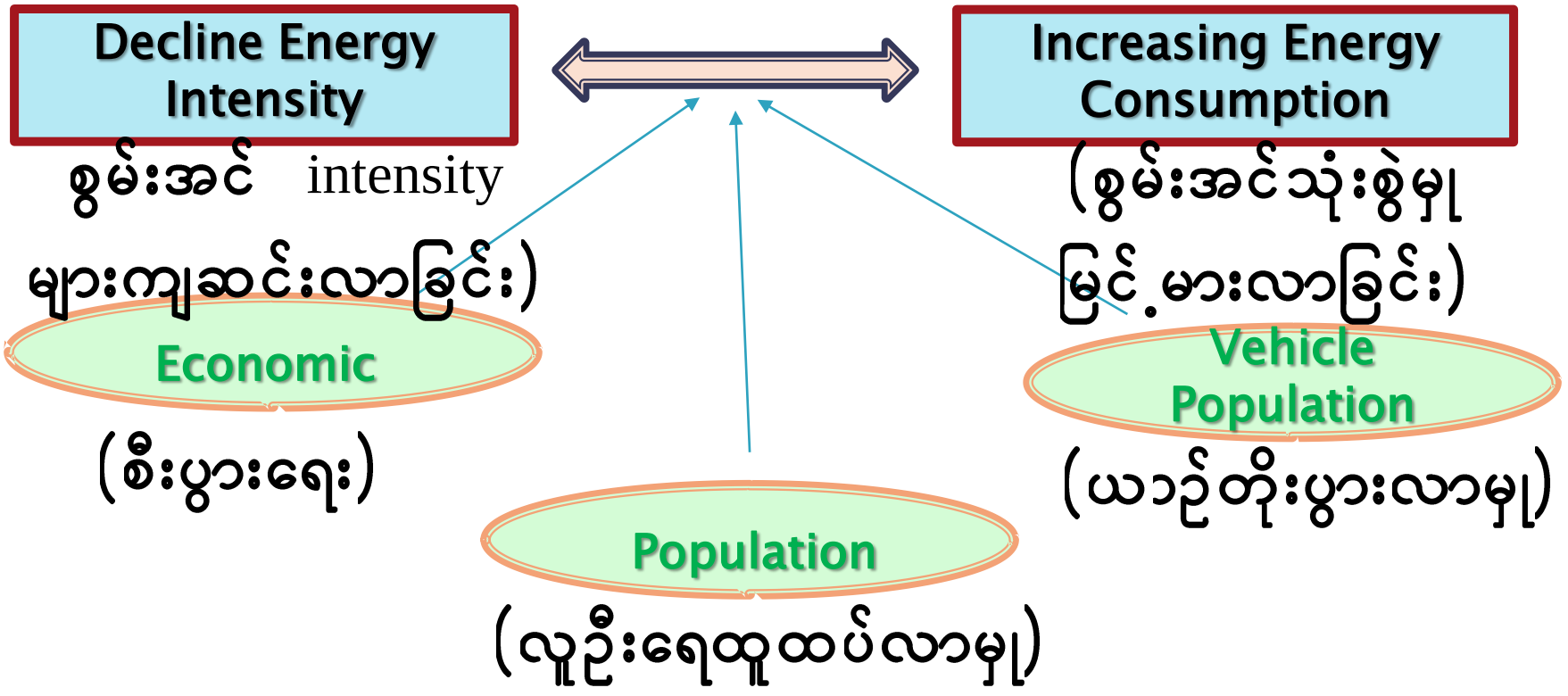
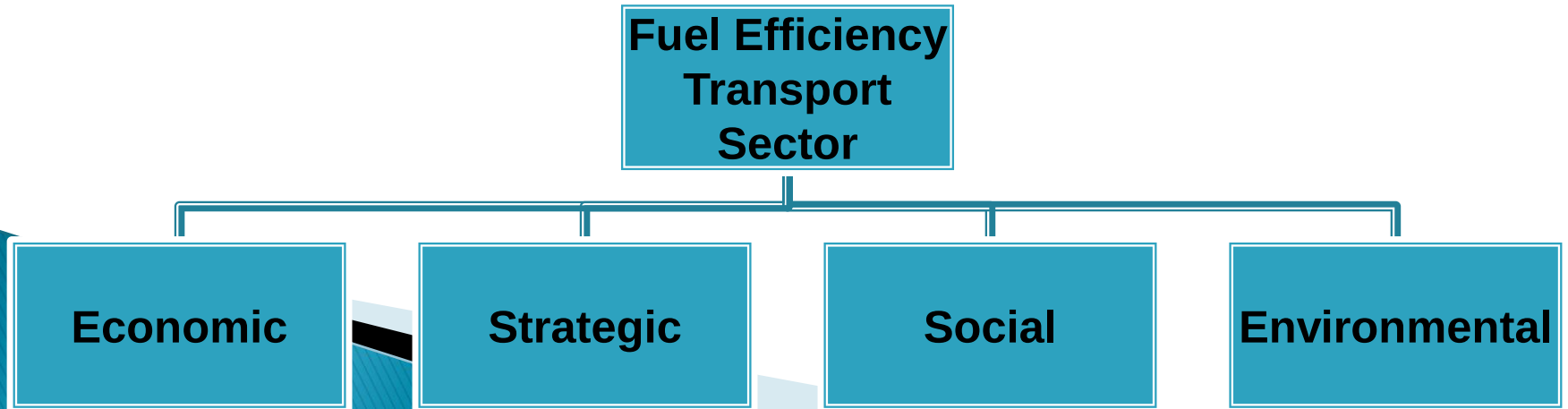
- **Predictions say temperatures will increase between 1.4-5.8 C in next 100 years**
- **Small changes in average temperatures make a big difference**

Objective of Study on EE of Transport Sector





သယ်ယူပို့ဆောင်ရေးကဏ္ဍတွင်စွမ်းအင်၏စွမ်းဆောင်ရည်အဓိပ္ပယ်သတ်မှတ်ချက်

စွမ်းအင်၏စွမ်းဆောင်ရည်သတ်မှတ်ချက်အယူအဆများ

- မောင်းနှင်မှုစွမ်းရည်
- အသုံးပြုမည့်သူများ
- အသုံးပြုမည့်ရည်ရွယ်ချက်
- လောင်စာဈေးနှုန်း

လောင်စာများ၏ စွမ်းဆောင်ရည်

လောင်စာ၏ စီမံမှု

တစ်ယူနစ်လောင်စာတွင်ယာဉ်သွားနိုင်သောခရီးအကွာအဝေး

Fuel efficient vehicles

use less oil (လောင်စာသုံးစွဲမှုနဲ့)

burn less gas (လောင်ကျွမ်းမှုနဲ့)

cut global warming emissions (လေထုညစ်ညမ်းမှုနဲ့)

produce less pollution

miles per US gallon → L/100 km:	235 / mpg_{US} = L/100 km
miles per Imp. gallon → L/100 km:	282 / $mpg_{Imp.}$ = L/100 km
L/100 km → miles per US gallon:	235 / (L/100 km) = mpg_{US}
L/100 km → miles per Imp. gallon:	282 / (L/100 km) = $mpg_{Imp.}$

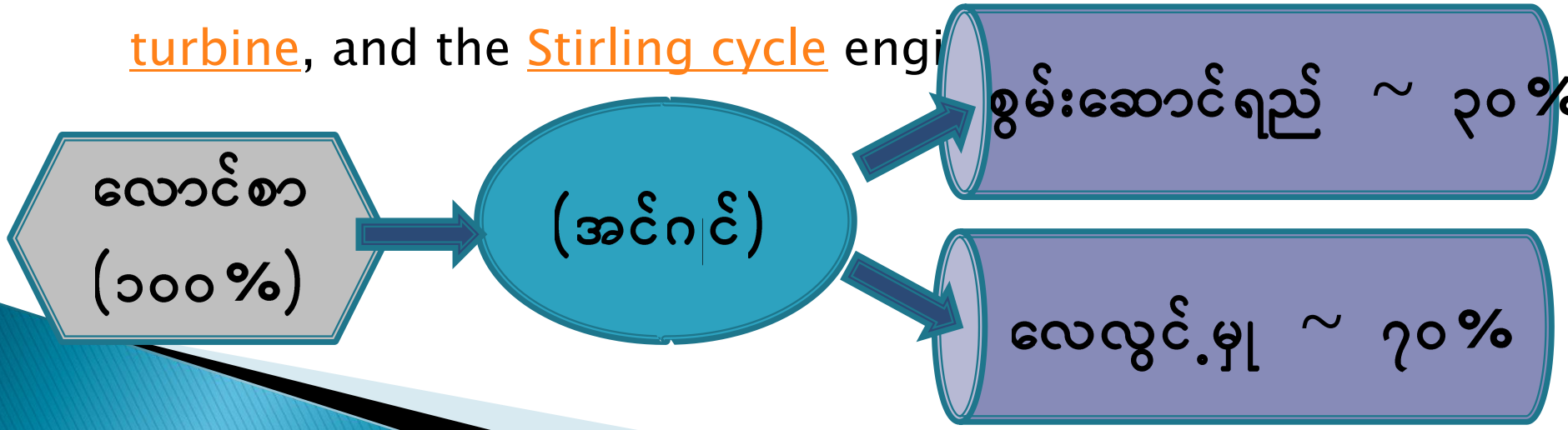
အင်ဂျင်များ၏ စွမ်းဆောင်ရည်

အင်ဂျင်များ၏ စွမ်းဆောင်ရည်ဆိုသည်မှာ

အင်ဂျင်၏ လောင်စာသုံးစွဲမှုနှင့် ၎င်းလောင်စာသုံးစွဲမှုနှင့် အညီရရလမည့်

အင်ဂျင်၏ စွမ်းဆောင်ရည်ဆက်သွယ်ချက်

- There are two classifications of thermal engines–
- Internal combustion (gasoline, diesel and gas turbine, i.e., Brayton cycle engines) and
- External combustion engines (steam piston, steam turbine, and the Stirling cycle engi



Energy Efficiency Terminology

- Energy efficiency is similar to fuel efficiency but the input is usually in units of energy such as
- British thermal units (BTU), megajoules (MJ),
- gigajoules (GJ),
- kilocalories (kcal), or
- kilowatt-hours (kW·h).

"Energy intensity", or the amount of input energy required for a unit of output such as MJ/passenger-km (of passenger transport),

BTU/ton-mile (of freight transport, for long/short/metric tons),

GJ/t (for steel production),

BTU/(kW·h) (for electricity generation), or

litres/100 km (of vehicle travel). Litres per 100 km

Fuel economy standards and testing procedures

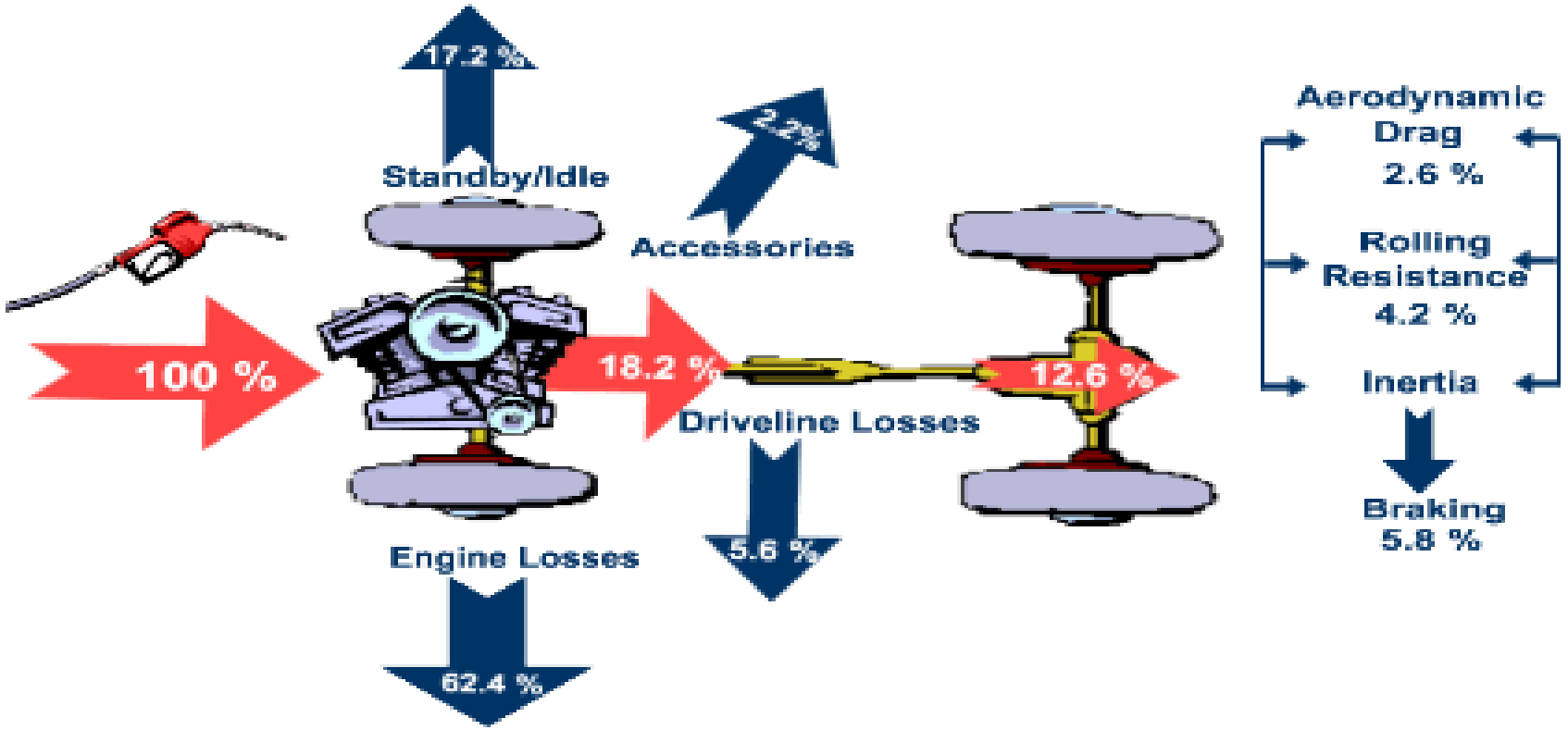
Gasoline new passenger car fuel efficiency					
Country	2004 average	Requirement			
		2004	2005	2008	Later
People's Republic of China[20]			6.9 L/100 km	6.9 L/100 km	6.1 L/100 km
United States	24.6 mpg (9.5 L/100 km) (cars and trucks)*	27 mpg (8.7 L/100 km) (cars only)*			35.5 mpg (6.6 L/100 km) (2016)
European Union					5 L/100 km (2012)
Japan[10]					6.7 L/100 km CAFE eq (2010)
Australia[10]	8.08 L/100 km CAFE eq (2002)	none			6.7 L/100 km CAFE eq (2010) (voluntary)

Important Facts in Efficient Transport Sector

- **Vehicle fuel efficiency and Engine efficiency** are determined by the technical energy efficiency;
- **Vehicle travel** denotes the type of travel/driving and the number of miles driven;
- **Vehicle population** is the number of vehicles on the road.

$E_{\text{road transport}}$ = (vehicle fuel efficiency) x (vehicle travel) x (the vehicle population)

Where does fuel energy go in a conventional car

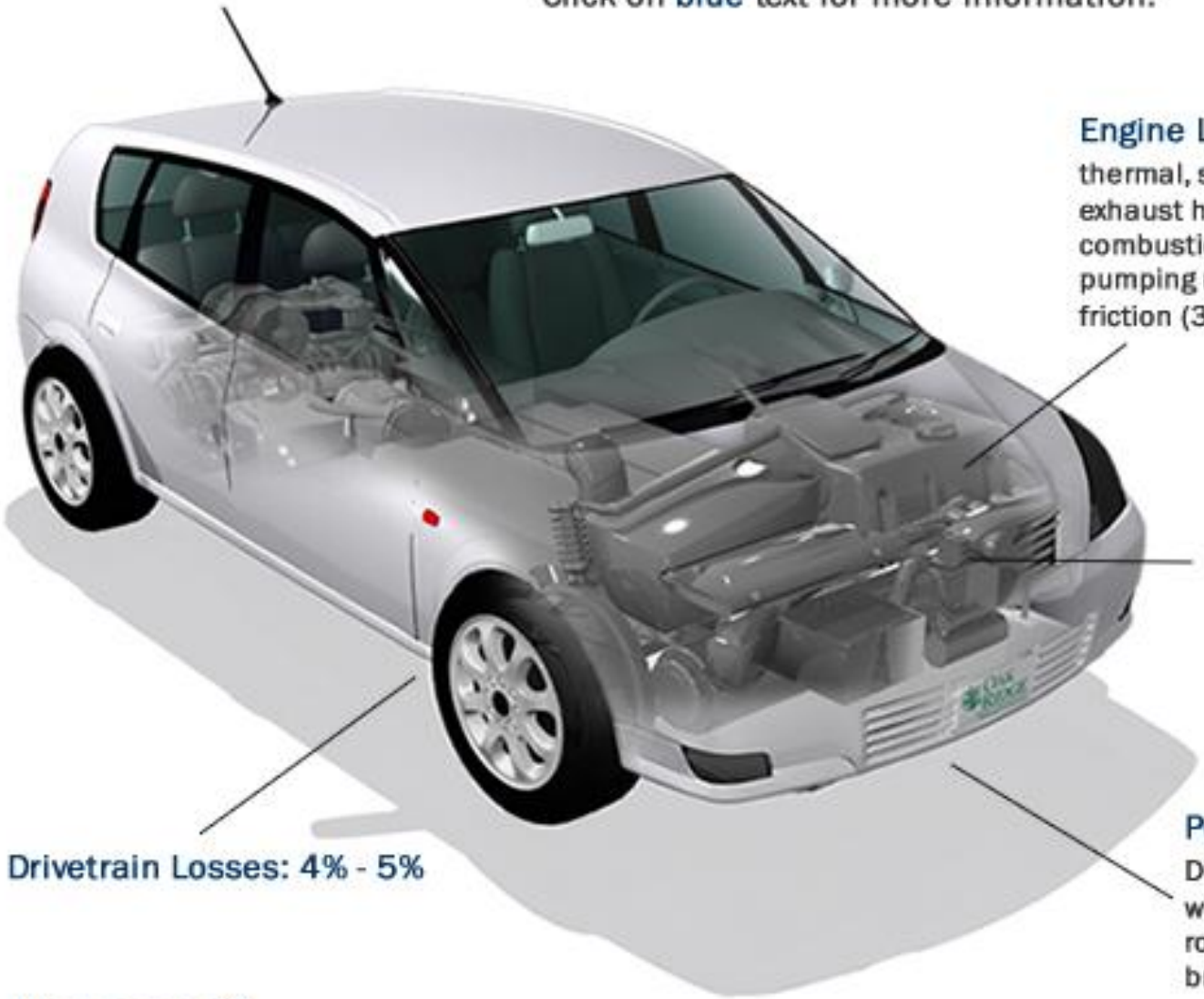


- 87.4 % of fuel energy is wasted
- Only 12.6 % of fuel energy is transferred to the wheels
- 5.8 % is turned to kinetic energy, consumed in the brake
- 17.2 % idling losses, engine on with no torque

Source: www.fueleconomy.gov
US DOE

Energy Requirements for City (Stop and Go) Driving

Click on blue text for more information.



Engine Losses: 71% - 75%

thermal, such as radiator, exhaust heat, etc. (60% - 64%)
combustion (3%)
pumping (5%)
friction (3%)

Parasitic Losses: 5% - 7%

(e.g., water pump, alternator, etc.)

Drivetrain Losses: 4% - 5%

Power to Wheels: 14% - 20%

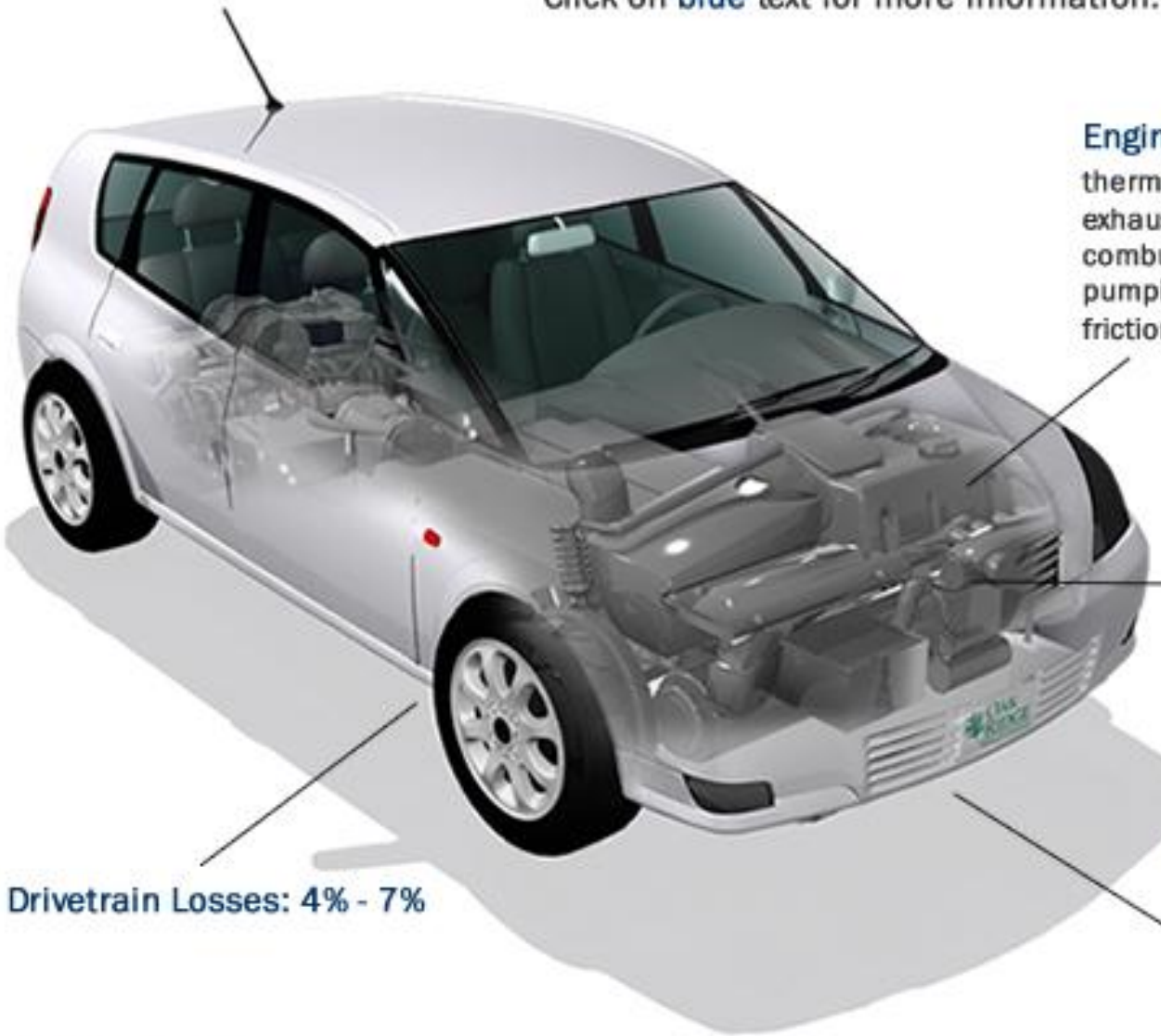
Dissipated as
wind resistance: (3% - 5%)
rolling resistance (3% - 5%)
braking (7% - 10%)

Idle Losses: 6%

In this figure, they are accounted for as part of the engine and parasitic losses.

Energy Requirements for Highway Driving

Click on blue text for more information.



Engine Losses: 64% - 69%

thermal, such as radiator, exhaust heat, etc. (56% - 60%)
combustion (3%)
pumping (3%)
friction (3%)

Parasitic Losses: 3% - 4%

(e.g., water pump, alternator, etc.)

Drivetrain Losses: 4% - 7%

Power to Wheels: 22% - 30%

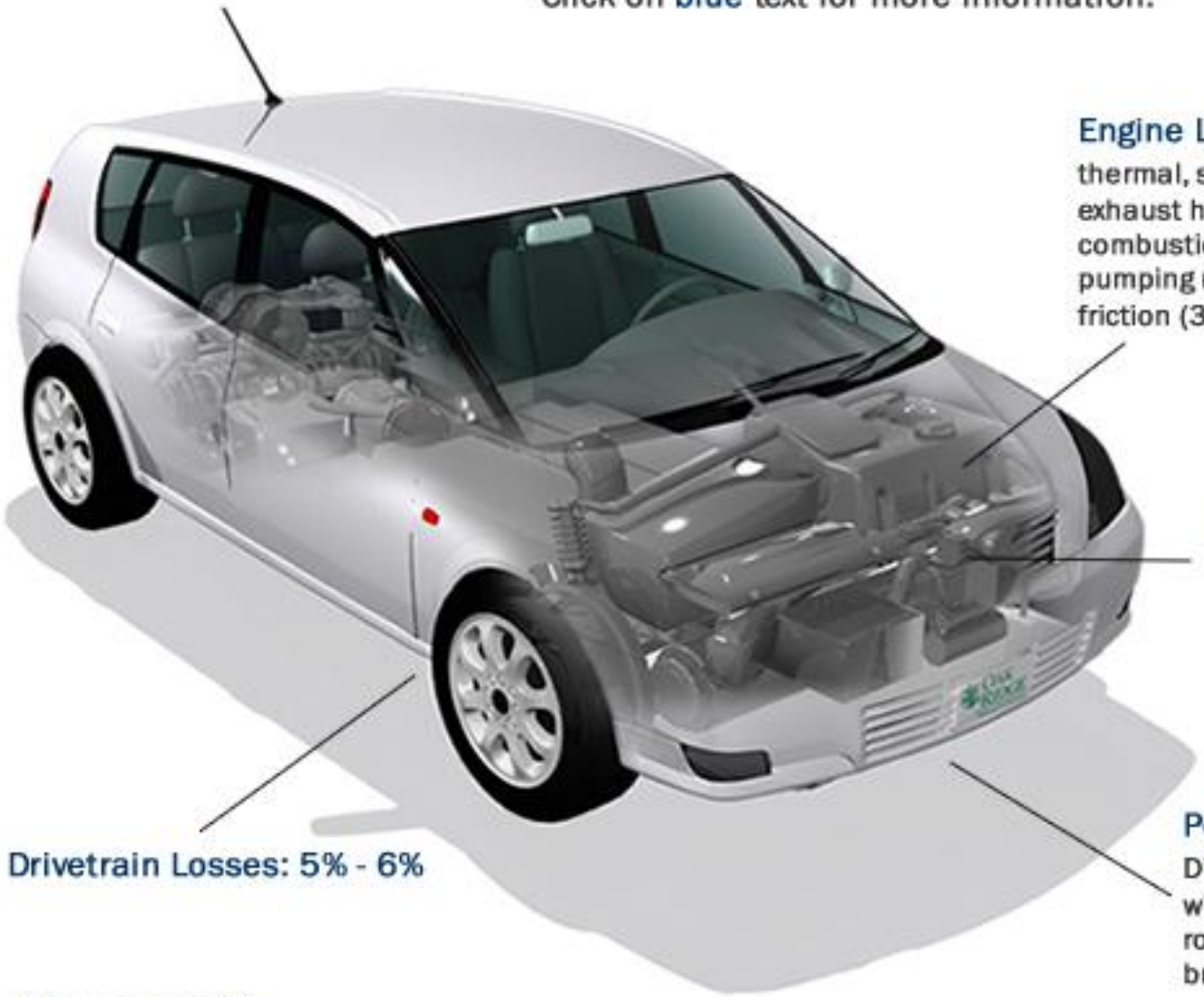
Dissipated as
wind resistance: (13% - 19%)
rolling resistance (6% - 9%)
braking (2% - 3%)

Idle Losses: 0%

Highway driving does not include idling.

Energy Requirements for Combined City/Highway Driving

Click on blue text for more information.



Engine Losses: 68% - 72%

thermal, such as radiator, exhaust heat, etc. (58% - 62%)
combustion (3%)
pumping (4%)
friction (3%)

Parasitic Losses: 4% - 6%

(e.g., water pump, alternator, etc.)

Drivetrain Losses: 5% - 6%

Power to Wheels: 18% - 25%

Dissipated as
wind resistance: (9% - 12%)
rolling resistance (5% - 7%)
braking (5% - 7%)

Idle Losses: 3%

In this figure, they are accounted for as part of the engine and parasitic losses.

Driving Force

Vehicle kinetic energy

$$E = \frac{1}{2} m(V_A^2 - V_B^2)$$

- $V_B > V_A$ accelerating, fuel is consumed, kinetic energy is increased

- $V_A > V_B$ braking, vey little fuel is consumed, kinetic energy is reduced
  energy is dissipated in the brakes as heat in conventional cars

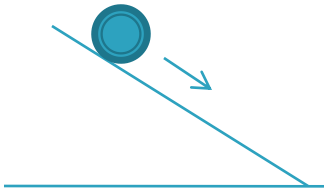
  In hybrids braking energy is recovered by an electric generator and stored in a battery
  it is called regenerative energy, or “Regen Energy”

Driving Force

Vehicle potential energy

$$E = mgh$$

Need engine power, fuel is consumed, potential energy is increased

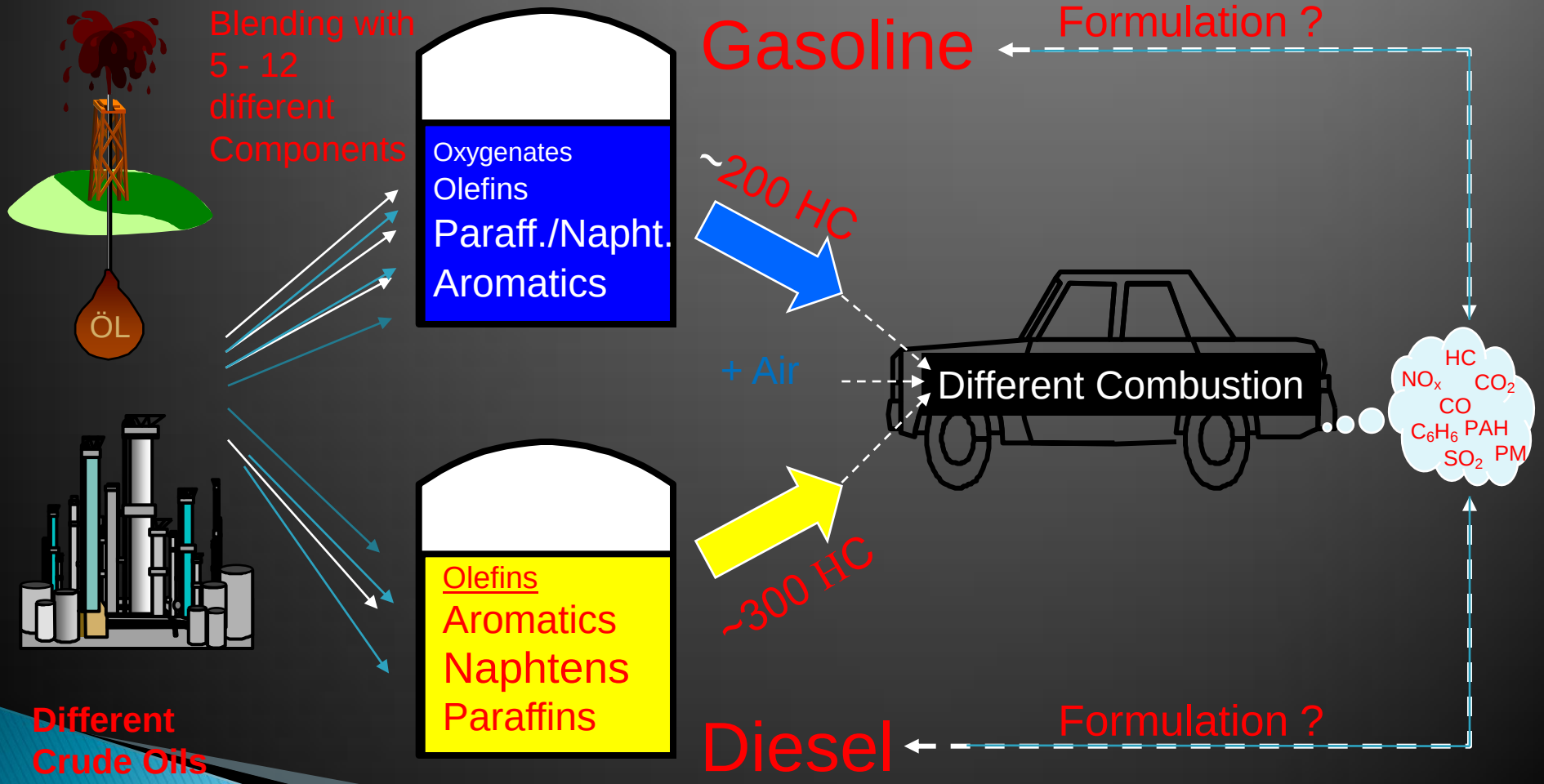


no need for engine power

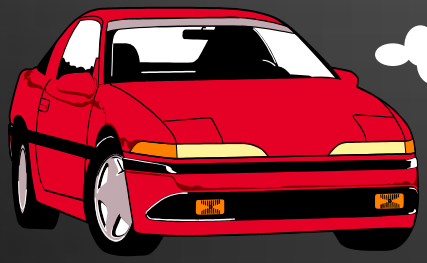
Braking, vey little fuel is consumed, potential energy is reduced
energy is dissipated in the brakes as heat in conventional cars

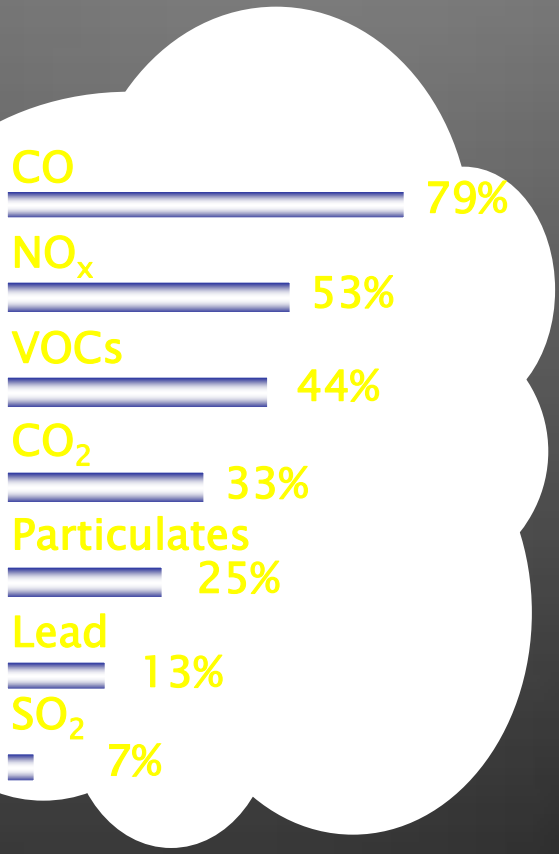
In hybrids braking energy is recovered, Engine can be turned off automatically going downhill

Different Automotive Fuels = Different Exhaust Emissions



Transportation Share of Emissions





- **Still a major contributor, despite reductions in new vehicle emissions achieved over the last decade**

Source: EPA

Current Status of Yangon

Urban Transportation
(Mainly depends on bus system)

- **Bus Routes - 310 Nos**
  (15 Main Organizations)
- **Bus Fleet - 6330 Nos**
- **Bus Trip/day - 30876 Trips**
- **Passenger/day - 3.14 Millions**

Current Status in Yangon

Existing situation of Circular Rail (2008)

- Myanmar Railways runs 21 sets of train
- Total 200 trips are running every day, carrying about 130,000 passengers per day.
- Carrying about 48 million passengers per year.

Transportation Sector in Myanmar

Current Status in Yangon

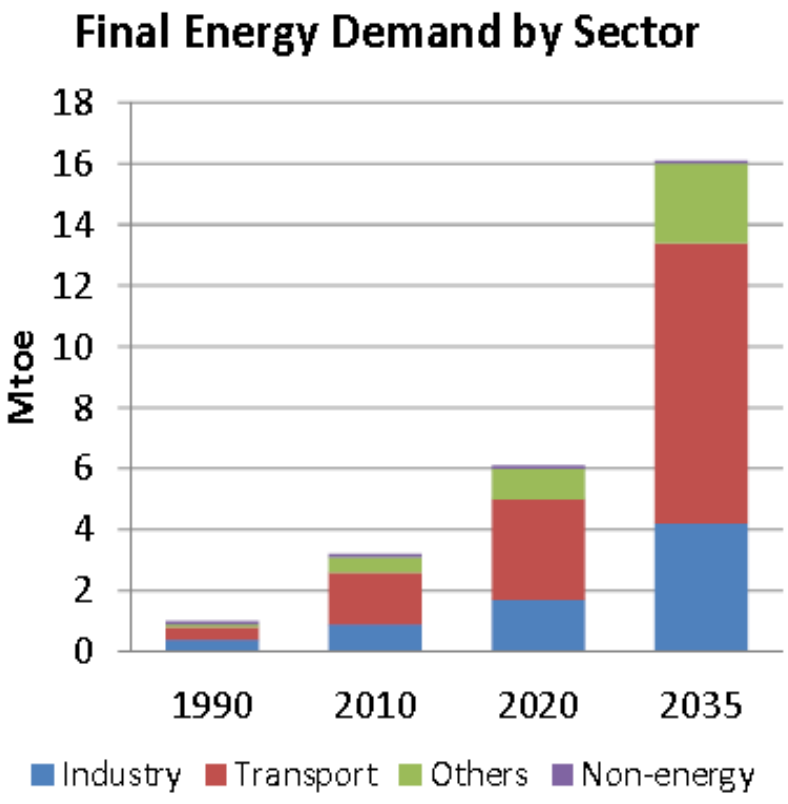
Number of Parami Taxi in Yangon
239

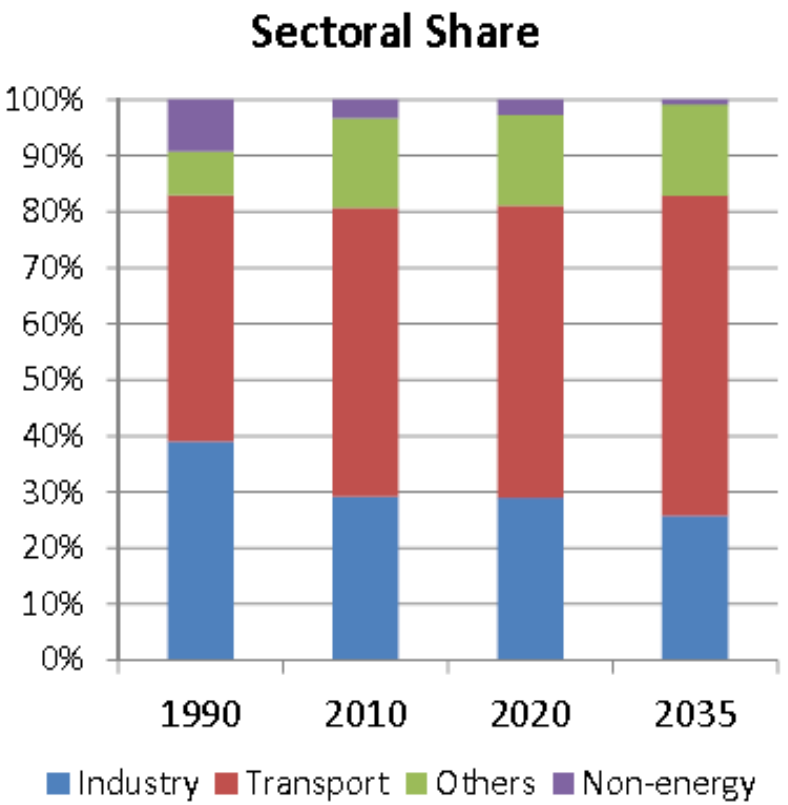
Number of City Taxi in Yangon
17533

Marine transportation

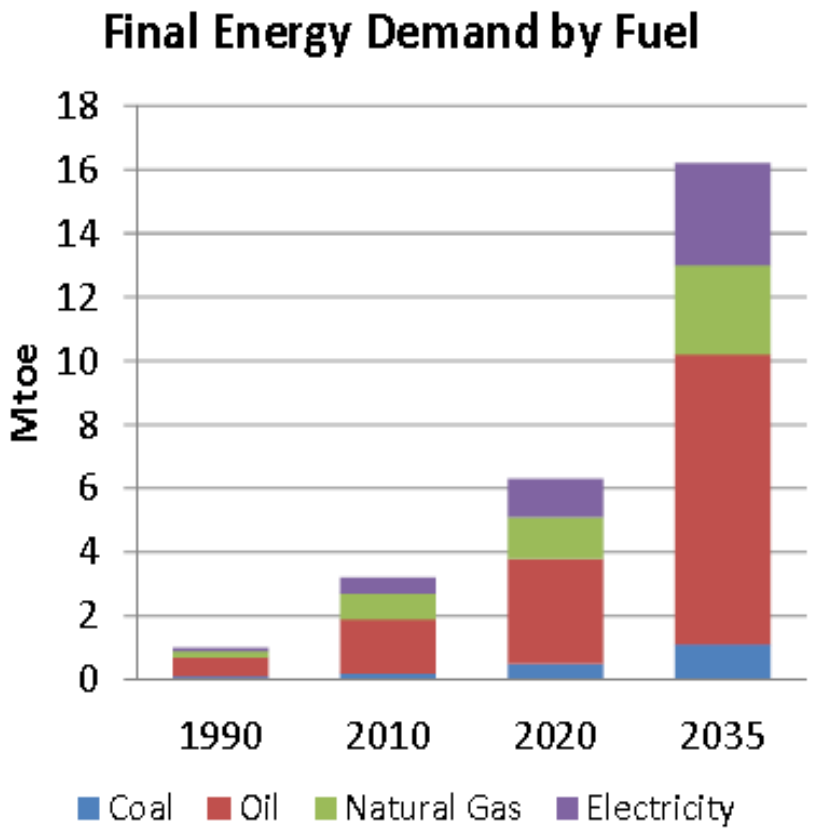
About 44%
of the total freight-ton
or
28% of the total
freight- ton-miles
were transported by the inland water transport system in 2002.

Myanmar Energy Outlook (BAU): Final Energy Demand





Myanmar Energy Outlook (BAU): Final Energy Demand



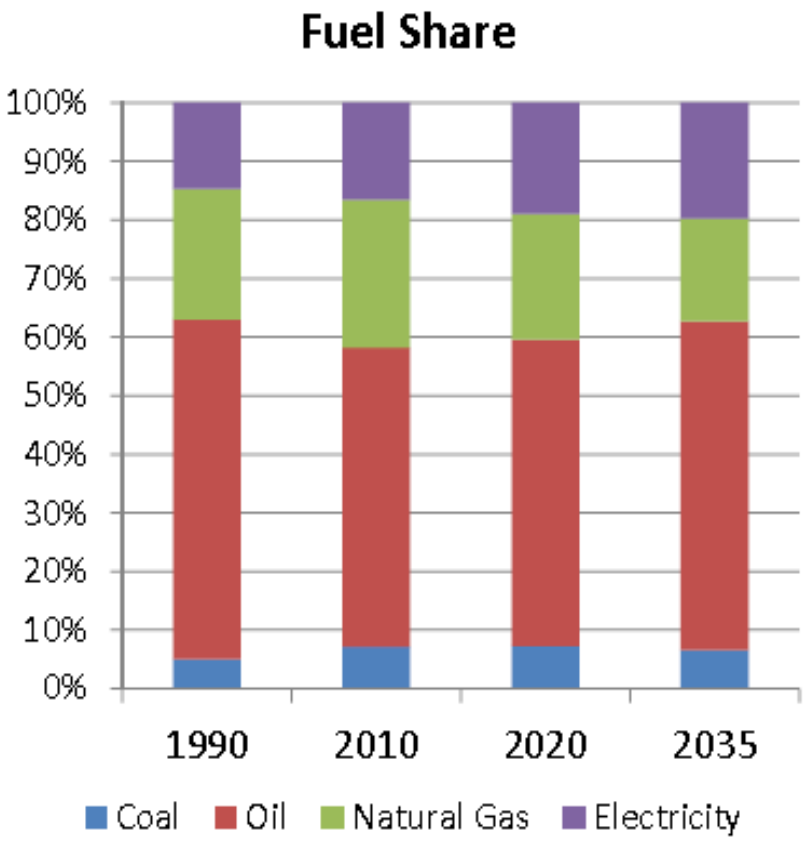


Table: Energy Consumption by Source and Sector in 2005

(thousand tons of oil equivalent)

Sector	Petroleum Products	Natural Gas	Coal	Renewable and Waste	Electricity	% Consumption
Industry	187	441	82	304	121	7.0
Transport	1,334	3	—	—	—	10.1
Other sectors	219	605	9	9,566	194	
Residential	153	—	—	9,566	126	74.3
Commercial and public service	—	—	—	—	68	0.5
Agriculture and Forestry	1	—	—	—	—	0.01
Others	65	605	9	—	—	6.6

Source: International Energy Agency, 2007.

Number of Motor Vehicles, Motorcycles, Percentage of Motorcycles & Driver Licenses (2005 - 2012)

Year	2005	2006	2007	2008	2009	2010	2011	2012
Motor Vehicle	338209	345883	369631	385586	2067839	359997	420602	461055
Motorcycle	640313	645683	654741	1608772	1674246	1880986	1933673	3153201
Percentage of Motorcycle Fleet	65.40%	65%	63.90%	80.60%	80.96%	81.83%	82.13%	87.24%
Driver Licenses	1541792	1715711	1834056	2078997	2177404	2468291	2530853	2713992

Motor Vehicles By Types

No.	Type of Vehicle	2010	2011	2012
1.	Passenger Car	259712	263046	281575
2.	Truck (Light Duty)	27623	29173	29478
3.	Truck (Heavy Duty)	36355	38053	41075
4.	Bus	20717	20065	19522
5.	Others	15590	15212	17603
6.	Two Wheelers	1880986	1933673	3153201
7.	Three Wheelers	12842	15867	36220
8.	Trawlergyi	44852	38758	34862
9.	Machaniary	9	428	720

Current transport Facilities(2000–2009)

1	**Number of Automobiles**	**418,691**
2	Number of Motorcycles	1,880,986
3	Number of Steam Locomotives	37
4	Number of Diesel Electric Locomotive	247
5	Number of Diesel Hydraulic Locomotives	105
6	Number of Passenger Coaches	1,246
7	Number of Freight Wagon	3,427

CNG Vehicles/Fuel Switching

Number of Vehicles running in Yangon Division in the year 2011

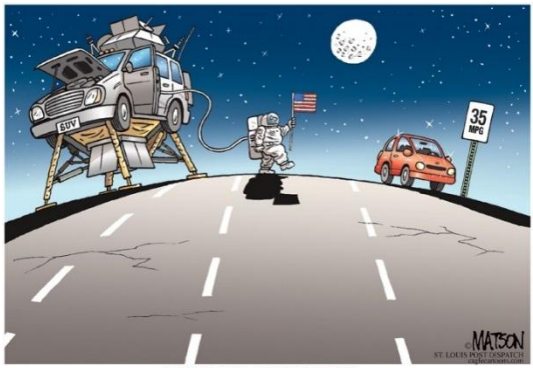
Sr. No	Type of Vehicles	Type of Fuel			Total
		Gasoline	Diesel	CNG	
1	Cars+Taxis	79,000	62,500	-	141,500
2	Light Truck	1,400	12,300	-	13,700
3	Heavy Truck	130	9,900	-	10,030
4	Bus	950	4,400	-	5,350
5	Others	260	10,425	-	10,685
6	Two wheelers	50,541	-	-	50,541
7	Three Wheelers	145	-	-	145
8	NGV	-	-	27,470	27,470
	Total	**132,426**	**99,525**	**27,470**	**259,421**

*** CNG vehicles account for 10.6% of total vehicles used in Yangon Division

The Best Ways to Conserve Energy in Transportation

A fail safe system?

- Keep your car free from heavy objects.
- Drive the speed limit and avoid rapid acceleration for best efficiency.
- Keep your tires properly inflated and maintain regular tune-ups that keep the air filters clean.
- Anything that makes your engine work harder causes additional gasoline usage.
- When possible, walk or ride your bike to nearby locations .
- Carpool with others who live around you, or use public transportation.



ONE SMALL STEP FOR MAN...

Environmental Actions in the Transport Sector

- Highlighting environmental awareness in Policies of Ministries concerned
- Promotion of public awareness and environmental education for environmental improvement in transport sector
- Improvement of Infrastructures related to transport sectors

- Collection of data and sharing information related to environmental improvement in transport sector
- Subsidization for environmental improvement in transport sector
- To encourage the use of pubic transport and induce the use of rail transport modes
- To adopt appropriate measures in marine and air transport

- Monitoring air quality of large cities
- Monitoring noise pollution and vibration at urban areas
- To encourage utilizing alternative fuel for automobiles
- To upgrade vehicle inspection system
- To initiate environmentally friendly driving

Tips to Save Energy in Transportation

Use Public Transportation

- The use of public transportation, such as buses, trains and subways.
- With mass transportation, the energy consumed per passenger is nearly always less than if the passenger were to travel the same distance in an automobile.

Driving Tips

- Avoid idling
- Avoid aggressive driving
- Avoid high speeds.
- Avoid keeping heavy items in your car
- Reduce drag by placing items inside the car or trunk rather than on roof racks
- Combine errands
- Check into telecommuting, carpooling, and public transit to save driving and car maintenance costs.

Maintenance Tips

- Use the grade of motor oil your car's manufacturer recommends.
- Using a different motor oil can lower your gas mileage by 1%–2%.
- Inflate your tires to the pressure listed in your owner's manual or on a sticker in the glove box or driver's side door jamb.
- This number may differ from the maximum pressure listed on your tire's sidewall.

Maintenance Tips

- Get regular maintenance checks to avoid fuel economy problems due to worn spark plugs, dragging brakes, sagging belts, low transmission fluid, or transmission problems.
- Don't ignore the check-engine light—it can alert you to problems that affect fuel economy as well as more serious problems, even when your vehicle seems to be running fine.
- Replace clogged air filters on an older car with a carbureted engine to improve gas mileage by as much as 10% and to protect your engine.

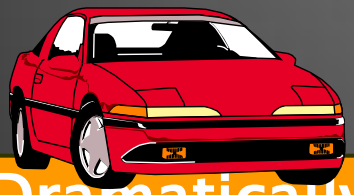
Long-Term Savings Tips

- Choose vehicles according to your need. For example, if you mostly drive in cities, a smaller hybrid might be right for you because they get better mileage in city driving and are easier to park.
- If you need a vehicle for towing or heavy use, consider a clean diesel vehicle.
- Diesel engines are quieter, more powerful, and 30%–35% more efficient than similar-sized gasoline engines.
- The new generation of clean diesel vehicles must meet the same emissions standards as gasoline vehicles.

Long-Term Savings Tips

- Consider buying a highly fuel-efficient vehicle.
- A fuel-efficient, plug-in electric (PHEV), hybrid, or alternative fuel vehicle could cut your fuel costs and help the environment.

"On the Road" Goals to Achieve Sustainable Vehicle Transportation



Dramatically Improve "Emissions & Efficiency"

Use Clean Alternative & Renewable Fuels

Reduce Vehicle Miles Traveled

Energy Saving(စွမ်းအင်ချွေတာခြင်း)

The Methodology of energy saving is based on:

The Cleaner Production (CP) strategy:

- Prevention of waste
- Systematic approach (နည်းစနစ်ကျကျ)
- Integrated into business processes (စီးပွားရေးလုပ်ငန်းအသွင်)
- Aimed at continuous improvement (စဉ်ဆက်မပြတ်တိုးတက်မှု)

The Cleaner Production **strategy**

Step 1: Planning and Organization

(အစီအစဉ် နှင့် အဖွဲ့အစည်း)

Step 2: Assessment (အရည်အသွေးခန့်မှန်း)

Step3: Identification of Options

(စစ်ဆေးရွေးချယ်နိုင်ခွင့်များ)

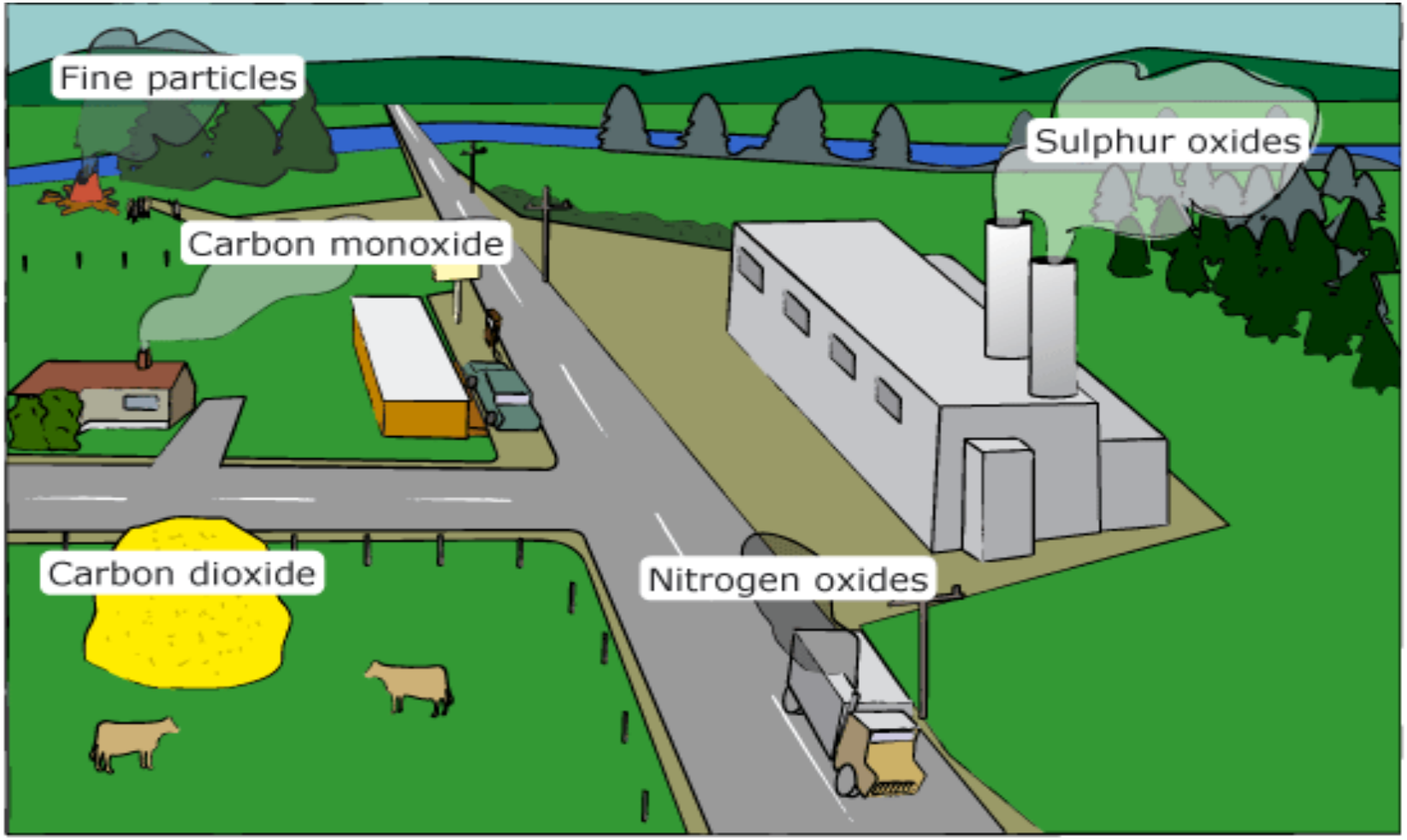
Step 4: Feasibility Analysis of Options

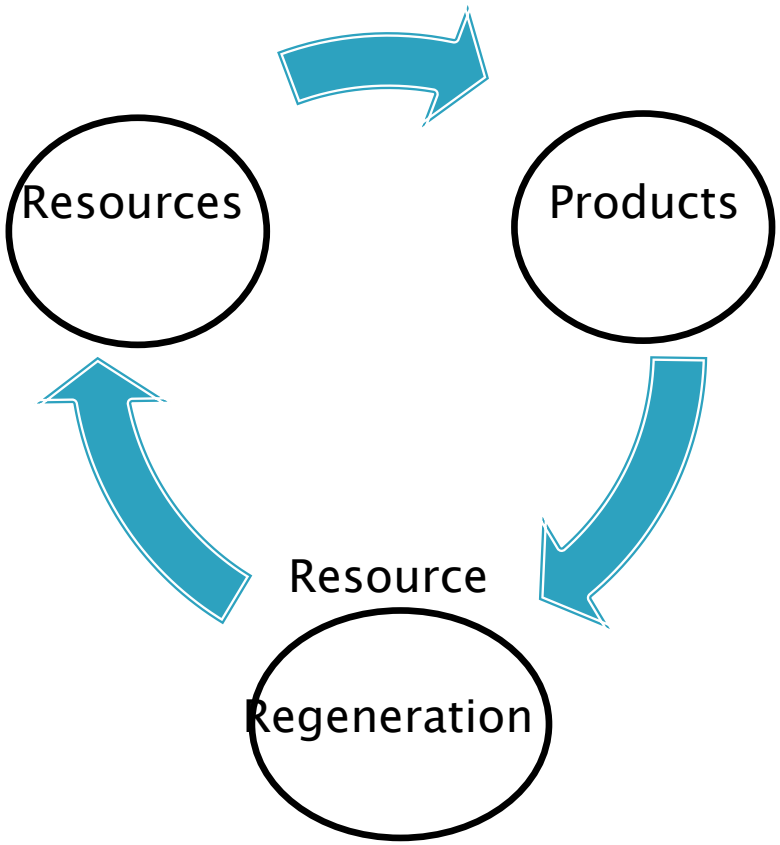
(လက်တွေ့ခွဲခြားစိတ်ဖြာခြင်း)

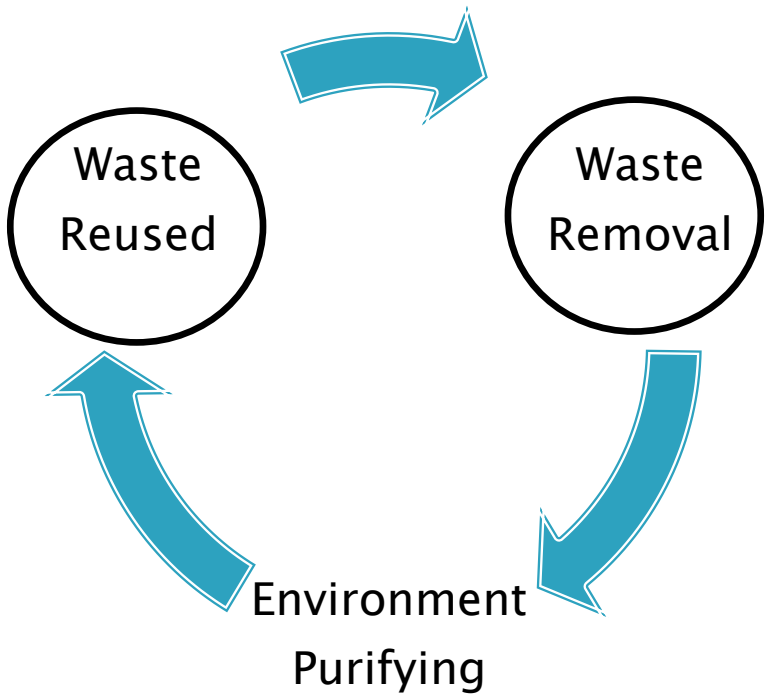
Step 5: Implementation and Monitoring of Options (အကောင်အထည်ဖေါခြင်း)

Step 6: Continuous Improvement(စဉ်ဆက်မပြတ်တိုးတက်မှု)

Mitigation of Global Warming and Clean Technology

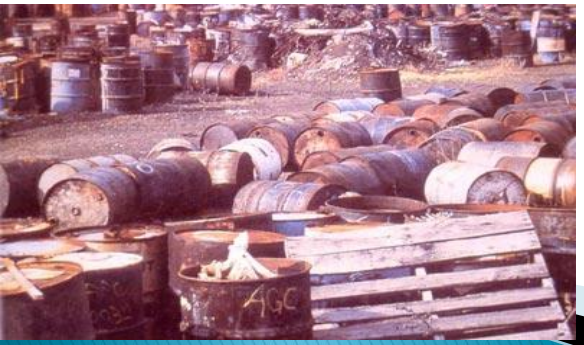






Clean Technology

Production of Paper from Solid Waste by using Recycle Method (Clean Technology)



Clean & Green City

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- Road Transport Administration Department has been equipped inspection devices to respond automobile source air pollution.
- Using CNG in place of petrol and diesel (short term) and bio-fuel (long term)
- Number of vehicles (December 2008)

Gasoline	Diesel	CNG	LPG	Total
1763594	209070	21653	41	1994358

List of CNG Station

No.	Location	No of Station
1	Chauk	1
2	Yanan Gyaung	2
3	Yangon	39
4	Paleik	1
5	Mandalay	1
Total		44

- The Government is encouraging the use of CNG for City transportation & commercial vehicles

Electric Vehicle/ Clean Alternative

Greenhouse Gas Emission Control

- Measures to reduce greenhouse gas (GHG) emissions from buildings fall into one of three categories: reducing energy consumption and embodied energy in buildings, switching to low-carbon fuels including a higher share of renewable energy, or controlling the emissions of non-CO2 GHG gases.

- Increasing PAS

To protect the permanent forest area by reducing deforestation rate and increasing protected area system(PAS).

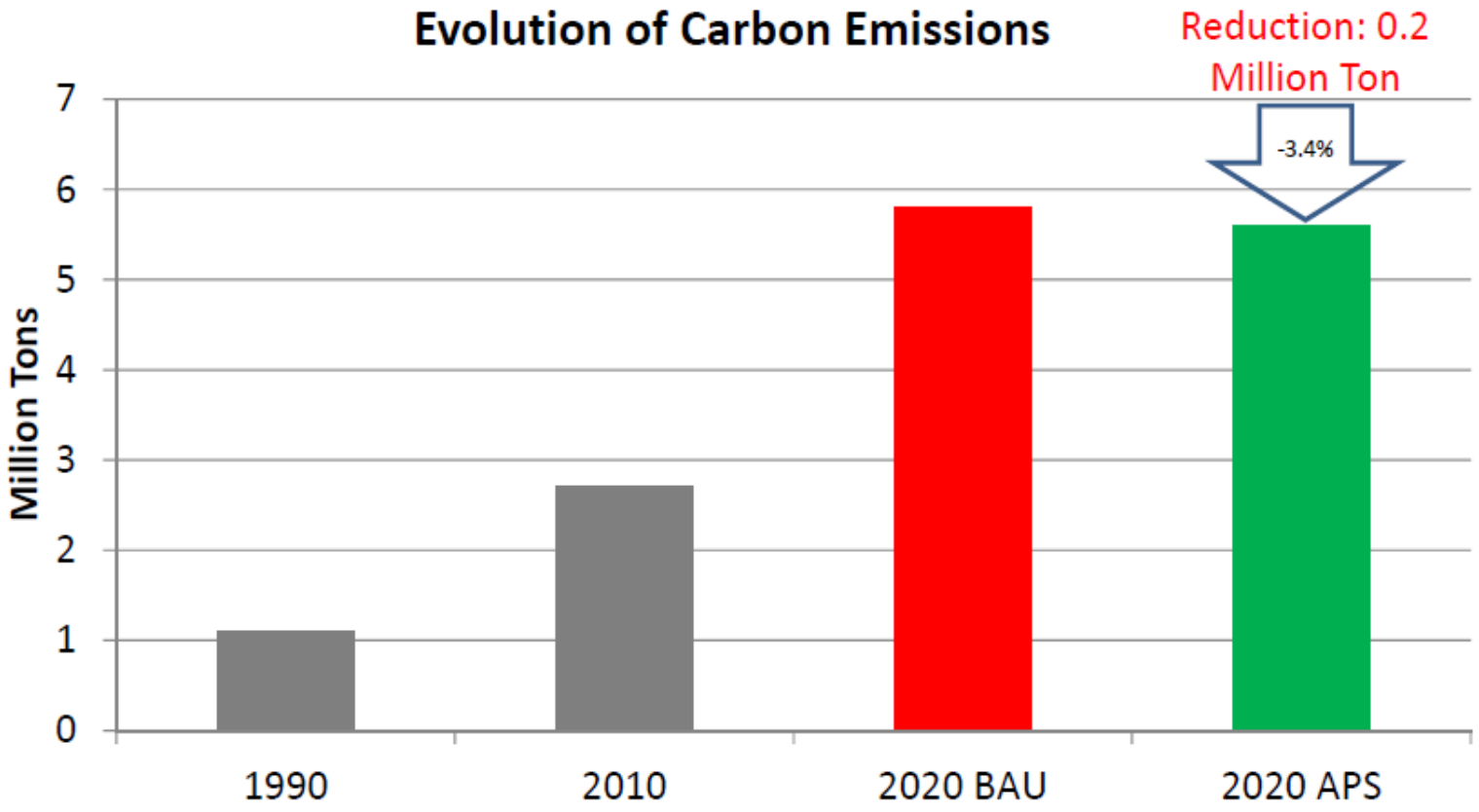
(PAS area was 10275.52 sq mile in 2008.

Enhancement of carbon stock (Re- afforestation)
Area of forestation (1981 – 2010)

Plantation type	Area (ha)	% of total area
Commercial	1,113,120	53.7
Village supply	444,621	21.5
Watershed	334,584	16.2
Industrial	179,121	8.7
Total	2,071,446	100

Source: Forest Department, 2010

Reduction in Carbon Emissions



Energy Efficiency Project in Myanmar

Myanmar Petrochemical Enterprise is mainly major activities for energy efficiency as below:

- Myanmar Carbonix Project in No(1) Refinery, Thanlyin (energy saving and Energy Efficiency)

- Energy Conservation Project in No(3) Fertilizer Factory, Kyaw Zwa

No.1 Refinery (Thanlyin)

COD(B) – 1963, 14000BPSD, Foster Wheeler Co., England
COD(C) – 1982 , 6000BPSD, Mitsubishi Heavy Industry Japan
COD(B) Renovation – 1999, Nichimen Corporation Japan
Today capacity of COD (B) + COD(C) – 17000BPSD