

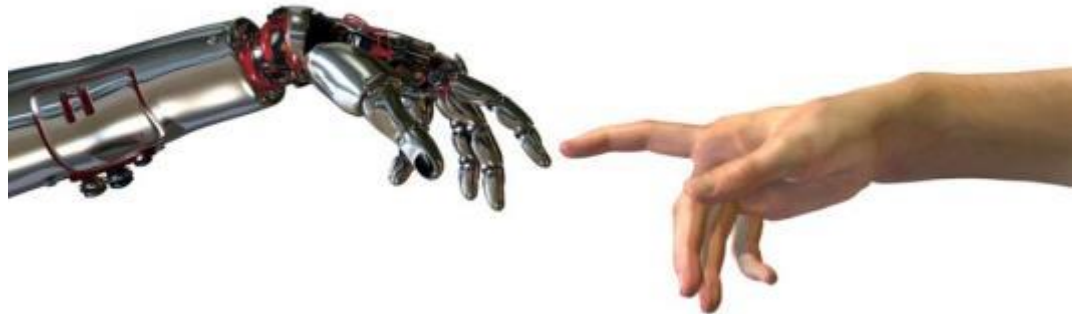
Digitalisation and energy grids

energy transition · today's innovation and in future · mathematics in innovation

Esther Hardi

Corporate Strategy Alliander

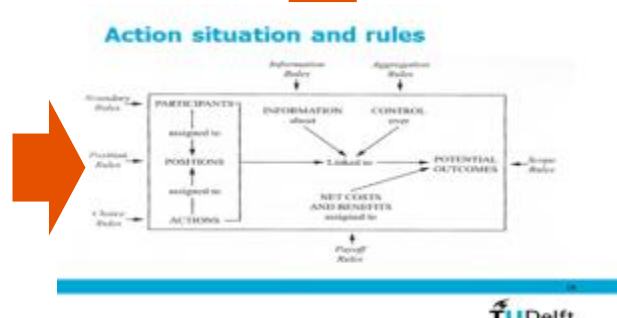
Delft, June 2018



Esther Hardi



$$\begin{aligned}
 (22-27) \quad & \frac{\partial^2(\gamma_{11} + \gamma_{22} + \gamma_{33} - \gamma_{44})}{\partial x^2 \partial x^2} \\
 & + \sum_{\alpha=1}^{\alpha=4} \sum_{\beta=1}^{\beta=4} \frac{\partial}{\partial x^\alpha} \left(v^{\alpha\beta} \left(\frac{\partial \gamma_{\alpha\beta}}{\partial x^\alpha} + \frac{\partial \gamma_{\alpha\beta}}{\partial x^\beta} - \frac{\partial \gamma_{\alpha\beta}}{\partial x^2} \right) \right) = 0 \\
 & + \frac{\partial^2(\gamma_{11} + \gamma_{22} + \gamma_{33} - \gamma_{44})}{\partial x^2 \partial x^2} + \sum_{\alpha=1}^{\alpha=4} \sum_{\beta=1}^{\beta=4} \frac{\partial}{\partial x^\alpha} \left(v^{\alpha\beta} \left(\frac{\partial \gamma_{\alpha\beta}}{\partial x^\alpha} + \frac{\partial \gamma_{\alpha\beta}}{\partial x^\beta} - \frac{\partial \gamma_{\alpha\beta}}{\partial x^2} \right) \right) = 0 \\
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 \end{aligned}$$

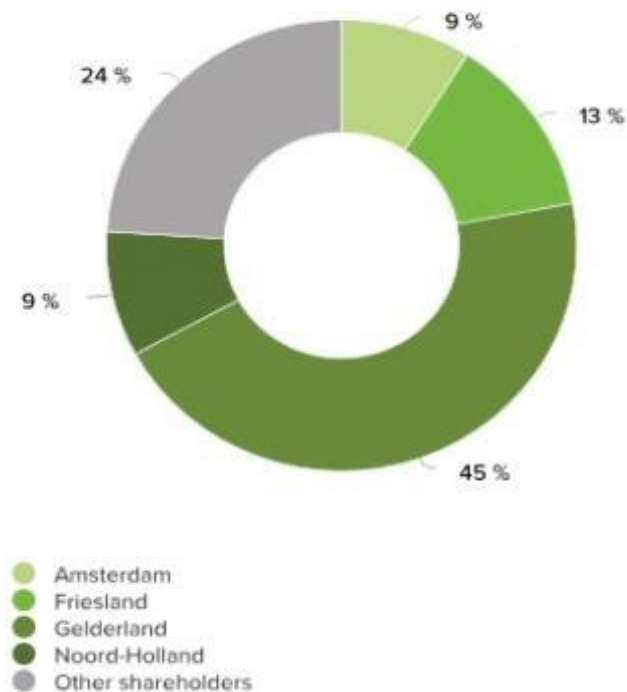


Alliander



Alliander

Shareholders



Service area



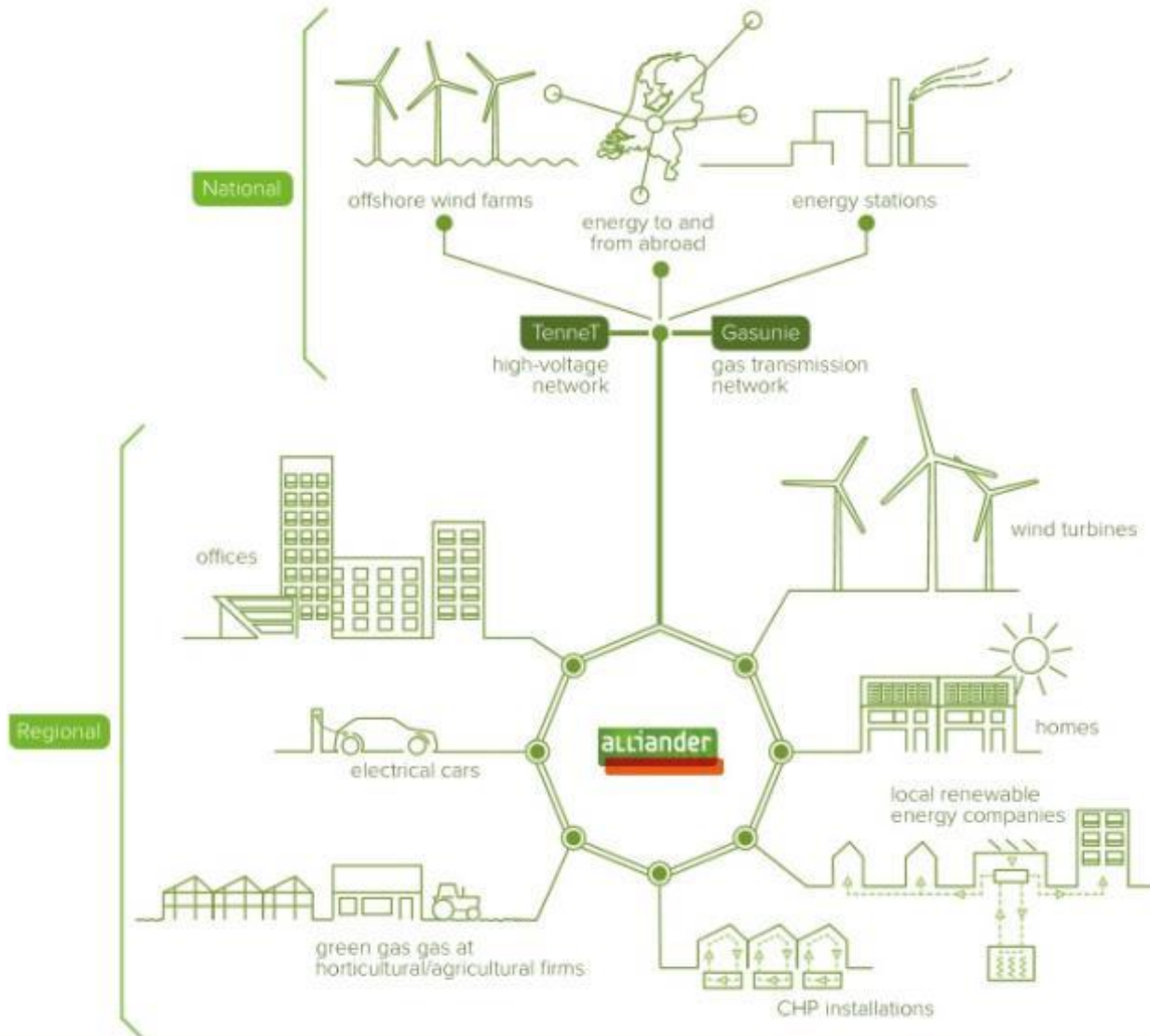
Vision

We stand for an universal access to reliable, affordable and sustainable energy

Strategy

Support customers in their choices, support and invest new open markets, digitalisation, excellent network performance

Alliander



Agenda

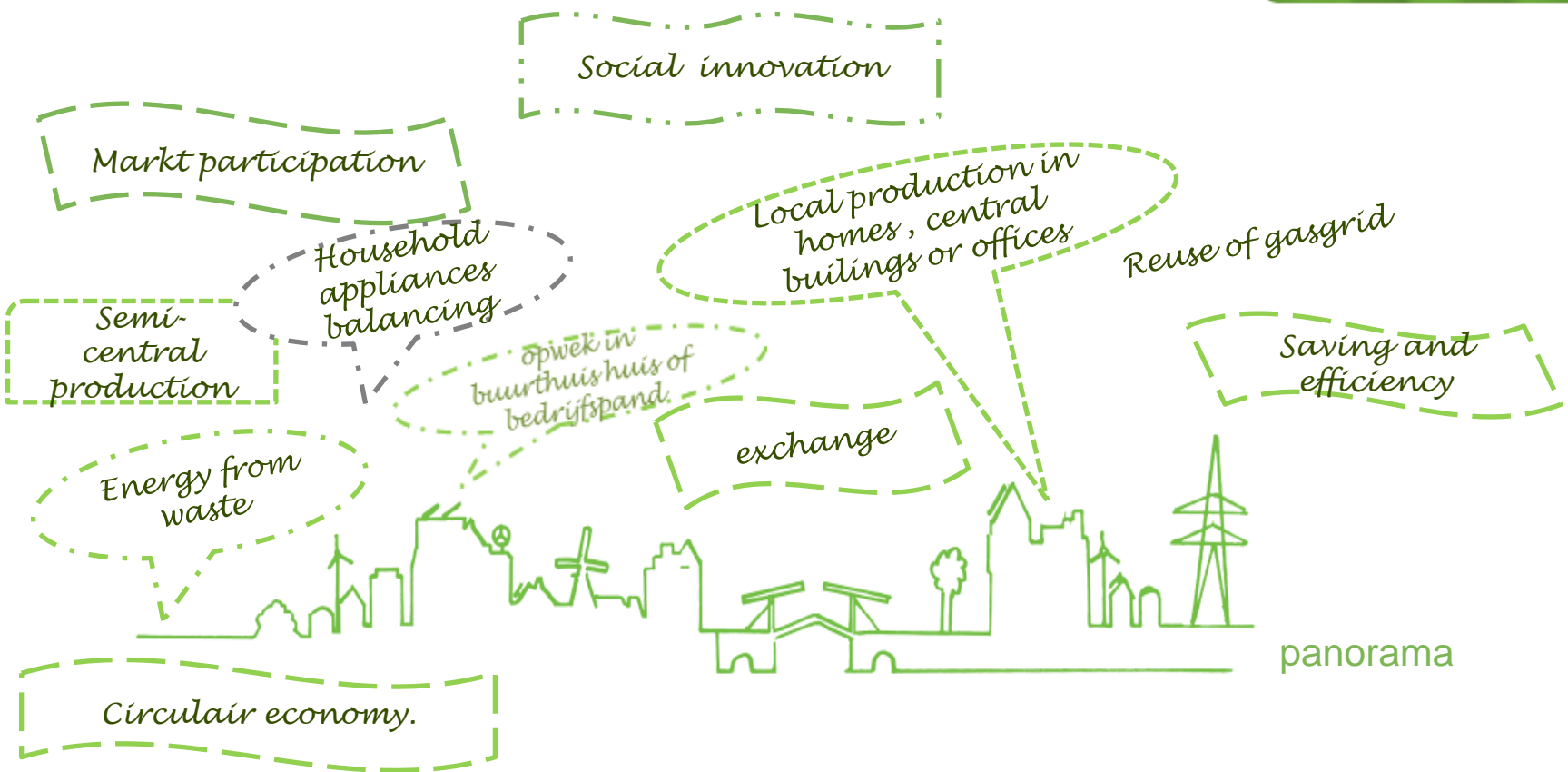
1. Introduction Alliander

2. Market trends

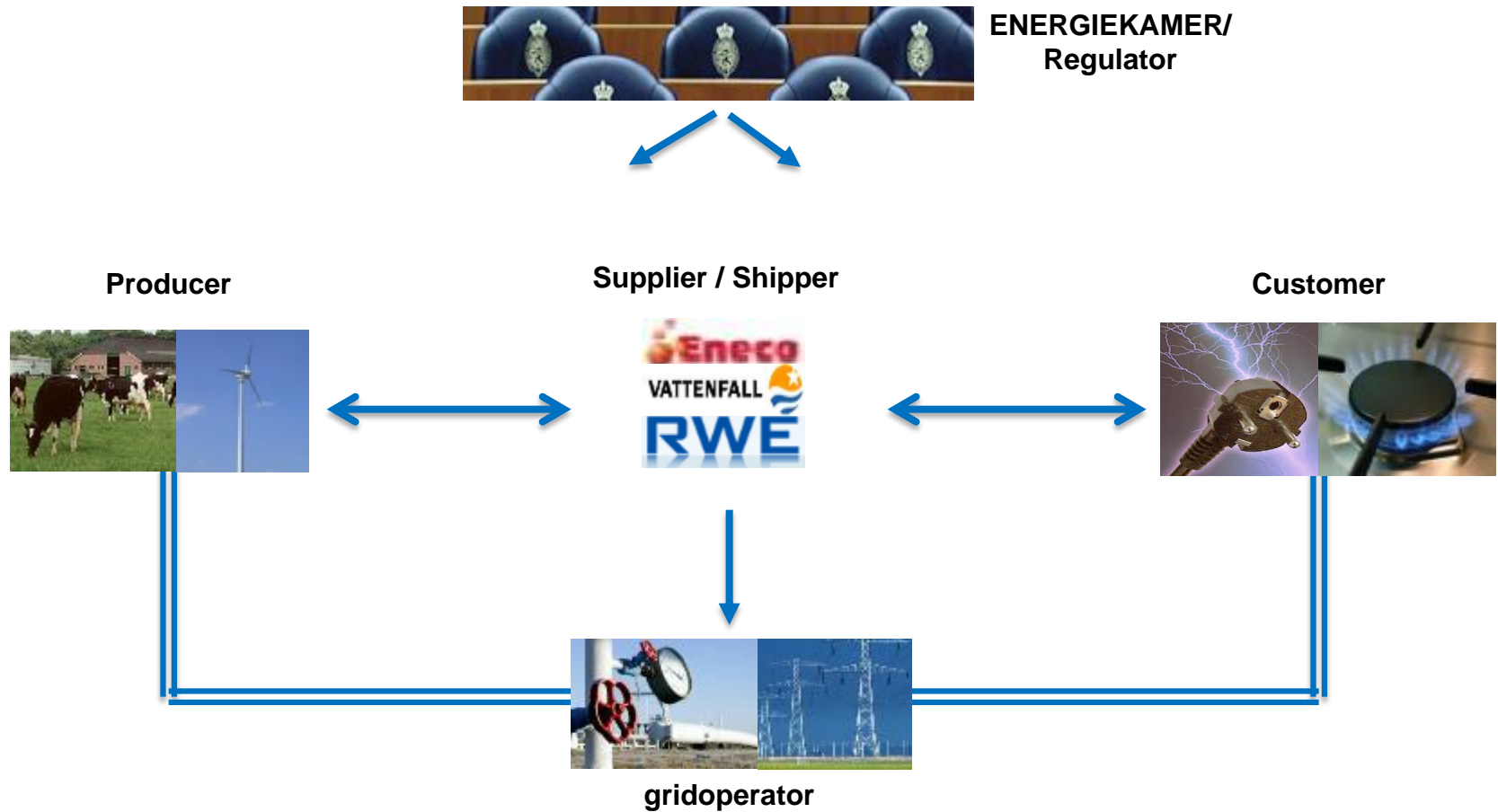
3. Today's new business/ market enablers (data driven)

4. Today's innovation day to day grid operation

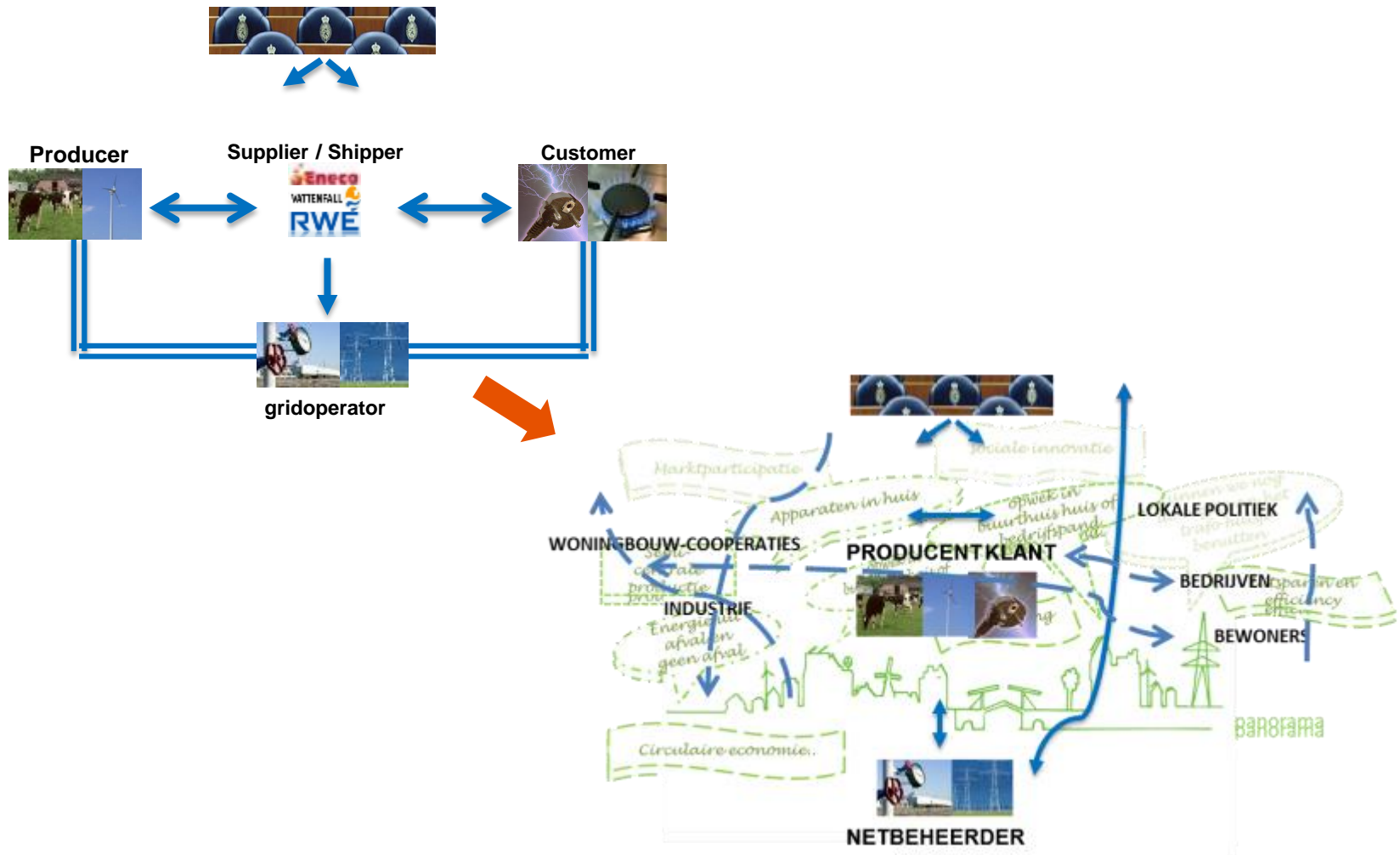
5. New developments (future)



Role of the gridoperator



More participants, more roles

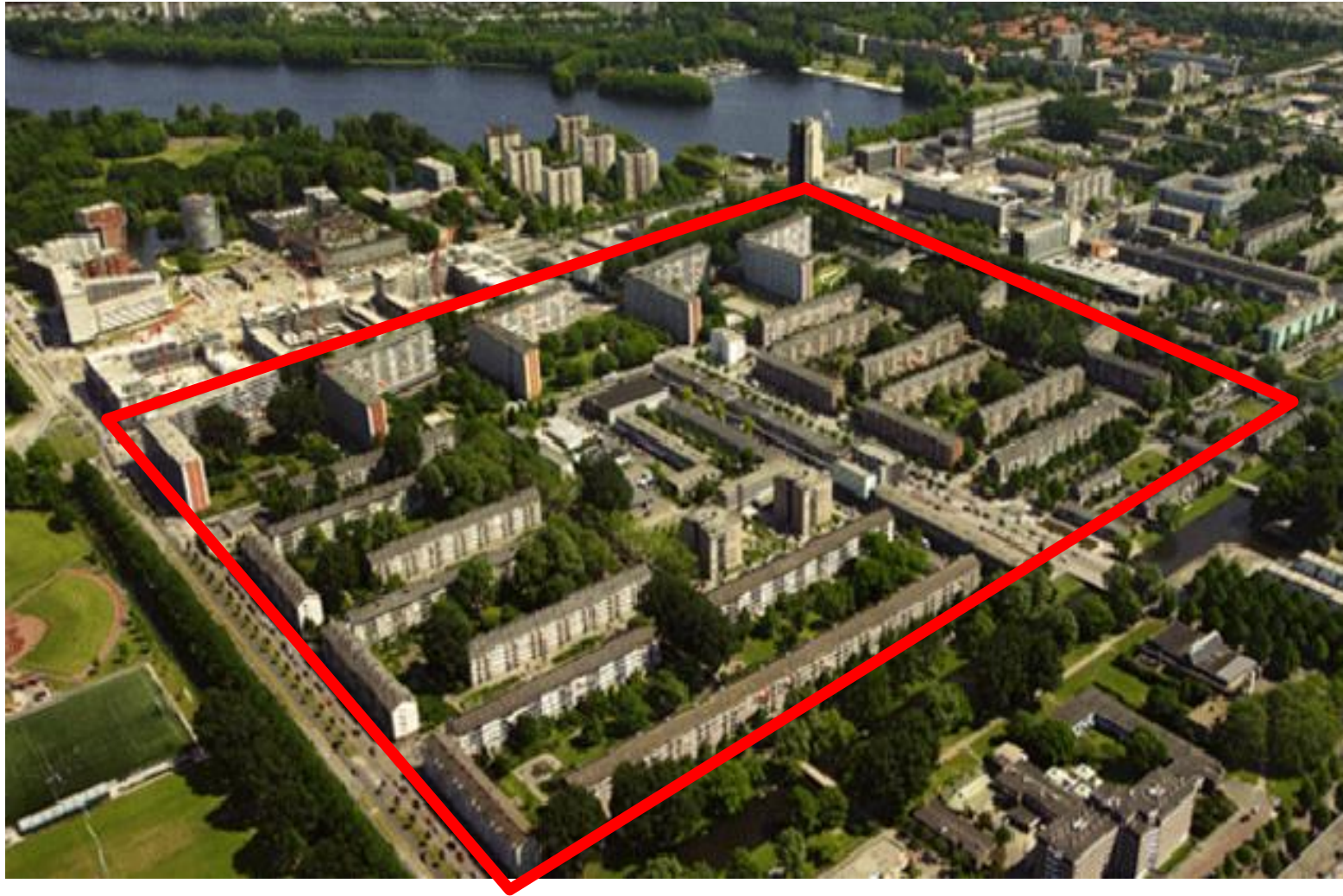


House insulation, new heat solutions

- “Nul op de meter” households
- Clean up gasgrid, district heating 4.0, heat sources geothermal energy or low temperature grids



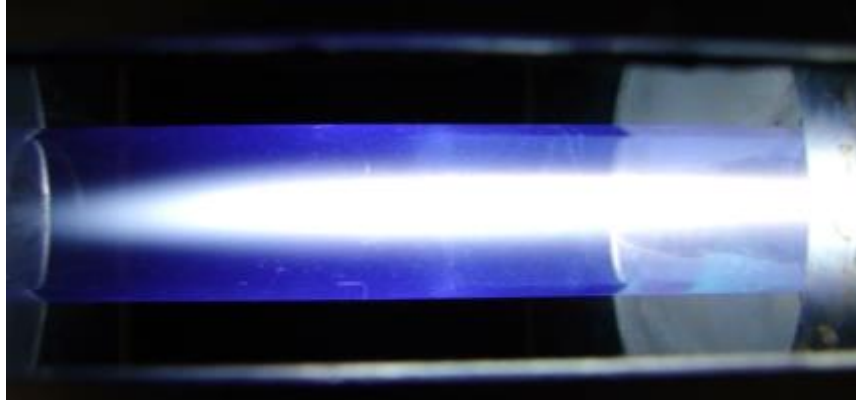
Decentral neighbourhood approach



Decentral supply, right scale



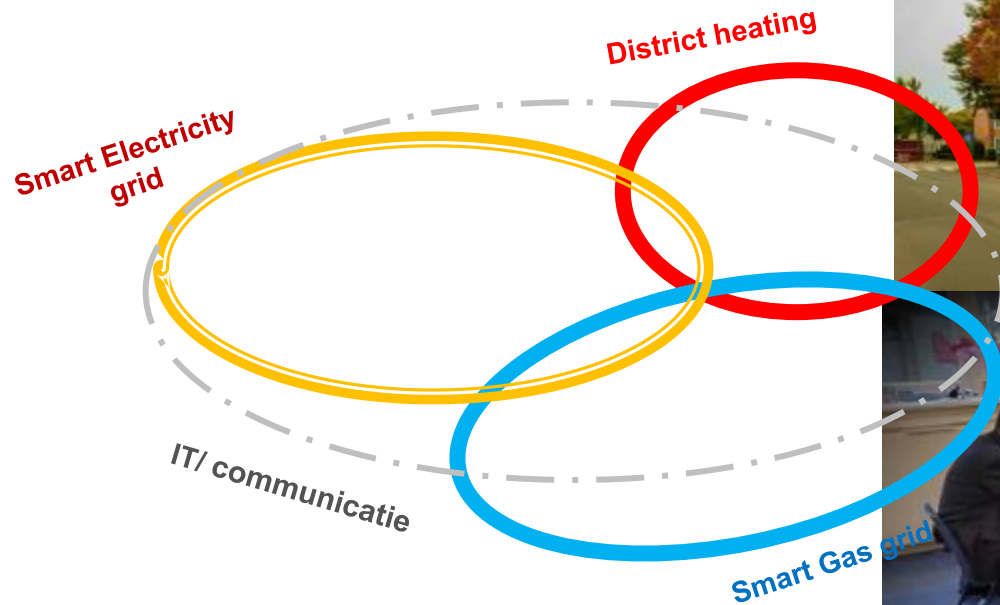
Decentral supply, right scale



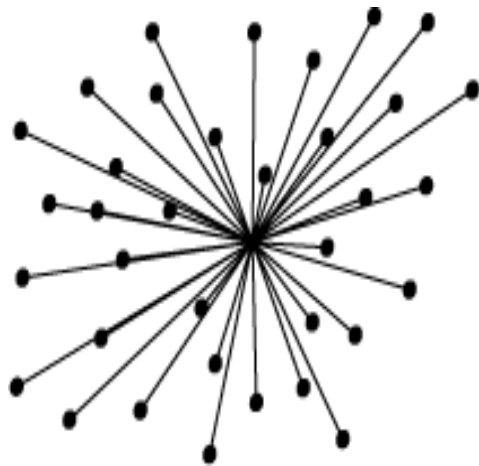
1200 euro/kW (6MW installation of Audi). Are there easy and affordable ways?

Integration of the energy system

Interconnection and integration, lokale optimum



Decentral approach



centralised



decentralised



distributed



200 km

Energy

Data

Digital Topics



Connected, IoT



Digital identity



Transaction, Trust, Blockchain



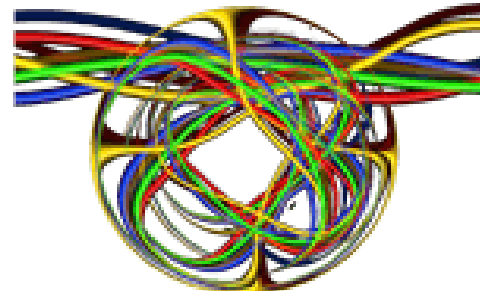
Sensing



Cryptography



Social media



Artificial intelligence



Privacy



Big / open data



Gamification

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Smart energy grids – smart customers



Customer access to Power Markets

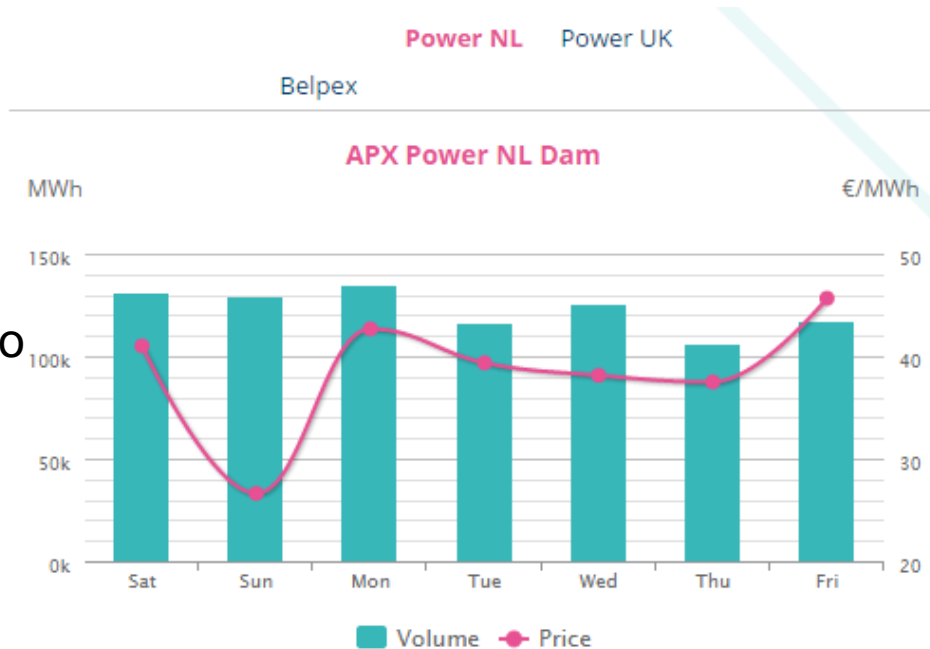
1 Quarter / Month	Endex (day ahead, spot, intraday)
2 Day, hour	EPEX (APX)
3 15 minutes	Secondary reserve
4 Seconds	Primary control, frequency
5 OTC	Bilaterally contracts



Customer access to Power Markets

ENWIRE an online platform to support local energy trades

REX balancing tool to enable customer to balance production and consumption anticipating on the volatile energy prices.



Customer access to Energy Markets

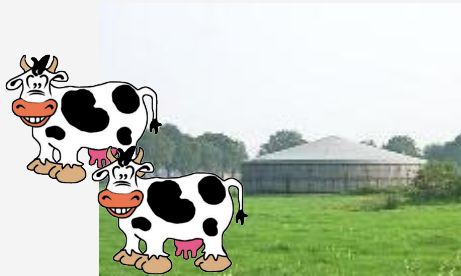
Electricity

Energy
Storage

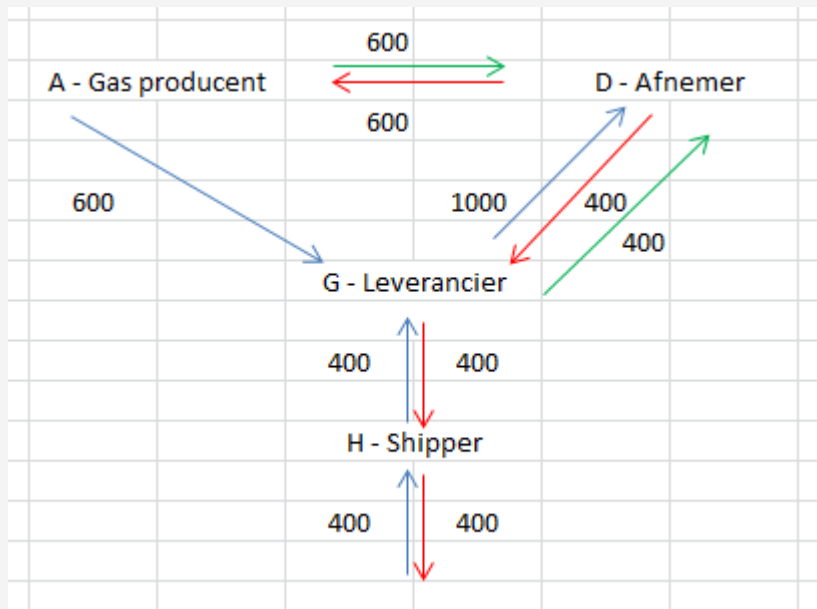
Heat

CO₂
Reducti
on

Gas



Possibility of an accessible market where energy in the form of gas, electricity and heat with possibilities for storage and conversion are traded and combined to provide a total energy package to the consumer.



Customer access to Energy Markets

Theorem 2.3 *Black-Scholes formula. At time t let $S(t)$ be the underlying stock, K the strike price and T the maturity date then the price of an European call option $C(t, S(t))$ is given by*

$$C(t, S(t)) = S(t) N(d_1) - Ke^{-r(T-t)} N(d_2) \quad (2.11)$$

with

$$d_1 = \frac{\ln\left(\frac{S(t)}{K}\right) + r(T-t) + \frac{1}{2}\sigma^2(T-t)}{\sigma\sqrt{(T-t)}}$$

and

$$d_2 = \frac{\ln\left(\frac{S(t)}{K}\right) + r(T-t) - \frac{1}{2}\sigma^2(T-t)}{\sigma\sqrt{(T-t)}}$$

where $N(x)$ is the cumulative probability distribution function for a Gaussian distribution

$$N(t) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^t \exp\left(-\frac{x^2}{2}\right) dx.$$

Bron: Anna Julia Ostaszewicz, The Hurst parameter and option pricing with fractional Brownian motion, 2012.

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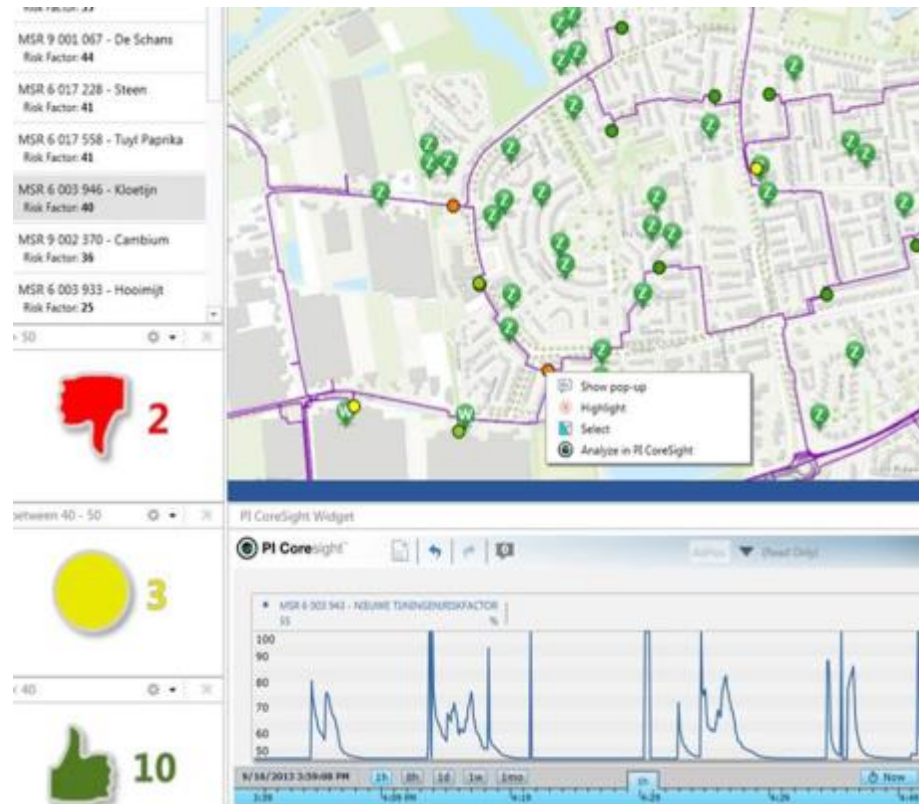
Data-driven innovations Asset Maintenance & Investment planning



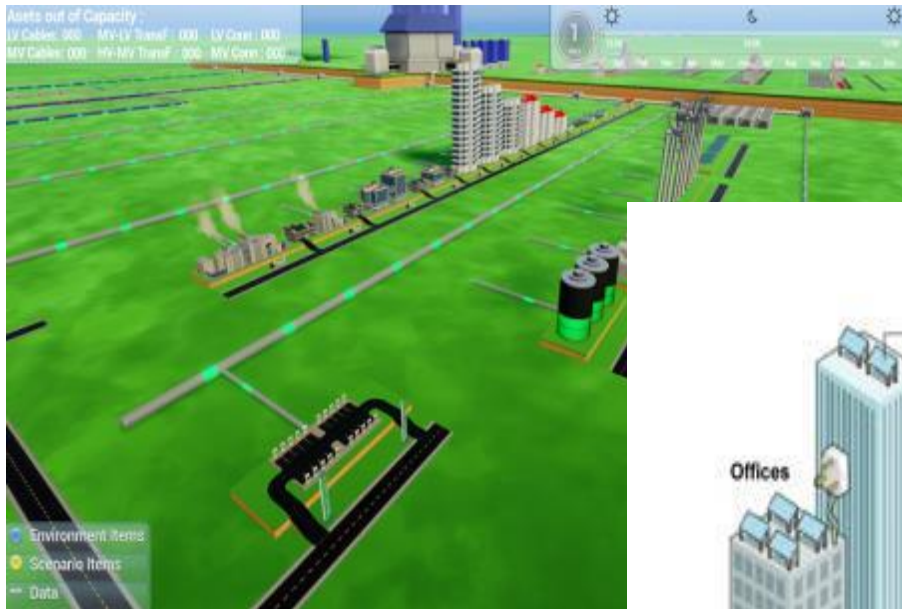
The effect of increase of solar energy and electrical vehicles etc.



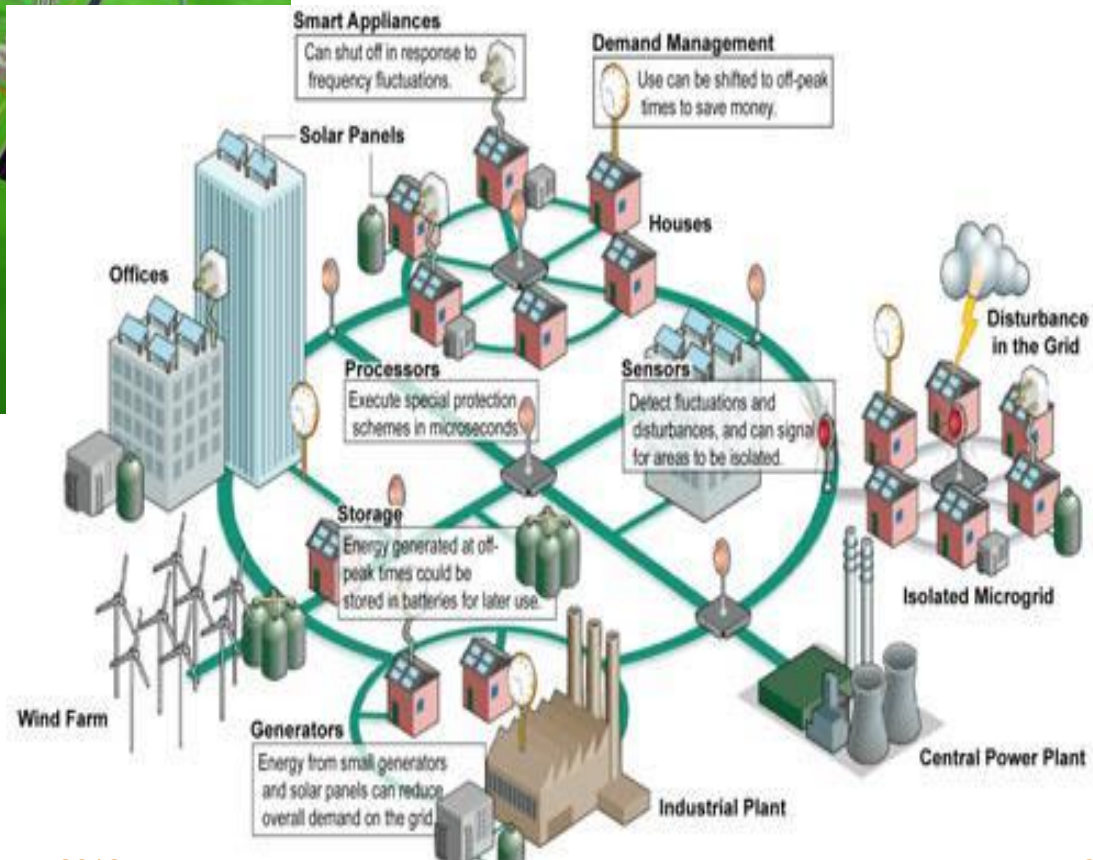
Data-driven innovations “Smart City Sensor Fusion” (and real-time energy load forecasting)



Data-driven innovations “The self managing grid”



Artificial intelligence for automated decision making



Data-driven innovations for the energy transition: Smart Societies



Communication between devices of different customers/users

Communication to devices using open source technologies enabling multiple use cases



Open - no lock-in on a specific technology and/or supplier by using open protocol standards and open source technology



Generic - not limited to one use case, one value proposition or specific device(s)



Independent - stay in control of your own roadmap and be flexible to future changes by building on an open platform ecosystem



Scalable – designed for high performance, dynamically scaling up and down with number of devices



Customer participation increases

- Internet of Things IoT
- Industrial IoT platform for critical infrastructures
- Big data



Blockchain for energy transactions



Local currencies

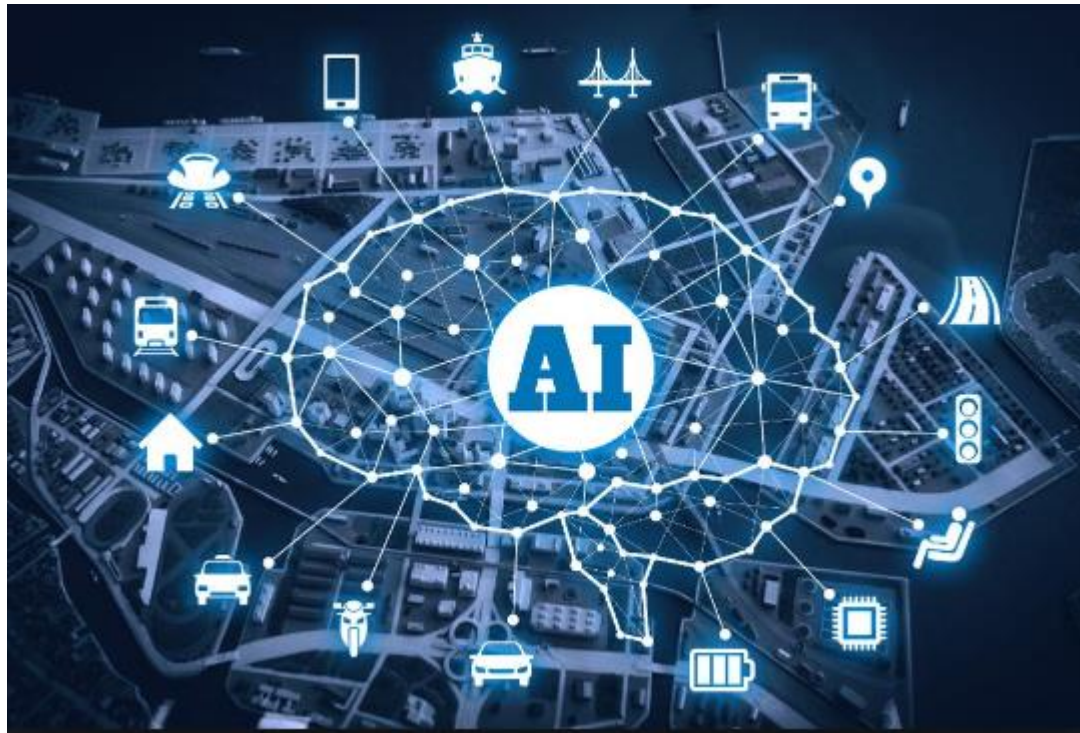


Peer to peer transactions

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Artificial intelligence in energy supply



Picture: Article Xiaomi Redmi, A great budget phone from AmazingByte, June 2018

Virtual reality at the workflow



Thank you!

