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Eco-Energy: Design of Green Gym Equipment

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Abstract

The fitness services market expands each year due to people's awareness of physical health. Through the introduction of sustainable training gym equipment, the research aims to transfer the fitness industry into sustainable power generation system. By lowering carbon emissions, gyms will not only lessen their reliance on traditional energy sources but also protect environment. Furthermore, by encouraging a culture of sustainability and innovation within the fitness community, this initiative encourages a wider adoption of environmentally friendly practices. This research paper includes the design-phase work for the equipment and measurements of the power harvesting. Finally, an overview of some gym equipment that could be modified to harvest energy as a step to create an environment friendly gym where all the needed energy is produced from the gym equipment is presented. It is found that for average use of a gym equipment a power 100 - 500 Watt can be produced.

Keywords

Sustainability, Renewable Energy, Power, Cost of Energy

1. Introduction

Sustainable and eco-friendly gym equipment is becoming increasingly popular as more people become aware of the environmental impact of traditional gym equipment [1].

It is more important than ever to consider how energy use and environmental impact interact in the modern goal of sustainable living. Fitness centers are important places where this balance is frequently neglected. Gyms are known for using a lot of energy for everything from lighting to powering exercise equipment [2]. But what if the energy used for exercise could be utilized to encourage energy conservation and environmental preservation? The development of eco-friendly training gym equipment that not only improves fitness experiences but also

produces energy for sustainable operations within the gym ecosystem is the innovative idea behind the project.

This project proposes a new technique which incorporates an alternator into the operation of the bicep curl machine. Users' rhythmic motion during exercise powers the alternator, which transforms mechanical energy into electrical power. Closing the energy loop within the fitness ecosystem, this extra electricity can then be fed back into the gym's grid or stored for later use to power lights, music systems, or other equipment.

The report content offers information about different methods and gym devices that are used for generating renewable energy. The documents related to the designing phase of this project such as the responsibility matrix, work break-down structure, Gantt chart and risk assessments are added to this report. This report technical work consists of all design work done related to designing the model, placement of the generator, design specifications of the pulleys, calculating the power generated while exercising.

1.1. Objectives and Scope

- Research: A thorough research and investigation have been conducted regarding sustainable gym equipment and its benefits.
- Energy Harvesting: Developing the mechanism to capture and convert kinetic energy from bicep curl machine into usable electrical power with the help of appropriate calculations.

1.2. Energy Producing Gym

With the need for energy is exponentially increasing day by day, it is a necessity to generate new ideas and techniques to generate energy in a compact area, be it a gymnasium building or a home. People apply forces in the exercise machines while working out at the gymnasium. The authors of this published work offer a theoretical method that could enable energy harvesting from certain exercise equipment. The main goal of the research is to convert mechanical energy from gym equipment into electrical energy as shown in **Figure 1**. Low revolution per minute (RPM) generators can be added to the gym's equipment for this reason [3].

The grip of the recoil cord will be fixed to the gymnasium machine, and the rotor movement mechanism will be fastened to the generator shaft. The generator's recoil cord winds and unwinds on the shaft every time the gym machine is turned on. The restoring force of spring causes the cord to wind back up when it is relaxed. The generator's armature only rotates in a clockwise or anticlockwise direction [3].

In a push-pull manner, the motor gets rotated when a member pulls and utilizes the machine while working out. The electromotive energy is generated in the output of the motor because of the push-pull movement caused by the member working out using the machine, this energy generated are all carefully rectified in the

controller circuit/rectifier and is finally processed to get stored in the battery for charging [4].

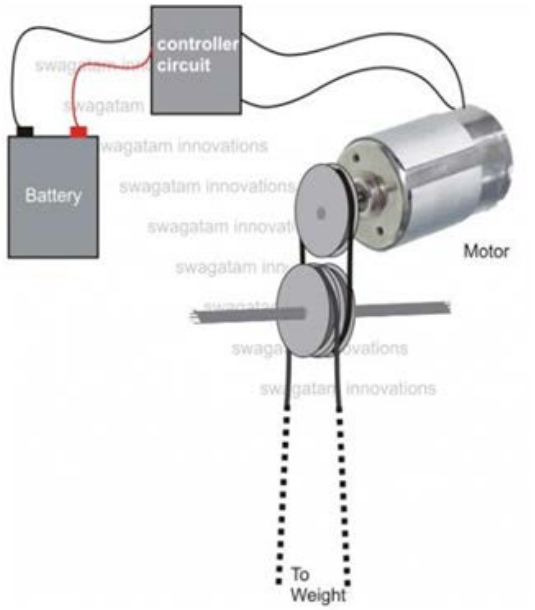


Figure 1. Conversion of human energy into electrical energy [3].

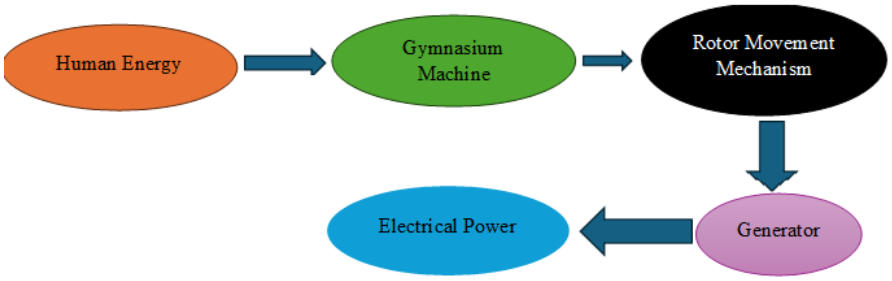


Figure 2. Working Schematic Diagram [4].

The rotation ratio is enhanced when the pulley of the motor is comparatively smaller in size than the machine pulley. Due to this rotation ratio, the maximum number of rotations above the pulley of the motor aids in generating the required optimal power from the motor [4] as presented in **Figure 2**. When the pulley rotates in both clockwise and counterclockwise directions, the electrical voltage and current will alternate. To charge the D.C. batteries, a rectifier is required [3].

In other machines, A low revolution per minute (RPM) generator is placed in the basement of the machine which helps in converting the butterfly machine into an energy-generating machine [3]. This produced voltage can be kept in a battery to be used for regular tasks like lighting the lights [5]. An example of power generation is an elliptical trainer that is used consistently for two days can generate one kilowatt hour, or 1000 watts of power in an hour, according to another ReRev statistic [6].

Eco-friendly businesses modify cardio equipment to redirect the energy released

as a heat-related byproduct. Energy is sent to a central processing unit that transforms human power into utility-grade electricity, rather than the equipment boosting interior temperatures and making air conditioners work harder (during the heat) [7]. Using a V-belt, the generator and roller Flywheel are connected to produce electricity through human labor. One can charge a battery or use the electricity produced during exercise for any other purpose [8]. The stored energy can be used to run electric appliances [9]. The electrical infrastructure at Lasell Gym would need to support roughly 600 persons using these kinds of machines during peak hours due to the facility's 60 kW.

It should be mentioned here the prices of high-quality spin bikes varies from $1000 to $4000 based on features and construction [10]. In comparison of such devices with solar and wind, which need construction, money, and property, this is an advantage. But because human power is limited, the power produced by exercise equipment cannot be compared to other renewable sources [5]. However, the following are the limitations on gym equipment that generates power [11]:

- Power generation is reduced to approximately 30 - 40 W.
- Intermittent power generation.
- There are more mechanical moving parts.

2. Model Derivation

The machine chosen for calculation is ES810 [12]. The given height of the weight stack is 1.468 m, the perpendicular height for the calculation is assumed 40% of it that is, h = 0.6 m.

Total energy produced can be calculated as:

$$E = PE + KE \tag{1}$$

where:

E is the total energy (J)

PE is the potential energy (J)

KE is the kinetic energy (J)

Potential Energy:

$$PE = m * g * h \tag{2}$$

where:

PE is the potential energy (J)

m is the mass (kg)

g is the acceleration due to gravity (9.81 m/s^2)

h is the height (m)

Assuming the initial weight lifted by the trainer is 10 kg,

$$PE = 10 * 9.81 * 0.6$$

$$PE = 58.86\ J$$

Most people use a standard tempo when they do curls on a bicep and triceps curl machine. This involves spending 2 seconds for the concentric or upward portion and 2 seconds for the eccentric or downward phase of the curl. So, on average,

a single repetition would take about 4 seconds. Based on that, the perpendicular linear velocity is [13]:

$$v = d/t \tag{3}$$

where:

v is the velocity (m/s)

d is the distance (m)

t is the time (s)

$v = 0.3\ m/s$

Kinetic Energy [14]:

$$KE = 0.5\ mv^2 \tag{4}$$

$$KE = 0.45\ J$$

Which means that the total energy produced per single repetition is:

$$E = 58.86 + 0.45 = 59.31\ J$$

If the trainer repeats the repetition for 10 times, which means that the total energy produced per training set is:

$$E = 59.31 * 10 = 593.1\ J$$

Power is the amount of energy divided by the time it took to use the energy [15] [16]. For 10 reps total time taken is $10 * 4 = 40\ seconds$.

$$P = W/t \tag{5}$$

where:

P is power (W)

W is the work done (J)

t is the time (s)

$$P = 14.83\ W$$

The angular velocity can be calculated using [15]:

$$\omega = v/r \tag{6}$$

where:

ω is the angular velocity (rad/s)

v is the velocity (m/s)

r is the radius (m)

$\omega = 12\ rad/s$

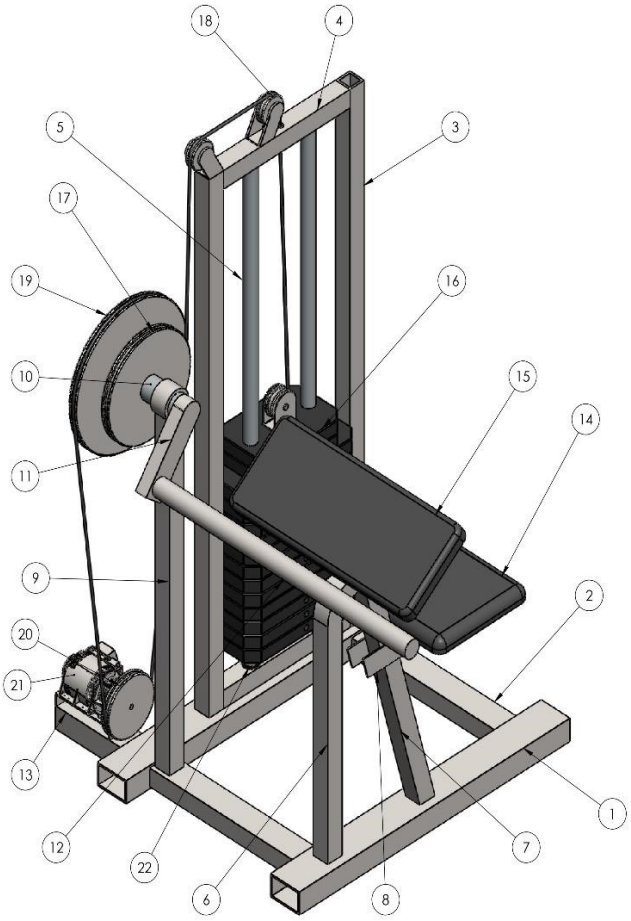
The results of the power generated is displayed on a screen, where the electrical and electronic work are conducted and programmed using ARDUINO. **Figure 3** shows the electronic work and display where helped in the energy monitoring in the modified gym equipment shown in **Figures 4-6**.

Lastly, Gym green energy is considered safer than other renewable energy sources [17] [18] that deal with hazardous substances as an example [19] [20] where polychlorinated biphenyl and halogenated wastes [21] are incinerated in rotary kilns as a source of energy.

Figure 3. Electronic Circuit to display the value of power generation.

3. Model Sketch—Design

The following sketches represent the design and components of the selected training machine



S. No.	Component Name	Description	QTY
1	Curl Machine Frame (Base)	Steel ASTM A36, Rectangular Hollow, L=80mm, W=50mm, Th=4mm, H=750mm	2
2	Curl Machine Frame (Base x-axis)	Steel ASTM A36, Rectangular Hollow, L=80mm, W=50mm, Th=4mm	2
3	Weight Stack Frame (Column)	Steel ASTM A36, Square Hollow, S=40mm, Th=5mm, L=1160mm	2
4	Weight Stack Frame (Top/Bottom)	Steel ASTM A36, Square Hollow, S=40mm, Th=5mm, L=350mm	2
5	Weight Stack Slider	Stainless Steel grade 304, Round Bar, D=30mm, L=1080mm	2
6	Arm Rest Support (Column 1)	Steel ASTM A36, Square Hollow, S=40mm, Th=5mm, L=504.27mm	1
7	Arm Rest Support (Column 2)	Steel ASTM A36, Square Hollow, S=40mm, Th=5mm, L=727.25mm	1
8	Seat Support	Steel ASTM A36, Square Hollow, S=46mm, Th=3mm, L=352mm	1
9	Cam Holder	Steel ASTM A36, Square Hollow, S=40mm, Th=5mm, L=764mm	1
10	Cam Rod	Stainless Steel grade 304, Round Bar, D=50mm, L=153mm	1
11	Handle Bar Lever	Steel ASTM A36, Rectangular Hollow, L=50mm, W=30mm, Th=4mm, H=170mm	1
12	Handle Bar	ASTM A36, Round Bar, D=30mm, L=700mm	1
13	Generator Holder	Steel ASTM A36, Square Hollow, S=50mm, Th=5mm, L=180mm	1
14	Seat	Padded Cushioned Seat	1
15	Arm Rest	Padded Cushioned Arm Rest	1
16	Weight Stack	Cast Iron Weight Stack	14
17	Curl Machine Pulley (Large)	Steel cable pulley, D=240mm, W=38mm	1
18	Curl Machine Pulley (Small)	Steel cable pulley, D=50mm, W=19mm	3
19	Generator Pulley (Large)	Steel belt pulley, D=300mm, W=20mm	1
20	Generator Pulley (Small)	Steel belt pulley, D=120mm, W=20mm	1
21	Generator	3 Phase power generator, maximum power = 240 W	1
22	Weight Support	Steel ASTM A36, Cylinder, D in=30mm, D out=36mm, W=5mm	2

Figure 4. 3D CAD drawing of the fabricated device.

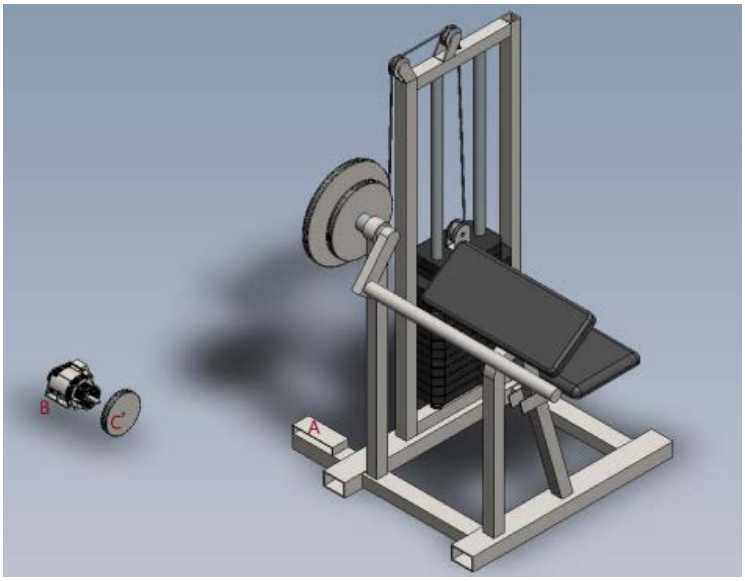


Figure 5. Solid works drawing of the fabricated device.

Figure 6. GYM machine that is modified to produce power.

4. Results and Discussion

The operation phase of the model showed that power generation is possible. A power of 120 Watt is generated. The amount of generated power depends on the applied weight, speed of rotation, and the working distance. People of different

physical situations can produce certain amount of power depending on the time of operation. The generated power is stored in a battery to be used later in different applications such as lighting and operating small electrical appliances.

The size of the training machine is also a factor that affects the power generated. Applying the energy harvesting device is possible on any Gym machine, the amount of power harvested depends on the factors mentioned above. The power harvested could be used to operate the same machine or for another applications. Applying energy harvesting system on all Gym devices and machines helps in establishing a sustainable and ecofriendly Gym. The techniques used can encourage customers in the GYM to practice more by providing them with a chance to get certain stuff by selling energy to the GYM to secure extra points or to run some vending machines and get free stuff out of them. equipment is possible; however, design parameters and mechanism are different and needs special.

Finally, the implementation phase has a lot of preparations and modifications that have been made to the machine to achieve the goal of allowing it to generate energy from the movement of the pullies (the selected mechanism). There were many challenges faced during the manufacturing of the machine. The machine was very heavy, which made transporting it to one place to another a very challenging task to do and could not use the welding booths to weld the components that hold heavy loads like pullies. This required the use of alternative methods of attaching the pulley of the generator to the frame of the machine. These alternatives were by trying to fix the pulley to the frame using bolts as well as three types of strong glues. However, since the generator's pulley is made of plastic, it broke during testing because it could not withstand the applied forces. Also, pullies that are made of steel were not available in the local market and required to be custom made which took an extended time which could not be managed.

On the other hand, the Arduino controlling unit was programmed and wired to achieve the goal of reading and managing the power generated by the motor. Testing of the generator while it was not attached to the machine showed that the electrical drive system was properly functional. The generator was generating energy when it was turned and transporting the reading to the LCD connected to the Arduino.

5. Conclusions

Information about different methods and gym devices that are used for generating renewable energy had been presented in this report for the sake of preparation for designing the biceps curl machine model. The calculations, modeling process, project management documents were presented in this report. The calculations concluded that generator selected to be connected to the biceps curl machine will be able to produce 140W per hour of exercising. Risk assessments for the designing, implementing and operating phases for the project had been presented too along with the designing phase responsibility matrix, work break-down structure and Gantt chart. The manufacturing phase of the machine was also covered in this

report including the assembly instructions of the device.

Less effort or investment is needed to use this renewable source because the gym already has many exercise machines that are in use all time. To ensure that the gym has enough extra electric circuits to handle all of the newly generated electricity, all that is required is a professional electrician. Compared to solar and wind, which need construction, money, and property, this is an advantage. But because human power is limited, the power produced by exercise equipment cannot be compared to other renewable sources, however, it can be used to run vending machines and provide lighting for gym facilities.

The idea of applying energy harvesting systems to gym machines can be expanded to involve all gym machines and form what so called green gym. This research shows the ability to redesign the machines to generate power that can be utilized latter to save energy. Other gym machines that the literature shows their ability to be redesigned to produce power involve small and big machines such as lat pull down machine, Butter-fly machine, Leg-Extension Machine, Stationary Bike, elliptic machines, Treadmill, and Biceps and Triceps Curl Machine.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Patil, R., *et al.* (2023) Eco-Friendly Electricity Generation via Gym Equipment. *European Chemical Bulletin*, **12**, 685-697.

[2] World Economic Forum (2018) This Gym Gets Its Power from Your Workout. https://www.weforum.org/stories/

[3] Musharraf, M., *et al.* (2018) Energy Generating Gymnasiums Machines for Renewable, Sustainable and Green Energy. *International Research Journal of Engineering and Technology*, **5**, 153-160.

[4] Swagatam (2013) Generate Electricity from your Gym Workout—Homemade Circuit Projects.

[5] Globalspec (2020) Power Sweat: Electricity from Gym Equipment. GlobalSpec. https://insights.globalspec.com/article/14389/power-sweatelectricity-from-gym-equipment

[6] Dodge, J. (2010) Reaping Electricity from Gym Machines. https://www.zdnet.com/article/reaping-electricity-from-gym-machines/

[7] Sustainability (2024) Elliptical Trainers Generate Electricity. https://sustainability.williams.edu/news-events/elliptical-trainersgenerateelectriity

[8] Ali, S., *et al.* (2016) Design of Manual Treadmill with Electricity Generator for Energy

Saving. *International Journal of Research in Engineering and Applied Sciences*, **5**, 1-15.

[9] Tukas, E.V. (2024) TukasEV. https://www.tukasev.com/en/

[10] World Fitness (2023) Spin Bikes. https://worldfitness.com.au/

[11] Ansari, *et al.* (2024) Power Generation through Gym Equipment. *IOSR Journal of Engineering* (*IOSR JEN*), 40-45. https://iosrjen.org/Papers/Conf.19050-2019/Volume-6/MECHANICAL/11.%2040-45.pdf

[12] Freemotion Fitness (2021) BICEPS CURL|Strength Gym Equipment. https://freemotionfitness.com/strength-machine/biceps-curl/

[13] Lambda Geeks (2023) Velocity Formula: Unleashing the Power of Speed. https://lambdageeks.com/velocity-formula/

[14] Testbook (2023) Power Formula: Definition, Formula, Solved Examples, and FAQs. https://testbook.com/physics-formulas/power-formula

[15] Mathematics LibreTexts (2017) Velocity and Angular Velocity. https://math.libretexts.org/Bookshelves/A_The_Trigonometric_Functions/Velocity_and_Angular_Velocity

[16] Physicsclassroom (2023) Potential Energy. https://www.physicsclassroom.com/class/energy/Lesson-1/Potential-Energy

[17] Bani Hani, E. (2017) Recent Applications of Biomass Wastes in Industry for Environmental Sustainability. *Journal of Industrial Pollution Control*, **33**, 1622-1626.

[18] Ayoub, H. and Bani Hani, E. (2020) Performance and Cost Analysis of Energy Production from Offshore Wind Turbines. *Energy Engineering*, **117**, 41-47.

[19] Bani-Hani, E. and El Haj Assad, M.M. (2018) Halogenated Wastes Safe Disposal: Polychlorinated Biphenyls. *International Journal of Petrochemistry and Research*, **1**, 76-78. https://doi.org/10.18689/ijpr-1000113

[20] Bani-Hani, E.H., Hammad, M., Matar, A., Sedaghat, A. and Khanafer, K. (2015) Analysis of Polychlorinated Biphenyl Wastes Incineration in Rotary Kilns: Model Development and Validation. *International Journal of Mechanical Systems Engineering*, **1**, Article No. 103. https://doi.org/10.15344/2455-7412/2015/103

[21] Bani-Hani, E.H., Hammad, M., Matar, A., Sedaghat, A. and Khanafer, K. (2016) Numerical Analysis of the Incineration of Polychlorinated Biphenyl Wastes in Rotary Kilns. *Journal of Environmental Chemical Engineering*, **4**, 624-632. https://doi.org/10.1016/j.jece.2015.12.006

Nomenclature

m	Mass
g	Acceleration due to gravity
v	Velocity
d	Distance
t	Time
P	Power
W	Work done
ω	Angular velocity
r	Radius
N	Rotational speed in revolution per minute
D	Diameter
W	Watts
m	Meters
J	Joles
kg	Kilograms
s	Seconds

Acronyms

2D	Two-dimensional
3D	Three-dimensional
AC	Alternating current
BoQ	Bill of Quantity
CAD	Computer Aided Design
DC	Direct Current
EGGM	Energy-generating gymnasium machine
LCD	Liquid-crystal display
MPH	Miles per hour
RPM	Revolution per minute