



**Platte River**  
Power Authority

# Integrated EV & PV Workshop

July 2016

The Energy We Live By™



# Introductions

- **Host & Moderator: Joel Danforth**

- With over 10 years of experience in renewable energy and project management, Danforth is currently a distributed energy program manager at Platte River Power Authority. Danforth holds a B.S. in Energy Infrastructure and is certified as a Federal Technical Project Officer. He is also a recent recipient of the professional certificate in Energy Innovation and Emerging Technologies from Stanford University.

- **EV Panelist: Doug Hatch**

- Doug Hatch is a Linux project manager within the HPE Servers business unit at Hewlett Packard Enterprise (HPE). He joined Hewlett-Packard in 1983 and has held positions in various business units for software development, program management and project management. Doug has driven a Nissan Leaf EV since February of 2014. During this same timeframe, he has been a very active volunteer for Drive Electric Northern Colorado (DENC). Doug additionally helps with the EV charging at his workplace. Working with site management, he helps EV owners register for EV charging and stay informed on workplace EV events and topics.

- **PV Panelist: Norm Weaver**

- Norman Weaver, Sr. Energy Services Engineer with Fort Collins Utilities, is a registered professional engineer and energy efficiency technology specialist with over 30 years involvement in the building science and renewables field. Mr. Weaver oversees Fort Collins' photovoltaics net-metering and solar electric incentives programs.



# Today's Agenda

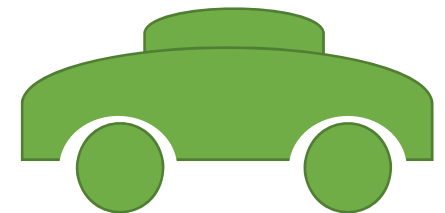
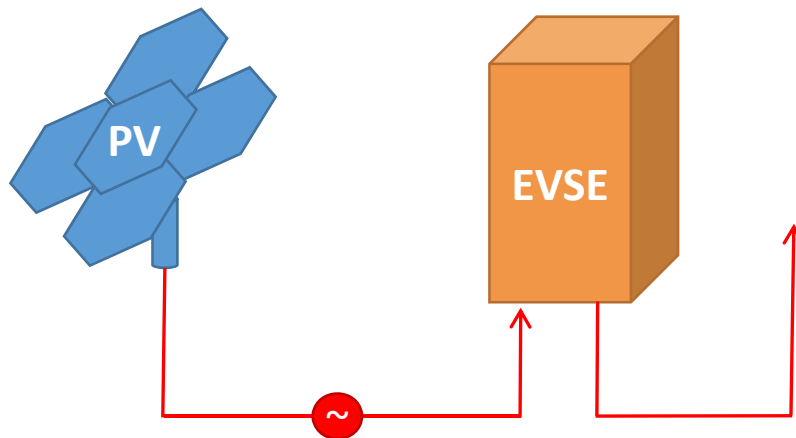
- Overview of the EV/PV Landscape
  - Objectives
  - Technology Review
  - Safety Standards
- Electric Vehicle (EV) Charging Stations
  - Workplace Charging Case Study
  - Available Incentives
- Photovoltaic (PV) Systems
  - PV Carport Concept
  - Available Incentives
  - Permitting



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# Objectives

Our learning objectives for today are to better understand the basics of Electric Vehicle Supply Equipment (EVSE) and photovoltaic (PV) systems, and how the two might be integrated. Case studies on the subjects of EVSE and PV installations will be presented in hopes to better understand the technical and regulatory requirements associated with these projects; and information on available state and local incentives will be shared.



# Why EV+PV?

- EV “emissions” – a consumer perspective

Vehicle Emissions by Energy Source	Emissions Intensity	Emissions per Mile
ICE: National Average for Gasoline	8,887 g CO <sub>2</sub> /gal <sup>1</sup>	411 g CO <sub>2e</sub> /mile <sup>1</sup>
EV: Conventional Generation	790 g CO <sub>2</sub> /kWh	237 g CO <sub>2e</sub> /mile
EV: Daytime PV Charging	0 g CO <sub>2</sub> /kWh	0 g CO <sub>2e</sub> /mile

- While EV charging in our region is already less emissions intensive than the national average for gasoline powered vehicles, EV-associated emissions may approach zero when combined with daytime solar PV generation.

1 <https://www.epa.gov/sites/production/files/2016-02/documents/420f14040a.pdf>

# Charging & Generation Profiles

A. Loveland Public EVSE Charge Profile

Hour	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
1	0	0.36%	0	0	0	0	0	0.36%
2	0	0	0	0	0	0	0	0.00%
3	0	0	0	0	0	0	0	0.00%
4	0	0	0	0	0	0	0	0.00%
5	0	0	0	0	0	0	0	0.00%
6	0	0	0	0	0	0	0	0.00%
7	1.09%	0	0	0	0.36%	0	0.36%	1.82%
8	0.36%	1.09%	0.36%	1.46%	0.36%	0	0	3.65%
9	0	1.46%	1.09%	0.73%	0.73%	0.36%	0	4.38%
10	1.09%	0.36%	1.82%	1.09%	1.09%	0	0.73%	6.20%
11	0.73%	1.09%	2.19%	1.09%	1.46%	1.46%	0.36%	8.39%
12	1.09%	1.46%	0.73%	2.19%	1.09%	1.82%	1.46%	9.85%
13	1.09%	0.36%	2.19%	1.09%	1.46%	1.82%	2.55%	10.58%
14	2.19%	2.92%	0.36%	1.82%	1.82%	1.46%	2.92%	13.50%
15	1.09%	1.09%	1.09%	0.73%	1.82%	0.73%	0.73%	7.30%
16	1.09%	2.55%	2.92%	1.82%	2.55%	1.82%	1.09%	13.87%
17	1.09%	1.46%	1.09%	1.46%	0.73%	1.82%	1.09%	8.76%
18	0	0.36%	1.09%	0.73%	0.73%	1.46%	1.82%	6.20%
19	0	0	0	0.73%	0	0	0.36%	1.09%
20	0.36%	0	0	0	0.36%	0	0.73%	1.46%
21	0	0	0	0	0.36%	0.73%	0.73%	1.82%
22	0	0	0	0	0	0	0.36%	0.36%
23	0	0	0	0	0	0	0.36%	0.36%
24	0	0	0	0	0	0	0	0.00%

B. Simulated Single-axis Tracking Solar

Hour	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0.00%	0.01%	0.00%	0	0	0	0	0
6	0	0	0	0.02%	0.10%	0.16%	0.12%	0.03%	0.00%	0	0	0
7	0	0	0.04%	0.21%	0.42%	0.48%	0.46%	0.26%	0.16%	0.05%	0.00%	0
8	0.02%	0.16%	0.33%	0.57%	0.75%	0.77%	0.83%	0.64%	0.54%	0.37%	0.20%	0.03%
9	0.39%	0.57%	0.76%	0.89%	0.92%	0.93%	1.04%	0.93%	0.88%	0.76%	0.61%	0.40%
10	0.70%	0.78%	0.96%	1.02%	1.04%	1.07%	1.13%	1.10%	1.03%	0.91%	0.76%	0.62%
11	0.73%	0.84%	0.99%	1.05%	1.06%	1.10%	1.12%	1.13%	1.03%	0.92%	0.79%	0.60%
12	0.73%	0.80%	0.99%	1.01%	1.05%	1.09%	1.05%	1.05%	0.95%	0.89%	0.69%	0.57%
13	0.71%	0.74%	0.95%	1.01%	1.05%	1.05%	1.00%	0.97%	0.92%	0.86%	0.71%	0.59%
14	0.64%	0.65%	0.89%	1.00%	1.02%	1.00%	0.98%	0.92%	0.93%	0.87%	0.69%	0.56%
15	0.68%	0.60%	0.89%	0.96%	0.95%	0.94%	0.93%	0.86%	0.88%	0.83%	0.62%	0.55%
16	0.59%	0.60%	0.82%	0.88%	0.83%	0.80%	0.84%	0.73%	0.81%	0.73%	0.43%	0.37%
17	0.17%	0.38%	0.66%	0.77%	0.70%	0.68%	0.77%	0.65%	0.62%	0.39%	0.09%	0.06%
18	0.01%	0.06%	0.30%	0.50%	0.55%	0.60%	0.62%	0.46%	0.26%	0.07%	0.00%	0.00%
19	0	0.00%	0.06%	0.18%	0.28%	0.36%	0.31%	0.15%	0.03%	0.00%	0	0
20	0	0	0	0.00%	0.04%	0.09%	0.08%	0.01%	0	0	0	0
21	0	0	0	0	0	0.00%	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0

- Note: the majority of charging events (~80%) still occur overnight. The EV/PV concept applies primarily to public, commercial, and workplace charging.

# Technology Review – EV (1 of 2)

- Electric Vehicle Supply Equipment (EVSE):
  - Level 1 – Single Phase / 120 V
  - Level 2 – Single or Split Phase / 208 V or 240 V
  - DC Fast Charger (DCFC)
    - Two or Three Phase / 240 V or 480 V



# Technology Review – EV (2 of 2)

- “Smart” (Networked) Chargers
  - Wifi or CDMA connection required
  - Capable of accepting credit/RFID card payment
  - Track information on usage, metering, DR, etc.
- Connectors
  - J1772
  - CHAdeMO
  - SAE Combo-connector
  - Tesla connectors





# Technology Review – PV

- Solar Modules
  - Monocrystalline vs. Polycrystalline
  - Ground-mount vs. Rooftop
  - Tilt vs. Azimuth
  - String configuration for higher voltages
- Inverter
  - DC-AC Conversion: 96%<sup>2</sup>
  - System Losses: 14%<sup>2</sup>
  - IEEE 2030.5 Standard



<sup>2</sup> <http://pvwatts.nrel.gov/pvwatts.php>

# Technology Review – Integration

- System Sizing

EVSE Type	Power Requirement	Approx. # of PV Modules	Approx. Surface Area
Level 1	1.8 kW	9 (250 W ea.)	112 sq. ft.
Level 2	6.6 kW	33 (250 W ea.)	411 sq. ft.
DCFC	50+ kW	250+ (250 W ea.)	3,117+ sq. ft.

- Grid support likely required for DCFC.

# Safety Standards

- Equipment
  - EVSE: UL 2594
  - PV: UL 1703, 1741
- Installation
  - EVSE: NFPA 70 – Article 625
  - PV: NFPA 70 – Article 690



# EV Charging Station Experience

**Doug Hatch – Hewlett Packard Enterprise**

Integrated EV and PV

Wednesday, July 27, 2016 8:00 AM-10:30 AM

215 N. Mason St. - Community Room



# Topics

- Charge Ahead Colorado Grant
- Permitting/Installation
- Installation Photos
- Process Perspectives
- Benefit Perspectives

# Charge Ahead Colorado Grants

In an effort to improve air quality and encourage deployment of electric vehicles across the State of Colorado, the Regional Air Quality Council (RAQC) and Colorado Energy Office (CEO) have teamed up to provide financial support for electric vehicles (EV) and electric vehicle supply equipment (EVSE).

<http://cleanairfleets.org/programs/charge-ahead-colorado>



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# Charge Ahead Colorado Grants (Continued)

## Criteria and Eligibility Differs Between RAQC and CEO

	RAQC	CEO
<b>Funding</b>	Electric vehicles (EV) and Electric Vehicle Supply Equipment (EVSE) – Level 2 and Level 3	Electric Vehicle Supply Equipment (EVSE) – Level 2 and Level 3
<b>Eligible Fleets</b>	Fleets and entities located in the seven county Denver Metro Area (Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas or Jefferson Counties).	Entities located in Colorado outside of the seven county Denver Metro Area.
<b>EV Funding Available</b>	RAQC will fund 80% of the incremental cost differential between an EV and the comparable gasoline vehicle up to \$8,260.	CEO is not funding EVs.
<b>EVSE Funding Available</b>	RAQC and CEO will fund 80% of the cost of an EVSE up to the following set maximums: <ul style="list-style-type: none"> <li>• Level 2, Single Port Station: \$3,260</li> <li>• Level 2, Multi-Port Station: \$6,260</li> <li>• Level 3, Single Connection Standard Station: \$13,000</li> <li>• Level 3, Multiple Connection Standard Station: \$16,000</li> </ul> Please see the Application Guide for more information on EVSE Type.	
<b>Funding Priority</b>	Priority is directed to those organizations that are excluded from existing state tax credits and incentives. For both EVSE and EV funding, eligible applicants include local governments, school districts, State / Federal agencies, non-profit educational institutions and other non-profit agencies. Apartment / condominium complexes and businesses that own multi-vehicle parking facilities for fleet, public or guest / visitor are also eligible for EVSE funding.	Funding is directed to private non-profit or for-profit corporations, state agencies, public universities, and public transit agencies, in addition to local governments, landlords of multi-family apartment buildings and homeowner associations (as defined more specifically in C.R.S. Article 33.3 of Title 38).

# Charge Ahead Colorado Grants (Continued)

- Applications Are Submitted Online (Word Template For Preparation)
- Charge Ahead Colorado Application Guide Must Be Read
- Next Application Round Will Be July 2016
- No Funding For Retroactive Projects
- Upon Award, A Procurement Plan (Including Bid Process) Is Submitted
- Once Procurement Plan Is Approved, Bids May Be Solicited
- An Awardee Training Meeting Is Provided For Granted Funding
- Must Have Dedicated Parking For EV Use Only
- Five Years Minimum Operation
- See Application And Application Guide For More Details

## Contacts:

- RAQC: Matt Mines 303.629.5450 x210 <mailto:mmines@raqc.org>
- CEO: Zach Owens 303.866.3279 <mailto:zachary.owens@state.co.us>



# Permitting/Installation

- General Contractor Coordinated Electrical, Concrete, Painting
- Boring Costs High So Located Close To Power Panels
- Used Larger Conduit To Allow For Future Expansion

# Installation Photos



# Process Perspectives

- Plan Ahead... When Funds Are Ready, You Can Move Quickly
- Find Funding For Chargers
- Get An Executive Sponsor
- Take Advantage Of Other Construction Projects
- Be Aware Of Local Regulations & How You Can Charge For Charging
- Anticipate Expansion of Charging Station Infrastructure
- Consider Charging Policies (Move Cars After Charging, Free or Fee,...)

# Benefit Perspectives

- Supports Corporate Stewardship Objectives
- Helps Attract And Retain
  - Employees Want Green Alternative Transportation



# Carport PV for EVs?

**Norm Weaver – Fort Collins Utilities**

Integrated EV and PV

Wednesday, July 27, 2016 8:00 AM-10:30 AM

215 N. Mason St. - Community Room



# Carport PV for Evs?

- Currently 50+ charging stations in Ft. Collins area
- Currently 53 commercial PV sites, 900kW
- Three examples of solar carport structures
  - Innosphere, Insitu, Intel (not currently tied to EVSE)





# PV Incentives

- FC Utilities PV Rebates – currently up to **\$10,000** (for 20kW)  
CAP proposals may expand rebates for larger systems
- Level 2 Example – Three 6kW stations – 20kW PV carport (~1300sf)
  - “Employee Benefit”
  - Estimated Net Install Cost \$35k (solar only)  
(with structure & foundation, ITC and PV rebate)
  - 12 year payoff of station implies “Cost to Charge” of 12 ¢ /kWh
  - Equiv. to about 3 ¢/mile vs. gas car at about 7 ¢/mile

# Permitting

- Make choice on charging level to be offered
- Solar Installer/Electrician will likely handle project permitting through the Fort Collins Building Services dept.
- Permitting for Roof mount and Carport PV is usually straightforward  
See also FC Building Services: [www.fcgov.com/building](http://www.fcgov.com/building)

Add'l Info: [www.fcgov.com/ElectricVehicles](http://www.fcgov.com/ElectricVehicles)



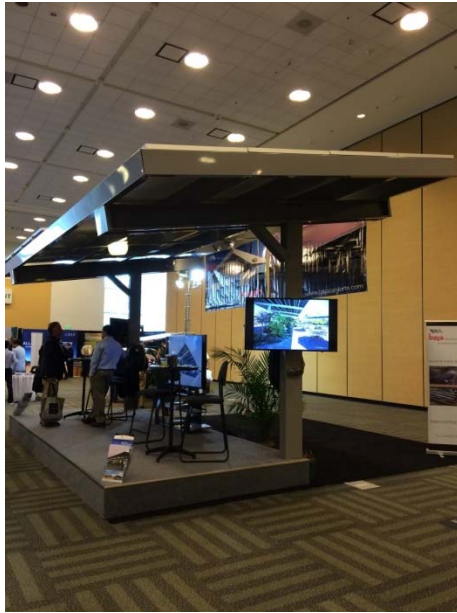
# PV Interconnection

- PV Interconnection Application at [www.fcgov.com/solar](http://www.fcgov.com/solar), no fee
- Provide initial site and one-line information to FC Utilities
  - Permit pre-review sent to FC Building dept.
- Complete installation – after final electrical inspection FC Utilities schedules commissioning check and send Permit-to-Operate

# San Francisco EV Charging Biz Model

- Locate 100 to 200 sites with 50kW PV arrays, ~50kWh battery storage and 4 to 6 charging stations on Commercial rental property
- Multiple value streams” from
  - Net metering savings to building tenants
  - EV Charge site rent to building owner
  - “Cap Rate” value to building owner
  - Grid regulation value from Utility from dispatchable battery bank
  - EV charging revenue from membership model with Uber-style phone app to locate and reserve charging session
- Developer’s “IP” is a permittable package in SF (fire code and elec. code viz custom batteries, ...), bldg owners agreements, and EV driver membership system.

# Pre-Engr'd Carports, InterSolar2016



[info@bajacarports.com](mailto:info@bajacarports.com)

# Austrian 2kW Smartflower !





# Questions

# Utility Resources & Permits

- Fort Collins Utilities
  - Electric Service Standards: Ordinance No. 066, 2016
    - [http://www.fcgov.com/utilities/img/site\\_specific/uploads/ElectricServiceStandards\\_FINAL\\_17June2016.pdf](http://www.fcgov.com/utilities/img/site_specific/uploads/ElectricServiceStandards_FINAL_17June2016.pdf)
  - Commercial Service Information Form
    - [http://www.fcgov.com/utilities/img/site\\_specific/uploads/c-1\\_form.pdf](http://www.fcgov.com/utilities/img/site_specific/uploads/c-1_form.pdf)
  - Parallel Generation & Interconnection Requirements
    - <http://www.fcgov.com/utilities/residential/renewables/parallel-generation>
  - Solar Rebates
    - <http://www.fcgov.com/utilities/residential/renewables/solar-rebates>



# Utility Resources & Permits

- Loveland Water & Power
  - Request for Electric Service
    - <http://www.ci.loveland.co.us/modules/showdocument.aspx?documentid=25225>
  - Solar Photovoltaic Systems Checklist
    - <http://www.ci.loveland.co.us/modules/showdocument.aspx?documentid=7318>
  - Interconnection Standards
    - <http://www.ci.loveland.co.us/index.aspx?page=1553>



# Utility Resources & Permits

- Longmont Power & Communications
  - Electric Service Request
    - <http://longmontcolorado.gov/departments/departments-e-m/longmont-power-communications/electric-service>
  - Solar System Documents & Forms
    - <http://longmontcolorado.gov/departments/departments-e-m/longmont-power-communications/electric-service/renewable-energy/solar-energy>
  - Interconnection Standards
    - <http://longmontcolorado.gov/home/showdocument?id=2865>

