Advanced Grid Modelling (AGM) Center for Korea's Energy Transition:

Building an Open Analytical Foundation for Decarbonization

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KENTECH
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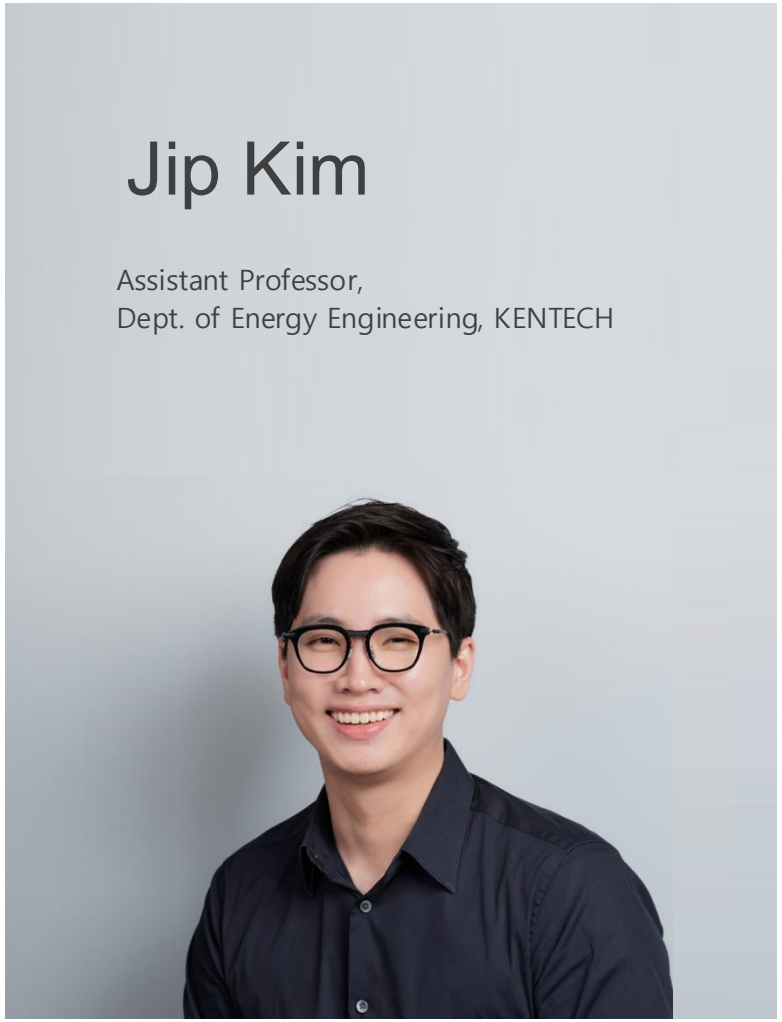
About me



Experience

- Director, Advanced Grid Modelling (AGM) Centre, KENTECH, 2025-present
- Assistant Professor, Dept. of Energy Engineering, KENTECH, 2022-present
- Postdoctoral Research Scientist, Dept. of Electrical Engineering, Columbia University 2021-2022

Education

- Ph.D. in Electrical Engineering, New York University, 2021
- M.S. in Electrical Engineering & Computer Science, Seoul National University, 2014
- B.S. in Electrical & Electronic Engineering, Yonsei University, 2012

Main Activities

- KEPCO Grid Modernization Forum Committee Member, 2024-present
- KIEE Planning Policy Committee Member, 2023-present
- KIEE Active Distribution System and DER Working Group Member, 2023-present
- KPX Real-time Unit Commitment Advisory Board Member, 2023-present
- KPX Energy and Future Research Committee Member, 2023-present
- NEXT Group Advisory Board Member , 2022-present
- IEEE Power & Energy Society Member, 2012-present

Korea's Ambitious Renewable Target by 2030

- Ministry of Climate, Energy and Environment established on October 1st, 2025
  - Objective: to integrate climate and energy policies and accelerate Korea's energy transition
  - The ministry set a national target of **100GW of renewable energy capacity by 2030**
- However, Korea's rapid renewable expansion is outpacing grid infrastructure capacity

Fig. Government's 100GW renewable energy target announcement [1]

Fuel type	GW
Coal	40.22
LNG	46.33
Nuclear	26.05
Pumped hydro storage	4.70
Solar	27.10
Wind	2.24
Hydro	1.80

Table. Power capacity of Korea (2024) [2]

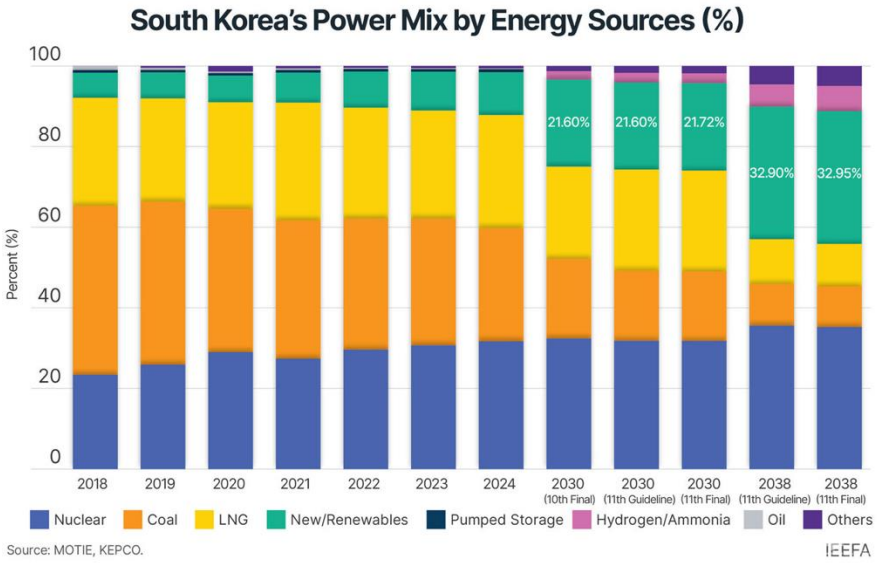


Fig. Korea's capacity mix by energy sources (2018-2038) [3]

[1] Chosun Biz. https://biz.chosun.com/en/en-policy/2025/10/01/GUAYQBRTSNC4TPWNP4DM3XLP44/
[2] KPX, EPSIS. https://epsis.kpx.or.kr/epsisnew/selectEkpoBftChart.do?menuId=020100
[3] IEEFA. https://www.electimes.com/news/articleView.html?idxno=353343

Critical Barriers in Energy Transition

- **Transmission Expansion Bottleneck**
  - Chronic delays and social resistance hinder timely grid reinforcement, worsening congestion and renewable curtailment
- **Declining System Inertia and Stability Challenges**
  - Growing shares of inverter-based renewables reduce rotational inertia, threatening system stability and increasing cascading failure risks
- **Politically-driven Planning System**
  - Planning prioritizes political interests over a balanced consideration of economics, reliability and environmental sustainability in power supply
- **Outdated Electricity Market Structure**
  - The cost-based pool system fails to reflect true value and price signals, limiting investment and innovation

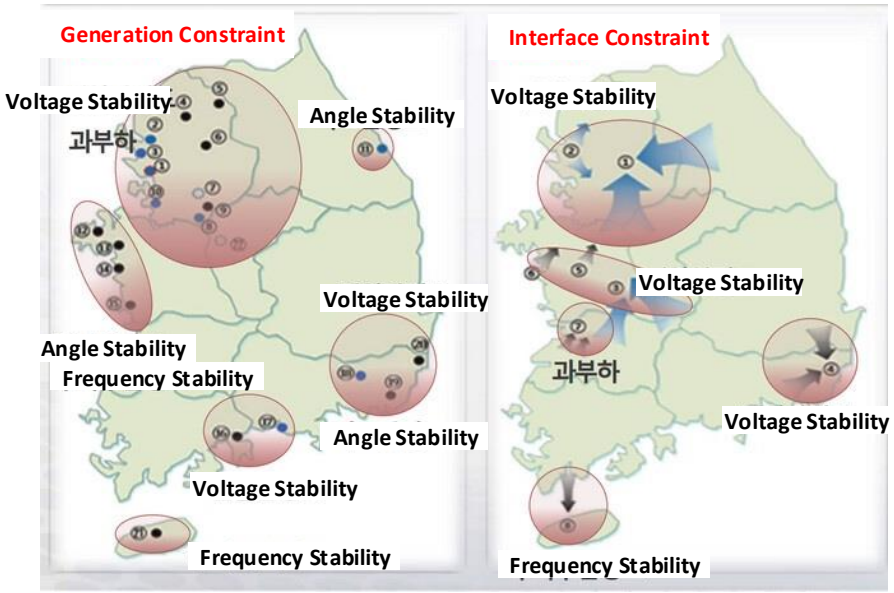


Fig. Korea's system constraints [4]

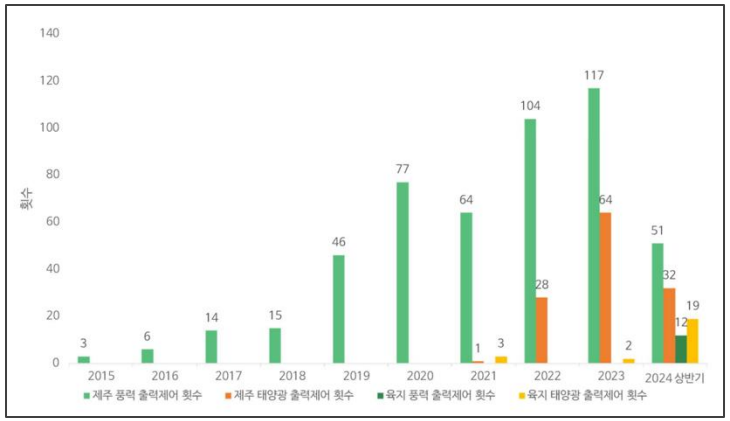
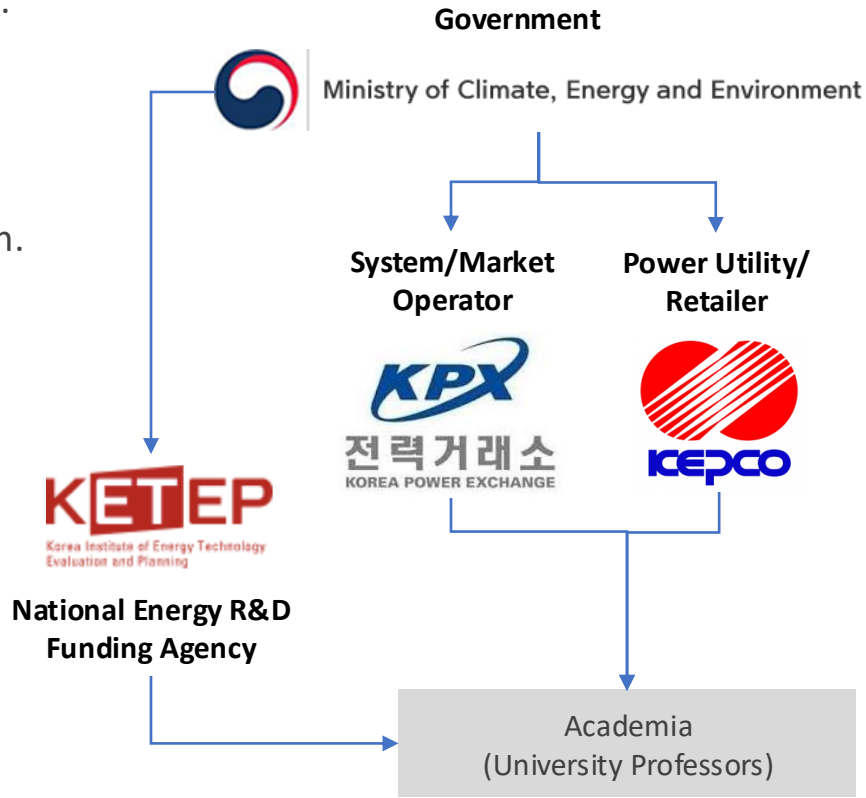


Fig. Korea's wind and solar curtailment events. Jeju wind (green), Jeju solar (orange), Mainland wind (dark green), Mainland solar (yellow) [8]

[4] E2news. https://www.e2news.com/news/articleView.html?idxno=308987
[5] E2news. https://www.e2news.com/news/articleView.html?idxno=251084

Why model-based, data-driven decision-making remains difficult in Korea?

- Fragmented and Episodic Decision-Making
  - Policy decisions are often made through **ad-hoc working groups**, formed temporarily when issues arise.
  - **No permanent analytical body** or open repository exists to ensure continuity of knowledge.
  - Each new administration reconstitutes committees, resetting discussions.
- Lack of Transparency and Open Data
  - Analytical results and grid data are **not publicly accessible**, limiting independent verification.
  - Stakeholders — even researchers — cannot trace how decisions were made.
  - As a result, **trust and technical accountability** remain low.
- **Incentive-Driven Expert Ecosystem**
  - Professors and experts are often invited based on **alignment with policy preferences**, not methodological rigor.
  - **Disagreement discourages future participation** in committees or project funding.
  - This dynamic weakens the role of academia as a **neutral analytical voice**.



▶ ***Current decision structure: ad-hoc, closed, and non-reproducible.***

Advanced Grid Modelling (AGM) Centre's Mission

Empowering Korea's energy transition through
open-source grid modelling and ***collaborative stakeholder engagement***




Advanced Grid Modelling (AGM) Centre

- Founded on May 20, 2025
- AGM Research Centre addresses technical and market barriers through:

Advanced & Reproducible Modelling

- Mathematical representation of grid physics and market structure with DERs
- Modelling VRE uncertainty with Probabilistic Modelling
- Enabling reproducibility by using open data and transparent methodology

Open Discussion between Stakeholders

- A hub for fostering dialogue and collaboration among diverse stakeholders
- Aim to facilitate shared understanding and meaningful exchanges between the system operator (KPX) and the sole power utility (KEPCO)

Professional Education for Practitioners

- Training programs tailored to the needs of key stakeholders (KPX, KEPCO)
- Offer public online tutorials regarding
  - Power system modelling
  - Electricity Market
  - Open-source models of AGM Centre

Why Academic Institutions are Essential for Model-Based Energy Policy

- **Academia as a Neutral Analytical Ground**
  - Academic institutions are **free from market or political interests**, providing a **trusted and balanced space** for discussion.
  - We can host **model-based, fact-based dialogues** among utilities, system operators, regulators, and civil society.
  - This neutrality allows **stakeholders to exchange evidence**, not positions — essential for rational policymaking.

- **About Korea Institute of Energy Technology (KENTECH)**
  - Foundation: May 21, 2021
  - Established under the **Special Law of the Korean National Assembly** to lead the nation's clean-energy transition through technology, policy, and innovation.
  - The **first university solely dedicated** to energy research and technology.

Fig. KENTECH campus

- **Institutional Strength for AGM Research Centre**
  - Embedded within KENTECH's energy transition ecosystem, enabling **active engagement with policymakers and energy stakeholders**
  - Supported by **strong research networks with national institutes and industry**, driving open collaboration and grid innovation
  - Along with **KENTECH's model-based and data-driven research culture**, promoting rigorous and reproducible energy system analysis

Advanced Grid Modelling (AGM) Research Centre

- Our Vision
  - *"An **open platform** where reproducible grid analysis shapes the path toward a sustainable and resilient power system."*

- Our Goal
  - Advance power system analysis and modelling capabilities across Korea's energy sector
  - Bridge collaboration among policymakers, industry, and academia
  - Build a modelling-based cooperative ecosystem

- What we do
  - We provide **open, reproducible** test systems & power system models
  - We provide **open Discussion Hub** for grid stakeholders
  - We provide **tutorials** on power system modelling and electricity market

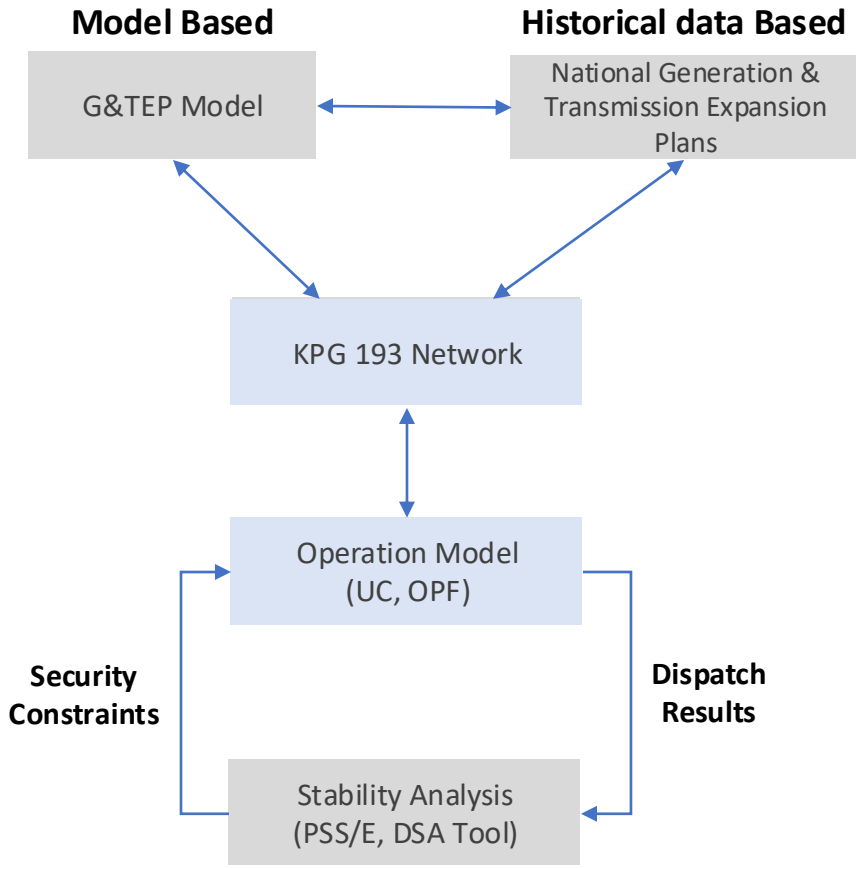


Fig. Open-source model overview

AGM Centre Framework: From Open Models to Public Engagement

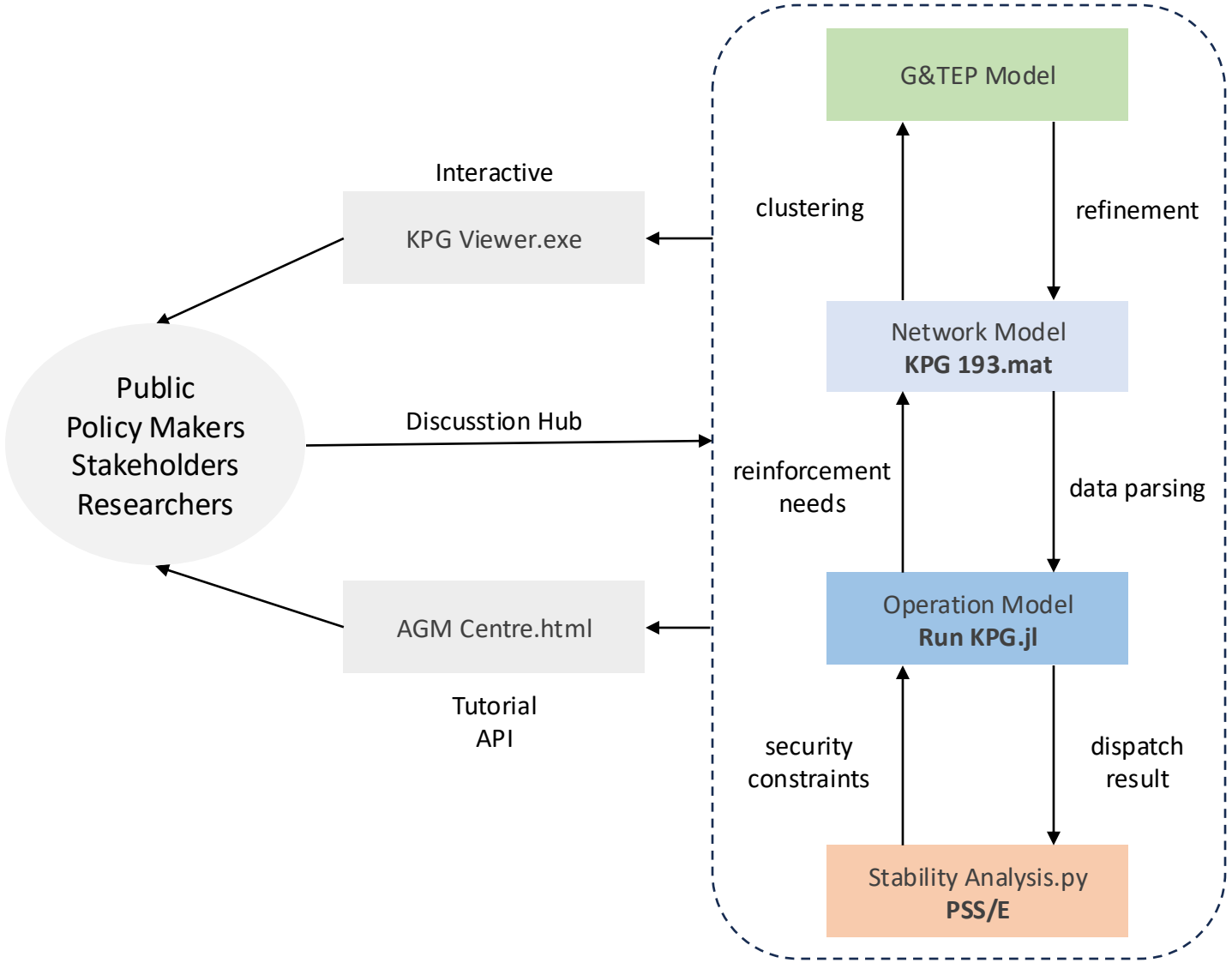


Fig. AGM research centre framework

Development of Open-source Models

- **Korean Power Grid (KPG) 193 test system**
  - A synthetic test system of the 2022 Korean power system
  - Based **only on publicly available data**
  - Provides comprehensive datasets for power system analysis:
    - KPG 193 network(Ver 1.4) comprises
      1. 193 buses
      2. 122 conventional generators
      3. 359 transmission lines
    - Renewable generation capacities
    - 8760-hour profiles for demand and renewables
  - Capacity Mix of KPG 193

	Coal	LNG	Nuclear	Solar	Hydro	Wind	Total
Capacity [GW]	38.13	41.20	24.65	23.75	7.20	1.65	136.57
Share [%]	27.9%	30.2%	18.0%	17.4%	5.3%	1.2%	100%

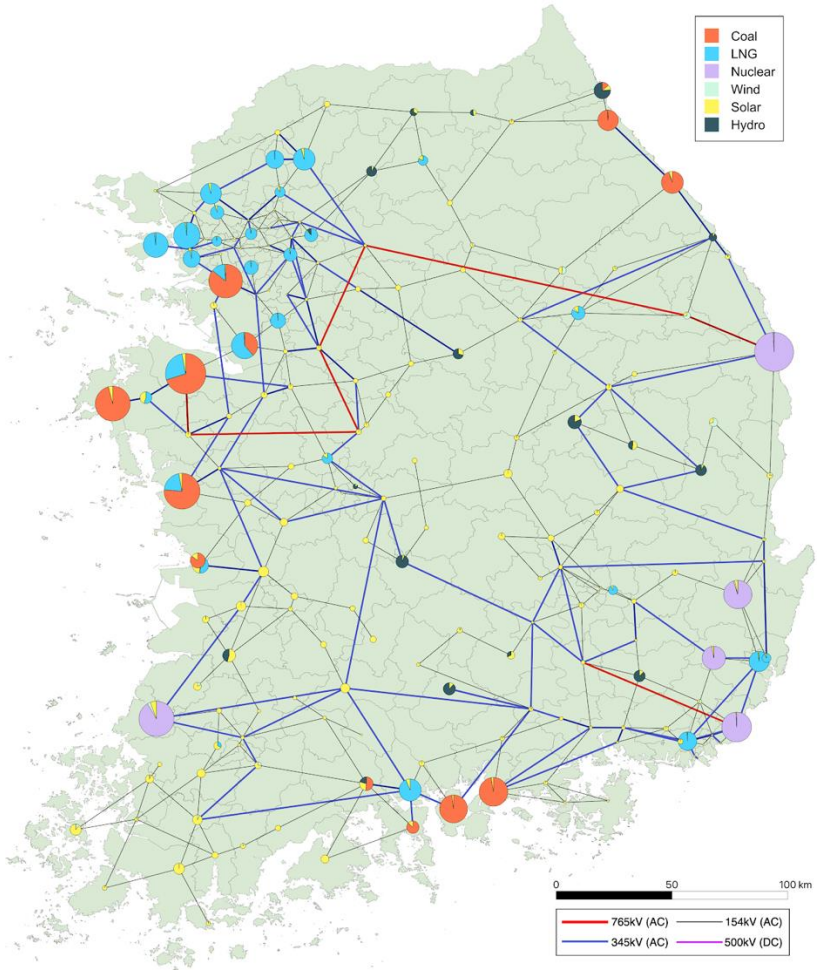


Fig. Network topology and generation mix for KPG 193. Pie charts indicate the generation mix by fuel type, with sizes reflecting relative generation capacities

Development of Grid Models

- **Power system operation model**
  - Cost-effectively optimizes generators' schedules (on/off status) and dispatch decisions, while ensuring grid reliability
  - Key models:
    - ED (Economic Dispatch)
    - UC (Unit Commitment)
    - OPF (Optimal Power Flow)

- **(2025.09.24) Grid Modelling Collaboration Day with NEXT group**
  - Discussed alignment of KPG 193 and NEXT's OPEN model under "OPEN Grid Initiative"
  - Significance
    - First collaborative effort to establish integrated national power system modelling in Korea
    - Discussed model integration, public accessibility and dfd to ensure transparency and sustainability
    - Set the foundation for joint validation and comparative studies between planning and operational models

Fig. Grid modelling collaboration day

Strategic Partnership and Stakeholder Engagement

- **(2025.06.30) Strategic MOU with Korean Electric Power Corporation (KEPCO)**
  - Partnership with KEPCO's Division for National Transmission Expansion Planning
  - Key Commitments under the MOU
    - Receive practical feedback from KEPCO engineers on open-source models and analytical results
    - Access non-confidential grid data for model verification and refinement
    - Facilitate active participation of KEPCO practitioners in workshops and Discussion Hub

Fig. KEPCO-KENTECH MOU Signing for AGM Research Centre

- **(2025.10.16) Discussion Hub with KEPCO**
  - Shared the advancement of the KPG 193 model and discussed future development direction
  - Significance
    - KEPCO recognized open-source models as an platform for transparent discussion
    - Confirmed KEPCO's preference for trend-based analysis and periodic public insights

Fig. AGM Research Centre Discussion Hub

Major Activities for the Remaining Project Period

- **Empowering practitioners through education (Q4 2025, Q1 2026)**
  - Provide professional power system modelling and electricity market education to utilities, system operator and researchers
  - Provide publicly accessible model, online tutorials and educational contents to foster broad participation in open-source grid modelling

- **Online showcasing and publication (Q1 2026)**
  - Publish a comparative report between open-source and commercial tools to inform stakeholders on performance and transparency
  - Launch an online exhibition presenting practical use cases with interactive and replicable examples

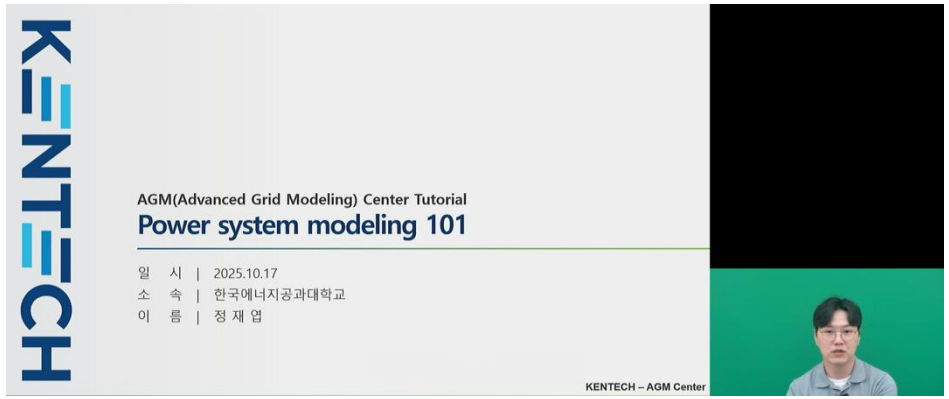


Fig. Online tutorial

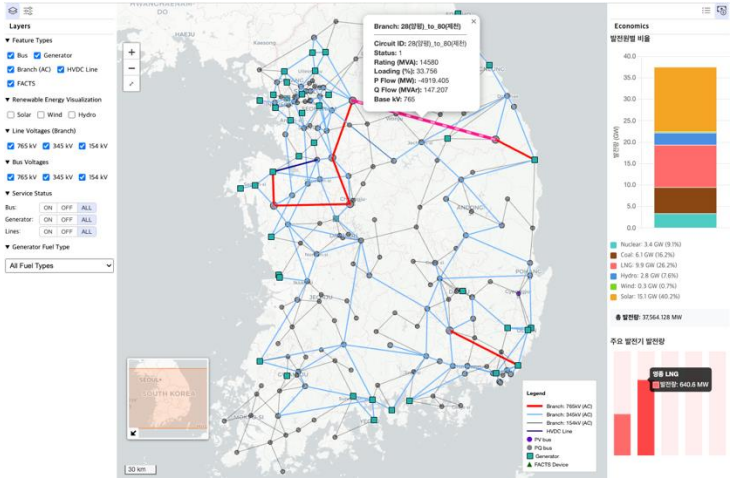


Fig. Viewer app: ViewKPG

Next Steps and Roadmap

- **Building an integrated modelling ecosystem**
  - Develop multi-layered models by region and analysis domain (Planning / Operation / Stability)
  - Ensure data interoperability across planning, operation, and stability analysis models
  - Establish a standardized simulation and data environment for reproducible analysis

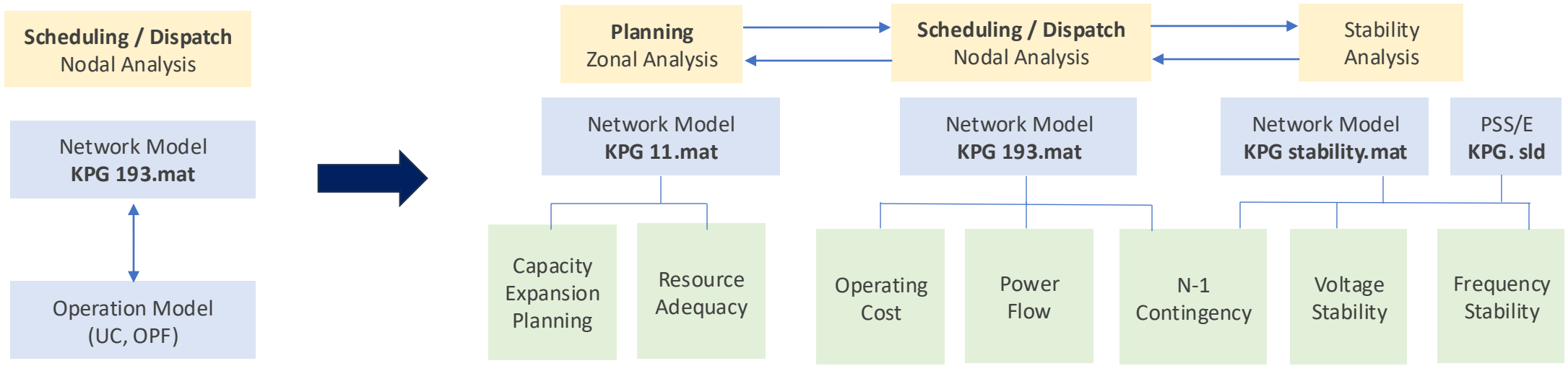


Fig. Roadmap for integrated grid modelling framework

Next Steps and Roadmap

- **Korean Grid Annual Analysis**
  - Publish annually to present quantitative trends in Korea's power system operation and planning
  - Based on publicly available data to ensure policy-neutral and transparent analysis
  - Building a common analytical ground for industry, academia and policymakers
  - Topic Examples :
    - Grid stability trends under increasing renewable penetration
    - Regional electricity price dynamics under different market structures (LMP/SMP)

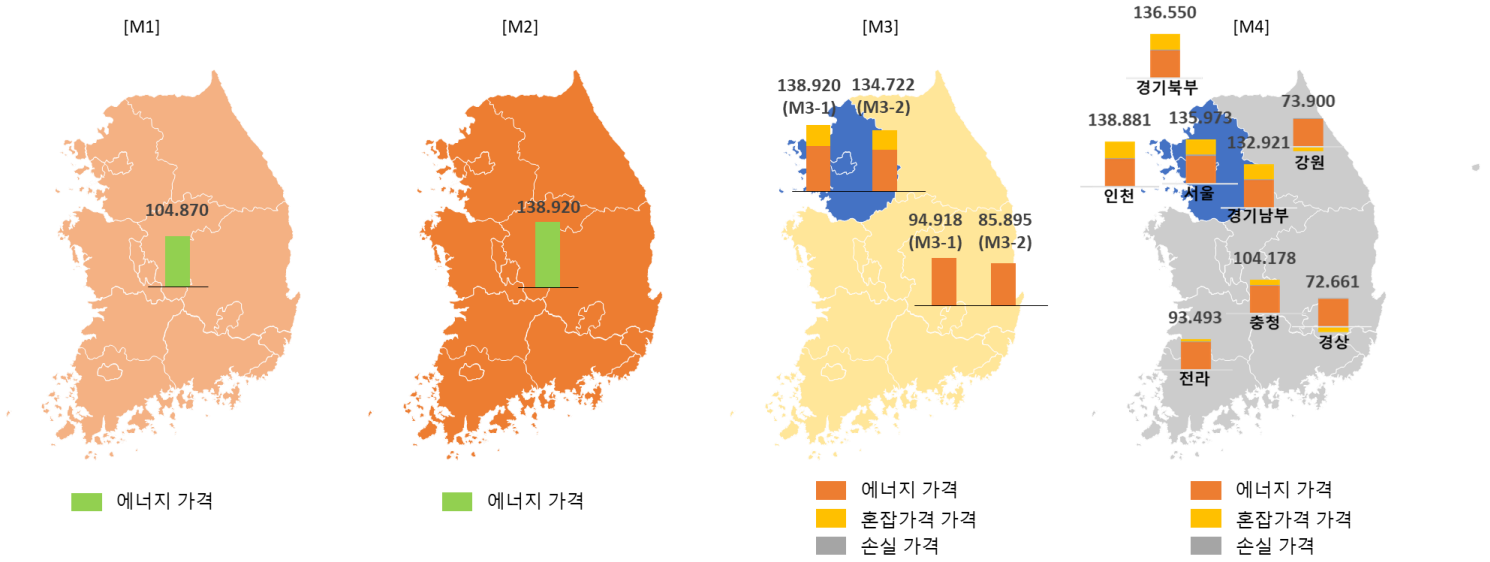


Fig. Regional electricity price under SMP (left) and LMP (right)

Next Steps and Roadmap

- **Power system planning model**
  - Development of transmission expansion planning & generation expansion planning models
  - Methodological groundwork for long-term transmission planning
    - Referencing international long-term power system planning practices (e.g. FERC Order 1920, DOE National Transmission Planning Study)
    - *Cf.* FERC Order 1920 mandates a 20-year regional transmission planning horizon, integrating regional, interregional and local planning

Year	OPEN-EGO model development scope	
Year 1	**Power system operation**	• Economic Dispatch (ED) • Optimal Power Flow (OPF) • Unit Commitment (UC)
Following years	**G&TEP**	• Generation Expansion Planning (GEP) • Transmission Expansion Planning (TEP) • +α

Table. Scope of OPEN-EGO Model Development

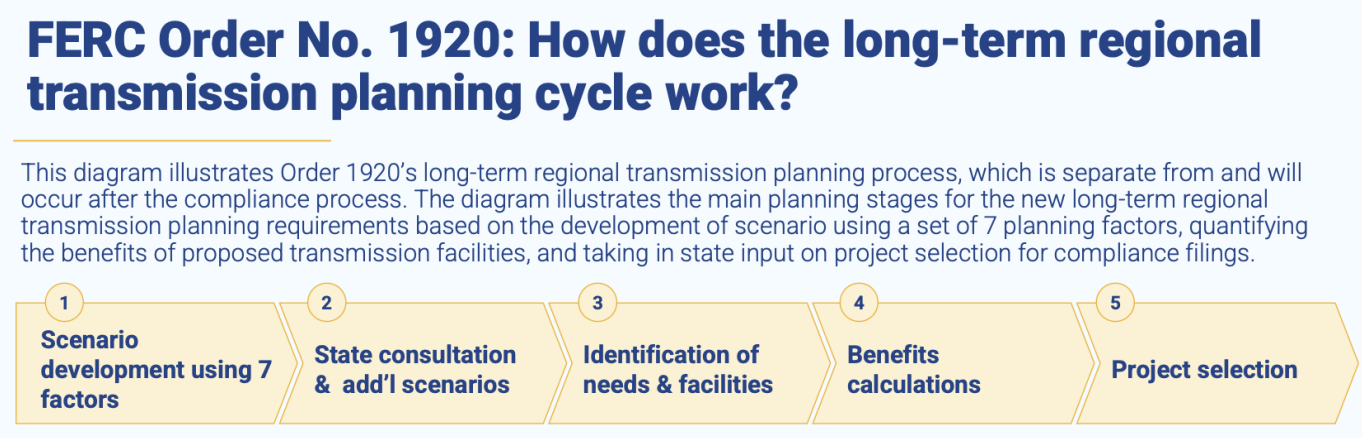


Fig. FERC Order 1920's long-term regional transmission planning process [10]

[10] GridStrategies

Thank you
for your attention!

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