Transactive Energy :
Party-to-Party Tenders and Transactions

Energy Interoperation
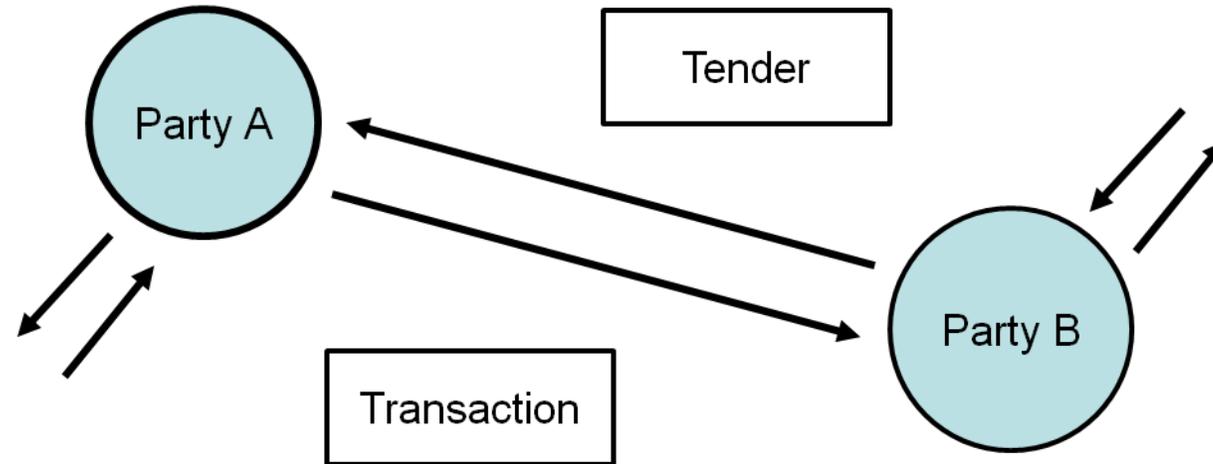
Tender: **CreateTender and GetTender** – A tender is an offer to buy or sell at a price a quantity of Product at an Interface over a time interval.

Transaction: **CreateTransaction and GetTransaction** – A transaction is the acceptance of all or a portion of a binding tender.

Position: **GetPosition** – the net quantity and extended price of all transactions of a Product at an Interface over a time interval

Delivery: **CreateDelivery and GetDelivery** – A meter reading for a Product at an Interface over a time interval.

Tender	Transaction	Delivery
{"tenderID": 187714951, "agreementID": 372 "partyID":2, "start": "2019-02-19T10:00:00Z" "durationID": 8 "side": "Sell", "type": "Binding", "price": "17.91", "quantity": 12.10, "expDate": "2019-02-19T09:55:00Z", "postDate": "2019-09-19T09:00:00Z"}	{"transactionID": 613756, "tenderID": 187714951 "quantity": 6.20, "postDate": "2019-03-19T09:54:00Z"}	{"deliveryID": 2744962, "meterID": 17 "start": "2019-02-19T10:00:00Z" "durationID": 4 "sourceID": "dist operator", "quantity": 13.20, "postDate": "2019-02-19T10:06:00Z}

Market Context
service conveys Agreement, Party, Interface, Product, Side and Interval Duration information.

AgreementID: From PartyID, ToPartyID, InterfaceID, ProductID
ProductID: Energy, Reactive Energy, Transport
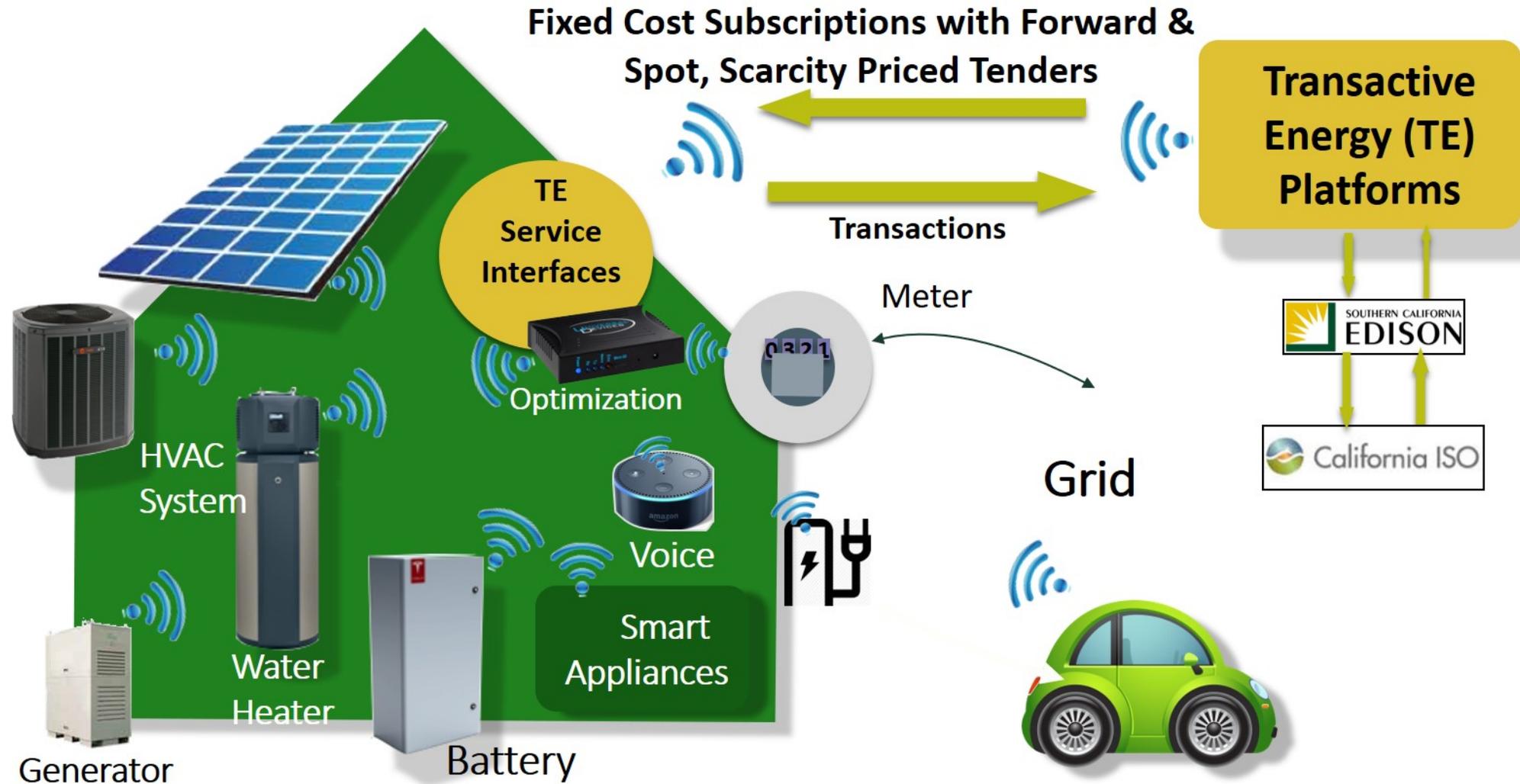**InterfaceID :** Facility Interface to the Grid
Side: "Buy"/"Sell"

| DurationId:	
1 : 4-sec	6: 15-min
2 : 6-sec	7: 30-min
3 : one-min	8: hour
4 : 5-min	9: day
5 : 10-min	10: month
	11: year

openADR ALLIANCE

Retail Automated Transactive Energy System (RATES)
One example application of the TE Protocols

RATES Can Reduce Costs of Meeting California's 2045 100% Clean Energy, Electrification, and GHG Goals

by

Enabling Retail Customers to Self-Manage, Shape, and Shift Electricity Use, Storage, and Supply

so that

Net Electricity Usage Better Follows Variable Solar & Wind Generation

using

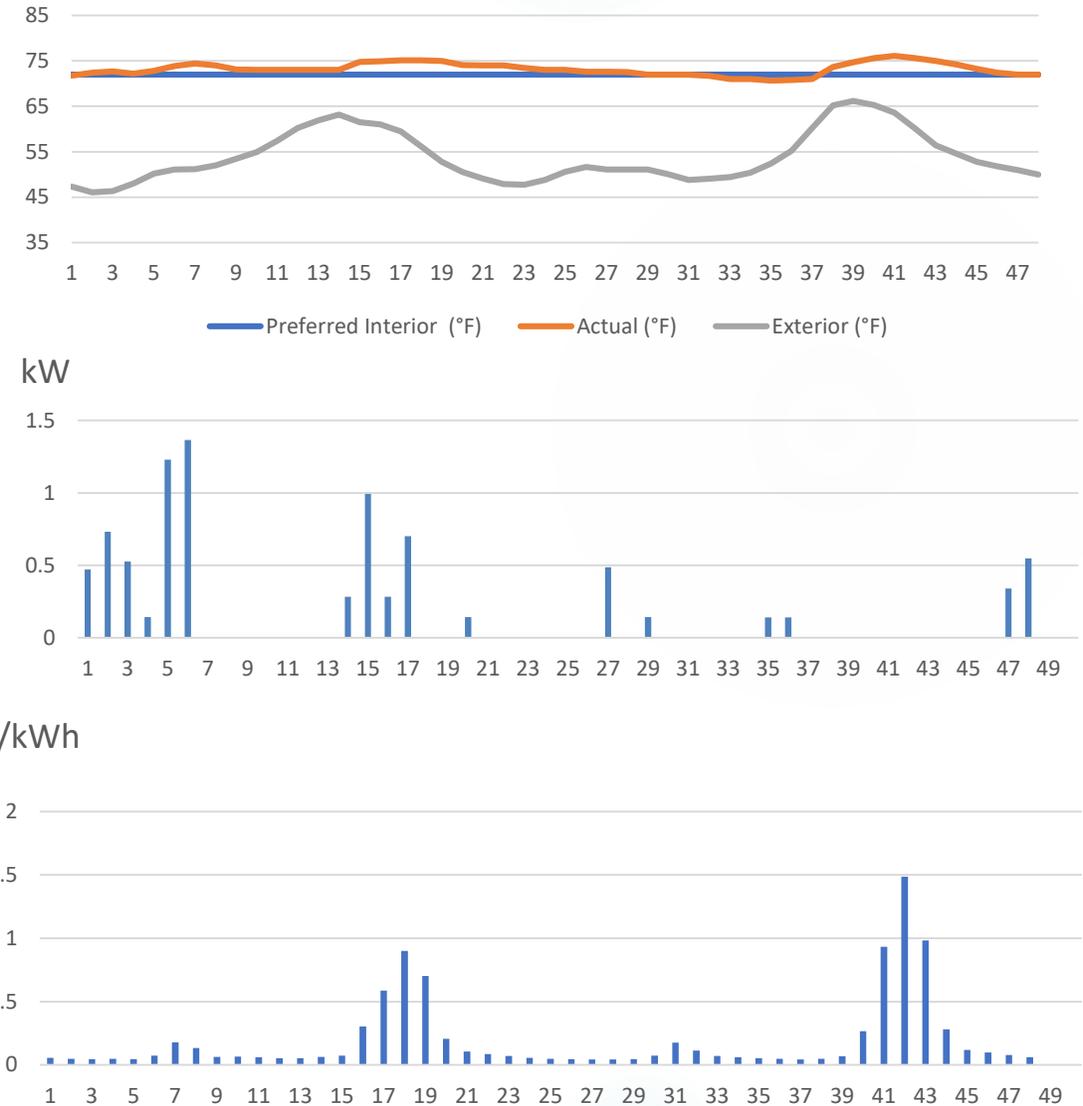IoT + Subscription Transactive Tariffs + Transactive Energy Platforms

Fixed Cost Subscriptions Stabilize Customer Electric Bills
Variable Buy and Sell Prices Enable Self-Management
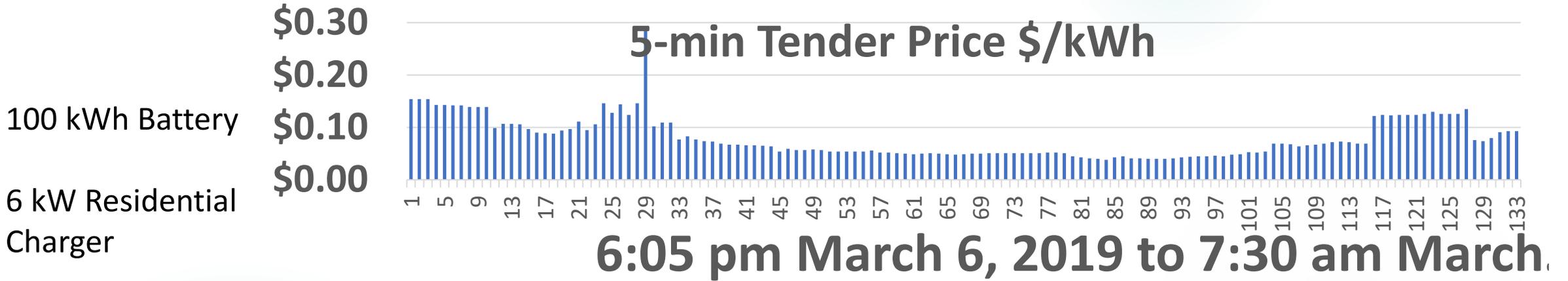
Tender Price Stack – January 29th & 30th, 2019

Legend: LMP · Delivery · Gen FCR · 3 Hr RAMP FCR
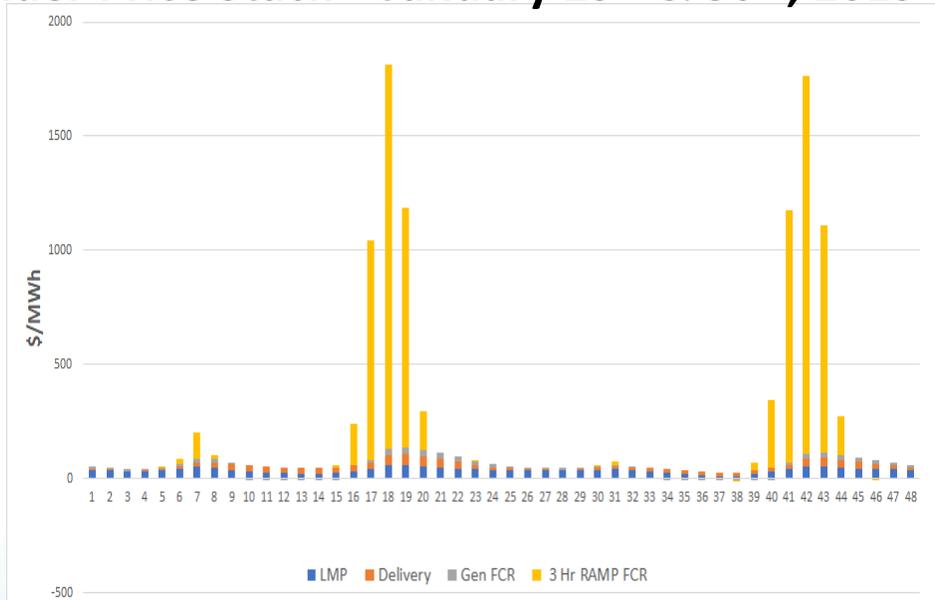
Heat Pump (Heating) Operation – January 29th & 30th, 2019

Legend: Preferred Interior (°F) · Actual (°F) · Exterior (°F)

kW

$/kWh

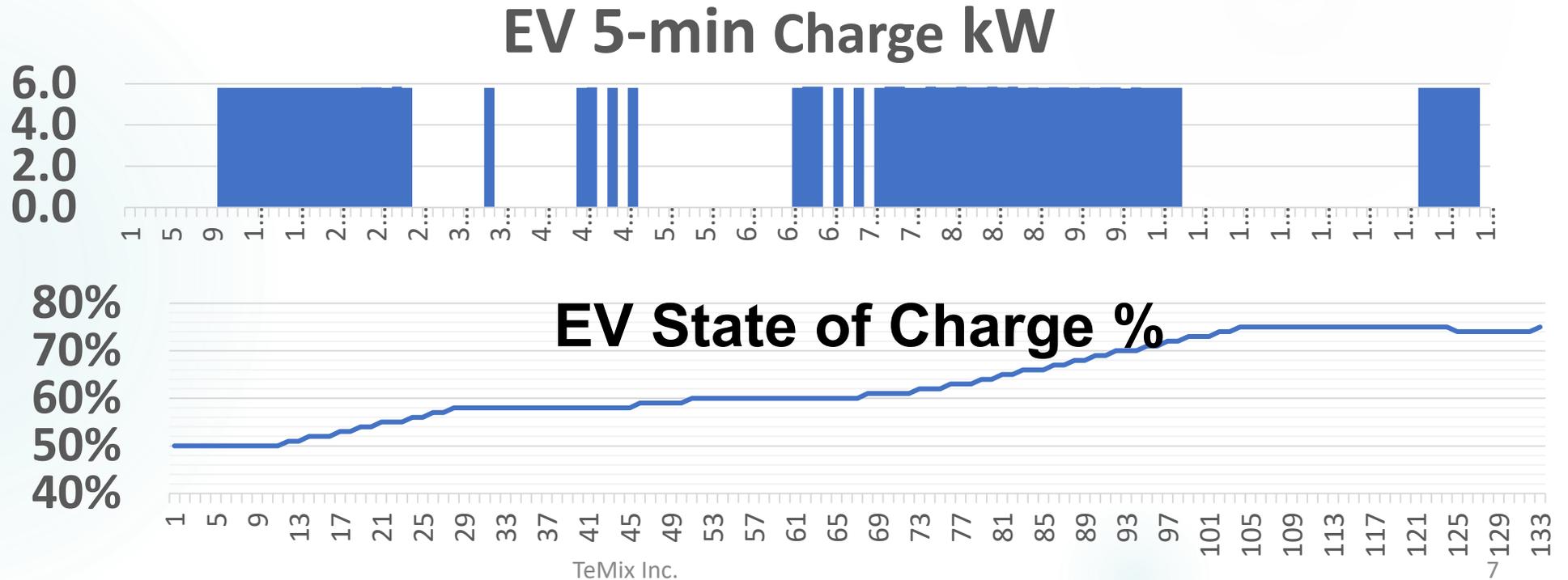# Pool Pump Operation – January 9th to 14th, 2019

Hour	9	10	11	12	13	14
1	0.74	0.00	0.74	0.73	0.00	0.73
2	0.74	0.74	0.73	0.73	0.00	0.74
3	0.74	0.74	0.00	0.74	0.00	0.74
4	0.74	0.74	0.00	0.74	0.73	0.74
5	0.00	0.00	0.00	0.74	0.00	0.73
6	0.00	0.00	0.00	0.74	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.74	0.00
9	0.00	0.00	0.00	0.00	0.73	0.00
10	0.00	0.00	0.73	0.00	0.73	0.00
11	0.73	0.74	0.74	0.00	0.73	0.74
12	0.74	0.74	0.00	0.00	0.73	0.74
13	0.74	0.74	0.00	0.74	0.74	0.00
14	0.74	0.73	0.00	0.74	0.74	0.00
15	0.00	0.72	0.00	0.73	0.00	0.00
16	0.00	0.00	0.00	0.00	0.00	0.00
17	0.00	0.00	0.00	0.00	0.00	0.00
18	0.00	0.00	0.00	0.00	0.00	0.00
19	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00
21	0.00	0.00	0.00	0.00	0.00	0.00
22	0.00	0.00	0.73	0.00	0.00	0.00
23	0.00	0.00	0.73	0.00	0.00	0.00
24	0.00	0.00	0.74	0.00	0.00	0.73

TeMix Inc.

6

Tesla Model S EV Agent

5-min Tender Price $/kWh

100 kWh Battery

6 kW Residential Charger

6:05 pm March 6, 2019 to 7:30 am March.

Initial Charge 50% at 6:30 pm

Requested Charge 75% at 7:30 am

EV 5-min Charge kW

**EV State of Charge %**

TeMix Inc.

RATES Customer Battery Example

Battery Specifications:
9.8 kWh Storage Capacity
8.5 kWh Maximum Storage
1.5 kWh Minimum Storage
5 kW Maximum Discharge Rate
3.5 kW Maximum Charge Rate
90% Round Trip Efficiency

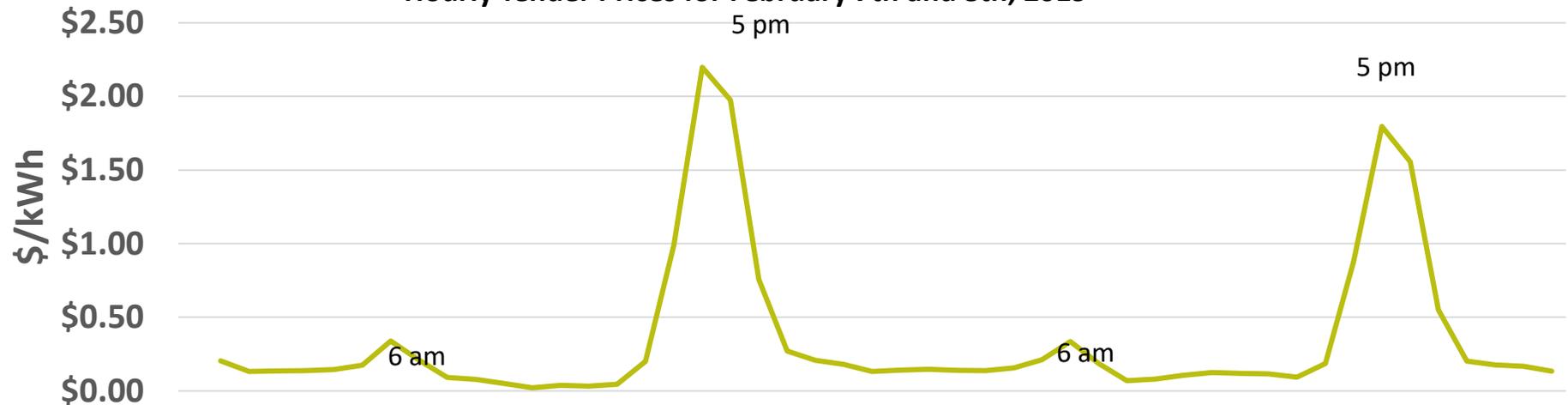**Operating Results:**
14 kWh / Day Discharge
15.56 kWh / Day Charge

$17.00 First Day Net Revenues
$13.50 Second Day Net Revenues

Self-Managed Battery Charge and Discharge for February 7th and 8th, 2019

Legend: Discharge kW · Charge kW · Stored kWh

y-axis: kW or kWh
x-axis: Hours of Two Days
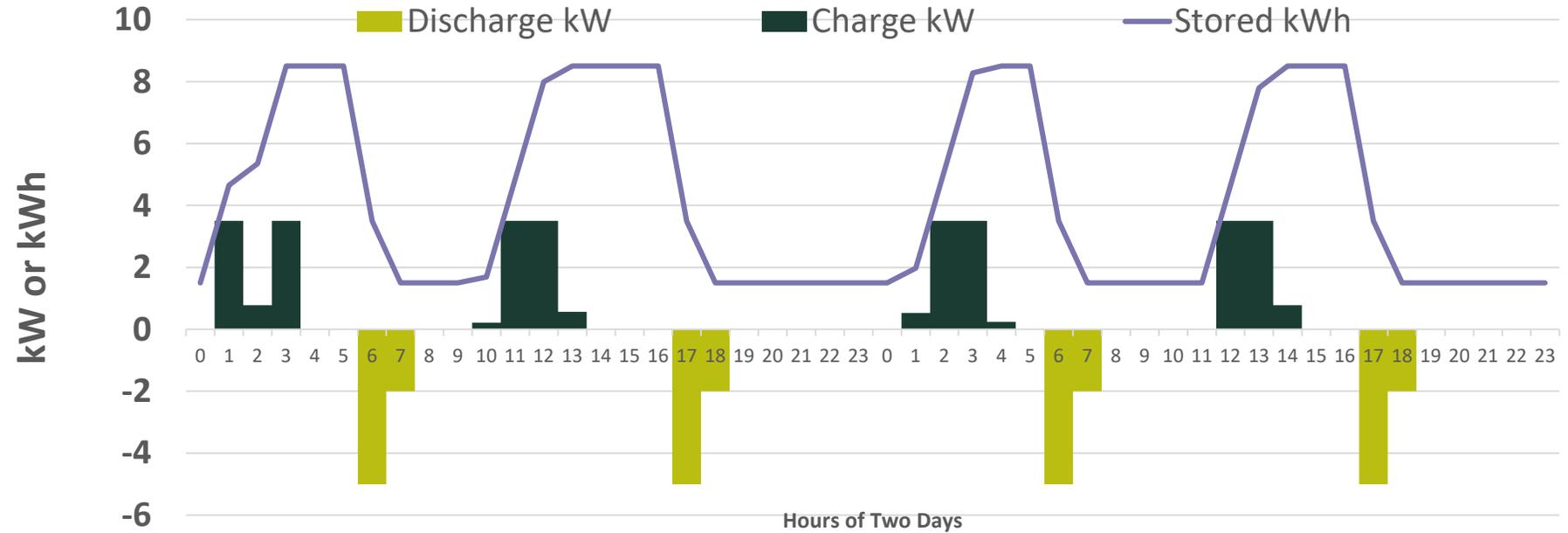
Hourly Tender Prices for February 7th and 8th, 2019

y-axis: $/kWh
labels: 5 pm, 5 pm, 6 am, 6 am

The RATES Team Recommends:

- Further deployment of RATES focus on medium and larger retail customers with flexible technology:
  - electric heat pumps, electric water heating, pumps, battery storage, solar, and electric vehicles.
  - California's 100 percent clean energy and electrification goals will result in many customers with these technologies.
- Load serving entities and distribution operators implement:
  - automated interfaces to RATES, and
  - the Subscription Transactive Tariff on an opt-in basis by the customers with flexible technologies.
- Tailoring RATES to each customer's situation to reduce deployment costs: RATES can
  - operate with 5-, 15-minute or hourly metering,
  - with and without HAN interface to the home meter and settlement, and
  - and with and without automated energy management systems and forward transactions.
- RATES as foundation for California retail electricity markets interfaced the California ISO, whether applied by
  - a vertically integrated entity,
  - an LSE including CCAs, or
  - a distribution operator that is transporting electricity for one or more LSEs.
- Step-by-step deployment of RATES as outlined above.