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Evaluating Cost-Effectiveness in Energy Codes

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Background

DOE is tasked with supporting cost justified and technologically feasible improvements in energy codes

- Commercial and residential
- National and state
- Traditionally uses LCC from the perspective of a building owner as the metric to determine cost effectiveness
- Follows standard engineering economic metrics based on the NIST method
- Cost effectiveness is based on published methodology described at
  - ✓ https://www.energycodes.gov/development/residential/methodology
  - ✓ https://www.energycodes.gov/development/commercial/methodology

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Commercial Cost Effectiveness – ASHRAE 90.1-2019

- Metrics: LCC, Simple Payback and Expanded Scalar Ratio
- Uses a subset of climate zones and prototype buildings
- ASHRAE 90.1-2019 weighted average life-cycle net energy cost savings is $4.12 per sq.ft.

COMMERCIAL ECONOMIC PARAMETERS (2019)

Economic Parameter	Commercial State Cost-Effectiveness Scenario 1 without Loans or Taxes	
	Value	Source
Nominal Discount Rate[(a) (d)]	3.1%	*Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis - 2019*, NIST annual update (Lavappa and Kneifel 2019).
Real Discount Rate[(b) (d)]	3.0%	
Inflation Rate[(c) (d)]	0.1%	
Electricity and Gas Price	$0.1063/kWh, $0.98/therm	SSPC-90.1 for 90.1-2019 scalar
Energy Price Escalation	Uniform present value factors	*Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis - 2019*, NIST annual update (Lavappa and Kneifel 2019).
	Electricity 19.17 Natural gas 23.45	The NIST uniform present value factors are multiplied by the first year annual energy cost to determine the present value of 30 years of energy costs and are based on a series of different annual real escalation rates for 30 years.

ASHRAE 90.1-2019 NATIONAL COST EFFECTIVNESS RESULTS

Prototype Model	Climate Zone and Location					
Life-Cycle Cost Net Savings, $/ft^2	2A Tampa	3A Atlanta	3B El Paso	4A New York	5A Buffalo	Weighted
Small Office	$4.20	$4.16	$4.23	$4.00	$3.98	$4.11
Large Office	$4.40	$4.39	$3.92	$4.29	$4.22	$4.29
Standalone Retail	$4.83	$4.56	$4.70	$4.34	$4.28	$4.50
Primary School	$5.43	$5.06	$5.45	$5.04	$5.10	$5.19
Small Hotel	$14.14	$14.04	$14.07	$13.86	$13.81	$13.97
Mid-rise Apartment	$2.65	$2.66	$2.19	$1.83	$1.80	$2.18
Weighted Total	$4.50	$4.44	$4.03	$3.79	$3.91	$4.12

National Residential Cost Effectiveness – IECC 2021

- Metrics: LCC, Simple Payback and Cash Flow
- Analysis considers:

  US climate zones: All US Climate zones

  Building Type: Single Family, Low-rise Multifamily

  Foundation: Crawlspace, Heated Basement, Unheated Basement and Slab-on-grade

  Heating Types: Heat Pump, Oil Furnace, Gas Furnace and Electric Resistance

Residential IECC 2021 weighted average life-cycle net energy cost savings is $2,254 per dwelling unit.

Life-Cycle Cost Savings for the 2021 IECC

Climate Zone	Compared to the 2018 IECC ($/dwelling unit)
1	3,534
2	2,858
3	2,832
4	1,892
5	1,037
6	973
7	3,787
8	6,786
National Average	2,254

Societal Benefits

- DOE is considering evaluating additional metrics that go beyond building owner and include societal benefits
- We are updating the cost-effectiveness methodology and thinking about how to possibly incorporate:
  - Impacts on the grid
  - Impacts on emissions and SC-GHGs
  - Impacts on job creation

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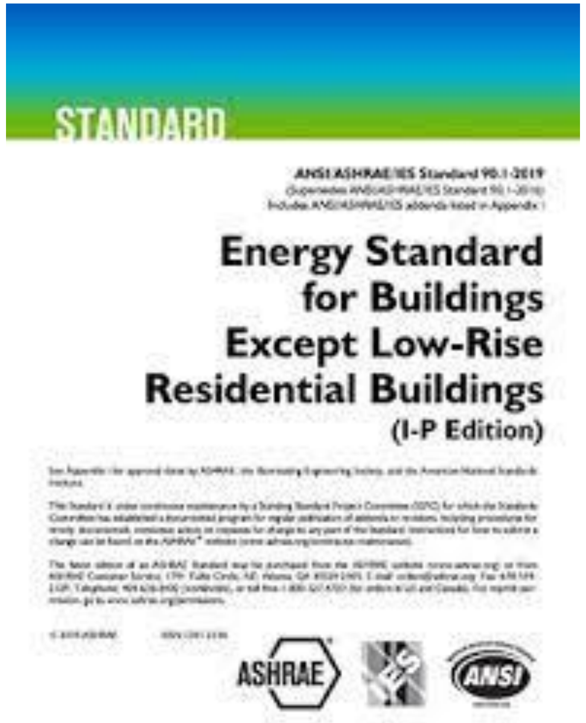
Evaluating the Impact of Buildings on the Grid

TOU Pricing

- ASHRAE 90.1-2022 adopted an optional TOU cost metric for evaluating electric efficiency measures
- On-peak/Off-Peak rates for both Winter and Summer periods.
- Intended for efficiency measures that reduce peak electric demand, provide demand flexibility and promote load shifting.
- A measure to reduce lighting power by 20% shows increased energy cost savings of 80%-100% using a TOU electric rate.
- Excel based TOU calculator: https://drive.google.com/file/d/1At7NCrXzJJce_Wex5gbHg43t9JcmL4hT/view?usp=sharing
- Exploring how TOU rates can be incorporated into cost effectiveness calculations.



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Evaluating Societal Costs and Benefits of Energy Codes

Carbon Emissions

- ASHRAE 90.1-2019 determination supporting analysis included calculations of carbon emissions savings (tons/kft^2-yr) and associated societal cost (\$/kft^2-yr). Not part of the determination.
- Evaluating options to quantify additional GHG emissions and related costs in other PNNL analysis (e.g., state cost-effectiveness analysis)
- Based on the Interagency Working Group (IWG) on the Social Cost of Greenhouse Gases:
  - The 2020 SC-CO2 average cost is $51.086 per metric ton of CO2 based on 3% discount rate
  - Learn more about the current IWG guidance: https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf.

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Evaluating Additional Economic Impacts

Impact on Job Creation

- The PNNL Building Codes Program is currently evaluating two value streams:
    1. *Primary*: Economic benefits as a factor of total utility bill savings ($) returned to the economy, and;
    2. *Secondary*: Jobs created by increased energy efficiency achieved through energy codes (# jobs)

- Previous PNNL analysis, such as that used for DOE Appliance & Equipment Standards Program analysis, indicates that an average of 8 jobs are created per $M of utility bill energy savings
- An economic analysis of improved building energy codes should yield similar results

Discussion Topic and Questions

A life-cycle cost perspective is the most effective means of balancing incremental costs of energy efficiency vs. longer-term savings

- How can code analysis better characterize environmental impacts (e.g., CO2 emissions and related costs)?
- How should code cost-effectiveness methods balance consumer benefits (e.g., utility bill savings) with societal benefits (economic impacts associated with GHG emissions)?
- How should cost-effectiveness be addressed in pursuing advanced goals, such as zero energy?