

#### Pro-sumer AwaRe, Transactive Markets for Valorization of

**Distributed flexibilITY enabled by Smart Energy Contracts** 

### The PARITY approach – Local Flexibility Market (LFM) concept and user involvement

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**Distributed flexibility markets in H2020 projects Workshop** 16th March 2021



This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under grant agreement no 864319.





## Concept

- Local Market design
- Market participants and traffic light concept
- User involvement



# **PARITY concept**



### Vision

- Enable set-up and operation of Local Flexibility Markets (LFMs) at the distribution network level based on
  - Blockchain technology, smart contract enabled LFM
  - IoT-enabled DER flexibility management tools
  - Smart Grid monitoring and management tools

#### Contribute on topics such as

- Investigation of market coupling mechanisms
- Definition of LFM actors
- Policy reform recommendations



## **PARITY concept**

control strategies





Local Flexibility Market Platform

16/03/2021

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#### IoT

- Monitoring and automated control actions
- Automated user profiling: Thermal and visual comfort, occupancy
- Flexibility forecasting per controllable asset/DER

#### Blockchain

- > Definition: An immutable decentralized distributed digital ledger
- Blockchain Agent
  - Multiple instances running, one per market participant
  - Connection to Blockchain platform
- From Service Level Agreements (SLAs) to smart contracts
  - Representation of SLA in human & machine-readable format
  - Automated monitoring and KPI validation
  - Actions for transaction settlement





### Important parameters for defining a local market structure



# **LEM and LFM**



### Two markets introduced

- Local Electricity Market (LEM): Facilitates P2P trading among prosumers and is operated by LEMO
- Local Flexibility Market (LFM): Activates flexibility mainly for the DSO's needs
  - Explicit LFM design: dedicated market platform operated by the LFMO
  - Implicit LFM design: implicitly integrated in the LEM. The DSO imposes varying grid prices to the prosumers. Prosumers can react to these price signals by adapting their trades on the LEM





No constraint violations detected in the distribution grid: DSO performs active grid monitoring

Constraint violations have been forecasted by the DSO

Distribution grid stability is in danger due to constraint violations such as congestions and voltage violations

Grid outage

Reg.	LEM	LFM	AS/WS markets	Activities
GREEN	active	paused	active	LEM is cleared by LEMO. Aggregator bundles flexibilities and trades on AS/WS markets
VELLOW	paused	active	paused	Explicit LFM is activated and cleared by LFMO
	active	active	active	Implicit LFM: DSO imposes varying grid prices. LEM is cleared by LEMO. Aggregator bundles flexibilities and trades on AS/WS markets
RED	paused	paused	paused	DSO is allowed to override market-based contracts and to perform direct load control (through the aggregators' or the DSO's own infrastructure)
BLACK	paused	paused	paused	All connections in the constrained area are disconnected for grid safety reasons



#### Flexibility aggregation

> Aggregates flexibility of prosumers and their assets

#### Creation of Virtual Power Plants (VPPs)

- Asset and prosumer dynamic clustering
  - Input data: assets per prosumer, flexibility forecasts per asset, location of asset, SLAs, status of assets engaged in LEM

#### Optimization & flexibility activation

- Flexibility through the market (DSO / TSO, BRP), prioritization based on grid state
- Flexibility to DSO in near real-time



#### Interoperability

- Data models in JSON structure: Entities such as Users, Assets, SLAs, Sensors, Buildings, Events, Flexibility description/activation are defined
- > Off-chain data stored in LEM/LFM platform Repository. Access via HTTP web services API

#### Privacy

- Pseudonymization for use in the Blockchain to protect identities of users and assets
  - Method: Keyed hash for encoding pseudonym (actual name → pseudonym). Use of mapping table for recovery (pseudonym → actual name)

#### Security

- Blockchain offers security by design (use of cryptography)
- > Authentication, for both users and system components
- > Authorization
- ➤ Use of secure protocols (TLS)



- **End-users** may be tempted to perform investment decisions on flexibility assets
- End-users should:
  - be interested in participate in the P2P trading
  - rely on smart contracts based on Blockchain
  - react to price signals
  - understand that the control of some flexibility assets will be granted to operator in cases of yellow/red signalling







# Barriers that hinder the end-user participation on LFM



Workshop



# Barriers that hinder the end-user participation on LFM



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# **Risks about emerging technologies in P2P trading systems**

### Main Risks Categorisation



#### Count of main risks



# **Risks about emerging technologies in P2P trading systems**

### Second order risks





- We surveyed 832 people from the different countries represented in PARITY about the willingness to participate in a trade-based P2P market with transactions audited.
  - Semi-autonomous mode was the most solicited.
    - Lesson learned I: People do no want to lose autonomy
  - > In general, people preferred a system run by a neutral company hired by the community.
    - Lesson learned II: It is needed to convincing users about the neutrality of the LFMO and their intentions to not make profit or abuse the system
  - > People are willing to audit each transaction and complain about any error found.
    - Lesson learned III: Large part of customers will not leave the company if errors are detected
    - Lesson learned IV: The user should always have to give the last consent in large transactions
    - Lesson learned V: Openness and explainability of the autonomous system is advisable to increase trust



- We surveyed 832 people from the different countries represented in PARITY about the willingness to participate in a trade-based P2P market with transactions audited.
  - People are afraid about potential system errors or cyberattacks.
  - High monetary investments and reluctance about ROI are main barriers for participation.
  - People prefer a system that optimises the use of energy (energy efficiency/sufficiency first principle) rather than purchase electricity directly.
    - **Lesson learned VI:** People requires that the system ensures the electricity in any circumstances
    - Lesson learned VII: However, as said before, if the prices are higher than usual they want to give the last consent.



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## **Questions & Answers**

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