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International Energy Policy Conference

Korea Electricity Market Reform in the Era of Net Zero

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1 Korea Electric Power Industry Status

2 Challenges of Electricity Market

3 Market Reform Plan

4 Closing Remarks



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Korea Electric Power Industry Status

1. Korea Electric Power Industry Status



➤ Isolated power system : South Korea and North Korea

➤ Large scale power system : 11th place in the world (CIA)



➤ Slowing down Electricity Demand Increase Rate

Demand increase Rate	Comparison('90~'13)	Rate of increase
'80-'89 : 10.8%	USA	0.5%
'90-'99 : 9.5%	Germany	0.6%
'00-'09 : 5.7%	Japan	0.9%
'10-'19 : 2.1%	France	1.3%

High dependence on imported energy : 97% imports

Korea	Japan	France	Germany	USA	U.K
97.0	95.7	91.7	71.5	34.9	26.6

1. Korea Electric Power Industry Status

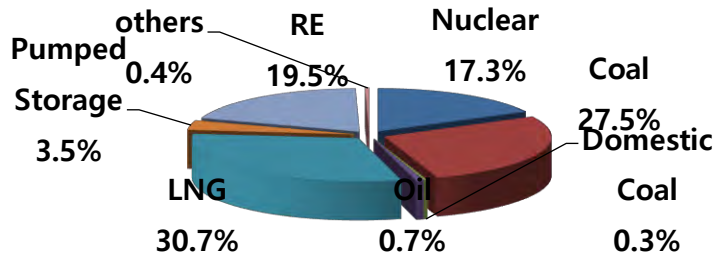
◆ Installed Capacity and Generation

▶ Total Installed Capacity : 114,206MW (As of Jun. 2022)

▶ Total Generation : 577 TWh, (Nuclear 158 TWh, Coal 192 TWh, LNG 158 TWh, RE 39 TWh)

Installed Capacity by Type (As of Jun. 2022)

Source	Unit	Capacity (MW)	Share(%)
Nuclear	24	23,250	17.3
Coal	72	36,938	27.5
Oil	226	960	0.7
LNG	252	41,202	30.7
Pumped Storage	16	4,700	3.5
Renewables	107,063	26,125	19.5
Total	26,893	114,206	100.0



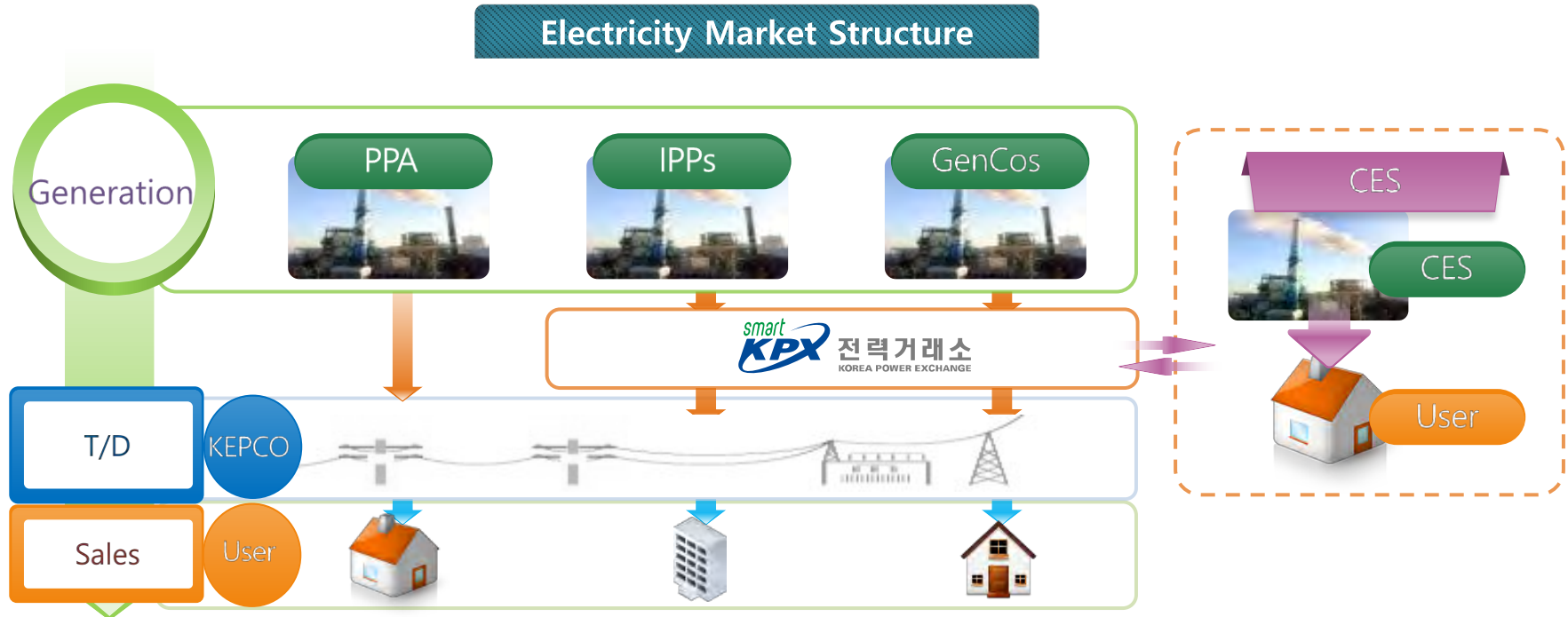
Renewable Capacity Details

Source	Unit	Capacity (MW)	Share(%)
Wind	131	1,754	6.6
Solar(PV)	106,516	19,705	74.4
Hydro	Small	181	0.9
	General	41	1,582
Byproduct Gas	1	30	0.1
Waste	64	321	1.2
Fuel Cell	87	806	3.0
IGCC	2	346	1.3
Tidal	4	255	1.0
Bio	97	1,096	4.1
Total	107,124	26,125	100.0

1. Korea Electric Power Industry Status

◆ Electricity Market Structure

- ▶ **Mandatory Pool** : All Generators more than 1MW capacity must participate in electricity market which is operated by KPX(Korea Power Exchange).
- ▶ **Cost Based Pool**
 - All costs of generation are determined by KPX (Cost Evaluation Committee).
 - Generation production levels are also set by KPX according to ED.
 - The results of cost evaluation shall be established for ED and the cost information.



1. Korea Electric Power Industry Status

◆ Generation Sector

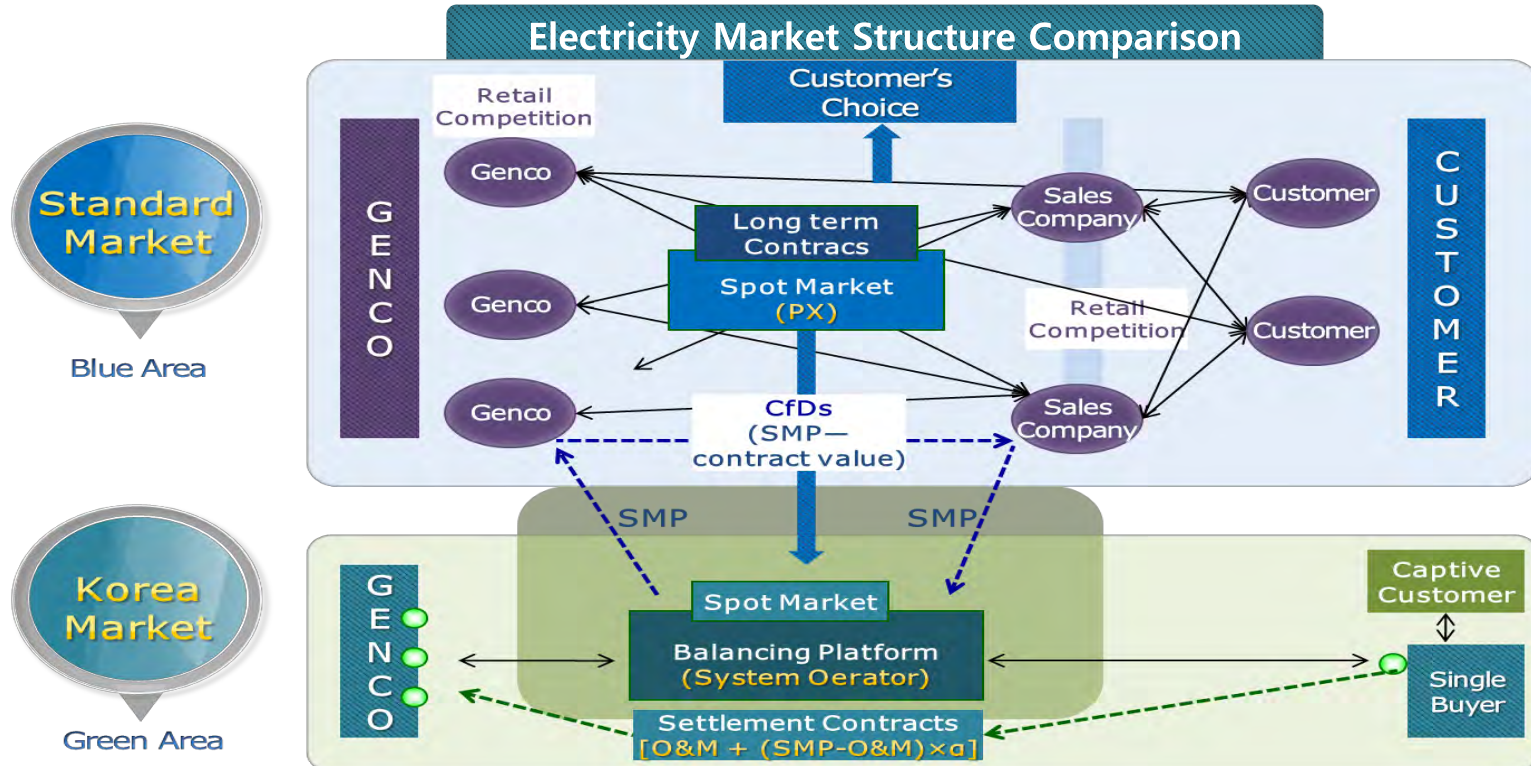
- ▶ 6 Large GenCos were separated from Korea Electric Power Corporation(KEPCO) as subsidiaries.
- ▶ Over 5,000 generation companies are participating in the market.

◆ Transmission, Distribution and Retail Sector

- ▶ Power System is operated by KPX(as ISO), but owned by KEPCO.
- ▶ KEPCO should purchase the electricity from the market and resale to end user.

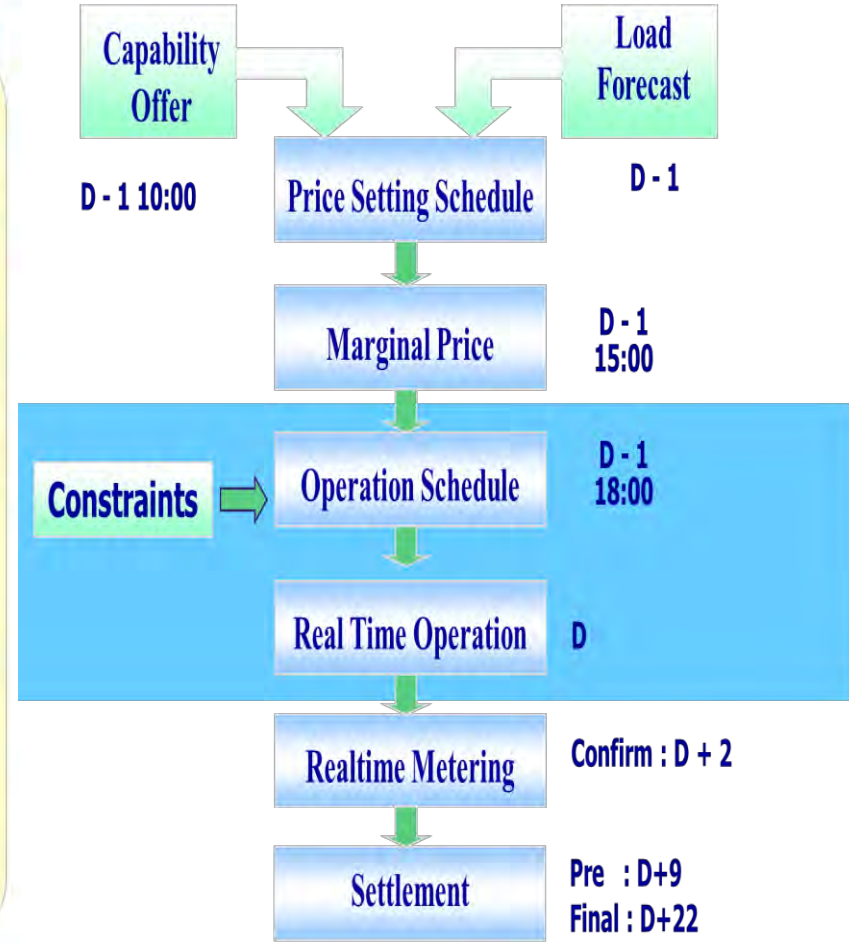
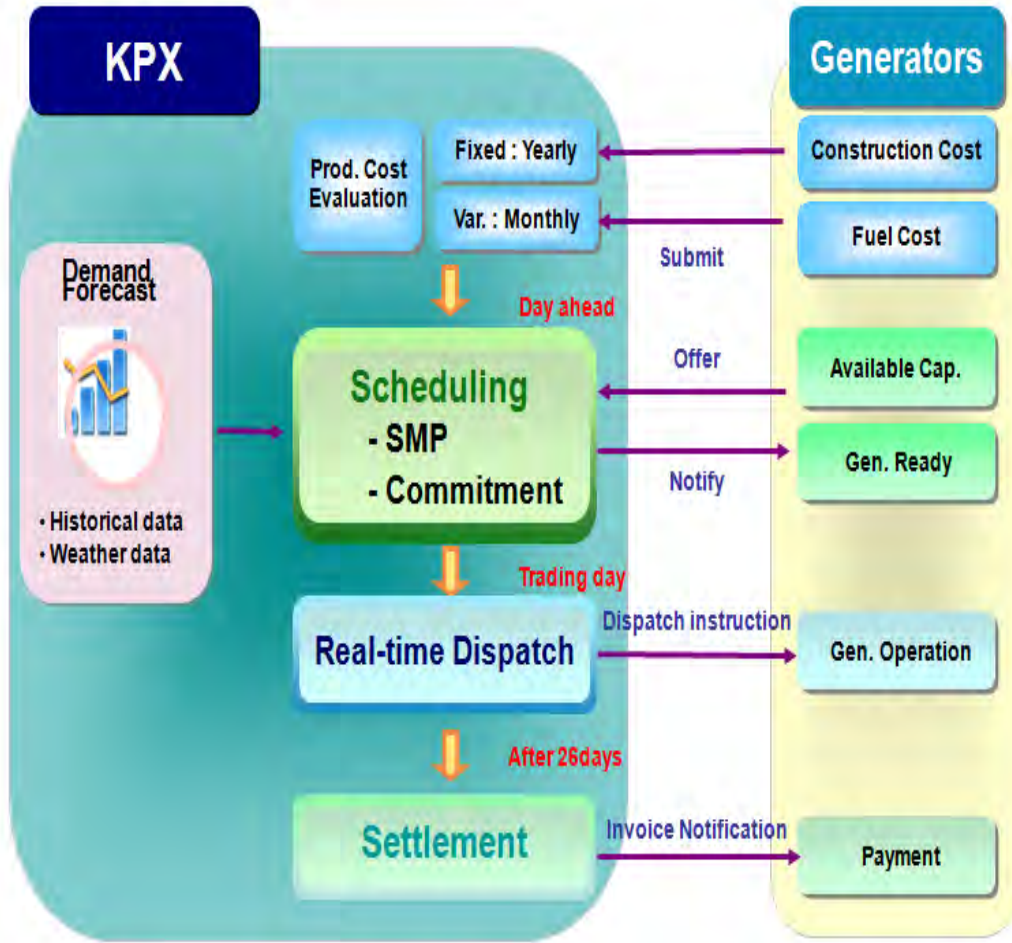
◆ Consumer's Choice

- ▶ General consumer should purchase the electricity from KEPCO.
- ▶ Large customers and Community Energy Supply System (CES) have options to purchase their electricity from the market or KEPCO directly.




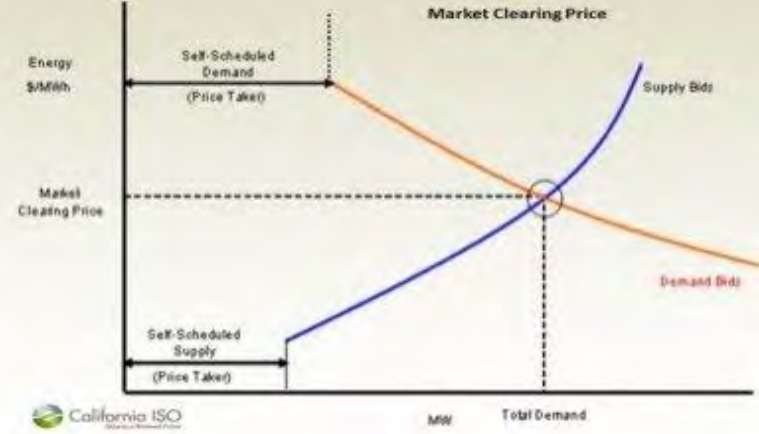
1. Korea Electric Power Industry Status

◆ Market Operation Overview



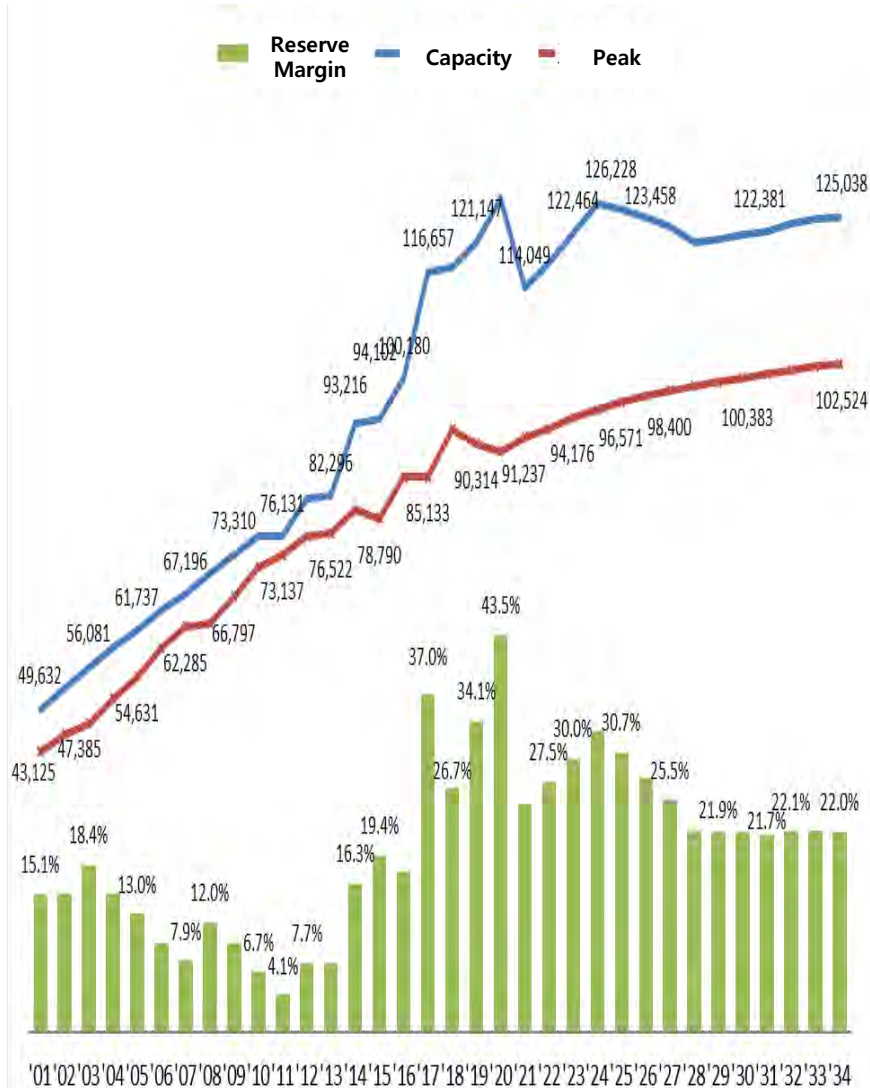
1. Korea Electric Power Industry Status

◆ Korea Electricity Market vs. other Electricity Markets

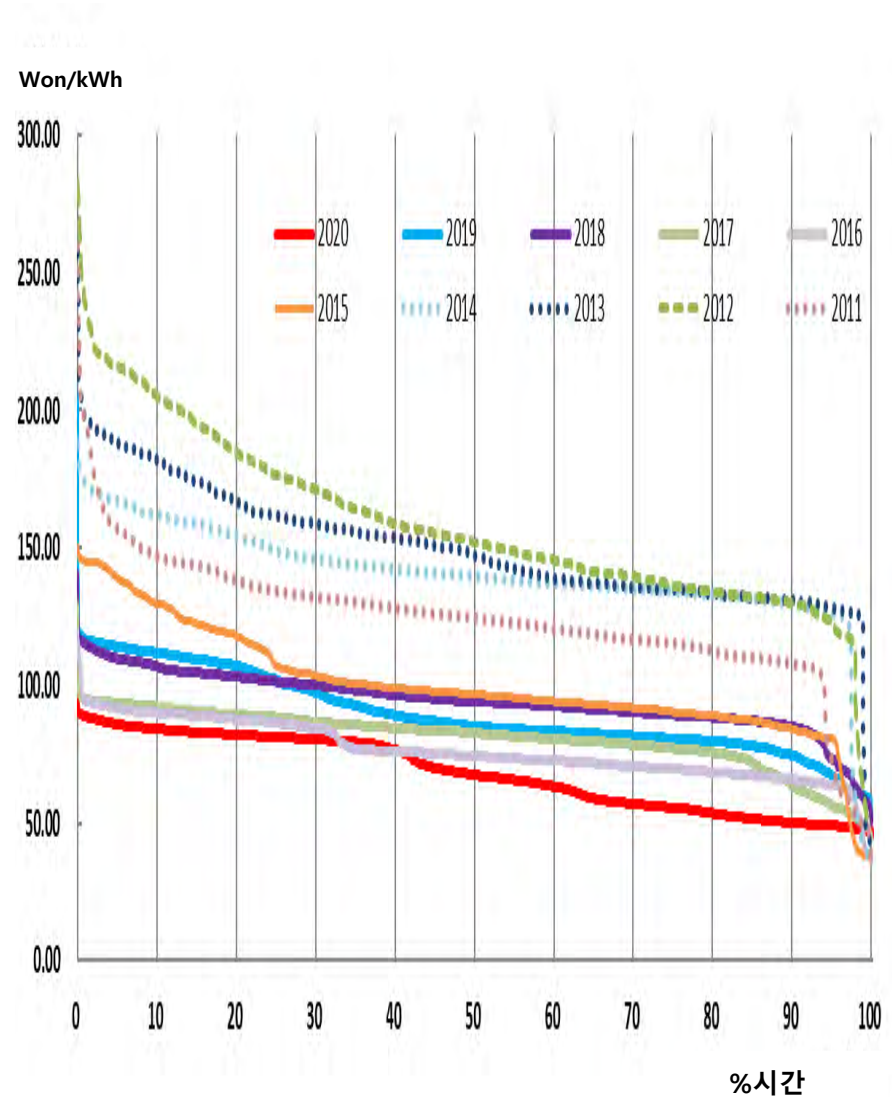
	Korea Electricity Market	U.S. and European Countries
Characteristics	Cost Based Pool	Price Based Pool
Bid/Offers Information	Generation Output	Electricity Price, Generation Output
Bids/Offers Entity	GenCos Only	GenCos(Supply) / Sales Company(Demand)
Offers Methodology	Fuel Costs (Cost Evaluation)	Individual Companies' Strategy
RE Costs	Need to reflect as additional cost	Included in Price
Comparison		

1. Korea Electric Power Industry Status

◆ Supply & Demand Outlook



◆ SMP Trend



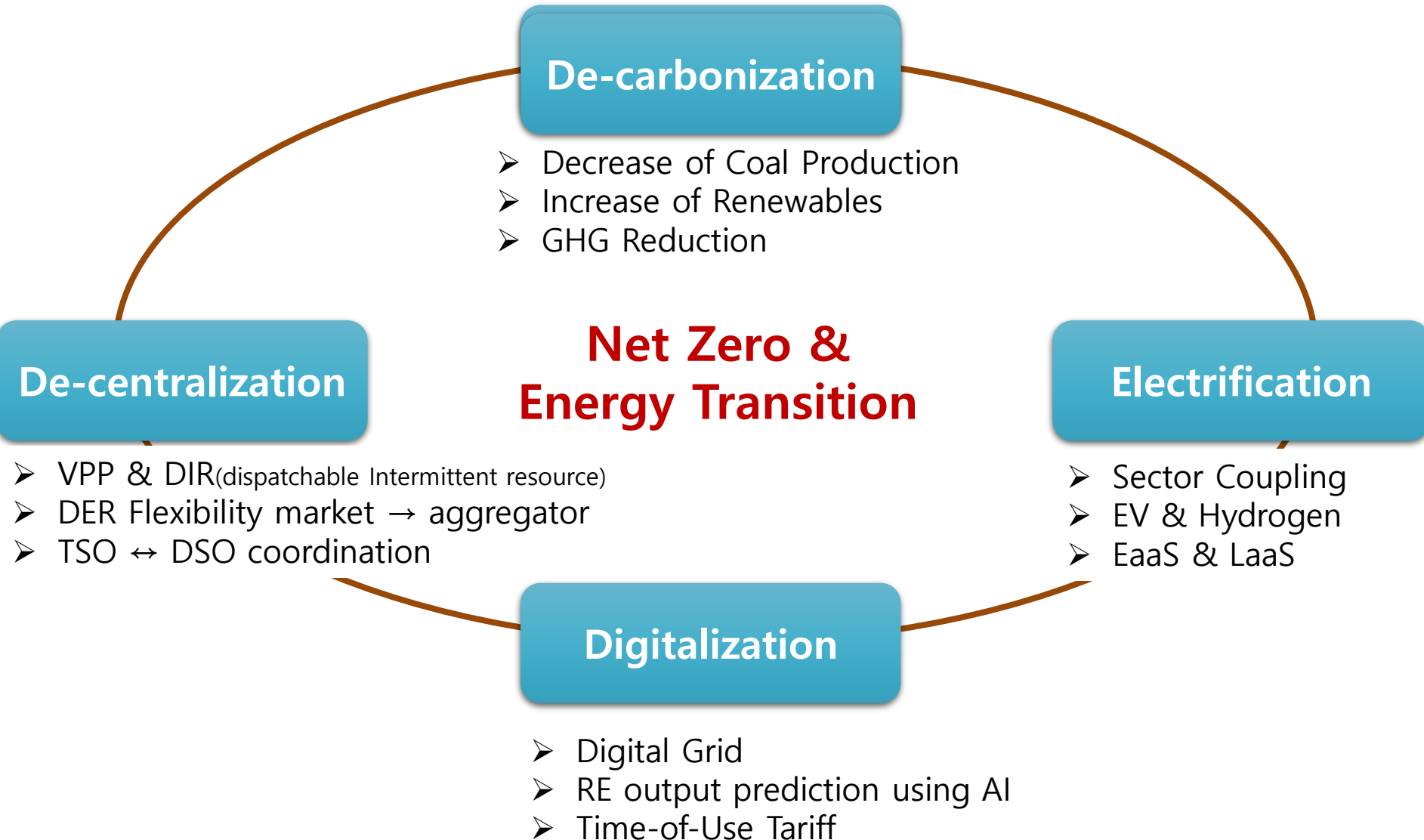


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Challenges of Electricity Market

2. Challenges of Electricity Market

◆ Rising Issues

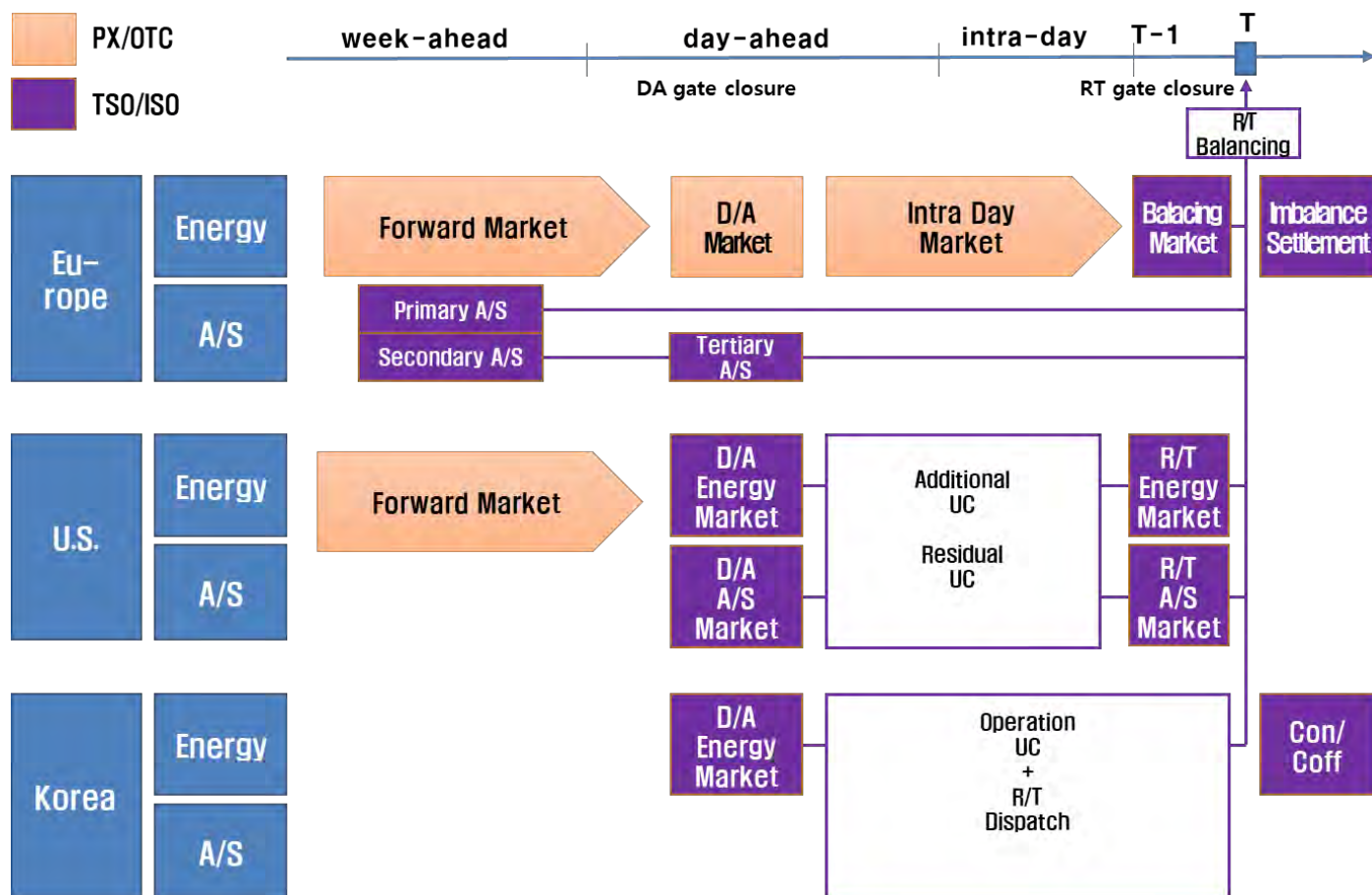


2. Challenges of Electricity Market

◆ Imperfect Spot Market only

- ▶ Limited competition, Settlement Contracts among KEPCO and subsidiaries
- ▶ Absence of R/T market, Insufficient A/S market, and No Imbalances

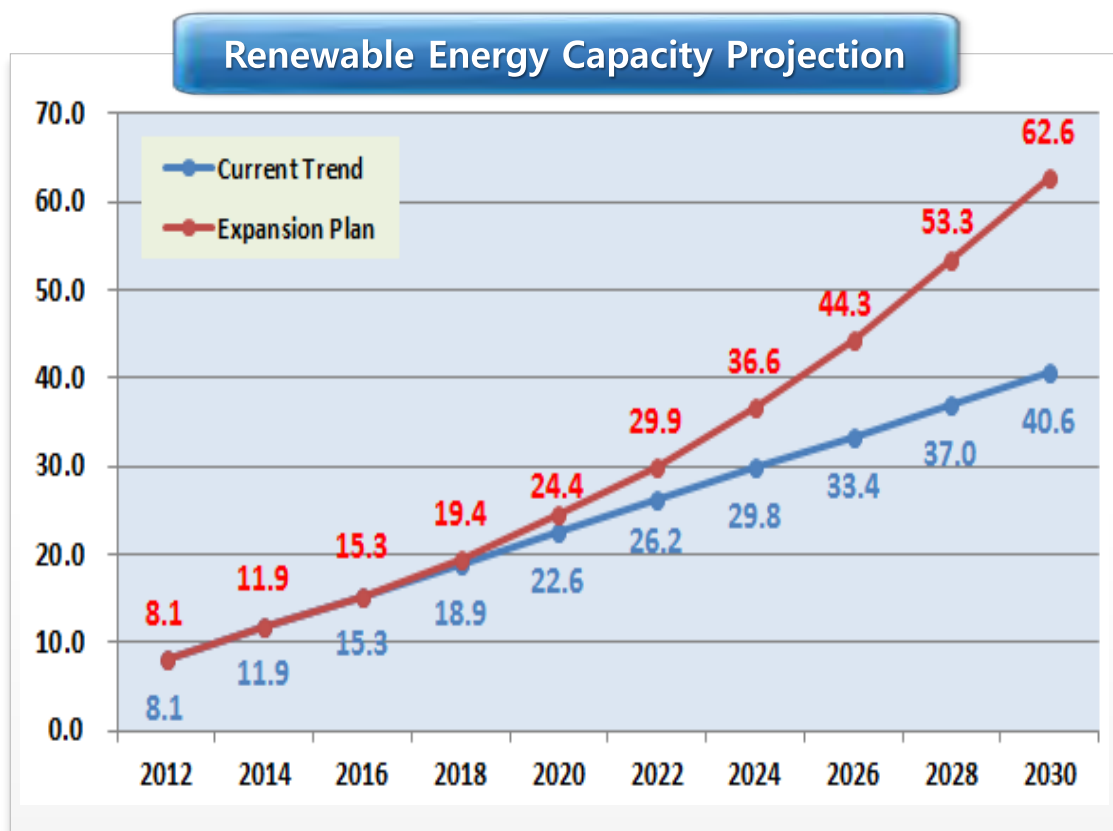
Electricity Market Comparison



2. Challenges of Electricity Market

◆ RE Expansion Outlook

- ▶ Target of Renewable Energy Capacity by 2030 is about 62.6GW.
- ▶ They are mainly variable energy resources like solar and wind power.
⇒ Variability of electricity system will be increased greatly.



Source	2016	2020	2025	2030
Solar	4.5 (29.4)	10.4 (42.8)	20.1 (49.6)	33.0 (52.7)
Wind	1.0 (6.5)	2.6 (10.7)	7.7 (18.9)	15.7 (25.0)
Etc.	9.8 (64.1)	11.3 (46.5)	12.7 (31.4)	13.9 (22.3)
Total	15.3 (100)	24.4 (100)	40.4 (100)	62.6 (100)

2. Challenges of Electricity Market

◆ Greenhouse Gas Reduction

- ▶ International communities are trying to control the global temperature rise below 2°C.
- ▶ Korea is trying to control national GHG emissions below to 433.6 Mt CO₂eq by 2030.

Nation wide GHG Reduction Target

(Unit : Mt CO₂eq)

Sector		Base Year ('18)	Previous NDCs (compared to Base Yr)	Current NDCs ('21) (compared to Base Yr)
GHG Emissions		727.6	536.1 (△191.5, △26.3%)	436.6 (△291.0, △40.0%)
Emissions	Electricity/Heat	269.6	192.7 (△28.5%)	149.9 (△44.4%)
	Industry	260.5	243.8 (△6.4%)	222.6 (△14.5%)
	Building	52.1	41.9 (△19.5%)	35.0 (△32.8%)
	Transportation	98.1	70.6 (△28.1%)	61.0 (△37.8%)
	Agriculture/ livestock/ fisheries	24.7	19.4 (△21.6%)	18.0 (△27.1%)
	Waste	17.1	11.0 (△35.6%)	9.1 (△46.8%)
	others	5.6	5.2	11.5
Sinks	Sinks	-41.3	-22.1	-26.7
	CCUS	-	-10.3	-10.3
	others	-	-16.2	-33.5

2. Challenges of Electricity Market

◆ Fuel Price Fluctuations

- ▶ Fuel Price Fluctuation due to energy sector supply chain risk from Russian-Ukraine war.
- ▶ Absence of forward market and bilateral contracts is weak point of Korea Market.
⇒ Wholesale price can soar up.

Fuel Price Fluctuations

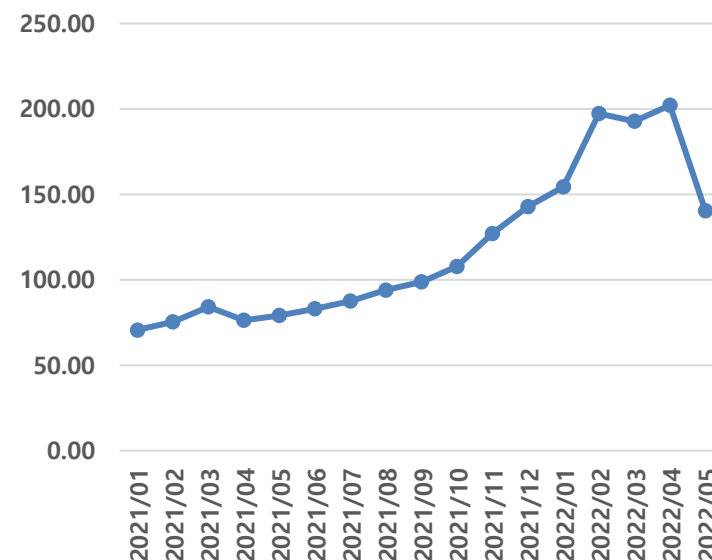
World Bank Commodities Price Data (The Pink Sheet)

2-Jun-2022

Commodity	Unit	Annual Averages			Quarterly Averages				Monthly Averages				
		Jan-Dec	Jan-Dec	Jan-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Mar	Apr	May	
		2019	2020	2021	2021	2021	2021	2021	2022	2022	2022	2022	
Energy													
Coal, Australia	\$/mt	a/	77.9	60.8	138.1	89.5	109.7	169.1	183.9	197.0
Coal, South Africa	\$/mt		71.9	65.7	119.8	86.8	100.5	135.4	156.7	219.8	294.4	302.0	280.0
Crude oil, average	\$/bbl		61.4	41.3	69.1	59.3	67.1	71.7	78.3	96.6	112.4	103.4	110.1
Crude oil, Brent	\$/bbl	a/	64.0	42.3	70.4	60.6	68.6	73.0	79.6	99.0	115.6	105.8	112.4
Crude oil, Dubai	\$/bbl		63.2	42.2	68.8	59.5	66.4	71.4	77.9	96.5	113.1	102.7	108.3
Crude oil, WTI	\$/bbl		57.0	39.3	68.0	57.8	66.1	70.6	77.3	94.5	108.5	101.8	109.6
Natural gas, Index	2010=100		61.1	45.5	130.7	78.7	83.2	140.3	220.5	221.4	271.1	243.4	251.9
Natural gas, Europe	\$/mmbtu	a/	4.80	3.24	16.12	6.52	8.79	16.93	32.23	32.63	42.39	32.20	29.85
Natural gas, U.S.	\$/mmbtu	a/	2.57	2.01	3.85	3.43	2.91	4.32	4.74	4.62	4.88	6.53	8.14
Liquefied natural gas, Japan	\$/mmbtu	a/	10.56	8.31	10.76	8.93	8.94	10.87	14.32	14.91	15.11	16.29	16.53

Korea SMP Trends

SMP (Monthly Avg.)





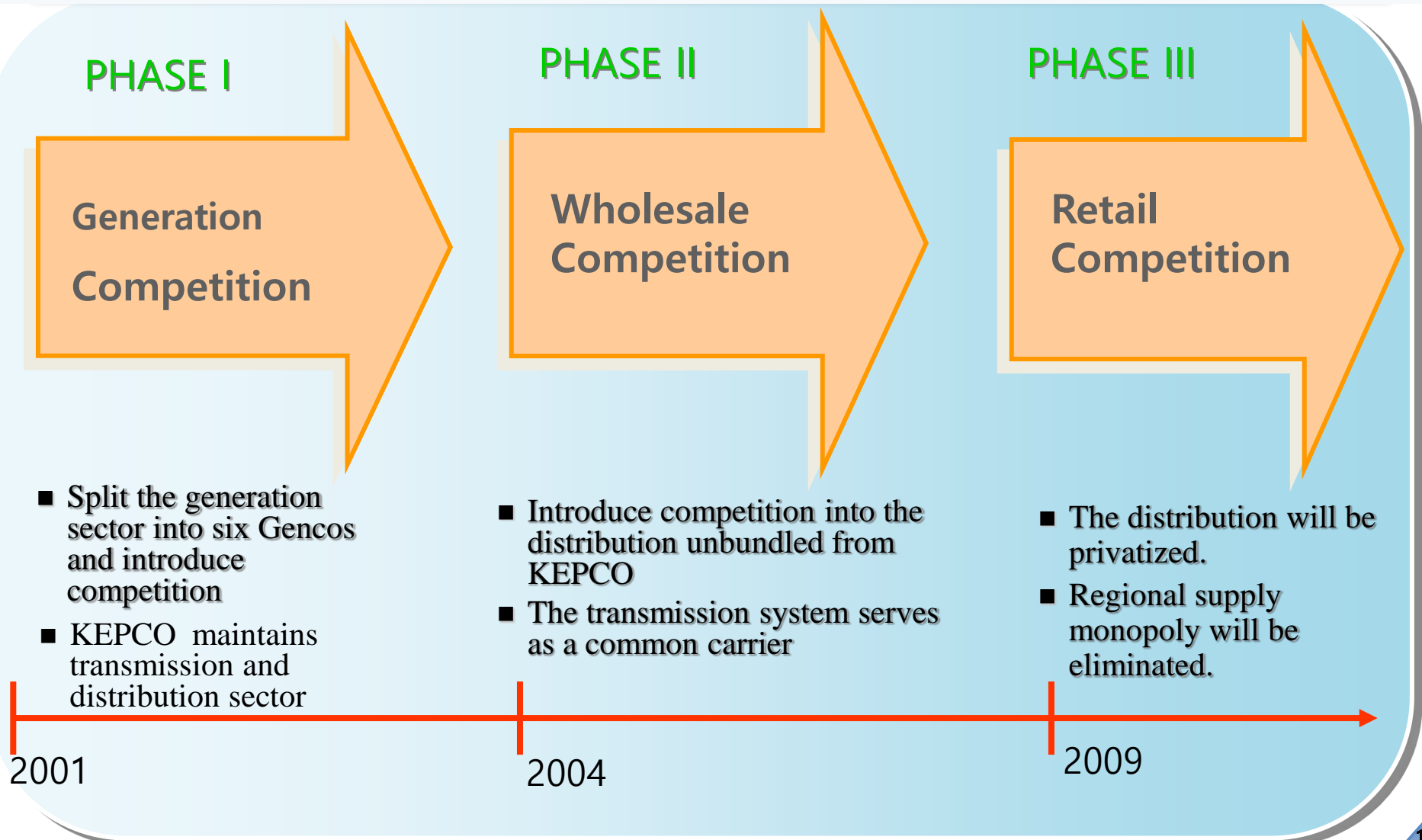
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Market Reform Plan

3. Market Reform Plan

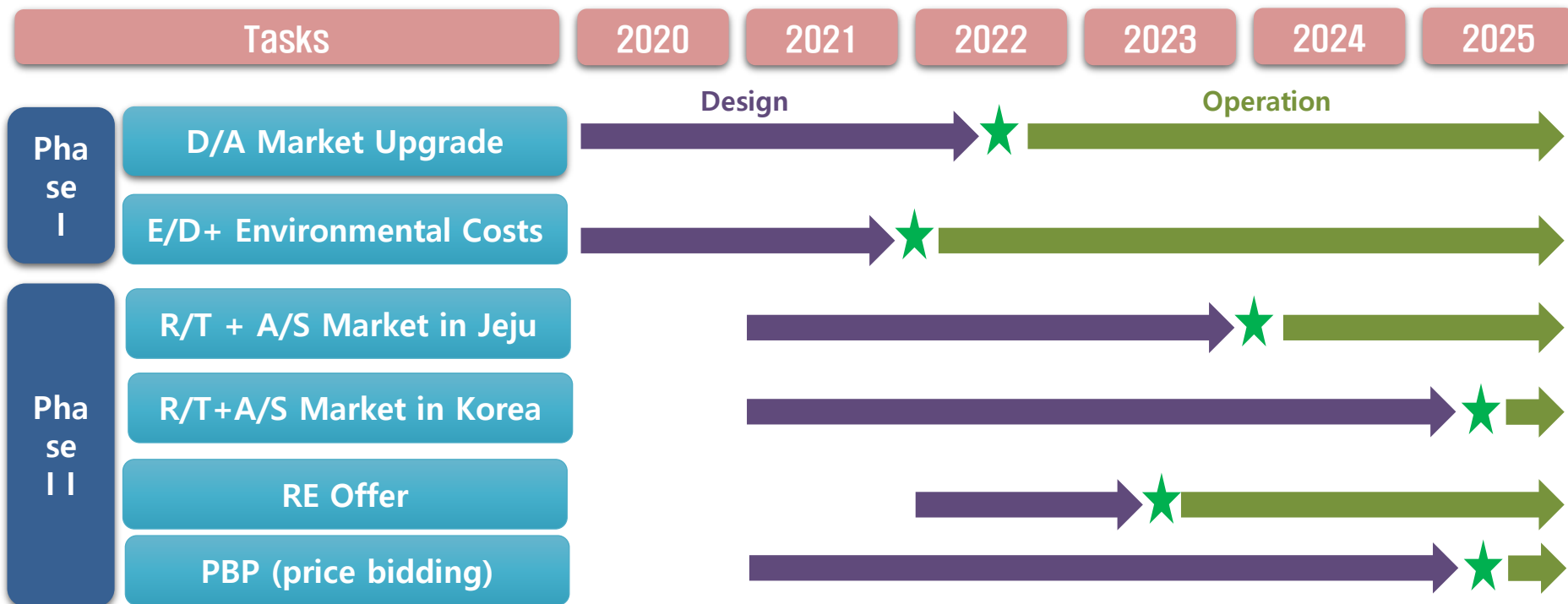
◆ Original Restructuring Plan

▶ Wholesale competition is withheld due to political issues in 2004.

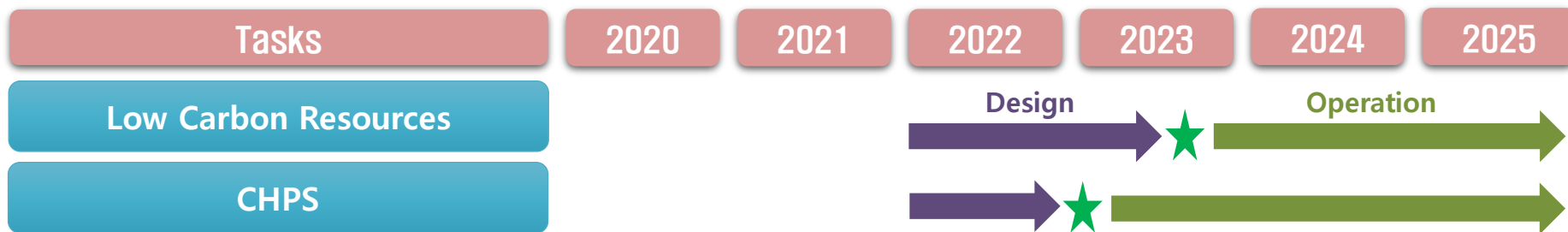


3. Market Reform Plan

◆ Spot Market Upgrade



◆ Low Carbon Contracts Market



▶ This plan is KPX version. Contents and schedules of Market Reform Plans can be changed.

3. Market Reform Plan

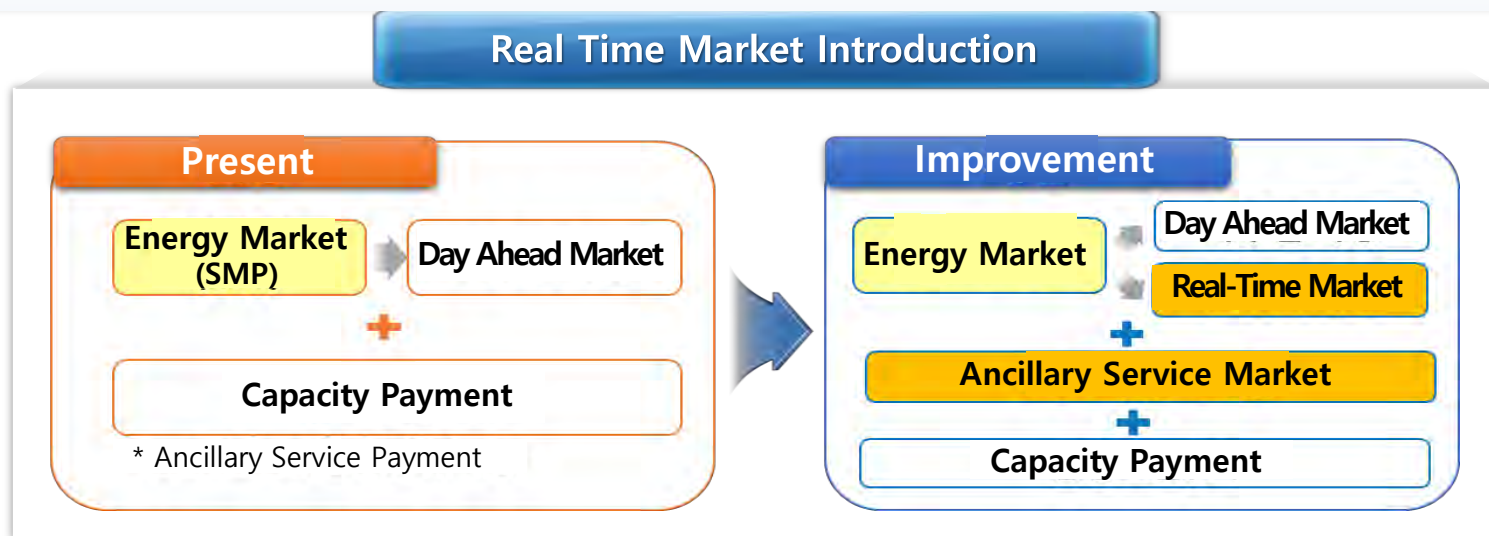
◆ D/A Market Upgrade (reflecting network constraints, starting as of Sep. 2022)

- ▶ SMP calculated based on Fuel Costs, Demand and network constraints.



◆ Real Time Market

- ▶ Near real-time trading to cost-effectively and efficiently solve RE variability problem.
- ▶ Market price can reflect real time demand & supply and network conditions.



3. Market Reform Plan

◆ Low Carbon Contracts Market

- ▶ Set up central contract market for new low-carbon sources to join in
- ▶ New low-carbon source examples : ESS, Hydrogen generation, CCS, new A/S, etc.



◆ Price Bidding

- ▶ In place of rigid cost evaluation (CBP), price bidding (PBP) is used to allow more autonomy of participants and enhance market price function

◆ Renewable Energy Offer

- ▶ All RE should offer their possible outputs and price into D/A market.
- ▶ RE GenCos predict their outputs more precisely and offer price can be used as a curtailment criteria.

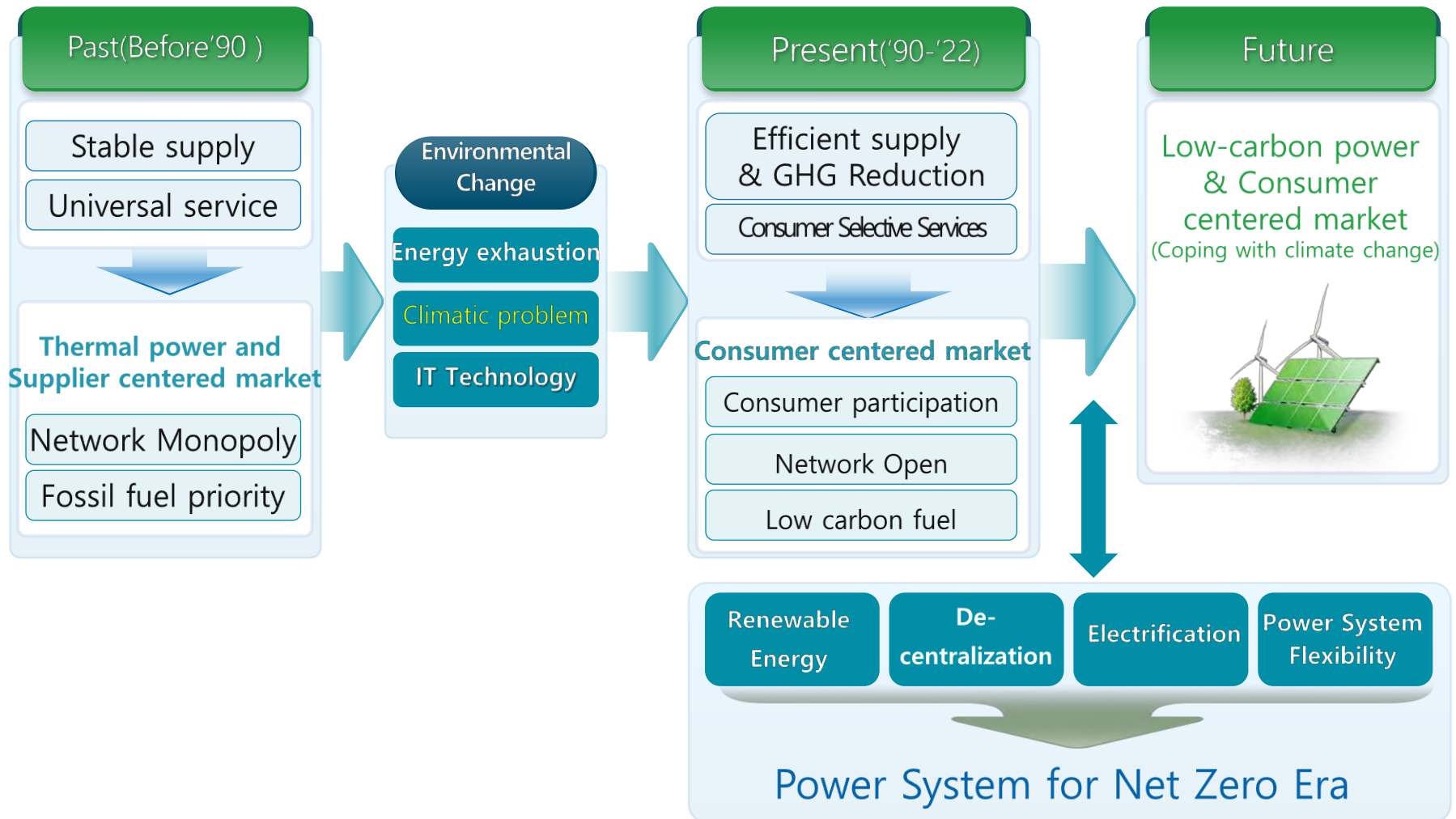


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Closing Remarks

4. Electric Power Industry Paradigm Shift

Past Supplier-oriented → Present Consumer participation → Future Net Zero Era



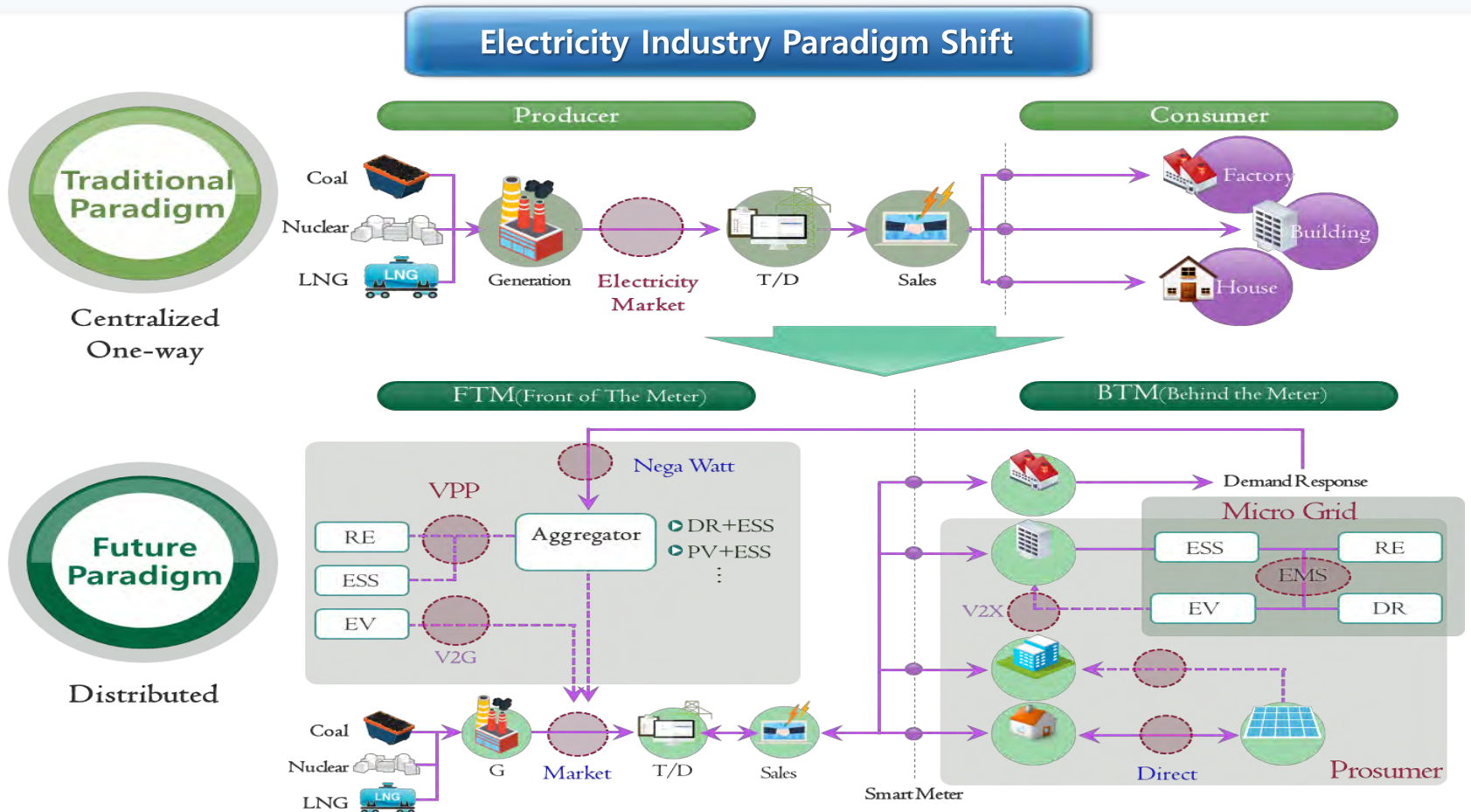
4. Electric Power Industry Paradigm Shift

◆ Fossil fuel oriented, Centralized

▶ Generation → Transmission → Distribution → End User (One Way, Top-down Protocol)

◆ Renewable energy, Demand Response, Distributed

▶ Generation ↔ Transmission ↔ Distribution ↔ End User (Two-Way Protocol)



Thank You!!