Study Committee C2

System Operation and Control

10635

Applying Big Data Analytics to Demand Forecast in Island Power Systems towards Large Installation of Renewable Energy

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Motivation

- This paper studies about electricity demand forecasting methods for **nine islands** that have independent power systems from each other.
- Demand forecasting is important for reducing the number of the output control of renewable energy.

Fig. 1 Location of nine islands

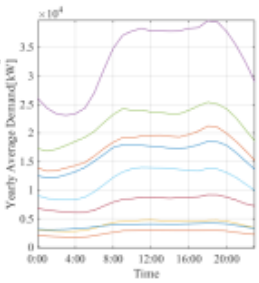

Fig. 2 Yearly average demand

Experimental setup and results

- The accuracy of the demand forecast at 0:00, 1:00, ... 23:00 of the next day is evaluated with the four cases shown in Table 1.
- The mean absolute percentage error (MAPE) is shown in Fig. 4.

Table I Setting of the cases

	Explanatory Variable Selection Period	Forecast Error Evaluation Period
Case 1	Period 1	Period 1
Case 2		Period 2
Case 3	Period 1+Period2	Period 1
Case 4		Period 2

Period 1 is from November 1, 2017 to October 31, 2018.
Period 2 is November 1, 2018 to October 31, 2019.

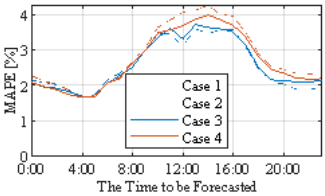

Fig. 4 MAPE of one of the nine islands

Method

- As a demand forecasting method considering the difference in demand trends between the islands, a method that automatically constructs forecasting formulae by applying big data analysis to past data is proposed.
- The feature of the proposed method is that the explanatory variables used in the forecasting formula are automatically selected based on the past data.

Discussion and conclusion

- The forecast errors are considered to be within an appropriate range because the validity of the individual forecast results has been visually confirmed. The proposed method is a promising forecast method.
- A future work is to develop forecasting techniques which can follow changes in demand trends because the experimental results suggests that the trends of the islands can change over time and old past data is not always useful for forecasting.

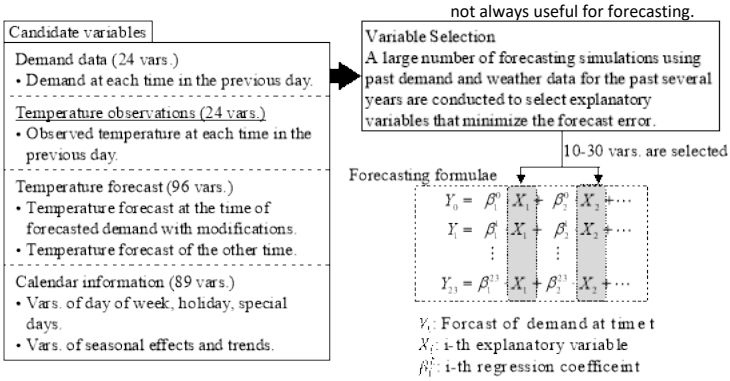

Fig. 3 Selecting effective variables by using big data analytics.

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continued

Candidate variables

- Table II shows the candidate variables for the explanatory variables.
- The cooling and heating variables, denoted by X cooling and X heating respectively, are calculated as follows:

$$X^{cooling} = \max\left(0, X^{Temperature} - Threashold\right)$$
$$X^{Heating} = \max\left(0, Threshold - X^{Temperature}\right)$$

- The yearly cycle variables are calculated as follows:

$$X^{yearly-cycle} = \sin\left(\frac{2\pi n}{365}\right)$$

Selected variables

- The explanatory variables selected for each island in Case 3 and Case 4 are shown in Table III. The places where many variables have been selected are shown with background color. This background color indicates the places of maximum value in each row.
- The tendency of the selected variables differs from island to island.

Table II Candidates of explanatory variables

(i) Demand data (24 vars.) • Demand during the period from 0:00 to 23:00 on the previous day of the date the forecast is performed.
(ii) Temperature observations (24 vars.) • Temperature observations during the period from 0:00 to 23:00 on the previous day of the date the forecast is performed.
(iii) Temperature forecast (96 vars) (a) Forecasted temperature at a specific time (40 vars.). (b-1) Forecasted temperature at the time of the demand to be forecasted (14 vars.). (b-2) The forecasted maximum temperature for the next day (14 vars.) (b-3) The forecasted minimum temperature for the next day (14 vars.) (b-4) The Average of (b-1), (b-2), and (b-3). (14 vars.).
(iv) Calender information (89 vars.) • Day of the week (7 vars.), holidays (19 vars) and before and after holidays (36 vars). • Trend variables (3 vars.) and yearly cycle variables (24 vars.).

Table III Numer of selected variables

Candidate Variable	Island Number								
	1	2	3	4	5	6	7	8	9
Demand observation	2	1	2	1	1	1	1	2	0
Temperature Observation	0	0	0	0	0	0	0	1	0
Temperature Forecast at the time of the demand to be forecasted	2	2	1	2	2	1	1	3	1
Maximum Temperature Forecast	0	0	1	1	1	1	1	1	0
Minimum Temperature Forecast	0	1	1	0	0	1	1	0	1
Temperature Forecast Average	4	1	0	0	1	3	1	3	2
Temperature Forecast of Specific Time	5	4	2	2	3	2	4	1	4
Day of the Week	1	1		1	1	1	2	1	1
Holiday	5	2	2	2	2	3	2	1	3
Before and After Holiday	6	2	1	3	3	1	3	1	2
Yearly Cycle Variable	2	2	0	1	0	1	0	0	1
Trend Variable	0	0	0	0	0	0	0	0	0

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Experimental results of nine islands

- MAPE is calculated as follows:

$$\mathrm{MAPE}=100\times\frac{1}{D}\sum_{d=1}^{D}\left|Y_d^{\mathrm{forecast}}-Y_d^{\mathrm{true}}\right|\Big/Y_d^{\mathrm{true}}$$

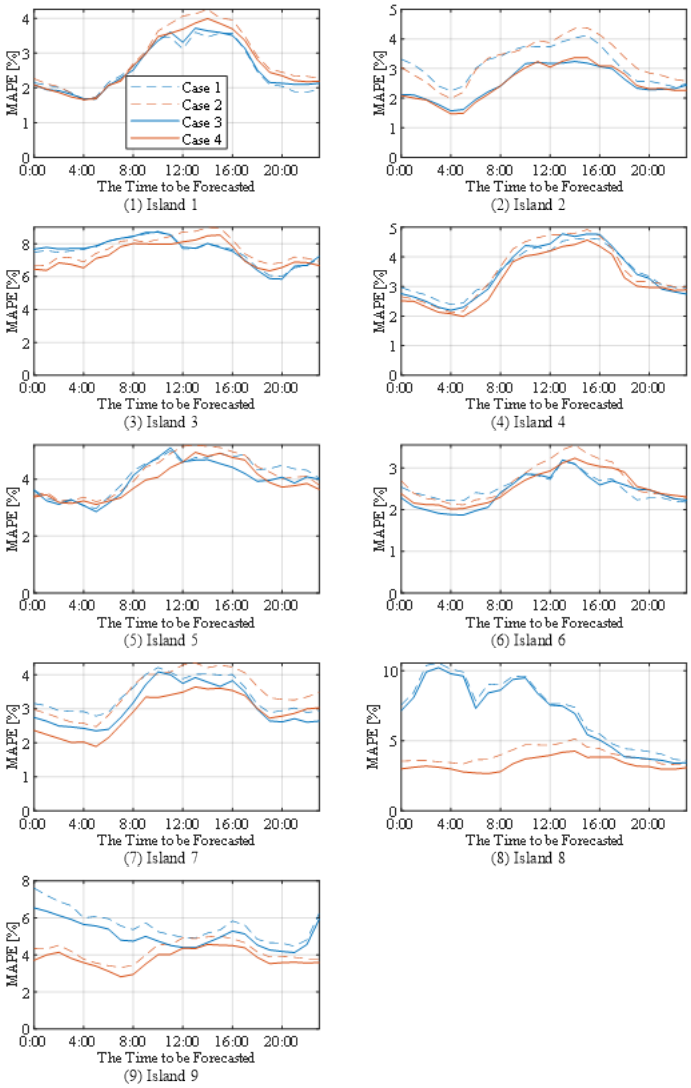

Fig. 5 MAPE of each island