Advanced Grid Modeling Workshop 2025

Open Grid Initiative (OGI) & KPG Platform

Building an Open Analytical Foundation for Decarbonization

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About me

Jip Kim

Assistant Professor,
Dept. of Energy Engineering, KENTECH

Experience

- Director, Advanced Grid Modeling (AGM) Center, 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

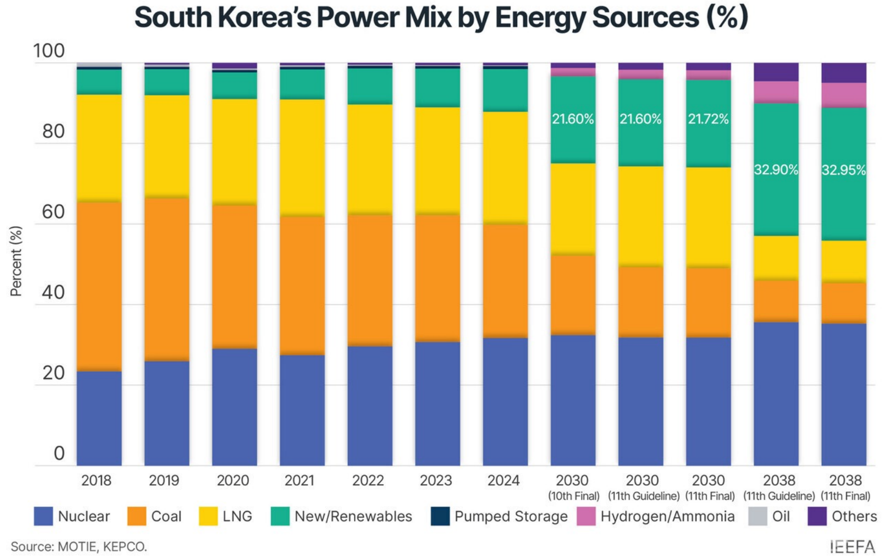

Kim Seong-hwan vows expand renewable energy to 100GW and enact Carbon Neutral Industry Act

By Ahn So-young
Updated 2025.10.01. 13:41

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

Power capacity of Korea (2024) [2]



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

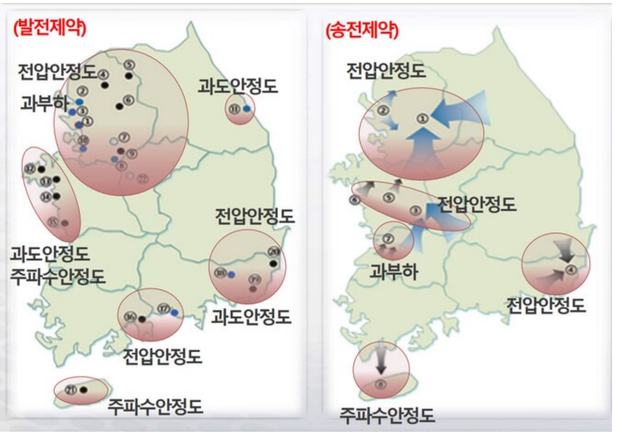
- Growing shares of inverter-based renewables reduce rotational inertia, threatening system stability and increasing cascading failure risks

Politically-driven Planning System

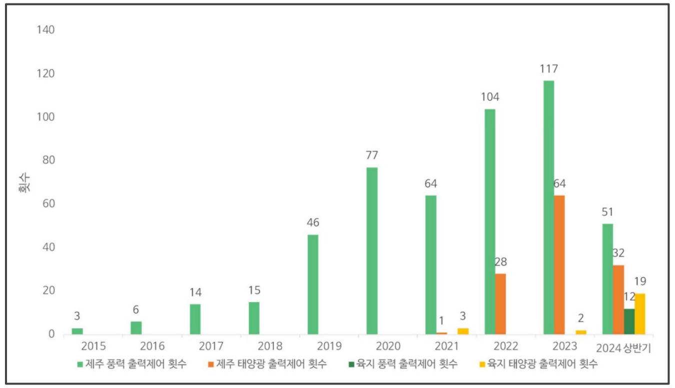
- Planning prioritizes political interests over a balanced consideration of economics, reliability and environmental sustainability in power supply

Outdated Electricity Market Structure

- The cost-based pool system fails to reflect true value and price signals, limiting investment and innovation



Korea's system stability constraints [4]



Korea's wind and solar curtailment events - Jeju wind (green), Jeju solar (orange), Mainland wind (dark green), Mainland solar (yellow) [5]

Advanced Grid Modeling (AGM) Center's Mission

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

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

Advanced Grid Modeling (AGM) Center

Founded on May 20, 2025

: AGM Center addresses technical and market barriers through

Advanced & Reproducible Modeling

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

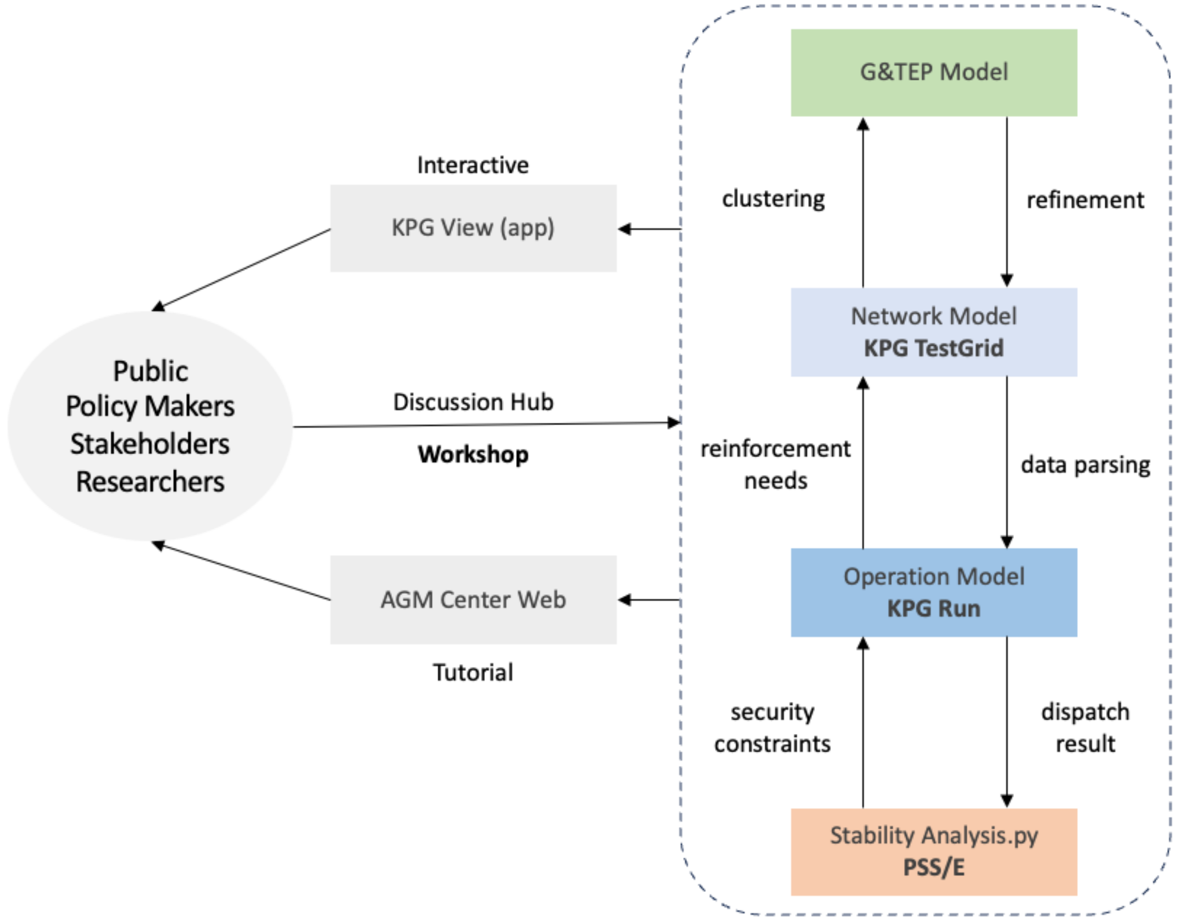
Open Discussion between Stakeholders

- 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 modeling
  - ✓ Electricity Market
  - ✓ Open-source models of AGM Center

KPG Platform: From Open Models to Public Engagement



Korean Power Grid (KPG) platform framework

Part 1.

KPG TestGrid

Development of Open-source Models

Korean Power Grid (KPG) 193 Test Grid

- 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 (ver1.5) comprises

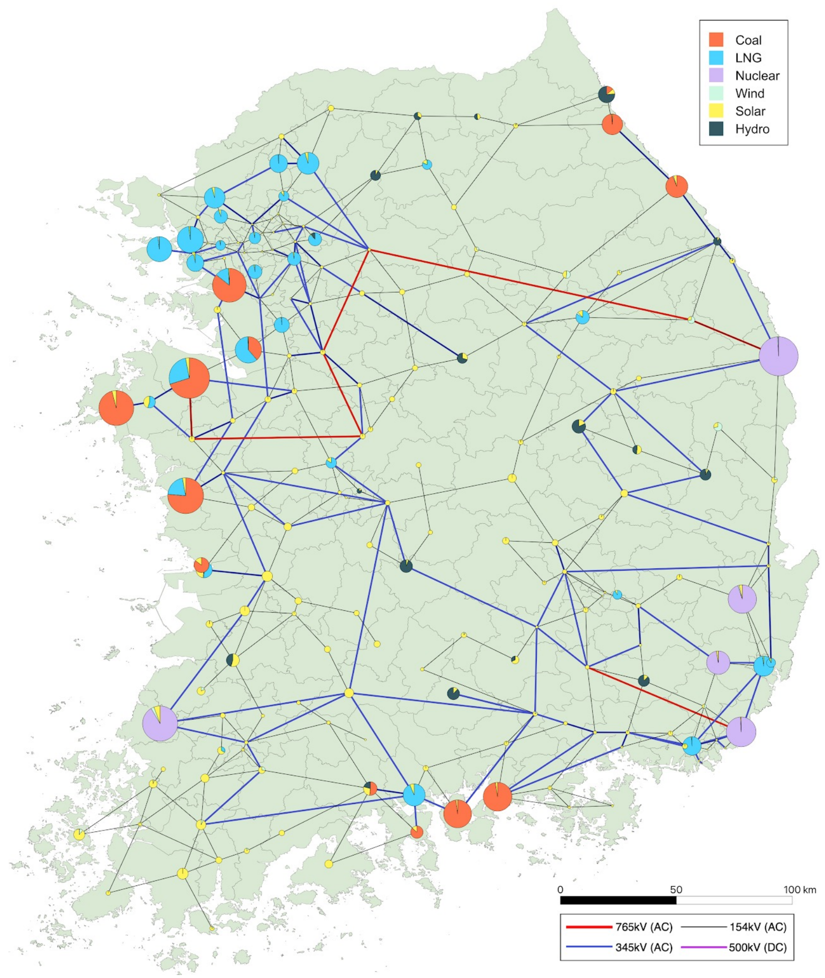
1. 193 buses
2. 122 conventional generators
3. 359 transmission lines

Renewable generation capacities

8760-hour profiles for demand and renewables

- Capacity Mix of KPG 193

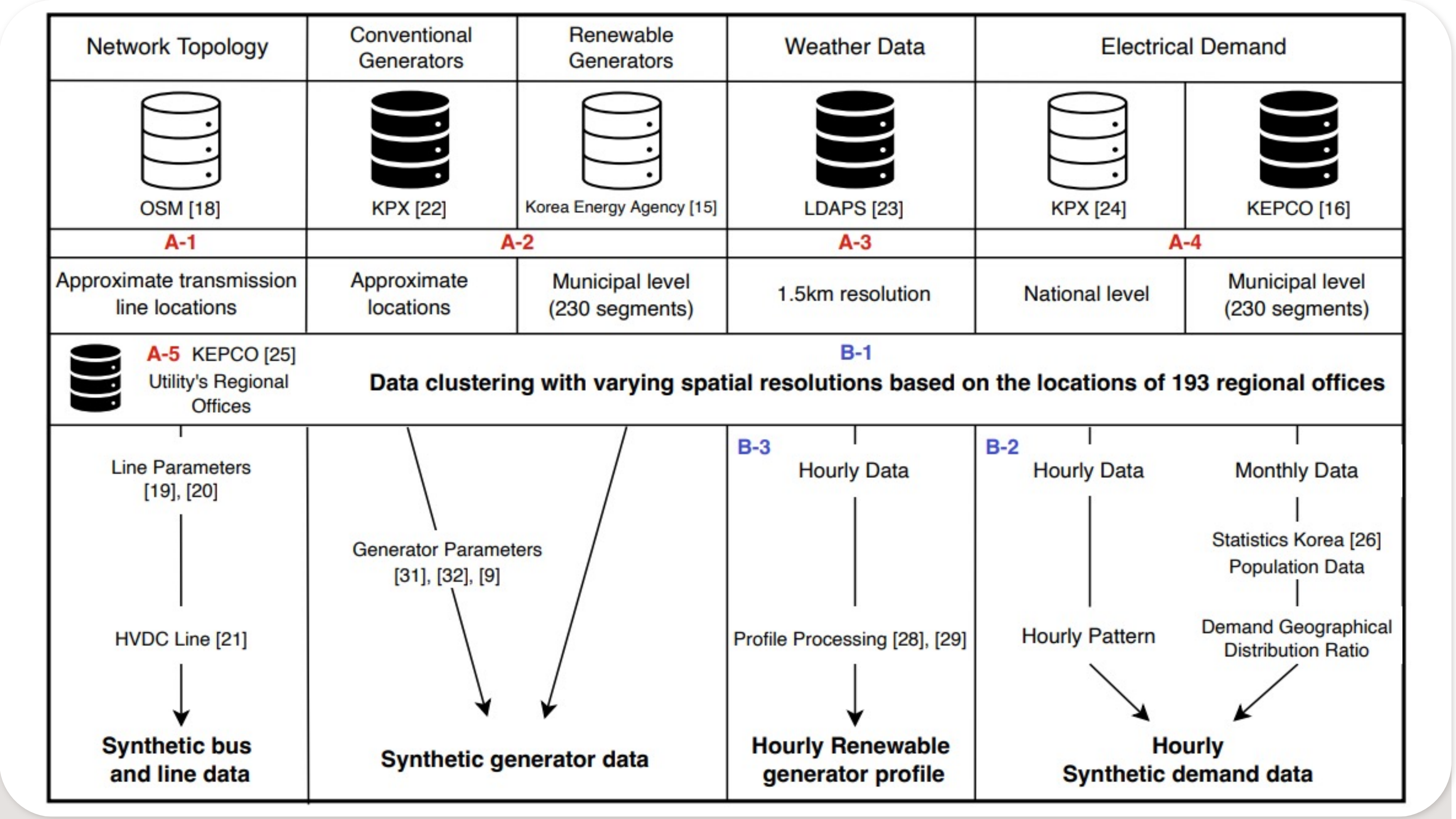
	Coal	LNG	Nuclear	Solar	Hydro	Wind	Total
Capacity [GW]	38.13	41.20	24.65	23.75	7.20	1.65	136.57
Share [%]	27.9%	30.2%	18.0%	17.4%	5.3%	1.2%	100%



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 Open-source Models

Four stages for open-source power system modeling for Korea

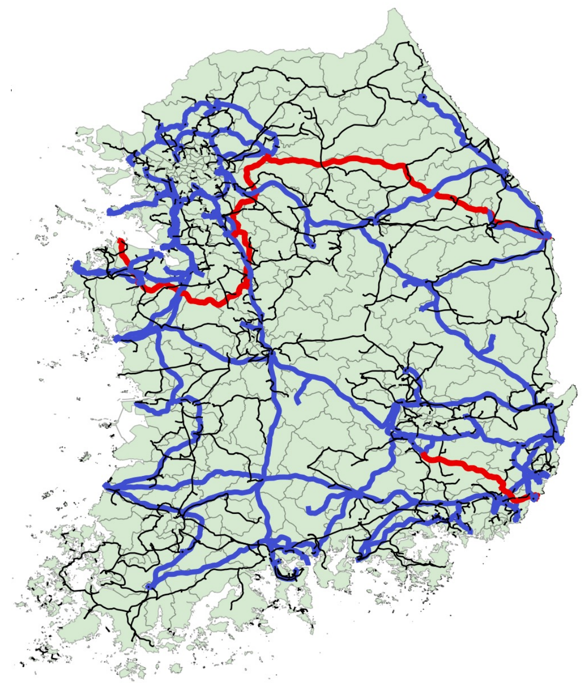


Workflow for developing the KPG 193 test system with data sources and processes for modeling network topology, generator parameters, weather data, and electrical demand

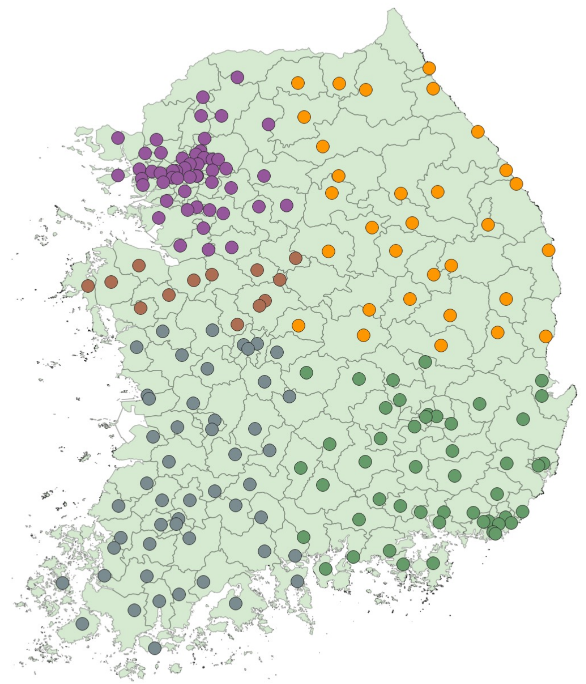
1. Data Collection
2. Data Clustering
3. Data Enrichment & Processing
4. Validation

Development of Open-source Models

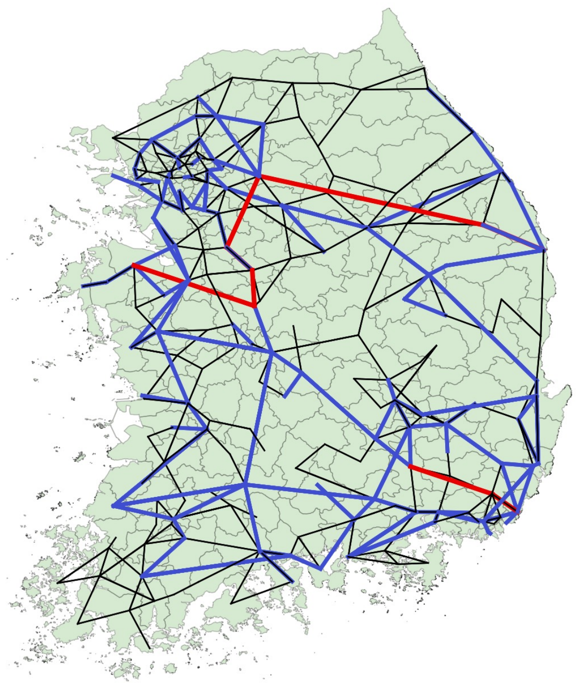
- The regional offices serve as buses in the power grid
- The endpoints of power lines and cables and conventional generators were clustered to the nearest bus
    - ✓ Generator capacities were divided into standard generator units (e.g., 500MW, 600MW, etc.)



Open Source Data
(e.g. Open Street Map)



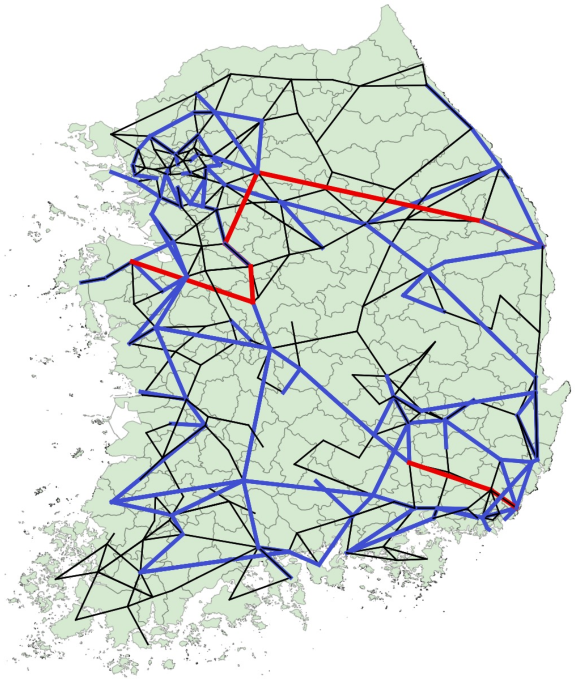
Utility's Regional Office
(less sensitive information)



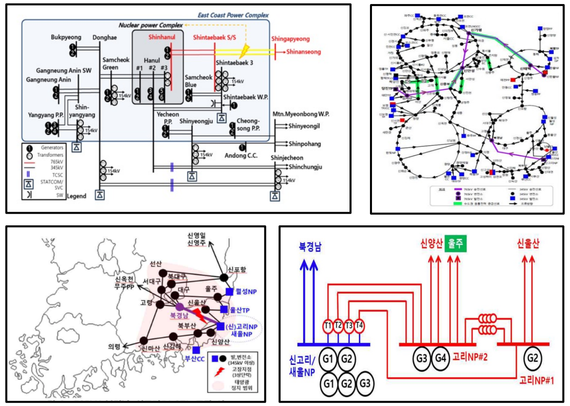
Clustered Grid
(193 bus test system)

Development of Open-source Models

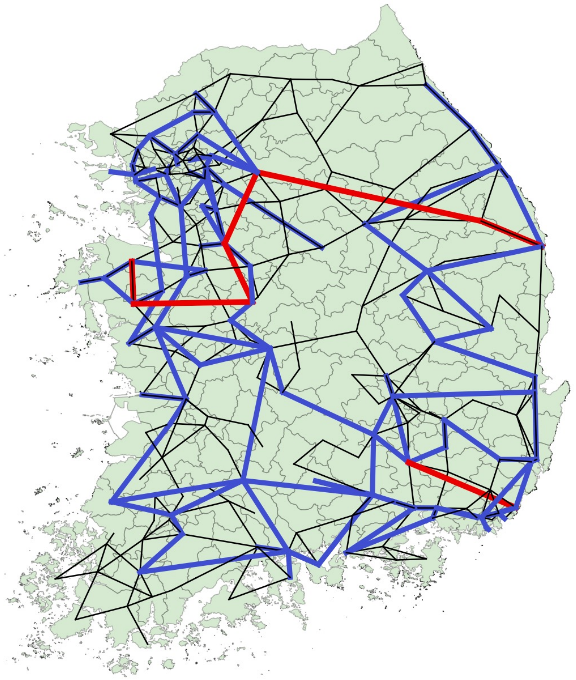
- There is no official public source for the complete network topology of the Korean power system
  - ✓ Instead, we collected academic papers related to the national power system
  - ✓ These references were used to validate and enhance the topology of the KPG 193 test system



Clustered Grid



Topology References
(Conference and Journal Papers. [6]-[9])



Topology-Refined Grid

[6] Kim et al. (2024). Analysis and Operation Strategy of Energy Storage Systems for Mitigating Generation Constraints of Non-Tripped Units under System Protection Scheme (SPS) Conditions.The Transactions of the Korean Institute of Electrical Engineers (KIEE),
[7] Kwon et al. (2024). Inter-Regional Power Flow Analysis and Tool Development for Long-Term Future Grid Using DC Power Flow.The Transactions of the Korean Institute of Electrical Engineers (KIEE)
[8] Kim et al. (2024). Stability Measures for the Yeongnam Region Considering the Construction of Saeul Units 3 & 4 and Continued Operation of Kori Units 2-4. Proceedings of the Korean Institute of Electrical Engineers (KIEE) Summer Conference
[9] Han et al. (2022). Effect Analysis of High-Speed Circuit Breakers for SPS Review of the Hanbit Power Complex. Proceedings of the Korean Institute of Electrical Engineers (KIEE) Conference.

Development of Open-source Models

- The feasibility of KPG 193 was validated by solving
  - ✓ Daily Unit Commitment (UC) for the entire year of 2022
  - ✓ Hourly AC Optimal Power Flow (ACOPF) for the entire year of 2022

$$C_g^{\mathrm{G}}(p_{gt}) = C_g^{(2)} p_{gt}^2 + C_g^{(1)} p_{gt} + C_g^{(0)}$$

- Since UC parameters and generation cost coefficients are not available, parameters are derived from reference [10], [11]

Fuel Type	Min. Gen. [% Cap.]	Ramp Rate [% Cap./hr]	UT [h]	DT [h]	Startup Cost [KRW/MW]	$C_g^{(2)}$ [KRW/MW^{2}h]	$C_g^{(1)}$ [KRW/MWh]	$C_g^{(0)}$ [KRW]
LNG	52%	100	4	3	53,862	2.1215 – 6.6711	36,872 – 70,956	637,657 – 6,531,339
Coal	40%	66	6	12	12,606	25.6102 – 30.5675	22,912 – 27,174	1,227,022 – 2,629,634
Nuclear	95%	18	8	12	-	1.6591 – 3.0364	3,339 – 8,292	0

TABLE. Generator Parameters by Fuel Type: The parameters are adopted, randomized, and modified from [10], [11] and [12]. The cost parameters $C_g^{(2)}, C_g^{(1)}, C_g^{(0)}$ are presented as ranges across generator units for each fuel type.

- Cost coefficients are modified to reduce discrepancies with historical data using methodologies from reference [12]

	Coal	Gas	Nuclear	Renewables	Etc.*	Total
Historical [%]	32.5%	27.5%	29.6%	9.6%	0.8%	100%
KPG193 [%]	33.9%	27.8%	28.2%	10.1%	0%	100%

TABLE. Comparison of annual electric generation share by fuel type in 2022: Historical data and KPG 193

[10] D. Lew and G. Brinkman, “The western wind and solar integration study phase 2 (executive summary),” National Renewable Energy Laboratory (NREL), Golden, CO (United States), Tech. Rep., 2013.
[11] D. Krishnamurthy et al., “An 8-zone test system based on iso new england data: Development and application,” IEEE Transactions on Power Systems, vol. 31, no. 1, pp. 234-246, 2015.
[12] Y. Xu et al., “US test system with high spatial and temporal resolution for renewable integration studies,” in 2020 IEEE Power & Energy Society General Meeting (PESGM). IEEE, 2020, pp. 1-5.

Validation : Network Constrained Unit Commitment [13]

$$\min_{\Xi'} \sum_{g\in\mathcal{G}}\sum_{t\in\mathcal{T}}\Big(C_g^G(p_{gt}) + C_g^U v_{gt} + C_g^D w_{gt}\Big) \quad (1)$$ Total Cost

$$\text{s.t.} \sum_{g\in\mathcal{G}} r_{gt}^{+} = P_t^r, \quad (2)$$ Spinning reserve constraint

$\forall g\in\mathcal{G},\ t\in\mathcal{T}$:

$$p_{gt} - r_{gt}^{-} \geq \underline{P}_g u_{gt}, \quad (3)$$
$$p_{gt} + r_{gt}^{+} \leq \overline{P}_g u_{gt} - (\overline{P}_g - P_i^{\mathrm{SU}}) v_{gt} - (\overline{P}_g - P_i^{\mathrm{SD}}) w_{g,t+1}, \quad (4)$$

(3)–(4): Generation constraints with Startup/Shutdown limit, $P_i^{\mathrm{SU}}, P_i^{\mathrm{SD}}$

$$p_{gt} + r_{gt}^{+} - p_{g,t-1} \leq P_i^{\mathrm{RU}}, \quad (5)$$
$$p_{g,t-1} - (p_{gt} - r_{gt}^{-}) \leq P_i^{\mathrm{RD}}, \quad (6)$$

(5)–(6): Ramp Up/Down Limit, $P_i^{\mathrm{RU}}, P_i^{\mathrm{RD}}$

$$\sum_{\tau=t-TU_g+1}^{t} v_{g,\tau} \leq u_{g,t}, \quad t\in[TU_g, T], \quad (7)$$
$$\sum_{\tau=t-TD_g+1}^{t} w_{g,\tau} \leq 1 - u_{g,t}, \quad t\in[TD_g, T], \quad (8)$$

(7)–(8): Minimum Up/Down time, UT_i, DT_i

$$u_{gt} - u_{g,t-1} = v_{gt} - w_{gt}, \quad (9)$$ Logical Constraint

$\forall l\in\mathcal{L}^{\mathrm{AC}},\ t\in\mathcal{T}$:

$$p_{lt}^{ft} = \frac{1}{X_l}\big(\theta_{s(l),t} - \theta_{r(l),t}\big), \quad (10)$$
$$p_{lt}^{tf} = \frac{1}{X_l}\big(\theta_{r(l),t} - \theta_{s(l),t}\big), \quad (11)$$
$$-\overline{F}_l \leq p_{lt}^{ft} \leq \overline{F}_l, \quad (12)$$
$$-\overline{F}_l \leq p_{lt}^{tf} \leq \overline{F}_l, \quad (13)$$
$$-\Delta_l \leq \theta_{s(l),t} - \theta_{r(l),t} \leq \Delta_l, \quad (14)$$

(10)–(14): DC Power Flow

$\forall l\in\mathcal{L}^{\mathrm{DC}},\ t\in\mathcal{T}$:

$$\underline{P}_l^{\mathrm{DC}} \leq p_{lt}^{ft} \leq \overline{P}_l^{\mathrm{DC}}, \quad (15)$$
$$\underline{P}_l^{\mathrm{DC}} \leq p_{lt}^{tf} \leq \overline{P}_l^{\mathrm{DC}}, \quad (16)$$
$$p_{lt}^{ft} + p_{lt}^{tf} = (L_l^0 + L_l^1 p_{lt}^{ft}), \quad (17)$$

(15)–(17): Simplified HVDC line model [14]

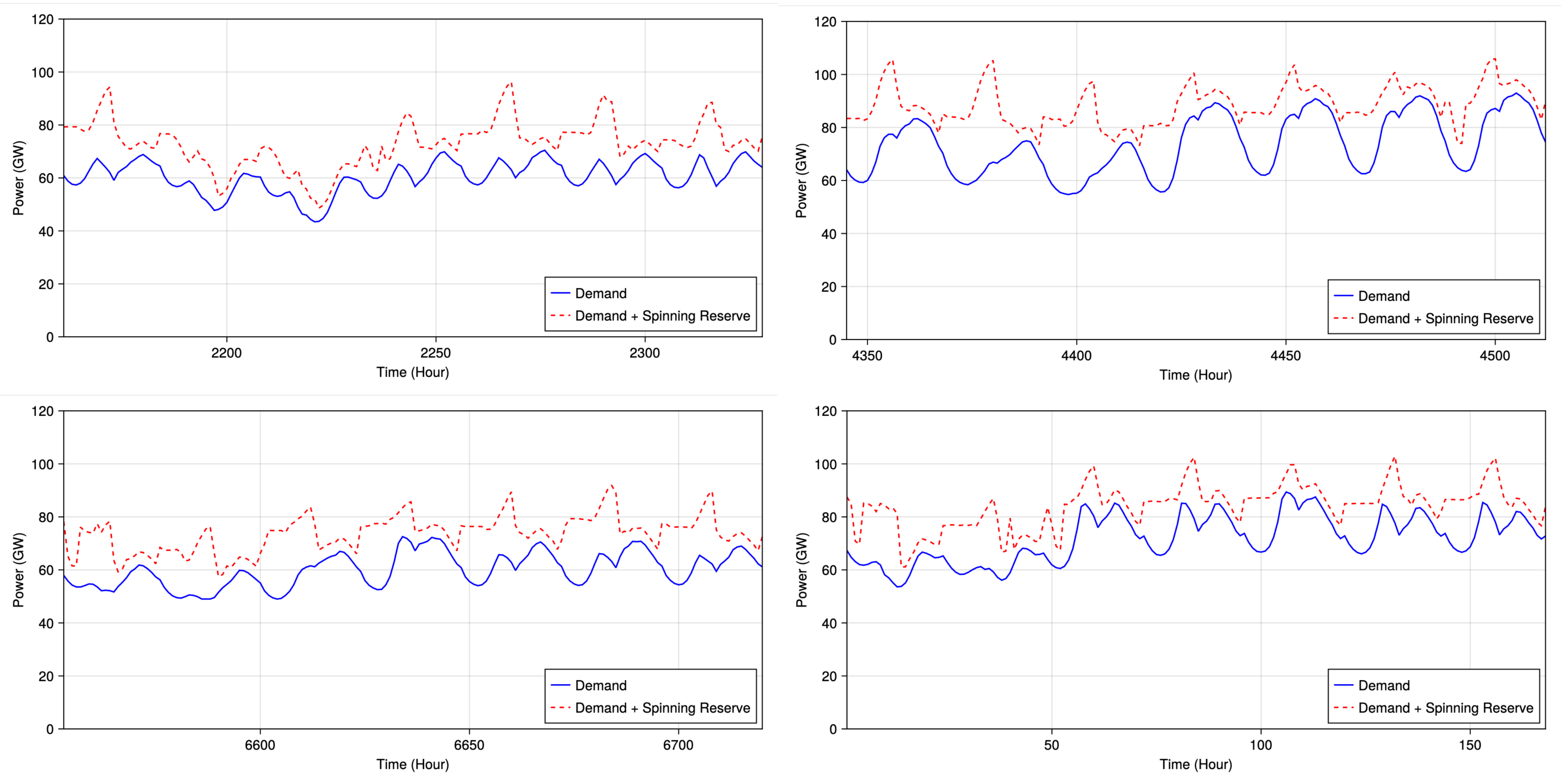
$\forall b\in\mathcal{B},\ t\in\mathcal{T}$:

$$P_{bt}^d + \sum_{l|s(l)=b} p_{lt}^{ft} + \sum_{l|r(l)=b} p_{lt}^{tf} = \sum_{g\in\mathcal{G}_b} p_{gt} + P_b^{\mathrm{H}} W_t^{\mathrm{H}} + P_b^{\mathrm{WT}} W_{bt}^{\mathrm{WT}} + P_b^{\mathrm{PV}} W_{bt}^{\mathrm{PV}}. \quad (18)$$

(18): Power balance

[13] Morales-España, G., Latorre, J. M., & Ramos, A. (2013). Tight and compact MILP formulation for the thermal unit commitment problem. IEEE Transactions on Power Systems, 28(4), 4897-4908.
[14] C. Coffrin et al., “PowerModels.jl: An Open-Source Framework for Exploring Power Flow Formulations”, 2018

Validation : Network Constrained Unit Commitment (Cont'd)



Electrical Demand and Spring Reserve in (a) Spring (2022.04.01-2022.04.07), (b) Summer (2022.07.01-2022.07.07),
(c) Fall (2022.10.01-2022.10.07), (d) Winter (2022.01.01-2022.01.07)

Validation : AC Optimal Power Flow

$$\min_{\Xi''} \sum_{i\in\mathcal{I}} \sum_{t\in\mathcal{T}} C_i^G(p_{it}) \quad (1)$$

Operation Cost

s.t.

$\forall g \in \mathcal{G},\ t \in \mathcal{T},$

$$\underline{P}_i \hat{u}_{it} \le p_{it} \le \overline{P}_i \hat{u}_{it}, \quad (2)$$

$$\underline{Q}_i \hat{u}_{it} \le q_{it} \le \overline{Q}_i \hat{u}_{it}, \quad (3)$$

Generation of Unit **i**

$\forall l \in \mathcal{L}^{\mathrm{AC}},\ t \in \mathcal{T},$

$$p_{lt}^{ft} = v_{s(l),t} v_{r(l),t} [G_l \cos(\theta_{s(l),t} - \theta_{r(l),t}) + B_l \sin(\theta_{s(l),t} - \theta_{r(l),t})], \quad (4)$$

$$p_{lt}^{tf} = v_{r(l),t} v_{s(l),t} [G_l \cos(\theta_{r(l),t} - \theta_{s(l),t}) + B_l \sin(\theta_{r(l),t} - \theta_{s(l),t})], \quad (5)$$

$$q_{lt}^{ft} = v_{s(l),t} v_{r(l),t} [G_l \sin(\theta_{s(l),t} - \theta_{r(l),t}) - B_l \cos(\theta_{s(l),t} - \theta_{r(l),t})], \quad (6)$$

$$q_{lt}^{tf} = v_{r(l),t} v_{s(l),t} [G_l \sin(\theta_{r(l),t} - \theta_{s(l),t}) - B_l \cos(\theta_{r(l),t} - \theta_{s(l),t})], \quad (7)$$

AC Power Flow

$$(p_{lt}^{ft})^2 + (q_{lt}^{ft})^2 \le \overline{F}_l^2, \quad (8)$$

$$(p_{lt}^{tf})^2 + (q_{lt}^{tf})^2 \le \overline{F}_l^2, \quad (9)$$

Line Current Limit

$$-\Delta_l \le \theta_{s(l),t} - \theta_{r(l),t} \le \Delta_l, \quad (10)$$

Voltage Angle Limit

$\forall l \in \mathcal{L}^{\mathrm{DC}},\ t \in \mathcal{T},$

$$p_{lt}^{ft} + p_{lt}^{tf} = (L_l^0 + L_l^1 p_{lt}^{ft}), \quad \forall l \in \mathcal{L}^{\mathrm{DC}}, \quad (11)$$

$$\underline{P}_l^{\mathrm{DC}} \le p_{lt}^{ft} \le \overline{P}_l^{\mathrm{DC}}, \quad (12)$$

$$\underline{P}_l^{\mathrm{DC}} \le p_{lt}^{tf} \le \overline{P}_l^{\mathrm{DC}}, \quad (13)$$

$$\underline{Q}_l^{\mathrm{DC}} \le q_{lt}^{ft} \le \overline{Q}_l^{\mathrm{DC}}, \quad (14)$$

$$\underline{Q}_l^{\mathrm{DC}} \le q_{lt}^{tf} \le \overline{Q}_l^{\mathrm{DC}}, \quad (15)$$

Simplified HVDC line model [14]

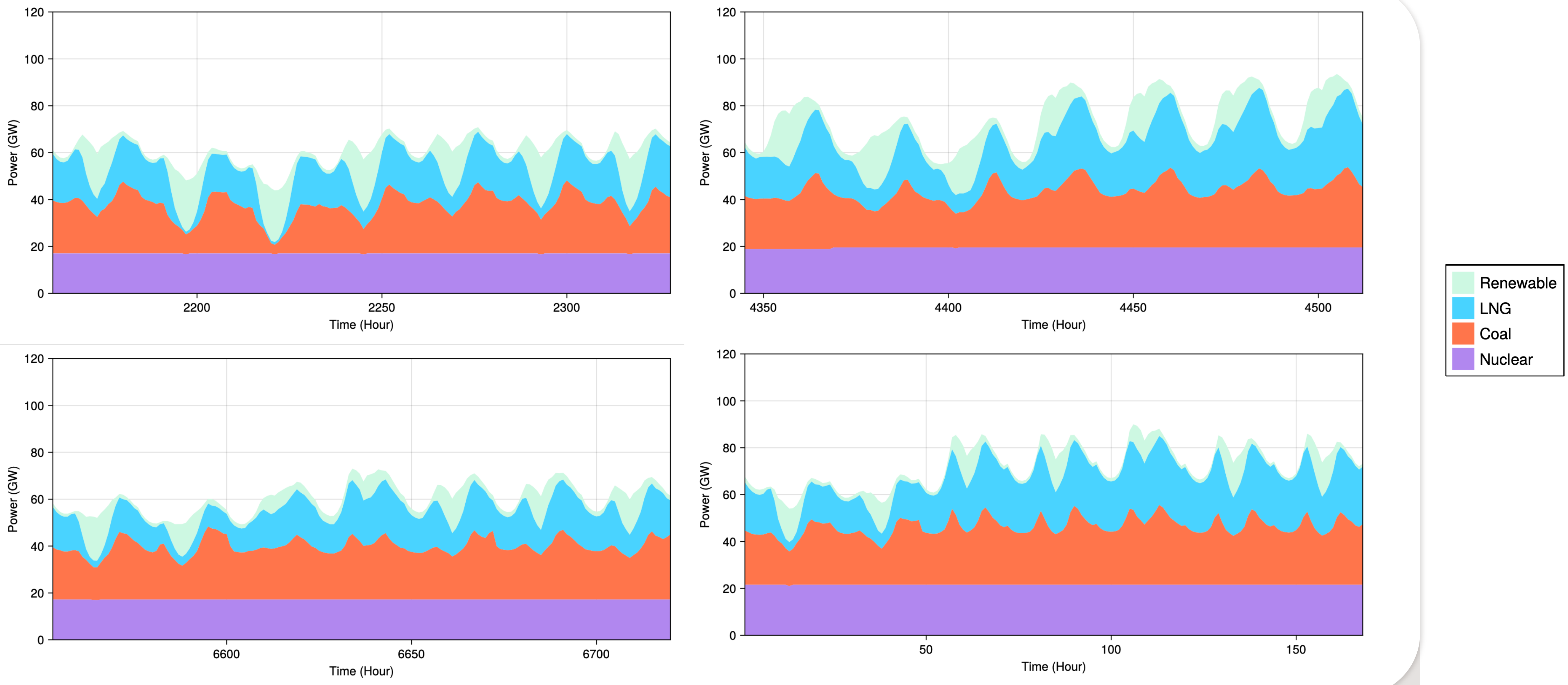
$\forall b \in \mathcal{B},\ t \in \mathcal{T},$

$$P_{bt}^d + \sum_{l|s(l)=b} p_{lt}^{ft} + \sum_{l|r(l)=b} p_{lt}^{tf} = \sum_{i\in\mathcal{I}_b} p_{it} + P_b^{\mathrm{H}} W_t^{\mathrm{H}} + P_b^{\mathrm{WT}} W_{bt}^{\mathrm{WT}} + P_b^{\mathrm{PV}} W_{bt}^{\mathrm{PV}}, \quad (16)$$

$$Q_{bt}^d + \sum_{l|s(l)=b} q_{lt}^{ft} + \sum_{l|r(l)=b} q_{lt}^{tf} = \sum_{i\in\mathcal{I}_b} q_{it}. \quad (17)$$

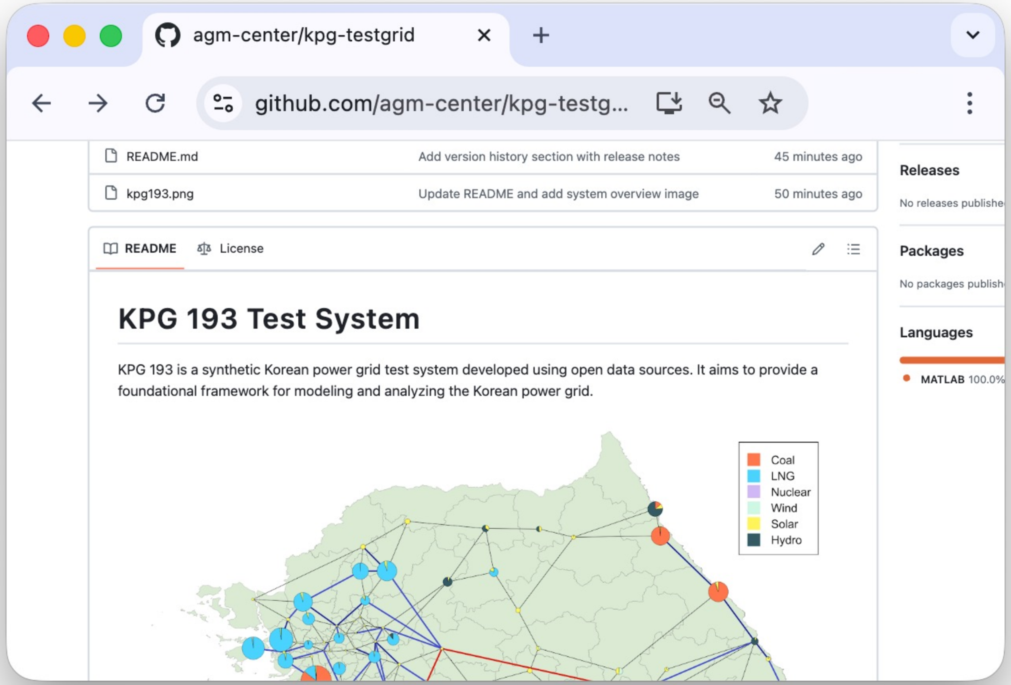
Power Balance

Validation : AC Optimal Power Flow (Cont'd)



Dispatch result of generator by fuel in (a) Spring (2022.04.01-2022.04.07), (b) Summer (2022.07.01-2022.07.07),
(c) Fall (2022.10.01-2022.10.07), (d) Winter (2022.01.01-2022.01.07)

What we provide in the repository



- KPG-TESTGRID
  - mustoff
    - nuclear_mustoff.csv — Nuclear generator maintenance data (Historical)
  - network
    - location
      - bus_location.csv — Latitude, longitude, name of each bus
    - m
      - KPG193_ver1_5.m
    - mat
      - KPG193_ver1_5.mat
    - (m, mat: Network data (MATPOWER))
  - profile — Profile data (CSV)
    - commitment_decision
    - demand
    - renewables
    - weather
  - renewables_capacity — Capacity of renewable generator by bus
    - hydro_generators_2022.csv
    - solar_generators_2022.csv
    - wind_generators_2022.csv
  - kpg193.png
  - LICENSE
  - README.md

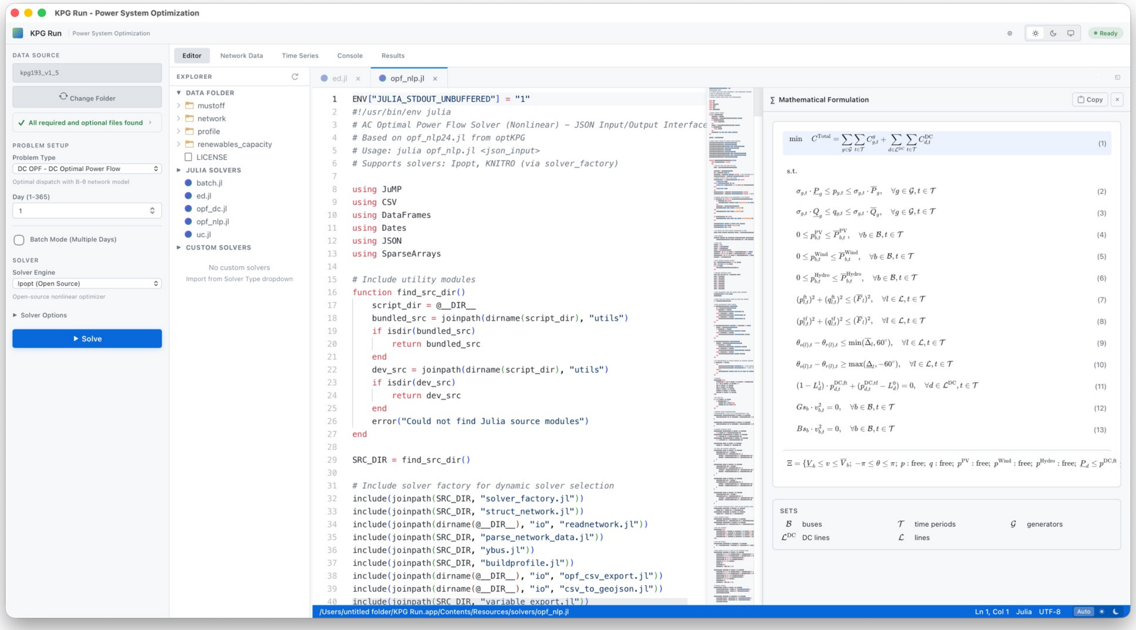
Part 2.

KPG Run & View

KPG Platform: KPG Run and View

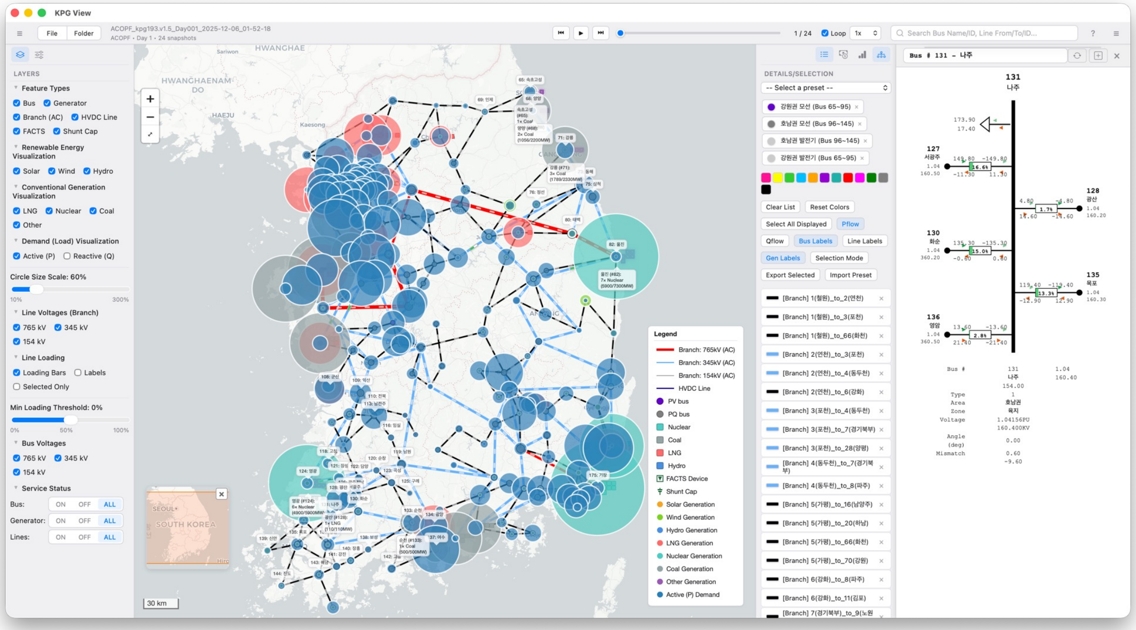
KPG Run

- Korean power grid simulation engine
- ED, UC, ACOPF, DCOPF models are available (2025-12-16)



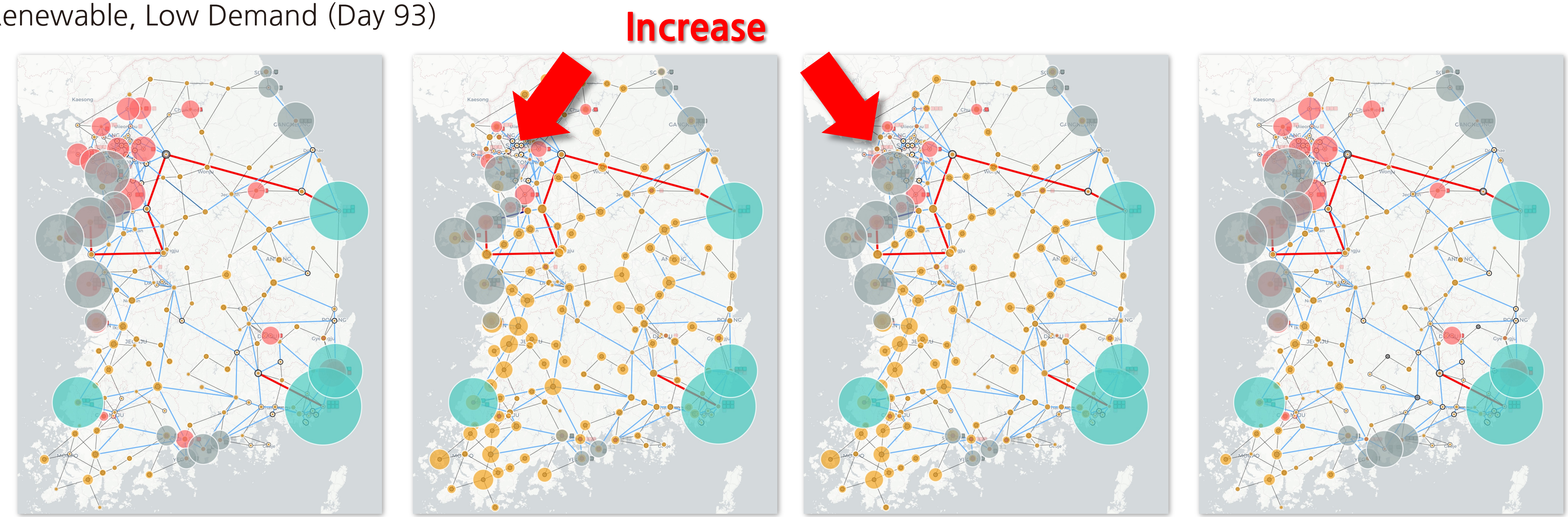
KPG View

- Interactive grid visualization and results explorer



KPG Platform: KPG Run and View

- High Renewable, Low Demand (Day 93)



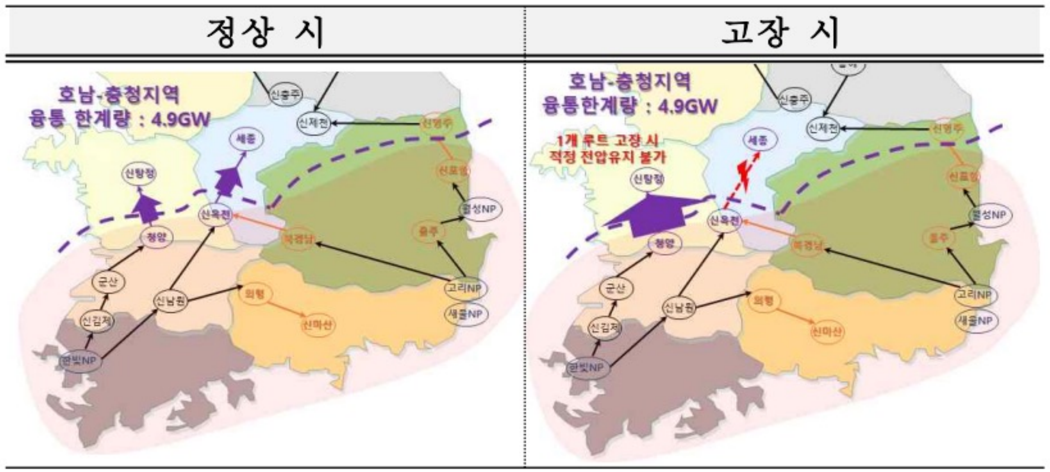
	T = 8	T = 11	T = 16	T = 18
LNG	Decrease (High Cost)	Decrease	-	Increase
Coal	-	Decrease	Increase (Low Cost)	Increase
Nuclear	-	-	-	-
Solar	Increase	Increase	Decrease	Decrease

KPG Platform: KPG Run and View

Curtailment issues in the Honam region

- Causes of PV curtailment in the Honam region [15]
  - ✓ 수급 불균형
  - ✓ 154kV 송전제약 (열적용량 초과)
  - ✓ 한빛원전 배후 송전제약
  - ✓ 호남-충청 융통선로 송전제약 (4.9GW 이하) [16]

- Actual PV curtailment has been implemented since 2023 [15]



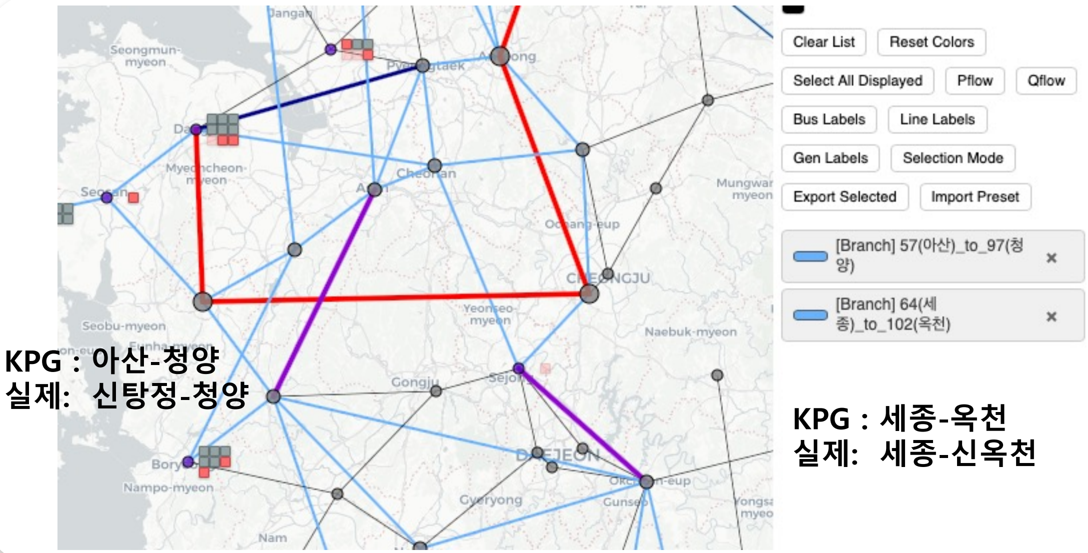
Honam-Chungcheong inter-regional flowgate constraint [16]

[15] 한국전력, “봄철 계통안정화를 위한 조치, 재생에너지 출력제어”, 2025.
[16] 신훈철, 송태용, “태양광 이용률에 따른 호남지역 전력계통 영향 분석”, 2024

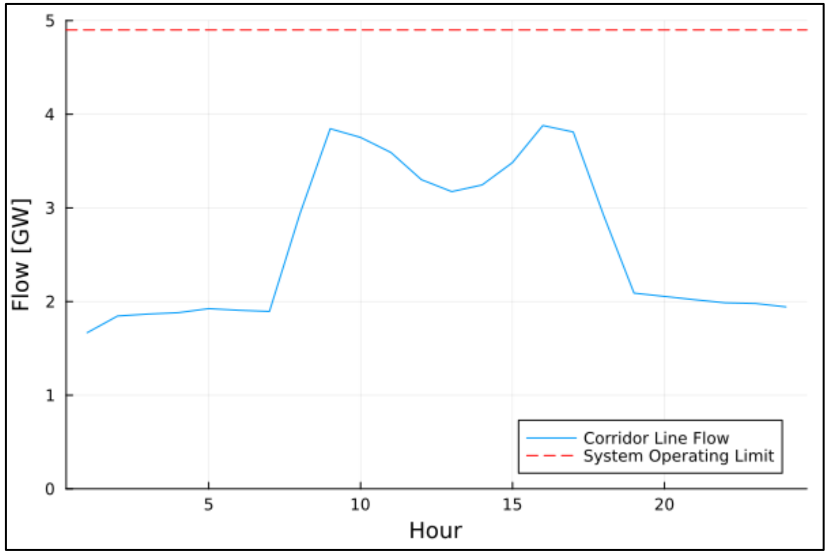
KPG Platform: KPG Run and View

Curtailment issues in the Honam region

- In the KPG 193 test system, the (아산-청양) and (세종-옥천) lines are flowgate lines
- On Day 93 (April 3, 2022), these corridors do not reach their transfer limits
- However, violations may occur as PV penetration increases
  - ✓ Cumulative installed PV capacity: 20GW (2022) → 23GW (2023) → 25GW (2024) → 29GW (2025) [17]



Flowgate lines in the KPG test system

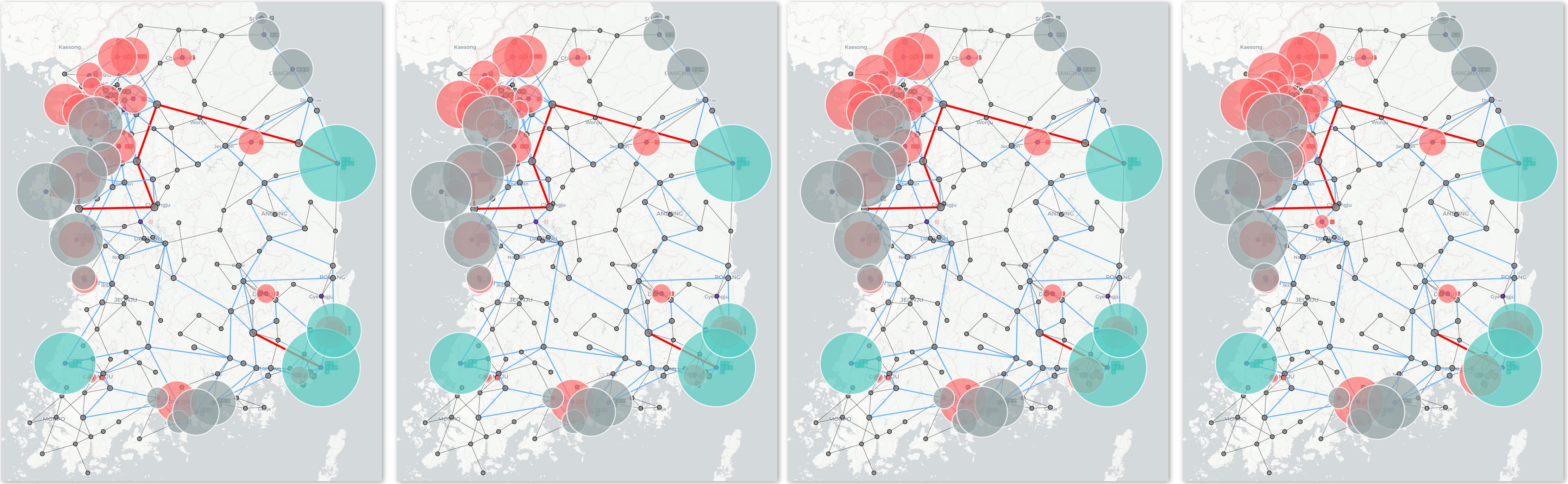


Power flows on the flowgate lines

[17] 한국에너지공단, “재생에너지 클라우드 플랫폼”, Accessed in 2025

KPG Platform: KPG Run and View

- Low Renewable, High Demand (Day 355)



	T = 5	T = 7	T = 8	T = 9
Demand	-	Increase	Increase	Increase

- As demand increases, output from LNG generators in the metropolitan area rises

KPG Platform: KPG Run and View

- Low Renewable, High Demand (Day 355)

	T = 5	T = 7	T = 8	T = 9
파주	On: 2, Off: 2	On: 2, Off: 2	On: 3, Off: 1	On: 4, Off: 0
서인천	On: 1, Off: 3	On: 2, Off: 2	On: 2, Off: 2	On: 3, Off: 1
Demand	-	Increase	Increase	Increase

Part 3-1.

- Highlights from the First Six Months
- Vision & Roadmap

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)

Grid modeling collaboration day

(2025.09.24) Grid Modeling 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 to ensure transparency and sustainability
  - ✓ Set the foundation for joint validation and comparative studies between planning and operational models

Development of Grid Models

(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

KEPCO-KENTECH MOU Signing for AGM Research Center

(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 and platform for transparent discussion
  - ✓ Confirmed KEPCO's preference for trend-based analysis and periodic public insights

AGM Center Discussion Hub

Part 3-2.

- Highlights from the First Six Months
- Vision & Roadmap

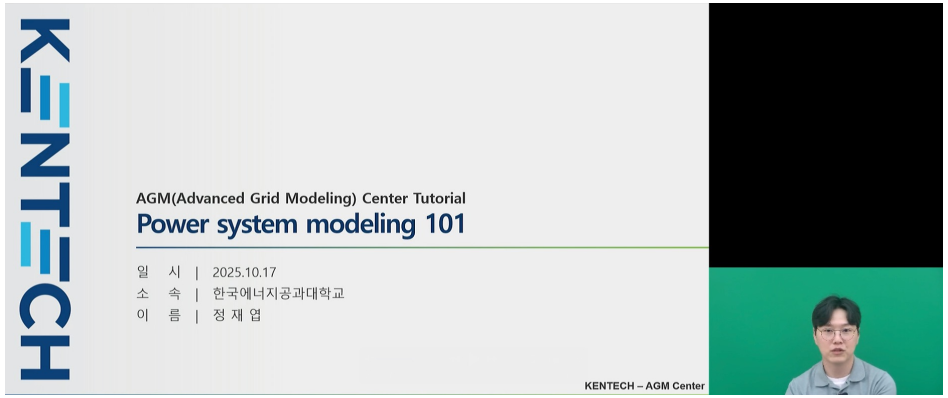
Major Activities for the Remaining Project Period

Empowering practitioners through education

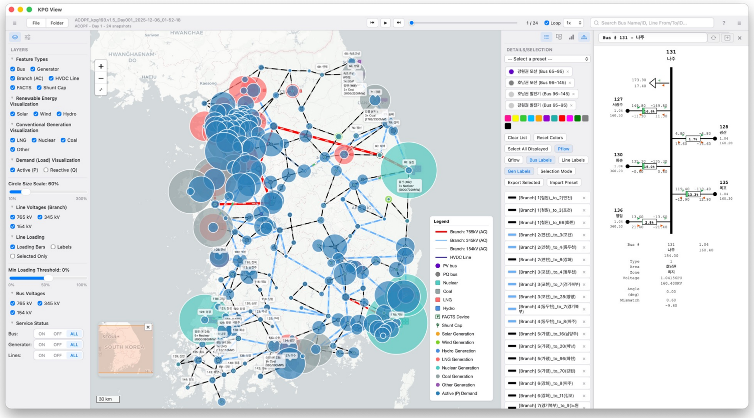
- Provide professional power system modelling and electricity market education to utilities, system operator and researchers
- Provide publicly accessible model, online tutorials and educational contents to foster broad participation in open-source grid modelling

Online showcasing and publication

- 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



Online tutorial

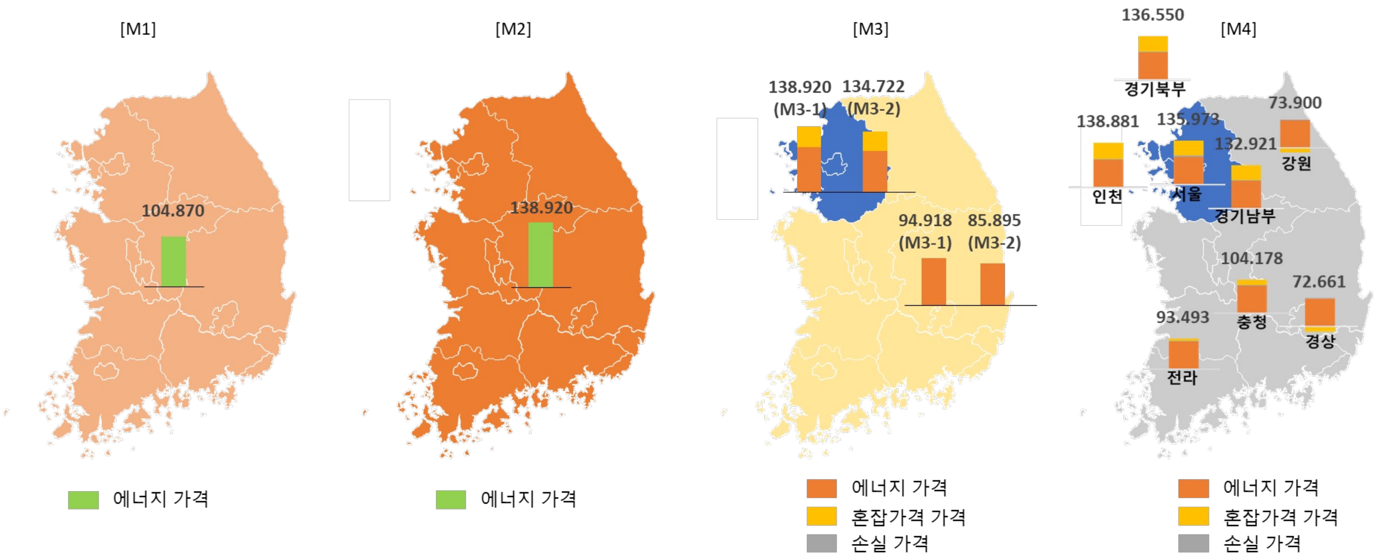


Viewer app: KPG View

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)



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

Next Steps and Roadmap

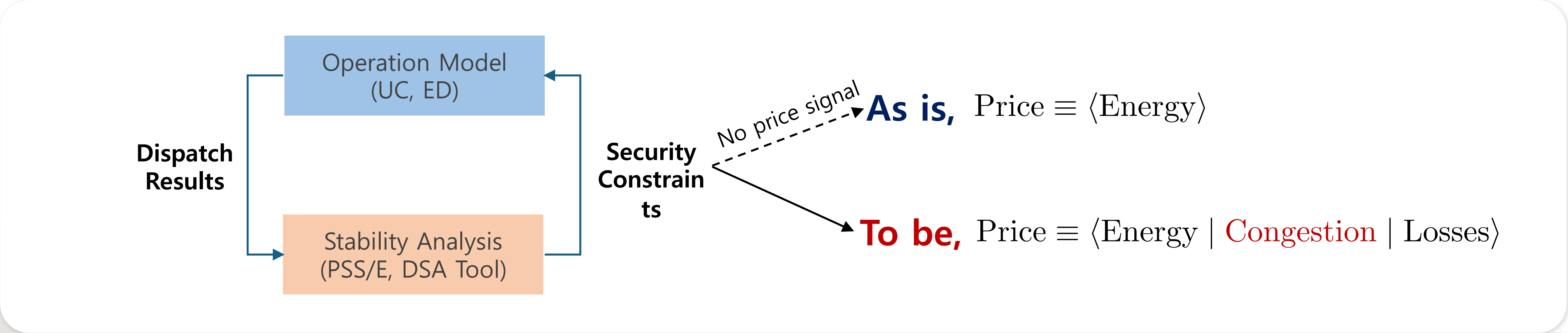
Bridging Stability Analysis and Electricity Markets

- Current wholesale electricity prices in Korea do not reflect the outcomes of stability analysis
- Results of stability analysis can be formulated as security constraints,

$$(\pi_k) : \sum_{g \in \mathcal{G}_k} \alpha_g p_g + \sum_{l \in \mathcal{L}_k} \beta_l f_l \leq \text{Limit}_k$$

- Congestion prices derived from the operational model enable these security considerations to be reflected in market prices

$$\text{Congestion} = -\mathbf{PTDF} \cdot \boldsymbol{\pi}$$



Bridging stability analysis and electricity markets

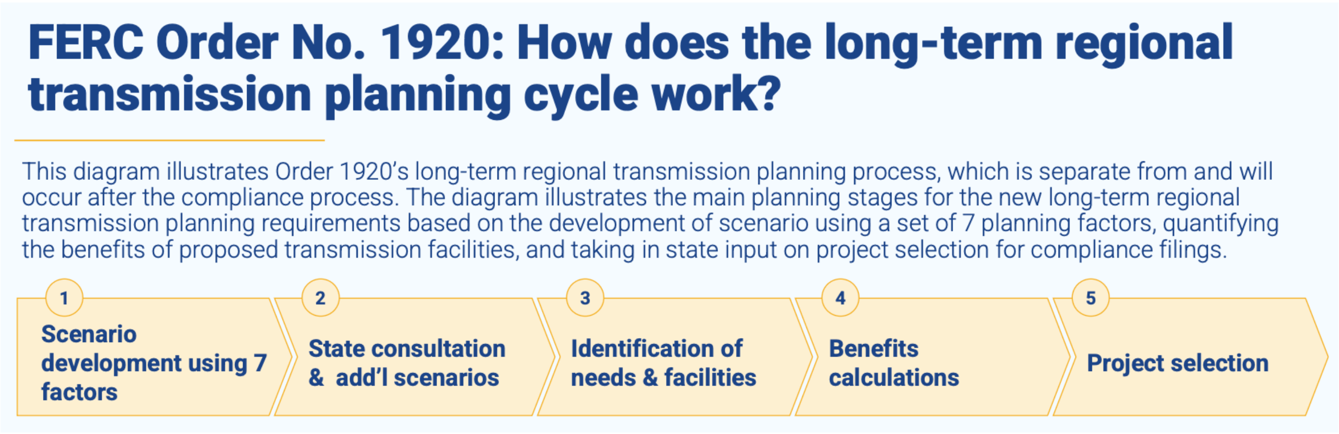
Next Steps and Roadmap

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	KPG Platform 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

Scope of KPG Platform Development



FERC Order 1920's long-term regional transmission planning process [18]

[18] GridStrategies

Open Grid Initiative (OGI)

NEXT group

Most credible policy thinktank

- Future scenario development (demand, electrification, AI growth, population)
- Model scenario assumptions
- Narrative design
- Outreach & communication platform

KENTECH
Korea Institute of Energy Technology

Leading energy-specialized national univ.

- Model verification (academic credibility)
- Model enhancement
- Computing power (Campus datacenter)
- Training & Education
- Academic conference

INETTT
International Network of Energy Transition Think Tanks

BloombergNEF

Wood Mackenzie

IPSL
Inha Univ. Power System Lab

Mokpo National University 1946

KEEi
에너지경제연구원

KDI

KEPCO

Agora Energiewende

AURORA ENERGY RESEARCH

TU KOREA
TECH UNIVERSITY OF KOREA

GIST

KPX
KOREA POWER EXCHANGE

Greenhouse Gas Inventory and Research Center of Korea

KEI Korea Environment Institute

광운대학교
KwangWoon University

"We would like you to join us"

Thank you

For your attention

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