SCE Summer Discount Plan:
2017 Load Impact Evaluation

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SCE Summer Discount Plan (SDP) Program Description

- Summer Discount Plan (SDP) uses direct load control of central air conditioning to curtail residential and commercial load on event days

  - Participants earn bill credit during summer months based on which cycling option they select

  - SCE calls events by 'load control group' based on need; not all customers called for every event

- Residential program has 266,000* participants and offers two cycling strategies (50% and 100%)

  - 18 residential SDP events called in 2017

- Commercial program ("Commercial SDP") has 11,100* participants and offers three cycling strategies (30%, 50%, and 100%)

  - 15 Commercial SDP events called in 2017

Hours of Availability	2017 Hours of Actual Use	Available for Dispatch
180 hours annually	31.5	Reliability Events = Year Round 24/7 Economic Events = All Non-SCE Holiday Weekdays, up to 4 hours, no more than 3 consecutive days

* At the beginning of PY 2017

Ex Post Methodology

- Developed impact estimates using matched control group

  - Assembled two control groups: residential and commercial

  - Selected control groups using propensity score match to find customers with load shapes most similar to SDP customers on hot, non-event weekdays

  - Performed matching within specific customer segments (A Bank, CARE status, industry, etc.)

  - Used difference-in-difference fixed effects regression model which estimates the impact by subtracting differences between control and treatment customers on hot non-event days from differences between groups on event days

Residential Matched Control Group on Hot, Non-event Weekdays
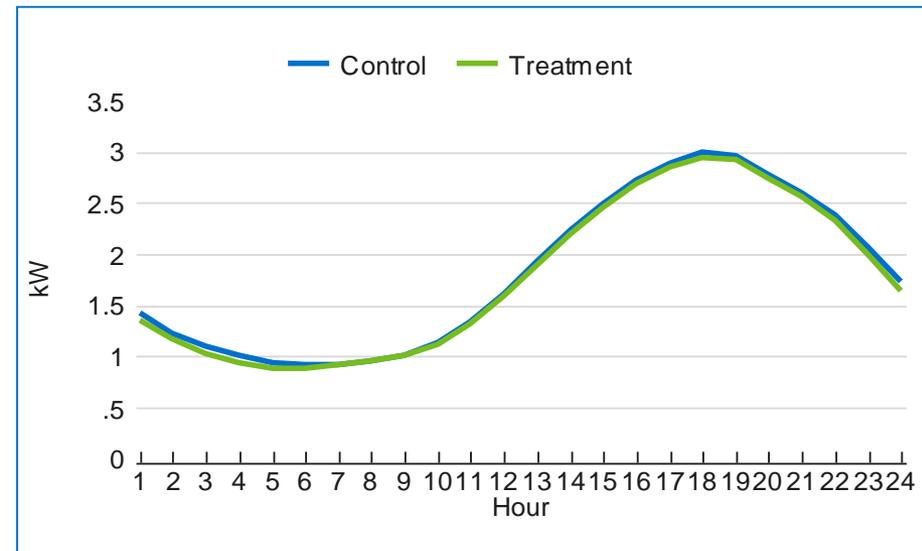
Ex Post Impacts – SCE & CAISO System Peak

- September 1, 2017 3 to 4 PM: 100.8 MW of total load reduction
  - 42.6k residential customers (C-4) and 4.4k commercial customers (C) called during this hour
  - Residential customers provided 73.6 MW
  - Commercial customers provided 27.2 MW
- Temperature reached 110°F

Ex Post Impacts (Residential)

Date	Load Control Groups Called	Event Participants	Event Start	Event End	Event Temp. (°F)	Reference Load (kW)	Observed Load (kW)	Impact (kW)	Percent Impact	Aggregate Impact (MW)
4/21/2017	Territory-wide	259,572	7:00 PM	8:00 PM	77.5	1.12	1.02	0.10	9.0%	26.1
4/24/2017	C1, C2, C3, C4, H, N, W	248,915	7:00 PM	8:00 PM	61.2	0.91	0.93	-0.02	-1.8%	-4.1
5/2/2017	Territory-wide	258,910	7:00 PM	8:00 PM	72.7	1.32	1.14	0.18	13.3%	45.3
5/3/2017	Territory-wide	258,818	7:00 PM	8:00 PM	73.7	1.47	1.23	0.25	16.8%	63.9
5/3/2017	Territory-wide	258,818	8:00 PM	9:17 PM	71.3	1.45	1.27	0.18	12.4%	46.6
5/22/2017	Territory-wide	257,861	7:00 PM	8:00 PM	75.0	1.68	1.34	0.33	19.8%	85.7
5/23/2017	C1, C2, C3, C4, H, W	215,946	7:00 PM	8:00 PM	74.4	1.60	1.29	0.31	19.4%	67.0
6/21/2017	Territory-wide	257,017	4:00 PM	8:00 PM	87.0	2.69	1.72	0.97	35.9%	248.4
6/22/2017	Territory-wide	256,912	5:00 PM	8:00 PM	79.1	2.15	1.49	0.65	30.5%	168.0
8/1/2017	C1, C3, C4, N, NW, W	210,849	5:00 PM	8:00 PM	84.2	2.52	1.81	0.71	28.1%	149.1
8/1/2017	C2, H	42,804	6:00 PM	8:00 PM	84.3	2.39	1.65	0.73	30.6%	31.3
8/2/2017	C2	26,813	6:00 PM	7:00 PM	83.7	2.46	1.61	0.85	34.5%	22.8
8/2/2017	NW	10,470	6:00 PM	8:00 PM	78.0	2.67	2.24	0.43	16.1%	4.5
8/28/2017	H, W	75,940	5:00 PM	8:00 PM	81.2	2.46	1.77	0.69	28.0%	52.2
8/28/2017	C1, C2, C3, C4, N, NW	177,314	6:00 PM	8:00 PM	91.0	3.35	2.26	1.09	32.6%	193.6
8/31/2017	C3, C4	75,144	2:52 PM	5:15 PM	89.3	3.43	2.05	1.38	40.2%	103.6
9/1/2017	C4	42,660	2:49 PM	8:31 PM	100.0	3.76	2.30	1.46	38.8%	62.3
9/1/2017	C1, C2, C3, H, N, NW, W	210,249	3:41 PM	8:31 PM	94.2	3.17	2.19	0.98	30.9%	206.0

- SCE called territory-wide and specific load control group events: Dispatched customers ranged from about 10k to about 250k

- Aggregate impacts peaked at 248 MW on June 21

Residential Ex Post- June 21 4 – 8 PM by Load Control Group

- Group C-3 experienced the highest event temperature and provided one of the greatest percent impacts

- Groups NW and W had cooler event temperatures and the smallest per-customer impacts

- Group C-4 had the greatest percent and aggregate impacts

Load Control Group	Customers	Event Temperature	Observed Load (kW)	Reference Load (kW)	Impact (kW)	Aggregate Impact (MW)	Percent Impact
C-1	35,149	92	2.06	3.22	1.16	40.8	36%
C-2	27,074	84	1.51	2.49	0.98	26.4	39%
C-3	32,854	100	1.97	3.24	1.27	41.7	39%
C-4	43,394	93	1.82	3.10	1.28	55.5	41%
H	16,265	92	1.57	2.45	0.87	14.2	36%
N	31,038	95	2.14	3.29	1.15	35.6	35%
NW	10,548	75	1.85	2.34	0.49	5.2	21%
W	60,695	71	1.22	1.71	0.49	29.5	28%
All Load Control Groups	**257,017**	**87**	**1.72**	**2.69**	**0.97**	**248.4**	**36%**

Ex Post Impacts (Commercial)

- SCE called territory-wide and specific load control group events: Dispatched customers ranged from less than 1k to nearly 11k

- Aggregate impacts ranged from less than 1 MW to about 27 MW

Date	Load Control Groups Called	Event Participants	Event Start	Event End	Event Temp. (°F)	Reference Load (kW)	Observed Load (kW)	Impact (kW)	Percent Impact	Aggregate Impact (MW)
4/21/2017	Territory-wide	10,686	7:00 PM	8:00 PM	79.3	17.30	16.55	0.75	4.4%	8.0
4/24/2017	C, H, N, W	9,538	7:00 PM	8:00 PM	62.9	16.14	15.40	0.75	4.6%	7.1
5/2/2017	Territory-wide	10,713	7:00 PM	8:00 PM	74.2	18.39	17.36	1.03	5.6%	11.0
5/3/2017	W	4,034	7:00 PM	8:00 PM	68.8	18.40	17.98	0.42	2.3%	1.7
5/3/2017	C, H, N, NW	6,250	7:00 PM	9:00 PM	76.3	18.78	18.21	0.57	3.0%	3.6
5/3/2017	W	4,034	8:00 PM	9:00 PM	66.5	17.40	17.21	0.20	1.1%	0.8
6/21/2017	Territory-wide	10,691	4:00 PM	8:00 PM	85.9	18.49	16.77	1.72	9.3%	18.4
6/22/2017	NW	701	5:00 PM	8:00 PM	67.9	13.57	12.88	0.68	5.0%	0.5
6/22/2017	C, H, N, W	9,563	6:00 PM	8:00 PM	77.7	16.62	15.34	1.29	7.7%	12.3
8/1/2017	Territory-wide	10,519	6:00 PM	8:00 PM	83.3	17.01	15.85	1.16	6.8%	12.2
8/2/2017	Territory-wide	10,696	5:00 PM	8:00 PM	85.2	19.67	18.30	1.37	7.0%	14.6
8/28/2017	Territory-wide	10,480	5:00 PM	8:00 PM	88.6	21.79	19.20	2.59	11.9%	27.1
8/31/2017	C	4,362	2:49 PM	5:00 PM	96.6	33.75	28.37	5.38	15.9%	23.5
9/1/2017	C	4,392	2:50 PM	9:00 PM	101.2	26.26	23.12	3.14	12.0%	13.8
9/1/2017	H, N, NW, W	5,738	3:41 PM	9:00 PM	91.0	23.85	21.78	2.07	8.7%	11.9

More Events During School Year Contributed to Higher Commercial Ex Post Results

- Schools account for 65% of AC tonnage in Commercial SDP

- In 2016, SCE called most events in June and July (not during the school year). SCE called more school-year events in 2017

- Average impact per school increased from 3 kW for the 2016 territory wide event to 8.7 kW for the August 28, 2017 territory wide event

| Industry	Number of Customers	% of Customers	AC Tonnage	% of AC Tonnage
Agriculture, Mining & Construction	281	3%	2,672	1%
Manufacturing	696	6%	9,631	2%
Wholesale, Transport & Other Utilities	739	7%	9,349	2%
Retail Stores	1,923	17%	18,383	4%
Offices, Hotels, Finance, Services	3,117	28%	31,829	7%
Schools	1,967	18%	295,787	65%
Institutional/Government	2,416	22%	84,396	19%
All	**11,139**	**100%**	**452,047**	**100%**

Ex Ante Methodology

Ex ante estimates are developed using a multi-step process:

1) Developed ex post estimates for 2017 using a matched control group

2) Estimated regression models that relate 2016 and 2017 ex post load impacts in each hour from 4 to 8 PM to average temperatures from midnight to hour of interest (e.g. "Mean17," etc.) on event day

   ➢ **Commercial customers**: estimated separate models for each AC cycling strategy, hour, and demand category

   ➢ **Residential customers:** estimated separate models for each AC cycling strategy and hour

3) Use regression model output to predict hourly impacts on monthly system peak days and a typical event day under ex ante weather conditions

4) Used similar method to estimate reference loads

5) Adjusted ex ante impact estimates to apply to RA window: 1 to 6 PM for summer and 4 to 9 PM for winter

Ex Ante Methodology

- Scatterplot illustrates ex ante model for residential customers (ex post impacts vs. *Mean17*)

- Ex ante modeling dataset includes population-weighted impact estimates for each LCG

Graphs by cycling
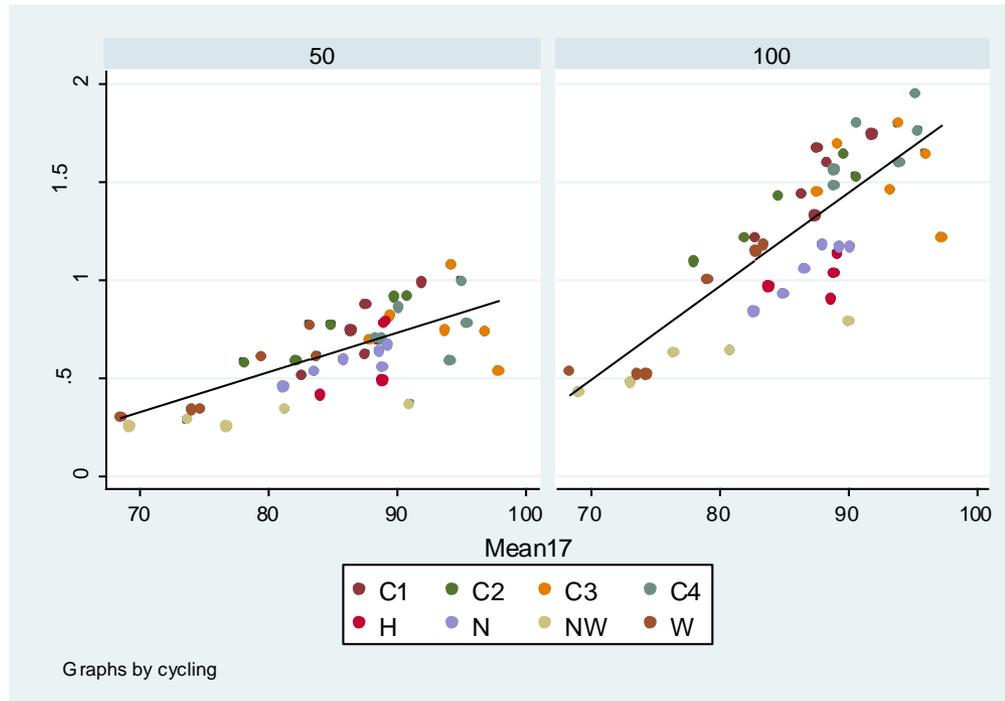
Residential and commercial enrollment expected to decline gradually from 2018 - 2028

- Residential enrollments: decrease from 235k to 132k

- Commercial enrollments: decrease from 10.1k to 7.1k

- Reasons for decline

  - A group of non-performers will be removed from program

  - Program incentives are being reduced by 10% in 2018
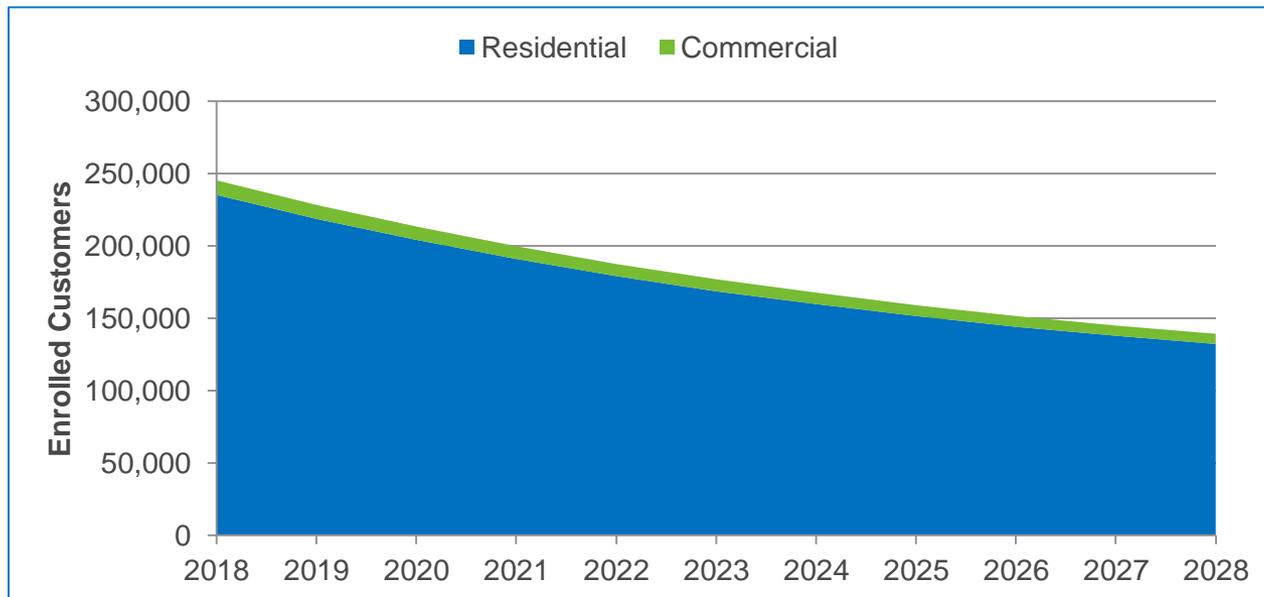
# Ex Ante Impacts (August System Peak, 1-in-2 SCE Weather)

- Assumption: per-customer impacts remain constant from year to year

- Aggregate impacts gradually decrease from 2018 to 2028 due to decrease in enrollment

- Expected impacts are similar under CAISO weather conditions, and slightly higher under 1-in-10 weather year conditions

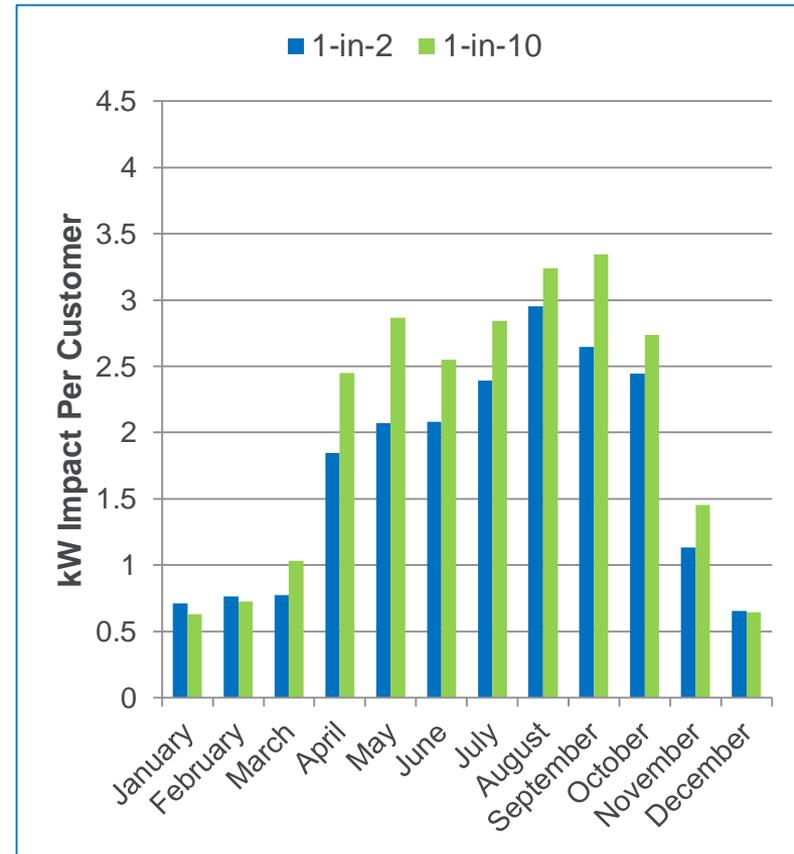| Group	Program Year	Enrollment	kW Impact per Customer	Aggregate MW Impact
Commercial	2017 Ex Post	10,480	2.6	27
	2018	10,116	3.0	30
	2019	9,601	3.0	28
	2028	7,055	3.0	21
Residential	2017 Ex Post	257,017	1.0	248
	2018	235,310	0.8	198
	2019	218,629	0.8	184
	2028	132,089	0.8	111
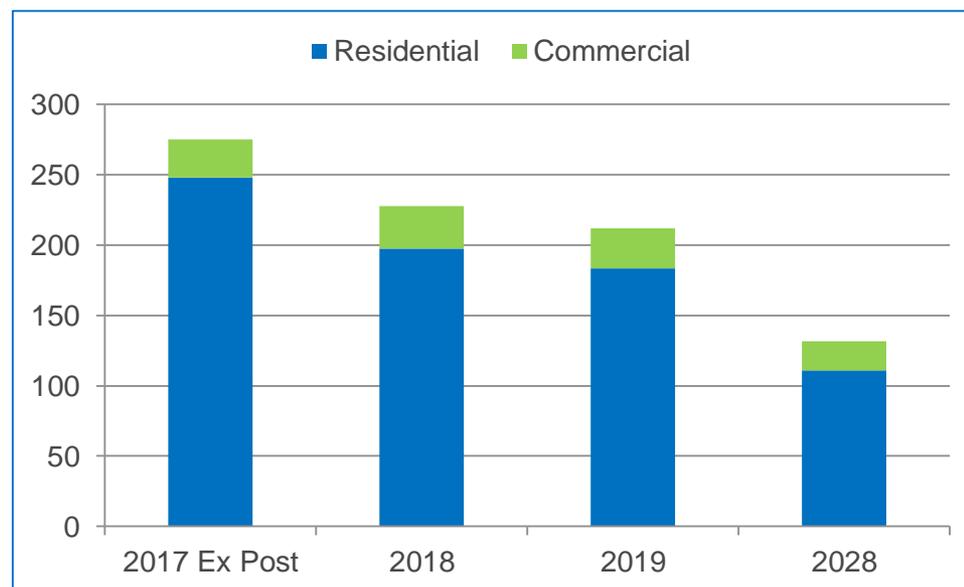
Ex Ante Impacts

- Residential results: SCE weather
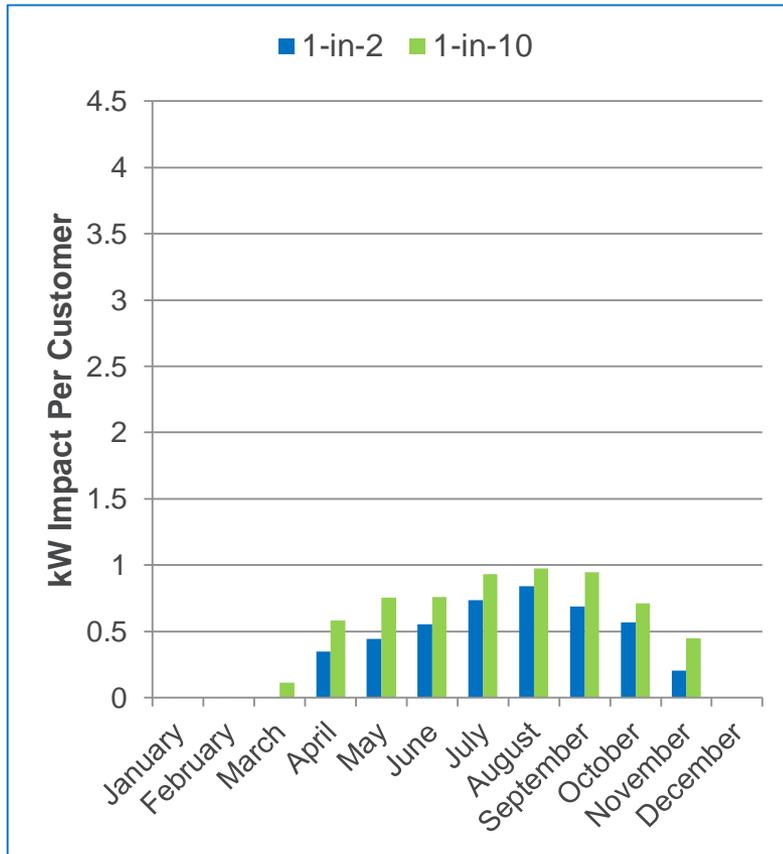
- Commercial results: SCE weather

Comparison to 2016 Evaluation Estimates – August 2018 Ex Ante Forecast SCE 1-in-2 Monthly Peak

Residential

Evaluation Year	Per-Customer Impact (kW)	Aggregate Impact (MW)	Customers Enrolled	Mean17
2016	0.82	202	246,682	81.5
2017	0.84	198	235,310	81.5

Commercial

Evaluation Year	Per-Customer Impact (kW)	Aggregate Impact (MW)	Customers Enrolled	Mean17
2016	3.50	34	9,747	79.9
2017	2.95	30	10,116	79.9

Recommendations

- SCE should continue to call events during and outside of the school year
  - Schools provided greatest aggregate impact for commercial SDP events
  - Having both will allow load impacts to be estimated under both "school in session" and "school out of session" conditions
- Call SDP events during RA window to provide important data points for estimating ex ante impacts
- Develop ex ante for likely dispatch hours in addition to RA window
  - Likely to be dispatched 7-9 PM, RA window 1-6 PM
- Continue to call SDP under a variety of weather conditions

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