**Derivation of Supply Curve of PV**

Seungho Jeon1, Gildong Hong2,Gyeonggi Do 2\*,

*1 Climate & Environment Data Center, Gyeonggi Research Institute, South Korea*

*2 Climate & Environment Data Center, Gyeonggi Research Institute, South Korea*

*\* Corresponding author. Email:* [*email@gri.re.kr*](mailto:email@gri.re.kr)

# Supplementary Materials

# Note 1: Ratio (Area covered by PV to the total area, %)

- South Korea consists of a total of 17 provinces, each of which encompasses cities & counties, as indicated in the following table. In this paper, the administrative category at high-level is consistently referred to as 'province', while at low-level it is expressed as 'city & county'.

# Note 2: Coefficient (Required area to install PV, m2/kW)

- In the standard version of GCAM, there are two systems: the model engine (GCAM-core) and the model interface for querying scenario output. In contrast, GCAM-EML combines a model engine with a model interface. The model engine of GCAM-EML is written in C#, and the model interface is developed using Windows Presentation Foundation (WPF). The requirements for the GCAM-EML are as follows.

텍스트, 스크린샷, 도표, 라인이(가) 표시된 사진

자동 생성된 설명

Fig. 2. Area covered by PV to total area of individual site. (Total area vs. PV installation area)

텍스트, 스크린샷, 도표, 그래프이(가) 표시된 사진

자동 생성된 설명

Fig. 3. Required area for PV installation in log scale. (capacity(kW) vs. area(m2))

# Note 2: Projection of population and GRDP at 229 citiy level

- (Population) Each province has projected its future population at the city level by 2040. To extend the data for the next ten years (2040-2050), the Auto-Regressive Integrated Moving Average (ARIMA) method has been applied. The augmented data is then converted to represent each city & county’s share of the national population over the entire period (2020-2050). The city & county’s population share is applied to the midpath of the national population by 2050. Ultimately, the future population pathways of all 229 city & counties are projected.

- (

# Note 3: Electricity consumption of electric vehicle

- (Number of BEVs) The complete set of registered BEVs data is not universally accessible across all 229 cities & counties. Table SM 4 serves as a summary of the most comprehensive BEV data we were able to compile. This table includes information on provincial populations (KOSIS, 2023), the number of BEVs (KSGA, 2023), their proportions in South Korea, and the count of cities & counties within each province. The data on registered BEVs is sourced from various provinces and cities & counties. Provinces in Group A provide fully available data, encompassing cities & counties, time horizons, and vehicle type information. Group B provinces do not distinguish between vehicle types in their data. Group C provinces lack vehicle type information for the year 2020, even though they possess BEV data organized by cities & counties. In the case of Group D, GJ province, BEV data is available for three out of the five cities & counties, categorized by vehicle types in 2022, while the remaining two cities & counties lack any data. Group E provinces do not possess any BEV data at the city & county level. For provinces from Group B to E, missing BEV data was estimated as follows. Assumptions are made to estimate the number of registered BEVs in 2020 by cities & counties and vehicle type. Firstly, in cases where the number of EVs per city & county is unavailable for a given province, it is assumed that the distribution of total vehicles by city & county reflects the distribution of EVs across cities & counties. Secondly, in the absence of data for 2020, the growth rate of the total BEVs for the entire province is calculated from 2020 to the available data year. This growth rate is then applied to estimate the number of BEVs in 2020. Thirdly, if the data does not specify the number of BEVs by vehicle type and only provides the total count, the vehicle type distribution in the province for 2020 is uniformly applied to each city & county.

**References**

EPSIS, 2020, Power generatio by plants, URL: <https://epsis.kpx.or.kr/epsisnew/selectEkgeGepGbpGrid.do?menuId=060105> (accessed 04.03.24), Electric Power Statistics Information System.

Hyndman, RJ and Khandakar, Y., 2008. Automatic time series forecasting: The forecast package for R, Journal of Statistical Software, 26(3).

Hyundai, 2023. Catalog. URL: <<https://www.hyundai.com/contents/repn-car/catalog/ioniq5-catalog.pdf>> <<https://www.hyundai.com/kr/ko/e/vehicles/porter2-electric/spec>>

KCA, 2023, Number of passengers, URL: <https://www.airportal.go.kr/knowledge/statsnew/air/airport.jsp> (accessed 04.03.24), Korea Civil Aviation Association.

KDHC, 2023. Handbook of CHP (combined heat and power), URL: <http://www.kdhca.co.kr/Board/boardView/158?board_type_cd=05> (accessed 04.03.24), Korea District Heating Corporation.

KEPCO, 2023. Statistics of Electric Power in Korea, URL: <https://home.kepco.co.kr/kepco/KO/ntcob/ntcobView.do?pageIndex=1&boardSeq=21062112&boardCd=BRD_000099&menuCd=FN05030103&parnScrpSeq=0&categoryCdGroup=&regDateGroup2=> (accessed 04.03.24), Korea Electric Power Corporation.

KESIS, 2023. Energy balance, URL: <https://www.kesis.net/main/main.jsp> (accessed 04.03.24), Korea Energy Statistical Information System.

KITA, 2023. Volume of exports and imports, URL: <https://stat.kita.net/stat/kts/prod/ProdWholeList.screen> (accessed 04.03.24), Korea International Trade Association.

KOSA, 2023. Membership status, URL: <https://www.kosa.or.kr/> (accessed 04.03.24), Korea Iron&Steel Association.

KOSIS, 2023. Population Projection by country, province, city & county URL: <nation: <https://kosis.kr/statHtml/statHtml.do?orgId=101&tblId=DT_1BPA402&conn_path=I3>> <province: <https://kosis.kr/statHtml/statHtml.do?orgId=101&tblId=DT_1BPB001&conn_path=I2>> <city &county:

SU: <https://kosis.kr/statHtml/statHtml.do?orgId=201&tblId=DT_PBOOO1_11&conn_path=I2>

BS: <https://kosis.kr/statHtml/statHtml.do?orgId=202&tblId=DT_PBOOO1_21&conn_path=I2>

DG: <https://kosis.kr/statHtml/statHtml.do?orgId=203&tblId=DT_203010_2020_01&conn_path=I2>

IC: <https://kosis.kr/statHtml/statHtml.do?orgId=204&tblId=DT_PBOOO1_23&conn_path=I2>

GJ: <https://kosis.kr/statHtml/statHtml.do?orgId=205&tblId=DT_PBOOO1_24&conn_path=I2>

DJ: <https://kosis.kr/statHtml/statHtml.do?orgId=206&tblId=DT_PBOOO1_25&conn_path=I2>

US: <https://kosis.kr/statHtml/statHtml.do?orgId=207&tblId=DT_PBOOO1_26&conn_path=I2>

GG: <https://kosis.kr/statHtml/statHtml.do?orgId=210&tblId=DT_PBOOO1_31&conn_path=I2>

GW: <https://kosis.kr/statHtml/statHtml.do?orgId=211&tblId=DT_PBOOO1_32&conn_path=I2>

CB: <https://kosis.kr/statHtml/statHtml.do?orgId=212&tblId=DT_PBOOO1_33&conn_path=I2>

CN: <https://kosis.kr/statHtml/statHtml.do?orgId=213&tblId=DT_PBOOO1_34&conn_path=I2>

JB: <https://kosis.kr/statHtml/statHtml.do?orgId=214&tblId=DT_PBOOO1_35&conn_path=I2>

JN: <https://kosis.kr/statHtml/statHtml.do?orgId=215&tblId=DT_PBOOO1_36&conn_path=I2>

GB: <https://kosis.kr/statHtml/statHtml.do?orgId=216&tblId=DT_PBOOO1_37&conn_path=I2>

GN: <https://kosis.kr/statHtml/statHtml.do?orgId=217&tblId=DT_PBOOO1_38&conn_path=I2>

JJ: <https://kosis.kr/statHtml/statHtml.do?orgId=218&tblId=DT_PBOOO1_39&conn_path=I2>

KOrean Statistical Information Service, (accessed 04.03.24)

KPA, 2023, Business overview of member companies, URL: <https://www.petroleum.or.kr/association/member_1_3> (accessed 04.03.24), Korea Petroleum Association.

KPX, 2023. Renewable integrated Energy Storage System, URL: <https://www.data.go.kr/data/15080672/fileData.do> (accessed 04.03.24), Korea Power Exchange.

KSGA, 2023. Registered BEVs. URL: <https://chargeinfo.ksga.org/front/statistics/evCar>, Korea Smart Grid Association

MOLIT, 2023. Open Building Data, URL: <http://open.eais.go.kr/> (accessed 04.03.24), Ministry of Land,Infrastructure and Transport.

MOTIE, 2023. The 10th basic plan for long-term electricity supply and demand. URL: https://www.kpx.or.kr/menu.es?mid=a10403070000 (accessed 2.29.24), Ministry of Trade, Industry and Energy.

OECD, 2023. Real GDP long-term forecast, URL: [https://data.oecd.org/gdp/real-gdp-long-term-forecast.htm#indicator-chart](https://data.oecd.org/gdp/real-gdp-long-term-forecast.htm) (accessed 04.03.24), Organization for Economic Cooperation and Development.

TS, 2023. Vehicle kilometer distance, URL: <https://kosis.kr/statHtml/statHtml.do?orgId=426&tblId=DT_426001_N004&lang_mode=ko&vw_cd=MT_ZTITLE&list_id=I1_426&conn_path=I4> (accessed 04.03.24), Korea Transportation Safety Authority.

Wang, X, Smith, KA, Hyndman, RJ., 2006. Characteristic-based clustering for time series data, Data Mining and Knowledge Discovery, 13(3), 335-364.