Energy and Carbon Market

Peak load shaving key issues and strategies of high-proportion renewable energy power systems

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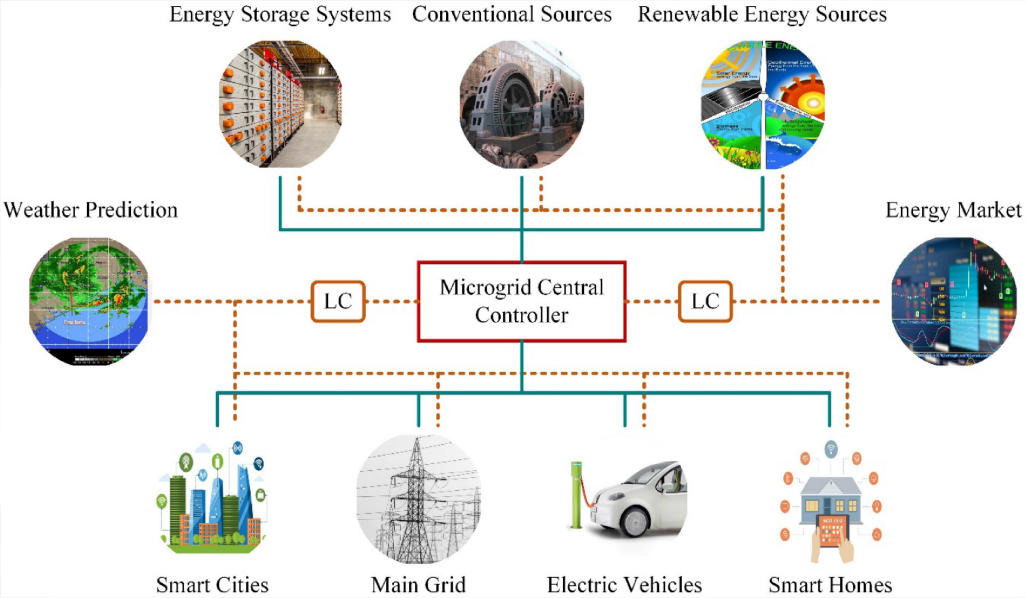
Introduction

Power supply structure has undergone tremendous changes with the increasing proportion of renewable energy in the power system.

The high randomness and uncertainty of the output of renewable energy cause problems increasingly prominent, such as demand of power system peak-shaving resources on both power supply and load side.



Peak load shaving strategies

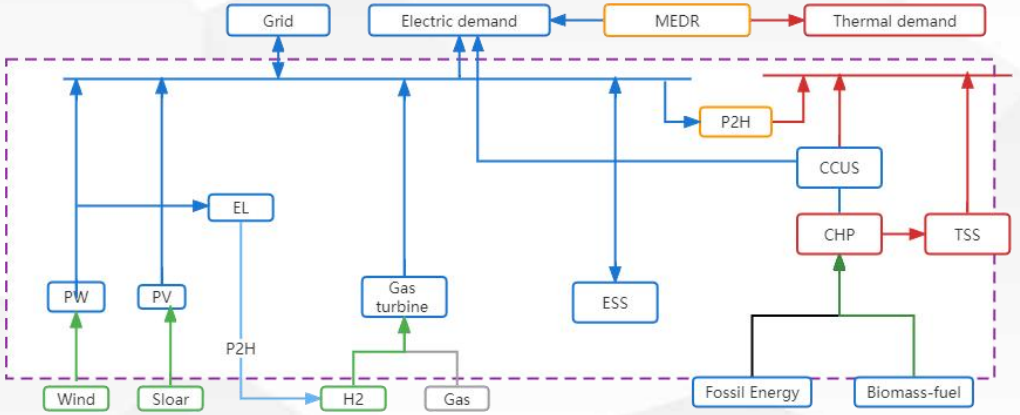
- Complementarity and diversity of power sources
- Development of auxiliary peaking service market
- Energy storage system
- Demand side management

◆ Multi-energy complementarity

Electric system

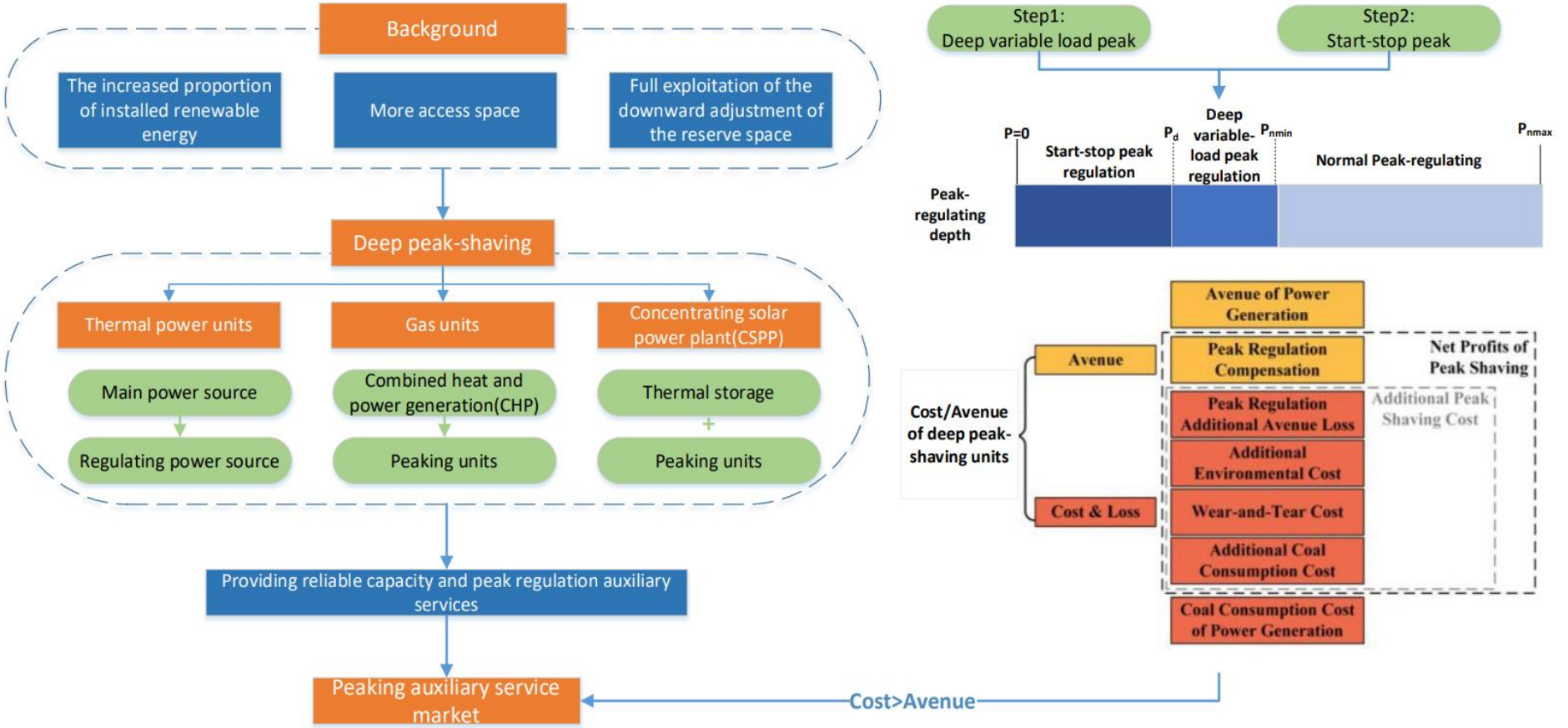
Wind Power	Low marginal cost	Anti-peaking characteristics	High randomness and volatility
Solar Power		High randomness and volatility	Highly influenced by geographical location, season and climate
Hydro Power		Mature technology	
Nuclear Power		Faster regulation	
Thermal Power	Government support		Carbon emission issues
	High marginal cost	High existing installed capacity	
Gas Turbine		Small equipment capacity and flexible operation	

Integrated energy system



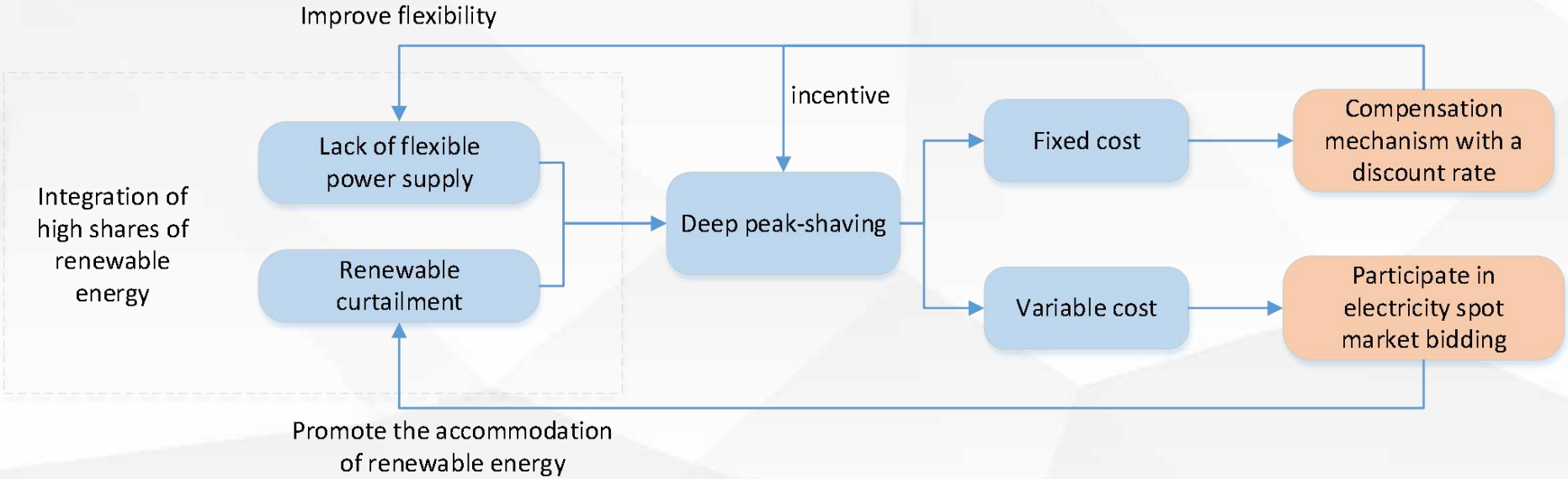
Cross-zone peaking

◆ Deep peak-shaving

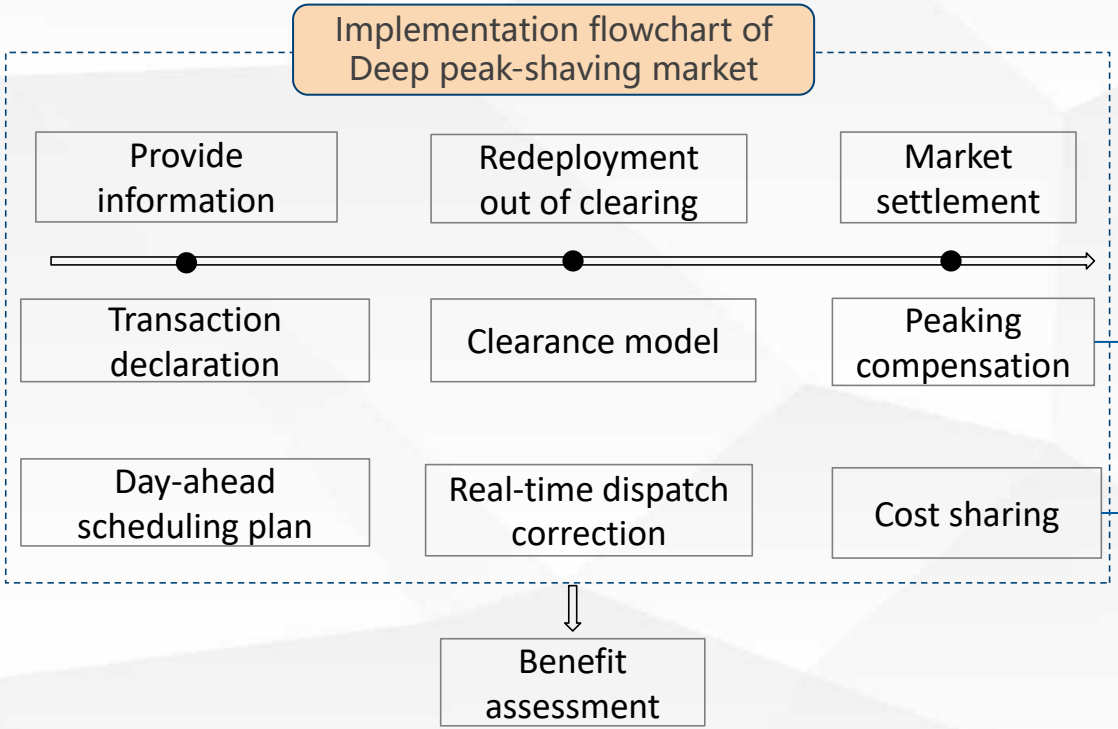


Deep peak-shaving market

- The deep peak-shaving market distorts the market price relationship to a certain extent, which tends to lead to unfair competition and overcompensation issues.



Deep peak-shaving market



Implementing a ladder-type compensation mechanism based on unit load factor

Theory: Cost makers pay the costs, and value creators enjoy the value.

Fair cost sharing: The proportion of DPR cost paid by each beneficiary should be determined by the proportion it shares in the total incremental value created by the DPR service.

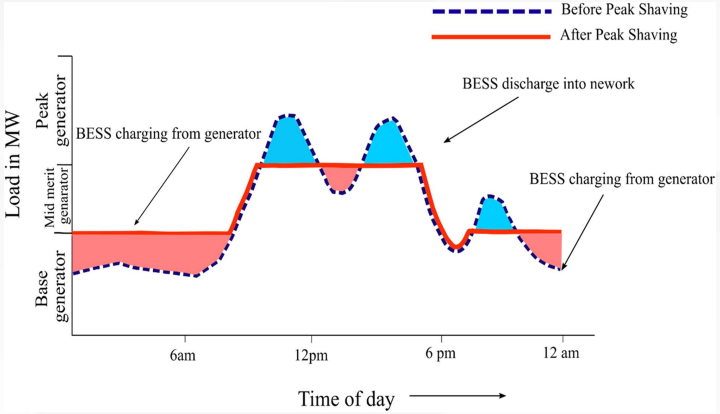
$$C^{g}_{i,t,basic} = \frac{P^{g}_{i,t,basic}}{P^{g}_{i,t,basic} + P^{w}_{i,t} + P^{v}_{i,t}} \times C^{g}_{i,t,peak}$$

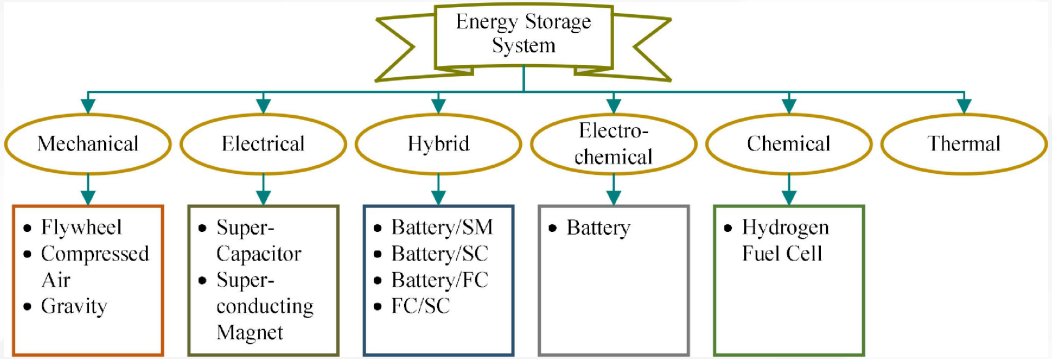
$$C^{w}_{i,t} = \frac{P^{w}_{i,t}}{P^{g}_{i,t,basic} + P^{w}_{i,t} + P^{v}_{i,t}} \times C^{g}_{i,t,peak}$$

$$C^{v}_{i,t} = \frac{P^{v}_{i,t}}{P^{g}_{i,t,basic} + P^{w}_{i,t} + P^{v}_{i,t}} \times C^{g}_{i,t,peak}$$

Energy storage system

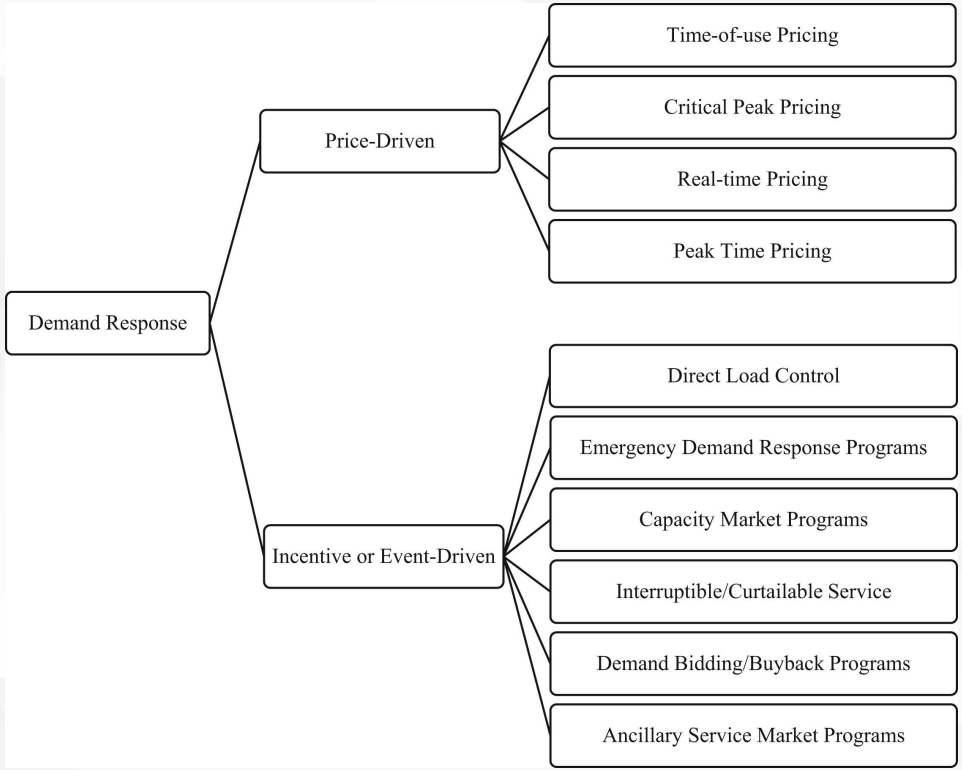
- Peak shaving is achieved through the process of charging ESS when demand is low (off-peak period) and discharging when demand is high.





- Replacing expensive peaking plants
- Transmission and distribution (T&D) system upgrade deferral
- Energy loss reduction
- Economic arbitrage
- Reduction in CO2 emission

◆ Demand response (DR)



The transfer-able loads——reduce the peak-valley difference and improve the spinning reserve capacity of the conventional power units by utilizing the time-of-use electricity price.

The reduce-able loads——enhance spinning reserve capacity of the power system by participating into the electricity market exchange.

Customers may not be willing to shift their activities from peak period to off-peak period. → Reasonable time-sharing tariff

Customers' comfort level might be affected by the demand response. → Smart home energy management system

Suggestions

1

Maximize utilization of various types of peaking resources

1) Accelerate thermal power flexibility transformation and electro-thermal decoupling technology; 2) Building highly flexible power transmission lines.

2

Promote the construction of auxiliary service market

1) Promote the transition and convergence of the auxiliary services market to the electricity spot market; 2) Accelerate the transition of auxiliary service transactions to a competitive market approach.

3

Use distributed energy storage

Implementation of distributed ESS in the grid for peak load shaving to overcome the difficulties of large scale ESS installing.

4

Application of smart home energy management system

This will reduce the dependency on customer willingness to implement the DSM strategy for peak shaving. However, to maximize the effectiveness of DR, technical assistant education for the customer is requisite.

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Thank you for listening

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