Transmission Planning: Cluster Analysis

OVERVIEW

The Clean Energy Act requires the 2011 Integrated Resource Plan (IRP) to include a description of 30-year transmission needs including an assessment of clean and renewable resource development in B.C. by geographic region. This assessment addresses the increasing concern that existing planning processes do not provide for timely development of transmission infrastructure to meet system requirements given transmission projects long lead-time and result in suboptimal transmission system development in the long run (e.g., an excessive number of transmission corridors in a given area and limitations on economic development in other areas). This desire to advance transmission development must be balanced against the risk of stranded investment should the long-term need not materialize as expected. All these set the context for why BC Hydro proposes to analysis clusters. This brief explains how the cluster approach is different from the traditional planning approach used by BC Hydro.

Traditional Planning Approach (Bundle Approach) vs. Cluster Approach

Given the complexity and the large number of resources considered in portfolio analysis (in filling future load resource gap), generation resources need to be aggregated into manageable and meaningful sizes for ease of evaluation and comparison. BC Hydro aggregates resources with the same resource types and similar costs within one of its 10 transmission regions and refers to the aggregate as a “Bundle”. The cost of generation resources includes the cost to interconnect to the existing grid. Figure 1 shows the 10 transmission regions.
As seen in Figure 1, transmission regions such as the North Coast cover a large area including areas with dense transmission coverage (e.g., the Northern area) and areas with close to none (e.g., the Southern area). In this case, high density concentration of generation resource potential in the Northern area may benefit from having a bulk transmission built to the north (interconnection cost wise) because the potential projects there would then only need to connect to the new bulk transmission line (Cluster approach) instead of needing to individually interconnect to existing grid (Bundle approach). This is the essence of the Cluster approach.

In the context of the IRP, clusters refer to regions of high density generation resource potential. For large resource clusters, consideration will be given to building a single large transmission line capable of interconnecting the resource potential in that region. Clusters are only considered if a minimum of 500 MW total resource capacity is available with a minimum of 0.06 MW/km² resource density.
For each cluster in the IRP, a potential cluster transmission line interconnected to a potential new cluster transmission substation is considered. The location of the potential new cluster transmission substation (referred to as ‘new nodes’ in Figure 2) is assumed based on cost and concentration of the generation resource potential, the terrain and professional judgment. Generation resources that have lower cost connecting to the potential new cluster transmission substation compared to the existing grid form the resources within a cluster. Each cluster is inclusive of the different types of resources in that region such as wind and run of the river.

Figure 2 shows an energy density map and the locations of the potential new cluster transmission substation within clusters (referred to as new node in the figure) considered in the IRP.
Figures 3 and 4 illustrate the Bundle versus Cluster approach. Assuming both Figures 3 and 4 cover the North Coast transmission region for example, projects 1 to 6 are all projects within a transmission region. In the Bundle approach (Figure 3), the cost of interconnecting each project to the existing grid (represented by the pentagon) is calculated (T1). These projects are then grouped into bundles by cost range and resource type (e.g., wind or small hydro etc).

In the Cluster approach (Figure 4), a potential transmission substation (represented by the hexagon) is identified within an identified cluster. The cost of interconnecting each project to the nearest substation/grid is calculated (T2). Projects connected to the potential transmission substation (the hexagon) will be considered as a cluster. They can be further sub-grouped into similar cost and resource type for analysis. A cluster transmission option to interconnect the potential transmission substation and the existing grid must also be considered (T3) in order to carry the aggregated power from the cluster to the existing grid and be equivalent to T1. However, the size of T3 does not need to accommodate all aggregated power from the cluster; it is a consideration for the cluster analysis in the IRP.
GEOGRAPHICAL REPRESENTATION IN PORTFOLIO MODELLING

The representation of transmission regions in the portfolio analysis planning tool (System Optimizer) can be illustrated in nodal diagrams shown in Figure 5. The yellow (circle) and white (hexagon) nodes show the Bundle approach of the 10 transmission regions and the US and Alberta export markets. Figure 5 shows the Cluster approach including identified clusters (grey octagon) for all 10 transmission regions used in the IRP portfolio analysis.

Figure 5 Nodal Diagram Illustrating the Geographical Representation in Planning Tool
Key Considerations

The consideration of building T3 (a transmission line into areas of high generation potential) in the IRP is different from the traditional planning approach of only planning transmission to meet contracted generation resources or to consider generation resource clusters in acquisition process. Clusters may reduce the overall cost of transmission for remotely located generation potential if they are fully utilized. However, building a bulk transmission T3 may not be economically justified if the load requirements are not large enough to justify using enough resources in the region.

This consideration is a balance between the benefits of building transmission infrastructure in advance of need to optimize efficiency and the risk of stranded investments. In particular, the timing and size and the risk mitigation strategy to prebuild (building in advance of committed generation projects) are key factors to consider.

A second consideration is the confidence of the planning level information available. Even if analysis shows that pre-building transmission is optimal, it is not clear how and when BC Hydro would translate this into actual spending and building decisions for capital projects and acquisition processes.