ACEEE
American Council for an Energy-Efficient Economy

Convergence of Energy Efficiency & Demand Response: The Role of Intelligence

Presented to:
LSU Center for Energy Studies
Energy Summit 2015

R. Neal Elliott, Ph.D., P.E.
Associate Director for Research
ACEEE

The American Council for an Energy-Efficient Economy (ACEEE)

- ACEEE is a nonprofit 501(c)(3) that acts as a catalyst to advance energy efficiency policies, programs, technologies, investments & behaviors.
- Nearly 50 staff based in Washington, D.C.
- Focus on end-use efficiency in industry, buildings, utilities & transportation
- Other research in economic analysis; behavior; national, state & local policy.
- Funding:
  - Foundation Grants (52%)
  - Contract Work & Gov. Grants (20%)
  - Conferences and Publications (20%)
  - Contributions and Other (8%)

www.aceee.org

ACEEE
American Council for an Energy-Efficient Economy

“Smart” vs. “Intelligent”

ACEEE defines ***intelligent efficiency*** as “a systems-based, holistic approach to energy savings, enabled by information and communication technology and user access to real-time information. Intelligent efficiency differs from component energy efficiency in that it is adaptive, anticipatory, and networked.”

Smart is used for equipment, appliances or networks that have the ability to communicate digitally

Intelligent Efficiency implies an approach where interconnected devices can be used to harmonize their operations to achieve system-wide energy savings.

ACEEE
American Council for an Energy-Efficient Economy

The Technology behind *Intelligent Efficiency*

Component Evolution

- Dumb & inefficient
- Dumb & efficient
- Informative & efficient
- Interactive & efficient

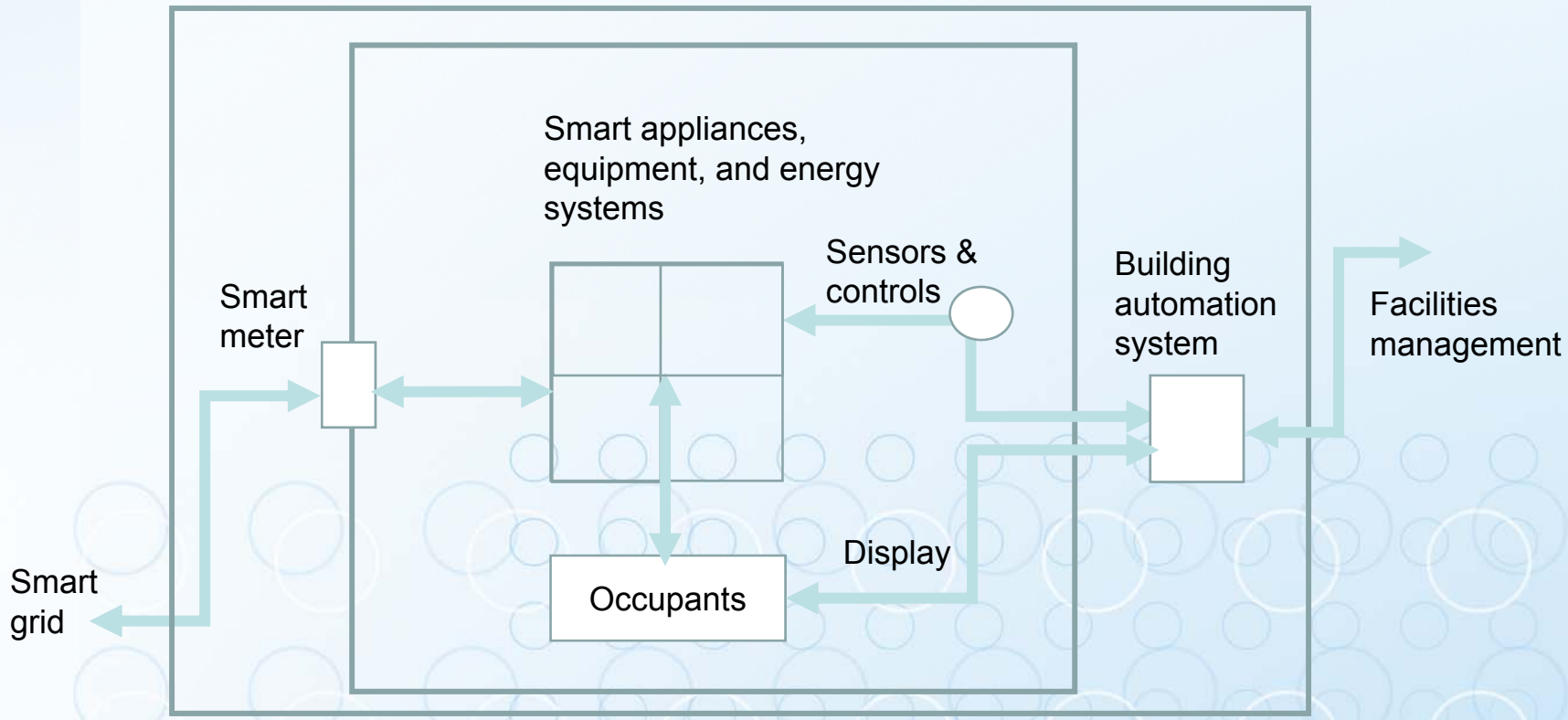
intelligent efficiency

Controls Evolution

- Simple (on/off)
- Reactive
- Programmable
- Variable response
- Adaptive & predictive

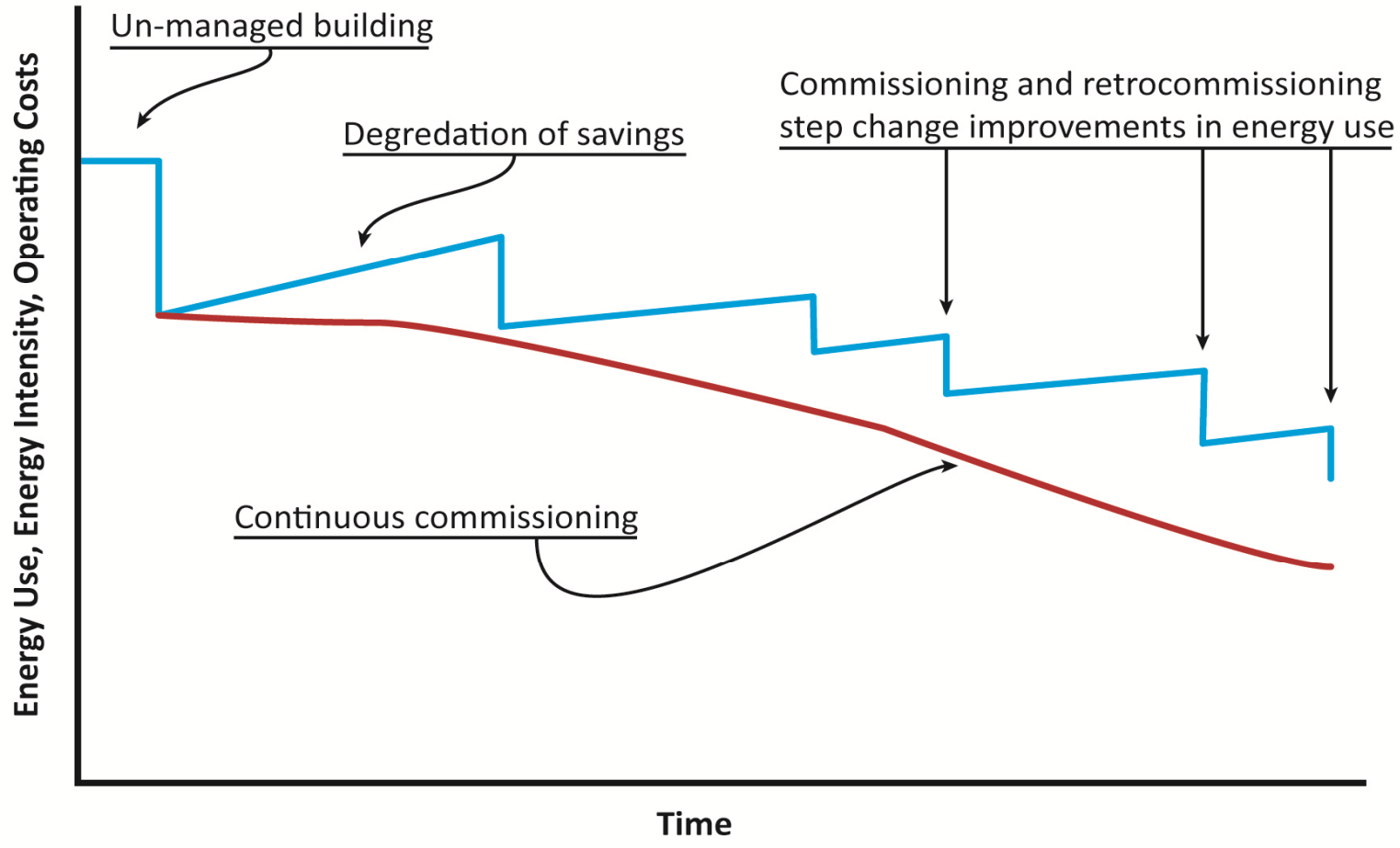
ACEEE
American Council for an Energy-Efficient Economy

Using Smart Components to Build an Intelligent System

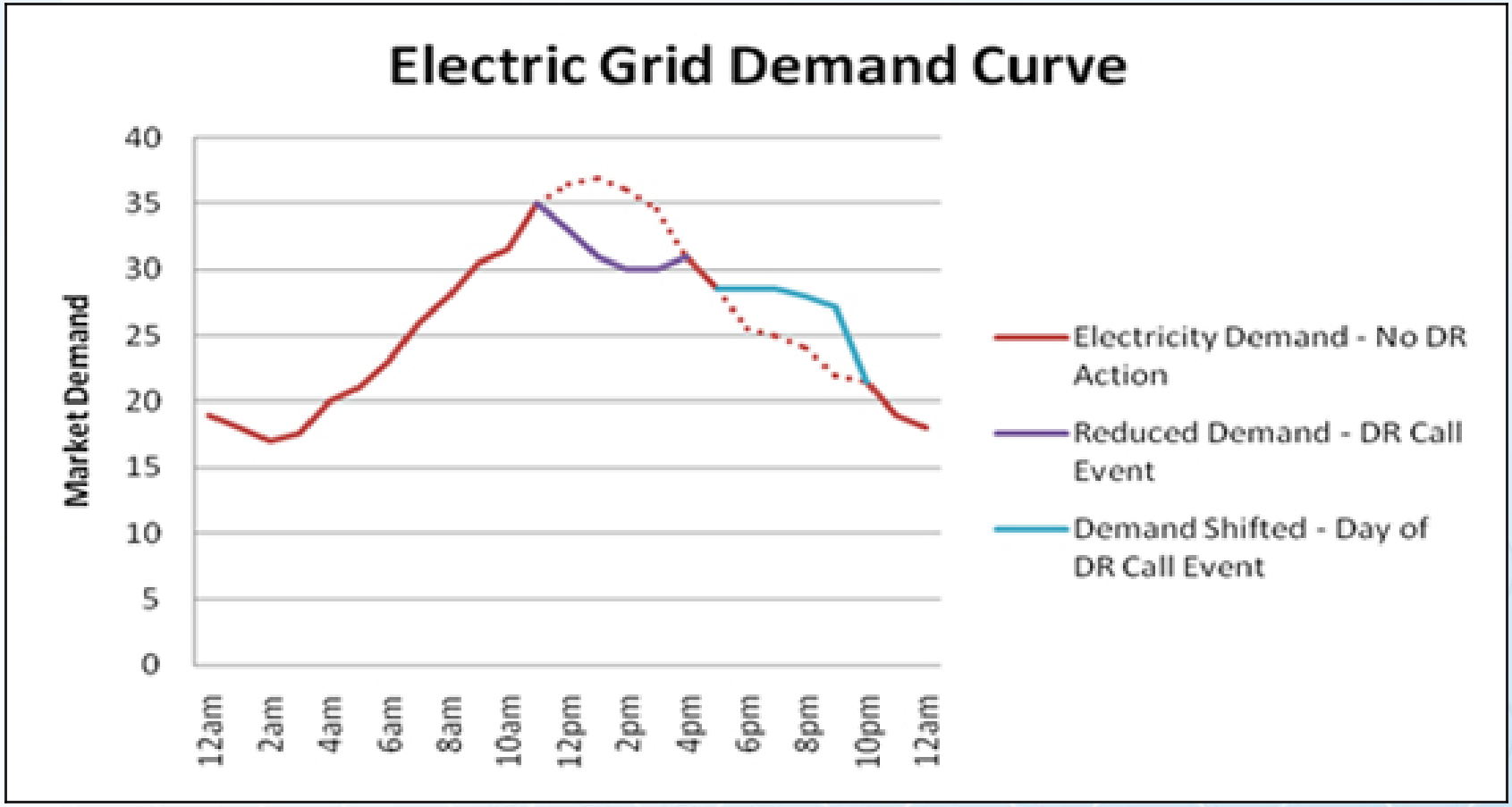


ACEEE
American Council for an Energy-Efficient Economy

Savings Trends Over Time with Intelligent Efficiency



Traditional Demand Response: Shifts or Curtails Customer Loads



ACEEE
American Council for an Energy-Efficient Economy

Engineer | Area Senior | Admin | Logout

Edit Forecast: Franklin / Canyon Substation A / 8671112 ×

Forecast for: 8671112

Before Projects | After Projects

Model | Results

Chart: Load Forecast

	2014	2015	2016
Projected load (Amps)	410	416	418
Surplus / Deficiency (Amps)	8	2	0
Percent loaded	98%	100%	100%

Regression
Adjusted R Square: 0.88 (High)

Corporate
Spatial Growth: 0.79 (High)
Adjusted R Square: 0.9 (High)

Regression coefficients:

Variable	Coefficient
3-Day Weighted-Avg High Temperature	0.202533
Income: Total Personal, (Mil. $)	0.000229
Employment: Service Sector/Full or Part Ti	0.022601

Blend

Final forecast: 100% Corporate, 0% Regression
Recommended: 49% Corporate, 51% Regression

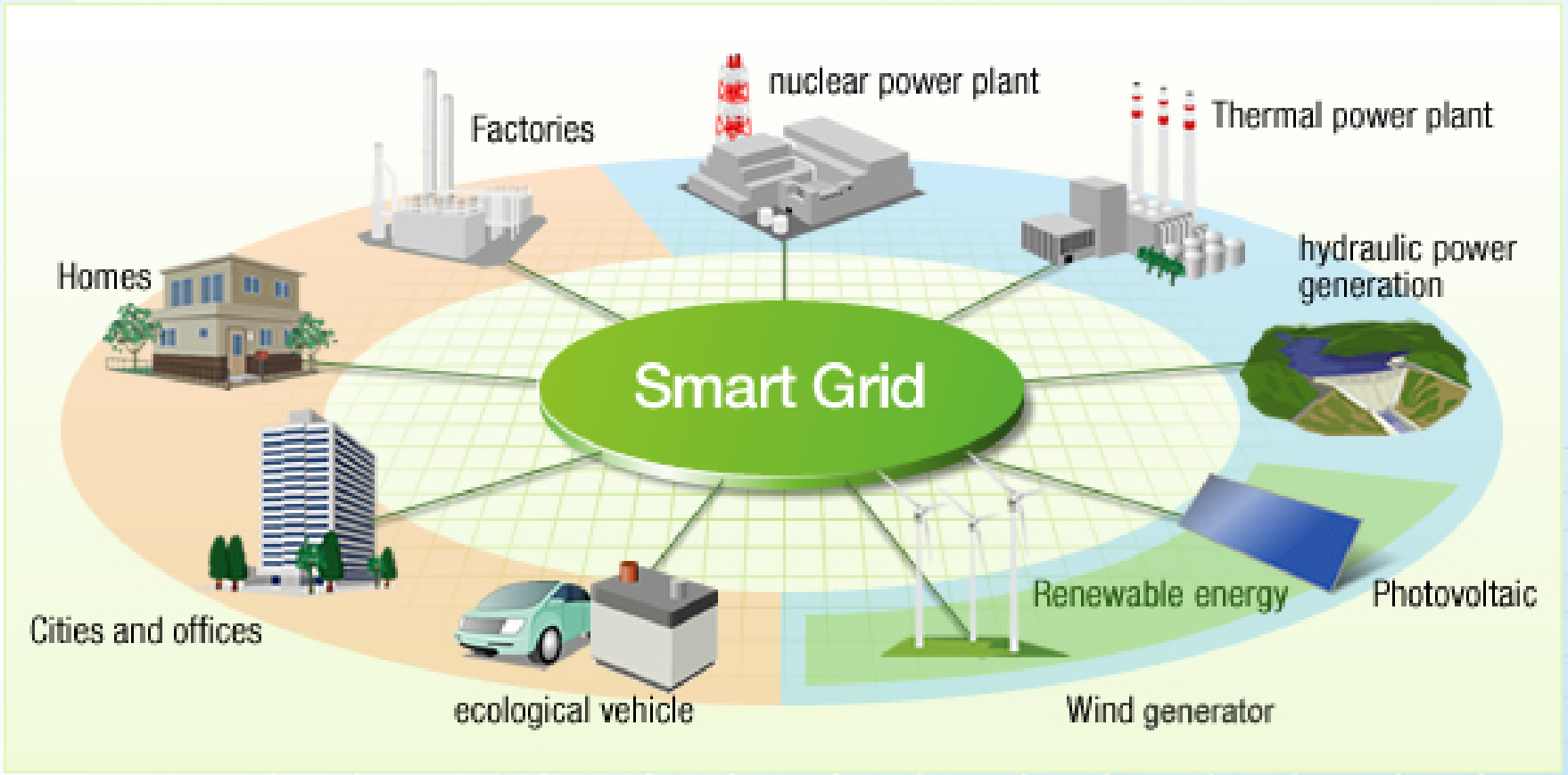
OK | Cancel

How Intelligent Loads & Grid Save Energy & Money

- Continual system optimization
  - Parts working better as a whole, anticipating needs
  - The whole working towards the goal
  - Avoid unnecessary infrastructure investments
- Early fault detection
- Integration of customer-side resources
  - PV, Storage, EVs, Intelligent Efficiency

ACEEE
American Council for an Energy-Efficient Economy

The Smart Grid Enables Resource Management at the Edge of the Grid



ACEEE
American Council for an Energy-Efficient Economy

Source: Hitachi

Smart Meters Only Providing a Fraction of Functionality

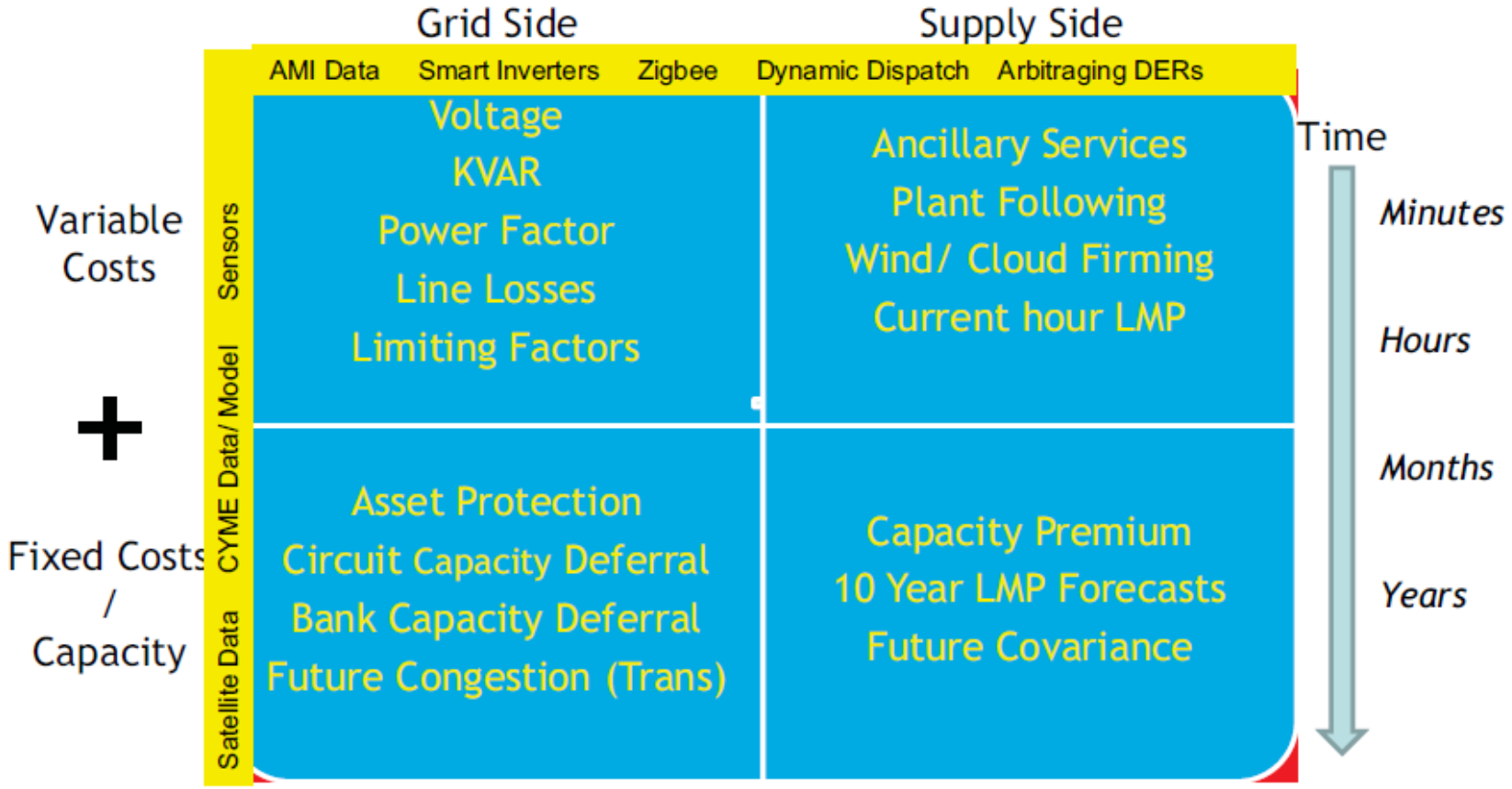
- Smart meters can measure 8 parameters
- Most utilities disabling 5 channels due to bandwidth/data processing limitations
- Currently serving as AMR/fault detection
- Future capabilities await grid & utility capabilities

ACEEE
American Council for an Energy-Efficient Economy

New Concept: Distributed Marginal Cost

- Cost of service measured at feeder or distribution transformer level
- Time & location dependent
- Provides new system planning insights
- Smart grid enables new operational options
- Capabilities didn't exist 3 years ago
- Potential for new pricing strategies—creates value for utility & customer

ENGINEERING MEETS ECONOMICS
DISTRIBUTED MARGINAL COSTS (DMC)

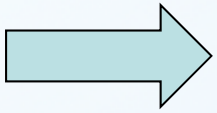


DMC = DMP, which would be market traded price for nodal kW and kWh.
DMC is the actual Cost to Serve, and can be used in non ISO markets as well.

More Accurate Measurement Captures Value

- Conventional approaches miss much of value of EE&DR
- Accurately measuring locational & temporal benefits can increase value 5X
- Avoid significant T&D costs & improve reliability

Distributed Resource Planning

IRP  **DRP**

- Enabled by:
  - Data collection ability
  - High-performance computing capability
  - Advanced analytic capability
- Allows for true least-cost resource plan
- Informs grid management to enable coordinated grid/distributed resource management

Engineer | Area Senior | Admin | Logout

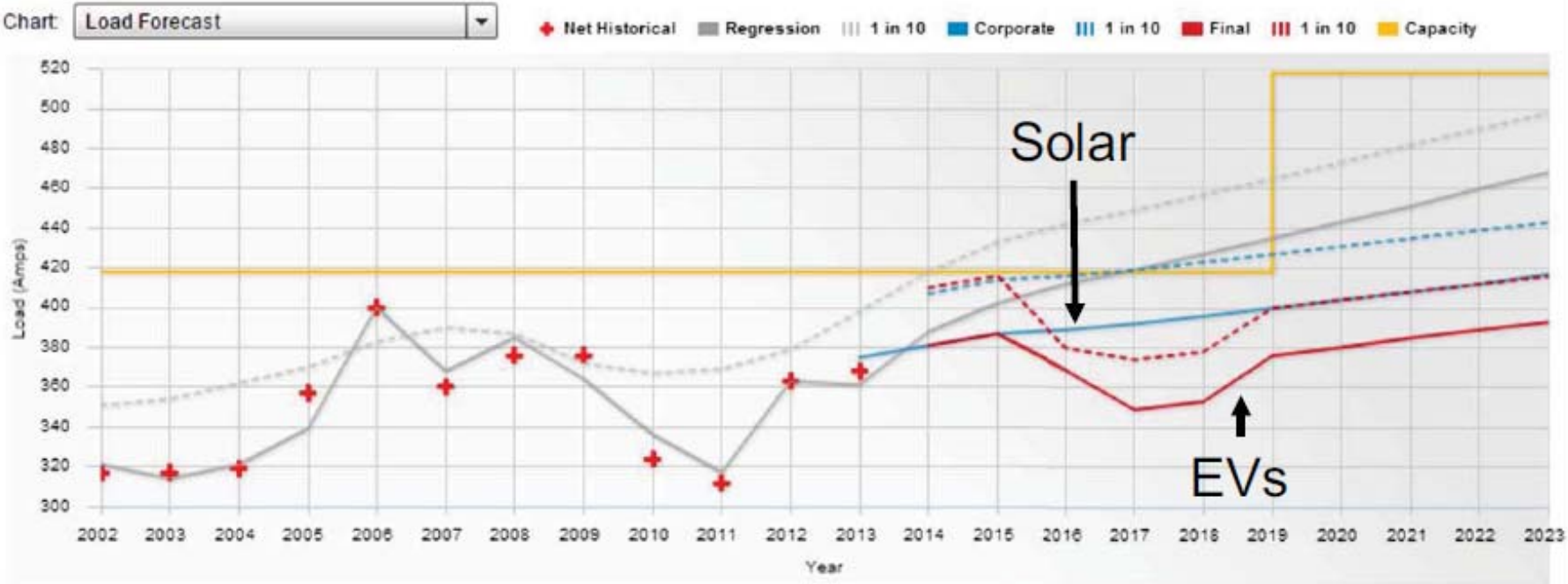
Edit Forecast: Franklin / Canyon Substation A / 8671112 ×

Forecast for: 8671112

Before Projects | After Projects

Model | Results

Chart: Load Forecast



	2014	2015	2016
Projected load (Amps)	410	416	380
Surplus / Deficiency (Amps)	8	2	38
Percent loaded	98%	100%	91%

Regression
Adjusted R Square: 0.88 (High)

Corporate
Spatial Growth: 0.79 (High)
Adjusted R Square: 0.9 (High)

Regression coefficients:

Variable	Coefficient
3-Day Weighted-Avg High Temperature	0.202533
Income: Total Personal, (Mil. $)	0.000229
Employment: Service Sector/Full or Part Ti	0.022601

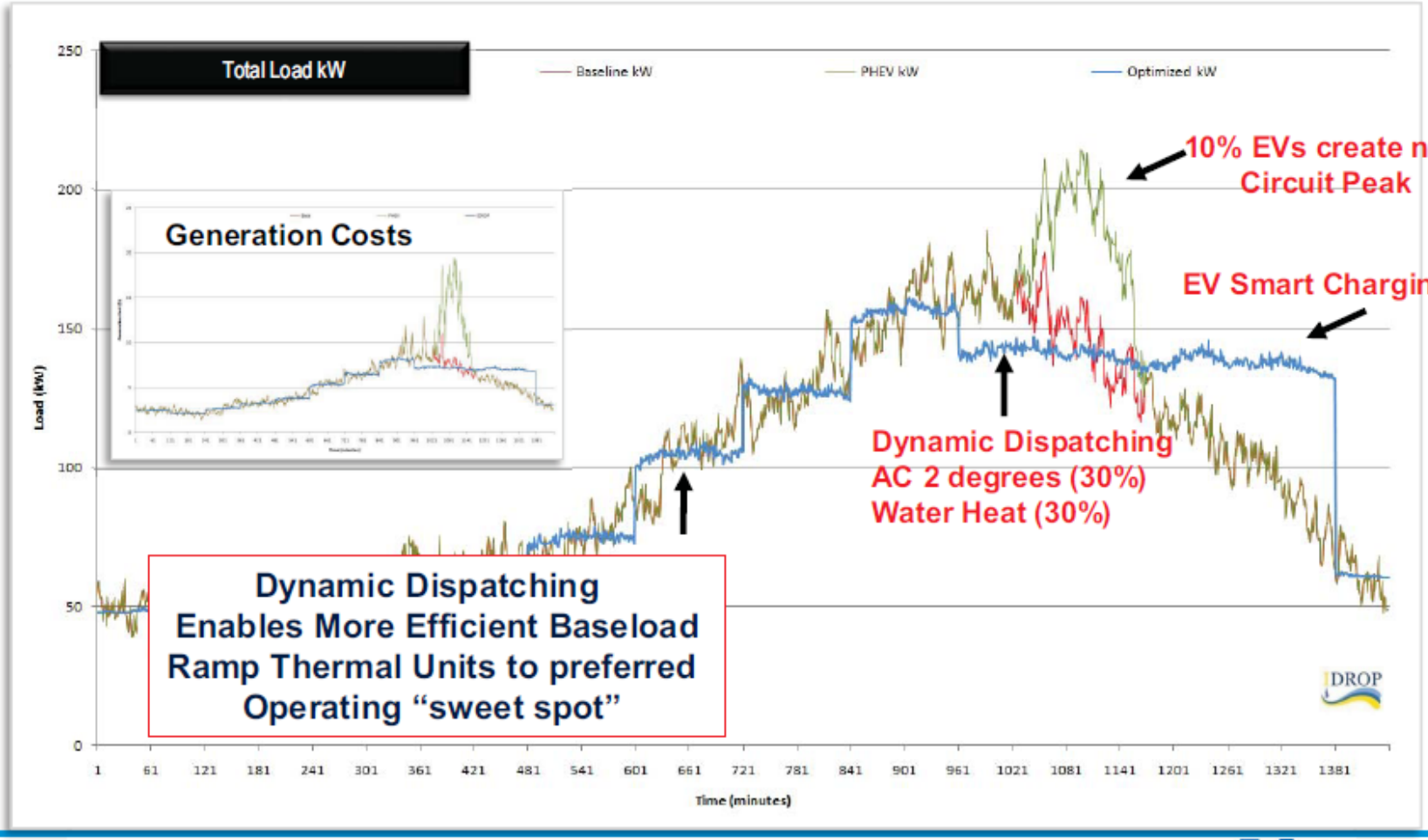
Blend

Final forecast: 100% Corporate, 0% Regression
Recommended: 49% Corporate, 51% Regression

OK | Cancel

DMP LEVELS LOADS DYNAMICALLY

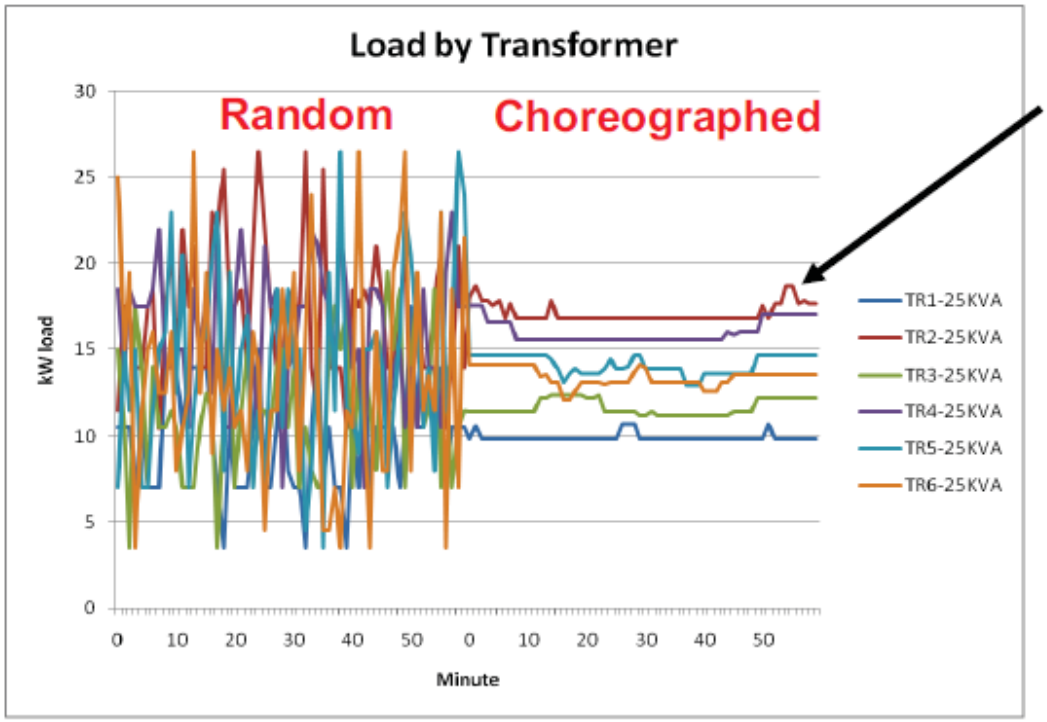
Instead of load following, we talk about plant following, wind following, cloud following.
Instead of demand response, IDROP enables "supply response".



CHOREOGRAPHY OF DERS

Voltage Improves, Asset Protected

IA only needs 25%-40% customer participation to levelize load, which saves utility money and does not force customers to participate.



Bumps intentional to limit the extent that AC units are started/stopped, and to optimize on customer marginal costs, not just on load alone.

Loads are flat enough to observe improved voltages and protects the service transformer

Six transformers, 30 homes, displaying normal volatility in load prior to IA vs. after optimizations are operational.

2015 ACEEE Intelligent Efficiency Conference

The Westin Boston Waterfront • Boston, MA • December 6 - 8, 2015

Who Should Attend:

- Energy efficiency program developers
- Program administrators
- Energy efficiency service providers
- Investors
- Entrepreneurs
- Hardware and software developers
- ICT solution providers
- Building automation providers
- Smart manufacturing and smart transportation leaders

ACEEE
American Council for an Energy-Efficient Economy

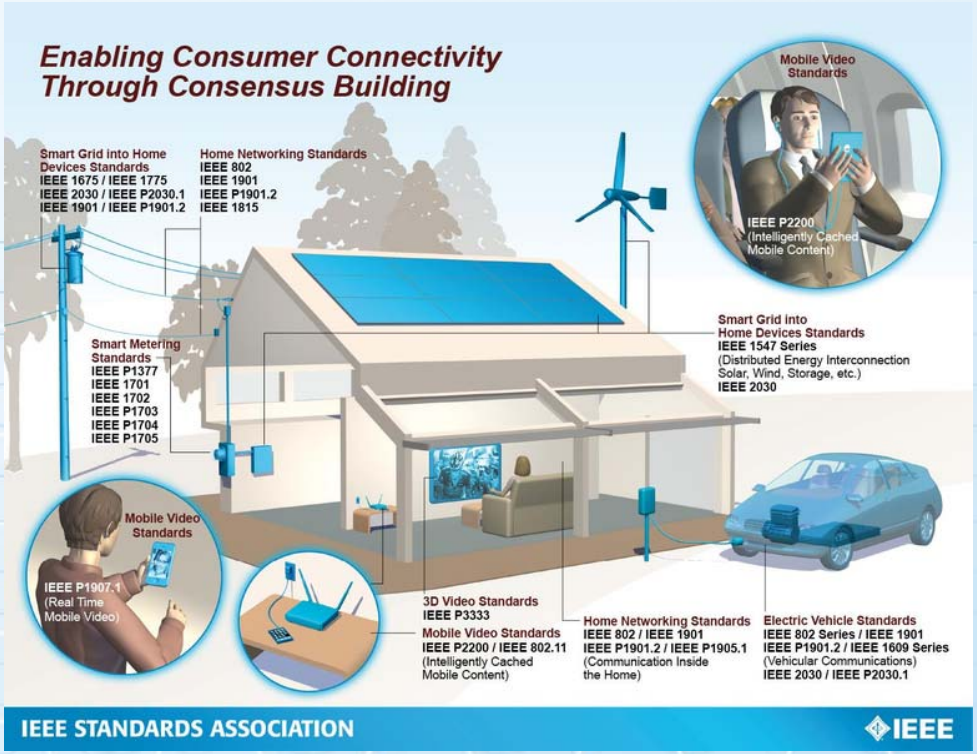
Conclusions

- Advances in sensors, communications & computation enabling new generation of utility planning & management
- EE & DR are converging as intelligence is enabling dynamic optimization of grid & distributed resources
- Potential for substantial cost savings
- Creates new value opportunities for utilities, customers & distributed resource providers

Thank you!

Neal Elliott, ACEEE, Washington, D.C.

rnelliott@aceee.org
+1-202-507-4009
http://www.aceee.org



ACEEE
American Council for an Energy-Efficient Economy