**Detailed view of Tokyo Energy Production**

We can see the energy breakdown by hour there is 4 main suppliers of energy, we have

* Fossil
* Solar
* Hydro (Negative and Positive)
* Interconnectors

What counts as an Interconnector / Import into Tokyo Region?

Anything arriving over HVDC or back-to-back converters is logged by OCCTO/ISEP as an interconnection import.

What fossil fuel stations contribute to the Tokyo region?

Counting only stations ≥ 500 MW that were online at some point in 2024-25, there are 12 utility-scale fossil units—one inside the Tokyo prefectural border and eleven in the surrounding prefectures—that meet your “direct to Tokyo” criterion; anything arriving over HVDC or back-to-back converters is logged by OCCTO/ISEP as an interconnection import and is not in the list below.

**List of Power Plants (Tokyo TEOCO Region)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Plant (Prefecture)  LNG | Net Capacity (MW) | Fuel | Thermal Efficiency (LHV) | O&M Cost | Typical Operation |
| Futtsu (Chiba). H | 5,040 | LNG (CCGT) | ~58–59% (new units; Group-4)*(older units ~47%)* | ~0.7 JPY/kWh (low) | Base-load, older units provide mid-merit flexibility. |
| Chiba (Chiba). H | 4,380 | LNG (ACC/MACC)1 | ~50% (1300°C ACC units) to ~55% (1500°C MACC units) | ~0.7 JPY/kWh | Base-load & mid-merit –meet steady demand. |
| Kawasaki Thermal (Kanagawa). H | 3,420 | LNG (MACC/MACC II) | ~59% (1500°C class) up to ~61% (1600°C class) | ~0.7 JPY/kWh | Base-load –highly efficient baseload power. |
| Sodegaura (Chiba).H | 3,600 | LNG (Steam Turbine) | ~40–43% (legacy steam plant) | ~0.7 JPY/kWh (avg.)*(older units may be higher)* | Mid-merit/peaking –Typically kept for higher demand periods due to lower efficiency, |
| Yokohama Thermal (Kanagawa)  .H | 3,016 | LNG (CCGT + steam) | ~54–56% | ~0.7 JPY/kWh | Mid-merit supply mid-load and peak power |
| Goi GTCC (Chiba)  M | 2,340 | LNG (CCGT – new) | ~61% (advanced GTCC, GE 9HA.02) | ~0.7 JPY/kWh | Base-load – will run at high efficiency to meet base demand. |
| Higashi-Ogishima (Kanagawa)  L | 2,000 | LNG (Steam Turbine) | ~38–40% (1970s conventional) | ~0.7 JPY/kWh | Peaking reserve – 2×1000 MW older gas-fired boilers, generally held for reserve/peak |
| Ohgishima (Kanagawa)  M | 1,221 | Natural gas (CCGT) | ~55% (est.) – modern IPP CCGT | ~0.7 JPY/kWh | Mid-merit –run as needed under contract, often mid-merit. |
| Kashima Group-7 (Ibaraki)H | 1,260 | Natural gas (CCGT) | ~55% (advanced combined-cycle, 2014) | ~0.7 JPY/kWh | Baseload. Serve baseload using gas |
| Anegasaki New (Chiba)H | 1,950 | LNG (CCGT – new) | ~60% (latest J-Class GTCC) | ~0.7 JPY/kWh | Base-load –~60% efficiency. |
| Shinagawa (Tokyo)M | 1,140 | LNG (ACC) | ~50% (advanced CCGT, 380 MW x3) | ~0.7 JPY/kWh | Mid-merit/peaking for intermediate load and grid stability. High flexibility |
| Minami-Yokohama (Kanagawa).L | 1,150 | LNG (Steam Turbine) | ~35% (1970-era LNG steam plant) | ~0.7–1.0 JPY/kWh (higher end) | Serve seasonal peak support only, due to low efficiency. |
| Kawasaki Natural Gas Power (Kanagawa, IPP).L | 847 | Natural gas (CCGT) | ~55% (modern CCGT, 2×420 MW) | ~0.7 JPY/kWh | Mid-merit – Industrial zone IPP (Keihin area). Supplies contracted intermediate hours. |
| Tokyo Gas Yokosuka (Kanagawa, IPP)L | 240 | Natural gas (GTCC) | ~40–45% (small GTCC peaker) | ~0.7–1.0 JPY/kWh (est.) | Used for quick reserve and peak loads. High ramp rate prioritized over efficiency. |
| JFE Chiba “Clean” (Chiba, JFE Steel).L | 398 | Blast-furnace & COG gas (CCGT) | ~50% (est.) – utilizes waste gases | ~0.7–1.0 JPY/kWh (est.) | Runs continuously to supply JFE Steel works and feed surplus to grid. |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Plant (Prefecture)  Coal | Net Capacity (MW) | Fuel/Tech | Thermal Efficiency | O&M Cost | Typical Operation |
| Hitachinaka (Ibaraki).H | 2,000 | Coal – USC (2×1000 MW) | ~43–44% (ultra-supercritical) | ~1.3 JPY/kWh | Base-load |
| Hirono Units 5–6 (Fukushima).H | 1,800 | Coal – USC (2×600 MW) + IGCC (~600 MW) | ~40% (USC units); ~42% (IGCC demo) | ~1.3 JPY/kWh | Base-load |
| Yokosuka (Kanagawa).L | 1,300 | Coal – USC (2×650 MW) | ~46% (new USC units) | ~1.3 JPY/kWh | Mid-merit/Base-load – **New (2023)** ultra-supercritical plant. |
| Hitachinaka Joint (Ibaraki).L | 650 | Coal – USC (1×650 MW IPP) | ~43% (modern USC) | ~1.3 JPY/kWh | Base-load –Runs near full load on contracted basis to utility. |
| Kashima Steel Works (Ibaraki).L | 645 | Coal – USC CHP (1×645 MW) | ~42–44% (power gen efficiency) | ~1.3+ JPY/kWh (incl. CHP costs) | Base-load/CHP |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Plant (Prefecture)  Oil | Net Capacity (MW) | Fuel | Thermal Efficiency | O&M Cost | Typical Operation |
| Oi Thermal (Tokyo).L | 1,050 | Heavy Oil (crude) | ~36–38% (vintage steam) | ~1.6 JPY/kWh | Emergency reserve |
| Kashima-Kita (Ibaraki, IPP).L | 650 | Heavy Oil / Gas | ~38–40% (dual-fuel steam) | ~1.5+ JPY/kWh (est.) | Peak/contract supply Not typically run base-load due to fuel cost. |

Questions

Interconnectors take a large proportion first look at the capacity of the lines, then you can see when these lines are likely not to be full. i.e. when these are not at capacity, hypotheses maybe in the early morning there is not much demand, so all treated as one block.

Now in these other regions there is going to be some factor which allows them to transport energy maybe they naturally over produce energy. Maybe they have a large wind amount or solar amount all of these will affect how much energy gets transported to Tokyo.

**Slide: Hypotheses Overview**

**Title:** Key Hypotheses & Analytical Approach

* We test six main hypotheses linking grid structure, market coupling and physical flows to spot–imbalance dynamics
* Each hypothesis is examined via time-series statistics and scatter/box plots (graphs to follow)
* Insights will guide feature selection for our predictive model

**Slide: H1 – Pure Area Inclusion Effect**

**Title:** H1: Impact of Area Count in Wide-Area Block

* **Premise:** Tokyo is typically highest-cost; adding more areas into its imbalance block pulls merit-order curve down
* **Expectation:** As the number of service areas in Tokyo’s real-time balancing region increases, mean Tokyo imbalance – spot spread decreases
* **Graph:** Yearly mean spread vs. count of included areas

**Slide: H2 – Neighboring Region Composition**

**Title:** H2: Influence of Tohoku/Wind–Solar Exports

* **Premise:** Tohoku’s abundant renewables export to Tokyo; export volumes track solar+wind forecasts
* **Expectation:** High Tohoku renewables → larger physical flows → tighter Tokyo balancing block → imbalance > spot
* **Graph:** Tokyo imbalance – spot vs. Tohoku export (MW)

**Slide: H3 – Hour-of-Day Block Effects**

**Title:** H3: Diurnal Block Composition Changes

* **Premise:** Certain 30-min blocks group Tokyo with different neighbors (e.g. midnight vs. peak)
* **Expectation:** Blocks where Tokyo stands alone show larger positive imbalance – spot; midday and evening join largest blocks with muted spreads
* **Graph:** Mean spread by hour/block

**Slide: H4 – Tightness Index (Correction Fee)**

**Title:** H4: Role of Wide-Area Reserve Margin

* **Premise:** When reserve margin dips below thresholds, a surcharge (¥200 / kWh cap) applies to imbalance pricing
* **Expectation:** Low margin blocks exhibit pronounced positive imbalance – spot spreads; margin index is a leading indicator of surcharge events
* **Graph:** Spread vs. reserve-margin index

**Slide: H5 – Exchange Physical Flows**

**Title:** H5: Interconnector Loading & Decoupling

* **Premise:** High cross-area flows indicate binding congestion, splitting balancing areas and decoupling prices
* **Expectation:** As flow / ATC ratio on key ties approaches 1.0, Tokyo imbalance price diverges sharply from coupled-area average
* **Graph:** Spread vs. flow / ATC on Tokyo–Tohoku and Tokyo–Chubu ties

**Slide: H6 – Hydro Pumped Storage Patterns**

**Title:** H6: Pumped-Storage Fill/Pump Cycles

* **Premise:** Storage units fill during low-price hours (≈12:00) and pump at high-price hours (≈18:00)
* **Expectation:** High pumping volumes at 18:00 correlate with negative imbalance – spot spreads (imbalance < spot), filling at 12:00 aligns with positive spreads
* **Graph:** Spread vs. hydro net-flow (pump – generation) by hour

Feel free to tweak wording or reorder slides as needed—then just drop in your charts under each!

**You said:**

Ok this is really good expect for the first slide can you just mention the 6 hypotheses and then link do the linking

**ChatGPT said:**

Thought for 4 seconds

Here’s the revised deck with an updated first (overview) slide:

**Slide 1: Hypotheses Overview**

**Title:** Hypotheses Overview

* **H1:** Impact of Wide-Area Block Size (Pure Area Inclusion)
* **H2:** Influence of Tohoku Renewable Exports
* **H3:** Hour-of-Day Block Composition Effects
* **H4:** Tightness Index (Reserve-Margin Surcharge)
* **H5:** Interconnector Loading & Price Decoupling
* **H6:** Pumped-Storage Fill/Pump Cycle Patterns

*Each hypothesis is detailed with supporting charts on the following slides.*

**Slide 2: H1 – Pure Area Inclusion Effect**

**Title:** H1: Impact of Area Count in Wide-Area Block

* **Premise:** Tokyo is typically highest-cost; adding more areas into its imbalance block pulls merit-order curve down
* **Expectation:** As the number of service areas in Tokyo’s real-time balancing region increases, mean Tokyo imbalance – spot spread decreases
* **Graph:** Yearly mean spread vs. count of included areas

**Slide 3: H2 – Neighboring Region Composition**

**Title:** H2: Influence of Tohoku/Wind–Solar Exports

* **Premise:** Tohoku’s abundant renewables export to Tokyo; export volumes track solar + wind forecasts
* **Expectation:** High Tohoku renewables → larger physical flows → tighter Tokyo balancing block → imbalance > spot
* **Graph:** Tokyo imbalance – spot vs. Tohoku export (MW)

**Slide 4: H3 – Hour-of-Day Block Effects**

**Title:** H3: Diurnal Block Composition Changes

* **Premise:** Certain 30-min blocks group Tokyo with different neighbors (e.g. midnight vs. peak)
* **Expectation:** Blocks where Tokyo stands alone show larger positive imbalance – spot; midday/evening join larger blocks with muted spreads
* **Graph:** Mean spread by hour/block

**Slide 5: H4 – Tightness Index (Correction Fee)**

**Title:** H4: Role of Wide-Area Reserve Margin

* **Premise:** When reserve margin dips below thresholds, a surcharge (¥200 / kWh cap) applies to imbalance pricing
* **Expectation:** Low-margin blocks exhibit pronounced positive imbalance – spot spreads; margin index is a leading indicator of surcharge events
* **Graph:** Spread vs. reserve-margin index

**Slide 6: H5 – Exchange Physical Flows**

**Title:** H5: Interconnector Loading & Decoupling

* **Premise:** High cross-area flows indicate binding congestion, splitting balancing areas and decoupling prices
* **Expectation:** As flow / ATC ratio on key ties approaches 1.0, Tokyo imbalance price diverges sharply from coupled-area average
* **Graph:** Spread vs. flow / ATC on Tokyo–Tohoku and Tokyo–Chubu ties

**Slide 7: H6 – Hydro Pumped Storage Patterns**

**Title:** H6: Pumped-Storage Fill/Pump Cycles

* **Premise:** Storage units fill during low-price hours (≈12:00) and pump at high-price hours (≈18:00)
* **Expectation:** High pumping volumes at 18:00 correlate with negative imbalance – spot spreads (imbalance < spot), filling at 12:00 aligns with positive spreads
* **Graph:** Spread vs. hydro net-flow (pump – generation) by hour

| **Region** | **Primary Generation Mix (2023)** | **Future Highlights** |
| --- | --- | --- |
| **Hokkaido** | - **Renewables 40.5 %**: Solar 10.3 %, Wind 6.9 %, Hydro 16.2 %, Biomass 6.7 %, Geothermal 0.3 % ([isep.or.jp](https://www.isep.or.jp/en/1529/?utm_source=chatgpt.com))- **Nuclear 0 %**- **Thermal 59.5 %** (Coal ∼25 %, LNG ∼20 %, Oil ∼15 %) | - Aim to raise renewables to 60 % by 2030, led by offshore wind (Ishikari Bay 112 MW commissioned 2024) ([en.wikipedia.org](https://en.wikipedia.org/wiki/Ishikari_Bay_New_Port_Offshore_Wind_Farm?utm_source=chatgpt.com))- Large-scale flow-battery projects to firm up variable output, supporting another 15 wind farms by 2030 ([washingtonpost.com](https://www.washingtonpost.com/climate-solutions/interactive/2024/flow-batteries-renewable-energy-storage/?utm_source=chatgpt.com)) |
| **Tohoku** | - **Renewables 40.2 %**: Solar 13.6 %, Wind 5.6 %, Hydro 14.3 %, Geothermal 1.4 % ([isep.or.jp](https://www.isep.or.jp/en/1529/?utm_source=chatgpt.com))- **Nuclear ∼5 %** (Onagawa reactors)—restarts in planning- **Thermal ∼54.8 %** (Gas ∼30 %, Coal ∼20 %, Oil ∼5 %) | - New pumped‐storage projects to balance renewables ([enecho.meti.go.jp](https://www.enecho.meti.go.jp/en/category/brochures/pdf/japan_energy_2023.pdf?utm_source=chatgpt.com))- Expansion of onshore wind and solar, targeting a 50 % renewables share by 2035 under METI’s Sixth Basic Energy Plan ([gevernova.com](https://www.gevernova.com/content/dam/gepower-new/global/en_US/downloads/gas-new-site/en/jp/English_Japan_Energy_Outlook_Whitepaper_A4_FINAL.pdf?utm_source=chatgpt.com)) |
| **Tokyo (Kanto)** | - **Renewables 14.6 %** (VRE 12.1 %) ([isep.or.jp](https://www.isep.or.jp/en/1529/?utm_source=chatgpt.com))- **Nuclear 0 %**- **Thermal 85.4 %** (LNG dominant ∼60 %, coal ∼20 %, oil ∼5 %) | - TEPCO plans +6–7 GW new renewables by 2030 and restart idled reactors post-2011 ([worldbenchmarkingalliance.org](https://www.worldbenchmarkingalliance.org/publication/electric-utilities/companies/tokyo-electric-power-company-tepco-2/?utm_source=chatgpt.com))- Phasing out low‐efficiency coal; piloting hydrogen/ammonia co-firing at JERA plants ([asahi.com](https://www.asahi.com/ajw/articles/15519797?utm_source=chatgpt.com)) |
| **Chubu** | - **Renewables ∼22.7 %** (solar+wind 11.8 %) ([isep.or.jp](https://www.isep.or.jp/en/1529/?utm_source=chatgpt.com))- **Nuclear ∼20 %** (Hamaoka, Tokai)—partial restarts under review- **Hydro ∼15 %**, **Thermal ∼42 %** (LNG ∼25 %, coal ∼12 %, oil ∼5 %) | - OCCTO-led boost of Tokyo–Chubu interconnector from 2.1 GW to 3.0 GW by FY2027 ([gevernova.com](https://www.gevernova.com/content/dam/gepower-new/global/en_US/downloads/gas-new-site/en/jp/English_Japan_Energy_Outlook_Whitepaper_A4_FINAL.pdf?utm_source=chatgpt.com))- Major offshore wind tenders off Mikawa Bay, aiming for 1 GW by 2030 |
| **Hokuriku** | - **Renewables ∼22.7 %** (solar+wind 11.8 %) ([isep.or.jp](https://www.isep.or.jp/en/1529/?utm_source=chatgpt.com))- **Hydro ∼35 %** (multi-purpose dams)- **Nuclear ∼0 %**- **Thermal ∼42 %** (coal ∼20 %, LNG ∼15 %, oil ∼7 %) | - Upgrading large pumped-storage at Kurobe and Kamioka to absorb surplus PV ([enecho.meti.go.jp](https://www.enecho.meti.go.jp/en/category/brochures/pdf/japan_energy_2023.pdf?utm_source=chatgpt.com))- Strengthening ties to Chubu/Hokuriku and Kansai grids for better cross-area dispatch |
| **Kansai** | - **Renewables ∼22.7 %** (solar+wind 11.8 %) ([isep.or.jp](https://www.isep.or.jp/en/1529/?utm_source=chatgpt.com))- **Nuclear ∼16.5 %** (Ohi, Mihama, Takahama)—several restarts underway- **Hydro ∼10 %**- **Thermal ∼50 %** (coal ∼18 %, LNG ∼24 %, oil ∼8 %) | - Kansai Electric aiming for 50 % non-fossil by 2030; ramping up biomass co-firing ([fepc.or.jp](https://www.fepc.or.jp/english/data/electricity_review_japan/__icsFiles/afieldfile/2024/08/23/electricity_2024.pdf?utm_source=chatgpt.com))- Offshore wind pilot off the Kansai coast (Goal: 500 MW by 2030) |
| **Chugoku** | - **Renewables ∼22.7 %** (solar+wind 11.8 %) ([isep.or.jp](https://www.isep.or.jp/en/1529/?utm_source=chatgpt.com))- **Nuclear ∼20 %** (Shimane)—Unit 2 restart in 2024 ([en.wikipedia.org](https://en.wikipedia.org/wiki/Ishikari_Bay_New_Port_Offshore_Wind_Farm?utm_source=chatgpt.com))- **Hydro ∼10 %**- **Thermal ∼48 %** (coal ∼25 %, LNG ∼18 %, oil ∼5 %) | - Shimane 2 restarting → 820 MW nuclear capacity restored ([en.wikipedia.org](https://en.wikipedia.org/wiki/Ishikari_Bay_New_Port_Offshore_Wind_Farm?utm_source=chatgpt.com))- New battery storage and biomass projects to firm up solar output |
| **Shikoku** | - **Renewables 34.4 %**: Solar 16.6 %, Wind 2.0 %, Hydro ∼14.0 % ([isep.or.jp](https://www.isep.or.jp/en/1529/?utm_source=chatgpt.com))- **Nuclear 21.7 %** (Ikata)—phasing out by 2030 per Basic Energy Plan- **Thermal ∼44 %** (LNG ∼30 %, coal ∼10 %, oil ∼4 %) | - Interconnector reinforcement to Kansai (1.2 GW → 1.5 GW) by 2025 ([occto.or.jp](https://www.occto.or.jp/en/information_disclosure/outlook_of_electricity_supply-demand/index.html?utm_source=chatgpt.com))- Shikoku EPC developing 300 MW offshore wind off Iyo Gulf by 2030 |
| **Kyushu** | - **Renewables 28.4 %** (VRE 16.6 %) ([isep.or.jp](https://www.isep.or.jp/en/1529/?utm_source=chatgpt.com))- **Nuclear ∼20–25 %** (Genkai, Sendai)—several units returning online- **Hydro ∼10 %**- **Thermal ∼46 %** (LNG ∼25 %, coal ∼15 %, oil ∼6 %) | - Kyuden plans 1 GW offshore wind by 2030; first floating pilot off Amami in 2025 ([enecho.meti.go.jp](https://www.enecho.meti.go.jp/en/category/brochures/pdf/japan_energy_2023.pdf?utm_source=chatgpt.com))- Hydrogen co-firing trials at Sendai plant and expanded biomass blending |