EN 606 Energy Resources, Economics and Environment

Assignment : To study the energy balance of a country

Objective:

This assignment intends to expose students to the various aspects of the energy problem that one must consider while analysing the scenario for a country. Various indicators that are used for comparison as well as their potential consequences have been highlighted. Furthermore, students will be able to understand the tools that are commonly used for this purpose.

Please adhere to all the guidelines listed out in this document.

Specifics:

1. **Groups:** Students will be divided randomly into groups of 3 (one group has 2 members). Each group will have students from various degrees (MSc-PhD, MTech and PhD).
2. **Output:** At the end of this assignment, students will be required to submit a written report of approximately **10 pages**. Students will also be required to represent their allotted country in a mock UN setting. The deadline for the submission of the report will be 09:00 pm on Sunday, **11 August 2019**. The reports will be made available to students in order to prepare questions for other countries for the mock UN. Questions for the mock UN should be submitted no later than 09:00 pm on 13 August 2019. The mock UN will be conducted on 14 August 2019.
   Please note that late submissions will attract penalties.

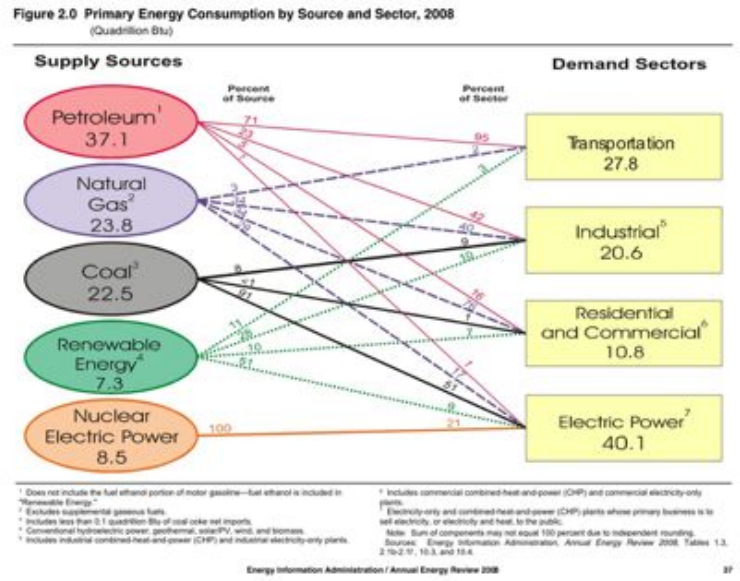
3. **<u>Contents of the report:</u>** The report must contain the following:
    a. Data source (must be written very clearly, in appropriate format)
    b. Energy balance table for the country (as shown in the figure given below:) [Units for energy must be PJ]

Primary Energy		Secondary Energy		Sectoral Energy Conusmption		End-Use Energy Consumption	
Parameter	**Value (PJ)**	**Parameter**	**Value (PJ)**	**Parameter**	**Value (PJ)**	**Parameter**	**Value (PJ)**
Source 1:	Coal	**Electricity**		**Residential**		End-Use 1	
Production		Production					
Import		Import				End-Use 2	
Export		Export					
Source 1 Total		Total				End-Use 3	
Source 2:	Crude Oil	**Oil Products**					
Production		Production		**Industrial**		End-Use 1	
Import		Import					
Export		Export				End-Use 2	
Source 2 Total		Total					
Source 3:	Nuclear	**Heat**				End-Use 3	
Production		Production					
Import		Import		**Transport**		End-Use 1	
Export		Export					
Source 3 Total		Total				End-Use 2	
Source 4:							
Production						End-Use 3	
Import							
Export				**Others**		End-Use 1	

Source 4 Total							
Source 5:						End-Use 2	
Production							
Import						End-Use 3	
Export							
Source 5 Total							
All Sources Total		**All Sources Total**					

c. Sankey diagrams are a specific type of flow diagrams, in which the width of the arrows is shown proportionally to the flow quantity. They are excellent tools to visualize national level energy flows between various sectors. Students may use the online resource http://sankeymatic.com in order to create the same. An example Sankey diagram for Tanzania has been shown on the next page, constructed on the same resource. **Screenshots of the Sankey diagram, if present in the report will be penalized.**

d. PECSS diagram: **P**rimary **E**nergy **C**onsumption by **S**ource and **S**ector diagram



e. Compare the energy mixes for the country in **2000 and 2015** using the **Sankey diagram** and the **PECSS diagram**. Based on this, identify the significant changes that have taken place in the country.

f. Collect data to calculate the short term (2010-2015) and long term (2000-2015) compound annual growth rate for the **population, GDP, primary energy use, import/export of energy, CO_2 emission, installed power, GDP per capita and emission**. Calculate using the **Kaya identity** the different indicators relating to emissions in the country and comment on the implications of this change. Compare these parameters with those for India and the world in the same time. Comment upon the energy security of the country. What is the implication of the energy/energy product export of the country on its economy? What is the share of renewables and nuclear energy in the country? How does this affect the emissions in the country?

g. Highlight the significant policies that have been undertaken by the country to reduce energy consumption and energy related emissions or pollution. Comment on the barriers to implementation of these policies as well as the bottlenecks imposed by them. Conclude the report with what this country can learn from India and what India can learn from this country. What challenges do you anticipate for this country going forward?

4. **Mock UN:** In the mock UN setting, each country will be required to present the data collected in the course of the assignment as a 4 minute powerpoint presentation. Based upon the presentation and the report, other countries will pose questions to identify the strengths and weaknesses of the countries that have been allotted for 3 minutes. The exact format of the mock UN will be given to you at a later date.

5. **Plagiarism:** Plagiarism is defined as the act of passing someone else's work off as your own, without giving due credit to the person. Plagiarism of any form in the report (a similarity index of greater than 20 %) will attract penalties. Students will be required to submit their report on the platform Turnitin. A separate guide to getting and using Turnitin will be made available to you. Styles that must be followed for references of websites and papers will be provided to students.

   All sources used in order to obtain the data necessary for the assignment should be duly referred to.

   a. **Sample reference styles:**

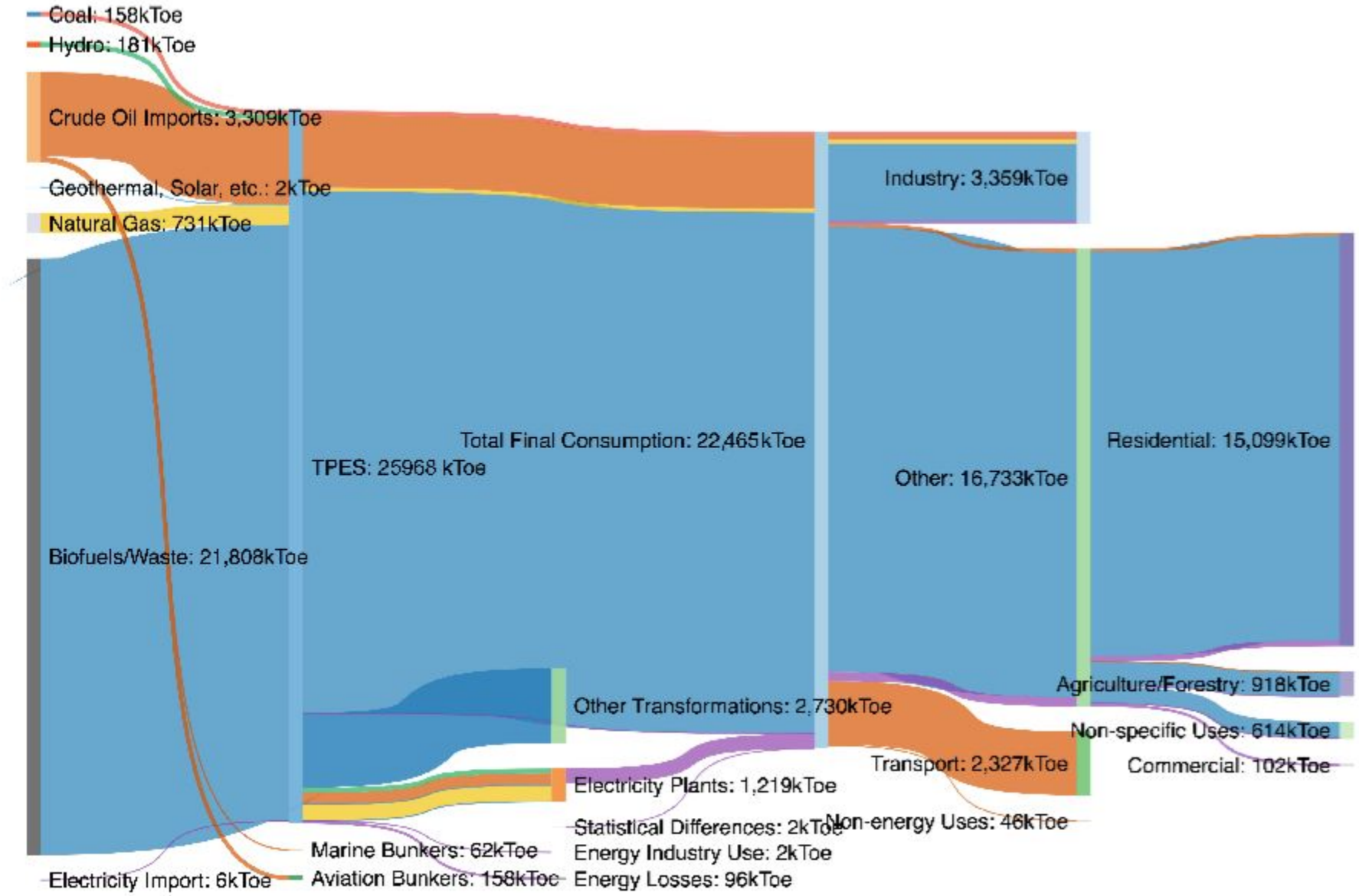
      i. For an article in a journal: name of the authors, title, *name of the journal, volume (issue number),* range of pages, and **year.**

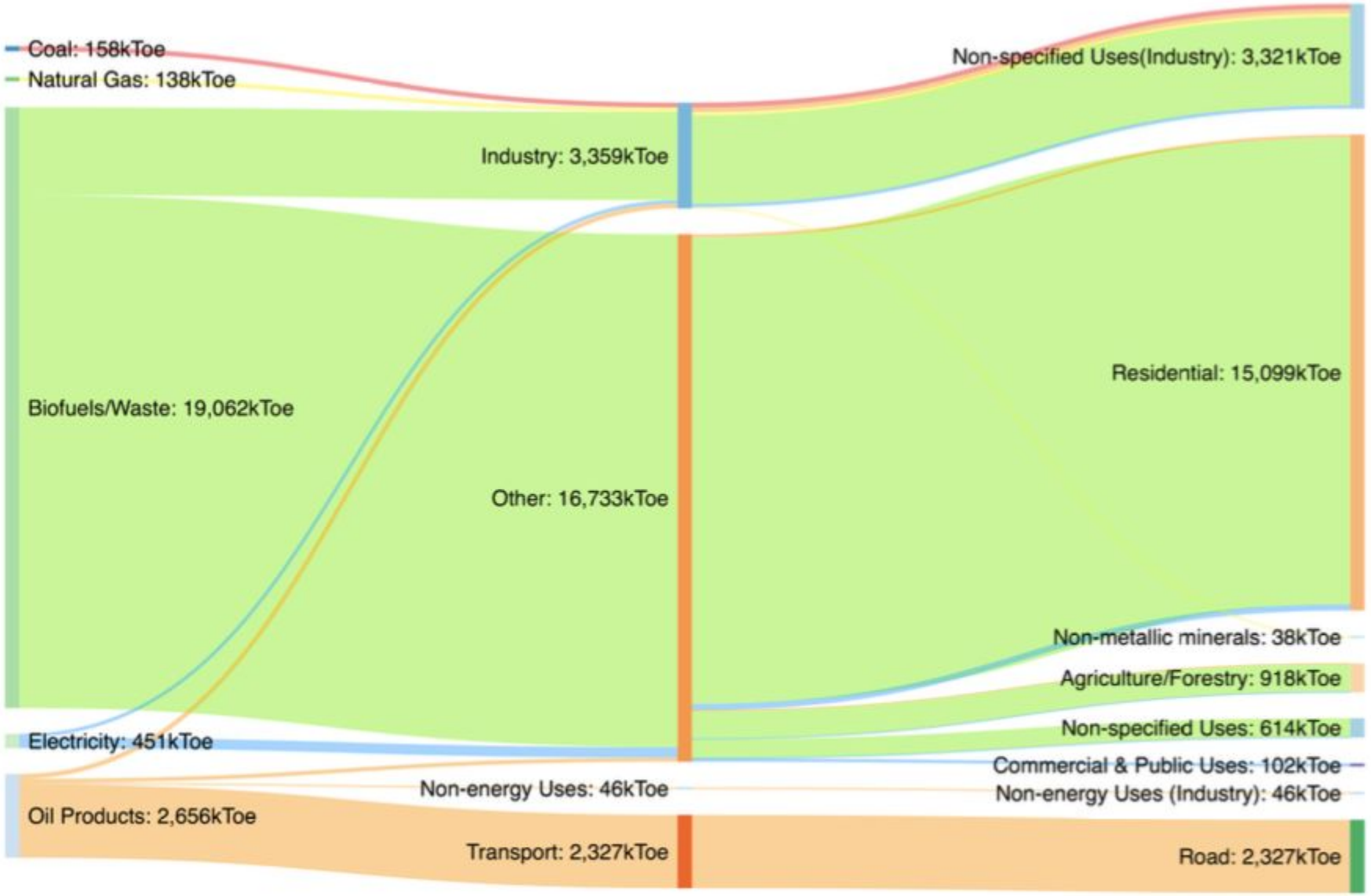
      Example: Bandyopadhyay S., Bera N.C. and Bhattacharyya S., 'Thermoeconomic Optimization of Combined Cycle Power Plants', *Energy Conver. Mgmt., 42(3),* 359-371*,* **2001**.

      ii. A web-site : Author or Organization, *name of the site,* complete address of the site, date visited

      Example: Danish Wind Industry Association, *Aerodynamics of Wind Turbines: Lift, http://www.windpower.org/*tour/wtrb/lift.htm, Aug 16, 2002

You may contact any of the teaching assistants for the course in case you have any queries.


Coal: 158kToe
Hydro: 181kToe
Crude Oil Imports: 3,309kToe
Geothermal, Solar, etc.: 2kToe
Natural Gas: 731kToe
Biofuels/Waste: 21,808kToe
Electricity Import: 6kToe
TPES: 25968 kToe
Total Final Consumption: 22,465kToe
Marine Bunkers: 62kToe
Aviation Bunkers: 158kToe
Other Transformations: 2,730kToe
Electricity Plants: 1,219kToe
Statistical Differences: 2kToe
Energy Industry Use: 2kToe
Energy Losses: 96kToe
Industry: 3,359kToe
Other: 16,733kToe
Transport: 2,327kToe
Non-energy Uses: 46kToe
Residential: 15,099kToe
Agriculture/Forestry: 918kToe
Non-specific Uses: 614kToe
Commercial: 102kToe


Coal: 158kToe
Natural Gas: 138kToe
Biofuels/Waste: 19,062kToe
Electricity: 451kToe
Oil Products: 2,656kToe
Industry: 3,359kToe
Other: 16,733kToe
Non-energy Uses: 46kToe
Transport: 2,327kToe
Non-specified Uses(Industry): 3,321kToe
Residential: 15,099kToe
Non-metallic minerals: 38kToe
Agriculture/Forestry: 918kToe
Non-specified Uses: 614kToe
Commercial & Public Uses: 102kToe
Non-energy Uses (Industry): 46kToe
Road: 2,327kToe

EVALUATION

Suggested break up: 75 marks for report, 25 marks for presentation and the mock UN

Evaluation criteria for the Mock UN will be made available to you at a later date.

Evaluation criteria for report:

1. Presence of data sources and references in appropriate format (2 marks)
2. Energy Balance Table (5 marks)
3. Sankey Diagrams (2 x 5 marks)
4. PECSS diagrams (2 x 5 marks)
5. Analysis based on Sankey diagram and PECSS diagram (3 marks)
6. CAGR calculation, Kaya break up, comparison with India and the world, inferences based on that (7 marks + 7 marks + 7 marks + 6 marks)
7. Significant policies and policy bottlenecks (5 marks)
8. What India can learn from this country (5 marks)
9. What this country can learn from India (5 marks)
10. Critical conclusion (3 marks)
11. Plagiarism
    a. Less than 10 % (Bonus 5 marks)
    b. Less than 15 % (Bonus 3 marks)
    c. Less than 20 % (Bonus 1 mark)
    d. 20 - 25 % (Negative 1 mark)
    e. 25 - 30 % (Negative 5 marks)
    f. 30 % and above (Repeat assignment with 50 % deduction in total marks)
12. Total marks achievable: (75 marks + a bonus of up to 5 marks in report + 25 marks + a bonus of up to 5 marks in presentation)

JAPAN

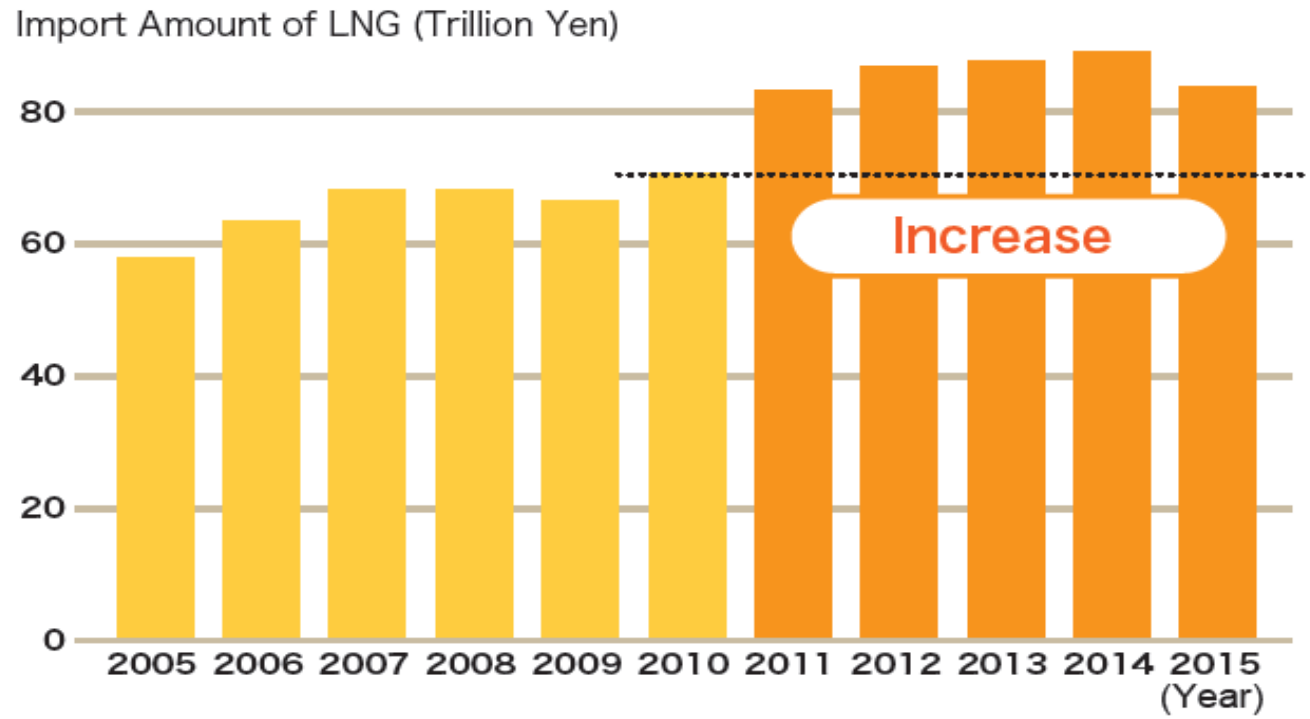
Salient features of energy balance.

Presented by:
Group_23

1. Low energy self-sufficiency ratio.
   i) Low among OECD countries.
   ii) Concerns over stable energy supply.

2. Coal / oil / natural gas are the main imports.
   i) 90% dependence on primary energy supply basis.
   ii) About 86% of the crude oil is imported from the middle east.
   iii) Strong diplomatic relations with those countries.

3. Before and after Great East Japan Earthquake.



Source: Japan's Energy White Paper 2017【213-1-9】Natural gas supply,
Annual report on energy production · supply and demand statistics, Trade statistics

- Electricity rates are on an increase since FY 2010.
- Greenhouse gas emissions peaked in 2013.

Why nuclear power?

- Securing a stable supply.
- Reducing electric power costs.
- Suppressing CO_2 emission costs.

Conformation to new regulatory standards is required for restarting.

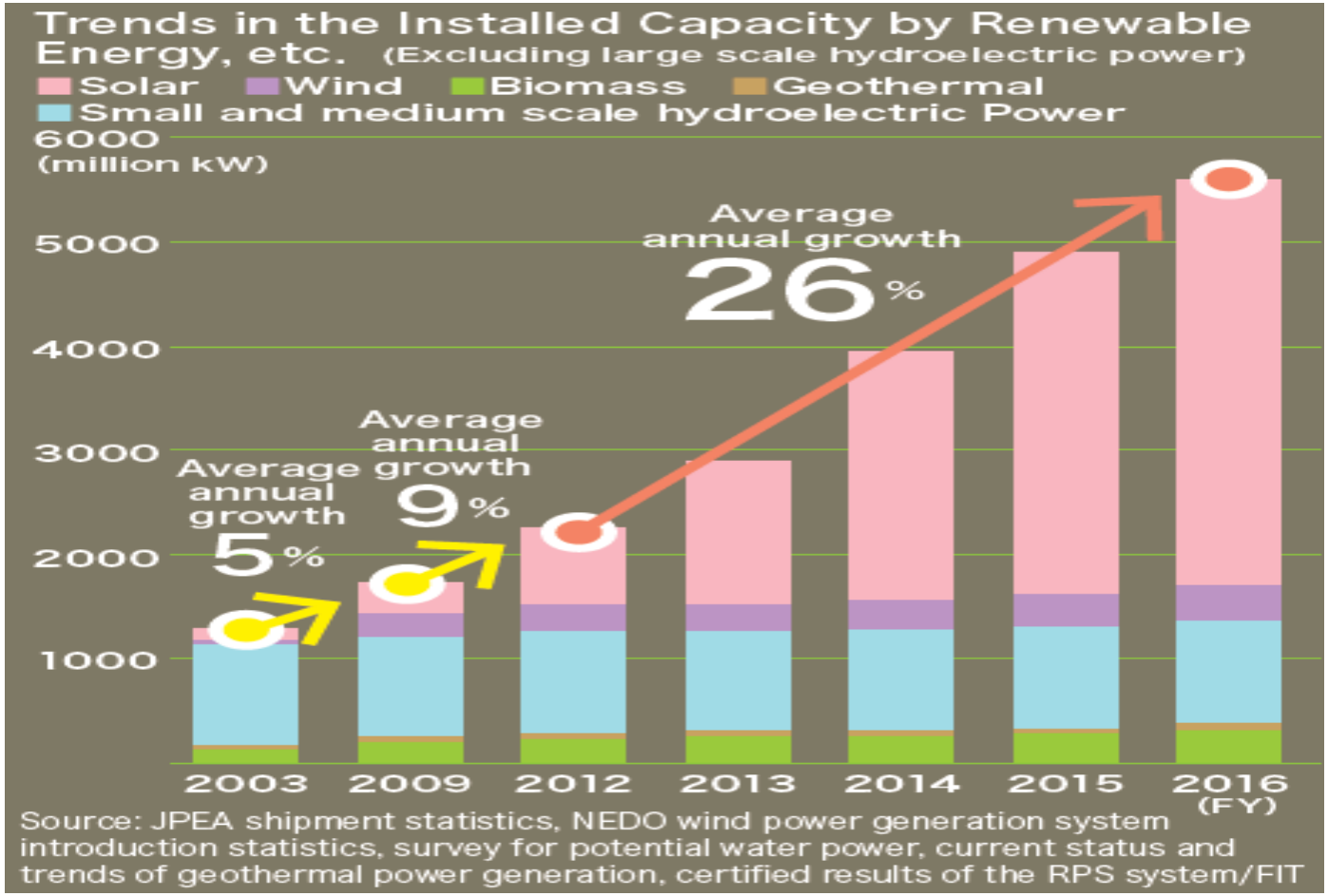
4. Key developments in energy sector.

- R&D of methane hydrate as non-conventional domestic source.
- Hydrogen energy is expected to play a central role in replacing oil and other resources.
- Advanced energy efficiency measures.

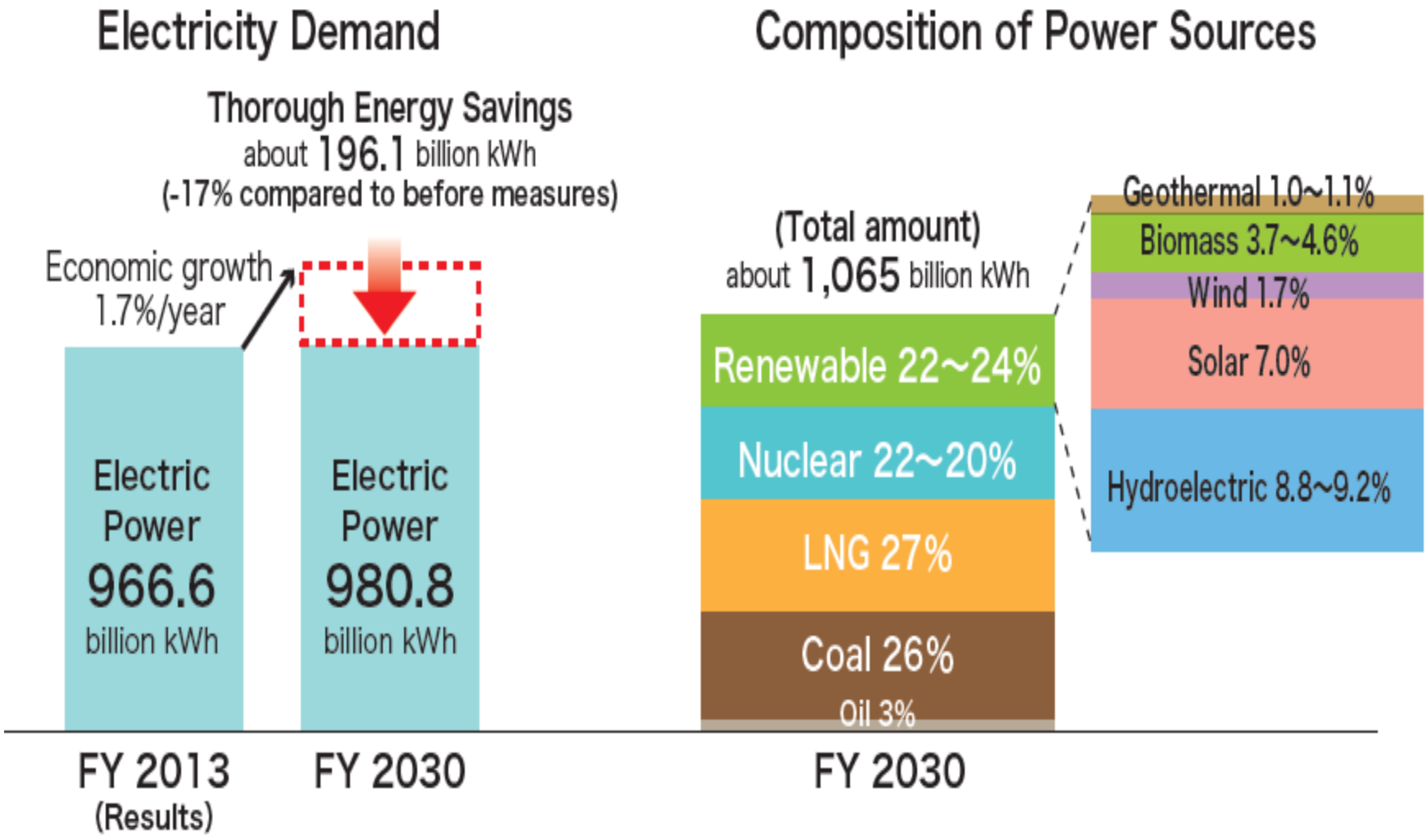
  From 2000-2015 GDP grew 1.12 times while energy consumption decreased 0.83 times.

Renewable energy

- As of 2015, the renewable energy ratio in generated electric power is 14.5%
- The feed in tariff scheme.



5. Future


Electricity Demand
Thorough Energy Savings
about 196.1 billion kWh
(-17% compared to before measures)
Economic growth
1.7%/year
Electric Power 966.6 billion kWh
Electric Power 980.8 billion kWh
FY 2013 (Results)
FY 2030
Composition of Power Sources
(Total amount)
about 1,065 billion kWh
Renewable 22~24%
Nuclear 22~20%
LNG 27%
Coal 26%
Oil 3%
Geothermal 1.0~1.1%
Biomass 3.7~4.6%
Wind 1.7%
Solar 7.0%
Hydroelectric 8.8~9.2%
FY 2030

EN 606: Energy, Economics and Environment

Australia : An Analysis of Energy Balance

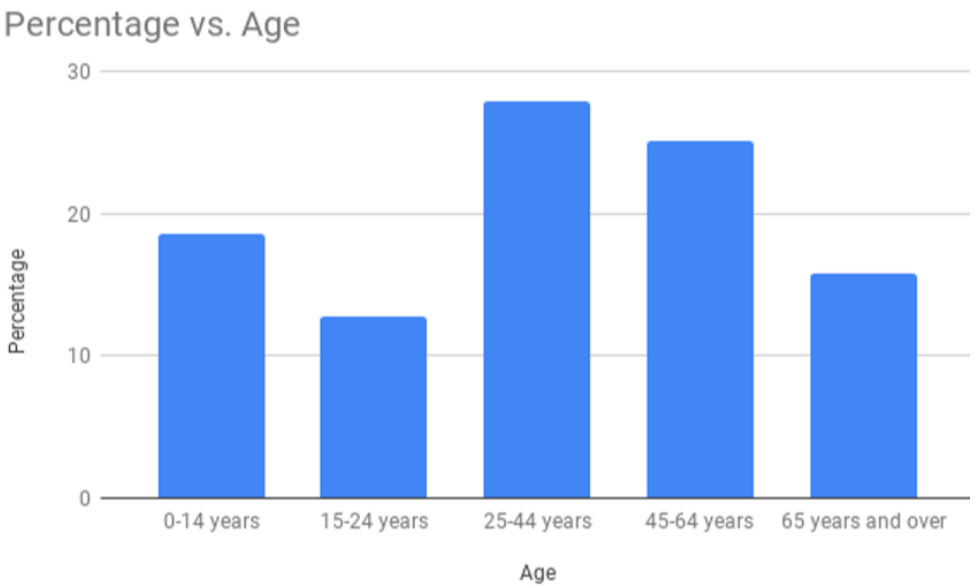
Presented By

Mr. Asokan S (194178002)
Mr. Nawaf A (18i170010)
Ms. Mamini Kumari Parida (194403001)

Department of Energy Science and Engineering
Indian Institute of Technology Bombay.

Date : 14 Aug 2019

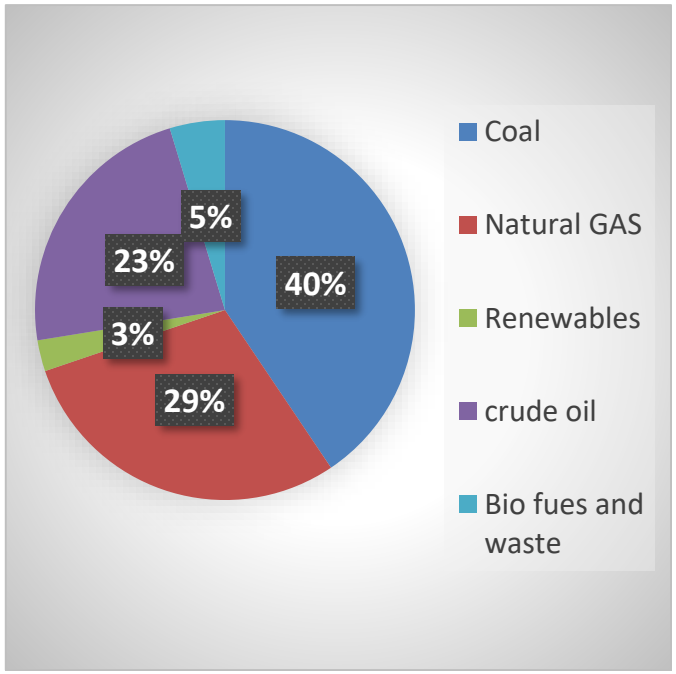
Demography & Economy1



Area	7.692 million km²
Population	25,458,100 (as of 8 Aug 2019)
GDP (billion 2010 USD)	1493
GDP PPP (billion 2010 USD)	1084
Life Expectancy	Men :75 Y, Women : 80 Y
Birth Rate	13.8 (per thousand people)
Literacy rate	99%

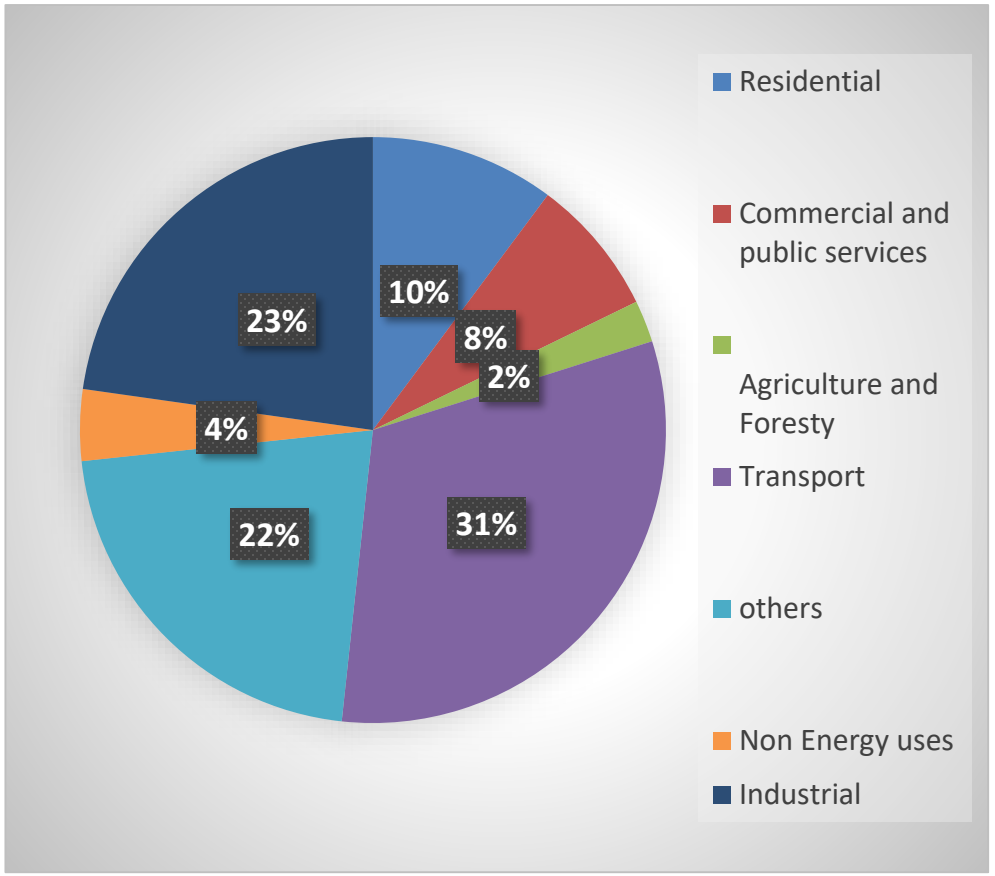
Energy Balance 2015

Primary Energy in PJ

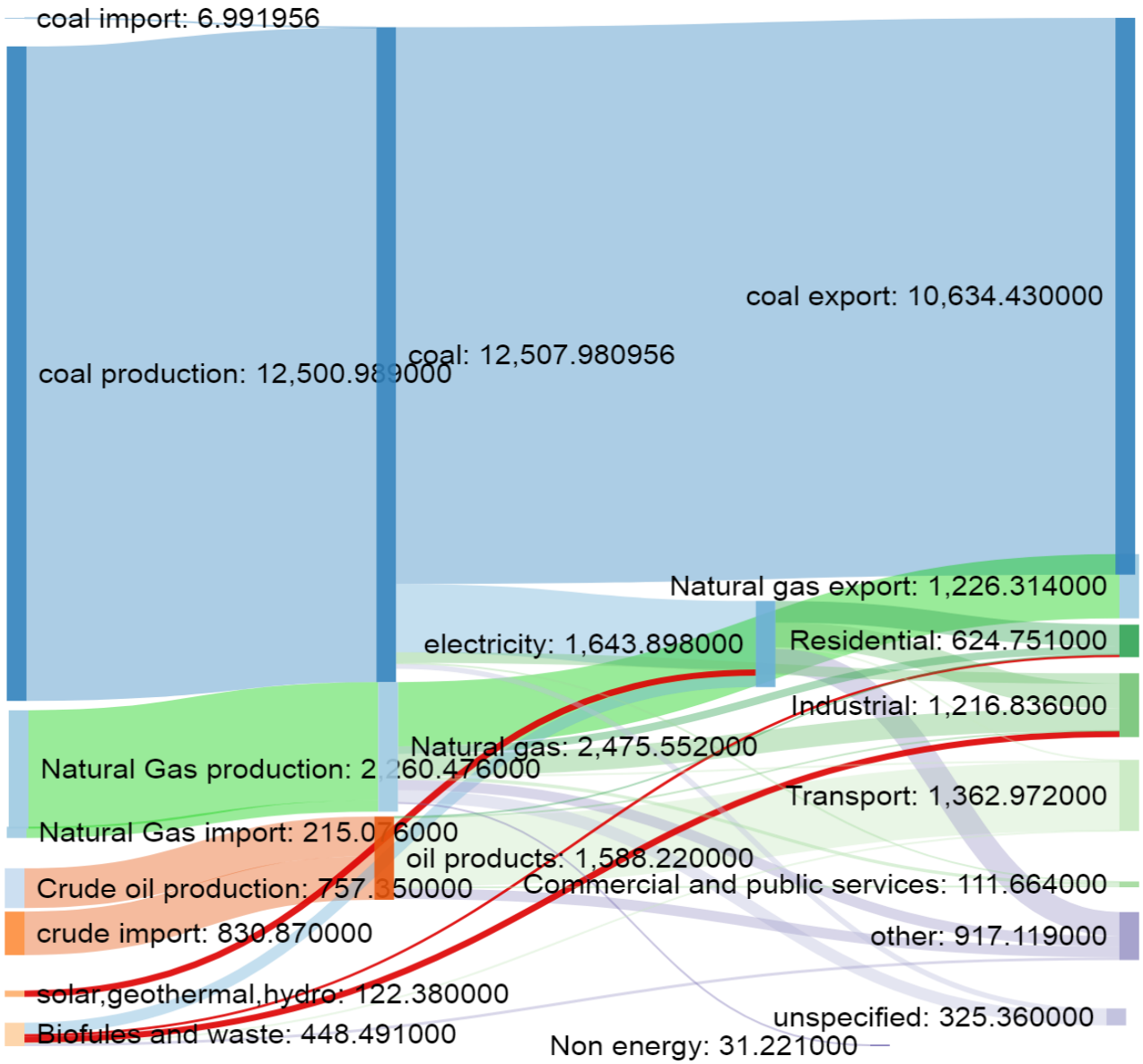


Coal	1873.551
Natural gas	1349.238
Crude oil	1055.45
Biofuels and waste	122.38
Total	***4617.328***

Sector wise usage



Sankey Diagram (2015)

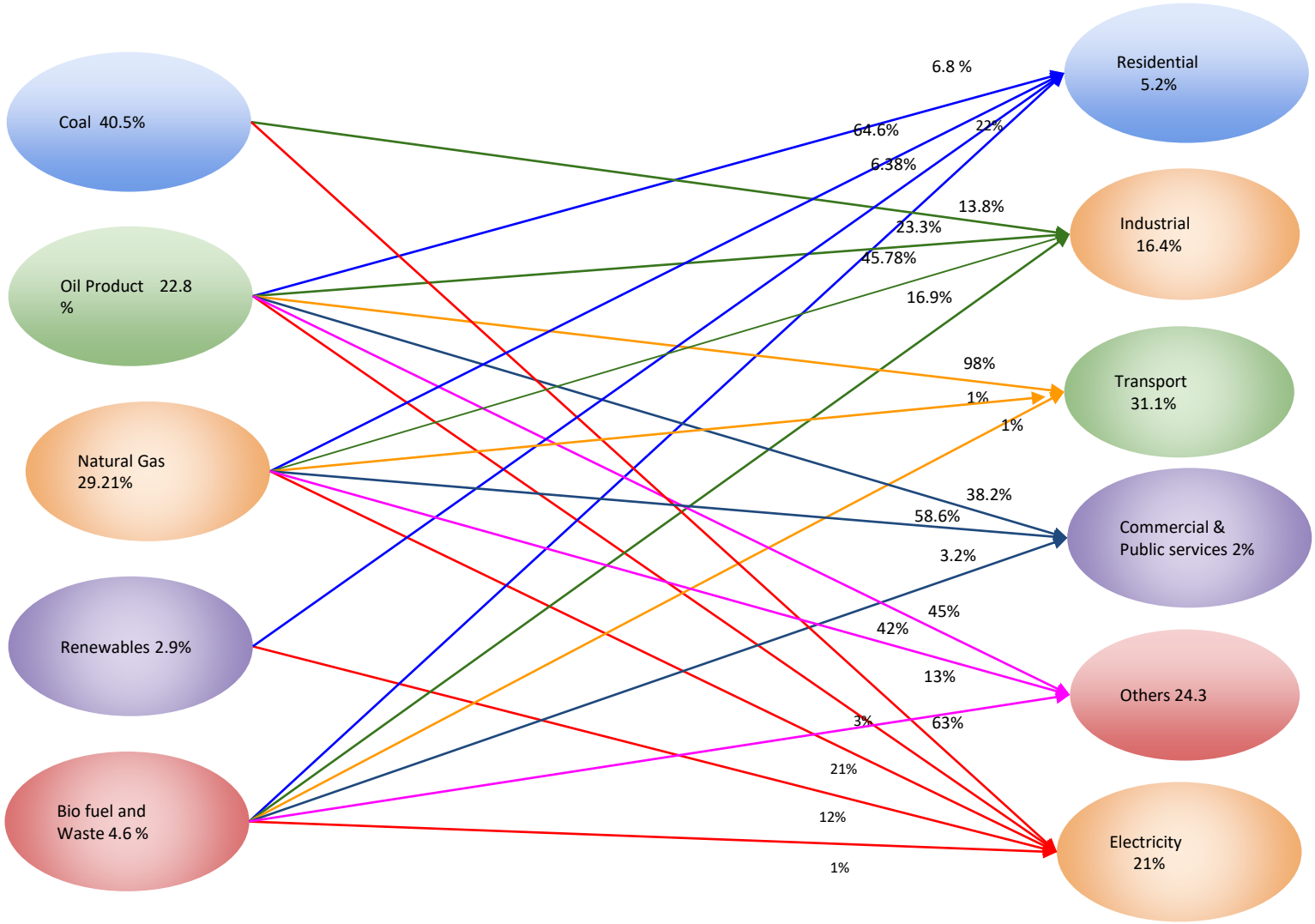


90+ % of Energy Supplied by Coal , Oil & Natural gas

63 % of electricity from Coal alone !

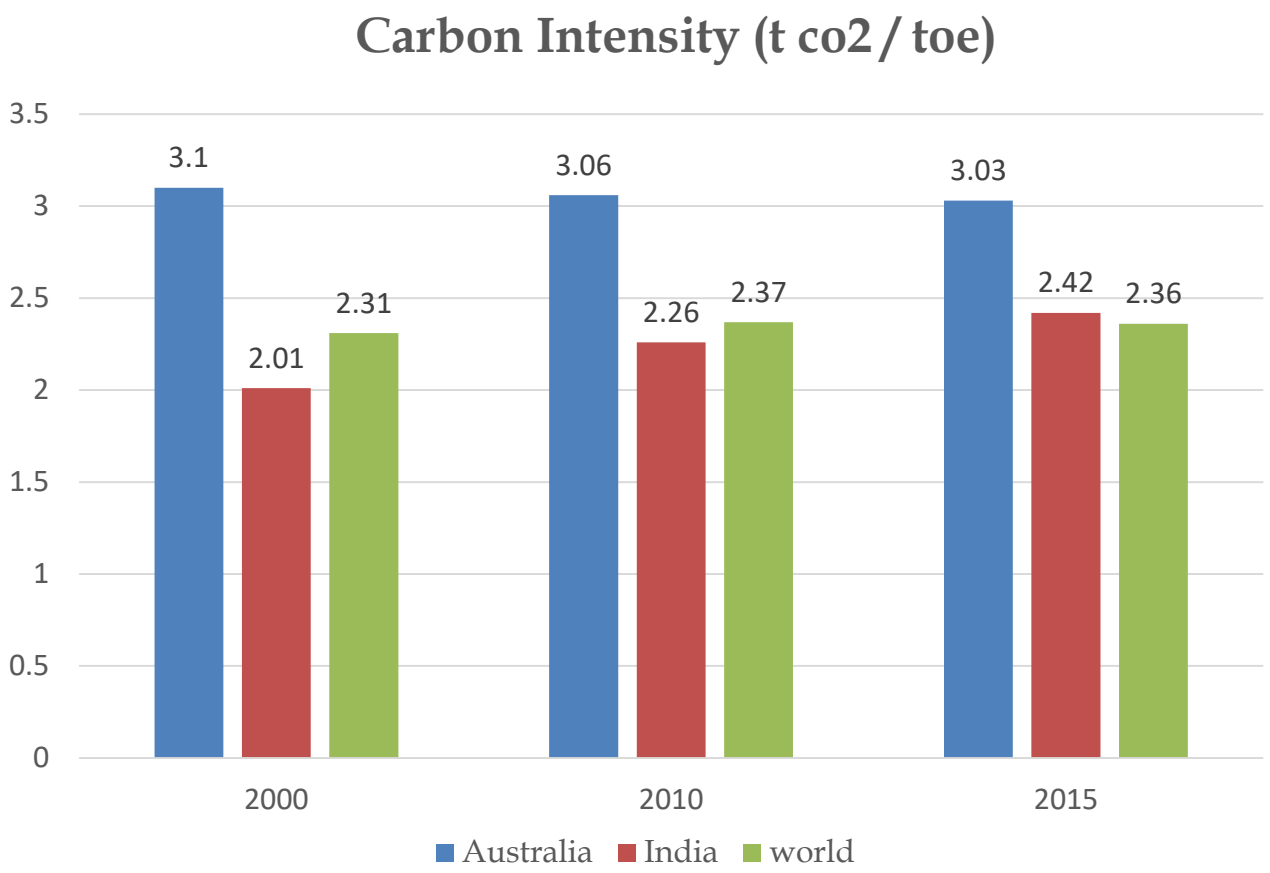
No significant contribution from Renewables

PECSS Diagram (2015)

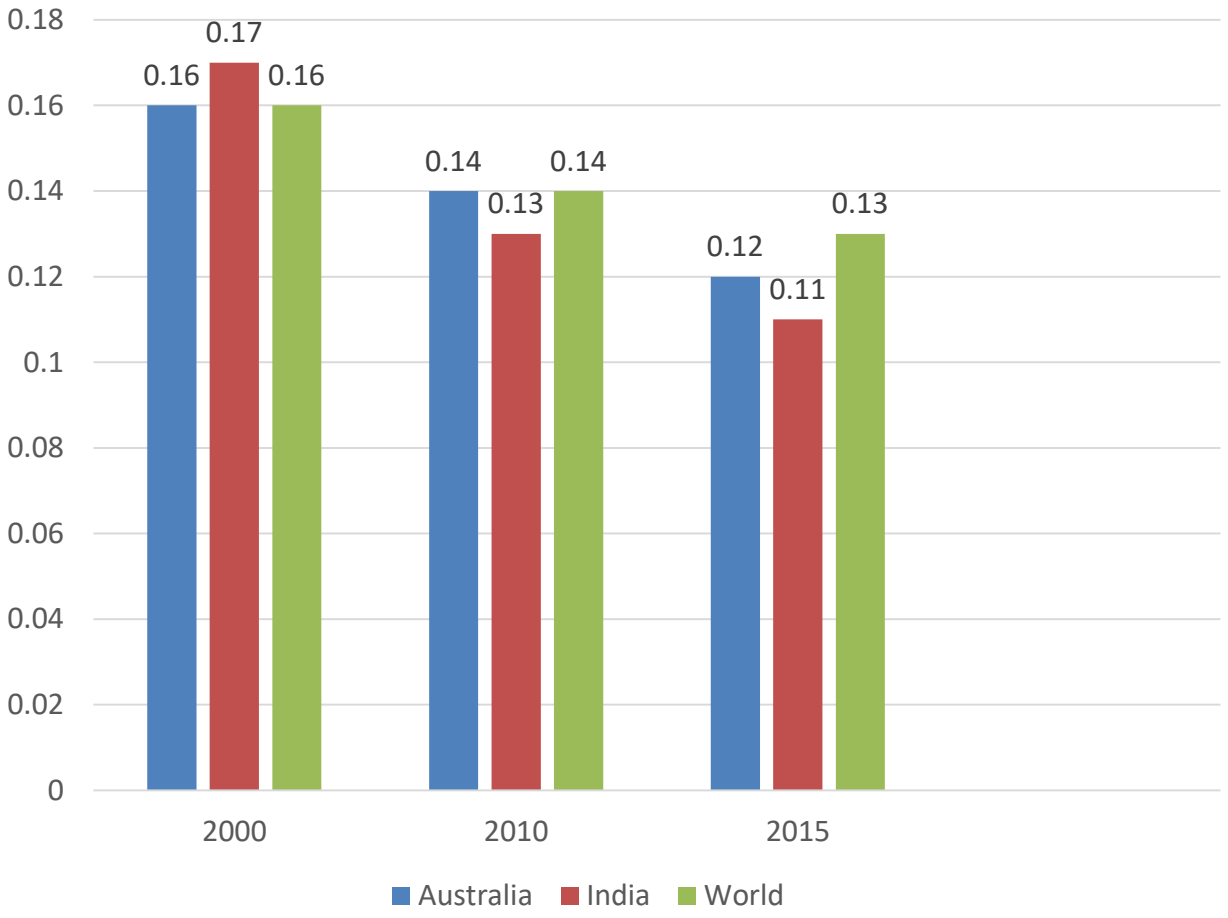


Kaya Identity

Total Carbon Emission = Carbon Intensity x Energy Intensity x GDP per Capita x Population



Energy Intensity (toe /thousand 2010 USD)



CAGR for various indicators

Indicator	2000 Value	2010 Value	2015 Value	Short term CAGR	Long term CAGR
Population (millions)	19	22	24	1.755	1.570
GDP (billion 2010 USD)	957	1297	1493	2.855	3.009
GDP PPP (billion 2010 USD)	695	942	1084	2.848	3.008
Primary Energy Production (Mtoe)	234	323	381	3.358	3.303
Net Energy Imports (Mtoe)	-127	-186	-250	6.093	4.619
TPES (Mtoe)	108	127	125	-0.317	0.979
Energy Consumption (TWh)	195	236	239	0.253	1.366
CO2 emissions (Mt)	335	389	379	-0.520	0.826
Per capita energy consumption (MWh/capita)	10	11	10	-1.888	0.000
Per capita CO2 emission	17	17	16	-1.205	-0.403

Significant energy policies and energy security of Australia

- 2005 lower emissions by 26-28% by 2030

- **Renewable energy policy** : The Renewable Energy Target (RET)

  Target : 33,000 GWh of electricity by 2020 from renewables

  (a) the Large-scale Renewable Energy Target (LRET)

  (b) The Small-scale Renewable Energy Scheme (SRES)

- Clean Energy Innovation Fund (CEIF) (launched in 2016)
- Clean Energy Finance Corporation(CEFC)
- Australian Renewable Energy Agency (ARENA)
- Individual initiatives by various state governments

- **Energy security**

significant energy security concerns: A*ffordable* and *secure energy supplies* due to numerous *power outages, rise in energy prices, a tightening gas market on the east coast .*

Energy bottlenecks:

- infrastructure
- needs to invest in added transmission of electricity, storage of energy,
- structured electricity infrastructure framework, working on reforms of the electricity market.
- Risks for livelihood of workers in coal power sector

Australia & India - mutual lessons to be learnt:

For India:

- **development of quality of life style.**
- The energy production was thrice the consumption in the last few years in Australia
- **Increase investments by $4 billion** but still **decrease overall wholesale cost by 5%; renewables** are expected **to almost double** by 2035.
- Electricity loss in India: 25% (242093 GWh) of electricity is lost , whereas in Australia it is 5% (12904 GWh)
- India should take measures to **reduce its electricity loss**.

For Australia

- To curb the huge amounts of **per capita CO2**, usage of renewables should be encouraged.
- **Diversification of fuel sources** to tackle the problem of growing dependence on oil product imports.
- **NITI Aayog's National Energy Policy (NEP)** focuses on two time period terms as near-term to 2022, medium-term to 2040
- Australia should work upon **structured long term policy plans** accounting for the management of emissions and sustainable energy production.
- The policy focuses on **decarbonization concept**
- India’s NDCs aim for 33-35 % by 2030 from that of 2005 levels; also it aims at installing 175 GW of renewable energy by 2022;
- Australia should **raise its NDCs.**

Conclusion

- Prolonged high usage of coal for production of electricity (near about 65%) increased the absolute as well as per capita emission of CO2 ;
- Australia should explore more cleaner energy alternatives
- shift from coal-based power generation to relatively more reliance on natural gas
- Emphasis on doubling renewable share
- Initiatives to be taken up for development of nuclear energy production
- Energy bottlenecks are to be taken care of

References

1. Ride, W. L, et. al., Encyclopedia Britannica Online version, “https://www.britannica.com/place/Australia/Economy”, Accessed : 9 Aug 2019
2. 2. International Energy Agency Database for Australia,“https://www.iea.org/statistics/?country=AUSTRALI&year=2015&category=Energy%20supply&indicator=TPESbySource&mode=table&dataTable=BALANCES”, Accessed : 7 Aug 2019.
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4. International Energy Agency Database for Australia “https://www.energy.gov.au/government-priorities/energy-data/australian-energy-statistics framework”, Accessed : 8 Aug 2019.
5. Power, “https://en.wikipedia.org/wiki/List_of_coal_fired_power_stations_in_Australia” , Accessed : 10 Aug 2019.
6. Renewable energy policy, “ https://www.aph.gov.au/About_Parliament/ Parliamentary_Departments/Parliamentary_Library/pubs/BriefingBook45p/ RenewableEnergy”, Accessed : 10 Aug 2019.
7. National Energy Policy,“ https://www.iea.org/policiesandmeasures/pams/india/ name-168042-en.php”, Accessed : 10 Aug 2019.
8. Energy bottlenecks, “ https://www.theguardian.com/australia-news/2019/feb/19/renewables-urgent-investment-australia-transmission-bottlenecks”, Accessed : 10 Aug 2019.
9. Global Energy Statistical, “ https://yearbook.enerdata.net/co2-fuel-combustion/CO2-emissions-data-from-fuel-combustion.html, Accessed : 10 Aug 2019.

THANK YOU

Q & As

- **Why there is no nuclear power in Australia despite being largest source of Uranium ?**

- Only real driver- reduction of CO2 emissions, or costs arising from that
- Risky, expensive and not a fast enough solution to climate change
- several legal hurdles: NSW's Uranium Mining and Nuclear Facilities (Prohibition) Act 1986, Victoria's Nuclear Activities (Prohibitions) Act 1983, Environment Protection and Biodiversity Conservation Act 1999 and Australian Radiation Protection and Nuclear Safety Act 1988 will need to be amended to remove prohibitions against effective regulation of nuclear power

- **How big a hurdle is democracy for Australia's energy solutions?**

- 3- tier govt. system (commonwealth, state, local)
- Challenges for local govt.- financial constraint, Current pricing and regulation of energy market, perception that RE projects are outside the traditional and core service of local govt.
- Current party in power is promoting coal based industries so as to produce cheaper power
- Economy is given more priority: labor – environment; coalition- about pricing
- Carbon tax repealed by Abott govt. (2014)

- **CO2 emission in Australia is quite high, what are the coming policies and methods in order to curb this problem?**

- Emission Reduction Fund (ERF), major one now- proving incentives
- Encouraging renewable energy
- Improving fuel efficiency, setting fuel emission standards in transport sector etc.
- Shifting from coal to natural gas to lower carbon footprint

Mexico and Energy: An Overview

EN-606

Mock-UN 2019

Presented By:

Group: 03

Neha Durga (194467001), Ravi Kumar (18I170013), Vijay Shankar (184170006)

Department of Energy Science and Engineering,
Indian Institute of Technology, Bombay
Powai Mumbai-400076

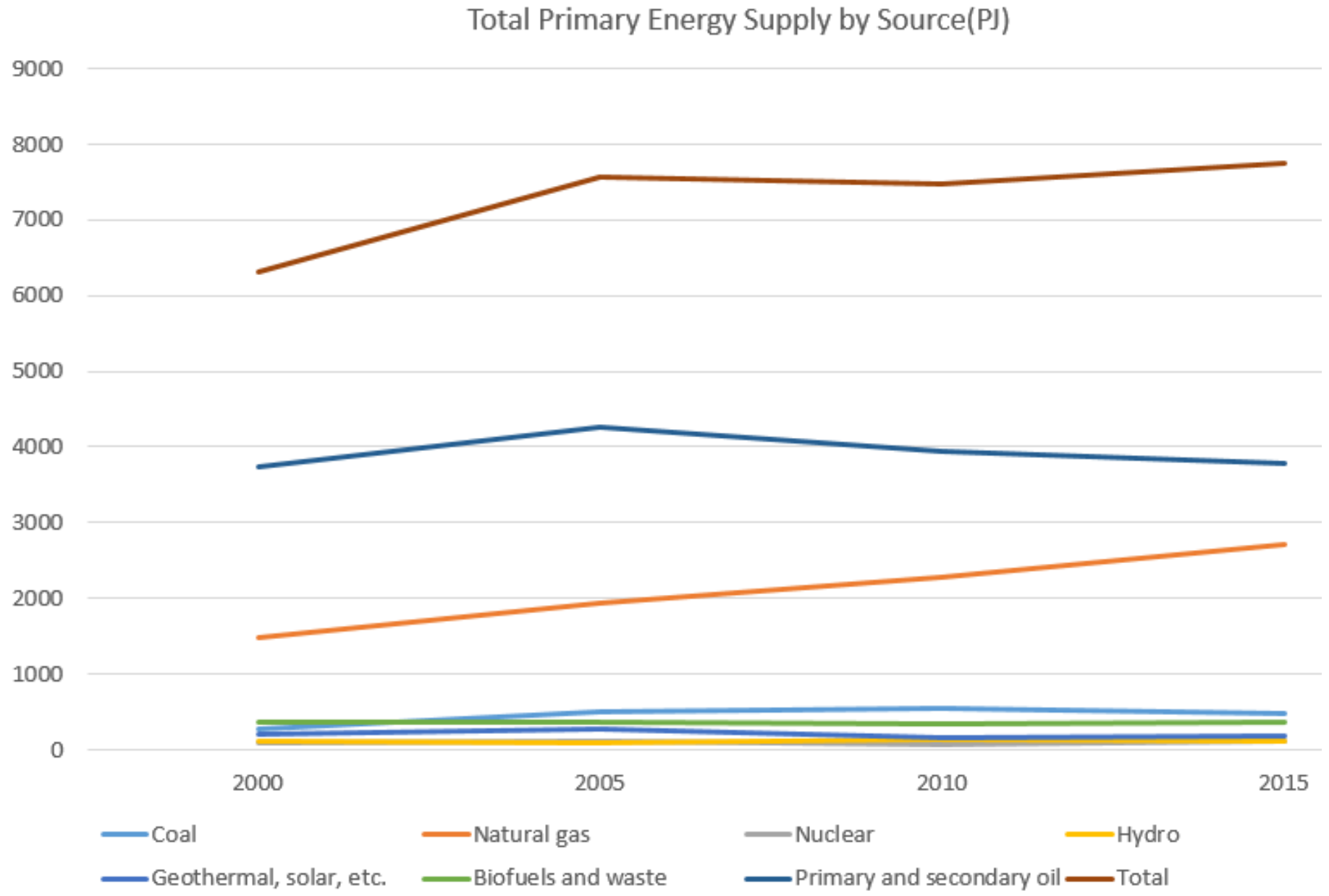
We are more than just *"Burrito and Tortilla"*

- United Mexican State
- 13th largest independent state
- 2 million sq-km and population of 128.6 million people
- We are a young and *'newly industrialized'* country

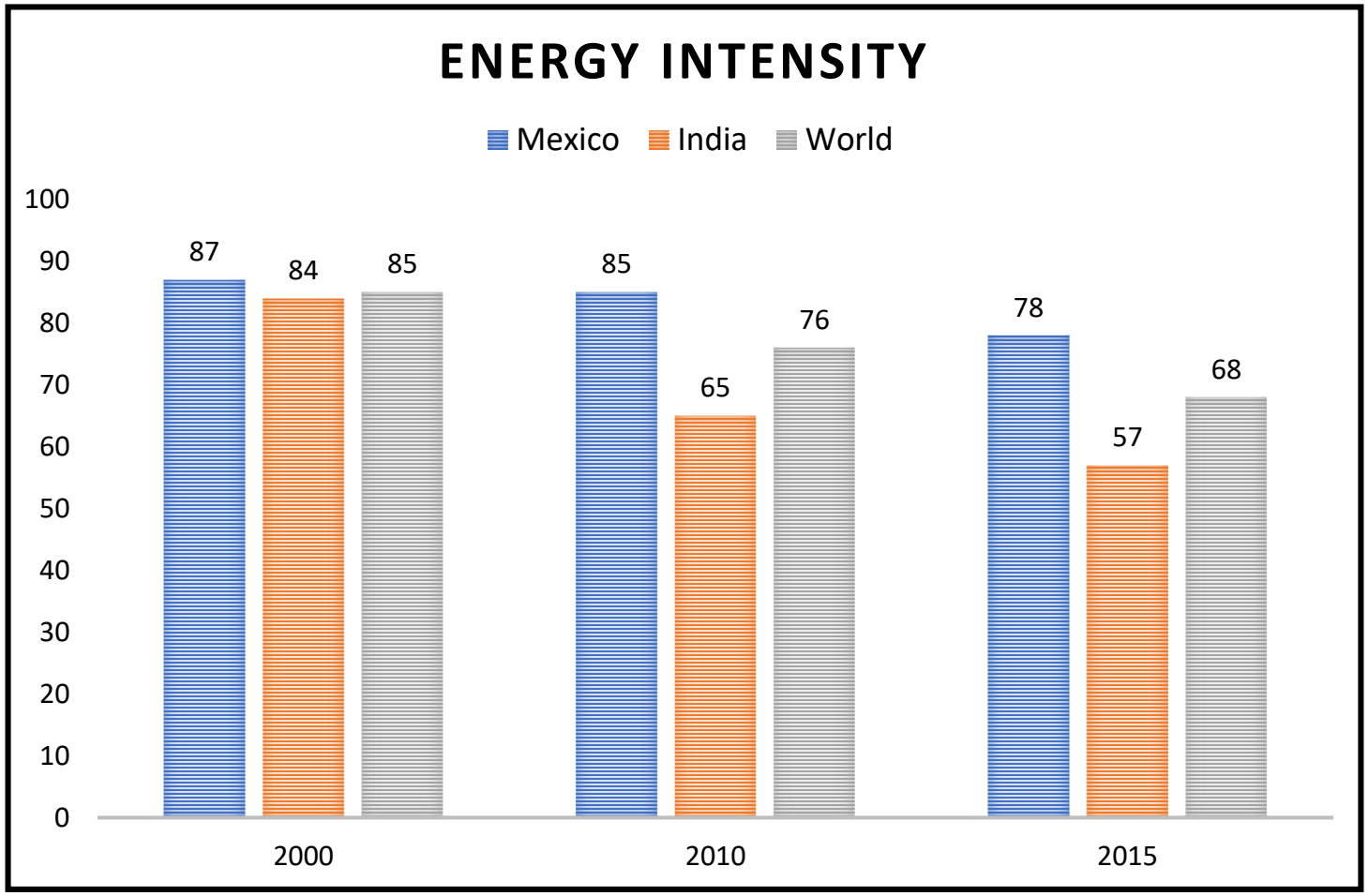
Economy and Energy

- Service sector
- Human Development Index Rank: 74
- Installed generation capacity: 68 GW(2015)
- oil (46%) and natural gas(40 %)

	2000	2010	2015	CAGR(2000-2015)	CAGR(2010-2015)
Population(million)	100.9	114.3	121	1.22	1.15
TPES(PJ)	6311.517	7478.546	7743.319	1.37	0.70
Import of Energy(ktoe)	25706	47984	70673	6.97	8.05
Export of Energy(ktoe)	98046	88337	72235	-2.02	-3.94
CO_2 emission(million tonnes)	359.6	440.3	442.3	1.39	0.09
Installed power (GW)	40.98	52.86	67.54	3.39	5.02
GDP(PPP)(Billion US $)	1432.5	1730.2	1990.2	2.22	2.84
GDP per capita(US $)	14197.22	15137.36	16447.93	0.99	1.67
Emission per capita(tonnes per capita)	3.563925	3.852143	3.655372	0.17	-1.04
Carbon Intensity (tonnes/TJ)	56.97	58.87	57.12	0.02	-0.60
Energy Intensity(MJ/US $)	4.405946	4.322359	3.890724	-0.83	-2.08



Source: www.iea.org



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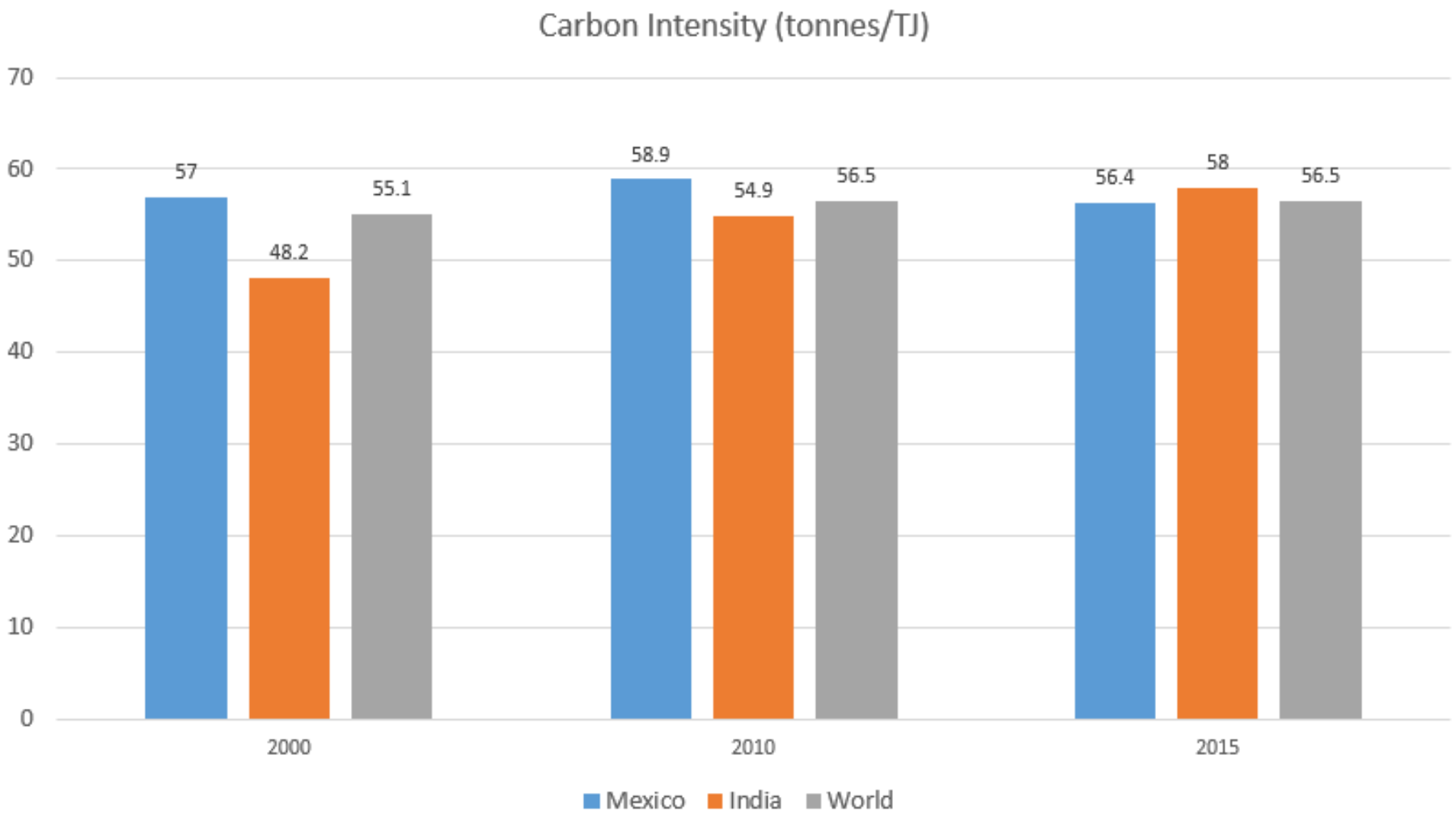


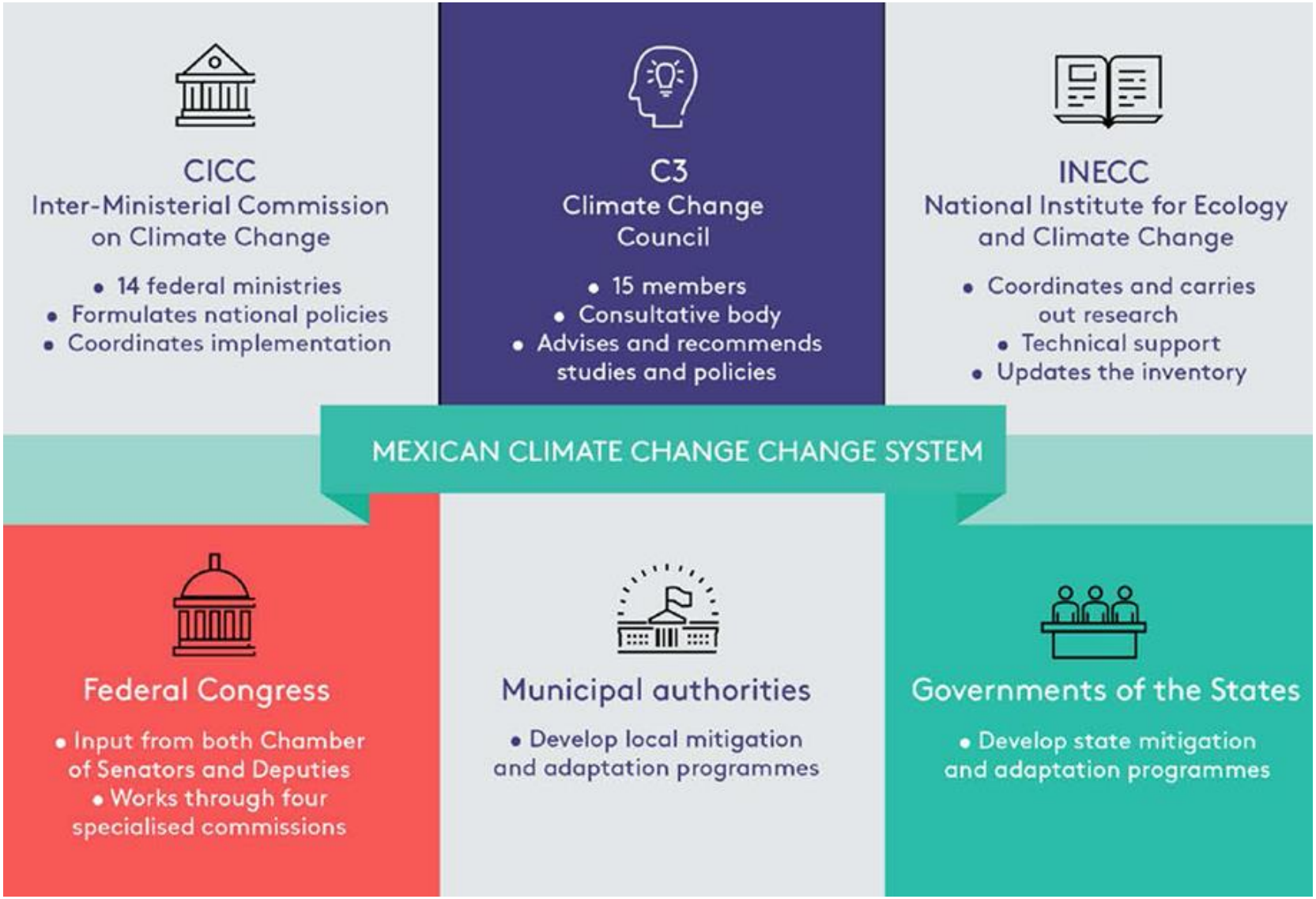
https://www.iea.org/media/statistics/CO2Highlights.XLS

Greening Mexico and World

- We have been negotiating for a better world and have played an active role in the last 25 years to advance the agenda

- We were the first in the oil producing world to frame a national law in 2012 to tackle climate change

General Law on Climate Change in 2012



Source: The Grantham Research Institute on Climate Chang, LSE 2018