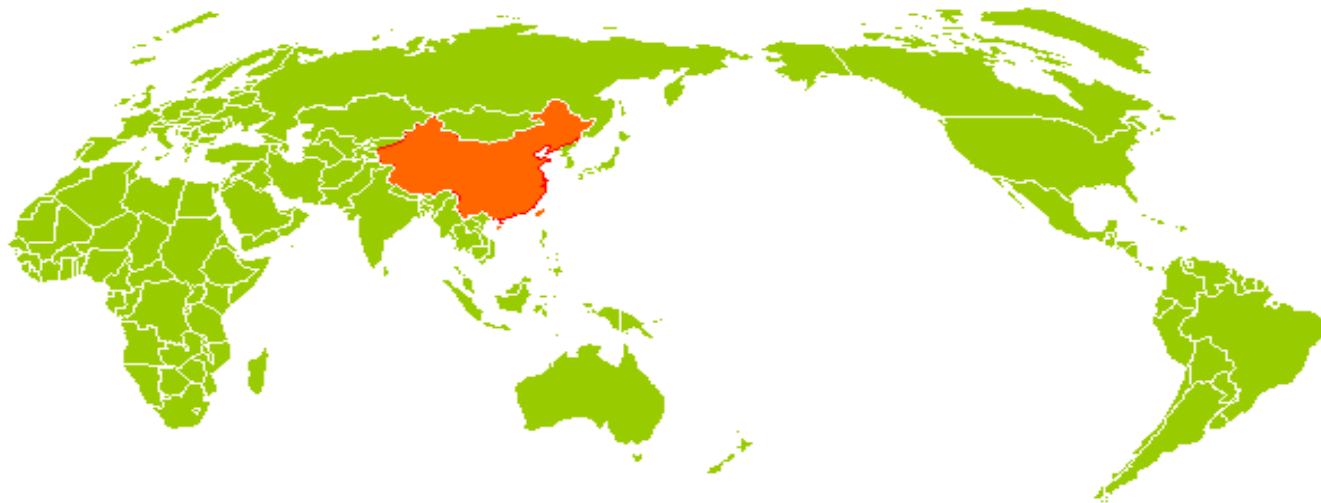


# Global Oil and Gas Development Advancement and Tendency



**CNPC RIPED**  
**December, 2019**

# Background

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<b>Who did it:</b>	CNPC RIPED Technical Team
<b>What were analyzed:</b>	7 Million Data, 270 Reports, 13789 O&G Fields, 133 Countries
<b>Information Covered:</b>	Situation, Features, Potential, Tendency
<b>Anything different:</b>	Full Life Cycle Scenario In Depth Analysis by Features, by Regions, by Sectors, by Stages
<b>Value added:</b>	for CNPC for IOC/NOC/Independents for Stakeholders for Services .....

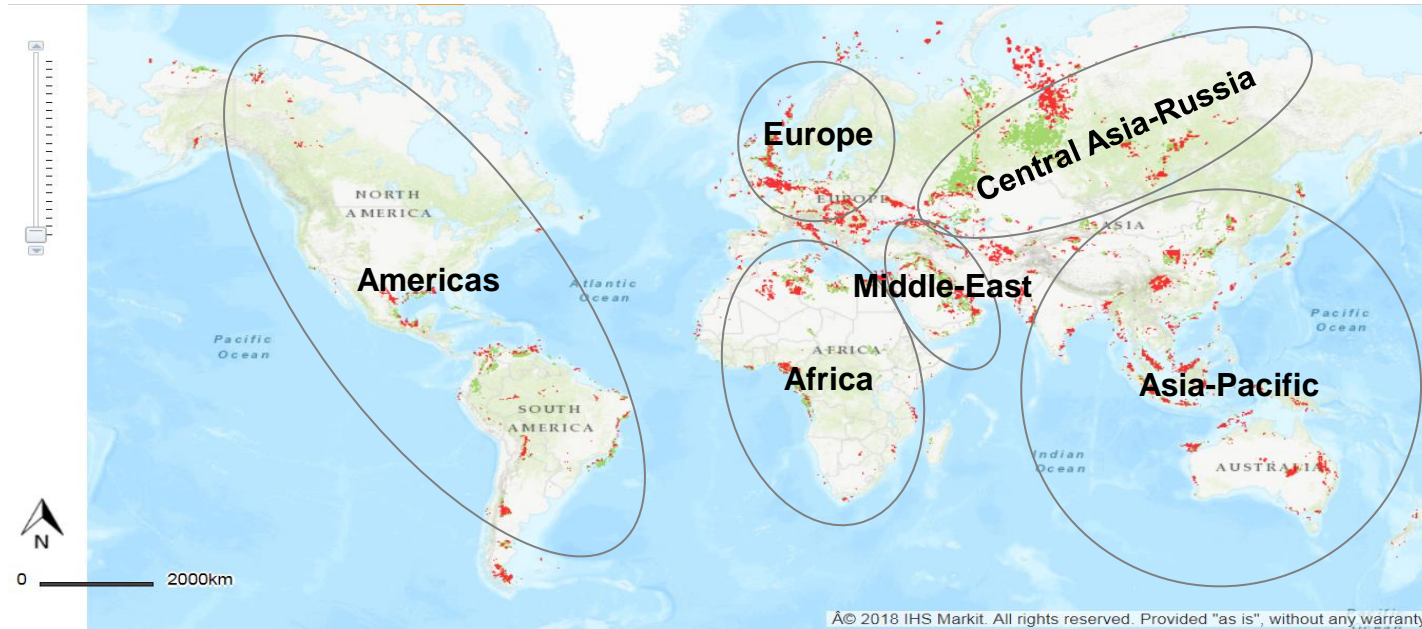
**Situation and Distribution of Oil & Gas Development**

**Advancement and Features of Oil & Gas Development**

**Characteristics and Tendency in Key Sectors**

## Global O&G Regions/Basins/Fields at a Glance

- ❑ By the end of 2018, **133** countries in **6** regions
- ❑ Total **423** basins and **13789** O&G fields (Oil: **8291**, Gas: **5498** )
- ❑ **3624** on stream O&G fields (Oil: **2441**, Gas: **1183**)



## Global 2018 O&G Production by Region & Type

- Major producing regions: 2 high, 1 medium, 3 low
- Oil Vs Gas: 59: 41 (YOY gas production ↑ 1%)
- Different contribution by types

Region	On Stream O&G Fields	Production in 2018			Production Contribution By Type
		Crude oil 100 MT	Natural Gas 100 MCM	O&G 100 MToE	
Americas	1591	14.14	11699	24.02	unconventional oil (28%) onshore conventional oil (20%)
Middle-East	199	15.41	6571	20.96	onshore conventional oil (54%) offshore oil (18%)
Central Asia-Russia	484	7.08	8669	14.4	onshore conventional gas (48%) onshore conventional oil (43%)
Asia-Pacific	449	3.46	6030	8.55	offshore gas (30%) onshore conventional gas (21%)
Africa	426	4.13	2628	6.35	offshore oil (33%) onshore oil (31%)
Europe	475	1.75	2515	3.87	offshore gas (40%) offshore gas (37%)
<b>TOTAL</b>	<b>3624</b>	<b>45.97</b>	<b>38112</b>	<b>78.15</b>	

## Regional O&G Production & the Additional by Year

- Annually average in a decade: **↑+1.94%**
- Faster growth in 2018: **↑ 263 MT, ↑ 3.48%**
- **Gas** faster than oil: **4.85% & 2.57%**
- **Americas:** Largest production contributor: **179 MT, 68.1%** of total Production Increment

Year Region	2017			2018			2018 Production Increment			2018 Rate of Growth (%)		
	Crude Oil 100 MT	NG 100 MCM	O&G 100 MTtoE	Crude Oil 100MT	NG 100 MCM	O & G 100 MTtoE	Crude Oil 100MT	NG 100 MCM	O&G 100 MTtoE	Crude Oil	NG	O&G Equivalent
Central Asia-Russia	6.97	8256	13.94	7.08	8669	14.40	0.11	413	0.46	1.58	5.00	3.30
Africa	4.03	2271	5.95	4.13	2628	6.35	0.1	357	0.4	2.48	15.72	6.72
Middle-East	15.48	6348	20.84	15.41	6571	20.96	-0.07	223	0.12	-0.45	3.51	0.58
<b>Americas</b>	13.00	10925	22.23	14.14	11699	24.02	<b>1.14</b>	<b>774</b>	<b>1.79</b>	<b>8.77</b>	<b>7.08</b>	<b>8.05</b>
Asia-Pacific	3.59	5903	8.57	3.46	6030	8.55	-0.13	127	-0.02	-3.62	2.15	-0.23
Europe	1.75	2646	3.99	1.75	2515	3.87	0	-131	-0.12	0	-4.95	-3.01
Total	44.82	36349	75.52	45.97	38112	78.15	1.15	1763	<b>2.63</b>	<b>2.57</b>	<b>4.85</b>	<b>3.48</b>

## Regional O&G Production & the Additional by Type/ by Year

- ❑ Oil: Gas **59: 41** (Gas **↑ 1%**)
- ❑ Contribution by Type: **4: 2: 1**
- ❑ Additional by Oil Vs by Gas: **44: 56 (Gas > Oil)**
- ❑ Additional by Sector: **Onshore Conventional ≈ Offshore + Unconventional**

Year Type	2017			2018			2018 Production Increment			2018 Rate of Growth (%)		
	Crude Oil 100 MT	NG 100MCM	O&G 100 MTtoE	Crude Oil 100MT	NG 100 MCM	O&G 100 MTtoE	Crude Oil 100MT	NG 100 MCM	O&G 100 MTtoE	Crude Oil	NG	O&G Equivalent
<b>Onshore conventional oil&amp;gas</b>	25.42	19073	41.52	25.92	20069	42.87	<b>0.50</b>	<b>996</b>	<b>1.35</b>	1.97	5.22	3.25
<b>Offshore oil&amp;gas</b>	12.14	10961	21.40	12.33	11372	21.93	0.19	411	0.53	1.57	3.75	2.48
<b>Unconventional oil&amp;gas</b>	7.26	6315	12.60	7.72	6671	13.35	0.46	356	0.75	<b>6.34</b>	<b>5.64</b>	<b>5.95</b>
<b>Total</b>	<b>44.82</b>	<b>36349</b>	<b>75.52</b>	<b>45.97</b>	<b>38112</b>	<b>78.15</b>	<b>1.15</b>	<b>1763</b>	<b>2.63</b>	<b>2.57</b>	<b>4.85</b>	<b>3.48</b>

## Global None Producing O&G Fields Analysis by Region

- ❑ Onstream O&G fields : None-producing O&G fields: 3624: 10165
- ❑ None-producing **gas fields**: 78% of Total gas fields
- ❑ None-producing oil fields: 70% of Total gas fields
- ❑ **Key factor: poor economy: 6363**
- ❑ Pre--commission: 1963, Decommission: 1031
- ❑ None-producing : On stream : Decommission 7: 2: 1

None Producing O&G Fields in 2018

Reason	Asia-Pacific	Central Asia- Russia	Europe	Americas	Africa	Middle- East	Total
Relinquished	14	10	165	46	11	1	247
Decommission	238	149	368	145	107	24	1031
<b>Uneconomical</b>	1590	1528	1058	814	1073	280	<b>6343</b>
Lack of technology	123	48	99	70	78	72	490
Under construction	19	8	30	12	15	7	91
Pre--commission	389	314	295	827	76	62	1963
Total	2373	2057	2015	1914	1360	446	10165



**Situation and Distribution of Oil & Gas Development**

**Advancement and Features of Oil & Gas Development**

**Characteristics and Tendency in Key Sectors**

**Oil:** Steady enhancement, Americas outstanding

**Gas:** Fast growth, all types involved

**Investment:** Stable increasement, efficiency improved

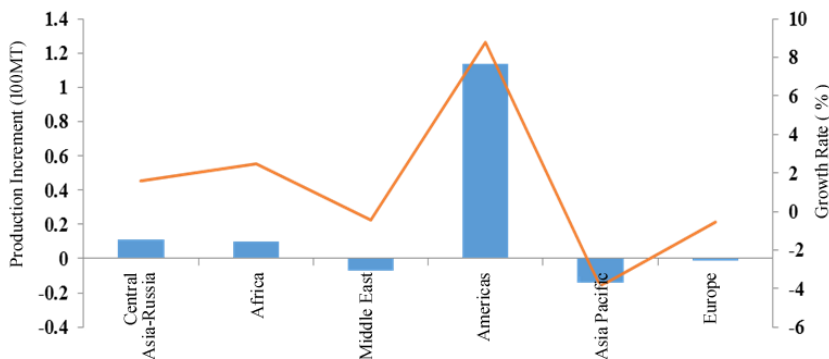
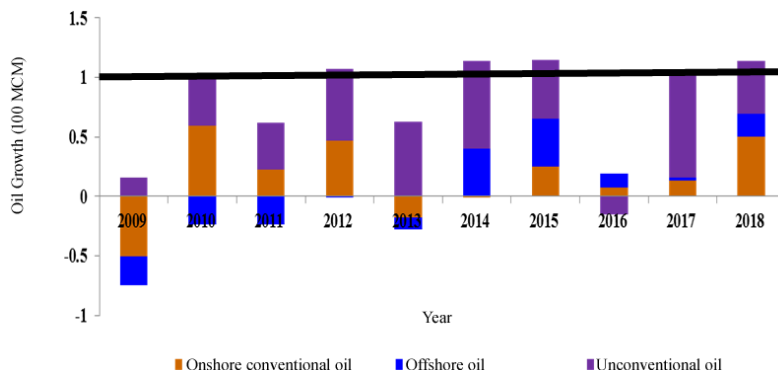
**Transaction:** Moderate Asset transaction, portfolio optimized

**Oil Prices:** High level fluctuating, downside risks there

**International Relationships:** Intensified geopolitics, “hotspot” countries obvious

## Steady enhancement, Americas outstanding

- **Average growth rate : 1.54%, +Production > 100 MT/Year: 6 years /10years**  
Unconventional: major contributor --- annual average growth rate :9.58 %, 2018: 6.34%  
 Onshore conventional: Uneven--- - 50 MT → +59 MT, 2018: ↑ 50 MT  
 Offshore oil: Challenge, fluctuation
- **Americas: Major Production Contributor, the US: 107 MT**  
 Americas: the largest: 114 MT, 8.77%  
 Central-Russia, Africa: ↔ 11 MT, 10 MT, 1.58%, 2.48%  
 Asia-Pacific, the Middle East, Europe: ↓ 12MT, 7MT, 2 MT, 3.24%, 0.43 %, 0.86%

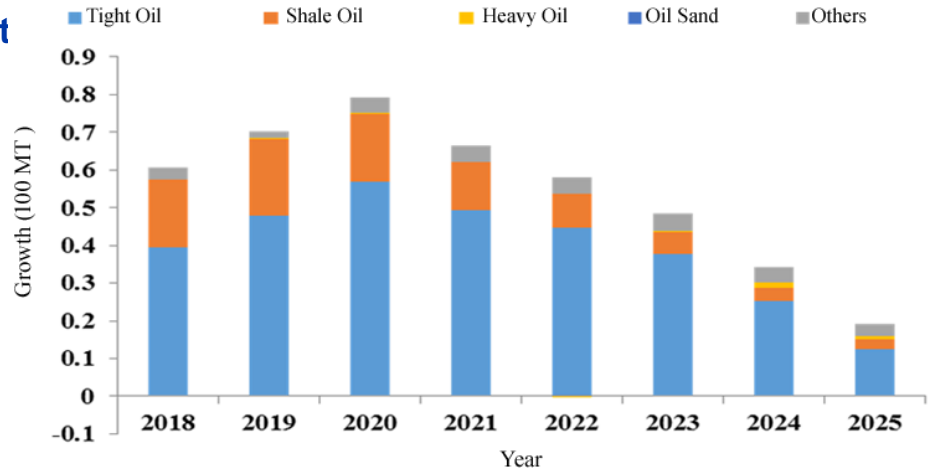


## Steady enhancement, Americas outstanding

- **Fast growth in 2018:** ↑ 115 million tons (2.57%), fastest in the past decade
- **3 Types of oil grew differently:**
  - Onshore conventional: largest: 50 MT (43.48%), major contributors: the US, Iraq, Canada
  - Unconventional oil: **fastest:** 46 MT (6.34%), major contributors: USA
  - Offshore oil: slight: ↑ 19 MT, major contributors: **Saudi Arabia, Brazil**

- **Challenges for sustainable growth in short**

- Unconventionals: slow down ↘
- Onshore conventional: lack large scale
- Offshore: high development cost



### Fast growth, all types involved

#### □ Dramatically growth in the recent 2 years

2018: 176.3 BCM, (4.85%), > 2.57% (annual average in the past decade )

#### □ Contributed by all types

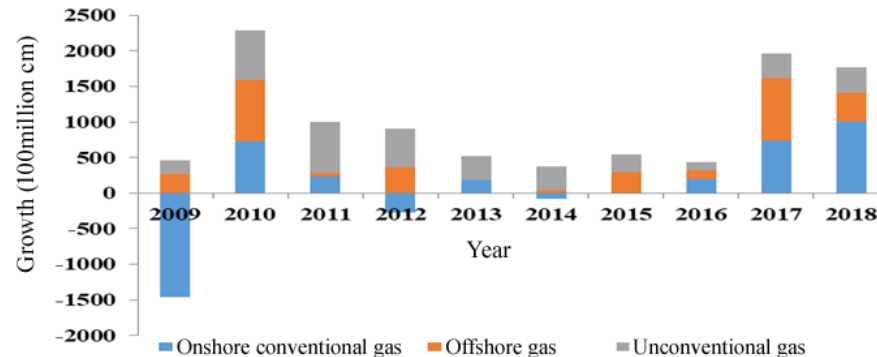
Onshore conventional: 56.5% mainly from: the US, Russia, Canada; sustainability?

Offshore: instable increasement, dominated by Egypt, Australia, Iran;

2018 & 2017

Unconventional: stable increased, mainly from: the US, Oman

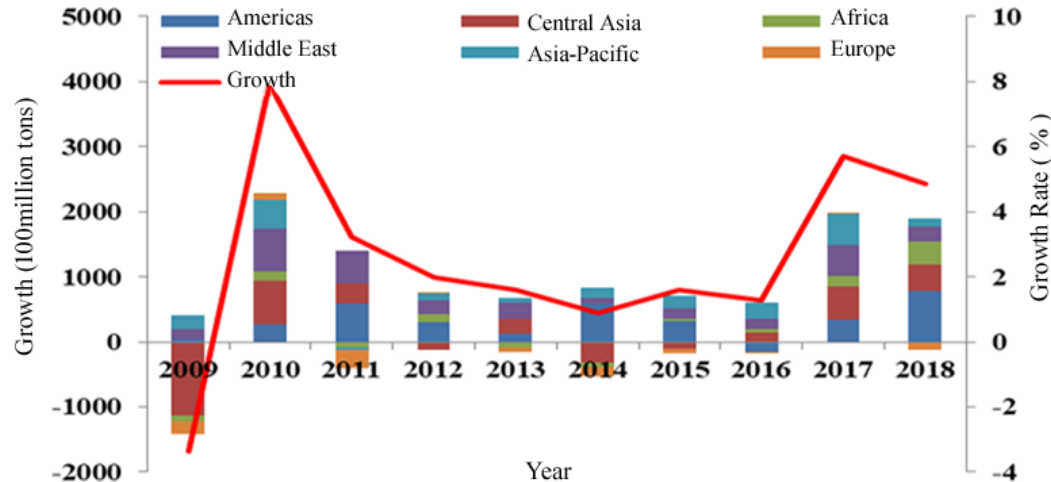
China, less contribution



## Fast growth, all types involved

### □ Gas Production & the additional by Region

- **Americas:** both the largest in output and increase
- Africa: small output, but high growth rate
- Central-Asia & Russia, Middle East and Asia-Pacific: relatively large output, steady growth
- **Europe:** continuous decline



### Stable increasement, efficiency improved

#### □ E&D investment: ↑

407.91 \$ bln (2018) ↑ 7.7% YoY

#### ➤ Onshore:

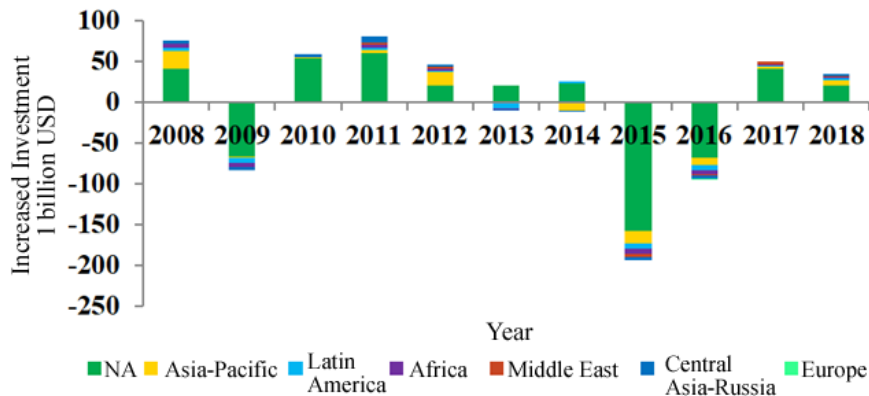
+ ↑ 33.51 \$ bln

North America/Total: 20.4 \$ bln , 63.64%

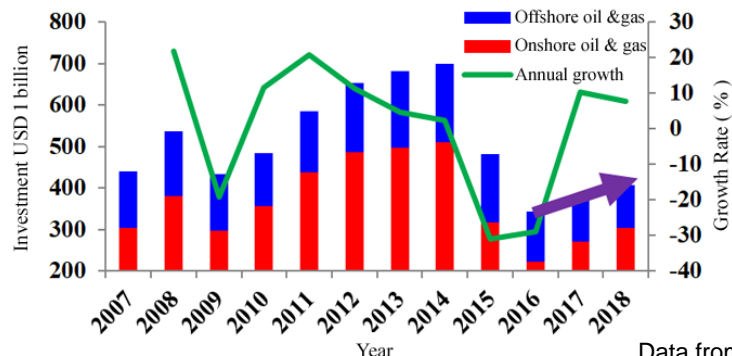
#### ➤ Offshore :

↓ 2.91 \$ bln

+ ↑ 1.46 \$ bln (ME), ↑ 6.78% YoY

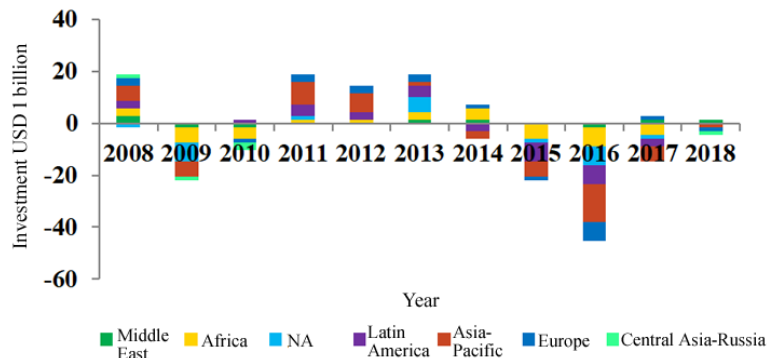


Onshore Additional Oil & Gas Investment by Region & Year



Global Oil & Gas Investment by Year

Data from IHS

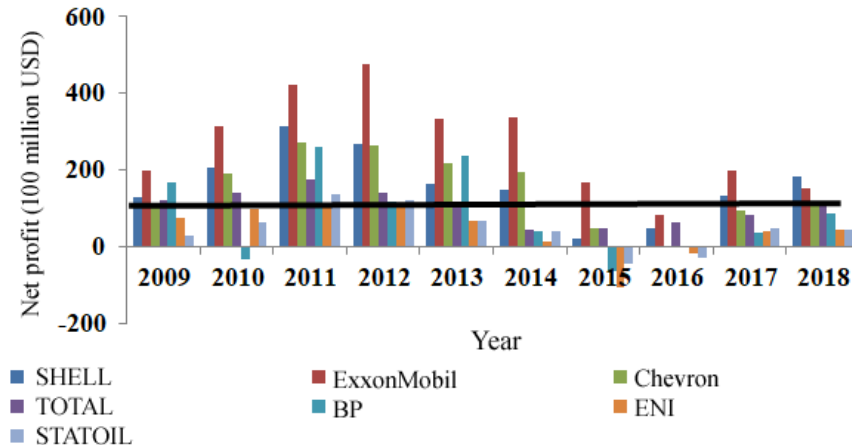


Offshore Additional Oil & Gas Investment by Region & Year

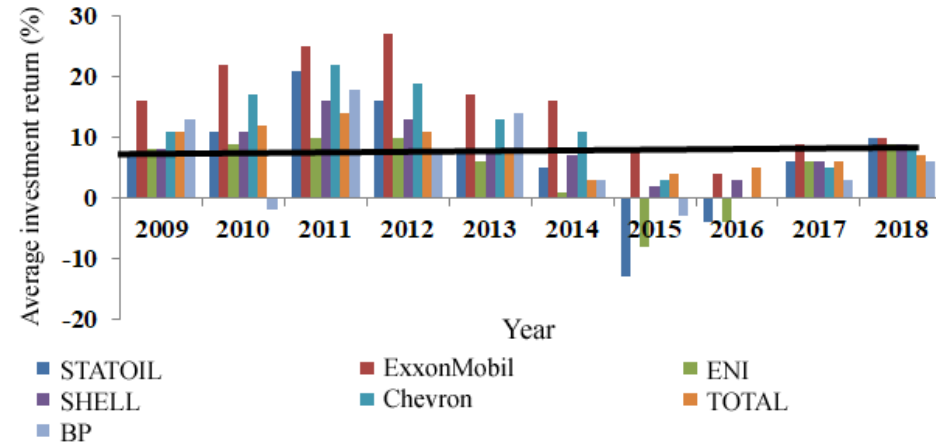
### Stable increasement, efficiency improved

#### 7 Majors' Investment Review in 2018

- Average net profit :  $\uparrow 15.1\%$ , \$10.3 bln ( 2018 ) < \$12.2 bln (the average in 10 years)  
 > Annual Average: ExxonMobil, SHELL, Chevron , TOTAL  
 Best performance: BP (151.43%)
- Average ROIC : 8.4%  
 > Average: EXXON, Eni, SHELL , Chevron



Net profit



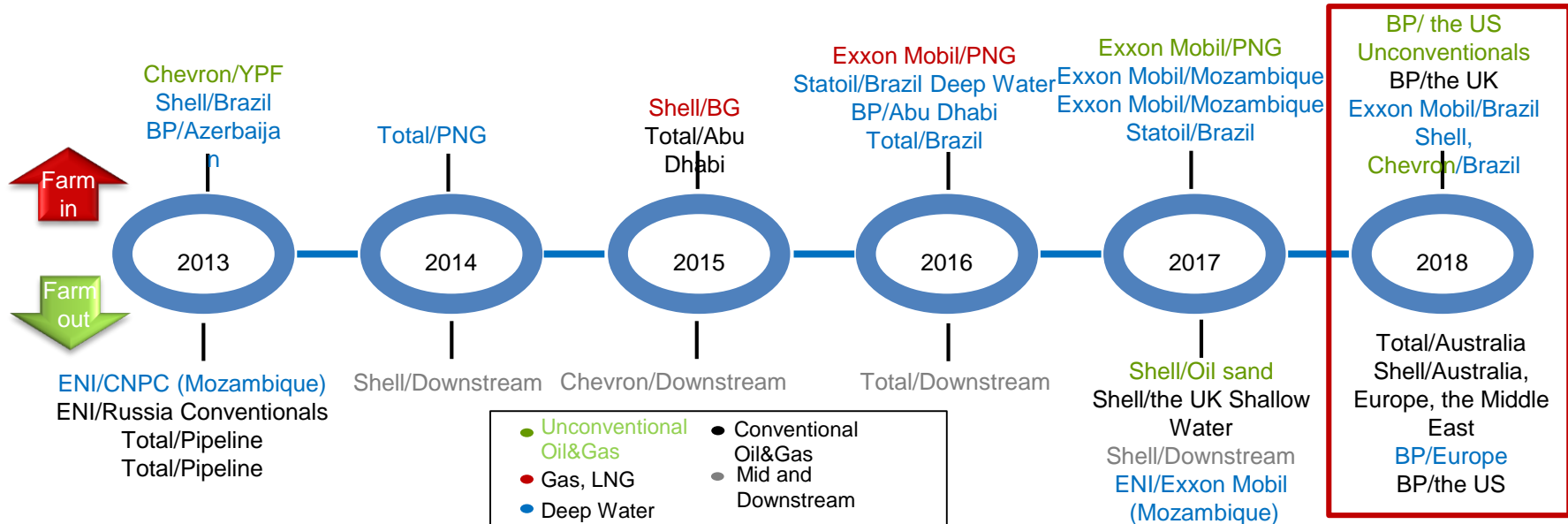
Average ROIC



### Moderate asset transaction, portfolio optimized

#### IOCs: Portfolio Optimization, Operational Excellence

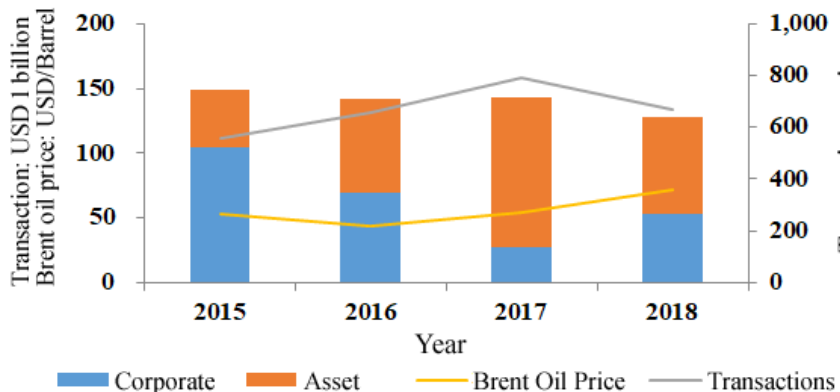
- Portfolio Optimization : Core Potential Asset, highly diversity
- Strategies Highlight : **Technical driven**  
e.g. Exxon Mobil: Unconventionals, back to North America  
Shell: Natural Gas integration
- Operational Excellence: cost effective + operation efficiency → **Enhanced SHs' returns**



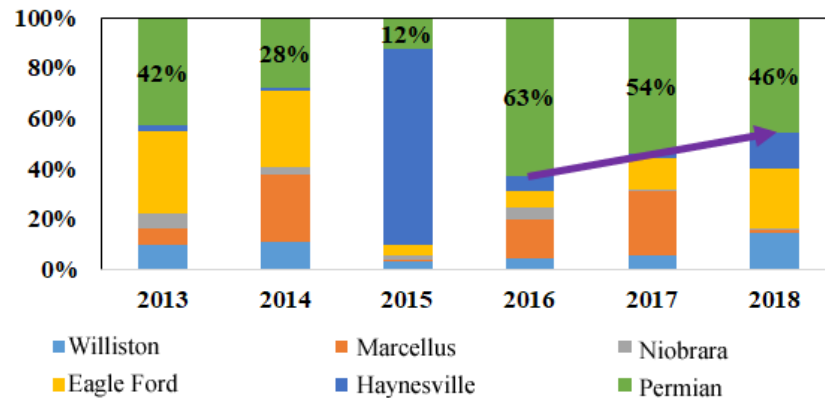
## Moderate asset transaction, portfolio optimized

### Global 2018 Upstream M&A Review

- M&A Transactions:** 672, Capital: USD\$127.5 bln, YoY: ↓ 11%,  
 Asset : USD\$74.9 bln  
 Inter firm: USD\$52.6 bln
- North America:** 68%, the US unconventional assets: most attractive  
 Tight and shale O&G : 57%
- Permian Basin:** Major target, >40.83%(the recent annual average)  
 Reasons: Asset deal price, Transportation restriction



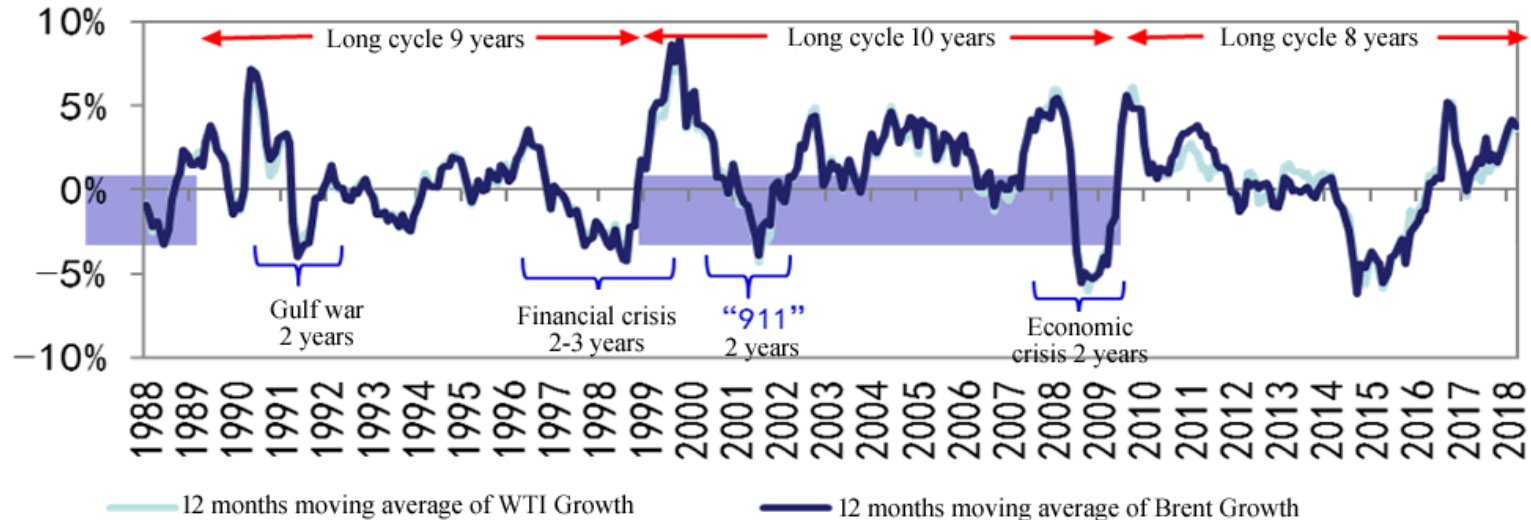
Global upstream M&A Market



Transaction Activities by Basin/Year

### High level fluctuating, downside risks there

- ❑ Fluctuating periodically
- ❑ Long cycle : Supply & Demand.
- ❑ Short cycle : Unexpected & Significant events
- ❑ Current Oil: Plateau of the long cycle
- ❑ Positive factors: Geo-Political & Regional Turmoils

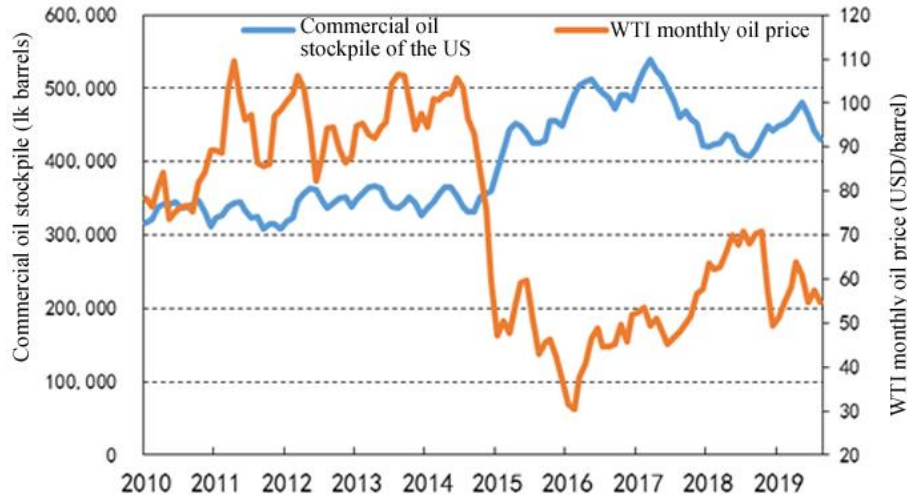


### High level fluctuating, downside risks there

#### Downside Risks

- ❑ Unbalance supply & demand, excess inventory
- ❑ Depressional Manufacturing & Hard Rejuvenation: Global manufacturing PMI: ↓ <50,
- ❑ Trade frictions, anti-globalization

Commercial Crude Oil Inventory in the US

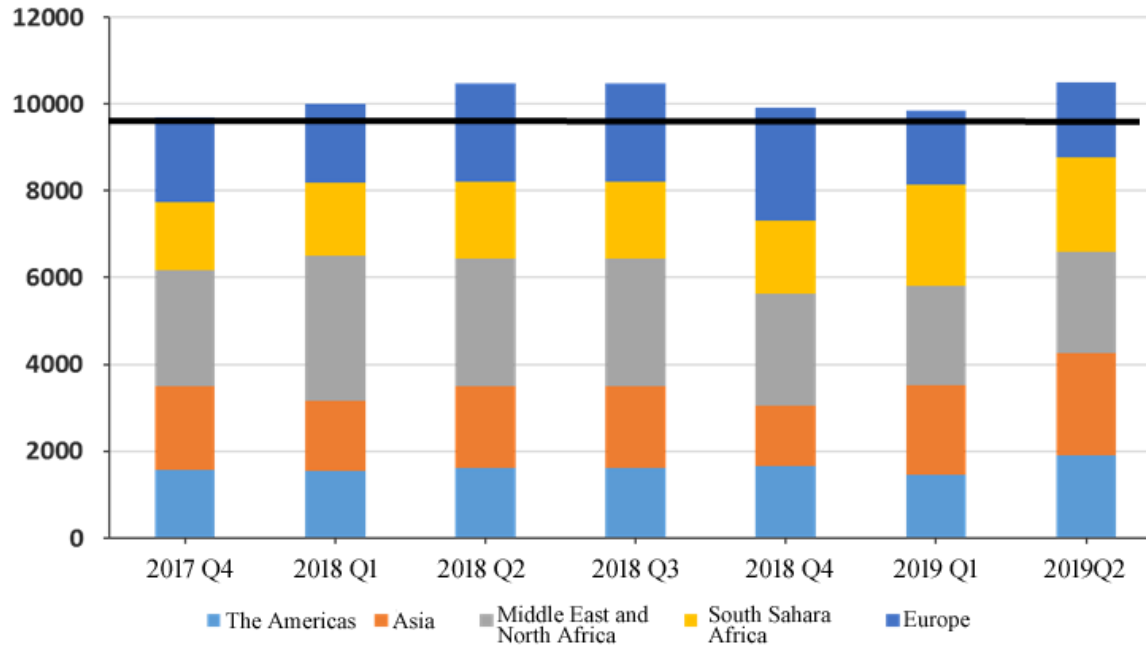


PMI of China and the US



### Intensified geopolitics, “hotspot” countries obvious

- ❑ the US-China-Europe-Russia
- ❑ Security Issues



Political Violence & Crime Events by Region



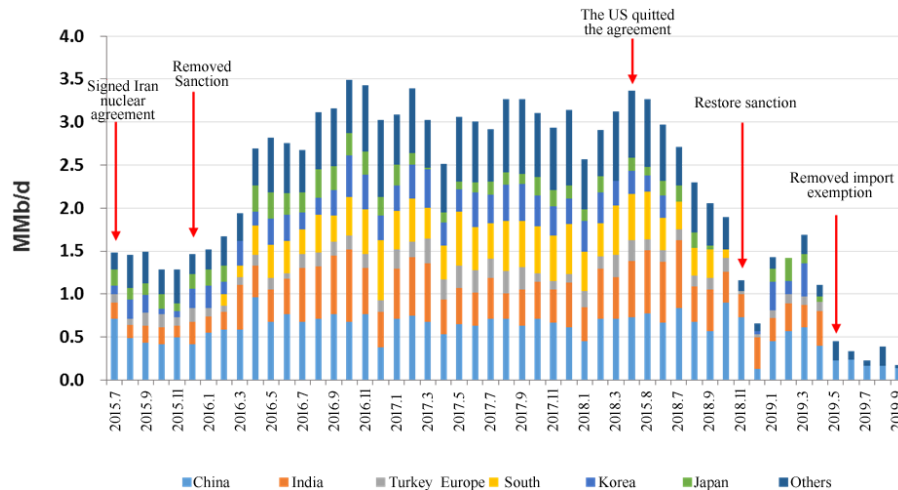
RIPED

# Advancement and Features of Oil & Gas Development

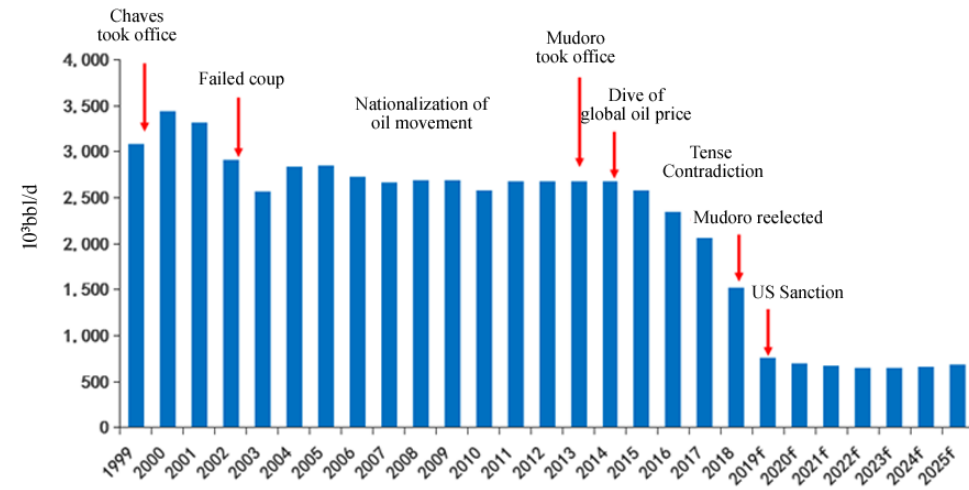
International Relationships

## International Relationships: Intensified geopolitics, “hotspot” countries obvious

- ❑ Iran: Tension with US + Wars risks, → Energy supply from the ME countries
- ❑ Venezuela: Fragile Politics, Hard Economic Rejuvenation → Production decline
- ❑ Saudi Arabia, Iraq, Libya, Sudan, Ecuador, etc.: Uncertainty political situation



Iran Crude Oil Exportation Destination

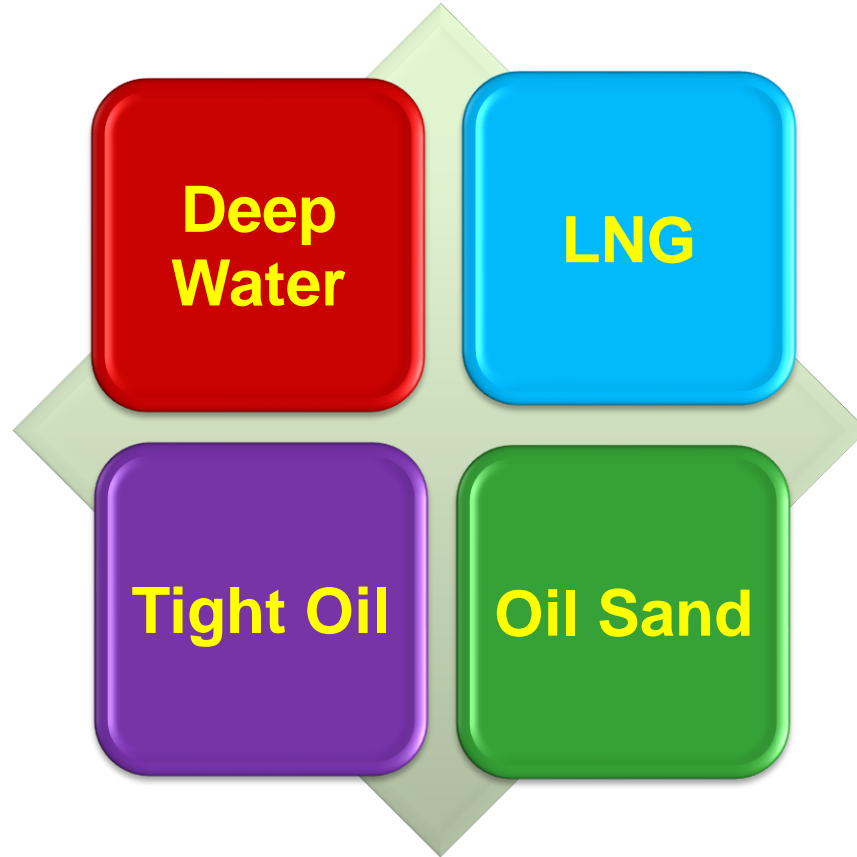


Venezuela Oil production Profile & Prediction

**Situation and Distribution of Oil & Gas Development**

**Advancement and Features of Oil & Gas Development**

**Characteristics and Tendency in Key Sectors**





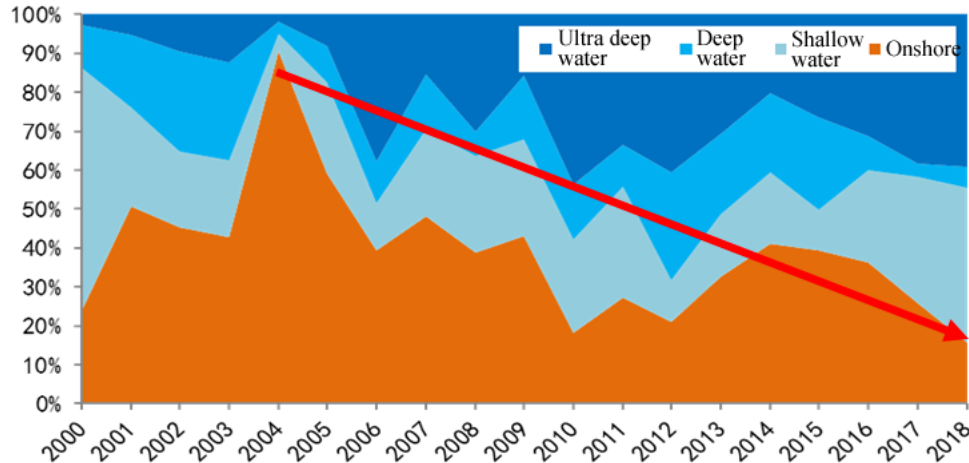
### Deep Water Oil & Gas Development & Outlook

Since 2000

- Offshore resources: major contributor to reserves increasement
- Global average annual newly added reserves  
from offshore: 61 %  
>84 % in 2018

In 2018

- Newly added reserves > 100 mmb : 17 O&G fields  
16 Offshore



No.	Country	Basin	Oil&Gas field
1	Brazil	Santos basin	Guanxuma block A
2	Cyprus	Eratosthenes platform	Crispsos gas field block 1
3	Russia	West Siberian basin	North orbi gas field
4	Guyana	Guyana basin	Langjie block 1
5	Guyana	Guyana basin	Longtaier oil fieldl block 1
6	Australia	Roebuck basin	Duoladuo oil field block 1
7	Russia	Northern sakhalin basin	Triton oil field
8	Norway	Viking graben	Norway block 6506/11/10
9	the UK	Frysseland basin	the UK block 206/04a-04
10	Grenada	Tobago basin	Nutmeg block 2
11	the US	Mexico bay deep water basin	Dover oil field
12	Malaysia	Northwest shaba geosyncline	Trepas oil field block 1
13	Guyana	Guyana basin	Hammerhade oil field block 1
14	Malaysia	Central lucania basin	Timmy oil field block 1
15	Nigeria	Niger delta basin	Hoyo block 1
16	the US	Slope basin in the north	Willoughby westoil field
17	Mexico	Surist basin	Mulah oil field block 1

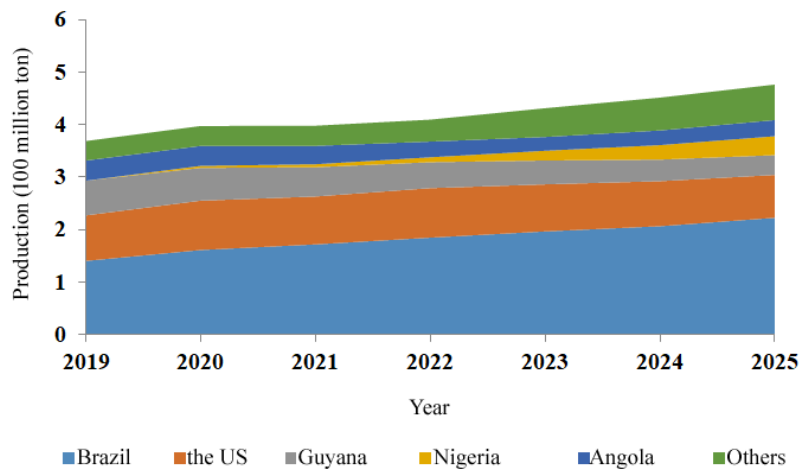
### Great Potential for Deep-water & Ultra-deep-water Petroleum Resources

#### Deep-water and ultra-deep-water O&G resources

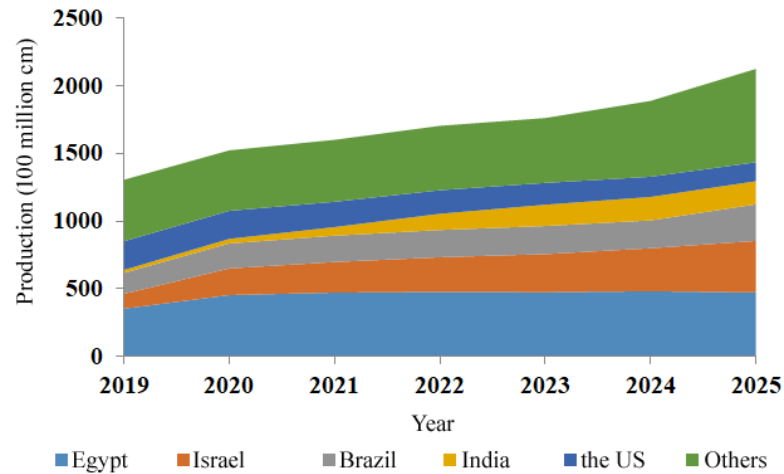
Remaining technical reserves: **26.021 BTOE**

Recovery Factor: **19.03%**

Production: fast growth and long term sustainable



Global Deep Water Crude Oil Production Prediction



Global Deep Water Natural Gas Production Prediction

### Cost is the challenge for Deep-Water Oil & Gas Development

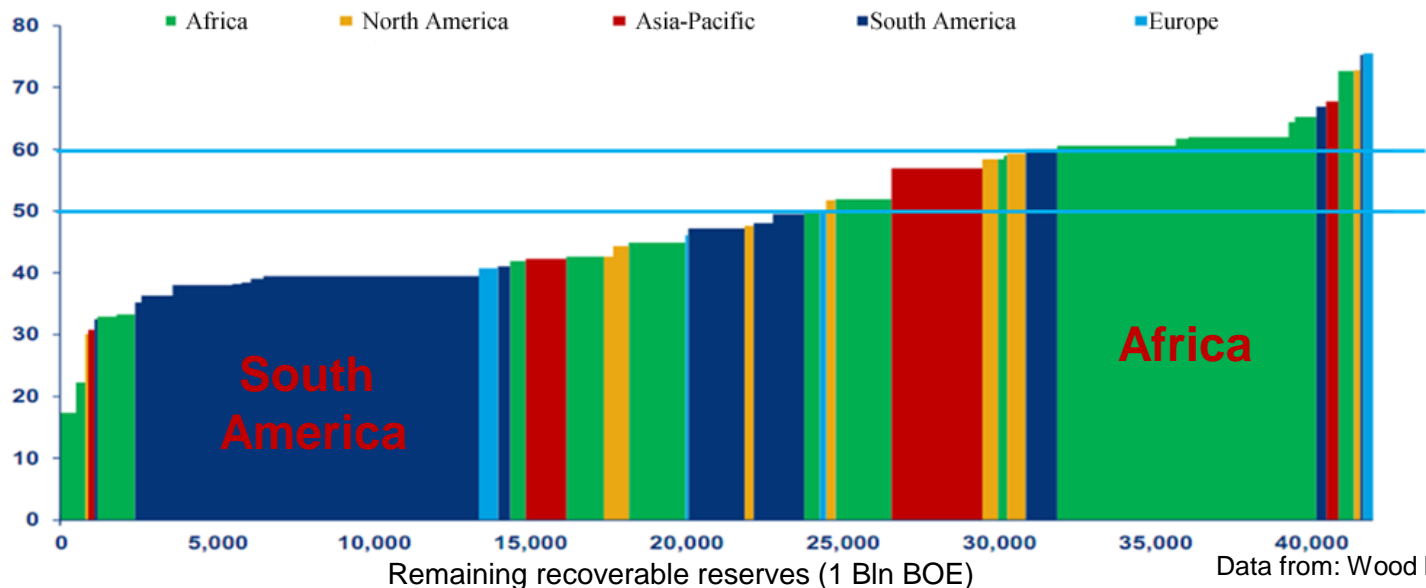
#### Deep- Water O&G Development Cost

Cost reduction by: ↓ 37%

Breakeven UTC < USD60\$: 70%

Regional uneven UTC : Africa > South America, >USD60\$

Pre-FID Deep-Water Breakeven Price profile since 2014



## Petrobras and Majors are in command Global Deep-water Oil & Gas Resources

### Petrobras & Majors (Shell, Exxon, BP, Chevron and Total)

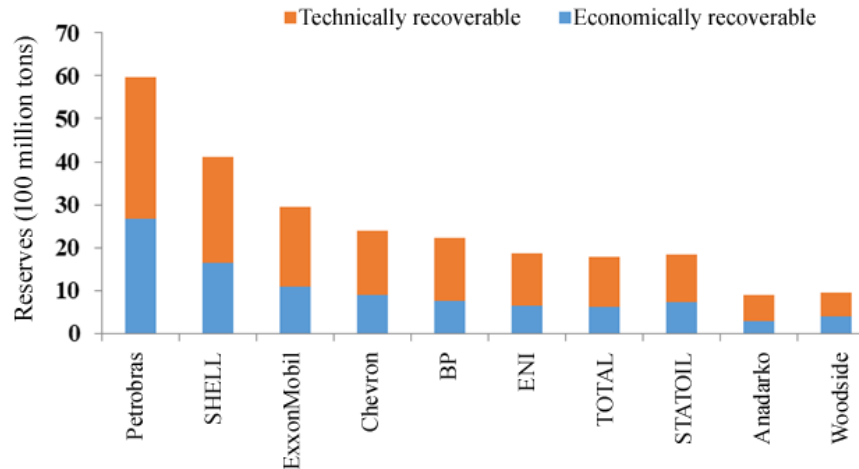
Remaining technical recoverable reserves / Total : 45%

Production / Total : 68%

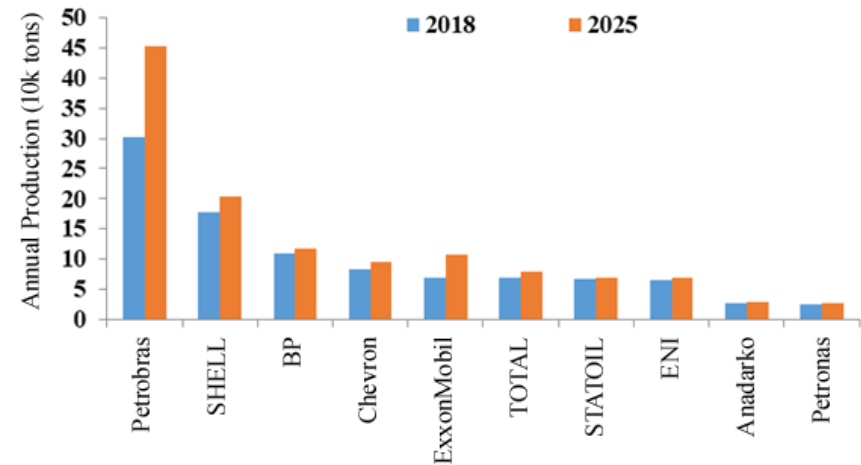
### Chinese oil companies

Strategies & Methodologies

Development & Capability



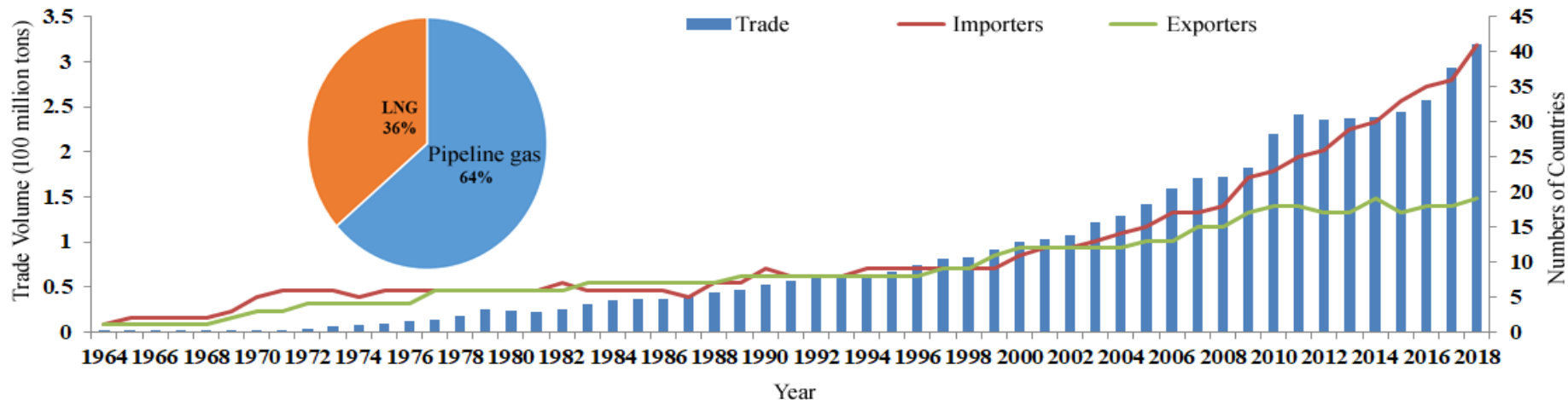
Top 10 oil companies by deep-water oil & gas resources



Top 10 oil companies by deep-water oil & gas production

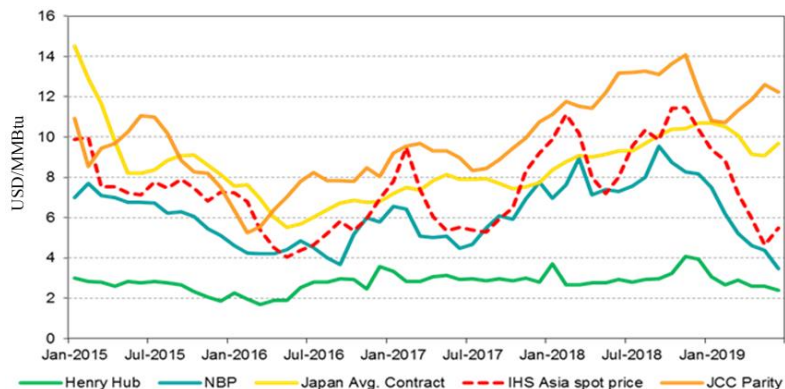
### LNG Operation & Outlook

- ❑ LNG trade: Volume(2018): 320 MT, ↑ 9.6%,  
LNG/NG: 36% 28% → 36% (10years)
- ❑ 19 LNG exporters: Qatar, Australia, Malaysia, the US  
Supply Contribution: 61% of total LNG supply
- ❑ 42 LNG importers, Asia-Pacific region  
Demand : 75% of total demand

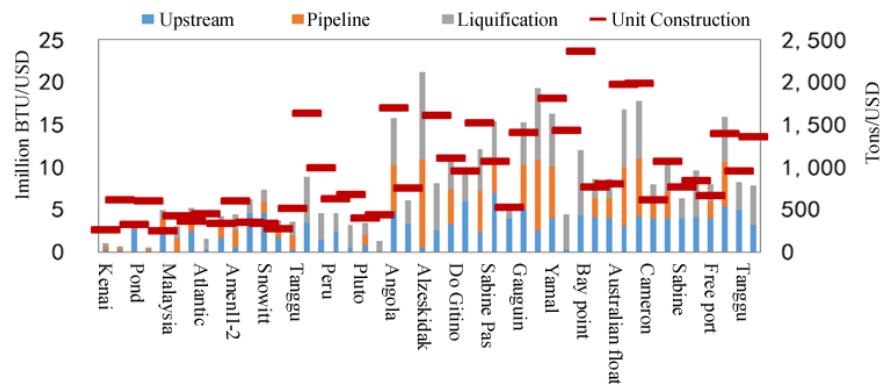


### LNG Price Rebounded While Construction Cost Rising

2015-2018 Natural Gas Price in Global Major Regions



LNG construction cost



**LNG is greatly affected by seasonal factors. The price trend shows U-shaped.**

In 2018, the annual average LNG price **by region**

Asia-Pacific Spot price: **US\$9.78/MM BTU**  
YoY **↑ 43%**

European NBP price: **US\$7.98/MMBTU**  
YoY **↑ 38%**

the US HH price: **US\$3.13/MMBTU**  
YoY **↑ 6%**

The average LNG construction cost **by project stage**

2009-2018 VS 2000-2008

Operational projects: **1005 USD\$ /ton** VS **404 USD\$ /ton**

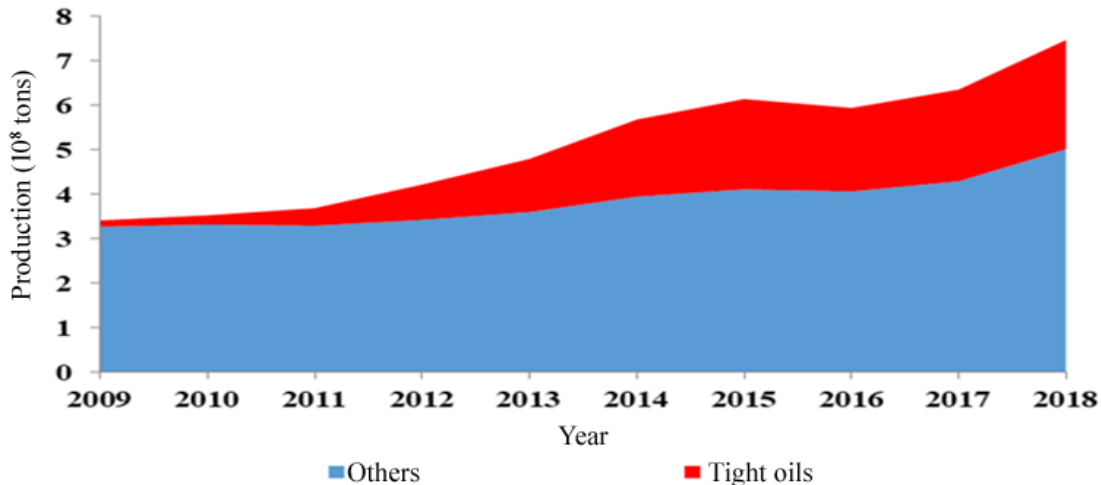
Brand new project: **1501 USD\$ /ton** VS **527 USD\$ /ton**

Expanding project: **58 USD\$ /ton** VS **321 USD\$ /ton**

### Tight Oil Development & Outlook—the US

- ❑ Remaining technical recoverable reserves: 10.35 bln tons
- ❑ Major producing basins:
 

Delaware Basin : 3.596 bln tons	Midland Basin: 2.477 bln tons
Bayshore Basin : 1.724 bln tons	Williston Basin : 1.191 bln tons
- ❑ 2018 Tight oil production contribution: >44%  
2018 crude output: 748 MT

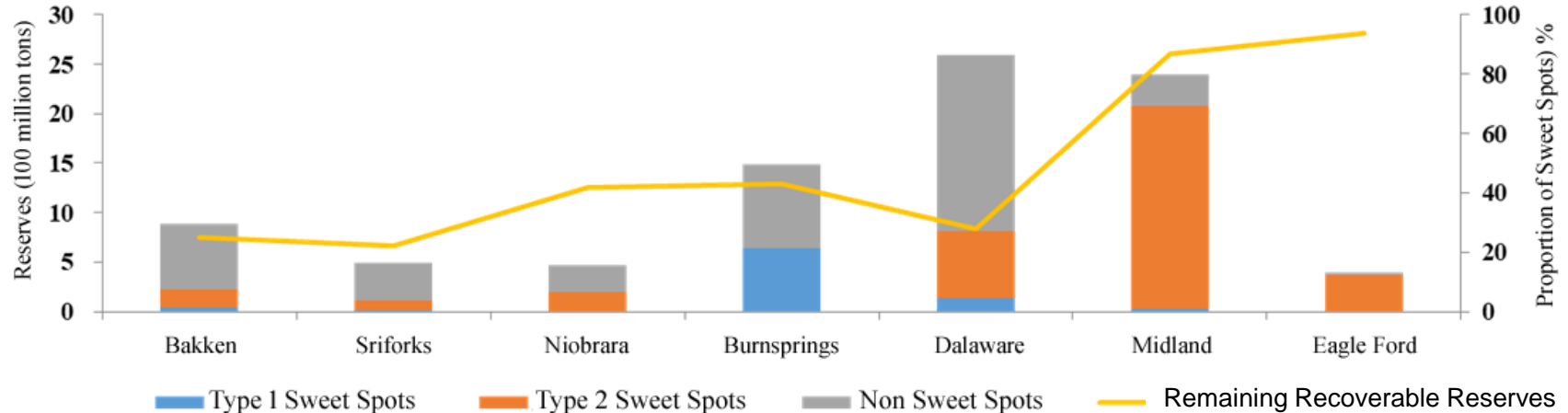


### Tight Oil Development & Outlook—the US

**Sweet spot remaining recoverable reserves: 4.294 Bln tons, 41.49% of the tight oil remaining total**

Sweet spots highlight

- Prolific: Sub-zones in Midland, Eagle Ford: 87-94%  
Major future producing target
- Inferior: Delaware sub-zone  
Challenge & Cost

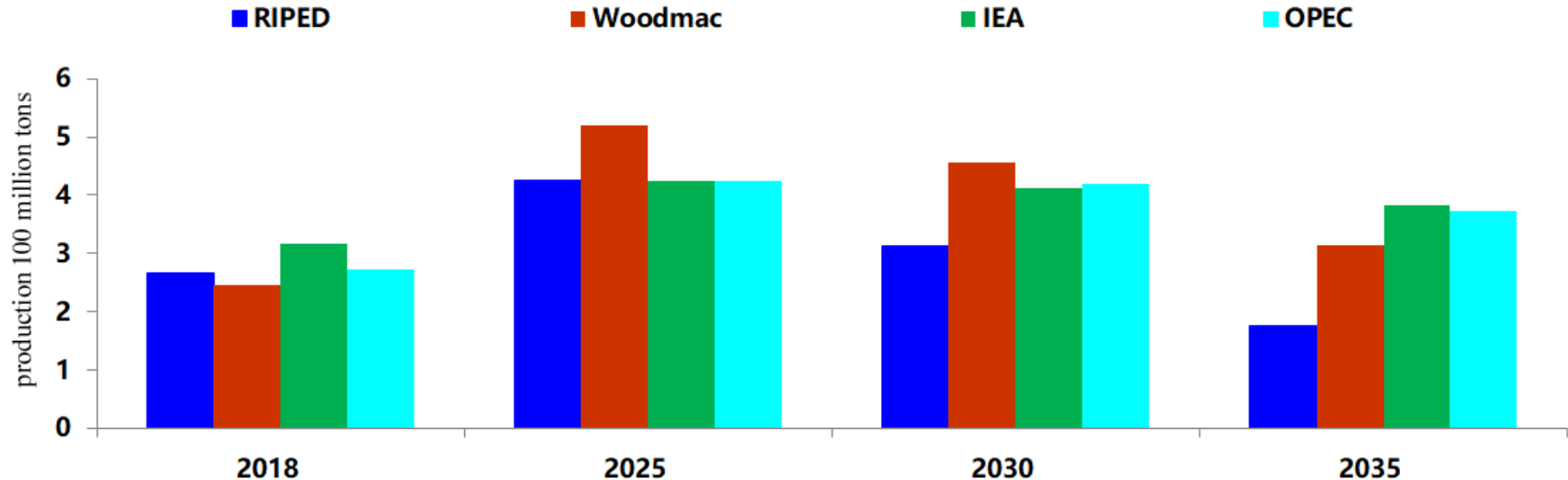




### The US Tight Oil Production will Peak around 2025

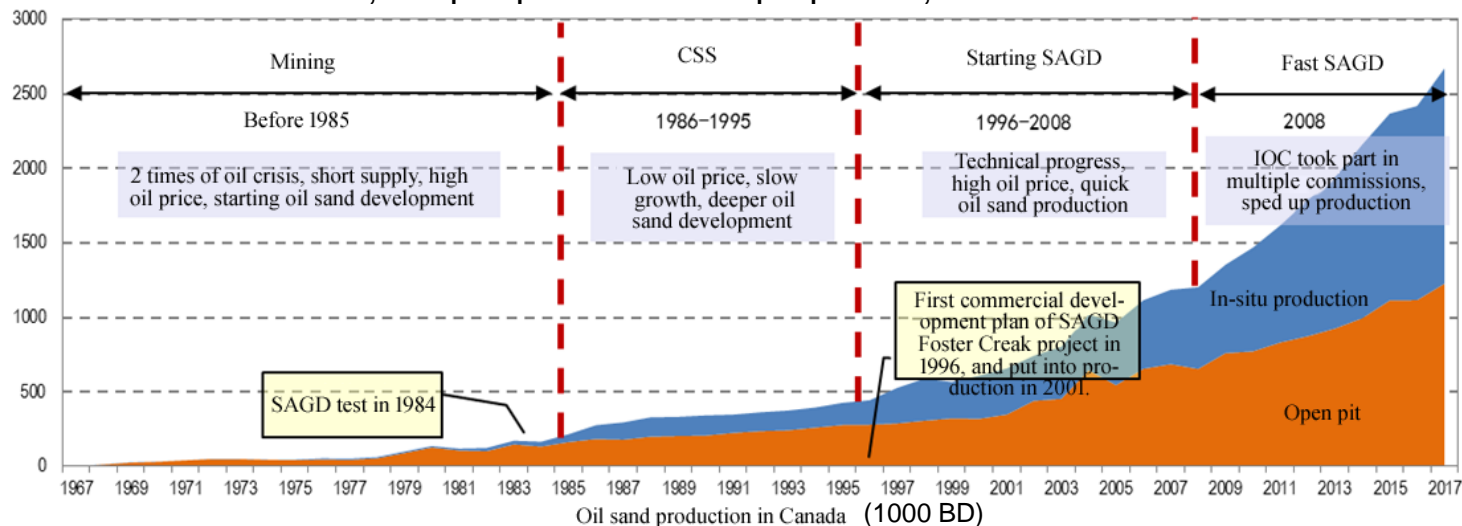
Prediction for tight oil plateau production of the US tight oil in 2025

- ❑ Wood Mackenzie: 520 MT
- ❑ IEA & OPEC : 425 MT
- ❑ **CNPC RIPED**: Similar with IEA & OPEC  
Plateau production in 2025, then declining rapidly



### Oil Sand Development & Outlook — Canada

- ❑ Technical Remaining recoverable reserves: **19.124 bln tons**  
**80.8%** of national total, **36.8%** of North America total  
 production: **134 MT**, increased by **9.11%**
- ❑ Reserves by region: **Alberta (3 Districts)**  
 Athabasca: **80%**, Porosity↑, Permeability↑, Oil saturation↑  
 Open pit mining & SAGD  
 Cold lake: **12%**, poor reservoir properties, CSS  
 Peace lake: **8%**, deep & poor reservoir properties, CSS



### Large Variation on Development Efficiency

#### 83 oil sand projects in Canada

- ❑ Operational projects: 28
- ❑ Commercial potential: 34
- ❑ No favorable condition for commercial: 49

#### Development restriction

- ❑ Reservoir conditions
- ❑ Single well daily production
- ❑ Investment & Cost

Operation before 2012: IRR >10%

Operation after 2012: IRR < 5%

Classification		Open pit	In-situ		Total
			CSS	SAGD	
Production (10k tons/d)	>1.4	6	1	5	12
	0.14<production<1.4		2	14	16
Breakeven (USD/barrel)	>50	3	3	11	17
	<50	3		8	11
IRR (%)	>10	2	2	4	8 (Operation before 2012)
	5--10	3		2	5
	<5	1	1	13	15 (Operation after 2012)

### Slow Oil Sand Development Due to Low Oil Price

Production (2018): **13,400 tons**, YoY **↑9.11%**

In-situ production: **47.75%**. after 2020: **→ Slow down**

Production Prediction: Scaled back by the agencies

IHS & Wood Mackenzie: 2030 Production Prediction: **195 MT**, **60%** from in-Situ

