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Investigation of a Cow Urine-Based Power Generation Technology model for a Cost-Effective and Sustainable Energy Source

Md Wahidul Hasan[1], Khang Huynh[2], Tazkia Hassan Soha[3], Jamshedul Alam Md Rubayet[4], and Sefatul Wasi[3]

[1]Department of Mechanical Engineering, South Dakota School of Mines and Technology, Rapid City, South Dakota, USA

[2]Department of Chemical and Biological Engineering, South Dakota School of Mines and Technology, Rapid City, South Dakota, USA

[3]Agency Lab, Independent University, Dhaka, Bangladesh

[4]Bangladesh Bank, Dhaka, Bangladesh

ABSTRACT: The energy issue has two aspects: fossil fuels are depleting more quickly than ever before, while energy consumption is rising rapidly. Conventional sources like coal, oil, and natural gas used to satisfy the demand, while solar and wind energy are becoming more and more popular. Energy stored in biomass contributes to the production of renewable electricity and heat. Bio-energy can be a pivotal sustainable renewable energy option that can tackle numerous stumbling blocks in the energy section and contribute to developing rural areas with sustainable solutions. We have studied in case of the rural and undeveloped areas of Bangladesh for this research which can also be implied in the case of rural areas of other underdeveloped countries. Cow urine has been proposed to help meet some energy demand, especially in rural communities. This resource, abundant in rural cow farming, is generally considered waste and could be utilized to generate a substantial amount of electricity. Cow urine is an alkaline solution and serves as a source of electrolytes in the power cell. From urine collection to production, the whole model has been evaluated through Life Cycle Analysis (LCA) process to check the system feasibility. This article describes numerous surveys to find the different aspects and demand ratios of using inexpensive electricity from an end-user point of view. The proposed project works on an elementary basis of chemical reactions and, in turn, generates current flow. The main configuration uses an anode, cathode, alkaline electrolyte (fresh urine), and a connecting wire; the imbalance of the electron makes it possible for the current to start flowing to neutralize the imbalance. In this article, we propose a community-based tri-faceted community currency system with the aim that exchange held within the local economy results in additional economic benefits for that locality and promotes other green projects. Therefore, a hybrid approach of solar power, cow urine-based power, and IoT-based distribution systems are proposed, which will offer a significant advantage in renewable energy research and solve the scarcity of electricity to a greater extent. This proposed system will draw a line to meet the SDG 2030 goals.

KEYWORDS: Urine; Battery Storage; Off-grid electrification; Chemical Modeling; Internet of Things; LCA; CO_2 emissions; Renewable Energy.

1 INTRODUCTION

Around 65% of carbon emissions are caused by fossil fuel usage, and 25% of greenhouse gases are produced due to electricity generation and heating processes. Since 1900, the world's carbon emissions from fossil fuels have considerably risen. Nearly 80% of the entire increase in greenhouse gas emissions between 1970 and 2011 was caused by emissions from the burning of fossil fuels and industrial operations. Since 1970, CO_2 emissions have grown by about 90%. China accounted for 30% of global carbon dioxide (CO_2) emissions in 2014, followed by the United States (15%) and the European Union (9%) [1–3].

These statistics cover CO_2 emissions from cement production, gas flaring, and the burning of fossil fuels. It is well-known that the excess use of fossil fuel to generate electricity is a problem for the earth's environment. Although it can take million of years for biomass to get converted to fossil fuel, the current excessive usage greatly depleted this natural resource.

Crude oil reserves are expected to be eroding at a pace of 4 billion tons per year; if this trend continues without adjusting for our population growth or goals, our known oil reserves will last until 2052. By 2060, all of our oil reserves will be gone, and by 2088, all of our coal supplies will be used up [3,4]. Overusing fossil fuels to generate electricity is problematic as the resource is finite and finishes quickly. That was a generalized perspective of the world. The situation is even more complicated for countries like Bangladesh. In rural and underdeveloped areas, people live where there is no proper electrified society or cannot connect due to insufficient money; however, the situation is complicated for countries like Bangladesh. Moreover, here in Bangladesh, about 65% of the population lives in the countryside, and of which many lives in remote locations and have limited or no access to electricity. Over the past few decades, the demand for energy and the global crisis for energy has increased in parallel.

Not only fossil fuel reservoirs are perishing at an exceptionally high rate, but they also cause enormous damage to the environment, such as 'Global Warming.' Therefore, meeting the ever-growing demand for energy and keeping the environment safe, finding an alternative energy source is a great challenge. However, we can efficiently utilize materials generally considered waste to generate electricity. For example, cow urine, a yellowish alkaline solution, could be a source of electrolyte for electric cells [5–8]. Though only 2.5% are electrolytes present in cow urine and 95% of the water, that amount is sufficient for generating enough power for a small firm by its urine supply [9–11]. According to a research conducted in 2016, 87% of the world population already had access to electricity. However, the electricity demand has been steadily increasing by at least 10% per year [12]. Although presently we have the generation capacity to meet the demands, a significant portion remains untapped due to deficiency of gas or coal, unreliable old powerplants, and lack of development of the electricity grid infrastructure [13]. Therefore, we need alternative sustainable and renewable sources of electricity to meet the people's demands, particularly in the rural areas of Bangladesh with a lower income bracket. About 64.96 % of the total population of Bangladesh lives in rural areas. A solvent rural family owning a pair of cows or buffaloes is a typical scenario there. The small farms have 12-15 cows on average; thus, urine generation is quite significant in scale. There are around 0.5 million dairy farms in Bangladesh, and 50 million people rely on the dairy industry for a living, both directly and indirectly. A prototype was tested using containers with 3 to 6 slots and 1/2 liter to 6 liters of cow urine to confirm the suggested procedure. The small farms have 12-15 cows on average; thus, the amount of urine generation is quite significant in scale. These farm owners can easily install this project inside their compound and have their power plant, potentially empowering the whole farm without any external power supply. Since the proposed project has a simple structure with a straightforward operation system, this project is viable to make space in people's lives.

It is widely perceived that one of the most challenging issues in the energy sector [9,14]. For green future economic growth, clean energy sources have become mandatory nowadays. Hence, what could be a better source of energy generation than cattle waste? There are approximately 0.5 million dairy farms in Bangladesh, and around 50 million people in Bangladesh, directly and indirectly, depend on the dairy business for livelihood. A prototype has been tested with 1/2 litres to 6 litres of cow urine and containers having 3 to 6 slots to validate the proposed method.

The Sustainable Development Goals, or SDGs, aim to create a more peaceful and prosperous world. The agenda of the goals focus on a wide variety of goals, including eradicating poverty and hunger and ensuring access to excellent education, gender equality, clean energy, responsible consumption, economic growth, sustainable communities, and many other goals. Seventeen sustainable development goals are intended to achieve the targets by 2030 and build a perfect world for everyone. Here we will be focusing on how our model and further developments in this type of solution can contribute to Sustainable Development Goals [15].

2 Project Genre

This is a relatively new and highly potent source of electricity. Electricity can be harnessed from bovine urine through electrolytic conductions [11]. The alkaline characteristic of uncured and unprocessed cow urine is a potent electrolyte liquid. Cow urine is an abundant resource that remains otherwise unused. The project model is distributed in several categories. Fig.1 Shows how it will work to integrate a community.

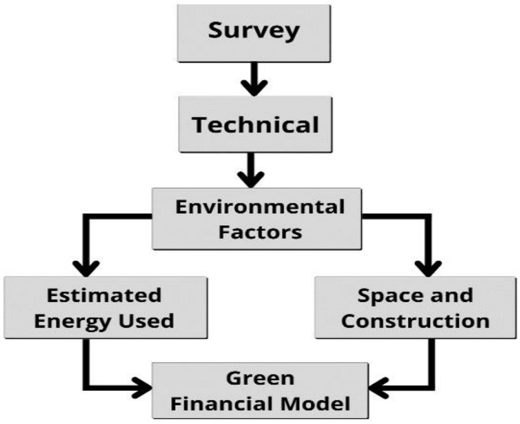

Fig. 1. Flow-Chart of the green modelling system

3 METHODOLOGY

3.1 SURVEY

A study of more than 200 people was undertaken to determine the demand for energy among those with low incomes or other disadvantages. We visited local businesses and rickshaw garages to gather information from them and ask the residents few questions about their lives, such as their names, the size of their family, whether they have a cow, what their paramount need for electricity is, and whether they have a roof over their heads to let in sunlight and so on. They also shared their issues. Some of them mentioned they paid much more, especially in the summer. Table 1 shows the primary energy demand per household, given the survey questions and a few sample answers. The data also implied that they are interested in having their own electricity facility.

Table 1. Survey questionnaire about the primary demands for electricity

For what do they need electricity mainly?	Minimum duration for which they need electricity everyday	Do they Already have an electricity?	From whom they connected the electricity line	How much do they pay for it?	Do they own cows?	Do they have a roof to exposed to sufficient sunlight?
Charge Vehicle and Basic need	20 hours	Yes	PDB	800 Tk/Month	No	No
Children's Study and Basic need	20 hours	Yes	Solar Power And PDB	700 Tk/Month	No	Yes
Basic need	16 hours	Yes	PDB	600 Tk/Month	Yes	No
Children's Study and Basic need	14 hours	Yes	PDB	500 Tk/Month	No	No
Basic need	16 hours	Yes	PDB	600 Tk/Month	No	No

3.1.1 GRAPHICAL REPRESENTATION OF SURVEY DATA

The data suggests that the people interviewed have demands or more suitably electricity needs that are not being met from the minimal access they have. They need electricity to alleviate themselves from poverty and improve their living standards. Cow urine and the solar-based hybrid system can facilitate their activities to a greater extent. The demand chart is depicted in Fig.2, while the daily load profile is listed in Table 2.

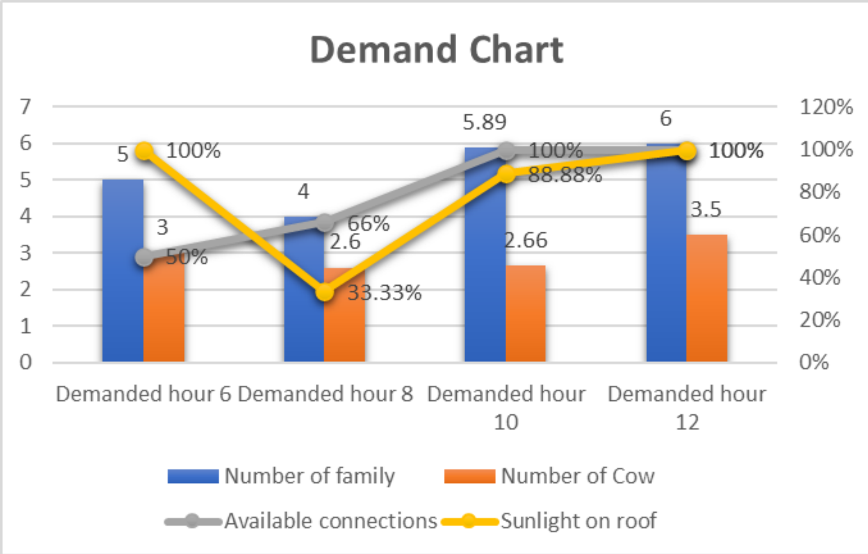

Fig. 2. Survey Data

Table 2. Daily load profile survey

Daily Load Profile					
Appliance	**Type**	**Unit**	**Watt**	**Hours of Operation**	**Appliance**
LED	DC	2	6	8	24
FAN	DC	2	20	14	20

3.2 Survey Results

According to table 1, most people use electricity 24 hrs/day. People who mainly share their rooms use less electricity (14 to 18 hrs./day) than others. A family with children needs more electricity for their children's study purposes. Other shops and tea stalls use electricity all day long. People who have many family members also use more electricity for various purposes. Rickshaw pullers are mainly used electricity at night to recharge their vehicles. The data suggests that the people interviewed have demands or more suitably electricity needs that are not being met from the minimal access they do have. They need electricity to alleviate themselves from poverty and improve their living standards.

4 Technical

4.1 Theory Of Electricity Derived From Cow Urine

This cow urine-based electricity generation technology employs the same principles of simple Voltaic Cells.

Anode reaction: $\mathrm{Zn\ (s)} \rightarrow \mathrm{Zn^{2+}\ (aq)} + 2e^-$ (1)

Cathode Reaction:

$\mathrm{Cu^{2+}\ (aq)} + 2e^- \rightarrow \mathrm{Cu\ (s)}$ (2)

Essential half reaction copper and zinc electrodes are submerged in solutions of copper (II) sulfate and zinc sulfate, respectively, since uric acid is employed as a solution and electrons can flow from zinc plate to copper plate [11]. Zinc is oxidized at the anode following the following half reaction:

$\mathrm{Zn\ (s)} \rightarrow \mathrm{Zn^{2+}\ (aq)} + 2e^-$

(Standard Potential=-0.7618V) (3)

Copper is reduced at the cathode following the following reaction:

Cu^{2+} (aq) + 2e^{-} → Cu (s)

(Standard Potential=+0.340V) (4)

The total reaction resulting:

Zn (s)+ Cu^{2+} (aq)→ Zn^{2+} (aq)+ Cu (s)

(Open-circuit voltage=1.1018V) (5)

In a typical electrolytic chamber, uric acid from cow urine reacts with the cathode (here Cu plates) that forms a copper-urate $Cu.C_5H_2N_4O_3$ complex [11]. The transfer of electrons from the anode (here Zn Plates) to the cathode through a wire creates a smooth flow of electricity.

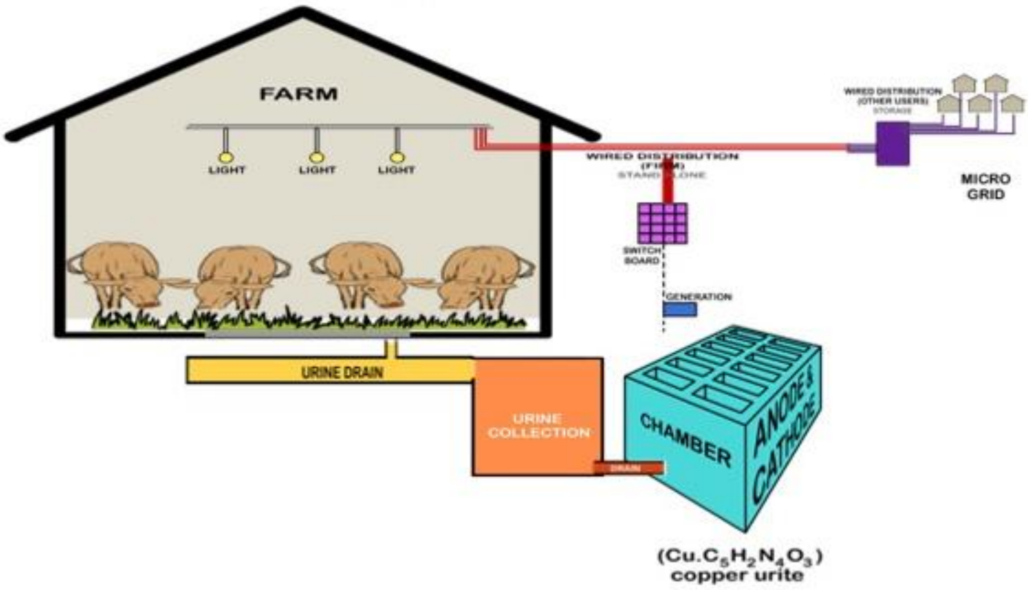

Fig. 3. Shows the process of generating electricity for distribution

4.2 IoT In Energy Monitoring

The proposed electricity generation system will also be defined as the integrated technology system to monitor demand-based energy distribution. For example, energy will be distributed by a micro-scale system so that every household in this community may get equal energy. The system will be working in the following methodology.

1. After generating electricity, it will store in a central system
2. There will be an Energy monitoring device on the plant side that will indicate how much energy has been stored in the storage
3. GSM-based wireless communication tools will be integrated with the primary control system to transfer data to the central server, which may or may not be located inside the plant area. The following flowchart shows how the monitoring system will be distributed from the main supply to the end-user

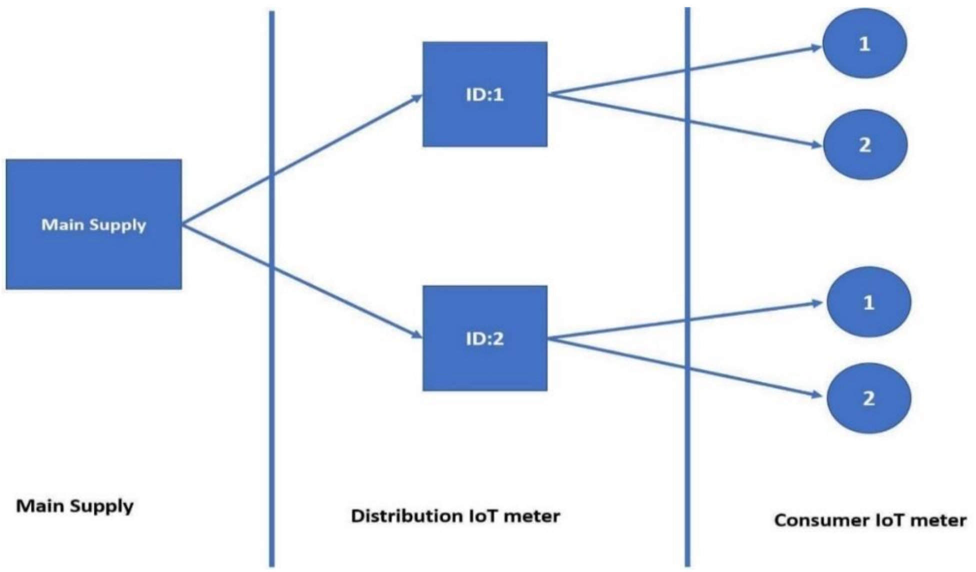

Fig. 4. Distribution Unit flow-chart

The central supply is responsible for providing the distribution meter's exact generation rating through the integration unit. This system is designed for single-unit community plants where one or two farms or households can be connected. Figure 4 shows that the distribution channels are divided into two parts, *ID: 1* and *ID: 2,* respectively. Here, ID denotes the distribution identity channel, and it has not limited to only ID: 1 or 2. It could be in more channels to facilitate more community. Distribution units are responsible for sending the data to consumer IoT meters so that individual consumers can see the exact uses. The working principle of this system is mainly run by an IoT mechanism to process and monitor the exact demand for electricity. All data (generation, distribution, and consumption) will be stored in a cloud-based central server so that systems can measure the ratio of the assigned sector. Figure 5 shows the IoT unit configuration.

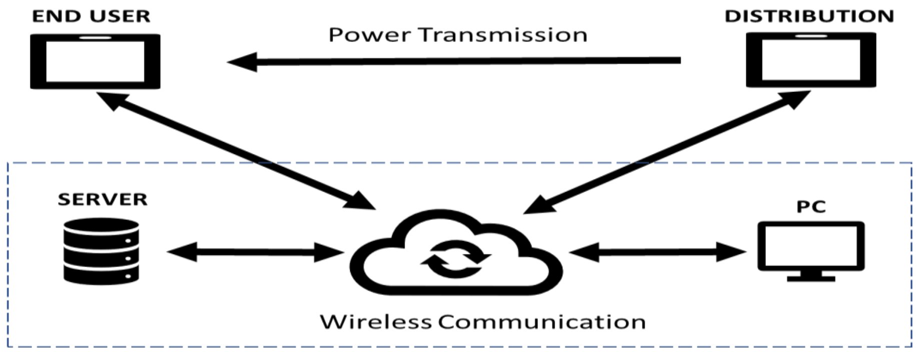

Fig. 5. IoT unit configuration for energy supply and monitoring

4.3 PROPOSED HYBRID SYSTEM

Here we propose a new technology to store electricity from urine and solar power and an IoT-based distribution method to solve the scarcity of electricity in rural Bangladesh (figure 6). In this method, power from both sources will be stored, and IoT will control the distribution based on need, reducing energy loss and ensuring efficient utilization.

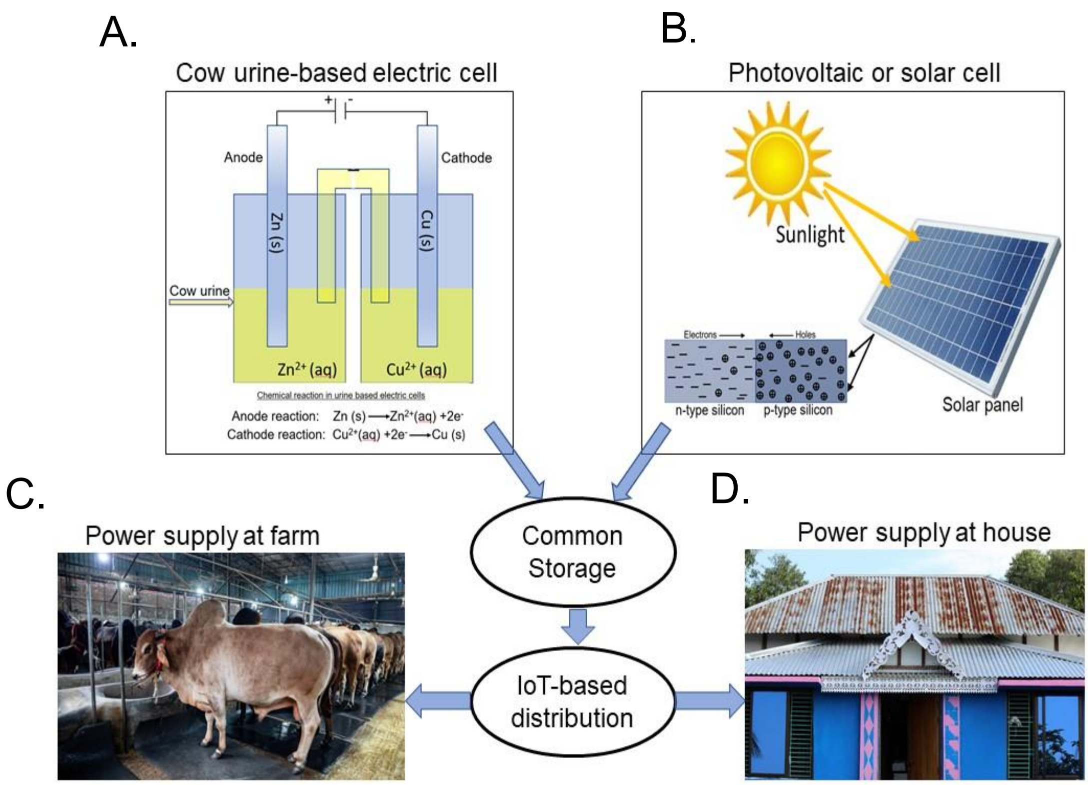

Fig. 6. (A, B, C, D). Unified renewable energy distribution

The top left, and correct figures depict cow urine-based electricity generation technology's schematic diagrams and sunlight conversion into electricity. Energy from these two sources will be stored in a unified storage system, and later, it will be distributed to either farm or house as per need using an IoT-based distribution technology.

4.4 Physical Data Collection

As depicted in figures 7 (3D design of the chamber) and 8 (physical module of the pilot plant), a small-scale prototype power plant based on cow urine is created on a dairy farm in a suburb of Dhaka city in Bangladesh to verify the practicality of the suggested urine-based power plant.

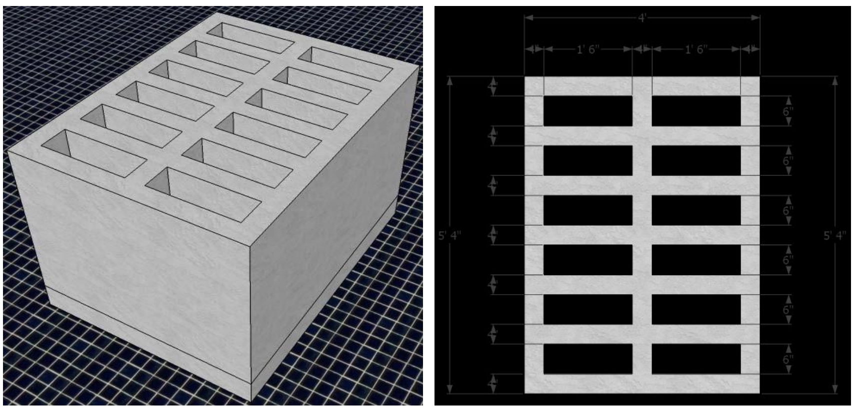

Fig. 7. Diagram of a 2D physical system in AutoCAD

Using AutoCAD software, the prototype of the urine-based plant was created, and the 2D design gives a sense of the actual space required for execution. The urine chamber measures 5 feet long and 3 feet wide.

Fig. 8. (A, B, C, D). Physical model of pilot plant

Fresh urine is used as the electrolyte in three separate phases of the tests, while the electrodes are left untouched. The following subsections detail the experiments as well as the measurements.

Table 3. Urine-based Real-Time power consumption

Urine (Liter)	Time Interval (Hr)	Voltage (V)	Current (mA)	Power (Watt)
12	0-3	16.03	613	9.826
12	3-6	14.96	427	6.387
12	6-9	13.02	196	2.551
12	9-12	11.96	49	0.586

Each chamber has 6 cells that are filled with fresh urine. Per cell contains 2 electrodes; in total, 24 electrodes were used in the system. Measurements are taken every 3 hours time interval, and it is observed that both currents and power decrease in time, as illustrated in Table 3. It clearly shows that the Power ratio was decaying within a time interval, and from *Ph* level of urine, it is optimized that urine will be neutralized after a particular time of conduction within the electrodes.

We require extra electrodes and urine litters if we wish to expand the number of chambers. The power capacity will also grow when these are increased. However, since the voltage is stabilized by a parallel connection and uniformed by a gate drive circuit, adding more chambers will not change the uniformed voltage. More electrodes (anode and cathode), electrolyte (cow urine), and power are required as the number of chambers rises, but the voltage remains stable. The sum of all voltages within a circuit's loop is equal to zero, according to Kirchhoff's Voltage Law, or KVL. To refer to the equation given below-

$$V = V_1 + V_2 + V_3$$

The primary source is an all-natural substance, and the system does not emit harmful chemicals, making it an ultimate contender for a trustworthy renewable and green energy source. The mentionable problems would be if the chemical formation of the cow urine is altered by some disease of the cow or the supply of fresh urine is unavailable at the end time of an exhausted batch. For larger implants, an extensive size of electrodes would be needed increasing the overall cost. The data from the experimental setup is compelling, but at the beginning of the product's launch, it can impress several people but can start self-promoting after several sales. One more problem can be the belief in people that the source, which is cow urine, might be an unholy component, but this idea can be cured with the fact of our long-observed culture of the usage of cow dung in the field of energy production and thus contributing towards greener future. If not given a commission, the political parties may create a hassle. Since it is a continuous process and any lagging in the refill of the electrolyte will result in uneven power generation, to mitigate this, the owner can have a specific person who can change the old urine and replace it with a fresh batch.

5 ENVIRONMENTAL FACTOR

Providing electricity for all its people in Bangladesh is a problem that needs green, faster, and cheaper solutions. According to an estimation, there are millions of cattle in Bangladesh, and every day they produce a vast amount of urine, and if it is released into the soil directly, the soil gets poisoned and acidic that no plant can grow. As an overpopulated country, every small piece of land is essential. The proposed project also provides some solutions for the environment and will be aiding to following factors:

1. Neutralize toxicity of cow urine
2. Generate electricity using cow urine so that, in rural and remote areas, green electricity can be provided to underprivileged people by a micro-distribution model (Need and demand based)
3. Waste Management process (e.g., Utilization of dung and urine)
4. Employment opportunity

As mentioned in the previous section that there are three significant problems that we have identified to provide a solution to, and they are:

Neutralize toxicity of cow urine: This project proposes the production of electricity by using Cow Urine. While generating electricity using cow urine, after a fresh batch of urine is used for electricity generation using our proposed method, the toxicity of the urine is completely neutralized, and the biproduct is a form of liquid fertilizer that is very mineral-rich. We gain some understanding from a brief observation of the cow urine’s effects. Preliminary two to three months analysis revealed that plants or other natural materials are more likely to be affected by cow urine before the neutralizing processes. To get a general overview of whether neutralized cow urine affects the environment, we tested by dumping it on grass or plants. It demonstrates that freshly neutralized cow urine can be used as compost. In the next phase of the research, we will talk about cow biology and its environmental effects, enabling us to get more in-depth information and analysis in this regard. Thus, we believe the proposed method will not only help to detoxify cow urine it will also produce mineral-rich liquid fertilizer.

Generate green electricity for the underprivileged: Key issue of providing electricity for the underprivileged is the availability of electricity generation resources, cost, and ease of use. This project proposes the production of electricity by using Cow Urine. Our preliminary work has shown that if a household has two cows, it is possible to produce enough electricity such that the household can use two LED lights and a fan for 8 hours daily. Bangladesh government has a project titled ‘ (Ekti Bari Ekti Khamar): A House is a farm’. The philosophy of this project is to provide a family with a house on a small land, a cow, so they can be as self-sustained as possible.

6 SOCIAL IMPACT ON LOCAL COMMUNITIES

The primary beneficiaries would be the Farms or the Milk and meat Industry. Since they possess many cows, a large amount of urine is always present; thus, a small plant can be set up quickly, and a regular serving of electricity can be obtained from there [16–18]. Even in a rural area, the farmers having two to three cows can be facilitated with this system.

Currently, Bangladesh has the facility of renewable energy in the form of solar systems; besides, conventional power plants are frequently used to alleviate the need for electricity. Thus, compared to these available options, this biomass-based project can become a revolutionary change in contrast to the expensive conventional alternatives; Despite being a free-of-cost source system, the setup and maintenance are very user-friendly and budget-friendly. It is a very low-cost configuration to generate electricity as the main component of the configuration is a form of waste, cow urine.

About 64.96 % of the total population of Bangladesh lives in rural areas (data of 2016). A solvent rural family owning a pair of cows or buffalo is a standard scenario there. With the utilization of the proposed project, these small families can create a small capacity power plant of their own. The small farms have 12-15 cows on average, and thus the amount of urine generation is quite significant in scale. These farm owners can easily install this project inside their compound and have their own power plant, which can potentially empower the whole farm without any external power supply. Since the proposed project has a simple structure with a straightforward operation system, this project is viable to make space in people’s lives.

7 SUSTAINABILITY INDICATORS

Here we cover the four sustainability indicators and the project's contribution to meeting the Sustainable Development Goals (SDG). Environmental, social, economic, and technical concerns are among the indicators. Within the indicators that ensure part of the Sustainable Development Goals is reached, there are 11 sub-indicators, as illustrated in figure 9.

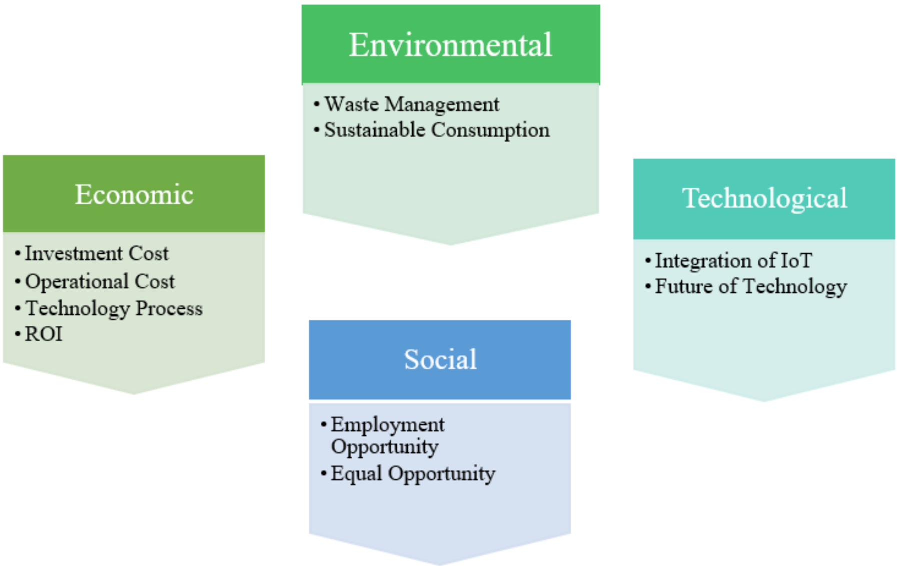

Fig. 9. Sustainability Indicators

7.1 ENVIRONMENTAL

7.1.1 WASTE MANAGEMENT

Waste management guarantees that any waste material is used efficiently by employing various strategies. Biodegradable materials that can be reused and recycled can be an excellent source of green solutions for converting waste to energy [19]. Methods such as burning, pyrolysis, drying, reduction, and others can all help generate energy from waste. Cow urine is a harmful waste that harms the environment by decomposing into nitrate, nitrous oxide, and other greenhouse gas sources. The suggested green model may exploit this waste and use it as a sustainable energy source. This sustainable waste management and renewable energy consumption solution are being implemented modestly at local dairy farms. This will also help achieve SDG 13- Life on Land, which seeks to sustainably manage forests and reduce deforestation, land degradation, and biodiversity loss. The neutralization of hazardous waste such as cow urine and its use as a sustainable renewable energy source helps protect land and environmental integrity and contributes to the fundamental goal of SDG 13.

7.1.2 SUSTAINABLE CONSUMPTION

Sustainable consumption is primarily concerned with using renewable energy and solutions that have a low environmental effect. Green solutions, energy efficiency, and renewable energy contribute to a more sustainable economic future. Here, an alkaline solution derived from cow urine is used to create significant power on a small scale. The approach meets Sustainable Development Goals (SDG) 7 and 12. SDG 7 focuses on affordable and clean energy to deliver efficient energy utilization and renewable energy in underdeveloped countries to enable long-term growth. SDG 12 focuses on responsible consumption and production, corresponding to SDG 7's focus on clean energy. SDG 12 aims to minimize the worldwide use of natural resources while increasing the use of renewable energy. The concept contributes to social and economic advancement as we strive for a more sustainable lifestyle [15].

7.2 SOCIAL

7.2.1 EMPLOYMENT OPPORTUNITY

The proposed solution focuses on making the optimum use of every resource and seizing every opportunity to build a more sustainable society. Employment opportunity is one of the elements that can make a significant contribution to this solution. As we strive for economic growth and a better quality of life in our communities, the proposed green financial model would generate job possibilities for individuals in various roles. A wide range of career opportunities will be available, ranging from operational to technical. This will help achieve Sustainable Development Goal (SDG) 8 - Decent work and economic growth [15]. A sustainable solution generates job opportunities and propels a community's economic progress. The proposed approach is an excellent chance to assist local farmers in generating power from cow urine on their dairy farms. This is also an excellent opportunity to develop and employ the local community's young minds. The procedure helps to keep the unemployment rate low.

7.2.2 EQUAL OPPORTUNITIES

The proposed project offers everyone a wide range of opportunities. Equal opportunities for men and women must be mentioned to ensure proper societal contribution. Women have been contributing equally to agricultural activities in underdeveloped countries. Africa is a fantastic example of this, with more than 60% of employed women working in agricultural enterprises [20]. There are still challenges in this industry but implementing a long-term solution might significantly improve over time. Women in rural parts of nations such as Bangladesh contribute significantly to dairy farm duties, and this project may serve as a bridge between women in the field, engineering, and business by merging various experiences and providing the most significant end to success. This contribution will help meet the SDG 5 - Gender Equality objective, which seeks to advance equal rights in all aspects of life [15].

7.3 ECONOMIC

7.3.1 INVESTMENT COST

Investment costs are essential expenses for various components that contribute to the overall process of a business or project. The suggested model includes costs for the building of the dairy farm, the power plant, electrical components, IoT devices, solar panels, and other critical operational services. The investment cost is an essential economic factor in appraising the energy infrastructure.

7.3.2 OPERATIONAL COST

Operational expenses are necessary expenditures of a project or business process to continue operations and services. There are a variety of charges for a biomass-based enterprise like the suggested model, including salaries, maintenance costs, dairy farm maintenance costs, energy prices, and more.

7.3.3 ENHANCE TECHNOLOGY PROCESS

There are technological processes involved in the project that contribute as economic factors. The processes involving the energy components, the energy note, energy voucher, and energy card, are essential contributions to the advancement of technological processes that comprise the project's proposed energy-based tri-facet local Economy model. Improving technology also encompasses processes such as the pace of technological investment, the influence of environmentally safe alternatives, ecologically sound product creation, and much more [21].

7.3.4 RETURN ON INVESTMENT (ROI)

The method of determining the profitability of an investment is known as return on investment (ROI). It assessed initial expenses, operating costs, and other essential expenditures before calculating the amount returned after relevant costs or investments.

7.4 TECHNOLOGY

7.4.1 INTEGRATION OF IOT

The Internet of Things (IoT) contribution is critical in practically all sectors of modern industry that require technical components. It provides a computational advantage in all processes and assures asset digitization and real-time data processing [11]. Overall, it improves the project's efficiency and production. By establishing a monitoring system and demand-based energy distribution, the proposed project would leverage the power of IoT. The use of blockchain technology in conjunction with IoT for future research can be a powerful strategy for ensuring data integrity and security.

7.4.2 FUTURE OF TECHNOLOGY

The future of technology aspect is primarily concerned with the technology's future viability. Its goal is to assess the processes and technology elements involved and determine whether they are future-proof. Limitations and other factors may contribute to the technology's relevance and the solution's efficiency [22].

7.4.3 CHEMICAL ANALYSIS

This section will go through the chemical analysis, a critical component of the proposed solution. This is a green energy solution in the form of a urine-based electricity-producing system [11]. The system's chemical modelling is depicted more below-

Reaction between Uric Acid and Electrodes:

The uric acid obtained from cow urine is utilized as a system solution. The redox reaction occurs when copper and zinc electrodes are submerged in solutions of copper (II) sulfate and zinc sulfate, correspondingly. We see zinc oxidation at the anode and copper reduction at the cathode [11]. The standard potential for both half-reactions is provided below-

Anode (Oxidation):

$$\mathrm{Zn\ (s) \rightarrow Zn^{2+}\ (aq) + 2e^{-}}$$

$$\text{(Standard Potential=-0.7618V)}$$

Cathode (Reduction):

$$\mathrm{Cu^{2+}\ (aq) + 2e^{-} \rightarrow Cu\ (s)}$$

$$\text{(Standard Potential=+0.340V)}$$

Total Reaction:

$$\mathrm{Zn\ (s) + Cu^{2+}\ (aq) \rightarrow Zn^{2+}\ (aq) + Cu\ (s)}$$

$$\text{(Open circuit voltage=1.1018V)}$$

As a result of these electrochemical reactions, a small quantity of electricity is produced. These processes include the anode, where current travels via electrons as they head toward the cathode [11]. Thus, electrical contact may be made between the electrodes and the uric acid solution.

8 PROPOSED GREEN FINANCIAL MODEL

An eco-friendly or ecovillage community is a small-scale community with little ecological or regenerative impact. Such communities aim to become socially, culturally, economically, and ecologically sustainable. While the planet can recycle some wastes back into the environment, humankind began converting resources to garbage faster than waste could be converted back into resources in the last five decades. Since then, the planet has been in a state of global ecological overshoot, and we are rapidly depleting the resources that support human existence and biodiversity. As a result, SDG goal 12 is to achieve sustainable management and efficient use of natural resources by 2030.

On the other hand, Goal 13 is to take urgent action to combat climate change and its impacts. So, it is the challenge to reduce energy usage through reduced consumption, altered lifestyles, and increased energy efficiency, and then convert the remaining energy use to as nearly 100% renewable energy like solar power as possible. Commercial bank credit makes up the bulk of the money supply in the modern monetary system. The widespread use of fiat currencies and the fractional reserve banking system coincided with the availability and ability to use energy-dense fossil fuels, resulting in unparalleled economic growth and inflation. It creates the illusion of wealth and encourages unsustainable debt build-up; it has little to do with promoting general welfare or economic efficiency. The concept of implementing an energy-based exchange system alongside or as a substitute for fiat currencies is proposed by many persons. These proposals aim to alleviate the adverse effects of fiat currency and support sustainable energy transition.

Universal energy-backed currency implementation is still possible theoretically. Though there are many 'debits' and credit-based energy currency concepts, very few are successfully implemented and sustained. Like successfully implemented coal-backed historical Wära currency, present-day's WAT [23], which is pegged to renewable electricity, indicates that energy-backed alternative currency will be effectively implemented if the user community is small. Hence, this article proposes a community-based tri-faceted community currency system. As with exchange held within the local economy, local community currency can result in additional economic benefits for that locality, known as the local multiplier effect. Implementing such currency can also create a scope to promote other green projects in that community. Before implementing local energy-backed currency, it is expected to form a community-electricity cooperative as most of the successful 'energetic credit' projects are operated by centrally managed businesses. According to Bangladesh Dairy Farmers' Association (BDFA) [24], there are 1,200,000 dairy farms in the country, and 9,400,000 people are directly or indirectly involved in the industry. So, installing the proposed urine-based power plant project inside farms' compounds and eventually supplying the excess electricity in the local power grid managed by the community-electricity cooperative is very much possible in the rural areas in Bangladesh.

a. Energy Note: Our first proposed currency, CC-2, is a credit-based energy currency. In this model, the community-electricity cooperative issues kilowatt-hour promissory note for future energy supply. These energy notes would be sold to consumers and investors at the current electricity rate, who would receive a pro-rata share of the cooperative without costs. These energy notes would raise the funding to purchase the tools needed to supply the household with electricity and meet direct operating expenses. The annual cash dividend will be converted into a kilowatt-hour electricity price. Shareholders enjoy free kilowatt-hour electricity each year equal to the share dividend declared.
b. Energy Voucher: This is a simple voucher-based scheme of investment where customers can purchase vouchers to invest in green energy, proposed as CC-1 in our model. Nevertheless, they will not become shareholders in this model. Vouchers can not only be redeemed against energy but against all products produced in this region that are environmentally friendly. Such an initiative encourages ecological enterprises. Examples of such enterprises would be I) organic agribusiness, II) production of bio-fertilizer, III) effluent treatment plant installation, IV) implementing an integrated pest control system rather than a pesticide. Receipts in fiat currency are either invested in energy production or any other eco-friendly enterprise, which could be an attempt by a commitment to nature to achieve something good.
c. Energy Card: The prepaid electricity cards against stored electricity for households act as a debit currency of our model because these prepaid energy units become a currency, as they are used to pay between customers and be transferred to third parties in our model. Moreover, in this model, electricity can be purchased with the bonus coin earned in the green projects. The power of using prepaid cards as a means of payment between clients holds the injected physical money in circulation to the local economy much longer.

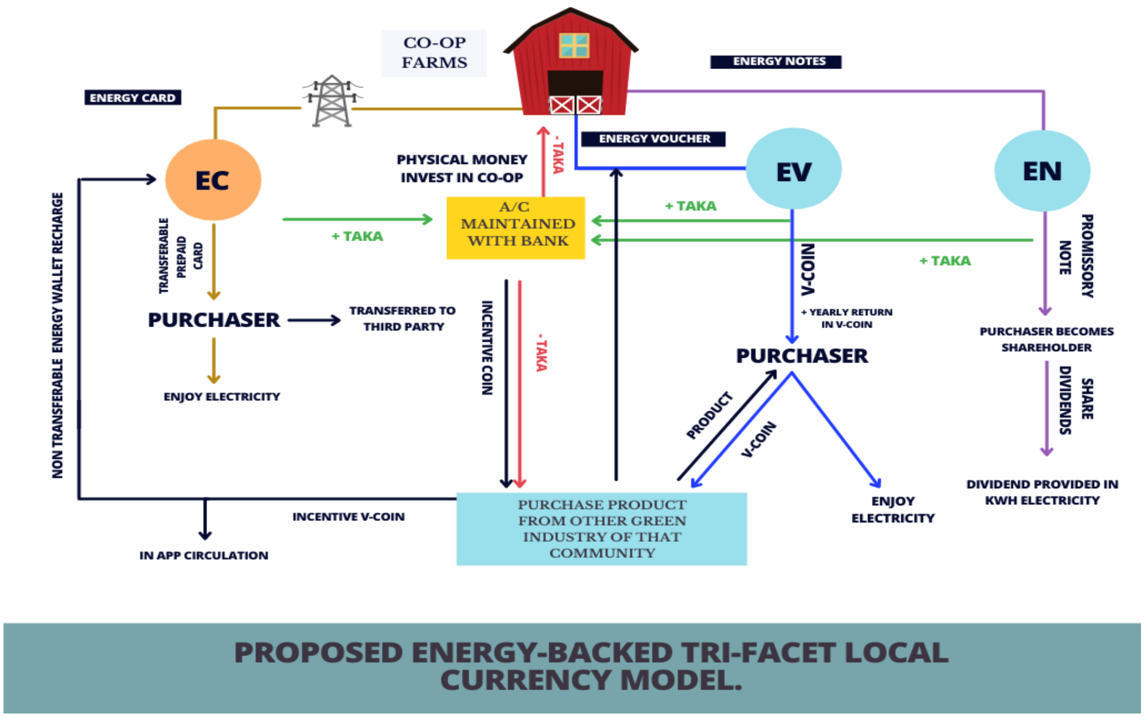

Fig. 10. Proposed Green Financial Model

The inability to purchase anything lower denomination than the unit of energy-backed currency is a classical problem in such previously proposed models. However, the classical problem can be overcome by converting the energy voucher to an app-based digital version presented as V-coin. The energy voucher stored the value of the unit (s) of kilowatt-hour electricity. Input the voucher code to a community app and converts the price into lower denomination values, v-coins. For example, one business-KWh cost approx. 9.00 BDT. If we consider the price for our model, a voucher costs 900 BDT stored 100 business-KWh electricity. So, physically anyone with an energy voucher could not redeem it with electricity or any other eco-friendly product priced lower than 100 business-KWh electricity. However, the conversion of the voucher to V-coin in apps will generate 90000 coins with which anyone can pay fractional payment also.

A respectable (nominal) return or bonus in v-coin is rewarded to the lender (energy voucher purchasers). Moreover, if anyone spent the V-coins on any eco-friendly projects, a bonus rewarded coins would be added to their virtual wallet, redeemable against energy. On the other hand, the eco-friendly projects can redeem the V-coins from the cooperative earned by selling products against fiat currency and bonus coins. In this way, cooperatives can encourage other green industries. Moreover, the physical money injected into the green model circulated longer than the direct buying and selling of electricity. As a result, the local multiplier effect occurs.

9 Conclusions

With the utilization of the proposed project, these small families can create a small capacity power plant of their own. These farm owners can easily install this project inside their compound and have their very own power plant, which can have the potential to empower the whole farm without any external power supply. Since the proposed project has a simple structure with a straightforward operation system, this project is viable to make space in people’s lives.

For green future economic growth, clean energy sources have become mandatory nowadays. Hence, cattle wastes offer a potential means of meeting the energy requirements and a better source of energy generation.

Conflicts of Interest

The authors declare no conflict of interest.

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