of the pipeline is yet to be assessed.

**The Sirte basin is more mature and complex, but operators indicate the southeastern fields could come online soon**

The Sirte basin is more mature, with more complex reservoirs, and many fields, which were operated by many different companies. Typically, the Sirte fields are the ones supported by gas and water injection. Some of these fields could require over a year or more for ramp-up to full production. However, of the southeastern fields, the facilities and pipelines at the Sarir and Misla fields have been largely repaired following damage sustained by attack from Qaddafi's forces. Agoco indicates that they could restart output (pre-war levels of 450-k b/d) soon after the security situation stabilizes.

**TNC has indicated that contracts with IOCs will be honored moving forward...**

Managing the continuation or renegotiation of contracts with IOCs will also be an issue. European companies with an upstream presence will be making contingency plans to return; they include BP, Total, Royal Dutch Shell, Eni, Repsol YPF. US companies ConocoPhillips, Marathon, Hess and Occidental will likely be preparing for the same. Prior to civil conflict, Eni was the largest foreign producer, with total output of around 270-k b/d of oil equivalent, accounting for over 15% of its production. Further, Eni operates the Greenstream gas pipeline which was supplying Libyan natural gas to Italy of around 8-9 billion cubic meters per year prior to this February.

The TNC has made it clear that IOC upstream contracts will be honored, particularly for US and European firms. However, there has been some talk that Brazil, China, Germany and Russia's tepid support for the UN-proposed no-fly zone in March may hurt their chances of re-entering the Libyan oil sector, although other forms of reconstruction support may negate this. However, Gazprom has publicly declared stand-offishness until what they consider a "legitimate" regime governs the country. Gazprom had reached an agreement to develop the Elephant field only a few days before the conflict began. Of the over \$150 billion of Libyan assets abroad, the European countries should be quick to unfreeze Libyan assets, although the US looks to be slower. We now see Libyan crude exports of 400-k b/d by Q1'12 and upwards of 800-k b/d by end-2012.

**...and there are prospects for a more favorable fiscal regime post-Qaddafi**

Oil companies operating in Libya have historically been subject to relatively high effective tax rates; however, IOCs have been attracted to the country by the large reserve base, relatively predictable geology, and more recently the prospect of substantial resource growth through exploration and EOR techniques. Although Libya's concession agreements were not the most generous, the fast cost recovery provided IOCs with respectable cash flows and project returns. When Qaddafi came to power, he began nationalizing much of the oil industry and renegotiated the concession agreements which were in place. As a result, many companies left the country, those which remained were somewhat hesitant to invest heavily and drilling activity began to fall steadily. In an effort to increase exploration, Qaddafi's government implemented EPSAs (Exploration Production Sharing Agreements) for all new projects. However the terms of these agreements (the EPSA I began implementation in 1974, EPSA II in 1979) were not met with enthusiasm as the terms were not perceived to outweigh the risks. Due to continued fiscal stress and the need to increase production and reserves, the country offered better terms in

1988 within its EPSA III. In 2005, the first competitive bid round (EPSA IV) was held since sanctions against Libya were lifted. The NOC made 15 licenses available, for which 60 companies submitted over 100 bids. We believe the removal of Qaddafi and the potential for more favorable terms could add unforeseen production growth in the coming years, as the TNC and subsequent governing bodies improve the fiscal landscape for IOCs.

Figure 11. A comparison of Libyan fiscal regimes in the oil and gas sector

	Concession	Exploration Production Sharing Agreements (EPSAs)*
	Initially established beginning in 1950s	Initially introduced in 1974, terms have evolved (EPSA III and IV summarized here)
Exploration & Appraisal Costs	Partners pay equitable share	Contractor bears 100%
Development Costs	Partners pay equitable share	Contractor bears 50%
Operating costs	Partners pay equitable share Fully recoverable 1st year	Generally proportional to equity interest
Royalty	Royalty of 16.67% (is deductible operating expenditure)	N/A
Share of Production	Margin of 6.5% of gross revenue	Proportional to equity interest
Cost recovery	No set limit, done over short period (e.g. Waha is over three years)	N/A
Cost oil		Terms are negotiated. Formula utilizes production and payback factors

\* The first EPSA I agreement was signed in 1974, EPSA II in 1979, EPSA III in 1988 and EPSA IV in 2005

Source: Citi Investment Research and Analysis

**Eni, Marathon Oil and OMV have over 15% of their total production from Libya**

The companies that stand out as having a significant amount of their oil and natural production volumes exposed to high risk countries in the MENA region are Eni, BG, Apache, OMV, Nexen, Marathon Oil, Occidental, Hess, Total and Anadarko, in that order. Of these, Eni, OMV, Marathon, Occidental and Hess had significant operations in Libya prior to the civil war. In particular, Eni, Marathon and OMV stand out as companies with over 15% of their total production from Libya.

**Figure 12. Libyan oil volume exposures by company**

<i>k b/d</i>	Libyan production	Total production	% Libya
Eni	244.0	997.0	24.5%
Total	60.0	1,340.0	4.5%
Marathon	55.0	262.3	21.0%
ConocoPhillips	46.9	977.8	4.8%
OMV	29.4	173.7	16.9%
Hess	25.0	320.6	7.8%
Occidental	15.2	591.3	2.6%
Repsol	13.0	146.0	8.9%
Statoil	5.0	968.0	0.5%

Source: Citi Investment Research and Analysis estimates

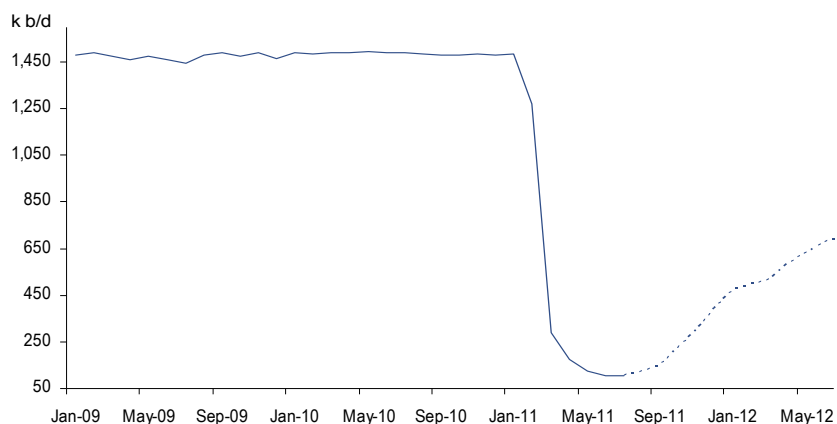
## Outlook and risks

We are cautiously optimistic about the prospects for the establishment of security and a move towards political transition in Libya, though we do not underestimate the risks. We see the return of Libyan crude sooner than markets expect, and continue to see Libya as able to produce 400-k b/d by Q1'12 and upwards of 800-k b/d by end-2012.

A quicker return to higher levels of Libyan supply is bearish on Brent prices, and should help reduce sweet-sour spreads, and perhaps even the WTI-Brent spread. Risks to the upside could transpire if the success of the rebels in Libya emboldens other uprisings in the region and if Algerian and/or Nigerian production is seen at risk.

The success of the Libyan rebels could also embolden opposition efforts elsewhere, potentially re-invigorating the ongoing anti-regime movements in Syria and Yemen. Production from these countries plays a less significant role in global balances, but given the likely continuation of protest activity in the region, geopolitical risks remain high.

**Figure 13. Libyan wellhead production should come back in fits and starts from Q3'11**



Source: EIG, Citi Investment Research and Analysis estimates



## Appendix A-1

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