From Promises To Action

The Story of a Real Zero Energy Building

Farnsworth GROUP

How Zero Energy Buildings Fit into the Bigger Picture

- Why Change?
- Pueblo Community Healthcare Clinic
- Results
- How the team made it happen
- What's next?

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Learning Objectives

- **Understand industry terms** for measurement of building energy use
- **Learn about the process** applied to achieve Zero Energy verification
- **Increase knowledge** regarding goal setting, energy modeling and integrated design
- Understand how Zero Energy building strategies:
  - **Reduce** the impact on the environment
  - **Impact** the project's bottom line
  - **Benefit** the communities they serve

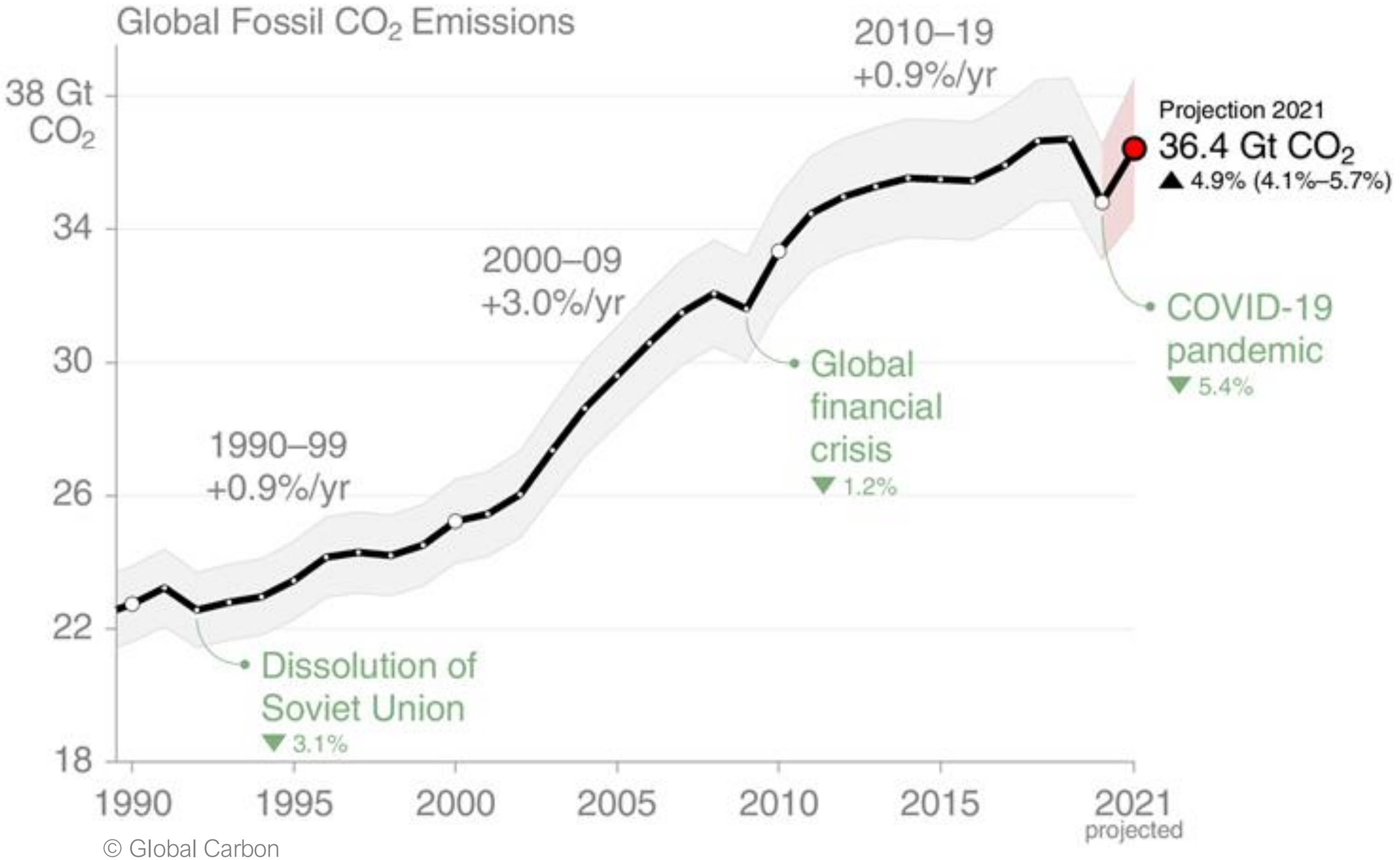
Why We Need Zero Energy Buildings

Question

How much did global CO_2 emissions drop in 2020 due to the pandemic (from 2019 levels)?

A) 21%   B) 65%   C) 6%   D) 96%

The world shut down and CO2 emissions fell less than 6%!



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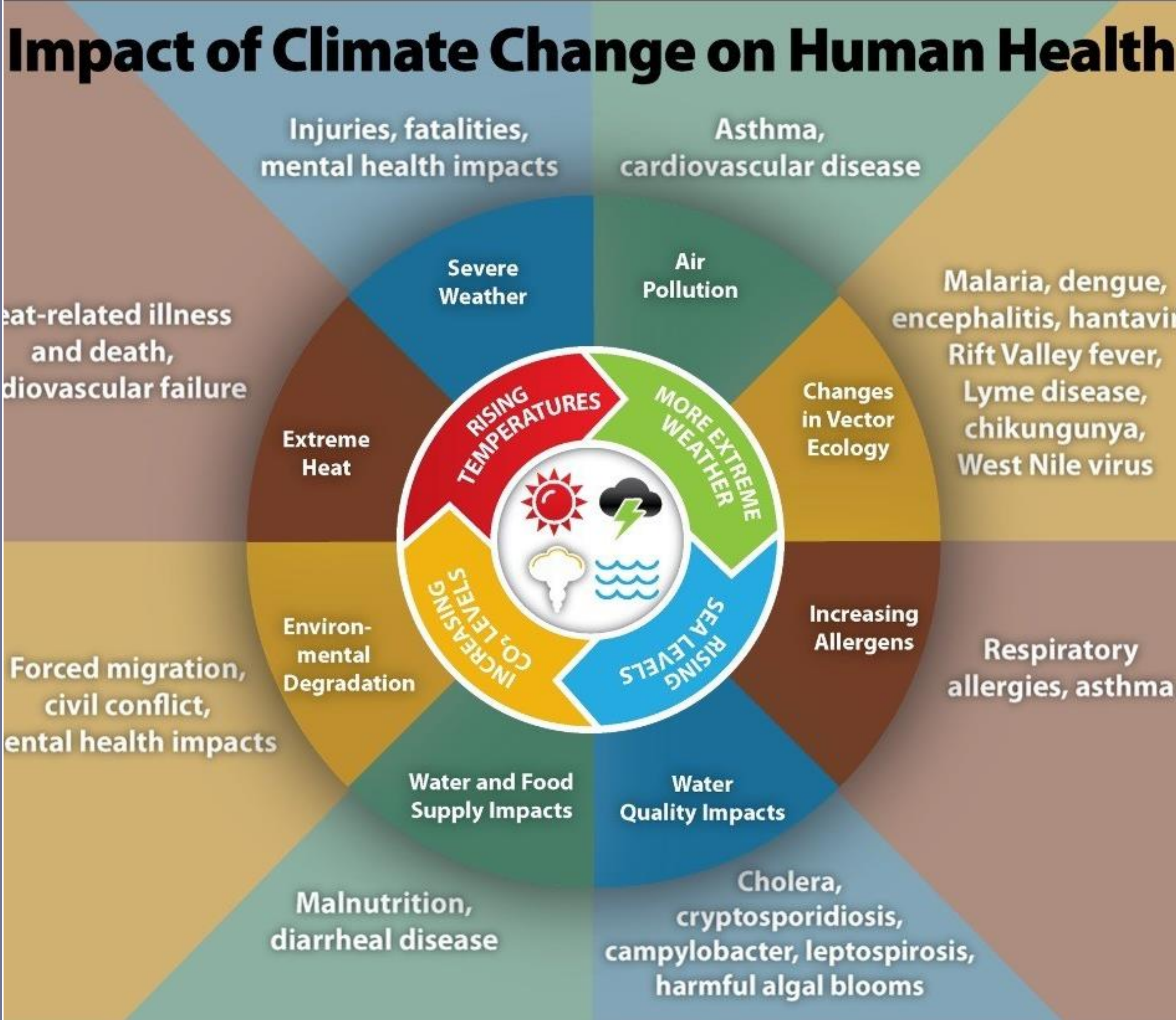
What is healthcare’s responsibility?

Healthcare contributes over 10% of US greenhouse gas emissions.
That’s equal to 141 coal-fired power plants per year.



Department of Health & Human Services (HHS) is urging health systems to commit to reducing greenhouse gas (GHG) emissions:

50%

by 2030

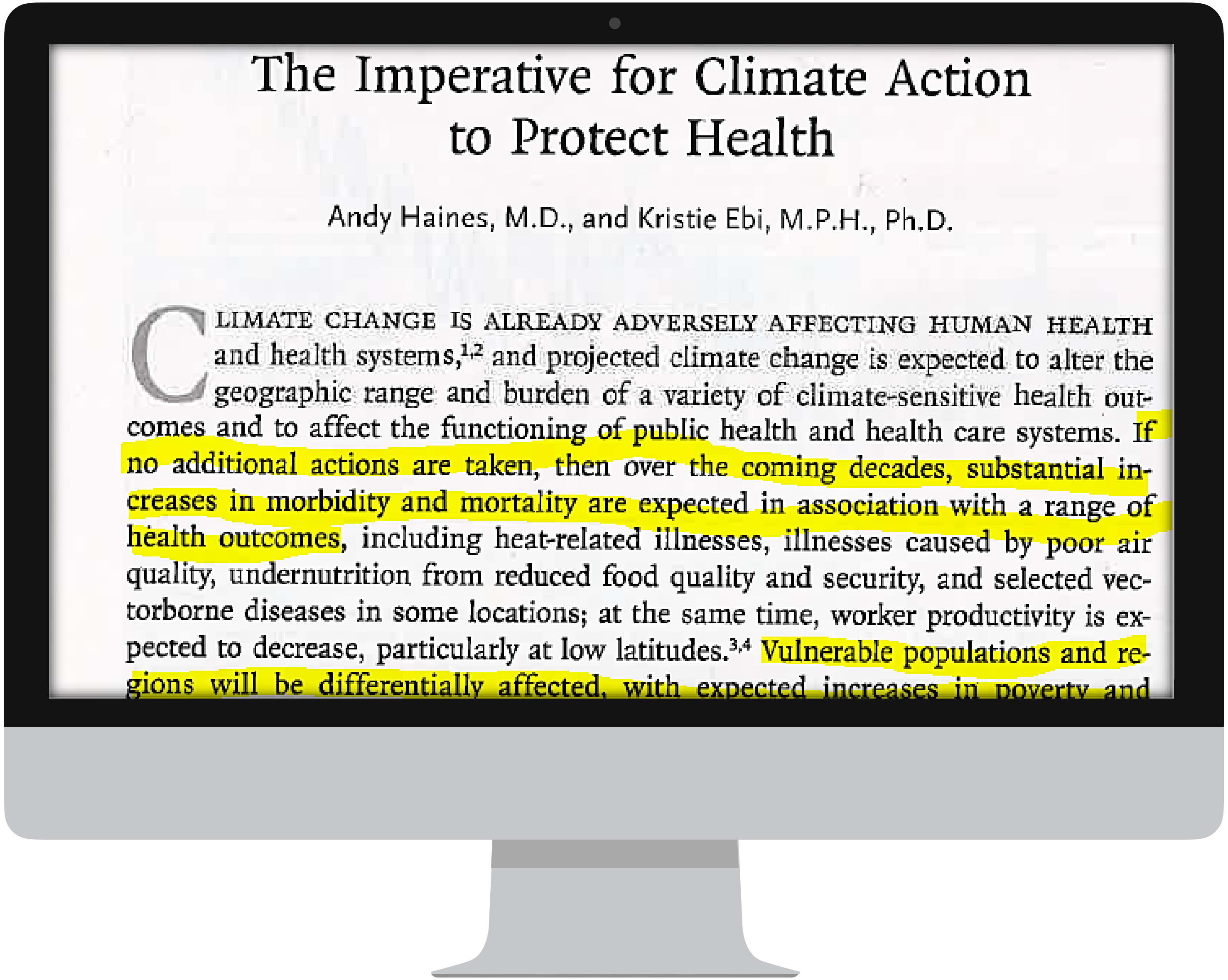
Net zero

by 2050

Climate Change & Health

The NEW ENGLAND JOURNAL of MEDICINE

January 17, 2019



The Imperative for Climate Action to Protect Health

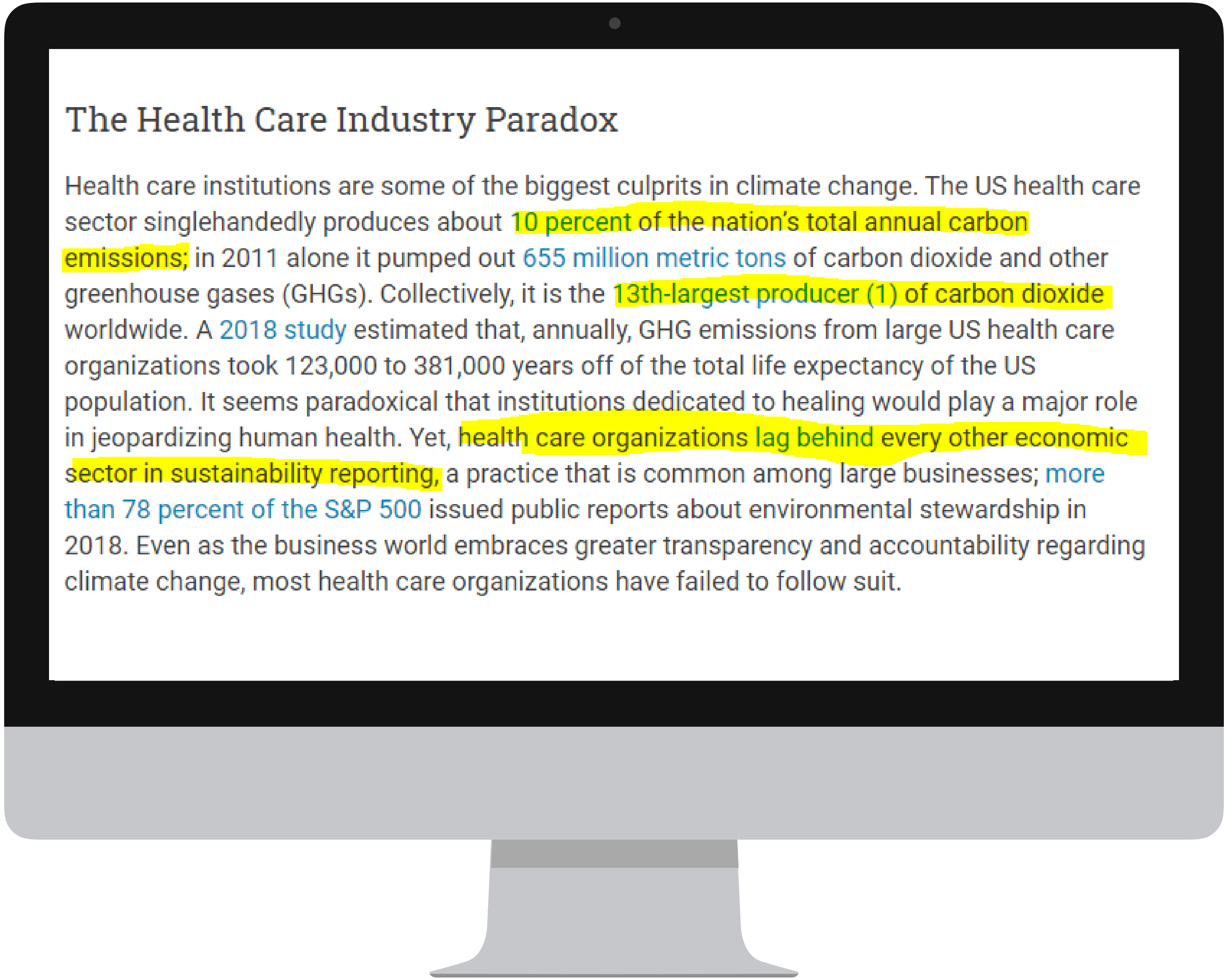
Andy Haines, M.D., and Kristie Ebi, M.P.H., Ph.D.

CLIMATE CHANGE IS ALREADY ADVERSELY AFFECTING HUMAN HEALTH and health systems,[1,2] and projected climate change is expected to alter the geographic range and burden of a variety of climate-sensitive health outcomes and to affect the functioning of public health and health care systems. If no additional actions are taken, then over the coming decades, substantial increases in morbidity and mortality are expected in association with a range of health outcomes, including heat-related illnesses, illnesses caused by poor air quality, undernutrition from reduced food quality and security, and selected vectorborne diseases in some locations; at the same time, worker productivity is expected to decrease, particularly at low latitudes.[3,4] Vulnerable populations and regions will be differentially affected, with expected increases in poverty and

Health Care Industry Emissions

Health Care System to Reckon with the Human Costs of Climate Change Health Affairs

October 16, 2019



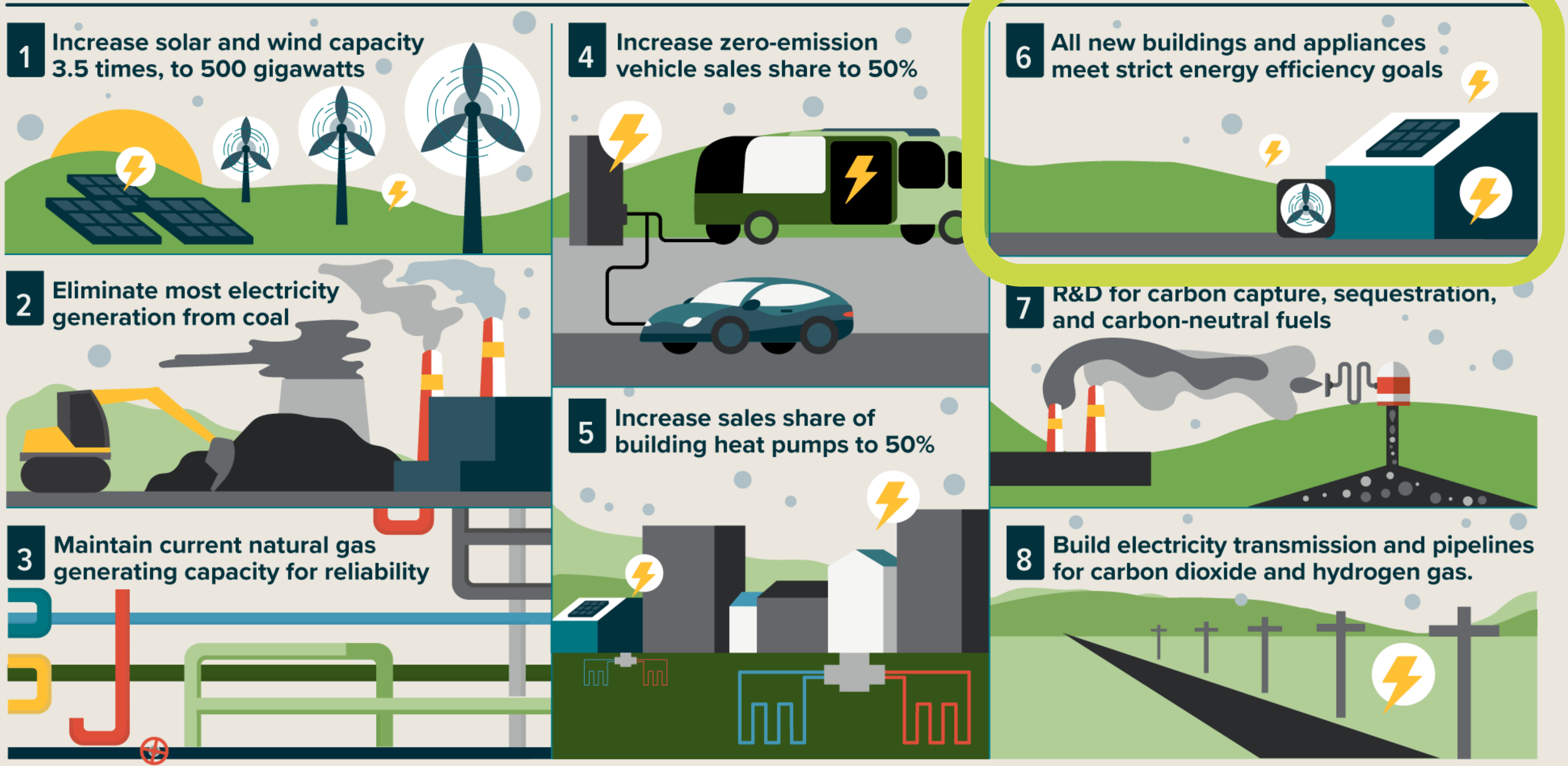
The Health Care Industry Paradox

Health care institutions are some of the biggest culprits in climate change. The US health care sector singlehandedly produces about 10 percent of the nation's total annual carbon emissions; in 2011 alone it pumped out 655 million metric tons of carbon dioxide and other greenhouse gases (GHGs). Collectively, it is the 13th-largest producer (1) of carbon dioxide worldwide. A 2018 study estimated that, annually, GHG emissions from large US health care organizations took 123,000 to 381,000 years off of the total life expectancy of the US population. It seems paradoxical that institutions dedicated to healing would play a major role in jeopardizing human health. Yet, health care organizations lag behind every other economic sector in sustainability reporting, a practice that is common among large businesses; more than 78 percent of the S&P 500 issued public reports about environmental stewardship in 2018. Even as the business world embraces greater transparency and accountability regarding climate change, most health care organizations have failed to follow suit.

BERKELEY LAB

Getting to Net-Zero Carbon Emissions by 2050

8 actions needed by 2030



Zero Energy Buildings – How do we do it?

Sustainable Design + Energy Efficiency + Renewable Energy = Zero Energy Potential

Question

How many zero energy buildings are in the US?

A) 5 B) 160 C)746 D)2,567

160

Verified Zero Energy Buildings in USA

591

Emerging Zero Energy Buildings in USA

Source: NBI (New Building Institute)

Zero Energy Healthcare Buildings in US

Zero Net Energy

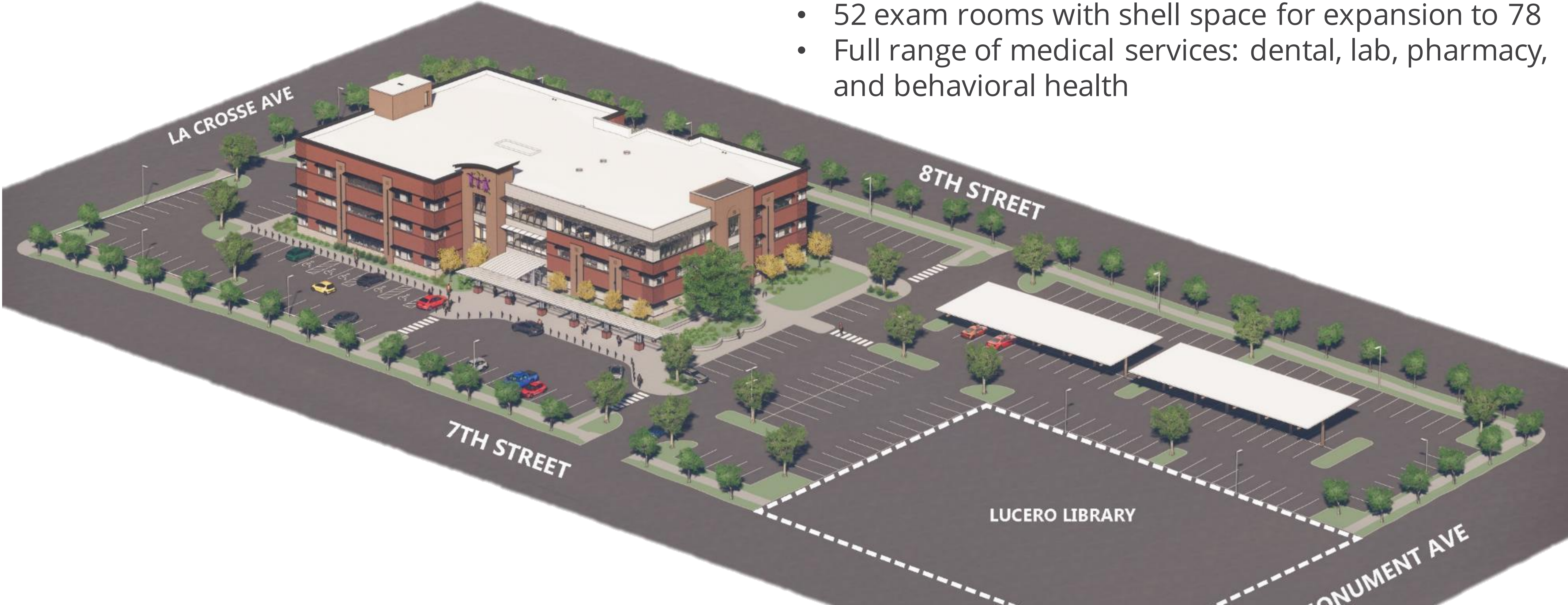
ZE Status	State or Province	Name	Certifications	City	Building Type	Size (sf)	Total Site EUI	Net Site EUI
Verified	CO	PCHC East Side Clinic		Pueblo	Health Care (Outpa..	64,000	22	0
Emerging	CA	ASU Primary Care Clinic		Lancaster	Health Care (Outpa..	2,600		
Emerging	CA	Berkeley Mental Health Clinic		Berkeley	Health Care (Outpa..	5,260	63	
Emerging	CA	CMC ASU-EOP Mental Health Clinic	LEED	San Luis Obispo	Health Care (Outpa..	11,000		
Emerging	CA	CMC East Facility Primary Care Clinic and Health Admi..		San Luis Obispo	Health Care (Outpa..	13,000		
Emerging	CA	Complex Primary Care Clinic		Lancaster	Health Care (Outpa..	5,500		
Emerging	CA	Family Pet Hospital		Clovis	Health Care (Outpa..	8,700		
Emerging	CA	San Benito Health Foundation (SBHF)		Hollister	Health Care (Outpa..	17,584		
Emerging	CA	Weed Army Community Hospital - National Training Ce..		Fort Irwin	Health Care (Inpati..	217,000		
Emerging	MA	Soldier's Home		Chelsea	Health Care (Inpati..		67	
Emerging	OR	Yellowhawk Tribal Health Center		Pendleton	Health Care (Outpa..	63,000		
Emerging	WI	Gundersen Health System	LEED	La Crosse	Health Care (Inpati..			

Source: NBI (New Building Institute)

Zero Energy Process and the Results

New East Side Clinic

- New construction - 63,896 SF
- Community Health Center, FQHC
- Serving Pueblo’s East Side
- 52 exam rooms with shell space for expansion to 78
- Full range of medical services: dental, lab, pharmacy, and behavioral health



A Real Example of a Zero Energy Building

6.25%

over the cost of traditional construction

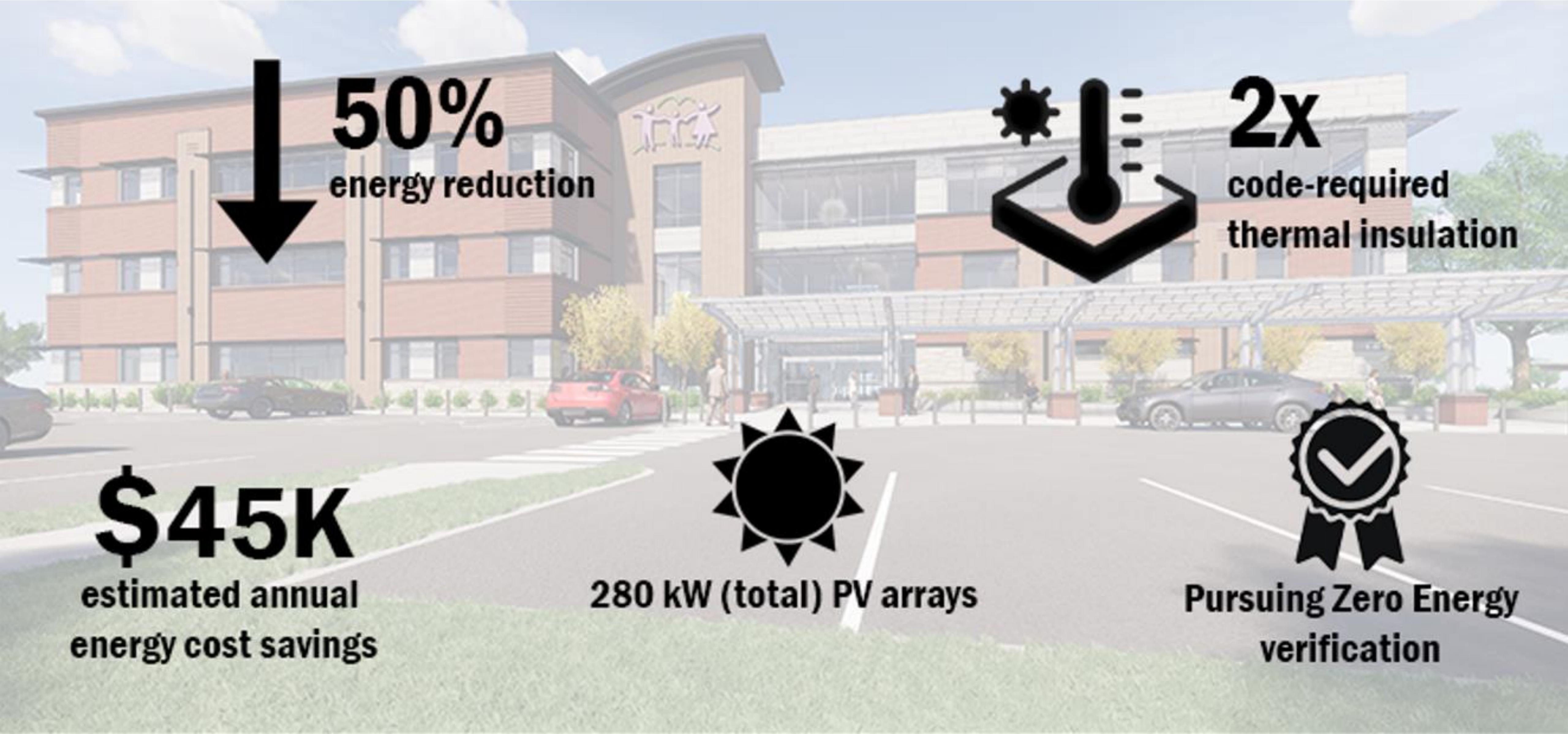
13-year

payback (baseline)

7-year

payback (replaced facility)

Big Picture Goals



Building Energy Use

What We Measured

Energy Utilization Index (EUI) = kBtu/SF/Yr

How much energy you're using per SF per year

Building was Designed to Save Over $70,000/ year!

	State MOB Benchmark	In-Network Baseline Building	East Side Project, As Designed
EUI	107 kBtu/SF/Yr	55.5 kBtu/SF/Yr	24 kBtu/SF/Yr
Energy Cost		$105,000/yr	$60,562/year (without PV)
On-Site Renewables	N/A	N/A	› PV Energy Reduction: $31,255/year › One-time utility rebate: $122,522

Results – How the Building Is Actually Performing

Savings over the building this replaced	$196,161
Savings compared to baseline comparison energy-efficient building	$103,136
EUI for this building	22.55

Baseline building performance in 2022 was $130,000*

Results – How Much Does Electricity Cost?

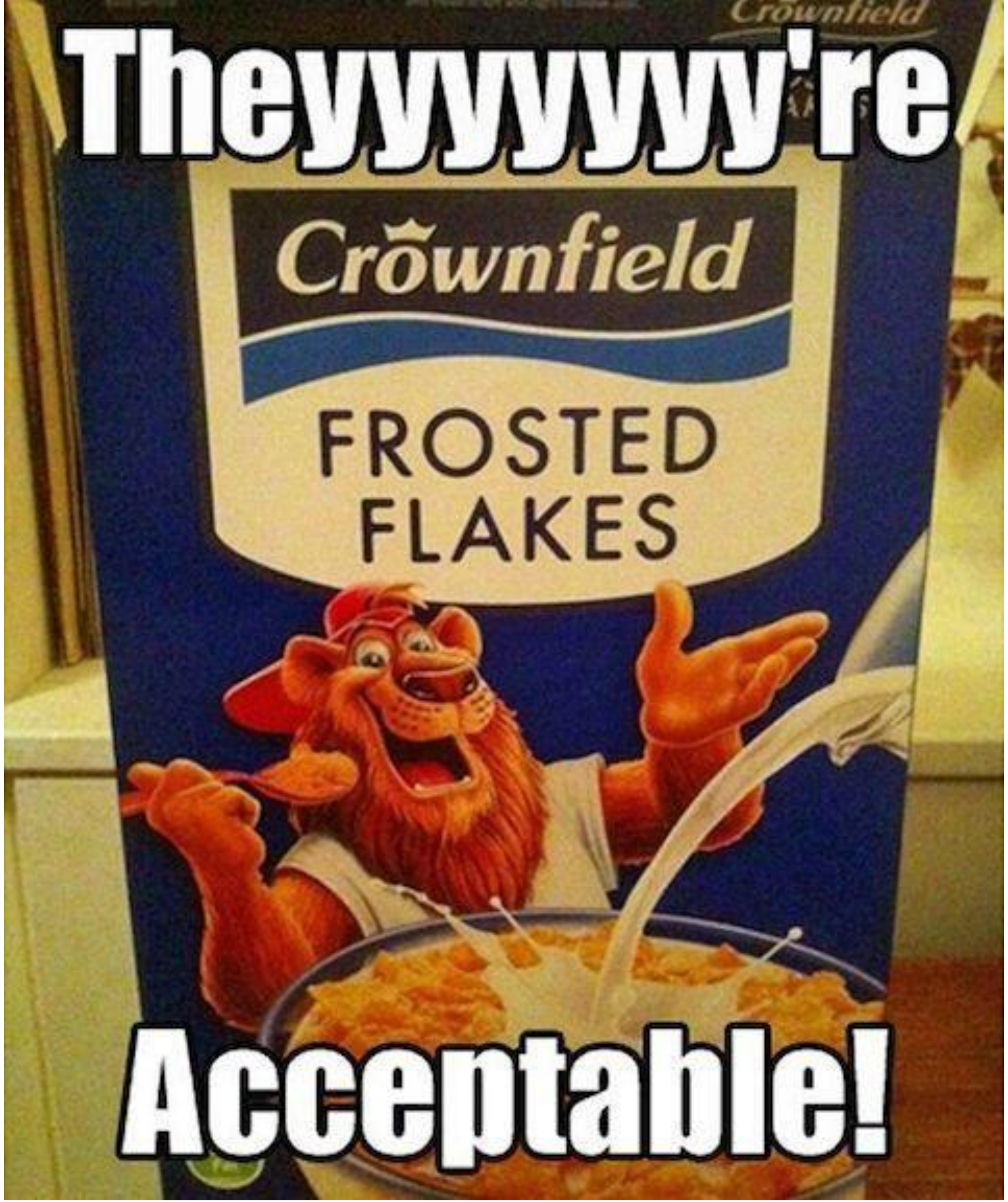
	Baseline Energy Efficient Building	Building this Replaced	PCHC
Energy Cost	$2.03	$3.48	$0.41/SF/year

How Did Our Team Do This?

Generic Keys to Success

All project teams claim to:

- Set clear goals
- Start early
- Collaborate
- Get Owner buy-in
- Educate
- Define expectations
- Measure & verify



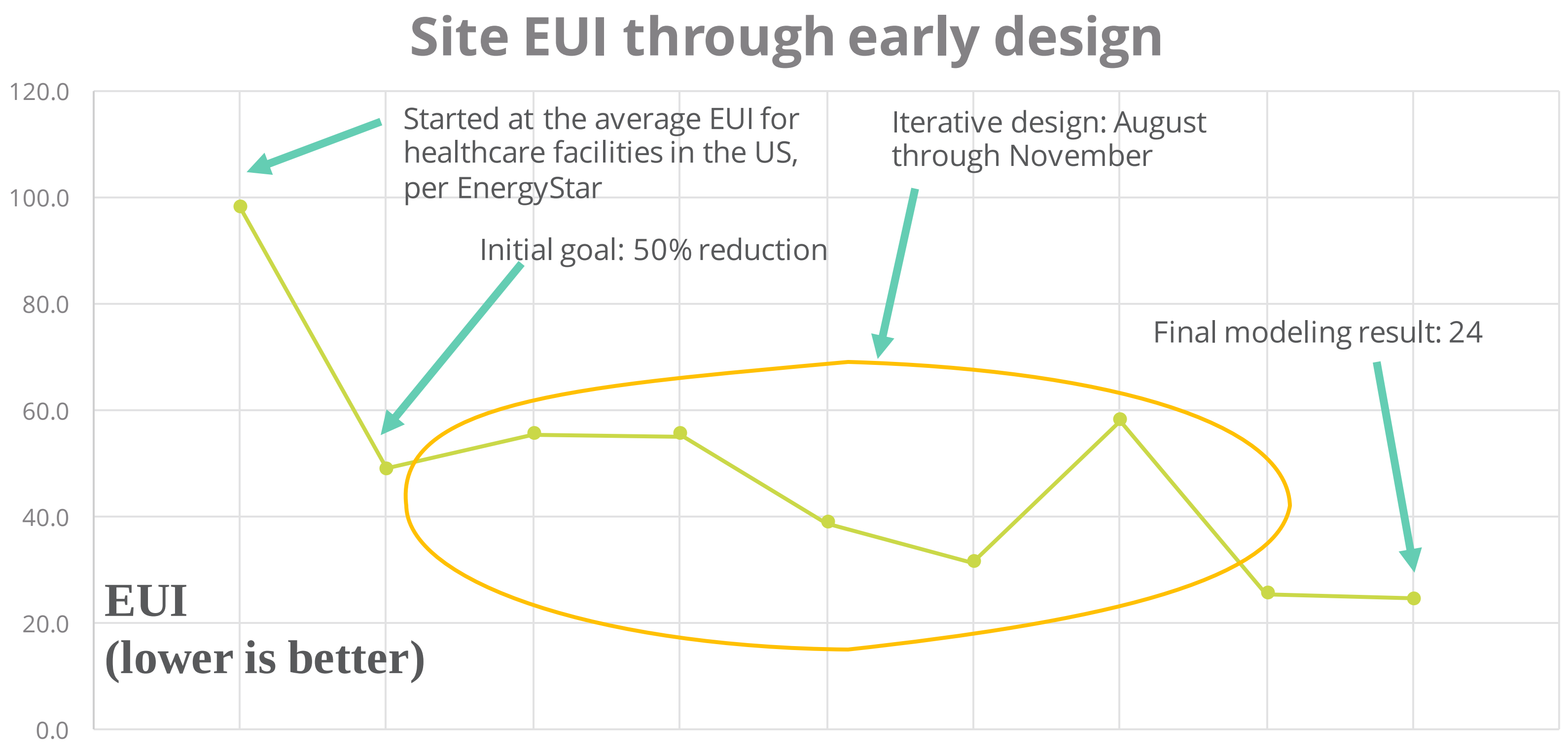
Key Element #1:

Understanding the Owner and how they use the building

- Location
- Culture
- Functional use
- Operations and Maintenance

COLORADO CLINIC	
Building SF	47,054
Year Constructed	2010
Electrical EUI (kBtu/SF/year)	36.7
Blended Electrical Rate ($/kWh)	0.14
Natural Gas EUI (kBtu/SF/year)	18.8
Natural Gas Blended Rate ($/therm)	$0.61
Total Site EUI (kBTU/SF/year)	55.5
Total Site ECI ($/SF/year)	$1.64
Average Annual Net Energy Cost ($)	$77,322.64

Benchmarking to Baselining



Pueblo Community Health Center
Your Health. Our Mission.

Key Element #2: Executive Sponsorship

Concern for polluting the communities that PCHC is trying to make more healthy.

- Board Vision
- Community Vision
- Business Case

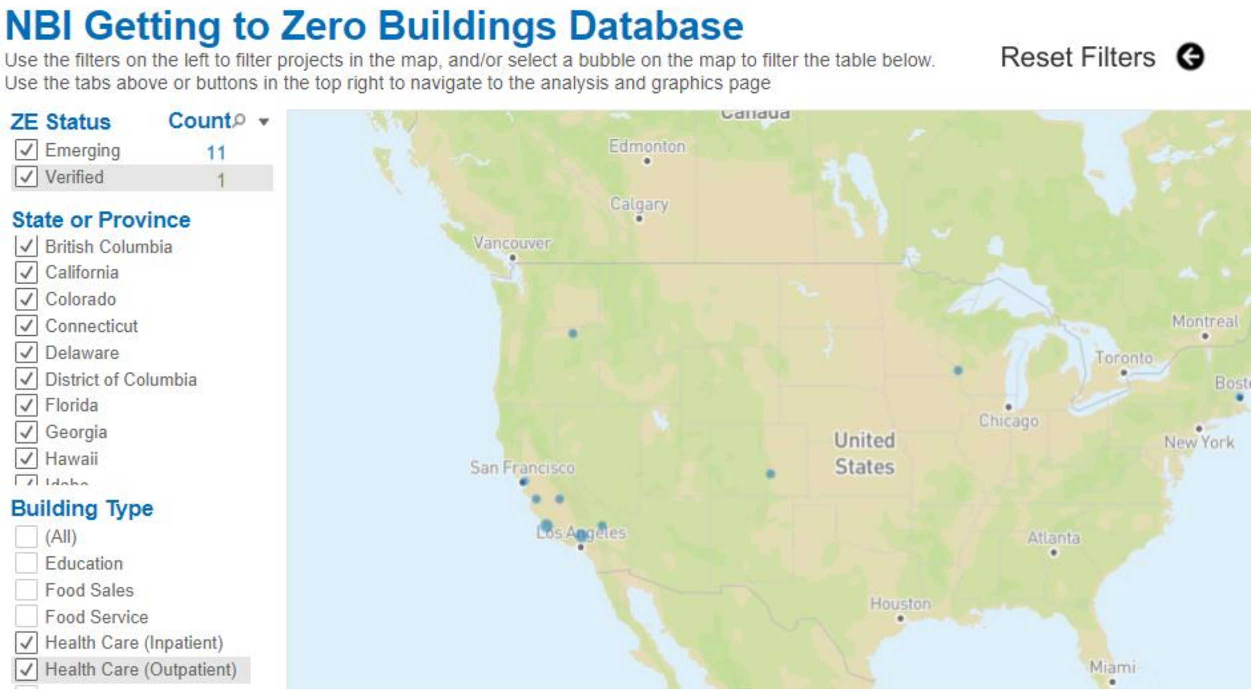
- A Federally Qualified Health Center (FQHC) serving the poor and underserved in Pueblo since 1983.
- 27,000 clients with 125,000 visits (pre-pandemic), providing medical, behavioral health, dental services, and pharmacy. Historic annual growth of 5-6%.
- Pueblo’s East Side identified as area of greatest need. Plans to build replacement began in 2017.

Pueblo Community Health Center

Your Health. Our Mission.

Zero Energy

- Practical Zero Energy
- Verification not certification
- 12 months of operational data (utility bills)



Project Timeline

PRE-DESIGN

- Master Plan Refresh
- Community Focus Groups
- User Groups
- Sustainability / Zero Energy Charrette
- 3P Events (Programming, Exam Room Mock-Ups)

SCHEMATIC DESIGN

- Development Plan / Site Amendments
- Site Plan
- Floor Plans
- Elevations
- Sustainability / Zero Energy Road Map

DESIGN DEVELOPMENT

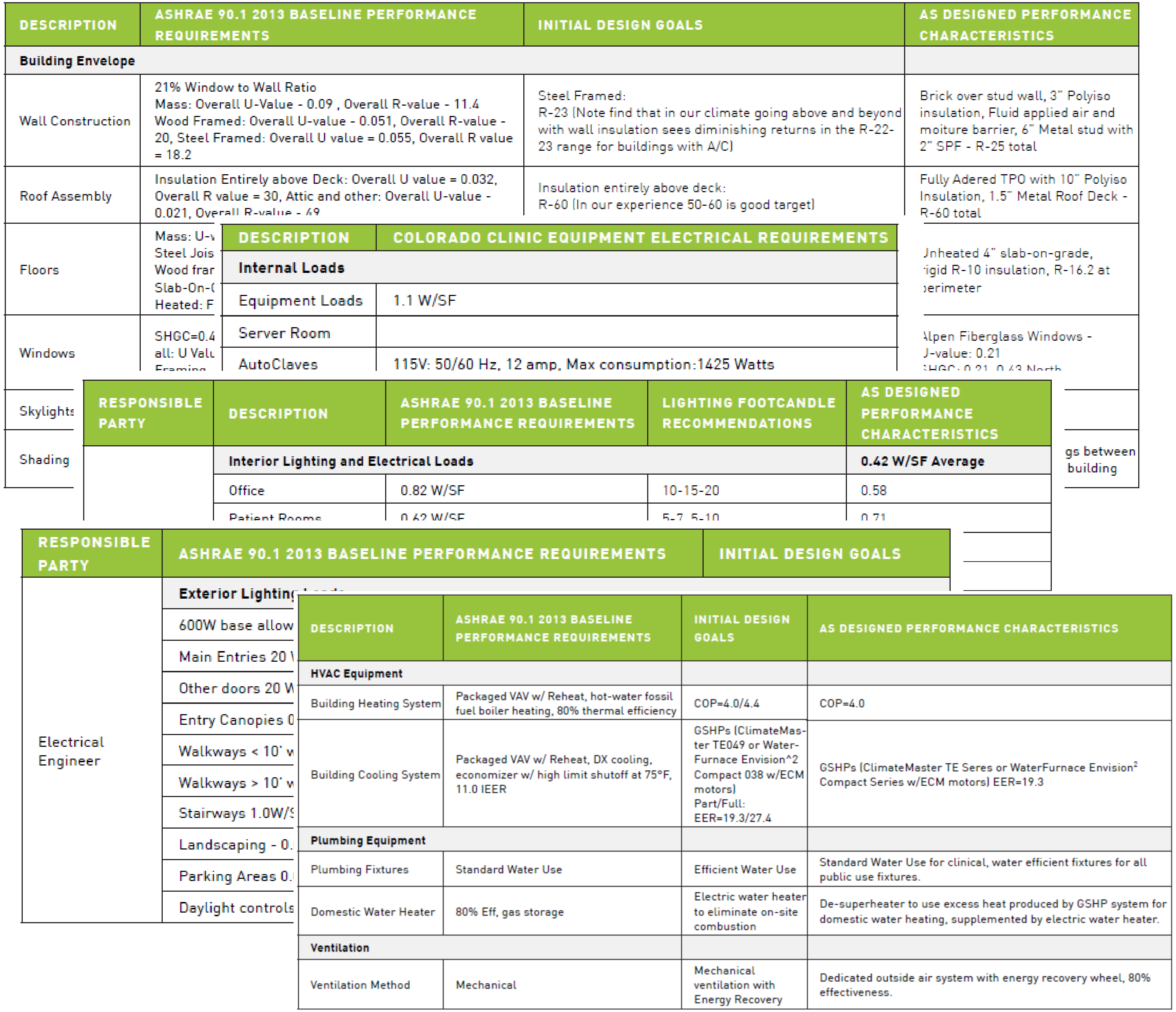
- Development of the Design
- Product Selections
- Draft Specifications
- Sustainability / Zero Energy Road Map

CONSTRUCTION DOCUMENTS

- Finished Drawing Set
- Fully Coordinated
- Specifications
- Sustainability / Zero Energy Road Map

Key Element #3:
Involve Everyone In Energy Goals

- Gave 30% energy reduction goals to each designer (envelope, lighting, HVAC)
- Iterative review of modeling results



DESCRIPTION	ASHRAE 90.1 2013 BASELINE PERFORMANCE REQUIREMENTS	INITIAL DESIGN GOALS	AS DESIGNED PERFORMANCE CHARACTERISTICS
Building Envelope			
Wall Construction	21% Window to Wall Ratio Mass: Overall U-Value - 0.09 , Overall R-value - 11.4 Wood Framed: Overall U-value - 0.051, Overall R-value - 20, Steel Framed: Overall U value = 0.055, Overall R value = 18.2	Steel Framed: R-23 (Note find that in our climate going above and beyond with wall insulation sees diminishing returns in the R-22-23 range for buildings with A/C)	Brick over stud wall, 3" Polyiso insulation, Fluid applied air and moiture barrier, 6" Metal stud with 2" SPF - R-25 total
Roof Assembly	Insulation Entirely above Deck: Overall U value = 0.032, Overall R value = 30, Attic and other: Overall U-value - 0.021, Overall R-value - 49	Insulation entirely above deck: R-60 (In our experience 50-60 is good target)	Fully Adered TPO with 10" Polyiso Insulation, 1.5" Metal Roof Deck - R-60 total
Floors	Mass: U-v Steel Jois Wood fran Slab-On-(Heated: F		Jnheated 4" slab-on-grade, rigid R-10 insulation, R-16.2 at perimeter
Windows	SHGC=0.4 all: U Valu Framing		Alpen Fiberglass Windows - U-value: 0.21 SHGC: 0.21-0.43 North
Skylights			
Shading			gs between building

DESCRIPTION	COLORADO CLINIC EQUIPMENT ELECTRICAL REQUIREMENTS
Internal Loads	
Equipment Loads	1.1 W/SF
Server Room	
AutoClaves	115V: 50/60 Hz, 12 amp, Max consumption:1425 Watts

RESPONSIBLE PARTY	DESCRIPTION	ASHRAE 90.1 2013 BASELINE PERFORMANCE REQUIREMENTS	LIGHTING FOOTCANDLE RECOMMENDATIONS	AS DESIGNED PERFORMANCE CHARACTERISTICS
	Interior Lighting and Electrical Loads			**0.42 W/SF Average**
	Office	0.82 W/SF	10-15-20	0.58
	Patient Rooms	0.62 W/SF	5-7, 5-10	0.71

RESPONSIBLE PARTY	ASHRAE 90.1 2013 BASELINE PERFORMANCE REQUIREMENTS	INITIAL DESIGN GOALS
Electrical Engineer	**Exterior Lighting Loads**	
	600W base allow	
	Main Entries 20	
	Other doors 20 W	
	Entry Canopies 0	
	Walkways < 10' w	
	Walkways > 10' w	
	Stairways 1.0W/	
	Landscaping - 0.	
	Parking Areas 0.	
	Daylight controls	

DESCRIPTION	ASHRAE 90.1 2013 BASELINE PERFORMANCE REQUIREMENTS	INITIAL DESIGN GOALS	AS DESIGNED PERFORMANCE CHARACTERISTICS
HVAC Equipment			
Building Heating System	Packaged VAV w/ Reheat, hot-water fossil fuel boiler heating, 80% thermal efficiency	COP=4.0/4.4	COP=4.0
Building Cooling System	Packaged VAV w/ Reheat, DX cooling, economizer w/ high limit shutoff at 75°F, 11.0 IEER	GSHPs (ClimateMaster TE049 or Water-Furnace Envision^2 Compact 038 w/ECM motors) Part/Full: EER=19.3/27.4	GSHPs (ClimateMaster TE Seres or WaterFurnace Envision² Compact Series w/ECM motors) EER=19.3
Plumbing Equipment			
Plumbing Fixtures	Standard Water Use	Efficient Water Use	Standard Water Use for clinical, water efficient fixtures for all public use fixtures.
Domestic Water Heater	80% Eff, gas storage	Electric water heater to eliminate on-site combustion	De-superheater to use excess heat produced by GSHP system for domestic water heating, supplemented by electric water heater.
Ventilation			
Ventilation Method	Mechanical	Mechanical ventilation with Energy Recovery	Dedicated outside air system with energy recovery wheel, 80% effectiveness.

Clearly Document
Lock In Expectations

- Achieved 50%+

SITE ENERGY USE (KBTUS)	ENVELOPE IMPROVEMENTS (WALL AND ROOF PLUS WINDOWS)	LIGHTING UPGRADES (WITH ENVELOPE IMPROVEMENTS)	GROUND SOURCE HEAT PUMP SYSTEM (WITH LIGHTING AND ENVELOPE IMPROVEMENTS)
Lighting (Interior)	615,852	298,820	298,820
Lighting (Exterior)	21,683	15,178	15,178
Plug/Process Loads (Electrical)	577,542	577,542	577,542
HVAC - Pumps	17,422	18,026	76,712
HVAC - Fans	349,866	321,257	198,302
HVAC - Electrical (Cooling)	251,553	215,376	143,577
HVAC - Electrical (Heating)	0	0	108,041
Electrical Subtotal Site Energy	**1,833,919**	**1,446,198**	**1,418,172**
HVAC (Thermal-Heating)	403,406	463,561	0
DHW (Thermal)	165,597	165,597	0
Thermal Htg Subtotal Site Energy	**569,003**	**629,158**	**0**
Total Site Energy	**2,402,922**	**2,075,356**	**1,418,172**
Calculated Site EUI (kBTU/SF/Year)	**37.4**	**32.3**	**22.1**
Modelled Incremental Energy Savings*=	**934,857**	**1,262,423**	**1,919,608**
Modelled % Savings =	**28%**	**38%**	**58%**
Energy Cost			
Electrical Cost	$76,323.71	$60,187.61	$59,021.22
Natural Gas Cost	$3,470.92	$3,837.86	$-
Total Cost	**$79,794.63**	**$64,025.48**	**$59,021.22**
Cost Savings*=	$14,608.53	$30,377.68	$35,381.93
Proposed % Savings=	15%	32%	37%

Photo-Voltaic Array

Target =

448,000 kWh/yr

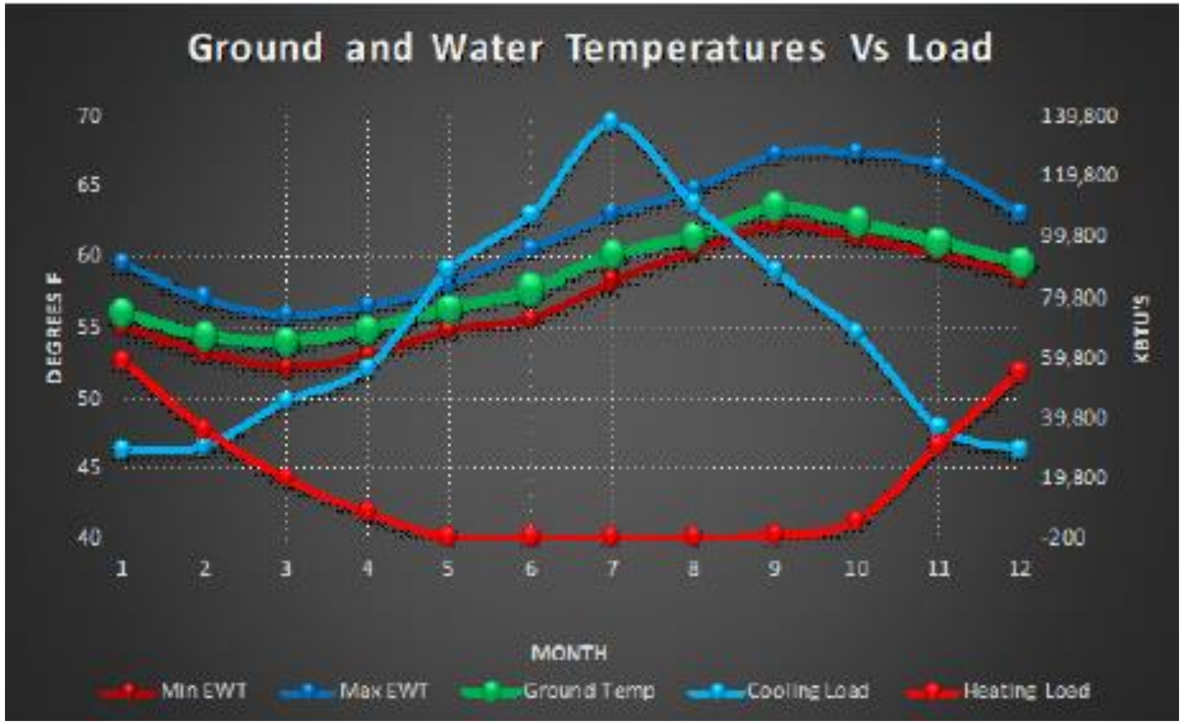
Actual Produced =
449,280 kWh/yr

ENERGY MODEL RESULTS & EXPECTED ENERGY USE (2 OF 2)

ENERGY PRODUCTION	11/4/2019 2013 APPENDIX G BASELINE HAP MODEL	6/12/2020 ENERGY MODEL AS-DESIGNED
Photovoltaic - Site Energy production (kbtuh/yr)	2,538,528	1,528,576
Photovoltaic - Array Size (KW)	465	280
Total PV Energy Production Required- Site	**2,518,280**	**1,416,776**
Total PV Energy Production Required - Source	**7,932,582**	**4,462,846**
Net Zero Status (Total Source Energy - Total Source Total Source Energy Production < or = 0)	**-63,781**	**-352,169**
Net Zero Source EUI	**-1**	**-6**

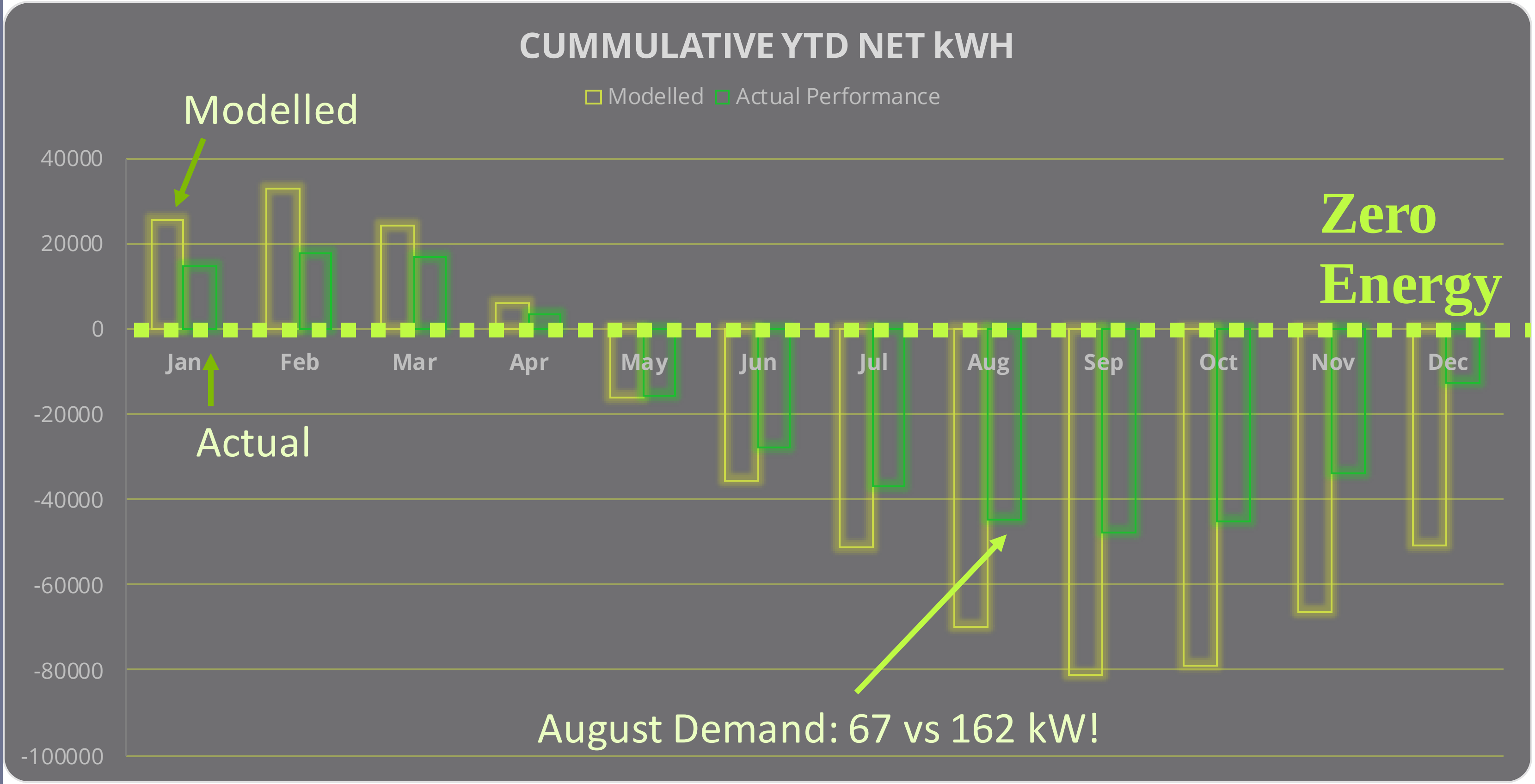
Ground Source Heat Pumps

GROUND SOURCE HEAT EXCHANGE SCHEDULE	INITIAL VALUES
Total Bores/GPM	32 Bores/190 GPM
U-Bend Depth from Bottom of Header Trench	500'
Min. Grout Thermal Conductivity	0.9 Btu/hour-FT-°F
Soil Thermal Conductivity	1.2 Btu/hour-FT-°F
Soil Thermal Diffusivity (Estimated)	1.30 ft²/day
Undisturbed Soil Temperature	54 °F
Fluid	Potable Water, 15% PG
Min/Max Entering Water Temperature	40/80 °F
Min/Max Leaving Water Temperature	30/90 °F
U-Bend Material	1-1/4" HDPE SDR 11
Peak Cooling/AEFLH	62.5 tons/1300 hours
Peak Heating/AEFLH	60,000 kBtuh/1040 hours

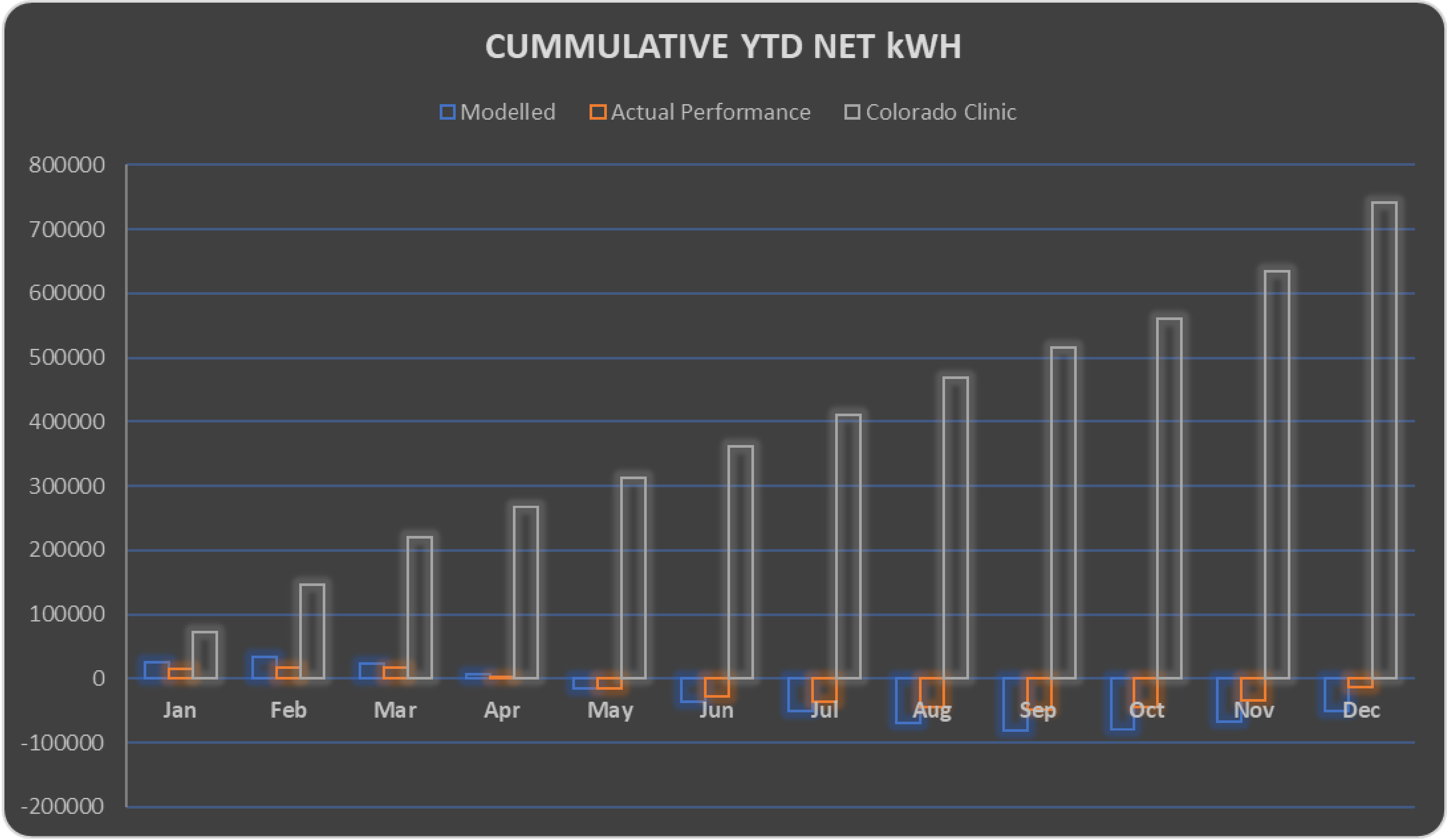


Simplified, Smaller Mechanical Room

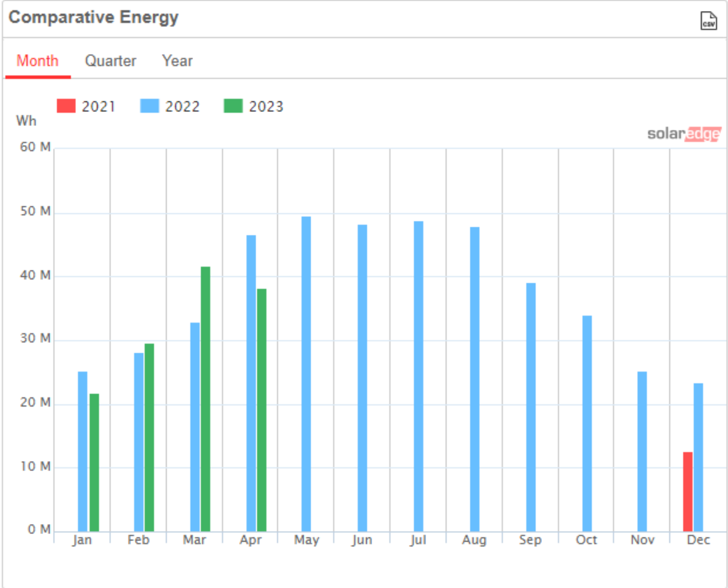
Key Element #4: Actually Do Post-Occupancy Measurement & Verification



PCHC compared to existing 47,000 sf Colorado Ave. Clinic (baseline)



Key Element #5:
Continuous Training



Key Takeaways

- Owner buy-in
- Team collaboration with a "what if?" attitude
- Zero Energy doesn't have to be complicated or expensive
- Think total life-cycle costs of building
- Think community impact

Farnsworth GROUP

Thank you!

Any questions?

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