1.1 Energy Sources

The demand of alternative source of energy is rapidly increasing day by day. Extensive use of fossil fuels, as an energy source for both power plants and transport, leads to production of significant amounts of CO_2 and other pollutants. Not only because of limited resources of fossil fuels, these are extremely hazardous to the environment and cause huge amount of waste of which are volatile and difficult to dispose, much research is being undertaken to develop more environmental friendly fuel based or fuel less technologies for power generation. For that people are looking for alternate sources like solar, wind, hydro, hydrogen and many others. But these forms of energy production can also be limited in a sense that the ongoing destruction and manipulation of the environment could have an adverse effect on how we harness these important natural resources. Therefore, more and more people have looked to the use of magnets and magnetism for alternate source of energy [1, 2. 3].

Table1.1: Comparison between different energy sources

Energy Source	Energy Density	Land Required	Dependency	Storage Device	Technological Advancement	Cost/KW	Availability
Renewable Energy	Very less	Very huge	on climate	Required	Good proven	Moderate/ High	Abundant
Fossil Fuel	Very high	Less	on fuel	No	Well proved	Less	For next 200 years only
Magnetic Energy	High	Less	on magnet	No	New	Less	Abundant

Fossil fuels are extremely hazardous to the environment and cause huge amount of waste of which are volatile and difficult to dispose. But because of its limited resources available, people will look to alternative means of energy production, including, not limited to hydro, solar and wind. The table 1.1 gives a brief comparison between different sources like renewable, fossil fuel and magnetic energy sources for parameters like energy density, land requirement for power plant, their availability etc.

1.2 Magnetism and Magnetic Engine

Magnetism is a phenomenon by which materials exert an attractive and repulsive force upon other materials. Some well-known materials that exhibit detectable magnetic properties include iron and steel, a metal alloy whose major component is iron with carbon being the primary alloying material. However, all materials are influenced to a greater or lesser degree by the presence of the magnetic fields. Magnetic forces are fundamental forces that occur from the movement of an electrical charge. Accordingly, magnetism is present whenever electrically charged particles are in motion. This can happen from movement of electrons in an electric current, resulting in electromagnetism, or from quantum mechanical spin and orbital motion of electrons, resulting in what is now known as permanent magnets [4].

Magnetic fields are made of dipoles, two equal and opposite points charges, and are commonly referred to as the North Pole and the South Pole or the positive and the negative pole sides. As well known, two magnets of like poles repulse one another while two magnets of different poles attract each another. This is because a magnetic dipole tends to align itself in an opposed polarity to that magnetic field, thereby canceling the net field strength as much as possible and lowering the energy stored in that field to a minimum [5].

The use of magnetism to produce energy is one of the very popular methods among the researchers from past many decades. For many years people have been trying to harness the energy associated with magnets. The fundamental reason behind the attraction of people to produce power from the magnetic field is that the energy produced from the magnetism is very clean among all other power generation sources. The efficiency of the magnetic power system is found more than other existing sources [6, 7].

Magnetic engines are under investigation by a number of research groups worldwide due to their potential advantages in terms of efficiency and engine emissions. Some proto types have emerged mainly aimed for vehicle propulsion and stand-alone power source. This research report describes the working mechanism of the GOPI engine, applicable to electrical and mechanical power generation in large-scale system. The operating characteristics of the engine are found to differ significantly from those of

conventional engines, giving potential advantages in terms of fuel efficiency and emission. Change in shape and size in magnetic piston does not affect the working of the engine. The frequency of the engine depends upon gate cycle which further depends upon gate factor.

Magnetic engines, as an alternative of the conventional source, are being investigated by a number of research groups worldwide for various applications. Potential advantages of the magnetic engine include possible multi fuel operation with prime source as magnet, simple design, and compact in size and reduced frictional losses due to less moving parts [8, 9, 10].

Magnetic engine as a prime power generation source can have many benefits like, no damage to environment and human health if it is shielded properly with magnetic shield materials, no waste production at any stage of the power generation process and no extra cost is required for power storage system. It has also many benefits over existing techniques like, its running cost is very less compared to fuel based engines, almost maintenance free, one time investment for the end users, portable in size, independent of climatic conditions and eco-friendly device.

The research efforts primarily shall focus on design and development and further simulation and modeling of a "Gate Operated Repulsive Magnetic Piston Engine" hereafter called "Gate Operated Piston Engine" or "GOPI Engine (GOPI engine)" or Engine. This engine works on the principle of repulsive force of magnets.

The engine can be used to produce electrical and/or mechanical output with very high efficiency. The engine is producing zero pollution as it is not using any type of fuel. For start of the engine and to operate gate mechanism and control units of the engine, some kind of storage energy as in the form of battery is required.

When one magnet is fixed and another magnet is brought near to the fixed magnet then the movable magnet can be brought to a maximum approach distance, the minimum distance between the magnets. After that distance, a huge force is required to bring the movable magnet nearer the fixed magnet. From the maximum approach distance, if the movable magnet is made free to move then it will move to the opposite direction in a straight path. The covered distance by the movable magnet depends upon the power of the magnets. Let the fixed magnet is m_1 and movable magnet is

m_2. The arrangement is made in such a way that the same pole of the m_1 and m_2 are facing. If the m_2 is brought from a long distance (at this place both magnets feel no forces of any kind between them) to the m_1 then the quantity of external force to bring the m_2 near to the m_1 will increase as reciprocal of the distance square. This external force will increase the potential energy of the system. After reaching the maximum approach distance, if the m_2 is released then it will move in opposite direction (180^0) with greater kinetic energy which will reduce as distance increases. Now if m_2 can bring back to the fixed magnet m_1 and released again, then the kinetic energy and potential energy of the system can be maintained and kinetic energy can be attained at the cost of the potential energy of the system.

In the Gate Operated Magnetic Piston Engine (GOPI Engine), one magnet (m_1) is kept fixed and another magnet (m_2) is brought again and again near to the m_1 (after a fix interval). Generally force is to be applied on the system when work is to be done on the system and force can be gained when work is done by the system. If we consider the two magnets as a system then someone has to spend energy in bringing the magnets to nearby and energy can be gained when the movable magnet m_2 moves away from the fixed magnet m_1. But gaining and spending the energy will worth nothing.

In the GOPI engine the moving magnet m_2 is arranged in such a way that when it is to be moved away from the m_1 the kinetic energy can be used as output of the engine. When the m_2 is to be brought near the m_1 then also the engine should work in the same direction and net output is gained. So in the GOPI engine work in same direction is gained both when the m_2 is moving away from the m_1 and when m_2 is to be brought near the m_1.