

EN 410

Energy Management

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Course Outline

General Aspects of Energy Management and Energy Audit

- Energy scenario
- Energy audit
- Monitoring and targeting
- Economics
- Energy Billing

Energy Efficiency and Energy Performance Assessment of

Electrical Utilities

- Electrical systems
- Electricity distribution
- Motors and drives

Energy Efficiency and Energy Performance Assessment of Thermal

Utilities

- Boilers
 - Steam distribution system
 - Furnaces
 - Insulation
 - Waste heat recovery
 - Heat exchangers and their networks
 - Cogeneration
 - Compressed air systems
 - Refrigeration and air conditioning systems
 - Pumps
 - Fans
-Many more (environment, PAT Scheme)

Course Pre-requisites

- Thermodynamics
- Heat transfer
- Fluid mechanics

Energy and Civilization

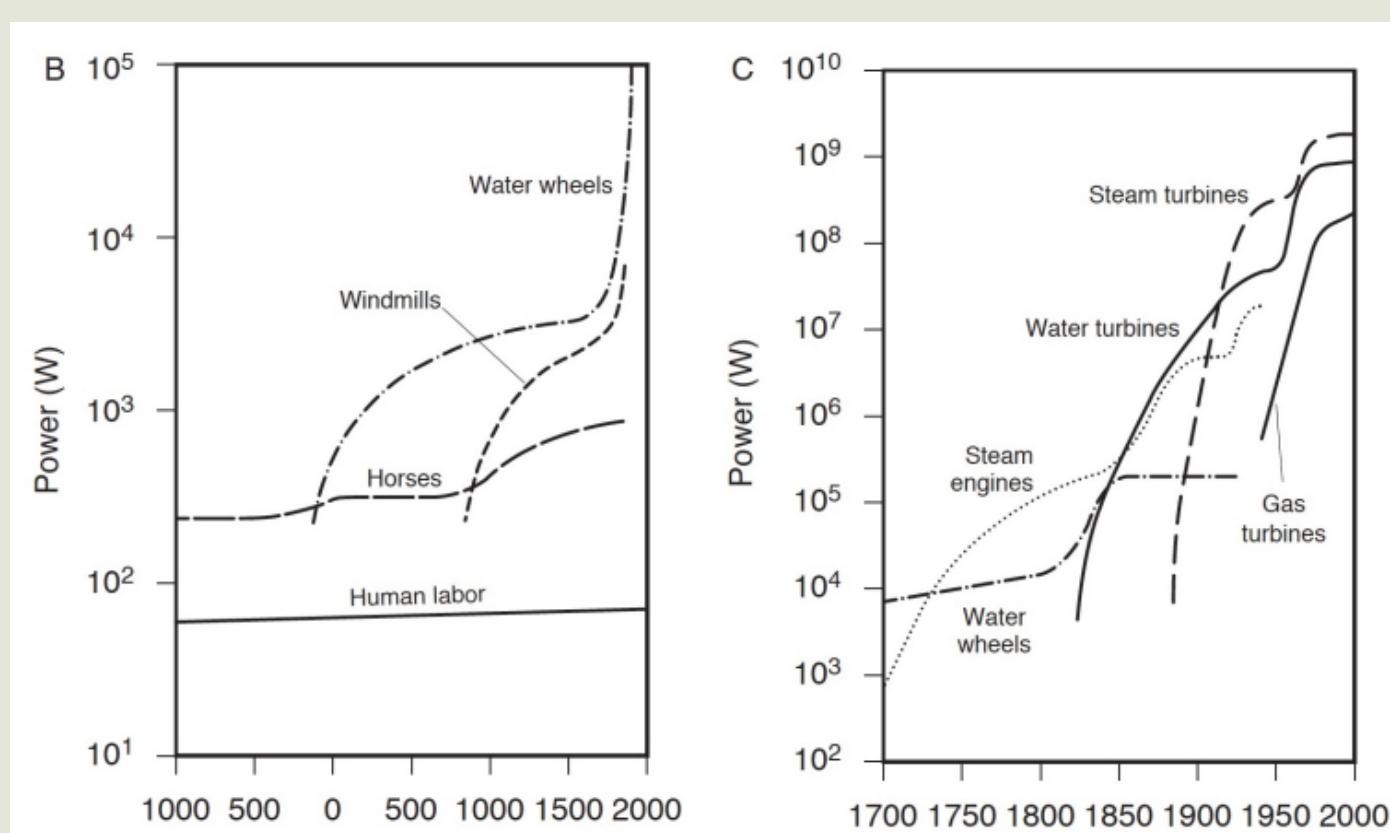
Humans branched off from the other species roughly 200,000 years ago

About 5,000 years ago, humans began to build cities, to store food and use

About 1,500 years ago humans used tools to civilize less-hospitable areas

About 300 years ago we began to build machines to do real work

About 200 years ago, we began to extract energy rich sources from the earth



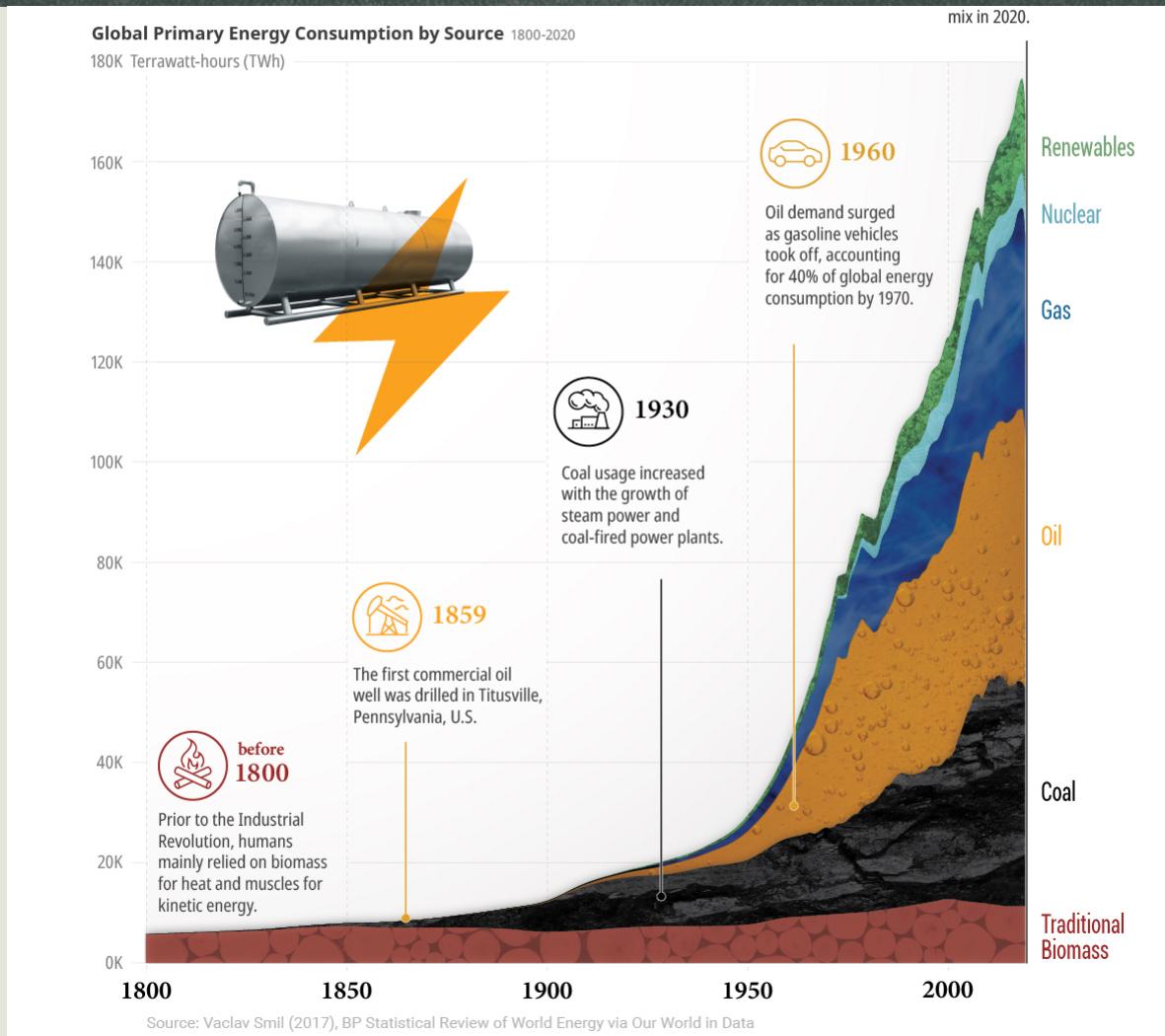
Types

- Primary/secondary energy
- Renewable/non-renewable energy
- Commercial/non-commercial energy

Energy Sources

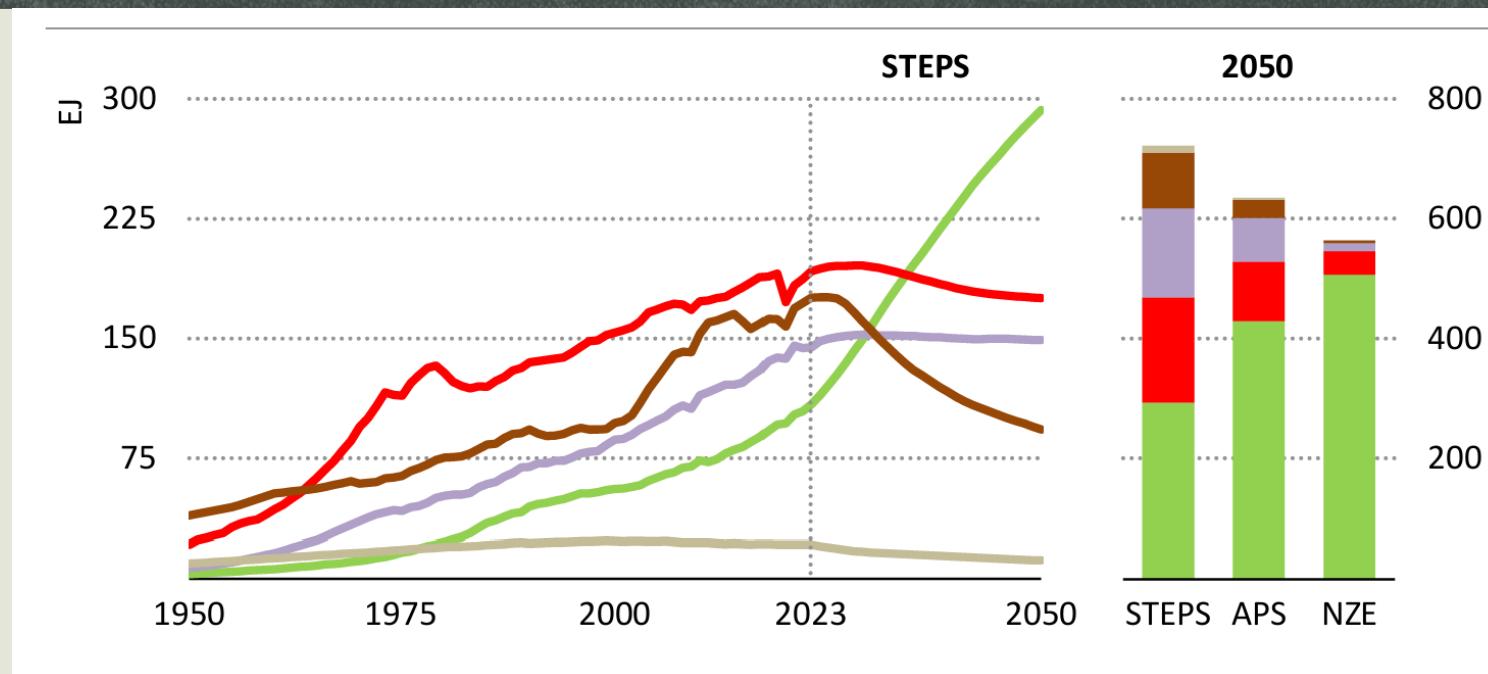
- Coal
- Oil
- Natural Gas
- Nuclear
- Biomass
- Renewable
 - Reserve to production ratio
 - The tonne of oil equivalent (toe) is a unit of energy defined as the amount of energy (41868 MJ) released by burning one tonne of crude oil.

Energy Transition



- Fossil fuel accounts for 60 to 80% in 2020

Global Energy Demand and Sources

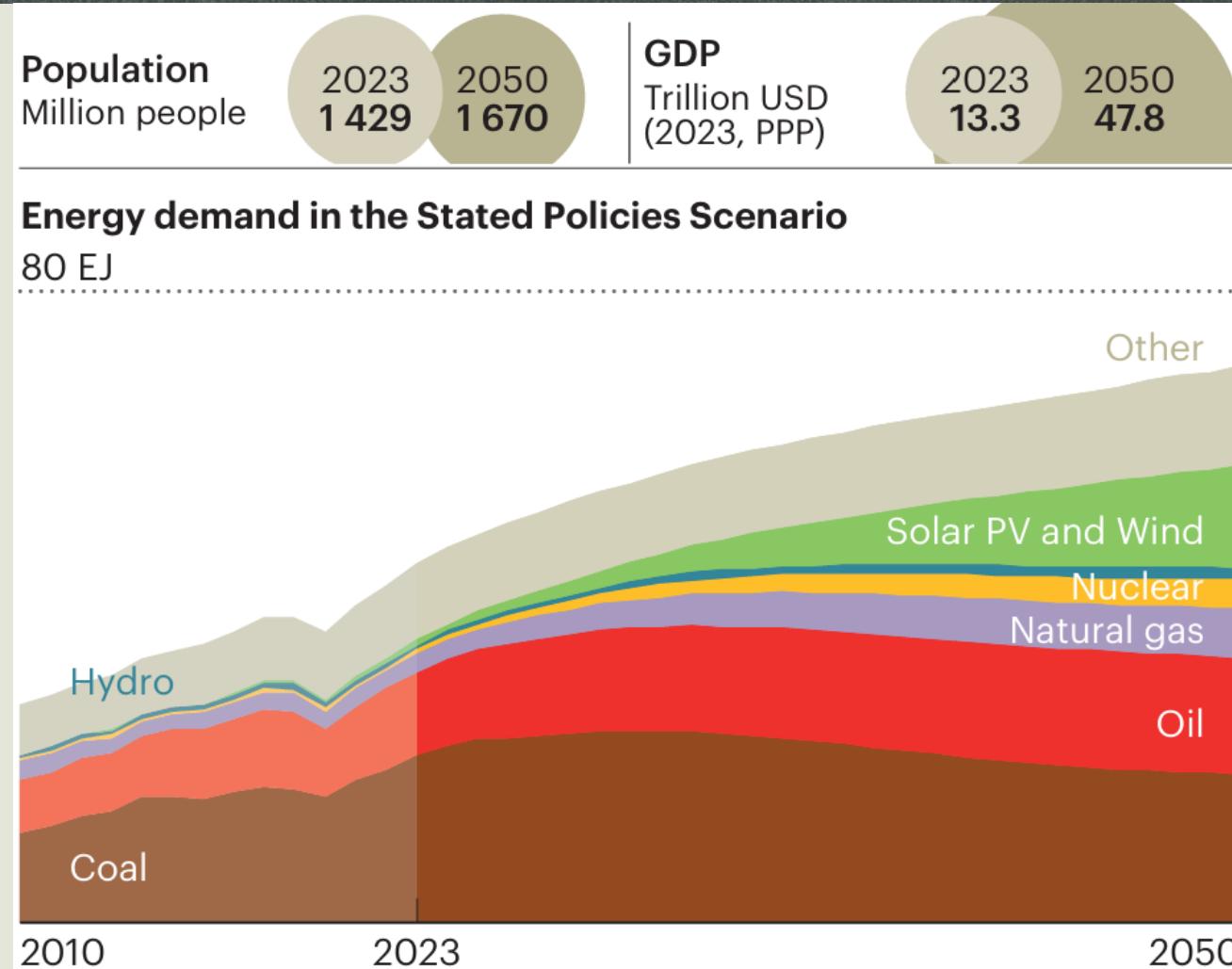


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STEPS, a scenario based on current policy settings, sees clean energy poised for huge growth, while coal, oil and natural gas each reach a peak by 2030 and then start to decline

Notes: EJ = exajoules; STEPS = Stated Policies Scenario; APS = Announced Pledges Scenario; NZE = Net Zero Emissions by 2050 Scenario. Oil, coal and natural gas refer to unabated uses as well as non-energy use. Clean energy includes renewables, modern bioenergy, nuclear, abated fossil fuels, low-emissions hydrogen and hydrogen-based fuels. Other includes traditional use of biomass and non-renewable waste.

India's Energy Demand



2070

Net zero emissions target

50%

Share of total power generation capacity targeted to be non-fossil by 2030

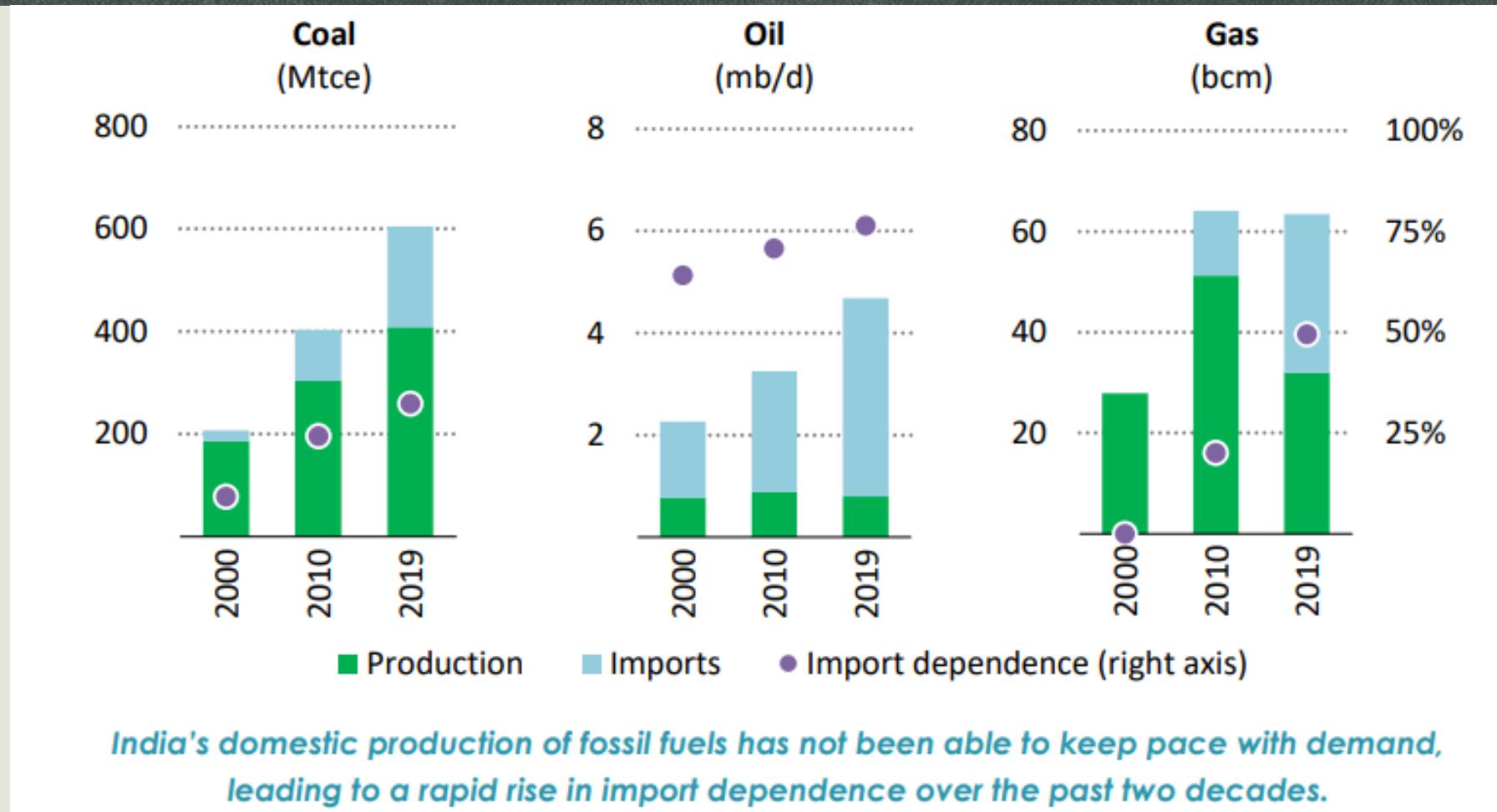
8.2 Billion USD

Earmarked for subsidies under the Production Linked Incentives (PLI) Scheme for low-carbon vehicles, solar PV and battery sectors

20 750 ckm

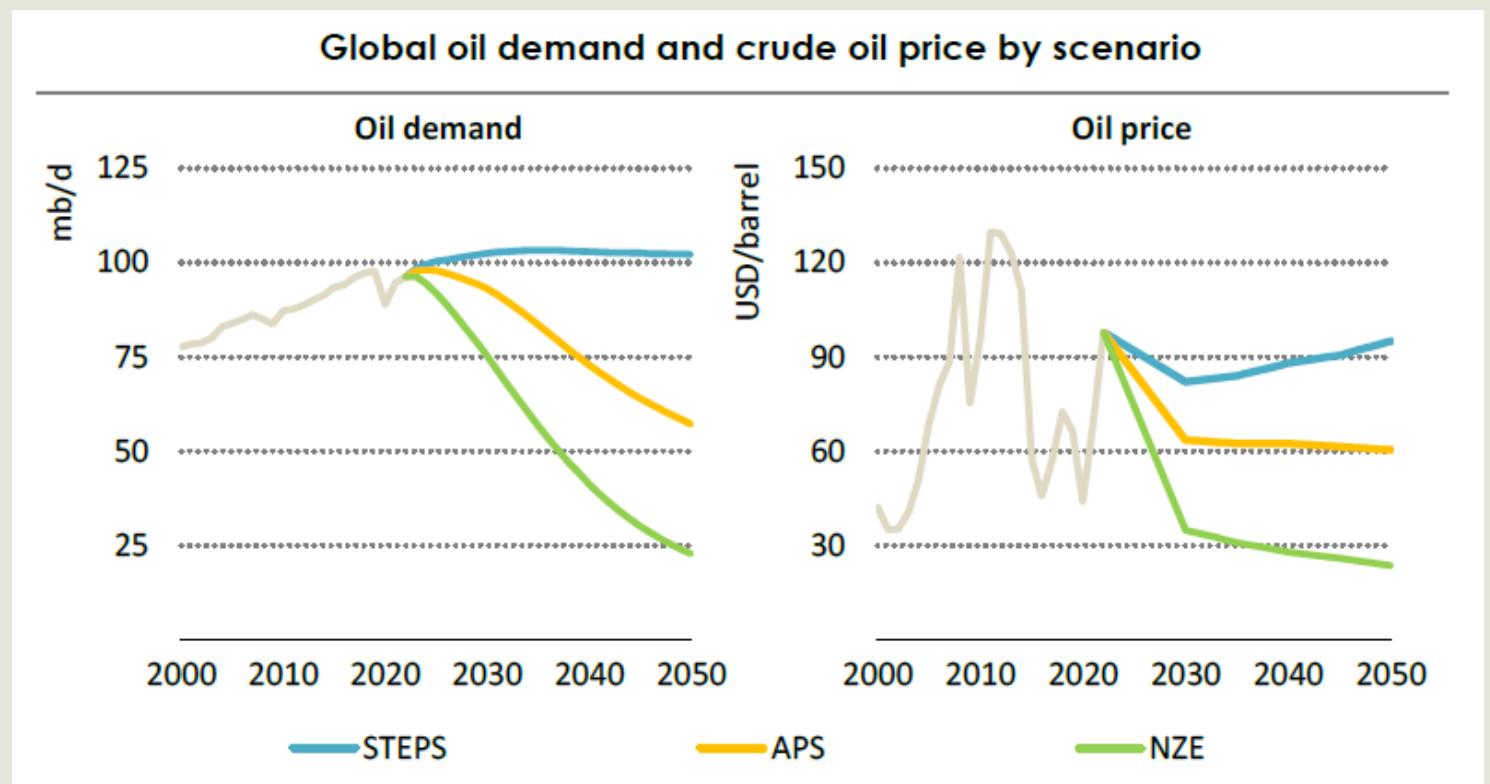
Intra-state Green Energy Corridor electricity transmission lines completed or planned to be completed by 2026.
ckm = circuit kilometres.

India's Fuel Scenario

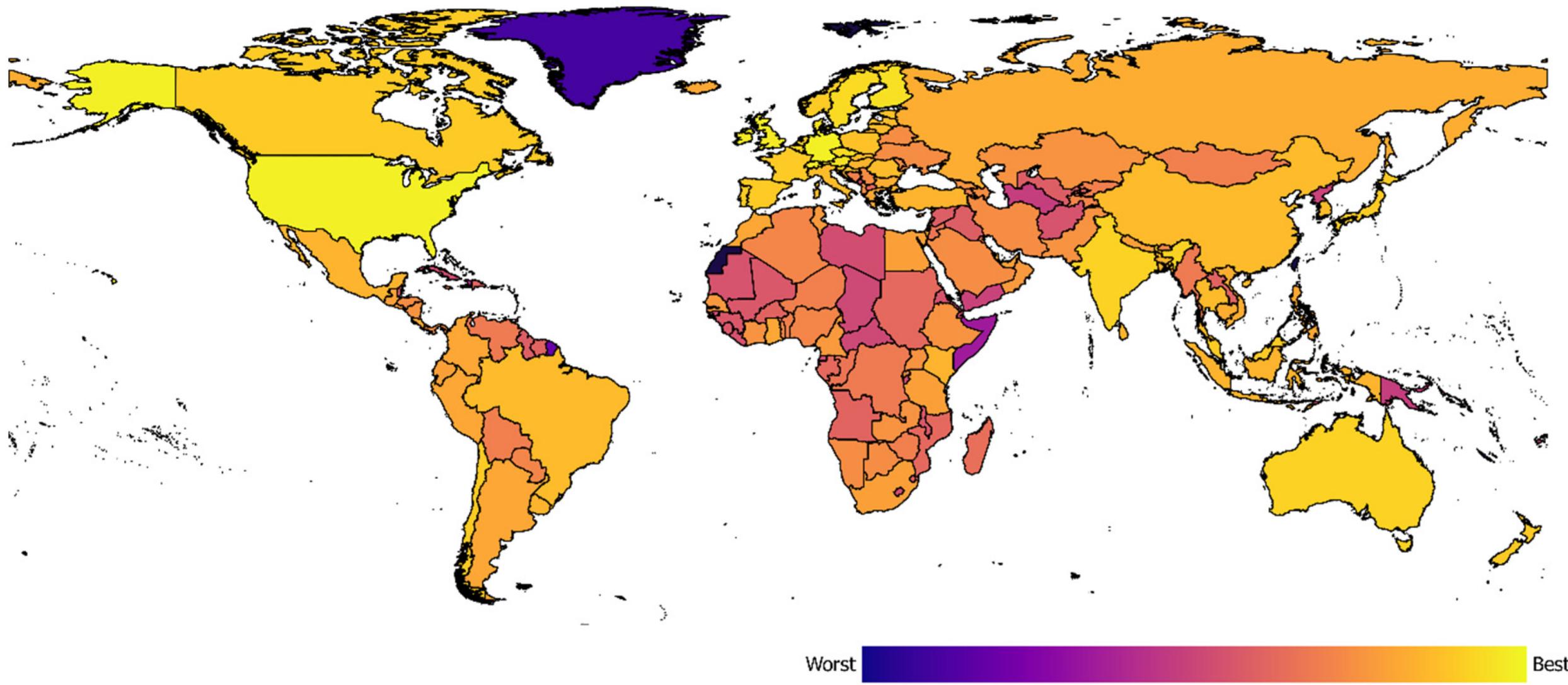


Energy Security

- Continuous availability of energy in various forms in sufficient quantity at reasonable prices
- Not depend on one fuel as well as country for import



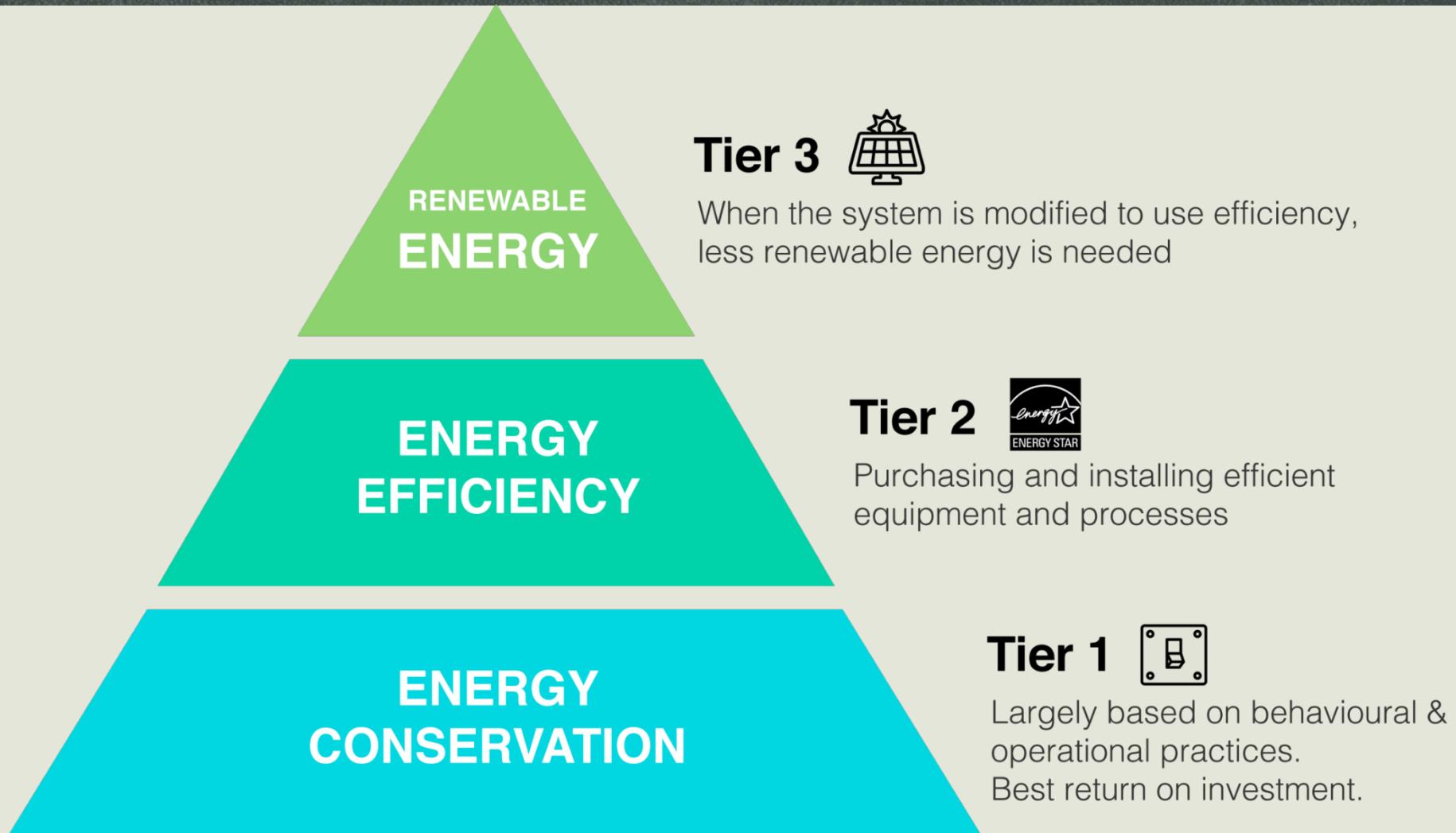
Energy Security



How to improve the energy security

- Reducing the energy requirements
- Diversifying the energy supply sources
- Substituting imported energy resources with domestic alternatives
- Expanding energy resources and developing alternative energy resources

Energy Pyramid



Energy Management

Objective

The judicious and effective use of energy to maximize profits (minimize costs) and enhance competitive positions

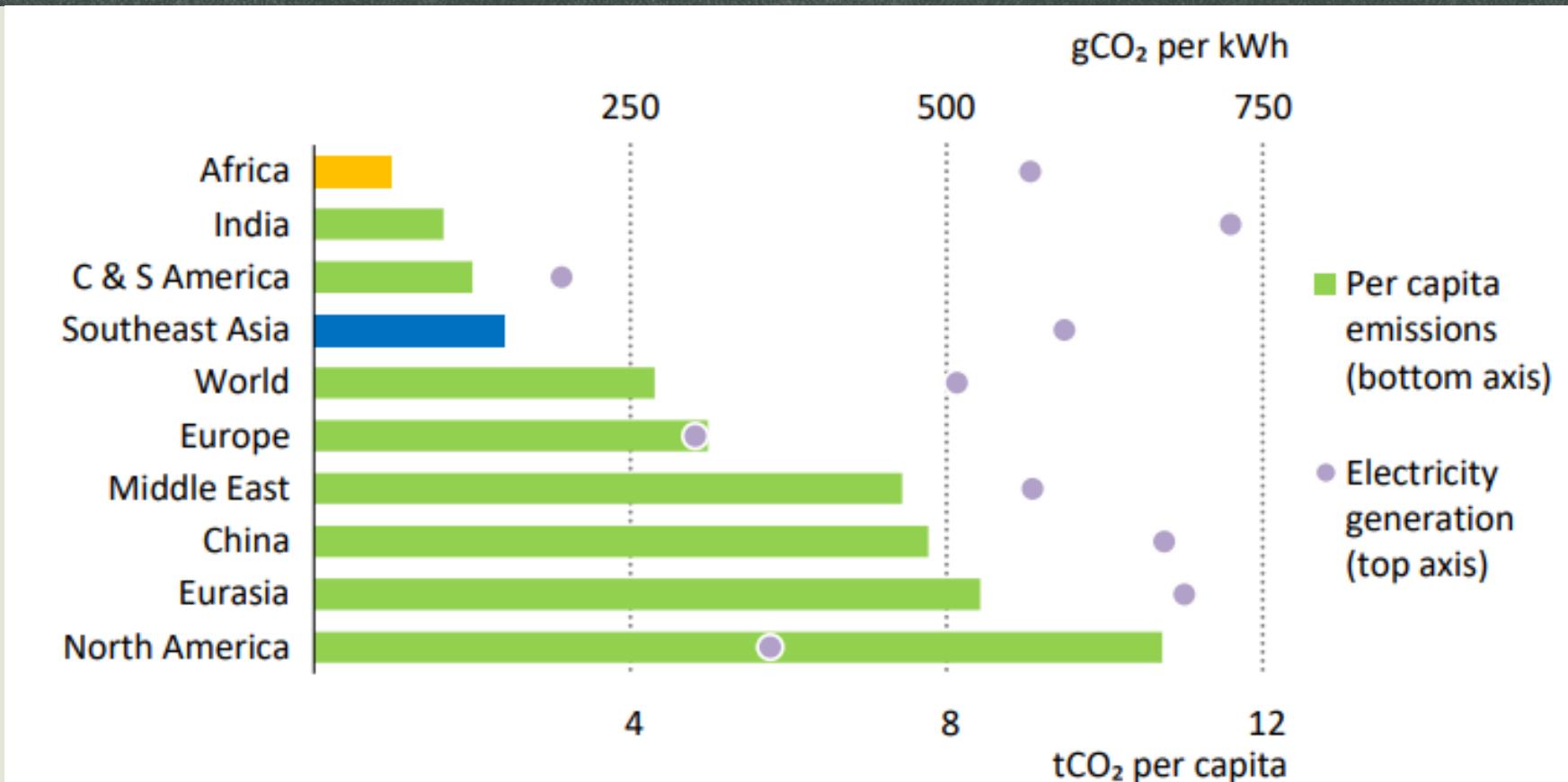
Sub-objectives

- Improving the energy efficiency and reduce the energy use
- Reduce the green house gases and improving air quality
- Improving the national energy security index
- Reduce the impact of brownouts or interruption in supplies

Why Energy Management

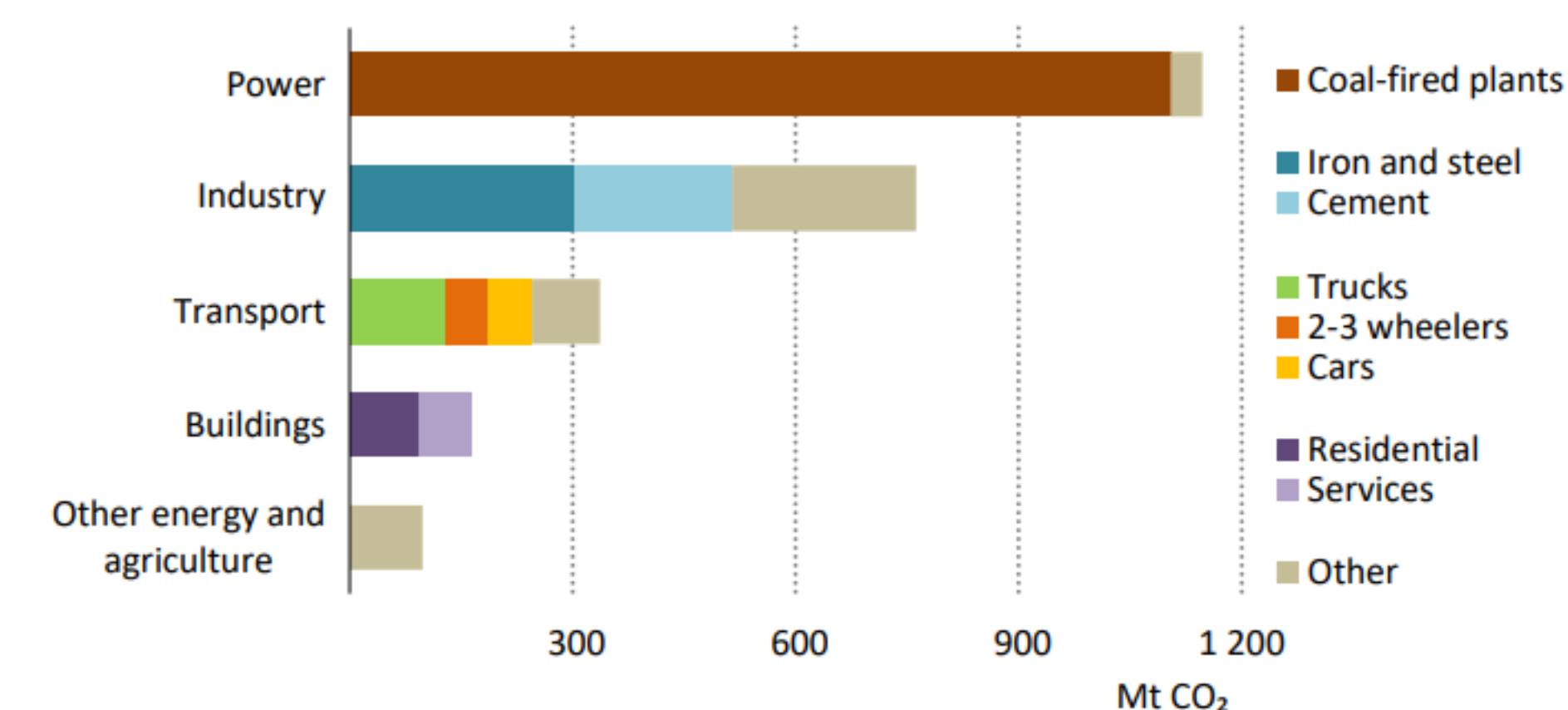
- Present consumption pattern predominantly fossil fuel based
- Limited fossil reserves
- Adverse environmental impacts
- *Renewables – In general not yet cost-effective*
- *Gestation period for new power plants*
- *Capital cost requirement for new capacity.....*

India's CO₂ Emission



India's per capita CO₂ emissions are 60% lower than the global average, but the emissions intensity of its electricity generation is among the highest of any country.

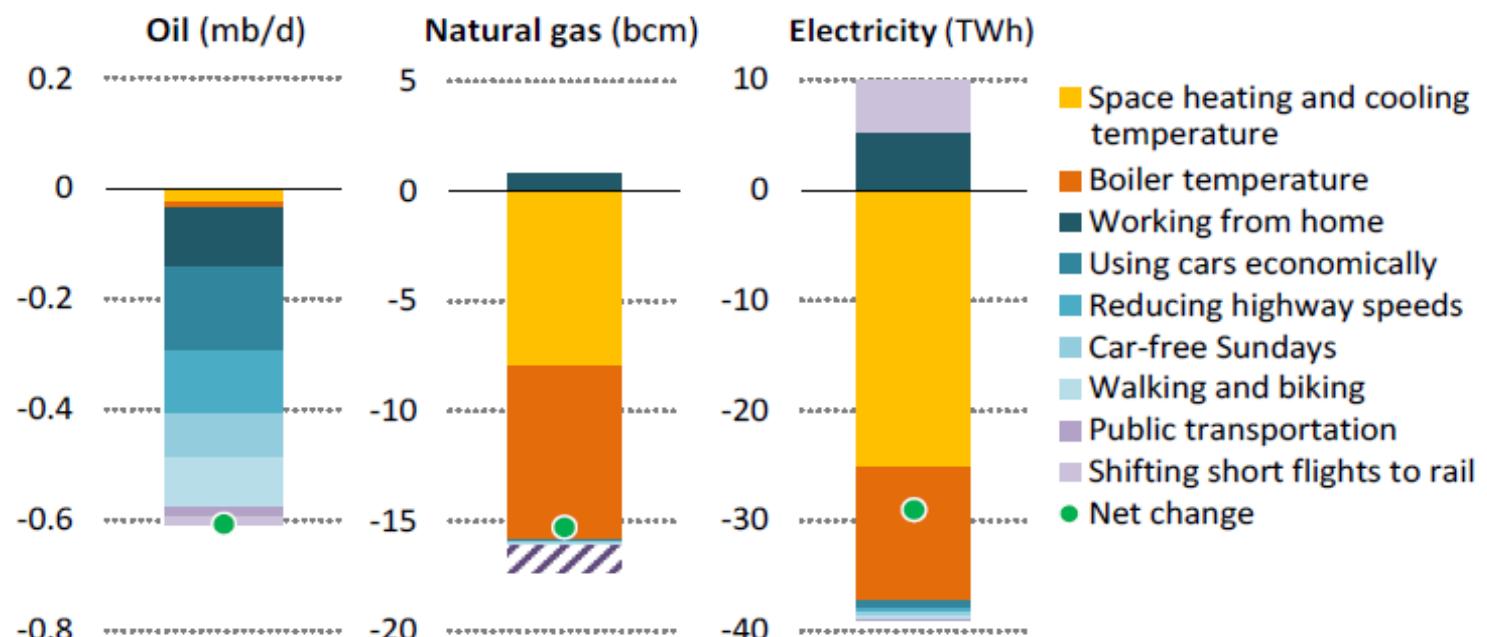
India's CO₂ Emission



India's power sector is the largest contributor to its CO₂ emissions, and coal-fired power plants are responsible for the great majority of power sector emissions.

Energy Conservation

Oil, natural gas and electricity demand reductions from EU citizen actions based on the *Playing My Part* recommendations

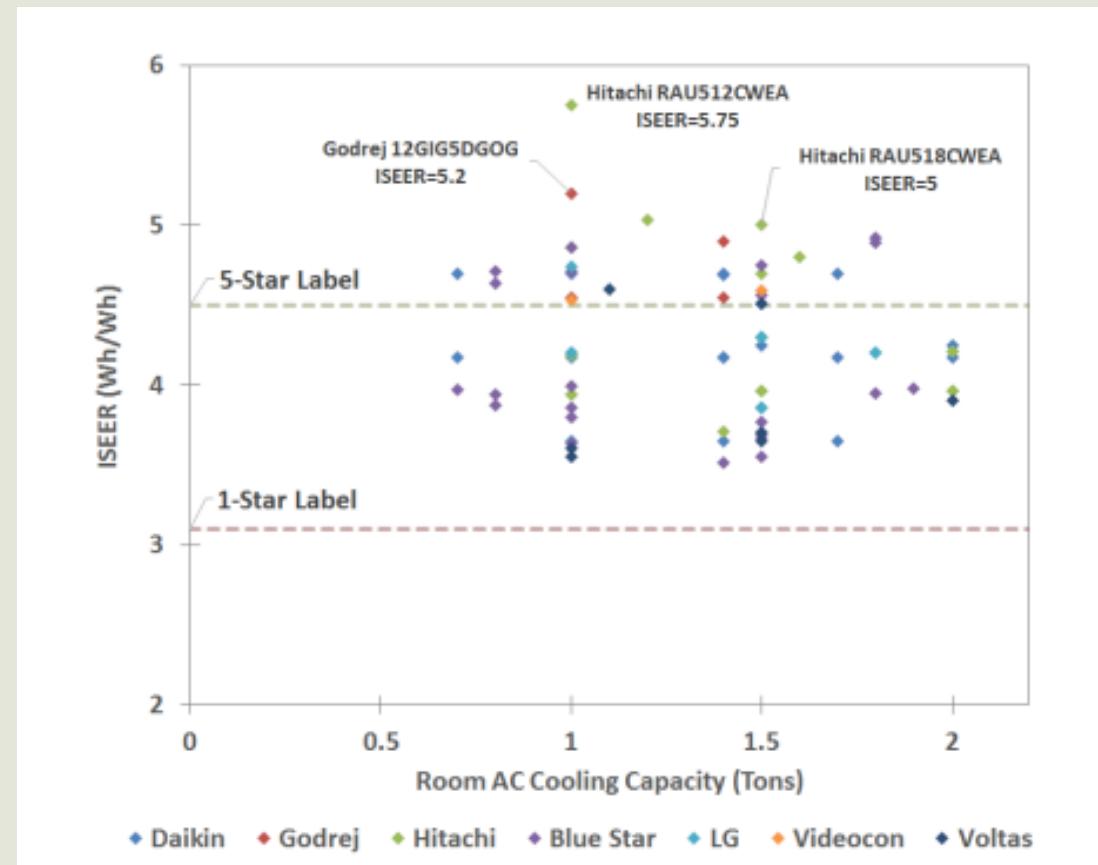
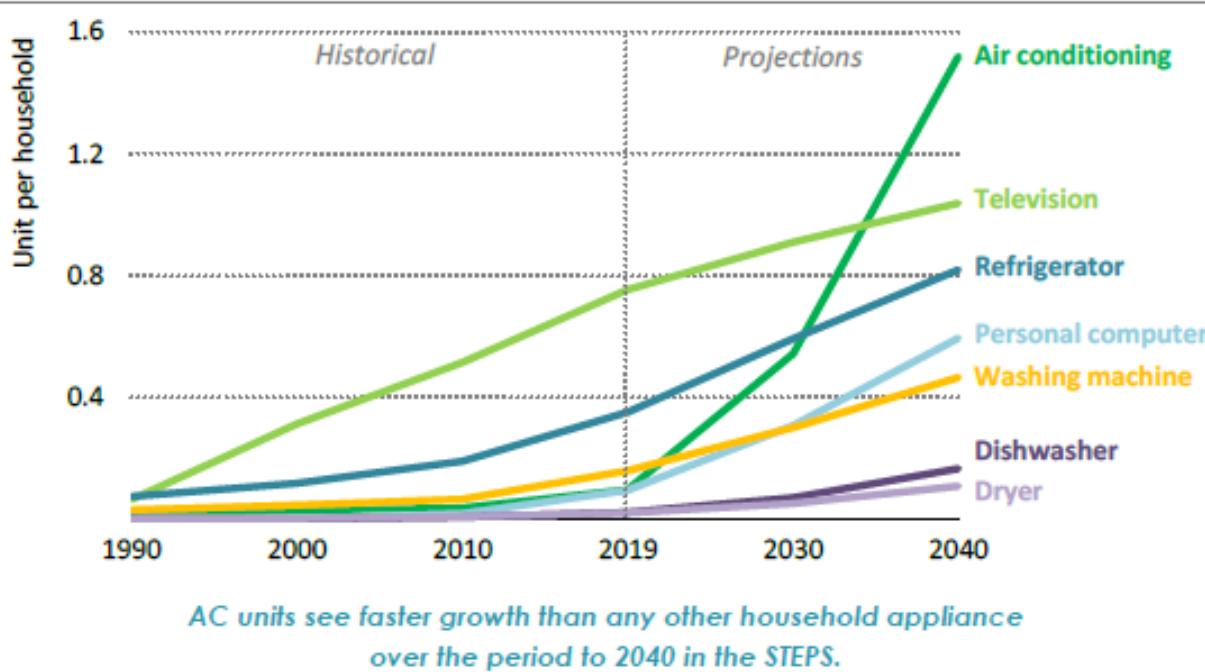


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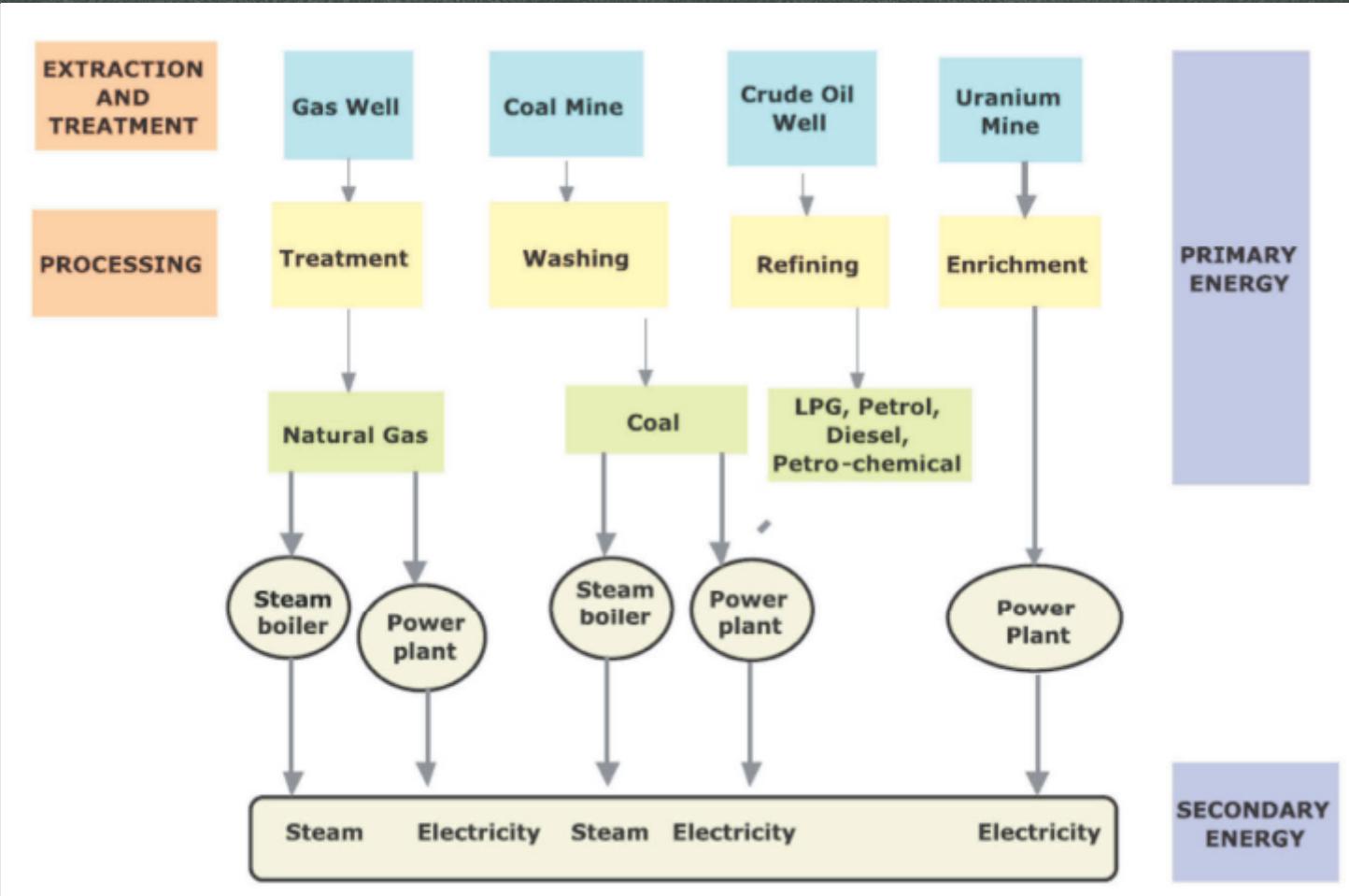
Behavioural changes could immediately save 0.6 mb/d of oil,
17 bcm of gas and 30 TWh of electricity a year

Energy Efficiency - Often considered as an alternative fuel

Figure 2.11 ▷ Appliance ownership in Indian households in the STEPS

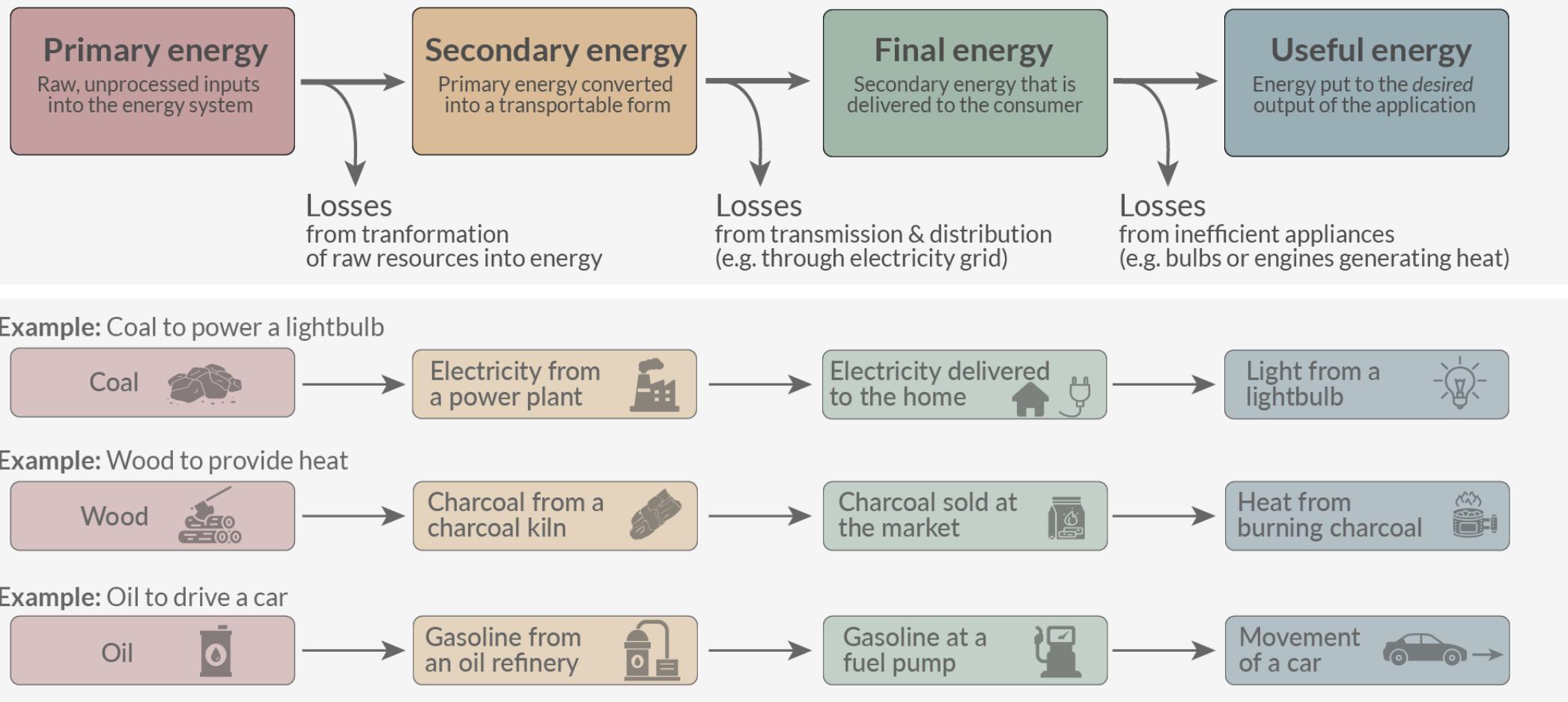


Flow of Energy



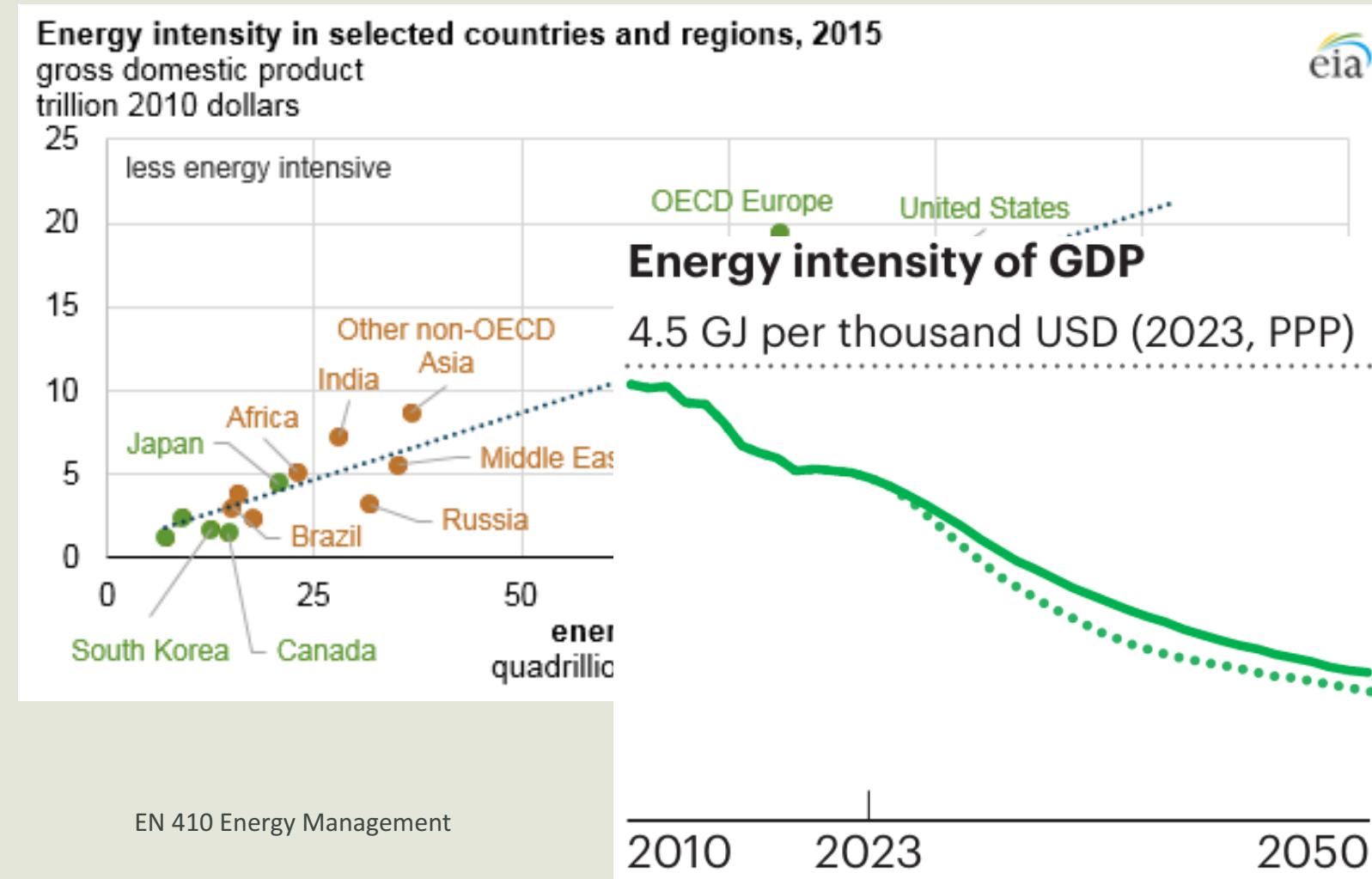
- Treatment – Sulfur
- Washing – Sulfur, Ash and Slag
- Refining – Extract different types of oil
- Enrichment - Increasing the percentage of Uranium-235

Flow of Energy



Energy Intensity

- Energy intensity is a measure that is often used to assess the energy efficiency of a particular economy
 - Ratio of energy use to gross domestic product
 - Low energy intensity is the desired goal
 - Trying to decouple energy use and economic output to enhance that quality



Energy Management and Audit

Continuous improvement of a building **Vs timely study**

- Audit may be considered the first step of this process

Audit – financial connotation – examination with an intent to verify

Energy audit – coined in the 70's after the oil shocks

- ✓ A study of a plant or facility to determine how and where energy is used and identify methods for energy savings
- ✓ The key to a systematic approach for decision-making in the area of energy management
- ✓ Translation of energy conservation ideas into realities

Remember

- Efforts should not be equated with discomfort
- Should not interfere with the preliminary function of the organization or facility
- Activities that disrupt or impede with the normal functions of the workers and/or processes, , adversely affect productivity constitute false economics

It should be a systematic process to avoid above factors

Recap

- Global and Indian energy scenario
- Energy security and intensity
- Flow of energy
- Intro to energy management

References

- World Energy Outlook 2024 by International Energy Agency
- <https://www.eia.gov/todayinenergy/detail.php?id=27032>
- <https://www.mdpi.com/1996-1073/13/10/2502>
- Energy and Civilization by Waseda University, SILS, Science, Technology and Society (LE202)
http://www.f.waseda.jp/sidoli/STS_Intro_06.pdf
- [BP Energy statistical review of World Energy, 2017](https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html)
- https://www.123rf.com/clipart-vector/energy_conservation_charts.html
- <https://ourworldindata.org/energy-definitions>
- Accelerating Improvements in the Energy Efficiency of Room Air Conditioners (RACs) in India: Potential, Cost-Benefit, and Policies (Interim Assessment) Nikit Abhyankar Nihar Shah Won Young Park Amol Phadke
- Energy Efficiency: Concepts and Calculations BY Daniel M. Martínez, Ben W. Ebenhack and Travis P. Wagner