PROOF OF RENEWABLE (POR) THE ROBE^2 PROTOCOL

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ABSTRACT

We are at a serious crossroads as it relates to carbon emissions and the condition of our planet. Global conditions are spiraling out of control. Climate change is widespread, occurring extremely fast, and intensifying. The consumption of nonrenewable energy sources is impacting both the environment and the economy in equal proportions. Up to this point society has tried to solve these problems with local solutions but we have fallen short. The missing component to solve the global problem is an alignment of individuals and organizations coming together, taking responsibility, and creating global solutions to meet the goal of being carbon negative by 2050.

In this paper, we propose the ROBe^2 protocol as the global solution that brings everyone together to solve these very important issues. Renewable Obligation Base energy economy (ROBe^2) is a protocol attempting to aggregate local renewable energy solutions into a global impact while providing an economically sound framework and allowing the creation of an economic incentive for using renewable energy in place of a fossil one [1].

KEYWORDS

Scientific Research, Researcher, Research, Knowledge, Learning, Applied Research, Decentralized Autonomous, Organization, DAO, Research Model, Research Activity, Blockchain, Emerging Technology, Incentive Design, Reputation Staking, Distributed Ledger Technology, Decentralized Infrastructure, Renewable, Renewable Energy.

1. INTRODUCTION

The current energy model is spiraling our world into an unsustainable future. If the world continues down the path of high fossil fuel emissions, given current knowledge of the consequences, it would be an act of extraordinary intergenerational injustice [2]. Not only does it negatively impact our earth and society, it will also have a devastating effect on our children and their health [3]. The urban poor are particularly vulnerable with overcrowded living conditions and inaccessibility to safe infrastructure, making them highly vulnerable to climate change impacts [4]. Children in developing nations will suffer tremendously as most of the mortality and morbidity rates related to climate change will come from the accessibility of drinkable water, shortage of food and the accelerated spread of vector-borne diseases [5]. In fact, the urgency of the issue has recently been emphasised by European scientists, who warn that action must be taken now to stabilize climate if a catastrophe is to be avoided [6]. For a sustainable future, society has no choice but to come together and use current technological breakthroughs to solve this crisis and create a better future now and for generations to come [7].

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2. PROBLEM STATEMENT

The world's demands on the limited natural resources used to power industrial society are rapidly decreasing as demand for fossil fuels is rising. This accounts for more than 80% of the world's primary energy consumption [8]. In addition, the damage fossil fuels are causing in urban areas is causing hundreds of thousands of cases of premature deaths and respiratory illness [9]. Because of the seriousness of these issues, the Paris Climate Accord has declared a state of emergency and has called for a reduction in all carbon emissions with the goal of being carbon neutral by the year 2050 as well as declaring the objective of keeping the increase in global average temperature to well below 2°C above pre-industrial levels within this century and further to pursue efforts to limit the increase to 1.5°C [10].

In addition, the current IPCC (Intergovernmental Panel on Climate Change) report from August 9, 2021 has revealed new and disturbing data about the state of climate change and the effect of Co2 carbon emissions. Some of the most important empirical evidence includes: (1) It is unequivocal that human influence has warmed the atmosphere, ocean and land. Widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have occurred. (2) Many changes due to past and future greenhouse gas emissions are irreversible for centuries to millennia, especially changes in the ocean, ice sheets and global sea level. (3) The scale of recent changes across the climate system as a whole and the present state of many aspects of the climate system are unprecedented over many centuries to many thousands of years, and (4) Human-induced climate change is already affecting many weather and climate extremes in every region across the globe [11].

Evidence of observed changes in extremes such as heatwaves, heavy precipitation, droughts, and tropical cyclones, and, in particular, their attribution to human influence, has strengthened since the Fifth Assessment Report (AR5) [12].

However, there is good news to come out of the report which is why we must act now. The report states that an immediate reduction in carbon emissions would have a swift and positive impact, "From a physical science perspective, limiting human-induced global warming to a specific level requires limiting cumulative CO2 emissions, reaching at least net zero CO2 emissions, along with strong reductions in other greenhouse gas emissions," would create strong, rapid and sustained reductions in CH4 emissions and would also limit the warming effect resulting from declining aerosol pollution and would improve air quality [12]. In other words, acting now makes an immediate difference in helping us return back to normal.

In fact, for the first time in history, all 195 member nations unanimously signed on to the accord and agreed with the findings [12]. These are the most critical issues of our time.

3. CURRENT SOLUTIONS

Common solutions to help solve the climate crisis include, but are not limited to, (1) Keeping fossil fuels in the ground, (2) Switch to sustainable transport (3) Proper insulation of homes. (4) Improvisation of farming techniques, (5) Restore nature to absorb more carbon (6) Protect forests, (7) Protect the ocean, (8) Reduce plastic and (9) Invest in renewable energy. These are all important, but alone, they are not enough to make a significant impact.

The most popular form of fighting climate change and reducing carbon emissions is the deployment of the carbon credit system. In fact, carbon credits utilized for carbon load reductions could even be created through a private initiative to constitute a market that will complement regulatory-based initiatives such as national emissions trading systems [13].

Scientific advances could also improve the energy efficiency of existing technologies and develop newer, cheaper carbon-free technologies as discussed in detail by the "McKinsey abatement costs curve" [14] . We label this "the demand theory"— that is, the economy will stop demanding fossil fuels as alternatives become more cost-competitive [15].

But achieving net-zero CO2 emissions will require carbon capture and storage (CCS) to reduce current (Greenhouse Gas) GHG emission rates, and negative emissions technology (NET) to recapture previously emitted greenhouse gases but present NET examples are few, are at a small-scale and not deployable within a decade [16].

One of the greatest contributors to GHG is methane from mass producing agricultural farms around the world. Agriculture is a source for three primary GHGs: CO2, CH4, and N2O. It can also be a sink for CO2 through C sequestration into biomass products and soil organic matter [17]. These are responsible for a significant fraction of anthropogenic emissions, up to 30% according to the Intergovernmental Panel on Climate Change (IPCC) [18]. Without a global commitment to reducing GHG emissions from all sectors, including agriculture, no amount of agricultural adaptation will be sufficient under the destabilized climate of the future [19].

Many of these solutions can seem so overwhelming that smaller companies and individuals feel they aren't able to make much of an impact. While people may have a strong concern about the environment, the complexity of this particular social dilemma—its abstractness, time extendedness, and intergroup nature—tends to discourage actions that help reduce climate change [20]. Therefore, what is needed is a full-circle solution that everyone, and their networks, can be involved in that is making a statistical difference in reducing carbon emissions and creating renewable energies in each and every one of these areas.

4. THE EMERGENCE OF BLOCKCHAIN

Carbon credits, (Renewable Energy Credits) RECs and more advanced systems of those credits that are in development will soon be implemented via blockchain technology. These technologically driven forms of creating renewal makes the 2050 carbon-neutral goal a real possibility.

The requests for sustainable development technologies such as blockchain technology and smart contracts is extremely high. Blockchain and other distributed ledger technologies can enable global partnerships for open innovation that also help meet the goals of the EU Green Deal and the UN's Strategic Development Goals so blockchain is a forefront technology to solve the problem of sustainability and open innovation [21].

In this way, renewable energy sources, fuel cell systems, and other energy generating sources will be optimally combined and connected to the grid system using advanced energy transaction methods [22].

Blockchain technology often plays an essential role in the discussion about a base framework for new energy platform solutions or decentralized business models. Due to its unique ability to transparently document the common state of information within a network, it can provide trust between non-trusting parties in an increasingly granular energy system which has allowed the energy sector to be one of the most rapid adopters of blockchain technology [23].

5. Is Renewable a Valid Financial Option?

The real question is, "will renewable options work to sell back to the grid?" It's clear that renewable energy will save money on high electricity costs, but will the utility company buy back the power being generated? "Will there be enough interest from utilities to justify the investment in specific renewables like wind and solar energy?

The answer is yes.

Utilities are under increasingly stringent federal and state mandates to develop renewable portfolios as part of the overall supply. In fact, 37 states have mandated renewable or alternative energy standards or goals, and many federal and state organizations are willing to help those working to achieve them" [24].

Therefore, a renewable energy solution connected to the blockchain that could prove ongoing and consistent renewables, would not only be financially beneficial to all parties involved, it would also create a new form of energy credit that would accelerate the UN's SDG goals and 2050 carbon neutral goal.

6. THE PROPOSED SOLUTION

From our previous work presented in this paper, we clearly show that the biggest obstacle in adopting renewable energy is not the actual cost of the (conversion to) renewable energy but really the profitability of renewable energy usage. This effect requires us to think differently about how the energy is produced and how the energy producers are incentivized. The second point that we need to address in this proposed solution is that the solution should not be in the form of simple subsidization but rather needs to have means of continuing and being self-sufficient. This requires thinking about the system's sustainability over a long period of time. While there is no one solution that fits all, we can think about it in two stages. One would be the bootstrapping stage and the second is steady-state.

These are the factors that led us to suggest Renewable Obligation Base energy economy (ROBe^2). Similar to blockchain-based supply chains [25], the protocol brings forth a global economic incentive to produce renewable energy. The biggest factor in deciding how to produce energy is profitability. If producing energy through renewable sources is less profitable than the conventional methods, market dynamics will push energy producers towards not utilizing renewables [26].

To shift renewable energy production to profitability, the ROBe^2 protocol is going to compensate those committed to producing renewable energy so that producing renewable energy becomes more profitable than conventional ones [27].

7. RENEWABLE ENERGY SYSTEM

Standard renewable energy production can be viewed as a simple system that is composed of three stages: production, storage, and consumption [28] as outlined in Figure 1.

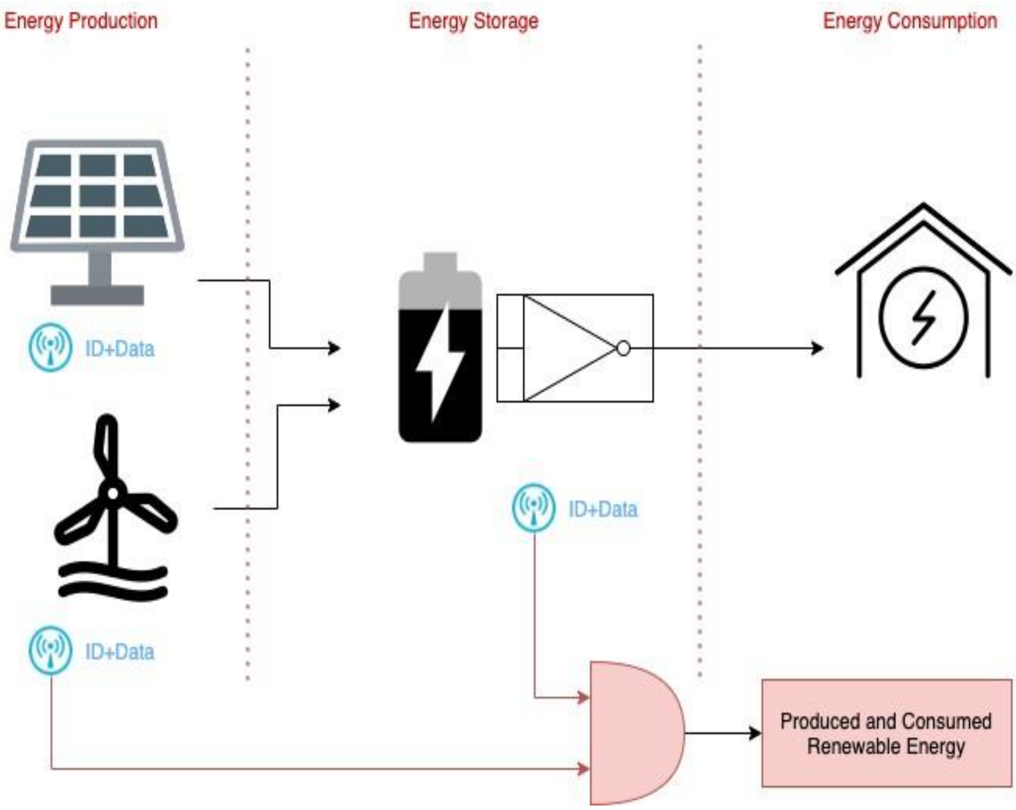

Figure 1. Renewable Energy System Depiction

Renewable Energy Production

There are many sources of renewable energy production, the most widely used are solar and wind production as mentioned earlier. In most cases, those sources utilize a form of charger unit that regulates the produced energy and delivers it to the storage unit [29].

In our proposal, those sources would be outfitted with a unique identifier by the manufacturer that is registered and authenticated. In advanced units, the control unit would also contain a method of communicating the produced energy through APIs to dashboards to measure the actual production. The measured production could be by a single unit or a whole farm of production units. The simplest format of the messages would be in the following format:

Device ID, Power Production. This is a critical part of validating the source of the energy.

Renewable Energy Storage

Since renewable energy is often generated in certain periods when the renewable source is ready to be harvested, that energy may not be ready to be consumed. The energy is then stored to be released at a later time. While many methods are used for energy storage, such as kinetic energy storage, hydraulic energy storage, the most prevailing method of storage is by utilizing a form of electric energy storage. This is normally done by utilizing a battery. Advanced batteries utilize a Battery Management System (BMS) [30]. The BMS's main functionality is to regulate the battery charging and discharging. In the case of a multi-cell battery, the BMS assesses the health of each cell, the capacity to hold a charge, and control which cells are used in order to optimize the battery bank operations. Modern BMS has a serial number to identify the battery bank and may also have a sub serial number to identify the actual cell. In our proposal, the discharge of the battery is reported upstream using the same format for the APIs to allow measuring of the consumed renewable energy.

Renewable Energy Consumption

Renewable energy is not only consumed locally but also can be sold back to the grid to generate revenue for the producer. The key point is the profit difference between the energy produced from renewable sources and those produced from conventional sources.

For our purposes, we are concerned with the profit deferential rather than the full cost of energy production. The justification here is that producers will naturally gravitate to the production method yielding the highest profit. This is where the key difference is, we aim to incentivize renewable energy production and consumption by providing the financial incentive which turns renewable energy production to an equal or more profitable as compared to the other sources.

Proof of Renewable Mining

ROBe^2 protocol utilizes a novel approach to mining. The current popular mining systems are using Proof of Work (PoW) or Proof of Stake (PoS) [31]. While PoW is energy-intensive, PoS focuses on the ownership of the underlying asset rather than the contributions of the participants.

ROBe^2 adopts a novel approach that rewards the production of renewable energy. The main concept can be boiled down to two main points, namely: Verification of renewable energy, and Incentivization of renewable energy.

Verification of Renewable Energy

This is achieved through the two measuring points in the renewable energy production systems. Since the energy production sources will be reporting the produced energy, that part would verify that the energy is renewably produced. The consumption part is measured by the BMS which would report the discharged power. Both produced and discharged energy is recorded with the manufacturer's authenticated serial number and the data reported.

Incentivization of Renewable Energy

The second part of the protocol is to be able to incentivize renewable energy production and consumption. While most approaches are only focused on allocating a limited supply of incentivization, the problem we are addressing is unlimited. A solution that adopts a dual tokeneconomics would be better suited [32]. To address this problem, two mechanisms are set up to provide the incentivization. The first is protocol-assigned tokens, while the second depends on the protocol operations as a green contribution.

Governance Structure

To be able to autonomously run the operations of the ROBe^2 protocol, A decentralized autonomous organization, DAO, needs to be set up so that it can take charge of the protocol rollouts as well as governance [33]. The DAO will be in charge of how the technical aspects of the protocol are implemented and updated, as well as any new decisions that must be taken to adopt new devices, protocols or tokens that will exist in the future. The DAO membership will start with the developers of the protocol itself and then be expanded to include other contributors based on their participation in the protocol development. This community-based governance ensures that the decisions of the protocol will not be biased by one entity or the other and will be in the best interest of the entire community. As part of the incentivizations a DAO reward wallet will be established for the DAO members [34]. It is proposed that the DAO be a green DAO, so that its operations by definition will agree with the philosophy of the protocol as well.

Renewable Alliance Mining Pool

The mining pool represents the current ROBe^2 tokens available in the pool. The pool is used to distribute the rewards to the participants.

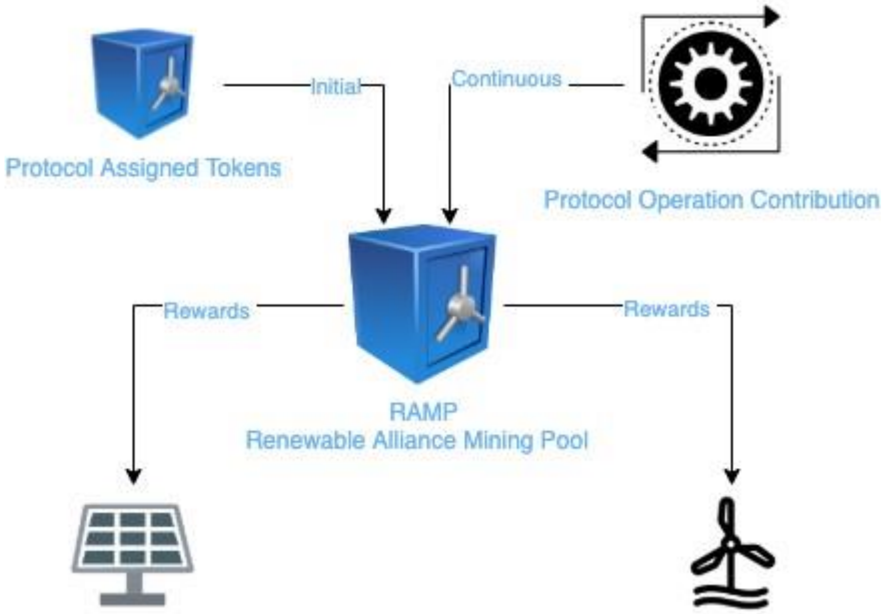

Figure 2. Renewable Alliance Mining Pool

The RAMP gets the tokens from two main sources:

Protocol Assigned Tokens

Those are the tokens assigned by the original protocol at inception. The tokens are locked in a mining contract and are released over time. Those tokens will eventually be exhausted.

Protocol Operation Contribution

To ensure the protocol's perpetual operations, the ROBe^2 protocol provides a way by which protocol users can contribute to the RAMP. Each time the ROBe^2 token is transacted, a **5%** contribution is deducted from the transaction and distributed as follows:

- **2%** to the GreenDAO development fund
- **3%** to the RAMP

The **3%** will provide the required revenue source for the perpetual rewards pool.

Mining Reward Distribution

The distribution depends on the size of the pool and the number of participants.
Rewards are calculated daily to provide a balance between the pool size and participation.
The equation used is shown below:

$$(EPi) = \frac{DR*REP(EP_i)*R(EP_i)}{\sum_{i=0}^{i=n} REP(EP_i)*R(EP_i)} \quad DMR$$

Where:
EP: Energy Producer
EP_i: The i^{th} Energy Producer
$REP(EP_i)$: The i^{th} Energy Producer daily renewable producedenergy
RAMP: Renewable Alliance Mining Pool *n*: number of energy producers
$R(EP_i)$: Reword rate for the i^{th} Energy Producer, set by the renewable alliance
$DMR(EP_i)$: Daily Mining Rewards for the i^{th} Energy Producer
DR: daily rewards

ROBe^2 Protocol Algorithm

The algorithm basically is represented as follows:

1. Energy Producer (EP) must register with the Renewable Energy Alliance (REA)
2. Each energy producer is assigned a wallet
3. Each device is registered on the network
4. Each device is approved by the REA
5. The REA assigned the cost differentials for the energy producer in the zone
6. Each energy producer is granted a relative portion of the REA budget
7. The energy producer generates the renewable energy
8. The energy producer contributes it to the grid
9. The REA approved device will sign a transaction indicating the energy generation
10. The transaction is validated
11. Once the transaction is validated, the ROBe^2 reward tokens are sent from the REA wallet to the energy producer wallet

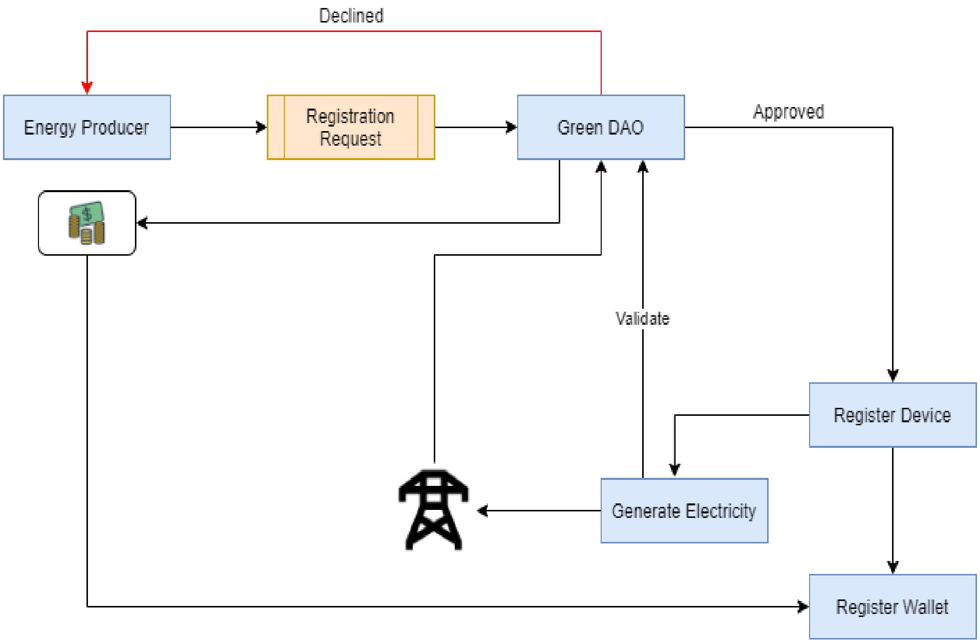

Figure 3. ROBe^2 Protocol Algorithm

CONCLUSION

In this work, we have explored the current status of global world energy production and how the current solutions fall short of addressing them. This is an unsustainable situation that leads to a spiral of consumption and poverty. Our proposed solution is not just an academic exercise, but rather provides a concrete way to measure proof of renewable energy consumption while subsequently utilizing the PoR as the basis of a blockchain-based incentivization protocol. We strongly believe that the outlined framework provides our best chance of changing the global trajectory from one way resource depletion into one of a renewable sustainable planet. We plan to call upon global thought leaders and industrial entrepreneurs to join our cause and adopt the protocol.

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