P2P energy trading using blockchain distributed ledgers

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Distributed ledgers in the energy transition

• **Decarbonisation causes distribution and intermittency leading to:**
  – A ‘supply-led’ energy system with bi-directional flows at the grid edge requiring local demand-supply matching of large numbers of small energy flows.

• **Digitisation enables:**
  – Control of distributed, intermittent supply and demand assets at the grid edge
  – Integration of information from energy data across multiple vectors and with non-energy data
  – Markets for value aggregation for energy and non-energy systems

• **Markets require:**
  – Regulation creating value aligned with social goods
  – Transaction cost minimisation minimising trade friction

• **Distributed ledgers enable:**
  – Economic value by transaction costs minimisation through automation and disintermediation
  – Social value by alignment with collaborative economy models and ‘localism’ agenda.
  – Democratisation by (potentially) vesting power in local actors and cooperatives
  – Differentiation and valuation of monetary and non-monetary social values
Distributed ledgers: Characteristics

**Trust**
Shift from trust in actors to trust in system. Allows:
- Trading between unknown parties
- Trading between parties of unequal knowledge/power
- Transparency

**Immutability**
Allows:
- Guarantees of origin
- Evidence and authentication

**Resilience**
Because:
- Distributed control
- Avoids central point of failure

**Digital scarcity**
Allows:
- Trading in a zero-sum pooled resource systems like money and energy
- Creating value for non-monetized social goods
Global shift in investment type and location of energy DLTs

- Start 2017
  - America leading: ~20 companies worth ~$100M
  - Europe second: ~15 companies worth ~$20M
    - ICO financing peaked in Q4 2017

- Mid 2018
  - Europe leading: ~75 companies worth ~$750M
  - East Asia second: ~25 companies work ~$250M
  - America third: ~40 companies worth ~$150M
    - Shift from ICO to VC financing throughout 2018.

Ref: World Energy Council (2018) ‘World Energy Insights Brief: Blockchain: Evolution or Revolution? Figure B: Different types of use cases
Blockchain in the Energy Sector - Future Outlook

Ref: World Energy Council (2018) 'World Energy Insights Brief: Blockchain: Evolution or Revolution? Figure D: Blockchain Enabled Scenarios
Peer-to-peer in a picture

- Imbalances socialised by supplier/aggregator
- Smart contracts + IoT control desynchronisation of heavy loads
- DLT + smart contracts = transaction layer for balancing & settlement
- Balance group size & diversity promotes load smoothing
- DSR from IoT adjusts load shape to balance schedule
- Mixed use developments diversify load profiles
- Local DNO transmits power between peers
- Prosumers supply peer-to-peer market
- Storage buffers variations between scheduled and realised demand.
- Peer-to-peer balance group boundary

DLT + smart contracts = transaction layer for balancing & settlement

DSR from IoT adjusts load shape to balance schedule

Mixed use developments diversify load profiles

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Local DNO transmits power between peers

Prosumers supply peer-to-peer market

Storage buffers variations between scheduled and realised demand.
Currently, bilateral trading in the DSR market precludes value aggregation across multiple beneficiaries. Electron are looking to release value through collaborative trading of DSR as a non-rival good. They disaggregate the components of DSR into its non-rival elements, and allow companies to price them individually. They then use blockchain to record all the trading commitments from the industry and enforce the trading protocols of the platform.

This then:
- creates fair and transparent DSR value allocation;
- facilitates trades that wouldn't otherwise happen;
- Encourages greater liquidity and participation in DSR;
- generates significant cost savings;
- leads to better investment decisions; and
- lowers carbon emissions across the energy industry.
Regulatory challenges

Draft EU Renewable Energy Directive (2016/0382(COD))

• Establishment of Rights:
  - Right to self-consumption and sell energy ‘including through...peer-to-peer trading arrangements’, without additional charges (Article 21)
  - This extends to energy communities (Article 22)
  - Proportionate costs charged to renewable self-consumers for grid management (Article 21)
  - Consumers can jointly engage in self-consumption and form one entity (Article 21)

• Current Status:
Council of European Energy Regulators
Regulatory Principles for P2P and CSC

Key Principles:
• Incorporate self-generation into network planning.
• Consumers as prosumers may entail additional responsibilities.
• Tariffs should be cost-reflective.
• Avoid perverse incentives. Consumers who rely exclusively on the network should not be unduly disadvantaged compared to prosumers.
• No cross-subsidisation.
• Access flexibility mechanisms on a level playing field.
• Adequate metering for prosumers.
• Avoid net metering of self-generation as it implies that system storage capacity is available for free.

— Ref: CEER Position Paper on Renewable Self-Generation (C16-SDE-55-03)
CommUNITY project

Supported through round 1 regulatory sandbox

Project selected as a part of the Ofgem Sandbox initiative

Project Lead
EDF Energy R&D UK

Social and behaviour aspects
University College London

Social enterprise (non-profit) providing the pilot sites
Repowering London

P2P Software platform
Electron

P2P trading algorithms
EDF Energy R&D UK
Metering, billing and commercial arrangement
EDF Energy

System integration
PassivSystems
# CommUNITY – Regulatory Issues

Some regulatory issues related to the CommUNITY trial include:

- **Informed choice principle**: How to compute the estimated annual cost? How to compute the relevant alternative cheapest tariff?
- **Tariffs**: single tariff supply contract including CommUNITY rebate or separate contracts?

Other issues related to different delivery options may include:

<table>
<thead>
<tr>
<th>Metering</th>
<th>Billing</th>
<th>Supplier license</th>
<th>Tariffs</th>
<th>Settlement</th>
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</thead>
</table>
| • Recording  
  • Meter ownership  
  • Registering and maintenance of metering asset  
  • Meter resolution  
| • Multiple-supplier billing  
  • Accounting for self-consumption  
| • Balancing Settlement Code (BSC)  
  • Distribution code  
  • Grid code  
  • Smart energy code  
  • Master registration agreement (MRA)  
| • Time of use tariffs  
  • Network charges  
  • Policy charges  
| • Local settlement for individual consumers  

Legal Challenges

• Data privacy and GDPR
  - Encryption & hashing are pseudonymisation – not anonymisation techniques.
  - Right to be forgotten (Art.17), or for data to be corrected (Art.16) clash with blockchain’s immutability.
  - Obligations on controllers and processors of data - who are these in a blockchain?

• Smart contracts
  - A smart contract can be considered a ‘contract’ under UK law
  - Smart contracts are immutable and irreversible, therefore cannot reflect changing circumstances (required in contract law).

• Prosumer rights
  - Domestic energy consumers producing their own energy (‘prosumers’) are not recognised in UK consumer law.

• Legal protection for P2P participants needed
  – Co-ops and LLPs can address some, but not all of these issues.

Key messages

• The policy outcome dictates the regulatory change which determines the business model which drives behaviour.
  – Locational charging = local balancing. Flat charging + REGOs = DER uptake
• P2P outcomes depend on how we socialize the cost of network infrastructure.
  – User pays <-> nationalised public asset paid from general taxation
• Permitting multiple suppliers per consumer
  – Peer-to-peer + Peer-to-local market + Peer-to-platform + Backstop supplier
• Commission phase I (PoC); II (uptake) & III (cost-benefit) trials
• Legal challenges exist beyond energy (e.g. GDPR & consumer law)
• Tailor trials to target audience (Govt; social role models; etc)
• UX is key. Must be co-designed & customer led (keep engineers out!)

“...without addressing the two obstacles of customer engagement and regulatory reform, a full transformative disruption may not be feasible; however, energy blockchain will continue to optimise the practices of today’s energy eco-system.”