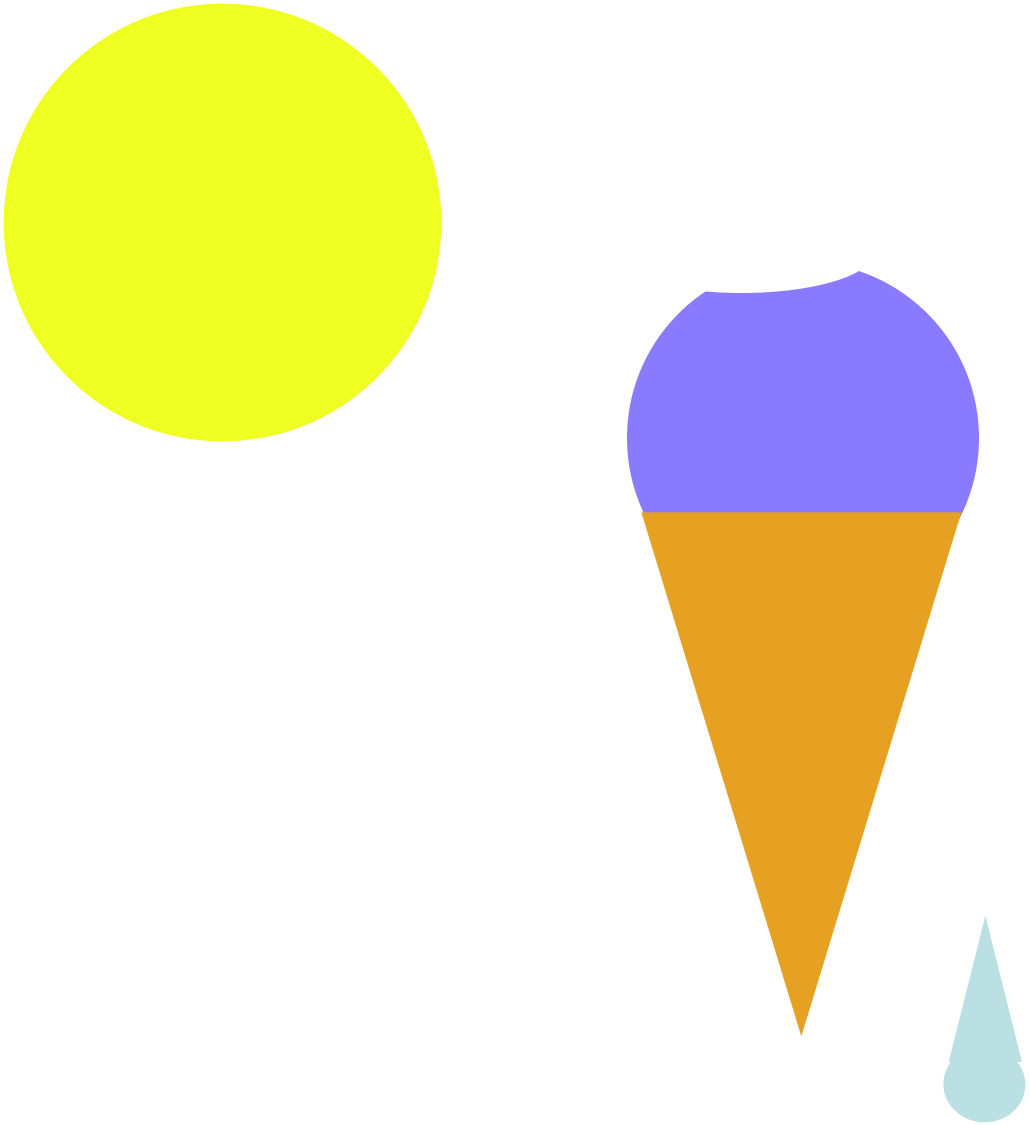
Going Beyond LEED

Carbon Accountability at the Development Scale

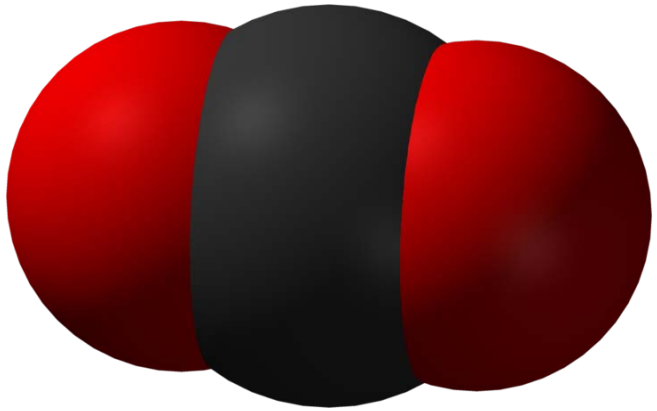
Rocky Mountain Land Use Institute

Pat Dawe, RNL

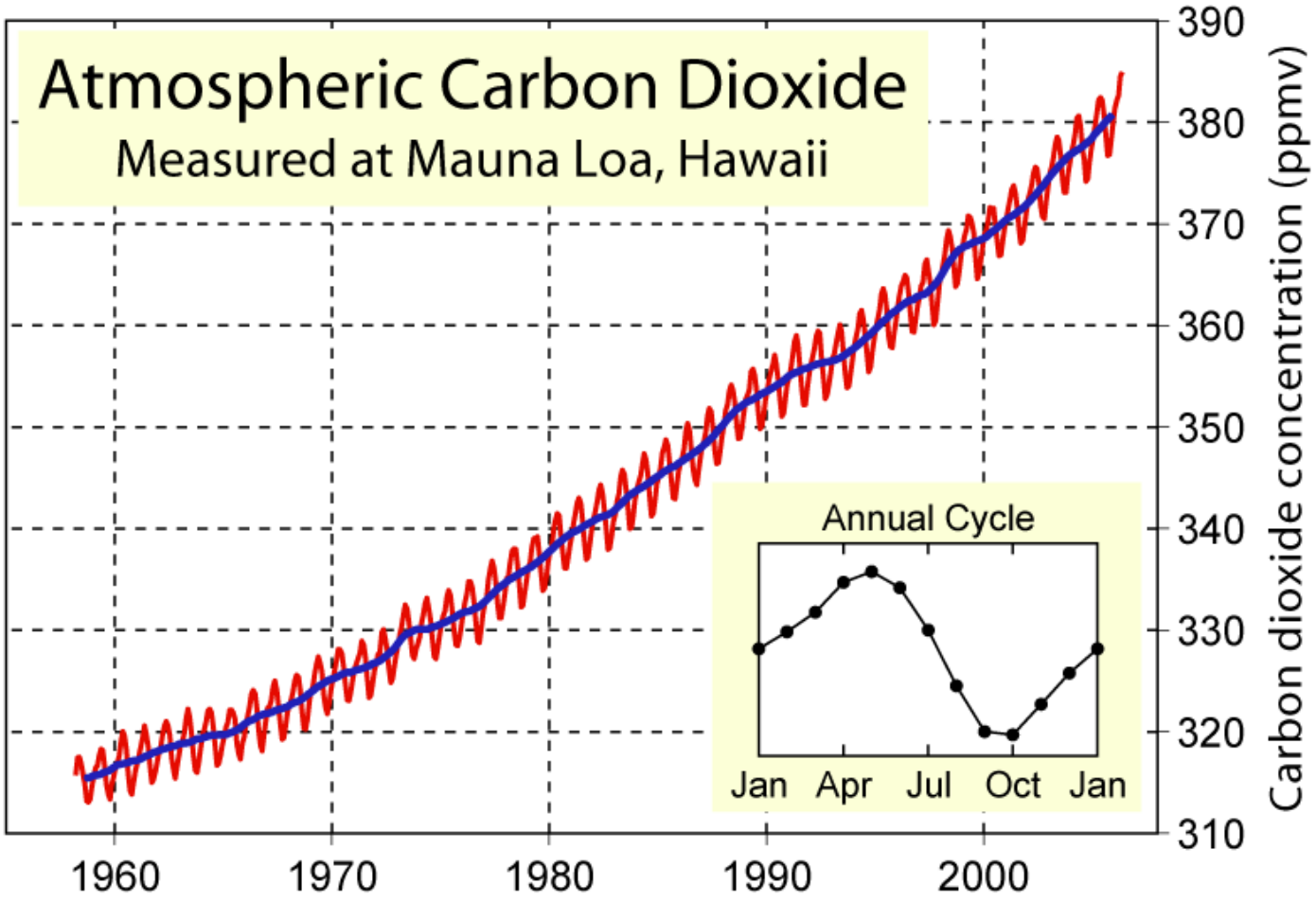
Tom Hootman, RNL



The Melting Earth Theory

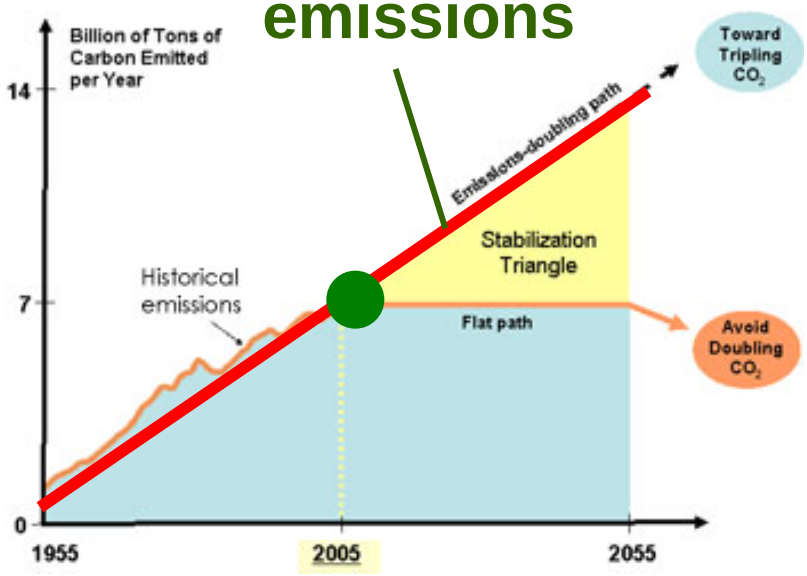


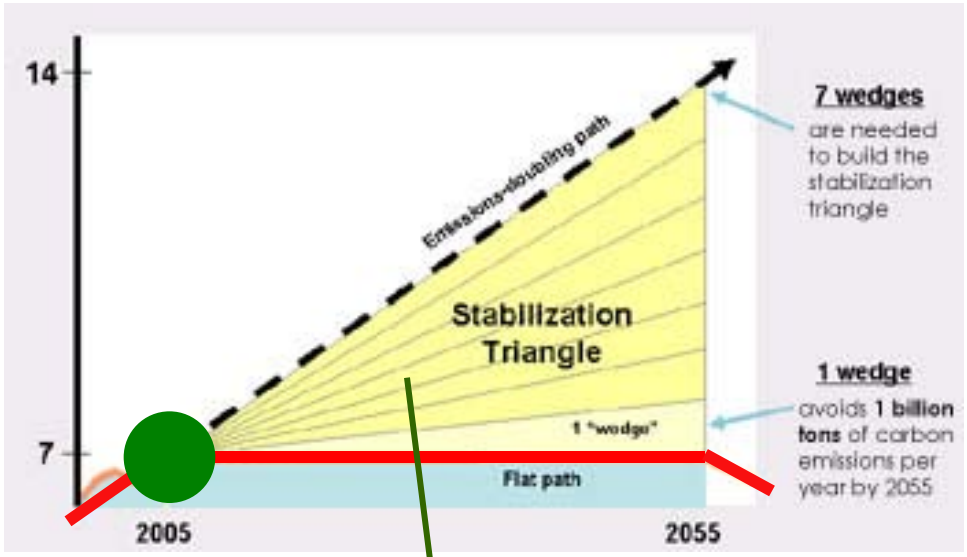
Carbon Dioxide



Keeling Curve

Rate of increase in carbon emissions



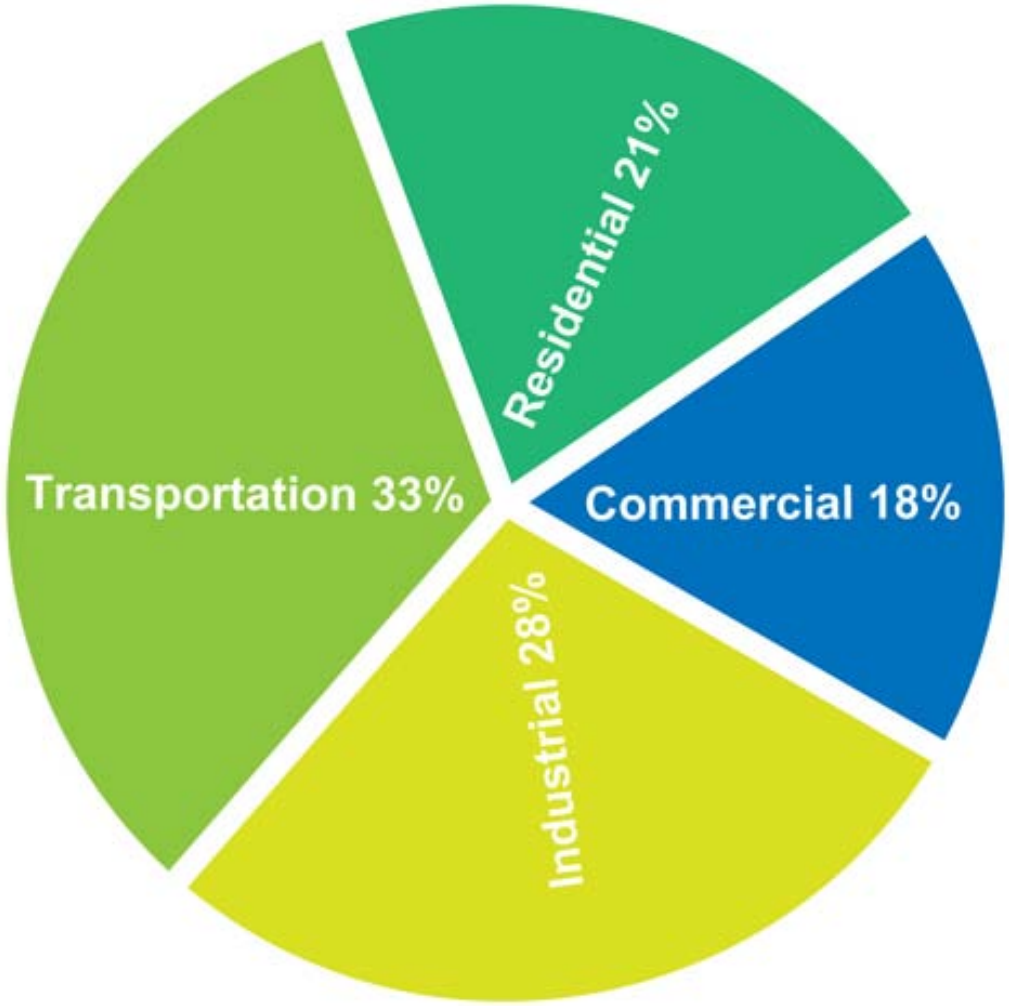


What if every economic sector took responsibility…

Source: Princeton University

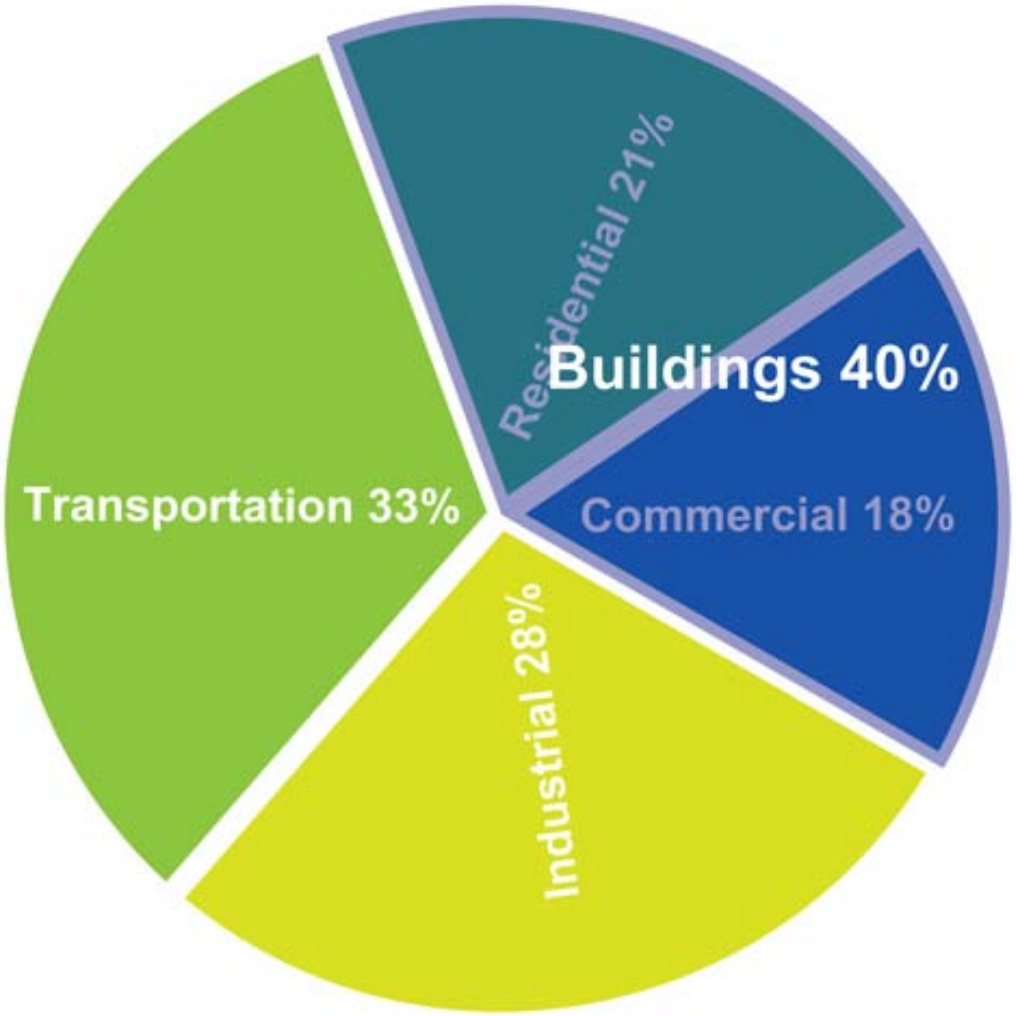
Environmental Wedges

Carbon Dioxide



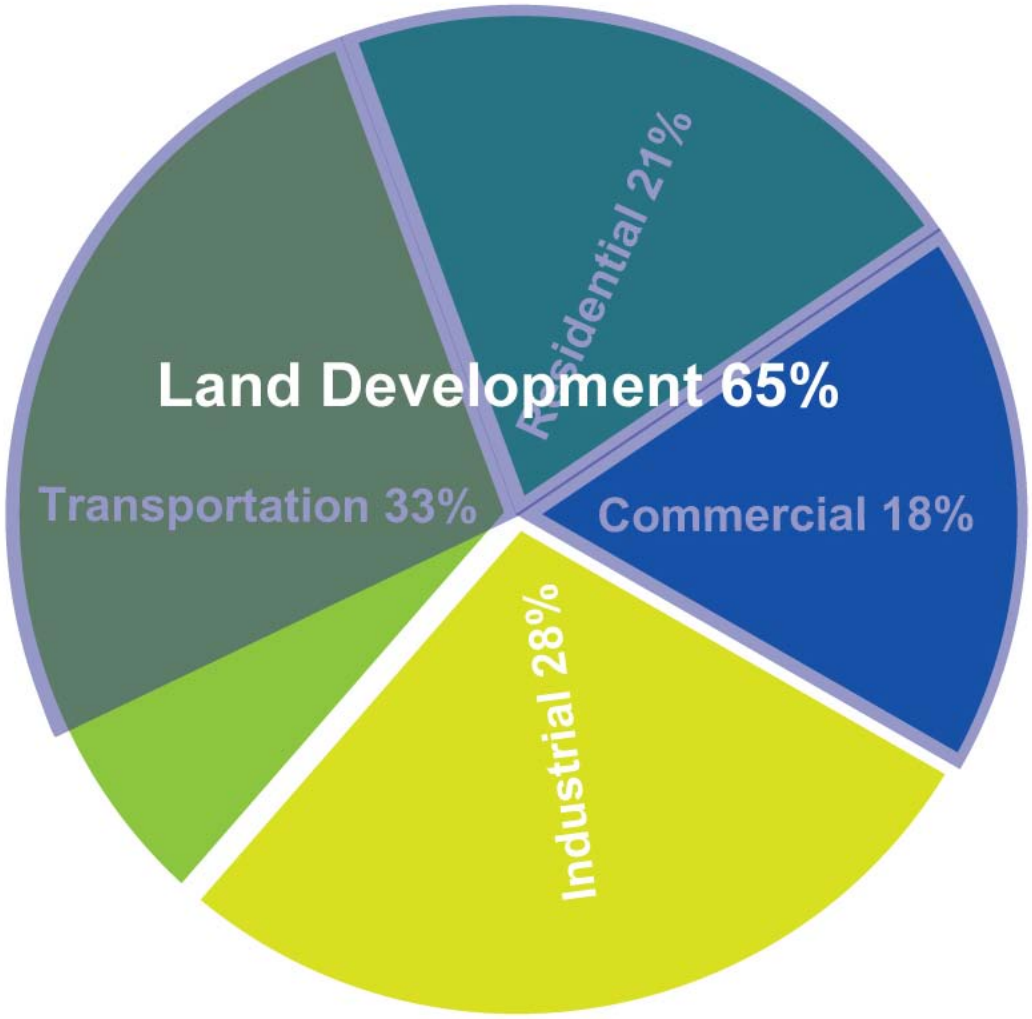
Emissions per Sector

Carbon Dioxide



Emissions per Sector

Carbon Dioxide



Emissions per Sector

Last 60 Years

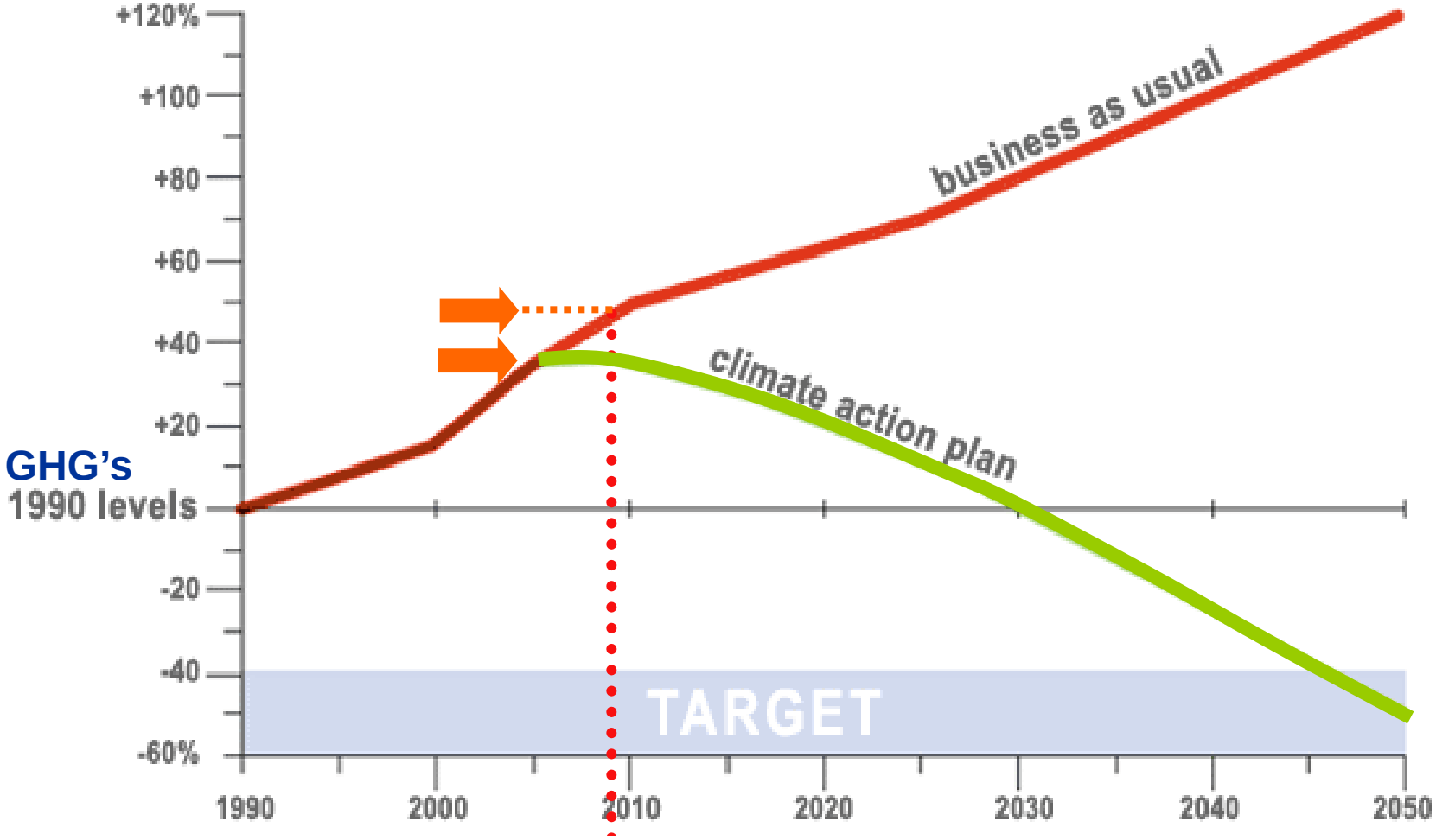
- 1950 Interstate Highway System—suburbs/sprawl
- 1973 US Gas “Crisis”—followed by US solar design era
- 1992 Earth Summit Rio de Janiero
- 1990’s LEED introduced
- 1997 Kyoto Protocol signing
- 2001 UN Intergovernmental Panel on Climate Change
- 2007 LEED ND Pilot

We are here

Next 40 Years

- 2009 LEED ND rollout
- 2020 Scientists: reduction of GHG to 1990 levels
- 2050 Scientists: reduction GHG to 80% below 1990 levels

100 Years of Climate Change



A Fork in the Road

Two Ways to Create the Future

Reactive

- do some of the “right things” and hope they work
  - …well enough to solve the problem
  - …in time
- measure the effects later
- revise the strategy--catchup

Pro-active

- predict the effectiveness
  - …and cost
- strategy based on what’s cost effective
  - …and will solve the problem
- measure the effects
- refine the strategy—stay ahead of the curve

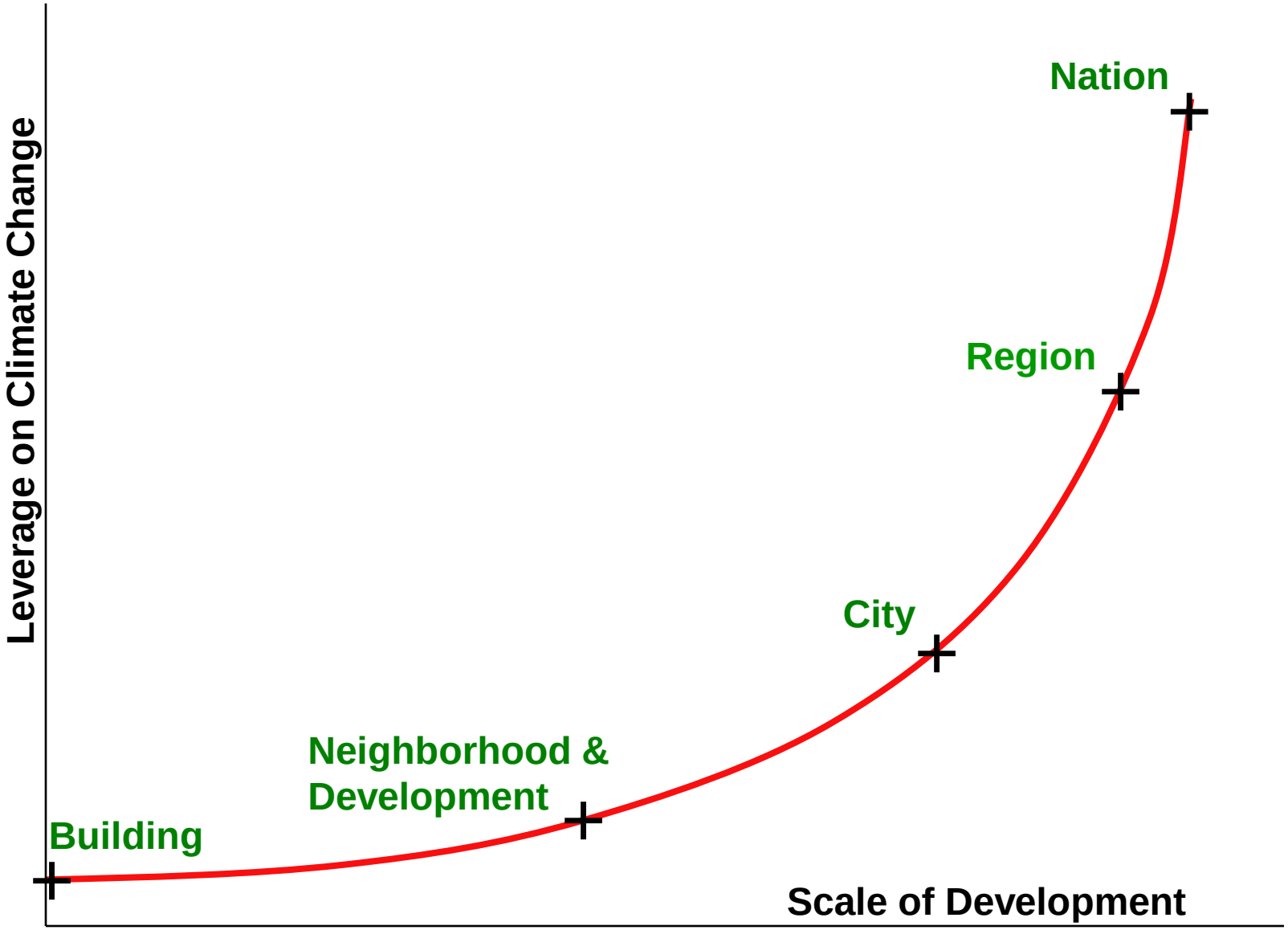
How do we know how where the leverage for climate change is in our projects?

LEED-NC—building-oriented, some site

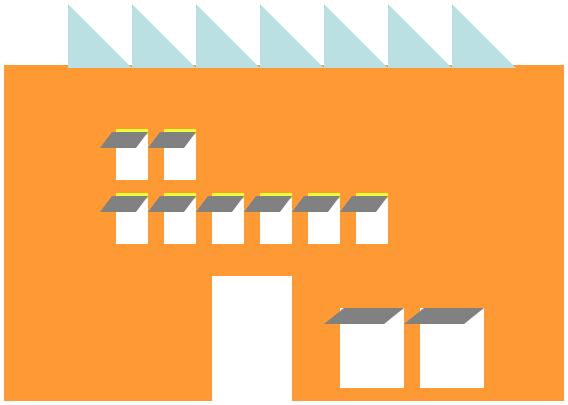
LEED-ND—only accounts indirectly for CO_2 emissions

2030 Challenge—doesn't consider site or external context

Sustainable Sites—landscape-oriented



Effects of Scale



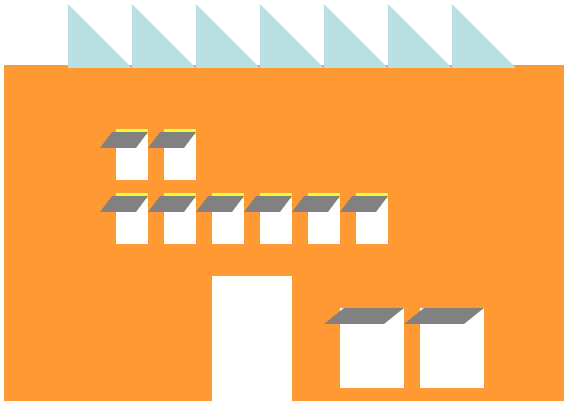
ENERGY STAR

2030 Challenge

LEED

ZEB (Zero Energy Building)

Building



ENERGY STAR

EPA and DOE program

Building label for energy efficiency

Measures energy use intensity

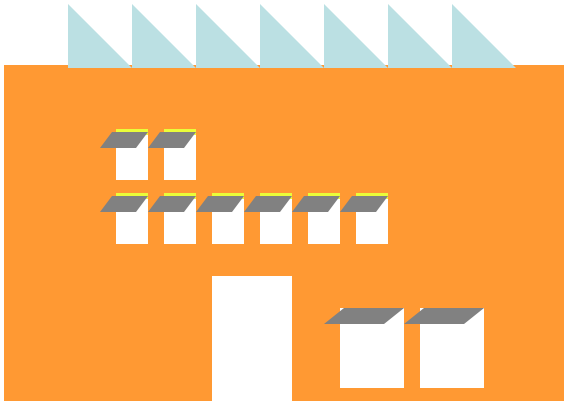
Based on Utility Bills

Score between 1-100

Benchmark based on “average” existing building stock

ENERGY STAR Target Finder

Building



2030 Challenge

Architecture 2030

Measures carbon

Carbon neutral by 2030

Phased reduction in consumption of fossil fuel in buildings

Benchmark based on “average” existing building stock

(CBECS) Commercial Building Energy Consumption Survey

Building

2030 Challenge

Existing and New buildings

50% NOW

New Buildings

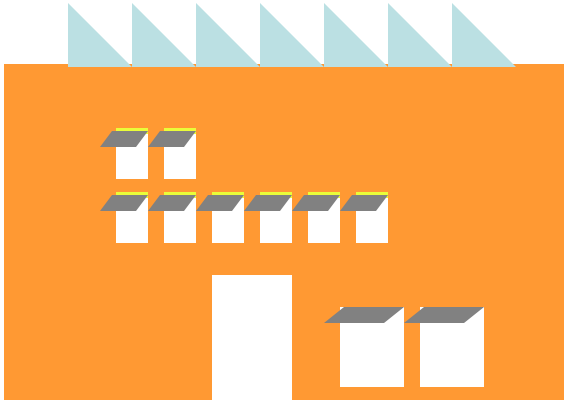
60% in 2010

70% in 2015

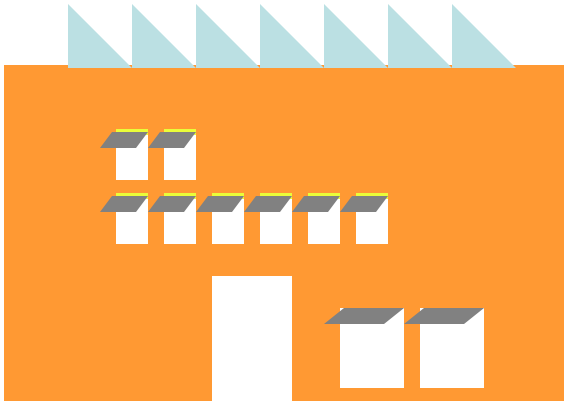
80% in 2020

90% in 2025

Carbon Neutral in 2030



Building



LEED

Green Building Rating System

Credits for energy performance and renewable energy

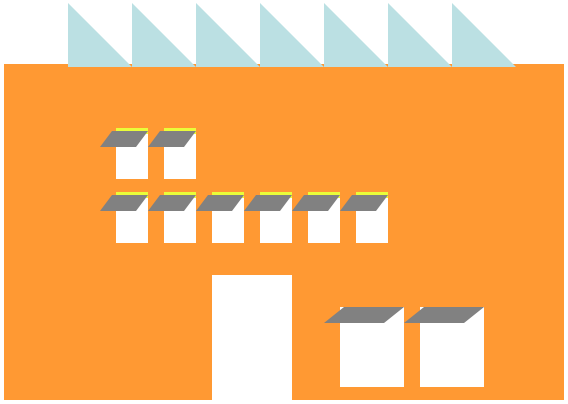
Measures energy cost savings

Energy & Atmosphere credits are 25% of the available in LEED-NC 2.2

and 35% in LEED-NC 2009

ASHRAE 90.1

Building



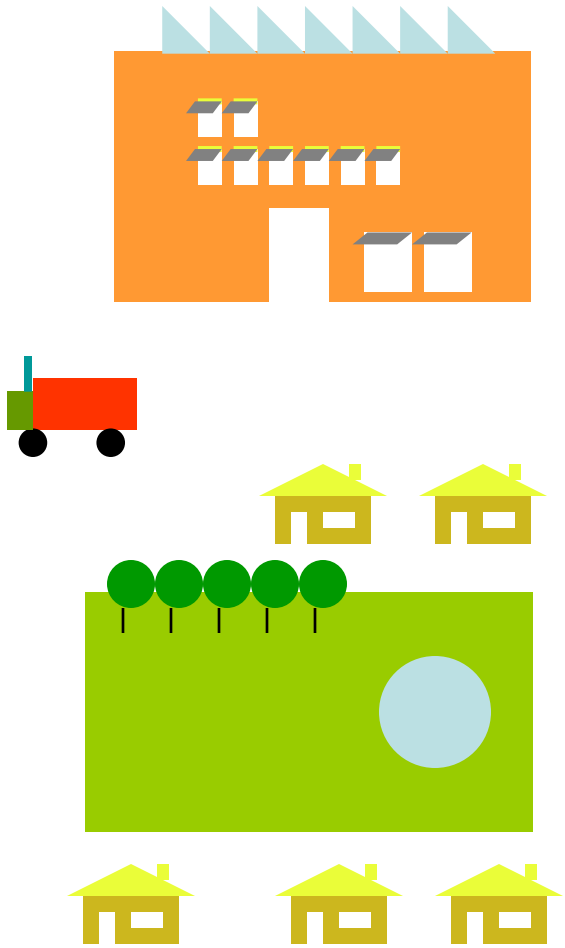
Zero Energy Buildings

National Renewable Energy Lab

NREL's Four Definitions:

1. Source Energy ZEB
2. Site Energy ZEB
3. Emissions ZEB
4. Cost ZEB

Building



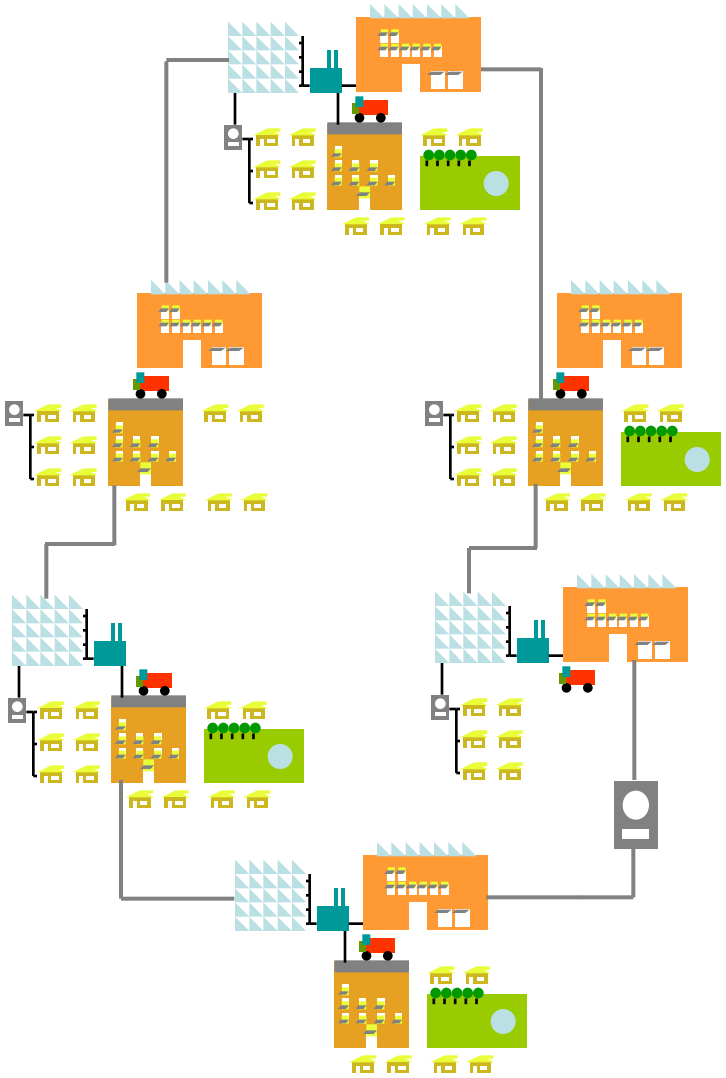
Mixed Uses

Site Design

Street Connectivity

Density

Neighborhood



Climate Action Plan

Smart Grid

Development Regulations & Review

Land Use & Transportation

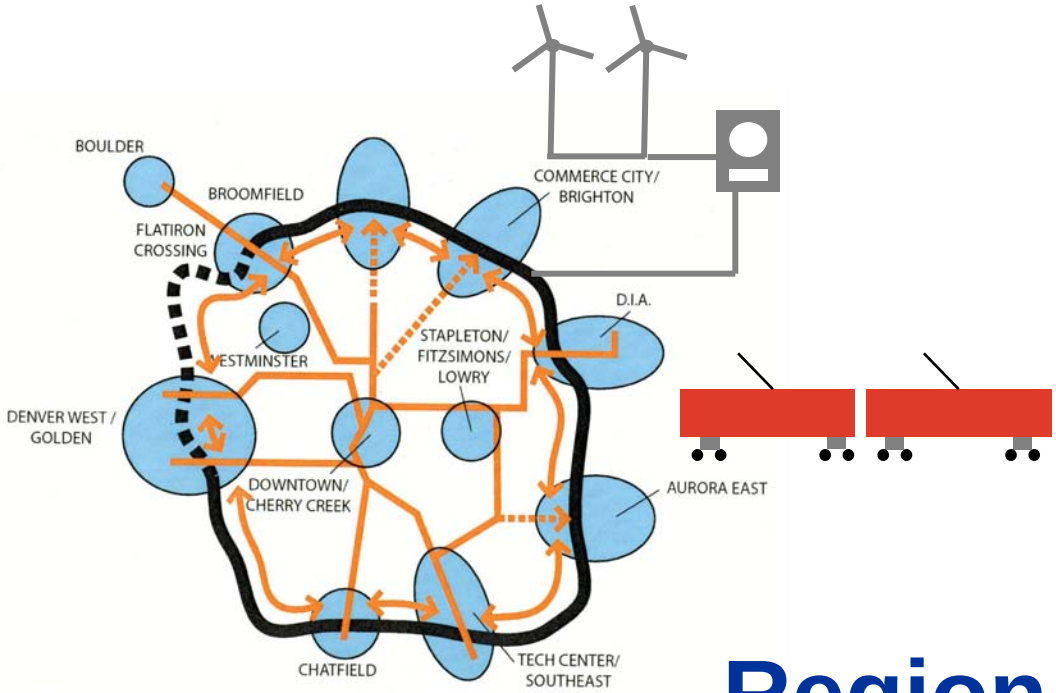
City Operations

City

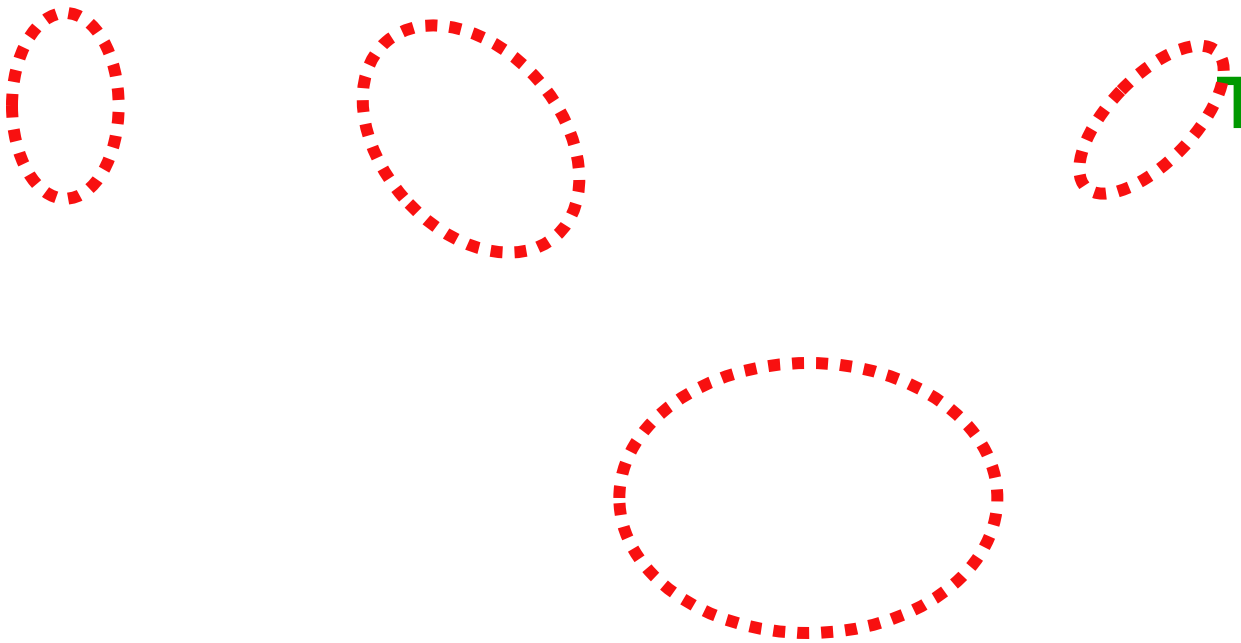
Integration of Land Use & Transportation

Reduction of VMT

Large Scale Systems



Region



National
Energy Goals

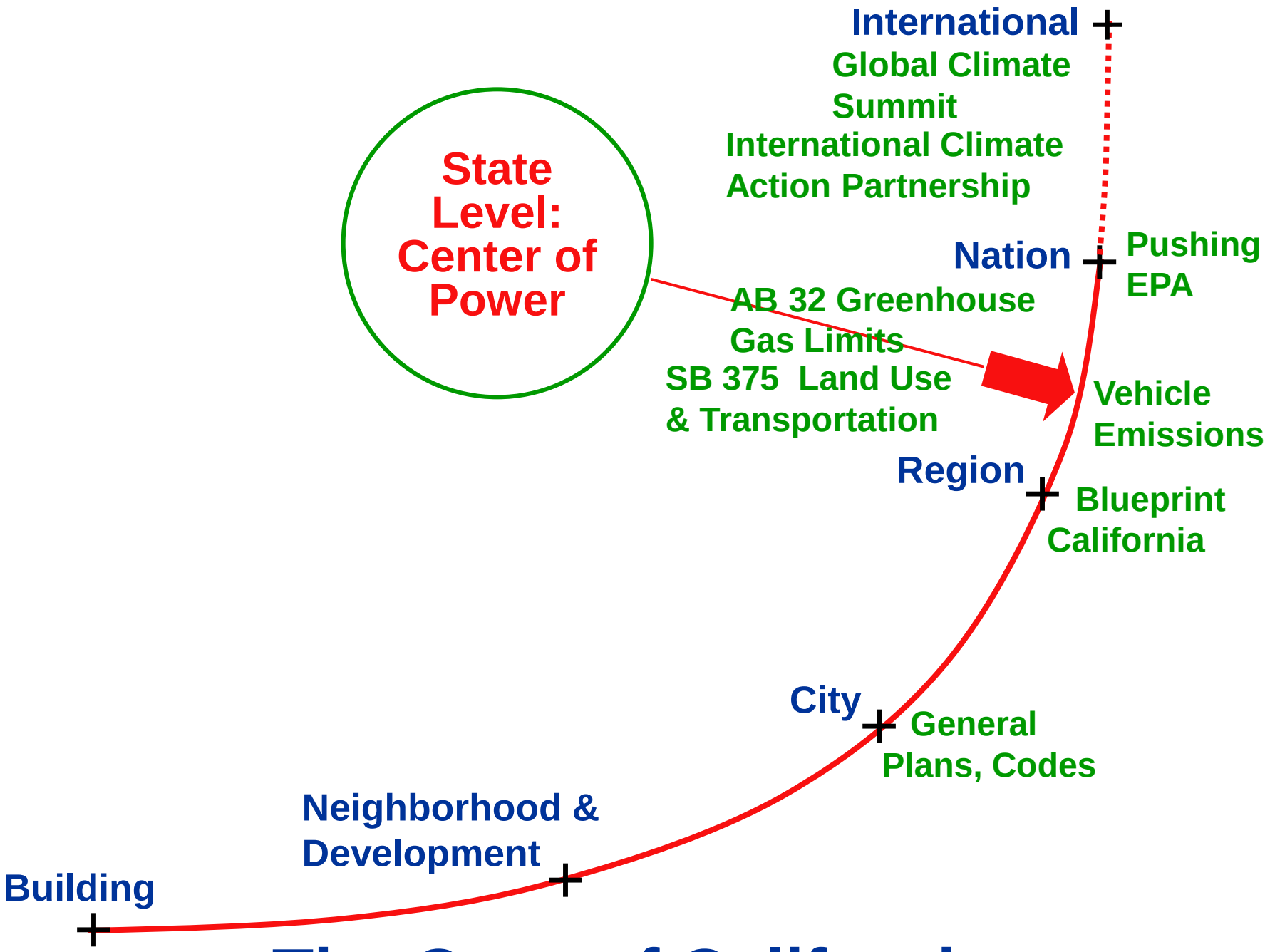
Electrical Grid

Tax Policy

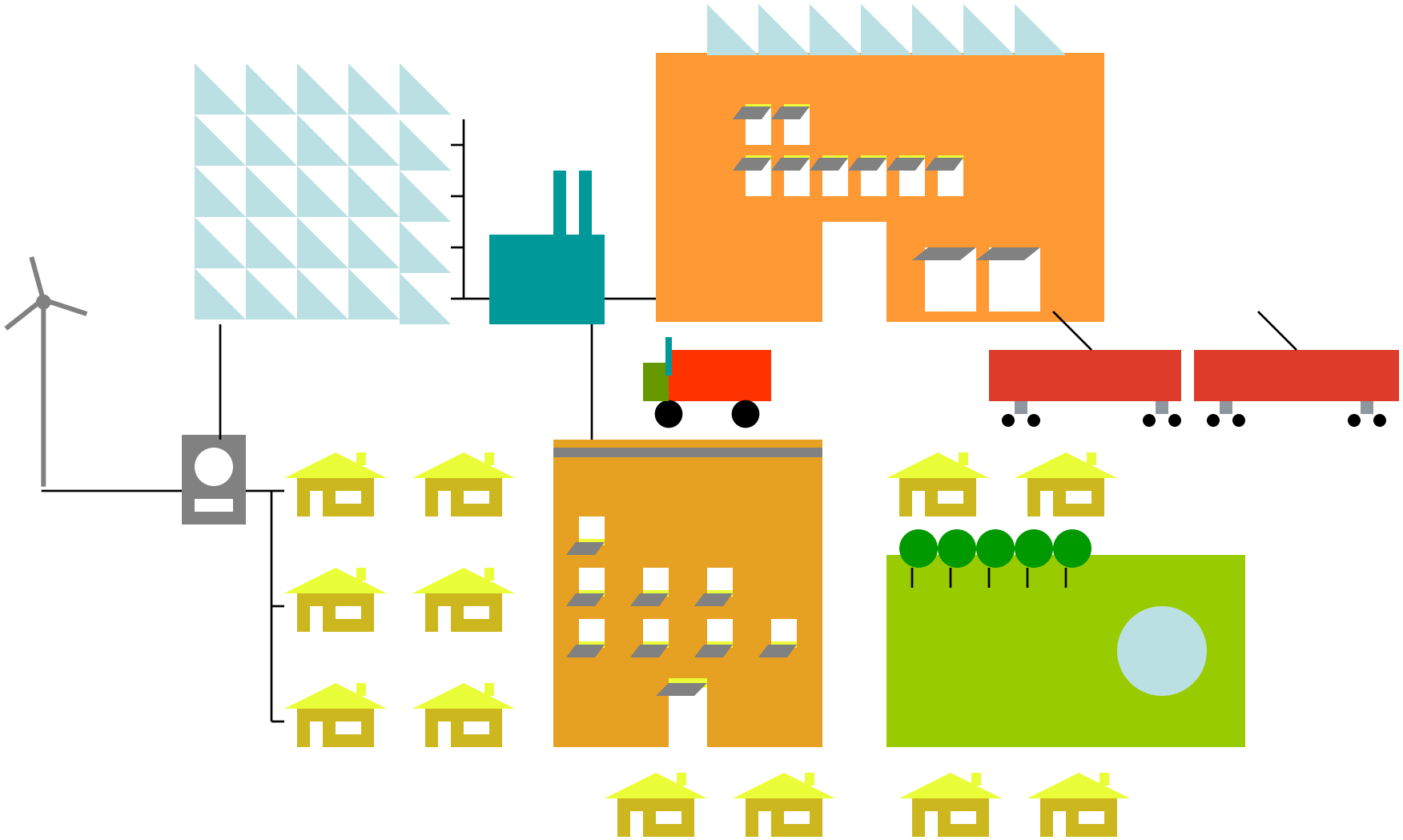
Nation

	1940	1945
Federal Spending % of GDP	9%	42%
Defense Spending % of GDP	1%	37%
Defense Spending % of Fed	7%	89%
US Increase in Output		830%
Unemployment	15%	2%
Military Aircraft WW II		128,000
Ships		5,800

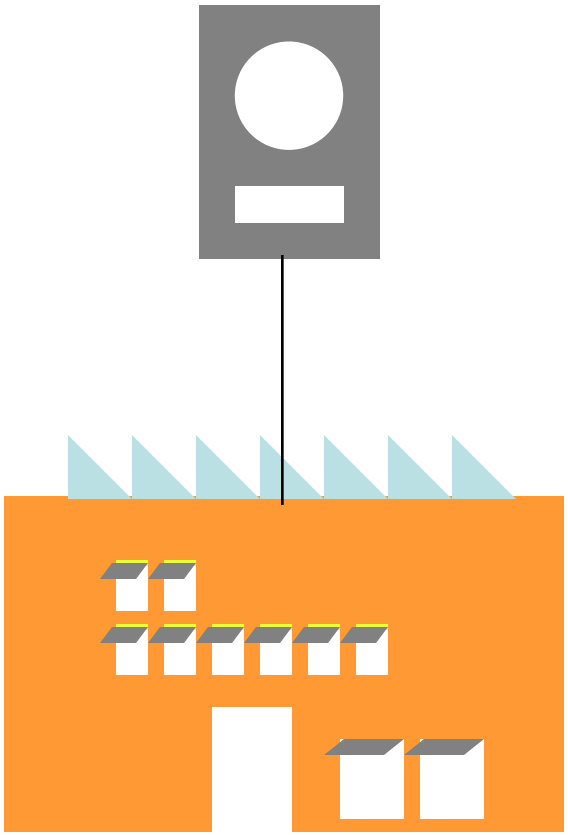
US Can Tackle Big Problems: WW II



The Case of California



Development Scale

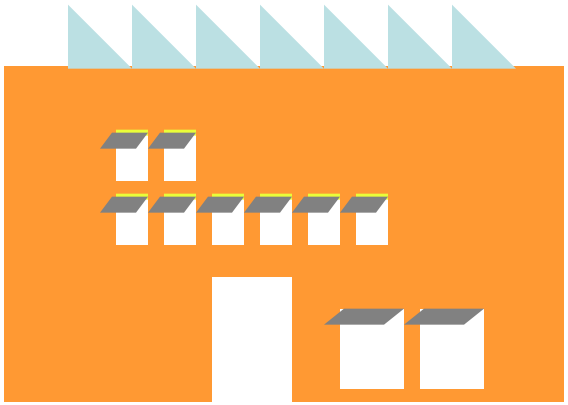


EUI

Annual energy use per sf of building area

= kBtu / SF / Yr

Energy Use Intensity



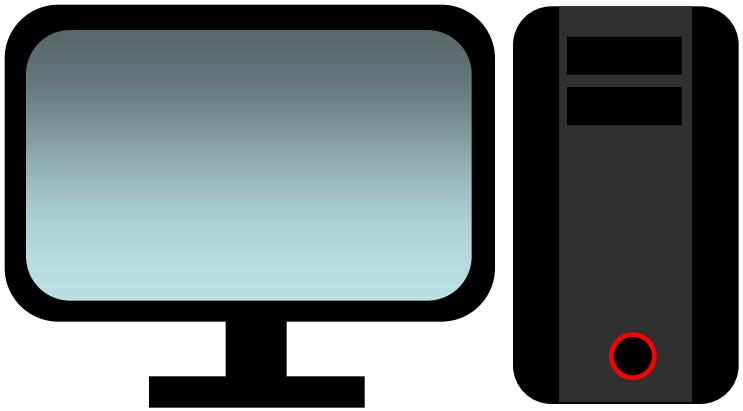
62.1 kBtu/SF/Yr

45 MPG

Energy Use Intensity

62.1 kBtu/SF/Yr **165.2 kBtu/SF/Yr**

Site Energy / Source Energy

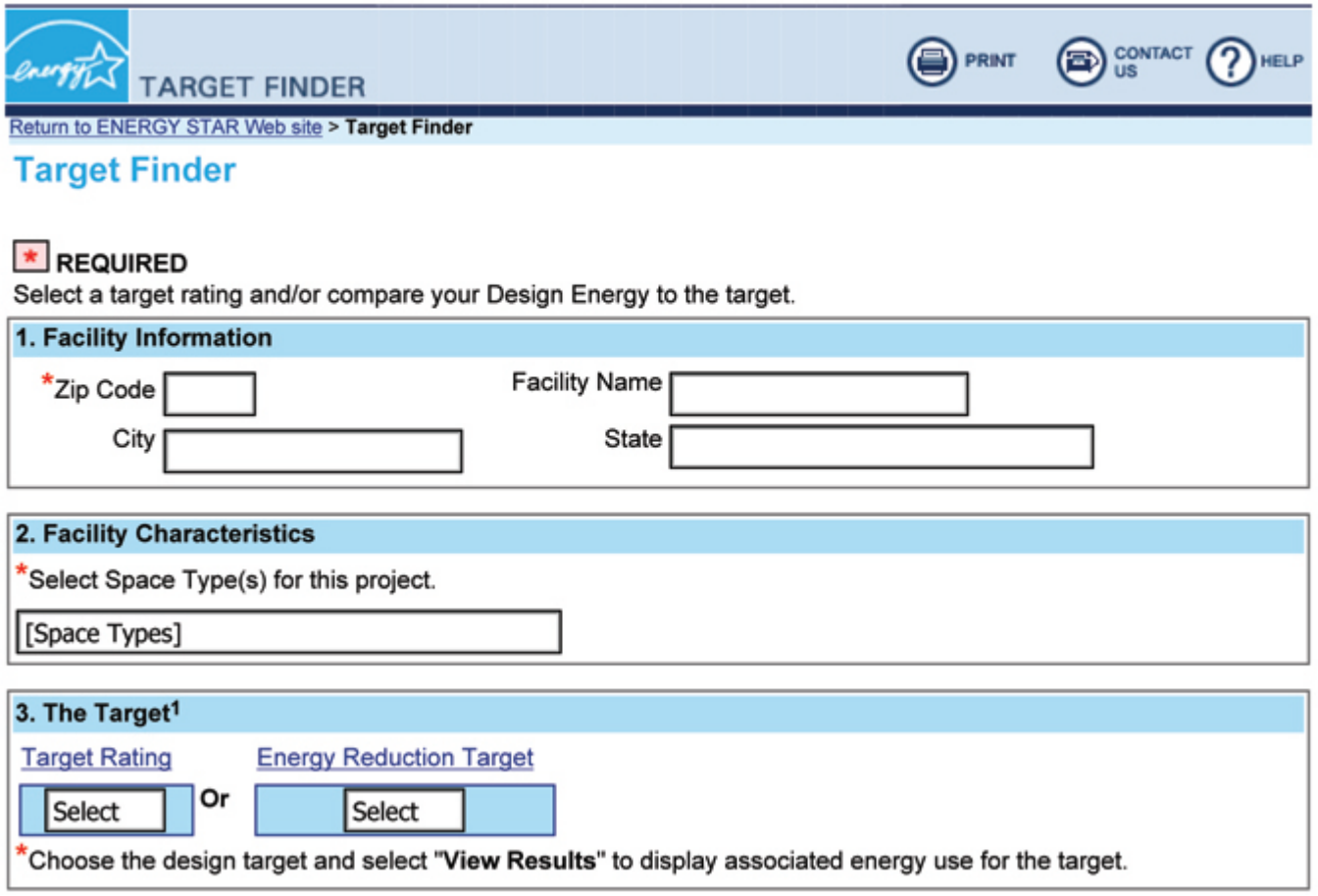


Energy Use Intensity Data Sources

- Energy Star Target Finder
- 2030 Challenge EUI Tables
- 2003 Commercial Building Energy Consumption Survey (CBECS)
- NREL EUI Tables

Energy Use Intensity

ENERGY STAR Target Finder



Energy Use Intensity

ENERGY STAR Target Finder Building/Space Types

- Offices
- K-12 Schools
- Hospitals
- Hotels
- Medical Offices
- Residence Halls
- Supermarkets
- Warehouses
- Banks
- Courts
- Retail

Energy Use Intensity

ENERGY STAR Target Finder Support Space Types

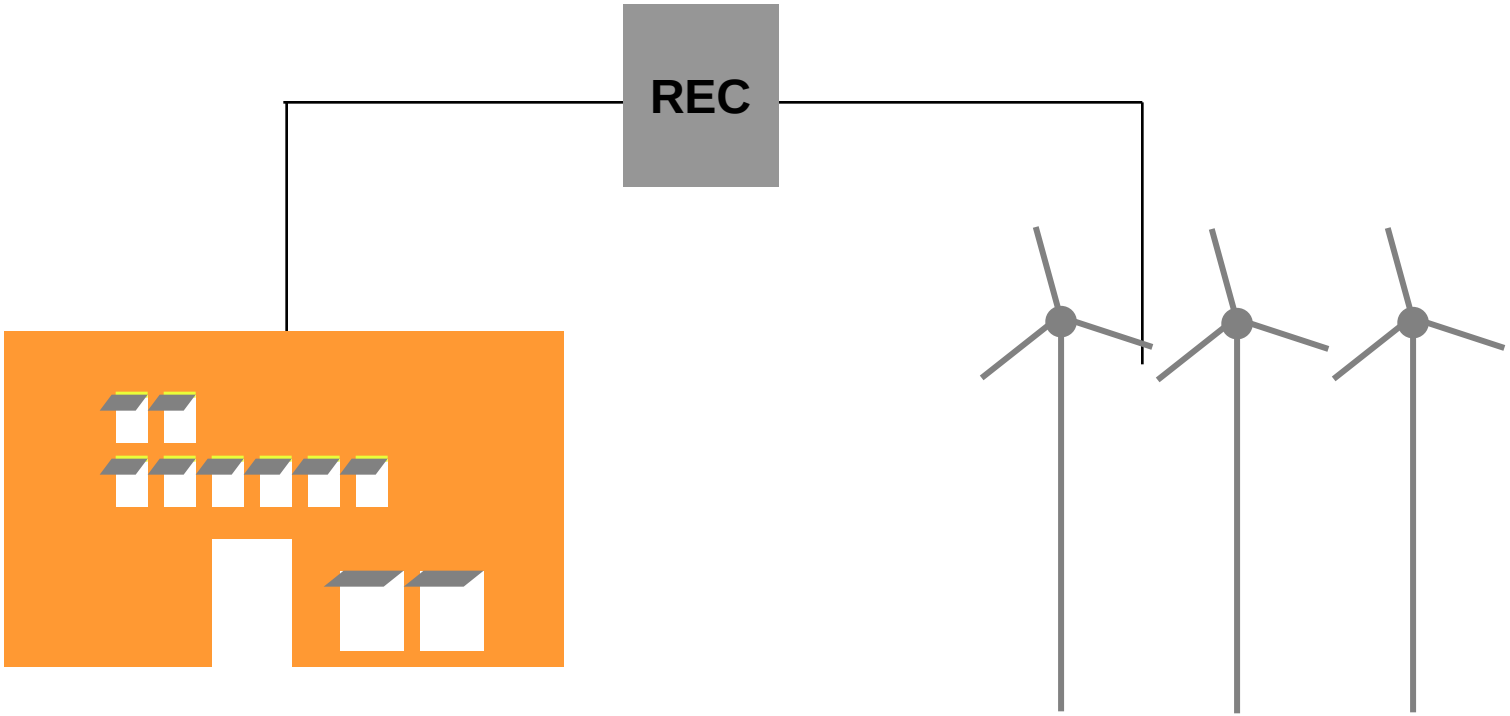
Computer / Data Center

Parking

Swimming Pool

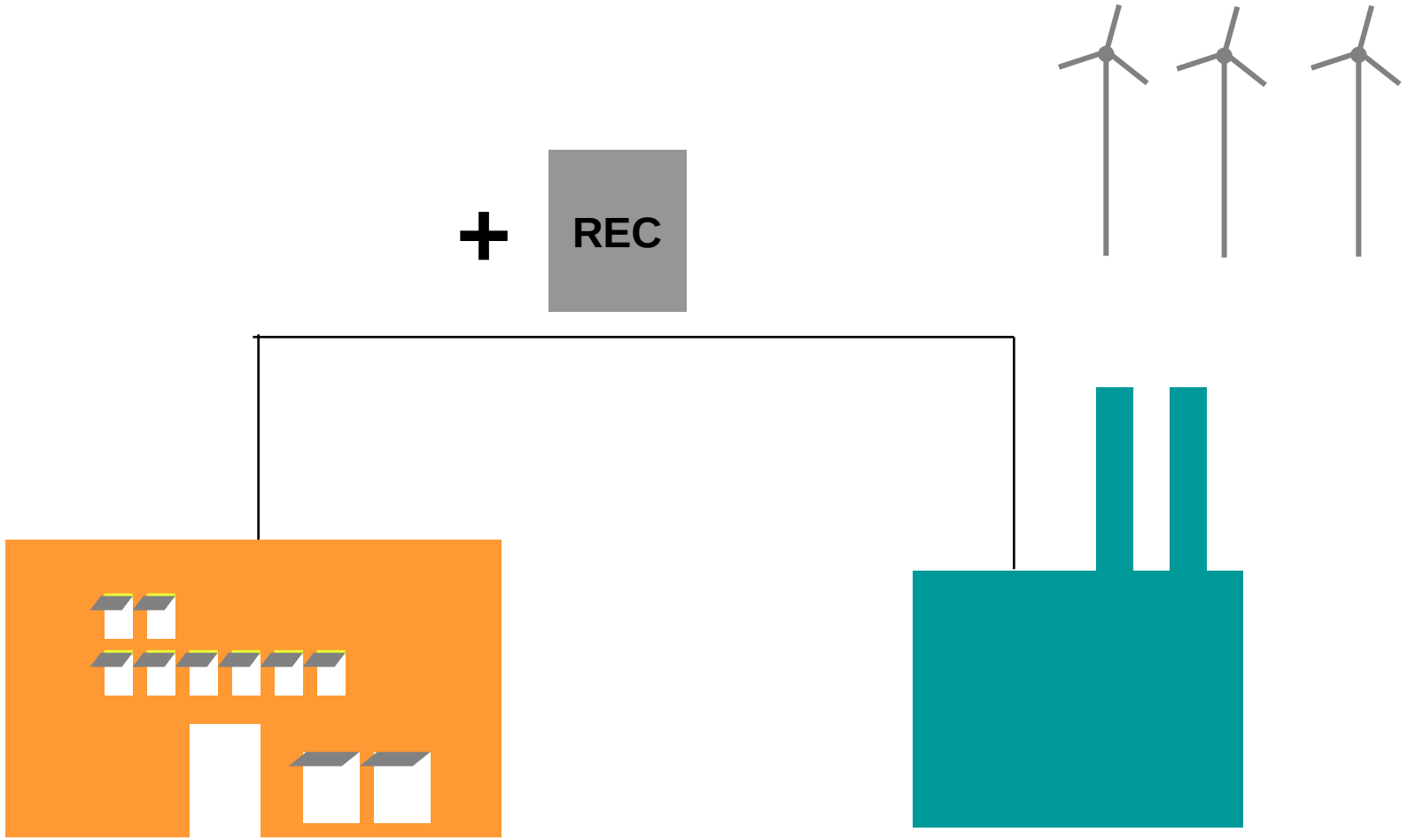
Other

Energy Use Intensity



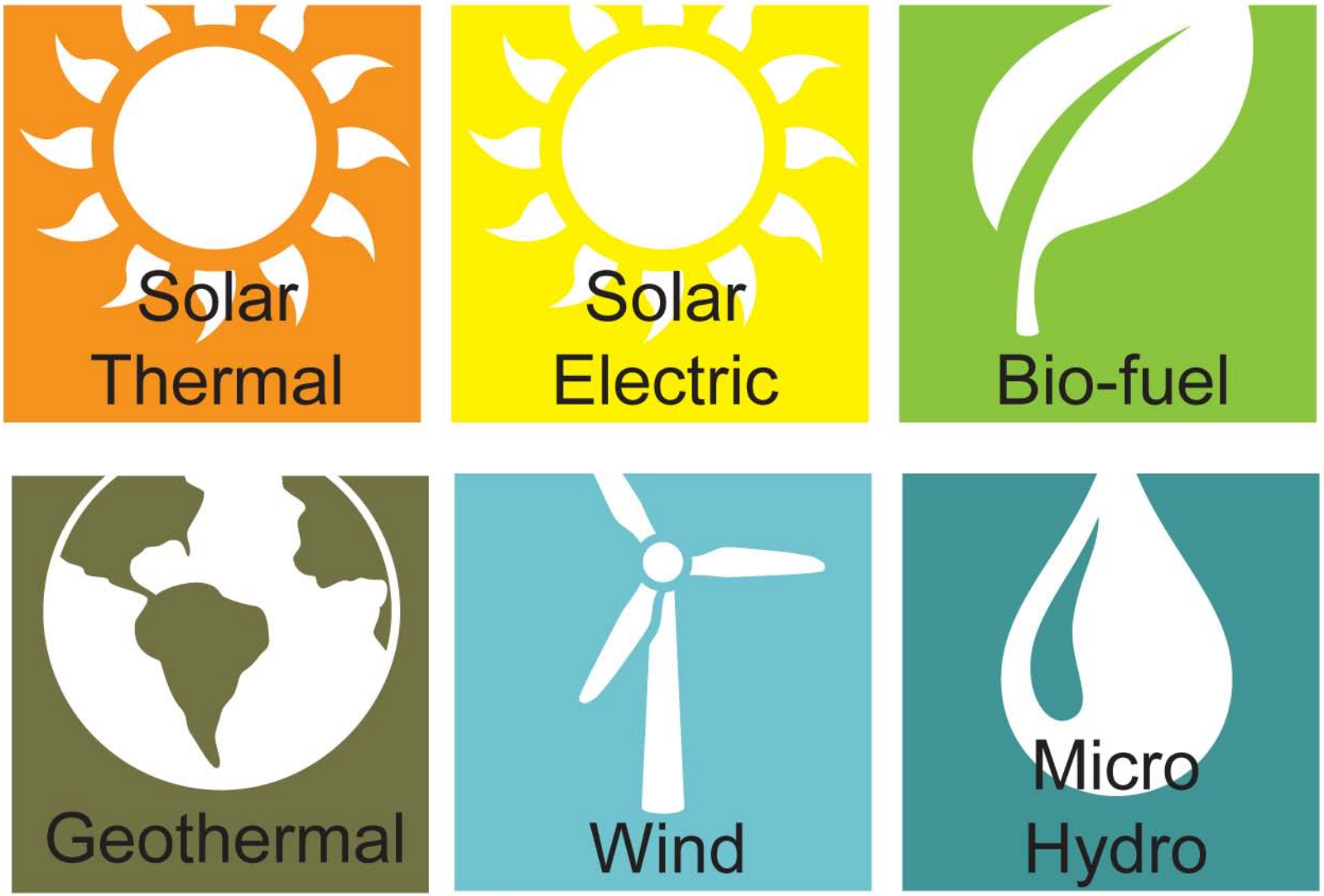
Renewable Electricity

Green Power

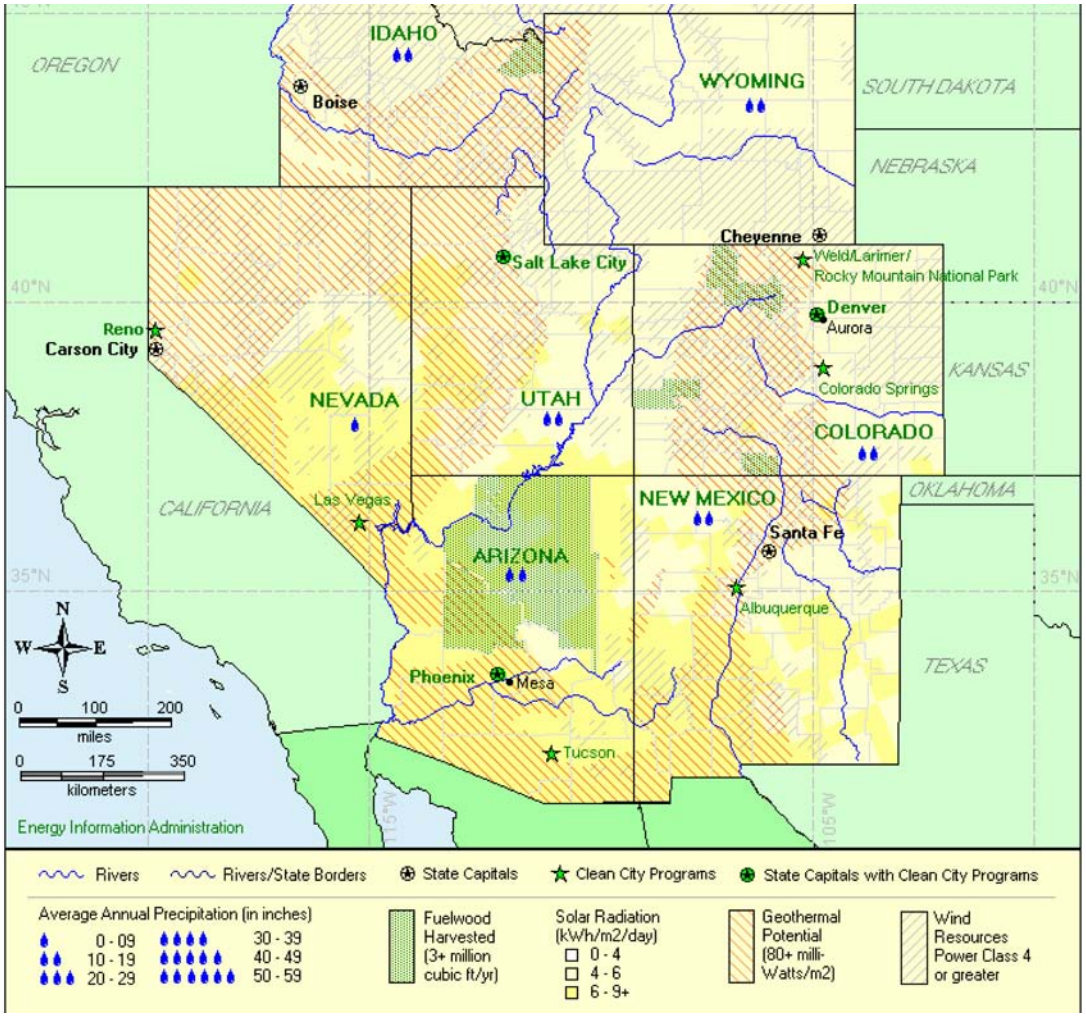


Renewable Energy Certificate (REC)

Green Power



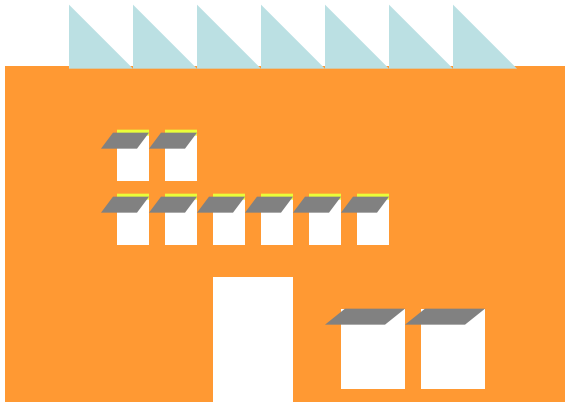
Renewable Energy



Renewable Energy Resources

Source: Energy Information Administration

Renewable Energy



Building Integrated PV (BIPV)

Approach

Reduce energy use first

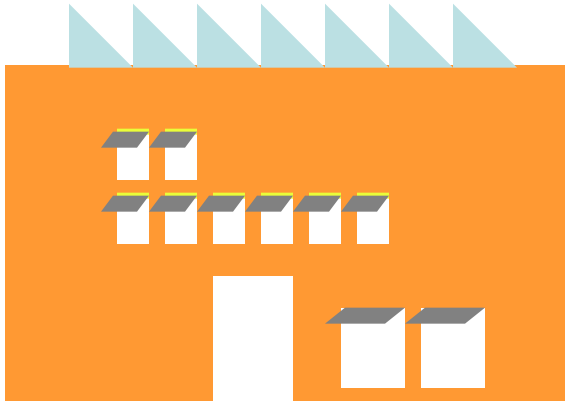
Determine PV goal and required size early

Design massing and form

- Solar access / prevent shading
- Provide adequate surface area

Use as part of the aesthetic / materials

Renewable Energy



Building Integrated PV (BIPV)

Financial

Use all incentives and rebates

- Federal 30% tax credit
- Xcel Solar Rewards

www.dsireusa.org

Determine the financial structure early

Power Purchase Agreements

Renewable Energy

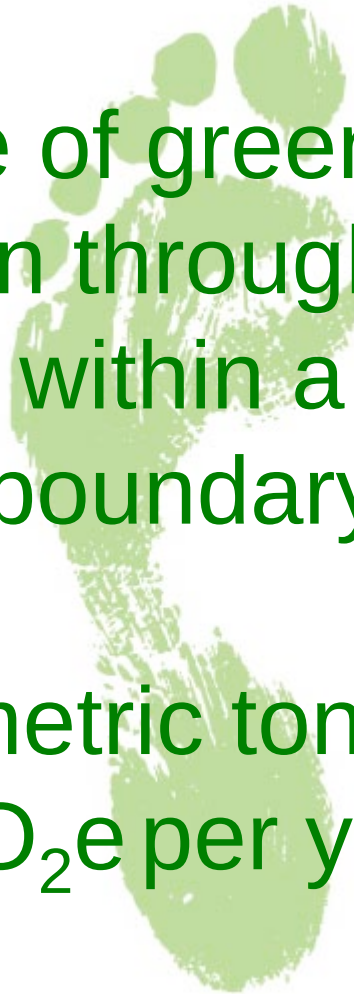
- Gets clean, renewable energy
- Gets a competitive long term power contract
- Provides roof or site area for PV

- Gets 30% Federal tax credit
- Gets Solar RECs from Utility
- Gets 20 year contract for power
- Installs and maintains equipment

- Gets to claim renewable energy toward renewable portfolio standard
- Provides net metering

Power Purchase Agreement (PPA)

Carbon Footprints



A measure of greenhouse gas emission through human activity within a defined boundary.

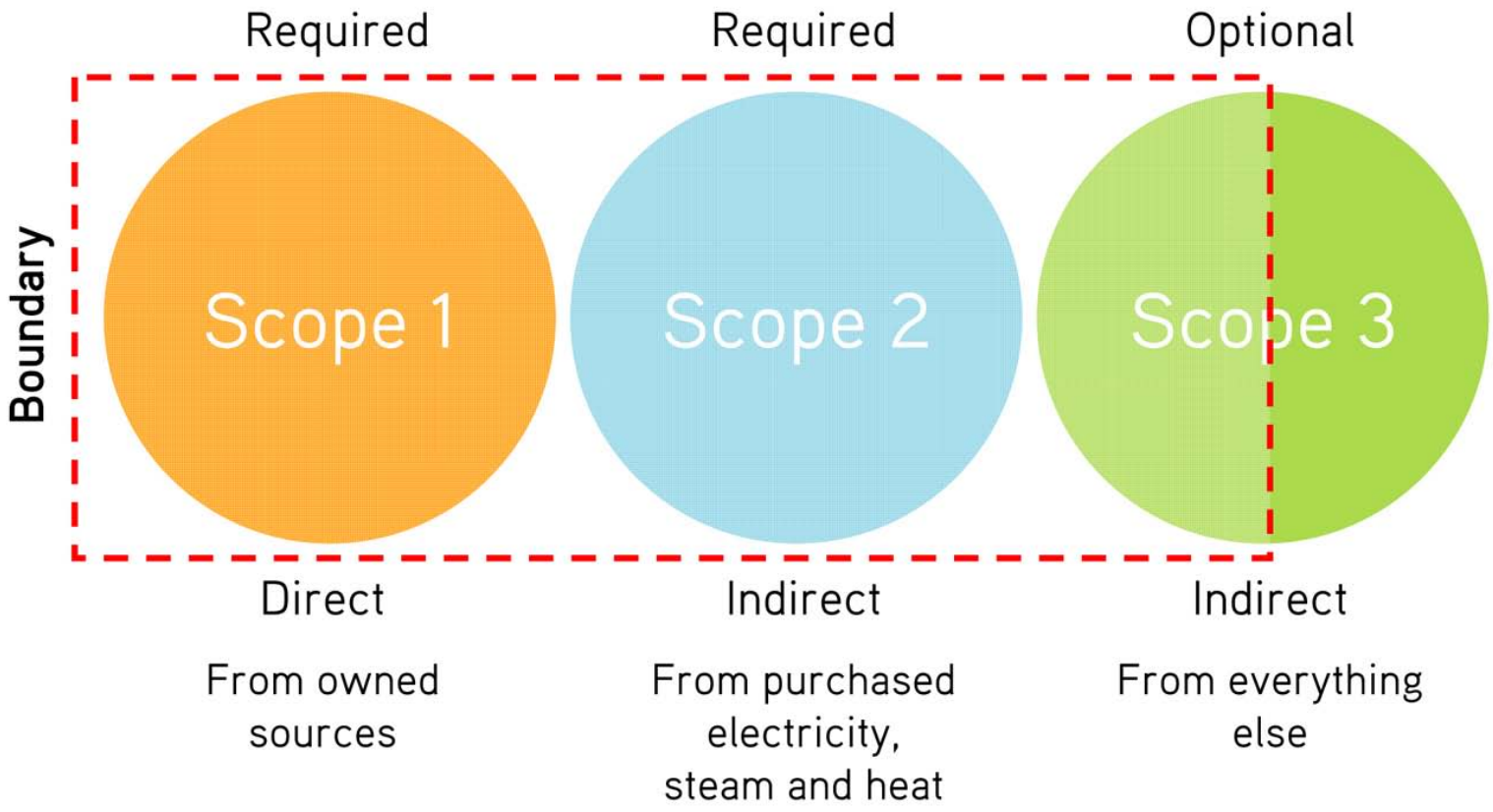
Typically metric tons of CO_2 or CO_2e per year

Carbon Footprints

Footprint = Annual Energy x Emission Factor

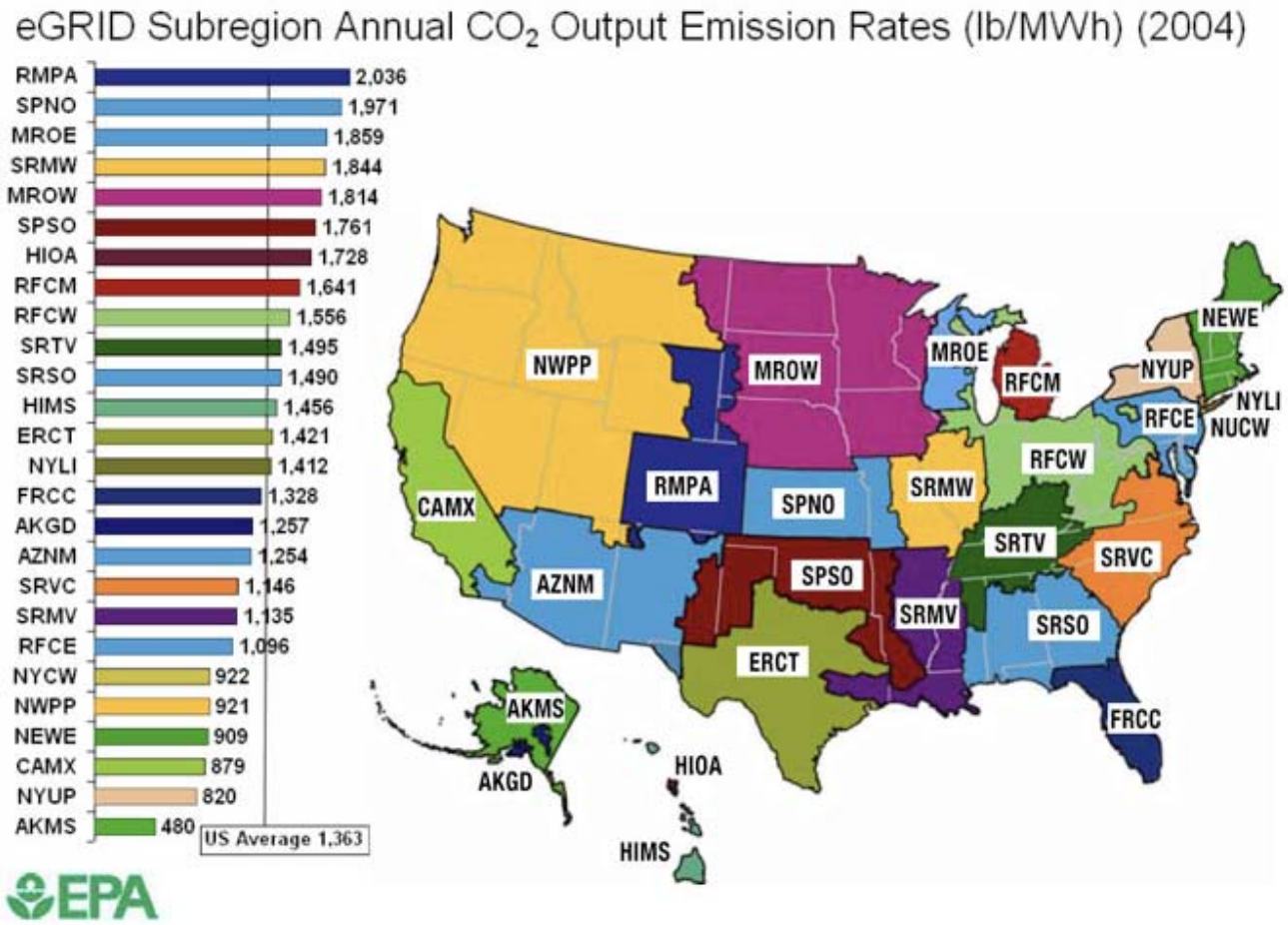
CO_2 = kBtu/yr x CO_2/kBtu

Carbon Footprints

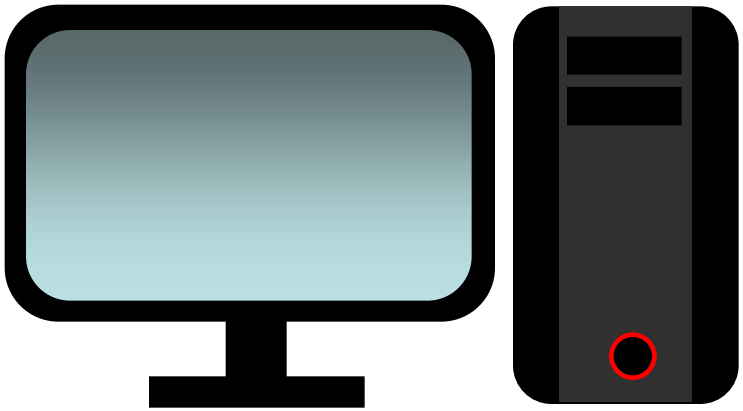


Carbon Footprints

Carbon Footprint
Emission Factors



Carbon Footprints



Carbon Footprint
Emission Factors
Data Sources

ENERGY STAR Target Finder

NREL “Source Energy and Emission Factors for Energy Use in Buildings”

eGRID

Building Carbon Footprints

Carbon Footprint Emission Factors

Emission factor for electricity in Colorado:

2.100 LB of CO_2/kWh or

0.615 LB of CO_2/kBtu

Emission factor for natural gas:

133.60 LB of CO_2/1000 ft^3 or

0.130 LB of CO_2/kBtu

Source: NREL “Source Energy and Emission Factors for Energy Use in Buildings”

Carbon Footprints

Carbon Footprint Emission Factors

Emission factor for vehicular travel:

1 gallon of gas = 19.4 LB of CO_2

20 MPG = 0.970 LB of CO_2 / Mile

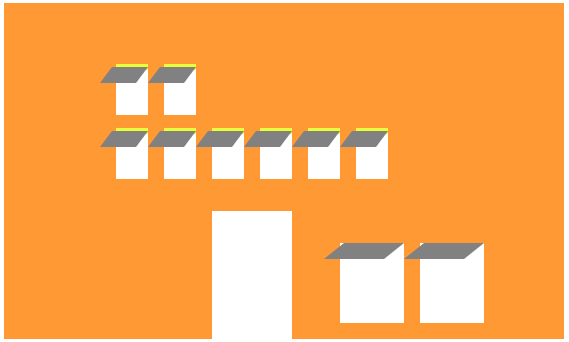
Carbon Footprints

Getting to Work

Average worker

car commute to/from work

5,850 LBS of CO_2/year



At Work

Average worker

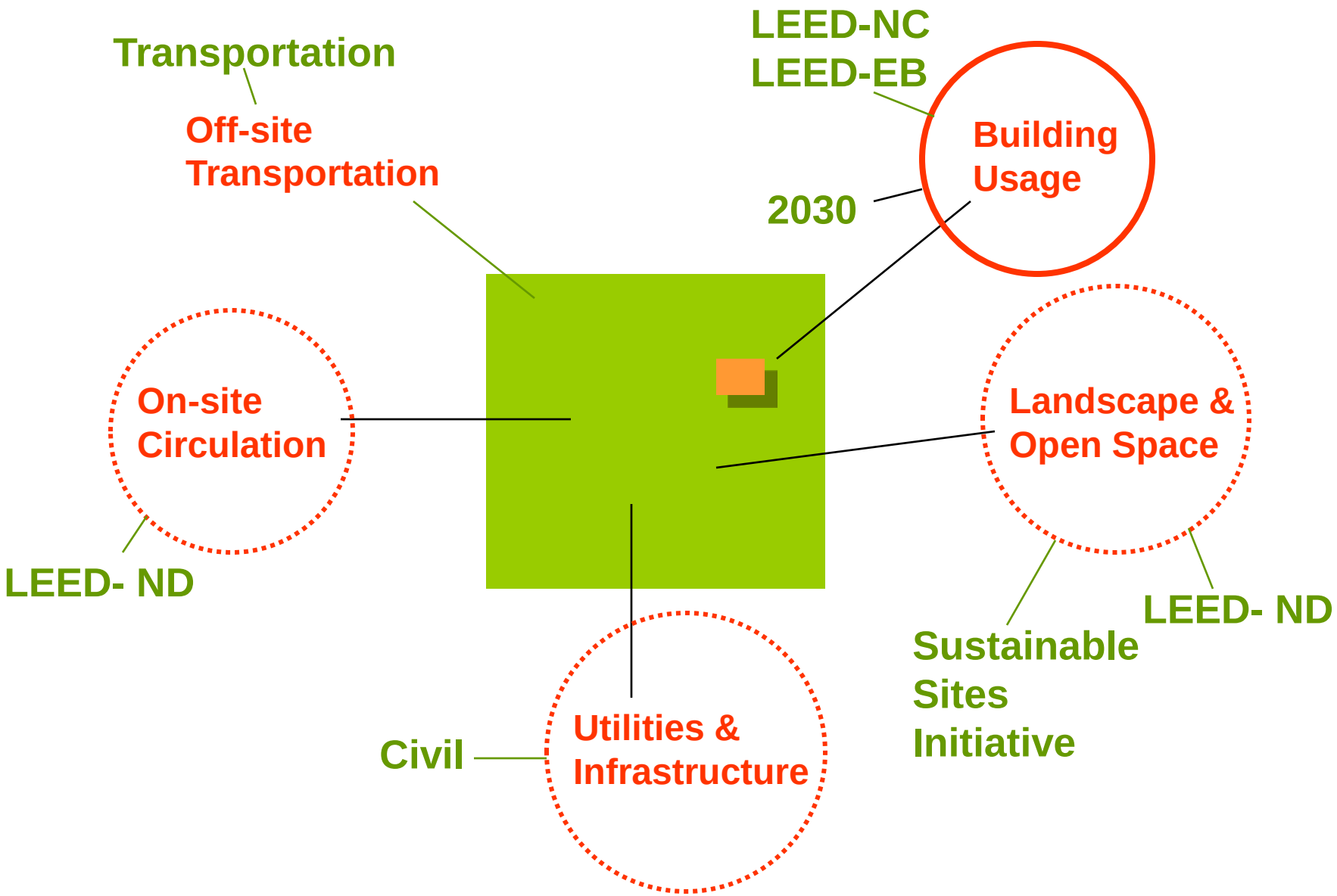
In an average office

9,330 LBS of CO_2/year

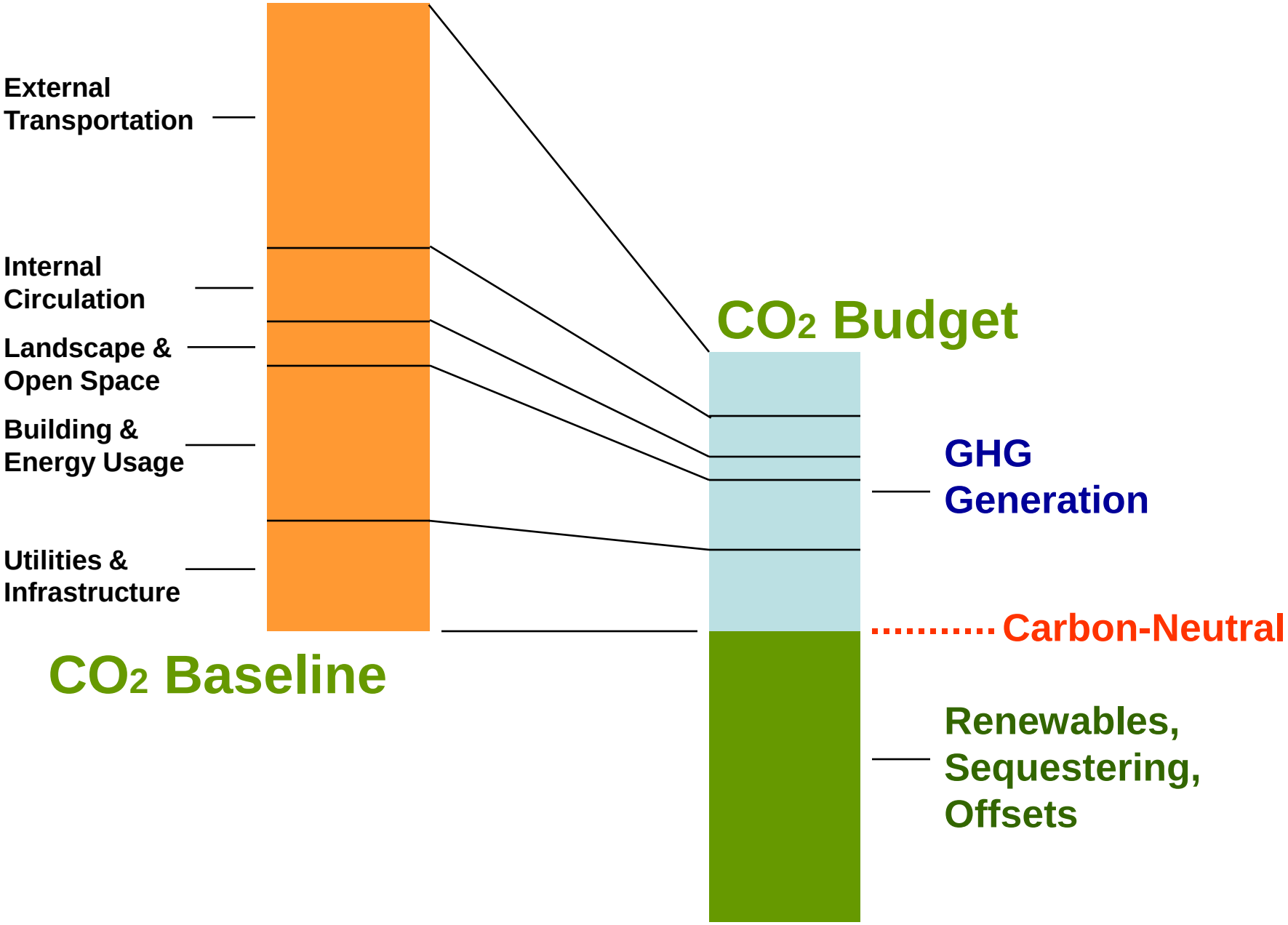
In a Energy Star 90 office

4,160 LBS of CO_2/year

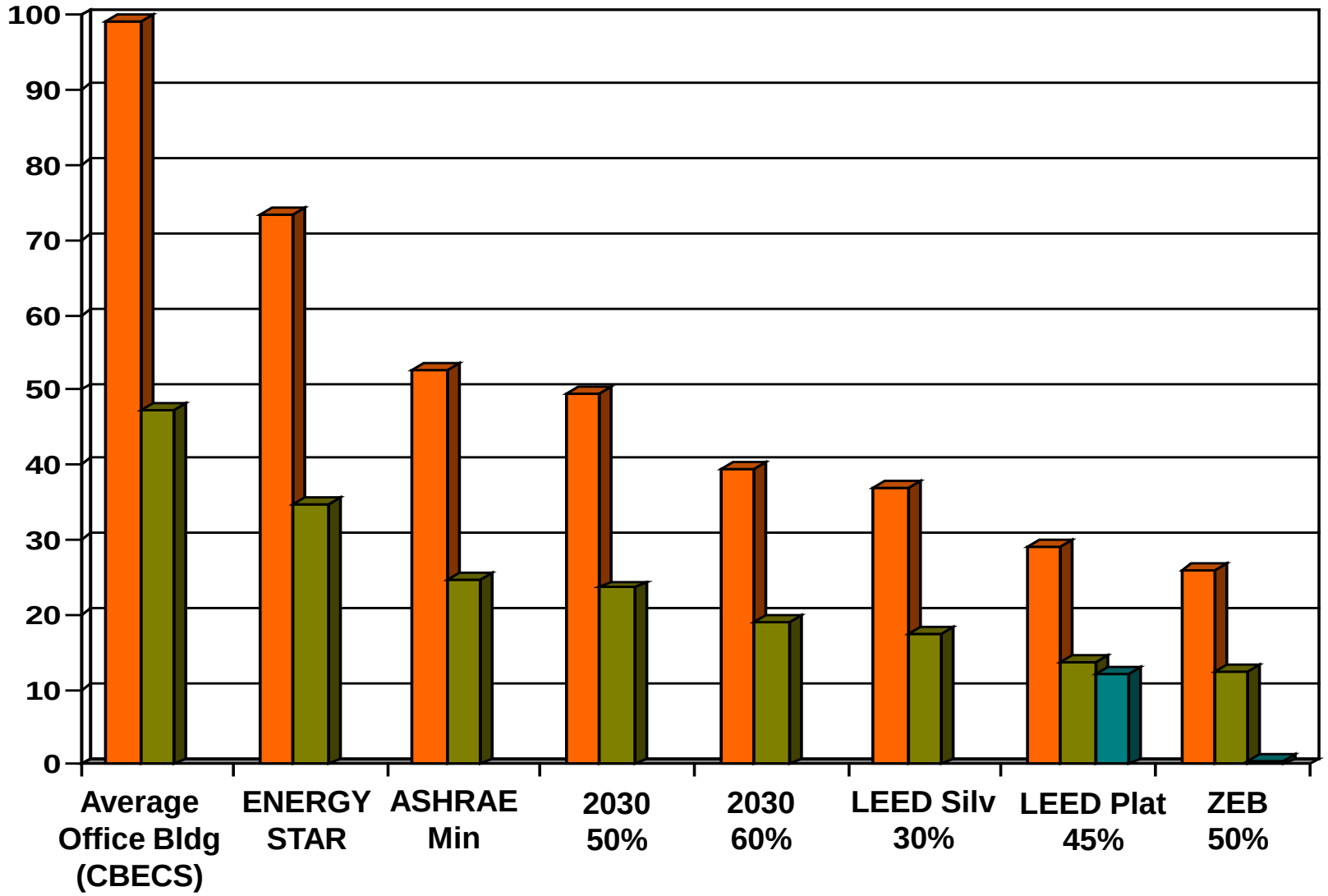
Carbon Footprints



A Development Scale Model



Carbon Neutral Development?



EUI – kBtu/sf/yr

Carbon – lb/sf/yr

Carbon after RE – lb/sf/yr

135,000 SF Office Building

Climate Zone 3

540 Employees / 40 hours a week

Credit Weightings

LEED-NC 2009 & Carbon

Weighted against 13 EPA TRACI impact categories

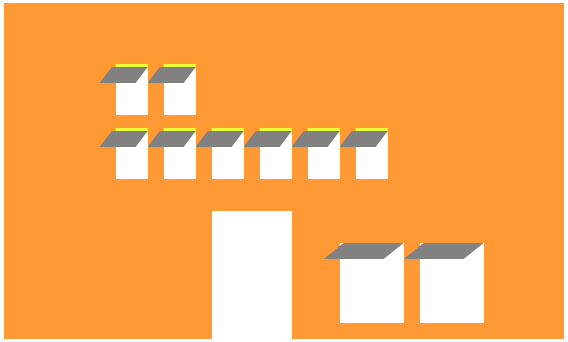
Carbon Footprint is the top weighted impact category.

The impact categories are applied to different activity groups

Building Systems, Transportation, Water, Materials and Land Use

Credit Weightings

LEED-NC 2009 & Carbon



Prototype Building

Building Systems

135,000 SF office building

Climate zone 3

ENERGY STAR 50

9 to 5, 5 days a week, 250 days a year

540 full time employees

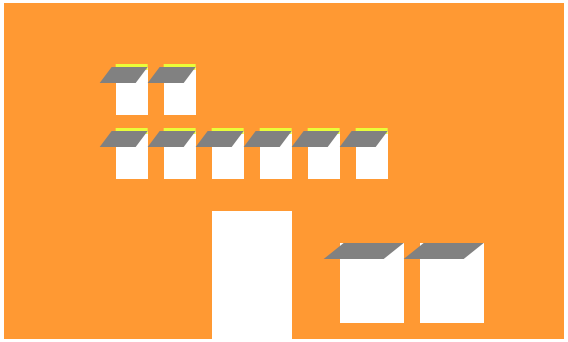
No on-site renewable energy

80% energy from electricity

Electricity emissions based on national average

Credit Weightings

LEED-NC 2009 & Carbon



Prototype Building

Transportation

9 to 5, 5 days a week, 250 days a year

20.5 mile average daily roundtrip commute

21 MPG

74% drive alone

12% carpool

4% rail

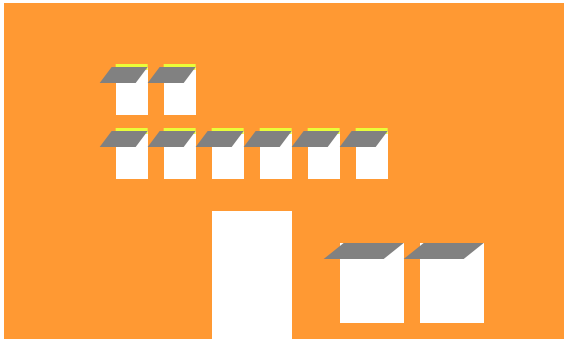
3% bus

1% bicycle

1% walk

Credit Weightings

LEED-NC 2009 & Carbon



Prototype Building

Water

50/50 male/female split

Conventional fixtures

1 acre of landscaping

Trees and shrubs

Climate zone 3

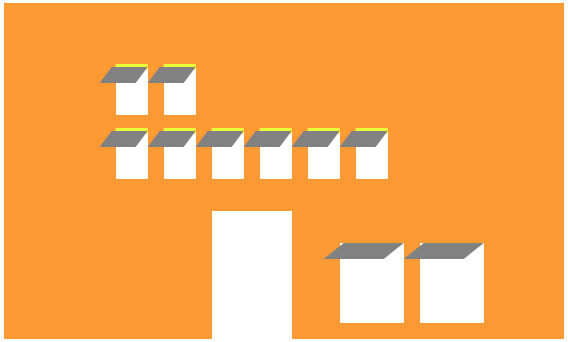
Conventional irrigation

Potable water

National average embodied energy

Credit Weightings

LEED-NC 2009 & Carbon



Prototype Building

Materials / Solid Waste / Land Use

Two story steel construction

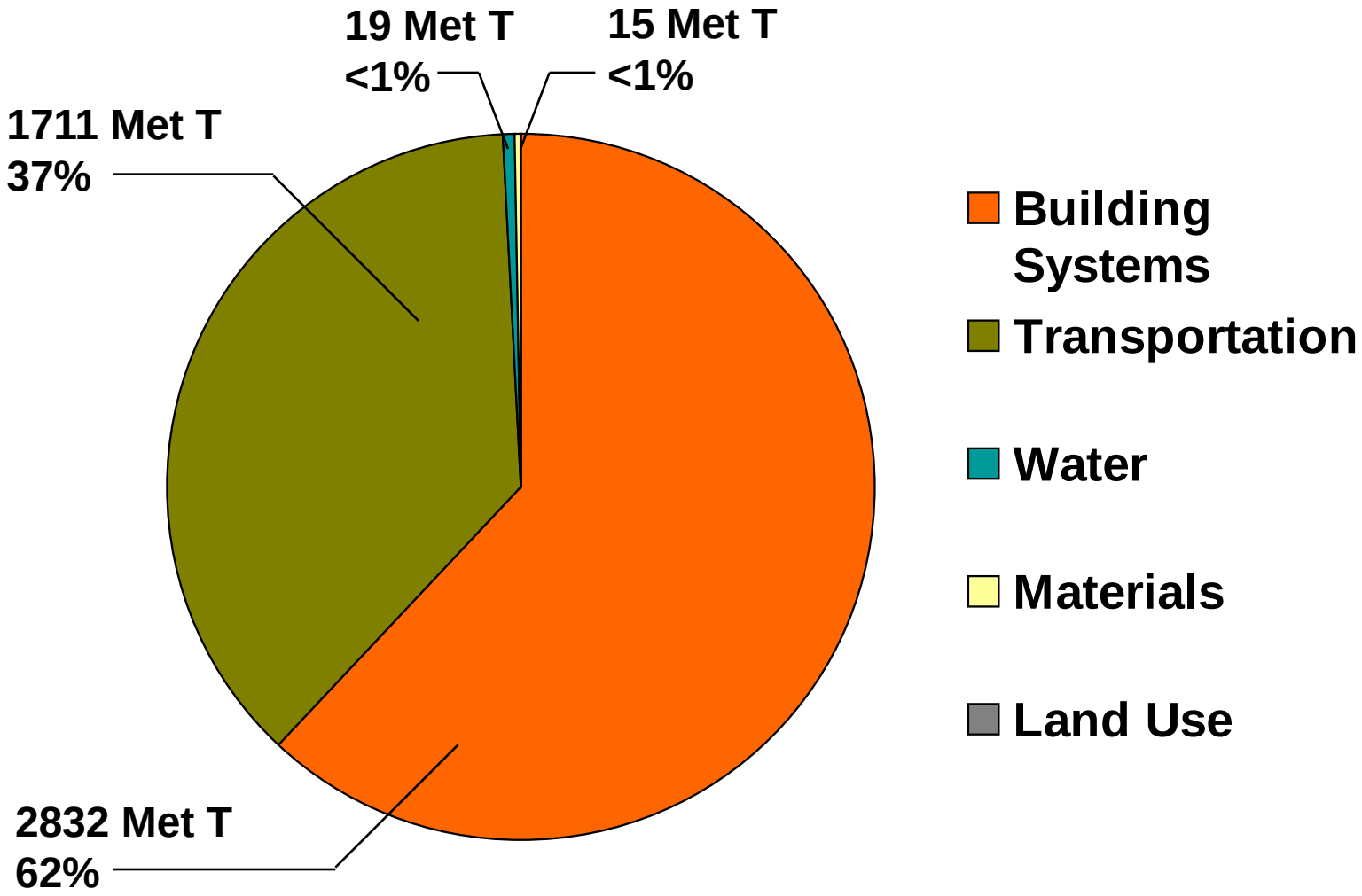
67,000 SF footprint

109,950 SF surface parking lot

Solid waste of 4.9 tons/1000 SF

Credit Weightings

LEED-NC 2009 & Carbon

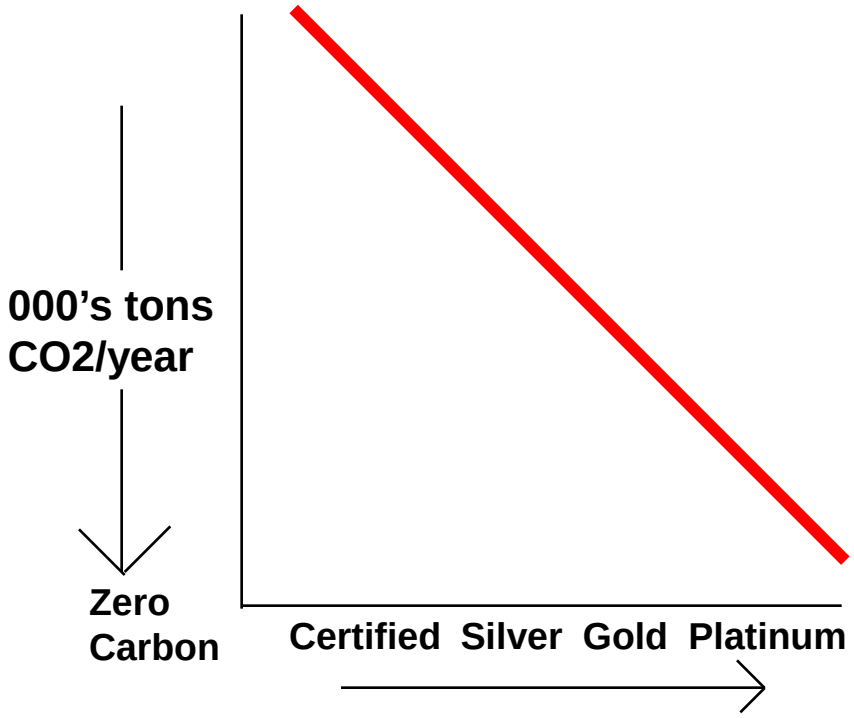


Credit Weightings

LEED-NC 2009 & Carbon

Reducing Carbon Footprints

Green Buildings
Neighborhood Infill
Mixed Use
Neighborhood Infill
Site Design



The LEED-Carbon Curve

LEED-ND Smart Location & Linkage

Project Location:

Brownfield, utilities, infrastructure, schools, wetlands, surrounding development, infill or greenfield

…affects modal choice, trip length, VMT—can convert to $mTCO_2$

LEED-ND Neighborhood Pattern & Design

Urban Design:

Compact development, walkability, access to open space and public facilities, street network, housing types

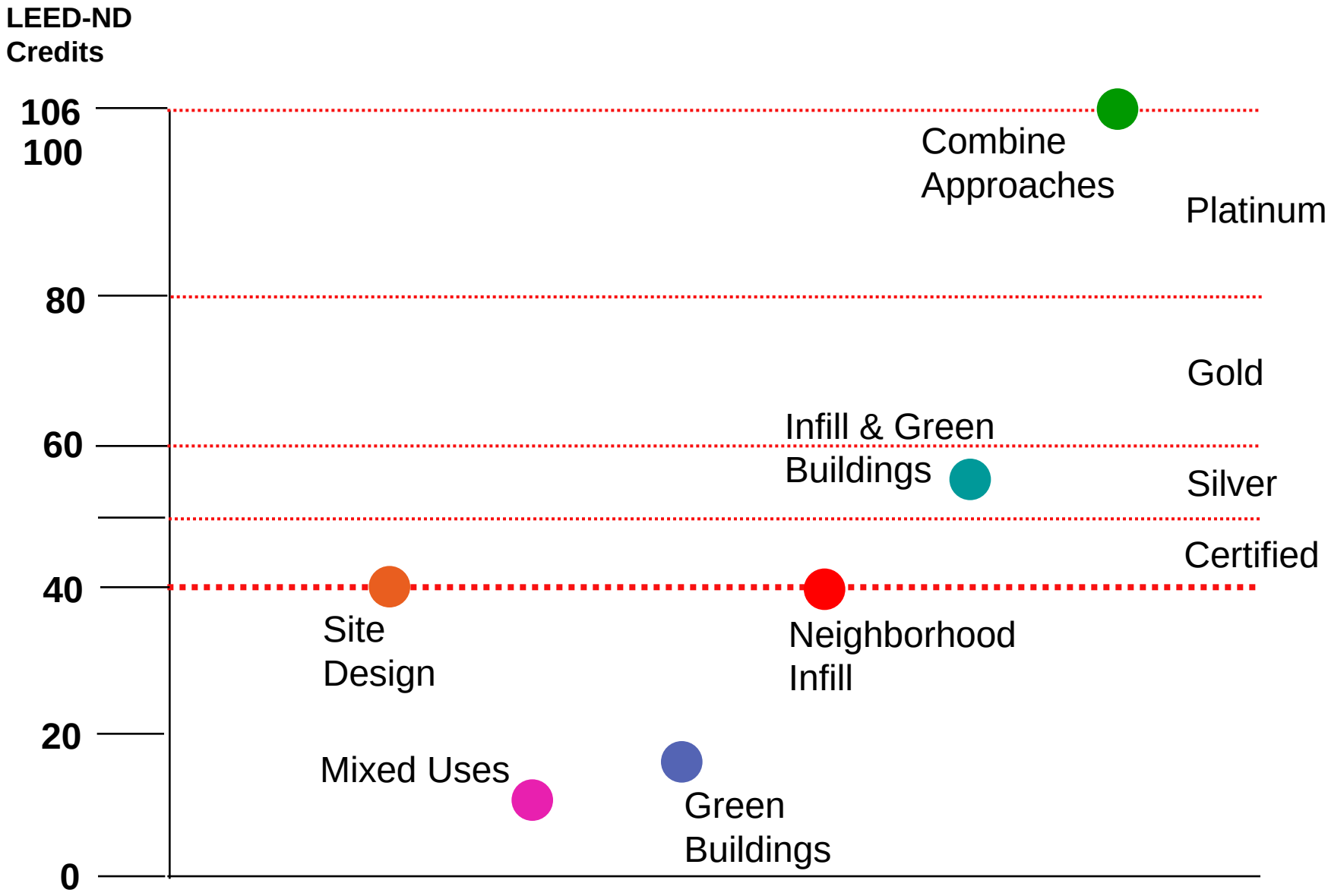
…density (energy), VMT reduction, trips avoided, pedestrian opportunities

LEED-ND Green Construction & Technology

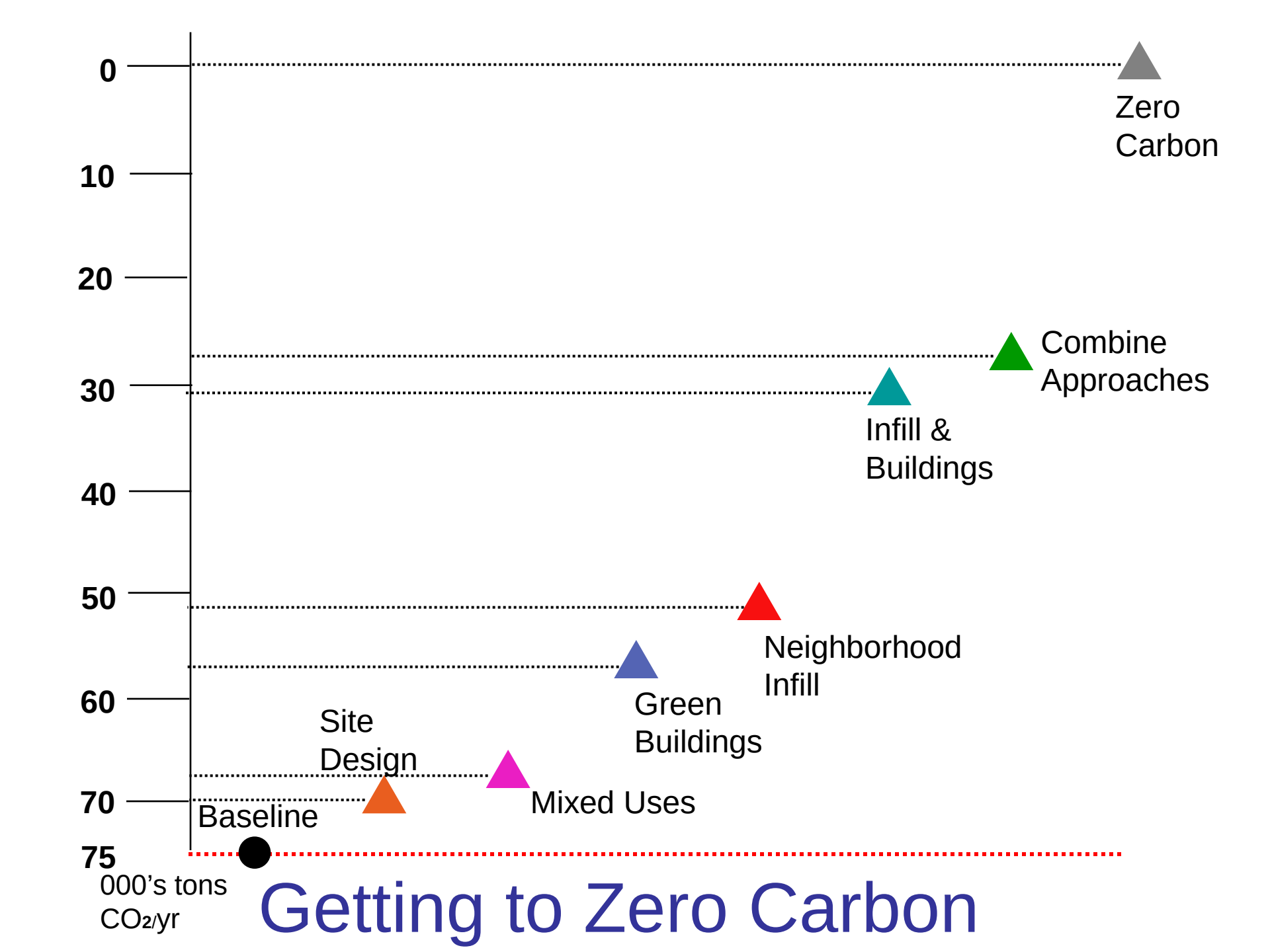
Architecture,
Engineering,
Landscape:

Stormwater management,
energy conservation,
renewables, waste,
solar orientation

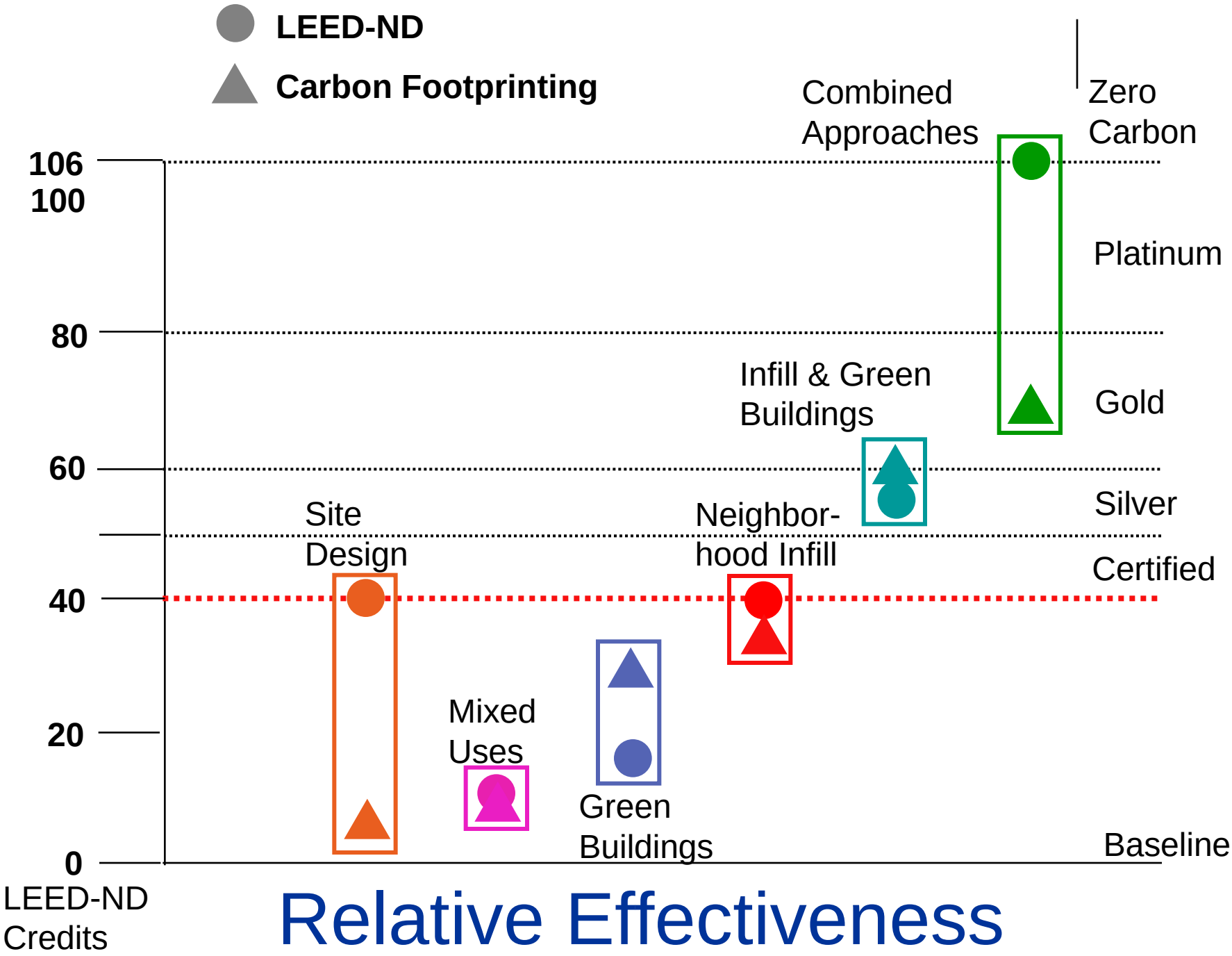
…carbon sequestering, water, net reduction of CO_2



LEED-ND: Getting to Platinum



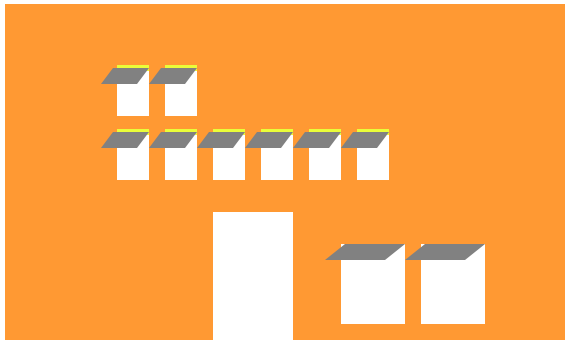
Getting to Zero Carbon


LEED-ND
Carbon Footprinting
Combined Approaches
Zero Carbon
106
100
80
60
40
20
0
Platinum
Gold
Silver
Certified
Baseline
Infill & Green Buildings
Site Design
Neighbor-hood Infill
Mixed Uses
Green Buildings
LEED-ND Credits
Relative Effectiveness

Characteristics of Development Model

- Comprehensive
- Strategic
- Easy to Use—menu driven
- Able to be Refined—with additional input
- Quantitative--measurable

Baseline Carbon Model

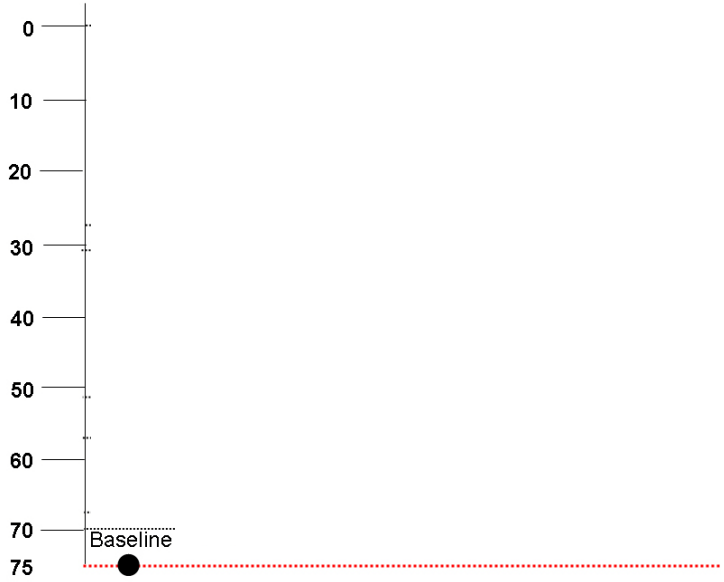


Greenfield 200 acres

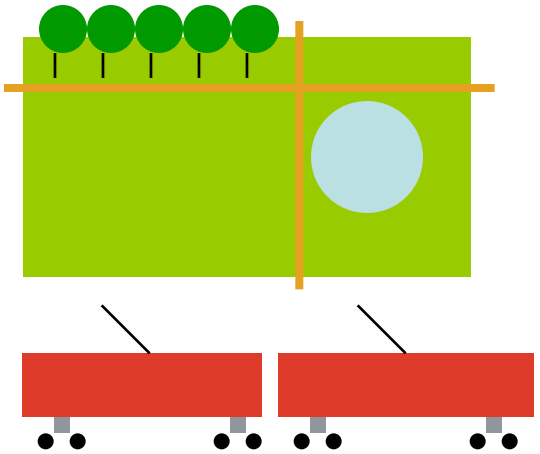
Single use office park at .3 FAR

Buildings built to code

No renewables



Buildings:	27,330 Tons CO2
Trips:	47,470 Tons CO2
Total:	74,800 Tons CO2

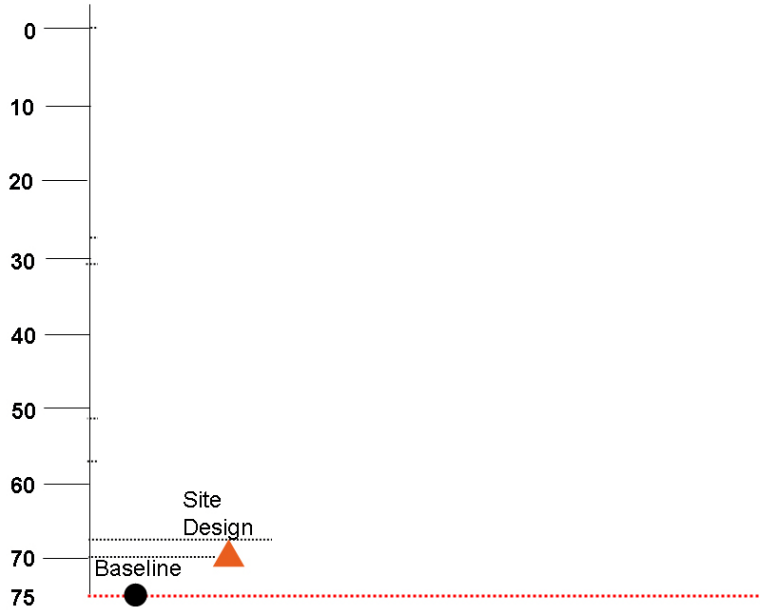


Site Design

Street Connectivity

Ped Walks & Open Space

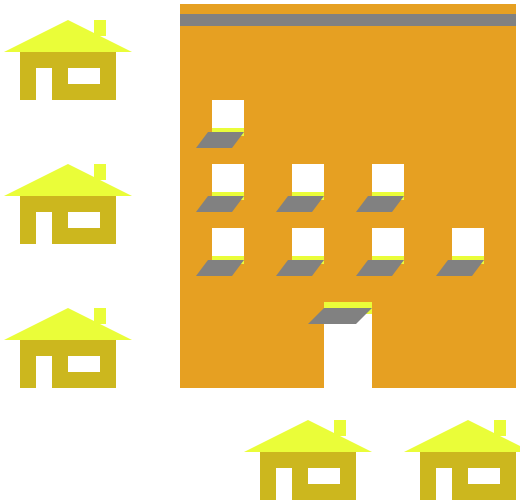
Transit Proximity

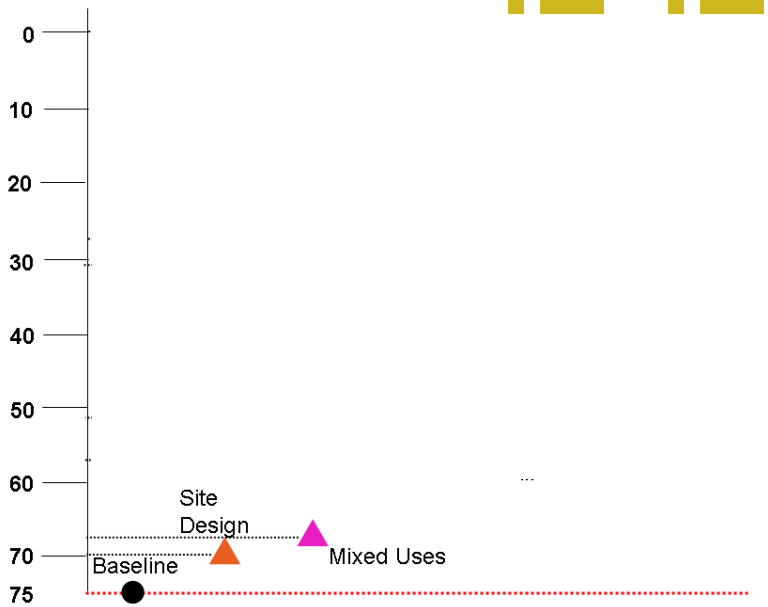


Buildings: 27,300 Tons CO2

Trips: 42,720 Tons CO2

Total: 70,020 Tons CO2





Mixed Uses:

Same 200 acres of office mixed with retail & residential

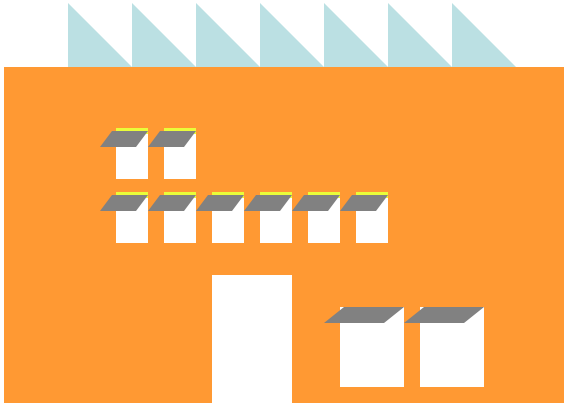
More trips internalized—change to walking

Reduces "peaking"—better use of access road capacity

Buildings: 27,330 Tons CO2

Trips: 40,350 Tons CO2

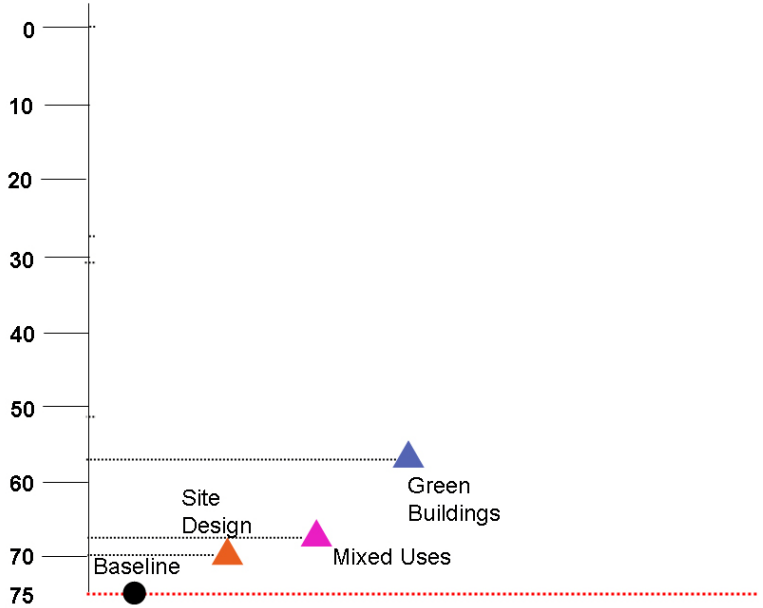
Total: 67,680 Tons CO2



Green Buildings

Phased reductions in energy

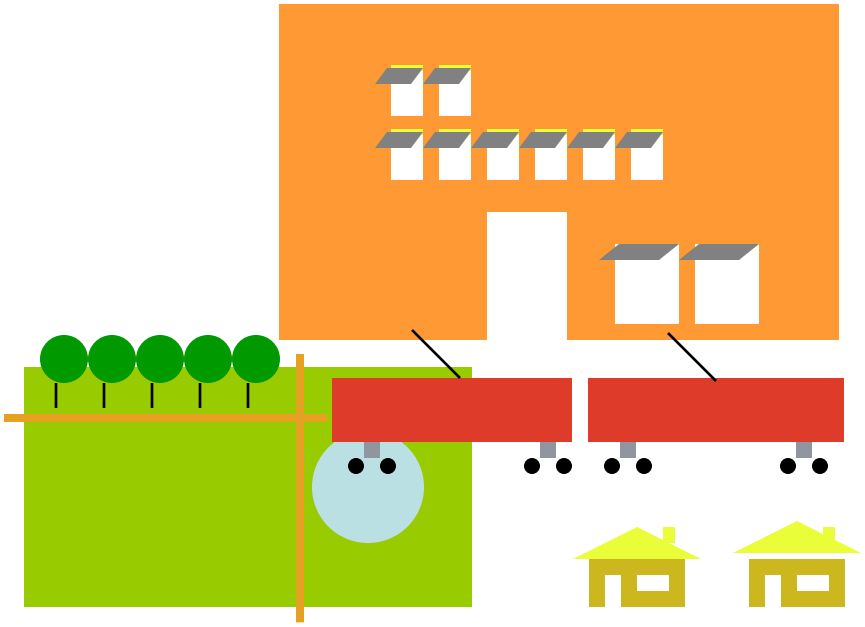
Initial 50% reduction based on code equivalents



Buildings: 8,200 Tons CO2

Trips: 47,470 Tons CO2

Total: 55,670 Tons CO2



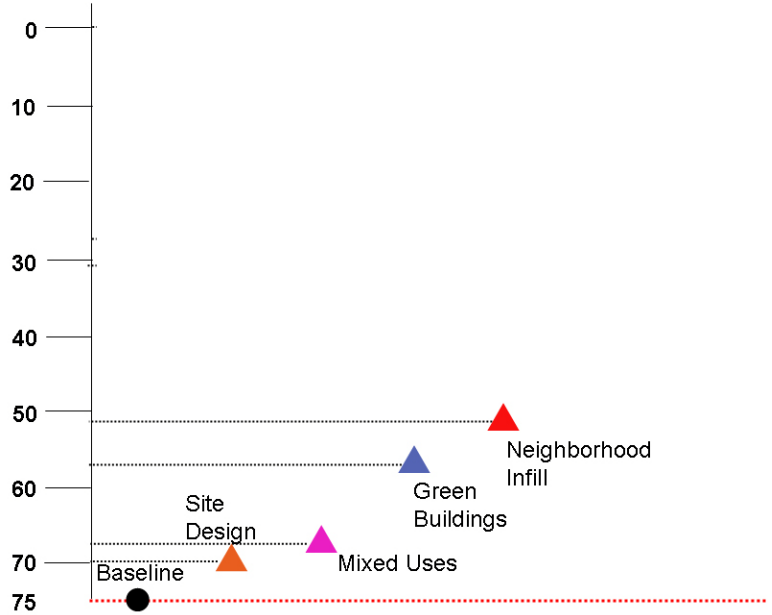
Neighborhood Infill :

Mixed uses fill in around office

Shorter trips to adjacent uses

Shared parking still works

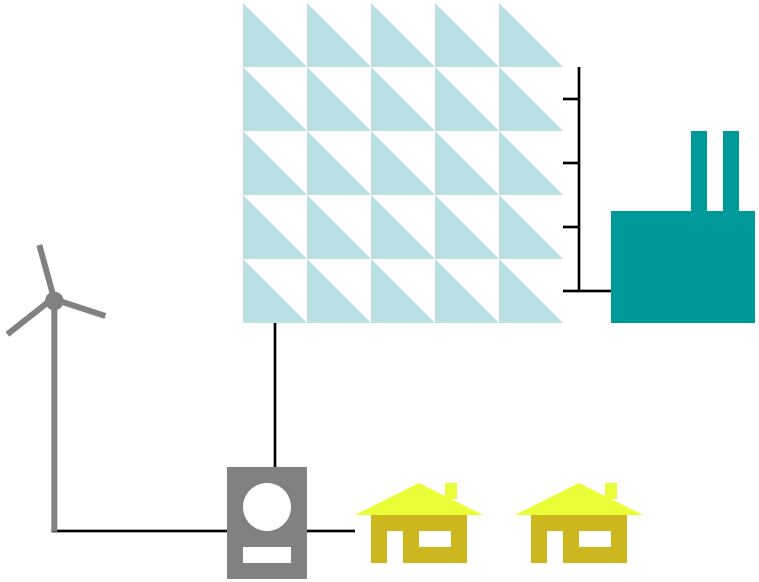
Add transit access



Buildings: 27,330 Tons CO2

Trips: 22,780 Tons CO2

Total: 50,110 Tons CO2



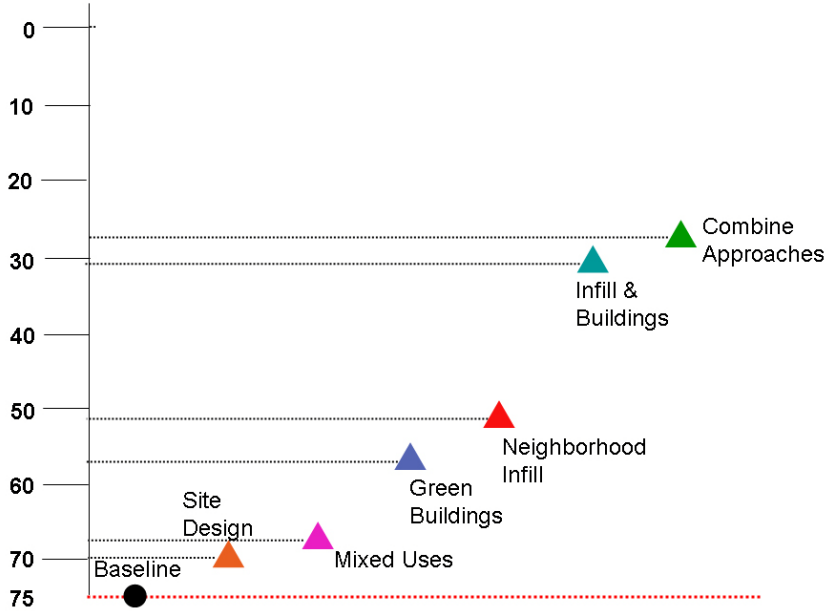
Combined Techniques

Mixed Use

Bldgs: 2030 Challenge

Neighborhood Infill

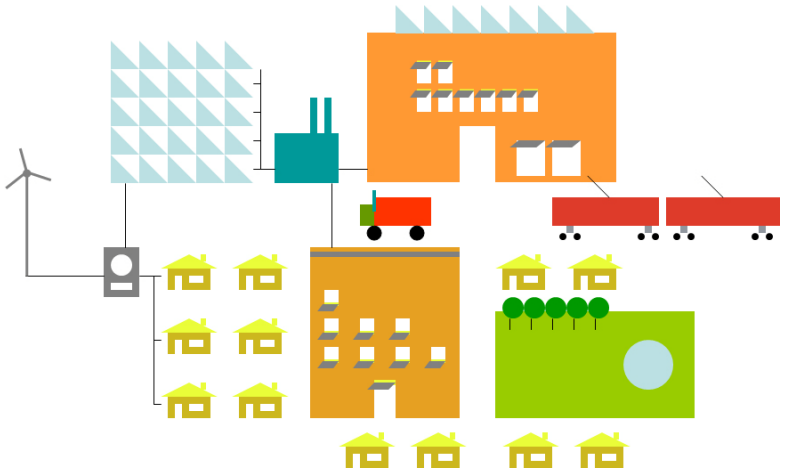
Site Design

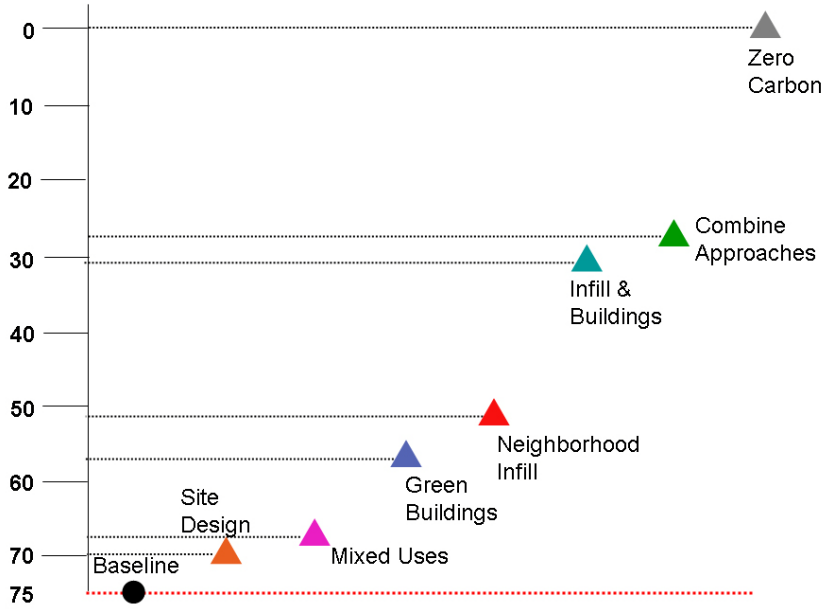


Buildings: 8,200 Tons CO2

Trips: 18,160 Tons CO2

Total: 26,360 Tons CO2





Zero Carbon Development

Zero Energy Buildings

PV on Parking & Building Roofs

Reduce Program

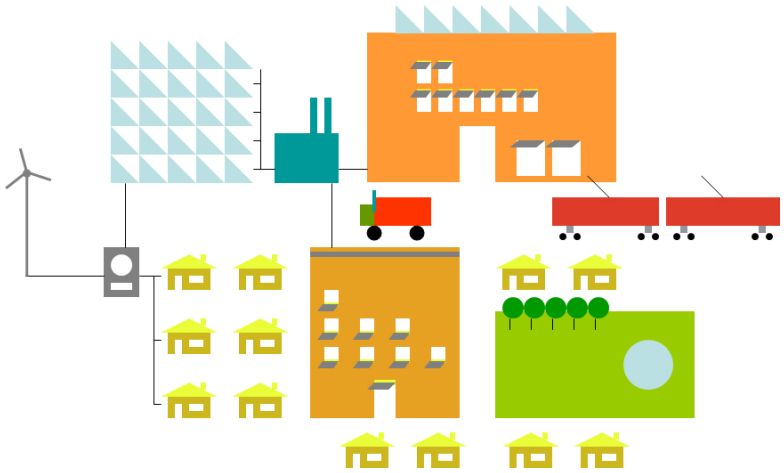
Aggressive TMA & Site-Wide

Buildings: 0 Tons CO2

Trips: 18,160 Tons CO2

- Other: (18,200)Tons CO2

Total: 0 Tons CO2



Zero Carbon Development

What makes up the remaining offset of 18,200 Tons CO2?

- Development has great leverage on climate change
- Demand side strategy can be no cost
- Measurement is key to success
- Comprehensive model is needed
- LEED and carbon neutrality are same quest
- Combining approaches has most value
- Regulation is already here—more coming

Conclusions

Community Inventory & Update

Adopt Climate Action Plan

Set Comprehensive Community Goals-LEED

Define Carbon Budgets for New Development

Build Carbon Footprinting into Project Review

What Can a Community Do?