BLOCKCHAIN AS A NEW ENERGY DIGITAL INFRASTRUCTURE TECHNOLOGY LAYER

Claudio Lima, Ph.D.
Blockchain is digital ledger of transaction data recording system, distributed across many computing systems, that makes it difficult or impossible to change, hack, or fraud the system.

Blockchain/DLT Ledgers

- Data/user security
- Tamper-proof (immutability)
- No intermediaries
- Track & trace
- Data transparency

Source: BEC
Blockchain in Energy Grid Applications

T&D Blockchain

- Smart contract
- Field data
- Transmission & Distribution
- Substation
- DER

Customer-Facing Blockchain

- Smart contract
- Field data, energy contracts, transactions
- Rooftop Solar/Battery
- Electric Vehicle Infrastructure

source: BEC
Blockchain as a New Energy Standards Layer

IEEE P2418.5 BLOCKCHAIN-DLT IN ENERGY STANDARD GRID SEGMENTATION

Permissioned Mission-Critical Energy Blockchain

Permissioned & Permissionless Energy Blockchain

Customer-Facing Energy Blockchain

- smart energy contract
- synchrophasor/PMU network

Generation | Transmission | Substation
---|---|---
AMi: Advanced Metering Infrastructure
EMS: Energy Management System
DERMS: DER Management System
DER: Distributed Energy Resource
C&I: Consumer & Industrial
PMU: Phasor Measurement Unit
MC: Mission Critical
T&D: Transmission & Distribution

Shall comply with 2P2S design principles (Performance, Privacy, Security & Scalability)

Source: BEC, IEEE
Creating a Legally-Binding Energy Smart Contract

SLEC for Energy Markets

Smart Contract

Generic
- Healthcare
- Manufacturing
- Supply chain… etc.

Non-Legally Binding
- Just a computer logical (what..if) Code
- No penalties or clauses that establish consequences
- Solidity
- Chaincode, etc.

Energy
- contains legally binding clauses and conditions
- specific for ENERGY

Gnostic to computer languages/constructs

Smart Legal Energy Contract

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Creating a Legally-Binding Energy Smart Contract

SLEC for Energy Use Cases

Reference Smart Contract

Technology Agnostic
Can be used by any blockchain technology platform

Public Blockchain
permissionless

Private Blockchain
permissioned

Hybrid Blockchain

Consortium-Based Blockchain

source: BEC

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BEC Methodology for Blockchain Design 80-20-80

And Implementation

80%

BEC DESIGN 80-20-80 Methodology

Business and Operation Process Mapping

- Business/operation rules definition
- Operation transaction work flows
- Logical business mapping
- Participants access control specs
- Governance model

Smart Contract Design

Blockchain Ledgers, Cloud

20%

80%

20%

- Logical processing coding
- Code functions design
- Logical transaction design

- Ledger provisioning
- Cloud/host design/dimensioning

PROCESS WORKFLOW

Smart Contract Design

Blockchain Ledger Design

Source: BEC
First Use Case Using Ethereum

How GridMix is Supported

GridMix GitHub
GridMix Community Chat
GridMix Online Wiki Documentation

Developed and maintained

Community support/online documentation

Use/application

Toolkit

Use/application

GridMix & IEEE
Blockchain Transactive Energy (BCTE) Initiative

How to Use GridMix

Hackathon
teaching/learning/events
demo lab
GridMix is composed of a modular and structured smart energy contract **generic reference model** that contains logical functions that can be customized for local energy markets.
GridMix Smart Contract Transaction Workflow

GridMix SLEC Data Model for Energy Trading Smart Contract

source: BEC
GridMix Smart Energy Contract

GridMix Reference Framework
source: BEC

Mapped on to Ethereum Solidity coding

500 lines of GridMix Master SLEC code released as a generic framework (version 1.0)
Key Takeaways

- Blockchain is a new enabling digital layer infrastructure for energy grid and new energy markets applications;

- Blockchain in Energy has several applications and use cases being explored by the **IEEE Blockchain in Energy Standards, IEEE P2418.5**
  
  - **Electric vehicle charging station** roaming, tokenization, tracking, energy usage reporting on Blockchain.

  - **Solar-PV/battery, Distributed Energy Resources (DER) energy markets grid transactions**, contract registration/negotiation on Blockchain.

  - **T&D supply chain/logistic** track and trace of mission critical equipment, software, devices on Blockchain.
Blockchain in Energy and Utilities: Definitions, Use Cases, Standards, and Frameworks

by Claudio Lima

Claudio Lima explains how blockchain technology can be used to digitize and foster growth in the energy sector. Distributed ledger technology (DLT) has the potential to optimize energy management processes and to deal with the growing complexity in the decentralized energy system. Lima introduces the IEEE P2418.5 Standard for Blockchain in Energy, which creates an industry framework that will help with interoperability among different blockchain use cases and technologies. A DLT layer complements existing smart grid architectures, improves grid security and efficiency, and reduces the costs of utility operation.
References

https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=8625908
INTRODUCTION

BEC Blockchain in Energy

Blockchain in Energy Markets
Virtual Training

February 4th 2021

https://forms.gle/Pk6tnHnAqXzSj3r8A
Thank You!

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