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Energy Generating Gymnasiums Machines for Renewable, Sustainable and Green Energy

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Abstract - *Most of the newly invented technologies entirely depend upon electricity for their proper operation therefore the energy demand is increasing day by day. Increasing population of world is also a major factor of increase in energy demand, that's why scientists are exploring major and minor energy resources to fulfill the energy demands. Energy has been a big cause for the development of human being. Conventional energy resources include fossil oil, natural gas and coal are ultimately depleting and for the reason scientific community is shifting its attention towards renewable energy resources. A theoretical model of Energy Generating Gymnasiums System (EGGS) is proposed in this paper which will contribute its share in renewable energy sector. People of modern society are conscious about their health and adopt gymnasium exercises in order to achieve their desired fitness level. Gymnasium is a place where people physically operate many machines by applying force on the machines. The idea behind smart EGGS is that the human expended energy on machines in a gymnasium should be converted into electrical energy. Electrical energy harvested by using smart EGGS will be clean, renewable and sustainable. Research proposed for smart EGGS suggest that human being is also a source of renewable energy and chemical energy possessed by humans can be converted into electrical energy [8]. EGGS will be very beneficial for the countries that are facing severe energy crises. Total output of all the gymnasium machines will give a sufficient amount of electrical energy needed by the gymnasium electrical appliances. The excessive electrical energy can be sold back to utility [9].*

***Key Words*: EGGS, Renewable energy, smart grid, EGGM, Gymnasium, Lat Pull down machine**

1. INTRODUCTION

The world around us is being changed significantly and technology has become one of the major drivers for economic and social development. The rapid advancement of Information Technology (IT) all over the world has transformed not only the way people think, but also the way people act. Nearly all the technologies functioning depends on the utilization of electricity so the share of electricity is increasing rapidly than the total primary energy supply. Every human being is very conscious about his health in this modern world therefore they join gymnasium to burn their calories to increase their fitness level. It is possible to construct gymnasium machines that can convert the expended energy by the users into electrical energy throughout the exercise [8], [10]. The great outdoor gym (TGO) company in United Kingdom (UK) has been producing energy generating gymnasium equipment for cardio charge and lightning [2]. Equipment that charges mobile phones called Cardio Charger [1]. TGO has installed green energy generating fitness machines at Sir George Monoux College, Trafalgar Square, and the Green Heart in Hull city [1]. TGO have launched 4 amazing outdoor gym pieces which offer a cardiac workout and generate electricity and has upgrade the Cross Trainer, Recumbent Bike, Spinning Bike and Hand Bike to green energy gymnasium equipment that generates on average 50-100 watts each depending on the fitness of the user [1]. World total final consumption (TFC) by fuel was 9,384 metric ton oil equivalents (MTOE) in 2015 and by 2040 it will be 10706 MTOE [3]. World net electricity generation increases by 45%, rising from 23.4 trillion kilowatt hours (kWh) in 2015 to 34.0 trillion kWh in 2040 [4]. According to world energy council *fossil oil* remained the world's leading fuel, accounting for 32.9% of global energy consumption [5]. The proposed model of EGGS will produce energy from the moving parts of gymnasium machinery increase the potential of renewable energy resources. Sunlight is the ultimate sources for generating renewable and sustainable environment friendly energies. There are various ways of harvesting and using solar energy for fulfilling the energy needs of the modern society. In nature photosynthesis is the process to bring and spreads solar energy into the living system through food chain and food web. Naturally, plant's leaves, green algae and some other organism like cyanobacteria convert light energy into chemical energy through photosynthesis that can be later released and used as an energy source by those organisms to fuel their activities. The converted chemical energy is stored in the form of carbohydrates such as sugars, which are synthesized from CO_2 and water. The process of photosynthesis not only generates fuel but it also releases

oxygen as a byproduct. The benefits of mimicking the process of photosynthesis can benefit the living organism on earth two fold. There are producers and energy converter in this natural cycle.

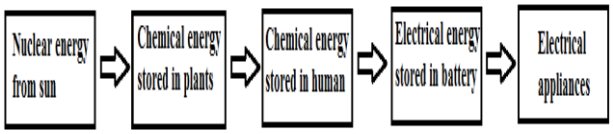

Fig -1: Human body converts solar nuclear energy into electrical energy

Producers make food (glucose) by using water and sun light, human consume this food and chemical energy of this food is converted into mechanical energy in doing some useful work. This mechanical energy is then can be converted into electrical energy with the help of EGGS. Fig- 1 describes the consecutive stages of conversion of solar nuclear energy to electrical energy. Energy is defined as the ability to do work and human body contains enormous quantity of energy which fuels the daily activities.

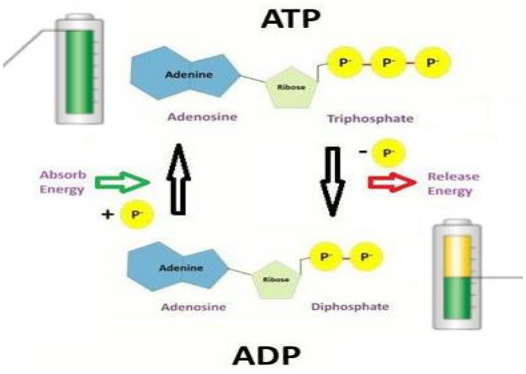

Fig -2: The ATP-ADP cycle

Man gets this energy from food through a food chain. A food chain is a chronological pathway that represents the exchange of energy from sun to organism. Sun is the ultimate source of energy in this universe and energy can never be created nor be destroyed, but it can be passed from one organism to other through food chains and webs. Every biological community have multiple and diverse food chains but every food chain starts with a primary source of energy that is the sun. Primary producers are the first organisms that get benefit from this initial source because they can harness and use the energy from the sun by a process called photosynthesis. Human beings are not primary producers and can't create their own food to survive. As a human we get food from primary producers/ consumer and biochemical energy of food nutrition is converted into *Adenosine triphosphate* (ATP) by a process of "*cellular respiration*". ATP is a stored energy in human muscles and a single molecule of ATP contains ten carbon atoms, sixteen hydrogens, five nitrogens, thirteen oxygen and 3 phosphorus atoms. The shorthand formula is $\mathbf{C_{10}H_{16}N_5O_{13}P_3}$. Three phosphate groups attached to a conglomeration called adenosine.

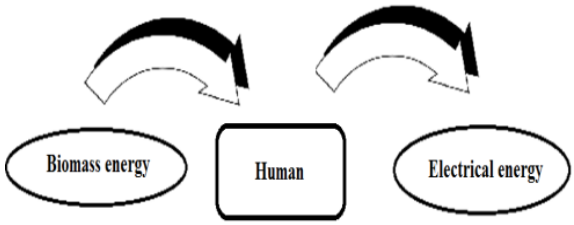

Fig -3: Human as a transducer

The last two bonds on the phosphate groups contain especially high energy and therefore are very useful for doing work within living cells. To take advantage of the high energy bonds in ATP there are within many cells a substance called *ATPase*. This is really an ATP splitter and it cuts off the last phosphate group of the ATP molecule turning it into *adenosine di-phosphate* (ADP). The ATP-ADP cycle shown in Fig -2 has everything to do with the storage and use of energy in living things. In the process of this splitting a great deal of energy is released and used in the cell to do work, move things and build things. A convenient way to remember the cycle is ATP = ADP + P + Energy. The adding and subtracting of a phosphate to ADP is a metabolic process. Metabolic process can be separated into two phases; *catabolism* is the process of breaking down (breaking down food to make ATP), and *anabolism* is the process of building up (using the energy created in converting ATP to ADP to build up cells or move molecules around the cell). The ATP - ADP cycle occurs in plants and animals. This stored ATP energy in muscles, on movement of the muscles produce kinetic energy which can be converted into other form of energy.

2. PROPOSED WORK

Energy demand graph is ascending day by day and scientists are exploring the new ideas and resources to get any form of energy. In this paper we will discuss a method in order to harness energy from human. In proposed method human is considered a device or machine for converting biomass

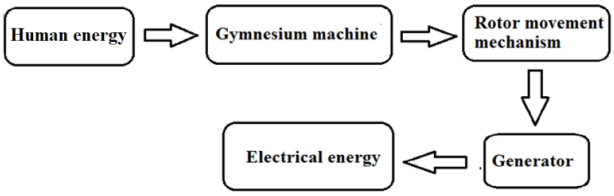

Fig -4: Conversion of human energy into electrical energy

energy into electrical energy as shown in Fig- 3. The device which converts one form of energy into another form of energy is called a *transducer*. Man takes calories from food and performs work, however excess of calories due to unbalanced diet will store in adipose tissues giving a fatty appearance. People join gymnasium in order to maintain healthy look and fitness where they perform different types of exercises, like running, weight lifting, muscles building. There are specified machines for exercise of specific portion of human body, e.g., cable preacher curl, close grip bar curl, barbell curl, and dumbbells lifting are some exercises for biceps. Exercises for chest are barbell bench press, flat bench dumbbell press, low inclined barbell bench press, seated machine bench press, etc. Some of the cardiovascular machines in gymnasium equipment are made of cables and pulleys. These machines are main focus of this research since these machines can contribute to harvest energy. As the demand of energy is increasing day by day so it is necessary to invent new ways and techniques to produce energy within a small area which may be a home or a gymnasium building. During exercise in gymnasium people apply force on machines and expend energy to do some work. In this proposed work the authors suggest a theoretical technique which will make it possible to harvest energy from some gymnasium machines. The basic idea behind the research is to harness energy from the moving parts of gymnasium machines in electrical form. For this purpose, low RPM (revolution per minute) generators can be installed in the gymnasium machinery. A simplified block diagram of energy conversions is described in Fig -4.

Fig -5: Generator is being started by pulling recoil cord

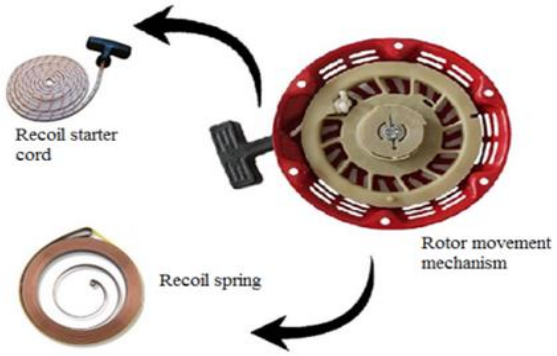

Fig -6: Parts of rotor movement mechanism

2.1 Installation of low RPM generator

Low RPM generator is a generator which has heavy winding and induces voltage by rotating at relatively low speed. Generators may be connected with gymnasium machines by installing rotor movement mechanism in the generators

2.1.1 Parts of generator

Armature/ Rotor: Armature is a rotating part of generator which has conductors winding on it. The armature of Low RPM generator will be rotated whenever the machine of gymnasium will be operated.

Stator: Stator is the stationary part of generator which consists of permanent magnet or electro magnet made by stator coil winding.

2.1.2 Design of rotor movement mechanism

Rotor movement mechanism which is shown in Fig -6 is commonly installed in conventional domestic generators consists of a recoil cord with a grip or handle at one end and a spiral spring. The body of the rope wraps around the crankshaft's end of generator. A crankshaft refers to an engine part that converts linear motion into rotation.

2.1.3 Operation of rotor movement mechanism

The operator pulls the rope's handle or grip this causes the rope to unwind around the crankshaft and spin it. The spinning motion of the crankshaft rotates the rotor of generator. When recoil cord is released it winds again on the shaft of generator due to the restoring elastic force of a

spring. This rotor movement mechanism is commonly used to make pull starter engines. Pull start engines are often used in such small machines as chainsaws, lawn mowers and engine generator devices. Some types of small vehicles, such as mini bikes and go-carts, also carry pull start engines.

2.1.4 Armature rotation by machines

Rotor movement mechanism will be attached with the shaft of generator and the grip of recoil cord will be attached with gymnasium machine. Whenever gymnasium machine will be operated it causes recoil cord to wind and unwind on the shaft of generator. When cord is relaxed it winds again due to restoring force of spring. Armature of generator rotates anti- clock wise or clock wise direction only.

2.2 Energy generating gymnasium machines (EGGM)

(i) Lat pull down machine

The word "*Lat*" is short form for Latissimus Dorsi which is the name of the muscle. Late pull down machine is constructed for the development of latissimus dorsi muscle. Pull down machine simply consist of pulleys and metallic cable rolled over pulleys. One end of cable is attached with adjustable weight and on other end force is applied by user to lift the weight. Cable may be pulled up or down depending on the nature of exercise. Working principle of Lat pull down machine is expressed in Fig -7(a) & 7(b), which is a multipurpose machine used to exercise for multi joints, biceps, triceps, shoulder and legs. Weights are selected by adjusting the nail into the specific holes (A, B, C, and D) if metallic rod. For example, if nail is entered into the "B" hole then 3 upper weights will be selected to lift them up for exercise. This machine can be made as energy generating machine by installing a generator in it directly [12]. Lat pull down machine may be connected with a generator by 2 methods.

Method 1: The shaft of generator will be attached with the axle of pulley in first method which is represented in Fig -8. This combination will give result of transformation of torque from pulley to the armature of the generator. Rotation of armature will produce electrical energy. The electrical voltage and current will be the alternating as the direction of rotation of pulley will change in clock wise and anti-clock wise direction. A rectifier will be necessary in orderto charge the D.C batteries.

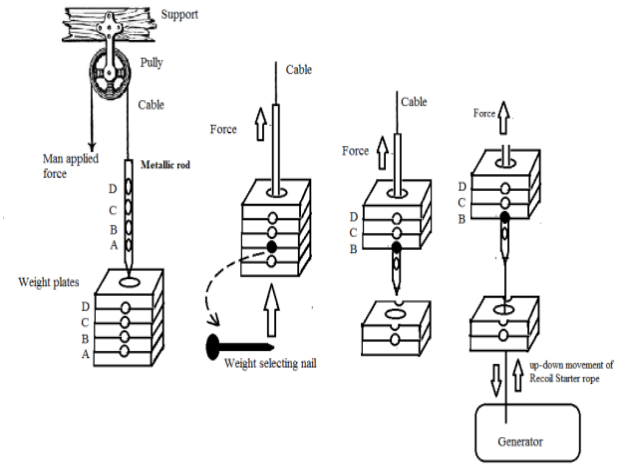

Fig -7 (a): Working principle and installation of generator in Lat pull down machine

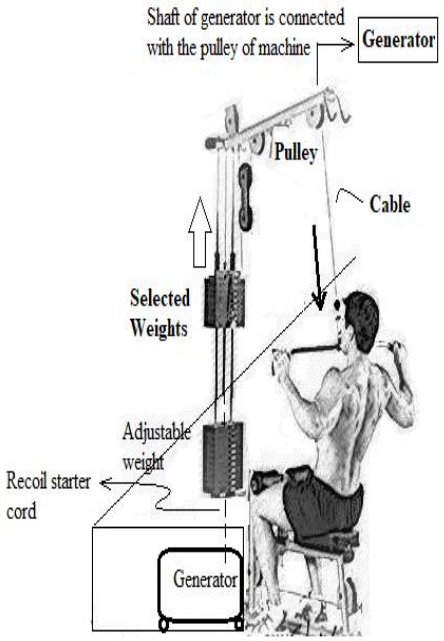

Fig -7 (b): Lat pull down machine as a energy generating machine

Method 2: The second way of installinng the generator will be so that the generator will be placed in the basement of machine. when the cable is pulled downward the armature of generator will rotate and electrical power will be produced through the generator, this process is explained by Fig -7(a) & Fig -7(b).

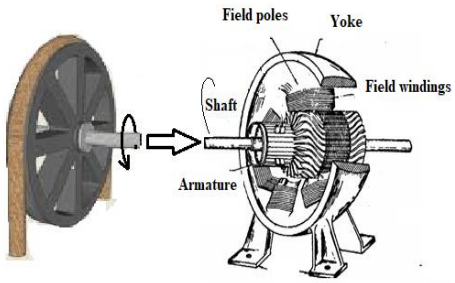

Fig -8: Pulley and generator are combined to generate energy

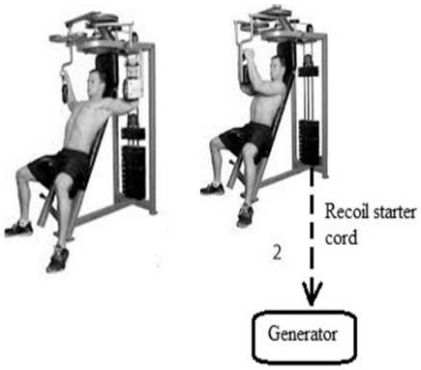

Fig -9: Butterfly as an energy producing gymnasium equipment

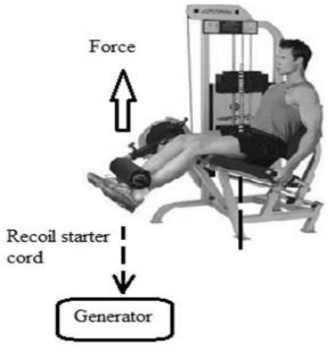

Fig -10: Leg extension machine working as a power generating machine

(ii) Butter fly

It is usually a stand-alone machine in gymnasium and also known as butter fly arms. The butterfly machine offers an effective chest and shoulders workout. It is operated to strengthen the chest muscles.

Operation: Sitting on the seat, place hands or forearms on the long boards, pull arms together then expand chest to release.

Fig -11: Generator operated by leg press machine

Return slowly to start position. It is possible to convert butterfly machine into an energy generating machine by installing a low RPM generator in the basement of machine which is displayed in Fig -9.

(iii) Leg press machine

The leg press is a popular and simple piece of gymnasium exercise which can help build key muscles in our legs.

Operating principle: User sits on the machine with his back and head resting comfortably against the padded support. Place feet on the footplate while ensuring that heels are flat

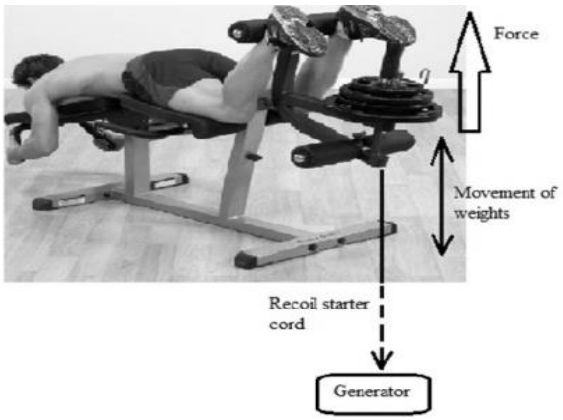

Fig -12: Generator installed in leg curl machine

and legs should form an angle of about 90 degrees at the knees. Knees should be in line with feet and neither is bowed inward nor outward. Whenever press, make sure to keep this alignment and bottom should not be raised from the seat. Seat is made moveable for a comfortable position. These provide support during the movement and help keep your spine and head in position. Placing hands on the knees is a common mistake that will break one's form. Leg press

machine may also be converted into energy generating device by using a pulley, recoil rope and placing a generator in basement of machine as presented in Fig -11. Whenever machine will be operated, recoil rope over the pulley will rotate the armature of generator.

(iv) Leg curl an extension machines

Leg curl machine in Fig -12, is used to work out the muscles in the back or posterior of the leg, primarily the hamstrings. The leg extension machine makes the legs straighten against load resistance and thus works the muscles on the front or anterior of the leg called quadriceps.

Quads: The quadriceps muscles work when we use the leg extension machine. These muscles comprise of the rectus femoris, the vastus lateralis vastus medialis and the vastus intermedius. During leg extension exercise, the rectus femoris is the most engaged muscle. At the end position of the motion, when your knee is almost straight, the vastus medialis then contracts. The leg extension is a weight resistance exercise that targets the quadriceps muscle in the legs.

Hamstrings: During use of leg curl machine, the muscles on the back of the thigh contract to bend the knee. The hamstrings are made of three muscles: the biceps femoris, the semimembranosus and the semitendinosus. The largest of the three is the biceps femoris.

Calves: The calf muscles consist of two muscles, the gastrocnemius and the soleus however that is used the most during leg curl is the gastrocnemius, which is the most superficial. It crosses the back of the knee and supports the hamstrings to bend the knee when using either of the leg curl machines. The exercise is done using a machine called the Leg Extension Machine as shown in Fig -10.

(v) Stationary bicycle

A stationary bicycle also known as exercise bicycle or spinning bike is a simple machine made of saddle, pedals, wheels, chain and some form of handlebars arranged on a bicycle. The rider of stationary bicycle revolves the pedals which in turn spin the wheel of bicycle. Consistent workouts on a cycling machine should lead to less fat on rider's body. A generator is connected to a stationary bicycle in such a way as the circular rotation of the front wheel rotates the coils of wires inside the generator between the poles of the magnets [11]. Stationary bicycle generates energy by connecting the shaft of generator with spinning wheel results in rotation of armature of generator; this process is given in Fig -13. In this arrangement more force will be needed in order to spin the wheel of bicycle because of the load of generator. Generator's load will act like a weight to which rider has to lift as compared with leg extension machine. The electrical energy is then stored in battery packs (power packs). A stationary bicycle is also an energy generating gymnasium machine (EGGM).

3. SCOPE OF EGGS

The concept of Energy generating gymnasium system has great scope in developing countries where youths are becoming more fitness conscious [13]. System of EGGM will be able to pay its share in the electricity demand of single gymnasium building. Smart grid system which is evolving for the power delivery in the 21st century enables the customer to sell excess of electric energy from distributed energy sources (DES) back to the utility via micro grids (MG). MG is small groupings of interconnected power generation and control technologies that can operate within or independent of a central grid and increasing system reliability. By enabling the integration of distributed generation (DG) such as wind and solar, these systems can be more flexible than traditional grids. EGGS will be taken as a new distributed power generating source in the field of renewable energy resources in Fig 14. MG concept was originally proposed in 2002, as a building block of future low voltage distribution system. It was based on the idea of aggregating number of micro sources (Renewables) and loads into one unique entity which could be interpreted as a single dispatch-able prosumer from the overhead power system view point [6].

Fig -13: Stationary bicycle is producing electrical energy

The key differences between a MG and a conventional power plant are that MG are of much smaller capacity with respect to the large conventional power plants and power generated at distribution voltage can be directly fed to the utility distribution network. The technical features of a MG make it suitable for supplying power to remote areas of a country where supply from the national grid system is either difficult to avail due to the topology, severe climatic conditions or man-made disturbances [7]. From grid point of view, the main advantage of a MG is that it is treated as a controlled

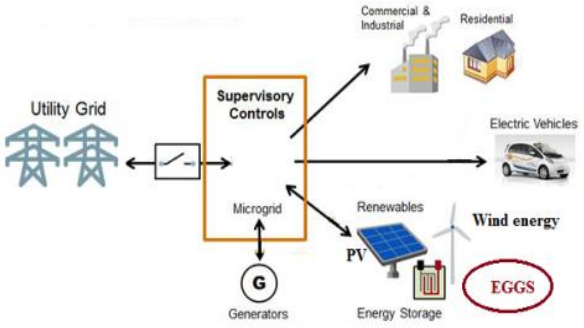

Fig -14: Renewables connected with Micro grid

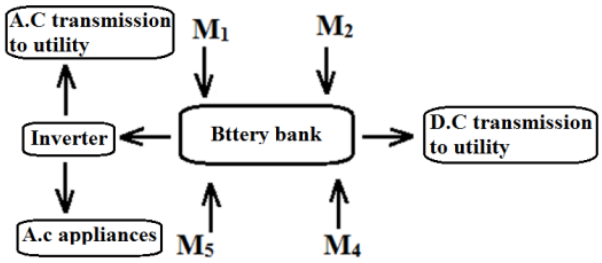

Fig -15: Storage and flow of energy from EGGS

entity within the power system [7]. From customers' point of view, MG are beneficial for locally meeting their electrical/ heat requirements and can supply uninterruptible power, improve local reliability, reduce feeder losses and provide local voltage support [7]. The overall generation and transmission of energy up to the appliances and utility from EGGS is represented in Fig- 15. The direct current (D.C) will be first converted into alternating current (A.C) by the use of an inverter in order to operate the A.C appliances.

4. CONCLUSION

This paper has dealt with evolution in gymnasium machines by making each gymnasium machine as EGGM. This research is although theoretical but a very vital step towards a new way of energy generation by using men power. The Solution of depletion of energy sources is DG of power locally by Integration of RESs. EGGM will be operated by human power, so human beings are considered as a RES in proposed research.

AUTHORS CONTRIBUTIONS

M. Musharraf conceived and designed the idea and construct theoretical model of proposed research. Ifrah saleem suggested the biological data for the proposed idea and helped in write up of the manuscript. Dr. Farhat Iqbal revised and reviewed the document.

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