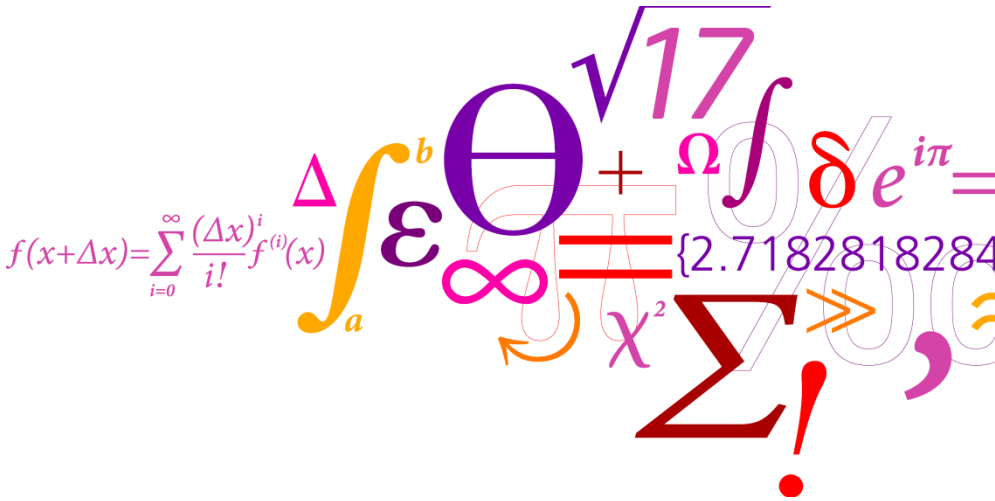
Virtual Power Plants: Enabling 100% Renewable Energy Systems

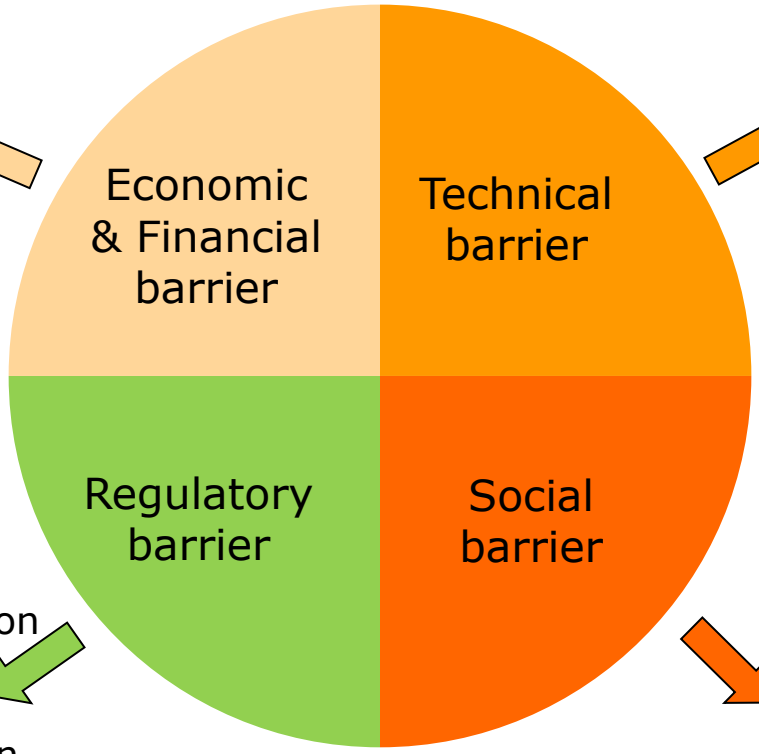
Shi You

August 1, 2011



Centre for Electric Technology
Department of Electrical Engineering

Challenges For Renewable Energy Development



High capital cost

Long payback period

…

Subsidized electricty

Grid reliability

Power quality

…

Lack of coordination

Wholesale market access

Ancilliary services provision

…

Costs & benefits allocation

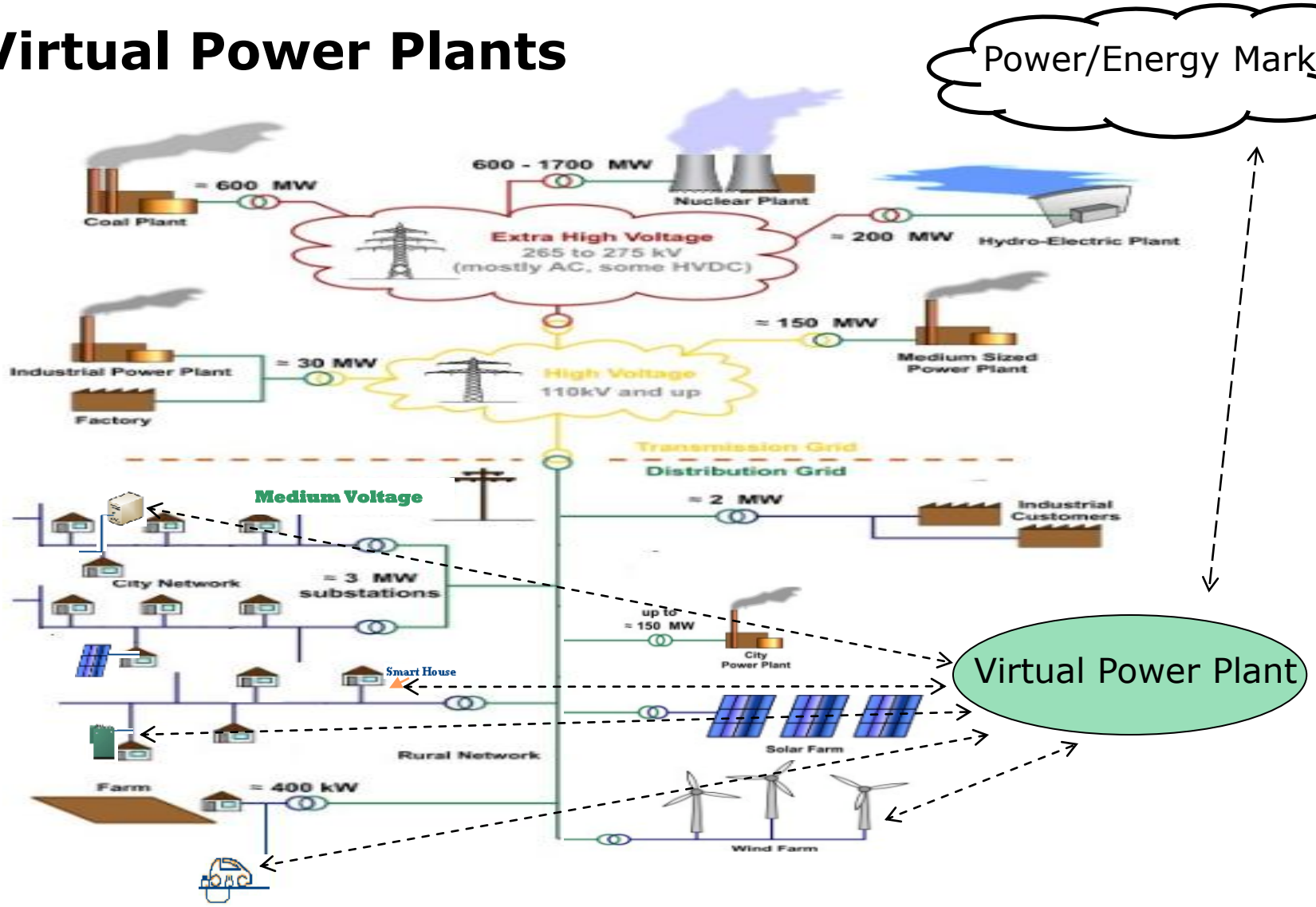
Lack of social acceptance

Unawareness of the benefits

…

Invisibility of the full costs of electricity from non-renewable energy sources

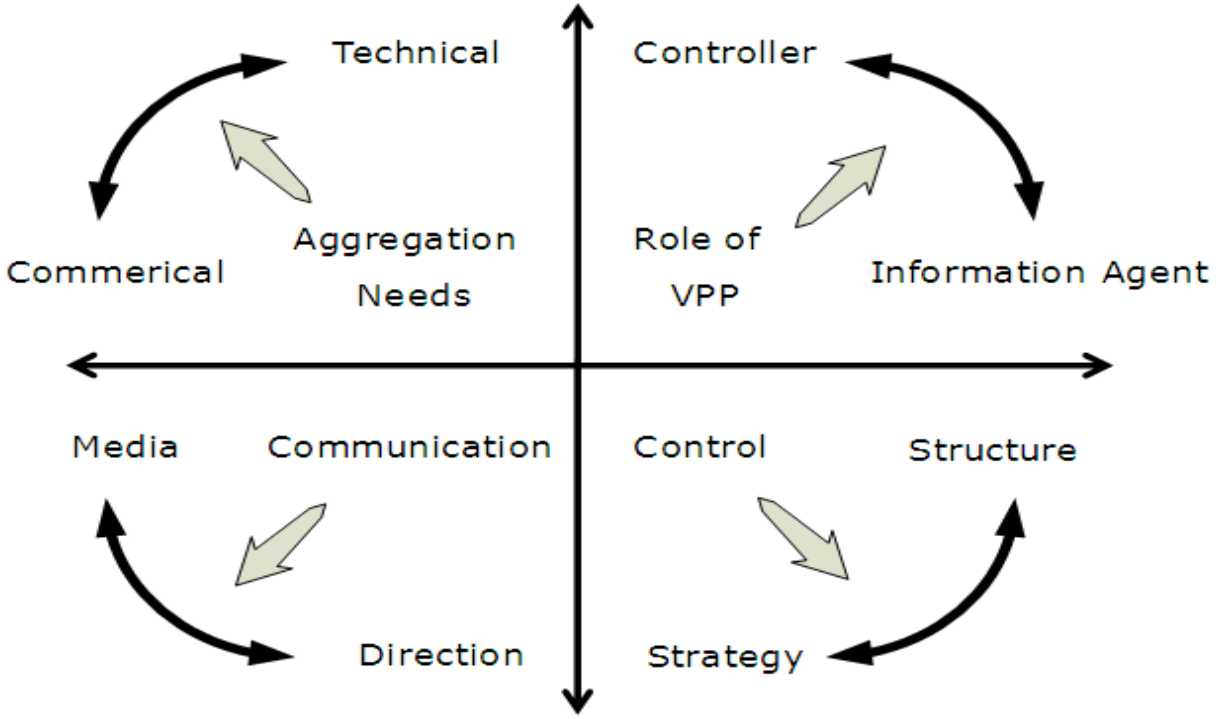
Virtual Power Plants



Advantages of VPP aggregation

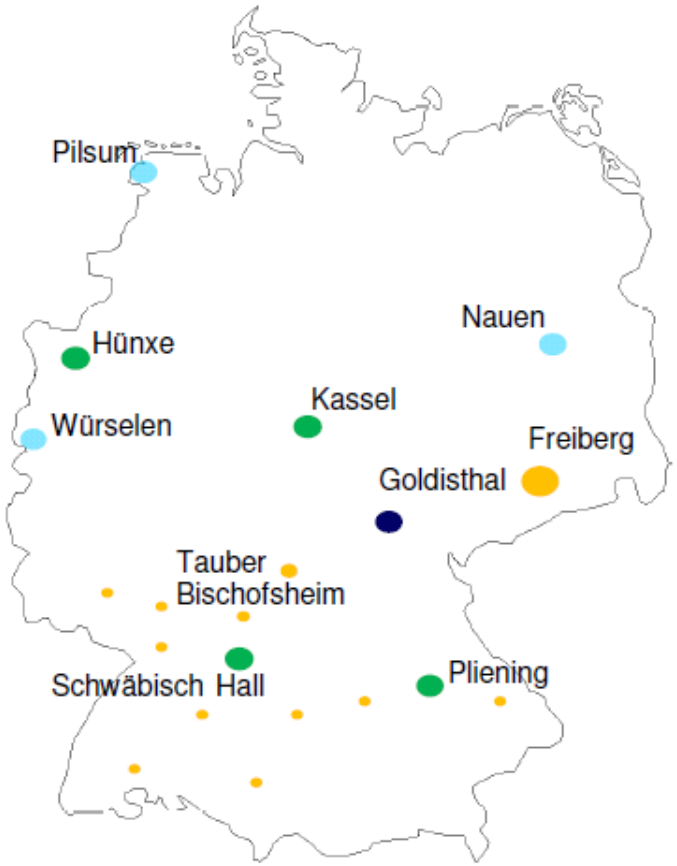
- **Visibility**: VPP can give transparency to TSO/DSO of its aggregated portfolio, providing real-time information
- **Controllability**: appropriate aggregation can perform close to conventional power plants (e.g. Wind+ CHP+DR)
- **Market access**: provides new business fields for DER owners and other investors
- **Improved local intelligence**: DER owners can obtain more valuable information from VPP
- **Feasibility**: VPP can be implemented under current regulatory structures.

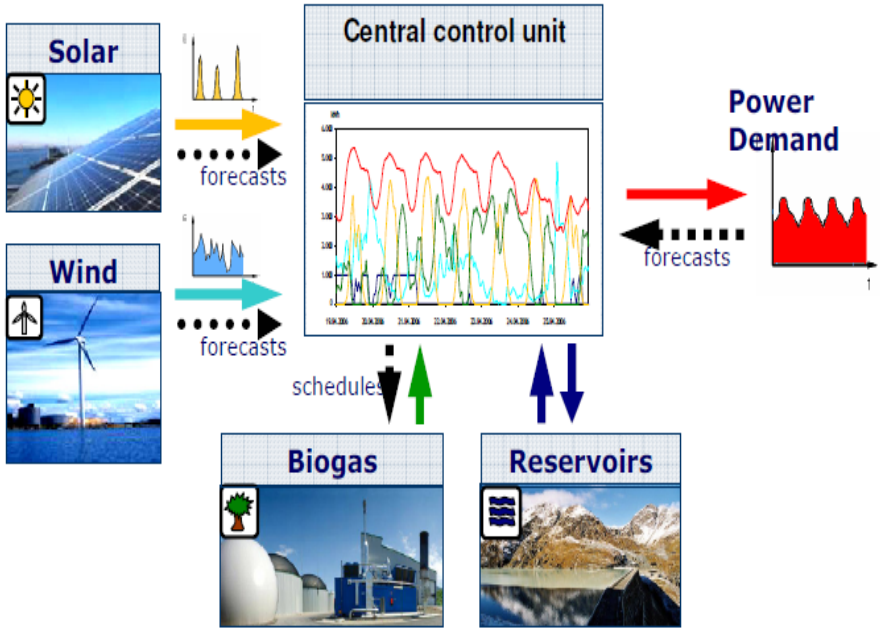
What is the state of the art of VPP?



- Direct control is normally much more favored than in-direct control
- Two way communication is also preferred
- Optimal operations have been claimed

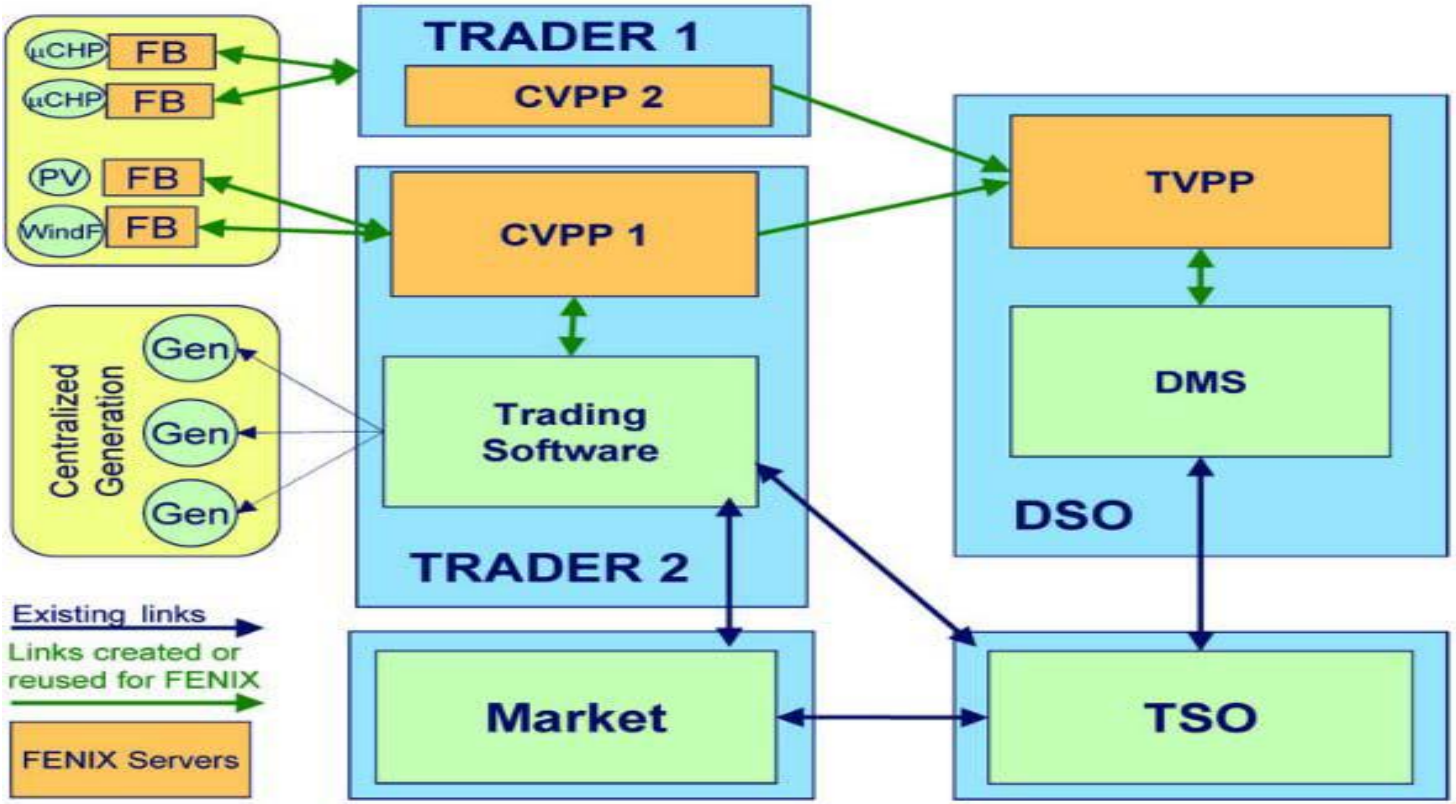
Combined Power Plant (Germany)



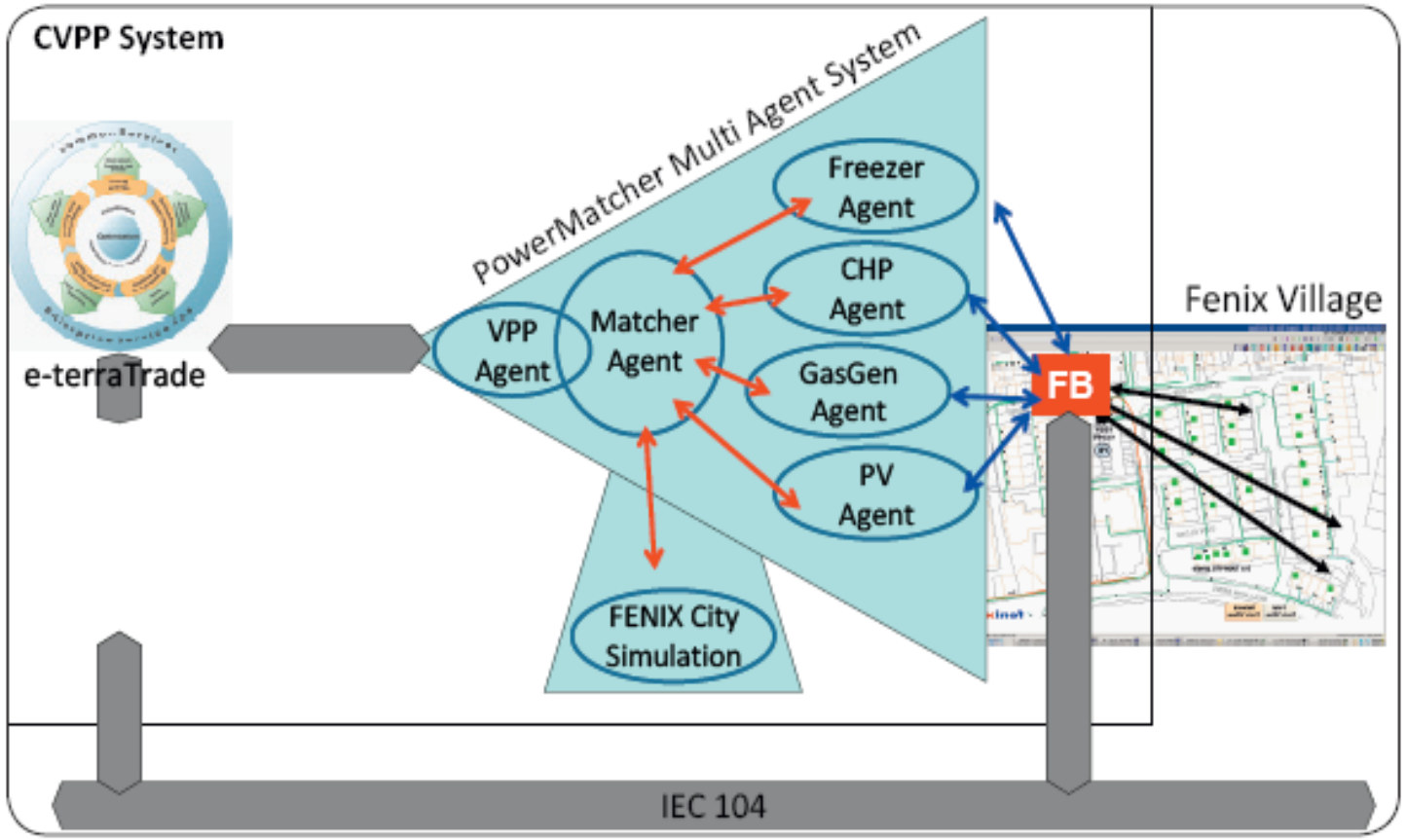


	Wind	Solar	Biogas	Reser-voirs	Import/Export	Total
Installed capacity [MW]	12.6	5.5	4.0	1.06	-/1.0	-
Electrical energy [GWh/a]	26.5	6.2	10.8	-0.6	0.02/1.8	41.1 (43.5)
% of Total	60.9	14.3	24.8	-	-	100.0

FENIX VPP(EU)

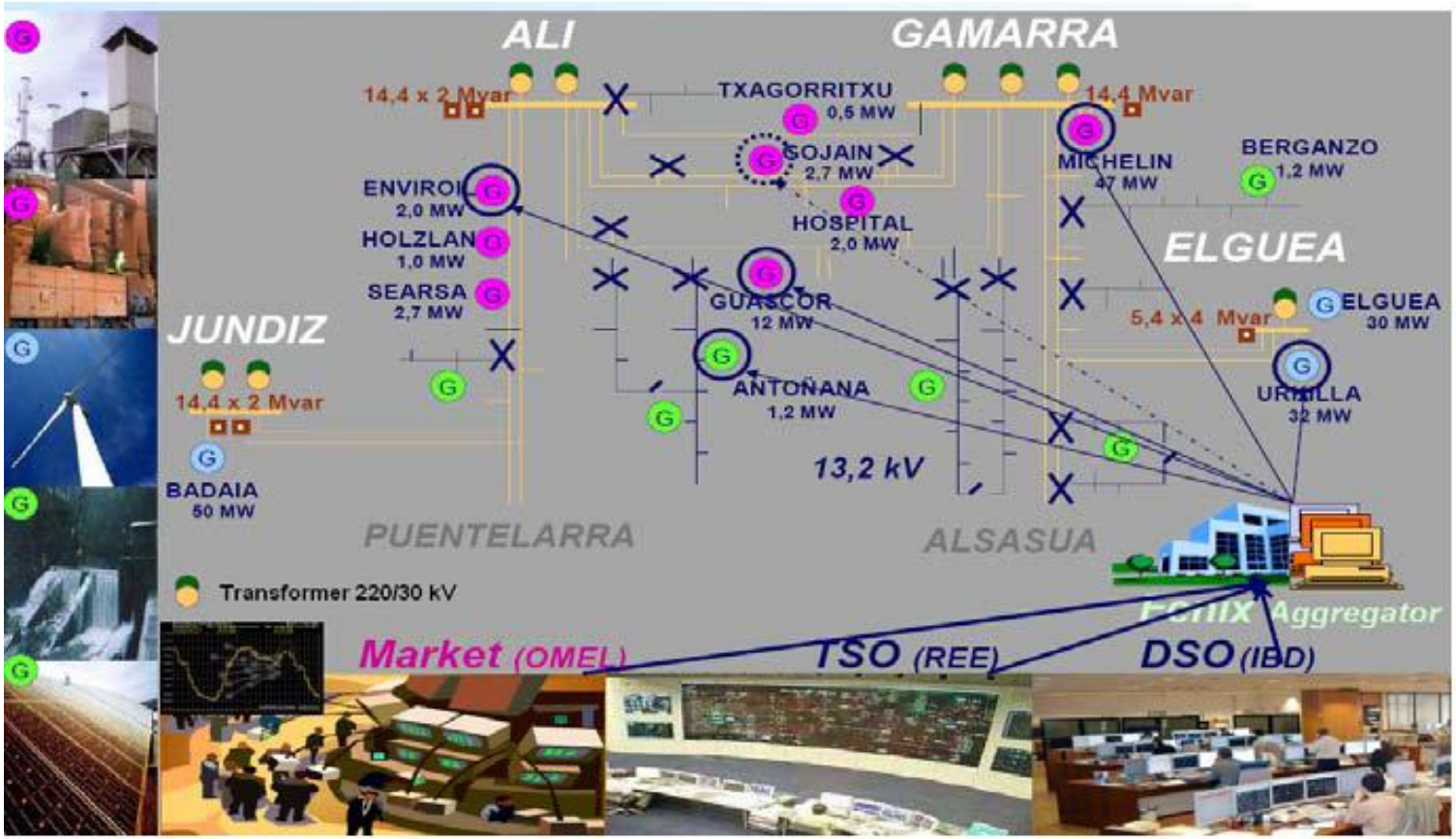

µCHP
FB
µCHP
FB
PV
FB
WindF
FB
Centralized Generation
Gen
Gen
Gen
TRADER 1
CVPP 2
CVPP 1
Trading Software
TRADER 2
TVPP
DMS
DSO
Market
TSO
Existing links
Links created or reused for FENIX
FENIX Servers

FENIX VPP(Northern Scenario)



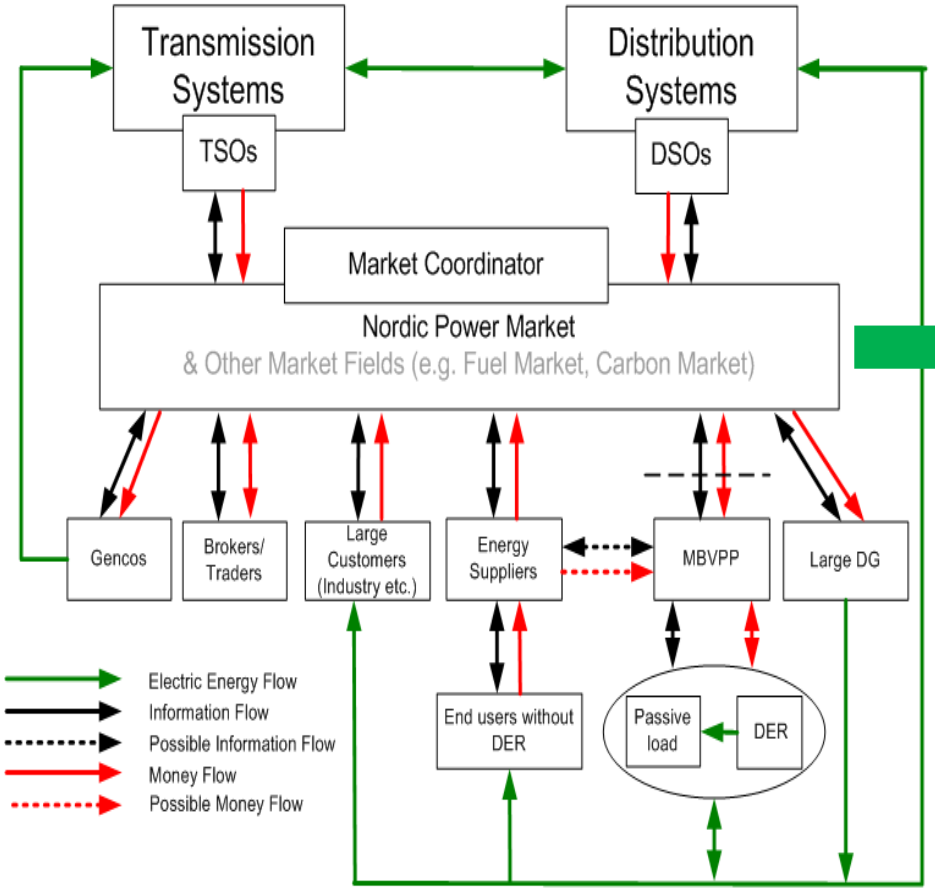
- (Non-operational) Commercial aggregation
- Optimized power market participation
- Active internal balancing
- Balancing services to the TSO.

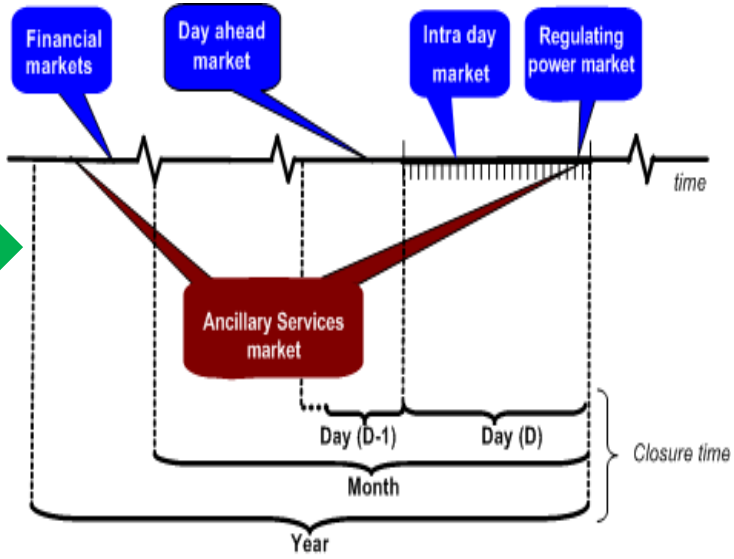
FENIX VPP(Southern Scenario)



- Participating in the day ahead market with the VPP
- Offering tertiary reserve ancillary service
- Contributing to maintain the voltage levels in transmission and in distribution

Market-based approaches (Denmark)





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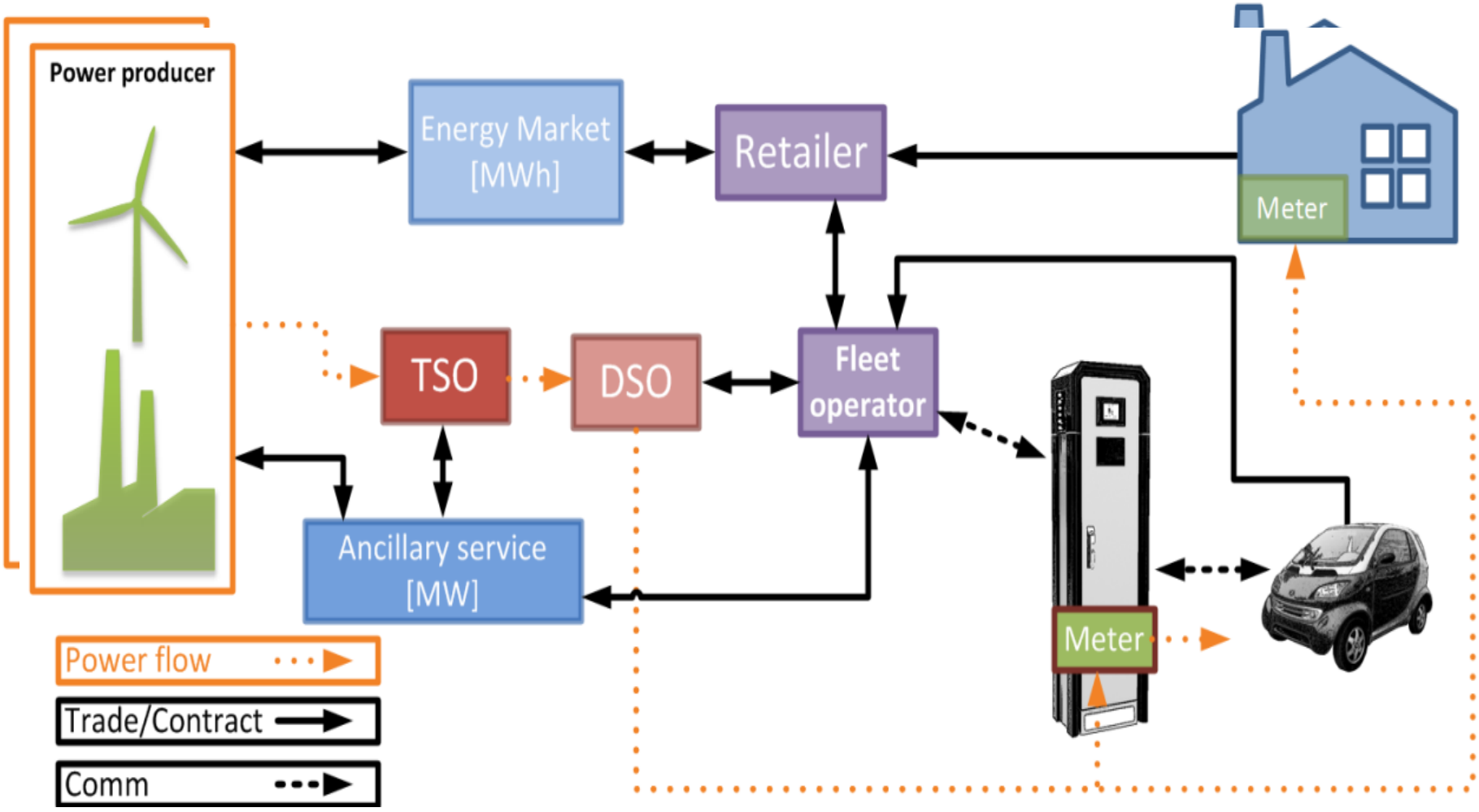

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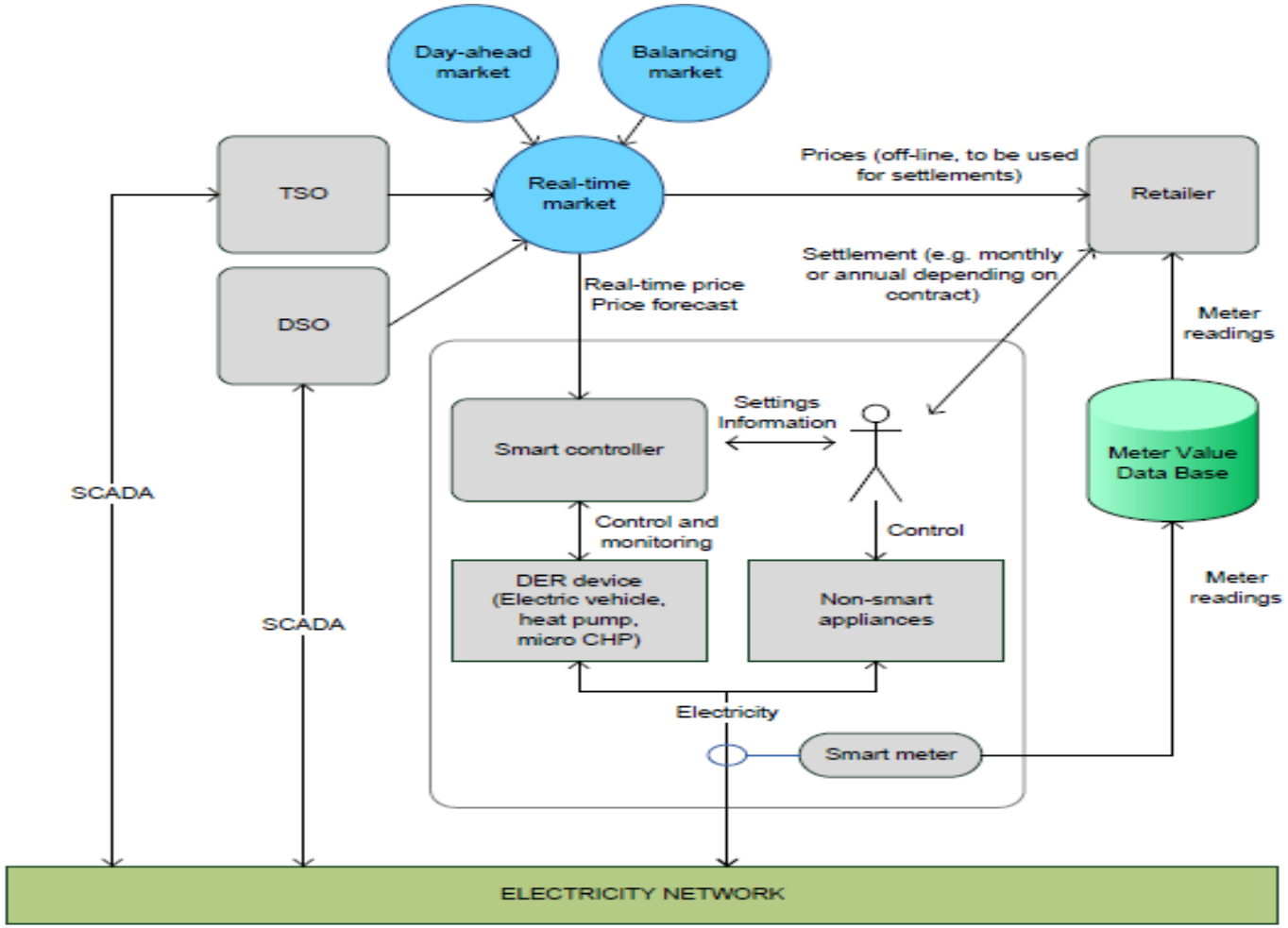
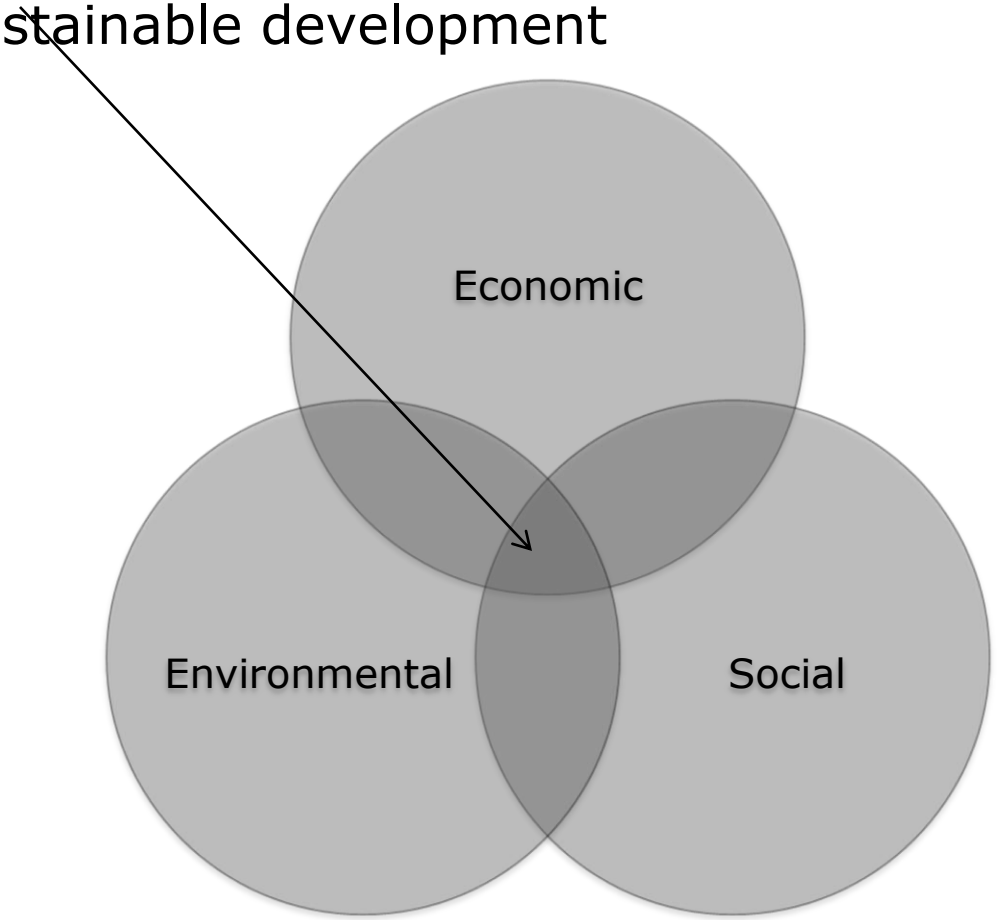


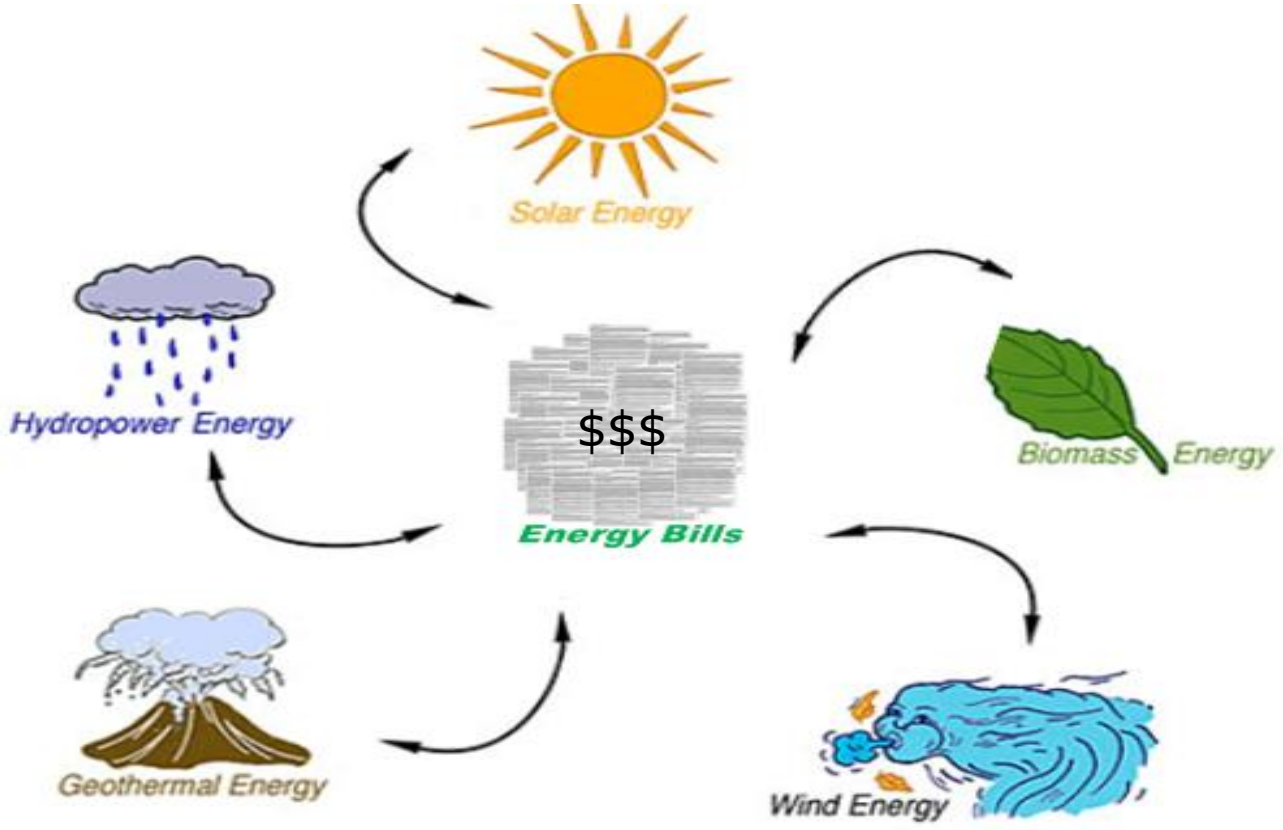
Remarks

Sustainable business models are required to meet the goal of sustainable development



Remarks

Market always decides energy choices, but we can develop & introduce new ***markets***.



Thank You!