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Learn more about Professor Gadh's work in this YouTube video about the UCLA Smart Grid Energy Research Center:
http://www.youtube.com/watch?v=j_U9Sb30aEE

Smart Grid Characteristics

Renewables For Clean Energy And Clean Environment
- Efficiently incorporates existing and new renewable generation such as Wind and Solar thereby helping generate clean energy and be environmentally cleaner

Energy Efficiency
- Allows grid to be more efficient, self healing, and, resilient

Benefit To Consumers
- Enables energy efficiency programs, peak reduction incentives, etc., eventually reducing prices

Electric Vehicles Integration
- Allow EVs to be integrated into the grid

Peak Demand Reduction Via Demand Response
- Enables utilities to use Demand Response to incentive peak demand reduction resulting in reduced needs for peaker plants.

Utility Moving Towards Market Oriented Pricing
- Enables utilities to become more market oriented by connecting supply and demand with pricing

National Security
- Helps national security by improving Safety, security and reliability

Better Control
- Smarter monitoring and control of power (Voltage, frequency, current)

UCLA Smart Grid Center Thought Leadership Forums

Next Smart Grid Forum – October 23, 2012

Speakers from previous forums include:

Andres Carvallo *Chief Information Officer* Austin Energy	**Dave Chassin** *Staff Scientist* PNNL	**Vikram Budhraja** *President* Electric Power Group	**Luke Clemente** *General Manager, Metering & Sensing* GE Energy - Digital Energy
Kshamit Dixit Director of IT Security Toronto Hydro	**Livio Gallo** Chief Executive Officer Enel Distribuzione	**Mike Gravely** *Manager - Energy Systems Research Office* California Energy Commission	**Erich Gunther** *Chairman and CTO* EnerNex Corporation
Aloke Gupta *Energy Analyst* California Public Utilities Commission	**Joel Ibarbia** *Senior Consulting Engineer - SmartMeter* PG&E SmartMeter Engineering	**Doug Kim** *Director, Advanced Technology* Southern California Edison	**Lee Krevat** *Director - Smart Grid* San Diego Gas & Electric
Jayant Kumar *Director, Strategy & Partnership* AREVA T&D Inc	**Matthew Lampe** *Chief Information Officer* Department of Water and Power	**Mark McGranaghan** *VP* EPRI	**Michael Montoya** *Director Engineering Advancement* Southern California Edison
John Nelson *Chief, Electricity & Renewables* Defense Energy Support Center	**Scott Pugh** *Science & Technology Directorate* Defense Energy Support Center	**Ted Reguly** *Director - Smart Meter Program Office* San Diego Gas and Electric	**Commissioner Timothy Simon** *Commissioner* California Public Utilities Commission
Weston Sylvester *Director Distribution Solutions/Smart Grid* Siemens Energy, Inc.	**Malcolm Unsworth** *President & CEO* Itron, Inc.	**David Watson** *Program Manager* Lawrence Berkeley National Laboratory	**David Wollman** *Manager, Electrical Metrology Groups* NIST

Smart Grid Energy Research Center (SMERC)

Major Funded Project

- DOE Funded Regional Demo Grant – LADWP, UCLA, USC, JPL-Caltech
- KIER-UCLA Smart Grid Grant
- DOE Funded EPRI, NESCOR Grant – EPRI + several DOE, University partners
- SMERC IPP (Industry Partners Program): 18 industry members

Industry Thought Leadership Forums – Every Six Months, Next Scheduled For October 23, 2012

Smart Grid Living Lab (SMERC LL)

- UCLA has its own natural gas cogeneration power plant
- UCLA gets a fraction of its power from LADWP, the local utility

External Leadership Council (SMERC LC)

Educational Programs (courses, training workshops, demonstration days)

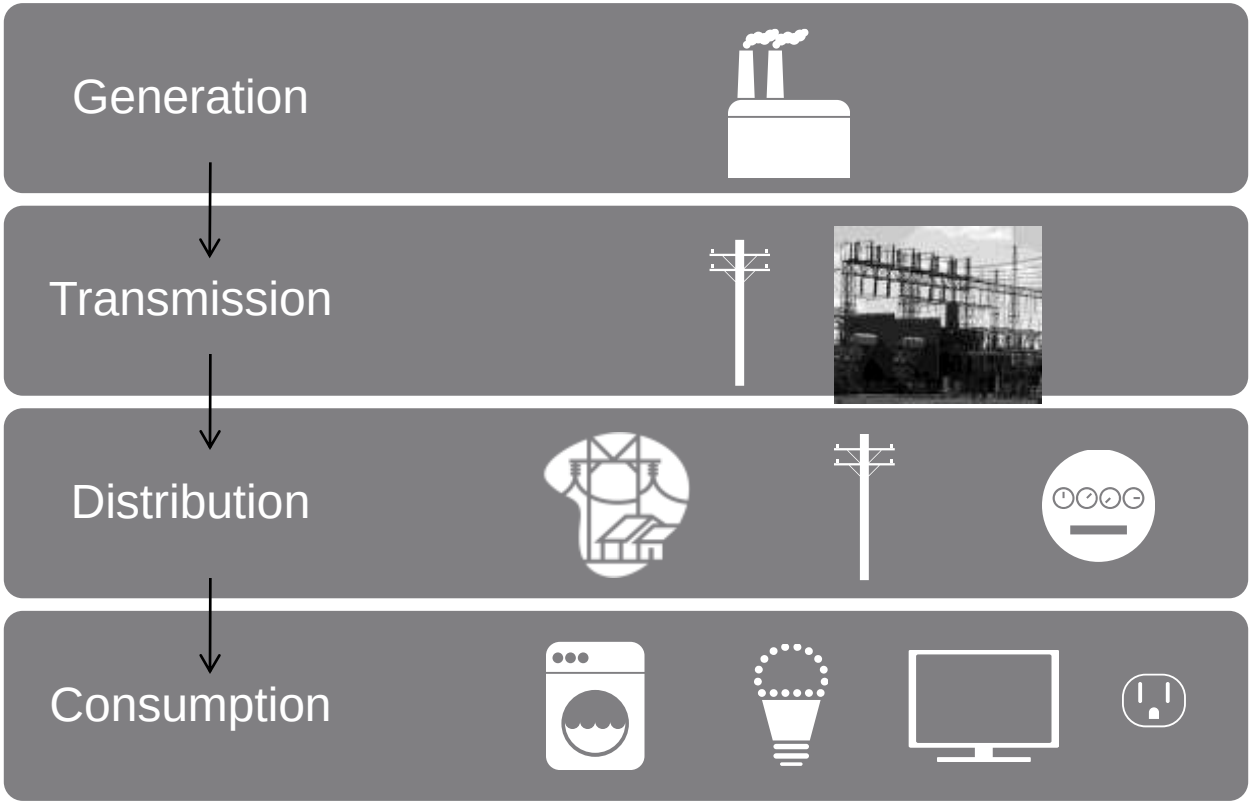
Publish Research Papers

Current IPP Participants

Areas of research and demonstration

- Smart Grid Technologies and Demonstrations

Traditional Electricity Flow Model



Traditional hierarchical model

New electricity flow model - the opportunity Smart Grid

Technologies?

Cloud intelligence

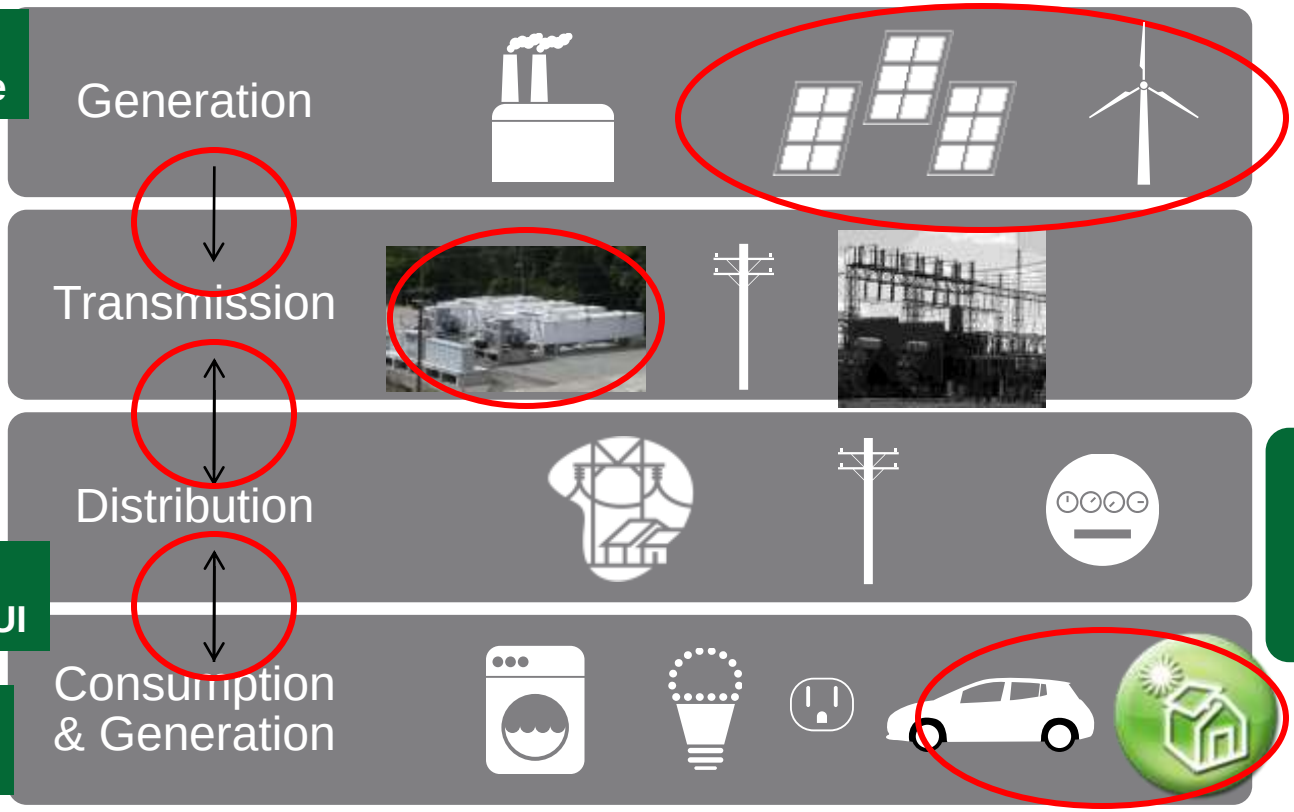
Wireless/ Comm.

Sense & Control

Storage

Mobile Devices & UI

Embedded systems



Non-hierarchical model

Renewables - Solar, Wind, BioM, GeoT, Hydro

Key Players

DOE
- $

ARPA-E
- $

NIST
- Standards

FERC
- The federal agency that regulates interstate gas pipelines and interstate gas sales under the Natural Gas Act. The FERC is considered an independent regulatory agency responsible primarily to Congress, but it is housed in the Department of Energy.

NERC
- Founded by the electric utility industry to develop and promote rules and protocols for the reliable operation of the bulk power electric transmission systems of North America.

FCC
- Communications

Utilities
- Move electricity

Telecom companies
- Comm. service

Vendors
- GE, Siemens, ABB, IBM, Google, Yahoo, Oracle, Microsoft, Intel, Hughes

Societies
- SAE, IEEE, ISO, Zigbee alliance, DRSG (DR Smart Grid Coalition)…

VC's and Startups

UCLA SMERC Smart Grid Research

WINSmartGrid™ Platform for Smart Buildings and Smart Campus

- Open, plug-and-play, wireless sense-and-control to enable smart buildings and smart homes, HAN and AMI interfaces

Demand Response

- Automated load control in smart buildings, smart offices, smart homes, smart appliances, renewable integration and local storage

EV Integration to the Grid

- Grid to Vehicle (G2V) and Vehicle to Grid (V2G) interfaces, sensing, communications and control; distribution-side capacity considerations, pricing incentives-based consumption, using aggregated EV as energy source, EV interface and architecture

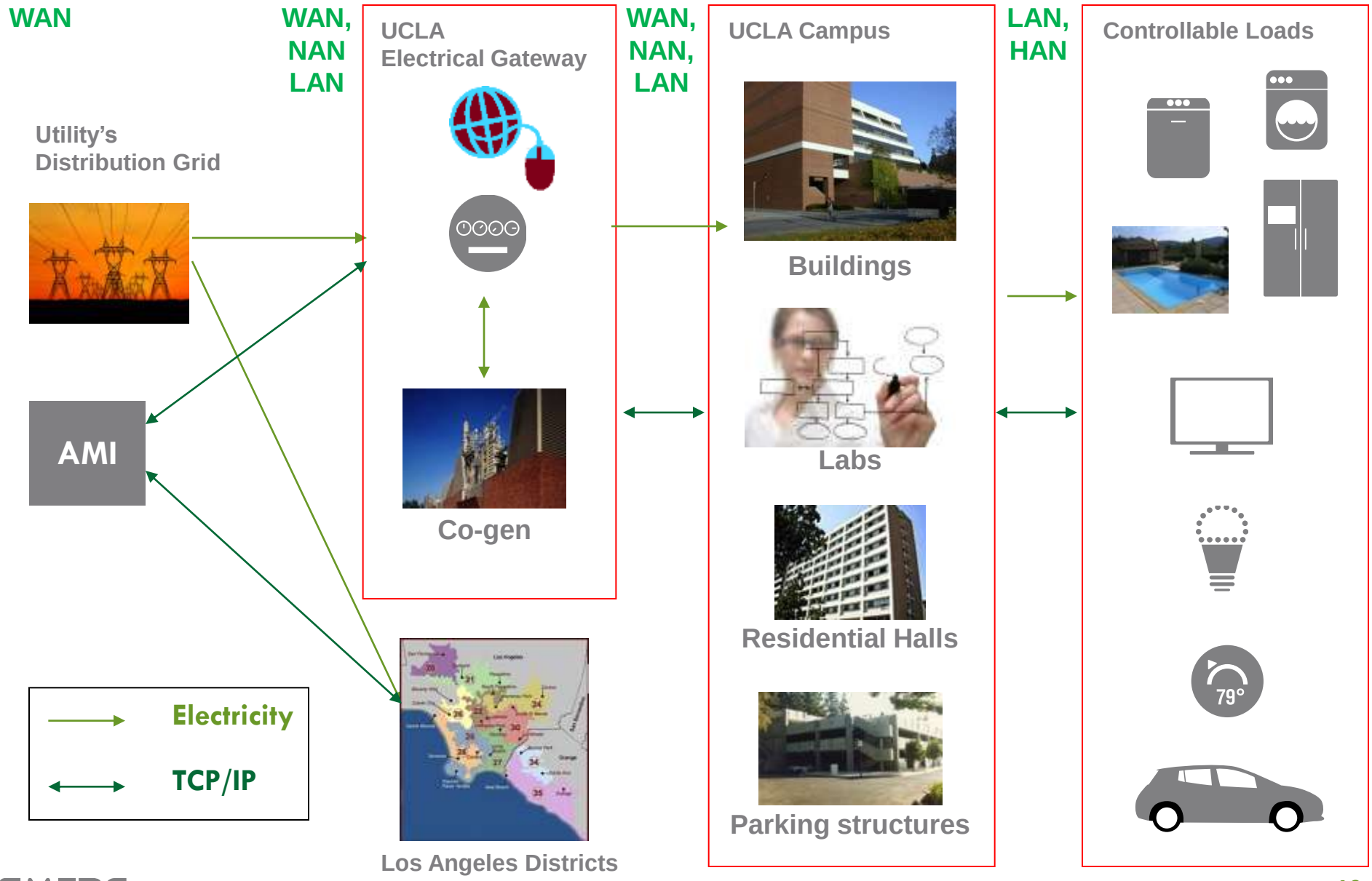
Microgrid

- Comm, sense and control for integrating renewables, EVs and smart loads

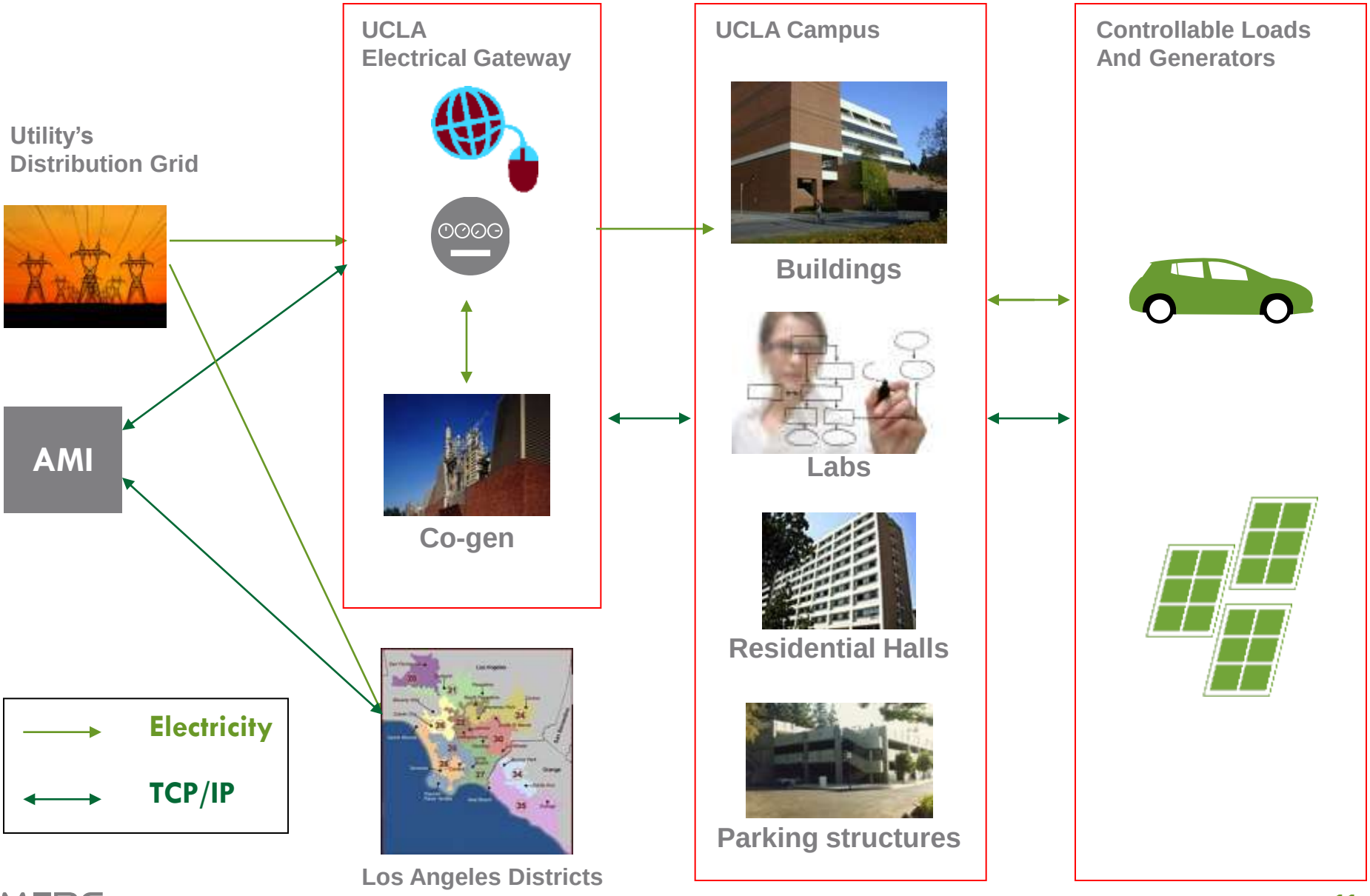
Cybersecurity of Communications Infrastructure

- Wireless communications for EV charging infrastructure uses RF devices; zigbee network security as used by meshed meters, security of mesh networks in charging stations.

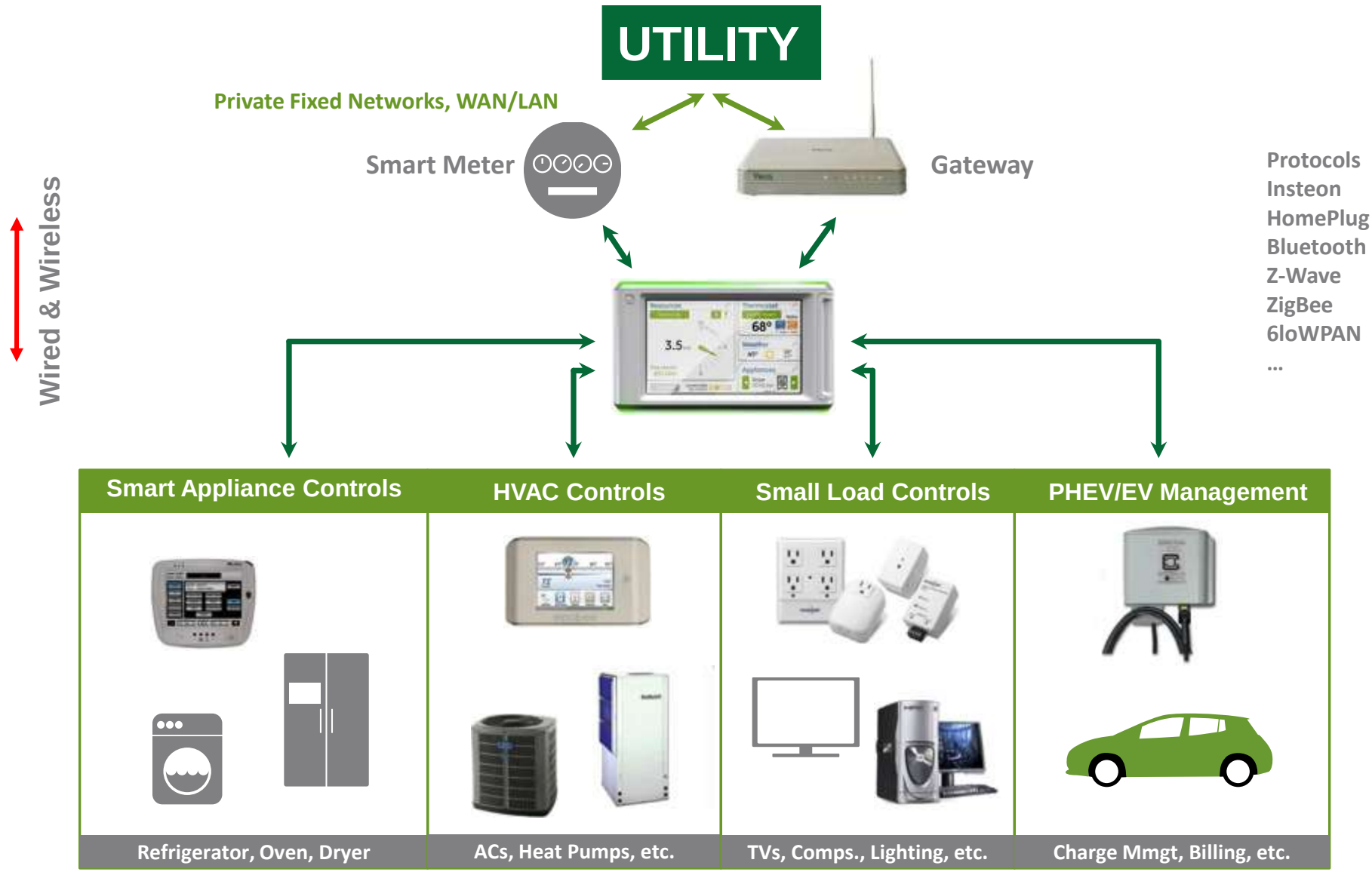
WINSmartGrid™ - Power and information flow



WINSmartGrid™ - Power and information flow



Demand Response - Automation Network

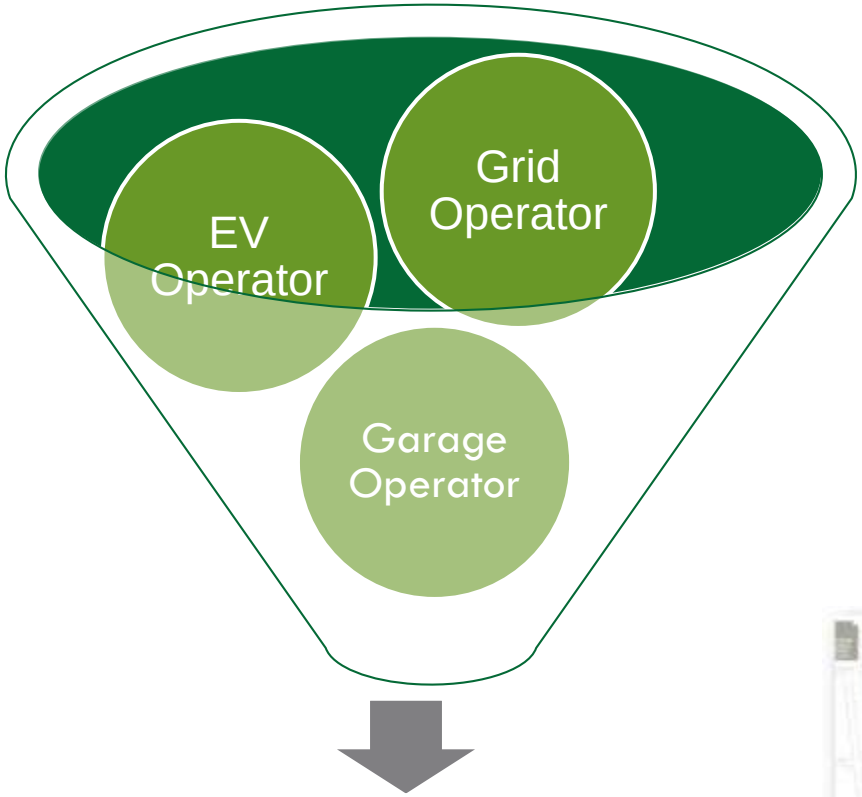


WINSmartGrid DR – Wireless Appliance Interface

DR - Research Issues

- Architecture of wireless comm, sense-and-control to enable smart buildings
- Intelligence distributed between appliances, sensor, HAN, meters, NAN, and cloud
- Layered approach to sensing, control, comm, data and intelligence
- Architecture of wireless comm, sense-and-control in support of DR signal transmission
- Communications interfaces and responsiveness of appliances to DR signals
- Consumer interfaces and consumer response to DR
- DR messaging language
- Effectiveness of DR signals under varying conditions and circumstances
- Technology integration, standards and plug-and-play
- Open ADR and its interfaces to WINSmartGrid
- Scaling up from UCLA to utility partner

EV Smart Grid Integration: Fundamental Approach

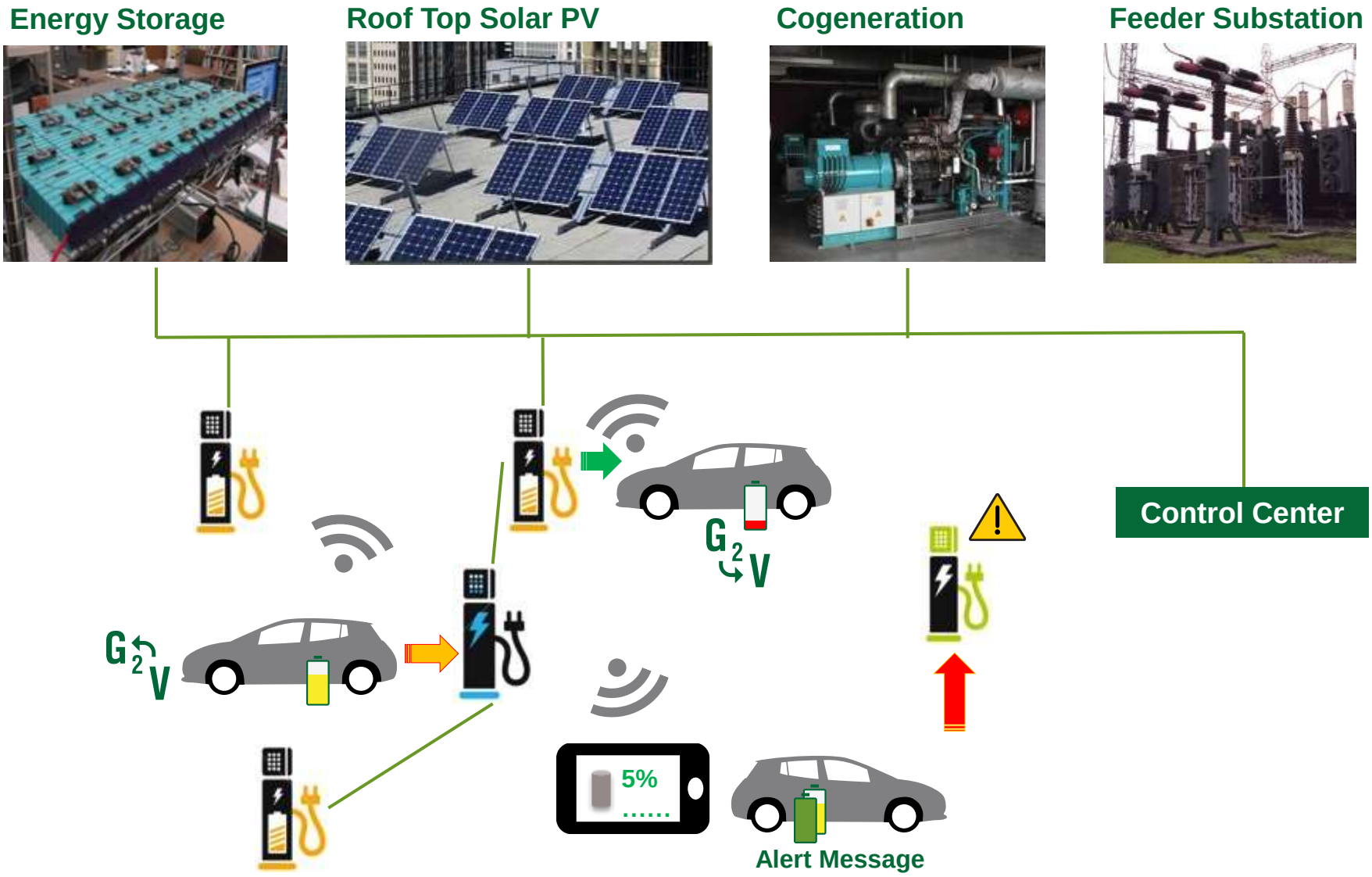


Smart Charging within a Smart Grid

WINSmartEV™ - Mobile App

WINSmartEV™ – Control Center

UCLA Microgrid Integration



EV Integration - Research Issues addressed

- Scheduling with user requirements, garage constraints and utility requirements
- System control and characteristics
- User participation
- Price-based control
- Ability to offer aggregated services in utility markets – frequency, DR, voltage-VAR
- Distributed intelligence between vehicle, smart charger, parking garage infrastructure, and cloud
- EV aggregation model and implementation
- G2V – Modeling, planning, scheduling for optimum use of power
- V2G – power systems and communication interfaces
- Mobile UI for consumer and aggregator
- Communications and control for aggregation of EVs to provide services - Load control, DR, Back-fill, Voltage/Frequency/VAR regulation

UCLA Electric Vehicle Integration Demo Project

Key components
- Sensing /monitoring of charge status, location, local facilities, vehicle, grid inputs, user preference
- Communicating information to intelligent algorithms
- Decision based on – status of charge, price, consumer preference, utility input, facility constraints, etc.
- Sending control signals to smart chargers
- Control loop - Cycle of above steps in control system

Charge and discharge characteristics
- At unit EV
- With aggregated set of EVs

Wireless and sensor-based infrastructure
- Monitoring of battery status
- Charge and discharge planning and execution

V2G and G2V issues

Within V2G, EV's to provide power to micro-grid during
- High priced intervals
- During shortage

Hierarchical and decentralized aggregation of battery resources

Real-time two-way communication with utility needs including DR

Integration with stochastic renewable solar PVC to smooth micro-grid consumption

Integration with community storage

Local grid stability

Utility and Consumer Considerations for EV Integration

Capacity and infrastructure

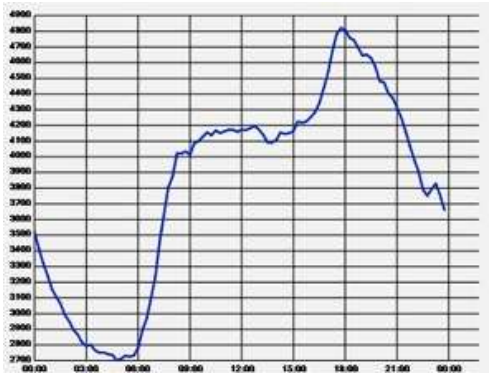
- Variable pricing models not yet universally available
- Overheating of transformers in case of evening charging
- Localized high density of EVs such as in West LA may become an issue
- Time of use reduction plans would help utility cut peak consumption through V2G
- Localized demand peaks resulting in requirement for smart DR planning
- Potential to help utilities stabilize grid frequency and/or help with Demand Dispatch
- EV integration would vary by state / region due to availability of renewables (e.g. in wind and solar in CA, Wind in Iowa and Texas)
- Metering infrastructure exclusively for EVs giving separate pricing?

Consumer issues

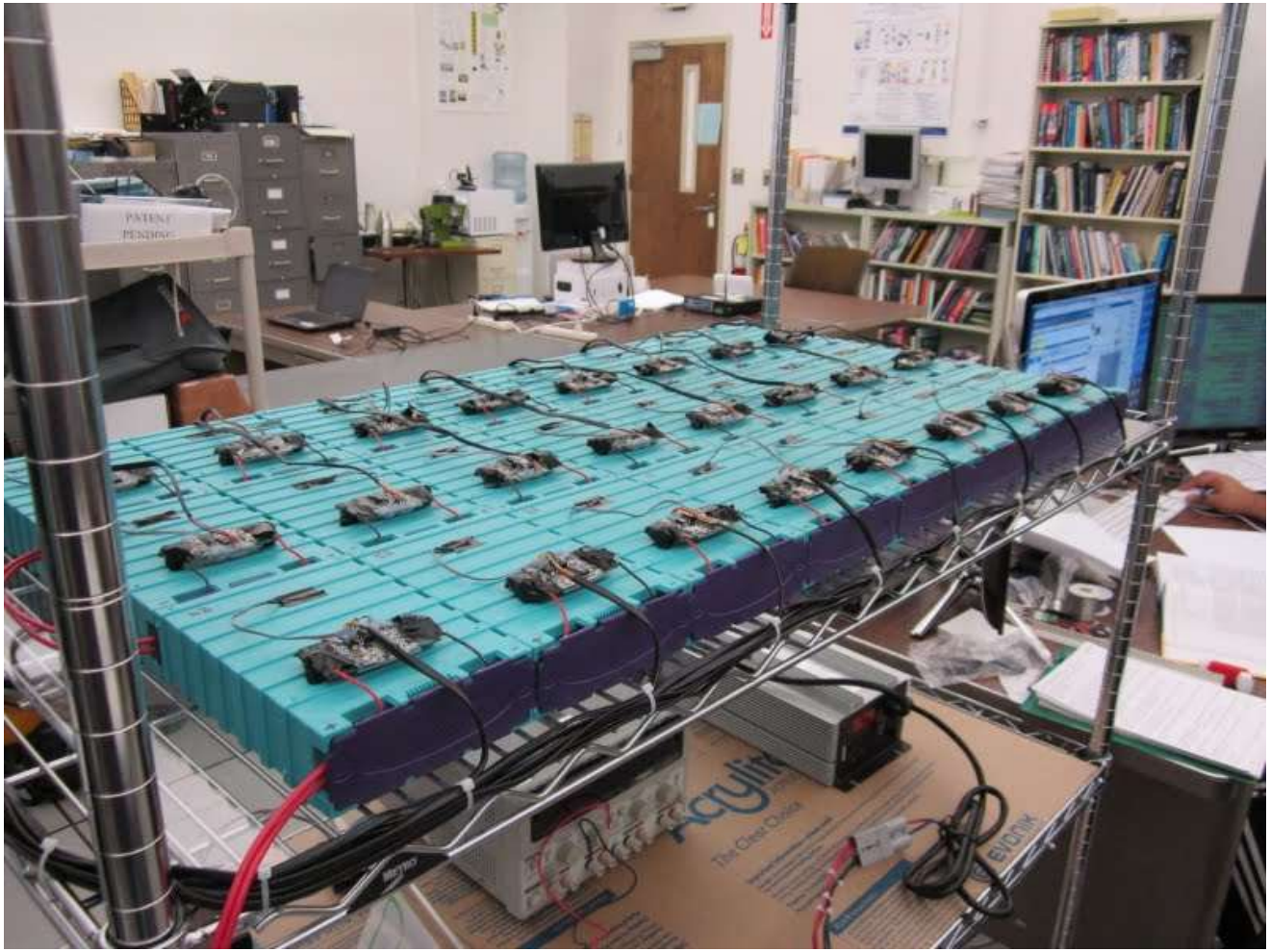
- Levels 1, 2, or, 3?
- Support for Level 2 (7KW+) and 3 not available easily everywhere
- Range anxiety
- Battery cycles and warranty in case of V2G

Aggregation model and verification

Aggregate user charging requirements and preferences. Intelligently use aggregate data to meet peak-load demand response by turning off chargers while still fulfilling user charging schedules.



Simulated EV-Grid in Lab – Li Ion



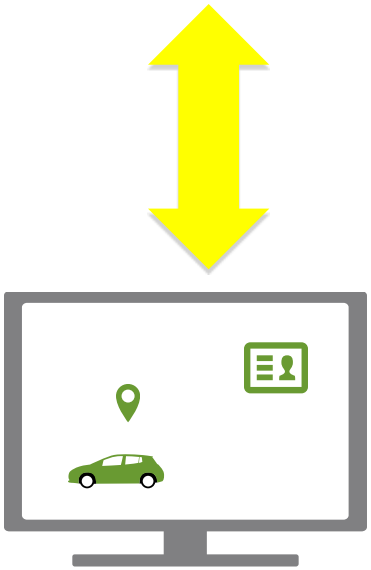
Infrastructure in UCLA – about one dozen EVs plugged into 3 parking lots

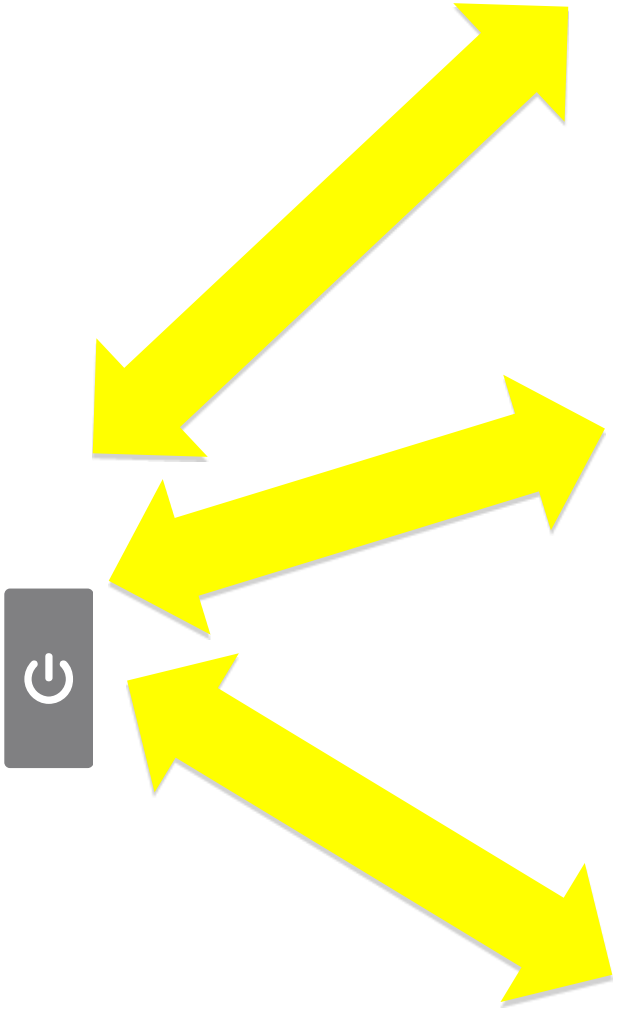
Lot A

Lot B

Lot C

Levels 1,2, and, 3 Integration





Level 1

Level 2

Level 3

UCLA Smart Grid Research Lab

Charging Stations and Control Center

Solar PV Micro-grid test in lab

Demonstration - Feb. 29, 2012

APPENDIX

A

Recent SMERC News And Meetings

Secretary of Energy Dr. Steven Chu meeting with UCLA Faculty and Staff (including Smart Grid Energy Research Center [SMERC]) Friday, May 13, 2011 at LA Science Center

Recent Visitors to UCLA

Patricia Hoffman,
Assistant Secretary, DOE
(March 1, 2011): DOE, Keynote Address at
UCLA Engineering 2011 Annual Tech Forum.

Ron Nichols,
GM of Los Angeles Water and Power, October 2011.
With Kathryn Atchison and Rajit Gadh

President of California Public Utilities Commission (CPUC), Mr. Michael Peevey, introduced at his Keynote Address at UCLA Smart Grid Energy Research Center, Smart Grid Thought Leadership Bi-Annual Event, March 28, 201ASDA2

SMERC
UCLA Smart Grid Energy Research Center

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