Today's Transit for Tomorrow's World

Advancing Zero Emission Vehicle Bus Deployments

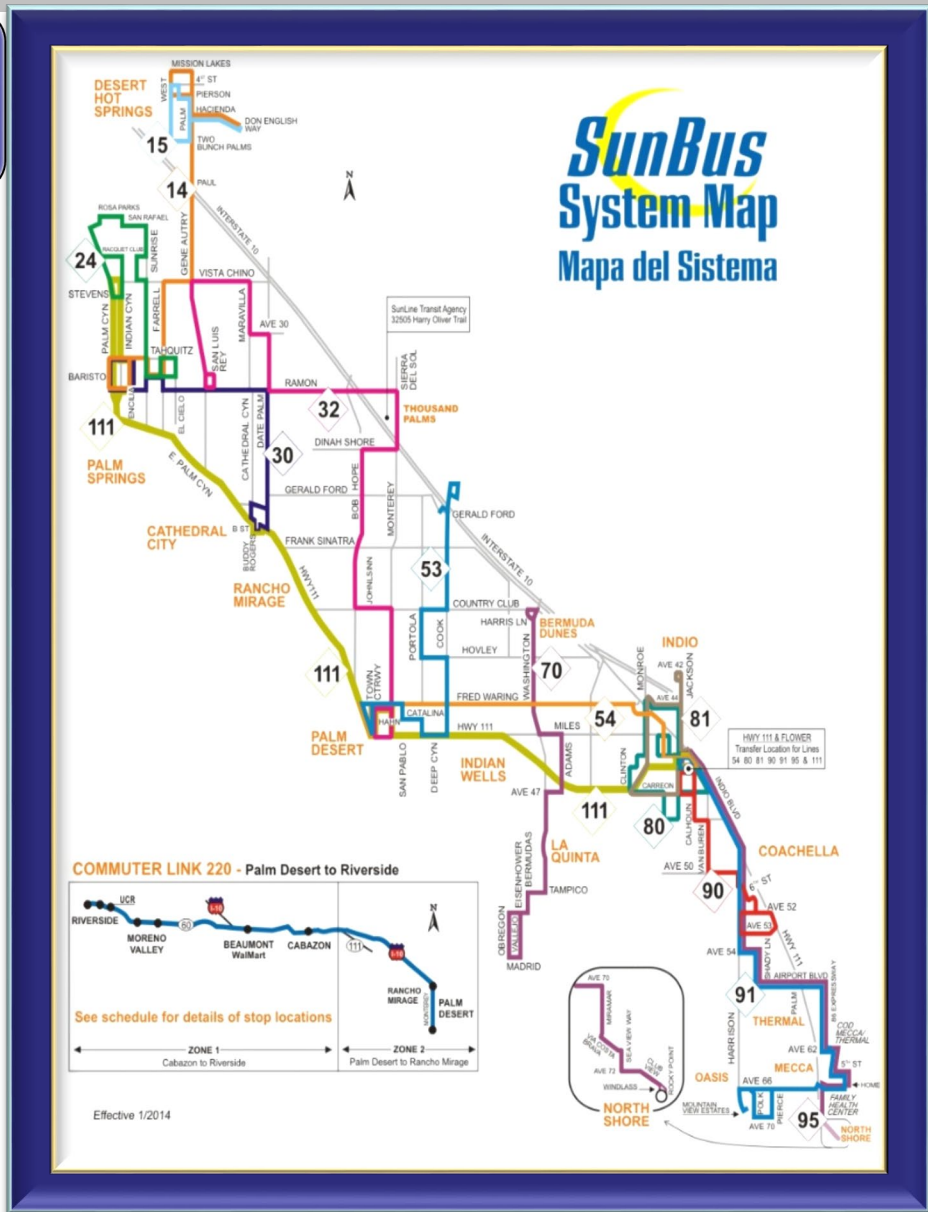
Lauren Skiver
CEO/General Manager
SunLine Transit Agency

Coachella Valley

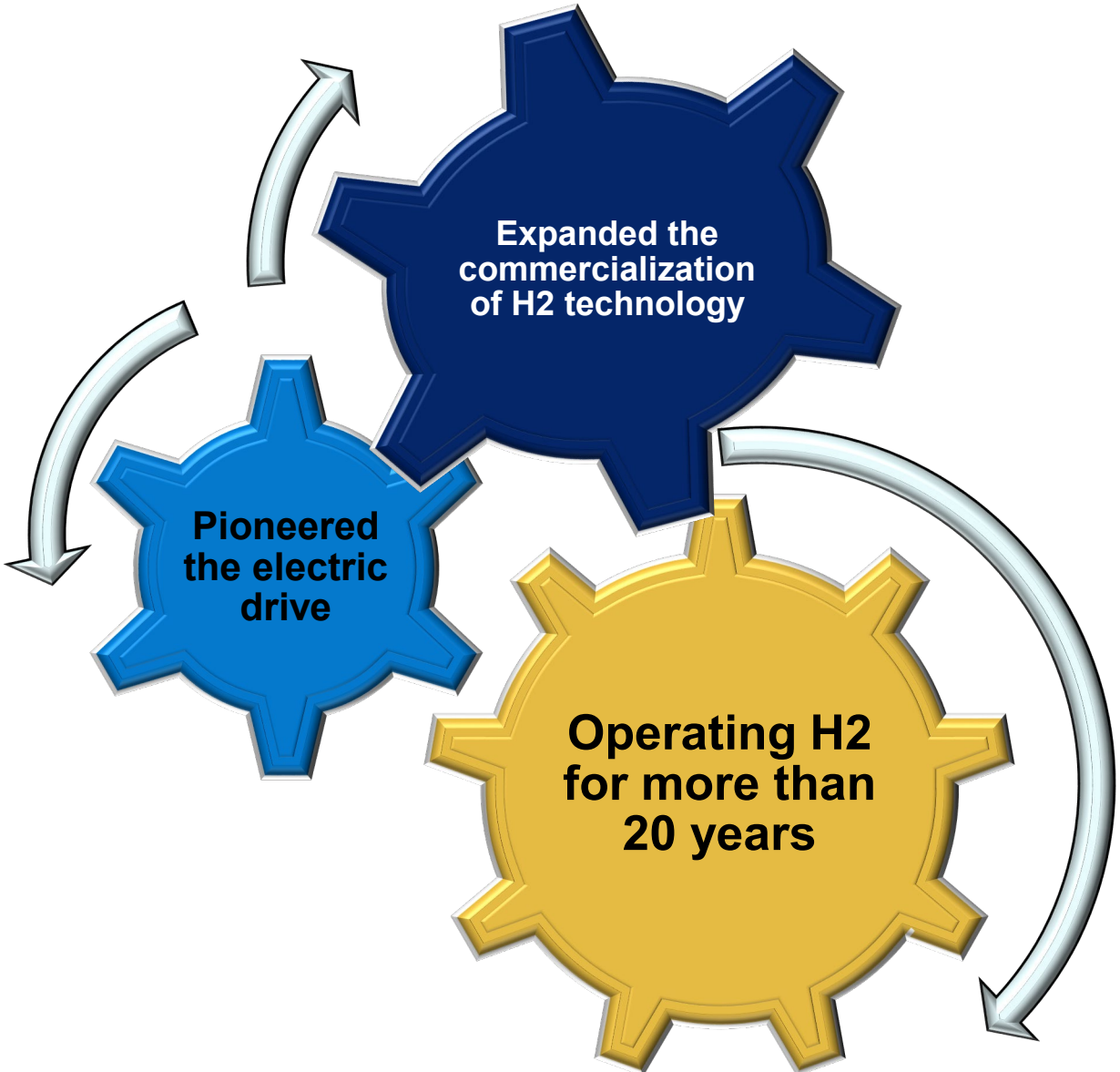
SunLine Facts

SunLine Operations

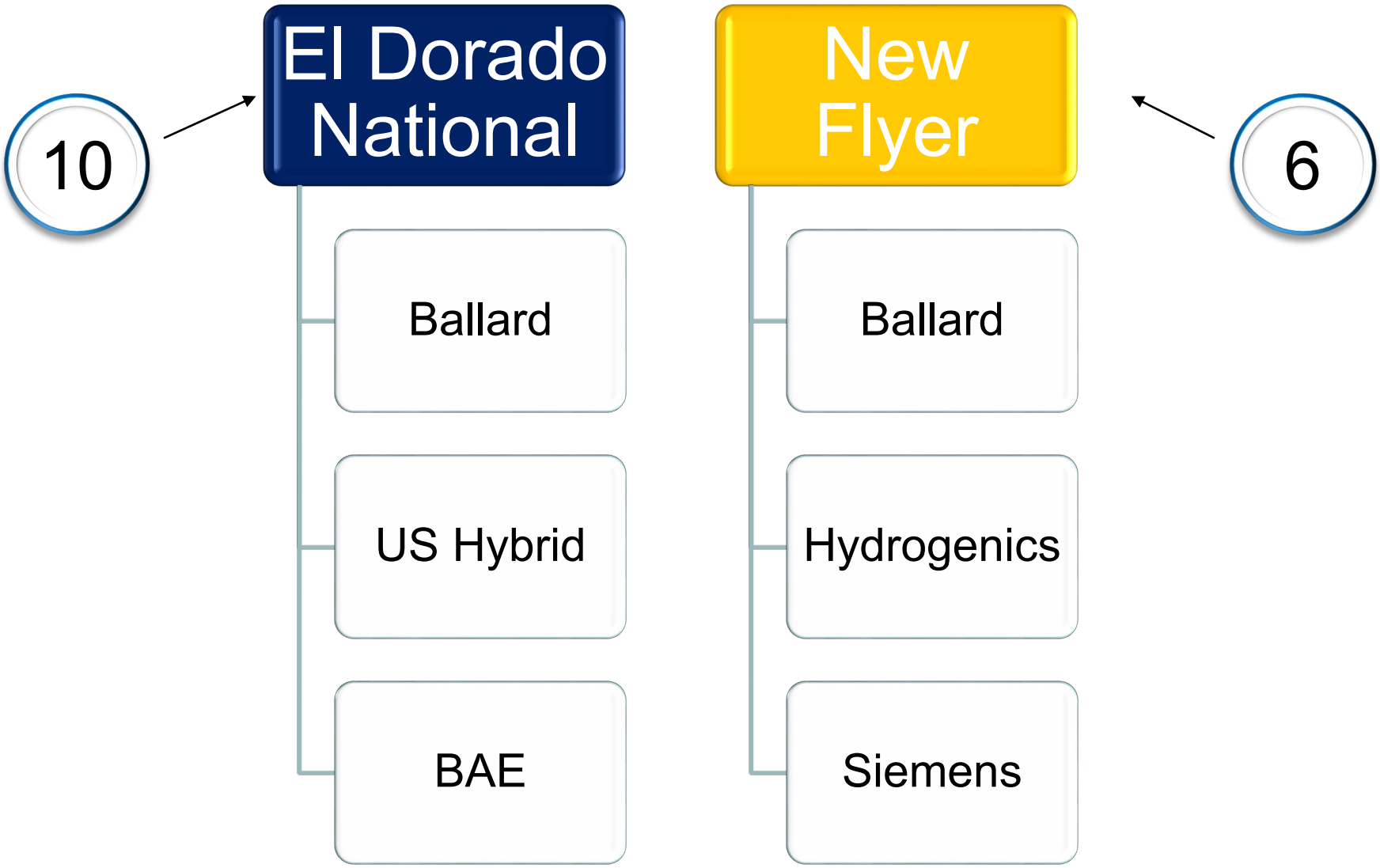
- Fourteen (14) local SunBus fixed routes, (1) express line, (1) Riverside Commuter Link, ADA Paratransit
- **61 CNG buses**
- **16 Electric Hydrogen Fuel Cell buses (2 more in production)**
- **4 All Electric Battery BYD buses**
- **39 CNG Paratransit Vehicles**
- Operated 4.3 million revenue miles for 4.5 million passenger trips
- 350 Employees



SunLine's Hydrogen Program



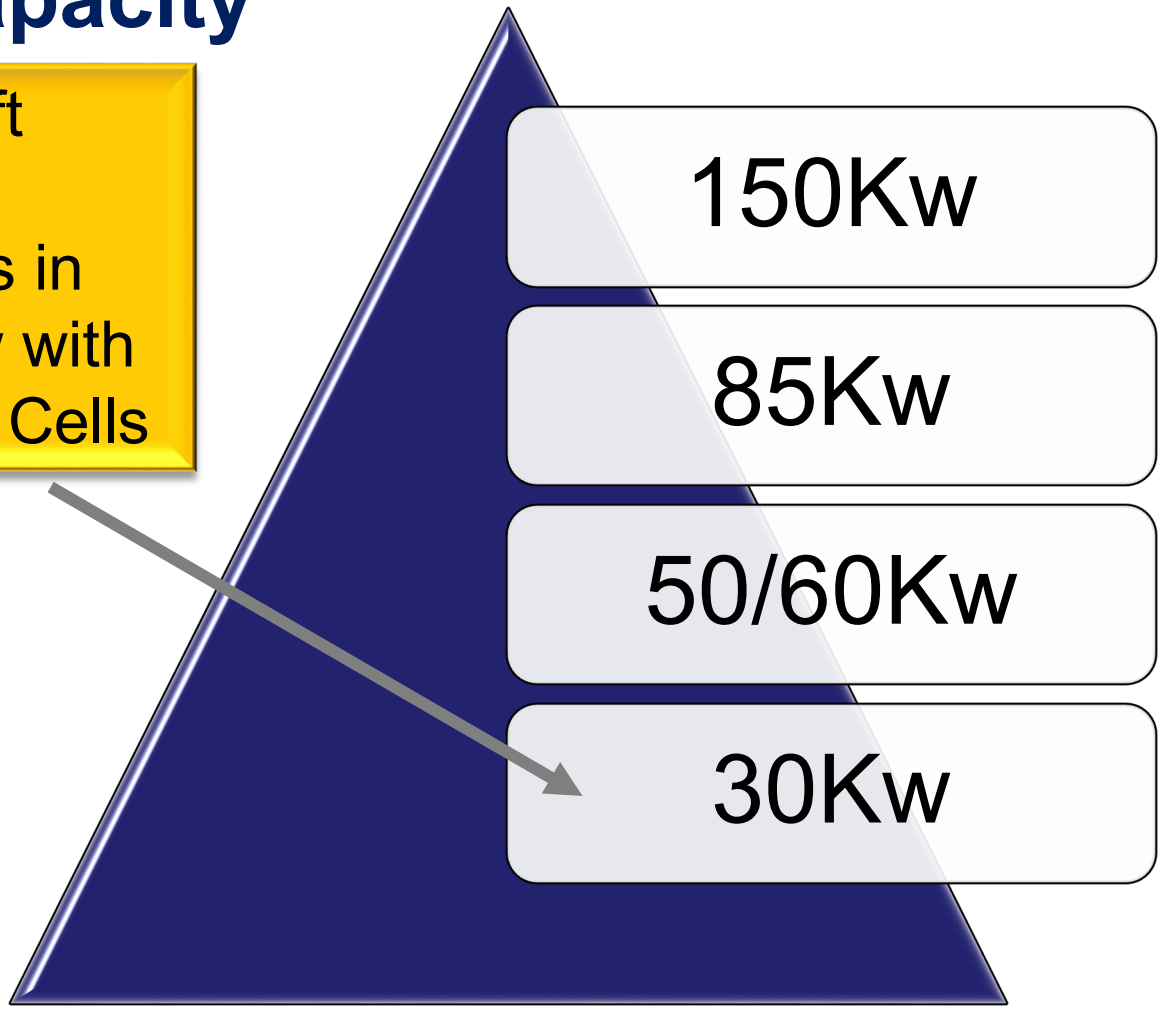
SunLine's Hydrogen Fleet



SunLine's Hydrogen Program

Fuel Cell Capacity

Two (2) 32ft
El Dorado
Shuttle Buses in
production now with
US Hybrid Fuel Cells



SunLine's Hydrogen Program

Current Fueling

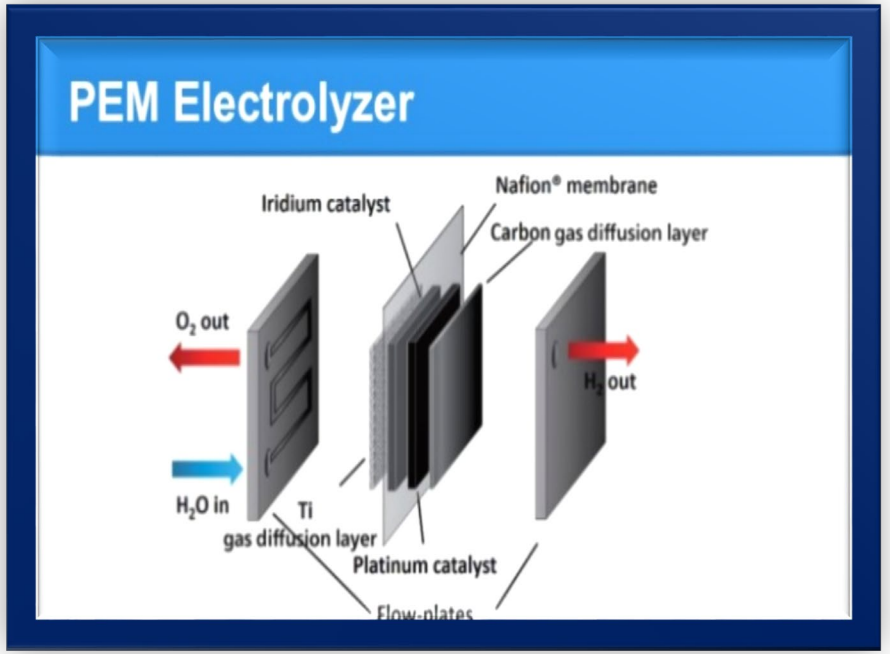
Hyradix SMR

- 220 Kg per day capacity
- Natural Gas / Bio Gas (landfill) source fuel
- Past its capacity for rolling stock
- Public fueling station – 350 Bar

SunLine's Hydrogen Program

In Commissioning

- Proton/Nel PEM Electrolyzer
- 900 Kg per day production
- 60% renewable solar electricity
- 380 Kg use per day
- 2 dispenser fast fill rate
- $8.7 Million CARB Grant
- Public Fueling – 700 Bar expansion for future



Overview – SunLine Hydrogen Fueling Station

Electrolyser and H2Station® for world's largest onsite hydrogen fueling station in California

- $8.3 million order for SunLine – World's largest onsite hydrogen fueling station to be located in California
- Turn-key solution including civil works, permitting, installation, commissioning and maintenance for 3 years:
  - 1 PEM electrolyzer with 2 compressors (not pictured) for hydrogen production – 900kg/day
  - 1 temporary 35MPa dispenser with supporting hydrogen storage and compression (future placement of 2 dispensers)
  - Capacity for up to 25 hydrogen fuel cell buses per day

Electrolyser | 2 x Hydrogen Storage | 2 x Station Module | 1 x Temporary Dispenser

© 2017 Nel Hydrogen | www.nelhydrogen.com

© 2017 Nel Hydrogen | www.nelhydrogen.com

© 2017 Nel Hydrogen | www.nelhydrogen.com

SunLine's Hydrogen Program

Future Fueling Exploration

- SunLine is looking to add a redundancy system that may include liquid Hydrogen or other solution to include outside purchases that are closer to our facilities
  - Contracted services for Hydrogen escalate to approx. $30 Kg
- We would also like to upgrade our second station in Indio for Hydrogen production and outside sales

Solar Energy

SunLine produces approximately 33 percent of it's electrical energy power from solar

FY19 – Second phase under construction now and provide approximately 60 percent of electrical energy usage from solar power

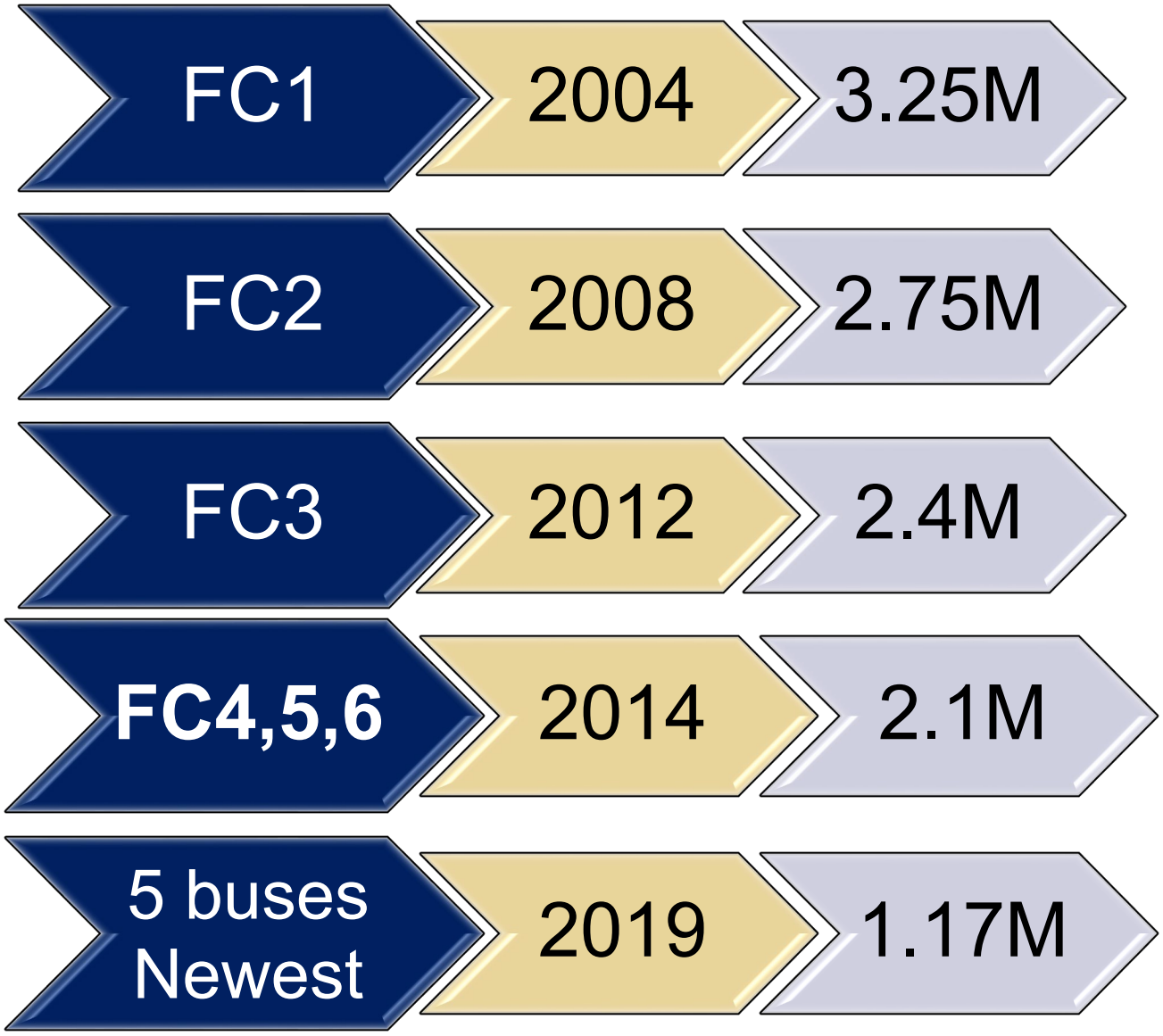
The goal is to be 100 percent on solar power for energy needs outside of nighttime fueling

SunLine has a net metering energy agreement/rate with our local municipal provider at about 13 cents a kWh with standard industry demand charges

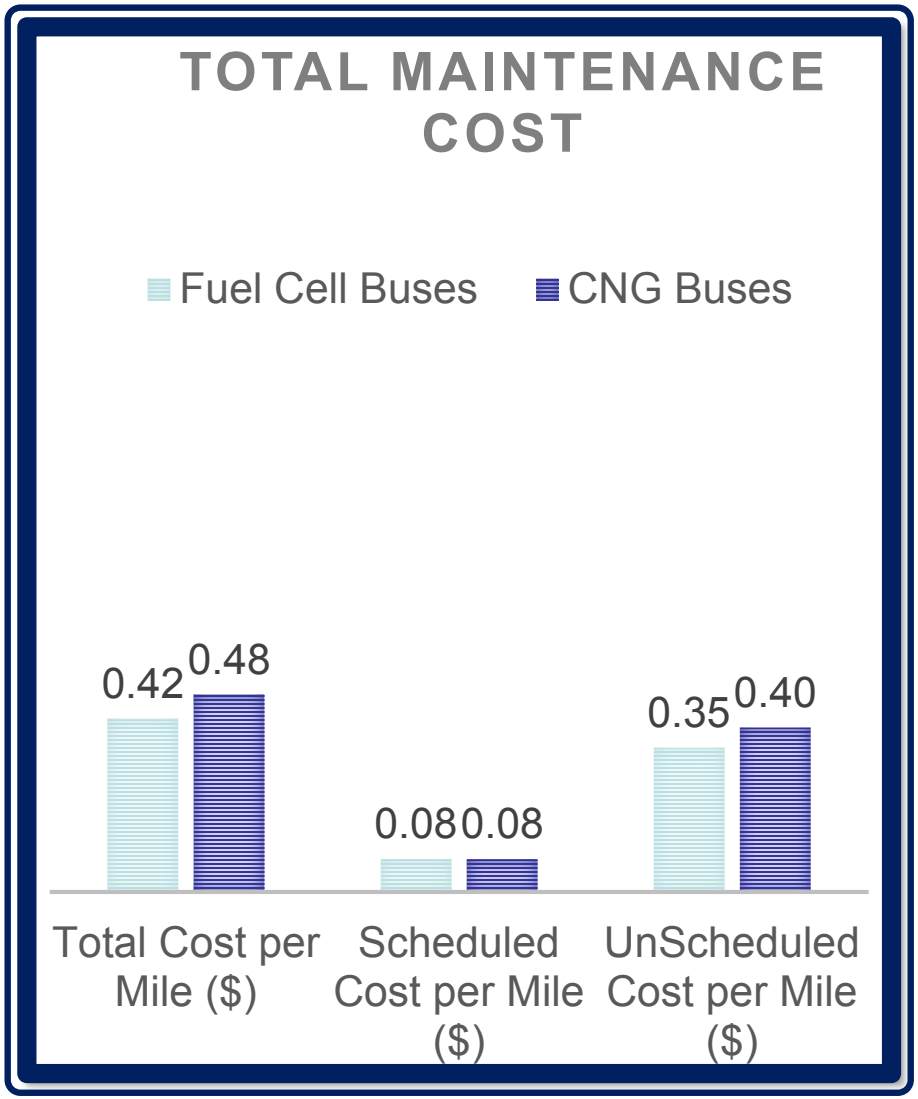
Phase 1

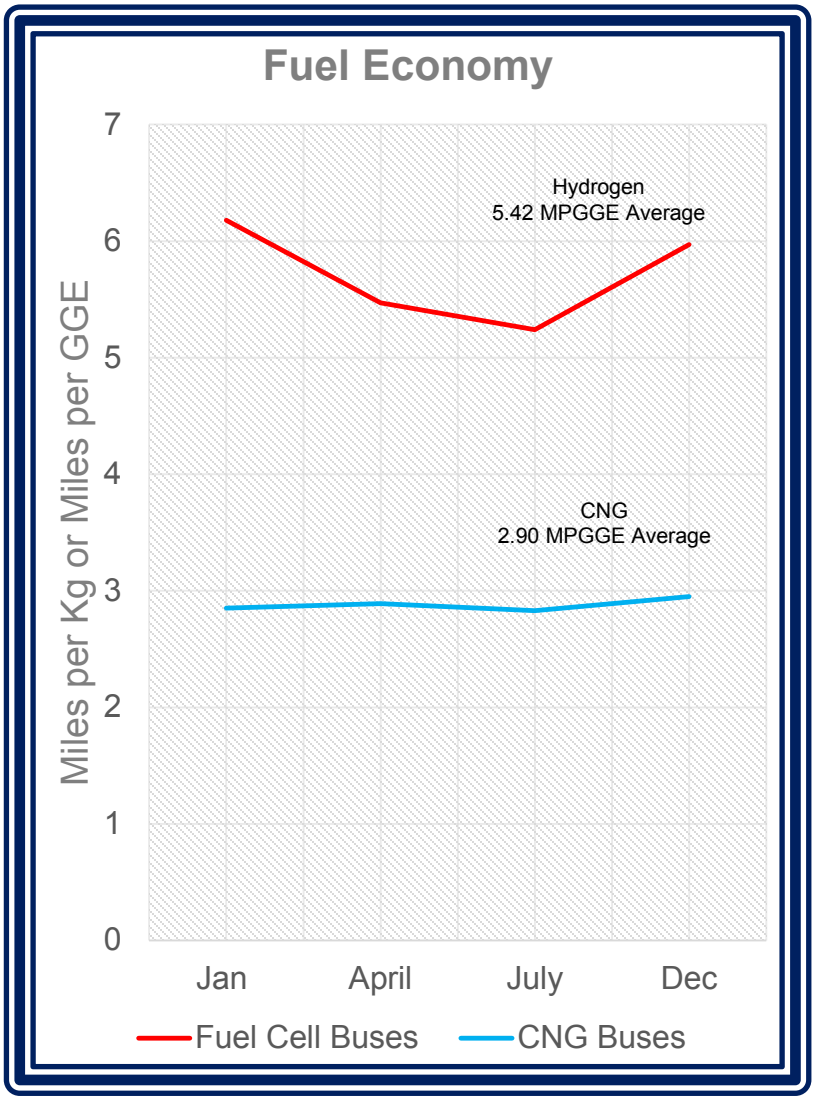
Phase 2

H2 Bus Affordability



Maintenance Costs





Infrastructure Costs Comparison

Infrastructure and Scalability

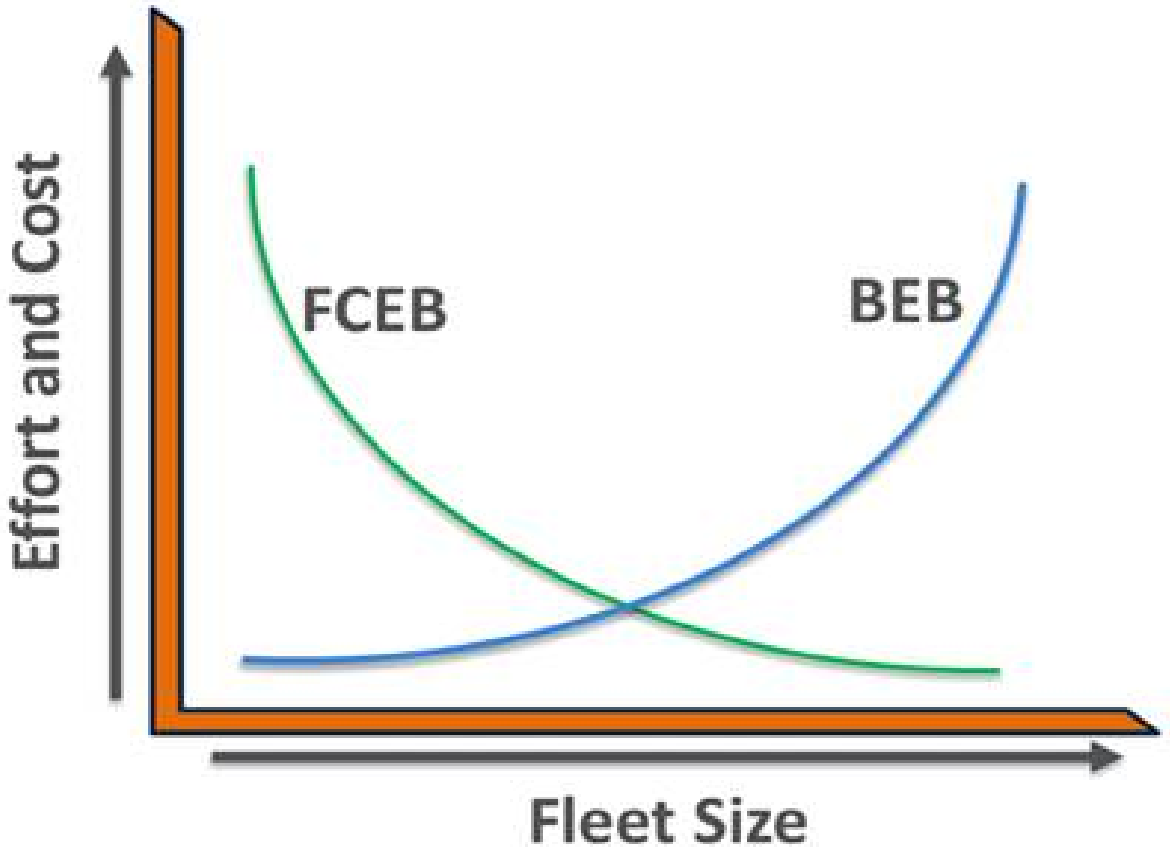


Chart Furnished by The Center for Transportation and the Environment

CARB Innovative Clean Transportation Regulation

Regulations

Developed to regulate the heavy duty sector to zero emission vehicles in California

Requires that all heavy duty trucking include transit buses transition to zero emission vehicles by 2040

Transit Requirements:

- January 2023 – 25% of fleet purchases must be ZEB
- January 2026 – 50% of fleet purchases must be ZEB
- January 2029 – All fleet purchases must be ZEB
- Requires the development of an agency

West Coast Center of Excellence

West Coast Center of Excellence
IN ZERO EMISSION TECHNOLOGY

SunLine TRANSIT AGENCY

West Coast Center of Excellence

- Funding from FTA and California Fuel Cell Partnership
- For every investment in technology, there is investment in training and learning
  - Will provide on-sight and portable training
  - OEM interest and support
  - Component, maintenance, procurement, planning, and operations training modules
- A site to preserve and enhance those learning investments

West Coast Center of Excellence
IN ZERO EMISSION TECHNOLOGY

West Coast Center of Excellence

mission

Serves to bring education to transit agencies looking to establish or increase their zero-emission fleets and technologies

focus

Provide training, best practice information and access to technology and software geared toward the planning, procurement and deployment of zero emission buses

West Coast Center of Excellence
IN ZERO EMISSION TECHNOLOGY

SunLine TRANSIT AGENCY

West Coast Center of Excellence
IN ZERO EMISSION TECHNOLOGY

ZERO EMISSION BUS TECHNOLOGY OPERATIONS

Objective

1

- Review operational adjustments for the deployment of Zero Emission Buses (ZEB)

2

- Methods to engage staff with the transition to ZEB

3

- Review benefits, challenges and best practices

A Look at the Future of ZEB Technology

Training Operators

Zero Emission vs. Conventional Bus Operations

Operators Support

- Offer Training	- Encourage Open Discussions About the New Technology	- Assign Champions	- Create a Culture of ZEB Acceptance and Conformity

Operational Considerations

ZEB Range

- Weather Conditions
- ZEB Rage
- Charge Time

Rolling

- Acceleration
- Deceleration
- ZEB Speed vs. Speed Required

Training

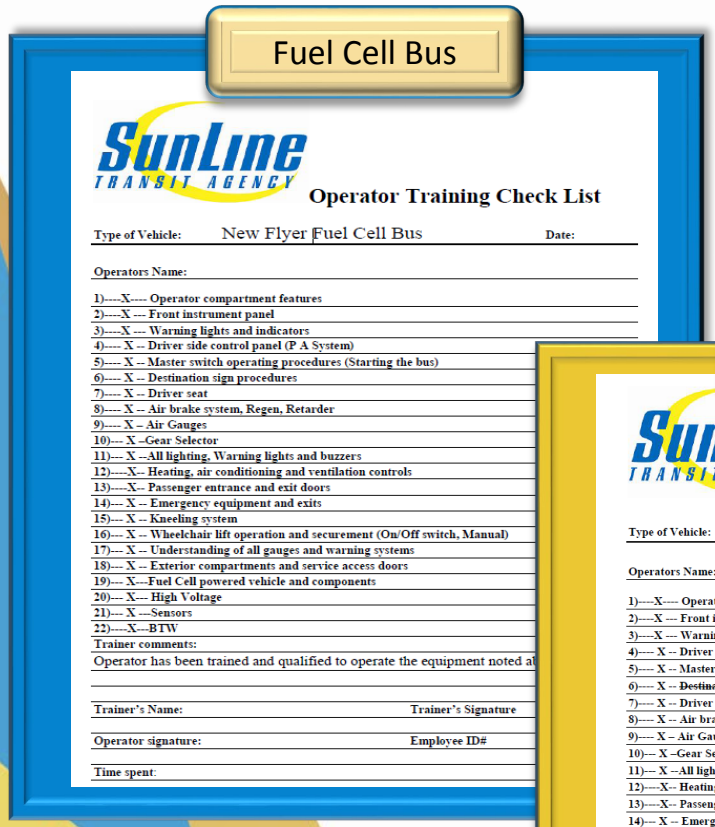
- Understand your ZEBs
- Consider All Possibilities

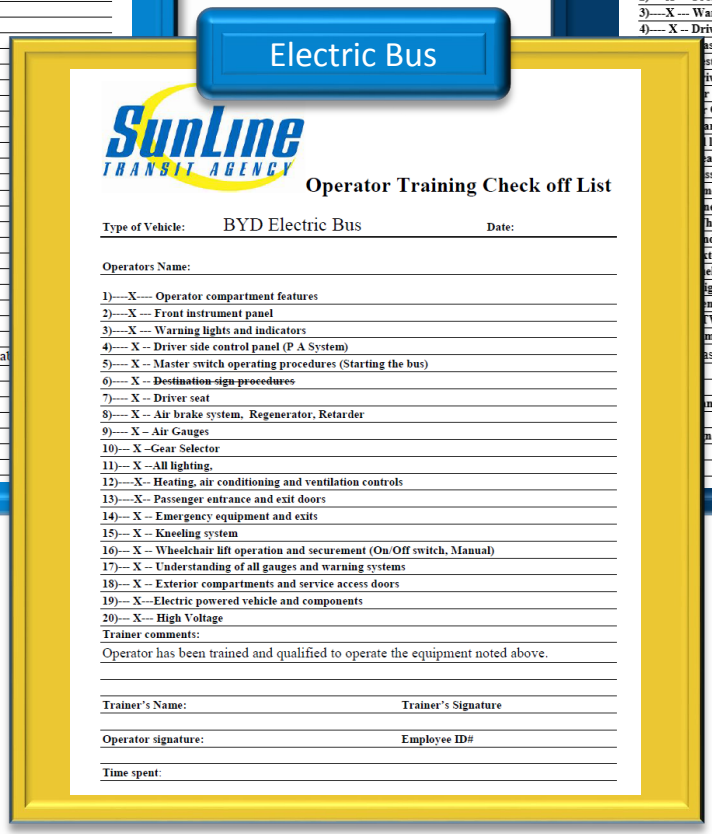
Technology Training

ZEB Operation

- Charger Operation
- Fueling and Nozzle Function
- Handling and Response
- Regenerative Breaking
- Optimizing Fuel Efficiency
- Dashboard Instrumental and Measurements

Training Checklist





Performance Data

- **Identify Data**
  - Key Performance Data
  - Create a System
  - Software Support
- **Log Performance**
  - Operators Support in Tracking Data
  - Analyze Data
- **Report Performance**
  - Communication with OEMs

West Coast Center of Excellence
IN ZERO EMISSION TECHNOLOGY

ZERO EMISSION BUS TECHNOLOGY MAINTENANCE

What is High Voltage

High voltage is any voltage great enough to cause harm or injury

Generally, NEC 70E states high voltage is any voltage in the range of 30 to 1,000 VAC or 60 to 1,500 VDC

ZEB technology utilize voltages up to 15,000 volts (15kV)

Basic High Voltage Safety Precautions

Wearing insulating shoes prohibits a pathway for electrons by providing a large resistance in that path

Work with the one hand or chop-stick rule for testing high voltage

Whenever working with power tools (drills, impacts), or in risky situations, ensure that you do not provide a pathway for current flow (especially through the heart, one hand rule)

Minimum Training for High Voltage

Qualified maintenance personnel must possess the following skills and training:

- Skills and techniques necessary to distinguish exposed energized electrical conductors and circuit parts from other parts of ZEB equipment
- Skills and techniques necessary to determine the nominal voltage of exposed energized electrical conductors and circuit parts
- Decision making process necessary to be able to do the following
  - Perform job safety planning
  - Identify electrical hazards
  - Assess the associated risk
  - Select the appropriate risk control methods

West Coast Center of Excellence
IN ZERO EMISSION TECHNOLOGY

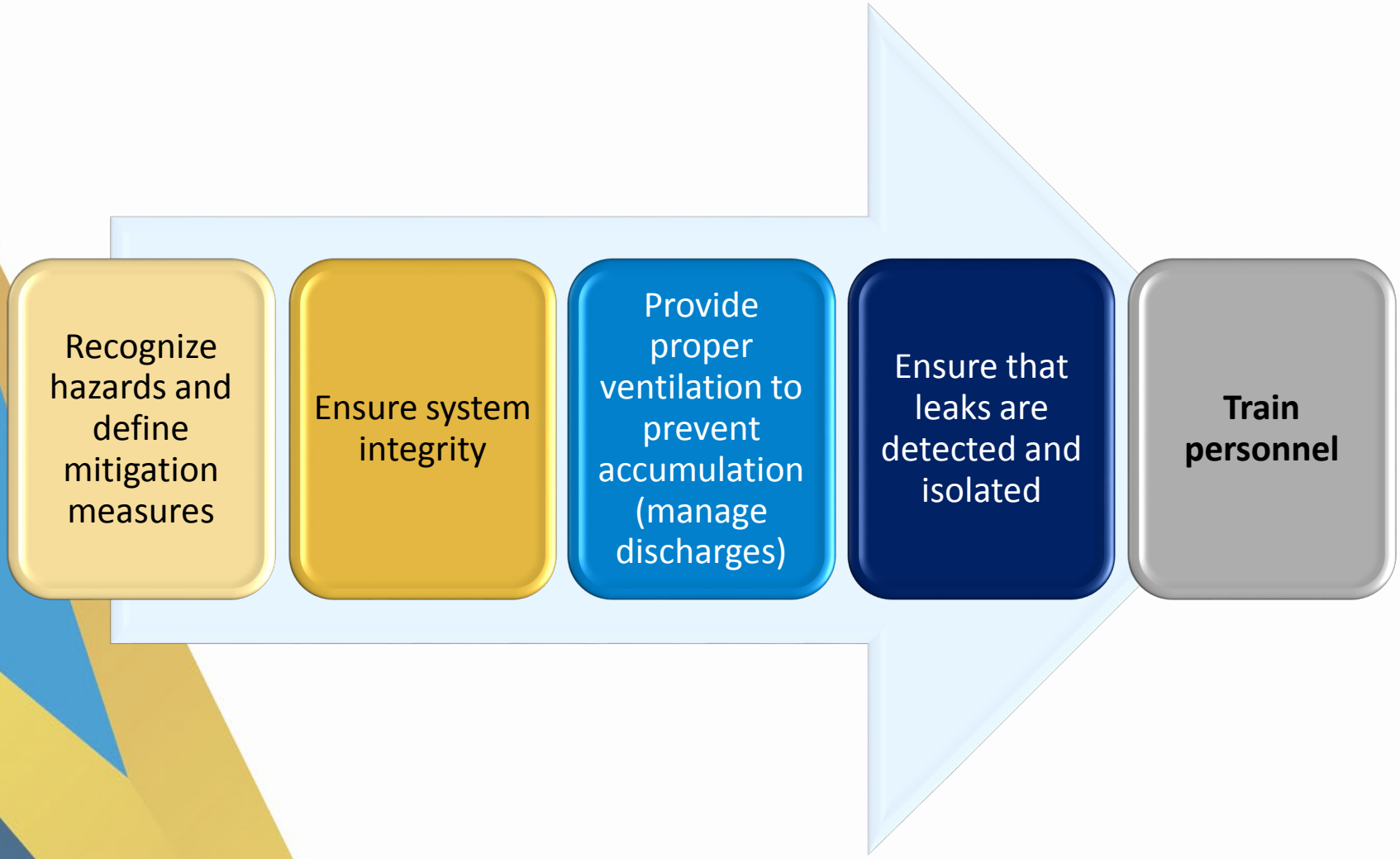
HYDROGEN SAFETY

NFPA 2

Hydrogen Technologies

2016 Edition

General Safety Precautions



West Coast Center of Excellence
IN ZERO EMISSION TECHNOLOGY

DIAGNOSTICS AND TROUBLESHOOTING

Diagnostic Starting Points

Like all batteries, ZEB battery systems need to be checked for charge and condition regularly

Fuel cell voltages

Diagnostics will vary greatly with OEM specifications

ZEB diagnostic software is available (SMART)

Maintenance Planning with ZEBs

Maintenance planning must incorporate service intervals, down time, etc. which will vary from ZEB to traditional powertrain buses

Preventative maintenance and regular condition assessments are vital

Plan for necessary spare parts

Other considerations…

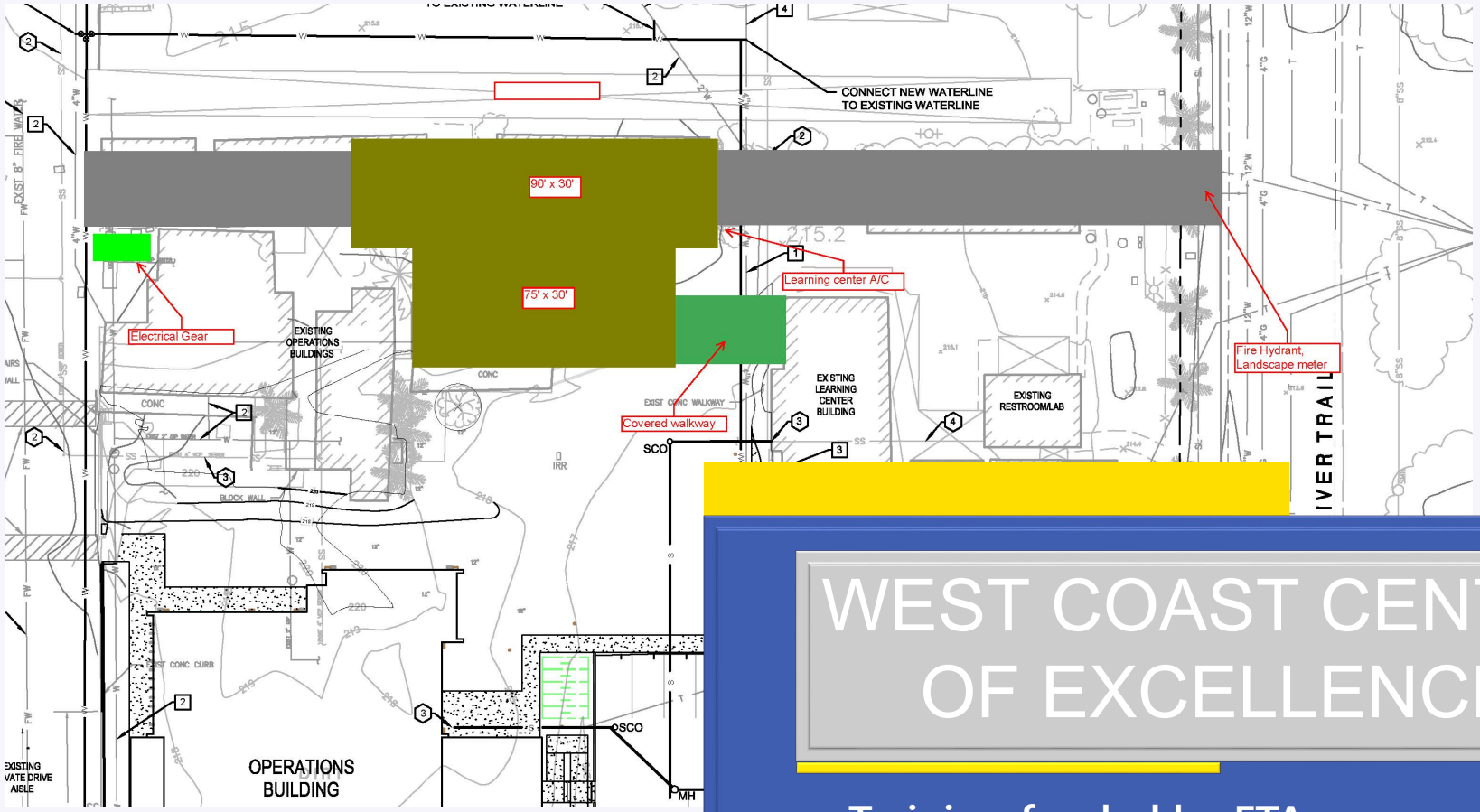
Completed Training Modules

Advanced Technology Technician Training

Procurement Insights for ZEB purchases

Planning and executing ZEB's in service

Leadership, mission, value creation for a successful ZEB Program



WEST COAST CENTER OF EXCELLENCE

- Training funded by FTA
- Infrastructure for Center partially funded by FTA

Key Takeaways

SunLine TRANSIT AGENCY

- SunLine has made a deep commitment to reducing environmental impacts while delivering world-class transit services
- The Hydrogen industry must create smaller scale, lower costs options for on-sight production
- SunLine does not use any solid fuel to deliver transit to the Coachella Valley
- Zero emission technology works
- California's Innovative Clean Transportation Rule is a game-changer for the clean fuels industry

Thank You

Lskiver@sunline.org