

CTA-2045 Enables Low-Cost Grid-Interactive Water Heaters

Conrad Eustis
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Portland General Electric

852,000 customers, 52 cities served

Service territory population 1.7 million,
43% of state's population

4,000-square-mile service area

2,600 employees

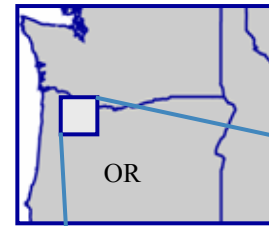
Summer peak load of 3,950 MW (2009)

Winter peak load of 4,073 MW (1998)

**Number #1 in US by NREL in Renewable
energy sales and customers**

First multi-MW Li-Ion battery-inverter system
placed in operation by a utility

21% of owned-generation nameplate
capacity is wind generation; 36% is
renewable.



Support a standard socket: Why you should care!



Photo Credit
Chris Whitehouse

<http://www.geograph.org.uk/reuse.php?id=2777522>

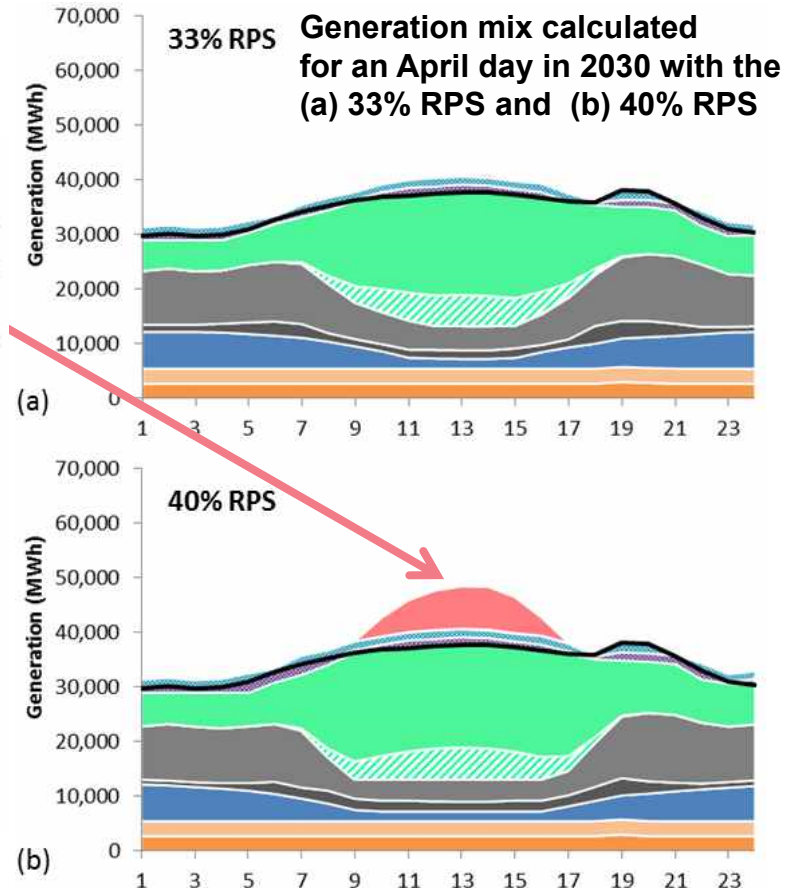
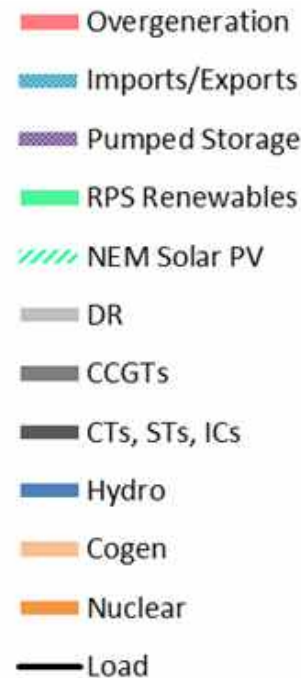
Solutions in the age of renewable generation

Daily over-generation

Three solutions:

1. Turn off wind PV (*wasteful*)
2. Battery storage (*expensive, but part of solution*)
3. Loads are flexible to use renewable electricity when surplus

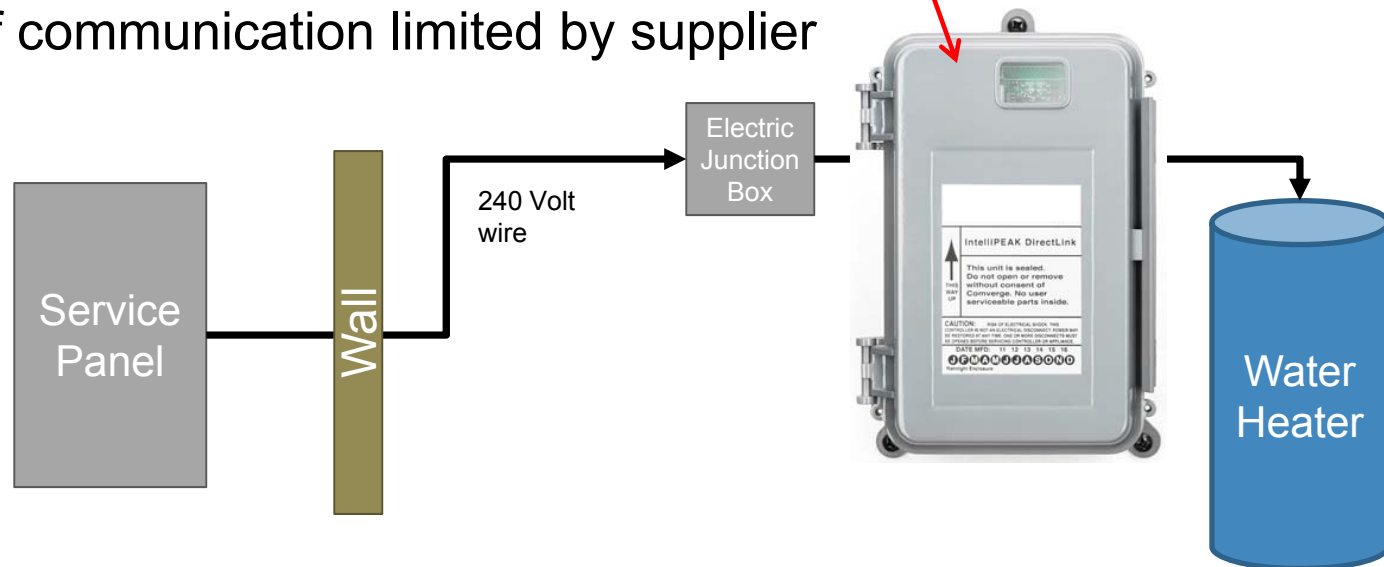
E.g. hot water heaters, pool pumps, HVAC, refrigerators, PEVs, water pumping, dryers



Reference: *Investigating a Higher Renewables Portfolio Standard in California*, Energy and Environmental Economics, Inc., 101 Montgomery Street San Francisco, CA 94104. Jan 2014

Water heater load control box

- Licensed electrician
- Often a city permit
- Customer at home
- Water heater loses all power
- Choice of communication limited by supplier



The Box Install is Too Expensive

Control Method => Install Component	Control Box	Standard Socket on Tank
Factory tank modification	none	\$15 (in volume; only \$1 for heat pump WH)
Control box	\$100	none (uses tank controls)
Communication device	included above	\$50 -> \$10 (in volume)
Installation & materials	\$175 (\$25 (average) for aborted starts)	\$0 (customer-installed)
Join program incentive	\$50 (to leave work to meet installer)	\$0
Reserve to remove unit	\$50	\$0
Marketing	\$M	50%*\$M
Permit	\$15	\$0
Total	\$390 +\$M	\$65 -> \$10 + 0.5*\$M

Socket is means
to lower \$

Standard communication interface

Need to reduce cost: Choices

- Wired
 - E.g. RS-485, Ethernet, BACnet
 - **Secure, but hassle**
- Wireless
 - PLC (e.g. Home Plug), Wi-Fi, CDMA, Z-wave, Bluetooth
 - **Always-on energy use, even if never connected**
 - **Opens vector for hackers**
 - Many appliances can not upgrade software
- Socket (*socket allows all of above standards*)
 - USB, ANSI/CTA-2045
 - USB, prone to noise, does not support PLC
 - [ANSI/CTA-2045](#)
 - Today, **to address issues in red**, smart appliances have **proprietary sockets**



[Credits: Creative Commons](#)



Advantages of a standard socket

- Enables any WAN, or LAN, or wired connection method
- Compared to embedded communication, doesn't incur energy or hardware cost until customer elects connected-operation... maybe never.
- Security issues solved in the communication device not the appliance
- Volume lowers the cost of the communication device
- Cheap memory means communication device can have a "library" of device-specific knowledge
- [Remote] communication protocols can come and go, without ever affecting the functionality of an appliance with a 20-year life

The customer install



GOAL:
ANSI/CTA-2045 socket on tank.
This one proprietary

ANSI/CTA-2045 "plug"
on communication
device



Early communication device from e-Radio

What is CTA-2045, really?

- Digital communications are complex and break
- A single, end-to-end communication requires multiple standards
- Before the CTA-2045 question, let's review human-to-human communication.

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          You're using an older web browser version that
          may make your computer unsafe. <a
            href="http://browsehappy.com/">Download the latest version</a> to keep
            your information safe and improve your experience.
            <a href="#" class="alert-close" aria-label="Close
              alert"></a>
            ...
```

HTTP, JPG, XML, WSP, TCP, IP,
Ethernet, Sonet, GSM, DSL,
IEEE802.11, USB, RS-232



Human-to-human communication

- Communication is between two people (or two machines in the digital world)
- In sports, ever try to **talk to a ball** you just hit?
 - **Doesn't work**, reliably does it?
 - Why not? **(Serious Question!)**
 - Answer: Balls lack a standard physical layer



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Human Communication Requires Use of 3 standards

1. Use the same physical communication method
2. Use the same rules to exchange information
3. Use the same language (for example: Latin)

Quod erat demonstrandum!

Lo entiendes?

你明白吗？

Erhalten sie es?

#1 The Physical Standard

- This is about physical ability to perceive a communication signal
 - You have the right sensor and signal processor
 - Humans use light, sound, and touch
- Most of us have vocal cords and ears with brains to create/process sound waves
 - Most humans have the same physical standard, even if they use different languages
 - Hearing-impaired people example of difficulty and cost of not having a working hearing sensor
 - *Spoiler Alert: CTA-2045 is like putting ears and vocal cords on all appliances, or a USB socket on all computers*



#2 Use Same Rules for Info Exchange

On the next slide I list many human-to-human conventions for information exchange

You learned most of these rules before age 5.

The single take away:

We follow a lot of rules to communicate effectively!



#2 Information exchange protocols

- Two strangers meet:
 - My language or yours? Neither => partial communication with simple words, or pointing, or charades, or body language, smiles, frowns, yes and no, etc.
- More effective than Yes/No
 - Repeat message end with “Aye, Aye” or Negative. Digital world equiv. ACK or NAK
- Telephone etiquette: [ring] next R: “Hello” next C: “This is Joe, may I speak to Sam”
- Tone at end of message: WMWV↘ = “.” MWMW[↑] = “?” ↘ = “!”
- Legal Documents: Misplaced “,” “;” and “.” can cost millions during a dispute
- Follow rules for effective communication
 - Articulate points, not too aggressive or too passive, eye contact or none
 - Good listener, personal space, appropriate body language, and attire
 - Don’t talk over another speaker; okay to interrupt “air-time” hog
 - Dynamic group start talking as current speaker about to finish (not all cultures)
 - Follow rules of grammar/linguistics/syntax, e.g.: subj, verb, object, “.”
- When asked a question impolite not to respond
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