Workshop - “The *Science of Climate Change & Climate Change Vulnerability & Adaptation*”

Methods & Technologies for Mitigation

Climate Studies Group Mona (CSGM)- University of the West Indies.

Institute of Meteorology of Cuba (INSMET).

Presented by David Barrett – ENBAR Consulting (MSc., MPhil.).

Contents

Definitions

Mitigation:

A human intervention to reduce the sources or enhance the sinks of greenhouse gases.

(Glossary - IPCC Working Group I: The Scientific Basis).

- Interventions which limit or reduce climate change driving forces and hence reduce the degree and likelihood that significantly adverse conditions will result.

- Mitigation is therefore a risk management strategy needing global collaboration.

1. Key Definitions.
2. Energy Efficiency and Conservation.
3. Low-Carbon Methodologies.
4. Opportunities in Transportation.
5. Opportunities in Industry.
6. Opportunities in Commercial Operation.
7. Carbon Sinks.
8. Policy Interventions.

ENERGY EFFICIENCY AND CONSERVATION.

Energy Efficiency

- Latin America and the Caribbean could cut electricity consumption by 10 % over 20 yrs using EE technologies.
- Savings of $36 Bn in investments that would otherwise have to be made to expand power generation capacity.

(Source – IDB).

- Jamaican (Energy Efficiency) Building Code has potential to reduce national energy consumption by 40% (GEF/UNDP 2012).

ENBAR CONSULTING

Estimated GHG Emission Reduction in Buildings to 2016 (Tons CO_2 Equivalent)

PARTICIPATING COUNTRY	DIRECT	DIRECT-POST	TOTAL DIRECT	INDIRECT	GRAND TOTAL
Antigua & Barbuda	160,000	200,000	360,000	840,000	**1,200,000**
Belize	65,000	400,000	465,000	1,085,000	**1,550,000**
Grenada	100,000	400,000	500,000	1,167,000	**1,667,000**
St. Lucia	30,000	200,000	230,000	537,000	**767,000**
Trinidad & Tobago	880,000	-	880,000	4,791,000	**5,671,000**
SUB-TOTAL	***1,235,000***	***1,200,000***	***2,435,000***	***8,419,000***	***10,854,000***

EE Standards, energy labels, building integrated REN, policy, legislation, financing, PR, other.

Energy Efficiency

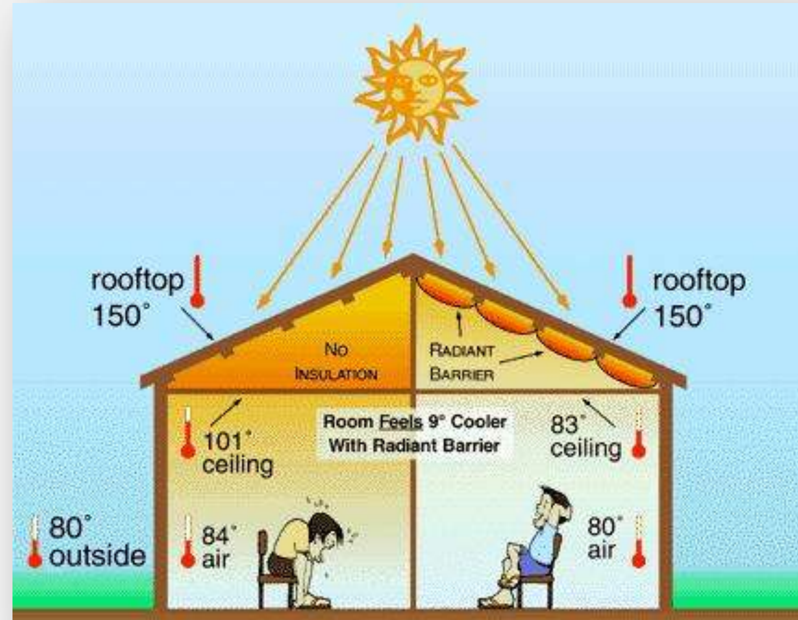
- EE is a useful mitigation tool as it reduces the amount of energy (hence fuel) required for the same amount of products and services as for non efficient means.

- Typical EE mitigation options include:
  - Insulation reducing heating/cooling needs.
  - Less energy intensive lighting or natural lighting.
  - Efficient engines and electrical devices operating on less fuels or producing more of the desired product (e.g. less heat in electricity generation).
  - Energy Efficient Building Designs.

Insulation.

- Potential savings of **up to 20% on heating and cooling costs** (or up to **10%** on their total annual energy bill) by sealing and insulating.

- **Infrared Image of 2 Windows from Interior:**
  - ENERGY STAR qualified window (orange) is warmer in the winter.
  - Other window (blue) **2/3 <u>more</u> heat loss** than EE window.



Insulation options:

- Insulation on AC and hot water pipes/ducts/conduits.
- Roofing insulation (foam, fiber pads).
- Roof reflective surfaces.
- Wall insulation (foam, fiber pads other).
- Green roofs.

Lighting.

- CFLs & LEDs use 3 – 15 times less power (wattage) than incandescent lights.
- Saving up to 75% of the initial lighting energy vs. incandescent bulbs.
- Produce 90% less heat.
- Last 6–20 times as long (6,000–15,000 hours).

  (How CFLs Compare with Incandescent).
- Replace fluorescent exit lights with LED = savings of 0.25 tons CO_2/yr. (USEPA)
- Natural lighting (windows, skylights, solar tubes).

Efficiency Improvements

Conversions.	Efficiency Improvements.
• Magnetic ballasts +T12 to electronic ballasts +T8 lighting	35 – 40 %
• Incandescent to CFL	75%
• Electric water heaters to SWH	70%
• EE Refrigerators	16 – 25%
• Standard to LED Displays	25%
• EE Air conditioners	20%

Efficient Building Design

- EE Building Designs may incorporate many features:
  - Radiant barriers.
  - Insulation.
  - Natural lighting.
  - PV & SWH.
  - Green roofs.
  - Other.

Margarido House - McDonald Construction & Development, Inc. California.

Energy Efficiency Buildings

- **GEF-UNDP 48-month Project Projections**:
  - **Mandatory EE Standards**. Target: reduce national electricity consumption by 15 – 20%.
  - **National Building Code**. Target: reduce energy consumption by 10 – 20% (passive energy designs).
  - **Rating-Based Incentive Schemes for Financing**. Targets: energy savings of 20%.
  - **Rating Systems and Demonstration of Savings**. Targets: 50% reduction in energy consumption by 2033.

1. Key Definitions.
2. Energy Efficiency and Conservation.
3. Low-Carbon Methodologies.
4. Opportunities in Transportation.
5. Opportunities in Industry.
6. Opportunities in Commercial Operation.
7. Carbon Sinks.
8. Policy Interventions.

LOW CARBON METHODOLOGIES.

Reducing Carbon Intensity

- **Less Carbon Intense Fuels: CNG, NG, LPG.**
  - Replacement of gasoline and diesel with NG (CNG or LNG) in light duty vehicles.
  - CNG facilitates GHG **reduction ~ 30%** in cars (gasoline) and **23%** in buses (diesel) *(CCCC Technology Assessment Report 2012).*
  - LNG facilitates GHG **reductions as high as 25%** *(U S. Department of Energy Alternative Fuels & Advanced Vehicles Data Centre).*
  - LPG(propane) as a replacement of (diesel or gasoline) in light duty vehicles. Gasoline engines emitting approximately **20%** more GHGs than LPG vehicles.
  - Approx **19% reduction** in GHG emissions in NG ferries versus conventional diesel vessels *(Norway). (CCCC Technology Assessment Report 2012).*

Reducing Carbon Intensity

Less Carbon Intense Fuels: Biofuels

- Life-cycle GHG emission reductions of **44% and 26%** for 100 year and 30 year assessment period from sugarcane based ethanol.
- Waste derived biofuels (e.g., waste grease biodiesel) can achieve significantly higher life-cycle reductions in GHGs. *(USEPA).*
- Biodiesel contains 11% oxygen by wt. => more complete combustion.
- B20 - B100 reduces net CO_2 emissions by **15%** ; HC, SO_x, CO, TSP, PM_{10} also reduced (slight elevation in NO_x).
- B5, B10 biofuels do not require engine retrofits . Biodiesel and ethanol can be blended with conventional fuels or full substitution.

Reducing Carbon Intensity.

- Advanced biofuels for aviation.
  - Lufthansa.
  - Virgin Atlantic.
  - Quantas.
  - KLM.
  - Royal Dutch Air Force.
  - US Air Force.
  - British Airways.

- 2009 Jamaica - edible waste oil bio-diesel for 20 solid waste trucks. Emission control and fuel savings.

- Savings of 20% in fuel and operational cost.

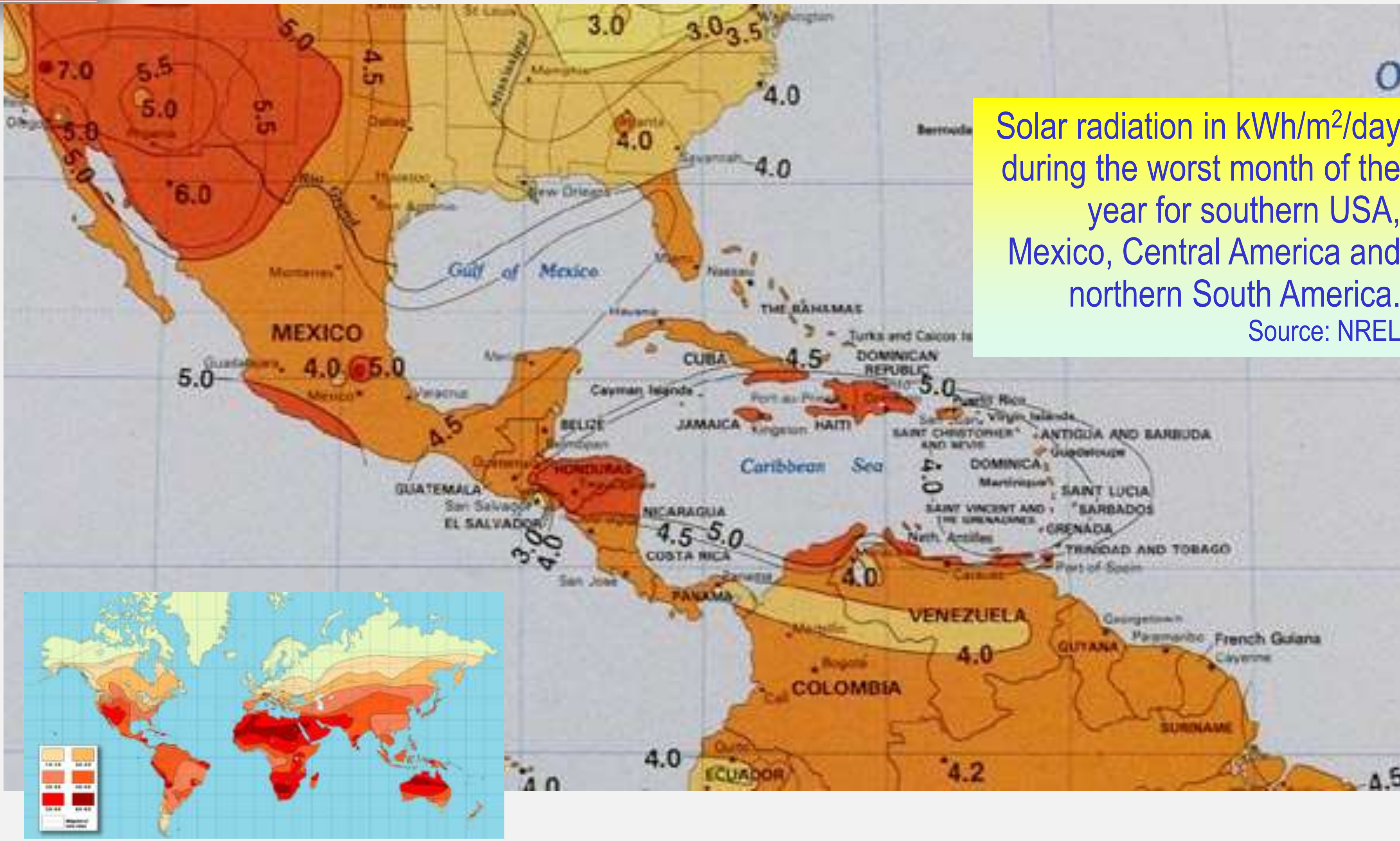
- Biodiesel consistency close to that of distillates.

Caribbean RE Potentials (MW)

Country	Wind	Hydro	Solar-Thermal & PV	Geo-thermal	Bio-mass	Potential for RES coverage (estimate)
Dominica	✓ 10 - 20	✓5 Ex.+ 5 (add.)	✓	✓	(✓)	Up to 100%
Grenada	✓ 20 - 30	✓ 2	✓	?	(✓)	10 - 30%
St. Lucia	✓ 20 - 40	< 0.5	✓	✓	?	Up to 60 %
St. Kitts & Nevis	✓ 5 – 10	0	✓	✓	?	Up to 60 %
SVG	✓ 20+	✓5 Ex.+ 5 (add.)	✓	✓	(✓)	30 - 40 % Source: GTZ

Solar Potentials

ENBAR CONSULTING



Solar radiation in kWh/m^2/day during the worst month of the year for southern USA, Mexico, Central America and northern South America.
Source: NREL

Solar Potentials

SOLAR is possibly the most resilient and ubiquitous domestic and commercial application.

- **Photovoltaic - Power.**
  - **Zero emission and avoided CO_2.** (E.g.. 1.52 KW PV system avoids annually, 465.90 lbs CO2; 0.90 lbs NOx.; 2.56 lb SOx; 3.96 mg Hg).
  - Modular to provide incrementally affordable commercial power or domestic supply.
  - 1,540 MWh PV saves 1,260 tCO2/yr.

Solar Potentials

<u>Various Proposals:</u>

- **250 SHW** in 10 yrs to reduce GHG by 14,000 tons CO_2 equivalent *(Antigua & Barbuda, Belize, Grenada, St Lucia, T&T*).

- **100 kW PV** to reduce GHG by 6,300 tons of CO_2 over 20 years *(Antigua & Barbuda, Belize, Grenada, St Lucia, T&T)* (GEF/UNDP).

- **60 MW PV** farm *(Jamaica) (Solamon Energy Corp, 2012)*

- **1 MW PV** (1,540 MWh/yr) farm *at Soapberry to reduce FF use and methane GHG emissions by 1,261 t CO_2/yr (Jamaica).*

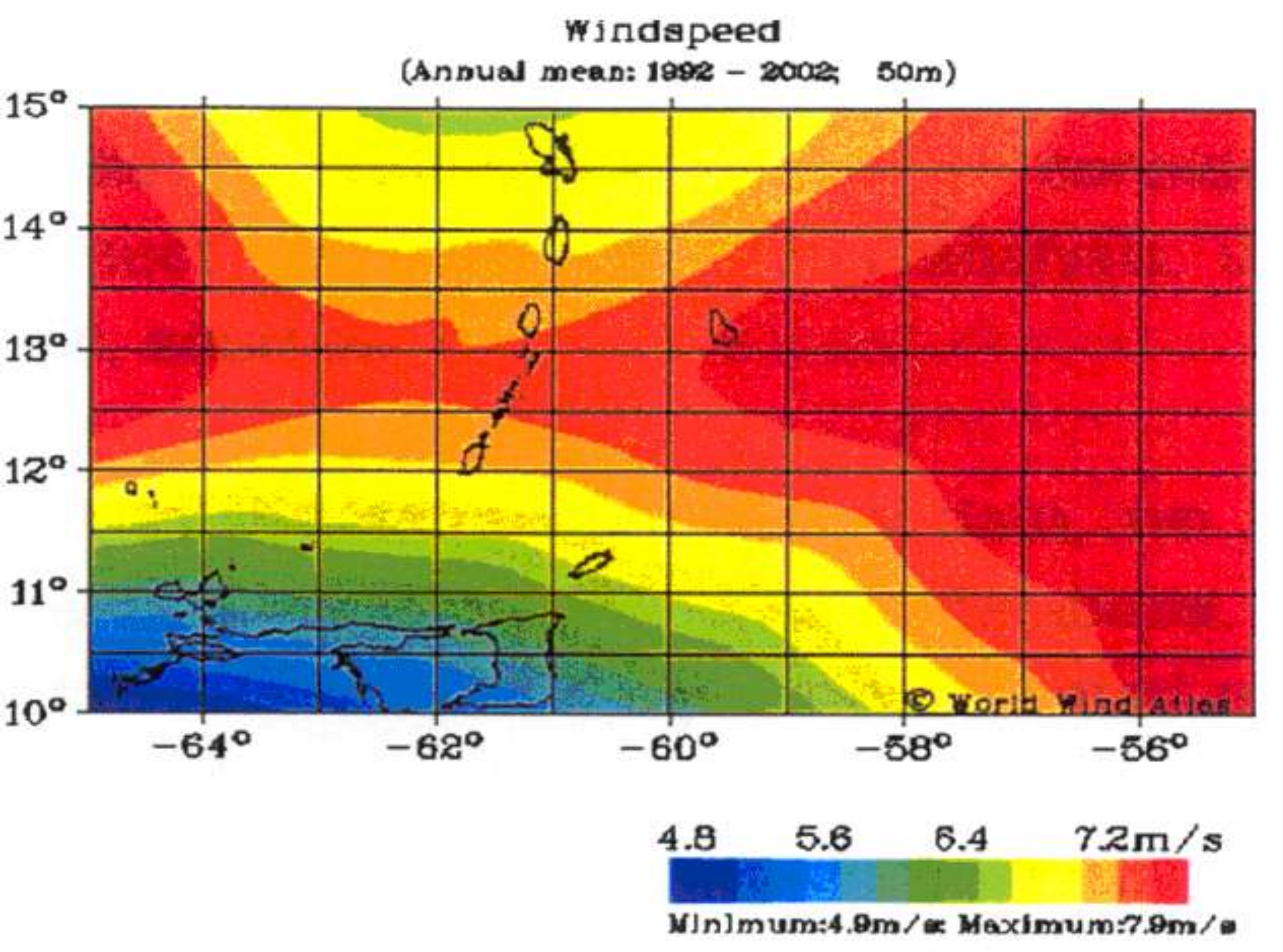
Solar Potentials

Solar Thermal (SWH):

- Zero emissions and avoided emissions. **100 liter system could avoid emission of 1.5 tones of CO_2/yr.**

- Applicable for residential and commercial applications (hospitals, offices, processing facilities etc).

Wind Potentials



Source: Benjamin Jagstoref, Factor 4

Wind Potentials

Country	Project	Level Of Preparation	Potential Developer	Status Of Financing/ Observations
St. Lucia	12.6 MW Wind Park (Sugar Mill)	Pre-Feasibility, site selection, wind data analysed	LUCELEC	KfW is preparing financing offer (expected in Dec 2007).
St. Vincent	7.2 MW Wind Park (Ribishi Point)	Pre-Feasibility, site selection, wind data analysed	VINLEC	KfW is preparing financing offer (expected in Dec 2007) for wind park and hydro.
Barbados	10 MW Wind Park (Lamberts)	Feasibility study, EIA, financing secured through EIB	Barbados Light and Power (BLP)	EIB has committed financing.
Grenada	10 MW (SE Grenada).	Land negotiations on-going, wind measure-ments starting soon	GRENLEC	GRENLEC expressed interest to join CAWEI.

Future Projects:

(1) St. Kitts & Nevis (approx. 3 MW); (2) Aruba (approx. 5-8 MW); (3) Cuba (up to 100 MW).
Existing - Jamaica 21 MW +18 MW + 3 MW.

(Source: Caribbean Wind Power Initiative [CAWEI]).

Hydropower Potentials

Country	Project	Level of Preparation	Potential Developer	Remarks
Jamaica	Great Laughland River Hydropower Project + Maggoty (2 + 6.3 MW)	Feasibility, financial and economic analysis.	PCJ , WWF Ltd. JPS.	PCJ interested , EIA and business plan required, land issue is pending. Maggoty launch 2012.
St. Vincent	Richmond Hydropower Station upgrading and extension project (1.2 to 1.5 MW)	Feasibility, some construction work started.	VINLEC	VINLEC’s Board decision to implement. Call for interest published (2007). KfW preparing financing offer.
St. Vincent	South River Hydropower Station upgrading and extension project (1.1 to 1.3 MW)	Feasibility, some construction work started.	VINLEC	VINLEC’s Board decision to implement. Call for interest published (2007). KfW is preparing financing offer.

(Source: GTZ)

1. Key Definitions.
2. Energy Efficiency and Conservation.
3. Low-Carbon Methodologies.
4. Opportunities in Transportation.
5. Opportunities in Industry.
6. Opportunities in Commercial Operation.
7. Carbon Sinks.
8. Policy Interventions.

OPPORTUNITIES IN TRANSPORTATION

Transportation Strategies.

- BIODIESEL - B20 reduces total hydrocarbon emissions, NOx, SOx, CO, TSP, PM_{10}.

- B100 reduces net CO_2 by 78% due to carbon recycling by the soy plants.

- Net CO_2 emissions are reduced by 15%.

e.g. Jathropha *saccharum and castor.*

Transportation Strategies.

ENBAR CONSULTING

World Ethanol Production Forecast 2008 - 2012

Millions of Gallons

	2008	2009	2010	2011	2012	CAGR, %
Brazil	4,988	5,238	5,489	5,739	5,990	2.80%
U.S.	6,198	6,858	7,518	8,178	8,838	5.70%
China	1,075	1,101	1,128	1,154	1,181	1.40%
India	531	551	571	591	611	2.20%
France	285	301	317	333	349	3.20%
Spain	163	184	206	227	249	6.90%
Germany	319	381	444	506	569	9.70%
Canada	230	276	322	368	414	9.90%
Indonesia	76	84	92	100	108	5.60%
Italy	50	53	55	58	60	2.80%
Rest of the World	2,302	2,548	2,794	3,040	3,286	5.70%
World Totals	**16,215**	**17,574**	**18,934**	**20,293**	**21,653**	**4.60%**

Source: Market Research Analyst® 2008

SIDs and LDCs can participate (e.g. Cuban potential ~ 3.0 billion gal. per annum from sugar. Jamaica production of fuel ethanol 70 – 80 million gallons/annum for expansion

Transportation Strategies

- GHG reduction (C-fixing) and project funding.
  - E.g. Jamaica's motor vehicle fleet using E10 can consume approximately 68 million liters of ethanol (approx 10,000 ha of cane or 800,000 t of sugar cane).

- Estimated to produce **3% less GHG emissions** in miles travelled /gallon.

Source - Petrojam Ethanol Ltd., 2008.

Source – Jamaica Broilers Ethanol, 2008.

Transportation Strategies

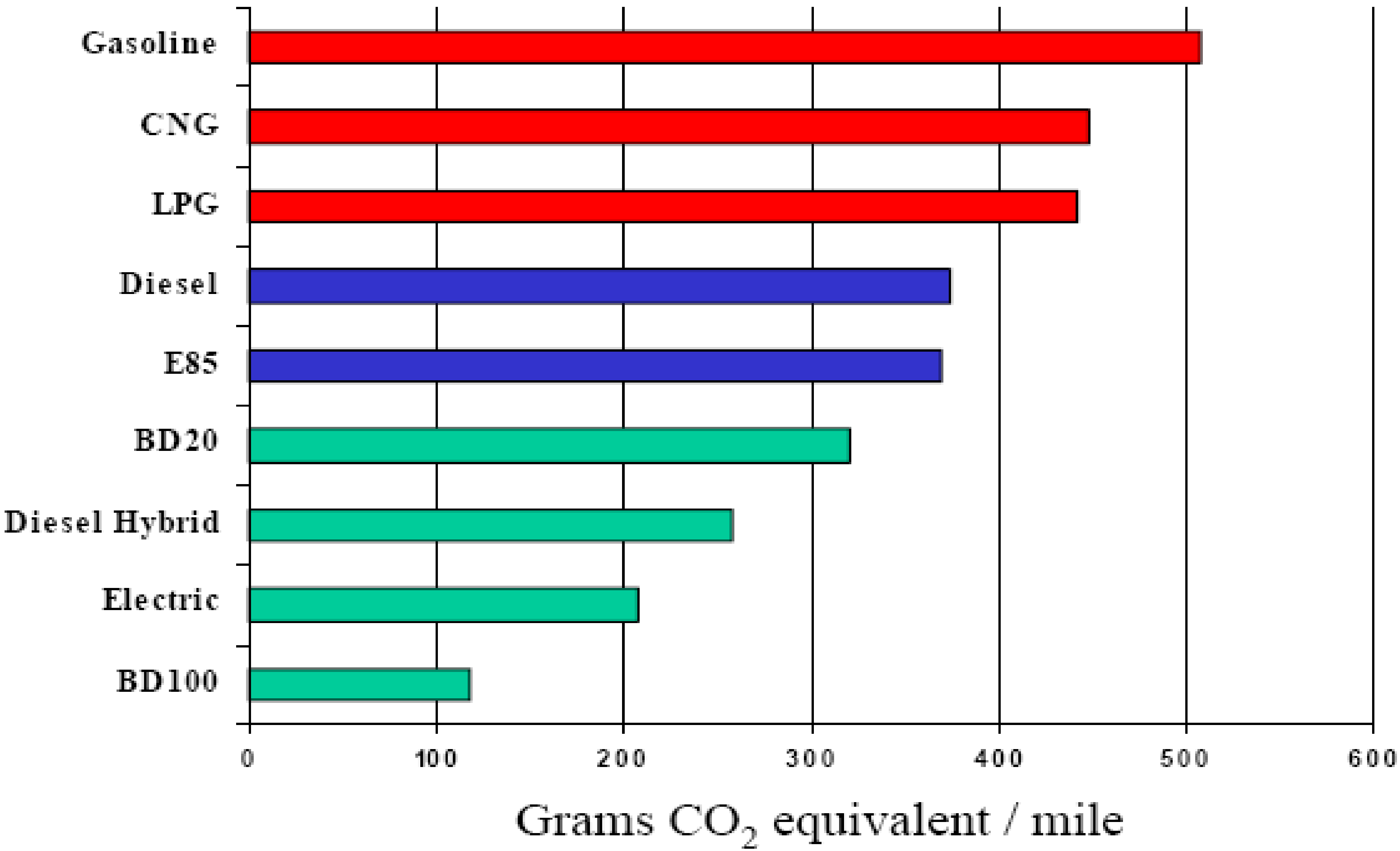
- **LPG and CNG** cars results in **10-15%** reduction in CO_2 relative to petrol cars, similar to diesel vehicles.

  Energy Saving Trust (EST).

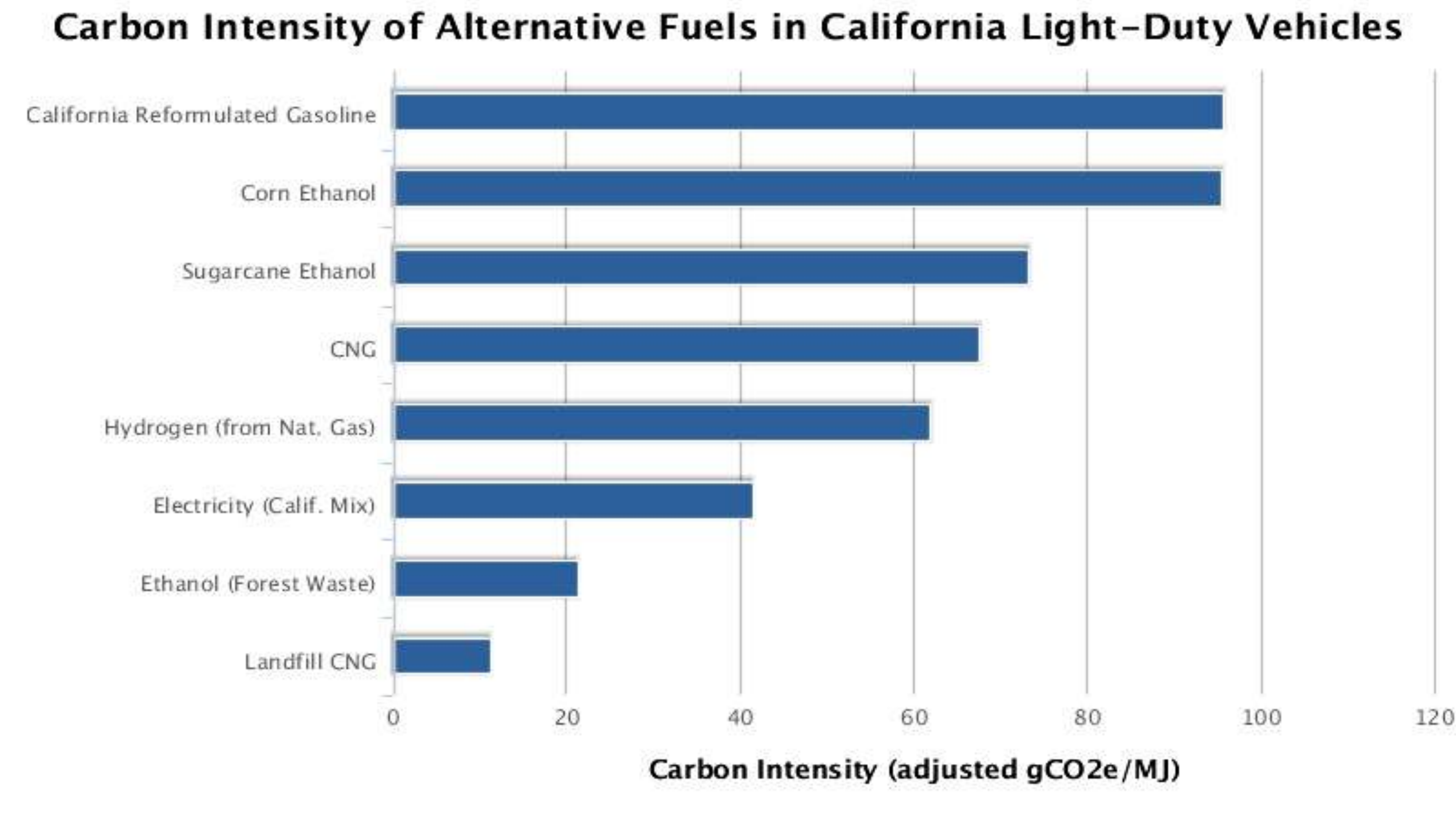
- New factors for LPG and CNG cars were calculated based on an average 12.5% reduction in CO_2 emissions relative to the emission factors for petrol cars .

- Due to the significant size and weight of the LPG and CNG fuel tanks, only medium and large sized vehicles are available.

GHG Emissions / Mile for a Passenger Car



Source – David Harris Jr., General Manager Transportation Services, Harvard University. 2006



- Intensity of life cycle GHG emissions of alternative fuels in LDV. Greatest GHG benefits - CNG from landfills, ethanol from forest waste and electricity.

(Source: California's Low Carbon Fuel Standard Final Regulation Order, April 15, 2010)

Transportation Strategies

- Reduce number of individual LDV-Gasoline.
- LDV gasoline vehicles have high GHG impact.
  - Total national fleet.
  - Emission/ unit.
- Increase diesel fleet & mass transport.

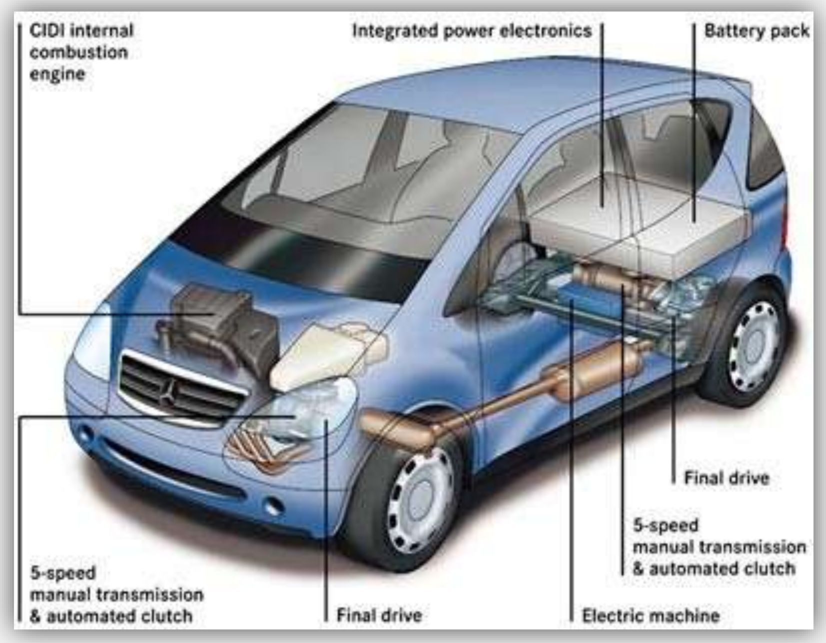
Canadian greenhouse gas emissions from on-road transportation sources, 2004

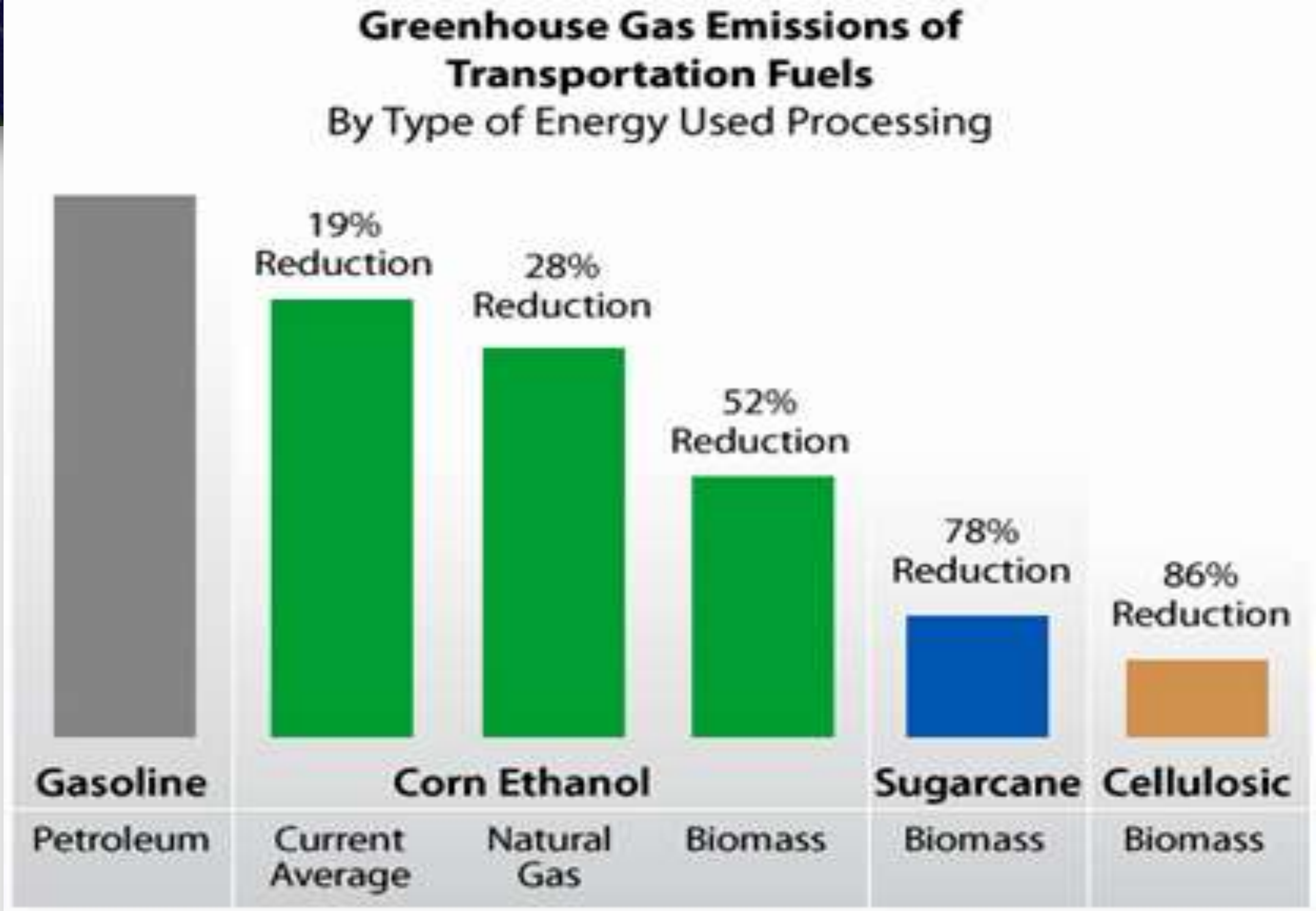
Source	Kilotonnes of CO_2 equivalent
Gasoline Automobiles	47,800
Light-Duty Gasoline Trucks	41,000
Heavy-Duty Gasoline Vehicles	4,010
Motorcycles	214
Diesel Automobiles	750
Light-Duty Diesel Trucks	873
Heavy-Duity Diesel Vehicles	44,400
Propane & Natural Gas Vehicles	837
Total (18.5% of national emissions)	139,884

Source: Environment Canada National GHG Inventory

Fuel Efficient Vehicles:

- Fuel efficiency reduces fuel consumption and emissions of GHGs.
- Flex fuel vehicles (FFVs) – efficient, less C-intense clean fuel.
- Hydrogen vehicles – efficient; zero CO_2 emission.
- Hybrid electric drive trains (fuel+electric) - up to approx. **50%** reduction in GHGs in light duty vehicles.

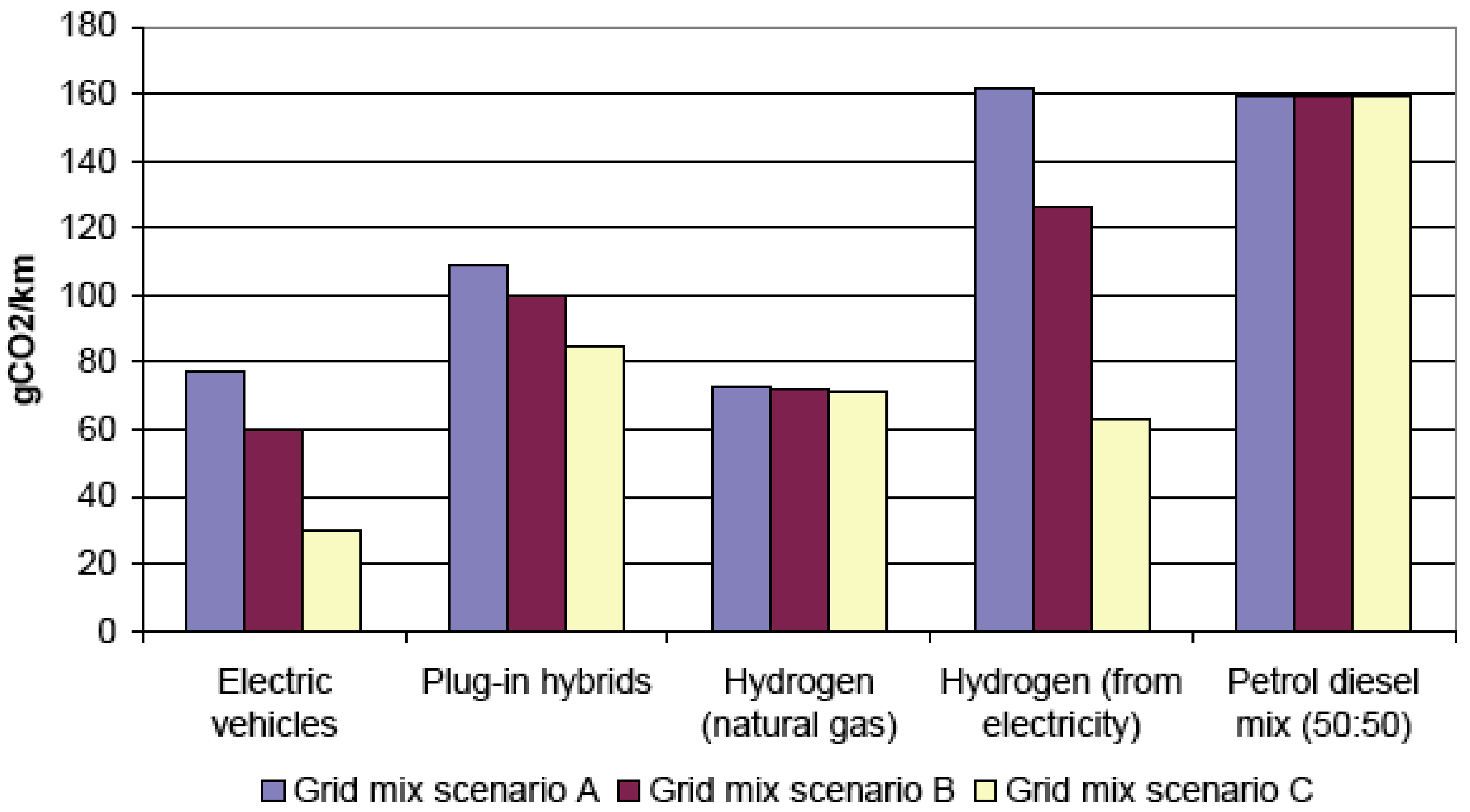




Source: Life Cycle Energy & GHG Emission Impacts of Different Corn Ethanol Plant Types (2007) and DOE Biomass Program.

Upstream Emissions

- Energy source for alternative fuel vehicles can determine overall GHG emissions.



- Grid mix scenario A: 450gCO_2/kWh – equivalent to current grid mix
- Grid mix scenario B: 351gCO_2/kWh – equivalent to a new combined cycle gas turbine plant
- Grid mix scenario C: 176gCO_2/kWh – increased renewables and use of CCs with coal

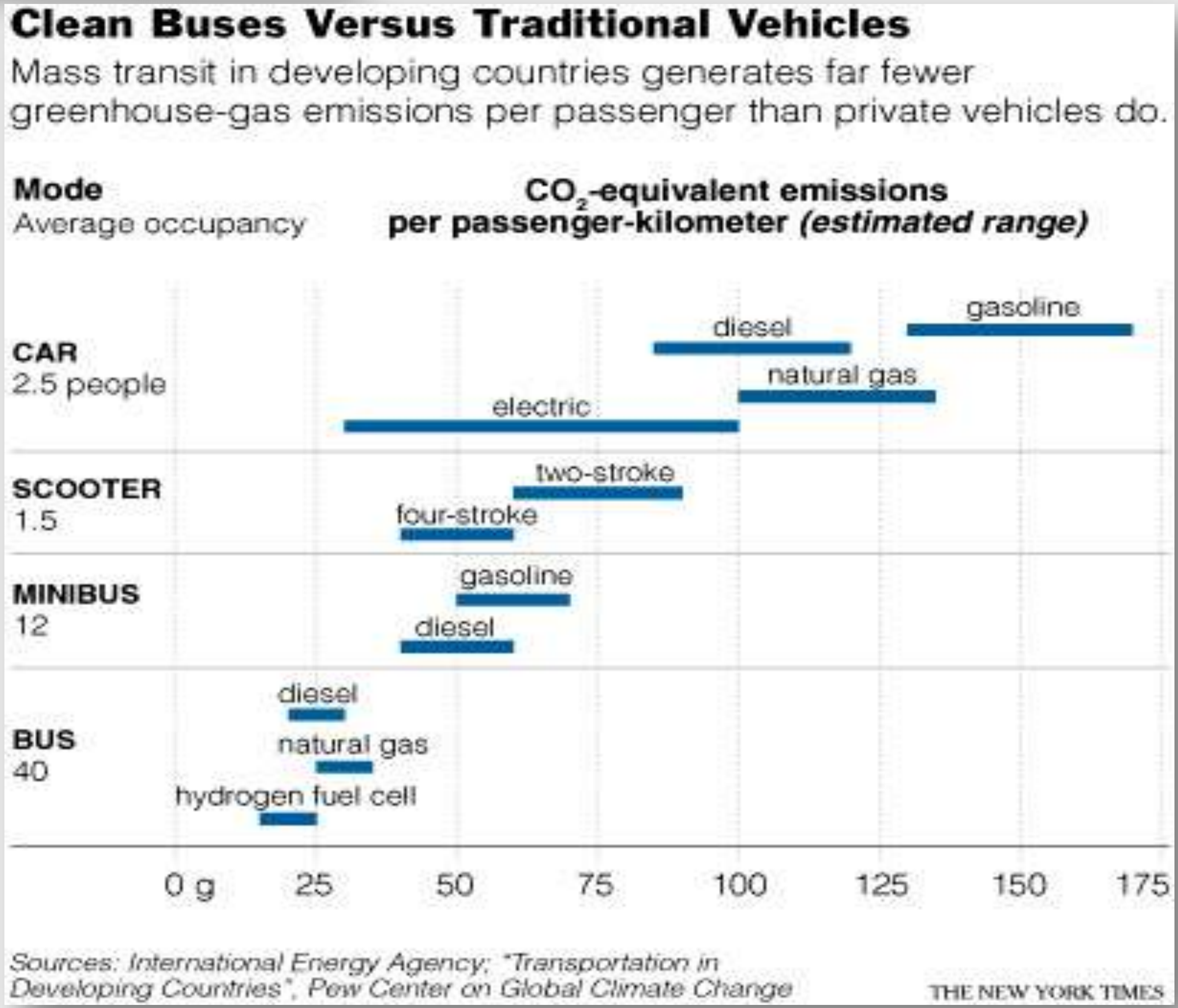
- Source: www.scotland.gov.uk/Publications/2009/06/25103442/5.

Transportation Strategies

- **Car Pooling in Tour Sector:**
  - Tour operators share vehicles and costs = reduced number of trips of vehicles and emissions.
  - E.g. Tobago and Miami (protected areas, eco-sensitive areas etc.).
- **Operational Maintenance:**
  - Fleet renewal to more modern and efficient units.
  - Engine retrofits and upgrades for fuel efficiency improvements (fuel injection, compression, turbo charger).

Transportation Strategies

- Mass transportation as as tool for GHG reduction.
- Less C-intense fuels increase benefits.



Transportation Strategies

- **Efficiency, Fuel Switching and Retrofitting:**
  - Retrofitting aerodynamic additions (e.g. winglets) cuts turbulence with potential fuel savings of up to 6% CO_2.
  - Advanced biofuels for aviation reduces GHG emissions.
  - Use of renewables (e.g.. Wind) for mass transportation (e.g. wind power for above rail systems in Calgary, Canada).

ACTIVITY

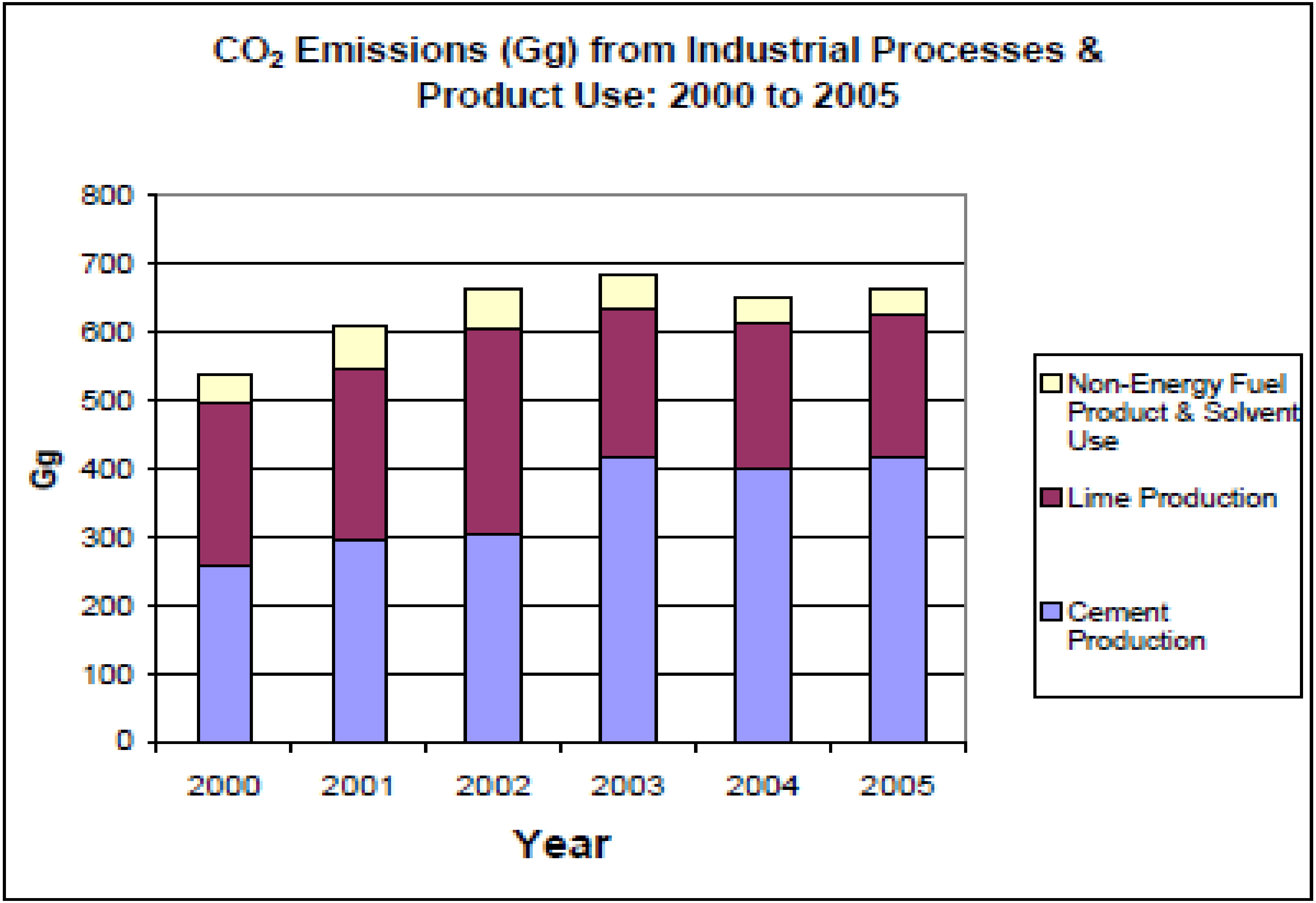
- CALCULATE EMISSIONS FOR MEDIUM PETROL (GASOLINE) CAR (10,000 MLS/YR) (table 6b).
- CALCULATE EMISSION FOR MEDUIM DIESEL CAR. (10,000 MLS/YR) (table 6c).
- CALCULATE EMISSIONS FOR MEDIUM HYBRID AND CNG CAR (10,000 MLS/YR) (table 6d).
- CALCULATE EMISSIONS FOR DIESEL VAN ≥ 3.5 TONNES (table 6i).* (8,500lbs = 3.8 t)

1. Key Definitions.
2. Energy Efficiency and Conservation.
3. Low-Carbon Methodologies.
4. Opportunities in Transportation.
5. Opportunities in Industry.
6. Opportunities in Commercial Operation.
7. Carbon Sinks.
8. Policy Interventions.

OPPORTUNITIES IN INDUSTRY

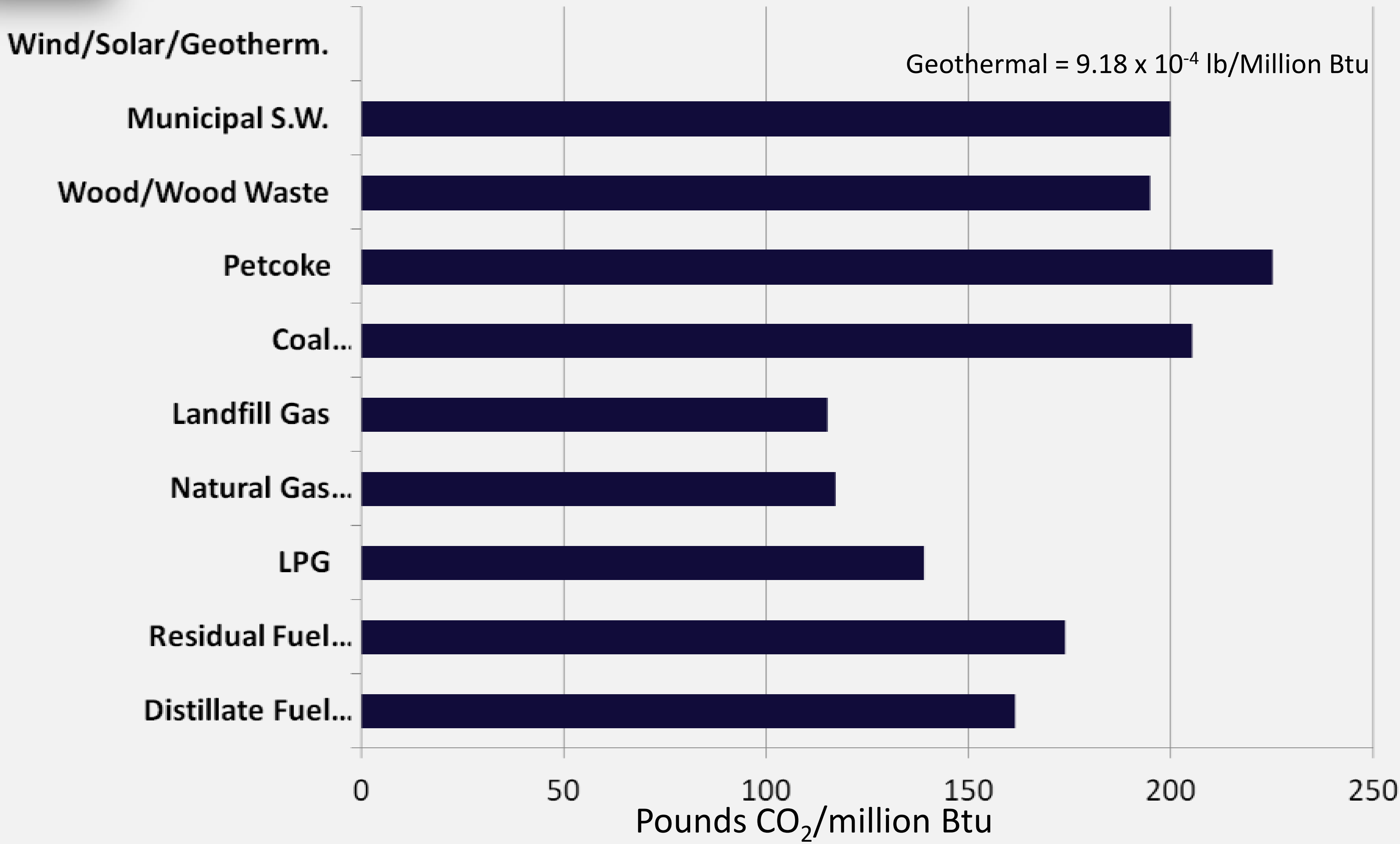
PROCESS RELATED EMISSIONS [1]

PROCESS		EMISSION					
		CO_2	CH_4	N_2O	PFC	SF_6	HFC
Mineral Products	Cement Production	■					
	Lime Production	■					
	Limestone Use [2]	■					
	Soda Ash Production and Use	■					
	Fletton Brick Manufacture [3]	■	■				
Chemical Industry	Ammonia	■	■				
	Nitric Acid			■			
	Adpic Acid			■			
	Urea			■			
	Carbides	■	■				
	Caprolactam			■			
	Petrochemicals		■				
Metal Production	Iron, Steel and Ferroalloys	■	■				
	Aluminium	■			■		
	Magnesium					■	■
	Other Metals	■					
Energy Industry	Coal mining		■				
	Solid fuel transformation	■					
	Oil production	■	■				
	Gas production and distribution	■	■				
	Venting and flaring from oil/gas production	■	■				
Other	Production of Halocarbons				■		■
	Use of Halocarbons and SF_6				■	■	■
	Organic waste management	■	■				

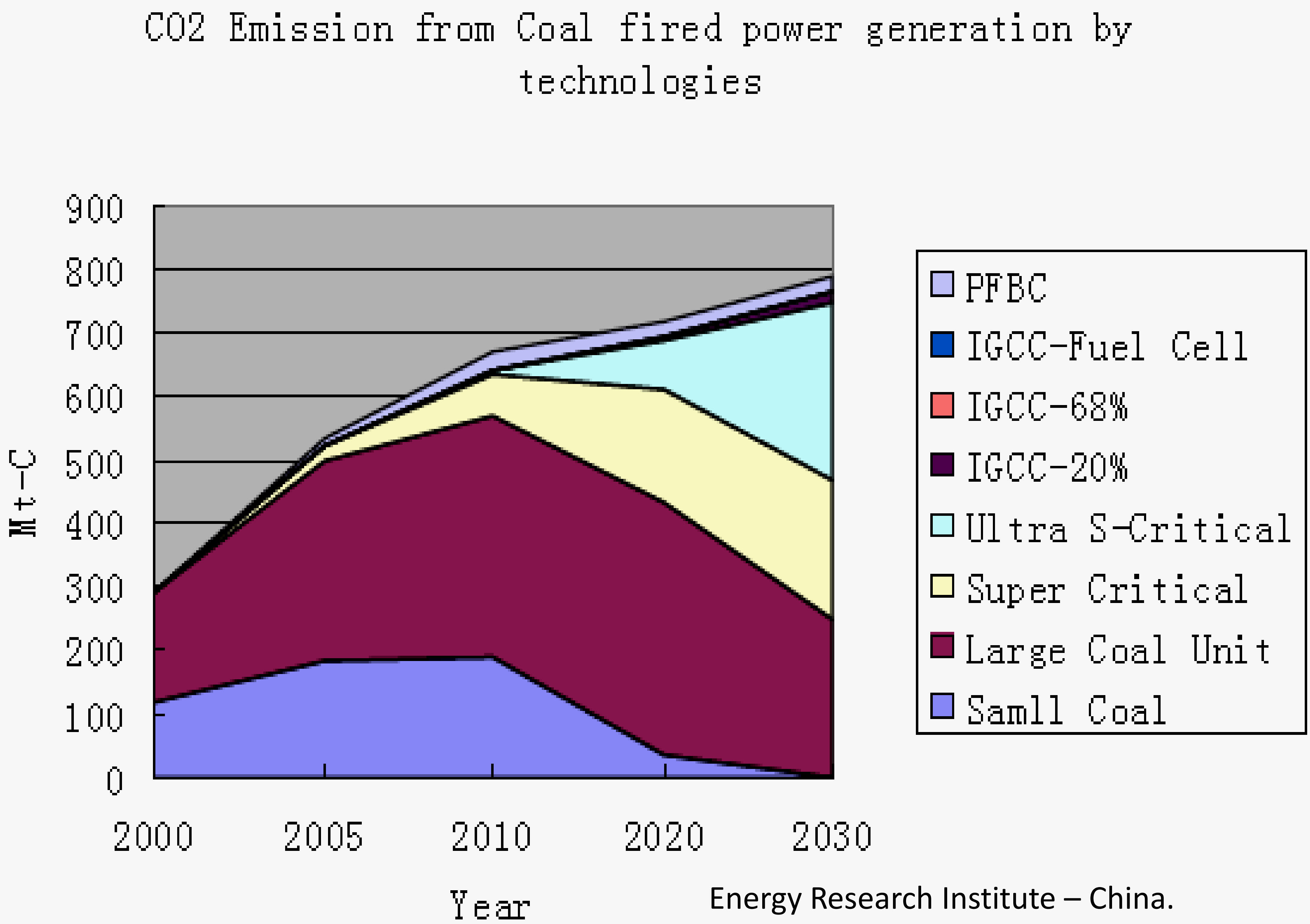


Jamaica's Green House Gas Emissions, 2000 - 2005, Claude Davis & Associates. Second National Communications – UNFCCC.

Generation Emissions lb-CO_2 per Million Btu



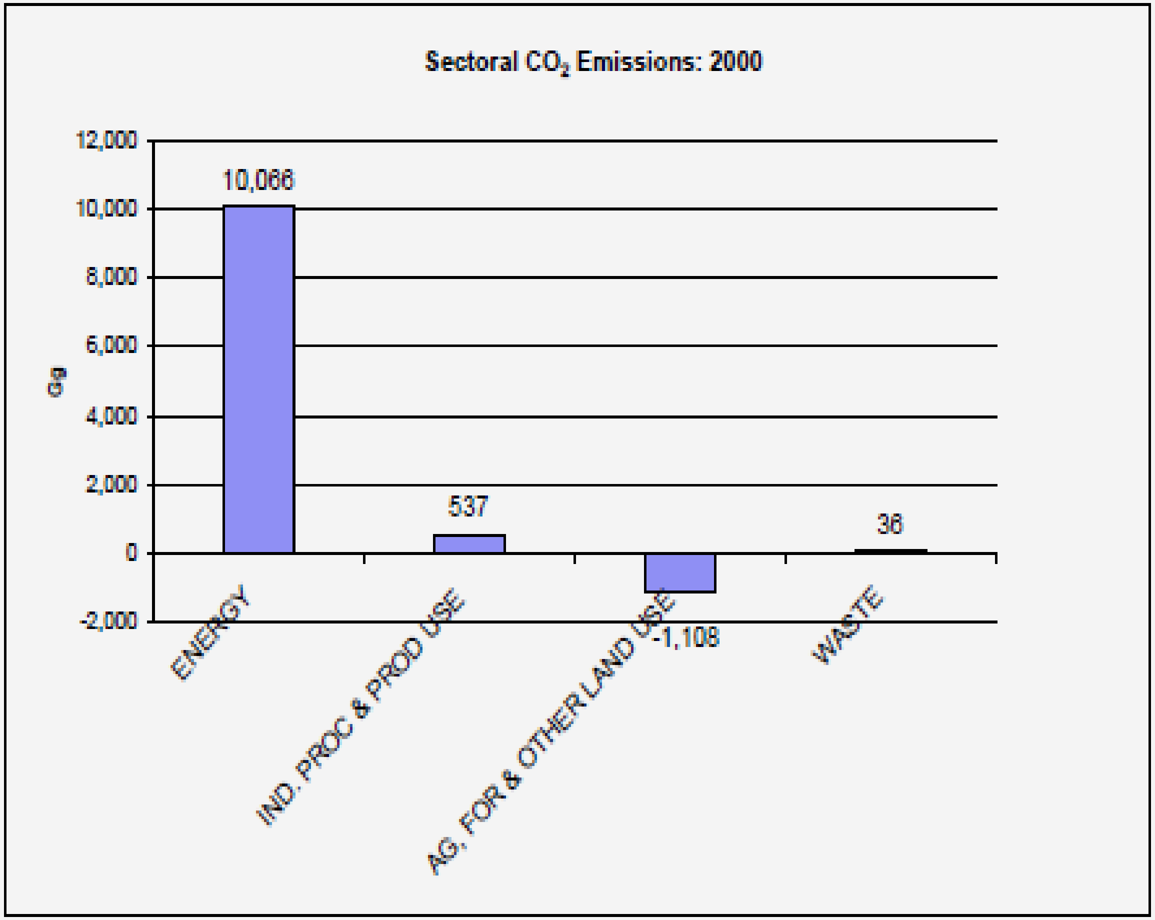
EIA – "Voluntary Reporting of Greenhouse Gases Program Fuel & Energy Source Codes & Emission Coefficients"



Energy Research Institute – China.

Heat & Power

- POWER GENERATION is a primary contributor to CO_2 emissions due to fossil fuel use.
- Generation can account for **66%** (e.g. Trinidad) and higher (e.g. Bahamas, St. Lucia) of total CO_2 Emission *(Trotz, 2007)*.



Jamaica's Green House Gas Emissions, 2000 - 2005, Claude Davis & Associates. Second National Communications – UNFCCC.

Heat & Power

Biomass (e.g. Sugar Industry):

- Fuelwood + bagasse (Internal + Export power = 15 MW).
- Plantation > 8,000 Ha; 170,000 t/year; 50 M Trees [5 yrs]
- Total Generation = 190,000,000 kWh-yr.

Mitigation Benefits:

- Avoided CO_2 generation per annum (248 M litres of diesel) = 755,000 tons CO_2.
- CO_2 sequestered = 480,000 tons CO_2. (80% C-closure by trees & cane; 15 yrs).

Heat & Power

- GEOTHERMAL negligible GHG emissions (CO_2).
- Process heat qualities not available in all LDCs, SVEs and SIDs.
- Potential for displacing significant amount of CO_2 emissions from FF for heat and power (mitigation).
- Intra-regional export opportunities (e.g. Nevis total potential for 900MW; plans for 50 MW plant and sale of 35 MW to neighbours). (increasing energy security and reduced need for new FF plants).

Power

- WIND is critical to the power sector - zero emissions and energy security.
- Resource is site specific.
- Climate change agreements may increase CDM project potentials.

CAPACITY	WIGTON WIND FARM
Installed Capacity (23 NegMicron Vesta X 900 kW)	**20.7 MW**
Average Output	**7.0 MW**
Estimated Manual Output	**62.97 GWH**
Estimated CO_2 Reduction	**52,250 tCO_2e per yr.**

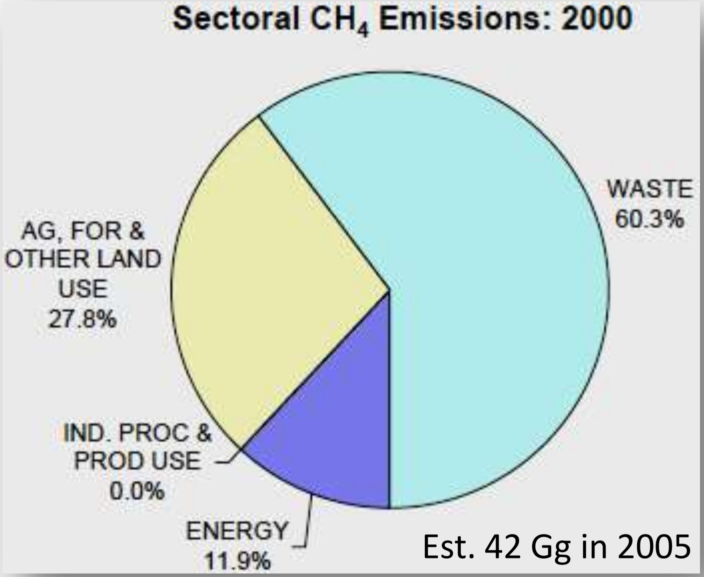
Power

- Diversion type HYDROPOWER SYSTEMS are suited to many SIDs, LDCs and SVEs. zero CO_2 emissions.

- Reduced energy imports and GHG emissions:
  - E.g. 21.5 MW; approx. 88GWh.
  - Avoided 162,000 tonnes of CO_2 [No. 4 Fuel oil/Diesel].
  - Potentially savings of USD 19.8 M @ USD115/bbl*.(*21/8/2008).

Waste Facilities & Power

- WTE - landfill gas and wastewater/sewerage for power.
- CH_4 capture and utilization - potential GHG trading financing.
- Limited by low volume flows in SIDs and disorganised disposal sites.
  - E.g.. Jamaica – disposal of approx. 950,000 tonnes/yr.
  - Organic content is approx. 65% with a potential for generating 15 MW at US$ 0.08 cents/kWh.



Jamaica's Green House Gas Emissions, 2000 - 2005, Claude Davis & Associates. Second National Communications – UNFCCC.

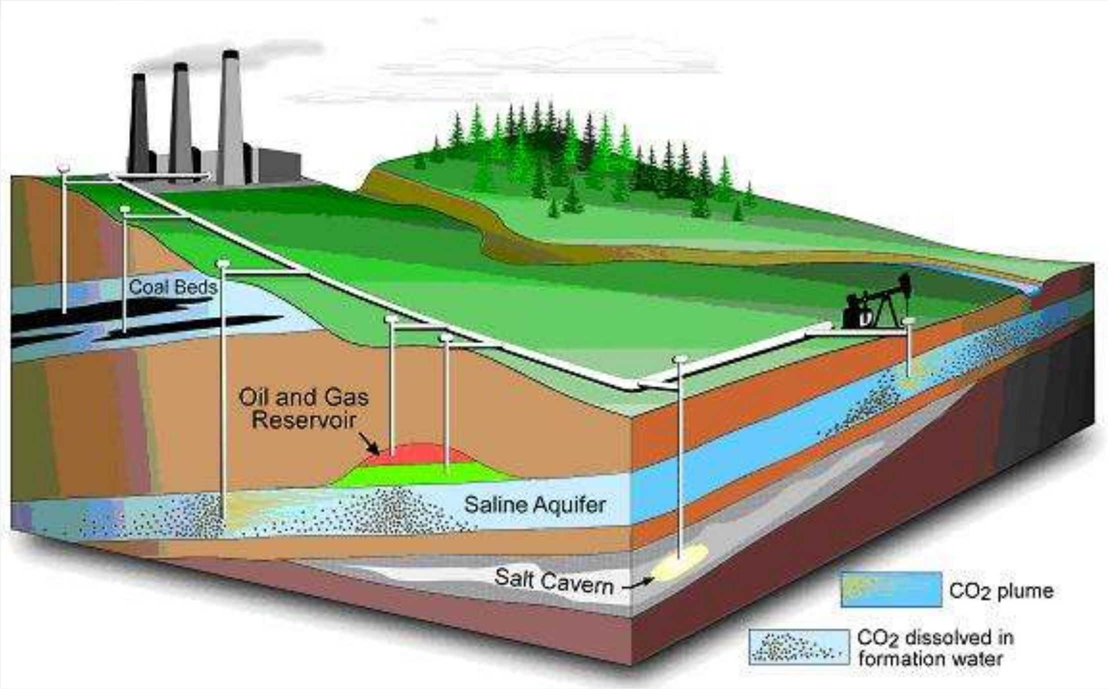
ACTIVITY – GHG EMISSIONS BY FUEL TYPE

1. Key Definitions.
2. Energy Efficiency and Conservation.
3. Low-Carbon Methodologies.
4. Opportunities in Transportation.
5. Opportunities in Industry.
6. Opportunities in Commercial Operation.
7. Carbon Sinks.
8. Policy Interventions.

CARBON SINKS.

Carbon Capture & Storage

- Carbon capture and storage(CCS) technology - captures CO_2 for storage underground.
- Increases building and operational costs while reducing power output.
- Careful selection and monitoring of geologic storage (or "sequestration") sites.
- Regulatory Standards and mechanisms needed to minimize the environmental risks of CO_2 leakage (including groundwater contamination).



- CCS technology for coal-fired power plants CO_2 captured and injected into geologic formations (e.g. depleted O&G reservoirs, unmineable coal seams, or saline aquifers).
- Commercial scale demonstration projects.

(Source: Alberta Geological Survey).

Carbon Capture & Storage

- IPCC - CCS could contribute **10% - 55%** of the cumulative worldwide carbon-mitigation effort over the next 90 years.

- 2011 - total CO_2 storage capacity of 14 projects in operation or under construction is estimated at over **33 million tonnes/year** *(equivalent to approx. emissions from six million cars/yr).*

Carbon Sequestration

- Agricultural soil of the LAC Region have lost, due to past agricultural practices, an average of **30-40 Mg C.ha-1**.
- Carbon sequestration by soils is finite, and smaller that the historical loss.
- Mitigation potential in storing carbon in soils would decline after a period of 30 to 50 years.
- IPCC 4th Assessment Report - **technical mitigation potential of the LAC Region is 0.76 Pg CO_2-e.g. per year** (14% of global potential in agriculture).

(CC Mitigation in Agriculture in LAC, Daniel Martino - Carbosur 2011).

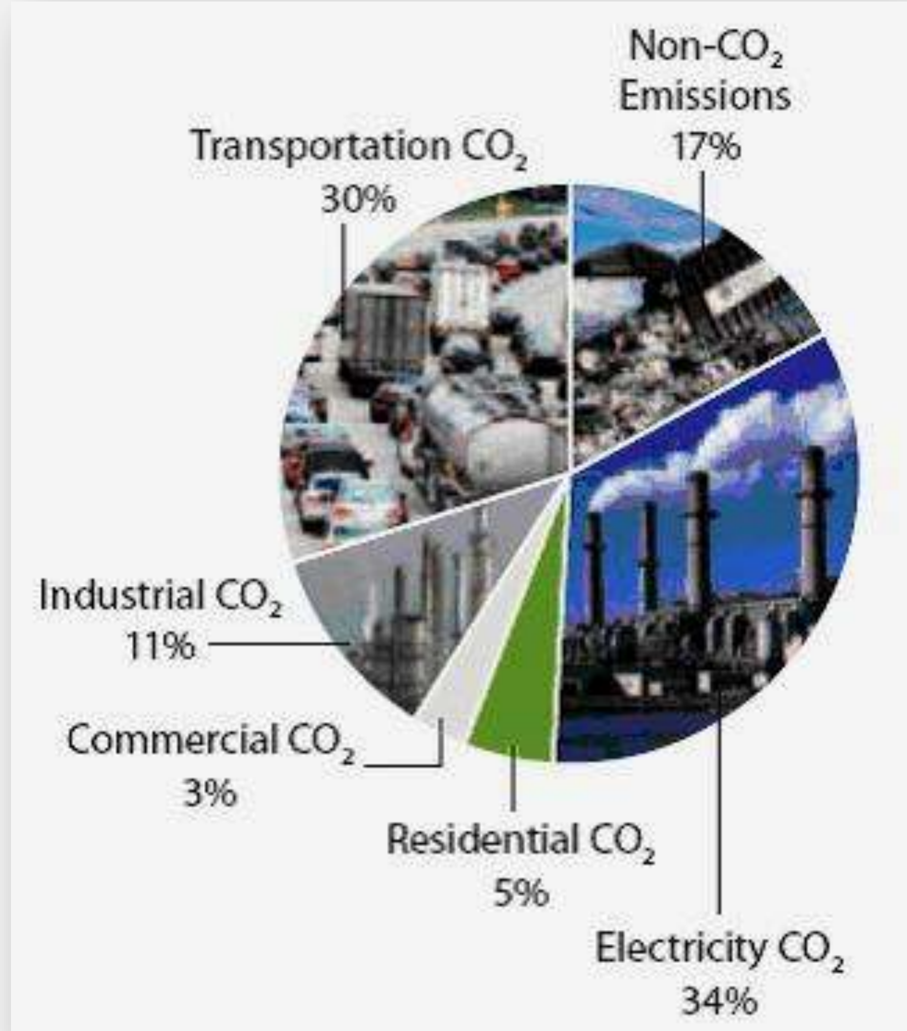
1. Key Definitions.
2. Energy Efficiency and Conservation.
3. Low-Carbon Methodologies.
4. Opportunities in Transportation.
5. Opportunities in Industry.
6. Opportunities in Commercial Operation.
7. Carbon Sinks.
8. Policy Interventions.

POLICY INTERVENTIONS

National Strategies for Mitigation Plans.

- Identify the large sources of emissions.
- ID the available and affordable technologies.

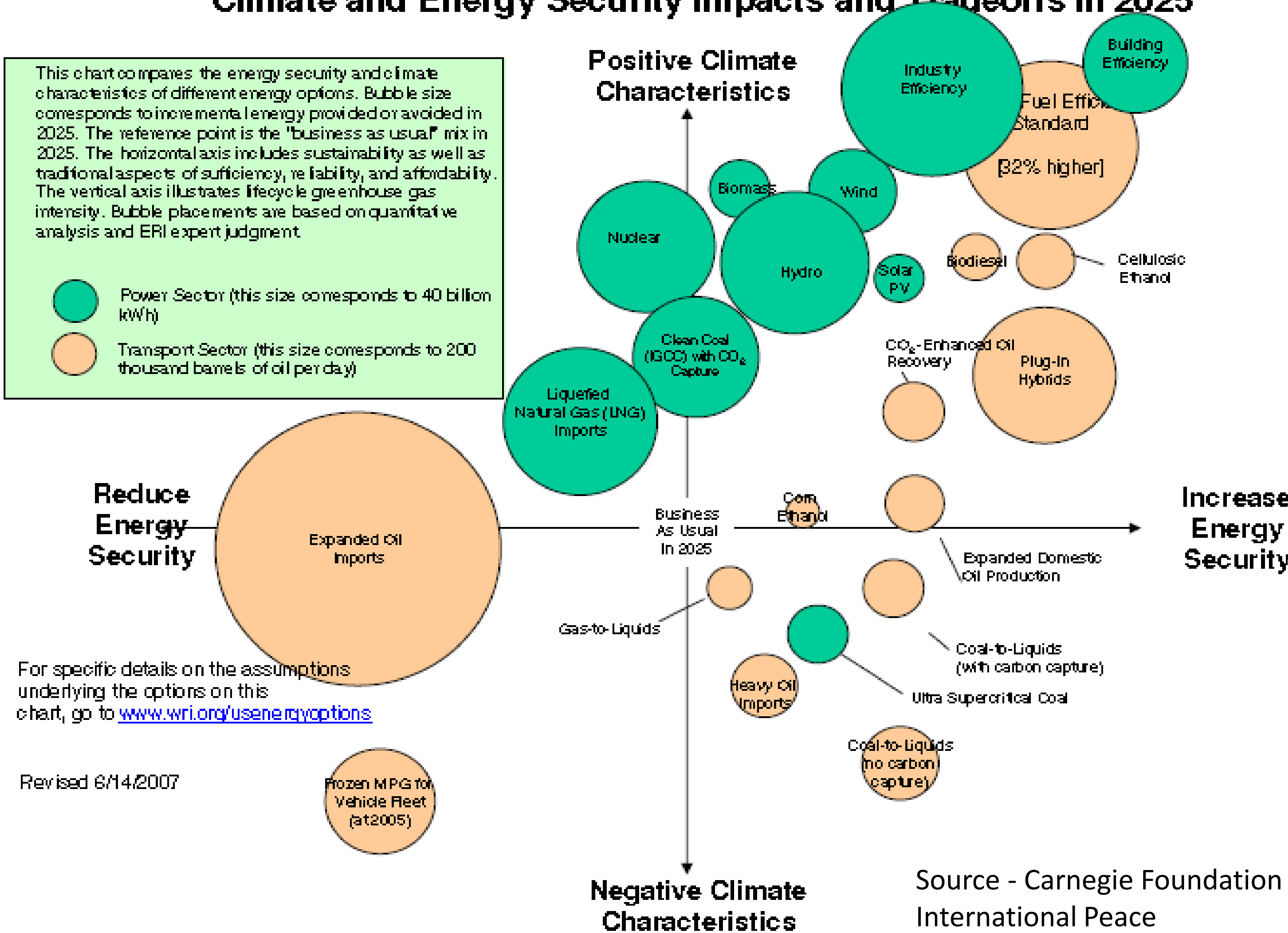
Sources of U.S. Heat-Trapping Emissions in 2005 (Source: U.S. EIA, 2008)



Policy Interventions.

- Specific policies and associated policies which facilitate economic, technical and financial feasibility of the various technologies.
- Regulatory frameworks for market mechanisms, and command and control mechanisms to encourage GHG mitigation,
- Strategic plans for energy forecasting, transportation, industrial initiatives.
- Capacity building for expertise within Government Ministries.
- Public education and sensitisation.
- Regional collaboration.

A Snapshot of Selected China Energy Options Today: Climate and Energy Security Impacts and Tradeoffs in 2025



Source - Carnegie Foundation for International Peace

A Snapshot of Selected U.S. Energy Options Today: Climate and Energy Security Impacts and Tradeoffs in 2025