


HSE ALERT - 014

Renewable Energy – Hydrogen

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RENEWABLE ENERGY

The Mother of All Energy

For more information refer to GSEC website to get the latest updates
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Q. *So what is the big fuss about using oil ? (fossil fuel) & why talk about renewable energy?*

A Best oil experts have been saying this, "we may run out of fossil fuel in another 60 years" and after 60 yrs they repeat the same statement

"CO₂ level increases is the biggest threat to the oil industry" is another one you may be familiar with

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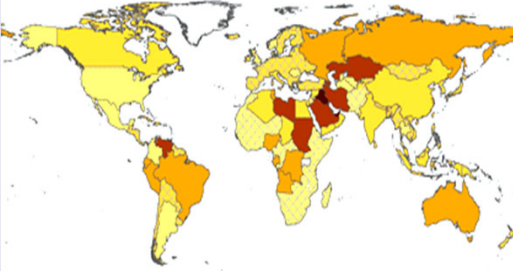


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Years to exhaust proven reserves at current production rates

<p>6-12</p> <p>13- 20</p> <p>21- 42</p> <p>Average for remaining countries in the region</p>	<p>43 -100</p> <p>over 100</p> <p>No Data</p>
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- Another price we have to pay other than the depleting oil wells is the rising environmental impact issues (alternative energy & clean-up) which goes parallel to the oil industry!
- The developer of heat engine at that time must have missed the CO₂ ton of bricks coming but they may have thought that it can be dodged as in any case nearly all of them are permanently resting and the CO₂ bricks hit the next generation hard

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- One thing we need to remember is that we consume as much energy and resources as the Western counterparts
- We need to re-invent & innovate if we are to help slow down global warming and habitat destruction
- Ministers have talked about going for sustainable development, which is the buzzword among many environmentalists nowadays. But it cannot be achieved if we don't take into account the cost of our economic growth in terms of pollution and degradation of our environment everywhere

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May is Earth Day

- On Earth Day in Sacramento, the standing president again described "a serious problem" America is addicted to oil, which is often imported from unstable parts of the world
- "Like any addiction, admitting to the problem is the beginning of recovery". What to do next, as a society, to kick this addiction (drive smaller / cleaner car instead and go green!)

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- Technologist has pointed to hydrogen technology as the possible solution to the nation's fuel supply problems
- Energy experts say the nation's petroleum addiction -- a key source of carbon emissions contributing to global warming -- won't end until an environmentally sound hydrogen supply and distribution system is available

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- "If we don't generate hydrogen in an environmentally responsible way, we'd be going five steps backward, rather than forward," said Scott Samuelsen, director of the National Fuel Cell Research Center at UC Irvine, where he is also an engineering professor

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- The total world energy consumption will reach 612 quadrillion BTU (British thermal unit) under the projected period by IEO (International Energy Outlook)
- Consumption of fossil fuel, namely oil, natural gas and coal, which still accounts for 80% of the energy consumption through the projected period

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- Industrialization and wide spread demand of electricity especially in developing countries of Asia, Central and South America is largely anticipated
- Growth of electricity consumption is projected at 1.6% annually

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Energy Consumption: Relative trends, United States, 1995 -2025

Energy Consumption: Relative trends, United Kingdom 1995 -2025

Energy Consumption: Relative trends, Brazil 1995 -2025

Energy Consumption: Relative trends, China 1995 -2025

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Energy Consumption: Relative trends, India 1995 -2025

Energy Consumption: Relative trends, Singapore 1995 -2025

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- Present day society heavily depends on fossil fuel for transportation and generation of electricity and heat. Electricity consumption is likely to rise over the next 2 decades
- By the year 2025, consumption of electricity will reach 22 trillion kWhr due to rapid population growth and economic upturn. Also note the bulk of electricity and green house gases produced is for the factory farm industry and their transportation & refrigeration needs

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Energy Consumption by Source, United States, 1971-1999

Energy Consumption by Source, United Kingdom, 1971-1999

Energy Consumption by Source, China, 1971-1999

Energy Consumption by Source, India, 1971-1999

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Energy Consumption by Source, Brazil, 1971-1999

Energy Consumption by Source, Singapore, 1971-1999

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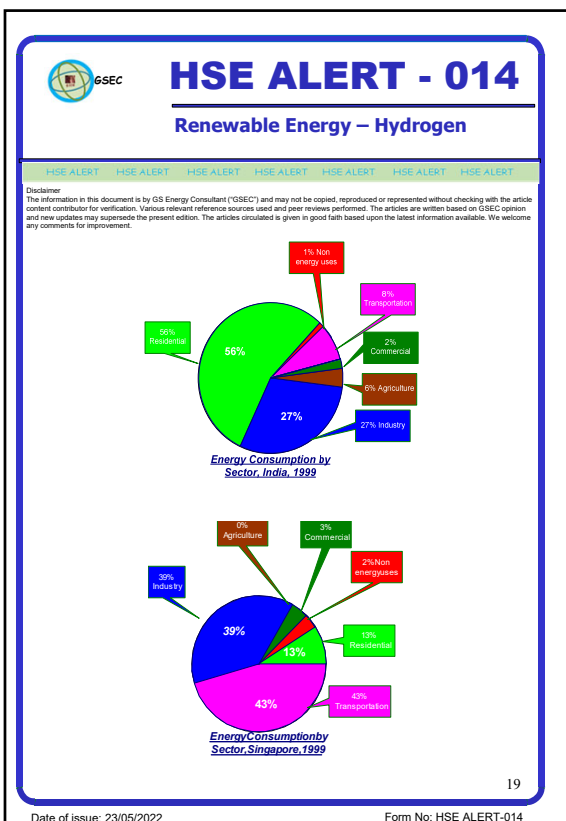
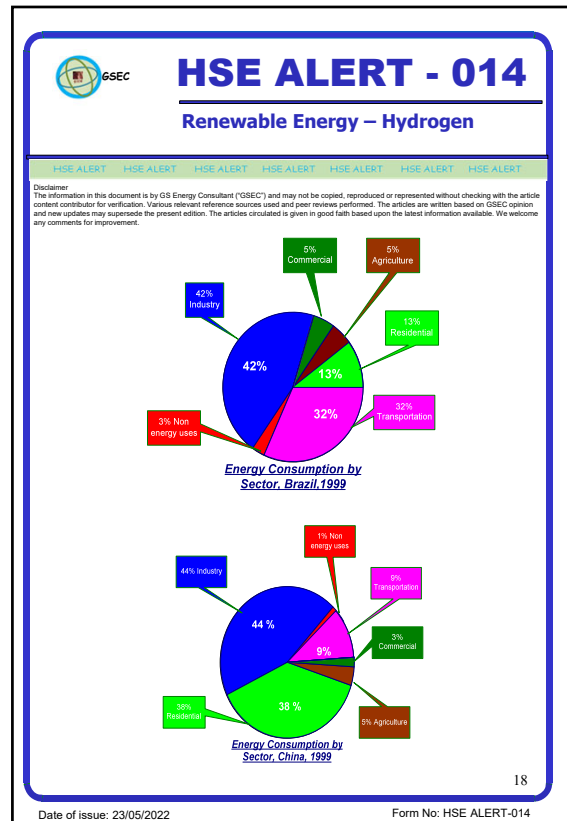
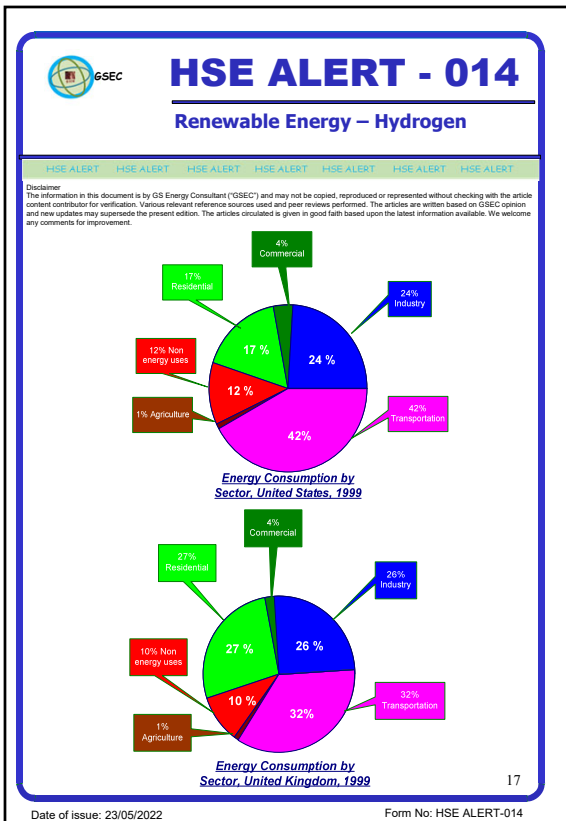
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Chart on energy production by source

Total Energy = 96.935 Quadrillion Btu Renewable Energy = 5.668 Quadrillion Btu

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- The current trend of fuel consumption addresses two problem's as in two sides to a coin. The first problem addresses the future energy availability?? but another worrying side is the issues of the ailing environment
- Major concerns about the environmental and health problems are greenhouse effect, global warming, formation of acid rain and pollution (particulate emission)

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Greenhouse Effect?

- Consumption of fossil fuel such as oil, coal and natural gas releases Carbon Dioxide (CO₂), Methane (CH₄) and oxides of Nitrogen (NO_x) and Sulphur (SO_x)
- These infrared absorbing gases, if released in large amount results in global warming. It was observed that the global temperature had raised 0.5°C on the average over the past 100 years (the evidence has not been concrete for the claims)

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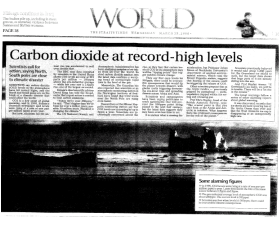


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- Prediction of CO₂ concentration will double by the year 2050 if current trend in green house gas emission continues. Global warming will bring about detrimental effect to the environment, causing melting of polar ice caps, subsequently raising the mean sea water level in some regions
- Droughts are expected as a result of overheating the globe surface, thereby affecting agriculture
- Animal factory farming food for the masses contributes the green house gas as it impacts the high electricity production & the transportation sector parallelly impacted as well

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Global Warming?

- The basics of global warming are as follows. Carbon dioxide (CO₂) is produced by the burning of fossil fuels as well as by nature's carbon cycle

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Global Carbon Cycle?

- Concentrations of carbon dioxide in the atmosphere are naturally regulated by numerous processes collectively known as the "carbon cycle". The movement ("flux") of carbon between the atmosphere and the land and oceans is dominated by natural processes, such as plant photosynthesis

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- CO₂, Methane, Sulphurous, Nitrous Oxides and other Noble gases used for aerosols act like a greenhouse in the atmosphere
- They let solar radiation through the atmosphere to heat the Earth's surface, but they prevent the re-radiation of some of that energy back into space, thus trapping heat. Hence, the more green house gases trapped and swirling around the atmosphere, the more heat is being held within

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- While these natural processes can absorb some of the net 2.0 billion metric tons of anthropogenic carbon dioxide emissions produced each year (measured in carbon equivalent terms), an estimated 6.3 billion metric tons is added to the atmosphere annually
- The Earth's positive imbalance between emissions and absorption results in the continuing growth in greenhouse gases in the atmosphere

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Atmosphere 730

Global Gross Primary Production and Respiration 179

Changing Land-Use 1.7

Ocean 38,000


Fossil Fuel Combustion and Industrial Processes 6.3

Vegetation and Soils 2,000

Carbon Flux Indicated by Arrows: Natural Flux = Blue Arrow Anthropogenic Flux = Red Arrow

Source: Intergovernmental Panel on Climate Change, Climate Change 2001: The Scientific Basis (U.K., 2001)

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- Rising temperatures may, in turn produce changes in weather, sea levels, and land use patterns, commonly referred to as "climate change"
- Assessments generally suggest that the earth's climate has warmed over the past century and that human activity affecting the atmosphere is likely an important driving factor

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- Roughly 75% of global CO₂ emissions are from the burning of fossil fuels and cement manufacturing
- These emissions, together with CO₂ from land-use changes and the emissions of five other gases; methane (CH₄), nitrous oxide (NO₂), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF₆) constitute the main sources contributing to climatic change

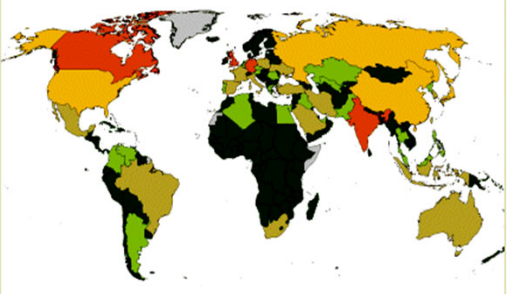
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Total CO₂ Emissions (thousands of tons of carbon dioxide)

Red	> 1,200,001
Orange	1,200,000 - 500,001
Yellow	500,000 - 200,001
Green	200,000 - 60,001
Black	< 60,000
Grey	No Data

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Idea to look into Renewable Energy

- The aim of the "Idea" is to study on the possibilities of harnessing free energy to be used as useful renewable energy in the factory so as to be less dependent on fossil fuel
- The energy harnessed shall be used to generate electricity which is further used to produce hydrogen which is a green and non polluting fuel

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- Hydrogen being an energy source can also be an energy carrier. It can be stored and used at a later time which makes it more attractive as compared to electricity which cannot be stored!

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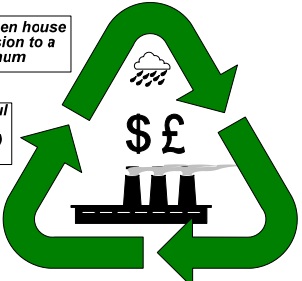
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Reduce green house gas emission to a minimum


Harness them to useful energy (hydrogen / electrical) with \$ saving

Identify the waste energy source in the company



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- In order for an energy source to be classified as renewable, the source must meet two important conditions; which are, they must not be depleted upon usage or they must be replaced after use and they must not harm the environment or the health of lives

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- If the source of hydrogen is obtained from fossil fuel, then the Hydrogen generation is not by a renewable source. Hydrogen obtained from wind energy, hydrolysis, biomass or solar, then it is categorized as a renewable energy

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Renewable energy sources of electricity: hydro, wind, solar, crops, geothermal

High voltage direct current transmission of electricity is efficient up to 1500 km

Water and oxygen are recycled via the atmosphere. No CO₂ or other pollution is produced.

oxygen restored to atmosphere

water as rain

Electrolyser

Gas Hydrogen

Liquidification plant

Local consumption of hydrogen & electricity

Local Distribution

Storage & local distribution by pipelines and ocean tankers

Used for domestic transport, industry energy needs

The only emission is water vapour

Regional, continental and inter-continental distribution by pipelines and ocean tankers

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Renewables

Non-Renewables

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Renewable Energy – Hydrogen

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- Hydrogen burns cleanly .The product of combustion is "pure water" and the best solution for all the global environment and health problems faced with fossil based fuels that we've discussed earlier

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- Hydrogen is one of the element now being considered as an alternative fuel because it is renewable, highly abundant, efficient, and unlike other fuels, produces almost no harmful emissions
- Many believe that this versatile material will become a primary fuel and energy carrier of the future

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- The clear benefits of hydrogen are, it is non-polluting, renewable form of energy, odorless, tasteless, colorless, does not leave a stain, non organic and it is an aversely abundant element in the universe
- It is the smallest and lightest element, with the simplest atomic structure

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Proposed Hydrogen Economy Road Map

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HYDROGEN ECONOMY FLOWCHART

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Hydrogen Generator Controls Overview

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Hydrogen Power Curves

Power Curves
60 Hz
50 Hz
AOC 15/50 Power Curve

Annual Energy Output
60 Hz
50 Hz
Annual Energy Production

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- The electricity generated by wind energy is sent to the electrolyzer for electrolysis. The desalination plants are very suitable for making high quality deionized water at 10 micro siemens / sec. or lower water purity requirement
- The electrolyser can be purchased easily from many reputed companies in the market manufacturing package electrolyzers

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- It is expected that for every 1 m³ of water electrolysis, it requires about 0.5 kw of power consumption for ideal electrolysis if the water conductivity can meet 10 microsiemens / sec. or lower
- The power consumption increases according to the water conductivity. Hence the water conductivity determines the electrolyzer power consumption

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PROCESS FLOW DIAGRAM FOR THE HYDROGEN PRODUCTION

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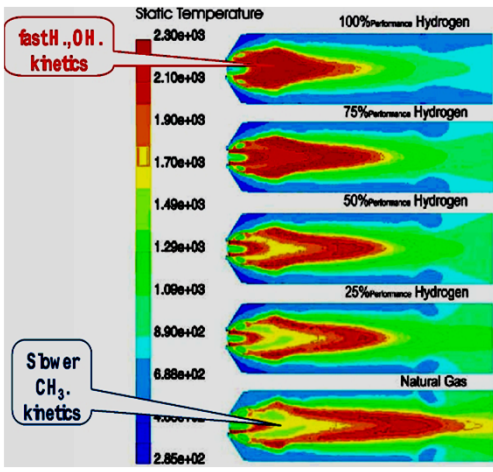


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Thank You

Contact us for any queries

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