

# POST OCCUPANCY EVALUATION WORKSHOP TEMFs/COFs/HQs - FT. CARSON, CO

3 MAY 2012

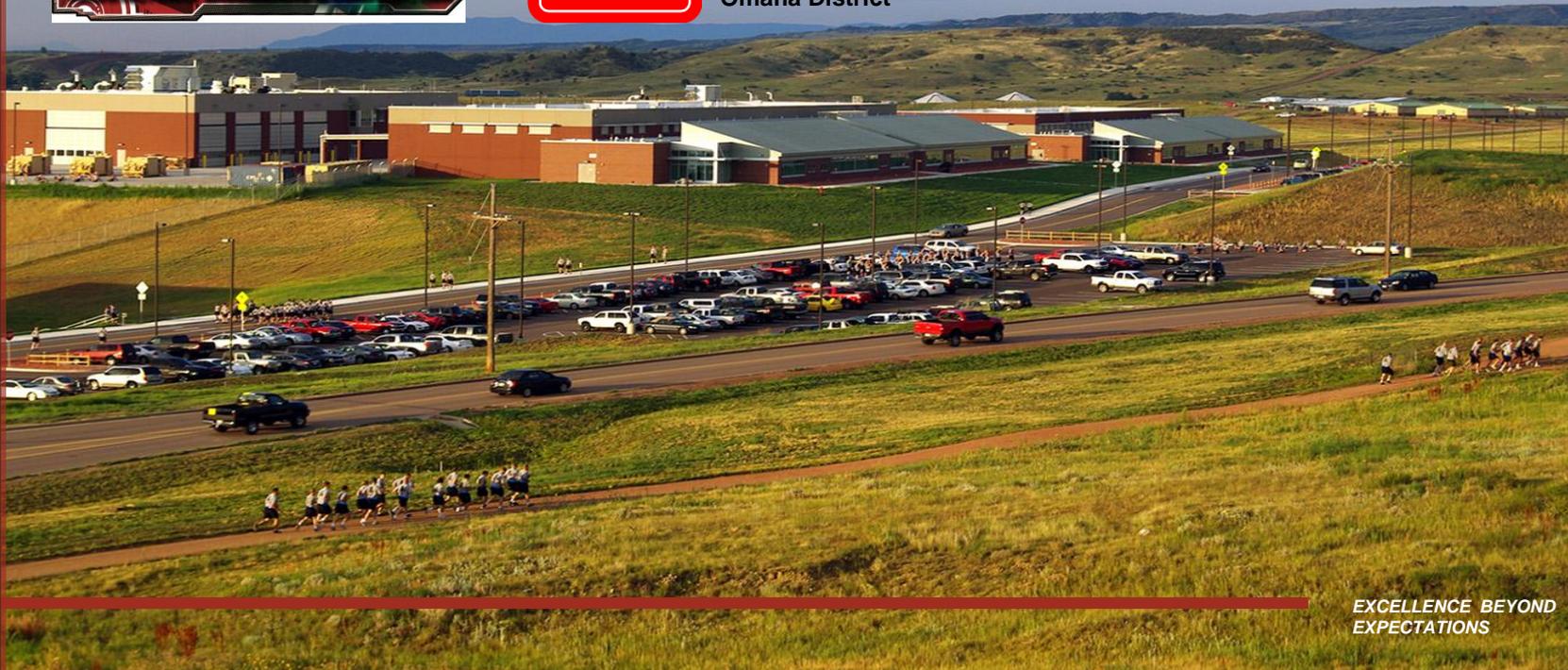
LEO A DALY

PLANNING ARCHITECTURE ENGINEERING INTERIORS

EXCELLENCE BEYOND  
EXPECTATIONS



US Army Corps of Engineers  
Omaha District



## NREL Research Project -

### Energy Efficiency Technology Evaluation of Ft. Carson LEED® Projects

- Shanti Pless, Senior Research Engineer - NREL
- Rois Langner, Research Engineer, Energy Modeling – NREL
- Jennifer Scheib, Research Engineer, Daylighting & Lighting Controls - NREL

NREL GOLDEN, CO



U.S. Dep't. of Energy – National Renewable Energy Lab - Research Support Facility

# U.S. ARMY CORPS of ENGINEERS (USACE) – OMAHA DISTRICT

- Vince Turner, RA, Project Manager
- Tia Chandler, PE, Project Manager
- Bill Rafferty, RA, Project Manager
- Matt Bird, PE, Project Manager



**GSA, Edward Zorinsky Federal Building - Omaha, NE**

**University of Nebraska – College of Engineering  
The Durham School of Architectural Engineering  
& Construction – Peter Kiewit Institute  
Omaha, NE**

- Dr. Clarence Waters, PhD, Professor of Architectural Engineering, UNL (Omaha)
- Tony Dupsky, A/E Masters Candidate (Mechanical Systems) – UNL (Omaha)
- Wyatt Wirges, A/E Masters Candidate (Mechanical Systems) – UNL (Omaha)
- Tyler Winnike, A/E Masters Candidate (Mechanical Systems) – UNL (Omaha)



# USACE - TEMFs & COFs - LEED® Gold & Silver Designs / Construction – Ft. Carson, CO

- Clay Benson, Director of Preconstruction, Mortenson Construction (Denver)



# USACE - TEMFs & COFs - LEED® Gold & Silver Designs / Construction – Ft. Carson, CO

- Phil Vogel, AIA, CID, Sr. Associate & Project Manager – LEO A DALY (Minneapolis)
- Debbie Reider, PE, LEED® AP, Mechanical Engineer, LEO A DALY (Minneapolis)



LEO A DALY

PLANNING ARCHITECTURE ENGINEERING INTERIORS

# Sustainable / Energy-efficient Engineering / LEED® Designs

- Lloyd Meyer, AIA, Vice President,
- Kurt Ubbelohde, PE, Vice President,
- Dan Dellovechio, PE, LEED®AP, Vice President
- Lisa Lyons, EI, LC, Lighting Design Group,

Managing Principal – LEO A DALY (Omaha)  
Director, Federal Programs – LEO A DALY  
Engineering Project Manager – LEO A DALY  
Electrical Engineer – LEO A DALY (Omaha)

**National Park Service Midwest Region HQ - Omaha, NE**

**LEO A DALY**

PLANNING ARCHITECTURE ENGINEERING INTERIORS





**COF & TEMP DESIGNS**



**COMPANY OPERATIONS**



**TACTICAL EQUIPMENT MAINTENANCE**



**TEMF & COF – BUTTS FIELD**





2620







POTENTIAL SOLAR ARRAY SITE

CDC (100 Pkt)

MED./DENT. (100 Pkt)

FITNESS CENTER (100 Pkt)

SHOPPETTE (100 Pkt)

POTENTIAL SOLAR ARRAY SITE

ODL HANGAR (100 Pkt)

FUTURE MISSION (100 Pkt)

FERS BUILDING (100 Pkt)

CONTROL TOWER & AIRFIELD OPS (173307)

ATTACK BN #1 HANGAR (173206)

DEAC ADDITION (173101)

FIRE STATION (173235)

ATTACK BN #2 HANGAR (173401)

ASSAULT BN HANGAR (173601)

RINSE FACILITY (100 Pkt)

CENTRAL HEAT PLANT (100 Pkt)

COMM. CROSS CONNECT (100 Pkt)

1/2 ATTACK COF ADDITION (100 Pkt)

ASD HANGAR (173201)

1/2 ATTACK COF (100 Pkt)

FLIGHT SIMULATORS (100 Pkt)

HQY CARGO PAD (173601)

CAD MOTOR POOLS COF AND TERMS (17301 & 17302)

BATTALION HQS (173201)

ASR COF (100 Pkt)

AIR FORCE WEATHER SQUADRON (100 Pkt)

BRIGADE HQ (100031)

SSA (100 Pkt)

RF SUPPORT FACILITIES (100 Pkt)

GSAB HANGAR (173001)

2102 RUNWAY EXTENSION (100 Pkt)

- 2012
- 2014
- 2015
- FUTURE
- EXISTING

POTENTIAL SOLAR ARRAY SITE

STORMWATER BASIN

STORMWATER BASIN

STORMWATER BASIN

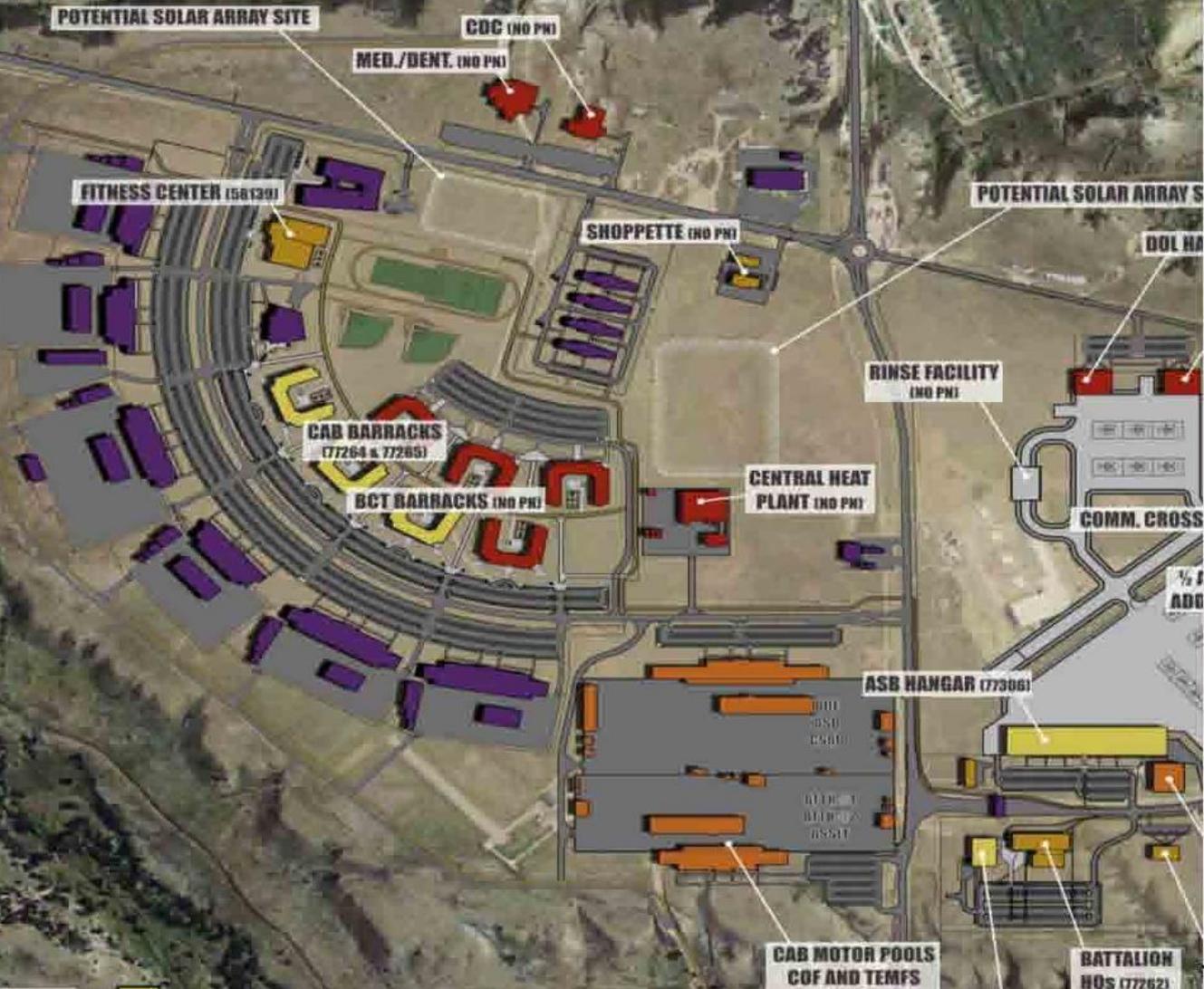
FUEL OFFLOAD (173101)

HQY REFUEL PADS (173101)

# FORT CARSON AIRFIELD ADP

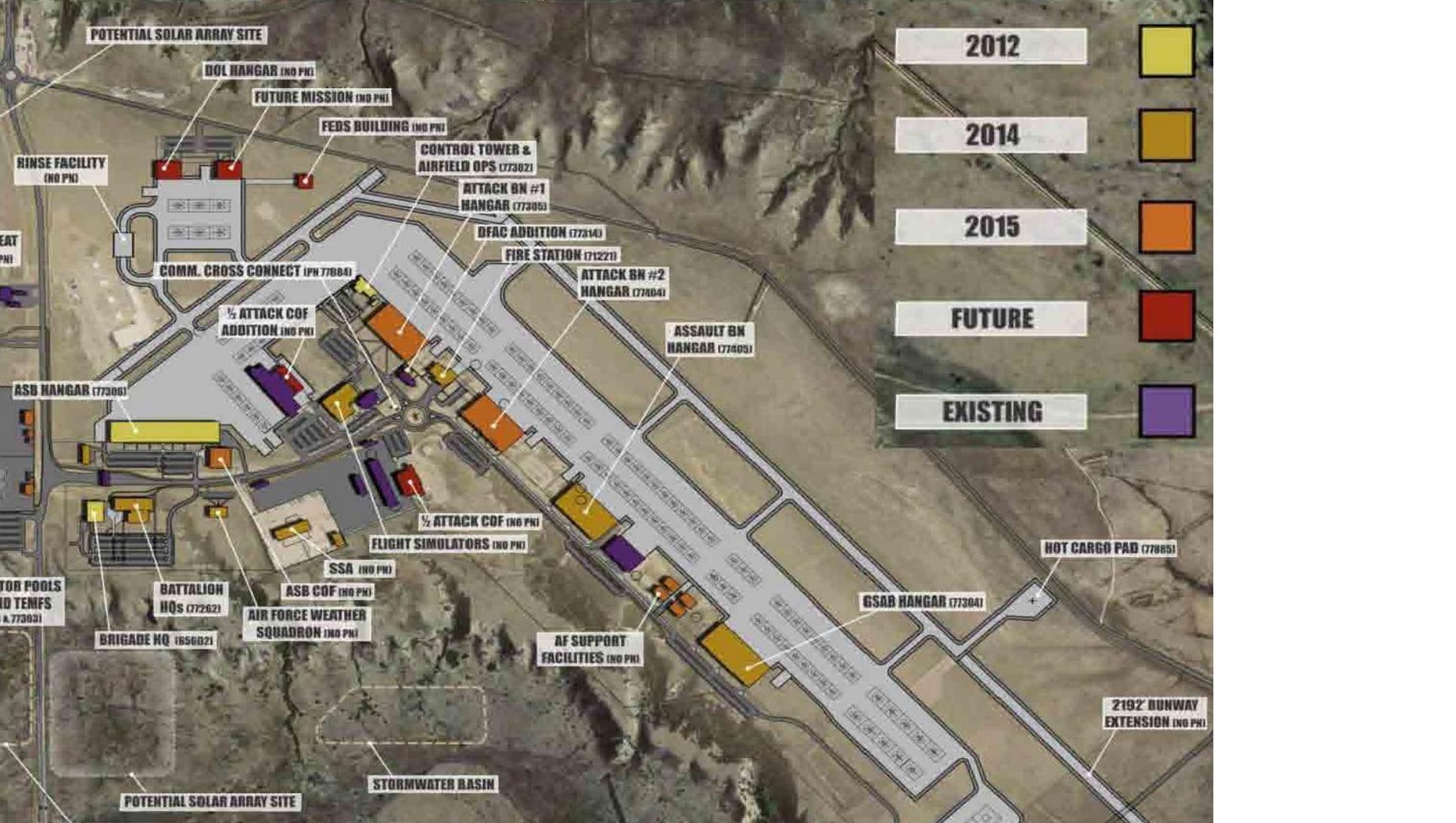
25 MAY 2011





- 2012
- 2014
- 2015
- FUTURE
- EXISTING





2012



2014



2015



FUTURE



EXISTING



POTENTIAL SOLAR ARRAY SITE

DOL HANGAR (NO PH)

FUTURE MISSION (NO PH)

FEDS BUILDING (NO PH)

CONTROL TOWER & AIRFIELD OPS (77302)

ATTACK BN #1 HANGAR (77305)

DFAC ADDITION (77314)

FIRE STATION (71221)

ATTACK BN #2 HANGAR (77404)

ASSAULT BN HANGAR (77405)

COMM. CROSS CONNECT (PH 77804)

1/2 ATTACK COF ADDITION (NO PH)

ASB HANGAR (77306)

1/2 ATTACK COF (NO PH)

FLIGHT SIMULATORS (NO PH)

SSA (NO PH)

BATTALION HQs (77262)

ASB COF (NO PH)

AIR FORCE WEATHER SQUADRON (NO PH)

BRIGADE HQ (65682)

STORMWATER BASIN

AF SUPPORT FACILITIES (NO PH)

GSAR HANGAR (77304)

HOT CARGO PAD (77805)

2192' RUNWAY EXTENSION (NO PH)

POTENTIAL SOLAR ARRAY SITE





13 November 2009

## Executive Summary

The *Nebraska-Specific Advanced Commercial Building Energy Code Study* evaluated and quantified the potential economic, energy and environmental benefits to the State of Nebraska of adopting a Statewide Advanced Commercial Building Energy Code. The study also assessed the benefits associated with the reduction in carbon emissions and other environmental pollutants attributed to the generation and consumption of energy in commercial buildings.

### An Increase of Between 1.28 and 3.36 Percent in Building Costs Achieves 30 Percent in Energy Savings

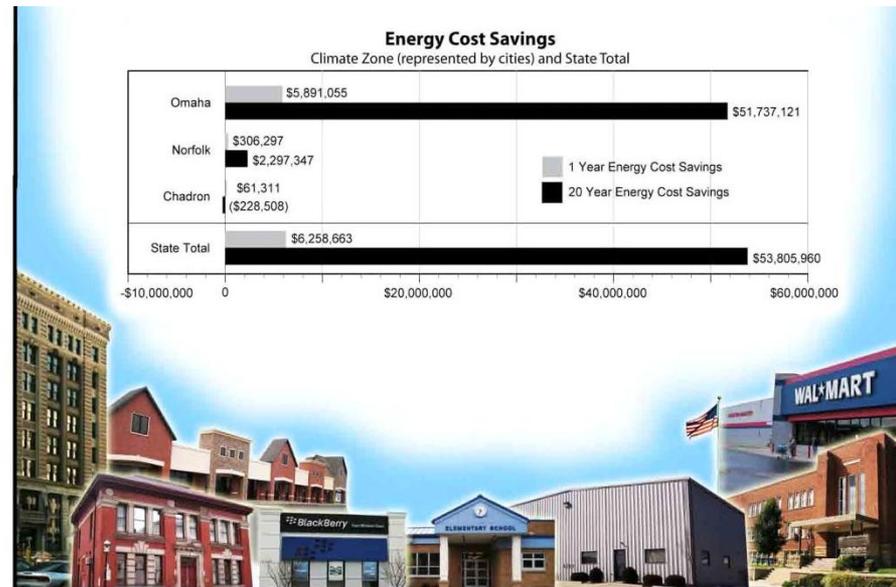
In the analysis of ten commercial building types in the state's three climate zones, the study found that an average incremental construction cost of between 1.28 and 3.36 percent would result in a 30 percent reduction in the energy savings in Nebraska.

### After 20 Years, Energy Cost Savings in Commercial Buildings Total \$53.8 Million

The study found energy cost savings associated with commercial buildings for the first year totaled \$6.2 million and the 20 year cumulative life cycle cost savings exceeded \$53.8 million. The specific energy cost savings are quantified by climate zone and for the state for one and 20 years in the figure below.

### And the Savings Compound for All Nebraskans

While the commercial building owners are the immediate beneficiaries of the energy cost savings, the advanced building energy code's attributes will provide benefits for other Nebraskans. The 30 percent reduction in energy use will help shield all Nebraskans from future energy price fluctuations. The benefits to the state's economy include additional investments in construction costs of an estimated \$63 million in the first year, primarily aiding local builders and supply companies. Since more than 80 percent of the money Nebraskans spend on energy leaves the state, any reduction in energy costs will have positive impact on the state's economy.





	Location Average Single Building			All Building Starts
	<i>Omaha</i>	<i>Norfolk</i>	<i>Chadron</i>	<i>Statewide Cumulative</i>
Cumulative Energy Savings [MMBtu]	11,443	12,207	9,761	108,738,240

**Table 9 – 20-Year Cumulative Energy Consumption Savings**

Environmental Impacts

A focus of the environmental impact assessment of this study was the reduction in carbon dioxide emissions, a detrimental atmospheric greenhouse gas, and other environmental pollutants created as by-products of energy production. Emissions are produced when fuels are combusted at off-site power plants producing electricity and by on-site heaters and furnaces producing heating energy. A reduction in the four major pollutants would be achieved by reducing commercial building demand for electricity and natural gas. Carbon dioxide, nitrogen oxides, sulfur dioxide, and mercury 20-year accumulated potential savings associated with the adoption of a statewide improved energy code are summarized in Table 10.

**974,000 Tons CO<sub>2</sub>**

<i>Emission</i>	Location Average Single Building			All Building Starts
	<i>Omaha</i>	<i>Norfolk</i>	<i>Chadron</i>	<i>Statewide Cumulative</i>
Carbon Dioxide (CO <sub>2</sub> ) [lbs.]	2,074,725	1,745,949	2,115,678	19,479,889,792
Nitrogen Oxides (NO <sub>x</sub> ) [lbs.]	2,785	2,914	3,160	26,535,025
Sulfur Dioxide (SO <sub>2</sub> ) [lbs.]	11,114	10,566	9,629	104,866,423
Mercury (Hg) [mg]	8,804	4,216	11,661	81,087,531

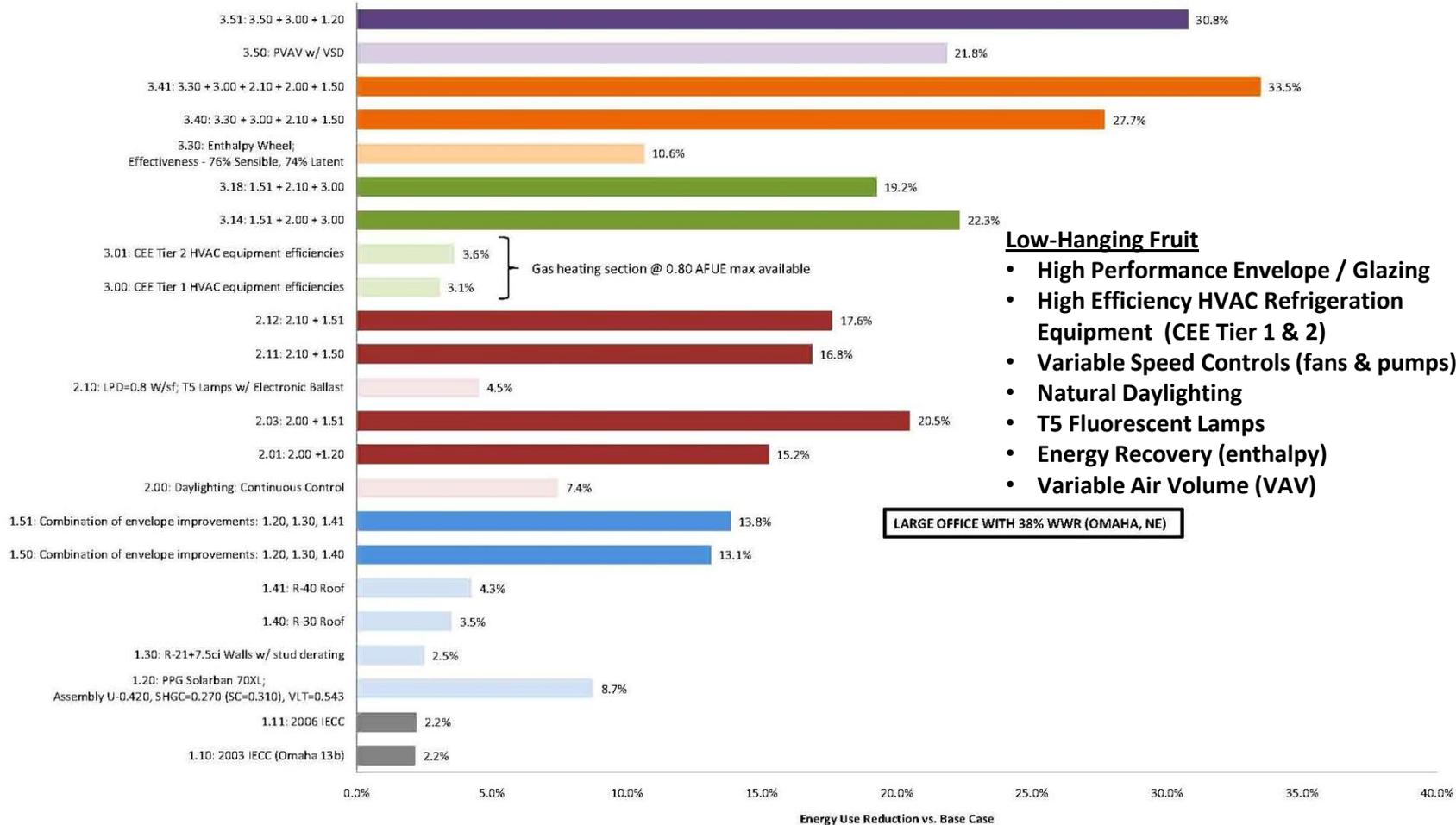
**Table 10 – 20-Year Cumulative Emissions Reductions**

# Nebraska-specific Advanced Commercial Building Energy Code Study

## Master Summary

Model	Variable	Unit	Omaha <sup>(a)</sup>	Norfolk <sup>(a)</sup>	Chadron <sup>(a)</sup>	State-wide Impact <sup>(b)</sup>
Large Office 38%	LCCA Net Present Worth	[\$]	141,315	172,244	184,688	1,726,709
	First year energy cost savings	[\$]	5,475	7,779	11,531	68,004
	Accumulated 20 year energy consumption savings	[MMBtu]	17,160	17,718	12,816	2,168,004
	Accumulated 20 year CO2 reduction	[lbs]	3,750,694	4,249,069	4,477,180	477,820,400
	Annual whole building site energy use intensity (EUI)	[kBtu/sf-yr]	34.61	34.94	32.79	34.64
Large Office 18%	LCCA Net Present Worth	[\$]	53,523	46,030	25,604	660,387
	First year energy cost savings	[\$]	7,104	9,341	9,011	96,496
	Accumulated 20 year energy consumption savings	[MMBtu]	16,748	15,438	12,978	2,232,732
	Accumulated 20 year CO2 reduction	[lbs]	4,672,657	3,473,442	4,133,959	619,569,540
	Annual whole building site energy use intensity (EUI)	[kBtu/sf-yr]	29.77	29.77	27.58	29.60
Small Office 38%	LCCA Net Present Worth	[\$]	-3,898	-8,164	-612	-148,860
	First year energy cost savings	[\$]	1,845	1,563	1,680	65,856
	Accumulated 20 year energy consumption savings	[MMBtu]	2,418	2,380	2,098	913,180
	Accumulated 20 year CO2 reduction	[lbs]	846,366	793,913	982,387	318,824,657
	Annual whole building site energy use intensity (EUI)	[kBtu/sf-yr]	31.99	32.89	30.80	32.04
Small Office 18%	LCCA Net Present Worth	[\$]	-15,999	-14,929	-15,357	-1,193,933
	First year energy cost savings	[\$]	1,447	1,297	1,056	107,384
	Accumulated 20 year energy consumption savings	[MMBtu]	2,128	2,290	1,784	1,680,682
	Accumulated 20 year CO2 reduction	[lbs]	599,279	588,710	455,312	469,865,448
	Annual whole building site energy use intensity (EUI)	[kBtu/sf-yr]	28.69	29.26	27.69	28.71
Small Retail	LCCA Net Present Worth	[\$]	44,558	41,961	25,480	16,467,610
	First year energy cost savings	[\$]	2,035	2,088	1,949	759,817
	Accumulated 20 year energy consumption savings	[MMBtu]	3,350	3,924	3,408	13,255,913
	Accumulated 20 year CO2 reduction	[lbs]	885,708	939,879	860,929	3,480,088,338
	Annual whole building site energy use intensity (EUI)	[kBtu/sf-yr]	67.90	70.30	60.68	67.94
Retail Strip Mall	LCCA Net Present Worth	[\$]	156,642	53,358	35,208	23,908,446
	First year energy cost savings	[\$]	15,636	9,108	7,734	2,428,578
	Accumulated 20 year energy consumption savings	[MMBtu]	13,844	15,570	12,730	23,427,499
	Accumulated 20 year CO2 reduction	[lbs]	4,278,361	4,385,075	3,756,652	7,193,372,978
	Annual whole building site energy use intensity (EUI)	[kBtu/sf-yr]	109.78	111.29	99.15	109.81
Big Box Retail	LCCA Net Present Worth	[\$]	303,163	336,866	458,965	32,527,001
	First year energy cost savings	[\$]	10,919	6,511	6,705	1,122,344
	Accumulated 20 year energy consumption savings	[MMBtu]	40,669	37,211	31,897	44,917,801
	Accumulated 20 year CO2 reduction	[lbs]	-1,566,839	-5,659,367	-4,760,647	-2,078,227,735
	Annual whole building site energy use intensity (EUI)	[kBtu/sf-yr]	48.28	50.09	45.27	48.37
Elementary School	LCCA Net Present Worth	[\$]	2,112	-53,498	-110,272	-175,726
	First year energy cost savings	[\$]	17,483	13,349	8,370	835,152
	Accumulated 20 year energy consumption savings	[MMBtu]	16,809	17,459	11,714	8,615,391
	Accumulated 20 year CO2 reduction	[lbs]	9,629,742	10,018,141	6,146,940	4,930,167,345
	Annual whole building site energy use intensity (EUI)	[kBtu/sf-yr]	38.77	38.38	33.99	38.65
Secondary School	LCCA Net Present Worth	[\$]	-670,001	-646,574	-692,847	-16,726,017
	First year energy cost savings	[\$]	21,975	19,199	14,606	536,454
	Accumulated 20 year energy consumption savings	[MMBtu]	25,417	26,127	20,799	6,638,429
	Accumulated 20 year CO2 reduction	[lbs]	13,696,142	14,109,395	10,518,037	3,570,545,434
	Annual whole building site energy use intensity (EUI)	[kBtu/sf-yr]	36.16	35.80	33.31	36.02
Warehouse	LCCA Net Present Worth	[\$]	-61,048	-47,774	-57,209	-3,239,657
	First year energy cost savings	[\$]	4,408	4,632	4,084	238,604
	Accumulated 20 year energy consumption savings	[MMBtu]	8,532	9,830	8,196	4,888,608
	Accumulated 20 year CO2 reduction	[lbs]	867,405	1,019,875	833,239	497,863,388
	Annual whole building site energy use intensity (EUI)	[kBtu/sf-yr]	21.94	21.94	20.25	20.73
<b>Total Advanced Energy Code Impact</b>	LCCA Net Present Worth	[\$]	62,035	40,304	-19,042	53,805,960
	First year energy cost savings	[\$]	7,064	5,374	5,109	6,258,689
	Accumulated 20 year energy consumption savings	[MMBtu]	11,443	12,207	9,761	108,738,240
	Accumulated 20 year CO2 reduction	[lbs]	2,074,725	1,745,949	2,115,678	19,479,889,792
	Annual whole building site energy use intensity (EUI)	[kBtu/sf-yr]	48.71	48.58	37.91	48.53

## Alternative Energy Savings vs. ASHRAE 90.1-2004 Base Case



### Low-Hanging Fruit

- High Performance Envelope / Glazing
- High Efficiency HVAC Refrigeration Equipment (CEE Tier 1 & 2)
- Variable Speed Controls (fans & pumps)
- Natural Daylighting
- T5 Fluorescent Lamps
- Energy Recovery (enthalpy)
- Variable Air Volume (VAV)

## Nebraska-specific Advanced Commercial Building Energy Code Study

### Total Building Construction Cost Increase

Model	Annual Construction Starts <sup>(a)</sup>	Model Area	Typical Area-based Cost <sup>(b)</sup>	Typical Model Total Cost	30% Energy Saving Building Average Incremental Cost <sup>(c), (d)</sup>	
					[sf]	[\$/sf]
Large Office 18% WWR	13	60000	\$170	\$10,200,000	\$275,526	2.70%
Large Office 38% WWR	12	60000	\$174	\$10,440,000	\$319,990	3.07%
<i>Subtotal</i>	25			\$257,880,000	\$7,421,718	2.88%
Small Office 18% WWR	75	10000	\$201	\$2,010,000	\$81,753	4.07%
Small Office 38% WWR	36	10000	\$206	\$2,060,000	\$94,660	4.60%
<i>Subtotal</i>	111			\$224,910,000	\$9,539,235	4.24%
Small Retail	373	5000	\$125	\$625,000	\$23,771	3.80%
<i>Subtotal</i>				\$233,125,000	\$8,866,583	3.80%
Retail Strip Mall	160	13500	\$110	\$1,485,000	\$112,384	7.57%
<i>Subtotal</i>				\$237,600,000	\$17,981,440	7.57%
 Large Big Box Retail	106	100000	\$138	\$13,800,000	-\$195,347	-1.42%
<i>Subtotal</i>				\$1,462,800,000	-\$20,706,782	-1.42%
Warehouse	54	48000	\$90	\$4,320,000	\$196,349	4.55%
<i>Subtotal</i>				\$233,280,000	\$10,602,846	4.55%
Elementary School	49	50000	\$159	\$7,955,000	\$181,443	2.28%
<i>Subtotal</i>				\$389,795,000	\$8,890,707	2.28%
 Secondary School	25	80000	\$162	\$12,960,000	\$18,520	0.14%
<i>Subtotal</i>				\$324,000,000	\$463,000	0.14%
<b>Total Average Statewide Construction Cost Increase</b>				<b>\$3,363,390,000</b>	<b>\$43,058,747</b>	<b>1.28%</b>
<i>Total excluding Big Box Retail</i>				<i>\$1,900,590,000</i>	<i>\$63,765,529</i>	<i>3.36%</i>

Notes:

(a) Annual construction start data as provided by NEO

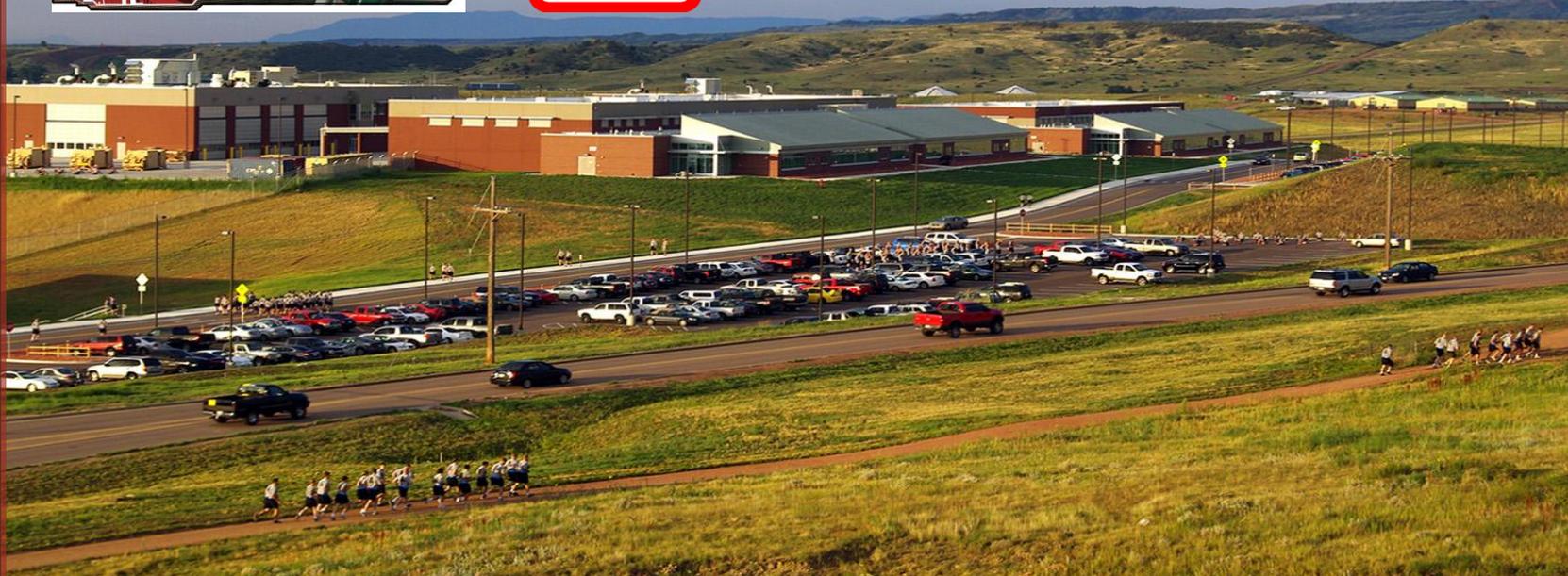
(b) Typical area-based costs based upon from RSMeans 2009 Square Foot Costs

(c) Average incremental costs of 30-percent energy saving alternative buildings over baseline buildings from capital cost estimate

(d) Percent additional cost over typical model total cost



**US Army Corps of Engineers**  
Omaha District



EXCELLENCE BEYOND  
EXPECTATIONS



**Carl T. Curtis, Midwest Regional Headquarters  
Building**  
Omaha, Nebraska

