



Une école de l'IMT



BLOCKCHAIN FOR SMART GRID



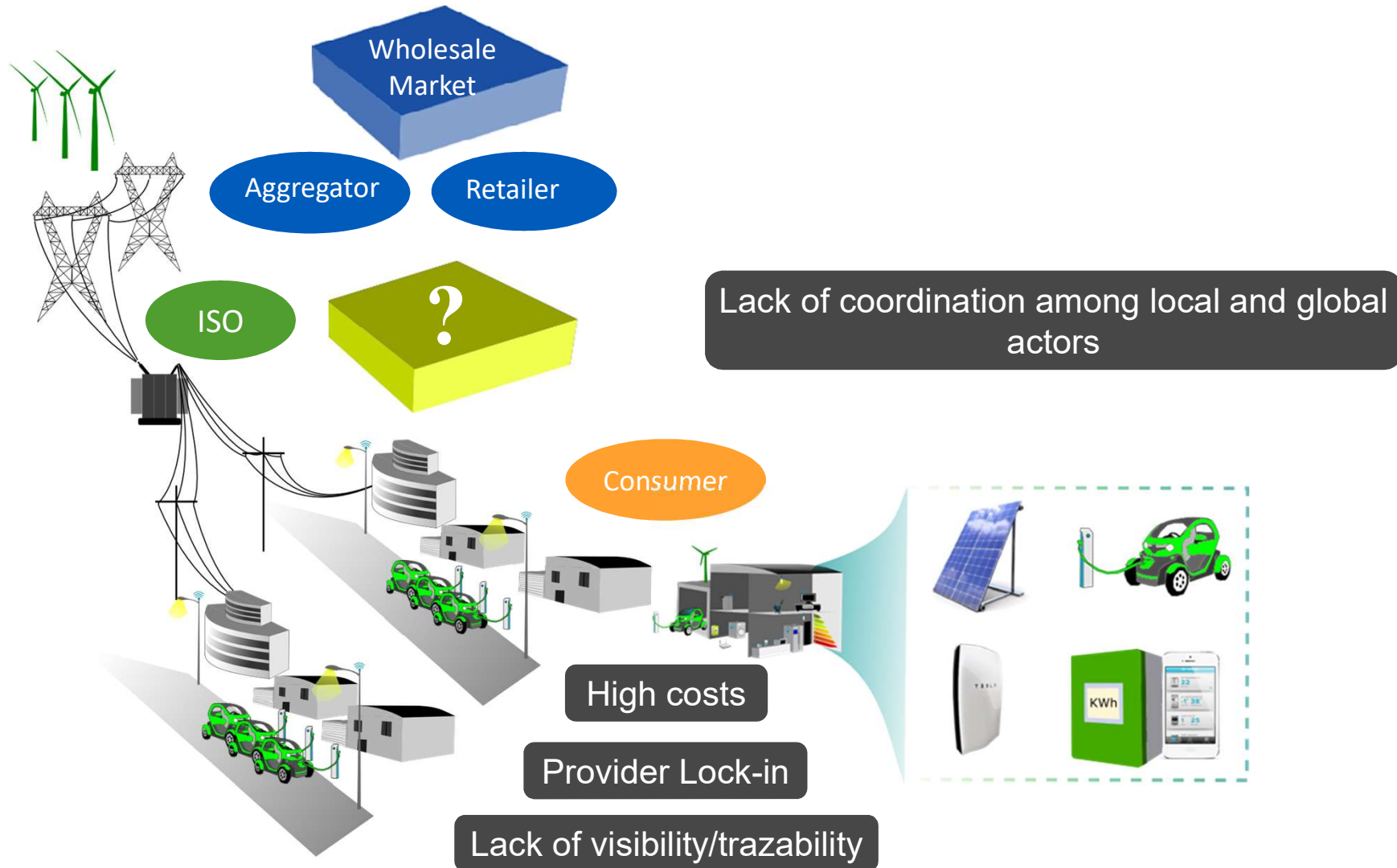
José Luis Horta



simpleTECH

Blockchain Day @LINCS – 12/06/2019

ENERGY TRANSITION CHALLENGES

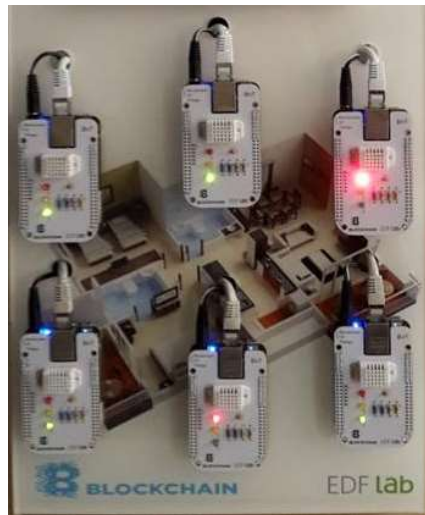


Blockchain for Smart Grid

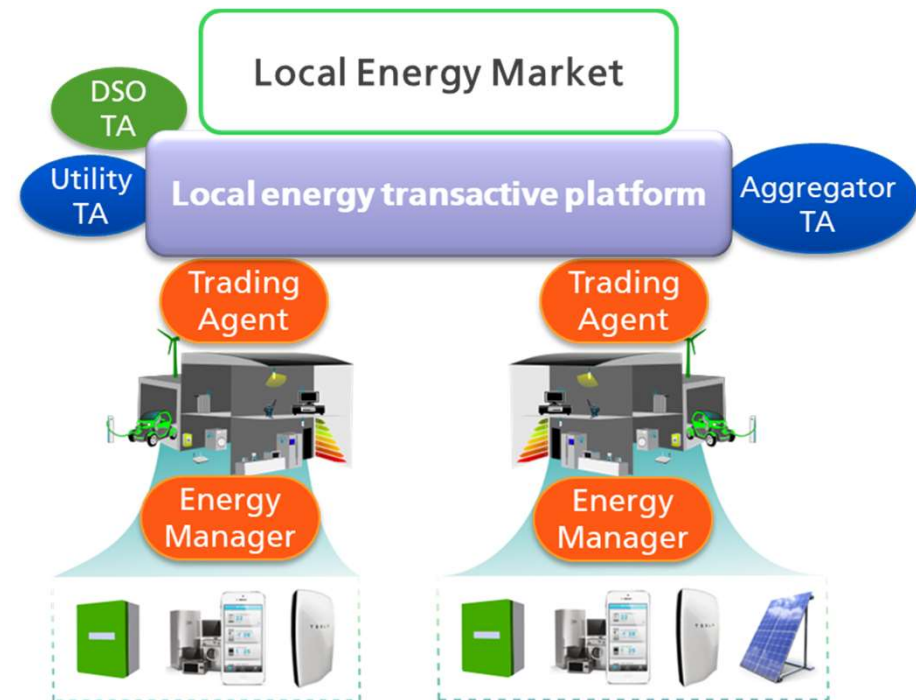
Design and implementation of local energy markets

BLOCKCHAIN FOR DEMAND SIDE MANAGEMENT

- Smart Home devices orchestration

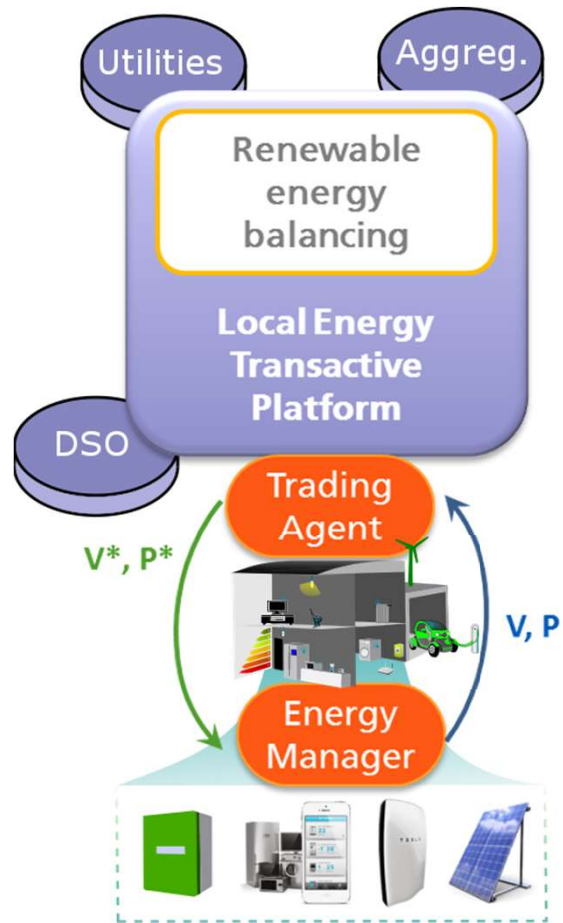


- Local renewable energy markets

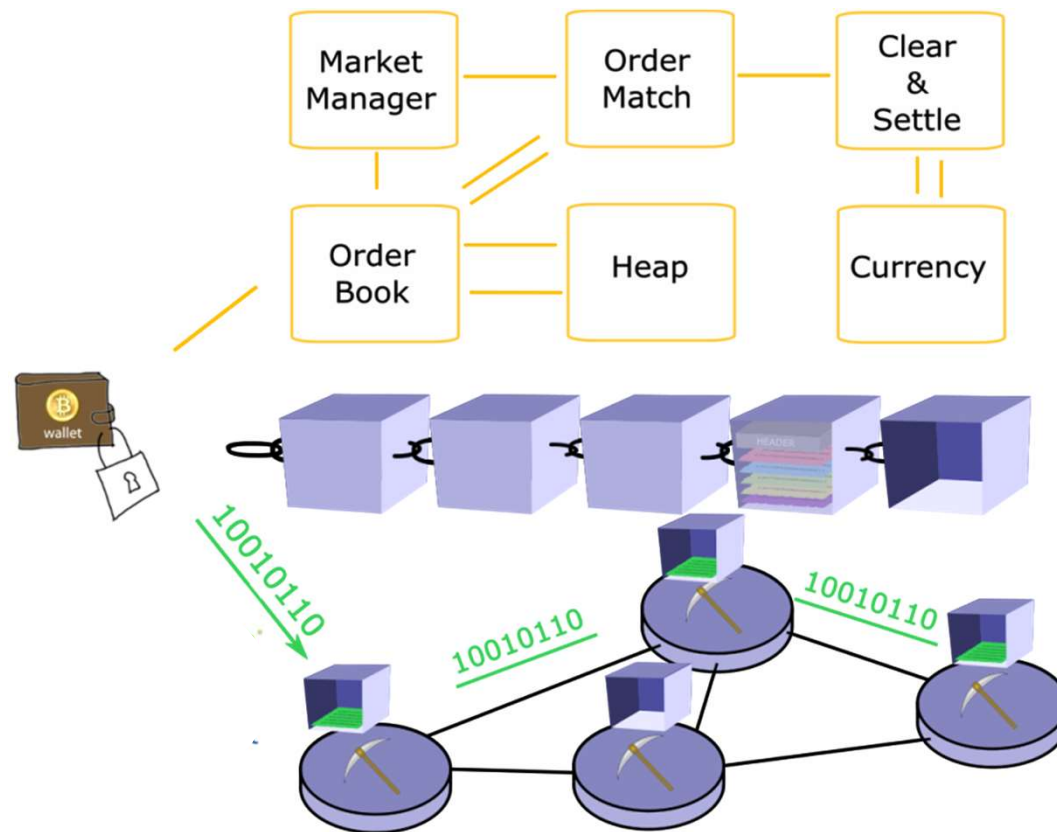


BLOCKCHAIN-BASED TRANSACTIVE PLATFORM

Functional architecture

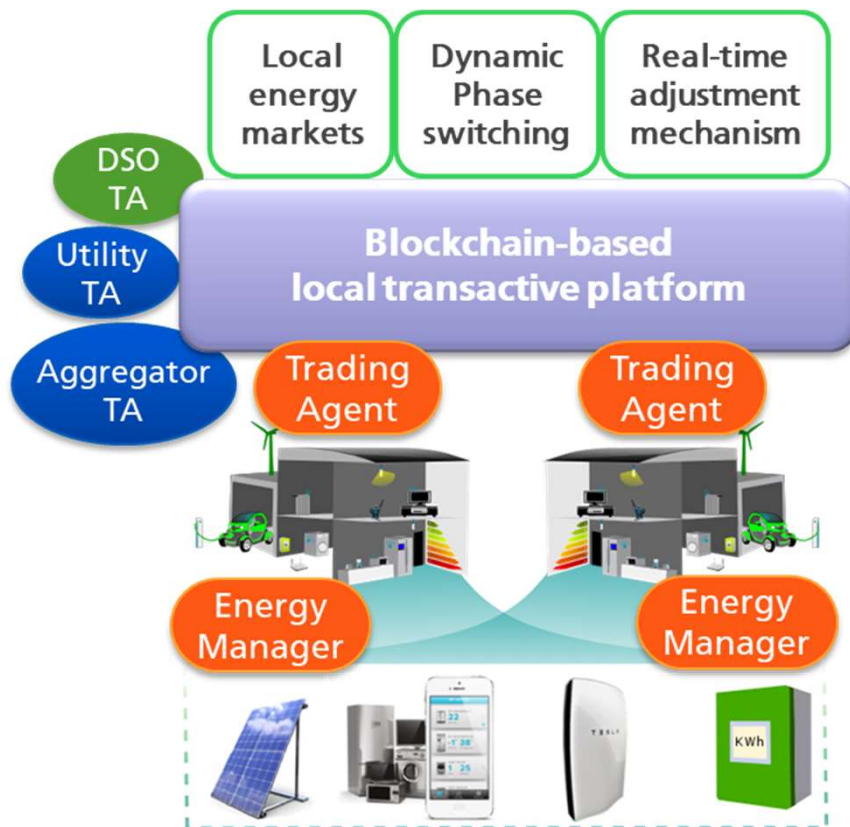


Blockchain-based Market Implementation



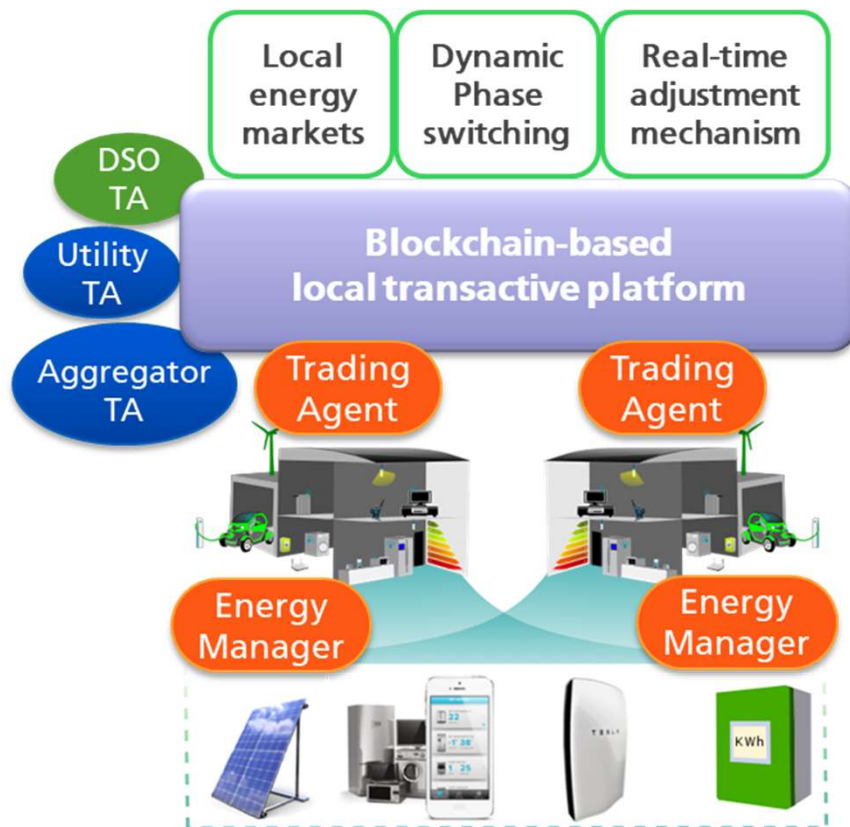
BLOCKCHAIN LOCAL ENERGY MARKET

UNIQUE DESIGN FEATURES



- **Impact on the electricity distribution grid**
 - Ex-ante trading with incentives
 - Voltage Unbalance Issues
 - Forecast uncertainty
- **No Cryptocurrency - No ICO**
 - Token minted in verified DR events
 - Token exchanged at fixed rate by utilities
- **Market design**
 - Strategy proof – Simple bidding strategies
 - Weakly budget-balanced

BLOCKCHAIN TECHNOLOGY FOR DISTRIBUTION GRID ENERGY MANAGEMENT



Energy management architecture

- ▶ Building blocks of a general IoT-based architecture
- ▶ Virtual Distribution Grid concept
- ▶ Local Blockchain transactive platform

Energy services / control mechanisms

- ▶ Market for balancing renewable energy locally
- ▶ Dynamic phase switching for network balancing
- ▶ Real-time control to cope with forecast errors

SMART CONTRACT DEVELOPMENT LEARNINGS

- **Limited resources and features**
 - Example: Sort
- **Inmutability**
 - Smart Contract update
- **Autonomous and trustless?**
 - No cron function
- **Code maturity**



Blockchain for Smart Grid

Beyond P2P markets

BUSINESS DEVELOPMENT EXPERIENCE

PLANNING & DISPATCH

TRANSMISSION & DISTRIBUTION

CLIENT

Intelligent Management of Distributed Energy Resources

Business Model Description

Minimum Viable Product

Business Development Experience
Business opportunities of Blockchain in Smart Grids

UTE **ICT4V** **TELECOM** **eit Digital**

GLASSFROG ENERGY

EMPOWERING THE CONSUMER TO DRIVE THE
TRANSITION TOWARDS A GREENER AND
TRANSPARENT ENERGY SUPPLY CHAIN



Emmanuel Crown

World Bank

José Luis Horta

SimpleTech

Varinder Sain

Intel

2nd price at Accenture's Hack for the earth during the Hyperledger Global Forum 2018

Blockchain for Smart Grid

Commercial solutions

END-TO-END TRACKING OF ELECTRICITY FLOWS



- Track source and wholesale transfers of energy with tokens



- Enable differentiated retailer energy services



- Enable governments to incentivize renewable energies and track carbon reductions

POWER  **LEDGER**

CLEAN ENERGY
BLOCKCHAIN
NETWORK 

Greenwood
solutions

Power Ledger & Clean Energy Blockchain Network Partner With Northwestern University For First Commercial Deployment In United States



Greenwood Solutions and Power Ledger Partner For First Commercial Deployment Of Power Ledger Platform In Melbourne, Australia



Products

Fully Developed



P2P Trading

Built & Being Tested



Electric Vehicle Trading



Neo-retailer



Autonomous Asset Management



Embedded Network/Micro Grid Operator

Under Development



Carbon Trading



Power Port



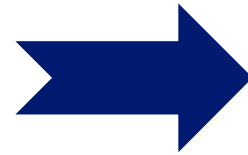
Distributed Market Management



Transmission Exchange



Wholesale Market Settlement



Vodafone.de 4G 17:12 48% Vodafone.de 4G 18:20 39%

Adresse suchen

Ladevorgang

Stundentarif: 7,80 € /h (inkl. 19% MwSt.)

Voraussichtlicher Preis: 3,90 € (inkl. 19% MwSt.)

0:30
Std. Min.

Ladepunkt: BA-1755-8

Ich akzeptiere die AGBs des Ladestationsbetreibers.

ZAHLUNGSPFLICHTIG LADEN



SUMMARY

- We presented the design and implementation of blockchain-based local energy markets
- Our early contributions are still very relevant thanks to its design features
- Blockchain for smart grids is a lot more than P2P energy trading
- Despite technological and regulatory challenges the energy industry has started adopting the technology

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- J. Horta, D. Kofman, D. Menga, M. Caujolle. Augmenting DER hosting capacity of distribution grids through local energy markets and dynamic phase switching, *9th ACM International Conference on Future Energy Systems (ACM e-Energy) 2018*.
- J. Horta, E. Altman, M. Caujolle, D. Kofman, D. Menga. Real-time enforcement of local energy market transactions respecting distribution grid constraints, *9th IEEE International Conference on Smart Grid Communications (SmartGridComm) 2018*.
- D. Kiedanski, D. Kofman, J. Horta, D. Menga. Strategy-proof local energy market with sequential stochastic decision process for battery control, *IEEE Innovative Smart Grid Technologies 2019, Feb 2019, Washington DC, United States*.
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- J. Horta, D. Kofman, D. Menga. Novel paradigms for advanced distribution grid energy management. *Telecom ParisTech, Research report, 2016*.