
Energy Scenarios

Part 1

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Energy-Economy Interaction: Why Care?

- **Energy to support future economic life**
 - ✓ Growing population and its needs
 - ✓ Depletion of resources (oil, gas, coal)
- **Environmental cost of the energy system**
 - ✓ Urban air pollution
 - ✓ CO₂ emissions and climate change
- **Planning future investments & policies**
 - ✓ Government agencies
 - ✓ Energy companies

Plan for These Two Sessions

- **Part 1: The energy-economy system**
 - ✓ **Background : some definitions**
 - ✓ **Interaction of energy and the economy**
 - ✓ **History of global energy use**
 - ✓ **Projections of future energy use**
 - **How it is done**
 - **Sample scenarios**
- **Part 2: Energy Emissions, Climate Change and Society's Response**

Measures of Economy and Energy

- **Gross Domestic Product (GDP):** Value of all the goods and services produced in an economy

- ✓ Food
- ✓ Housing
- ✓ Transportation
- ✓ Communications
- ✓ Health care

€
£ \$
¥

Examples: GDP per person

- ✓ Canada = \$42,000
- ✓ China = \$9,100
- ✓ India = \$3,800

- **Energy use**

- ✓ Coal, oil, gas
- ✓ Biofuels
- ✓ Hydroelectric
- ✓ Nuclear
- ✓ Solar, wind
- ✓ Geothermal

Heat
units

Examples of heat units

- ✓ Metric (joules)
- ✓ English (BTUs)
- ✓ Equivalent fuel quantity
(barrels of oil, tons of coal)

Energy in the Economy: Dynamic Interactions

One way to account for the change energy use over time

E = total energy use in an economy

Pop = population

GDP = level of economic activity (Gross Domestic Product)

$$E = \text{Pop} * \text{GDP/Pop} * E/\text{GDP}$$

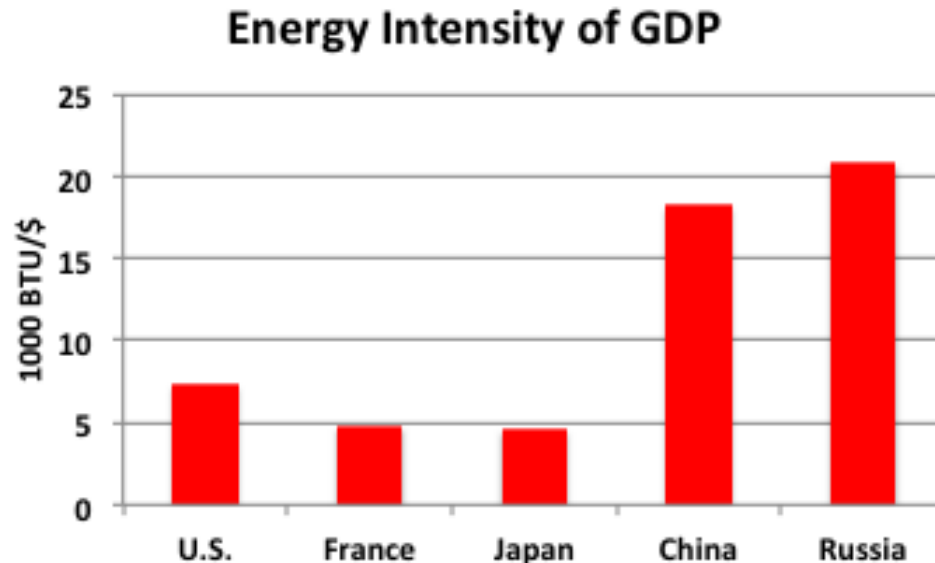
Population

Per-capita standard
of living

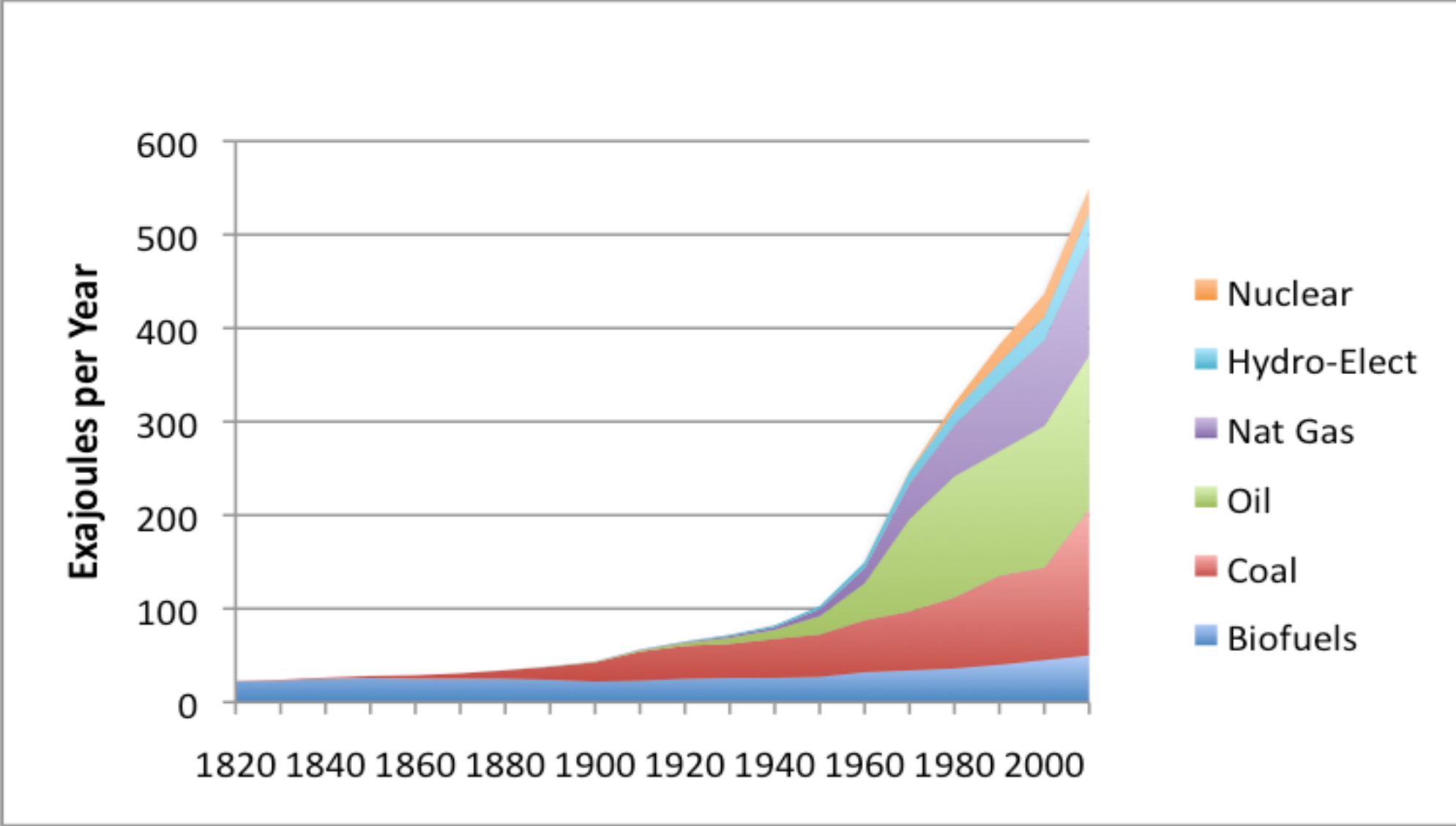
Energy efficiency
of the economy

What Affects Energy Efficiency (E/GDP)?

- **Some of the factors**
 - ✓ Geography (heat/cold, travel distances, housing space)
 - ✓ What the economy produces (software vs. steel)
 - ✓ Technology (old vs. new machines & appliances)
 - ✓ Conservation policies (automobile design standards)
 - ✓ Price of energy
- **Differences among countries**



History of Global Energy Use



Energy Scenarios

- **What is a “scenario”, and what are they for?**
- **Example: A plan to increase the number of students in your school over 10 years: What will be the additional energy needs?**
- **Things to consider**
 - ✓ **Fuel for school buses**
 - ✓ **Heat and air conditioning**
 - ✓ **Laboratory equipment**
 - ✓ **Lighting**
 - ✓ **Charging laptops & cell phones**
 - ✓ **.....**

Fuel for School Buses

Fuel = number of students (School plan)
*** fraction that ride** (Behavior)
/ students per bus (Bus size)
*** trip length per bus** (Area served)
*** liters per km** (Technology)

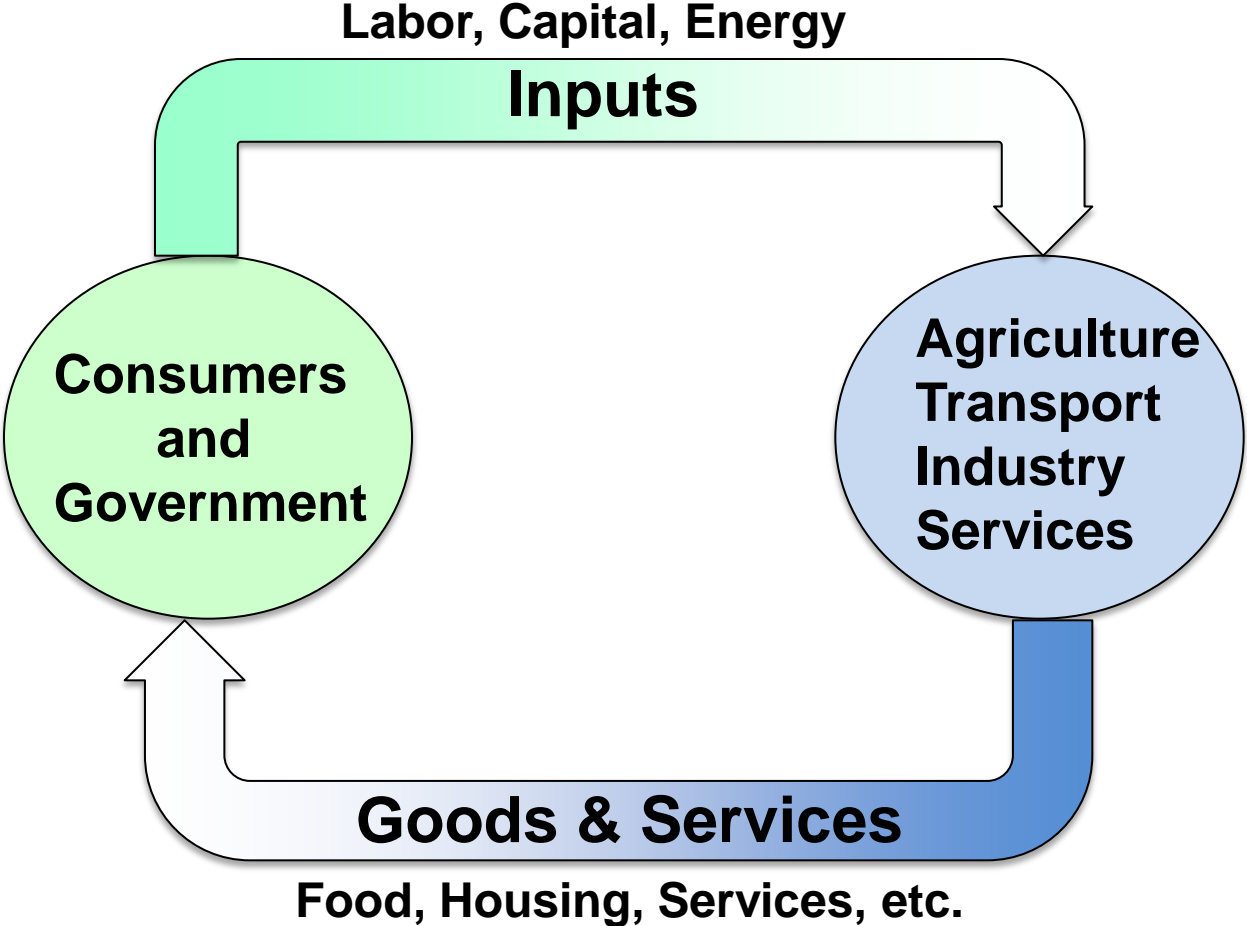
Note assumptions required

Many possible scenarios

Perhaps choose best guess

Others to explore uncertainty

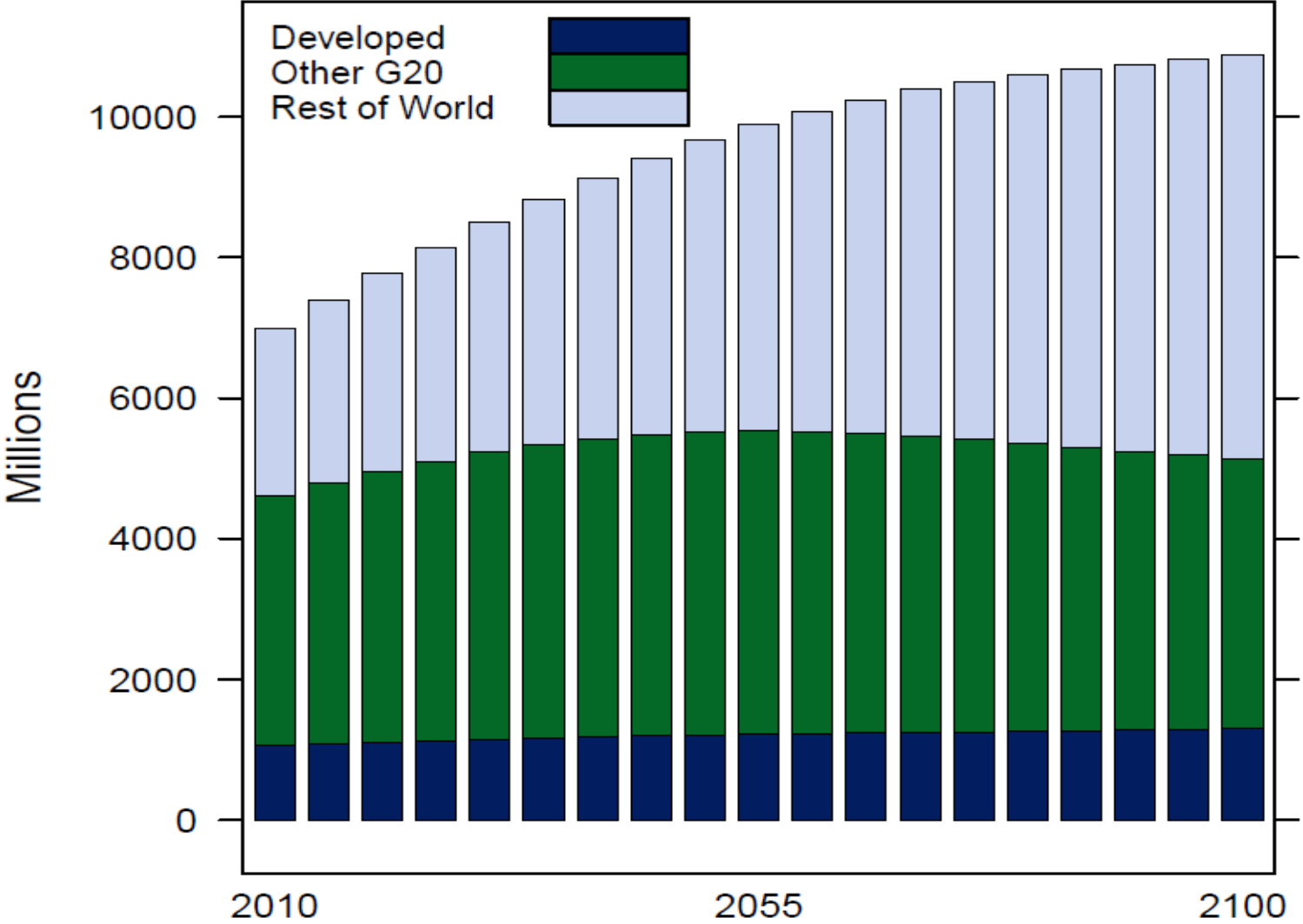
Constructing National Energy Scenarios



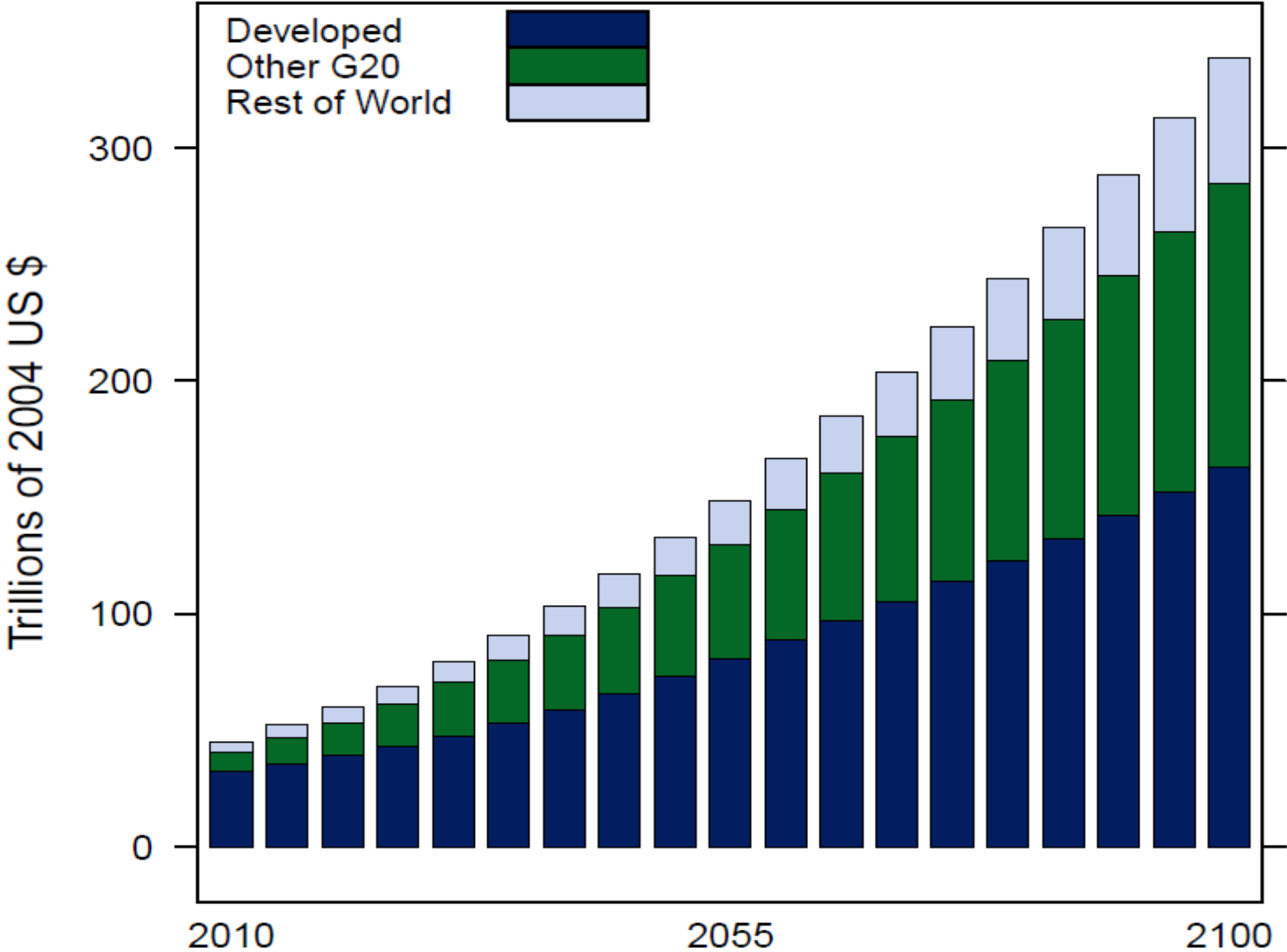
MIT Global Energy Scenario

- **Scenario assumptions (examples)**
 - ✓ **Costs of energy technologies**
 - ✓ **Country population & economic growth rates**
 - ✓ **Government energy policies in place**
- **Show countries in groups**
 - ✓ **Developed**
 - US, EU, Canada, Japan, Australia & New Zealand**
 - ✓ **Other G20**
 - Russia, Brazil, Mexico, China, India, Dynamic Asia**
 - ✓ **Rest of World**
 - Africa, Other Latin America, Middle East, Other East Asia, Other Eurasia**

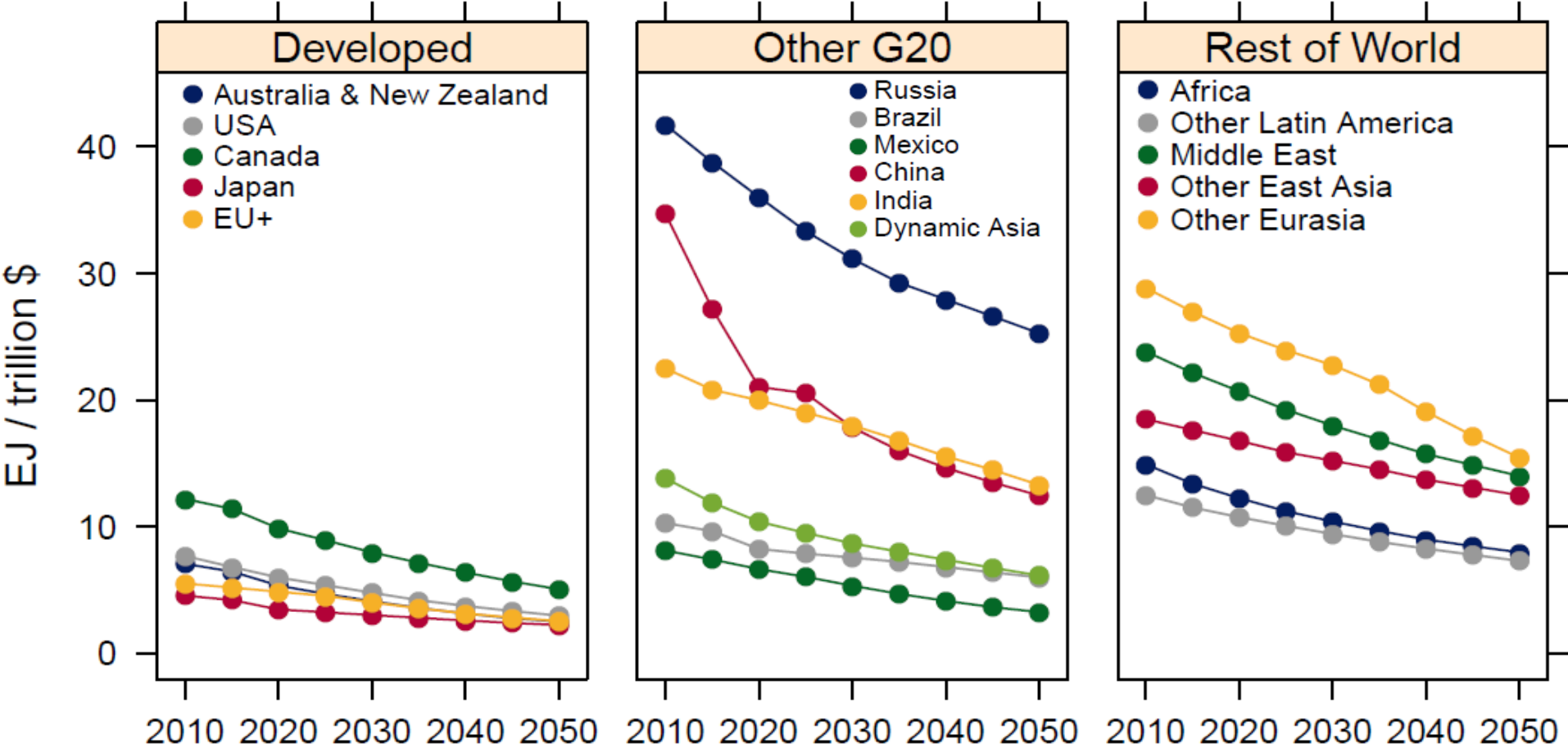
Global Population Growth



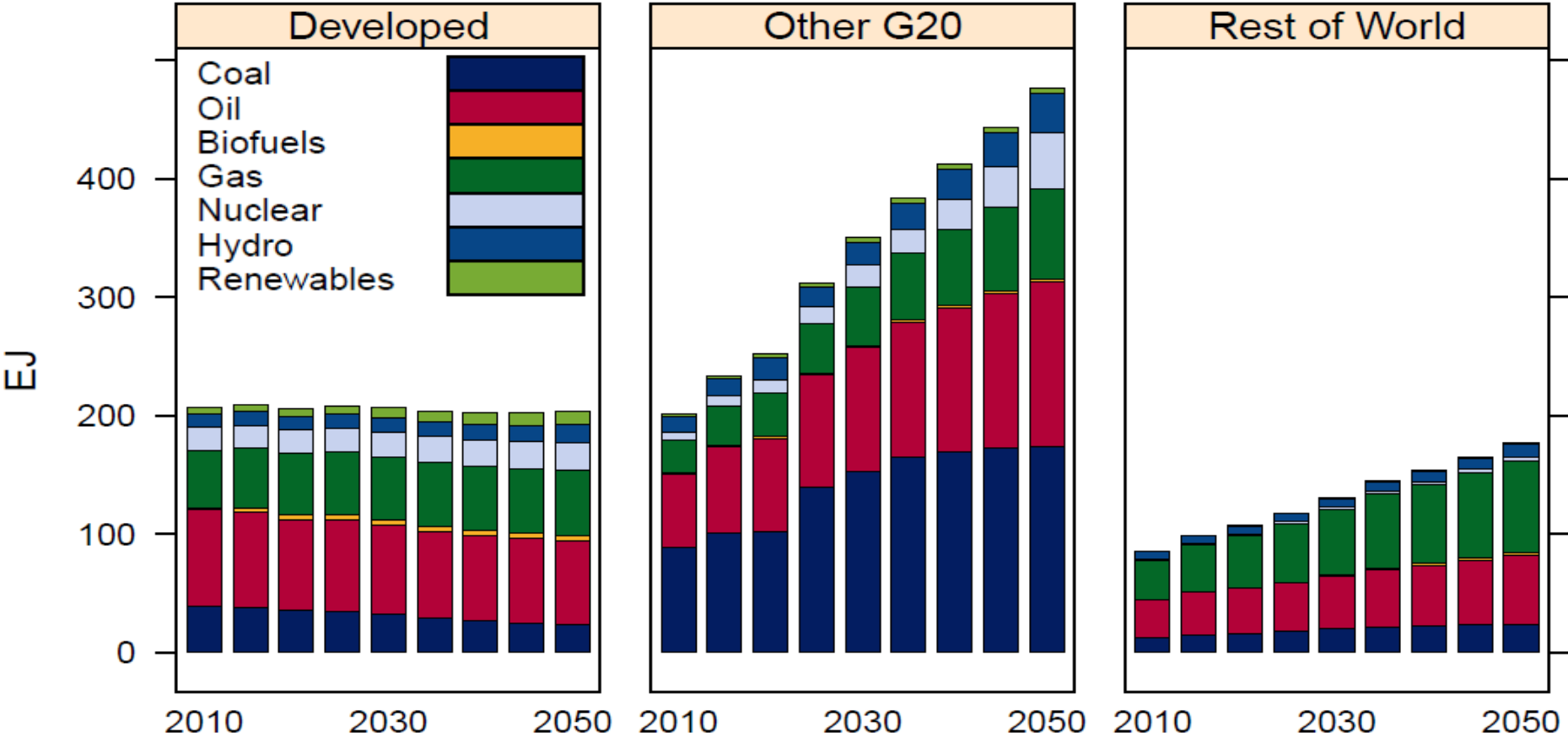
Global Economic Growth



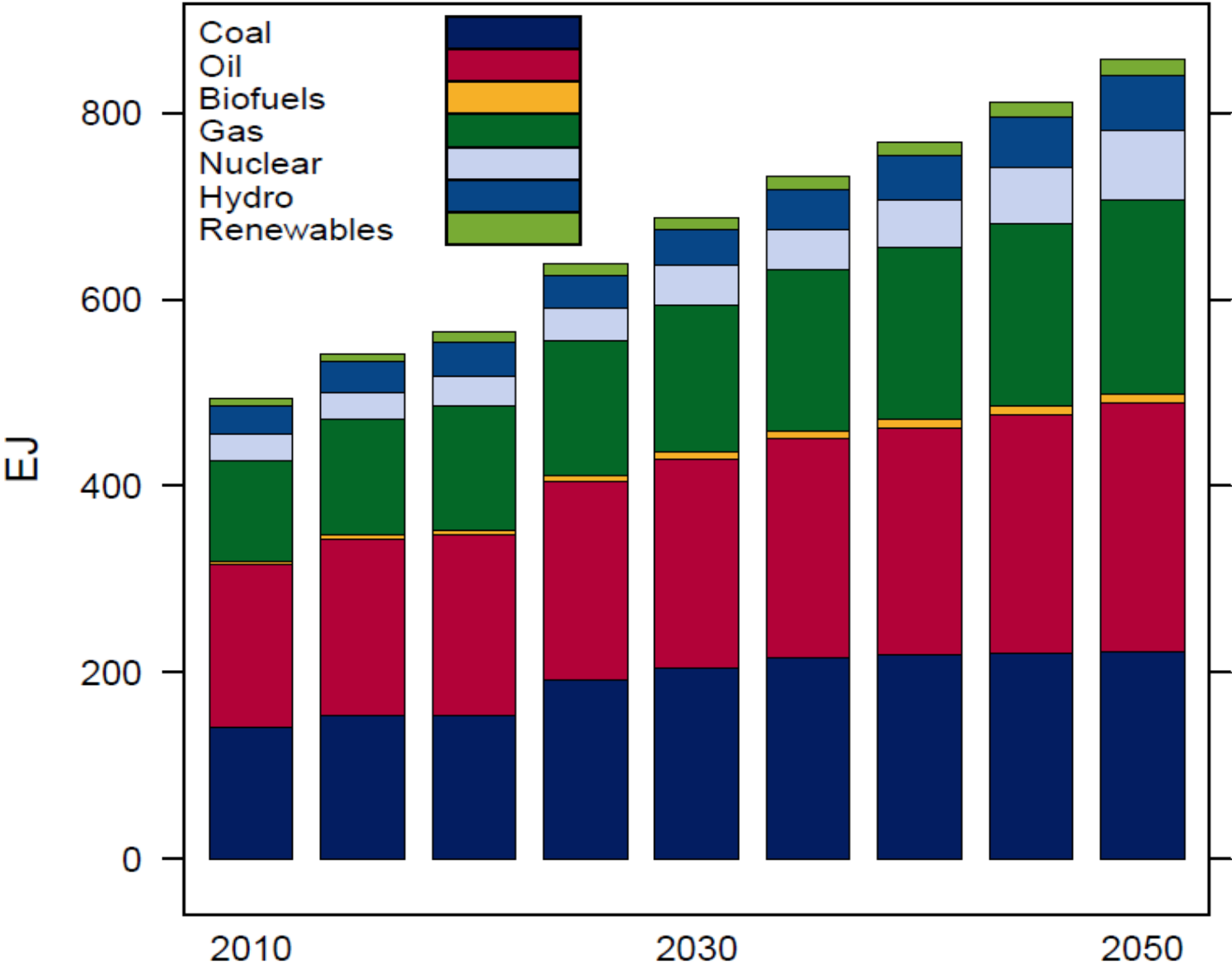
Energy Efficiency by Group



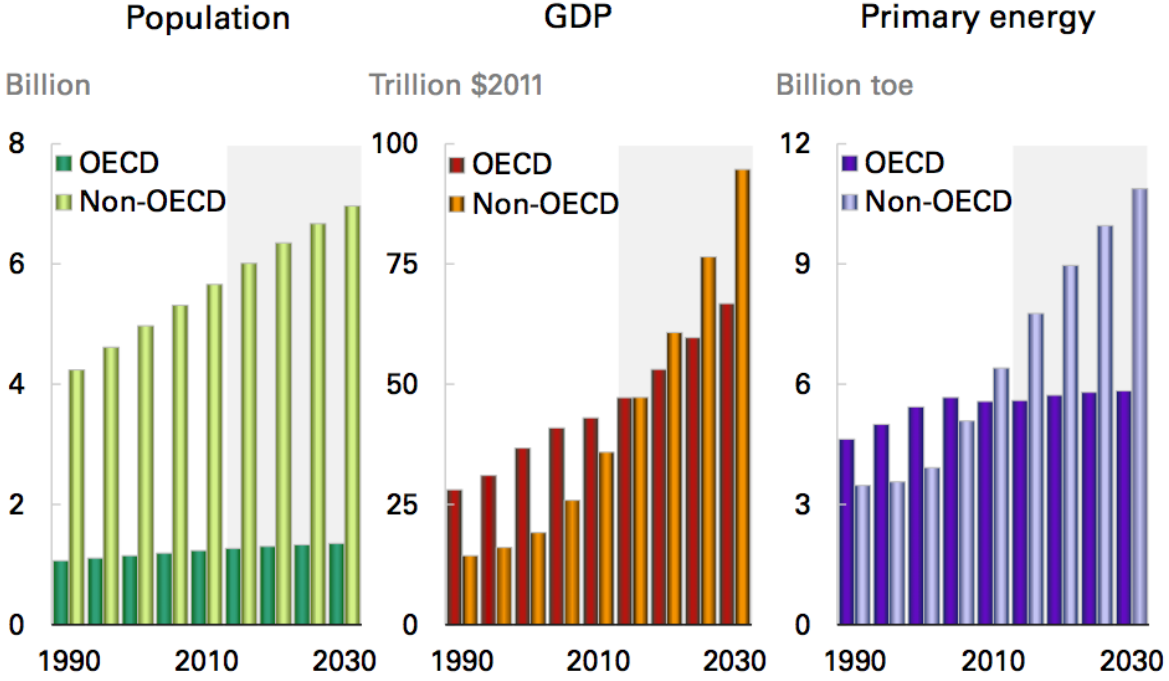
Energy Use by Group



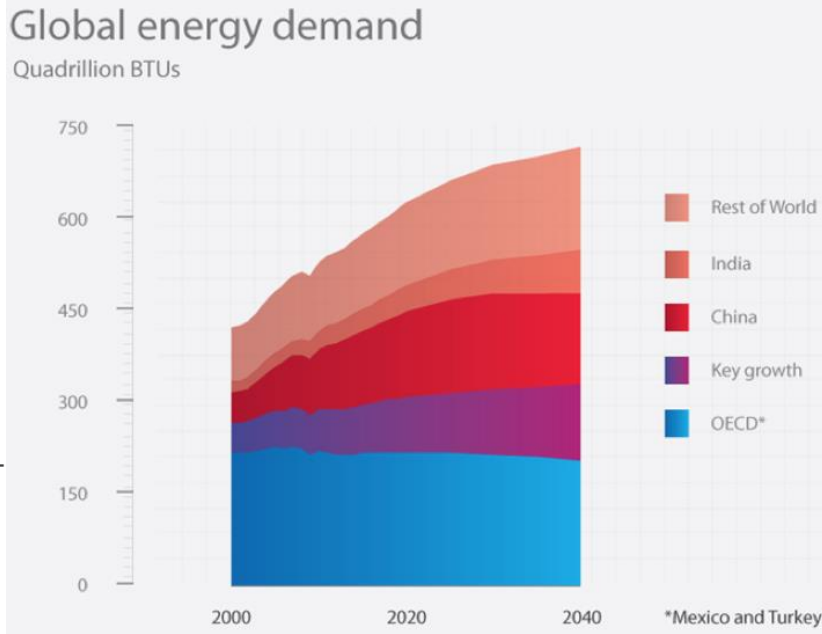
Global Energy Use



Other Scenario Examples, Corporate



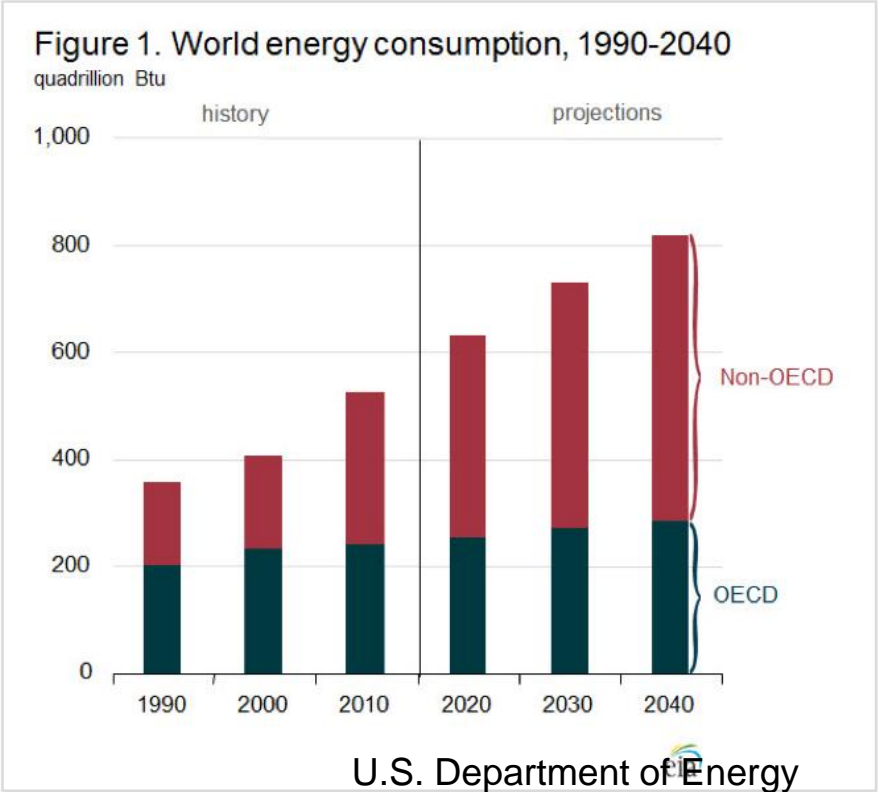
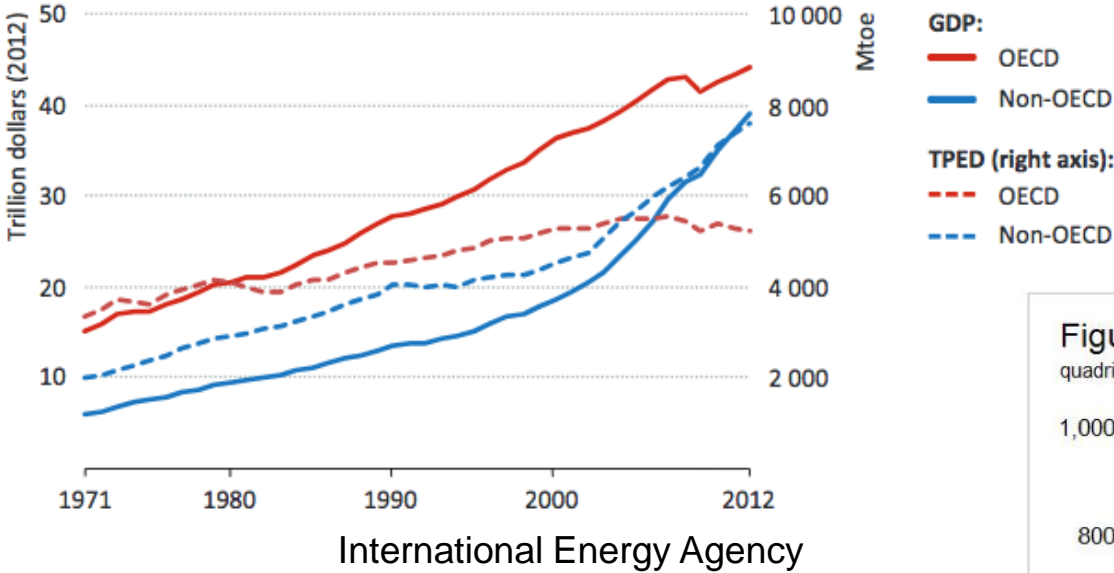
BP, 2013



ExxonMobil, 2013

Other Scenario Examples, Government

Figure 1.1 ▶ Primary energy demand and GDP



Thank you!

For more see

- M .I.T. Joint Program on the Science and Policy of Global Change, Energy and Climate Outlook (<http://globalchange.mit.edu/research/publications/other/special/2013Outlook>)
- U.S. Department of Energy, International Energy Outlook (<http://www.eia.gov/forecasts/ieo/>)
- International Energy Agency, World Energy Outlook http://www.iea.org/newsroomandevents/speeches/131112_WEO2013_Presentation.pdf

Next: Energy Emissions & Climate Change