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A Structural Design of Regional Virtual Power Plant Specific to Industrial Development Area


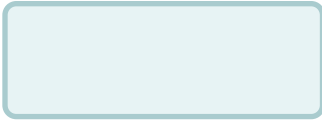
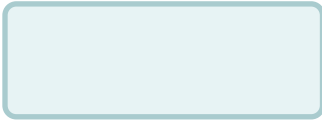
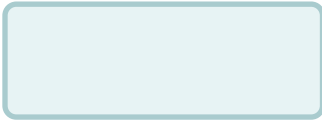
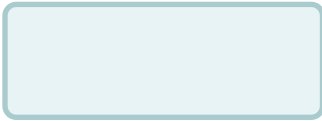
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Air Pollutions



Resource Exhaustion



Global Warming



PV



Wind Power

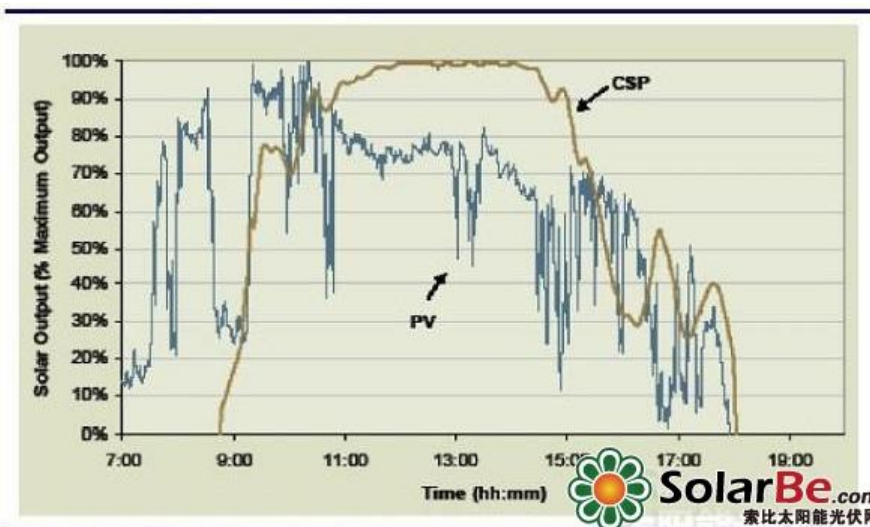


Tidal Power

Introduction



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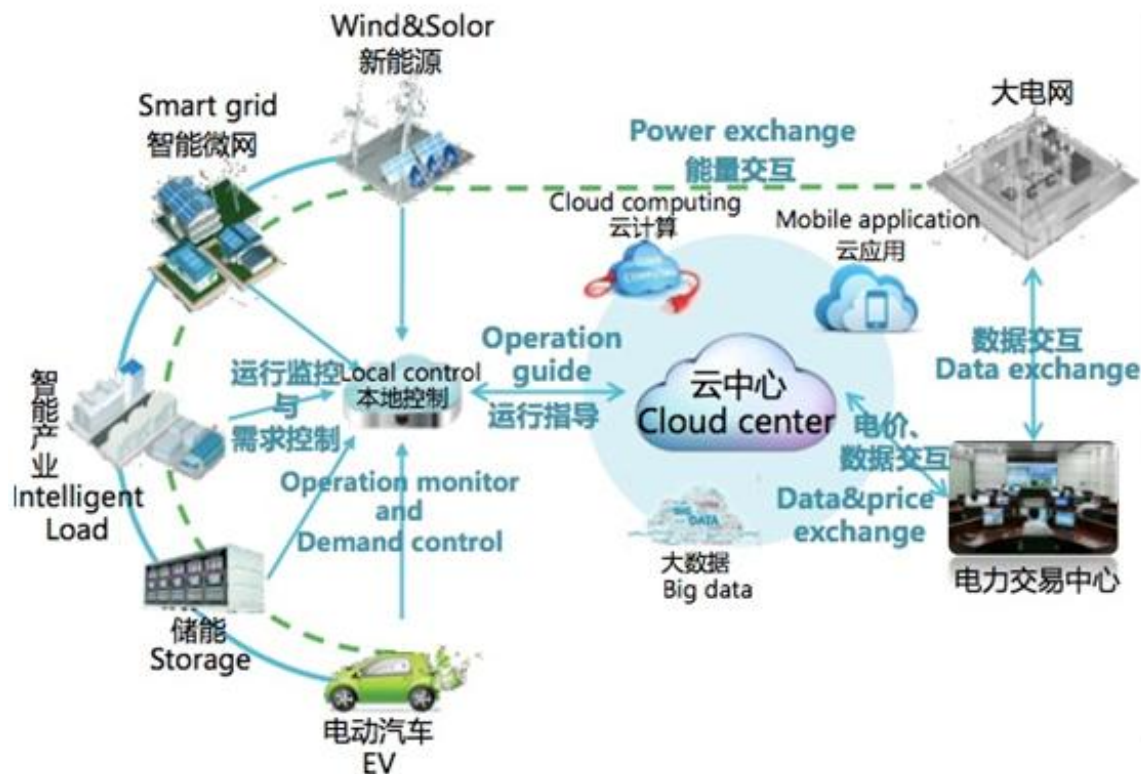


Typical Daily RES Output



RES + Storage

Virtual Power Plant (VPP) is, by advanced metering, communication and controlling technology, an aggregation of DG, Storage, Intelligent Loads and such DER, to coordinate and optimize operations of Multi-DER via higher software framework.





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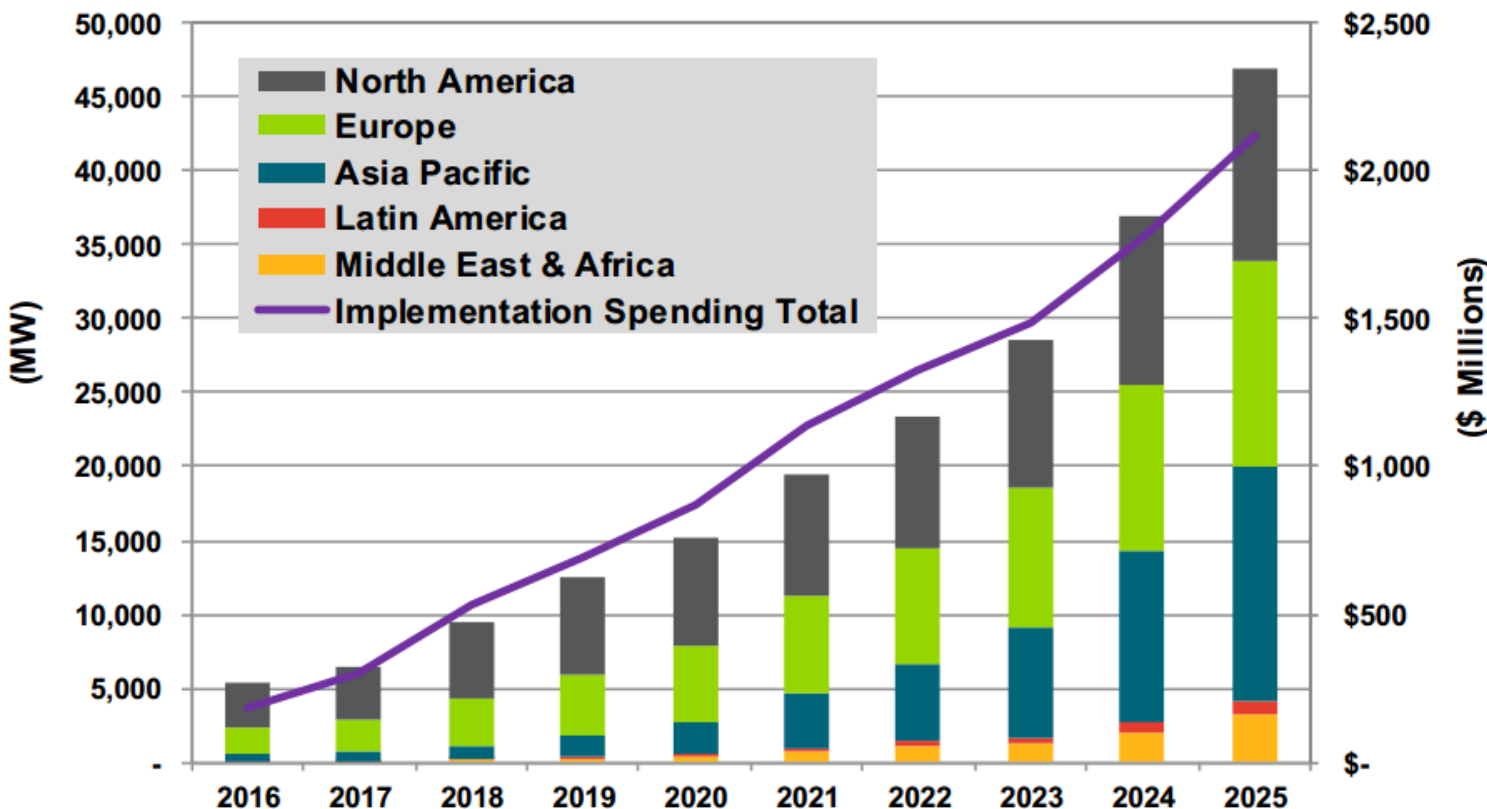
Major VPP Projects in Europe

Projects	Start-End Time	Status	Main Countries
STADG VPP	2003-2007	Accomplished	Germany
UNNA	2004-2006	Accomplished	Germany
VIRTPLANT	2005-2007	Accomplished	Germany
PM VPP	2005-2007	Accomplished	Netherlands
FENIX	2005-2009	Accomplished	UK, Spain, etc.
GVPP	2006-2012	Accomplished	Denmark
VGPP	2007-2008	Accomplished	Austria
HARZ VPP	2008-2012	Accomplished	Germany
Pro VPP	2008-2012	Accomplished	Germany
EDISON	2009-2012	Accomplished	Denmark
FLEXPOWER	2010-2013	Accomplished	Denmark
WEB2ENERGY	2010-2015	In Research	Germany, Portland, etc.
TWENTIES	2012-2015	In Research	Belgium, Germany, etc.

VPP Status Quo



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Total Annual VPP Capacity and Implementation Spending by Region, World Markets: 2016-2025 (Source: Navigant Research)

南瑞集团公司(国网电力科学研究院)

NARI GROUP CORPORATION / STATE GRID ELECTRIC POWER RESEARCH INSTITUTE



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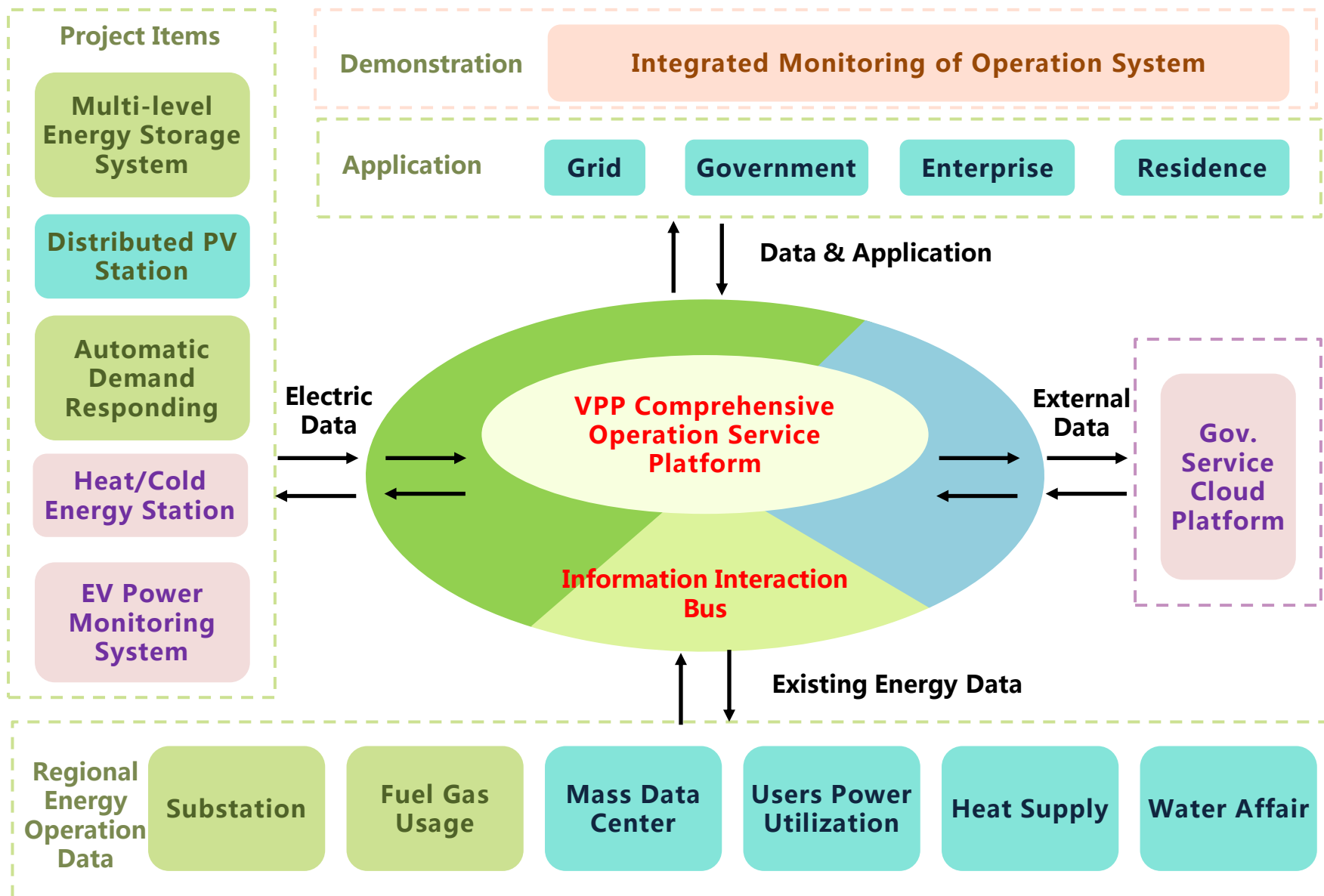
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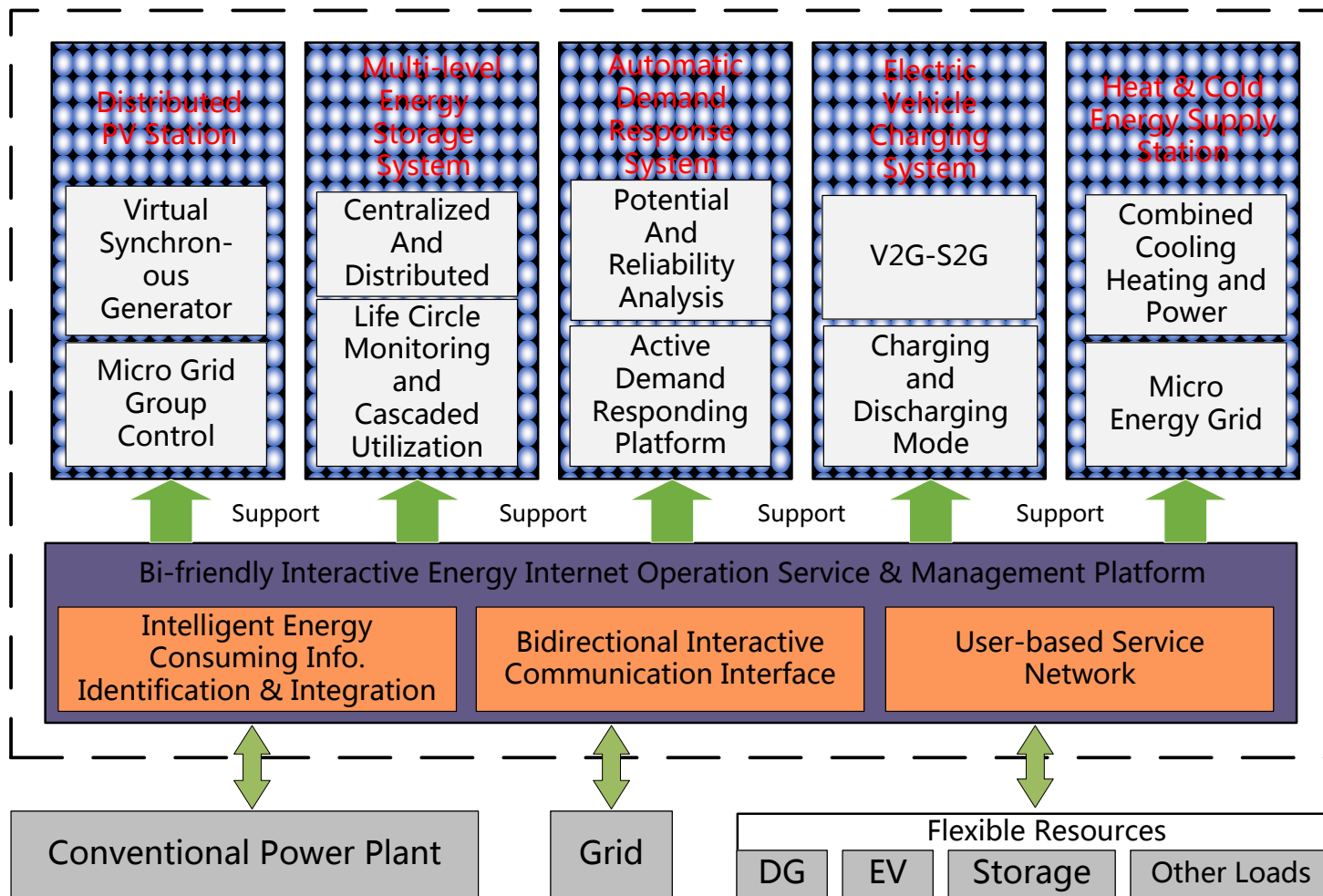
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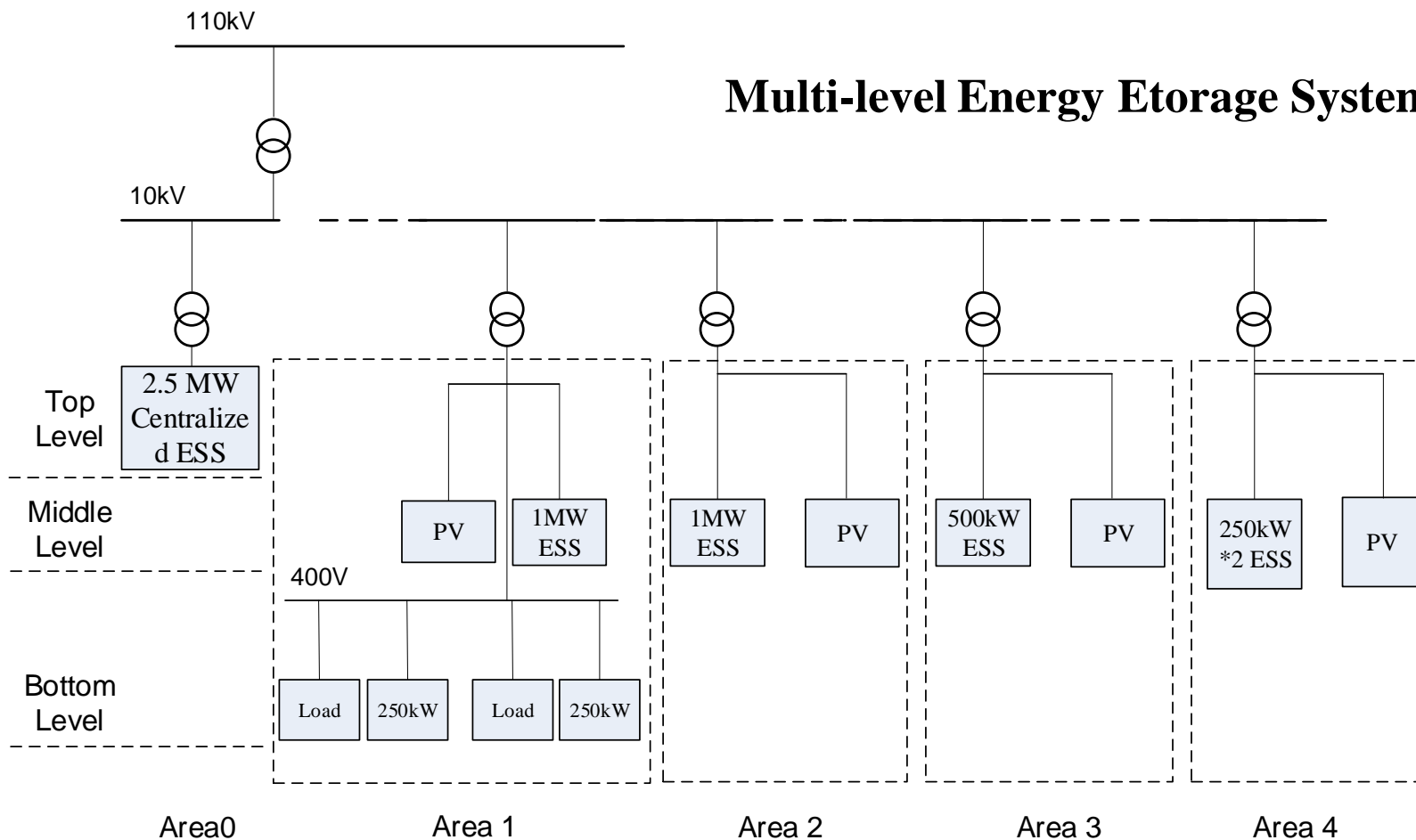
Structural Design



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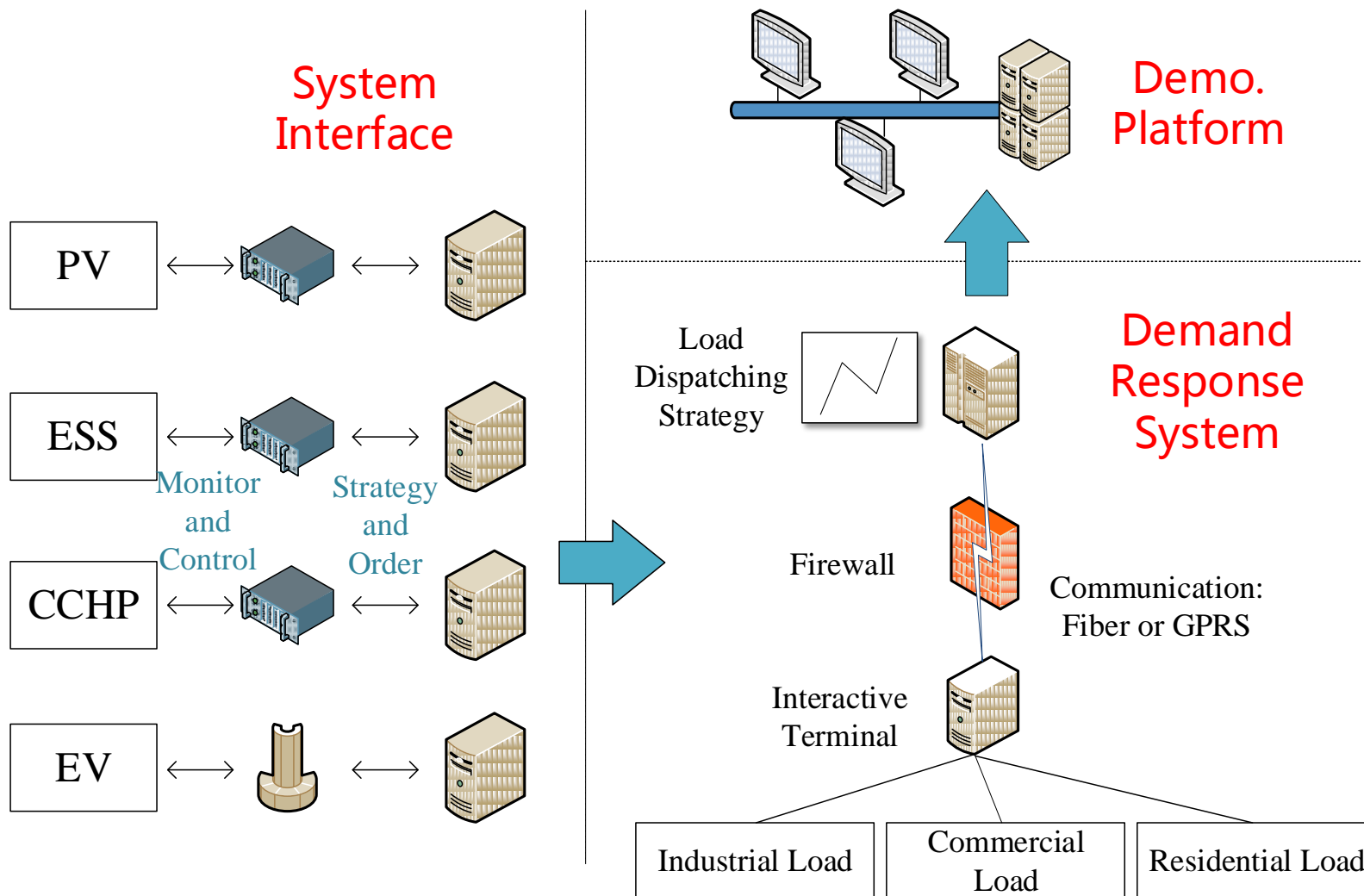
Multi-level Energy Storage System



Structural Design



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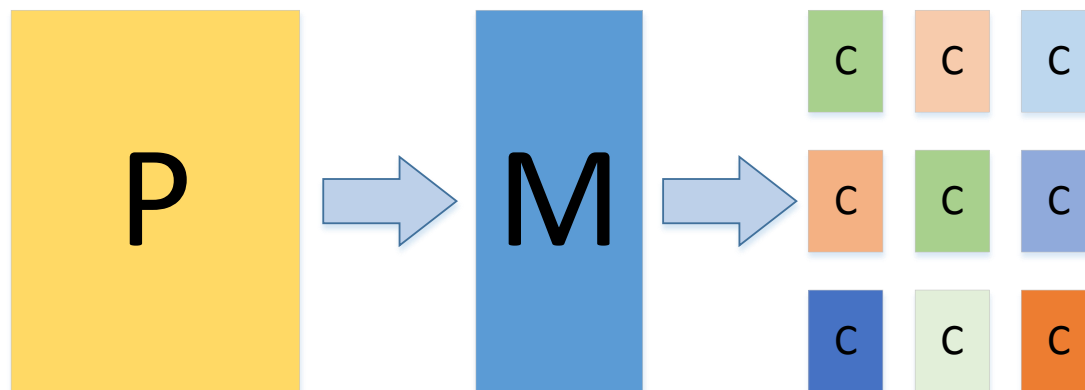
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Structural Design



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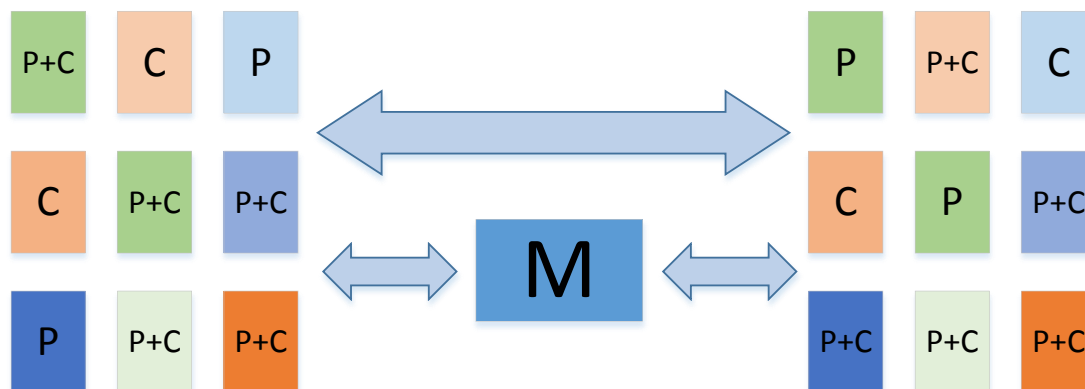
P: Producer
M: Mid-link
C: Consumer



Conventional Supply-Demand Relationship

Terminals can be both producer and consumer. The trade between suppliers and users can be either mid-linked or direct.

All the trading behaviors are based on the VPP operation service platform.



New Relationship in VPP Covered Area



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2016 Electricity Tariff in **Zhejiang** Province

Users Category	Voltage Level	Meter Price (RMB)	Time-of-use Price			Basic Price	
			Peak (RMB)	Medium (RMB)	Low (RMB)	Trans. Cap. (¥/kVA/Mon.)	Max Cap. (¥/kW/Mon.)
Large Industrial Consumers	1-10 kV	0.6966	1.1146	0.9326	0.4486	30	40
	20 kV	0.6766	1.0893	0.9093	0.4326	30	40
	35 kV	0.6666	1.0766	0.8976	0.4246	30	40
	110 kV	0.6446	1.0436	0.8686	0.4046	30	40
	220 kV+	0.6396	1.0336	0.8606	0.4006	30	40
General Industrial & Commercial Users and Others	1 kV-	0.8929	1.4029	1.0979	0.5749	--	--
	1-10 kV	0.8549	1.3529	1.0549	0.5429	--	--
	20 kV	0.8349	1.3269	1.0322	0.5262	--	--
	35 kV+	0.8249	1.3139	1.0209	0.5179	--	--

2016 Electricity Tariff in **Jiangsu** Province

Users Category	Voltage Level	Meter Price (RMB)	Time-of-use Price			Basic Price	
			Peak (RMB)	Medium (RMB)	Low (RMB)	Trans. Cap. (¥/kVA/Mon.)	Max Cap. (¥/kW/Mon.)
Large Industrial Consumers	1-10 kV	0.6601	1.1002	0.6601	0.3200	30	40
	20 kV	0.6541	1.0902	0.6541	0.3180	30	40
	35 kV	0.6451	1.0752	0.6451	0.3150	30	40
	110 kV	0.6301	1.0502	0.6301	0.3100	30	40
	220 kV+	0.6151	1.0252	0.6151	0.3050	30	40
General Industrial & Commercial Users and Others	1 kV-	0.8366	1.3943	0.8366	0.3789	--	--
	1-10 kV	0.8216	1.3693	0.8216	0.3739	--	--
	20 kV	0.8156	1.3593	0.8156	0.3719	--	--
	35 kV+	0.8066	1.3443	0.8066	0.3689	--	--

Projects Investment Budget Estimation

No.	Items	Sum (¥)
1	Distributed PV Station	119,850,000
2	Multi-level Energy Storage Station	76,768,050
3	Combined Cooling and Heating Power Station	42,984,692
4	Electric Vehicle Charging Station	7,850,000
5	VPP Comprehensive Operation Service Platform	26,343,937
6	Automatic Demand Responding System	14,230,000
7	Environmental Protection Investment	72,000
8	Labor Security and Industrial Hygiene Special Fund	1,711,000
Total		289,809,679

No.1 Distributed PV Station

Total Investment	119.85 million	Invest per Unit	7.99 million/MW
IRR (%)	10.42%	Ic	8%
NPV(¥)	21,929,200	Payback Period	7.57 years

No.6 Automatic Demand Responding System

Total Investment	14.23 million		
IRR (%)	13.35%	Ic	8%
NPV(¥)	3,546,200	Payback Period	5.19 years

No.2 Multi-level Energy Storage System

Based on 2016 Electricity Tariff in **Zhejiang** Province

Total Investment	76.7681 million	Invest per Unit	1.8278 million/MW
IRR (%)	5.25%	Ic	8%
NPV(¥)	-11,511,300	Payback Period	11.15 years

Based on 2016 Electricity Tariff in **Jiangsu** Province

Total Investment	76.7681 million	Invest per Unit	1.8278 million/MW
IRR (%)	8.41%	Ic	8%
NPV(¥)	1,745,100	Payback Period	8.68 years

No.3 Combined Cooling and Heating Power Station

Total Investment	42.9847 million	Invest per Unit	2.1071 million/MW
IRR (%)	15.18%	Ic	8%
NPV(¥)	22,764,600	Payback Period	5.82 years

No.4 Electric Vehicle Charging Station

Total Investment	7.85million		
IRR (%)	13.3%	Ic	8%
NPV(¥)	1,691,800	Payback Period	5.36 years

Overall Index of Finance

Static Invest.	277.2867 million	Basic Circulating Fund	107.4 million
Dynamic Invest.	290.1025 million	Ic	8%
Return of Invest.	3.13%	Net Profit Rate	4.92%

Analysis of Finance Before Fund-raising

	IRR (%)	NPV (million RMB)	PP (year)
Pre Income Tax	9.35%	25.7939	7.52
After Income Tax	8.56%	10.2929	7.82

Analysis of Finance After Fund-raising

	IRR (%)		
Capital	9.34%		



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1. Compared to the western markets, VPP is a budding concept in China yet with enormous development potential.
2. With large-scale application of energy storage system, VPP will be more flexible on the control of power flow.
3. Information Communication Technology makes it possible to realize point-2-point Energy trading.
4. Positive local policies will deeply affect the profit of constructions of VPP, especially the energy storage industry.



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Thank you!

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