A tale of two eras (1973–2014): World energy scene 40 years after the energy crisis

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The energy crisis of 1973 shocked the world from complacency about energy supply and price. The world has responded by significant improvement in energy efficiency and substitution of oil. Global warming concerns are further driving energy efficiency and the rise of renewables. This article looks at the energy scene in World and India before and after the energy crisis. Some observations are made based on available data for further action.

The Arab–Israeli war in 1973 led to energy crisis, awakening the world to limited availability and rising price of energy, especially oil. The International Energy Agency (IEA) was formed in 1974 by the developed world to ensure security of energy supply. It is worthwhile looking at the world energy scene in 1973 and 2014, 40 years after the energy crisis. The IEA has brought out its annual publication 'World Energy Statistics 2016'[1]. Also available is Key World Energy Trends, a summary from world energy balances 2016. These publications provide interesting trends in world energy supply and consumption in 1973 (before the energy crisis) and in 2014 (40 years after the energy crisis). This article analyses some characteristics of energy supply and use in the pre- and post-energy crisis world. It also includes similar comparison for India.

Table 1. Share of fuels in primary energy supply

Fuel	1973	2014
Oil (%)	46.2	31.3
Coal (%)	24.5	28.6
Natural gas (%)	16.0	21.2
Biofuels and waste (%)	10.5	10.3
Hydro (%)	1.8	2.4
Nuclear (%)	0.9	4.8
Others (solar, wind, etc.) (%)	0.1	1.4

Table 2. Regional share of energy supply

Region	1973	2014
OECD	61.3%	38.40%
Non-OECD, Europe (Russia and others)	15.5%	8.2%
China	7%	22.4%
The Middle East	0.8%	5.3%
Asia and others	5.5%	12.7%
Total	100%	100%

Primary energy supply

In 1973, the world energy supply was 6101 MTOE (million tonnes oil equivalent it is based on 1 kg oil = 10,000 kcal) while in 2014, it was 13,099 MTOE. Energy supply increased 2.25 times in 2014 compared to 1973. Table 1 shows the share of various fuels.

Sharp rise in oil prices has led to its substitution and efficient use. Oil provided only 31.3% of energy supply in 2014 compared to 46% in 1973. Share of coal and gas has increased to some extent. Biofuel which is mainly used in developing countries like India (firewood, dung cake) still accounts for 10% of energy supply. Share of nuclear energy showed a sharp increase with marginal increase in the share of hydro (Box 1).

The shares of different regions also showed a dramatic change (Table 2).

In Table 2, OECD includes Europe, USA, Japan and others. Non-OECD Europe includes Russia and its former associates like Ukraine, Turkmenistan, etc. Asia includes India, Indonesia, Sri Lanka and others. The table shows dramatic rise in energy production in China and the Middle East and decline in energy supply in USA and Europe. Share of Asia's energy supply has also increased.

Table 3 shows values of fuels in actual units and their ratios in 2014 and 1973. The table shows relative decline of oil, increase of gas and coal, as well as nuclear and hydro. It may be noted that hydro generation is (3883/2535) 31% more than nuclear, but the method of conversion used by IEA shows that contribution of nuclear is 4.8% of total energy compared to 2.4% of hydro.

It may be of interest to look at population, GDP and energy intensity (Table 4) (GDP and population data are from the World Bank website).

It can be seen that GDP is rising at a much faster rate than energy supply because of increasing energy efficiency as well as structural changes in the economy.

Table 3. Energy supply by fuels (actual units)

Fuel	1973	2014	2014/1973
Crude oil (million tonnes, Mt)	2869	4331	1.509
Natural gas (billion cubic metres – bcm)	1224	3590	2.933
Coal (Mt)	3074	7709	2.507
Nuclear (terawatt hour, TWh)	203	2535	12.48
Hydro (TWh)	1296	3983	3.073
Total primary energy (MTOE)	6106	13,699	2.245
Total electricity (TWh)	6131	23,816	3.88

Table 4. World population, GDP and energy intensity

Parameters	1973	2014	2014/1973
Population (million)	3,850	7,220	1.87
GDP (billion) (current US dollars)	4,580	78,100	17.05
GDP/capita (current US dollars)	1,169.5	10,757.3	9.19
Energy supply (MTOE)	6,101	13,699	2.25
Energy intensity kg Oil/GDP (dollar)	1.33	0.175	0.13

Table 5. World and OECD final energy consumption by sectors

Sector	World 1973 MTOE (%)	World 2014 MTOE (%)	OECD 1973 MTOE (%)	OECD 2014 MTOE (%)
Industry	1534.49 (32.9)	2751.17 (29.19)	958.18 (34)	808.49(22.28)
Transport	1081.26 (23.19)	2627.02 (27.87)	695.32 (24.6)	1215.16 (33.49)
Residential and commercial services, others	1758.88 (37.73)	3218.98 (34.15)	941.43 (33.4)	1262.19 (34.78)
Non-energy use	286.50 (6.14)	827.52 (8.78)	220.63 (7.8)	343.03 (9.45)
Total consumption (MTOE)	4661.19	9424.69	2815.6	3828.16

Table 6. Energy in India (1973–2014)

Parameters	1973	2014	2014/1973
Population (million)	593.4	1295	2.18
GDP (billion) (current US dollars)	83.01	2042.14* 8720 (PPP**)	23.47
CO_2/capita	0.378	1.6	4.23
GDP/capita (current US dollars)	150	1560	10.6
Coal	77	600	7.79
Oil (Mt)	23 (65% imported)	190 (80% imported)	8.26
Gas billion (m^3)	1.6	35.0	21.0
Power capacity (Mw)	17,000	270,000	14.70
Generation	70 billion kWh (50% hydro)	1080 billion kWh (15% hydro)	14.70
Firewood, agriwaste, dung cake	90 MTOE	200 MTOE	2.0
Total energy (MTOE)	180	824	4.57
Energy intensity Kg oil/GDP (dollar)	2.06	0.40	0.196

*Based on exchange rate; **Purchasing power parity.

Box 1. Differential treatment of nuclear and hydroelectricity. It must be mentioned here that IEA treats nuclear and hydroelectricity differently, when converting to oil equivalent.

- Hydroelectricity is converted by direct conversion.
  1 kWh = 860 kcal, 1 GWh = 0.000086 MTOE.
- Nuclear is converted by thermal equivalent using efficiency of 33%.
  1 kWh = 860/0.33 = 2606 kcal (1 GWh = 0.0002606 MTOE).
  This practice shows increased share of nuclear and reduced share of hydro, solar, etc. are treated like hydro.
- In 2014, hydro generation was 3983 TWh, which was significantly more than nuclear generation of 2535 TWh. But hydro is shown as 2.4% compared to 4.8% of nuclear.

This leads to a reduction in industrial energy consumption and increase in energy consumption in transport, residential and commercial services. Table 5 shows the final energy consumption by various sectors in 1973 and 2014. The table also shows a declining trend in industrial energy consumption, increase in transport and residential energy consumption, especially in OECD. Manufacturing has moved from OECD to Asia. It may also be worthwhile to note the ratio of final consumption and total energy supply in 1973 and 2014.

For 1973,

$$\frac{\text{Final energy consumption}}{\text{Total energy supply}} = \frac{4661}{6101} = 76\%.$$

For 2014,

$$\frac{\text{Final energy consumption}}{\text{Total energy supply}} = \frac{9424}{13,699} = 68\%.$$

This shows higher electrification of energy use. It leads to higher losses in electricity generation showing less final consumption compared to supply.

It may also be noted that while world energy consumption has more than doubled in 2014 compared to 1973, OECD energy consumption has increased by 28% only.

It may be worthwhile looking at the energy scene in India in 1973 and 2014 (Table 6). 2014 data are from the Energy Statistics of India[2] and IEA sources whereas 1973 energy data are from Desai[3] and other sources. GDP, population, etc. are from the World Bank website. International data are for the calendar year. Data for India are for this

financial year. In Table 6, a dramatic increase in energy supply and improvement in energy efficiency can be noted.

Summary and observations

World energy supply has more than doubled from 1973 to 2014. Oil production has increased by only 50%. This shows a significant increase in fuel efficiency and fuel substitution. Oil has been substituted by coal and gas in power generation and other uses. Transport remains the main sector to use oil.

- In India, oil demand has increased by 800% compared to 50% increase in world oil demand.
- Electricity production has increased nearly four times compared to doubling of energy supply. This shows the trend towards an electrified world. Coal and gas provide for 65% of electricity generation.
- Energy productivity (efficiency) has improved dramatically. World GDP increased 17 times (current US dollars) and energy supply has increased 2.25 times. Adjusted for inflation GDP will be about 10 times more.
- India has also made dramatic progress in all forms of energy: coal, gas and electricity production. It has improved energy productivity due to efficient use and structural change. Services provide more than 50% GDP now. The share of industries has dropped from 70% to 25%.
- Two major problems of the energy scene in India are rising oil demand and poor efficiency of biomass fuel use. Crude oil use has gone up eight times. This could have been avoided by proper policies.
- Rising oil demand can be and should be curbed by shifting transport from road to railways, and promoting public transport against private transport. These two steps are urgently required.
- Conventional biomass fuels still supply 25% of energy compared to 50% about 40 years ago. These fuels are used mainly for cooking. Cook stove efficiency remains at 8–10%, even when improved *chullas* are available. A major programme for promotion of efficient cook stoves and solar cooker is needed on the lines of LED lamps and renewable energy. By January 2018, 28 crore LED bulbs were distributed.
- Coal has to remain the major energy source for power generation.
- Recent Government programme for massive promotion of renewables is a step in the right direction. Similar programmes are required for energy efficiency.

1. Key World Energy Statistics 2016, International Energy Agency, Paris, Annual Publication; www.iea.org
2. Energy Statistics 2016, Central Statistics Office, Government of India; www.mospi.gov.in
3. Desai, B. G., *Energy Policy for India*, Jyoti Ltd, Baroda, 1978.

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