

**UCLA** Luskin School *of* Public Affairs

Luskin Center for Innovation

## **Transportation Electrification (TE) Curriculum Development Roadmap Workshop**

18 February 2014

SCE Energy Education Center

Irwindale CA

Brett Williams, MPhil (cantab), PhD

EV & Alt. Fuel Program Director / Asst. Adj. Professor

[bdw@ucla.edu](mailto:bdw@ucla.edu)

[innovation.luskin.ucla.edu/ev](http://innovation.luskin.ucla.edu/ev)

### **Agenda summary**

- Welcome, background, introductions
- Section 1: workforce characterizations (occupations)
- Section 2: existing training (educational offerings)
- Lunch, with thoughts from Ed Kjaer on the transformation that lies ahead
- Section 3: occupation/training matching and gap analysis
- Section 4: priority needs and opportunities, and other reflections
- Final section: wrap-up and next steps

## Welcome, background, introductions

Why are we here?

Who are we?

## Welcome!

Thank you for making the trip and for  
your engagement in this process

## And thanks to the team...

- The folks at Edison International Foundation, including Tammy Tumbling and Flor Tolley
- Bob Graham (retired), Ed Kjaer, and Deborah Coronel (SCE)
- The UCLA research team: JR DeShazo, Alan Kerbel Shein, and Tongxin Xu
- The Luskin Center staff: Ben Nguyen, and in particular, Christian Zarate for many hours lost to preparation

**UCLA** Luskin School of Public Affairs  
Luskin Center for Innovation

**UCLA** Luskin School of Public Affairs  
Luskin Center for Innovation

## Background

PEV commercialization update

**UCLA** Luskin School *of* Public Affairs

Luskin Center for Innovation

**PEVs: The First Three Years**  
(of the post-modern electric-vehicle era)

**U.S. Plug-in Electric Vehicle Sales Trends & Analysis**

Dec 2010 — Nov 2013

Brett Williams, MPhil (cantab), PhD  
EV & Alt. Fuel Program Director / Asst. Adj. Professor  
bdw@ucla.edu

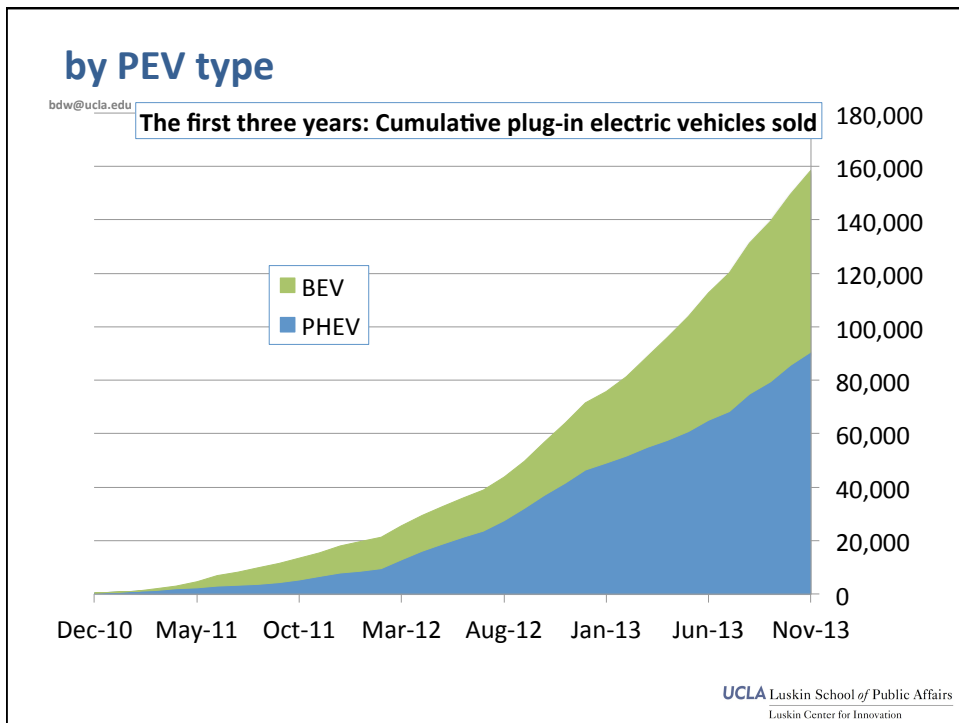
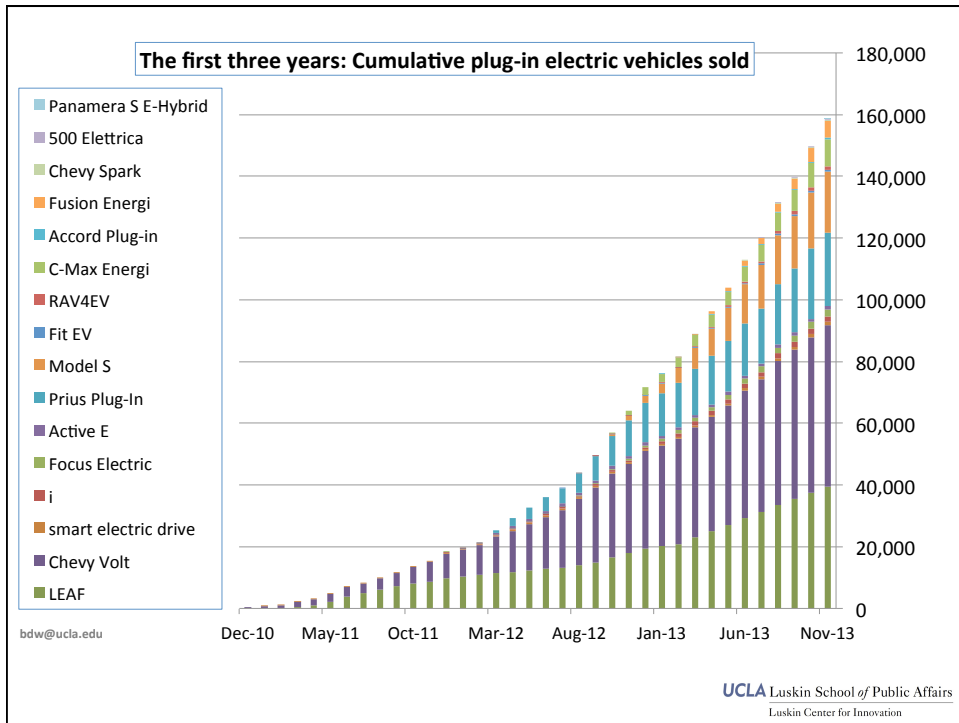
08-Dec-13

**UCLA** Luskin School *of* Public Affairs

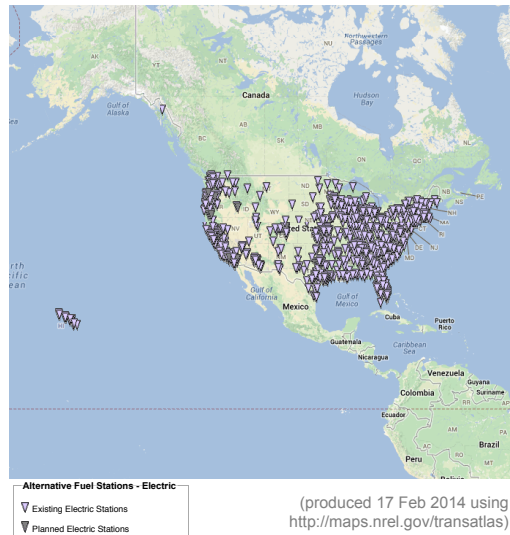
Luskin Center for Innovation

**Where are we with  
plug-in electric vehicles (PEVs)?**

Cumulative U.S. sales

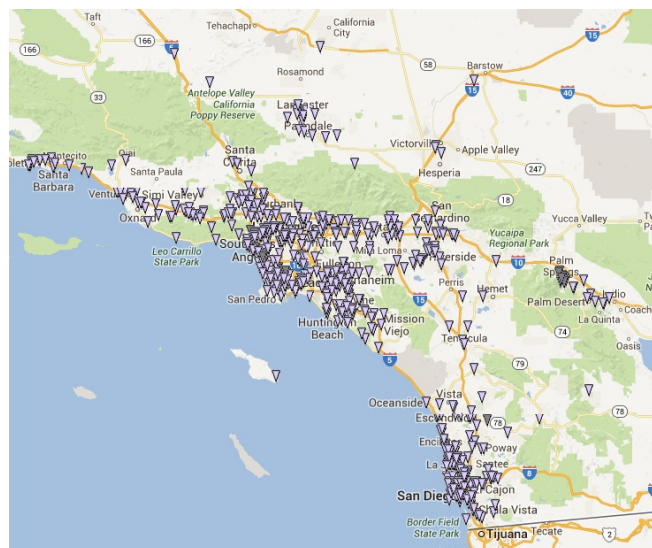


## U.S. charge stations: 7,587



UCLA Luskin School of Public Affairs  
Luskin Center for Innovation

## SoCal charge stations (1,626 total in California)



UCLA Luskin School of Public Affairs  
Luskin Center for Innovation

## Background

TE Curriculum Development Project Overview

## Overall focus

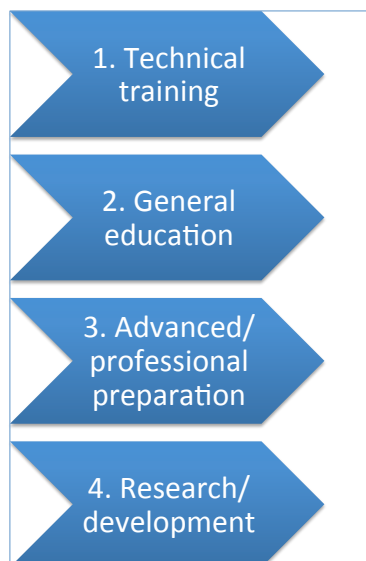
What is the path forward for curriculum development that will meet the needs of industries and organizations at the forefront of transportation electrification?

## Project phases



**UCLA** Luskin School of Public Affairs  
Luskin Center for Innovation

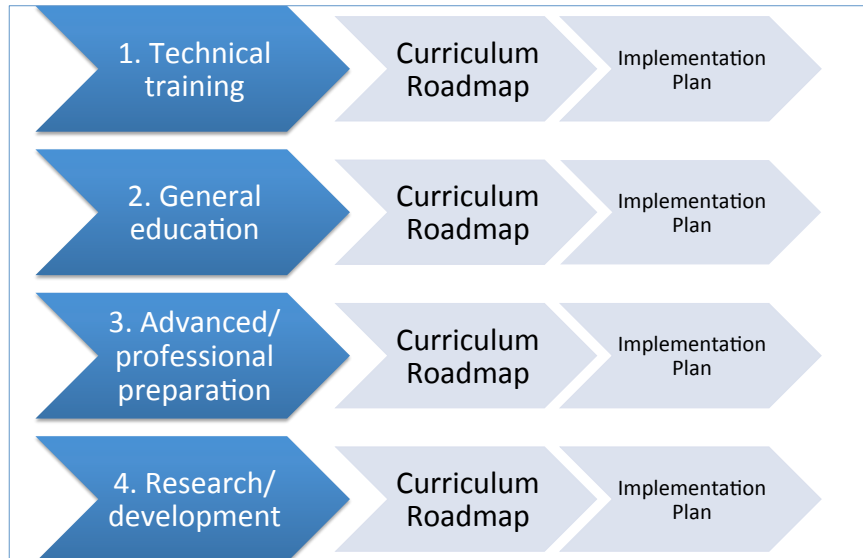
## Educational contexts



**UCLA** Luskin School of Public Affairs  
Luskin Center for Innovation

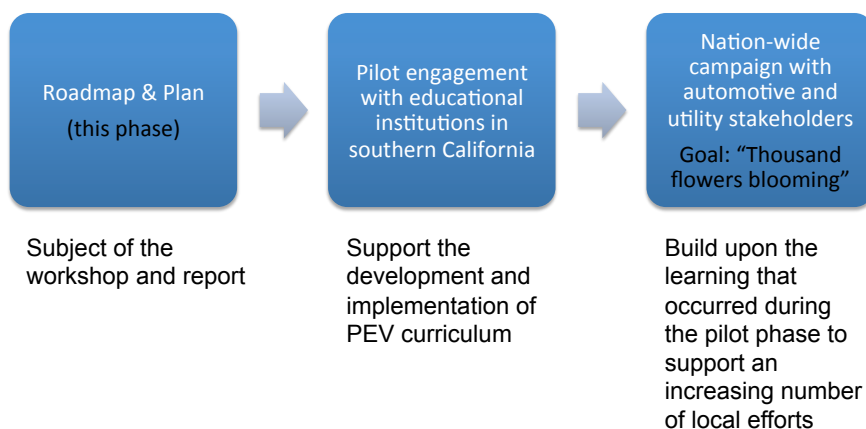


## Paths forward



**UCLA** Luskin School of Public Affairs  
Luskin Center for Innovation

## Implementation



**UCLA** Luskin School of Public Affairs  
Luskin Center for Innovation

## Housekeeping

**UCLA** Luskin School of Public Affairs  
Luskin Center for Innovation

**UCLA** Luskin School of Public Affairs  
Luskin Center for Innovation

## Introductions

Participants...

## Educational institutions



UCLA Luskin School of Public Affairs  
Luskin Center for Innovation

## Automakers



## LA County/Government



## Utilities



Los Angeles  
Department of  
Water & Power



UCLA Luskin School of Public Affairs  
Luskin Center for Innovation

## And a variety of others



**UCLA** Luskin School of Public Affairs  
Luskin Center for Innovation

## Self introductions

- “Workshop”
  - Participation warm-up: Please introduce yourselves...
  - Time permitting, we’ll try to bookend by going around the room at the end of the day for concluding thoughts
  - Hopefully lots of input and advice for us in between
- Have time for about ~½ minute per person
- Note: staff have managed to gather bios for most of us off of the internet
  - Please send Christian additions and updates for our workshop records
  - Ok to distribute information you used to register?

**UCLA** Luskin School of Public Affairs  
Luskin Center for Innovation

## Where are we?

- Welcome, background, introductions
- Section 1: workforce characterizations (occupations)
- Section 2: existing training / educational offerings
- Lunch, with thoughts from Ed Kjaer on the transformation that lies ahead
- Section 3: occupation/training matching and gap analysis
- Section 4: priority needs and opportunities, and other reflections
- Final section: wrap-up and next steps

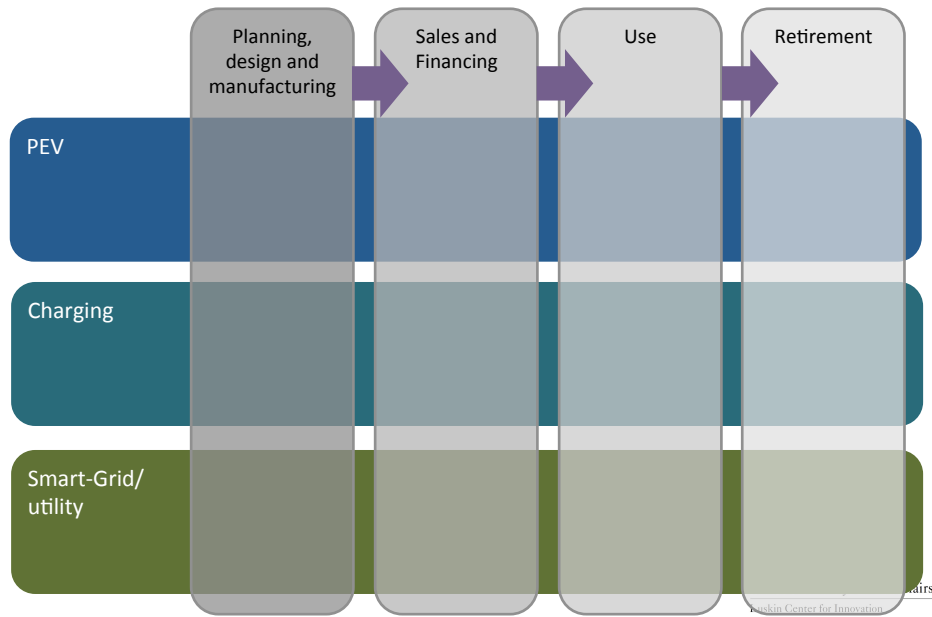
UCLA Luskin School of Public Affairs  
Luskin Center for Innovation

**UCLA** Luskin School of Public Affairs  
Luskin Center for Innovation

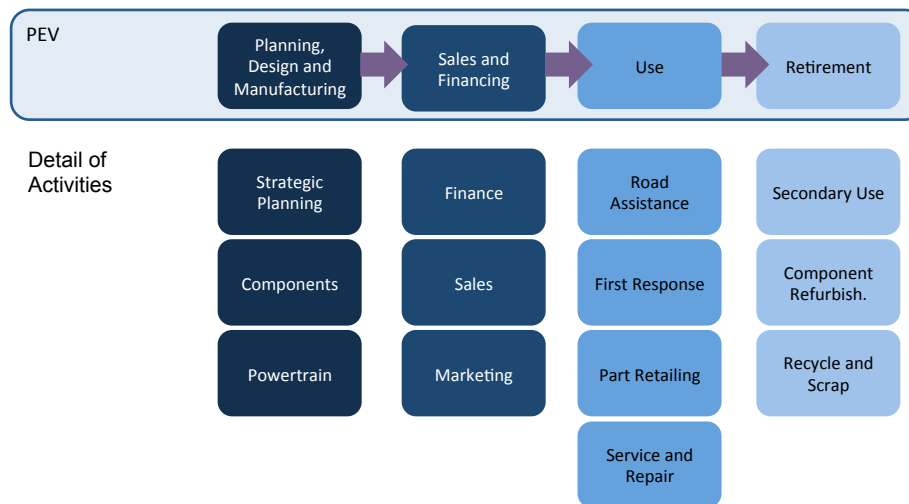
## At 11:05am: 1. Workforce Characterization

What are the occupations impacted by /  
needed for TE?

## Transportation electrification supply chain



## PEV supply chain



## PEV-sector occupations and employment (1 of 3)

Occupation	LA County employment (1)	LA County mean wage (1)
<b>Architecture and engineering:</b>		
Chemical engineers	660	\$102,464
Electrical and electronics engineering technicians	4450	\$66,131
Electrical engineers	5690	\$106,177
Electro-mechanical Technicians	220	\$55,549
Electronics engineers (not in BLS data)	n.a.	n.a.
Electronics engineers, except computer	6040	\$101,740
Industrial engineers	5440	\$97,802
Materials engineers	1240	\$104,195
Mechanical drafters	1150	\$54,714
Mechanical engineering technicians	870	\$58,652
Mechanical engineers	6260	\$93,988
<b>Computer and mathematical:</b>		
Computer programmers	9350	\$84,566
Computer soft-/hardware engineers (4)	13280	\$115,531
Computer system analysts	12480	\$92,801
Network and computer systems administrators	9660	\$81,552
Operations research analysts	1360	\$86,422
Software developers, application	15670	\$94,537
Software developers, systems software	13280	\$115,531
<b>Construction and extraction:</b>		
Electricians	9810	\$64,707

Public Affairs

Luskin Center for Innovation

## PEV-sector occupations and employment (2 of 3)

Occupation	LA County employment (1)	LA County mean wage (1)
<b>Installation, maintenance, and repair group:</b>		
Automotive service technicians and mechanics	13160	\$39,278
Electric motor, power tool, and related repairers	410	\$55,234
Electronic equipment installers and repairers, motor vehicles	280	\$31,107
Telecom equipment installers and repairers, except line installers	8190	\$56,608
<b>Life, physical, and social science group:</b>		
Chemists	2160	\$69,875
Material scientists	350	\$86,782
Urban and regional planners	1990	\$76,962
<b>Management group:</b>		
Industrial production managers	4820	\$101,558
<b>Office and administrative support group:</b>		
Customer service representatives	56710	\$38,114
<b>Production group:</b>		
Computer-controlled machine tool operators, metal and plastic	3100	\$37,754
Electrical and electronic equipment assemblers	4260	\$30,774
Electromechanical equipment assemblers	1130	\$29,211
Machinists	8610	\$38,221
Team assemblers	21320	\$26,912

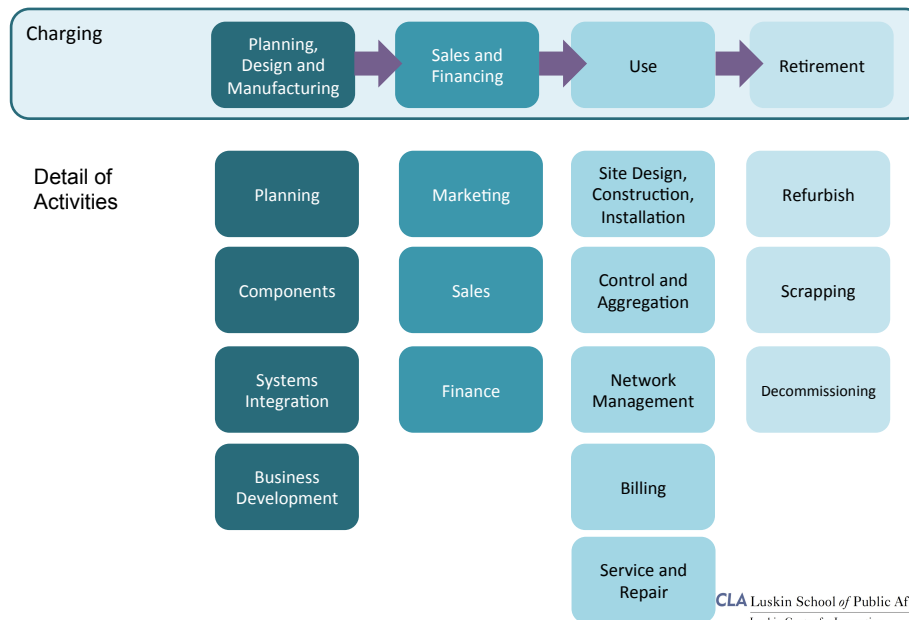
UCLA Luskin School of Public Affairs  
Luskin Center for Innovation

## PEV-sector occupations and employment (3 of 3)

Occupation	LA County employment (1)	LA County mean wage (1)
<b>Protective services group:</b>		
Fire fighters	7150	\$84,294
Police and sheriff's patrol officers	24590	\$85,898
<b>Sales and related group:</b>		
Retail sales persons	120620	\$25,833

UCLA Luskin School of Public Affairs  
Luskin Center for Innovation

## Charging supply chain



UCLA Luskin School of Public Affairs  
Luskin Center for Innovation



## Charging-sector occupations and employment (1 of 2)

Occupation	LA County employment (1)	LA County mean wage (1)
<b>Architecture and engineering group:</b>		
Architect	3050	\$92,285
Electrical and electronics engineering technicians	4450	\$66,131
Electrical engineers	5690	\$106,177
Electronics engineers (not in BLS data)	n.a.	n.a.
Electronics engineers, except computer	6040	\$101,740
<b>Arts, design, entertainment, sports, and media group:</b>		
Commercial and industrial designers	1290	\$57,913
<b>Computer and mathematical group:</b>		
Computer programmers	9350	\$84,566
Computer software (LA) / hardware (CA, U.S.) engineers (4)	13280	\$115,531
Computer system analysts	12480	\$92,801
Network and computer systems administrators	9660	\$81,552
Operations research analysts	1360	\$86,422
Software developers, application	15670	\$94,537
Software developers, systems software	13280	\$115,531
<b>Construction and extraction group:</b>		
Electricians	9810	\$64,707

Public Affairs

Lusk Center for Innovation

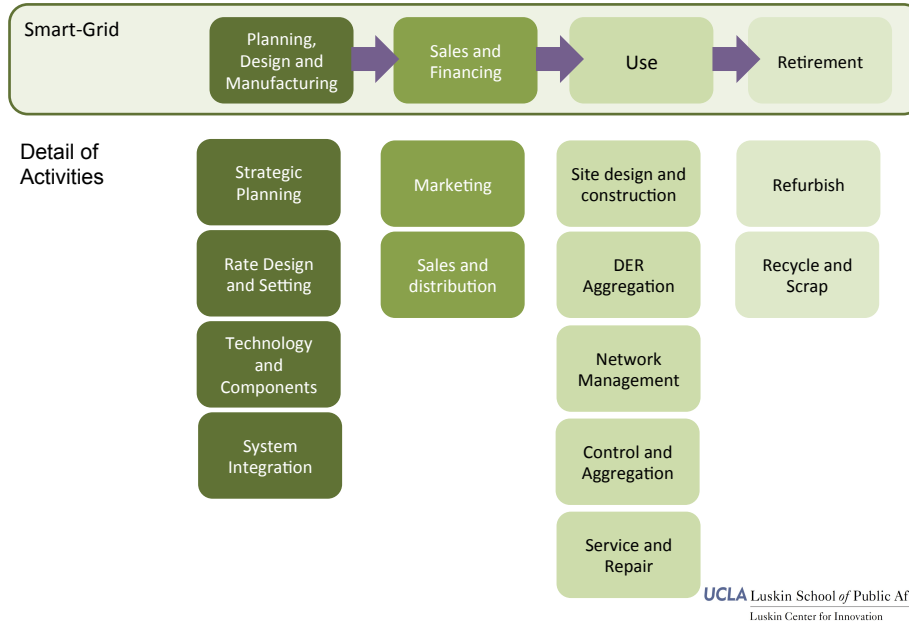
## Charging-sector occupations and employment (2 of 2)

Occupation	LA County employment (1)	LA County mean wage (1)
<b>Installation, maintenance, and repair group:</b>		
Electrical & electronics repair, commercial & industrial equip.	1530	\$54,744
Electrical power-line installers and repairers	1360	\$86,428
Telecom equip. installers & repairers, except line installers	8190	\$56,608
<b>Life, physical, and social science group:</b>		
Urban and regional planners	1990	\$76,962
<b>Management group:</b>		
Construction manager	4460	\$106,192
<b>Office and administrative support group:</b>		
Customer service representatives	56710	\$38,114
Procurement clerks	2160	\$38,916
<b>Production group:</b>		
Computer-controll. machine tool operators, metal and plastic	3100	\$37,754
Electrical and electronic equipment assemblers	4260	\$30,774
Team assemblers	21320	\$26,912
<b>Protective service group:</b>		
Fire fighters	7150	\$84,294
<b>Sales and related group:</b>		
Retail sales persons	120620	\$25,833

Public Affairs

Lusk Center for Innovation

## Smart-grid/utility supply chain



## Smart-grid-sector occupations & employment (1 of 2)

Occupation	LA County employment (1)	LA County mean wage (1)
<b>Architecture and engineering group:</b>		
Electrical and electronics engineering technicians	4450	\$66,131
Electrical engineers	5690	\$106,177
Electronics engineers (not in BLS data)	n.a.	n.a.
Electronics engineers, except computer	6040	\$101,740
Electro-mechanical technicians	220	\$55,549
Electrical and electronics drafters	1340	\$56,951
<b>Arts, design, entertainment, sports, &amp; media group:</b>		
Commercial and industrial designers	1290	\$57,913
<b>Computer and mathematical group:</b>		
Computer programmers	9350	\$84,566
Computer software (LA) or hardware (CA, U.S.) engineers (4)	13280	\$115,531
Computer system analysts	12480	\$92,801
Network and computer systems administrators	9660	\$81,552
Operations research analysts	1360	\$86,422
Software developers, application	15670	\$94,537
Software developers, systems software	13280	\$115,531
<b>Construction and extraction group:</b>		
Electricians	9810	\$64,707

Public Affairs  
Luskin Center for Innovation

## Smart-grid-sector occupations & employment (2 of 2)

Occupation	LA County employment (1)	LA County mean wage (1)
<b>Installation, maintenance, and repair group:</b>		
Electrical & electronics repairers, powerhouse, substation, and relay	430	\$87,693
Electrical & electronics repair, commerc. & industrial equip.	1530	\$54,744
Electrical power-line installers and repairers	1360	\$86,428
Electric motor, power tool, and related repairers	410	\$55,234
Telecom. equip. install. & repair, except line install.	8190	\$56,608
<b>Life, physical, and social science group:</b>		
Urban and regional planners	1990	\$76,962
<b>Office and administrative support group:</b>		
Meter readers, utilities	1050	\$47,171
Customer service representatives	56710	\$38,114
<b>Production group:</b>		
Electromechanical equipment assemblers	1130	\$29,211
Power distributors and dispatchers	240	\$94,304
Power plant operators	1270	\$85,336
Computer-controll. machine tool operators, metal & plastic	3100	\$37,754
Electrical and electronic equipment assemblers	4260	\$30,774
<b>Protective service group</b>		
Fire fighters	7150	\$84,294

Public Affairs

Lusk Center for Innovation

## All TE occupations by entry-level education requirements (1 of 2)

Occupations by entry-level education requirement (1)	Total LA County employment (2)
<b>Less than high school</b>	<b>120,620</b>
Retail sales persons	120,620
<b>High school diploma or equivalent</b>	<b>152,040</b>
Automotive body and related repairers	2,850
Automotive glass installers and Repairers	230
Automotive service technicians and mechanics	13,160
Computer-controlled machine tool operators, metal and plastic	3,100
Customer service representatives	56,710
Electrical and electronic equipment assemblers	4,260
Electrical power-line installers and repairers	1,360
Electricians	9,810
Electromechanical equipment assemblers	1,130
Engine and other machine assemblers	190
Machinists	8,610
Meter readers, utilities	1,050
Police and sheriff's patrol officers	24,590
Power distributors and dispatchers	240
Power plant operators	1,270
Procurement clerks	2,160
Team assemblers	21,320
<b>Postsecondary non-degree award</b>	<b>17,990</b>
Electric motor, power tool, and related repairers	410
Electrical and electronics repairers, commercial and industrial equip.	1,530
Electrical and electronics repairers, powerhouse, substation, and relay	430
Electronic equipment installers and repairers, motor vehicles	280
Fire fighters	7,150
Telecom. equipment installers and repairers, except line installers	8,190
<b>Associate's degree</b>	<b>8,030</b>
Electrical and electronics drafters	1,340
Electrical and electronics engineering technicians	4,450
Electro-mechanical technicians	220
Mechanical drafters	1,150
Mechanical engineering technicians	870

Affairs

Lusk Center for Innovation

Occupations by entry-level education requirement (1)	Total LA County employment (2)	(2 of 2)
<b>Bachelor's degree</b>	<b>116,540</b>	
Architect	3,050	
Chemical engineers	660	
Chemists	2,160	
Commercial and industrial designers	1,290	
Computer programmers	9,350	
Computer software engineers	13,280	
Computer system analysts	12,480	
Construction manager	4,460	
Electrical engineers	5,690	
Electronics engineers (not in data)	-	
Electronics engineers, except computer	6,040	
Industrial engineers	5,440	
Industrial production managers	4,820	
Material scientists	350	
Materials engineers	1,240	
Mechanical engineers	6,260	
Network and computer systems administrators	9,660	
Operations research analysts	1,360	
Software developers, application	15,670	
Software developers, systems software	13,280	
<b>Master's degree</b>	<b>1,990</b>	
Urban and regional planners	1,990	
<b>Grand Total</b>	<b>417,210</b>	

Public Affairs  
Luskin Center for Innovation

## Database details: TE jobs

Characterizes 48 TE-affected occupations by:

- Industry sector (PEV, charging, grid)
- Supply-chain stage (design/eng./manuf., sales & finance, use and retirement)
- Occupational group
- Employment data:
  - wages and employment numbers for LA, CA, and the U.S.
- Entry-level education requirements and on-the-job training
- Skill types (in development)

## Discussion

- Review: corrections, refinements, additions?
- Priorities?
- Next steps?
- Key resources?

## Additional & related questions: occupations

- What is the nature and magnitude of the automotive and utility workforces that may need (re)training about transportation electrification (TE)?
- Where is the workforce supply chain falling short? Where might future shortfalls be expected?
- Are there other key questions?

## We are here...

- Welcome, background, introductions
- Section 1: workforce characterizations (occupations)
- Section 2: existing training (educational offerings)
- Lunch, with thoughts from Ed Kjaer on the transformation that lies ahead
- Section 3: occupation/training matching and gap analysis
- Section 4: priority needs and opportunities, and other reflections
- Final section: wrap-up and next steps

**UCLA** Luskin School of Public Affairs  
Luskin Center for Innovation

**UCLA** Luskin School of Public Affairs  
Luskin Center for Innovation

## 2. Existing TE Educational Offerings

What TE-specific training and education is already underway, particularly in southern California?

## Database details: Existing training

- 207 records of one of three types: 1) organization, 2) center, or 3) educational product (degree, certificate, course, workshop/short-course, other)
- Can be analyzed by:
  - organization type,
  - organization,
  - department/institute/center,
  - product (degree, certificate, course, workshop, and other)
  - industry sector,
  - supply-chain stage
  - if located in SoCal or not
- Also contains web, city, state, and some additional information

UCLA Lusk School of Public Affairs  
Lusk Center for Innovation

## TE training catalogued to date

Focusing on southern California, with notable non-SoCal California and U.S. entries

- 62 organizations
  - 34 centers
    - 9 degree programs
      - 21 certificate programs
        - 65 courses
        - 12 workshops/short courses
        - 4 in an “other” category (currently all EV teams/clubs)

UCLA Lusk School of Public Affairs  
Lusk Center for Innovation

## TE Training Tables

Please see read-ahead materials for additional content  
and details

“Data, data, data. I can’t make bricks without clay”  
--Sherlock Holmes

### Centers, institutes, and departments with TE-specific offerings (1 of 6)

<b>Other</b>
<b>Nissan</b> Nissan North America EV Training Center
<b>Tech. school/community college</b>
<b>Cerritos College</b> Advanced Transportation Technology & Energy Center Automotive Technology
<b>City College of San Francisco</b> Automotive/Motorcycle, Construction, and Building Maintenance
<b>Cypress College</b> Advanced Transportation Technology Center Automotive Technology
<b>El Camino College</b> NAFTC National and Associate Training Center
<b>Fresno City College</b> Applied Technology NAFTC National and Associate Training Center
<b>Glendale Community College</b> Industrial Technology



## Centers, institutes, and departments with TE-specific offerings (2 of 6)

### Tech. school/community college (cont.)

#### J. Sargeant Reynolds Community College

School of Business

#### Long Beach City College

Advanced Transportation Technology & Energy Center

#### Los Angeles Trade-Technical College

Diesel, Alternative Fuel and Hybrid Vehicle Technologies Department

#### Modesto Junior College

Automotive Technology

NAFTC National and Associate Training Center

#### Pierce College

Industrial Technology

#### Rio Hondo College

Automotive Technology

NAFTC National and Associate Training Center

#### Yuba College

Automotive Technology

NAFTC National and Associate Training Center

## Centers, institutes, and departments with TE-specific offerings (3 of 6)

### University-teaching

#### California Polytechnic State University, San Luis Obispo

Electrical Engineering

Mechanical Engineering

#### California State Polytechnic University, Pomona

Electrical and Computer Engineering

#### California State University, Long Beach

Chemical Engineering

Electrical Engineering

#### California State University, Los Angeles

Department of Technology

#### California State University, Northridge

Electrical and Computer Engineering

#### California State University, Sacramento

California Smart Grid Center

University Enterprises, Inc.

#### Loyola Marymount University

Mechanical Engineering

#### San Diego State University

Electrical Engineering

## Centers, institutes, and departments with TE-specific offerings (4 of 6)

### University-research

#### California Institute of Technology

Electrical Engineering/Mechanical Engineering

#### Clemson University

Department of Automotive Engineering

#### Colorado State University

Hybrid-Electric Vehicle Engineering

#### Georgia Institute of Technology

Center for Innovative Fuel Cell and Battery Technologies

#### Michigan Technological University

Engineering

#### Pennsylvania State University

Battery and Energy Storage Technology (BEST) Center

Graduate Automotive Technology Education (GATE) Center

Grid Smart Training and Application Resource Center

#### Purdue University

DOE Hoosier Heavy Hybrid Center of Excellence

#### The Ohio State University

Center for Automotive Research

## Centers, institutes, and departments with TE-specific offerings (5 of 6)

### University-research (cont.)

#### University of California, Davis

College of Engineering

Communications Research in Signal Processing (CRISP):

National Sustainable Transportation Center

Plug-In Hybrid & Electric Vehicle Research Center

Policy institute for energy, environment and the economy

Sustainable Transportation Energy Pathways

#### University of California, Irvine

Advanced Power and Energy Program

Mechanical and Aerospace Engineering

The National Fuel Cell Research Center

#### University of California, Los Angeles

Chemical and Biomolecular Engineering

Luskin Center for Innovation

Luskin School of Public Affairs

Mechanical and Aerospace Engineering

Smart Grid Energy Research Center

#### University of California, Riverside

Chemical Engineering

Electrical Engineering

## Centers, institutes, and departments with TE-specific offerings (6 of 6)

**University of California, San Diego**  
Nano Engineering

**University of California, Santa Barbara**  
Electrical Computer Engineering

**University of Colorado, Boulder**  
Department of Electrical, Computer, and Energy Engineering  
Renewable and Sustainable Energy Institute (RASEI)

**University of Colorado, Colorado Springs**  
Department of Electrical and Computer Engineering  
GATE Center of Excellence in Innovative Drivetrains in Electric Automotive Technology Education

**University of Michigan-Dearborn**  
The Center for Electric Drive Transportation

**University of Southern California**  
Electrical Engineering  
USC SmartGrid

**Wayne State University**  
Electric-drive Vehicle Engineering

**West Virginia University**  
National Alternative Fuels Training Consortium (NAFTC)

## TE-specific degree programs

**Long Beach City College**  
A.S. with a major in Alternative Transportation Technology - Alternate Fuels  
A.S. with a major in Alternative Transportation Technology - Electric Vehicles

**Rio Hondo College**  
Alternative Fuels Technician A.S.

**University of California, Davis**  
Transportation Technology and Policy (M.S. and Ph.D.)

**University of Colorado, Boulder**  
Master of Science in Electrical Engineering emphasis area in Vehicle Power Electronics (MSEE-VPE)

**University of Colorado, Colorado Springs**  
Master of Science in Electrical Engineering option in Battery Controls

**Wayne State University**  
Associate of Applied Technology in Automotive Technology and Electronic Engineering Technology  
Bachelor of Science Degree in Electric Transportation Technology  
Master of Science Degree Program in Electric-drive Vehicle Engineering

## TE-specific certificate programs (1 of 2)

<b>Cerritos College</b>
Alternative Fuels Service Technician
EV Infra Training Program (EVITP) certification
<b>City College of San Francisco</b>
Automotive Alternative Fuel Technology
<b>Clean Tech Institute</b>
Certified Electric Vehicle Technician Training Program
<b>College of the Desert</b>
Automotive Alternate Fuels
<b>Colorado State University</b>
Hybrid-Electric Vehicle Engineering certificate
<b>EV Infra Training Program (EVITP)</b>
(certification provided)
<b>J. Sargeant Reynolds Community College</b>
Hybrid and Electric Vehicle Technology
<b>Key Training Corporation</b>
Smart grid
<b>Long Beach City College</b>
Certificate: Alternative Transportation Technology - Alternate Fuels
Certificate: Alternative Transportation Technology - Electric Vehicles

UCLA Luskin School of Public Affairs  
Luskin Center for Innovation

## TE-specific certificate programs (2 of 2)

<b>Los Angeles Trade-Technical College</b>
Hybrid & Electric Plug-In Vehicle Technology
<b>Michigan Technological University</b>
Hybrid Electric Vehicle Curriculum (HEV)
<b>Pierce College</b>
Automotive Advanced Level Hybrid Diagnostic Technician
Automotive Alternative Diagnostic Technician
Automotive Basic Hybrid Service Technician
<b>Purdue University</b>
Hybrid Vehicle Systems Certificate
<b>Rio Hondo College</b>
Alternative Fuels Technician
<b>University of Colorado, Colorado Springs</b>
Graduate Certificate in Electric Drivetrain Technology
<b>Wayne State University</b>
EDGE Engineering Entrepreneur Certificate
Graduate Certificate Program in Electric-drive Vehicle Engineering

UCLA Luskin School of Public Affairs  
Luskin Center for Innovation

## TE-specific workshops/short courses

### **El Camino College**

Alternative Fuel First Responder Training

### **Glendale Community College**

Developing and Enhancing Workforce Training Programs

### **National Fire Protection Association**

Electric Vehicle Safety Training

### **West Virginia University**

A Basic Understanding of Battery-Electric and Hybrid-Electric Vehicles

Clean Air and Energy Independence: An Overview of Alt. Fuels and Advanced Technology Vehicles

Electric Drive Vehicle Automotive Technician Training (Post-secondary)

Electric Drive Vehicle First Responder Safety Training

Electric Drive Vehicle Infrastructure Training

Introduction to Alternative Fuels and Advanced Technology Vehicles

Introduction to Battery-Powered Electric Vehicles

Introduction to Hybrid-Electric Vehicles

Petroleum Reduction Technologies

**UCLA** Luskin School of Public Affairs  
Luskin Center for Innovation

## Student EV teams and clubs

### **California Institute of Technology**

Caltech EV Club

### **California Polytechnic State**

### **University, San Luis Obispo**

Electric Vehicle Engineering Club

Hybrid Vehicle Development Team

### **Loyola Marymount University**

Eco Vehicle Project

**UCLA** Luskin School of Public Affairs  
Luskin Center for Innovation

## TE-related courses by org (1 of 5)

<b>California Institute of Technology</b>
Introduction to Mechatronics (EE/ME 7)
<b>California Polytechnic State University, San Luis Obispo</b>
Advanced and Hybrid Vehicle Design (ME 446)
Alternative Energy Vehicles (EE434)
Alternative Energy Vehicles (EE 434)
Sustainable Electric Energy Conversion (EE420)
<b>California State Polytechnic University, Pomona</b>
Power Electronics (ECE 469)
<b>California State University, Long Beach</b>
Electric Vehicles (451)
Electronic Control of Motors (450)
Green Engineering I: Alternative Energy (533/433)
<b>California State University, Los Angeles</b>
Electric, Hybrid and Alternative Fueled Vehicles (TECH 470)
<b>California State University, Northridge</b>
Electric Power Systems (ECE 411)
Electrical Machines and Energy Conversion and Lab (ECE 410/L)
Power Electronics (ECE412)
<b>California State University, Sacramento</b>
University Enterprises, Inc. Developing and Enhancing Workforce Training Programs

## TE-related courses by org (2 of 5)

<b>Cerritos College</b>
Advanced Electrical Systems (AUTO 260)
Advanced Technology Electric Vehicles (AUTO 55)
Alternative and Renewable Maintenance Training
Automotive Electricity (AUTO 160)
Automotive Electricity (AUTO 161)
Intro to Electric Vehicle (AUTO 54)
<b>City College of San Francisco</b>
Alternative Fuel Vehicles (AUTO 57)
Automotive Electrical (AUTO 51)
<b>College of the Desert</b>
Auto Electronics & Electrical Systems (AUTO 11B)
Hybrid, Fuel-Cell & Electric Technology (AUTO 43A)
Intro to Alternative Fuel Vehicles (AUTO 45A)
<b>Cypress College</b>
Intro to Electric/Hybrid Vehicles (AT 181C)
<b>Fresno City College</b>
Advanced Clean Air Car Course (AUTOT 161B)
Basic Clean Air Car Course (AUTOT 161A)

## TE-related courses by org (3 of 5)

### Glendale Community College

Advanced Metering Technology (ITECH 156)

### Long Beach City College

Advanced Hybrid Diagnosis & Repair (ATT 483)

Advanced Hybrid Fuel Cell & Electric Vehicles (ATT 481)

Alternative Fuels Conversion, Diagnosis & Repair (AMECH 493)

Heavy Duty Alternative Fueled Vehicles (AMECH 491)

Heavy Duty Alternative Fueled Vehicles Diagnosis & Repair (AMECH 492)

Intro to Hybrid & Electric Vehicles (ATT 480)

Introduction to Alternative Fuels (AMECH 490)

### Los Angeles Trade-Technical College

Advanced Hybrid and Plug-in Electric Vehicles (DIESLTK 303)

Hybrid and Plug-in Electric Vehicle (DIESLTK 302)

Introduction to Alternative Fuel & Hybrid Vehicle Technology (DIESLTK 301)

### Loyola Marymount University

Alternative Energy Systems (MECH521)

### Modesto Junior College

Automotive Electricity (AUTEC368)

Automotive Electricity (AUTEC369)

Introduction to Alternative Fuels (AUTEC 211)

## TE-related courses by org (4 of 5)

### NADA University

Alternative Fuels 101

### Pierce College

Hybrid Service and Safety (AST 55)

### Rio Hondo College

Advanced Hybrid/Electric Vehicle (AUTO 260)

Introduction to Hybrid and Electric Vehicle Technology (AUTO 147)

### San Diego State University

Power Electronics (EE484)

### University of California, Irvine

Engineering Electrochemistry: Fundamentals and Applications (ENGRMAE 212)

### University of California, Los Angeles

Design and Analysis of Smart Grids (MECH&AE C137/237)

Electrochemical Engineering (217)

Electrochemical Processes and Corrosion (C114)

Electrochemical Processes and Corrosion (C214)

Special Topics in Chemical and Biomolecular Engineering (290)

Special Topics in Public Policy: Electric-Drive Vehicles: Technologies and Policies (PUB PLC290-1)

Special Topics in Public Policy: Public Policies for Alt. Fuel Vehicles and Infrastruct. (PUB PLC290-1)

## TE-related courses by org (5 of 5)

<b>University of California, Riverside</b>
Electrochemical Engineering (CHE131)
Power Electronics (EE123)
Special Topics in Materials Electrochemistry (CEE 259)
<b>University of California, San Diego</b>
Advanced Micro- and Nano- Materials for Energy Storage and Conversion (NANO 164)
<b>University of California, Santa Barbara</b>
Introduction To Power Electronics (ECE142)
<b>University of Southern California:</b>
Electromechanics (EE 370)
Net-Centric Power-System Control (EE 527)
Power Electronics (EE528)
<b>Yuba College</b>
Engine Diagnosis and Rebuilding (AUTO 45)

## Courses by org. type and department: postsecondary & associate's (1 of 2)

<b>Training/workforce organization</b>	<b>1</b>
Alternative Fuels 101	1
<b>Tech. school/community college</b>	<b>24</b>
<b>Advanced Transportation Technology &amp; Energy Center</b>	<b>8</b>
Advanced Hybrid Diagnosis & Repair (ATT 483)	1
Advanced Hybrid Fuel Cell & Electric Vehicles (ATT 481)	1
Alternative and Renewable Maintenance Training	1
Alternative Fuels Conversion, Diagnosis & Repair (AMECH 493)	1
Heavy Duty Alternative Fueled Vehicles (AMECH 491)	1
Heavy Duty Alternative Fueled Vehicles Diagnosis & Repair (AMECH 492)	1
Intro to Hybrid & Electric Vehicles (ATT 480)	1
Introduction to Alternative Fuels (AMECH 490)	1
<b>Industrial Technology</b>	<b>2</b>
Advanced Metering Technology (ITECH 156)	1
Hybrid Service and Safety (AST 55)	1



## Courses by org. type and department: postsecondary & associate's (2 of 2)

<b>Automotive Technology</b>	<b>11</b>
Advanced Electrical Systems (AUTO 260)	1
Advanced Hybrid/Electric Vehicle (AUTO 260)	1
Advanced Technology Electric Vehicles (AUTO 55)	1
Automotive Electricity (AUTO 160)	1
Automotive Electricity (AUTO 161)	1
Auto Electronics & Electrical Systems (AUTO 11B)	1
Hybrid, Fuel-Cell & Electric Technology (AUTO 43A)	1
Intro to Alternative Fuel Vehicles(AUTO 45A)	1
Intro to Electric Vehicle (AUTO 54)	1
Intro to Electric/Hybrid Vehicles (AT 181C)	1
Introduction to Hybrid and Electric Vehicle Technology(AUTO 147)	1
<b>Diesel, Alternative Fuel and Hybrid Vehicle Technologies Department</b>	<b>3</b>
Advanced Hybrid and Plug-in Electric Vehicles (DIESLTK 303)	1
Hybrid and Plug-in Electric Vehicle (DIESLTK 302)	1
Introduction to Alternative Fuel & Hybrid Vehicle Technology (DIESLTK 301)	1

UCLA Luskin School of Public Affairs  
Luskin Center for Innovation

## Courses by org. type and department: teaching universities

<b>University-teaching</b>	<b>14</b>
<b>Chemical Engineering</b>	<b>1</b>
Green Engineering I: Alternative Energy (533/433)	1
<b>Department of Technology</b>	<b>1</b>
Electric, Hybrid and Alternative Fueled Vehicles (TECH 470 )	1
<b>Electrical and Computer Engineering</b>	<b>4</b>
Electric Power Systems (ECE 411)	1
Electrical Machines and Energy Conversion and Lab (ECE 410/L)	1
Power Electronics (ECE 469)	1
Power Electronics (ECE412)	1
<b>Electrical Engineering</b>	<b>6</b>
Alternative Energy Vehicles (EE434)	1
Alternative Energy Vehicles(EE 434)	1
Electric Vehicles (451)	1
Electronic Control of Motors (450)	1
Power Electronics(EE484)	1
Sustainable Electric Energy Conversion (EE420)	1
<b>Mechanical Engineering</b>	<b>2</b>
Advanced and Hybrid Vehicle Design(ME 446)	1
Alternative Energy Systems (MECH521)	1

UCLA Luskin School of Public Affairs  
Luskin Center for Innovation

## Courses by org. type and department: research universities

<b>University-research</b>	<b>17</b>
<b>Chemical and Biomolecular Engineering</b>	<b>4</b>
Electrochemical Engineering (217)	1
Electrochemical Processes and Corrosion (C114)	1
Electrochemical Processes and Corrosion (C214)	1
Special Topics in Chemical and Biomolecular Engineering (290)	1
<b>Chemical Engineering</b>	<b>2</b>
Electrochemical Engineering (CHE131)	1
Special Topics in Materials Electrochemistry (CEE 259)	1
<b>Electrical Computer Engineering</b>	<b>1</b>
Introduction To Power Electronics (ECE142)	1
<b>Electrical Engineering</b>	<b>4</b>
Electromechanics (EE 370)	1
Net-Centric Power-System Control (EE 527)	1
Power Electronics (EE123)	1
Power Electronics (EE528)	1
<b>Electrical Engineering/Mechanical Engineering</b>	<b>1</b>
Introduction to Mechatronics (EE/ME 7)	1
<b>Mechanical and Aerospace Engineering</b>	<b>2</b>
Design and Analysis of Smart Grids (MECH&AE C137/237)	1
Engineering Electrochemistry: Fundamentals and Applications (ENGRMAE 212)	1
<b>Nano Engineering</b>	<b>1</b>
Advanced Micro- and Nano- Materials for Energy Storage and Conversion (NANO 164)	1
<b>Public Policy/Urban Planning</b>	<b>2</b>
Special Topics in Public Policy: Electric-Drive Vehicles: Technologies and Policies (PUB PLC290-1)	1
Special Topics in Public Policy: Policies for Alt. Fuel Vehicles and Infrastructure (PUB PLC290-1)	1

Luskin Center for Innovation

## Discussion

- Review: corrections, refinements, additions?
- Priorities?
- Next steps?
- Key resources?

## Additional & related questions: training

- What current efforts are underway to supply the PEV industries with a skilled workforce?
- Where is workforce training falling short? Where might future deficiencies be expected?
- What workforce-training factors might affect a smooth transition to electrified transportation?
- What opportunities exist to improve and develop adequate curricula?
- How do these opportunities vary by educational environment (technical/vocational, undergraduate, graduate generalists, and professional/research)?
- Are there other key questions?

UCLA Luskin School of Public Affairs  
Luskin Center for Innovation

## Let's eat

- Welcome, background, introductions
- Section 1: workforce characterizations (occupations)
- Section 2: existing training / educational offerings
- Lunch, with thoughts from Ed Kjaer on the transformation that lies ahead
- Section 3: occupation/training matching and gap analysis
- Section 4: priority needs and opportunities, and other reflections
- Final section: wrap-up and next steps

UCLA Luskin School of Public Affairs  
Luskin Center for Innovation

## Where were we?

- Welcome, background, introductions
- Section 1: workforce characterizations (occupations)
- Section 2: existing training / educational offerings
- Lunch, with thoughts from Ed Kjaer on the transformation that lies ahead
- Section 3: occupation/training matching and gap analysis
- Section 4: priority needs and opportunities, and other reflections
- Final section: wrap-up and next steps

**UCLA** Luskin School of Public Affairs  
Luskin Center for Innovation

**UCLA** Luskin School of Public Affairs  
Luskin Center for Innovation

## 3. Occupation-Training Matching and Gap Analysis

Where do gaps and opportunities exist in training priority occupations?

## Section outline

- What do we have?
  - Which educational products serve which occupations?
- What do we lack?
  - Which occupations lack training opportunities?
- What opportunities are there for improvement?

**UCLA** Luskin School of Public Affairs  
Luskin Center for Innovation

**UCLA** Luskin School of Public Affairs  
Luskin Center for Innovation

## What do we have?

## How do we know what we have?

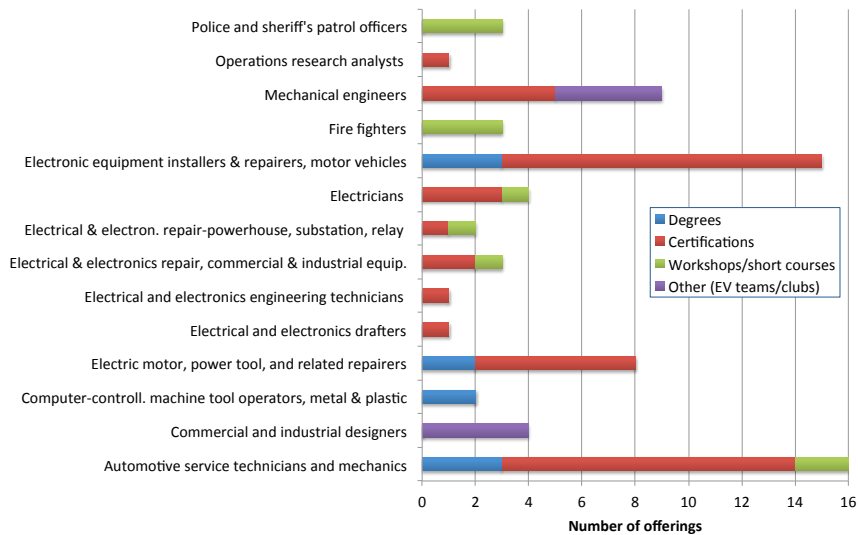
### Educational product analysis

Each educational product of four types (degrees, certificates, workshops, and “other”) has been coded in two ways to indicate which occupations it serves:

1. “Core”: Is this educational product for this occupation? (yes/no)
  - E.g., the “Alternate Fuels Service Tech.” Certificate is a “core” education product for the “Auto service technicians and mechanics” occupation
  - Others can be a little less straightforward
2. “Score”: Is it core, might it help educate this occupation, or is it not particularly applicable? (more on this later)

## What do we have?

### Core SoCal educational product counts by occupation



## What do we lack?

### Hierarchy of “gaps”

- Not every occupation is going to have a core, TE-specific educational product.
- What about related/helpful educational offerings?

## How do we know which occupations have related/helpful training?: Scoring system

2 = TE training is for the occupation, i.e., “core”

1 = TE training is reasonably helpful and arguably applicable

0 = TE training is either:

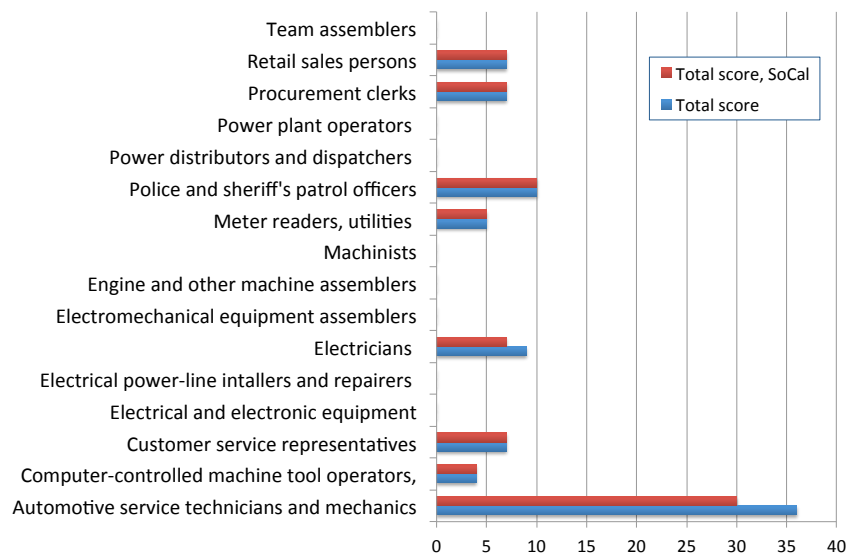
- not particularly applicable
  - e.g., first responder training, though helpful to everybody, is not particularly applicable for most occupations other than fire fighters and police
- above the typical education level of the occupation
  - NB: can vary from entry-level education categories, but usually only by one level

• Scores assigned for each product are summed across each occupation for each training type (degree, cert., workshop/short-course, or other) and again across all types.

• Note: Results are thus more illustrative/ordinal: 0 different than a small number, with is different than a big number

**UCLA** Luskin School of Public Affairs  
Luskin Center for Innovation

## TE educational product scores: High-school entry-level occupations



**UCLA** Luskin School of Public Affairs  
Luskin Center for Innovation

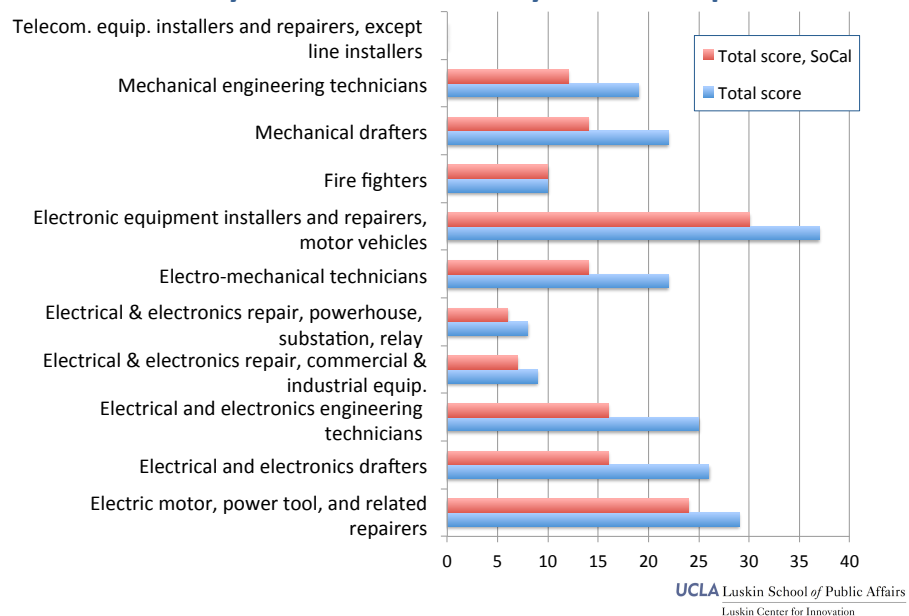


## Gaps: high-school entry-level occupations

- The following lack identified training of the types described above (degrees, certs., short-courses, and EV teams/clubs):
  - power-plant operators,
  - power distributors and dispatchers,
  - machinists,
  - electric power-line repairers and installers, and
  - assemblers of various types: machine, electromechanical, electrical, electronic
- Are any priority (e.g., nature of job appreciably changes?) or critical in any other way (e.g., dramatic shortfall)?

UCLA Luskin School of Public Affairs  
Luskin Center for Innovation

## TE educational product scores: Postsecondary & associate's entry-level occupations



## Gaps: postsecondary & associate's entry-level occupations

- The following lack identified training of the types described above (degrees, certs., short-courses, and EV teams/clubs):
  - telecom. equip. installers & repairers
- Is this a priority (e.g., nature of job appreciably changes?) or critical in any other way (e.g., dramatic shortfall)?

UCLA Luskin School of Public Affairs  
Luskin Center for Innovation

## Courses by org. type and department: postsecondary & associate's (1 of 2)

<b>Training/workforce organization</b>	<b>1</b>
Alternative Fuels 101	1
<b>Tech. school/community college</b>	<b>24</b>
<b>Advanced Transportation Technology &amp; Energy Center</b>	<b>8</b>
Advanced Hybrid Diagnosis & Repair (ATT 483)	1
Advanced Hybrid Fuel Cell & Electric Vehicles (ATT 481)	1
Alternative and Renewable Maintenance Training	1
Alternative Fuels Conversion, Diagnosis & Repair (AMECH 493)	1
Heavy Duty Alternative Fueled Vehicles (AMECH 491)	1
Heavy Duty Alternative Fueled Vehicles Diagnosis & Repair (AMECH 492)	1
Intro to Hybrid & Electric Vehicles (ATT 480)	1
Introduction to Alternative Fuels (AMECH 490)	1
<b>Industrial Technology</b>	<b>2</b>
Advanced Metering Technology (ITECH 156)	1
Hybrid Service and Safety (AST 55)	1

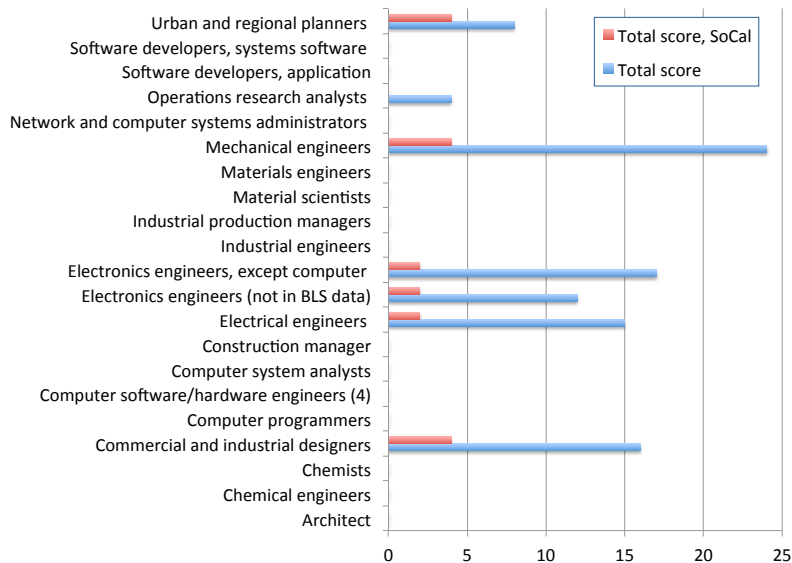
UCLA Luskin School of Public Affairs  
Luskin Center for Innovation

## Courses by org. type and department: postsecondary & associate's (2 of 2)

<b>Automotive Technology</b>	<b>11</b>
Advanced Electrical Systems (AUTO 260)	1
Advanced Hybrid/Electric Vehicle (AUTO 260)	1
Advanced Technology Electric Vehicles (AUTO 55)	1
Automotive Electricity (AUTO 160)	1
Automotive Electricity (AUTO 161)	1
Auto Electronics & Electrical Systems (AUTO 11B)	1
Hybrid, Fuel-Cell & Electric Technology (AUTO 43A)	1
Intro to Alternative Fuel Vehicles(AUTO 45A)	1
Intro to Electric Vehicle (AUTO 54)	1
Intro to Electric/Hybrid Vehicles (AT 181C)	1
Introduction to Hybrid and Electric Vehicle Technology(AUTO 147)	1
<b>Diesel, Alternative Fuel and Hybrid Vehicle Technologies Department</b>	<b>3</b>
Advanced Hybrid and Plug-in Electric Vehicles (DIESLTK 303)	1
Hybrid and Plug-in Electric Vehicle (DIESLTK 302)	1
Introduction to Alternative Fuel & Hybrid Vehicle Technology (DIESLTK 301)	1

UCLA Luskin School of Public Affairs  
Luskin Center for Innovation

## TE educational product scores: Bachelor's and master's entry-level occupations



UCLA Luskin School of Public Affairs  
Luskin Center for Innovation

## Gaps: bachelor's and master's entry-level occupations

- Note: Knowledge of individual courses becomes important at this level
- The following lack identified training of the types described above (degrees, certs., short-courses, and EV teams/clubs):
  - software developers
  - operations research analysts
  - computer systems administrators & analysts, programmers
  - engineers: materials, industrial, chemical, computer
  - material scientists
  - industrial production managers
  - construction manager
  - chemists
  - architects
- Are any priority (e.g., nature of job appreciably changes?) or critical in any other way (e.g., dramatic shortfall)?

UCLA Luskin School of Public Affairs  
Luskin Center for Innovation

## Courses by org. type and department: "Teaching" universities

<b>University-teaching</b>	<b>14</b>
<b>Chemical Engineering</b>	<b>1</b>
Green Engineering I: Alternative Energy (533/433)	1
<b>Department of Technology</b>	<b>1</b>
Electric, Hybrid and Alternative Fueled Vehicles (TECH 470 )	1
<b>Electrical and Computer Engineering</b>	<b>4</b>
Electric Power Systems (ECE 411)	1
Electrical Machines and Energy Conversion and Lab (ECE 410/L)	1
Power Electronics (ECE 469)	1
Power Electronics (ECE412)	1
<b>Electrical Engineering</b>	<b>6</b>
Alternative Energy Vehicles (EE434)	1
Alternative Energy Vehicles(EE 434)	1
Electric Vehicles (451)	1
Electronic Control of Motors (450)	1
Power Electronics(EE484)	1
Sustainable Electric Energy Conversion (EE420)	1
<b>Mechanical Engineering</b>	<b>2</b>
Advanced and Hybrid Vehicle Design(ME 446)	1
Alternative Energy Systems (MECH521)	1

UCLA Luskin School of Public Affairs  
Luskin Center for Innovation

## Courses by org. type and department: “Research” universities

<b>University-research</b>	<b>17</b>
<b>Chemical and Biomolecular Engineering</b>	<b>4</b>
Electrochemical Engineering (217)	1
Electrochemical Processes and Corrosion (C114)	1
Electrochemical Processes and Corrosion (C214)	1
Special Topics in Chemical and Biomolecular Engineering (290)	1
<b>Chemical Engineering</b>	<b>2</b>
Electrochemical Engineering (CHE131)	1
Special Topics in Materials Electrochemistry (CEE 259)	1
<b>Electrical Computer Engineering</b>	<b>1</b>
Introduction To Power Electronics (ECE142)	1
<b>Electrical Engineering</b>	<b>4</b>
Electromechanics (EE 370)	1
Net-Centric Power-System Control (EE 527)	1
Power Electronics (EE123)	1
Power Electronics (EE528)	1
<b>Electrical Engineering/Mechanical Engineering</b>	<b>1</b>
Introduction to Mechatronics (EE/ME 7)	1
<b>Mechanical and Aerospace Engineering</b>	<b>2</b>
Design and Analysis of Smart Grids (MECH&AE C137/237)	1
Engineering Electrochemistry: Fundamentals and Applications (ENGRMAE 212)	1
<b>Nano Engineering</b>	<b>1</b>
Advanced Micro- and Nano- Materials for Energy Storage and Conversion (NANO 164)	1
<b>Public Policy/Urban Planning</b>	<b>2</b>
Special Topics in Public Policy: Electric-Drive Vehicles: Technologies and Policies (PUB PLC290-1)	1
Special Topics in Public Policy: Policies for Alt. Fuel Vehicles and Infrastructure (PUB PLC290-1)	1

Luskin Center for Innovation Affairs

## Database details: Jobs/Training matrix

- Each TE-specific degree program, certificate program, workshop/ short course, and “other” (EV teams/clubs) is coded for its relevance to 48 TE-affected occupations (coding details follow)
- Can be sorted by:
  - industry sector (PEV, charging, grid)
  - occupation entry-level education requirement
  - total-occupation LA-county employment
  - whether the TE impact is relatively more or less pronounced:
    - more: the nature of the job changes appreciably
    - less: the demand for the job increases with TE demand, but the changes are less important
  - whether the TE educational offering is in SoCal, CA (non-SoCal), or the U.S. (non-CA)

UCLA Luskin School of Public Affairs  
Luskin Center for Innovation

## Where are the critical gaps in TE education?

“Gap” = no as-yet identified educational offerings of a given type for a given occupation

- “Critical” gaps =
  1. “Priority” TE occupation
    - Priority = the nature of the occupation changes appreciably due to TE, not just an increase in # of bodies needed
  2. Level of training necessary for entry-level
  3. Dramatic shortfall in supply

UCLA Luskin School of Public Affairs  
Luskin Center for Innovation

## What opportunities are there for improvement?

- How to best assess not just gaps, but more subtle opportunities?
- What processes of engagement would be most effective?

UCLA Luskin School of Public Affairs  
Luskin Center for Innovation

## Discussion

- Review: corrections, refinements, additions?
- Priorities?
- Next steps?
- Key resources?

## Additional & related questions: matching

- Where is the workforce supply chain falling short? Where might future shortfalls be expected?
- What workforce-training factors might affect a smooth transition to electrified transportation?
- What opportunities exist to improve and develop adequate curricula?
- How do these opportunities vary by educational environment (technical/vocational, undergraduate, graduate generalists, and professional/research)?
- Overall focus: What is the path forward for curriculum development that will meet the needs of industries at the forefront of transportation electrification?
- Are there other key questions?

## Where are we?

- Welcome, background, introductions
- Section 1: workforce characterizations (occupations)
- Section 2: existing training / educational offerings
- Lunch, with thoughts from Ed Kjaer on the transformation that lies ahead
- Section 3: occupation/training matching and gap analysis
- Section 4: priority needs and opportunities, and other reflections
- Final section: wrap-up and next steps

**UCLA** Luskin School of Public Affairs  
Luskin Center for Innovation

**UCLA** Luskin School of Public Affairs  
Luskin Center for Innovation

## 4. Priority Needs & Opportunities, Other Reflections

What are the key needs and opportunities,  
and what is the path forward?



## Additional & related questions

- What is the nature and magnitude of the automotive and utility workforces that may need (re)training about transportation electrification (TE)?
- What current efforts are underway to supply the PEV industries with a skilled workforce?
- Where is the workforce supply chain falling short? Where might future shortfalls be expected?
- What workforce-training factors might affect a smooth transition to electrified transportation?
- What opportunities exist to improve and develop adequate curricula?
- How do these opportunities vary by educational environment (technical/vocational, undergraduate, graduate generalists, and professional/research)?
- Overall focus: What is the path forward for curriculum development that will meet the needs of industries at the forefront of transportation electrification?
- Are there other key questions?

**UCLA** Luskin School of Public Affairs  
Luskin Center for Innovation

## Where are we?

- Welcome, background, introductions
- Section 1: workforce characterizations (occupations)
- Section 2: existing training / educational offerings
- Lunch, with thoughts from Ed Kjaer on the transformation that lies ahead
- Section 3: occupation/training matching and gap analysis
- Section 4: priority needs and opportunities, and other reflections
- Final section: wrap-up and next steps

**UCLA** Luskin School of Public Affairs  
Luskin Center for Innovation

## Concluding thoughts (fill in the blank)

**UCLA** Luskin School of Public Affairs  
Luskin Center for Innovation

## Next steps (fill in the blank)

**UCLA** Luskin School of Public Affairs  
Luskin Center for Innovation

**UCLA** Luskin School *of* Public Affairs  
Luskin Center for Innovation

**Thank you for your attention and  
efforts!**