# Overview of the Energy Efficiency Center & the NEPTUNE Program

Benjamin Finkelor, *Executive Director, Energy Efficiency Center*
Siva Gunda, *Director of Research, Energy Efficiency Center*

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UNIVERSITY OF CALIFORNIA

# UC Davis Energy Efficiency Center

- First University-based Energy Efficiency Center in US

- Founded with Partnerships with CA utilities and national industry leaders

# Host to the Honda Smart Home
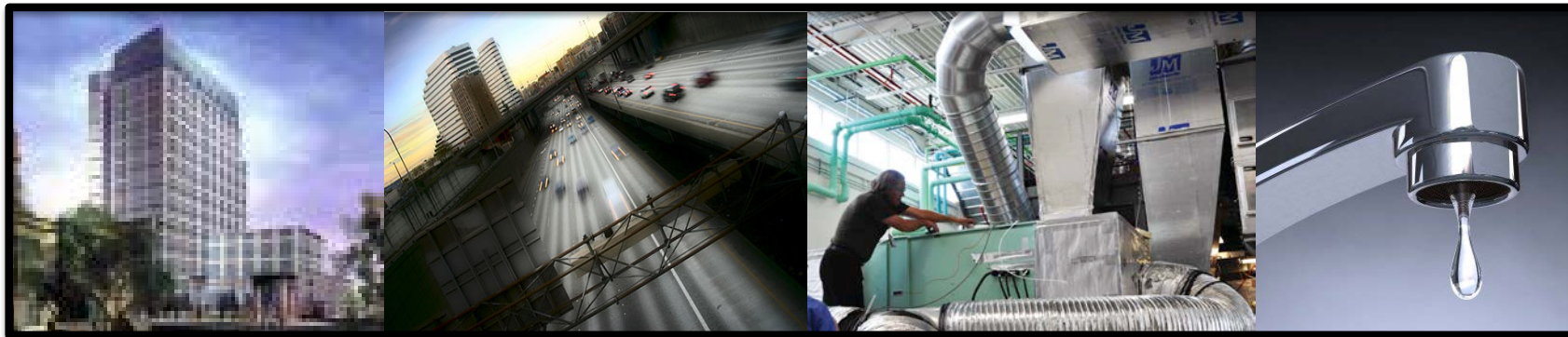
**Buildings**     **Transportation**     **Industry**     **Water**

# Accelerating the Development and Commercialization of Energy-Efficient Technologies & Solutions and Training Future Energy Efficiency Leaders

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**Buildings**     **Transportation**     **Industry**     **Water**



**Cross Cutting: Education, Markets, Controls, Tools & Analytics, Behavior, Policy, ZNE**

4 Technology Centers of Excellence:
- California Lighting Technology Center
- Western Cooling Efficiency Center
- Center for Water Energy Efficiency
- Plug-in Hybrid & Electric Vehicle Research Center

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# VIP Board of Advisors

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Co-Director Energy Program/
Senior Attorney, Natural
Resources Defense Council

**Amory B. Lovins**
Co-Founder, Chairman
and Chief Scientist, Rocky
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**Kathleen B. Hogan**
Deputy Assistant Secretary
for Energy Efficiency,
U.S. Department of Energy

**Barry Neal**
Executive Vice President
Wells Fargo

**Dan'l Lewin**
Corporate Vice President,
Microsoft

**Arthur H. Rosenfeld**
Distinguished Scientist
Emeritus, Lawrence Berkeley
Lab; Commissioner, California
Energy Commission (retired)

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# Strong Track Record of Student Engagement

- Energy Efficiency coursework at undergraduate and graduate level across multiple disciplines

- Intern Development Program (IDP) exposes students to experiential learning opportunities through projects with industry and agency partners



**Rob Bohn
UC Davis
Graduate School of
Management, 2017
Former Marine
Corps Officer**

Per year, we are engaging

- 10–15 Graduate and Professional students

- 30–40 Undergraduate students

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# Exciting Recent Partnerships in Workforce Development

# We Expect NEPTUNE Program To Enable Greater Impact

Goals of the NEPTUNE Program include:

1. Further important research on energy efficiency technology and solutions within the building and transportation sectors; and

2. Provide academic and professional development opportunities for prospective, current, and former military personnel.

Built out of an existing partnership:

On Febraury 16, 2011, Assistant Secretary of Navy Jackalyne Pfannenstiel signed an MOU with UC Davis to pursue development of advanced lighting and other energy efficiency solutions for Navy installations

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# Research Projects that Further Navy Interests

1. Data driven Plug in Electric Vehicle Decision Making Tools



1. Improved reliability of Occupancy Sensing for Lighting Controls in Outdoor Applications



1. High Performance Recuperators for Waste Heat Recovery Cycles



1. Portfolio-level Energy Auditing and Decision-making Methods & Tools

# Model for Engagement of ROTC and Veteran students

- Campus level recruitment efforts

- Provides students with a wide range of opportunities to engage

- Ensures professional development through mandatory participation requirement in our "Intern Development Program"

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# PROJECT 1:
# DATA DRIVEN PLUG IN ELECTRIC VEHICLE DECISION MAKING TOOLS

Principal Investigator: Dr. Gil Tal

Associated Researchers: Dr. Michael Nicholas, Dr. Thomas Turrentine

# Research Opportunity

- Plug in Electric Vehicle usage is on the rise

- Substituting gasoline driven miles for electric vehicle miles traveled (eVMT) has significant impacts on

  - energy sources

  - grid loads

  - energy security

  - local emissions and greenhouse gas emissions

  - capital requirements

  - operating costs

- Need for reliable models to address planning and policy of infrastructure and management of grid loads

# Simulated Statewide Charging Demand Based on Current Vehicle Locations and Ranges
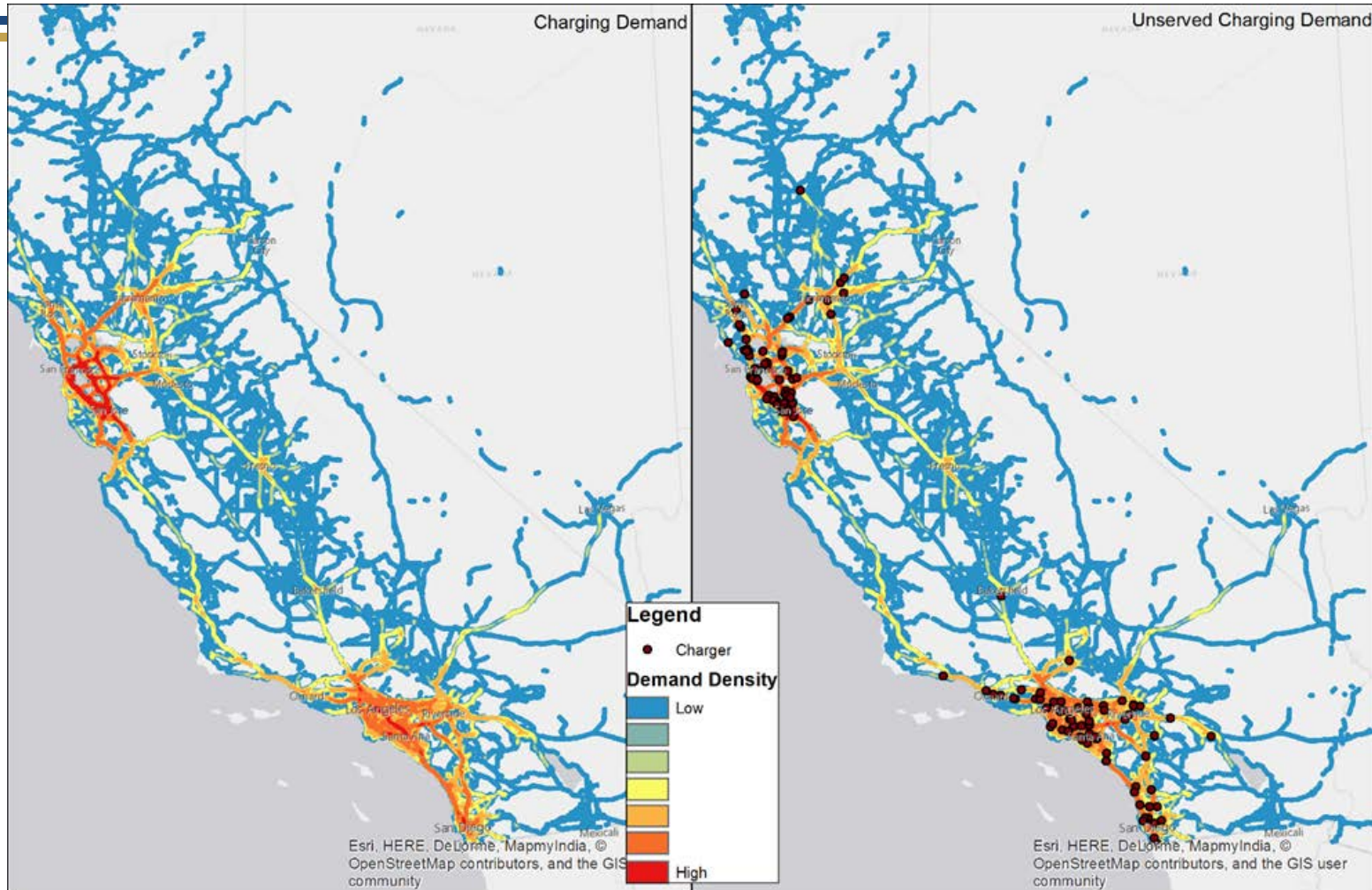


- Left figure shows potential scaled demand from current vehicles
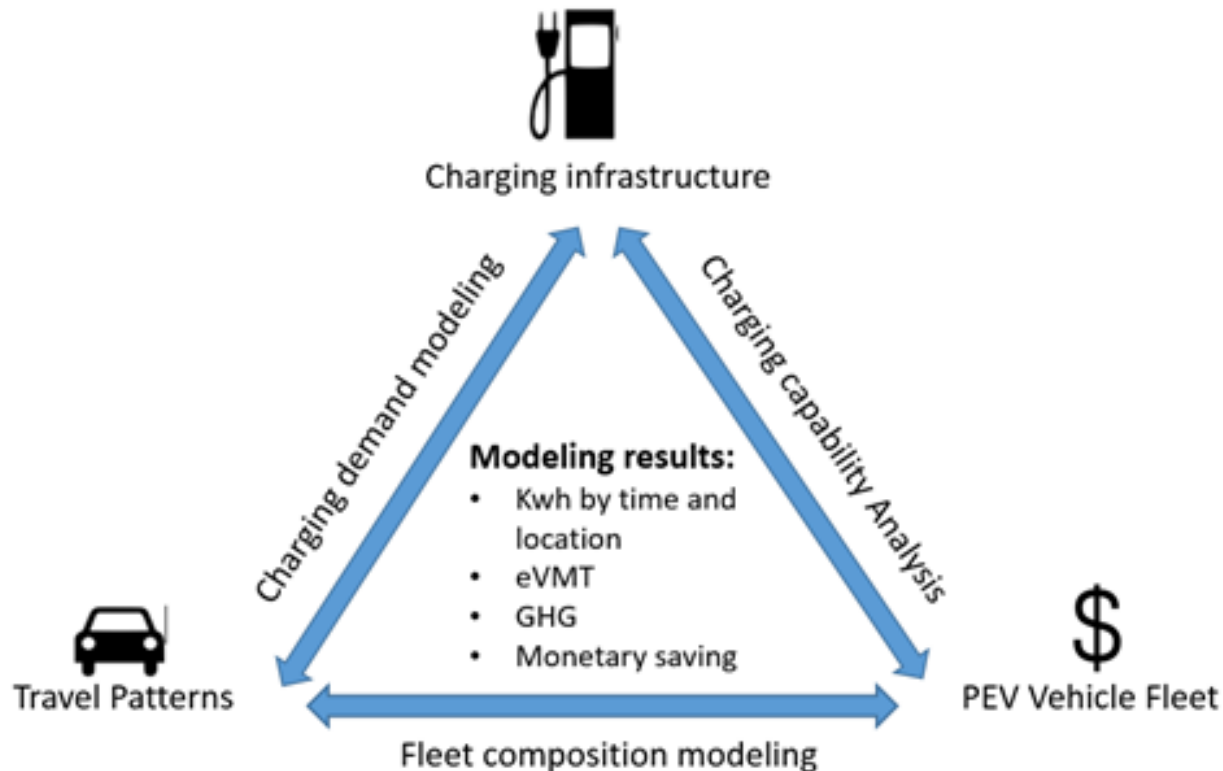- Right figure shows how much demand is met by current chargers

# Research Focus

- Development of data driven tools to facilitate important planning decisions related to charging infrastructure, fleet and grid management including vehicle-grid integration (VGI) for a growing PEV fleet.

- Special emphasis is on modeling potential rollout of PEVs using available internal combustion engine (ICE) vehicle fleet travel behavior datasets, charger usage datasets and plugin vehicle (PEV) datasets to develop tools for planners, policy makers and decision makers.

# Potential benefits to US Navy

- Facilitate deployment of optimum non-tactical PEV fleet and charging infrastructure strategy



Charging infrastructure

Charging demand modeling

Charging capability Analysis

**Modeling results:**
- Kwh by time and location
- eVMT
- GHG
- Monetary saving

Travel Patterns

PEV Vehicle Fleet

Fleet composition modeling

# PROJECT 2:
# IMPROVING THE PERFORMANCE OF OUTDOOR OCCUPANCY-BASED CONTROL SYSTEMS

Principal Investigator: Dr. Konstantinos Papamichael

Engineering Director: Keith Graeber

Project Manager: Cori Jackson

# Research Opportunity

- Passive infrared (PIR) sensing technology has limited range and reliability in outdoor environments

- For outdoor applications with luminaires at standard mounting heights, PIR technology cannot cover the entire area between adjacent poles/luminaires.

- Additional limitations apply during poor weather conditions and when the direct line of sight is obstructed

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# Research Focus

- Evaluate PIR-alternatives such as microwave detection, image recognition and embedded, ground-level pressure sensing

- Refine most-promising solutions to better serve outdoor applications

  - Optics

  - Range

  - Response time

- Demonstrate improved technology under real-world conditions

  - Validate performance

  - Document energy savings when used to control outdoor lighting

  - Refine solutions

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# Potential benefits to US Navy

- Increased applicability of adaptive, occupancy-based lighting controls for outdoor applications

- Energy reduction

- Improved safety and security of installations

- Improved sensing technology can translate to other functions including data collection

# PROJECT 3:
# HIGH PERFORMANCE WASTE HEAT RECUPERATORS FOR HEAT RECOVERY CYCLES

Principal Investigator: Dr. Vinod Narayanan

# Research Opportunity

- Waste heat recovery in ships can lead to enhanced efficiency and longer times between refueling

- Challenge is in designing a reliable recuperator

    - Cyclic operation

    - Corrosion

    - Low pressure drop designs needed

- There has been recent interest in sCO2 cycles for power generation and waste heat recovery.

# Research Focus

- Develop an experimentally-validated design of a compact recuperator for sCO2 waste heat recovery cycle

  ▪ Establish a thermal, fluidic, and mechanical model for the recuperator

  ▪ Validate the mechanical integrity and thermofluidic performance based on laboratory-scale experiments, and

  ▪ Optimize the design of the recuperator based on realistic constraints of system backpressure

- Specifically, designs will be explored for Additive Manufacturing

# Potential benefits to US Navy

- Novel recuperator designs for high-pressure sCO2 waste heat recovery cycle using Additive Manufacturing

  - High effectiveness recuperator

  - Compact

  - Low pressure drop on exhaust side

  - No weld/braze joints in AM- potentially more reliable

# PROJECT 4:
# PORTFOLIO-LEVEL ENERGY AUDITING AND DECISION-MAKING METHODOLOGY & TOOL

Principal Investigator: Siva Gunda

Collaborators: Dr. Frank Loge, Cori Jackson, Theresa Pistochini

# Research Opportunity

- Current energy audit process, method and analysis used by industry for small and medium sized commercial buildings are performed at a prohibitively high cost

- Workforce is limited to Professional Engineers and does not allow for and benefit from potential lower-cost entry-level building audit and retrofit professionals

- Lack of standardization of methods and framework for data integrity, collection and data ware-housing reduces potential for portfolio-level planning and management of facilities

# Research Focus

- Development of an expanded methodology for building energy and water audits

- Design of a robust database of lighting, HVAC, envelope, plug loads and water efficiency technologies

- Development of automated tools for portfolio level building energy and water data analysis, visualization and reporting

- Development of methodology to integrate building energy data into a "Universal Data Platform"

# Potential benefits to US Navy

- Energy & cost reduction through targeted retrofits of small and medium sized buildings on Naval bases and affiliated facilities

- Improved understanding and reliability of building operations

- Data platform for portfolio level management of building stock

- New employment opportunities for prospective, active, and retired military

# Thank you!