Life Cycle Assessment (LCA): the Unity Zum

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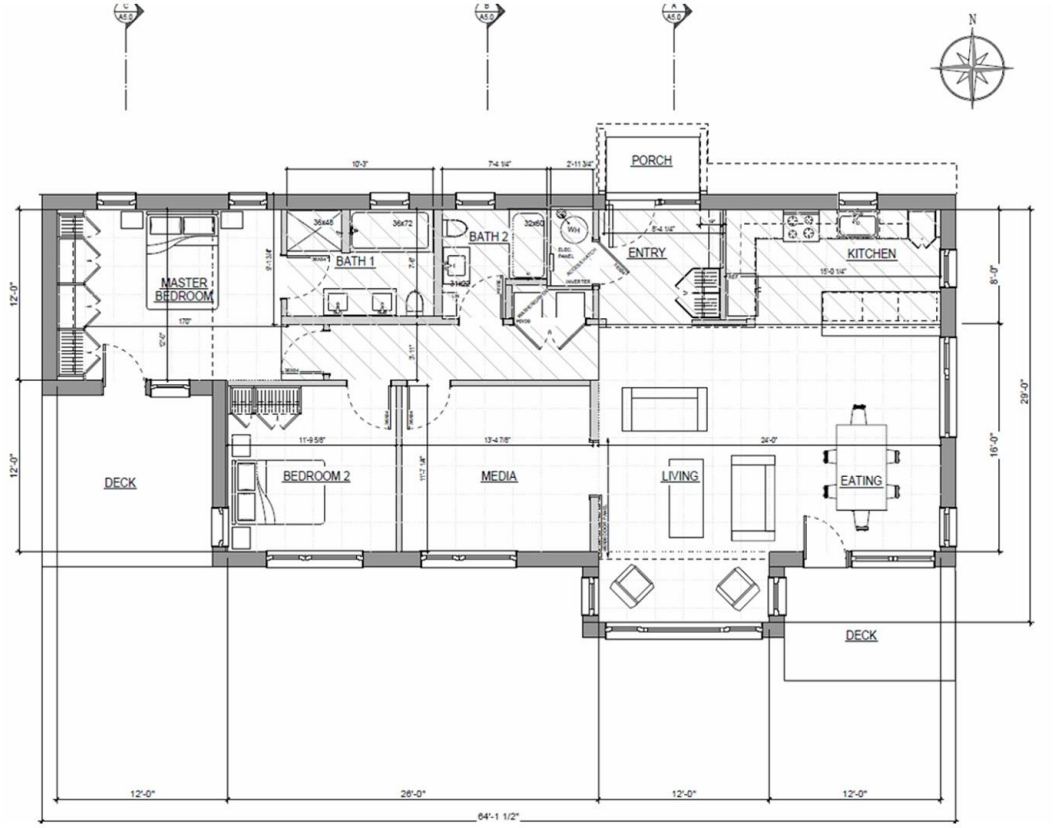
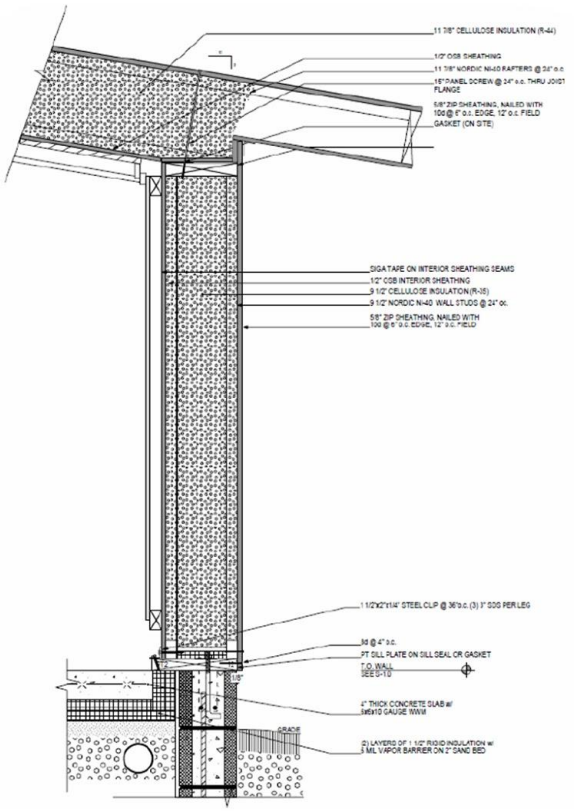

PORCH
MASTER BEDROOM
BATH 1
BATH 2
ENTRY
KITCHEN
DECK
BEDROOM 2
MEDIA
LIVING
EATING
DECK
12'-0"
26'-0"
12'-0"
12'-0"
64'-1 1/2"
29'-0"
16'-0"
8'-0"
12'-0"


11 7/8" CELLULOSE INSULATION (R-44)
1/2" OSB SHEATHING
11 7/8" NORDIC NI-40 RAFTERS @ 24" o.c.
16" PANEL SCREW @ 24" o.c. THRU JOIST FLANGE
5/8" ZIP SHEATHING, NAILED WITH 10d @ 4" o.c. EDGE, 12" o.c. FIELD
GASKET (ON SITE)
GIGA TAPE ON INTERIOR SHEATHING SEAMS
1/2" OSB INTERIOR SHEATHING
9 1/2" CELLULOSE INSULATION (R-35)
9 1/2" NORDIC NI-40 WALL STUDS @ 24" oc.
5/8" ZIP SHEATHING, NAILED WITH 10d @ 6" o.c. EDGE, 12" o.c. FIELD
1 1/2"x2"x14" STEEL CLIP @ 36"o.c. (3) 1" SDS PER LEG
M8 @ 4" o.c.
PT SILL PLATE ON SILL SEAL OR GASKET
TO WALL SEE S110
4" THICK CONCRETE SLAB w/ 6x6x10 GAUGE WWM
GRADE
(2) LAYERS OF 1 1/2" RIGID INSULATION w/ 6 MIL VAPOR BARRIER ON 2" SAND BED

Our Learning Objectives

Relative impacts of the various life cycle stages

An understanding of the importance of energy consumption

A basis on which to compare material choices (e.g. uPVC vs. wood windows)

Phases of a Life Cycle Assessment

Goal and Scope Definition

Inventory

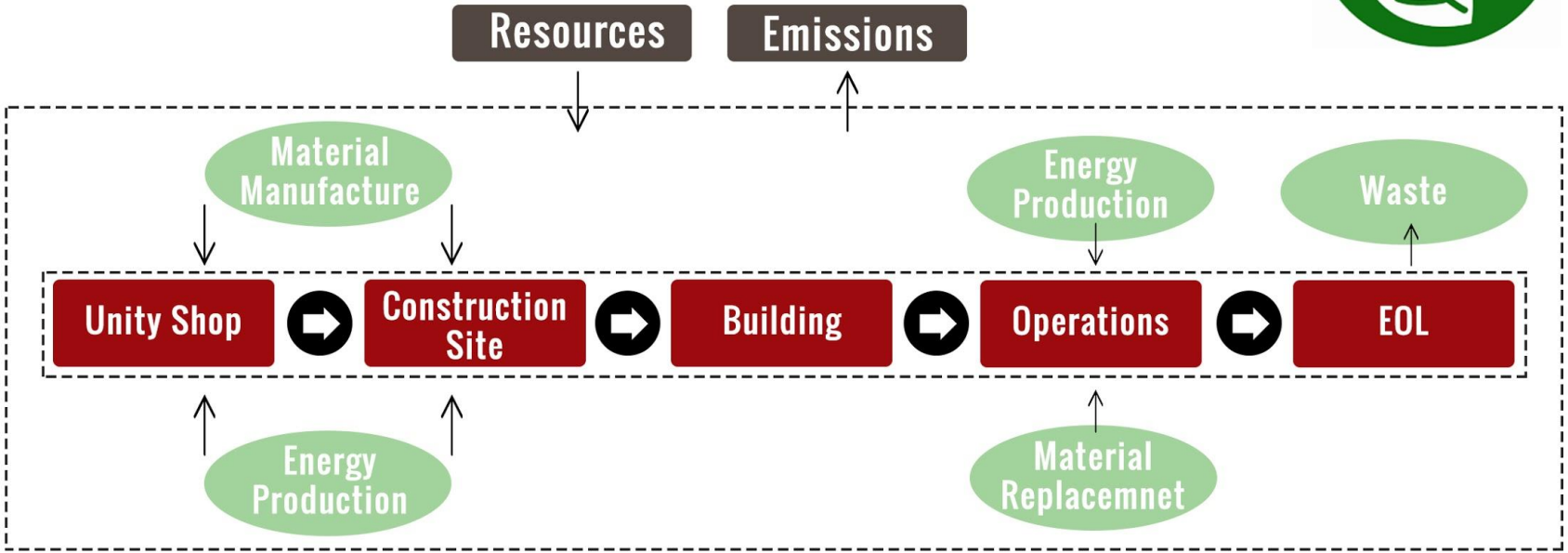
Impact Assessment

Interpretation

Impact Categories

- Global Warming Potential
- Acidification Potential
- Eutrophication
- Ozone Depletion
- Smog Formation
- Human Health-Carcinogenic
- Human Health, Non-Carcinogenic
- Human Health, Respiratory
- Ecotoxicity

System Diagram



Building Scenarios

As Designed: 50 year building lifespan, modeled energy consumption, Unity estimates of appliance use.

Typical New England: High heating and cooling loads, conservative material lifespans

Optimistic Assumptions: Most efficient appliances, long material lifespans.

Extended Building Lifespan

Extended Building Lifespan

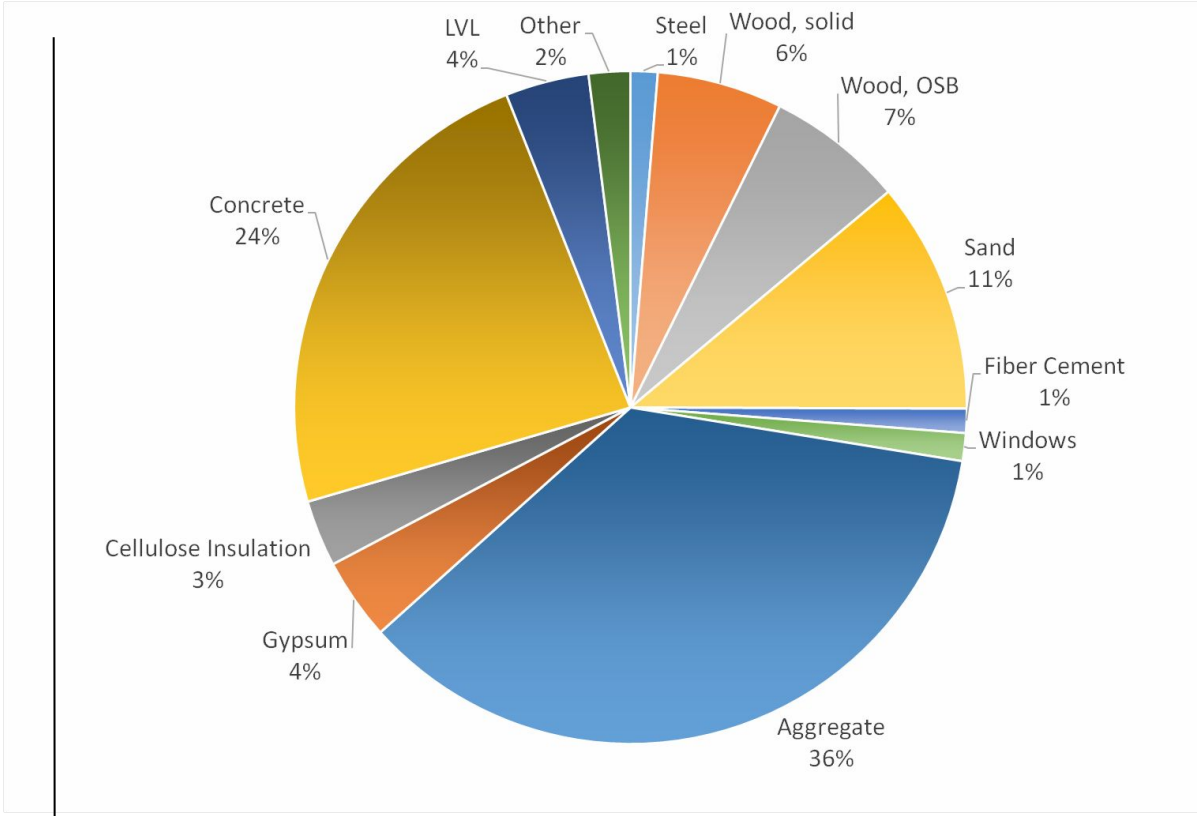
Prefabrication Shop

Construction

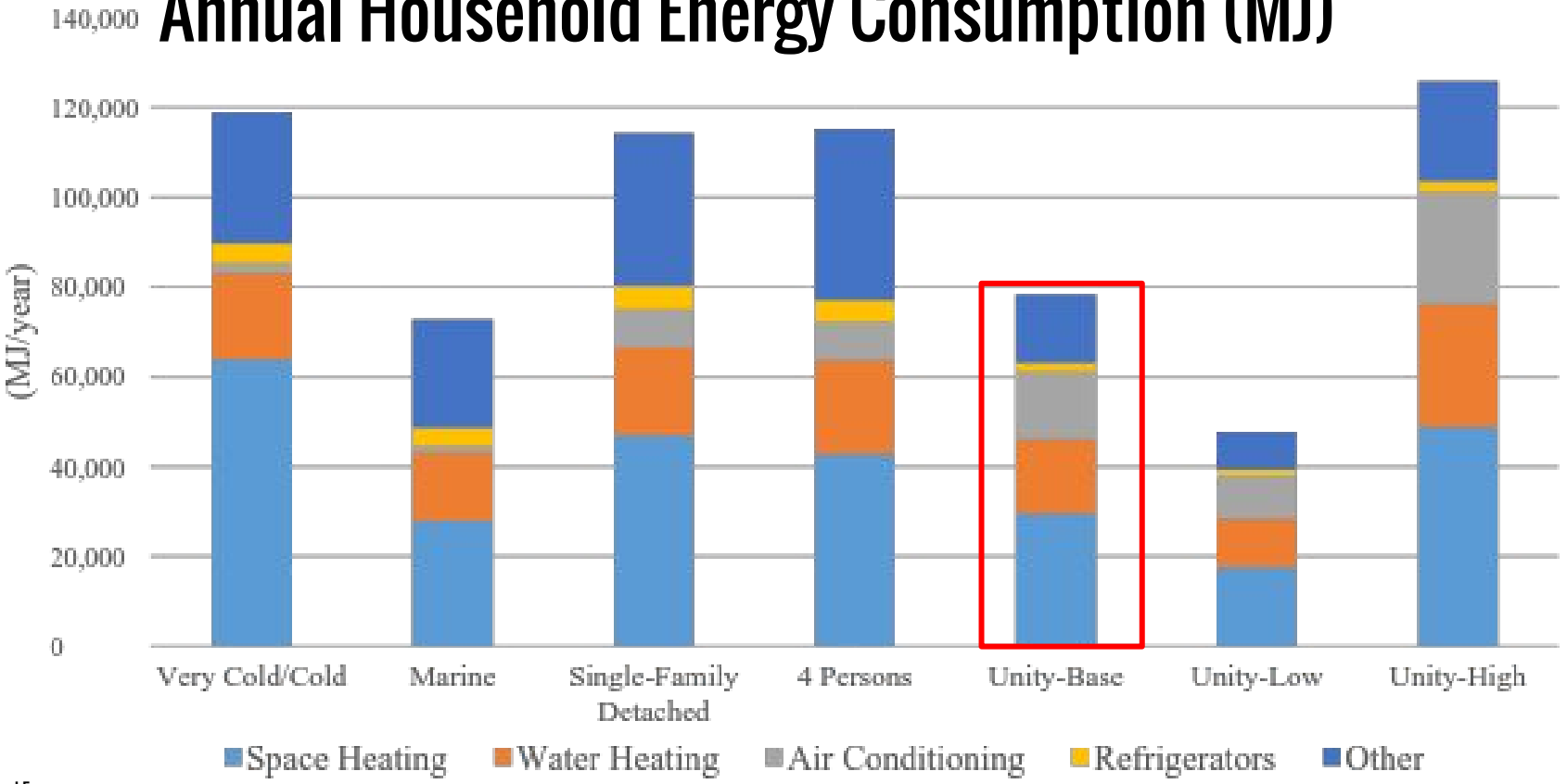
Building Materials

Weight of all Material:

133 Metric Tons



Annual Household Energy Consumption (MJ)



*Delivered Energy
*non-Unity energy use data from 2009 Residential Energy Consumption Survey (RECS 2009)

Household Energy Use

(Annual)

Use Category	Scenario (kWh)		
	Low	Base	High
Domestic Hot Water	880	1,658	3,355
Heating Load	2,836	2,944	5,672
Cooling Load	108	841	1,261
Lights & Appliances	2,713	5,503	6,854
Total Heat Pump	3,825	6,100	10,525
Heat Pump Output (MJ)	36,719	58,563	101,053

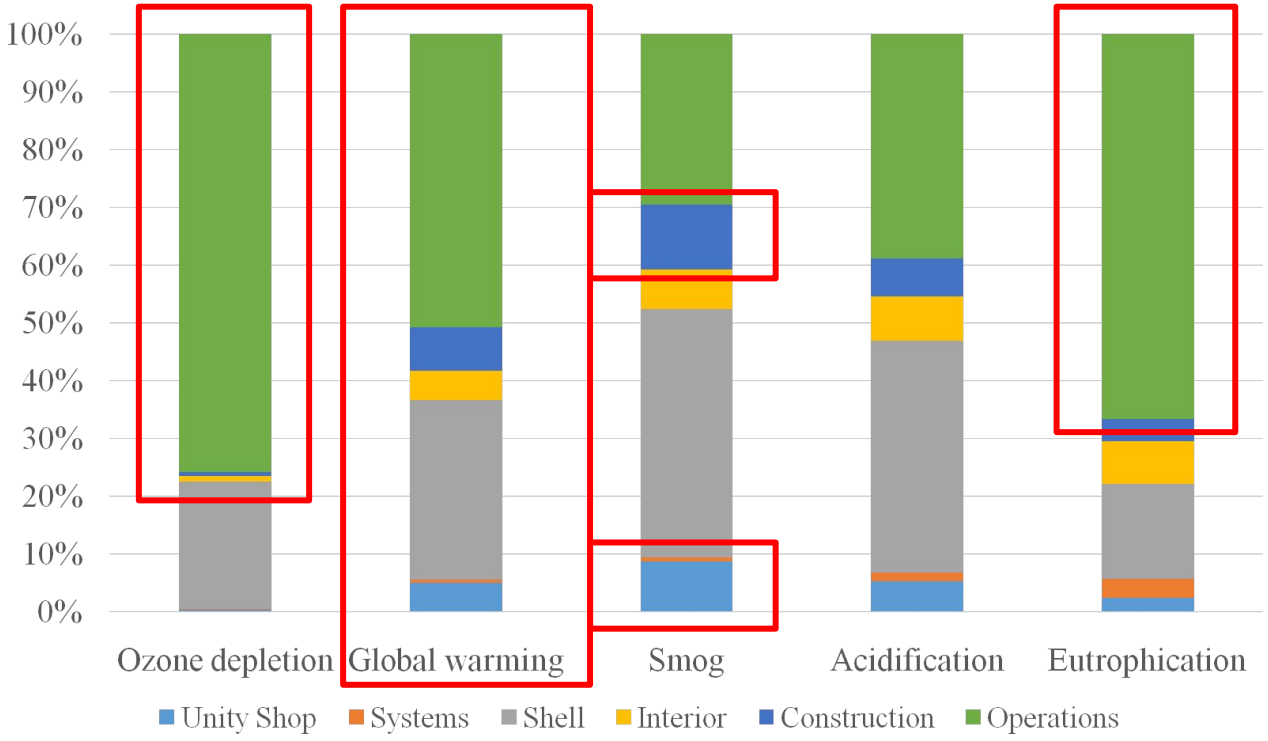
Material Replacement Rates

	Scenario (value in years)		
Material	**Base**	**Low**	**High**
Whole building	50	50	50
Exterior, paint	8	10	5
Mechanical, solar panels	30	30	30
Windows	30	50	15
Bathroom, sink	20	30	10
Appliances, washer	12	25	7

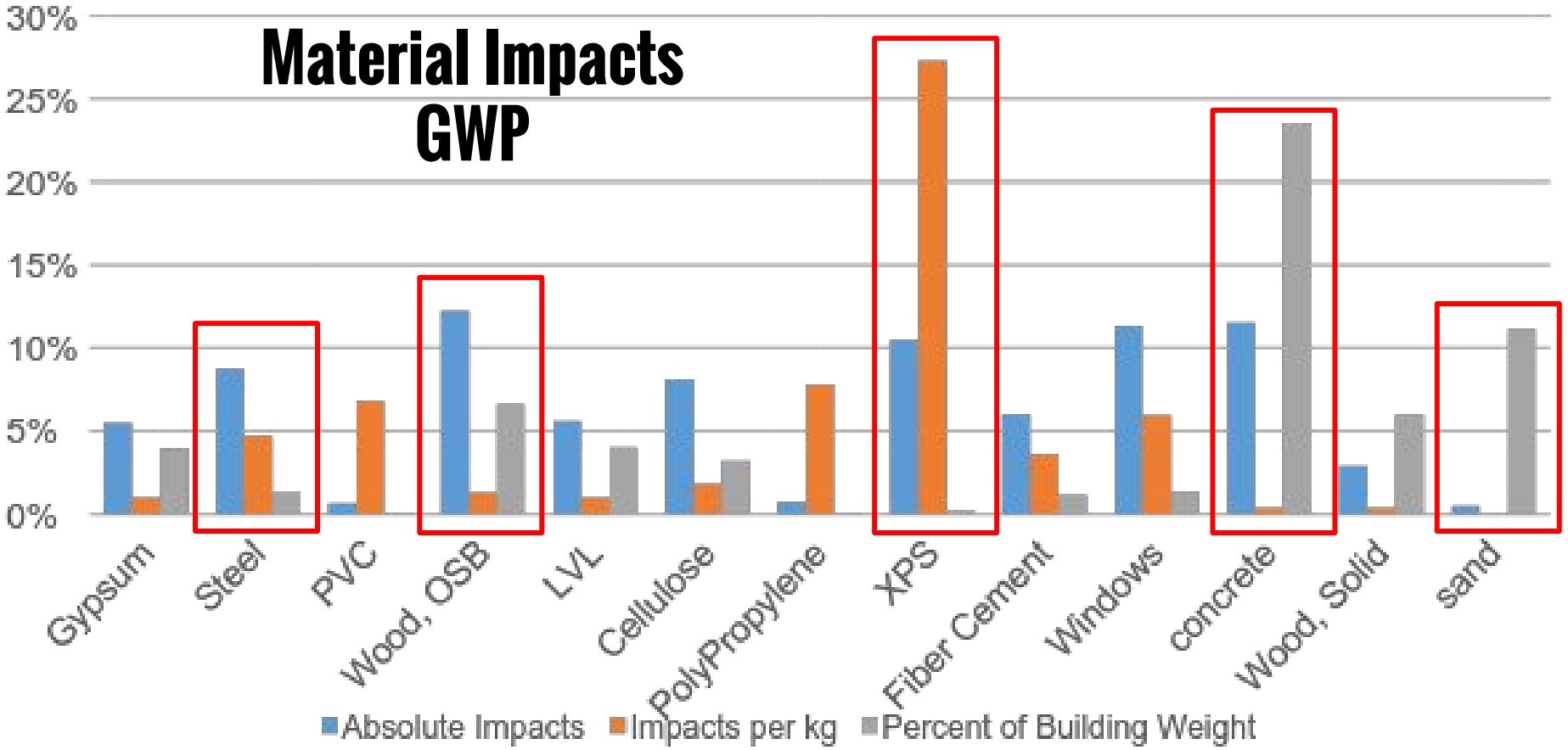
Fate of Materials at End-of-Life

Material	Reuse	Recycle	Dispose
Steel	0%	81%	19%
Timber	75%	0%	25%
Wood, OSB	0%	0%	100%
Concrete	0%	80%	20%
Cellulose Insulation	0%	80%	20%

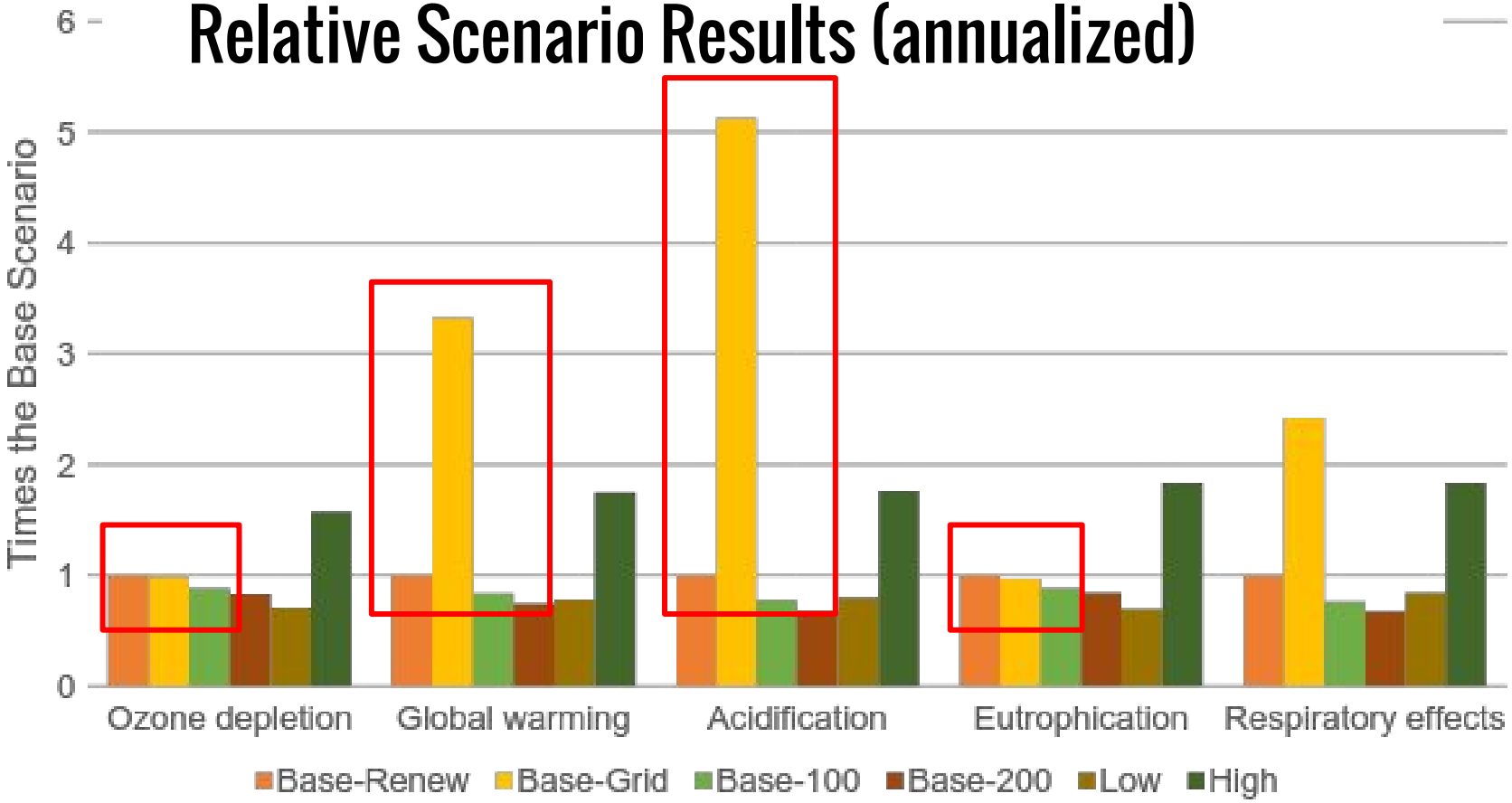
Contribution by Life Cycle Stage



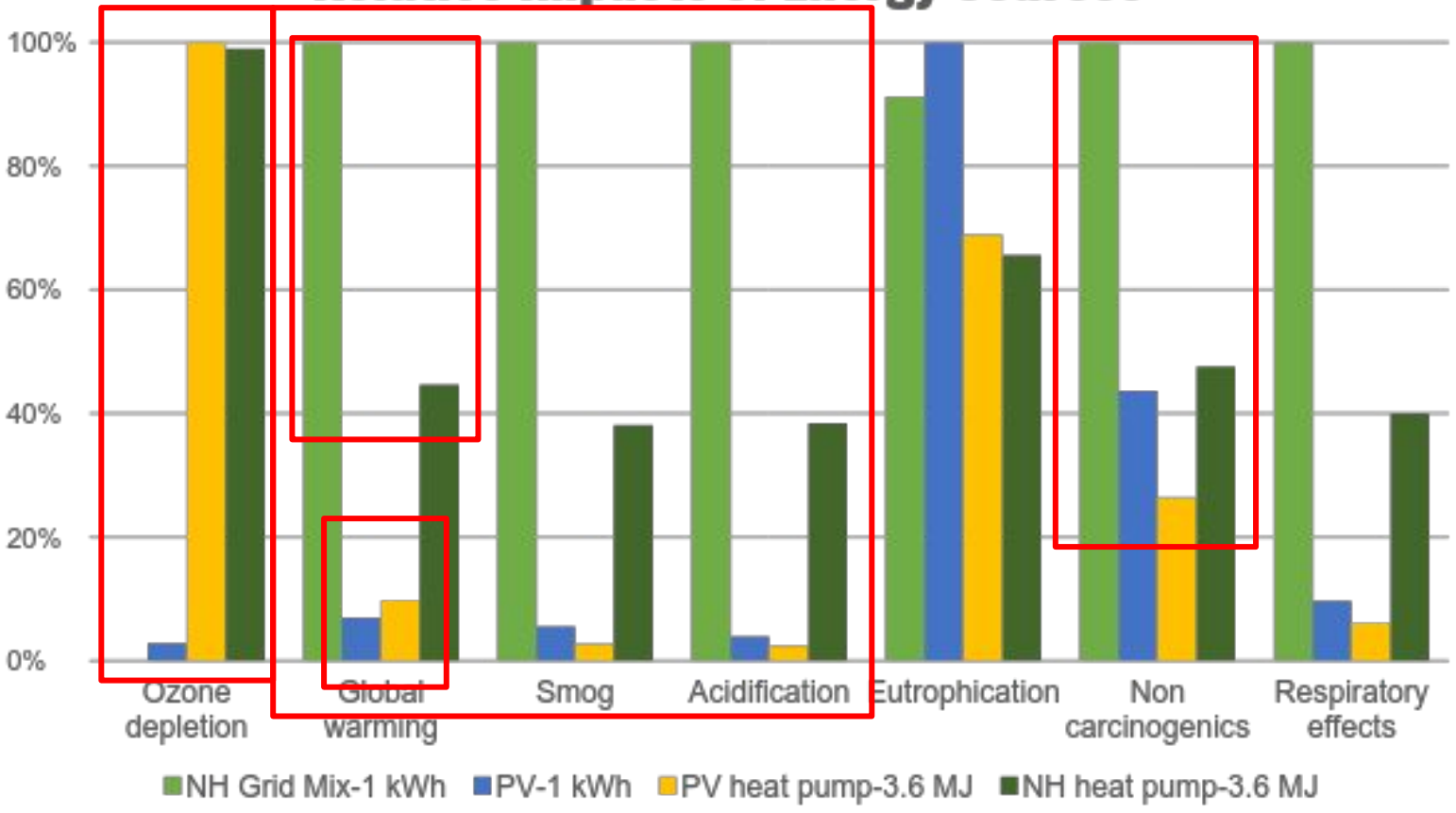
Material Impacts GWP



Relative Scenario Results (annualized)



Relative Impacts of Energy Sources



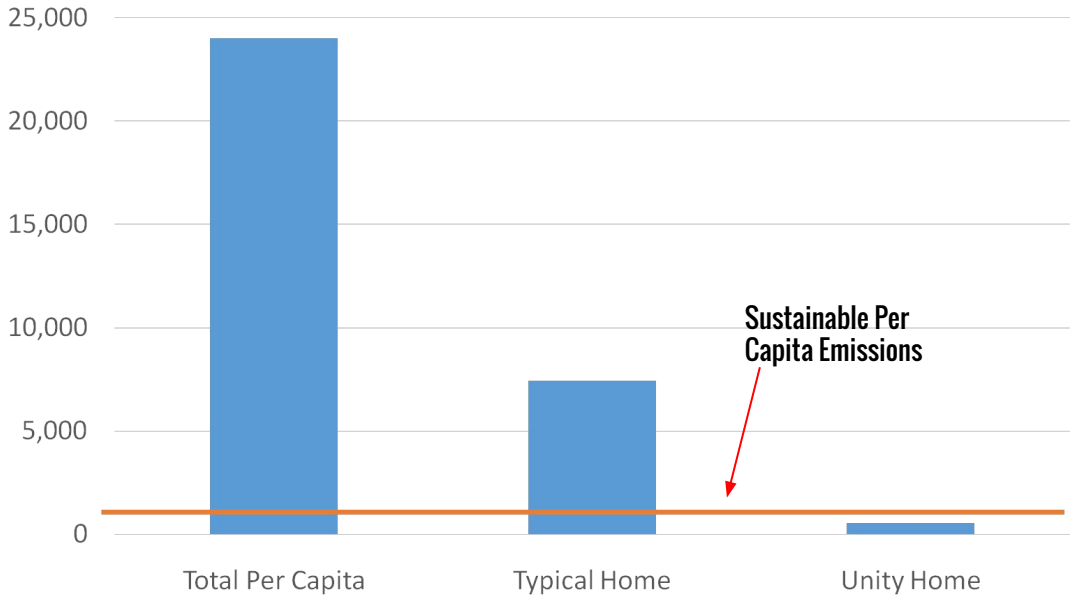
Comparison to National Emissions

Impact Category	Units	Per Capita Emissions	Unity Zum Fraction
Global Warming	kg CO2 eq	24,000	2.28%
Ozone Depletion	kg CFC-11 eq	0.16	0.97%
Acidification	kg SO2 eq	91	4.05%
Eutrophication	kg N eq	22	2.65%
Respiratory Effects	kg PM2.5 eq	24	1.46%

Is

Our Home Sustainable

?



Wood
Metal
PVC
a Showdown

- Thermal performance: **Critical**
- Materially speaking Wood < PVC < Wood Clad < Metal
- Finishing and lifespan matter!
- Some of the old health concerns are diminishing
- Not all PVC is created equal, do your due diligence
- Consider cost

Our *"Aha"* Moments

Long-term operational energy use has the highest environmental impact of any categories. As energy use reduces - impacts shift to materials.

High performance building envelopes that last = a strong strategy for reducing environmental impact.

Extruded polystyrene can be an ozone depleting hog.

Not all vinyl windows are bad. All wood windows are typically best, followed by vinyl, then wood/aluminum clad, with all metal at the rear.

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Questions to Ponder

Is an industry average of averages the right way to truly evaluate life cycle impacts for individual structures?

Is any given product/material better just because other related products/materials are worse?

Is there another metric or rubric that would be more helpful in determining a building's impact on heath & the environment?

Thank You

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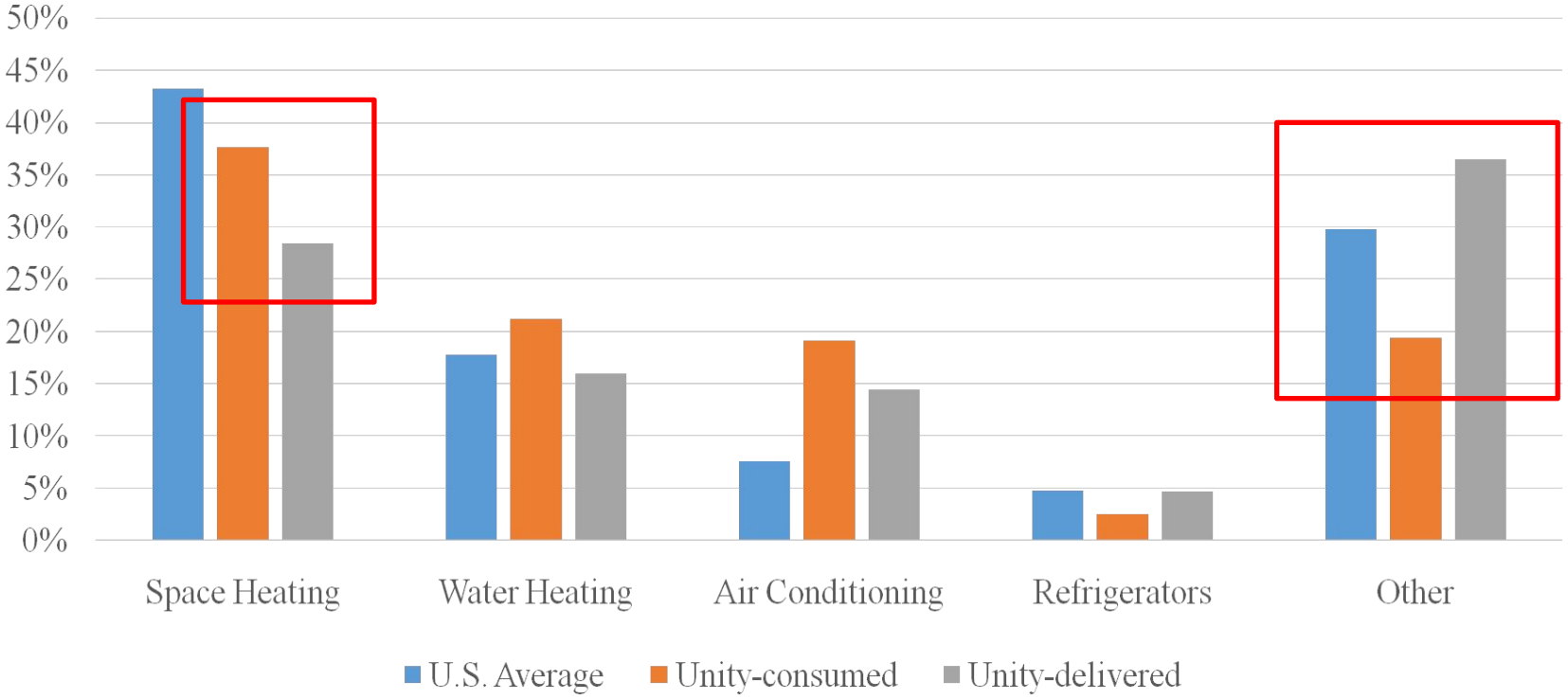
Fraction of Energy Consumption by End-Use



Solar PV Assumptions

Material Replacement Rates

	Scenario (value in years)		
Material	**Base**	**Low**	**High**
Whole building	50	50	50
Exterior, roofing	50	50	50
Exterior, paint	8	10	5
Exterior, Fiber Cement Siding	100	100	50
Exterior, doors	30	75	20
Roofing Insulation	100	100	100
Cellulose Insulation	100	100	100
Windows	30	50	15
Light fixtures	10	25	10
Bathroom, toilets	20	30	10
Bathroom, sink	20	30	10
Bathroom, Shower	20	30	10
Bathroom, tub	50	100	25
Bathroom, fixtures	20	30	10
Mechanical, Heat pump	20	20	20

Material Replacement Rates (cont.)

	Scenario (value in years)		
Material	**Base**	**Low**	**High**
Mechanical, solar panels	30	30	30
Mechanical, hot water heater	25	30	15
Mechanical, ducting	75	75	75
HRV	20	25	15
Plumbing, pipe	50	75	50
Kitchen, countertop	75	100	25
Kitchen, refrigerator	20	30	15
Kitchen, oven	16	25	10
Kitchen, dishwasher	12	25	7
Interior, doors	100	100	25
Interior, drywall	75	100	50
Interior, paint	10	10	5
Floor, tile	75	100	25
Floor, wood	100	100	30
Appliances, dryer	14	25	7
Appliances, washer	12	25	7

Fate of Materials at End-of-Life

Material	Reuse	Recycle	Dispose
Steel	0.00%	81.30%	18.70%
Timber	74.99%	0.00%	25.01%
Wood, solid	53.61%	0.00%	46.39%
Wood, OSB	0.00%	0.00%	100.00%
Sand	80.00%	0.00%	20.00%
Aggregate	79.68%	0.00%	20.32%
Gypsum	0.00%	0.00%	100.00%
PolyPropylene	0.00%	0.00%	100.00%
Concrete	0.00%	80.00%	20.00%
Extruded Polystyrene	0.00%	0.00%	100.00%
Cellulose Insulation	0.00%	80.00%	20.00%
PolyUrethane	0.00%	0.00%	100.00%
LVL	0.00%	0.00%	100.00%
Ceramic Tile	0.00%	0.00%	100.00%
PolyEthylene	0.00%	33.88%	66.12%
PVC	0.00%	0.00%	100.00%
Fiber Cement	0.00%	0.00%	100.00%
Ceramics	0.00%	0.00%	100.00%
Rubber	0.00%	0.00%	100.00%
Adhesive, sealant	0.00%	0.00%	100.00%
Adhesive, tape	excluded		
Paint	0.00%	0.00%	100.00%
Doors	0.00%	0.00%	100.00%
Windows	0.00%	0.00%	100.00%

Impact Category	Process Contribution	Contribution to Impact
Ozone Depletion	Refrigerant production	93.05%
Global Warming	Energy System	48.42%
	Heat pump	17.37%
	Material production	19.08%
	Transport/Machine operation	11.63%
	Other	3.50%
Eutrophication	Medium density fiber board	32.66%
	Wood ash disposal	13.59%
	Mining/Metal Processing Waste	43.36%
	Other	10.40%
Non-Carcinogens	Metal Production	17.46%
	Mining Waste	53.27%
	Other waste disposal	5.40%
	Other	23.87%