

Energy Distribution with the Use of Smart Contracts

Section 1: Summary

Use Case Summary			
Use Case ID:	IND-001	Use Case Type:	<i>Vertical</i>
Submission Date:	October 17, 2018	Is Use Case supporting SDGs	<i>Yes</i>
Use Case Title:	Energy distribution with the use of smart contracts	Domain:	<i>Industry</i>
Status of Case	PoC	Sub-Domain	<i>Energy</i>
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Proposing Organization	European Commission		
Short Description	In this use case, taking advantage of the potentialities of blockchain technologies, we propose a solar energy production and distribution architecture using smart contracts, a particular distributed ledger paradigm, to support automatic energy exchanges and auctions, potentially enabling a new, open and more fruitful, under an end-user perspective, energy micro-generation market.		
Long description	<p>In our model, we assume a local grid where energy is produced and consumed in a limited geographical area, such as a local neighbourhood. Energy produced by a prosumer may be saved in the user's local battery for later use or may be immediately injected in the local grid. An additional possibility is to have a common, central to the neighbourhood, battery shared as a temporary energy buffer. The model is divided in three layers: (a) the energy grid, (b) the middleware controller, and (c) the smart contract.</p> <p>When energy is injected in the grid a smart meter linked to each producer continuously measures how much energy has been injected in total. These smart meters, along with the software that handles their output, i.e. a middleware controller, are the input source for our smart contracts. After a predefined amount of energy has been injected to the grid, an Helios Coin (HEC) is awarded to the corresponding prosumer.</p> <p>The middleware controller interconnects the grid with the smart contract since these systems cannot communicate directly with each other. As a result, the controller plays the role of invoking the smart contract on one end, and on the other receiving the readings from the grid, thus facilitating communication between the two entities.</p>		

SDG in Focus (when applicable)	Goal 7: Affordable and clean energy		
Value Transfer:	tokens	Number of Users:	
Types of Users:	energy producer, energy consumer, smart meter		
Stakeholders	energy producer, energy consumer, electricity grid		
Data:	<i>energy data</i>		
Identification:	energy producer (anonymous), energy consumer (anonymous), smart meter		
Predicted Outcomes:	<p>The main aim of our model is to enable micro-grid prosumers to produce, consume and trade energy. In particular, they would be able to:</p> <ul style="list-style-type: none"> • Release excess energy to the grid and receive virtual coins in return • Transfer/Exchange the virtual coins • Redeem the virtual coins in exchange with energy • Enable prosumers to access the energy market 		

Overview of the Business Problem or Opportunity
<p>Business Problem:</p> <p>Micro-generation is the capacity for consumers to produce electrical energy in-house or in a local community. The concept of “market” indicates the possibility of trading the electricity that has been micro-generated among producers and consumers, where a user acting both as a producer and consumer is called a “prosumer”. Traditionally, this market has been served by pre-defined bilateral agreements between prosumers and retail energy suppliers. This means that until now, electricity-generating prosumers have not had real access to the energy market, which remains a privileged playing field for the institutionalised energy suppliers. This fact has, so far, heavily impacted on the real diffusion at large scale of micro-generation due to the limited economic advantages this energy generation approach would bring to the prosumers.</p> <p>Opportunity:</p> <p>The main options considered so far by the technical literature, were completely centralised and their viability (under a prosumer perspective) was in general challenged as they introduce additional management fees and costs and assume the intervention of a trusted third party reducing once again the potential gains of end-users. New approaches should be developed enabling end-users to have free access to the energy market. In this context the advent of distributed ledgers, i.e., blockchains, can be considered beneficial.</p>
Why Distributed Ledger Technology?
<p>Blockchain enable users to access the energy market and exchange energy directly with other entities without trusted centralized third party.</p> <p>The DLT features required are verifiability, security, resilience, transparency.</p>

Section 2: Current process

Current Solutions
<i>If there are existing systems which automate the above business problem/opportunity.</i>

Existing Flow (as-is)		
Step	User Actions	System Actions
1.		
2.		

Process scheme (as-is)

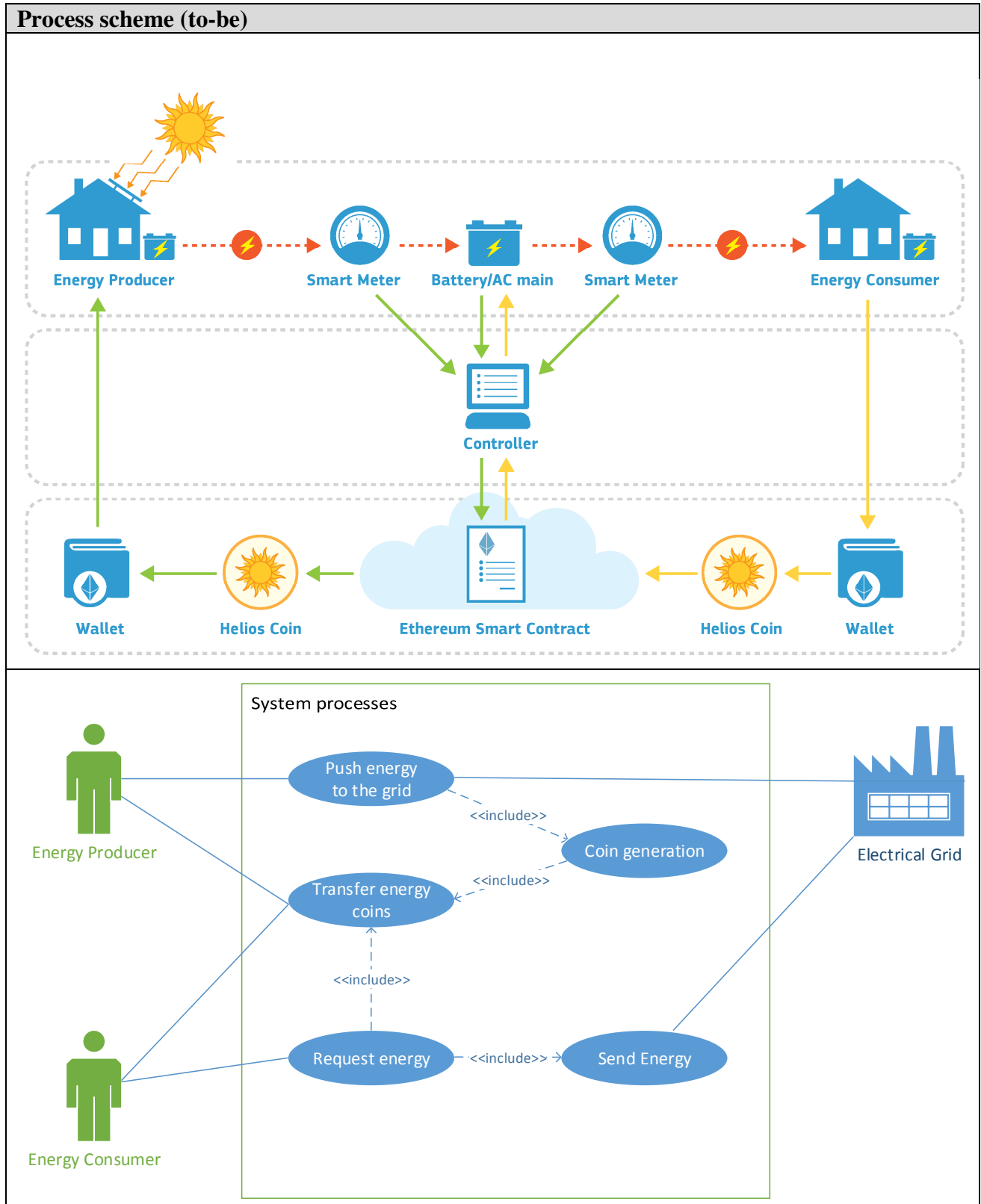
Data and information (as-is)		
Data	Type	Description

Participants and their roles (as-is)		
Actor	Type/Role	Description

Other Notes
<i>Any assumptions, issues</i>

Section 3: Expected process

Expected Flow (to-be)		
Step	User Actions	System Actions
1.	When energy is injected in the grid a smart meter linked to each producer continuously measures how much energy has been injected in total.	
2.	The measurement is sent to the middleware controller which triggers the corresponding smart contract function.	
3	The smart contract function issues the amount of energy coins that correspond to the energy injected. The coins are sent to the energy producer's address	
4	An energy consumer can purchase energy coins from the producer by different means (e.g., Bitcoin, Ether, Euro, etc.)	
5	When a consumer wants to purchase energy, he needs to send energy coins to a predefined smart contract address	
6	Once the coins are received, an event will be broadcasted to the network. Once the controller receives the event it will communicate with the grid and issue a command to release the amount of energy that corresponds to the number of virtual coins received to the consumer.	
7	The smart meter will monitor the energy flow and will stop it once the purchased energy is sent	



Participants and their roles		
Actor	Type/Role	Description
1	Energy Producer (user)	The entity that produces energy and pushed it in the grid

Participants and their roles		
Actor	Type/Role	Description
2	<i>Energy Consumer (user)</i>	The entity that buys/consumes energy from the grid
3	<i>Controller (system)</i>	Middleware entity that facilitates communication between the user and the smart contract
4	<i>Smart Contract (system)</i>	The application logic that enables transactions of virtual energy coins
5	<i>Electrical Grid (system)</i>	Physical layer for energy exchange (batteries, smart meters, inverters, etc)

Data and information		
Data	Type	Description
1	<i>Helios Coin</i>	A digital token that can be exchanged for a predefined amount of energy
2	<i>Energy Measurements</i>	The energy measurements obtained by the smart meters and transmitted to the smart contract

Security and privacy
<p>The access of energy data should be protected appropriately as they can be used for identifying end users and their activities from their energy consumption. Moreover, as the middleware is a key entity that controls the data input to the smart contract, it should be made sure that it is not manipulated. One way to do so could be to transfer the logic of the middleware to each smart meter, and with the use of a Trusted Platform Module (TPM) or a Trusted Execution Environment (TEE) guarantee that the measurements have not been tampered with.</p>

Main Success Scenario + expected time line

Conditions (pre- or post-)
<p>Pre-conditions</p> <p>We assume the existence of a local grid where energy is produced and consumed in a limited geographical area. The energy producers and consumers should be connected to an blockchain network (e.g., Ethereum). Moreover, the smart meters should be able to communicate with the middleware controller.</p> <p>Post-conditions</p> <p>With the use of the proposed system, energy accountability can be performed and mutual trust on the energy measurements is achieved. The measurements can be audited by any interested party without revealing personal data.</p>

Performance needs
Legal considerations
Risks
The middleware controller needs to be a trusted entity.
Special Requirements
External References and Miscellaneous
Details of this use case can be found in the paper: I. Kounelis, G. Steri, R. Giuliani, D. Geneiatakis, R. Neisse and I. Nai-Fovino, "Fostering consumers' energy market through smart contracts," 2017 International Conference in Energy and Sustainability in Small Developing Economies (ES2DE), Funchal, Portugal, 2017, pp. 1-6. doi: 10.1109/ES2DE.2017.8015343
Other Notes

Appendix 1:

Domains and subdomains for use cases categorization

Vertical:

1. Finance
 - a. Financial management & accounting
 - b. International & interbank payments
 - c. Clearing and settlement
 - d. Reduction of Fraud
 - e. Financial messaging
 - f. Asset lifecycles and history
 - g. Trade finance
 - h. Regulatory compliance & audit
 - i. AML/KYC
 - j. Insurance
 - k. Peer-to-peer transactions
2. Healthcare
 - a. Pharma
 - b. Biotechnology
 - c. Medicine
3. Industries
 - a. Manufacturing
 - b. Energy
 - c. Chemical
 - d. Retail
 - e. Real estate
 - f. IT and telco
 - g. Supply chain management
 - h. Transportation
 - i. Agriculture
4. Government and public sector
 - a. Taxes
 - b. Government and non-profit transparency
 - c. Legislation, compliance & regulatory oversight
 - d. Voting
 - e. Taxation and customs
 - f. Intellectual property management
 - g. Land Registries

Horizontal:

1. Identity management
2. Security management
 - a. Public Key Infrastructure
3. Internet of Things

4. Data processing, storage and management
 - a. Data Validation (includes provenance)
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