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Analyzing Effects of BESS(Battery Energy Storage System) in Korea's Electricity Sector

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Outline

1. Background

2. Korea TIMES Electricity Model

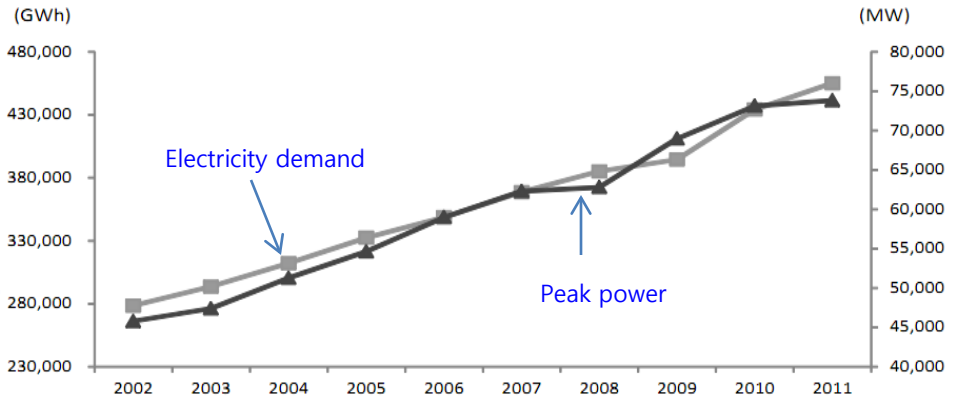
3. Scenario & Results

4. Conclusion

1. Background(1)

Current trend of Korea´s electricity sector

- Over the past 10 years, domestic electricity demand and peak power have steadily increased
- Average annual rate of peak power and electricity demand from 2002 to 2011 are 5.3% and 5.9% respectively



Yearly Electricity demand & peak power(KPX)

- The growth is higher than basic plan of long-term electricity supply & demand forecasts in the past

=> Therefore, the power plant capacity, which was estimated in the past, is lower than current need

1. Background(2)

Current trend of Korea´s electricity sector

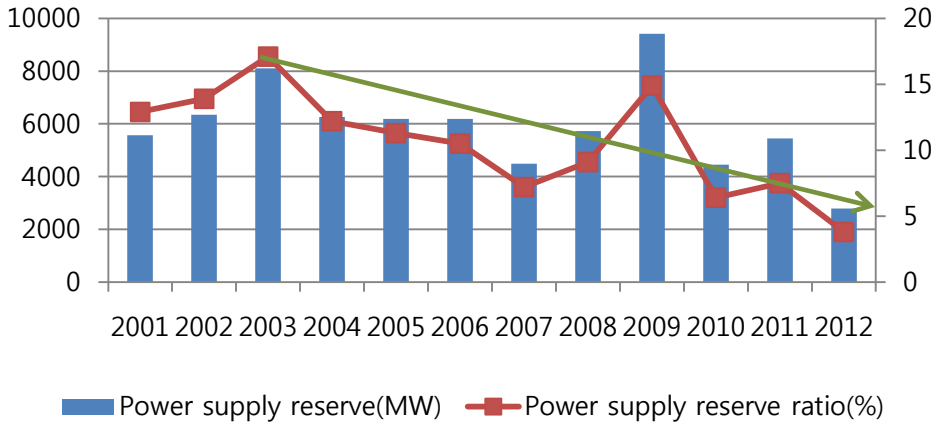
- Power plant construction plans have been delayed or canceled
- Capacity of power plants, which were scheduled to start operation in 2013, but have been canceled or delayed, is 4150MW

⇒ As a result , electric power reserve margin dropped

⇒ Korea even experienced a black out on Sep 15, 2011 due to shortage of reserve

yr	capacity	power plant
2013	4,150MW	Bu-gok LNG CC#3,4(1000MW) Seoul LNG CC #1,2(1000MW) Song-do LNG CC #1,2(900MW) Yang-ju LNG CC#1(700MW) Yul-chon LNG CC#2(550MW)

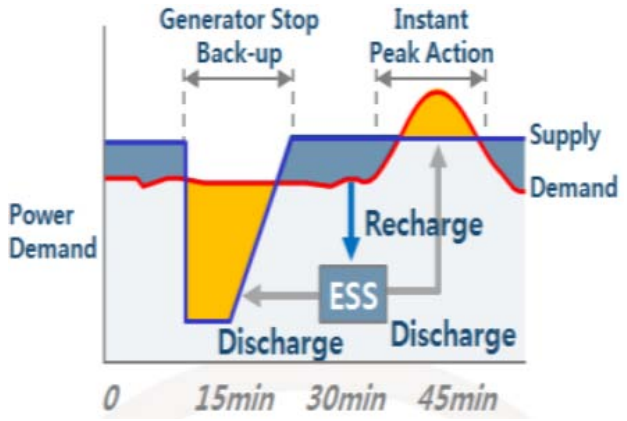
Power plants were Delayed or canceled in 2013



1. Background(3)

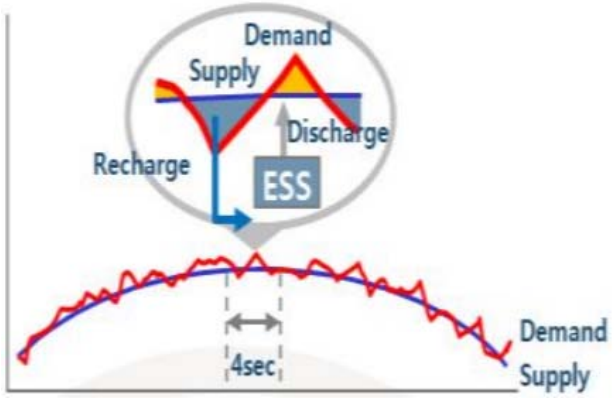
BESS (Battery Energy Storage System)

- It is expected in the future that the electricity demand will be continuously increased due to the expanding industries and advancement of IT service



- The government have examined several measures to raise the reserve power supply or to manage the peak demand

- Among the several measures, BESS is considered efficient, especially in the peak demand management



- According to KPX research report which was published in Feb. 2013, it is expected that Korea`s electricity sector can get benefit from using BESS like a pumped hydro storage, and as a frequency controller

1. Background(4)

BESS (Battery Energy Storage System)

- Government will prepare a plan to invest 6.4 trillion won for research development and research infrastructure and to achieve 30% of world market by 2020

- KEPCO will invest 650 billion won to build the world`s best ESS by 2017

- KEPCO is planning to install 50MW ESS for frequency control next year, and raise the size in phases to 500MW by 2017

=> It is expected that BESS capacity will be increased in electricity sector and this change will affect to generation mix and electricity price

=> So, it is necessary to analyze effects of BESS in electricity sector

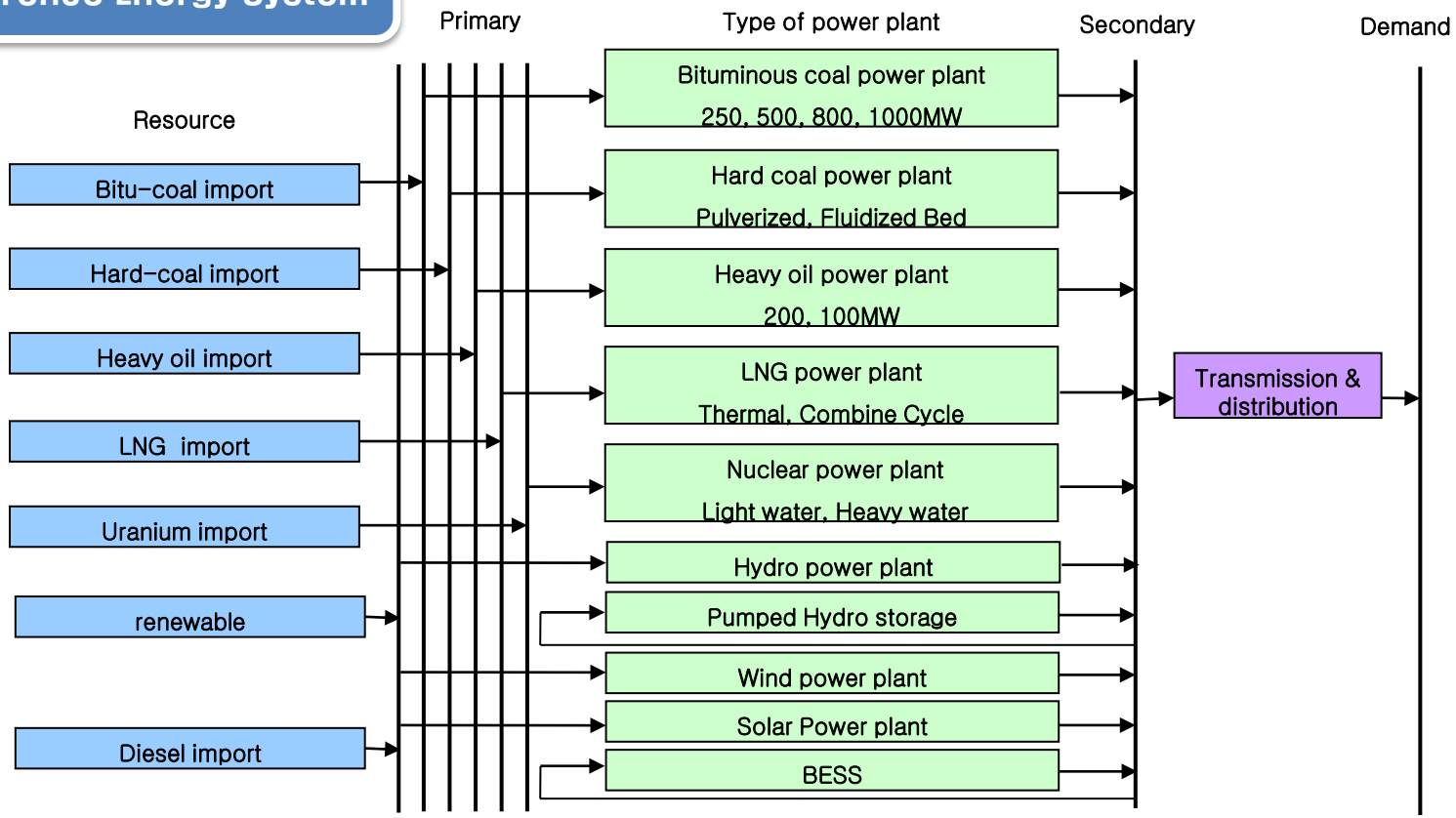
3. Korea TIMES Electricity Model(1)

Assumption

- Region is Single
- Times horizon is from 2010 to 2040 in 6 equal periods(5 years)
- Timeslice is 288 timeslices
  seasonal 12(Jan~Dec) * Daily 2(weekdays, weekend)
  * Hourly 12(2hours -> 1hour)
- Discount rate is 5%
- All power plants are centralized
- Reflect the plan of Power plant construction and retirement
  - Based on the 6th basic plan of long-term electricity supply & demand

3. Korea TIMES Electricity Model(2)

Reference Energy System



- Power plants are classified in seven-teen types by using fuel and capacity and applied technology
- We assumed that all primary energy resources are imported

3. Korea TIMES Electricity Model(3)

Technology cost and performance data

	Technology	Reference Capacity (MW)	Life time (yr)	Efficiency (%)	Availability (%)	Construction cost (₩1000/KW)
1	Nuclear (light water)	1000	40	-	0.85	2486
		1400	40	-	0.85	2108
2	Bituminous Coal Power plant	500	30	34.9	0.875	1338
		870	30	35.9	0.875	1271
		1000	30	40.7	0.875	1284
3	LNG Combine Cycle	500	30	50.5	0.935	810
		700	30	52.6	0.935	793
4	Pumped Hydro	300	50	70	0.25	935
5	Heavy oil	40	30	36	0.887	2219
		100	30	36	0.887	1884
6	PV	-	20	-	0.188	4916
	Wind	-	20	-	0.243	2500

- Efficiency and availability of power plants are based on power generation statistics in 2010
- Construction cost is based on 5th basic plan of long term electricity supply & demand (2010) and KPX website

3. Korea TIMES Electricity Model(4)

Power plant construction & termination plan

	Technology	Reference Capacity (MW)	Construction(MW)			Technology	Termination(MW)		
			2015	2020	2025		2015	2020	2025
1	Nuclear (light water)	1000	3000	0	0	Hard Coal Power plant	-	400	-
		1400	2800	4200	7200				
2	Bituminous Coal Power plant	500	0	3300	0	LNG Thermal & Combine Cycle	1788	480	1800
		870	1740	1740	0				
		1000	0	13000	1000				
3	LNG Combine Cycle	500	6400	5400	0				
		700	3000	800	0				
4	Pumped Hydro	300	800	0	0	Heavy oil	1000	1255	1400
5	PV	-	640	27	0				
	WIND	-	4830	2240	0				

- The Data is based on 6th basic plan of long-term electricity supply & demand(2013)
- 4GW of LNG and 3.6 GW Heavy oil Power plant will shut down over the next 10 years
- 17.2GW of nuclear and 21GW of coal power plant for baseload will be constructed

3. Korea TIMES Electricity Model(5)

Fuel Price Projection

(₩billion / PJ)

yr	2010	2015	2020	2025	2030	2035	2040
Bituminous coal	4.20	4.36	4.38	4.94	5.20	5.44	5.69
Diesel	19.82	34.82	37.21	39.03	39.44	39.72	40.01
LNG	13.88	12.49	13.12	15.00	16.08	18.02	19.32
Heavy oil	16.51	29.02	31.01	32.53	32.86	33.10	33.34
Uranium	0.32	0.57	0.61	0.64	0.64	0.65	0.65
Hard coal	6.16	6.40	6.57	6.92	7.25	7.63	7.98

Demand Projection

(PJ)

yr	2015	2020	2025	2030	2035	2045
Demand	1798	2057	2177	2437	2717	3030

- Fuel price projection is derived by using rising ratio of energy price which was forecasted by EIA, on the basis of fuel cost by type of power plant in 2010
- Electricity demand is estimated by the 6th basic plant of long-term electricity supply & demand(2013)

3. Scenario & Results(1)

Scenario

Five scenarios were analyzed to answer the following questions

- Can BESS replace the pumped hydro storage?

- A fall in Battery cell price would prompt deployment of BESS?
  - According to government document, battery cell price(2010) would fall 80% and 90% by 2020, 2030
  - Change of price is applied to scenario

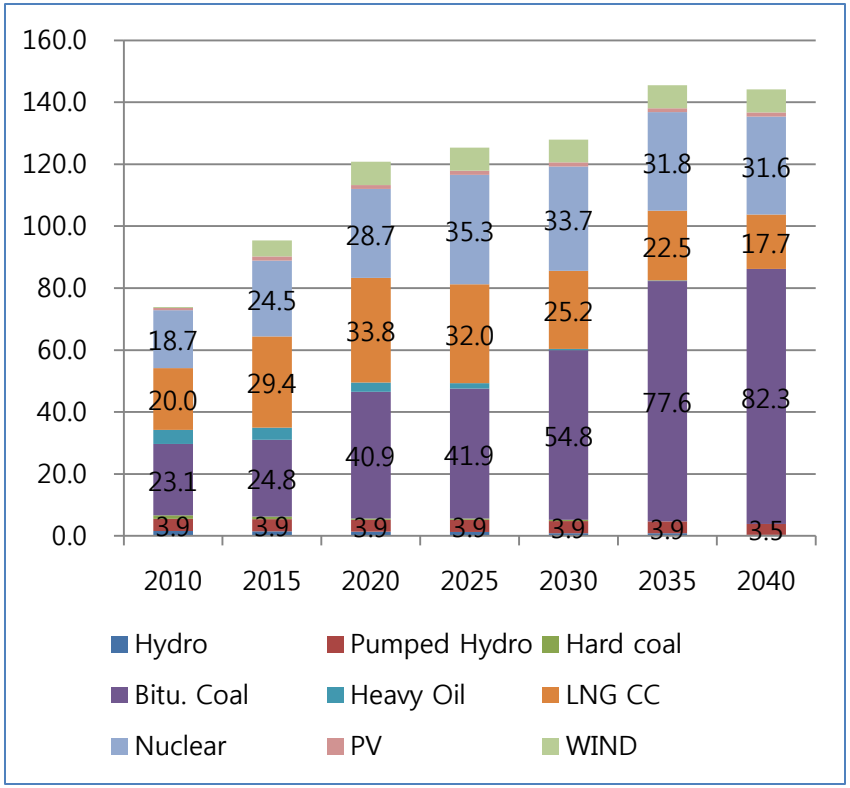
- Using BESS as a frequency controller instead of coal fire plant would raise the system cost?
  - Power authorities require that coal fire power plant should hold 5% of their full output for frequency control
  - KEPCO is planning to install BESS as a frequency controller
  - Raising 5% of coal fire power plant availability is applied to scenario

3. Scenario & Results(1)

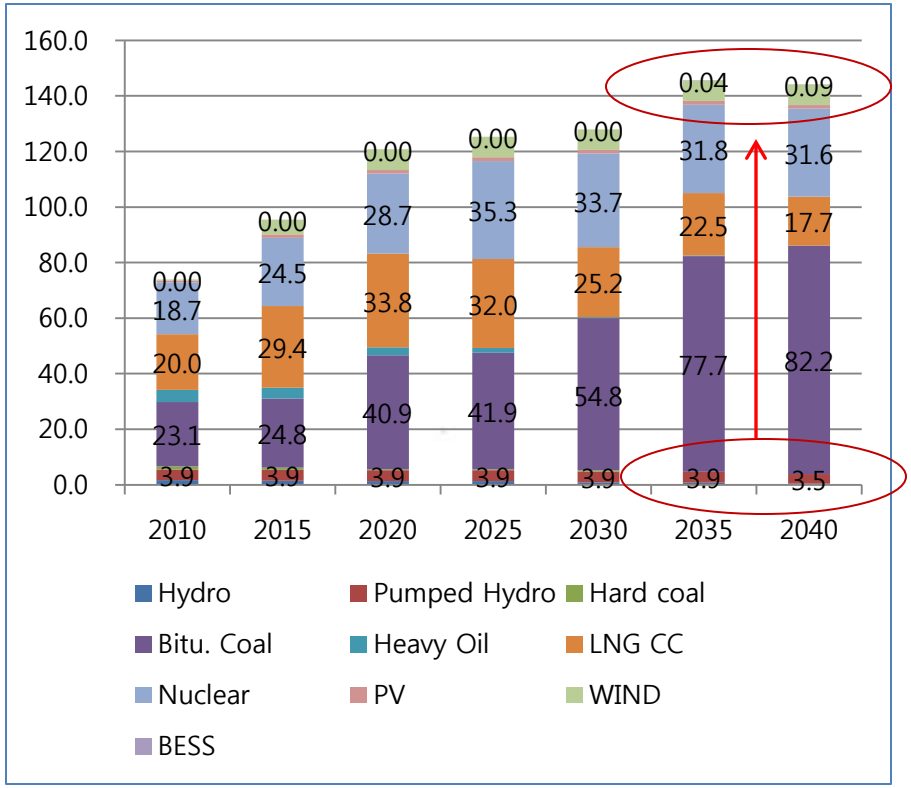
Scenario

	Scenario	Detail
1	BASE	- A least cost Korea electricity system - BESS is not available technology.
2	BESS	- BESS is available technology. - BESS cost is not change. - Not using BESS as a frequency controller
3	COST	- BESS is available technology. - BESS cost is change. - Not using BESS as a frequency controller
5	POLICY	- BESS is available technology. - BESS cost is not change. - Using BESS as a frequency controller
6	POLICY + COST	- BESS is available technology. - BESS cost is change. - Using BESS as a frequency controller

3. Scenario & Results(2)



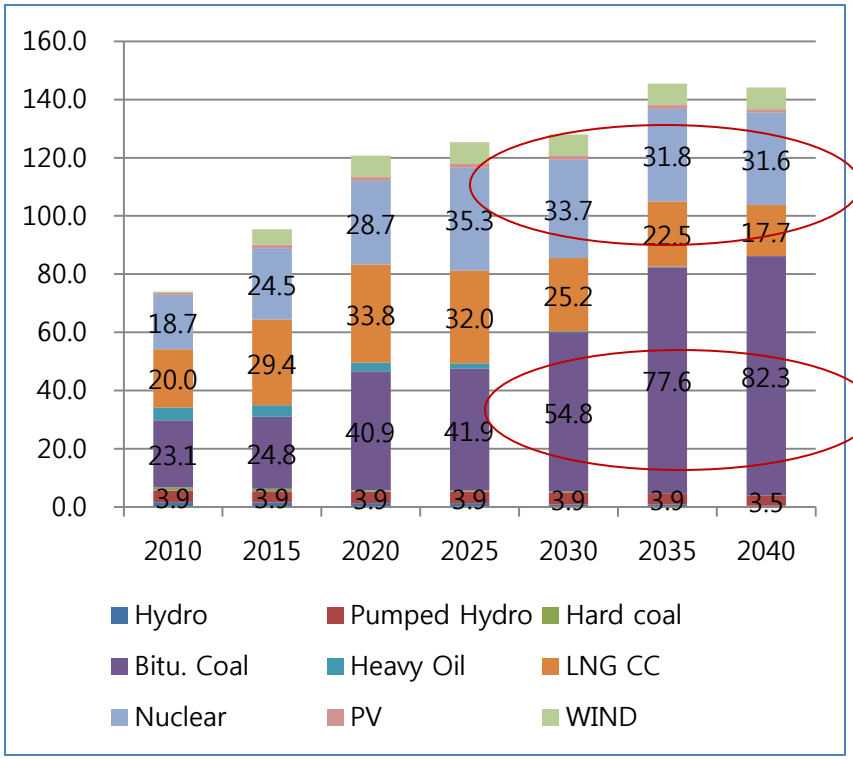
<capacity of power plant in BESS scenario >



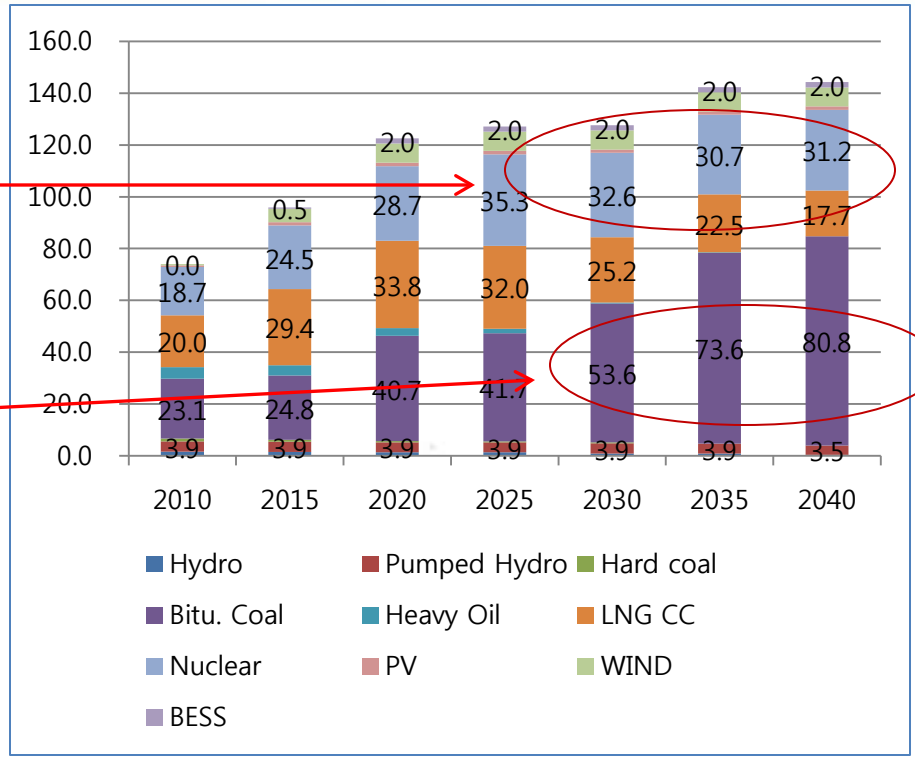
<capacity of power plant in COST scenario >

- BESS could not replace pumped hydro power plant in current price.
- When battery cell price fall, BESS could replace pumped hydro power plant partly from 2035

3. Scenario & Results(3)



<capacity of power plant in BASE scenario >



<capacity of power plant in POLICY scenario >

- Capacity of nuclear and coal power plant in POLICY scenario are lower 1GW(max) and 1.5GW(max) respectively than base scenario

- Capacity of power plant in POLICY scenario is decreased because of 5% increase of coal power plant availability

3. Scenario & Results(4)

➢ Ratio of total discounted system cost

$$= \frac{\text{Total discounted cost of each scenario}}{\text{Total discounted cost of BASE scenario}}$$

Scenario	Ratio of Total discounted system cost
BASE	1
POLICY	0.994
POLCY + COST	0.992

➢ When BESS is used as a frequency controller instead of coal fire plant, total discounted system cost fall from 0.6% to 0.8%

➢ This result shows that even though BESS is deployed for frequency control, electricity price would not be raised.

4. Conclusion

conclusion

- BESS is unable to replace pumped hydro storage, without a price decrease of battery cell

  -> Government subsidy policy would be needed to activate dissemination of BESS in the beginning

- When BESS is used as a frequency controller instead of coal fire plants, electricity price would not be raised and necessary capacity of power plant in the future will be decreased

  -> The installation of BESS for frequency control would be considered proper policy.

Thank you

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