Economic Consulting Associates

Wairoa Electricity Dispatch Model

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?

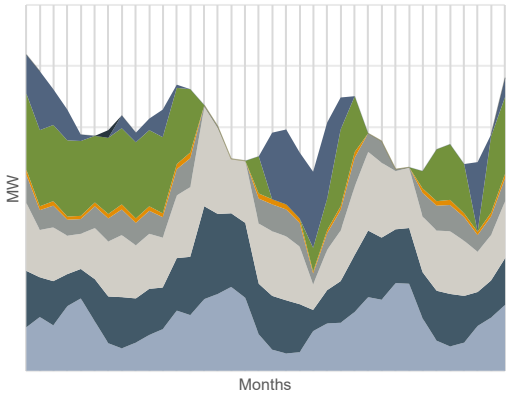
What is the impact of removing a transmission constraint?

What is the expected energy lost within a year due to outages?

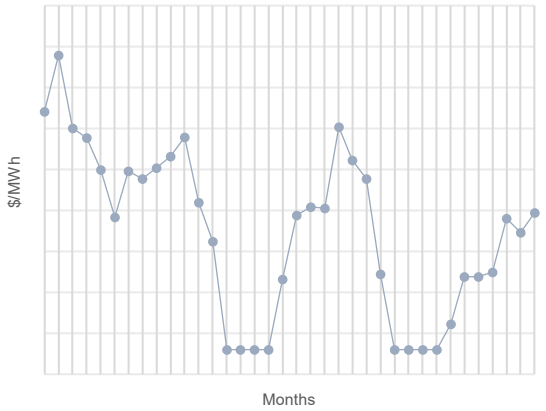
What is the environmental impact of a power generation plan?

Model outputs are visual and readily accessible

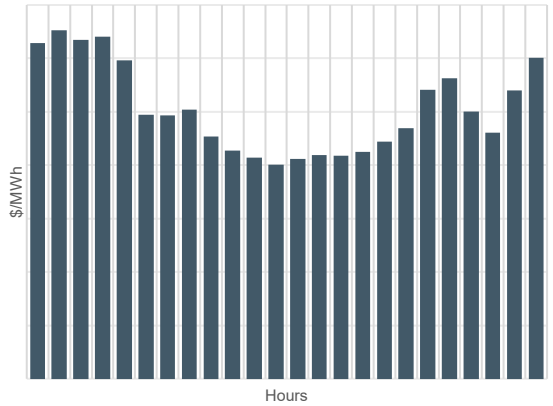
Generator dispatch



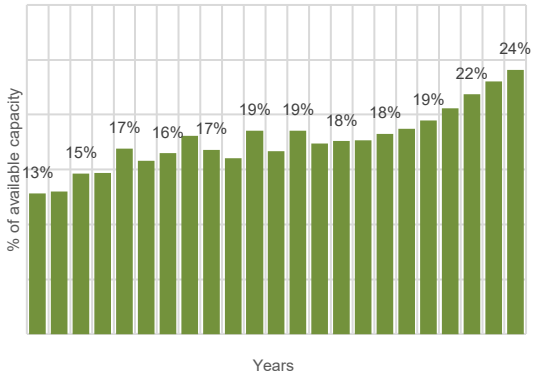
Average variable cost



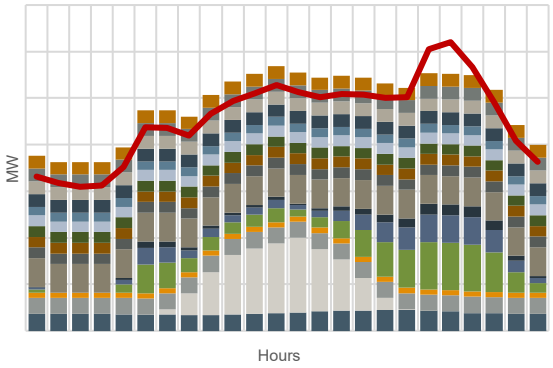
Hourly marginal cost



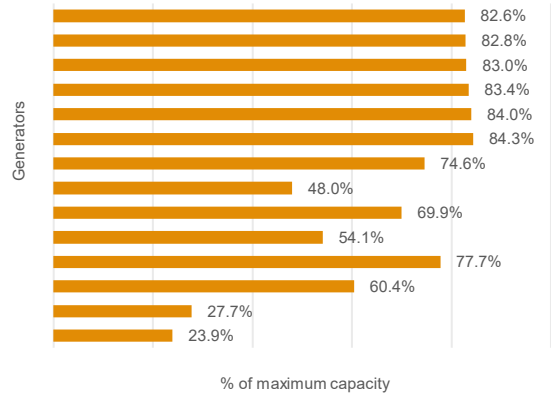
Utilisation of selected power plant



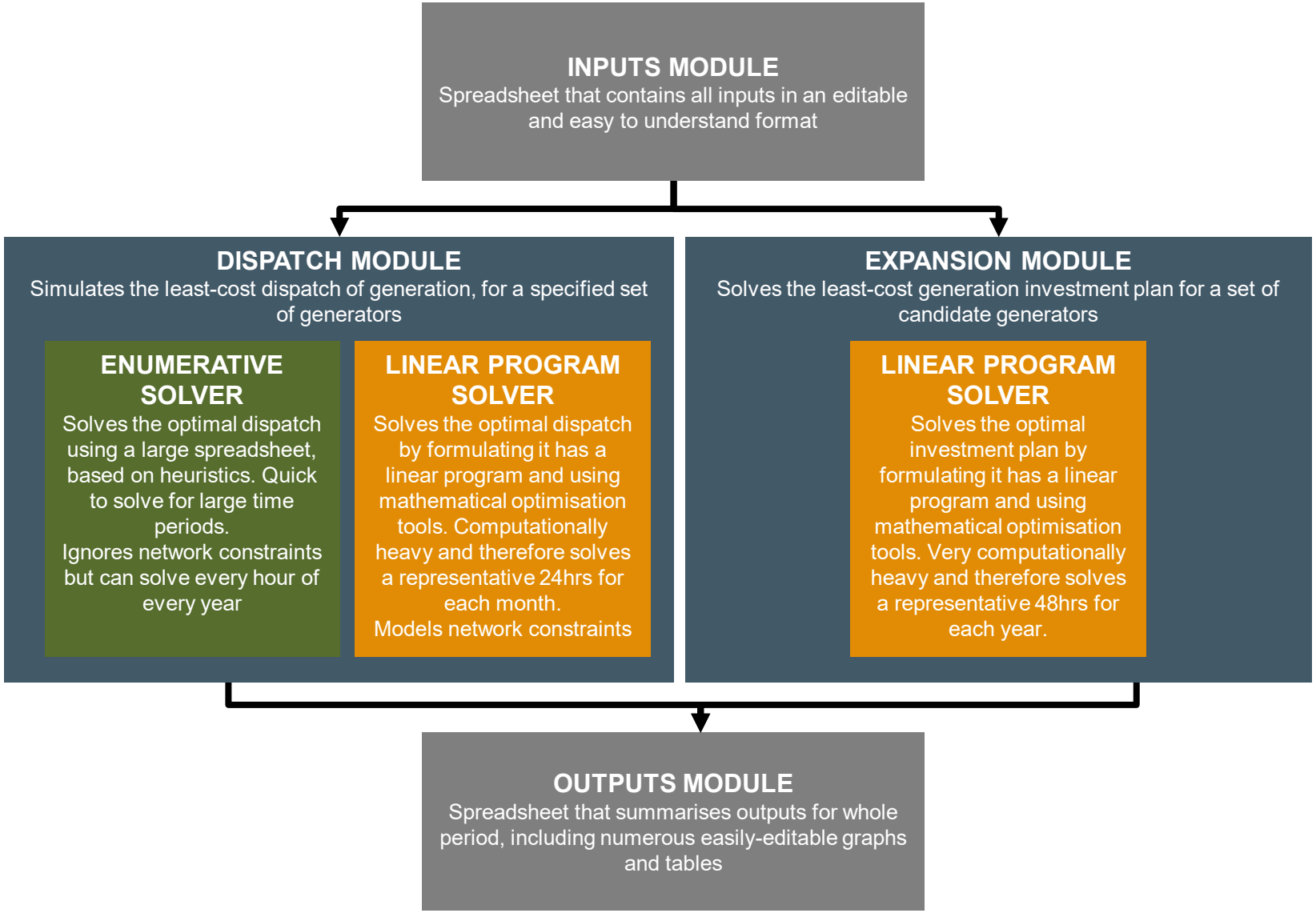
Hourly available capacity



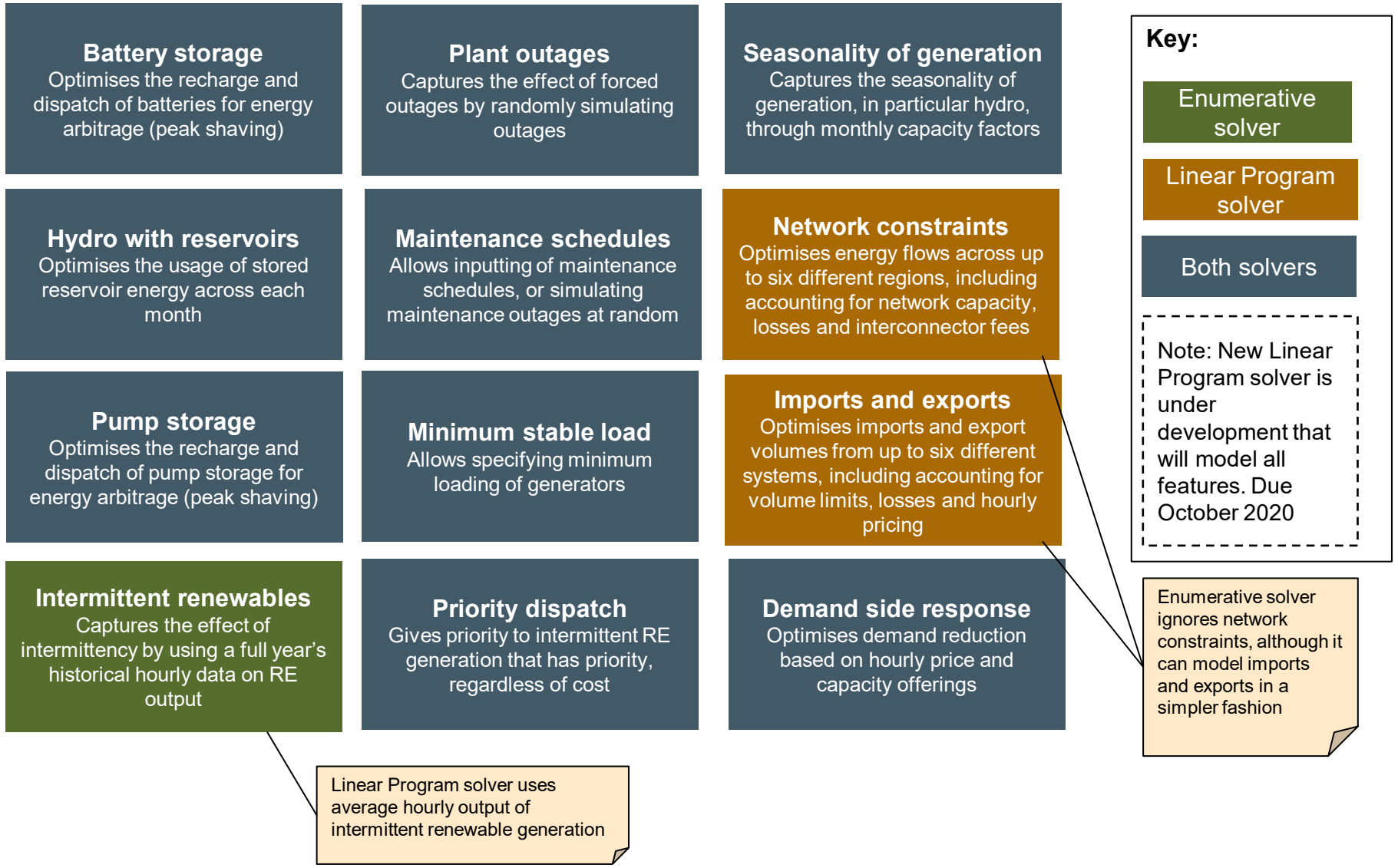
Utilisation by generator



The model is Excel based and consists of four modules



A wide range of power system complexities can be modelled



A flexible dispatch model that enables users to choose the type of solver

Wairoa has two different dispatch solvers

The enumerative module is best suited to systems that do not have significant network constraints and have significant intermittent generation.

The Linear Program solver is best suited to systems where network constraints have a significant impact on dispatch.

There is the option of feeding the results of the LP solver back into the enumerative solver (e.g. by constraining some generator availability) in an iterative manner to get results that best represent reality

	Enumerative solver	Linear Program Solver
Type of calculation	Solves as an enumerative spreadsheet calculation.	Includes network constraints and therefore needs to be solved as a Linear Program.
Speed of solve	Fast to run. It takes only a few seconds to solve a whole month (744 hours). It takes about 10 minutes to cycle through 20 years (240 months / 178,560 hours).	Slower to run. It takes approximately 1 minute to solve 24 hours. So it is slow to run it across large timeframes. Representative days are typically used to model large time frames (e.g. a representative day for each month over 20 years, which is 240 model runs).
Key advantage	Solving every hour allows full modelling of the effect of intermittent renewables (for example by inputting historical hourly output profiles of solar and wind generators).	Can be used for a multi-regional dispatch, where network constraints exist and are likely to be binding.

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).

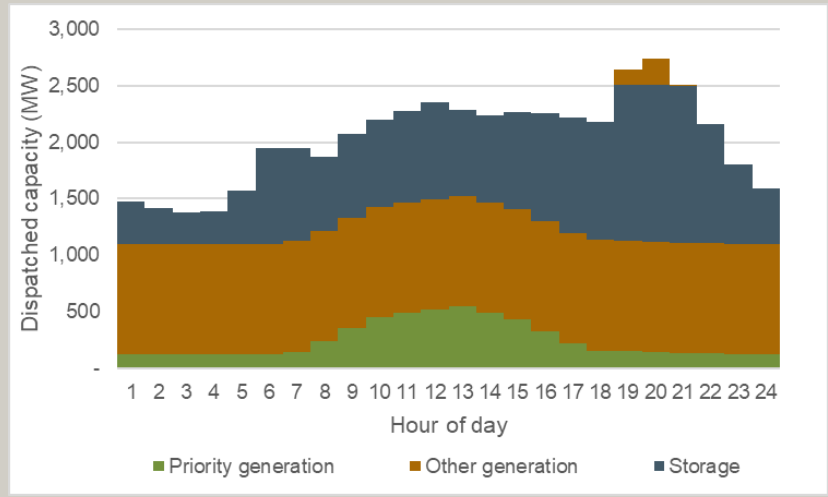
To advise an investor, it was important to simulate dispatch of hydro optimally or we would overestimate the average cost of generation and the utilisation of peaking plants. We also needed to reflect changing hydrological conditions (the amount hydro capacity available each month varies significantly).

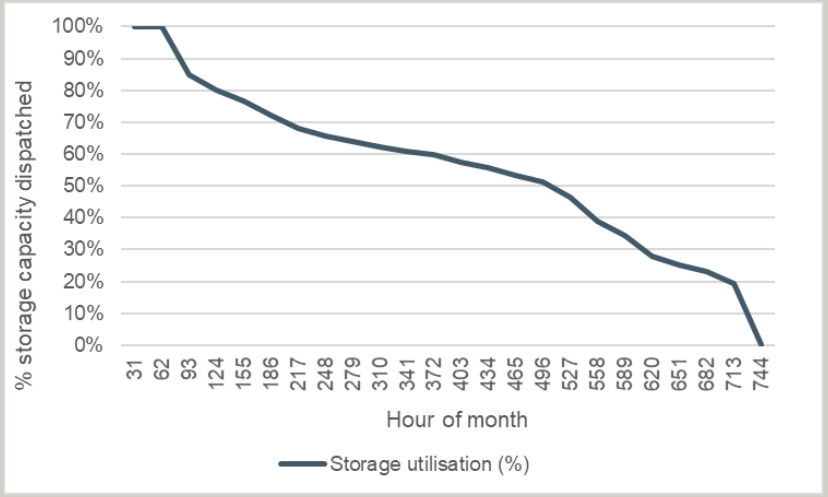
Approach

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.

Results





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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