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Market Innovation and Strategies to Secure a Stable Electricity Supply

Jinsoo Kim

HANYANG UNIVERSITY

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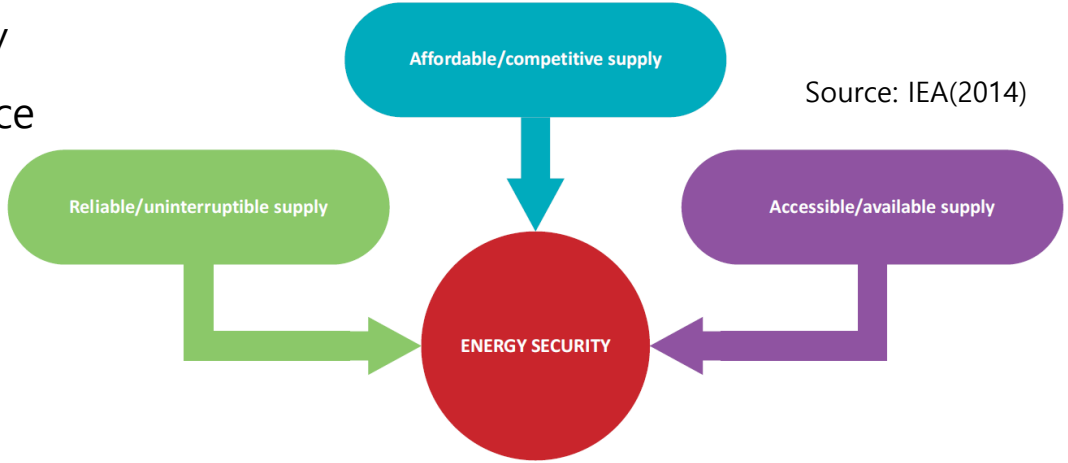
Energy Security Issues

Classical definition

- Availability of a regular supply of energy at an affordable price (IEA, 2001)
- Availability, Accessibility, Affordability, Acceptability (APERC, 2007)



Source: IEA(2014)

- Reliable and adequate uninterrupted supply of energy at reasonable prices (KEEI, 2009)
- Affordability, Reliability, Availability, Sustainability (UK ERC, 2018)

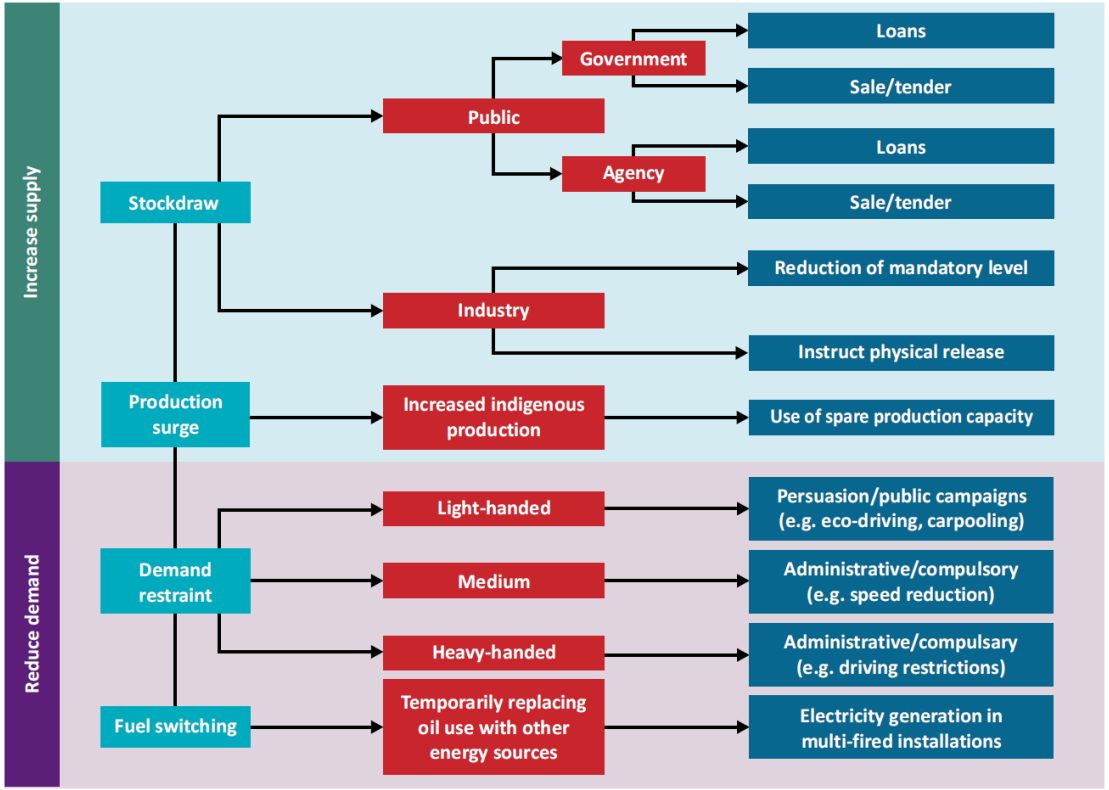
Energy Security Issues

Paradigm changes…

- Climate crisis and energy transition, including transport sector
- Competitive renewable sources
- Oil peak debates and the U.S. – oil and gas exporter
- War and geopolitics
- Critical minerals for energy transition
- Energy resilience: the ability of an energy system to retain, react, overcome and overpass perturbations caused by a shock in economic, social, environmental and institutional terms, coming from the learning capacity to adapt to change (Gatto and Drago, 2020)

Energy Security Issues

Classical options



Source: IEA(2014)

Electricity Security for Korea

Korea is also in the "grand" energy transition

2017	Renewable Energy 3020 Implementation Plan
2019	3rd Master Plan for Energy
2020	Green New Deal
2020	2050 Carbon Neutral Strategy of the Republic of Korea
2021	2050 ROK Carbon Neutrality Scenario

Electricity Security for Korea

The energy world is changing due to…

Carbon Neutrality

- E. transition
- Electrification
- Renewables
- Nuclear
- Sector coupling

GVC change

- Position change of emerging countries
- Division str.
- Protectionism
- Raise of AICBM
- Industry str.

Regionalization

- Geopolitics
- Weaponization of energy
- Hard-to-diversify

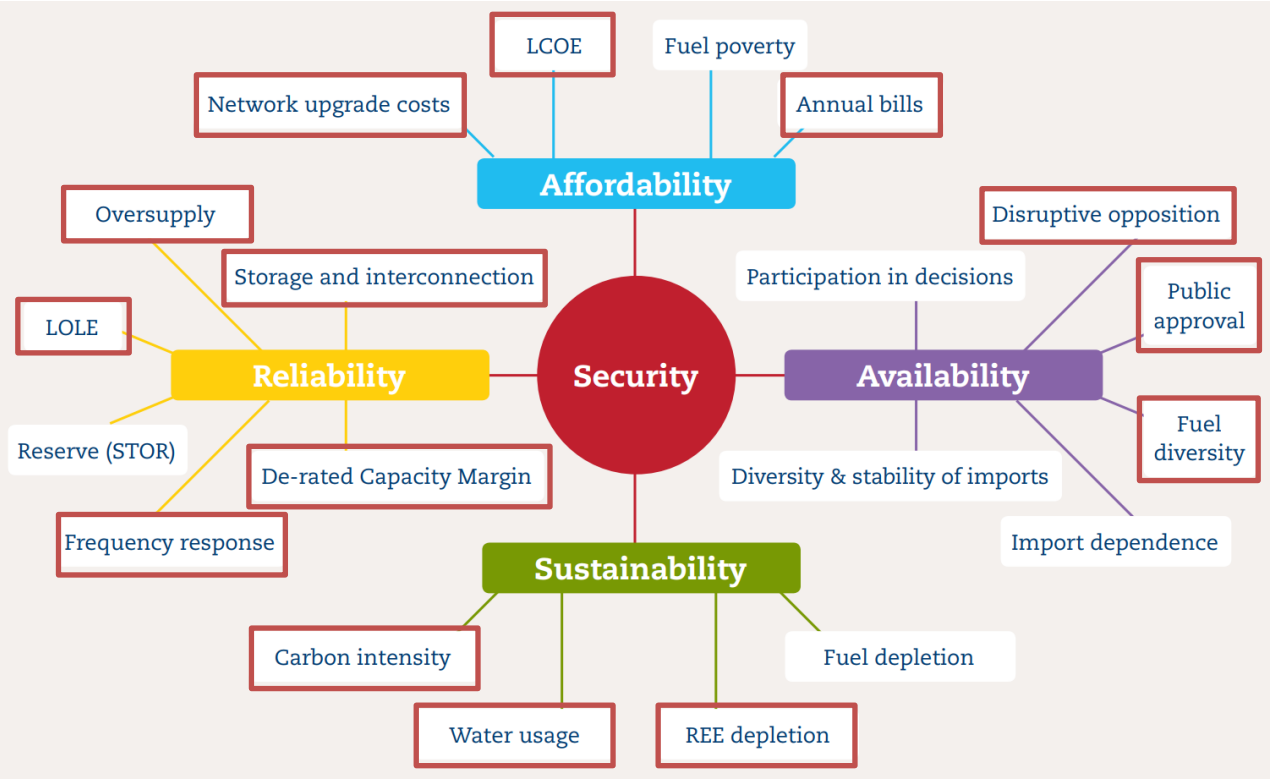
Financing

- ESG management
- Financing condition
- Increased Risk
- Stranded assets

Electricity Security for Korea

Energy & electricity security

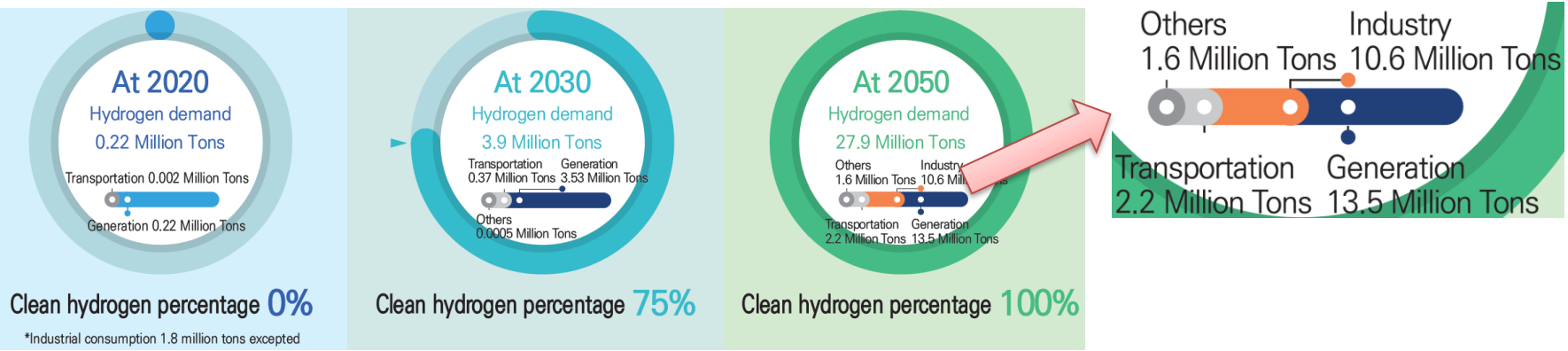
– the UK case



Source: UKERC(2018)

Electricity Security for Korea

Stable hydrogen supply will also matter



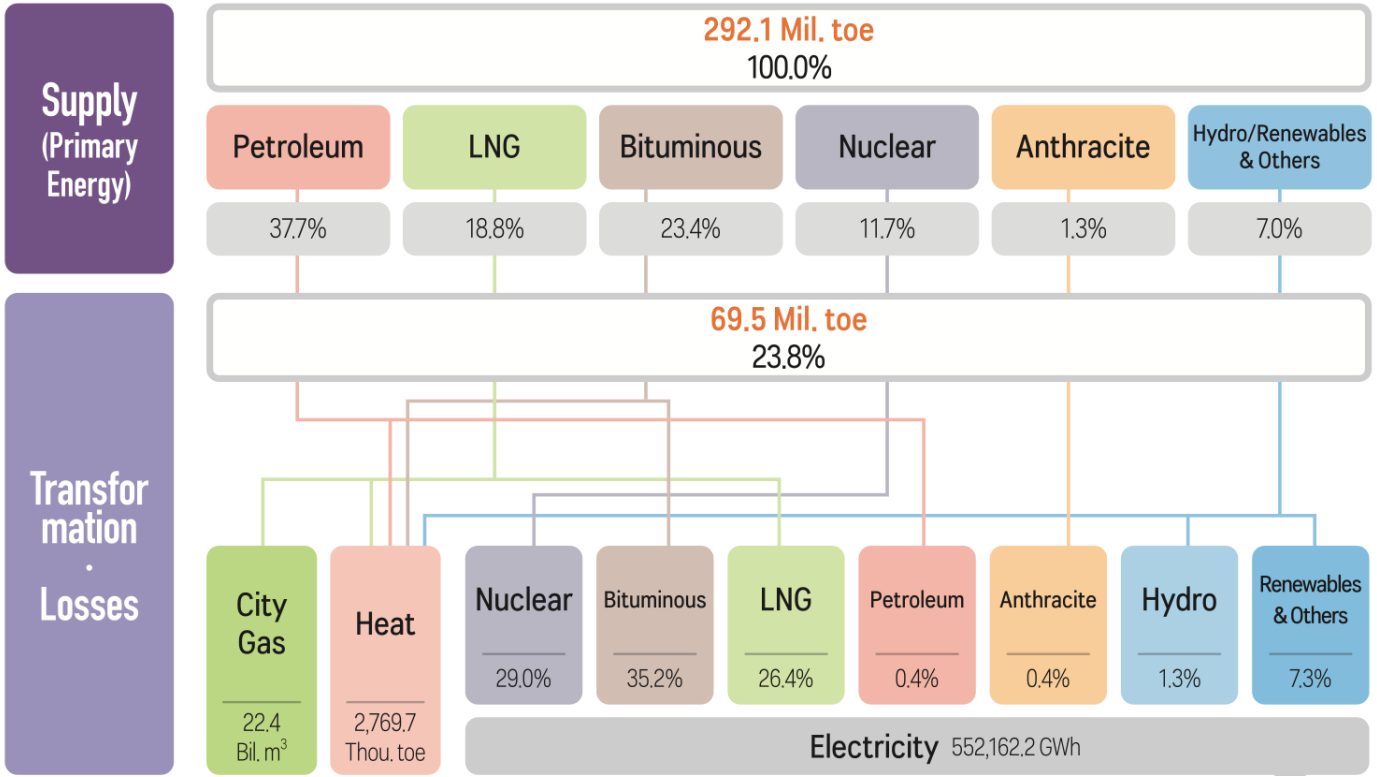
Source: MOTIE(2022)

- Korea will introduce a mandatory clean hydrogen power generation system
- H_2 will account for 33% of energy consumption and 23.8% of power generation

Electricity Security for Korea

[for reference]

Energy supply status of Korea (2020)



Source: KEEI(2021)

Electricity Security for Korea

Security Terms & Definitions (IEA, 2021)

- Operational security
  - The ability of the electricity system to **retain a normal state** or to return to a normal state after any type of event as soon as possible
- Adequacy
  - The ability of the electricity system to supply the aggregate electrical demand within an area **at all times under normal operating conditions**
- Resilience
  - The ability of the system and its component parts to **absorb, accommodate and recover** from both short-term **shocks** and long-term **changes**. These shocks can go beyond conditions covered in standard adequacy assessments

Electricity Security for Korea

Security Terms & Definitions (continued)

- Reliability
  - A metric for the historic or projected availability of electricity supply **within a region under all conditions**
- Robustness
  - The capability of the electricity system to **avoid extreme adverse impact**. Robustness is about avoiding impact, but not necessarily by adapting. Resilience can refer to situations with substantial negative impact, but where the system could overcome this by adaptation
- Stability
  - The property of the electricity system to **maintain the state of operational equilibrium** and to **recover from disturbances** on very short time scales (**a few seconds or less**)

Strategies for a Stable Electricity Supply

Recommended Action Process (IEA)

- Market innovation (update market design)
- Planning / Modernized stability procedures
- Investments – advanced technologies and infrastructure
- Security assessment
- New services / Demand-side management
- The Republic of Korea cannot utilize a powerful option – inter-state connections

Strategies for a Stable Electricity Supply

Market innovation

- Korea: Cost-based pool – centrally planned, regulated electricity market
- Administrative and regulatory decisions in various adequacy mechanisms

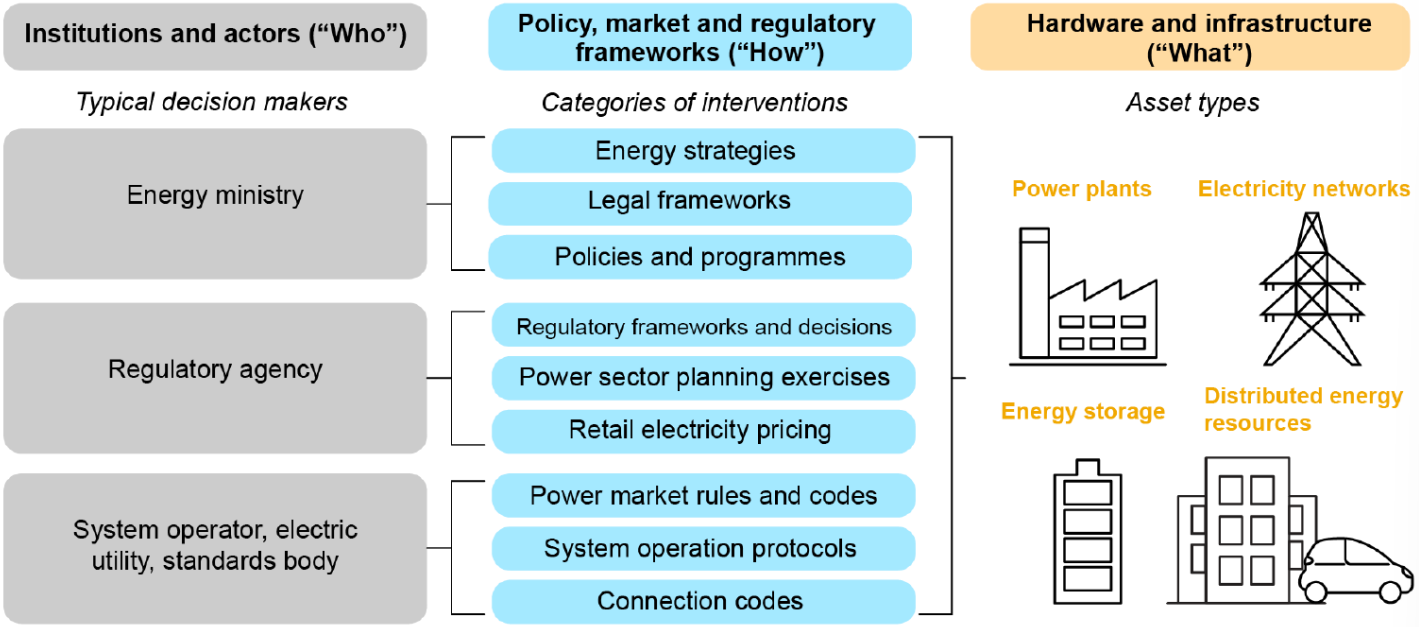
Administrative/regulatory decision	Centrally planned	Energy + centralised capacity market	Energy + decentralised capacity market	Energy only
Reliability standard	•	•	•	•
Energy prices in periods of stress		•	•	•
Level of operating reserves	•	•	•	•
Peak demand forecast	•	•	•	
Defining technologies capable of delivering the product	•	•	•	
Product definition	•	•	•	
Amount of capacity to be procured/capacity demand curve	•	•		
Technology/fuel	•			
Location	•			
Size	•			

Source: IEA(2019)

Strategies for a Stable Electricity Supply

Market innovation

- Update of current market design to provide needed adequacy and flexibility



Source: IEA(2019)

Strategies for a Stable Electricity Supply

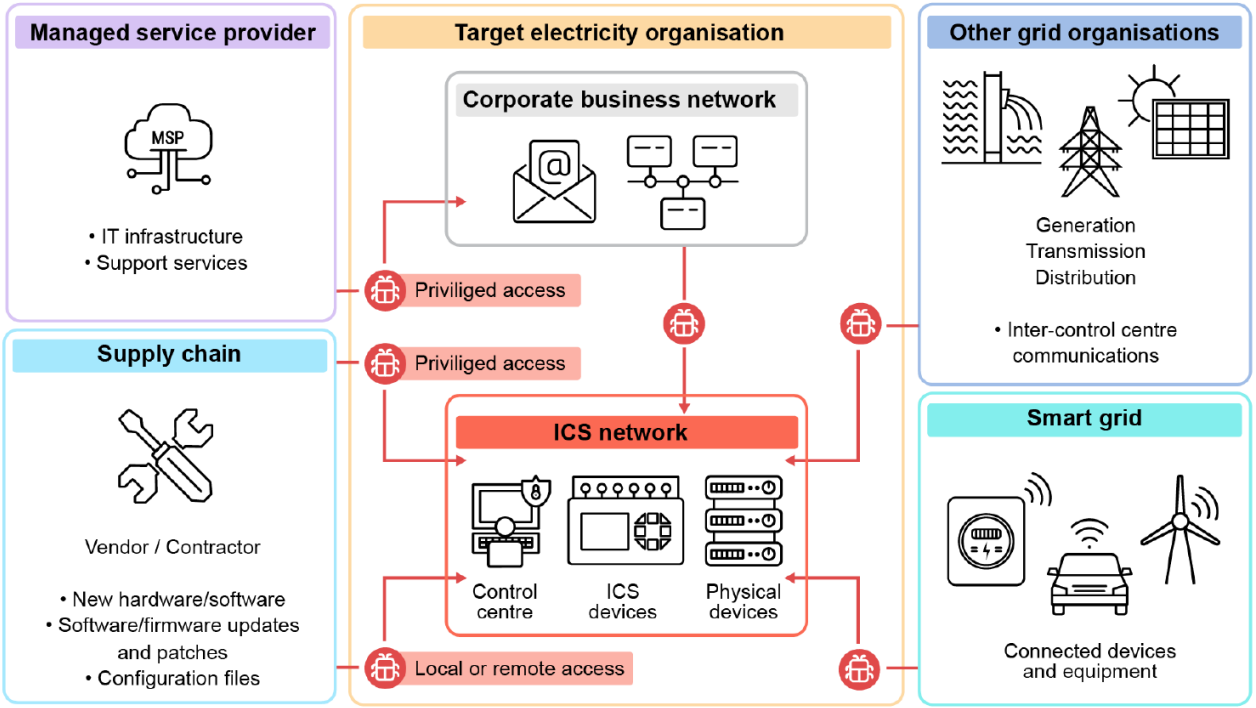
Planning / Modernized stability procedures

- Appropriate innovative solutions in system planning, operation, and services are essential to resolve technical challenges in electricity security
  - Fast frequency response or new infrastructure such as synchronous condensers to handle declining system inertia
- Gas security will become increasingly relevant to electricity security
  - Gas-fired plants will play an expanded role in the provision of adequacy, energy and flexibility in power systems, but the ROK is vulnerable because of the high dependency
- Need to establish the necessary logical steps in the system planning process
  - Review of connection requirements (including grid code revision and mandatory system service), revised operational practices, innovative market-based solutions, adequacy assessments of the impact of decommissioning plants of dispatchable supplies

Strategies for a Stable Electricity Supply

Planning / Modernized stability procedures

- Cyber security will also matter



Source: Canadian Centre for Cyber Security (2020)

Strategies for a Stable Electricity Supply

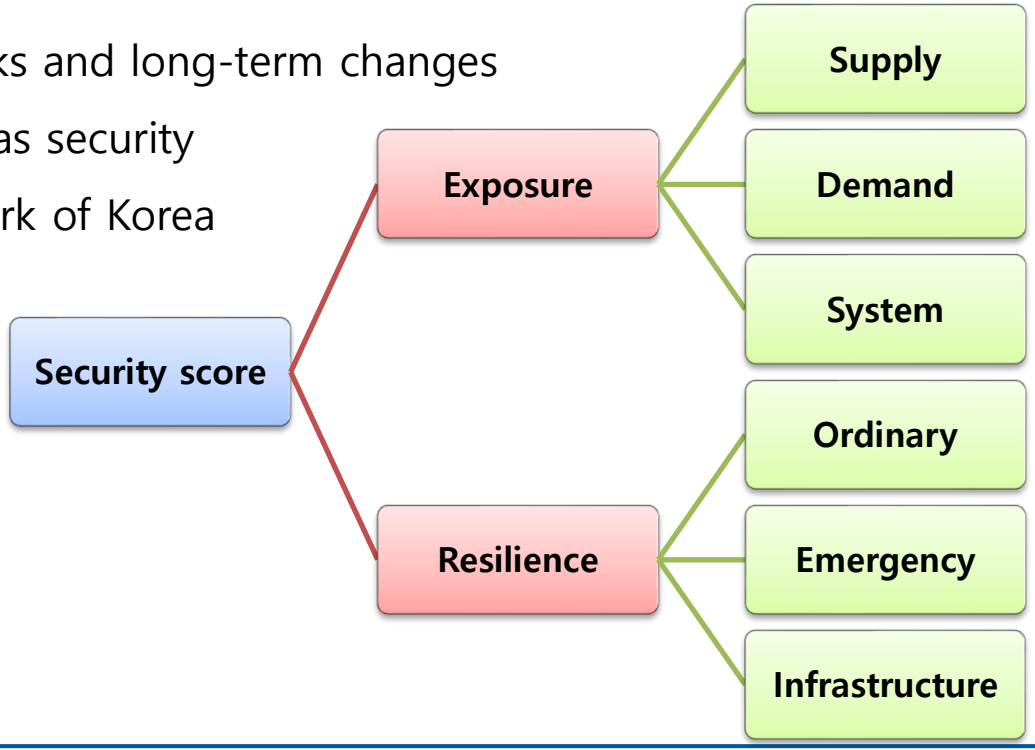
Investments – Advanced technologies and infrastructure

- Korea plans to invest for advanced technologies and grid to secure resilience but…
  - Master plans for electricity supply, smart grid, innovations for carbon neutrality, etc.
- Technologies to provide flexibility and adequacy
  - Storage, interconnections, demand-side response enabled by digitalization, etc.
  - We’ve spent approximately 4-5% of the energy sector’s value added
- Timely investments in networks and flexible resources
  - Including demand side, distributed and storage resources, to ensure that power systems are sufficiently flexible and diverse at all times
- Budget / funding sources are limited
- Grids have long construction lead times and often face social acceptance issues

Strategies for a Stable Electricity Supply

Security assessment

- For short-term shocks and long-term changes
- Example – oil and gas security assessment framework of Korea



Strategies for a Stable Electricity Supply

New services / Demand-side management

- Introducing new services, including auxiliary service, to make the system flexible
- Market and regulatory reforms to better reward all forms of flexibility
- Providing system balancing services
  - Balancing is one of the key processes to ensure security of supply – it will become more complex and interdependent
  - Market-based mechanisms to provide the cost-competitive services that allow for more dynamically managed system requirements (reserve quantity & short pricing intervals)
- Promoting demand-side management programs
  - General DR, public DR, plus DR, etc.

Thank you for your attention