California ISO

Transmission Capability Estimates as an input to the CPUC Integrated Resource Plan Portfolio Development

White Paper

May 20, 2019

Regional Transmission

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1 Introduction

In accordance with the May 2010 memorandum of understanding between the ISO and the California Public Utilities Commission (CPUC), and in coordination with the California Energy Commission (CEC), the CPUC develops the resource portfolios to be used by the ISO in its annual transmission planning process (TPP). The CPUC typically transmits to the ISO multiple distinct portfolios developed through its integrated resource plan (IRP) or previously, its long-term procurement plan (LTPP) process. The ISO utilizes the portfolios transmitted by the CPUC in performing reliability, policy and economic assessments in the TPP, with a particular emphasis on identifying policy-driven transmission needs necessary to accommodate renewable generation.

The CPUC currently uses for this purpose the RESOLVE tool, which co-optimizes investment and dispatch for identifying least-cost portfolios. One of the key inputs to this co-optimization is a set of transmission capability estimates supplied by the ISO for renewable zones in which candidate resources are selected. The purpose of this white paper is to describe the key sources of information and the methodology involved in the estimation of transmission capability for the specific purpose of providing input into portfolio development as part of the CPUC's IRP process.

2 Components of transmission capability estimates

The estimation of transmission capability out of renewable generation pockets is part of an iterative framework in which the ISO leverages completed and ongoing transmission assessments to estimate the amount of new resources that can be accommodated on the transmission system emanating from certain transmission renewable generation pockets of interest..

The information provided as part of the transmission capability estimates for transmission zones serving corresponding renewable generation pockets consists of four components:

A. Capability of the existing and approved transmission to accommodate full capacity deliverability status (FCDS) resources,
B. Incremental FCDS capability amounts provided by previously identified conceptual upgrades,
C. Cost estimates for the previously identified conceptual upgrades, and,
D. Capability of the existing and approved transmission to accommodate energy only deliverability status (EODS) resources.

Until the 2019-2020 TPP, all of the base portfolios transmitted to the ISO comprised of almost exclusively FCDS resources. In the 2019-2020 TPP, the base and sensitivity portfolios transmitted to the ISO are comprised of FCDS resources and EODS resources.

The four aforementioned components A, B, C and D are marked in Table 2-1 as separate sets of columns. Table 2-1 is the latest version of transmission capability estimates which was transmitted to the CPUC to support the IRP process.

Table 2-1: Transmission capability estimates as of May 20, 2019

	Transmission capability estimates to support CPUC's IRP process								
	Estimated FCDS Capability (MW)				Incremental Upgrade Cost Estimate ($million)				Estimated EODS Capability** (MW)
	A	B						C	D
Transmission zones and sub-zones	Existing System	Minor Upgrades	Major Upgrade #1	Major Upgrade #2	Existing System	Minor Upgrades	Major Upgrade #1	Major Upgrade #2	Existing System
Northern CA	**2,000**		**2,000**				**$ 285**		**3,900**
- Round mountain	500								2,100
- Humboldt	-								100
- Sacramento River	2,000								4,600
- Solano	600		2,000				$ 322		1,300
Southern PG&E	**1,100**		**1,000**				**$ 55**		**TBD**
- Westlands	1,100		1,000				$ 55		TBD
- Kern and Greater Carrizo	1,000		1,500				$ 241		TBD
- Carrizo	400		700				$ 53		400
- Central Valley North & Los Banos	1,000		1,000				$ 274		TBD
Tehachapi	**4,300**	**1,000**				**$ 100**			**5,100**
Greater Kramer (North of Lugo)	600		400				**$ 146**		**600**
- North of Victor	300		400				$ 485		300
- Inyokern and North of Kramer	100		400				$ 485		100
- Pisgah	400		400				$ 261		400
Southern CA Desert and Southern NV	**3,000**		**2,800**				**$ 2,156**		**9,600**
- Eldorado/Mtn Pass (230 kV)	250		1,400				$ 76		2,400
- Southern NV (GLW-VEA)	700		1,400				$ 150		700
- Greater Imperial*	1,200		1,400				$ 2,334		3,100
- Riverside East & Palm Springs	2,950		1,500				$ 2,156		5,500

* Subject to mitigation of the S-line constraint.

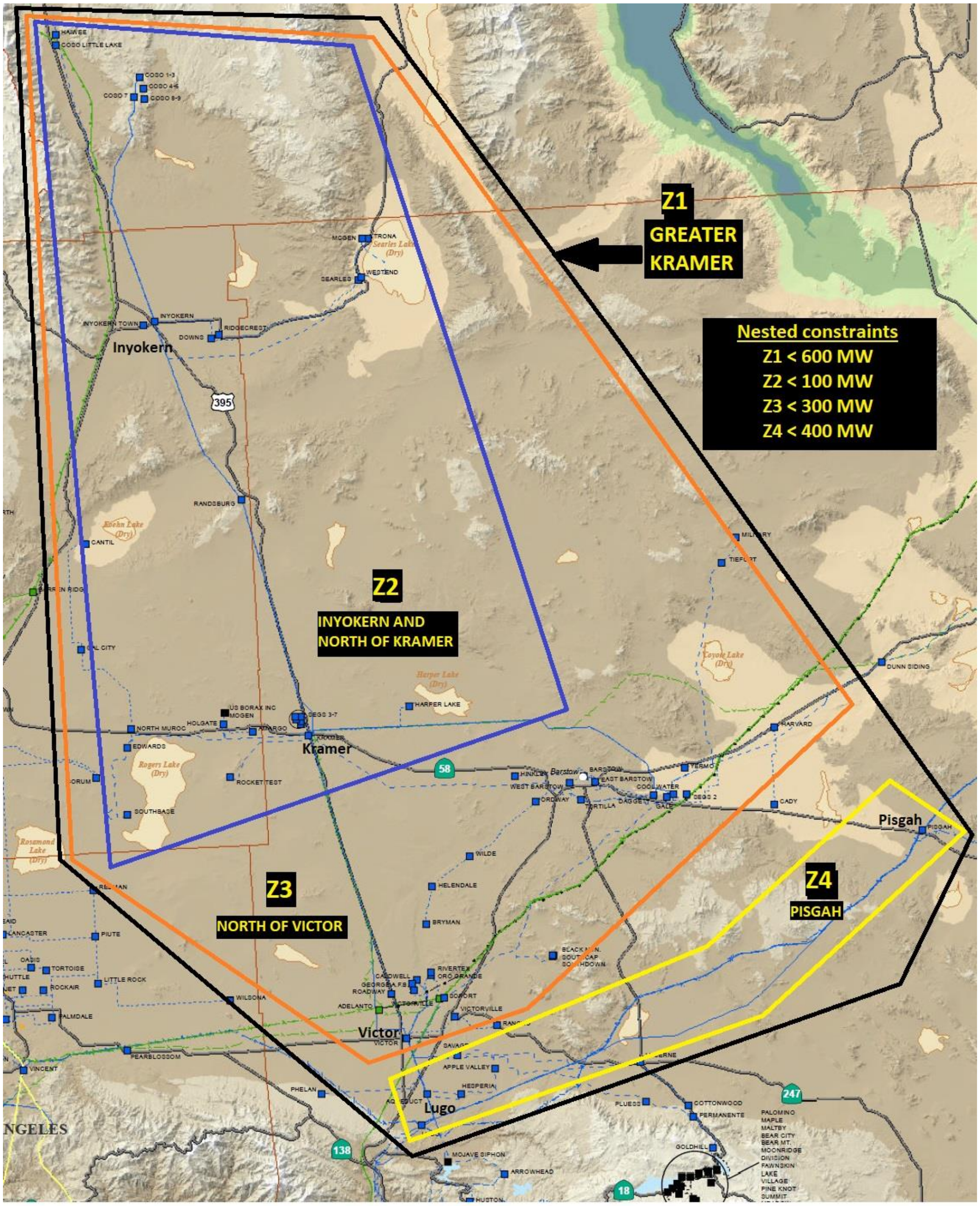
** Estimate EODS capability numbers are inclusive of the FCDS estimates. So the incremental EODS capability = Estimated EODS capability - Estimated FCDS capability

NOTE:
(i) The transmission areas indented in the table are subsets of the overarching transmission areas listed immediately above the indented areas.
(ii) The transmission capability estimates rely on the latest generation interconnection studies as one of the inputs. Estimated available transmission has been reduced by the amount of renewable resources that have come online by December 31, 2018 assuming that all these resources have a contract with an entity within CAISO BA.
(ii) The estimated capability added due to major upgrades and corresponding costs are ballpark numbers and are conceptual in nature.

Table 2-1 consists of several overarching zones and sub-zones within each of these overarching zones. The relationship between the overarching zones and sub-zones is because a single new resources is often found to adversely impact multiple transmission constraints. In this case, a resource selected in a certain transmission zone utilizes the available transmission capability limited by two or more constraints, each of which crosses a different zone or sub-zone boundary. For example, one constraint may be impacted by three generators, and another constraint may be impacted by the three plus seven additional generators. This results in a sub-zone comprising the first three generators nested inside a zone comprising all ten. Due to this overlapping nature of some transmission constraints, transmission capability estimations need to be nested in many transmission zones. Typically these constraints comprise of an overarching constraint that has the largest footprint of resource locations that adversely impact the constraint. Within this footprint, multiple smaller constraints create additional transmission limitations.

In order to help interpret the information in Table 2-1, consider the Greater Kramer (North of Lugo) transmission zone as shown in Figure 2-1, as an example.

Figure 2-1: Transmission capability estimates for Greater Kramer transmission zone



In this case, Greater Kramer [Z1] is the overarching zone that contains three sub-zones – (i) Inyokern and North of Kramer [Z2], (ii) North of Victor [Z3] and (iii) Pisgah [Z4]. The overarching zone is limited by a specific transmission constraint which limits the transmission capability available for generation located in this zone to 600 MW as shown in the nested constraint equations in Figure 2-1. The sub-zones Z2, Z3 and Z4 are limited by different transmission constraints which limit the amount of new resources that can be accommodated in these sub-zones to 100 MW, 300 MW and 400 MW respectively. Sub-zone Z2 is within sub-zone Z3, so the total resources selected in Z2 and Z3 should not exceed 300 MW. For example, if the RESOLVE model selects 50 MW in Z2, then it can only select 250 MW in Z3 without triggering an upgrade. If RESOLVE selects 50 MW in Z2 and 250 MW in Z3, then it cannot select more than 300 MW in Z4 even if the capability in Z4 is 400 MW due to the overarching limitation of 600 MW in Greater Kramer (Z1).

Another way to think about these nested constraints in this example is as follows. A resource selected in North of Kramer sub-zone is likely to adversely impact three transmission constraints that limit the capability in Z2, Z3 and the Greater Kramer zone (Z1). So the remaining capability for other resources in all these zones will reduce if a resource is selected in the North of Kramer sub-zone.

3 Sources of information used for transmission capability estimation

The ISO performs several transmission assessments throughout the year as part of its generation interconnection and deliverability allocation procedures (GIDAP) and TPP resulting in insights about constraints in various transmission zones in the ISO balancing authority area as well as in the neighboring systems.

The ISO relies on two key sources of information for the purpose of transmission capability estimation:

1. <u>Current and past GIDAP studies</u>
   As part of the GIDAP studies, the ISO conducts deliverability and reliability assessments of active generation in the ISO's interconnection queue. This assessment involves the identification of deliverability constraints and corresponding upgrades (scope and costs) in several study areas.

   The GIDAP assessment lends itself particularly well to the transmission capability estimation effort because the amount of active generation in ISO's generation interconnection queue far exceeds the total generation resources that are typically selected as part of the portfolios transmitted by the CPUC. Thus, the GIDAP assessments expose transmission constraints which typically would not be identified in the TPP assessments of generation amounts in the portfolios. Therefore, the ISO relies on GIDAP study results as the primary source of information for transmission capability estimation.

2. <u>Current and past TPP studies</u>

In each TPP study cycle the ISO conducts studies that assess whether transmission upgrades or other measures are needed to meet reliability standards and to address policy and economic considerations. The latest information about transmission upgrades and/or generation projects coming online are represented in the detailed power system models used for these annual studies.

As part of the policy assessment in the TPP, the ISO assesses the transmission impacts of renewable portfolios transmitted by the CPUC. This assessment provides insights about the reliability impact of the portfolios on the transmission system, deliverability constraints that would limit portfolio resource deliverability and renewable curtailment observed in the production cost simulations. These insights act as a supplementary source of information for transmission capability estimation. Depending on the sensitivity portfolio composition, the ISO can uncover transmission constraints and corresponding conceptual upgrade information that can be used for future portfolio development.

4 Steps involved in transmission capability estimation

The foundational element of transmission capability estimates in any transmission zone is one or more transmission constraints that limit delivery of generation from the study area to the rest of the ISO BAA. As mentioned in Section 3, the ISO heavily relies on GIDAP studies for identification of such constraints.

The four steps involved in transmission capability estimation are described in this section.

1. Constraint identification
   This step involves identification of an area deliverability constraint from a GIDAP cluster in which the highest amount of generation has been studied.

2. FCDS transmission capability estimation
   The ISO relies on the transmission plan deliverability (TPD) calculated for the constraint identified in step 1 to determine the amount of new renewable resources that can be accommodated behind this constraint.

$$\boxed{\boldsymbol{TxCap_{FCDS} = TPD - Gen_{online\ using\ TPD}}}$$

   Where,

   $TxCap_{FCDS}$ is the FCDS Transmission capability estimate
   TPD is the TPD behind the identified constraint
   $Gen_{online\ using\ TPD}$ is the generation counted in TPD calculation that has already achieved commercial operation

The term [***TPD***] is calculated in GIDAP cluster studies as the amount of queued generation behind a constraint that can be deliverable without exceeding the constraint limit. For the purpose of TPD calculation, any resource that was not online as of the date of transmittal of the latest official base portfolio by the CPUC to the ISO is considered to be a future resource that would utilize TPD. This assumption allows the ISO to test whether the available TPD behind a constraint is adequate to accommodate all the resources identified in the latest official base portfolio.

Before 2019-2020 TPP, the last official renewable portfolio transmitted to the ISO was the 33% RPS portfolio. In most study areas, a considerable amount of MW capacity identified as future resources in this 33% portfolio has achieved commercial operation in the recent past. The term [$\boldsymbol{Gen}_{\textit{online using TPD}}$] reflects the amount of MW that is already online and has utilized some of the available transmission capability behind the constraint. Therefore, [$\boldsymbol{Gen}_{\textit{online and using TPD}}$] needs to be subtracted from term [***TPD***] in order to estimate the available transmission capability for future resources from this point on. The MW amount for this generation to be subtracted from TPD is approximated from the latest data about generators achieving commercial operation.

3. Conceptual upgrade information

   This step involves providing information on potential transmission upgrades in order to allow the RESOLVE model to consider the trade-off between selecting only resources that fit within the existing transmission capability estimates or selecting resources beyond the existing transmission capability estimates and incurring the cost of additional transmission that is expected to be needed in order to do so. The information provided in this step is the amount of incremental transmission capability that could be added by building a transmission upgrade, and the cost of the incremental transmission.

   The Phase I and Phase II study reports for each GIDAP cluster study are the primary sources of information used in this step. These reports identify Area Delivery Network Upgrades (ADNUs) along with an estimate of the incremental deliverability provided by the upgrade and the corresponding cost estimate. This information is more accurate in cases where the the amount queued generation in the zone exceedsthe incremental deliverability provided by the ADNU. In cases where there is not enough queued generation to fully utilize the upgrade, currently the ISO does not estimate the incremental deliverability provided by the ADNU by considering hypothetical new resources.

4. EODS transmission capability estimation

   The estimation of EODS transmission capability is accomplished by using the FCDS transmission capability estimate as a starting point and by making an assumption that gas generation in the study area and imports into the study area have a significant marginal cost while renewable resources identified in the portfolios are zero marginal cost resources. Thus, additional future resources that are EODS can possibly be accommodated incremental to the FCDS transmission capability in a transmission zone as long as the new EODS resources only displace other generation and imports within the study area. Please note that this is a generalized assumption for rough estimation purposes and does not specificially take into account operational considerations.