Frito-Lay Electric Vehicle Fleet

Fast Responding Regulation Service (FRRS)

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Disclaimer

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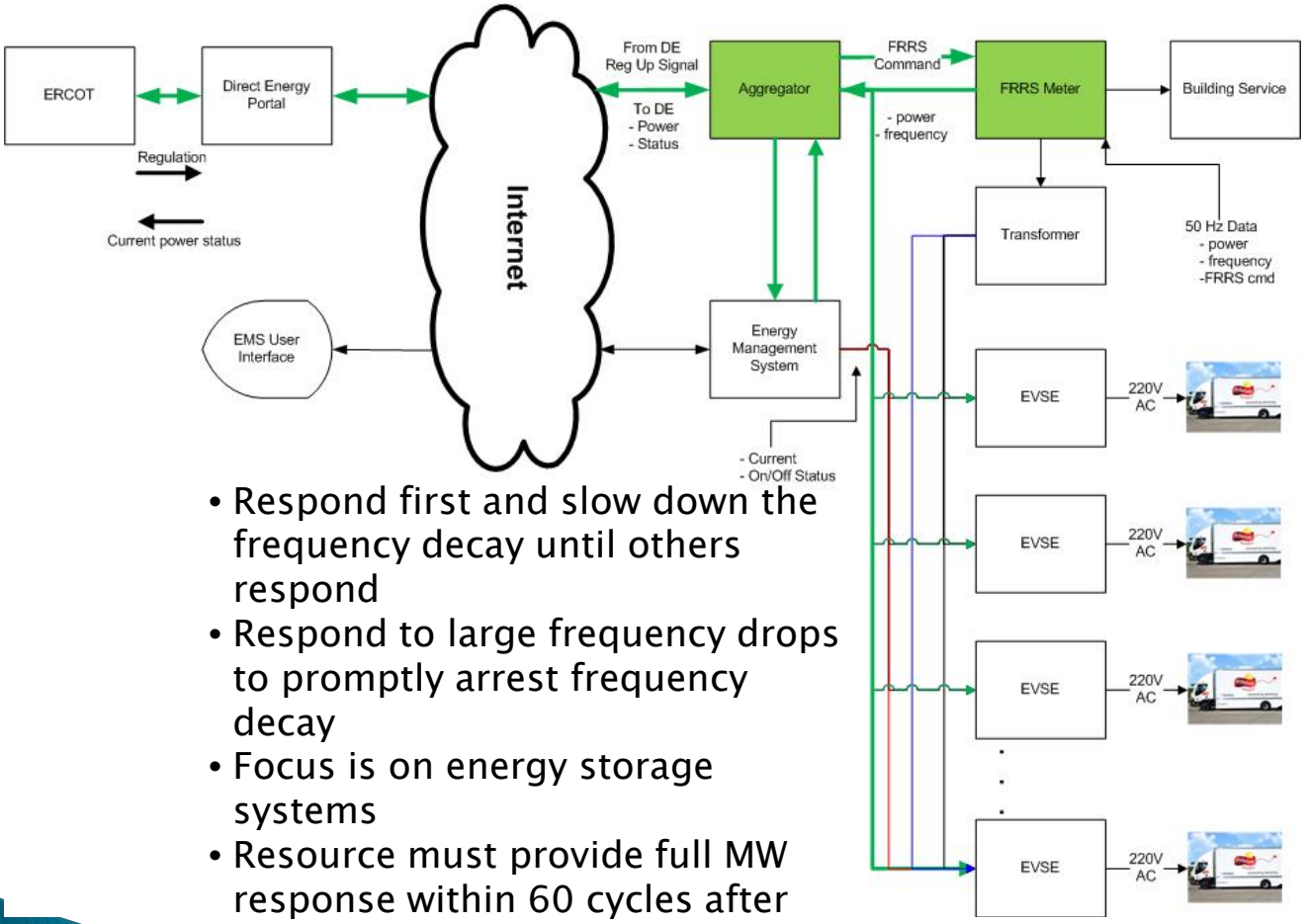
Fast Responding Regulation Service (FRRS)

- Electric grid need established to respond quickly to changes in generation/load balance – key to increased grid penetration of renewables
- Being implemented in all US ISOs under FERC authority – FERC Order 755 and 784 driven
- FRRS requires full response within 1 second of receiving a signal or detecting frequency variation.
- .1 MW minimum resolution for energy market participation
- ERCOT FRRS Pilot Feb 2013 to Feb 2014

Frito-Lay Ft Worth Facility

- Existing vehicle fleet
  - 12 Smith Electric trucks (11 were operational)
  - Average high load ~10-11kW
- Existing Energy Management System (EMS)
  - Energy/power/charge times monitored
- FRRS control hardware
  - Installed as part of FRRS Pilot
    - Individual charger high speed power monitoring
    - Individual charger on/off control
    - Secure telemetry in place between facility and ERCOT

Fast Response Regulation Service (FRRS)



- Respond first and slow down the frequency decay until others respond
- Respond to large frequency drops to promptly arrest frequency decay
- Focus is on energy storage systems
- Resource must provide full MW response within 60 cycles after frequency hits 59.97 Hz trigger

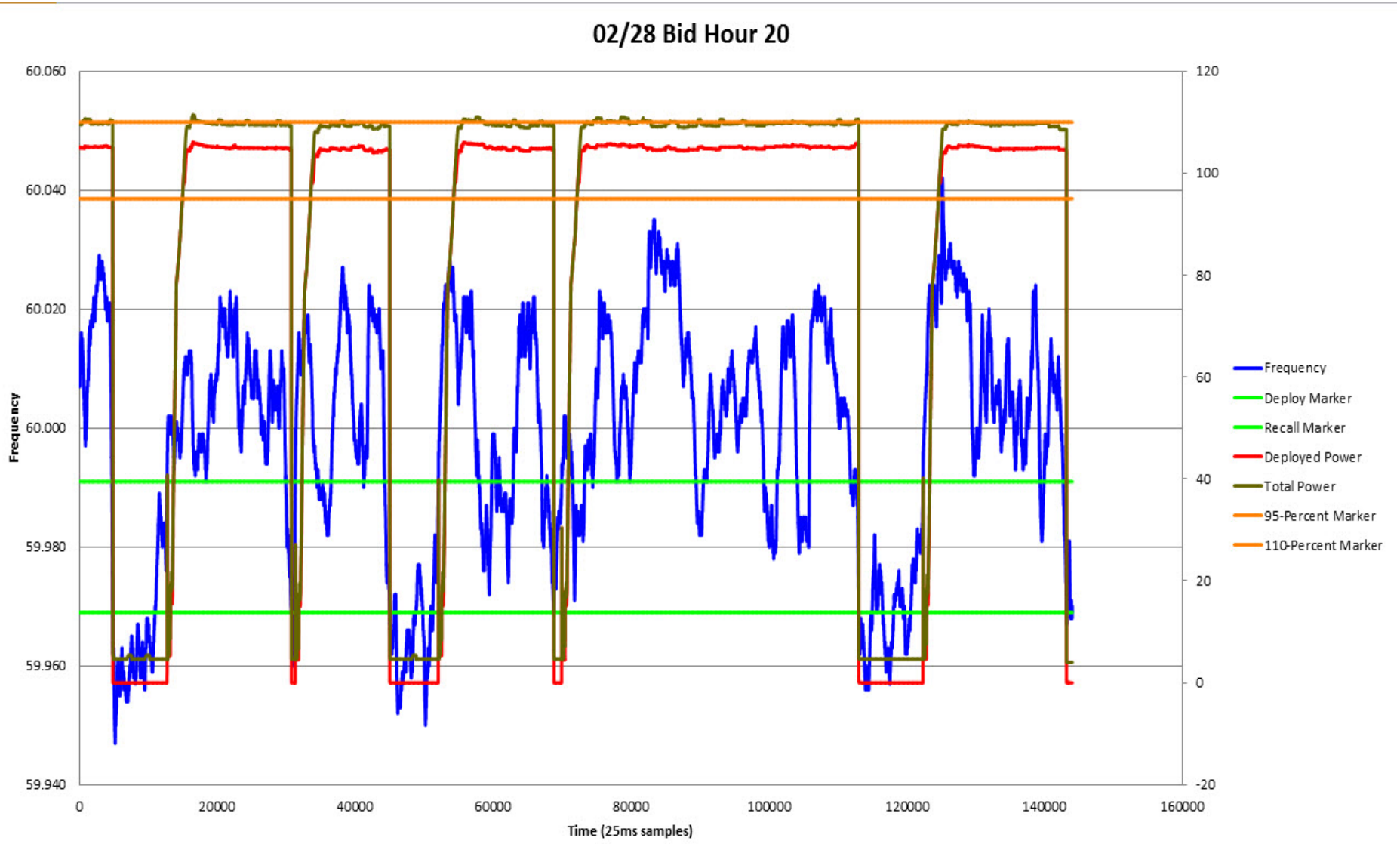

07/26/2013

Ft. Worth Opportunity Vehicle Fleet Charging

- Electric fleet stats
  - Individual truck daily route – 21 to 46 miles
  - Daily energy use – 40 to 60 kWhr
  - Individual truck charge rate – 10 to 11 kW
  - Individual truck required charge time – 3.5 to 5.5 hours

- FRRS participation
  - Need 10 trucks charging to reliability meet .1 MW participation threshold.
  - Need multiples of 10 trucks to increase participation beyond minimum level (100 kW to 200 kW)

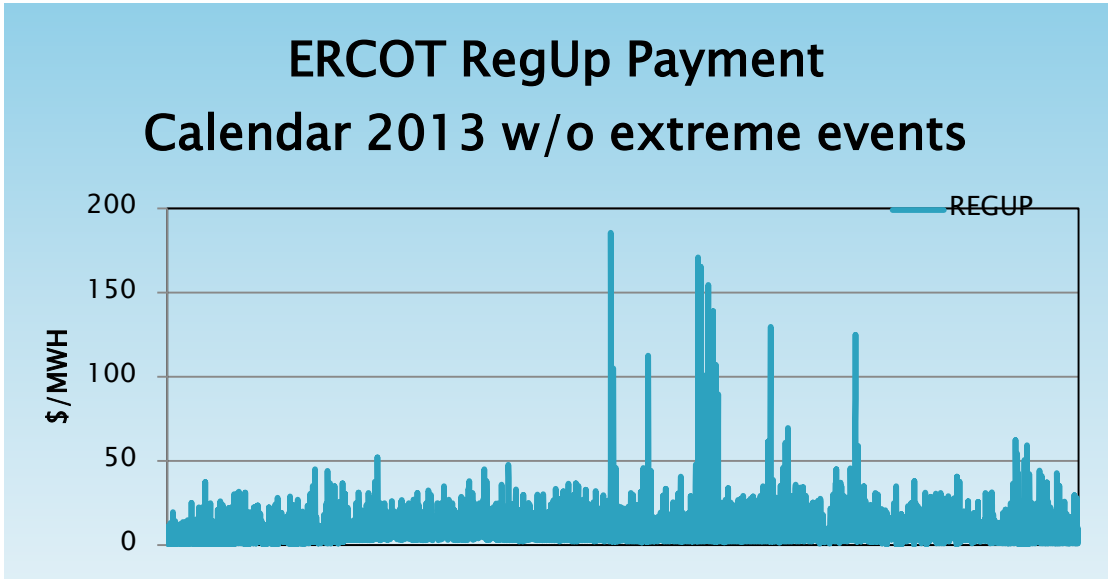
FRRS Deployment

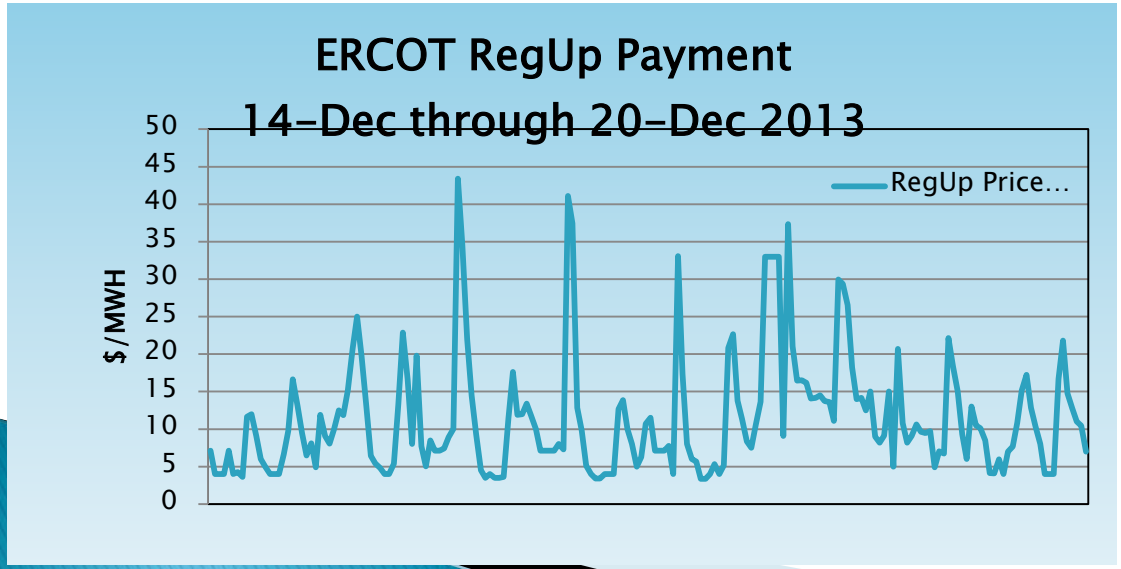


Operational Metrics

- 100% detection of frequency to .01Hz
  - 59.969Hz deployment boundary
  - 59.991Hz recall boundary
- 500ms average response time to remove load
- 100% hit rate for removing load
- 100% success rate for removing load within 95-100% of bid capacity (when available)
- 1 successful bid hour

FRRS Pilot Payment History





2013 Extreme Cost Events

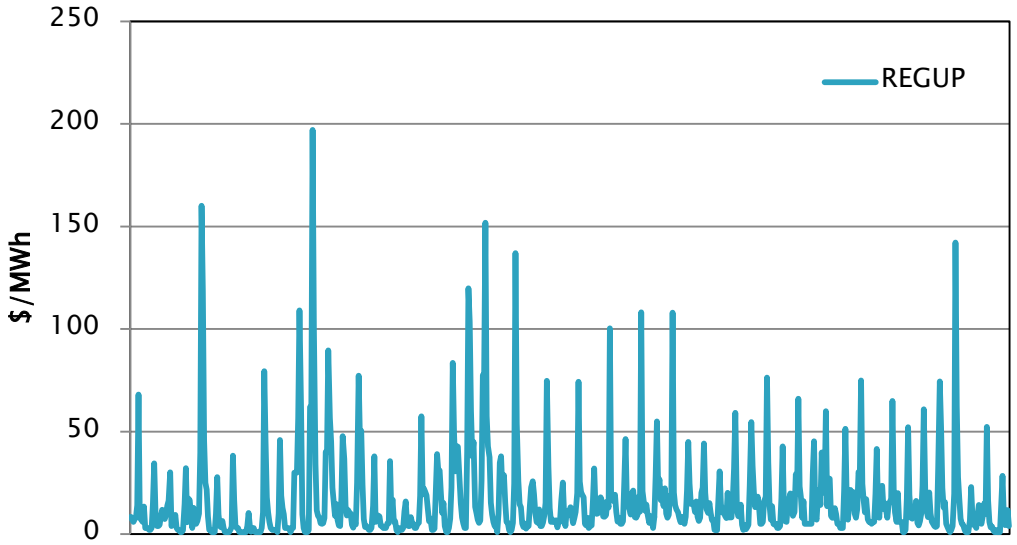
Date	Hour	Amount
6-Feb	1	$3,001
26-Jun	16/17/18	$496
7-Aug	17	$371
6-Aug	17	$253

Typical daily variation of RegUp Pricing

- Two daily peaks (HR 7, 16)
- Typical range from $5 to $20 /MWH

FRRS Pilot – Feb 2014

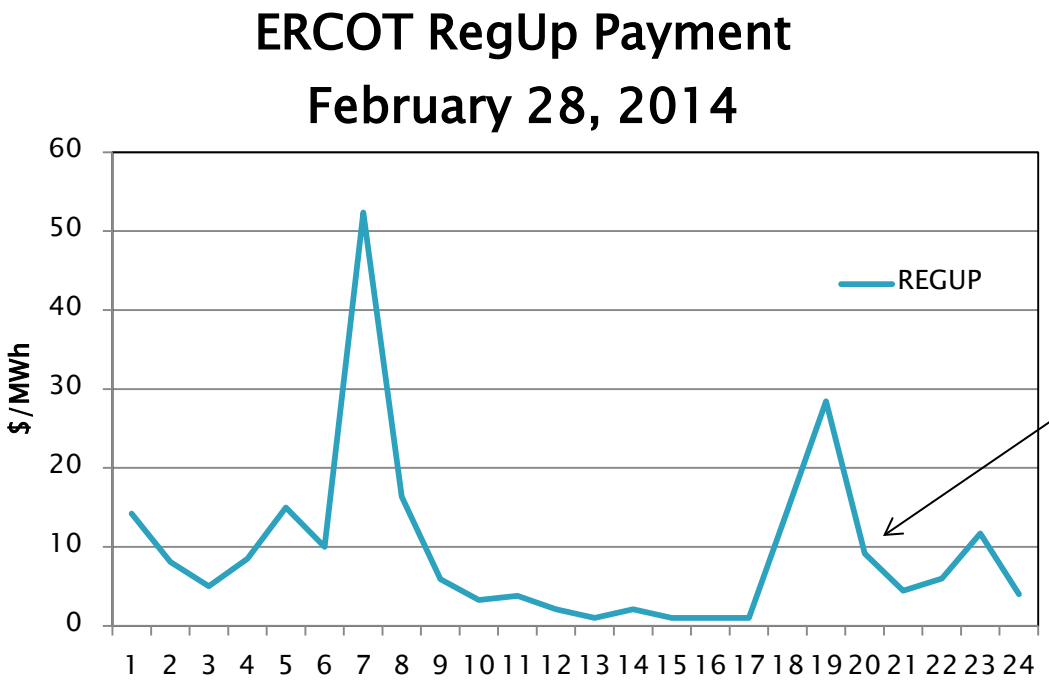
ERCOT RegUp Payment
February 2014 w/o extreme events



Feb Extreme Cost Events

Date	Hour	Amount
23-Feb	7	$4,999
12-Feb	7	$482
6-Feb	7/8	$413
6-Feb	19	$284

FRRS Pilot 28-Feburary 2014

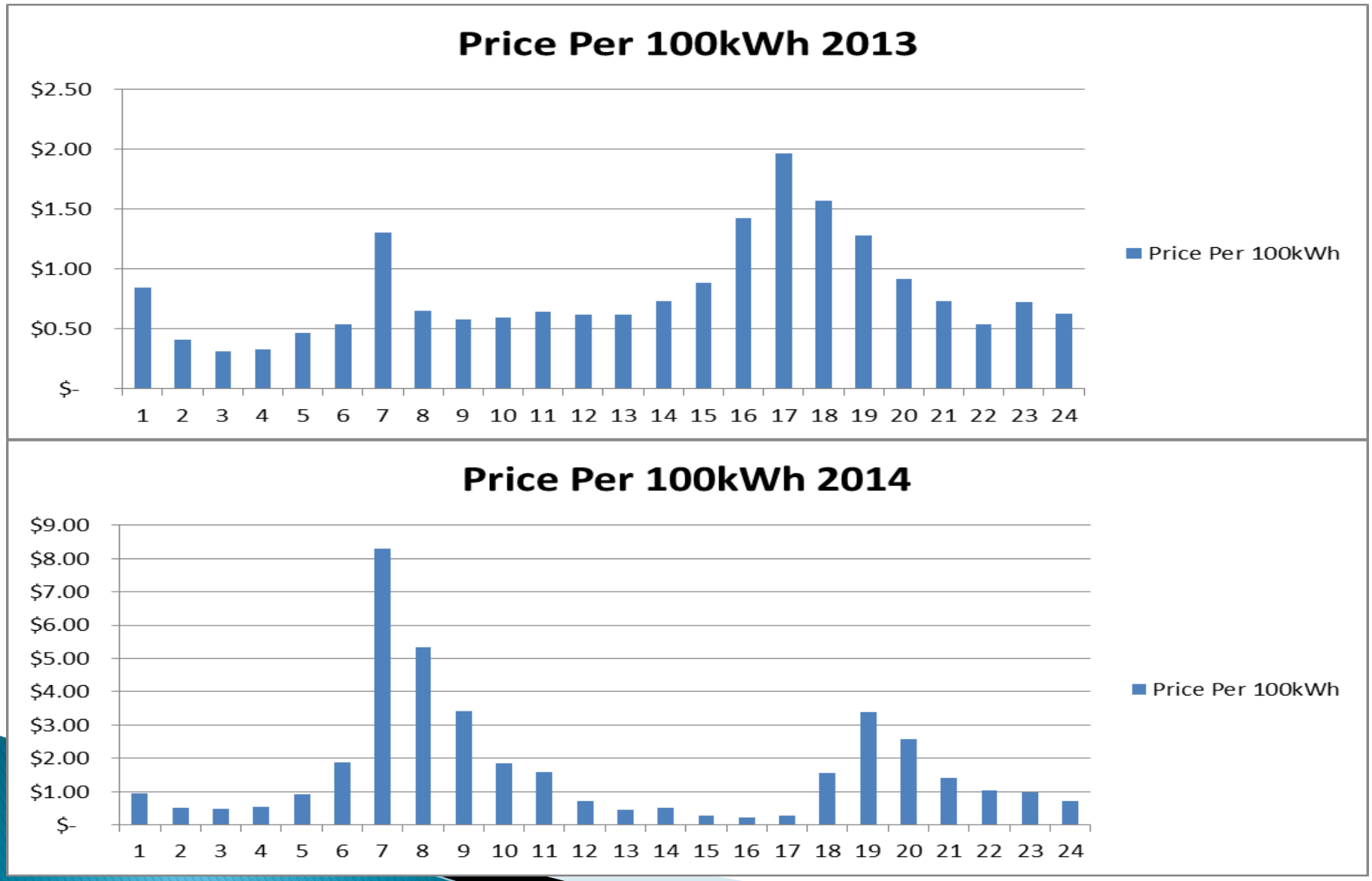


Frito-Lay Participated
Bid Hour 20

FRRS Pilot Bid hour 20 Payment $9.15 /MWH

Frito-Lay revenue received for 100 kW bid - $.91 ½

Price Comparison Per Hour



Comparison

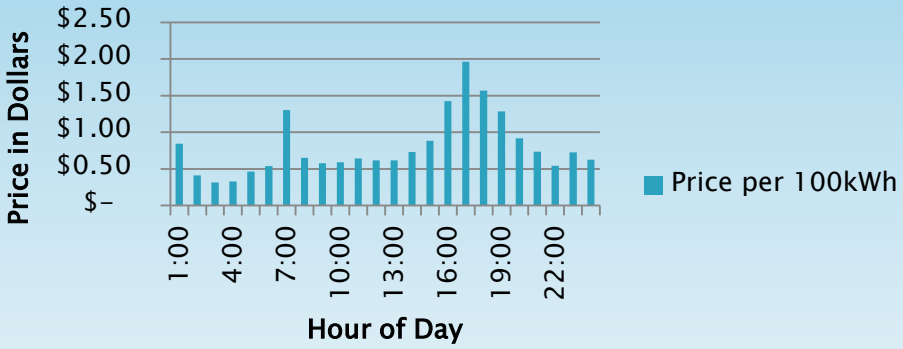
2013

HE	$ per 100kWh	30 Days
18:00	$ 1.57	$ 47.01
19:00	$ 1.28	$ 38.50
20:00	$ 0.92	$ 27.50
21:00	$ 0.73	$ 22.00
	Total Monthly Revenue	**$ 135.01**

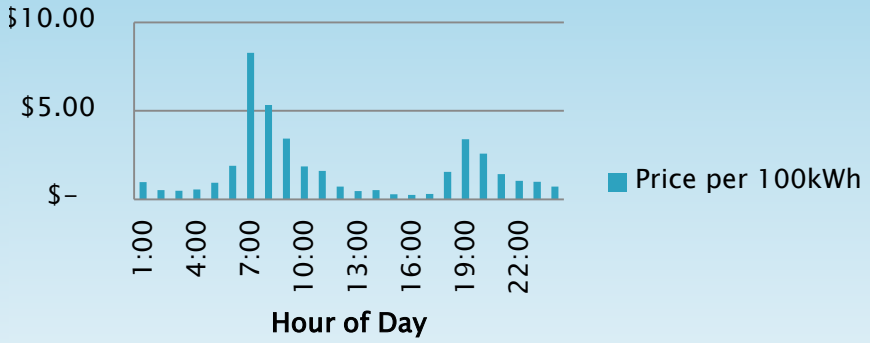
2014

HE	Price per 100kWh	30 Days
18:00	$ 1.55	$ 46.53
19:00	$ 3.40	$ 101.97
20:00	$ 2.58	$ 77.27
21:00	$ 1.42	$ 42.51
	Total Monthly Revenue	**$ 268.29**

Average Price per 100kWh – 2013



Average Price Per 100kWH: 1/1 – 3/15 2014



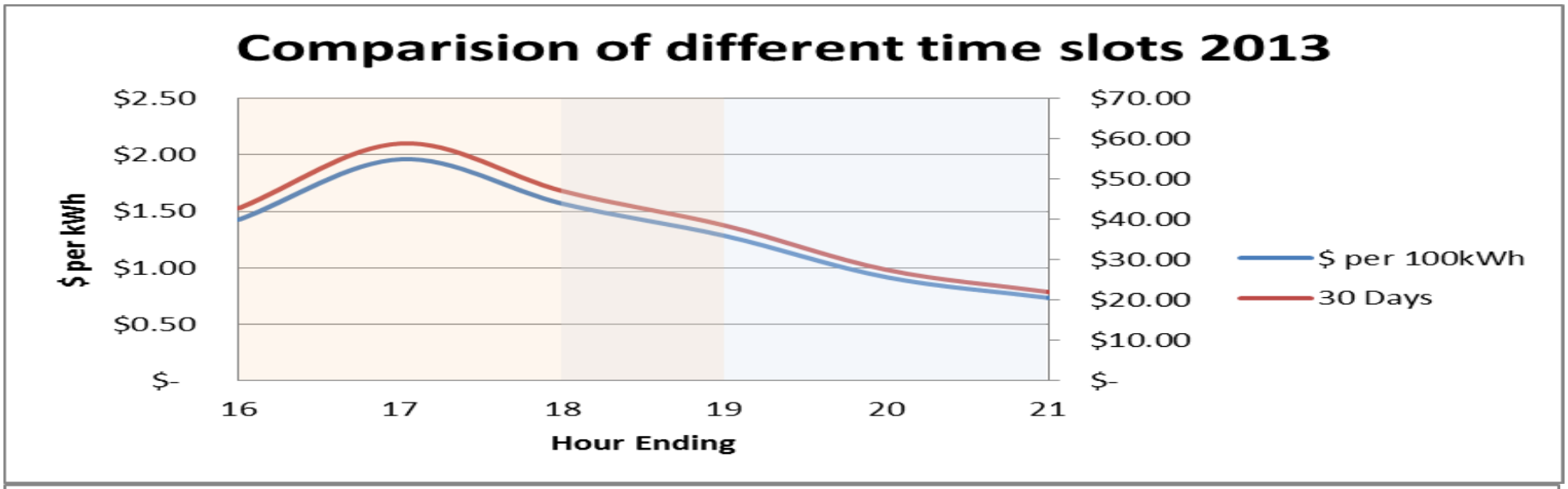
PEV Fleet Reg-Up Revenue Example – ERCOT

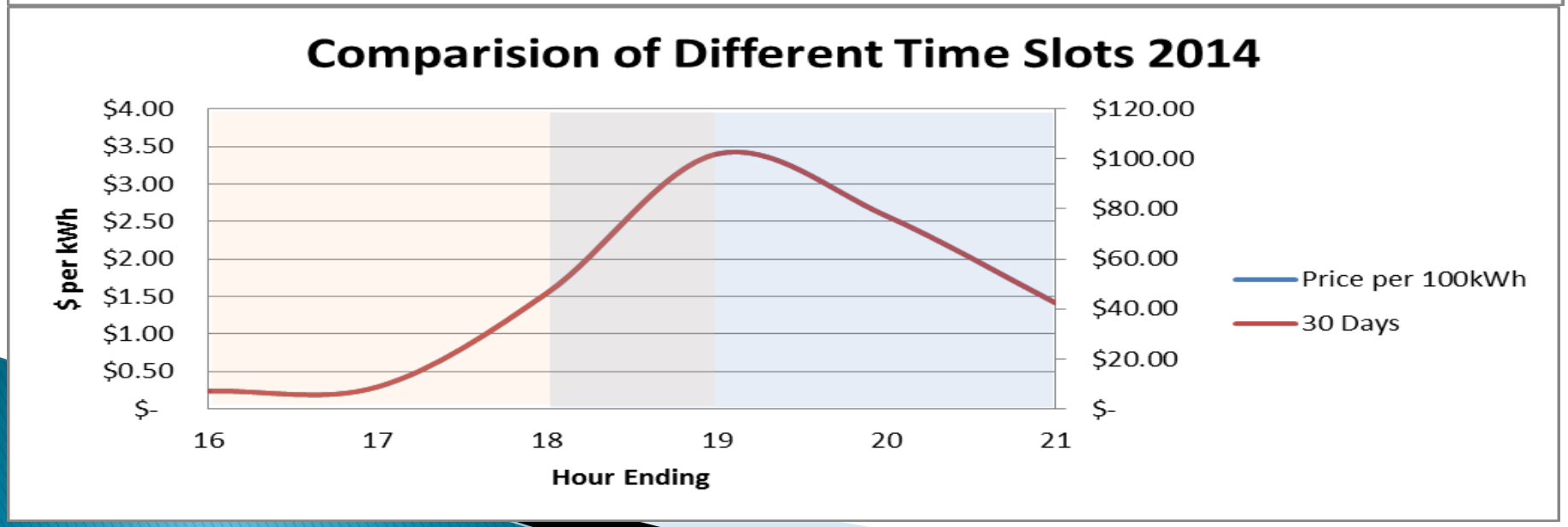
- Assumptions
  - Fleet of 10 PEVs – 100 kW bid
  - 10 kW charging
  - One way charge control (on/off)
  - One delivery route/day (3 to 5 hours charge)
  - Extrapolate 2014 Jan-Jul Reg-up payments through end of year

- **Results - In Example – not enough revenue to justify CC program based on FR only. Could be a part of an overall CC program.**

Hr	Price per 100 kW	30 Days
19:00	$1.82	$54.65
20:00	$1.62	$48.61
21:00	$1.95	$58.41
22:00	$1.49	$44.71
	Total Monthly Revenue	$206.38
	Total Annual Revenue	$2,476.54

Time Shifting Potentials





Extreme Events Lottery

2013 Events

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2014 Events

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Lessons Learned

- Fleet sizing
  - Vehicle health
  - Non-standard vehicle use
- Market rules inhibit successful participation
  - Pre-sized bids
- Market bidding rules not compatible with fleet structure
  - Future bid prediction
- Economics in current market structure not viable for participation
  - QSE requirement
  - Telemetry

What's Next?

- How do you incentivize the value to the resource owner for aggregated resources?
- What resources are allowed to be aggregated?
- How do you ease the market entry requirements?
  - Technology requirements (telemetry)
  - Dual use resources
- Can you manage dynamic resources for reliability services?
- Can you effectively manage distributed resources to meet reliability requirements?

What if you ..

- Could separate FRRS from current regulation market? You then could:
  - Develop a new ways (telemetry) to manage the small FRRS assets.
  - Consider self deployment for fast response, telemetry that could be based on real-time reporting (not at FRRS speeds)
  - Develop new ways to qualify the small FRRS asset for participation.
  - Develop new bid/payment system for small assets. (reporting, QSE?)

What if you ..

- Established the value of the FRRS service as separate from normal regulation market?
  - Develop ways to measure the value of FRRS capacity.
- Could have a wide variety of FRRS controllable assets available?
  - With a large body of small assets, could manage the variability of any single asset.
  - Different assets could be aggregated together by an owner to facilitate reporting/payment
  - Assets could be aggregated by a 3rd party to unburden the asset owner.

Further study

- Each of the questions
  - Could FRRS be separated from the current regulation market?
  - What is the value of the FRRS service as separate from normal regulation market?
  - What could be the number, variety and MW capacity of FRRS controllable assets available?
  - What's the best way to manage dynamic and/or dual use assets?
  - How much dynamic resource can the models handle and still maintain reliability? (DAM slop, SCED control)
  - How would you effectively manage distributed resources for fast response?

Could lead to a new opportunities and new FRRS market players offering services.