



**AMEU/SAIEE joint virtual webinar**

***“THE DIGITAL MUNICIPAL Dx ELECTRICTY UTILITY OF THE FUTURE”***

***25 August 2022***

**Session 6**

**Digitalisation, Decentralisation, Disruption**  
***The Energy Internet***

***By / Professors S Rahman***  
***& P Naidoo***

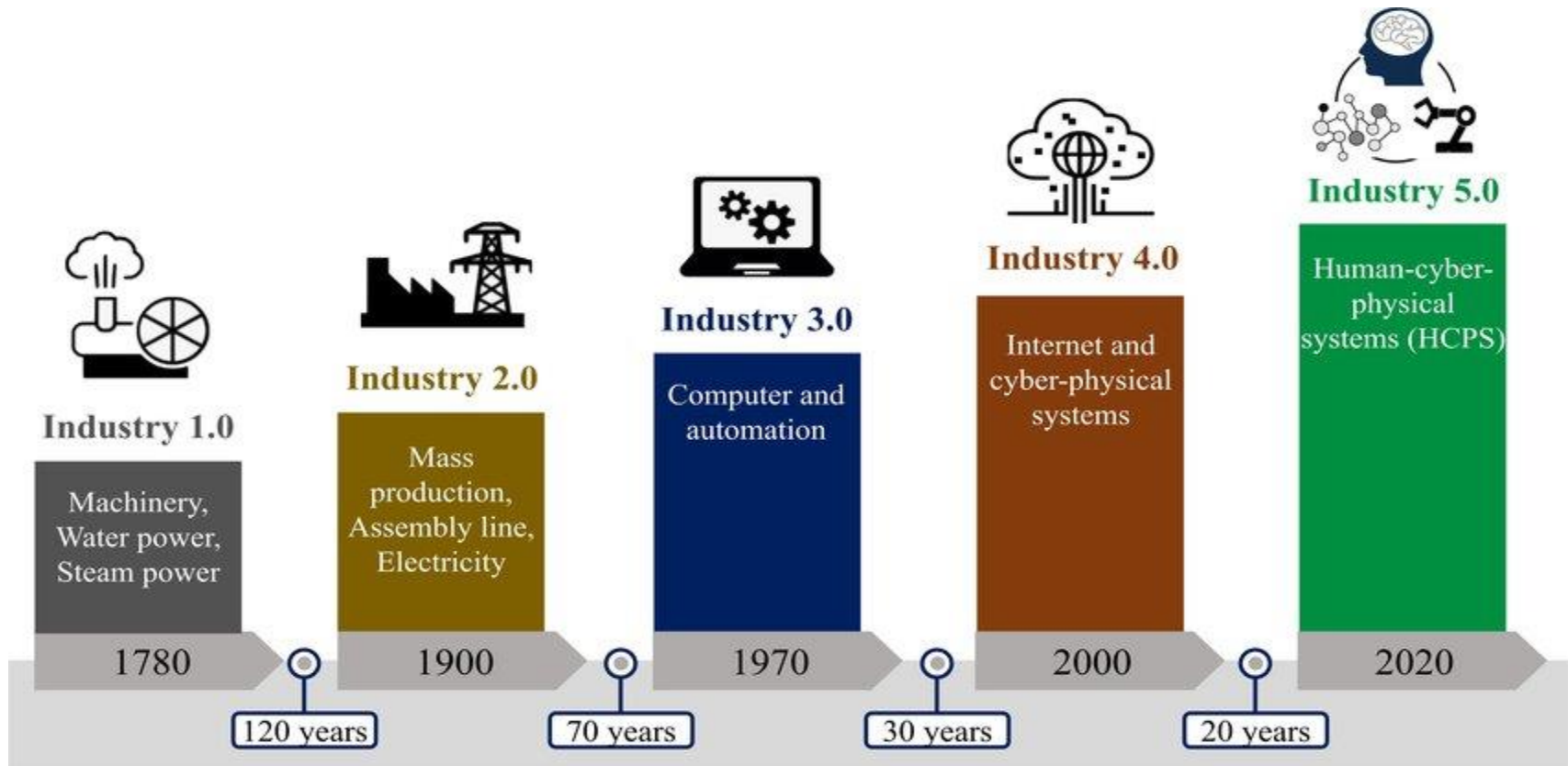
**SAIEE**





Prof. Saifur Rahman  
Director, Virginia Tech Advanced  
Research Inst., USA  
2022 IEEE President-elect





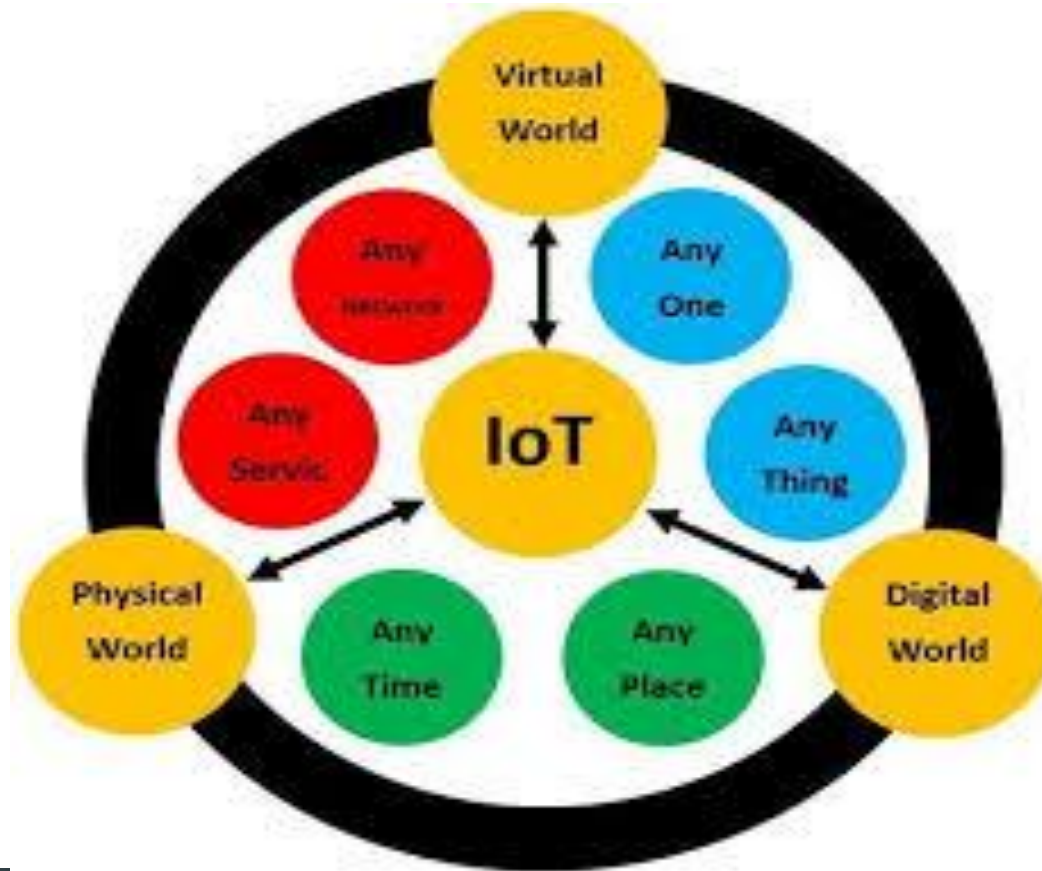
## What is the Energy Internet ?

The **Internet** allows information to flow to anyone from anywhere.

The **Energy Internet** is a vast network that will allow efficient distribution of electricity to anyone and from anywhere.

**EI** will utilize smart sensors, ICT technologies and algorithms to facilitate power supply in real-time, enhance storage applications, and integrate energy into the grid.





## Mission of the Energy Internet

Energy Internet is an online marketplace that transacts in energy  
(One-to-One, One-to-Many and Many-to-One)

O-to-O: Between individual users for bilateral transactions

O-to-M: One electric utility sells to Many customers

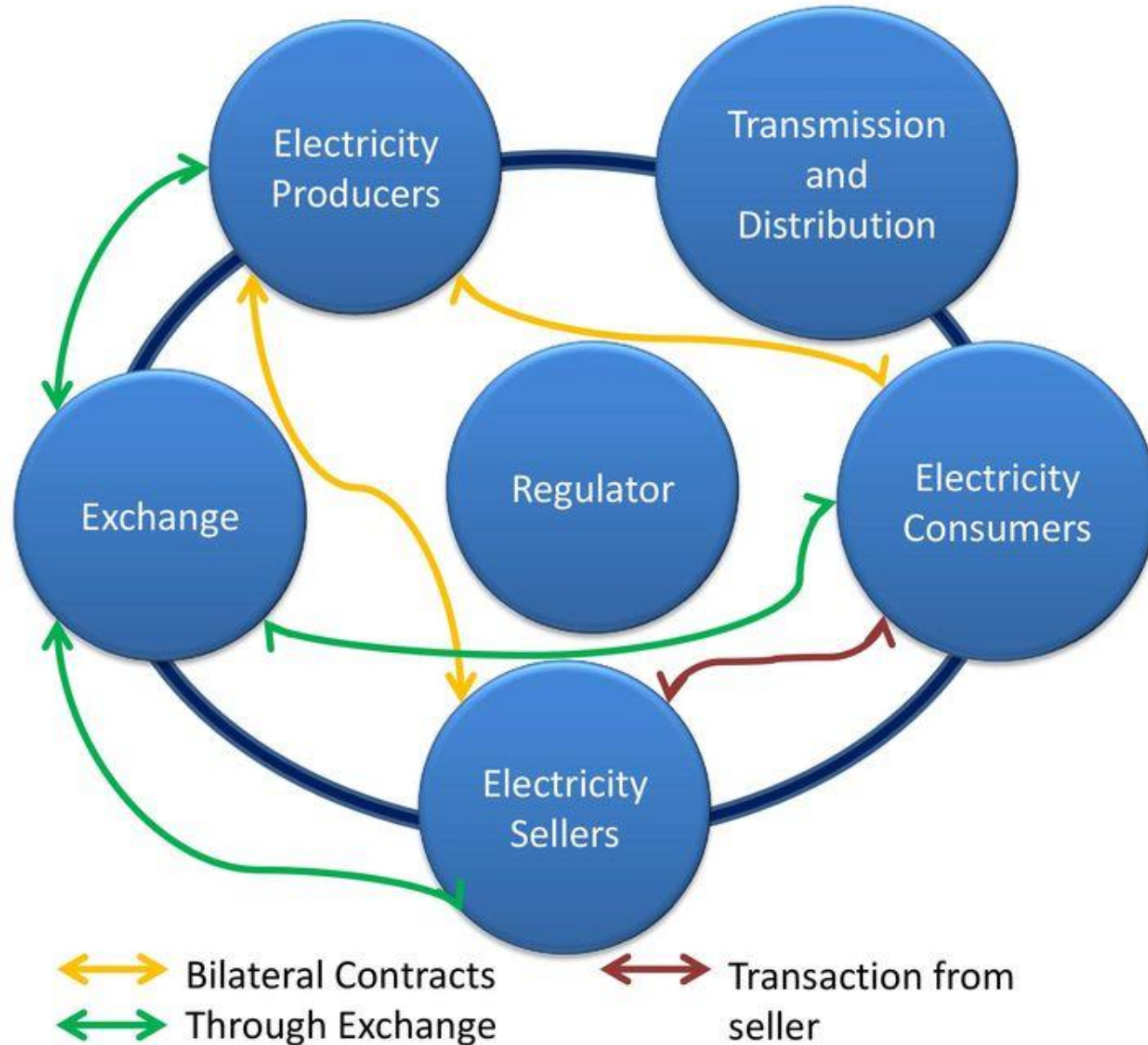
M-to-O: Many customers sell to One electric utility

### For the Energy Internet:

All transactions must be done in real-time

All network constraints must be met

# Electricity Market



## Participants of the Power Market:

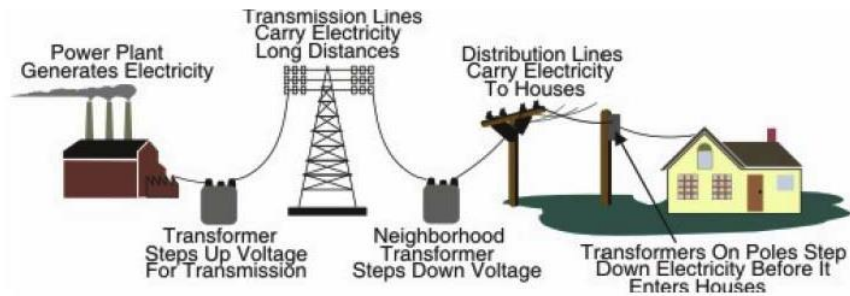
- Generating companies (Power producers)
- Consumers ( Industrial, Commercial and Household)
- Transmission companies
- Distribution companies
- Power Exchanges
- Regulators



## Smart Grid

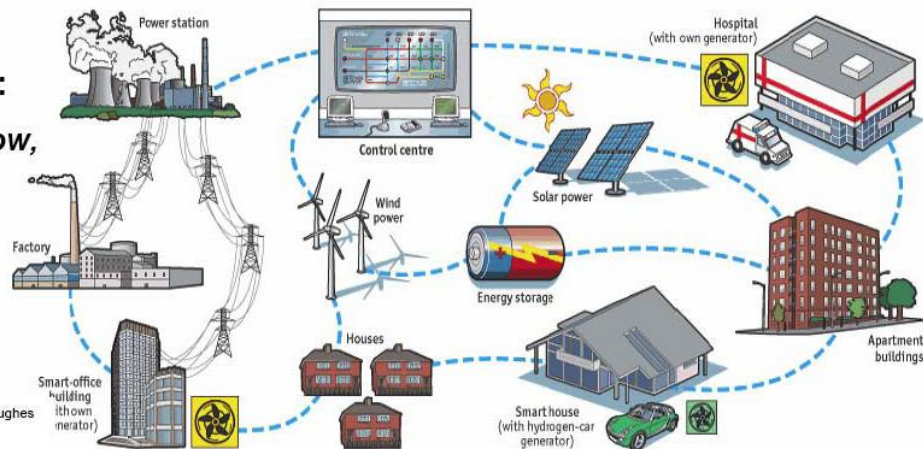
### **Before** Smart Grid:

*One-way power flow,  
simple interactions*



### **After** Smart Grid:

*Two-way power flow,  
multi-stakeholder  
interactions*



Adapted from EPRI Presentation by Joe Hughes  
NIST Standards Workshop  
April 28, 2008

Sources: The Economist; ABB

Source: Altalink, Alberta, Canada

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## THE ASSETS



Solar power



Industrial site



Wind power



Power grid



Hydropower



Storage



Thermal power



E-mobility



## INTERNET OF ENERGY ECOSYSTEM

### The key apps



Planning & design



Operations



Service



Yield

### The key elements



Cloud



Analytics



Artificial intelligence



Comms



Cybersecurity

## THE PLAYERS



Generators



Aggregators



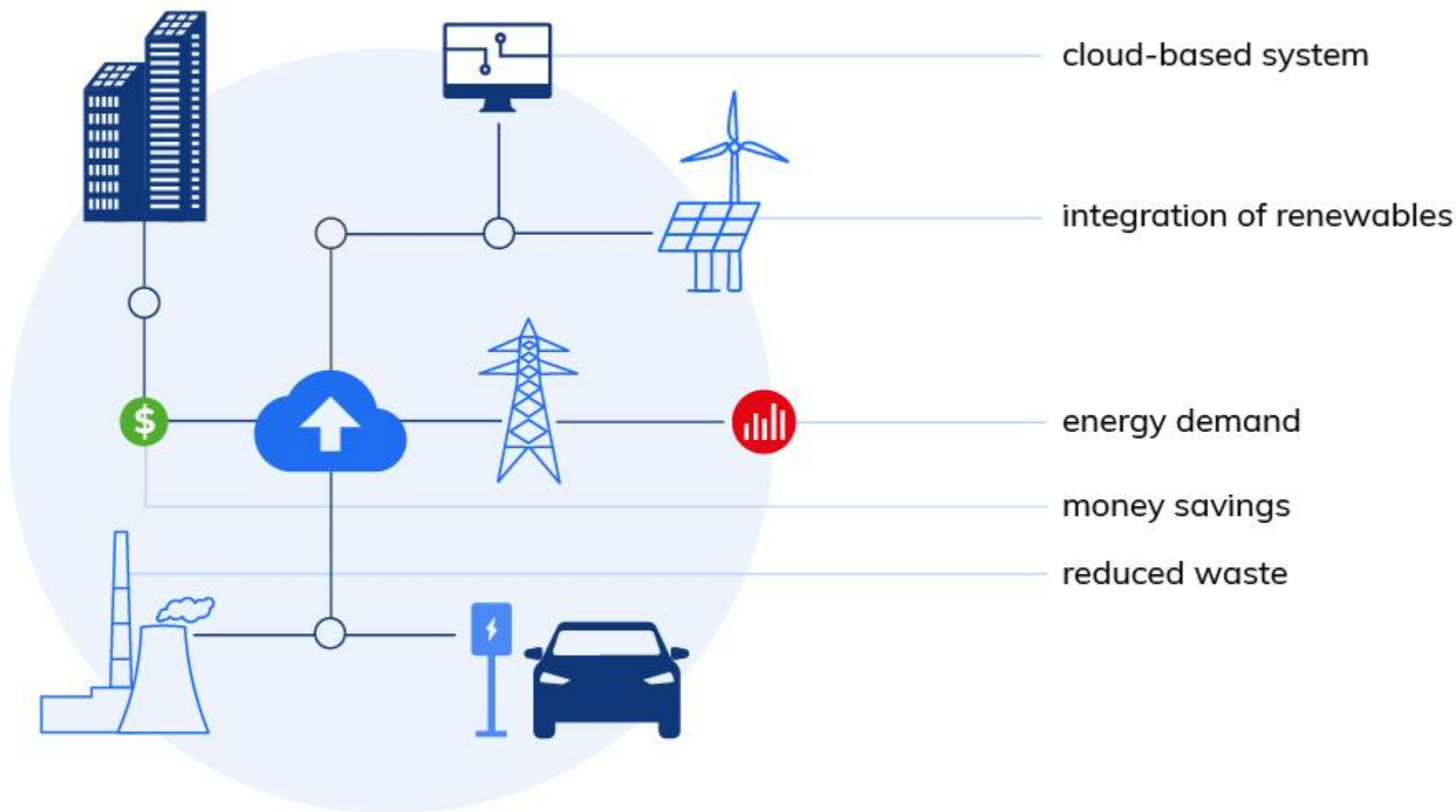
Grid operations

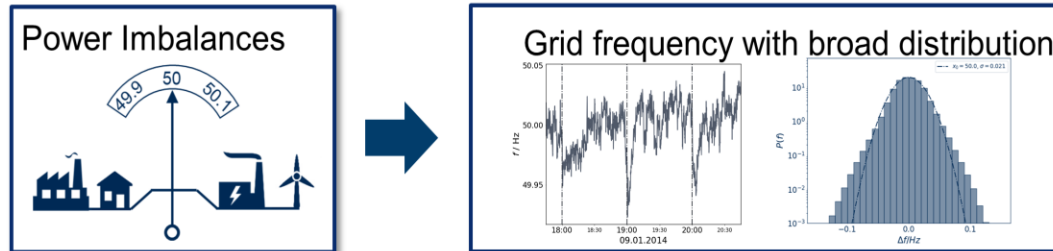


Market operators

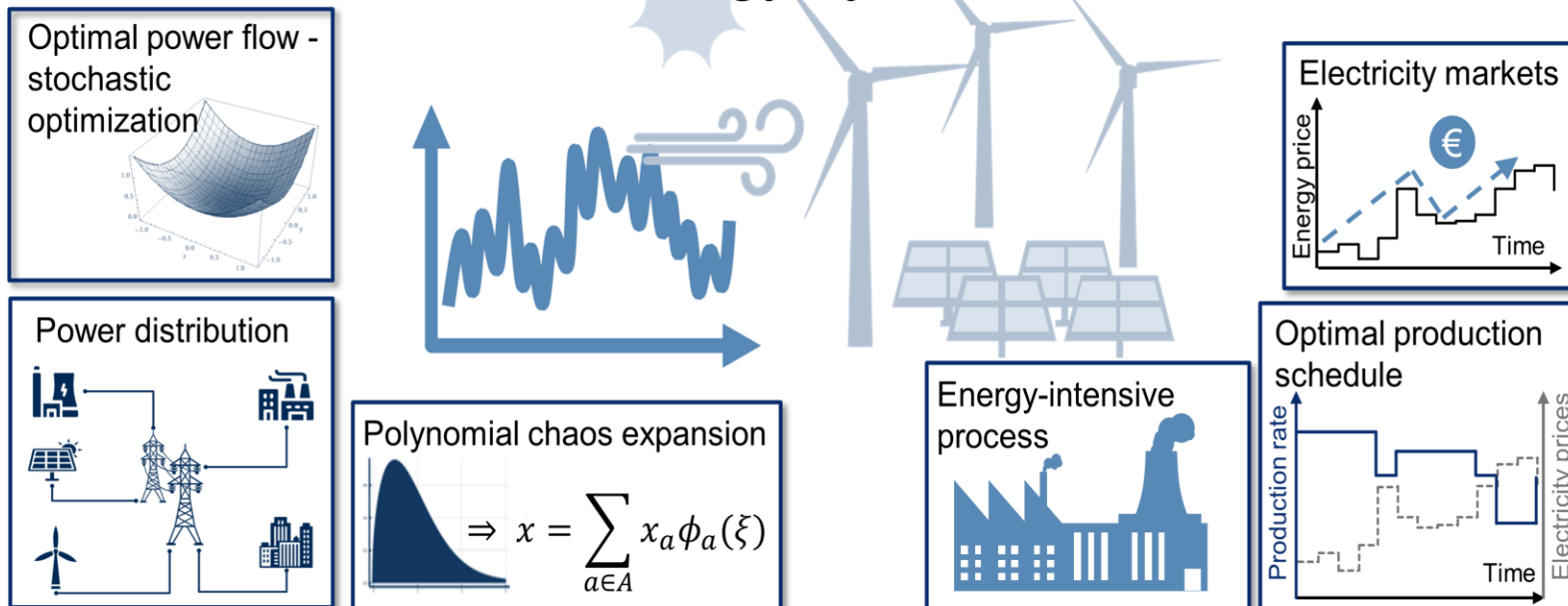






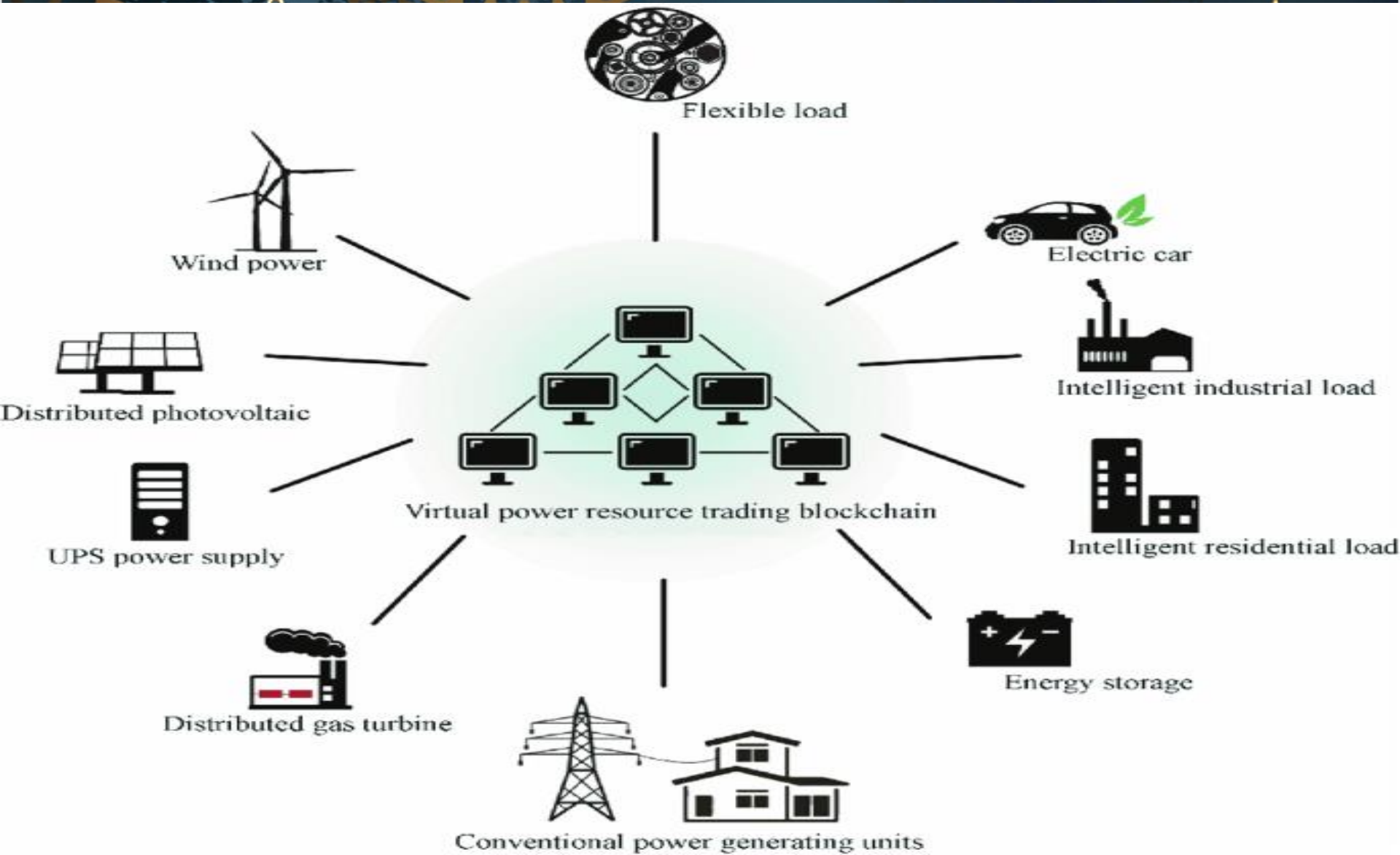


## Uncertainties in future energy systems

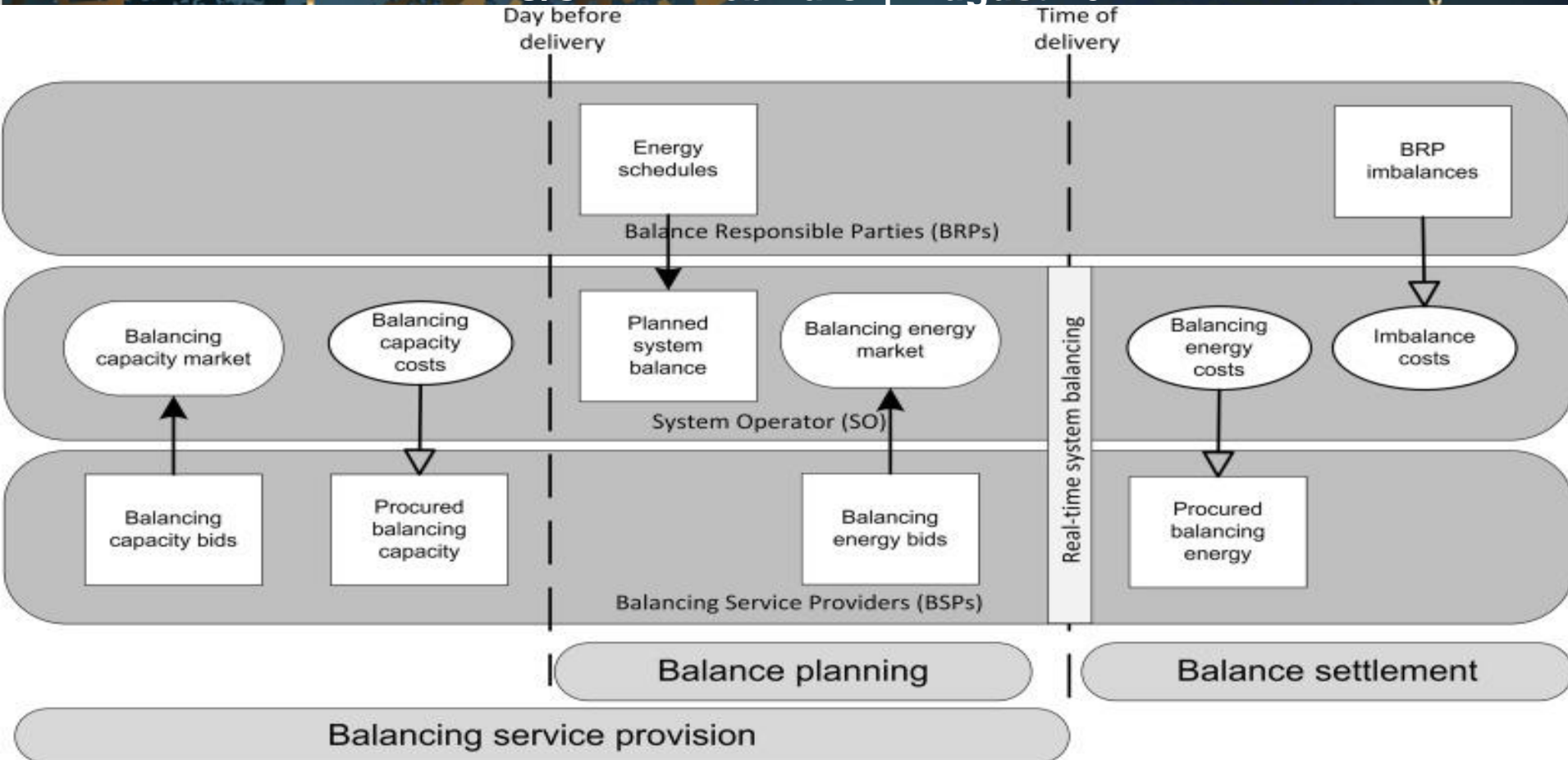




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# Thank you

## Key References

### **What Is Energy Internet? Concepts, Technologies, and Future Directions**

Hussain, Hafiz Majid; Narayanan, Arun; Nardelli, Pedro H. J.; Yang, Y.

*Published in: IEEE Access*

### **The electricity balancing market: Exploring the design challenge**

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