Trends in Building Energy Efficiency

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the energy practice of EYP Inc.

1. Movement to net zero and outcomes based codes
2. Net zero will change the load profile
3. Unclear what electric cars will do; three scenarios
4. Integrated renewable, efficiency, demand response and storage

Net Zero and Outcomes Based Codes

Types of Code Compliance

- Prescriptive

  Check list approach, do these things and you are code compliant

- Performance

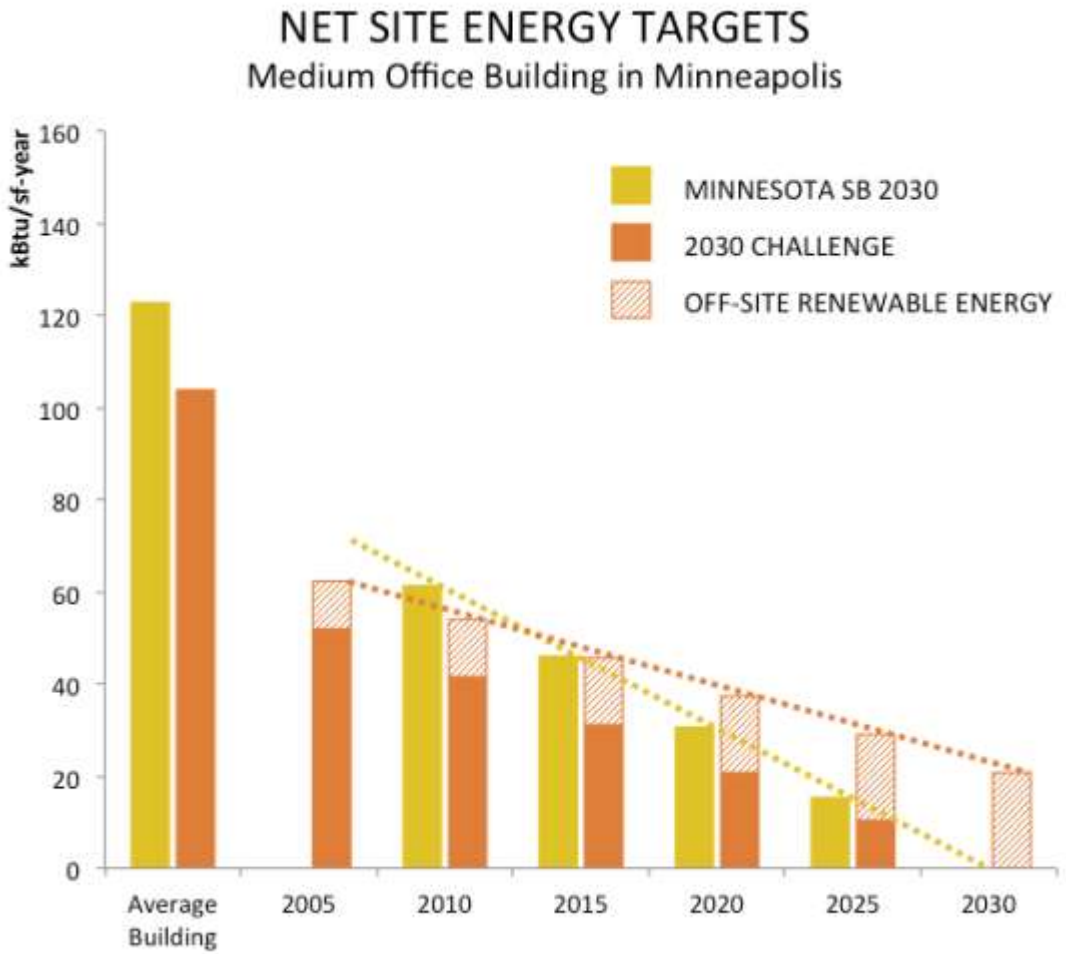
  Design a building that is expected to use less energy than the prescriptive building and you are code compliant

- Outcomes

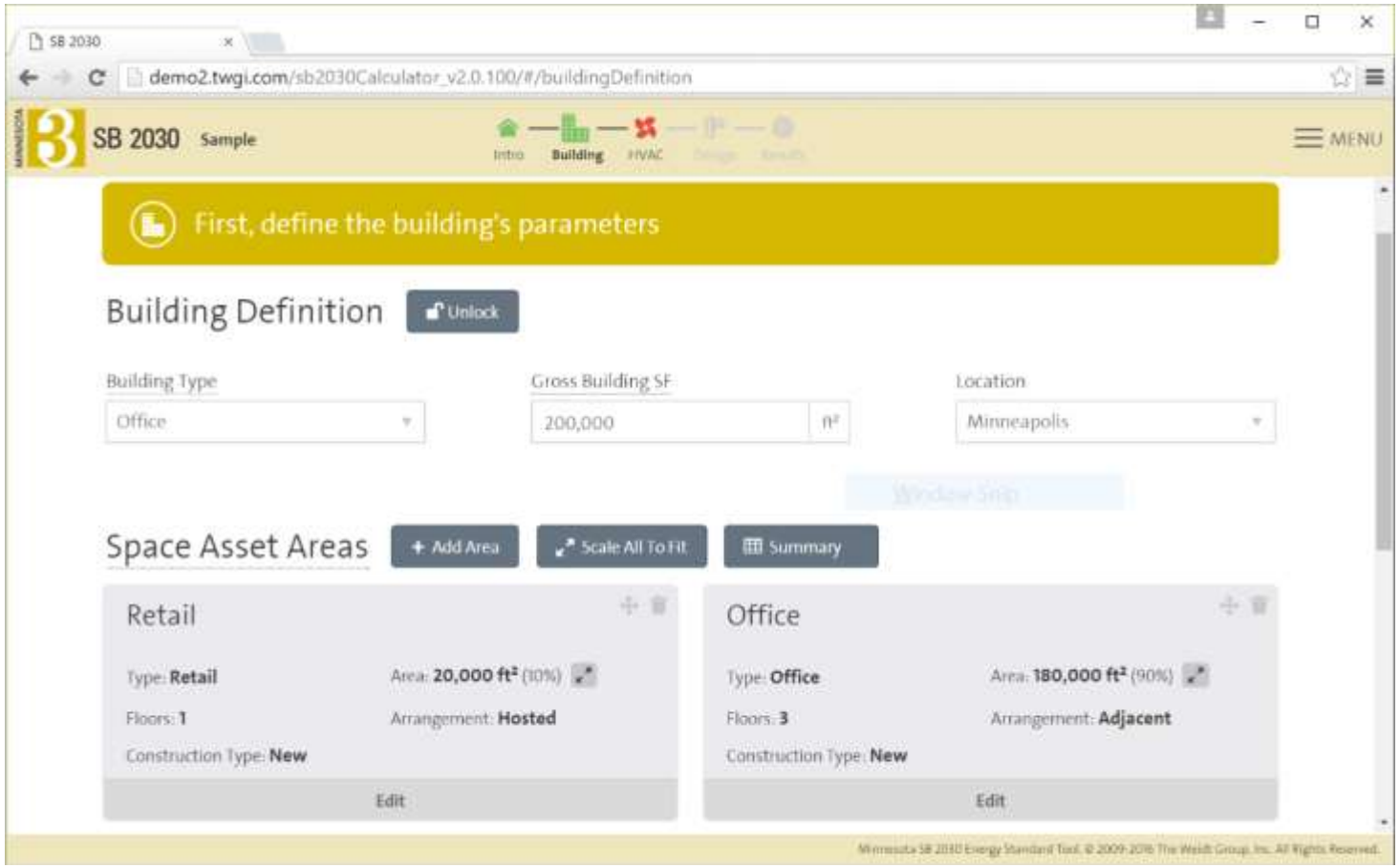
  Operate a building at less then the prescribed energy use and you are compliant

Minnesota and Outcomes Based Requirements for Public Buildings

- Programs and tools to manage energy and environmental impacts of buildings
- Required of state bonded buildings since 2004
- Outcomes based
- Adopted 2030 energy goal in 2009
- Executive Order 11-12, 20% reduction in state building energy consumption

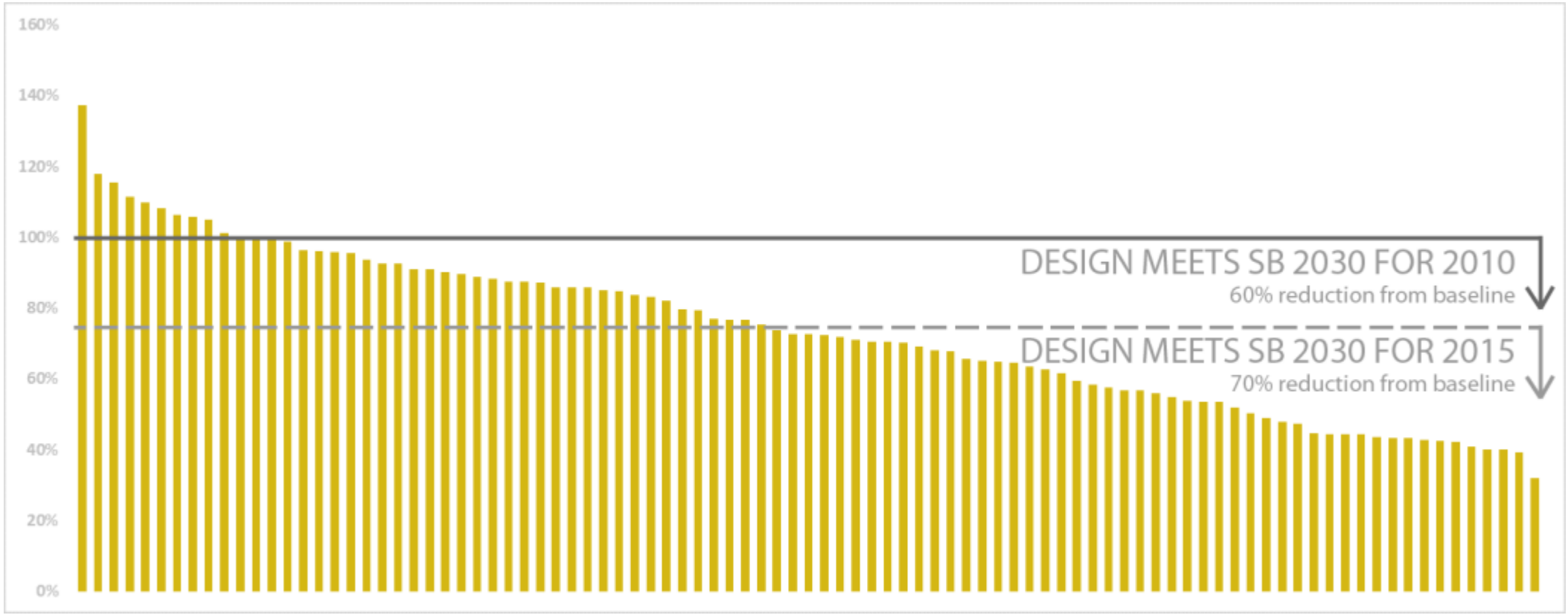


Set an Energy Use Intensity Standard

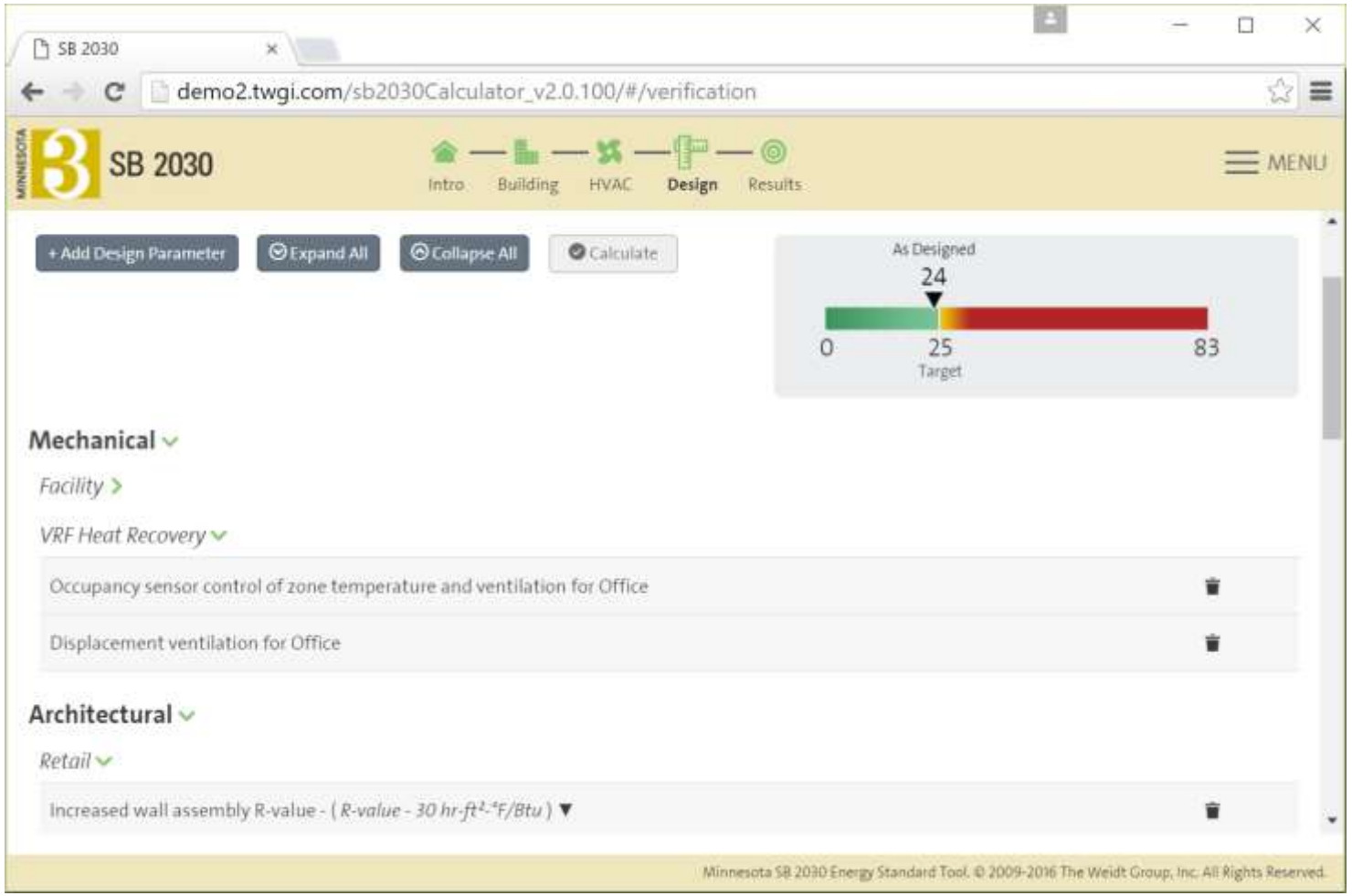


- EUI goal based on 70% reduction from typical 2003 building
- Online modeling tool adjusts for
  - Hours of use
  - Building type
  - Local weather
  - Unregulated loads

SB 2030


160%
140%
120%
100%
80%
60%
40%
20%
0%
DESIGN MEETS SB 2030 FOR 2010
60% reduction from baseline
DESIGN MEETS SB 2030 FOR 2015
70% reduction from baseline

Design to Meet EUI Goal



- Design and modeling reviewed for compliance with EUI goal
- Starting this fall modeling can be done with online tool
- Interventions at design are far less expensive than post construction

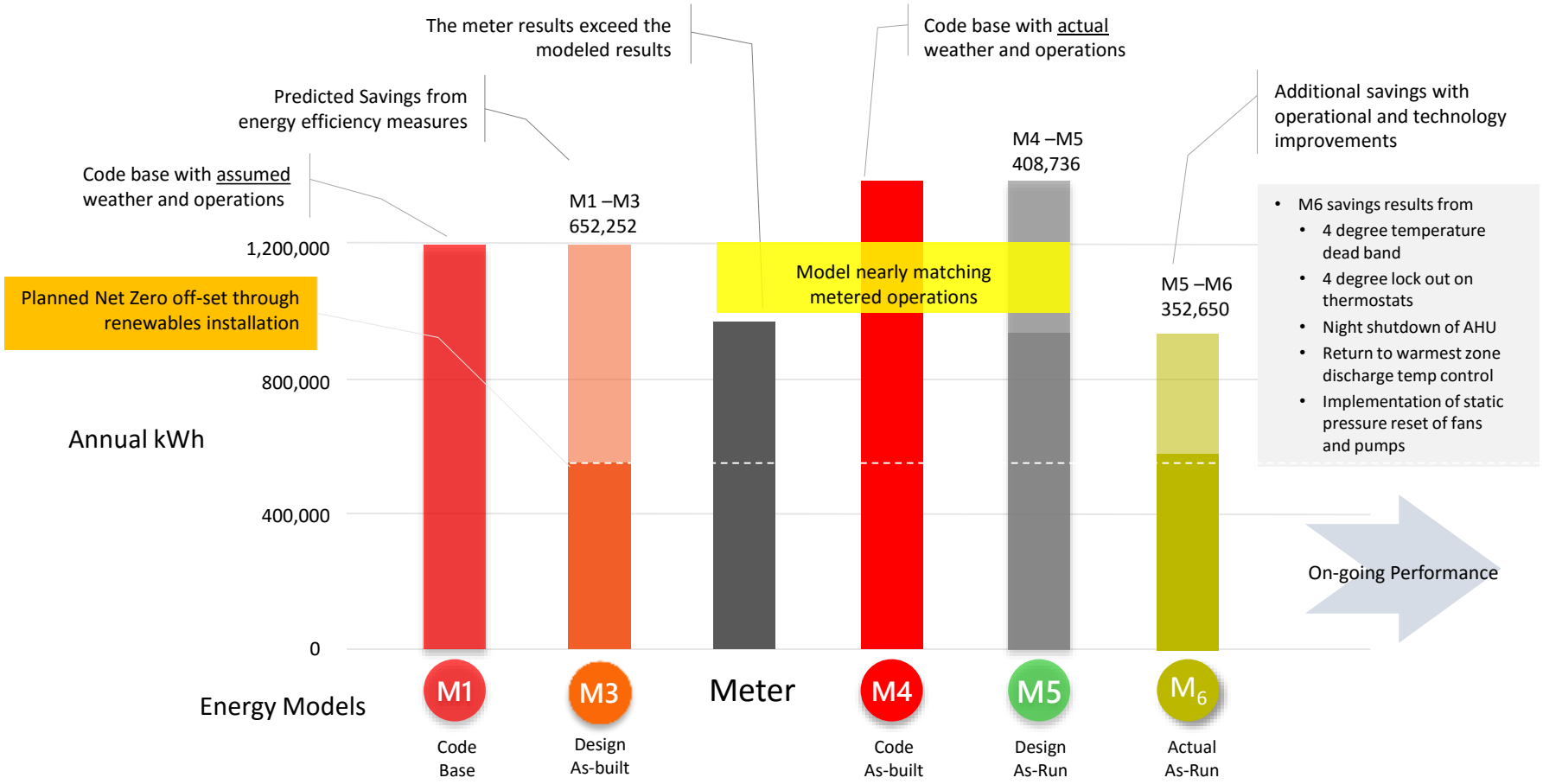
Track Actual Consumption for 10 Years

- Approximately 40 projects have two years of data
- Comparison of model and building benefits both
  - Identifies ways building is underperforming
  - Refines modeling assumptions
- Differences are not always errors
  - Change from expected usage
  - Occupant behavior
  - Not fully commissioned

Project	Area (sf)	SB2030 Standard	Design	Year 1	Year 2	Year 3
UMTC Akerman Hall	65,425	139	106	83	91	99
Hastings Armory Renovation	18,487	85	73	87	99	103
Camp Ripley COE Training Facility	22,100	74	71	57	72	75
Kendall's ACE Hardware	14,594	53	42	50	50	44
Prairie Horizons Townhomes	12,151	59	59	59	57	55
Big Bog State Recreation Area	3,040	81	37	36	35	38

Resilience Through Stewardship

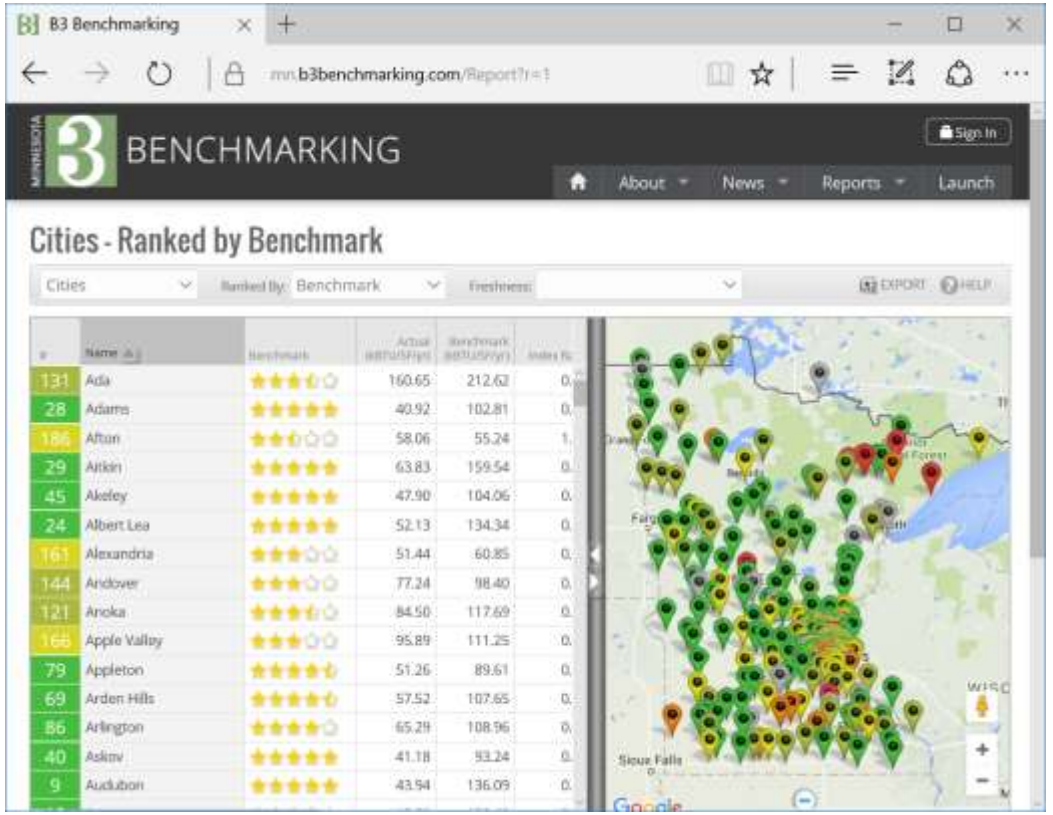
Results: College Classroom – Benchmarking with OPT



- M6 savings results from
  - 4 degree temperature dead band
  - 4 degree lock out on thermostats
  - Night shutdown of AHU
  - Return to warmest zone discharge temp control
  - Implementation of static pressure reset of fans and pumps

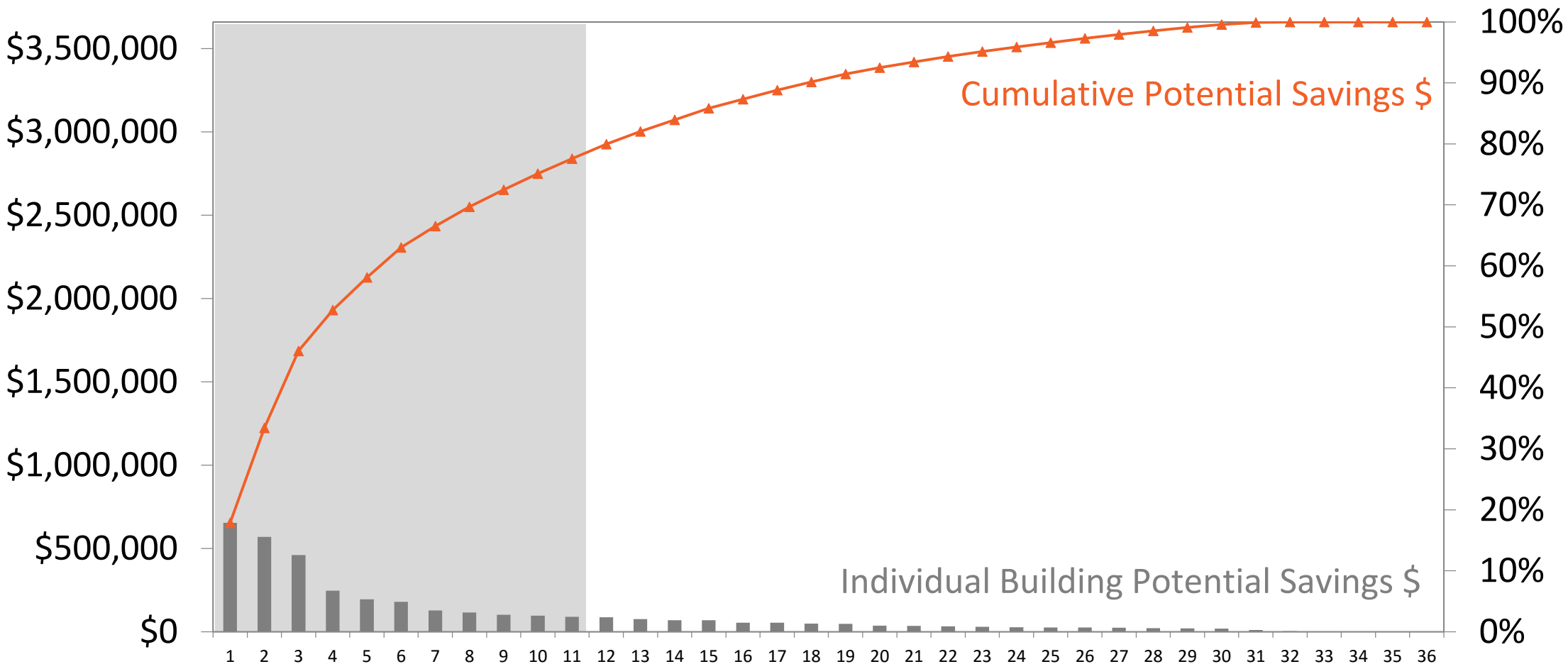
Benchmarking to Address Existing Buildings

- Benchmarked 8,229 buildings
- Identified 2,535 buildings with $47 million in potential savings
- Public buildings, including higher education, state agencies, schools, city, and county buildings



Pareto Principle

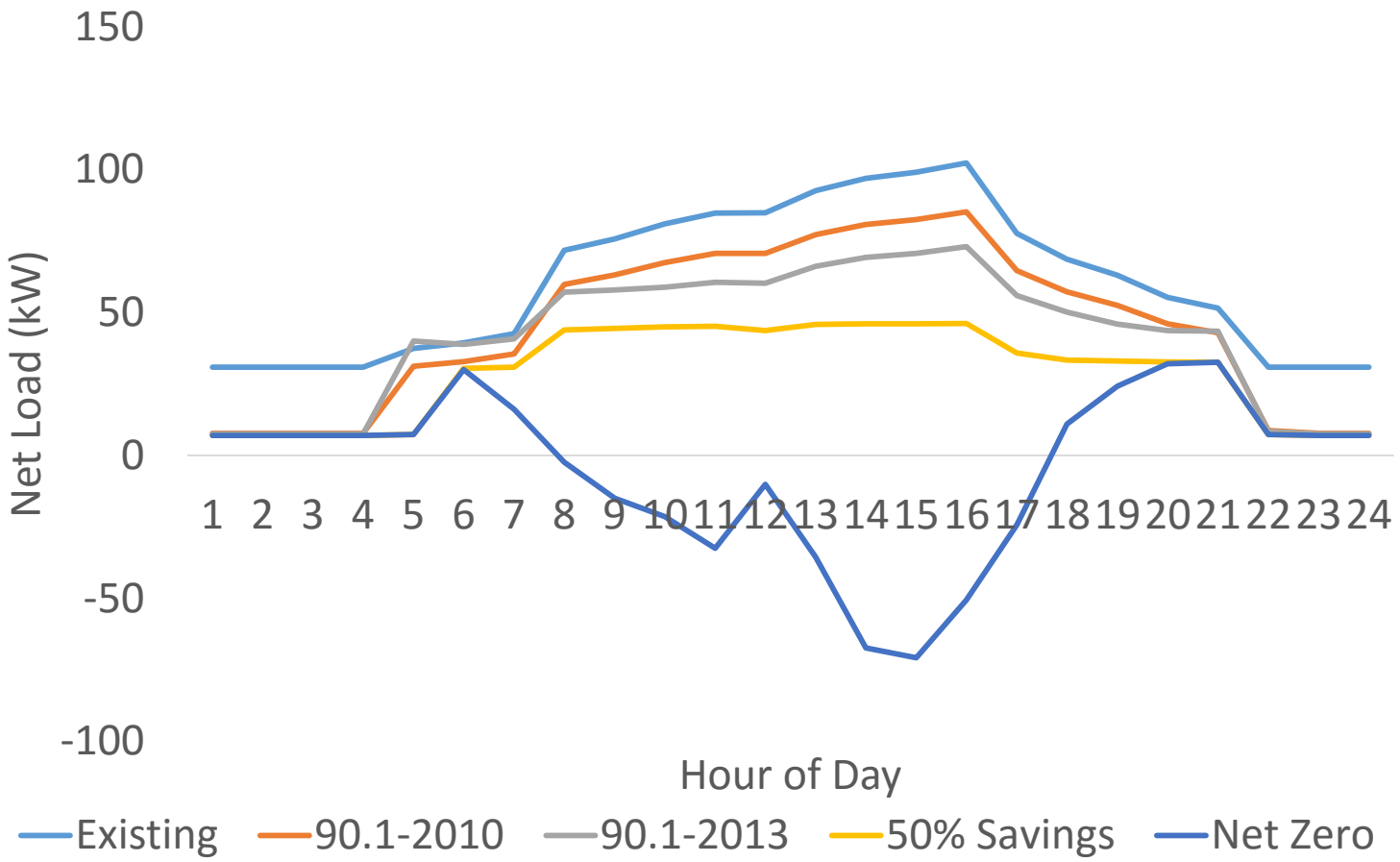
20-30% of the buildings have 70-80% of the savings



Net Zero’s Impact on Load Profiles

Office Load Profiles

25,000 sf office in Des Moines, IA, July 26

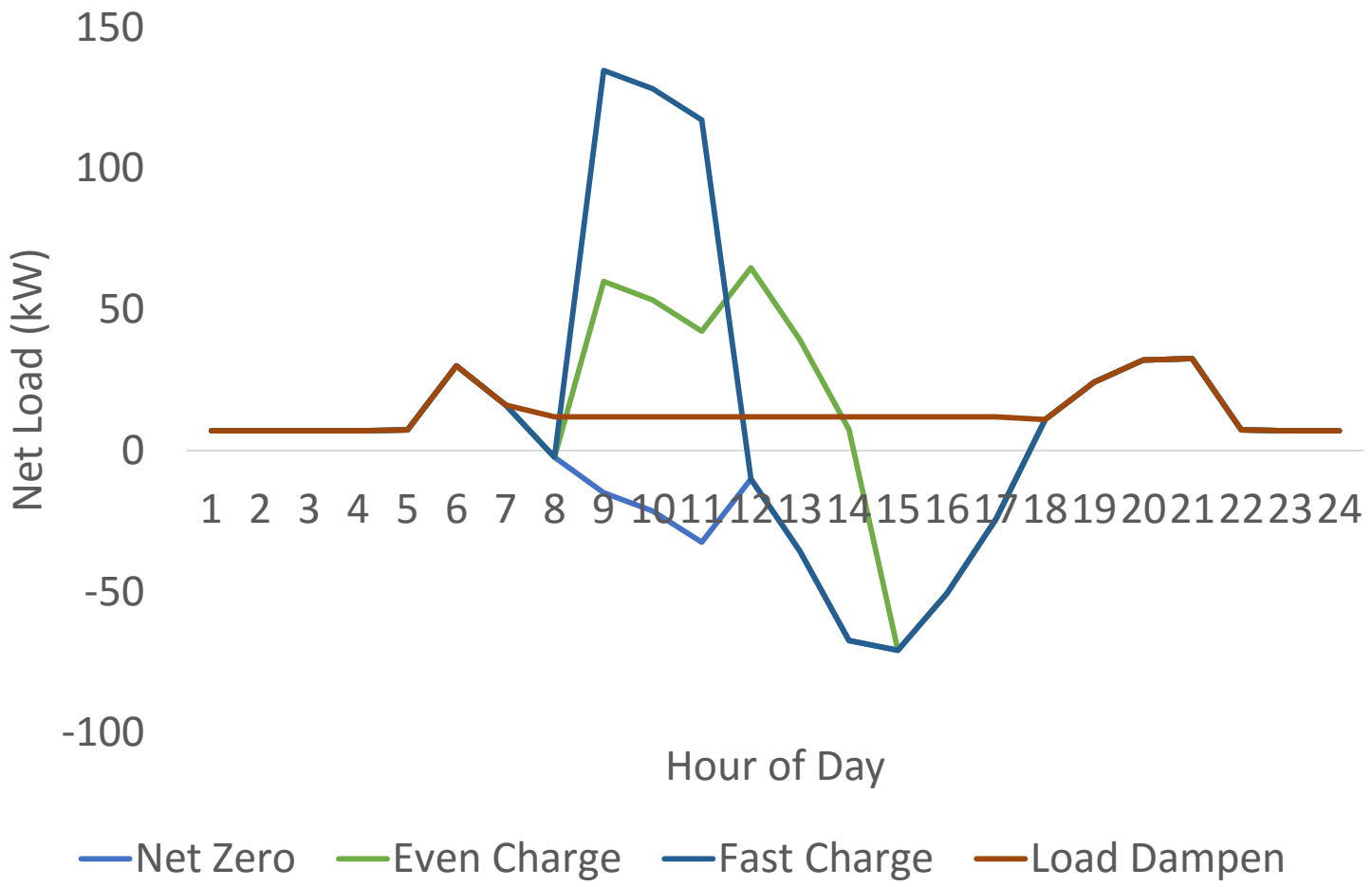


- 50% energy savings only drops peak 37%
- At peak net-generation of a net zero building is roughly as much as a typical existing building demands
- Net zero buildings have great load changes as they shift from net-generation to net-consuming over the day

Electric Vehicle Impact on Load Profiles

Office Load Profiles

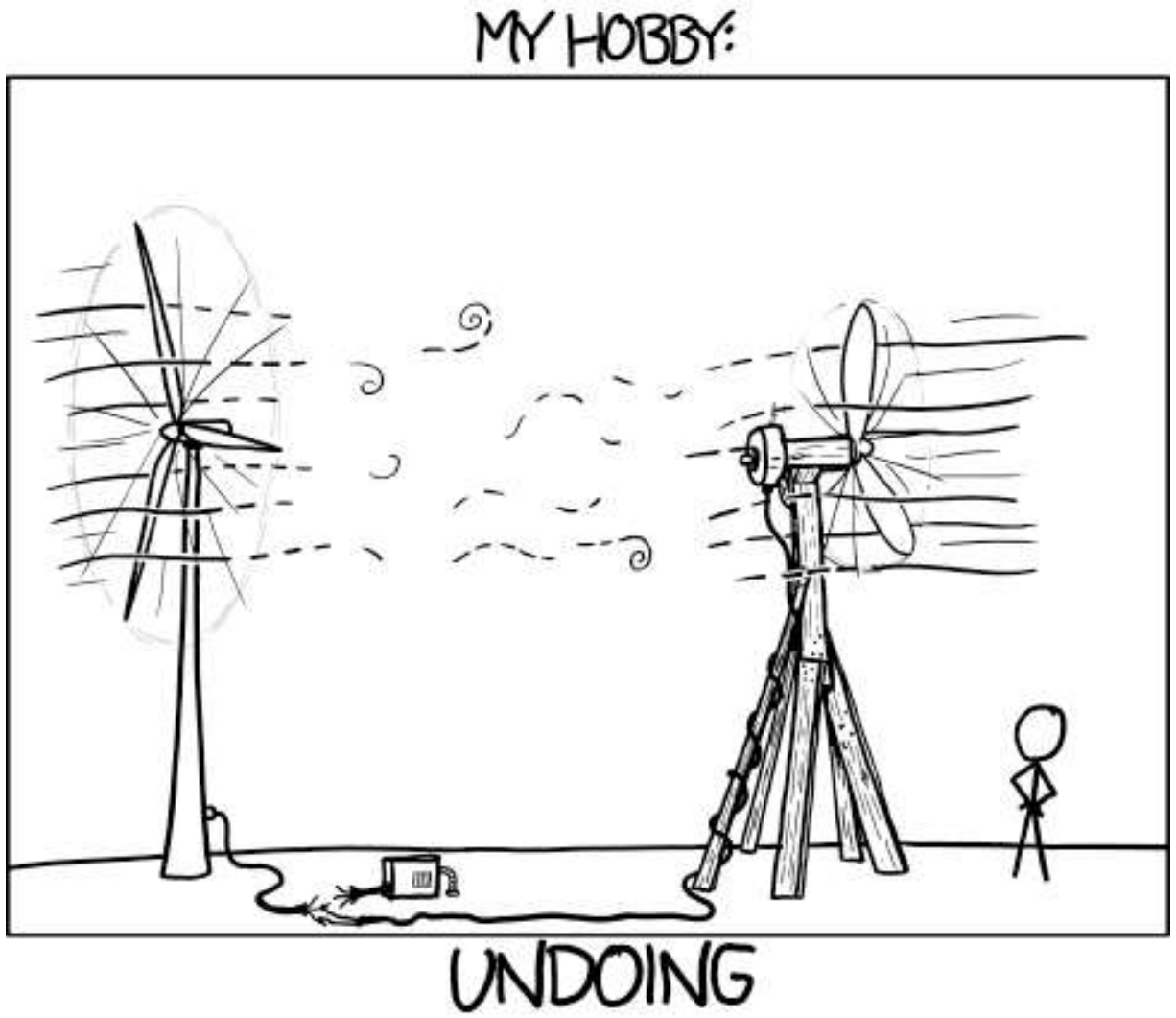
25,000 sf office in Des Moines, IA, July 26



- Vehicles without smarts produce 3x the load as a code level building
- Vehicles can load balance, or shift load from day to night in wind dominated grids
- Building operators could sell electricity to commuters

Integrated Renewable, Efficiency, Demand Response and Storage

No One Would Do This

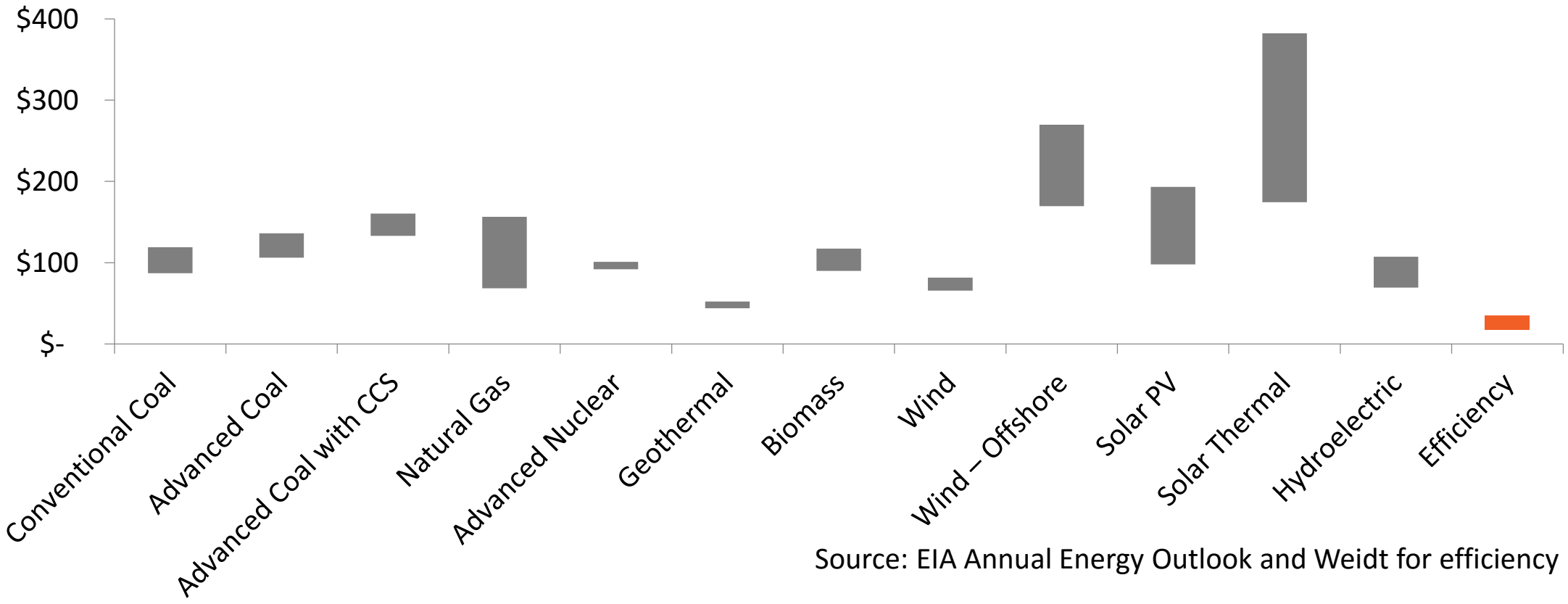


Source: XKCD.com

But We Do This Every Day

- 15% efficient solar panels feeding 13% efficient LEDs
- Lose 98% for lack of a skylight
- Each T8 lamp that is turned off is the same as 16 W (2-3 sf) of PV on the roof
- Renewable electricity should be used where it is most valuable

Estimated Levelized Cost of Electricity in 2020

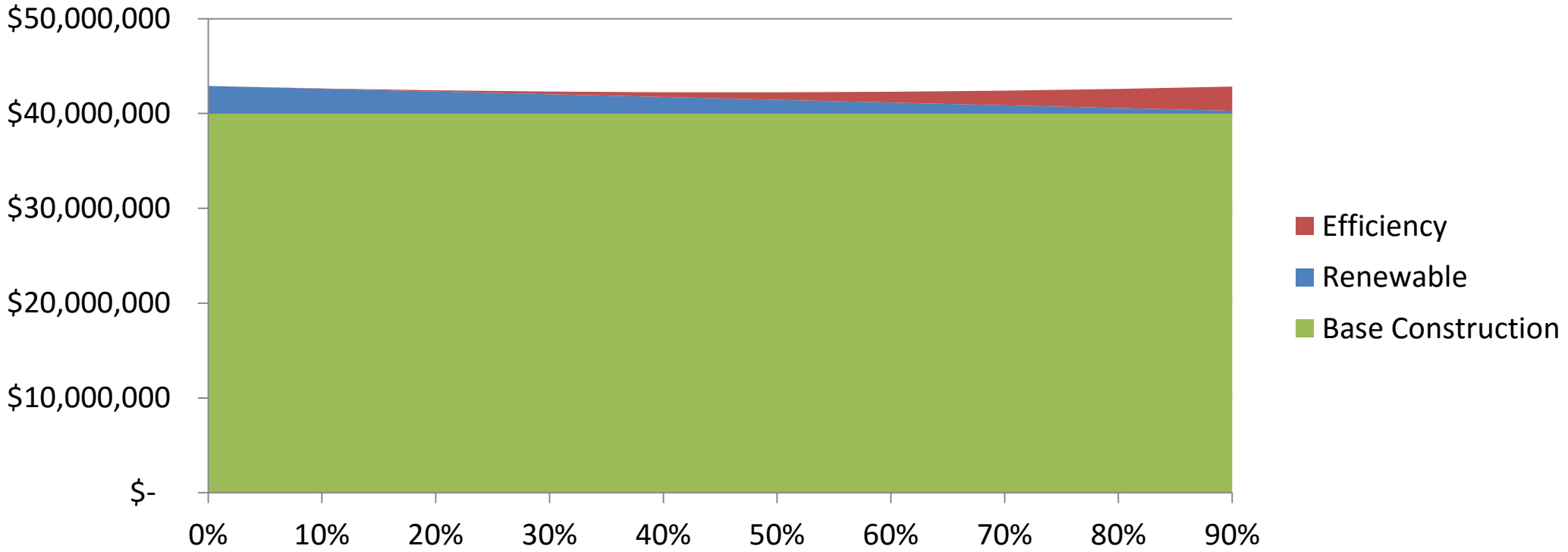


Source: EIA Annual Energy Outlook and Weidt for efficiency

Coupling efficiency and renewables will

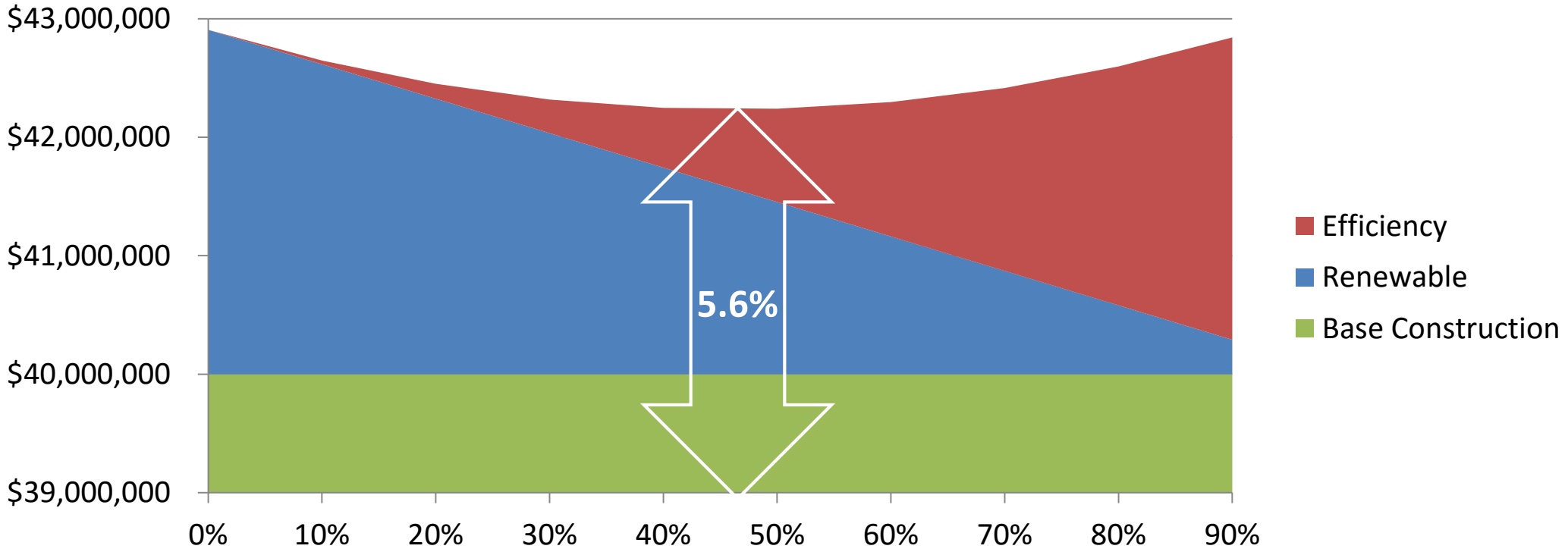
reduce payback for renewables and **increase market appeal of efficiency**

Illustration of Costs to Get to Net Zero



- Assumptions
  - 200,000 sf, 4-story office building
  - $200/sf construction costs
  - 13 kWh/sf code level electricity use
  - PV Costs $1.55/watt and 1,200 watt-hour/watt
  - Efficiency has 0 to 9 year payback

Minimize Total Investment



- Efficiency reduces incremental cost from $2.9 million to $2.2 million
- At 50% efficiency, net-zero is achievable and only adds $11/sf or 5.6%
- Each project will have a unique “balance point”

Thank You

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