ROAM CONSULTING

ENERGY MODELLING EXPERTISE

What will be the impact of the expanded MRET on the NEM?

Dr Jenny Riesz

Date: 15 February 2008

CEEM Seminar

ROAM Consulting

- Energy market modelling for
  - Generators
  - Transmission network service providers
  - Retailers
  - Regulators
  - Developers

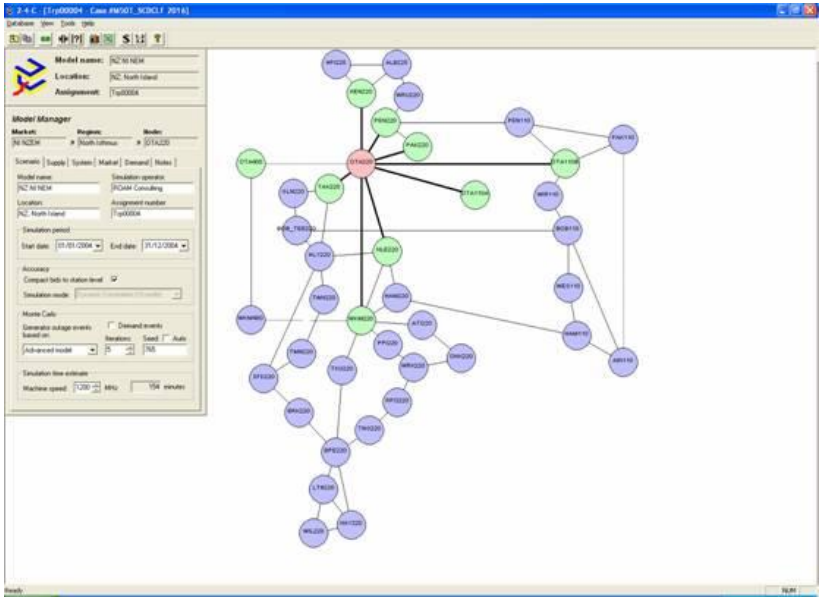
- Focus on detail
  - Pool price forecasting
    - Half hourly basis
  - Production and revenue forecasting
    - Individual generators on half hourly basis under variable bidding patterns
  - Marginal loss factor forecasting
    - New generation projects or expansions
  - Transmission planning
  - Generation planning
    - Integrated resource planning (IRP)
  - Regulatory research
    - Impact of new legislation and market rules

- Multidisciplinary backgrounds
  - Electrical and mechanical engineering
  - Pure and applied mathematics and physics
  - Computer and software engineering / information technology
  - Commerce

ROAM CONSULTING
ENERGY MODELLING EXPERTISE

2-4-C

- Market dispatch modelling system
- Initially developed to simulate the NEMMCO market dispatch engine (NEMDE)
- Bases dispatch decisions on generator bidding patterns and availabilities
  - Includes forced, partial and planned outages of each generator
- Inter-regional transmission capabilities and constraints included
- Multiple iterations are averaged to take account of random nature of outages
- Outputs:
  - Half hourly production levels and revenues of each generator
  - Half hourly pool prices
  - Inter-regional transmission flows and limits
  - Can be coupled with Powerworld simulation software to determine marginal loss factor forecasts



- Integrated Resource Planning
  - Uses 2-4-C engine to determine least cost planning of generation infrastructure
  - Trials possible future generation augmentation paths
    - Determines least cost development
  - Can select only paths that conform to certain constraints
    - Limit total emissions
    - Mandatory renewable energy target

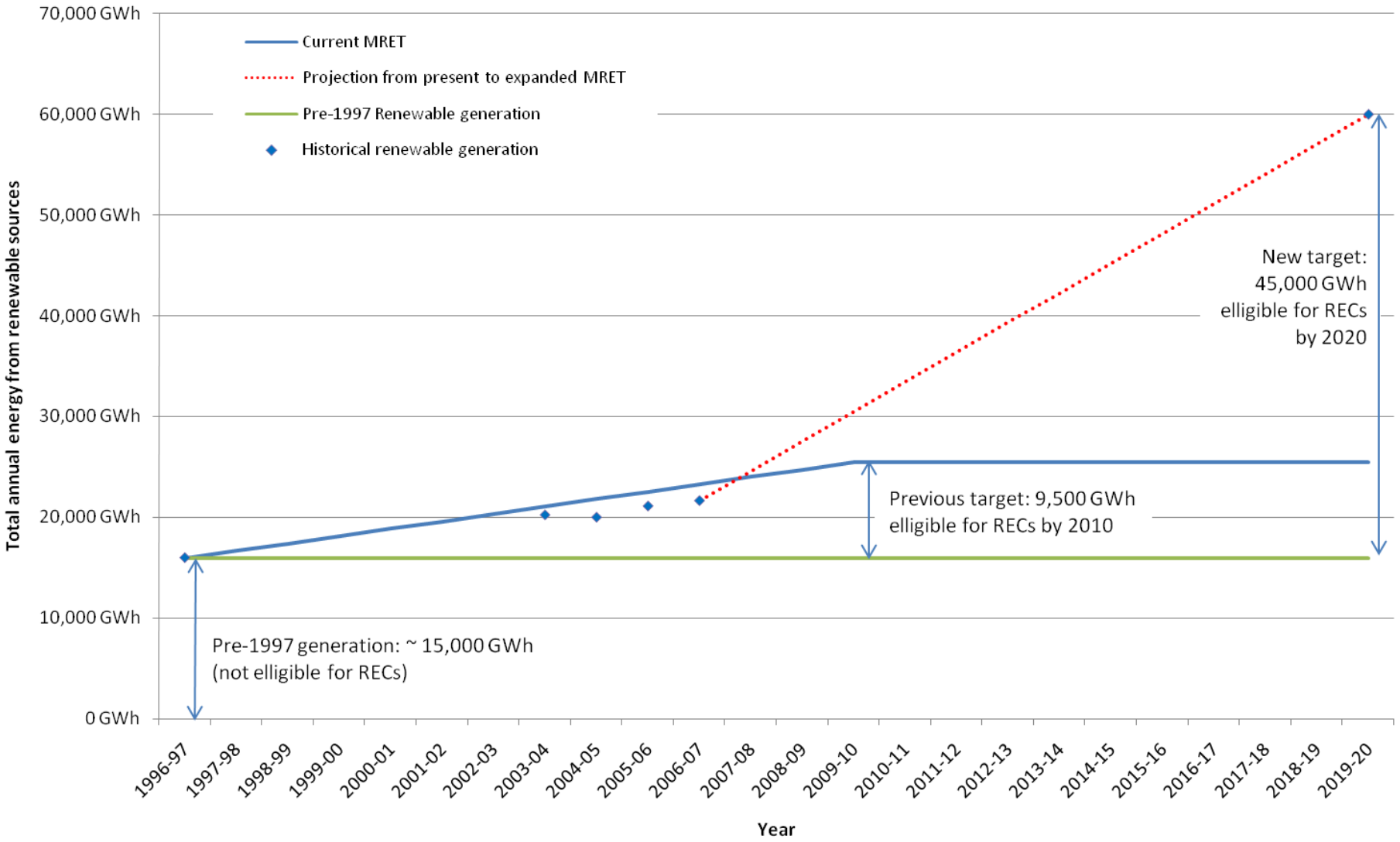
ROAM CONSULTING
ENERGY MODELLING EXPERTISE

- Removed content (available in ROAM Insight Issue 11):
  - Pool price forecasts (Business as usual)
  - Generation levels (Business as usual)

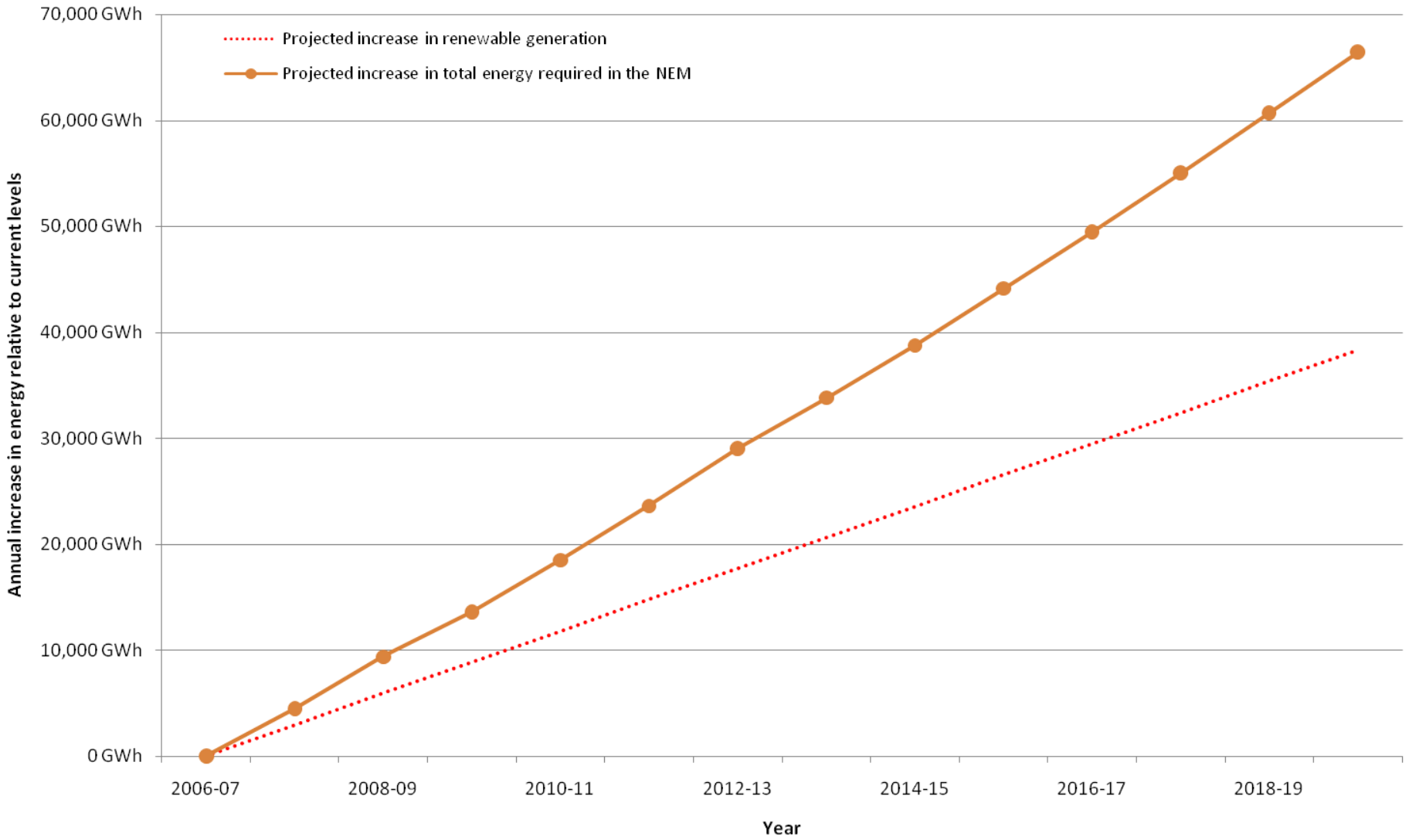
ROAM CONSULTING
ENERGY MODELLING EXPERTISE

Expanded MRET

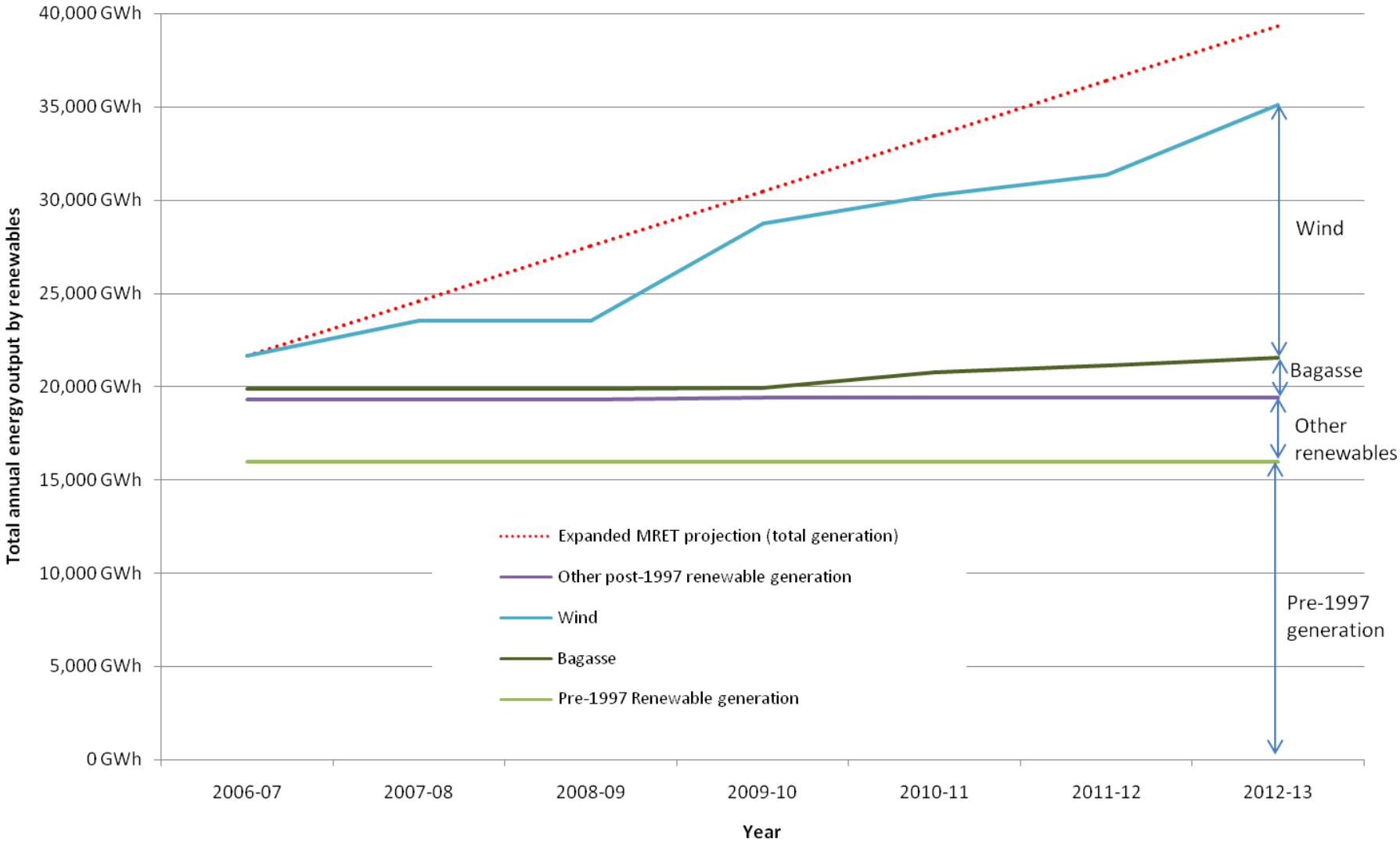
- New target (45,000 GWh by 2020) announced by recently elected Federal government
- Intended to replace state based targets



- Expanded MRET is equivalent to 60% of forecast increase in energy



- Short to medium term – target is expected to be met by mature technologies
  - Wind (690 MW existing, total of 6510 MW installed by 2014)
  - Some bagasse (130 MW existing, total of 640 MW installed by 2014)



- Removed content (available in ROAM Insight Issue 11):
  - Impact of MRET on the forecast pool price
    - General
    - NSW
    - QLD
  - Impact on price to customers
  - Impact of MRET on generation
  - Impact of MRET on emissions

ROAM CONSULTING
ENERGY MODELLING EXPERTISE

Emissions Trading

- Emissions trading has been identified as a more efficient way of reducing emissions
  - Lower cost to achieve same emissions outcome
  - Costs more distributed
- Federal government intends to implement domestic emissions trading by 2010, trading commencing 2011
  - With initially gentle caps
  - Scheme is currently in early stages of development
    - Essential structure has been recommended, but quantitative details are not yet decided upon

ROAM CONSULTING
ENERGY MODELLING EXPERTISE

Impacts of emissions trading

- Generators will be affected in different ways, due to their different properties

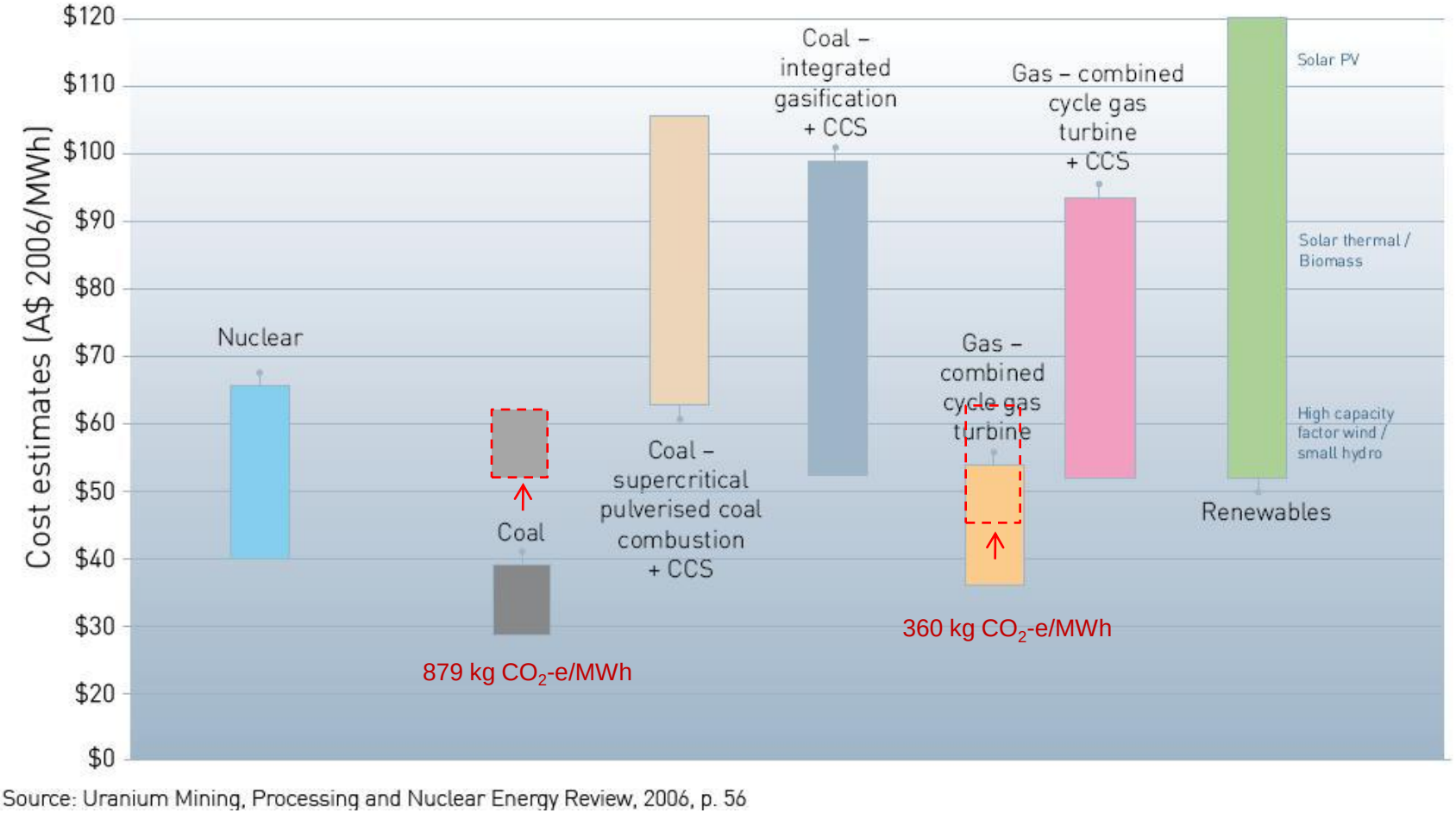
	Brown Coal	Black Coal	CCGT	OCGT	Hydro	Wind
Emissions factor (kg/MWh)	982	775	360	603	0	0
Capital cost ($/kW)	1900	1700	1050	720	2000	2000
Fuel cost ($/GJ)	0.55	1.00	4.00	4.00	0	0
SRMC ($/MWh) (no carbon price)	7.12	9.87	32.73	54.17	7.58	1.22

- These emissions factors are for state-of-the-art new plant
- Older existing plants will have much higher emissions factors
  eg. Hazelwood brown coal: EF = 1400 kg / MWh!

- To be effective, emissions trading must ultimately increase the cost of conventional generation to the point where low emissions technologies become competitive

ROAM CONSULTING
ENERGY MODELLING EXPERTISE

Cost ranges for various technologies



Source: Uranium Mining, Processing and Nuclear Energy Review, 2006, p. 56

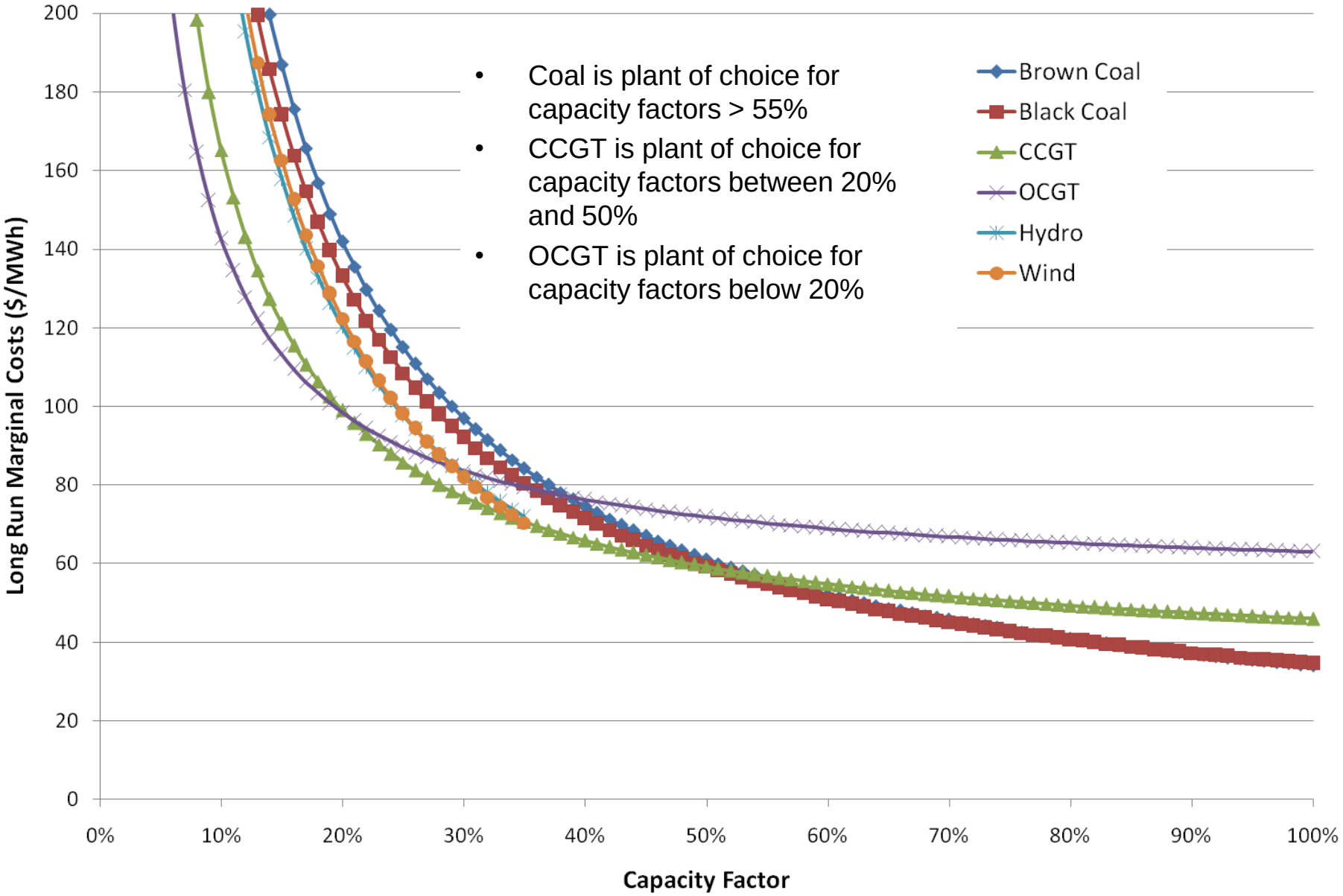
- If the price of coal increases sufficiently to make renewable generation competitive, gas will experience less of an increase in price
  - Due to lower emissions factor
- This may encourage gas generators to run as base-load, with coal generators functioning more as peaking plants

ROAM CONSULTING
ENERGY MODELLING EXPERTISE

- What will be the price of permits over time?
  - Dictated by
    - Level of emissions caps over time
    - Costs of abatement (all sectors) as a function of emissions
  - For the scheme to be effective, caps must be sufficiently challenging that they guide business investment towards lower emissions technologies

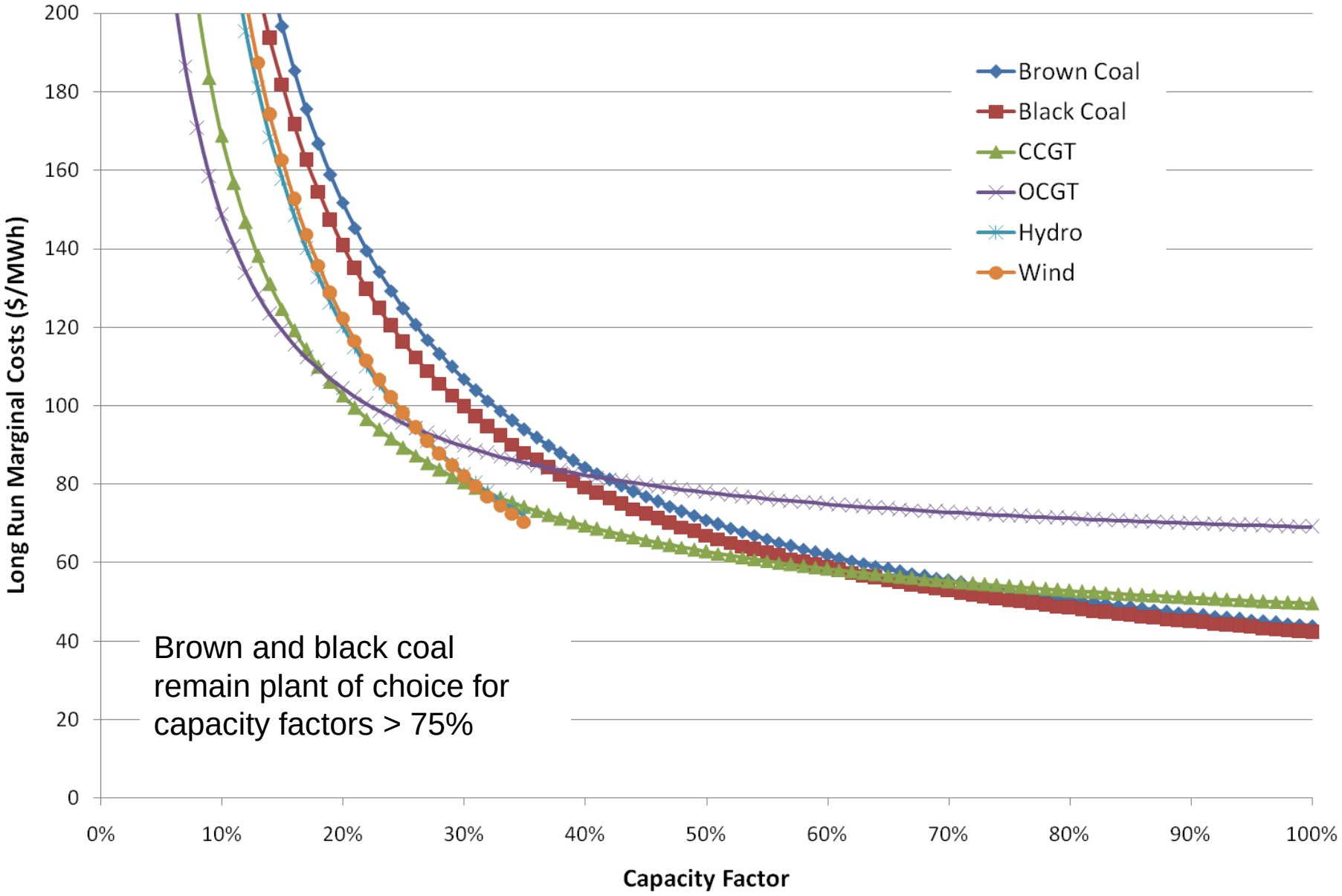
ROAM CONSULTING
ENERGY MODELLING EXPERTISE

Long Run Marginal Costs – No carbon price

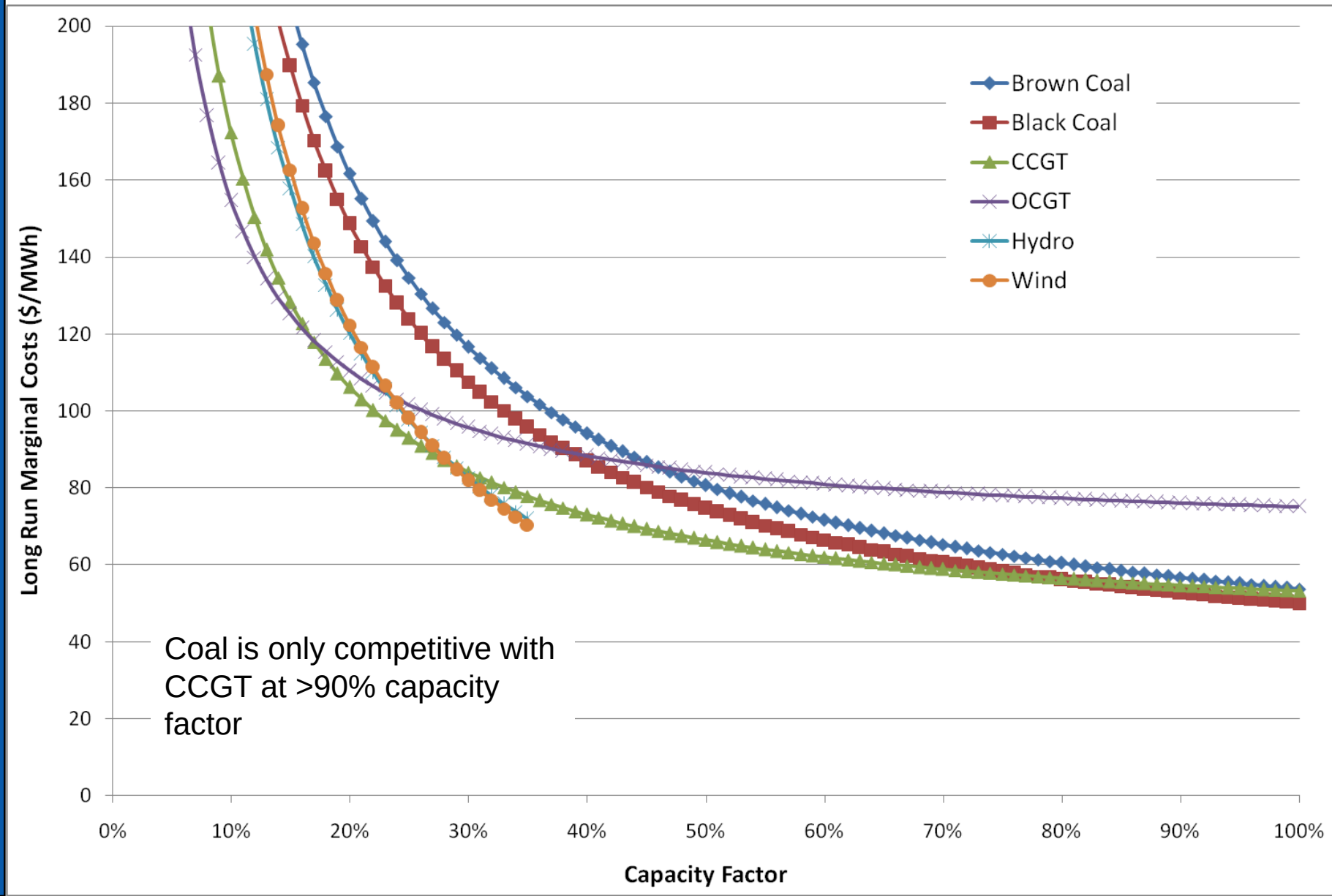


- Coal is plant of choice for capacity factors > 55%
- CCGT is plant of choice for capacity factors between 20% and 50%
- OCGT is plant of choice for capacity factors below 20%

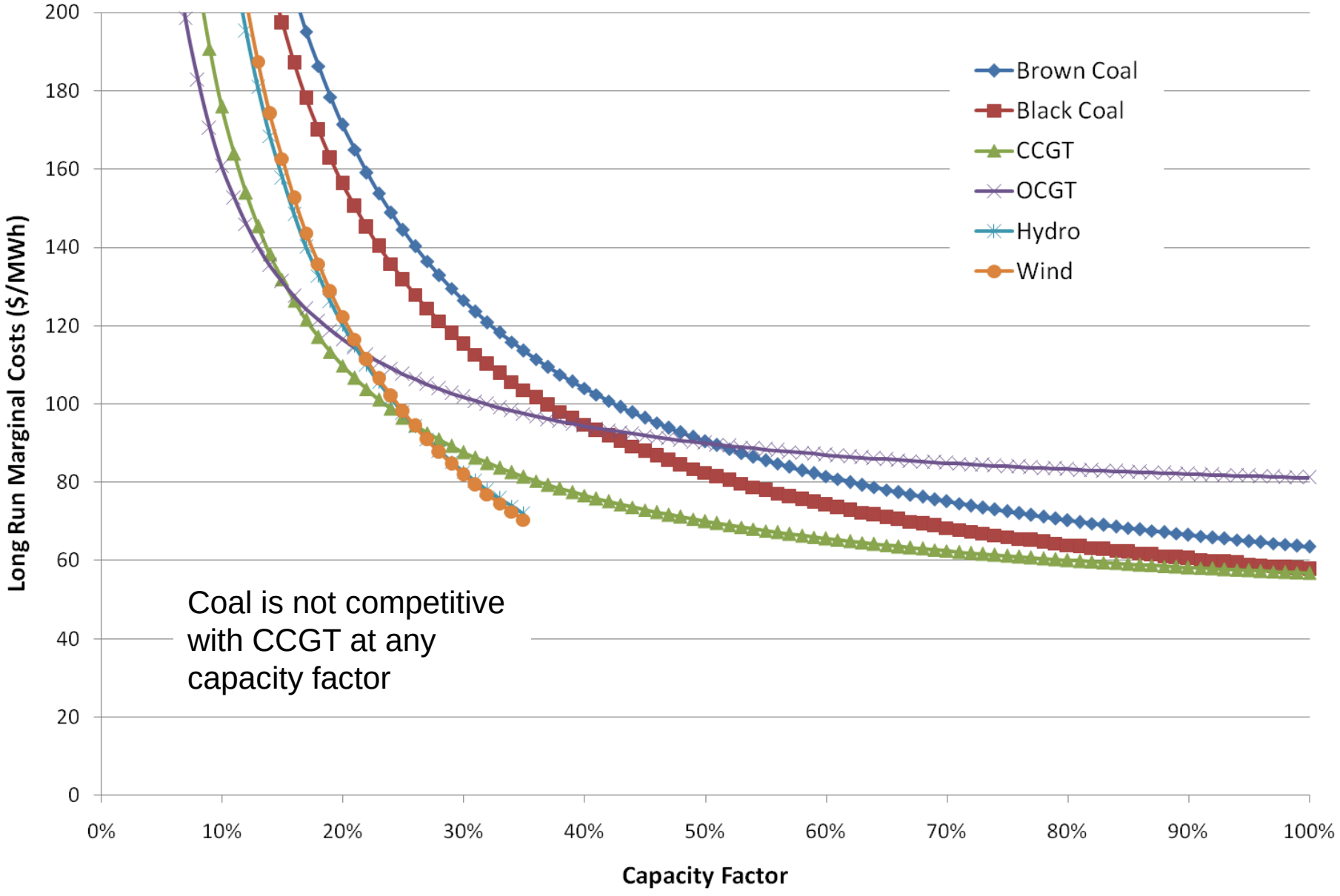
Carbon price = $10 /t$CO_2$-e



Carbon price = $20 /tCO$_2$-e



Carbon price = $30 /t$CO_2$-e



- With emissions permits auctioning for \$30 /tCO_2-e
  - New coal plants will not be built
  - New CCGT plants can be cost effectively built as base-load generation
    - This will vary with gas prices
  - New wind farms are strongly competitive
    - Without assistance from RECs
    - This will vary if additional control systems are required for new wind farms due to increasing levels of penetration
- A \$30 /tCO_2-e carbon price has a substantial impact on new plant decisions
- How will *existing* plants be affected?

ROAM CONSULTING
ENERGY MODELLING EXPERTISE

Short run marginal costs (SRMCs)

	SRMC ($/MWh)					
Carbon Price ($/tCO$_2$-e)	Brown Coal	Black Coal	CCGT	OCGT	Hydro	Wind
$0	7.12	9.87	32.73	54.17	7.58	1.22
$10	16.94	17.61	36.33	60.20	7.58	1.22
$20	26.76	25.37	39.93	66.23	7.58	1.22
$30	36.58	33.11	43.53	72.26	7.58	1.22
$40	46.40	40.87	47.13	78.29	7.58	1.22
$50	56.22	48.62	50.73	84.32	7.58	1.22
$60	66.04	56.36	54.33	90.35	7.58	1.22

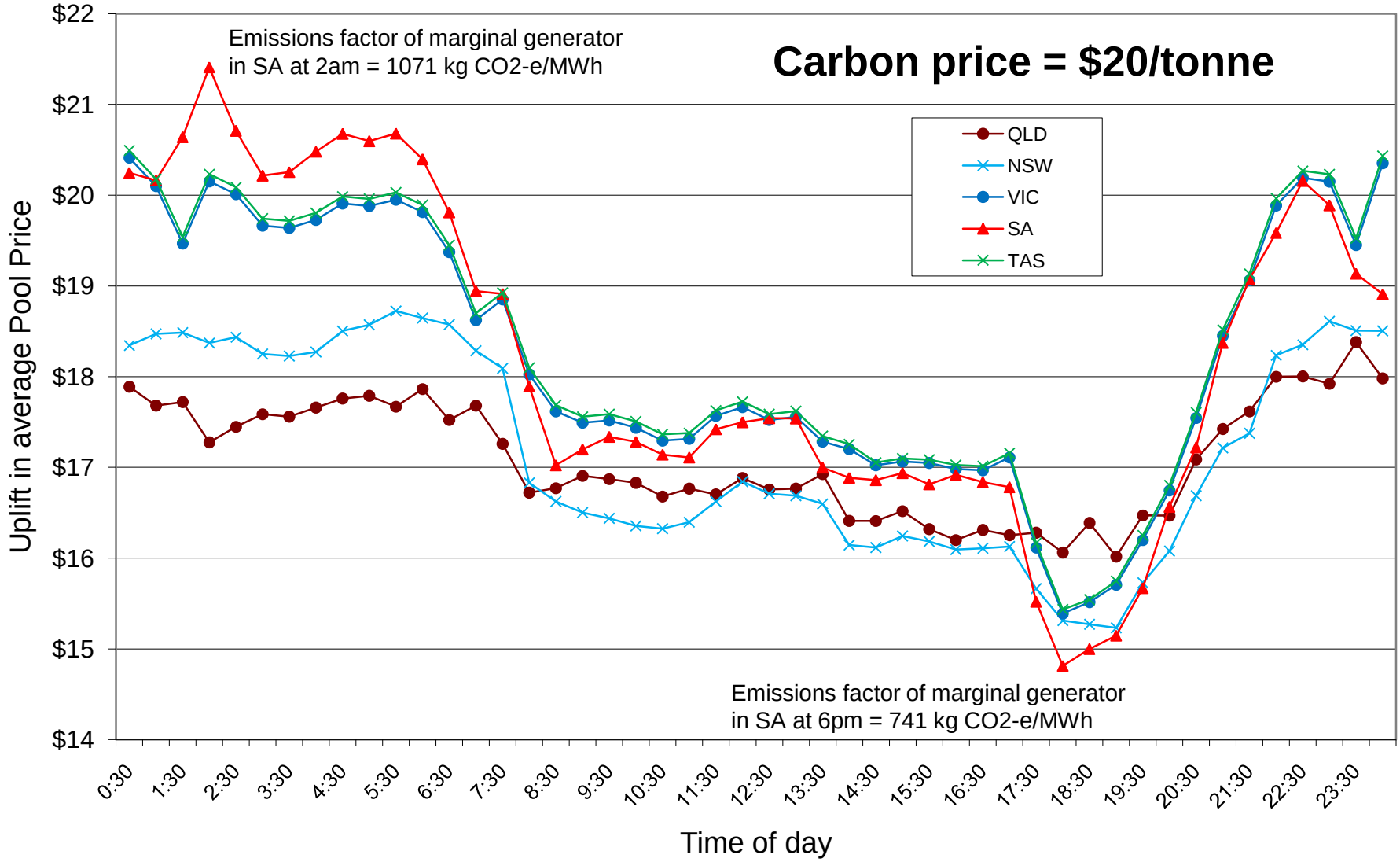
- To change the bidding behaviour of existing plants, carbon prices must reach:
  - $20 /tCO$_2$-e to favour black coal over brown coal
  - $60 /tCO$_2$-e to favour CCGT over coal
- However, our modelling has shown that even a low carbon price ($10 - $20/t) will affect dispatch to some degree

ROAM CONSULTING
ENERGY MODELLING EXPERTISE

Effect on pool price?

- Modelling shows that a carbon price lifts the average pool price by ~80% of the price/tonne CO_2
  - $60 carbon price will lift average pool price by $48
  - Current average pool price is ~$50
  - $60 carbon price would give a doubling of the pool price
- Varies by state
  - Victoria more strongly affected due to large quantities of brown coal
- Varies by time of day
  - Nights more strongly affected since price is set by baseload generators (coal), whereas during the day price is set by gas-fired generation (less affected by carbon price)

ROAM CONSULTING
ENERGY MODELLING EXPERTISE

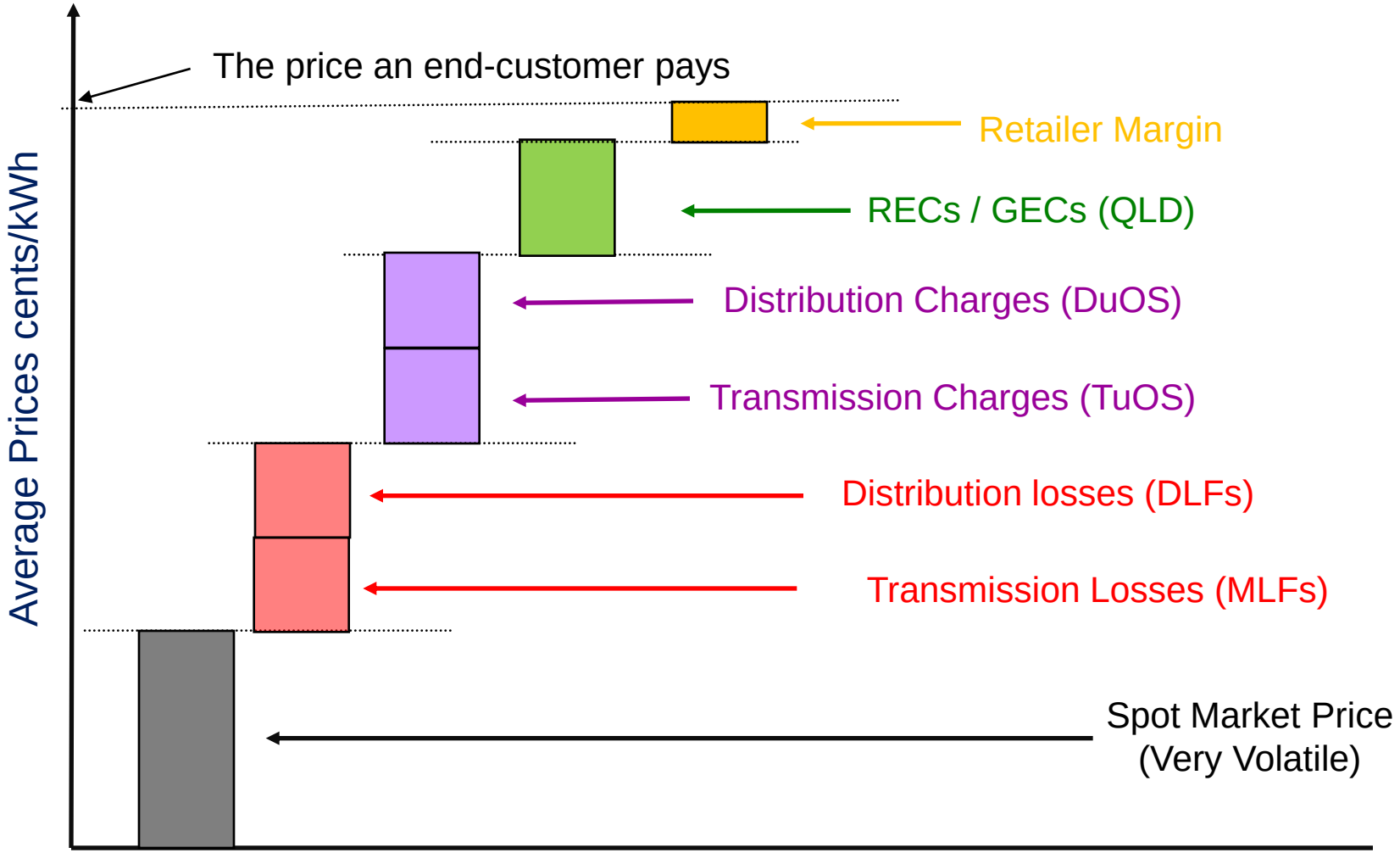


- Uplift is smallest when demand is highest
- Uplift in periods of low demand may exceed carbon price
  - Marginal generator has an emissions factor greater than 1000kg/MWh

ROAM CONSULTING
ENERGY MODELLING EXPERTISE

Price – End use

- Spot market price is only a part of the total cost of electricity
- Even if spot market price doubles, cost to consumers will increase by a smaller proportion



ROAM CONSULTING
ENERGY MODELLING EXPERTISE

For illustration only – relative proportions will vary depending upon the consumer size, location and contracts

- Higher carbon prices (eg. $40) causes significant increase in transmission congestion
  - Frequent pool price spikes, and price separation between regions
  - Particularly in QLD
    - QLD is most vulnerable to binding intra-regional constraints
  - Suggests changes will be required to manage congestion when carbon price rises that high
    - Change market rules
    - Upgrade transmission networks

ROAM CONSULTING
ENERGY MODELLING EXPERTISE

Summary

- Pool prices are currently high
- Base Case market simulations
- Expanded MRET scheme
- Emissions trading will commence in 2010
  - Potentially substantial inflation of pool price
    - $30/tonne prevents new coal plants
    - $60/tonne favours gas as baseload (if gas prices remain the same)
    - Transmission upgrades will be required
  - More modelling required
    - Need to be able to forecast carbon prices
    - MARKAL-TIMES?

ROAM CONSULTING
ENERGY MODELLING EXPERTISE