17th June 2024

Priority Access Modelling

AEMC Transmission Access Reform

Presentation for TWG

ACIL ALLEN

Scope of Work

- The AEMC asked for ACIL Allen to advise whether the effects of priority access can be meaningfully modelled by intending participants to support investment cases.
- In particular, AEMC requested technical advice on the following:
  1. How congestion modelling is currently completed in the NEM and how it contributes to the investment case of an intending participant
  2. Could priority access as currently designed be included in the usual modelling undertaken for investors in generation
     - Could a generator model the cash flow effects of priority access relative to the status quo and its impacts on congestion caused by new entrants.
     - Could a generator anticipate where its access would be limited/reduced by higher priority generators at certain points on the grid.
  3. Whether, in ACIL Allen's opinion, priority access could provide more certainty (relative to the status quo) to intending investors about the revenues a project would earn over its lifetime.
  4. Whether modelling of this nature would likely improve over time .

Congestion modelling and generation investments in the NEM

- Undertaking a generation investment is complex as it requires drawing together a range of uncertainties into a coherent package, which is then used to convince debt and equity providers to invest. For variable renewable energy (VRE) projects, the most significant risks are:
  1. volume risk (driven by uncertainty around the variable renewable energy source supplying the generator)
  2. price risk – exposure to volatile spot prices and demand for VRE PPAs
  3. economic curtailment (insufficient demand to use available renewable generation)
  4. network congestion.
- The first three risks can be modelled deterministically, and the effects can be predicted with some degree of certainty based on assumptions or modelled stochastically to develop a robust distribution of outcomes. In addition, the first three risks can, to some extent, be managed or mitigated by entering part or whole of meter-based PPAs and employing bidding strategies to avoid generating when prices are below a project's price of indifference/SRMC.
- Under current arrangements, network congestion is difficult to forecast because of the uncertainty associated with the location of future investment and the potential for future investment to alter the priority of dispatch when congestion occurs, with later entry potentially crowding out earlier entry.

Can priority access provide more certainty for investors?

- Prior to doing any modelling, we expected that introducing a hybrid priority access and CRM regime would make the NEM operations and investment decisions more efficient. We expected the hybrid regime will reduce the risks of new-generation investments' access being cannibalised by later investments wanting to locate in similar electrical locations.
- In theory, priority access combined with CRM should provide more certainty for future investors, but this hypothesis needs to be tested to see whether it is a reasonable assumption. To do this, we are developing a simple prototype that compares the operations and generation development plans based on generators making profit-maximising investments over a 10-20 year horizon with (a) status quo arrangements and (b) priority access plus CRM.
- If the prototype priority access and CRM produce more efficient investments and more certain cash flows for investors, then we would think that priority access combined with the CRM can achieve the goal of providing more certainty (relative to the status quo) to intending investors about the revenues a project would earn over its lifetime.

Incorporating priority access into investment modelling

- To incorporate priority access into investment modelling, the following need to be done:
  - **Dispatch and pricing**: Implement a two-pass dispatch process (the hybrid model) and determine the appropriate prices. The first pass involves priority access, and the second pass involves physical dispatch (CRM).
  - **Settlements**: determine spot market settlements (priority access and physical – CRM) and any contract settlements
  - **Market bidding**: implement sensible bidding strategies for the priority access dispatch and the physical dispatch
  - **Network modelling and security constraints**: develop a network model which includes future network enhancements and determine (formulate) appropriate network and other security constraint equations
  - **Market-based new investment**: develop a process for determining market-based new investments under priority access

Hybrid Model - dispatch and pricing

- To model priority access and CRM dispatch and pricing, the following need to be done:
  - Implement a two-pass dispatch process: access dispatch immediately followed by a CRM physical dispatch where
    - the access dispatch and pricing is the same as the current NEM dispatch and pricing
    - the CRM physical dispatch uses a new set of CRM energy bids for those participating in the CRM, and it includes a new set of CRM deviation constraints which can be used to limit the deviation of a dispatchable resource's CRM physical dispatch from its access dispatch
    - the CRM dispatch targets are assumed to be the actual metered dispatches for the dispatch interval and consequently become the starting states for the next access and CRM physical dispatches
  - Calculate the CRMPs for each dispatchable resource from the CRM physical dispatch optimisation as the nodal prices. This could be done directly from the nodal prices of a DC load flow model that explicitly models the transmission network or could be calculated based on the shadow prices of the binding network constraints as is currently done with NEMDE.

Hybrid Model - Network Study Modelling

- ACIL Allen would model the network and security constraints required for priority access and the physical dispatch (CRM) along very similar lines to what we currently do.
- This is because the physical network and security constraints are precisely the same for a normal NEM dispatch, a CRM physical dispatch and an access dispatch with priority access.

Market modelling of new investments

- The most challenging part of modelling priority access is determining market-driven entry investments.
- ACIL Allen would use a similar approach to what we currently do, where we use small generic investments to indicate the business opportunities of investing in different technologies in a region at a particular time. For the priority access model, we would extend this to all major network locations at which a variety of generation investments could be made. This would not be a centrally planned least-cost set of generation investments but market-driven investments.
- Once prospective locations have been determined using the small generic investments, modelling of realistically sized investments would be undertaken in an iterative approach whereby the most prospective new entrants are evaluated first to determine whether they are financial viable considering any curtailment due to network congestion and lack of demand (economic curtailment).
- We expect that under priority access new entrant investments will be installed in areas with a low risk of curtailment from existing investments and, also, priority access will in turn reduce the risks of new investments being cannibalised by subsequent investments.

Questions?

Are there any comments on how Priority Access, as currently designed, could be included in modelling undertaken for generation investment?

Prototype Model

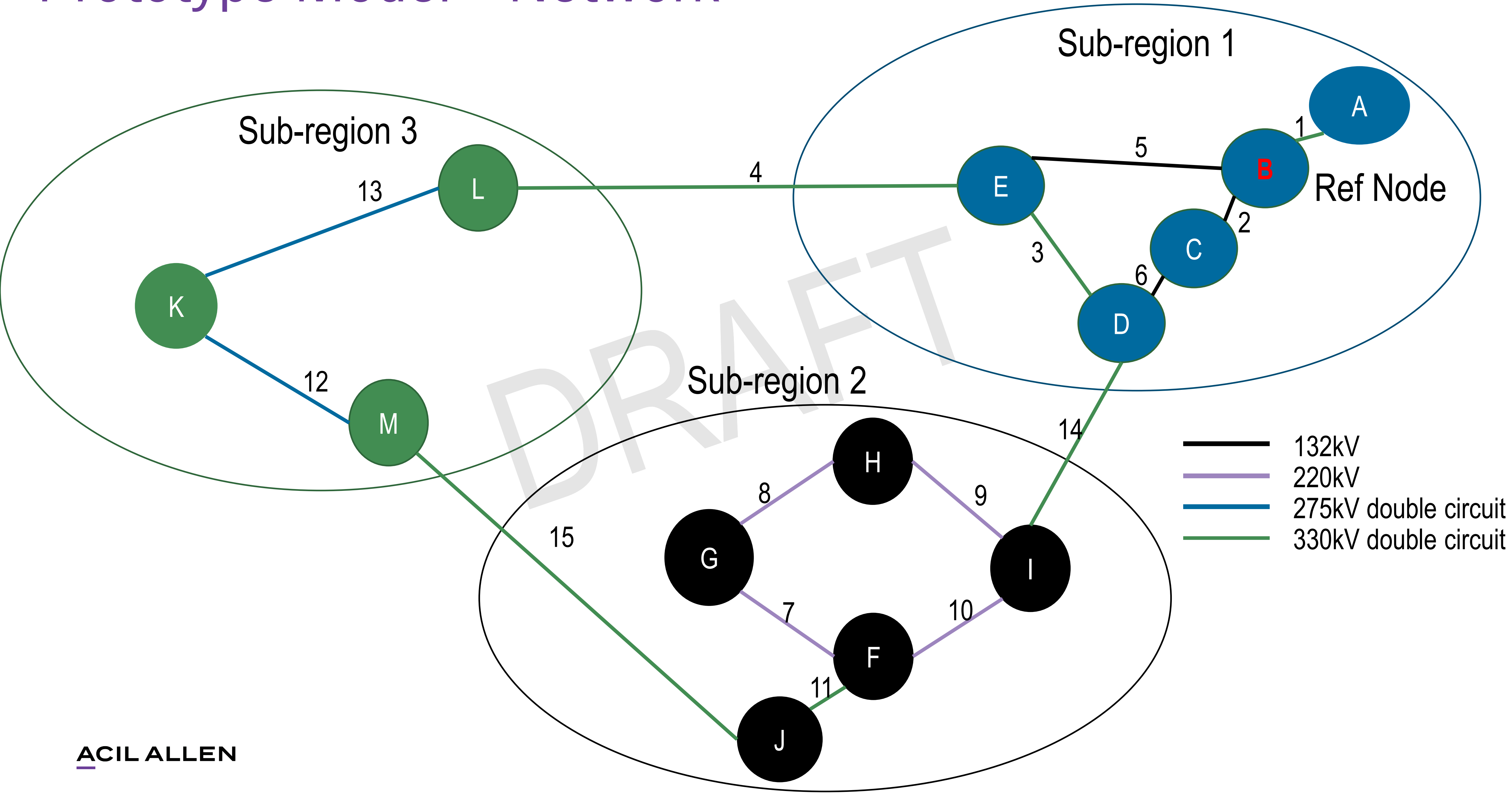
- A simple prototype model will be developed to test whether the AEMC preferred model for priority access is likely to provide more certainty for future investors.
- The model will compare the generation development plans based on generators making profit-maximising investments over a 10-20 year horizon with (a) status quo arrangements and (b) priority access plus CRM.
- We want a model that is as simple as possible to understand the dynamics of the hybrid model compared to the status quo but complex enough to capture the important issues of multiple constraints binding with a range of coefficients, multiple loop flows and a loop flow involving a regional reference node. Doing a full NEM model makes it too hard to understand what is going on.
- The simple prototype model will be designed to remove many additional complications (confounding factors in an experimental design).
- Thus, we are trying to design a market simulation experiment that will highlight the differences between the hybrid model and the status quo but not introduce other complexities that will confound the simulation experiment.

Prototype Model

To simplify the model, we propose the following assumptions:

1. All dispatchable resources participate in the CRM (if generator is bid optimally it can always increase profitability or do no worse by participating in the CRM)
2. Single region using a network of three sub-regions with the option to model two regions by moving existing nodes to a second region
3. Ignore Federal Government's Capacity Investment Scheme (CIS) and other government schemes but have annual new renewable capacity targets which are the same for the status quo and hybrid options
4. No REZs or other potential zones of priority access, priority access would be applied to individual dispatchable resources
5. Only allow market-based entry of wind, solar and gas (sufficient to maintain equivalent reliability between status quo and priority access + CRM) and meet the renewable capacity targets
6. Start with a relatively unconstrained generation fleet
7. Gradually decommission thermal generation
8. We will extract the following results at hourly resolution and annual summary :
    1. Regional data: demand, RRPs, CRMPs, frequency of negative prices
    2. Generation data: dispatch, availability, bid price, economic and network curtailment, net revenue (profit), net revenue per MW
    3. Constraints data: marginal value of binding constraints and summary statistics such as binding frequency

Prototype Model – Network



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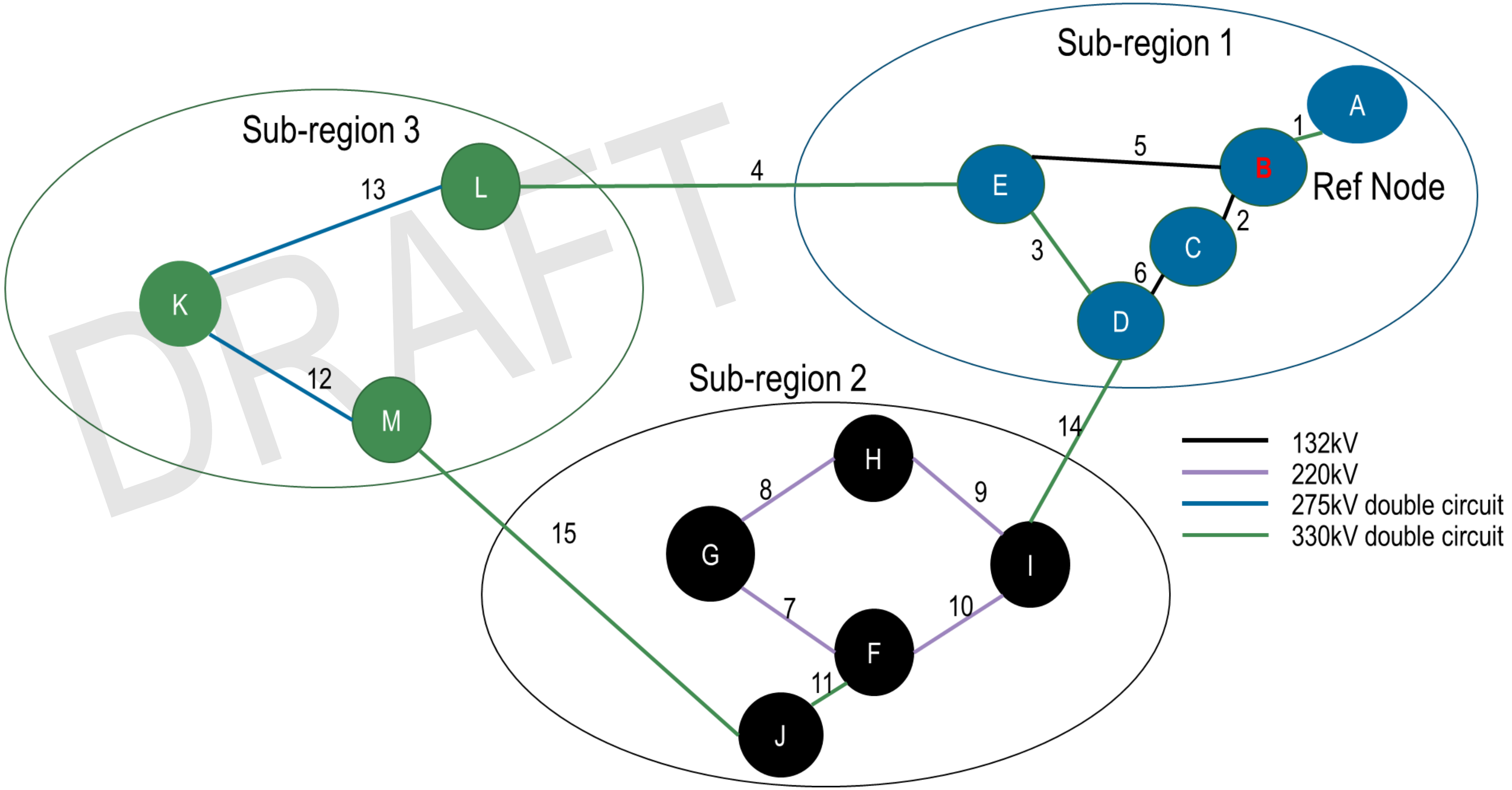
Prototype Model – N and N-1 Network Constraints

N and N-1 Network Constraints:

- Out=10, Monitor 7 G To F, Limit=679MW
- Out=12, Monitor 13 K To L, Limit=990MW
- Out=13, Monitor 12 K To M, Limit=1260MW
- Out=14, Monitor 4 L To E , Limit=720MW
- Out=2, Monitor 3 D To E, Limit=992MW
- Out=2, Monitor 5 E To B, Limit=450MW
- Out=3, Monitor 2 C To B, Limit=142MW
- Out=3, Monitor 6 D To C, Limit=166MW
- Out=4, Monitor 14 I To D, Limit=1350MW
- Out=7, Monitor 10 F To I, Limit=459MW
- Out=8, Monitor 9 H To I, Limit=292MW
- Out=9, Monitor 8 H To G, Limit=325MW
- Out=NIL, Monitor 11 J To F, Limit=998MW
- Out=NIL, Monitor 15 M To J, Limit=2116MW
- Out=NIL, Monitor 1 B To A, Limit=950MW

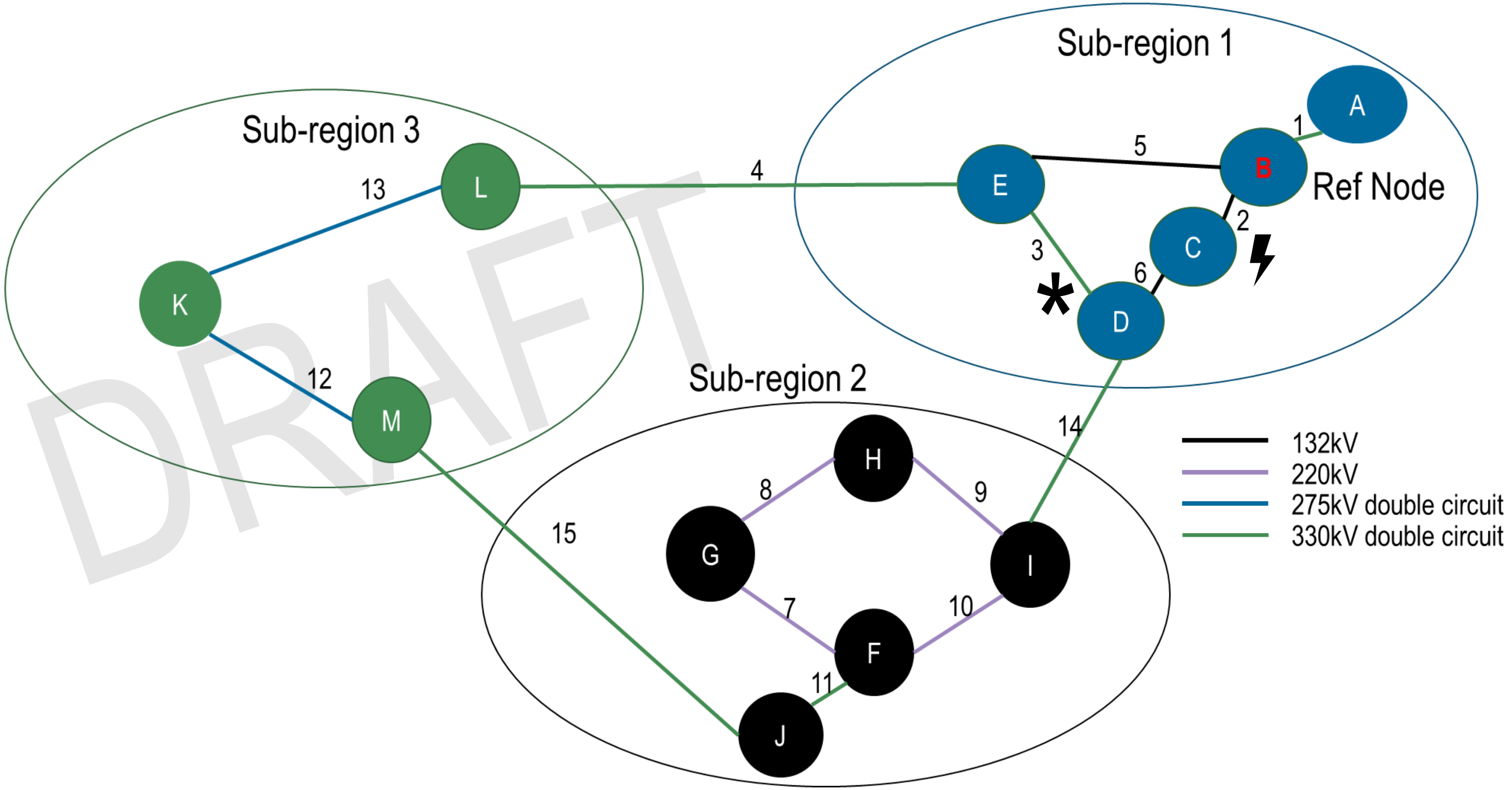


Prototype Model – N and N-1 Network Constraints

- The network constraints include constraints with a wide range of coefficients to test the impact of Priority Access on generation electrically close and far from congestion.
- For example, the constraint "Out=2, Monitor 3 (D To E)" has coefficients ranging from 0.12 to 1 on the LHS. The RHS is approximately equal to the line limit of 1000MW:

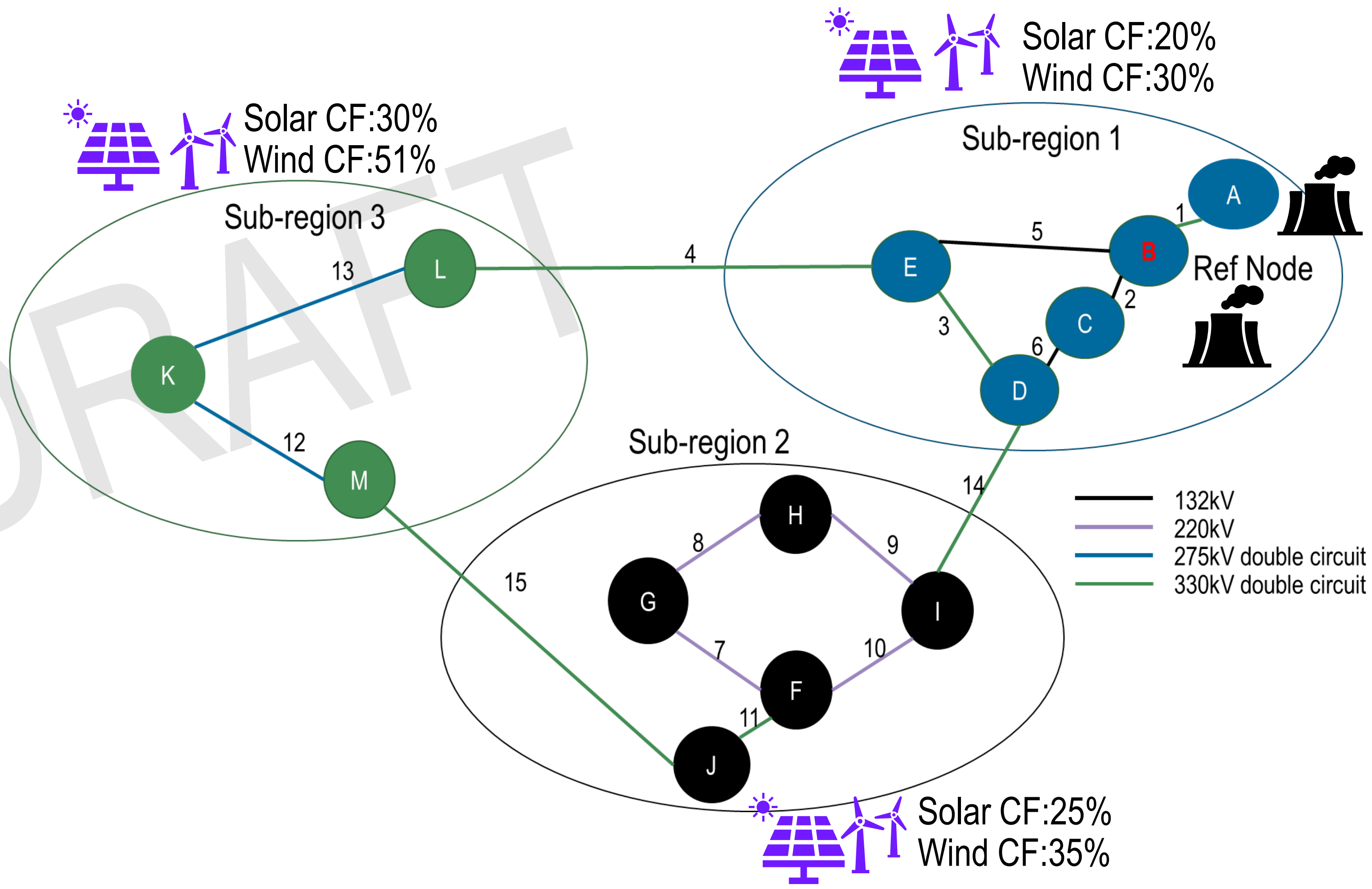
Generator	LHS Coeff
Gen_C	1
Gen_D	1
Gen_I	0.91
Gen_H	0.85
Gen_G	0.79
Gen_F	0.73
Gen_J	0.63
Gen_M	0.5
Gen_K	0.27
Gen_L	0.12

- Generator L contributes only 12% power from D to E because it's power flows mainly from L to E



Prototype Model – Model Assumptions

- 13 nodes (substations) from A to M
- B is the regional reference node
- The projection period is 10-20 years, from 2024 to 2033 at hourly simulation resolution (8760 periods per year)
- To encourage new investment: demand increases steadily from 2024 to 2033, the thermal generator at node B retires on 1/1/2028, line upgrades in each sub region are installed from 1/1/2028 onwards to alleviate existing congestion.
- 50MW increments of new entrant wind/solar projects are installed in nodes C to M when financially viable in the year. In nodes A and B, it is assumed that no new capacity can be installed which forces capacity into more areas subject to network constraints.
- Each sub-region has a different wind and solar profile to simulate the geographical variance in wind and solar resources in the NEM



Hypotheses to be tested by model – Priority Access vs. Status Quo

Hypothesis	Expected outcome of Priority Access Compared to Status Quo
Total curtailment	Overall lower curtailment of existing and new entrant investments. Under Priority Access, new entrants entering the same sub-region in the same year may incur some curtailment from cannibalisation. Under the proposed BPF table, some new entrants may incur curtailment after a few years if subsequent new entrants with a lower constraint coefficient in a regularly binding constraint enter the market. This is because when the priority access order is sooner, generators with lower coefficients in binding constraints can cannibalise existing generators.
New entrant investment certainty	Better returns for existing and new renewable plants due to reduced curtailment. There is a lower likelihood of new investments being heavily constrained from later investments causing high levels of curtailment
New entrant investment decisions	Less investment in congested areas
Thermal generation and emissions	Lower thermal generation and lower emissions due to more efficient investment given the same new capacity of renewable generation
Annual average load-weighted RRP	Similar in both cases

Questions?

Are there any comments on the assumptions or changes that we should make?

Frequently Asked Questions

Why aren’t you modelling the full NEM?

- We are planning to use a simple prototype model to inform us on whether
  a) introducing a hybrid priority access and CRM regime will make the NEM operations and investment decisions more efficient and
  b) reduce the risks of incumbents and new-generation investments' access being cannibalised by later investments wanting to locate in similar electrical locations.
- If the prototype priority access and CRM produce more efficient investments and more certain cash flows for investors, then we would think that priority access combined with the CRM can achieve the goal of providing more certainty (relative to the status quo) to intending investors about the revenues a project would earn over its lifetime.
- To answer the above questions, we want a model that is as simple as possible to understand the dynamics of the hybrid model compared to the status quo but complex enough to capture the important issues of multiple constraints binding with a range of coefficients, multiple loop flows and a loop flow involving a regional reference node. Doing a full NEM model makes it too hard to understand what is going on.
- The simple prototype model will be designed to remove many additional complications (confounding factors in an experimental design). Thus, we are trying to design a market simulation experiment that will highlight the differences between the status quo but not introduce other complexities that will confound the simulation experiment.

Why do you assume 100% participation in the CRM? Can you model with a lower CRM participation rate?

- It can be shown that a generator that has any of a wide variety of contracts (swaps, caps, whole of meter, LGC, etc.) is usually better off and certainly no worse off if it participates in the CRM and bids optimally. Thus, smart spot traders will want to participate in the CRM to increase an organisation’s profitability. Consequently, a reasonable assumption for our modelling is that spot traders want to profit maximise for their organisations and therefore there would be 100% participation in the CRM in the longer term.

How do investment decisions account for the CRM?

- Investment decisions will take into account the cash flows and profitability over a range of scenarios. These cash flows will include spot and contract payments. In the case of spot payments there will be a mixture of access dispatch revenue and physical dispatch (CRM) revenue. The access dispatch revenues will be a key determinant of how much contracting referenced to the RRP can be undertaken. In the case of storage located in constrained areas the CRM may provide a substantial component of a resource’s profitability.

Frequently Asked Questions

Are you including impacts on emissions in your modelling?

- We are directly modelling emissions via the amounts of thermal generation and their associated emissions. We are indirectly modelling government policies which aim to reduce emissions via support of renewable generation via annual renewable capacity constraints.

Do you incorporate consideration of contracts in investment decisions?

- In general, yes, but for this modelling exercise we are just looking at the spot market.

How will you assess and compare investment certainty?

- Normally for an investor we would look at scenarios or take a stochastic approach and look at expected outcomes, variance of outcomes, worst case outcomes etc. For this modelling we are just looking at expected profitability.

Can/could you include REZs in the modelling?

- We could include REZs but we wanted to make it easier to get clear inferences from our stylised model, so we have only allocated priorities to individual resources based on the time of their commitment to proceed.

How is the new renewable generation annual capacity target representative of government schemes?

- The target is just a proxy for government schemes and is the same for status quo and the hybrid model, thus removing one external source of potential variation between the models.

Why is the cost of capital constant between the status quo and the hybrid model the same?

- Theoretically, based on the capital asset pricing model, the cost of capital should be based on a project's correlation with market returns. In reality, this is not usually done. For our modelling we have kept the fixed and variable costs for new entrant generation the same for both the status quo and the hybrid model in order to not introduce a confounding factor that would favour one over the other. This implies that they have the same cost of capital. If one of them produces higher and more certain profits than the other then its cost of capital may end up being lower but to not prejudice our modelling we have kept them the same.

Appendix

Additional information on the prototype model

Model Methodology

- For each node (B to M), check if a dummy 0.1MW generator is financially viable in each forecast year in order from most viable to least viable.

  For each dummy generator, if it is financially viable, create a 50MW new entrant:

  - Check new entrant revenue to see if it is financially viable.
  - If not, remove 50MW

  Repeat all of the above:

  - If a dummy generator is financially viable where the new entrant has been installed, increase the new entrant capacity by 50MW
  - Repeat until there are no economically viable new entrants

- The model above was tested on a small system and will be used to simulate priority access and the status quo to compare investment decisions and financial performance.

  The same assumptions and methodology will apply to both models.

  The only difference in this approach to our normal approach to modelling new entrants is that Bid Price Floors (BPFs) are used to floor new entrant bids in the priority access simulations

Generator bidding – access dispatch

- For each period, two iterations are run to simulate how participants are likely to adjust their bids to maximise revenue and gain access to the RRP:
  - In iteration 1, generators are assumed to bid at opportunity cost
  - In iteration 2, if a generator is constrained in iteration 1 and the RRP is positive and higher than their opportunity cost, they bid to the floor

Generator	Opportunity Cost Bid Price
GT_A	$150
Coal_B	$70
Solar: B to M	-$15 to -$-27
Wind: B to M	-$15 to -$-27

Bid Price Floors under Priority Access

BPF	Priority									
Year	1	2	3	4	5	6	7	8	9	10
2024	-$ 1,000	-$ 200								
2025	-$ 1,000	-$ 600	-$ 200							
2026	-$ 1,000	-$ 733	-$ 467	-$ 200						
2027	-$ 1,000	-$ 800	-$ 600	-$ 400	-$ 200					
2028	-$ 1,000	-$ 840	-$ 680	-$ 520	-$ 360	-$ 200				
2029	-$ 1,000	-$ 867	-$ 733	-$ 600	-$ 467	-$ 333	-$ 200			
2030	-$ 1,000	-$ 886	-$ 771	-$ 657	-$ 543	-$ 429	-$ 314	-$ 200		
2031	-$ 1,000	-$ 900	-$ 800	-$ 700	-$ 600	-$ 500	-$ 400	-$ 300	-$ 200	
2032	-$ 1,000	-$ 911	-$ 822	-$ 733	-$ 644	-$ 556	-$ 467	-$ 378	-$ 289	-$ 200
2033	-$ 1,000	-$ 1,000	-$ 911	-$ 822	-$ 733	-$ 644	-$ 556	-$ 467	-$ 378	-$ 289