2018 Winter Conference ★ Chicago, IL

The Process of Zero Energy K-12 Schools: The Next Series of ASHRAE Advanced Energy Design Guides

Paul A. Torcellini, Ph.D., P.E.
National Renewable Energy Laboratory
Paul.Torcellini@nrel.gov

NREL

SMNR 49: The Process for Zero Energy K-12 Schools: The Next Series of ASHRAE Advanced Energy Design Guides

LEARNING OBJECTIVES

- Describe a process for creating a zero energy school
- Apply a set of Energy Use Intensity targets to achieve a zero energy school
- Provide an overview of the Advanced Energy Design Guide for Zero Energy Schools
- Describe the interactions between envelope, lighting, plug loads and HVAC design and the integrated roles that architects and engineers should follow to achieve low-energy design

Acknowledgments

- U.S. Department of Energy provided the funding to NREL for the effort to NREL including analysis and management. NREL provided funding to ASHRAE to cover costs of producing the AEDG. (Jason Hartke and Sarah Zaleski, EERE BTO)
- Advanced Energy Design Guide (AEDG) Steering Committee (Tom Phoenix, Chair)
  - Representation from AIA, ASHRAE, IES, USGBC
- Volunteer Project Committee
  - **Paul Torcellini**, Chair; **Dan Nall**, AIA Representative, **Sylvia Wallis**, AIA Representative, **Peter Jefferson**, ASHRAE Representative, **Carol Marriott**, ASHRAE Representative; **Shanna Olson**, IES Representative; **Kim Humiston**, IES Representative; **Steve Davis**, USGBC Representative; **Ken Seibert**, USGBC Representative; **Charles Eley**, Member at large, **John Chadwick**, Member at large, **Merle McBride**, Member at large, **Anoop Honnekeri**, Analysis Support; **David Goldwasser**, Analysis Support, **Lilas Pratt**, Staff Liaison

Introduction

- Educational guidance—not a code; not a standard; not a guideline
  - Intended audience are architects and engineers looking for beyond code guidance for implementing energy efficiency strategies
- Available for free as a PDF download from ashrae.org

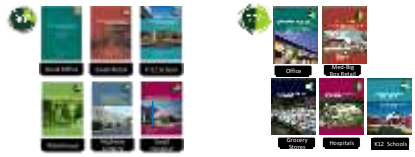
Advance Energy Design Guides

Guides for Energy Performance beyond ASHRAE 90.1

- Collaboration of professional organizations and DOE
- Specialized Project Committee for each guide
- Oversight is provided via AEDG Steering Committee
- Backed by DOE's national laboratory leadership, energy simulation, technical analysis and support
- Open peer review and commentary process

Advance Energy Design Guides

- Eleven guides published and available for free download
- Circulation is 600,000+ copies



ashrae.org

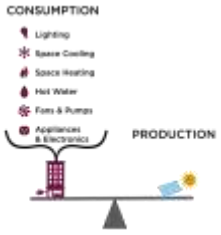
What are Zero Energy Buildings?

- Conceptually, a building that has no adverse energy [or environmental] impact [because of its operation]
- Energy consumption has been a long-term surrogate for environmental impact
- Boundaries and metrics
- What energy flows to measure

Zero Energy Building

Adding Renewables

Building on a Diet

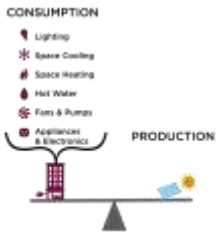


ZEB Concept

Goal 1:
Reduce Consumption

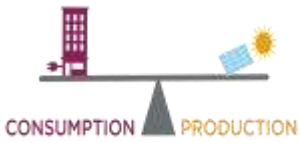
Goal 2:
Apply On-site Renewable Energy

BALANCE!



Zero Energy Building (ZEB) Definition

An energy-efficient building, where on a source energy basis, the actual annual delivered energy is less than or equal to the on-site renewable exported energy.



ZE AEDG Goals

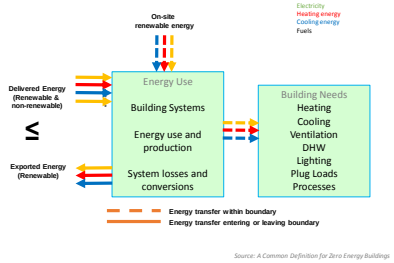
- Demonstrate that zero energy schools are attainable
- Provide direction for designing and constructing ZE schools in all climate zones
- Offer methodology for achieving energy goals that are:
  - Financially feasible
  - Operationally workable
  - Readily achievable
- Measurable goals

Advanced Energy Design Guidance

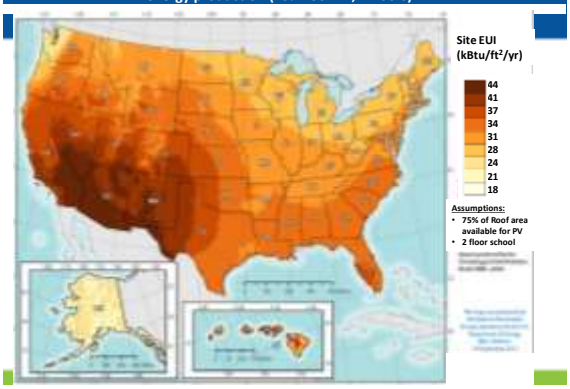
- Publication Date: January 2018

Process…

Energy Balance Boundary

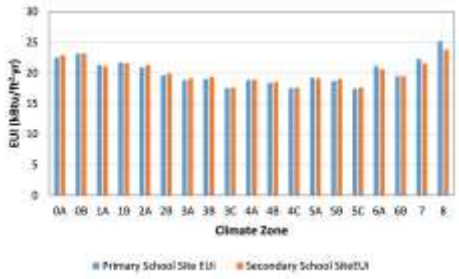


Site energy use intensity targets to meet the available rooftop PV annual energy production (75% roof PV, 2 floors)



K-12 School Modelling

Simulations



Energy Use Intensity Targets

- Did exhaustive simulations to determine energy use intensity targets
  - Can show that zero is possible and the types of strategies that can be used to get there
- Set of design decisions that can achieve the targets
  - Zero Energy Ready Buildings—buildings so efficient that on-site renewables can offset the energy needs

Energy Use Intensity Targets for Schools

Climate Zone	[illegible]	[illegible]	[illegible]	[illegible]
0A	22.5	22.9	69.1	70.5
0B	23.1	23.2	71.4	71.6
1A	21.3	21.1	65.5	65.0
1B	21.7	21.6	66.6	66.6
2A	20.9	21.3	63.8	65.1
2B	19.6	19.9	59.7	60.8
3A	18.8	19.1	58.7	60.8
3B	19.0	19.6	57.3	58.8
3C	17.5	17.6	52.6	53.8
4A	18.8	18.9	58.3	58.7
4B	18.4	18.5	55.3	55.5
4C	17.5	17.6	50.8	51.1
5A	19.2	19.1	57.5	56.9
5B	18.7	19.0	55.8	56.6
5C	17.4	17.6	49.7	51.3
6A	21.1	20.6	62.8	61.3
6B	19.5	19.5	57.9	57.9
7	22.3	21.5	68.2	63.7
8	25.2	23.8	75.1	70.3

What is in the Guide?

- Multiple Audiences
  - School Owners (Board, Facilities, Administration)
  - Engineers and Architects
- Chapter 1 – Introduction
- Chapter 2 – Rationale for Zero Energy
- Chapter 3 – Keys to Success
- Chapter 4 – Building Simulation
- Chapter 5 – How to Strategies

Chapter 5: How-to Strategies

- Table showing how the strategies can be applied
- Collection of small pieces of text with strategies to help move towards zero.
  - Building and Site Planning
  - Envelope
  - Lighting (daylighting and electric lighting)
  - Plug Loads and Power Distribution
  - Kitchen Equipment
  - Service Water Heating
  - HVAC Systems
  - Renewable Energy

23

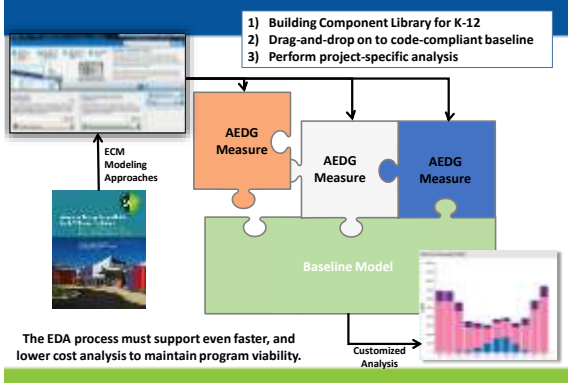
Case Studies

Discovery Elem. School EUI=15.8

Dearing Elem. School EUI=23.5

Friends School EUI=11.7

AEDG Measure Content for Faster Modeling



The EDA process must support even faster, and lower cost analysis to maintain program viability.

Resources

- Feasibility Studies
- Technical Support Documents
- Modeling Tools and Validation
- Sector Accelerators
- Up next--Office Buildings

Questions?

Paul A. Torcellini, PhD., PE
Paul.Torcellini@nrel.gov