Investment

in

exploration, production

and

refining

2016

G. MAISONNIER, G. HUREAU, S. SERBUTOVIEZ, C. SILVA

Economics & Technology Intelligence division

March 2017

The authors

This study has been prepared by the *Economics & Technology Intelligence division* of IFP Énergies nouvelles by:

- Guy Maisonnier: guy.maisonnier@IFPEN.fr: trends in oil and gas prices.

- **Geoffroy Hureau** - geoffroy.hureau@IFPEN.fr: investments in exploration/production.

- Sylvain Serbutoviez: sylvain.serbutoviez@IFPEN.fr: upstream activities and markets.

- Constancio Silva: constancio.silva@IFPEN.fr: investment in refining.

TABLE OF CONTENTS

1. TRENDS IN OIL AND GAS PRICES 6

1.1. IS RECOVERY IN SIGHT, OR IS ANOTHER CRISIS COMING? 6
1.2. OPEC AND SHALE OIL: AND THE WINNER IS…? 7
1.3. NATURAL GAS PRICES ARE EXPECTED TO RISE IN 2017 9

2. INVESTMENT IN EXPLORATION/PRODUCTION: IN SHARP DECLINE FOR THE SECOND CONSECUTIVE YEAR - THE FIRST TIME THIS HAS HAPPENED SINCE 1986 10

2.1. ANOTHER SHARP DECLINE IN INVESTMENT IN 2016 10
2.2. CONTRASTING TRENDS FROM REGION TO REGION 11

3. THE GLOBAL DRILLING MARKET 13

3.1. ONSHORE AND OFFSHORE DRILLING 13
3.1.1. Number of onshore wells drilled 13
3.1.2. Number of offshore wells 14
3.2. THE GLOBAL DRILLING AND SERVICES MARKET 16
3.2.1. Onshore drilling: the leading players 17
3.2.2. Offshore drilling: the leading players 18
3.2.3. Hydraulic fracturing - the leading players 18

4. GEOPHYSICAL: GLOBAL ACTIVITY AND MARKETS 19

4.1. GEOPHYSICAL ACTIVITY 20
4.1.1. Marine fleets by region 20
4.1.2. Nature of surveys 20
4.1.3. Survey prices and ship utilization rates 21
4.2. THE GLOBAL GEOPHYSICAL MARKET 21
4.2.1. Business volume and leading players 21
4.2.2. Trends in stock market prices 22

***5.* OFFSHORE CONSTRUCTION: MARKET AND BUSINESS 23**

5.1. OFFSHORE CONSTRUCTION AND SERVICES 23
5.1.1. Construction of floating platforms (FPS) 23
5.1.2. Construction of fixed platforms (all types) 24
5.1.3. Construction of drillships and platforms 24
5.1.4. Subsea construction 24
5.1.5. Offshore services 24
5.2. THE GLOBAL OFFSHORE CONSTRUCTION MARKET 25

6. A SIGNIFICANT REDUCTION IN REFINING PROJECTS (ATMOSPHERIC DISTILLATION AND CONVERSION) 27

6.1. REFINING MARGINS FALL IN 2016, BUT NO COLLAPSE 27
6.2. EXPENDITURE PEAKS IN 2016 THEN FALLS IN 2017 28
6.3. SHARP DECLINE IN PROJECTS TO EXPAND AND / OR BUILD NEW PROCESSING CAPACITY 31
6.3.1. New atmospheric distillation capacity 31
6.3.2. New conversion capacity 33
6.4. OVER-CAPACITY FALLS BETWEEN 2015 AND 2016 35
6.5. WILL INVESTMENT RECOVER AFTER 2017? 36

FIGURES AND TABLES:

Figure 1: Economic growth (left) and commodity price indexes (right)..... 6
Figure 2: Monthly and yearly prices of Brent, 2014-17 (based on futures market prices) 8
Figure 3: Trends in monthly natural gas prices, 2014-17 (based on futures markets prices) 9
Figure 4: Trends in global investment in E&P..... 10
Figure 5: Trends in E&P investment, prices and costs..... 12
Figure 6: Distribution of onshore drilling in 2016 by region (a) and growth in one year (b)..... 13
Figure 7: Number of drilling rigs in the United States active in the non-conventional sector (a) and the 4 principal fields (b) 14
Figure 8: Offshore wells sunk in 2016 by region (a) and growth in one year (b)..... 15
Figure 9: Trends in utilization rates by type of drilling equipment. 15
Figure 10: Day rates rates (000 $ per day) of semi-submersibles (a) and jackups by region (b). 16
Figure 11: Estimated share of the various segments of the global drilling market, 2016..... 17
Figure 12: Business volume (billions of $) for drilling equipment and services..... 17
Figure 13: Marine acquisition activity over a one-year period (a) and number of ships in operation (b)..... 20
Figure 14: Number of marine 2D and 3D acquisitions (a) and number of specialist acquisitions (b). 20
Figure 15: Daily prices of marine seismic survey acquisition (a) and ship utilization rates in % (b). 21
Figure 16: The global geophysical market (all segments) in billions of $. 22
Figure 17: Stock market price variations (%) of the leading geophysical contractors..... 22
Figure 18: Number of floating platforms under construction by year (a) and forecast demand up to 2020 (b)..... 23
Figure 19: Number of drilling vessels under construction by type in September 2016 (a) and the trend since 2012 (b). 24
Figure 20: Number of ships active in offshore services and the trend for 2013-16..... 25
Figure 21: The global offshore construction market in billions of $. 25
Figure 22: Refining margins (US$/b). 27
Figure 23: Global expenditure in the refining industry. 28
Figure 24: Refining projects –distillation capacity by geographical region (2009-2016), in kb/d..... 31
Figure 25: Refinery construction cost index..... 32
Figure 26: Cumulative additional atmospheric distillation capacity by type of expansion (kb/d). 32
Figure 27: Global project postponements, atmospheric distillation and conversion..... 33
Figure 28: Refining projects – conversion capacity by geographical region, in kb/d..... 33
Figure 29: Conversion capacity by type of unit in 2016. 34
Figure 30: Conversion capacity by type of unit – trends 2014-16 (kb/d). 34
Figure 31: Breakdown by type of project: distillation/conversion, kb/d. 35
Figure 32: Global medium-term trends in refining capacity and demand..... 35

Table 1: Estimated market share and trends in business volume in 2016 for the leading players in the onshore drilling sector..... 18
Table 2: Estimated market share and trends in business volume 2016 for the leading offshore drilling companies. . 18
Table 3: Estimated market share and trends in business volume 2016 for the leading hydraulic fracturing companies. 19
Table 4: 2015 and 2016 revenue by the 8 leading contractors, market share. 22
Table 5: Estimated market share by company, 2016. 26
Table 6: Planned closures of atmospheric distillation plants in the medium term: the situation in 2016..... 32
Table 7: Principal projects with refining capacity of 150 kb/d or higher. 33
Table 8: Principal conversion projects with capacity of 80 kb/d or higher. 34

SUMMARY TABLE OF INVESTMENTS AND MARKETS: (2015 and 2016)

$ billion	2015	2016
Global investments in E&P	**518**	**394**
North America	133	84
Latin America	70	46
Europe	46	36
CIS	45	42
Africa	59	44
Middle East	58	57
Asia-Pacific	107	86
Upstream markets analyzed	**263**	**176**
Geophysical market	11	7
Drilling market (*)	197	127
including:		
Onshore drilling	*23*	*14*
Offshore drilling	*55*	*40*
Offshore construction market	55	52
Investment in refining	**93**	**97**
Investment spending	32	32
Maintenance spending	39	42
Spending on catalysts and chemical products	22	23

(*) Including well services and equipment

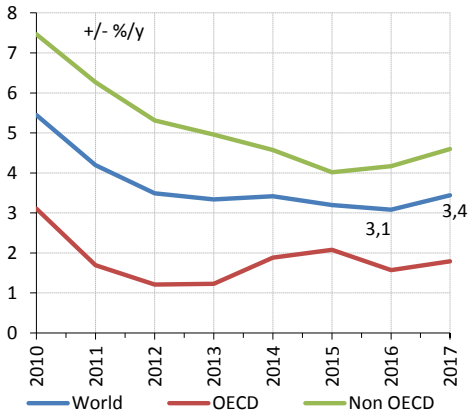
Sources:
- Upstream oil sector, IFPEN based on data from:
  - global investments: Barclay's, DTI, NPD, DEA, figures published by various companies and countries, IFPEN forecasts.
  - geophysical market: IHS Energy, First Break, Spears & Associates, IFPEN.
  - drilling market: Baker Hughes, IHS Energy, Offshore Rig Locator, Spears & Associates, IFPEN.
  - offshore construction market: IHS Energy, Spears & Associates, IFPEN.
- Downstream oil sector: IFPEN based on HPI Market Data, IFPEN forecasts

1. Trends in oil and gas prices

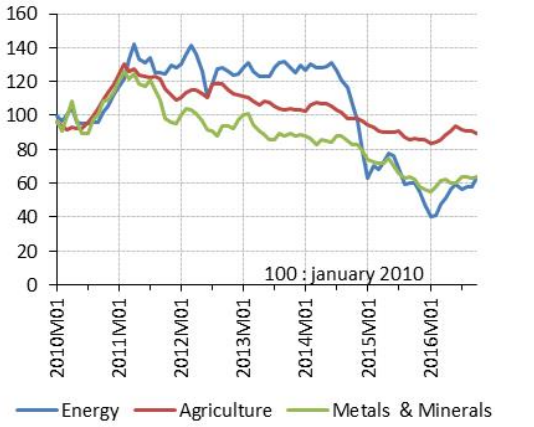
1.1. Is recovery in sight, or is another crisis coming?

After the mini-crisis of early 2016 triggered by concerns over the realities of economic growth in China, several signs give cause for cautious optimism on the world economy. The IMF estimates world growth of 3.4% in 2017, which is higher than the growth recorded in 2016 (3.1%). After dropping steadily since 2011 and nose-diving in 2014, commodity prices - and energy prices in particular – look to have bottomed out in 2016. A sign, perhaps, that a more sustained upturn is in the offing.

Figure 1: Economic growth (left) and commodity price indexes (right)



Source: IMF, January 2017



Source: World Bank, November 2016

However, major economic organizations including the World Bank[1], the IMF[2] and the OECD[3] have stressed the fragility of recent growth. Financial and monetary risks give cause for concern, and this concern is exacerbated by geopolitical instability - as well as instability in the global banking sector. On the political front, a new US president took office in January 2017 and some major elections and events are looming in Europe, Iran and China (with the upcoming 19th National Congress of the Chinese Communist Party).

The challenges facing the oil industry - and the energy market in general - are many. The level of economic growth determines the demand for energy. And demand for natural gas, which is in turn driven by the demand for electricity, is more affected by these variations than demand for oil. If historical trends are anything to go by, global demand for oil grows by around 1%, or 1 Mb/day, when economic growth is 3%, which is closed to the rate predicted by the IMF for 2017.

The stock markets also have an influence on the oil market, especially during periods with strong downward trends. This was the case in January 2016 for example, when stock and oil prices fell simultaneously on the back of growing concerns about the Chinese economy.

Changes in the dollar exchange rate can also affect oil prices: a stronger dollar generally means lower oil prices. But the correlation is neither permanent nor perfect. Recent trends in oil prices are above all a reflection of equilibrium on the oil market, not changes in the price of the dollar.

[1] Global Economic Prospects – World Bank, January 2017
[2] World Economic Outlook Report – IMF, January 2017
[3] Global Economic Outlook – OECD, November 2016

Political change can also influence the market, especially in the United States, where energy independence is apparently becoming a priority. North American fossil fuels, including oil and natural gas, can be expected to benefit from this new orientation, even if competitiveness will remain the prime driver of growth of this market.

On the geopolitical level, US sanctions against Iran (Iran Sanction Act - ISA, 1996) were extended by 10 years in December 2016, and there is now talk of new sanctions.

We should also remember the real or potential influence of geopolitical instability on oil prices, especially in the major oil-producing regions of North Africa and the Middle East.

1.2. OPEC and shale oil: and the winner is…?

As in the past, the parameters mentioned above are all likely to influence oil prices, to a greater or lesser extent, and for longer or shorter periods. But ultimately it is market forces - the equilibrium of demand and supply, and production costs - which will determine the future trend in oil prices. To plot this trend, we basically have to answer three questions:

- Will there be a reduction in excess production in the oil market?
- If this is the case, what price will ensure development of the new oil production units needed to balance the market in the medium term?
- What factors threaten to distort the price reached with this new equilibrium?

On the first point, analysis of supply/demand imbalances based on figures from three sources (IEA, EIA and OPEC[4]) points to the same trend: the market is emerging from the situation of surplus supply which marked the 2014-16 period and will gradually reach equilibrium during 2017. This means a considerable easing of the downward pressure on oil prices relative to recent trends.

In a context marked by excess supply, prices will normally fall in proportions sufficient to rekindle demand, and supply restricted to restore market equilibrium. This is what happened first in late 2014, then in 2015 (when the average price was $52 per barrel) when the lifting of the embargo on Iran seemed imminent. The downward trend was aggravated by fears over the Chinese economy early in 2016, with prices dropping to $30 per barrel in January of that year.

Prices recovered to around $40-50 per barrel in the second quarter as the prospects for market equilibrium improved. With the OPEC/non-OPEC agreements of November 30 and December 10, prices had risen above $50 by the end of the year. This increase brought the average price for 2016 to $44 per barrel.

Under the aforementioned agreement, production by OPEC countries was to be reduced by 1.2 Mb/day in the six-month period commencing on January 1 2017, with non-OPEC countries (including Russia) reducing their production by 0.6 Mb/day over the same period. Assuming the agreement is fully respected, which was broadly the case in January, the mean shortfall of supply relative to demand will stabilize at around 1 Mb/day in 2017, compared with a slight surplus had OPEC production simply been frozen at the October 2016 level. Exactly how much pressure is brought to bear on prices therefore depends on the extent to which the OPEC agreement is implemented.

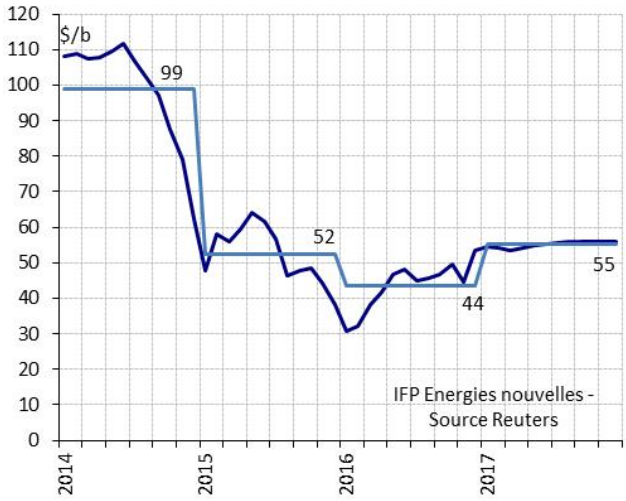
Nevertheless, these volumes are well below the levels reached in 2015, when supply outstripped demand by 1.5 Mb/day. The answer to our first question, therefore, is yes: market surplus will drop in 2017, and we can even envisage a significant deficit.

[4]IEA: International Energy Agency; EIA: Energy Information Administration; OPEC: Organization of Petroleum Exporting Countries.

If excess supply does drop, oil prices should reach a new benchmark. New investment will be required to balance the market after the fall-off in investment during 2015 and 2016. Analysis of production costs suggests that oil prices may level out between $50 and $60 per barrel. This spread would favor American production of shale oil and would also make the development of Middle Eastern onshore fields, particularly in Iraq, viable.

Given the global financial and political situation, however, it is quite possible that crude prices stray outside the equilibrium zone. Uncertainties about demand will also affect the price, along with level of production in the US. Finally, the extent to which the OPEC/non-OPEC agreement is respected will place varying degrees of pressure on prices. We should remain cautious, therefore, about future trends.

Figure 2: Monthly and yearly prices of Brent, 2014-17 (based on futures market prices[5])



The scale of recovery of American production will be a determining factor. If shale oil production increases rapidly, a return to the 2015 scenario with high surpluses cannot be ruled out in the longer term. Renewed drilling operations in the US lend weight to this possibility.

The OPEC/non-OPEC agreement: the verdict as of late February 2017

Brent prices have remained within the range of $50-56 per barrel since the start of 2017. This trend has been driven by the OPEC/non-OPEC agreement, whose compliance rate for the month of January was estimated at 86% in the report published by the monitoring commission. The challenge now is to reduce the huge oil stocks held by the Western countries. This issue will be well to the fore in the approaching OPEC discussions on extending the agreement to December. Iran has expressed fears concerning the continuation of this policy for boosting prices. As for Iraq, the Iraqi prime minister has called for increased pressure on the market to lift prices to $60 per barrel, which the country needs if it is to balance its budget. A way must be found to reconcile these diverging analyses, which threaten to open ever-wider breaches in the unity of OPEC.

[5]Prices and advance payments for 2017 are estimated at the end of January.

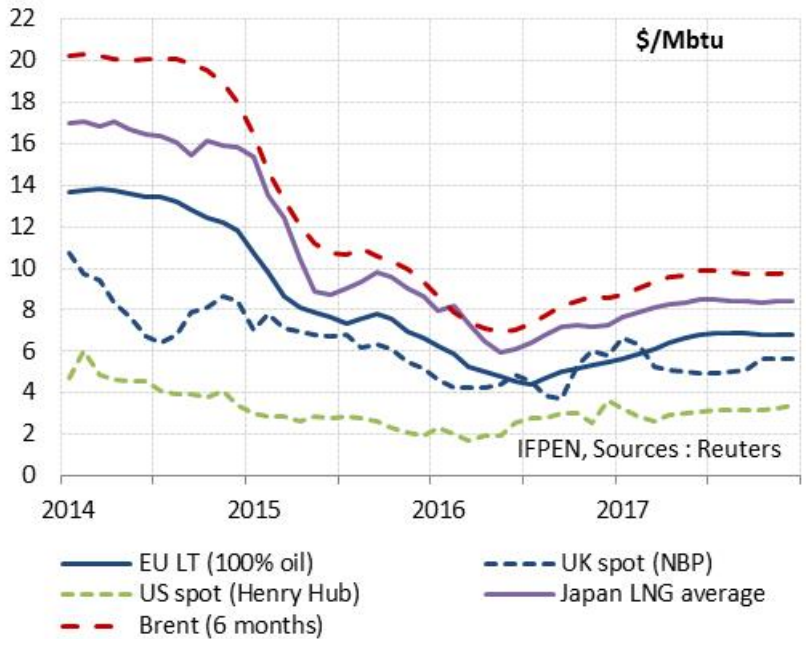
1.3. Natural gas prices are expected to rise in 2017

Regional gas prices are determined by a wide array of factors. Economic growth, oil, coal and CO2 prices, the health of the LNG market, production costs, and the contribution of renewable and nuclear energy to electricity production are just some of the factors affecting gas prices. Severe winter weather conditions not only affect price levels, but also price volatility, as was the case in 2016.

Globally, 2016 saw a significant drop in gas prices in all regions of the world:

- In Europe, oil-indexed futures contracts and spot prices fell by 36% and 29% respectively to settle at $5.2 and $4.7/MBtu.
- In Japan, the average import price fell by 32% to $7.0/MBtu. Spot prices fell in similar proportion, to $5.6/MBtu.
- In the United States, the drop was less severe, at 4%. The reason for this was that average prices were already extremely low at just $2.5/MBtu. That is a half and one third of European and Asian prices, respectively.

Figure 3: Trends in monthly natural gas prices, 2014-17 (based on futures markets prices)



In 2017, several factors are expected to drive a significant increase in the price of natural gas. In Europe, gas is more competitive than coal and this fact will continue to drive consumption as it did in 2016. In Asia, the increase in oil prices will affect the price of futures contracts, which are largely oil-indexed. Spot prices may fare better if the predicted LNG surplus proves to be a reality: but on the strength of the evidence so far this year, this remains to be seen. In the United States, prices are expected to rise significantly as the market reaches equilibrium.

In 2017 as a whole, natural gas prices are expected to rise by 20-25% in Asia, 30-35% in Europe and 30-35% in the United States. But that is still fairly low compared to the prices on offer in the 2010-14 period.

2. Investment in exploration/production: in sharp decline for the second consecutive year - the first time this has happened since 1986

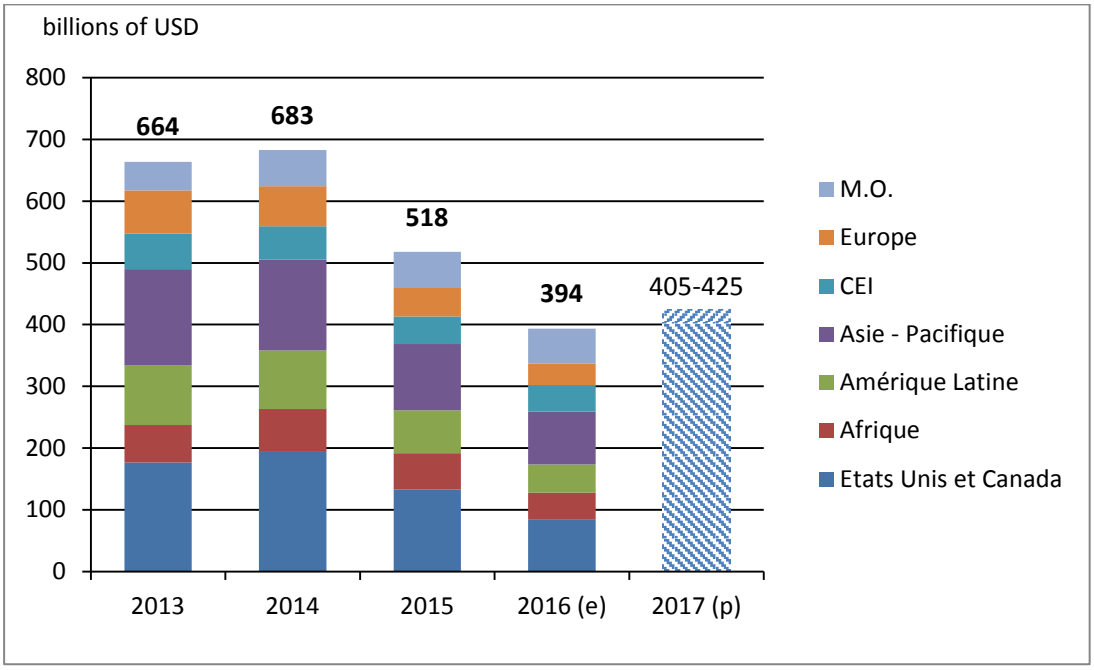
Investment in exploration and production peaked in 2015, with 2016 confirming the downward trend as oil and gas prices remained very low. Global investment in upstream oil and gas in 2016 is estimated at around 394 billion dollars - the lowest since 2007 and a reduction of 124 billion dollars relative to 2015. Not only this, but the drop in investment costs as measured by the UCCI[6] (IHS-CERA index) continued in 2016, although not as steeply as in 2015 (-10% against -20%).

2.1. Another sharp decline in investment in 2016

2015 saw a reversal in investment trends in upstream oil, marking the end of an upward cycle that had lasted for over a decade with a downturn of 25%. This trend was confirmed in 2016, with a new downturn estimated at 24%. In two years, therefore, investment has fallen by 42%: not since 1986 have we seen such a significant decline over two consecutive years.

Back then, investment slumped by 44% in the space of three years (1985 to 1987). The nadir came in 1986, with investment falling by 30%: the downturn was considerably less severe in 1985 (-8%) and 1987 (-13%). Another notable difference is that the mid-80s slump came after a period during which investment had stagnated: while the current trend follows years of sustained growth (+500% between 1999 and 2014!).

Figure 4: Trends in global investment in E&P



Sources: Barclay's, DTI, NPD, DEA, figures published by various companies and countries, IFPEN forecasts.

Again this year, the fall in investment has been especially pronounced among the independents, whose budgets fell by 34% compared with 26% for the majors, and only 14% for national companies (NOC). At regional level, the Middle East and CIS have been relatively spared, with investment expected to contract by 3% and 6% respectively. Investment in the Middle East is driven by NOCs, which represent over 70% of the expenditure in the region: a budget which on the whole has

[6] Upstream Capital Cost Index

remained at 2015 levels. The Americas have been harder hit, with investment falling by 37% (North America) and 34% (Latin America). Regions experiencing a broadly average decline in investment were Asia-Pacific (-20 %), Europe (-22%) and Africa (-25 %).

The volatility and uncertainty surrounding oil prices make it difficult predict levels of investment in 2017. If the price of a barrel remains between 50 and 60 dollars, however, exploration/production budgets may rise by between 3% and 8%. This increase would principally occur in North America, where some forecasts predict investment to leap by nearly 25%, driven mainly by the American independents. Outside of North America, we can expect a degree of stability. Increased investment by national oil companies will likely be offset by the continued decline in investment by the majors and by independents, whose primary objective is to restore their margins.

2.2. Contrasting trends from region to region

Significant falls in investment have affected every region in the world with the exception of the Middle East and CIS.

In North America, persistently low oil prices (lower on annual average than 2015) have once again penalized investment, which fell by over 30% for the second consecutive year. However, the gradual increase in the price of WTI over the course of the year, after reaching a low in January 2016, together with the fall in drilling costs, have resulted in an increase in the number of onshore drilling platforms in the United States in Q2, after 18 months of steady decline. This trend is expected to continue in 2017, with a consequent rise in investment and production in this region.

In Latin America, investment has been doubly penalized by generally high production costs in combination with parlous economic conditions, which have been exacerbated by the Petrobras scandal, the economic crisis in Brazil, and the meltdown in Venezuela. In Mexico, PEMEX is running at a loss and heavily in debt, and has reduced its investment budget by almost 20%. The cuts were even more drastic in Colombia, where the national oil company Ecopetrol slashed its budget by 60% relative to 2015.

In Europe, investment has fallen by just 14% by dollar in Norway (-11% in Norwegian krone) and 34% in the United Kingdom, although accentuated in the latter case by the fall in the value of the pound against the dollar (-11% in 2015). The outlook for 2017 is hardly encouraging, with a further contraction of 14% in E&P budgets expected in Norway. After peaking in 2014, investment in the British North Sea has entered terminal decline as reserves approach exhaustion.

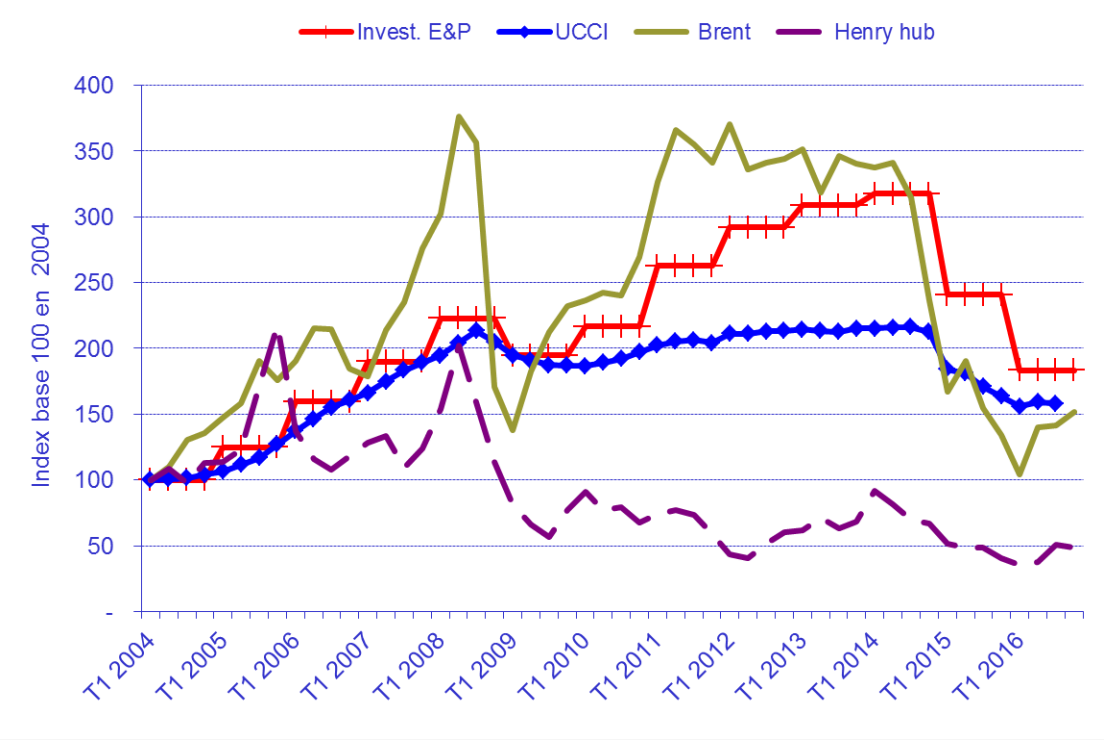
In Africa, investment has fallen by 25%. The decline is particularly severe in sub-Saharan Africa, and especially in Nigeria where investment by the NNPC has fallen by 42% relative to the previous year. Exploration budgets have been badly hit, falling by over 60%. Recovery is expected in 2017, with several projects in the offing, notably the LNG development projects in Mozambique (Coral FLNG) and Equatorial Guinea (Fortuna FLNG).

Investment in the Asia-Pacific region has been hit by the postponement or cancellation of many projects, although the fall in expenditure has been offset by the increasing costs of Australian LNG projects. Globally speaking, exploration and production budgets are 20 billion dollars lower than 2015, with particularly severe cuts by Petronas (down $3b), Petrochina (down $2.3b) and Petrovietnam (down $2.2b – that's a fourfold contraction relative to the 2015 budget!).

In the CIS, the fall in investment has been relatively mild (about -6%), mainly due to a 33% increase in exploration-production expenditure by Rosneft. Gazprom and Lukoil have continued to reduce their budgets. Russian companies have benefitted from the fall in the price of the ruble against the dollar, which has driven a rise in investment of 15% in ruble terms, bringing oil production to its highest levels in the post-Soviet era.

In a difficult context, the Middle Eastern NOCs have largely maintained, or even slightly increased, their levels of investment: +4% for Saudi Aramco and KOC (Kuwait), and +9% for PDO (Oman). Investment by Qatar Petroleum remains stable, and is slightly down (4%) for ADNOC (Abu Dhabi). At the regional level, investment is estimated to have fallen slightly (around 3%) due to falling expenditure by majors and independents.

Figure 5: Trends in E&P investment, prices and costs



3. The global drilling market

In 2016, the number of wells sunk worldwide is expected to fall by 30% for the second consecutive year, bringing the total number of wells to 50,000: half as many as there were in 2014. Around 2700 of these wells are offshore, i.e. 5% of the total number of wells sunk in 2016.

The reduction in onshore drilling has been particularly severe in the United States. In two years, the number of non-conventional wells has fallen threefold.

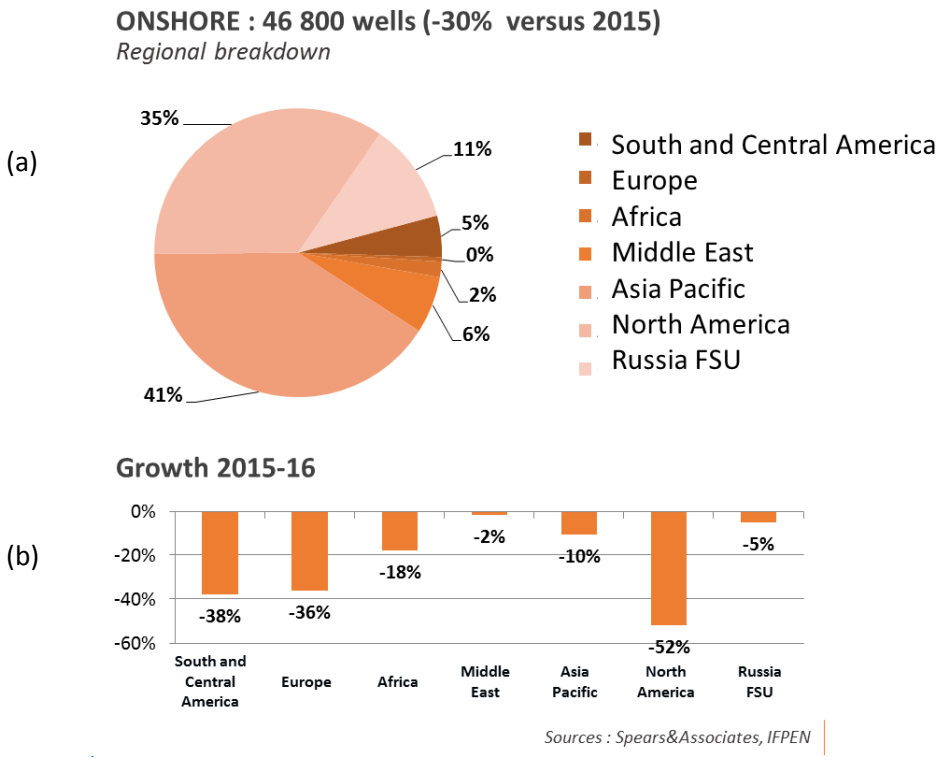
This fall in drilling and the market for related services is unprecedented. The global market for drilling and related services is expected to fall by 36% in 2016.

3.1. Onshore and offshore drilling

3.1.1. Number of onshore wells drilled

Global onshore drilling activity continued to fall in 2016, especially in North America (-52%), South America (-38%) and Europe (-36%). The Middle East was the only region to remain relatively stable (-2%). Onshore drilling has held up relatively well in the CIS (-5%) despite the international embargo; it fell in Asia Pacific (-10%) and Africa (-18%).

Figure 6: Distribution of onshore drilling in 2016 by region (a) and growth in one year (b).

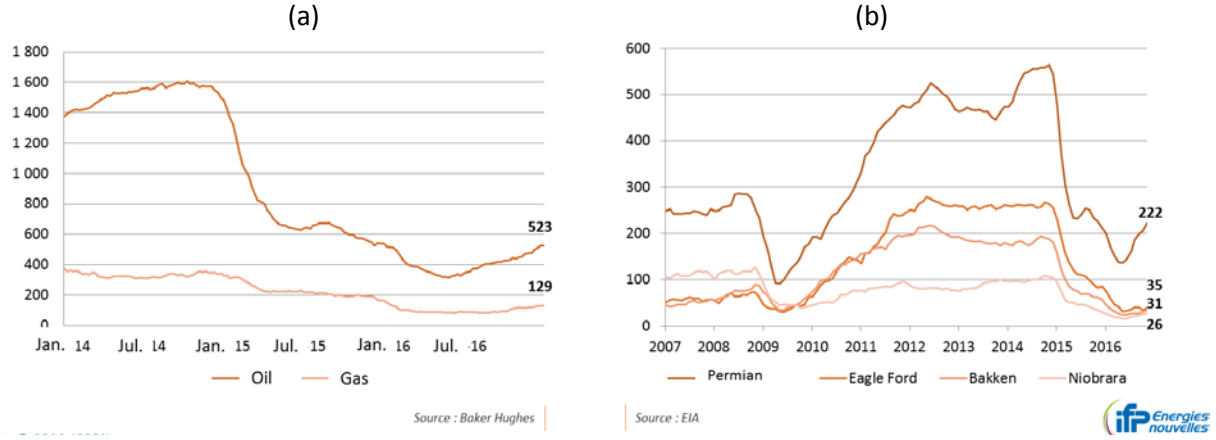


- **American shale oil and gas**

In the United States, falling oil prices over the last two years have been accompanied by a drastic reduction in the number of drilling rigs in operation for the exploration and extraction of shale oil and gas. Thanks to an improvement in the productivity of these wells, however, production of shale oil fell by just 1 Mb/day from its peak in March 2015, levelling out at 4.5 Mb/day by the end of 2016.

Four fields account for 80% of all drilling activity: the Permian Basin, the Eagle Ford group, and the Bakken and Niobrara formations. Compared with the peak of October 2014, the number of drilling rigs active in the shale oil and gas sector fell by 75%: that's around 1000 fewer active rigs than October 2014. Note however a recovery of 30% in the number of active rigs in the Permian Basin since May 2016. This recovery in drilling mainly concerns oil wells.

Figure 7: Number of drilling rigs in the United States active in the non-conventional sector (a) and the 4 principal fields (b)



Some 7000 non-conventional wells were drilled in the United States in 2016. There are approximately 5000 DUC (Drilled, Un-Completed) wells in the United States. The number of DUC oil wells has more than doubled since 2013 and now stands at 4000, which could allow a rapid take-off in the production of American shale oil.

- **Onshore rig leasing rates**

By mid-2016, international and Canadian leasing rates had stabilized with growth of 3% in a one-year period. In the United States, where drilling activity has been falling, onshore rig leasing rates have been falling by 8% per year.

3.1.2. Number of offshore wells

The drilling equipment fleet continues to grow as new rigs continue to appear on the market, while the rate at which old rigs are being scrapped is insufficient to put the market on an even keel. Rig utilization rates are in sharp decline, as are daily leasing rates.

On certain platforms, daily leasing rates are now lower than operating costs, and look unlikely to fall further. But there are still many platforms operating at the high rates negotiated between 2011 and 2013; these platforms can expect their rates to be adjusted downward if drilling contractors want to avoid the early termination of their contracts.

- **Number of offshore wells**

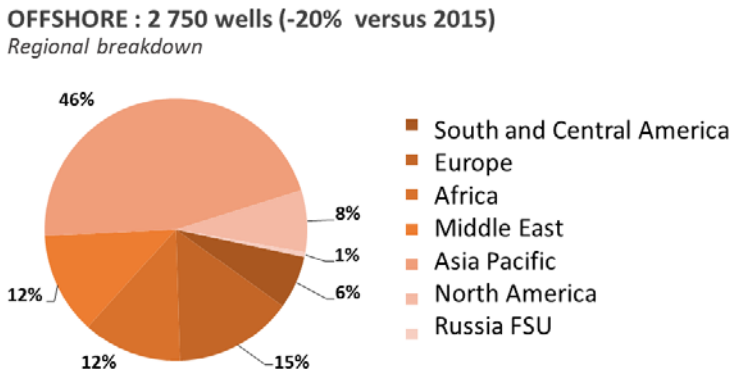
The falling price of crude has led to a fall in the number of offshore and development operations, especially in deepwater (over 1500 m) locations. The number of offshore drilling operations was expected to bottom out in 2016 at 2700 wells, a reduction of 20% against the previous year.

Activity was down in all regions in 2016, except for the Middle East, where it is expected to remain stable. The reduction has been particularly severe in South America (-40%) with the slowdown of offshore activity in Brazil and the financial tribulations of Petrobras. Offshore drilling in North

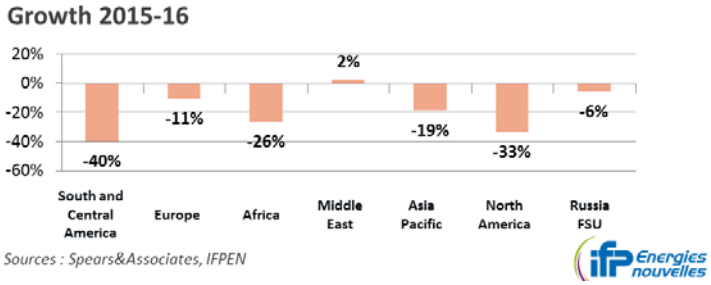
America (Gulf of Mexico) and Africa (Gulf of Guinea) fell by 33% and 26% over the course of one year, respectively.

Figure 8: Offshore wells sunk in 2016 by region (a) and growth in one year (b).

(a)



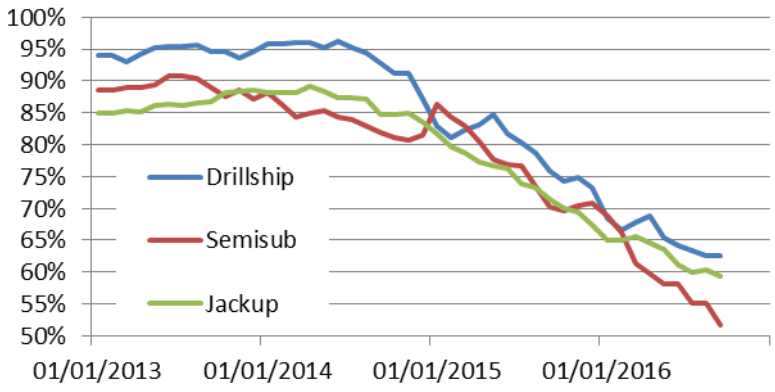
(b)



- **Offshore drilling rig utilization rates**

The utilization rate of the world offshore drilling fleet reached a record low in September 2016, at just 62% for drillships, 51% for semi-submersibles and 59% for jackups. All of these rates were above 85% in 2014. Rates have been in steady decline since the end of 2014.

Figure 9: *Trends in utilization rates by type of drilling equipment.*



Source: IHS Petrodata and IFPEN

- **Offshore drilling rig leasing rates**

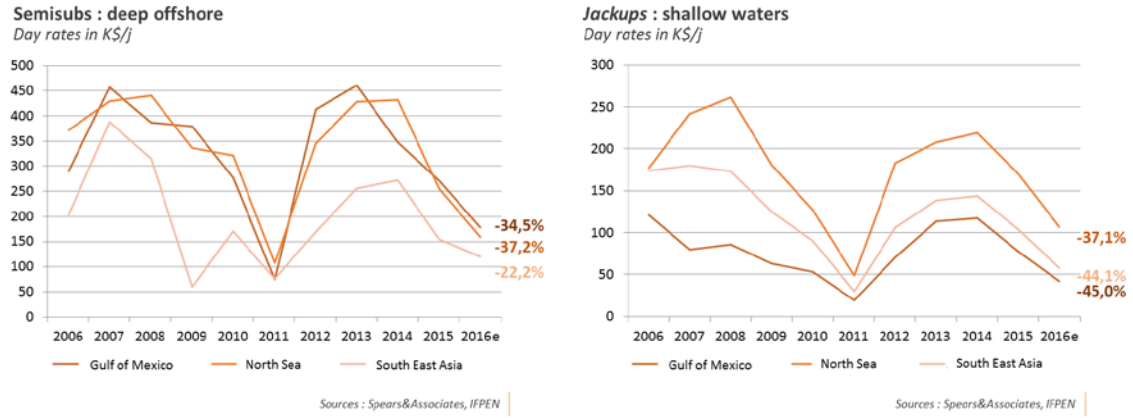
Leasing rates fell across the board in 2016 just as they had in 2015, for all regions and all types of rig. (2016 estimates are based on data for the first eight months of the year.)

Semi-submersible leasing rates fell by 34% in the Gulf of Mexico and 37% in the North Sea. Rates fell less severely in South East Asia (-22%).

The drop in rates for jackup rigs was more pronounced: 44% in South East Asia, 45% in the Gulf of Mexico and 37% in the North Sea.

Figure 10: *Day rates rates (000 $ per day) of semi-submersibles (a) and jackups by region (b).*

(a) (b)



Many rigs entered construction in 2014, when the price of a barrel of oil was at least twice as high as it is today. Even allowing for the drop-off in new-builds over the last 2 years, new equipment was still arriving on the market in late 2016. The result? Overcapacity.

3.2. The global drilling and services market

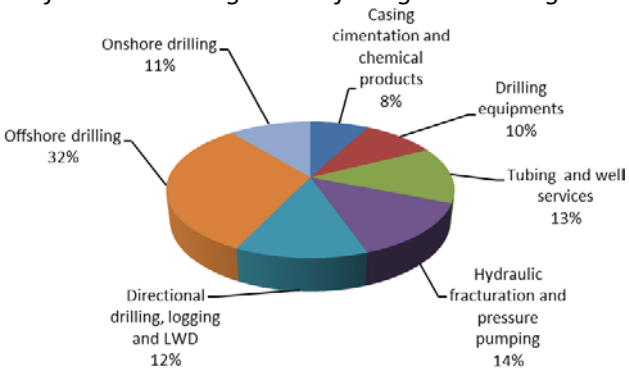
The global drilling and related services market is estimated to have been worth $127b in 2016. After falling by 30% in 2015, current estimates put the decline at 36% in 2016. As a reminder, this market reached a record high of $280b in 2014; in the two years since then, its value has more than halved. All players in the sector have been affected.

The decline in offshore drilling grew more severe in 2016 (-27%), but not as severely as onshore drilling (-39%). The global reduction in the fracking business (-39%) is comparable with the decline in onshore drilling, and is related with the drop in the non-conventional fossil fuels market in the United States.

The sharpest decline was in drilling equipment and products (drilling tools, cementation and chemical products), which has lost 47% of its value. This market has lost half its value in one year, and two thirds of its value in two years.

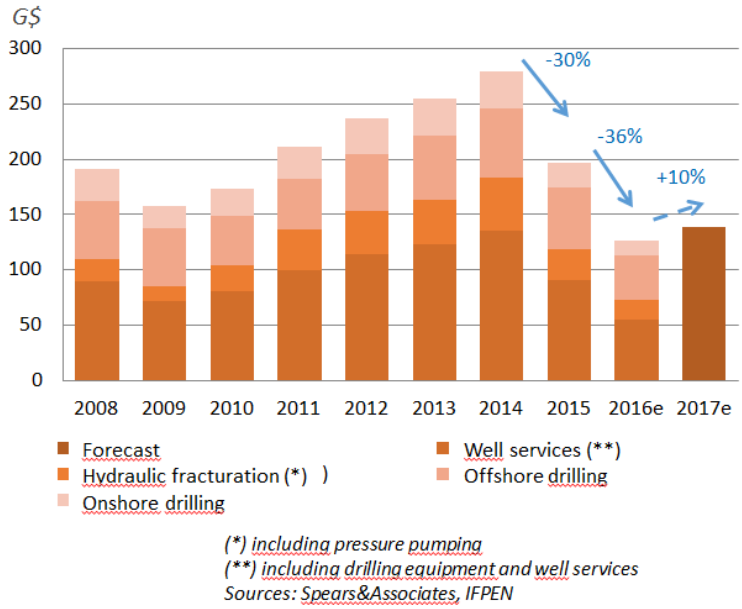
A similar trend can be observed in the well logging and directional drilling market (-37%); the same goes for the casing and well completion market. Certain operators in the non-conventional fossil fuel fields in the United States are continuing to drill but, to reduce their costs, do not complete their wells.

Figure 11: *Estimated share of the various segments of the global drilling market, 2016.*



Sources: Spears & Associates, IFPEN

Figure 12: *Business volume (billions of $) for drilling equipment and services.*



Spears & Associates forecast a recovery in the order of 10% in the market in 2017, in line with the upturn in drilling operations in the Permian Basin already underway by May 2016, and the increase in the price of oil to over $50 a barrel in December 2016.

3.2.1. Onshore drilling: the leading players

8 major groups account for 52% of the 14-billion dollar onshore drilling sector. The leader is Nabors Industries with 11% of market share, closely followed by Helmerich & Payne (10%). Eurasia Drilling is in third position with 8% market share.

In 4th, 5th and 6th places come Saipem, Precision Drilling and Schlumberger, all three with 4-5% market share. KCA Deutag and Patterson-UTI occupy 7th and 8th places, respectively.

Most companies recorded a reduction in business in the order of 40-50% in 2016. Only Eurasia Drilling, Saipem and KCA Deutag faired slightly better, with reductions of 13%, 23% and 4% respectively.

Table 1: Estimated market share and trends in business volume in 2016 for the leading players in the onshore drilling sector.

Onshore drilling	Estimated market share 2016	cumulative share	Growth %
Nabors Industries	11%	11%	-41%
Helmerich & Payne	10%	22%	-40%
Eurasia Drilling Co.	8%	30%	-13%
Saipem SPA	4.7%	35%	-23%
Precision Drilling	4.6%	39%	-41%
Schlumberger	4.4%	44%	-39%
KCA Deutag	4.1%	48%	-4%
Patterson-UTI	3.8%	52%	-54%

Sources: IFPEN, Spears & Associates

3.2.2. Offshore drilling: the leading players

Half of the 40-billion dollar offshore drilling market is held by 8 major companies. The leader is Transocean, with some 9% of the global market. Transocean is only just ahead of its nearest competitors, Seadill and ENSCO, each with nearly 8% of the market.

They're followed in descending order of share by Noble Drilling, Rowan Companies, Maersk Group, Ocean Rig and Diamond Offshore, who hold between 4 and 6% of the market.

Of these leading 8 companies, only Ocean Rig is expected to post a growth in business (+4%) for 2016. Rowan Companies (-8%) and Maersk Group (-7%) are holding up fairly well. But with a 45% slump in its business, Transocean's drilling operations will have nearly halved over the course of a year. The companies occupying second, third and fourth places are expected to report a loss of business in the order of 20%.

Table 2: Estimated market share and trends in business volume 2016 for the leading offshore drilling companies.

Offshore drilling	Estimated market share 2016	cumulative share	Growth %
Transocean, Inc.	9.2%	9.2%	-45%
Seadrill	8.4%	17.6%	-22%
ENSCO	7.6%	25.2%	-24%
Noble Drilling	6.6%	31.8%	-18%
Rowan Companies	4.9%	36.7%	-8%
Maersk Group	4.6%	41.3%	-7%
Rig ocean	4.5%	45.8%	4%
Diamond Offshore	3.9%	49.7%	-35%

Sources: IFPEN, Spears & Associates

3.2.3. Hydraulic fracturing - the leading players

The hydraulic fracturing segment is dominated by even fewer players than offshore and onshore drilling. In 2016, 8 companies accounted for 80% of the hydraulic fracturing market. Halliburton, Schlumberger and Baker Hughes together account for 2/3 of global business. Other players - FTS International, Weatherford, Calfrac Well Services - hold less than 4% of the market.

Global business in this segment has fallen dramatically (-39%) with the reduction in non-conventional drilling in the United States for the second consecutive year. Companies have seen their revenues fall by 30 to 60%.

Table 3: Estimated market share and trends in business volume 2016 for the leading hydraulic fracturing companies.

Hydraulic fracturing	Estimated market share 2016	cumulative share	Growth %
Halliburton	31%	31%	-33%
Schlumberger	24%	55%	-30%
Baker Hughes	9%	64%	-49%
FTS International	3.4%	67%	-60%
Weatherford	3.2%	70%	-44%
Calfrac Well Ltd Services.	3.0%	73%	-59%
C&J Energy Services	2.8%	76%	-60%
RPC	2.2%	78%	-54%
Patterson-UTI Energy	2.2%	80%	-54%

Sources: IFPEN, Spears & Associates

4. Geophysical: global activity and markets

With exploration budgets falling for the last two years, all segments of the geophysical sector (acquisition and processing of data, geosciences, equipment) have been hit. The global market is expected to shrink by 35% in 2016, with the sector worth a little over $7b worldwide.

Although the fleet is at an all-time low after the scrapping of older ships, the utilization rate of the surviving ships has fallen to a historic low of just 30% after stabilizing in mid-2016.

Orders have fallen in 2017, despite very low acquisition prices. Given the low number of contract purchases, the marine fleet is principally dedicated to multiclient surveys.

To keep ships and crews in work, the companies operating in the geophysical sector have decided to step up their multiclient acquisition activity. This type of service partially offsets the under-utilization of the ships. In 2016, the market for multiclient acquisitions in the oil and gas sector was strong, but it has also become very competitive.

After holding up well in 2015, the geoscientific surveys sector (reservoir analysis, imaging etc.) is now experiencing a significant increase in competition.

In the equipment sales market, the context does not yet favor the renewal of hardware. Equipment manufacturers are making sporadic sales and surviving on income from maintenance operations on existing equipment.

The financial situation is difficult for many contractors (bankruptcies, capital increases, debt restructuring) and cuts in workforces are continuing. In the stock markets, contractors' share prices have stagnated at an extremely low level.

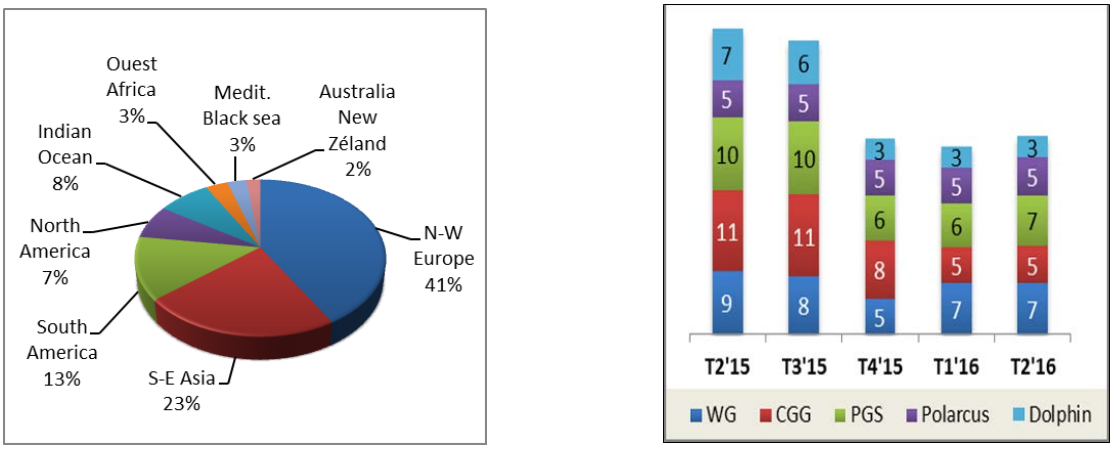
4.1. Geophysical activity

4.1.1. Marine fleets by region

Company fleets have not grown since the end of 2015, with only PGS buying a new ship. By mid-2016, most activity was located in the three major regions which account for around 80% of marine seismic research. The leading region is Northwest Europe (41%) with the North Sea, then Southeast Asia (23%) and South America (13%).

Figure 13: *Marine acquisition activity over a one-year period (a) and number of ships in operation (b).*

(a) *(b)*



Sources: IHS and IFPEN

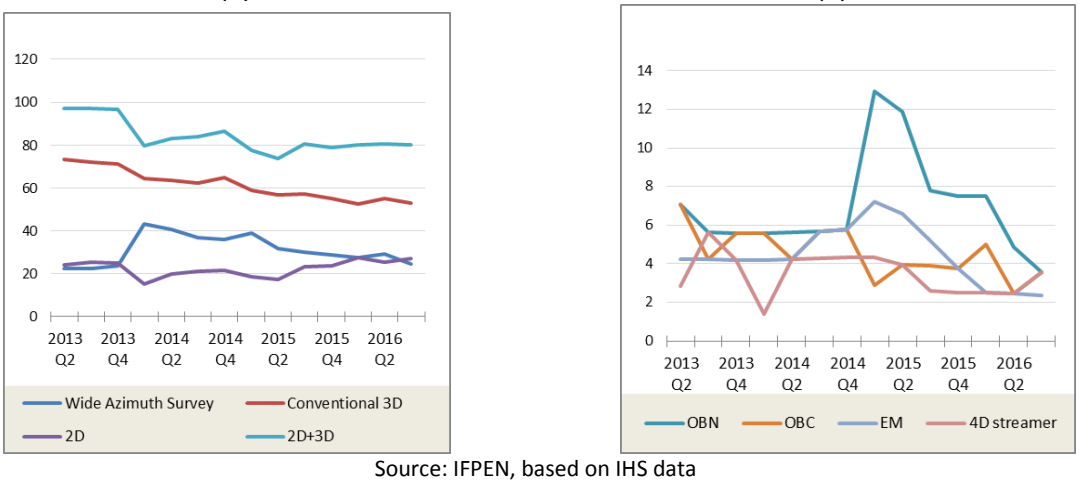
Year-end to year-end, the fall in activity on a global level is just 10%. The regions recording the most severe drops were North America with the Gulf of Mexico (-60%), West Africa with the Gulf of Guinea (-50%), the Middle East (-60%) and Australia (-44%). These reductions were partially offset by growth in Latin America (+35 %) and Northwest Europe (+22 %). The other regions remained more or less stable.

4.1.2. Nature of surveys

In the 3rd quarter of 2016, the number of conventional 3D surveys had fallen by 7% globally in comparison with the same period in 2015. Wide azimuth surveys fell by 17%. Only in the 2D sector did the number of surveys increase, by 16%. 3D acquisition has lost ground to 2D, which is less costly.

Figure 14: Number of marine 2D and 3D acquisitions (a) and number of specialist acquisitions (b).

(a) *(b)*



Source: IFPEN, based on IHS data

Over a one-year period, the number of specialist acquisitions (e.g. Ocean Bottom Cable (OBC) and 4D seismic) has stabilized. In the same period, however, the number of Ocean Bottom Nodes (OBN) and ElectroMagnetic (EM) surveys fell by half.

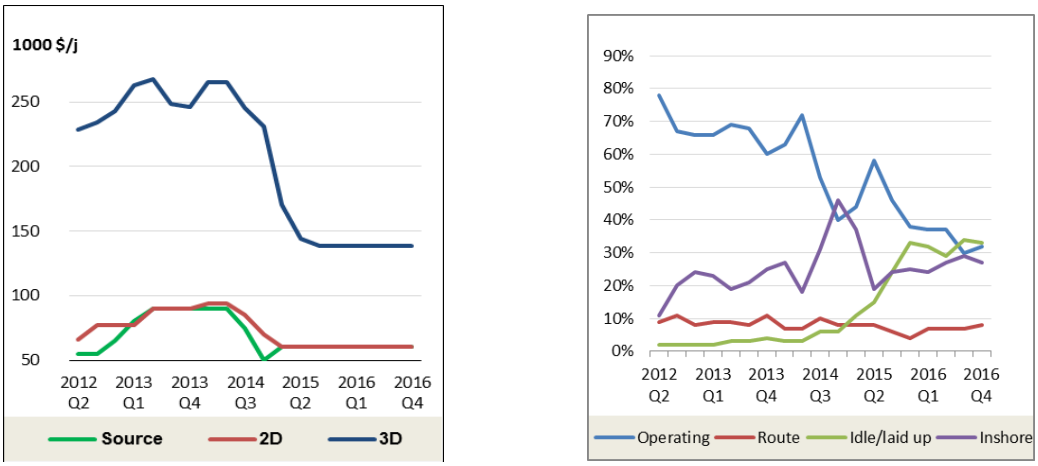
4.1.3. Survey prices and ship utilization rates

Acquisition prices remain desperately low: they have failed to rise since late 2015, despite the reduction in the global fleet. Contractors' margins are practically nil. The price of a 2D acquisition survey ranges between $55,000 and $60,000 per day. Prices for 3D surveys are between $100,000 and $200,000 per day, depending on the acquisition configuration. Prices do seem to have bottomed out.

After levelling out in mid-2016, ship utilization rates have fallen to just 30%. Numbers of laid-up and inshore ships have increased by 29% and 34% respectively.

Figure 15: Daily prices of marine seismic survey acquisition (a) and ship utilization rates in % (b).

(a) (b)



Sources: IFPEN, based on IHS data

4.2. The global geophysical market

4.2.1. Business volume and leading players

The fall in global business in 2016 is expected to be worse (35%) than initially forecast. As a reminder, in 2015 the global geophysical market (all segments) had fallen to 11 billion dollars, a reduction of 31% relative to 2014. The revenues of the 8 leading companies had fallen by between 21% and 46% by the close of 2016.

The equipment sector has been hit especially hard, falling by around 40% globally in 2016.

The leading player, WesternGeco, has a 30% share of the market. In 2nd and 3rd places, CGG and PGS account for respectively 19% and 9% of the market. Landmark, which concentrates exclusively on software, has a market share of 6%, as does TGS.

By the end of 2016, all companies had reported a fall in the number of orders relative to the previous quarter, which does not bode well for a recovery in early 2017.

Figure 16: The global geophysical market (all segments) in billions of $.

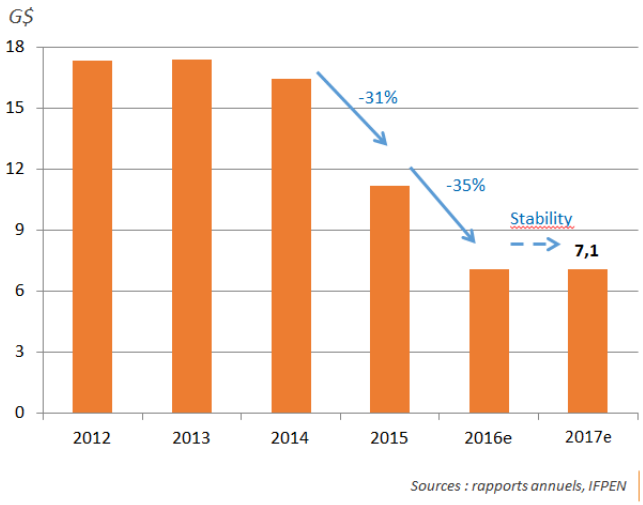


Table 4: 2015 and 2016 revenue by the 8 leading contractors, market share.

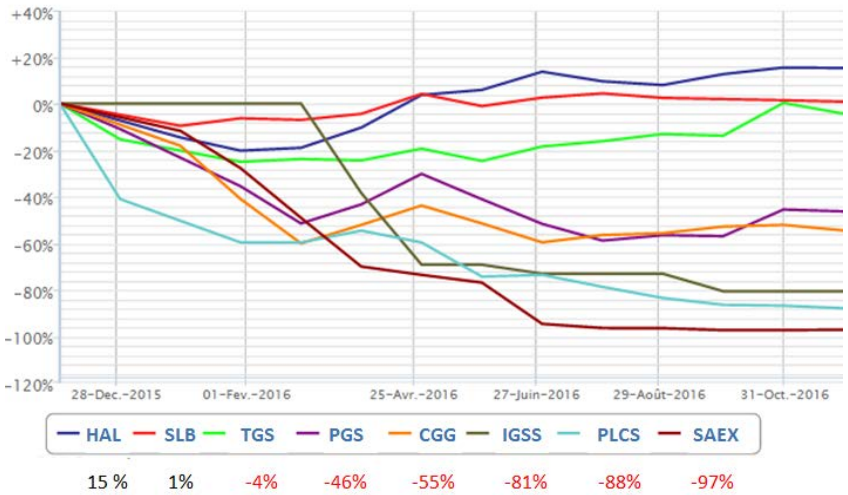
M$	2015	2016e	Growth	Market share
SLB WG+SIS	3200	1935	-40%	30%
CGG	2101	1265	-40%	19%
PGS	962	745	-23%	9%
Landmark	630	395	-37%	6%
TGS	612	360	-41%	6%
IGSS	340	270	-21%	3%
Polarcus	378	260	-31%	3%
COSL	242	130	-46%	2%

Source: IFPEN, based on data from Spears & Associates

4.2.2. Trends in stock market prices

Stock market prices have fallen more or less across the board, except Halliburton and Schlumberger, the two major integrated oil field service companies. After falling severely, prices tended to stabilize over the closing months of 2016.

Figure 17: Stock market price variations (%) of the leading geophysical contractors.



Source: IFPEN, based on Bloomberg data

It is important to remember that comparing stock market prices is difficult, for shares are quoted in different stock markets and refer to the companies as a whole. For major groups like Schlumberger and Halliburton, the geophysical sector accounts for less than 10% of their value.

5. Offshore construction: market and business

Many deepwater and ultra-deepwater offshore projects were postponed in 2016 as a consequence of falling investments. This situation has a direct impact on the global value of the offshore construction and services market, which was predicted to fall by around 24% in 2016.

The fall in the number of constructions has been limited to 13% by the construction of offshore platforms. The shallow offshore sector has been severely hit too, with construction of fixed platforms falling by 50%.

Subsea construction, a sector which just a few years ago was breaking records in terms of installation numbers, has fallen by 18%.

Despite falling service and equipment costs, few experts forecast a recovery in the offshore business in the short term. The price threshold at which offshore recovery is generally considered to be viable is around $60 per barrel.

5.1. Offshore construction and services

5.1.1. Construction of floating platforms (FPS)

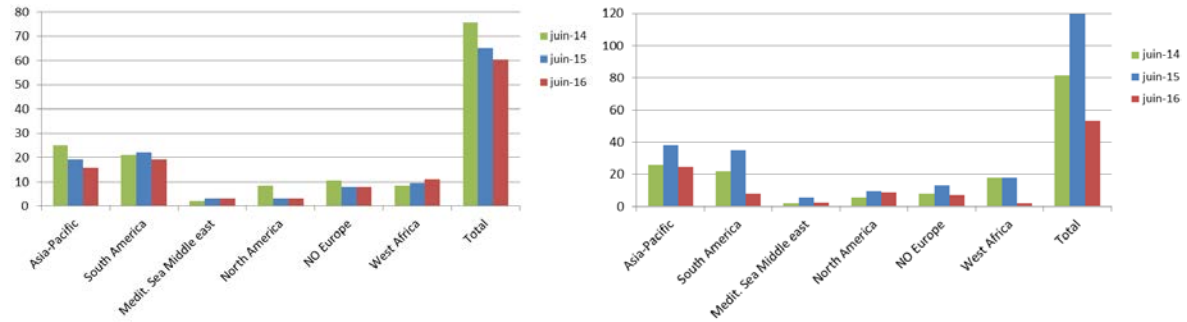
By mid-2016, 60 FPS were in construction around the world. Construction of this type of platform, which is used in deepwater projects, had fallen by 7%. The reduction over 2016 as a whole may reach 13%.

By mid-2016, the South America and Asia Pacific markets, which account for two thirds of the world's constructions, had fallen by 14% and 17% respectively. The only region to register growth in the number of constructions is West Africa (+7%). The other regions remained stable.

Forecasts for FPS construction in 2020 have been revised significantly downwards. By mid-2016, construction of this type of platform had fallen by 56% globally to just 54 units. The fall has affected all regions equally, with the exception of the Gulf of Mexico where it has been less severe (-10%).

Figure 18: Number of floating platforms under construction by year (a) and forecast demand up to 2020 (b).

(a) *(b)*



Sources: IFPEN, IHS

5.1.2. Construction of fixed platforms (all types)

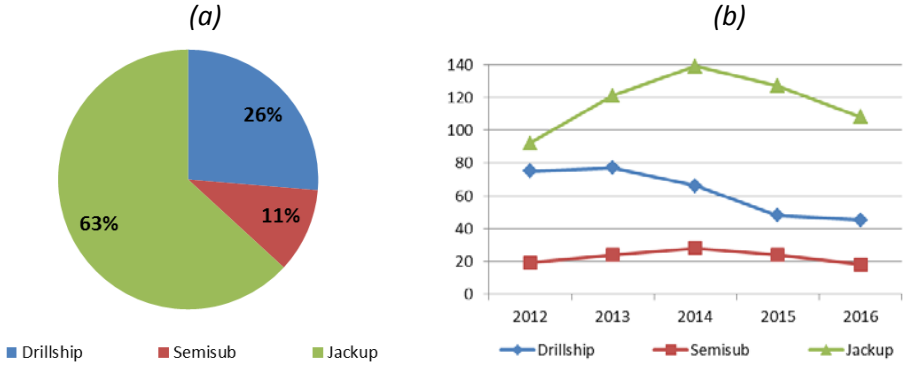
This type of platform is used in shallow offshore applications (200 to 300 m). It is estimated that the number of fixed platform constructions fell by 50% in 2016.

5.1.3. Construction of drillships and platforms

Since 2014, construction of drillships, semi-submersible and jackup drilling rigs has been hit by the global reduction in offshore drilling both in the exploration and development of offshore fields.

In September 2016, of 171 construction orders for offshore drilling rigs, 63% were for jackups, 26% for drillships and 11% for semi-submersibles. Over the year, global business fell by 14%, after a similar reduction in the previous year (-15%). The strongest fall (-25%) was in semi-submersibles, followed by jackups (-15%) and drillships (-6%).

Figure 19: Number of drilling vessels under construction by type in September 2016 (a) and the trend since 2012 (b).



Sources: IFPEN, IHS

5.1.4. Subsea construction

200 subsea wellheads were installed in 2016. That is a reduction of 20% compared with the previous year. In 2014, a record number of wellheads (over 300) were installed.

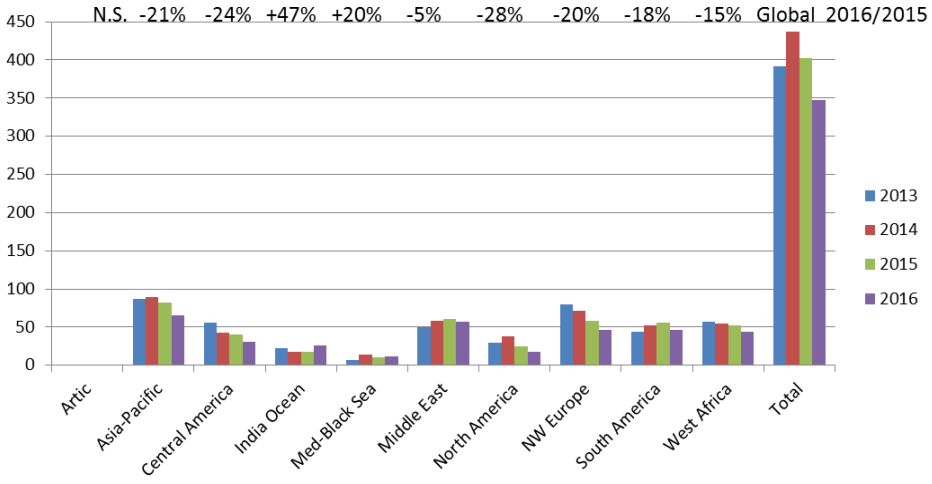
The North Sea, the Gulf of Mexico and the Gulf of Guinea are the regions with the highest concentration of subsea installations. They are followed by South America and West Africa, regions that are both seeing strong growth. 20% of subsea installations are located at depths of 300 to 1500 meters, and 16% at depths in excess of 1500 meters. This type of technology is particularly useful for developing several adjacent fields, but it remains costly. By connecting satellite fields to existing platforms, it reduces the number of surface installations.

5.1.5. Offshore services

Offshore services include accommodation ships, pipelayers and derrick ships, diving support vessels, ROVs, and well services.

This business peaked in 2014 with 437 ships in service. In 2015 it fell by 8%; for 2016, the forecast is a fall of 14%.

Figure 20: Number of ships active in offshore services and the trend for 2013-16.



Sources: IFPEN, IHS

5.2. The global offshore construction market

In 2016, the value of the offshore construction and services market was estimated at $42b, a reduction of 24% relative to 2015. And it fell by 19% in 2015.

For several years now, oil and gas companies have been postponing their development projects in a bid to rein in investment and reduce costs.

The offshore construction and services sector comprises three main segments: offshore construction, which represents 59% of the global market, subsea equipment (34%) and offshore services (7%).

The biggest reduction has been in floating platform services (-32%). The subsea equipment and offshore construction markets are predicted to fall by 24%.

Two thirds of the global business is held by 10 companies whose core activity is offshore and subsea construction. After its merger with FMC, a company specializing in subsea equipment, Technip has become the world leader in offshore construction with 19% of the global market. Saipem now occupies 2nd place, with 11% of the global market.

After its buyout of Cameron in mid-2016, Schlumberger is now level with Aker Solutions in terms of market share (4.7%).

Figure 21: The global offshore construction market in billions of $.

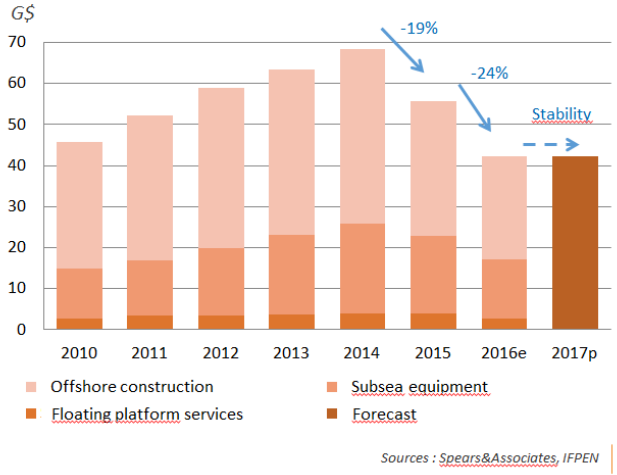


Table 5: Estimated market share by company, 2016.

Company	2016	%	Cumulative share
Technip FMC	8 020	19%	19%
Saipem	6 500	11%	30%
Subsea 7 S.A.	3 500	8,3%	38%
McDermott	2 755	6,5%	45%
Schlumberger-Cameron	2 000	4,7%	50%
Aker Solutions	1 960	4,7%	54%
GE Oil & Gas	1 645	3,9%	58%
KBR	1 390	3,3%	61%
Oceaneering International	1 290	3,1%	64%
SBM Offshore	1 065	2,5%	67%
Fugro	1 015	2,4%	69%

Source: IFPEN, based on data from Spears & Associates

6. A significant reduction in refining projects (atmospheric distillation and conversion)

Despite a broadly favorable context, investors remain cautious. Margins have fallen since the high of 2015, but without collapsing. They returned to a more "natural" level in 2016. In this new context, expenditure continues to rise but at a more moderate rate, although it has reached a new record nevertheless. The good performance of the margins explains the bulk of the rise, notably in maintenance activities.

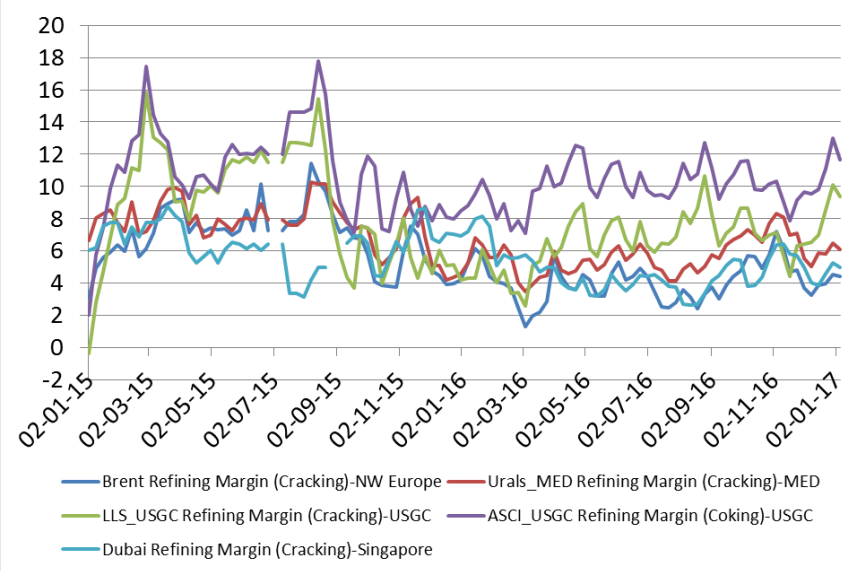
The caution of refiners will be most manifest at the level of medium-term projects: extensions to existing installations, addition of new processing capacity and conversion projects. A significant reduction is forecast here, in numbers as well as capacity (b/d), which will reduce over-capacity in the refining sector and improve supply-demand equilibrium.

Despite the uncertainty over future events, the investment outlook remains interesting. The introduction of new specifications/regulations at global level and the various revamping, modernization and development programs underway in the sector give investors cause for a certain degree of optimism.

6.1. Refining margins fall in 2016, but no collapse

2015 was a particularly good year for operators, with refining margins reaching historic highs. The margin on Brent reached $11 per barrel, a level unseen since 2012. Refiners took advantage of this favorable economic context by operating at full capacity (even if only to stockpile their production afterwards) and keeping maintenance stoppages to a minimum.

Figure 22: Refining margins (US$/b).



Source: IFPEN, Reuters

Margins returned to more normal levels in 2016. They even reached "reasonable" levels in the United States, where the LLS-USGC (cracking) margin oscillated between 6 and 8 dollars a barrel in the second quarter. In Europe, refining margins in mid-2016 remained at around 5 dollars a barrel thanks notably to gasoline crack, which remained buoyant, rising to 7 dollars a barrel in November. The relative increase in margins (especially from the second quarter) combined with sustained demand for oil products is encouraging refiners to limit their maintenance stoppages this year and to fast-track the return to operation of refineries undergoing maintenance.

Stocks of crude and oil products are at their highest levels in all regions of the world, and will not start to fall until Q4. By the end of 2016, stocks of crude in the USA and stocks of oil products were falling in Amsterdam-Rotterdam-Antwerp and Singapore. This slight downturn in the level of stocks can be explained by the decision of OPEC and certain non-OPEC countries to reduce production, and the resumption of maintenance operations in refineries. These stoppages are helping sustain product cracks, including fuel oil cracks, driven by rising demand in Asia. Refining margins have remained healthy, with the margin on Brent over $4.7 per barrel in Europe, despite the rise in the price of crude.

6.2. Expenditure peaks in 2016 then falls in 2017

In a global context of shrinking margins (2015-16), the growth in expenditure will slow down in 2016 (Figure 23).

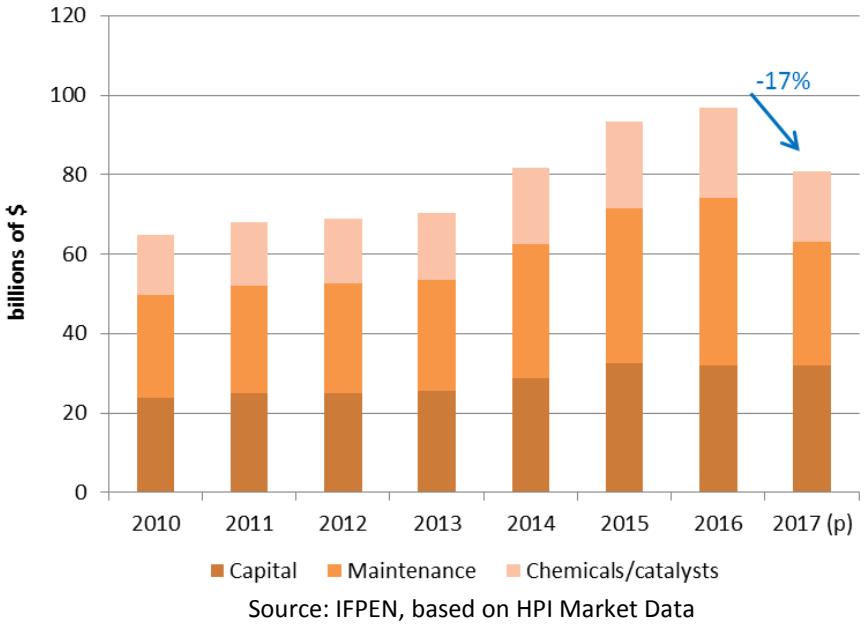
Overall expenditure, which contributes to an increase in global atmospheric distillation capacity (capital expenditure, expenditure on chemicals/catalysts and maintenance expenses), rose by 4% in 2016 (against 16% in 2015). Expenditure now stands at 97 billion dollars, a record level.

Most of the increase can be explained by rising maintenance expenditure, for reasons connected with the good performance of margins in late 2015 and early 2016, as we saw earlier.

Capital expenditure has remained stable, near the historic high of 2015, which came to 32.6 billion dollars. A combination of conflicting factors explains this continuity:

Second thoughts on existing projects, including stoppages and delays, closures and the reduction in capacity of existing installations (La Mède (150 kb/d) in Europe) (Table 5), and the uncertainty surrounding the major Russian modernization program (sanctions, economic crisis etc.) (see box) are the elements which explain the restraint in capital expenditure.

Figure 23: Global expenditure in the refining industry.



Source: IFPEN, based on HPI Market Data

Other elements, meanwhile, have contributed to an increase in expenditure, such as

- the adaptation of US refineries to lighter crudes (shales)
- and the construction of condensate splitters as a way of circumventing the ban on the export of crude. The United States lifted its ban on crude oil exports in 2016, rendering demand for

condensate splitters practically nil. The construction of new splitters has nosedived, but projects launched in 2016-17 are still underway.

- The implementation by the United States of Tier 3 specifications to improve the quality of products. In the long term, the Californian specifications will be implemented on the federal level, which will require significant investments by the refineries (desulfurizing units).

Global expenditure is expected to slip to 81 billion dollars in 2017 (-17%), again due to maintenance expenditure. Once again, part of this expenditure has been deferred (to 2018) to boost the relatively high margins still in place. And refiners are now turning their attention to the optimization of maintenance activities, and are increasingly outsourcing maintenance services in a bid to reduce costs.

Capital expenditure is expected to remain stable, as in 2016, at around 32 billion dollars.

The Russian refinery modernization program:

For several years, the Russian refining sector has been undergoing a modernization program with the aim increasing hydrocracking (800 kb/d), coking (360 kb/d) and FCC (170 kb/d) capacity by 2020.The units already in operation under this program aim to improve the quality of gasoline, including isomerization, hydrotreatment and reforming units.

Given that most modernization projects address hydrocracking and coking units - which process VGO and residues - the production of ultra-light diesel fuels will increase while, in contrast, the production of fuel oils will fall. Gasoline production will also increase due to the planned capacity in FCC units.

The Iranian program for the modernization of existing refineries and the development of new capacity:

Iran's ambitious program has a dual objective: to reduce the country's dependence on imported oil products on the one hand, and to reduce the production of heavy oils on the other. The emphasis is now on the production and exportation of lighter products such as aviation fuel, low-sulfur gasoline and diesel. More generally, the objective is to produce fuels which meets the Euro 5 standards.

In pursuit of these objectives, Iran is revamping, modernizing and expanding some of its existing refineries, and building new plants. The state oil company, NIORDC, plans to add 3.0 Mb/d of new capacity by 2020.

For the modernization/revamping part of the program, NIORDC has proposed a $14 billion plan for five of its refineries. The five refineries are:

- *Abadan (AORC) (400 kb/d)*
- *Bandar Abbas (BAORC) (330 kb/d)*
- *Esfahan (EORC) (375 kb/d)*
- *Imam Khomeini Shazand (IKORD), Arak (250 kb/d)*
- *Teheran (TORC) (250 kb/d)*

Five additional installations are included in the plans for increasing capacity:

- *The Persian Gulf Star Refinery in Bandar Abbas, with condensate processing capacity of 360 kb/d.*
- *The Siraf complex, with condensate processing capacity of 480 kb/d.*
- *The Bahman Geno Refinery, Bandar Abbas, with capacity for processing 300 kb/d of heavy and extra-heavy Iranian crudes.*
- *The Anahita oil refinery, with capacity of 150 kb/d: this refinery will process different types of Iranian crudes (North Desfull 26.35º; NaftShahr 42.43°; SarkanMalehkuh 42.66°)*
- *The Pars refinery, Shiraz, with capacity of 120 kb/d. This expanded capacity is not expected to go live until 2025.*

The program involves enormous amounts of investment, and NIORDC is looking for international investors. These initiatives come following the agreement reached in July 2015 on Iran's nuclear program and the easing of sanctions by the international community.

6.3. Sharp decline in projects to expand and / or build new processing capacity

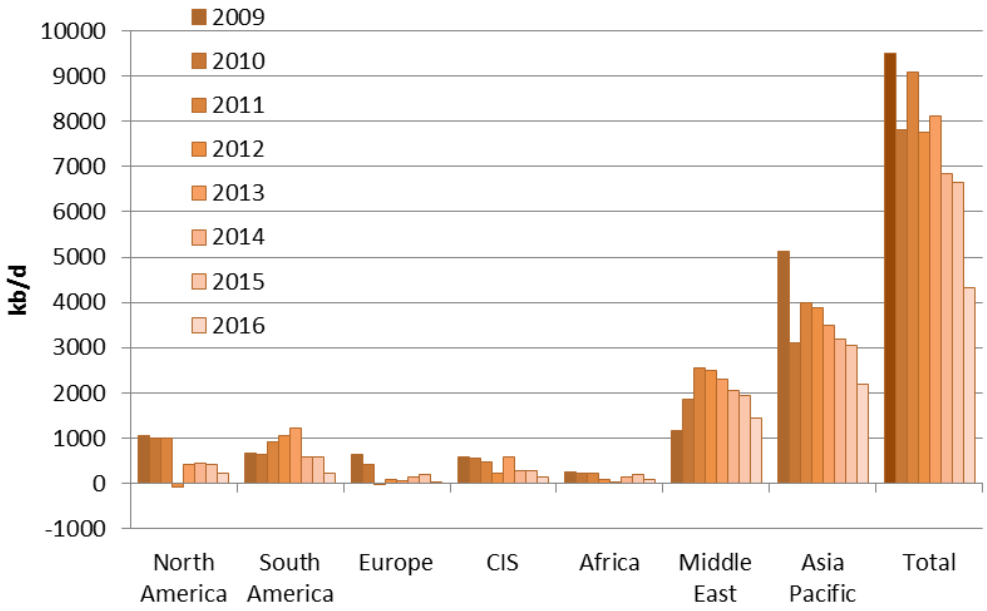
6.3.1. New atmospheric distillation capacity

Cumulatively, plans for the expansion of capacity for the next 5 years are well down in comparison with the situation one year ago (-35%). This figure only takes into account those projects which have moved beyond the feasibility study phase.

Although the context remains favorable - rising demand, continuing buoyancy in refining margins, industrial costs falling for the second consecutive year despite a minor uptick in Q3 (Figure 25) - investors remain cautious. Upcoming projects account for just 4.3 Mb/day in processing capacity, which is the lowest level since 2009.

The downturn is general and affects all zones (Figure 24). The most significant reduction is in the Atlantic Basin (-59%), followed by the Asia Pacific region (-28%) and the Middle East (-23%).

Figure 24: Refining projects –distillation capacity by geographical region (2009-2016), in kb/d.



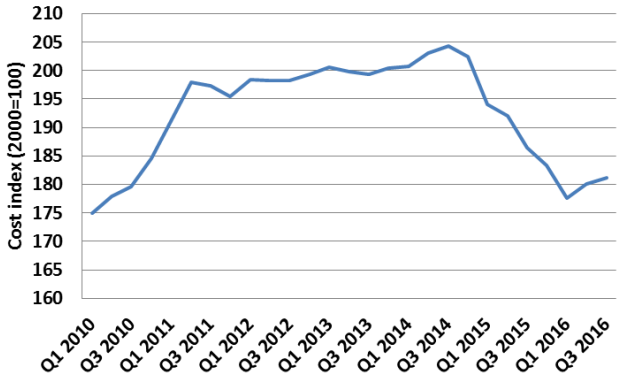
Source: IFPEN, based on KBC data

Additional capacity is spread almost equally between new refineries and extensions to existing plants (Figure 26), with just one major refinery commissioned in 2016: Yunnan, PetroChina (260 kb/d). Atmospheric distillation projects remained stable between 2015 and 2016, while extension projects contracted significantly (-12%).

Closures of refineries (Table 5), not including maintenance stoppages, increased slightly relative to the previous year, in terms of distillation capacity. It is estimated that 613 kb/d of capacity disappeared from the market in 2016, 65% due to total site closures. Some capacity - La Mède (150 kb/d) in France and NIS Serbia (60 kb/d) in Serbia - has been converted to other applications: La Mède is to become a bio-refinery producing HVO (hydrogenated vegetable oil) biodiesel, while the Serbian refinery is to become a lubricant production plant.

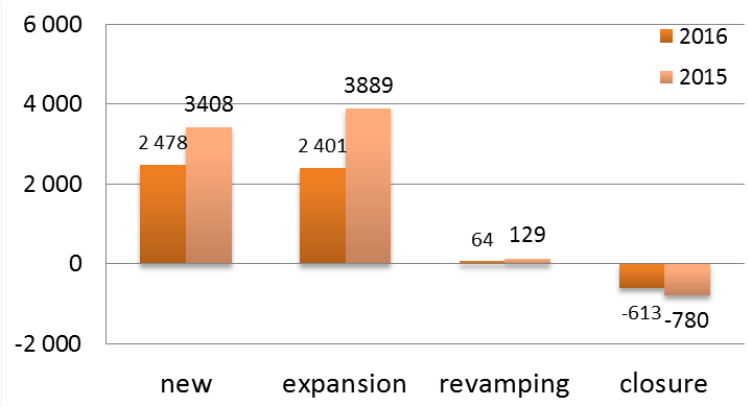
The three Kuwaiti refineries (Table 5) are to close in the medium term. Their closure dates have been adjusted (the adjusted dates are shown in red): closure of the Shuaiba refinery has been brought forward by two years, while the other two - MinaAbdullah and Mina Al-Ahmadi - have been given a year's reprieve each.

Figure 25: Refinery construction cost index.



Source: IHS CERA

Figure 26: Cumulative additional atmospheric distillation capacity by type of expansion (kb/d).



Source: IFPEN, based on KBC data

Table 6*: Planned closures of atmospheric distillation plants in the medium term: the situation in 2016.*

o	La Mède (conversion), France	153 kb/d	2016
o	NIS, Novi Sad (conversion), Serbia & Montenegro	60 kb/d	2016
o	KNPC, Mina Abdullah, Kuwait	80 kb/d	2018/2019
o	KNPC, Mina Al-Ahmadi, Kuwait	120 kb/d	2018/2019
o	KNPC, Shuaiba, Kuwait	200 kb/d	2020/2018

Source: IFPEN, based on data from KBC

The table below (Table 6) shows the 10 biggest projects, with expanded capacity of 150 kb/d or higher. These projects represent 70% of planned additional capacity and are mainly located in Asia Pacific and the Middle East (Figure 27), which remain the regions of choice for investors. Of these 10 projects, half have had their timelines shifted back (adjusted date in red) by at least a year. Only one project, in Vietnam, has been brought forward (by a year) and is now expected to be operational by 2017.

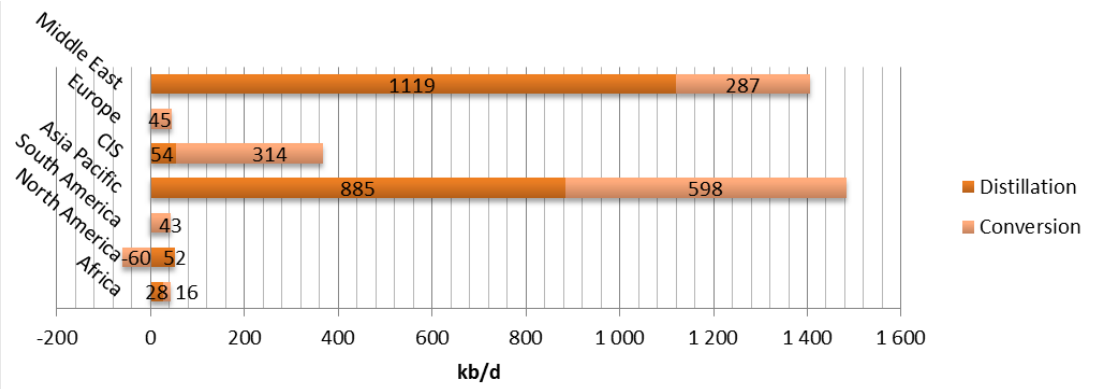
Finally, note the cancellation of the major Petrochina/PDVSA project in Jieyang, China, which made a significant contribution to the reduction in projects observed in 2016. This was a major project including an atmospheric distillation unit with capacity of 400 kb/d and a number of conversion units including an FCC unit with capacity of 80 kb/d, a delayed coker unit (120 kb/d) and a hydrocracking unit (120 kb/d). The plant was scheduled to enter operations in 2019.

Table 7: *Principal projects with refining capacity of 150 kb/d or higher.*

o	Sinopec, Zenhai Refining, eastern China	240 kb/d	2016/2019
o	CNOOC, Huizhou (Guangdong), southeast China	200 kb/d	2018
o	PetroChina, Kunming, Yunnan, southwest China	260 kb/d	2016
o	Petronas, RAPID Refinery, Pengerang, Johor, Malaysia	299 kb/d	2020
o	PetroVietnam/KPC/Mitsui/Idemitsu-Nghi Son, Vietnam	200 kb/d	2018/2017
o	KNPC, Mina Abdullah, Kuwait	264 kb/d	2018/2019
o	KNPC, Al Zour, Kuwait	615 kb/d	2020/2022
o	Oman Refineries & Petrochemicals/IPIC, Duqm, Oman	230 kb/d	2020/2021
o	Saudi Aramco, Jazan, Saudi Arabia	400 kb/d	2020/2021
o	Turcas/Socar, Aliaga, Turkey	210 kb/d	2018

Source: IFPEN, based on data from KBC

Figure 27: Global project postponements, atmospheric distillation and conversion.



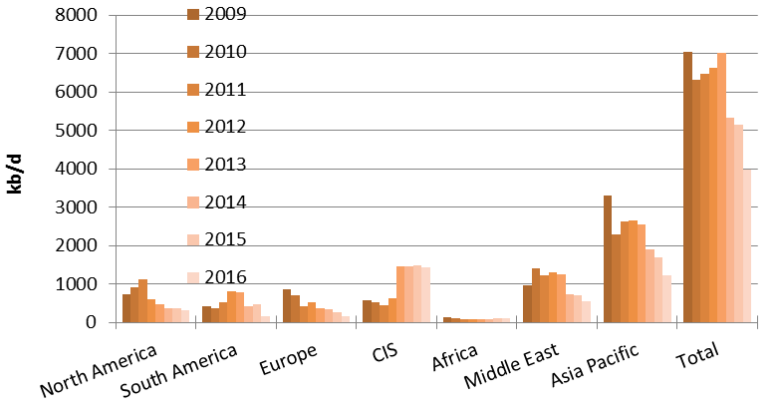
Source: IFPEN, based on HPI Market Data

6.3.2. New conversion capacity

Global planned new **conversion** capacity came to 4 Mb/day in 2016, a reduction of 22% by volume relative to the previous year (Figure 28). Portfolios are shrinking in terms of the number of projects too, falling from 140 projects in 2015 to a little over 110 in 2016. This is the third consecutive year that the number of projects has fallen. The worst-hit regions are Asia Pacific (-27%), the Middle East (-23%) and the Atlantic Basin (-19%).

Figure 28: Refining projects – conversion capacity by geographical region*, in kb/d.*

Source: IFPEN, based on data from KBC



In this latter zone, the most affected regions are South America (-66%) and Europe (-38%). Many projects came on-stream in South America in 2015, but no new project was launched in 2016; three projects in eight were postponed by one year. The downturn in the Europe zone comes after the completion in 2015 of two conversion projects (delayed coking - 52 kb/d;

hydrocracking - 50 kb/d) in the Tupras refinery in Turkey. In the CIS area, where the need for modernization of the refining sector is considerable, the decline is only 3%.

In all, from a total of 4 Mb/d, hydrocracking projects account for 42% of the planned volume, i.e. 1.7 Mb/d, followed by coking projects with 33% (1.1 Mb/d) and fluid catalytic cracking (FCC/RFCC) with 24% (0.94 Mb/d); visbreaking and thermal cracking account for only 1% of planned volume over the medium term (Fig. 29). In terms of market share, the situation remains largely unchanged since the previous year.

Figure 29: *Conversion capacity by type of unit in 2016.*

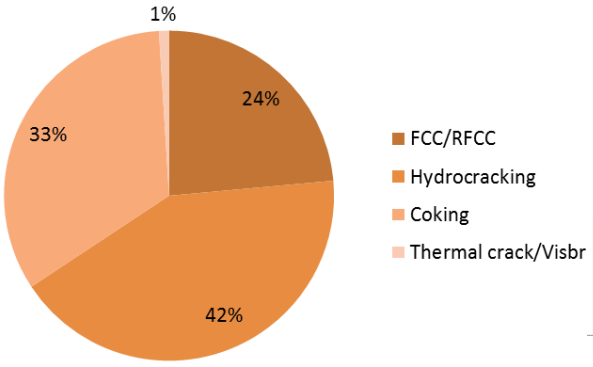
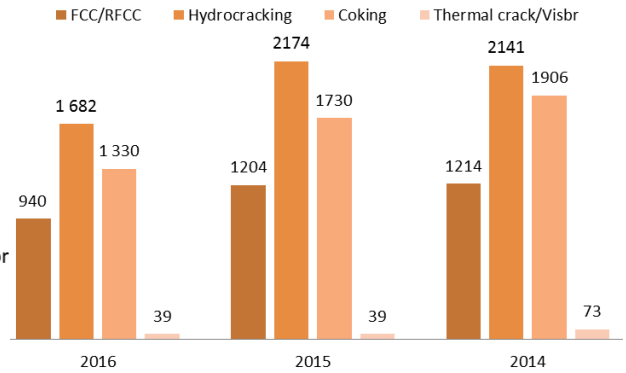


Figure 30: *Conversion capacity by type of unit – trends 2014-16 (kb/d).*



Source: IFPEN, based on data from KBC

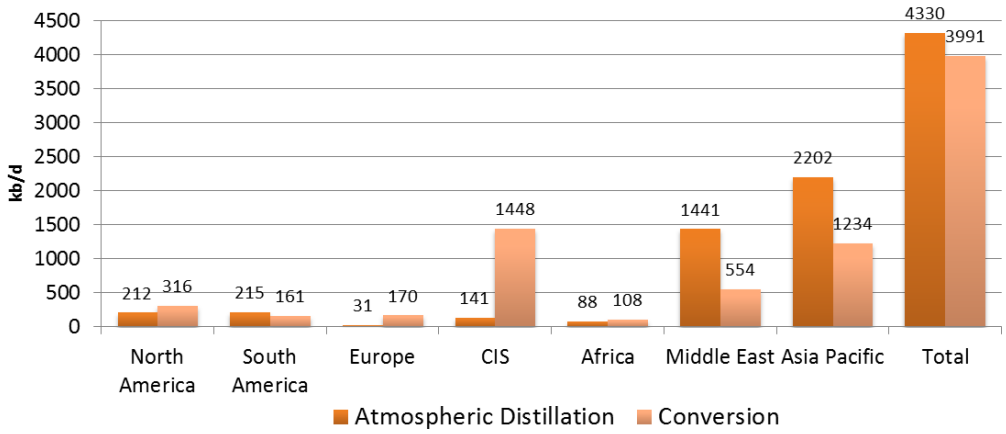
Table 8: Principal conversion projects with capacity of 80 kb/d or higher.

o	Sinopec, Zenhai Refining	Hydrocracking	80 kb/d	2016
o	Rosneft, Tuapse, Russia	VGO hydrocracking	86 kb/d	2017
o	Marathon Petroleum – Garyville, US	Residue hydrocracking	80 kb/d	2018
o	Pemex, Tula, Mexico	Coking	83 kb/d	2018
o	Lukoil, Nizhny, Novgorod, Russia	Hydrocracking	96 kb/d	2018
o	PetroVietnam/KPC/Mitsui/Idemitsu	RFCC	100 kb/d	2018
o	Saudi Aramco, Jazan, Saudi Arabia	Hydrocracking	106 kb/d	2020
o	Petronas, RAPID Ref., Malaysia	RFCC	124 kb/d	2020

Source: IFPEN, based on data from KBC

Globally, although projects are distributed more or less equally between atmospheric distillation and conversion (around 52%/48% respectively), showing little variation over time, some regions such as Asia-Pacific, the Middle East and to a lesser extent South America are clearly focusing more on distillation projects than on conversion projects (Fig. 31). These regions are concentrating their efforts on projects for adding new capacity (new refineries and/or increased capacity in existing units), contrary to the trend observed in the CIS countries. In this zone, where the revamping and modernization of the refining infrastructure is underway, most efforts (90%) have gone into conversion in an attempt to meet the immediate needs for improvement in product quality. Over time, this region may well come into competition with European refining.

Figure 31: Breakdown by type of project: distillation/conversion, kb/d.



Source: IFPEN, based on data from KBC

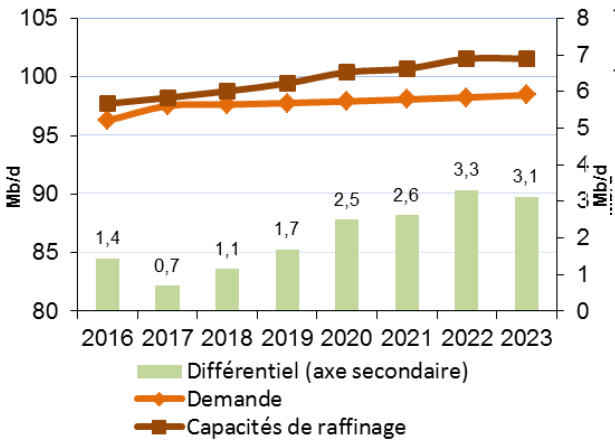
6.4. Over-capacity falls between 2015 and 2016

Figure 32 shows the increase in refining capacity throughout the world based on projects that are currently at an advanced stage of development and which are likely to be completed. It also shows predictions for increased demand according to the IEA [7]in its central scenario. This international organization forecasts a moderate increase in world oil demand over the medium and long terms[8]. This will result in a heightened overcapacity in the medium term.

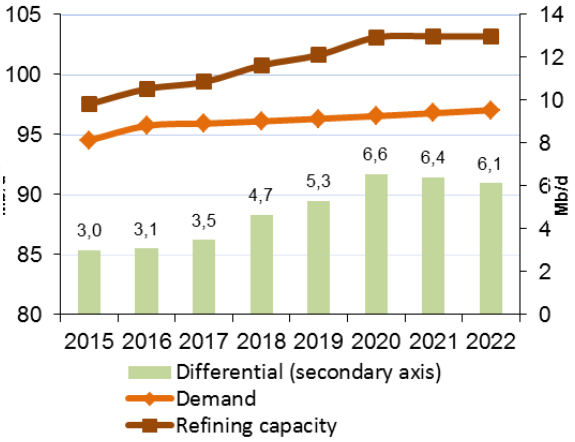
In 2016, refining capacity amounted to 97.7 Mb/day[9] and oil demand[10] to 96.3 Mb/day, i.e. a refining surplus of 1.4 Mb/day. In 2020, refining capacity should amount to 100.4 Mb/day, with demand reaching 97.9 Mb/day, bringing the surplus to 2.5 Mb/day, an increase of 1.1 Mb/day.

Figure 32: *Global medium-term trends in refining capacity and demand*

Situation in 2016:



Situation in 2015:



Source: IFPEN, based on data from KBC and IEA

However, when we compare the forecasts made in 2015 with those made in 2016, we can observe a reduction in overcapacity in the medium term. This situation is simultaneously the result of slower

[7] OMR – Oil Market Report and WEO 2016.
[8] Average annual growth in demand for oil of 0.5% in the 2015-40 period under the New Policies Scenario. WEO 2016.
[9] BP Statistical Review 2016
[10] BP Statistical Review 2016. Including marine fuels, aviation fuels and biofuels.

growth in refining capacity and relatively stable demand. The slowdown in new projects over the last year will have a favorable impact on demand-supply equilibrium.

6.5. Will investment recover after 2017?

Shrinking margins have impacted expenditure and investment in refining in every region in the world, leading to a slowdown in the launch of projects despite the broadly favorable global context.

The outlook for post-2017 is not at all somber for investors, however, given the increasing need for improvements to product quality and the drive to adjust supply to market requirements. Investment should recover in the coming years. And several factors suggest it will do just that:

- At the global level, late in 2016 the International Maritime Organization (IMO) adopted a resolution to reduce the maximum sulfur content of bunker oils from 3.5% to 0.5% beginning in 2020. This measure may require significant investment by refiners if the 0.5% target is retained. As a reminder, another option is to install smoke desulfurization equipment on ships, in which case the onus of investment would lie with the ship-owners. This question has yet to be settled, however.
- The introduction of Tier 3 in the United States (with the federal roll-out of the Californian specifications) will take several years to complete.
- In many countries, the need to improve product quality and therefore to strengthen specifications entails significant investments in conversion infrastructure. Examples include:
    - The continuation of the Russian refinery modernization program;
    - The Iranian program for modernization of existing refineries and the development of additional capacity. The development of this program is conditional upon the participation of international investors. The uncertainty surrounding the risk of new sanctions against Tehran by the new US administration may discourage investment in and trade with Iran, thereby "short-circuiting" the recovery, as the IMF has stressed;
- Strong demand for oil products is expected from emerging regions such as China, India and the Middle East, and perhaps other countries/zones.
- Changing environmental regulations on refineries, which are especially severe in Europe (but also and more recently in the United States), require a reduction in current levels of emissions of local (SO2, NOx, PM, CO etc.) and general (CO2 for the most part) pollutants by refineries.

In general, efforts must be made to modernize and consolidate the refining sector where this is deemed to be necessary, such as Asia Pacific, Latin and Central America and also the Middle East, in order to optimize production, notably by improving refinery utilization rates, which are very low in these regions. European refiners must address the trends set out above in a context of increasing competition that once again threatens to put the competitiveness of European refining to the test.

Finally, we must highlight the recent lifting by the US Congress of the ban on the export of crude oil by US producers. Europe will be the main destination for this "new" oil and European refiners stand to benefit, as they are better equipped to process this grade of oil than the US refineries themselves. In the medium term, the lifting of the embargo may be a factor in future investment decisions.