Blockchain for Energy, Environment, and Utilities

Neil Gerber
Director, New Energy & Blockchain
IBM

September 2018

Topics

- **Business Value of Blockchains**
- Blockchain Characteristics
- Network Governance and Scaling
- Energy & Utility Industry high value use cases
- Final thoughts on IoT integration

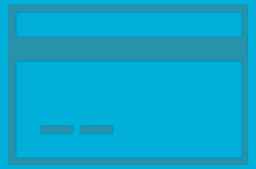
As a result of frictions many business transactions remain inefficient, expensive and vulnerable

Time

Many business transactions:

- are time sensitive
- require much settlement and reconciliation time
- are process-delay prone

Cost



Many business transactions:

- include overheads from multiple intermediaries
- are costly to manage and execute
- require extensive documentation

Risk

Many business transactions:

- are ambiguous and non-verifiable
- are prone to errors and tampering
- have no single source of truth

Source: IBM Institute for Business Value analysis

Topics

- Business Value of Blockchains
- **Blockchain Characteristics**
- Network Governance and Scaling
- Energy & Utility Industry high value use cases
- Final thoughts on IoT integration

Aspects of two blockchain types, with hybrids emerging

Main focus of this presentation

Public blockchain

- Permissionless, open access
- Anonymous participants and validators of transactions
- Allows anonymous transactions without need for a trusted intermediary

Business blockchain

- Permissioned access
- Consensus via trusted intermediaries
- Cryptographic database managed and shared by trusted parties
- *Used for enterprise and consortium applications*

Hybrid blockchain

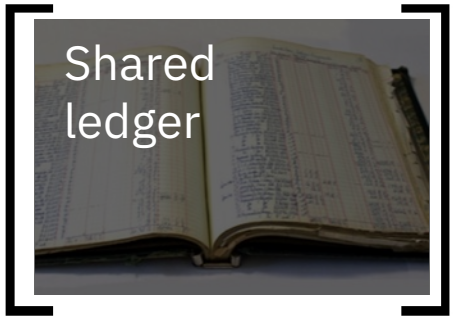
- Built on Public Chain Infrastructure
- Provide technology for permissioned networks

Adapted from: https://www.evry.com/globalassets/insight/bank2020/bank-2020---blockchain-powering-the-internet-of-value---whitepaper.pdf.

IBM

Attributes of blockchain for business

Append-only distributed system of record shared across business network



Business terms embedded in transaction database & executed with transactions

Ensuring appropriate visibility; transactions are secure, authenticated & verifiable

Transactions are endorsed by relevant participants

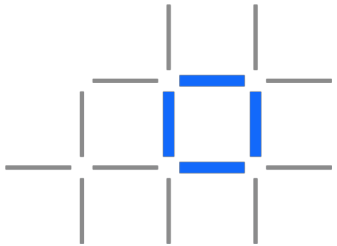
Example network interoperability Projects

HYPERLEDGER
QUILT

Hyperledger Quilt offers interoperability between ledger systems by implementing ILP, which is primarily a payments protocol and is designed to transfer value across distributed ledgers and non-distributed ledgers.

HYPERLEDGER
BURROW

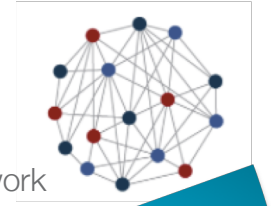
Hyperledger Burrow is a permissionable smart contract machine. The first of its kind when released in December, 2014, Burrow provides a modular blockchain client with a permissioned smart contract interpreter built in part to the specification of the Ethereum Virtual Machine (EVM).



Topics

- Business Value of Blockchains
- Blockchain Characteristics
- **Network Governance and Scaling**
- Energy & Utility Industry high value use cases
- Final thoughts on IoT integration

Enterprise Entry Points



Cross-Industry Network

New revenue
New services
New products

Collaborate with non-traditional partners to innovate to build new value propositions, digital platforms and marketplaces

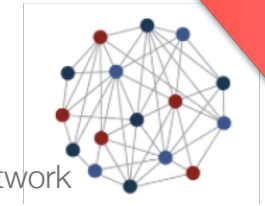
New Market Models

Cost
Innovation
Service

Collaborate with non-competitors to enhance today's differentiating processes B2B-2C

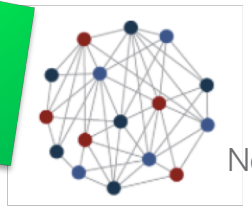
Business Differentiation

Enterprise



Founder Network

Market Utility



Network of Competitors

Optimize B2B costs
Optimize risk
Optimize capital

Collaborate with competitors to build market utilities to optimize shared B2B processes

Blockchain for Business – Design Principles

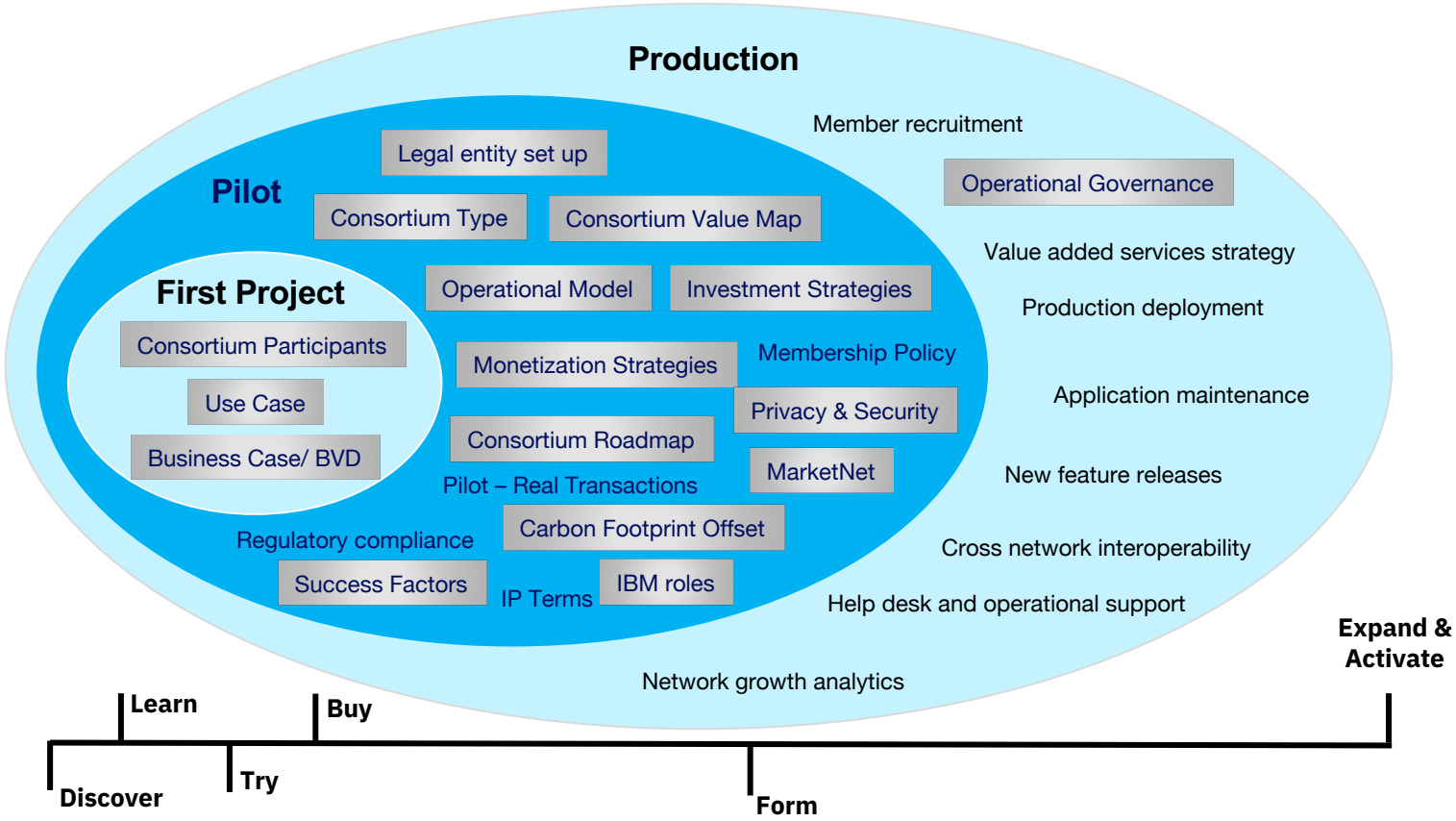
While blockchain technology alone is interesting, many other mechanics of a business network need to be evaluated as well. IBM has 7 key principles for Blockchain Solutions on the Hyperledger fabric:

Consensus models	• What trust system is appropriate for the business network?
Control and governance	• Which entities are allowed to do what? • Who owns and begins the investigative process in the event of a system anomaly? • Are Smart Contracts Legally credible?
Digital asset generation	• Who generates the asset in the system and who governs it?
Authority for issuance	• In a truly decentralized system, the notion of authority simply does not gel. • Who is responsible for governance, culpability, and eventually regulations?
Security considerations:	• How will enterprise security and new security challenges imposed by a shared business network be addressed?

7 design principles for sustainable blockchain business networks

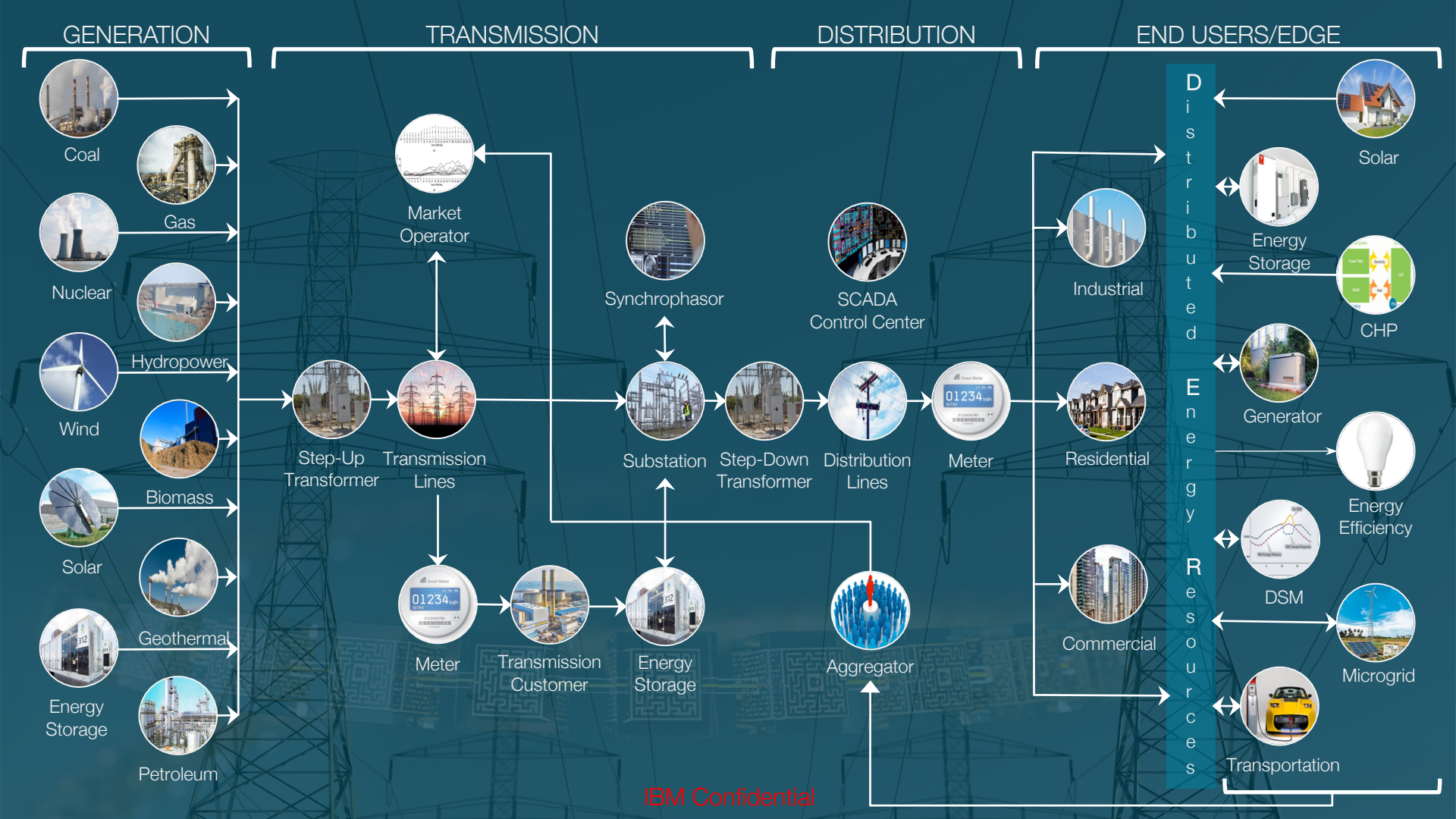
1. Network participants must have control of their business.
2. The network must be extensible, with membership flexibility.
3. The network must be permissioned but with competitive data protected.
4. The network must allow open access and global collaboration.
5. The network must be scalable for transaction processing and data encryption processing.
6. The network must be secure and address new security challenges of a shared network.
7. The network must co-exist with existing systems of record and transaction systems.

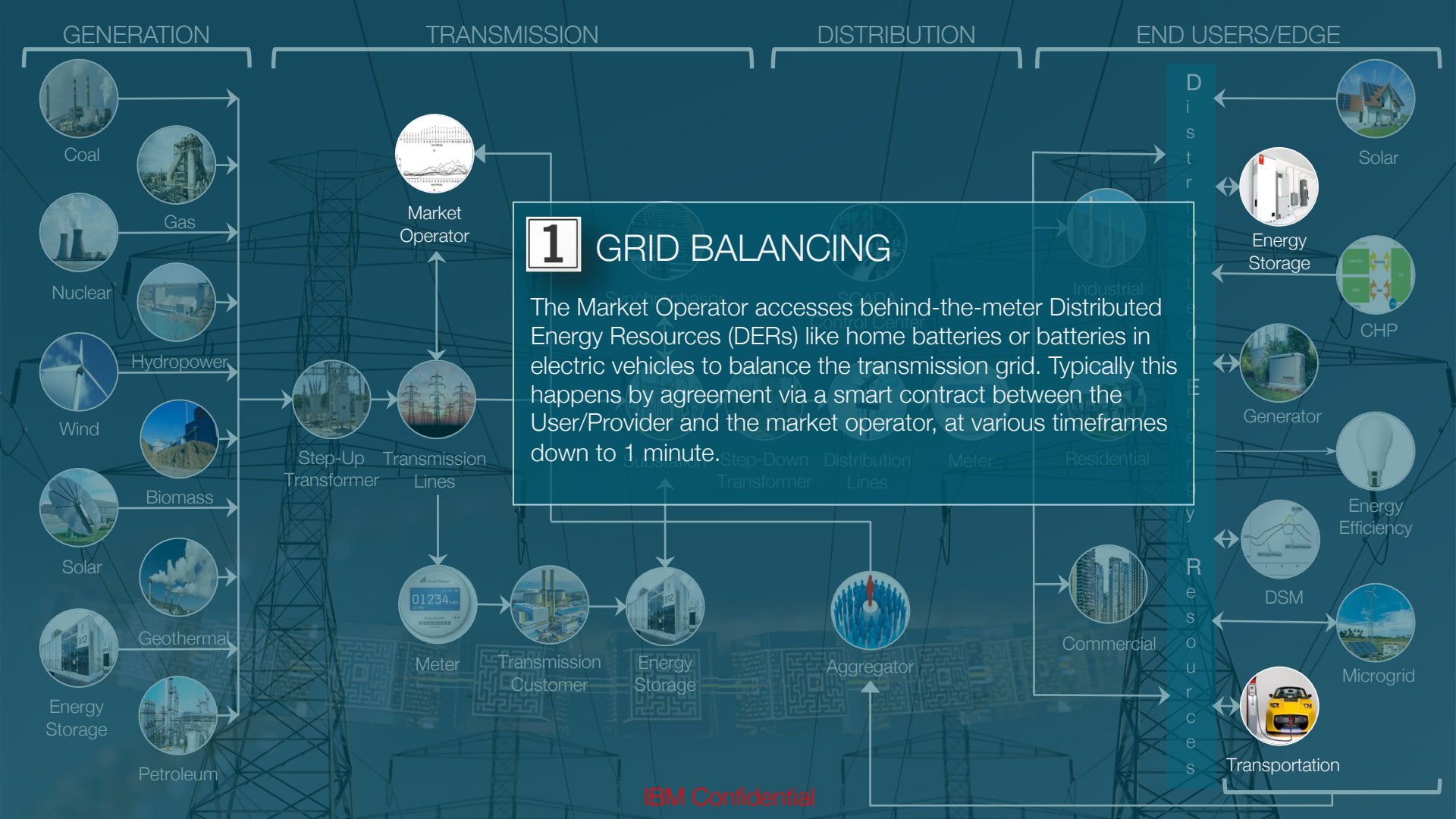
Blockchain Consortium Governance and Operating Model



Topics

- Business Value of Blockchains
- Blockchain Characteristics
- Network Governance and Scaling
- **Energy & Utility Industry high value use cases**
- Final thoughts on IoT integration


GENERATION
TRANSMISSION
DISTRIBUTION
END USERS/EDGE
Coal
Gas
Nuclear
Hydropower
Wind
Biomass
Solar
Geothermal
Energy Storage
Petroleum
Market Operator
Step-Up Transformer
Transmission Lines
Meter
Transmission Customer
Energy Storage
Synchrophasor
Substation
Step-Down Transformer
SCADA Control Center
Distribution Lines
Meter
Aggregator
Industrial
Residential
Commercial
Distributed Energy Resources
Solar
Energy Storage
CHP
Generator
Energy Efficiency
DSM
Microgrid
Transportation
IBM Confidential


GENERATION
TRANSMISSION
DISTRIBUTION
END USERS/EDGE
Coal
Gas
Nuclear
Hydropower
Wind
Biomass
Solar
Geothermal
Energy Storage
Petroleum
Market Operator
Step-Up Transformer
Transmission Lines
Meter
Transmission Customer
Energy Storage
Aggregator
Step-Down Transformer
Distribution Lines
Meter
Industrial
Residential
Commercial
Distributed Energy Resources
Solar
Energy Storage
CHP
Generator
Energy Efficiency
DSM
Microgrid
Transportation
1 GRID BALANCING
The Market Operator accesses behind-the-meter Distributed Energy Resources (DERs) like home batteries or batteries in electric vehicles to balance the transmission grid. Typically this happens by agreement via a smart contract between the User/Provider and the market operator, at various timeframes down to 1 minute.
IBM Confidential

TenneT is unlocking distributed energy resources flexibility via IBM Blockchain

The need:

- The electricity grid is becoming more volatile due to the growing share of renewable electricity generation in the overall supply
- TenneT is working to find new ways of maintaining the security of supply

Solution:

- TenneT is exploring the use of a permissioned blockchain network that will use Hyperledger Fabric to integrate flexible battery storage capacity into the electrical grid
- Blockchain enables owners of electric vehicles and residential solar batteries to indicate the available capacity of their batteries available to help TenneT balance grid supply and demand

"These pilot projects are part of TenneT's broader strategy of preparing the electricity system to accommodate the growing volume of renewable energy."

Mel Kroon
CEO, TenneT

Different ancillary energy products

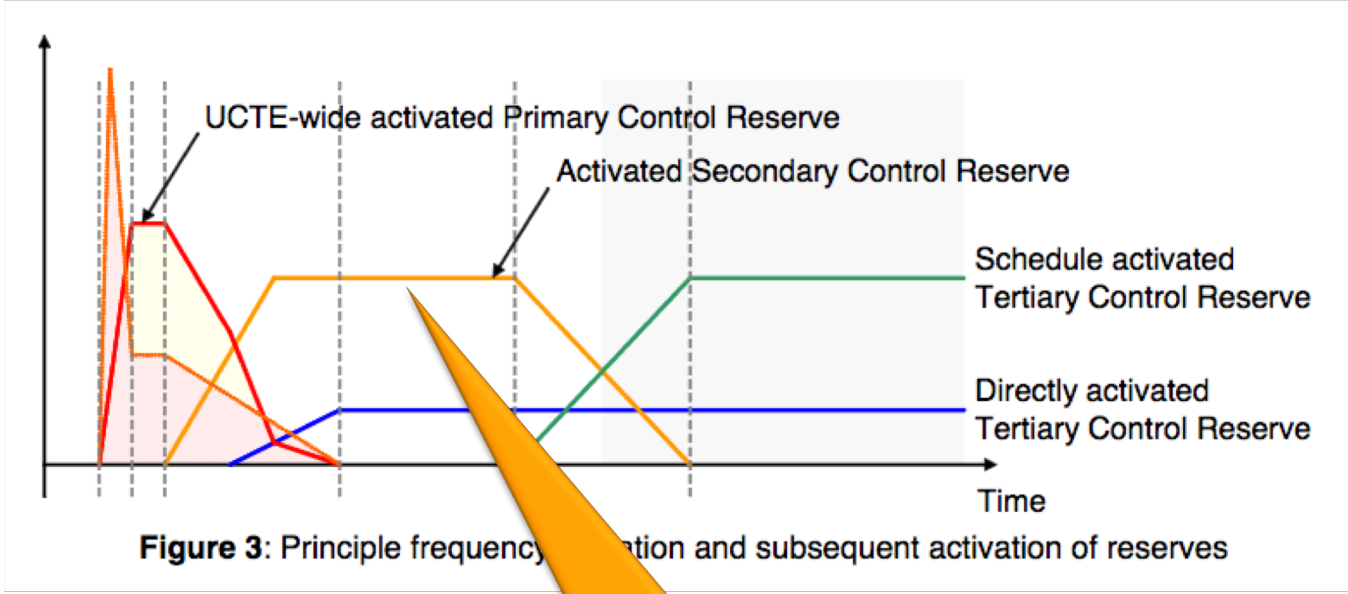
How Quickly can you respond to a request?

Remotely controlled systems are not fast

- Not for primary control reserve

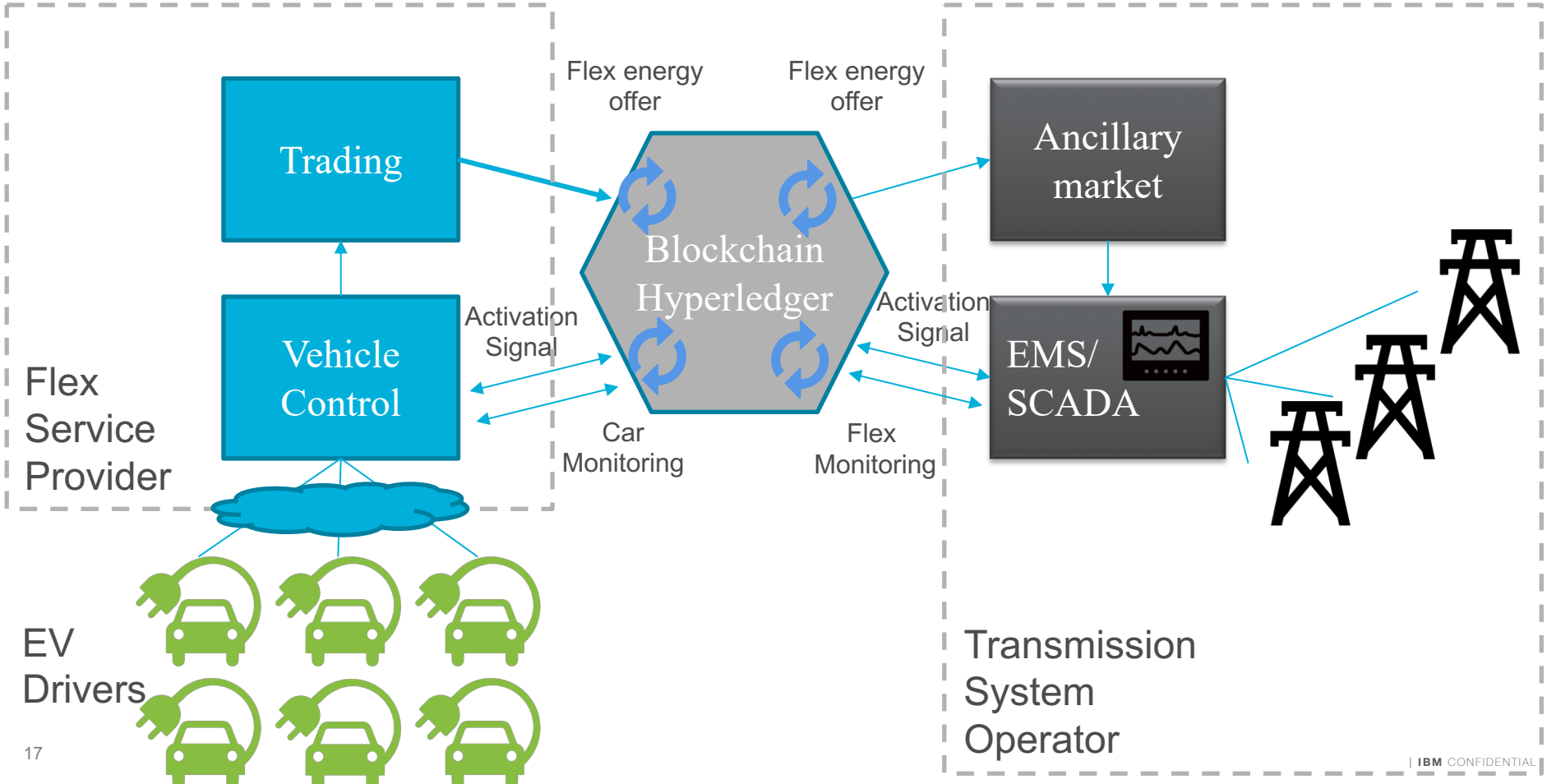
Electric vehicles have limited capacity

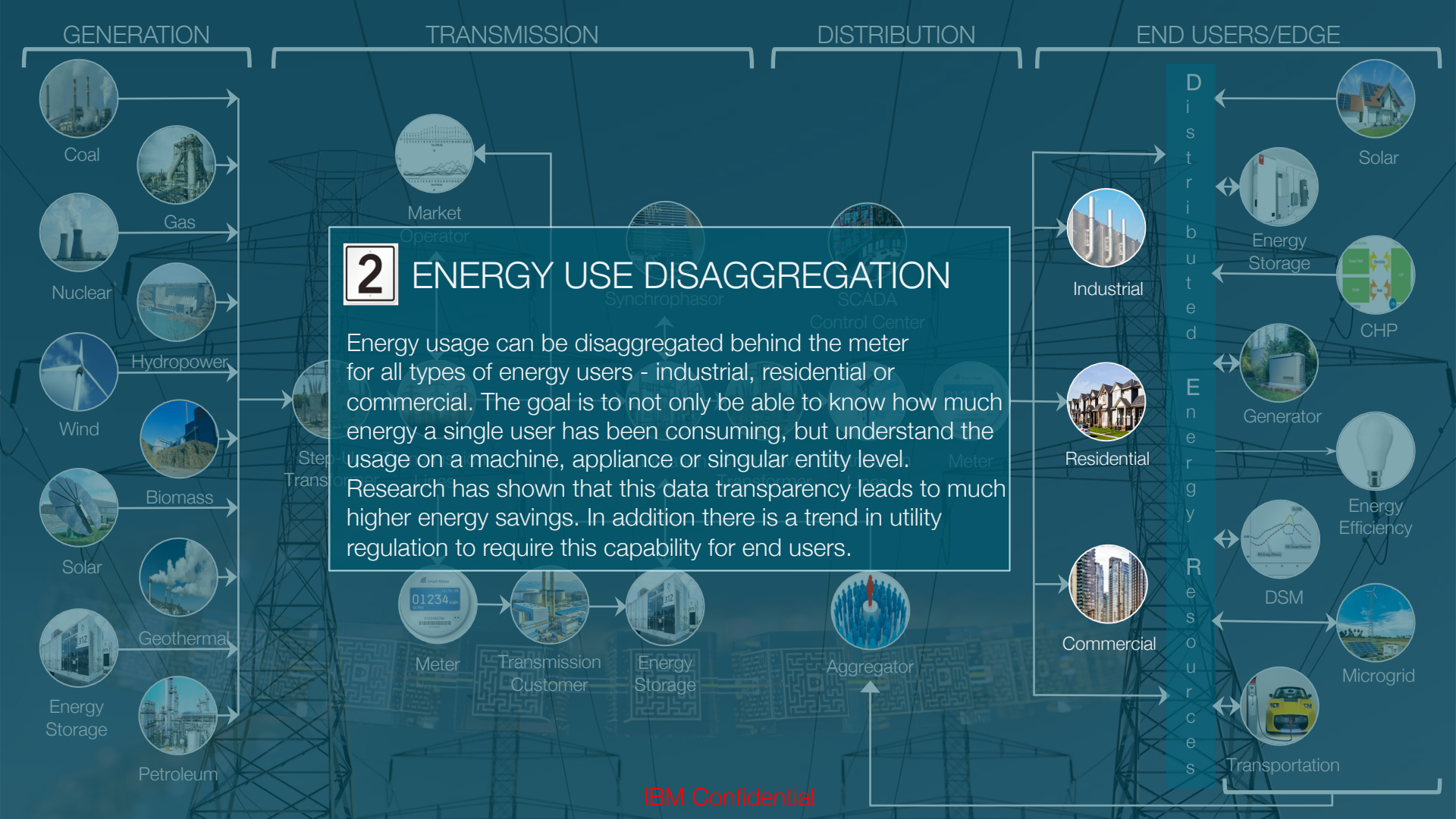
- Not suitable for tertiary control reserve



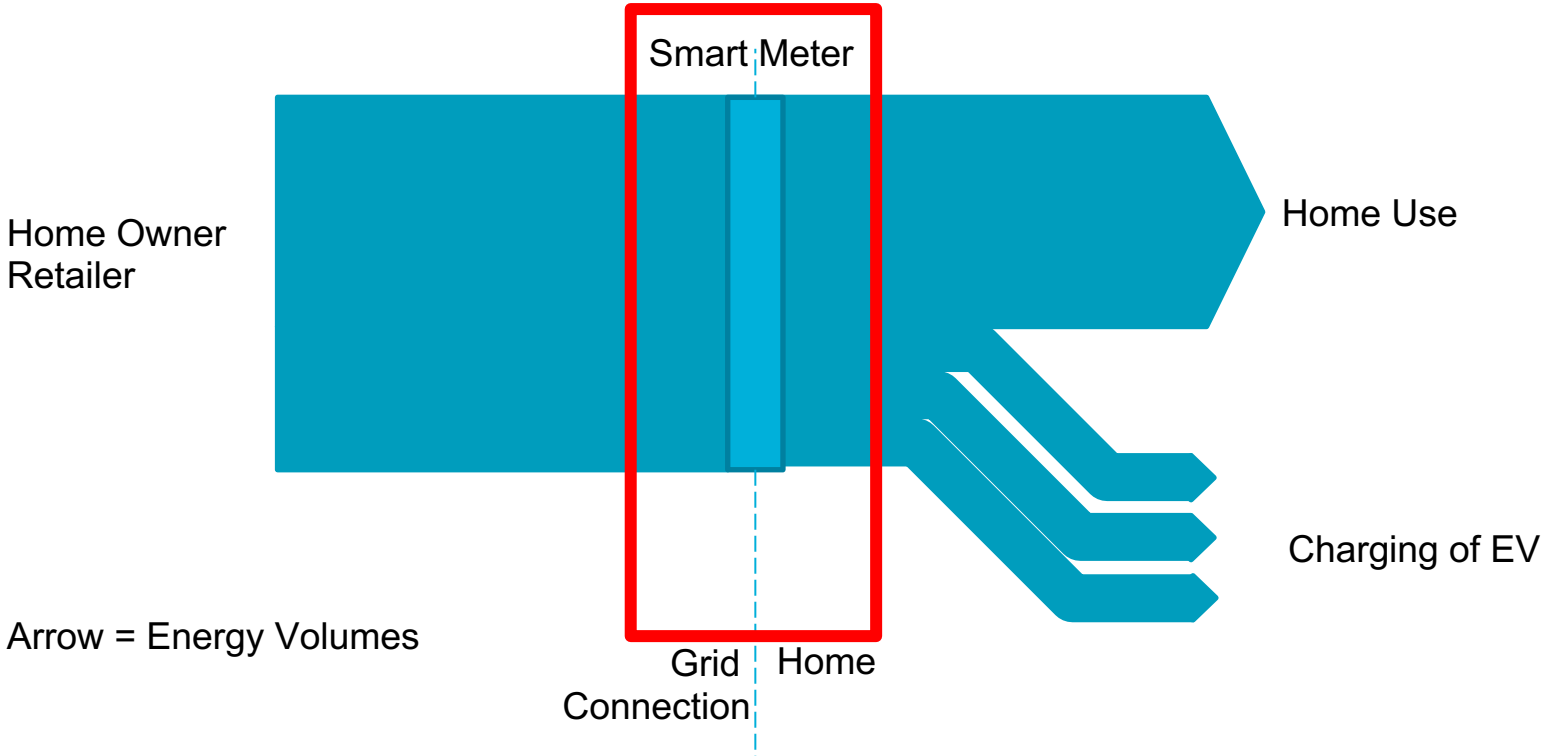
https://www.entsoe.eu/fileadmin/user_upload/_library/publications/entsoe/Operation_Handbook/Policy_1_final.pdf

Blockchain Based Energy Balancing



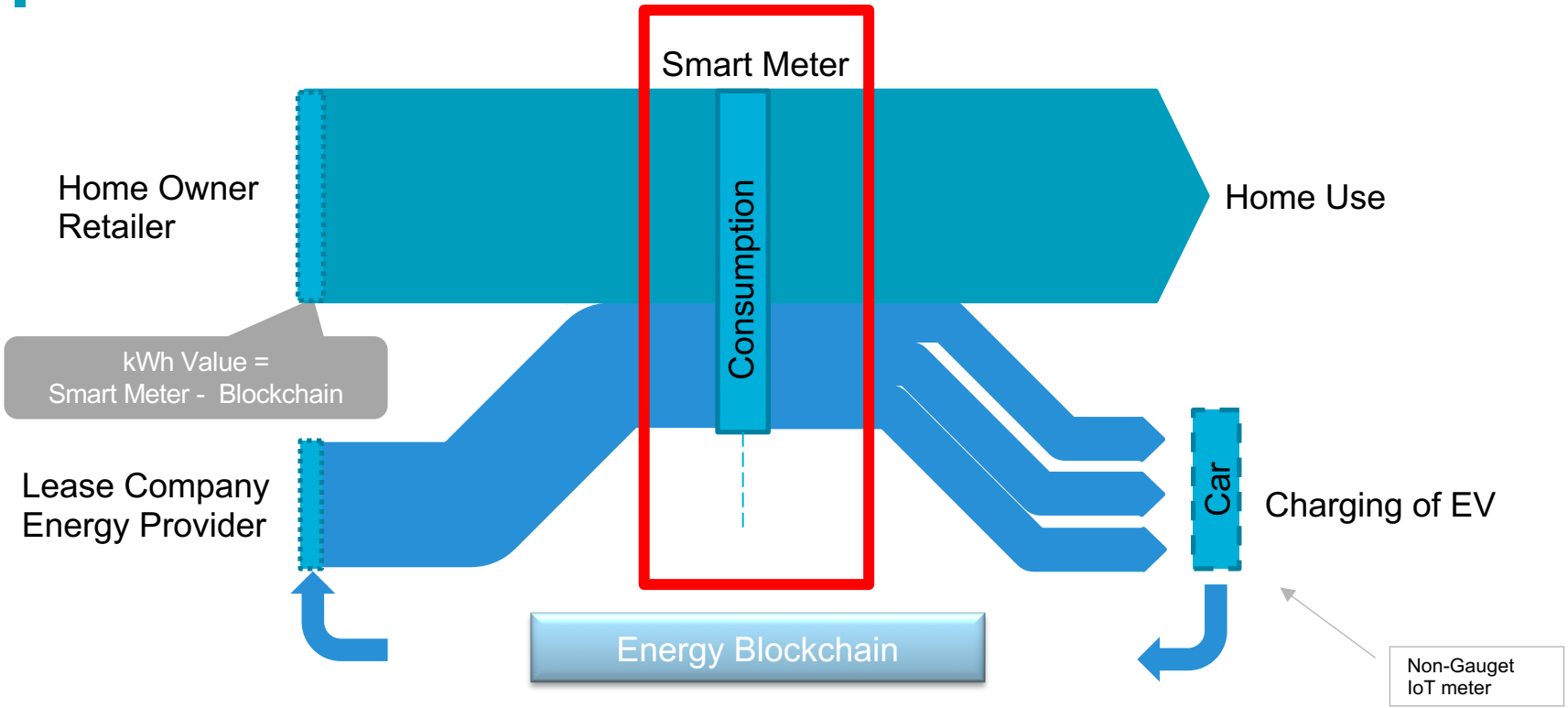

GENERATION
TRANSMISSION
DISTRIBUTION
END USERS/EDGE
Coal
Gas
Nuclear
Hydropower
Wind
Biomass
Solar
Geothermal
Energy Storage
Petroleum
Market Operator
Synchrophasor
SCADA Control Center
Meter
Transmission Customer
Energy Storage
Aggregator
Industrial
Residential
Commercial
Distributed Energy Resources
Solar
Energy Storage
CHP
Generator
Energy Efficiency
DSM
Microgrid
Transportation
2
ENERGY USE DISAGGREGATION
Energy usage can be disaggregated behind the meter for all types of energy users - industrial, residential or commercial. The goal is to not only be able to know how much energy a single user has been consuming, but understand the usage on a machine, appliance or singular entity level. Research has shown that this data transparency leads to much higher energy savings. In addition there is a trend in utility regulation to require this capability for end users.
IBM Confidential

Energy consumption for a given period: Current Situation



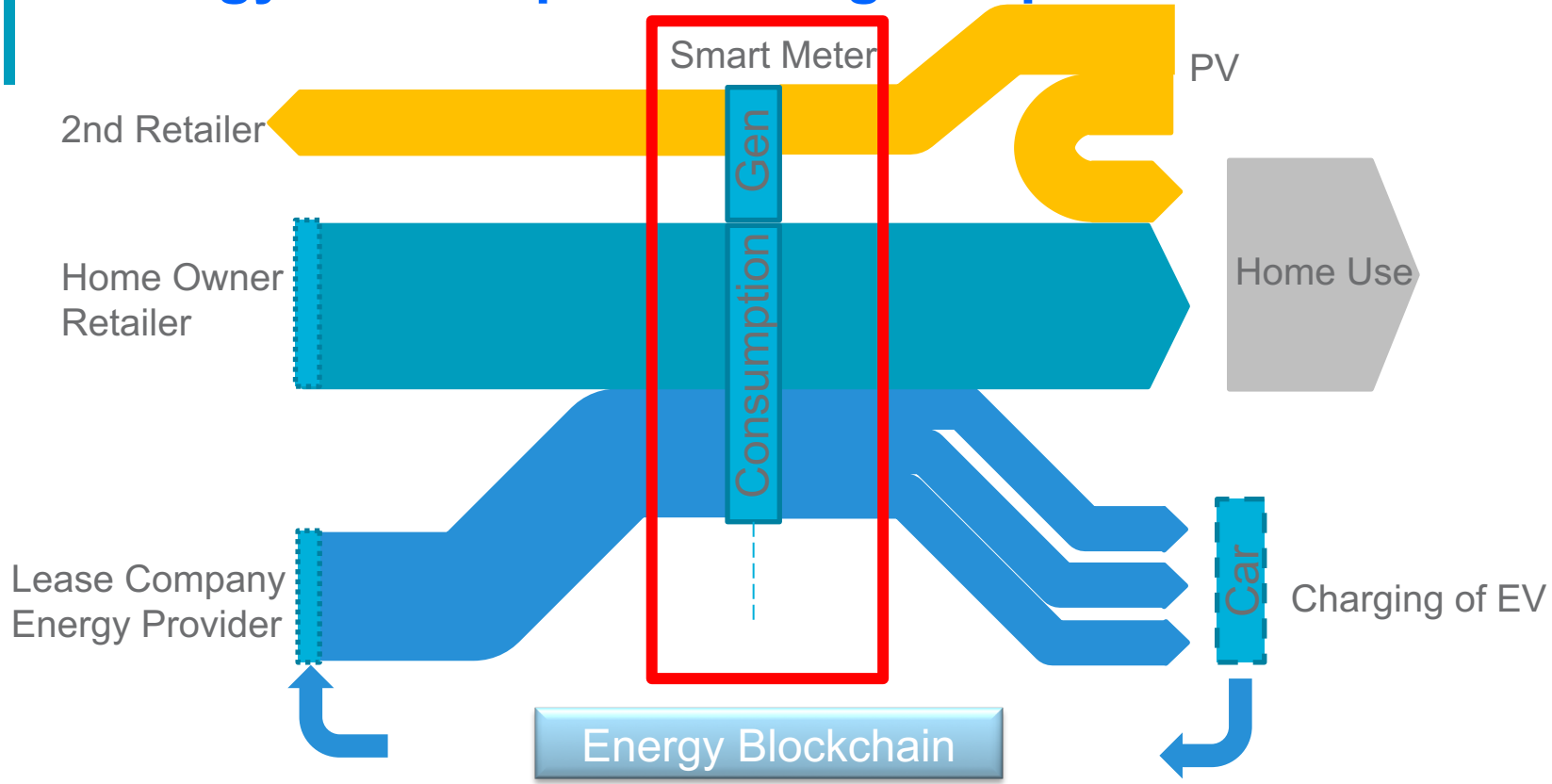
Smart Meter
IoT Meter
Virtual Meter

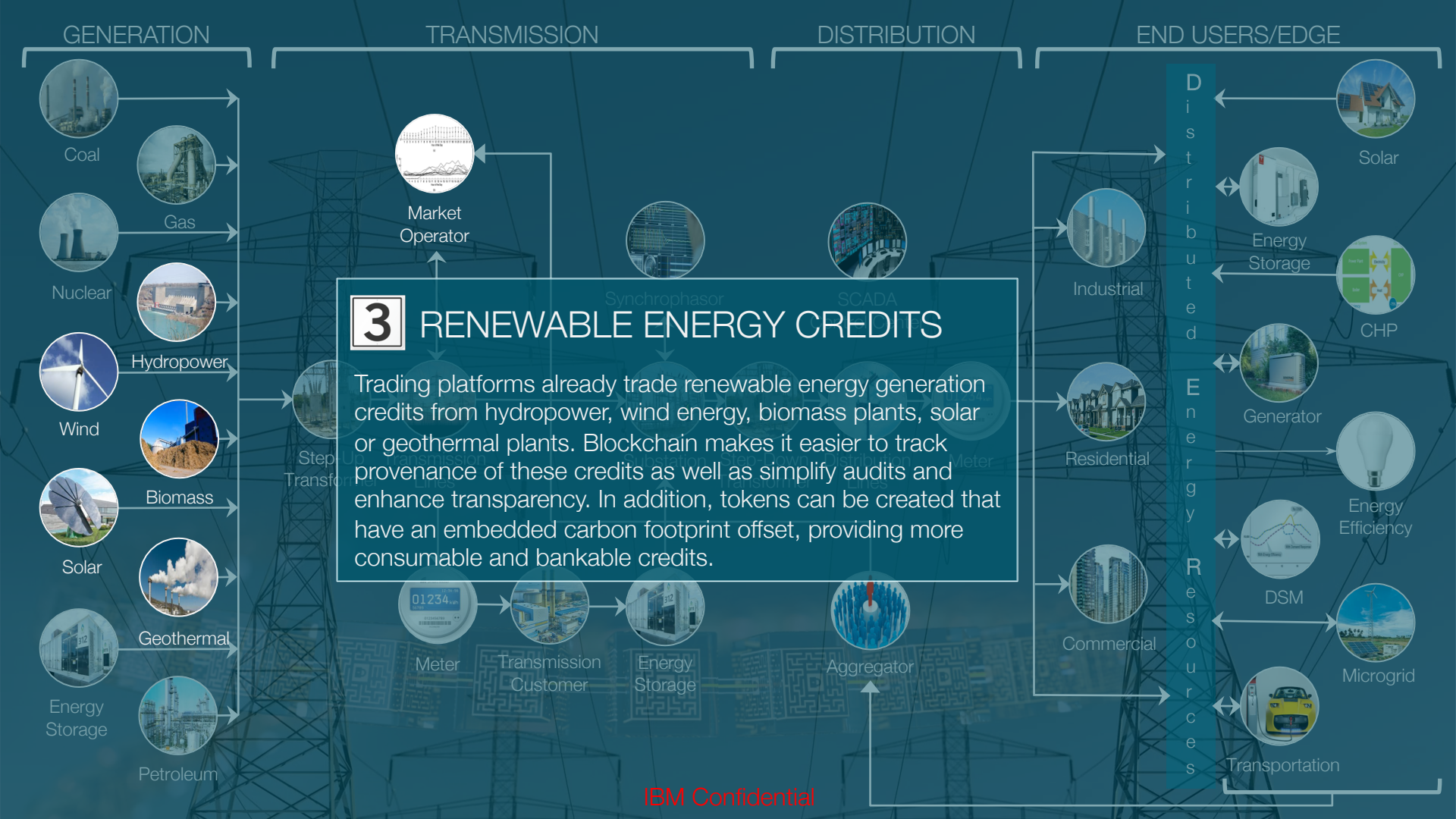
Energy consumption for a given period: Blockchain-based EV charging



Smart Meter
IoT Meter
Virtual Meter

Energy consumption for a given period





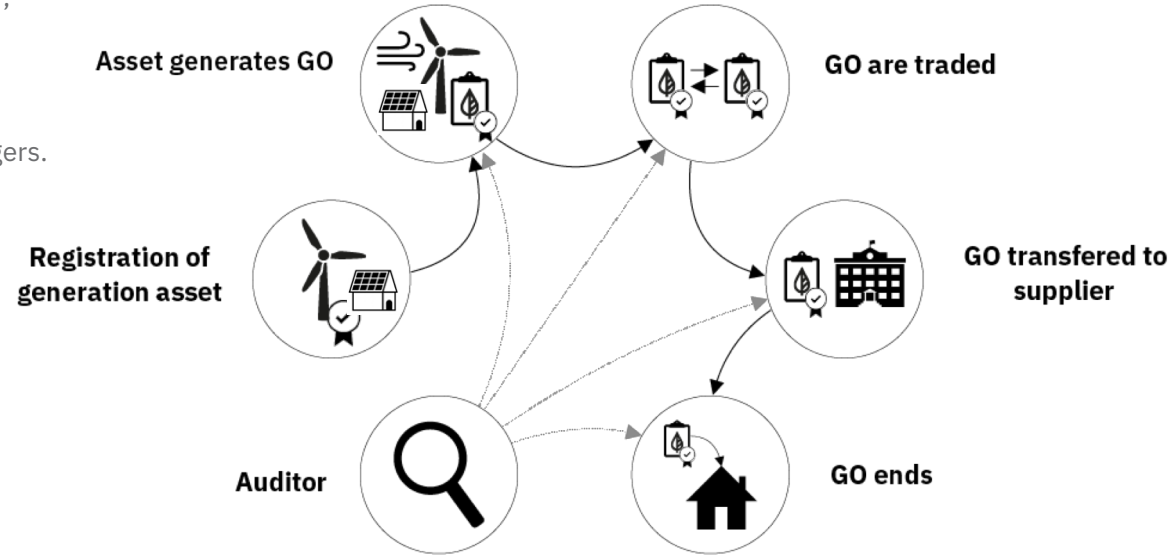
Current Guarantees of Origin processes

The current GO lifecycle is spread across multiple parties, systems and ledgers

Expensive
Every participant keeps
their own ledger, next to the current CertiQ ledger, with their transactions. Not fully-automated processes.

Inefficient
Disputes because organizations use different ledgers.
Corrections of mistakes
Does not scale to small scale assets.

Vulnerable
Non-automated processes require intensive auditing.



certiQ IBM

Guarantees of Origin processes using blockchain

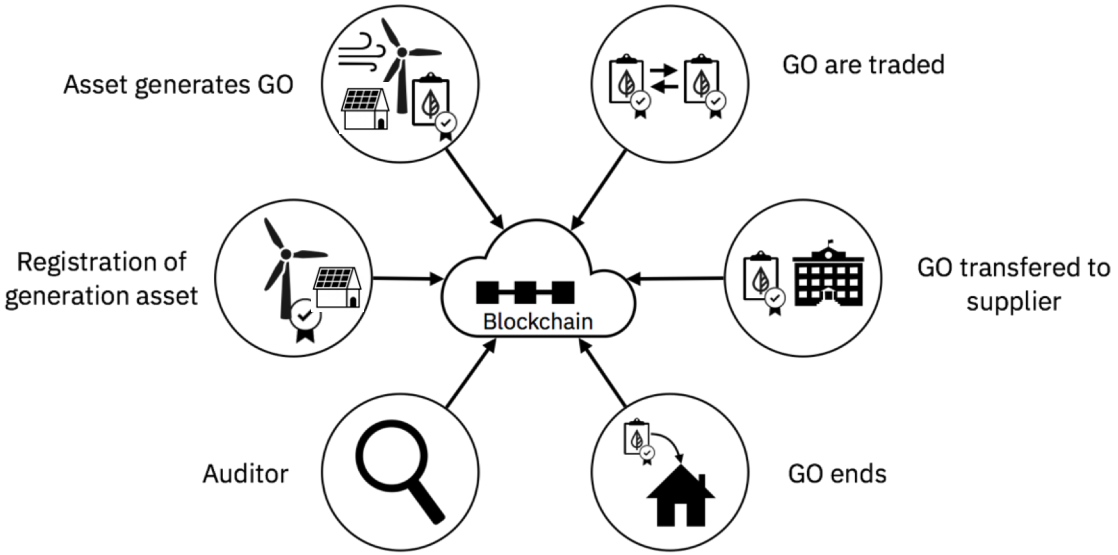
Blockchain captures the end-to-end process in one ledger. All parties work on the same data.

Transparent
Every participant keeps the shared ledger updated with their relevant transactions.

Trustworthy
All participants agree on what information is stored immutably on the blockchain and how.

Efficient
All participants share the same source of truth for their operations.

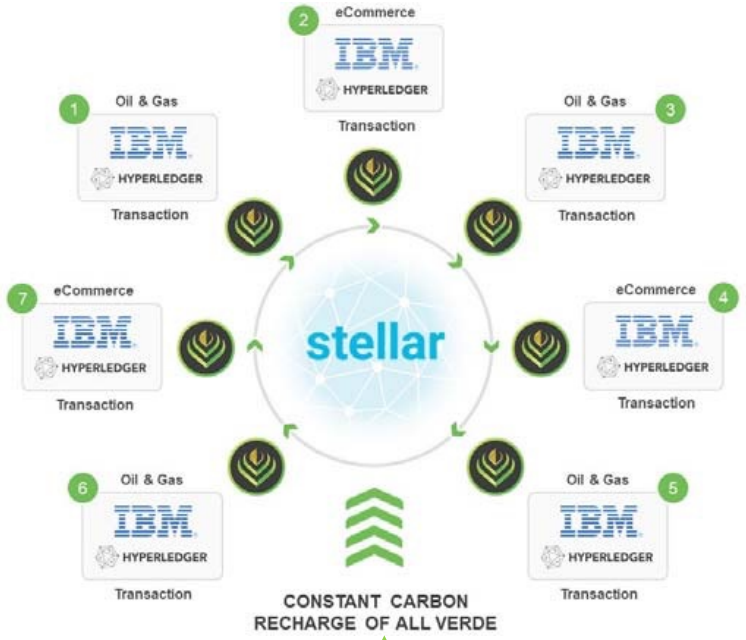
Granular
Smaller decentralized sources of renewable energy can receive GOs cost effectively.



With a private Blockchain, privacy between parties is ensured, and access is secure and controlled.

certiQ IBM

Veridium “Verde” Carbon Offset Token

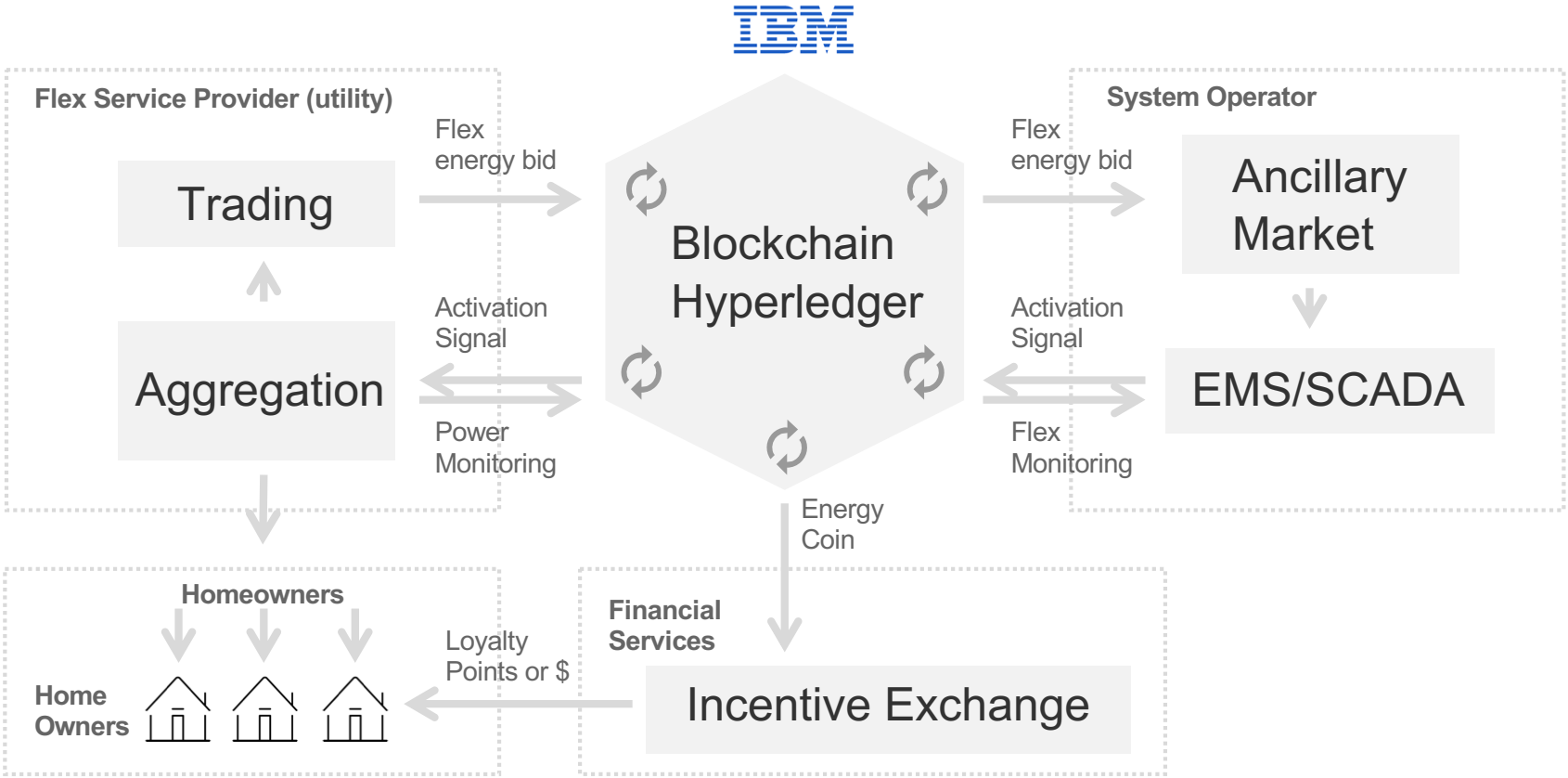


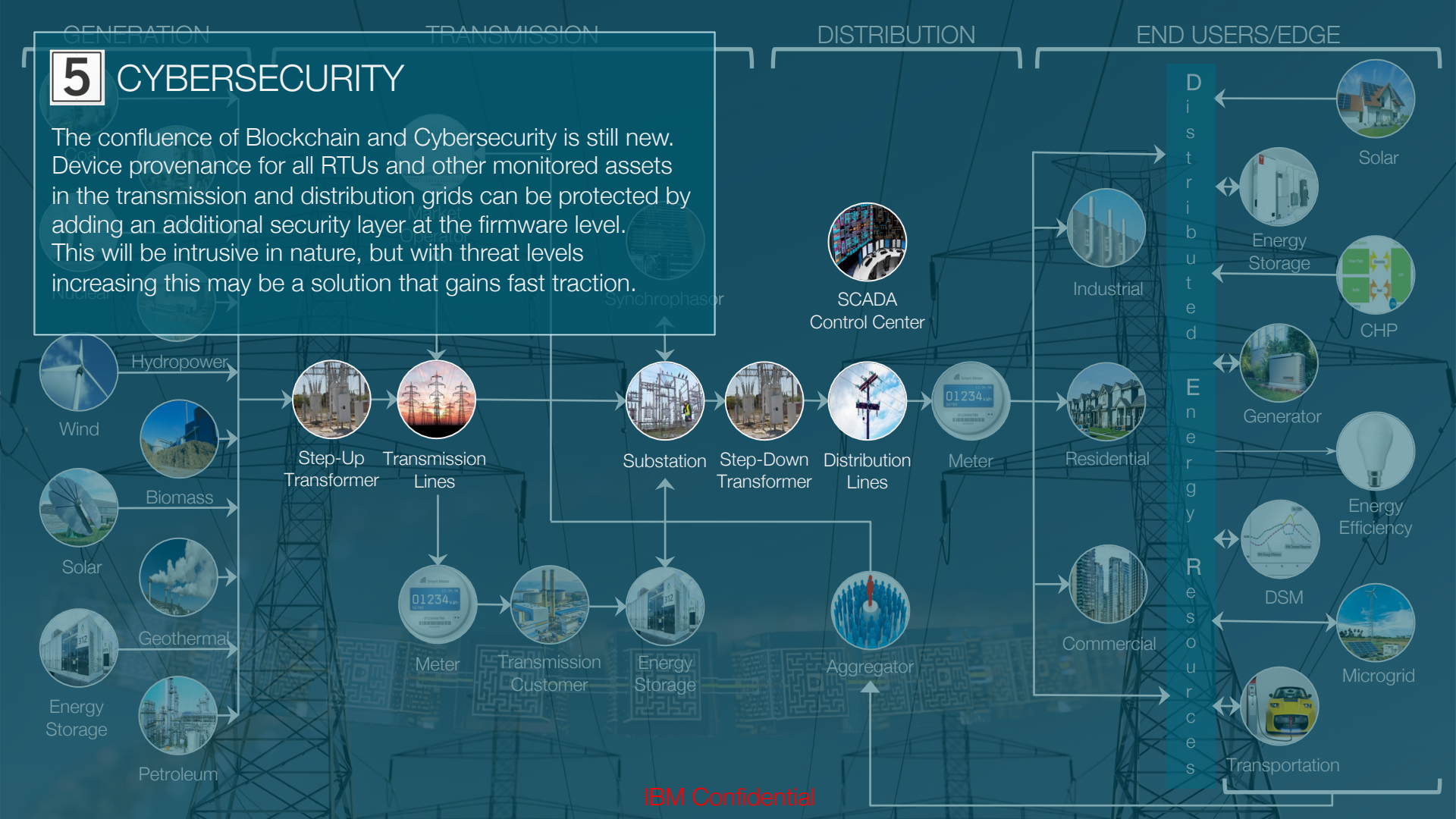
Transaction of tokens triggers “emptying and refilling” of carbon bank

Imagine as a “target” network for a variety of green credits

certiq IBM

P-U-P First steps

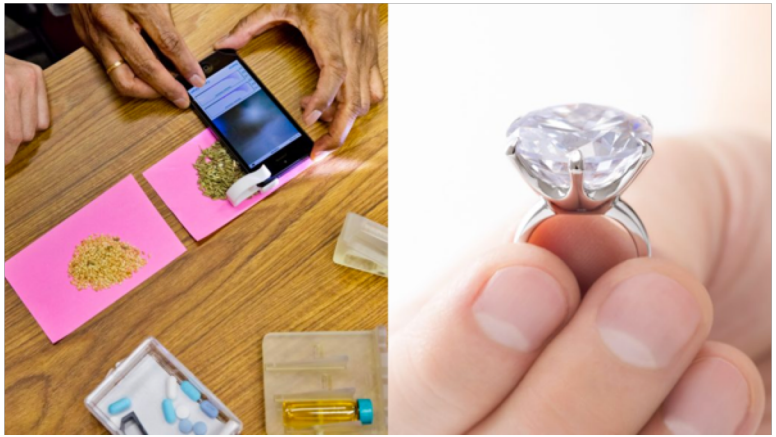


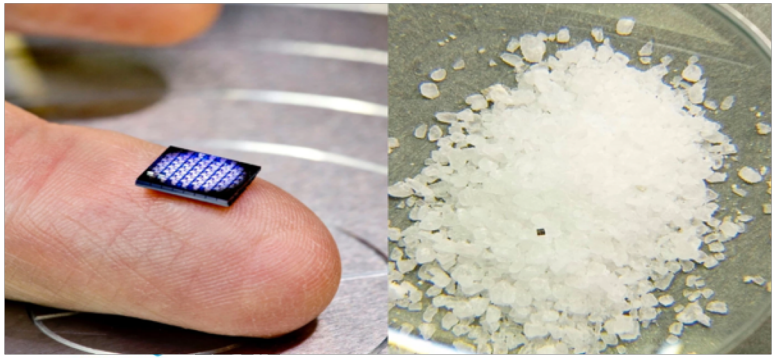

GENERATION
TRANSMISSION
DISTRIBUTION
END USERS/EDGE
5 CYBERSECURITY
The confluence of Blockchain and Cybersecurity is still new. Device provenance for all RTUs and other monitored assets in the transmission and distribution grids can be protected by adding an additional security layer at the firmware level. This will be intrusive in nature, but with threat levels increasing this may be a solution that gains fast traction.
Hydropower
Wind
Biomass
Solar
Geothermal
Energy Storage
Petroleum
Step-Up Transformer
Transmission Lines
Meter
Transmission Customer
Energy Storage
Substation
Step-Down Transformer
Distribution Lines
Meter
SCADA Control Center
Aggregator
Industrial
Residential
Commercial
Distributed Energy Resources
Solar
Energy Storage
CHP
Generator
Energy Efficiency
DSM
Microgrid
Transportation
IBM Confidential

Topics

- Business Value of Blockchains
- Blockchain Characteristics
- Network Governance and Scaling
- Energy & Utility Industry high value use cases
- **Final thoughts on IoT integration**

Final thought – Verifying authenticity of assets at source





Combining AI and Optical Imaging to codify authenticity for use in verification somewhere else in the blockchain network

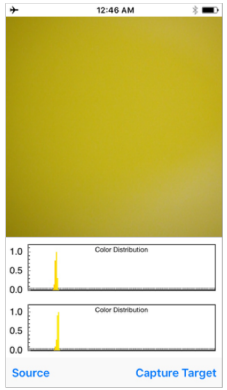
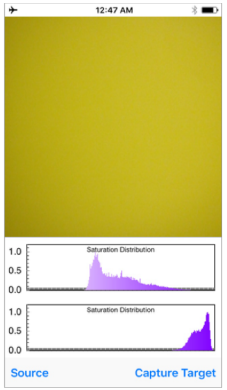


Image captured with cellphone that has the Verifier installed

Output from Verifier distinguishing different oils, liquids



Mobil-1 (5w-30)

Sunoco Ultra Premium (10w-30)