Crude oil and petroleum product flows and related important statistics

Stève Gervais

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IEA

Presentation overview

Key oil trends

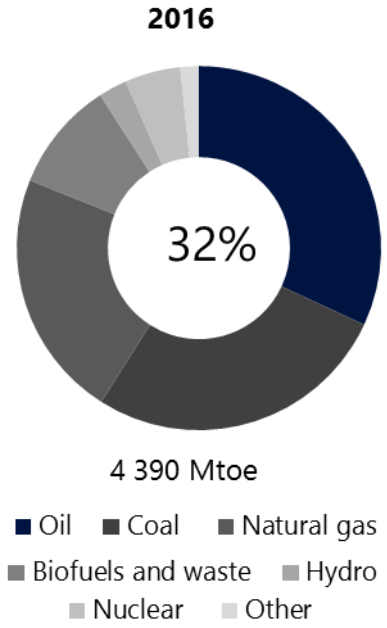
Key concepts

Key points for reporting monthly oil

Key oil trends

Key oil trends - Supply

Largest source of primary energy in 2016



A changing production landscape…

2016

Producers	Mt	% of world total
Saudi Arabia	583	13.5
Russian Federation	546	12.6
United States	537	12.4
Canada	220	5.1
Islamic Rep. of Iran	200	4.6
People's Rep. of China	200	4.6
Iraq	191	4.4
United Arab Emirates	182	4.2
Kuwait	159	3.7
Brazil	135	3.1
Rest of the world	1 368	31.8
World	**4 321**	**100.0**

2016 provisional data

2017

Producers	Mt	% of world total
United States	563	12.9
Saudi Arabia	560	12.8
Russian Federation	548	12.6
Canada	237	5.4
Islamic Rep. of Iran	229	5.2
Iraq	225	5.2
People's Rep. of China	192	4.4
United Arab Emirates	178	4.1
Kuwait	149	3.4
Brazil	137	3.1
Rest of the world	1 347	30.9
World	**4 365**	**100.0**

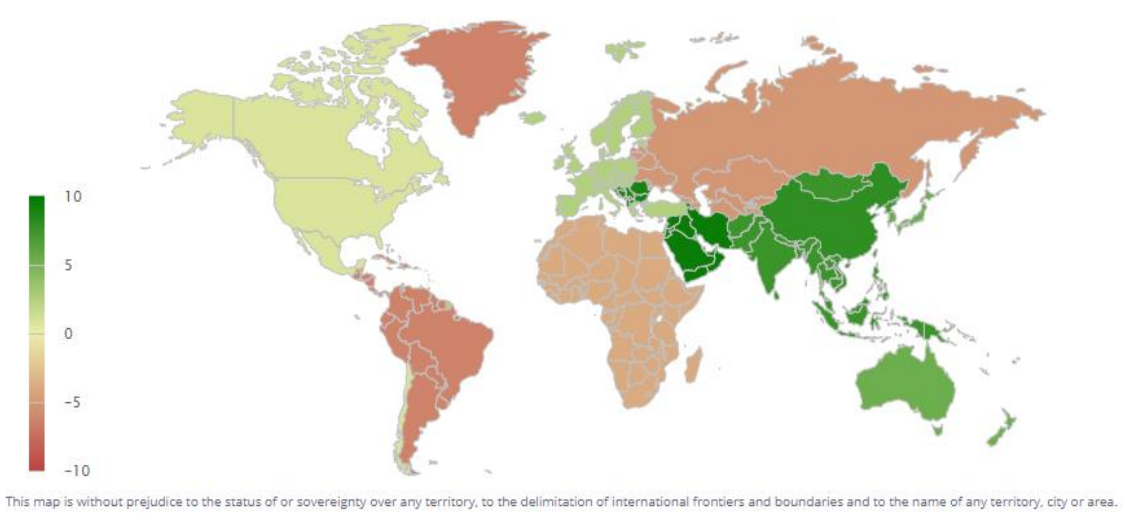
2017 provisional data

Source: World Energy Balances 2018 and Key world energy statistics 2018, IEA

Key oil trends - Refining

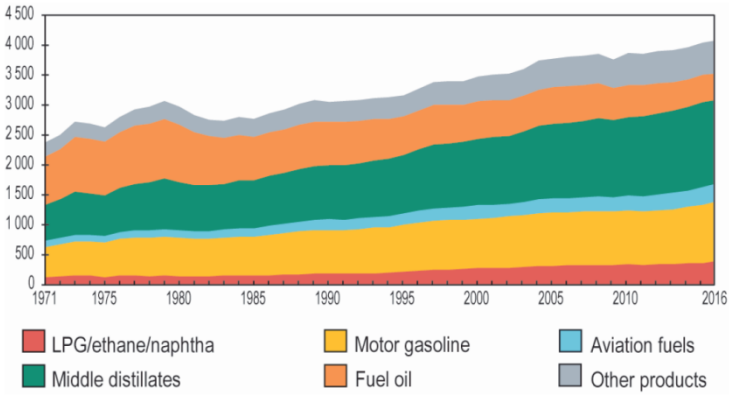
Most of the growth in refining has taken place in the Middle East and Asia Oceania.

Refinery throughput growth in 2016



This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Output of fuel oil and diesel is declining…

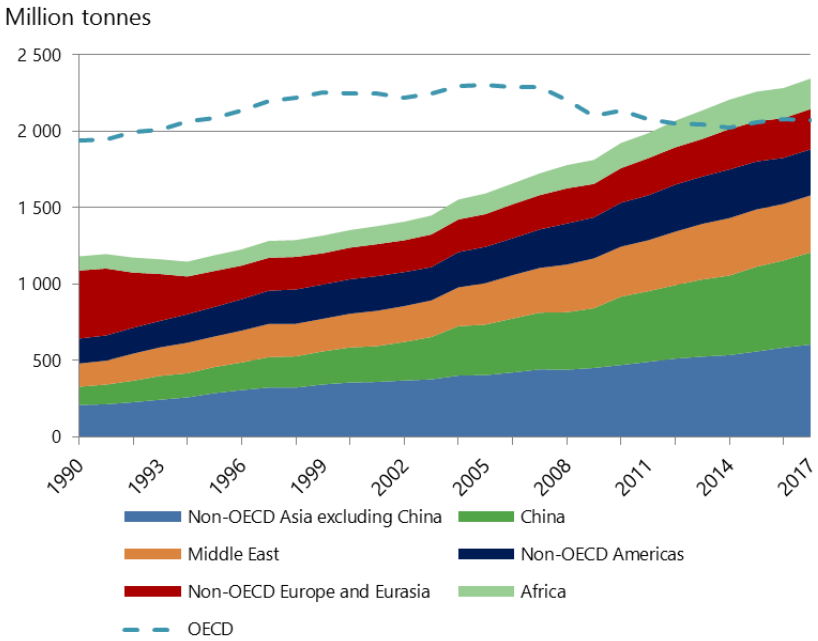


Source: Oil Market Reports Maps and Key world energy statistics 2018, IEA

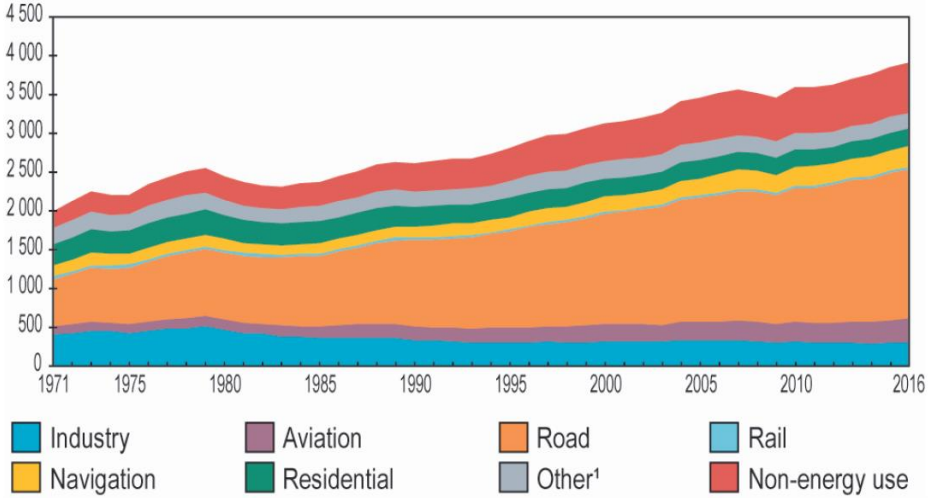
Key oil trends – Demand

Growth in oil demand is driven by non-OECD countries

Oil product demand by geographical region



Key demand trends

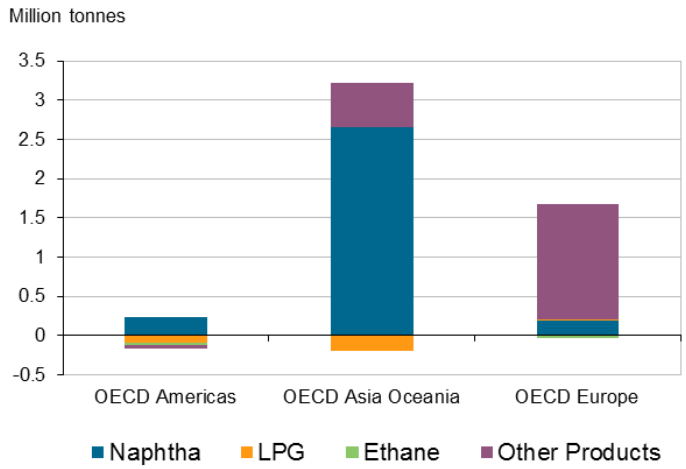


Source: Oil Information 2018 and Key world energy statistics, IEA

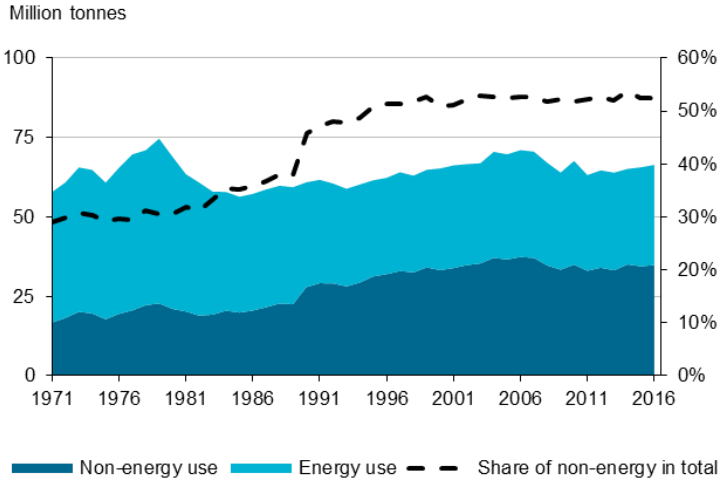
Key oil trends – Petrochemicals

- By the end of 2019 it is expected that 13 MT/y of petrochemical capacity will come online.
  - This will impact demand for petrochemical feedstocks of oil origin, traditionally: **naphtha, LPG, ethane** and **other oil products**.

Refinery output of petrochemical feedstocks growth between 2015 and 2016



Global consumption of oil in industry



Source: Oil Information 2018, IEA

Key concepts

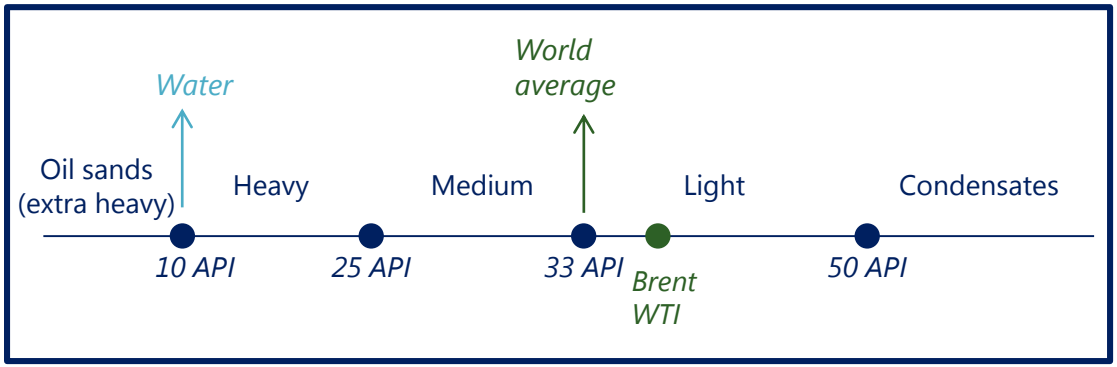
Oil classification – Primary and secondary oil products

Primary oil products
Crude oil
Condensates
Natural gas liquids
Synthetic crude oil, shale oil…
Secondary products inputs to refinery
Additives/blending components
Refinery feedstocks

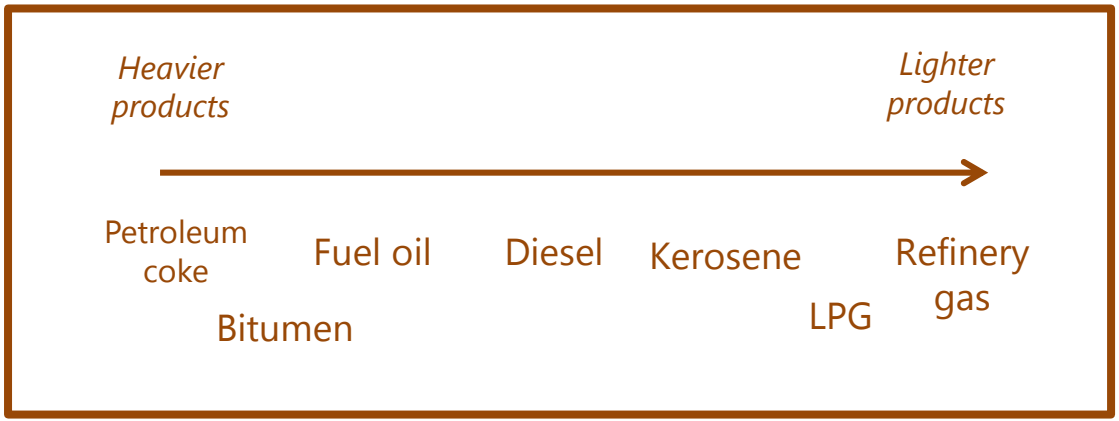
Finished secondary oil products	
Refinery gas	Gas/diesel oil
Ethane	Fuel oil
LPG	White spirit + SBP
Naphtha	Lubricants
Aviation gasoline	Bitumen
Gasoline type jet fuel	Paraffin waxes
Motor gasoline	Petroleum coke
Kerosene type jet fuel	Other products
Other kerosene	

Oil classification – Density

- Most oil is lighter than water, but extra heavy oils have higher density than water.



- The specific gravity or density of the liquid is needed to convert from mass to volume and vice versa.
  - The API gravity is commonly used to express the specific gravity of petroleum.



Source: Oil Industry and Markets Division analysis, IEA

Oil classification - Condensates

- **Condensate** is a *high-quality light oil* recovered from associated or non-associated gas reservoirs.
- In comparison to normal crude oil, condensate needs to undergo *fewer refining* processes and is therefore *versatile* and in *high demand*.
  - Condensate used directly (petrochemicals) or further processed to produce secondary oil products.

Field condensate

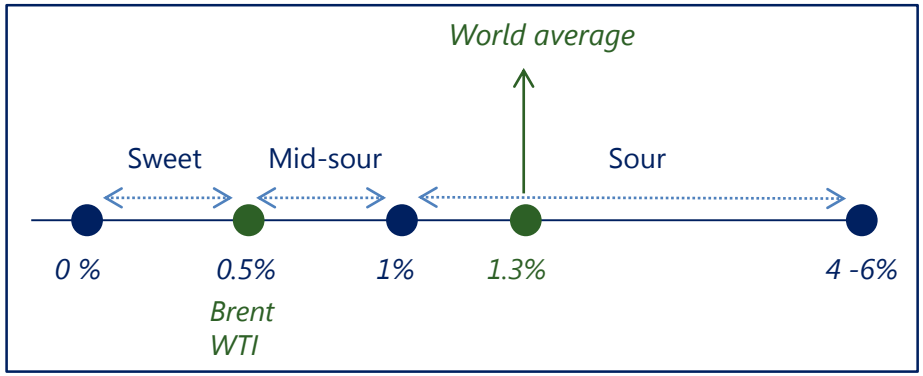
Recovered from associated and non-associated gas *fields* and is normally intermixed with the crude oil stream.

Plant condensate

Recovered in natural gas processing plants or separation facilities.

Oil classification – Sulphur content

- Sulphur content is another key characteristic of oil that serves to differentiate between products.
- From an average crude oil barrel, 70-80% of Sulphur has to be removed to meet product specifications.



Sulphur pyramids in Alberta, Canada

Source: Oil Industry and Markets Division analysis, IEA

Oil classification – Energy content

- Because oil products can vary greatly in their characteristics it is key to collect net calorific values information.
  - Production
  - Imports
  - Exports

- This information is essential to compile the energy balance and to derive CO2 emissions.

Example *net calorific values of United States crude oil.*

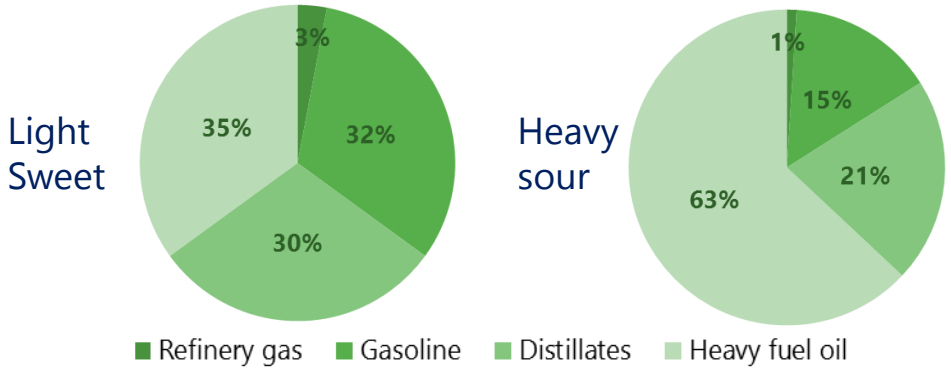
Flow	kj/kg
NCV Production	42 679
NCV Imports	43 604
NCV Exports	42 694
Average NCV	42 871

Weighted average!

Oil classification – Density, Sulphur and refinery yields

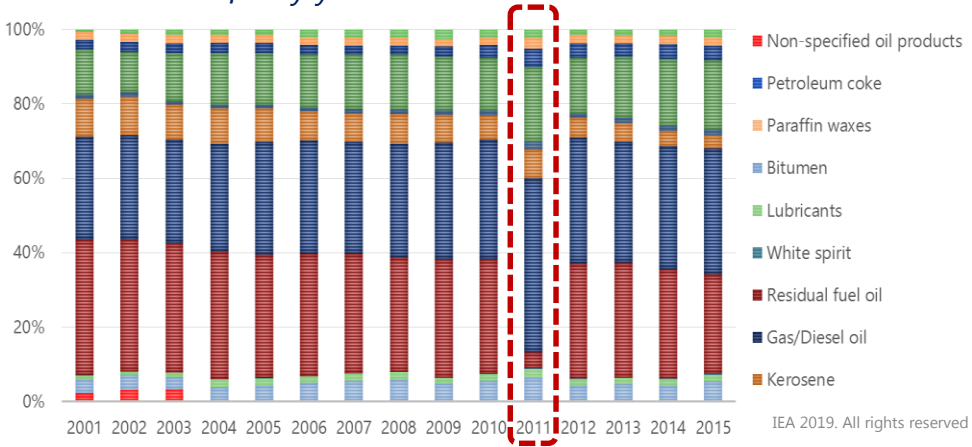
- Crude oils have a wide range of physical and chemical properties.

Example *of inherent yields from different crude oil types*

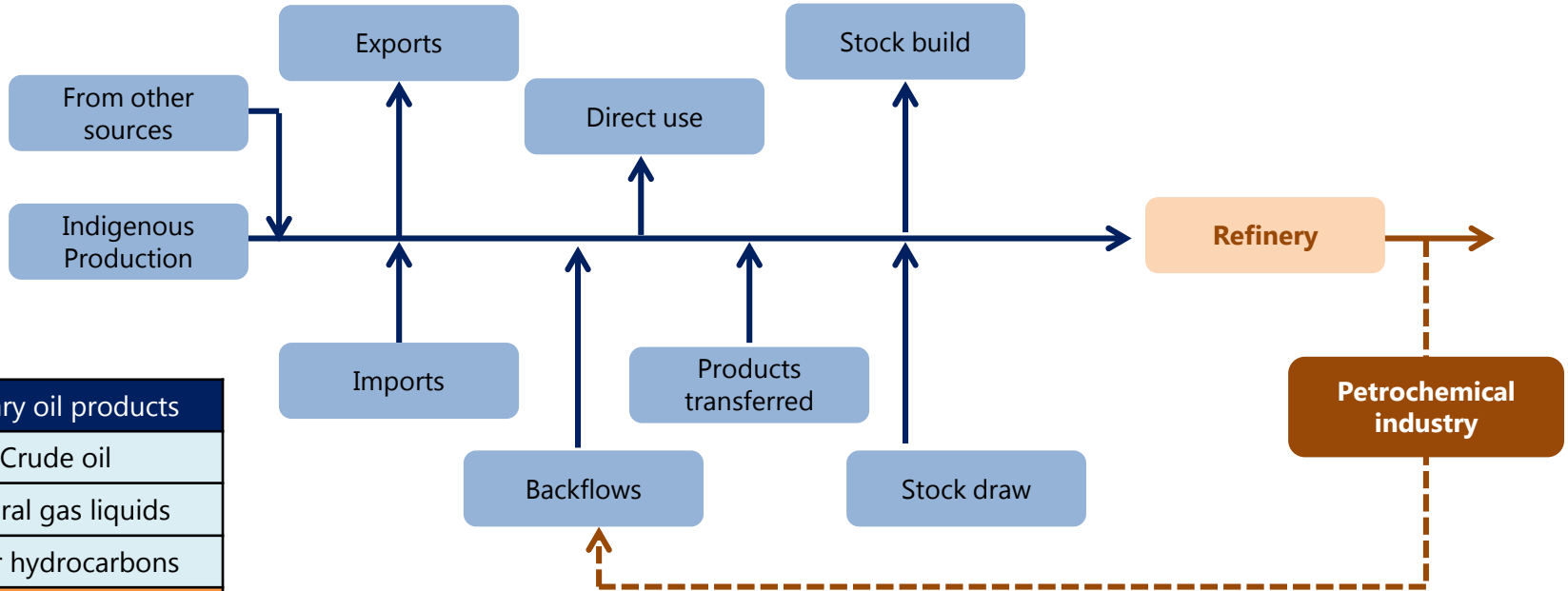


- Refinery specifications determine the type of input and output (refinery yield)
  - Reconfiguring a refinery is expensive, so refinery yields tend to remain stable over time

As a result refinery yields are consistent over time…



Oil balance – Supply of primary oil products



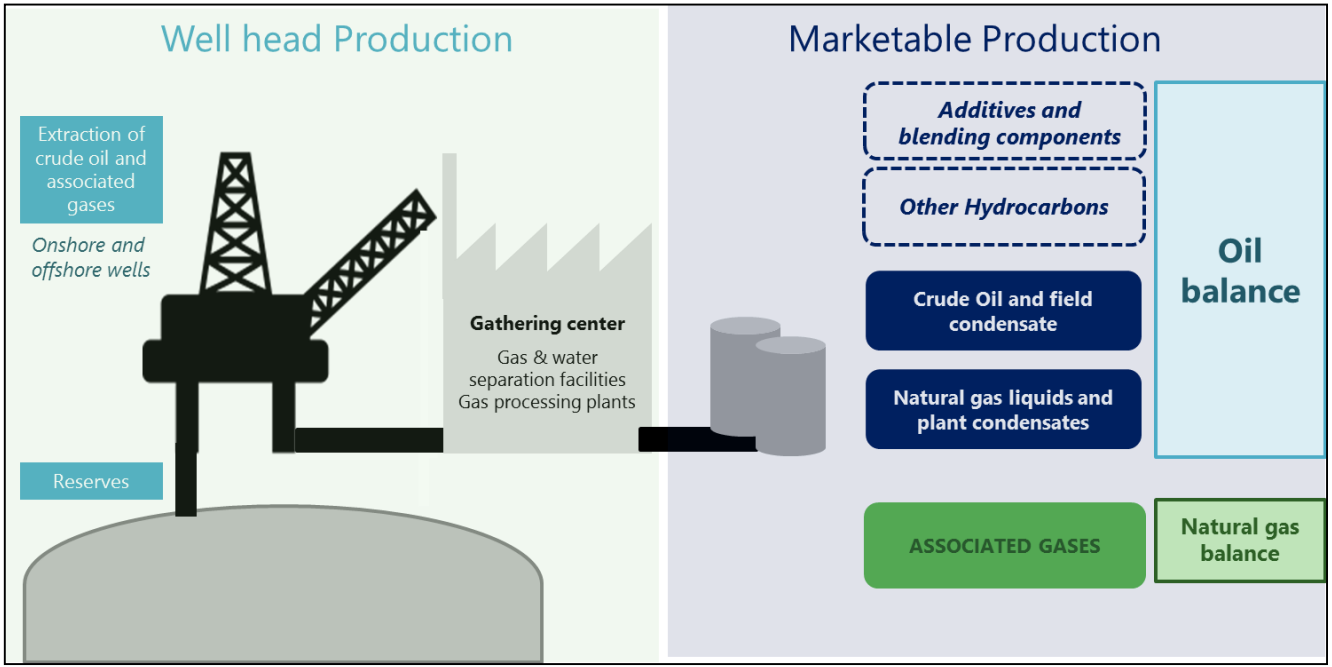
Primary oil products
Crude oil
Natural gas liquids
Other hydrocarbons
Secondary products inputs to refinery
Additives/blending components
Refinery feedstocks

Refinery intake is mostly crude oil but they also process other primary and unfinished secondary oil products.

Oil balance – Indigenous production

- Production should include both onshore and offshore production and exclude amounts returned to formation.

- It is important to determine the point of measurement of production.



Oil balance – Receipts from other sources

- As well as oil products, receipts from other fuel sources can enter the refinery process.

Solid fuels	*For example liquids produced from coal liquefaction plants.*
Natural gas	*Natural gas can be used to :* *- upgrade synthetic crude oil and petroleum products.* *- manufacture of synthetic gasoline in the petrochemical sector.*
Biofuels	*Amounts of biofuels for blending with transport fuels (bio gasoline, bio diesel, bio jet kerosene)*

Oil balance - Stocks

- Stocks are held for three main reasons: logistics, security and business.
- Stocks can be divided into three categories:

Primary stocks

Held in the **supply chain** (producers, importers, refiners, etc.) and for **strategic purposes** by government or stock holding organizations.

Secondary stocks

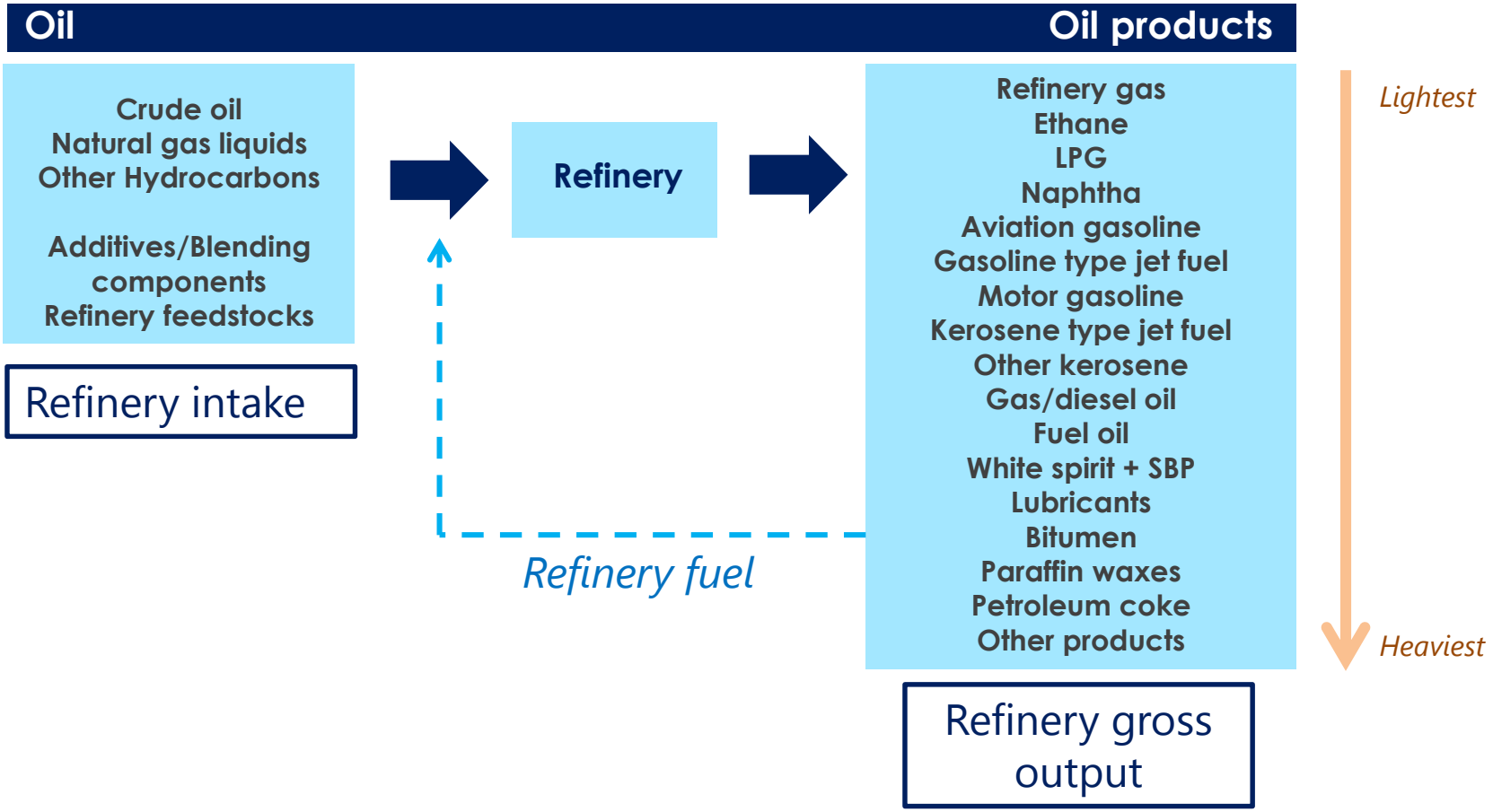
Held in small bulk plants (marketing facilities below a certain capacity) and retail establishments.

Tertiary stocks

Held by final end-consumers (power plants, industrial entities, or consumers in the residential/commercial sector)

- They can be further divided based on the stockholding structure: industry stocks, government stocks and agency stocks.

Oil balance – Transformation



Oil balance – Transformation efficiencies

Oil

Primary oil products
Secondary oil products (input to refinery)

→

Refinery

→

Secondary finished oil products

Refinery intake

Refinery gross output

Losses can occur during the refining process due to evaporation.

When refinery intake > refinery gross output = **refinery losses.**

When refinery intake < refinery gross output = **refinery gains.**

The units matter!

Mass units – small losses with no gains.
Volume units – gains are likely because lighter products are produced.
Energy units – small losses with no gains.

$$\text{Refinery Yield (\%)} = \frac{\text{Refinery Output of Total Secondary Products}}{\text{Refinery Intake of Total Primary Products}} \times 100$$

Refinery yield < 100% = Losses

Refinery yield > 100% = Gains

Oil balance – Product reclassifications within a refinery

- Reclassification of products within a refinery is common.
  - Change in **specification**
  - **Blended** into other products.

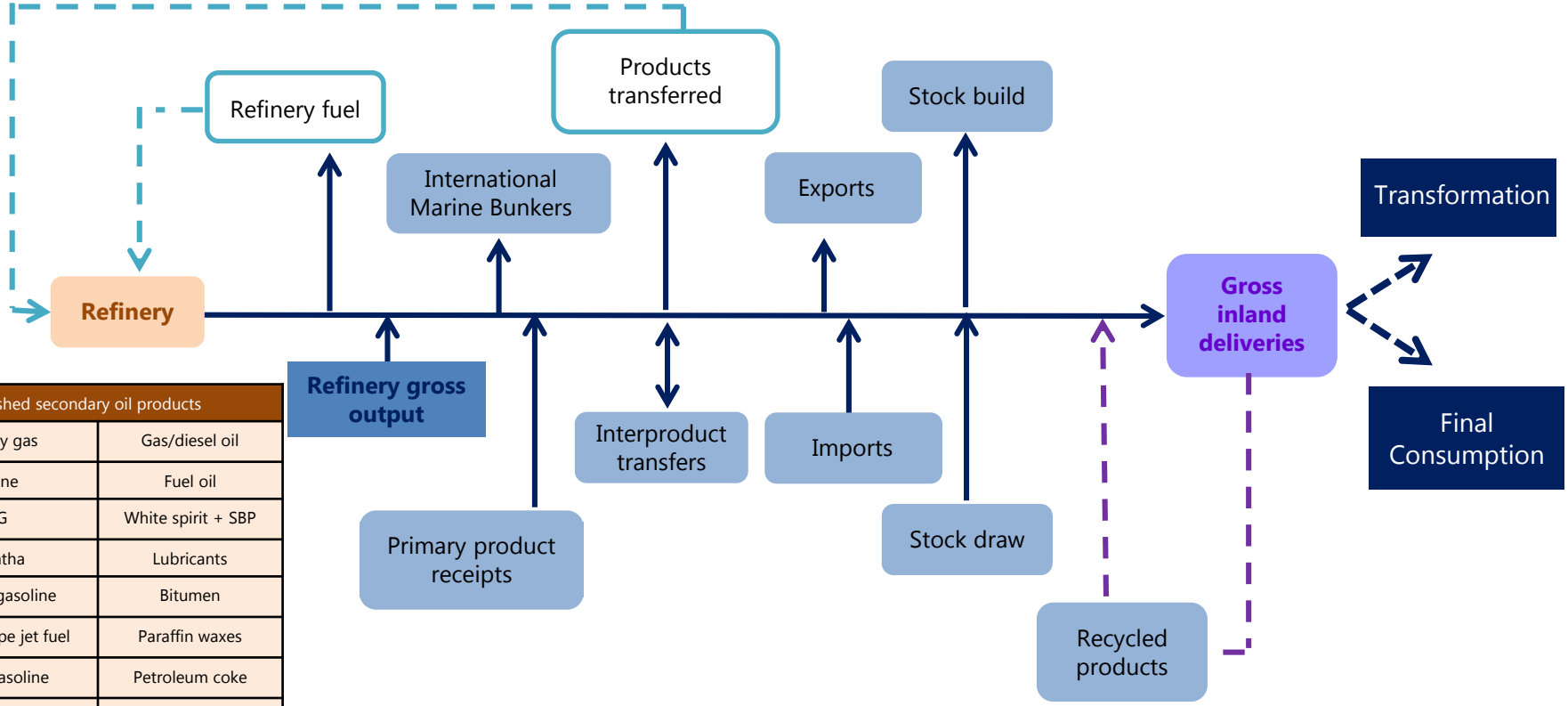
- We refer to these as **inter-product transfers**, this does not involve further processing.

- The *density* and *value* of the oil products will impact the reclassifications.

- When products are *reprocessed* in a refinery we consider these "**products transferred**", these products are not delivered to the market.

Possible	
Kerosene to gasoil Jet kerosene to diesel	Naphtha to gasoline Diesel to fuel oil
Possible but not very likely	
Fuel oil to gasoil	Kerosene to LPG
Not likely	
Gasoline to naphtha LPG to fuel oil	Diesel to jet kerosene
More generally heavy to light products	

Oil balance – Supply of secondary oil products



Finished secondary oil products	
Refinery gas	Gas/diesel oil
Ethane	Fuel oil
LPG	White spirit + SBP
Naphtha	Lubricants
Aviation gasoline	Bitumen
Gasoline type jet fuel	Paraffin waxes
Motor gasoline	Petroleum coke
Kerosene type jet fuel	Other products
Other kerosene	Primary products used directly

Oil balance – International marine bunkers

- This flow covers the deliveries of oil to:
  - Ships of **all flags** undertaking an **international** voyages.

The domestic/international split should be determined on the basis of **port of departure and port of arrival**.

- Domestic navigation and consumption by fishing vessels are covered elsewhere in the balance.

Why it matters:

- Important **outlet** for the **refining industry**.
- Important part of **demand** for oil in a country.
- 80% of global trade in physical goods is done by sea – key to track **policy impact.**
- The distinction between national and international navigation matters for **emissions** calculations (they are excluded from national inventories).

Oil balance - Final consumption

- Due to their specific properties, different oil products have specific uses.

Examples *of the types of oil products one can expect to find in different consumption sectors*

Electricity plants	Chemical and Petrochemical	Aviation	Road transport	Navigation	Residential	Non-energy use
Crude oil Diesel	Naphtha Diesel LPG Ethane Kerosene Other products	Jet kerosene	Gasoline Diesel	Heating oil* Fuel oil	Naphtha Kerosene Heating oil	Bitumen Paraffin waxes



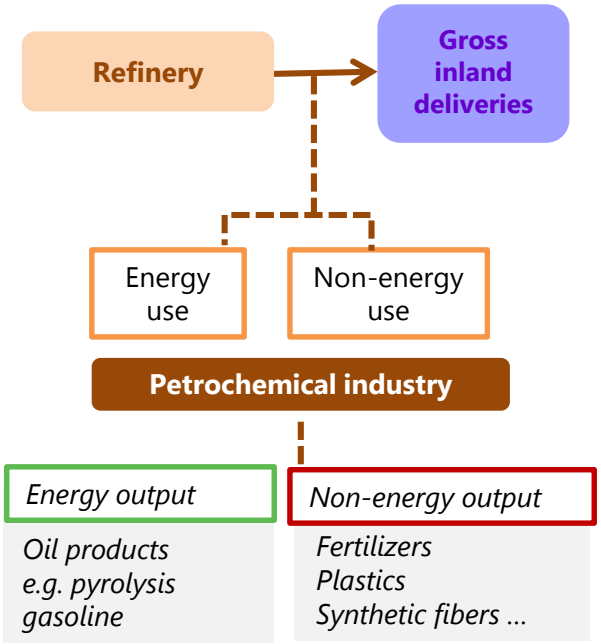


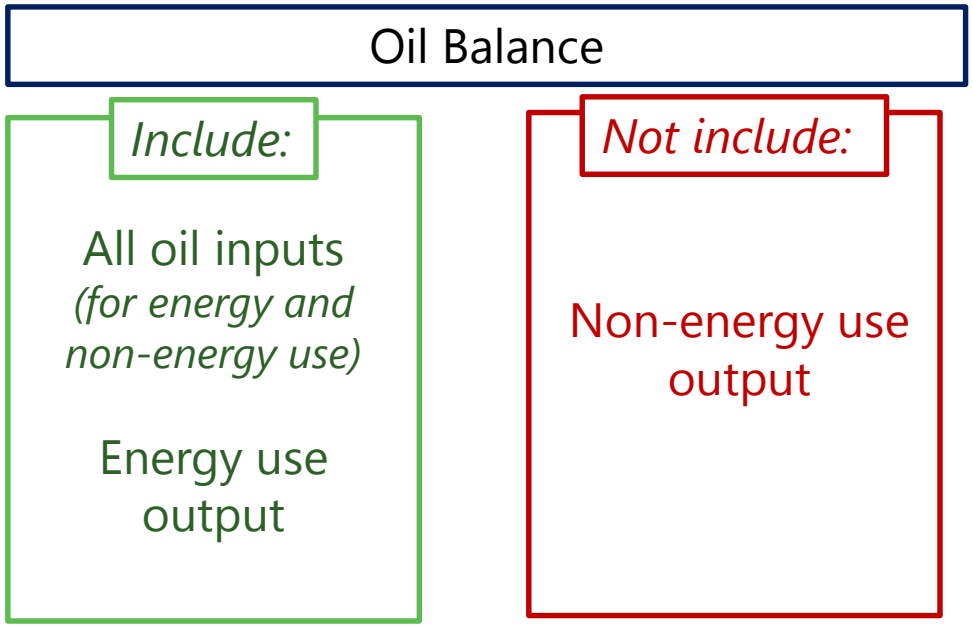


**The category Heating oil includes marine diesel and diesel used in rail traffic.*

Oil balance – The petrochemical sector

- The petrochemical industry is a special case as it is not only a large consumer of oil but also a producer of oil products. As such it is an integral part of the oil balance.





Oil data sources – Where does it all come from?

Supply Data

Producers, oil terminals, importers/exporters or customs data, refiners.
Surveys, company reports, etc.

Demand Data

Energy Consumers, wholesalers.
End-use survey for households and enterprises, sales data, etc.

Integrated Approach

Using existing surveys, direct measurement, estimation and modelling

Oil data sources – Types of data collection

Surveys

Enterprise
Household

Administration data

Energy regulator, custom office, excise tax records etc.
Industry associations, chamber of commerce etc.

Estimation/modelling

e.g. NGL production-> LPG exports/refinery output

Beyond data collection

Annual and quarterly Publications

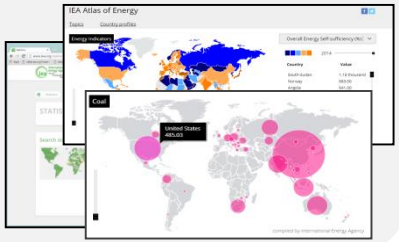
Fuel Information books, World energy statistics & balances, CO_2 emissions…

Data support

Oil Market Report, World energy outlook…

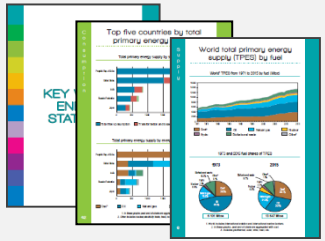
IEA website

Atlas, Sankey flows…



Booklet

Key World Energy Statistics

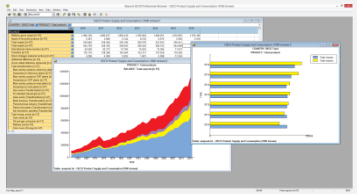


Mobile App

Android, apple and windows

Electronic data files

Online data service



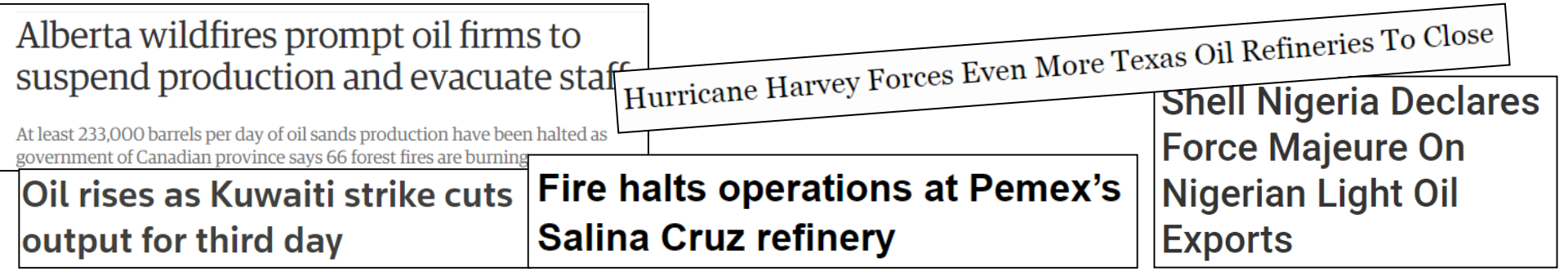
Key points for reporting monthly oil

Why collect monthly oil data?

Transparency in the oil market

Improved analysis and policies

Energy security



Why collect monthly oil data?

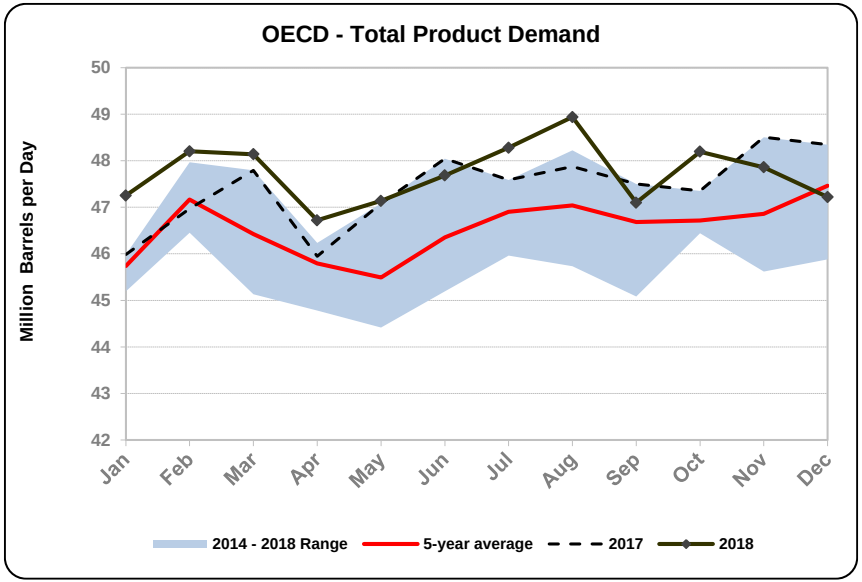
- Transparency in the oil market
  - Short-term/Trend indications
  - Seasonality
  - Impact of events (planned or unplanned)
  - Data validation

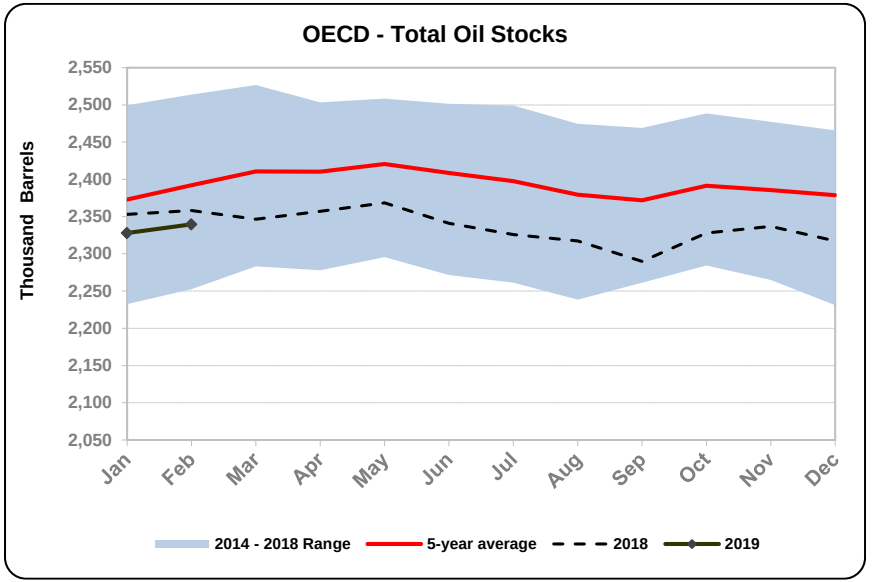
- Improved analysis and policies
  - Preliminary source of information
  - Basis for comparison with annual data

- Energy security purposes
  - Recent/quick assessment of markets
  - Size of a supply disruption
  - Ad-hoc assessment
  - Monitoring of a country's ability to face a disruption

Why collect monthly oil data – Transparency in the oil market

Short term – Trend indicators

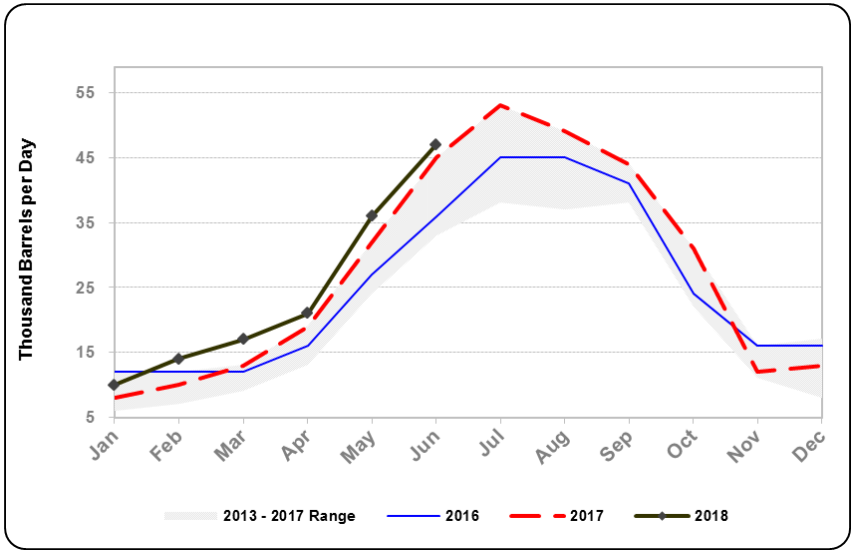




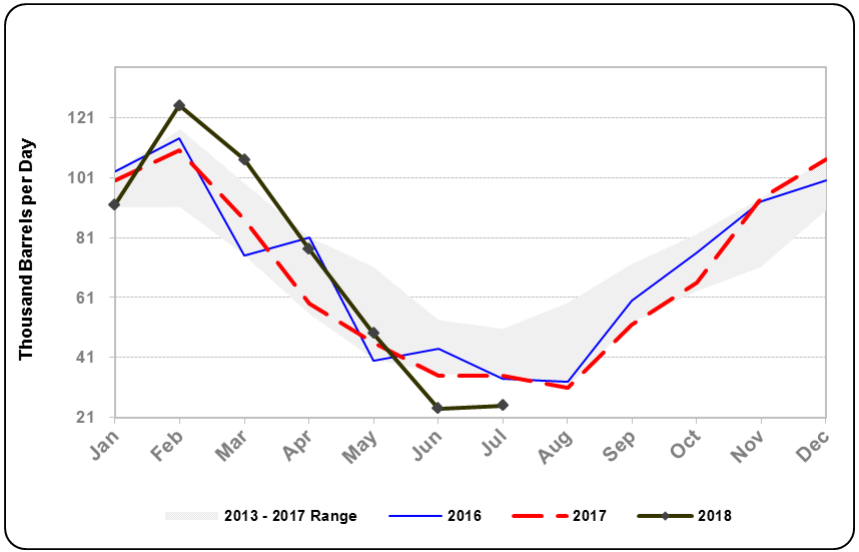
Why collect monthly oil data – Transparency in the oil market

Seasonality

Greece – Jet Kerosene Demand



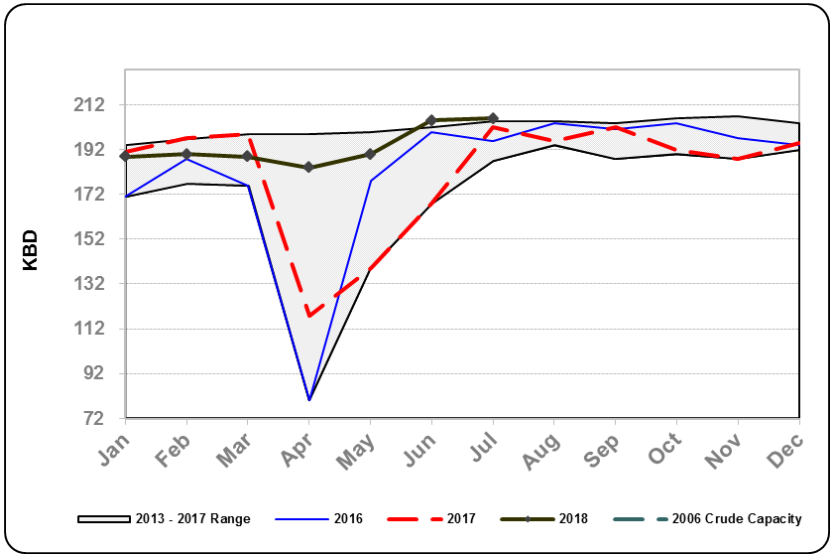
UK – Other Kerosene Demand



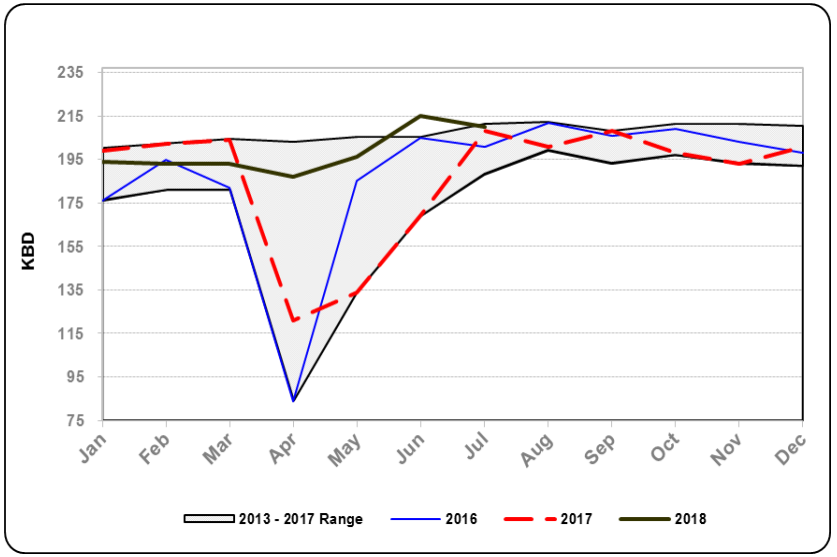
Why collect monthly oil data – Transparency in the oil market

Impact of events - Scheduled maintenance

Austria – Crude, NGL + Feedstocks
Refinery Intake



Austria – Total Products
Refinery Gross Output

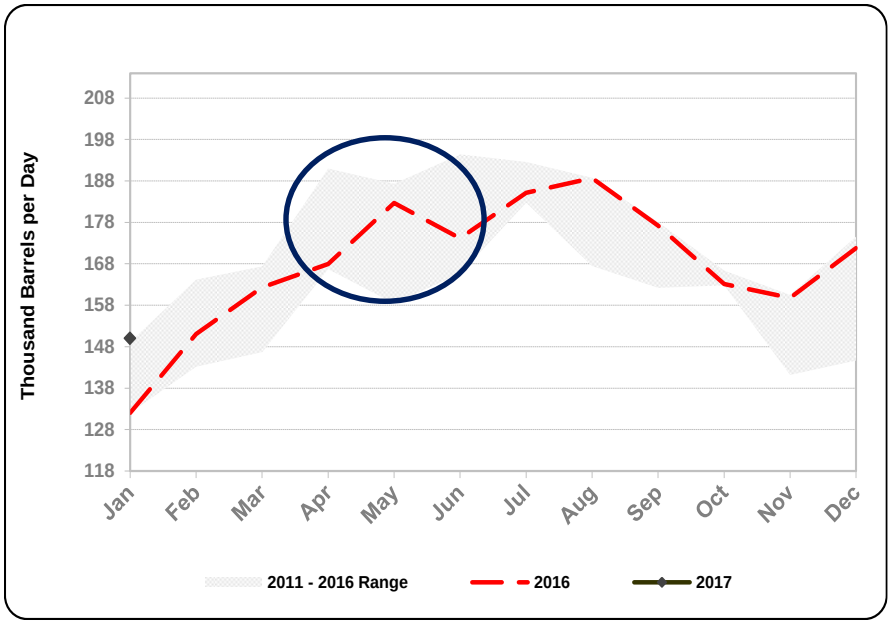


Why collect monthly oil data – Transparency in the oil market

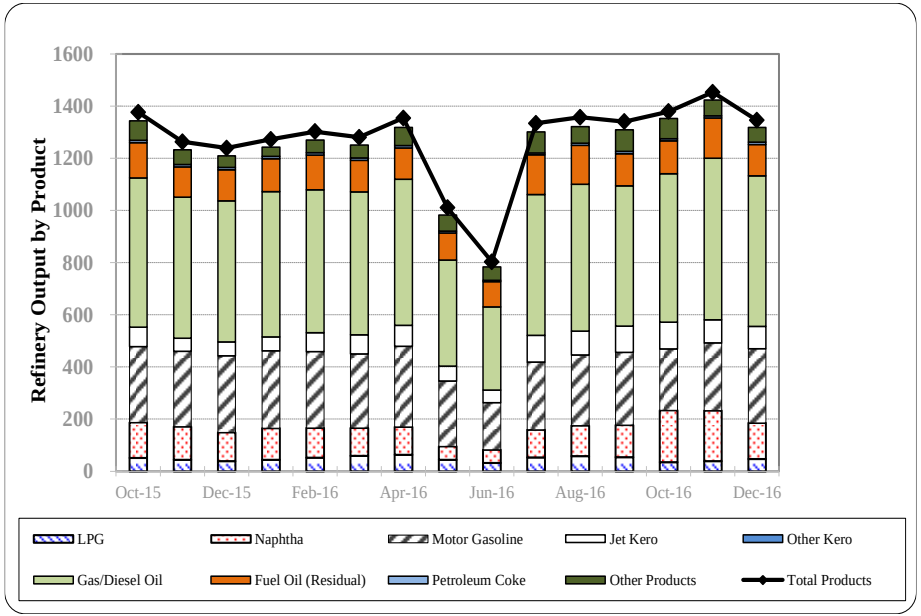
Impact of events - Detailed visualization of the effects of unplanned events

- Example: France 2016 - Impact of strike on oil markets / oil industry

Gasoline demand



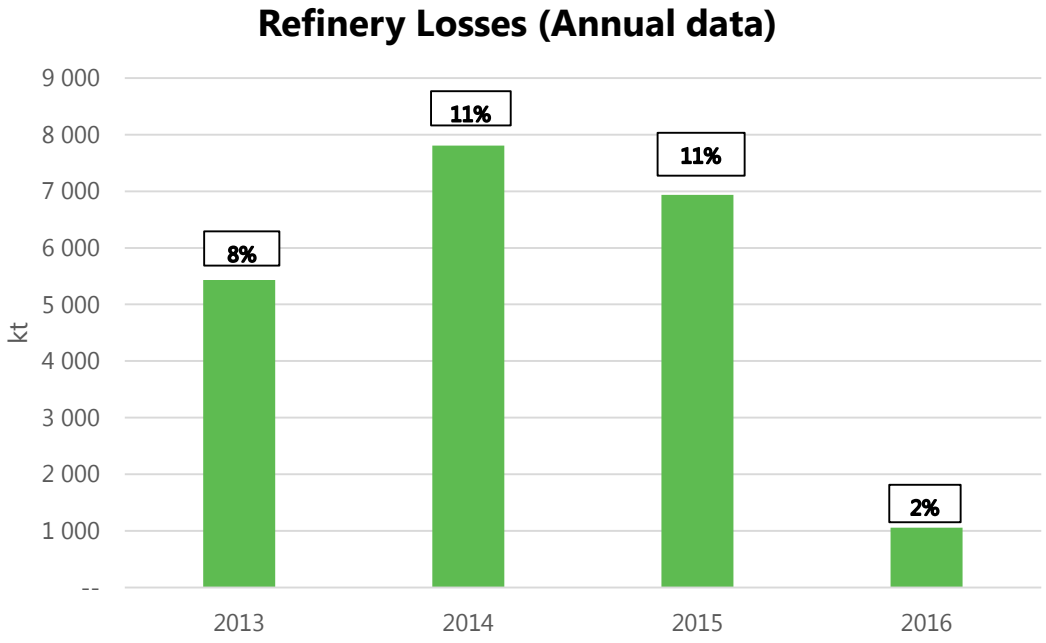
Refinery outputs

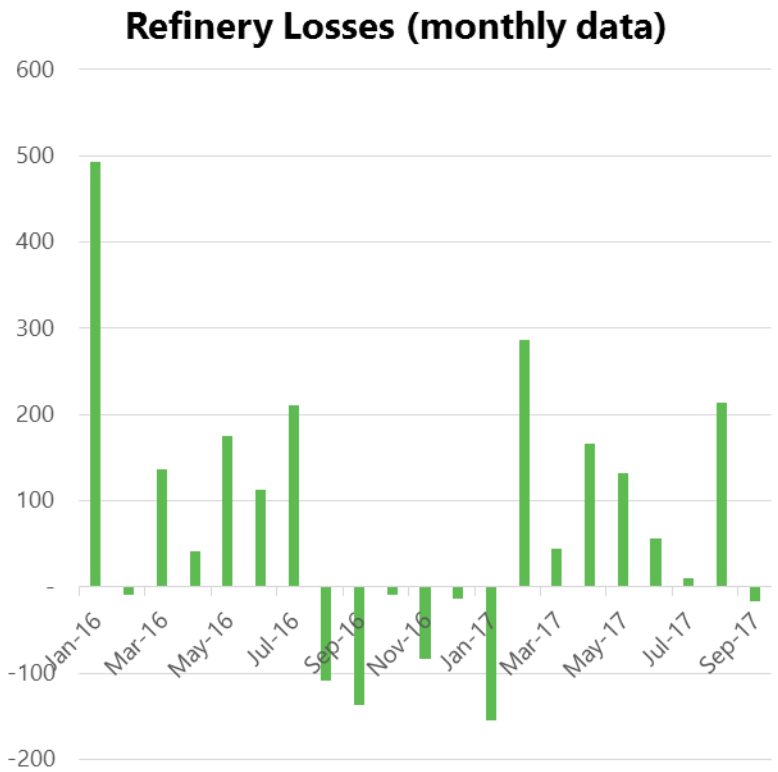


Source: IEA, Monthly oil data service

Why collect monthly oil data – Transparency in the oil market

Data validation - Detailed visualization of possible data issues



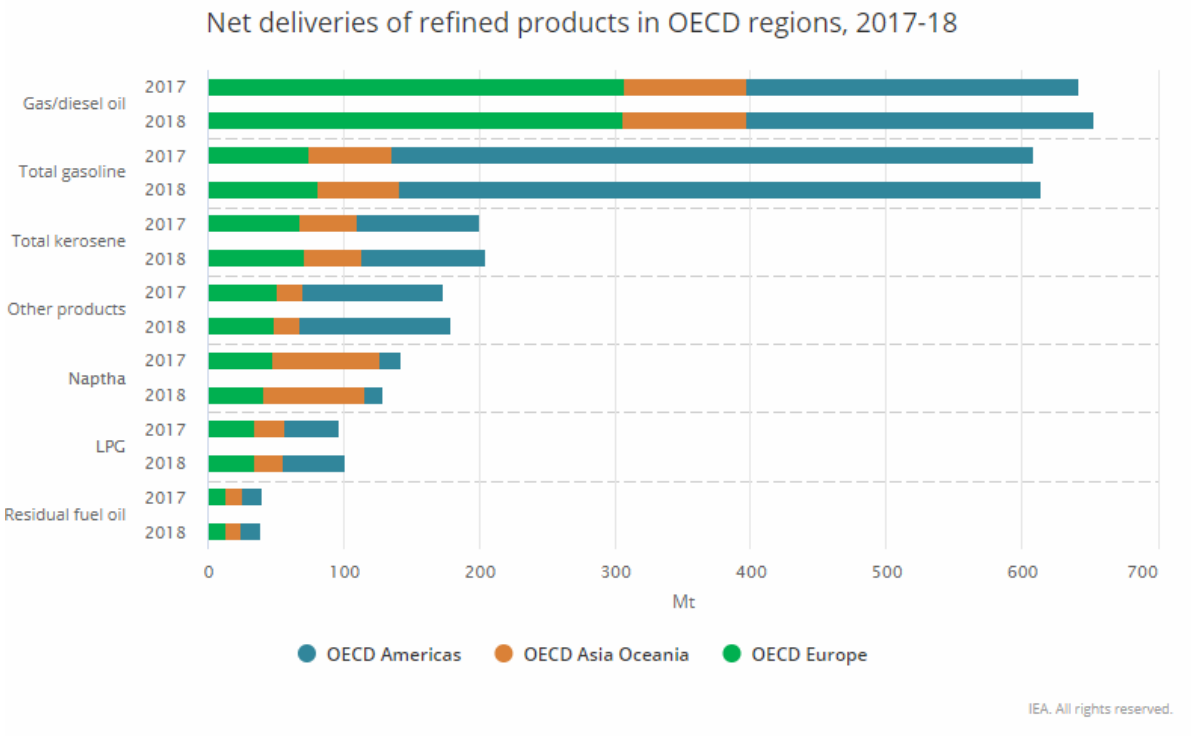


% - Refinery losses as a percentage of refinery intake
*A **negative** refinery loss implies a refinery **gain***

Source: IEA, Monthly oil data service, Oil Information 2017

Why collect monthly oil data – Improved analysis and policies

Preliminary source of information



https://www.iea.org/newsroom/news/2019/april/key-oil-trends-2018.html

Why collect monthly oil data – Improved analysis and policies

Basis for comparison with annual data

South Africa - Total Gasoline - Demand

South Africa

Press once you select the country

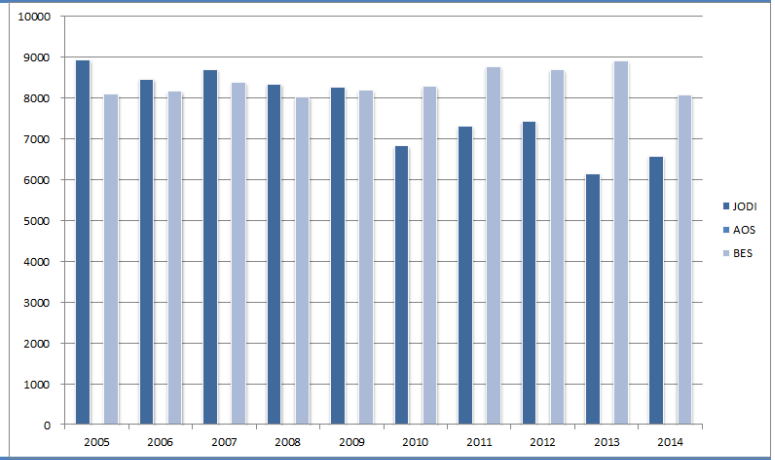
Choose a product:

Total Gasoline (motor,aviation)

Choose a flow:

Demand

Time Series



South Africa - Total Gasoline - Demand 0

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016E	0	0	0	0	0	Trend
JODI	8946	8473	8708	8353	8276	6830	7309	7431	6157	6582	6101	0	0	0	0	0	0	
AOS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
BES	8093	8169	8380	8030	8198	8292	8779	8701	8921	8082	0	0	0	0	0	0	0	
JODI-AOS	No AOS	No AOS	No AOS	No AOS	No AOS	No AOS	No AOS	No AOS	No AOS	No AOS	No AOS	No AOS	No AOS	No AOS	No AOS	No AOS	No AOS	
as % JODI																		
# of JODI months[1]	12	12	12	12	12	12	12	12	12	12	10	0	0	0	0	0	0	

1. Number of months per year in which JODI Maxi data are present

Why collect monthly oil data – Improved analysis and policies

Basis for comparison with annual data

Nigeria - Crude Oil - Production

Nigeria

Press once you select the country

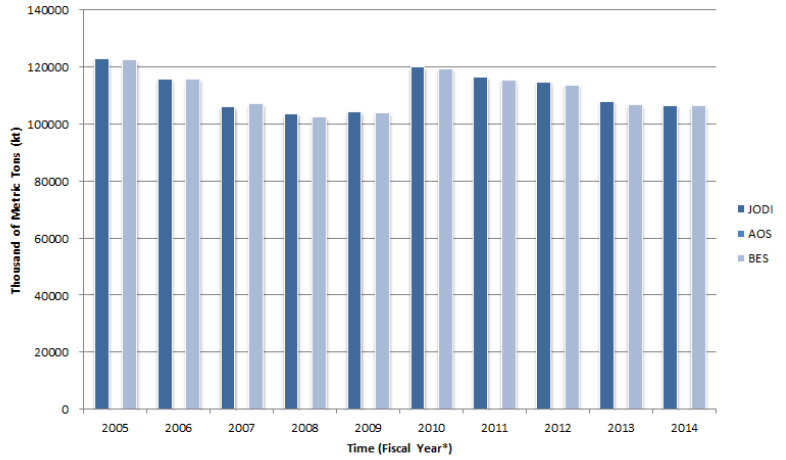
Choose a product:

Crude Oil

Choose a flow:

Production

Time Series



Nigeria - Crude Oil - Production 0

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016E	0	0	0	0	0	Trend
JODI	122840	115845	106105	103739	104371	120083	116557	114863	107975	106533	103887	88901	0	0	0	0	0	
AOS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
BES	122488	115893	107067	102499	104046	119472	115499	113704	106732	106472	0	0	0	0	0	0	0	
JODI-AOS	No AOS	No AOS	No AOS	No AOS	No AOS	No AOS	No AOS	No AOS	No AOS	No AOS	No AOS	No AOS	No AOS	No AOS	No AOS	No AOS	No AOS	
as % JODI																		
# of JODI months[1]	12	12	12	12	12	12	12	12	12	12	12	12	0	0	0	0	0	

1. Number of months per year in which JODI Maxi data are present

Why collect monthly oil data – Improved analysis and policies

Basis for comparison with annual data

Nigeria - Natural gas liquids - Production

Nigeria

Press once you select the country

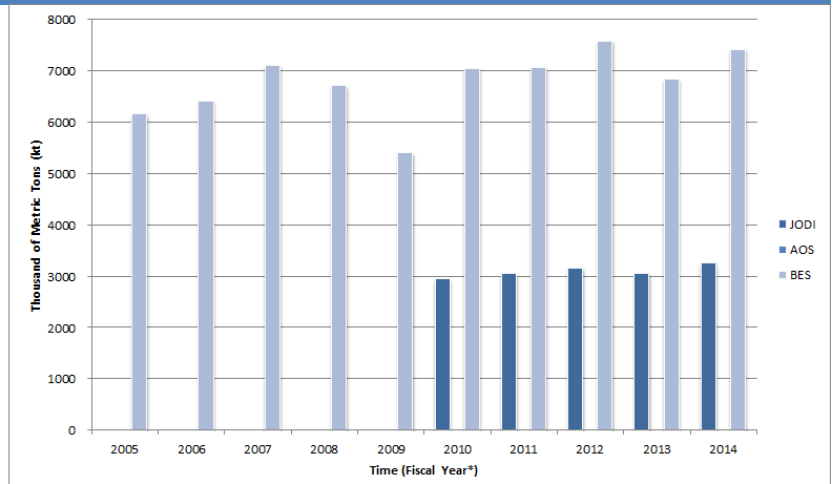
Choose a product:

Natural Gas Liquids

Choose a flow:

Production

Time Series



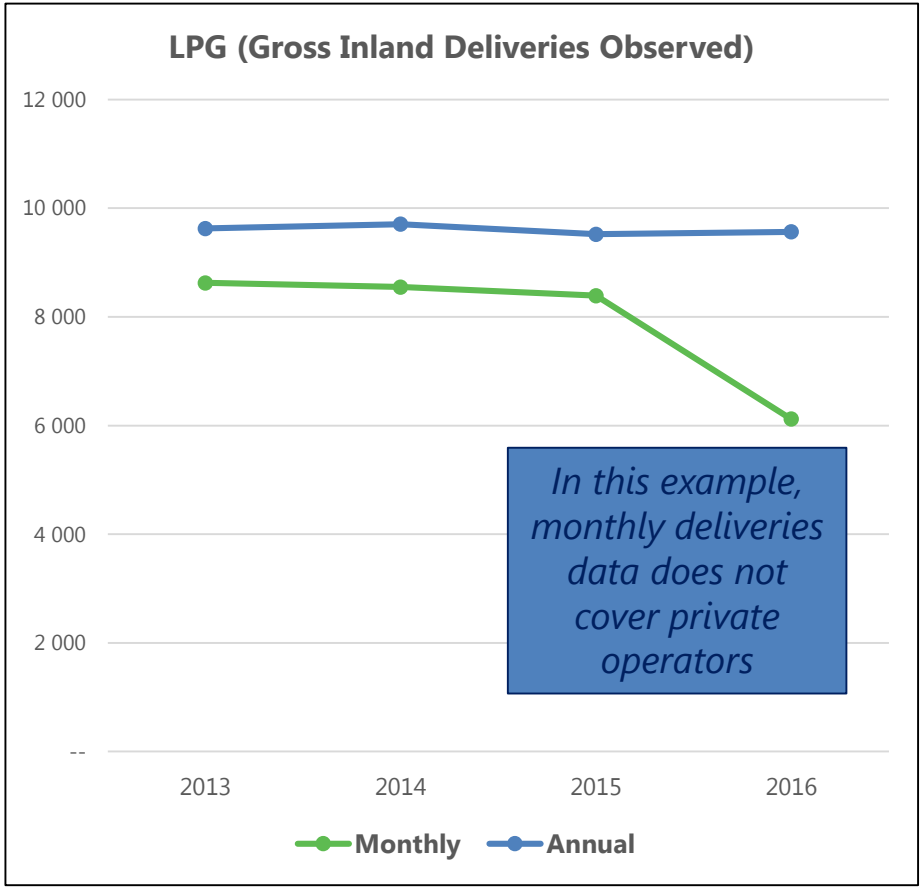
Nigeria - Natural gas liquids - Production 0

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016E	0	0	0	0	0	Trend
JODI	0	0	0	0	0	2950	3061	3169	3065	3270	2970	2747	0	0	0	0	0	
AOS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
BES	6160	6421	7107	6715	5405	7039	7061	7590	6840	7426	0	0	0	0	0	0	0	
JODI-AOS as % JODI	No AOS	No AOS	No AOS	No AOS	No AOS	No AOS	No AOS	No AOS	No AOS	No AOS	No AOS	No AOS	No AOS	No AOS	No AOS	No AOS	No AOS	
# of JODI months[1]	0	0	0	0	0	11	12	12	12	12	12	12	0	0	0	0	0	

1. Number of months per year in which JODI Maxi data are present

Challenges in collecting monthly data

- Timeliness can be a factor
- The data collection system of a country also matters (voluntary v. mandatory)
- Confidentiality issues



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