Economic Consulting Associates

Wairoa Electricity Dispatch Model
ECA provides economic consulting advice to governments, regulators, and investors

20 years in business

60+ assignments annually

15+ years average experience

23 Economists

100% Employee owned

30+ Regulators advised

65+ Countries worked in

3 Office locations

15+ National utilities advised
Wairoa is ECA’s in-house electricity dispatch model

What is Wairoa?
An Excel based dispatch model developed by ECA power systems experts.

It simulates electricity market outcomes under different conditions, using both enumerative and linear programming algorithms.

Simulations can be run quickly, even with large datasets, which allows testing of the sensitivity of results to multiple input scenarios.

Wairoa is designed to be user friendly without requiring large input databases at extra charges.

‘Wairoa’ means waterfall in Maori. It reflects ECA’s strong links to New Zealand and the dispatch model’s particular applicability to hydro heavy power systems.

Who uses Wairoa?
- Investors
- Utilities
- Policymakers
- Regulators
- Network and market operators

What can Wairoa be used for?
- Power development planning
- Asset valuations
- Generation investment decisions
- Network investment decisions
- Hydro optimisation
- Tariff studies
- Interconnection and trade studies
- Reliability assessments
- Integration of renewables
Wairoa outputs can be used to address a range of questions

**Market outcomes**
- What is the marginal cost of generation over a specified period?
- What is the average cost of generation?
- How can hydro assets optimally be dispatched?

**Asset valuation & Investment decision**
- What is expected capacity factor of specific power plant?
- What is the net economic benefit of an investment?
- Which plants compete directly with a given investment?

**Cross border trade**
- What are the expected flows across interconnectors?
- How do changes in other markets affect domestic generation?
- What is the commercial value of an electricity interconnector?

**Policy and planning**
- What is the fuel consumed for electricity generation?
- What is the impact of removing a transmission constraint?
- What is the expected energy lost within a year due to outages?
- What is the environmental impact of a power generation plan?
Model outputs are visual and readily accessible

Generator dispatch

Average variable cost

Hourly marginal cost

Utilisation of selected power plant

Hourly available capacity

Utilisation by generator
The model is Excel based and consists of six building blocks:

**Inputs**
Contains all inputs, some of which are constant over the whole timeframe, others that vary by period.

**Storage optimisation**
Optimally allocates stored energy across period, ignoring network constraints.

**Merit order**
Optimises dispatch for the whole period, ignoring network constraints.

**LP All**
Optimises dispatch for the whole period, including optimising stored energy, based on network constraints. Very computationally heavy.

**LP**
Optimises dispatch for one interval at a time, based on network constraints and pre-allocated stored energy. Computationally heavy.

**Outputs**
Compiles outputs for each period across the whole timeframe (depending on the calculation approach chosen).
A flexible dispatch model that enables users to choose the type of dispatch

Dispatch option 1: Merit order

The Merit order component of the model is a traditional merit order ‘stack’ of generation options. It optimises the dispatch of generation based on its variable cost of generation. It can prioritise renewable dispatch.

This dispatch option is fast to run, even with large datasets, and is therefore very useful for exploring the sensitivity of results to multiple input scenarios. But it cannot cope with network constraints, which requires a more sophisticated optimisation algorithm (see option 2).

Dispatch option 2: linear programming

This option can be used for a multi-regional dispatch, where network constraints exist. The linear programming option distinguishes between up to 10 regions and assesses the impact of network constraints.

Depending on the size of the system being modelled, the user can either optimise each hour separately (based on pre-optimised stored energy) or optimise the whole month or year simultaneously. This additional functionality comes with a high computational load and simulations can take longer.

Other adjustable key functionalities

- Hydro storage
- Hydro seasonality
- Battery storage
- Intermittency of renewables
- Selection of priority dispatch generators
- Forced outage rates
- Transmission constraints
- Transmission losses across interconnectors
- Transmission losses across generator connection lines
- Pumped storage treatment
- Battery storage treatment
- Number of regions/nodes modelled
- Maintenance schedules
- De-rating factors
Example application - hydro optimisation in Sri Lanka

Background

Sri Lanka is a hydro dominated system, with 1.4GW of installed hydro storage (peak load in 2017 was ~2.6GW).

To advise an investor, it was important to simulate dispatch of hydro optimally or we would overestimate the average cost of generation and the utilisation of peaking plants. We also needed to reflect changing hydrological conditions (the amount hydro capacity available each month varies significantly).

Approach

We simulated each month separately, including using different load profiles and different amounts of available hydro energy (i.e. water inflows). We assumed that stored hydro energy can be allocated across the month.

Allocating hydro energy optimally is about dispatching hydro during peak hours, when the avoided cost is highest. Other dispatch models simply ‘turn on’ hydro at full capacity during the peak hours, until the stored energy (i.e. water) runs out. This is sub-optimal and does not reflect reality. Wairoa smoothly ramps hydro dispatch down along the load duration curve, so that the stored energy is used optimally.
ECA’s offering for the usage of Wairoa

Access to Wairoa

We offer Wairoa as an integrated component of the services provided by ECA. We combine the application of Wairoa with the following advisory service lines:

- Investment appraisals and due diligence
- Tariff setting
- Market design
- Generation planning
- Dispute and litigation
- Energy planning and policy
- RES integration
- Impact assessments and Cost Benefit Analyses

Contact and further information

For further information on Wairoa and how the model can address commercial, regulatory or policy questions you may have, please contact Richard Bramley

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