Introduction to Non-Conventional Energy Systems

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Why Fossil Fuel Base?

- Applications need concentrated energy i.e. high energy densities.
- Extraction, storage, distribution and service infrastructure is well established and stable.
- Large scale production results in affordable running cost.
## Why fossil fuel base?

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Wh/kg</th>
<th>density Kg/m³</th>
<th>Wh/m³</th>
<th>Wh/lt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Gasoline</td>
<td>12300</td>
<td>~700</td>
<td>9348000</td>
<td>9348</td>
</tr>
<tr>
<td>2 Natural Gas</td>
<td>9350</td>
<td>~800</td>
<td>7480000</td>
<td>7480</td>
</tr>
<tr>
<td>3 Methanol</td>
<td>6200</td>
<td>791</td>
<td>4904200</td>
<td>4904</td>
</tr>
<tr>
<td>5 Kerosene</td>
<td>12300</td>
<td>870</td>
<td>10701000</td>
<td>10701</td>
</tr>
<tr>
<td>6 Coal</td>
<td>8200</td>
<td>1250-1550</td>
<td>10250000</td>
<td>10250</td>
</tr>
<tr>
<td>7 Battery (lead- acid)</td>
<td>35</td>
<td></td>
<td></td>
<td>80</td>
</tr>
<tr>
<td>8 Flywheel</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 Solar thermal**</td>
<td>-</td>
<td></td>
<td>900/day</td>
<td>0.9/day</td>
</tr>
<tr>
<td>10 Solar PV*</td>
<td>-</td>
<td></td>
<td>500/day</td>
<td>0.5/day</td>
</tr>
</tbody>
</table>

*Efficiency is assumed as 10% and 1m height is required for installation with appropriate inclination.

**Efficiency is assumed as 18% and 1m height is required for installation with appropriate inclination.
Why fossil fuel base?

COSTS

- Cost of petrol Rs.40/Lt > Rs.4.27/KWh
- Cost of kerosene Rs.15/Lt > Rs.1.4/KWh
- Cost of PV Rs.200/W > Rs.40000/KWh of capital investment
Why fossil fuel base?

- Petrol/diesel fuel stations infrastructure is available
- LPG gas is distributed at your doorstep
- LPG and CNG service infrastructure is also well established
- Customer need not bother about storage and service infrastructure costs. Payment is only for running cost of fuel.
Then why move away from fossil fuel base?

- Depletion of fossil fuels
- Environmental hazards
- Health hazards
- Life Cycle costs versus running costs
How long will fossil fuel last?

Let the earth be made of a thin shell that is filled entirely with fossil fuels.

Consider the earth as a sphere of radius $R=6378.137$ kms.

This amounts to about $1.1 \times 10^{21}$ m$^3$ of fossil fuel.

Take the average energy density of fossil fuel to be about 10000 Wh/ltr or 10000 KWh/m$^3$.

(refer table on energy densities – slide 03)
How long will fossil fuel last?

- The amount of stored energy within the earth is $1.1 \times 10^{25}$ KWh.
- The current annual world energy consumption is about $55 \times 10^{12}$ KWh.
- Considering a 7% growth in energy consumption annually.
How long will fossil fuel last?

In 372 years with an annual energy consumption growth rate of 7%, all the fossil fuel is emptied within the earth even though we started with earth being full of fossil fuel. However, earth is not composed fully of fossil fuel. Only a fraction of its volume is stored as fossil fuel.
How long will fossil fuel last?

The pinnacle of fossil fuel usage is passed. Its usage will now decay exponential and in the next 100 years will gradually die.
So now a Paradigm shift…

“Concentrated usage of energy to Distributed usage of energy”
A case for environment...

.....rush hour pictures....

1. Majestic railway station
2. MGRoad
3. Shivajinagar bus station
A case for environment...

- Greenhouse effects
- Climate change
- Depletion of stratospheric ozone layer
Green house effect

- Green house gases – carbon dioxide, nitrous oxide, methane, chloro fluoro carbons.
- Green house gases are the temperature stabilisers of the earth’s atmosphere.
- Temperature stabilisation is by trapping radiated heat from the earth’s surface by these green house gases.
Global warming

Due to emissions from the fossil fuel based systems, the green house gases in the atmosphere increases.

As a result, the average temperature of the earth is becoming higher.
Effects of Global warming

- changes in rainfall patterns
- rise in sea level
- impacts on flora and fauna
- impacts on human health
Health is an issue!

- CO poisoning.
- Asthma.
- Skin diseases and cancer due to depletion of stratospheric ozone.
Cost in the long run...

- Life cycle costing gives more realistic estimates.
- This gives a much better correlation of cost to energy used.
What are the alternatives?

- Nuclear fuel – is it viable?
- What are its implications?
- Then what?
Non-conventional fuel base

- Muscular
- Solar thermal
- Solar PV
- Wind
- Hydro
- Biomass
- Wave
- Hybrids
Scope for alternative energies...

- 75% of energy comes from fossil fuels such as crude oils, coal and natural gas
- 12% from bio fuels such as methane
- 9% from hydro based
- 3% from nuclear
- 1% from windmills and photovoltaic put together