CHAPTER 6

Transportation

Domestic

GAS UTILIZATION

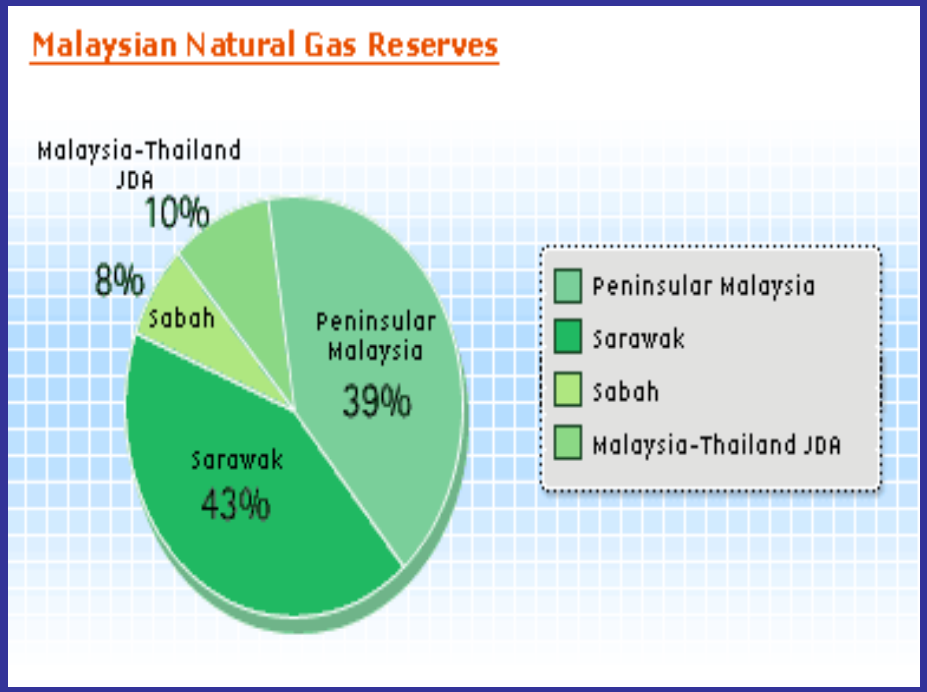
Power generation

Industrial

Space cooling

MALAYSIA GAS RESERVES STATUS

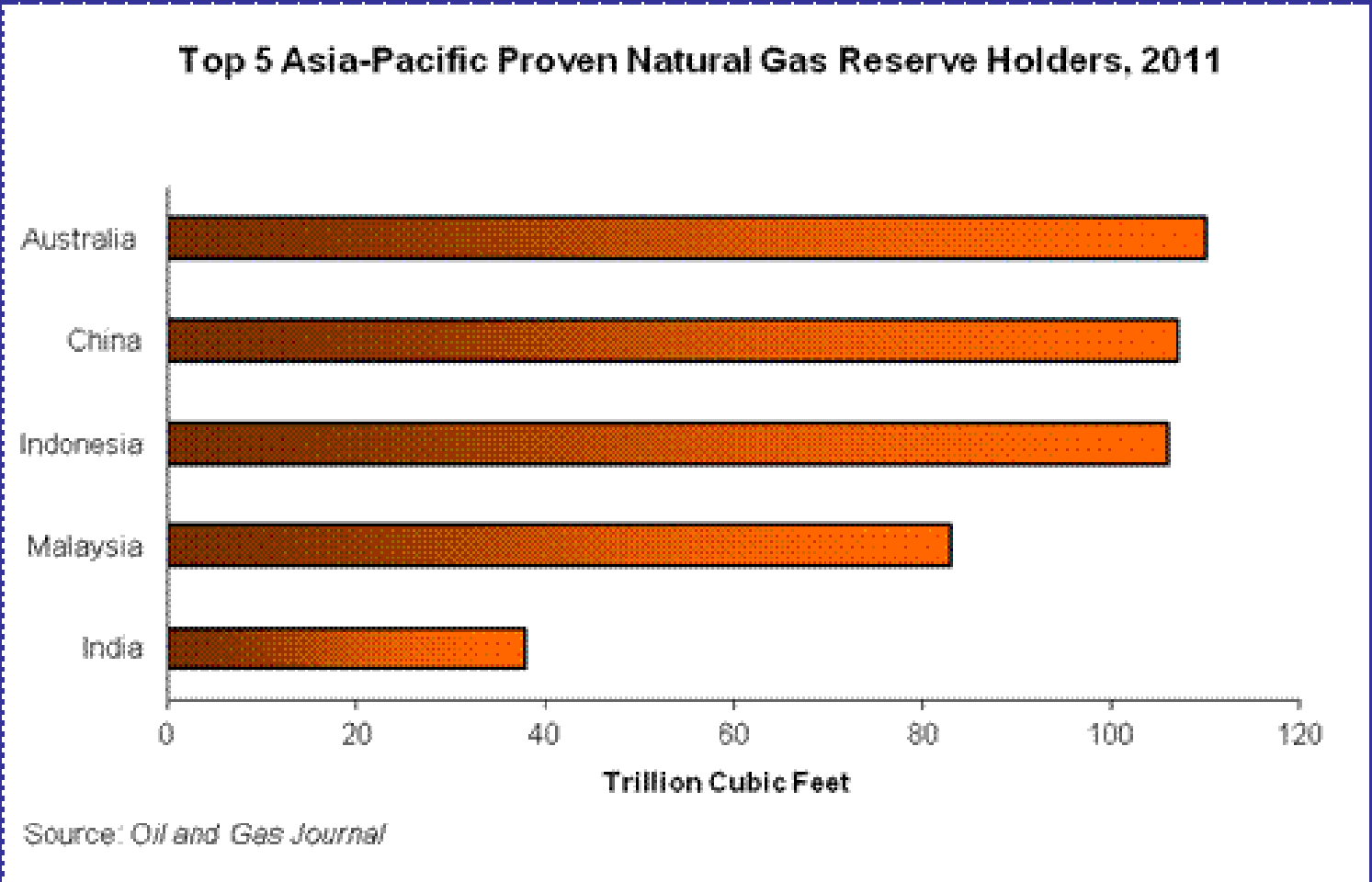
15th largest gas reserves & 30th largest crude oil reserves in the world.



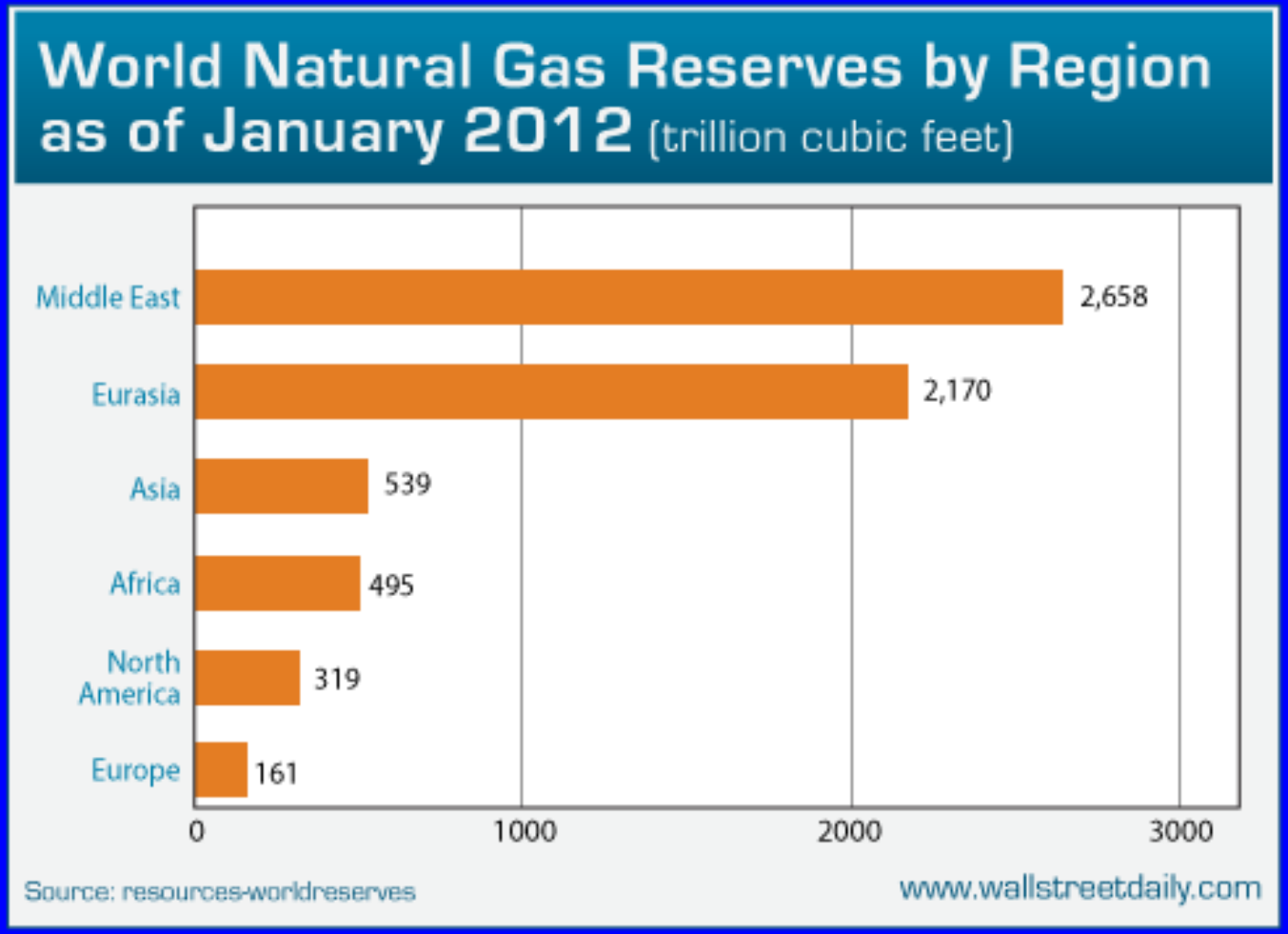
Malaysia's gas reserves stood at 84.9 tcf ~ 66.8 years

Malaysia-Thai JDA
West Natuna
South Sumatra
Africa (Angola LNG plant)

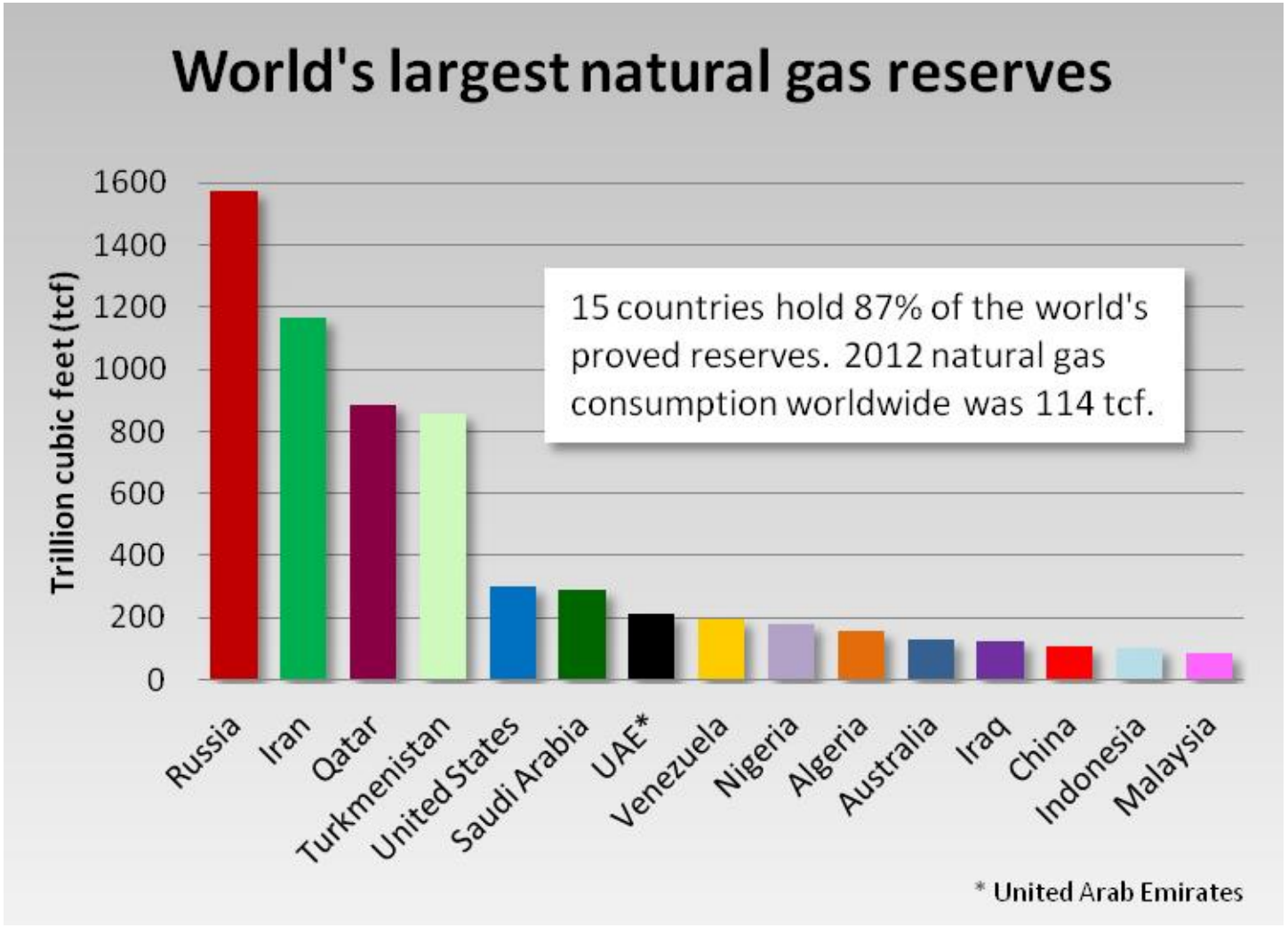
Asian proved gas reserves status



WORLD GAS RESERVES STATUS

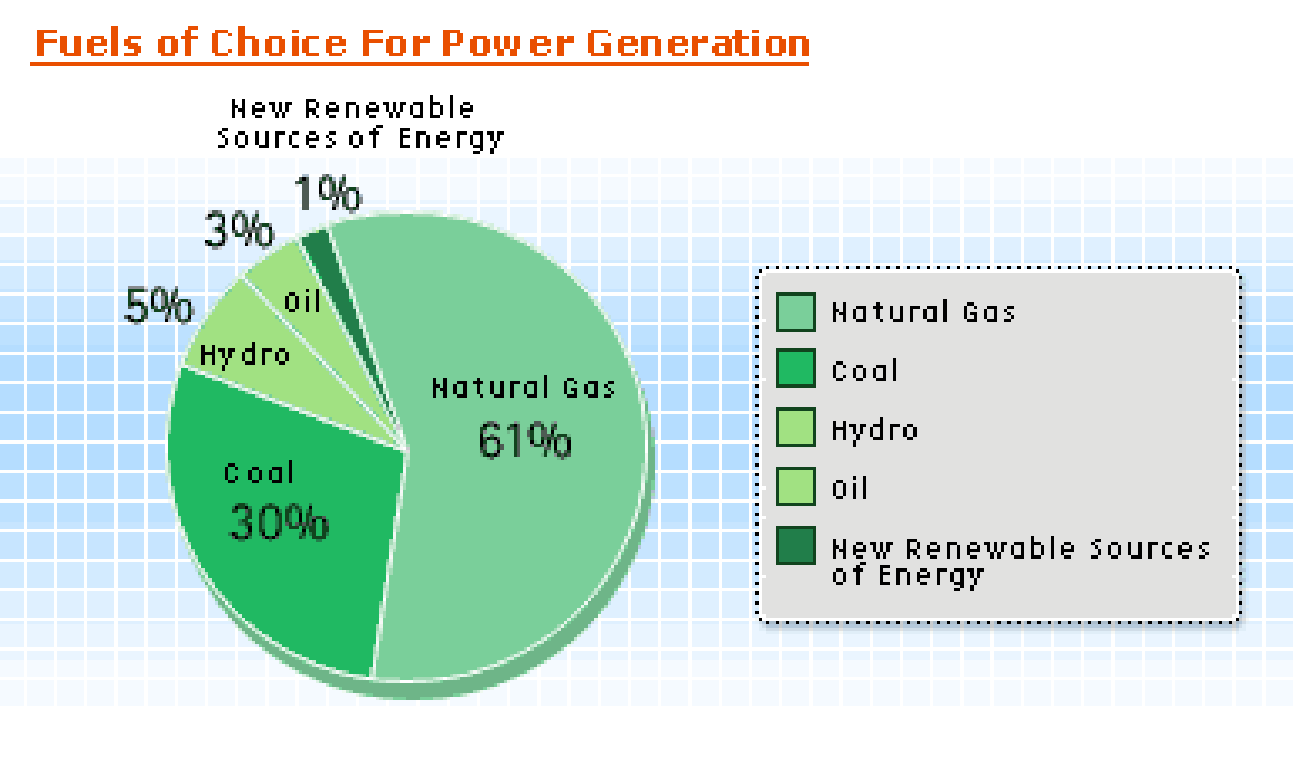


Proved natural gas reserves



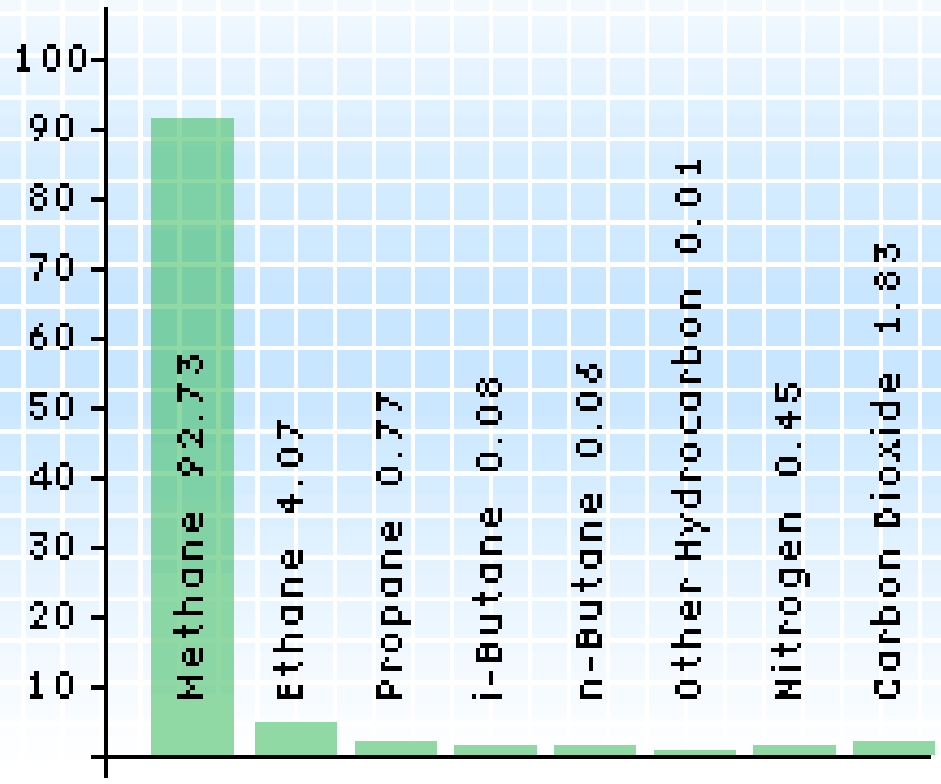
MALAYSIA ENERGY DEMAND

Fuel for Power Generation



COMPONENT OF NATURAL GAS

Natural Gas Compositon



Methane	92.73
Ethane	4.07
Propane	0.77
i-Butane	0.08
n-Butane	0.06
Other Hydrocarbon	0.01
Nitrogen	0.45
Carbon Dioxide	1.83
TOTAL	100.00

Factors which influence the pattern of gas utilization

- Sources of gas (locally produced vs. import)
- Infrastructure (existing pipeline vs. newly built)
- Weather
- Energy Intensive vs. Non energy intensive industries
- Population density
- Alternative fuel (price)
- Government policy

Pattern of Gas Utilization

	M'SIA (%)	EUROPE (%)	USA (%)	JAPAN (%)
Petrochemical	9	6	4	2
Power generation	79	13	14	67
Industrial/Commercial	10	27	29	7
Domestic	1	48	40	22
Others	1	6	13	2

NATURAL GAS FOR POWER GENERATION

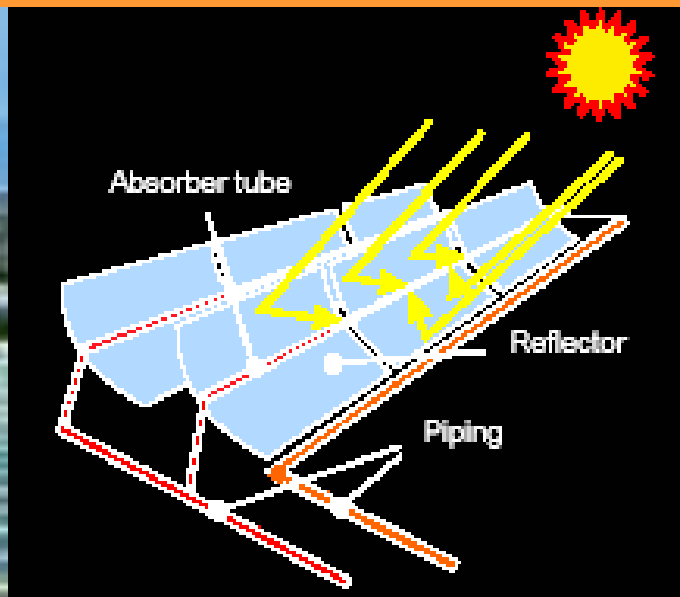
- **Sources of primary energy:-**

  a) **Hydropower (water)**
  b) **Nuclear power (uranium, thorium converted to plutonium)**
  c) **Solar power (sun)**
  d) **Fossil fuels (coal, fuel oil, NG)**
  e) **Renewable (wind, tidal waves, geothermal, biomass, municipal waste)**

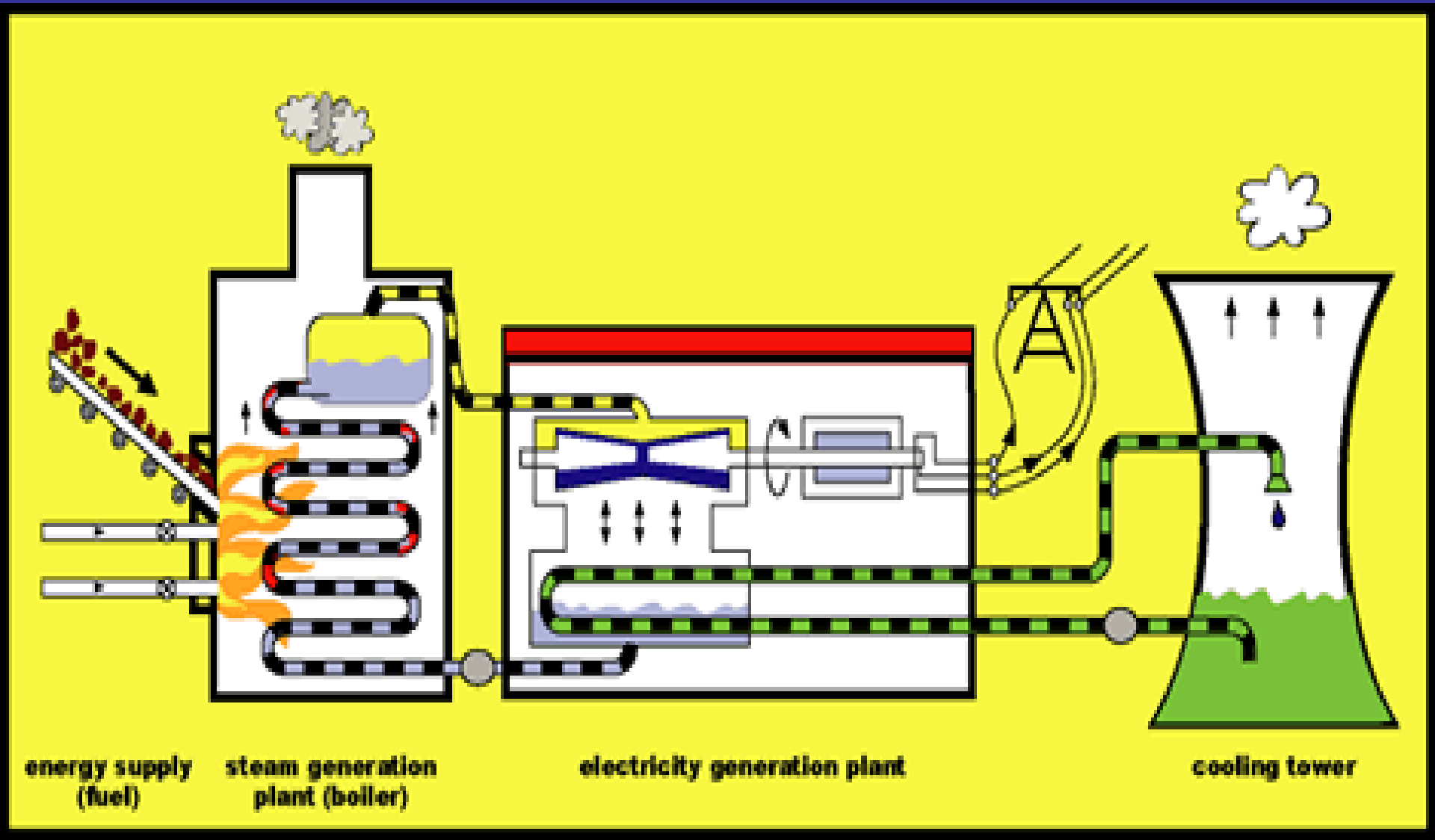
Hydropower (water)

Nuclear power

Solar power - sun



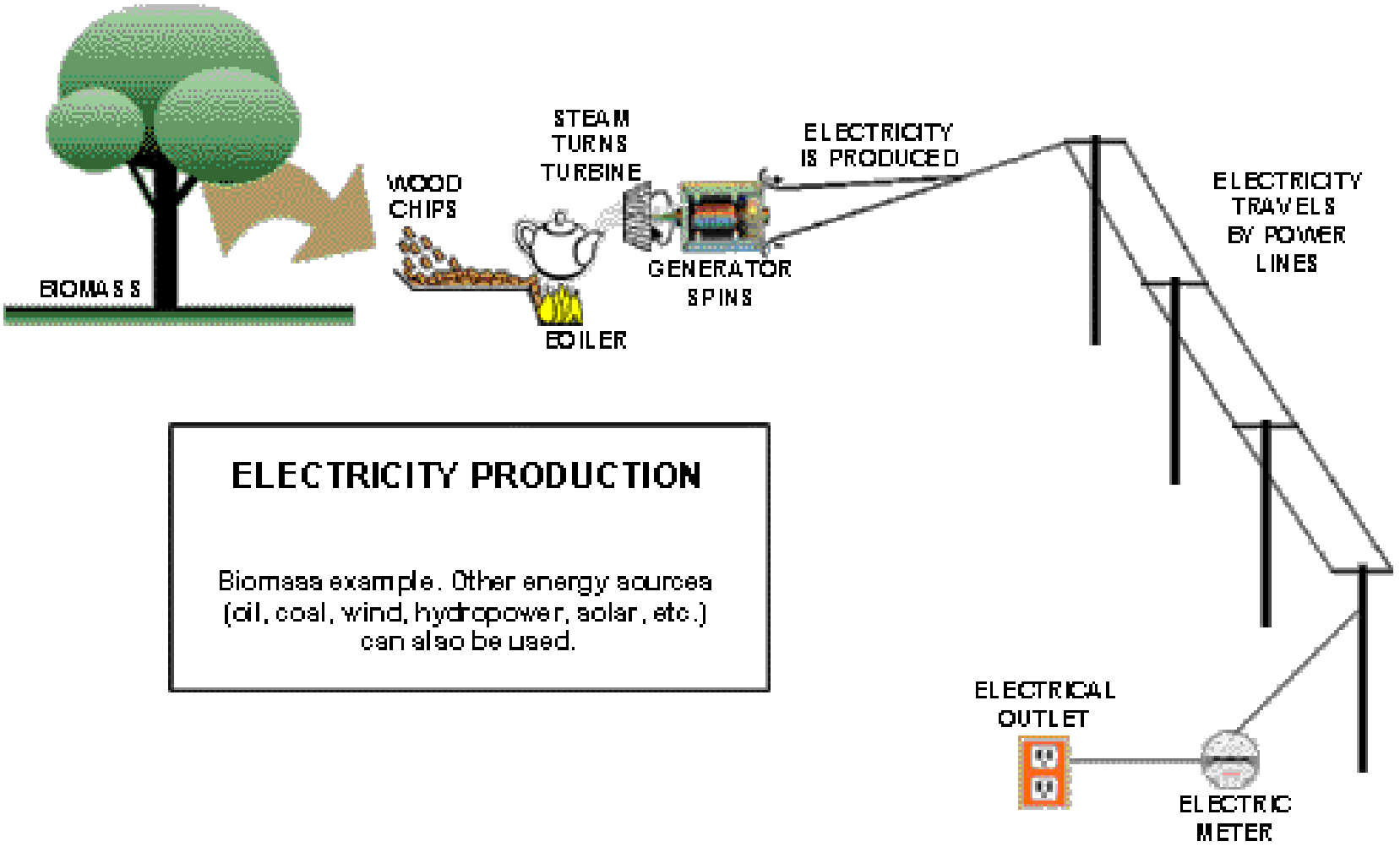
Fuel (coal, oil)



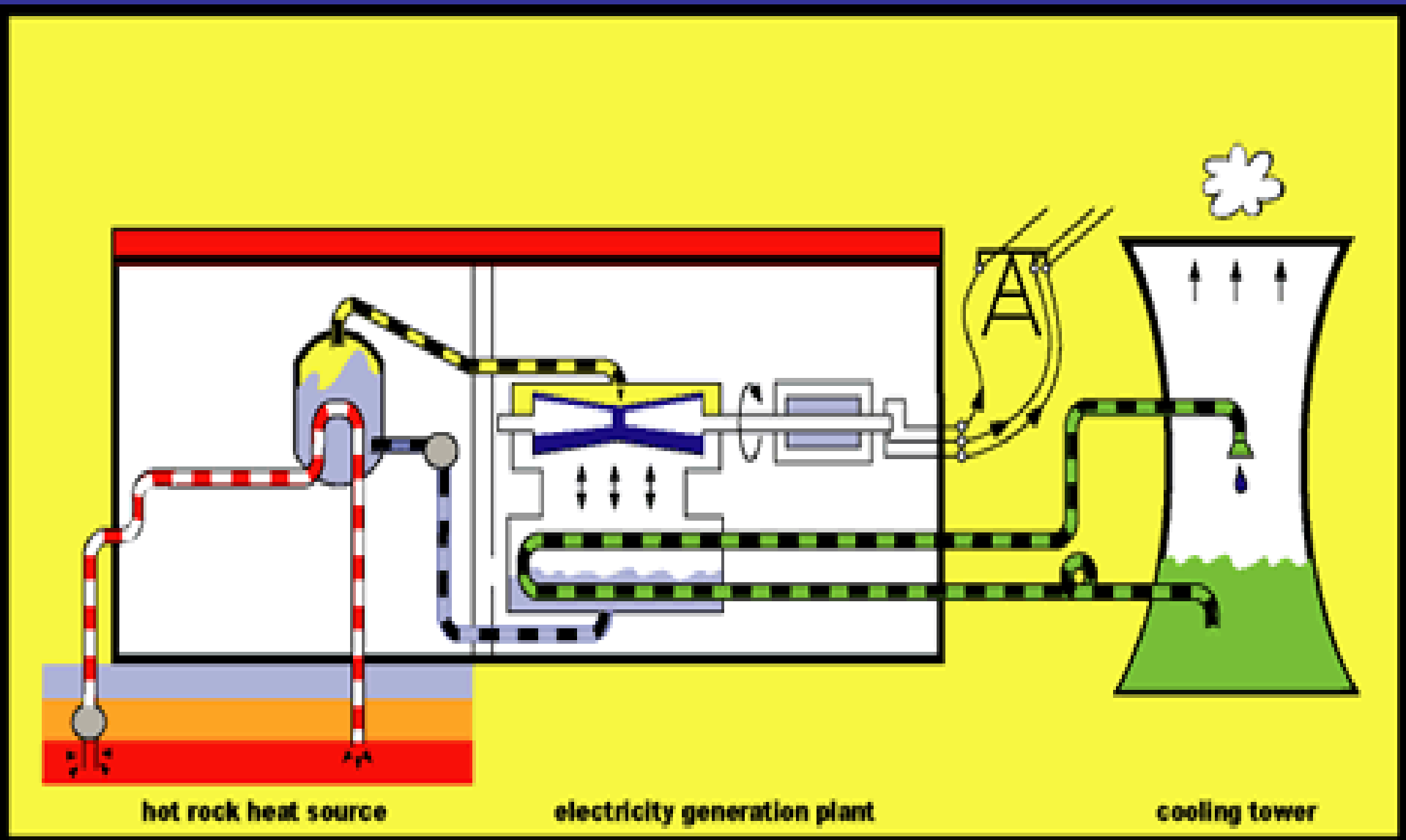
Natural gas


What is this?

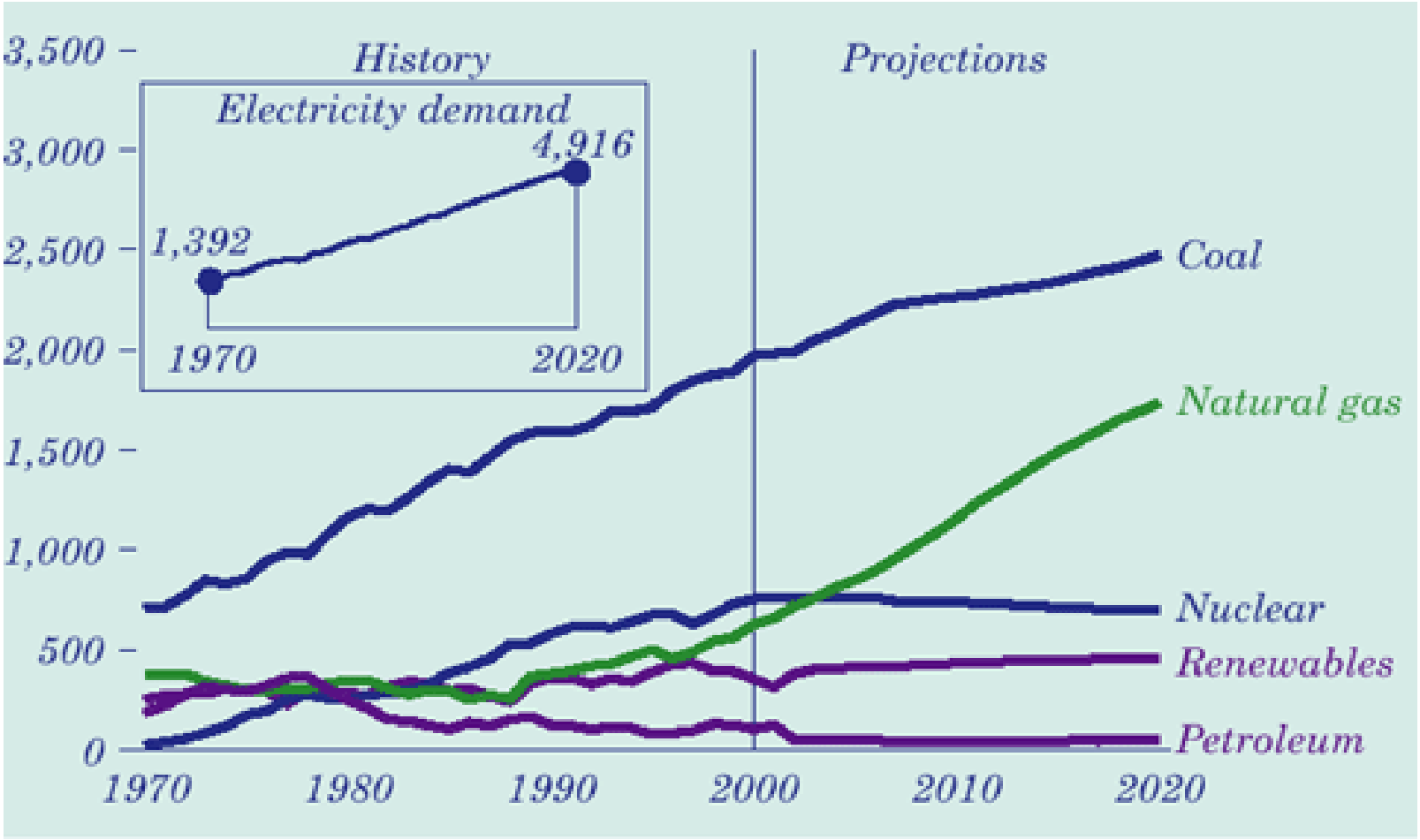
Biomass


BIOMASS
WOOD CHIPS
STEAM TURNS TURBINE
BOILER
GENERATOR SPINS
ELECTRICITY IS PRODUCED
ELECTRICITY TRAVELS BY POWER LINES
ELECTRICAL OUTLET
ELECTRIC METER
ELECTRICITY PRODUCTION
Biomass example. Other energy sources (oil, coal, wind, hydropower, solar, etc.) can also be used.

Geothermal


hot rock heat source
electricity generation plant
cooling tower

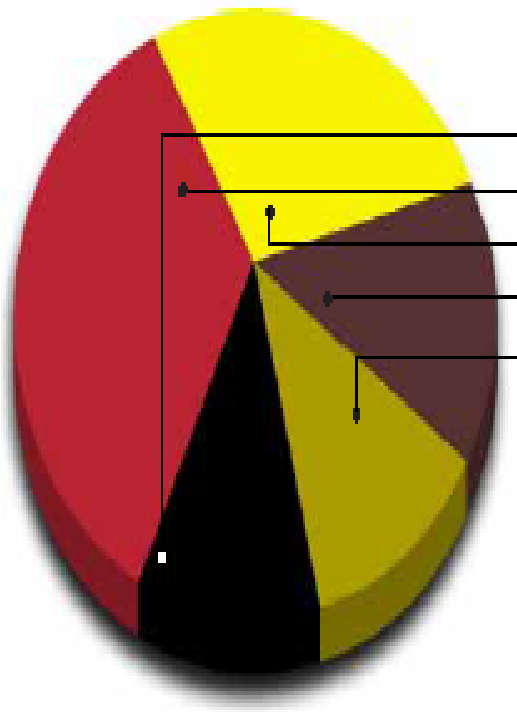
Electricity Generation by Fuel 1970-2020 (106 kWh)



Fuel% for power generation in Malaysia

FUEL/YEAR	1980	1984	1986	1988	1993	1998	2000
Hydropower	14	25	25	28	20	8	12
Oil	85	73	58	49	25	18	13
Natural gas	1	2	17	21	45	67	70
Coal	0	0	0	2	10	7	5

TNB'S GENERATION MIX



TNB'S GENERATION MIX

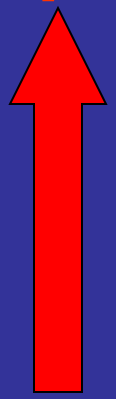
GWh	%	
4,035.1	10.514	Hydro
13,476.4	35.116	Conventional Thermal (Coal)
10,962.9	28.566	Combined Cycle
5,724.6	14.917	Conventional Thermal (Oil/Gas)
4,178.3	10.887	Gas Turbine
38,377.3	100.00	

54%

Capital cost of power plants

1. Hydropower
2. Nuclear power
3. Steam turbine (oil, coal)
4. Combined Cycle PP (gas)
5. Gas turbine (gas)

most expensive



least expensive

Typical Power Plant Efficiency

a) Combined Cycle	40-55%
b) Diesel Engine	40-45%
c) Steam Turbine	26-42%
d) Nuclear Plant	30-35%
e) Gas Turbine	25-30%

Advantages

- Reliant supply
- Environmental-friendly
- Site is clean and compact
- Development of high efficiency and low cost CCPP
- CCPP can be built in much more shorter time than other technologies

Disadvantages

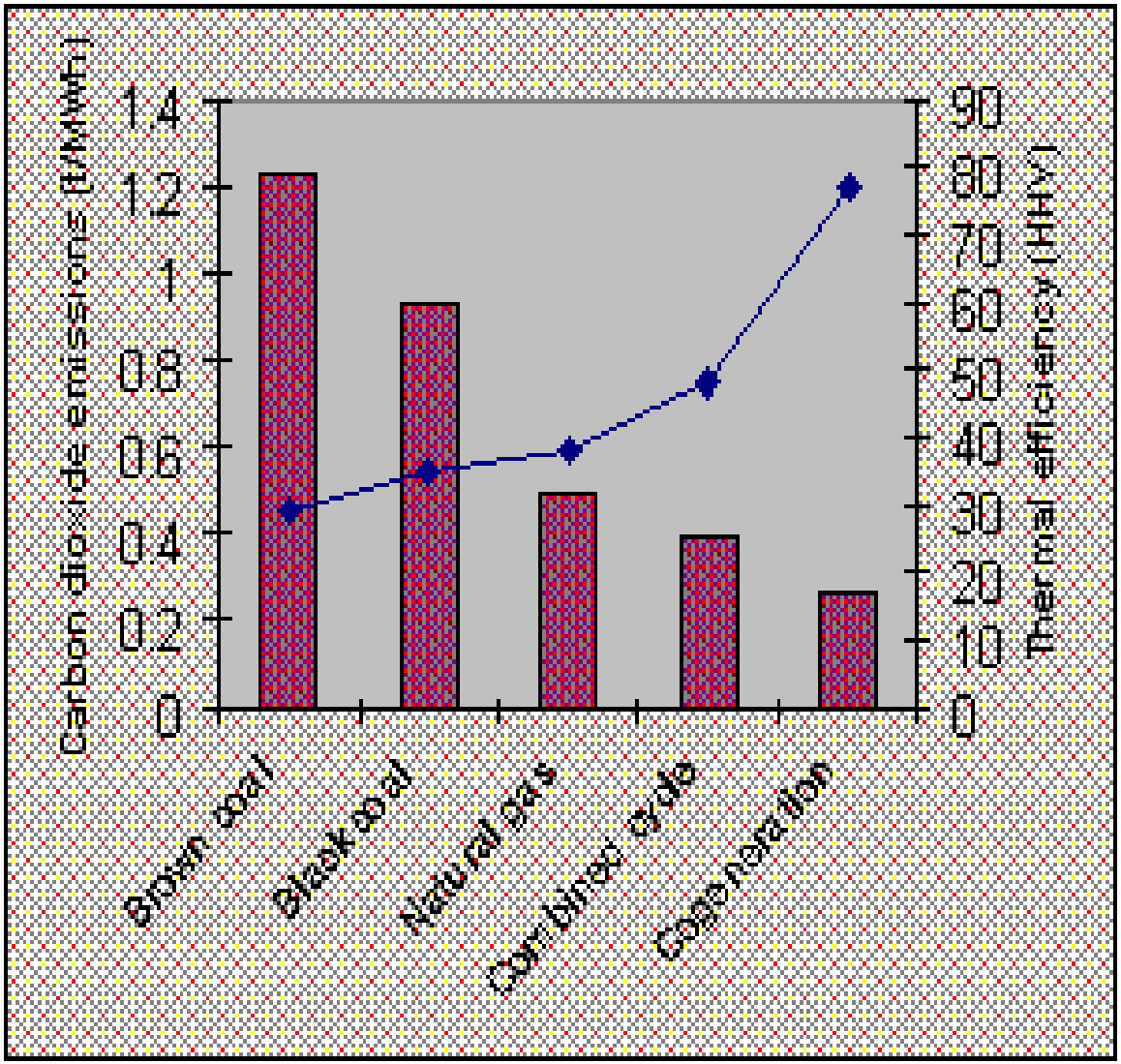
- Possible leakage problem from pipeline
- Not a sustainable fuel
- Can destroy natural habitat for animals and plants.
- Possible land resource impacts

Environmental-friendly

- **Less emission of harmful gases**

Fuel source	Natural gas	Oil	Coal
Carbon dioxide	117,000	164,000	208,000
Nitrogen oxide	92	448	457
Sulphur dioxide	0.6	1,122	2,591
Particulates	7	84	2,744

Energy benefit



- **High energy efficiency**

Thermal efficiency of several methods in electricity generation

Article Study

- Please find your group of three.
- From article supplied, summarized your group findings regarding on using fossil fuel (coal, oil and gas) for energy generation with regards the current situation status on using solar, wind and biomass as the fuel for energy generation in Malaysia.
- Describe the solar system that gives power to India and comment on the cost involved.

NATURAL GAS FOR INDUSTRIAL

Low temperature applications (<500^{o}C)

High temperature applications (>500^{o}C).

Low temperature applications

- Steam raising
- Space heating
- Drying
- Air conditioning

Low temperature applications

- Steam raising

  - Centralized boiler that distributed steam through piping system for industrial process

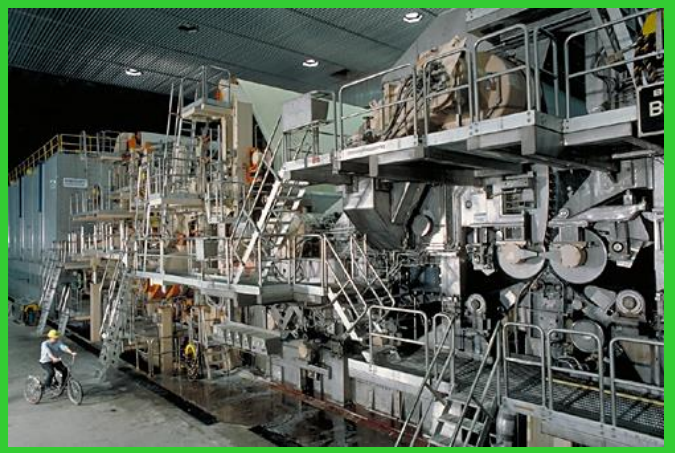

PMD 2367
1

Low temperature applications

- Space heating
- heater, Hot water, steam, direct gas fired

Low temperature applications

- Drying
- Direct drying – battery plate drying
- Air drying – paper mill



Low temperature applications

- Air conditioning
- Absorption chiller, Gas engine vapour compression cycle, cogeneration

High temperature application

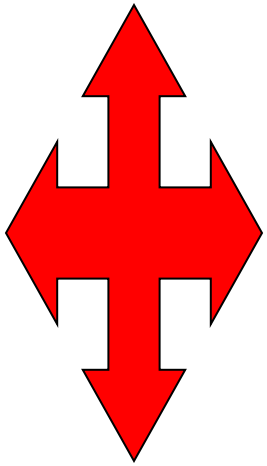
- Metal melting
- Metal reheating
- Metal heat treatment
- Glass melting
- Glass annealing
- Ceramics

Natural Gas for Transportation

Primary fuel - Petrol and Diesel

Alternative – Natural gas

large supply



economical cost

adaptability as an engine fuels

Automotive fuel derived from natural gas

Gaseous fuels	Liquid fuels
Natural gas, LPG, Propane, Hydrogen, Hytane	Methanol, Di-methyl ether (DME)

Natural Gas Vehicle in Malaysia

- Pilot programme in Kertih (1986-1988)
- 1 NGV station; 21 bi-fuel vehicle
- NGV for vehicle programmes in Klang Valley and Miri (1991-1994)
- 14 NGV stations in Klang Valley; 930 bi-fuel vehicle
- 1 NGV station in Miri
- NGV progress in M’sia
- As at 31st Jan 2002, there are about 6,000 NGV around Kuala Lumpur – nearly 95% are taxis. 22 NGV station exist and 5 under construction.

Retail price of automotive fuels (2004/2012)

FUEL	PRICE, RM/LITRE
NGV	0.5~0.6/0.68
Petrol	1.42/1.90
Diesel	0.83/1.80

CNG vs. petrol

Price per Kilometer comparison
Petrol RM0.22 / km
NGV RM0.06 / km

Saving of RM0.16 /km that is about 73%

If I were to drove 60km daily for 30 days per month.

Total distance 60 x 30 = 1800km

CNG vs. petrol

Total fuel price consume per month:
Petrol RM0.22 x 1800 = RM396
Natural Gas (CNG) RM0.06 x 1800 = RM108

Saving per month is RM288

The installation of NGV conversion kit in Malaysia for carburetor : about RM3000 at most.

How long (month) do I need to drive for actual return of my NGV kit investment?
RM3000 / RM288 = 10.4 months

In about 10.4 months or 18720 km (1800km x 10.4 mth) you will get back your investment .

Advantages

a) Clean burning

- Lower level of air pollution
- 20% less CO_2
- 70% less CO
- No lead, No Sulfur
- No particulate/ash

Advantages

b) High octane rating

- Efficient burning
- Less knocking

c) Run more quietly

- Gas burn more slowly than petrol
- Reduced wear on engine component

Advantages

d) Better safety

- Lighter than air (SG ~ 0.6)
- Higher lean (low flammability/explosion limit ~5%v/v)
- High ignition temperature (~630^{o}C)
- Easily detected (odouriser added)
- Strong/durable storage design (high pressure ~3000 psi) –can withstand direct impact form a car speeding at 90 km/hr

Advantages

e) Cleaner engine

- Improvement in spark plug life
- Extend lubricating oil life

NGV benefit to nation

- Cleaner environment
- Positive effect on nation’s cash balance (reduce cash outflow by minimizing import of crude oils)
- Reduce dependence on liquid petroleum (extend life of oil reserves)
- Cost savings (healthcare, pollution reduction)
- Spin-off industries

NGV benefit to customers (vehicle's owner)

- Substantial savings (50%) in fuel cost
- Lower maintenance cost
- Contributes to cleaner environment
- Better safety
- Extended travel range
- 25% road tax deduction
- Duel fuel (petrol & NG) system possible

NGV limitations

- More frequent refueling
- Slight reduction in acceleration power (10-15%)
- Additional weight
- Boot space reduction

Boot space limited

NGV STATION IN JOHOR

Johor	PSS Jalan Batu Pahat, kluang	HWY50 Lot PTD 43258 Mukim Kluang Jalan Air Hitam	In operation	07:00 - 01:00
Johor	PSS Jalan Gangsa	Plo 305, Jalan Gangsa 81700 Pasir Gudang	In operation	07:00 - 01:00
Johor	PSS Lebuhraya Pasir Gudang	81750 Masai	In operation	00:00 - 24:00
Johor	PSS Senai	lot PTD 8797,Jln Lapangan Terbang Sultan Ismail	In progress	06:30 - 24:00

Johor	PSS Ayer Hitam 1	Hwy 50 Jalan Keluang	In progress	
Johor	PSS Desa Cemerlang	PTD 84376, Taman Desa Cemerlang, Jalan Kota Tinggi,	Closed	06:00 - 24:00
Johor	PSS Taman Desa Tebrau	Jln Desa Tebrau	In operation	07:00 - 23:00
Johor	PSS Pasir Gudang Highway 3	Lot PTD 105660 HS (D) 3316 Highway Perling-Pasir Gudang, Kempas Baru,	In operation	07.00 - 23:00
Johor	PSS Jalan Datin Halimah	Lot PTB 21228 HS (D) 359045, Jalan Datin Halimah,	In operation	06:30 - 24:00
Johor	PSS Damansara Aliff	Lot PTD 104981 HS(D) 351223, Taman Damansara Alif, Jalan Tampoi	In operation	06.45 - 23.45
Johor	PSS Bayu Senibong	Lot PTD 148135 HS(D) 270889 (New Lot No.PTD 173047), Bayu Senibong	In operation	07:00 - 24:00
Johor	PSS Mount Austin	Mutiara Emas Utama 8	In operation	07:00 - 24:00
Johor	PSS Rosmerah	Lot/ PTD 52710,Jalan Rosmerah 2/1, Taman Johor Jaya	In operation	07:00 - 02:00
Johor	PSS Langkasuka	Lot PTB 20457, HS(D) 303968, Jalan Langkasuka,	In operation	06.30 - 24:00
Johor	PSS Taman Delima 1	Jalan Daya Taman Daya	In operation	06:30 : 24:00
Johor	PSS Tampoi 2	Lot PTB 20846, HS(D) 302912, Jalan Tampoi Taman Gembira	In operation	07:00 - 24:00
Johor	PSS Tampoi 3	Lot 6179 Mukim Bandar Jalan Tampoi, Johor Bahru	In operation	07:00 - 23:00
Johor	PSS Taman Daya	Jalan Bertam 23, Taman Daya	In operation	06:30 : 23:30
Johor	PSS NGV Jln Datin Halimah	No 10, Jln. Petaling 1,Off Jln Datin Halimah,80350 Johor Bharu	In operation	00:00 - 24:00
Johor	PSS Ayer Hitam 2	Jalan Kluang Hyw 50, Lot PT 5309, Bandar Baru Air Hitam	In operation	07:00 - 23:00
Johor	PSS Taman Teok	Lot 7949, Taman Teok	In operation	

Johor	PSS Jalan Masai Lama	PTD 111519 Bandr Sri Alam, Jalan Masai Lama Pasir Gudang	In operation	
Johor	PSS Kota Masai	Lot 13602,Jln Kota Masai 2 Tmn Kota Masai P. Gudang Johor	In operation	
Johor	PSS Pekan Kulai	Lot 7320, Batu 21, Jln Air Hitam,Hyw 1 Kulai Johor	In operation	07:00 - 2400
Johor	PSS Saleng, Bandar Putra	Leburaya Senai Lot 66916 Kulai Johor	In operation	
Johor	PSS Jln Kulai-Kota Tinggi	PTD 94525, KM 1 Jalan Kulai- Kota Tinggi, Taman Mas	In operation	06:00 - 24:00
Johor	PSS Bandar Putra IOI		In operation	
Johor	PSS Jaya Sepakat	Jaya sepakat	In progress	

TUTORIAL

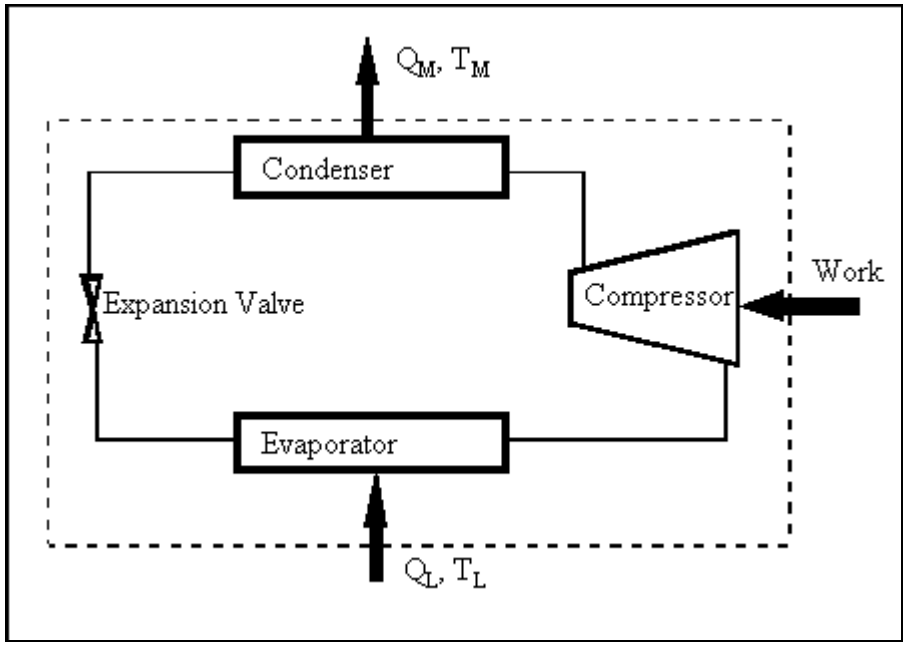
Solve tutorial 2a, 2b, 3a, 4 and 5 (NGV part) and hand in after the class

SPACE COOLING

- Chiller – air conditioning
- Almost 50% of building electricity consumption is for space cooling.

Vapour Compression Chiller	Absorption Chiller
- conventional/commonly used - use mechanical energy as the primary driving force	- use heat as the primary driving source - this heat can be from direct fired gas burner and hot water or steam

Vapor compression chiller



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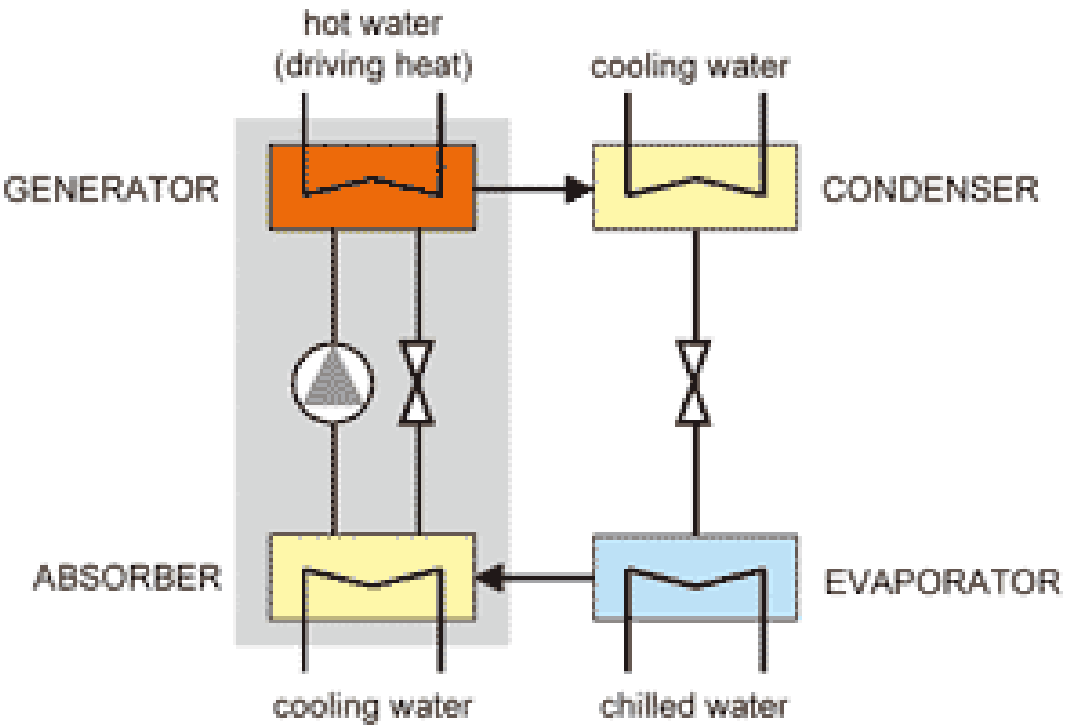
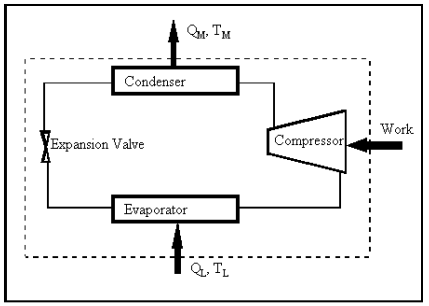
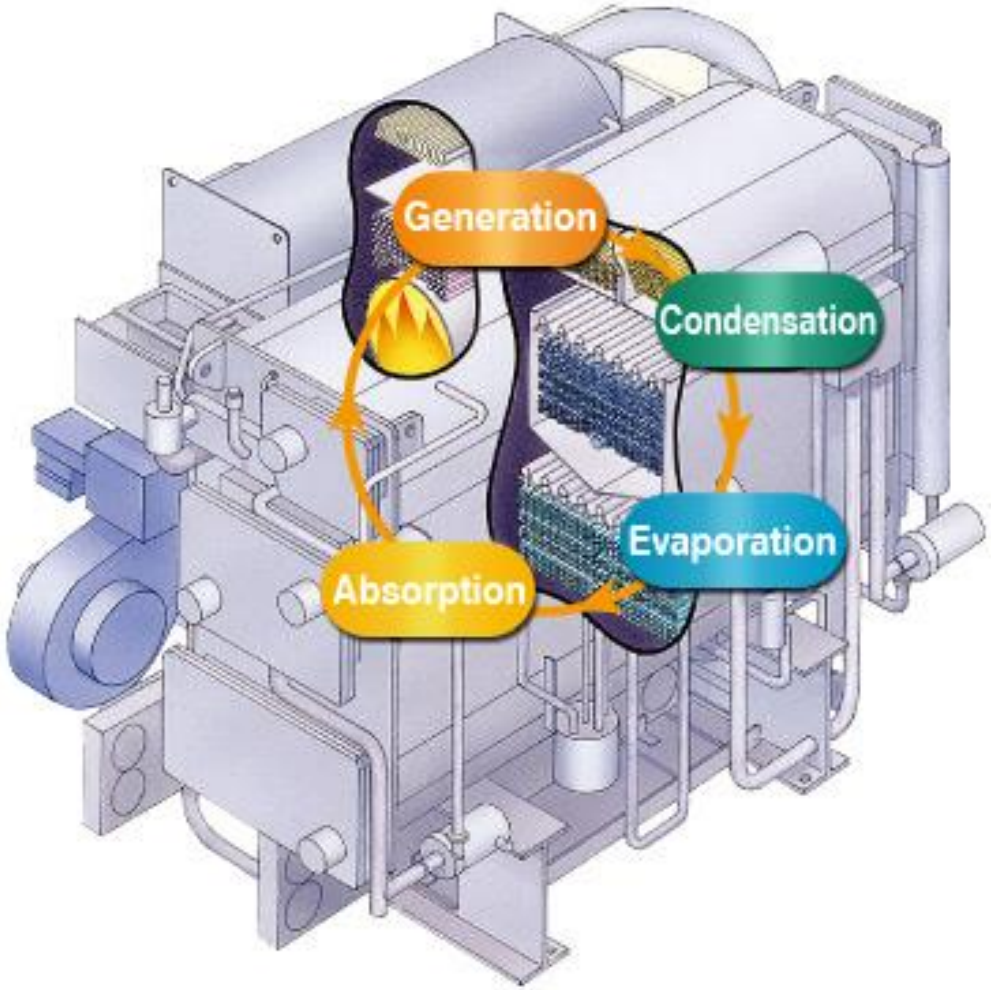
Absorption chiller





Absorption chiller

Absorption chiller



Why Gas Absorption Chiller?

1. Low running cost → low power demand
   → cheaper

2. No major moving parts to break down
   → less noise
   → long life span

3. Environmental friendly
   → CFC's free
   → Clean fuel

Why Gas Absorption Chiller?

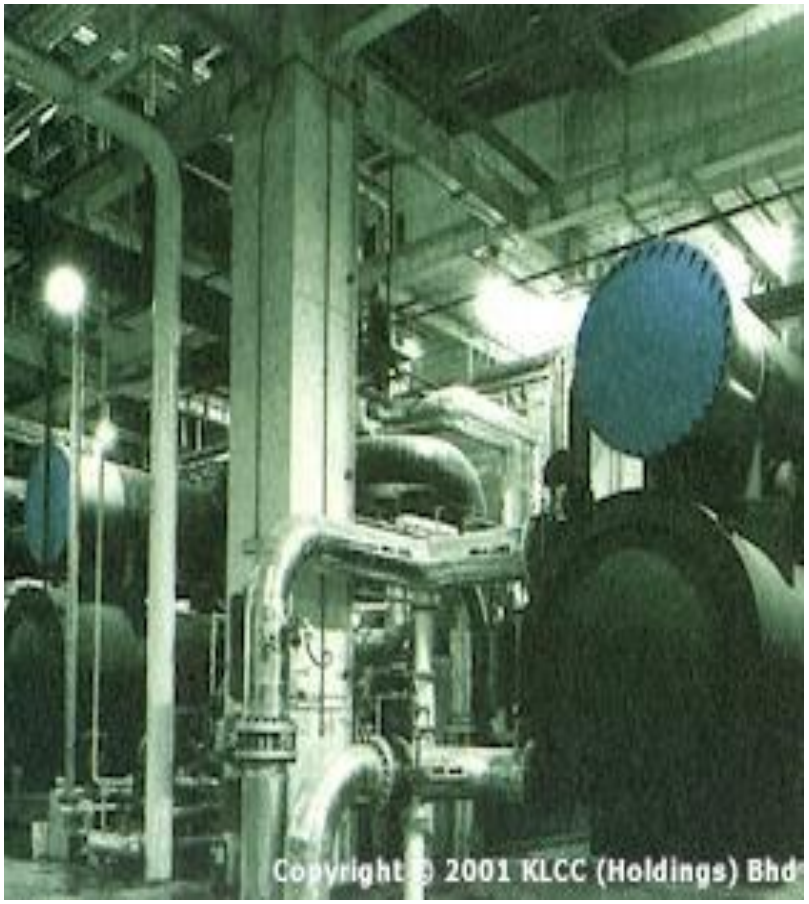
4. Efficient part load operation
5. Technology is established
6. Do not take valuable floor space
7. CHP/absorption chiller package is very cost effective
8. Combination of chilling and heating option is available.

Natural Gas District cooling

Centralized energy plant generating chilled water for air conditioning requirement of several building in a district

Example KLCC, KLIA and Putrajaya

Gas District Cooling (M) Sdn Bhd – manage the district cooling project



Natural Gas District cooling

- The KLCC is served by a 30,000 ton chilled water plant.
- Operate using the R-134A ozone-friendly refrigerant, replacing the ozone depleting chloro-fluorocarbons (CFC).

Domestic application

- Kuala Lumpur City Centre (KLCC)
- Kuala Lumpur Int Airport (KLIA)
- New Adm. Centre Putrajaya
- Universiti Teknologi Petronas(UTP)
- Tanjung Langsat

PETROCHEMICAL INDUSTRY

Physical conversion - involve change in physical state e.g.

- Liquefaction to LNG (liquefied natural gas) MLNG at Bintulu, Sarawak
- Processing to produce NGLs (natural gas liquids), GPP at Kerteh, Trengganu
- Compression to produce CNG for NGV mother station at Shah Alam

PETROCHEMICAL INDUSTRY

Chemical conversion – involves change in molecular structure e.g.

- Methanol plant at Labuan
- Ammonia plant at Bintulu

Advantages

- Reliability of supply (via pipeline)
- Constant feedstock material quality

DOMESTIC MARKET

- Europe and USA (~40%)

Breakdown of UK domestic gas utilization

USAGE	%
Hot water & space heating (central)	70
Gas fires (space heating)	18
Cooking	6
Gas fired heater	3
Others (tumble dryer, refrigerator)	3

NG for Malaysia Domestic Market

- Consumption rate is very small - cooking. Potential market gas – cooking and air conditioning (condo)
- Major competitors: LPG and electricity

TUTORIAL

Solve tutorial 6 and hand in after the class