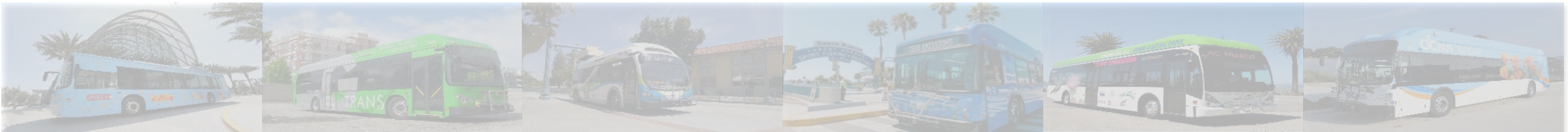
CALIFORNIA
AIR RESOURCES BOARD

Transit Infrastructure Workgroup Meeting

January 31, 2023



General Information

- This meeting is being recorded
- All meeting materials are available on the Innovative Clean Transit website

Purposes

- Strategize on how to move toward a one hundred percent zero-emission bus fleet
- Understand the current successes
- Discuss infrastructure related challenges and solutions needed for a full-scale conversion
- Identify next steps

Agenda

- Introduction (9:30-9:40)
- California's ZEB Transition–present and future (Caltrans and Go-Biz) (9:40-9:50 AM)
- Hydrogen track (9:50-12:00)
  - Case studies (9:50-10: 45)
  - Discussion topics (10:45-11:20)
  - Questions and comments (11:20-11:45)
  - Next Steps (11:45-12:00)
- Lunch
- Electrical track (1:00-4:00)
  - Case studies (1:00-2:20)
  - Discussion topics (2:20-3:10)
  - Questions and comments (3:10-3:40)
  - Next Steps (3:40-4:00)

California's Zero-emission Bus Transition–Present and Future

- **Gia Brasil Vacin**

  Deputy Director of Zero Emission Vehicle Market Development

  Governor's Office of Business and Economic Development (GO-Biz)

- **Kyle Gradinger**

  Chief, Division of Rail and Mass Transportation

  California Department of Transportation (Caltrans)

Case Study 1: Successes & Lessons Learned

- Station construction timeline (Foothill, OCTA)
- Back-to-back fueling (AC Transit)

Roland Cordero

Director of Maintenance and Vehicle Technology, Foothill Transit

Fuel Cell Consulting Services SOW

Foothill Transit

- Develop Hydrogen Fueling Station Plan
- Determine Joint Use Fueling Facility
- Grant Funding
- Develop Specifications for the Fueling Facility
- Develop Fuel Cell Bus Specifications
- Project Management
- Training

Required Procurements

Foothill Transit

- Bus Procurement
- Design, build, install fueling stations
- Maintenance facility upgrades
- O&M of fuel cell station
- Provision of hydrogen (liquid or gas)

Cliff Thorne

Cliff Thorne

Director of Maintenance,

Orange County Transportation Authority (OCTA)

OCTA H2 Fueling Station Timeline

RFP

- **6 Months**
  - 2 months to submit bids
  - 2 months to evaluate bids and Board approval
  - 2 months to prepare and execute agreement

Design

- **8 Months**
  - 7 months from NTP to 100% Plans
  - 1 month for OCTA to approve

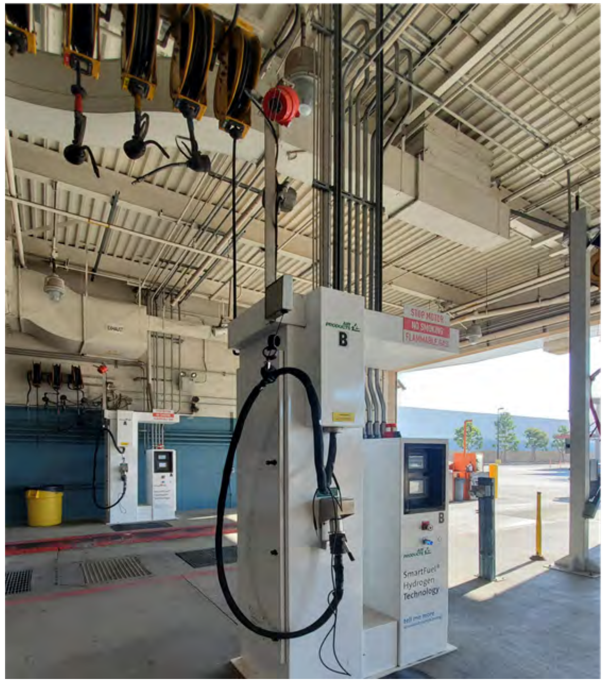
Construction

- **16 months**
  (Originally 9 months)
  - Combination of several issues
  - Documents
  - Permits
  - Unforeseen items

30 Months

Lessons Learned

- Research lead times
  - Permitting process
  - Equipment
- Electrical demands
  - How will the station be powered
  - Are upgrades needed
  - Contact electricity provider early
- Talk to others
  - Transit agencies
  - Private companies



Zero Emission for a Heathy Community

Cecil Blandon

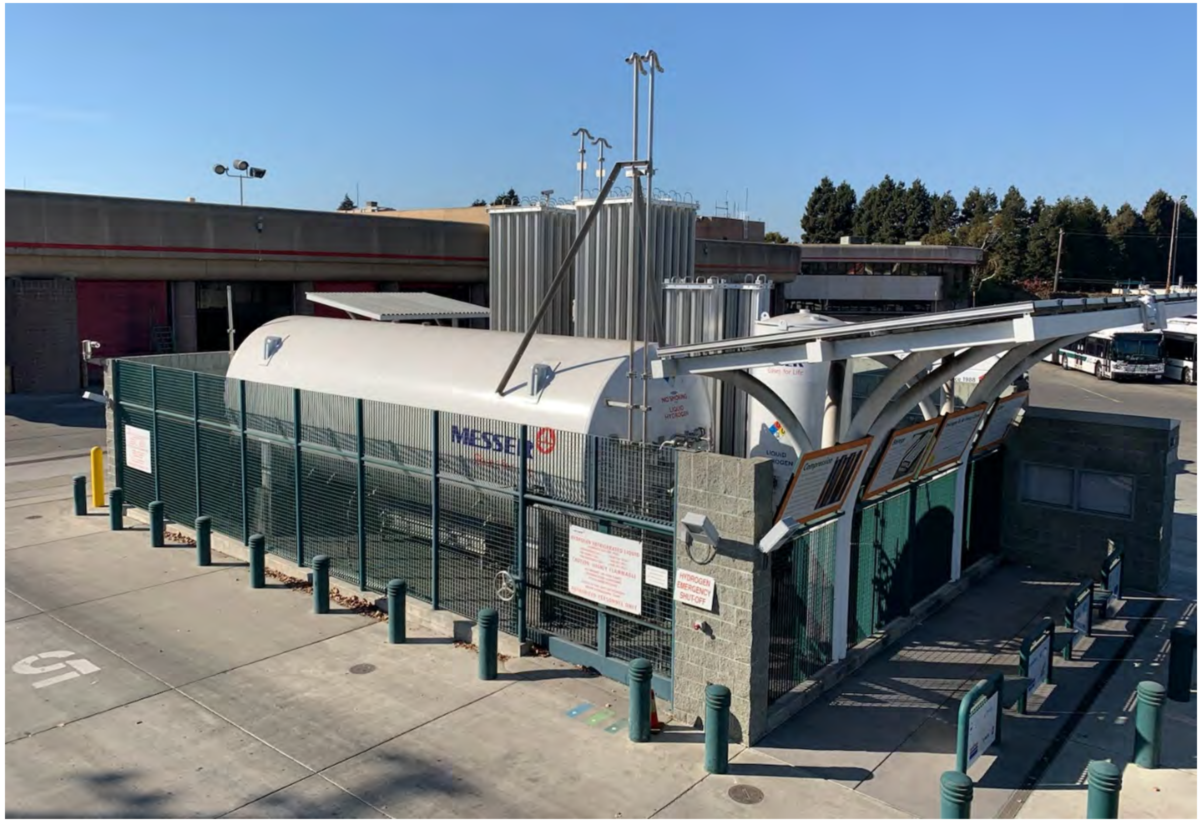
Director of Maintenance
Alameda-Contra Costa County Transit (AC Transit)

Back to Back Fueling

- Dual Cryogenic Hydrogen Pumps
- Liquid Hydrogen Tank (15,000 gal)
- Pressure Vaporizers
- High Pressure Storage (360kg @ 7,777 psi)
- Dispensers (5,000 psi/350bar)
- 2019 Upgrade Cost $3.8M

Back to Back Fueling

- Fueling Capacity = 65 buses
- Fueling Time = 6-8 min
- Lesson Learned
  - 1 Cryogenic Pump Can Continuously Support 1 Dispenser
  - Higher Availability & Reliability



Case Study 2: Cost and Supply Methods

- Cost (SunLine)
- Rural area cost and supply (Humboldt)

Lauren Skiver

CEO/General Manager, SunLine Transit Agency

The Hydrogen Bottom Line

- Hydrogen based transport is expected to reach the break-even point by 2028
  - Factors that will impact this goal are source energy prices, infrastructure, education and willingness, regulatory frameworks
- Hydrogen can make the most sense in the short term for large, long-range vehicles
  - Buses, trains, trucks, and marine
  - Hydrogen is already an economically viable alternative to BEB technology for these vehicle types

H2 Costs Puzzle

- Electricity Costs
- Maintenance Agreements
- Water
- Production Amount

Opportunities of Hydrogen Cost Containment

- Control energy cost
  - Microgrid/solar connected to the hydrogen production
- Enter into long term agreements
  - Operation & Maintenance Period
  - Long term delivery contracts
- Legislation to control utility costs for hydrogen production
- State/Federal Rebates
  - Low Carbon Fuel Standard (LCFS) Credits
  - Renewable Energy Credits
- Commercialization

Current Hydrogen Costing Metrics

- H2 price goes down when usage of our produced H2 goes up
- Understanding electricity costs is crucial
- FC buses get 7 to 10 miles per kg as compared to 2.8 miles per CNG gge
- Range and reliability are key for SunLine

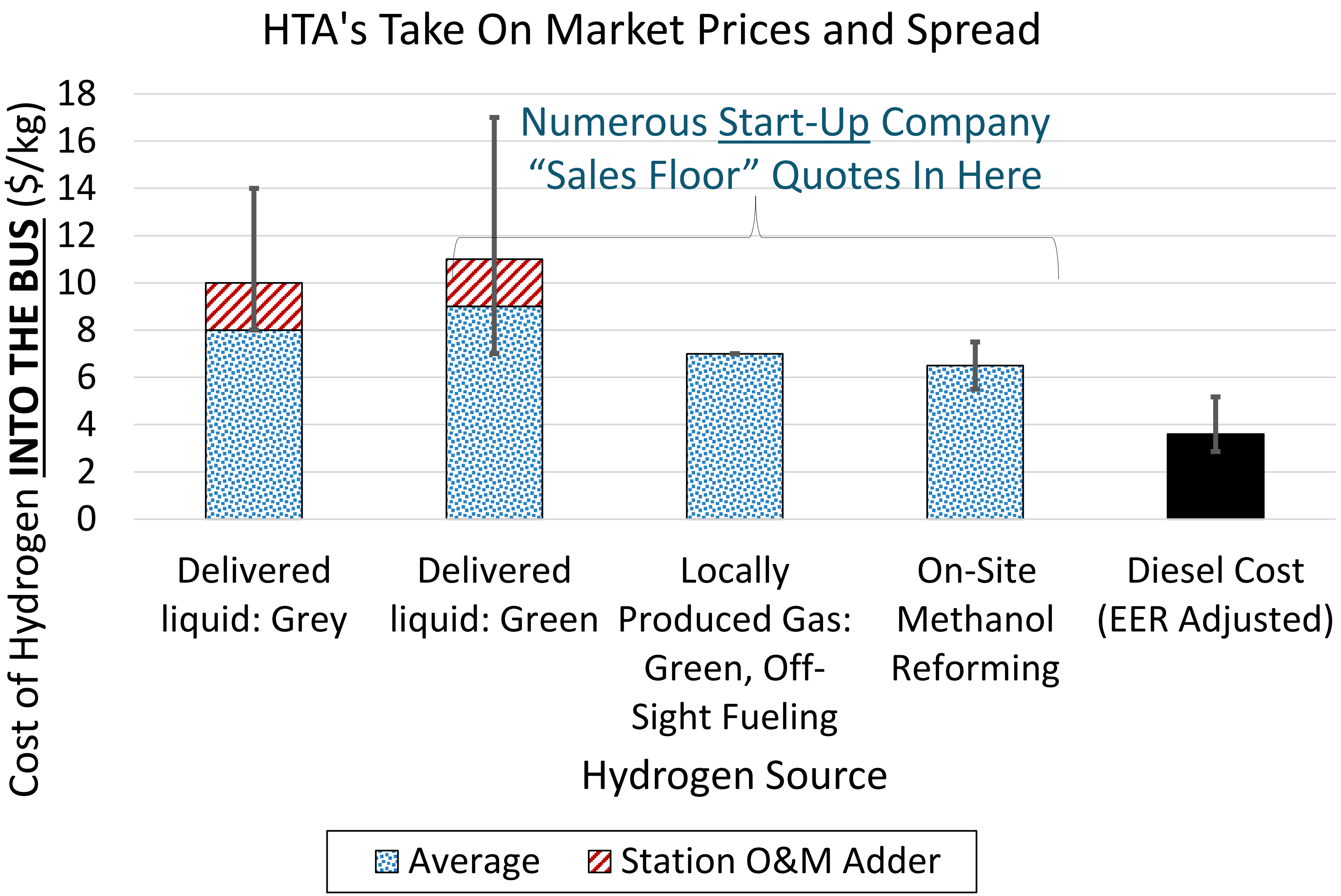
SunLine Transit Agency Contact Information

- SunLine Transit Agency Website
- Phone number: 760-343-3456
- SunLine Transit Agency Email address

Jerome Qiriazi

Transit Planner, Humboldt Transit Authority

Case Study 2: Cost and Supply Methods



- Significant variability and uncertainty in supply cost
- Delivery + onsite liquid storage presents the least complicated solution to resiliency. However, delivery disruptions from road conditions presents a challenge.

Case Study 3: Infrastructure Resiliency

- Fueling in emergency and power outage (AC Transit, OCTA)
- More infrastructure resiliency for on-site production (SunLine)

Cecil Blandon

Director of Maintenance
Alameda-Contra Costa County Transit (AC Transit)

Infrastructure Resiliency

- Power Outage Risks
  - PG&E Power Shut Off
  - Road Incident
  - State Emergency
- Process Doesn't Change
- Exploring Alternative Methods to Power Generation

Cliff Thorne

Director of Maintenance,

Orange County Transportation Authority (OCTA)

(Reserved)

Lauren Skiver

CEO/General Manager, SunLine Transit Agency

(Reserved)

Discussion Topics for Hydrogen Track

- What to expect for low carbon-intensity H2 supply and price?
- What is the economics for FCEBs and H2 dispensing? Funding? Investment? Long-term price predictability?
- How would a rural H2 station be different from an urban station in terms of fuel cost, maintenance support, and delivery frequency?
- Are station designs becoming more replicable? If so, what effect does that have on permitting, station build timelines, and capital cost?
- What policy drivers are needed?
- How could H2 be a solution for range and infrastructure resiliency (use of H2 for grid load relief)?

Questions & Comments Reminders

Use the raised hand function (#2 if calling in by phone) on Zoom to ask your question or provide comment.

Please clearly state your **name** and **affiliation** before asking a question or making a comment.

Next Steps

Lunch… Is Important

- We are coming back at 1:00 pm

Recap of the Morning Discussions

Case Study 1: Successes & Lessons Learned

- Deployment size (LA Metro)
- Pilot experience (Foothill, AC Transit)
- Planning and collaboration (Tulare)

Steve Schupak & John Drayton

- Steve Schupak. VP, National ZE Transit Lead · AECOM
- John Drayton, Zero Emission Mobility, National Practice Lead, Burns Engineering, Inc.

Case Study 1: LA Metro Orange Line BRT Success Story

- 18 miles from end to end
- 40 NF 60’ articulated buses
- 3 en-route stations with 8 pantograph chargers
- Over 2.5 million revenue service miles

Case Study 1:
LA Metro Orange Line BRT Success Story

Case Study 1: LA Metro – Project Inception – Metro Orange Line BRT

Project Selection – "Where is the low hanging fruit?"

- Understanding technology status and limitations
- Short product development cycles

Project Alignment

- Political and Exec Leadership (who is the champion?)
- Utilities
- Supplier Relationships

Project Initiation

- Meeting Cadence

Roland Cordero

Director of Maintenance and Vehicle Technology, Foothill Transit

Foothill Transit

BEB Experience

- 11 years experience
- Limited Range
- Demanding charging requirements
- Operational impacts
- High cost of in-route chargers
- High cost of technology parts

Foothill Transit

Existing and Future Depot Operational Assessment

- $120 M to electrify entire fleet
- Not one to one bus replacement
- Buses will be charged when returning to the depot.
  - Overnight charging will be the bottleneck in the future
  - Charged buses will move to parking area and another bus will be charged
- Only electrify 60% of bus routes

Richard Tree

Executive Director,

Tulare County Regional Transit Agency

TCRTA
Tulare County Regional Transit Agency

Case Study 1: Strength In Partnerships

- 13 Heavy-Duty Transit Buses
- 15 Medium-Duty Shuttle Vans
- 3 Infrastructure Projects
  - 24 DCFC Charging Stations
    - 2 Depot Charging
    - 1 Opportunity Charging

Planning and Collaboration

- Opportunities for Partnerships
  - Transit, School, Public Works
- Early Engagement with Utility Provider
- ZEB Rollout Plan
- Site Planning & Evaluation
- Grid Analysis
- Fleet and EVSE Acquisition

Jose Vega

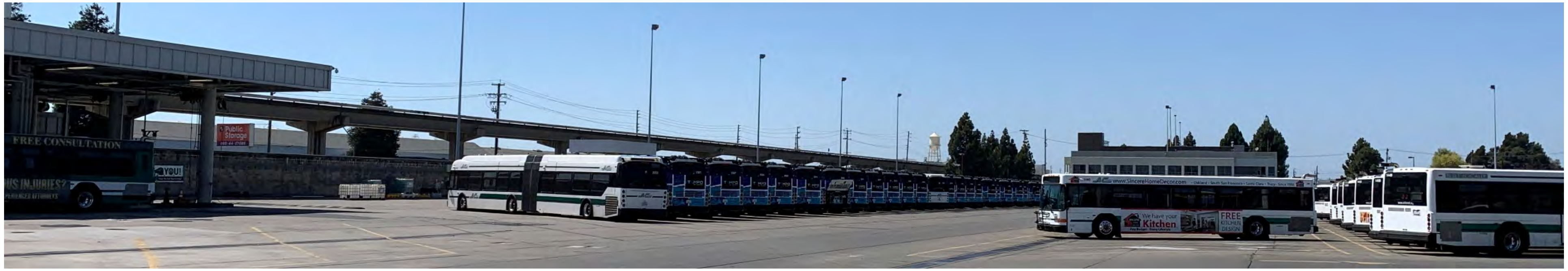
ZEB Programs Administrator
Alameda-Contra Costa County Transit (AC Transit)

BEB Pilot Experience

- (5) 2019 NF 40’ 466kW
- Jan 2020 To Present
- Total Fleet Miles 329,851
- Lifetime Totals
  - Avg Miles Per Bus 65,970
  - MBCR 5,997
  - CPM 1.77 (1.25/.51)
  - kWh Avg $0.23
  - Availability 65%

BEB Pilot Experience

- Charging Infrastructure
  - (7) CPE250 62kW
  - Daisy Chain Connection
- Lessons Learned
  - Charger Availability
  - Warranty Cost
  - OEM Handshake
  - Resiliency
  - Turn Around Time for Service
  - Adjusted Transition Plan 30% BEB/70% FCEB



Case Study 2: Rural Transit Grid Capacity—Upgrade Is More Than Site Make-ready

- Microgrid study (Central Valley)
- Rural transit (Humboldt)

Amy Hance

General Services Manager, City of Clovis

Understanding Your Power Options

Electrical Grid Analysis Study - FCRTA

Fresno County Generation and Transmission

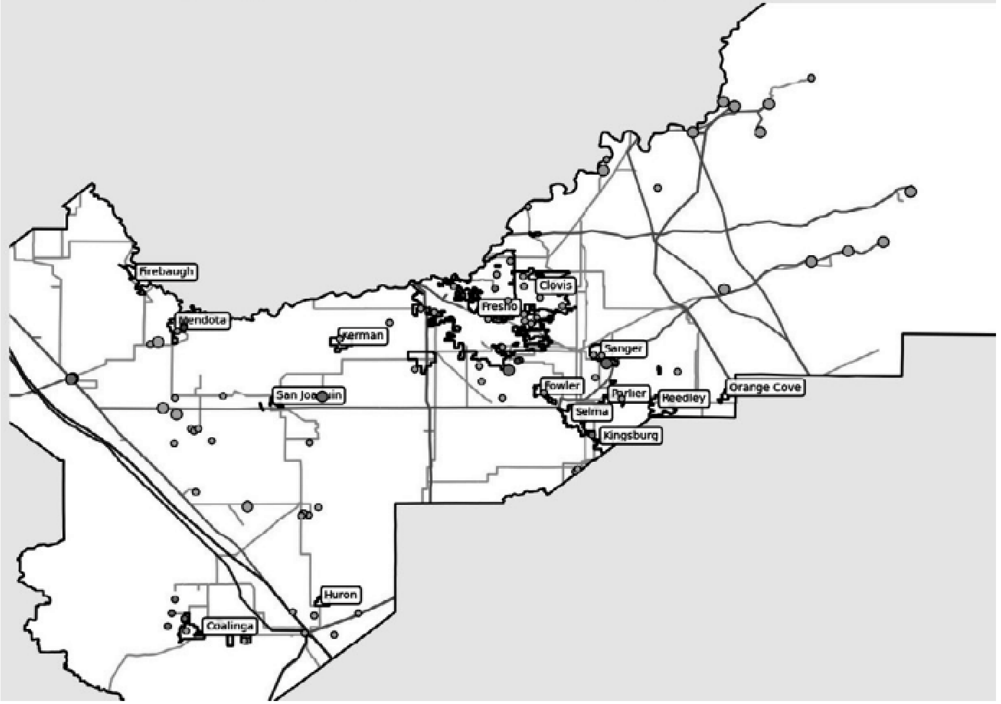
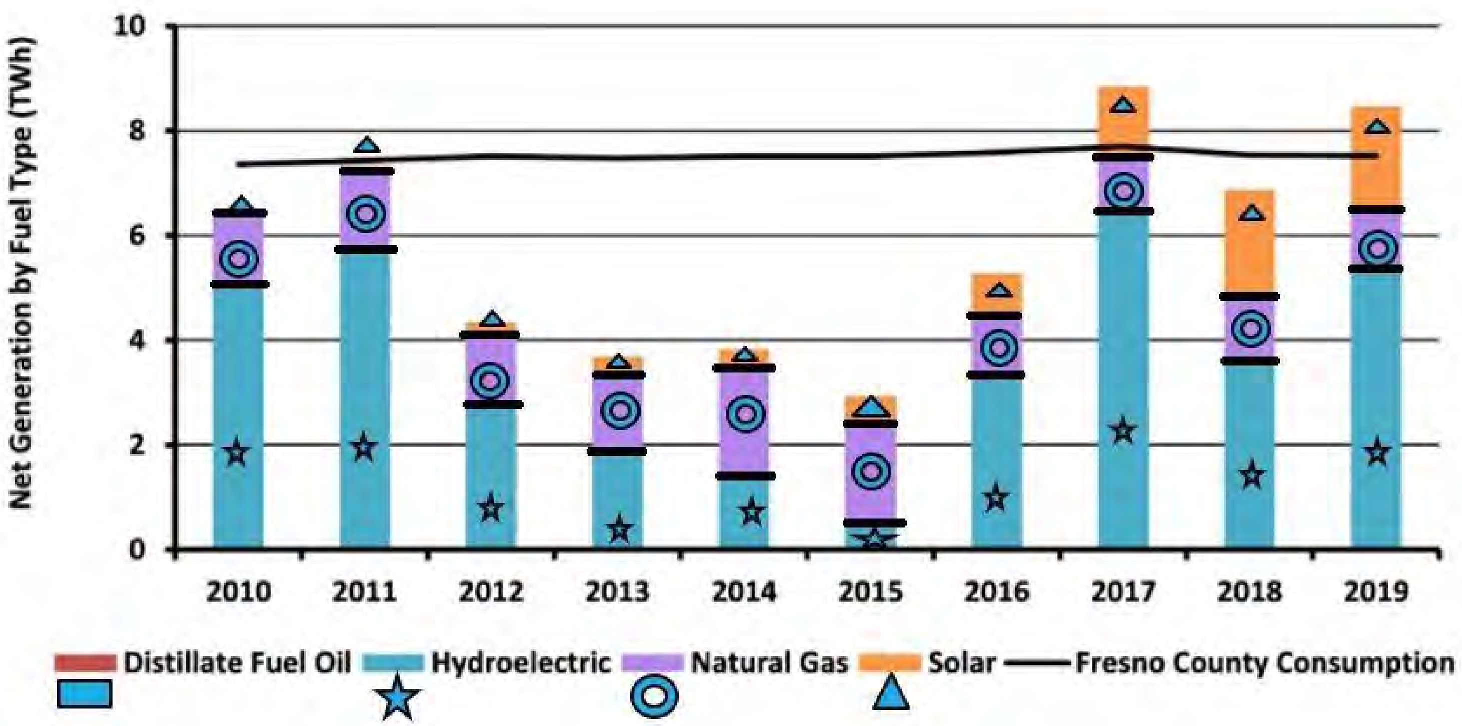


Figure 31: Net Generation in Fresno County by Fuel Type




CAUTION
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ZEUS

Jerome Qiriazi

Transit Planner, Humboldt Transit Authority

Case Study 2: Rural Transit Grid Capacity—Upgrade Is More Than Site Make-ready

- End of distribution line at main facility
- Little remaining capacity in Southern Humboldt for the foreseeable future
- Difficult navigating EV Fleet Program
  - Utility limited us to 150kW with requirement to purchase 5 buses
  - This lends uncertainty regarding how many more buses we could electrify, if any, in the future.

Case Study 3: Large Transit Grid Capacity—Substation and Regional Grid Load

- High power need (LA Metro)

Steve Schupak & John Drayton

- Steve Schupak. VP, National ZE Transit Lead · AECOM
- John Drayton, Zero Emission Mobility, National Practice Lead, Burns Engineering, Inc.

Case Study 3: Large Transit Grid Capacity—Substation and Regional Grid Load

- LA Metro Divisions 9 in El Monte requires 10mW for full division electrification
  - SCE had an immediate 5mW available
  - Additional 5mW substation negotiated between SCE and LA Metro, CalTrans
  - Anticipated completion at 2-5 years

Case Study 3: Large Transit Grid Capacity—Substation and Regional Grid Load

- LA Metro Divisions 18 in Carson requires 10mW for full division electrification
  - SCE was able to accommodate the full 10mW immediately
  - Redundancy options ranged 10mW without redundancy over existing circuitry (Approx. $300k), to full dual 66kv lines transformers and separate dedicated substation (Approx. $25 mil)
  - Ongoing monthly utility charges varied depending on level of service significantly with increases in equipment

Jose Vega

ZEB Programs Administrator
Alameda-Contra Costa County Transit (AC Transit)

Planned Upgrades For BEB Deployment

- Emeryville D2 (construction)
  - 26 Distributed Charging Stations
  - 160 to 200 kW Charger with Dual Ports
  - Plug In
  - Switchgear Delay of 1 year

Planned Upgrades For BEB Deployment

- Oakland D4 (design)
  - 24 Distributed Charging Stations
  - 160 to 200 kW Charger with Dual Ports
  - Bus Yard Overhead Trellis, Plug in
  - Needed Service 4,000amp
  - Large Load Study Estimated 3-6 Months to Determine Power to Site
  - PG&E Not Making Grid Upgrade, Focused on Wildfire Prevention

Case Study 4.1: Infrastructure Resiliency—Charger Operation In A Power Outage

- LA Metro

Steve Schupak & John Drayton

- Steve Schupak

  VP, National ZE Transit Lead

  AECOM

- John Drayton

  Zero Emission Mobility, National Practice Lead

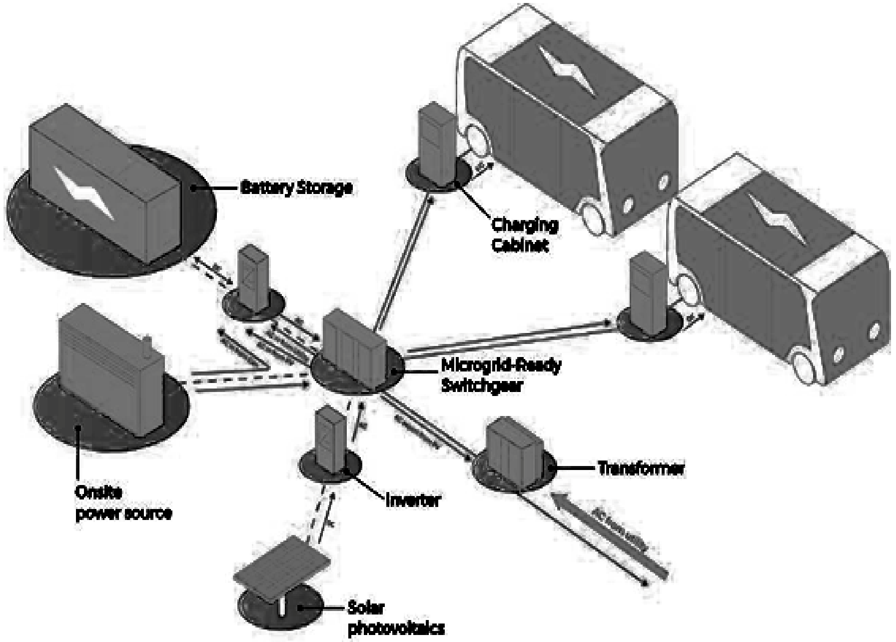
  Burns Engineering, Inc.

Case Study 4.1: Infrastructure Resiliency—Charger Operation in a Power Outage

- LA Metro has geographic separation of charging circuits for better resiliency on the MOL
  - Division 8 - ten 150kW plug in chargers fed by dedicated LADWP circuit
  - Chatsworth Station – two 600kW pantograph chargers (1.5 miles from Division 8)
  - Canoga Station – two 600 kw pantograph chargers (4.5 miles from Chatsworth, & ~13 miles from North Hollywood Station)
  - North Hollywood Station – four 450kW chargers
  - One instance to date of power failure at one station

Utility Coordination, Resiliency and Microgrids

- Review public data on local energy assets and constraints
- Early utility engagement to determine loads available
- Evaluation of utility reliability and value of resilience
- Energy bill review and future tariff analysis
- Interconnection agreements for on site power generation
- Detailed design of on-site power generation



Case Study 4.2: Infrastructure Resiliency—Opportunities And Limitations For Off-grid Charging

Richard Tree

Executive Director,

Tulare County Regional Transit Agency

Case Study 4.2 Infrastructure Resiliency

- Planning In-Progress
  - FTA's Helping Obtain Prosperity for Everyone
  - CEC's Blueprint
  - DOT's Strengthening Mobility and Revolutionizing Transportation (SMART)

Infrastructure Resiliency - Opportunities

- Living Laboratories
- Maximize Investments
- Reduce TCO
- Optimization
  - Energy
  - Infrastructure
- Integrated Charge Management

Infrastructure Resiliency - Challenges

- Limitations with Utility Programs
  - Separate Meters
- Space Requirements
  - Microgrid
  - Energy Storage
- Interoperable and Integration
- Cost

Case Study 5: How Grid Upgrades Are Planned And Funded (IOU Process)

- Southern California Edison
- Pacific Gas and Electric

Roger Salas & Mike McCarty

- Roger Salas

  Principal Manager Distribution System Analysis

  Southern California Edison

- Mike McCarty

  Distribution Engineering Manager

  Pacific Gas and Electric

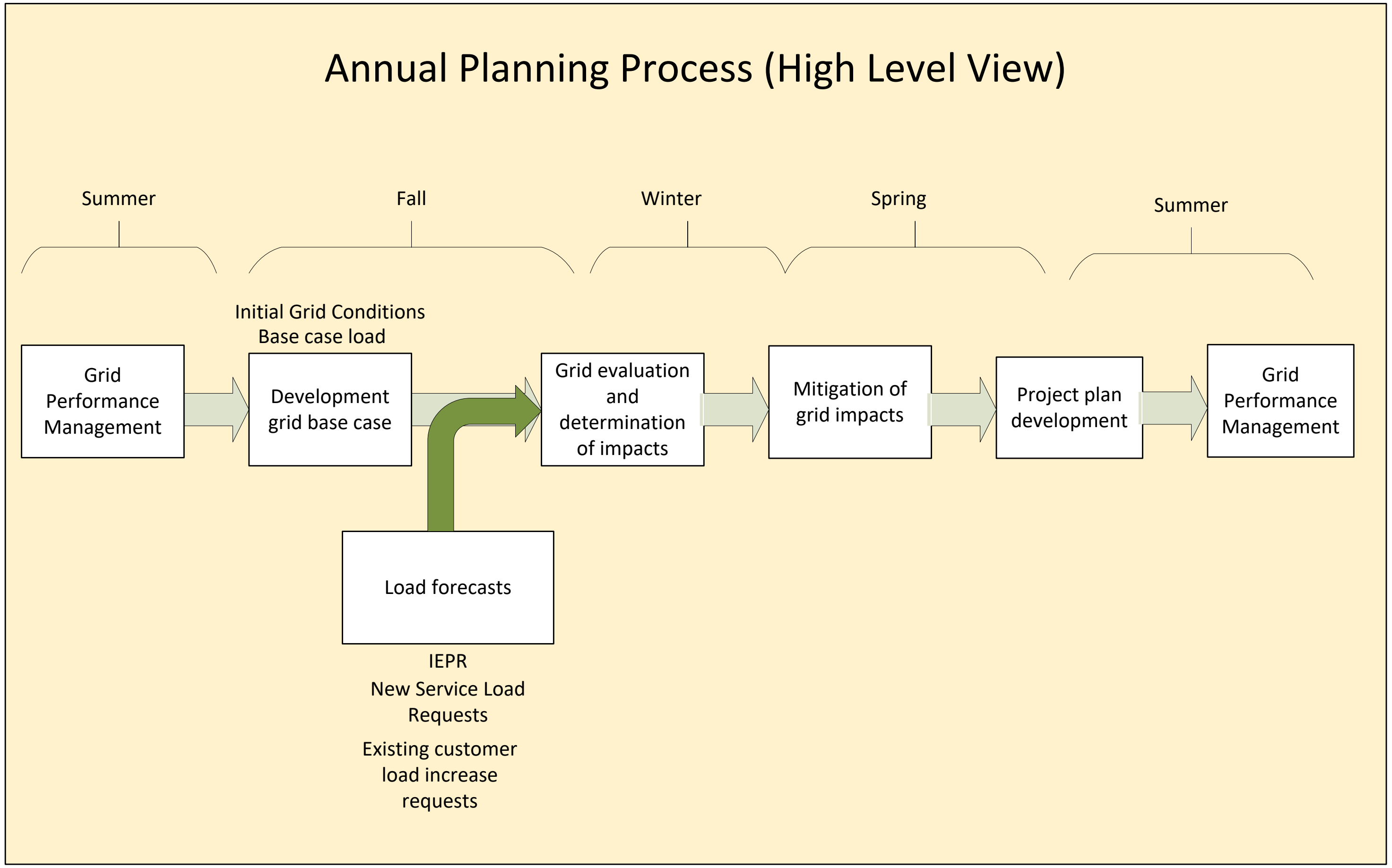
Case Study 5: How Grid Upgrades Are Planned And Funded (IOU Process)

- Primary method for determining grid upgrades is via annual Distribution Planning Process(DPP)
- Annual DPP accounts for:
  - Load and DER projections as stablished in the Integrated Energy Policy Report (IEPR)
  - New load growth projects known to be of high confidence to the IOUs (new residential tracks, new business, new charging station services with actual plans)
  - Grid capacity limitation on the distribution systems (such as, substation capacity, circuit capacity, equipment capacity)
- Through the DPP, short term and long-term upgrades are produced-General times outlined below
  - Small system upgrades (typical 2-3 year time frame) – Such as increases cable/conductor size, modification of underground conduit systems
  - Medium system upgrades(typically 3-5 year time frame) – Such as: New distribution feeders, increase in substation capacity
  - Large system upgrades (typically 4-6 years) –Large projects which may require licensing (such as new high voltage lines)
  - Very Long system upgrades – (typically 7+ years) – Large projects requiring licensing (such new substations – Applicable to SCE)
- Funding for DPP generated upgrades are funded via IOUs GRCs

Case Study 5: How Grid Upgrades Are Planned And Funded (IOU process)

- Important elements in the DPP process
- Long term forecasts (5+ years out)
  - Information from customer-base long-term forecast is essential for IOUs to consider in their long-term planning along with other forecasts (such the IEPR)
  - This information will allow IOUs to determine needs for large system upgrades (such as new substations)
- Short term forecasts (2-5 years)
  - It is extremely important that customers inform IOUs as early as possible of the development of customer projects
  - Certain areas of distribution grid are constrained and distribution upgrades will be needed to support these projects
  - At this range (2-5 years), IOUs would be able to insert small to medium distribution upgrades in their DPPs to support customer need
- Excessive short time (<2 years) of new load requests
  - This should not be practiced as this will likely not give IOUs time to develop the system upgrade to meet the customer needs

Case Study 5: How Grid Upgrades Are Planned And Funded(Graphical)



Case Study 5: How Grid Upgrades Are Planned And Funded (IOU process) – Large Load Requests

- Large single customer projects (typically 10 MW+) require special attention
- While these projects are needed for system planning, some aspect of funding may be different
- These large projects may require a customer-dedicated substation at the site
- Customers may be required to fund certain costs that may be beyond typical service
- These types of services are connected to high voltage distribution lines (>50 kV) which will likely require licensing under CEQA and GO 131-D
- Request of these type should be made at least 5 years in advance

Discussion Topics—Planning for current and future potential grid needs

- Are the local utilities getting sufficient information to accurately plan for grid upgrades?
- How far into the future do utilities plan for upgrades?
- How is the process or experience different in rural/remote settings vs. populated urban settings?

Discussion Topics—How ready are we if the electrical upgrades need to be completed in 3, 5, and 10 years?

- How to optimize the scale up process on the utility side? Staggered vs. one-time upgrade
- What is needed to promote early action—upgrading the grid ahead of demand, and how far in advance is acceptable?
- Assessing grid capacity from the utility perspective for each project
- Review and permitting process—at what point in permitting process are timelines for upgrades and utility connection/energization established?

Discussion Topics—Infrastructure Resiliency

- How could on-site solar power and energy storage be utilized?
- What are the regulatory requirements? Utility incentives or restrictions?
- What policy drivers are needed?

Questions & Comments Reminders

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Next Steps