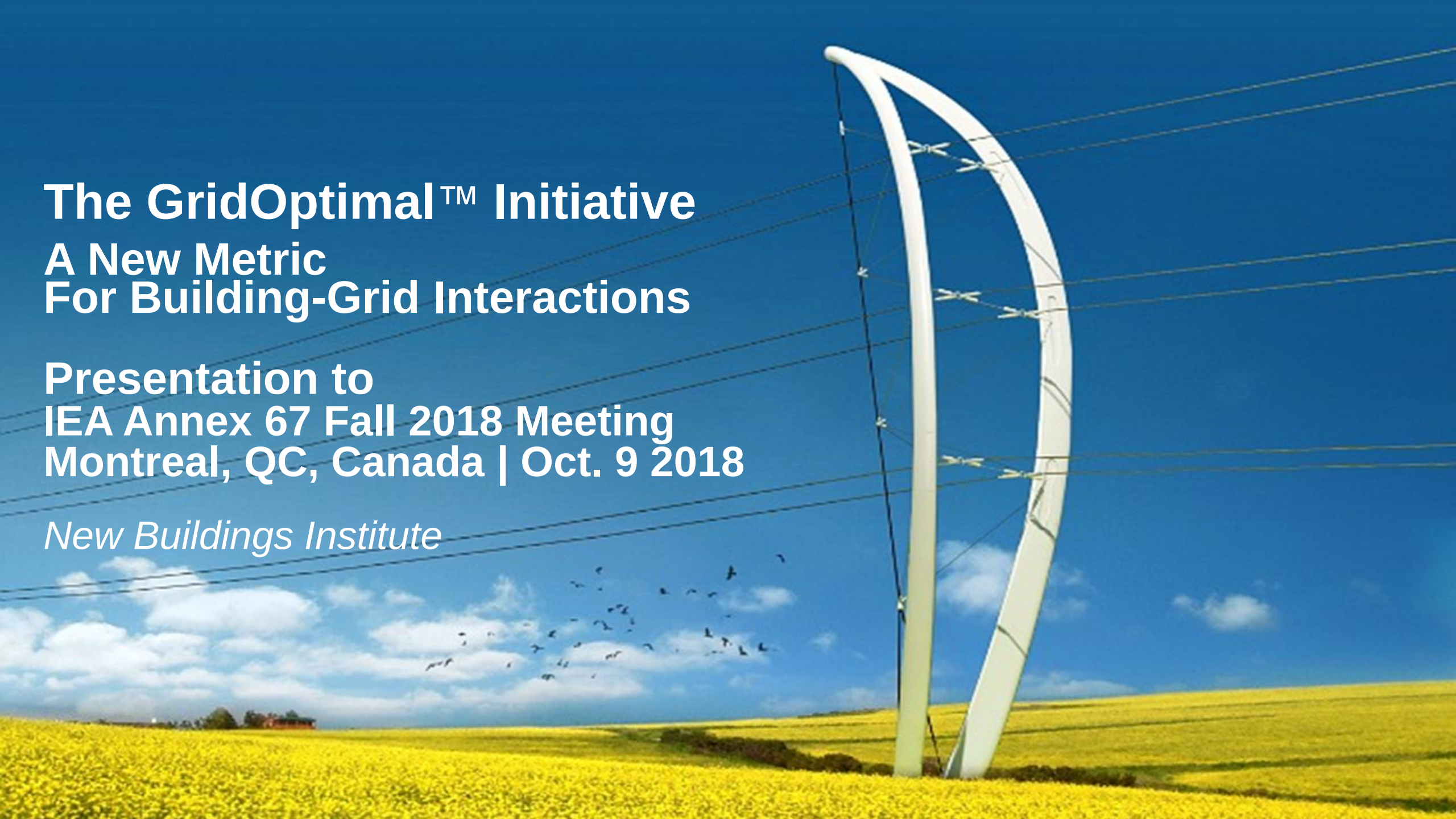


The GridOptimal™ Initiative

A New Metric For Building-Grid Interactions

Presentation to
IEA Annex 67 Fall 2018 Meeting
Montreal, QC, Canada | Oct. 9 2018

New Buildings Institute

Key Themes

- The way buildings interact with the electric grid is evolving rapidly.
- Buildings will face increasing regulatory and economic pressure to be able to respond to changing utility price and delivery structures.
- Designers will need to understand and incorporate strategies that allow buildings to directly interact with the utility grid.
- Adapting to the *Interactive Grid* will be critical to maintaining building services and comfort, and to grid reliability.
- Clarity and Consistency is needed on strategies and impacts of building integration strategies

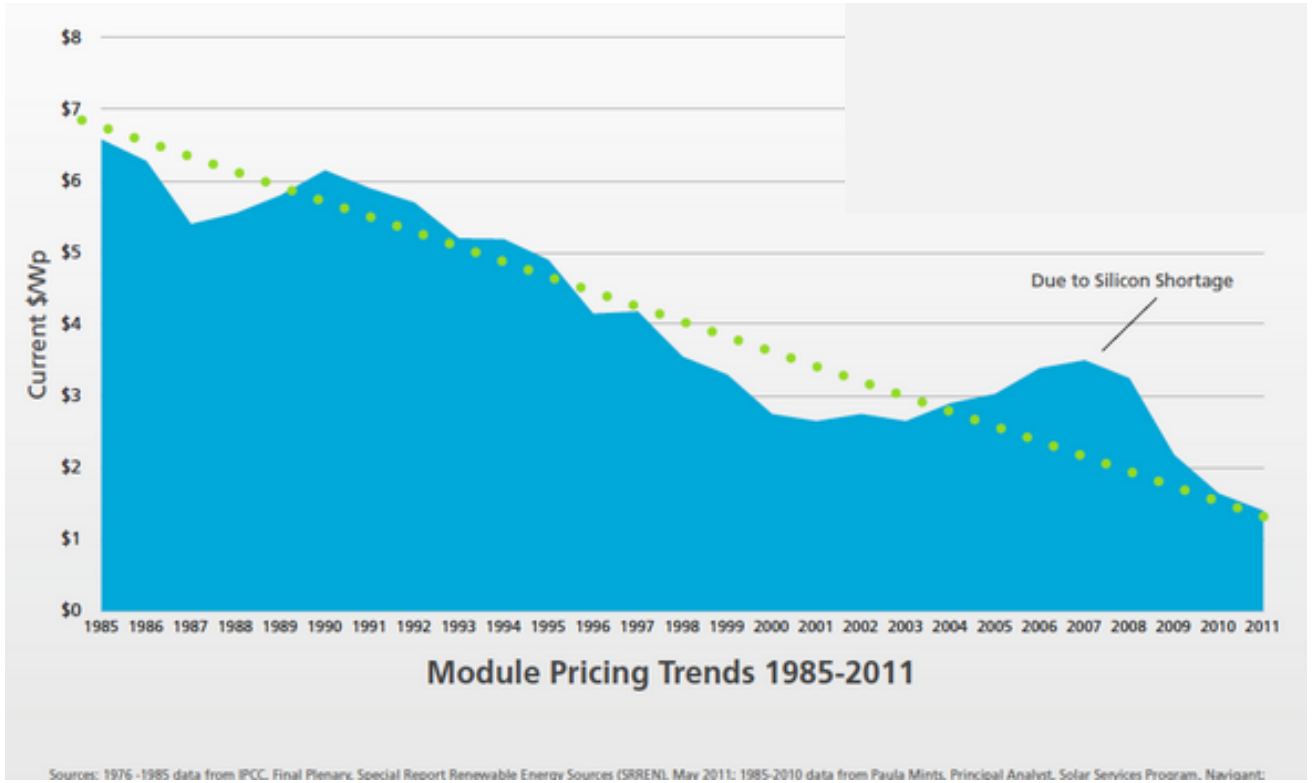
The GridOptimal Initiative's Supporting Members

NBI and USGBC recognize these leading organizations for their generous support for and participation in the GridOptimal Initiative.

Grid Evolution

“Use As Much As You Want, Whenever You Want”

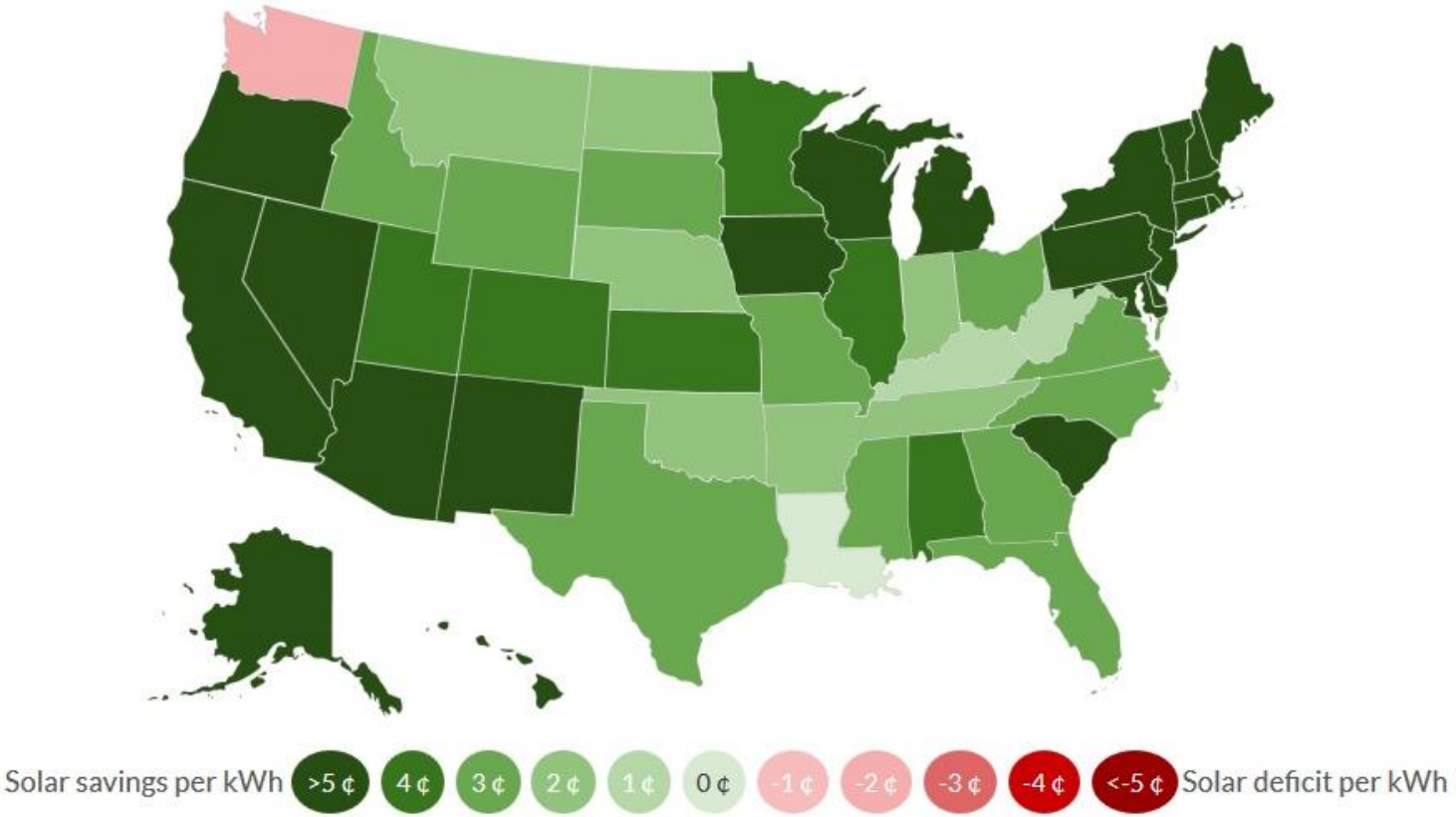
PV Cost Trend Increases Solar Deployment



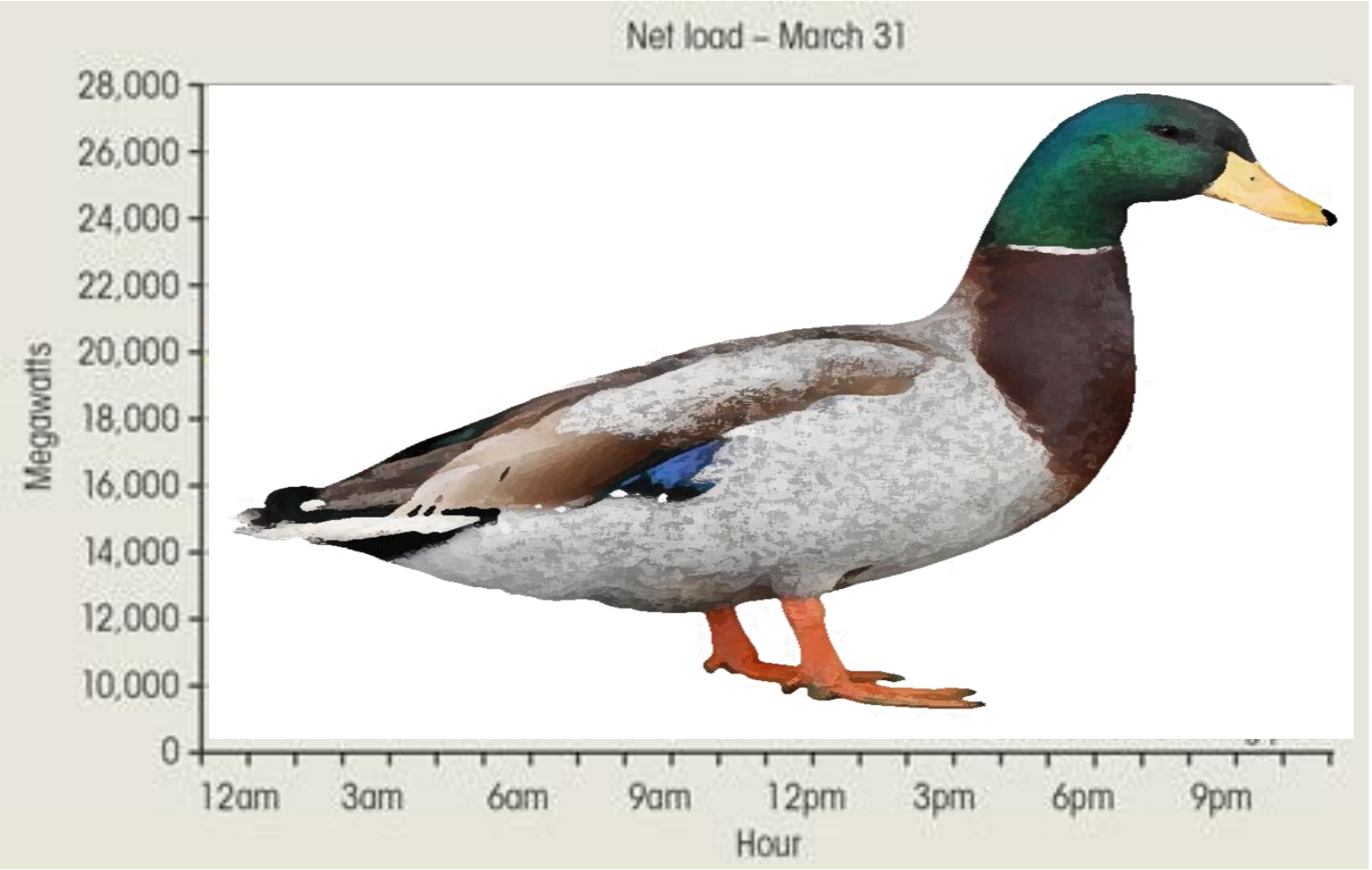
Source: P. Mints, Navigant Solar Services Program, 2011

✖ **2016: 55¢**

Grid Parity

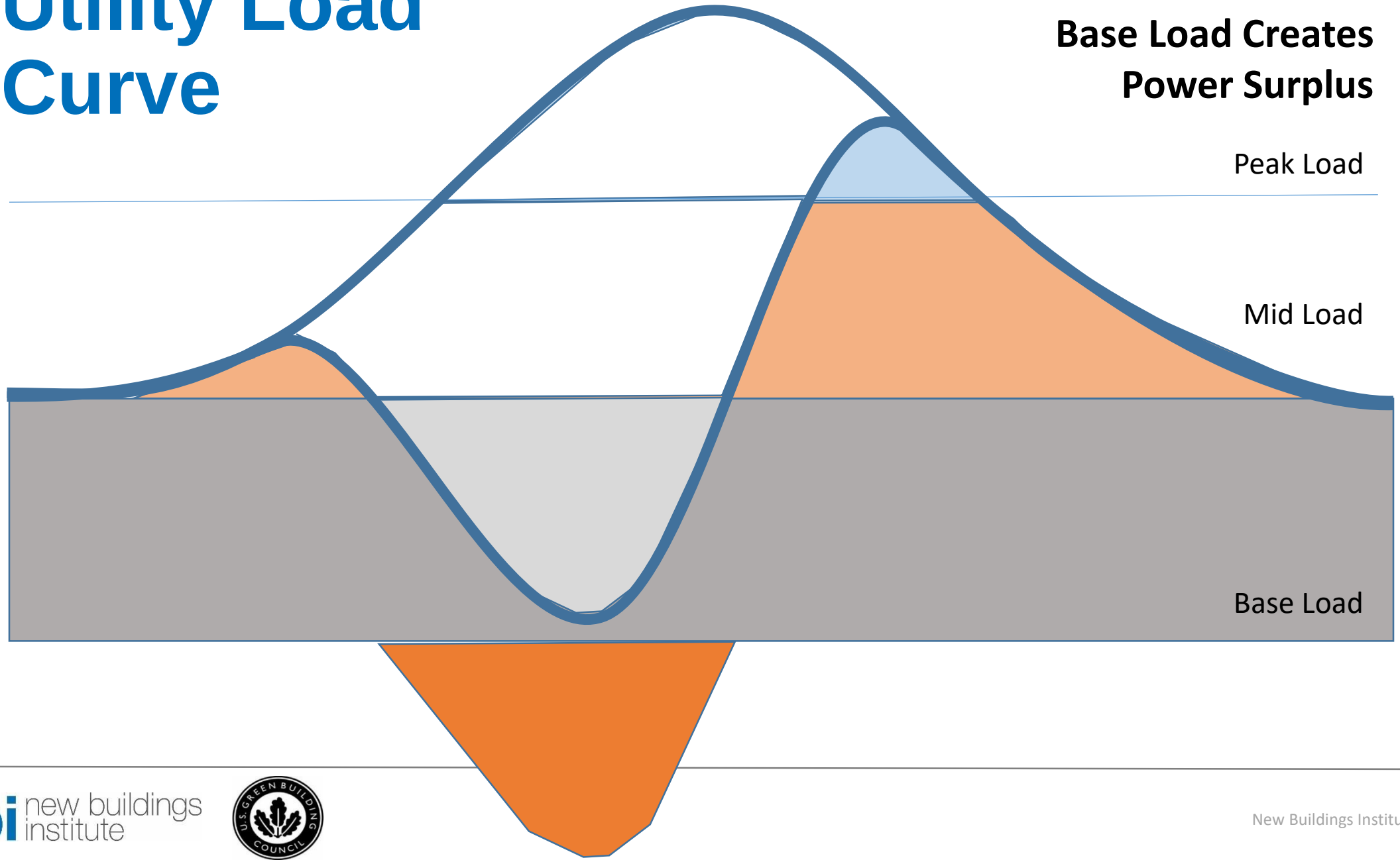


The Ominous "Duck Curve"



Utility Load Curve

Renewable Offset of Base Load Creates Power Surplus



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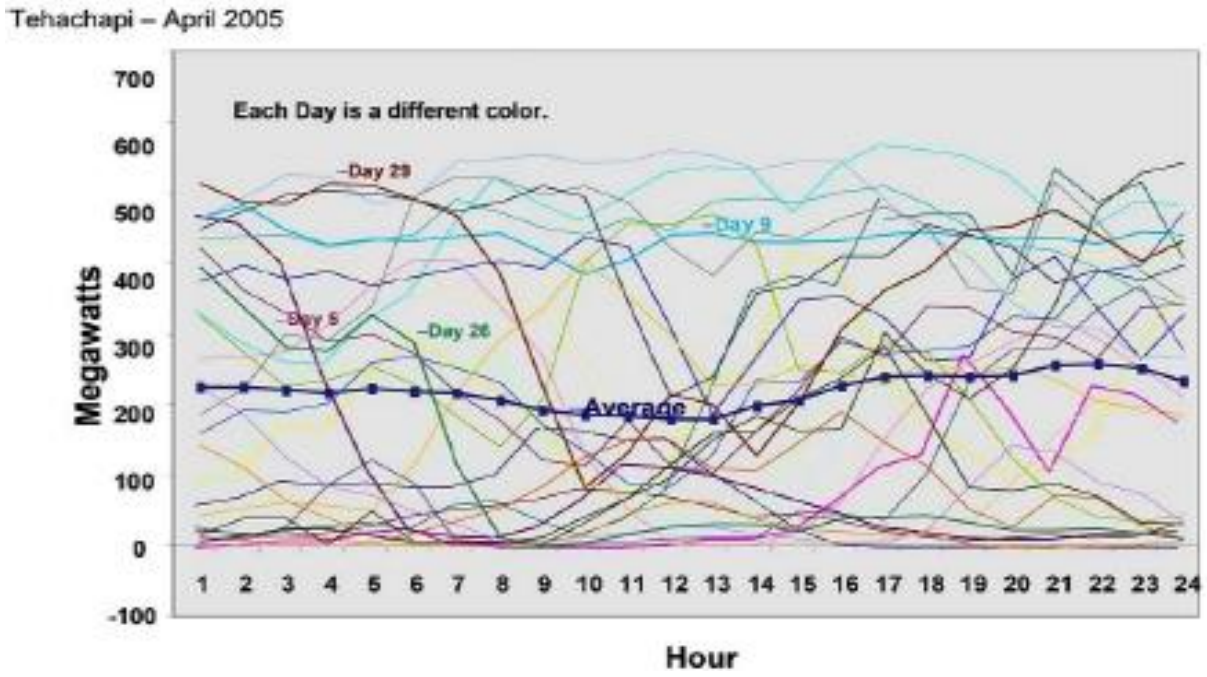
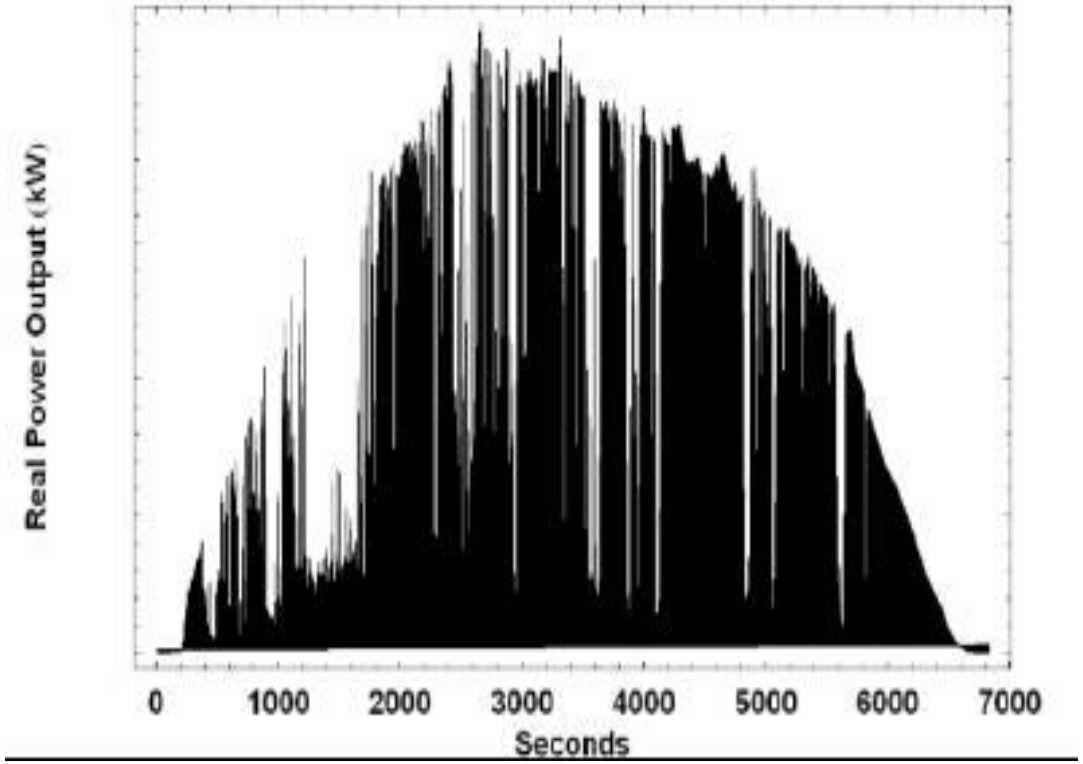
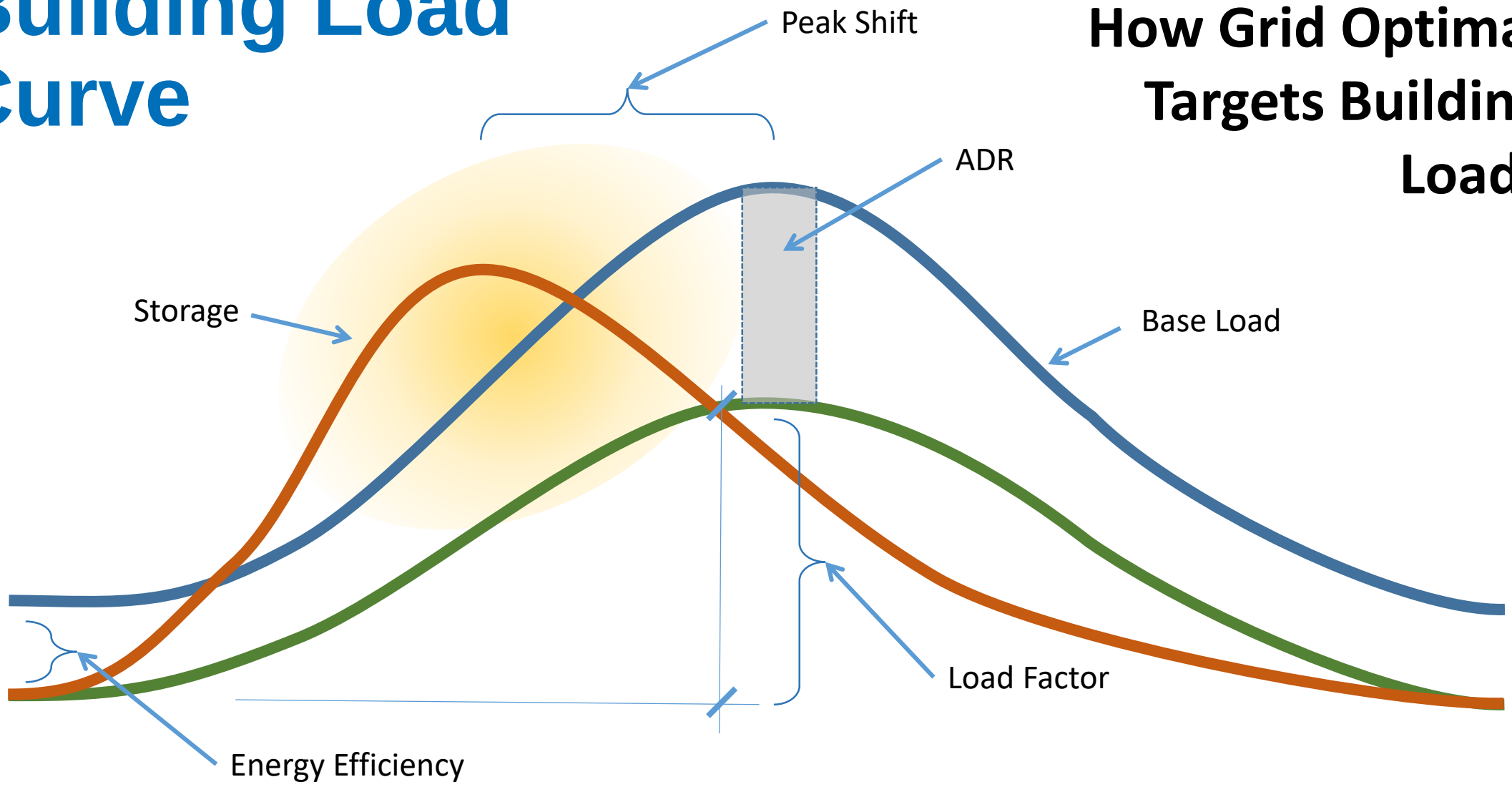
Impacts of Clean Generation





Building Load Curve

How Grid Optimal Targets Building Loads



Opportunities for Enhancing Energy Flexibility and Improving Static Features

Permanent Efficiency

- Reduce building energy loads…

Peak Shifting

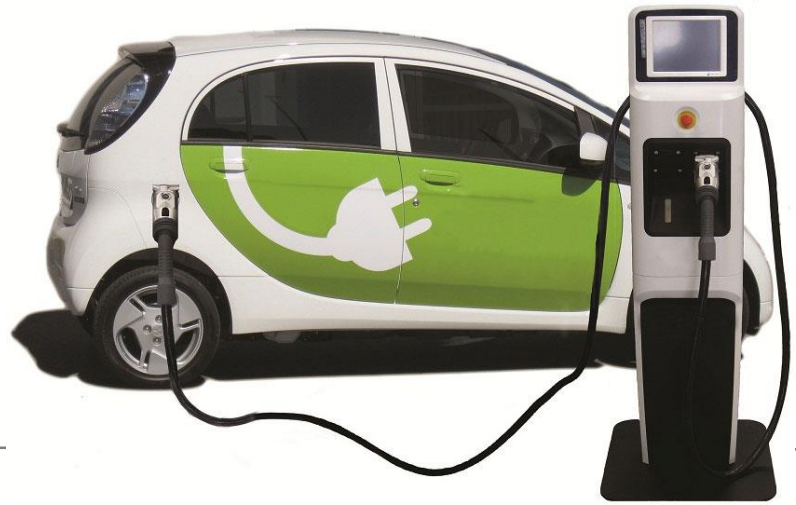
- Design to modify time of peak building energy use to adapt to grid…

Dynamic Response

- Actively reduce building energy use in response to short-term grid constraints…

Dispatchable Energy Storage

- Actively manage energy use patterns based on grid signals…



Conventional passive features, carefully deployed, support grid management and resiliency goals

Thermal Mass

Daylighting

Passive Solar Gain

Natural Ventilation

Solar Shading

Natural Ventilation

Super-Insulation

2,600 ft2 home in St. Peter, Minnesota, designed by Sarah Nettleton Architects. Photo Don Wong

Technologies and Design Strategies with specific load shape impacts will become more compelling

Operating patterns will increasingly drive system selection preferences

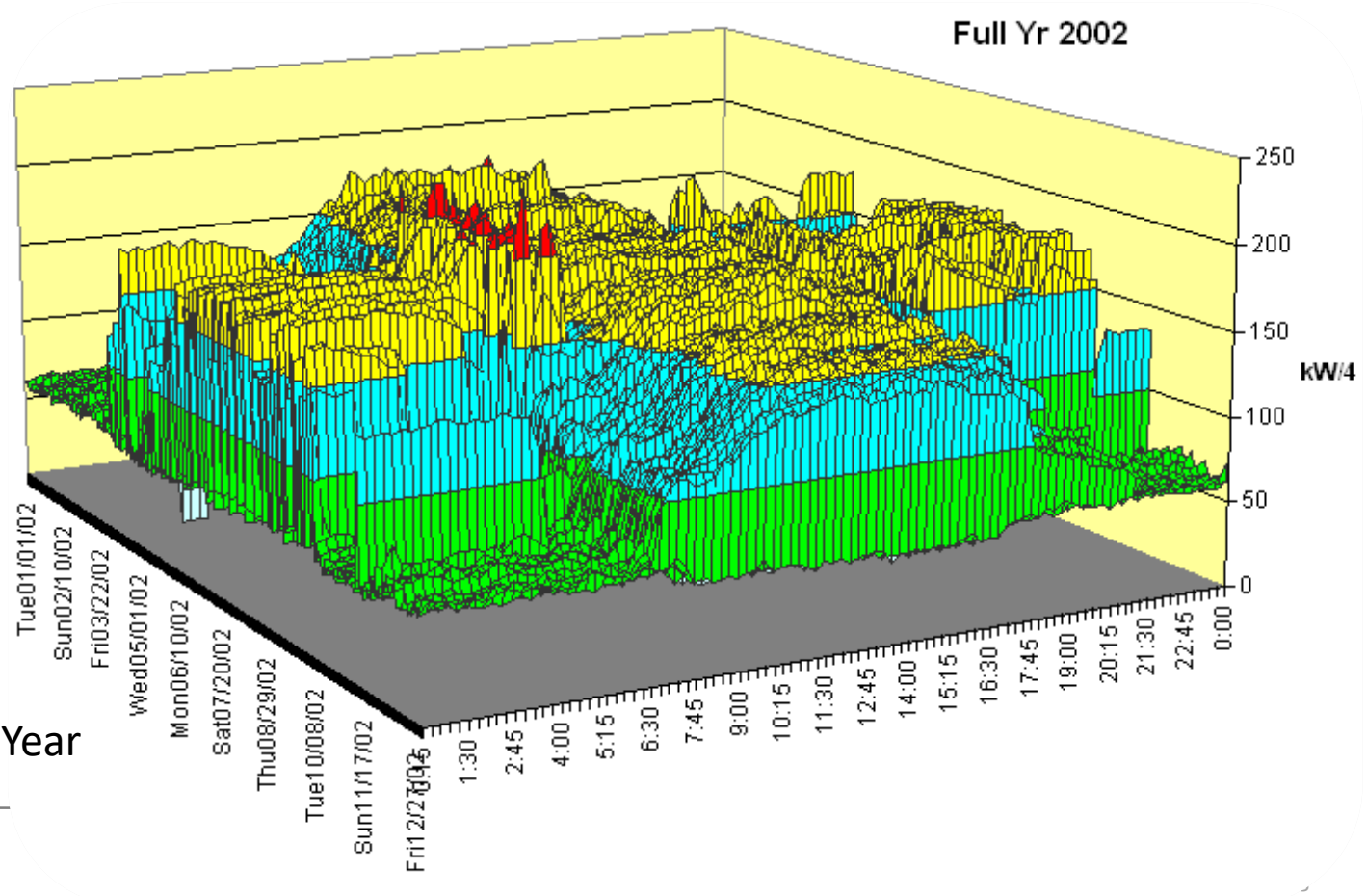
New grid-integrated technologies and active systems becoming more common to support grid operation

- Direct Load Shifting / DR Capabilities
- Thermal Storage
- Heat Pump Space & Water Heat
- Dynamic Glazing
- Grid-Integrated Appliances
- On-Site Storage
- Renewable Generation
- Integrated Vehicle Charging
- Staged Workstations

Fossil Ridge High School, Fort Collings
Thermal Ice Storage System

Building design evaluation should include load shape predictions so that fixed and adjustable building features can be incorporated to manage load shape.

Energy Modeling with load prediction



3D Electric Profile, Full Year

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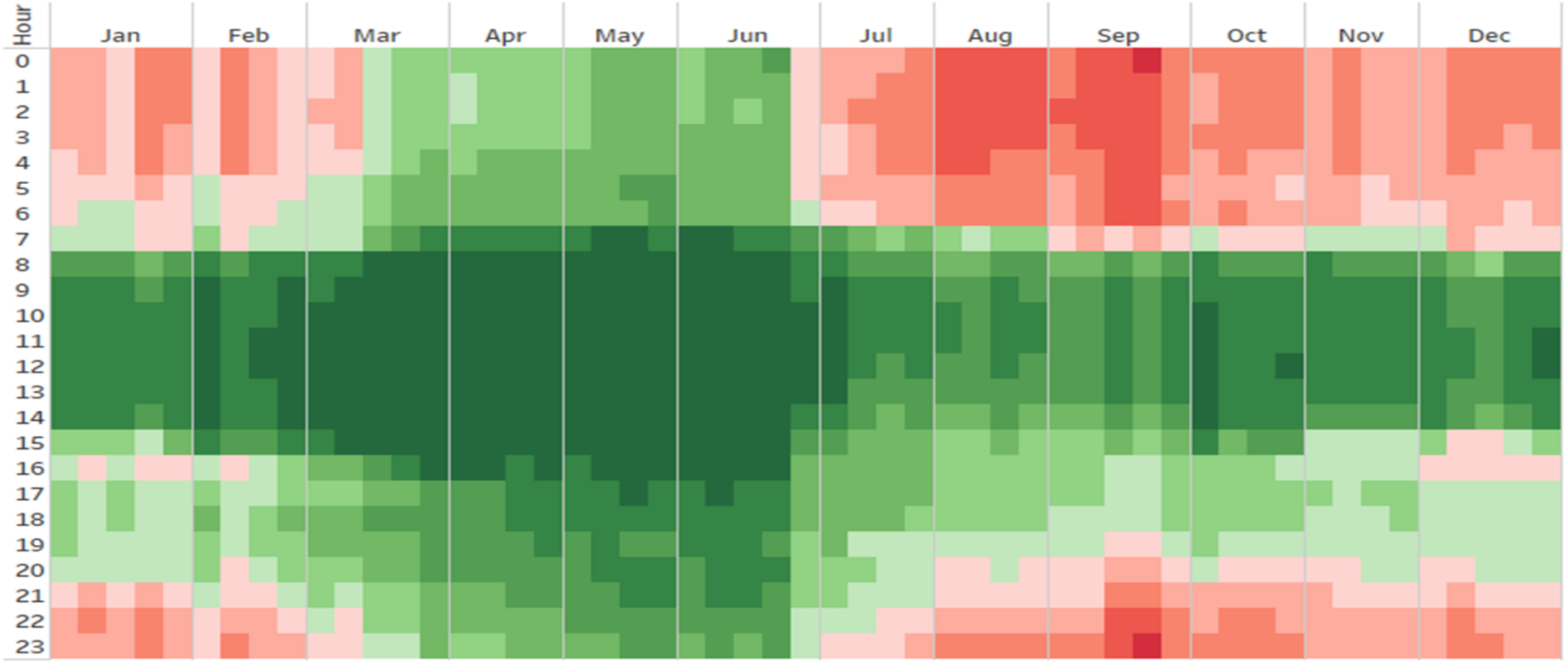
Alternate Grid Metrics (Carbon) can be Considered. California, USA: Annual CO_2 Heatmap



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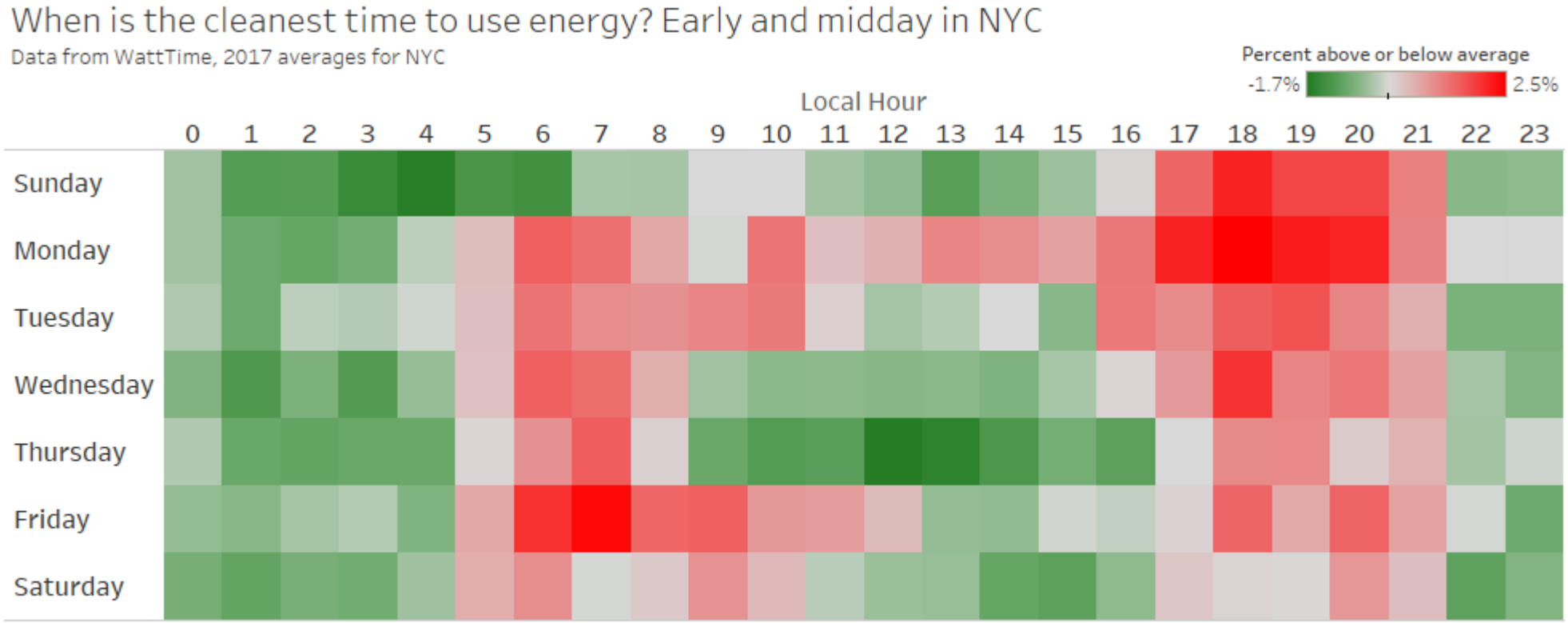
New York City, USA: Weekly Hour Average CO_2 Heatmap



Puerto Rico, 9/22/17 (NBC)

Grid Resiliency

Grid Integration Features in Buildings Support Resiliency Goals

- Independent power sources (PV) may allow grid-independent operation (islanding)
- Passive features support building habitability during no-power operation
- Staged start up capabilities can support faster grid recovery after outages
- On-site energy storage can provide emergency support for communities (communication, refrigeration, etc.)

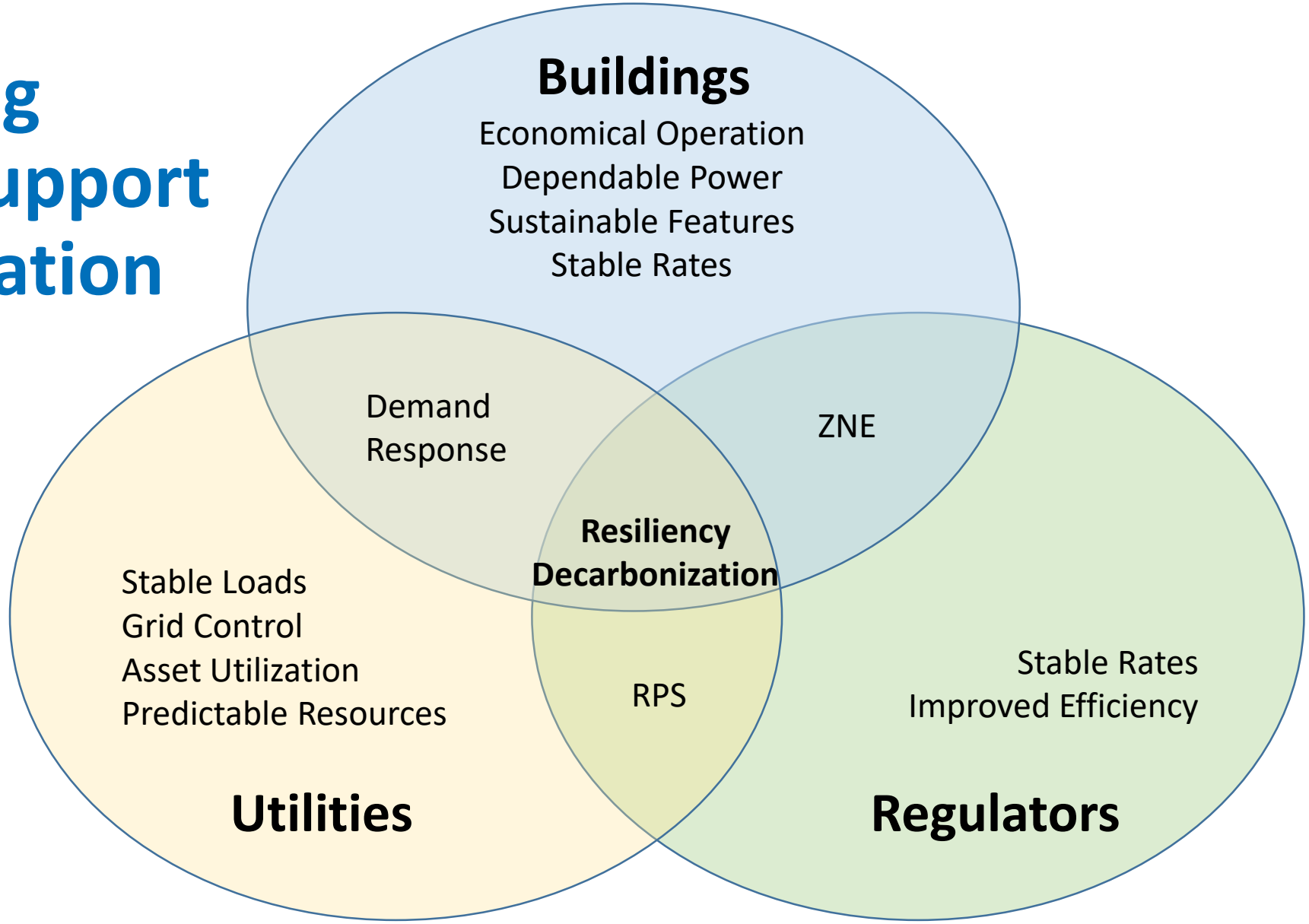
Mercedes-Benz Smart Home Integration Advertisement

New Industries are Becoming Engaged in the Building Sector

- Car Manufacturers
- Battery Manufacturers
- Smart Home Technology
- Renewable Systems
- Appliance Manufacturers
- Internet Service Providers
- Personal Technology
- Internet Enabled Building Controls
- Dynamic Glazing

As new industries move aggressively into the buildings space, they create expectations about design features and performance capabilities that will directly impact building design and operation.

Overlapping Interests Support Grid Integration



GridOptimal Methodology Framework

Building-Grid Interaction Elements:

Static Attributes:

- EE, flat load, targeted load shape

Flexible Attributes:

- Seasonal, daily, hourly, instantaneous

Dispatchable Attributes:

- Grid connected/controlled (third party aggregator)

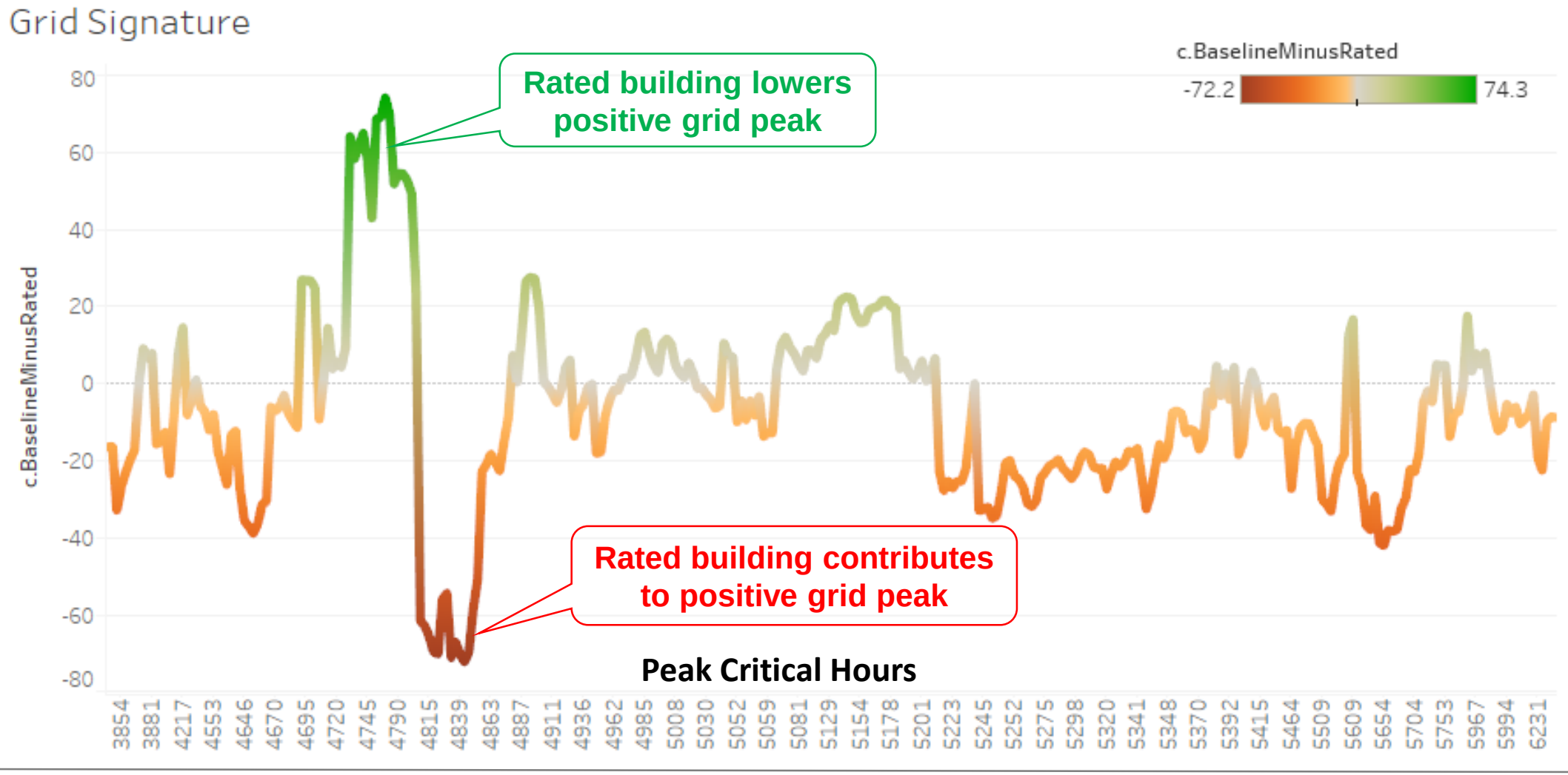
Dimensions:

1. Capacity (kW)
2. Duration
3. Time of use
4. Direction (load +/-)
5. Ramp rate/Response time

Features (examples):

1. Generation
2. Storage
3. Building Management System
4. Networked +/- (Open ADR Carbon)
5. Contract vs. behavior
6. Cx (prove out)
7. Power conditioning

One Piece of the Puzzle: The Grid Signature



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(Conference Papers: ASHRAE, January 2016 & January 2017)
(Authors: Alexi Miller, PE & Jim Edelson)

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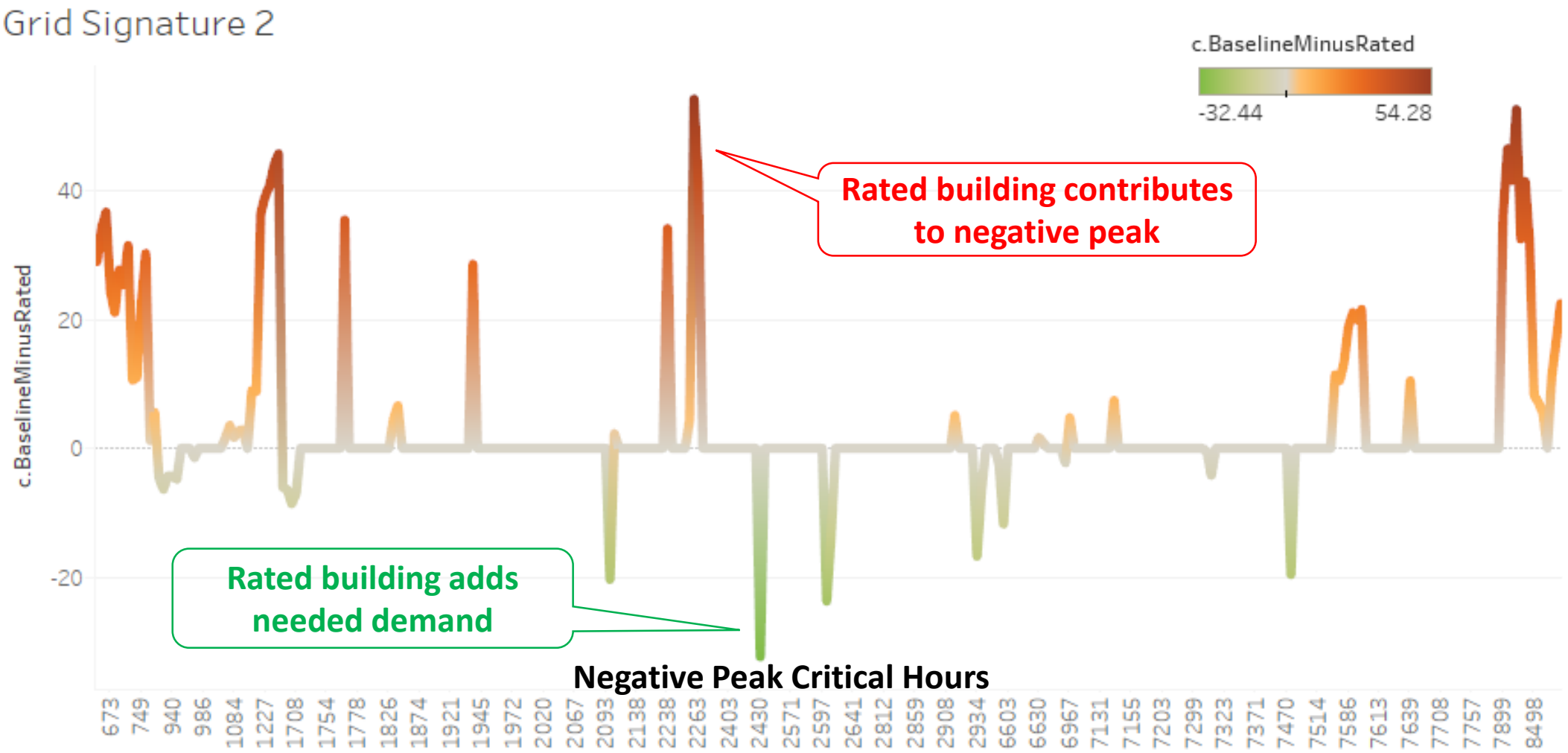

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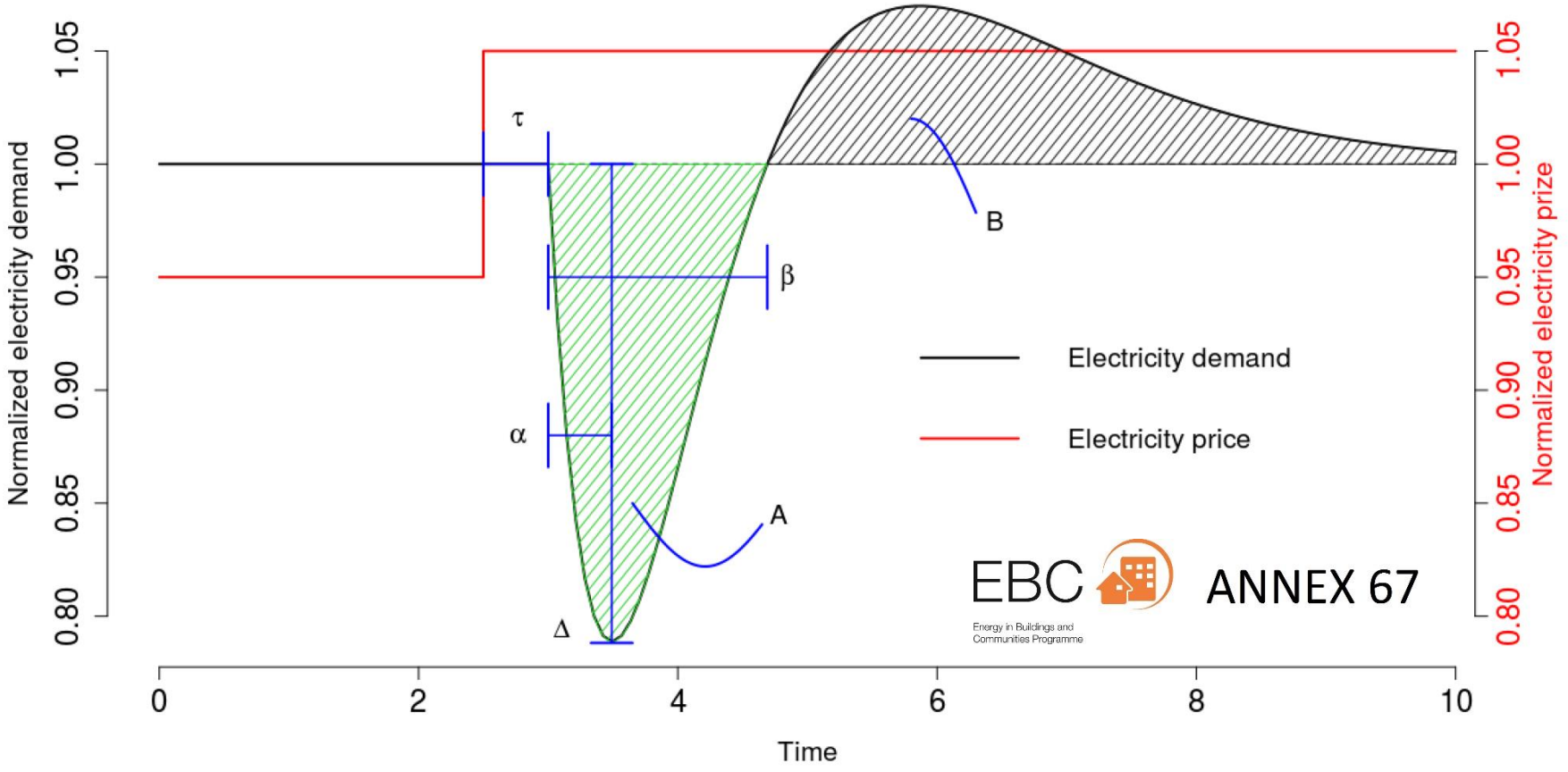
(Conference Papers: ASHRAE, January 2016 & January 2017)
(Authors: Alexi Miller, PE & Jim Edelson)

Another CRITICAL piece of the Puzzle

From the Annex 67 Position Paper:

1. **Capacity** (amount of energy that can be shifted per time unit, including the rebound effect)
2. **Time** aspects (like starting time & duration)
3. **Cost** (potential cost saving or energy use associated to activating the available flexibility)

Establishing Flexibility Parameters



Defining the Opportunity in Buildings

GridOptimal Initiative's Current Preliminary Modeling:

- 3 Buildings, all medium office, modeled in OpenStudio:
  - 1 *Baseline* building
  - 2 *High-Performance* buildings with different HVAC system types
- 3 climate zones for energy analysis (all in USA)
- 6 to 10 building control sequences
  - Night flush integration, thermal energy storage, DR-Light, DR-HVAC, airspeed adjustments…
- Battery sizing evaluation added on top

Stakeholders and Value Proposition

Key Groups	Stakeholders	Value provided to each stakeholder	Collective Value
Designers, Owners, Operators	• Architects • Owners • Engineers • Operators • Developers	**Decarbonize better and cheaper, access new revenue** • Increase building asset value • Minimize cost/risk • Resilient and decarbonized buildings • Incentives and rate benefits • New revenue stream	A common language
Utilities	• Resource and distribution planners and operators • Customer programs • Rates department	**Reveal DER's and engaged owners** • Predictable and adjustable loads • Rewards DER's and owners • Buildings as "new" zero-CO^2 balancing resources • Reduce future distribution infrastructure and stranded assets	
Regulators and Policy Makers	• Governments • Regulators • Building rating system • Codes and standards	**A new path to least cost and least carbon grid** • Overall CO^2 and cost savings to operate grid • Alignment of building standards to larger grid needs • Increased reliability	
Services and Industry	• Aggregators • Energy service providers • Vendors	**Reveal new customers** • New markets • Lower acquisition costs • Understand market size and potential	

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What will be Expected of the Building Community?

- Familiarity with grid integration technologies
- Knowledge of features and systems that allow operational flexibility
- Integration of disparate systems
- Ability to continuously implement new technologies
- Awareness of local grid connection issues
- Ability to predict building operational patterns
- Familiarity with operating implications of grid integration
- Ability to support ZNE, de-carbonization, and resiliency goals

GO Initiative Phases and Schedule

Phase 1 – Technical Development – now

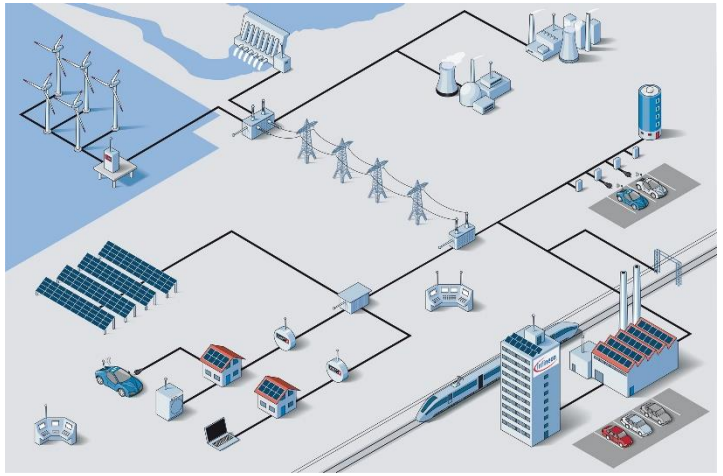
- Launch TAC and Market Scan
- Develop building modeling methodology/utility data framework
  - Scan available modeling software and systems
  - Standardization of utility data collection
- Initiate data collection and analysis/understanding

Phase 2 – Metric Creation and Standardization –Q1-Q2 2019

- Defining Metrics – which characteristics make up metric
- GridOptimal Score and Rating System – which elements determine score

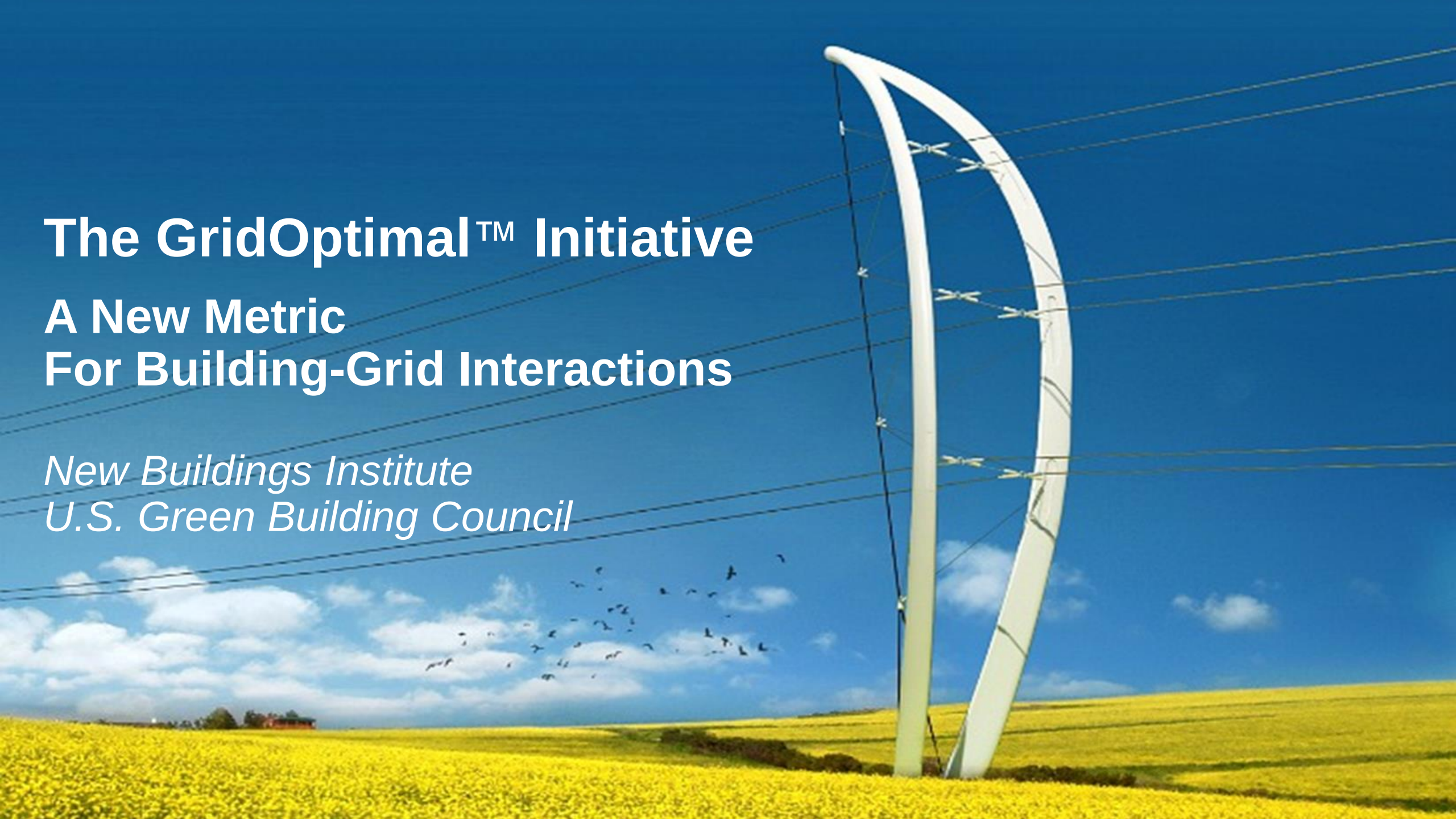
Phase 3 – Market Deployment – 2019

- Utility Program Criteria and Business Planning
- LEED and PEER integration – Pilot Credits
- Develop code criteria/venues for proposals



GRIDOPTIMAL INITIATIVE

https://newbuildings.org/gridoptimal-initiative/



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