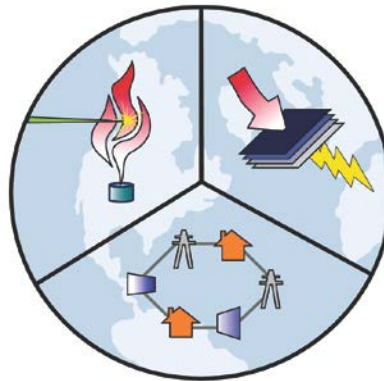


# Fueling Infrastructure Needs for the Future Automobile

**Professor Scott Samuelsen**  
**Mechanical, Aerospace, and Environmental Engineering**  
**University of California, Irvine**

**Director**  
**Advanced Power and Energy Program**



**October 11, 2011**

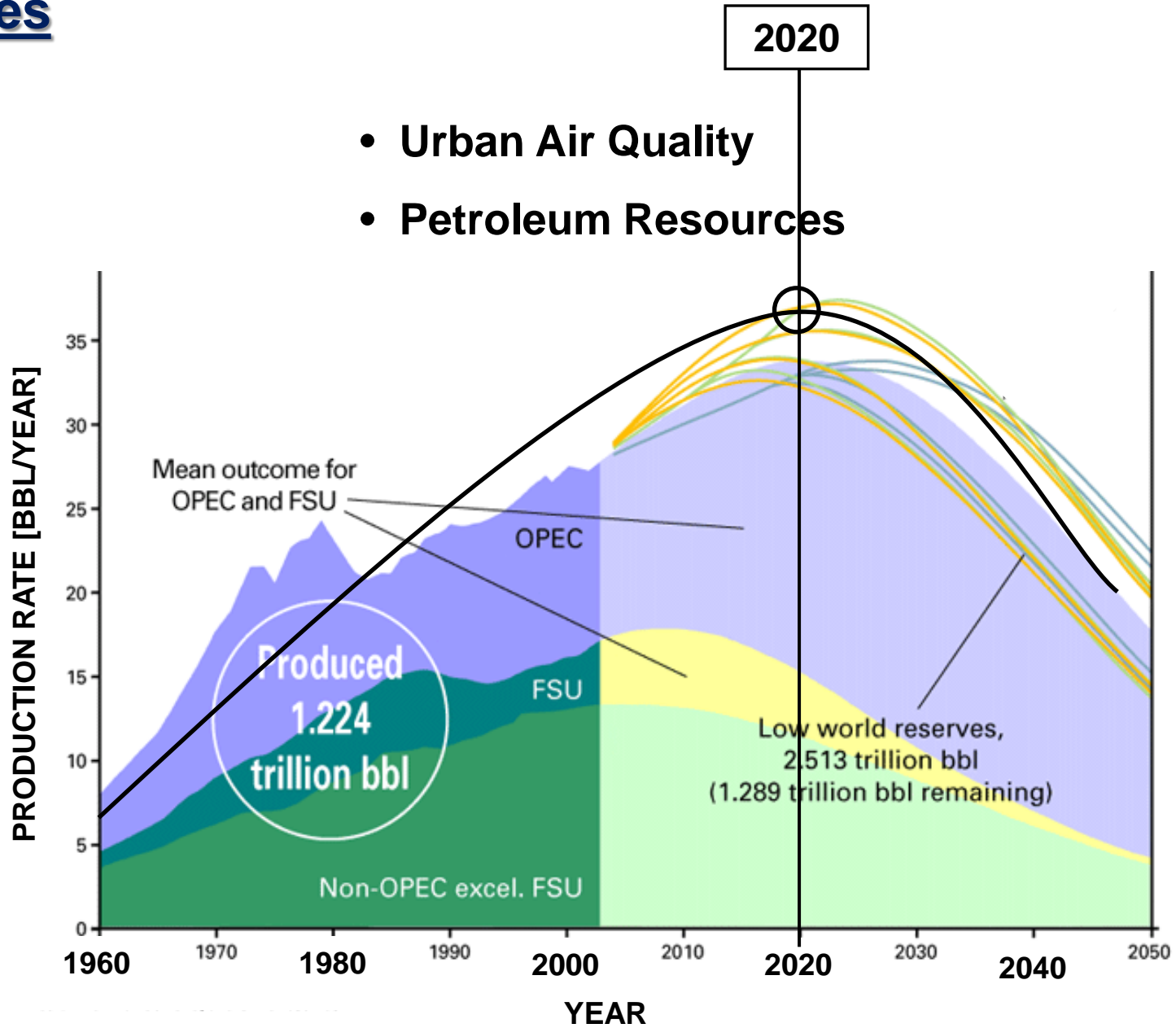
# Forces

- **Urban Air Quality**



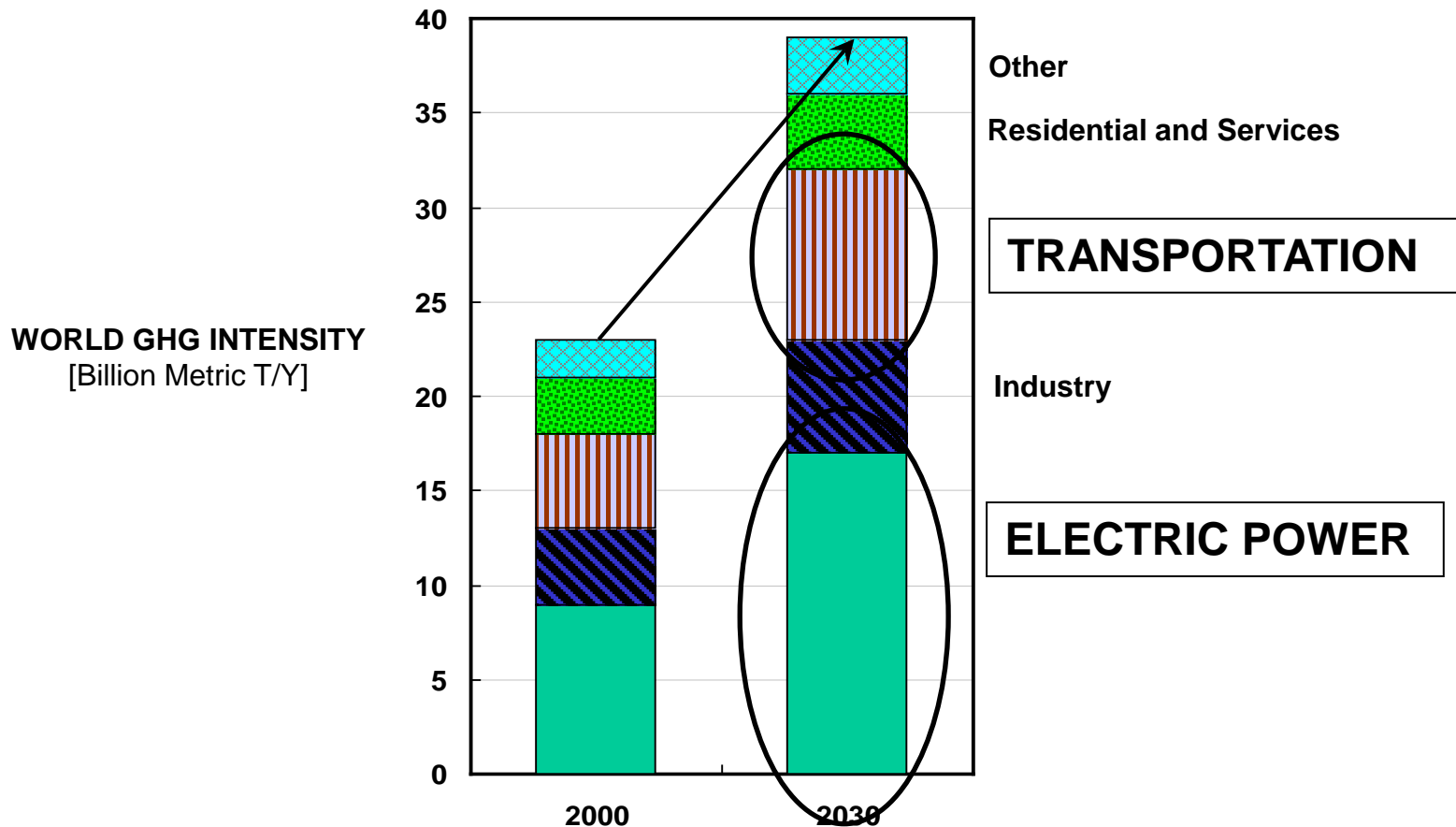
# Forces

- Urban Air Quality
- Petroleum Resources



# Forces

- Urban Air Quality
- Petroleum Resources
- Climate Change



# Forces

- **Urban Air Quality**
- **Petroleum Resources**
- **Climate Change**
- **Fuel Independence**
- **National Security**



# Paradigm Shifts

***INFRASTRUCTURE***

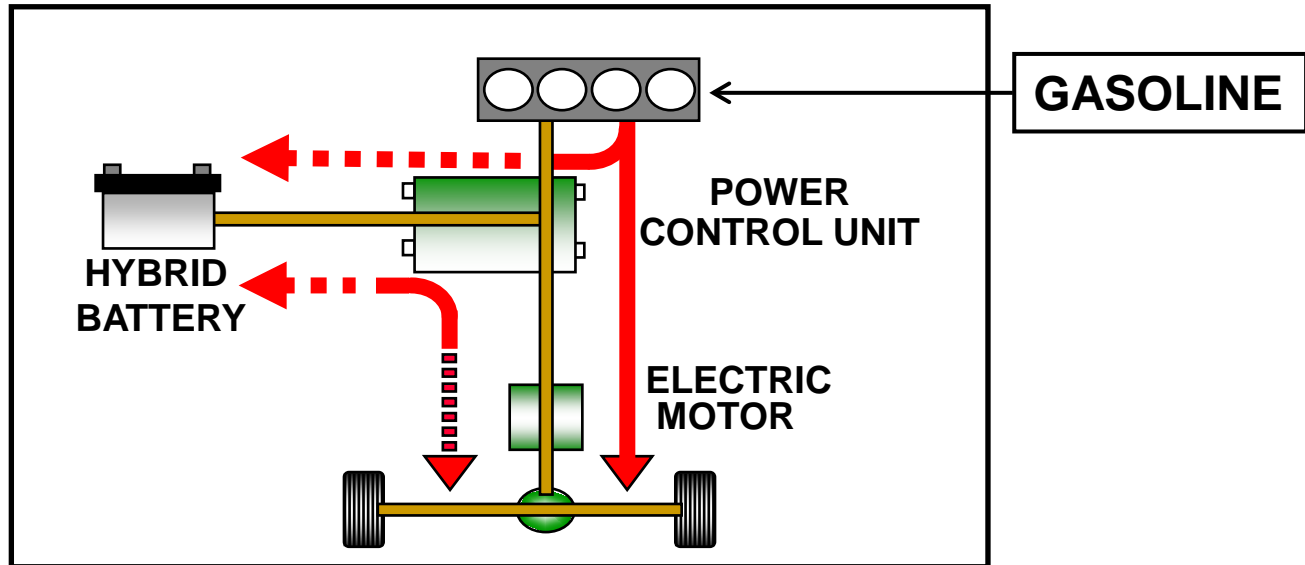
***ORANGE COUNTY***

- **Drive Train**
  - **Electric**
- **Fuel**
  - **Electricity**
- **Dual Fuel**
  - **Gasoline/Electricity**
- **Power Plant**
  - **Fuel Cell**
- **Fuel**
  - **Hydrogen**
- **Dual Fuel**
  - **Hydrogen/Electricity**



# Paradigm Shifts

- Drive Train
  - Electric



# Paradigm Shifts

- Drive Train
  - Electric
- **Fuel**
  - **Electricity**
- Dual Fuel
  - Gasoline/Electricity
- Power Plant
  - Fuel Cell
- Fuel
  - Hydrogen
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  - Hydrogen/Electricity

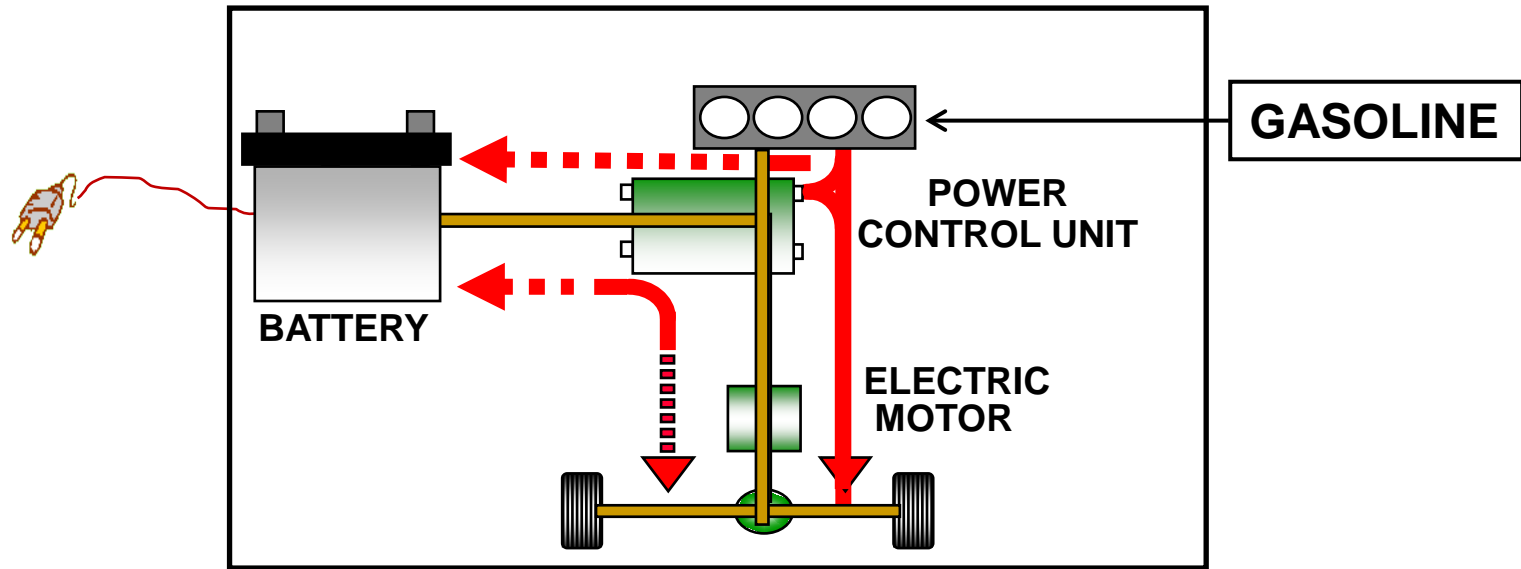
*INFRASTRUCTURE*

*ORANGE COUNTY*



# Paradigm Shifts

- Fuel
  - Electricity



# Paradigm Shifts

- Drive Train
  - Electric
- Fuel
  - Electricity
- **Dual Fuel**
  - **Gasoline/Electricity**
- Power Plant
  - Fuel Cell
- Fuel
  - Hydrogen
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  - Hydrogen/Electricity

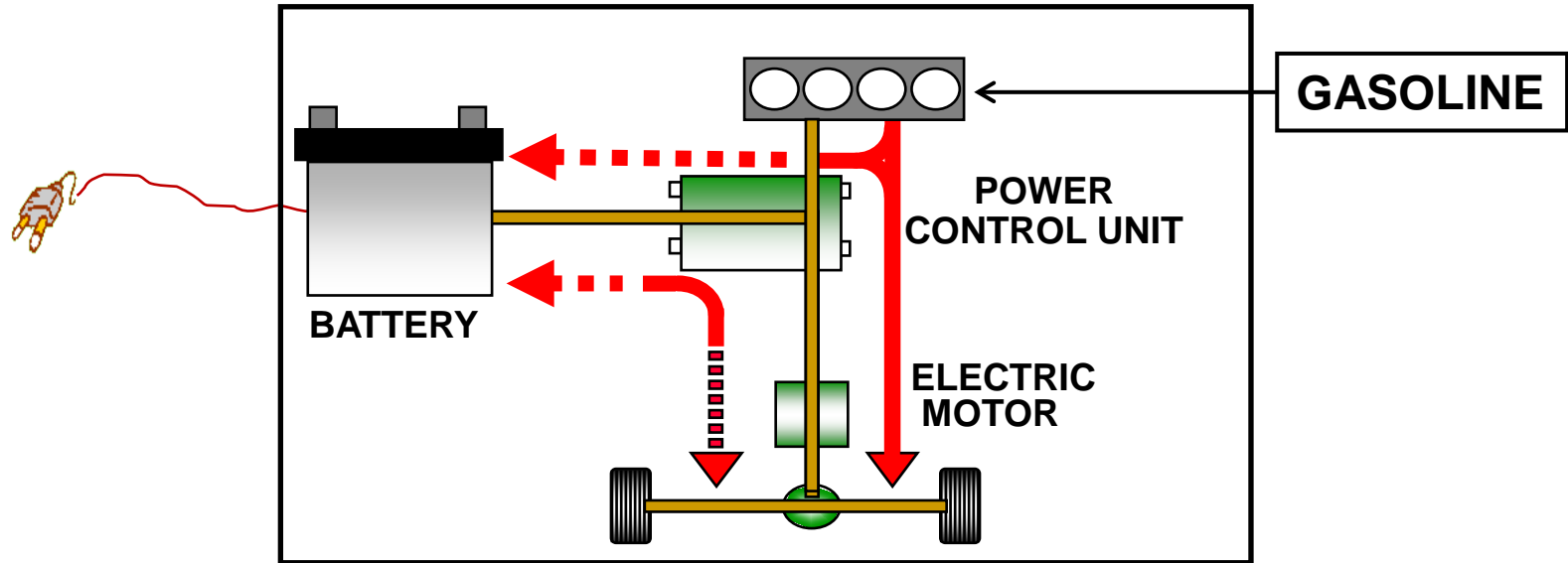
*INFRASTRUCTURE*

*ORANGE COUNTY*



# Paradigm Shifts

- Dual Fuel
  - Gasoline/Electricity



# Paradigm Shifts

- Drive Train
  - Electric
- Fuel
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  - Gasoline/Electricity
- **Power Plant**
  - **Fuel Cell**
- **Fuel**
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- Dual Fuel
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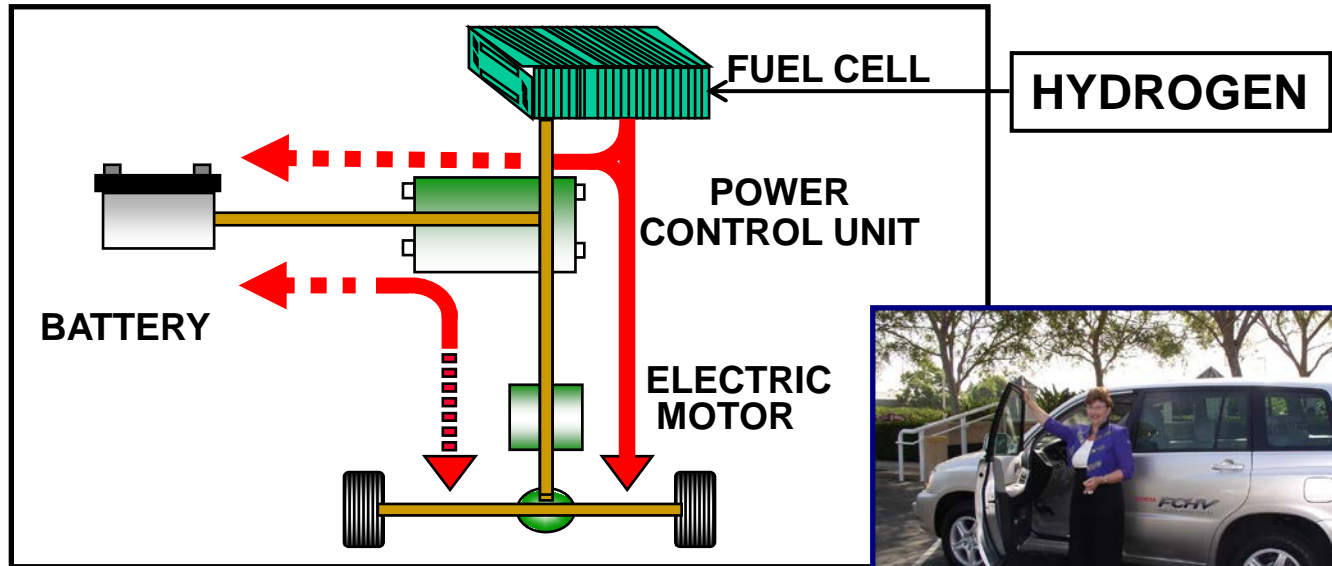
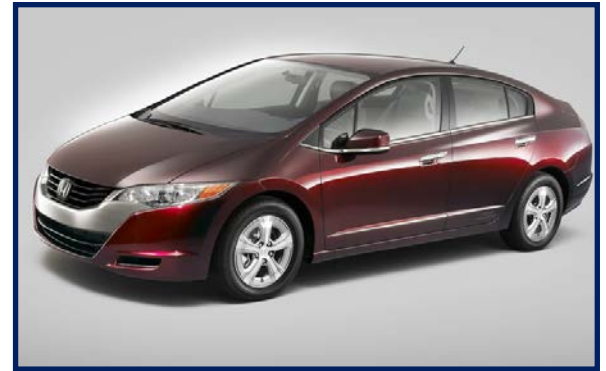
*INFRASTRUCTURE*

*ORANGE COUNTY*



# Paradigm Shifts

- Power Plant
  - Fuel Cell
- Fuel
  - Hydrogen



# Paradigm Shifts

*INFRASTRUCTURE*

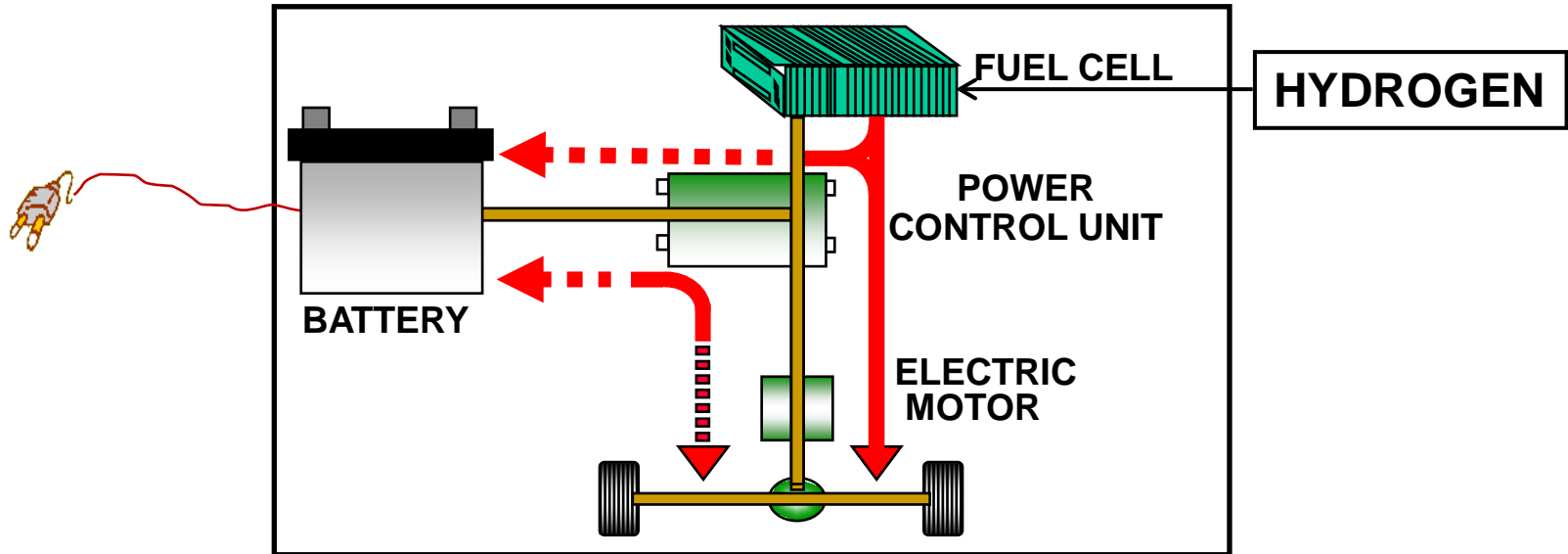
*ORANGE COUNTY*

- Drive Train
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  - Hydrogen
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  - **Hydrogen/Electricity**



# Paradigm Shifts

- Dual Fuel
  - Hydrogen/Electricity



# Paradigm Shifts

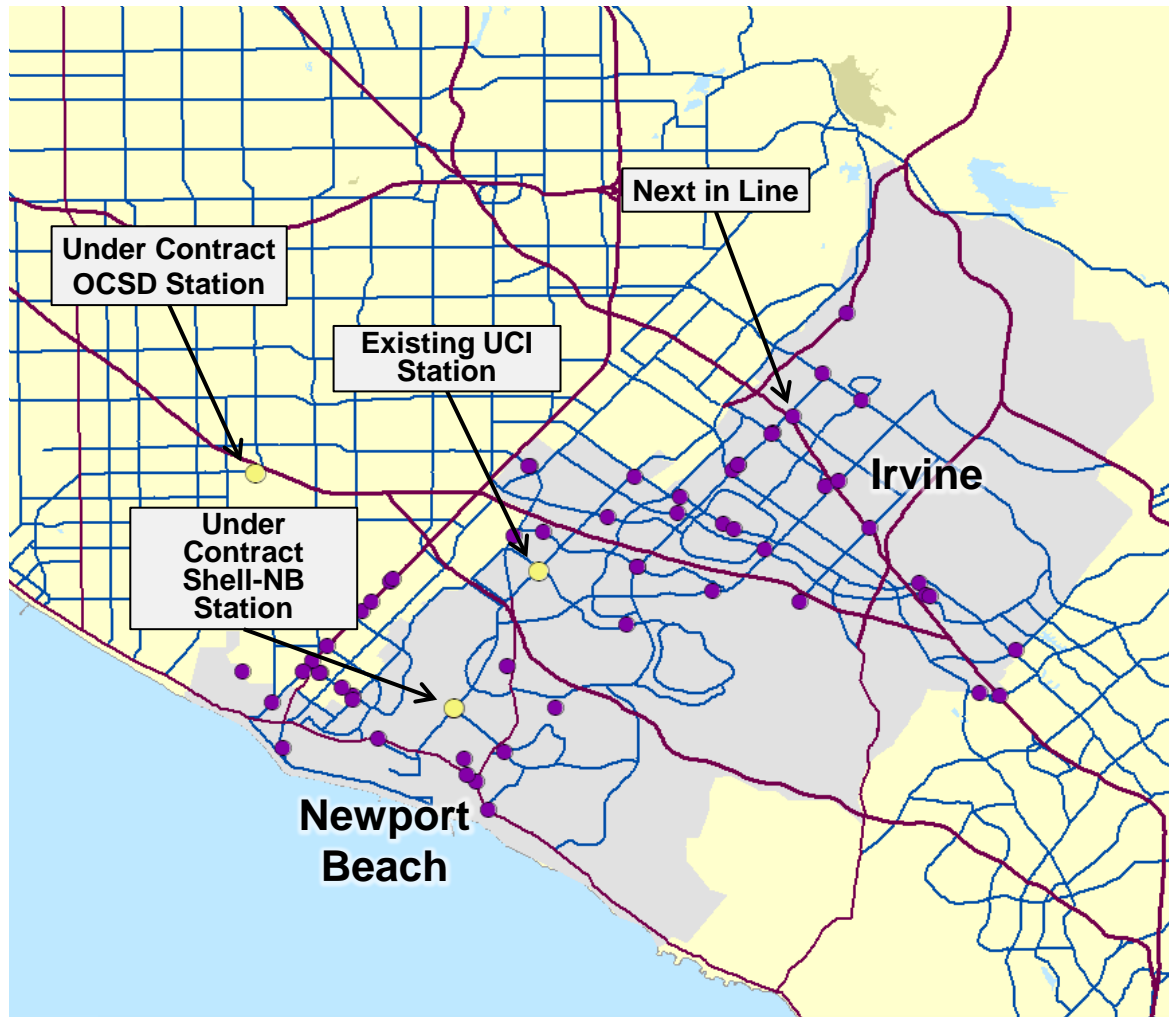
*INFRASTRUCTURE*

*ORANGE COUNTY*

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# Smart Grid: Hydrogen Fueling Infrastructure



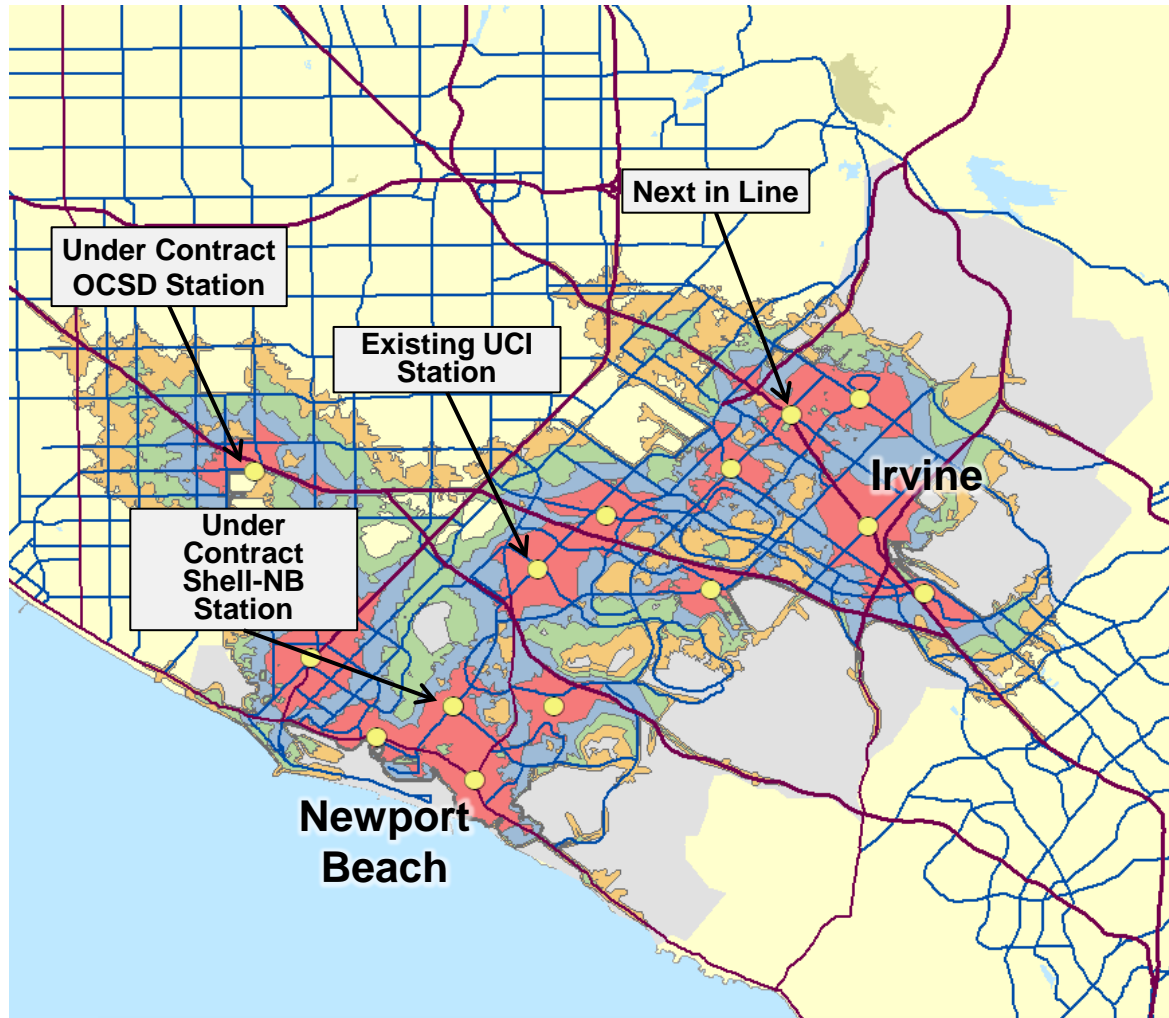
Total existing gasoline stations in Irvine/Newport Beach (59)

- Gasoline stations
- Interstates and freeways
- Principal arterial roads
- Hydrogen Stations
- Residential Land Use

SYSTEMATIC PLANNING TO OPTIMIZE INVESTMENTS IN HYDROGEN INFRASTRUCTURE DEPLOYMENT  
*International Journal of Hydrogen Energy*, Vol. 35, No. 10, pp. 4652-4667, 2010  
(Shane Stephens-Romero, Tim M Brown, Jee E. Kang, Wilfred W. Recker, and G.S. Samuelsen)



# Smart Grid: Hydrogen Fueling Infrastructure



Total existing gasoline stations in Irvine/Newport Beach **59**

- Gasoline stations
- Interstates and freeways
- Principal arterial roads
- Hydrogen Stations
- Residential Land Use

**14** hydrogen stations

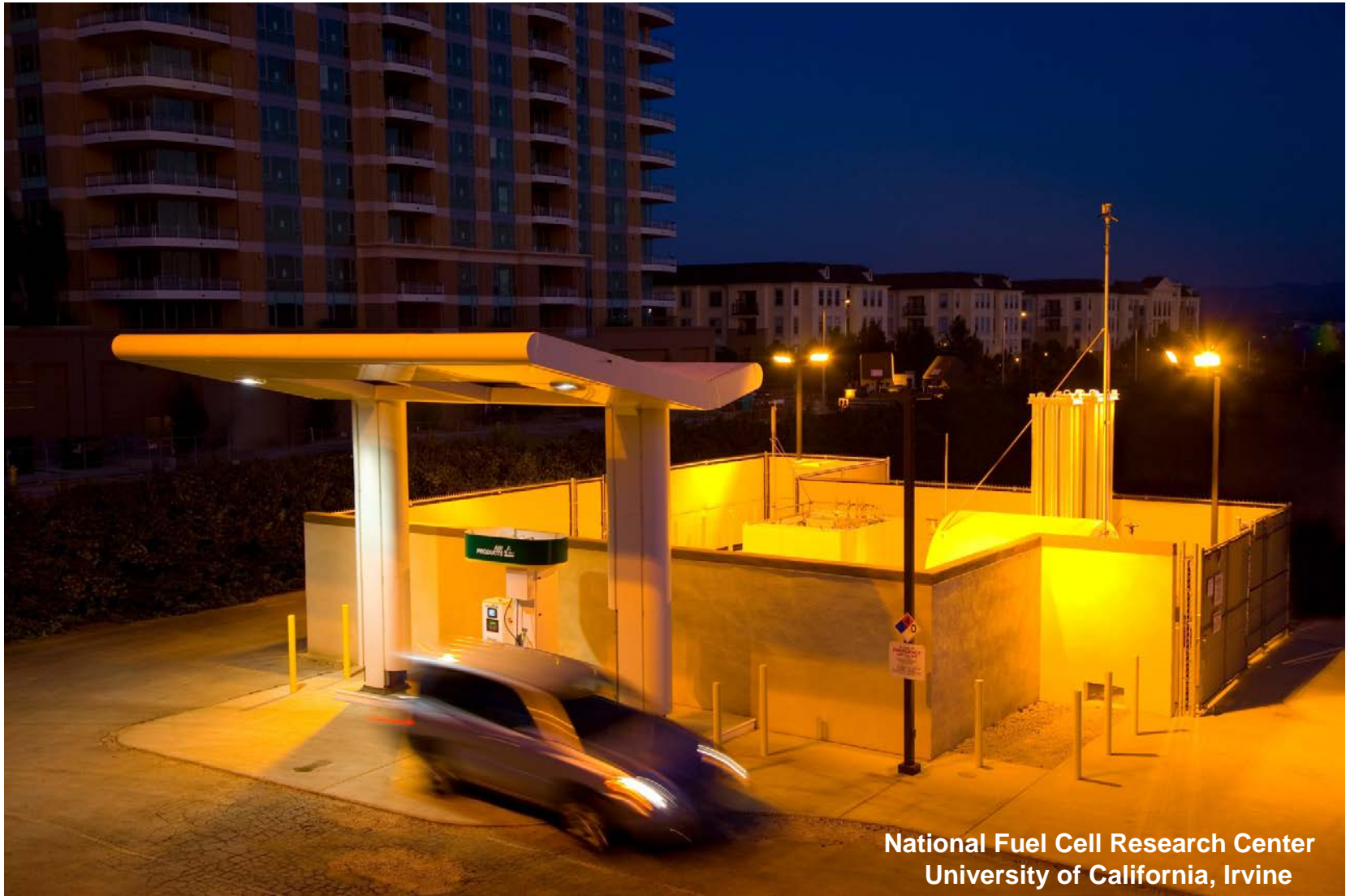
Travel Times:

- 2 min
- 3 min
- 4 min
- 5 min

**SYSTEMATIC PLANNING TO OPTIMIZE INVESTMENTS IN HYDROGEN INFRASTRUCTURE DEPLOYMENT**  
*International Journal of Hydrogen Energy*, Vol. 35, No. 10, pp. 4652-4667, 2010  
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# Smart Grid: Hydrogen Fueling Infrastructure



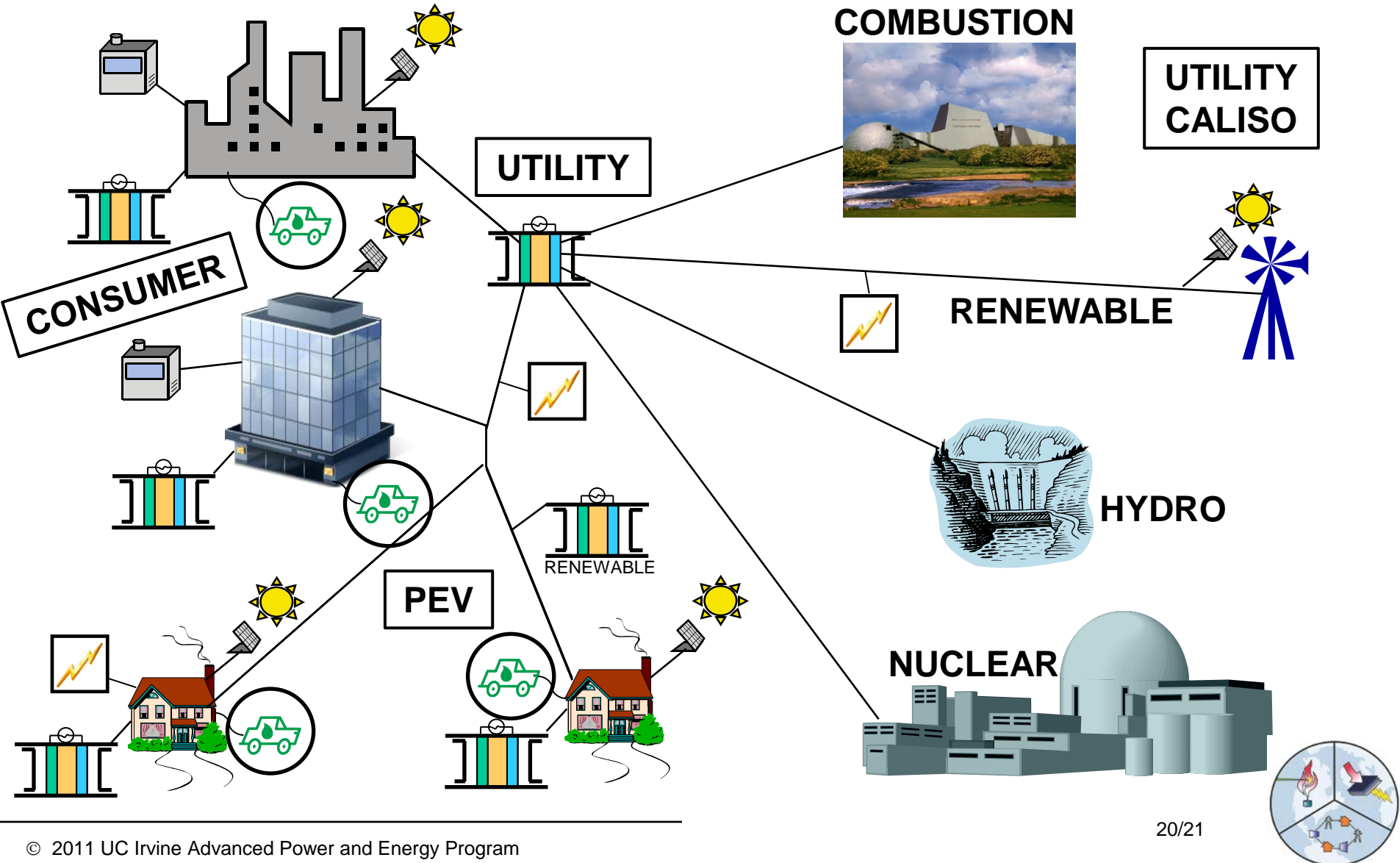
National Fuel Cell Research Center  
University of California, Irvine



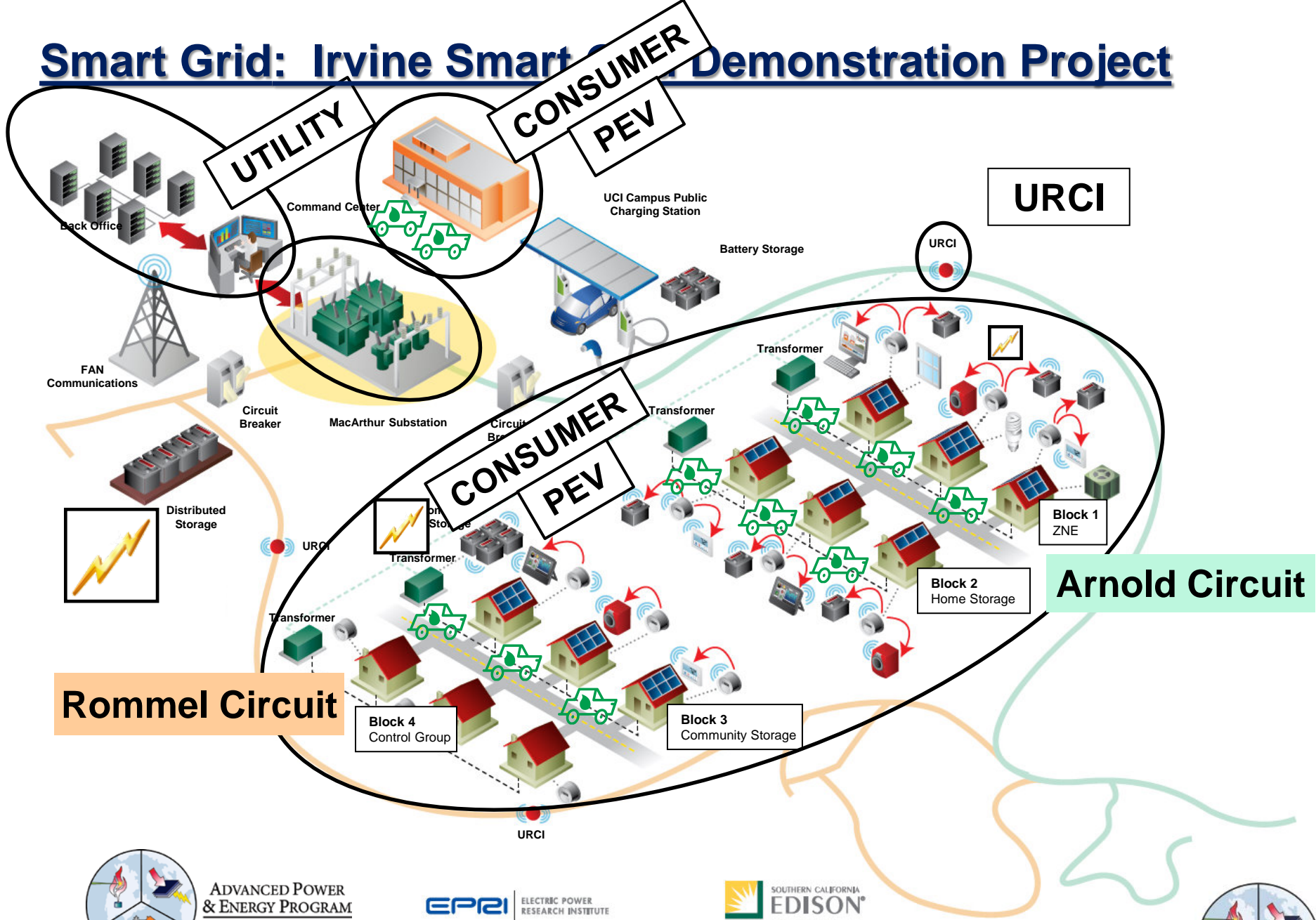
# Smart Grid: Electric Infrastructure

## DISTRIBUTED GENERATION

## CENTRAL GENERATION



# Smart Grid: Irvine Smart Grid Demonstration Project



Rommel Circuit

Arnold Circuit



ADVANCED POWER & ENERGY PROGRAM  
UNIVERSITY OF CALIFORNIA - IRVINE

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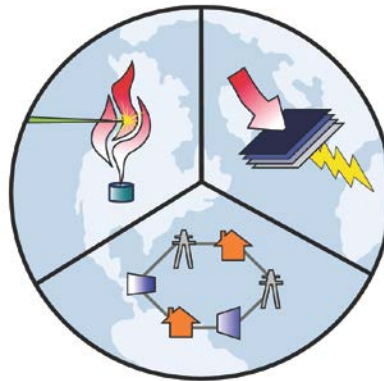
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