Transmission to Enable Renewables update

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Background

- Current expectations of high fuel prices and carbon charges are likely to result in at least 90% of electricity generation from renewable generation by 2025.
- Transmission investments which are needed to support remote renewable generation investment are a current concern.
- The Part F rule framework should provide support for the integration of renewable generation when this is efficient.
- In 2007, the Commission initiated the Transmission to Enable Renewables (TTER Phase 1) project to better understand the related policy issues.

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Phase 1

- Phase 1 consisted of :
  - constructing a 'resource map' of possible wind, hydroelectric, and geothermal generation;
  - looking at real option analysis for investment timing; and
  - identifying network augmentations required to accommodate possible renewable generation.
- The information gathered fed into the 2008 Statement of Opportunities scenarios.
- A summary report was published in July 2008.

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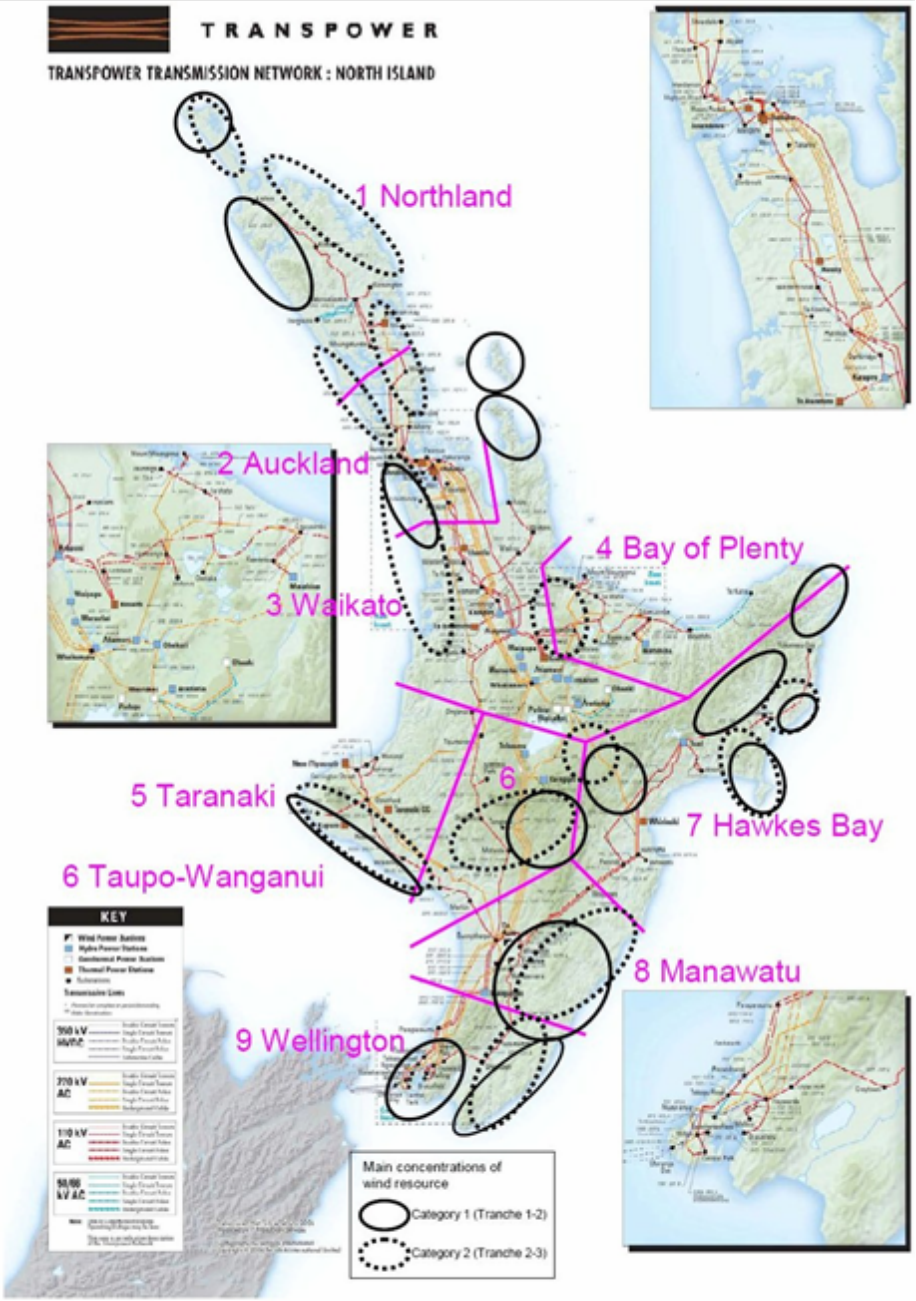
TRANSPOWER TRANSMISSION NETWORK : NORTH ISLAND



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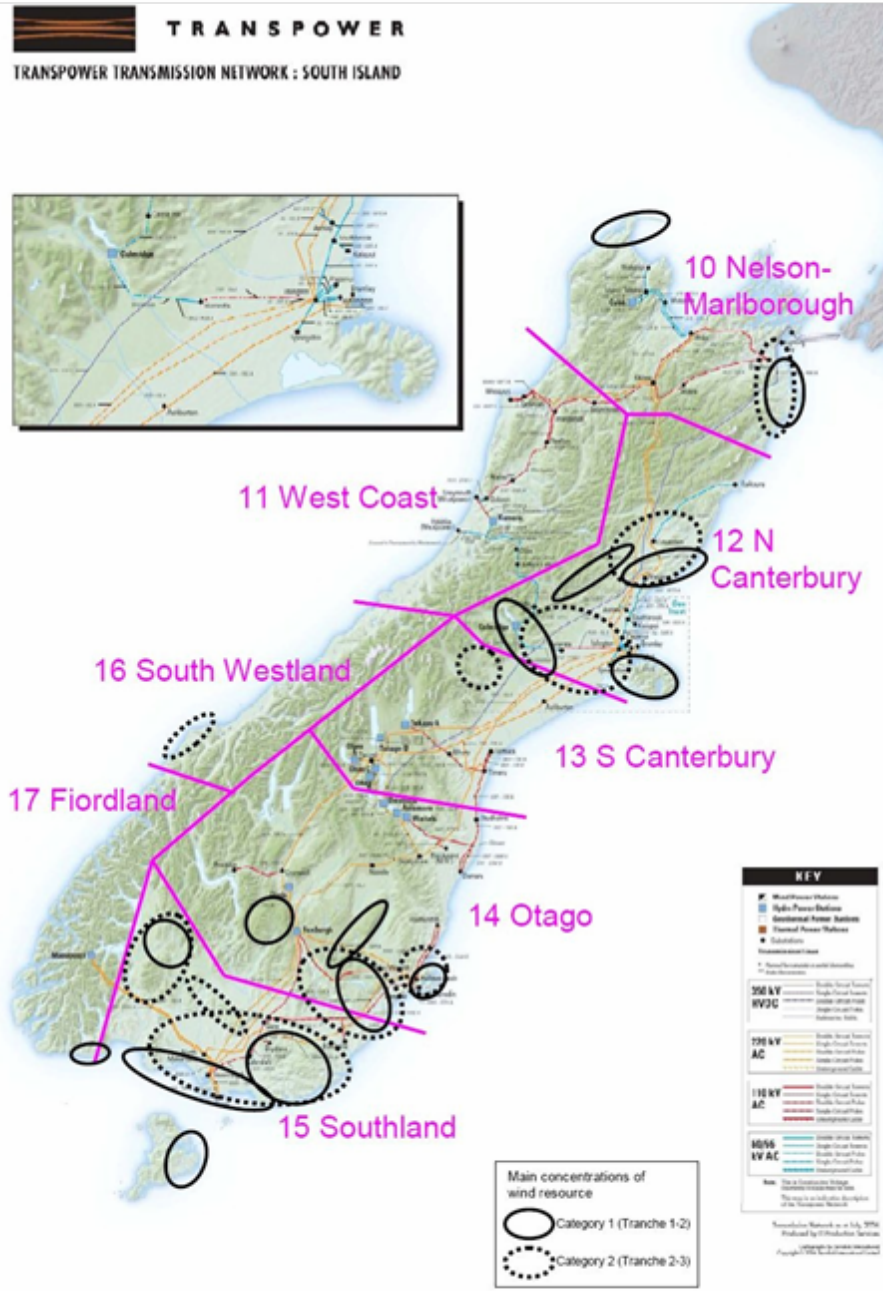

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Phase 2

- Key questions that remained unanswered from Phase 1 are:
  - Where and of what magnitude are the economic renewable resources located?
  - What are the costs and constraints for the development of these resources and would new transmission technologies better support development?
  - What possible changes to the regulatory framework should be considered?
- Phase 2 of the project will focus on:
  - new technologies: investigate possible economic benefits that could result from new transmission technologies; and
  - economic analysis: using the Commission's Generation Expansion Model (GEM) to support consideration of regulatory issues.

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New technologies

- The Commission has initiated work on:
  - System Protection Schemes (SPS): This work is looking at the potential benefits from the use of SPS, the types of SPS, development process and issues around SPS.
  - Dynamic Line Rating (DLR): This work will look at the current state of play internationally and will identify DLR opportunities available in NZ.
  - Conductor technologies: The Commission will review use of replacement conductors for typical lines used in NZ.
- The output of this work will be used as inputs to the economic analysis.

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Economic analysis

- The Commission has further developed the GEM to co-optimise generation and transmission analysis (i.e. a list of potential generation and transmission options)

- During Phase 2, the Commission will:
  - use the information acquired during Phase 1 to update the GEM input data (wind, hydro, marine, and geothermal);
  - update assumptions regarding biomass and peakers;
  - update the transmission information in GEM with the latest set of Commission's approvals (e.g. HVDC);
  - prepare a base case scenario with a high carbon charge and high gas price; and
  - use the GEM co-optimisation tool to identify opportunities for transmission investment.

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Economic analysis – cont.

- Sensitivity analysis would be required to fully understand the results of the co-optimisation runs.

- The Commission intends to perform sensitivity analysis on:
  - generation parameters (e.g. turbine costs);
  - new technology parameters; and
  - higher maximum levels of total energy from wind (current assumption is 20%).

- Using the outputs of the research to investigate possible refinements to the regulatory framework.

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GEM base case inputs

- Main key drivers
  - Carbon charge \$75/tCO_2
  - Shortage of gas – import LNG in 2020 at \$25/GJ (assumed oil at 100 USD/barrel and exchange rate at 0.65)
  - Diesel cost at \$33/GJ (~\$1.30/litre)
  - Coal price at \$4/GJ ??
- Wind assumptions
  - Capital cost: \$2600/kW
  - Variable O&M: \$15/MWh
  - Plant life: 20 years
  - Depreciation rate: 19%
  - Capacity factor: 0.35-0.45

  LRMC ~\$100/MWh
- Connection costs

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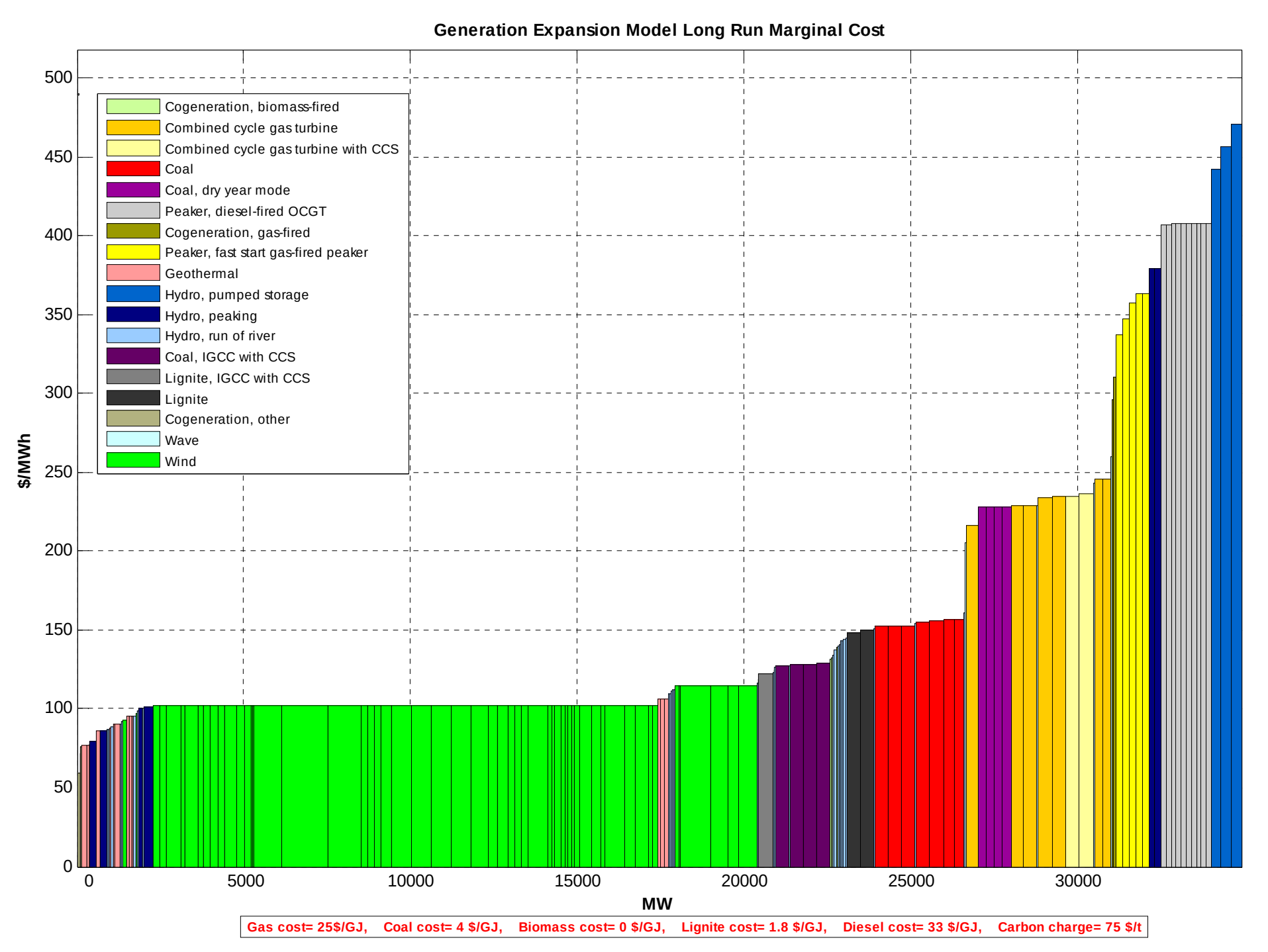
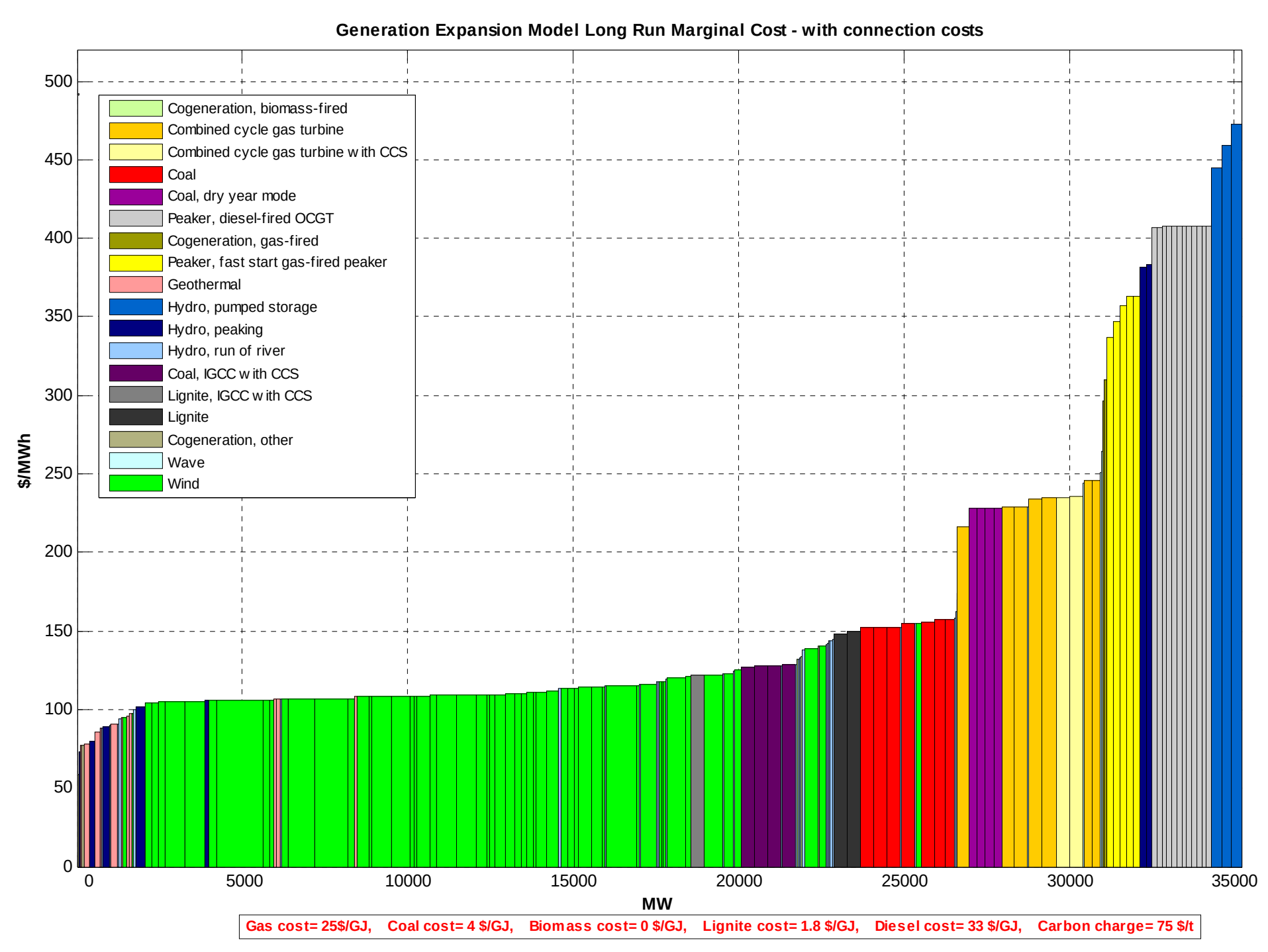
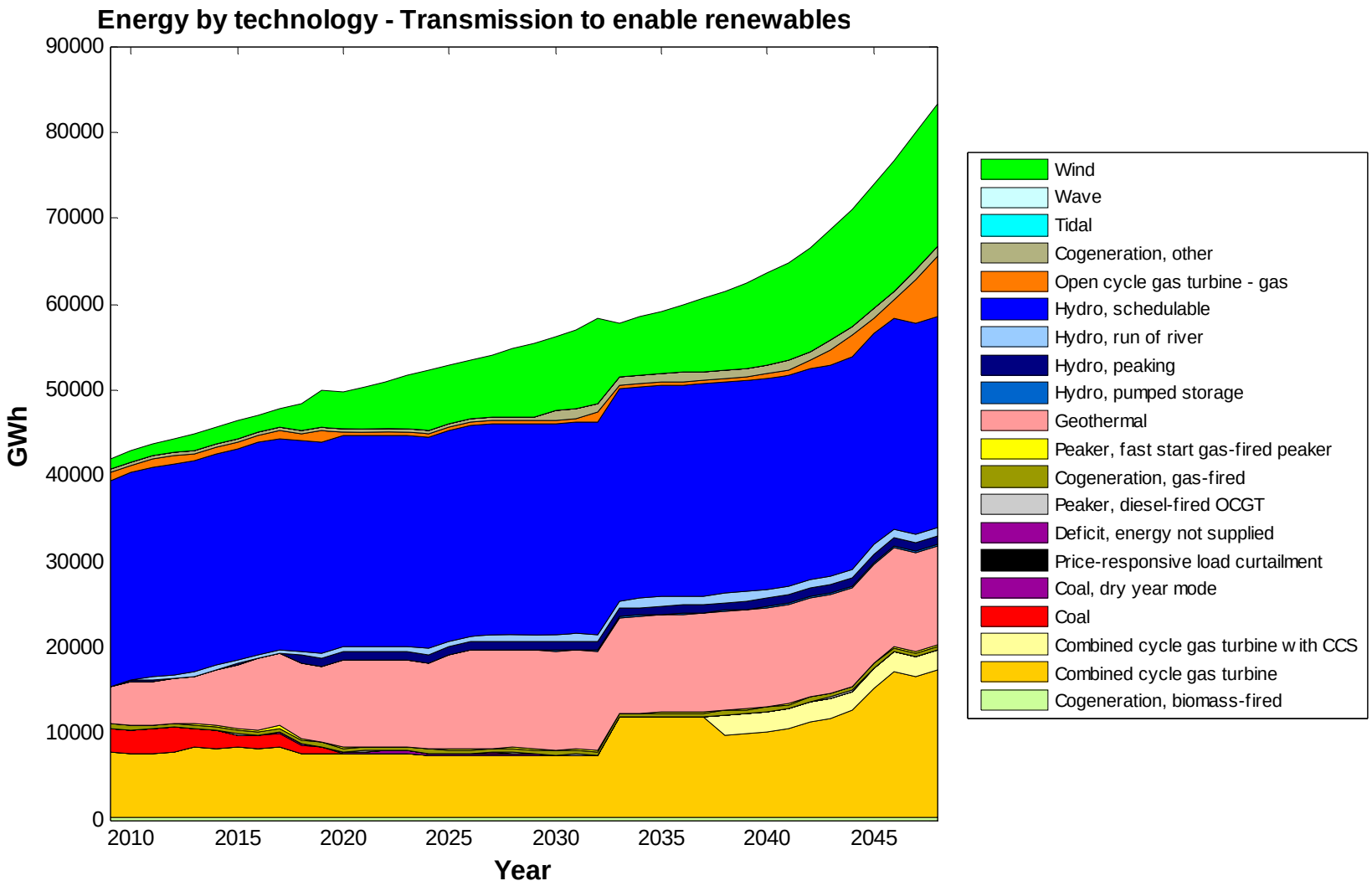

Generation Expansion Model Long Run Marginal Cost
Cogeneration, biomass-fired
Combined cycle gas turbine
Combined cycle gas turbine with CCS
Coal
Coal, dry year mode
Peaker, diesel-fired OCGT
Cogeneration, gas-fired
Peaker, fast start gas-fired peaker
Geothermal
Hydro, pumped storage
Hydro, peaking
Hydro, run of river
Coal, IGCC with CCS
Lignite, IGCC with CCS
Lignite
Cogeneration, other
Wave
Wind
$/MWh
MW
0
50
100
150
200
250
300
350
400
450
500
0
5000
10000
15000
20000
25000
30000
Gas cost= 25$/GJ, Coal cost= 4 $/GJ, Biomass cost= 0 $/GJ, Lignite cost= 1.8 $/GJ, Diesel cost= 33 $/GJ, Carbon charge= 75 $/t


Generation Expansion Model Long Run Marginal Cost - with connection costs
Cogeneration, biomass-fired
Combined cycle gas turbine
Combined cycle gas turbine with CCS
Coal
Coal, dry year mode
Peaker, diesel-fired OCGT
Cogeneration, gas-fired
Peaker, fast start gas-fired peaker
Geothermal
Hydro, pumped storage
Hydro, peaking
Hydro, run of river
Coal, IGCC with CCS
Lignite, IGCC with CCS
Lignite
Cogeneration, other
Wave
Wind
$/MWh
0
50
100
150
200
250
300
350
400
450
500
0
5000
10000
15000
20000
25000
30000
35000
MW
Gas cost= 25$/GJ, Coal cost= 4 $/GJ, Biomass cost= 0 $/GJ, Lignite cost= 1.8 $/GJ, Diesel cost= 33 $/GJ, Carbon charge= 75 $/t

Preliminary results



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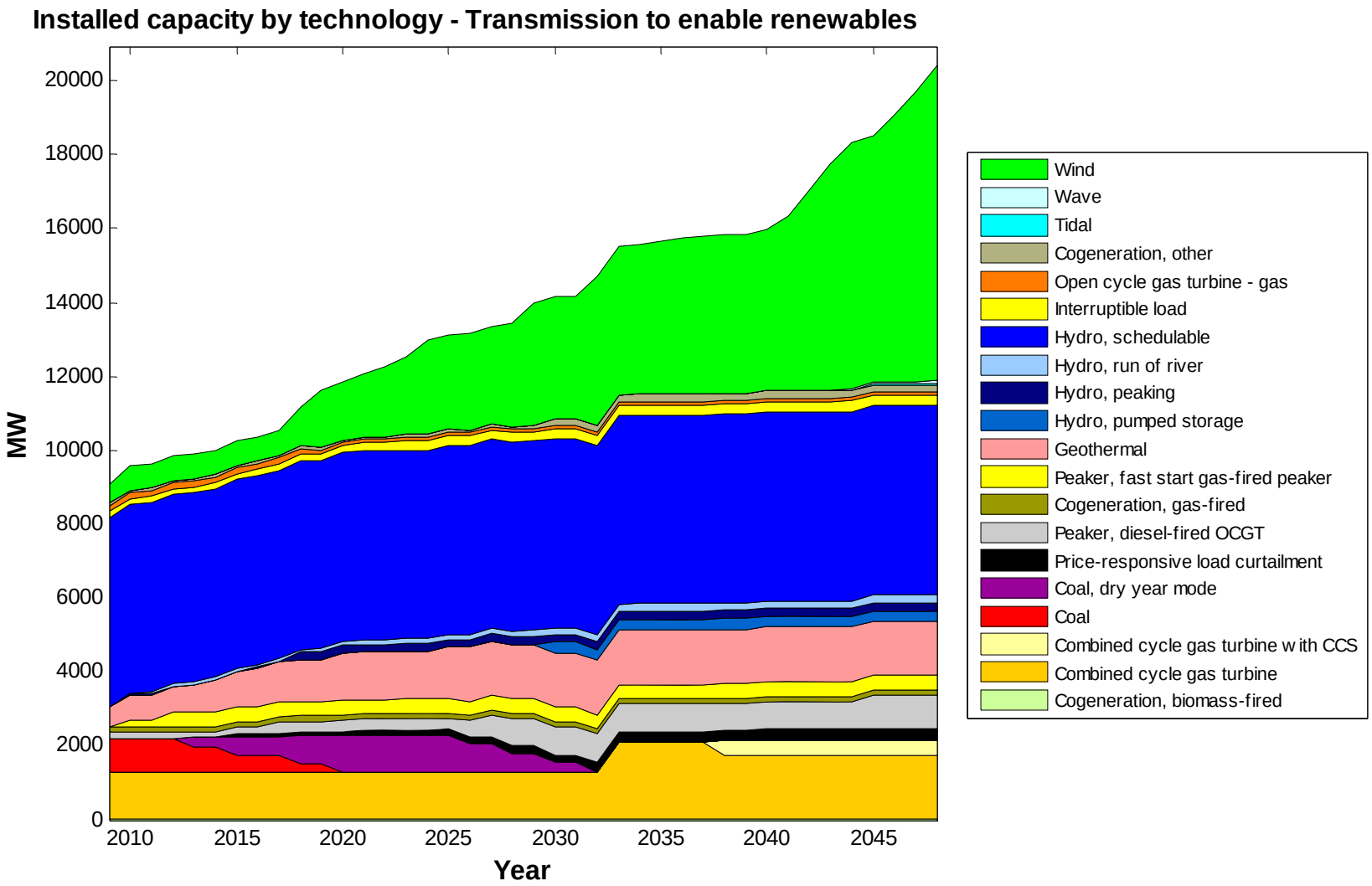

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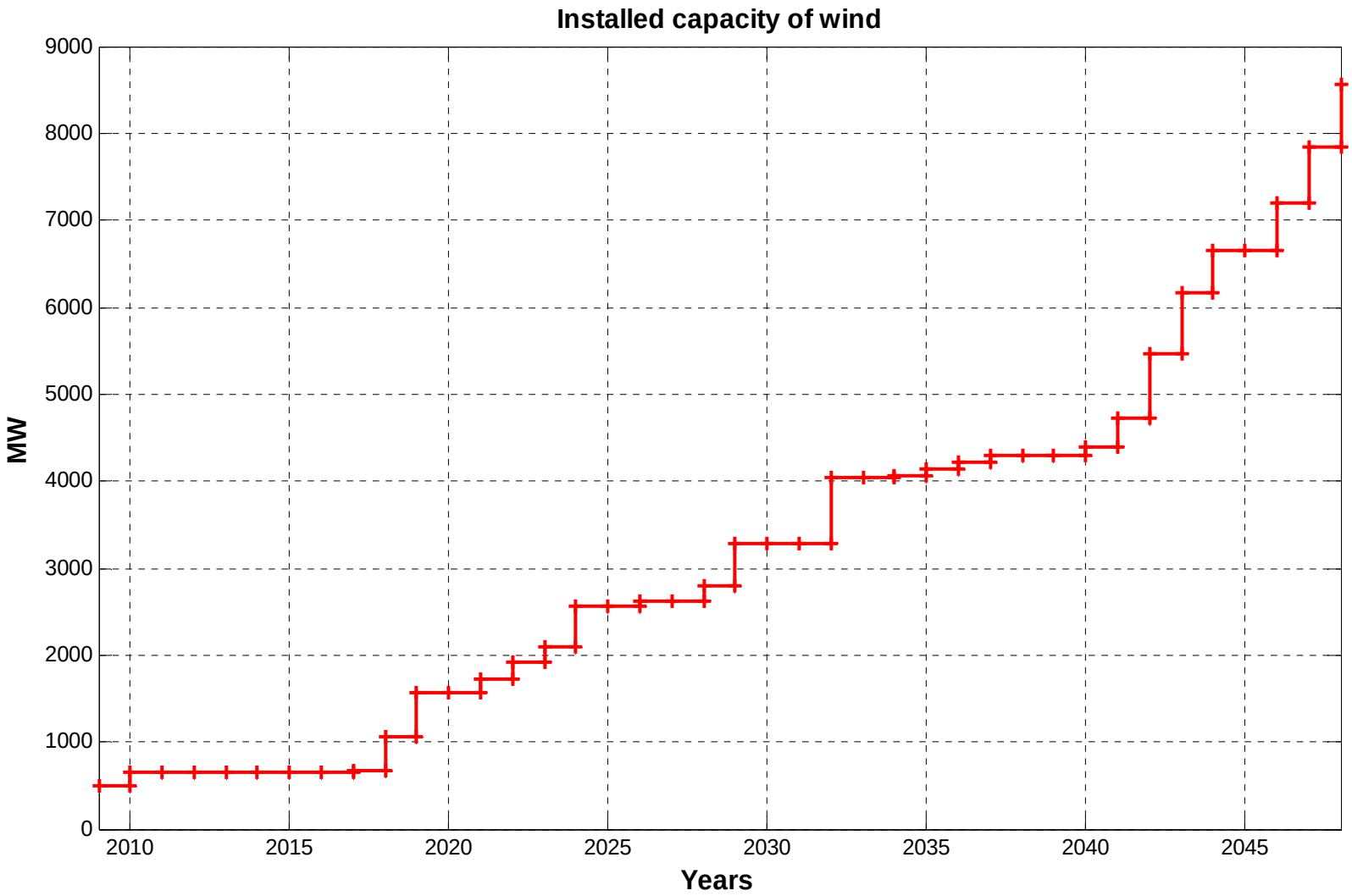
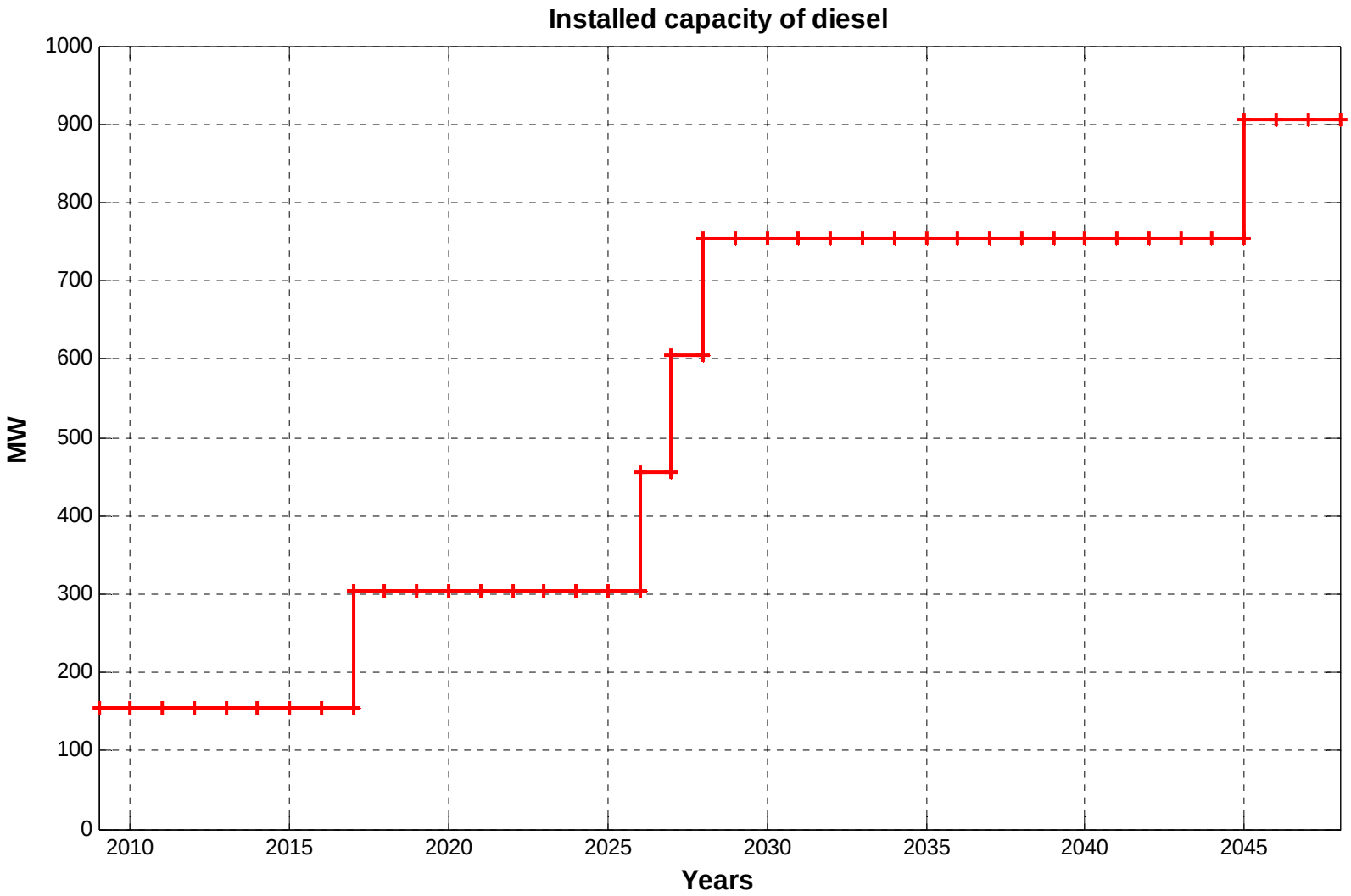
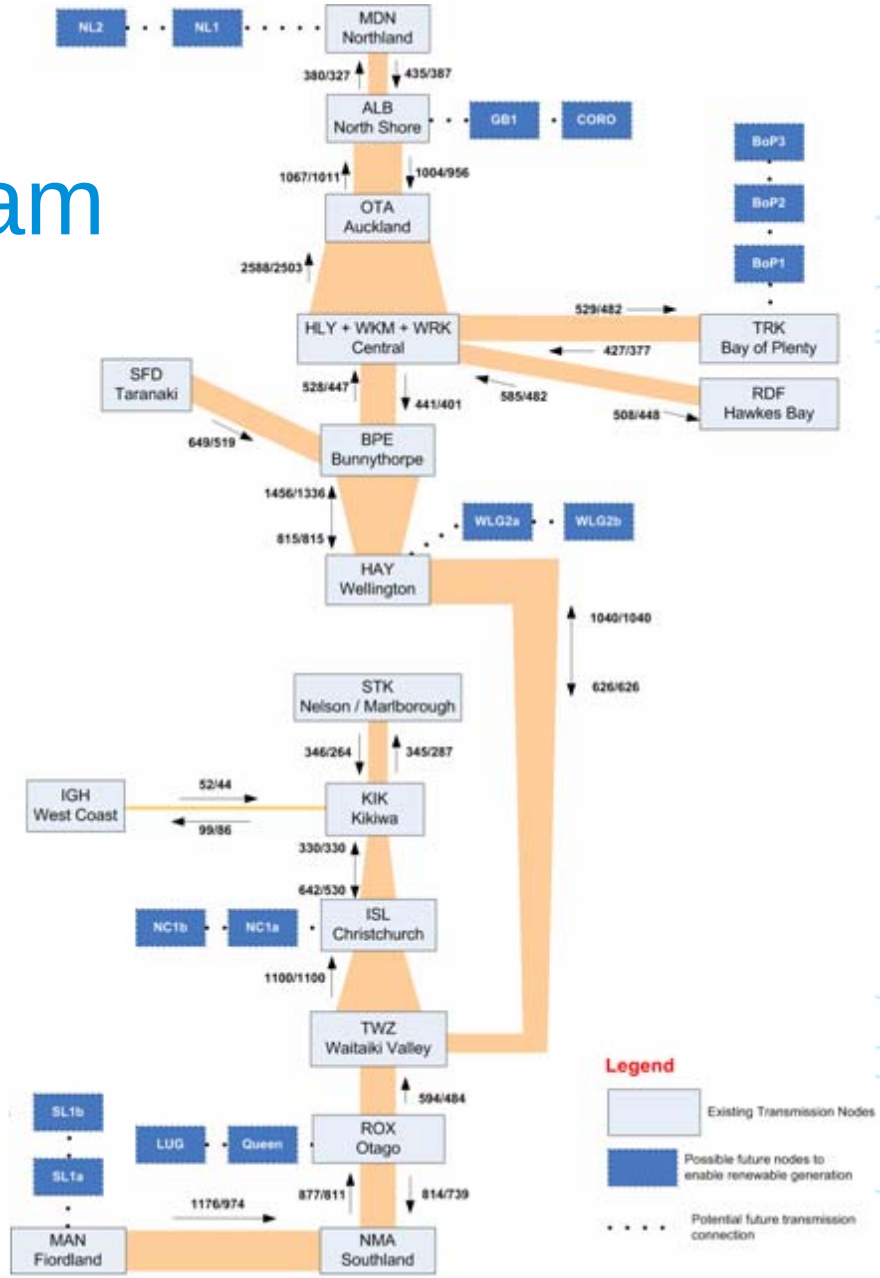


Preliminary results



SSG network diagram



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Representative base case co-optimised upgrades

Project	From	To	From state	To state	Year
Restore half pole	Wellington	Waitaki Valley	initial state	1st upgraded	2010
HVDC stage 1	Wellington	Waitaki Valley	1st upgraded	2nd upgraded	2011
WKM-OTA 400kV at 220kV	Auckland	Waitaki Valley	initial state	1st upgraded	2012
HVDC stage 2	Wellington	Waitaki Valley	2nd upgraded	3rd upgraded	2012
Capacitors at ASB and SVC at ISL	Christchurch	Waitaki Valley	initial state	1st upgraded	2013
HVDC stage 3	Wellington	Waitaki Valley	3rd upgraded	4th upgraded	2018
Duplex HPI-BRB circuit	Northland	North Shore	initial state	1st upgraded	2020
Thermally upgrade ROX-NSY-LIV	Waitaki Valley	Otago	initial state	1st upgraded	2022
Duplex BPE-TKU-WKM and BPE-TNG-RPO-WRK-PPI-WKM	Waikato	Bunnythorpe	initial state	1st upgraded	2024
Duplex ROX-NSY-LIV	Waitaki Valley	Otago	1st upgraded	2nd upgraded	2026
Thermal upgrade of BRK-SFD	Taranaki	Bunnythorpe	initial state	1st upgraded	2038
SVC at each of ISL and ASB	Christchurch	Waitaki Valley	1st upgraded	2nd upgraded	2038
WKM-OTA 400kV at 400kV	Auckland	Waikato	1st upgraded	2nd upgraded	2041

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Other renewable sources

- Phase 1 of the project provided a “map” of wind, geothermal and geothermal resources.
- Report on marine energy published.
- Biomass assumptions currently being revised.
- Current solar energy costs do not make it attractive for large scale generation.

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Conclusion

- TTER phase 2 will
  - look at economic transmission investment opportunities in NZ
  - investigate the opportunity for new technologies to assist renewable generation uptake.
- Outputs of this project will be used to investigate possible changes to the regulatory framework.
- Report will be published for consultation mid-2009.
- Project will contribute to developing the next Statement of Opportunities and other activities.

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Questions?

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