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An application of parametric modelling to New Zealand wind power

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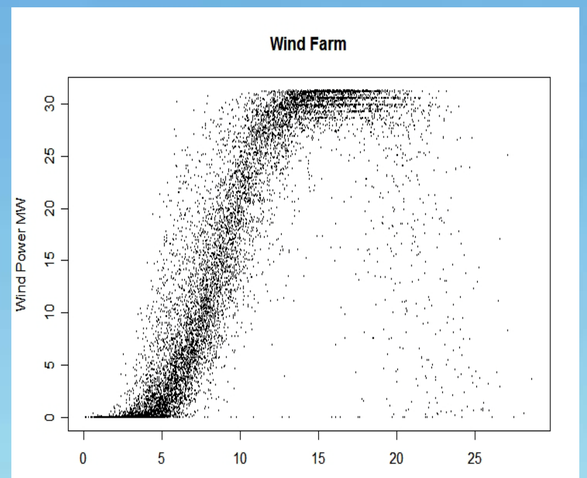
Abstract: To model wind power within a conditional probability density framework and to estimate parameters through regression polynomial functions, finally to apply simulation data to a Dispatch Model for validation.

• INTRODUCTION

Wind energy is a source of renewable power generated from wind flowing. In New Zealand, it is one of the fastest growing sources of electricity. The utility of wind provides potential ability to meet future demand from the society. It presents challenges to the New Zealand Electricity Market (NZEM).

Methods to model wind power [1] includes persistence predicted wind, transforming wind to power at a turbine and forecasting the uncertainty in a wind farm.



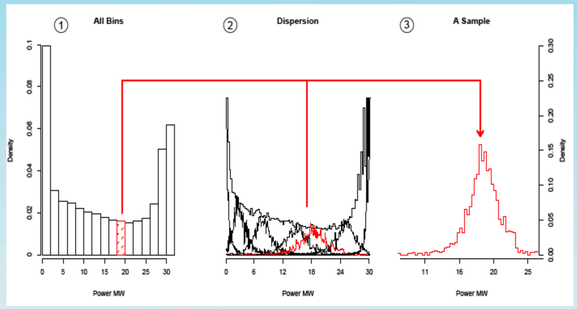
• METHODS

The conditional probability density function is a key concept which returns a probability of uncertainty at time t+1 given power at time t.

STEP 1. Tararua wind farm [2] is chosen as an example. Observations are divided into smoothing groups according to the power outputs.

STEP 2. Based on sub groups, data in each bin produces a conditional data set which has a distributed form with a characterised unimodal besides of two fat tails.

STEP 3. Various methods are developed to estimate the distribution densities.



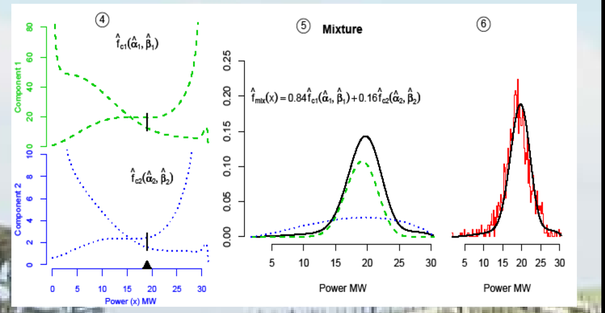
• MODELS

Mixture Beta distribution with two components interprets the information revealed by power outputs. The components have flexibility for different unimodal shapes.

STEP 4. Each component has two parameters, α and β. The values of α and β are mathematically explained by power outputs. Two simplified polynomial functions evaluate parameters.

STEP 5. The components, each of which represents a group of outputs with similar behaviours, are combined into a mixture model.

STEP 6. The Mixture Beta distribution estimates the density function of wind power.

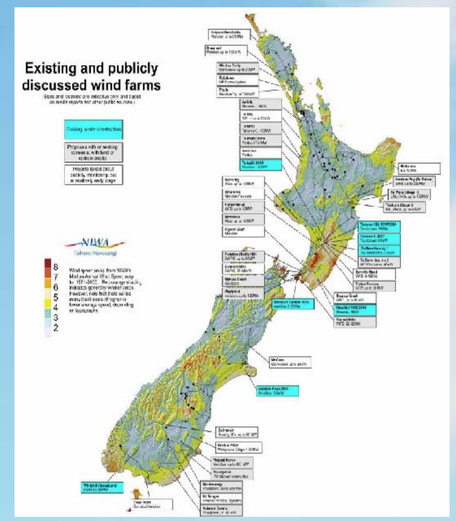


• SIMULATION

National Institute of Water and Atmospheric Research (NIWA) investigated New Zealand wind map [3]. The Electricity Commission [4] provided background information.

Three wind scenarios are simulated in the Dispatch Model by applying synthetic power data as one of input variables.

- Scenario A: installed wind capacity 420MW
- Scenario B: installed wind capacity 1250MW
- Scenario C: installed wind capacity 2250MW



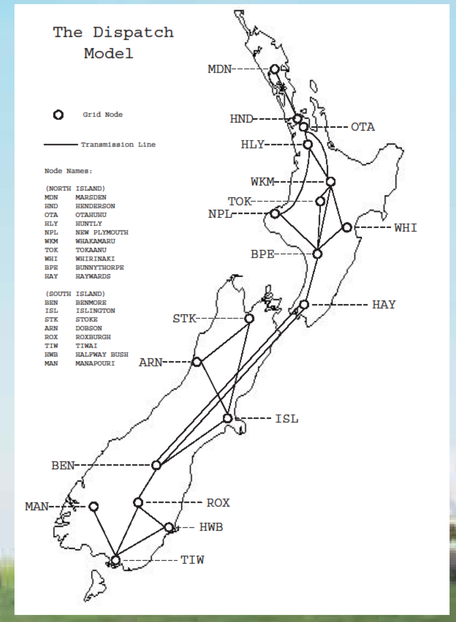
• DISCUSSION

The Dispatch Model models NZEM [5]. It uses linear programming techniques to optimise generation cost.

The New Zealand optimal Load dispatch model consists of 18 nodes and corresponded electricity network. Its structure has input decision variables, objective functions and constraints.

Validation of Mixture Beta simulation in the Dispatch Model requires:

- Input variables: actual grid loads, offers from generators and synthetic wind power offers
- Modification on the Dispatch Model for simulation runs
- Output analysis: time dependent prices and transmission line constraints
- Offer management thought different uncertainty levels of wind power



• REFERENCES

[1] A. Costa, A. Crespo, J. Navarro, G. Lizcano, H. Madsen and E. Feitosa (2008). A Review on the Young History of the Wind Power Short-term Prediction. Renewable and Sustainable Energy Reviews. Vol, 12 : 1725–1744
[2] Electricity Commission (2010). The Centralised Dataset. Wellington.
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[5] T. Alvey, D. Goodwin, X. Ma, D. Streiffert and D. Sun. (1998). A Security-constrained Bid-clearing System for the New Zealand Wholesale Electricity Market. IEEE Transactions on Power System. Vol. 13, No. 2.