DOCKETED

Docket Number:	20-FDAS-01
Project Title:	Flexible Demand Appliance Standards
TN #:	240203
Document Title:	WattTime Corporation Comments - on FDAS RFI
Description:	N/A
Filer:	System
Organization:	WattTime Corporation
Submitter Role:	Public
Submission Date:	11/1/2021 4:28:32 PM
Docketed Date:	11/1/2021

Comment Received From: WattTime Corporation
Submitted On: 11/1/2021
Docket Number: 20-FDAS-01

WattTime FDAS RFI Comments

Additional submitted attachment is included below.

Date: November 1, 2021

Via e-filing

California Energy Commission
Dockets Office, MS-4
Docket No. 20-FDAS-01
1516 Ninth Street
Sacramento, CA 95814-5512

Comments on the 'Request for Information Flexible Demand Standards' document

WattTime applauds the California Energy Commissions for establishing load flexibility standards for appliances with a focus on greenhouse gas (GHG) emissions. WattTime supports this goal of maximizing the potential of flexible appliances to reduce GHGs and appreciates the opportunity to comment on the program design and evaluation methods.

To achieve this goal, WattTime recommends that the flexible demand capability standard for appliances should be based on automation to respond to a real time marginal GHG signal that can vary every 5 minutes, as well as other signals like price. This is key to maximizing the potential of load flexibility as the emissions intensity of electricity delivered at a specific time and place can vary significantly every 5 minutes depending on the marginal resource. In addition, WattTime submits the following comments for consideration by the CEC to advance this goal:

I. Proposed amendment should be evaluated for its effectiveness in reducing GHGs

Senate Bill No. 49 requires the California Energy Commission (CEC) to facilitate the deployment of flexible demand technologies, as specified, and would require that those standards be cost effective and based on "feasible and attainable efficiencies or feasible improvements that will enable appliance operations to be scheduled, shifted, or curtailed **to reduce emissions of greenhouse gases associated with electricity generation.**" [Section 25402 (c)(1)(A) of the CA Public Resources Code]

SB 49 is unequivocal that the central purpose of the flexible demand appliance standards is to reduce GHG emissions from electricity. As a result, any proposal under this rulemaking should primarily be evaluated on whether the standards can effectively maximize GHG reduction.

II. Load shift calculation methodology should be based on more than TOU windows

In the 'Request for Information Flexible Demand Standards' document, the California Energy Commission proposes to, *".... estimate the flexible demand capability of appliances based on the current time of use (TOU) electricity rates by the five major load serving entities (LSEs)… Staff plans to calculate the daily load shift capability of each appliance as a consumer's reaction to utility price changes between off-peak and on-peak charges using time-of-use rates. "*

What comments are there on this approach to estimating flexible demand capability?

It should be noted that the stated purpose of the Rulemaking is to adopt regulations establishing standards and labeling requirements for appliances that promote flexible demand technologies, which can schedule, shift, or curtail electric demand of appliances, in order to reduce the greenhouse gases (GHGs) emitted in electricity generation.

However, TOU windows stretch to around 2-6 hours, which does not reflect the full variability in emissions over a single day. These hours-long periods are of insufficient granularity to capture the full variation in grid emissions (and price) that occur regularly. Instead of TOU periods, the use of a dynamic, real-time marginal emissions would help achieve the purpose of SB 49 more effectively. As can be seen in figure 1, the more granular and more real-time the emissions signals used to control flexible load, the greater the emissions reduction potential. This is due to the fine-grained variation in grid emissions that is not captured in less granular signals. Figure 1 compares the savings achieved with a flexible load under ideal conditions—5 minute granularity and real-time control—to less granular signals.

CAISO	realtime	monthly	seasonaly	annually
5min	100%	72%	67%	58%
15min	97%	71%	67%	58%
1hr	89%	68%	65%	55%
3hr	73%	59%	57%	51%
8hr	29%	26%	26%	24%

Figure 1: Flexible load savings using different signal granularities and update frequencies

What other methods are there to estimate the flexible demand capability of appliances that better account for the range of benefits enabled?

WattTime recommends evaluating more granular and dynamic load flexibility in response to active control signal, including GHG grid signals and real-time prices, in addition to evaluating load flexibility responding to a TOU signal.

Marginal emission rates measure the change in emissions caused by additional electricity demand at a particular time and location. The emissions intensity of electricity delivered at a specific time and place can vary widely. Every 5 minutes, the power plant supplying that additional electricity can change; resulting in a change of emissions intensity. The real-world emissions impact of a particular change in load, for example when a dishwasher is turned on, can be determined using these time-varying marginal emissions rates.

A more granular emissions signal can be co-optimized with a TOU rate to achieve further emissions savings. While TOU rates reflect the broad strokes of grid costs and emissions, the grid changes substantially more frequently than the periods indicated in TOU rates. Instead of limiting load shifting between on-peak and off-peak hours, the standard should allow for selective shifting within a TOU window, as this would achieve additional GHG savings. Because of the broad TOU windows, these GHG savings can be realized without negatively affecting customer bills, as can be seen in figure 2. This capability should be included in the load shift calculation methodology to determine potential savings because using TOU rates as the only signal to control loads artificially limits the potential value of flexibility. This more granular flexibility will be essential in integrating higher level of variable renewables and achieving a carbon free grid.

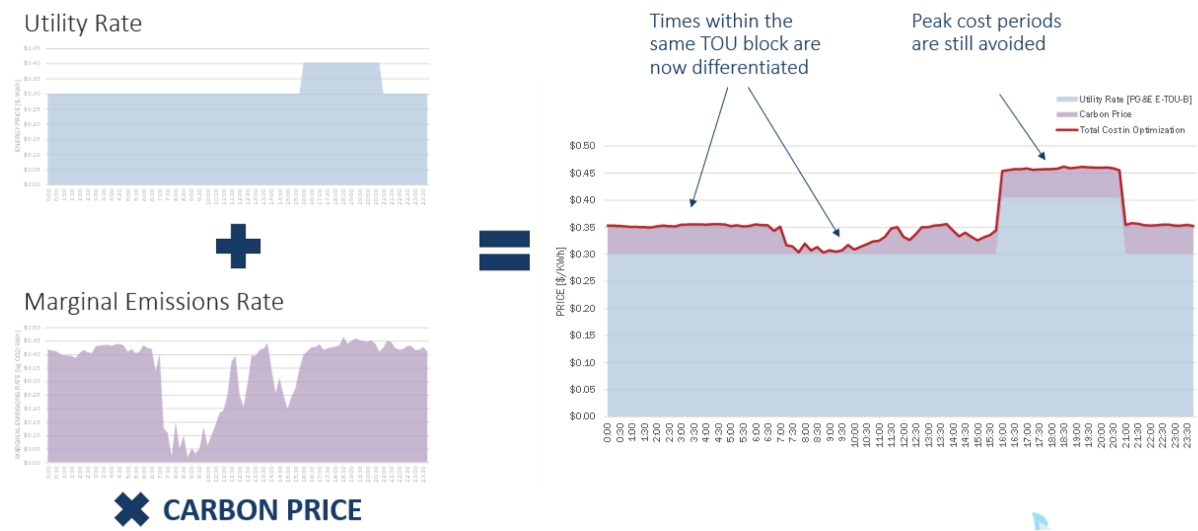

Figure 2: Combining static TOU rates with dynamic emissions signals

A more granular emissions signal provides greater opportunity for emissions reduction because the greater variability in the emissions rate allows more frequent emissions arbitrage between low and high emissions periods.

III. Change the GHG emissions calculation methodology to use marginal emissions rates

"*From the data in Table 7, staff plans to estimate changes in GHG emissions due to flexible demand capability of appliances through use of hourly average emission intensity projections through 2033*."

What other methods are there to estimate changes in GHG emissions from demand flexibility of appliances?

WattTime recommends using marginal emissions factors to accurately estimate the effect and benefit of load flexibility. A marginal emissions evaluation approach better reflects how the grid responds to a change in demand compared to an average emissions factor.

The marginal emission factor captures the effect of a change in load by capturing which resources would respond to that change in load. For example, even if nuclear, solar and wind are operating during a peak demand period, if load flex moves demand away from that period, the most expensive dirty resources will ramp down, not the clean resources. Conversely, during a period when solar is being curtailed, increasing demand will allow less of the solar power to be thrown away by consuming it, even if fossil resources are operating. An average emissions rate does not accurately capture the emissions effect of load flexibility. An average emission factor includes all resources on the grid, including nuclear and other clean generators that may not respond to a change in demand.

What forecasts for hourly average GHG emissions intensity are available?
For distributed energy resource evaluation, the CPUC publishes the Avoided Cost Calculator every year. While primarily intended for evaluating a variety of benefits distributed resource and demand response, **the Avoided Cost Calculator (ACC) does include detailed projections of future marginal emissions for the electric grid in California. Hourly marginal emissions factors in the 2021 ACC can be under 'Emissions' tab in the '2021 ACC Electric Model v1b'. The CEC should use this reliable source of marginal emissions data to evaluate the emissions benefit of load flexibility.**

The ACC undergoes extensive development and undergoes an open and public review process feedback to ensure it captures future grid dynamics effectively. The ACC "is closely aligned with the grid planning efforts of the Integrated Resource Planning (R. 16-02-007) and Distributed Resource Plan (R. 14-08-013) proceedings" and uses capacity planning and energy price projections to estimate grid conditions.

California's Self Generation Incentive Program has already enabled emissions-optimization for charge/discharge cycles of energy storage systems based on a real-time GHG signal with 5-minute granularity and 72-hour forecasts for integration into control systems. This signal enables energy storage systems to co-optimize for both emissions and revenue and ensure they are in compliance with the program requirements. Details on the signal can be found at sgipsignal.com. This signal is based on the ACC.

For long-term projections on changes in GHG emissions due to load shifting, will estimates of hourly marginal emissions or hourly system average emissions be the best metric?
The projections of future marginal grid emissions anticipate considerable solar curtailment. This zero emissions electricity will be wasted unless load flexibility opportunities like the FDAS take advantage of it. The charts below show monthly and hourly projections of marginal emissions, excerpted from the 2021 Avoided Cost Calculator.

Hour		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	0	0.33	0.28	0.16	0.04	0.09	0.16	0.13	0.29	0.33	0.39	0.31	0.29
	1	0.27	0.27	0.16	0.11	0.10	0.18	0.11	0.28	0.31	0.31	0.37	0.28
	2	0.28	0.28	0.19	0.06	0.19	0.17	0.20	0.27	0.33	0.30	0.30	0.27
	3	0.29	0.28	0.18	0.09	0.10	0.23	0.13	0.29	0.34	0.34	0.30	0.28
	4	0.29	0.27	0.19	0.15	0.13	0.18	0.12	0.29	0.34	0.39	0.31	0.28
	5	0.29	0.31	0.30	0.26	0.25	0.24	0.25	0.30	0.34	0.32	0.36	0.38
	6	0.34	0.30	0.42	0.22	0.26	0.24	0.32	0.28	0.33	0.33	0.33	0.33
	7	0.34	0.31	0.27	0.24	0.16	0.27	0.31	0.25	0.28	0.28	0.32	0.33
	8	0.28	0.30	0.23	0.13	0.17	0.37	0.27	0.24	0.26	0.26	0.28	0.31
	9	0.29	0.26	0.21	0.10	0.19	0.35	0.32	0.24	0.26	0.27	0.30	0.31
	10	0.27	0.21	0.22	0.13	0.19	0.31	0.41	0.26	0.25	0.24	0.24	0.30
	11	0.25	0.23	0.18	0.13	0.17	0.37	0.36	0.60	0.26	0.26	0.29	0.36
	12	0.29	0.24	0.15	0.11	0.16	0.42	0.40	0.38	0.29	0.27	0.24	0.27
	13	0.25	0.23	0.16	0.10	0.16	0.47	0.46	0.42	0.27	0.27	0.28	0.34
	14	0.25	0.26	0.24	0.09	0.20	0.47	0.43	0.41	0.29	0.55	0.27	0.28
	15	0.27	0.38	0.35	0.17	0.37	0.41	0.58	0.42	0.36	0.37	0.66	0.29
	16	0.61	0.38	0.58	0.68	0.55	0.39	0.53	0.41	0.64	0.47	0.61	0.43
	17	0.43	0.45	0.44	0.56	0.53	0.45	0.53	0.48	0.56	0.49	0.46	0.41
	18	0.58	0.52	0.54	0.43	0.56	0.51	0.53	0.77	0.94	0.64	0.52	0.44
	19	0.47	0.59	0.63	0.60	0.69	0.62	0.64	0.57	0.61	0.37	0.48	0.47
	20	0.45	0.50	0.51	0.58	0.44	0.37	0.38	0.36	0.43	0.34	0.43	0.45
	21	0.37	0.43	0.28	0.23	0.11	0.23	0.26	0.29	0.33	0.32	0.38	0.39
	22	0.32	0.34	0.20	0.11	0.09	0.17	0.16	0.27	0.30	0.30	0.35	0.33
	23	0.30	0.29	0.17	0.16	0.07	0.13	0.11	0.29	0.30	0.32	0.32	0.30

Figure 3: 2022 Marginal Emissions Rates (tonnes CO2/MWh)

Hour	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.31	0.31	0.24	0.22	0.09	0.27	0.04	0.31	0.31	0.31	0.35	0.39
1	0.31	0.25	0.25	0.14	0.12	0.18	0.12	0.27	0.29	0.30	0.32	0.36
2	0.30	0.25	0.25	0.16	0.19	0.13	0.19	0.27	0.29	0.30	0.30	0.33
3	0.29	0.25	0.21	0.18	0.12	0.14	0.16	0.28	0.29	0.30	0.30	0.34
4	0.30	0.25	0.24	0.23	0.13	0.10	0.20	0.29	0.31	0.31	0.31	0.35
5	0.32	0.30	0.35	0.26	0.21	0.19	0.27	0.35	0.42	0.42	0.36	0.38
6	0.40	0.42	0.48	0.19	0.09	0.19	0.20	0.25	0.32	0.41	0.42	0.40
7	0.43	0.35	0.20	0.02	0.01	0.08	0.05	0.16	0.18	0.26	0.33	0.41
8	0.35	0.21	0.11	0.02	0.01	0.05	0.02	0.12	0.10	0.16	0.21	0.40
9	0.27	0.12	0.08	0.00	0.01	0.04	0.04	0.10	0.12	0.17	0.21	0.33
10	0.30	0.10	0.04	0.00	0.00	0.05	0.03	0.13	0.08	0.11	0.17	0.28
11	0.27	0.16	0.06	0.00	0.02	0.05	0.04	0.14	0.11	0.11	0.10	0.25
12	0.28	0.14	0.05	0.00	0.01	0.14	0.06	0.17	0.13	0.12	0.13	0.33
13	0.27	0.14	0.03	0.00	0.01	0.15	0.05	0.19	0.16	0.14	0.13	0.24
14	0.25	0.15	0.13	0.00	0.01	0.24	0.09	0.31	0.20	0.15	0.14	0.44
15	0.26	0.12	0.05	0.00	0.05	0.39	0.21	0.33	0.25	0.25	0.22	0.39
16	0.54	0.24	0.23	0.07	0.44	0.41	0.49	0.45	0.49	0.69	0.69	0.80
17	0.59	0.56	0.41	0.26	0.44	0.47	0.53	0.58	0.69	0.77	0.71	0.61
18	0.61	0.58	0.64	0.58	0.51	0.57	0.80	0.95	1.14	0.76	0.65	0.58
19	0.59	0.53	0.76	0.74	0.73	0.96	1.09	1.00	0.75	0.53	0.59	0.57
20	0.58	0.59	0.49	0.51	0.62	0.72	0.85	0.54	0.49	0.48	0.50	0.53
21	0.53	0.41	0.40	0.26	0.31	0.39	0.50	0.37	0.41	0.36	0.48	0.47
22	0.39	0.34	0.29	0.15	0.15	0.30	0.17	0.31	0.34	0.38	0.37	0.38
23	0.34	0.31	0.24	0.12	0.05	0.20	0.04	0.30	0.32	0.32	0.35	0.40

Figure 4: 2025 Marginal Emissions Rates (tonnes CO_2/MWh)

Hour	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.36	0.35	0.38	0.19	0.24	0.27	0.31	0.31	0.32	0.35	0.33	0.30
1	0.32	0.33	0.25	0.24	0.16	0.20	0.19	0.27	0.31	0.31	0.34	0.33
2	0.31	0.29	0.28	0.18	0.14	0.22	0.24	0.32	0.34	0.30	0.34	0.35
3	0.30	0.30	0.28	0.11	0.16	0.21	0.12	0.29	0.36	0.31	0.38	0.29
4	0.29	0.30	0.30	0.34	0.15	0.26	0.22	0.29	0.39	0.32	0.30	0.30
5	0.35	0.31	0.36	0.21	0.23	0.31	0.19	0.30	0.35	0.35	0.33	0.40
6	0.35	0.42	0.46	0.27	0.30	0.36	0.24	0.26	0.31	0.36	0.43	0.38
7	0.35	0.34	0.25	0.09	0.03	0.13	0.12	0.20	0.21	0.26	0.29	0.38
8	0.30	0.25	0.12	0.00	0.00	0.11	0.02	0.15	0.14	0.19	0.19	0.31
9	0.26	0.16	0.06	0.00	0.01	0.05	0.03	0.14	0.15	0.16	0.15	0.26
10	0.27	0.17	0.05	0.00	0.00	0.03	0.01	0.12	0.08	0.13	0.11	0.26
11	0.23	0.13	0.04	0.00	0.01	0.04	0.02	0.14	0.09	0.12	0.10	0.23
12	0.23	0.11	0.02	0.09	0.03	0.05	0.03	0.22	0.12	0.12	0.11	0.21
13	0.23	0.16	0.03	0.00	0.02	0.08	0.06	0.22	0.16	0.15	0.12	0.21
14	0.23	0.14	0.03	0.01	0.02	0.12	0.12	0.27	0.21	0.25	0.16	0.22
15	0.36	0.17	0.08	0.10	0.09	0.26	0.24	0.31	0.26	0.44	0.32	0.35
16	0.67	0.37	0.29	0.07	0.20	0.40	0.42	0.32	0.41	0.47	0.47	0.82
17	0.82	0.63	0.52	0.32	0.40	0.51	0.52	0.52	0.81	0.82	0.52	0.48
18	0.43	0.49	0.80	0.66	0.44	0.68	0.68	1.33	1.30	0.69	0.53	0.62
19	0.35	0.43	0.93	0.90	0.82	0.91	1.13	1.09	0.58	0.46	0.54	0.44
20	0.37	0.44	0.61	0.49	0.57	0.70	0.73	0.39	0.41	0.49	0.72	0.52
21	0.49	0.57	0.45	0.23	0.40	0.42	0.47	0.35	0.47	0.36	0.47	0.40
22	0.47	0.42	0.28	0.14	0.29	0.32	0.33	0.30	0.33	0.35	0.32	0.32
23	0.33	0.33	0.30	0.13	0.20	0.27	0.24	0.28	0.30	0.31	0.37	0.31

Figure 5: 2030 Marginal Emissions Rates (tonnes CO_2/MWh)

As can be seen the figure 3, in 2022 curtailment is still clustered primarily during spring days, but as more resources are built out in 2025 (figure 4), curtailment extends later into the summer. By 2030 (figure 5), curtailment is anticipated deep into winter as well. These charts illustrate both, that there is increasing variability in emissions rate anticipated as well as significant value for load flexibility to reduce emissions. The CEC should consider requiring devices to shift load based on a granular marginal emissions signal.

Submitted by

Henry Richardson
WattTime
1901 Harrison St.
Suite 200
Oakland, CA 94612
Email: henry@watttime.org