

# تجزیه و تحلیل صنعت تبدیل گاز طبیعی به مایعات هیدروکربوری (GTL)

وب سایت مرکز مطالعات زنجیره ارزش در صنعت نفت و گاز

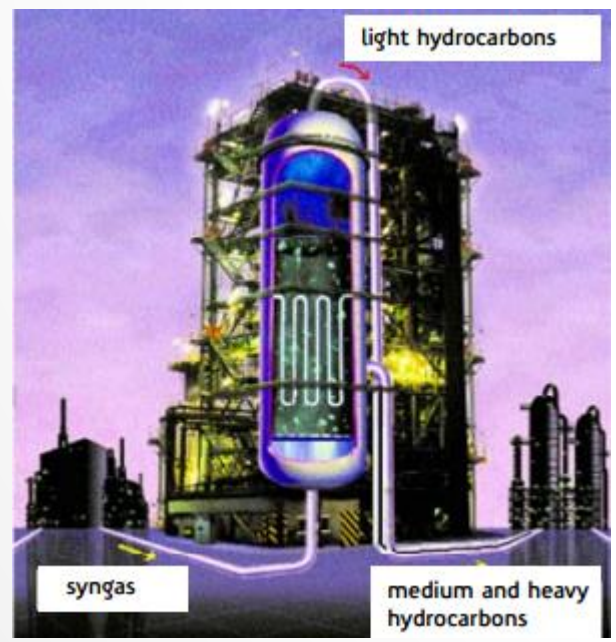
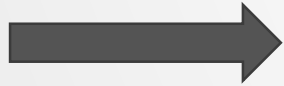
رضا مهدوی پور

خرداد ۹۴



# Definition of GTL Process

**Natural Gas**



**Diesel (70%)**

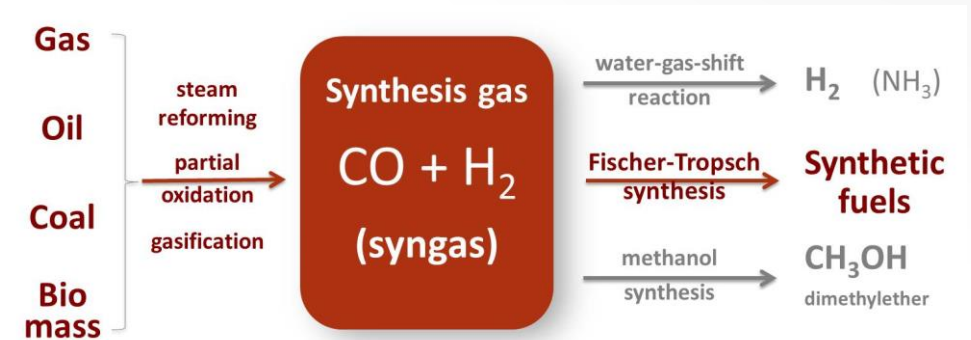
**Naphtha (25%)**

**LPG, Lubes , Waxes (5%)**

**First Process:** Syngas Generation Step

**Second Process:** Fischer- Tropsch Synthesis Step

**Third Process:** Product upgrading Step



Each process step has its own history that has converged to make F-T GTL feasible

**There are three modes of mass transport in which the energy or hydrocarbon content of natural gas can be transported over long distances to a user:**

- 1. By pipeline.**
- 2. As liquefied natural gas (LNG) in specialized ships.**
- 3. By conversion at or near the wellhead to liquid or solid products (methanol, DME, F-T liquids, fertilizers) followed by ocean tankers.**

- Large natural gas reserves,
- Clean fuels regulations,
- Rising oil prices,
- Energy security concerns,
- New technology developments



**have raised interest in Fischer-Tropsch gas-to-liquids (GTL) processes**

Interest in Fischer-Tropsch GTL technologies has greatly depended on

- Oil-natural gas price differentials
- The perception of the size,
- Depletion rate,
- Lifetime of oil and gas reserves.



# Commercial GTL Plants

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**Sasol's ORYX-1 in Qatar (34,000 b/d)**



**Shell's Pearl GTL plant in Qatar (140,000 b/d)**



**Chevron's 34,000 b/d GTL plant at Escravos in Nigeria**



# First Commercial GTL

Sasol's ORYX-1 in Qatar was completed in 2006, which did not achieve its nameplate production level of 34,000 b/d until late 2009. Costs rose from an initial estimate (\$6 billion) of \$950 million to \$1.5 billion.

The front-end engineering and design of the Oryx phase one GTL complex was carried out by **Foster Wheeler Energy, UK**. The engineering, procurement and construction contract was awarded to **Technip-Coflexip of Italy**.

**Oryx, a joint venture between Qatar Petroleum (51%) and Sasol of South Africa (49%)**



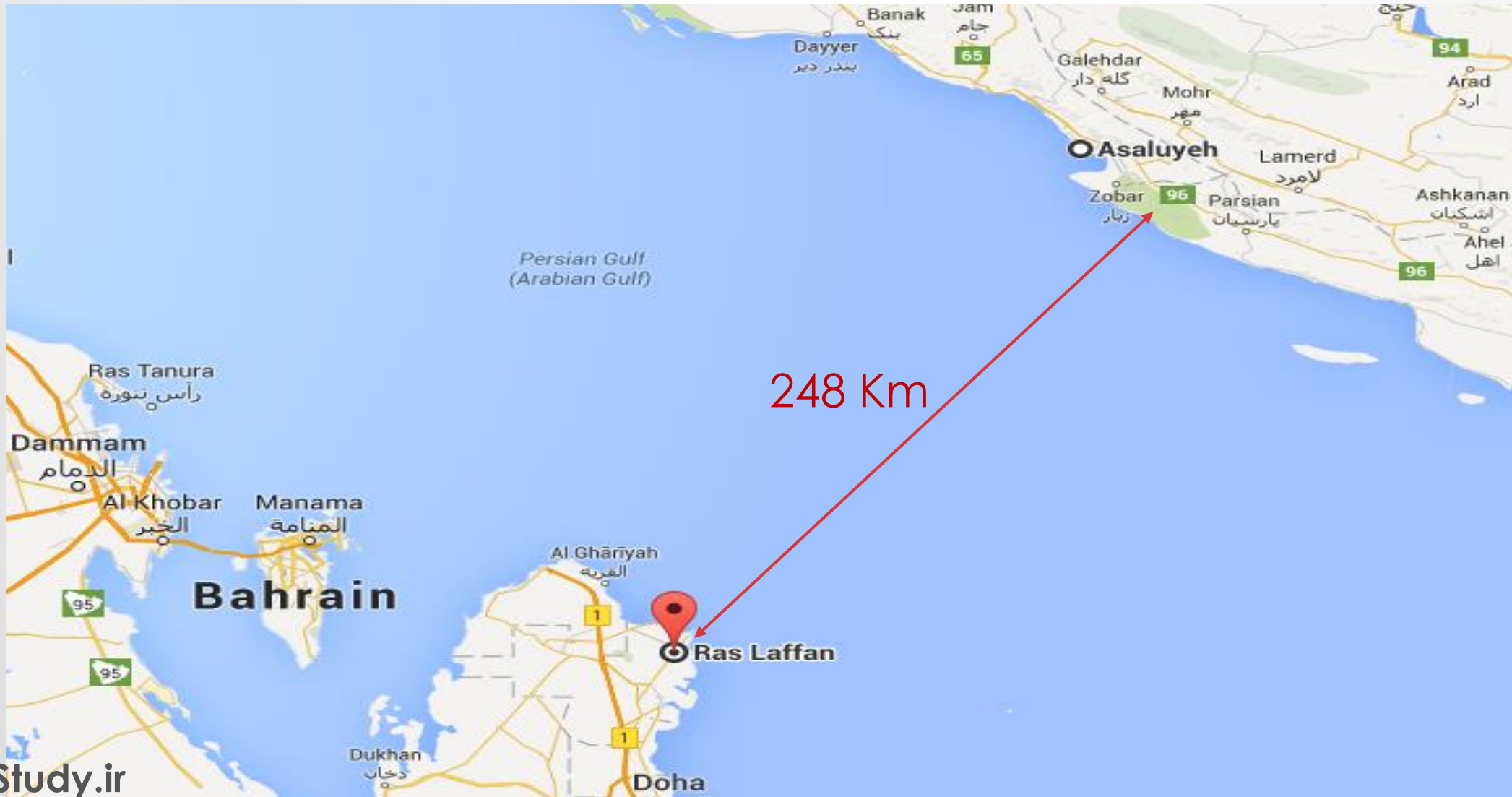
# Second Commercial GTL

Shell's Pearl GTL plant in Qatar, the world's largest GTL project, with an ultimate capacity of 140,000 b/d and an estimated price tag of \$10–12 billion.

The project is a Production Sharing Agreement (PSA) between Qatar Petroleum and Shell.

The proprietary **Shell Middle Distillate Synthesis (SMDS) process** is at the heart of the **two-train Pearl GTL plant**. Developed over more than three decades, the process has been proven on a commercial scale at the **14,700-barrel-per-day Bintulu GTL plant in Malaysia**, which began operation in 1993.

# Commercial GTL Plants in Qatar

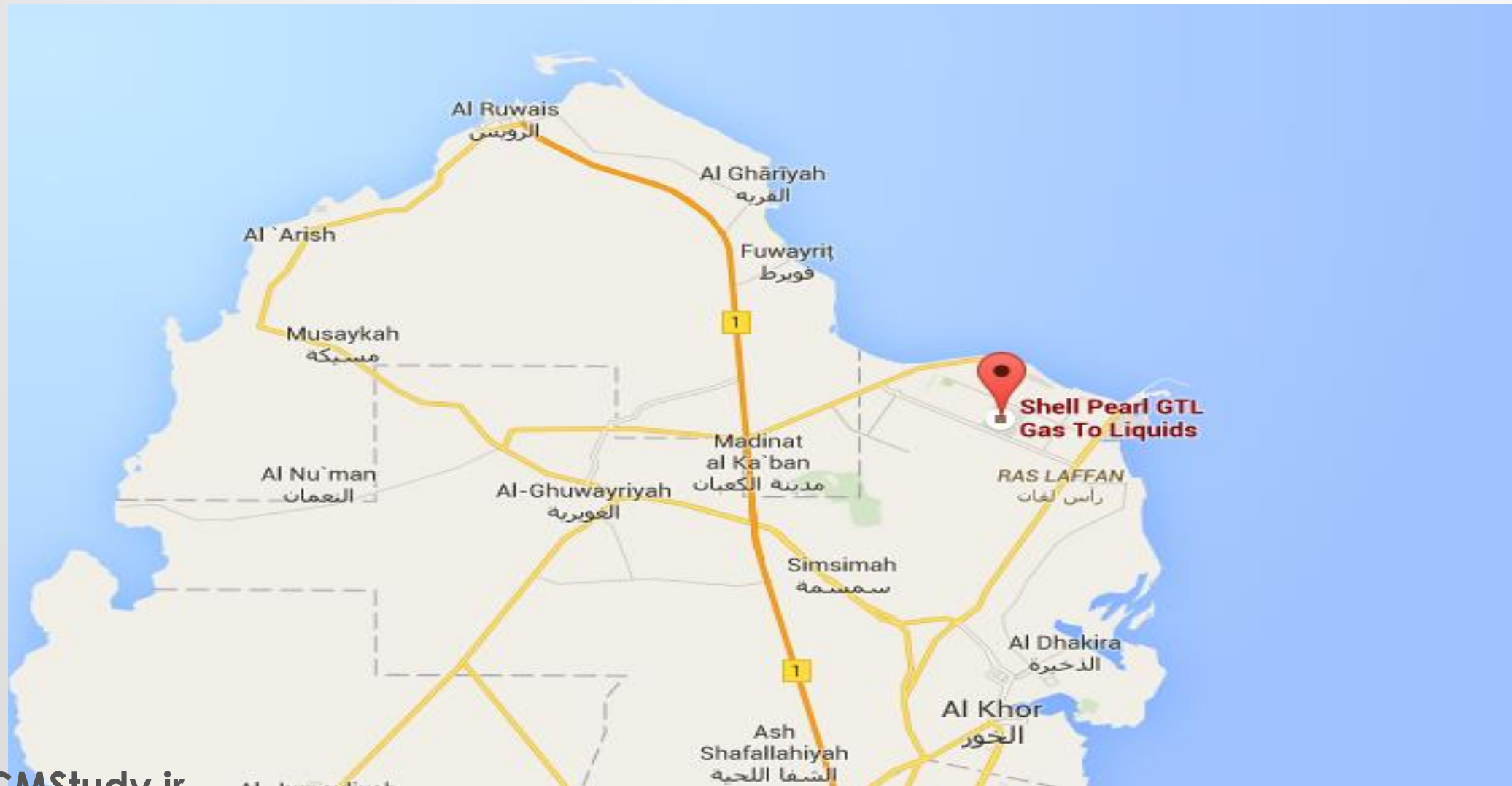


# Commercial GTL Plants in Qatar

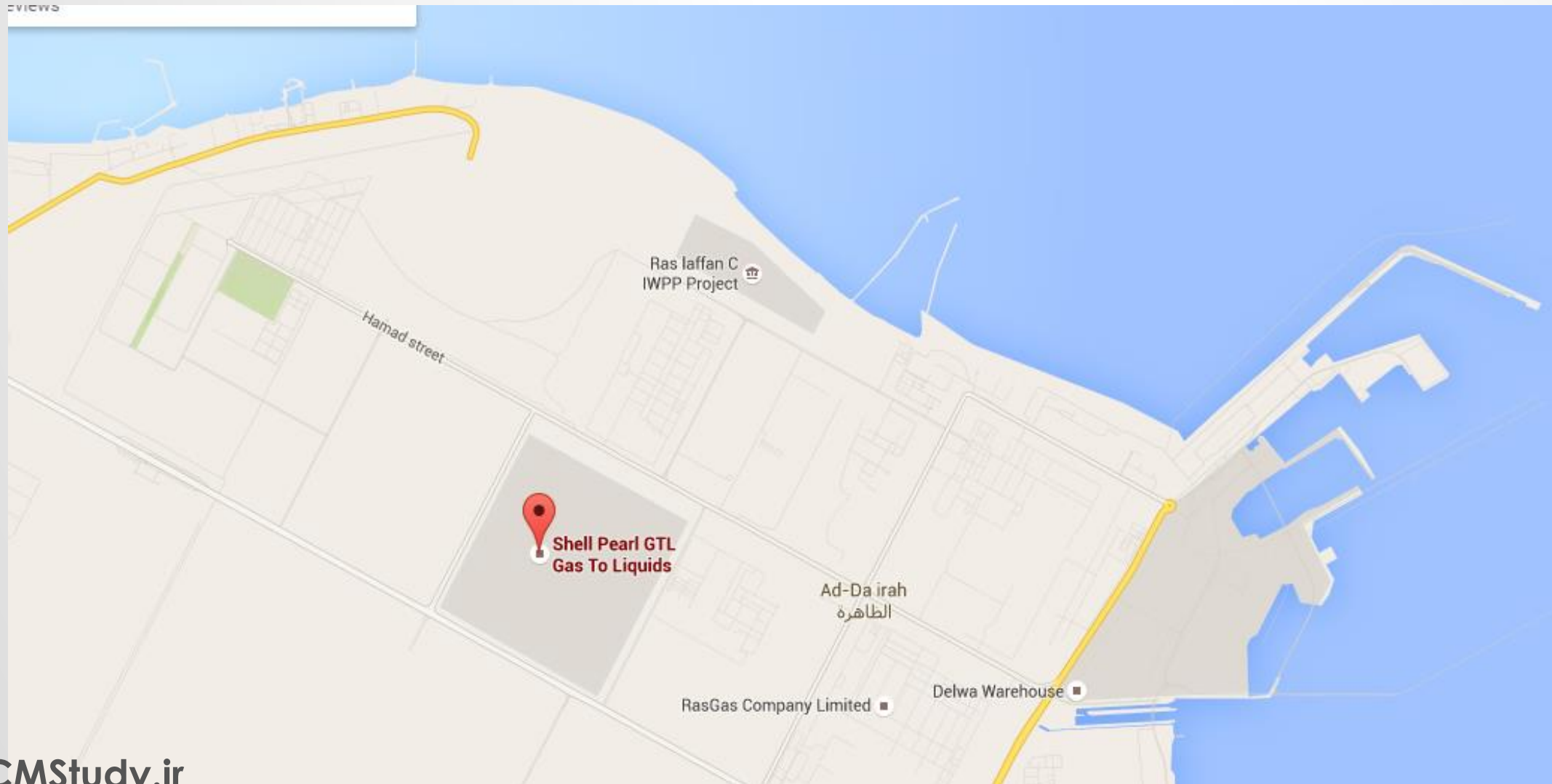




# Commercial GTL Plant in Qatar



# Commercial GTL Plants in Qatar



# Shell Pearl GTL



# Third Commercial GTL

Chevron's 34,000 b/d GTL plant (EGTL) at Escravos in Nigeria will cost an estimated \$10 billion and started up in 2014.

The project was developed by **Chevron Nigeria Limited** (75%) and the **Nigerian National Petroleum Company** (15%). Sasol gained interest in the project early on, acquiring half of Chevron Nigeria's stake; however, due to increased cost and delays, **Sasol** reduced its stake to 10% in late 2008.

The plant uses the Fischer-Tropsch process technology of Sasol and Chevron's ISOCRACKING technology.



# Commercial GTL Plant in Nigeria



# Commercial GTL Plant in Nigeria



# Escravos GTL



# Technology Evaluation of GTL

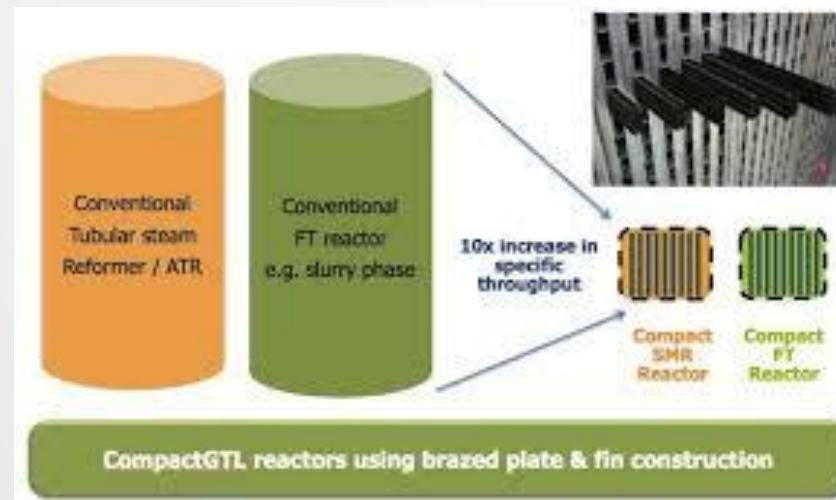
# Commercial Status of GTL Technologies

## World Scale

1. Sasol
2. Sasol Chevron
3. Shell

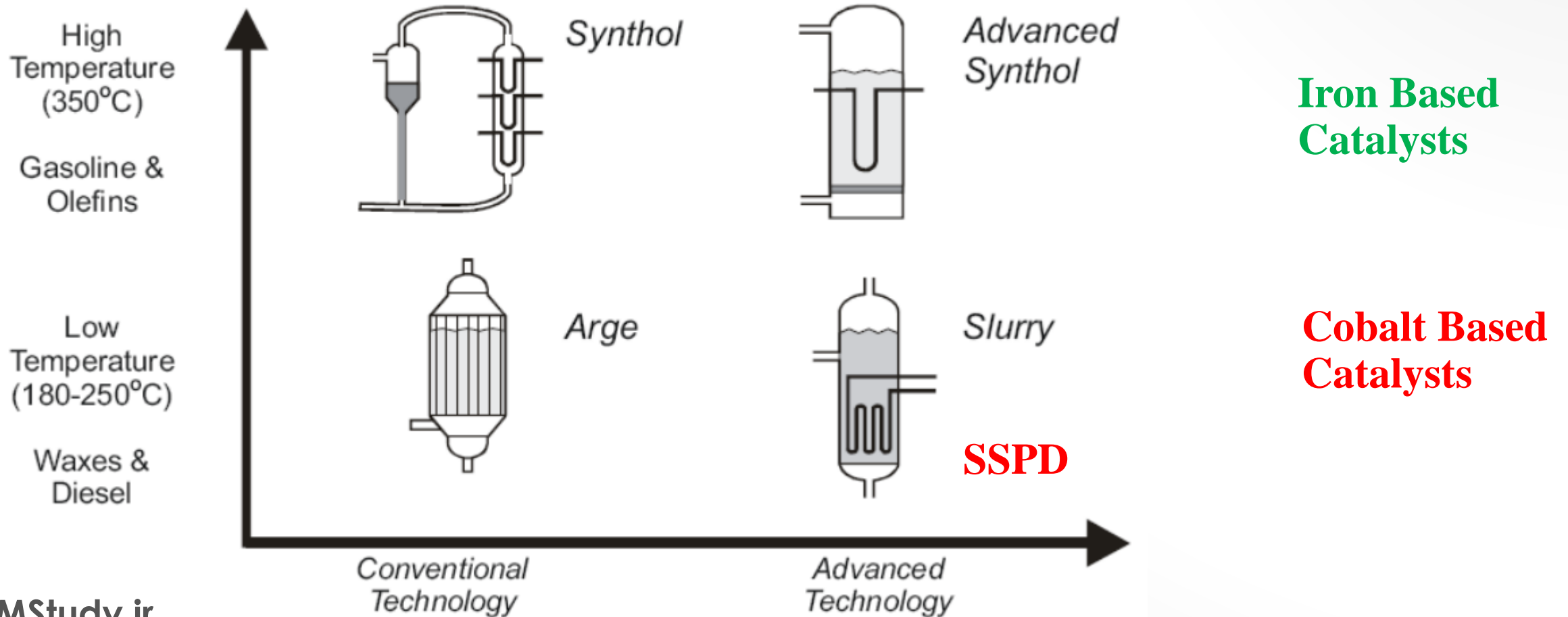
## Small Scale

1. Syntroleum
2. Velocys
3. Compact GTL

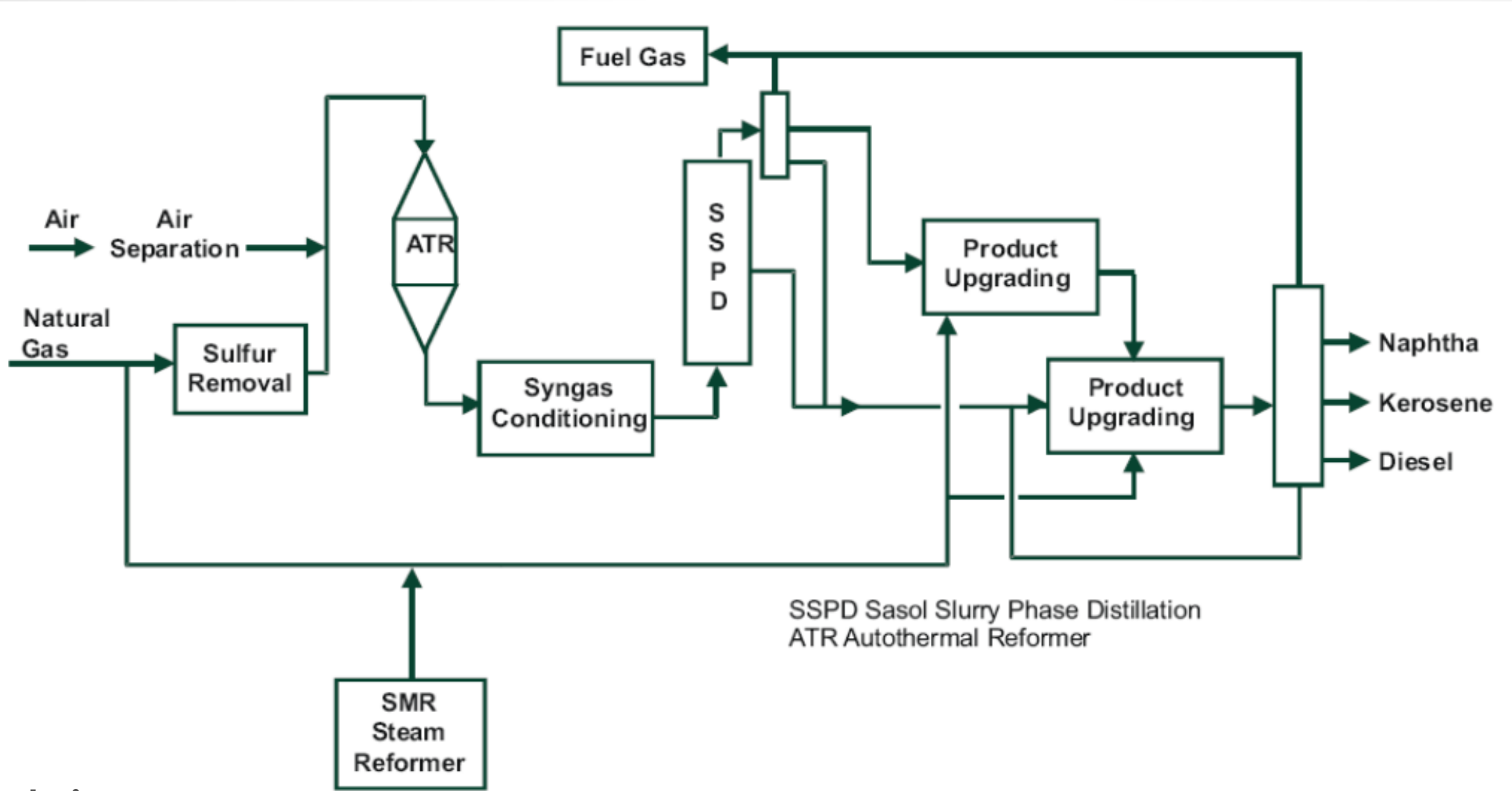


# F-T Reactor Characteristic (Sasol)

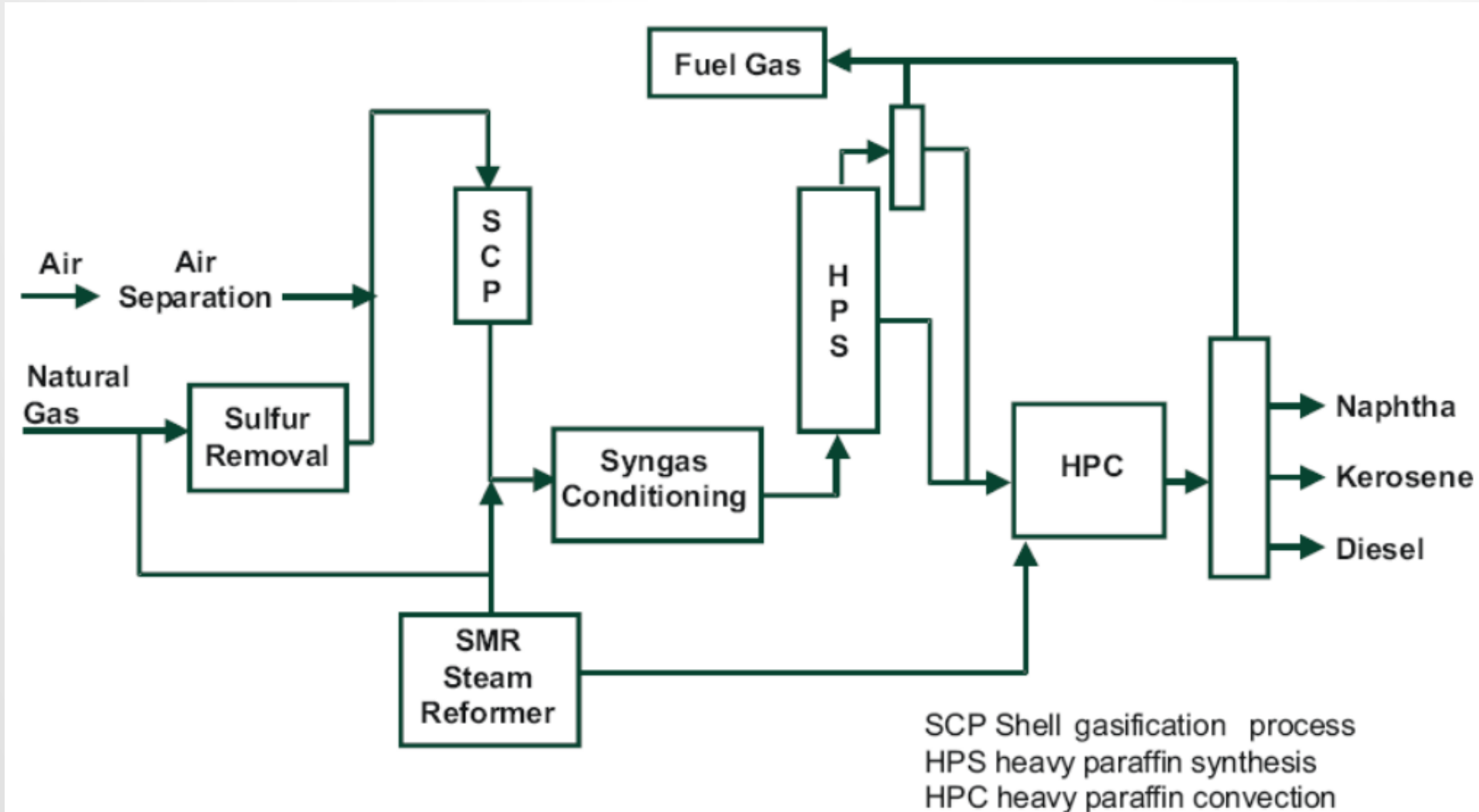
## CFB & SAS Reactors



# SSPD Process of Sasol



# SMDS Process of Shell



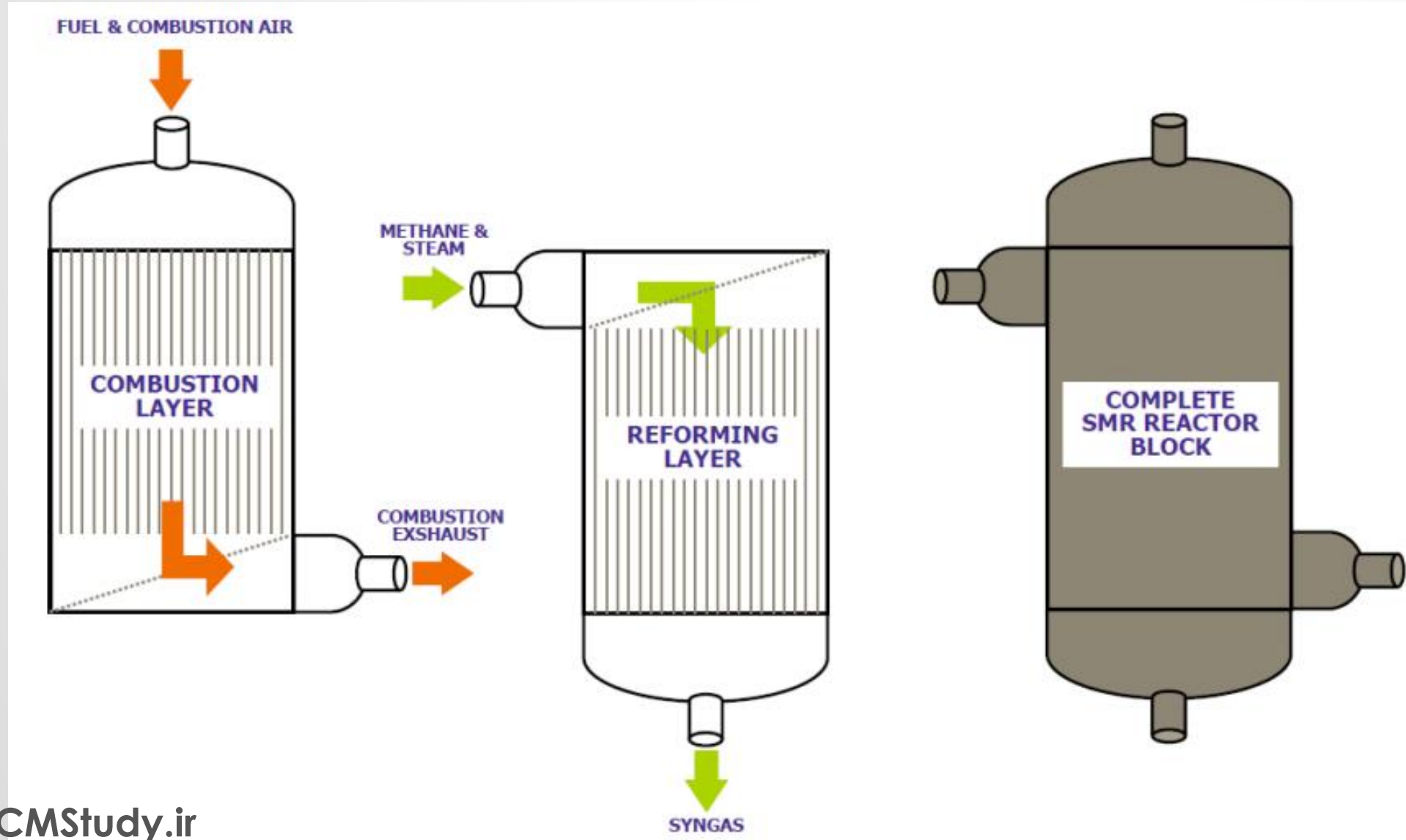


# Key Features of Pearl GTL

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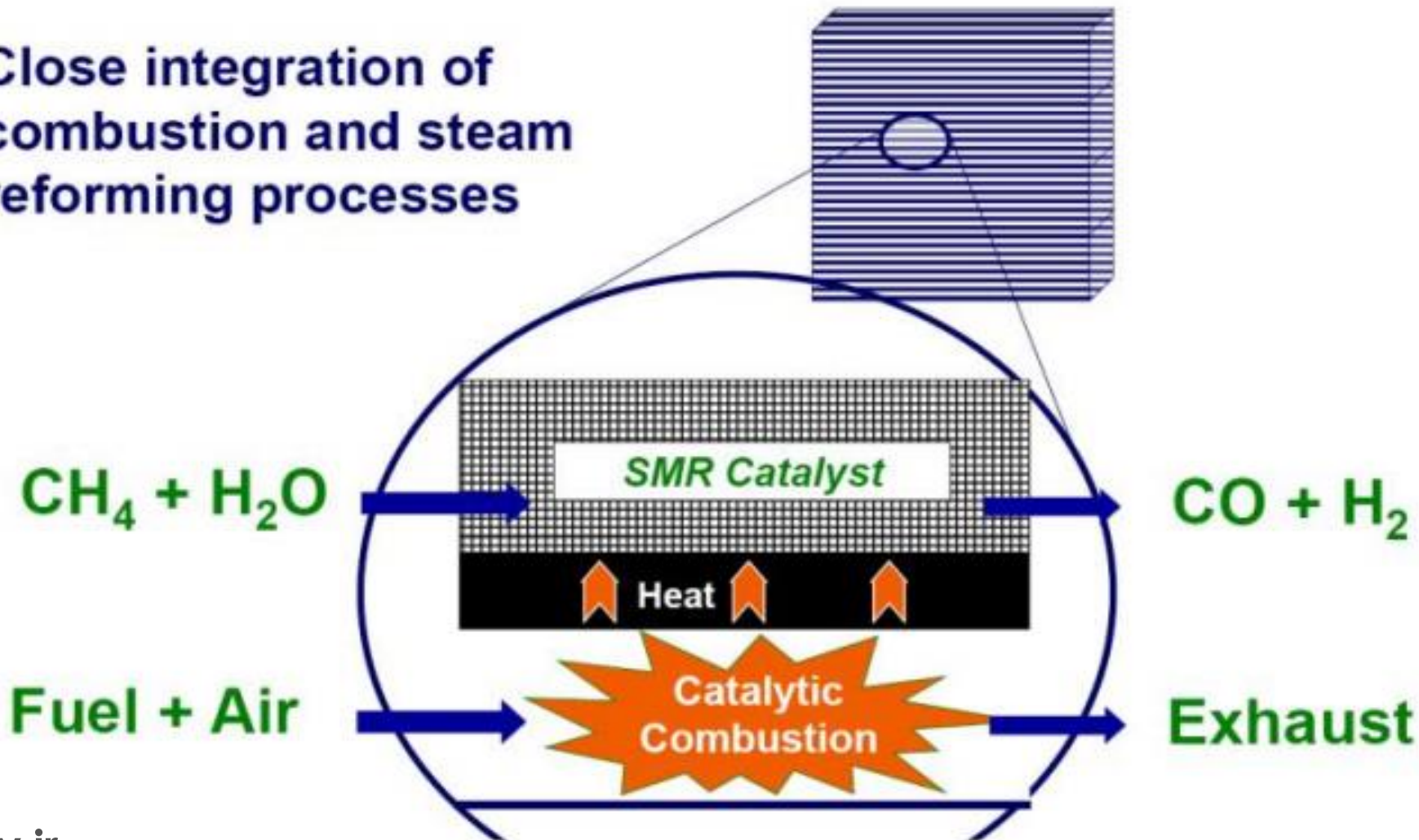
- Downstream, dry gas will be used as feedstock for the onshore integrated GTL complex that will manufacture an additional 140,000 barrels per day of liquid hydrocarbon products. The Pearl GTL complex will consist of two 70,000 bpd GTL trains and associated facilities.
- The **GTL plant consists of 24 F-T reactors**, each holds tens of thousands of tubes containing a Shell proprietary catalyst.
- The contract to supply 8 ASU trains with a total oxygen capacity exceeding 30,000 ton/d for the Pearl GTL project in Qatar was awarded to Linde.
- The investment in Pearl GTL, which was originally estimated to be \$5 billion in 2003, is reported to be between \$18 and \$19 billion now.

# Small Scale GTL Technology (SMR Reactor)

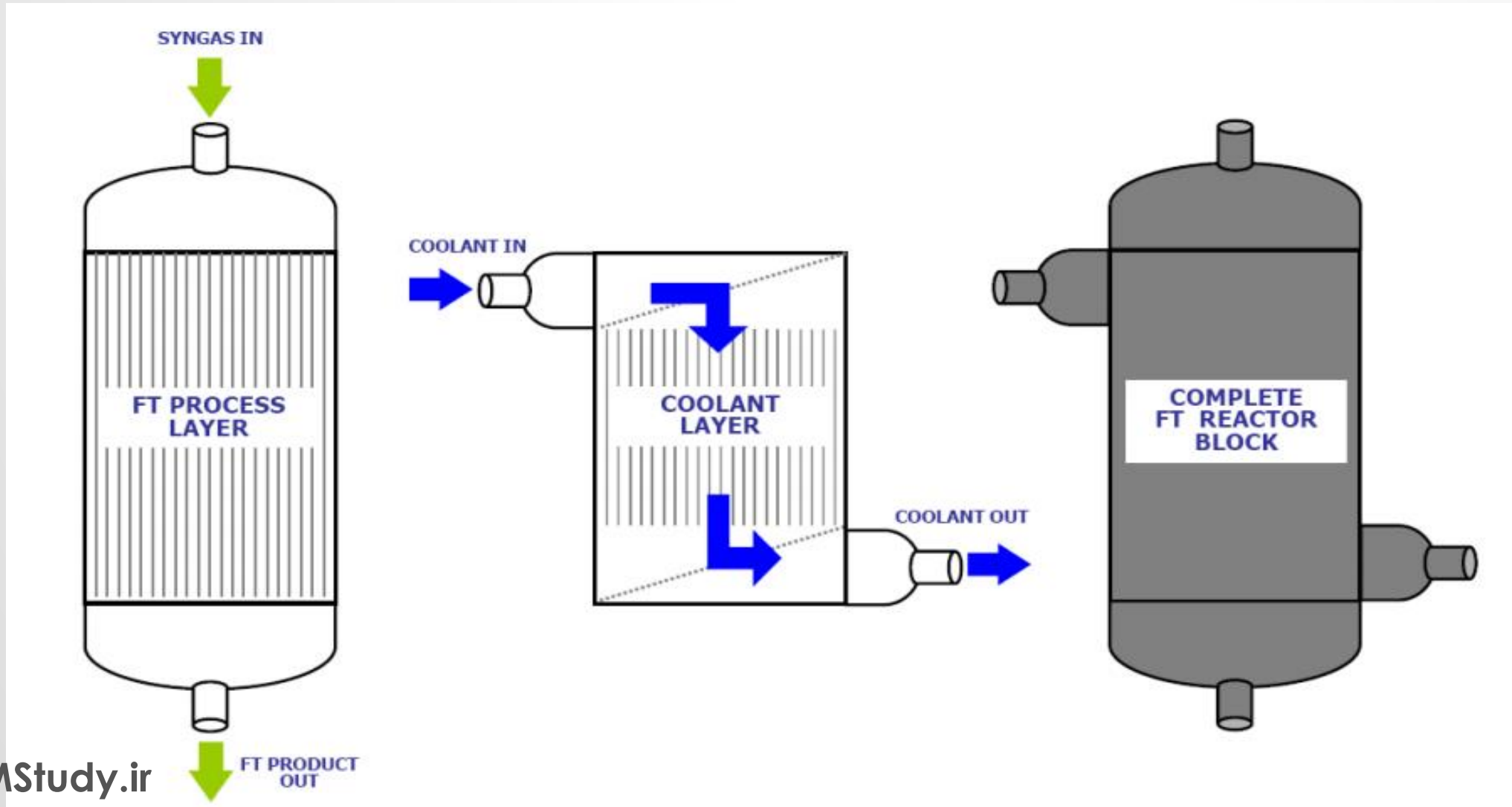


# Small Scale GTL Technology (SMR Mechanism)

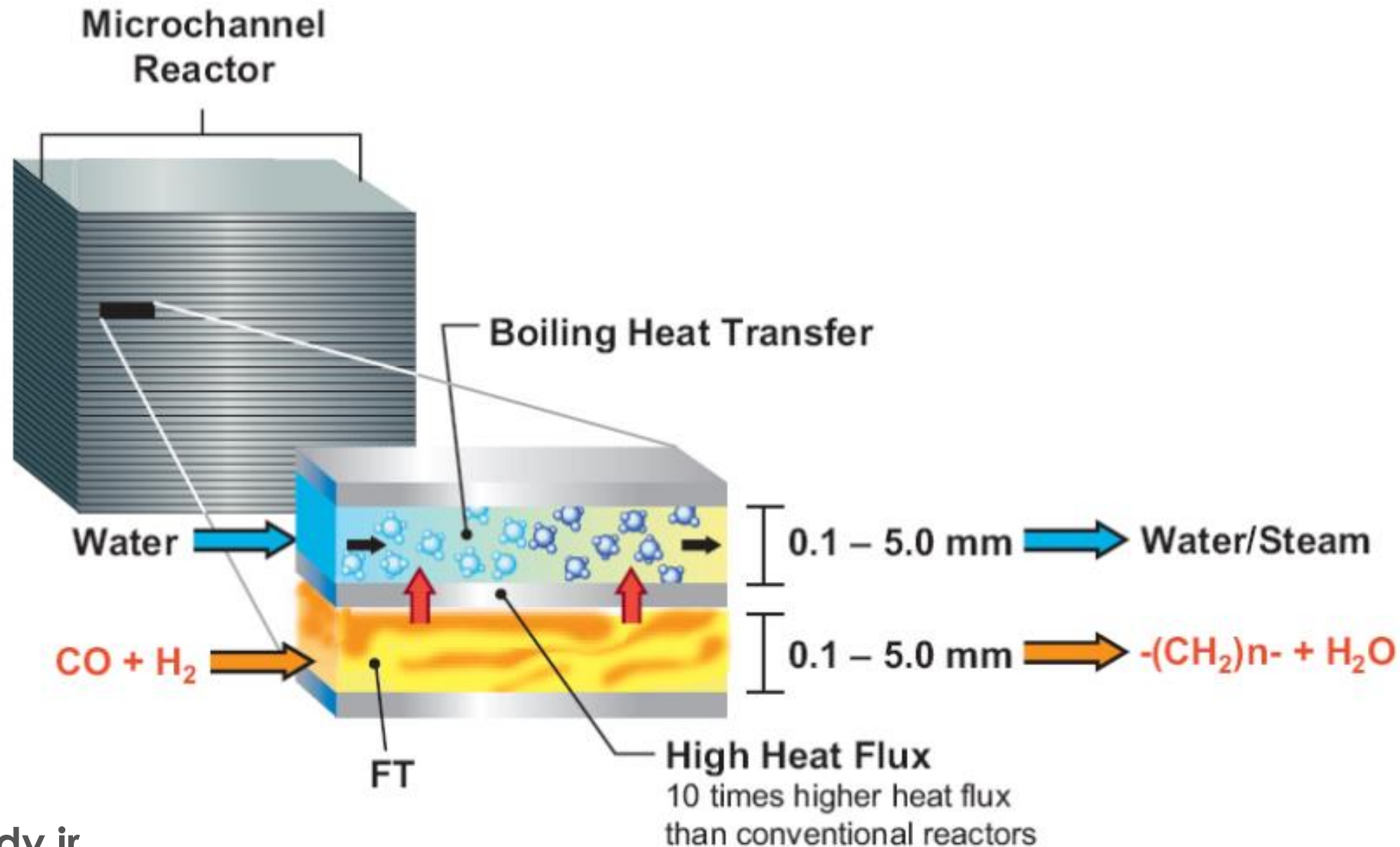
Close integration of combustion and steam reforming processes



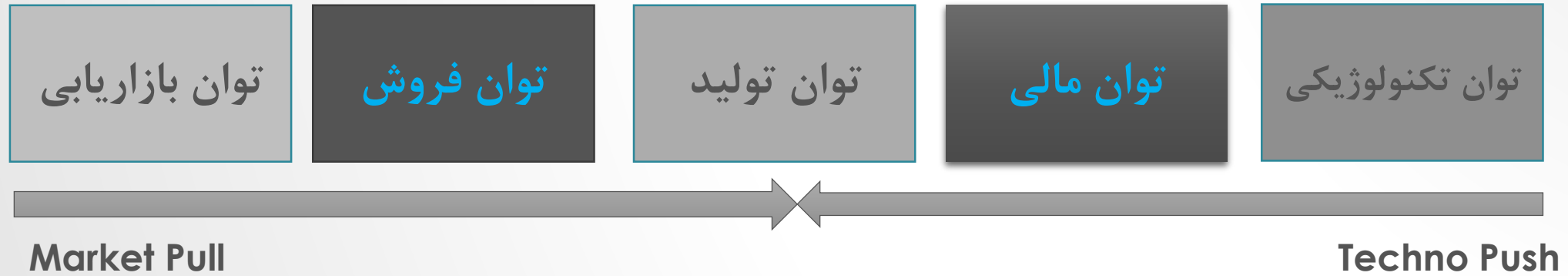
# Small Scale GTL Technology (F-T Reactor)



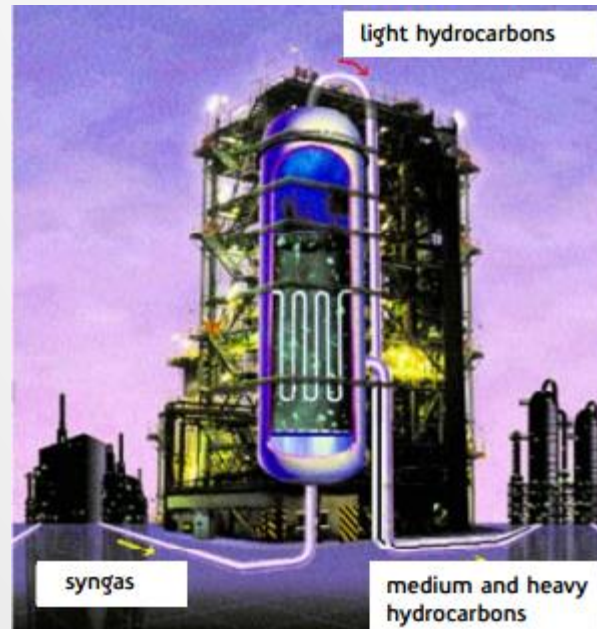
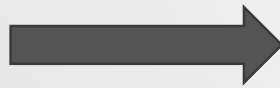
# Small Scale GTL Technology (F-T Mechanism)



# Business Model Generation



**Natural Gas**

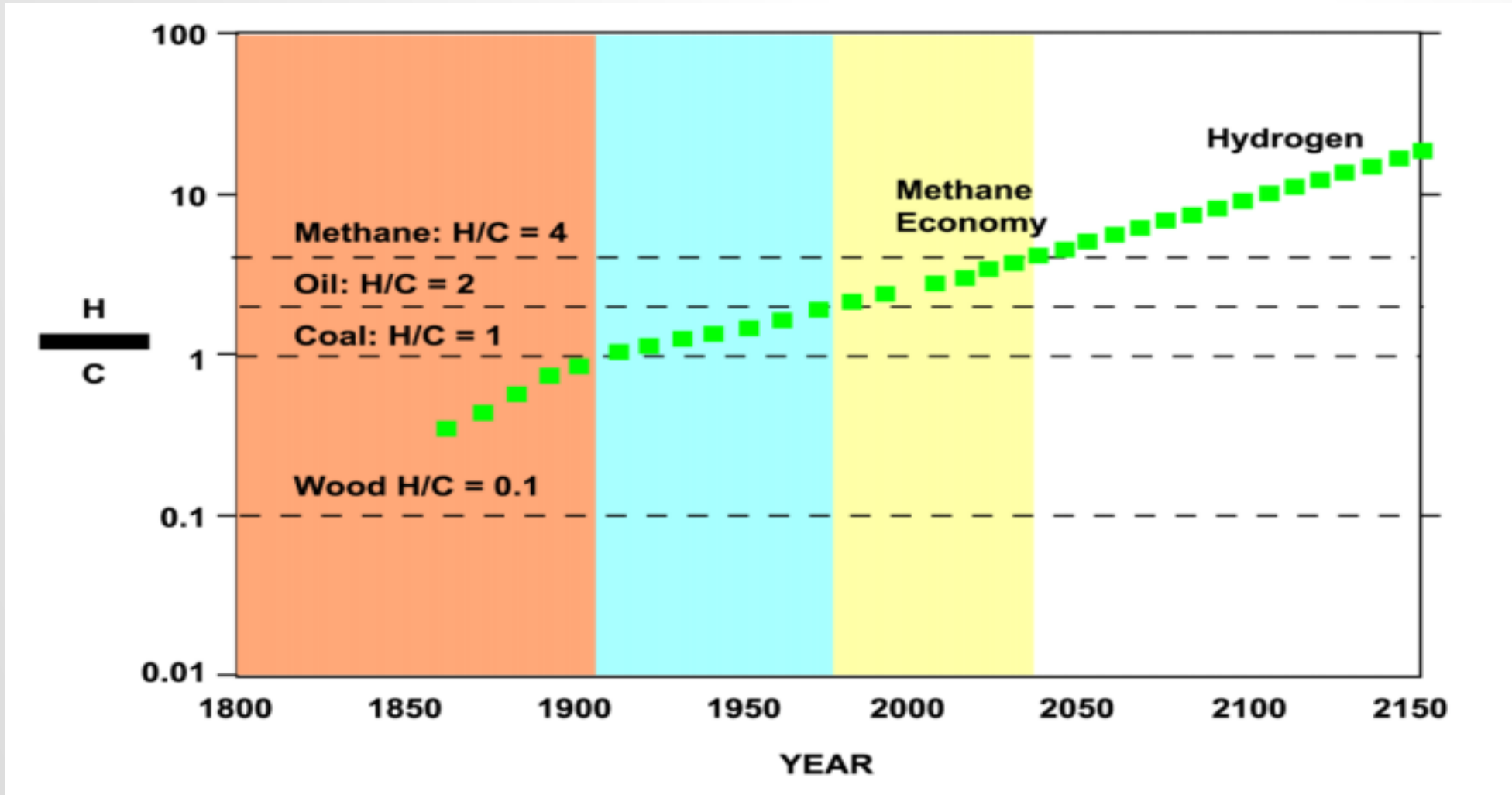


**Diesel (70%)**

**Naphtha (25%)**

**LPG, Lubes , Waxes (5%)**

# Fuel use progression



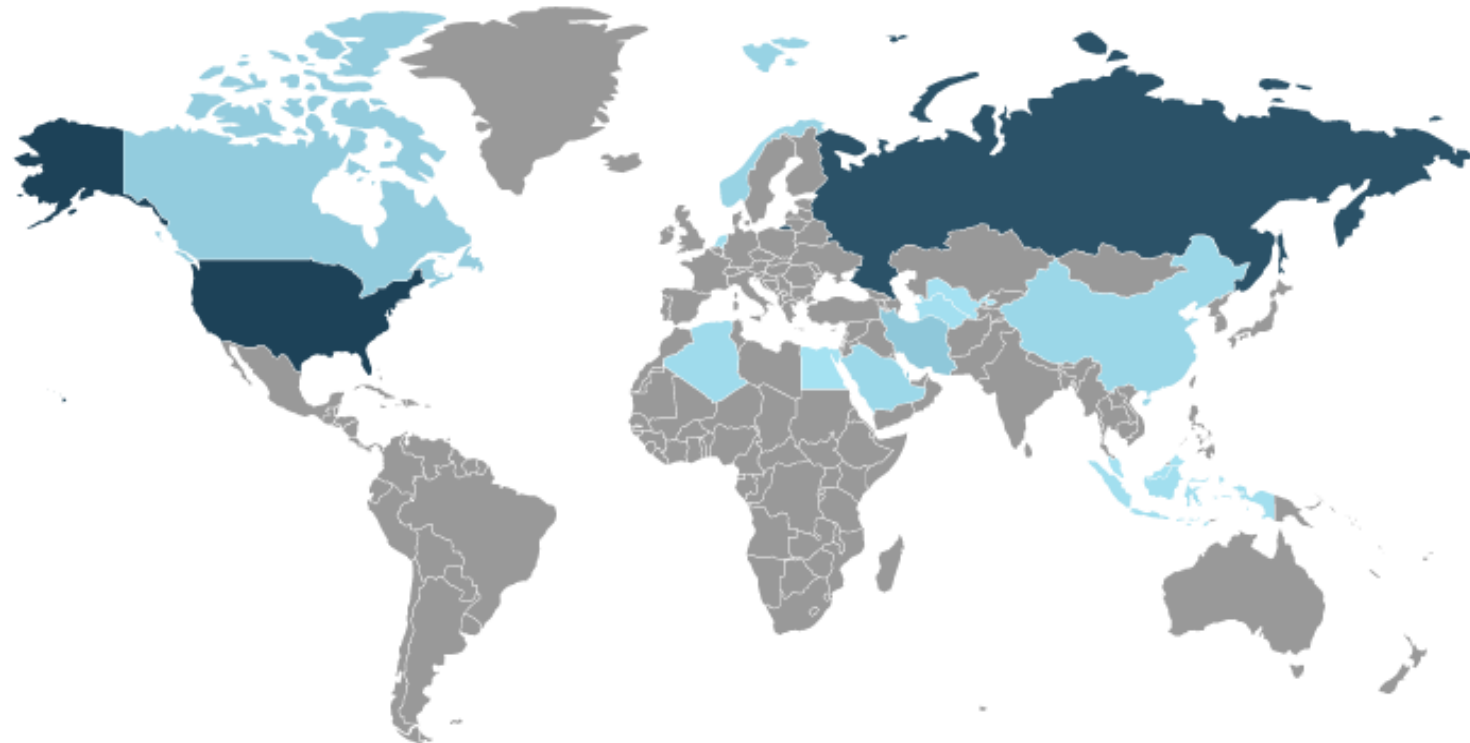
Type	%
Oil	37
N. Gas	27
Coal	22

# Ranking of countries (Natural Gas)

## Dry Natural Gas Production - 2012\* > (\*most recent year with sufficient data for ranking)

*Billion Cubic Feet*

1. United States
2. Russia
3. Iran
4. Qatar
5. Canada
6. Norway
7. China
8. Saudi Arabia
9. Algeria
10. Netherlands
11. Indonesia
12. Turkmenistan
13. Uzbekistan
14. Malaysia
15. Egypt





# World Natural Gas Supply and Demand

## WORLD NATURAL GAS SUPPLY AND DEMAND

BILLION CUBIC METERS

	<u>2005</u>	<u>2006</u>	<u>2007</u>	<u>2008</u>	<u>2009</u>	<u>2010</u>
Capacity						
Estimated proven reserves	174,037	176,068	176,989	178,821	186,724	188,701
Production						
Natural gas	2,777	2,876	2,947	3,049	3,104	3,212
Consumption						
Chemical uses	140	145	145	143	149	149
Direct fuel uses	2,647	2,708	2,787	2,884	2,940	30,60
Gas to liquids (GTL)	4	6	6	6	6	10
<i>Consumption total</i>	2,791	2,859	2,939	3,034	3,095	3,219

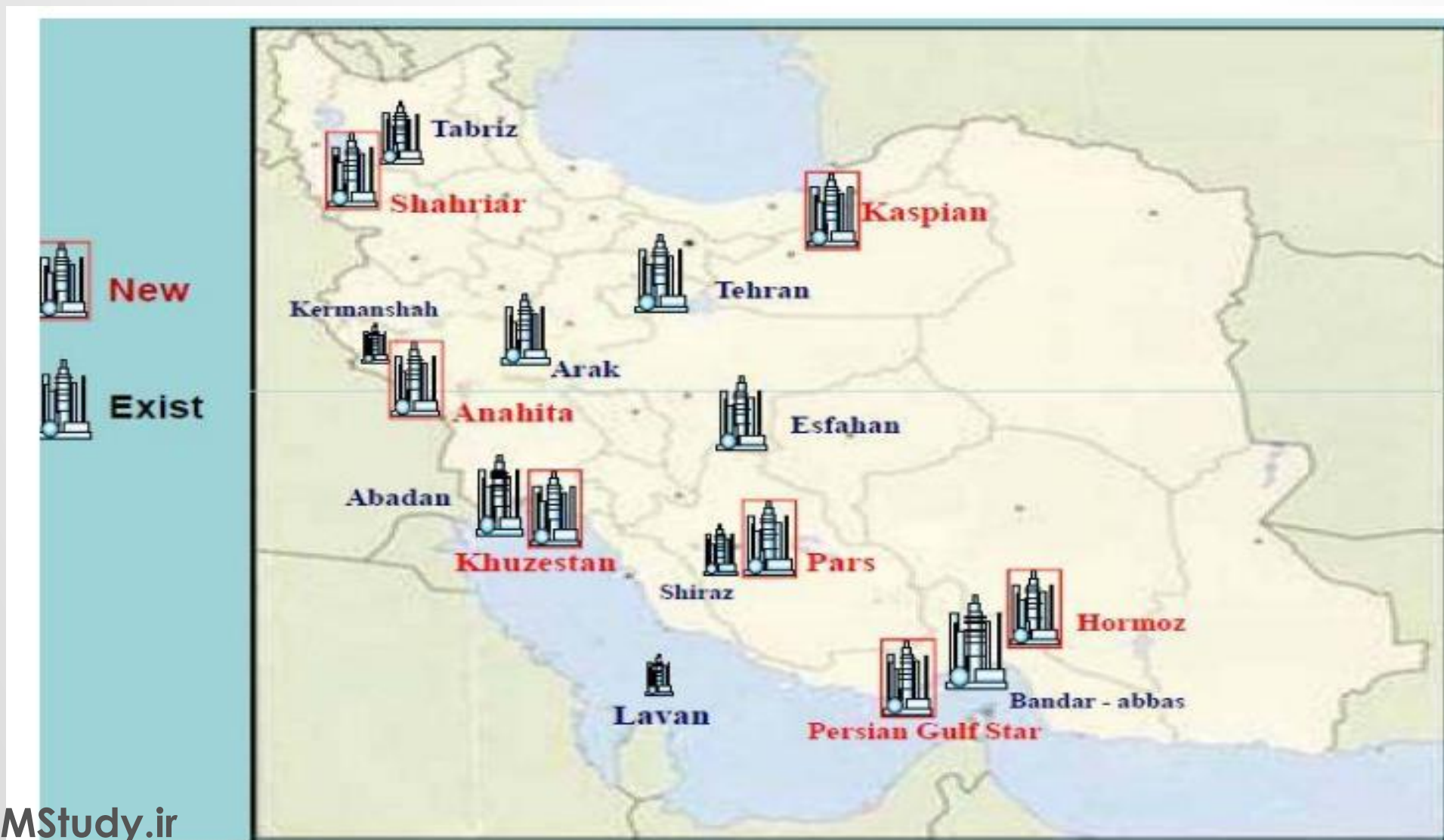
# ME Natural Gas Supply and Demand

## MIDDLE EAST NATURAL GAS SUPPLY AND DEMAND

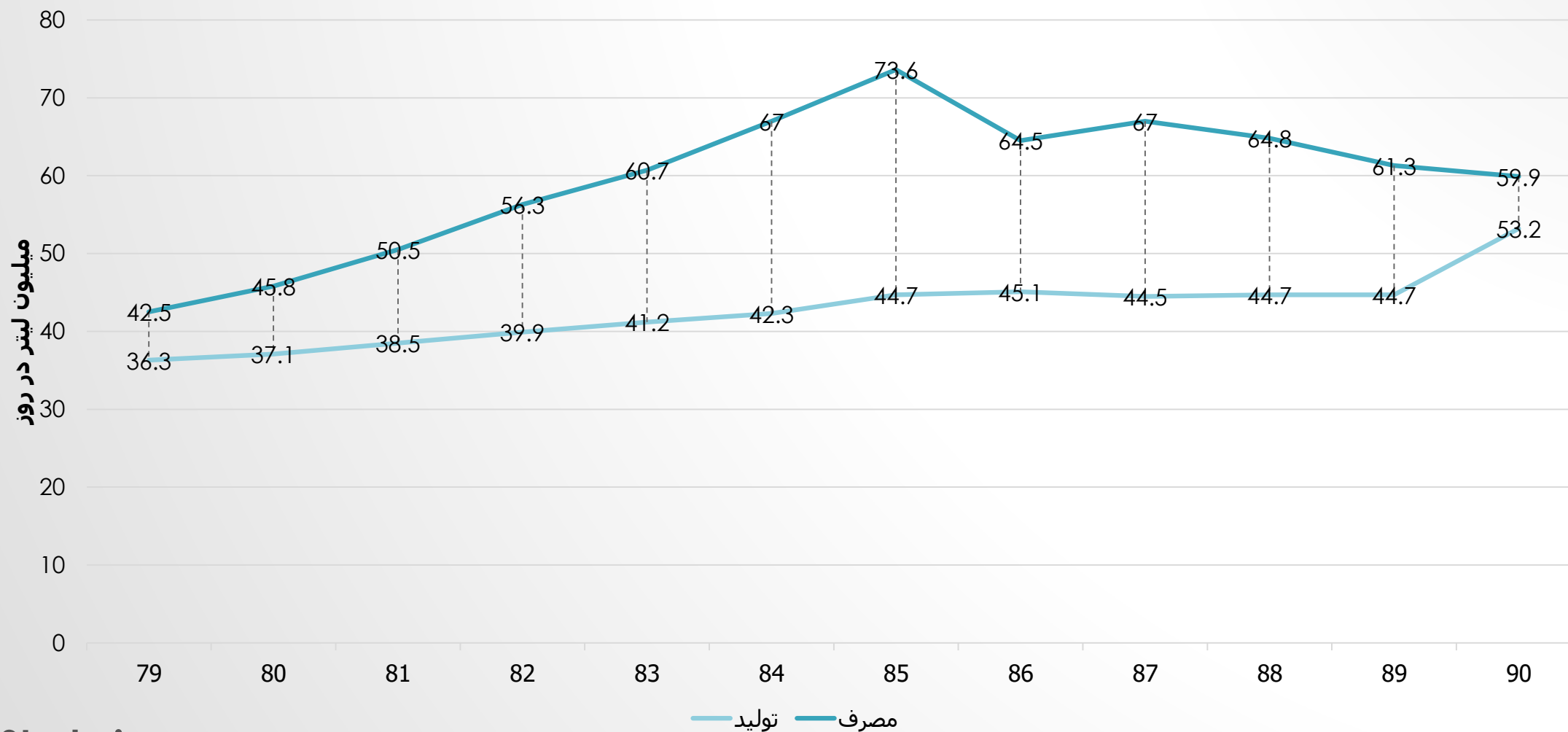
BILLION CUBIC METERS

	<u>2005</u>	<u>2006</u>	<u>2007</u>	<u>2008</u>	<u>2009</u>	<u>2010</u>
Capacity						
Estimated proven reserves	72,046	71,856	73,258	72,574	74,438	75,219
Production						
Natural gas	302	328	345	382	426	464
Consumption						
Chemical uses	16	18	19	20	24	25
Direct fuel uses	273	291	303	338	357	369
Gas to liquids (GTL)	0	2	2	2	2	6
<i>Consumption total</i>	288	311	324	360	383	400

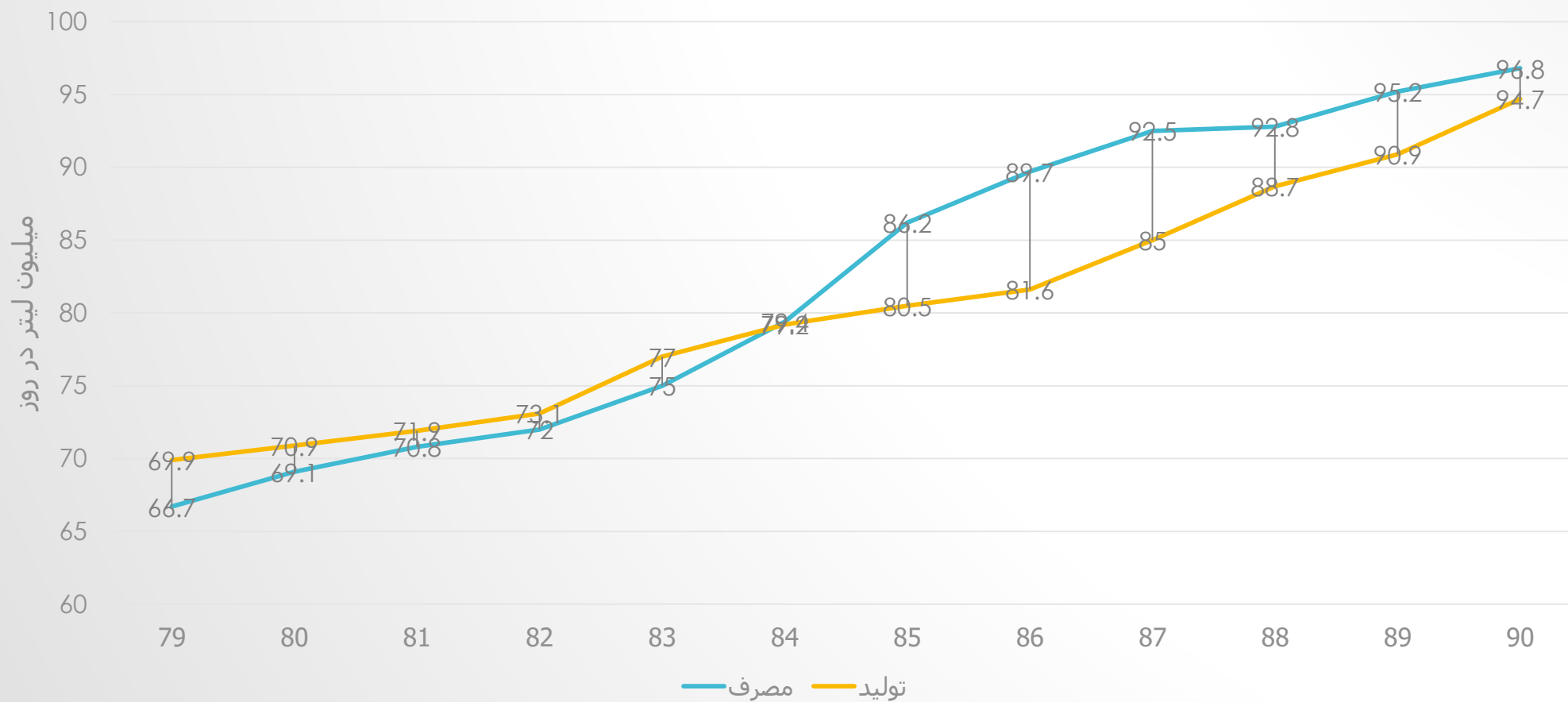
## Iran's new & exist refineries



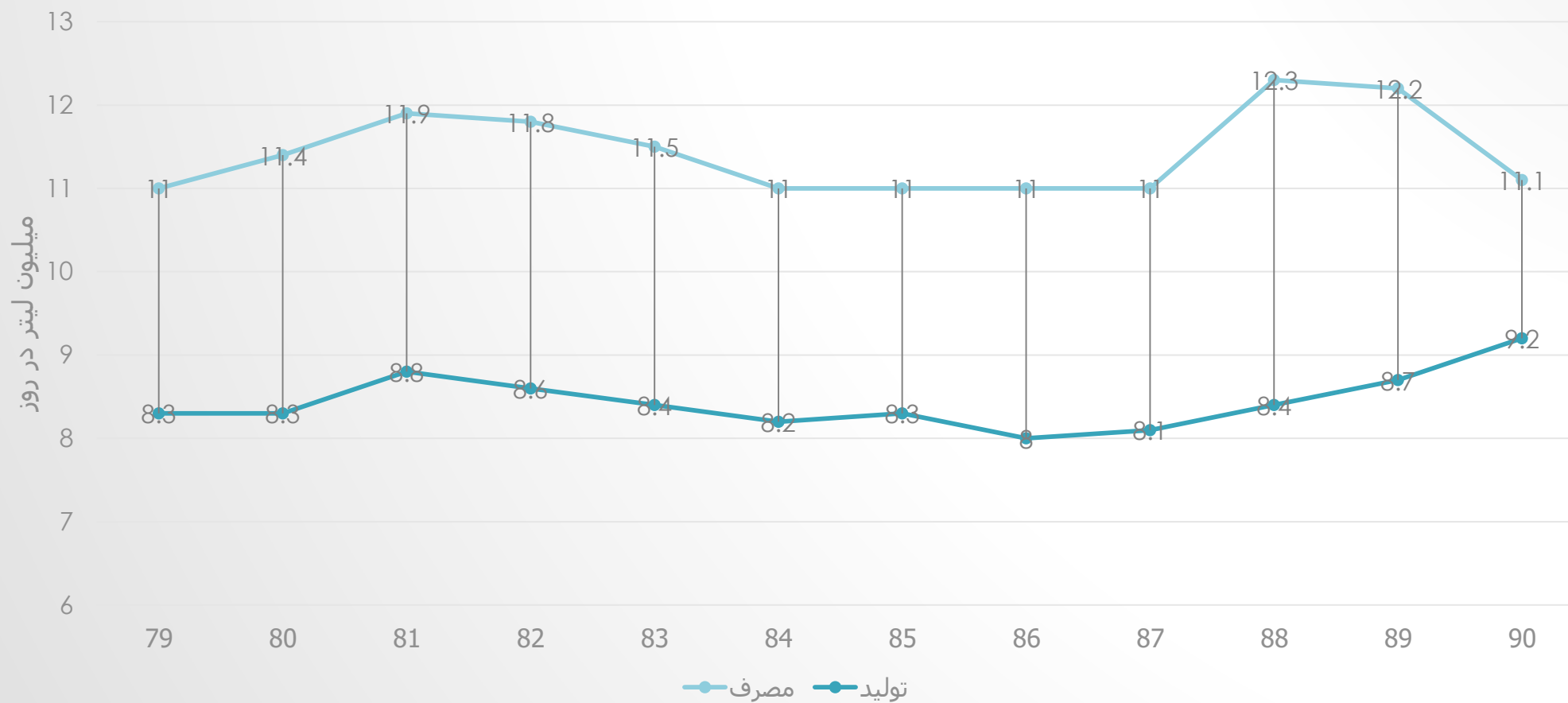
# Gasoline Consumption



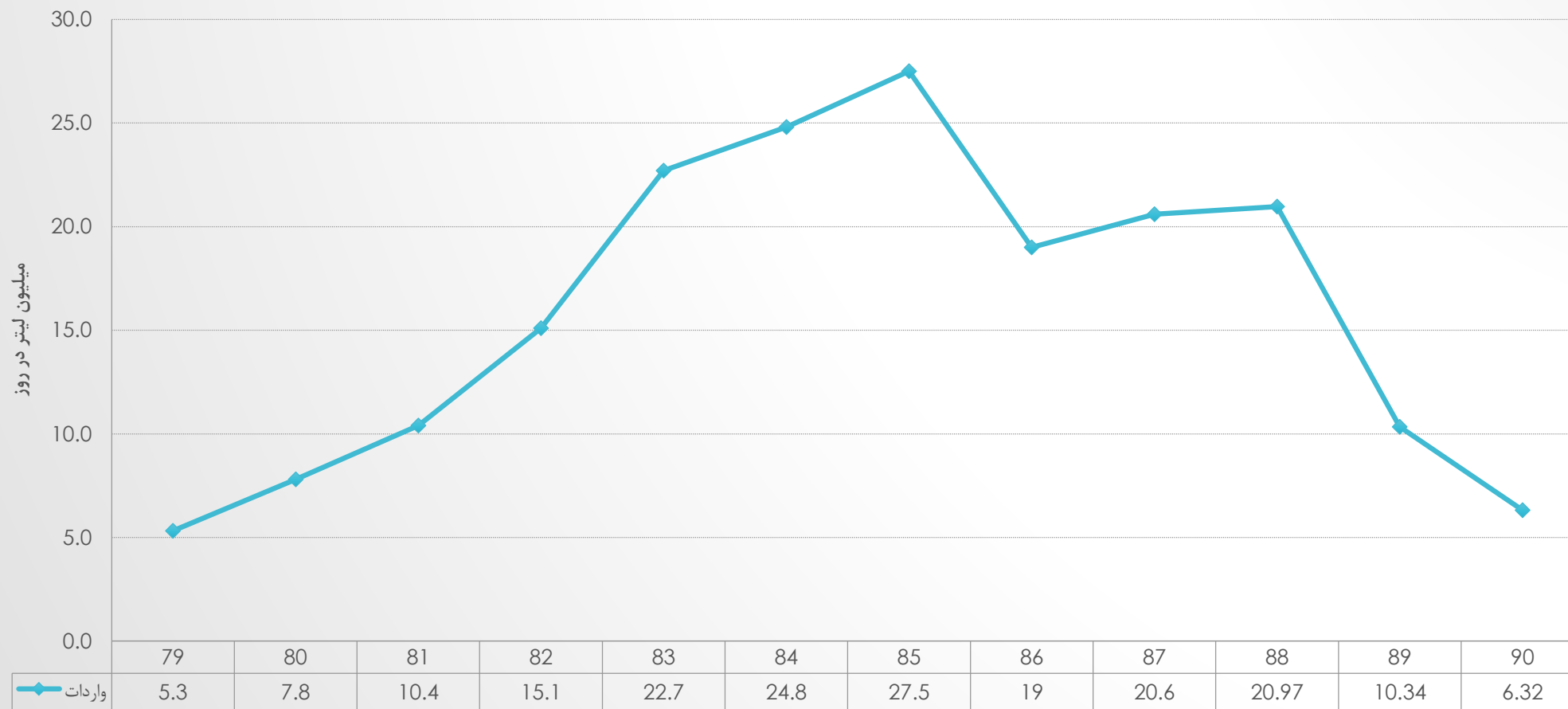
# Diesel Consumption



# LPG Consumption



# Import of Gasoline



UNCERTAINTY

CLARITY / FOCUS



*research  
& understand*

*design business  
model prototypes*

*implement business  
model design*



با تشکر از توجه شما