Transmission Access Charges (TAC) Structure

Structure and implications of a TED-based TAC

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STRUCTURE OF THE TED-BASED TAC

1. **How a TED-based TAC would work**
   a. TRR cost recovery formula, with examples
   b. TAC allocation among LSEs

2. TED-based TAC would alter procurement

   a. TED-Based TAC maps delivery costs onto procurement

3. Procurement changes would reduce future transmission investment

   a. Reduces all 4 drivers of transmission investment
   b. Numerical model of transmission avoidance

4. Policy Arguments

   a. Rate design principles
   b. Policy objectives

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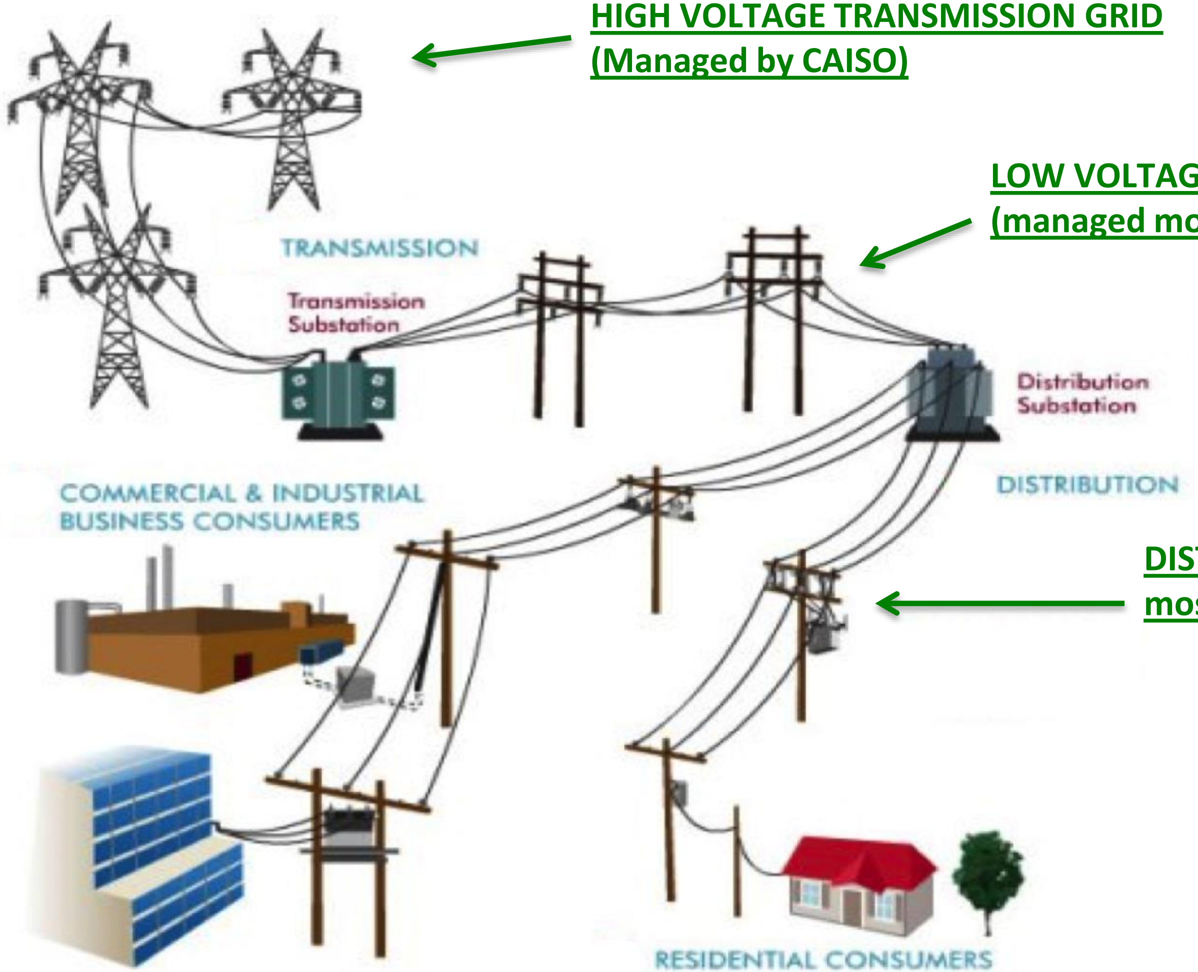
The grid consists of a three parts

HIGH VOLTAGE TRANSMISSION GRID (Managed by CAISO)

LOW VOLTAGE TRANSMISSION GRIDS (managed mostly by various utilities)

DISTRIBUTION GRIDS (managed mostly by various utilities)

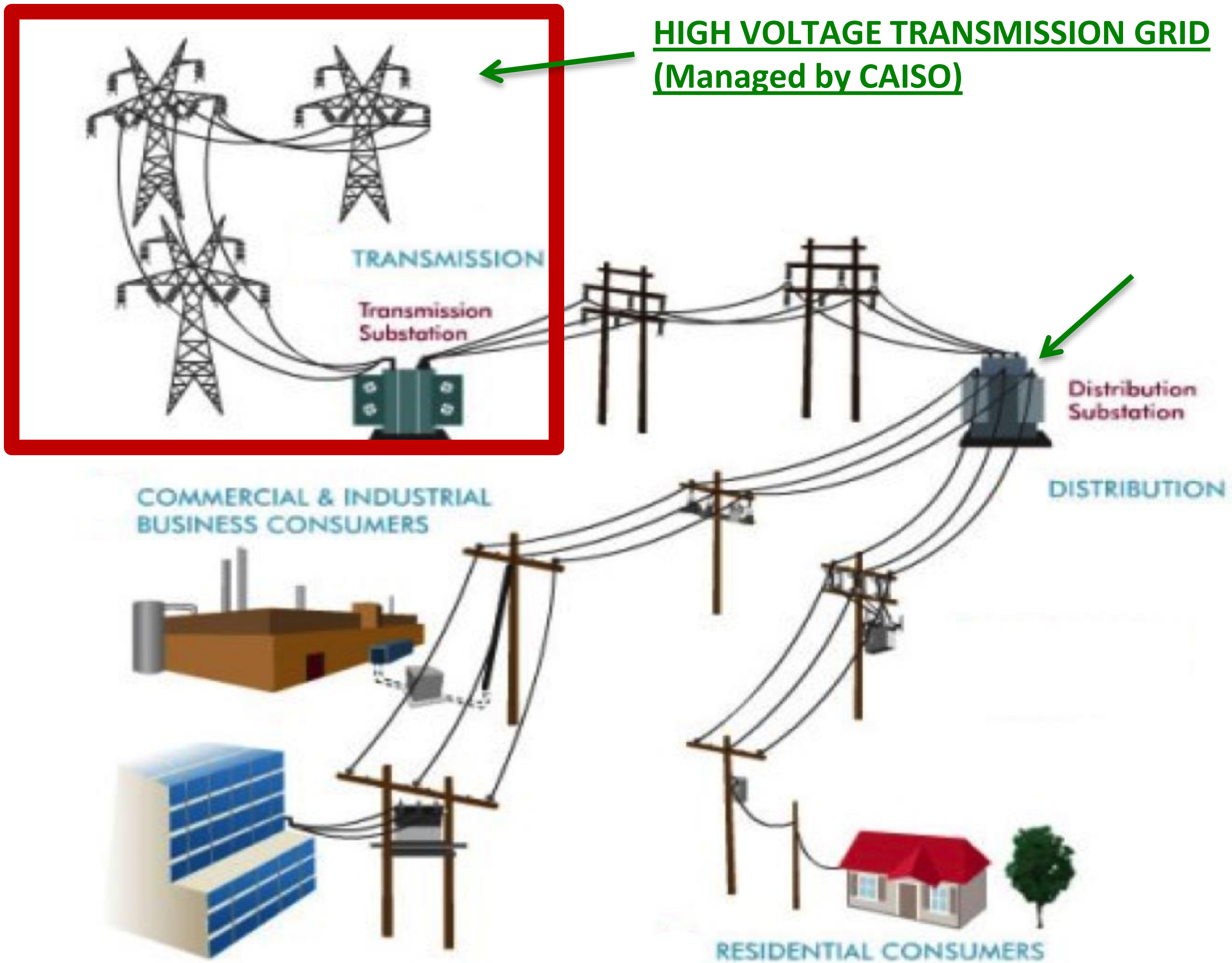


Key TAC definitions

- **Transmission Access Charges (TAC)**
  - **Volumetric fees** assessed on energy consumption for using the CAISO-controlled transmission grid
  - Low Voltage (LV) and High Voltage (HV) TAC
- **Transmission Energy Downflow (TED)**
  - **GROSS metered energy flow** from **higher to lower voltages across defined transmission interfaces (backflow doesn't net out or affect DOWNflow)**
- **Customer Energy Downflow (CED)**
  - **GROSS Metered energy flow** measured across customer meters (a.k.a. end-use customer metered load) **(backflow doesn't net out or affect DOWNflow)**
- **Participating Transmission Owner (PTO)**
  - Entity that **owns part** of the CAISO-controlled transmission grid
- **Distributed Generation (DG) Output**
  - Energy produced by distribution connected resources and consumed with the distribution area
    - IFOM wholesale distributed generation
    - Net energy metering (NEM) exports

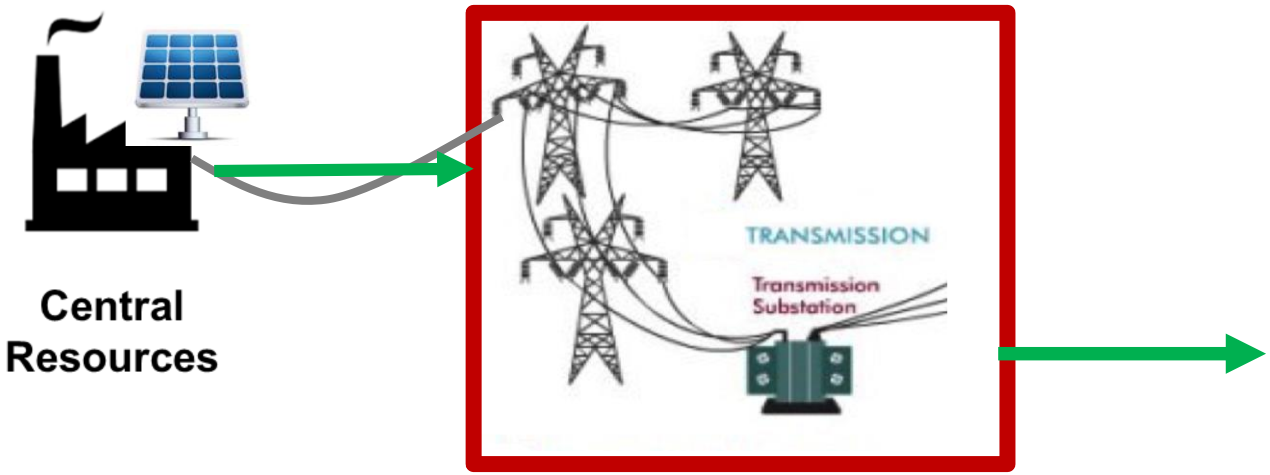
This stakeholder proceeding is concerned with this part

HIGH VOLTAGE TRANSMISSION GRID (Managed by CAISO)



All the energy flowing across this section of the grid comes from upstream generation and…

HIGH VOLTAGE TRANSMISSION GRID
(Managed by CAISO)



leaves the transmission grid to a lower voltage downstream section of the grid

Costs for this section of the grid are recovered by
- a fee on energy
- charged to the entities procuring that energy.

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1.a. How to calculate TED-based TAC

1. Examples and 2017 cost impacts

The Clean Coalition Proposal:

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TED-Based TAC:

Recover the costs of the HV transmission grid with

-a fee

-on energy crossing **the HV transmission grid**.

HV Transmission Revenue Requirement:

money to be recovered to pay for the transmission grid

HV TED: the energy flowing across the HV grid

$$\text{HV TAC Rate} = \frac{\text{HV Transmission Revenue Requirement (costs associated with facilities operating >200kV)}}{\text{HV TED}}$$

The Clean Coalition Proposal

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- This proposal involves:
  - No change in the TRR reporting process
  - No change in TRR
  - No change in operations
  - No change in TAC formula

  - Only a change in *where* energy is measured

PART 1: Cost Effects: A ILLUSTRATIVE example

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Three procuring entities in the State of Honalee

- Popeye G&E - An IOU needing 75 GWH to serve load
  - Procures 3 GWH from wholesale DG (4%)
  - Procures 72 GWH from transmission grid resources
- Magic Dragon Clean Power - a CCA needing 25 GWH
  - Procures 2 GWH from wholesale DG (8%)
  - Procures 23 GWH from transmission resources
- Knifefish ESP needing 10 GWH to serve load
  - Procures 0 GWH DG
  - Procures 10 GWH from transmission grid
  - Analogous to Municipal utility using TED-based charges today

PART 1: Cost effect example: Breakdown of procurement

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Step 1: Calculate how much TAC the LSE owes for the energy it procures

2016 Scenario	IOU	CCA	ESP	Total	Notes
LSE Customer Energy Downflow (CED, in GWh)	**75**	**25**	**10**	**110**	*Gross Load*
Distribution sourced energy DG output (GWh)	**3**	**2**	**0**	**5**	
Share of LSE CED served by DG	4%	8%	0%	4.5%	*4% is the highest current % of DG in any PTO utility service territory*
Transmission sourced energy TED (GWh)	**72**	**23**	**10**	**105**	***Proposed TAC basis***
% of Total CED	68%	23%	9%	100%	*Share of total CED*
% of Total TED	68.6%	21.9%	9.5%	100%	*Share of total TAC basis (proposed)*

PART 1: Cost effect example: Calculation of TED-Based TAC

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2017 Scenario	IOU	CCA	ESP	Total	Notes
LSE Customer Energy Downflow (CED, in GWh)	**75**	**25**	**10**	**110**	*Gross Load*
Distribution sourced energy DG output (GWh)	**3**	**2**	**0**	**5**	
Share of LSE CED served by DG	4%	8%	0%	4.5%	*4% is the highest current % of DG in any PTO utility service territory*
Transmission sourced energy TED (GWh)	**72**	**23**	**10**	**105**	***Proposed TAC basis***
% of Total CED	68%	23%	9%	100%	*Share of total CED*
% of Total TED	68.6%	21.9%	9.5%	100%	*Share of total TAC basis (proposed)*
TRR (in thousands)	NA	NA	NA	$1,650	
TAC RATE (¢/kWh)	1.57¢	1.57¢	1.57¢	1.57¢	(=TRR/Total TED)
TED-Based TAC Payments (in thousands)	**$1131**	**$362**	**$157**	**$1,650**	*TRR is completely recovered*

PART 1: Cost effect example: Comparison to CED

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2017 Scenario	IOU	CCA	ESP	Total	Notes
Customer Energy Downflow CED (GWh)	**75**	**25**	**10**	**110**	*Gross Load*
Distribution sourced energy (GWh)	**3**	**2**	**0**	**5**	
Share of LSE CED served by DG	4%	8%	0%	4.5%	*4% is the highest*
Transmission sourced energy TED (GWh)	**72**	**23**	**10**	**105**	***Proposed TAC basis***
% of Total CED	68%	23%	9%	100%	*Share of total CED*
% of Total TED	68.6%	21.9%	9.5%	100%	*Share of total TAC*
TRR (in thousands)	NA	NA	NA	$1,650	
TAC RATE (¢/kWh)	1.57¢	1.57¢	1.57¢	1.57¢	(=TRR/Total TED)
TED-Based TAC Payments (in thousands, rounded)	**$1131**	**$362**	**$157**	**$1,650**	*TRR is completely recovered*
CED-based TAC Rate	1.50¢	1.50¢	1.50¢	1.50¢	*4.4% lower*
CED-Based TAC Payments (thousands)	$1,125	$375	$150		
Change (Percent and dollar amounts)	**+0.5% (+$6.4)**	**-3.6% (-$13.6)**	**+5% ($7)**		

PART 1: Cost effect example: Impact on delivery charges to customers

Step 2: Recovery those TAC charges from customers through delivery charges

2017 Scenario	IOU	CCA	ESP	Total	Notes
LSE Customer Energy Downflow (CED, in GWh)	75	25	10	110	*Gross Load*
Distribution sourced energy DG output (GWh)	3	2	0	5	
Transmission sourced energy TED (GWh)	72	23	10	105	*Proposed TAC basis*
TED-Based TAC Payments (in thousands, rounded)	$1131	$362	$157	$1,650	*TRR is completely recovered*
Average Delivery charge per kWh	**1.52¢**	**1.46¢**	**1.57¢**	**AVG: 1.50¢**	**The same rate charged to all LSE's customers, regardless**

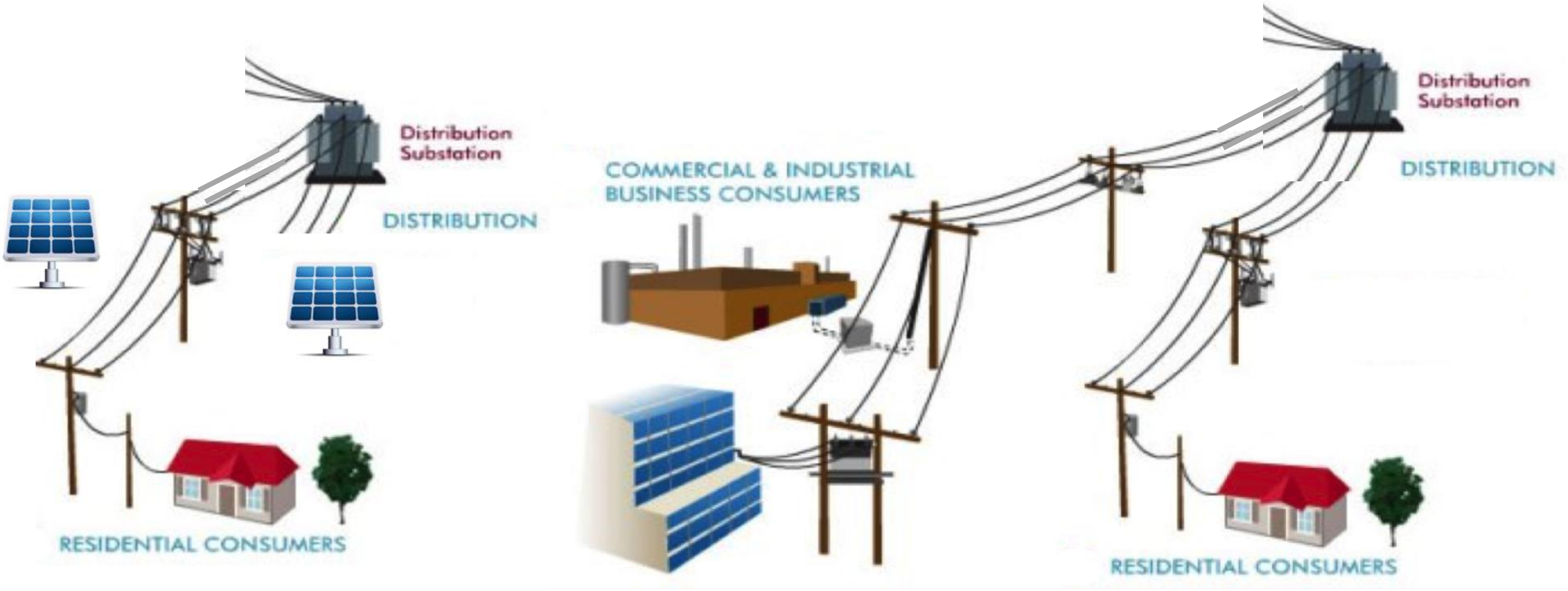
Delivery charges are applied to customer classes served by LSE according to its rate design.

PART 1: Cost Effect Example: Impact to different distribution areas

All LSE customers in a customer class are charged the same delivery charge whether their particular load is served by DG or not.

Popeye G&E Distribution Area 1:
Mostly supplied by local DG resources
Delivery charge: $0.0152/kWh

Popeye G&E Distribution Area 2:
No local DG resources
Delivery charge: $0.0152/kWh



PART 1: Cost effect example: Catching up in DG

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2017 Scenario	IOU	CCA	ESP	Total	Notes
Customer Energy Downflow CED (GWh)	**75**	**25**	**10**	**110**	*Gross Load*
Distribution sourced energy (GWh)	**6**	**2**	**0.8**	**8.8**	
Share of LSE CED served by DG	8%	8%	8%	8%	*4% is the highest current %*
Transmission sourced energy TED (GWh)	**69**	**23**	**9.2**	**101.2**	***Proposed TAC basis***
% of Total CED	68%	23%	9%	100%	*Share of total CED*
% of Total TED	68%	23%	9%	100%	*Share of total TAC basis*
TRR (in thousands)	NA	NA	NA	$1,650	
TAC RATE (¢/kWh)	1.63¢	1.63¢	1.63¢	1.63¢	(=TRR/Total TED)
TED-Based TAC Payments (in thousands, rounded)	**$1125**	**$375**	**$150**	**$1,650**	*TRR is completely recovered*
CED-based TAC Rate	1.50¢	1.50¢	1.50¢	1.50¢	*4.4% lower*
CED-Based TAC Payments (in thousands)	$1125	$375	$150		
Change (Percent and dollar amounts)	**+0.0% (+$0)**	**+0.0% (+$0)**	**+0.0% (+$0)**		

PART 1: Cost effect example: using CAISO data

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California ISO

March 01, 2016 TAC Rates
Based on Filed Annual TRR/TRBA and Load Data

TAC Components:

	Filed Annual TRR ($) [1]	Filed Annual Gross Load (MWh) [2]	HV Utility Specific Rate ($/MWH) [3] = [1] / [2]	TAC Rate ($/MWH) [4] = total [1]/total [2]	TAC Amount ($) [5] = ([2]) * [4]
PG&E	$ 607,131,854	90,445,937	$ 6.7126	$ 11.1337	$ 1,006,995,411
SCE	$ 1,004,417,227	90,511,765	$ 11.0971	$ 11.1337	$ 1,007,728,318
SDG&E	$ 469,609,354	20,824,991	$ 22.5503	$ 11.1337	$ 231,858,623
Anaheim	$ 29,372,296	2,507,620	$ 11.7132	$ 11.1337	$ 27,919,019
Azusa	$ 3,163,102	257,416	$ 12.2879	$ 11.1337	$ 2,865,985
Banning	$ 1,274,841	144,652	$ 8.8132	$ 11.1337	$ 1,610,508
Pasadena	$ 14,679,975	1,231,980	$ 11.9158	$ 11.1337	$ 13,716,461
Riverside	$ 32,665,860	2,180,985	$ 14.9776	$ 11.1337	$ 24,282,372
Vernon	$ 2,973,458	1,181,728	$ 2.5162	$ 11.1337	$ 13,156,972
DATC Path 15	$ 25,407,824	-	$ -	$ 11.1337	$ 0
Startrans IO	$ 3,587,536	-	$ -	$ 11.1337	$ 0
Trans Bay Cable	$ 118,857,411	-	$ -	$ 11.1337	$ 0
Citizens Sunrise	$ 11,783,984	-	$ -	$ 11.1337	$ 0
Colton	$ 3,485,980	372,179	$ 9.3664	$ 11.1337	$ 4,143,719
VEA	$ 11,934,204	544,970	$ 21.8988	$ 11.1337	$ 6,067,517
ISO Total	**$ 2,340,344,906**	**210,204,223**			**$ 2,340,344,906**

PART 1: Cost effect example: using CAISO data

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2017 Scenario	PG&E	SCE	SDG&E	Total	Notes
Customer Energy Downflow (GWh)	**90,500**	**90,511**	**20,825**	**201,782**	*Gross Load*
Distribution sourced energy (GWh)	**3,527**	**2,263**	**833**	**6,623**	
Share of LSE CED served by DG	3.9%	2.5%	4.0%	3.28%	*-SCE, SDG&E DG penetration rates are chosen to illustrate MAXIMAL IMPACTS* *-PG&E rate calculated from DRP filings*
Transmission sourced energy TED (GWh)	**86,919**	**88,248**	**883**	**194,254**	***Proposed TAC basis***
TRR (in millions)	NA	NA	NA	$2,081	*From March 2016 filing*
TED-based TAC RATE (¢/kWh)	1.066¢	1.066¢	1.066¢	1.066¢	(=TRR/Total TED)
TED-Based TAC Payments (in thousands)	$927	$941	$213	$2,081	*TRR is completely recovered*
CED- based TAC RATE (¢/kWh)	1.031¢	1.031¢	1.031¢	1.031¢	*3.7% lower*
CED-Based TAC Payments (in millions)	$933	$933.5	$214.8		
Change (Percent and dollars, millions)	**-0.64% (-$5.9)**	**+0.81% (+$7.5)**	**-0.74% (-$1.6)**		

PART 1: Cost effect example: Impact on delivery charges to customers

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Distribute to ratepayers, on average

2017 Scenario	PG&E	SCE	SDG&E	Total	Notes
Customer Energy Downflow (GWh)	90,500	90,511	20,825	201,782	*Gross Load*
TED-Based TAC Payments (in thousands)	$927	$941	$213	$2,081	*TRR is completely recovered*
Average Delivery charge per kWh	1.025¢	1.040¢	1.024¢	1.031¢	*Proposed TAC basis*
CED-Based TAC Payments (in millions)	$933	$933.5	$214.8		
Average delivery charge per kWh	1.031¢	1.031¢	1.031¢	1.031¢	
Change in Average delivery charge	-0.00659¢	0.00834¢	-0.00765¢		

Delivery charges are applied to customer classes served by LSE according to its rate design.

<u>Shifts BETWEEN IOUs</u> would be less than 1%

PART 1: Cost Effect:
A shift of $0.0000835 is small compared to delivery charges

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https://www.pge.com/includes/docs/pdfs/myhome/customerservice/energychoice/communitychoiceaggregation/mce_rateclasscomparison.pdf

Customer Schedule	Class	PG&E	Adjusted
E-1	Residential	$0.14049	$0.13390
E-1 (CARE)	Residential	$0.04161	$0.03502
E-6	Residential	$0.13848	$0.13189
EV-A	Residential	$0.11894	$0.11235
EV-B	Residential	$0.07683	$0.07024
A-1	Small & Medium Bus.	$0.13391	$0.12732
A-10X	Small & Medium Bus.	$0.10100	$0.09441
E-19S	Industrial	$0.08420	$0.07761
E-20	Industrial	$0.06694	$0.06035

Rate changes would be less than 1% of the differences AMONG RATE CLASSES

PART 1: Calculation of TED-Based TAC:

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1.a. How to calculate TED-based TAC

2. Cost impacts over the next 20 years

PART 1: Cost effect example 2037
What happens when you restrain TAC growth

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2037 Scenario	IOU	CCA	ESP	Total	Notes
LSE Customer Energy Downflow (CED, in GWh)	**75**	**25**	**10**	**110**	*Gross Load*
% of Total CED	68%	23%	9%	100%	*Share of total CED*
CAISO PROJECTED 2035 TRR (in thousands)	NA	NA	NA	$5,280	*FUTURE TRR*
CED-Based TAC RATE (¢/kWh)	4.8¢	4.8¢	4.8¢	4.8¢	(=TRR/Total CED)
CED-Based TAC Payments (in thousands)	**$3,600**	**$1,200**	**$480**	**$5,280**	*TRR is completely recovered*

A 5% growth rate in TAC rate projected over 20 years from the initial 1.5¢ would predict **a TAC rate of 4.8¢**

Actual TAC Rates have been growing FASTER than that.

PART 1: Cost effect example 2037
1.5X RATE OF DG DEPLOYMENT

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2037 Scenario	IOU	CCA	ESP	Total	Notes
LSE Customer Energy Downflow (CED, in GWh)	**75**	**25**	**10**	**110**	*Gross Load*
CAISO PROJECTED 2035 TRR (thousands)	NA	NA	NA	$5,280	*FUTURE TRR*
CED-Based TAC RATE (¢/kWh)	4.8¢	4.8¢	4.8¢	4.8¢	(=TRR/Total CED)
CED-Based TAC Payments	**$3,600**	**$1,200**	**$480**	**$5,280**	*TRR is completely recovered*
Distribution sourced energy (GWh)	**10**	**10**	**0**	**20**	
Share of LSE CED served by DG	13%	40%	0%	18%	*1.5XBAU projections*
Transmission sourced energy TED (GWh)	**65**	**15**	**10**	**90**	***Proposed TAC basis***
TRR (in thousands)	NA	NA	NA	$3,040	***Cost increases at 3.1%, compared to 5%*** ***See Transm'n avoidance model***
TAC RATE (¢/kWh)	**3.38¢**	**3.38¢**	**3.38¢**	**3.38¢**	(=TRR/Total TED)
TED-Based TAC Payments (in thousands, rounded)	**$2,196**	**$507**	**$338**	**$3,040**	*TRR is completely recovered*
Change (Percent and dollar amounts)	**-39% (-$1,404)**	**-57.8% (-$693)**	**-29.6% (-$142)**		

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1.b. How to calculate share of TED among LSEs

PART 1: Calculation of TED – Based TAC: Allocating TAC between LSEs sharing distribution area.

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Principle: Allocate TAC liability according to each LSE's proportional share of TED

*LSE TAC liability = TAC rate * LSE share of TED*

LSE share of TED = LSE CED – (LSE LV and DG output)

This can be done as long as the UDC knows the **HV TAC rate** and each **LSE's DG output**.

PART 1: Allocating TAC between multiple LSEs on the same distribution grid: Overcollect + Refund Method

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1. CAISO files the HV TAC rate with FERC and assigns costs to utilities based on their TED.

   HV TAC rate = (HV TRR)/(HV TED)

2. Each LSE can identify their LV and DG output using information available to their scheduling coordinator.

   LSE LV and DG output = LV output + WDG output + NEM metered exports
   (available from scheduling coordinators reporting to UDC)

3. The UDC that serve multiple LSEs would apply the HV TAC rate to each kilowatt-hour of CED and collected from customers.

   *HV TAC rate * LSE total CED = LSE TAC liability + overcollection*

4. The UDC would refund the excess fees to each LSE in proportion to their LV and DG output.

   *LSE Refund = HV TAC rate * LSE LV and DG output*
   (will match the overcollected amount from each LSE)

PART 1: Cost effect example: Allocation of TAC among LSEs

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Scenario	IOU	CCA	ESP	Total	Notes
Customer Energy Downflow CED (GWh)	**12**	**5**	**3**	**20**	
Distribution sourced energy (GWh)	**3**	**1**	**0**	**4**	
Share of LSE CED served by DG	25%	20%	0%	20%	
Transmission sourced energy TED (GWh) = CED(metered) – DG procurement	**9**	**4**	**3**	**16**	
TAC RATE (¢/kWh)	1.57¢				
TED-Based TAC Payments (thousands)	**16 GWh * $00157 = $251,200**				*Charged to the UDC*
Collected by UDC based on CED	20 GWH * $0.0157 = $314,000				
Overcollection	$62,800				*Refunded to LSEs for DG*
Refund to LSE (= DG * TAC)	**$47,100**	**$15,700**	**$0**	**$62,80 0**	

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2.a. Implications of TED-based TAC for procurement

PART 2: Impacts of TED-based TAC on procurement

Procurement is done by

- Least cost
- Best fit

- Currently, less than 4% of energy comes from distribution-connected generation.

PART 2: Impacts of TED-based TAC on procurement

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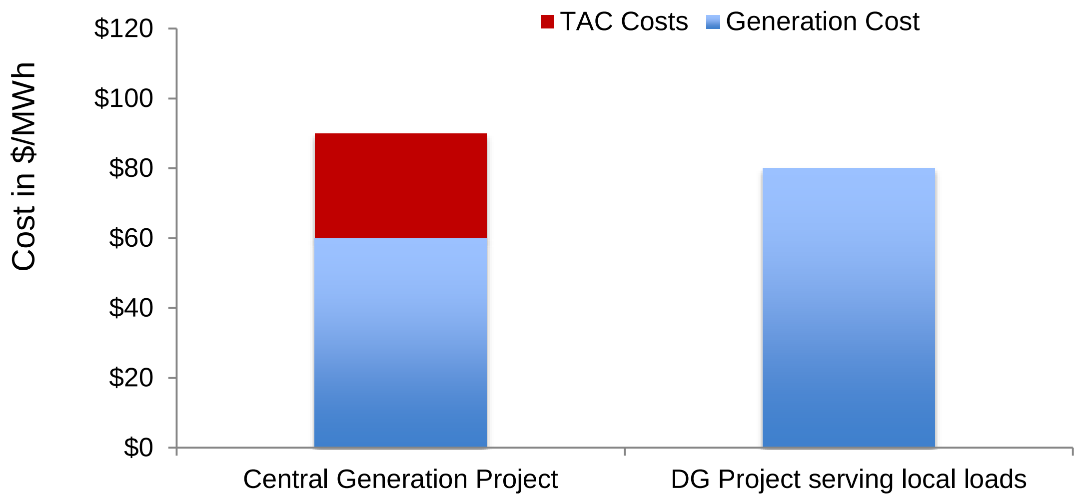
Least Cost with delivery costs with TED-based TAC



- Procurement costs include both costs of generation and delivery.
- Existing LCBF methodologies can incorporate this cost information without additional regulatory changes.

PART 2: Impacts of TED-based TAC on procurement

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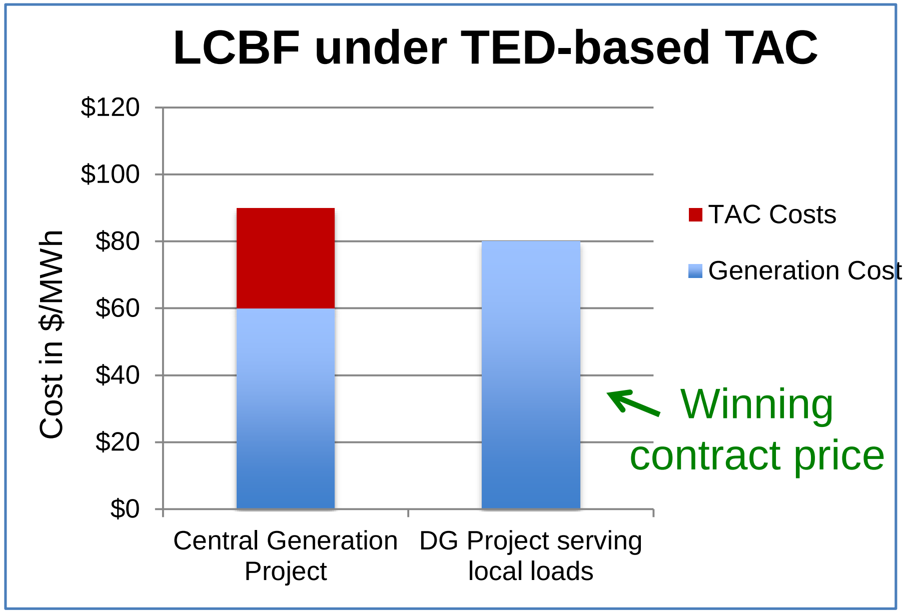

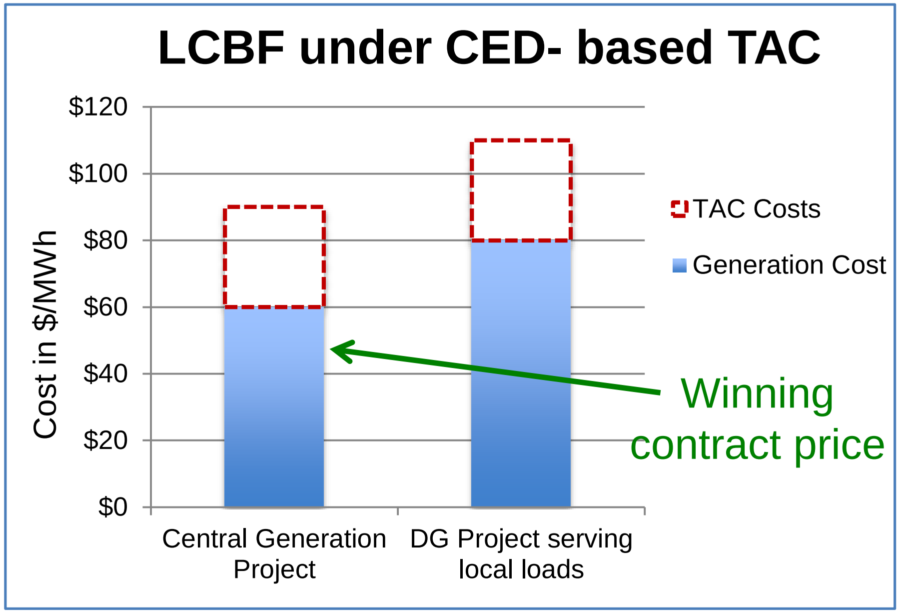

- TED-based TAC will allow the costs of the transmission delivery system to be incorporated into procurement decisions.
- Where local energy supplies are cheaper, these will be procured
- Where transmission-sourced energy supplies are cheaper, these will be procured

PART 2: Impacts of TED-based TAC on procurement: Identification of most cost effective resources.

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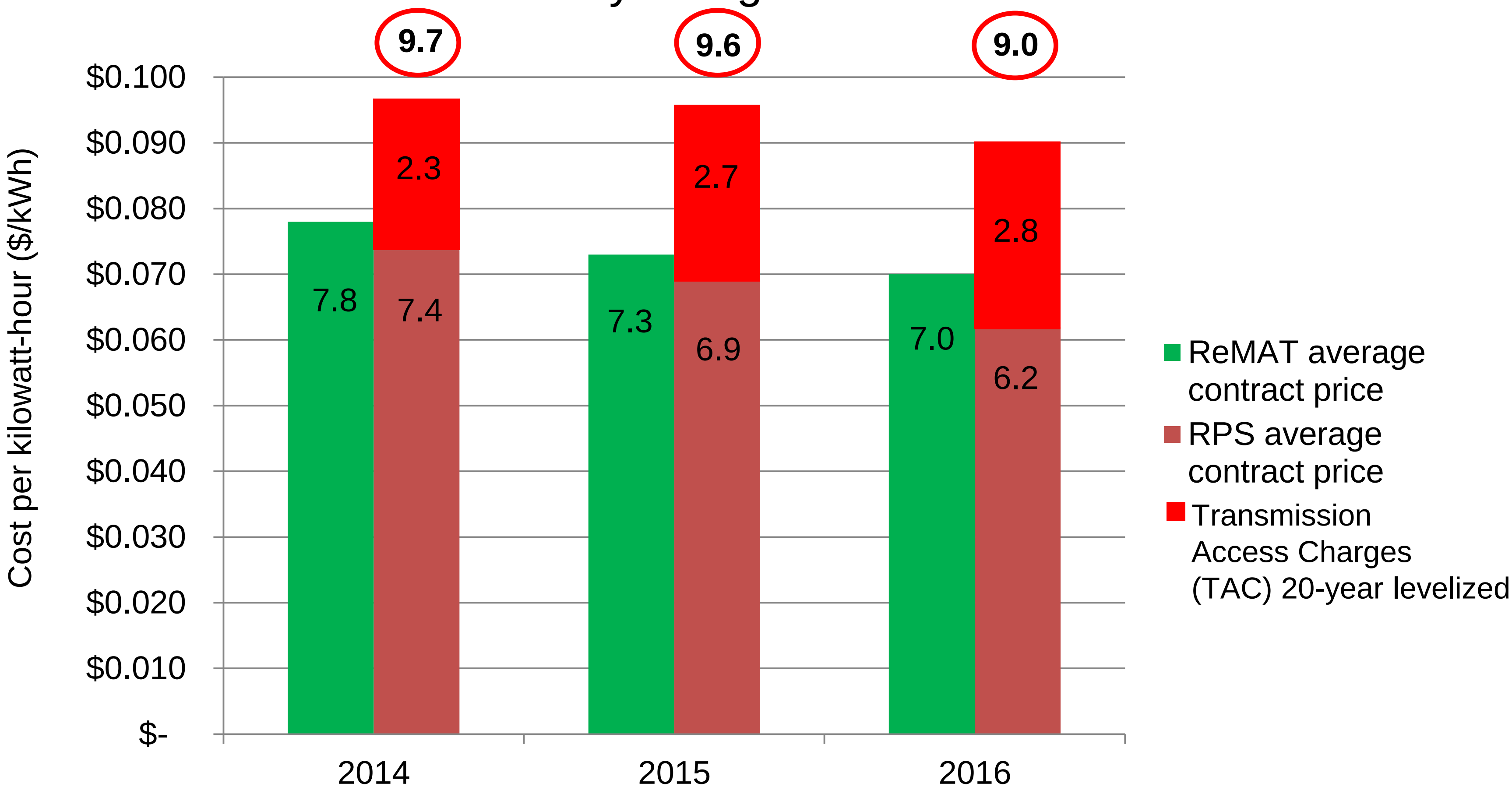
Recent contract prices from central renewable sources (RPS) and distributed renewables (ReMAT) indicate that in some instances DG should be procured when delivery charges are included



Data sources: 2014-16 RPS via CPUC; 2014-16 ReMAT via PG&E, SCE ReMAT web sites.

NOTE: 2017 SCE ReMAT contracted price was 4.5c/kWh as of May. The most recent offer price was 4.1c/kWh.

PART 2: Impacts of TED-based TAC on procurement: changes in procurement mix hypothetical illustration

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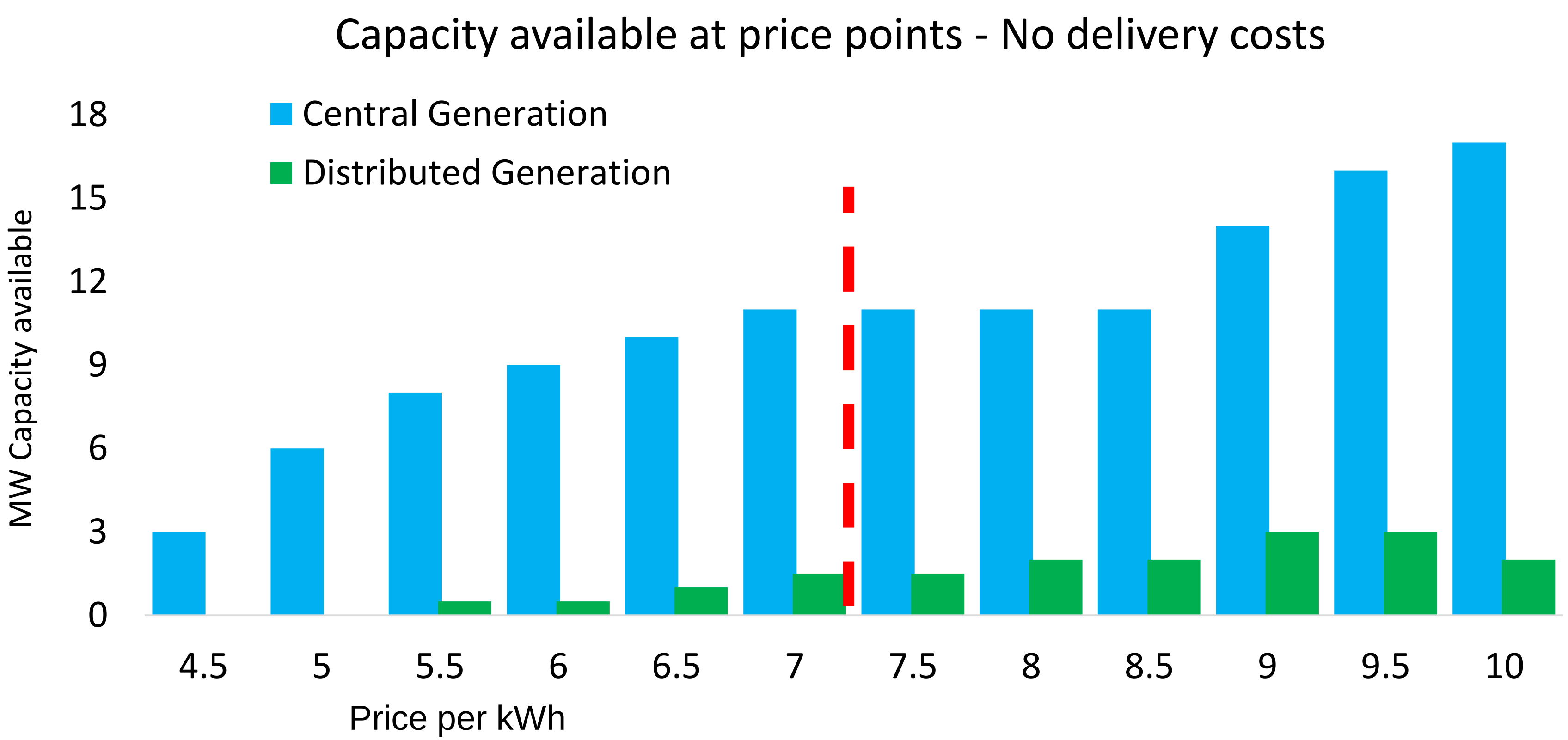
•Popeye G&E 50 MW procurement



50 MW capacity procured:

47 MW central Generation, 3 MW Distributed

@7 cents per kWh or lower (+2 cents/ kWh TAC)

PART 2: Impacts of TED-based TAC on procurement: changes in procurement mix hypothetical illustration

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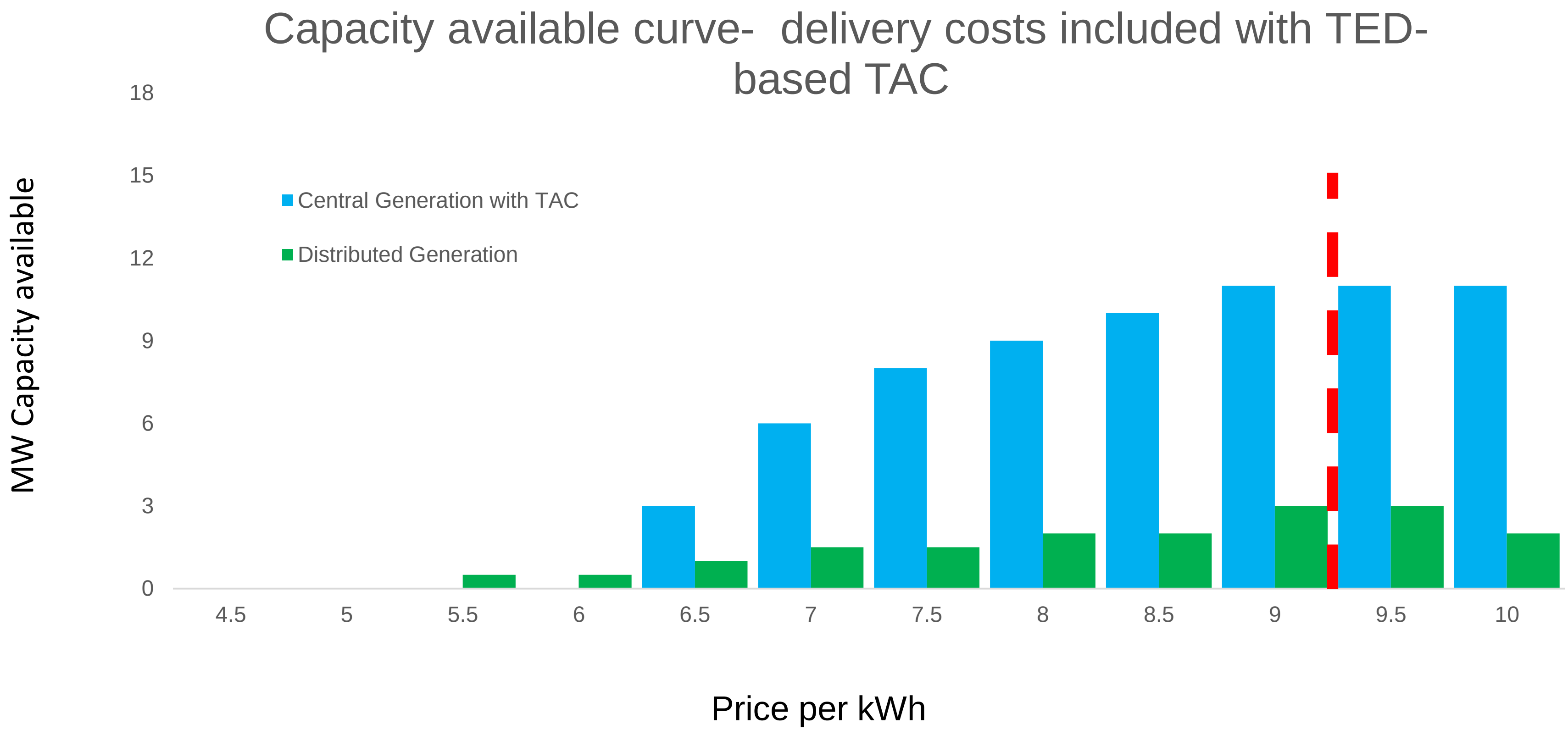
- Popeye G&E 50 MW procurement
  - Same distribution of generation costs +2 cents/kWh TAC charge for transmission sourced offers



50 MW capacity procured:

42.5 MW central Generation, 7 MW Distributed

@9 cents per kWh or lower (+no additional TAC added)

PART 2: Impacts of TED-based TAC on procurement: Changes in procurement mix hypothetical illustration

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- Popeye G&E 50 MW procurement

	Transmission – sourced	Distribution grid- sourced	Average price per kWh including TAC
TED-Based TAC	42.5 MW	7.5 MW	**$0.0781**
Traditional TAC	47 MW	3 MW	**$0.08125**

TED-Based TAC

Results in more DG winning procurement contracts in a non-linear relationship
Results in lower average costs because not all procured energy carries TAC charges
How much more DG results depends on the overall distribution of bids.

PART 2: Impacts of TED-based TAC on procurement: General conclusions

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TED-Based TAC should:

- **Lead to more DG procurement**
- **Result in lower average procurement costs because not all procured energy carries TAC charges**
  - **(Municipal customers already get this discount)**
- **Drive a non-linear relationship between TAC and increase in DG deployment, depending on the distribution of projects**

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3. How increasing Distributed Generation constrains the growth in TAC

a. The Four Cost Drivers of Transmission investment

PART 3a: Impacts of TED-based TAC on TAC growth rate

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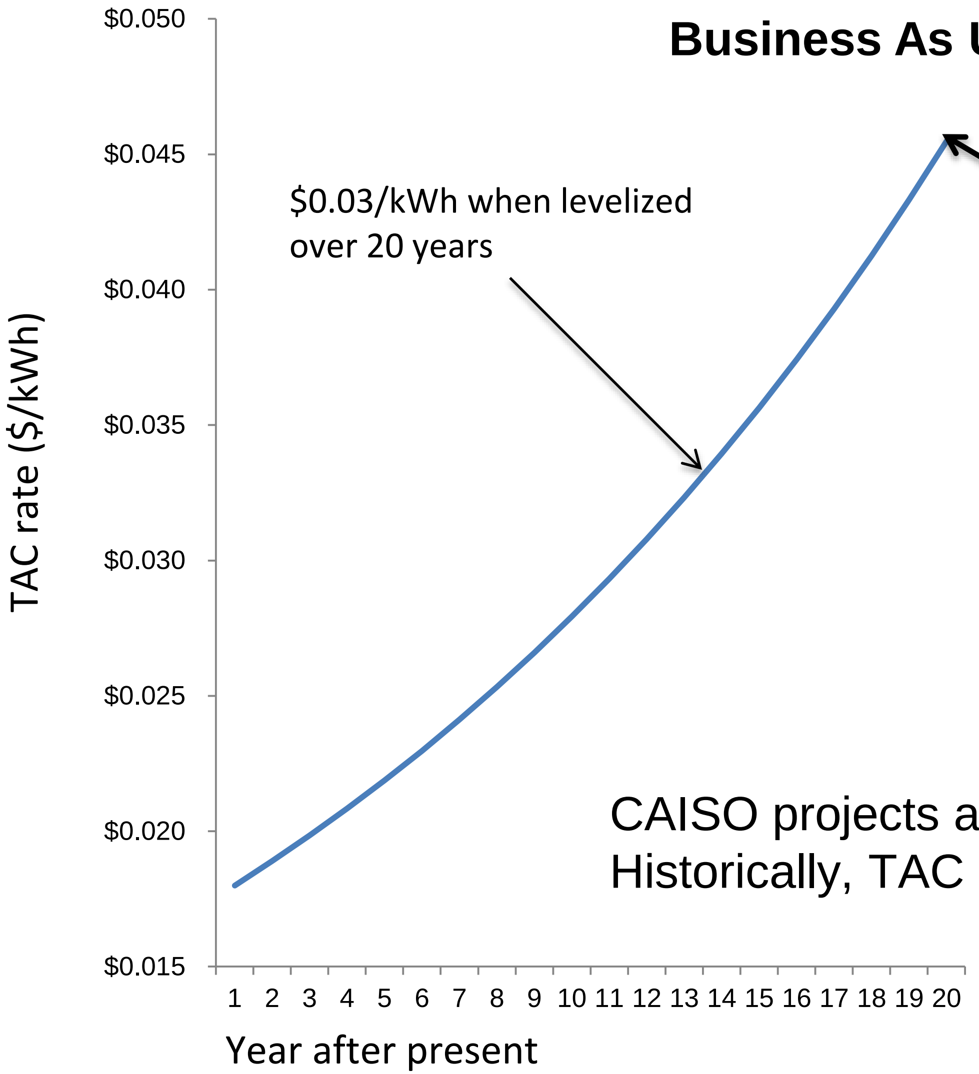
Forecasted PG&E Total TAC Rate



20 year TAC savings compared to BAU:

BAU

(Current baseline trends would result in 12.4% of load met by local renewables after 20 years)

The 20-year levelized TAC is about 3 cents/kWh, which is roughly 50% of the current wholesale cost of new energy contracts in California.

CAISO projects a 5% real growth rate in TAC

Historically, TAC rates have grown between 9% and 11%

Clean Coalition

DER reduces existing and future transmission costs

DER deployment can reduce the need for future transmission grid investment.

- 12/2016, Fresno Bee: Growth of local solar puts plans for $115 million transmission project on hold
- 5/2016, Greentech Media: $192 million in PG&E transmission projects cancelled due to energy efficiency and local solar

PART 3a. Impacts of TED-based TAC on TAC growth rate: Four Drivers of Transmission investment

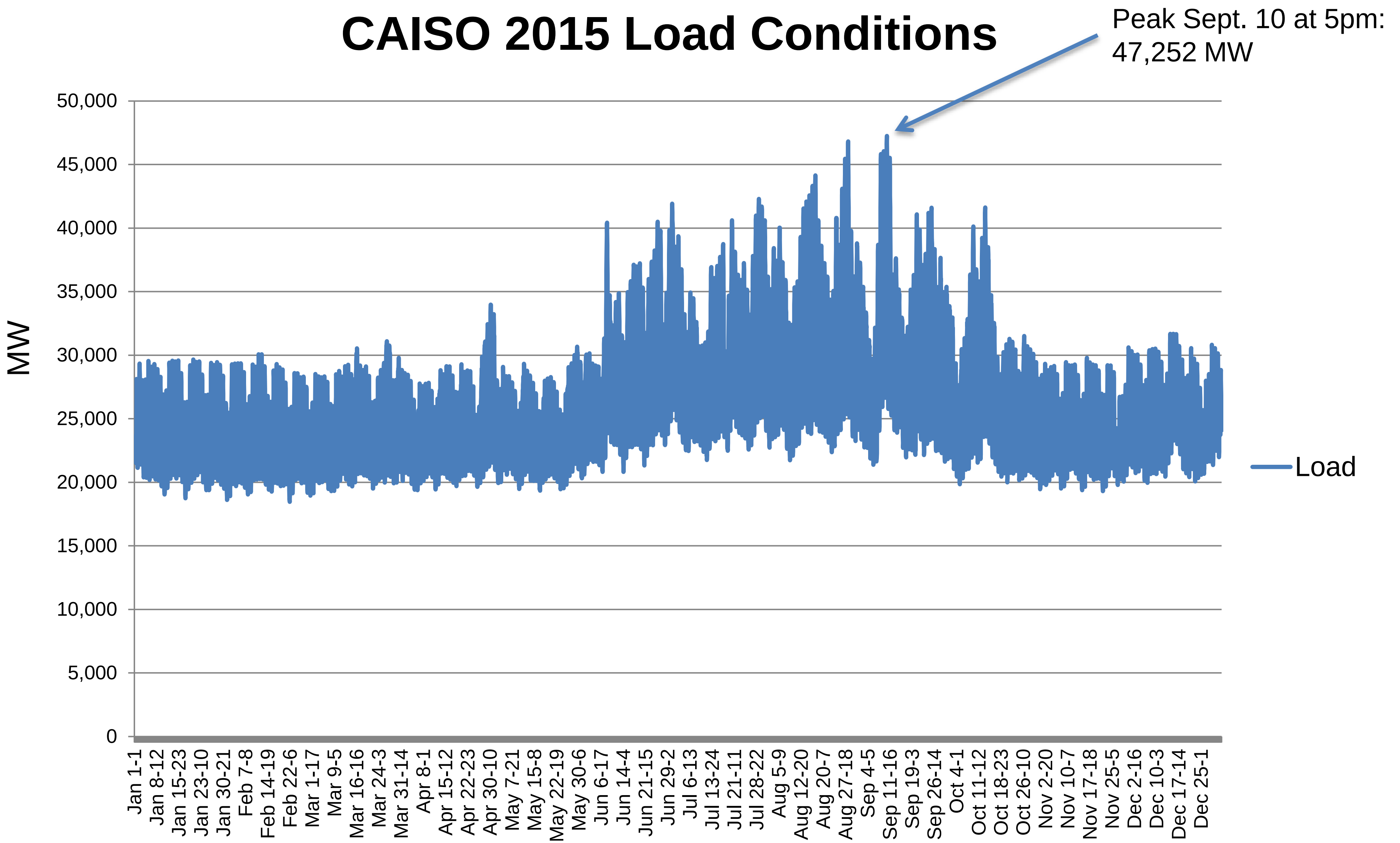
Clean Coalition

The Issue Paper identified 4 main drivers of transmission investment, and DER can address needs for each driver.

1. Peak load
2. Policy
3. Economics
4. Reliability

PART 3a. Impacts of TED-based TAC on TAC growth rate: Four Drivers of Transmission investment—Peak Load

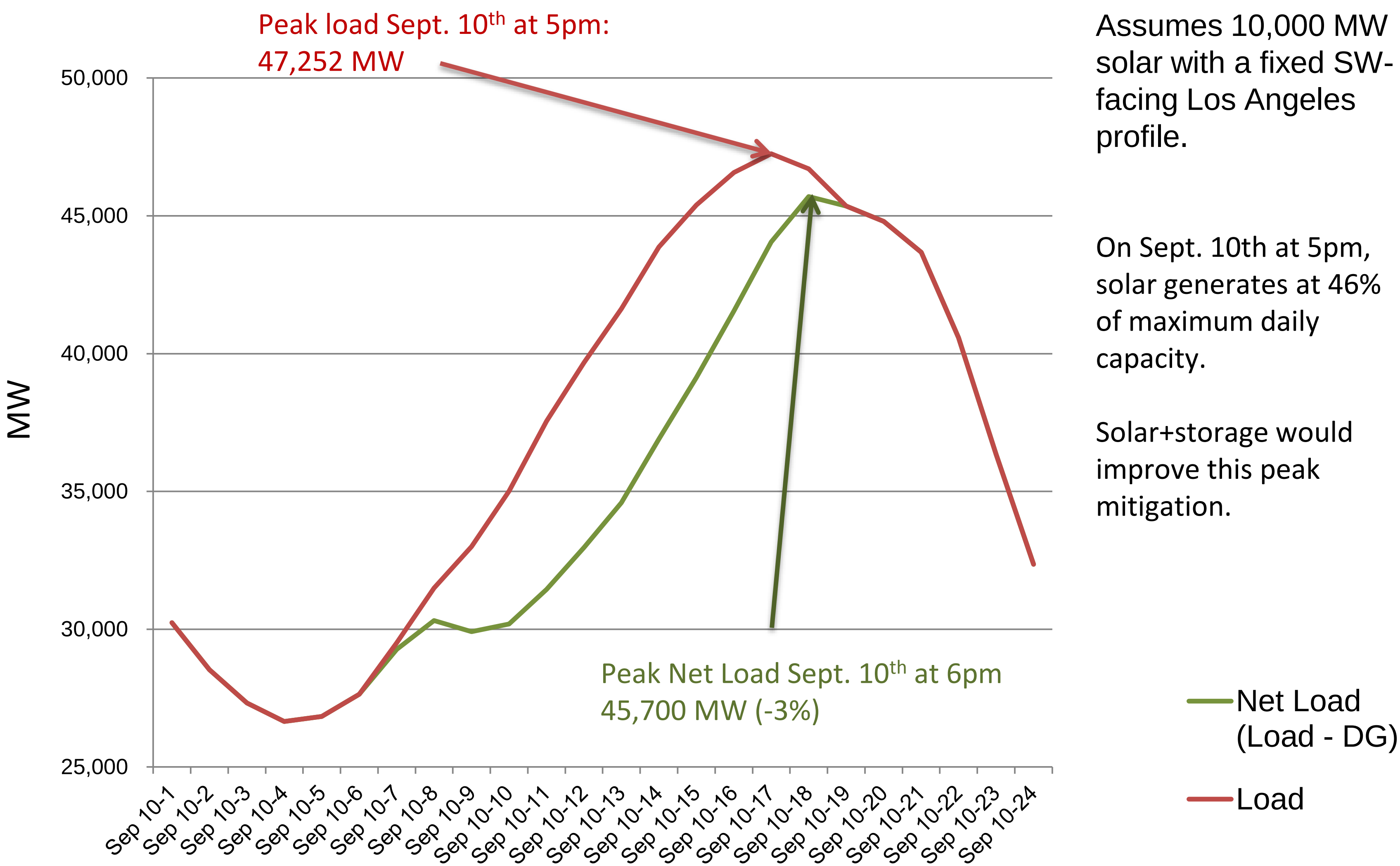
Clean Coalition



PART 3a. Impacts of TED-based TAC on TAC growth rate: Four Drivers of Transmission investment

Clean Coalition

Example DG production during peak load conditions



Assumes 10,000 MW solar with a fixed SW-facing Los Angeles profile.

On Sept. 10th at 5pm, solar generates at 46% of maximum daily capacity.

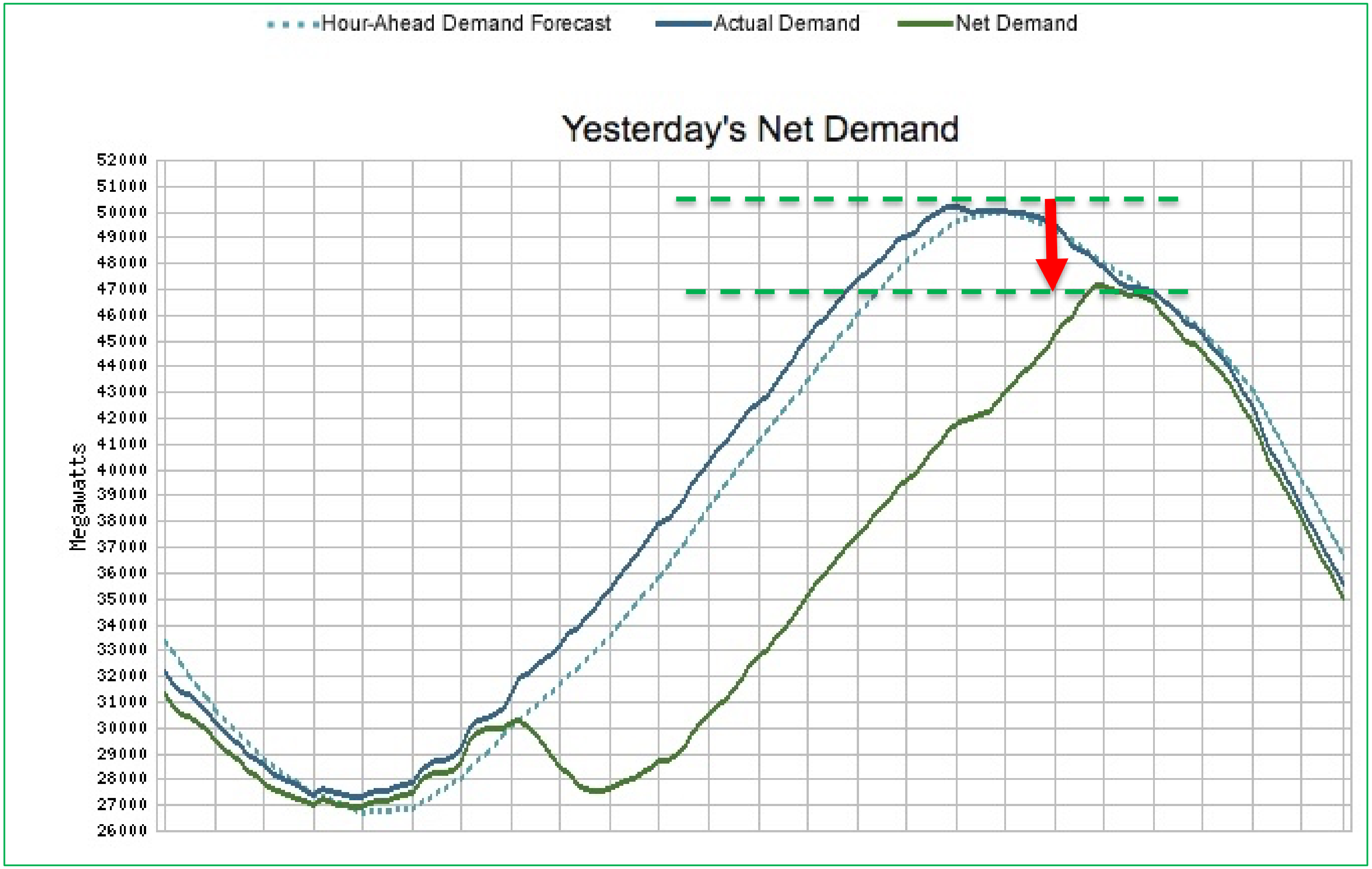
Solar+storage would improve this peak mitigation.

Renewable Reduction in Peak Demand

Clean Coalition

Sept 1, 2017, CAISO near record peak

Total demand (net DER) and contribution of Transmission level Solar & Wind



PART 3a. Impacts of TED-based TAC on TAC growth rate: Four Drivers of Transmission investment—Policy Goals

Clean Coalition

- Policy goals are likely to make up a substantial portion of new transmission investment.
  - RETI 2.0 report estimates at least $5 billion in new transmission build will be required to meet the 50% RPS by 2030
  - O&M costs increase that cost by 5x → $25b over 50 years
  - Plus financing costs (return on equity)

- Aggregated wholesale distributed generation can be RPS-eligible resources.

PART 3a. Impacts of TED-based TAC on TAC growth rate: Four Drivers of Transmission investment—Economics

Clean Coalition

- DG can reduce peak transmission and transmission flows locally
  - DG frees up transmission capacity, creating opportunities for more cost-effective delivery of remote energy
  - DG at important locations can reduce the marginal costs of energy by reducing congestion and line losses
- When excess capacity exists to reach new, cheap remote resources, the cost of accessing resources decreases.

Clean Coalition

DER can provide essential reliability services. [1]

- Energy storage can provide frequency and voltage stability services under varying real load conditions.[2]
  - Solar+Storage can provide real power
  - Automated DR can manage load profiles
  - Advanced inverters can provide reactive power for voltage support if needed.
  - DERs also provide resiliency by adding diversity to the generation portfolio.

1 C. Loutan et al., *Demonstration of Essential Reliability Services by a 300-MW Solar Photovoltaic Power Plant* (March 2017), available at https://www.nrel.gov/docs/fy17osti/67799.pdf.
2 Khalsa, Amrit S., and Surya Baktiono. *CERTS Microgrid Test Bed Battery Energy Storage System Report: Phase 1., 2016*, available at https://certs.lbl.gov/sites/all/files/aep-battery-energy-storage-system-report-phase1.pdf.

There are Three Vital Grid Services

Clean Coalition

Service	Key to Delivering Service
Power Balancing	Capacity of real power (W)
Voltage Balancing	Location of reactive power (VAr)
Frequency Balancing	Speed of ramping real power (W)

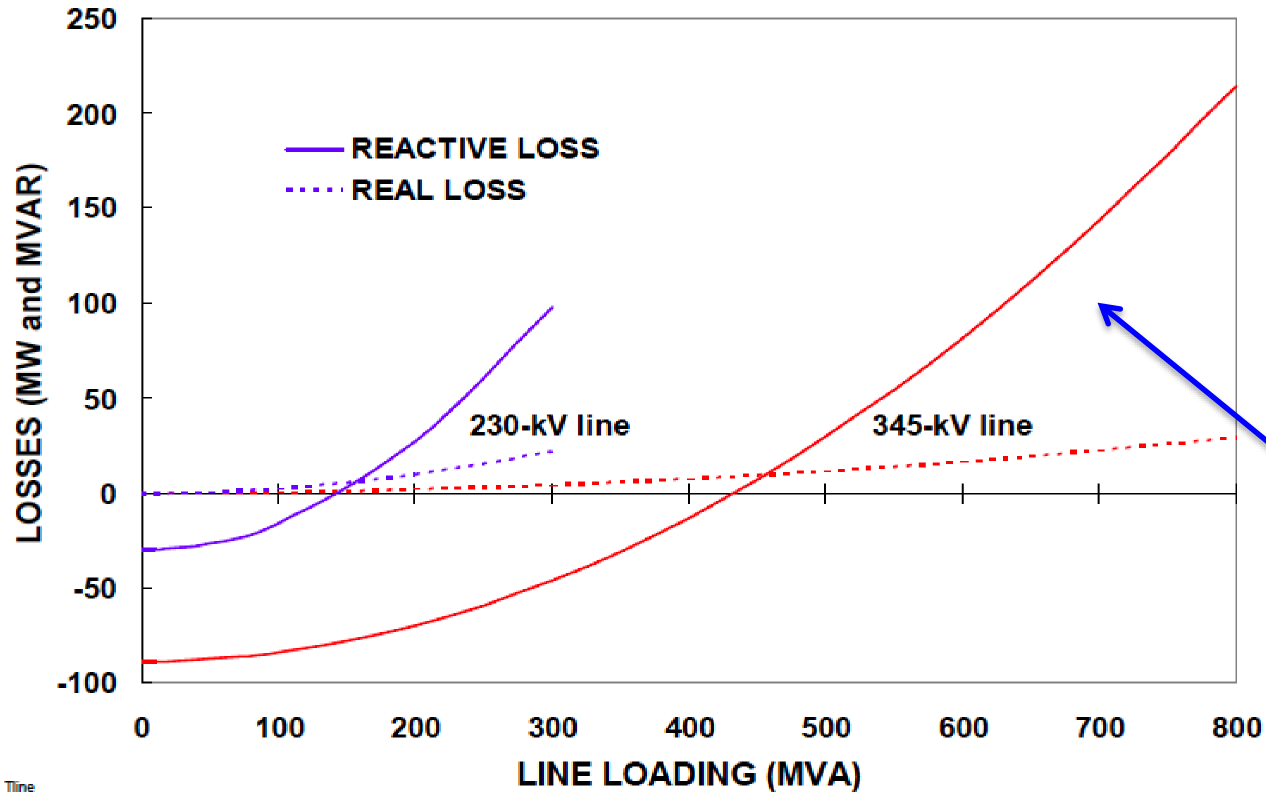
The Duck Chart only addresses Power Balancing but Distributed Energy Resources deliver unparalleled location and speed characteristics

Distributed Voltage Regulation – Location Matters

Clean Coalition

"The old adage is that reactive power does not travel well."

Oak Ridge National Laboratory (2008)



T&D lines absorb 8-20x more reactive power than real power.

Prevent Blackouts: When a transmission path is lost, remaining lines are heavily loaded and losses are higher.

Figure 1-1. Transmission line absorption of reactive power.

Source: Oak Ridge National Laboratory (2008)

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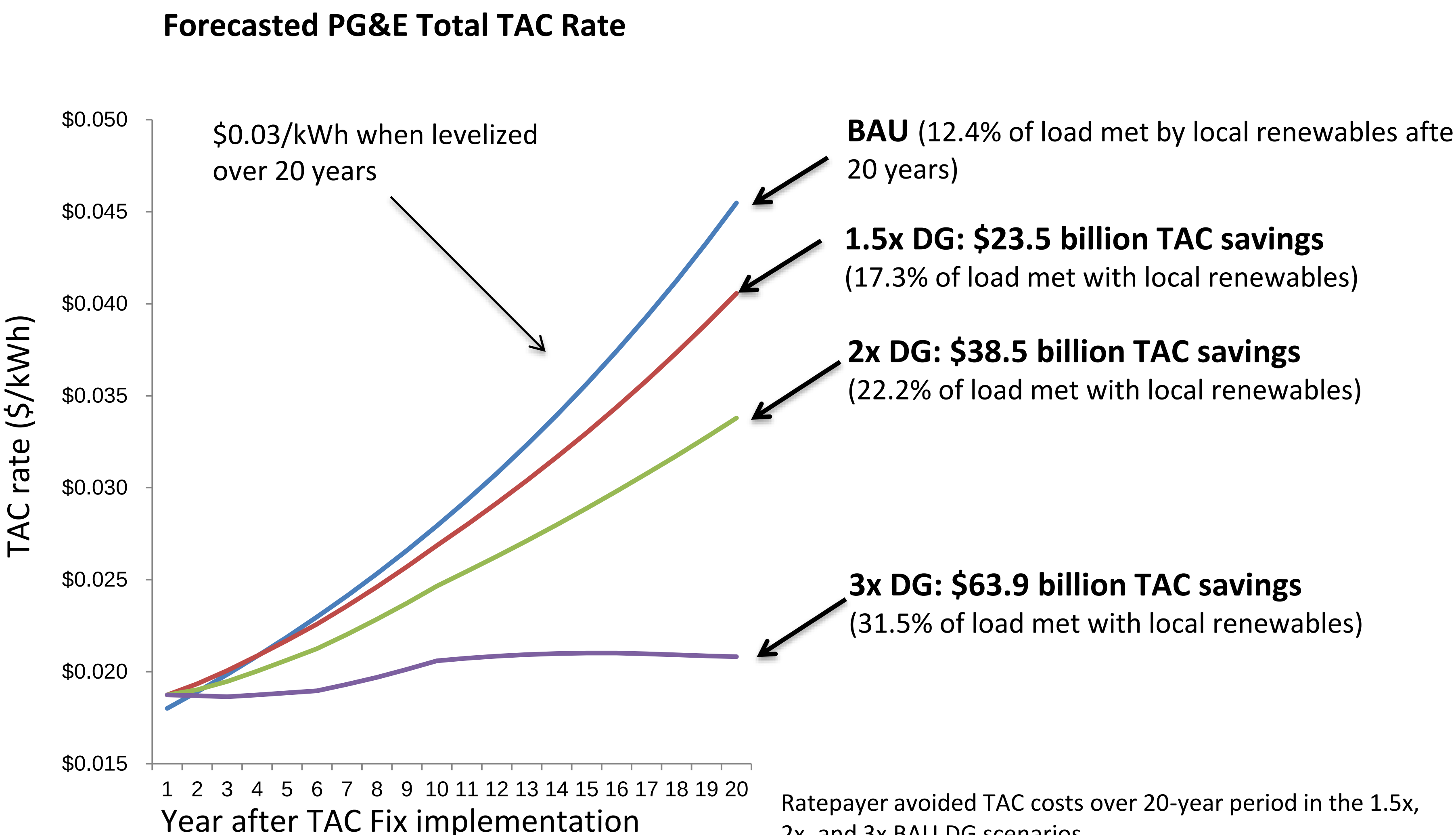
3. How increasing Distributed Generation constrains the growth in TAC

b. Numerical model of the impact of increased DG on transmission investment

Part 3b: DG deployment result in avoided transmission investment

Clean Coalition



Ratepayer avoided TAC costs over 20-year period in the 1.5x, 2x, and 3x BAU DG scenarios.

Clean Coalition

We emphasize that this model was developed to ***illustrate*** the TRR and associated TAC rate impacts of reducing new transmission investment proportional* to reductions in total delivered energy over time (MWh)

- While we use reasonable estimates, these are not actual forecasts – the number of variables make that impossible
- The tool illustrates the type of impacts that can be expected and compares different levels of DER adoption. The actual change in DER deployment will depend on what the market can deliver.
- We're offering the tool to:
  - allow stakeholders to see how inputting different assumptions influences the magnitude and nature of the results, and
  - also as an open source to make improvements to the formulae, methods, and assumptions. Feel free to make changes.

* = Typical generation profiles are considered. Alternate approaches are welcome to give greater emphasis to peak capacity (MW) or avoided remote RPS procurement

Clean Coalition

- STEP 1:
  - Establish expected total energy delivered by
    - Wholesale DG based on PG&E's estimates
    - NEM exports
  - Extrapolated over 20 years.

Part 3b: DG deployment avoids transmission investment
TAC fix Impact Model – DER input sheet

Clean Coalition

Total Annual Share of Gross Load Served Locally Example: (	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Assumption/Source* See Spreadsheet	Capacity Factor
CHP from Feed in Tariffs (MW)	23	30	36	43	50	56	63	70	76	83		
Wholesale Distributed Generation (DG) (MW)	557	665	770	828	885	947	947	947	947	947		67%
Total Wholesale DG (WDG) (MW)	**580**	**695**	**806**	**871**	**935**	**1,003**	**1,010**	**1,017**	**1,023**	**1,030**		
NEM Photovoltaic (PV) (MW)	2,224	2,694	3,076	3,471	3,874	4,288	4,718	5,153	5,591	6,035		34%
NEM Non-PV DG (MW)	220	255	292	328	367	407	448	492	535	578		60%
Total NEM DG (MW)	**2,444**	**2,949**	**3,368**	**3,799**	**4,240**	**4,695**	**5,166**	**5,645**	**6,126**	**6,614**		
Total WDG + NEM DG (MW)	**3,023**	**3,644**	**4,174**	**4,670**	**5,175**	**5,697**	**6,175**	**6,661**	**7,149**	**7,643**		
Share of NEM DG generation entering grid	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%		
NEM DG capacity plus WDG capacity serving local loads (MW)	1,801	2,169	2,490	2,770	3,055	3,350	3,592	3,839	4,086	4,336		
Average MWh Yield per MW DG capacity	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000		
WDG + NEM exports (GWh)	3,603	4,338	4,979	5,541	6,110	6,700	7,185	7,678	8,171	8,673		
Gross Load (GWh)	91,500	93,330	95,197	97,101	99,043	101,023	103,044	105,105	107,207	109,351		
Share of Gross Load served by WDG + NEM exports	**3.9%**	**4.6%**	**5.2%**	**5.7%**	**6.2%**	**6.6%**	**7.0%**	**7.3%**	**7.6%**	**7.9%**		
Share of new Gross Load served by new WDG + new NEM exports		40.2%	34.3%	29.5%	29.3%	29.8%	24.0%	23.9%	23.5%	23.4%		

Clean Coalition

- STEP 2:
  - A - Develop projection of load growth (CAISO)
  - B - Develop projection of WDG + NEM exports
  - C - Calculate transmission revenue requirement based on total transmission-sourced energy
    - Calculate TAC
  - Alter rate of WDG + NEM growth to recalculate TRR over time.
    - Calculate TAC

Part 3b: DG deployment avoids transmission investment TAC fix Impact Model – future year projection

Clean Coalition

Business As Usual (BAU)

		1	2	3	4	5
PG&E TAC Rates	**Assumption/Source**	**2,016**	**2017**	**2018**	**2019**	**2020**
HVTAC rate ($/MWh)	2016 data: TAC filings September 1, 2016	$10.68	$11.21	$11.77	$12.36	$12.98
Nominal annual growth in HVTAC rate	CAISO projected increase, 2012;		7.0%			
Inflation	Clean Coalition		2.0%			
Real annual growth in HVTAC rate	Real growth = nominal growth - inflation		5.0%			
20 year levelized HVTAC rate (current $/MWh)	**Average of 20 years, including current year**	**$17.65**				
Total TAC rate ($/MWh)		$18.00	$18.90	$19.84	$20.84	$21.88
20 year levelized Total TAC rate ($/MWh)		**$29.76**				
PG&E TAC Payments to CAISO (Equals TRR)						
HVTAC payments to CAISO (HVTRR) ($ billions)		$0.98	$1.05	$1.12	$1.20	$1.29
LVTAC payments to CAISO (LVTRR) ($ billions)	Maintains 2016 ratio LVTAC:HVTAC over 20 years	$0.67	$0.72	$0.77	$0.82	$0.88
Cumulative Total TAC payments to CAISO (Total TRR) ($ billions)		$1.65	$3.41	$5.30	$7.32	$9.49
20 year levelized Total TAC payments to CAISO ($ billions)	**Average of 20 years, including current year**	**$3.41**				
PG&E Share of Gross Load served by WDG + NEM exports						
PG&E Gross Load (GWh)	PG&E growth is same as Total PTO growth	91,500	93,330	95,197	97,101	99,043
New PG&E Gross Load (GWh)			1,830	1,867	1,904	1,942
Share of PG&E Gross Load served by WDG + NEM exports	PG&E DRP filings; Trajectory growth scenario. Annual increase in growth after 2025 is average of increase in growth 2016-2025	3.9%	4.6%	5.2%	5.7%	6.2%
Absolute growth in share of PG&E Gross Load served by WDG + NEM exports			0.7%	0.6%	0.5%	0.5%
PG&E WDG + NEM exports (GWh)		3,603	4,338	4,979	5,541	6,110
New WDG + NEM exports (GWh)			736	641	562	569
Share of new Gross Load served by new WDG + new NEM exports			40.2%	34.3%	29.5%	29.3%
PG&E NEM DG capacity plus WDG capacity serving local loads (MW)	2000 average MWh yield per MW DG capacity	1,801	2,169	2,490	2,770	3,055
PG&E Total WDG + NEM DG (MW)	Ratio of DG capacity serving local loads to total DG remains after 2025 is same as 2025: 57%	3,023	3,644	4,174	4,670	5,175
Total WDG + NEM DG added (MW)			621	530	496	505

Part 3b: DG deployment avoids transmission investment TAC fix Impact Model – sample scenario outputs

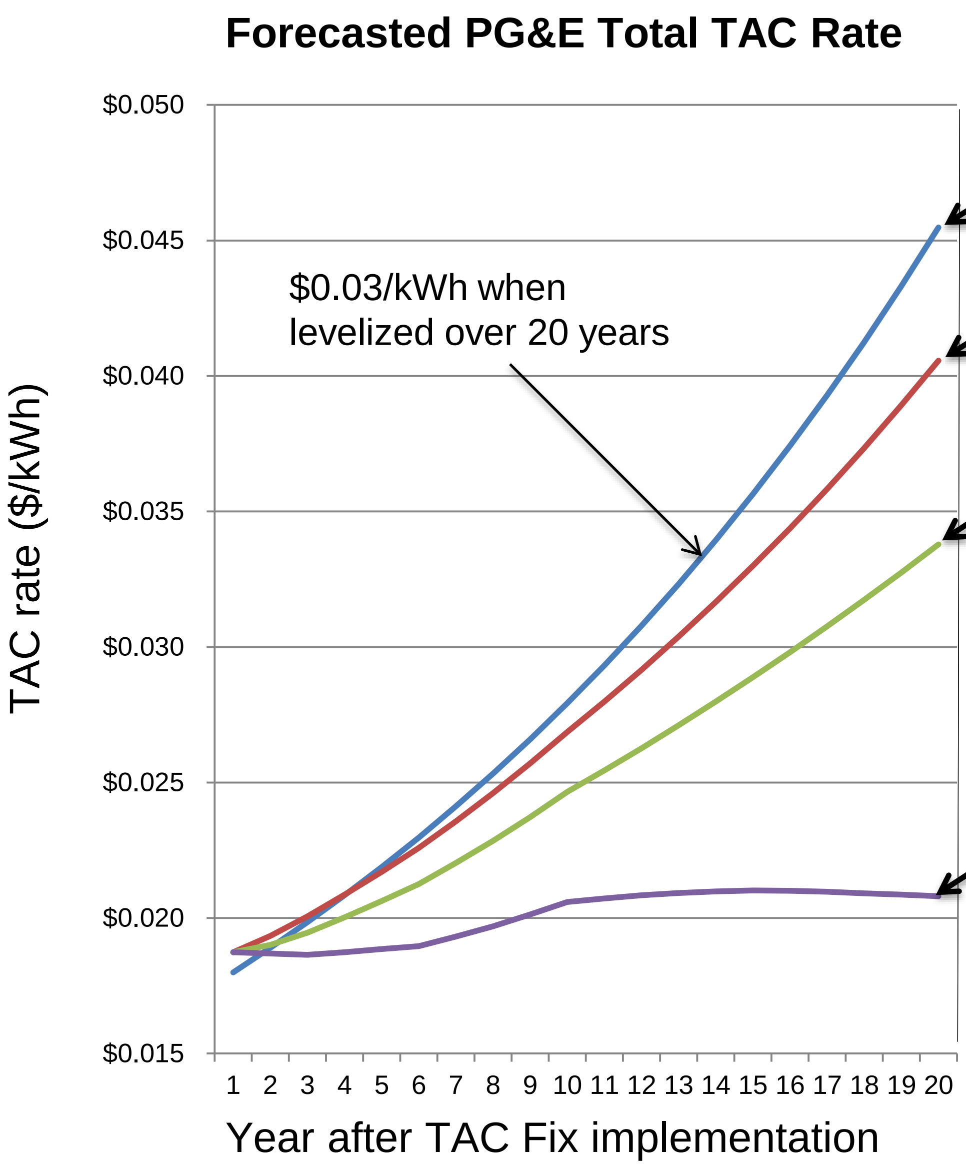
Clean Coalition

Cumulative Total TAC payments to CAISO ($ in billions)	Year 1	Year 20	Year 20 Change	Year 20 Change	Notes
Business As Usual (BAU)	$3.3	$135.8	$-	-	
Post-TAC fix Scenario 0: BAU with new billing determinant	$3.3	$128.4	$(7.5)	-6%	Change versus BAU
Post-TAC fix Scenario 1: Total DG added per year 1.5x of BAU	$3.3	$112.4	$(23.5)	-17%	Change versus BAU
Post-TAC fix Scenario 2: Total DG added per year 2x of BAU	$3.3	$97.4	$(38.5)	-28%	Change versus BAU
Post-TAC fix Scenario 3: Total DG added per year 3x of BAU	$3.3	$71.9	$(63.9)	-47%	Change versus BAU

CAISO peak load after additional WDG versus baseline (MW)	2016	2017	2018	2019	2020
Post-TAC fix Scenario 0: BAU with new billing determinant	49,243	49,392	49,542	49,692	49,843
Business As Usual (BAU)	49,243	49,392	49,542	49,692	49,843
Post-TAC fix Scenario 1: Total DG added per year 1.5x of BAU	49,243	49,200	49,185	49,187	49,191
Post-TAC fix Scenario 2: Total DG added per year 2x of BAU	49,243	49,008	48,827	48,682	48,539
Post-TAC fix Scenario 3: Total DG added per year 3x of BAU	49,243	48,823	48,334	47,891	47,450

Part 3b: DG deployment avoids transmission investment TAC fix
Ratepayers benefit from avoided transmission

Clean Coalition



TAC savings over 20 years:

BAU (results in 12.4% of load met by local renewables after 20 years)

$23.5 billion TAC savings vs BAU
(17.3% local renewables)

$38.5 billion TAC savings vs BAU
(22.2% local renewables)

$63.9 billion TAC savings vs BAU
(31.5% local renewables =

68.5% transmission connected resources which continue to support TRR for existing transmission

Clean Coalition

4. Policy rationales for TED-based TAC

Clean Coalition

FERC Principles require that transmission pricing:

1. ✓ Must meet the traditional revenue requirement
2. ✓ Must reflect comparability
3. ✓ Should promote economic efficiency
4. ✓ Should promote fairness
5. ✓ Should be practical

Courts and FERC require cost responsibility to track cost causation.

Clean Coalition

FERC Principle 1: Tradition Revenue Requirement is always guaranteed

- No change in the TRR reporting process
- No change in TRR
- No change in operations
- No change in TAC formula
- Only a change in *where* energy is measured

$$\text{HV TAC Rate} = \frac{\text{HV Transmission Revenue Requirement (costs associated with facilities operating >200kV)}}{\text{HV TED}}$$

FERC Principle 2: TED-based TAC facilitates comparability

- Does not create price incentives to use utility owned transmission resources
- Provides similar costs for customers for PTO and non-PTO utilities
- Puts sources on comparable footing with respect to delivery costs.

PART 4: Policy rationales for TED-based TAC

Clean Coalition

- FERC Principle 3: Promotes economic efficiency
  - Provides for cost effective procurement
    - Where DG is not cost effective, more transmission-sourced resources will be procured.
    - Where DG is more cost effective, less transmission-sourced resources will be procured.
  - Constrains on transmission costs growth
  - Distribution connected resources do not need transmission assets to serve customers
    - Reliability needs can be met with distribution-sourced assets
    - "Back up" for offline assets can be supplied by distribution resources for transmission connected assets
    - Ancillary services (frequency, etc.) are paid for separately from TAC

PART 4: Policy rationales for TED-based TAC

Clean Coalition

- FERC Principle 4: Promotes fairness
  - LSEs driving the need for transmission growth should contribute to paying for that growth.
  - Similarly situated customers should not face different disincentives for local power.
  - Ratepayers should be allowed to realize opportunities for savings from local resources.

Clean Coalition

- FERC Principle 5: should be practical
  - Municipal utilities already use TED as a WAC basis
  - TED-based TAC can be implemented with several options, including meters or accounting approaches

Clean Coalition

Use TED as the TAC billing determinant

Consistent, unbiased, and technology-neutral

PRINCIPLES

a. More accurate measurement of transmission usage
b. Cost allocation principles support it

IMPACTS

a. Reduces distortion on DER and creates market signal for resources that avoid the transmission grid
b. Results in avoided transmission investment and major ratepayer savings
c. DER reduces all 4 drivers of transmission investment

The TAC Fix is backed by a broad range of organizations

Clean Coalition

SolarCity
CALSEIA California Solar Energy Industries Association
Sierra Club California
Vote Solar
Sunrun
Center for Biological Diversity – Because life is good.
350 Bay Area
Solar Land Partners
Lean Energy US – Local Energy Aggregation Network
Center for Sustainable Energy
Sustainable Economies Law Center
UCLA Luskin School of Public Affairs – Luskin Center for Innovation
Enphase
the Energy Coalition – Generating Capital for Communities Through Energy
Efficient
Appraccel
BBL Solar Design & Consulting
California Alliance for Community Energy
Californians for Energy Choice
California Consumers Alliance
Carbon Free Mountain View
Carbon-Free Palo Alto – Advocates of carbon-free energy for Palo Alto, California
Berkeley Climate Action Coalition
CivicSolar
Commercial Solar Design
Community Choice Partners – Securing Your Community's Energy Future
Community Environmental Council
Community Renewable Solutions LLC – Reducing emissions. Saving money.
DGC Dynamic Grid Council
Earthwise Energy
East Bay Clean Power Alliance
eMotorWerks – Smart [Grid] EV Charging
Energy and Policy Institute
Environment California – Clean air. Clean water. Open spaces.
Fossil Free California
Foundation Windpower
Green Lynx, LLC – Environmentally Sound Solutions
ILSR Institute for Local Self-Reliance
ImMODO Energy Services Corporation
Integrated Resources Network
JTN Energy LLC
JKB Energy – Capturing the Power of Nature
Local Clean Energy Alliance
Local Power.
McCalmont Engineering
Menlo Spark
Microgrid Media
Mirasol Development LLC
MRC Microgrid Resources Coalition
nectarsolar
Nutter Consulting
The Offset Project
Pacific Environment
panel the planet
Photon Power – Solar. Everywhere.
Preserve Wild Santee
Pristine Sun
Promise Energy
Récolte Energy – www.recolteenergy.com
REP Energy
San Diego Energy District
SimplySolar
SkyCentrics
SLO Clean Energy – Your Power to Choose
SolAgra – Solar + Agriculture + Water Solutions
Solar Electric Solutions
Soltage – Renewable Energy Provider
Sustainable Silicon Valley
Sustainable
TeMix – Transactive Energy Services
TerraVerde Renewable Partners
Voltaic Capital Markets LLC
Yaskawa Solectria Solar
Solar Engineering Consultants

Additional Information

For more information on the TAC Campaign, visit www.clean-coalition.org/tac or email doug@clean-coalition.org