



Retrofit - Police Station



Autocase

LEED

Planet People Profit Impact
(P³I) Analysis
Documentation



Application Towards

Informing Design Using Triple Bottom
Line Analysis
(INpc113)

and

Informing Design by Major Credit
Category Using Triple Bottom Line
Analysis
(INpc122)



Total Value of LEED Investments Analyzed



Summary

This project is a police station type building located in Texas, US and has an occupied floor space of 31,000 ft². A triple-bottom line cost-benefit analysis (TBL- CBA) has been performed to assess the financial, social and environmental outcomes associated with 39 of the points achieved. This analysis looks at the costs and benefits, over a 51-year study period, of these points in the following LEED credits: Building Life-cycle Impact Reduction, Construction and Demolition Waste Management, Optimize Energy Performance, Enhanced Commissioning, Renewable Energy Production, Green Power and Carbon Offsets, Enhanced Refrigerant Management, Indoor Water Use Reduction, Outdoor Water Use Reduction, Low-Emitting Materials, Quality Views, Enhanced Indoor Air Quality Strategies, Thermal Comfort, Interior Lighting, Daylight, Heat Island Reduction, Open Space, Rainwater Management, Bicycle Facilities and Green Vehicles. -\$3,810,736 of the total value is attributed to financial outcomes and \$9,572,208 are attributed to social and environmental ones. These values are in net present value (NPV), summing the total of the costs and benefits through the study period, with a value greater than zero representing more benefit than cost. \$5,761,472 is total value of the credits assessed, representing the return on investment across the triple bottom line.

Total LEED Points



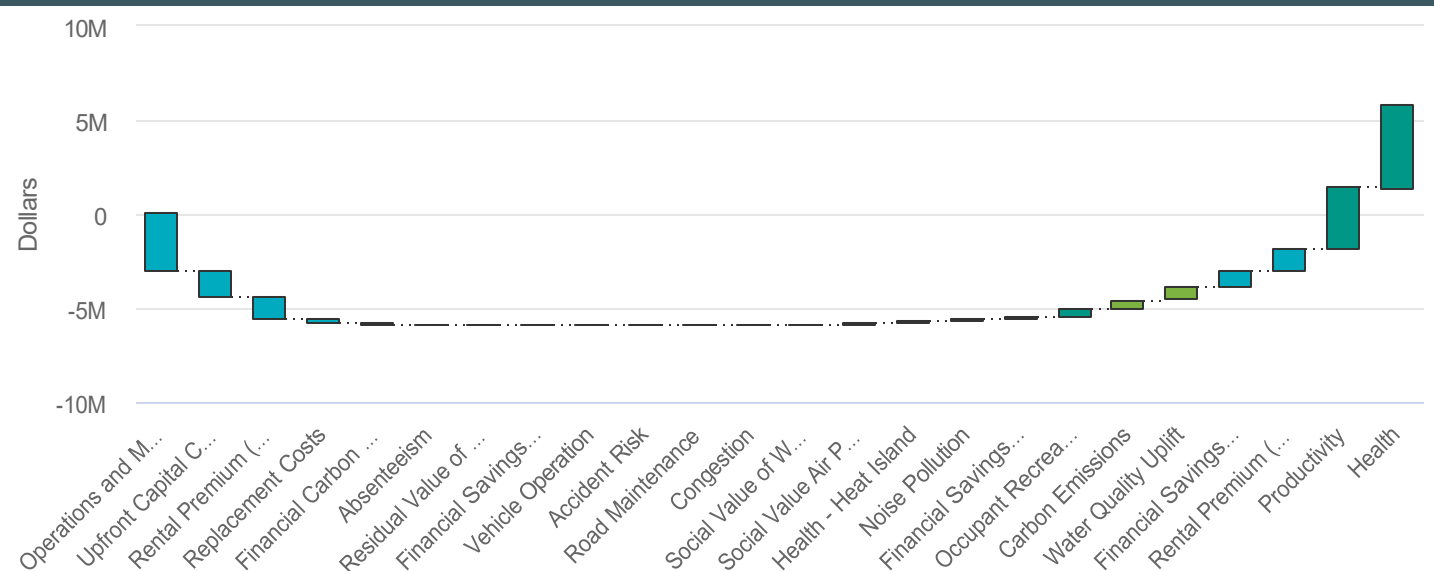
Total Value per Point

\$147,730

Total Carbon Reduction

7,155 MtCO₂e

Value by Impact



TBL Category	Cost or Benefit Category	Lifetime Value
Financial	Financial Savings from Electricity	\$819,000
Financial	Financial Carbon Costs	-\$99,500
Financial	Financial Savings from Water	\$117,700
Financial	Financial Savings from Electric Vehicles	\$2,310
Financial	Upfront Capital Costs	-\$1,379,700
Financial	Replacement Costs	-\$205,170
Financial	Residual Value of Assets	\$1,234
Financial	Operations and Maintenance Costs	-\$3,066,610
Financial	Rental Premium (Owner)	\$1,217,000
Financial	Rental Premium (Tenant)	-\$1,217,000
Social	Absenteeism	-\$6,000
Social	Health	\$4,416,000
Social	Noise Pollution	\$105,300
Social	Congestion	\$12,400
Social	Road Maintenance	\$10,300
Social	Accident Risk	\$6,310
Social	Vehicle Operation	\$4,170
Social	Health - Heat Island	\$78,800
Social	Occupant Recreation	\$453,100
Social	Productivity	\$3,258,600
Environmental	Social Value Air Pollution	\$70,915
Environmental	Carbon Emissions	\$454,413
Environmental	Social Value of Water	\$22,100
Environmental	Water Quality Uplift	\$685,800
Financial		-\$3,810,736
Social		\$8,338,980
Environmental		\$1,233,228
Net Present Value (NPV)		\$5,761,472

Credits included in this project	
	Building Life-cycle Impact Reduction
	Construction and Demolition Waste Management
	Optimize Energy Performance
	Enhanced Commissioning
	Renewable Energy Production
	Green Power and Carbon Offsets
	Enhanced Refrigerant Management
	Indoor Water Use Reduction
	Outdoor Water Use Reduction
	Low-Emitting Materials
	Quality Views
	Enhanced Indoor Air Quality Strategies
	Thermal Comfort
	Interior Lighting
	Daylight
	Heat Island Reduction
	Open Space
	Rainwater Management
	Bicycle Facilities
	Green Vehicles

LEED Pilot Credit Checklist	
<input type="checkbox"/>	Minimum of 6 total LEED credits analyzed



Inputs



Inputs Summary

General Inputs	
Location	Texas, US
Building Types	police station
Building Size	31,000 ft ²
Site Size	3 acres
Is LEED ID+C Project?	No

Building Life-cycle Impact Reduction	
How many LEED points did you achieve with this credit?	4
Base Case Total CO ₂ e	100000
Percent reduction in CO ₂ e in the design	50 %
Use Autocase Cost?	No
Incremental Initial capital costs	20000 Dollars
Incremental Annually recurring non-utility O&M costs	2000 Dollars
Incremental Replacement costs (as a percentage of initial costs)	100 %

Construction and Demolition Waste Management	
How many LEED points did you achieve with this credit?	1
Did you achieve this credit via Option 1 or Option 2	Option 2
Use Autocase Cost?	No
Incremental Initial capital costs	10000 Dollars
Incremental Annually recurring non-utility O&M costs	0 Dollars
Incremental Replacement costs (as a percentage of initial costs)	0 %

Optimize Energy Performance	
How many LEED points did you achieve with this credit?	6
What is the percent reduction in electricity consumption (excluding renewable energy) in your proposed design?	20 %
What is your baseline annual electricity consumption?	624771 kWh
Energy Input Type	Percent Reduction
What is your baseline annual natural gas consumption?	0 MMBtu
What is the percent reduction in natural gas consumption in your proposed design?	0 %
Use Autocase Cost?	No
Incremental Initial capital costs	500000 Dollars
Incremental Annually recurring non-utility O&M costs	5000 Dollars
Incremental Replacement costs (as a percentage of initial costs)	50 %

Enhanced Commissioning	
How many LEED points did you achieve with this credit?	4
What is your design's expected annual electricity consumption	499816.8 kWh
What is your design's expected annual natural gas consumption	0 MMBtu
Did you achieve this credit via Option 1 or Option 2	Option 2
Use Autocase Cost?	No
Incremental Initial capital costs	50000 Dollars
Incremental Annually recurring non-utility O&M costs	1000 Dollars
Incremental Replacement costs (as a percentage of initial costs)	25 %

Renewable Energy Production	
How many LEED points did you achieve with this credit?	1
Percent of renewable energy offsetting electricity	100 %
Annual Production	14653.55 kWh
Use Autocase Cost?	No
Incremental Initial capital costs	10000 Dollars
Incremental Annually recurring non-utility O&M costs	3000 Dollars
Incremental Replacement costs (as a percentage of initial costs)	50 %

Green Power and Carbon Offsets	
How many LEED points did you achieve with this credit?	2
Annual carbon equivalent emissions addressed by carbon offsets	100 Tonnes
Contract length	50 Years
Price of carbon offsets	25 \$/tonne
Start year of carbon offsets purchase	2026
Annual amount of electricity addressed by renewable energy credits	20000 kWh
Length of the contract	50 Years
Location where the REC generated	TX
Price of renewable energy credits	10 \$/MWh
Start year of RECs purchase	2026
Use Autocase Cost?	No
Incremental Initial capital costs	0 Dollars
Incremental Annually recurring non-utility O&M costs	0 Dollars
Incremental Replacement costs (as a percentage of initial costs)	100 %

Enhanced Refrigerant Management	
How many LEED points did you achieve with this credit?	1
Base Average Refrigerant Impact	2 lbs CO ₂ per ton-year of Refrigerants
Base All Equipment QTotal	80 Tons
Design Average Refrigerant Impact	1.5 lbs CO ₂ per ton-year of Refrigerants
Design All Equipment QTotal	60 Tons
Use Autocase Cost?	No
Incremental Initial capital costs	5000 Dollars
Incremental Annually recurring non-utility O&M costs	1500 Dollars
Incremental Replacement costs (as a percentage of initial costs)	50 %

Indoor Water Use Reduction	
How many LEED points did you achieve with this credit?	4
What is the annual baseline indoor potable water consumption?	344100 Gallons
Water analysis input type	Percent Reduction
What is the reduction in indoor water consumption from the baseline?	40 %
Use Autocase Cost?	Yes
Incremental Initial capital costs	25921.85 Dollars
Incremental Annually recurring non-utility O&M costs	0 Dollars
Incremental Replacement costs (as a percentage of initial costs)	0 %

Outdoor Water Use Reduction	
How many LEED points did you achieve with this credit?	2
What is the project's baseline annual landscape water requirement?	50000 Gallons
Water analysis input type	Percent Reduction
What is the reduction in outdoor water consumption from the baseline?	50 %
Use Autocase Cost?	No
Incremental Initial capital costs	15005 Dollars
Incremental Annually recurring non-utility O&M costs	3000 Dollars
Incremental Replacement costs (as a percentage of initial costs)	25 %

Low-Emitting Materials	
How many LEED points did you achieve with this credit?	2
Select the material types included in your project	Paints and Coatings, Ceilings, Adhesives and Sealants, Insulation, Flooring, Furniture, Wall Panels and Composite Wood
Use Autocase Cost?	No
Incremental Initial capital costs	10000 Dollars
Incremental Annually recurring non-utility O&M costs	3000 Dollars
Incremental Replacement costs (as a percentage of initial costs)	50 %

Quality Views	
How many LEED points did you achieve with this credit?	1
View 1 baseline	55 %
View 1 design	75 %
View 2 baseline	0 %
View 2 design	0 %
View 3 baseline	0 %
View 3 design	0 %
View 4 baseline	45 %
View 4 design	25 %
View 5 baseline	0 %
View 5 design	0 %
Use Autocase Cost?	No
Incremental Initial capital costs	100000 Dollars
Incremental Annually recurring non-utility O&M costs	3000 Dollars
Incremental Replacement costs (as a percentage of initial costs)	10 %

Enhanced Indoor Air Quality Strategies	
How many LEED points did you achieve with this credit?	2
Which strategies were pursued for this credit?	Filtration and Ventilation
Use Autocase Cost?	No
Incremental Initial capital costs	400 Dollars
Incremental Annually recurring non-utility O&M costs	500 Dollars
Incremental Replacement costs (as a percentage of initial costs)	5 %

Thermal Comfort	
How many LEED points did you achieve with this credit?	1
What percentage of group occupant spaces have access to thermal comfort controls?	100 %
What is the total number of group occupant spaces?	60
What percentage of individual occupant spaces have access to thermal comfort controls?	60 %
What is the total number of individual occupant spaces?	200
Use Autocase Cost?	Yes
Incremental Initial capital costs	180000 Dollars
Incremental Annually recurring non-utility O&M costs	0 Dollars
Incremental Replacement costs (as a percentage of initial costs)	0 %

Interior Lighting	
How many LEED points did you achieve with this credit?	2
What percentage of employees have access to lighting controls in your design?	90 %
Use Autocase Cost?	No
Incremental Initial capital costs	10000 Dollars
Incremental Annually recurring non-utility O&M costs	1000 Dollars
Incremental Replacement costs (as a percentage of initial costs)	50 %

Daylight	
How many LEED points did you achieve with this credit?	1
Baseline spatial daylight autonomy (sDA) or access to daylight (percent) for the regularly occupied floor area	50 %
Spatial daylight autonomy (sDA) or access to daylight (percent) of the regularly occupied floor area in your design	90 %
Use Autocase Cost?	No
Incremental Initial capital costs	50000 Dollars
Incremental Annually recurring non-utility O&M costs	1500 Dollars
Incremental Replacement costs (as a percentage of initial costs)	20 %

Heat Island Reduction	
How many LEED points did you achieve with this credit?	1
Initial SR of the LEED design non-roof area	0.85 Solar Reflectance
Initial SR of the baseline non-roof area	0.28 Solar Reflectance
Initial SRI of the LEED design roof area	85 Solar Reflectance Index
Initial SRI of the baseline roof area	32 Solar Reflectance Index
Use Autocase Cost?	No
Incremental Initial capital costs	50000 Dollars
Incremental Annually recurring non-utility O&M costs	2000 Dollars
Incremental Replacement costs (as a percentage of initial costs)	100 %

Open Space	
How many LEED points did you achieve with this credit?	1
Low Height Vegetation	100 %
Medium Height Vegetation	0 %
Percentage of the site area that is vegetated	25 %
Use Autocase Cost?	No
Incremental Initial capital costs	100 Dollars
Incremental Annually recurring non-utility O&M costs	100 Dollars
Incremental Replacement costs (as a percentage of initial costs)	100 %

Rainwater Management	
How many LEED points did you achieve with this credit?	1
Percentile storm event infiltrated in the base case	2 %
Percentile storm event infiltrated in the design case	70 %
Use Autocase Cost?	Yes
Incremental Initial capital costs	47969.2037 Dollars
Incremental Annually recurring non-utility O&M costs	60202.2498 Dollars
Incremental Replacement costs (as a percentage of initial costs)	0 %

Bicycle Facilities	
How many LEED points did you achieve with this credit?	1
Bicycle Facilities	Bike Racks, Locked Rooms/Cages, Bicycle Policy, Clothes Storage, Bike Lockers and Showers
Use Autocase Cost?	No
Incremental Initial capital costs	5000 Dollars
Incremental Annually recurring non-utility O&M costs	3000 Dollars
Incremental Replacement costs (as a percentage of initial costs)	25 %

Green Vehicles	
How many LEED points did you achieve with this credit?	1
DCFC Chargers (150kW)	2
DCFC Chargers (350kW)	2
DCFC Chargers (50kW)	2
Level 2 Chargers	2
Use Autocase Cost?	Yes
Incremental Initial capital costs	290328.82 Dollars
Incremental Annually recurring non-utility O&M costs	8709.8646 Dollars
Incremental Replacement costs (as a percentage of initial costs)	0 %



Cost-Benefit Approach



Cost-Benefit Analysis Best Practice

This P3I.GLOBAL – P3I Analysis has been designed such that it follows and implements general principles for best practices in CBA as outlined by the US Federal Government. This includes the Office of Management and Budget (OMB) Circular A-94, the document which provides guidance on US Federal Government CBAs. Below are more detailed explanations of key concepts from federal guidance.

Cost-Benefit Analysis

Cost-benefit analysis is a formal way of organizing the evidence on the key good and bad effects of projects and/or decisions. The objective may be to decide whether to proceed with the project, or to decide which of various possible alternatives are most cost-effective.

To compare different alternatives that may have costs and benefits occurring different through time, discounting is used to convert future benefits and costs into a current year perspective. The standard criterion for evaluation using CBA is the net-present value (NPV), which is the discounted, monetized value of expected net benefits through the study period.

Discounting

This P3I Analysis defaults the discount rate to 3%. The discount rate used is a real social discount rate ("discount rate"). This means that the effect of inflation is excluded from the determination of future cash flows and P3I.GLOBAL compares costs and benefits in real dollars. Literature suggests that the social discount rate can be between 2% and 7% ([TBS 2007](#); [U.S. EPA 2010](#); [OMB 1992](#); [U.S. DoT 2015](#)) with the lower bound representing the social rate of time preference and the upper bound representing the social opportunity cost of capital.

While the social discount rate proposed by the Office of Management and Budget is 7%, it has not revised since 1992. The 7.0% rate has been challenged by Municipal Research and Services Centre suggesting it considers a higher opportunity cost of capital. Washington State Institute of Public Policy (WSIPP), suggested a social discount rate of 2-5%. The 2-5% range was defined after considering social discount rate estimates from various policy analysis research papers and federal agency bodies including Congressional Budget Office. Heckman, et al for Preschool program uses 3% for cost benefit analyses. Moore (2013) restates their argument for 3.5% and 5% discount rate,

while the Council of Economic Advisers (2017) recommends a 2% discount rate. A book by The National Academies of Sciences, Engineering, and Medicine, suggests a social discount rate of 3%. TIGER Benefit Cost Analysis guidance (provided by the US Department of Transportation) suggests a 3% social cost of carbon. And finally, the EPA (2010) has been cited using discount rates between 2% to 4%.

Impacts vs Benefits

This P3I Analysis calculates the economic benefit or value of a project. It does not calculate the economic impact (jobs created, GDP, or income created). While these statistics may have value for some, there are more reliable and impartial statistics for measuring value or welfare.

Base and Alternate Cases

The P3I Analysis cost-benefit must be run relative to a base case. This analysis displays the comparative benefits or tradeoffs of the proposed design versus this user- informed base case.

Energy & Atmosphere

Optimize Energy Performance

Financial Savings

- Lower dependency on energy from the grid in the design case may generate financial benefits due to utility cost savings.
- This P3I Analysis estimates the financial savings from a project using state-level utility prices from the U.S. Energy Information Administration (EIA; [Electricity Prices, 2019](#); [Natural Gas Prices, 2019](#)) for U.S. cities and from provincial/territorial energy regulators for Canadian cities.
- Any upfront capital costs and/or ongoing non-utility operations & maintenance costs associated with energy investments should be recorded in the Life Cycle Cost Analysis

Air Pollutants

- Reducing energy consumption from the grid (in the design case compared to the base case) may generate environmental benefits from reduced air pollution being emitted.
- For each unit of energy produced and used, air pollution emissions are released into the atmosphere and; quantified using emission factors.
- The environmental benefit from reducing air pollution emissions is monetized by applying the social cost of each air pollutant to the respective amount of that air pollutant reduced.
- This P3I Analysis calculates the environmental benefit for the following air pollutants: NO_x, SO₂, PM_{2.5}, and VOC.
- Non-baseload, location-specific emission factors per unit of electricity are gathered from the U.S. Environmental Protection Agency (EPA) [eGRID \(2018\)](#) and U.S. EPA [National Emissions Inventory \(NEI, 2017\)](#) for U.S. locations and Environment and Climate Change Canada [Air Pollutant Emission Inventory \(APEI, 2018\)](#) for Canadian locations.

Greenhouse Gas Emissions

- Reducing energy consumption from the grid may also reduce greenhouse gas emissions, thereby generating environmental benefits.
- For each unit of energy produced and used, carbon dioxide equivalent (CO_e) emissions are released into the atmosphere and quantified using emission factors.

- The environmental benefit of reduced CO₂e is monetized by applying the social cost of carbon to the amount of CO₂e emissions reduced.
- Non-baseload, location-specific emissions factors for CO₂e emissions per unit of electricity are gathered from the U.S. EPA [eGRID \(2018\)](#) for U.S. locations and [Energy Star Portfolio Manager Technical Reference: Greenhouse Gas Emissions \(2018\)](#) for Canadian locations. CO₂e from electricity include: methane (CH₄), carbon (CO₂), and nitrous oxide (N₂O).
- Carbon emission factors for natural gas combustion for U.S. and Canadian locations are gathered from the US EPA, [AP-42: Compilation of Air Pollutant Emission Factors, Section I.4 Natural Gas Combustion \(1998\)](#).

Renewable Energy Production

Financial Savings

- Lower dependency on energy from the grid in the design case may generate financial benefits due to utility cost savings.
- This P3I Analysis estimates the financial savings from a project using state-level utility prices from the U.S. Energy Information Administration (EIA; [Electricity Prices, 2019](#); [Natural Gas Prices, 2019](#)) for U.S. cities and from provincial/territorial energy regulators for Canadian cities.
- Any upfront capital costs and/or ongoing non-utility operations & maintenance costs associated with renewable energy production investments should be recorded in the Life Cycle Cost Analysis

Air Pollutants from Renewable Energy

- Renewable energy production may be sold to the grid. When this occurs, it generates environmental benefits as the grid becomes cleaner by being partially offset by renewable energy.
- For each unit of energy produced and used, air pollution emissions are released into the atmosphere and quantified using emission factors.
- The environmental benefit from reducing air pollution emissions is monetized by applying the social cost of each air pollutant to the respective amount of that air pollutant reduced.

- This P3I Analysis calculates the environmental benefit for the following air pollutants: NO_x, SO₂, PM_{2.5}, and VOC.
- Non-baseload, location-specific emission factors per unit of electricity are gathered from the U.S. Environmental Protection Agency (EPA) [eGRID \(2018\)](#) and U.S. EPA [National Emissions Inventory \(NEI, 2017\)](#) for U.S locations and Environment and Climate Change Canada [Air Pollutant Emission Inventory \(APEI, 2018\)](#) for Canadian locations.

Greenhouse Gas Emissions (GHGs) from Renewable Energy

- Similar to air pollution, the sale of on-site produced renewable energy can also facilitate the reduction of greenhouse gas emissions, thereby generating environmental benefits.
- The environmental benefit from renewable energy is monetized by applying the social cost of carbon to the total amount of CO₂e emissions reduced.
- Non-baseload, location-specific emissions factors for CO₂e emissions per unit of electricity are gathered from the U.S. EPA [eGRID \(2018\)](#) for U.S locations and [Energy Star Portfolio Manager Technical Reference: Greenhouse Gas Emissions \(2018\)](#) for Canadian locations. CO₂e from electricity include: methane (CH₄), carbon (CO₂), and nitrous oxide (N₂O).

Green Power & Carbon Offsets

Renewable Energy Credits (RECs)

Financial Costs of RECs

- A project may choose to purchase RECs to offset some of the electricity used for the project.
- This is an additional cost to the project calculated using the amount of RECs purchased and the unit price of RECs for the duration of the contract. Any applicable growth in price and quantity will also be applied.

Air Pollution and Greenhouse Gas Emissions of RECs

- RECs are purchased to indirectly reduce energy emissions from those generated by the traditional electricity grid.

- The amount of emissions reduced is estimated using the amount of RECs purchased and the emission factors for the local electricity grid where the REC was generated.
- Non-baseload, location-specific emission factors per unit of electricity are gathered from the U.S. Environmental Protection Agency (EPA) [eGRID \(2018\)](#) for CO₂e, NO_x, and SO₂ and U.S. EPA [National Emissions Inventory \(NEI, 2017\)](#) for PM_{2.5} and VOC for U.S. locations. For Canadian locations, non-baseload, location-specific emission factors per unit of electricity are gathered from [Energy Star Portfolio Manager Technical Reference: Greenhouse Gas Emissions \(2018\)](#) for CO₂e and Environment and Climate Change Canada [Air Pollutant Emission Inventory \(APEI, 2018\)](#) for NO_x, SO₂, PM_{2.5}, and VOC. CO₂e from electricity include: methane (CH₄), carbon (CO₂), and nitrous oxide (N₂O).
- The reduced emissions are then monetized using their respective social costs.

Carbon Offsets

Financial Costs of Carbon Offsets

- A project may choose to purchase carbon offsets to offset the carbon footprint.
- This is an additional cost to the project calculated using the amount of carbon offsets purchased, the unit price of offsets and any growth in price and quantity of offsets. This is estimated for the duration of the contract.

Greenhouse Gas Emissions from Carbon Offsets

- Carbon offsets calculate the amount of carbon emission avoided, hence only the social cost of carbon is used to value the social benefit.
- The amount of carbon emission avoided is equal to the amount of carbon offsets purchased and is monetized using the social cost of carbon.
- Environmental benefits from carbon offsets are only recorded when they are purchased to improve user carbon footprint from the base case. They are not recorded when offsets are purchased to even out the increase in emissions in the design case, beyond carbon emission increases due to energy usage.

Water Efficiency

Indoor & Outdoor Water Use

Financial Savings

- Local water and wastewater prices, collected from [American Water Works Association \(2014\)](#) and [Environment and Climate Change Canada \(2009\)](#), are used to estimate the financial savings of reducing utility water and wastewater.
- Growth rates are applied water and wastewater prices to forecast real growth in prices over the study period. These growth rates are forecasted using [American Water Works Association \(2014\)](#) historical price growth.

Social Value of Water

- A social value of water will be applied to any water taken out of the water table. For instance, using water from a utility or capturing water from a well will imply water being taken out of the water table or a body of water, and a corresponding social value of water will be applied.
- Reducing the amount of water consumed from a utility or a well will realize a benefit to society in terms of the social value of water.
- This P3I Analysis uses the research conducted by [United States Geographical Survey Water Survey \(2010\)](#) and [Environment Canada Municipal Water Use Report \(2009\)](#) to allocate

Air Pollutants and Carbon Emissions

- Water supplied by a utility as well as wastewater treated by a wastewater treatment plant require significant energy use.
- Using emission factors and the amount of offset energy from the grid, the societal benefit is monetized by applying the social cost to each air pollutant, including: NO_x, SO₂, PM_{2.5}, and VOC.
- This P3I Analysis uses information on energy intensities from the [Water Research Foundation and Electrical Power Research Institute \(2013\)](#).
- Non-baseload, location-specific emission factors per unit of electricity are gathered from the U.S. Environmental Protection Agency (EPA) [eGRID \(2018\)](#) for CO₂e, NO_x, and

SO₂ and U.S. EPA [National Emissions Inventory \(NEI, 2017\)](#) for PM_{2.5} and VOC for U.S. locations. For Canadian locations, non-baseload, location-specific emission factors per unit of electricity are gathered from [Energy Star Portfolio Manager Technical Reference: Greenhouse Gas Emissions \(2018\)](#) for CO₂e and Environment and Climate Change Canada [Air Pollutant Emission Inventory \(APEI, 2018\)](#) for NO_x, SO₂, PM_{2.5}, and VOC.

Indoor Environmental Quality

Thermal Comfort

Productivity

- Using the relationship between temperature and productivity from [Seppänen, et. al. \(2006\)](#), Autocase quantifies the change in productivity driven by each degree of temperature change
- As temperature converges toward 22°C, occupants become more productive.
- Using either building-specific average wage or the default local average industry wage (county level in the US, provincial in Canada), employee productivity increases are monetized by valuing the increase in productive work hours.

Health

- A 1°C decrease in temperature (between the range of 21 and 25°C) leads to a lower prevalence of illness for occupants of a building ([Jakkola & Heinonen, 1989](#)).
- These illnesses include headache, dry skin, stuffy nose, itchy throat, nasal congestion, itchy skin, itchy eyes, irritated eyes, dry eyes, and lethargy.
- The change in the prevalence of symptoms are monetized using the cost of illness for each symptom ([National Service Center for Environmental Publications, 2007](#))

Enhanced Indoor Air Quality Strategies

Ventilation

Productivity

- [Seppanen et. al. \(2006\)](#) study found that there are employee productivity increases due to increases in air flow.
- Using either building-specific average wage or the default local average industry wage (county level in the US, provincial in Canada), employee productivity increases are monetized by valuing the increase in productive work hours.

Health

- From the research produced by [Fisk et. al. \(2009\)](#), Autocase relates the prevalence of illness, and in-turn the societal health costs from improved air flow rates.
- These illnesses include headache, dry skin, stuffy nose, itchy throat, nasal congestion, itchy skin, itchy eyes, irritated eyes, dry eyes, and lethargy.
- The change in symptoms are monetized using the cost of illness for each symptom ([National Service Center for Environmental Publications, 2007](#)).

Absenteeism

- [Milton et al. \(2000\)](#) found a decrease in employee sick days due to improved air flows within a building.
- Using either building-specific average wage or the default local average industry wage (county level in the US, provincial in Canada), reduced absenteeism is monetized by valuing the increase in productive work hours.

Filtration

Health

- Using the [EPA's](#) concentration response functions, Autocase estimates the change in sick building syndrome symptoms due to the reduction in particulate matter exposure.
- These illnesses include lower respiratory, upper respiratory, and shortness of breath symptoms, asthma attack and mortality.
- The change in incidence rates is monetized using the EPA's [Cost of Illness Handbook](#), [Maleki-Yazdi, et al. \(2012\)](#) and the Value of Statistical Life.

- This is then applied to each occupant in the building.

Absenteeism

- Using the EPA's concentration response function, Autocase relates the reduction in particulate matter to a decrease in work days lost.
- The reduction in work days lost is monetized using the average employee salary and applied to all employees in the building.

Interior Lighting

- A meta-analysis completed by [Kats et al. \(2003\)](#) and the study by [Loftness \(2003\)](#) illustrate that improved lighting performance and lighting controls are linked to productivity gains.
- Using either building-specific average wage or the default local average industry wage (county level in the US, provincial in Canada), productivity increases are monetized by valuing the increase in productive work hours.

Daylighting

Productivity

- Increased exposure to daylight leads to increased sleep duration for employees ([Boubekri et al, 2014](#)).
- This P3I Analysis quantifies productivity increases for employees from daylighting through putting a dollar value on the benefits of increased sleep hours for employees ([Hafner et al., 2016](#)).
- Using either building-specific average wage or the default local average industry wage (county level in the US, provincial in Canada), productivity increases are monetized by valuing the increase in productive work hours.

Health

- This P3I Analysis quantifies the change in risk mortality for occupants as a result of gaining

- The health benefits from daylighting are monetized using the value of statistical life set out by Federal guidance ([EPA, 2010](#); Policy Horizons Canada, 2013).

Quality Views

Productivity

- By changing the occupant's primary view, there can be a productivity increase of up to 13.5%, for the best view rating ([Heschong et al, 2003](#)).
- Autocase quantifies this relationship by accounting for the various types of views.
- Using either building-specific average wage or the default local average industry wage (county level in the US, provincial in Canada), productivity increases are monetized by valuing the increase in productive work hours.

Absenteeism

- Changing the occupant's primary view from "bad" to "great" is linked to 11.0 fewer sick hours annually, as provided by [Elzeyadi \(2011\)](#).
- This P3I Analysis uses this relationship by addressing the different view factors affecting occupants, in order to evaluate the change in absenteeism.
- Using either building-specific average wage or the default local average industry wage (county level in the US, provincial in Canada), reduced absenteeism is monetized by valuing the increase in productive work hours.

Low Emitting Materials

Absenteeism

- Some building materials release VOCs during and after installation, compromising a building's indoor air quality, occasionally leading to increase in sick days ([Levin, Hal & Hodgson, Alfred. \(2006\)](#), [Holos et al \(2020\)](#), [Gosselin, Lemyre, and Corneil \(2013\)](#), [Lawrence Berkeley Labs \(2021\)](#)).
- This model monetizes the decrease in absenteeism because of the installation of low-emitting materials in the workplace using average annual salaries, number of employees, and the percent of employees who take sick days because of asthma.

- For residential buildings, absenteeism becomes sick leave and is a community benefit as opposed to a tenant benefit Residential buildings sick leave measures the reduced sick leave of tenants in their workplace which is assumed to be a business in the metropolitan area (where the wage used is the city average wage).