# SUSTAINABLE ENERGY PRODUCTION A SOLUTION TO GLOBAL ENVIRONMENTAL CRISES

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Bachelor’s Thesis

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**SAVONIA UNIVERSITY OF APPLIED SCIENCES** **THESIS**
**Abstract**

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Abstract

The idea of energy is a multidisciplinary idea with a concept that is fundamental to understand the important and the use of energy couple with its environment and global crisis, this theses is intended to analysis more insight into the fundamentals of energy conversion following the laws of thermodynamics to understand energy transition from stone age till present. The understanding of energy is fundamental to the survival of mankind for a better and sustainable future and a safer world for the incoming generation.

Energy has been underlined as the greatest resources available to the benefit of man, to enable mankind to enjoy life and energy is to function to allow human mobility and adventure but the activities of man in extracting these energy has also in turn endanger the environment and the future of unborn generation.

This thesis will highlight the merits and the drawback of each energy source, compare the fundamental differences and similarities in each of the energy sources, also point out the tradeoff in deciding the preferred energy source using individual and governmental policies that can shape the world, to a better and more prosperous future and to adopt the an environmental friendly energy source, called renewable energy.

The idea of renewable energy source is to save the world from environmental disaster of global climate change, the human society will have to formulate and adopt a rescue mission to save the world using sustainable engineering methods and fact, this thesis will give insight into the meaning, concept and dangers of global warming and the defining elements of global warming and hoe the adoption of renewable energy will not only end global environmental challenges but will also lead the world to prosperous energy future.

Using scientific proven fact and solution to the energy and environmental problems from different renewable energy sources in a sustainable way without endangering the environment for the future generation.



Keywords

Thermodynamics, Carnotcycle, Energy, Fossilfuel, Energy mix, Trade off, ConventionalFuel, Unconventionalfossilfuel, Renewableenergy, Global climatechange

CONTENTS

# 1 INTRODUCTION

The energy production, transportation and utilization is one of the biggest industry in the world, classified among the top four such as production, banking and technology. The type of energy in use can be us to differentiate modern society and preindustrial society also can be use to determine the quality of life even though energy production is the biggest polluter of the planet earth.

This multidisciplinary final thesis topic is aim to give overview on different fuel source, environmental impact and public policies. This topic will be interdisciplinary and will give an introductory insight into quantitative concept in energy, different fuels source, energy technology, energy policy and social aspects of energy.

This thesis will cover the theoretical background of energy, methodology in energy conservation and result by comparing fuel sources in respect to merits, drawback and comparable advantages of every fuel namely coal, natural gas, petroleum and will use scientific fact to prove the benefit of renewable sources as compare to other sources.

THIS THESIS WILL EXPLAIN

- Energy terminology
- How energy transition work
- The primary source of different fuels
- Energy sectors and consumption
- How energy is connected across sector
- How energy production and conversion works
- Thermodynamics of energy
- Environmental impact of energy
- How renewable energy can rescue the future.

Energy is very important and linked to every sector that which will care about, things like transportation, electricity and food, its cross cutting to education, national security, poverty, environment and public health.

# 2 Theoretical background

In last decade headlines are “The end of cheap oil” in 2004, The Economics in 2003 says “The end of oil age” but the headlines can change with time, like in March 2013 National Geography says “America strikes oil” and in May 2013, The Atlantic says, “We will never run out oil” (U.S. Energy Information and Administration)

## 2.1 Energy transition

In span of a decade the oil history change from we are running out oil, to we have abundant than we know what to do with it, the transition has happen many times and it will happen again it just a matter of time and the energy transition are more similar in occurrence than it can be anticipated, it take a long time and follows a path toward high performance fuel also tend tends to go from one from one fuel to a better fuel source and as the introduction of better fuel with more efficient technology solve one problem it also tends to introduce another fuel which follow a path toward decarburization.

With the transition from wood, to coal, to petroleum, to natural gas and now renewable energy

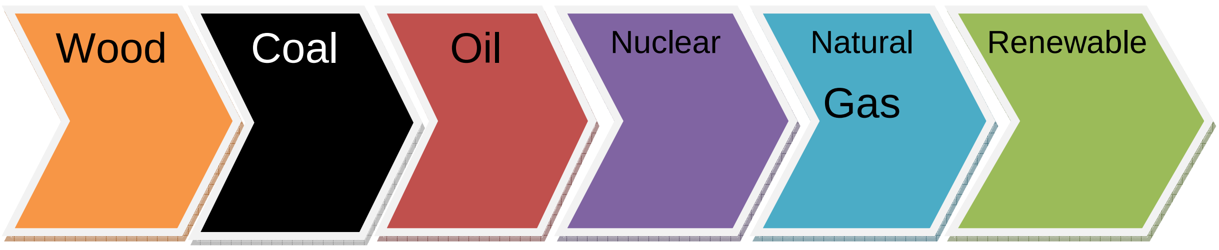


Fig. 2.1 Energy transition from one fuel source to another in time.

## 2.2 Energy basics and fundamentals

In the world today petroleum and its constituents account for 36% of the total energy source which is the largest energy in use in every sector of  life, only 10% of this 36% goes to power generation, while the remaining 90% goes to other sectors (transportation sector, industrial sector etc.) 27% of energy sources is obtained from Natural Gas also for transportation, power generation and domestic uses closely followed by 18% coal mainly for power generation and other uses, while Renewable is 9% and Nuclear account for 8% of our total energy sources.

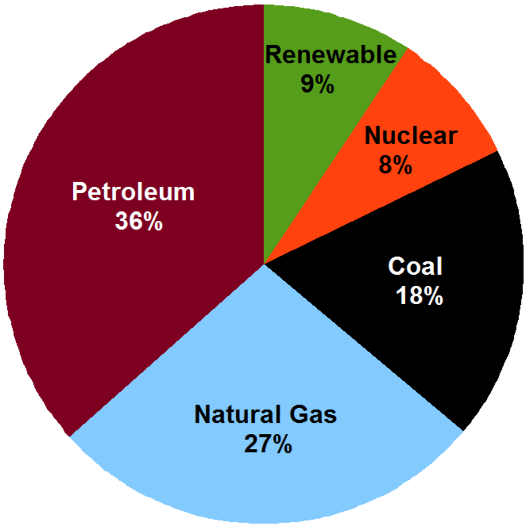


Fig. 2.2: U.S. Energy consumption by source in percentage (U.S Energy Information Administration. 2013)

## 2.3 Thermodynamics of energy

The conservation of energy is a fundamental concept of physics along with the conservation of mass and the conservation of momentum (Tom Benson. (2008).within the same domain, the amounts of energy remain constant and energy is neither created nor destroyed. But energy can be converted from one form to another (mechanical energy can be converted to electrical energy) and the total energy within the domain remain fixed. (http://www.grc.nasa.gov/WWW/k-12/airplane/thermo1f.html.
)

$$K = \frac{1}{2}mv^2 \text{ (Joules)} \quad (1)$$

*Where K is the kinetic energy, m is the mass and v is the speed of the object*

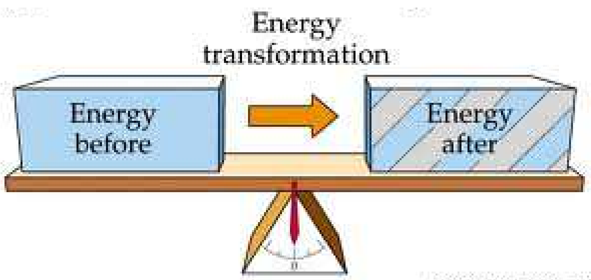


Fig. 2.3 First law of thermodynamics (https://jahschem.wikispaces.com/First+Law )

Basic fact about Energy

Energy is a conserved quantity it can neither be crated nor destroyed energy may be converted from one form to another energy may be converted to work or work converted to energy.

Potential energy $P.E = m * g * [Joules]$ (2)

Where m is mass, $g = 9.81 m/s^2$ is gravitational force and h is the height of the object.

Thermal energy $Q = m * c * \emptyset\ [Joules]$ (3)

Thermal where m is mass, c is specific heat capacity and Ø is the change in heat of an object.

Electrical Energy $E = V * I * t\ [kwh]$ (4)

Where V is voltage, I is current and t is time of travel.

Chemical Energy $H = U - pV\ [Joules]$ (5)

Where U is internal energy, H is enthalpy, p is pressure and V is volume.

Nuclear Energy $E = mc^2$ (6)

Light Energy $E = \frac{hc}{\lambda}\ [Joules]$ (7)

Where f=frequency [Hz] and λ=wave length[m]

These Formulas are extracted from hand book [JormaHonkanen 2012]

The efficiency of heat engine is less than 100% and any system which convert steam into mechanical energy.

# 3 Geological formation of fossil fuels

Contrary to what many people believe, fossil fuels are not the remains of dead dinosaurs. In fact, most of the fossil fuels we find today were formed millions of years before the first dinosaurs. Fossil fuels however were once a living thing, the formation of fossil happen over millions of years ago.

According to, U.S. department of energy February 2013, on formation of fossil fuels, started that when these ancient living things died, they decomposed and became buried under layers and layers of mud, rock, and sand. Eventually, hundreds and sometimes thousands of feet of earth covered them. In some areas, the decomposing materials were covered by ancient seas, then the seas dried up and receded.

During the millions of years that passed, the dead plants and animals slowly decomposed into organic materials and formed fossil fuels. Different types of fossil fuels were formed depending on what combination of animal and plant debris was present, how long the material was buried, and what conditions of temperature and pressure existed when they were decomposing.
(http://www.fe.doe.gov/education/energylessons/coal/gen_howformed.html)

According science daily of May 2014, stated that fossil fuel is a general term for buried combustible geologic deposits of organic materials, formed from decayed plants and animals that have been converted to crude oil, coal, natural gas, or heavy oils by exposure to heat and pressure in the earth's crust over hundreds of millions of years. The burning of fossil fuels by humans is the largest source of emissions of carbon dioxide, which is one of the greenhouse gases that allows radioactive forcing and contributes to global warming.
A small portion of hydrocarbon-based fuels are bio-fuels derived from atmospheric carbon dioxide, and thus do not increase the net amount of carbon dioxide in the atmosphere. (http://www.sciencedaily.com/articles/f/fossil_fuel.htm)

## 3.1 Forms of fossil fuel

Today, there are several forms of fossil fuel, oil, coal and natural gas but the primary source of energy is the sun, wind and falling water.

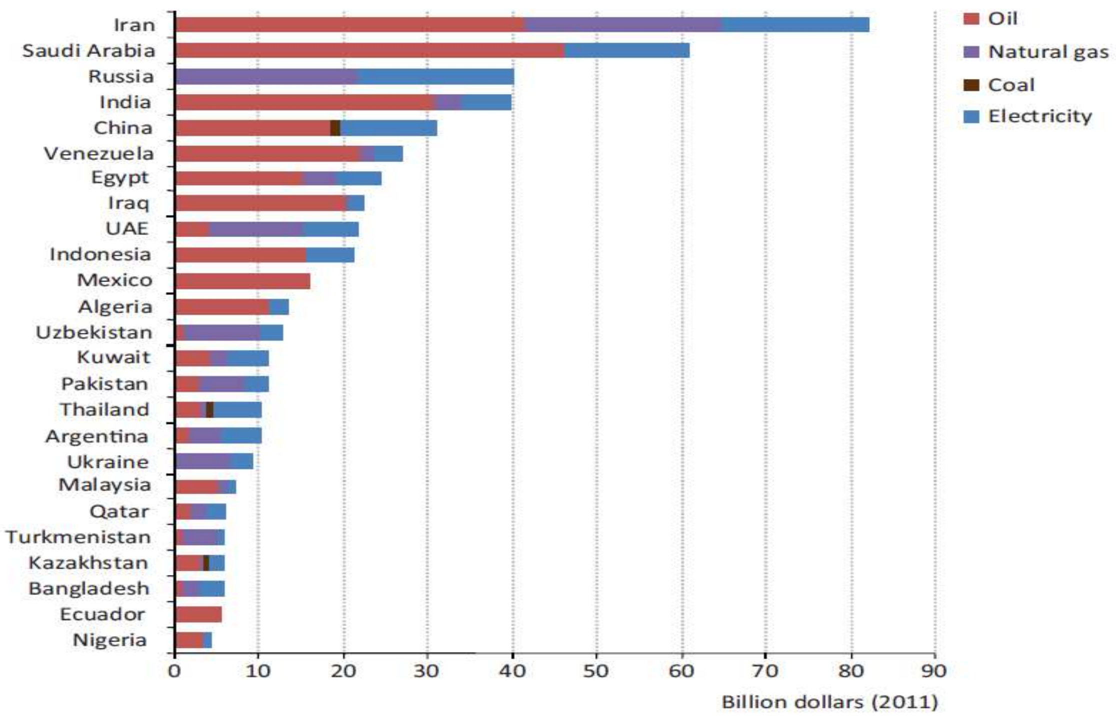


Fig. 3.1: Fuel distribution across the world. (U.S Energy Information Administration. 2013)

## 3.2 Coal

According to Dr. Webber M. (12.12.2013). There are four types of coal in use today, bituminous coal and sub-bituminous coal, two grades of coal which are available for extraction across the world and small quantity of lignite and anthracite

In total, United state use about a billion tons per year which is produce and consume in the domestically,10% is exported to China from the US which is about 100 million tons while the remaining 90% is use in electrical generation that is about 928 million tons per year for electric power with another 72 million tons use in steelmaking industry with a little bit for residential and commercial purpose.

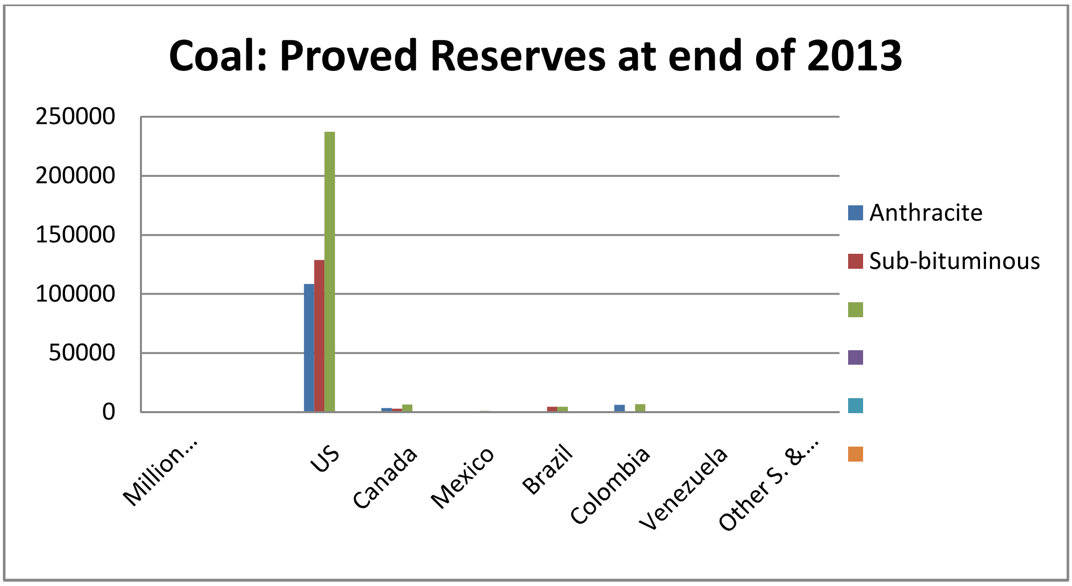


Fig. 3.2: Coal reserves in north and South America (BP Statistical Review of World Energy: 2013).

According to the National Academy of Sciences (2013), the world's largest known coal reserves, bigger than any other country in the world is about 267 billion tons, this is enough to last a couple hundred years at the level of today use but the abundance of coal those not implies that the price will be low due very expensive technology that is required for coal extraction.

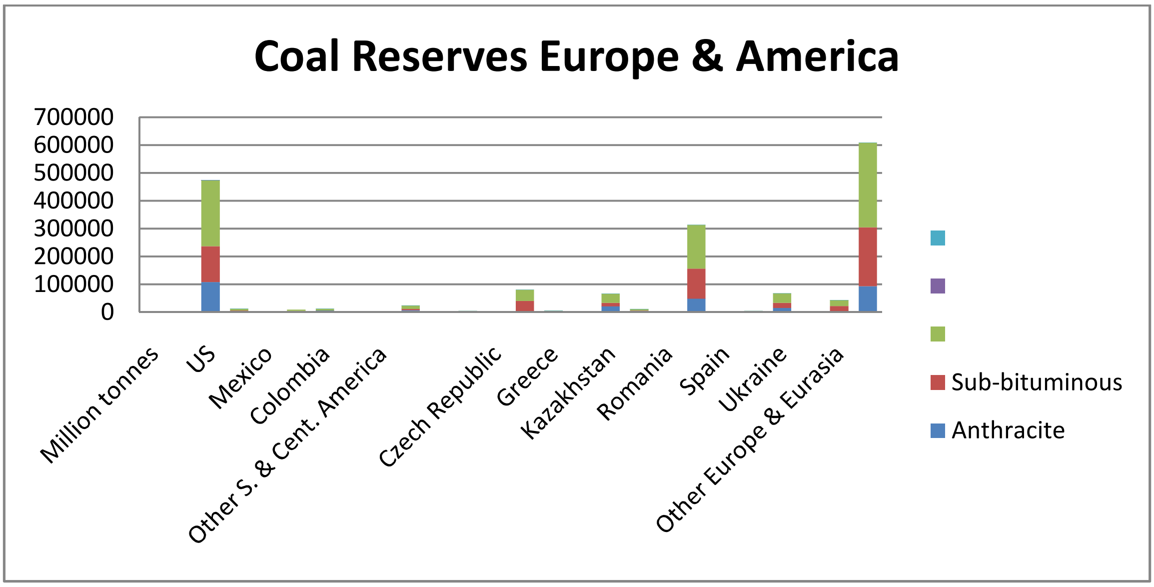


Fig.3.3: Coal reserves in Europe and America (BP Statistical Review of World Energy: 2013)

Coal is cheap compare to petroleum and natural gas and no price fluctuation for over a long period of time.

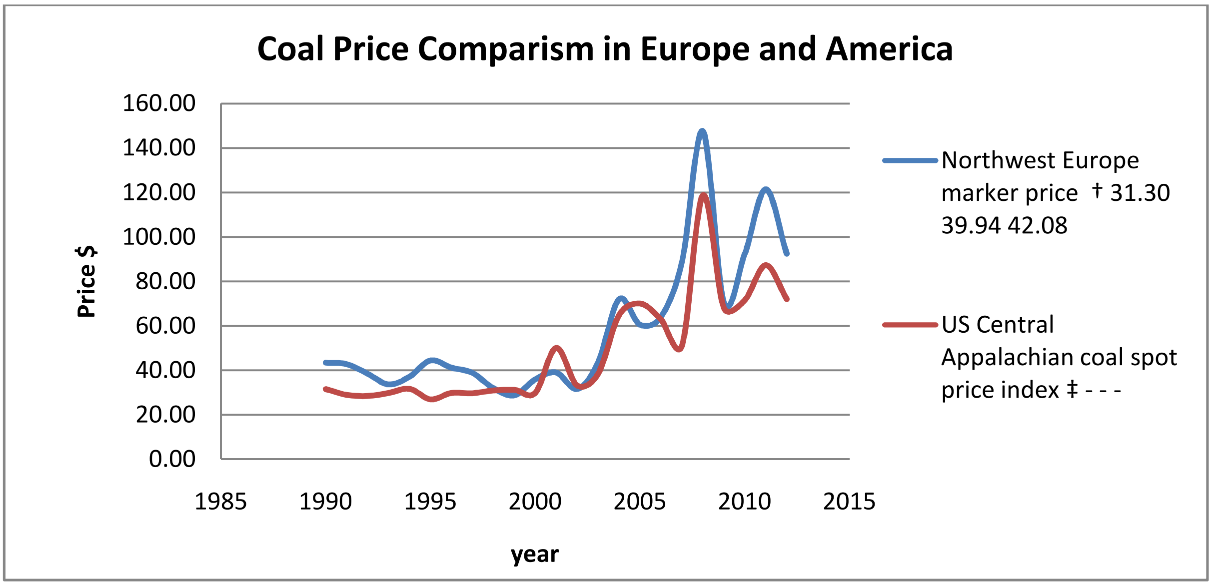


Fig.3.4: Coal price in Europe and America (BP Statistical Review of World Energy: 2013).

## 3.3 Natural gas

According to RinkeshKukreja of CEF in 2013, define natural gas as a fossil fuel that exist in a gaseous state and is composed mainly of methane ($CH_4$) a small percentage of other hydrocarbons like ethane. The use of natural gas is becoming more and more popular as it can be used with commercial, industrial, electric power generation and residential applications.

Various schools, hospitals, hotels, motels, restaurants, office buildings also use natural gas for cooking and water and space heating. It is popular because of its property of instant heating and thus commercially used, in hotels, restaurants, motels, small manufacturing units, commercial office buildings, hospitals and schools mainly for cooking and heating purposes. (http://www.conserve-energy-future.com/advantages-and-disadvantages-of-natural-gas.php#sthash.KUblatz0.dpuf)

According to clean energy in 2014, the natural gas power production process begins with the extraction of natural gas, continues with its treatment and transportation to the power plants, to generate electricity.

Initially, wells are drilled into the ground to extract the natural gas from the earth, after extraction, then treatment at gas plants to remove the impurities such as, moisture, hydrogen sulphide, carbon dioxide, helium and hydrocarbons. After treatment the gas is then piped from the plant to the power station for power generation and use.

Power plants use several methods to convert gas to electricity. One method is to burn the gas in a boiler to produce steam, which is then used by a steam turbine to generate electricity. A more common approach is to burn the gas in a combustion turbine to generate electricity. ([http://www.epa.gov/cleanenergy/energy-and-you/affect/natural-gas.html](http://www.epa.gov/cleanenergy/energy-and-you/affect/natural-gas.html)).

RinkeshKukreja

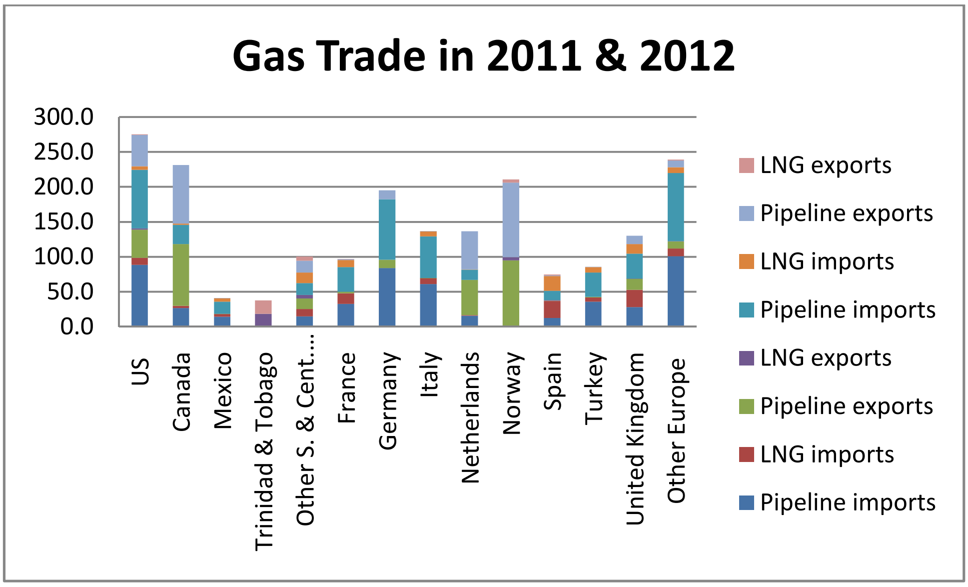


Fig.3.5: Gas trade in Europe and America (BP Statistical Review of World Energy: 2013).

## 3.4 Petroleum

According to Dr. Webber M. of webber energy group in University of Texas at Austin, described petroleum as the most important of all the three fossil fuels and the most popular worldwide today, in the united state alone the flow of petroleum is about a million barrel per day, coal is in tons and natural gas in trillion cubic feet.

In late 60s and 70s power plants in the US where built to run on petroleum until that decision leads to power crisis in the petroleum sector, due to over dependant by power generation company, industries and in transportation on petroleum base fuel but today most country around the world including has switched her power generation to coal, natural gas and uranium base on the available technology and resources. In the 60s petroleum contribute 17% of US power source but today it is less than 1% because it is so expensive compare to coal and natural gas.

Table 3.1: The structure in petroleum sector

| OIL INDUSTRIES ARE STRUCTURED WITH FOUR MAJOR PIECES |
|---|
| ➢ Upstream: Exploration and production (E&P), development, gas & power marketing |
| ➢ Midstream: pipelines |
| ➢ Downstream: refining, fuels marketing, lubes |
| ➢ Chemicals: chemicals, intermediates, synthetics, polymers |

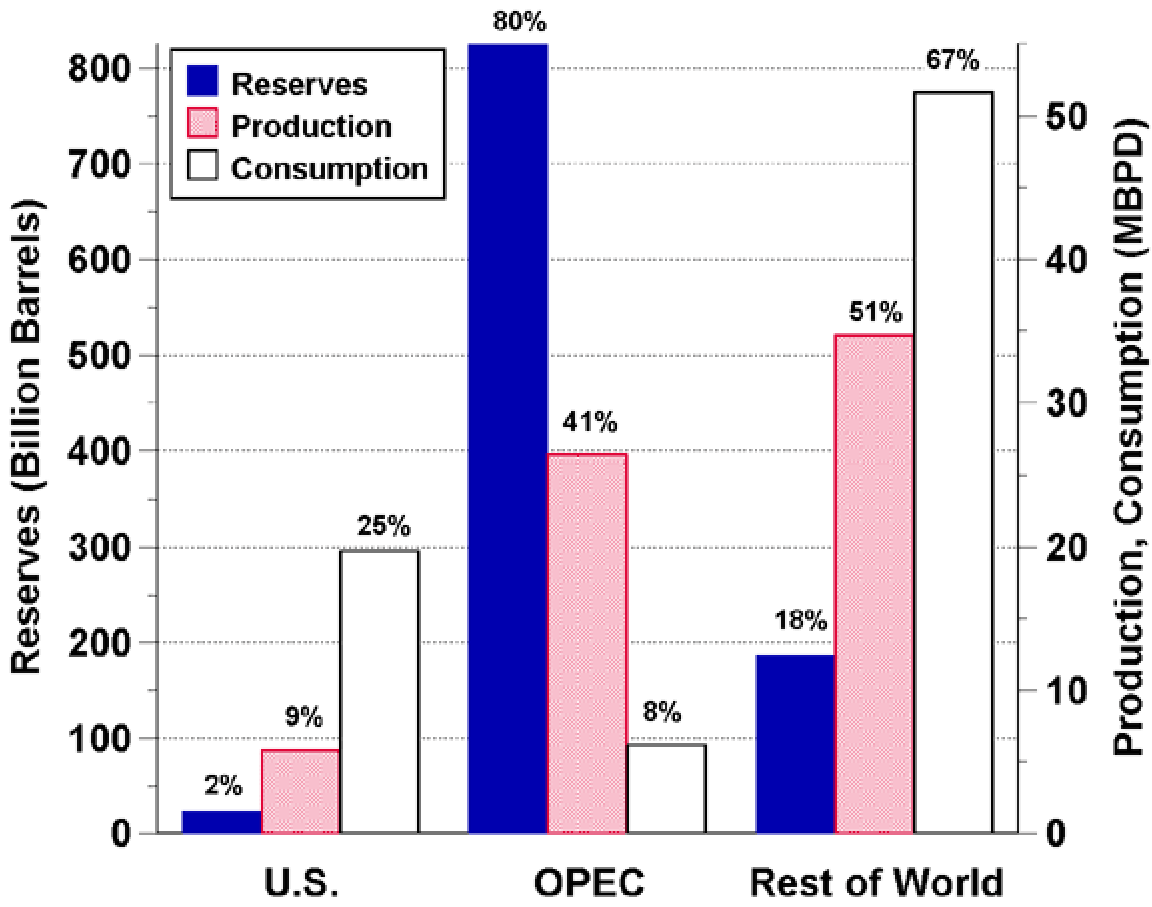


Fig.3.6: Major petroleum reserves and consumption (US energy information and administration. 2013)

The existing petroleum infrastructure is very large and expensive, it represents trillions of euro in capital investment, construction of a refinery cost at least a billion euro such as Porvoo refinery one of Europe and most advanced and versatile refin-

ery, due to its cracking ability which enable broad production structure and enhanced the product value, with capacity of 200,000 bbl/d and produce about 12 million tons of petroleum product per year.
(http://www.nesteoil.com/default.asp?path=1,41,537,2397,2398).

## 3.5 Unconventional fossil fuels

According to Organization for Economic Cooperation and Development (OECD) and EIA in 2013,concluded that technology and economy changes will be a determining factor in defining conventional and unconventional fossil fuel, because today unconventional fuel could become a conventional fuel tomorrow due to technological advancement and economic power.

> *"Conventional – Conventional natural gas refers to gas trapped in multiple, relatively small, porous zones in various rock formations, like sandstone. This natural gas is often difficult to find, but once discovered, it is typically the easiest to produce through standard methods, including hydraulic fracturing, which have been used for the last 60 years.*
>
> *Unconventional – Most growth in supply fromtoday's recoverable natural gas resources is found in unconventional reservoirs. Technological advances in horizontal drilling and multi-stage hydraulic fracturing have made shale, tight gas and other unconventional gas supplies commercially viable."*
> *(http://issuu.com/capp/docs/natural_gas_fact_book/9?e=1293643/1197275)*

Shale gas – Natural gas found in fine-grained sedimentary rock called shale. The natural gas is tightly locked in small pore spaces in the reservoir rock requiring advanced technologies to drill and fracture the gas-bearing zones.

Coal bed methane – Coal bed methane (CBM) is natural gas that is found in coal seams. The natural gas is trapped in the matrix of the coal by a process called adsorption. Reducing the pressure in the coal seam allows the natural gas to be released from the coal and flow to the wellbore.

Tight gas – Natural gas found in sands and carbonate that have a very low permeability, which is a measure of how well a gas or fluid flows through a rock. The natural Canada's annual production is 5.3 tcf/year gas is stored in the very small pore spaces in the rock.
(http://issuu.com/capp/docs/natural_gas_fact_book/1?e=1293643/1197275)

Fig: 3.7 Shows the matrix for U.S. energy use for a period of 12 months by sources (Coal, Natural Gas, Geothermal, Wind, Hydro, Nuclear Solar) for electrical generation and Petroleum and Biomass are mainly for residential, commercial, industry and transportation use while 65% of natural gas is use in residential, commercial and industrial, and 35% of natural gasis use in to generate electricity.

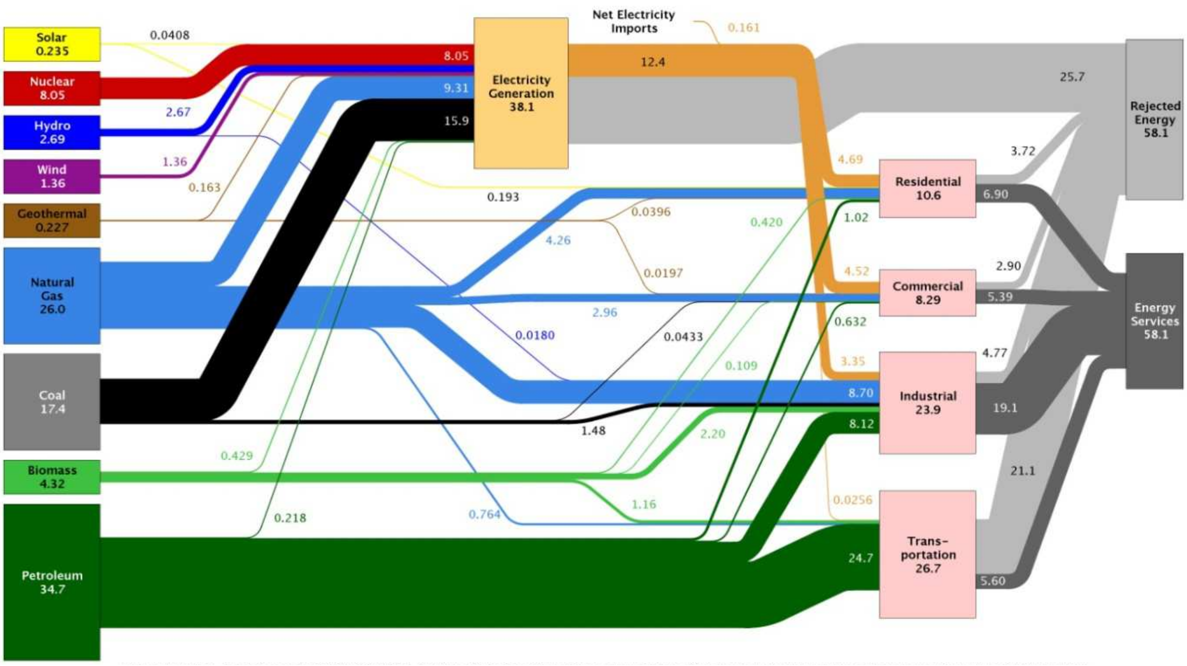


Fig: 3.7 Estimated U.S. Energy Use in 2012 (U.S Energy Information Administration. 2012).

## 3.6 Renewable energy

Renewable energy is the energy resource that is naturally regenerated over a period of time and derived directly from the sun (such as thermal, photochemical, and photoelectric), indirectly from the sun (such as wind, hydropower, and photosynthetic energy stored in biomass), or from other natural movements and mechanisms of the environment (such as geothermal and tidal energy). Renewable energyexcludes energy resources derived from fossil fuels, waste products from fossil sources, or waste products from inorganic sources. (http://www.treia.org/renewable-energy-defined)

- Wind
- Hydropower
- Photosynthetic energy store in biomass

- Geothermal
- Tidal energy

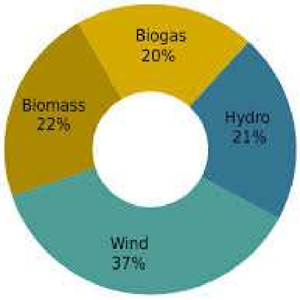


Fig.3.8: World Total renewable Energy sources (U.S Energy Information Administration. 2014).

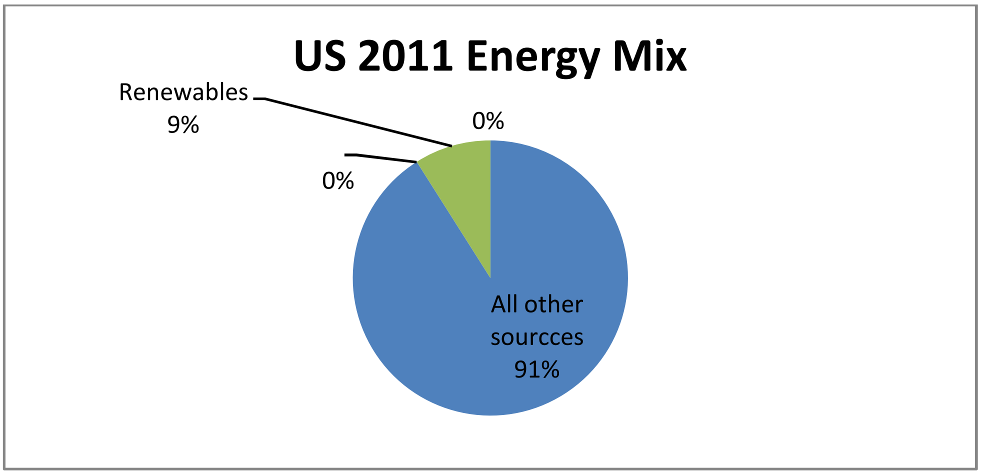


Fig. 3.9: U.S. 2011 Energy Mix (BP Statistical Review of World Energy: 2013)

Over the last decade renewable energy accounted for just 9% of all energy mix in the US alone and the same can be said for the rest of the world, but the future of renewable energy is more promising in the nearest future.

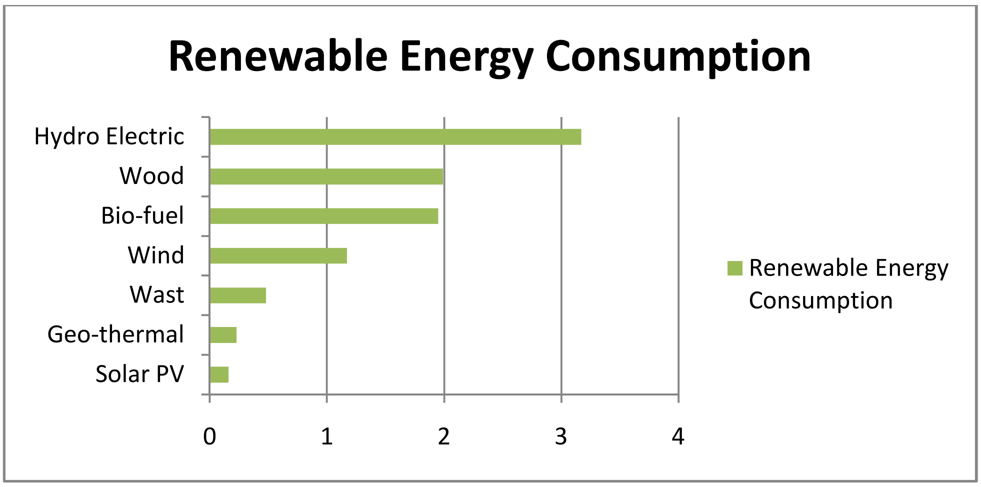

Fig. 3.10: Renewable Energy Consumption World (BP Statistical Review of World Energy: 2013).

# 4 Methodology of the research (Energy tradeoff)

Base on scientific finding on the characteristics of all the available fossil fuel source both conventional and unconventional fuel on which this thesis project is based, a study merits and drawbacks of all the fuel sources will be analyses and a tradeoff will be recommended as the aim of this thesis project.

The world must balance the three priorities while addressing energy problem facing the world today.

- National security
- Economies and supply
- Environment

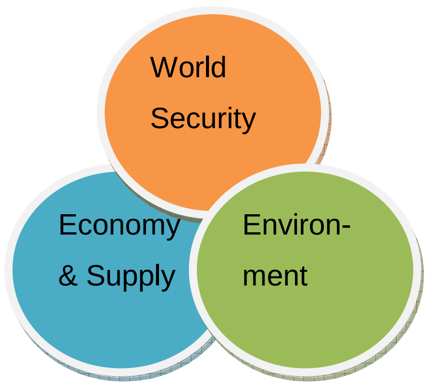


Fig.5.1: energy shortfalls

## 4.1 Coal

Coal energy is a nonrenewable energy which means that this is a type of energy that we cannot re-create. The supply of coal energy is limited and therefore if we contin-ue to consume too much of this, we will eventually run out of this kind of energy.

Coal energy is used for the creation of electricity to power industrial or manufacturing plants and even to power our appliances at home. Many industrial plants or manu-facturing plants use coal energy to generate electricity because coal energy is an affordable source of energy. Moreover, coal is very abundant even if it is non-renewable because it has the largest reserve around the world. (http://sunglitz.wordpress.com/2011/02/01/advantages-and-disadvantages-of-using-coal-energy/)

Table 5.1: Merits and drawbacks of coal

| MERITS OF COAL | DRAWBACKS OF COAL |
|---|---|
| Abundant | Significant land disturbance for its extraction |
| Domestic | Carbon intensive |
| Cheap (Historically) | Burning realises trapped pollutant including sulphur, mercury and heavy metals |

| | |
|---|---|
| Easy to store | |

Table 4.2 Comparing coal, natural gas and petroleum

| COAL | NATURAL GAS | PETROLEUM |
|---|---|---|
| Less expensive | Price fluctuation | Price fluctuation |
| Since 1970s the price has been flat | Presently cheaper compared to petroleum | More expensive than Natural gas |
| Less volatile compared to any fuel source. | still more expensive than Coal | |
| | Volatile compared to coal | Most volatile |

## 4.2 Natural gas

Natural gas is produced along with oil beds and coal, it is found inside the earth and drilled in the same way as petroleum. It is cleaner and cheaper than gasoline and produce less greenhouse gas emission that petroleum. It can be safely stored and burn completely in combustion.

Table 4.3 Merits and Drawbacks of natural gas

| MERITS OF NATURAL GAS | DRAWBACKS OF NATURAL GAS |
|---|---|
| Relatively clean compare with coal and petroleum | Non-zero environmental impact |
| Domestically abundant | Significant flaring |
| Relatively abundant today | Safety concern from leaks |
| Flexible for use in many sectors | Historically volatile price |
| | |

Natural gas can be used in two ways, form of CNG (Compressed Natural Gas) or LPG (Liquefied Petroleum Gas) both options with its own merits and drawbacks, as shown in table 4.3.

Table 4.4 Uses of natural gas

| MERITS OF NATURAL GAS | DRAWBACKS OF NATURAL GAS |
|---|---|
| Relatively clean compare with coal and petroleum | Non-zero environmental impact |
| Domestically abundant | Significant flaring |

| | |
|---|---|
| Relatively abundant today | Safety concern from leaks |
| Flexible for use in many sectors | Historically volatile price |
| Instant energy | Complex processing |
| Precision in kitchen | Non renewable |
| Industrial use | Expensive installation |
| | Inefficient in transportation |

## 4.3 Making distinctions between natural gas, petroleum and coal

Natural gas is relatively clean compared to petroleum and coal, when burn is air it emits less pollutant based on it chemical composition and  research in area marking has shown that it is globally and domestically abundant for the next generation by today's use and relatively affordable and flexible for us in many sectors.

Table 4.5 Distinctions between NG, petroleum and coal

| NATURAL GAS | PETROLEUM | COAL |
|---|---|---|
| **Relatively clean** | Dirty fuel | Dirty fuel |
| **Emits less pollution** | Emits more pollution compare to natural gas | Emits heavy pollution |
| **Can be transported through pipelines** | Can also be transported through pipelines | Cannot be transported through pipelines |
| **Flexible for use in many sectors** | | |

## 4.4 Petroleum

Petroleum is a liquid mixture that consist of hydrocarbons present in rock, which is extracted and refined to produce fuels such as gasoline, kerosene, diesel, fuel oil, alcohol, benzene, naphtha, lubricating oil and residuum, petroleum are also distilled hydrocarbon, which can be use in production of plastic and PVCs.

It is a very useful product as it provides heat liquid and power for tractors, automobile, planes and ships.(U.S Energy Information Administration)

Table 4.6 Many attractions of petroleum base product

| **PETROLEUM BASED FUELS HAVE MANY ATRACTIVE PHYSICAL CHARACTERISTICS** |
|---|
| • **High energy density** |
| ➢ **gravimetric: density per unit mass** |
| ➢ **volumetric: density per unit volume** |
| • **Can be piped thousands of miles in raw or finished form** |
| • **Convenient boiling and freezing points: stays liquid under most climatic conditions** |

Table 4.7 Distinct characteristics of a conventional crude oil

| **Sweetness: Refers to sulphur content** | **Lightness: Refers to viscosity** | **Most nations prefer light, sweet crude** |
|---|---|---|
| sweet = low sulphur content | light = low viscosity | light crudes are easier to refine |
| sour = high sulphur content | heavy = high viscosity | sweet crudes have lower emissions |
| | | |

The transportation of petroleum in its crude form has approximately four distinct stages as stated in section 3.4 but closely related and significantly important from exploration, transportation, refining and the extractions of further benefits of petroleum as shown in table 4.8.

Table 4.8 Major structures of petroleum industry

| **OIL INDUSTRIES ARE STRUCTURED WITH FOUR MAJOR PIECES** |
|---|
| ➢ Upstream: Exploration and production (E&P), development, gas & power marketing |
| ➢ Midstream: pipelines |
| ➢ Downstream: refining, fuels marketing, lubes |
| ➢ Chemicals: chemicals, intermediates, synthetics, polymers |

According to NRC in 2010, it says that oil is a vital source of energy for the world and will likely remain so for many years to come, even under the most optimistic assumptions about the growth in alternative energy sources.
Most countries are significantly affected by developments in the oil market, either as producers, consumers, or both. In 2008, oil provided about 34% of the world's energy needs, and in the future, oil is expected to continue to provide a leading component of the world's energy mix.

The International Energy Agency (IEA) projects that oil will provide 30% of the world's energy mix in 2030.In most part of the world, oil is more commonly used for space heating and power generation than for transportation but in the United States and Canada about 2/3 of oil is used for transportation. Oil is a key product for the world's agriculture sector, which helps feed the world's population of more than six billionpopulation. (http://www.nrcan.gc.ca/energy/publications/markets/6505).

Base on historical and important of petroleum to world's energy need, technology has evolve in upstream and downstream sector of petroleum industry, as a result refining can be turn to suit any purpose as desired, since petroleum in it chemical composition has incredible high energy density which can be define as the density per unit volume. Therefore small amount of volume or mass can be tune to give a lot of energy.

Table 4.9 World's refineries

| WORLD'S REFINING HAS CHANGED SIGNIFICANTLY IN THE LAST FEW DECADES | |
|---|---|
| **IN 1981** | **TODAY** |
| • **Simple** | • Average capacity has gone up four-fold |
| • **Small** | • Can take in more complicated crude |
| • **Inefficient** | • More efficient and cleaner overall |
| • **Flexible refineries** | • New refineries are under construction for the first time in decades |

Table 4.10 Fractions of petroleum

| PETROLEUM-DERIVED FUELS ARE A BLEND OF SEVERAL CONSTITUENTS |
|---|
| **Gasoline, kerosene, diesel, etc., are NOT pure chemicals** |
| **Sulphur is both a pollutant (bad) and lubricate agent (good)** |

Table 4.11 Typical composition

| TYPICAL COMPOSITION | | |
|---|---|---|
| **FRACTION** | CLASS | EXAMPLE OF SPECIES |
| **75% - 85%** | Refines & Isomers | Methane, ethane, propane, isooctane, n-pentane, cyclic parans (naphthenes) |
| **13% - 22%** | Aromatics | Benzene, toluene, xylene, etc. |
| **<3%** | Olefins | Ethylene, propylene, butylenes, etc. |
| **<1%** | Heteroatoms | Sulphur, nitrogen, oxygen, etc |
| | Contaminant | Salt, water, trace metals (nickel, vanadium) |

The world today perform better operation in meeting petroleum demand and does less in meeting diesel demand as well, as a consequence, petroleum prices are comparably lower than diesel prices, though there are global abundant of petroleum compared to diesel, that is because one barrel of petroleum yield many different products, a typical average output in the U.S is a 44 gallon barrel, where 42 gallon as input but 44 gallon as output as processing gain, that is consequence of technology and dedicated manpower that made the world's refining more flexible than ever witnessed.

Table 4.12 Refining today

| REFINERIES HAVE BETTER CAPABILITIES TODAY THAN IN THE 1970S |
|---|
| Advanced techniques for turning heavier crudes into lighter, sweeter products |
| ➢ Thermal and catalytic cracking |
| ➢ Hydrocracking |

| | |
|---|---|
| ➢ | Coking |
| Refineries are better at meeting world demand for gasoline than middle distillates (i.e., diesel) | |
| ➢ | Gasoline prices are relatively lower than diesel prices |
| | |

European refineries can actually give out a slightly higher fraction of diesel and a slightly lower fraction of gasoline, the world has taken the advantage of technology, it can tune refineries different output base on needs.(U.S Energy Information Administration).

## 4.5 Unconventional fossil fuel

According to Yusuke Kuwayama in November 2013 concluded that, crude oil and natural gas production from unconventional reservoirs is experiencing accelerated growth in the world today, much of which is expected to continue for the foreseeable future. The shift in the energy industry has been accompanied by rising concerns over its potential impact on water resources. Developing these fuels is thought to require more water per unit of energy produced than conventional sources, while leading to greater degradation of water quality. (http://common-resources.org/2013/unconventional-fuel-production-and-water-resources/)

Table 4.12 Unconventional fossil fuels

| UNCONVENTIONAL FOSSIL FUELS ARE COMPRISED OF SEVERAL SOURCES | |
|---|---|
| **I.** | **Unconventional coal:** |
| • | **Coal to liquids (CTL)** |
| **II.** | **Unconventional natural gas:** |
| • | **Coal-bed methane, gas to liquids (GTL), and shale gas** |
| **III.** | **Unconventional petroleum:** |
| • | **Tar sands (or oil sands), heavy oil, oil shale, shale oil** |

Table 4.13 Production of unconventional fuel

| NEW PRODUCTION TECHNOLOGIES (AND HIGH NATURAL GAS PRICES) ENABLED ECONOMIC PRODUCTION OF SHALE GAS |
|---|

| |
|---|
| • **Hydraulic fracturing of the shale** |
| ➢ **Jets of high-pressure water cracks the shale** |
| ➢ **Proppants (e.g. sand) keep the cracks open** |
| • **Horizontal drilling** |
| ➢ **Enables high productivity along the seams** |
| ➢ **Increases output per drilling pad** |

Unconventional fuels production has significant drawbacks of leaks and flaring, when there is leaked gasses the consequence is that the quality of air in such an environment is degraded, emission from the pump and trucks because gas is cheap but pipeline are expensive to build, sand used for proppants as sand blow away as a consequence of dust storm, which could armful to the lungs as health hazard, also a great source of noise pollution. (National Academic of Science)

Table 4.14 Environmental risk of unconventional fossil fuels

| SHALE PRODUCTION HAS | ENVIRONMENTAL RISKS |
|---|---|
| • Land disturbance from the pad | • Freshwater use |
| • Drilling through aquifer | • Effects from the fracturing process |
| • Wastewater retrieval | • Wastewater storage |
| • Water/Wastewater transportation | • Wastewater treatment |
| • Wastewater reinjection | • Flaring |
| • Gas leakage | |

Table 4.15 Waste water disposal

| INJECTION IS ONE METHOD OF WASTEWATER DISPOSAL |
|---|
| • Some states allow wastewater injection to specified locations |
| ➢ Texas does, Ohio does, Pennsylvania does not |
| • Injecting at a fault can induce seismicity |
| • Reinjection is easier (and probably cleaner) than treatment |
| • Re-use is even cleaner (but not necessarily easier) |

# 5 Result

Human are the only living thing which can manipulate energy by conversion from one form to the other intentionally, that is an energy characteristic of human being, these ability makes Dr. Webber of university of Austin Texas in 2013, to conclude that, “energy is the defining element of humanity”, because is only human that can control fire to her desires, convert mechanical energy to any form she desires and convert chemical energy to light as she so places.

The reason why the debates about energy seems confusing to many people around the world today, is that, the language of resources depletion allows anyone to make strong and accurate point to justify widely but vivid state of energy resources, even though with scientific and statistical prove but the bases are time dependant, which in fact the world will never run out fossil fuel, there will always be some amount that will be left on the ground as unconventional fuel today which could also be conventional for next generation, with advance technology, value, appetite for risk, time horizon as well as urgency for social priorities.

The concluding part of this final thesis will be base on two most important factors on energy, which are climate and energy security.

## 5.1 Climate

The increasing use of fracking and possibly methane does not change much on climate, the world is never going to run out oil reserves, the world has coal, the misconception about coal reserves argue whether a 100 or 200 years of supply, the world has roughly ten times as much carbon in coal in the ground as world can afford to put in the atmosphere without risking disruptive global climate change.

Coal is easy to extract, cheap and a large energy resources for key economies notably U.S, India, Nigeria, and Russia, coal has always been sufficient to destabilize the climate and undermine international agreements to reduce green house gases causing global warming, fracking and methane hydrate come on top of the list.

Addressing climate change will involves getting to a broad consensuses, adopting risk management perspective and making climate change a sustained social priority, aided by focusing on interpretation of events as a priority, considering ethics and valuing health. This is not what resources depletion will force on.

## 5.2 Energy security

Energy security is about using oil for transportation and to do that a lot has to change for natural gas to become an important transportation fuel, at present natural gas accounts for 2% of Europe and the U.S. transportation energy, despite that a unit of energy from oil costing about five times more that a unit of energy from natural gas, this will change, if price spreads increase persistently, even though it will an infra-structural transition from what it present today and high technological knowhow to attained that sift, as seen the world is more interconnected, not just for energy, global trade as a portion of world gross world product is more is more than twice what it was 100 years ago.

## 5.1 Renewable energy

We have three different sources of energy and the renewable are the ones that come back on a rate of renewal that's relevant for our planning purposes, there are many forms of renewable energy.

Hydroelectric power generation is the most important power source, water flowing down the hill, there is also wind turbine, which is use for sailboats and for mechanical energy and electrical power generation, there is solar energy, which is use for heating and for electrical power.

Geothermal can use for passive heating or passive cooling and power generation, Bio-energy are crops, trees, and plants as well as organic waste materials, like cow dung, old tires, municipal solid waste, agricultural waste, landfill gas and then ocean and water energy are waves and tidal energy and ocean thermal energy conversion.

If more can be stream turned into useful fuel, it could solve about 15% of energy and environmental problem.

## 5.2 Renewable energy as a solution

Here is example of how we can solve our energy, environmental and economy problem in one instance:

- There are unrecyclable plastics, which will be sent to the recycling facility, but are also contaminated with organic matter, things like baby diapers that have organic matter in them and are also very energy dense, we can push them through a machine to make fuel pellets out of them, we can burn those pellets in places like cement factories.

- Organic waste can also be turned into bio-gas through anaerobic decomposition, so if we use anaerobic decomposition of these organic waste, we will generate CH4 or RNG or biogas, and then we use it just like natural gas for cooking, heating and power generation.

- Landfill gas is a very famous one, where we actually mine for biogas at landfills by punching holes in landfill to capture the biogas that comes out from the anaerobic di-gestion of municipal solid waste. The landfill prevents oxygen from getting down to the decomposition, so it's like a huge anaerobic digester. We can collect those gases, and then use them to make our electricity.

- Here's one illustration of a research, it's called cow power, its one possible solution and we can convert agricultural manure to biogas through anaerobic digestion. In Ni-geria, we generate about 80 million tons of manure a year, which is enough, if it were converted to biogas, to generate about 2% of our electricity needs and it also would create a second revenue stream for farmers. So the economics might workout advantageously for the farmers.

And in terms of environmental liability, manure into a valuable commodity, fuel so we might solve several problems at once. What do we do with our manure? What do we do with our fuel? So it's an opportunity for us to take environmental problems and solve multiple environmental problems in a way that's economically profitable and sustainable without impacting negatively on energy and environmental need of the present and future generations.

# 6 Conclusion

Perhaps the best solution to our growing energy CHALLENGES comes from The Union of Concerned Scientists: “No single solution can meet our society’s future energy DEMANDs. The solution instead will come from a union of diverse energy technologies that share a common thread, which will do not deplete our natural resources or destroy our environment.

## 6.1 Energy for today

There is a great deal of information, awareness and enthusiasm today about the development, sustenance and increased production of our global energy needs from renewable energy sources. Solar energy, wind power and moving water are all traditional sources of renewable energy that are making progress. The enthusiasm everyone shares for these great developments has in many ways created a sense of hope that our future energy demands will easily be met.

## 6.2 Now is the time to shift to renewable energy

The Intergovernmental Panel on Climate Change (IPCC) estimates that approximately $3.7 trillion or more must be invested in renewable energy form, from 2011-2020 to stay within 2°C, the accepted limit for dangerous climate change, so safe our climate from dangers of global warming.

The numbers are staggering but the total yearly investment needed to move world toward the 2°C safety mark represents approximately 1% of the overall annual total global energy market.

There’s an estimated gap of $220 billion above business-as-usual-investments in renewable energy needed by 2017.

Renewable energy is gaining ground, but time is short and greater investment in renewable energy is needed now. (U.S Energy Information Administration)

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