



EnergyVille

Peer-to-Peer Energy Sharing
Technology Enablers from the lab to the market
FEBEG 19-Dec-2017

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Product and Project Manager



EnergyVille: Flemish energy research partnership



“Employees”	200
Revenues (Meuro)	34
PhD’s	95




VITO

- Flexibility & markets
- Sustainable Cities
- Thermal networks
- Battery systems



- KU Leuven**
- AC & DC smart grid architectures
 - Building integration
 - Thermal energy



- imec**
- Photovoltaics
 - Batteries
 - Internet of Things

- UHasselt**
- Material synthesis
 - Reliability


Expertise in sustainable energy and intelligent energy systems in the built environment

Research – Development – Training – Industrial Innovation

 For:

-  Industry
-  Public entities

 With:

-  Local partners
-  Regional partners
-  International partners

Why Peer-to-Peer Energy Sharing

- Increase **investments** in RES (*financial attractiveness*)
- **Manage** impact of more RES (*mitigate – local, e.g. at distribution grid - grid problems by aligning consumption with RES generation*)
- **Solidarization** ... facilitate access to RES for all (*also those that cannot afford to invest themselves in an asset, either because of financial or locational reasons*).

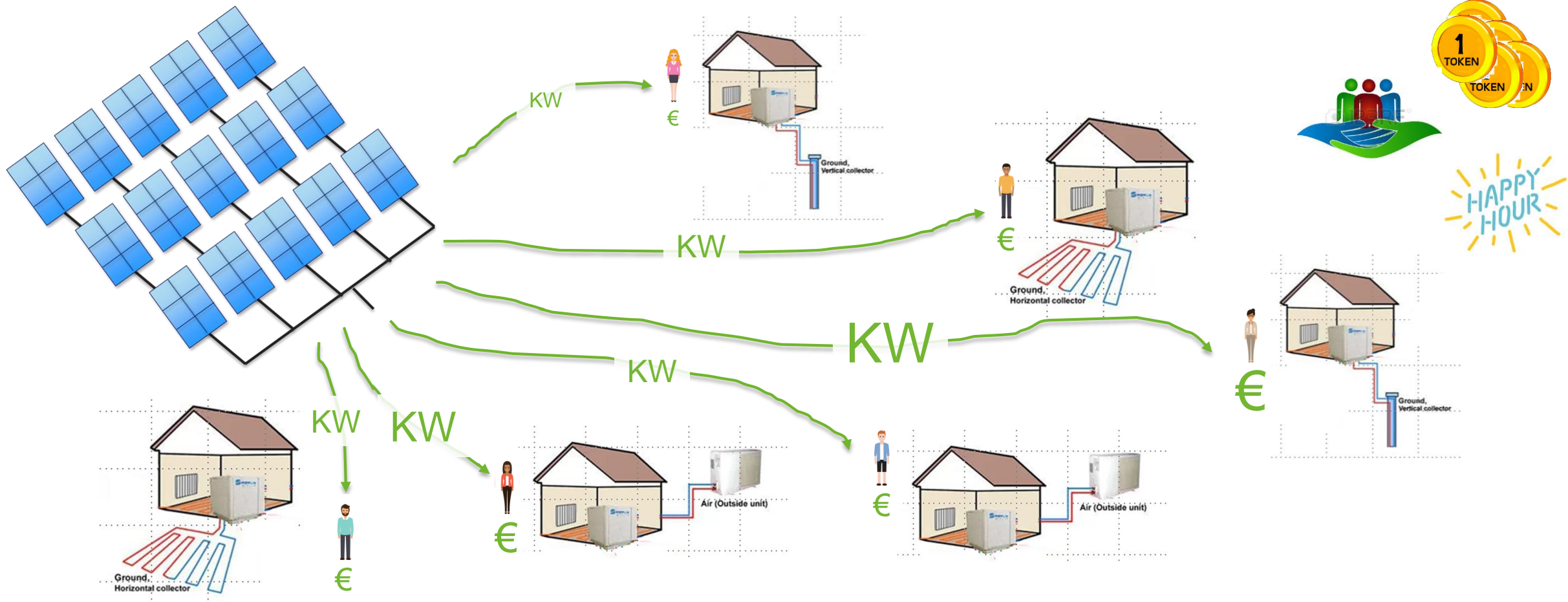


EU Winter Package: Enabling active consumers and energy communities

- Entitlement to all consumers to **generate, self-consume, store or sell** self-generated electricity, while ensuring non-discriminatory network tariffs.

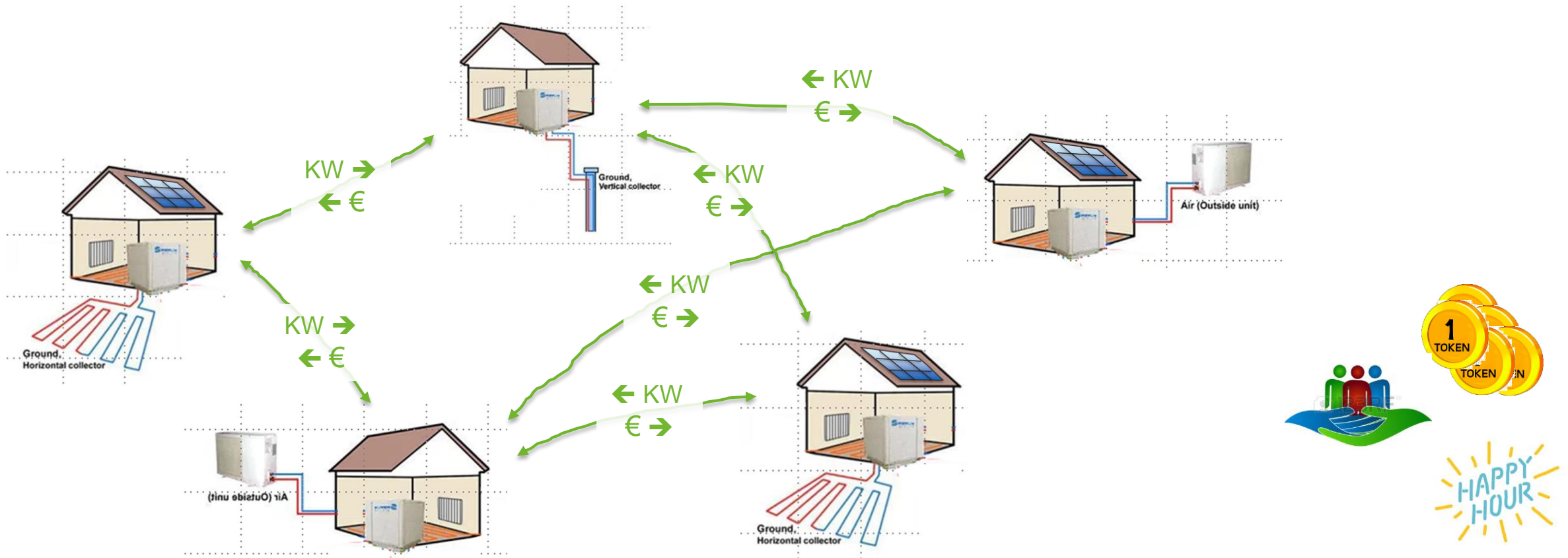
Peer-to-Peer Energy Sharing Model classification

Asset Sharing model: Joint Ownership of generation assets



Peer-to-Peer Energy Sharing Model classification

Energy Sharing model: Asset owners sharing (selling) energy with non-owners



Peer-to-Peer Energy Sharing Requirements

🍃 P2P Passive: sharing without active control

Let it flow ...

🌱 Peers

- 🏠 Local producers with a surplus
- 🏠 Local consumers
- 🏠 Smart Meters taking care of the ‘token’ bookkeeping (Utility sub-metering versus P2P sub-metering)

🌱 Multi-agent framework

- 🏠 Enabling the necessary information exchanges for the ‘token’ bookkeeping

Peer-to-Peer Energy Sharing Requirements

🌿 P2P Active: sharing with active control

✦ Peers

- 🏠 Local producers with a surplus + **forecasting**

- 🏠 Local consumers **with controllable (flexible) devices (+ forecasting: optionally): Demand Side Management, Demand Response**

- 🏠 Smart Meters taking care of the 'token' bookkeeping (Utility sub-metering versus P2P sub-metering)

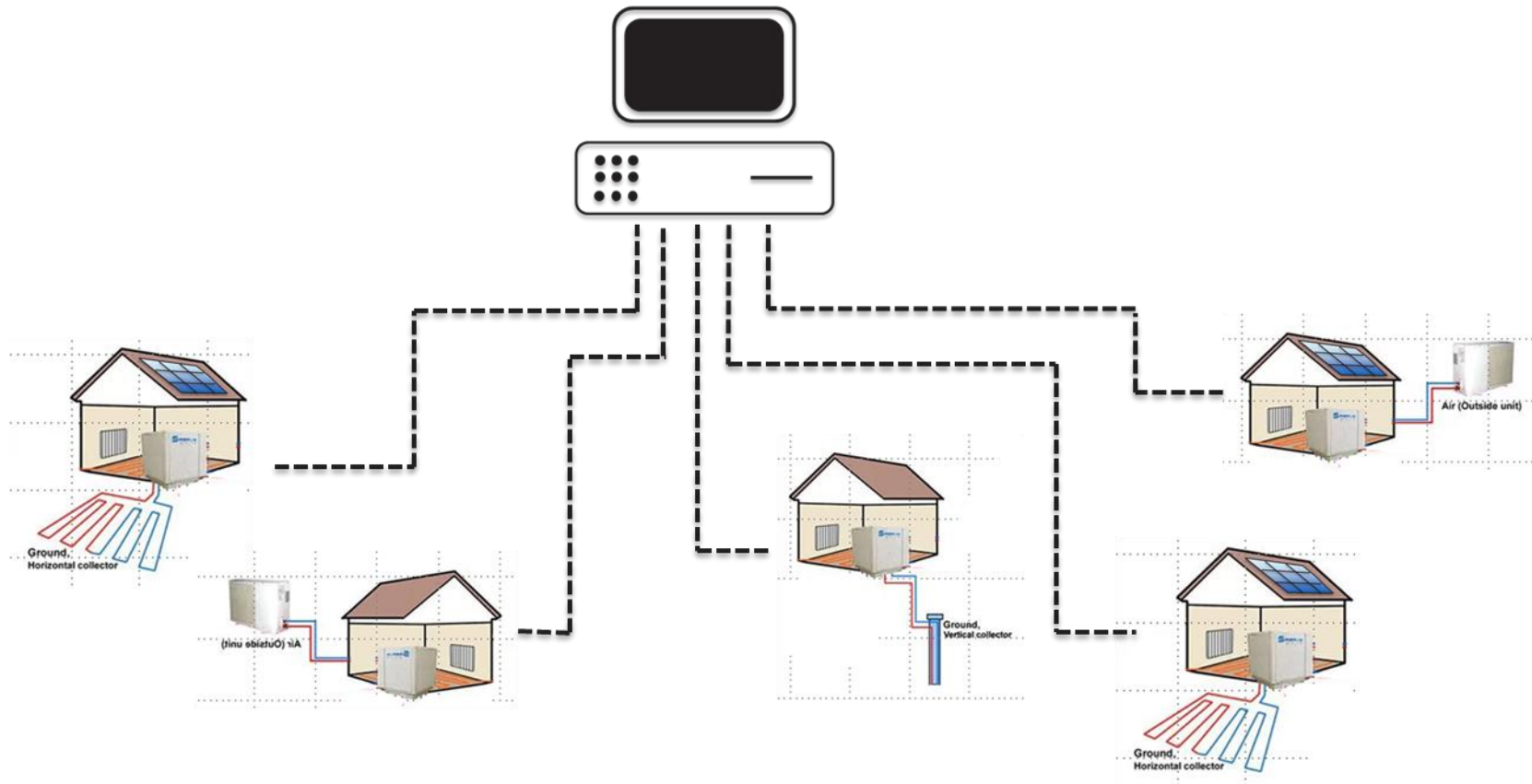
✦ Multi-agent framework

- 🏠 Enabling the necessary information exchanges

*Align consumption
with production*

Peer-to-Peer Multi-Agent Framework Options

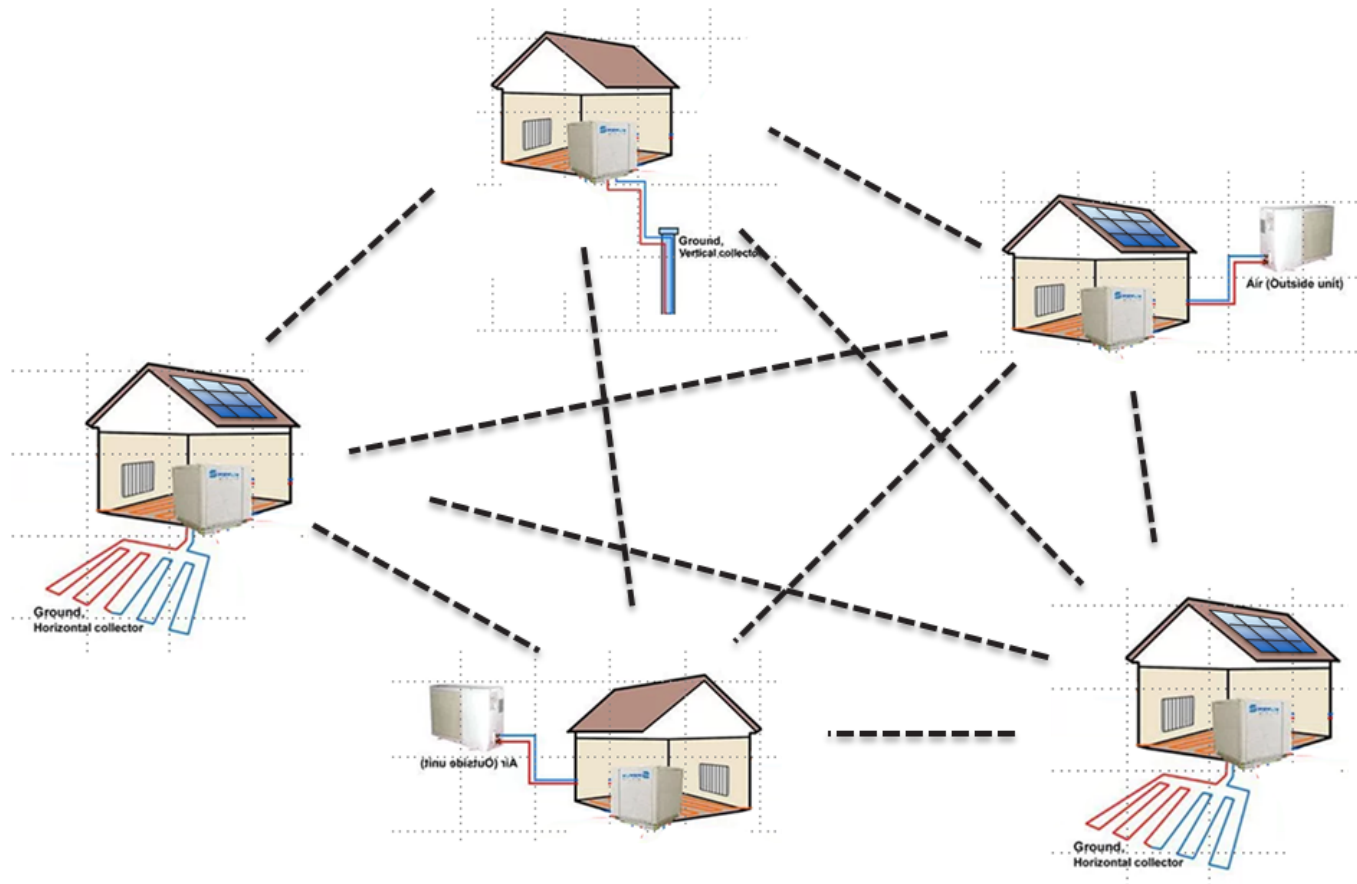
Option 1: 'central' coordination and administration



Peer agents interact via a common central coordinating agent ('matchmaker')

Peer-to-Peer Multi-Agent Framework Options

Option 2: 'Truly' Peer-to-Peer (Distributed Ledger Technology)



No central administrator or coordinator, no trusted middleman.

Transactions are agreed in a distributed manner.

Consistency ?!

Distributed Ledger Technologies

“No double spending” challenge: ‘mining’ and transaction clearing by consensus

No central data storage

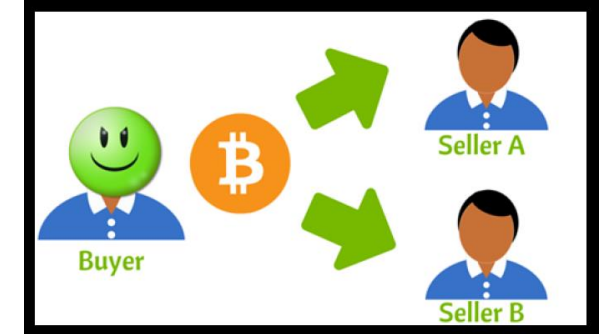
Information is replicated at all participants: all participants can view all of the information

Immutability: verifiable and auditable history of all transactions through cryptographic signatures (hashing) and timestamping

Example: blockchains

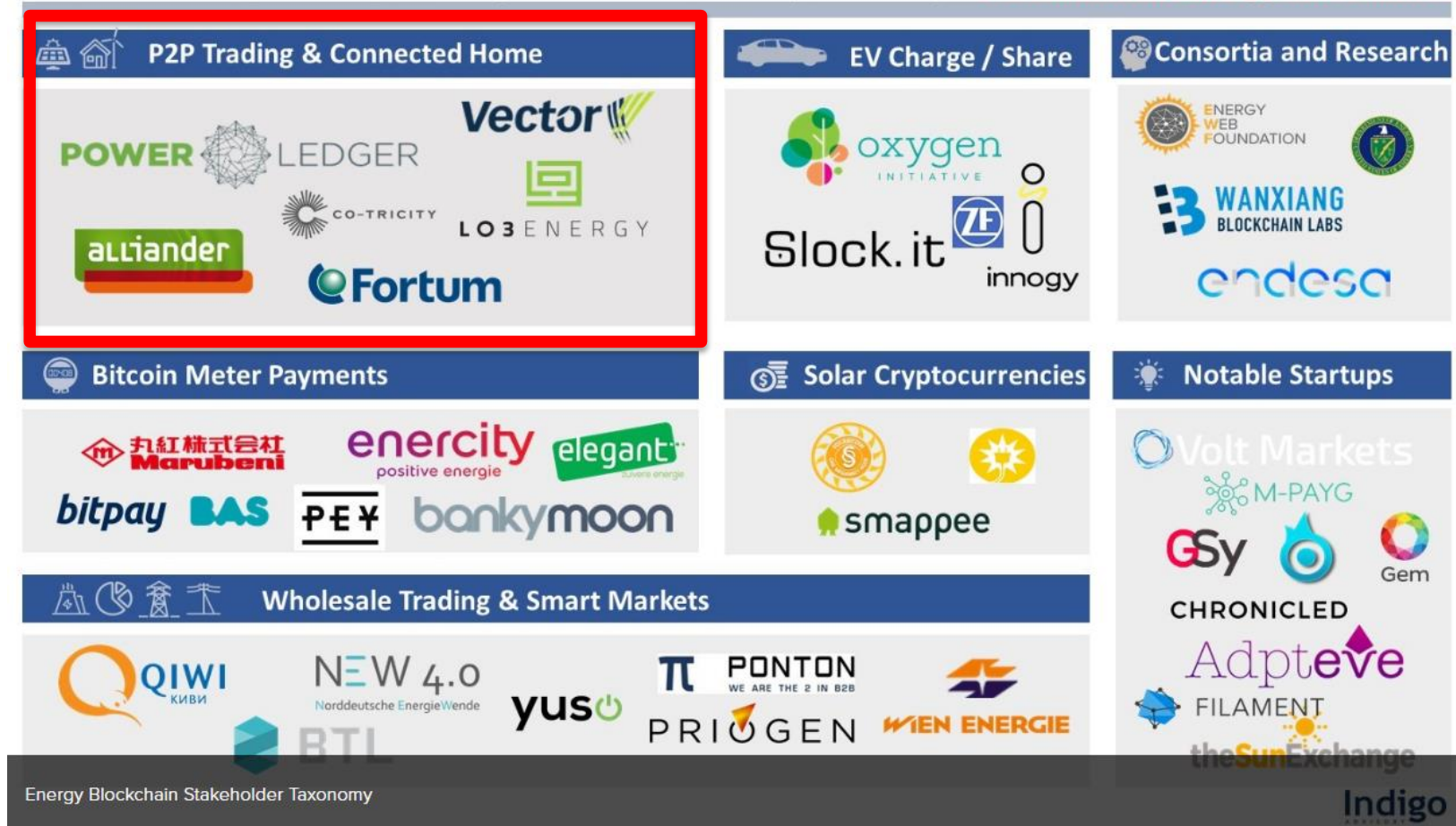
Transactions are encoded as blocks

Next Block = Previous Block + Transaction → chain of blocks



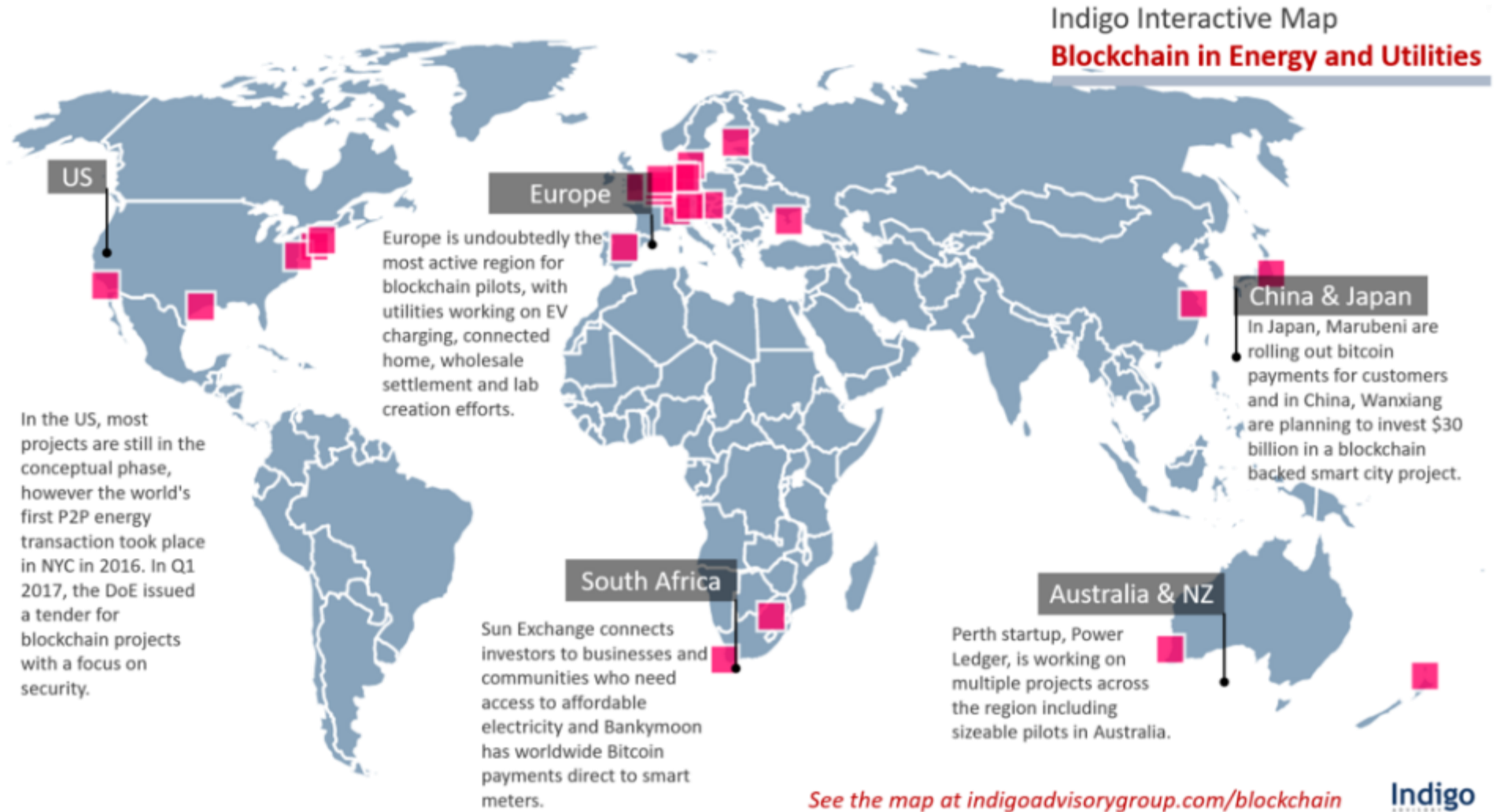
Blockchain Energy Use Cases

Indigo Stakeholder Activity Taxonomy - **Blockchain in Energy and Utilities**



Source: <https://www.indigoadvisorygroup.com/>

Blockchain Energy Pilots



Source: <https://www.indigoadvisorygroup.com/>

Bitcoin, Ethereum & dAPPs, ICO

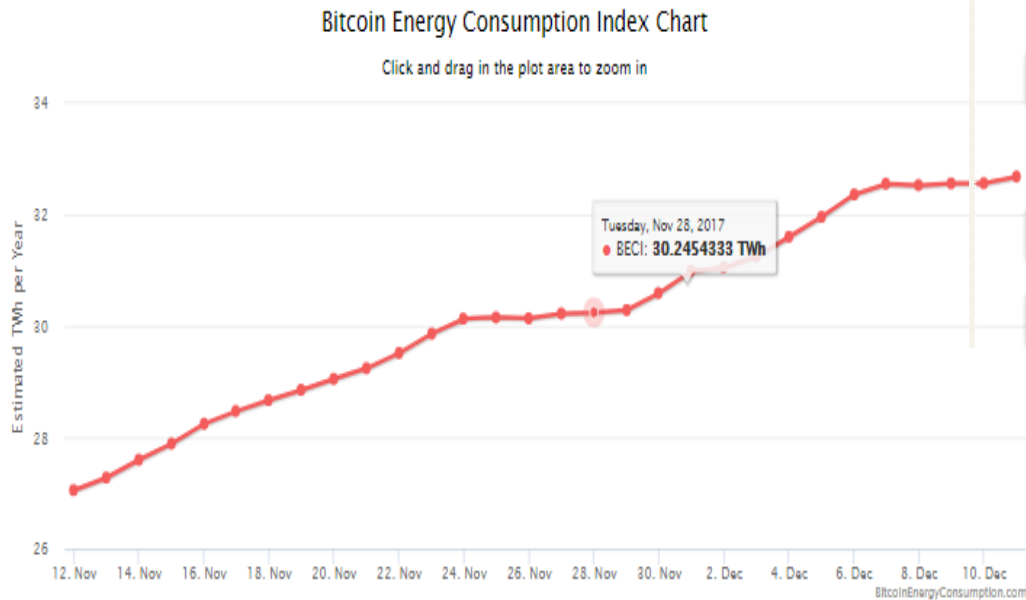
- ✦ Bitcoin = cryptocurrency (one of many): Blockchain 1.0
 - The 'payment' part of a (blockchain) transaction
 - Cryptocurrencies may or may not have monetary value
 - Bitcoins have !
 - Buy/sell goods/services versus encourage 'good' behavior
- Blockchain 2.0: Ethereum and dAPPS
 - Adding 'Smart Contracts' and Decentralized Applications
 - More complex transactions (decision logic)
- Initial Coin Offerings: pre-sale of cryptocurrency to raise investment money

Food for thought ...

Bitcoins vreten steeds meer energie: equivalent van 39% van Belgische stroomverbruik

Vrtnews: 12/Dec/2017

Bitcoin Energy Consumption Index



Key Network Statistics

Description	Value
Bitcoin's current estimated annual electricity consumption* (TWh)	32.68
Annualized global mining revenue	\$16,193,624,848
Annualized estimated global mining costs	\$1,634,215,427
Country closest to Bitcoin in terms of electricity consumption	Denmark
Estimated electricity used over the previous day (KWh)	89,546,051
Implied Watts per GH/s	0.283
Total Network Hashrate in PH/s (1,000,000 GH/s)	13,389
Electricity consumed per transaction (KWh)	235.00
Number of U.S. households that could be powered by Bitcoin	3,026,325
Number of U.S. households powered for 1 day by the electricity consumed for a single transaction	7.93
Bitcoin's electricity consumption as a percentage of the world's electricity consumption	0.15%
Annual carbon footprint (kt of CO2)	16,015
Carbon footprint per transaction (kg of CO2)	114.95

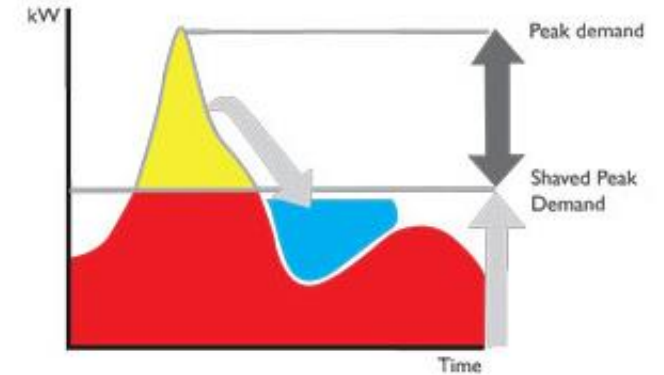
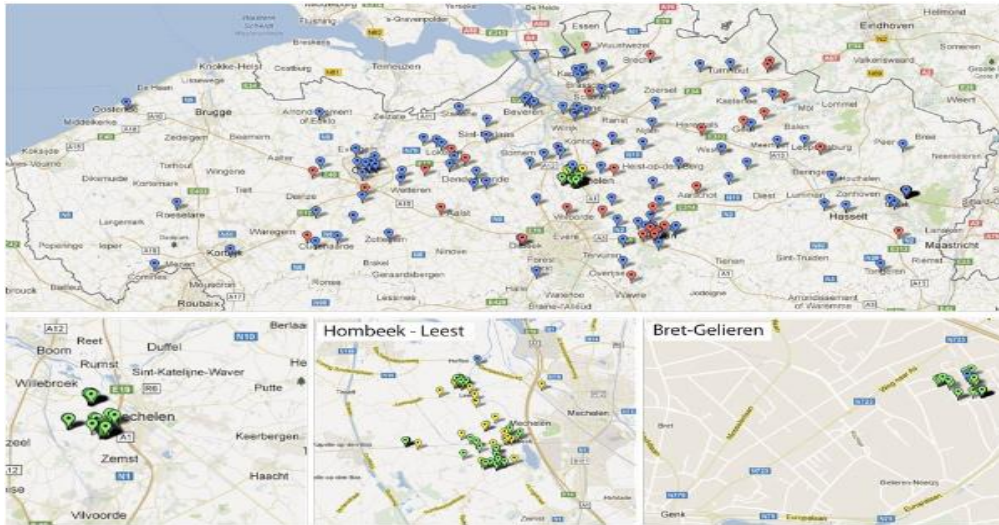
Source: <https://digiconomist.net/bitcoin-energy-consumption>

Example pilot : Linear

Residential Demand Response (250 families)

- ✦ Active control of residential consumption to coincide with excess PV or Wind generation
- ✦ Whitegood appliances and boilers

Flanders (2009 - 2014)



Learnings - P2P sharing requires:

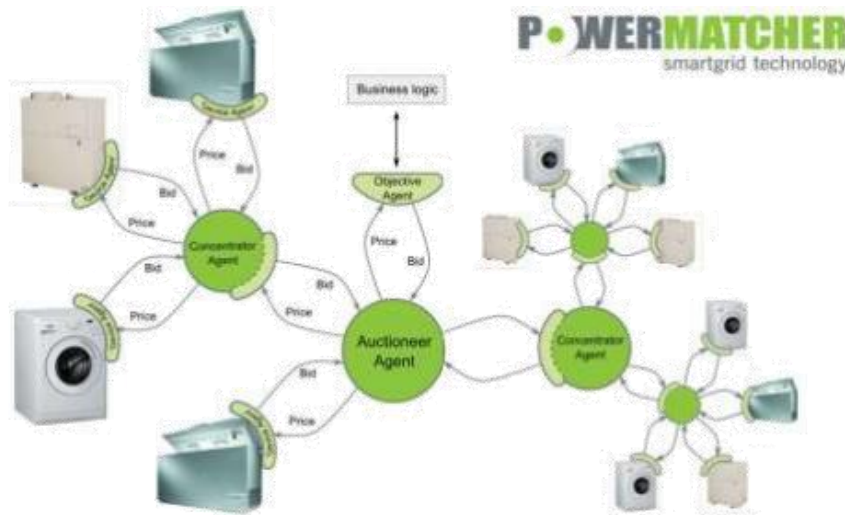
- ✦ Smart Meters
- ✦ Automation
- ✦ Interoperability
- ✦ Incentives
- ✦ Regulation

Example pilot : PowerMatching City

Residential Demand Response (40 families)

- ✦ Active control of residential consumption to coincide with excess local generation
- ✦ Including heatpumps and EVs

Hoogkerk/Groningen, the Netherlands (2009 - ...)



Demonstration of PowerMatcher multi-agent framework

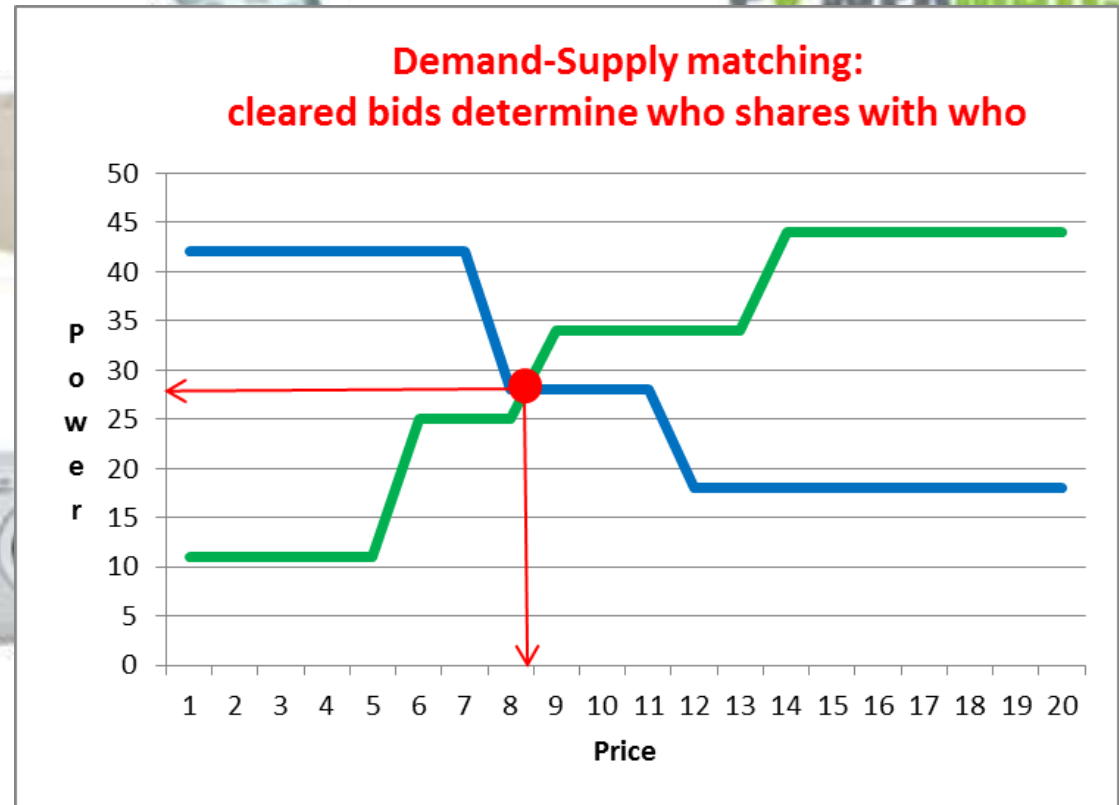
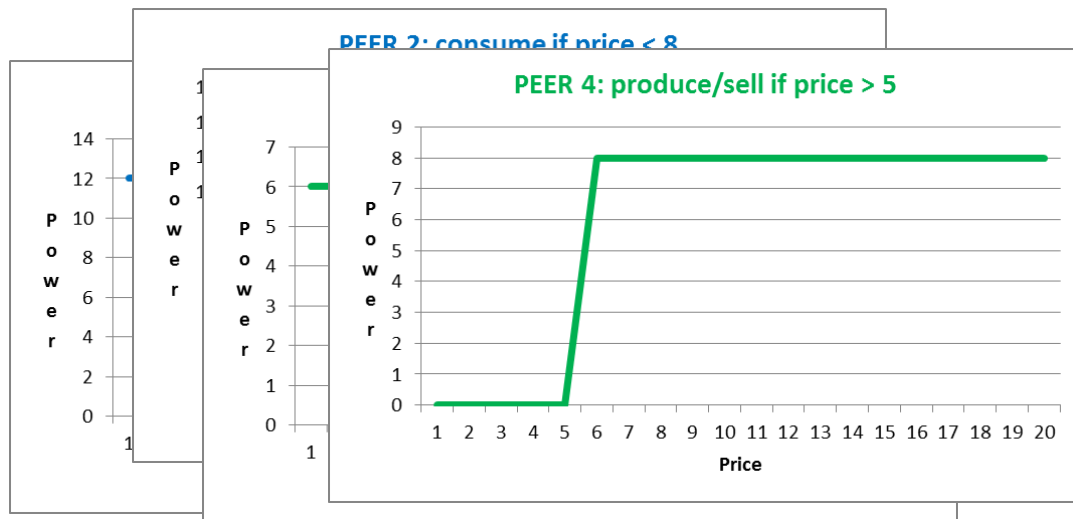
- ✦ Device agents
- ✦ Concentrator agents (aggregation)
- ✦ Auctioneer agents / Business Logic

Example pilot : PowerMatching City

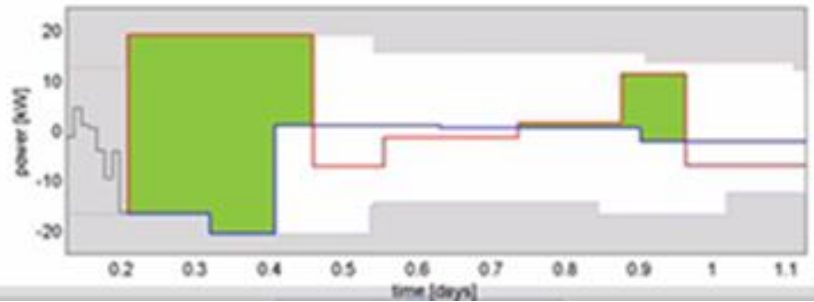
Central administrator/coordinator collects bids from local producers and consumers

PM Bids are price/energy pairs

Double Auction market clearing for Demand-Supply Matching

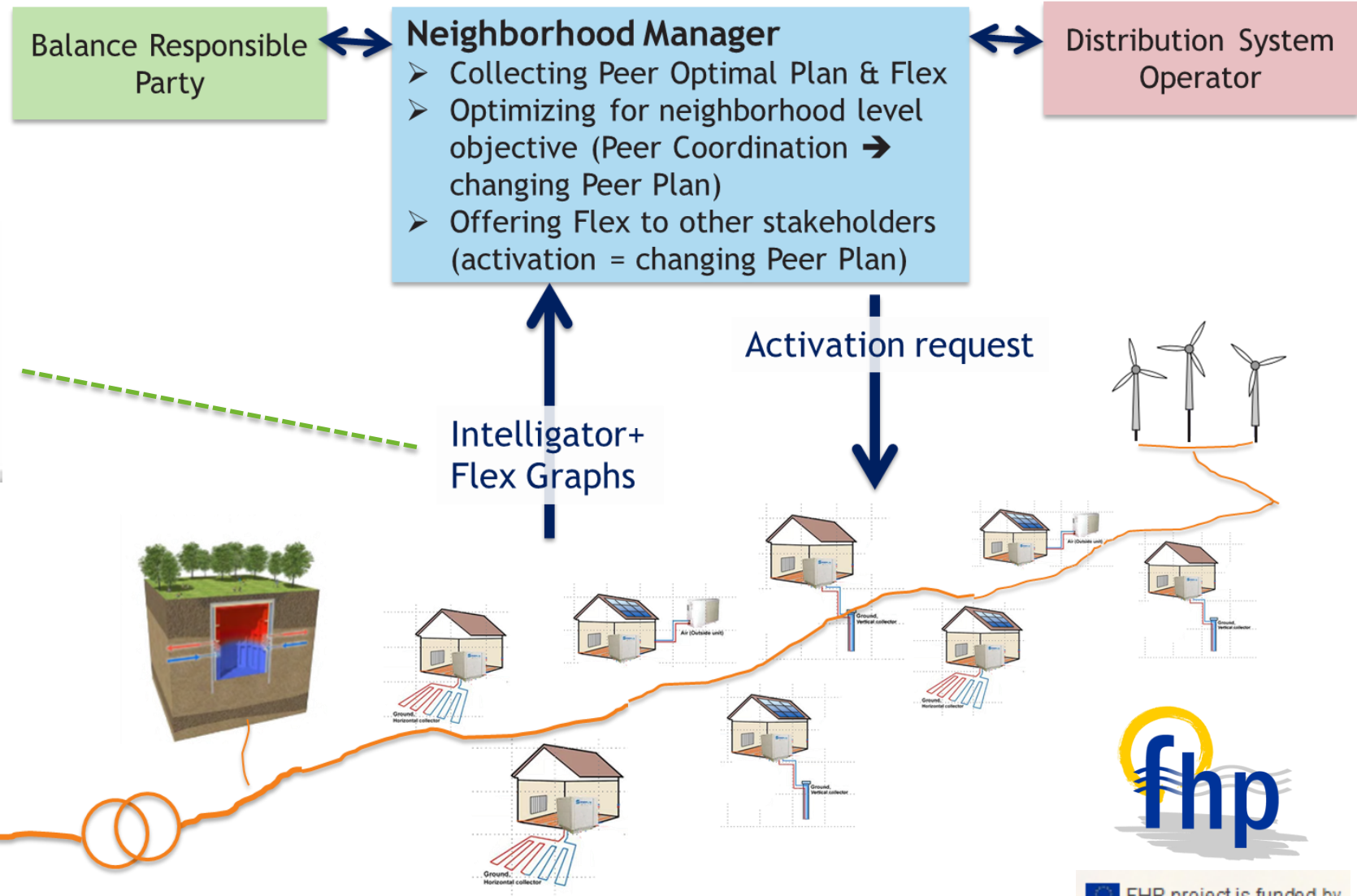


Example pilot : FHP



Optimal and Alternative Power Profiles (n time-steps)

Enhanced Peer Coordination potential compared to 'next time-step bids', leveraging forward looking information



FEBEG: Peer-to-Peer energy sharing

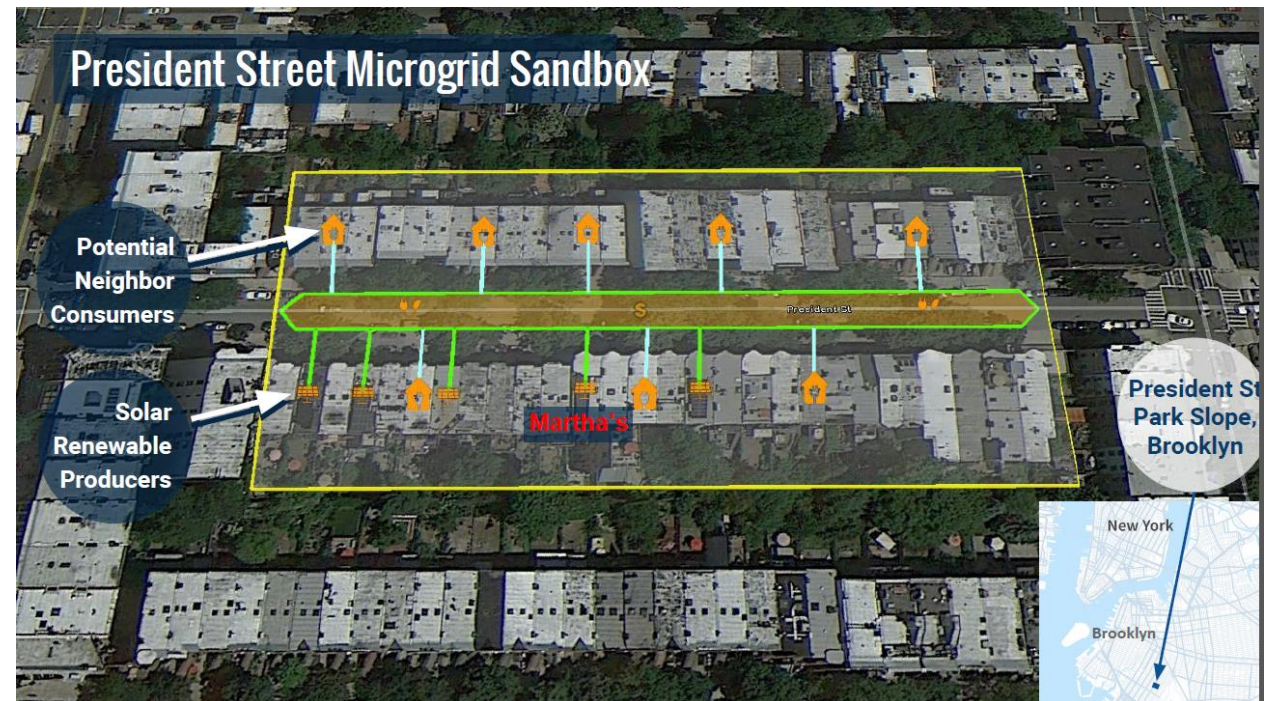
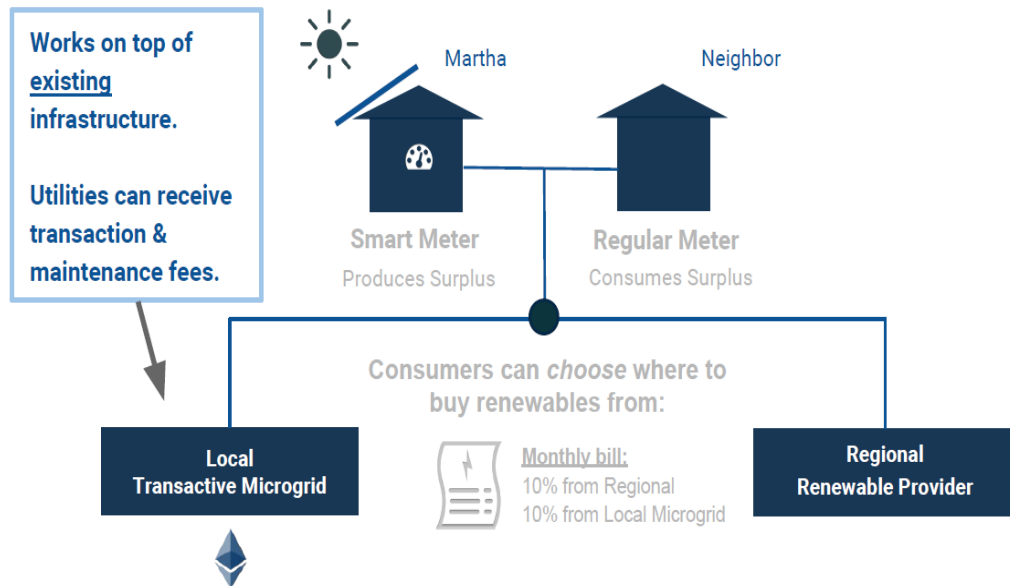
FHP project is funded by European Union under the grant agreement no. 731231.

Example pilot : Brooklyn Microgrid

🌿 Blockchain enabled community power (April 2016 - ...)

🌿 ~50 families: PV Have's and Have Not's

🌿 Sell excess solar energy to neighbors



Example pilot : Antwerp Circular South

🍃 District New South in Antwerp (200 apartments) : Nov'2017 – Nov'2020

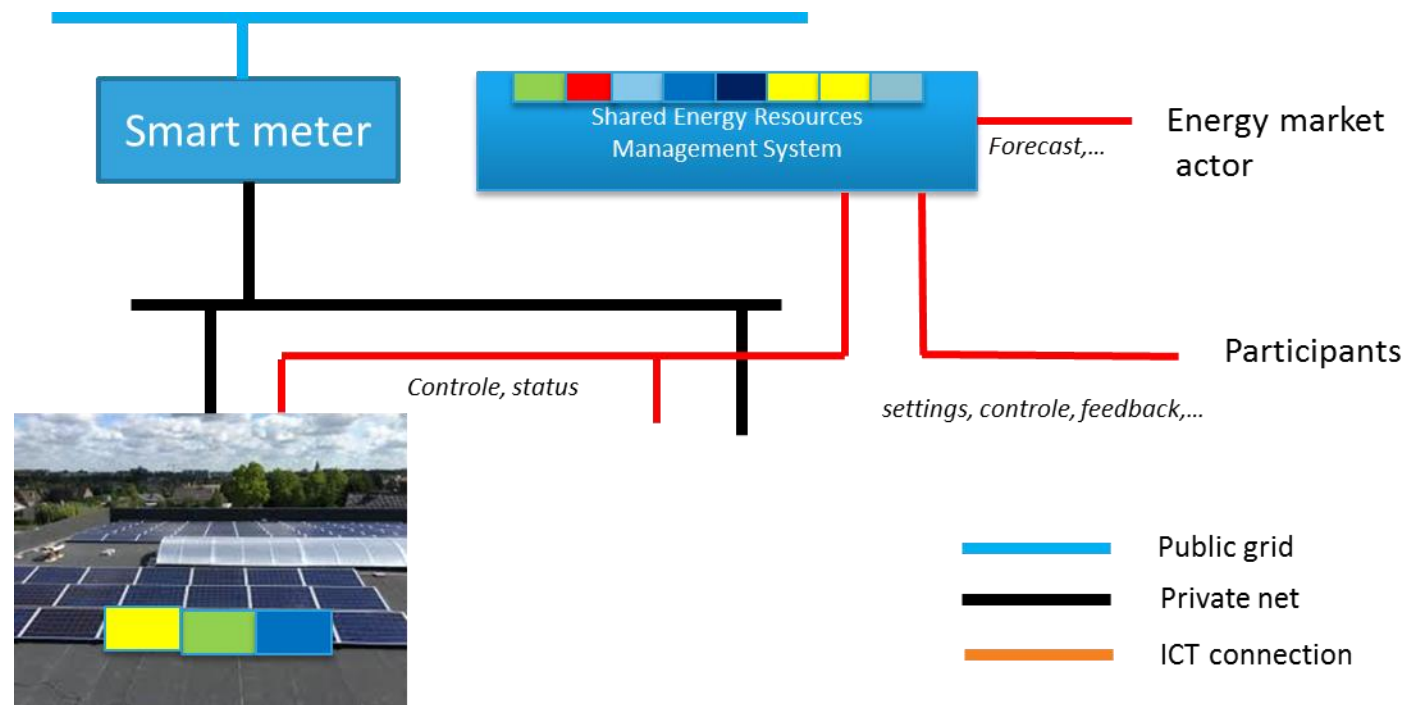
✦ Community driven innovation: engage individuals in tackling collective circular challenges (**behavioral adaptation** by means of **nudging**)

✦ **Energy related:**

🏠 PV & Battery asset sharing

🏠 Battery virtualization

🏠 Reward system (for 'good' behavior) based on blockchain technology



Example pilot : Buurzame Stroom - Gent

🍃 Start Q1'2018

🍃 Incentify installing more rooftop solar (x2 → 700 MWh)

✂ on rented out buildings

✂ on neighbour rooftop solar

🍃 Active management of consumption to coincide with solar generation

✂ Avoid grid problems

✂ Max local consumption of locally generated energy (minimize losses)

🍃 Combine economic rentability with solidarity

Commercial Examples : the Netherlands

PowerPeers

Consumers

Choose your green source for electricity

If still using gas: compensate your CO2

Prosumers (e.g. PV owners)

Extra incentive on top of net metering

REX-Liander

EnWire: buy/consume from local source

ENTRNCE: direct trading between large scale producers and consumers

Samenstroom
Heb je zelf geen zonnepanelen, maar wil je toch gebruik maken van 100% duurzame energie uit Nederland? Met Powerpeers Samenstroom kan dit! De voordelen:

- kies zelf van welke energiebronnen jij stroom afneemt
- stap moeiteloos volledig over op groene energie

Voorwaarden en tarieven:
[Samenstroom variabel contract](#)
[Samenstroom vaste prijs 1 jaar](#)

Opwekkersstroom
Heb jij zonnepanelen en een slimme meter? Ga dan voor Powerpeers Opwekkersstroom! De voordelen:

- saldering: betaal alleen voor de stroom die je netto gebruikt (teruggeleverde stroom wordt afgetrokken van je stroomverbruik)
- ontvang €0,0484 extra voor elke kWh die je via ons platform deelt met anderen (oplopend tot zo'n €50 extra per jaar bovenop je salderingsvergoeding!)
- kies je eigen opwekkers waar jij, bijvoorbeeld op het dak, stroom

Voorwaarden en tarieven:
[Opwekkersstroom variabel](#)
[Opwekkersstroom vaste prijs](#)

Gas met CO2-compensatie
Powerpeers biedt volledig CO₂ gecompenseerd gas. Dus als jij je huis verwarmt, kookt, of een douche neemt, zorgen wij dat de CO₂ uitstoot gecompenseerd wordt. Wij ondersteunen namelijk diverse projecten wereldwijd die de CO₂ uitstoot terugdringen.

Voorwaarden en tarieven:
[Gas + samenstroom variabel](#)
[Gas + opwekkersstroom variabel](#)
[Gas + samenstroom vaste prijs](#)
[Gas + opwekkersstroom vaste prijs](#)

[bereken nu mijn maandbedrag](#)

CO₂ compensatie projecten

Projecten
1. Araba Windpark Vader Piet
2. India Godawari Solar Thermal
3. China Qinghai Solar PV

What's next

🌿 Pilots → upscaling & replication → commercial products and services



Publicly accessible test network for blockchain applications: Tobalaba

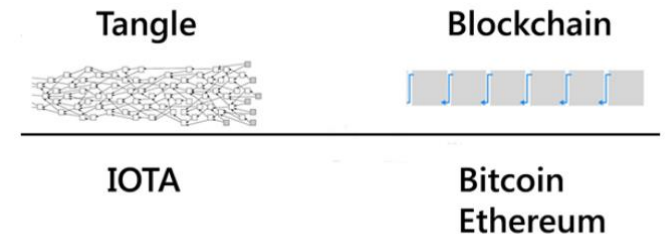
🌿 Distributed Ledger Technology/Blockchains → IOTA

✦ The Tangle, a revolutionary new block-less distributed ledger

🏠 Using Directed Acyclic Graphs instead of blockchains

🏠 Zero-fee transactions, fast, infinitely scalable, ...

✦ Hashgraphs, holochains, ...





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