CHAPTER - I

WORLDWIDE ENERGY SCENARIO
- AN OVERVIEW
1.1 Introduction

The world is hurtling towards two major crises: serious energy shortages and accelerating climate change. Together, they threaten to torpedo the achievements of human civilization. Solutions to both the crises are interlinked; the diversification of the fuel base and adoption of emerging clean and green alternatives for energy production. Fortunately, such clean and diverse alternatives have emerged on the technology horizon. But society-wide barriers to their adoption are legion, especially in the developing world. The consumption of energy (TW) worldwide is shown in Figure (1.1).

The estimates of worldwide energy resources is accounted with the remaining sources such as fossil fuels totaling an amount of 0.4 YJ (1 YJ = $10^{24}$ J), the available nuclear fuel such as uranium exceeding 2.5 YJ and reserves of methane group of resources range from 0.6 – 3.0 YJ. Of all above the most thankful and replenishing source -the Sun, can provide the renewable usable energy flux which can exceed 120 PW (8,000 times 2004 total usage), or 3.8 YJ/yr, dwarfing all non-renewable resources.
1.2 Types of energy sources and their consumption

Since the advent of the industrial revolution, the worldwide energy consumption has been growing steadily. In 1890 the consumption of fossil fuels roughly equaled the amount of biomass fuel burned by households and industry. In 1900, global energy consumption equaled 0.7 TW ($0.7 \times 10^{12}$ watts)$[^1]$. Global power usage of energy sources represented in Figure (1.2).

a) Fossil fuels

According to the US Energy Information Administration's 2006 estimate, the estimated 15TW total energy consumption of 2004 was divided as follows, with fossil fuels supplying 86% of the world's energy. Power and energy consumption by various fuels shown in Table (1.1):

Table (1.1). Power and energy consumption by various fuels

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Oil</td>
<td>5.6</td>
<td>180</td>
</tr>
<tr>
<td>Gas</td>
<td>3.5</td>
<td>110</td>
</tr>
<tr>
<td>Coal</td>
<td>3.8</td>
<td>120</td>
</tr>
<tr>
<td>Hydroelectric</td>
<td>0.9</td>
<td>30</td>
</tr>
<tr>
<td>Nuclear</td>
<td>0.9</td>
<td>30</td>
</tr>
<tr>
<td>Geothermal, wind, solar, wood</td>
<td>0.13</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
<td>471</td>
</tr>
</tbody>
</table>
The growth of oil as the largest fossil fuel was further enabled by steadily dropping prices from 1920 until 1973. Coal and nuclear became the fuels of choice for electricity generation and conservation measures increased energy efficiency. Over the last forty years, the use of fossil fuels has continued to grow and their share of the energy supply has increased. The remaining fossil energy source available is shown as pie-diagram in Figure (1.3).

b) Nuclear power

In 2005 nuclear energy accounted 6.3% of world's total primary energy supply[5]. The nuclear power production in 2006 accounted 2,658 TW, which was 16% of world's total electricity production[6,7]. In November 2007, there were 439 operational nuclear reactors worldwide, with total capacity of 372,002 MW. A further 33 reactors were under construction, 94 reactors were planned and 222 reactors were proposed.

c) Renewable energy

In 2004, renewable energy supplied around 7% of the world's energy consumption. The renewable sector has been growing significantly since the last years of the 20th century, and in 2005 the total new investment was estimated to have been 38 billion US dollars. Germany and China lead with
Heavy oil 3 ZJ
Tar sands 2 ZJ
Oil shales 11 ZJ
Proven Reserves 8 ZJ
Future Additions 11 ZJ
Unrecoverable oil 22 ZJ

Proven Reserves 8 ZJ
Gas 23%
Coal 25%
Oil 37%
Nuclear 6%
Biomass 4%
Hydro 3%

Solar heat 0.5%
Wind 0.3%

Figure (1.1). Worldwide energy supply in TW

Figure (1.2). Global Power Usage in Successively Increasing Detail

Figure (1.3). Remaining fossil energy source available
investments of about 7 billion US dollars each, followed by the United States, Spain, Japan, and India. This resulted in an additional 35 GW of capacity during the year.

i) **Hydropower** : Worldwide hydroelectricity consumption reached 816 GW in 2005, consisting of 750 GW of large plants, and 66 GW of small hydro installations. Large hydro capacity totaling 10.9 GW was added by China, Brazil and India during the year, but there was a much faster growth (8%) in small hydro, with 5 GW added, mostly in China where some 58% of the world's small hydro plants are now located.

ii) **Biomass and biofuels** : Until the end of the nineteenth century biomass was the predominant fuel, today it has only a small share of the overall energy supply. Electricity produced from biomass sources was estimated at 44 GW for 2005.

iii) **Wind power** : According to the Global Wind Energy Council, the installed capacity of wind power increased by 27% from the end of 2006 to the end of 2007 to total 94.1 GW, with over half the increase in the United States, Spain and China. Doubling of capacity took about three years. The total installed capacity is approximately three times that of the actual average power produced as the nominal capacity represents peak output; actual capacity is generally from 25-40% of the nominal capacity.
iv) **Solar power**: The available solar energy resources are 3.8 YJ/yr (120,000 TW). Less than 0.02% of available resources are sufficient to entirely replace fossil fuels and nuclear power as an energy source. Assuming that our current rate of usage remains constant, we will run out of conventional oil in 35 years, coal in 200 yrs. In practice neither will actually run out, as natural constraints will force production to decline as the remaining reserves dwindle.

V) **Geothermal**: Geothermal energy is used commercially in over 7 countries. By the end of 2005 worldwide use for electricity will reach the margin of 9.3 GW and if heat recovered by ground source is included, the non-electric using geothermal energy will be more than 100 GW.

1.3 **Consumption by country wide**

Energy consumption broadly tracks with gross national product, although there is a significant difference between the consumption levels of the United States with 11.4 kW per person and Japan and Germany with 6 kW per person. In developing countries such as India the per person energy use is closer to 0.7 kW. Bangladesh has the lowest consumption with 0.2 kW per person. Industrial users (agriculture, mining, manufacturing, and construction) consume about 37% of the total 15 TW. Personal and commercial transportation consumes 20%; residential heating, lighting, and
appliances use 11%; and commercial uses (lighting, heating and cooling of commercial buildings, and provision of water and sewer services) amount to 5% of the total. The other 27% of the world's energy is lost in energy transmission and generation.

1.4 Alternative energy paths

Solar energy is one eternal source of energy whose widespread adoption is shrouded in misgivings and doubts. Globally, it is the fastest growing source of energy with an annual average growth of 35%, as seen during the past few years. By 2005, the cumulative installed capacity of solar photo voltaic has crossed 5000 MW which is projected to increase to 4,33,000 MW by 2025, with an investment value of US$102 billion. Similarly, solar thermal power installations are expected to catapult from the current global capacity of 355 MW to 36,850 MW in 2025, with investment volumes of US$16.4 billion per year. Solar energy is thus one of the major emergent sources of sustainable energy.

We need to abandon our business-as-usual approach and get our place in the sun! To do that, mindsets across the board will have to change: among policy makers, among industry personnel, among financial institutions, and the consumers. Cobwebs about reliability, economics and viability of this emergent technology will have to be cleared. Considering
the urgency of climate change mitigation, such changes have to occur fast. 'Solar India 2007' is intended as the first-ever platform for charting the way forward for solar energy development in India.

1.5 References


