Updated Transmission Capability Estimates for Use in CPUC's Resource Planning Process

Transmission Infrastructure Planning

July 5, 2023

Contents

- Background
- Overview of changes from previous estimate
- The updated transmission capability estimate
- Implementation in CPUC's resource planning process

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Background

- As part of its IRP process, the CPUC develops resource plans needed to meet the state's GHG targets and resource adequacy requirements.
- Transmission capability estimate information supplied by the ISO in the form of a white paper and accompanying documentation is one of the inputs in the resource planning process (resource optimization and bus bar mapping).
- It is used by CPUC to assess the amount of resources that can be selected in an area without triggering transmission upgrades and whether triggering transmission upgrades by mapping more resources than available transmission capacity is cost effective.
- The information includes FCDS and EODS related transmission capability and related information

Background - cont'd

- As the name suggests, transmission capability estimates are only estimates. They are developed primarily based on resource and other assumptions used in generation interconnection studies.
- The accuracy of these estimates is affected, among other things, by the differences in the location, type and size of resources selected in the CPUC portfolios and the resources in the interconnection queue.
- The final determination of the transmission upgrades triggered by the resource portfolios is made in the policy-driven assessment the ISO conducts as part of the TPP.
- This presentation provides stakeholders with an overview of the updated transmission capability estimate package the ISO developed and is providing to the CPUC.

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Overview of changes from previous estimate

- The previous transmission capability estimates package released in October 2021 was used to develop resource portfolios for the 2022-2023 and the current 2023-2024 TPP cycles
- The 2021 estimate was developed mainly based on QC 13 Phase I studies and included a total of 43 transmission constraints
- It provided available transmission capability for resources over and above existing and in-development resources provided by the CPUC for the 2020-2021 TPP
- Cost estimates provided for network upgrades were escalated to the year of commercial operation

Overview of changes from previous estimate – cont'd

- The current estimate is based primarily on QC 14 Phase I and supplemental studies and includes a total of 104 transmission constraints
- Provides available transmission capability after accounting for only online resources (as at January 1, 2022)
- Costs estimates for network upgrades are provided in 2022 dollars
- Due to timing, projects approved in the 2021-2022 TPP were not modeled in the initial cases but were considered as mitigation as appropriate.

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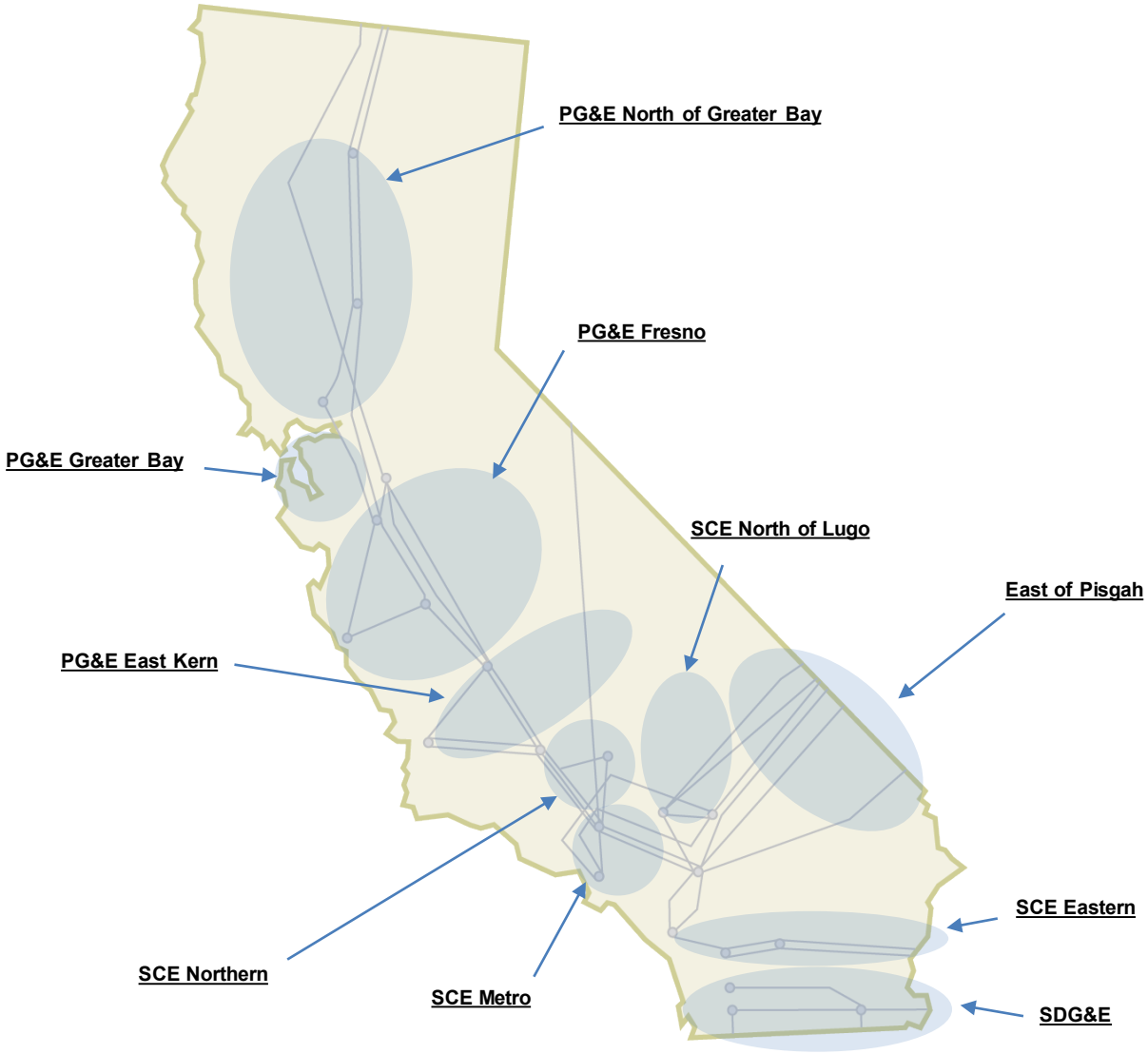
Contents of the updated transmission capability estimate

- The updated transmission capability estimate package consists of:
  - An updated white paper explaining the information provided in the package and how the transmission capability estimates provided may be implemented by the CPUC. http://www.caiso.com/Documents/White-Paper-2023-Transmission-Capability-Estimates-for-use-in-the-CPUCs-Resrouce-Planning-Process.pdf
  - The updated transmission capability estimate worksheet providing, for each constraint, the affected resource areas, existing FCDS and EODS capability, incremental capability due to identified network upgrades along with lead time and cost of the upgrade. http://www.caiso.com/Documents/Transmission-Capability-Estimates-for-use-in-the-CPUCs-Integrated-Resource-Planning-Process.xlsx
  - PowerPoint Slides containing constraint boundary diagrams showing the (POI) buses behind the constraint. http://www.caiso.com/Documents/Attachment-B1-Deliverability-Constraint-Boundaries.pdf
  - In addition, constraint-POI bus matrix is provided for PG&E area because of limitations in showing all POI buses in the diagrams. http://www.caiso.com/Documents/Attachment-B2-PGE-Constraint-Boundary-Substation-List.xlsx

Resource Interconnection Areas



California ISO

Updated transmission capability estimates - Southern California

Transmission Constraint	Affected Resource Locations	Condition Under Which Constraint is Binding (On-peak and/or Off-peak)	Estimated FCDS Capability Based on On-peak Study Resource Output (MW)**		ADNU & Cost Estimate ($million)		Estimated EODS Capability Based on Off-peak Study Resource Output (MW)**		AOPNU & Cost Estimate ($million)		Wind/Solar Area Designation
			Transmission Plan Capability***	Incremental due to ADNU	ADNU (Time to Construct)	Cost (2022$)	Transmission Plan Capability***	Incremental due to AOPNU	AOPNU (Time to Construct)	Cost (2022$)	
SCE Northern Interconnection Area Constraints											
Antelope-Vincent Constraint	Tehachapi, Big Creek	On-Peak	7396	1,500	Upgrade Antelope-Vincent No.1 and 2 500 kV Lines (2 yrs)	$13	7396*	N/A	N/A	N/A	Solar
Vincent-Lugo Constraint	Tehachapi	On-Peak	9,184	2,000	Upgrade Vincent-Lugo No.1 and 2 500 kV Lines (4 yrs)	$86	9184*	N/A	N/A	N/A	Solar
Pardee-Sylmar Constraint	Big Creek, Ventura	On-Peak	4,884	1,800	Install Phase Shifters at Pardee on the Pardee-Sylmar No. 1 and No. 2 230 kV Lines, Reconductor Pardee-Vincent No. 2 220 kV line (9 yrs)	$660	4884*	N/A	N/A	N/A	Solar
Windhub Constraint	Tehachapi	On-Peak	2,400	2,500	New 500 kV Transmission Line from Whirlwind to Windhub 500 kV (9 yrs)	$612	2400*	N/A	N/A	N/A	Solar
Moorpark-Pardee Constraint	Ventura	On-Peak	3,792	900	Upgrade the Moorpark-Pardee #2 and #3 220 kV and Santa Clara-Vincent 220 kV lines (9 yrs)	$600	3792*	N/A	N/A	N/A	Solar
North of Magunden Constraint	Big Creek	On-Peak	1,387	500	Rebuild Magunden - Vestal No.2 230 kV and Magunden - Springville No.2 230 kV Lines (9 yrs)	$1,253	1387*	N/A	N/A	N/A	Solar
South of Magunden Constraint	Big Creek, Ventura	On-Peak, Off-Peak	740	2,000	Rebuild various SOM lines (9 yrs)	$4,358	500*	2,000	Rebuild Magunden-Pastoria 230 kV line (9 yrs)	$66	Solar
Antelope-Neenach Constraint	Antelope/Bailey/Pastoria area	On-Peak, Off-Peak	0	2,000	Reconductor Antelope-Bailey 66 kV lines (2 yrs)	$100	0*	15	Bailey-Neenach-Westpac 66 kV line upgrade	$45	Solar
SCE Metro Interconnection Area Constraints											
Del Amo - Barre Area Constraint	LA Basin	On-Peak	6,700	1,058	Upgrade the Del Amo - Barre 220 kV Transmission Line (27 months)	$11	6700*	N/A	N/A	N/A	Solar
Hinson - Del Amo Constraint	LA Basin	On-Peak	3,544	800	Upgrade the Hinson - Del Amo 220 kV Transmission Line (27 months)	$28	3544*	N/A	N/A	N/A	Solar
SCE Metro Area Default Constraint	LA Basin	None	13731*	N/A	N/A	-	13731*	N/A	N/A	N/A	Solar
SCE North of Lugo (NOL) Interconnection Area Constraints											
Control to Inyokern area constraint	Inyokern_North	On-Peak	15	186	Build a new, series compensated Control-Inyokern 115 kV line and upgrade Inyo Phase Shifter (105 months)	$329	15*	N/A	N/A	N/A	Solar
Kramer to Victor Area Constraint	Inyokern_North_Kramer Victor	On-Peak	1,300	1,206	Convert Kramer - Victor 115 kV lines to 230 kV (120 months)	$300	1,300	N/A	N/A	N/A	Solar
Victor to Lugo Area Constraint	Inyokern_North_Kramer Victor	On-Peak	1,350	1,221	Re-conductor the four Lugo-Victor 230 kV lines (54 months)	$112	1,350	N/A	N/A	N/A	Solar
Lugo Transformer Area Constraint	Inyokern_North_Kramer, Victor, Pisgah	On-Peak	1,585	1,178	Add a third 500/230 kV transformer at Lugo Substation (54 months)	$70	1,585	N/A	N/A	N/A	Solar
Calcite to Lugo Area Constraint	Pisgah	On-Peak	548	1,046	Rebuild Calcite-Lugo 220 kV Transmission Line (105 months)	$239	548*	N/A	N/A	N/A	Solar
SCE Eastern Interconnection Area Constraints											
Colorado River 500/230 kV Constraint	Colorado River 230 kV	On-Peak, Off-Peak	545	1,370	New Colorado River No. 3 500/230 kV transformer (4 years)	$67	1,414	1,299	Same as ADNU	$67	Solar
Colorado River-Red Bluff Constraint	SCE Eastern (east of Colorado River), East of Pisgah, and SDG&E areas	On-Peak	10,933	1,000	New Colorado River-Red Bluff No. 3 500 kV line (10 years)	$305	10933*	N/A	N/A	N/A	Solar
DCRT Constraint	Cielo Azul, Delaney	On-Peak	2,300	3,000	New Cielo Azul - Colorado River No. 2 500 kV line, Upgrade the series cap on Cielo Azul - Colorado River No.1 500 kV line to match the conductor rating (6 years)	$463	2300*	N/A	N/A	N/A	Solar
Devers-Red Bluff Constraint	SCE Eastern (east of Red Bluff), East of Pisgah, and SDG&E areas	On-Peak, Off-Peak	4,050	2,500	New Devers-Red Bluff No. 3 500 kV line (9 years)	$875	10,167	4,334	Same as ADNU	$875	Solar
Eagle Mountain Constraint	Eagle Mountain, Julian Hinds, Mirage	On-Peak	0	600	New Devers-Julian Hinds 220 kV line (10 years)	$1,182	300*	N/A	N/A	N/A	Solar
Etiwanda-Rancho Vista Constraint	SCE Eastern area	On-Peak	7,734	3,350	Upgrade Etiwanda-Rancho Vista No. 1 & No. 2 220 kV lines, New Etiwanda-Rancho Vista No. 3 220 kV line (3 years)	$89	9689*	N/A	N/A	N/A	Solar
Red Bluff 500/230 kV Constraint	Red Bluff 230 kV	On-Peak, Off-Peak	722	1,200	New Red Bluff No. 3 500/230 kV transformer (4 years)	$69	1,684	39	Same as ADNU	$69	Solar
Serrano-Alberhill-Valley Constraint	SCE Eastern and SDG&E areas	On-Peak, Off-Peak	5,328	6,000	New Devers-Mira Loma 500 kV line, Mira Loma-Mesa 500kV Underground Cable Addition, Upgrade San Bernardino-Vista 220 kV line, Upgrade Etiwanda-Vista 220 kV line, Upgrade Mira Loma-Vista No. 2 220kV line (9 years)	$1,234	13,529	2,123	Same as ADNU	$1,234	Solar
East of Pisgah (EOP) Interconnection Area Constraints (SCE, GLW, VEA)											
VEA 138kV area constraint	VEA 138kV buses	On-Peak, Off-Peak	260	1,367	VEA 230kV conversion project (4 years)	$175	105	930	Same as ADNU	$175	Solar
GLW 230kV area constraint	VEA 138kV and GLW 230kV buses	On-Peak, Off-Peak	900	1,100	ISO approved GLW upgrade (4 years)	$278	760	1,023	ISO approved GLW upgrade (4 years)	$278	Solar
Lugo - Victorville area constraint	East of Pisgah, SCE Eastern,SDG&E and SCE Northern areas	On-peak	10,100	6,800	Eldorado - Lugo 500kV No.2 line (10 years)	$2,165	9600*	6800*	Same as ADNU	$2,165	Solar
SDG&E Interconnection Area Constraints											
Capistrano-San Onofre 230 kV constraint	SDGE local area	On-peak	1,500	920	Capistrano-San Onofre 230 kV upgrade (60 months)	$58	1500*	N/A	N/A	N/A	N/A
Chicarita 138 kV constraint	Baja, Imperial, SDGE local area	On-peak	224	700	Chicarita 138 kV Upgrades (48 months)	$100	224*	N/A	N/A	N/A	N/A
El Cajon 69 kV constraint	SDGE local area	On-peak	406	547	El Cajon 69 kV Upgrade (48 months)	$15	406*	N/A	N/A	N/A	N/A
Internal San Diego Area constraint	Baja, Imperial, SDGE local area	On-Peak, Off-Peak	1,001	2,757	Internal San Diego Area reconductors (48 months)	$107	70	2,757	Same as ADNU	$107	Solar
Miguel 69 kV constraint	SDGE local area	On-peak	231	431	Miguel 69 kV upgrades (48 months)	$671	231*	N/A	N/A	N/A	N/A
Encina - San Luis Rey 230 kV constraint	Baja, Imperial, Arizona, SDGE local area	On-Peak, Off-Peak	1,922	4,660	New Encina - San Luis Rey 230 kV line (120 months)	$84	2,586	4,660	Same as ADNU	$84	Solar
East of Miguel constraint	Baja, Imperial, Arizona, Riverside East	On-Peak, Off-Peak	1,035	1,286	New Imperial Valley - Serrano 500 kV line (188 months)	$2,713	1,377	1,286	Same as ADNU	$2,713	Solar
San Luis Rey-San Onofre 230 kV line constraint	Baja, Imperial, Arizona, SDGE local area	On-Peak, Off-Peak	2,018	4,254	New San Luis Rey-San Onofre 230 kV line (120 months)	$107	6,764	4,254	Same as ADNU	$107	Solar
Ocean Ranch 69 kV constraint	SDGE local area	On-peak	274	692	Ocean Ranch 69 kV upgrade (48 months)	$28	274*	N/A	N/A	N/A	N/A
Otay Mesa 230 kV constraint	Imperial, SDGE local area	On-peak	1,425	2,189	Otay Mesa 230 kV upgrade (60 months)	$80	1425*	N/A	N/A	N/A	N/A
Silvergate - Bay Blvd 230 kV constraint	Baja, Imperial, SDGE local area	On-Peak, Off-Peak	663	4,887	Silvergate - Bay Blvd 230 kV 3-ohm Series Reactor (36 months)	$30	883	4,887	Same as ADNU	$30	Solar
Silvergate-Old Town 230 kV constraint	Baja, Imperial, SDGE local area	On-peak	1,221	2,522	Silvergate-Old Town 230 kV Upgrades (60 months)	$283	1221*	N/A	N/A	N/A	N/A
Talega 230 kV constraint	SDGE local area	On-peak	1,205	2,201	Talega 230 kV Upgrades (60 months)	$211	1205*	N/A	N/A	N/A	N/A
Trabuco-Capistrano 138 kV constraint	SDGE local area	On-peak	501	556	Trabuco-Capistrano 138 kV upgrade (48 months)	$103	501*	N/A	N/A	N/A	N/A

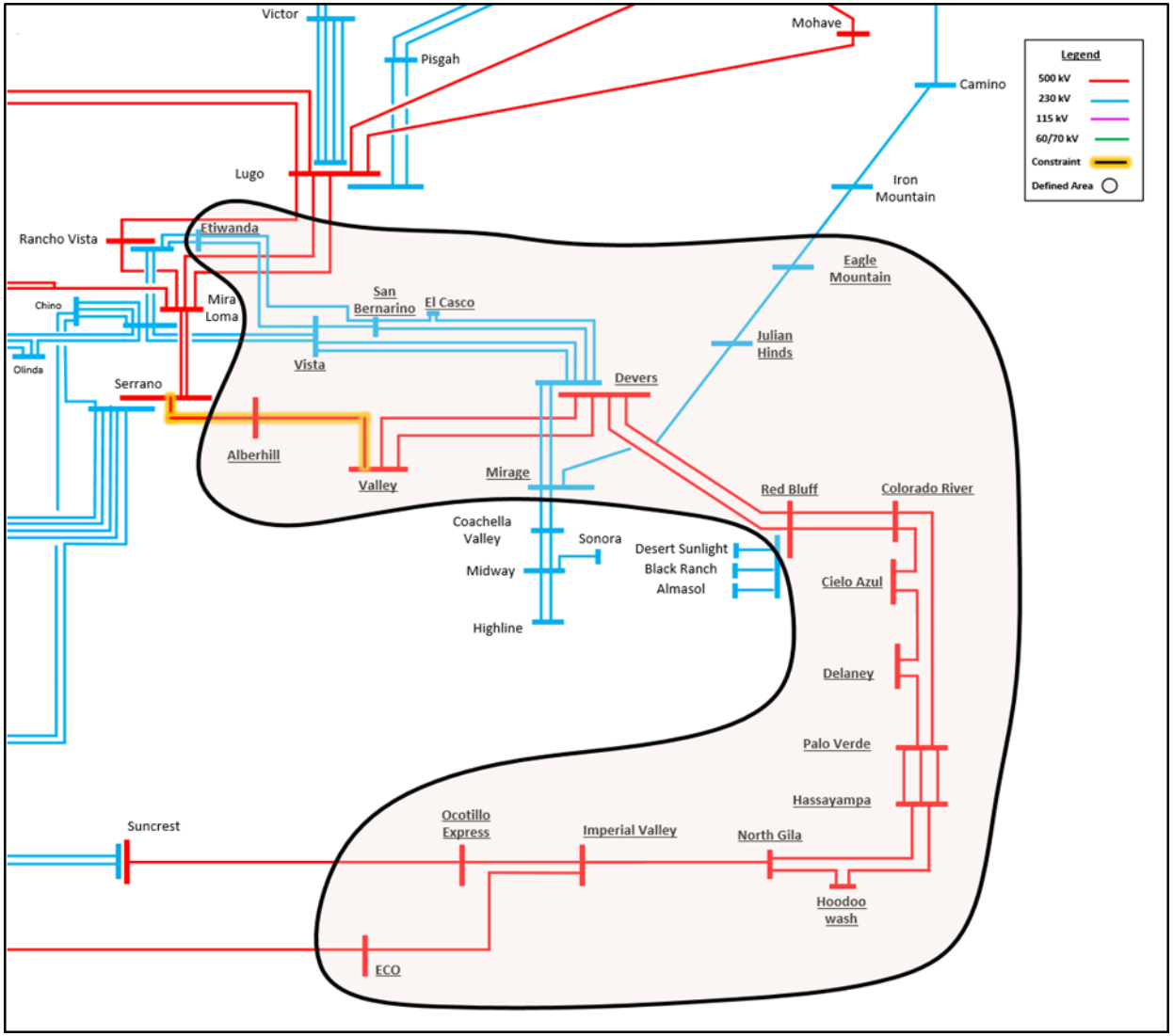
Updated transmission capability estimates - Northern PG&E

Transmission Constraint	Affected Resource Locations	Condition Under Which Constraint is Binding (On-peak and/or Off-peak)	Estimated FCDS Capability Based on On-peak Study Resource Output (MW)**		ADNU & Cost Estimate ($million)		Estimated EODS Capability Based on Off-peak Study Resource Output (MW)**		AOPNU & Cost Estimate ($million)		Wind/Solar Area Designation
			Transmission Plan Capability***	Incremental due to ADNU	ADNU (Time to Construct)	Cost (2022$)	Transmission Plan Capability***	Incremental due to AOPNU	AOPNU (Time to Construct)	Cost (2022$)	
PG&E North of Greater Bay Interconnection Area Constraints											
Santa Rosa-Corona 115 kV line	Greater Bay Area and North of Greater Bay Area	On-Peak	3,995	703	New line from Fulton-Vaca Dixon 230 kV (180 months)	$725	3995*	N/A	N/A	N/A	Wind
Vaca Dixon-Tesla 500kV Line	Greater Bay Area, North of Greater Bay Area and PG&E South 500 kV	On-Peak	1,044	8,645	500kV Delevan (144 months)	$2,852	1,415*	N/A	N/A	N/A	Wind
Woodland- Davis 115kV line	North of Greater Bay Area	On-Peak	76	109	Reconductor Q653F-Davis 115 kV Line (60 months)	$9	76*	N/A	N/A	N/A	Wind
Cortina-Eagle Rock 115 kV line	North of Greater Bay Area	On-Peak	1,575	50	Re-conductor Q1284 Sw Sta-Lower Lake Sw Sta/Eagle Rock 115 kV Line (Q1284 Sw Sta-Cache Jct 1) (60 months)	$50	1575*	N/A	N/A	N/A	Wind
Bell-Placer 115kV Line	North of Greater Bay Area	On-Peak	630	480	Re-conductor Higgins-Bell and Bell-Placer 115 kV Lines (120 months)	$185	630*	N/A	N/A	N/A	Wind
Carberry-Round Mountain 230kV Line	North of Greater Bay Area	On-Peak, Off-Peak	14	26	Re-conductor Pit 3-Carberry and Carberry-Round mountain 230 kV Lines (84 months)	$180	183	25	Same as ADNU	$180	Wind
Rocklin-Pleaseant grove 115kV line	North of Greater Bay Area	On-Peak	92	707	Re-conductor Rio Oso-Lincoln 115 kV Line and Lincoln-Pleasant Grove 115 kV Line (72 months)	$125	226*	N/A	N/A	N/A	Wind
Bellota-Weber 230kV line	Greater Bay Area, North of Greater Bay Area and Fresno	On-Peak	2382	460	Subacco (120 months)	$400	2382*	N/A	N/A	N/A	Wind
Rio Oso-Brighton 230kV line		On-Peak	423	574			423*	N/A	N/A	N/A	Wind
Rio Oso-Lockeford 230kV line		On-Peak	935	485			935*	N/A	N/A	N/A	Wind
PG&E Greater Bay Interconnection Area Constraints											
Dumbarton-Newark 115 kV line	Greater Bay Area and North of Greater Bay Area	On-Peak	1,270	978	New Collinsville 500/230 kV substation (2028)	N/A (TPP approved project)	1270*	N/A	N/A	N/A	Wind
Eastshore-San Mateo 230 kV line		On-Peak	2,349	548			2349*	N/A	N/A	N/A	Wind
Lakeville-Ignacio 230 kV line		On-Peak	517	861			517*	N/A	N/A	N/A	Wind
Sobrante-Moraga 230 kV line		On-Peak	3,944	653			3944*	N/A	N/A	N/A	Wind
Windmaster-Delta pumps 230 kV line	Greater Bay Area and North of Greater Bay Area	On-Peak	710	6,034	Contra Costa to Tesla and Newark 230 kV lines and Birds Landing series reactors(Bay Area ADNU) (86 months)	$417	710*	N/A	N/A	N/A	Wind
Contra Costa- Windmaster 230 kV line		On-Peak	1,233	5,601			1233*	N/A	N/A	N/A	Wind
Tesla-Tracy-Pump 230 kV line #2		On-Peak	4,776	3,521			4776*	N/A	N/A	N/A	Wind
Contra Costa #1 115kV Line	Greater Bay Area	On-Peak	29	131	Contra Costa 115kV, 60kV reconductors and Bank Replacement (120 months)	$185	29*	N/A	N/A	N/A	Wind
Kasson Jct-Heinz 115 kV line	Greater Bay Area, North of Greater Bay Area and Fresno	On-Peak	91	1,255	Nikola (216 months)	$1,700	91*	N/A	N/A	N/A	Wind
Newark-Newark Distribution 115 kV line		On-Peak	3,822	831			3822*	N/A	N/A	N/A	Wind
Tesla-Bellota 230 kV line		On-Peak	4,065	300			4065*	N/A	N/A	N/A	Wind
Eight Mile-Tesla 230 kV line		On-Peak	3,738	163			3738*	N/A	N/A	N/A	Wind
Grant - Eastshore #2 line 115 kV	Greater Bay Area	On-Peak	961	290	Reconductor 1869-Eastshore #1 and #2 115 kV lines (84 months)	$125	961*	N/A	N/A	N/A	Wind
Salado-Crow Creek Sw Sta 60 kV line	Greater Bay Area	On-Peak	76	74	Reconductor Salado 115kV and 60kV Area (144 months)	$400	76*	N/A	N/A	N/A	Wind
Tesla-Salado 115 kV line		On-Peak	1,087	70			1087*	N/A	N/A	N/A	Wind
Los Esteros-Silicon Valley 230 kV	Greater Bay Area	On-Peak	605	348	San Jose Area HVDC Line (Newark - NRS) (2028)	N/A (TPP approved project)	605*	N/A	N/A	N/A	Wind
Los Esteros-Nortech 115 kV line		On-Peak	639	160			639*	N/A	N/A	N/A	Wind
Newark-Los Esteros 230 kV line		On-Peak	4758	70			4758*	N/A	N/A	N/A	Wind
Morganhill-Metcalf 115kV Line	Greater Bay Area	On-Peak	314	712	Metcalf-Morgan Hill 115kV reconductoring (144 months)	$380	314*	N/A	N/A	N/A	Wind
Tesla-Tracy Pump 230 kV Line #1	Greater Bay Area and North of Greater Bay Area	On-Peak	4,177	4,344	Re-conductor 1883 Sw Sta-Tracy Pmp (2.9 miles) (60 months)	$25	4177*	N/A	N/A	N/A	Wind
Birds Landing-Contra Costa 230kV Line	Greater Bay Area and North of Greater Bay Area	On-Peak	836	1,766	New double circuit line from Vaca-Contra Costa 230 kV (144 months)	$700	836*	N/A	N/A	N/A	Wind

Updated transmission capability estimates - Southern PG&E

Transmission Constraint	Affected Resource Locations	Condition Under Which Constraint is Binding (On-peak and/or Off-peak)	Estimated FCDS Capability Based on On-peak Study Resource Output (MW)**		ADNU & Cost Estimate ($million)		Estimated EODS Capability Based on Off-peak Study Resource Output (MW)**		AOPNU & Cost Estimate ($million)		Wind/Solar Area Designation
			Transmission Plan Capability***	Incremental due to ADNU	ADNU (Time to Construct)	Cost (2022$)	Transmission Plan Capability***	Incremental due to AOPNU	AOPNU (Time to Construct)	Cost (2022$)	
PG&E Kern Interconnection Area Constraints											
Oceano-Calendar 115kV line	Kern, Los Padres	On-Peak, Off-Peak	937	1,418	Morro Bay Looping (98 months)	$1,008	174	230	Same as ADNU	$1,008	Solar
Midway-Q2005 230kV Line	Kern	On-Peak, Off-Peak	1,099	16,891	Re-conductor and reconfigure Gates-Arco-Midway 230 kV Lines (144 months)	$940	278	962	Same as ADNU	$940	Solar
Smyrna -Q1984 115kV line	Kern	On-Peak, Off-Peak	144	687	Alpaugh-Semitropic Reconductor(96 months)	$220	132	632	Same as ADNU	$220	Solar
Kern 230/115kV TB #4	Kern	On-Peak	1,869	179	Add New Kern 230/115kV Transformer Bank (54 months)	$30	1869*	N/A	N/A	N/A	Solar
Maricopa-Copus 70 kV line	Kern	On-Peak, Off-Peak	51	206	Reconductor Kern-Old River 115 and 70 kV	$620	53	68	Same as ADNU	$620	Solar
Midway-Taft 115 kV line	Kern	On-Peak	263	9			263*	N/A			Solar
Kern-Tevis-Stockdale-Lamont 115kV line	Kern	On-Peak, Off-Peak	109	367	Reconductor Kern-Stockdale-Lamont 115 kV	$120	177	107	Same as ADNU	$120	Solar
Midway 230/115kV TB #3	Kern	On-Peak, Off-Peak	1,370	784	Add new Midway 230/115 kV Transformer Bank	$150	1,051	1,477	Same as ADNU	$150	Solar
Semitropic-Midway 115kV Line	Kern	On-Peak, Off-Peak	255	637	Reconducotr Semitropic-Midway-Kern 115 kV and 70 kV Lines	$760	241	475	Same as ADNU	$760	Solar
Midway-Q2011 230 kV Line	Kern	On-Peak	438	234	Reconductor Midway-Q2011 230 kV Line	$100	438*	N/A	Same as ADNU	$100	Solar
PG&E Fresno Interconnection Area Constraints											
Gates 500/230kV TB #12	Fresno, Kern	On-Peak, Off-Peak	3,213	14,825	Gates Bank 500/230kV Bank #13 (48 months)	$35	3,148	6,843	Same as ADNU	$35	Solar
Gates 500/230kV TB #11	Fresno, Kern	On-Peak, Off-Peak	3,684	10,038			6,343	3,856			Solar
Gates 230/70kV TB #5	Fresno	On-Peak, Off-Peak	272	47	New Gates #6 230/70kV (96 months)	$110	356	390	Same as ADNU	$110	Solar
Tranquility-Helm 230kV Line	Fresno	On-Peak, Off-Peak	2,229	2,274	Gregg 500kV (180 months)	$1,500	1,170	607	Same as ADNU	$1,500	Solar
Dairyland-Chowchilla 115kV Line	Fresno	On-Peak, Off-Peak	2,865	1,211	Mendota 230 kV Conversion (120 months)	$250	128	122	Same as ADNU	$250	Solar
Chowchilla-Le grand 115kV Line	Fresno	On-Peak, Off-Peak	699	1,211	Le Grand 230 kV Station Conversion (180 months)	$550	908	546	Same as ADNU	$550	Solar
Panoche-Los Banos 230kV line #2	Fresno	On-Peak, Off-Peak	206	6,367	New Manning 500/230 kV Substation (2028)	N/A (TPP approved project)	3,478	3,139			Solar
Dos Amigos-Los Banos 230kV line	Fresno	On-Peak	516	6,367			516*	N/A			Solar
Los Banos 500/230kV TB	Fresno	On-Peak, Off-Peak	3930	4,931			206	402			Solar
Schindler 115/70kV TB #1	Fresno	On-Peak, Off-Peak	0	3,160	Manning 115 kV Addition (120 months)	$370	92	87	Same as ADNU	$370	Solar
Panoche- Mendota 115 kV line	Fresno	On-Peak, Off-Peak	1,798	2,019			7	302			Solar
Coalinga #1-Coalinga #2 70 kV line	Fresno	On-Peak, Off-Peak	1,660	878			175	5			Solar
Panoche-Oro Loma 115kV Line	Fresno	On-Peak	3,661	588	Reconductor Oro Loma-Panoche 115 kV Lines (months)	$0	3661*	N/A	N/A	N/A	Solar
Borden-Storey #1 230kV line	Fresno	On-Peak, Off-Peak	300	3,895	Reconductor Wilson-Storey-Borden 230 kV Lines (86 months)	$75	1,811	2,047	Same as ADNU	$75	Solar
Merced 115/70kV TB#2	Fresno	On-Peak, Off-Peak	247	358	Replace Bank, and Reconductor Lines at Merced (144 months)	$125	100	291	Same as ADNU	$125	Solar
Helm 230/70kV TB #1	Fresno	On-Peak, Off-Peak	4	60	Helm 230/70 kV Transformer Bank replacement	$135	0	226	Same as ADNU	$135	Solar
Oro Loma-El Nido 115kV Line	Fresno	On-Peak, Off-Peak	1,410	3,192	Oro-loma- El nido-Wilson Reconductor (120 months)	$330	243	65	Same as ADNU	$330	Solar
Q2008-Gates 500 kV line	Kern, Fresno	On-Peak, Off-Peak	5,203	4,125	New Diablo-Midway #4 500 kV Line (98 months)	$830	345	395	Same as ADNU	$830	Solar
Mustang-Henrietta 230 kV line	Fresno	On-Peak	10,302	2,479			10302*	N/A			Solar
Gates-Panoche 230 kV #1 and #2 Lines	Fresno	On-Peak	7,440	8,379	Reconductor Gates-Panoche #1 and #2 230 kV Lines (86 months)	$214	7440*	N/A	N/A	N/A	Solar
Moss Landing-Las Aguilas 230 kV Line	Fresno, Bay Area	Off-peak	2276*	N/A	N/A	N/A	0	1,760	Reconductor Moss Landing-Las Aguilas 230 kV Line (98 months)	$40	Solar
Jacksson-Waukena–Corcoran 115kV line	Fresno	Off-peak	85*	N/A	N/A	N/A	28	66	Reconductor Jacksson-Waukena–Corcoran 115kV line (120 months)	$150	Solar

Constraint boundary diagram example - Serrano-Alberhill-Valley



Sample PG&E area constraint-POI bus matrix

POI	Santa Rosa-Corona 115 kV line	Vaca Dixon-Tesla 500kV Line	Woodland- Davis 115kV line	Cortina-Eagle Rock 115 kV line	Bell-Placer 115kV Line	Carberry-Round Mountain 230kV Line	Rocklin-Pleaseant grove 115kV line	Bellota-Weber 230kV line	Rio Oso-Brighton 230kV line	Rio Oso-Lockeford 230kV line	Dumbarton-Newark 115 kV line	Eastshore-San Mateo 230 kV line	Lakeville-Ignacio 230 kV line	Sobrante-Moraga 230 kV line	Windmaster-Delta pumps 230 kV line	Contra Costa- Windmaster 230 kV line	Tesla-Tracy-Pump 230 kV line #2
7th Standard 115 kV																	
Agnew/River Oaks 115 kV																	
Alpaugh 115 kV																	
Arco 230 kV																	
Arco 70 kV																	
Arco-Carneras 70 kV																	
Atlantic 230 kV		√			√			√	√	√							
Atlantic 60 kV		√			√			√	√	√							
Avenal 70 kV																	
Bahia 230 kV		√												√			√
Bakersfield 230 kV																	
Bear Mountain - Bear Mountain Tap 115 kV line																	
Bellota 115 kV								√									
Bellota-Warnerville 230 kV								√									
Bellota-Warnerville and Bellota-Cottle Lines 230 kV								√									
Berrenda "C" Tap 70 kV																	
Birds Landing 230 kV		√													√	√	√
Borden 230 kV								√									
Borden 70 kV																	
Brentwood 230 kV		√													√	√	√
Caliente 230 kV																	
California Flats 230 kV																	
Callender 115 kV																	
Callender SW STA 115 kV																	
Cantua 115 kV Bus																	
Cayetano 230 kV		√													√	√	√
Cayuma 70 kV																	
Cherokee 60 kV								√									
Chowchilla 115 kV								√									
Christie 60 kV	√	√									√	√		√	√	√	√
Cloverdale 115 kV	√	√		√										√		√	√
Coburn 230 kV																	√
Coburn-Basic Energy 60 kV Line																	√
Contra Costa 230 kV															√	√	√
Contra Costa PP - Contra Costa 230 kV Line		√													√	√	√
Contra Costa PP 230 kV															√	√	√
Contra Costa-Delta 230 kV Line		√													√		√
Cooley Landing 60 kV																	√

Explanation of the contents of the updated estimates

1. Transmission constraint

- Constraints are organized by interconnection zones
- The constraints are primarily identified in GIDAP studies in accordance with the current deliverability methodology. The constraints can be on-peak, off-peak or both.
- Includes areas with commercial interest in which no deliverability constraints are identified such as the SCE Metro Area Default Constraint
- In cases where buses or groups of buses with commercial interest are not included in any constraint, CPUC may use queue information up to QC 14 to calculate default transmission capability limits

2. Affected zones

- Provides a general idea as to the location of resources that will be limited by the deliverability constraint. Constrained zones can be standalone, nested or overlapping
- More detailed locational information about resources affected by each constraint is provided in single-line diagrams and in the case of PG&E area a separate Constraint-POI bus matrix.

Explanation of the updated information - cont'd

3. Condition under which constraint is binding

- Indicates whether the constraint was identified in the on-peak scenario, off-peak scenario, both scenarios or neither scenario.
- Determines whether the associated FCDS and EODS capability estimates are actual or default as explained below.

4. Estimated existing system FCDS capability

- FCDS capability estimates associated with actual on-peak deliverability constraints represent the transmission plan deliverability (TPD) calculated for the constraint in accordance with the on-peak deliverability methodology.
- In areas where on-peak deliverability constraints are not identified, the amount of resources studied in on-peak deliverability case are provided as "default" FCDS capability. Default FCDS estimates are marked by an asterisk.
- FCDS estimates indicate the available transmission capacity for resources that were not online as of the cut-off date. The estimates account for retirements of Diablo and the OTC units

Explanation of the updated information - cont'd

- FCDS estimates are expressed based on the resource output assumptions used in on-peak deliverability assessment rather than name plate capacity.
- As a result, the FCDS capability is resource-type neutral and can be translated into any combination of resource types by applying the applicable on-peak resource output factors shown below.

Resource output factors used in FCDS capability estimates

Resource type	HSN			SSN		
	SDG&E	SCE	PG&E	SDG&E	SCE	PG&E
Solar	3.00%	10.60%	10.00%	40.20%	42.70%	55.60%
Wind	33.70%	55.70%	66.50%	11.20%	20.80%	16.30%
Non-Intermittent resources	NQC or 100%					
Energy storage	100% if duration is ≥ 4-hour or 4-hour equivalent if duration is less			50% of HSN amount		
Hybrid	[The lesser of Net MW to Grid (ISC) or the sum of the study amounts of the individual paired resources]/ISC					
New Mexico Wind	67%			35%		
Wyoming/Idaho Wind	67%			35%		
Morro Bay OSW*	100%			49%		
Humboldt Bay OSW*	100%			53%		

- The ISO is currently evaluating available data to update dispatch assumptions for OSW and will communicate the results once the values are finalized.

Explanation of the updated information - cont'd

5. Estimated incremental FCDS capability due to ADNU

- It provides an estimate of the incremental deliverable capacity due to the identified conceptual ADNU and is expressed based on the same on-peak resource output assumptions.
- Incremental FCDS capability is not provided for areas with default existing system FCDS limits.

6. Description of ADNU

- A description of the ADNU, which is the basis for the incremental FCDS capability, is included to enable the CPUC to avoid double counting transmission upgrade cost in cases where an ADNU addresses more than one constraint.
- The information also includes estimated time to construct each ADNU that can be used to determine when the associated incremental capacity can become available.

Explanation of the updated information - cont'd

7. ADNU cost estimate

- The information will allow the CPUC to include transmission upgrade cost in the resource optimization.
- The cost estimates are in 2022 dollars.

8. Estimated existing system EODS capability

- Off-peak deliverability limits determined using the off-peak deliverability methodology are used as the basis for EODS capability estimates.
- By definition, EODS limits represent the amount of renewable resources that can be located in an area beyond which curtailment would become excessive and potentially trigger transmission upgrades.
- Actual existing system EODS capability estimates are calculated for the off-peak constraints identified in GIDAP using data and results from the study.
- In areas where off-peak deliverability constraints are not identified, the amount of resources studied in the off-peak deliverability case are provided as "default" OPDS capability. Default OPDS estimates are marked by an asterisk.

Explanation of the updated information - cont'd

- While actual EODS estimate can be less than the FCDS estimates, default EODS estimates are increased to the FCDS estimate to avoid unduly limiting the amount of FCDS resources that can be selected.
- EODS estimates indicate the available transmission capacity for resources that were not online as of the cut-off date.
- Energy storage increases EODS capability as it is dispatched in charging mode to address off-peak deliverability constraints.
- EODS capability estimates are also expressed based on the resource output assumptions used in off-peak deliverability assessments rather than ISC.

Resource type	Wind Area			Solar Area		
	SDG&E	SCE	PG&E	SDG&E	SCE	PG&E
Solar	68%			79%	77%	79%
Wind	69%	64%	63%	44%		
Hydro	30%					
Off-shore Wind	100%					
New Mexico Wind	67%					
Wyoming/Idaho Wind	67%					
Thermal	0%					
Energy storage	100% in charging mode if duration is ≥ 4-hour or 4-hour equivalent if duration is less than 4-hour					

Explanation of the updated information - cont'd

9. Estimated incremental EODS capability due to AOPNU

- It provides an estimate of the incremental EODS capacity due to conceptual AOPNUs that are primarily identified in GIDAP and is expressed based on the same off-peak resource output assumptions.
- Incremental EODS capability is not provided for areas with default existing system EODS limits where off-peak constraints are not identified.

10. Description of AOPNU

- A description of AOPNUs, which provide the incremental EODS capability, enable the CPUC to avoid double counting transmission upgrade cost in cases where an AOPNU addresses more than one constraint.
- The information also includes estimated time to construct each AOPNU that can be used to determine when the associated incremental capacity would become available.

Explanation of the updated information - cont'd

11. AOPNU cost estimate

- The information will allow the CPUC to include transmission upgrade cost in the resource optimization.
- The cost estimates are in 2022 dollars.

12. Designation as Wind Area or Solar Area

- The transmission capability estimate information includes the designation of off-peak constrained areas as Wind Area or Solar Area in accordance with the off-peak deliverability methodology.
- The information indicates which wind and solar resource output factors above are applied in the EODS capability estimates.

Contents

- Background
- Overview of changes from previous estimate
- The updated transmission capability estimate
- Implementation in CPUC's resource planning process

Intended implementation in the CPUC's resource planning

- This section explains how the transmission capability estimates may be implemented in RESOLVE and the busbar mapping process.
- The CPUC may adjust the proposed implementation approach due to practical limitations or other reasons in consultation with the ISO.

Representation of constraints as linear expressions

- As explained earlier, the capability estimates are resource-type neutral and can be translated into any combination of resource type amounts by applying the respective deliverability study resource output factors.
- Each FCDS and EODS estimate can be implemented using three linear expressions in which the capacities of the future resource types selected are the variables and the applicable resource output factors are the coefficients.
- Implementing this approach in resource planning allows different resource types to take-up available deliverable capacity headroom in accordance with their resource output factors used in deliverability studies.

Implementation of FCDS capability estimates

- In order to ensure FCDS resources selected in IRP portfolios do not exceed on-peak deliverability constraints both in the HSN and SSN scenarios, each FCDS capability estimate can be implemented using the two linear expression shown below.
- HSN Scenario

*FCDS capability estimate ≥ Sum of the capacity of each resource type selected * respective resource output factor for the HSN scenario*

- SSN Scenario

*FCDS capability estimate ≥ Sum of the capacity of each resource type selected * respective resource output factor for the SSN scenario*

- Where FCDS capability estimate is the planned system FCDS capability estimate or the planned system FCDS capability plus the incremental FCDS capability due to ADNU.

Implementation of EODS capability estimates

- Each EODS capability estimate can be implemented using the linear expression below.

> *EODS capability estimate ≥ Sum of the capacity of each non-storage resource type selected * respective resource output factor for EODS estimates – Storage capacity selected (or 4-hour equivalent if duration is less than 4-hours)*

- Where EODS capability estimate is the planned system EODS capability estimate or the planned system EODS capability plus the incremental EODS capability due to AOPNU and the resource output factors for wind and solar are the applicable values for the area depending on whether it is designated as Solar Area or Wind Area.
- Future energy storage included in the portfolio is subtracted from the right hand side of the expression because it increases EODS capability because it is dispatched in charging mode to address off-peak deliverability constraints.

Baseline reconciliation

- As noted earlier, the transmission capability estimates provide the available capacity for resources that were not online as at January 1st, 2022.
- The CPUC will need to adjust the estimates to account for resources that came online after the cut-off date.
- The respective resource output factors should be applied when adjusting the FCDS and EODS capability estimates to account for new resources.
- The CPUC may use updated OSW output assumptions when the values become available.
- The on-peak transmission plan capability estimates assume Diablo Canyon and the existing Alamitos, Huntington Beach, Redondo Beach and Ormond Beach OTC units are retired.
- Depending on the CPUC's retirement assumptions for the units, the TPD for the constraints the units contribute to should be reduced by the NQC of the units in the earlier years or throughout the planning horizon.