Sustainable Green Hydrogen and Oxygen Production by Gravity-Powered Giant Wheel and Steel Balls Mechanism with Integrated Employment Opportunities

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Article

Sustainable Green Hydrogen and Oxygen Production by Gravity-Powered Giant Wheel and Steel Balls Mechanism with Integrated Employment Opportunities

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Abstract

This paper presents an innovative gravity-driven energy system utilizing a giant steel wheel equipped with multiple buckets that cyclically carry and release steel balls to generate mechanical torque and continuous rotation. The rotational energy powers an electric generator, producing green electricity to drive water electrolysis for sustainable green hydrogen and oxygen production. By incorporating manual labor, simple lever mechanisms, and animal-assisted lifting to elevate steel balls, the system is designed to operate continuously and independently of weather conditions, enabling round-the-clock green power generation. The modular and scalable design makes it suitable for deployment across diverse geographic regions, particularly rural and economically disadvantaged areas, where it can simultaneously provide stable employment opportunities and contribute to India's growing demand for clean energy. Preliminary mechanical modeling estimates a power output of approximately 5 kVA and a coefficient of performance around 2.5, though further experimental validation and optimized design are required. This work calls for focused research, prototype development, and funding to realize the potential of gravity as a reliable renewable energy source that integrates technological innovation with socioeconomic upliftment.

Keywords: giant steel wheel; steel balls; generator & electrolyzer; global warming; increasing demand of electric power; increasing demand of green hydrogen; scarcity of fossil fuels; gravi-power

1. Introduction

As the world is running behind green electric power and green hydrogen [1–6], engineers and scientists are working day and night in search of green power and associated technologies. In this context, we try to utilize 'gravity' as a possible nature friendly ever green energy source [7–10]. Considering giant wheel like robust structure [11–14] aided by steel balls falling on the giant wheel top side buckets, we have developed a simple theoretical mechanism for producing a 20 kW of electric power. It's very amazing to note that, estimated COP is around 2.5. With further research and engineering, compact gravi-power systems associated with Tungsten like high density metals can be developed with high COP values. It may be noted that, energy conservation point of view, to maintain high COP values, in this model, there is a possibility for maintaining ample number of steel balls and lifting process of the steel balls can be accompanied with manual help and simple leverage mechanisms. We are very confident to say that, in near future, gravity can be used as a reliable power

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maker and permanent employment can be given to poor people while producing green current and green hydrogen that are having ever increasing global demand.

2. Giant Wheel-Steel Ball Model

Considering a heavy giant flywheel [11–14] made of steel having a width 50 mm and 5-meter diameter, it seems possible to produce a torque of 9 kN-m and power of 3.5 kW where the estimated angular velocity is approximately 0.37 rad/sec. It can be understood as follows.

It is planned to arrange 12 specially designed small buckets on the periphery of the giant wheel separated by an angle of 30 degree each. These buckets are allowed to swing freely as per the rotation of the giant wheel. Four balls of each 25 kg are allowed to sit in the bucket. Important point to be noted is that, at the bottom of the bucket, a sensor-based door is arranged for locking the balls inside the bucket and letting the balls to go out from the bucket. Starting from the vertical point of giant wheel, 12 buckets are arranged for every 30 degree with a separation distance of 1.31 meter. It is planned to arrange a hopper above the giant wheel. To run the giant wheel in a self-sustainable mode, it is planned to arrange ample number of steel balls in the hopper. Downside of the hopper, there is a ball shooter. It collects four balls from the hopper and directs them towards the bucket that comes to the right side clockwise 30-degree position from the top vertical axis of the giant wheel. This process is continued for the consecutive 5 buckets.

Assuming a clockwise direction, when the first bucket reaches 150-degree position from the top vertical axis, bucket's door sensor is triggered by the prefixed ground level sensor, bucket's door gets opened and the four balls are allowed to leave the bucket. When the bucket reaches 210-degree position from the top vertical axis, bucket doors are closed. The let-out steel balls are allowed to fall on the pre-designed ramp having a wide gap at the beginning and narrow gap at the end. It may be noted that, circular distance between each bucket is 1.31 meter and rotating speed of the giant wheel is 0.925 m/sec. Thus, approximately, for every second, 4 steel balls are entering one bucket at the top of the giant wheel and 4 balls are leaving from one bucket at the bottom of the giant wheel. Thus, the 4 steel balls follow a canal arranged at the narrow end of the ramp and finally reaches to the ball lifting belt drive. As the giant wheel is having excess torque than required for running a 5 kVA generator, part of the giant wheel power can be taken for operating the ball lifting belt drive. It consists of small buckets separated by distance of half meter and capable of holding two steel balls at a time. Thus, the steel balls are taken to the hopper arranged above the giant wheel. At the same time, causal labors also will assist in taking the fallen and leftover balls to the hopper via simple leverage mechanisms. This process is continued round the clock with strict supervision. In a nutshell, the giant wheel is rotated continuously by 6 buckets having a total mass of 6x(4x25)=600 kg by virtue of endless and enormous gravity power with human assistance. This kind of electric power can be called as 'Gravi-power'.

3. Approximate Torque and Power Calculations

Considering the collective weight of the four balls and 6 buckets, with a very rough approximation, it is possible to estimate the torque developed on the giant wheel. For understanding purpose, consider the top vertical point of the giant wheel axis with clockwise rotation.

Let us assume that, giant wheel is stationary and 24 balls are arranged in 6 buckets starting from 30 degree to 180 degree position of the top vertical axis of the giant wheel.

Let, Radius of the giant flywheel = 2.5 meter

Width of giant flywheel = 50 mm=0.05 m

Acceleration due to gravity is 9.81 m/sec^2

Mass of each steel ball = 100 kg

Now average torque developed on the giant wheel for one bucket of 100 kg having 6 different positions can be approximated with,

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$$\left.\begin{aligned}\left(\tau_{gw}\right)_{100\text{kg}} &\cong \frac{1}{6}\left[100\times 9.81\times 2.5\sin 30\right]+\left[100\times 9.81\times 2.5\sin 60\right]+\left[100\times 9.81\times 2.5\sin 90\right]\\ &\quad+\left[100\times 9.81\times 2.5\sin 120\right]+\left[100\times 9.81\times 2.5\sin 150\right]+\left[100\times 9.81\times 2.5\sin 180\right]\\ &\cong \frac{1}{6}\left\{100\times 9.81\times 2.5\times\left[\sin 30+\sin 60+\sin 90+\sin 120+\sin 150+\sin 180\right]\right\}\\ &\cong \frac{1}{6}\left\{100\times 9.81\times 2.5\times\left[3.732\right]\right\}\cong \frac{9152.9}{6}\cong 1525.5\text{ N-m}\end{aligned}\right\} \quad (1)$$

Thus, for the 6 successive buckets, total torque can be expressed with,

$$\left(\tau_{gw}\right)_{600\text{ kg}} \cong 6\times\left(\tau_{gw}\right)_{100\text{kg}} \cong 6\times\left(\frac{9152.9}{6}\right)\cong 9152.9\text{ N-m} \quad (2)$$

Mass of the giant steel wheel can be approximated with,

$$\left.\begin{aligned}M_{gw} &\cong \text{Steel density}\times\text{gaint wheel volume}\\ &\cong 7700\text{ kg.m}^{-3}\times\pi\left(2.5\right)^2\times 0.05\text{ m}\\ &\cong 7700\text{ kg.m}^{-3}\times 2.945\text{ m}^3\cong 7560\text{ kg}\end{aligned}\right\} \quad (3)$$

Let us fix the total mass of giant wheel and all of its fitting accessories = 8000 kg.
Moment of inertia of the giant wheel unit can be approximated with,

$$I_{gw}\cong\frac{1}{2}\times 8000\times\left(2.5\right)^2\cong 25000\text{ kg.m}^2 \quad (4)$$

If so, angular velocity of the giant wheel can be approximated with,

$$\tau_{gw}\cong I_{gw}\omega_{gw} \quad (5)$$

$$\omega_{gw}\cong\frac{\tau_{gw}}{I_{gw}}\cong\frac{9153\text{ N-m}}{25000\text{ kg.m}^2}\cong 0.37\text{ rad.sec}^{-1} \quad (6)$$

Power given to the giant wheel can be approximated with,

$$P_{gw}\cong\tau_{gw}\omega_{gw}\cong 3351\text{ watt}\cong 3.35\text{ kW} \quad (7)$$

It may be noted that, our method is related with giant wheel's rest position. During operation, as the giant wheel is in rotation, and steel balls are falling on the top most bucket, potential energy of 6 consecutive buckets having 100 kg mass each and falling from a height of 4.67 meters from the ground can have significant effect in increasing the torque and power further. It needs a review.

It is planned to arrange a girth gear round the giant steel wheel. Generator's pinion is made to mesh with this girth gear to get the electric power. Considering 750 teeth on the girth gear and 25 teeth on the generator's pinion, RPM of the generator can be approximated with,

$$\left.\begin{aligned}RPM_{gen} &\cong\left(\frac{750}{25}\right)\times\text{Giant wheel RPM}\\ &\cong\left(\frac{75}{25}\right)\times\left[\left(\frac{0.37}{2\pi}\right)60\right]\cong\left(\frac{750}{25}\right)\times 3.53\cong 25\times 3.53\cong 88\text{ RPM}\end{aligned}\right\} \quad (8)$$

Thus, it is planned to select a Low RPM generator that can produce 5 kVA. It may be noted that, torque required to run a 5 kVA generator having 300 RPM is 5000/31.4=159 N-m. Compared to this value, torque available at the giant wheel is estimated to be 9000 N-m and is 56 times higher than the requirement. Hence, a generator having (300 to 500) RPM can be selected with a suitable step-up gear box at the giant wheel girth gear. Proceeding further, part of the giant wheel's torque can be transferred to the steel ball lifting belt drive. If (1.5 to 2.0) kW is taken from the giant wheel for

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running steel ball belt drive, COP is around 5/2 =2.5. It's a very big value and is having its immense role in generating endless electric power, and green hydrogen and green oxygen.

It may also be noted that, by replacing giant steel wheels with other low-density metals or strong wood for increased angular velocity and power and replacing steel balls with Tungsten like heavy metals [15,16] for easy handling of balls, power outputs and COPs can be increased to higher levels with a possible compactness in the design. It may also be noted that, lower moment of inertia may step down the expected power.

4. Advantages and Various Applications

Advantage of this process is that, after a small starting push, the assumed giant wheel is allowed to run continuously in the presence of gravity without any aid of external power. Alternator's electric power output can be used directly at various places like residential apartments, commercial buildings, near to crop fields, villages, sub-urban, urban areas and seashores. As per the increasing demand of power storage, batteries of the newly coming electric vehicles can also be charged with this electric power at bus depots and petrol pump like places. Proceeding further, in view of global warming and severe air pollution caused by CO2, SOx and NOx gasses, increasing scarcity and increasing cost of fossil fuels, high risk involved nuclear fission power and nuclear waste, and increasing demand of green hydrogen, alternator's electric output can be utilized for generating green hydrogen and green oxygen by means of electrolysis [17–19]. By fixing such kind of giant wheels across Kasmir to Kanyakumari, tons of green hydrogen and green oxygen can be generated. Rikshawala like poor people, having no fixed daily earnings and no bread butter [20] can be given suitable jobs in running and maintaining these giant wheels on permanent basis.

As a special case, major agriculture water pumping motors can be allowed to run with this kind of gravi-electric power. By arranging such giant wheels at the seashores, desalinating plants (salt water treatment) [19] can be operated continuously and water treatment cost can be reduced and treated water can be used for electrolysis, harvesting in wastelands, abandoned lands and deserts.

5. Difficulties Involved

Even though it seems highly attractive, construction and installation point of view, some difficulties are involved in this model. High initial cost seems to be one important drawback. It can be compensated with near future enormous nature friendly gravi-power. Like wind turbines [21–23], very high risk is involved in making, transporting, lifting and managing large steel rings having 5 meter diameter. This risk can be eliminated to some extent by making giant steels with specially designed steel ingots. Natural calamities like cyclones, heavy winds, earthquakes and floods may destroy these high-budget giant wheels. Having strong underground foundations instead of ground level foundations and constructing multi-store buildings one either side of the giant wheel may help in reducing the risk.

6. Scope and Near Future Benefits

It's very interesting to note that,

1) Gravity can be considered as a major power source of near future.
2) In a phased manner green hydrogen cost can be reduced to lower levels [24–26].
3) Most of the internal combustion engines can be modified to run on hydrogen gas.
4) Village and sub-urban area power requirements can be fulfilled with gravi-power.
5) Agriculture filed can have a good progress in view of increased power demand.
6) Unit cost of electric power can be reduced to lower levels.
7) Small scale industries can be encouraged to use gravi-power.
8) Poor people can have permanent employment.

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7. Discussion

It may be noted that,

1) It may be noted that, the basic aim of the paper is to produce green hydrogen and green oxygen and hence we sincerely appeal the engineers and scientists to consider this model.
2) A lot of advanced research is going on developing the efficiency of water electrolysis and related techniques [27,28]. It will certainly help in developing the efficiency of our model.
3) Even though initial costs are very high, as it is a 'one time' investment process and gravity is a free power source, we sincerely appeal the science and engineering communities to review and correct our rough calculations for its workability. It may also be noted that, unlike solar power, wind power and tidal power, gravity power is available everywhere and round the clock.
4) For any new technology, in its budding stage, due to lack awareness or confidence or belief, lack of appropriate technical solutions or due to lack of funding, it may take some time to have a good progress. Here it is worth to note that, 1960s computer is quite different from the current computer.
5) Our assumed giant wheel is having an estimated rotating speed of 0.925 m/sec and bucket separation distance is 1.3 meter. Thus, for every second, at the top of the giant wheel, one bucket to be loaded with 4 steel balls and at the bottom of the giant wheel, one bucket to be emptied by detaching 4 steel balls. It seems essential to shift 4 balls for every second to the hopper. In that case, COP is coming down. As the torque produced is very high on the giant wheel, steel ball belt lifter power can be taken from the giant wheel to some extent. It needs a review.
6) To maintain high COP and to shift the steel balls to the hopper, it seems better to maintain ample number of steel balls in the hopper. Human help can be taken in the form of causal labors along with simple leverage mechanisms like winches to speed up the shifting process and to reduce the workload on the causal labors. In this way, employment can be given to poor people on permanent basis. It may help in increasing and maintaining poor people's economy across India with required bread and butter while producing the most wanted green current and green hydrogen.
7) Like the process of constructing a bridge with onsite precast concrete moulds, to manufacture the giant wheels, it is planned to consider steel ingots with special changes like ingot holes for binding top and bottom ingots with rods, dovetail joints at their ends to couple them in such a way to bind other ingots on either side of its ends. This method can be used efficiently in fabricating the giant wheels at the site itself and activities like casting, transporting and erecting the massive giant wheel can be eliminated to some extent.
8) To some extent, casting point of view, cost point view and weight point of view, giant steel wheels can be replaced with ductile iron.
9) While installing the giant wheel, basement and foundation process should consider the vibrations caused by the steel balls while entering the giant wheel buckets.
10) Our model can be reviewed and recommended for designing a prototype for understanding various advantages and disadvantages.

8. Socioeconomic Impact and Operational Advantages of the Giant Wheel–Steel Ball Model

Our proposed model represents an innovative convergence of mechanical engineering and social welfare objectives. By continuously cycling steel balls to a height of five meters through manual labor, lever mechanisms, or animal-driven inclined planes such as bullock carts, the system harnesses gravitational potential energy to generate round-the-clock green electricity. This energy, in turn, is utilized to produce green hydrogen and oxygen via electrolysis.

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8.1. Key Strengths and Societal Impact:

1) Job Creation: The deliberate design requiring human or animal assistance for lifting steel balls provides permanent employment opportunities for local and rural communities. This not only generates income for economically disadvantaged populations but also positions the technology as both a renewable energy solution and a meaningful tool for social upliftment.
2) Universal Feasibility: The modular and horizontally scalable design ensures that these units can be deployed nationwide, independent of varying solar or wind resource availability, since gravity is an omnipresent and reliable energy source.
3) Integration of Traditional Technologies: By incorporating straightforward lever mechanisms and conventional animal-powered carts for ball lifting, the model lowers technological barriers inherent to sophisticated renewable systems, facilitating ease of maintenance, operation, and adoption within resource-constrained and remote environments.
4) Continuous, Weather-Independent Operation: Unlike solar or wind power, this gravity-based system can operate uninterrupted, enabling reliable and consistent hydrogen and oxygen production regardless of climate or daylight conditions.

8.2. Considerations for Further Optimization:

1) Comprehensive Energy Accounting: It is crucial to rigorously quantify the energy input required to lift the steel balls—whether supplied manually, by animals, or via mechanical means—in line with conservation of energy principles. This input must be incorporated into the overall system efficiency and net green energy output assessments.
2) Balancing Employment and Efficiency: While maximizing energy efficiency is traditionally prioritized in renewable technologies, our model intentionally emphasizes employment generation as a core objective. Clearly articulating this dual-purpose philosophy will aid in communicating the model's unique value proposition to technical stakeholders, policymakers, and potential funders.
3) Scaling Up Nationwide: A widespread deployment of these units could establish a network of micro-scale, decentralized power stations contributing significantly to green hydrogen and oxygen production as well as rural economic development. Coordinated logistics for ball management, system maintenance, and adaptation to diverse climatic conditions will be essential for successful nationwide implementation.
4) Demonstration via Pilots: Developing working prototypes, particularly those operated entirely by manual or animal-powered lifting, will provide valuable empirical data on technical feasibility, employment generation, and operational sustainability. Pilot projects will be instrumental in refining the design and showcasing its socioeconomic impacts.

Thus, our model presents a visionary, integrative solution that fuses renewable mechanical energy generation with social empowerment objectives. By harvesting gravitational energy through accessible lifting methods and steel ball circulation, it promises not only continuous green electricity and valuable hydrogen/oxygen production but also the creation of sustainable livelihoods across India. This fusion of technology and social design enhances the relevance and transformative potential of our proposal.

To advance this work, further clarification and optimization of energy input accounting, logistical frameworks for deployment, and thorough emphasis on social benefits will be critical. Our idea holds significant promise to inspire both technological innovation and inclusive economic growth.

9. Conclusions

In this work, we have proposed an innovative theoretical model for sustainable green energy generation, harnessing the natural force of gravity through a giant steel wheel system operated by steel balls. This gravity-powered mechanism converts gravitational potential energy into continuous

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green electric power, which is subsequently utilized to produce green hydrogen and oxygen via water electrolysis. The model's estimated coefficient of performance (COP) of approximately 2.5 is promising but requires rigorous experimental validation and critical review to confirm its real-world feasibility.

The high torque generated by the giant steel wheel underlines the mechanical robustness of the system, indicating substantial potential for scalable, uninterrupted power generation. Moreover, the integration of manual and simple mechanical ball-lifting methods not only contributes to system sustainability but also opens significant avenues for decentralized employment, especially in rural and economically challenged regions.

To advance this concept from theoretical design to practical application, further comprehensive research is essential. This includes development and testing of compact prototypes to empirically verify power output, COP, mechanical losses, and operational stability under real-world conditions. Exploration of alternative materials with higher density or superior mechanical properties, such as tungsten balls or lightweight composite wheels, could further enhance power density and system efficiency.

Additionally, integrating state-of-the-art electrolysis technologies will be critical to maximize hydrogen and oxygen yield per unit of electrical energy produced, ensuring economic viability and environmental sustainability. Evaluating long-term operational durability, maintenance requirements, and lifecycle costs must be integral parts of future studies.

Finally, securing dedicated funding and initiating trial runs or pilot projects will be vital steps in demonstrating the practicality and social benefits of this model at scale. Such efforts will pave the way for deploying gravity-driven renewable energy systems capable of meeting India's growing hydrogen demand while simultaneously fostering inclusive economic development through permanent, sustainable employment opportunities.

In summary, the giant steel wheel and steel ball gravity model presents a compelling, multifaceted solution to the pressing challenges of clean energy production and rural socio-economic upliftment. With focused research, development, and policy support, this novel approach could become a transformative contributor to the future green hydrogen economy.

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