



Report to the Project

Sustainergy

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Chapter 1: Introduction

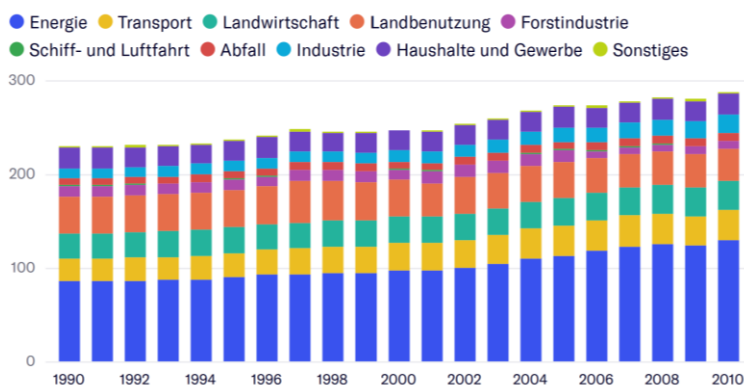
Problem description

Arguably, one of the most important challenges our generation faces is the rapid global increase in temperature caused by our ever-increasing CO₂ emissions. It is therefore crucial that we lower those emissions in order to slow down or even stop climate change and save our planet. The biggest contributing sector is still energy, which is responsible for 40% of the global CO₂ emitted into our atmosphere (see Figure 1). Transportation and agriculture are other big greenhouse gas ejectors. By 2050, 85% of the total energy consumption must come from renewable energy sources to comply with the Paris climate agreement. To achieve this, everyone has to lower their energy consumption, reduce the degree to which they use unsustainable transportation systems and buy more sustainable products, be it local fruits and vegetables or solar panels to power their house. But sustainable products are usually more expensive than their unsustainable counterpart, which means they are less attractive to a majority of citizens. [1], [2]

Currently, there is only little economic or competitive incentive for most companies to use sustainable resources. And neither is there much legislation nor is the public backlash for those companies big enough to nudge them into acting more environmentally friendly. Until politics catch up and introduce laws to overcome the vested interests of those big firms it is up to us, the consumer, to do something to save our planet.

Wie viel die einzelnen Sektoren weltweit zum Treibhausgasausstoss beitragen

Treibhausgasausstoss nach Sektoren, in Tonnen (in Milliarden)



Quelle: FAO – Grafik: osr.

Figure 1. CO₂ Emission of each sector [1]

Challenge

The stated challenge was to create and prototype a concept that lets households participate in a blockchain based system in order to incentivize a reduction of their CO₂ emissions. We were also asked to conceptualize a system, where the money saved by reducing energy consumption is not fully spent by the households on consumer goods. Instead, there should be a system that makes this money go to local sustainability projects.

Additionally, households should be able to monitor their energy savings. Most people only reduce their energy consumption when it is properly presented to them and they are reminded about what impact they have.

Approach

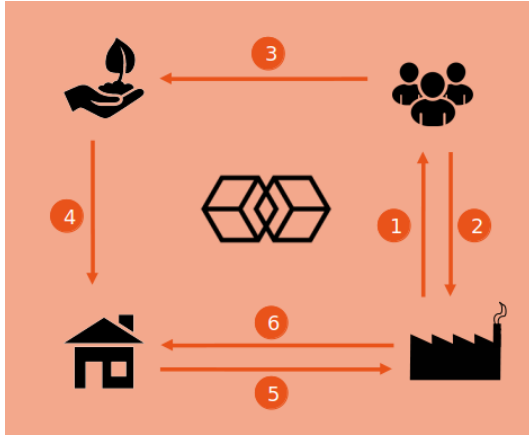


Figure 2. Schematic Interactions of the actors

Figure 2 shows the interactions of our system. The companies, displayed in the bottom right corner, can register their sustainable products (1) and get a product certification by the community (2). The community receives tokens as a reward for their effort to certify those products. The other task of the community is to choose and certify sustainable projects (3). The households which execute these projects gain tokens that way (4).

All tokens that the people own, can be used to get discounted pre-approved sustainable products (5). The companies can collect those tokens, or they can give them back to their employees or shareholders (6).

Tokens can be gained by applying energy reduction projects. Instead of following a “before-after remuneration”, we propose a project-based token allocation. The latter has the benefit of lacking the need for a baseline estimation, which is always hard to define and can create unfairness. Also, we decided not to try to monitor gross CO2 emission but instead reward simple good deeds. We chose to do it that way, because measuring gross emissions gets arbitrarily complex when considering special cases and because it’s possible to make the measurement way cheaper or even free.

Chapter 2: Conceptual model

Project idea

The concept of our project, in a nutshell, is to incentivize households to save energy which generates tokens. These tokens enable them to get a discount on selected sustainable products which companies offer to benefit their reputation. A community is responsible for moderation and awarded tokens for their work.

Actors

Households

A household can register a project with a positive impact on the environment. After its approval by the community the household is awarded tokens for the CO2 savings it created. Those tokens now serve as a way to get other sustainable products more cheaply and, therefore, incentivizing the households to improve their sustainability in more ways.

Projects

Bigger projects not maintained by households can also apply to get tokens for their positive environmental impact. The people behind the project can now sell those tokens to households which can cover some of the funding for the project. That way projects gain an alternative funding option which allows for more such projects to get created as they can easily be crowdfunded to some degree. In addition to that, households that do not yet have sustainable projects can buy tokens in order to get discounts on certified products. They do not pay more but a part of their money goes to environmentally friendly projects.

Companies

While tokens enable households to get a discount on these products, firms are incentivized to participate in this program and to collect tokens because it benefits their reputation. Furthermore, a company that gives rebates to people who try to be more environmentally sustainable is more likely to sell more products to those people. This will be caused by both the economic incentive of cheaper prices and the exposure which makes those potential customers more likely to notice a particular firm with rebates.

This, in turn, leads to an increase in sales on top of the already higher demand caused by the discounts. All of those additional sales result in a positive effect on the firm's bottom line which shareholders will very much appreciate.

At the end of the year, the company is able to equally distribute the collected tokens to its employees.

The higher the number of tokens that are redistributed to each employee is, the higher the number of people who will want to work at said company will be. This boost in attractiveness as an employer is an additional benefit the company could see on top of the higher degree of satisfaction among its workforce. Moreover, those tokens also enable the employees to buy new products again for a cheaper price which may lead to a few added sales.

That way the tokens circulate and never pile up in one place which means they are used more often driving the economy.

Community

The decision on which company and products get certified to introduce rewards in exchange for tokens is made by a community. The community also moderates the projects individual households undertake to reduce their emissions. It decides which projects will get tokens and which won't.

As a reward for moderating each community member will receive a number of tokens. However, abuse will be punished with a lower reward rate of tokens and in severe cases even exclusion. Whether a member of the community abused the system could be determined by taking into account how many times it voted against a big majority and other community members could decide as well.

The influence of moderators rises after every well-intended contribution and also with the amount of tokens it earns in its own projects. Therefore, people who do a lot in favor of the environment are the most influential members of the community.

Why blockchain?

Blockchain has multiple advantages compared to other solutions. First of all, it is decentralized. There's nothing dependent on only one company or server location. If this weren't the case, corruption could impact the data or the company responsible could deny other companies access to the system. On top of that, the company could exclude a country, so the system's purpose would be shifted. The system has to be as accessible as possible so everybody can participate, and the more companies that are using the system, the more possibilities of buying sustainable products with tokens are created. That again increases the attractiveness of the system. It also encourages users to create their own IoT devices and apps that monitor reductions in emitted greenhouse gases. The last advantage of the decentralization is that the consumers do actually own their tokens.

Another advantage of the blockchains is transparency. Everyone can see all transactions. So you can see if something is manipulated or if your neighbors are more sustainable than you.

On the other hand, the blockchain needs a lot of energy to be operated. This is quite a contrast to the goal of this system which is to try to make the world more sustainable. Our approach to tackling this problem is to lower the number of transactions to the bare minimum that is needed. That way the IoT devices only report their measurements very infrequently and new tokens are not created all the time.

Architecture

There should be three parts to our smart contract: one for proposing projects, one for voting on proposed projects and another one for creating and transacting tokens. We already have a crude version of the latter but have not started with the former. We would like to empower the community to build their own devices and initiate projects instead of a top-down scheme. By doing that, we can take advantage of the creativity of the whole community which can come up with things we probably couldn't ever have thought of.

Components

Everybody can reduce their CO₂ emission in many ways. And for every option, there could be a number of ways to measure said reductions. So there are many opportunities to create measuring devices. Such devices could include temperature sensors, light sensors, GPS and more.

One core advantage of our system is its decentralization. That also offers the possibility, that everyone can create measuring devices. But these devices will need to be certified by the community first because, for the same CO₂ savings, everyone should be rewarded with the same number of tokens. Also, there should be no loopholes in the devices which would allow them to be exploited.

There are many ways to create cheap measuring devices. We are only going to elaborate on two, the most important ones. The first one is the use of IoT devices. They offer a cheap and energy efficient way to quantify energy savings. Because there are presumably many measuring devices in one household, it would be more energy efficient if every measuring device sent its data to a master device in the household, like a Raspberry Pi, which collects all the data, saves it and creates the tokens. The last process, namely the token creation, could happen on a daily, weekly or even monthly basis. This reduces the number of interactions with the blockchain because now there are fewer transactions which in turn reduces the energy used by the blockchain.

The second cheap way is to create apps. The latest smartphones have many sensors, capable of measuring a variety of things, in them. Nowadays nearly everyone owns such a phone. This opens up an opportunity to use these sensors. The advantage is that by doing that you don't have to buy an additional physical sensor and the software to read their data is easily replicable, which generates little to no cost. Here it is again possible to create an application at the core, which collects all the data from the measuring devices and creates tokens. This results in the same energy reduction effect that the Raspberry Pi yields.

A big problem is, that the whole system runs on the internet. So everyone needs a connection to the internet. But there are many places where people have no access to the internet, so the devices save the data offline if there's no internet connection. If you then go to a place, where you have a connection the device can create the tokens.

Project Example: reducing the amount of energy required for heating

Mr. X wants to reduce his room temperature down to 20°C in order to cut his carbon dioxide emissions. In order to be rewarded for his savings, he buys an IoT device, which measures the temperature in his room. The device he buys has already been accepted by the community and can, therefore, be used for this task. For it to generate tokens he only has to upload a picture of the device showing where it has been placed. After approval from the community, he earns tokens proportionally to the approximate CO₂ reduction a generic household would achieve by heating to his average room temperature. The Smart contract creates the tokens and awards them to Mr. X's account.

In the future, the system could also be able to take different methods of heating and the size of the room or house into account and reward tokens accordingly.

A couple of weeks afterward Mr. X's washing machine breaks down and needs to get replaced. He decides to buy a new one from a manufacturer offering certified products. That way, Mr. X benefits from the price discount offered by the company and he can pay a fraction of his brand-new machine with the tokens he collected by reducing his emissions.

Chapter 3: Development of our project idea

During the planning of the project, we had to figure out, where the best place for the accumulation of tokens is. There will be lots of tokens created by sustainable projects for energy and CO2 savings, but we have to be careful, that the inducement to do sustainable acts doesn't get lost. So, we had to create a competition to collect tokens. The first idea was to create one between households. But if some households aren't interested in collecting tokens, because they don't get an advantage from doing so, these households won't do any sustainable acts. Or maybe some people don't want to publish their balance due to privacy concerns and, because there's no disadvantage to do so.

So we had to create an incentive for the households that act sustainably. Then the idea came up, that these households could get a discount on more sustainable products in order to get even more sustainable. But why should the companies offer such discounts, as they do not benefit from doing so. To prevent this, we decided to shift the competition from the households to the companies and that people that participate can use their tokens to pay a certain amount of the price of a sustainable product. This also moved the place of accumulation of tokens to the companies. The problems with uninvolved households disappear. You might think that the same problems now occur with the companies instead of the households because uninvolved companies won't get any tokens. But the customers, who are environmentally friendly, probably prefer sustainable companies with tokens, so the uninvolved companies will lose customers. The difference compared to households is that the companies are in a free market and there is always competition which is not the case for households.

But every advantage brings a disadvantage. In a free market, there are some smaller companies which compete with bigger companies. The people could prefer the bigger ones because they have more tokens. Our solution is that there is not just one leaderboard that compares absolute numbers. Instead, we would create multiple leaderboards: one with absolute values, one with token numbers relative to the revenue of the company and one comparing the number of tokens per employee.

An extension to the result so far is, that the companies cannot just collect the tokens, they could also give them to their stockholders as dividends or to their employees as a gift. That would increase the company's attractiveness and as a consequence their value.

Now, this seems to be a pretty solid solution, but the longer we worked with it, we asked ourselves more and more questions. Who decides if a product or a project is sustainable? Who proves that the companies or households are not cheating? To solve this, we created a third party: the community. The first task of the community is to rate the sustainability of the products that the companies offer to their customers. Each product's sustainability can be scored on a scale. Sustainable products get a higher score and less sustainable

ones a lower. The higher the score is, the more discounts in exchange for tokens a company can give to their customers. The second task is to decide whether a household's project can indeed lower their carbon footprint or energy usage. If a measurement device returns data that is out of the ordinary, because the owner is cheating by placing the device in the wrong place or because of a defect with the device, the community could detect the anomaly.

The community itself consists of as many people as possible to ensure that a small number of people can affect a decision disproportionately. Every person can be part of it. Although in this community not everybody's vote has the same weight. People who have studied something related to climate or emissions have more voting power. People who already have invested in living more sustainably got many tokens, and because of that can also influence a decision more heavily. Of course, only a few people might invest their time to moderate in the community, so we decided that each person would get a few tokens for sacrificing their time. The reward could be higher the more each person decides to engage in the community. This motivates the individuals to do research on topics related to sustainability and to spend more of their time doing this. To keep sustainability in focus the reward has to be much smaller than the one for sustainable projects and products.

To summarize the whole project, here's what we decided on: The households get tokens for sustainable projects and energy savings. Those tokens can then be used to get a certain discount on sustainable products. The companies which get these tokens are listed in a public leaderboard that puts the tokens into perspective relative to different business figures. Uninvolved companies will get a competitive disadvantage because they are not seen as a company that tries to further our civilization by selling products that reduce emission. The companies can either collect the tokens or give them back as a dividend or a gift. To control this process, there will be a community that rates the sustainability of the projects and products. Everyone can be part of it and will earn a small number of tokens.

Chapter 4: Evaluation

How to test the system

A small pilot project should be chosen, combined with a small number of local retailers that are willing to participate. By testing the model in a small community, it can be evaluated whether the system works or not without doing much harm, should the latter occur.

Additionally, the energy needed to run the blockchain should be taken into consideration and it should be evaluated whether it offsets the potential energy reductions that are made.

Challenges

While we have implemented measures against people with malicious intent our current concept is still vulnerable to them. If a person decides to displace their sensor after it has been approved and the sensor consequently measures a more beneficial value, the system is currently not able to detect that and there are no countermeasures in place. Of course, there could be a program that can detect patterns in the data with deep

learning neural networks. For example, if the temperature progression in a cellar during the day is different from the temperature changes in the living room or in the bathroom.

Another problem we might encounter in our system is the formation of a cartel. The size of the community is thus far the only thing preventing that from happening. Although, if the group of people with bad intentions grows too numerous, even the members of the community that act in good faith don't stand a chance. However, given the fact that a majority of people do have moral standards, especially those that care about the environment and democratic values that are at the core of our society, such a scenario where the community is overrun by people who seek to abuse the system is highly unlikely.

Most of this applies to the problem of displaced sensors as well, as people that willfully abuse a system are vastly outnumbered by people who wouldn't ever think of doing that. Therefore, we mostly rely on goodwill besides our community moderation system, which won't stop all of the abuse but might keep it in check.

A big problem could also be hyperinflation. For every sustainable project, tokens will be created. This leads to an accumulation of the tokens at the companies (see Chapter 3), so we have to pay attention, that the value of the tokens isn't oscillating too much, else the system would get unstable. To prevent this, the amount of created tokens has to adapt to the sales. A similar situation happened with the introduction of CO₂-Certificates in the EU. At first, lots of people thought, that the trade doesn't work. But now the price of these Certificates rose threefold and the trade works. One cause is, that the companies bought them already because the certificates were cheap. The same effect can also happen in our system. [3]

All of these challenges could be of little importance if the system doesn't gain traction among households and companies. A community only consisting of a few dozen people might not be big enough to make decisions democratically. Furthermore, if only one or two companies offer discounts on their products to a small number of households that actually own tokens it could very well be that none of those people are even interested in those products. Additionally, if only a few people even know about the tokens, companies do not have enough to gain in terms of their reputation to offer rebates. This all means that widespread adoption is key to get this system to work as it is intended to.

Chapter 5: Software and prototype

At the core of our system is the smart contract which interacts with the Blockchain. It currently has three basic methods. The first is for creating tokens. You can create a certain amount of tokens which will be added to a specific address. It will increase its balance. This method will be used to give small rewards to the community and to award tokens to sustainable projects which are executed by households.

The second method transfers a certain amount of tokens from one account to another and returns if it was successful. This method is used, when a customer buys a product. The tokens will be transferred to the company. The third function basically returns the balance of an account. This is used to create leaderboards. Actually, there must also be methods to certify products and projects, but we didn't get that far.

For demonstration purposes, we developed an IoT device, that measures the room temperature and sends tokens to the owner. The lower the room temperature is, the more tokens will be created. So, if you save heating energy, you get a bonus. We chose this project, because heating is a major factor in energy consumption and because it could be done cheaply and easily.

The room temperature measurement is done with a microcontroller, which automatically sends the data to a Raspberry Pi, which will calculate the average temperature. The advantage of undocking the temperature measurement from the Raspberry Pi is, that you could add multiple sensors for different rooms to the Raspberry Pi.

On the Raspberry Pi a script runs, that calculates the number of tokens a household gets for their heating savings. It only creates an integer number of tokens and saves the rest for the next token creation. The reason is simplicity for the households. The token creation happens way less often than the temperature measurement because each transaction that doesn't happen will save energy.

We have also written two python scripts with a graphical user interface. The first is for transferring tokens from one account to another. This can be used if one household sends tokens to another as a gift or if a company gives their tokens back to their employees. The second script is for showing a leaderboard between ten accounts. The list is sorted. This program can show the competition between multiple companies and shows the most sustainable one.

Of course, the whole software is not finished at all. The certification process and the community interface are not implemented. This is mainly because none of us are "Coders" and we had not had enough time for the development of the software part and focused on our concept instead.

Chapter 6: Conclusion/Outlook

The success of the proposed model is mainly dependent on the participation of the three stakeholders: households, companies and the community. If these three are willing to take part in the system, it could be a success. But if the community is not actively doing their part, the certification wouldn't take place and without that, no tokens can get created. That possible issue is described in more detail in chapter 3.

If the households aren't motivated to participate, then the sustainable products which the companies are offering won't be bought. However, there are still discounts on the products if you pay with tokens. The membership programs most supermarkets use today show that households are willing to work for discounts if they only have to put in very little effort. Putting a temperature sensor in a room is very little effort.

If the companies don't take part, the households have no incentive to collect tokens from sustainable projects. To counter that a competition between the households could be introduced, although this would not create any disadvantages for households, that don't participate. We address this topic in chapter 3 as well.

The main advantage of the model is its nearly unlimited scalability. Any number of additional energy reduction components can be included. For example, the GPS receiver in a smartphone can detect if someone is flying in a plane and the less a person flies the more tokens the person gets. Because of that, most people may prefer

traveling by train. The same can be done with other transportation methods or even food. In Figure 1 it is also apparent, that agriculture is a non-negligible CO₂ emitter.

But you can go way beyond that. You can use the same model for reducing rubbish by certifying products with little or sustainable packaging. But that isn't part of our challenge anymore even though this would quite possibly also reduce the CO₂ emissions.

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