World Energy Use and Carbon Dioxide Emissions, 1980-2001

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Energy Information Administration

Contacts

Staff from the Office of Energy Markets and End Use (EMEU), Energy Markets and Contingency Information Division (EMCID) prepared this report.

General questions concerning the content of the report may be referred to Mark Rodekohr (Mark.Rodekohr@eia.doe.gov, 202-586-1130), Director of EMCID; or Lowell Feld (Lowell.Feld@eia.doe.gov, 202-586-9502), Leader of the Contingency Information Team. Specific questions about the report should be referred to Nathan Wilson (Nathan.Wilson@eia.doe.gov, 202-586-9883).

Table of Contents

Abbreviations and Acronyms

Bkwh	Billion kilowatt-hours
Btu	British thermal unit(s) (the amount of energy required to raise the temperature of 1 pound of water 1 degree Fahrenheit; 8 gallons of gasoline contain 1 million Btu)
EE&FSU	Eastern Europe and the Former Soviet Union (for list of countries in EE&FSU, see Appendix A)
FSU	Former Soviet Union
GDP	Gross Domestic Product
G-7	Group of Seven (Canada, France, Germany, Italy, Japan, United Kingdom, United States)
Kwh	Kilowatt-hours
MENA	Middle East and North Africa (for list of countries in EE&FSU, see Appendix A)
MMT	Million metric tons
OECD	Organization for Economic Cooperation and Development (for list of countries in OECD, see Appendix A)
Non-OECD	All countries that are not included in the OECD
PPP	Purchasing power parity exchange rates
Quads	Quadrillion Btu(s)

Highlights

Key conclusions of this report include:

The relationship between economic development and energy use varies significantly across country groups. In the OECD countries, real gross domestic product (GDP) grew faster than energy use between 1980 and 2001, indicating the developed economies' increasing reliance upon comparatively non-energy-intensive sectors. In the majority of non-OECD countries outside Developing Asia, development and energy use remain closely correlated.

In the OECD, the ratios of energy consumption and carbon dioxide emissions to GDP fell more rapidly prior to the oil price decline of 1985 – 1986 than they did thereafter. Between 1980 and 1985, the OECD's energy and carbon dioxide intensities declined an average of 2.3% and 3.2% per year, respectively. The pace of decline from 1986 to 2001 was just under half as rapid for both ratios.

Declines in the developing countries' energy and carbon dioxide intensities mostly took place during the late 1980s and the 1990s. The non-OECD's energy and carbon dioxide intensities actually rose until 1985, after which they declined an average of 1.8% and 2.3% per year, respectively. Both ratios fell even more rapidly during the 1990s. It should be noted that these aggregate rates conceal the heterogeneity of experience between and within regions of the non-OECD. See below for details

Developing Asia grew rapidly between 1980 and 2001. During this period, Developing Asia experienced tremendous growth in energy consumption, real GDP, carbon dioxide emissions, and electricity consumption. Much of this growth came from China and, to a lesser extent, India.

Energy consumption and carbon dioxide emissions grew fastest in the developing world in the 1980s and 1990s. Most of the growth in worldwide energy consumption and carbon dioxide emissions over the past two decades took place in large, developing countries such as China, Brazil, India, and South Korea. A key factor in this growth has been the rapid growth in motor vehicle ownership.

The share of energy sources that do not emit carbon dioxide in the world's energy portfolio increased over the past two decades. The share of non-fossil energy sources grew rapidly in the developed countries -- from 12% in 1980 to 18% in 2001. Most of this increase was due to growth in nuclear power generation. In the developing countries, non-fossil energy sources grew from 7% in 1980 to 11% of total energy supply in 2001. This reflects the development of nuclear sectors and expanded exploitation of hydroelectric resources.

Fuel-use patterns in the developing countries were generally more carbon-intensive than in the developed countries over the past two decades. In large part, this reflects

the larger share of energy consumption accounted for by fossil energy sources in the non-OECD. It also indicates the more carbon-intensive nature of the fossil fuels used in the developing world. Because of its reliance upon coal, China's carbon dioxide emissions per unit of energy consumption were twice those of Canada, which possesses large hydropower resources.

Partly as a result of increasing non-fossil energy consumption and structural economic shifts in the OECD, the developed countries' share of world carbon dioxide emissions declined between 1980 and 2001, falling below developing countries' share. During the period, OECD emissions increased 15%, while non-OECD emissions grew 47%. Per capita carbon dioxide emissions in the developed world (12.2 metric tons per person) remain significantly higher than in the developing world (2.4 metric tons per person).

Natural gas is becoming an increasingly important part of the energy portfolios of both developed and developing countries. In the developed world, natural gas' share of energy consumption increased from 19% to 22% between 1980 and 2001. During the same period, its share of energy consumption in the developing world grew from 18% to 24%. Natural gas is the least carbon-intensive fossil fuel.

Electricity use worldwide increased significantly faster than overall energy use, particularly in the developing countries. In the non-OECD countries, the rapid growth in consumption (an average of 3.8% per year) stems from population growth, rapid economic development, and rural electrification. The relatively modest growth in demand (2.5% per year) in the OECD in part reflects increasing use of computers and other office equipment. Even with the surge in usage, office equipment only accounts for a small fraction of total electricity demand. For example, it comprises between 2% and 4% of total electricity consumption in the U.S.[1] Increases in electricity consumption in the economically developed world were somewhat offset by gains in efficiency.

Per capita electricity demand grew very rapidly in both the Middle East and North Africa region and Developing Asia between 1980 and 2001, rising 177% and 232%, respectively. In the MENA region, this growth took place despite falling per capita incomes. Despite their rapid growth, Developing Asia's and the MENA region's citizens still consume electricity at less than a tenth and a quarter of the OECD rate, respectively.

The role of non-fossil energy in electricity generation rose in both developed and developing countries. The change in the OECD's "electricity mix" was more pronounced. Between 1980 and 2001, the share of electricity generated in thermal power plants fell from 68% to 60%. In the non-OECD, the reduction was more modest, from 73% to 70%. Most of the shift towards non-thermal electricity is accounted for by nuclear power.

The world's electricity intensity changed relatively little between 1980 and 2001. The non-OECD's electricity intensity increased modestly, while the OECD fell slightly over the period.

Introduction

This report examines a variety of energy-related national- and regional-level indicators between 1980 and 2001. These indicators include absolute totals, per capita levels, and the ratios of the following energy-related indicators: carbon dioxide intensity (carbon dioxide / economic output), energy intensity (energy consumption / economic output), and electricity intensity (electricity consumption / economic output).*

Except where noted, all GDP figures in this survey are based on OECD estimates expressed in constant 1995 dollars adjusted for purchasing power parity ($1995-PPP). [2]

Throughout the report, the data presented are highly aggregated. While these summary measures might not permit strong, specific conclusions, the broad review of international energy-use patterns presented here is useful in understanding global energy use and carbon dioxide emissions patterns.

Outline

The report presents data and analyses of trends in energy use and carbon dioxide emissions within both economically developed and developing areas of the world between 1980 and 2001. The variety of experience within the developing world is also explored. The six main groupings of countries presented here include: 1) OECD/Developed; 2) Eastern Europe and the Former Soviet Union; 3) Developing Asia; 4) the Middle East and Northern Africa; 5) Africa; and 6) Latin America.

These six regional categories closely adhere to those used in the Energy Information Administration's *International Energy Outlook 2003* (*IEO*), and are based on an historic view of these groupings. Thus, the category referred to as 'developed' or 'the OECD' excludes many countries that are currently included in that group (e.g. Turkey, South Korea, Poland and other former communist states). Turkey is placed with the Middle East and North Africa (MENA); South Korea is included in Developing Asia; and the former communist states are part of Eastern Europe and the Former Soviet Union (EE&FSU).

The definitions used in this survey diverge from the *IEO* in regards to North Africa. The *IEO* does not separate the fossil fuel rich countries of Egypt, Tunisia, Libya, and Algeria from the rest of Africa. This report does so, believing that those countries' energy behavior and economic development are more consistent with the Middle East than with the rest of Africa.

A precise listing of the countries in each category is included in the Appendices.

* The ratios are often incorrectly equated with efficiency. The relationship between energy consumption and economic output is complex. A comparison of unadjusted ratios fails to take account of the many factors that may cause one nation to use more energy per unit of output than another that have nothing to do with efficiency. These factors include, but are not limited to, weather, the manufacturing mix, and natural resource endowments. For more information, see http://www.eia.doe.gov/emeu/efficiency/contents.html.

Background: Energy Consumption and the Environment

Since at least the early 19th century, consumption of fossil fuels (oil, gas, and coal) has been critical to economic growth. Early on, however, it became apparent that fossil fuel consumption had harmful environmental effects, contaminating the air, water, and land.

In recent years, concern over these effects has been heightened by the possibility that the release of greenhouse gases -- the most important of which are carbon dioxide, methane, and nitrous oxide – may contribute to global warming. While other human activities promote emissions of each of these gases, adding to existing natural atmospheric levels of gases such as water vapor, the largest source of human-caused greenhouse gas emissions is the burning of fossil fuels, which releases carbon dioxide.

In considering the environmental ramifications of energy consumption, this report focuses only on emissions of carbon dioxide. It does not examine other greenhouse gases or aspects of energy consumption that impact the natural environment (e.g. oil spills).

This report defines "energy" strictly as commercial (or marketed) energy. Many developing economies remain dependent on "traditional" energy consumption (e.g. fuel-wood, waste, dung) in their residential and agricultural sectors. In some non-OECD countries, estimates suggest that traditional fuel consumption equals or surpasses commercial energy use. Unfortunately, despite its importance, traditional energy use cannot be included in this survey due to the lack of reliable data.

Fuel Mix and Carbon Dioxide Emissions

Most nations rely upon a wide variety of sources for their energy needs. A particular country's fuel mix has a major impact on its carbon dioxide emissions levels. Other things being equal, countries with larger shares of non-fossil energy consumption tend to release less carbon than countries that are more dependent on fossil fuels. In addition, a country's choice among fossil fuels (coal, oil, natural gas) can have a major impact on carbon dioxide emissions levels. Coal is the most carbon intensive of the major fossil fuels, while natural gas is the least. Oil falls in between coal and natural gas in terms of carbon dioxide emissions intensity. According to the United Nations Environment Program, coal emits around 1.7 times as much carbon per unit of energy when burned as does natural gas and 1.25 times as much as oil.[3]

In part because consumption of non-carbon-emitting energy sources grew relative to fossil fuel consumption between 1980 and 2001, the world's carbon dioxide emissions rose more slowly (1.2% per year) than energy use (1.7% per year) during the period. In the OECD, the share of non-carbon-emitting energy sources (nuclear, hydroelectricity, other renewables) rose from 12% to 18% between 1980 and 2001, largely as a result of increased consumption of nuclear power. During the same period, the shares of coal and oil declined, though consumption of both increased in absolute terms. Non-carbon-emitting energy sources also gained a progressively larger share in developing countries' fuel mixes between 1980 and 2001.

One way of considering what the changes in the world's energy mix mean is to compare actual world carbon dioxide emissions to a hypothetical scenario where the world retained its 1980 energy portfolio (with the implication that the per capita emissions rate also remained constant) and population rose to its 2001 level. In this hypothetical scenario, carbon dioxide emissions would have been 7.3% higher (25,900 million metric tons (MMT) as opposed to around 24,100 MMT) than actual 2001 emissions.

Economic Development and Energy Use

A number of factors influence energy use, with economic growth being the most important. Broadly speaking, economic growth is often accompanied by industrialization, electrification, and increased automobile ownership. These factors help foster demand for energy in the form of industrial feedstocks, heat, light, and motive power. Not surprisingly, therefore, per capita energy consumption in the developed world is six times greater than it is in the developing countries.

Economic growth tends to be directly correlated with increased energy consumption, at least to a certain point. Increased levels of household income, for instance, often lead to the purchase of larger housing units, raising residential energy consumption. Residential energy consumption levels also expand along with higher rates of appliance penetration and usage. In addition, increased wealth is often associated with "luxury" purchases, like larger, heavier vehicles that use energy more intensively.

Beyond a certain point, however, further economic development actually can lead to structural shifts in the economy that reduce the prominence of energy intensive industries. For example, more energy-intensive (and polluting) heavy industrial processes tend to move from developed to developing countries. Second, higher income levels can lead to the development and diffusion of more technologically sophisticated, but less energy intensive, machines. This trend has been especially prominent in the home appliances sector, where new models use only a small fraction of the electricity consumed by earlier models. In part, this reflects the imposition of efficiency standards by governments. Third, as economies develop beyond a certain point they may move into a "post-industrial" phase in which services become relatively more important as opposed to manufacturing, while capital and labor become more important compared to raw materials and energy.[4]

Economic Structure and Changes in Energy Consumption

One of the most significant energy-related changes in the last 20 years has been the significant reduction in energy intensity in the world's developed countries. Between 1980 and 2001, the OECD's energy intensity declined 26%; the Group of Seven's (G-7) fell 29%; and the U.S.' dropped 34%. These changes suggest an increased decoupling between GDP growth and increased energy consumption in the developed world. This has caused some commentators to argue that the developed world might be entering a "post-industrial" phase, in which the engines of economic expansion are knowledge, capital, and labor-intensive industries, as opposed to those that exploit natural resources. This shift towards a "post-industrial" structure has been characterized by the more rapid growth of the non-energy intensive, service sector relative to the industrial and

manufacturing sectors. Another important ingredient has been the migration overseas of energy-intensive industries from developed to developing countries.

The developing world has not experienced an analogous structural shift, despite the fact that the non-OECD's real GDP also grew faster than energy use between 1980 and 2001. This apparent reduction in the non-OECD's energy intensity does not take into account widening divisions within the developing world. Developing Asia, for example, has increasingly diverged from the rest of the non-OECD in terms of energy use patterns. When that region is excluded, it becomes clear that much of the developing world's GDP growth is still tightly correlated with increased energy consumption (and carbon dioxide emissions).

Developing Asia's divergence from other parts of the non-OECD stems in large part from the relatively rapid, export-led economic growth in that region. By the late 1990s and early 2000s, some East Asian countries achieved levels of output and consumption analogous to lower-tier members of the OECD.[*] It is important to note, however, that much of Developing Asia's new wealth has been unevenly distributed among and within its countries.

The change in energy usage patterns in Developing Asia has a different underlying set of causes from that of the OECD. While some economies in the region also began to shift towards post-industrialism, much of the reduction in energy intensity was achieved through technological modernization. This is especially true for China, the region's dominant energy consumer. There, the shift towards a more market-based economic system and away from central planning led to dramatic increases in energy efficiency as old, wasteful plants were shut down. The policies pursued during the previous era (i.e., the "Great Leap Forward" period under Mao Tse-tung), when rapid growth and self-sufficiency were prioritized, had led to extreme inefficiency.[5]

Other Factors Impacting Energy Usage

A review of energy consumption trends between 1980 and 2001 reveals that a number of factors other than economic development also profoundly impacted energy usage.

Increases in population had a major influence, both directly on the demand for energy as well as indirectly through economic growth. *Ceteris paribus* (i.e. all else being equal), population growth is correlated with increased energy consumption and economic activity. Over the past few decades, the developed countries have experienced slow population growth and rising per capita incomes. The slow population growth reflects declining fertility rates. As noted above, increasing incomes beyond a certain point may actually lead to falling energy intensities or even lower absolute consumption levels.

Between 1980 and 2001, many developing countries experienced rapid population growth. While fertility rates are now declining in much of the developing world, growing populations in the region continue to create upwards pressure on demand for goods and

[*] South Korea has in fact joined the "real" OECD. As noted earlier, South Korea is not included in the OECD-group in this report because of historical considerations.

services. This increased demand tends to exert upward pressure on energy consumption. In addition, many developing countries maintain energy price subsidies. These allow for higher energy consumption rates than market prices would imply.

A country's factoral endowments exert yet another influence on national energy consumption and carbon dioxide emissions patterns. Some countries, like Canada and the United States for instance, based their development historically on relatively cheap and abundant natural resources, including energy. Comparative advantage theory, of course, states that those countries with relatively higher factor endowments in one particular area – labor, capital, or "land" -- are likely to specialize in industries utilizing that factor. Countries poor in natural resources, like Japan, tend to substitute for these with capital and highly skilled labor. Such differences in industrial mix (or industrial processes) can result in considerable variation in energy demand even among countries with similar levels of per capita income.

Government policy also has a major impact on energy use through taxes, subsidies, efficiency standards, industrial policies, etc. In formerly communist countries, for instance, decisions often were made to promote heavy industry and to subsidize the cost of energy. Today, more than ten years after the transition from centrally-planned to market-based economies, many of these former communist states continue to have comparatively high energy and carbon dioxide intensities. However, change is occurring rapidly as the countries integrate themselves increasingly in the globalized world economy.

Conclusion

Although no simple, unified theory of energy consumption and carbon dioxide emissions patterns is presented here, an examination of historical trends across countries and regions can help to increase understanding in this area. It also might potentially be of use in guiding future policy choices.

Data Sources

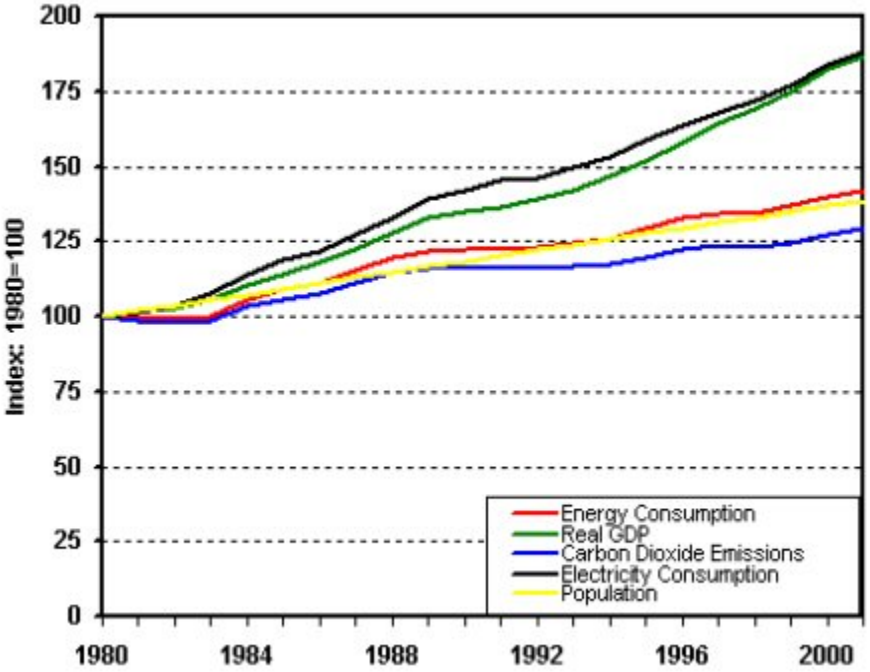
Most of the energy data used in this report come from the Energy Information Administration. Other significant sources include: 1) the OECD's *Energy Balances of OECD Countries 2002-2003*; 2) the OECD's *Energy Statistics and Balances of Non-OECD Countries*; and 3) the International Energy Agency's *Carbon Dioxide Emissions from Fuel Combustion (2003 Edition).*

Economic and price information is taken mainly from the OECD's *National Accounts, Volume 2 (2003 edition).* Other data sources for this report include: 1) Ward's *World Motor Vehicle Data (2003 Edition)*; 2) Ward's *World Automotive Yearbook* (multiple years); and 3) specific journal and government publications.

Whenever non-EIA sources are used, these are noted in endnotes included within the Appendices. Data are available upon request.

I. Overview

World Trends



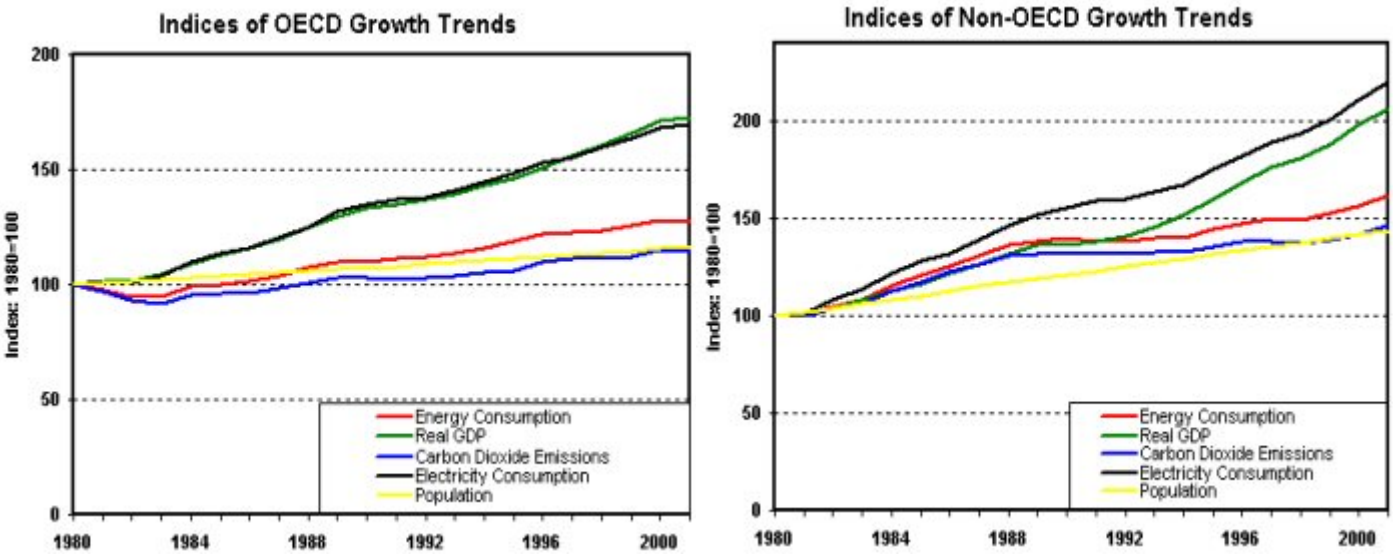
- Between 1980 and 2001, the world's electricity consumption expanded an average of 3.0% per year, resulting in an overall increase of 88%. Real GDP (adjusted for inflation) grew at the same rate during the period.

- World energy consumption grew more slowly (1.7% per year) than real GDP between 1980 and 2001, reflecting improvements in energy efficiency as well as a shift towards less energy-intensive industries in many countries.

- Increased use of non-carbon-emitting energy sources, such as nuclear and hydroelectric power, helped limit growth in world carbon dioxide emissions to 1.2% per year, significantly lower than the growth in energy consumption between 1980 and 2001.

- The world's population expanded an average 1.6% per year between 1980 and 2001. During this period, per capita income levels rose, per capita energy consumption levels stayed nearly constant, and per capita carbon dioxide emissions declined.

Developmental Trends: OECD vs. Non-OECD



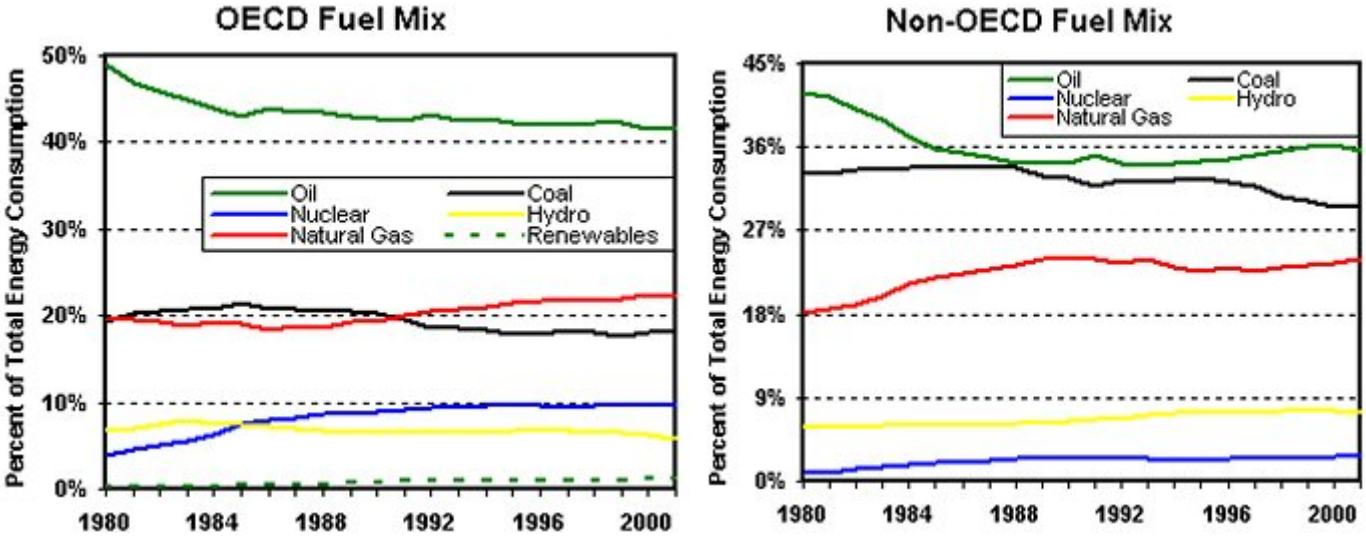
- All of the indicators examined here rose more rapidly (on average, more than twice as fast) in the non-OECD than in the OECD between 1980 and 2001.

- In both regions, real GDP and electricity consumption grew the fastest of all the indicators during this period. In the OECD, they increased 2.6% and 2.5% per year, which was much faster energy consumption (1.2%), carbon dioxide emissions (0.7%), and population (0.7%). In the non-OECD, real GDP and electricity consumption rose 3.5% and 3.8% per year, respectively. Energy consumption, carbon dioxide emissions, and population grew at the comparatively slow rates of 2.3%, 1.8%, and 1.7%.

- Carbon dioxide emissions in both the OECD and non-OECD grew more slowly than energy consumption between 1980 and 2001. This was a result of an increase in the share of nuclear and hydroelectric power, an overall trend away from energy intensive industries, and a shift towards less carbon intensive fossil fuels (e.g., natural gas as opposed to coal).

- Population grew twice as rapidly in the non-OECD as in the OECD between 1980 and 2001.

Changing Fuel Usage



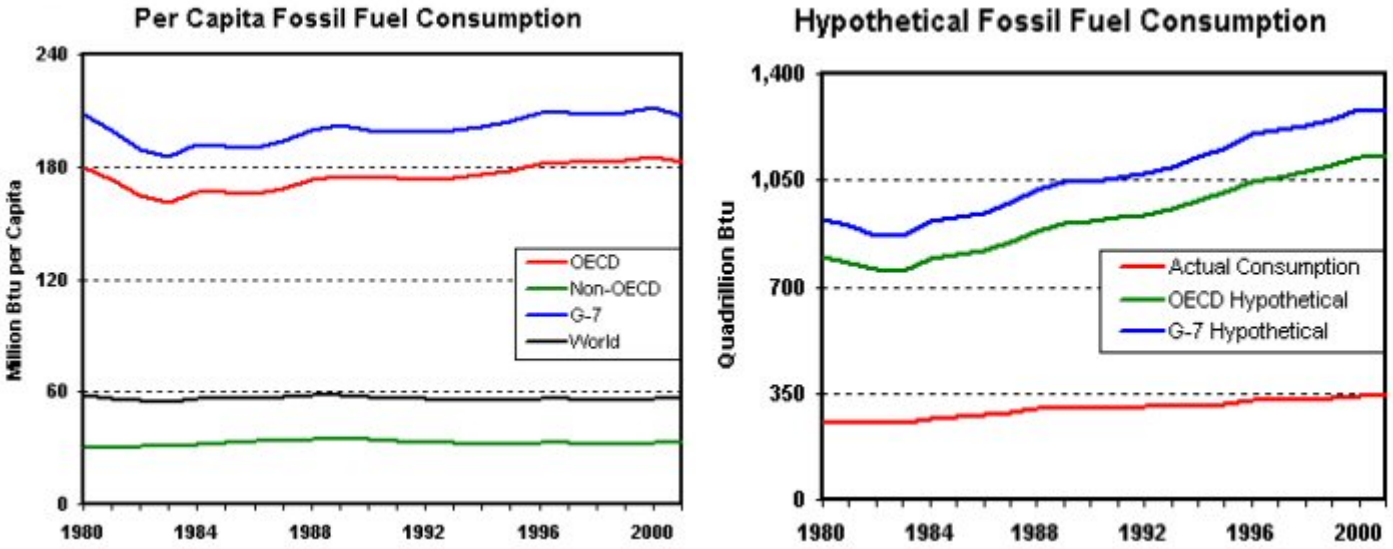
- Excluding non-commercial energy, fossil fuels accounted for the vast majority of world energy consumed between 1980 and 2001, although the fossil fuel share declined over time. In the OECD, fossil fuel's share fell from an 88% share of energy consumption in 1980 to 82% in 2001. In the non-OECD, fossil fuel's share fell from 93% to 89% during that period.

- In both OECD and non-OECD countries, the shares of oil and coal declined between 1980 and 2001, while the share of natural gas grew. Oil's share fell mainly during the early 1980s, after the Iranian Revolution and subsequent oil shock. Since the mid-1980s, oil's share has essentially stabilized or even grown slightly. Oil remains the world's largest source of commercial energy.

- In the non-OECD countries, nuclear and hydroelectric power increased their combined share of total energy consumption, from 7% in 1980 to 10% in 2001. In the OECD, the combined share of hydroelectric and nuclear energy increased from 11% to 16%. Nuclear power accounted for most of this growth.

- In the OECD countries, non-hydroelectric renewable commercial energy sources (e.g. solar, wind, biomass) accounted for an increasingly large share of energy consumption between 1980 and 2001. Even with this growth, however, these energy sources comprised only 1% of total OECD energy consumption in 2001.

Per Capita and Hypothetical Fossil Fuel Consumption

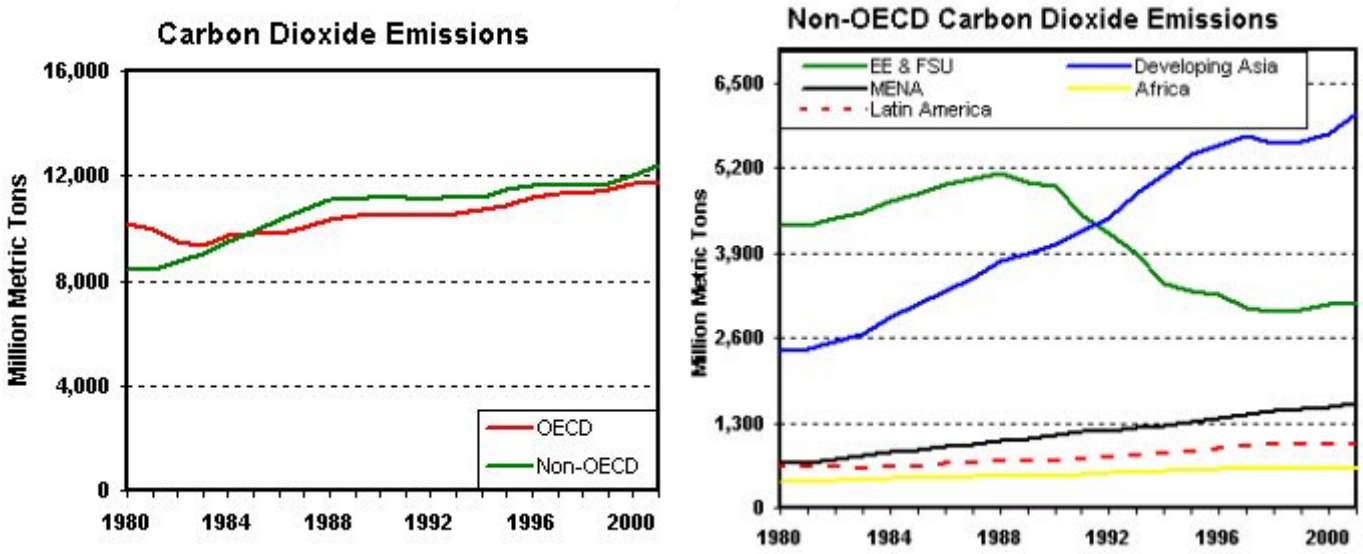


- Per capita use of fossil fuels remained about flat between 1980 and 2001 in both the OECD and the non-OECD. After declining in the OECD during the early 1980s as a result of the oil price shocks of the 1970s, per capita fossil fuel usage returned to its initial level.

- Per capita consumption of fossil fuels in the non-OECD was significantly lower than in the OECD between 1980 and 2001. For example, in 2001, per capita consumption in the OECD was 450% higher than in the non-OECD. The G-7 highly industrialized countries consumed even more fossil fuels per person than the rest of the OECD.

- If the entire world consumed fossil fuels at OECD per capita rates, global fossil energy consumption would be over 1,100 quads in 2001, more than three times the actual level of around 350 quads. If the rest of the world consumed fossil fuels at G-7 rates, global fossil fuel consumption would reach 1,300 quads.

Carbon Dioxide Emissions Overview



- World carbon dioxide emissions grew at an average annual rate of 1.2% between 1980 and 2001, from 18,651 MMT to 24,082 MMT. During this period, the average annual growth rate of OECD and non-OECD carbon dioxide emissions was 0.7% and 1.8%, respectively.

- Total OECD carbon dioxide emissions increased from 10,202 MMT in 1980 to 11,690 MMT in 2001. Non-OECD emissions increased from 8,448 MMT in 1980 to 12,392 MMT in 2001.

- The non-OECD countries began emitting more carbon than the OECD in 1985. Since then, the non-OECD has emitted consistently more carbon than the OECD despite a sharp decline in the EE&FSU region during the early- and mid-1990s.

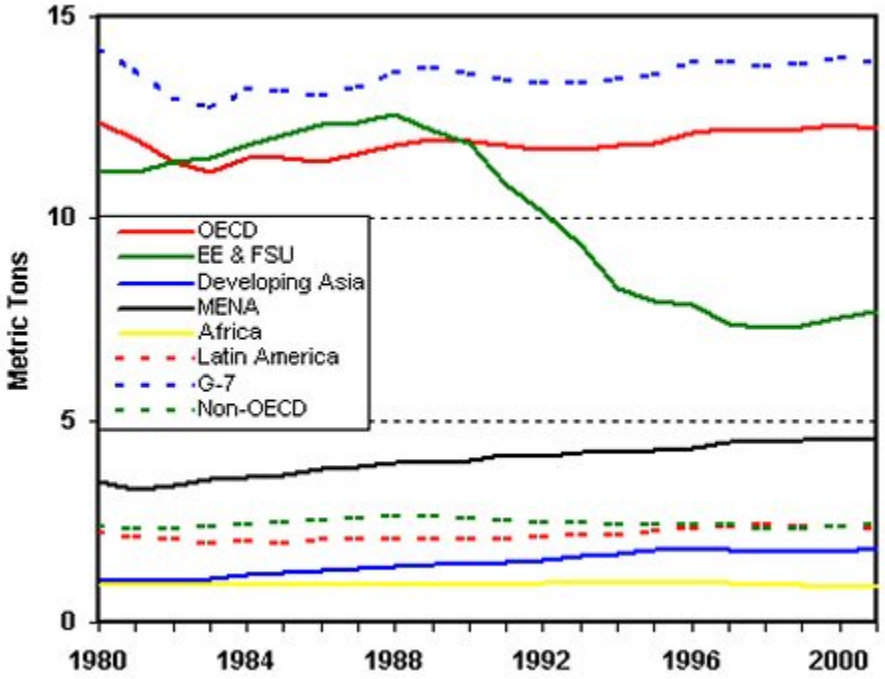
- Carbon dioxide emissions in the EE&FSU region fell sharply following the collapse of communism in the early 1990s, but then leveled off by the mid- and late-1990s.

- During the 1980s and 1990s, the engine behind much of the increase in non-OECD carbon dioxide emissions was Developing Asia, especially China and India. Between 1980 and 2001, Developing Asia's emissions more than doubled, from less than 2,400 MMT to almost 6,030 MMT.

- The increase in Developing Asia's carbon dioxide emissions between 1980 and 2001 was driven by rapid industrialization, growth in automobile ownership, and electrification.

- Developing Asia's emissions fell following the economic crisis that hit the region in the late 1990s, but began to rise once again in 2001.

Per Capita Carbon Dioxide Emissions



- Throughout the 1980s and 1990s, the per capita carbon dioxide emissions rate in the OECD remained about five times greater than in the non-OECD. It was even higher in the G-7 countries.

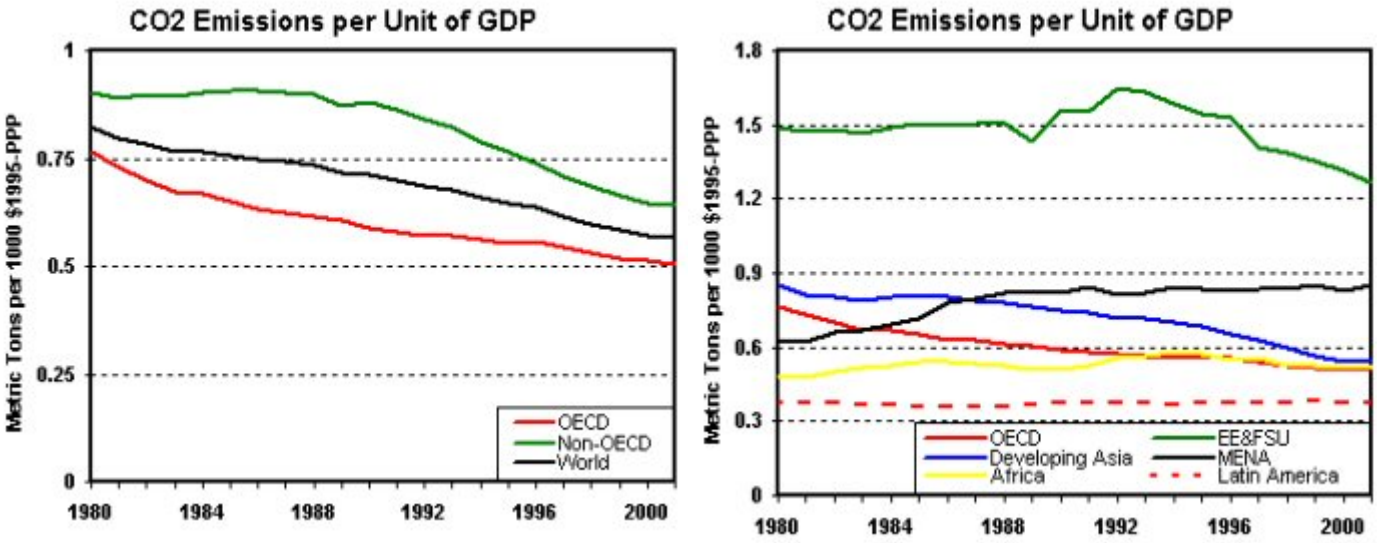
- The OECD's per capita carbon dioxide emissions rate fell in the early 1980s, but overall changed little between 1980 and 2001. In 2001, the OECD emitted 12.2 metric tons of carbon per person. Non-OECD per capita carbon dioxide emissions rose slightly over the time period, reaching 2.4 metric tons per person in 2001.

- Non-OECD per capita carbon dioxide emissions were relatively constant between 1980 and 2001, with a sharp decline in EE&FSU per capita carbon dioxide emissions during the 1990s offsetting an increase in the rest of the non-OECD.

- Within the OECD, although overall energy consumption increased from 1980 to 2001, the share of carbon intensive fuels declined, largely balancing each other out.

- If the entire world emitted carbon at OECD per capita levels, total carbon emission would be over three times greater than they actually are. If the entire world emitted carbon at G-7 per capita levels, total carbon dioxide emissions in 2001 would have been 3.5 times greater than they were. By contrast, if the entire world emitted carbon dioxide at non-OECD per capita levels, 2001 carbon dioxide emissions would have been only 60% of their actual level.

World and Regional Carbon Dioxide Intensity



- Between 1980 and 2001, world carbon dioxide intensity declined at an average annual rate of 1.7%, from 0.82 metric tons per thousand $1995-PPP to 0.57 metric tons per thousand $1995-PPP.

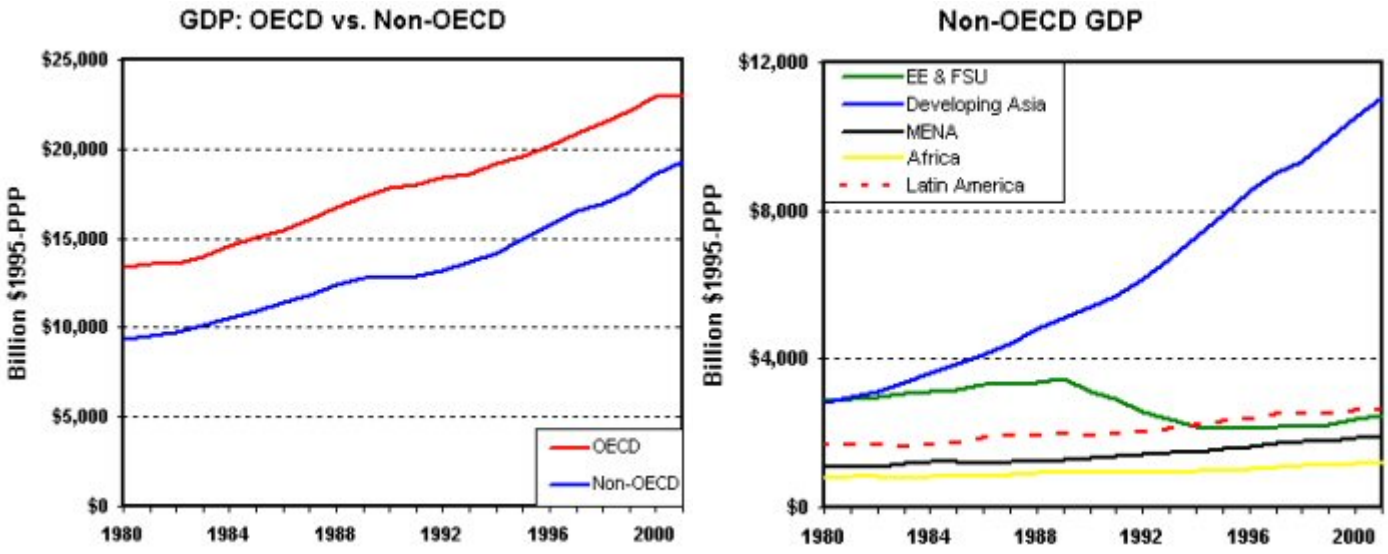
- During this period, the OECD's carbon dioxide intensity fell by one third, from 0.76 metric tons per thousand $1995-PPP in 1980 to 0.51 metric tons per thousand $1995-PPP in 2001. The OECD's carbon dioxide intensity fell more than twice as rapidly between 1980 and 1985 (3.5% per year) as it did thereafter (1.5%). This suggests the impact of the extreme oil price volatility seen during this period.

- By contrast, carbon dioxide intensity in the non-OECD declined rapidly during the 1990s after remaining constant for much of the 1980s. It fell from 0.90 metric tons per thousand $1995-PPP in 1990 to 0.24 metric tons per thousand $1995-PPP in 2001. This occurred because the impact of oil prices was overwhelmed by other factors like China's industrial maturation and the massive changes occurring in the EE&FSU region.

- Carbon dioxide intensity in the MENA region grew an average of 3.2% during the 1980s, following the oil price spikes of the 1970s, before leveling off in the 1990s. Latin America experienced almost no change in carbon dioxide intensity between 1980 and 2001. This reflects the more rapid growth of relatively non-carbon intensive natural gas and non-carbon hydroelectric energy over the period.

- The EE&FSU region became more carbon dioxide intensive in the early 1990s. Once economic growth returned in the mid-1990s, carbon dioxide intensity began to decline. Between 1993 and 2001, the region's carbon dioxide intensity fell from 1.64 metric tons per thousand $1995-PPP to 1.27 metric tons per thousand $1995-PPP. See EE&FSU section below for further discussion.

GDP Growth Trends



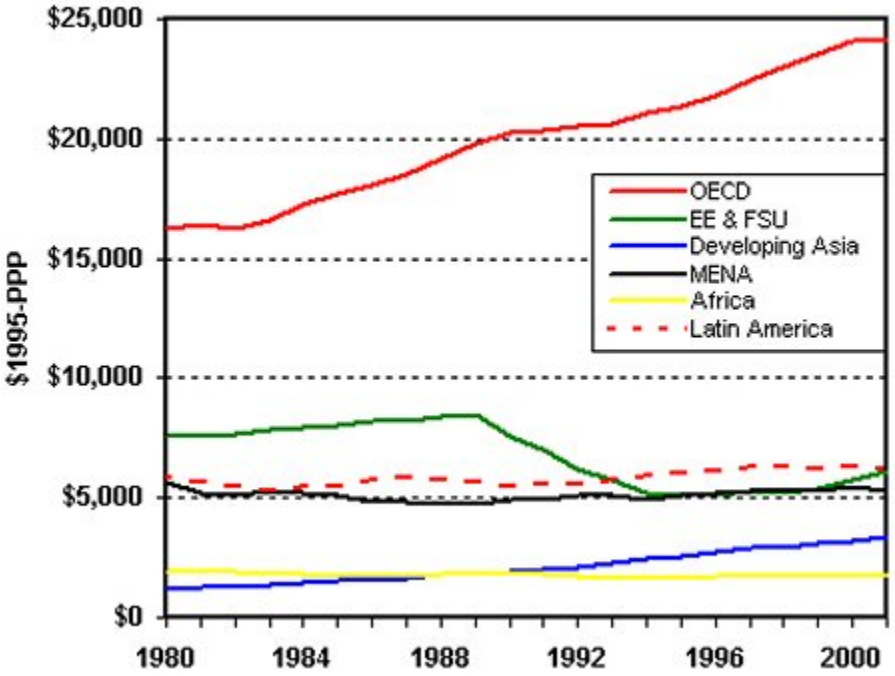
- Between 1980 and 2001, the OECD countries' combined real GDP grew from $13.4 trillion to $23.1 trillion, reflecting an average annual growth rate of 2.6%. The non-OECD countries' real GDP expanded from $9.4 trillion $19.3 trillion, a rate of 3.5% per year.

- Developing Asia experienced extremely rapid real GDP growth between 1980 and 2001, far outpacing the rest of the developing world. During these years, Developing Asia's GDP nearly quadrupled, from $2.8 trillion to $11.1 trillion. This translates into an average annual growth rate of 6.8%.

- With the exception of Developing Asia, the non-OECD grew poorer relative to the developed world during the 1980s and 1990s. Real GDP actually fell in the EE&FSU region, while increasing very slowly in MENA, Africa, and Latin America.

- The collapse of the Soviet Union and the other communist governments in the late 1980s and early 1990s severely disrupted economies in the EE&FSU. For the region as a whole, economic growth did not return until the mid-to late-1990s.

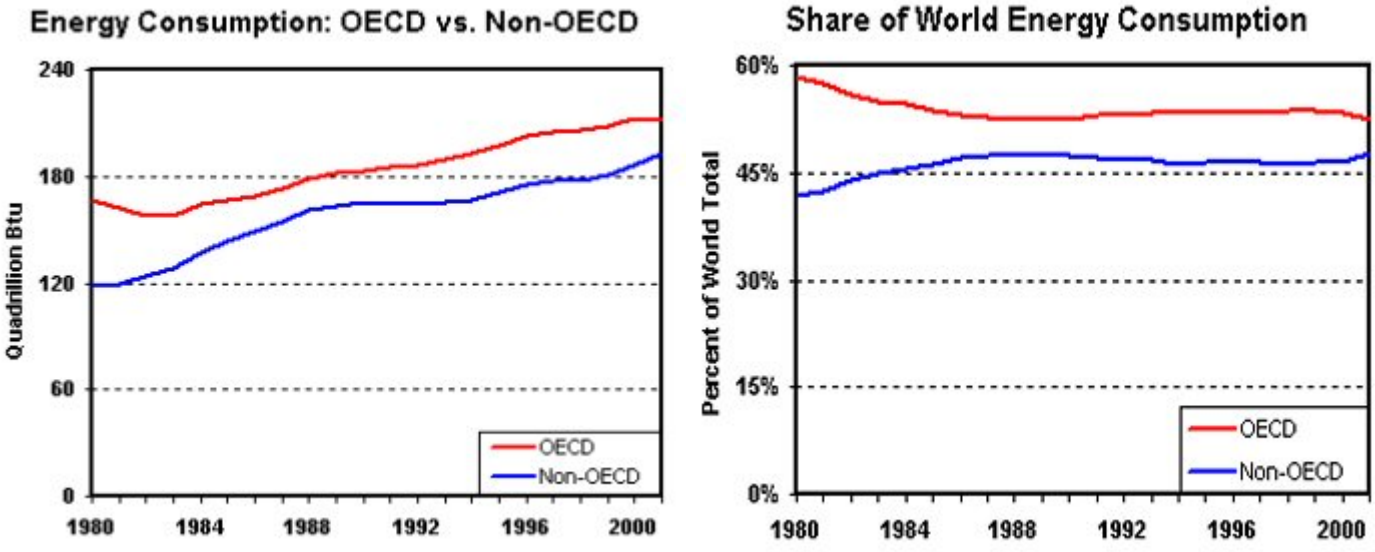
Regional GDP per Capita



- Between 1980 and 2001, the OECD's real GDP per capita grew at an average annual rate of 1.9%, increasing from $16,200 to $24,100. The non-OECD countries real GDP per capita increased by 2% per year, from $2,600 to $3,700. During the period, the gap between OECD and non-OECD real incomes widened from $13,600 to $20,400.

- Between 1980 and 2001, the average annual changes in per capita income in the EE&FSU, Africa, MENA, and Latin America were –1.0%, -0.5%, -0.3%, and 0.2%, respectively. Only Developing Asia experienced more rapid per capita GDP growth (5% per year) than did the OECD between 1980 and 2001.

Economic Development and Energy Usage



- World energy consumption increased from 285 quads in 1980 to 404 quads in 2001. This represented a 1.7% annual growth rate during the period.

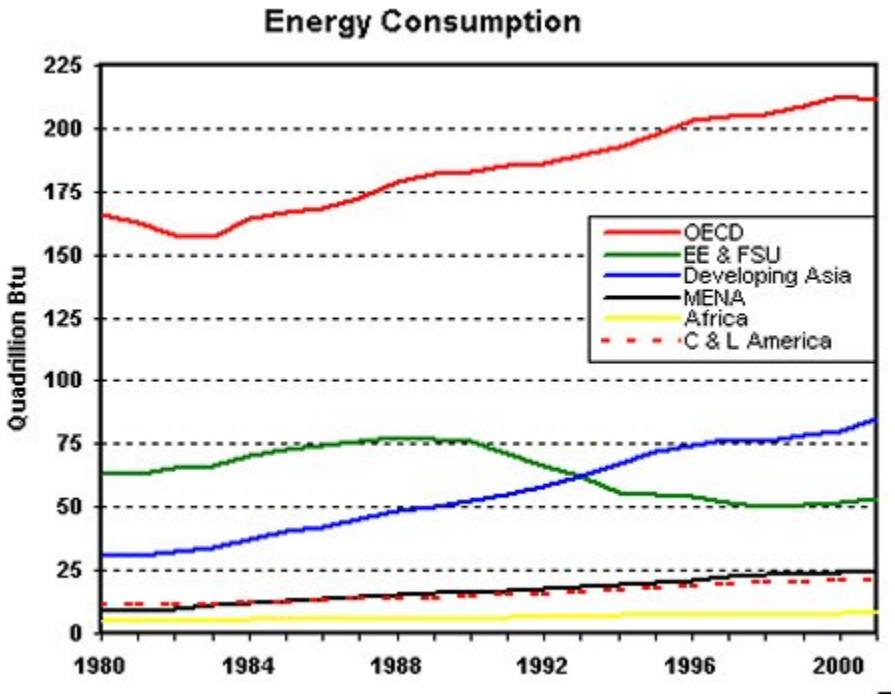
- Between 1980 and 2001, the OECD countries consistently held a larger share of world energy consumption than the non-OECD, although the gap has narrowed considerably since 1980.

- The OECD's total energy consumption grew from 166 quads in 1980 to 211 quads in 2001, a 1.2% annual rate of increase. Energy consumption in the non-OECD grew at a rate of 2.3% per year, from 119 quads in 1980 to 192 quads in 2001.

- Most of the increase in non-OECD energy consumption relative to the OECD took place in the 1980s. This reflected very rapid (1.9%) annual growth in the EE&FSU region during that period. During the early- and mid-1990s, the EE&FSU region's rate of energy consumption declined significantly, and non-OECD energy consumption grew at roughly the same pace as in the OECD.

- The oil shocks of the 1970s caused an absolute decline in energy consumption in the OECD in the early 1980s. After oil prices collapsed in late 1985 and early 1986, energy consumption in the developed countries rose steadily until 2000 and 2001. At that time, demand growth paused as the world economy entered a recession.

Regional Variation in Energy Consumption

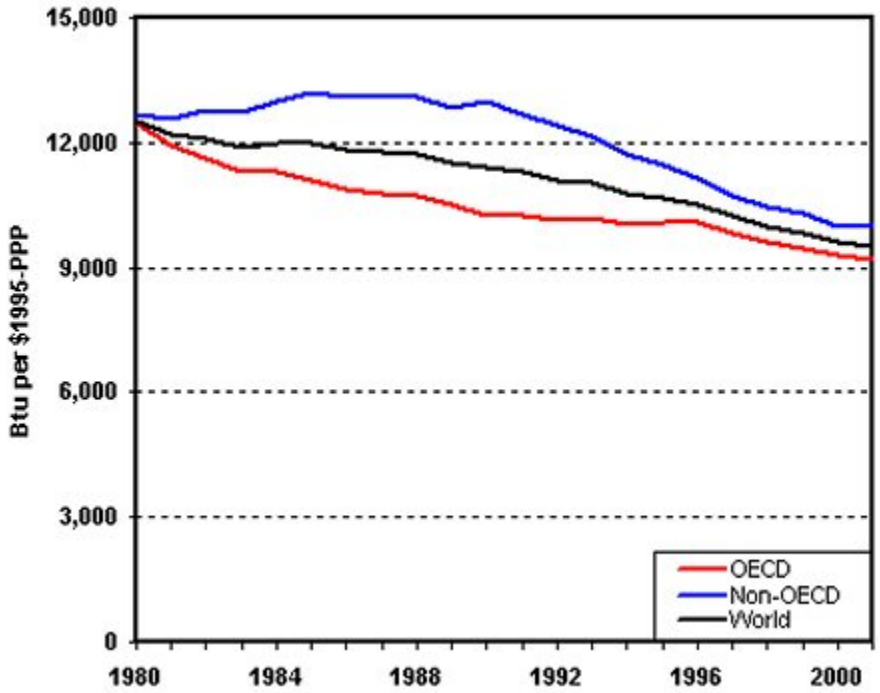


- Driven by rapid economic growth, Developing Asia's energy demand increased at a rapid annual rate of 5% during the 1980s and 1990s, nearly tripling from 30 quads to 85 quads.

- Energy consumption in most non-OECD regions increased more rapidly than in the OECD between 1980 and 2001. In the EE&FSU region, energy consumption fell an average of 0.8% between 1980 and 2001, from 63 quads to 53 quads. This understates the severity of the decline, because consumption actually grew until 1989. Then, between 1989 and 1998, the EE&FSU region's energy demand declined an average of 4.6% per year.

- Energy consumption in the MENA region grew at an extremely rapid 5.1% annual rate between 1980 and 2001, almost tripling from 9 quads to 25 quads. This growth was driven by population and economic growth, combined with development of energy intensive industries like petrochemicals and oil refining,

Development and Energy Intensity



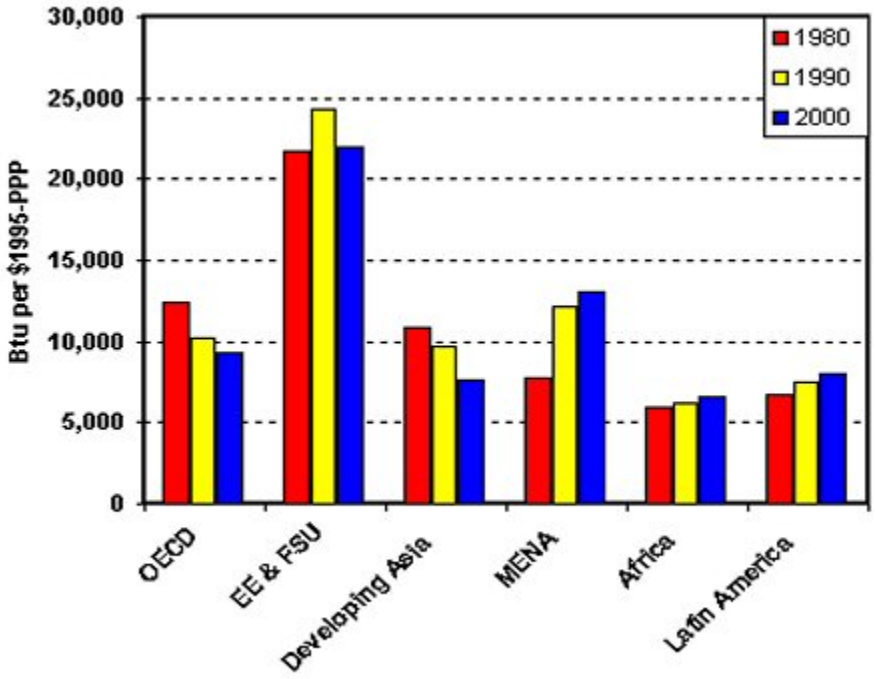
- The world's energy intensity declined an average of 1.3% per year between 1980 and 2001, from 12,538 Btu per $1995-PPP to 9,532 Btu per $1995-PPP. This change reflects reductions in both the OECD and non-OECD.

- Between 1980 and 2001, the OECD nations' energy intensity declined 1.4% per year, from 12,443 Btu per $1995-PPP to 9,165 Btu per $1995-PPP. While energy intensity in the developed countries fell throughout the period, it fell significantly more rapidly in the early and mid 1980s (2.3% per year) than it did following the decline of oil prices in 1985 – 1986 (1.1% per year).

- The reduction in OECD energy intensity stemmed from gains in energy efficiency combined with shifts in economic structure. Energy intensive industries within many developed economies declined relative to the less energy-intensive service sector. Simultaneously, the manufacturing mix in the OECD shifted towards less energy-intensive products. Many of the most-intensive processes (e.g., steel, automobiles, mining) shifted overseas, to non-OECD countries in particular.[6]

- Between 1980 and 2001, the non-OECD countries' energy intensity declined 1.1% per year, from 12,674 Btu per $1995-PPP to 9,972 Btu per $1995-PPP. In the developing world, energy intensity declines stemmed from a combination of energy efficiency gains and structural shifts. Similar to carbon dioxide intensity, the bulk of the reduction in non-OECD energy intensity took place in the 1990s. The reasons for this pattern are the same as those described above for carbon intensity.

Regional Energy Intensity Trends

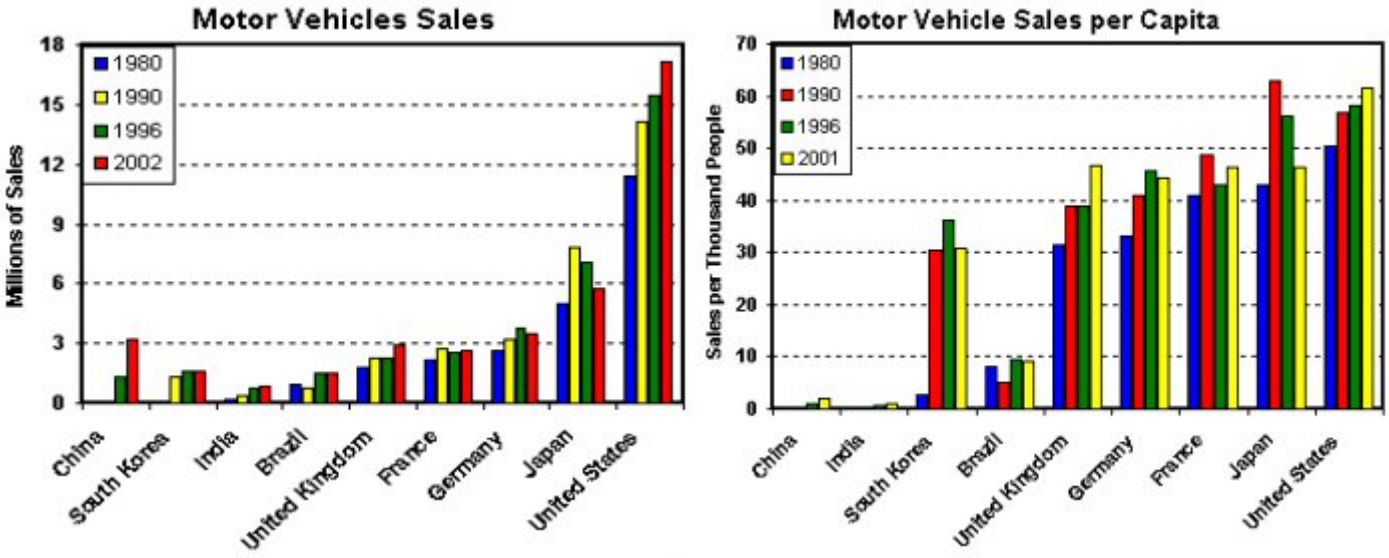


- Between 1980 and 2001, Developing Asia drastically reduced its energy intensity, from around 10,864 Btu per $1995-PPP to roughly 7,681 Btu per $1995-PPP, an average annual decline of 1.6%. The other non-OECD regions actually grew more energy intensive over the period. Developing Asia accounted for a disproportionate share of non-OECD energy consumption, resulting in a decline in overall non-OECD energy intensity.

- For China, Developing Asia's largest energy consumer, the reduction in energy intensity has been attributed much more to improving technical efficiency than to changes in economic structure.[7]

- Between 1980 and 2001, the MENA region's energy intensity grew an average of 2.7% per year, from 7,723 Btu per $1995-PPP to 13,385 Btu per $1995-PPP. This reflects the steady growth in energy demand created by the region's rapidly growing population and energy-intensive industrialization, as well as government policies to keep energy prices low.

Growth in Vehicle Penetration in Selected Countries

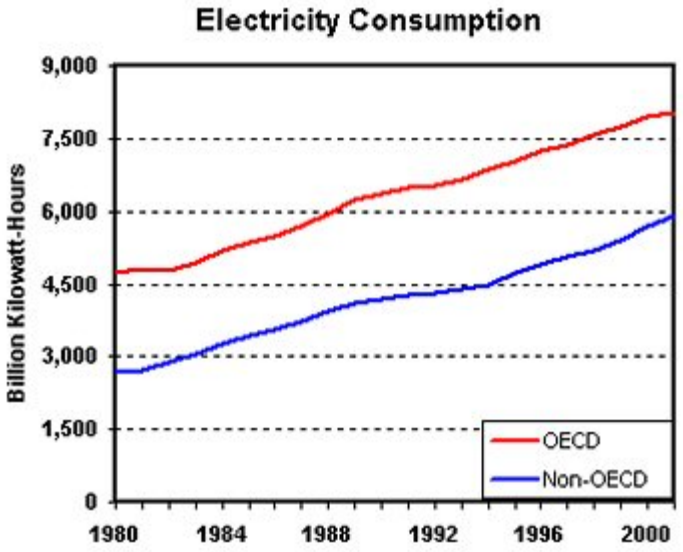


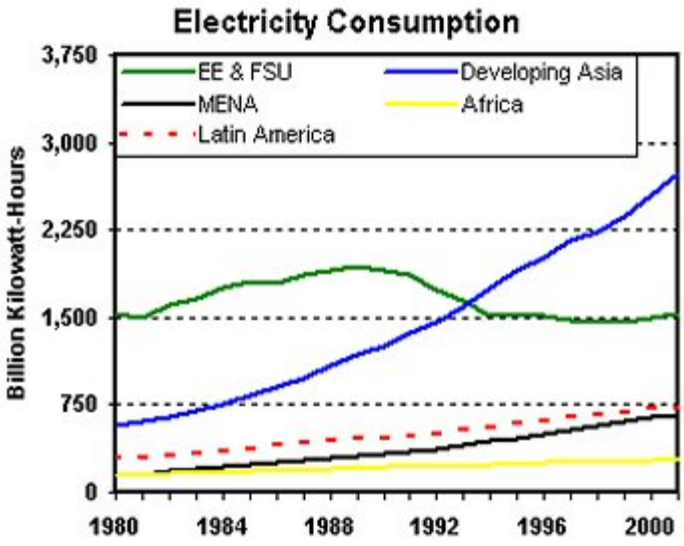
- Between 1980 and 2001, one of the most important contributors to the growth in energy consumption and carbon dioxide emissions was motor vehicle ownership.

- Of the four years examined, the United States was the leader in sales per capita among the nations surveyed in all but one. At the height of its economic boom in 1990, Japan had more domestic car sales per thousand people than anywhere else in the world.[8]

- Though motor vehicle sales per capita remain low in China and India compared to OECD countries, they have risen dramatically since 1980. As a result, more cars were sold in China in 2001 than in four of seven G-7 countries. This has large implications for world energy use and carbon dioxide emissions trends.

Electricity Consumption Overview





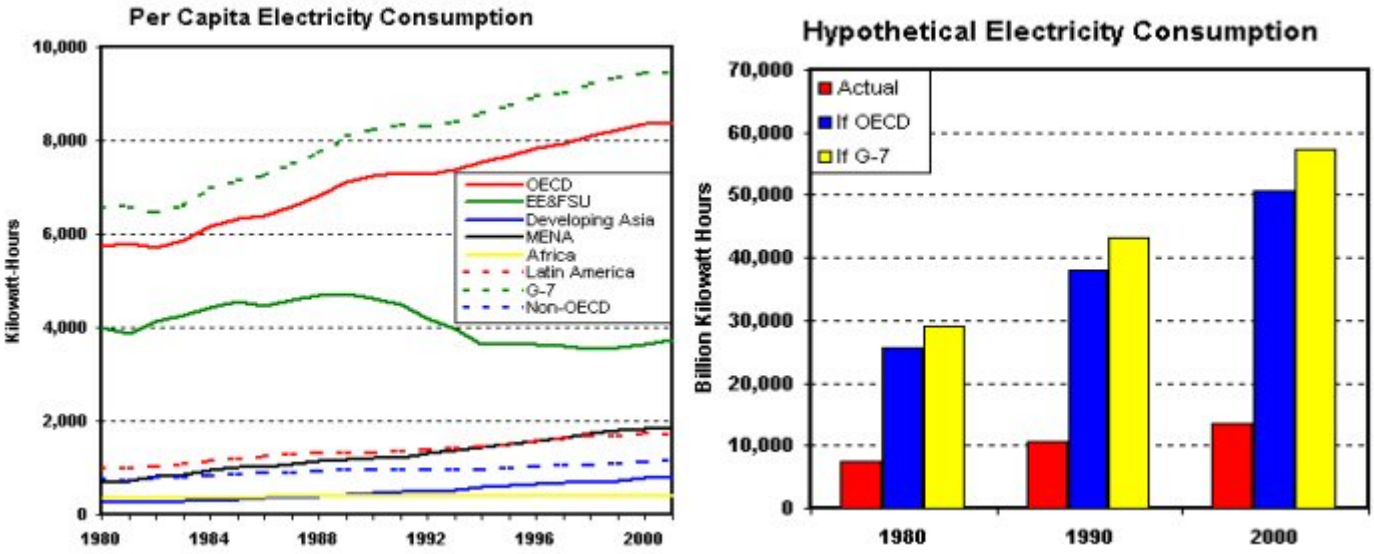
- Between 1980 and 2001, world electricity consumption increased 88%, an average of 3.0% per year, from 7,417 billion kilowatt-hours (bkwh) to 13,934 bkwh. Electricity demand grew relatively faster in the non-OECD than in OECD.

- During the 1980s and 1990s, electricity consumption grew at an annual rate of 3.8% in the non-OECD, from less than 2,700 bkwh to over 5,900 bkwh. In the OECD, demand grew an average of 2.5% per year, rising from 4,730 bkwh to 8,016 bkwh.

- Much of the increased electricity consumption in the non-OECD took place in Developing Asia. Between 1980 and 2001, demand for electricity in the region grew 7.7% per year, rising from less than 600 bkwh to more than 2,700 bkwh.

- The MENA region's electricity consumption grew at the same rapid rate as Developing Asia's between 1980 and 2001, though it started the period at a much lower base. In large part, the region's rapid growth reflected efforts to provide electricity to its rapidly growing population.

Electricity Consumption Per Capita



- Though electricity consumption grew faster in the non-OECD than in the OECD between 1980 and 2001, the non-OECD's per capita power consumption remains far smaller.

- During the 1980s and 1990s, per capita electricity consumption in the OECD increased at an average annual rate of 1.8%, from 5,751 kilowatt-hours (kwh) to 8,368 kwh. The G-7's per capita electricity consumption also grew 1.8% per year, rising from 6,550 kwh to 9,449 kwh.

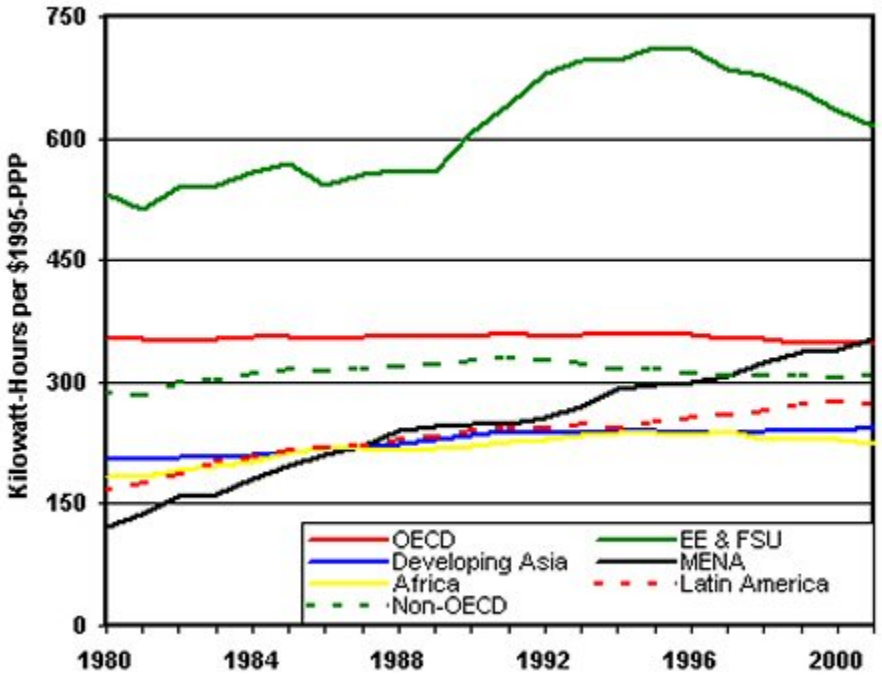
- Between 1980 and 2001, demand for electricity in the non-OECD increased by an even more rapid 2.1% per year, from 744 kwh to 1,141 kwh.

- If the entire world's population consumed electricity at the per capita rate of the OECD in 2001, then about 51,400 bkwh of electricity would have been consumed, 269% more than actual consumption levels.

- If the entire world had consumed at G-7 per capita levels in 2001, almost 58,100 bkwh of electricity would have been consumed. The additional electricity (44,100 bkwh) is equivalent to 70.1 million barrels per day of oil equivalent – almost equal to actual world oil consumption in 2001.

- Per capita electricity demand grew very rapidly in both the MENA region and Developing Asia between 1980 and 2001, rising 5.0% and 5.9% per year, respectively. In the MENA region, this growth occurred despite falling per capita incomes.

Electricity Intensity



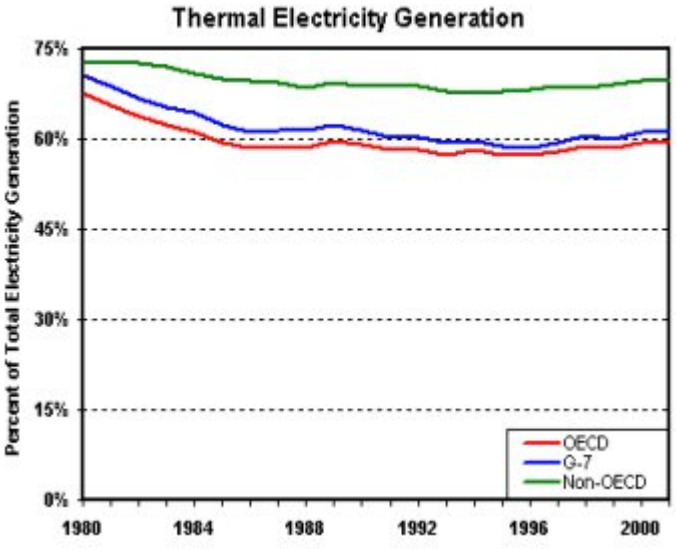
- The world's electricity intensity remained almost constant around 330 kwh per $1995-PPP between 1980 and 2001. It rose during the 1980s, but fell back to close to its initial position by the end of the period.

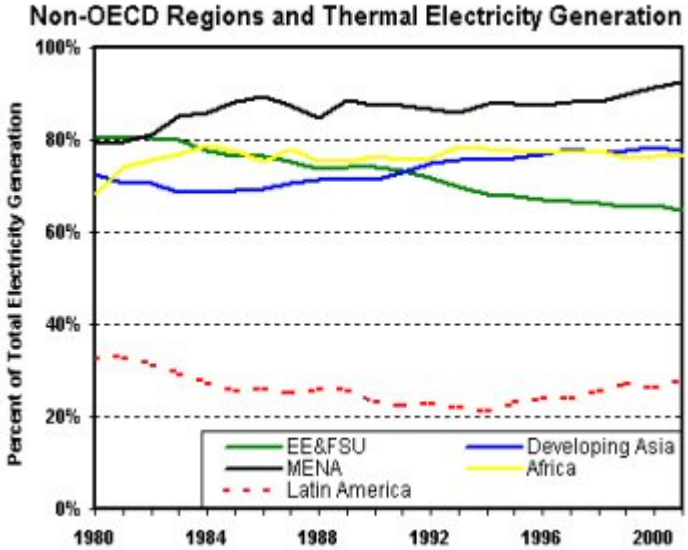
- During the same period, the OECD's electricity intensity fell slightly, declining an average of 0.1% per year. The non-OECD's electricity intensity grew slightly, rising an average of 0.3% per year between 1980 and 2001.

- The EE&FSU region's electricity intensity rose between the late 1980s and mid-1990s in large part because Russia, the region's dominant economy, maintained price controls on the factors involved in electricity production and on electricity itself. This permitted both generation and consumption to continue at comparatively high levels while the rest of the economy declined. The decline in the region's electricity intensity during the late 1990s is partly explained by the eventual reduction of these subsidies.[9]

- Latin America's electricity intensity rose 63% between 1980 and 2001. This growth reflects widespread rural electrification and the development of more power-intensive industries.

Thermal Electricity Generation





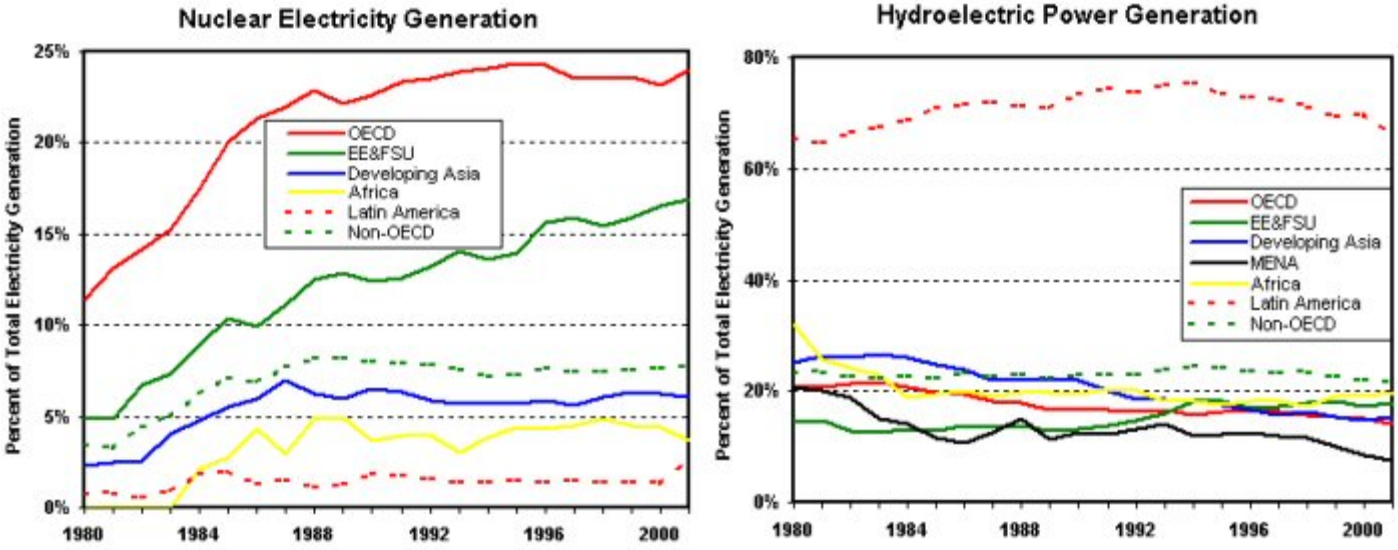
- Between 1980 and 2001, the share of fossil energy in the world's electricity generation portfolio declined -- from 70% to 64%. The bulk of the decrease took place in the early 1980s in response to the oil price hikes of the 1970s. Once oil prices declined in 1985 and 1986, the trend away from thermal generation slowed.

- The trend away from thermal electricity generation was more pronounced in the OECD than in the non-OECD. Between 1980 and 2001, the share of electricity generated by thermal power plants fell from 68% to 60% in the OECD. In the non-OECD, thermal plants' share of electricity generation decreased more modestly, from 73% to 70%.

- The non-OECD remains more dependent upon fossil fuels for its electricity generation needs than the OECD. This is true throughout the non-OECD, except in Latin America, which uses its hydroelectric resources very intensively. In fact, Latin America is the only region in the world where thermal power plants account for less than half of all electricity generation.

- In the late 1990s, thermal generation began to grow in importance around the world. In the OECD, especially, this reflects the growing use of natural gas-fired power plants and the relative stagnation of nuclear and hydroelectric power.

Non-Thermal Electricity Generation



- In the OECD, the increasing share of non-thermal electricity generation between 1980 and 2001 resulted mainly from the relative growth of the nuclear sector. Nuclear's share of OECD electricity generation rose dramatically, from 11% to 24%, over the period. Most of the increase took place in the 1980s.

- During the 1990s and early 2000s, lower oil prices and increased concerns over the environmental impact of nuclear power slowed the sector's expansion.

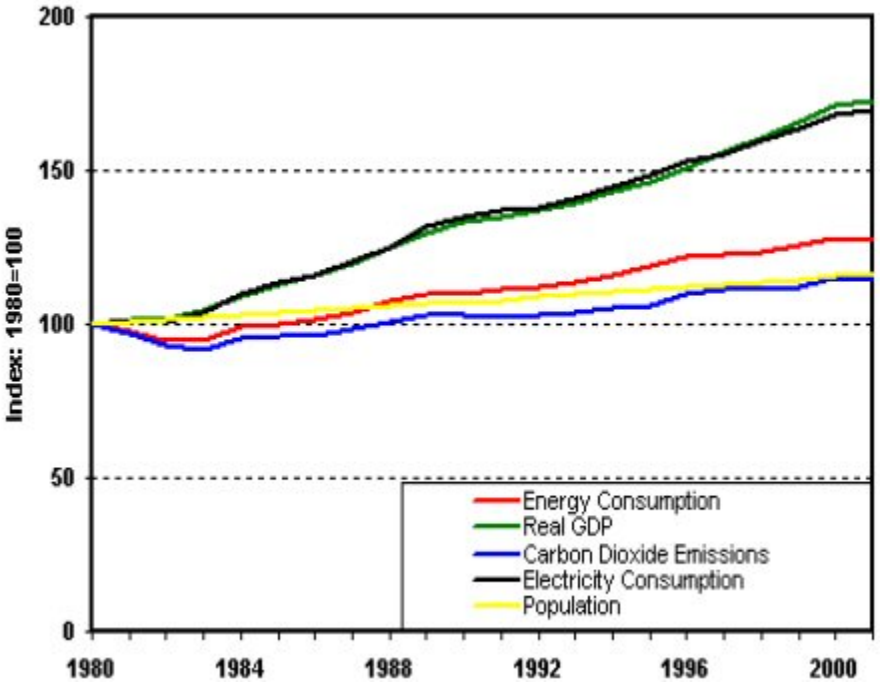
- In the non-OECD, the absolute growth in nuclear power as a share of total power generation was more modest than in the OECD between 1980 and 2001. Its share of electricity generation grew from 3% to 8% during these years.

- Hydropower's share grew only in one region -- Latin America -- between 1980 and 2001. Much of this growth, however, took place in the 1980s and early 1990s. Since that time, the share of Latin America's electricity generation from hydroelectric plants has declined.

- Although now growing rapidly, non-hydroelectric renewable energy sources still account for only a small share of world electricity generation. In 2001, these sources accounted for 2% and 1% of total electricity generation in the OECD and non-OECD, respectively.

II. OECD & G-7

OECD Development Trends



- Between 1980 and 2001, the largest overall increases occurred in electricity demand and GDP, which grew 69% and 73%. These reflect average annual growth rates of 2.5% and 2.6%, respectively. By comparison, energy consumption increased just 27% overall (1.2% per year), and carbon dioxide emissions grew even more slowly, rising 0.7% per year.

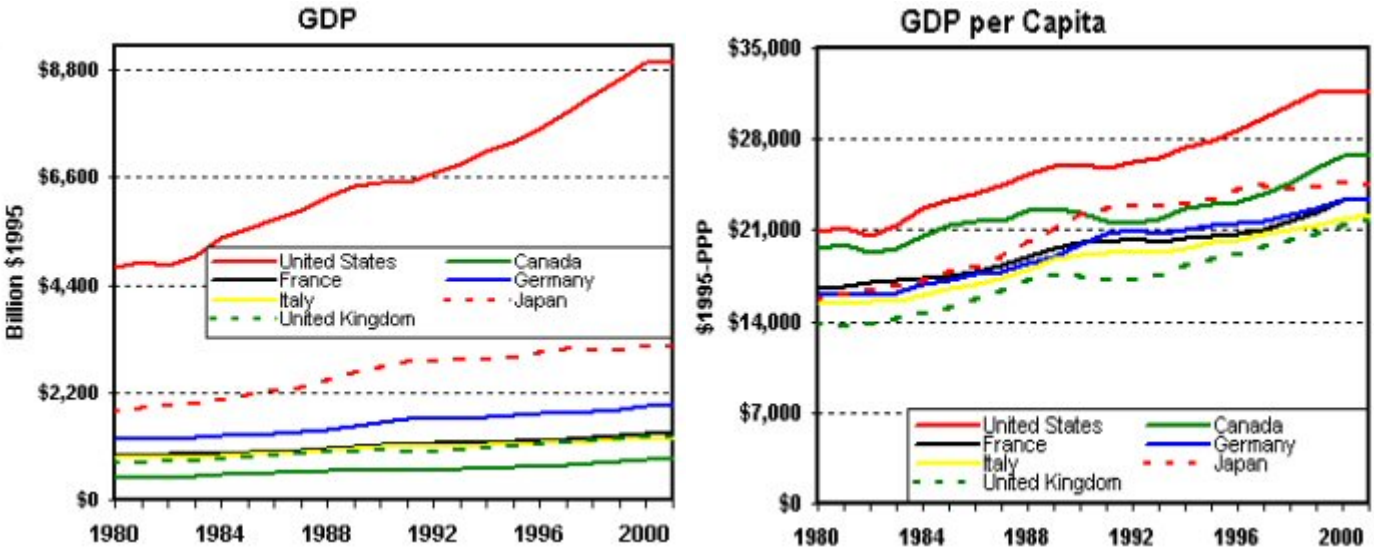
- This strongly suggests that the OECD has entered a phase of development where GDP growth is no longer contingent upon energy intensive heavy industries.

- Only population continued to grow during the early 80s as the oil price shocks and economic downturn slowed energy consumption, carbon dioxide emissions, economic growth, and electricity consumption. GDP and electricity consumption remained more or less constant while energy consumption and carbon dioxide emissions declined slightly.

- Once the price of oil declined in the mid-1980s, energy consumption and carbon dioxide emissions steadily increased, with energy consumption rising slightly faster than carbon dioxide emissions.

- Though it grew consistently over the period, the OECD's population only registered an overall increase of 16% (0.7% per year).

G-7 Economic Output



- Between 1980 and 2001, OECD real GDP grew by 2.6% per year, rising from $13.4 trillion to $23.1 trillion. The economic output of the G-7 countries grew slightly faster (2.7% per year).

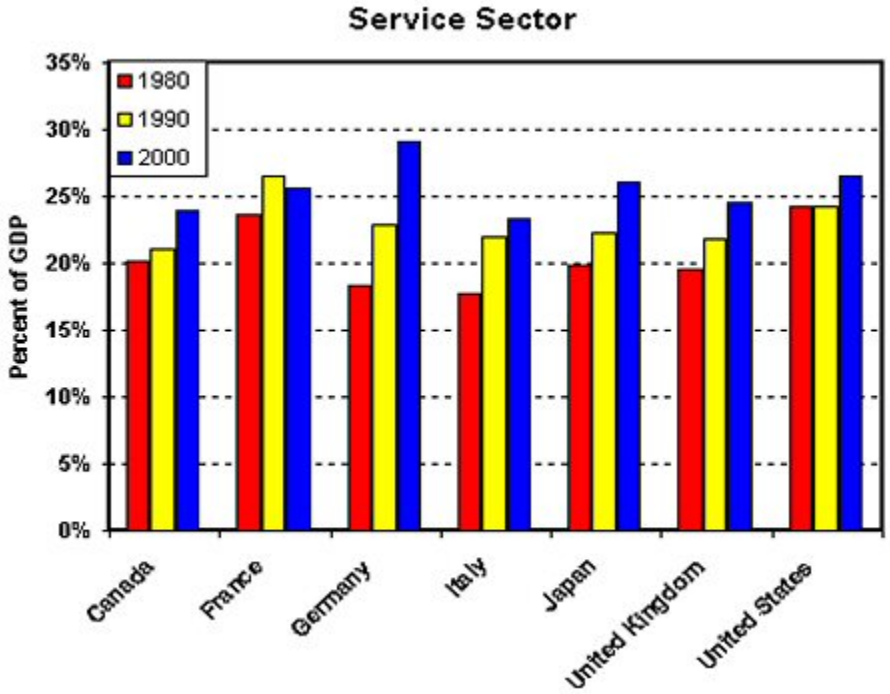
- Because the G-7 countries experienced little population growth (just 0.6% per year), their economic expansion led to considerable growth in real per capita incomes (1.7% per year) during the 1980s and 1990s. Canada's real GDP per capita grew the slowest (1.5% per year) between 1980 and 2001, but still increased by more than 36% overall.

- The growth of the G-7 economies slowed only during the recessions of the early 1980s, early 1990s, and between 2000 and 2001.

- U.S. real per capita GDP grew the third most rapidly (2% per year) within the G-7 between 1980 and 2001. Only Japan and the United Kingdom grew faster, both experiencing average annual increases of 2.2%.

- Between 1980 and 2001, the annual growth rates in real per capita GDP for France, Germany, and Italy were 1.7%, 1.8%, and 1.8%, respectively.

Commercial Services Share of GDP in the G-7



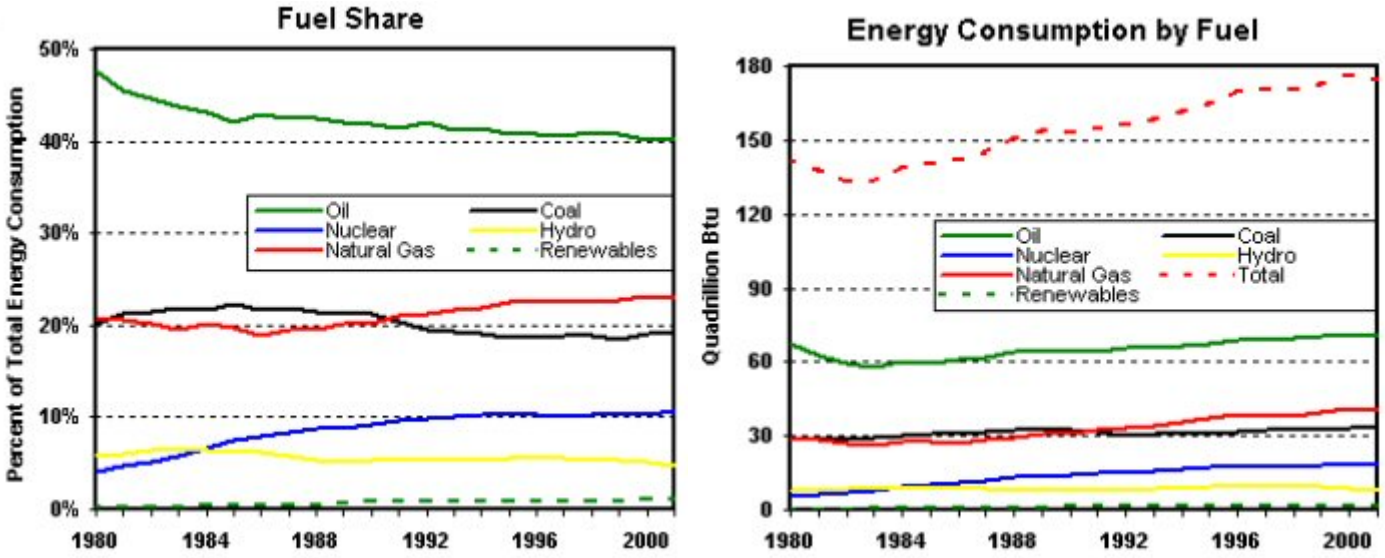
Note: Estimates of Japan's economic output from commercial services exclude "renting and business activities."[10]

- Commercial services' (defined here to include financial intermediation, real estate, renting, and business activities) share of G-7 economic output grew between 1980 and 2000. On average, commercial services accounted for 26% of a G-7-member's real GDP in 2000, up from 21% in 1980.

- The industrial sector consumes considerably more energy per unit of output than the services sector used. This indicates that, other things being equal, as the economy becomes more service-oriented, energy intensity should decline since an increasingly large share of economic output is produced with comparatively little energy.[11]

- Also reducing G-7 energy intensity during this period was the shift of many heavy industrial processes to the developing world. In part, this reflects the mobile nature of capital in a global economy.

Energy Consumption by Fuel Type in the G-7



- The G-7's total energy consumption grew an average of 1% a year between 1980 and 2001, rising from 142 quads to 174 quads. Of this increase (32 quads), nuclear, hydroelectric, and other renewables accounted for 15 quads. G-7 fossil fuel consumption grew almost 18 quads during this period, of which natural gas accounted for 11 quads, coal for 4 quads, and oil for 3 quads.

- While the G-7 used more of each type of fuel in 2001 than it did in 1980, the share of fossil fuels in overall energy consumption declined from 88% to 82%.

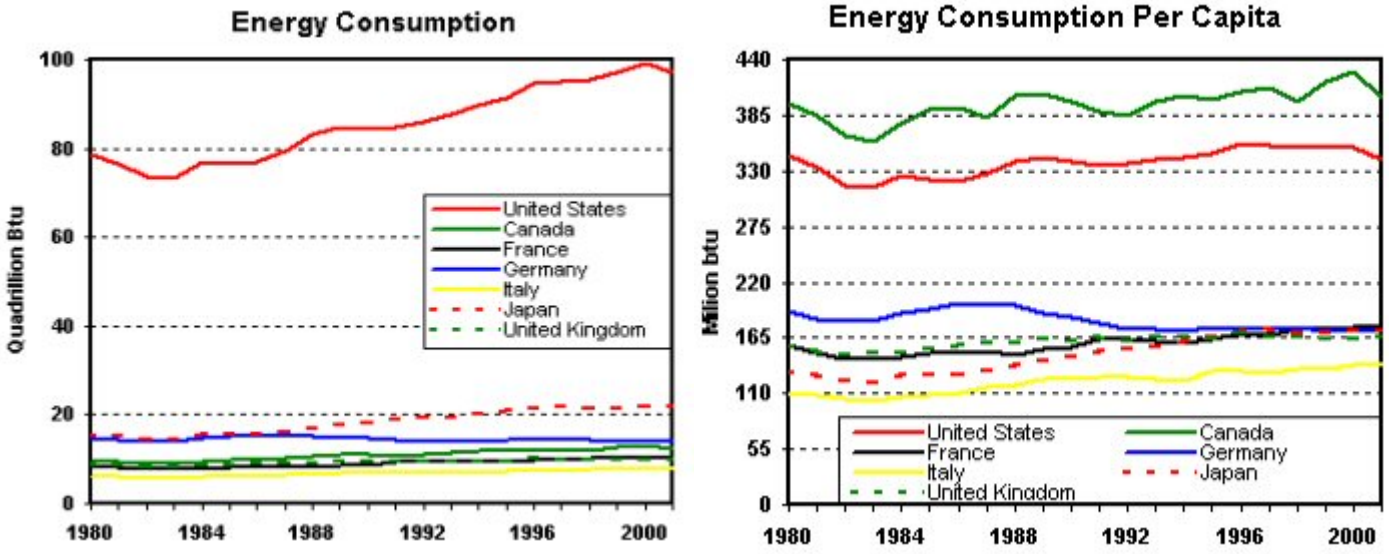
- The G-7's fossil fuel mix also became less carbon intensive. Both oil's and coal's shares of total energy consumption declined, from 48% to 40%, and from 20% to 19%, respectively. Natural gas increased its share from 21% to 23%.

- The decline in oil's share of G-7 energy consumption began in the 1970s in response to large oil price spikes. Despite the oil price collapse of 1985/1986, oil's share did not recover to 1980 levels.

- During the same period, nuclear energy almost tripled its share of G-7 energy consumption, from 4% to 11%. Since the early 1990s, however, nuclear energy's share has remained almost constant.

- Between 1980 and 2001, hydroelectric power's share declined from 6% to 5%. During the same period, non-hydroelectric renewables increased their share from 0.2% to 1%.

G-7 Energy Consumption



- The United States is by far the largest consumer of energy in the G-7. Between 1980 and 2001, U.S. energy consumption grew from 79 quads to 97 quads. Among the rest of the G-7, only Japan's energy consumption was higher than 20 quads in 2001.

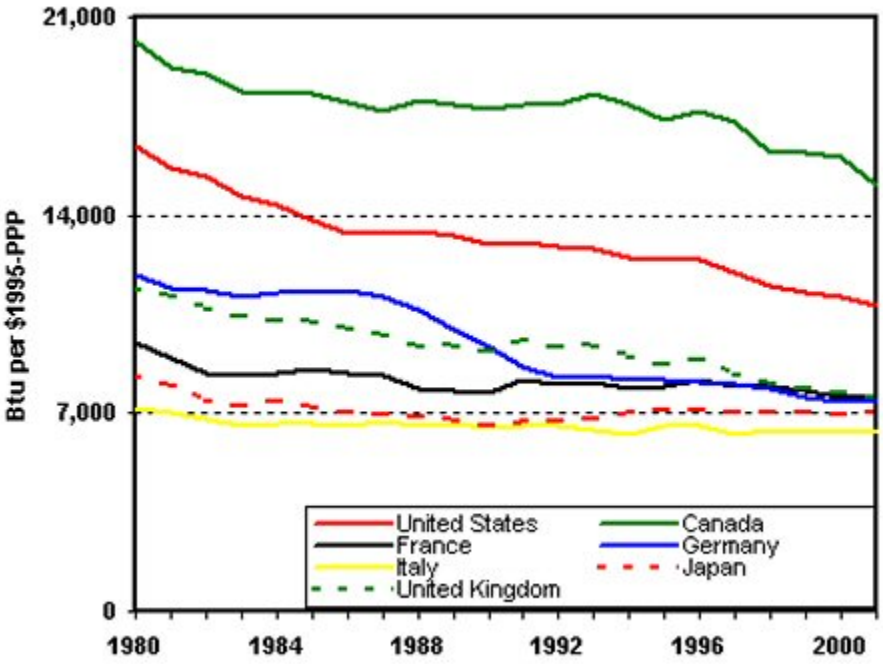
- Between 1980 and 2001, energy consumption per capita fluctuated throughout the G-7. In response to higher oil prices, it declined in the early 1980s. Following the oil price collapse in 1985 and 1986, energy consumption per capita rose until the global economic downturn in 2000 and 2001. In 2001, G-7 per capita energy consumption was 248 million Btu, up 16% from 1983.

- In 2001, the United States and Canada consumed 342 million Btu's per person and 403 million Btu's per person, respectively. No other G-7 member's per capita consumption exceeded 200 million Btu's in that year.

- Unlike in Japan or in Western Europe (except for North Sea oil), Canada and the United States contain considerable natural resource deposits, which have led to the development of sizable extractive and processing industries. These industries are heavily energy intensive.

- Japan's per capita energy consumption increased an average of 1.7% per year between 1980 and 1996. From 1997 to 2001, however, its annual growth rate was -0.1%, which likely reflects the country's economic downturn. Japan's low overall per capita consumption rate is indicative of Japan's comparatively smaller share of energy intensive industries, as well as different standards of consumption in the residential and transportation sectors. [12]

G-7 Energy Intensity



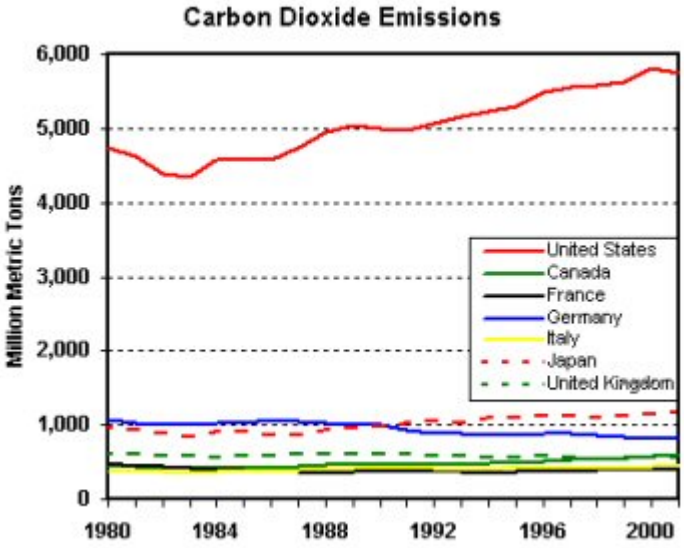
- Between 1980 and 2001, the G-7's energy intensity declined 28% overall -- an average of 1.6% per year -- from 13,039 Btu per $1995-PPP to 9,254 Btu per $1995-PPP. The most rapid decline took place prior to the oil price collapse of 1985 – 1986. Between 1980 and 1985, G-7 energy intensity fell an average of 2.7% per year; from 1986 to 2001, it fell 1.2% per year.

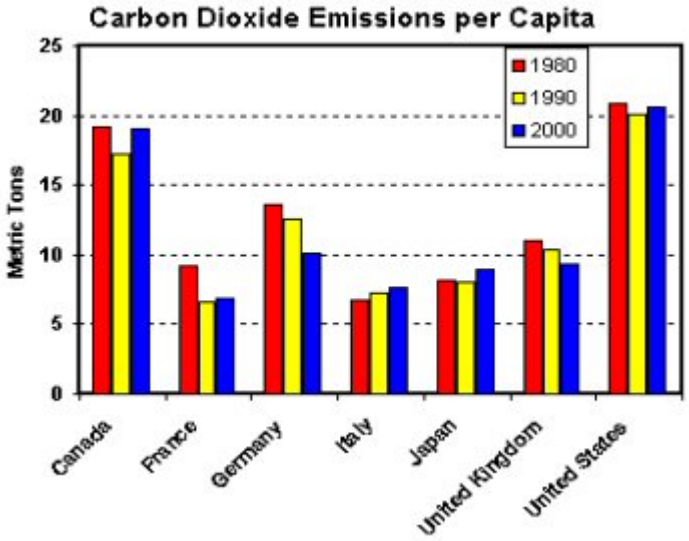
- Structural shifts in the G-7 countries' economies towards activities that are relatively less energy intensive accounted for much of the reduction in energy intensity. This is especially true after the oil price collapse of 1985 – 1986 reduced some of the need to improve efficiency. The changes in economic structure included faster relative growth in the service sector as well as changes in countries' manufacturing mixes. For example, manufacturing information technology equipment, an increasingly important activity, is much less energy-intensive than producing raw materials such as steel.[13]

- Especially since the 1990s, a number of crosscutting factors have moderated declines in energy intensity within G-7. These factors include increased residential energy intensity (in part a result of larger homes, space heating, and appliance penetration), and growing consumption in the transportation sector (a result of increased travel and slowing fuel intensity declines during the 1990s).[14]

- The presence of large extractive and natural resource-processing industries help to explain why the United States' and Canada's energy intensities are significantly higher than they are elsewhere in the G-7. Such industries consume more energy per unit of economic output than do most other types of activities.

G-7 Carbon Dioxide Emissions Overview





- The G-7's carbon dioxide emissions grew relatively slowly – just 0.5% per year -- between 1980 and 2001, rising from 8,722 MMT to 9,697 MMT. However, emissions growth accelerated during the 1990s, rising to around 1% per year. This rate increase reflects a number of factors, including: slowing energy savings in most sectors, less switching from carbon intensive fuels for electricity production (in some countries), rising household emissions, and dramatic increases in emissions from the transportation sector.[15]

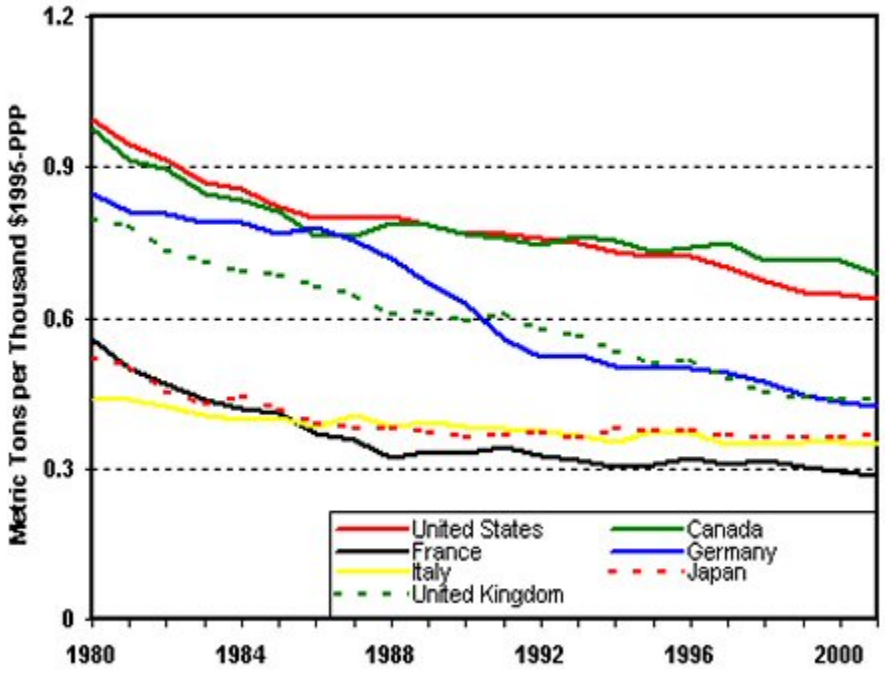
- Most of the absolute growth in G-7 emissions occurred in the United States. The U.S. accounted for 59% of all G-7 carbon dioxide emissions in 2001. Between 1980 and 2001, U.S. carbon dioxide emissions increased an average of 0.9% per year, rising from 4,742 MMT to 5,739 MMT.

- While U.S. carbon dioxide emissions grew the most in absolute terms between 1980 and 2001, other nations' carbon dioxide emissions increased at similar rates. Italy, Japan, and Canada all had similar growth rates.

- Between 1980 and 2001, annual per capita carbon dioxide emissions in the G-7 fell from 14.2 metric tons to 13.8 metric tons. This decline echoes the experience of the United States, where per capita emissions decreased from 20.8 metric tons to 20.2 metric tons.

- France is the smallest carbon emitter in the G-7, both in overall and per capita terms. To a great extent, this reflects France's status as the state with the largest share of nuclear energy in its fuel mix. This makes France far less dependent on carbon-emitting fossil fuel combustion for its electricity generation needs. Between 1980 and 2001, France's carbon dioxide emissions actually declined an average of 1.1% per year.

G-7 Carbon Dioxide Intensity



- Across the G-7, countries reduced their carbon dioxide intensities between 1980 and 2001. Overall, the G-7's carbon dioxide intensity fell 36% during the period -- an average of 2.1% per year -- from 0.8 metric tons per thousand $1995-PPP to 0.51 metric tons per thousand $1995-PPP.

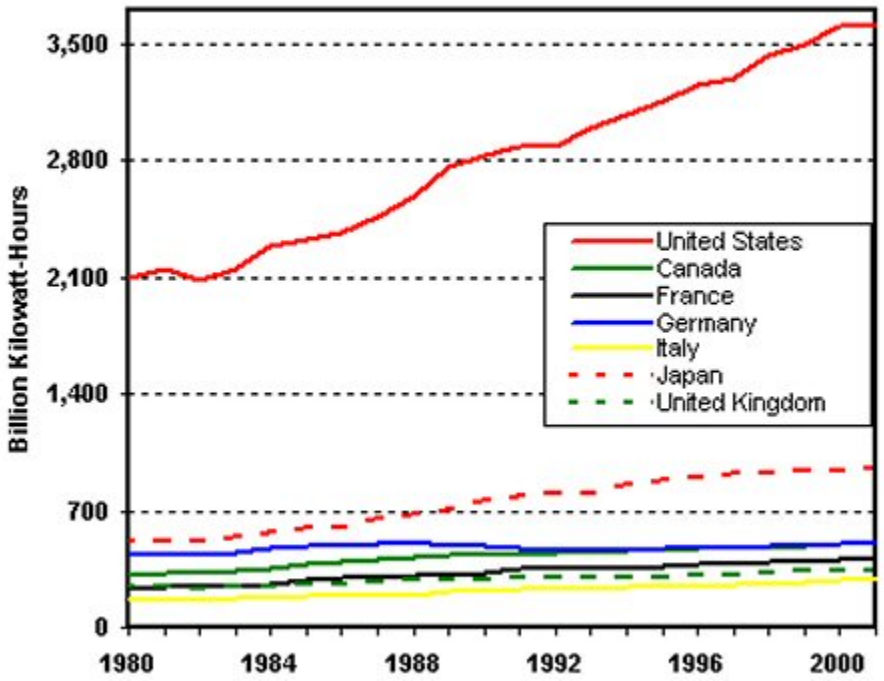
- As with energy intensity, the most rapid declines occurred prior to the oil price declines of the mid-1980s. Some analysts attribute this to the slower reductions in energy savings during the late 1980s and 1990s.[16] It also likely reflects the slowdown in the shift away from coal and oil in the region's fuel mix. This trend can be seen in the fuel mix charts above.

- G-7 countries have moved away from energy intensive industries while increasing the share of non-fossil energy in their fuel mixes. If the G-7 had not reduced its carbon dioxide intensity from 1980 levels, *ceteris paribus*, carbon dioxide emissions in 2001 would have been almost twice the actual figure of 9,697 MMT.

- As previously noted, carbon dioxide intensity levels largely reflect the sectoral composition, resource endowments, and fuel mixes of individual countries. For example, France with its large nuclear sector had a lower carbon intensity than natural resource intensive Canada.

- Setting Germany aside, the countries with the largest overall declines in carbon dioxide intensity between 1980 and 2001 were France (49%) and the United Kingdom (45%). These two countries made the largest relative shift away from carbon intensive coal and oil consumption.

G-7 Electricity Consumption



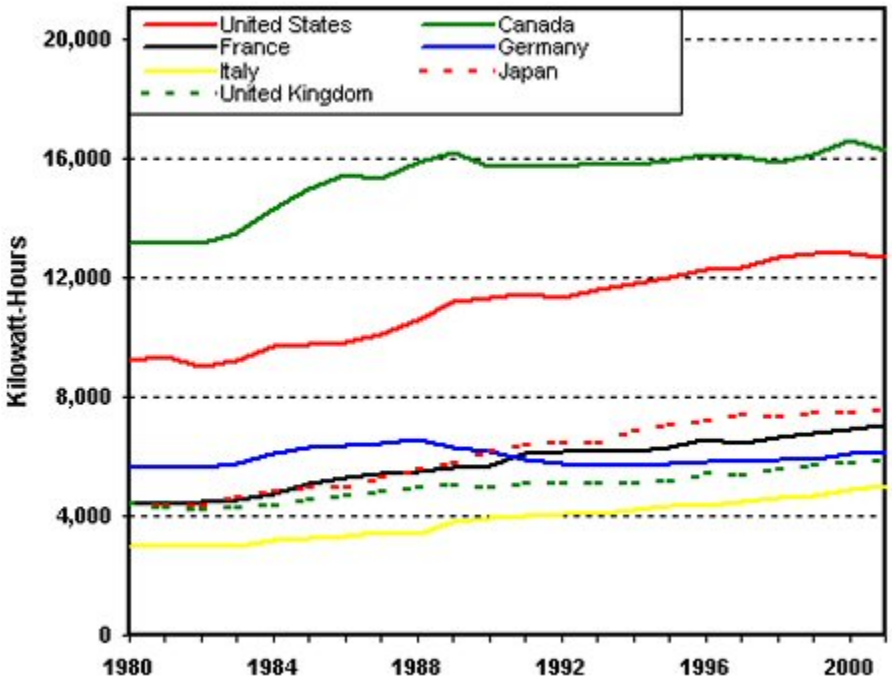
- Electricity consumption grew rapidly in the G-7 between 1980 and 2001 -- 2.4% annually -- from 4,019 bkwh to 6,628 bkwh. Most of this growth in power consumption took place in the United States, by far the G-7's largest electricity consumer throughout this period. The increase in U.S. electricity consumption accounted for 58% of all G-7 growth.

- Between 1980 and 2001, the U.S.' share of G-7 electricity consumption rose from 52% to 54%. During this time, U.S. power demand grew from 2,094 bkwh to 3,602 bkwh, a 2.6% average annual rate of increase.

- Electricity demand in other G-7 countries grew at a similar pace to that in the United States. France's and Japan's electricity consumption grew an average of 2.7% and 3.1% per year, while Canada's and Italy's grew 2.3% and 2.6%, respectively. The United Kingdom grew slightly more slowly, increasing 1.6% per year.

- According to International Energy Agency data, the most rapid growth in G-7 electricity consumption took place in the commercial and residential sectors. While industrial demand for electricity grew as well, it did so at a comparatively slow pace.[17] Commercial sector power consumption growth was driven by demand for electric cooling, lighting, and ventilation systems, as well as the new demand for office equipment (e.g. computers, routers, printers).[18] Recent estimates suggest that computers and other information technology equipment account for perhaps 2% to 4% of all electricity consumption in the U.S.[19]

Per Capita Electricity Demand in the G-7



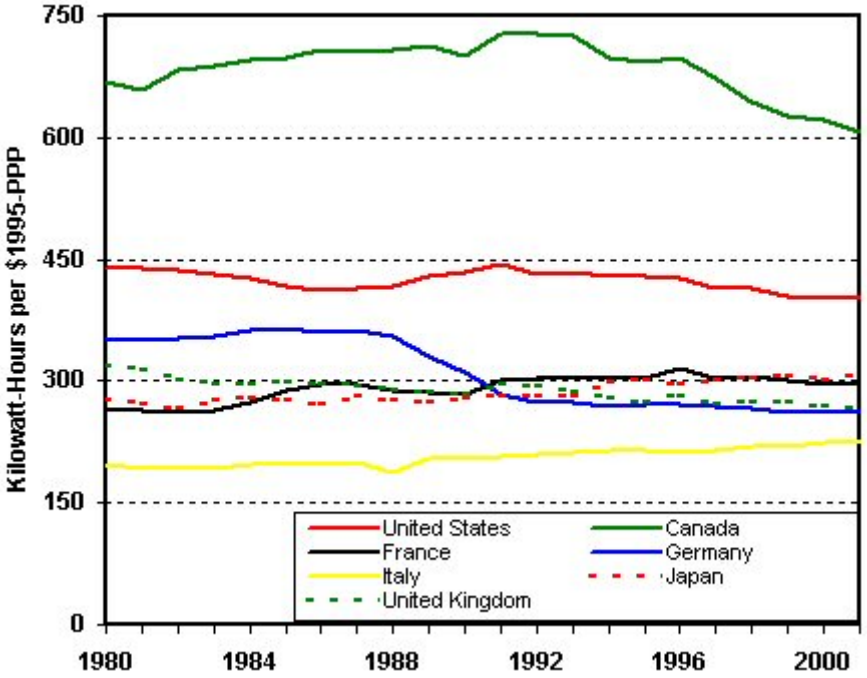
- Between 1980 and 2001, G-7 per capita electricity consumption increased 44% overall -- an average of 1.8% per year -- from 6,550 kwh to 9,449 kwh.

- The United States remains the second largest per capita electricity consumer in the G-7 behind Canada. U.S. per capita electricity consumption grew at a comparatively modest pace between 1980 and 2001 -- an average of 1.5% per year -- from 9,197 kwh to 12,685 kwh.

- Canada is the G-7's largest per capita electricity consumer. To a considerable extent, this is because of Canada's large, hydro-powered aluminum-manufacturing sector. Between 1980 and 2001, Canadian per capita power consumption increased an average of 1.0% per year, from 13,100 kwh to 16,200 kwh.

- Between 1980 and 2001, per capita power electricity consumption in France, Italy, and Japan grew at annual rates of 2.3%, 2.4%, and 2.7%, respectively. Despite this relatively rapid growth, these three countries consumed far less electricity per person than in the United States or Canada throughout the period.

G-7 Electricity Intensity



- Relative levels for G-7 electricity intensity between 1980 and 2001 closely resemble those for energy and carbon dioxide intensity. Canada had the highest intensity, followed by the United States and, another notch down, the rest of the G-7 countries.

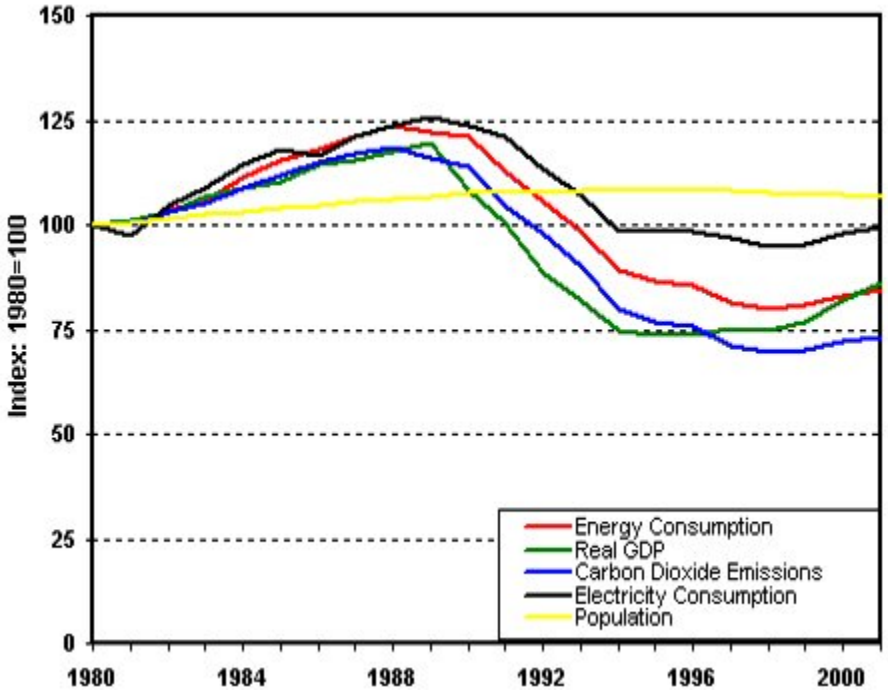
- Electricity intensities declined little throughout the period for most countries in the G-7. In part, this reflects growing electricity use in the expanding service sector offsetting efficiency gains in home and office appliances, machines, etc.

- Canada's high electricity intensity reflects its large aluminum processing industry, which requires very large quantities of electricity. This industry is powered mainly by hydroelectricity.

- While many home appliances are now much more efficient than in the past, this has not necessarily translated to substantially reduced electricity intensities overall. This is largely due to increases in both appliance ownership and usage.

III. EE&FSU

EE&FSU Development Trends

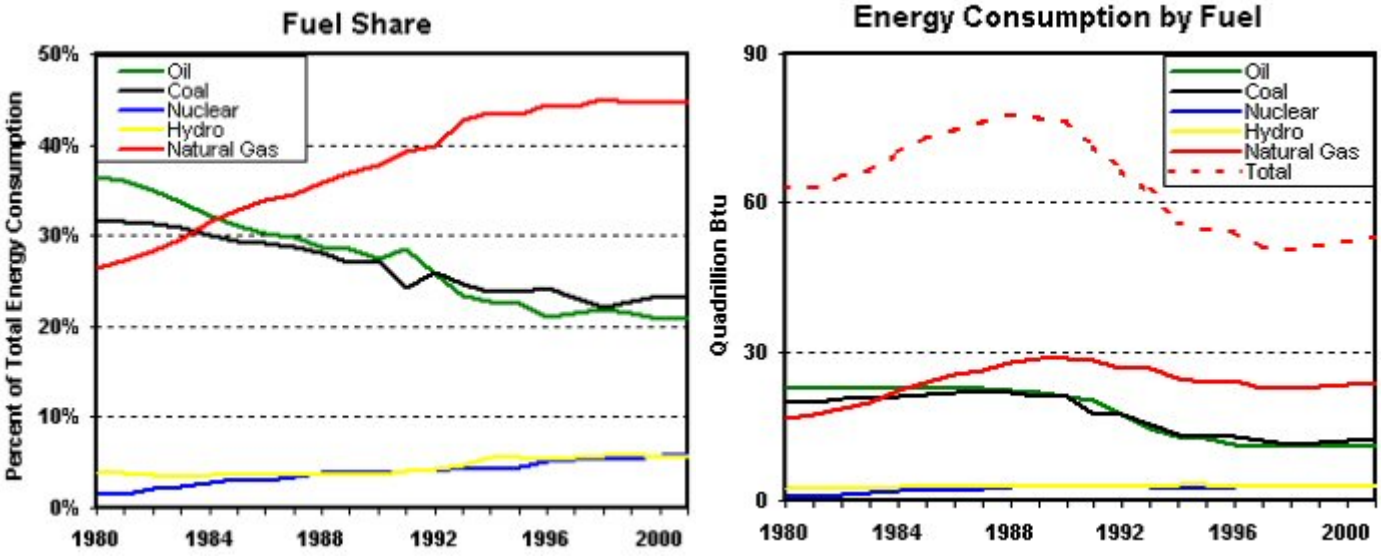


- All of the economic and energy indicators examined here fell sharply following the collapse of the region's communist governments in the late 1980s and early 1990s. Prior to this collapse, the EE&FSU region's real GDP rose steadily until 1989. The dramatic events that followed produced a sharp decline in economic output that continued until 1993. The region's GDP then remained static until 1999, when economic growth returned.

- Both energy consumption and carbon dioxide emissions in the EE&FSU region continued to decline until the late 1990s. Energy consumption increased towards the end of the period, however, while carbon dioxide emissions remained stable. The decline during the transition away from communism was so significant that the EE&FSU region's energy consumption and carbon dioxide emissions in 2001 were lower than their 1980 levels.

- Population change reacted less sharply to the political and economic changes impacting the region. However, population was impacted as well. The EE&FSU region is unique in that its population actually declined between 1991 and 2001, after growing steadily until 1990. This reflects the region's increasing mortality, particularly among men, as well as rising emigration and falling birth rates.

Energy Consumption by Fuel Type in the EE&FSU



- The rocky transition from command-based to market-based economies during the late 1980s and early 1990s drastically reduced the EE&FSU region's energy consumption. Between 1980 and 1988, demand grew from 63 quads to 78 quads. By 2001, regional energy consumption had fallen to 53 quads, of which fossil fuels accounted for 47 quads.

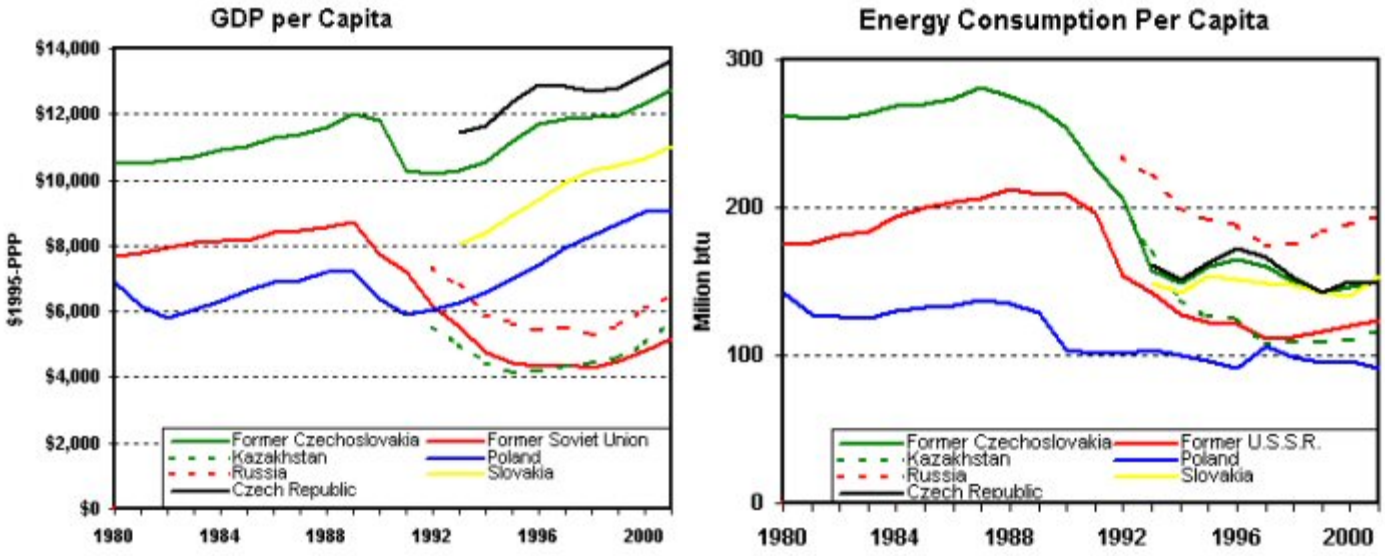
- During the 1980s and 1990s, the importance of nuclear and hydroelectric power in the EE&FSU region doubled. In 1980, non-fossil fuels accounted for 6% (3.4 quads) of total energy consumption. In 2001, non-fossil fuels' share had risen to 12%. During this time, absolute consumption of non-fossil energy increased 82% to 6 quads.

- Nuclear and hydroelectric energy's share of consumption grew disproportionately for several reasons. First, hydroelectric plants in particular can be operated at very low cost once they have been built while fossil plants require consistent expenditures on fuel. This made it cheaper to intensify use of existing hydroelectric sources and phase out fossil energy as demand declined.

- Second, even if the fuels for thermal power plants were very cheap, obtaining them became more difficult after the collapse of the command economies. The distribution of petroleum and petroleum products was thrown into disarray when the Soviet Union collapsed.

- Natural gas consumption has the largest share in the EE&FSU region's fuel portfolio, having risen from 26% to 45% between 1980 and 2001. Though its share rose throughout, consumption of natural gas actually declined between 1989 and 2001, but the region's total energy consumption declined faster.

Per Capita Trends in the EE&FSU



- The EE&FSU region's countries experienced a significant decline in per capita income in the early 1990s as they struggled to shift from centrally-planned to market-based economies. Overall, the region's per capita GDP fell 20% between 1980 and 2001, from $7,553 per person to $6,069 per person.

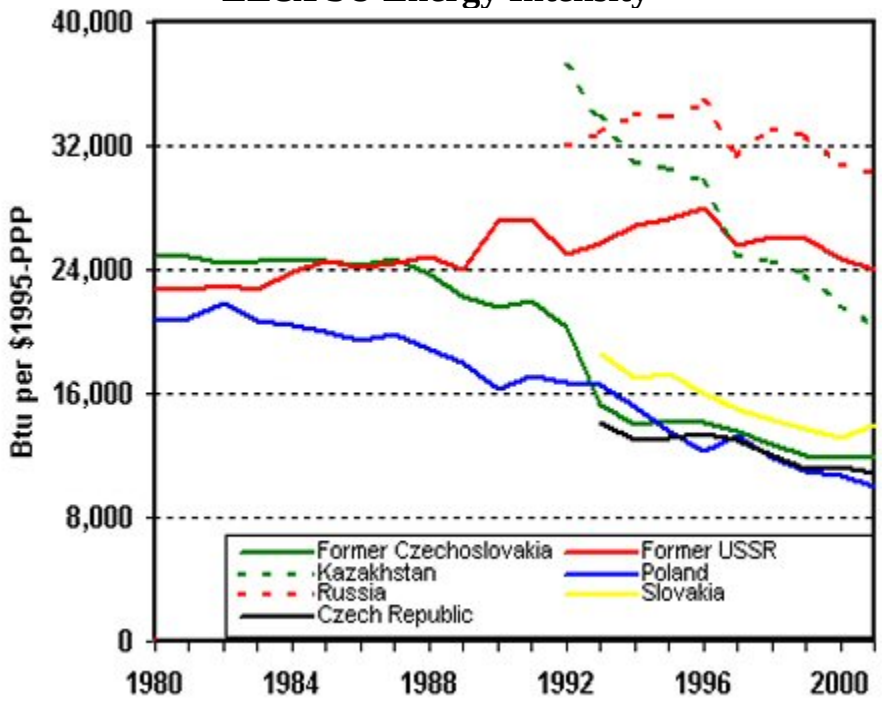
- Within the region, declines were not equally severe or prolonged. The countries of the FSU suffered an especially acute economic collapse between 1989 and 1998. During this period, the FSU's per capita income fell by half, from more than $8,700 to about $4,300, before rebounding to end the period at $5,161 in 2001. Russia's per capita income was $6,458 in 2001, 12% lower than in 1992.

- Some of countries of Eastern Europe endured a shorter and less severe downturn than the countries of the FSU. In 2001, Poland, Slovakia, and the Czech Republic had equivalent or higher per capita incomes than in the final years of the Warsaw Pact and the Soviet Union. Other countries in Eastern Europe, particularly those in the southeast part of the region, suffered harsher economic downturns.

- Following the fall of communism, energy consumption also declined across the EE&FSU region. Overall, between 1980 and 2001, per capita energy demand declined 11%, from 164 million Btu to 130 million Btu.

- Changes in per capita energy consumption varied between countries within the EE&FSU region. In large part, these differences reflect differing industrial compositions. In many countries, per capita consumption did not rebound, reflecting the permanent closure of some energy intensive industries.

EE&FSU Energy Intensity



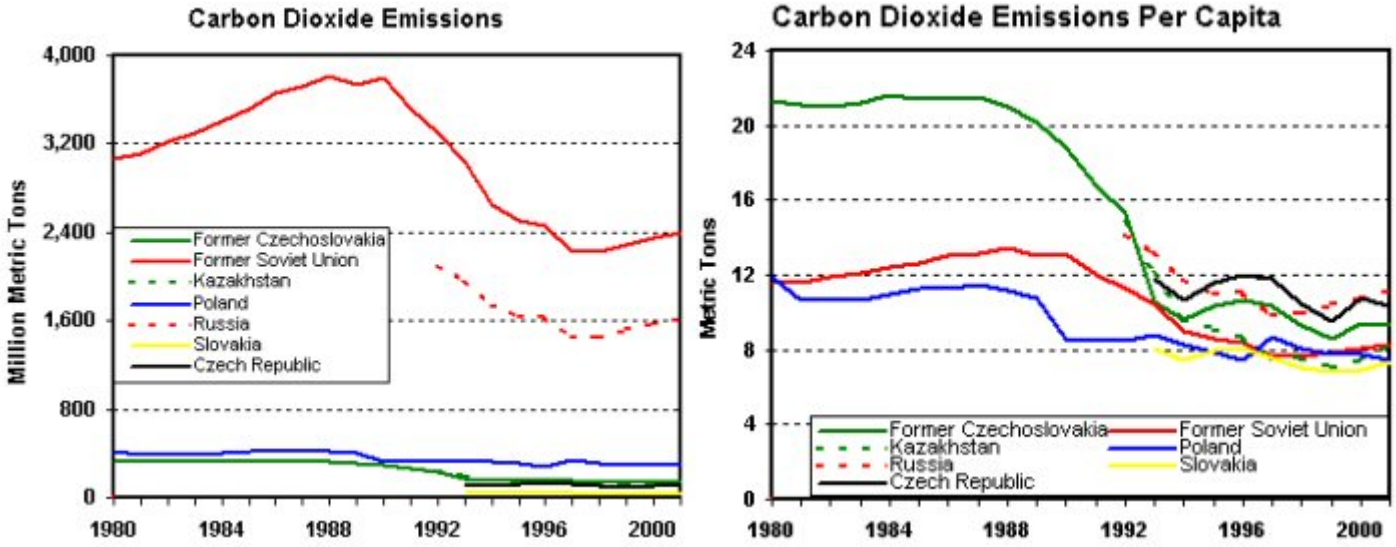
- Between 1980 and 2001, the EE&FSU region's energy intensity only declined an average of –0.1% per year, from 21,776 Btu per $1995-PPP to 21,419 Btu per $1995-PPP.

- This modest decrease masks the significant declines experienced by some countries in Eastern Europe. Some of these countries were beginning to use energy less intensively prior to the fall of communism. These declines accelerated following the transition to market economies. For example, the average annual change in the energy intensity of the countries of the former Czechoslovakia between 1980 and 1990 was a 1.4% decline. Between 1980 and 2001, it was a 3.5% decline.

- This declining trend likely reflects Eastern European countries' early attempts at market reforms and their subsequent broad conversion to freer markets. Reforms led to reallocation of capital and labor, which meant closure of money-losing, energy-intensive industries.

- The modesty of the region's aggregate change reflects the rise of energy intensities in the disproportionately influential countries of the FSU, particularly Russia. Over the entire period, the FSU's energy intensity rose an average of 0.2% per year. This growth likely derived in part from the maintenance of price controls on energy products. This may have kept energy consumption from falling as rapidly as economic output.

EE&FSU Carbon Dioxide Emissions Overview



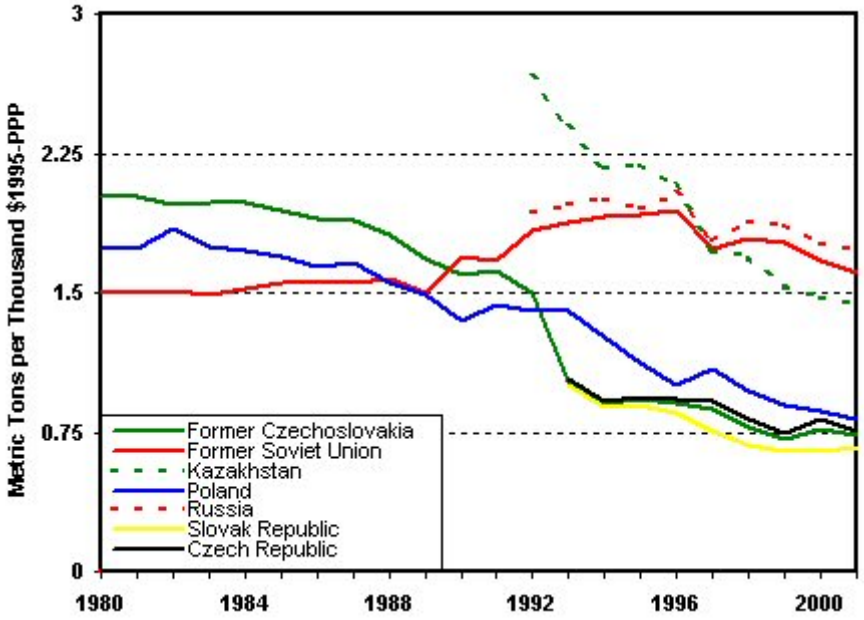
- Between 1980 and 2001, carbon dioxide emissions in the EE&FSU region fell an average of 1.5% per year, from 4,300 MMT to 3,148 MMT. The bulk of this decline took place during and after the fall of communism, though emissions had begun to fall during the 1980s in some Eastern European countries. Between 1991 and 2001, carbon dioxide emissions declined an average of 3.5% per year.

- While all countries in the EE&FSU region experienced a reduction in carbon dioxide emissions in the second half of the period, the nature and degree of decline varied considerably. For example, between 1991 and 2001, carbon dioxide emissions in the Former Czechoslovakia, the FSU, and Poland, fell an average of 5.7%, 3.7%, and 1.2% per year, respectively.

- The Former Czechoslovakia and the FSU experienced the most severe decline in per capita emissions. This reflects both their rapid decline in energy consumption and the decreasing share in their energy portfolio of carbon-intensive fossil fuels, particularly coal.

- In recent years, there has been considerable convergence of per capita carbon dioxide emissions within the EE&FSU region. For example, between 1980 and 2001, the difference in carbon dioxide emissions per capita between Poland and the former Czechoslovakia declined from 9.4 metric tons per person to 1.8 metric tons per person.

EE&FSU Carbon Dioxide Intensity



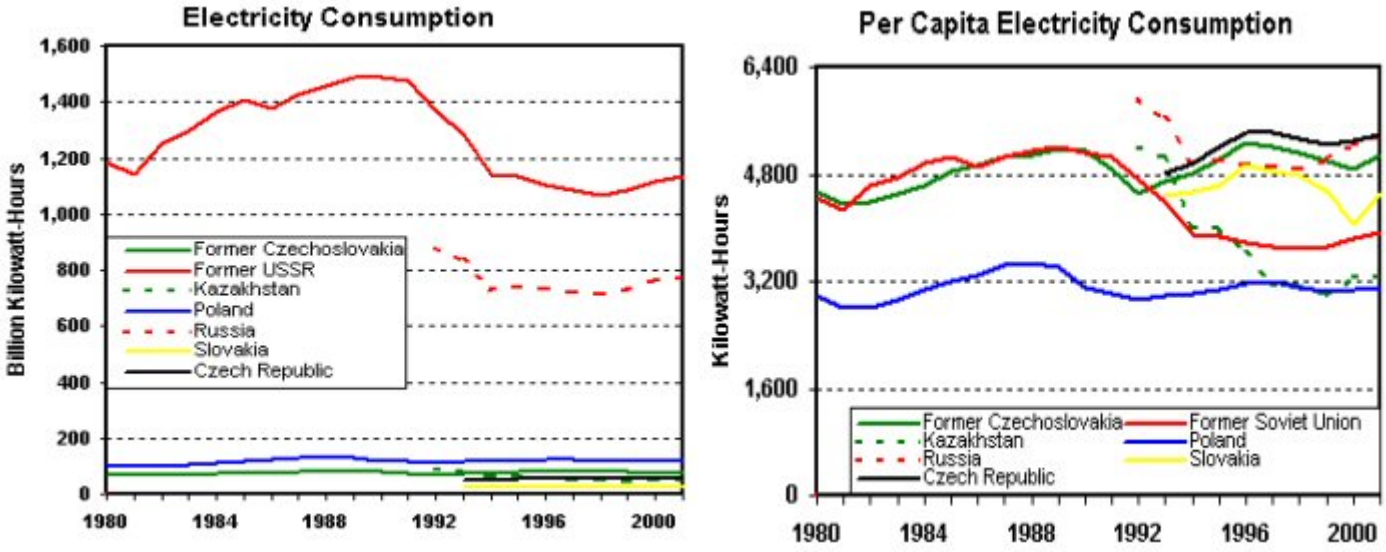
- Between 1980 and 2001, carbon dioxide intensity in the EE&FSU region fell from 1.49 metric tons per thousand $1995-PPP to 1.27 metric tons per thousand $1995-PPP. Despite the decline, the region continues to have the highest carbon dioxide intensity in the world.

- Between 1980 and 2001, the average carbon dioxide intensity for Poland, the FSU, and the Former Czechoslovakia declined from 1.76 metric tons per thousand $1995-PPP to 1.05 metric tons per thousand $1995-PPP.

- Poland and the former Czechoslovakia experienced particularly sharp reductions in their carbon dioxide intensities between 1980 and 2001.

- Carbon dioxide intensity in Russia and the remainder of the FSU countries declined more slowly. In part, this reflected the continuation of energy subsides, in contrast to Eastern Europe's quicker and more comprehensive embrace of market-reforms.

EE&FSU Electricity Consumption



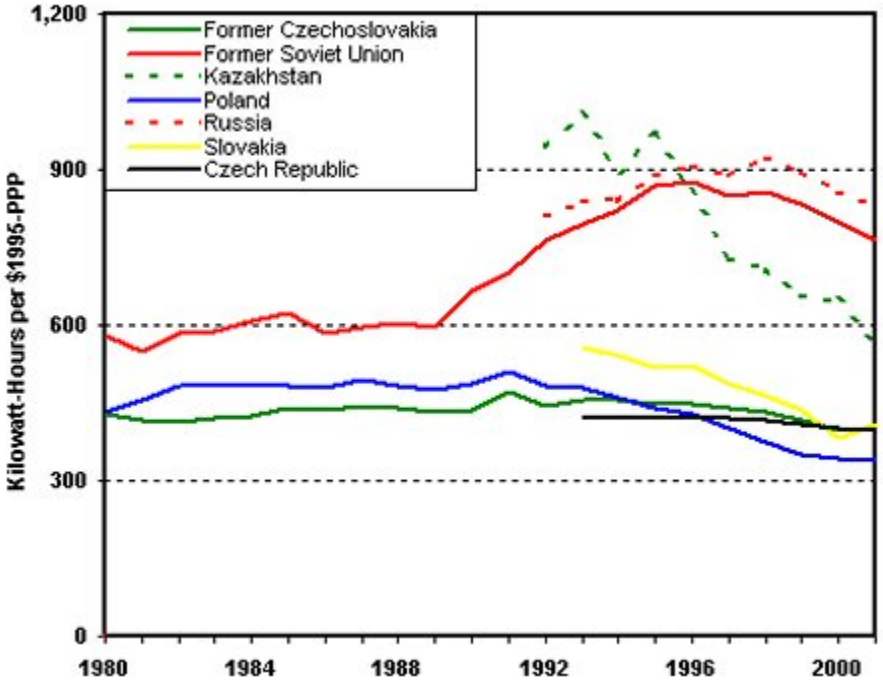
- At about 1,500 bkwh, electricity consumption in the EE&FSU region was roughly the same in 1980 as it was in 2001. This lack of overall change masks the rise in electricity consumption during the 1980s and the decline that followed the collapse of the region's communist governments. Between 1989 and 1998, demand in the EE&FSU region fell 24%, from 1,934 bkwh to 1,463 bkwh.

- The countries of the FSU, especially Russia, accounted for the bulk of this decline. FSU consumption fell from a peak of 1,491 bkwh in 1989 to 1,069 bkwh in 1998. It then remained largely constant until 2001.

- By contrast, Eastern European consumption remained relatively constant following the collapse of communism. Between 1989 and 2001, Polish electricity consumption fell less than 10%, from 131 bkwh to 119 bkwh.

- Electricity demand in the EE&FSU continued at a relatively high level in part because of the maintenance of price subsidies for both producers and consumers. These subsidies mitigated the impact of the region's falling real income levels.

EE&FSU Electricity Intensity



- Between 1980 and 2001, electricity intensity in the EE&FSU region increased at an average annual pace of 0.7%, from 531 kwh per $1995-PPP to 615 kwh per $1995-PPP.

- Between 1980 and 1989, the region's electricity intensity grew only 0.5% per year. This leapt to 3.3% per year during the period between 1990 and 1995, before falling an average of 2.8% per year between 1996 and 2001.

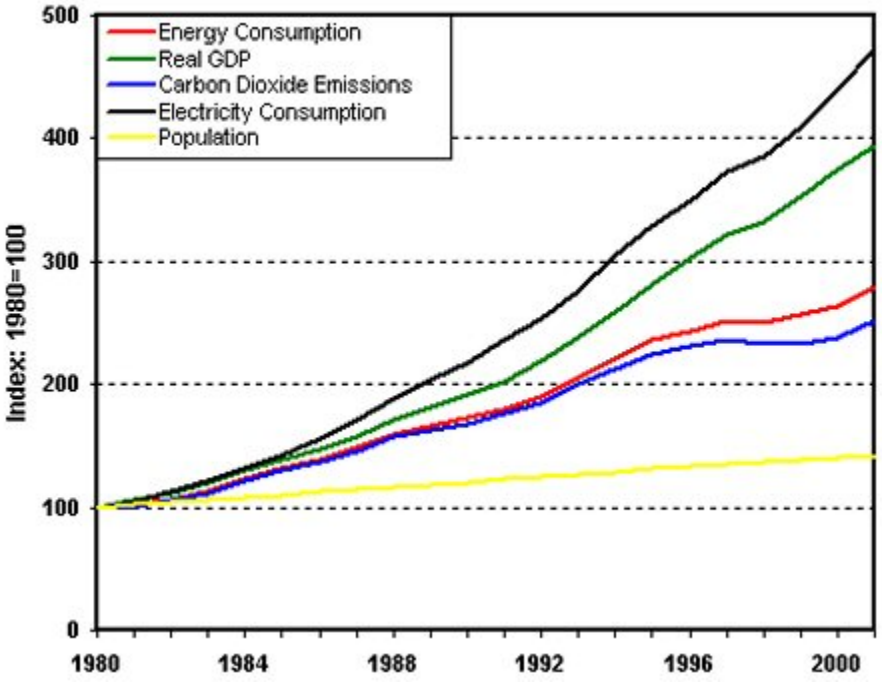
- The sharp increase in regional electricity intensity during the early 1990s reflects the disproportionate influence of the FSU countries (especially Russia). The FSU experienced especially sharp increases in electricity intensity because many governments chose to maintain energy subsidies. This kept electricity consumption from declining as rapidly as real GDP.

- The decline in FSU electricity intensity in the late 1990s in part reflects the phasing out of some energy subsidies.

- Poland, the Czech Republic, and Slovakia all had relatively stable electricity intensities until the early 1990s, after which they declined steadily. Reduced electricity intensity levels in Eastern Europe during the 1990s suggest a gradual rationalization of the region's industrial mix, as inefficient heavy industries declined relative to less electricity-intensive, higher-value-added activities.

IV. Developing Asia

Developing Asia Development Trends



- Between 1980 and 2001, Developing Asia grew tremendously in every energy-related and economic category. The region's population also expanded rapidly (1.7% per year), but far slower than GDP (6.8% per year), meaning that per capita real income rose dramatically during the period.

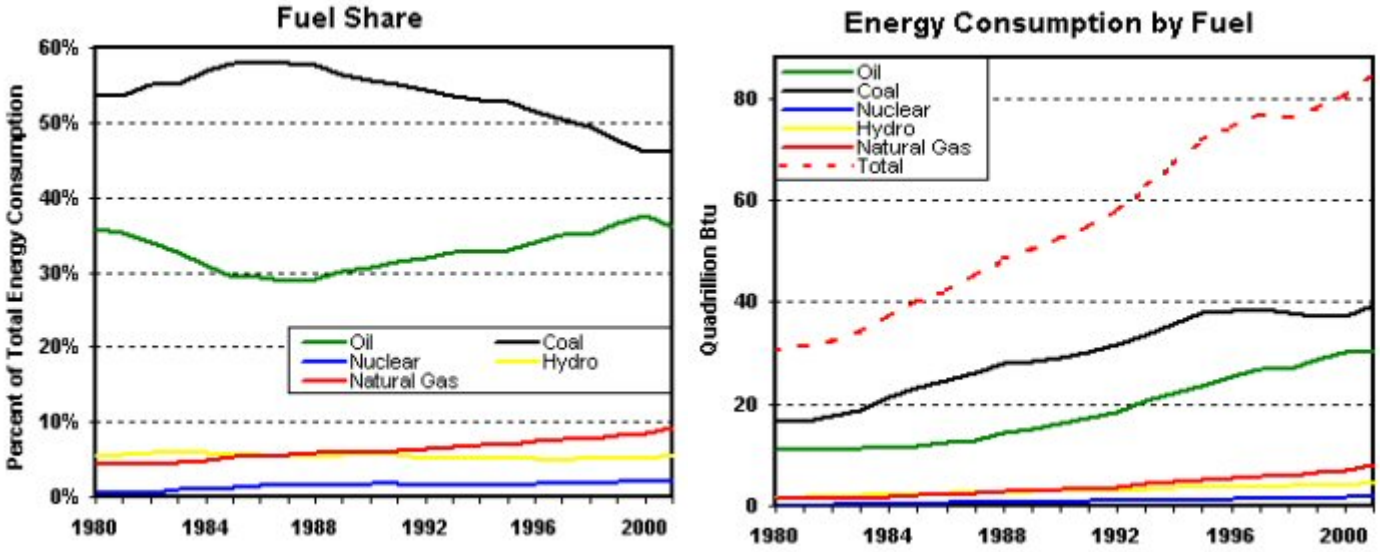
- Developing Asia's electricity consumption grew the most rapidly in percentage terms during the 1980s and 1990s. In 21 years, it grew 373%, reflecting an average annual increase of 7.7%. Only the MENA region's electricity consumption grew more in percentage terms (379% overall).

- No region came close to equaling the pace of Developing Asia's economic expansion between 1980 and 2001. During that period, the region's real GDP grew an average of 6.8% per year, for an overall increase of almost 300%.

- Over the period, energy consumption increased 179% overall (5.0% per year), which was second only to the MENA region (183%).

- Developing Asia's population grew an average of 1.7% per year between 1980 and 2001, far slower than real GDP, resulting in a rapid increased in per capita real incomes.

Energy Consumption by Fuel Type in Developing Asia



- Throughout the 1980s and 1990s, Developing Asia derived more than 90% of the energy it consumed from fossil fuels. This dependence remained roughly constant despite the region's dramatic increase in total energy consumption, from 30 quads in 1980 to 85 quads in 2001.

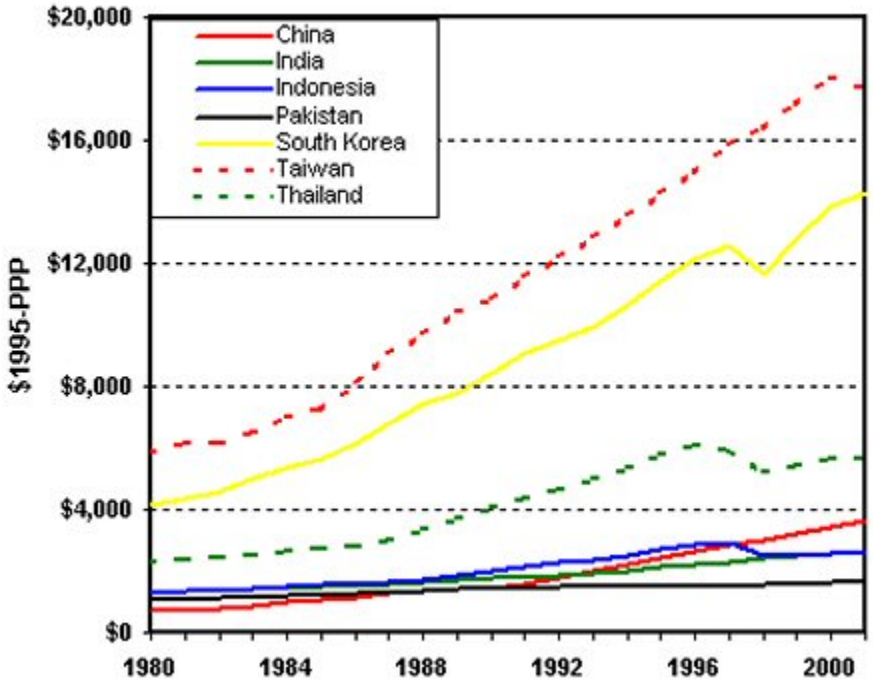
- Many countries in Developing Asia are significant consumers of traditional energy (e.g. fuel-wood), especially in South Asia. Unfortunately, reliable data on traditional energy consumption are unavailable.

- The region's non-fossil energy comes mainly from hydroelectric plants. Nuclear power plays a small but increasingly important role. Between 1980 and 2001, hydroelectric power increased its share of total energy consumption from 5% to 6%, while nuclear energy's share grew from less than 1% to 2%. In absolute terms, consumption of hydropower grew from 1.6 quads to 4.7 quads during the period. At the same time, nuclear energy consumption grew from 0.1 quads to 1.8 quads.

- India and China dominate Developing Asia's energy consumption statistics. The two countries combined to account for 52 quads of the region's 85 quads of total energy consumption in 2001.

- Coal continues to make up the bulk of the region's energy portfolio, but its importance declined relative to both oil and natural gas between 1980 and 2001. Despite rising briefly in the 1980s in response to high oil prices, coal's share of Developing Asia's total energy consumption fell from 54% to 46% over the period.

Per Capita Income in Developing Asia



- Between 1980 and 2001, many Developing Asia countries experienced rapid growth in their per capita incomes. Regionally, real GDP per capita rose from $1,210 to $3,355 during the period -- an average annual rate of 5.0%. Incomes in Taiwan and South Korea grew enough to converge with members of the OECD.

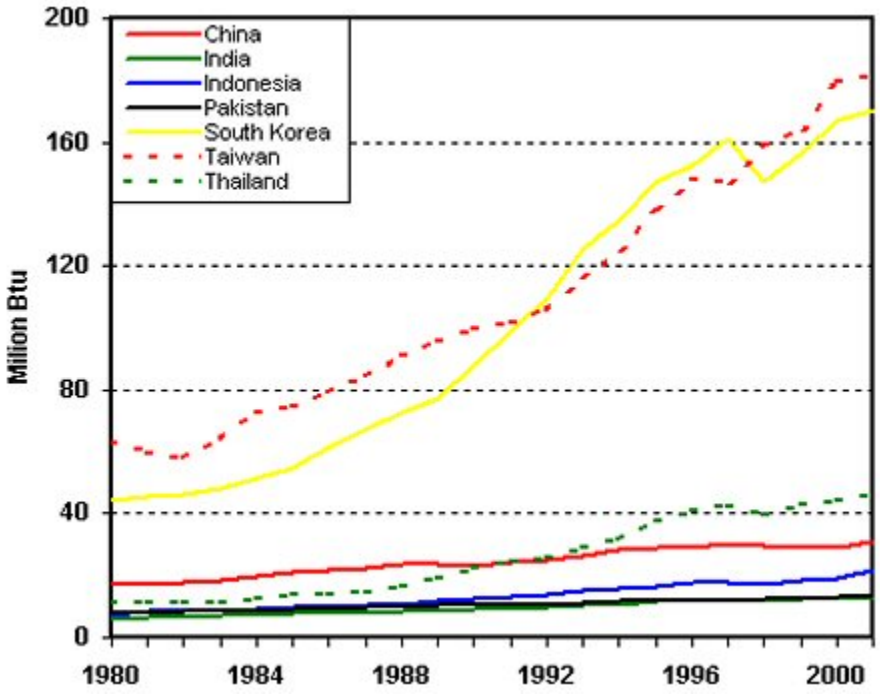
- The region's economic growth was not distributed evenly, causing significant changes in relative prosperity within the region. For example, in 1980 Pakistan's per capita income was 150% of China's. By 2001, Pakistani per capita income had fallen to just 45% of the Chinese level due to far more rapid real GDP growth in China during the 1980s and 1990s.

- Within Developing Asia, China experienced the greatest percentage increase in per capita real GDP between 1980 and 2001. During that period, China's per capita income grew 425% -- 8.2% per year -- from $699 to $3,664. Most of this growth was concentrated along China's coast, as an income gap opened up between rural and urban workers.[20]

- India, the other regional giant, experienced more modest income growth. India's per capita real GDP grew from $1,276 to $2,660 -- 3.6% per year-- between 1980 and 2001. The majority of this growth occurred in the last ten years of the period.

- Like China, India's growth was unevenly distributed within the country. The bulk took place in prosperous, comparatively urbanized regions where economic structures were converging to OECD standards. The rest of the country's economic and energy patterns remained more similar to poorer countries.[21]

Per Capita Energy Consumption in Developing Asia



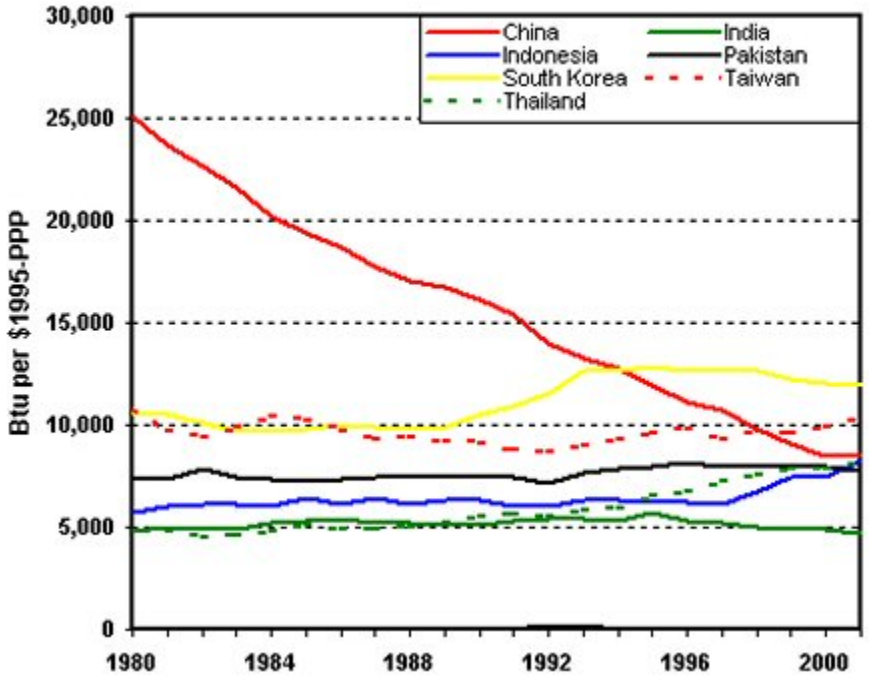
- Overall, Developing Asia's per capita energy consumption grew from 13 million Btu per person to 26 million Btu per person between 1980 and 2001, which represents an average annual growth rate of increase of 3.3%. The growth rates of individual countries' varied considerably.

- As with real income, per capita energy consumption data suggest a growing developmental divide in Asia. Energy consumption levels in East Asia tended to grow faster than those in South Asia despite being higher initially. Between 1980 and 2001, South Korean and Taiwanese citizens' per capita consumption expanded an average of 6.7% and 5.1% per year. Indian and Pakistani per capita consumption grew 3.5% and 2.5% during the same period.

- By 2001, these different growth rates resulted in per capita consumption levels in Taiwan (182 million Btu) and South Korea (170 million Btu) that were an order of magnitude higher than those in India (13 million Btu) and Pakistan (13 million Btu).

- Chinese per capita energy consumption grew from 18 million Btu to 31 million Btu during the 1980s and 1990s, a far smaller rate of increase (2.7% per year) than for per capita real income. The modest change in per capita energy consumption reflects the considerable improvement in China's energy efficiency over the period.

Energy Intensity in Developing Asia



- Between 1980 and 2001, Developing Asia's energy intensity declined 29% overall -- a pace of 1.6% per year -- from 10,864 Btu per $1995-PPP to 7,681 Btu per $1995-PPP. This decline was almost completely accounted for by one country, China.

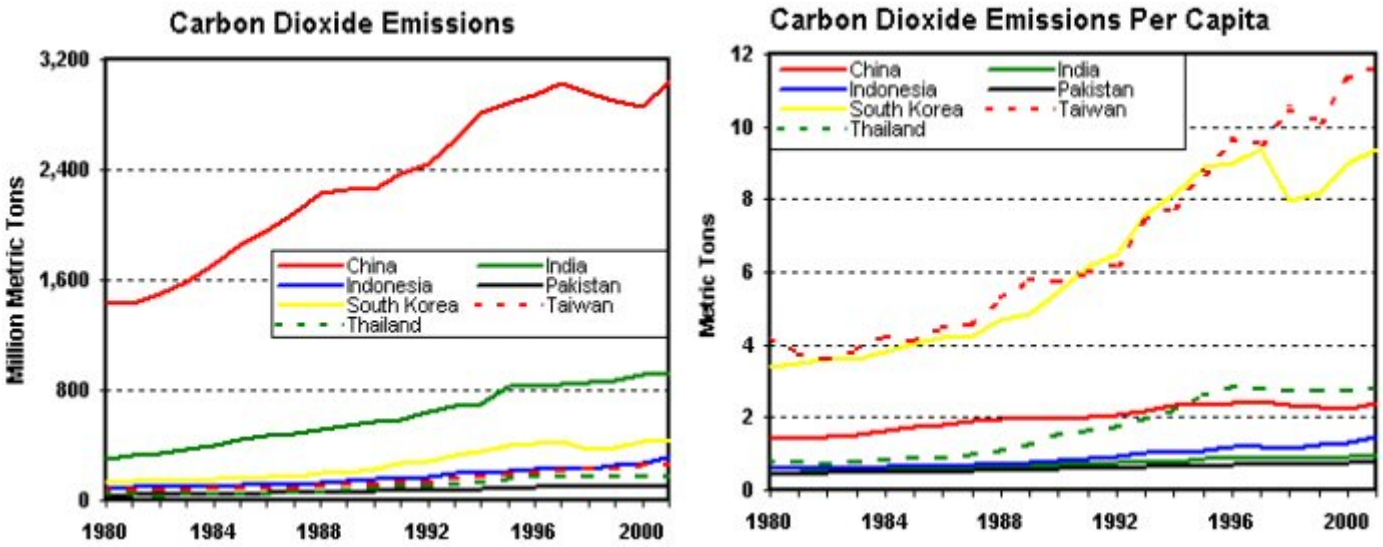
- China's energy intensity declined 66% -- 5.1% per year -- between 1980 and 2001, from 25,078 Btu per $1995-PPP to 8,425Btu per $1995-PPP.

- If China's energy intensity had not declined between 1980 and 2001, the country's total energy consumption in 2001 would have been 118 quads, 78 quads higher than the actual amount and 20 quads higher than that of the United States.

- The dramatic declines in China's energy and carbon dioxide intensities resulted from a number of factors. The most important elements were improvements in technical energy efficiency and changes in product mix and quality. Structural shifts in China's economy played a smaller, albeit still important role.[22]

- The energy intensities of Indonesia and Thailand rose an average of 1.7% and 2.5% per year between 1980 and 2001, reaching 8,254 Btu per $1995-PPP and 8,137 Btu per $1995-PPP, respectively. This increase reflects the two countries' development of domestic energy resources as well as the expansion of their respective heavy industries.

Overview of Carbon Dioxide Emissions in Developing Asia

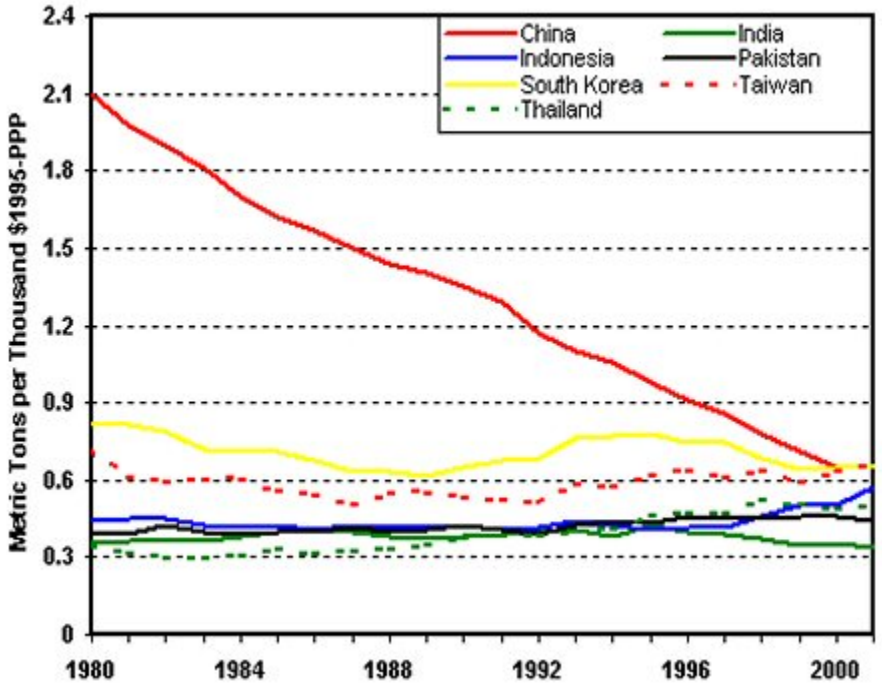


- Carbon dioxide emissions grew substantially in Developing Asia between 1980 and 2001, rising 151% -- 4.5% per year -- from 2,398 MMT to 6,027 MMT. The bulk of the region's carbon dioxide emissions come from its two populous giants, India and China. In 2001, these two countries accounted for two thirds of all of Developing Asia's carbon dioxide emissions.

- China's carbon dioxide emissions grew more slowly than India's between 1980 and 2001, rising 111%, or 3.6% per year, from 1,445 MMT to 3,050 MMT. During the same period, Indian carbon dioxide emissions more than tripled (annual growth of 5.4%), increasing from 303 MMT to 922 MMT.

- Carbon dioxide emissions in Indonesia and Thailand grew the fastest among Developing Asian countries examined here between 1980 and 2001. This reflects those two countries' development of energy-intensive industries. Indonesian carbon dioxide emissions grew an average of 6.4% per year, from 86 MMT to 319 MMT, between 1980 and 2001. Thai carbon dioxide emissions increased at an average annual pace of 7.9%, from 36 MMT to 178 MMT.

Carbon Dioxide Intensity in Developing Asia



- Between 1980 and 2001, the carbon dioxide intensity of Developing Asia fell 26% -- an average annual decline of 2.1% per year -- from 0.85 metric tons per thousand $1995-PPP to 0.54 metric tons per thousand $1995-PPP. As with energy intensity, China accounted for most of this decline.

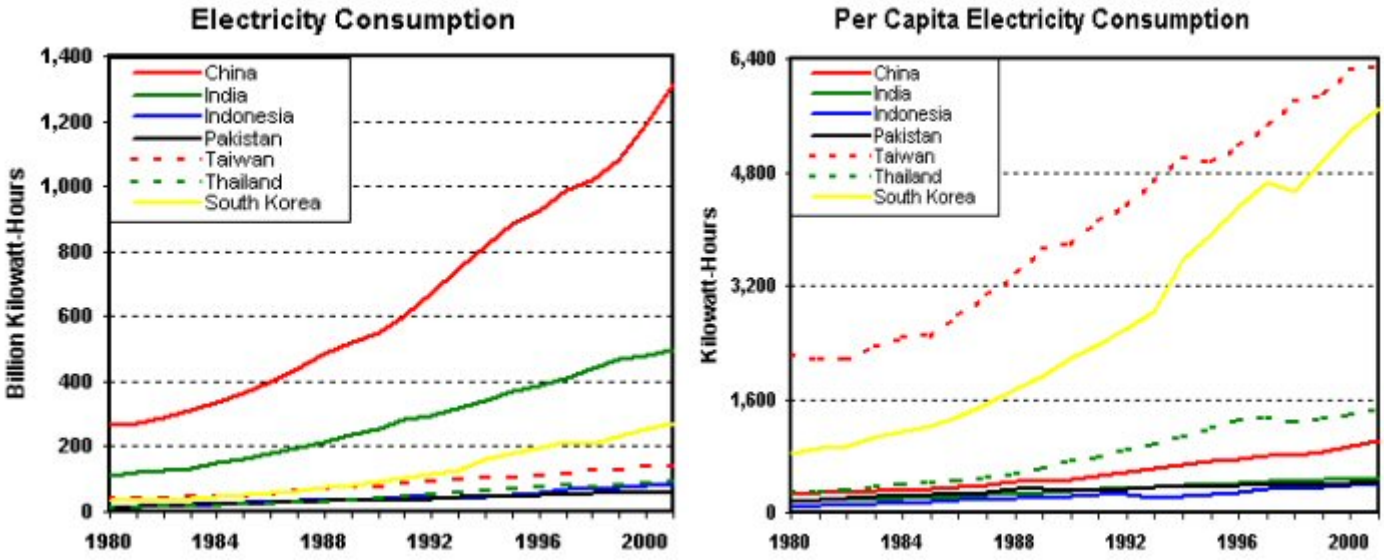
- China's carbon dioxide intensity fell 69% -- an average annual decline of 5.4% per year -- from 2.10 metric tons per thousand $1995-PPP in 1980 to 0.65 metric tons per thousand $1995-PPP in 2001.

- If China's carbon dioxide intensity had not declined between 1980 and 2001, *ceteris paribus*, the country would have emitted about 9,870 MMT of carbon dioxide in 2001. This is more than all the carbon dioxide emitted by the G-7 in that year.

- South Korea and Taiwan, two of the most developed nations in Developing Asia, experienced very slow declines in carbon dioxide intensity -- an average of 1.0% and 0.4% per year, respectively – during the period. These two countries each experienced growth in nuclear energy during the period, along with non-carbon-intensive and non-energy-intensive industries.

- Thailand's carbon dioxide intensity increased an average of 1.9% per year between 1980 and 2001. Thailand's growth likely indicates the steady expansion of its energy and heavy industrial sectors.

Overview of Electricity Consumption in Developing Asia



- Electricity consumption in Developing Asia grew tremendously between 1980 and 2001. During the period, total regional demand for electricity increased an average of 7.7% per year, rising from 577 bkwh to 2,730 bkwh. This rapid growth reflected the region's industrialization and rural electrification efforts.

- In absolute terms, much of the growth in Developing Asia's power demand took place in the region's two giants, India and China. Together, these two countries' power consumption levels grew by almost 1,500 bkwh between 1980 and 2001.

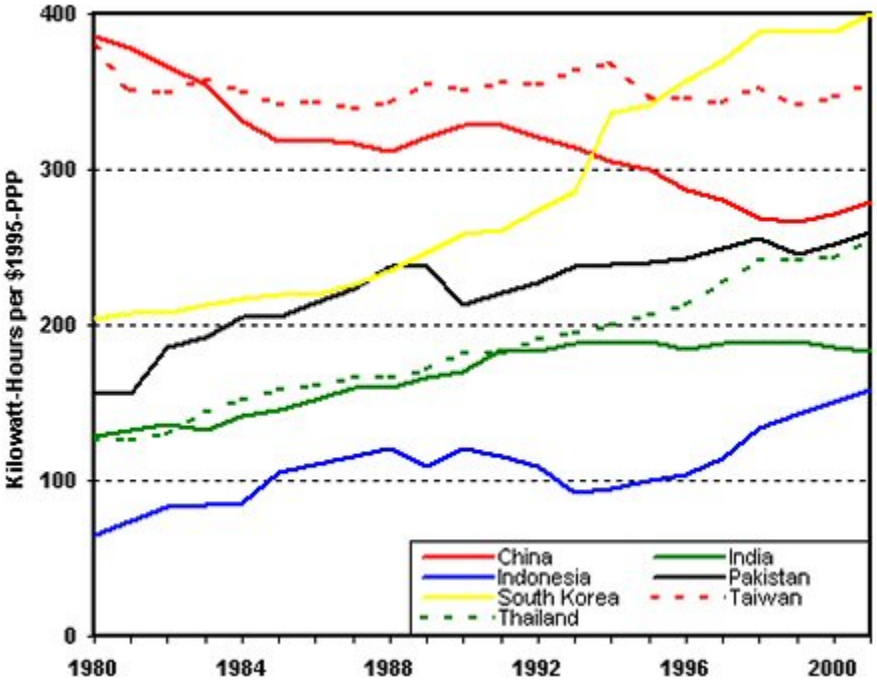
- China's electricity demand increased at an average rate of 7.9% per year between 1980 and 2001, rising from 266 bkwh to 1,312 bkwh. At the same time, Indian electricity consumption grew at an average annual pace of 7.4%, from 111 bkwh to 497 bkwh.

- One of the fastest growing end uses for electricity in China has become refrigerators and air conditioners. This reflects the rising incomes of part of the coastal, urban population.[23]

- Per capita electricity consumption grew faster in Developing Asia than anywhere else in the world between 1980 and 2001, increasing 5.9% per year, from 249 kwh to 827 kwh.

- Some countries in the Developing Asia region experienced even more rapid growth in per capita power consumption than India (5.3% per year) or China (6.6% per year) between 1980 and 2001. During the period, per capita power demand in Indonesia, Thailand, and South Korea grew an average of 7.8%, 8.0%, and 9.5% per year, respectively.

Electricity Intensity in Developing Asia



- Between 1980 and 2001, Developing Asia's electricity intensity increased 15%, from 206 kwh per $1995-PPP to 247 kwh per $1995-PPP. This suggests a comparatively modest annual increase of 0.9%.

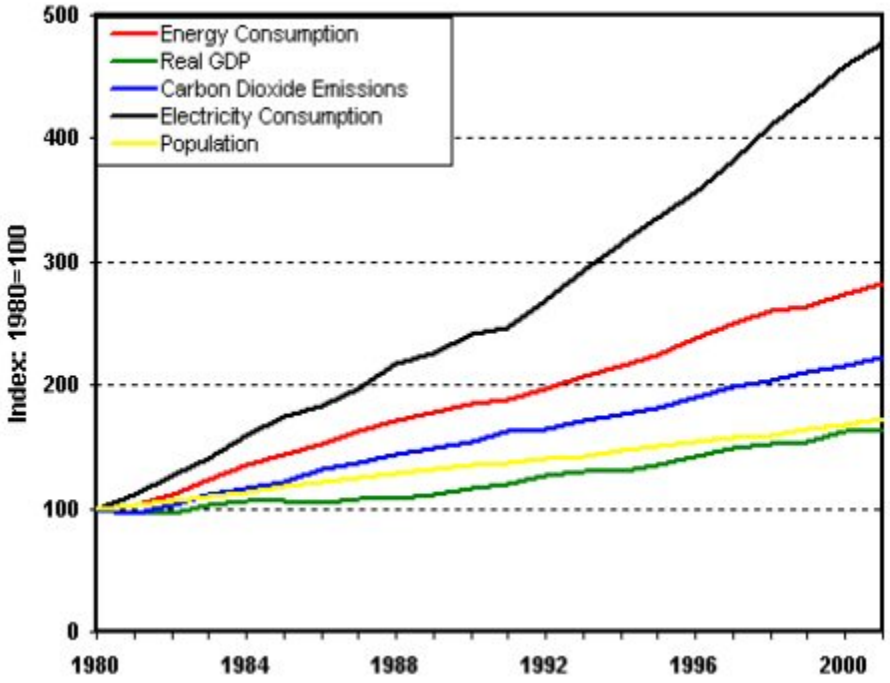
- As with carbon and energy intensity, China's disproportionate share of regional energy consumption and economic output skews the regional picture. China's electricity intensity declined an average of 1.5% per year between 1980 and 2001, which is significantly faster than any country in the G-7. If China were excluded, Developing Asia's electricity intensity actually would have risen an average of 2.0% per year, faster than any other region except for MENA and Latin America.

- Much of the decrease in Chinese electricity intensity reflects an increase in technical efficiency as small, wasteful power plants were replaced by larger, more modern and energy efficient facilities.

- Some of the reasons for the rest of Developing Asia's rising electricity intensity likely include efforts to electrify rural areas, as well as the decision of an increasingly large portion of consumers to purchase electricity intensive appliances like refrigerators and air conditioners.

V. Middle East and Northern Africa

MENA Development Patterns

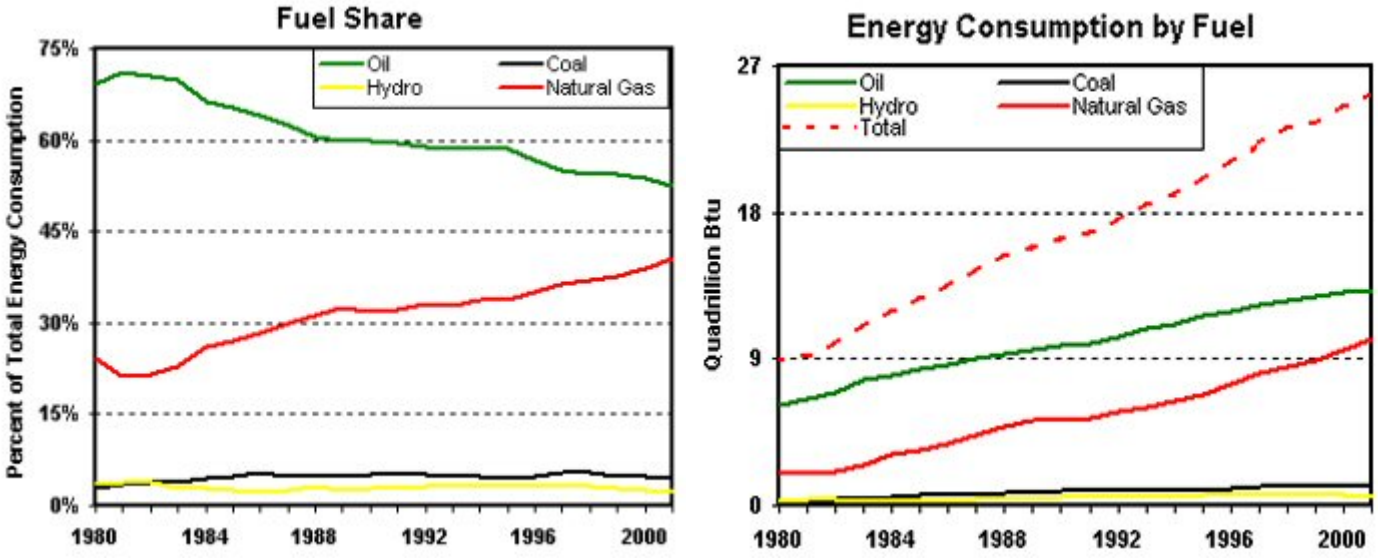


- Between 1980 and 2001, the MENA region experienced significant growth in all five categories examined here. Of the four energy-related and economic indicators, electricity consumption grew the fastest, almost quintupling between 1980 and 2001. Energy demand grew the second most rapidly, almost tripling. Carbon dioxide emissions increased a comparatively modest 122% overall.

- By comparison, real GDP grew only 63% overall, meaning per capita incomes shrank, while carbon, electricity, and energy use became more intensive. In part, these intensities rose because governments in the region subsidized energy production and consumption.

- Increased MENA energy consumption and carbon dioxide emissions between 1980 and 2001 reflected the region's rapid population growth, combined with the development of energy intensive industries.

Energy Consumption by Fuel Type in the MENA



- Energy consumption grew dramatically in the MENA region between 1980 and 2001, nearly tripling from 9 quads to 25 quads. This reflects an average annual increase of 5.1%, the fastest growth in the world.

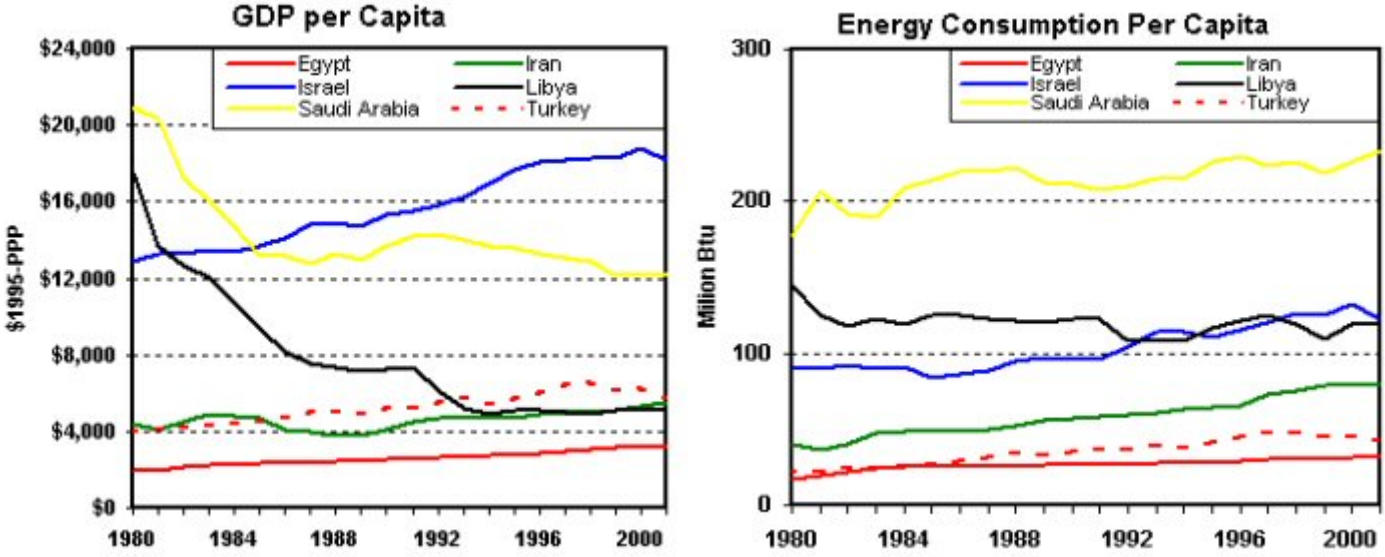
- Almost all of the increased energy consumption came from fossil fuels, whose share of total energy consumption increased from 96% to 98% over the period. The MENA region's almost total reliance upon fossil energy reflects the decisive relative cost advantage of fossil fuels in that region. With much of the world's most accessible and abundant oil and natural gas reserves, non-fossil fuels generally have played only minor roles in regional countries' energy pictures.

- The composition of the MENA region's fossil fuel portfolio evolved during the 1980s and 1990s. While oil accounted for an absolute majority of the MENA region's fuel mix throughout the period, its share declined after the early 1980s, when it accounted for 70% of total energy consumption, to only 53% in 2001.

- As oil's share fell, the importance of natural gas rose. In 2001, oil accounted for 53% of the region's energy mix, compared to 41% for natural gas (up from 24% in 1980), 4% for coal, and 2% for hydroelectric power.

- Egypt is one of the few countries in the MENA region where non-fossil energy plays an important role. The Aswan High Dam accounts for around a fifth of the country's electricity generating capacity.

Per Capita Trends in the MENA



- Between 1980 and 2001, per capita income in the MENA region fell 5.0%, from $5,617 to $5,317 per person. An absolute rise in the region's real GDP of 63% was offset by even faster population growth.

- Between 1980 and 2001, countries in the Persian Gulf suffered severe declines in per capita real GDP as a result of falling real oil prices and rapidly increasing populations. Saudi Arabia's per capita income fell from over $20,900 per person in 1980 to about $12,200 per person in 2001.

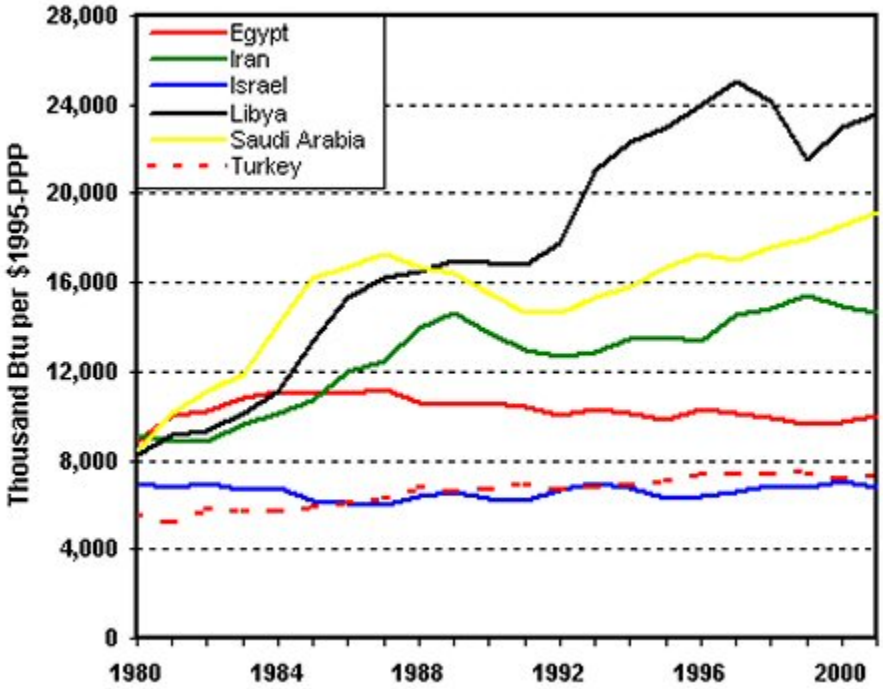
- Saudi real (adjusted for inflation) oil export revenues, a cornerstone of the country's economy, fell more than 70% between 1980 and the 2004 forecast, while per capita real oil export revenues in 2004 were only 13% of their 1980 figure.[24]

- Turkey and Israel, the region's two most economically developed countries, both experienced significant economic growth relative to population expansion. Between 1980 and 2001, Israel's real per capita income grew an average of 1.7% per year, from $12,858 per person to $18,148 per person. During the same period, Turkey's GDP per capita also rose 1.7% per year, growing from $4,016 per person to almost $5,700 per person.

- In much of the region, per capita energy consumption increased, reflecting efforts to industrialize. Overall, regional per capita energy consumption grew from 43 million Btu to 71 million Btu between 1980 and 2001.

- Between 1980 and 2001, per capita energy consumption increased in Israel, where income grew, and in Saudi Arabia, where income plummeted. During the period, per capita energy demand in these two countries increased from 90 million Btu to 123 million Btu, and from 178 million Btu to 234 million Btu, respectively.

MENA Energy Intensity



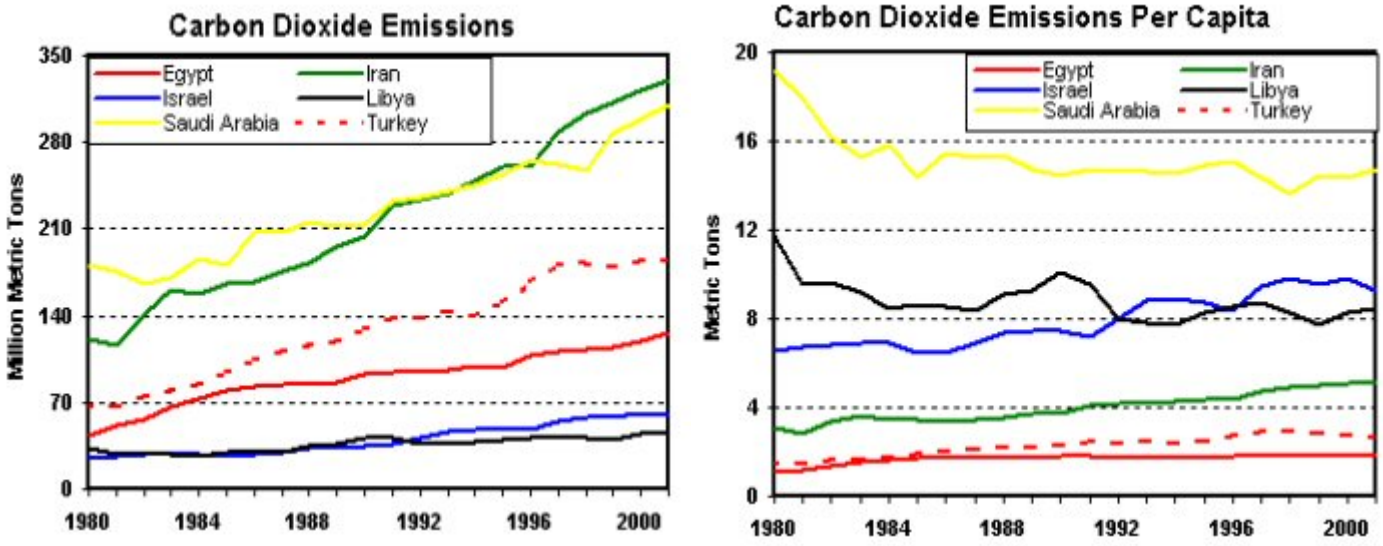
- The MENA region is the world's second most energy intensive region (behind the EE&FSU region). Overall, the region's energy intensity increased 73% between 1980 and 2001 -- an average 2.7% per year -- from 7,723 Btu per $1995-PPP to 13,385 Btu per $1995-PPP. No region's energy intensity increased faster than the MENA's during the period.

- The MENA region's energy intensity increased most rapidly during the early- and mid-1980s. Between 1980 and 1987, the region's energy intensity increased an average of 6.0% per year, reflecting the expansion of energy intensive petroleum-processing industries in the Persian Gulf, as well as the need to supply more electricity to growing populations.

- Over the entire period examined here, energy consumption increased dramatically in MENA despite relatively slow economic growth. This occurred in part because of the very low cost of fossil fuel extraction in the region. Governments also subsidized energy production and prices.

- Israel, the region's most developed economy, departed from this trend. Its energy intensity declined slightly, from 7,012 Btu per $1995-PPP to 6,766 Btu per $1995-PPP, between 1980 and 2001. Like the OECD countries, Israel is becoming more of a post-industrial economy where non-energy-intensive sectors account for a growing share of GDP.

MENA Carbon Dioxide Emissions Overview



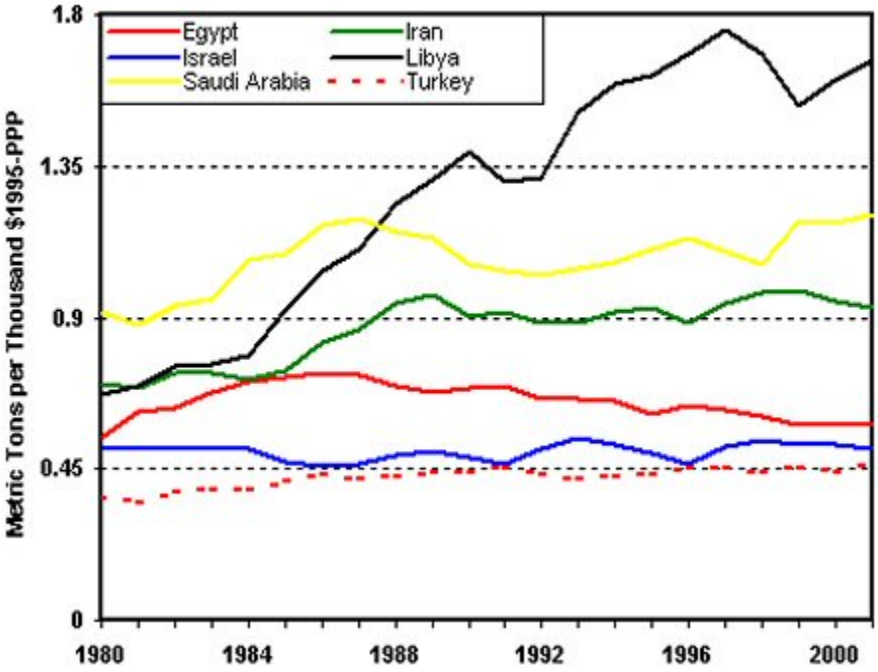
- Between 1980 and 2001, carbon dioxide emissions in the MENA region grew 122% overall -- an average of 3.9% per year -- from 721 MMT to 1,603 MMT. Only Developing Asia's carbon dioxide emissions grew faster.

- In the Persian Gulf and North Africa, increased carbon dioxide emissions reflected almost total reliance upon fossil energy, as well as countries' efforts to develop "downstream" refining and petrochemical industries.

- In Turkey, growth in carbon dioxide emissions was also very rapid between 1980 and 2001. This resulted in large part from that country's rapid economic growth, industrialization and electrification.

- Relative levels of per capita carbon dioxide emissions in the MENA region tended to remain largely consistent over time. Those countries with large fossil fuel reserves, like Saudi Arabia, tended to have higher per capita emissions than those countries without such resources. Egypt has especially low carbon dioxide emissions because of its comparatively large hydroelectric sector.

MENA Carbon Dioxide Intensity



- The MENA region has the world's second highest carbon dioxide intensity behind Developing Asia. Unlike Developing Asia and all other regions, carbon dioxide intensity in the MENA region is increasing. In 2001, MENA's carbon dioxide intensity was 0.85 metric tons per thousand $1995-PPP, 36% higher than in 1980. This reflects a 1.5% average annual rate of increase.

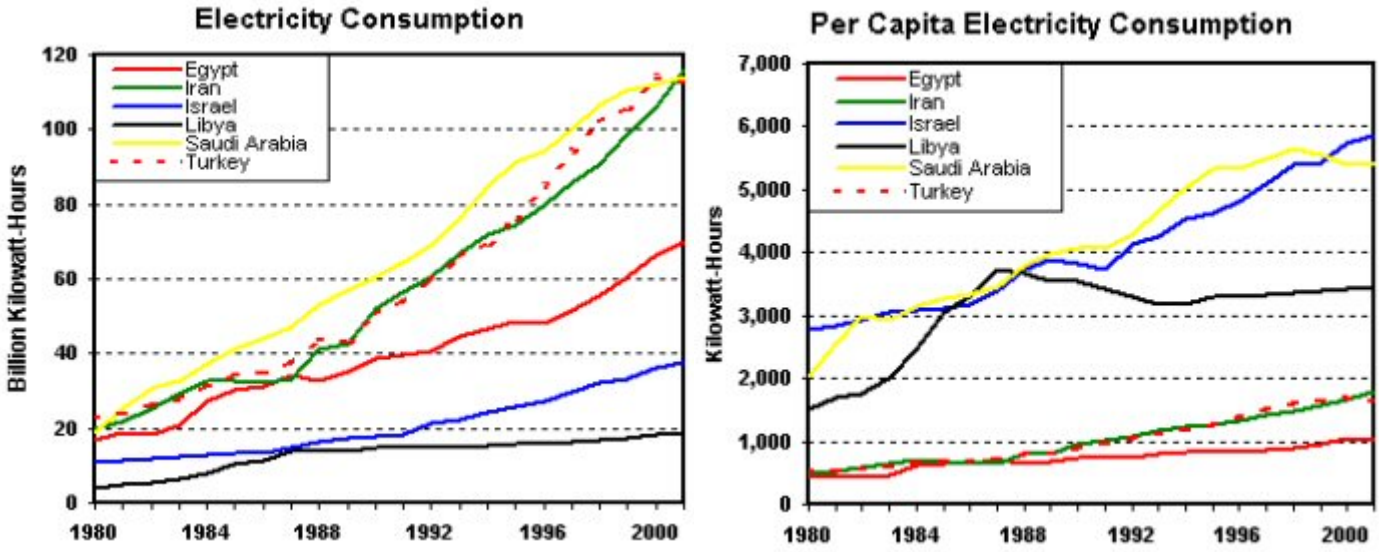
- As with energy intensity, most of the growth in the MENA region's carbon dioxide intensity occurred in the 1980s.

- The MENA region's increasing carbon dioxide intensity reflects its increasing reliance on energy-intensive industrialization, including the development of refining and petrochemical industries.

- During the 1980s and 1990s, Israel and Turkey, the region's two most developed economies, had carbon dioxide intensities lower than the MENA regional average. This reflects the more diversified nature of their economies, as well as their somewhat less carbon intensive energy portfolios (Turkey, for instance, relies increasingly on hydropower and natural gas). Most of the rest of the region's economies are based almost exclusively on industries related to hydrocarbons. Such industries are highly carbon dioxide intensive.

- After Israel and Turkey, Egypt had the next lowest carbon dioxide intensity in the region during the 1980s and 1990s. This reflects its comparatively large consumption of hydroelectric energy, largely from the Aswan High Dam on the Nile River.

MENA Electricity Overview



- Electricity consumption rose dramatically in the MENA region between 1980 and 2001, more than quadrupling from 139 bkwh to 664 bkwh. The region's rapidly rising electricity demand (7.7% per year) reflects both population growth, particularly in the Persian Gulf and North African states, and higher per capita electricity consumption rates.

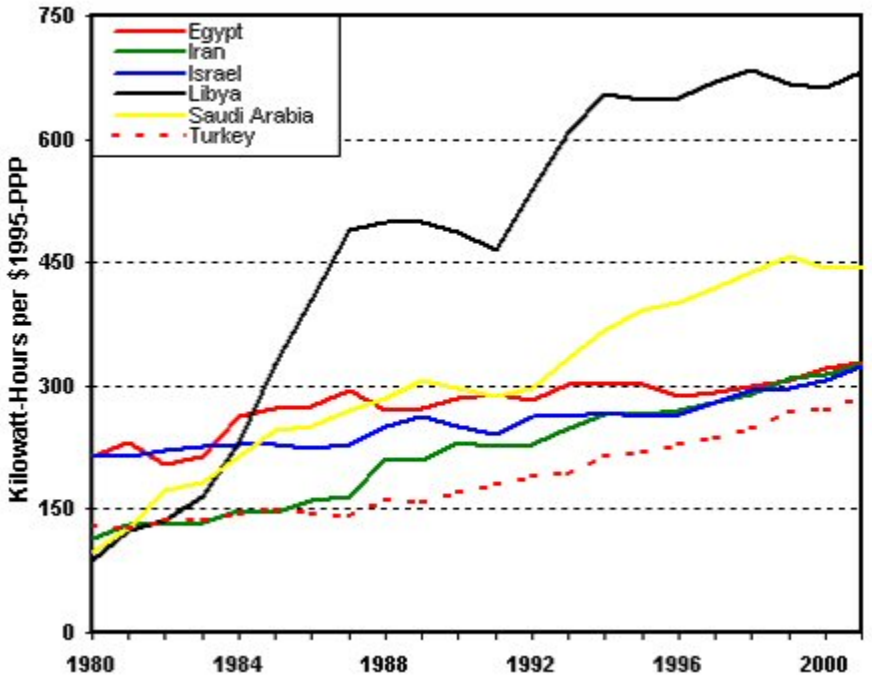
- Overall, the MENA region's per capita electricity demand almost tripled during the period, from 676 kwh to 1,873 kwh. This reflects an average annual growth rate of 5.0%, the second most rapid in the world behind Developing Asia.

- Reasons for this increased per capita electricity demand varied within the region. Growth in economically developed countries like Turkey and Israel in part reflected structural changes and increased industrial development. For example, Israel's high-technology sector grew rapidly between 1980 and 2001.

- In developing countries like Saudi Arabia and Iran, growth in per capita electricity demand reflected a number of other factors, including: 1) efforts to industrialize; 2) rural electrification campaigns; and 3) increased residential and commercial power consumption.

- Oil-exporting countries like Saudi Arabia and Libya experienced especially rapid per capita electricity demand growth during the early 1980s. This was an era of rising incomes due to the 1970s oil price increases. After oil prices fell in the mid-1980s, the rate of power demand growth slowed as real incomes fell. Electricity consumption patterns were only partially affected, however, due to intervention in energy markets by governments in the region (e.g. Saudi Arabia).

MENA Electricity Intensity



- Between 1980 and 2001, the overall electricity intensity in the MENA region rose 193%, from 120 kwh per $1995-PPP to 352 kwh per $1995-PPP. This reflects an average annual growth rate of 5.2%, the fastest rate in the world.

- In part, the MENA region's rapid growth in electricity intensity reflects the maintenance of substantial subsidies on fossil fuels, which allowed consumption to grow despite falling incomes.[25]

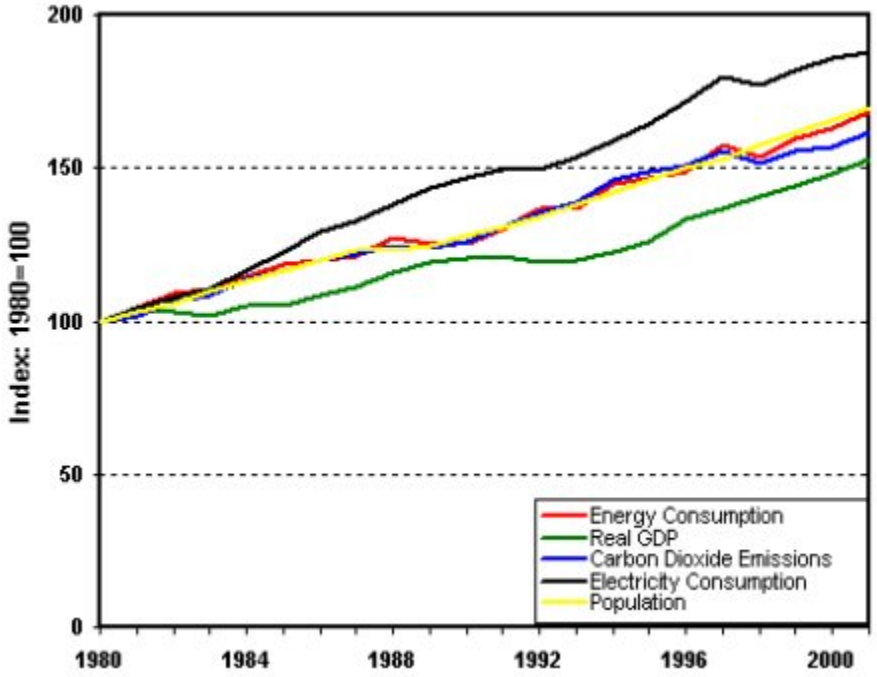
- MENA's electricity intensity rose especially rapidly during the 1980s, growing an average of 8.2% per year between 1980 and 1989. From 1990 to 2001, the MENA region's electricity intensity increased at a comparatively modest 3.2% per year. The change likely reflects the impact of lower oil prices on countries dependent on petroleum exports.

- Egypt exemplifies the trend of many nations in the MENA region. Between 1980 and 2001, Egypt's population and per capita real GDP each grew substantially, fueling a rise in electricity intensity. By 2001, Egypt consumed 328 kwh per $1995-PPP, a 54% increase compared to 1980.

- Saudi Arabia's electricity intensity grew even more rapidly between 1980 and 2001, rising from less than 100 kwh per $1995-PPP to 444 kwh per $1995-PPP.

VI. Africa

African Growth Trends



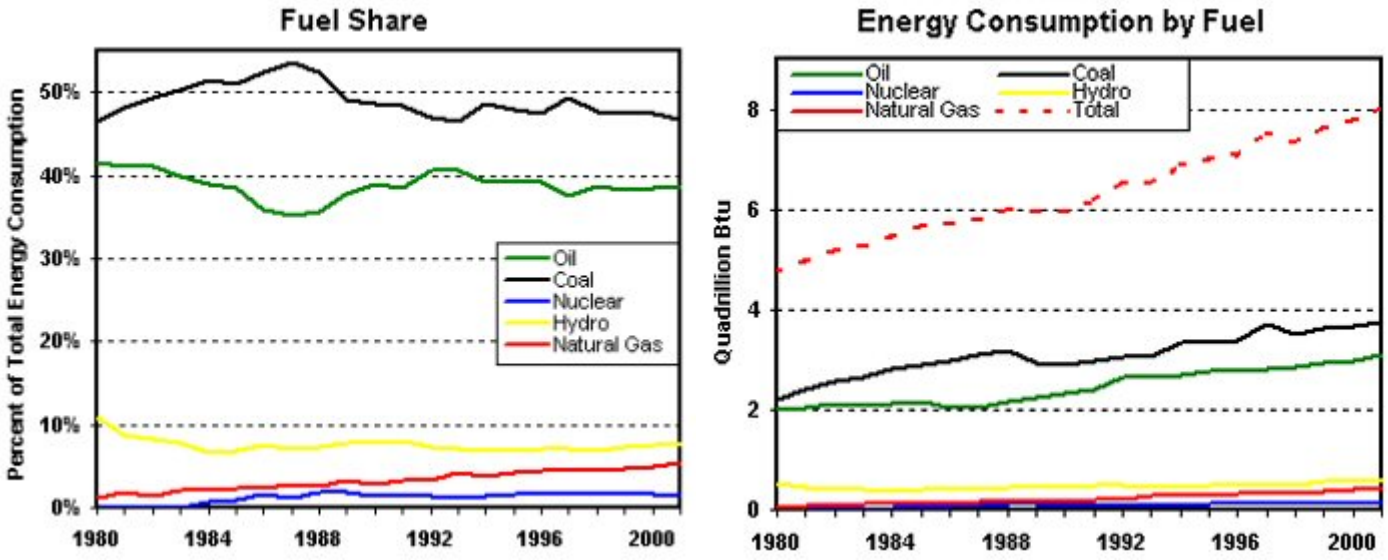
- Between 1980 and 2001, Africa experienced growth in all five of the indicators examined here. All five indicators grew at roughly the same pace, between 2.0% and 3.1% per year.

- Africa's electricity consumption grew the most rapidly over the period, rising 88% overall -- an average rate of 3.1% per year.

- Population (2.5% per year), energy consumption (2.5%), and carbon dioxide emissions (2.3%) increased at approximately equal rates, with per capita energy use and carbon dioxide emissions rates declining very gradually.

- Between 1980 and 2001, Africa's real GDP grew the least rapidly – just 2.0% per year -- of all indicators examined here. As a result, per capita real income fell, while electricity, carbon, and energy intensity levels increased.

Energy Consumption by Fuel Type in Africa



- African commercial energy consumption increased from 5 quads in 1980 to 8 quads in 2001. Africa is by far the smallest consumer of commercial energy of all the world's regions.

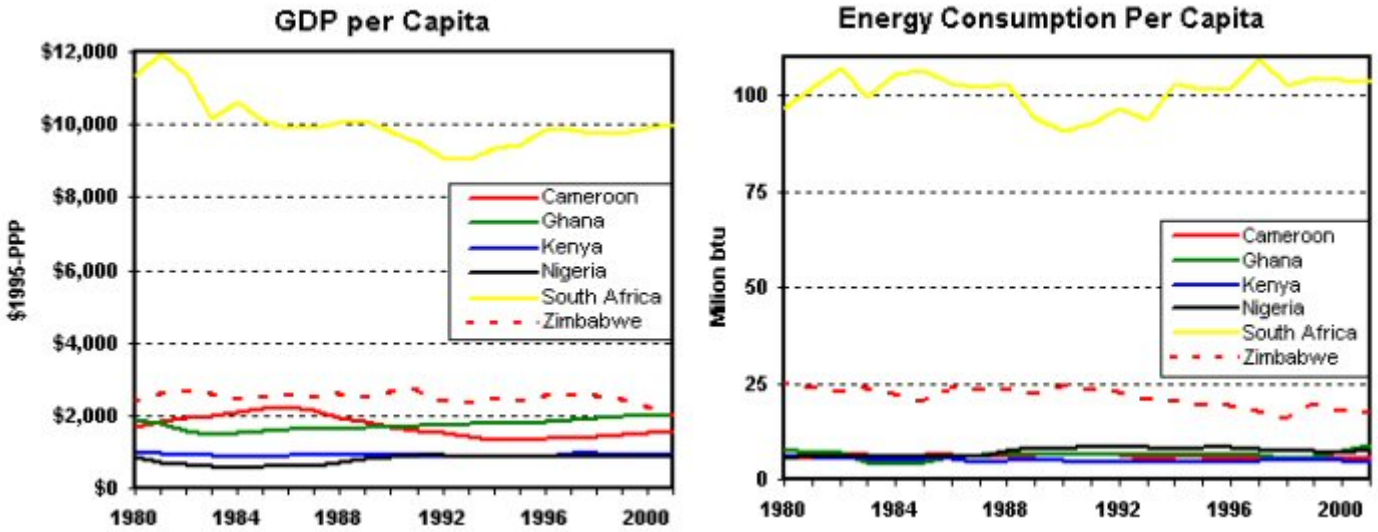
- At the same time, Africa is probably the largest consumer in the world of "traditional" energy sources like fuel wood and animal waste. They meet a huge portion of Africa's energy needs. While this type of consumption is of great importance, it is not reflected in the numbers because of the difficulty of collecting accurate data. For that reason, only commercial energy is included here. It is worth noting that the heavy reliance on "traditional" energy sources is closely linked with deforestation and a likely net loss in carbon sequestration.

- Throughout the 1980s and 1990s, fossil fuels consistently comprised around 90% of Africa's commercial fuel mix. While natural gas increased its share from 1% to 5% of total energy consumption, coal and oil remain the region's dominant sources of fossil energy. These two fuels' relative shares have remained essentially constant since the late 1980s, with coal contributing slightly less than 50% of the region's energy demand and oil providing slightly less than 40%.

- Africa was the only region other than the MENA where non-fossil energy's share declined between 1980 and 2001. Most of this decline -- from 11% to 9% of total energy consumption-- reflects the decline in hydroelectric power's share from 11% to 8% during the period.

- Nuclear power's share of total African energy consumption has fluctuated between 1% and 2% since 1980. Only South Africa generates nuclear power, but even that country has not significantly increased its nuclear output since 1988.

Per Capita Trends in Africa



- Africa is the world's poorest region, and it grew poorer both absolutely and comparatively between 1980 and 2001. During this period, Africa's per capita real GDP declined an average of 0.5% per year, from $1,945 to $1,756, as the region's economy failed to grow as rapidly as its population. At the same time, Africa's per capita real GDP declined from 38% of the global average in 1980 to just 25% in 2001.

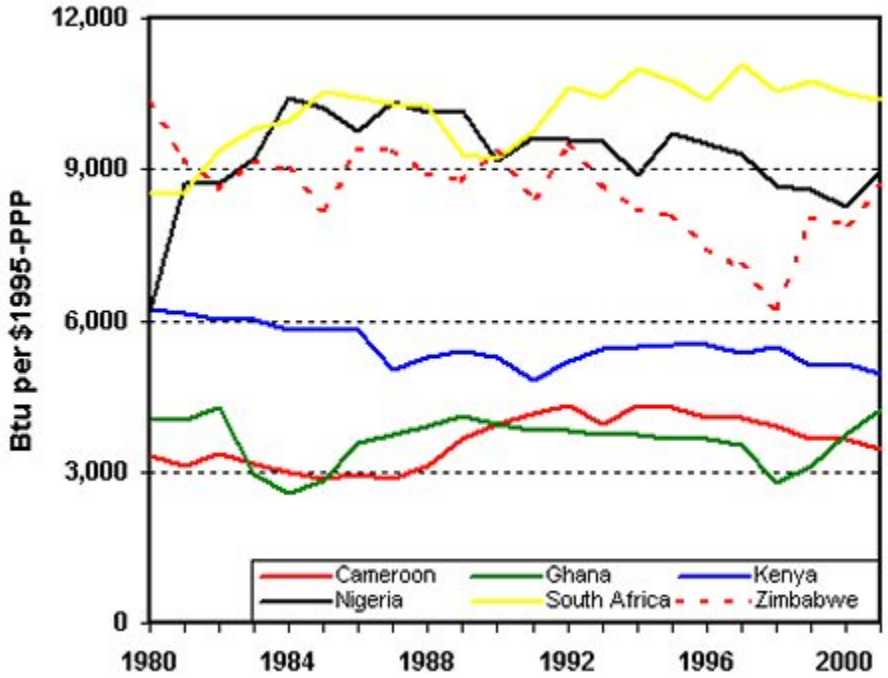
- In 1980, Africa's per capita real GDP was more than 50% higher than that of Developing Asia, which was the lowest at the time. As a result of African economic stagnation and Asian growth during the 1980s and 1990s, Africa's per capita GDP fell to barely half that of Developing Asia in 2001.

- The trend of declining incomes affected both rich and poor African nations. South Africa, the continent's strongest economy, experienced a 20% decline in its real per capita income between 1980 and 1993, from $11,339 to $9,016. It subsequently recovered to almost $9,987 in 2001, but this still represented a 12% decline from 1980.

- African per capita energy consumption remained almost constant over the period, averaging around 11.5 million Btu. In 2001, Africa's per capita energy consumption was less than 16% of the rest of the world's per capita average and just 5% of the G-7 per capita average. This figure actually overstates consumption in the region, for it includes South Africa, which consumes at an anomalously high rate and accounts for a disproportionate amount of African consumption.

- In 2001, South African citizens consumed 104 million Btu per person, almost 10 times the regional average. Excluding South Africa, the African per capita energy consumption rate would fall to 5 million Btu per person, 2% of the G-7's level.

Energy Intensity in Africa



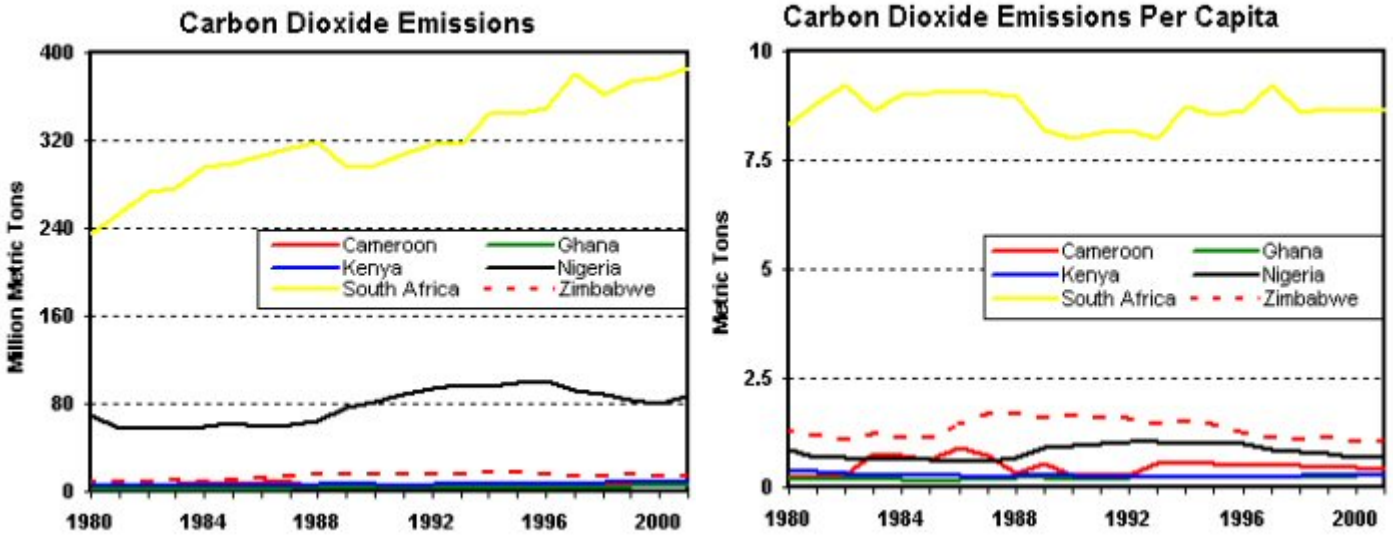
- Africa's energy intensity increased slightly between 1980 and 2001, from 5,953 Btu per $1995-PPP to 6,555 Btu per $1995-PPP. Nigeria and South Africa accounted for the bulk of this increase, as they consume the bulk of the region's energy and constitute the largest economies.

- Nigeria's energy intensity rose rapidly between 1980 and 2001, increasing an average of 1.8% per year, from 6,175 Btu per $1995-PPP 8,973 Btu per $1995-PPP. Most of this increase took place in the early 1980s, when high oil prices helped fuel development. Since then, Nigeria's energy intensity has declined.

- Between 1980 and 2001, South African energy intensity grew an average of 1.0% per year, from 8,508 Btu per $1995-PPP to 10,391 Btu per $1995-PPP.

- The decline in Zimbabwe's energy intensity in the 1990s likely reflects its difficulty procuring fuel due to economic and political problems.

Overview of Carbon Dioxide Emissions in Africa



- Between 1980 and 2001, Africa's energy related carbon dioxide emissions grew 61% overall -- an average of 2.3% annually -- from 390 MMT to 630 MMT. During this period, the region's per capita carbon dioxide emissions rate declined 5% overall, from 0.95 metric tons per person to 0.9 metric tons per person. Both Africa's absolute carbon dioxide emissions and its per capita carbon dioxide emissions rate were the lowest in the world in 2001.

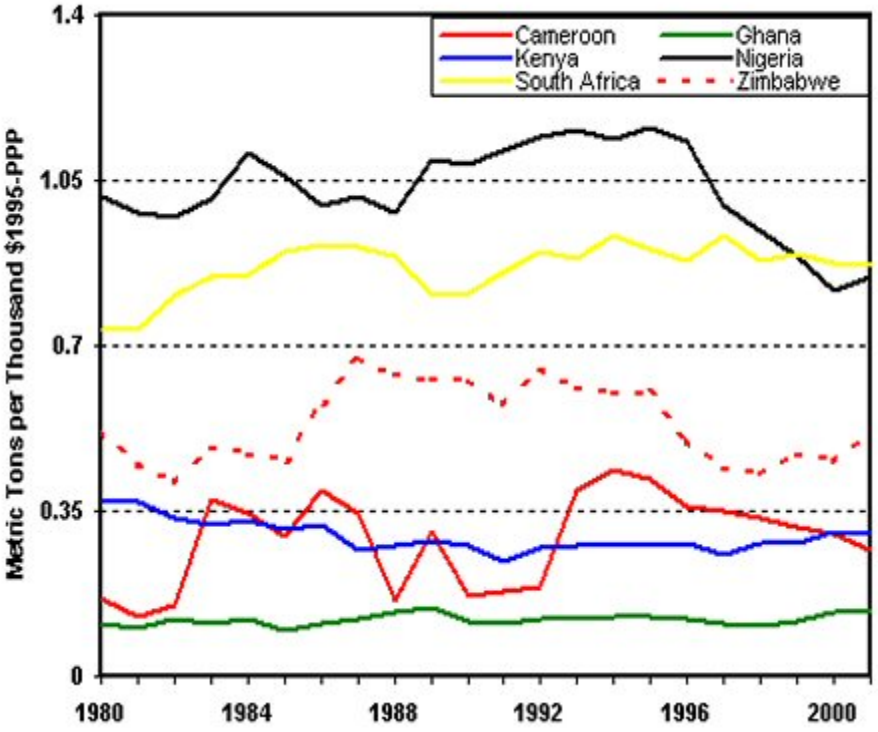
- Africa has very low carbon dioxide emissions because of its lack of a large transportation sector, combined with relatively low rates of electrification, appliance penetration, and industrialization.

- Africa is not converging to other non-OECD regions' per capita carbon dioxide emissions rates. Between 1980 and 2001, Africa was the only non-OECD region other than the EE&FSU to experience a decline in per capita carbon dioxide emissions. This reflects the relative absence of economic and industrial development compared to other non-OECD regions.

- Much of Africa's carbon dioxide emissions growth between 1980 and 2001 came from South Africa, the region's only major carbon emitter. In 2001, South Africa accounted for 61% of Africa's total carbon dioxide emissions. During this period, South African emissions grew from 235 MMT to 386 MMT. Much of the reason for South Africa large carbon dioxide emissions is its reliance on coal.

- Despite having a population almost three times larger than South Africa's, Nigeria emitted less than a quarter as much carbon during the past 20 years. This reflects the relative absence of industrial development. Nigeria's carbon dioxide emissions grew modestly, rising an average of 1.0% a year, from 69 MMT to 86 MMT.

Carbon Dioxide Intensity in Africa



- Between 1980 and 2001, African carbon dioxide intensity grew slightly, from 0.49 metric tons per thousand $1995-PPP to 0.51 metric tons per thousand $1995-PPP. Other than the MENA, Africa was the only world region where carbon dioxide intensity increased during this period.

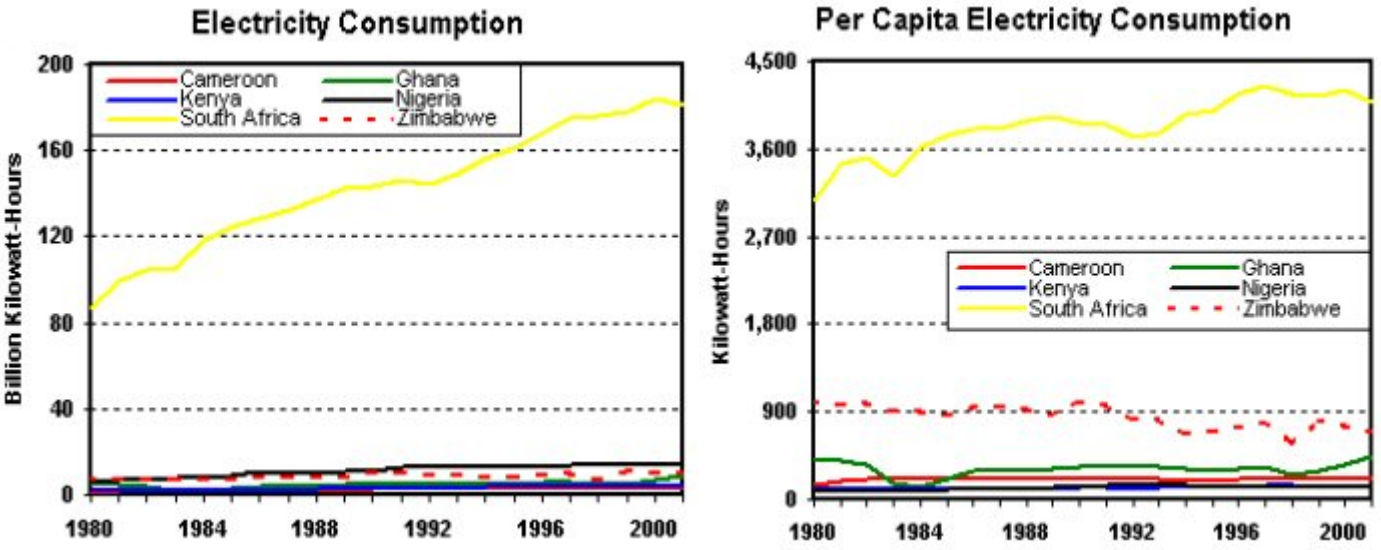
- South Africa and Nigeria released the most carbon per dollar of GDP throughout the 1980s and 1990s, reflecting their status as the most industrialized country and largest energy producer, respectively, in Africa.

- Nigeria's carbon dioxide intensity is the lowest of all OPEC members, but it remains significantly higher than the levels of rest of the major African economies' (other than South Africa).

- Nigeria's carbon dioxide intensity declined 26% between 1996 and 2001, likely reflecting its decision to reduce the flaring of natural gas.

- South Africa's carbon dioxide intensity is particularly high (0.87 metric tons per thousand $1995-PPP in 2001) because it derives so much of its energy consumption from highly carbon-intensive coal. In 2001, coal accounted for 75% of South African energy consumption.

Overview of Electricity Consumption in Africa



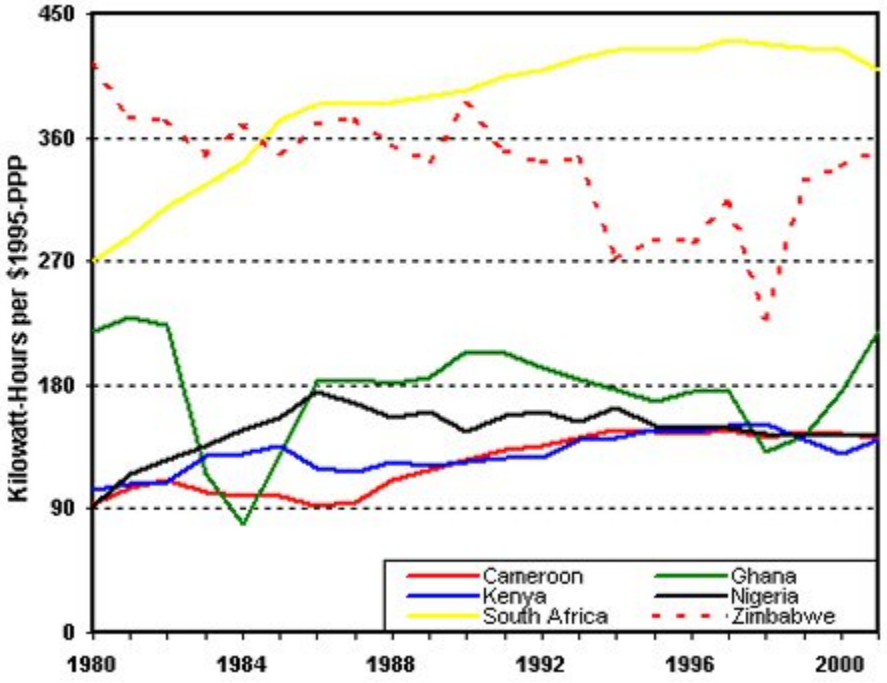
- African electricity consumption grew an average of 3.1% per year between 1980 and 2001, from 146 bkwh to 275 bkwh. During this time, Africa's per capita demand for electricity declined relative to that in the MENA region, making Africa the region with the smallest per capita consumption of electricity in the world.

- Africa's lack of industrialization is apparent from its very low per capita demand for electricity. In 2001, Africans consumed only 394 kwh per person, which is less than 5% of the OECD per capita electricity consumption rate and just over 50% of Developing Asia's consumption rate.

- South Africa consumes an absolute majority of the electricity used in Africa, and has a significantly higher per capita consumption rate than the region's other countries. South Africa's share of Africa's electricity consumption grew from 59% in 1980 to 66% in 2001 as its electricity consumption increased from 87 bkwh to 181 bkwh.

- If South Africa is excluded, Africa's per capita electricity consumption in 2001 would have been around 140 kwh, less than 2% of OECD per capita power consumption.

Electricity Intensity in Africa

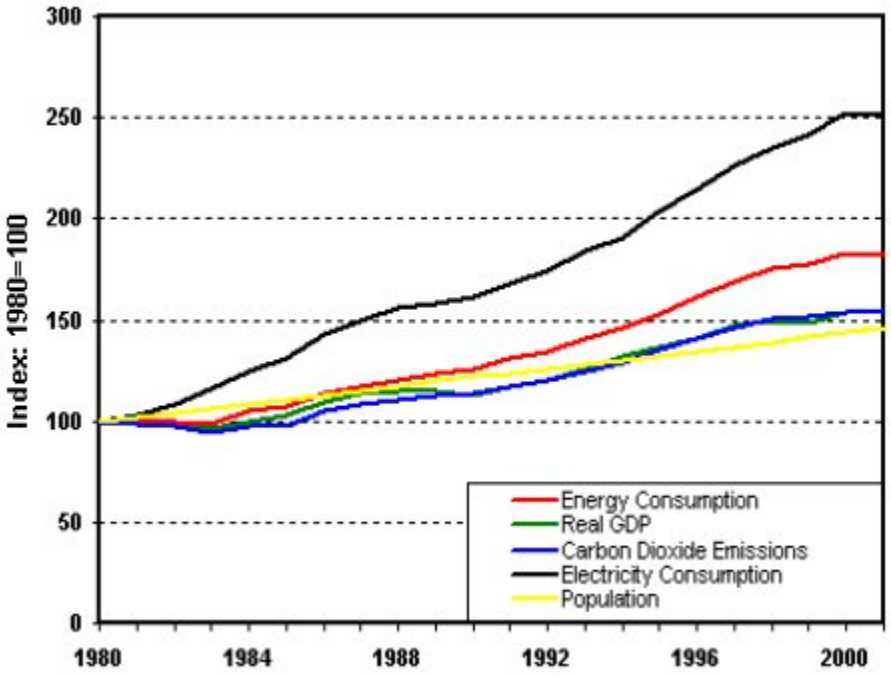


- Overall, African electricity intensity grew 23% between 1980 and 2001, rising from 183 kwh per $1995-PPP to 224 kwh per $1995-PPP. This constitutes an average annual increase of 1%.

- South Africa accounted for the bulk of this increase due to its disproportionate consumption of electricity. South Africa's electricity intensity grew from 270 kwh per $1995-PPP in 1980 to 409 kwh per $1995-PPP in 2001. By 2001, South Africa's electricity intensity actually was 18% higher than the OECD average.

VII. Latin America

Latin American Growth Trends



- Latin America experienced growth in every indicator examined here between 1980 and 2001. For carbon dioxide emissions, real GDP, and energy consumption, this growth did not begin until the mid-1980s, following the oil price collapse of late 1985/early 1986.

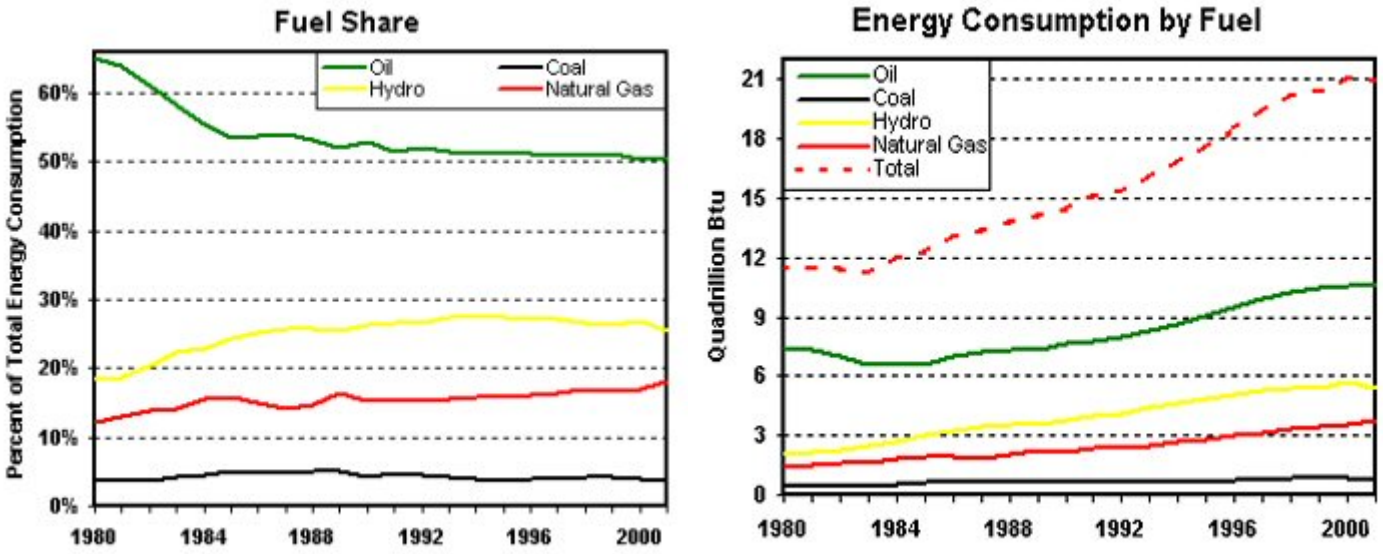
- Electricity consumption grew the most rapidly over the period, rising 151% overall, with average annual increases of 4.5%.

- Real GDP, carbon dioxide emissions, and energy consumption increased an average of 2.1%, 2.1%, and 2.9% per year, respectively, between 1980 and 2001. Latin America's population averaged growth of 1.8% per year during this period.

- All of the energy and economic indicators stopped growing in 2000 and 2001, when many countries in Latin America suffered financial crises. These produced dramatic declines in economic output and energy consumption in some of the region's largest countries.

- Not all Latin American countries suffered economic declines during this period, however. For example, Chile was comparatively unaffected by the severe late 1990s economic turmoil, which may reflect the fact that the chief purchasers of Chilean exports are outside the region.[26]

Energy Consumption by Fuel Type in Latin America



- Between 1980 and 2001, energy consumption in Latin America grew 82% overall -- an average of 2.9% annually -- from 11 quads to 21 quads.

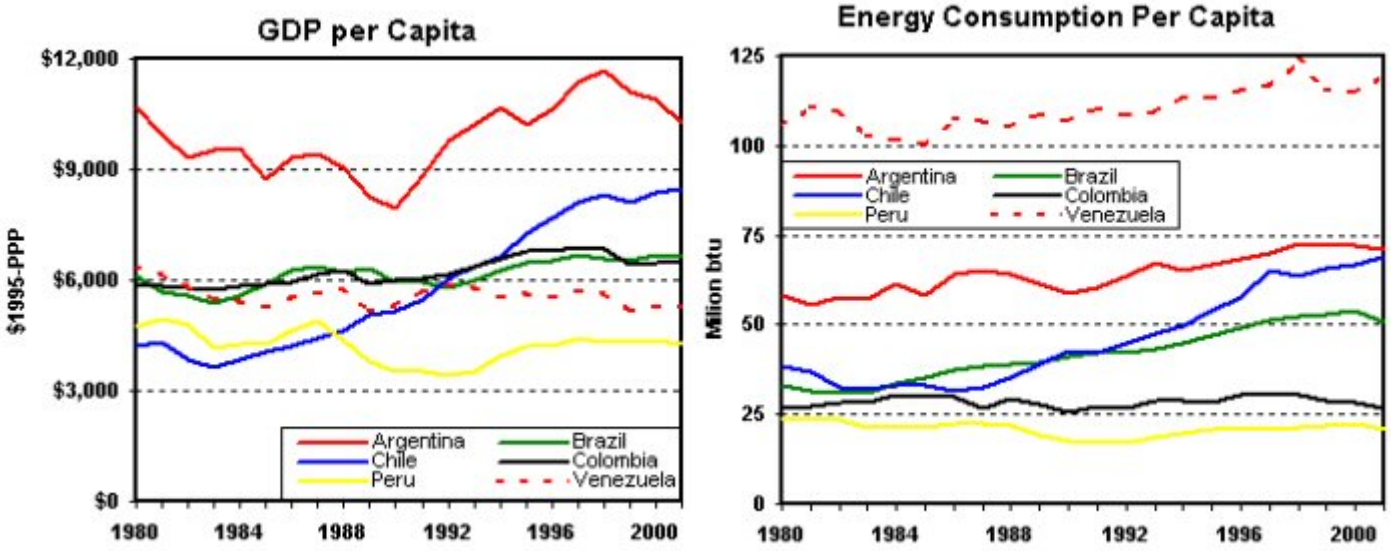
- During this period, the region grew less dependent upon fossil fuels, mainly because of a relative decline in oil consumption and an increase in hydroelectricity production.

- In 1980, petroleum accounted for 65% of energy consumed in Latin America. This share fell rapidly during the early 1980s, reflecting that period's high oil prices. While the slide moderated in the mid-1980s after the fall in oil prices, petroleum never recovered its previous share of energy consumption. Oil did, however, remain the single most important source of energy in the region, accounting for half of the region's 2001 energy consumption.

- Both natural gas and hydroelectric power increased their shares of Latin America's energy consumption between 1980 and 2001. Natural gas' share grew 67%, from 12% (1.4 quads) to 18% (3.8 quads) of all energy consumed. Hydroelectric power's share grew almost as much, increasing from 18% (2.1 quads) to 26% (5.3 quads).

- Coal accounted for a much smaller share of energy consumption in Latin America than it did anywhere else in the world. Coal's share of the region's energy portfolio remained fairly constant at 4%-5% during the 1980s and 1990s.

Per Capita Trends in Latin America



- Per capita income in Latin America barely rose between 1980 and 2001, growing from $5,872 to $6,184. Because of the large absolute declines in per capita GDP in the EE&FSU region, however, Latin America became the sub-region of the non-OECD with the highest per capita income.

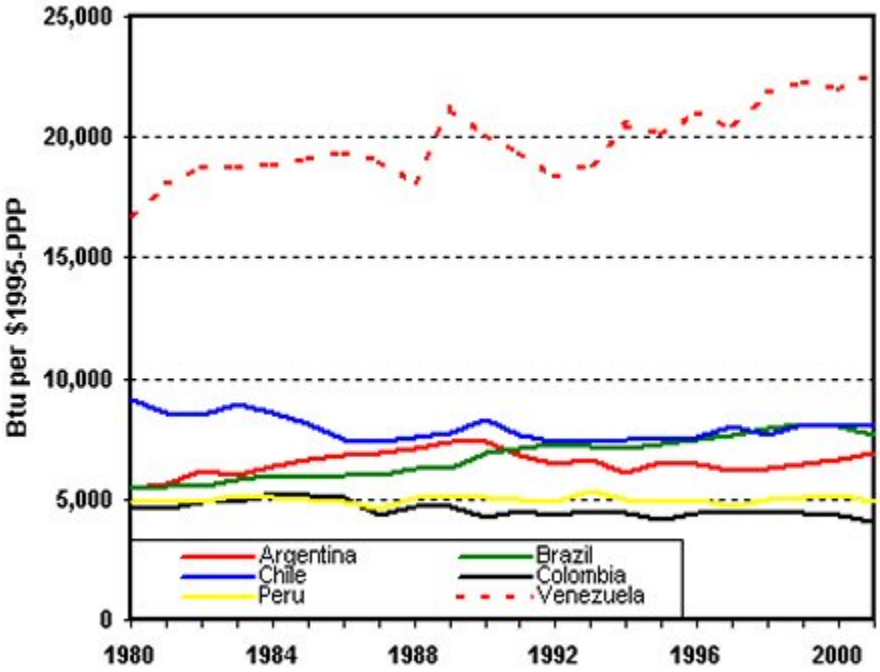
- Between 1980 and 2001, Chile's per capita GDP more than doubled, from $4,206 to $8,495, an average annual growth rate of 3.4%.

- Among the region's major economies, Argentina experienced the largest income fluctuations. Between 1980 and 2001, Argentina's real GDP per capita almost reached $11,700 and fell below as $8,000. At the end of the period, per capita GDP was $10,287, 4% lower than the country's 1980 level of $10,677.

- Venezuela's per capita GDP declined 17% between 1980 and 2001. Much of this reduction reflected declines in Venezuelan oil export revenues. While revenues declined 54% between 1980 and 2003, Venezuela's population almost doubled.[27]

- Between 1980 and 2001, Latin America's per capita energy consumption grew 24% over the period -- an average of 1.0% per year -- from 39 million Btu to 49 million Btu. This reflects the region's industrialization and electrification efforts, as well as its increasing motor vehicle penetration.

Energy Intensity in Latin America

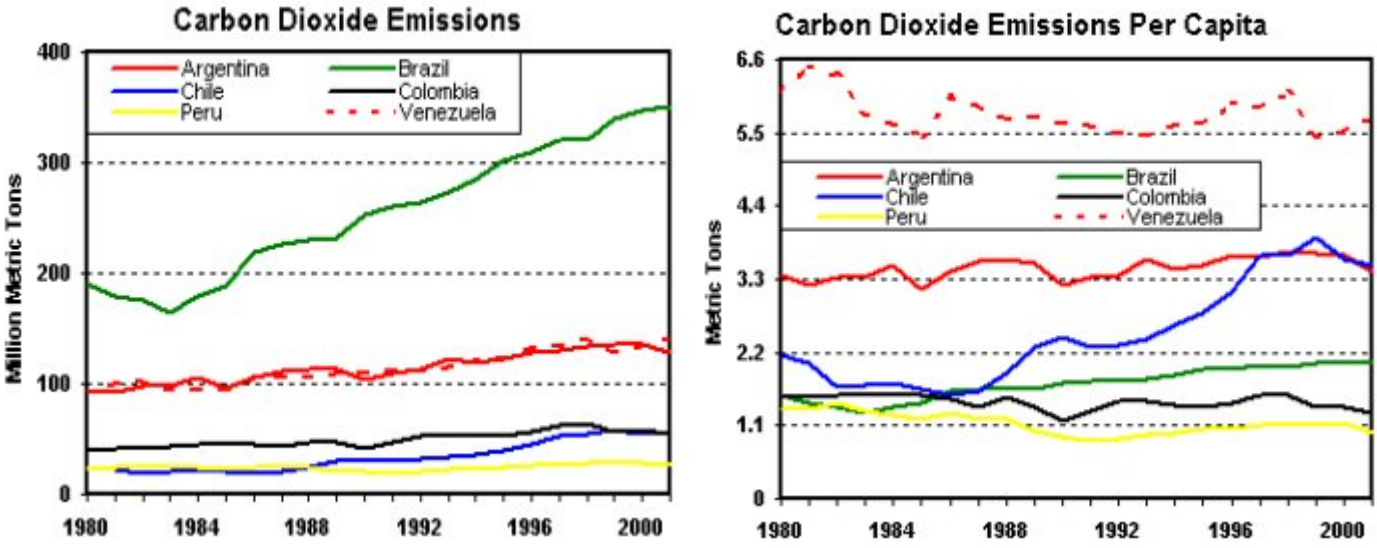


- Latin American energy intensity rose 18% between 1980 and 2001 -- 0.8% per year -- from 6,717 Btu per $1995-PPP to 7,938 Btu per $1995-PPP.

- Venezuela's and Brazil's energy intensities grew by 37%, and 41%, respectively, between 1980 and 2001.

- Reflecting its large energy sector, Venezuela's energy intensity was consistently the highest in the region during the period. In 2001, Venezuela's energy intensity was 22,691 Btu per $1995-PPP, or nearly triple the regional average.

Overview of Carbon Dioxide Emissions in Latin America



- Between 1980 and 2001, Latin American carbon dioxide emissions grew 54%, an average of 2.1% annually, from 640 MMT to 984 MMT. Latin America's carbon dioxide emissions increased more slowly than those of any other non-OECD region (excluding the EE&FSU region).

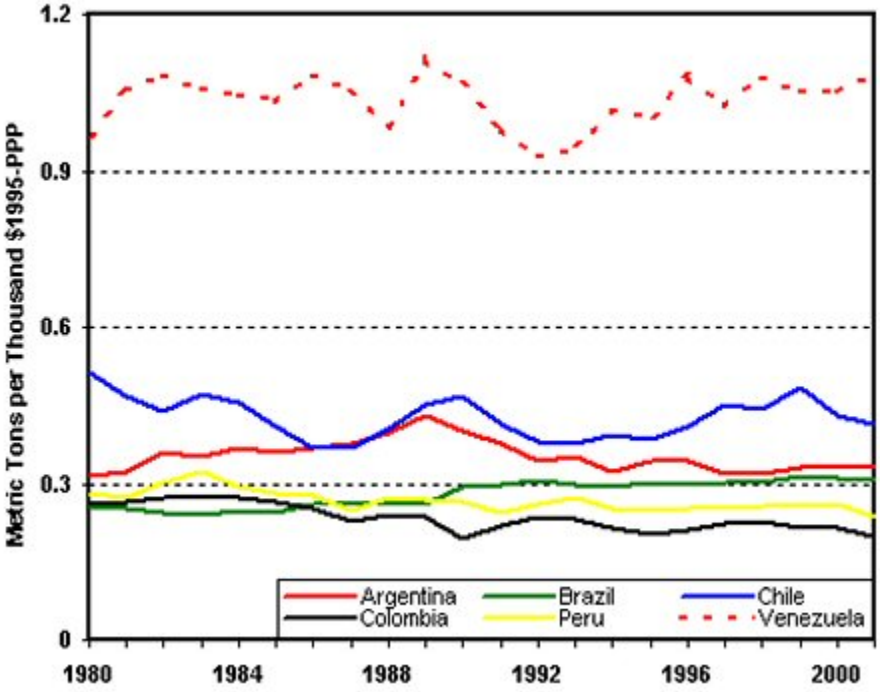
- The relatively slow growth of carbon dioxide emissions reflects Latin America's relatively increased use of natural gas and, especially, hydroelectric power. In 2001, hydroelectric power's share of Latin America's energy portfolio was 26%. In no other region, including the OECD and G-7, did hydroelectric power contribute more than 8% of energy consumption.

- Most of Latin America's carbon dioxide emissions growth occurred in Brazil. Industrialization, increased exploitation of fossil fuel resources, the rise of automobile ownership, broad electrification campaigns, and population increases helped to cause Brazilian carbon dioxide emissions to grow from 191 MMT to 351 MMT between 1980 and 2001. This reflects average annual growth of 3.0%.

- During this period, Chile's carbon dioxide emissions grew even faster, at 3.9% per year, rising from 24 MMT to 54 MMT. This rapid growth reflects, in part, Chile's increasing concentration on energy intensive heavy industries like copper mining and processing.

- Overall, Latin American per capita carbon dioxide emissions remained about flat between 1980 and 2001, at slightly over 2 metric tons per person. Only Chile experienced significant growth in per capita emissions, in part reflecting the importance of its heavy industries sector.

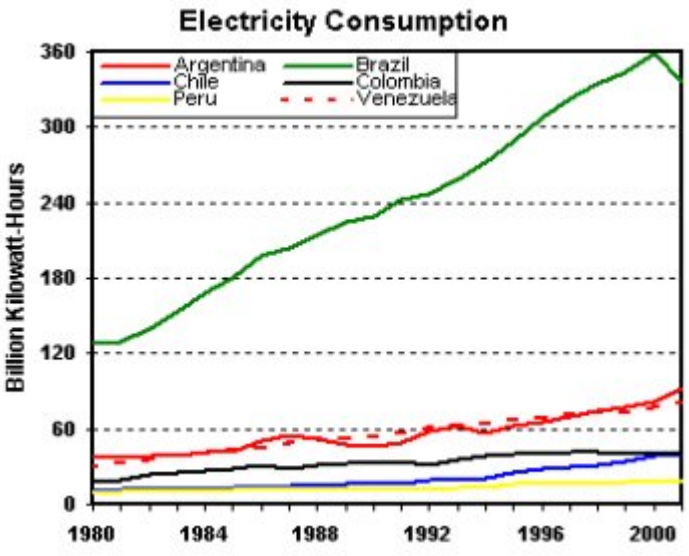
Carbon Dioxide Intensity in Latin America

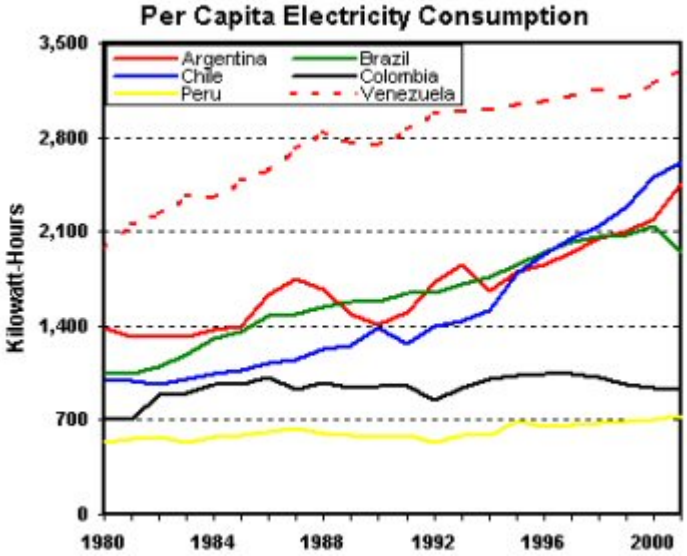


- Carbon dioxide intensity remained relatively constant in Latin America between 1980 and 2001, hovering around 0.37 metric tons per thousand $1995-PPP. Throughout the period, Latin America had the lowest carbon dioxide intensity of any world region, a result of its large hydroelectric sector.

- Variations in carbon dioxide intensity levels within the Latin America region likely are reflective of the countries' differing natural resource endowments. For example, Venezuela's carbon dioxide intensity is the highest in the region in part due to its huge hydrocarbon reserves.

Overview of Electricity Consumption in Latin America





- Latin American electricity consumption grew from 287 bkwh to 721 bkwh between 1980 and 2001 -- an average annual growth of 4.5%.

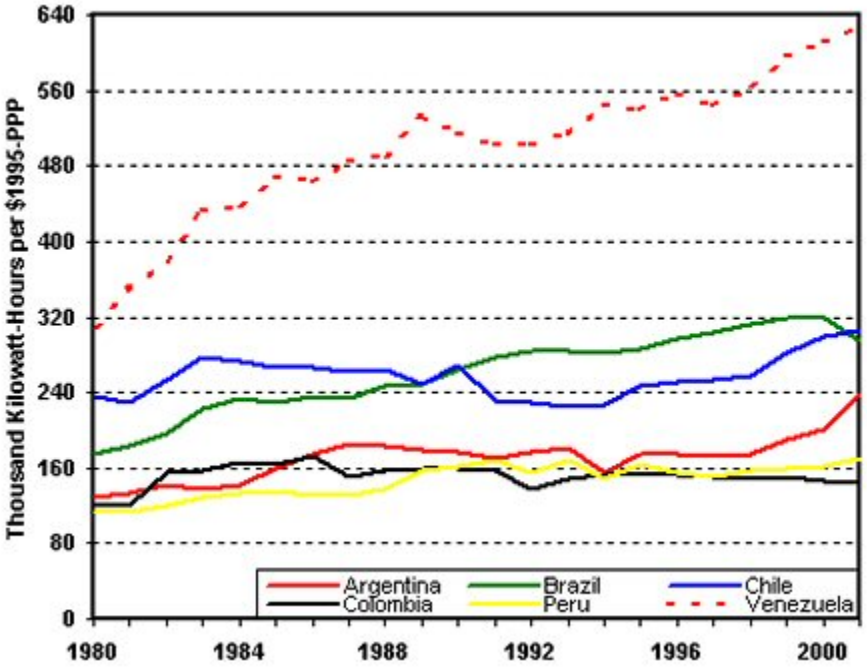
- Brazil accounted for more than half of the increase in Latin American power consumption between 1980 and 2001. Brazil's electricity consumption nearly tripled, growing an average of 4.7% per year -- from 129 bkwh to 336 bkwh -- over the period.

- While Brazilian demand for electricity grew more rapidly in absolute terms, Chile's demand grew at a more rapid rate -- an average of 6.3% per year. Chile consumed 40 bkwh in 2001, 264% more than it did in 1980.

- During the 1980s and 1990s, Chilean per capita electricity consumption grew the most rapidly of the major economies in the region. Between 1980 and 2001, Chilean per capita power consumption increased an average of 4.7% per year, growing from 989 kwh to 2,606 kwh. The large increase in per capita electricity consumption in Chile reflected the country's ongoing industrialization as well as rural electrification efforts.

- Peru and Colombia grew the least rapidly between 1980 and 2001 in terms of both overall power demand as well as per capita power consumption. This was illustrative of the two countries' economic and political struggles during the period.

Electricity Intensity in Latin America



- Latin America's electricity intensity increased 63% between 1980 and 2001 -- an average of 2.3% per year -- from 168 kwh per $1995-PPP to 273 kwh per $1995-PPP. This growth rate was greater than that of any other region except Developing Asia, and reflects the region's industrialization, electrification, and emphasis on heavy industries.

- Venezuela's electricity intensity grew particularly rapidly during the period, rising an average of 3.4% per year, from 311 kwh per $1995-PPP to 626 kwh per $1995-PPP. This significant growth occurred in part because Venezuela maintained price controls on electricity.

- Chile's electricity prices were not controlled, but Chilean electricity intensity nonetheless grew 30% -- 1.3% per year -- from 235 kwh per $1995-PPP in 1980 to 307 kwh per $1995-PPP in 2001. This growth stemmed in part from Chile's industrial development, and in part from its rural electrification activities.

Appendices

Appendix A: Country Categories

OECD

Australia; Austria; Belgium; Canada; Denmark; Ireland; Finland; Faroe Islands; France; Germany; Gibraltar; Greenland; Greece; Iceland; Italy; Japan; Luxembourg; Malta; Mexico; Netherlands; Norway; New Zealand; Portugal; Spain; Sweden; Switzerland; United Kingdom; United States

EE&FSU

Azerbaijan; Albania; Armenia; Bosnia and Herzegovina; Belarus; Bulgaria; Estonia; Czech Republic; Georgia; Croatia; Hungary; Kyrgyzstan; Kazakhstan; Latvia; Lithuania; Moldova; Macedonia (Former Yugoslav Republic); Poland; Romania; Russia; Slovenia; Slovakia; Tajikistan; Turkmenistan; Ukraine; Uzbekistan; Yugoslavia

Developing Asia

Afghanistan; American Samoa; Bangladesh; Burma; Solomon Islands; Bhutan; Brunei; Cambodia; Sri Lanka; China; Cook Islands; Fiji; French Polynesia; Guam; Hong Kong; Hawaiian Trade Zone; Indonesia; India; U.S. Pacific Islands; Korea, North; Kiribati; Korea, South; Laos; Macau; Mongolia; Maldives; Malaysia; New Caledonia; Niue; Vanuatu; Nepal; Nauru; Pakistan; Papua New Guinea; Philippines; Samoa; Singapore; Thailand; Tonga; Taiwan; Vietnam; Wake Island

MENA

Algeria; Bahrain; Cyprus; Egypt; Iran; Israel; Iraq; Jordan; Kuwait; Lebanon; Libya; Oman; Qatar; Saudi Arabia; Syria; United Arab Emirates; Tunisia; Turkey; Yemen

Africa

Angola; Benin; Botswana; Burkina Faso; Burundi; Cameroon; Cape Verde; Central African Republic; Chad; Comoros; Congo (Brazzaville); Congo (Kinshasa); Cote d'Ivoire (Ivory Coast); Djibouti; Equatorial Guinea; Eritrea; Ethiopia; Gabon; Gambia, The; Ghana; Guinea; Guinea-Bissau; Kenya; Lesotho; Liberia; Madagascar; Malawi; Mali; Mauritania; Mauritius; Morocco; Mozambique; Namibia; Niger; Nigeria; Reunion; Rwanda; Saint Helena; Sao Tome and Principe; Senegal; Seychelles; Sierra Leone; Somalia; South Africa; Sudan; Swaziland; Tanzania; Togo; Uganda; Western Sahara; Zambia; Zimbabwe

Latin America

Aruba; Antigua and Barbuda; Argentina; Antarctica; Barbados; Bermuda; Bahamas, The; Belize; Bolivia; Brazil; Chile; Cayman Islands; Colombia; Costa Rica; Cuba; Dominica; Dominican Republic; Ecuador; El Salvador; French Guiana; Falkland Islands; Grenada; Guadeloupe; Guatemala; Guyana; Haiti; Honduras; Jamaica; Martinique; Montserrat; Suriname; Netherlands Antilles; Nicaragua; Paraguay; Peru; Panama; Puerto Rico; Saint Pierre and Miquelon; Saint Kitts and Nevis; Saint Lucia; Trinidad and Tobago; Turks and Caicos Islands; Uruguay; Saint Vincent/Grenadines; Venezuela; Virgin Islands, British; Virgin Islands, U.S.

Appendix B: Non-EIA Sources

[1] Energy Information Administration, *International Energy Outlook 2003*, http://www.eia.doe.gov/oiaf/ieo/electricity.html; Energy Information Administration, *Annual Energy Outlook 2004*, http://www.eia.doe.gov/oiaf/aeo/demand.html#comm; International Energy Agency (IEA), *Oil Crises and Climate Challenges: 30 Years of Energy Use in IEA Countries* (Paris: OECD, 2004), 16-17. See footnote 14 for information on the share of total electricity consumption accounted for by computers and office equipment.
[2] The OECD's methodology for calculating their PPP estimates is explained on its website at: http://www.oecd.org/faq/0,2583,en_2649_34357_1799281_1_1_1_1,00.html#1799075.
[3] UNEP, "Energy and Greenhouse Gas Emissions," http://unfccc.int/resource/ccsites/senegal/fact/fs025.htm.
[4] A good introduction to the literature on "post-industrialism" is Andrew Bell *The Coming of Post-Industrial Society: A Venture in Social Forecasting* (New York: Basic Books, 1999).
[5] Zhong Xiang Zhang, "Why Had the Energy Intensity Fallen in China's Industrial Sector in the 1990s? The Relative Importance of Structural Change and Intensity Change," No. 200105 in CCSO Working Papers from University of Groningen, CCSO Centre for Economic Research, 2001; Lynn Price, Ernst Worree, Jonathan Sinton, and Jiang Yun, "Industrial Energy Efficiency Policy in China," *Proceedings of the 2001 ACEEE Summer Study on Energy Efficiency in Industry*, 2001; China Energy Group of Lawrence Berkeley National Laboratory, http://china.lbl.gov/index.html.
[6] IEA (2004).
[7] Zhong (2001).
[8] Ward's, *World Motor Vehicle Data, 2003 Edition*; Ward's, *World Automotive Yearbook*, multiple years.
[9] United Nations Environmental Program and OECD, "Reforming Energy Subsidies," 2002, p. 12.
[10] OECD, *National Accounts, Volume 2: 2003 edition*.
[11] IEA (2004), pp. 37, 112. One can gain some insight into the differences for the U.S. by comparing the Bureau of Economic Analysis' "Gross Domestic Product by Industry" data with EIA sectoral consumption figures. The comparison is slightly problematic because the groupings are not identical. However, the trends are clear.
[12] *Ibid*.
[13] IEA (2004), p. 14.
[14] *Ibid*, pp. 16-18, 121-135.
[15] *Ibid*, pp. 18-19.
[16] *Ibid*, pp. 18-19.
[17] OECD, *Energy Balances of OECD Countries 2002-2003*.
[18] IEA (2004), p. 16.
[19] Estimates include those performed by scholars at the Lawrence Berkeley National Laboratory and the Arthur D. Little technological consulting group. (Jonathan G. Koomey, "Debunking an Urban Legend: How Much Electricity Does the Internet Use?," http://www.rmi.org/sitepages/pid918.php, 2001; "Arthur D. Little Forecasts Minimal Increase in Power Consumption from Office and Telecommunications Equipment," *Business Wire*, Nov. 8, 2001. See also: http://tonto.eia.doe.gov/FTPROOT/presentations/oiaf/speeches/0329eia.html
[20] "Rich Man, Poor Man," *The Economist*, Sept. 25, 2003; "Income gap among urbanites widens," *China Daily*," Nov. 7, 2003.
[21] B. B. Bhattacharya and S. Sakthivel, *Regional Growth and Disparity in India: A Comparison of Pre and Post-Reform Decades*, Institute of Economic Growth Paper No. 74, 2003
[22] Zhong (2001); Price, et. al. (2001); China Energy Group of Lawrence Berkeley National Laboratory, http://china.lbl.gov/index.html.
[23] China Energy Group, Lawrence Berkeley National Laboratory, http://china.lbl.gov/appliance.html.
[24] Oil revenue figures are based on EIA estimates using 2000 constant dollars unadjusted for purchasing power parity. The updated estimates can be found at OPEC Revenues Fact Sheet.
[25] United Nations Environmental Program and OECD, "Reforming Energy Subsidies," 2002, p. 12. The table gives figures only for "oil producers", excluding Russia.
[26] Data on Chilean export partners from www.nationmaster.com.

[27] Oil revenue figures are based on EIA estimates using 2000 constant dollars unadjusted for purchasing power parity.