HEYWOOD INTERCONNECTOR UPGRADE RIT-T

Public Forum

24 November 2011

Presentation Outline

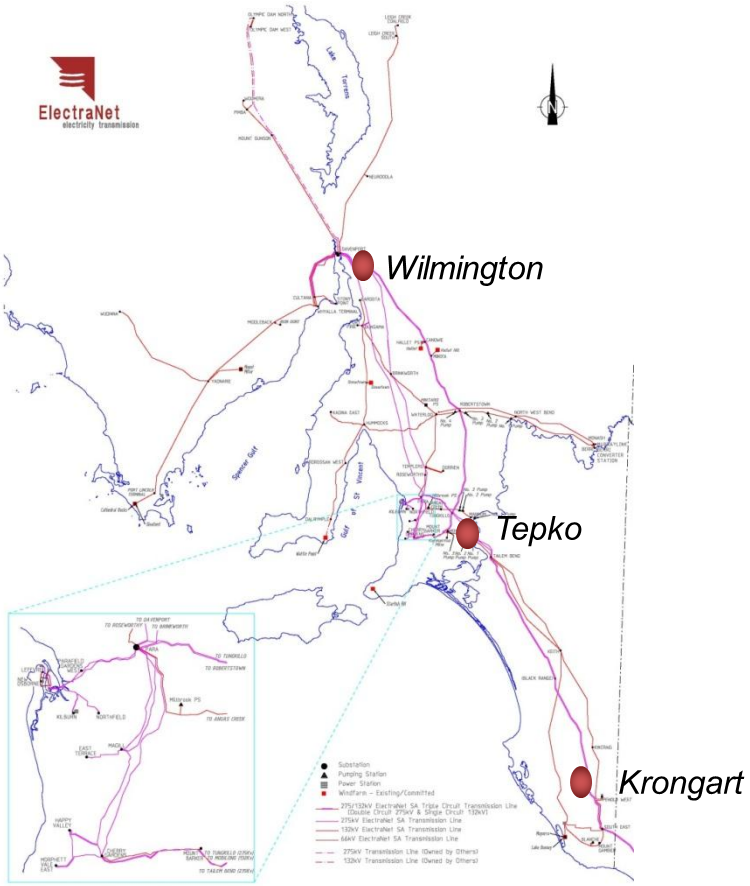
- Introduction and context (Rainer Korte)
- Drivers for the RIT-T (Luke Falla)
- Network augmentation options (Vinod Dayal)
- Market modelling approach (Bradley Harrison)
- Discussion/Feedback (Rainer Korte)
- AEMO Management perspective (Joe Spurio)
- Close (Rainer Korte)

Introduction and context

Rainer Korte – ElectraNet
Executive Manager Network Strategy and Regulatory Affairs

2010 SA Interconnector Study

- Investigated feasibility of transmission options that would…
  - provide additional support for South Australian at times of peak demand
  - allow further development of South Australia's renewable energy resource by increasing export capacity
- Incremental upgrades and major new interconnectors considered
- Impact of proposed Green Grid development considered as a sensitivity
- Report published February 2011



Feasibility Study Conclusions

- Study demonstrated the potential for increased interconnector capacity between SA and rest of NEM
- Upgrade of Heywood Interconnector shown to be feasible as early as 2017-18 under conditions of high growth, high carbon price and significant wind investment in SA
- Major new 500 kV interconnector options – lowest cost southern option was shown to be most feasible (in 2020 to 2030 timeframe)

Heywood Interconnector Upgrade

- Subsequently AEMO and ElectraNet examined more closely the feasibility of relatively low cost upgrades of the Heywood Interconnector
- Results indicated that an approx. 40% increase in capacity (up to 650 MW) would provide positive net market benefits over a wide range of scenarios with optimal timing between 2013 and 2017
- Results published in South Australian and Victorian Annual Planning Reports (June 2011)
- ElectraNet and AEMO immediately committed to and commenced application of the RIT-T to the Heywood Interconnector Upgrade

RIT-T Consultation

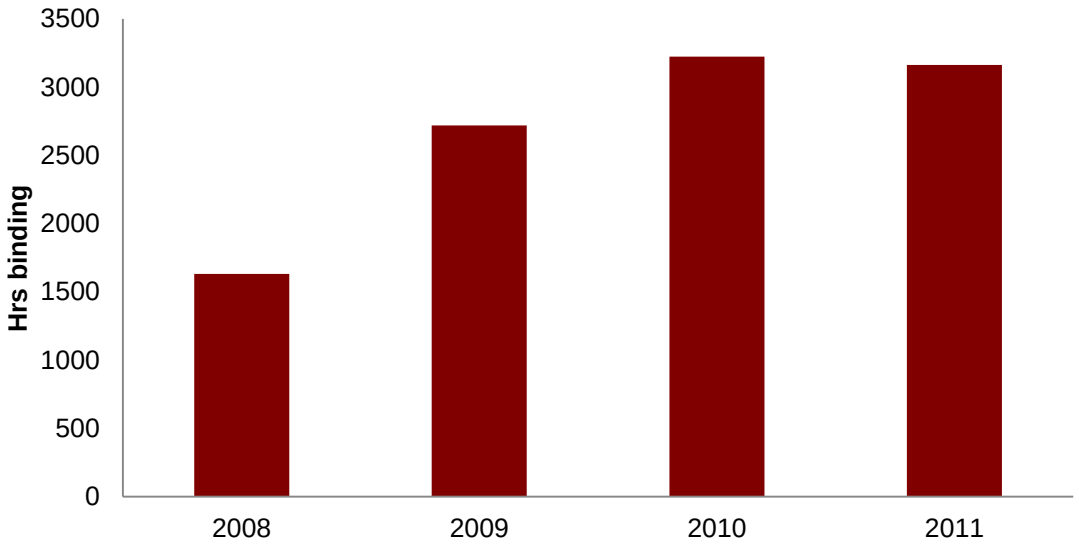
- Purpose of the RIT-T and public forum
  - Deliver cost effective investments that maximise market benefits
  - Promote understanding of the investment need and obtain input on credible options to achieve the above objective
- Project Specification Consultation Report (PSCR) has been published at www.electranet.com.au and www.aemo.com.au
- AEMO and ElectraNet invite comments on the PSCR
- Submissions to appleby.simon@electranet.com.au or planning@aemo.com.au by 30 January 2012
- Project Assessment Draft Report to be published mid-2012

Drivers for the RIT-T: Existing Interconnector limits and market impacts

Luke Falla – AEMO

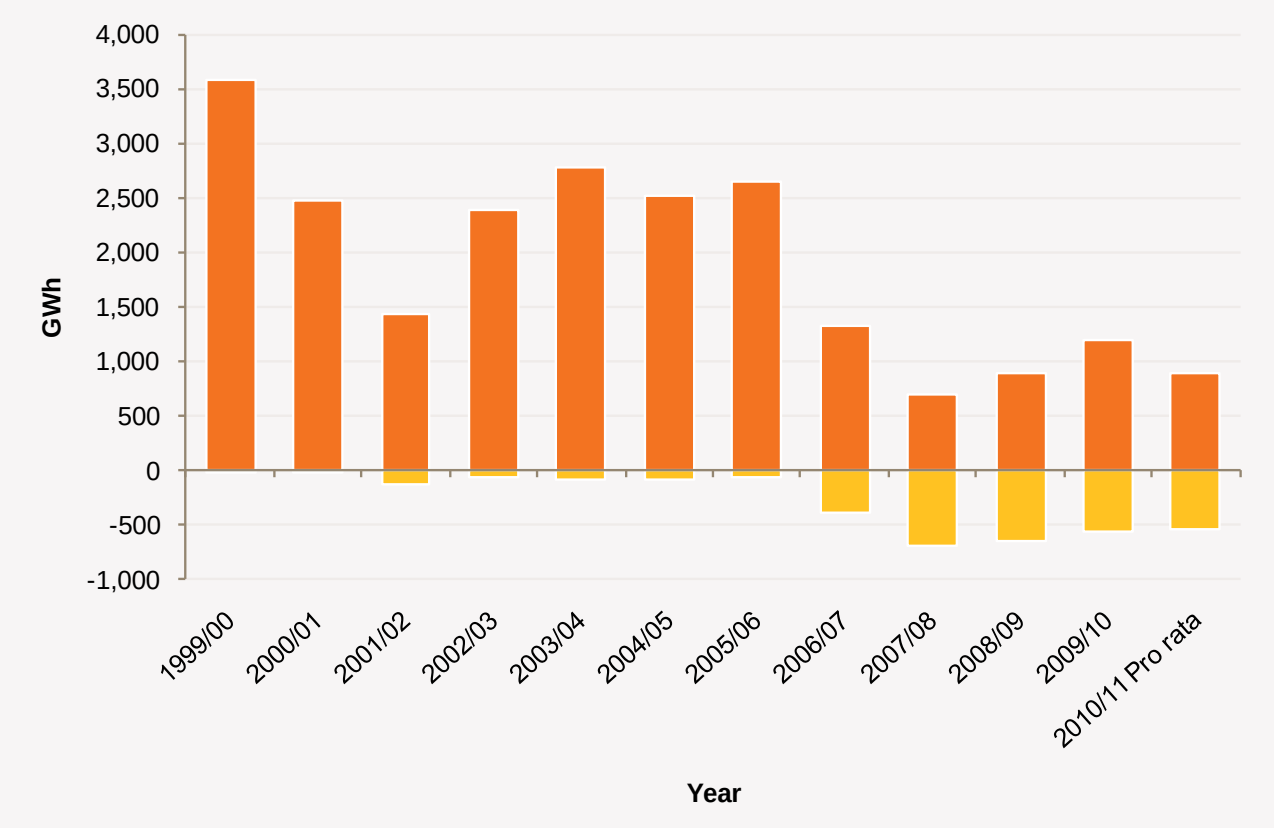
Principal Engineer, Network Planning

Increase in constraints binding



- Continuing trend of increasing VIC-SA interconnector binding hours
  - Data for 2011 only up to November
  - In January 2011 the SA to VIC combined limit with Murraylink was increased from 420 MW to 580 MW

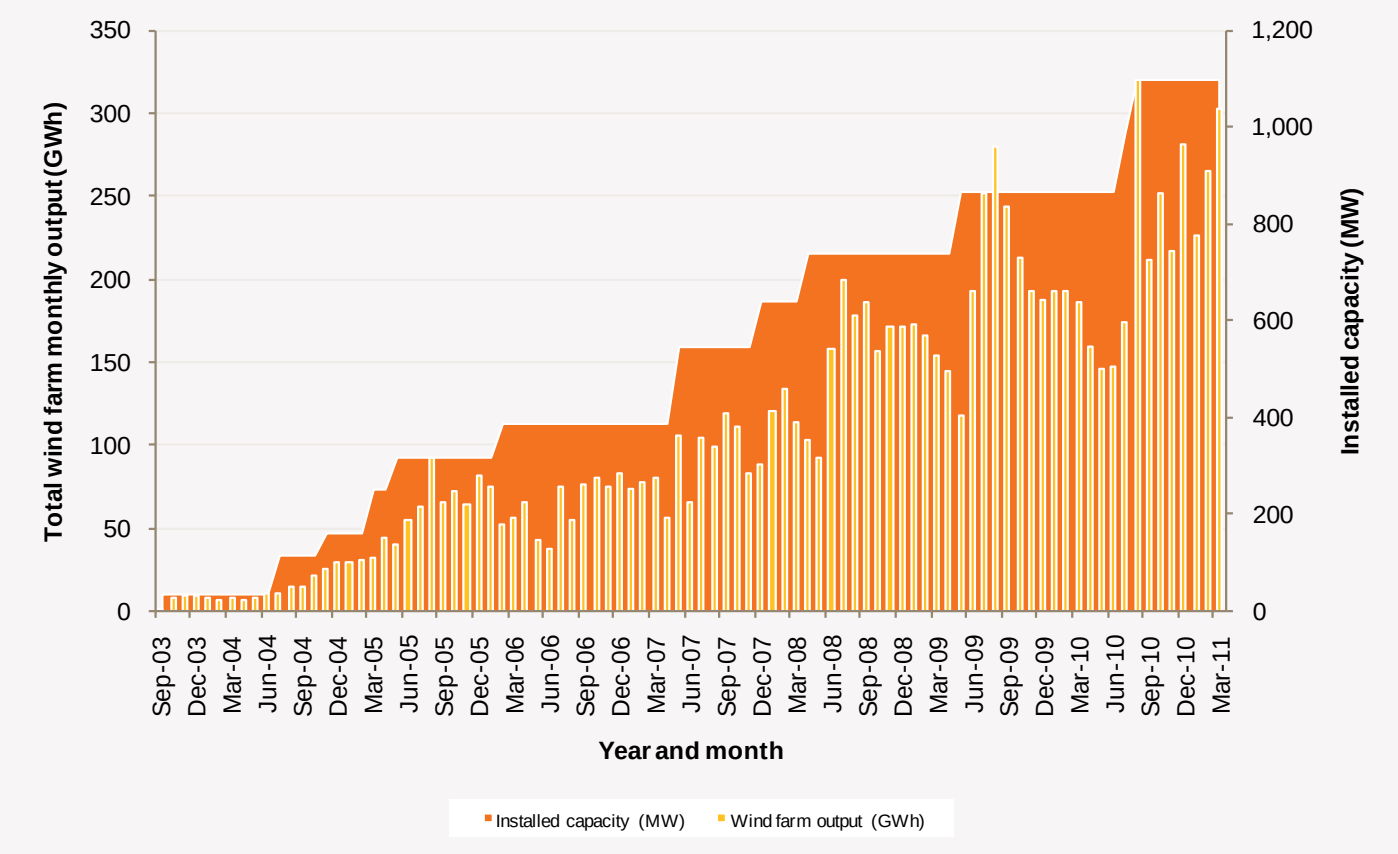
Interconnector energy transfers



- General decrease in net VIC to SA flow, and increased SA to VIC flow

Source- AEMO SASDO 2011

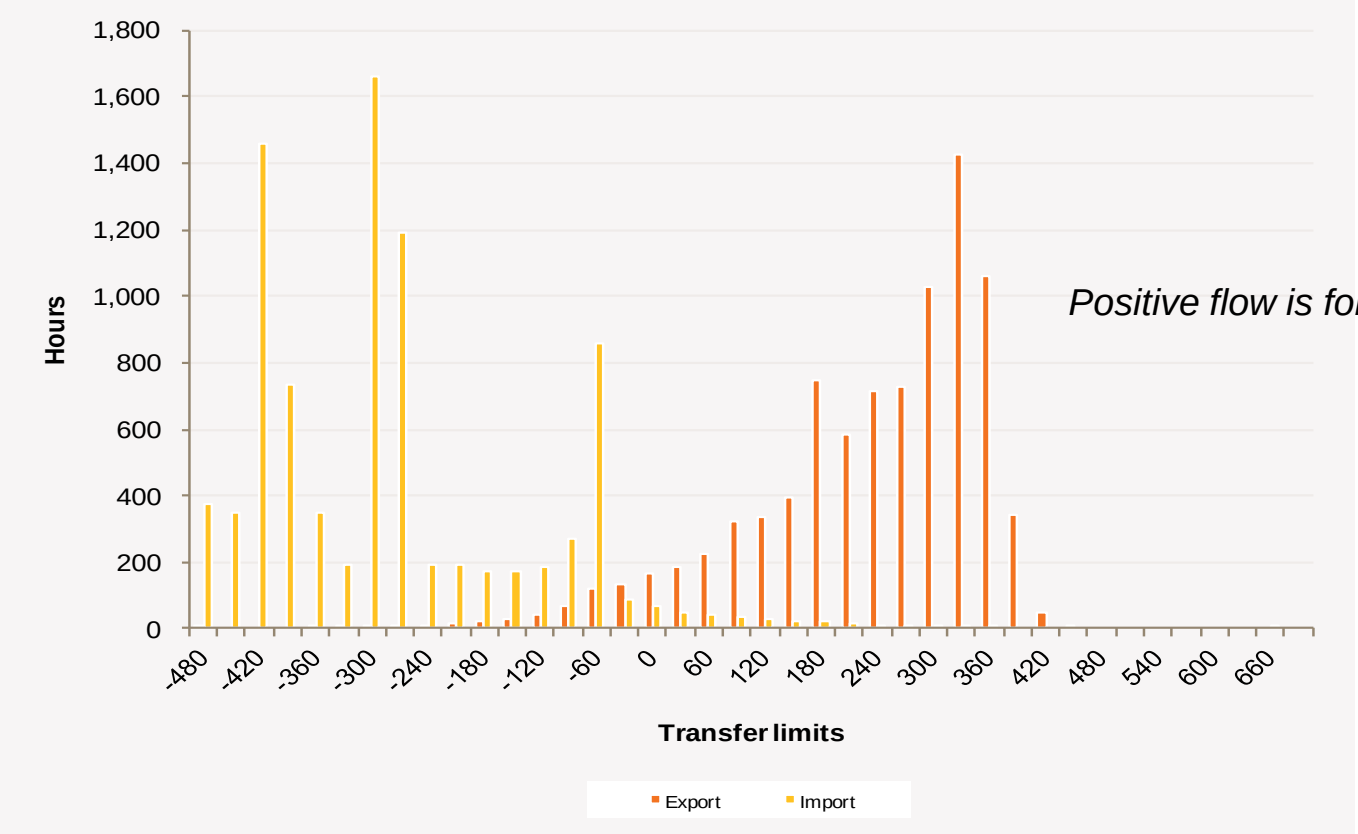
Increased wind farm generation



Financial Year	Maximum Half-Hourly Output (MW)
2004/2005	235
2005/2006	286
2006/2007	320
2007/2008	540
2008/2009	641
2009/2010	765
2010/2011	978

Source- AEMO SASDO 2011

Range of interconnector limits



Positive flow is for VIC to SA direction

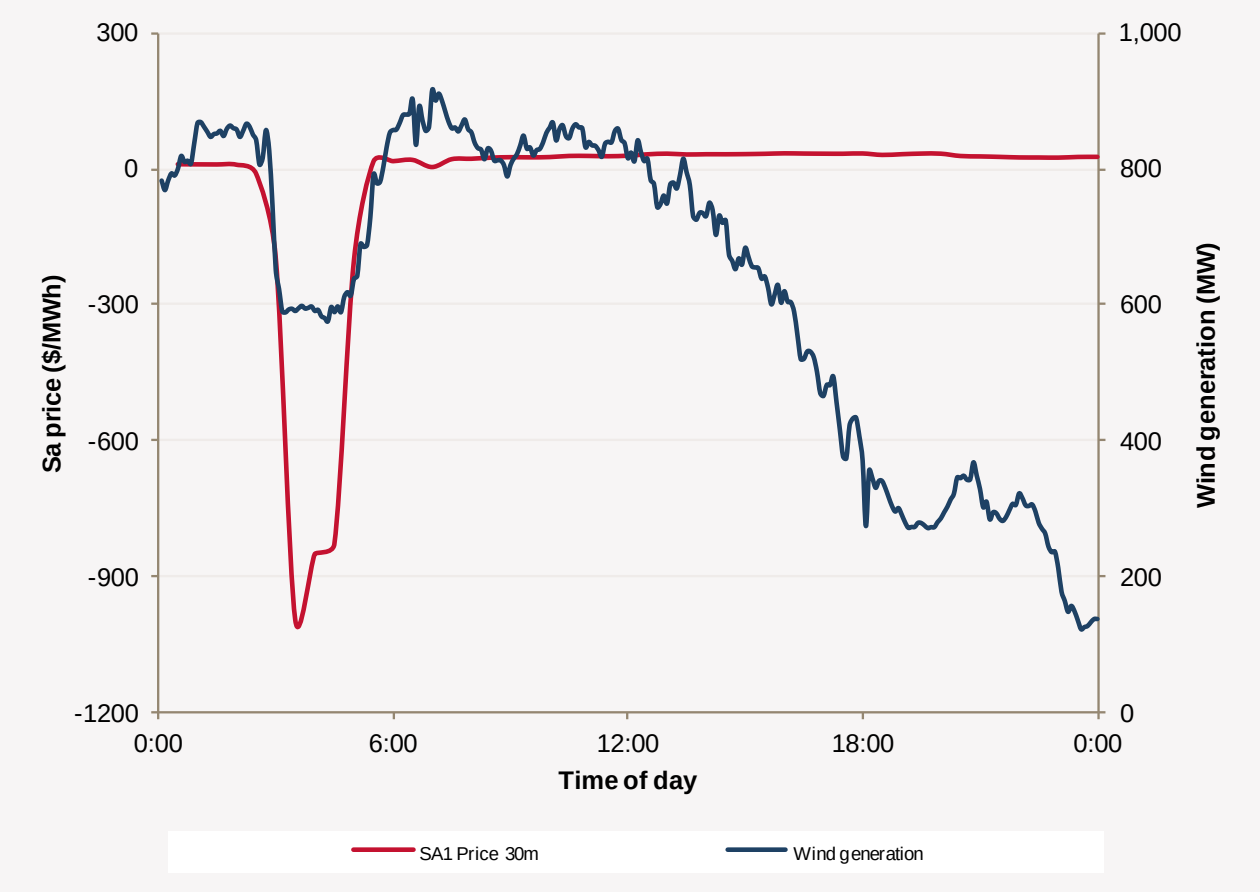
- Limits vary considerably depending on SA region demand and dispatch conditions.

Source- AEMO VAPR 2011

Impacts of SA to VIC limitations

Year	Total
2006	1
2007	10
2008	51
2009	93
2010	139

No. of negative price events in the SA region

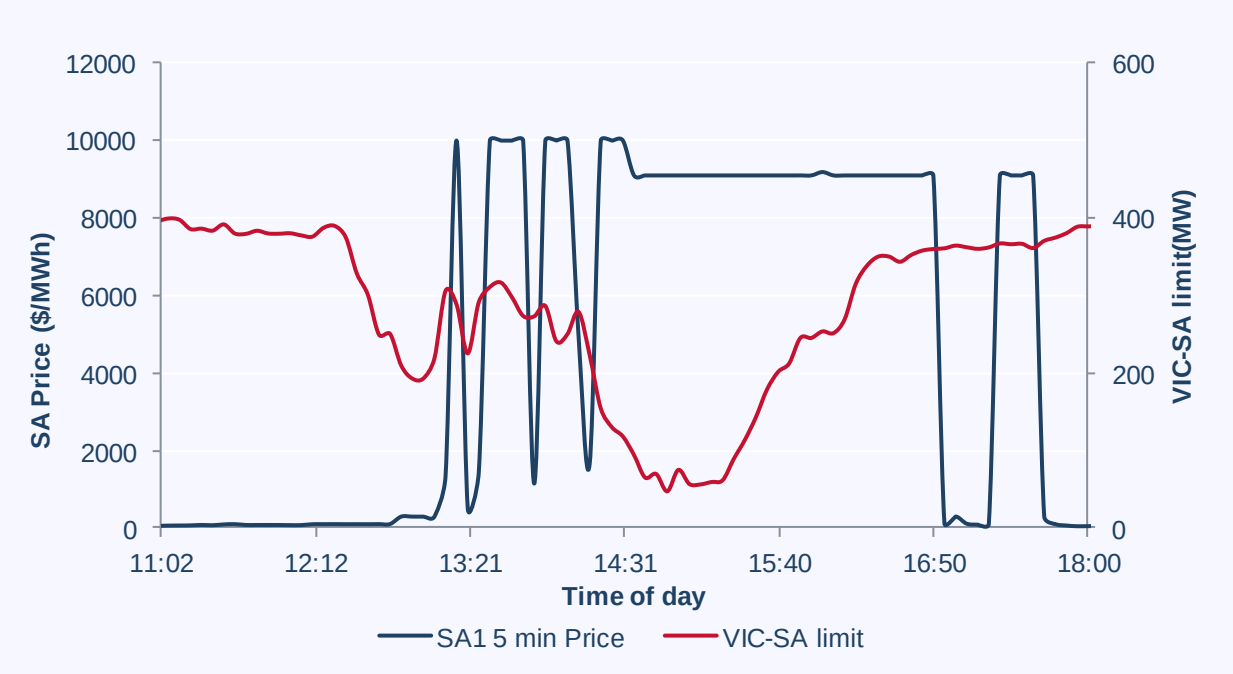


- ❑ Number of negative price events increasing
- ❑ Wind farms being constrained off

Impacts of VIC to SA limitations

Year	SA1	VIC1
2008	**66**	40
2009	**60**	36
2010	**40**	34
2011	**42**	32

Average annual region price ($/MWh)



- Can contribute to high SA region prices
- Price separation events between SA and VIC regions occurring

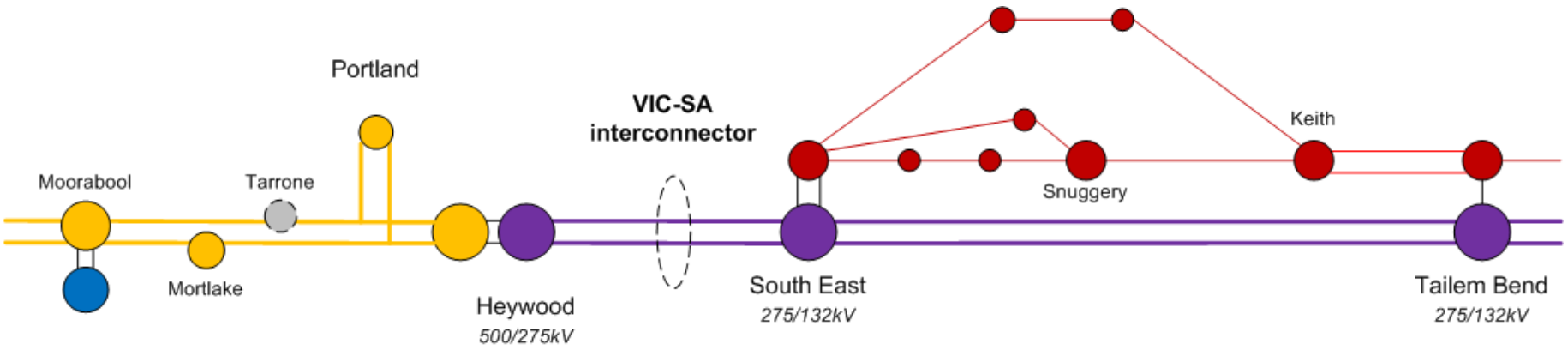
Constraint types setting limits

- For ‘Nil outage’ constraints in 2010
  - Voltage stability in SA – 542 hrs
  - Thermal limits in SA – 204 hrs
  - Transient stability in VIC – 430 hrs
  - Thermal limits in VIC – 493 hrs
  - Oscillatory stability – 42 hrs

  i.e. a number of complex issues are required to be considered and resolved

Source- AEMO Constraint Report 2010

Existing network-limiting factors



Existing Interconnector limits are due to:

- Heywood 500/275 kV transformer ratings (460 MW)
- Thermal ratings in SA 132 kV network
- Voltage stability limits in the South East area (trip of largest unit in SA)
- Oscillatory stability limit (limit for Murraylink and Heywood, 580 MW)

- 500/330 kV F2 transformer rating at South Morang (for high VIC - NSW flow)
- Victorian Export transient stability limits

Previous studies

- Joint Interconnector Feasibility Study
  - Studied in conjunction with larger upgrade options
  - Showed incremental option to have net benefits under all scenarios
- 2010 NTNDP
  - Incremental upgrade option chosen in some scenarios

Summary

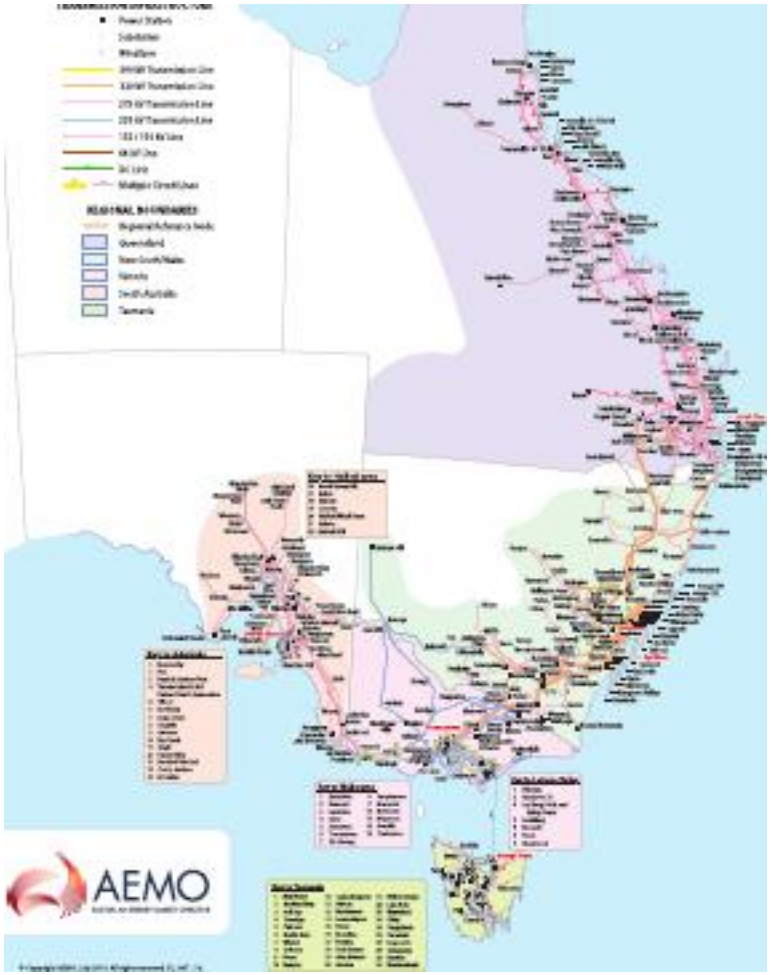
- The existing interconnector continues to be constrained more and more often in both flow directions.
- High prices in SA during high demand periods, and negative prices during low demand periods highlighting the issues.
- New wind generation causing more and more energy to be exported to VIC from SA, and now being constrained off at times.
- Limits caused by equipment ratings as well as stability limits.
- Previous ElectraNet/AEMO studies highlighting the potential of net market benefits for an upgrade.

Network Augmentation Options

Vinod Dayal - ElectraNet

Principal Engineer (Network Strategy)

South Australian power system – features and benefits of Interconnection

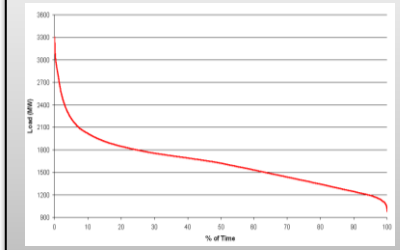


Source: NTNDP 2010

- Maximum Interconnector Capacity
  - Heywood ± 460 MW
  - Murraylink ± 220 MW

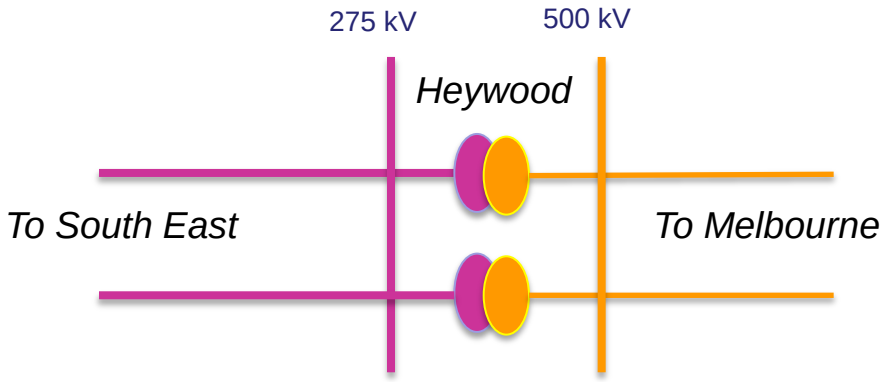
- Very peaky demand profile with average to low demands for most of the year
- Significant wind penetration - 1200 MW
- High wind generation mostly occurs during average to light demand periods
- Abundant renewable generation resources
- Significant mineral resources available
- Interconnection strengthens the South Australian power system
- Generation capacity reserves shared with Victoria, to effectively manage the short time that peak capacity is required in SA
- Export surplus wind generation at times of lower SA demand
- Importing lower cost generation from rest of NEM

Typical annual SA Load Duration Curve

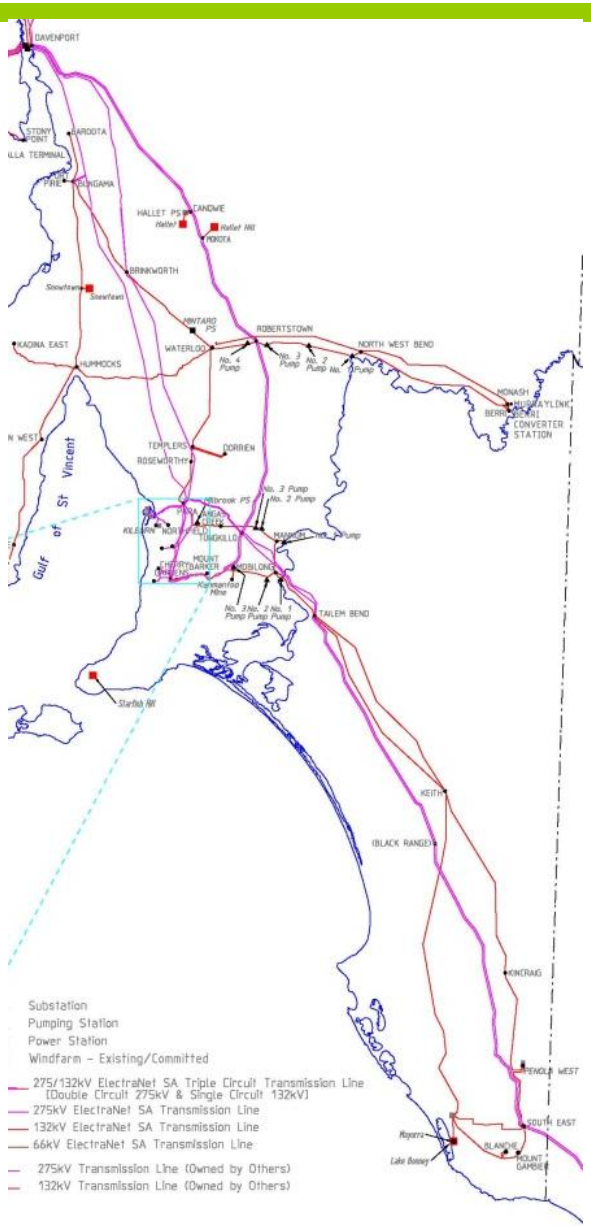


Victoria Transmission Network associated with SA Interconnector paths

- Heywood Interconnector is connected via 275 kV lines from SA, stepped up and connected to high capacity 500 kV lines to Melbourne (South-West corridor)
- Murraylink is connected via number of 220 kV lines; there are network limitations under certain operating conditions



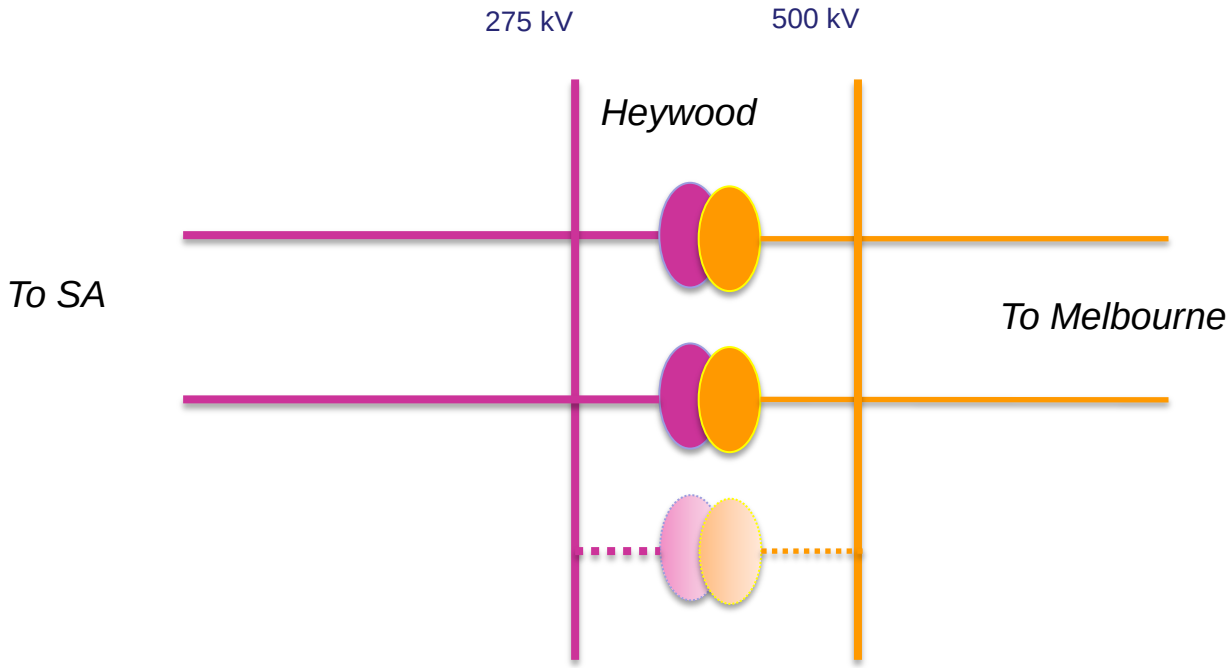
SA Transmission Network associated with Interconnector Paths



- Heywood interconnector is connected via 275 kV lines from South East to Adelaide with an underlying 132 kV network; thermal and stability constraints are applied under certain operating conditions, limiting both Imports and Exports
- Murraylink is connected via two 132 kV lines; there are network limitations under certain operating conditions, limiting both Imports and Exports

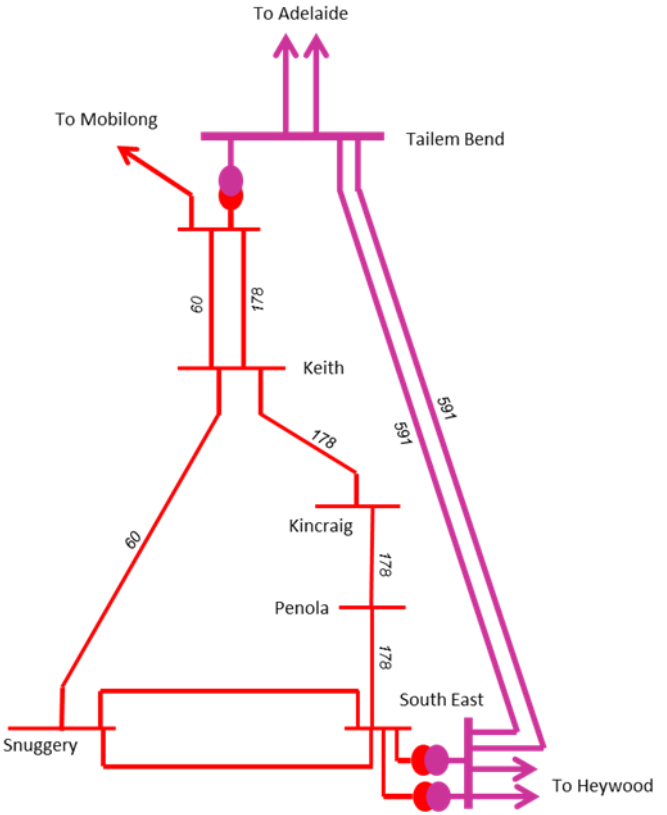
Augmentations - Victoria

- 3rd 500/275 kV transformer at Heywood
- Dynamic line rating of South East to Heywood 275 kV lines



Augmentations in SA – Issues for consideration

- Impact of the lower capacity underlying 132 kV transmission system
- Age of the lower capacity 132 kV transmission lines (~50 years)
- High maintenance costs identified for the upkeep of aged transmission assets
- Transient/Voltage stability consideration (Reactive Power requirements)
- Impact of network reconfiguration

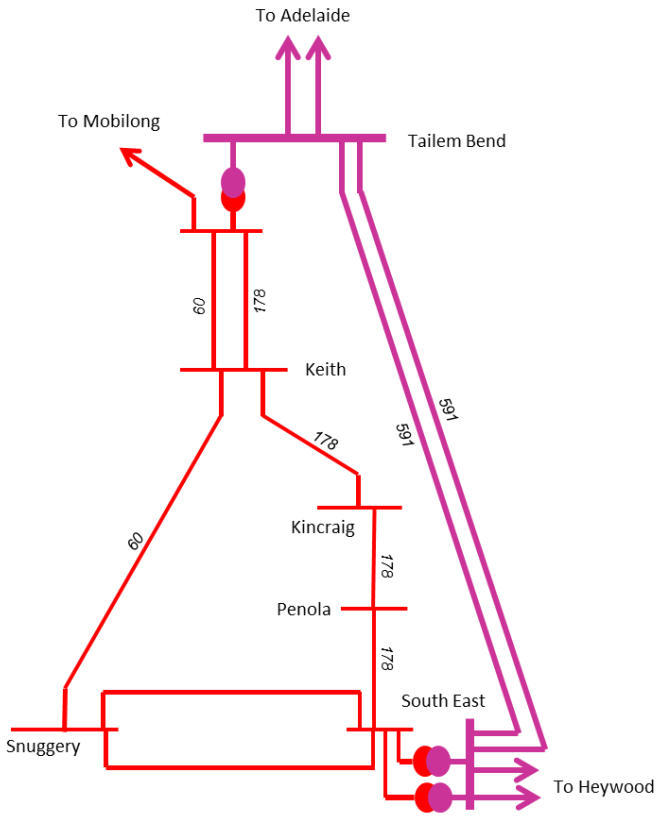


Summer design MVA ratings shown

SA augmentation options

- Options
  - Operational management of thermal limitations
  - Decommission/ disconnect the Snuggery-Keith and Keith-Tailem Bend #1 132 kV lines
  - Un-mesh the 132 kV system from the 275 kV network
- Common works
  - Upgrade minor plant to release additional transmission capacity in the interconnector corridor

Identification of additional requirements to support transfer capability (such as reactive plant) is an outcome of the technical assessment



Summer design MVA ratings shown

Assessment of SA options

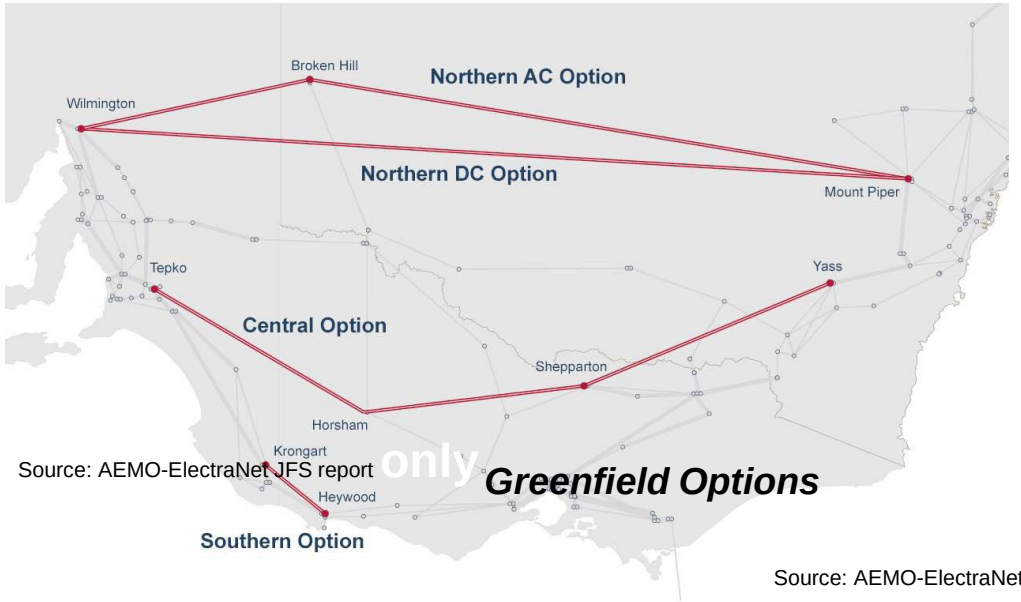
Options not technically feasible or cost effective:

- Operational Management
  - Insufficient thermal inertia of lines to allow short term rating
  - Security issues related to inter-trip schemes
  - Cost of maintaining the aged assets
- Un-meshing of 132 kV network
  - Significant reduction in stability limitations (and associated costs to fix the limitations)
  - Security impacts due to limited circuits across the transfer path
  - Cost of maintaining the aged assets

Assessment of SA options

- Option for consideration in market modelling
  - Decommission/ disconnect Snuggery-Keith and Keith-Tailem Bend #1 132 kV lines
  - 100 Mvar 275 kV Capacitor Bank OR 30% Series Compensation of Tailem Bend – South East 275 kV Lines
  - Additional 132 kV reactive support at Keith and Penola connection points
- Advantages
  - Provides significant thermal transfer capability
  - Good sharing of power flows between the 275 kV lines and the remaining 132 kV lines
  - Less reactive support required to meet stability requirements when 132 kV system is still connected
  - No on-going costs to maintain aged assets
  - Aligns with strategic planning outcomes for the region

Greenfield option



Source: AEMO-ElectraNet JFS report

Greenfield Options only

Support Projects

Source: AEMO-ElectraNet JFS report

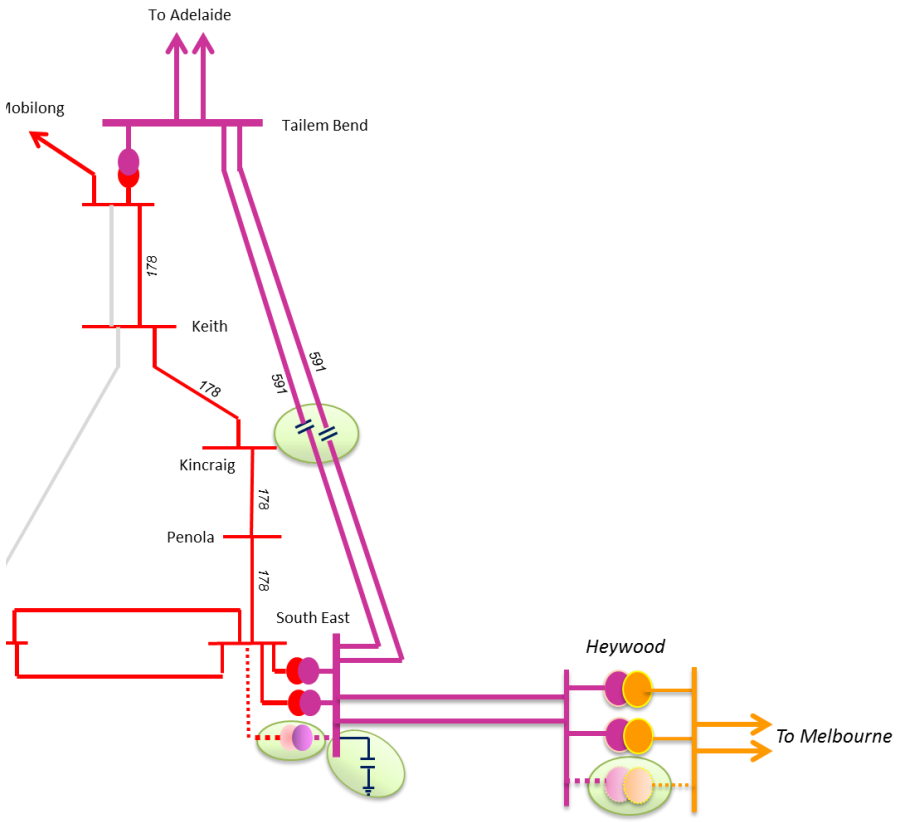
- SA Interconnector Feasibility Study concluded that the Southern option was the greenfield option showing a net positive market benefit in most scenarios
- Therefore, Southern option to be progressed as the Greenfield option for this RIT-T

Options for Market Modelling

Option	Victoria	South Australia
Base		Do nothing
1	➢ 3rd 500/275 kV Transformer at Heywood ➢ Dynamic Line rating of South East to Heywood 275 kV lines	➢ Decommission/disconnect Keith-Snuggery and Keith-Tailem Bend#1 132 kV lines ➢ 100 MVAr Capacitor at South East sub-station ➢ Additional reactive support at 132 kV connection points ➢ Upgrade plant to release additional transmission capacity in the interconnector corridor
2	➢ 3rd 500/275 kV Transformer at Heywood ➢ Dynamic Line rating of South East to Heywood 275 kV lines	➢ Decommission Keith-Snuggery and Keith-Tailem Bend#1 132 kV lines ➢ 30% Series Compensation of South East to Tailem Bend transmission lines ➢ Additional reactive support at 132 kV connection points ➢ Upgrade plant to release additional transmission capacity in the interconnector corridor
3	Krongart to Heywood 500 kV lines	
4	Demand side management	

Additional* option		3rd 160 MVA 275/132 kV transformer at South East sub-station

*to be considered along with the option with highest market benefit, to assess any additional benefits

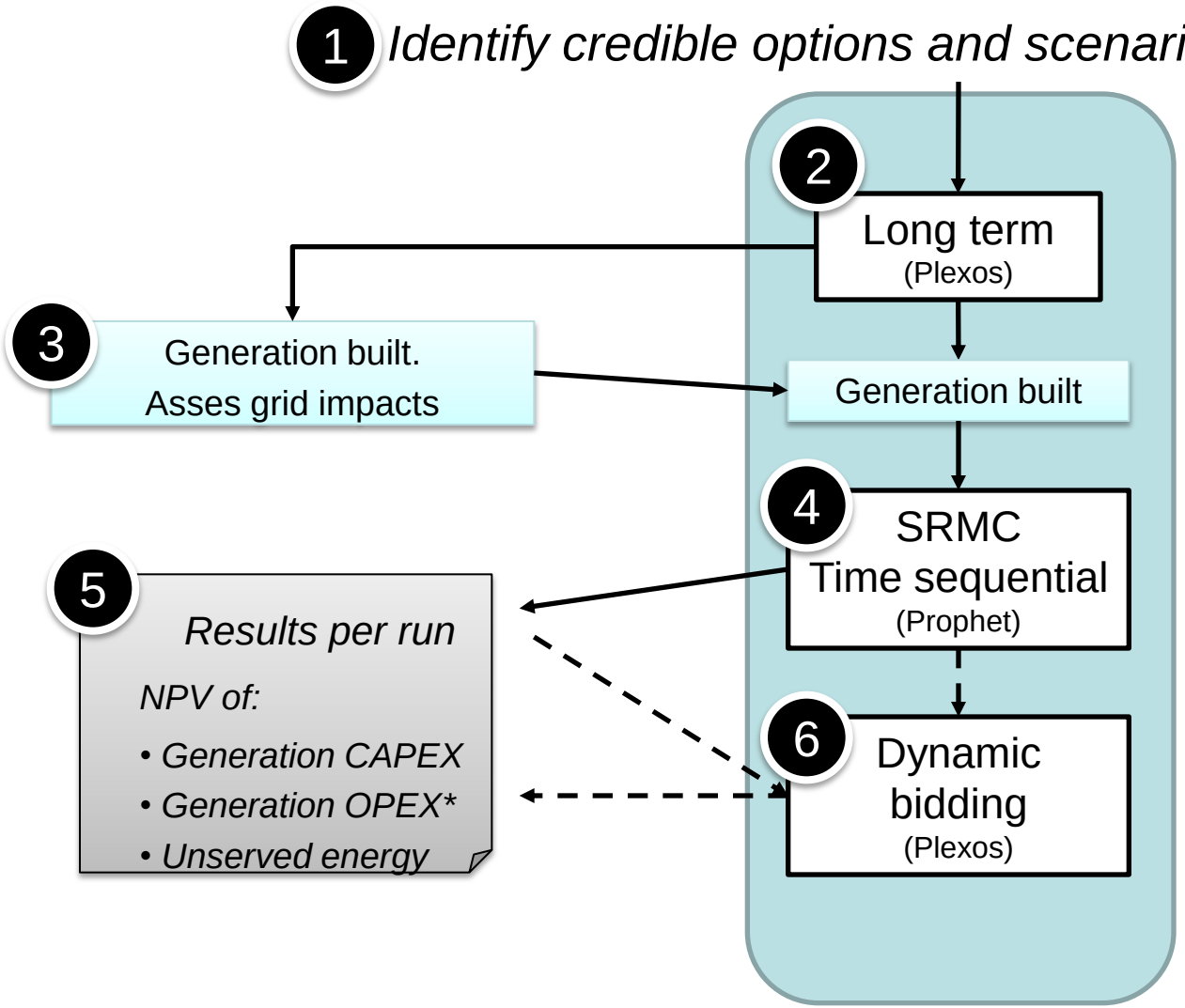


Market Modelling Approach

Brad Harrison, ElectraNet

Principal Energy Market Analyst

Market Modelling Approach



Horizon: to 2045

Time: Monthly, 18 load blocks

Losses: Load does not include losses, interconnector loss model consistent with market dispatch algorithm.

Horizon: 1 year at a time for 20 years

Time: Time sequential, hour by hour

Bidding: Short Run Marginal Cost

Bidding: Dynamic bidding strategy consistent with requirements of RIT-T.

** Includes fuel costs, losses and potential price impacts on consumption*

Step 1 – Scenarios

Theme	Scenario: Low growth	Scenario: Medium growth	Scenario: High growth
Economic growth	Low	Medium	High
Demand growth	Low	Medium	High + Eyre Peninsula and Olympic Dam Expansion
Carbon price	High Treasury price	Core Treasury price	Core Treasury price
Technology timings	Timings + 2 years	NTNDP refresh	Timings - 2 years
Gas prices	Low	Medium	High
Demand side tech and management	Zero	Low	High
LRET	Achieved	Achieved	Achieved

Step 2 – Modelling details

- Time resolution (to 2045)
  - Monthly resolution
  - Targeting 18 Load Duration Curve blocks
- Geography
  - Regional model
- Least cost co-optimisation
  - Requirement of the RIT-T
- Relaxed integer model
- Network losses – mark-up
- Network congestion –remote and low impact constraints removed

Step 3 – LT expansion

- Observe where and when the Step 2 modelling invests in new capacity
- Determine commissioning year:
  - Relaxed integer build allows for increments of power stations. Requires some judgement
- Review implications of investment decisions for
  - network management
  - network augmentation

Step 4 – Time sequential runs

- 20 year assessment
- Generators dispatched based on short run marginal cost
- Hour by hour simulation
- Ensure optimal operation given annual constraints
  - Hydro energy limits
- All NTNDP system normal network constraints
  - Additional constraints specific to the network options being modelled

Step 5 – Economic assessment

- Assumptions
  - Discount rates
    - WACC (10 %)
  - End effects
    - Benefits calculated to perpetuity
- Approach
  - Compare total discounted system costs for each option/timing with a base case without any upgrades
- Is there a clearly preferred option?
  - If not, assess dynamic bidding

Step 6 – Dynamic bidding

- Is modelling of dynamic bidding necessary?
  - What is the magnitude of market benefits from dynamic bidding (competition benefits)
  - Are these benefits required to differentiate between credible options
- RIT-T and wealth transfers
  - Net market benefits, not just a price change

Discussion/ Feedback

AEMO Management Perspective

Joe Spurio, AEMO

Senior Manager, Network Analysis

Next Steps

- Project Specification Consultation Report (PSCR) has been published at www.electranet.com.au and www.aemo.com.au
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