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Storage, processing, and transportation of crude oil and gas (onshore and offshore)

Module 6a

Oil and gas main sectors

The oil and gas industry is divided into 3 sectors:

- Upstream: searching for oil and gas, drilling, well completion, and bringing crude oil and raw natural gas to the surface.
- Midstream: transportation of crude oil and gas, storage, and delivering the various refined products to downstream distributors.
- Downstream: refining petroleum crude oil and processing and purifying raw natural gas as well as marketing and distribution of refined products.

Transportation (oil and gas)

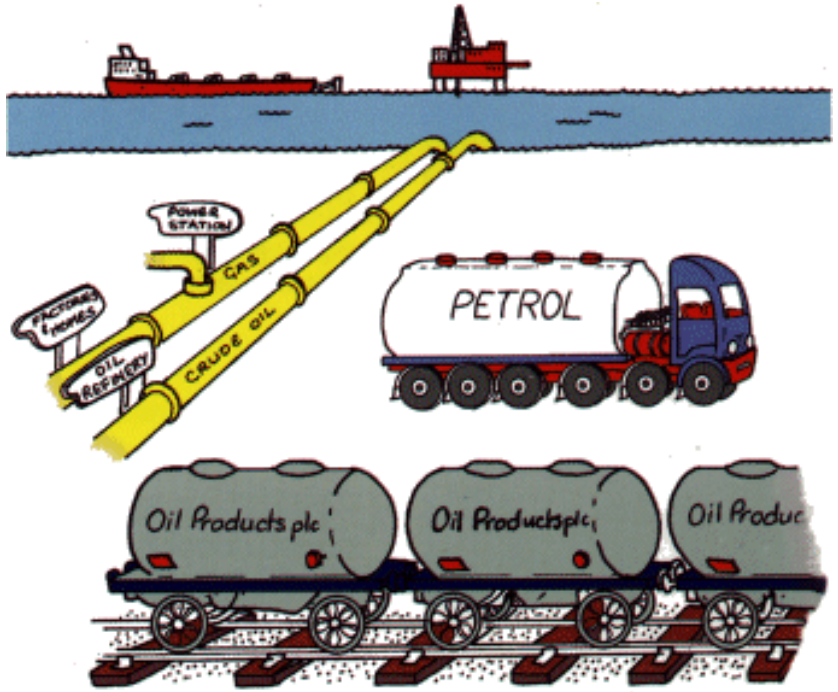
Hook-up and flow lines

- Flow lines are pipes conforming to the dimensional requirements of ASME (American Society of Mechanical Engineering) and used for conveying liquid, gas, or anything that flows.
- A flow line connects the wellhead to the pipe header at the surface facilities.
- The selection of a flow line depends on the operating pressure and temperature and the flow rate.
- The size of flow lines vary from 1 inch to 24 inches, including valves and flanges. They come in various classes (150, 300, 600, 900, 1500, etc.)

Flow line material

- The most common flow line materials are carbon steel and stainless steel.
- Stainless steel differs from carbon steel by the amount of chromium present.
- Unprotected carbon steel rusts readily when exposed to air and moisture; forming iron oxide (the rust).
- Stainless steels contain sufficient chromium to form a film of chromium oxide, which prevents corrosion. Most common stainless steel is Duplex.

Oil and gas transportation



Main methods of transporting oil and gas:

- Pipeline
- Rail
- Truck
- Ship

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Pipeline transportation

- The most used form of oil transportation is oil pipelines. Nearly 190,000 miles for liquid and 300,000 miles of pipeline of natural gas in USA.
- Moves crude oil from wellhead to gathering and processing facilities and from there to refineries and tanker loading facilities.
- Requires less energy to operate compared to other transportation.

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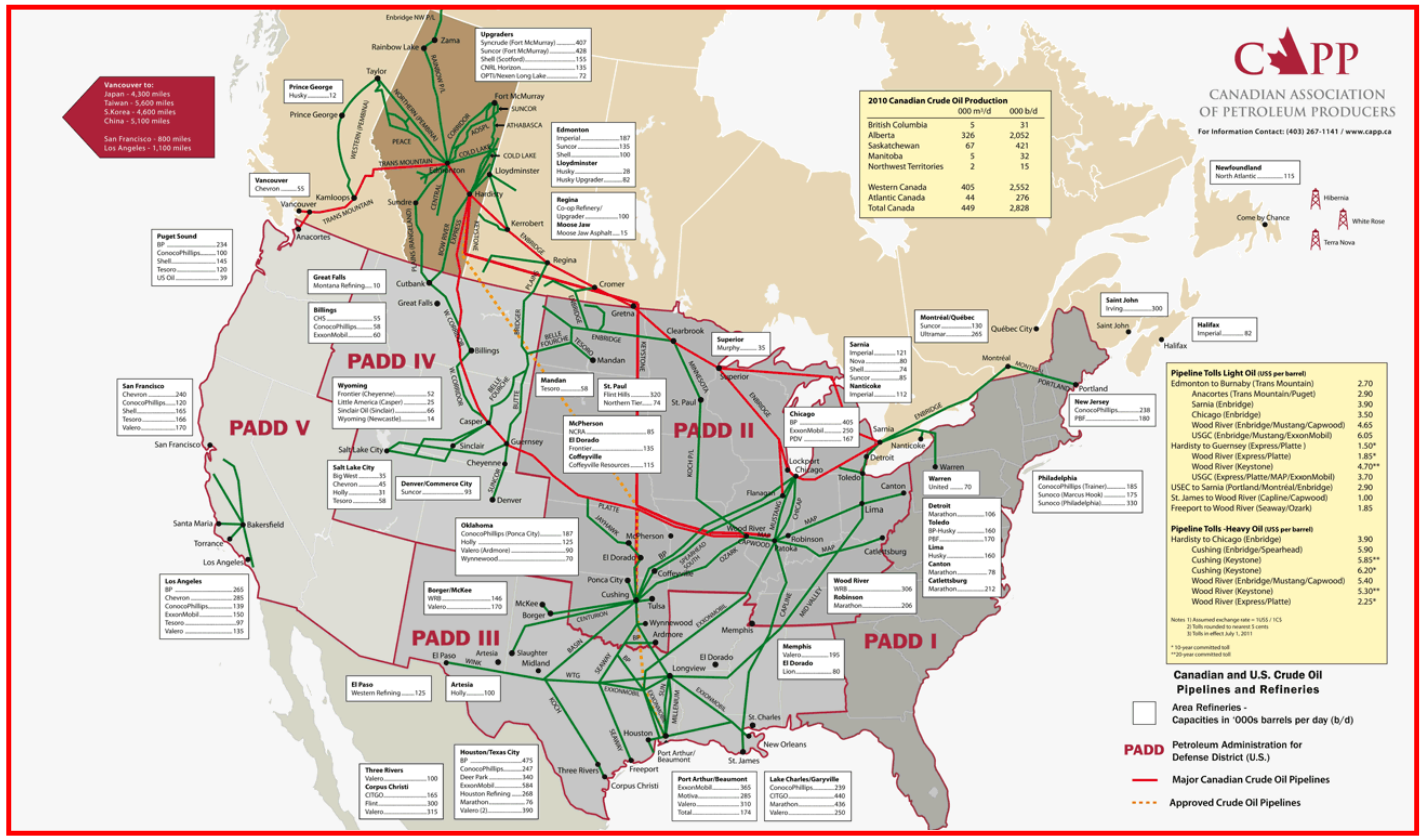
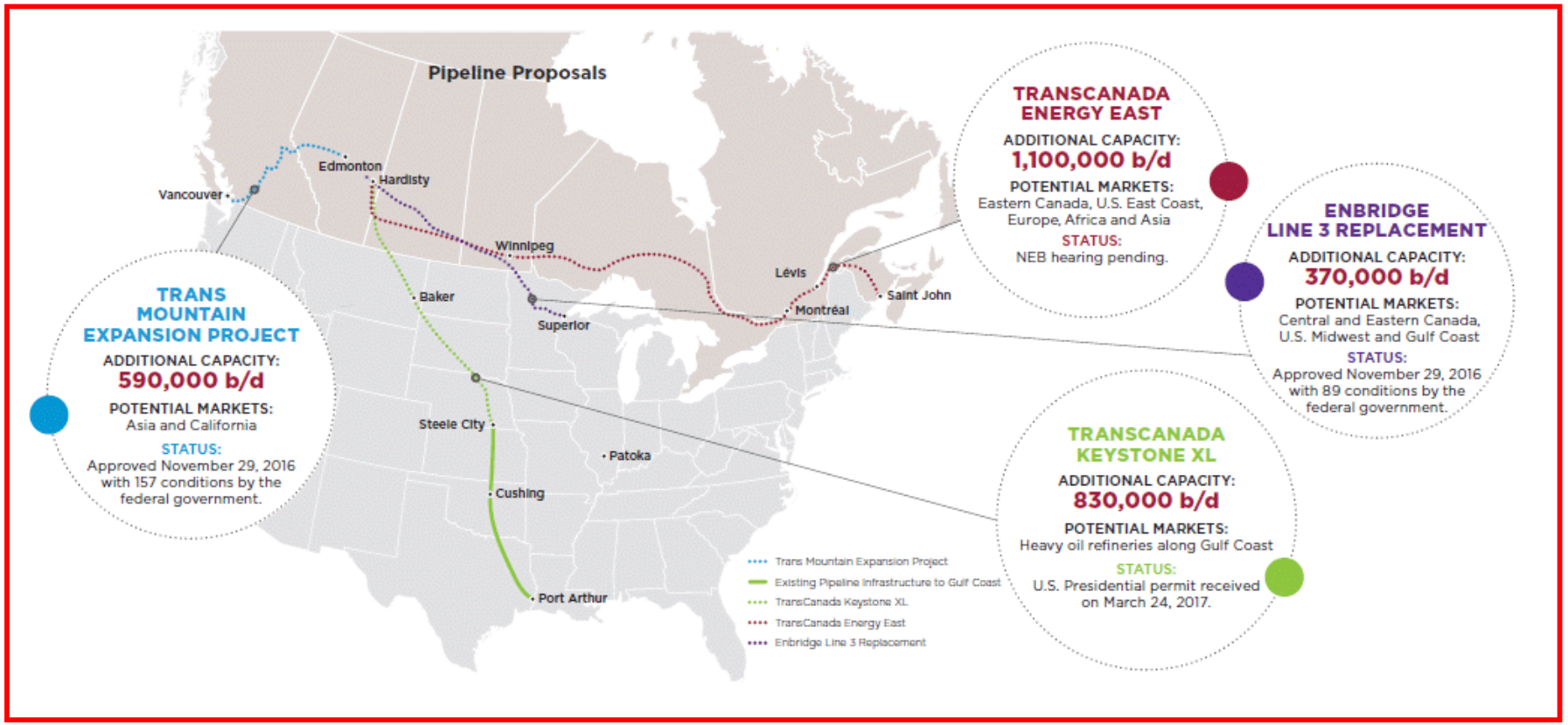
Canada/US connecting pipelines



Proposed pipelines in Canada



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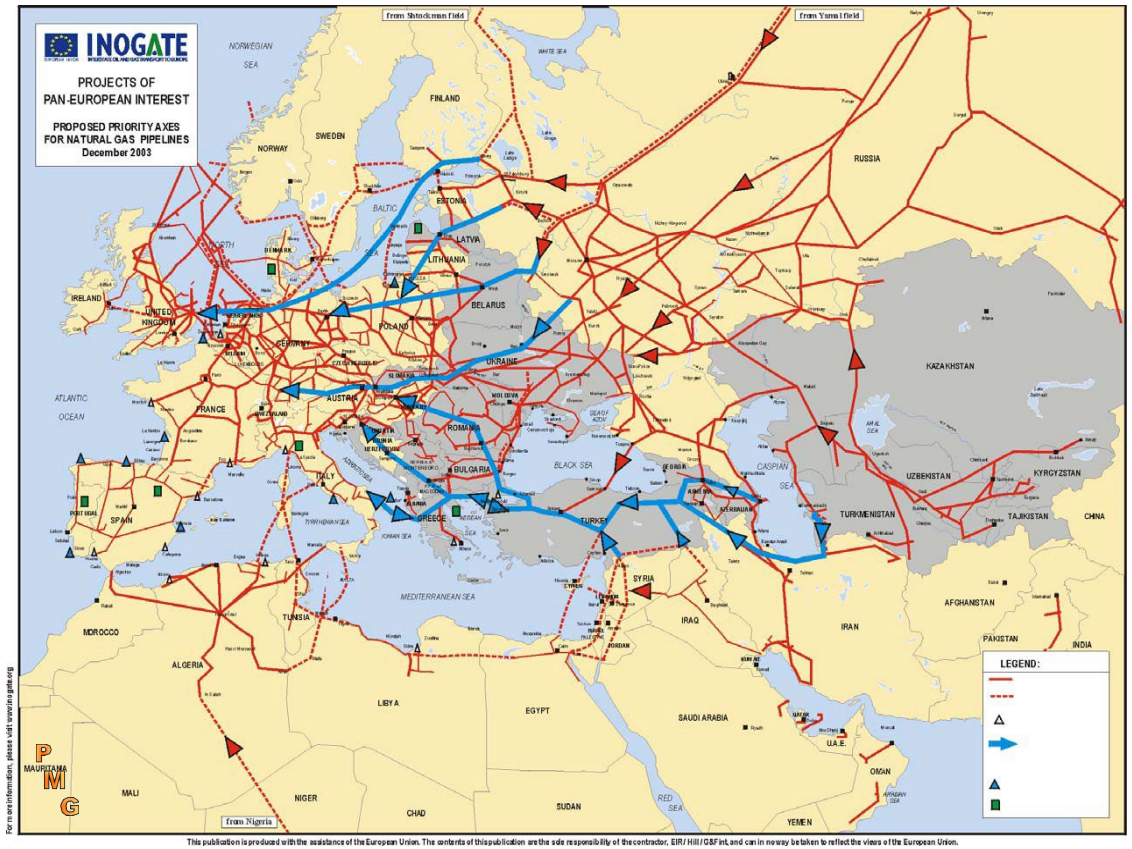
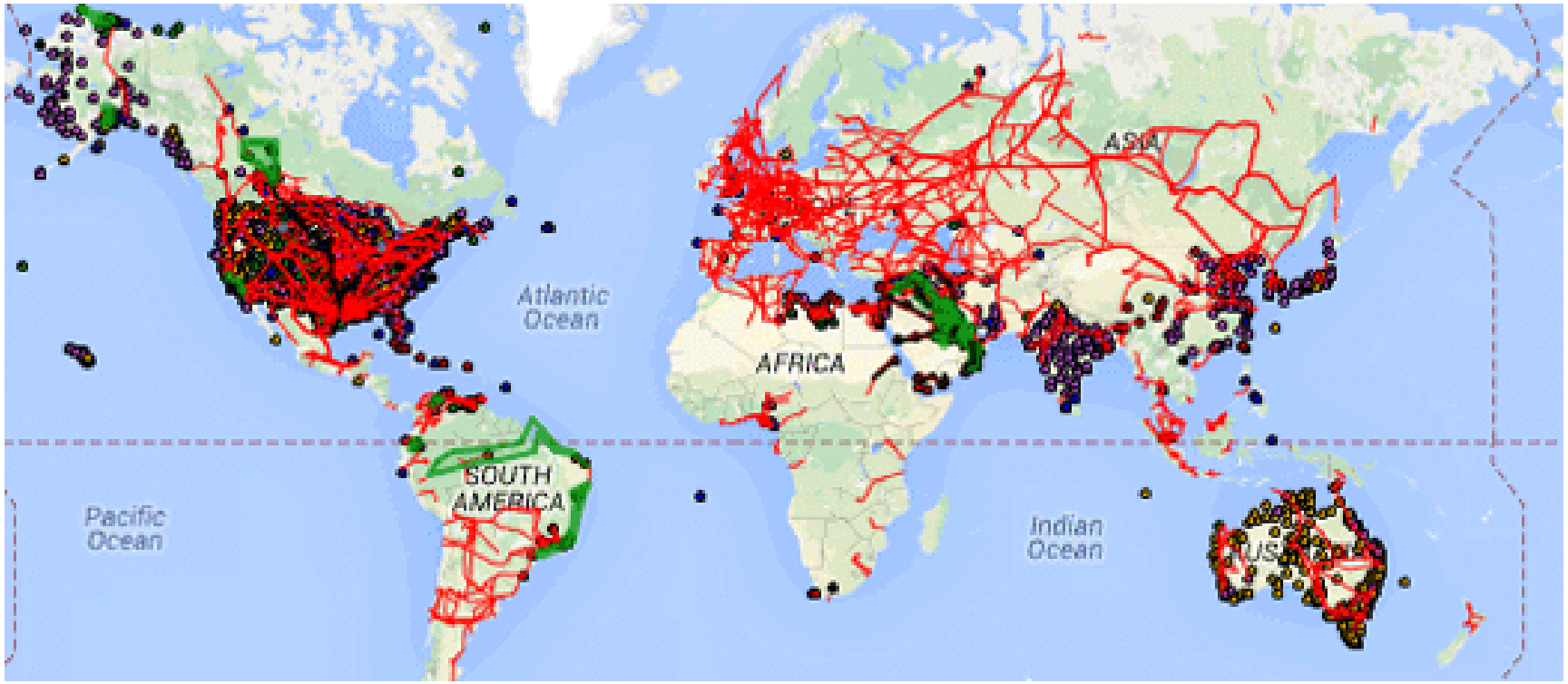
Europe/Africa/Asia pipelines



African pipelines

Global pipeline networks



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Rail transportation

- Oil shipment by train has become a growing phenomenon as new oil reserves are identified across the globe and train transport is made safe.
- The relatively small capital costs and construction period compares to pipeline.
- Carbon emissions and accidents are some significant drawbacks to rail transport.

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Safety of transportation by pipeline or rail

- Transporting oil and gas by pipeline or rail is generally safe.
- Pipeline transport is statistically safer than by rail.
- Specifically, rail is over 4.5 times more likely to experience an occurrence when compared to pipelines.
- Over 70% of pipeline occurrences result in spills of 1 m3 or less, and only 17 percent of pipeline occurrences happen in actual pipelines, meaning that most spills occur in facilities, which may have secondary containment mechanisms and procedures.

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Truck transportation

- The most limited transportation method in terms of storage capacity
- Greatest flexibility in potential destinations
- Last step in transport process

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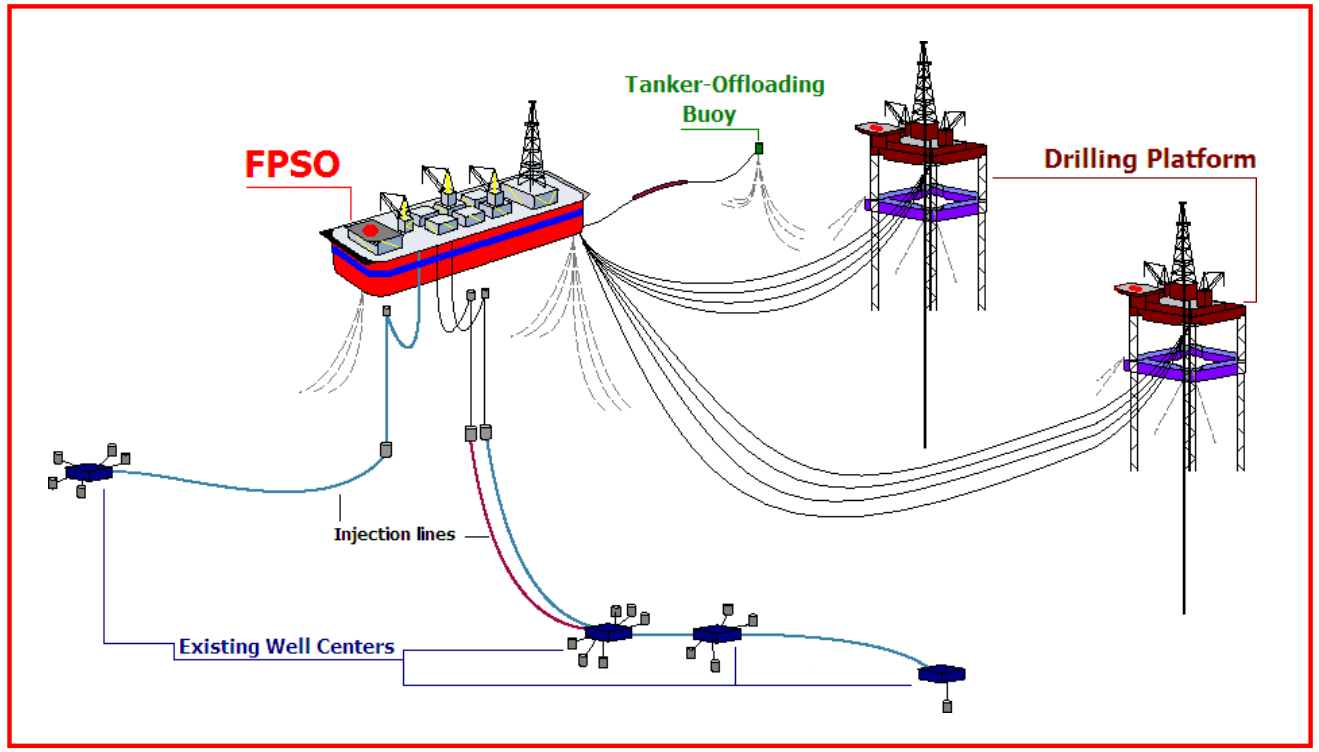
Offshore gathering/export system



FPSO: Floating production storage and off-loading

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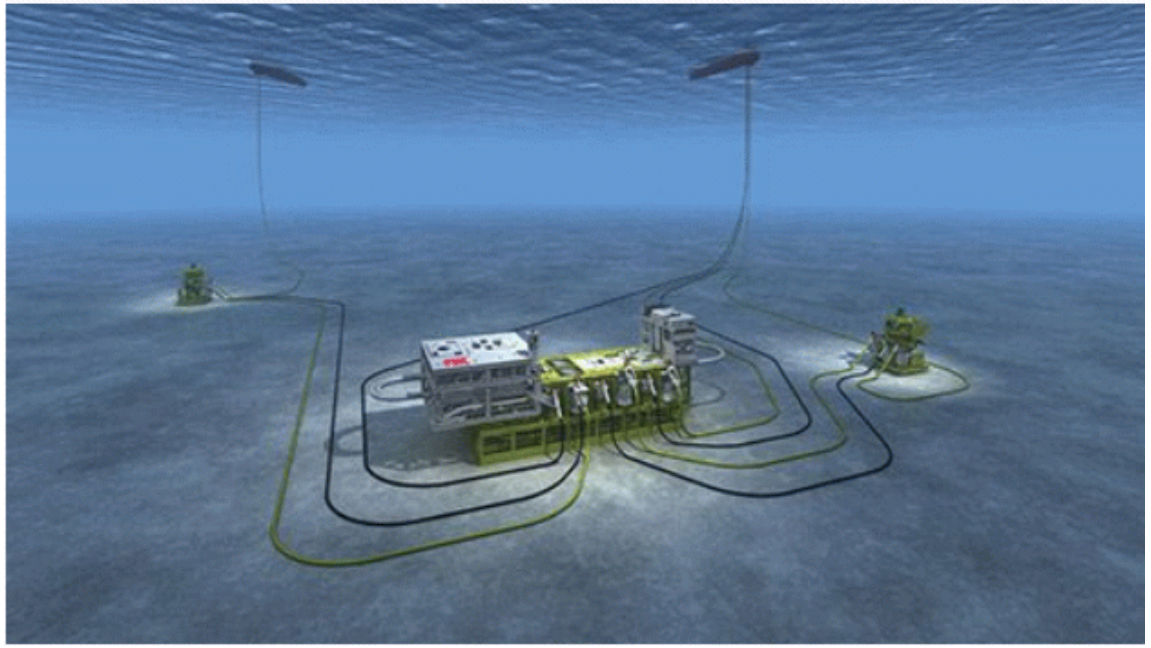
Subsea production systems



The subsea separation system on Petrobras' largest field in the Campos Basin separates heavy oil, gas, sand and water. The system de-bottlenecks the floating production facility and increases production by removing unwanted water from the production stream at the seabed.

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Advantages of FPSO

Less expensive than pipelines and more favourable for:

- Effective in remote locations
- Deep water locations
- Small field with limited reserves, where seabed pipelines are not cost effective

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Floating production storage and offloading (FPSO)

Eydehavn, Norway

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Ship transportation

- A typical 30,000-barrel tanker can carry the equivalent of 45 rail tank cars at about one-third the cost.
- Compared to a pipeline, barges are cheaper by 20-25%, depending on the route.
- The drawback are typically speed and environmental concerns.

Largest oil spills

Spill / Tanker	Location	Date	Tonnes of crude oil (thousands)[a]	Barrels (thousands)	US Gallons (thousands)
Kuwaiti Oil Fires [dubious – discuss] [b]	Kuwait	January 16, 1991 - November 6, 1991	136,000	1,000,000	42,000,000
Kuwaiti Oil Lakes [c]	Kuwait	January 1991 - November 1991	3,409-6,818	25,000-50,000	1,050,000-2,100,000
Lakeview Gusher	United States, Kern County, California	March 14, 1910 – September 1911	1,200	9,000	378,000
Gulf War oil spill [d]	Kuwait, Iraq, and the Persian Gulf	January 19, 1991 - January 28, 1991	818–1,091	6,000–8,000	252,000–336,000
Deepwater Horizon	United States, Gulf of Mexico	April 20, 2010 – July 15, 2010	560-585	4,100-4,900	172,000-180,800
Ixtoc I	Mexico, Gulf of Mexico	June 3, 1979 – March 23, 1980	454–480	3,329–3,520	139,818–147,840
Atlantic Empress / *Aegean Captain*	Trinidad and Tobago	July 19, 1979	287	2,105	88,396
Fergana Valley	Uzbekistan	March 2, 1992	285	2,090	87,780
Nowruz Field Platform	Iran, Persian Gulf	February 4, 1983	260	1,907	80,080
ABT Summer	Angola, 700 nmi (1,300 km; 810 mi) offshore	May 28, 1991	260	1,907	80,080
Castillo de Bellver	South Africa, Saldanha Bay	August 6, 1983	252	1,848	77,616
Amoco Cadiz	France, Brittany	March 16, 1978	223	1,635	68,684

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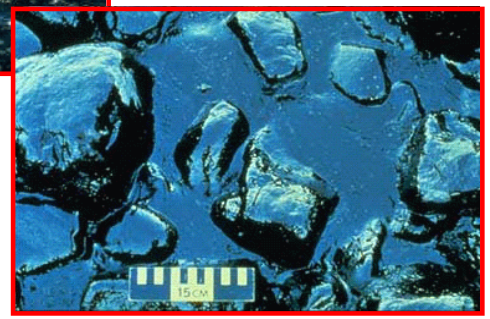
Exxon Valdez oil spill (March 1989)

The Valdez hit a reef off the Alaskan coast, dumping 11 million gallons of crude (ship was carrying 53 million gallons).

35,000 dead birds and 1,000 dead sea otters were found



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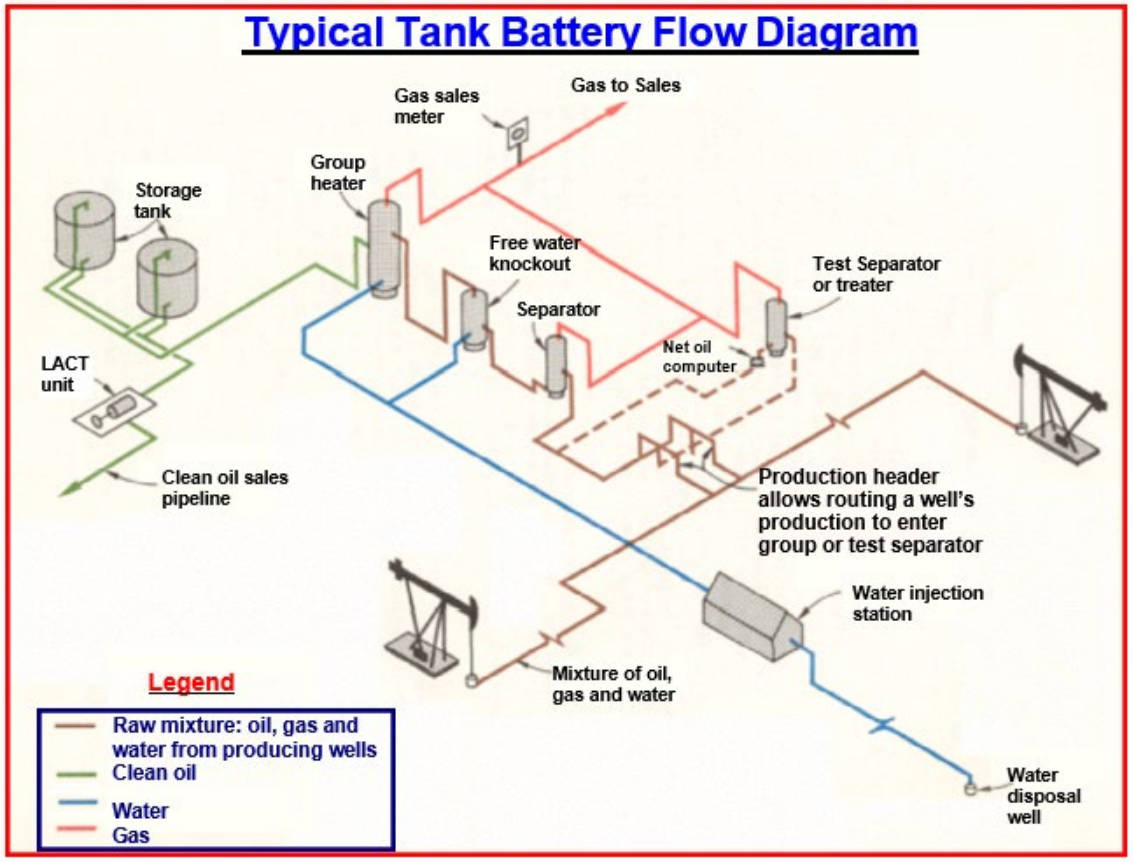
Processing

Surface facilities



Flow measurements

Test separator

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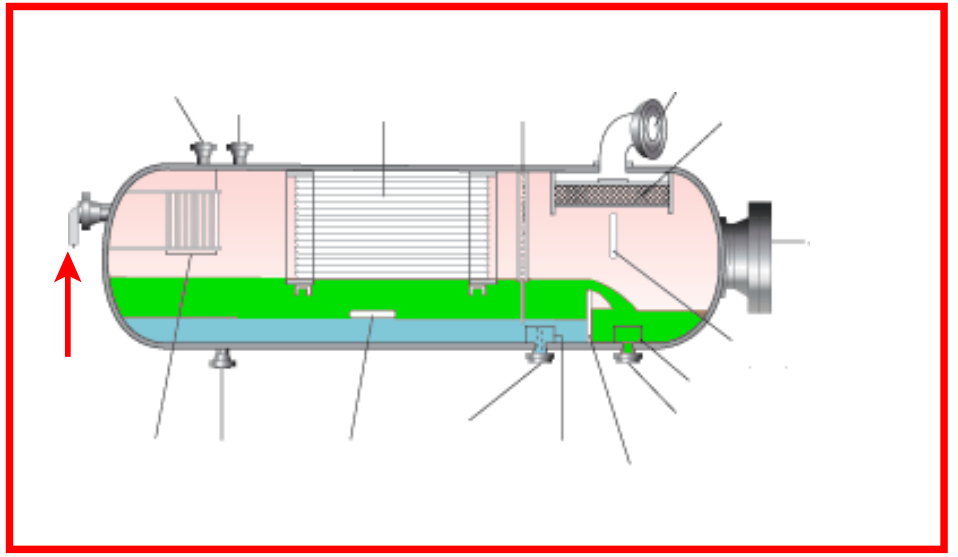
Surface equipment

Lease automatic custody transfer:

- Ensures accurate measurements of oil delivery to pipeline
- Ensures fair payments are made for delivered oil



Surface separator (3-phase):

- Allows efficient separation of produced fluids; oil, gas, and water
- Ensures separated fluids meet pipeline specifications

Gas flaring and the environment

Although gas flaring is undesirable, it is frequent in many operations; well testing, sour gas production, and for limited gas production in oil fields.

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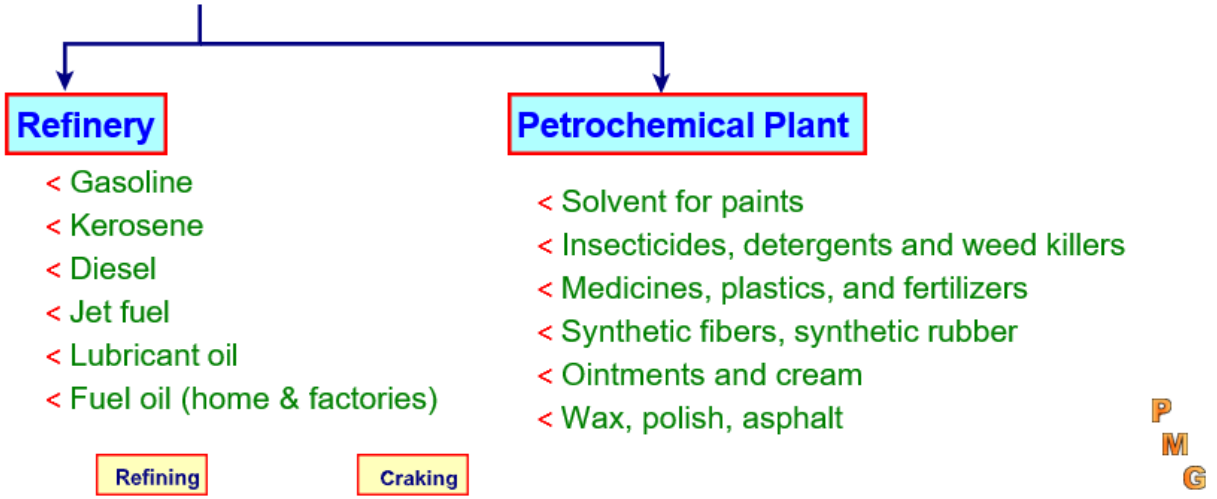
Crude oil and gas treatment

As oil and gas are produced, the following products are extracted at the surface facilities:

- **Natural gas**: Methane (CH_4) and Ethane (C_2H_6)
- **Natural gas liquid**: Propane (C_3H_8), Butane (C_4H_{10}),condensate (C^+_5)
- **Crude Oil**



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Oil and gas storage

Oil and gas can be stored in different ways:

- Farm tanks
- Pipelines
- Tankers
- Salt Caverns
- Tunnels

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Oil storage

- Farm tanks have capacity between 750 Bbl to 1800 Bbl.
- Tanks are placed on pills (concrete pad), not gravel in case of ground settlement.
- Farm tanks are used also for water storage and oil skimming.

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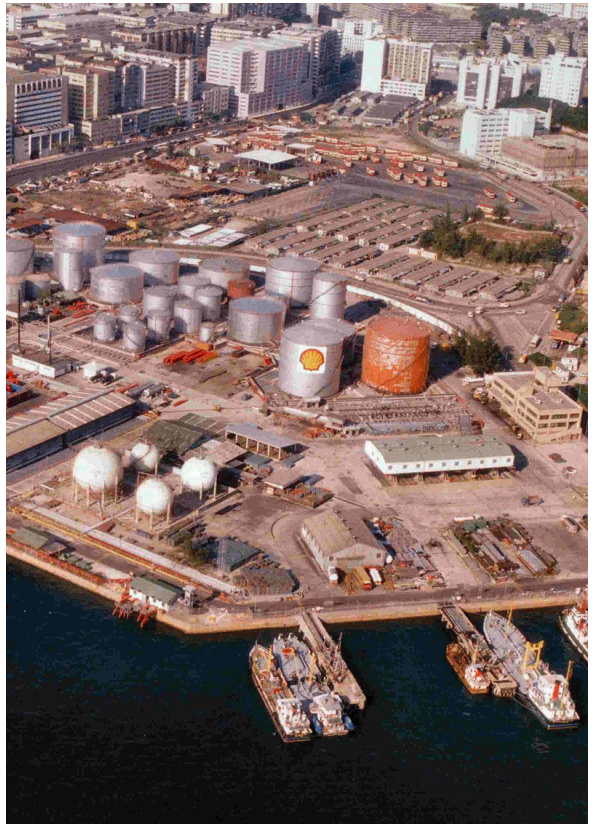
An oil depot in Kowloon, Hong Kong (mid-1980s)



An oil depot (sometimes called a tank farm, installation or oil terminal) is an industrial facility for storage of oil and/or petrochemical products and from which these products are usually transported to end users or further storage facilities.

Oil depots are usually situated close to oil refineries or in locations where marine tankers containing products can discharge their cargo. Some depots are attached to pipelines from which they draw their supplies and depots can also be fed by rail.

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Safety aspects

Massive fire at Buncefield Oil Depot, UK
December 2005

- One of key imperative is Health, Safety and Environment (HSE) and the operators of a depot must ensure that products are safely stored and handled. There must be no leakages which could damage the soil or the water table.
- Tank monitoring systems capable of detecting small leaks (must be capable of detecting a 0.1 gallons-per-hour with a probability of detection of 95% or greater, and a probability of false alarm of 5% or less).
- Fire protection is a primary consideration, especially for the more flammable products such as petrol (gasoline) and aviation fuel.

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Underground oil tanks (UTS)

A horizontal cylindrical steel tank with a factory applied coating and galvanic anodes (cathodic protection) prior to installation underground.

The U.S. Environmental Protection Agency (EPA) published underground storage tank regulations, including a 10-year phase-in period that required all operators to upgrade their USTs with spill prevention and leak detection equipment.

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Oil storage underground

Oil reserves stored underground will allow India to strengthen its energy security guarding them not only against sudden increase in supply and demand leading to increase in the crude oil prices.

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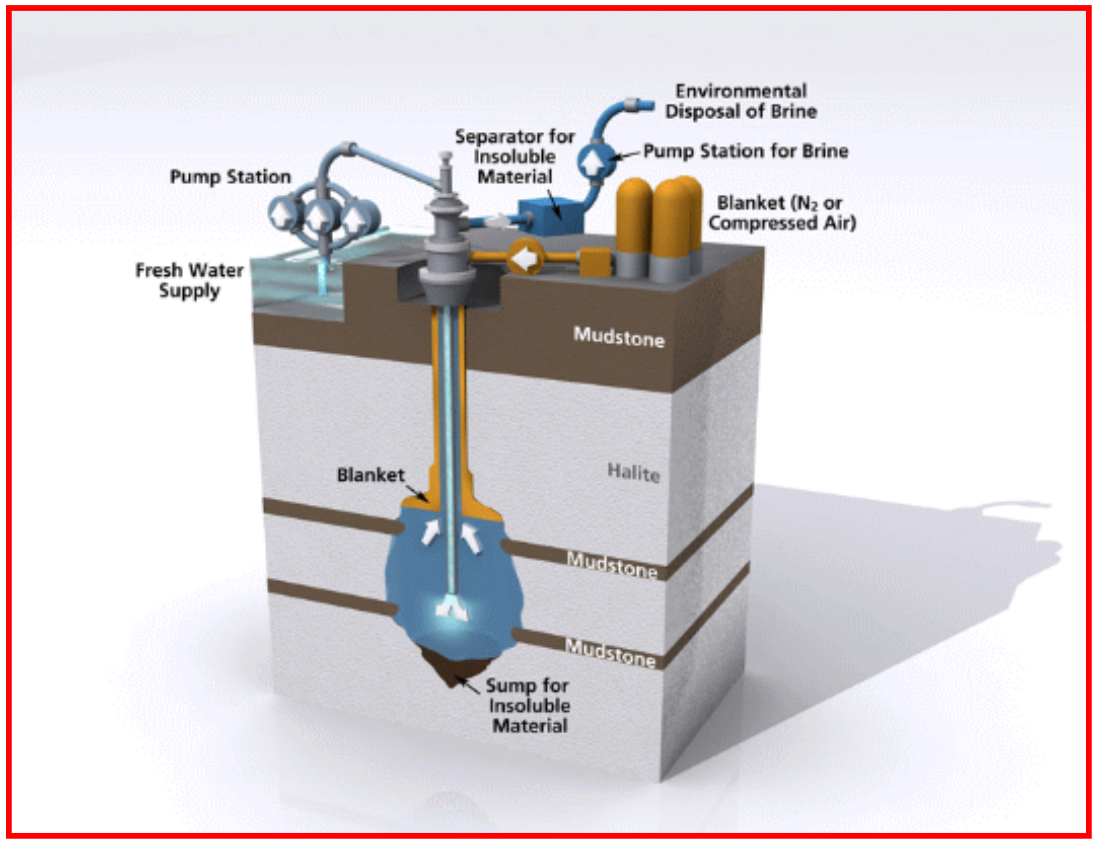
Subsurface salt caverns



- A vertical well is drilled through a salt formation.
- Fresh water is circulated to leach the salt and create a cavern.
- Liquid or gas can be stored in the cavern, which can be produced when needed.

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Produced water

Produced water from oil and gas fields are usually saline, which means it cannot be used for agriculture and drinking. Therefore, produced water must be disposed of safely without hurting the environment, as follows:

- For onshore operations, produced water is disposed of in subsurface aquifers that are saline and must meet environmental regulations.
- For offshore operations, produced water is treated before disposing it in the sea/ocean to meet environmental regulations.

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Thank you

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