Accelerating the Renewable Energy Transformation

Role of Green Power Tariffs and Blockchain

PRESENTED BY

Sanem Sergici, Ph.D.

Co-author:
Marty Turrin

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Customer desire for clean energy is increasing

Corporate customers are increasingly requesting tariffs or services that allow them to meet most, if not all of their loads, through clean energy to meet corporate sustainability goals

Large customers are making location decisions based on the availability of green tariffs

- In 2016, Facebook announced its decision to open a new data center in New Mexico. The decision was made in part based on the availability of a “green” tariff to supply 100% of its energy needs from renewable generation

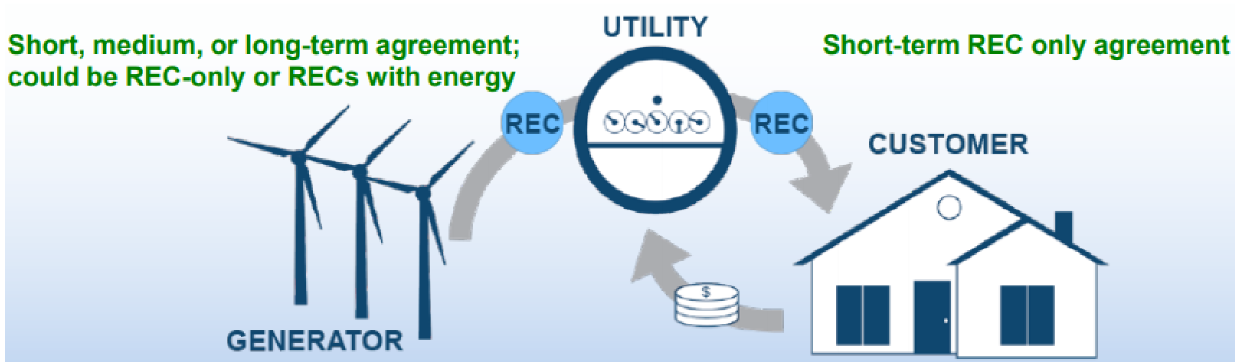
In restructured states, customers can have easy access to renewable energy resources through shopping with electricity suppliers

In vertically integrated states, customer options for accessing renewable resources are expanding through “Green Pricing” and “Green Tariff” programs

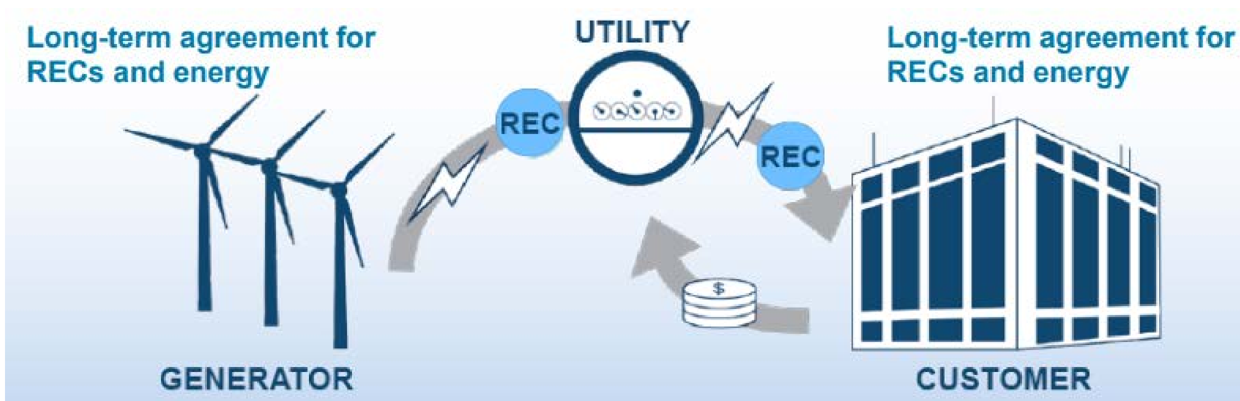
Customer access to renewable energy resources has improved substantially through standardized utility offerings

In most places, customers now have the ability to contract for renewable energy through Green Pricing or Green Tariff programs

Green Pricing



Green Tariffs



Source: "Utility Green Tariff Programs: Considerations for Federal Agencies," NREL, May 4, 2017, pp. 3-4.

Green Pricing

Contract Length:

- Monthly

- Customers do not need to sign annual or multi-year commitment

Price:

- Premium of one or two cents per kilowatt hour on top of customer's otherwise applicable rate

Ease of Joining:

- Easy

- No contract negotiations required

Renewable Source:

- Utility decides source of renewable energy

- No input from customer

Source: "Utility Green Tariff Programs: Considerations for Federal Agencies," NREL, May 4, 2017, p. 5.

- The utility procures renewable energy without customer input
- The utility typically procures RECs only instead of constructing new generation or negotiating a PPA
- Green Pricing programs typically feature shorter contracts

Green Tariffs

Contract Length:

- Annual or multi-year commitment
- Customers pay a termination fee for exiting earlier

Price:

- Rates per kilowatt-hour are cost competitive with typical utility rates

Ease of Joining:

- Typically must negotiate a contract with the utility

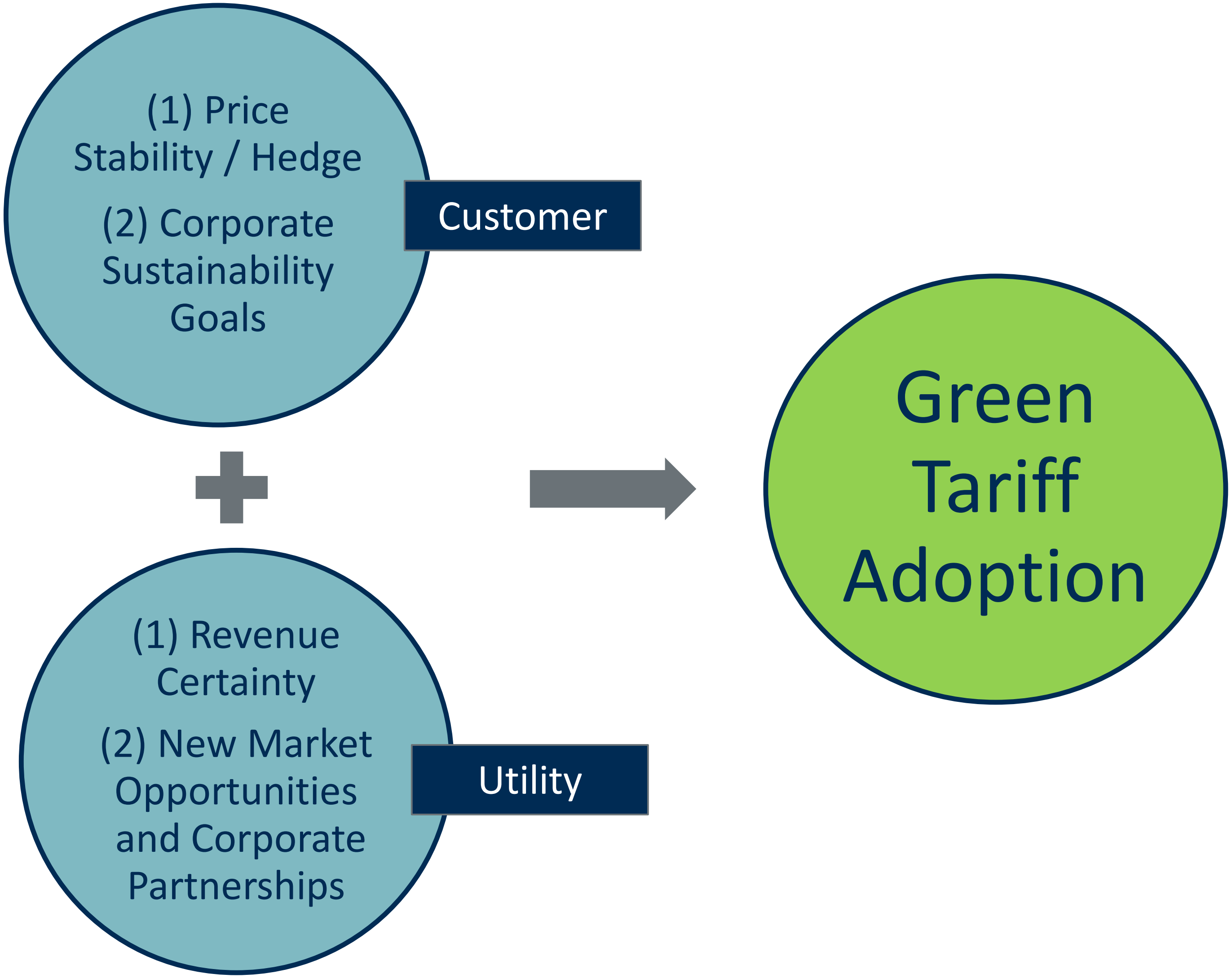
Renewable Source:

- Customer may provide input either through contract negotiations with utility or during PPA negotiation with third-party

Source: "Utility Green Tariff Programs: Considerations for Federal Agencies," NREL, May 4, 2017, p. 5.

- The utility provider may negotiate a PPA to procure renewable energy for the customer
- Green Tariff programs more likely feature PPAs with actual generators than only on RECs
- Green Tariff programs typically feature longer term contracts

Drivers of Green Tariff Adoption



Three Models of Green Tariff Programs

1) Sleeved PPAs allow an individual customer to engage in a PPA with a renewable generator via the utility

- NV Energy
- Duke North Carolina

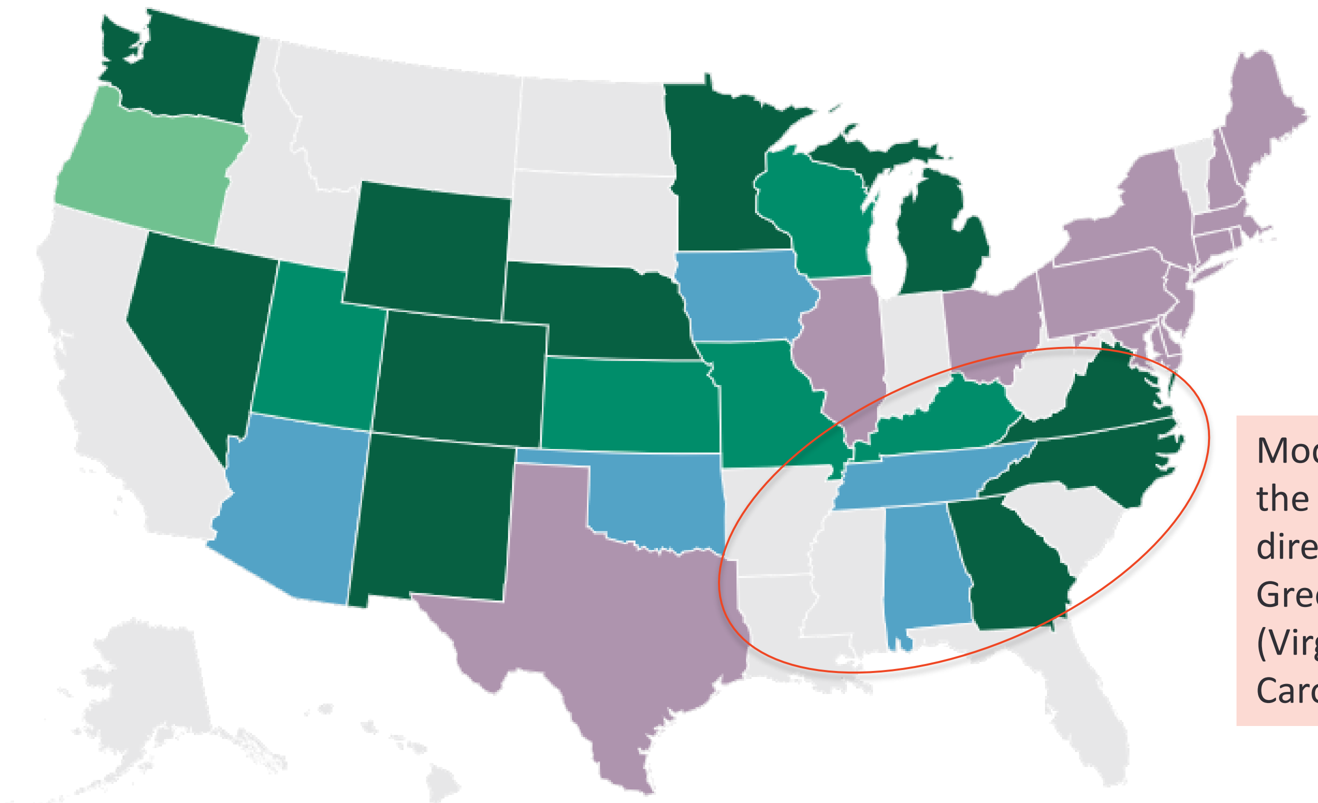
2) Subscriber Programs allow customers subscribe to a PPA while the utility holds the PPA (similar to a community solar project)

- Xcel Minnesota, Xcel Colorado
- Pacific Gas and Electric Company
- Washington Puget Sound

3) Market Based Rates (MBR) allows customers to participate in wholesale energy markets at market rates

- Consumers Energy
- OPPD

States with Green Tariff Programs (October 2018)



Modest activity in the Southeast through direct deals and a few Green Tariff deals (Virginia, North Carolina, and Georgia)

Utility Renewable Energy (RE) Deals

- Green tariff(s) and executed RE deal(s) through tariff
- Green tariff(s) but no deal(s) through tariff to date
- Considering a green tariff (proposal with the PUC)
- One-on-one RE deal(s) between companies and utilities, but no green tariff to date
- Electric retail choice easily available (EIA)
- No known direct large-scale RE access available

Source: AEE, 2018

Corporate Examples of Green Tariffs in Action

Facebook solicited utilities in two states to provide a rate option for the company to supply a planned data center with 100% renewable energy

- Public Service Company of New Mexico created the state's first green tariff program in response
- The data center attracted an initial capital investment of $250M and roughly five thousand jobs

Amazon Web Services (AWS) worked with Dominion Power (VA) to create a market-based tariff for several data centers

- AWS pays a retail rate to Dominion that resembles the market price for renewable energy from PJM
- The market-based price acts as a hedge against price volatility from non-renewable resources
- AWS entered into five new solar farm agreements following the creation of the tariff

Sleeved PPA Example:

NV Energy (NV) – "Green Energy Rider"

Eligibility	Structure	Cost Breakdown	Contract Length	Value of Contract
• Commercial and industrial customers • Demand between 50 and 500 kWs; or monthly usage greater than 10,000 kWhs	• (1) Customer negotiates with utility to dedicate new or existing renewable energy facilities; <u>or</u> • (2) Customer contracts with utility for 50% or 100% of their consumption	• 12-month average cost of utility RE resources less the base tariff energy rate and RE development charge (recalculated quarterly)	• Negotiated, minimum of two years	• Protection from fuel cost adjustments • Ability for customer to meet energy needs from renewable resources

Apple utilized the tariff for a total of 320 MW; and Switch utilized the tariff for A total of 179 MW to date

Subscriber Program Example:

Xcel Energy (CO) – “Renewable*Connect”

Eligibility	Structure	Cost Breakdown	Contract Length	Value of Contract
• Residential and C&I customers	• Utility enters into 20-year PPA with renewable energy facility • Utility assigns capacity and costs to program subscribers	• Standard retail rate plus Renewable Connect Charge (PPA cost, solar integration cost, admin fee, Risk adjustment) • Applies avoided energy and capacity bill credit	• Month-to-month; or • Five-year; or • Ten-year	• Price certainty guaranteed at time of subscription • Potential for credit to outweigh the cost of the program • Ability for customer to meet energy needs from renewable resources

Market-Based Rate

Omaha Public Power District (NE)

Eligibility	Structure	Cost Breakdown	Contract Length	Value of Contract
• Standard voltage of 161 or 345 kV • Minimum demand of 20,000 kW for 161 kV or 200,000 kW for 345 kV	• Customer contracts with the utility or procures directly, at a market-based rate	• $10,000 service charge per month • $22.45 per kW of billing demand • Market-based rate per kWh • Minimum bill of $495,000 (161 kV) or $4.5 m (345 kV) for first 18 months	• Minimum of one year • If OPPD is a signatory on the PPA, minimum length is length of PPA	• Ability for customer to meet energy needs from renewable resources

Facebook utilized the tariff for a total of 310 MW

Blockchain Technology in a nutshell

A blockchain is a form of digital ledger, composed of "blocks" of ledger entries which are "chained" together to provide a complete ledger history

A block typically contains a unique identification number, a timestamp, cryptographic keys, and other validating information

Blockchains rely on cryptographic algorithms which enable users to confirm the contents of a blockchain in a decentralized manner, avoiding reliance on a trusted central authority

- Information in a block is validated as a complete set, where validation includes checks for cryptographic signatures, consistency between transactions, and any other necessary block attributes

Blockchain has an embedded mechanism to prevent manipulation

Blockchain is formed when individual blocks are linked together supported by *cryptographic hash* – a unique identifier which confirms the contents of the previous block

A hash is irreversible and collision resistant ensuring that a user cannot manipulate the information in the previous block and still produce the same cryptographic hash

- By referencing a hash of the previous block, the new block retains a unique stamp of the previously validated data. This way, each hash becomes a function of all previous blocks
- If any of the earlier transactions are manipulated, the new hash will conflict with the hash stored by other users, ensuring the manipulated blockchain will not be validated.

Key attributes of blockchains (I)

Decentralized

- No single gatekeeper of the ledger entries and no single definitive copy of the ledger
- Removes the need to trust a central gatekeeper
- Reduce the ledger's vulnerability to outside manipulation

Trustless

- Solves trust problems associated with ledger management through its use of encryption, incentive mechanisms, and decentralization
- Eliminating the need for multiple layers of trust, makes new types of transactions economically viable

Transparent

- Blockchains can be designed at various levels of transparency depending on the tradeoffs between the benefits of transparency, ability to enforce regulation, and cost of securing the system against malicious actors

Key attributes of blockchains (II)

Secure, resilient and efficient

- Current state of the blockchain depends on previous transactions ensuring that a malicious actor cannot alter past transactions. This increases security and trustworthiness of the distributed ledger
- Since blockchain is a decentralized ledger with many copies, it is inherently more resilient compared to centralized systems
- "Smart Contracts" improve the efficiency of blockchain technology
  - Smart contracts are comprised of computer code that implement different business rules which must be verified and agreed upon by all peer nodes from the network.

Transaction speed and costs

- The processing speed of transactions may result in savings on the capital that may need to be held in reserves during the time the traditional transactions get processed

Blockchain Applications in Electricity I

Decentralized ledgers such as blockchain has the potential of introducing substantial transactional efficiency and cost savings in the energy applications

- Data is instantly verifiable and actionable on a decentralized ledger leading to significant time and cost savings

Peer-to-peer transactive energy

- Once regulatory hurdles are removed, the distributed nature of blockchain could allow energy prosumers to sell power directly to customers
- Power Ledger has recently announced a project in which Northwestern University will now be able to trade its excess solar energy inside its own campus and between multiple sites, using only Power Ledger's blockchain platform and its pre-existing energy meters

Blockchain Applications in Electricity II

Electric vehicle charging

- Current shortage of charging infrastructure led to pilot programs to promote the sharing of private home charging stations, just as Airbnb promotes the renting of private residences
- Share&Charge is an EV charging platform that has been tested in both California and Germany
  - Under Share&Charge, owners of home chargers set an energy price and broadcast their location on a mobile app to nearby EV drivers
  - EV drivers then review available prices and select a charging station to use. All transactions are validated on top of the Ethereum Blockchain

Blockchain Applications in Electricity II

Renewable energy credit (REC) trading

- RECs are tradable, non-tangible energy commodities that represent proof 1 megawatt-hour (MWh) of electricity was generated from an eligible renewable energy resource
- The U.S. currently does not have a national registry for RECs. However, there are ten regional electronic tracking systems that assign RECs unique IDs and tracks them
  - Each registry acts independently and assigns its own unique identifier; lack of communication among the registries leaves open the potential for double-counting of credits
- Tracking systems are not substitutes for third-party certification and verification, as tracking systems only monitor transactions. The Center for Resource Solutions (CRS) administers a voluntary program, Green-e Energy, to ensure the quality of a green power product and validates the product's environmental attributes

Blockchain Applications in Electricity III

Current limitations of REC trading systems:

- Presence of many administrative steps (certificate issuance, sale, tracking, retirement)
- High transaction costs in each of these steps
- Does not accommodate small generators less than 1 MW
- Risk of double-counting
- Inconsistencies across different markets that complicate operations for buyers active in different markets
- Although there are no recorded fraudulent REC transactions to date, paper certificates are at risk for fraud
- The lack of tracking standardization both within and outside the U.S. also makes it difficult for international companies and citizens seeking to support renewable energy or secure the environmental attributes for compliance purposes to participate in REC markets (EWF, 2017)

These shortcoming of the REC markets might be limiting investments in renewable energy

Blockchain Applications in Electricity IV

Blockchain's ability to permanently and securely store information onto a distributed ledger could increase transparency and verification of renewable energy generation and aid in the REC tracking and auditing system

- The "immutable" nature of data on a blockchain-based system can eliminate the risk of double-counting and fraud by automating certificate retirement and making "retirement events" public in real time
- Blockchain could reduce REC verification, tracking, and auditing transaction times and costs, which currently require multiple, often manual, steps requiring the use of brokers
- Blockchain can help to streamline and standardize the global market for RECs
- The Energy Web Foundation (EWF) is currently building an open-source blockchain infrastructure which would allow generators and certificate buyers to interact directly without the need of brokers, registries, or auditors

Block chain Applications in Electricity V

- SP Group (Singapore) launched its blockchain marketplace platform that will promote the international transaction of RECs by creating a standardized process to track the origin of the energy
- Silicon Valley Power in CA and Power Ledger launched a pilot program that uses Blockchain to track solar PV generation and EV charging at a six-story parking garage in Santa Clara
  - The California Air Resources Board's ("CARB") Low Carbon Fuel Standard program allows owners of EV charging infrastructure (such as utilities) to earn a credit for each metric ton of avoided CO2 emissions
  - The CARB's current process is labor-intensive and prone to accounting error, relying on excel spreadsheets and quarterly reconciliations
  - The slow and error-prone process makes it difficult for the program to scale-up and attract new utilities to participate
  - The SVP program will use Power Ledger's Blockchain technology to automate the data collection of electricity production and EV charging, and then report the data to the CARB and promote tokenization

Block chain Applications in Electricity VI

The Public Utilities Commission of Nevada ("PUCN") opened a docket in September 2018 to explore alternatives to the Nevada Tracks Renewable Energy Credits ("NVTREC") system

- The PUCN docket is focused on whether a Blockchain platform could simplify the tracking and trading of portfolio energy credits, and make the credits more accessible to smaller generators

Besides simply improving current REC systems, the application of blockchain could allow for other mechanisms to replace REC certificates altogether

- "Crypto-RECs" could be distributed to qualified renewable energy producers, who can then sell the crypto-REC to non-qualified energy producers. The crypto-RECs could serve as an immutable proof of purchase
- Eventually, it may be possible to automatically generate and distribute crypto-RECs to qualified renewable producers once energy is injected into the power grid
- Currently, the startup Swytch is partnering with Distributed Network Advisors to create a geo-stamped token capable of verifying when, where, how much, and by whom renewable energy was generated

Conclusions

Green pricing and green tariffs have been emerging as popular rate options in vertically integrated states for those customers who are interested in renewable energy consumption

- Leading to economic development by luring large companies with sustainable energy goals

Blockchain is touted to have the potential to be an "enabling technology for the future grid"

One of the most promising grid applications is certificates of origin (RECs):

- Blockchains with smart contracts could substantially simplify and lower the cost for certificate of origin systems
- Immutability of data in a blockchain makes it difficult to tamper with and eliminate risk of double counting
- An open-source, global blockchain may lead to standardization and accelerate investments in renewable generation