Ralph Dinola
CEO, New Buildings Institute
Vision: We envision a transformed built environment that is carbon-free, sustainable, and energy-efficient and supports thriving economies that benefit all people and the planet.

Mission: We push for better buildings that achieve zero energy, zero carbon, and beyond – through research, policy, guidance, and market transformation – to protect people and the planet.
"The historic slowdown in energy efficiency in 2018 – the lowest rate of improvement since the start of the decade – calls for bold action by policy makers and investors."

Fatih Birol, Executive Director, IEA
Rising Seas Will Erase More Cities by 2050, New Research Shows

By Denise Lu and Christopher Flavelle  Oct. 29, 2019

The disappearance of cultural heritage could bring its own kind of devastation. Alexandria, Egypt, founded by Alexander the Great around 330 B.C., could be lost to rising waters.
New York Context

Toward a Clean Energy Future: A Strategic Outlook 2020-2023

NYSERDA’s 2020-2023 Strategic Outlook

• Greenhouse Gas Emissions Reduction
• Renewable Energy
• Energy Efficiency
• A Distributed and Resilient Energy System
• Building a Clean Energy Economy
“There is no historical precedent for the ambitious changes on the bulk power system envisioned by policymakers”

NYISO Power Trends Report 2019
New York Context

• Real-time Energy Management (RTEM) is a pathway to Grid-Integrated Efficient Buildings (GEBs)

• Demand Response Programs
  • 4% of summer peak demand in 2018

• Local Law 97
  • GHG emissions limits at the building site

• Local Law 32
  • PREDICTED ENERGY USE TARGET. For each type of buildings, as such types correspond to the prototypes set forth in ASHRAE 90.1-2013, a maximum allowable predicted energy use of such buildings that are new buildings or existing buildings undergoing substantial reconstruction, as determined pursuant to this article
Climate Solutions?
Zero Energy Building Counts

10x Growth since 2012

2012: 60
2016: 332
2018: 482
2019: 620+

© New Buildings Institute 2019
Zero Energy Buildings
Zero Energy Building Performance

ZE Verified buildings on average use **60% less energy** than comparable existing U.S. commercial buildings and 46% less than new buildings under one of the most stringent U.S. base code (CA Title 24).
Zero Energy with and without Grid Integration

- **Solar PV only**
- **Energy Efficiency, Demand Response + Solar PV**

**Load Shape**

**Grid Impact**

(Courtesy: NREL, RMI)
California: The Duck Curve
The Grid Menagerie

California: The Duck Curve

Midwest: The Gator Curve

Texas: The Armadillo Curve

Hawaii: The Nene Curve
Macro Trends:

“a glimpse of the future”

- Zero Energy Proliferation
- Grid Decarbonization
- Building Decarbonization
- Vehicle Electrification
- Energy Resiliency
- Batteries
The Five Foundations of Zero Carbon Building Policies

- Energy Efficiency
- Renewable Energy
- Grid Integration + Storage
- Decarbonization
- Embodied Carbon

Zero Carbon Building Policy
Building Modifications for Grid-Integration

- **Efficiency**
  - Power Demand vs. Hour of the Day

- **Load Shed**
  - Power Demand vs. Hour of the Day

- **Load Shift**
  - Power Demand vs. Hour of the Day

- **Modulate**
  - Power Demand vs. Sub-Seconds to Seconds

Source: Department of Energy
Marginal Emissions Rates in NYC

15-minute timescale
Data from WattTime for 2017
NBI and USGBC recognize these leading organizations for their generous support for and participation in the GridOptimal Buildings Initiative.
Critical Bridge Between Buildings and the Grid
The GridOptimal Buildings Initiative - 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 rate 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 dependability**.
• Efforts to **decarbonize the electrical grid** will require **better integration** of distributed energy resources.
One-Way Grid
The proliferation of distributed generation creates a need for more active grid management.
Storage and smart devices can help support clean grid operations

GridOptimal Technologies and Strategies:
- renewable energy
- energy efficiency
- electric vehicle
- energy storage
- smart connected controls
GridOptimal empowers players on both sides of the meter to actively support the transition to a carbon free grid.

GridOptimal Technologies and Strategies:
- renewable energy
- energy efficiency
- electric vehicle
- energy storage
- smart connected controls
Opportunities for Building Integration with Grid

• 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…
Building Energy Load Shape

Reduce energy use in the

Winter mornings and Summer evenings
Looking at *when* energy is saved is key
GridOptimal Metrics
Select Pilot Projects

• Sonoma Clean Power HQ
• School in Vermont
Carbon Intensity of the Grid Varies Over Time

Marginal Carbon Emissions on the Grid

Emissions Rate Relative to Average
-95% 41%
Sonoma Clean Power HQ

45% Annual carbon reduction from baseline (mixed-fuel) building
Energy Efficiency Measures

Design Features
- Upgraded envelope
- Exceptional daylighting
- All electric heating, hot water
- Induction cooking
- Building dashboard
- Grid-connected appliances
- 41 kW Photovoltaic Array
- 150 kW battery
- Car charging

Time dependent measures modeled
- Summer Temp Setback
- Afternoon Lighting Setback
- Interoperable Thermofusers
- Early Morning Warm-Up
- **Daily battery deployment**
- Grid connected appliances
- Grid-managed vehicle charging
Additional Measures Cut Carbon Effectively

The ECMs save energy at opportune times: Carbon savings outpace energy

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>ECM-1</th>
<th>ECM-2</th>
<th>ECM-3</th>
<th>ECM-4</th>
<th>ECM-5</th>
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</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>-4.0%</td>
<td>-3.6%</td>
<td>-1.4%</td>
<td>-4.3%</td>
<td>-3.9%</td>
<td>-13.9%</td>
</tr>
<tr>
<td>Energy</td>
<td></td>
<td></td>
<td>-1.3%</td>
<td>-9.2%</td>
<td>-9.1%</td>
<td>-13.4%</td>
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GRIDOPTIMAL™ BUILDINGS INITIATIVE

© New Buildings Institute 2020
Battery Used to Change Load Shape

Battery Discharging
Battery Charging

Original Load Shape
Improved Load Shape

Monday, December 16

Net Demand - after PV and Battery

Building Energy Demand (kW)
Thermal Energy Storage in a Vermont School

- 20,000 square foot secondary school
- All-electric
- 2,000 gallon thermal storage tank
- What is the benefit of thermal storage?
  - Improved chiller COP
  - Shifting loads away from:
    - peak demand hours (utility $$)
    - higher carbon hours (societal $$)
    - demand response hours (rate savings $$)
Thermal Energy Storage in a Vermont School

Total Grid Demand Throughout the Year (VT Data)

VT Grid Load Factor

© New Buildings Institute 2020
Thermal Energy Storage in a Vermont School
Marginal Carbon Intensity Throughout the Year in Vermont

Thermal Energy Storage in a Vermont School
Thermal Energy Storage in a Vermont School

Marginal Carbon Intensity Throughout the Year in Vermont

<table>
<thead>
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<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
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Marginal Carbon (lb CO2/MWh)

972.6

1,569.3
## Thermal Energy Storage in a Vermont School

<table>
<thead>
<tr>
<th></th>
<th>Default Deployment</th>
<th>Simple Schedule</th>
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</thead>
<tbody>
<tr>
<td><strong>Operation</strong></td>
<td>Charge until full</td>
<td>Charge midnight to 7am</td>
</tr>
<tr>
<td></td>
<td>Discharge until empty</td>
<td>Discharge 8am to 11am</td>
</tr>
<tr>
<td></td>
<td>Rinse and repeat</td>
<td>Charge noon to 5pm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Discharge 5pm to 10pm</td>
</tr>
<tr>
<td><strong>Energy vs. No storage</strong></td>
<td>0.5% Penalty</td>
<td>8.9% Savings</td>
</tr>
<tr>
<td><strong>Carbon vs. No storage</strong></td>
<td>0.5% Penalty</td>
<td>9.7% Savings</td>
</tr>
</tbody>
</table>
Office Building Example

STATS
58,000 SF
4 Floors of Office
1 Floor Retail

BENCHMARKS
Living Building
Net Zero Energy & Water

ENERGY
• 19 EUI
• 325 kW PV Array for Net Zero Energy
• 160 kWh Battery required for LBC

PASSIVE FEATURES
• High performance envelope
• Manual and automatic windows
• All occupied spaces within 10’ of an operable window
• Designed for maximum daylighting
### Typical Use

- **Lights Off**
- **Temperature Set Back**
- **Ventilation Off**
- **Plug Loads reduced to laptops only**
- **Elevator not used**
- **Cold Domestic Water Only**

### Curtailment Strategies

- Lights Off
- Temperature Set Back
- Ventilation Off
- Plug Loads reduced to laptops only
- Elevator not used
- Cold Domestic Water Only

**Annual Energy Use Profile**

- **Daily kWh Used**
- **Date**
- **Typical Use**
- **Curtailed**

**Slides: PAE Engineers**

**© New Buildings Institute 2020**
Passive Design Features

- Lights Off
- Temperature Set Back
- Ventilation Off
- Plug Loads reduced to laptops only
- Elevator not used
- Cold Domestic Water Only

Usage curtailment

- 70% of reduction
- 30% of reduction

Slides: PAE Engineers
Days at Risk of an Empty Battery when Islanding

No curtailment, Net Zero with LBC-Size Battery (160 kWh)
8 Resilient Workdays
Days at Risk of an Empty Battery when Islanding

With energy curtailment, Net Zero with LBC-Size Battery (160 kWh 124 Resilient Workdays)
Days at Risk of an Empty Battery when Islanding

Increase battery from LBC-minimum to about 100% of a typical daily load 1000 kWh
210 Resilient Days
Looking Ahead
What’s coming down the line?

- GridOptimal version 1 metrics expected Q2 2020
- LEED Pilot Credit
- LEED Carbon credit – Grid Harmonization + Energy
- Utility programs
- Utility rates: Real-time pricing
Grid-Integration Value
Value Potential - GSA

• $50 million in annual cost savings to the GSA
• $70 million in value to grid users by reducing generation and transmission and distribution costs, benefiting all ratepayers
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.)

Puerto Rico, 9/22/17 (NBC)
Call to Action!
What can you do?

• Join the initiative
• Pilot a new project
• Keep an eye out for guidance coming out of the initiative
• Sponsor the upcoming Forum
Interested in Learning More?

Visit the web page: https://newbuildings.org/gridoptimal/

• Factsheets
• Recorded Webinars
• Articles

Join the GridOptimal Buildings Initiative! Make your voice heard and help define the future of buildings and the grid. Contact us:

alex@newbuildings.org  |  mark@newbuildings.org
kevin@newbuildings.org
Additional Resources

- New Buildings Institute – GridOptimal Initiative
  - [https://newbuildings.org/resource/gridoptimal/](https://newbuildings.org/resource/gridoptimal/)
- Rocky Mountain Institute - GEBs Homepage
  - [https://rmi.org/gebs](https://rmi.org/gebs)
- U.S. General Services Administration – GEBs Advice Letter
- DOE BTO – GEBs Homepage
- Berkeley Lab – FlexLab
  - [https://flexlab.lbl.gov/](https://flexlab.lbl.gov/)
- NASEO/NARUC – States Working Group
  - [https://www.naseo.org/issues/buildings/naseo-geb-resources](https://www.naseo.org/issues/buildings/naseo-geb-resources)
Codes for Loads Thought Leadership

• Three NBI white papers
  - Alexi Miller, Jim Edelson, & Kevin Carbonnier

• Considering and scoping IECC code proposal(s) for new informative appendix
  - Allows a jurisdiction to select most-critical load hours and credit targeted building load modifications during those hours

• Framework:
  - Sum of LOAD CREDITS ≥ Jurisdiction’s threshold
    1. Formula for Load Credits – related to load (kW) modification
    2. Must be Commissioned
    3. Can be minimum requirement or Section 406 credit
Save the Date!

GETTING TO ZERO FORUM 2021

March 15-17, 2021
New York City

Leading policymakers, design professionals, building owners and commercial real estate representatives, and others will gather at the 2021 Getting to Zero Forum. Participants will share perspectives on the growth of ZE, learned about best practices for successful projects and collaborated on opportunities for ZE to transform the built environment.
Thank you!

Ralph DiNola
ralph@newbuildings.org
GREENING THE GRID: GRID FRIENDLY BUILDINGS

February 27th 2020 | 32BJ
SPEAKERS

Ralph DiNola | CEO, New Buildings

Ellen Honigstock | Director of Education, Urban Green Council (Moderator)

Charles Marino | Director of Energy Services, AKF Group

Christopher Wetzel | Associate, Jaros Baum & Bolles
THANK YOU!

GREENING THE GRID: GRID FRIENDLY BUILDINGS

February 27th 2020 | 32BJ
UNLOCKING THE GRID: GETTING RENEWABLES TO NYC

Join us for Urban Green Council’s 2020 Conference – June 17, 2020