
Recycling/
Reuse/
Disposal
Resource
Extraction
Demolition
Athena
Institute
Manufacturing
Occupancy/
Maintenance
On-site
Construction

ATHENA EcoCalculator for Assemblies

John Carmody

Center for Sustainable Building Research

University of Minnesota

January 16, 2008

Project Partners:

Wayne Trusty, Athena Institute

John Carmody, CSBR, University of Minnesota

Mark Lucuik, Morrison Hershfield Engineers

Context and Recent Trends

1. A diverse set guidelines and rating systems are continually evolving in response to the scale of development, building type and regional issues
2. Guidelines are being adopted by states and cities as basis for codes, standards and incentives
3. There is a movement beyond simple point-based checklists toward more requirements and a focus on performance outcomes such as carbon emissions and energy consumption
4. Life cycle assessment of materials is beginning to be included in guidelines and ratings
5. There is increased focus on actual performance during operation and the need for a feedback loop and continuous improvement

Athena Institute Mission

Data — US LCI Database Project, Canadian database

Research — LCA ➔ buildings, infrastructure, service life issues

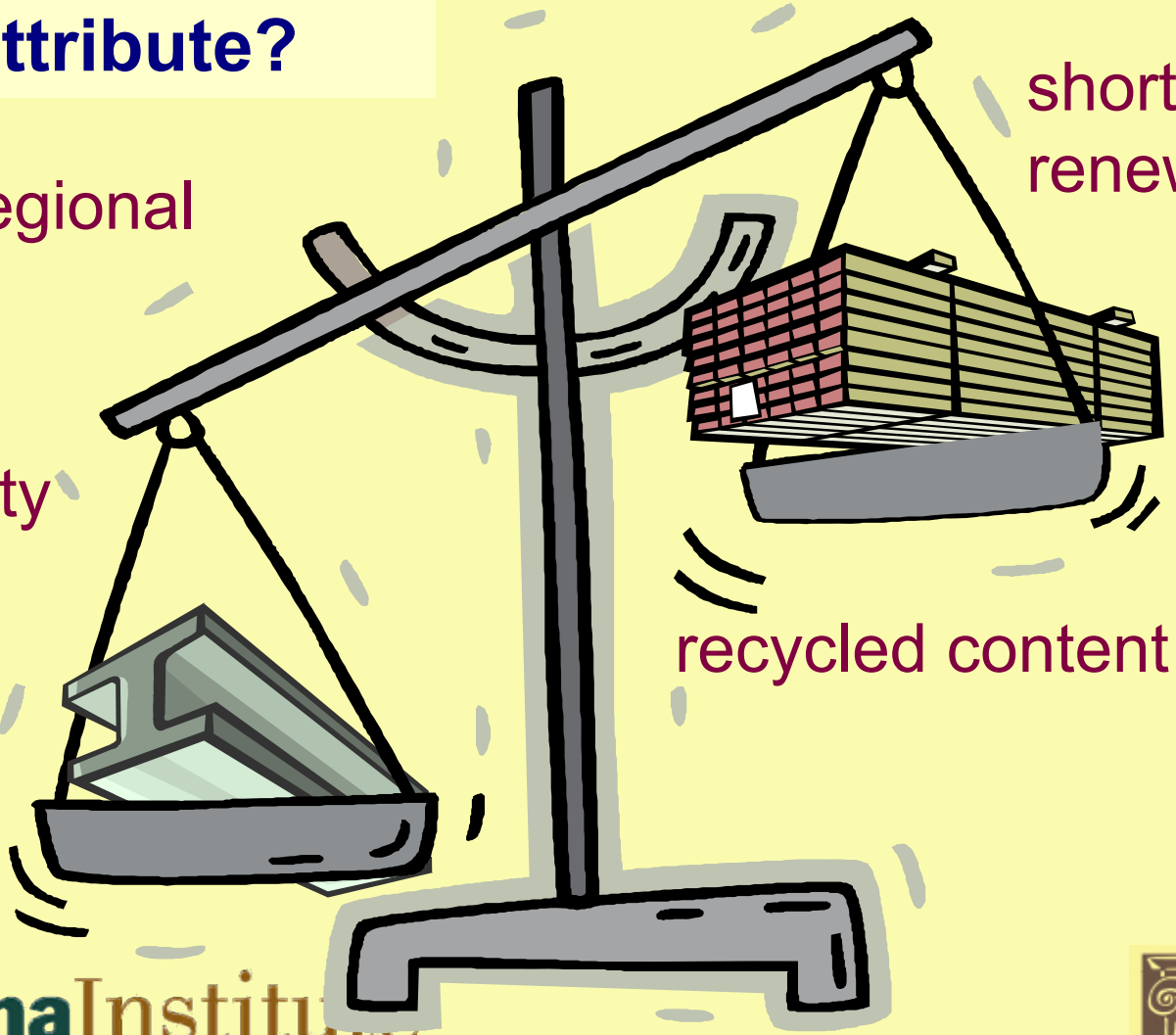
Tools — ATHENA Impact Estimator, Green Globes, LEED

Education — Universities, seminars, workshops, etc.

… to foster a sustainable built environment.

Weighing material options

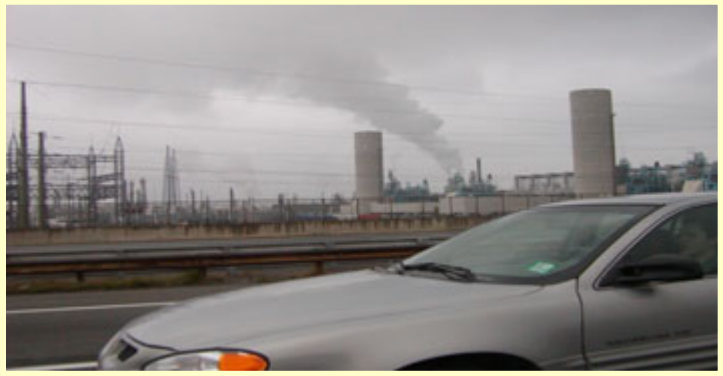
By attribute?



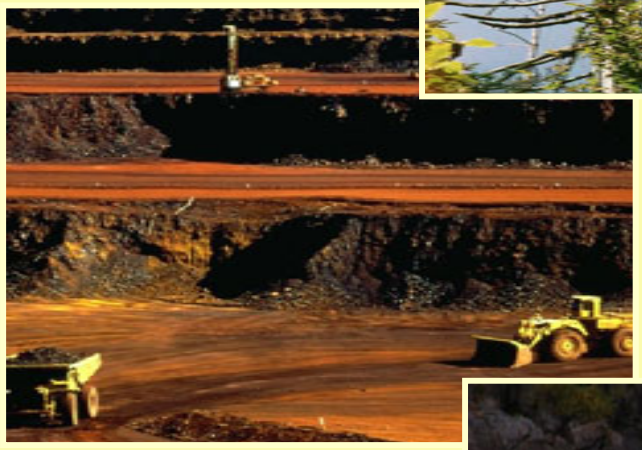
or...

By environmental performance ➔ LCA

Air pollution



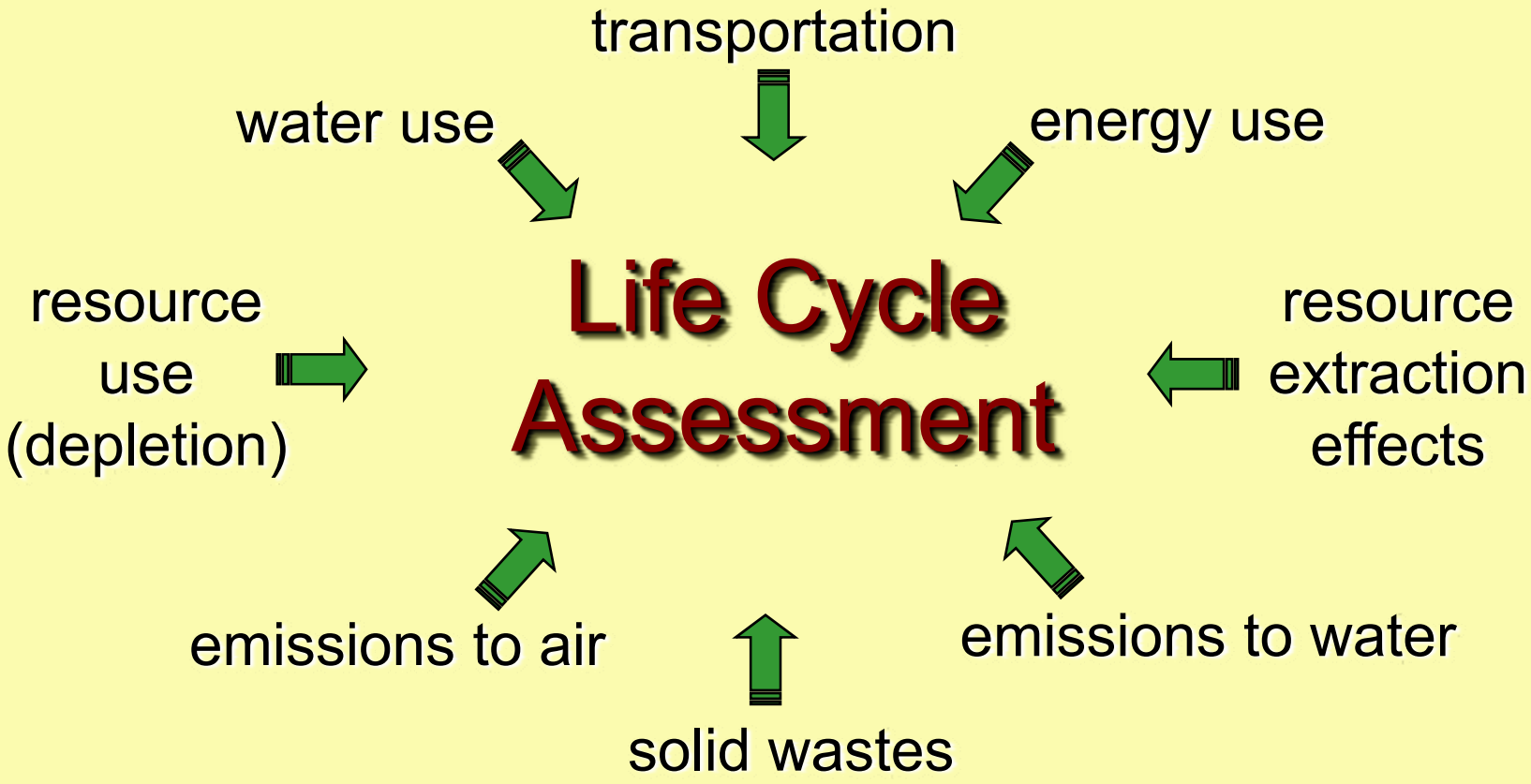
Acid rain damage



Climate change

Resource depletion

Water pollution



A methodology for assessing the environmental performance of a product over its full life cycle

Athena Institute

In the Case of Energy…

Even source energy doesn't get it all

End use energy estimates just one part of the story

The rest of the story is the energy to make and move energy — called pre-combustion in LCA

AthenaInstitute

Athena Institute

The LCA Tool Kit

Level 1 — Product Focus

1A - For LCA practitioners

✓ SimaPro, GaBi, Umberto

1B - LCA in the background

✓ BEES

Level 2 — Assembly Focus

ATHENA® *EcoCalculator*

✓ Funded by GBI for use in Green Globes™ rating system

✓ General use version available

Level 3 — Whole Building

ATHENA® *Impact Estimator*

✓ LCA in the background

Assessment and Rating Systems

✓ Green Globes
✓ LEED
✓ Minnesota Design Guidelines
✓ NAHB Green Home Guidelines

AthenaInstitute

Athena Institute

LCA in Green Globes

- Basically LCA education credits at present (option 2)
  - » encourage selecting materials with the lowest life cycle environmental burden
  - » but no firm benchmarks or measures
- Work completed on the assembly ranking approach (option 1)
  - » reviewed by BRE, NIST, 3rd party
  - » under review by Green Globes ANSI committee,
  - » ATHENA Impact Estimator for buildings used for basic LCA of assemblies
  - » points based on performance relative to benchmarks for each of several measures (e.g., global warming potential)

LCA into LEED

- September 2004 kick-off meeting
- Working Groups
  - » recommend how best to implement LCA-based credits
    - goal and scope
    - technical LCA issues
    - weighting of impact measures
- Goal and scope WG recommended assembly ranking approach
- Accepted by USGBC board
- Work underway to detail the approach

ATHENA® Impact Estimator for buildings

LCA-Based whole building tool for use at the conceptual design stage

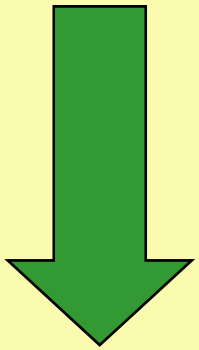
- Shows environmental effects of changes in shape, design or material make-up of a building
- Allows designers to optimize operating+embodied energy effects over the complete building life cycle
- A range of indicators without weighting

ATHENA®
Impact Estimator
for buildings

Takes Account Of

- Resource extraction
- Manufacturing and on-site construction
  - ✓ Including recycled content
- All related transportation
- Maintenance and replacement cycles
- Demolition and land filling
- Operating energy effects

ATHENA®
Impact Estimator
for buildings



ATHENA®
EcoCalculator
for assemblies

AthenaInstitute

Athena
Institute

ATHENA®
EcoCalculator
for assemblies

LCA-Based level 2 tool for evaluating and comparing the environmental effects of assemblies

- Initially developed for GBI for use in Green Globes
  - ✓ Developed in association with Morrison Hershfield and UMn Center for Sustainable Building Research
- Currently covers several hundred assemblies
- Uses 5 environmental impact indicators
- Green Globes™ credits better than average performance
  - ✓ For each indicator within an assembly category
- Free generic versions on the Athena Institute web site

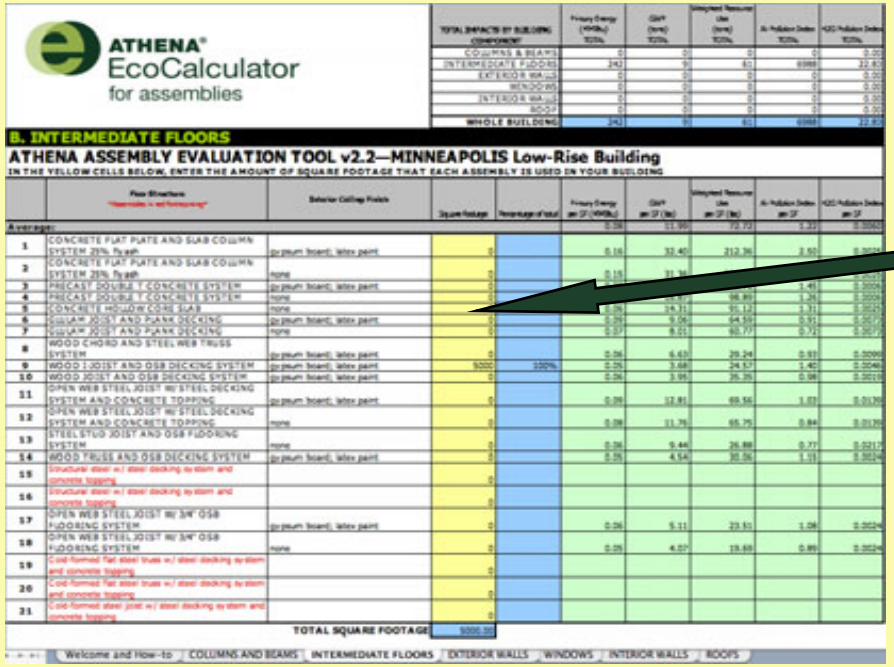
AthenaInstitute

Athena Institute

ATHENA® EcoCalculator for assemblies

Simple to Use

results in spreadsheet form



ATHENA® EcoCalculator for assemblies

B. INTERMEDIATE FLOORS

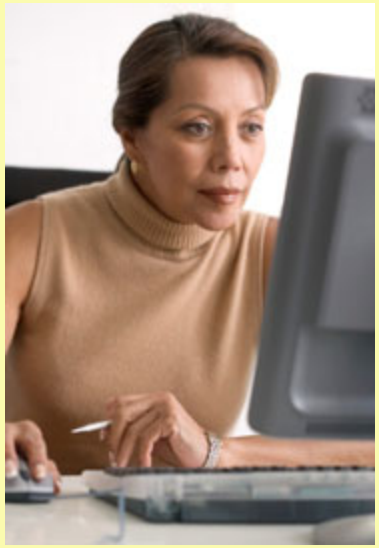
ATHENA ASSEMBLY EVALUATION TOOL v2.2—MINNEAPOLIS Low-Rise Building

IN THE YELLOW CELLS BELOW, ENTER THE AMOUNT OF SQUARE FOOTAGE THAT EACH ASSEMBLY IS USED IN YOUR BUILDING

	Floor Structure	Interior Ceiling Finish	Square Footage	Percentage of Total
1	CONCRETE FLAT PLATE AND SLAB COLUMN SYSTEM 25% fly ash	gypsum board; latex paint	0	
2	CONCRETE FLAT PLATE AND SLAB COLUMN SYSTEM 25% fly ash	none	0	
3	PRECAST DOUBLE T CONCRETE SYSTEM	gypsum board; latex paint	0	
4	PRECAST DOUBLE T CONCRETE SYSTEM	none	0	
5	CONCRETE HOLLOW CORE SLAB	none	0	
6	GLULAM JOIST AND PLANK DECKING	gypsum board; latex paint	0	
7	GLULAM JOIST AND PLANK DECKING	none	0	
8	WOOD CHORD AND STEEL WEB TRUSS SYSTEM	gypsum board; latex paint	0	
9	WOOD I JOIST AND OSB DECKING SYSTEM	gypsum board; latex paint	5000	100%
10	WOOD JOIST AND OSB DECKING SYSTEM	gypsum board; latex paint	0	
11	OPEN WEB STEEL JOIST W/ STEEL DECKING SYSTEM AND CONCRETE TOPPING	gypsum board; latex paint	0	
12	OPEN WEB STEEL JOIST W/ STEEL DECKING SYSTEM AND CONCRETE TOPPING	none	0	
13	STEEL STUD JOIST AND OSB FLOORING SYSTEM	none	0	
14	WOOD TRUSS AND OSB DECKING SYSTEM	gypsum board; latex paint	0	
15	Structural steel w./ steel decking system and concrete topping		0	
16	Structural steel w./ steel decking system and concrete topping		0	
17	OPEN WEB STEEL JOIST W/ 3/4" OSB FLOORING SYSTEM	gypsum board; latex paint	0	
18	OPEN WEB STEEL JOIST W/ 3/4" OSB FLOORING SYSTEM	none	0	
19	Cold-formed flat steel truss w./ steel decking system and concrete topping		0	
20	Cold-formed flat steel truss w./ steel decking system and concrete topping		0	
21	Cold-formed steel joist w./ steel decking system and concrete topping		0	
		TOTAL SQUARE FOOTAGE	5000.00	

Welcome and How-to | COLUMNS AND BEAMS | INTERMEDIATE FLOORS | EXTERIOR WALLS | WINDOWS | INTERIOR WALLS | ROOFS

Users only fill in yellow cells



Instant answers

AthenaInstitute

Athena Institute

ATHENA® EcoCalculator for assemblies

TOTAL IMPACTS BY BUILDING COMPONENT	Primary Energy (MMBtu) TOTAL	GWP (tons) TOTAL	Weighted Resource Use (tons) TOTAL	Air Pollution Index TOTAL	H2O Pollution Index TOTAL
COLUMNS & BEAMS	0	0	0	0	0.00
INTERMEDIATE FLOORS	242	9	61	6988	22.83
EXTERIOR WALLS	0	0	0	0	0.00
		0	0	0	0.00
IN		0	0	0	0.00
		0	0	0	0.00
WHO		9	61	6988	22.83

9 tons CO2e cradle to grave 60 year life

B. INTERMEDIATE FLOORS

ATHENA ASSEMBLY EVALUATION TOOL v2.2—MINNEAPOL

IN THE YELLOW CELLS BELOW, ENTER THE AMOUNT OF SQUARE FOOTAGE THAT EACH ASSE

	Floor Structure "Assemblies in red forthcoming"	Interior Ceiling Finish	Square Footage	Percentage of total	Primary Energy per SF (MMBtu)	GWP per SF (lbs)	Weighted Resource Use per SF (lbs)	Air Pollution Index per SF	H2O Pollution Index per SF
Average:					0.08	11.99	72.72	1.22	0.0060
1	CONCRETE FLAT PLATE AND SLAB COLUMN SYSTEM 25% fly ash	gypsum board; latex paint	0		0.16	32.40	212.36	2.50	0.0025
2	CONCRETE FLAT PLATE AND SLAB COLUMN SYSTEM 25% fly ash	none	0		0.15	31.36	208.54	2.31	0.0025
3	PRECAST DOUBLE T CONCRETE SYSTEM	gypsum board; latex paint	0		0.08	17.91	102.70	1.45	0.0006
4	PRECAST DOUBLE T CONCRETE SYSTEM	none	0		0.07	16.87	98.89	1.26	0.0006
5	CONCRETE HOLLOW CORE SLAB	none	0		0.06	14.31	91.12	1.31	0.0025
6	GLULAM JOIST AND PLANK DECKING	gypsum board; latex paint	0		0.09	9.06	64.59	0.91	0.0073
7	GLULAM JOIST AND PLANK DECKING	none	0		0.07	8.01	60.77	0.72	0.0073
8	WOOD CHORD AND STEEL WEB TRUSS SYSTEM	gypsum board; latex paint	0		0.06	6.63	29.24	0.93	0.0099
9	WOOD I-JOIST AND OSB DECKING SYSTEM	gypsum board; latex paint	5000	100%	0.05	3.68	24.57	1.40	0.0046
10	WOOD JOIST AND OSB DECKING SYSTEM	gy	0		0.06	3.95	35.35	0.98	0.0019
11	OPEN WEB STEEL JOIST W/ STEEL DECKING SYSTEM AND CONCRETE TOPPING						69.56	1.03	0.0139
12	OPEN WEB STEEL JOIST W/ STEEL DECKING SYSTEM AND CONCRETE TOPPING						65.75	0.84	0.0139
13	STEEL STUD JOIST AND OSB FLOORING SYSTEM						26.88	0.77	0.0217
14	WOOD TRUSS AND OSB DECKING SYSTEM						30.06	1.15	0.0024
15	Structural steel w/ steel decking system and concrete topping		0						
16	Structural steel w/ steel decking system and concrete topping		0						
17	OPEN WEB STEEL JOIST W/ 3/4" OSB FLOORING SYSTEM	gypsum board; latex paint	0		0.06	5.11	23.51	1.08	0.0024
18	OPEN WEB STEEL JOIST W/ 3/4" OSB FLOORING SYSTEM	none	0		0.05	4.07	19.69	0.89	0.0024
19	Cold-formed flat steel truss w/ steel decking system and concrete topping		0						
20	Cold-formed flat steel truss w/ steel decking system and concrete topping		0						
21	Cold-formed steel joist w/ steel decking system and concrete topping		0						
		TOTAL SQU E FOOTAGE	5000.00						

Wood I-joist and OSB decking system, gypsum board, latex paint

Welcome and How-to | COLUMNS AND BEAMS | INTERMEDIATE FLOORS | EXTERIOR WALLS | WINDOWS | INTERIOR WALLS | ROOFS

ATHENA® EcoCalculator for assemblies

Key Assumptions

- Results on a per unit area basis (e.g., per ft^2)
  - ✓ Estimates based on much larger areas, e.g., 1000 linear feet of wall
- Components and loadings typical for central U.S.
- Owner occupied buildings, 60-year lifespan
  - ✓ Affects maintenance and repair/replacement schedules
- Other specific assumptions:
  - ✓ Window to wall ratio
  - ✓ Concrete strength and fly ash content
  - ✓ Gypsum board type and thickness with latex paint
  - ✓ Live load for all intermediate floors, columns & beams, roofs
  - ✓ Bay sizes and column heights
  - ✓ External wall thicknesses depending on construction system
  - ✓ Stud size/strength and spacing
  - ✓ Sheathing and decking materials

ATHENA® EcoCalculator for assemblies

What's in and out?

- LCA of building assemblies takes account of:
  - resource extraction and processing
  - product manufacturing
  - on-site construction of assemblies
  - all related transportation
  - maintenance and replacement cycles over an assumed building service life
  - structural system demolition and land filling
- Operating energy effects covered in whole building LCA
- In a rating system operating energy covered in other sections
  - assembly tool shows R values

EcoCalc Versions

Current

- Northern USA averages
- Southern USA averages
- 8 Canadian regions
  - » Vancouver, Calgary, Winnipeg, Toronto, Ottawa, Montreal, Québec, Halifax
- 4 US regions
  - » Atlanta, Minneapolis, Orlando, Pittsburgh

Coming 2008

- Denver, Los Angeles, New York, Phoenix, Seattle

All with hi-rise and low-rise versions


AthenaInstitute
About the Institute
Impact Estimator
EcoCalculator
Databases
Projects
Reports & Publications
WELCOME
At the Athena Institute, we believe that better information and tools are critical to achieving a sustainable built environment. We also believe that a life cycle assessment (LCA) approach to sustainability is the only way to create a level playing field for the vast array of building materials in use.
From our Canadian offices, and through our US affiliate, Athena Institute International, the not-for-profit Athena organization undertakes and directs innovative
www.athenaSMI.ca
NEW! Now downloading Version 2.3 of the FREE EcoCalculator
Now Includes:
Calgary, Halifax, Montreal, Orlando, Ottawa, Quebec City, Toronto, Winnipeg
Please delete the previous version of the EcoCalculator and download the new version available here.
ATHENA Impact Estimator for buildings
Allows users to evaluate whole buildings and assemblies based on internationally recognized LCA methodology.
ATHENA EcoCalculator for assemblies
Provides instant LCA results for more than 400 common building assemblies (free of charge).
Click the images above for more information.