ROAM CONSULTING
ENERGY MODELLING EXPERTISE

Intermittent generation- Results of ROAM studies

October 2009

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westernpower

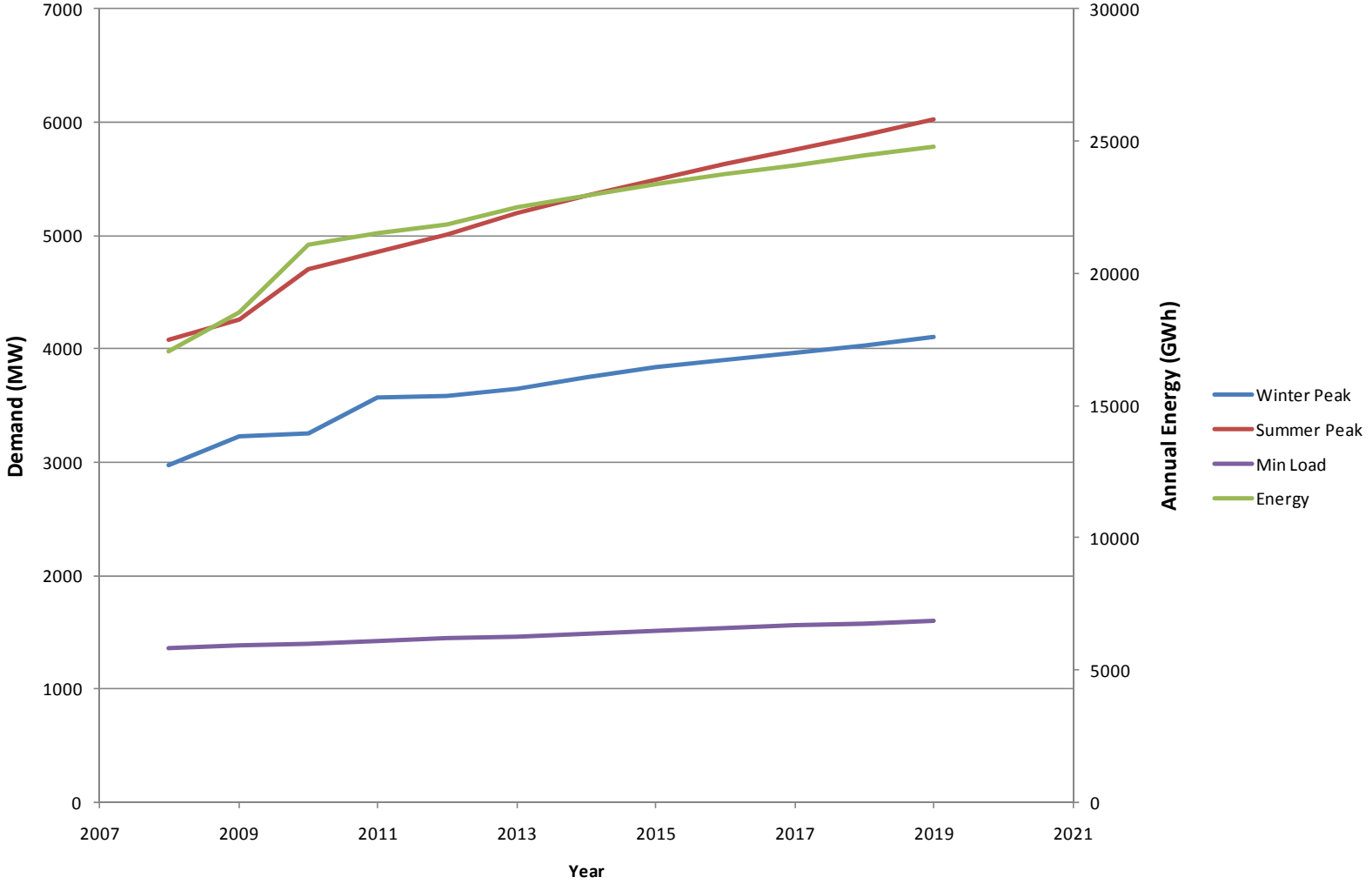
Analyses performed

- Scenarios:
  - Wind: high and low
  - Must-run generation: higher and lower
- Scenarios:
  - 2: high wind, lower must-run
  - 4: low wind, lower must-run
  - 5: low wind, higher must-run
  - 6: high wind, higher must-run
  - (scenarios 1 + 3 were minor variations of scenario 2)
- Two dispatch merit orders used:
  - Market Rules used based
  - Cost-reflective
- Must-run identified on basis of Power System Security.
  - Biomass plant also considered must-run.
- All wind assumed to be located in Merriden, Albany, Emu Downs and Walkaway
  - 2007-08 wind was used for all years
- This is one possible model that only considers known technologies
  - Did not consider: economic modeling for new capacity, network constraints, or CPRS.

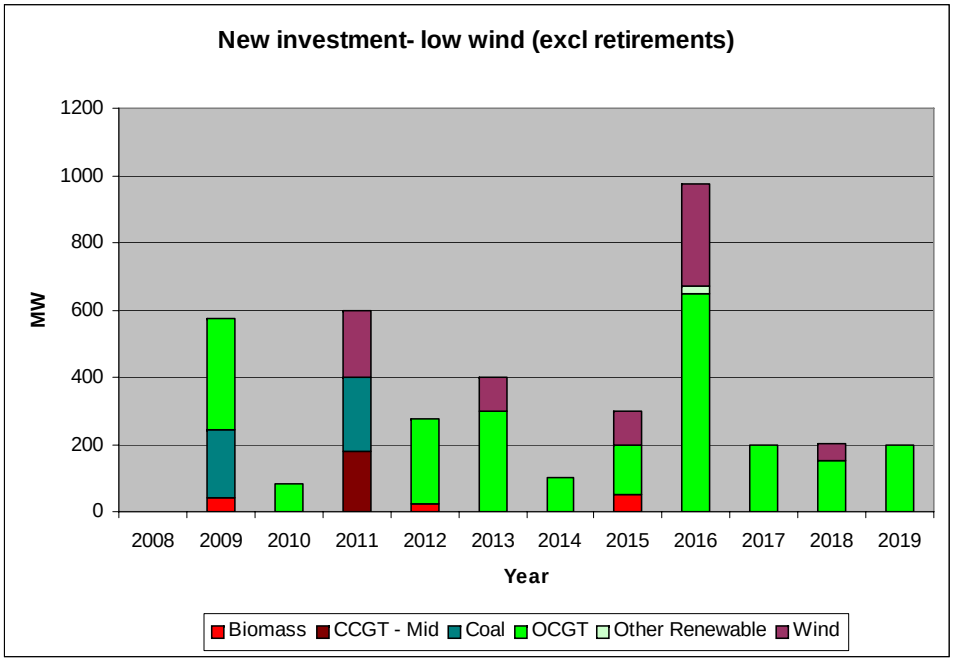
RET Target

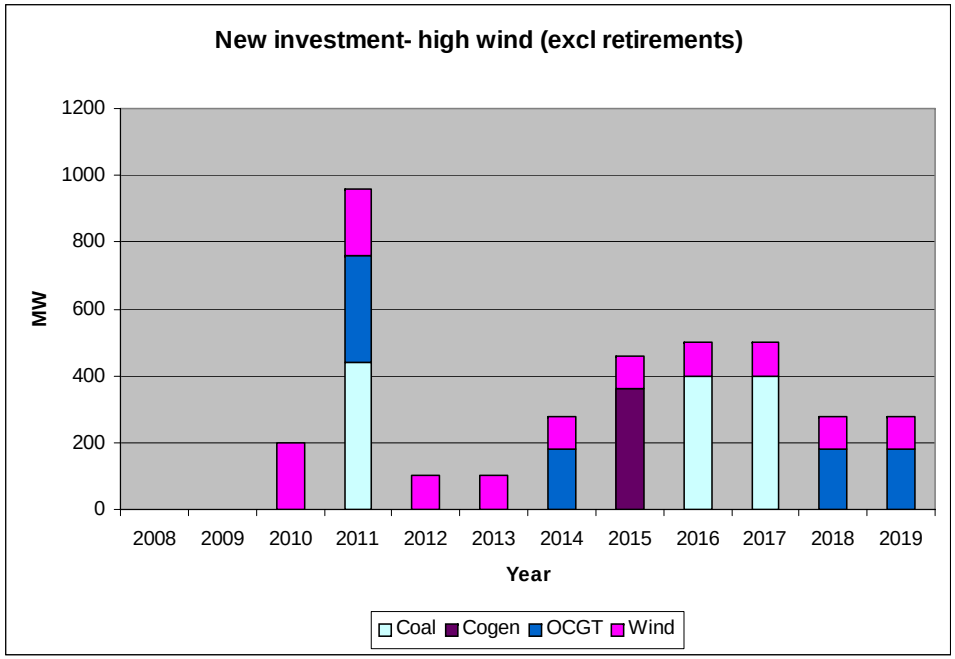
- National RET Target for 2020: 45,000 GWh
- Predicted SWIS energy for 2020: ~24,840 GWh
- Predicted national demand in 2020: ~292,000 GWh
- WA RET requirement: ~ 3830 GWh = 15.4%
- The requirement is not 20% of energy in 2020.

Assumptions- Demand



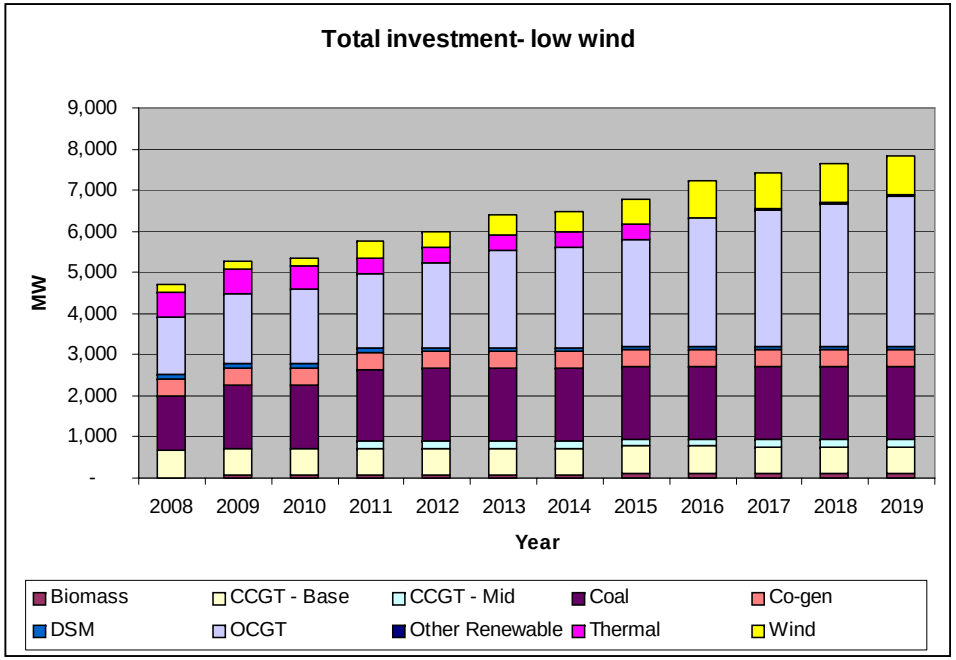
Assumptions- New capacity

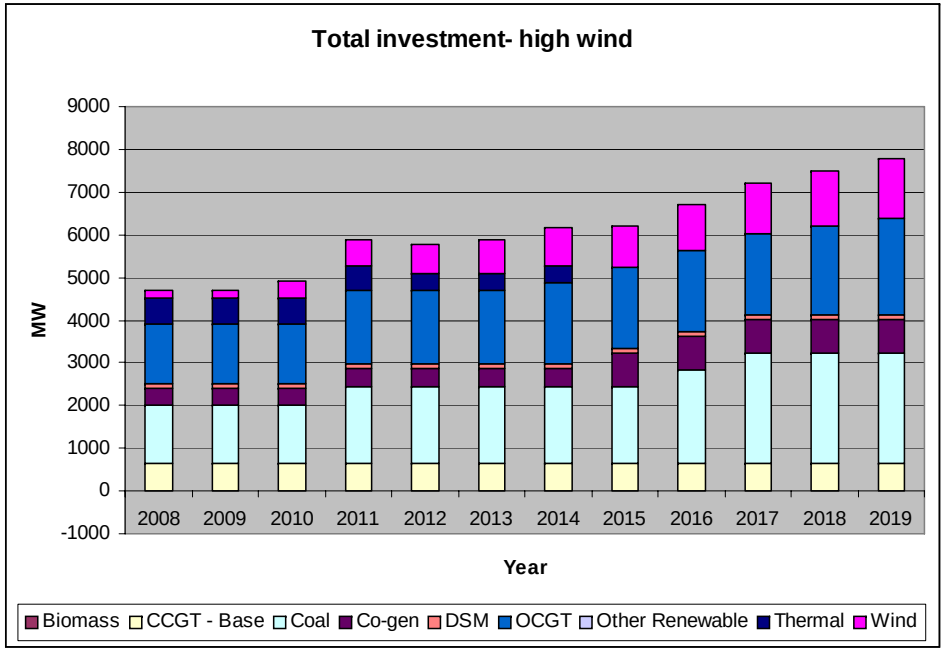




Low wind ⟷ High wind

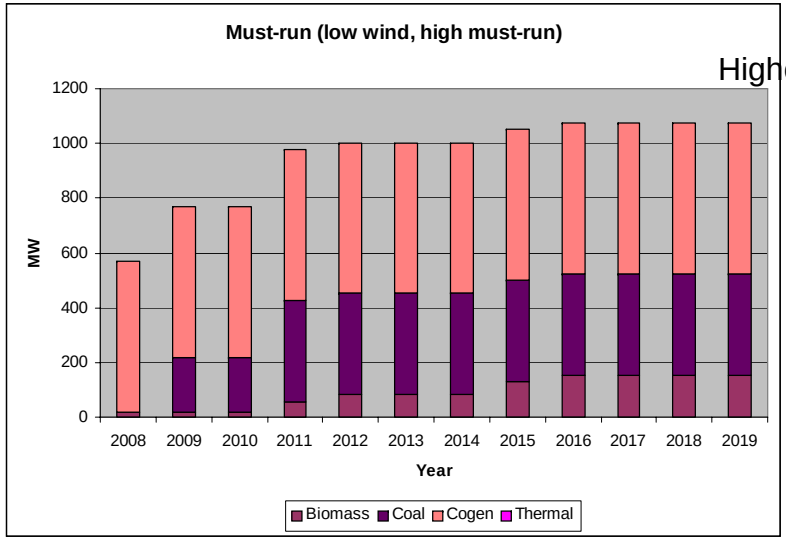
Assumptions- Total capacity



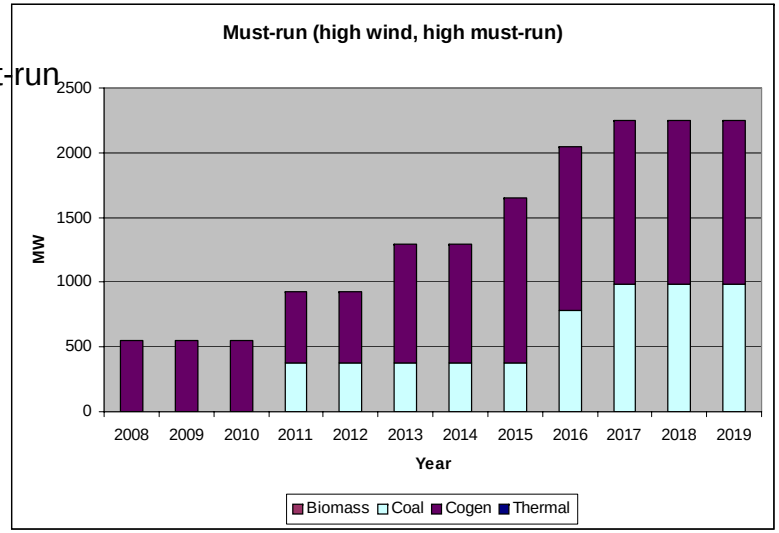


Low wind ⟷ High wind

Assumptions- Must-run generation

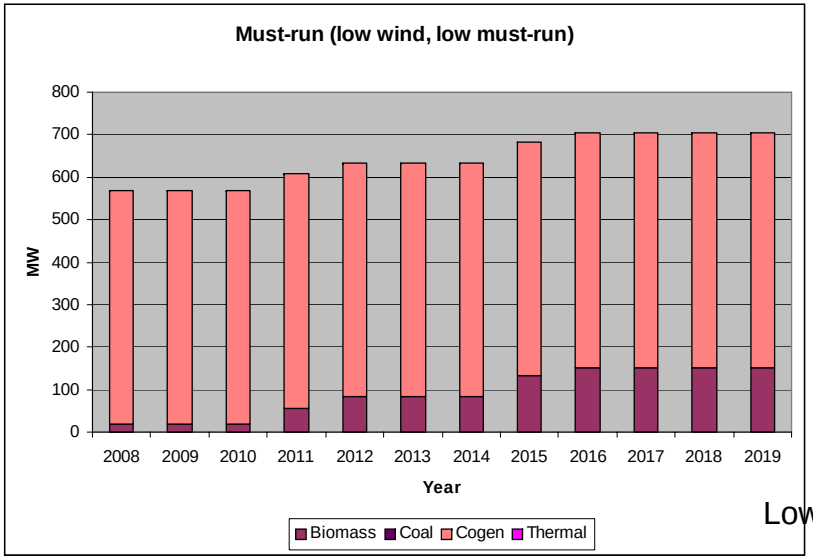


Higher must-run

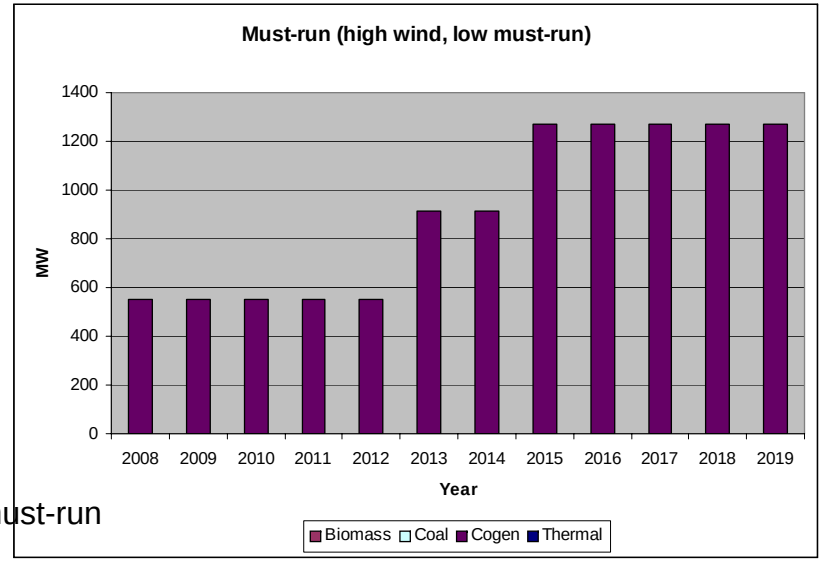


Low wind

High wind



Lower must-run



Load Following definition

- Load Following Service is the service of frequently adjusting the output of one or more Scheduled Generators within a Trading Interval so as to match total system generation to total system load in real time in order to correct any SWIS frequency variations [MR 3.9.1].
  - LF facilities must be able to quickly ramp up or down to maintain frequency at 50 Hz.
- The standard for Load Following Service is a level which is sufficient to provide Minimum Frequency Keeping Capacity, which is the greater of 30 MW and the capacity sufficient to cover 99.9% of the short term fluctuations in load and output of Non-Scheduled Generators and uninstructed output fluctuations from Scheduled Generators, measured as the variance of 1 minute average readings around a thirty minute rolling average [MR 3.10.1].
  - LF is a +/- value.
  - For Power System Security purposes, a ramp-rate requirement is also determined, giving a minimum ramp rate for plants providing LF.
- Included in quantum of Spinning Reserve (SR) [MR 3.10.2].
- SM must dispatch facilities to ensure that LF (and SR) are maintained *at all times*.

Load Following effects on operation

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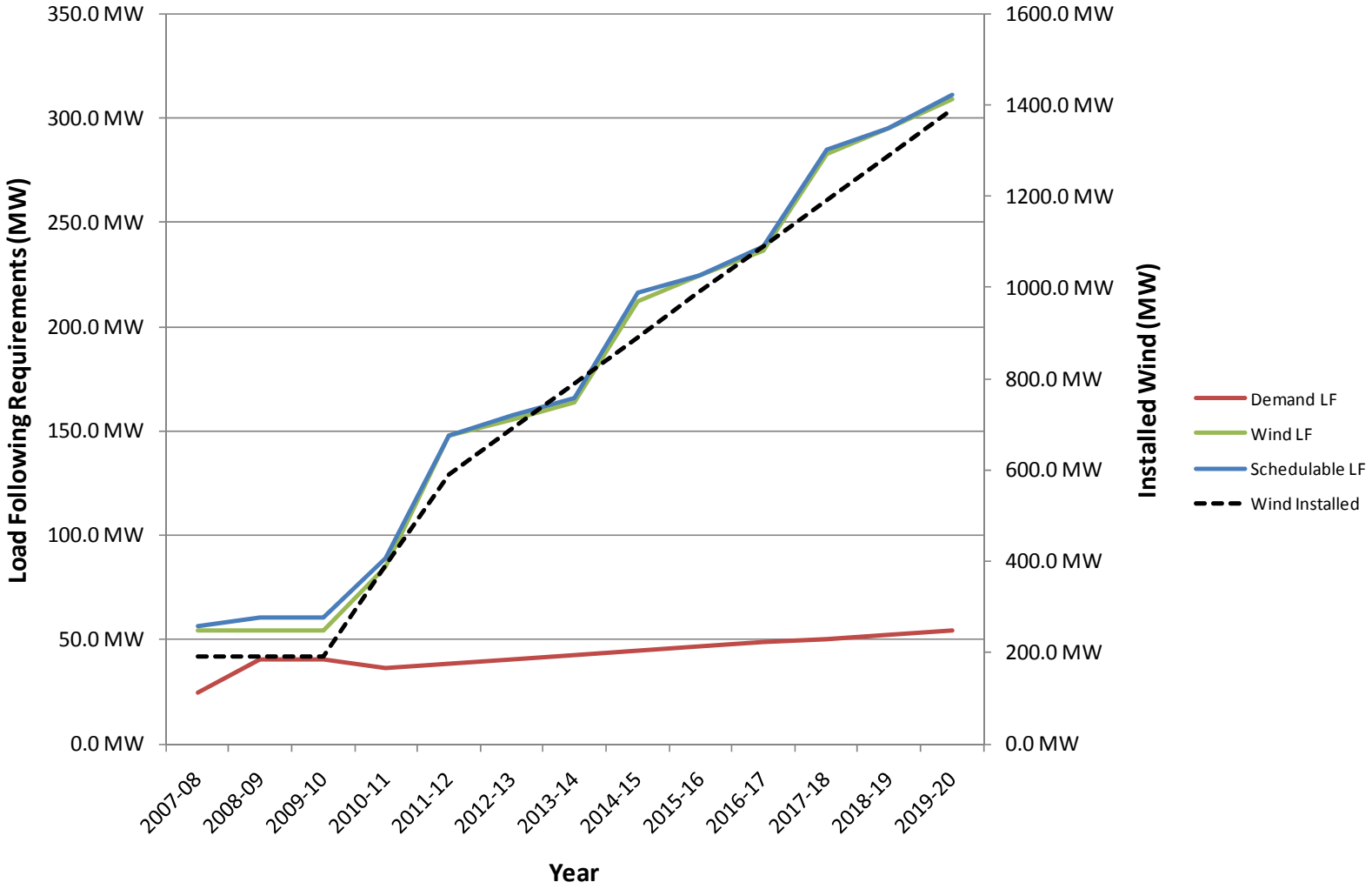
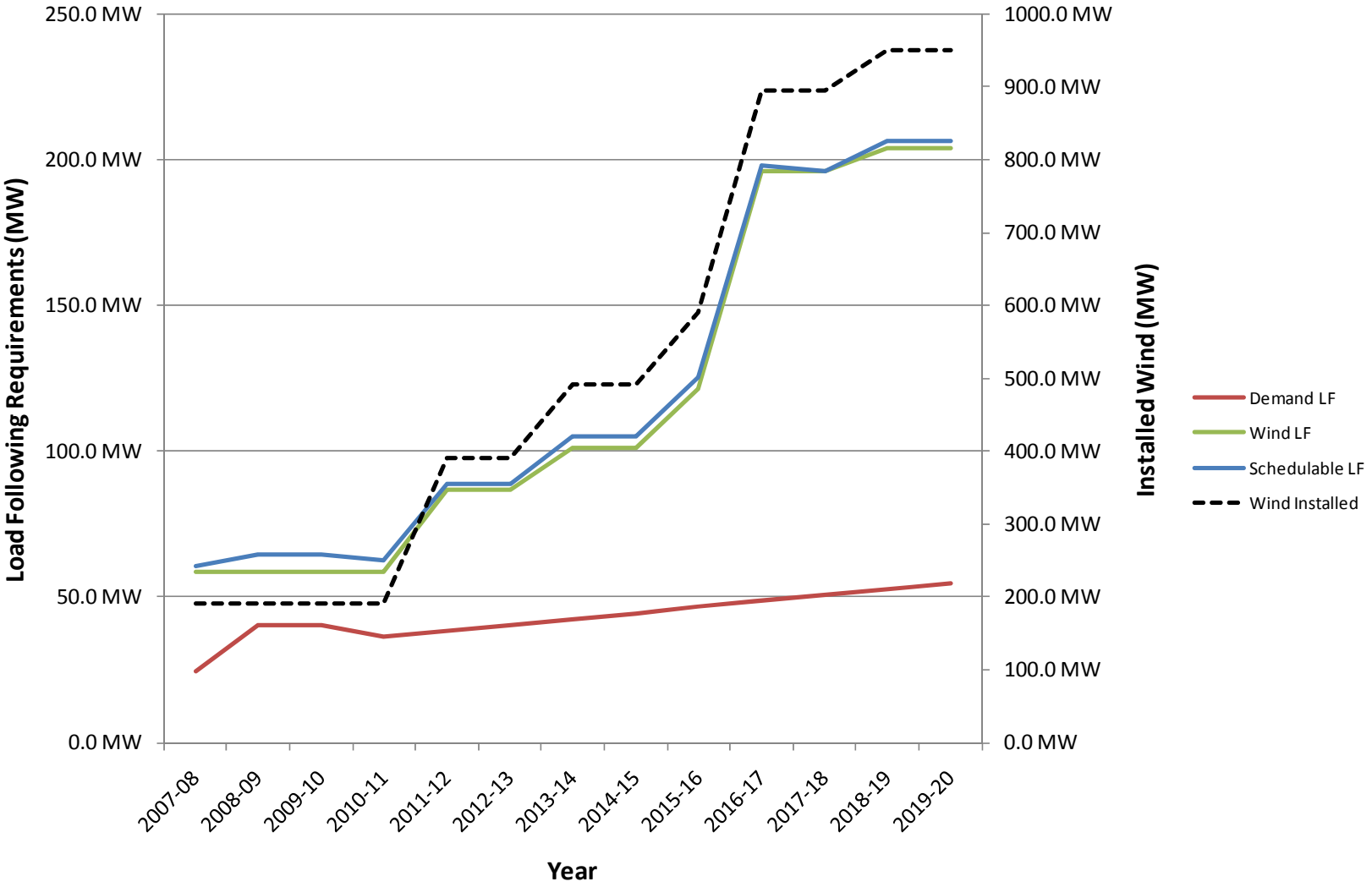
- Load Following (LF) can only be provided be flexible GT's with a high ramp-rate (> 5Mw/min).
- Thermal facilities (eg coal) are not flexible enough to provide LF.
- For every facility providing LF:
  - Maximum amount of LF available is half the difference between minimum and maximum generation
    - Eg If max gen cap=100 MW and min gen cap= 20 MW, then available LF= +/- 40 MW
  - Must-run generation increases by more than the Load Following requirement.

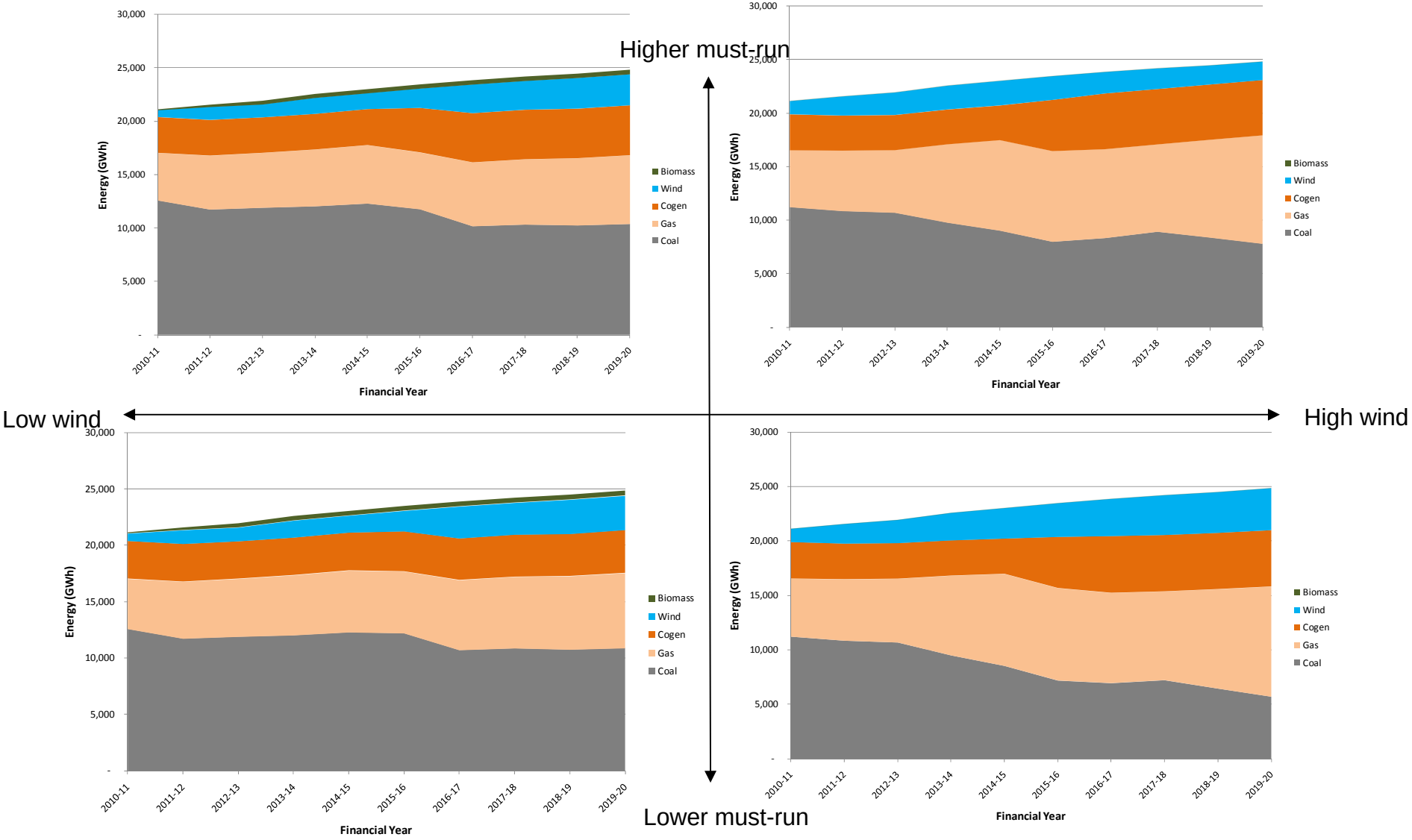
High wind scenario- Load Following requirement



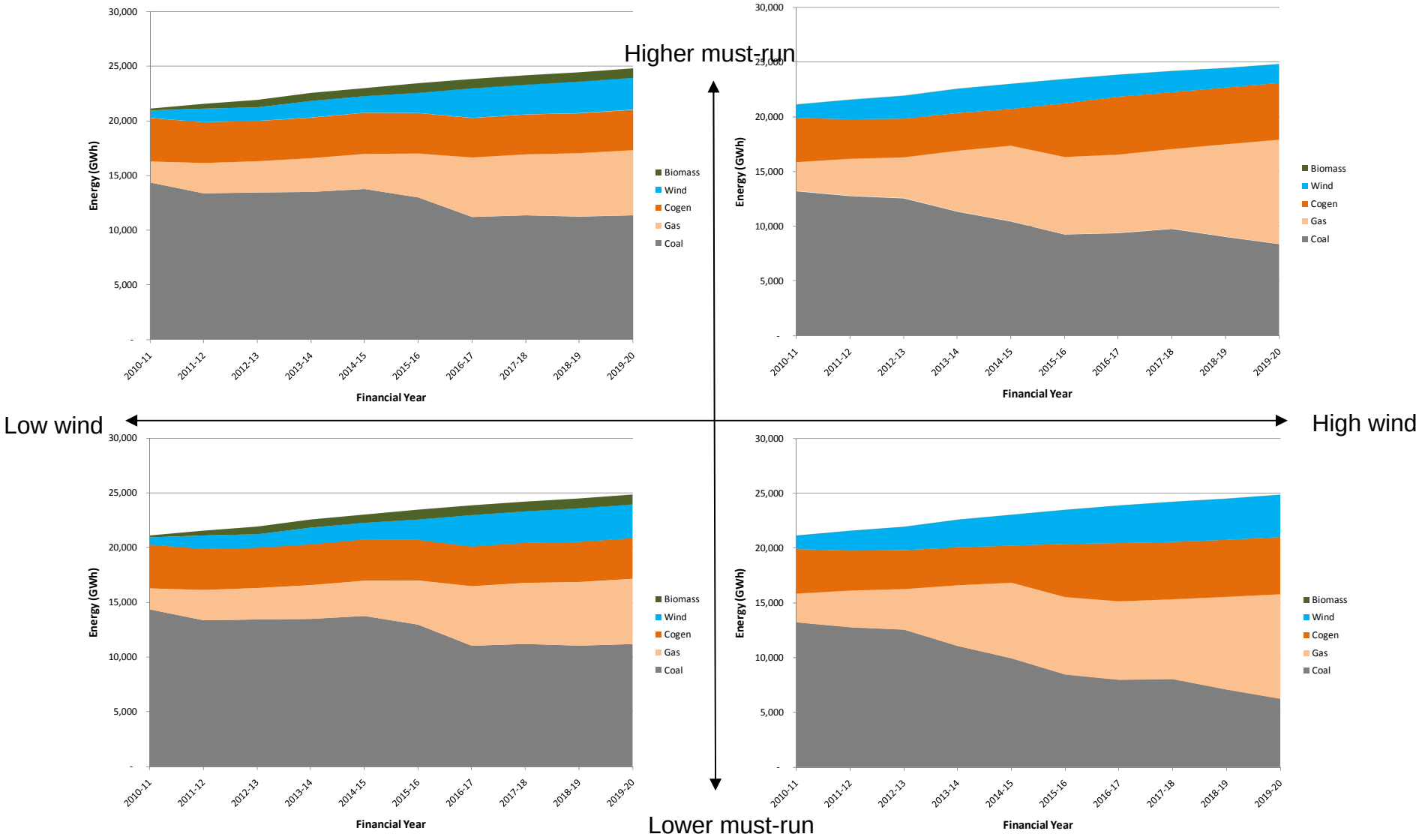
Low wind scenario- Load Following requirement



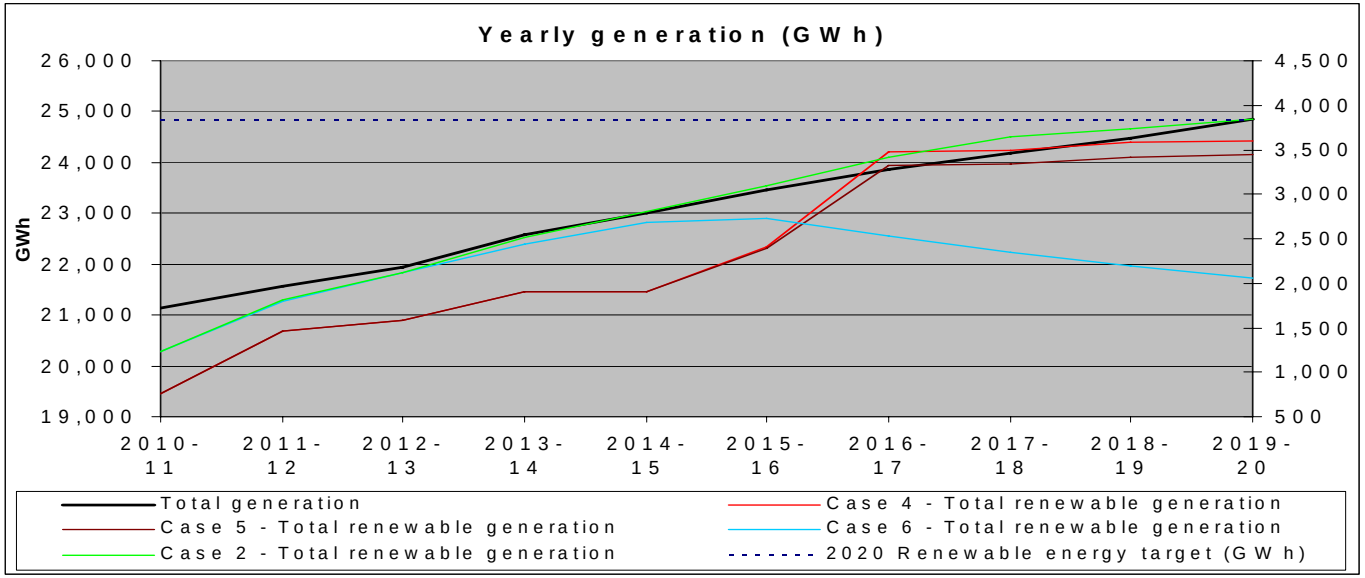
Results- Energy production in the SWIS- Market Rules based DMO

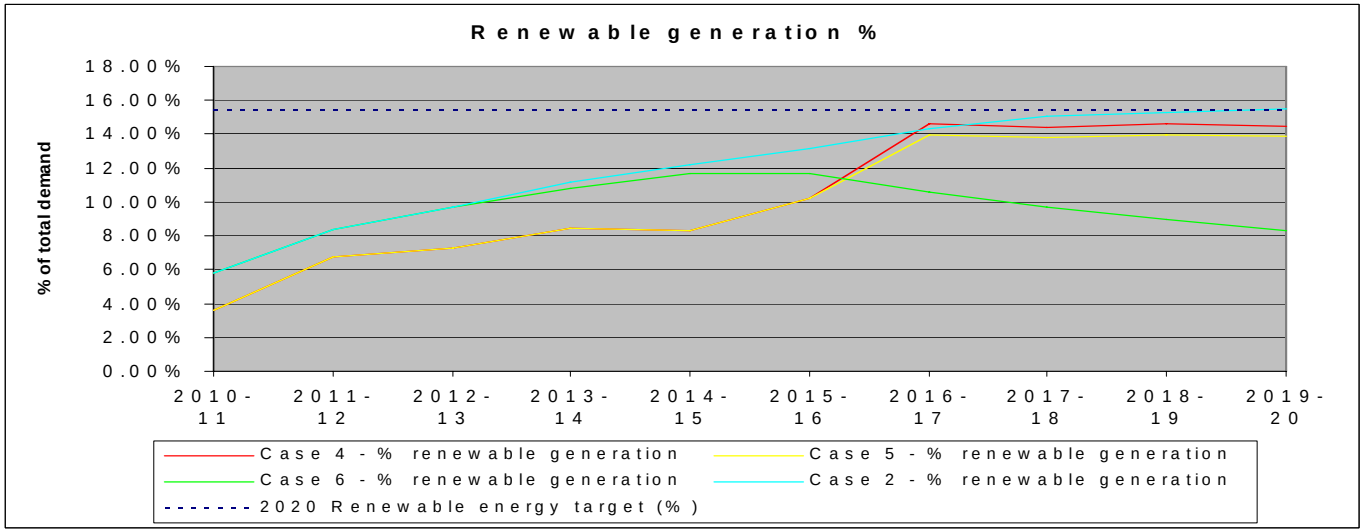


Results- Energy production in the SWIS- Cost-reflective DMO

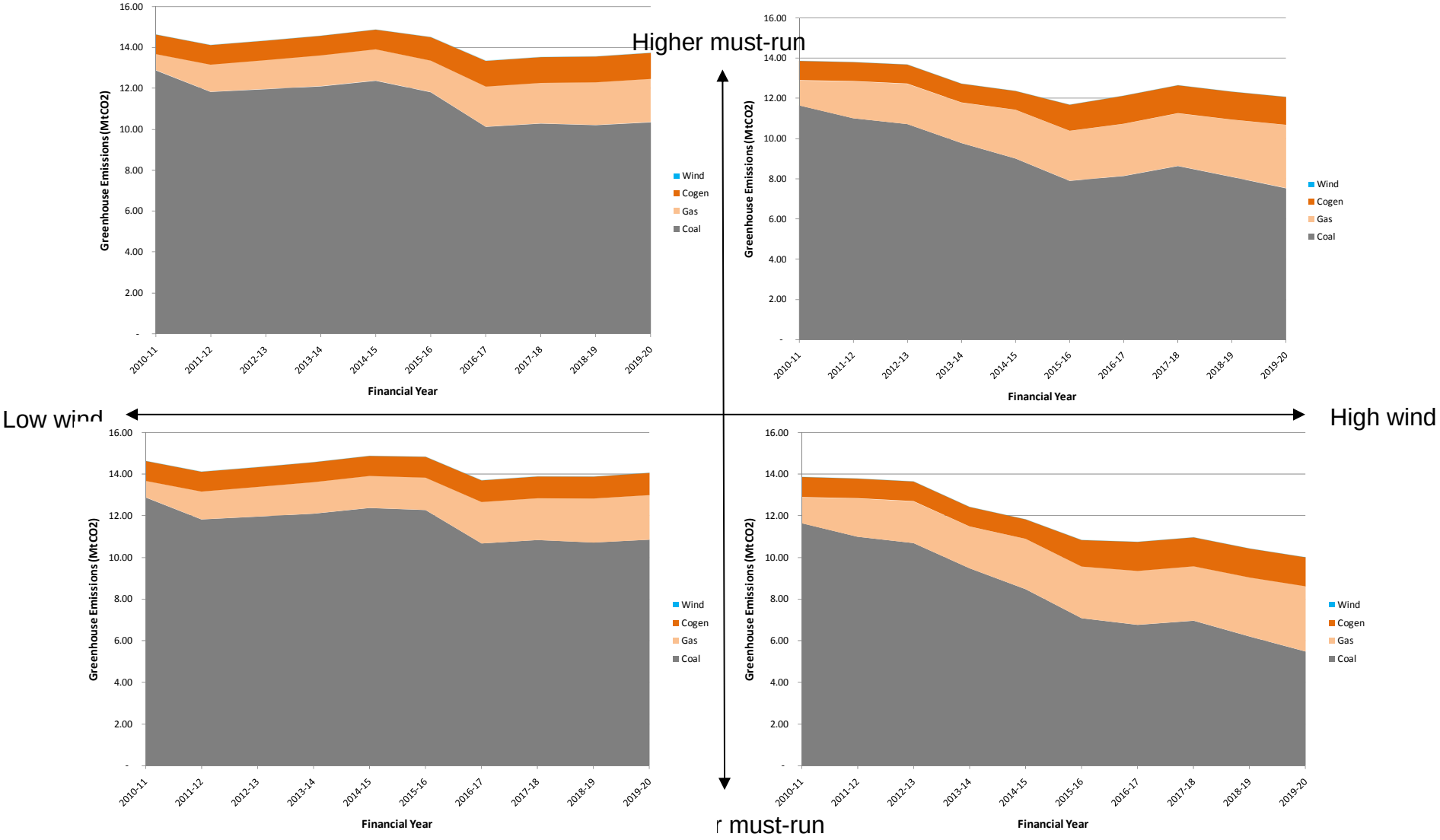


Results- Total renewable energy for Market based DMO

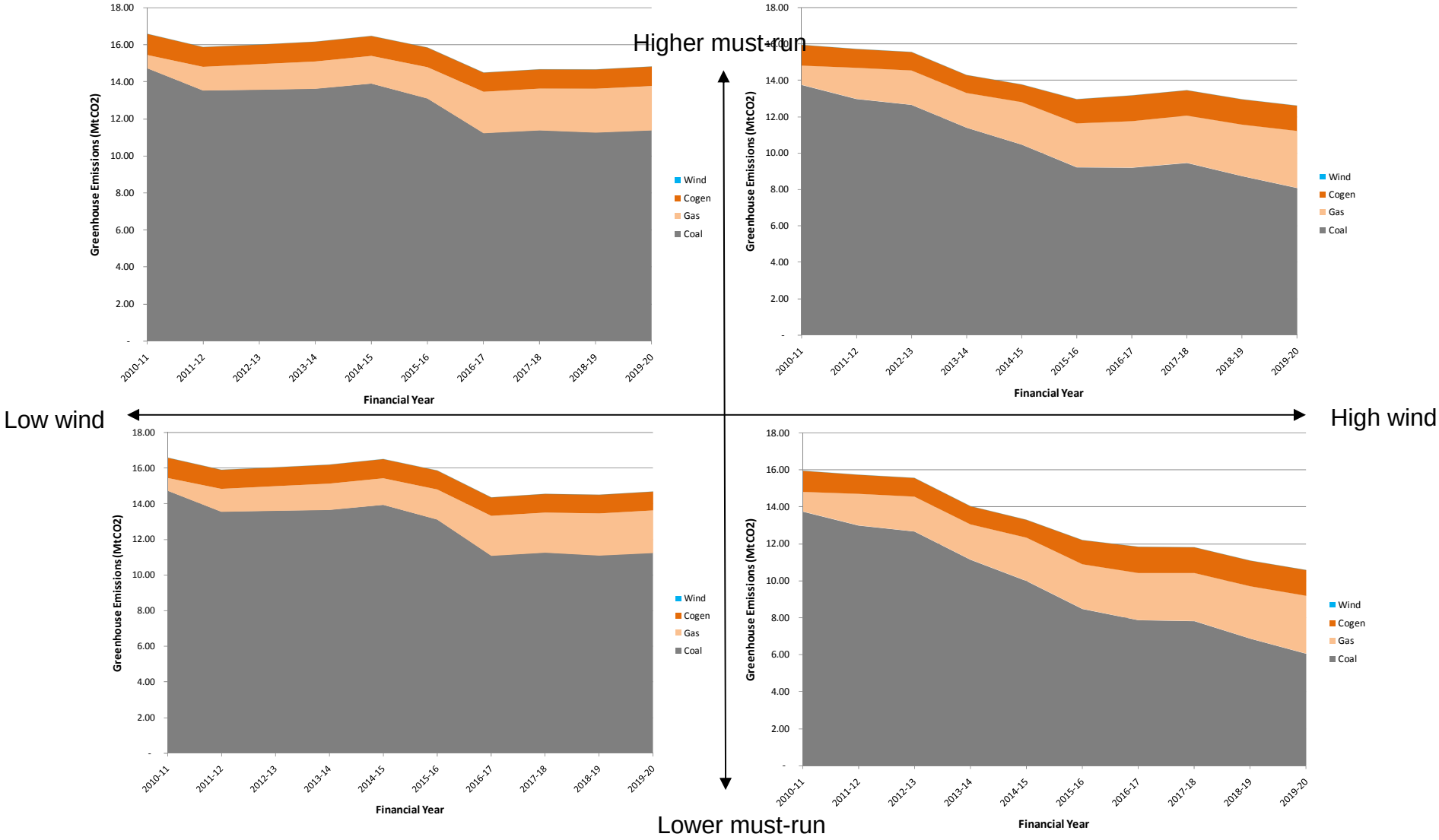




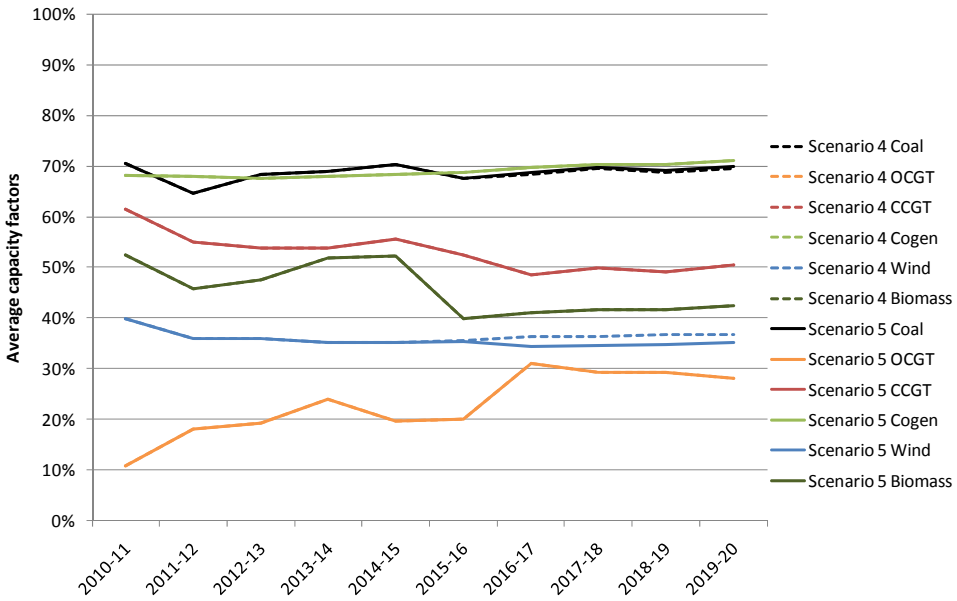
Results- Greenhouse emissions- Market Rules based DMO

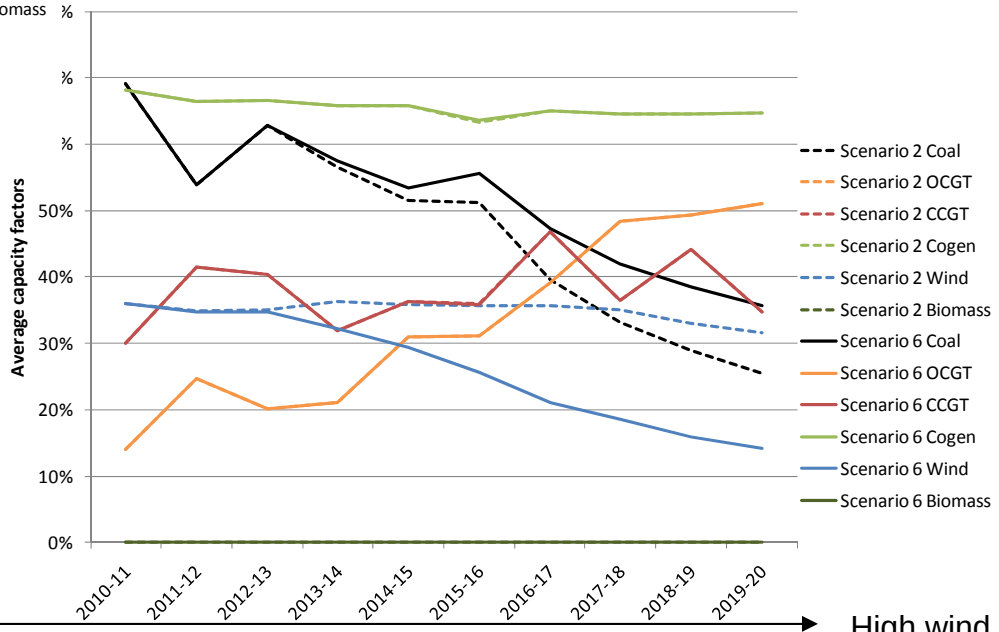


Results- Greenhouse emissions
Cost-reflective DMO



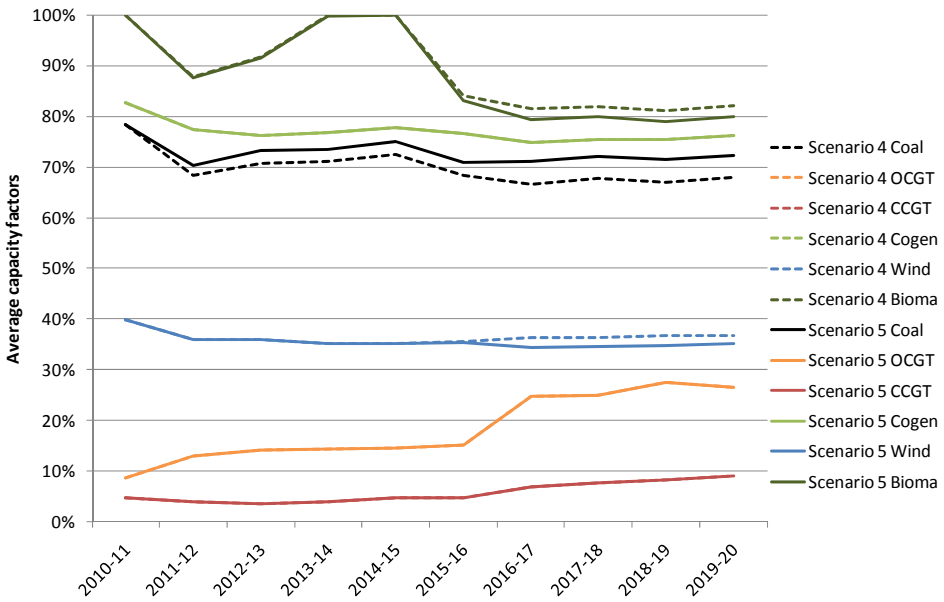
Results- Capacity factors- Market Rules based DMO

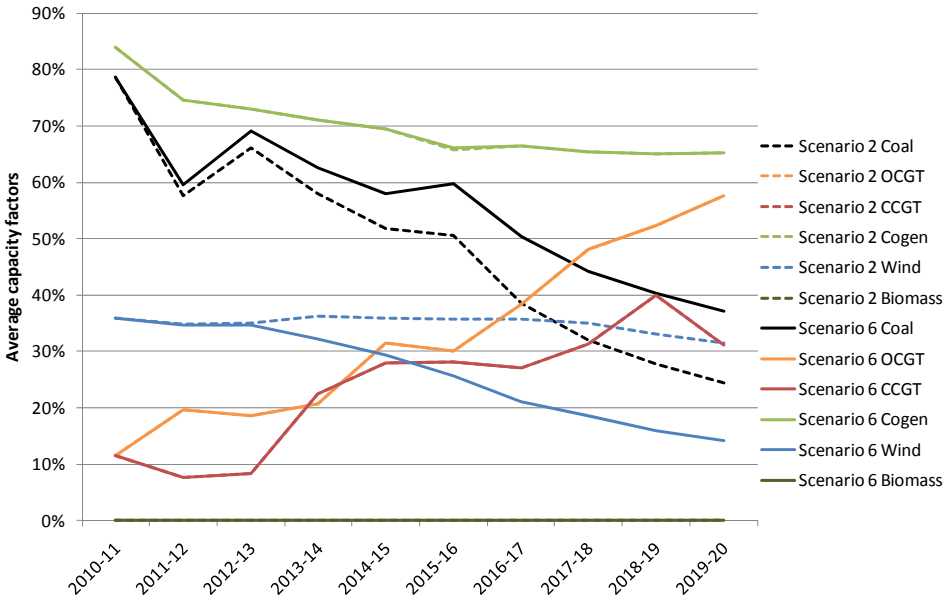




Low wind ◄——————————————————► High wind

Results- Capacity factors- Cost-reflective DMO





Low wind ⟷ High wind

Results- Wind curtailment
Both DMO's

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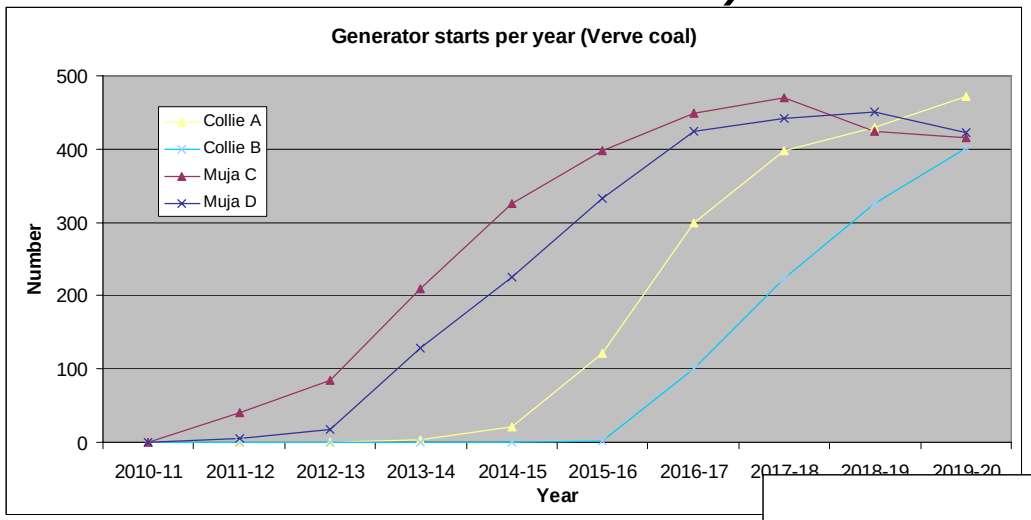
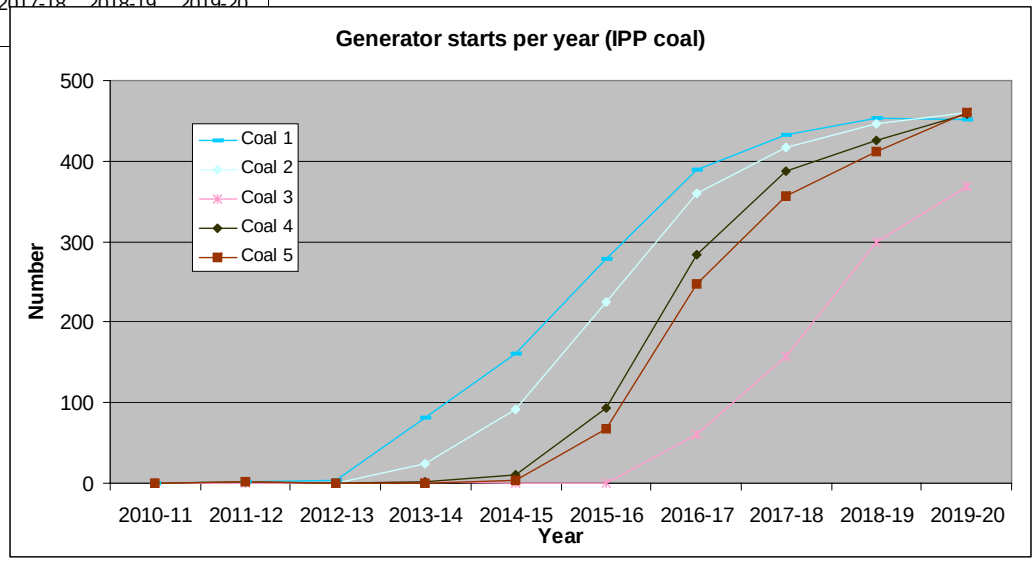
	Scenario	4	5		Scenario	2	6
	Wind	Low	Low		Wind	High	High
	Must-run	Low	High		Must-run	Low	High
Year	Total Installed Wind (MW)	% of Annual wind energy curtailed			Total Installed Wind (MW)	% of Annual wind energy curtailed	
2010-11	190.7	0.00%	0.00%		391	0.00%	0.00%
2011-12	390.7	0.00%	0.00%		591	0.00%	0.70%
2012-13	390.7	0.00%	0.00%		691	0.00%	1.10%
2013-14	490.7	0.00%	0.00%		791	0.00%	11.20%
2014-15	490.7	0.00%	0.00%		891	0.10%	18.00%
2015-16	590.7	0.00%	0.20%		991	1.00%	28.80%
2016-17	895.7	0.00%	5.00%		1091	2.90%	42.60%
2017-18	895.7	0.00%	4.50%		1191	3.90%	48.80%
2018-19	950.7	0.00%	5.40%		1291	9.30%	56.40%
2019-20	950.7	0.00%	4.60%		1391	14.90%	61.50%

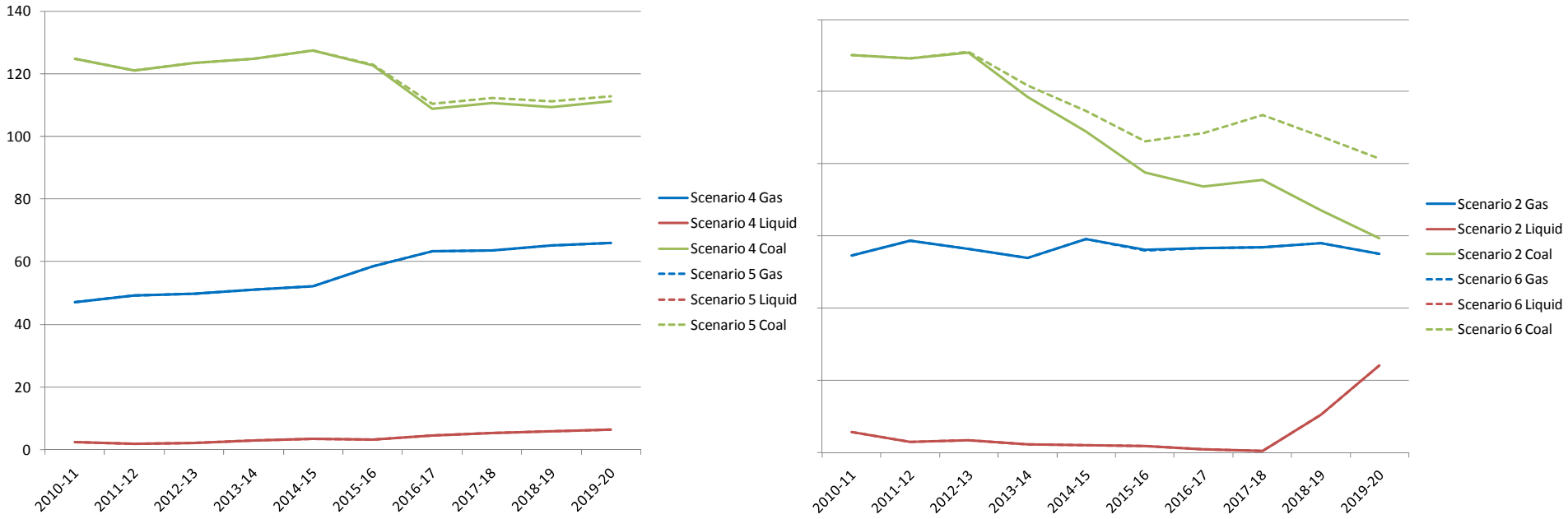
Results- Coal starts (high wind, lower must-run, Market based DMO)



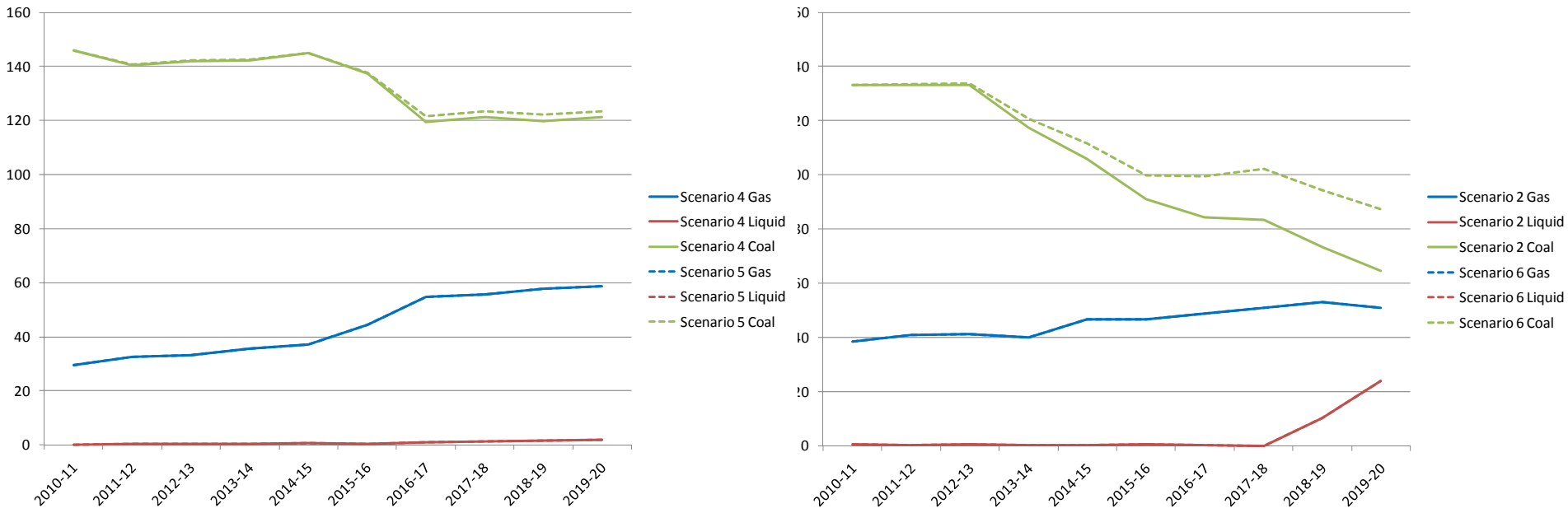
For Power System Security this is not technically feasible.



Results- Fuel usage
Market Rules based DMO



Results- Fuel usage
Cost-reflective DMO



Low wind ⟷ High wind

Conclusions

- The results are largely identical using a Market based or cost-reflective DMO.
- As wind penetration increases, a threshold will be reached where operational issues occur solely due to wind variation.
- High wind scenario results in significantly lower emissions. Low wind scenario does not decrease emissions much.
- In each scenario, as wind penetration increases the Load Following requirement increases adding a significant must-run burden.
- As must-run plant increases, wind-curtailment and cycling of coal plant increases due to low overnight loads.
- High amounts of wind with moderate/high amounts of must-run plant result in significant wind-curtailment and significant (probably untenable) cycling of coal plant.
- Only the high wind scenario meets the RET target.
- With high wind and moderate/high amounts of must-run plant capacity factors of coal plants decrease from 70% to 30%, and cycling of Verve/IPP coal plants rise to once a day (which is not feasible for Power System Security).