Transaction-Based Control of Workstations and Zones

Project Summary
May 2017

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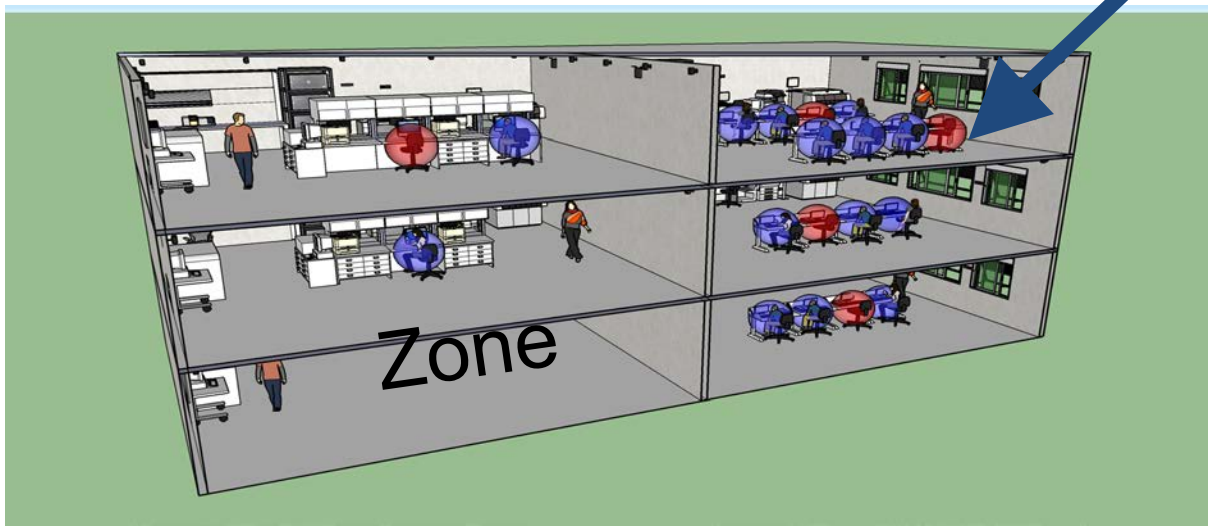
CBERD: Integrated Workstation Control

- Challenge:
  - Loads in buildings do not adjust to constrained energy resources
  - Manage power use at workstation, zone, and building level, while still giving individual occupants control.
  - Demonstrate that control of many workstation-level loads can noticeably reduce zone power by at least 10%



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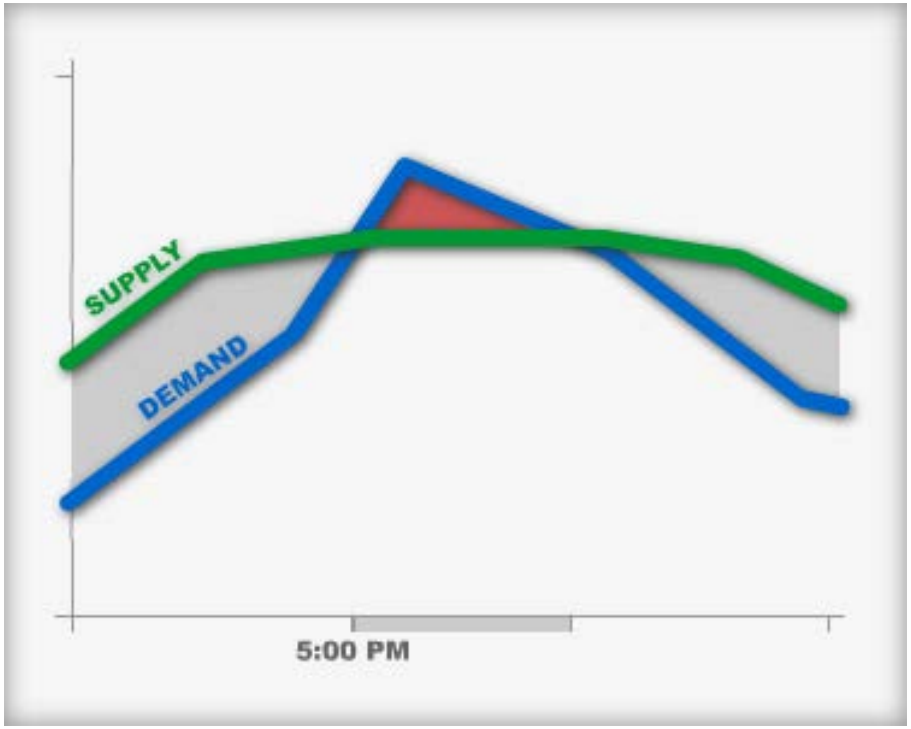
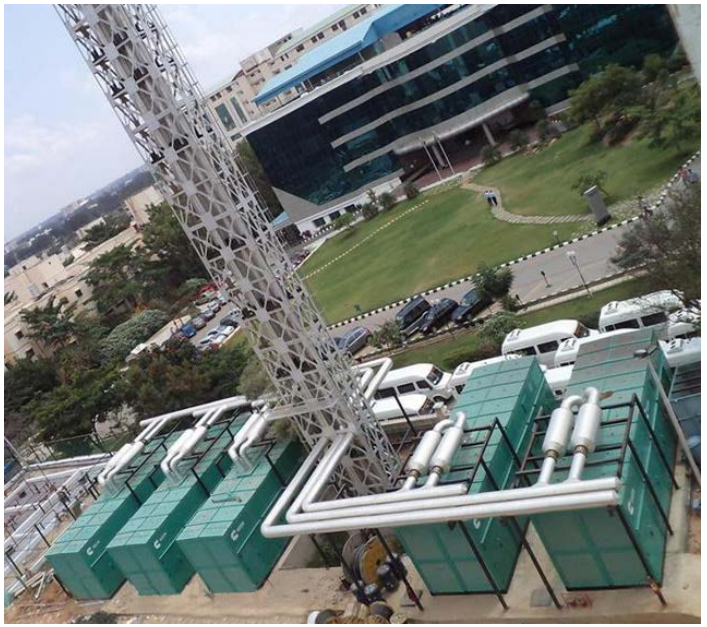
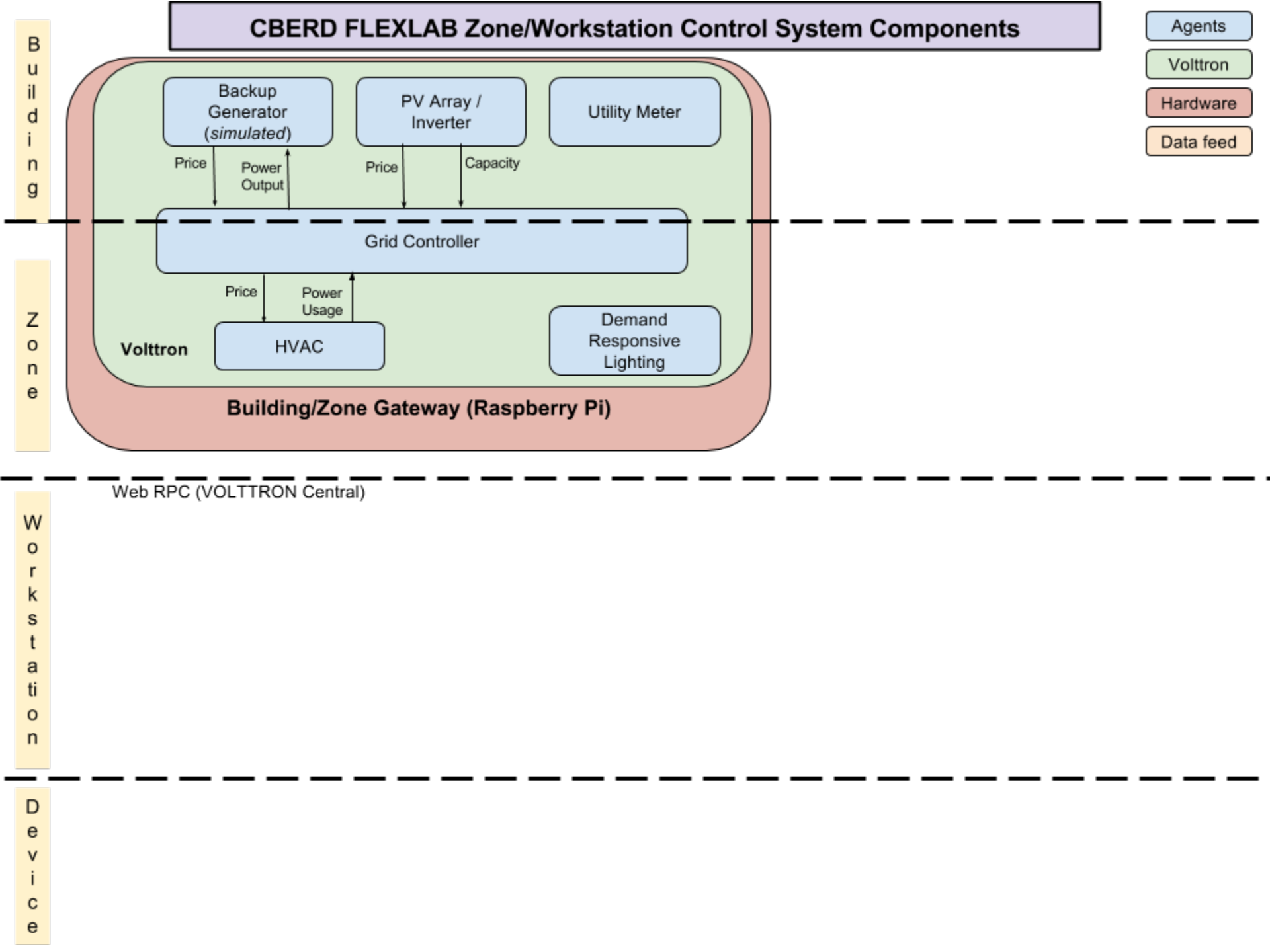
Problem: Constrained energy resources

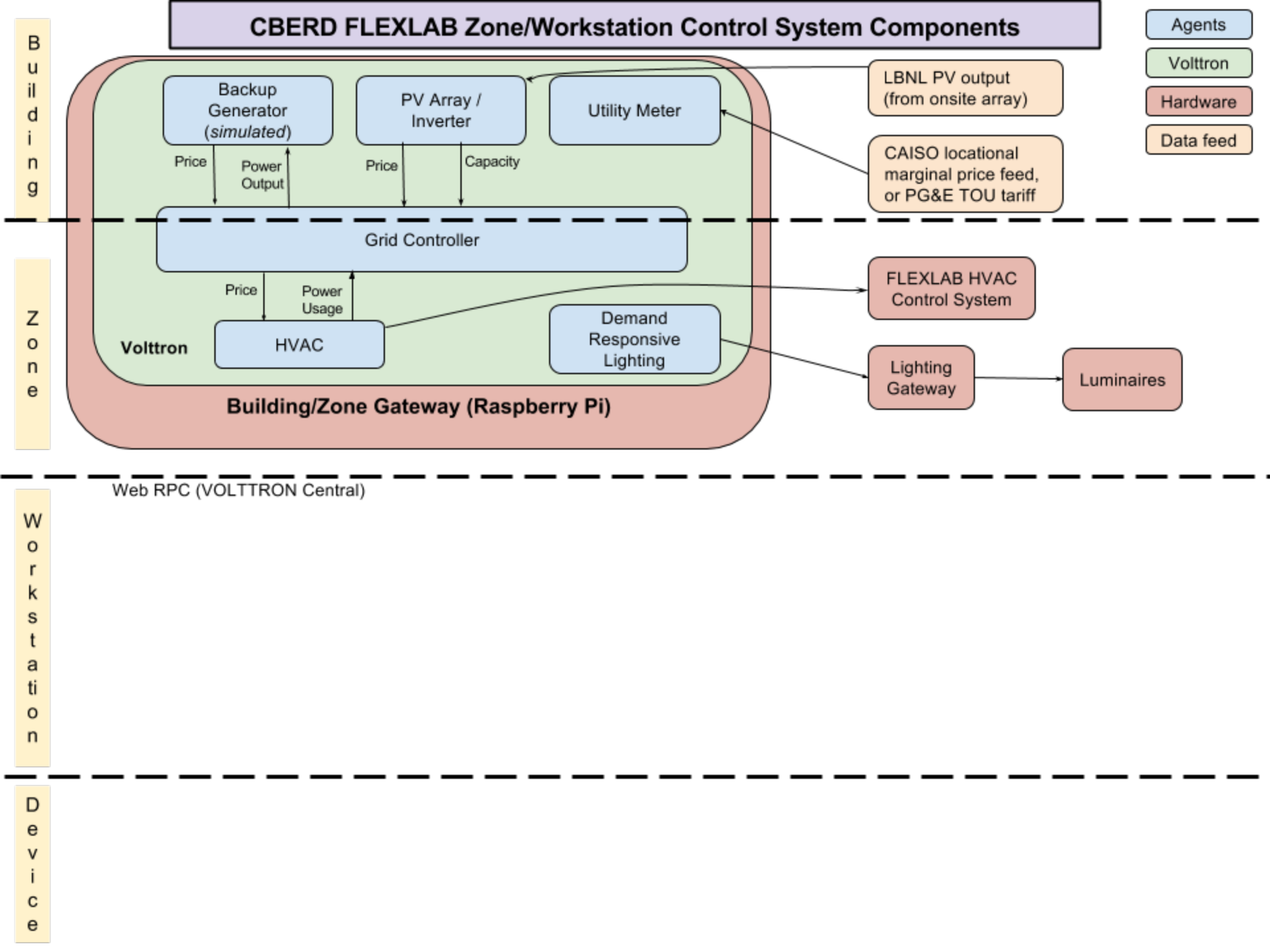


US: Demand Response programs to address limited supply
(source: NexEnergy)



India: 5x1.5MW backup generators at office complex for grid outages
(source: Powerica)


CBERD FLEXLAB Zone/Workstation Control System Components
Agents
Volttron
Hardware
Data feed
Building
Zone
Workstation
Device
Backup Generator (simulated)
PV Array / Inverter
Utility Meter
Price
Power Output
Price
Capacity
Grid Controller
Price
Power Usage
Volttron
HVAC
Demand Responsive Lighting
Building/Zone Gateway (Raspberry Pi)
Web RPC (VOLTTRON Central)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Utility Meter
Price
Power Output
Price
Capacity
LBNL PV output (from onsite array)
CAISO locational marginal price feed, or PG&E TOU tariff
Grid Controller
Price
Power Usage
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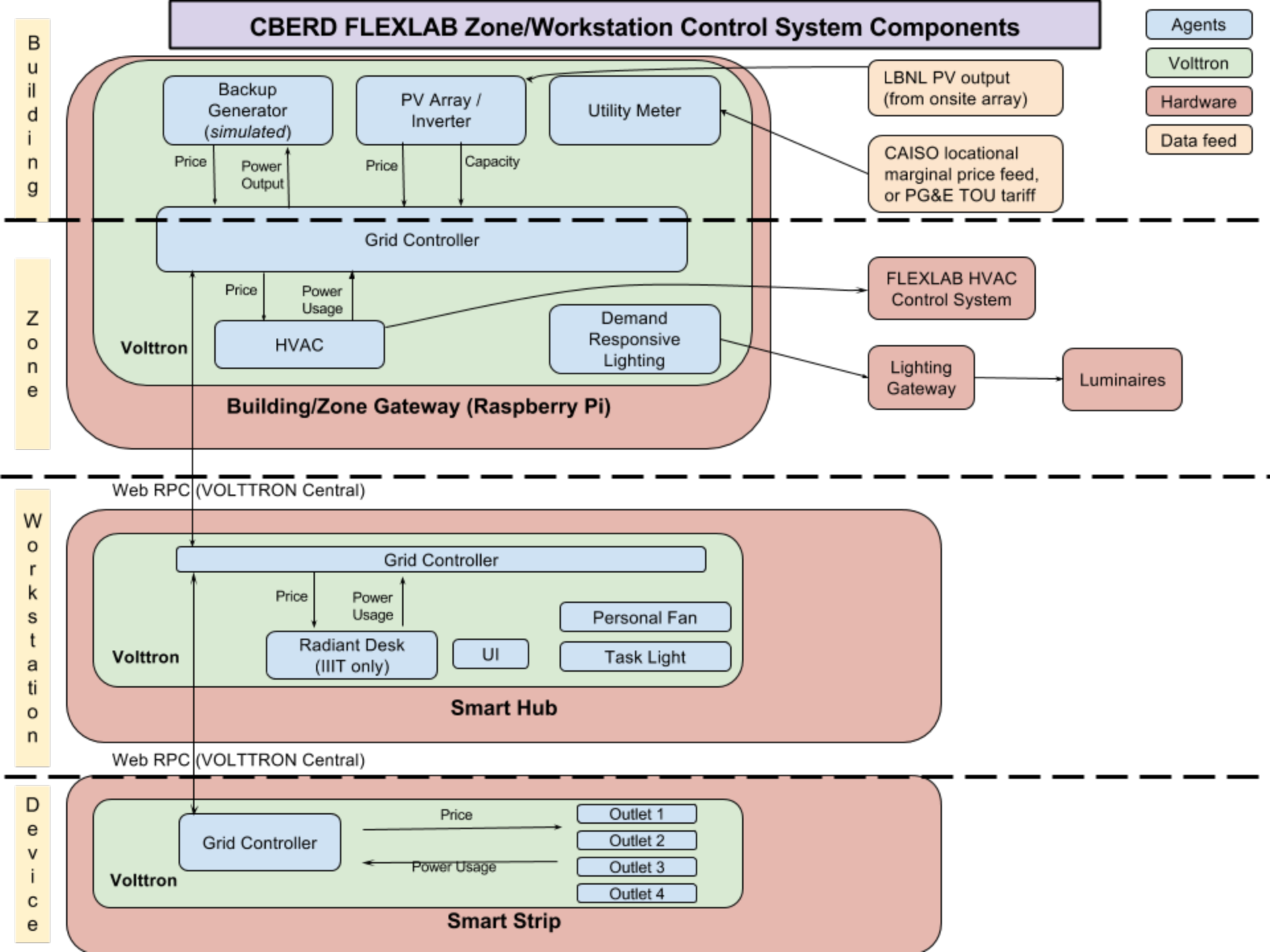
HVAC
Demand Responsive Lighting
FLEXLAB HVAC Control System
Lighting Gateway
Luminaires
Building/Zone Gateway (Raspberry Pi)
Web RPC (VOLTTRON Central)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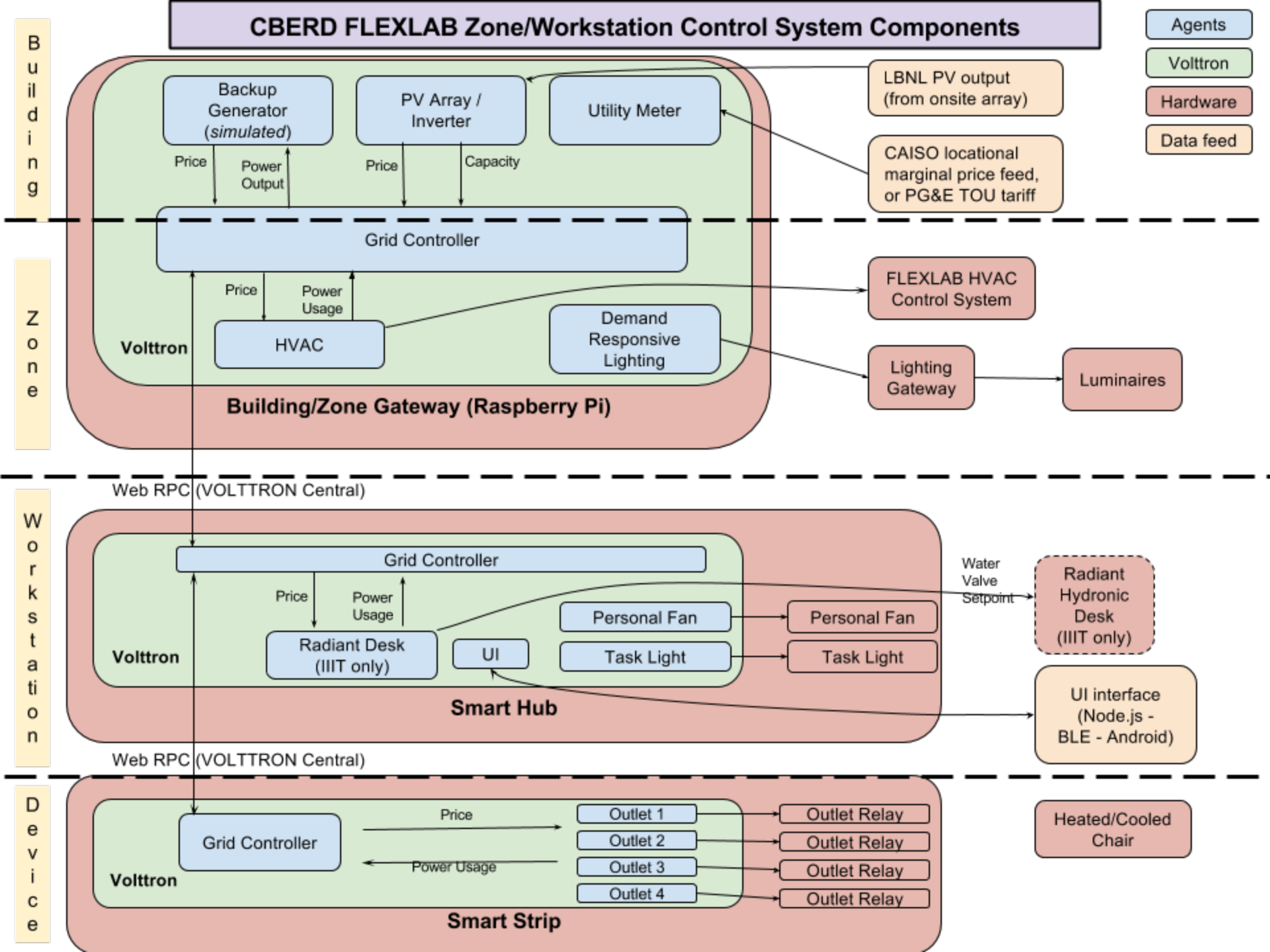
Building/Zone Gateway (Raspberry Pi)
Web RPC (VOLTTRON Central)
Grid Controller
Price
Power Usage
Volttron
Radiant Desk (IIIT only)
UI
Personal Fan
Task Light
Smart Hub
Web RPC (VOLTTRON Central)
Grid Controller
Price
Power Usage
Volttron
Outlet 1
Outlet 2
Outlet 3
Outlet 4
Smart Strip


CBERD FLEXLAB Zone/Workstation Control System Components
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Building
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PV Array / Inverter
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Lighting Gateway
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Building/Zone Gateway (Raspberry Pi)
Web RPC (VOLTTRON Central)
Grid Controller
Price
Power Usage
Volttron
Radiant Desk (IIIT only)
UI
Personal Fan
Task Light
Personal Fan
Task Light
Water Valve Setpoint
Radiant Hydronic Desk (IIIT only)
UI interface (Node.js - BLE - Android)
Smart Hub
Web RPC (VOLTTRON Central)
Grid Controller
Price
Power Usage
Volttron
Outlet 1
Outlet 2
Outlet 3
Outlet 4
Outlet Relay
Outlet Relay
Outlet Relay
Outlet Relay
Heated/Cooled Chair
Smart Strip

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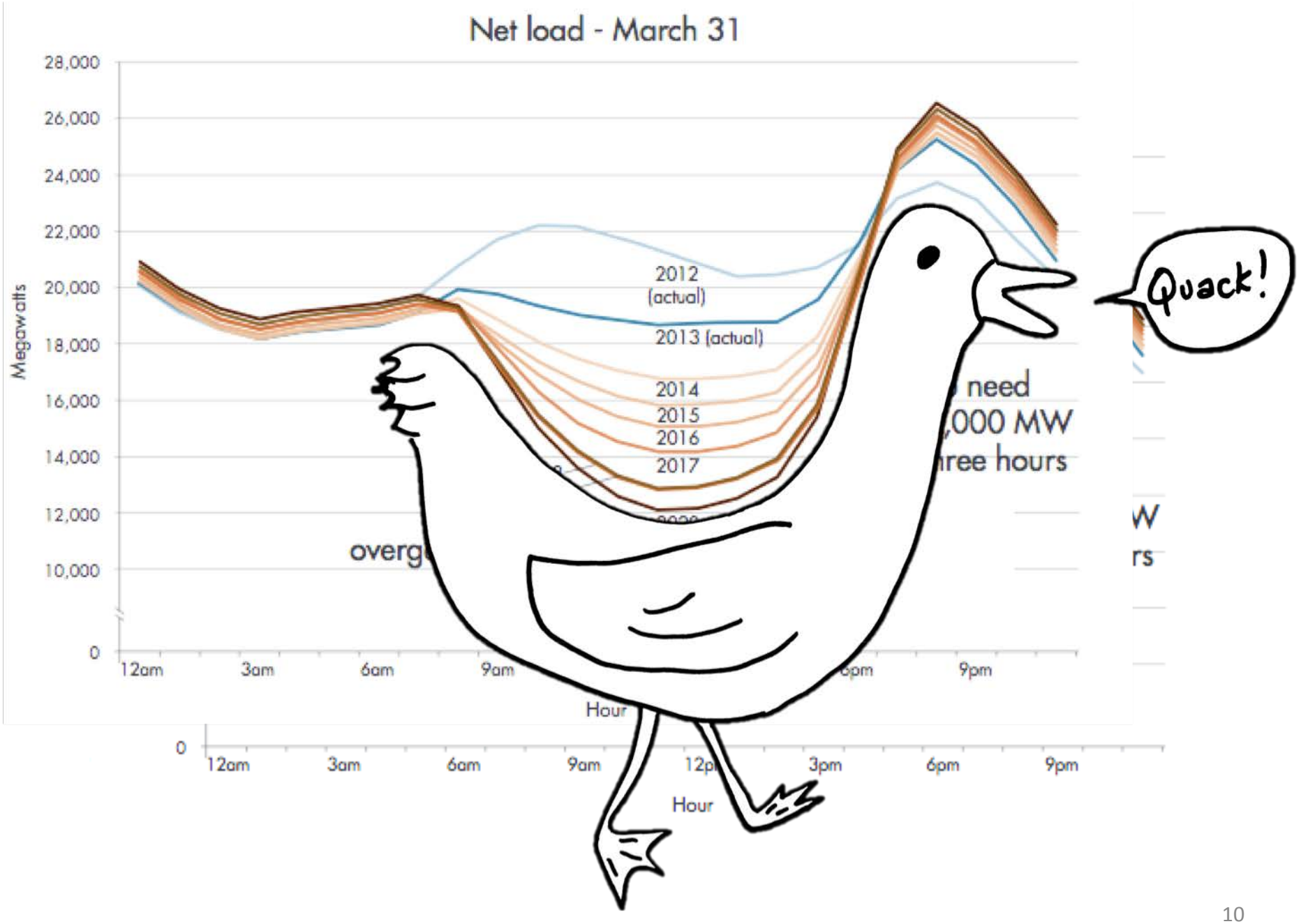
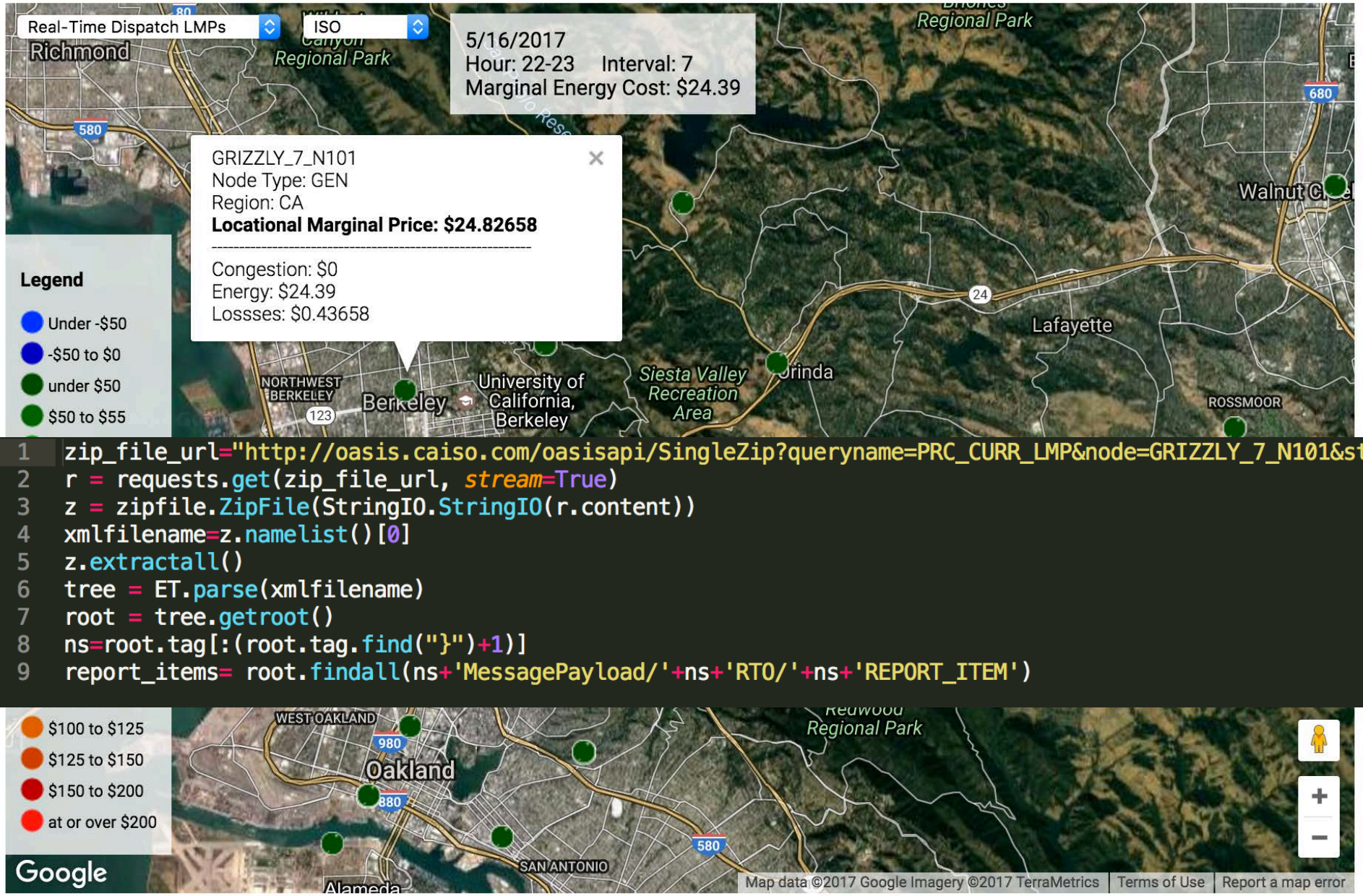
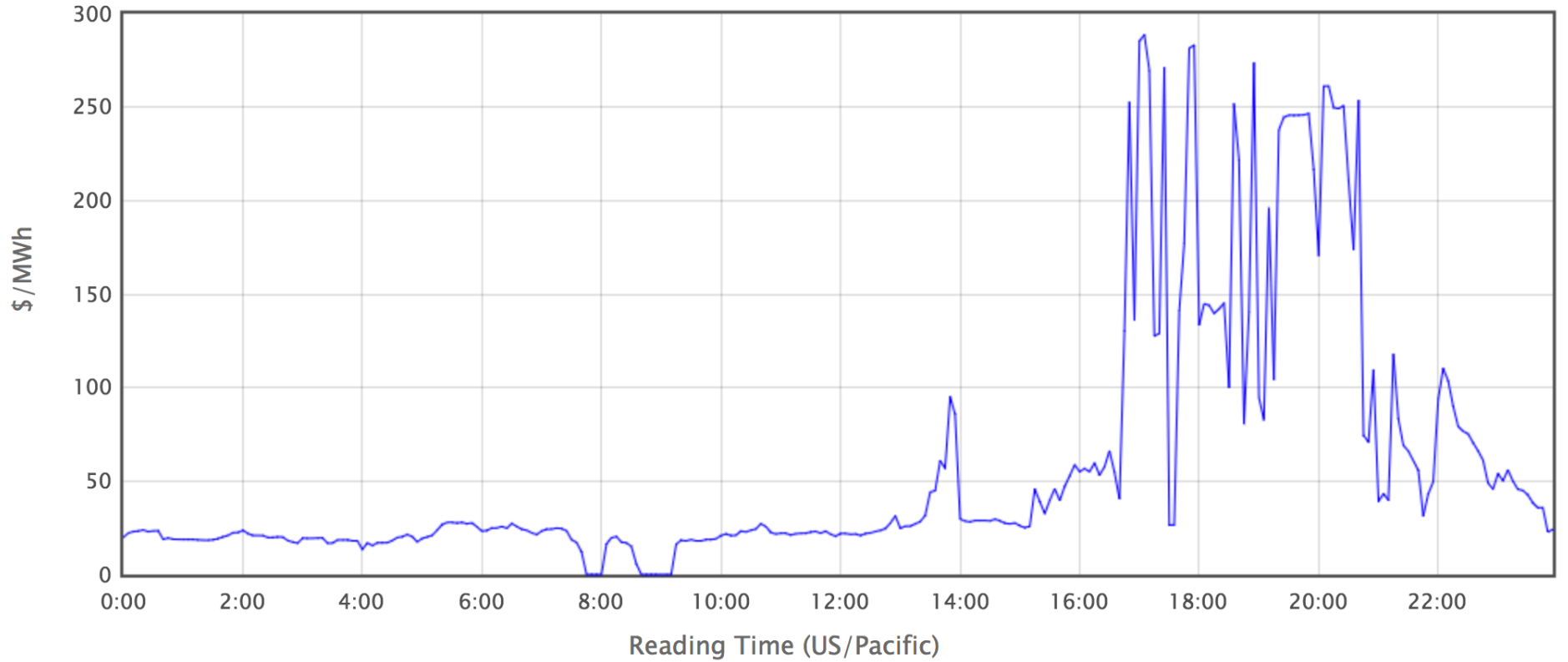
Laptop
Chair


Net load - March 31
Megawatts
28,000
26,000
24,000
22,000
20,000
18,000
16,000
14,000
12,000
10,000
0
12am
3am
6am
9am
12pm
3pm
6pm
9pm
Hour
2012 (actual)
2013 (actual)
2014
2015
2016
2017
Quack!




```
zip_file_url="http://oasis.caiso.com/oasisapi/SingleZip?queryname=PRC_CURR_LMP&node=GRIZZLY_7_N101&sta
r = requests.get(zip_file_url, stream=True)
z = zipfile.ZipFile(StringIO.StringIO(r.content))
xmlfilename=z.namelist()[0]
z.extractall()
tree = ET.parse(xmlfilename)
root = tree.getroot()
ns=root.tag[:(root.tag.find("}")+1)]
report_items= root.findall(ns+'MessagePayload/'+ns+'RTO/'+ns+'REPORT_ITEM')
```

Real-time Locational Marginal Prices

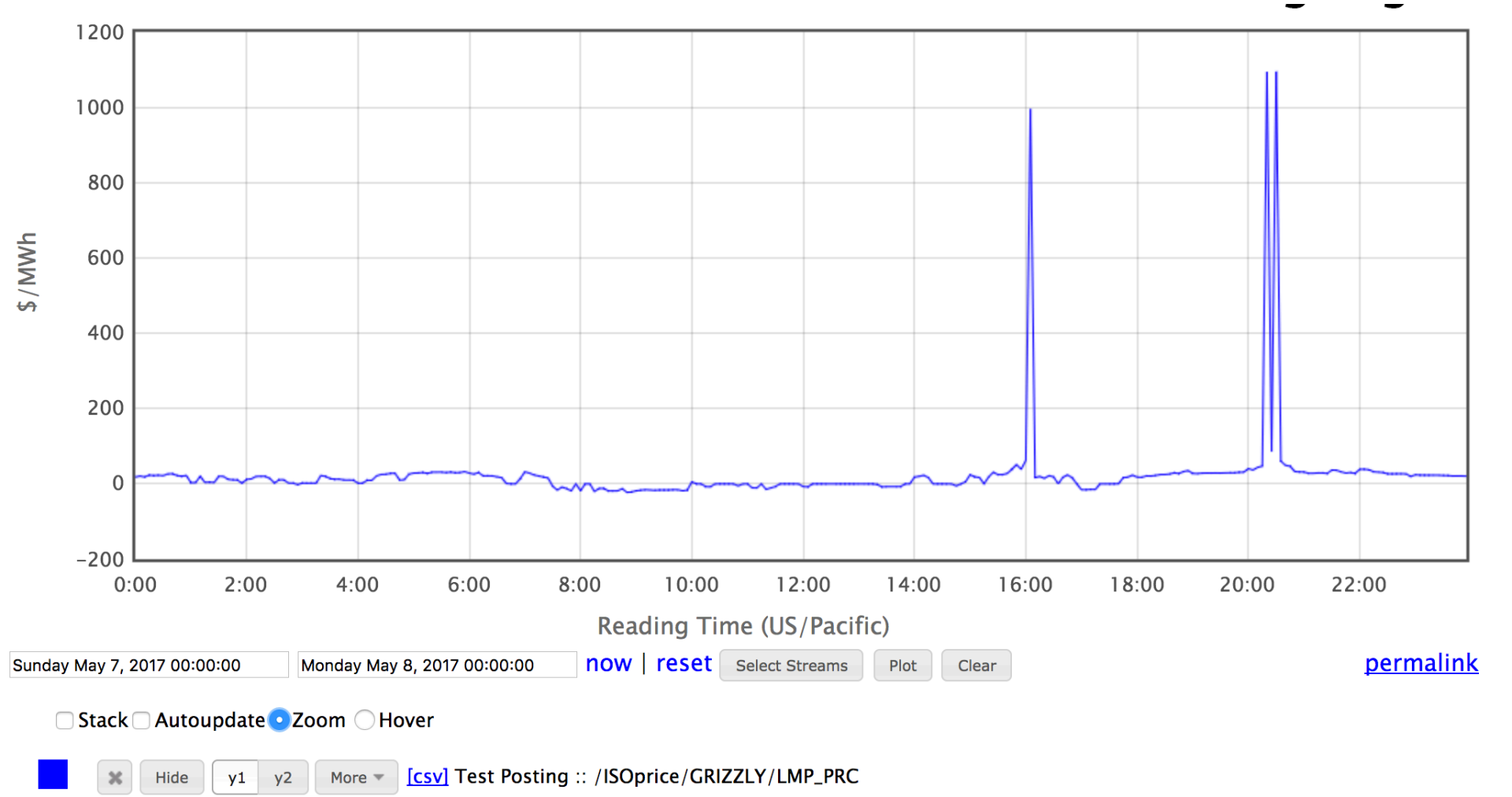


Tuesday May 2, 2017 00:00:00 Wednesday May 3, 2017 00:00:00 now | reset Select Streams Plot Clear permalink

Stack Autoupdate Zoom Hover

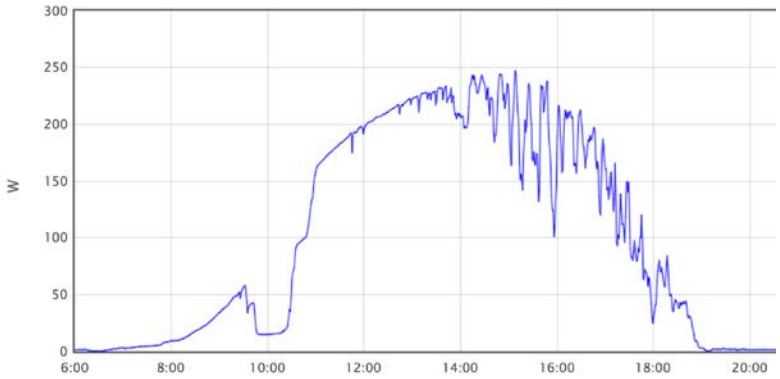
Hide y1 y2 More [csv] Test Posting :: /ISOprice/GRIZZLY/LMP_PRC

Real-time Locational Marginal Prices



Real-Time Pricing

- Scale CAISO real time locational marginal prices to $0-$1/kWh
- PV with price=$0/kWh
- Generator scenario (grid failure)
- Control HVAC setpoint based on price
  - High price, cooling setpoint 28C
  - Low price, cooling setpoint 18C
- Control lights based on price
  - Above $0.50/kWh switch to battery backup



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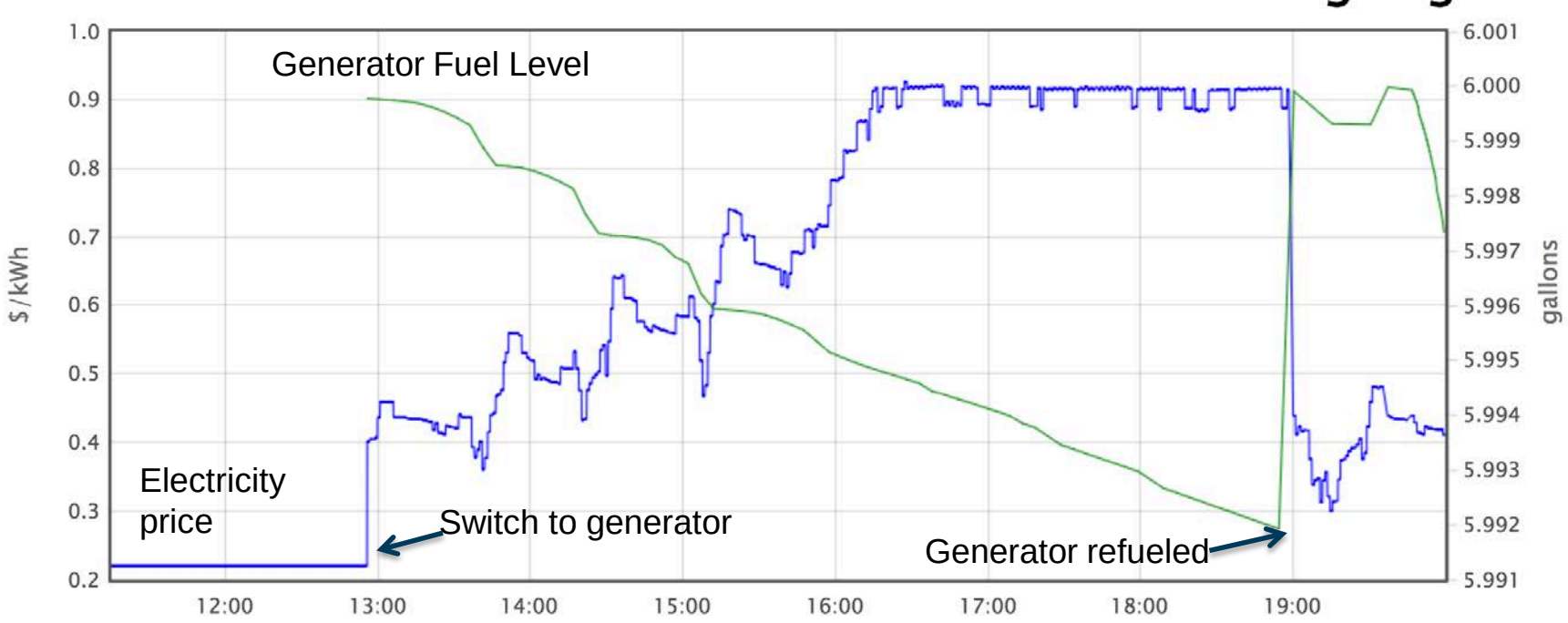
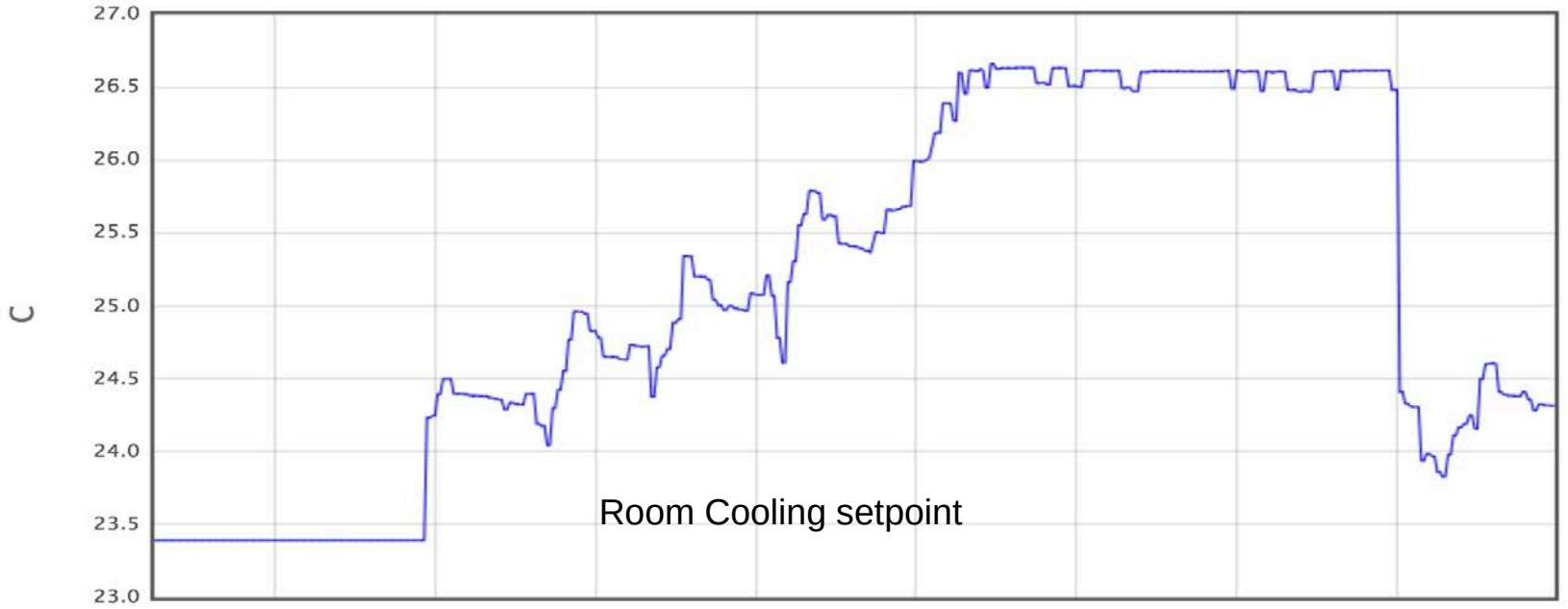
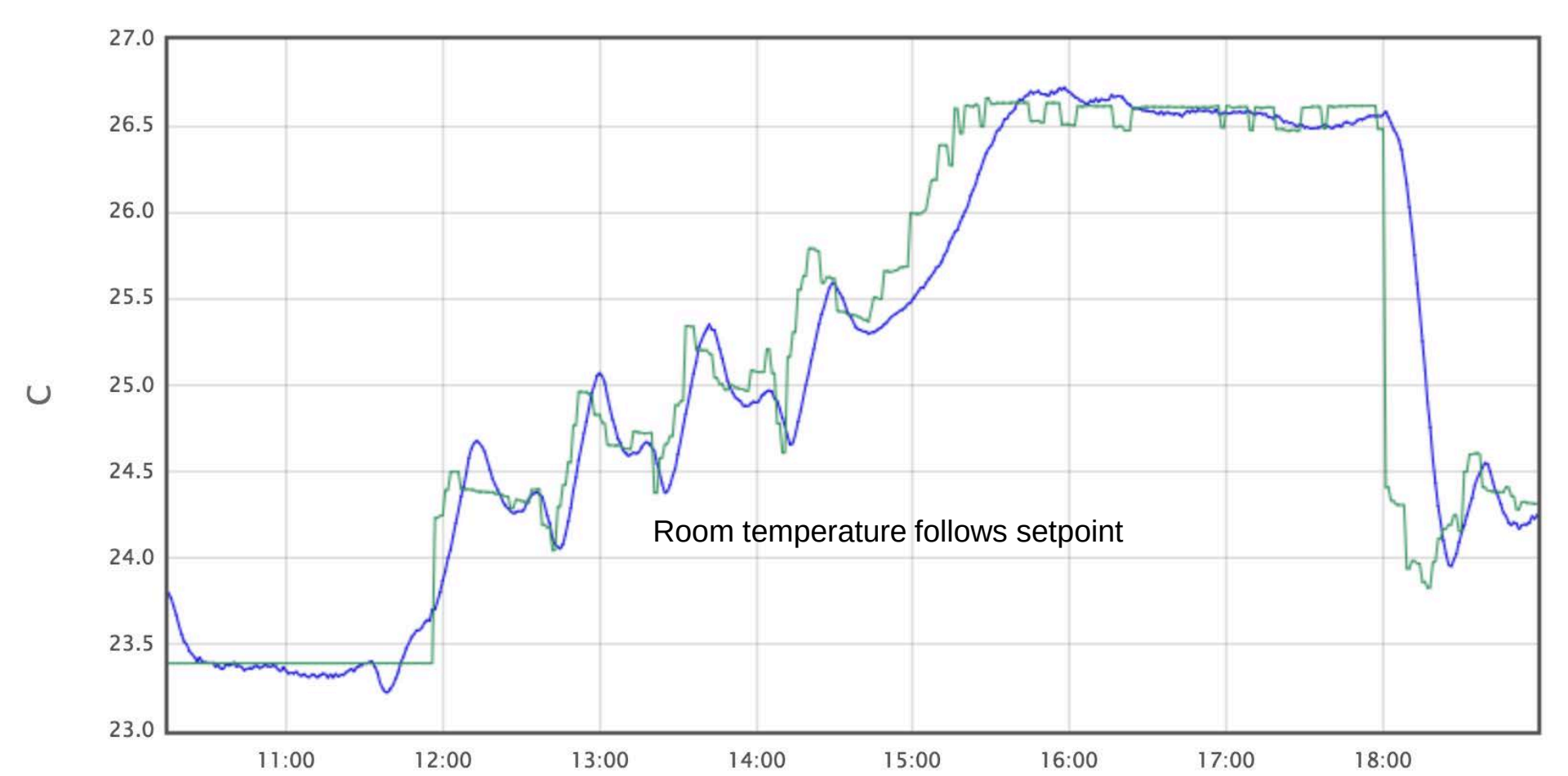

Generator Fuel Level
Electricity price
Switch to generator
Generator refueled
$/kWh
gallons
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
6.001
6.000
5.999
5.998
5.997
5.996
5.995
5.994
5.993
5.992
5.991
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00


C
27.0
26.5
26.0
25.5
25.0
24.5
24.0
23.5
23.0
Room Cooling setpoint



Tuesday May 9, 2017 10:15 Start date Tuesday May 9, 2017 19:00 End date Plot Reload

Recent Now Reset Hour Day Week Month Disable auto-resampling Maintain y-axis zoom

Select streams Chart options Clear | Export csv 1 minutes | permalink |

Hide y1 y2 More LBNL_Cal_X1AB :: /x1ab_all/Cell-HVAC-and-Perm-Sensors-1A/1A-IDBTS-1

Hide y1 y2 More PROJECTS :: /2017/CBERD/X1A/1A-Room Cooling SP

Issues / Lessons Learned

- The message bus works great for passing data around in an instance
- Connecting buses with WebRPC is possible
- Controlling devices based on price and consumption only works
- 10 ms schedule because of real-time hardware UI interactions creates problems with webRPC bridge
- Challenge using VIP because 3.5 in smarthub and 4.1 in zone
- Lacking auto-discovery, how does this scale?

Thank you

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