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ENERGY

Renewable energy system integration in single-buyer systems

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Agenda

- Background single-buyer electricity system
- Challenge of market / system integration of variable renewable energy (VRE)
  - Approach in decentralized market model
  - Status quo in single buyer model
- Proposals for improvement of VRE system integration in SB model

Challenges of VRE system integration include ensuring generation adequacy and network integration

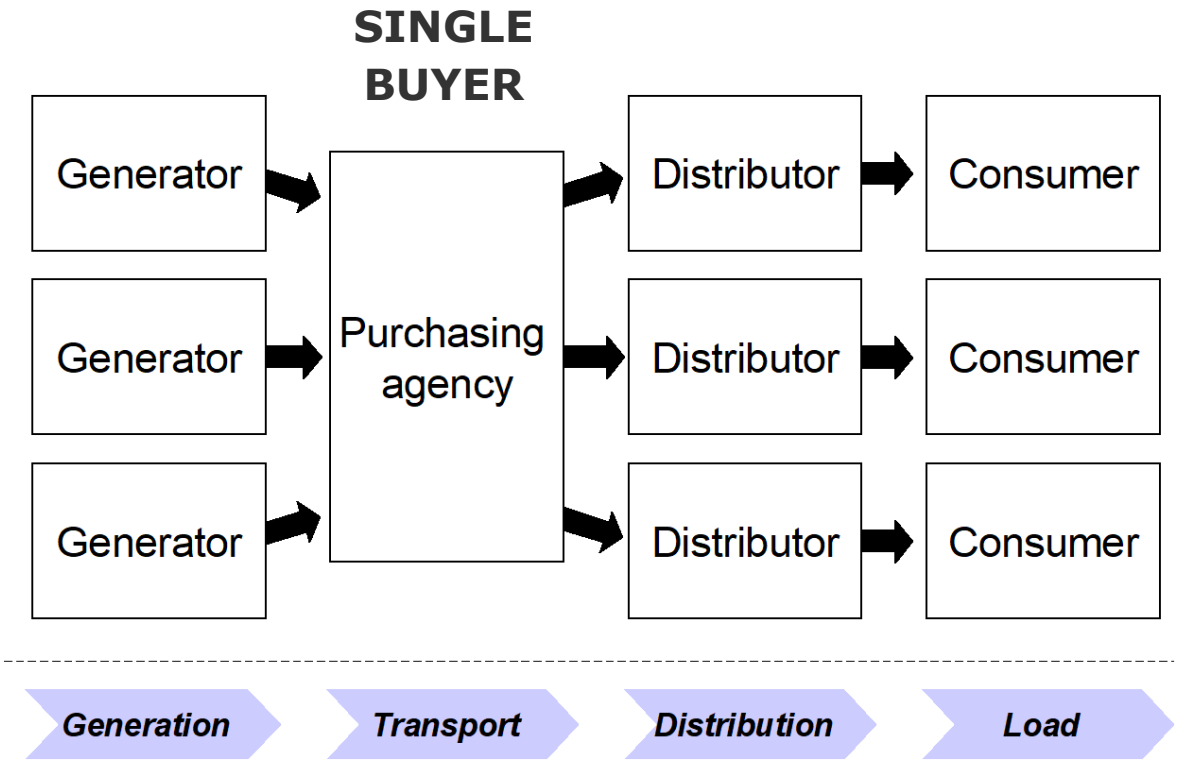
Focus of this presentation: efficient scheduling of VRE

Background single buyer model

Background Single Buyer model

Single buyer: competitive wholesale procurement & downstream regulated supply

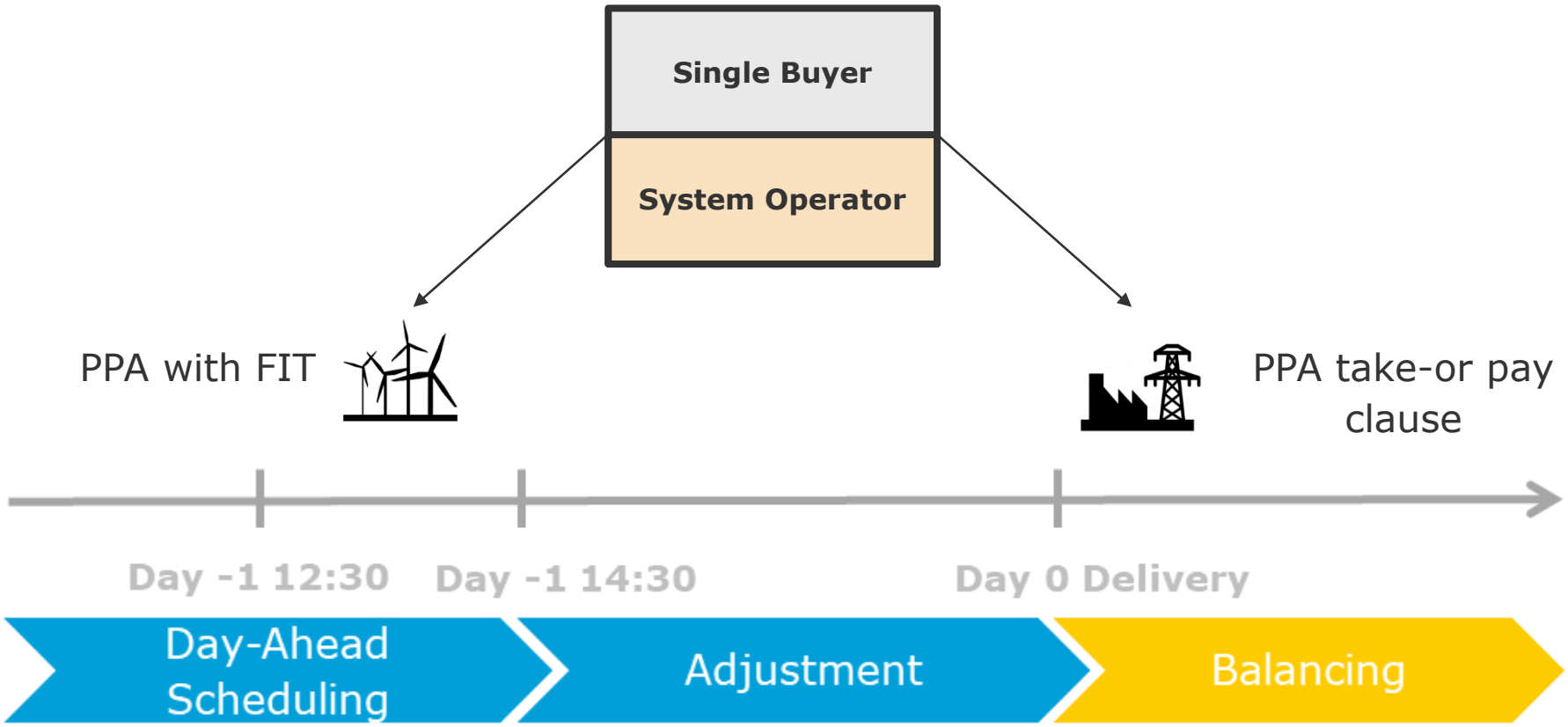
- A single entity, usually the transmission/dispatch company, acts as a single power purchasing and selling agent, buying all power from generators and, in turn, selling all power to wholesalers and large end-users directly connected to the transmission/distribution system
- Commonly used market model following advent of Independent Power Producers (IPPs)



Examples: Peninsular Malaysia, Egypt, Morocco

Scheduling VRE (and other generation assets) in SB system

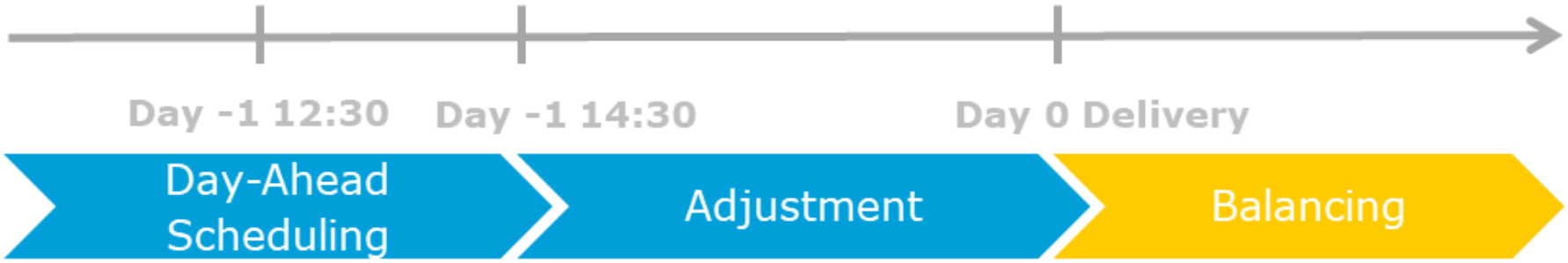
Single buyer (= System Operator) bears responsibility for stable delivery



- **Challenge of market / system integration of VRE**

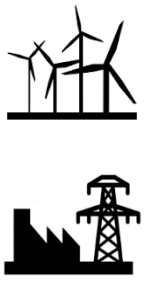
Scheduling variable renewable energy

Limits in predictability of VRE generation to be accounted for when planning schedule day ahead. Secure supply guaranteed by intra-day adjustment & real-time balancing



Based on weather forecast

Based on residual load forecast

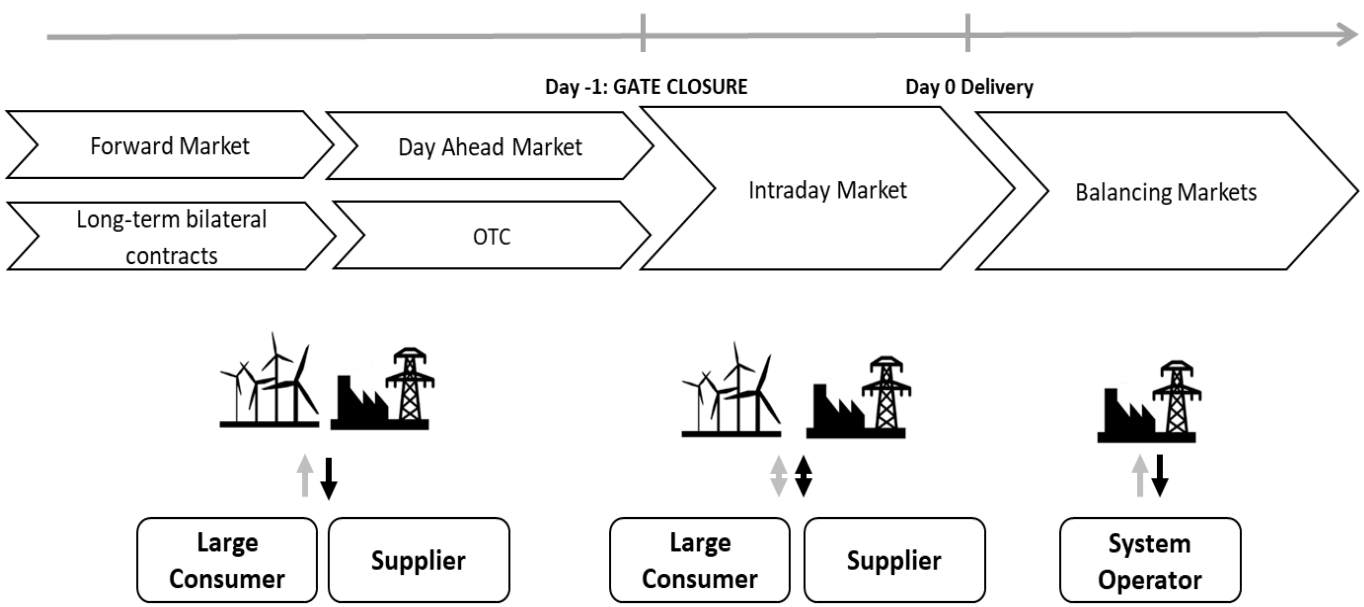


Based on improved weather & residual load forecast

Based on real-time deviation of scheduled delivery

Scheduling VRE in decentralized market (such as Germany)

In decentralized markets, (large-scale) renewable energy assets sell their generation output into the DA & ID market & assume full balancing responsibility



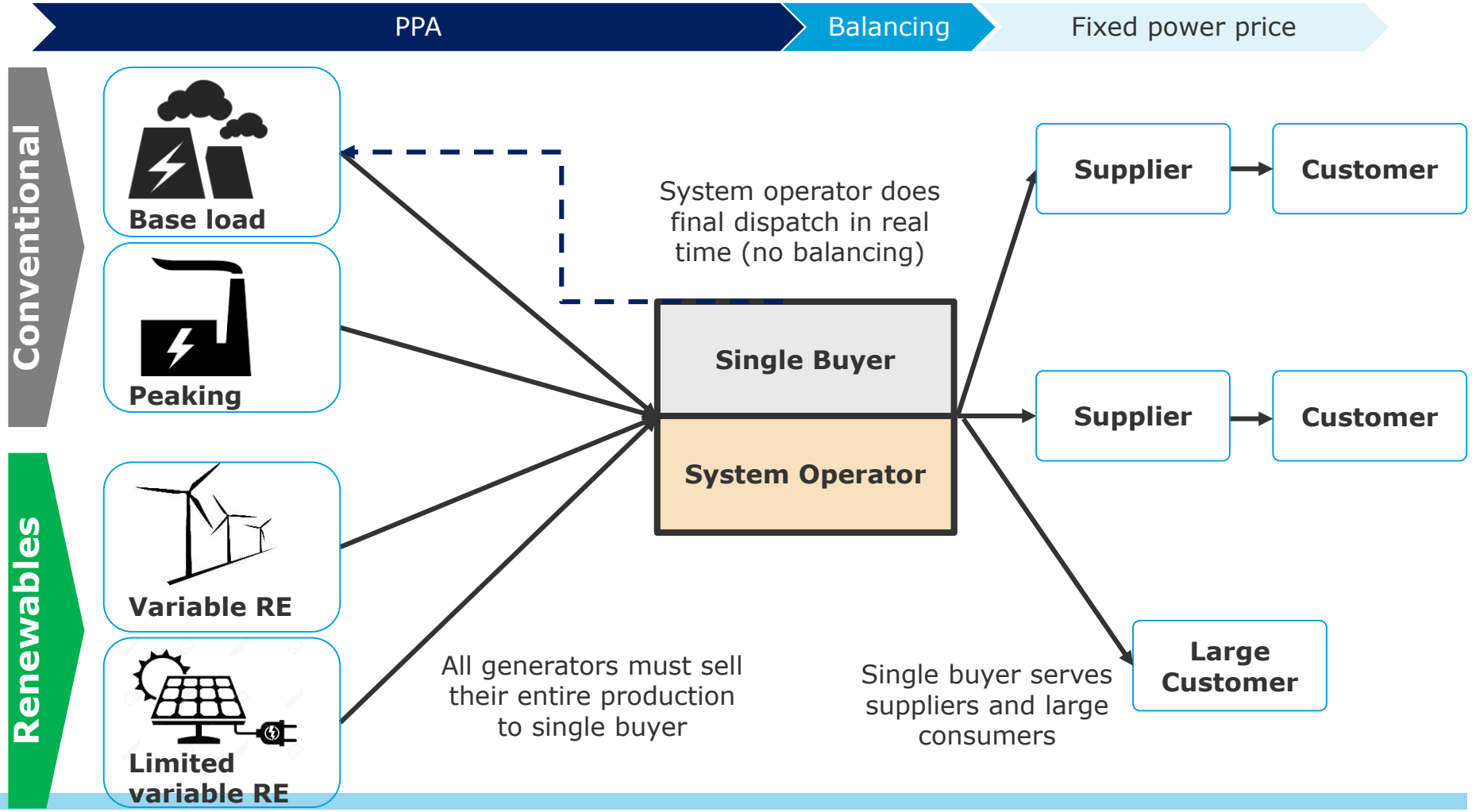
- VRE generated electricity typically sold in the DA market
- ID is used to clear imbalances before delivery
- Remaining imbalances cleared via balancing markets

Elements of decentralized market

- Bilateral trading
- Exchanges operated by MO
- Balancing responsible parties
- Self-dispatch
- Balancing markets operated by TSO
- (Other) ancillary services

Status Quo Single Buyer model

In the status quo, single buyer engages in non-remunerated technical balancing



Proposals for improvement of VRE system integration in SB model

Proposals for improvement of VRE system integration
Overview

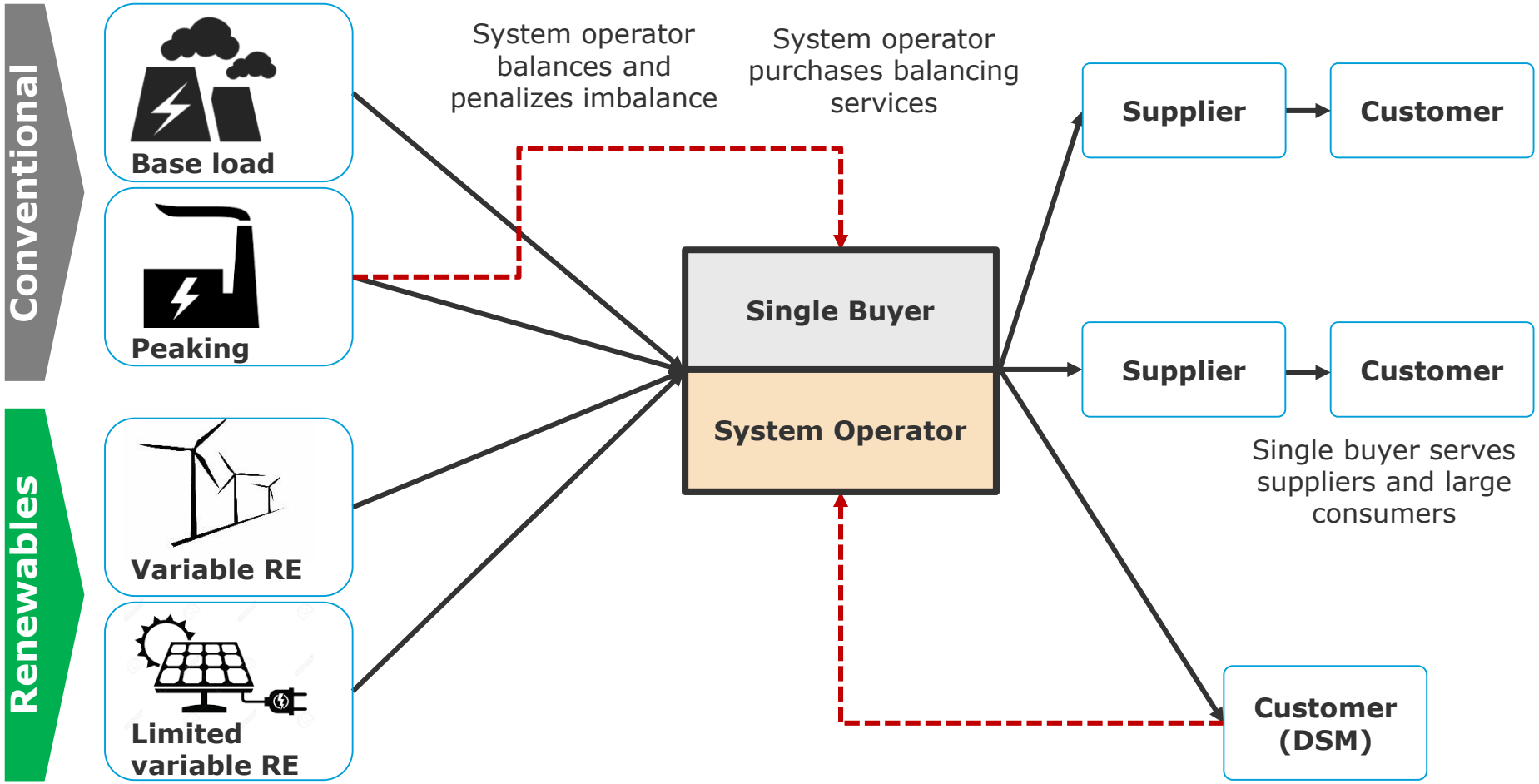
Several options exist to improve the integration of VRE into scheduling & dispatch

- Problem of status quo: insufficient incentives for balancing / balancing services
  - Technical balancing by SO works at low level of VRE penetration
  - With higher penetration rates, new arrangements have to be found
- Existing structure: balancing responsibility
  - In some ESI with single buyer, financially firm schedules have been introduced
  - Options for VRE to be balancing responsible are limited or non-existent
- Proposals for improvement
  - Introduction of options for balancing of VRE installations

Proposal 1: Commercial balancing

System operator purchases balancing services & penalizes imbalances

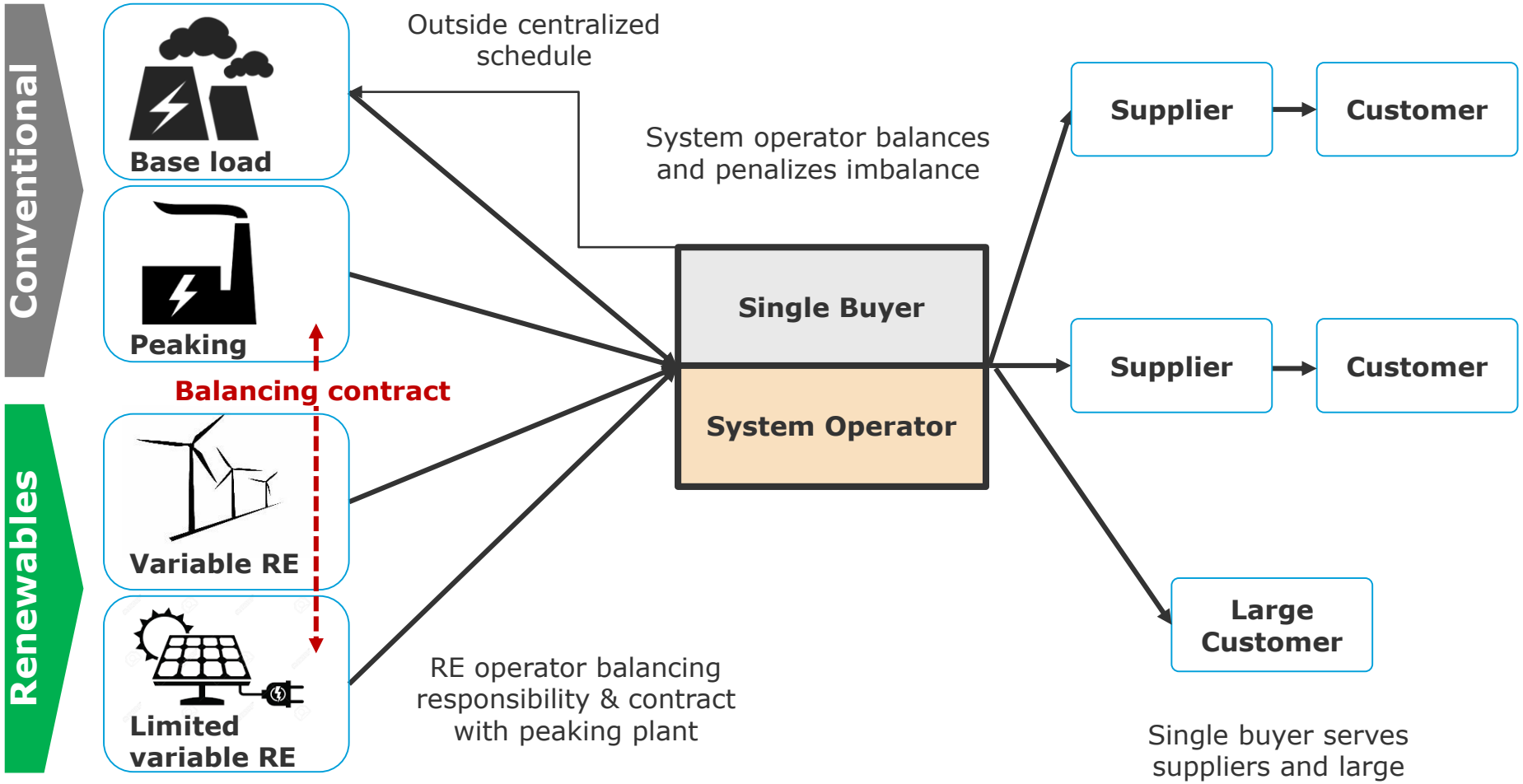
PPA with financially firm schedule (DA) | Balancing | Fixed power price



Proposal 2a: VRE balancing responsible

Contract with flexible power producer

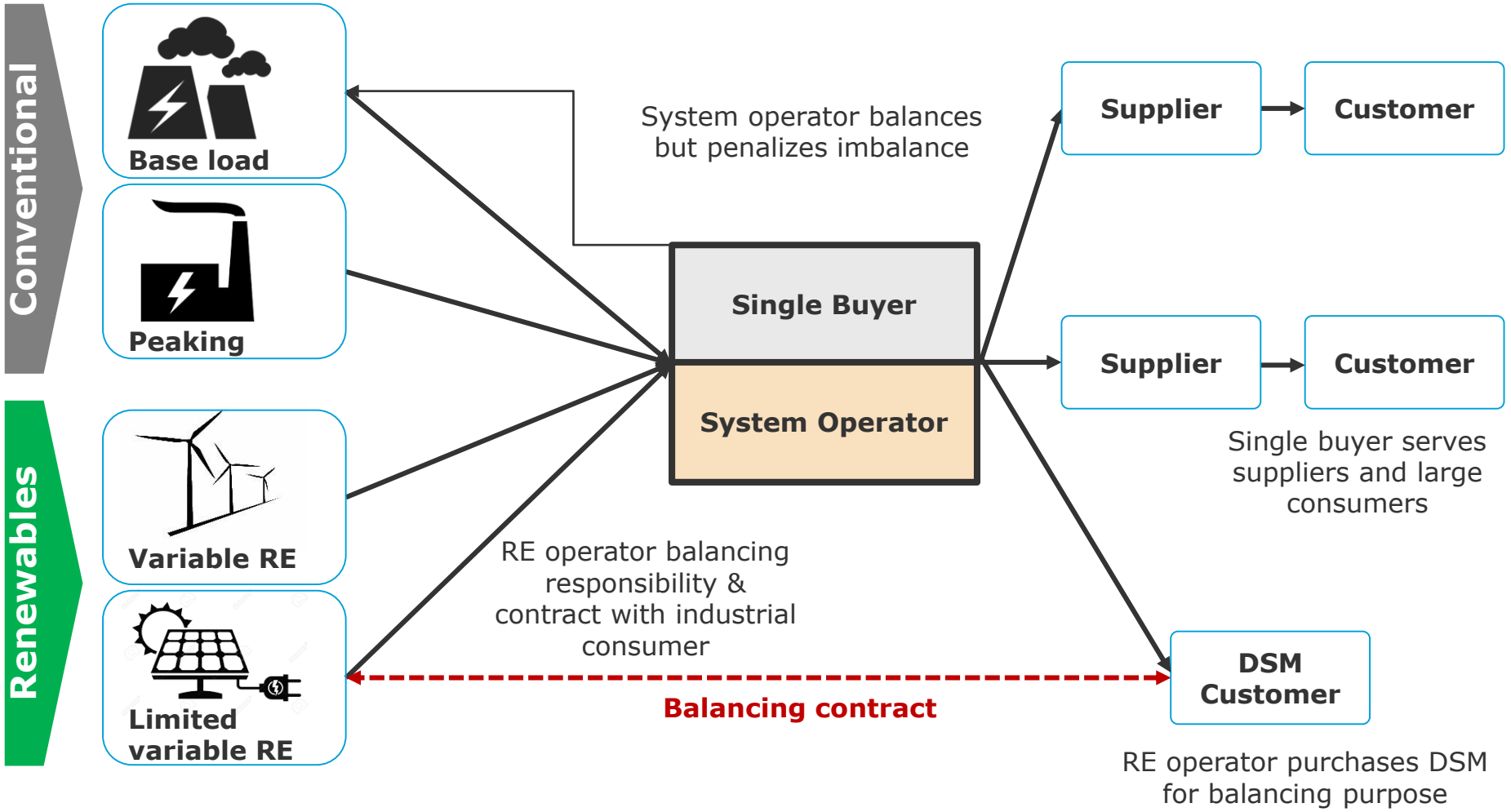
PPA with schedule + balancing responsibility | Balancing | Fixed power price



Proposal 2b: VRE balancing responsible

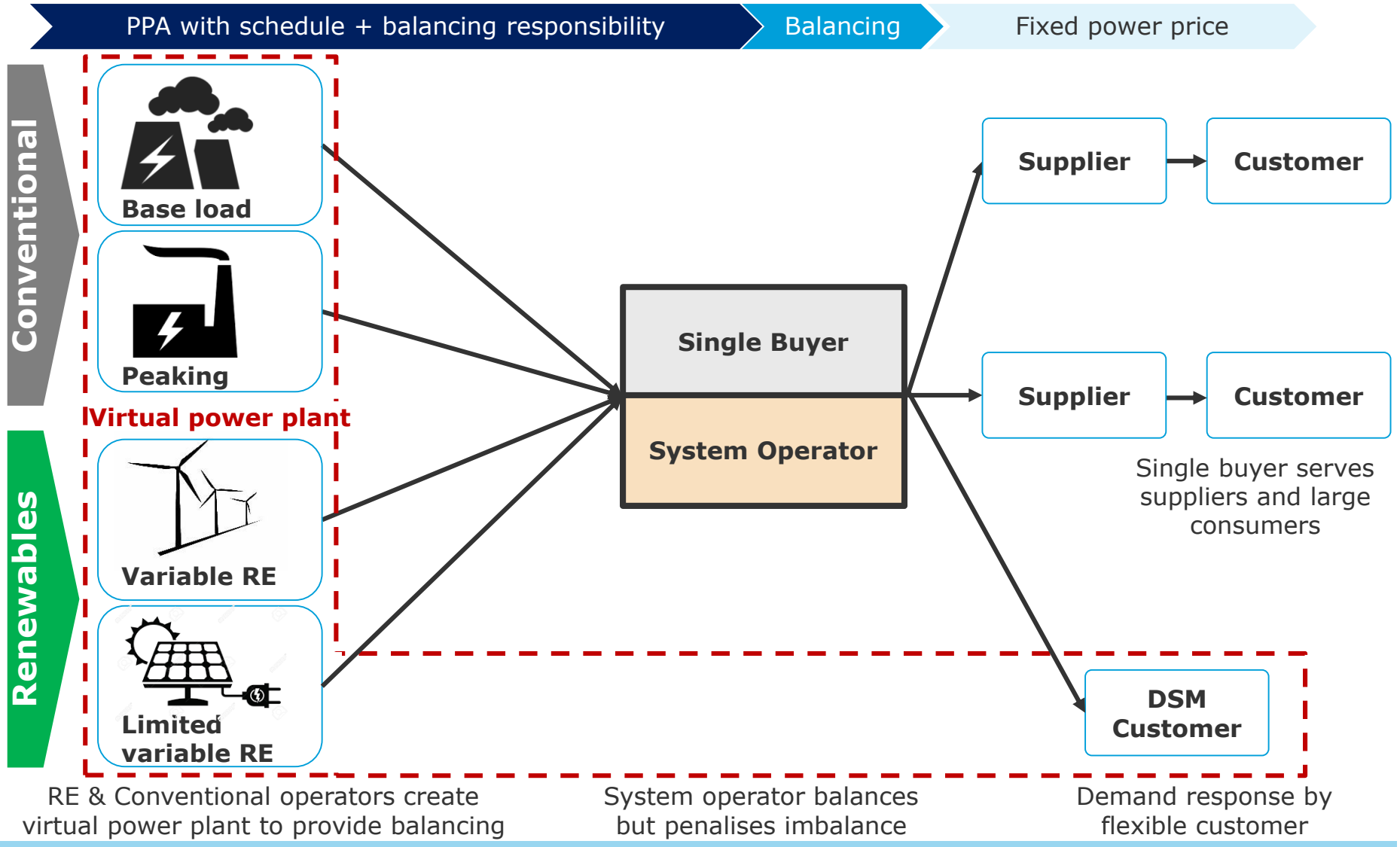
Contract with large & flexible consumer

PPA with schedule + balancing responsibility | Balancing | Fixed power price



Proposal 2c: VRE balancing responsible

Virtual power plant



Thanks for your attention

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Link to the DNV White Paper „Renewable energy integration and balancing in single buyer electricity markets"

https://www.dnv.com/Publications/renewable-energy-integration-in-single-buyer-electricity-markets-231850

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