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ENERCHAINGE

Executive summary

The EnerChainge project, conducted together with the partner company Edison, has the goal to investigate the properties and limitations of blockchain technology with an emphasis on the energy sector, and to design and develop a working prototype to address a specific energy related problem. The resulting solution is Virdis, an innovative, blockchain-based green energy tracker built around the concepts of transparency and fairness. The innovation lies in the application of blockchain technology to the tracking of the energy source of consumer goods, aiming to provide end users with an easy and seamless way to know, certify and track the environmental impact of their daily purchases. At the same time, by providing manufacturing companies with a way to communicate their energy consumption's choices, Virdis can help them to benefit from an improved brand awareness around sustainability. The enhanced reputation will result in an increased demand for renewables, which can be supplied by energy retailers through green Power Purchase Agreements (PPA). PPAs are indeed a useful instrument for companies, which can have access to green energy with a low capital expenditure, and a profitable business for energy retailers selling them. However, their diffusion is currently limited due the lack of instruments to properly monetize on these investments.

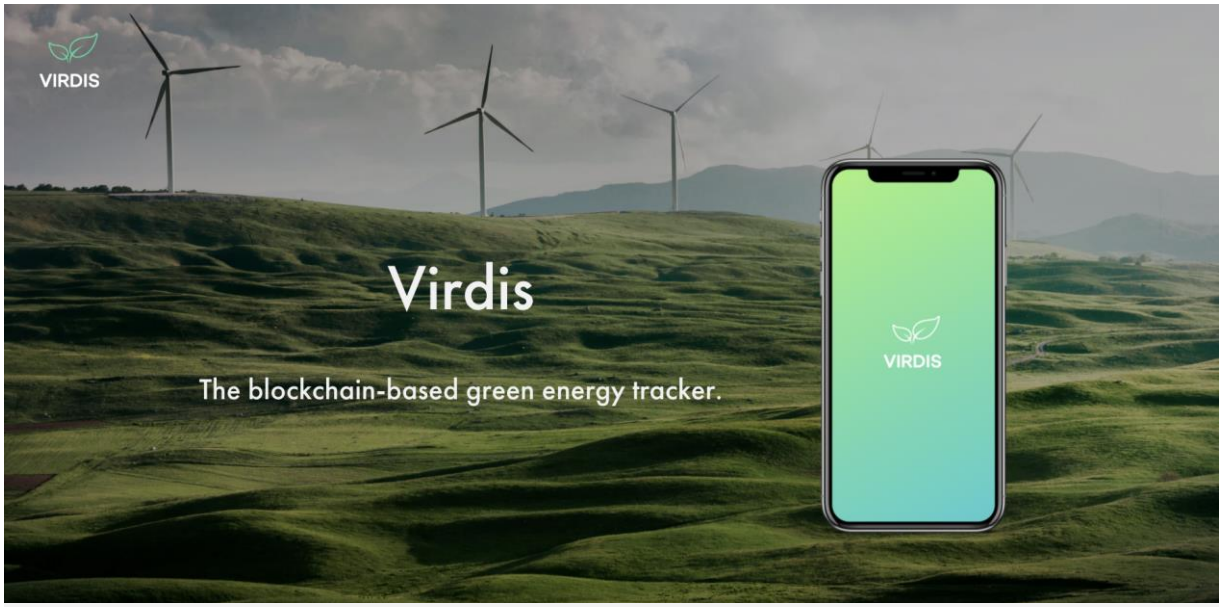
The technology-push approach drove the organization of the work. After a first phase dedicated to drafting a preliminary project plan, the team spent a considerable amount of time on understanding the technology, as well as on assessing the major issues of the energy sector. After a careful analysis, the team foresaw a huge opportunity for blockchain to overcome the limits of the current green energy certification systems. Once restricted the scope, the team brainstormed around possible solutions and gradually converged around the outlined idea. Finally, the implementation of the solution in both its technical and business sides led to a minimum viable product to be tested on the market.

Key Words

Blockchain, Sustainability, Energy Sector

VIRDIS

The Virdis logo



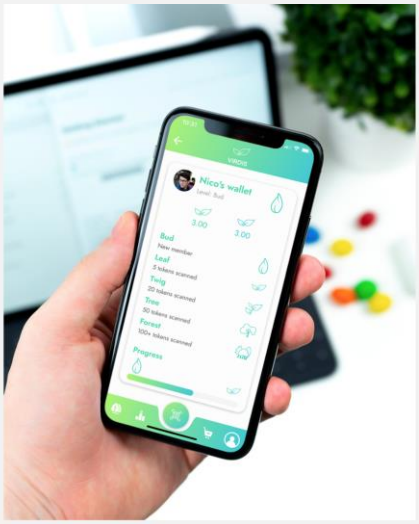
Install Virdis and...

Frame.

Everything starts with a QR code.

Discover.

All the energy-related information you wish for on your smartphone.



Choose.

Be the protagonist of your sustainable choices.

Remember.

Keep track of your purchases and your energy impact.

Project description written by the Principal Academic Tutor

The goal of the EnerChainge project is to provide an answer to the question: "Is the blockchain a technology able to change some of the paradigms which the energy sector relies on? Or is it just yet another buzzword which cannot be useful in the energy domain?". To this aim, EnerChainge, a technology push-oriented project, has firstly required to analyse the state of the art of the different type of blockchains nowadays existing. The initial steps of the project have been to first understand the main functionalities and technical foundations of a blockchain, then to research how this technology is adopted in different domains. Next, with the support of Edison, the team conducted a study on the current challenges in the energy sector, both regarding business-to-business and business-to-consumer applications. Finally, the team investigated on already existing blockchain-based solutions in the energy field, to assess how the technology is currently used as an enabler for a paradigm shift.

Based on this extensive analysis, the core of the project was to identify a use case where the features of a blockchain could be fully exploited. Based on different brainstorming sessions, interviews with experts, literature analysis, the identified case study concerns the adoption of blockchain as a mean for improving the awareness of citizens about the real usage of green certificates managed by companies when buying energy from energy providers like Edison. How the citizens can be aware whether the products they are buying are coming from companies which actually use green energy? Is there a way for a citizen to "award" these virtuous companies? The answer to these questions is tangible in a product called Virdis: an Ethereum-based application associated to a token which reflects the number of green certificates owned by a company. Thus, Virdis provides a connection point between the energy providers which emit green certificates to companies which, in turn, can make their customers aware about such certificates. With a win-win solution, exploiting the absence of third-party entities as provided by a blockchain, the process of distributing green certificates among energy providers and companies is simplified. Moreover, since a direct correspondence between certificates and Virdis tokens exists, the proposed solution will allow to create an interesting market of green certificates which potentials cannot be completely foreseen.

Team description by skill

Martina Caridi: Bachelor's degree in Management Engineering and currently enrolled in Management Engineering at Politecnico di Torino. She defines herself as talkative and entrepreneurship enthusiast.

Elena Arzenton: Bachelor's degree in Management Engineering; she is currently pursuing her Master of Science in Management Engineering at Politecnico di Milano. Her main skills are analytical and organizational.

Francesco Cavallo: Bachelor's degree in Aerospace Engineering and currently completing his studies in Aerospace Engineering at Politecnico di Torino. He is a creative and supportive person.

Matteo Corain: Bachelor's degree in Computer Engineering; he has already completed his Master of Science in Computer Engineering at Politecnico di Torino. He has technical expertise and prominent analytic skills.

Michele Da Re: Bachelor's degree in Mathematics for Engineering and currently enrolled in Master of Science in Mathematics Engineering. His main skills are communication and result-orientation.

Nicolas Figini: Bachelor's degree in Management Engineering; he is currently pursuing his Master of Science in Management Engineering at Politecnico di Milano. He defines himself as result-oriented and analytical.

Roberto Infantino: Bachelor's degree in Electrical Engineering and currently enrolled in Master of Science in Electrical Engineering-Smart Grid at Politecnico di Milano. He is particularly good at time management and team support.

Goal

The goal of this project is to investigate the applicability and the benefits of blockchain technology in the energy sector and come up with a working prototype, to define how this initial setup can scale-up and reach a commercial application. The vision is to enable innovative, technology-driven business models, which can create new opportunities for historical utilities like Edison, the company partner for this project.

The project explicitly required to follow a technology push approach, wherein the first important step was to understand the technical underpinnings, capabilities and limitations of blockchain and smart contracts in state-of-the-art applications. In parallel, aiming to find a useful application in the energy sector, it has been necessary to take a deep dive into the issues of the energy industry, to evaluate its current challenges and opportunities.

The common thread of this project is to develop a credible and technically feasible application, in which the blockchain potential is fully exploited. Indeed, the world "blockchain" is often abused or overused and the technology is only partially relevant to current products, even if promoted as a "blockchain-based". On the contrary, from the very beginning the whole team (Edison representatives included) wanted something which could fully leverage on the peculiarities and characteristics of the technology. At the same time, the feasibility from both a technical and business perspectives had to be considered. Thereafter, the industry needed to be fully investigated and understood, to create a solution which could be innovative and, at the same time, profitable for the committing partner. To this end, the requirements of our partners and the of the industry as a whole needed to be clear and constantly monitored.

Understanding the problem

The team conducted a thorough investigation of the most promising trends in the energy sector, where blockchain might foster the development of sustainable paradigms. The essential issues that blockchain inherently tackles were investigated and monitored, in order to spot the application in which blockchain characteristics could be exploited the most.

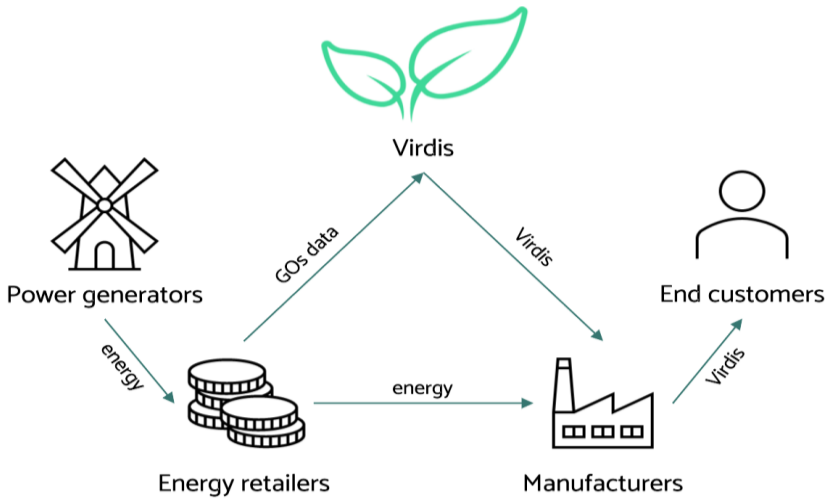
Peer-to-peer energy trading: it is an energy exchange model in which prosumers generate energy, consume it for their own needs, and trade the excess with each other. Blockchain can serve to decentralize energy trading among parties.

Smart meters: they are the evolution of traditional energy meters in that they allow a real-time management of supply and demand of energy. This is key as renewables are intrinsically intermittent. Here, blockchain could be used for data certification and billing.

E-mobility: in the broad field of e-mobility, we focused our attention on charging infrastructures, grid stabilization and autonomous vehicles. Here, blockchain could act as a security protocol to increase the trust between parties and allow to manage payments.

Energy Certificates: current sustainable energy certification systems struggle to reach a broad adoption due to the corporates' difficulty to communicate their green investments, creating the need of building reciprocal trust among involved parties. This, together with the necessity to collect e certify large amounts of data, could be effectively supported by blockchain and smart contracts.

At the end of this exploration, the team concluded that, while many projects involving blockchain in energy exists, only few of them actually need blockchain to operate. To reach the project goal and thus to identify a real-life problem for which blockchain can act as a breakthrough solution, the team decided for Energy Certificates as the most promising field. The team foresaw the possibility to combine the technology-specific characteristics with the issue of climate change and industrial energy-related emissions, one of the main causes of global warming and one of the broadest present-days problem to address.



Ecosystem for Virdis' generation and exchange

EnerChainge Team

Exploring the opportunities

In order to spur energy efficiency and incentivize the usage of renewable energy, new models to source renewable energy, such as Power Purchase Agreements (PPAs) with independent power producers, allow for a direct trade between companies of all sizes and renewable energy developers. In this context, Guarantees of Origin (GOs) are the most common tool used to track the energy provenience. Every MWh of energy coming from a certain renewable power plant carries a GO, which bears all the information about the energy it refers to, such as the production site, the type of renewable energy source and the company that owns the power plants. The certificate is generated when green energy is produced, and it is annulled to certify that such energy has been consumed.

A PPA is a contract between two parties, which defines a price structure and a volume of energy to be supplied over a fixed period of time. This scheme avoids the upfront investment in infrastructure and allows the off-taker to purchase power directly or indirectly for a price level agreed by parties. However, the diffusion of this instrument is still limited due to risks the off-taker need to bear (price, credit, scheduling and balancing risks) and for which it cannot receive proper compensation. Off-takers indeed lack ways to communicate their environmental commitment to their customers and therefore miss the market opportunity generated by the current trends towards sustainability. Indeed, on the one side, end-customers do not trust sustainability claims from corporates, as they can only access certified information on this topic via companies' sustainability report (a process which is complicated and difficult to undertake in many cases). On the other end, energy producers and retailers miss the opportunity to sign long-term green contracts, which could serve them both to boost the transition towards renewables (by securing revenue streams to finance the construction and maintenance of renewable power plants) and to increase their margins.

Generating a solution

To this purpose the team created Virdis: a blockchain-based energy tracking platform. The platform is built upon a new crypto-token, whose name is also Virdis, whose generation is integrated with the Guarantees of Origin and certification process. The ecosystem will work as follows:

1. The power generator produces green energy and supplies it to the energy retailer along with its Guarantees of Origin.
2. The energy retailer sells the energy and the Guarantees of Origin to its client, which is generally a manufacturer.
3. Virdis receives GOs data from the energy retailer and awards the manufacturer with the right to generate a fixed amount of Virdis tokens per green kWh.
4. The manufacturer can then distribute its Virdis tokens on the products using our platform: for each product, Virdis generates QR codes that can be scanned to access information.
5. Finally, customers receive Virdis by scanning participating products.

Once that tokens have been obtained, end-customers can use them for several purposes. For example, they may compete on the number of tokens they collected, proving their sustainable commitment. Or, if they do not care about that, they can always trade them with other entities in exchange for discounts. But these are only a few of the things that can possibly be done: thanks to blockchain, this "tokenization of energy" creates a system where new value generation schemes for Virdis tokens can continuously be invented, even independently from us.

Despite born in the context of a technology push approach, extensive validation efforts were made to make sure that Virdis was addressing a well-grounded concern in the potential user base. Those include interviews with experts, users' questionnaires and an online A/B testing campaign. Also, the technical feasibility of the solution was proven by means of a prototype implementation.

To conclude, the purpose of Virdis is to boost the energy transition by providing companies with an instrument to certify and properly communicate their environmental commitment. Indeed, we believe that the transition to a low carbon economy must not prescind from the involvement of end customers, who need to be aware of the environmental footprint of their daily purchases.

Main bibliographic references

Buterin, Vitalik. A Next-Generation Smart Contract and Decentralized Application Platform. [Online] 2013. https://ethereum.org/en/whitepaper/.

IEA. Global CO2 emissions in 2019. International Energy Agency. 2020.

European Parliament. Directive 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (RED II). EU Official Journal. 2018, Vol. 328, pp. 82–209.