# Electricity price forecasting method for the JEPX spot market based on ARIMA model

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## Background, Purpose and Vision

・Japan's power trades expand in Japan Electric Power Exchange (JEPX) market with the trade volume of the day-ahead spot market increased.

・Feed-In Tariff (FIT) based between household consumers and electricity companies start to expire sequentially from the end of 2019.

・Japan recorded large increases in solar energy and the growth is on course to accelerate over the coming years.


## Predictor Variable Selection

| | | Variable description | | | Variable selection process | | | |
|---|---|---|---|---|---|---|---|---|
| Variable | | Definition | Unit | URL | Step1 | Step 2 | Step 3 | Step 4 |
| X | *Dt* | Total demand of electricity | (GWh) | [1] | O | O | | |
| | *Dn* | Net demand for electricity (total demand minus Solar PV power generation) | (GWh) | [1] | O | O | O | O |
| | *Gf* | Fossil fuel power generation | (GWh) | [1] | O | O | - | - |
| | *Gs* | Solar photovoltaic power generation | (GWh) | [1] | O | O | - | - |
| | *Gh* | Hydro power generation | (GWh) | [1] | O | O | O | - |
| | *Gp* | Pumped-storage hydroelectricity | (GWh) | [1] | O | - | - | - |
| | *Gw* | Wind power generation | (GWh) | [1] | O | O | O | O |
| | *Gn* | Nuclear power generation | (GWh) | [1] | - | - | - | - |
| | *Gg* | Geothermal power generation | (GWh) | [1] | - | - | - | - |
| | *Gb* | Biomass power generation | (GWh) | [1] | O | - | - | - |
| | *Ei* | Electricity imports | (GWh) | [1] | O | - | - | - |
| | *T* | Temperatures | (°C) | [2] | O | O | O | O |
| | *W* | Wind speed | (m/s) | [2] | O | O | O | - |
| Y | *Ps* | System price in the JEPX spot market | (yen/kWh) | [3] | - | - | - | - |

* The circle symbol (O) means that the variable passed the corresponding selection check or test.

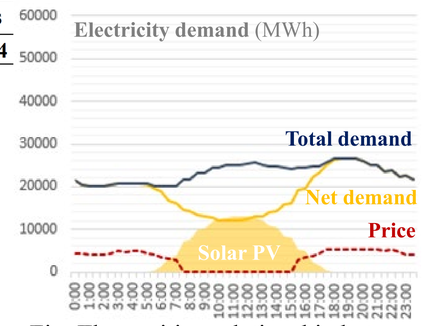


Fig. The positive relationship between net demand and spot market price

- **Step 1 :** validity check
- **Step 2 :** predictability check
- **Step 3 :** multicollinearity test
- **Step 4**: significant test

## Spot Market Price forecasting Results

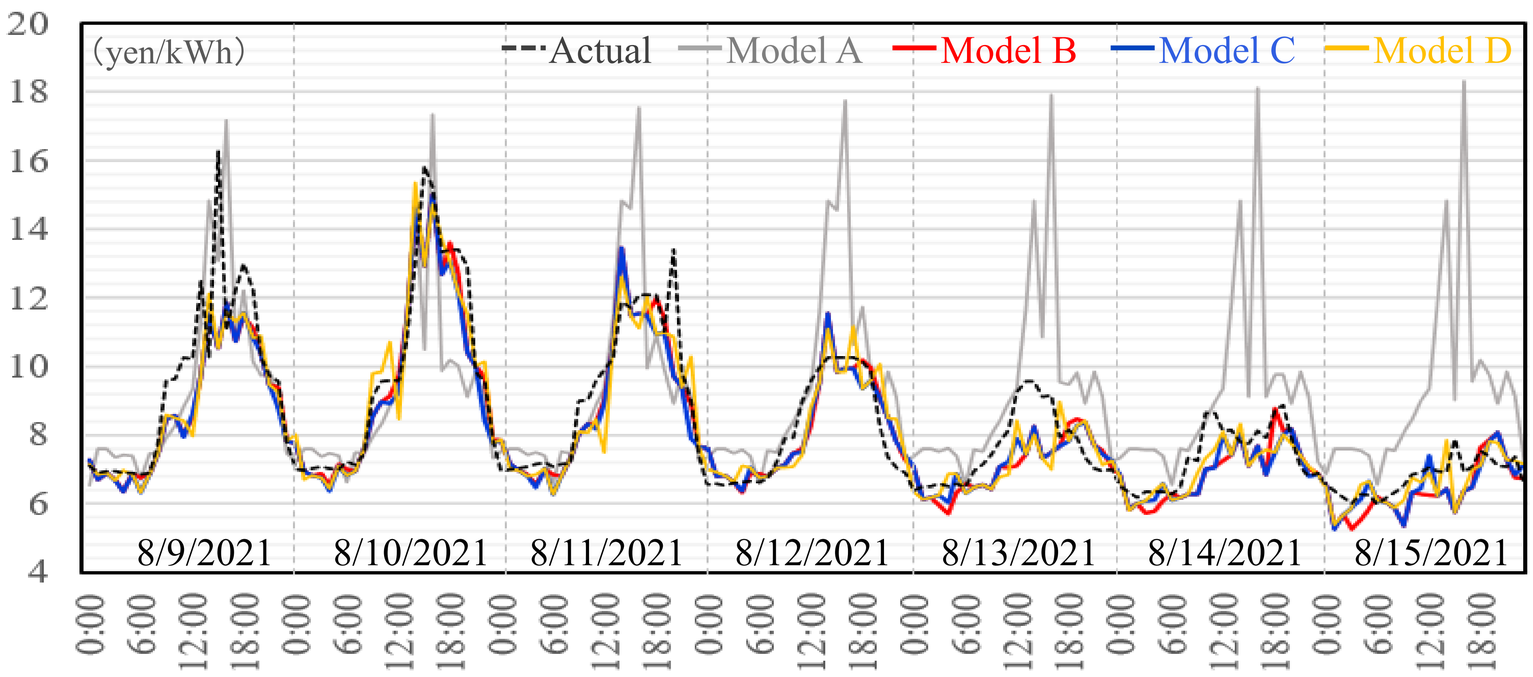


Fig. The actual and predicted prices result for one week

## Dataset and Method

・**Study area:** Tokyo area, Japan

・**Time period:** First half of FY2021

① Study time: 4/1/2021~8/8/2021

② Prediction time: 8/9/2021~8/15/2021

・**Data set:** 1-hour data

Actual values (Model validation)

Predict values (Future practical project)

・**Model:** ARIMA

(Autoregressive Integrated Moving Average)

・**Software:** SPSS statistics (28.0)

## Performance Evaluation

| Model | Dependent variable | Exogenous variables* | | | Estimation | | Evaluation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Dn* | *T* | *Gw* | Over | Under | MSE | RMSE | MAPE | MAE | $R^2$ | Σ z-score** |
| A | *Ps* | - | - | - | 94.64% | 5.36% | 5.900 | 2.429 | 18.505 | 1.565 | 0.847 | 13.499 |
| B | *Ps* | O | - | - | 54.17% | 44.64% | 0.976 | 0.988 | 7.526 | 0.668 | 0.974 | 3.455 |
| C | *Ps* | O | O | - | 55.95% | 42.86% | 0.996 | 0.998 | 7.724 | 0.693 | 0.973 | 3.586 |
| D | *Ps* | O | O | O | 54.76% | 44.05% | 0.971 | 0.986 | 7.489 | 0.675 | 0.974 | 3.460 |

Note: **Ps* (yen/kWh) means the system price in the JEPX spot market. *Dn* (GWh) means the net demand for electricity (total demand minus Solar PV power generation). *T* (°C) means the average temperature in Tokyo Metropolitan. *Gw* (GWh) means wind power generation. The circle symbol "O" means that the exogenous variable is used in the model. **Σ z-score is the sum of standarlized scores (between 0 and 2) of five evaluation results, where the $R^2$ scores took a negative value. A smaller Σ z-score means a better fit model.

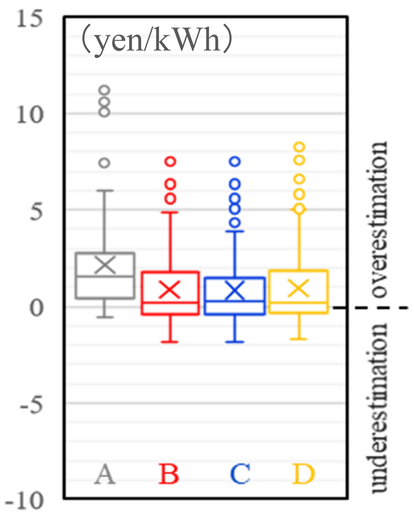


Fig. The error range
(Predicted minus actual prices)

## Conclusions

・There is an obvious positive relationship between the net demand (total demand minus Solar's contribution) and the spot price of the corresponding timeframes.

・ The ARIMA method combined with related predictor variables improves the forecast accuracy in JPEX spot market.

・ It can be basically fitted with a better performance in the daytime, but the accuracy needs to be further improved.

## Acknowledgments

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## References

[1] TEPCO, https://www.tepco.co.jp.

[2] Japan Meteorological Agency, https://www.jma.go.jp.

[3] JEPX, http://www.jepx.org/market.