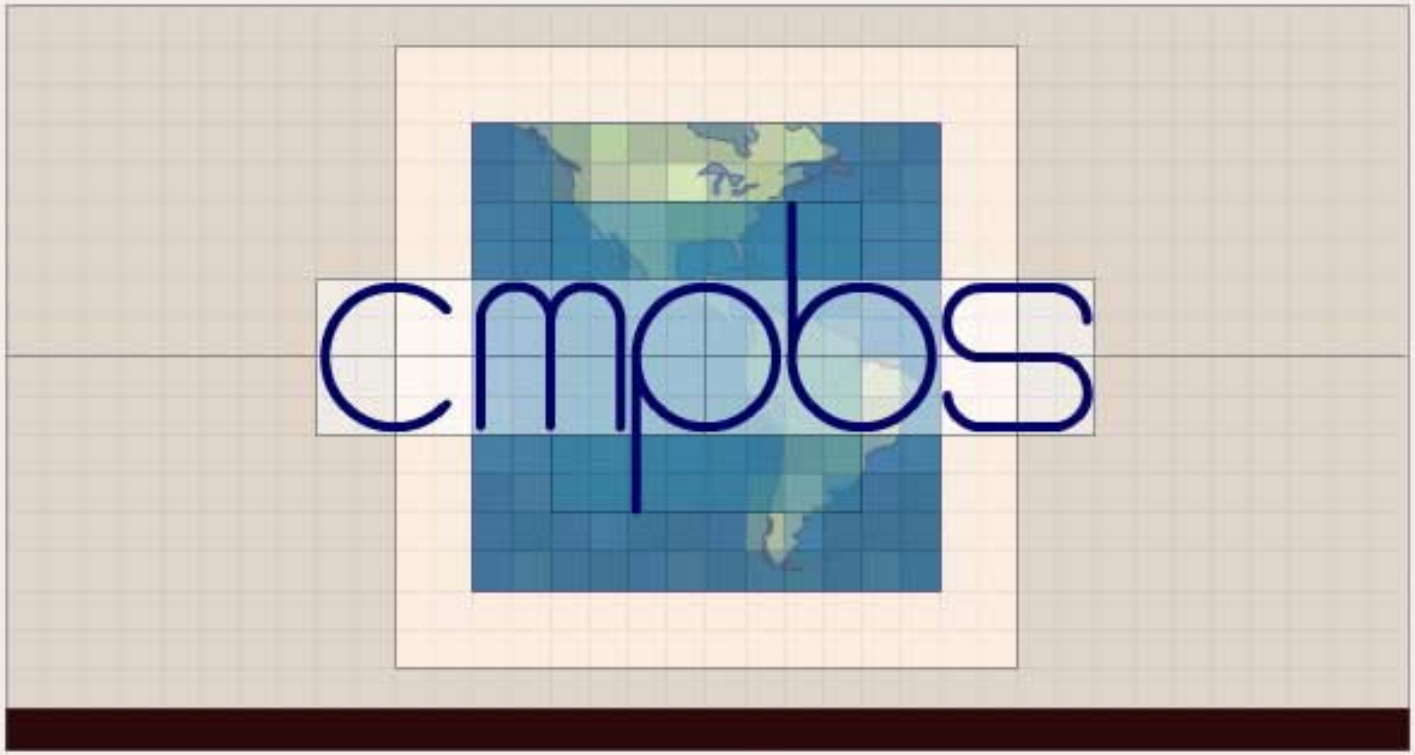
THE CENTER FOR MAXIMUM POTENTIAL BUILDING SYSTEMS




www cmpbs org

# The Emergence of LifeCycleSpace™ LifeCycleRatio™ LifeCycleBalance™

## Definitions Framework

By
Pliny FiskIII
David Armistead
THE CENTER FOR MAXIMUM POTENTIAL BUILDING SYSTEMS
AUSTIN, TEXAS

## ARCHITECTURE & DESIGN

### Flexible Open Building Systems Incorporating Life Cycle Design

- Internationally recognized green architecture
- Greenhouse gas-balanced design
- Flexible building systems procedures and methods
- Ecological communities

Blueprint Demonstration Farm
Laredo, TX

Advanced Green Builder
Demonstration, Austin, TX

Winston-Mize Residence
East Texas

School for Field Studies
Baja Del Sur, Mexico

## MASTER PLANNING

### Ecologically-Balanced Land Use Master Planning

- Nature centers & camps
- Sustainable villages
- Ecologically-designed educational facilities
- Integrated landscape utility systems

School for Field Studies
Baja Del Sur, Mexico

Longju Sustainable
Village, China

St. Mary's County, MD
Life Cycle Planning

Peaceable Kingdom
Washington-on-the-Brazos, TX

## POLICY & EDUCATION

### Sustainable Guidelines & Policy Initiatives

- Green building programs and guidelines
- County planning using life cycle procedures
- Professional development training seminars
- Environmentally preferred materials and methods

Municipal and Regional
Green Builder Program


Sustainable Resources
Database


Professional Training
Seminars


Guidebooks, Manuals,
Publications

## TOOLS

### Environmental/Economic Impact Baselining and Benchmarking

- BaselineGreen™
- GreenBalance™
- EarthLab™
- EcoBalance™ Planning/Game

Pentagon
Renovation Program

DOE Build America Program

Bio-Composites, Earth,
and Alternative Cements

EcoBalance™ Game

**“A GEODESIC IS THE MOST ECONOMICAL RELATIONSHIP BETWEEN ANY TWO EVENTS”**

**R BUCKMINSTER FULLER**

**“LIFE CYCLE BALANCING OF THE SOURCING AND RE-SOURCING OF ANY FLOW PROCESS SHOULD OPTIMALLY OCCUR AT THEIR COINCIDENCE WHEN SPATIALLY MAPPED”**

**CMPBS - RESOURCE BALANCED LAND PLANNING METHODOLOGY FOR THE TEXAS PARKS AND WILDLIFE DEPARTMENT**

# Life Cycle Space™ contains the following attributes:

1) A GIS FRAMEWORK CONSISTING OF AN
EQUAL AREA QUAD GRID MEASUREMENT SYSTEM
OF MULTIPLE HIERARCHICAL BOUNDARIES
FOR ABSOLUTE AND RELATIVE SPATIAL MEASURING

2) MEASUREMENT CONSISTING OF:

A) GEOGRAPHIC RESOURCE AREAS ( MATERIAL /ENERGY/ FOOD ETC. AREAS THAT CONTAIN PRIME ATTRIBUTES )

B) POINTS (BUSINESSES, WITH LIFE CYCLE LINKAGE TO AREA RESOURCES)

C) NETWORKS BETWEEN POINTS (LIFE CYCLE FLOWS CONNECTING SOURCING AND RE-SOURCING INCLUDING: ENERGY, MATERIAL,CURRENCY AND INFORMATION)

**Life Cycle Ratio™ contains the following attributes:**

1) THE PROPORTION OF ANY COLLECTIVE OR PARTIAL LIFE CYCLE ACTIVITY OCCURRING WITHIN A GIVEN BOUNDARY AS OPPOSED TO OUTSIDE THAT BOUNDARY

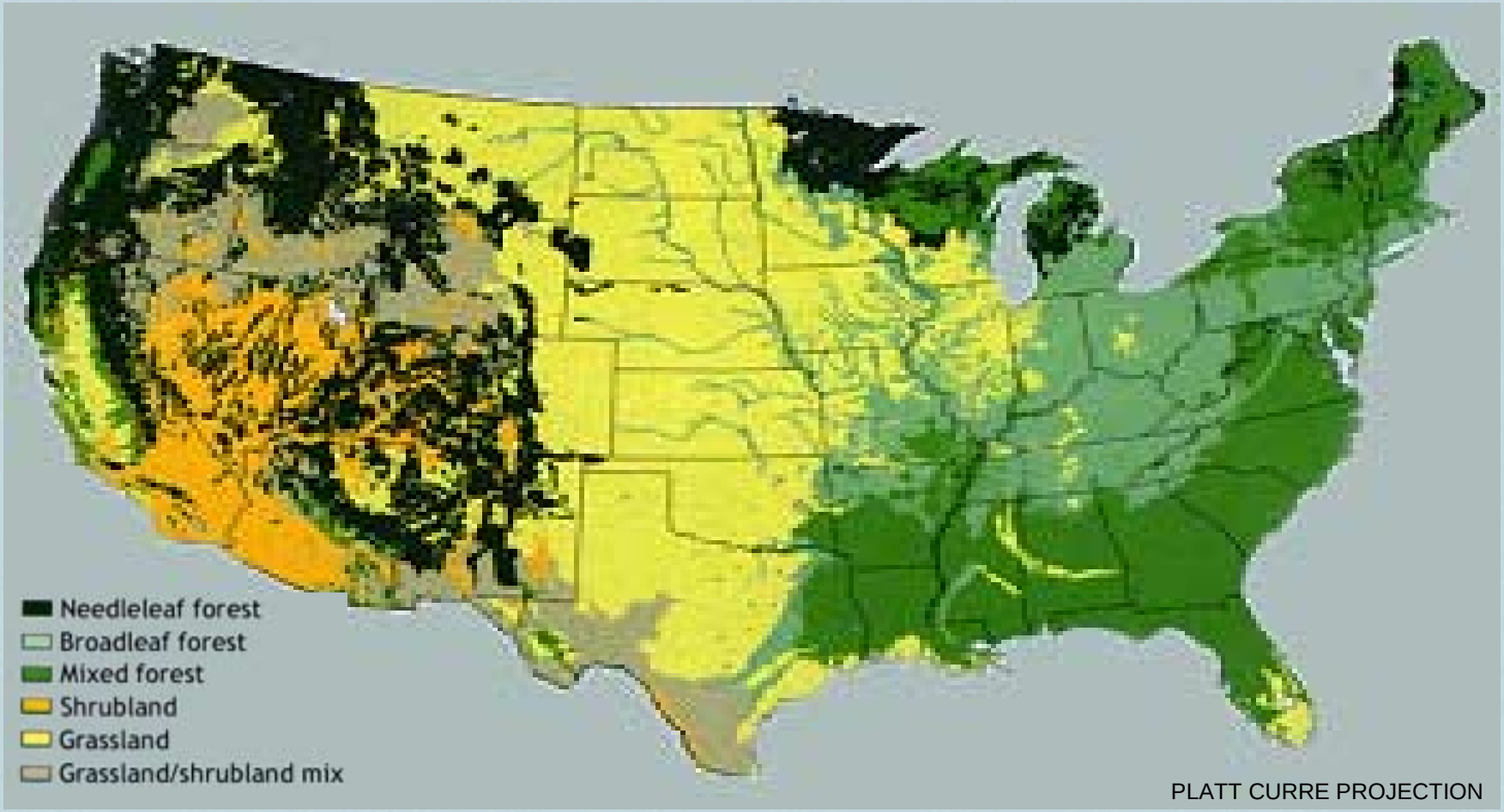
2) THE COMPARISON BETWEEN RATIO ACTIVITIES FROM ONE LOCATION TO ANOTHER OCCURS ONLY WHEN THE SAME EQUAL AREA GIS PROJECTION IS INCORPORATED

# Life Cycle Balance™ contains the following attributes:

1) ONCE LIFE CYCLE TYPES (BUSINESS) AND ACTORS (LLIFE CYCLE PHASE) ARE GEOGRAPHICALLY IDENTIFIED (MATERIAL,-GASEOUS, LIQUID, SOLID; ENERGY -RENEWABLE, NON-RENEWABLE; MONETARY, OR INFORMATION), BALANCE IS DEFINED ACCORDING TO THE DEGREE OF SOURCING AS COMPARED TO RE-SOURCING OF THAT FLOW OCCURES WITHIN THAT DEFINED BOUNDARY

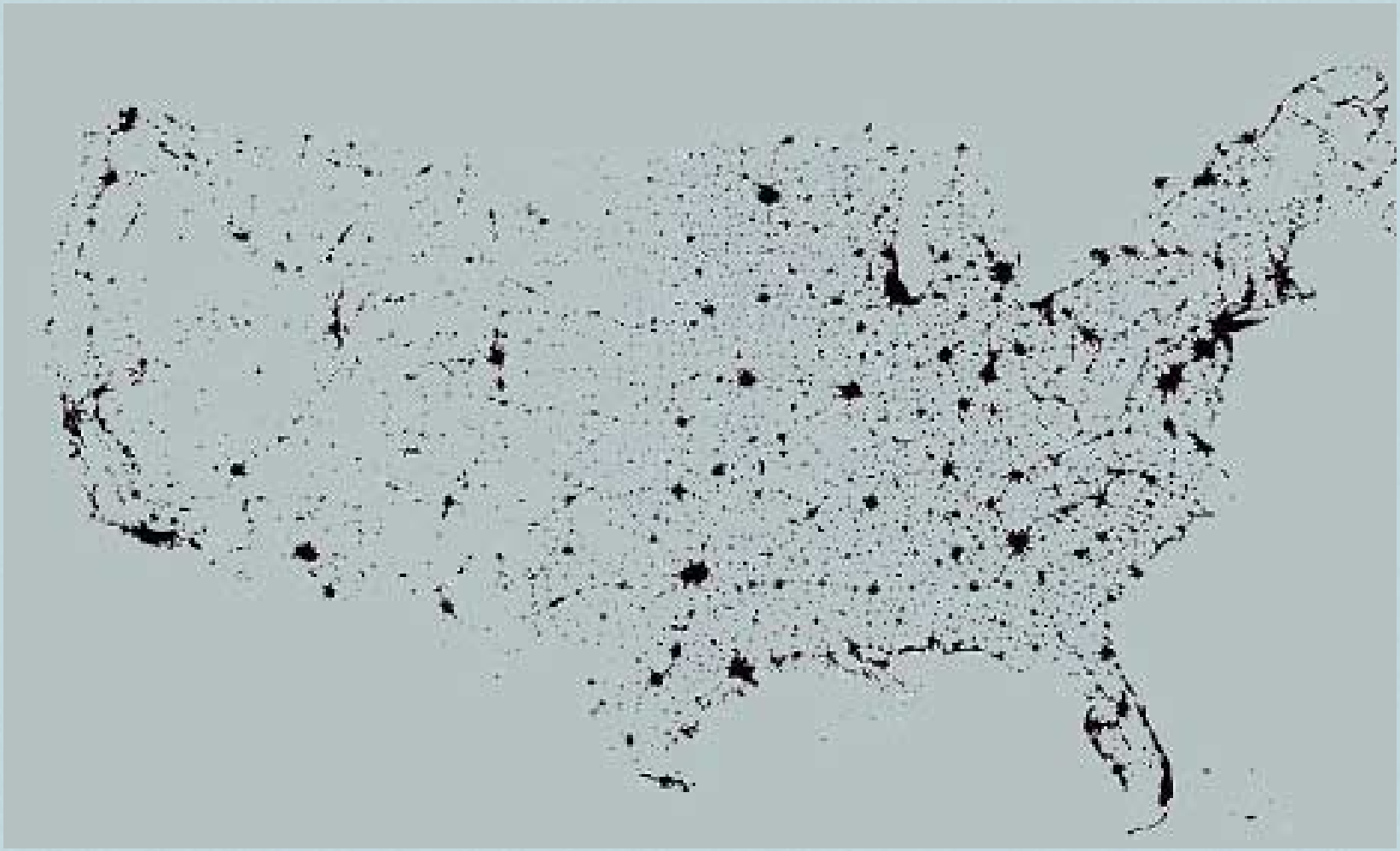
2) MEANINGFUL COMPARISON BETWEEN BALANCE IN ONE GEOGRAPHIC LOCATION TO ANOTHER IS ONLY POSSIBLE WHEN SIMILAR BIOGEOGRAPHIC CONDITIONS EXIST

# AREA RESOURCE




## VEGETATIVE COVER CONTINENTAL U.S.

# POINT AND NETWORK RESOURCES

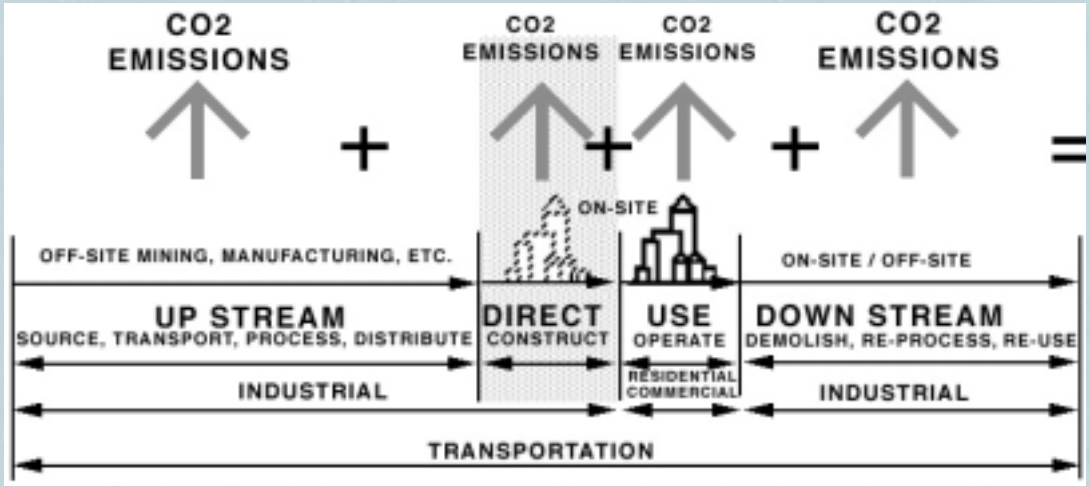


MAJOR HUMAN ACTIVITY AREAS CONTINENTAL U.S.


BASELINE-GREEN™
GREEN BALANCE™

BaselineGreen™ establishes a new “greener” baseline with reduced upstream environmental costs.

GreenBalance™ assessment provides a framework to go beyond the present approach of simply minimizing environmental burdens. GreenBalance™ attempts to neutralize or “balance” these conditions with the objective of mitigating and, in some cases, actually counteracting external environmental costs

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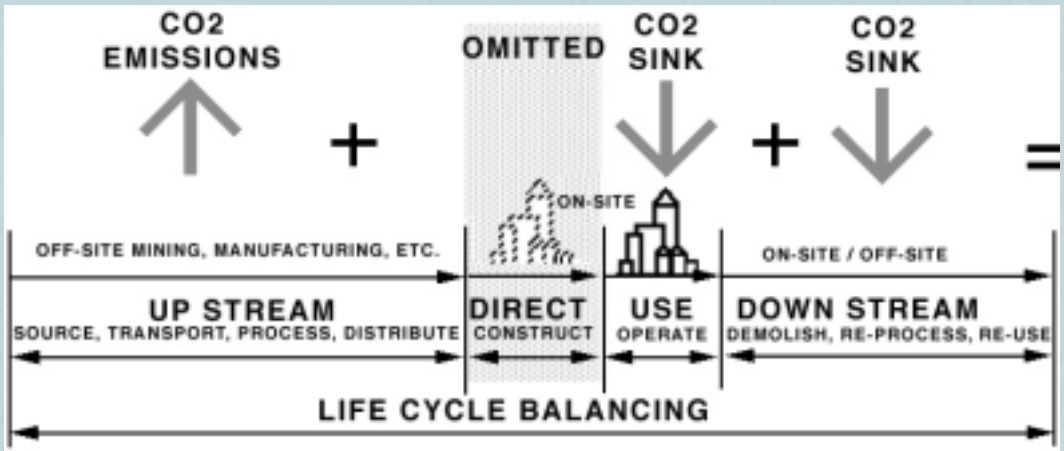
**$CO_2$ EMISSIONS BASELINE COMPARISON BUILDING**

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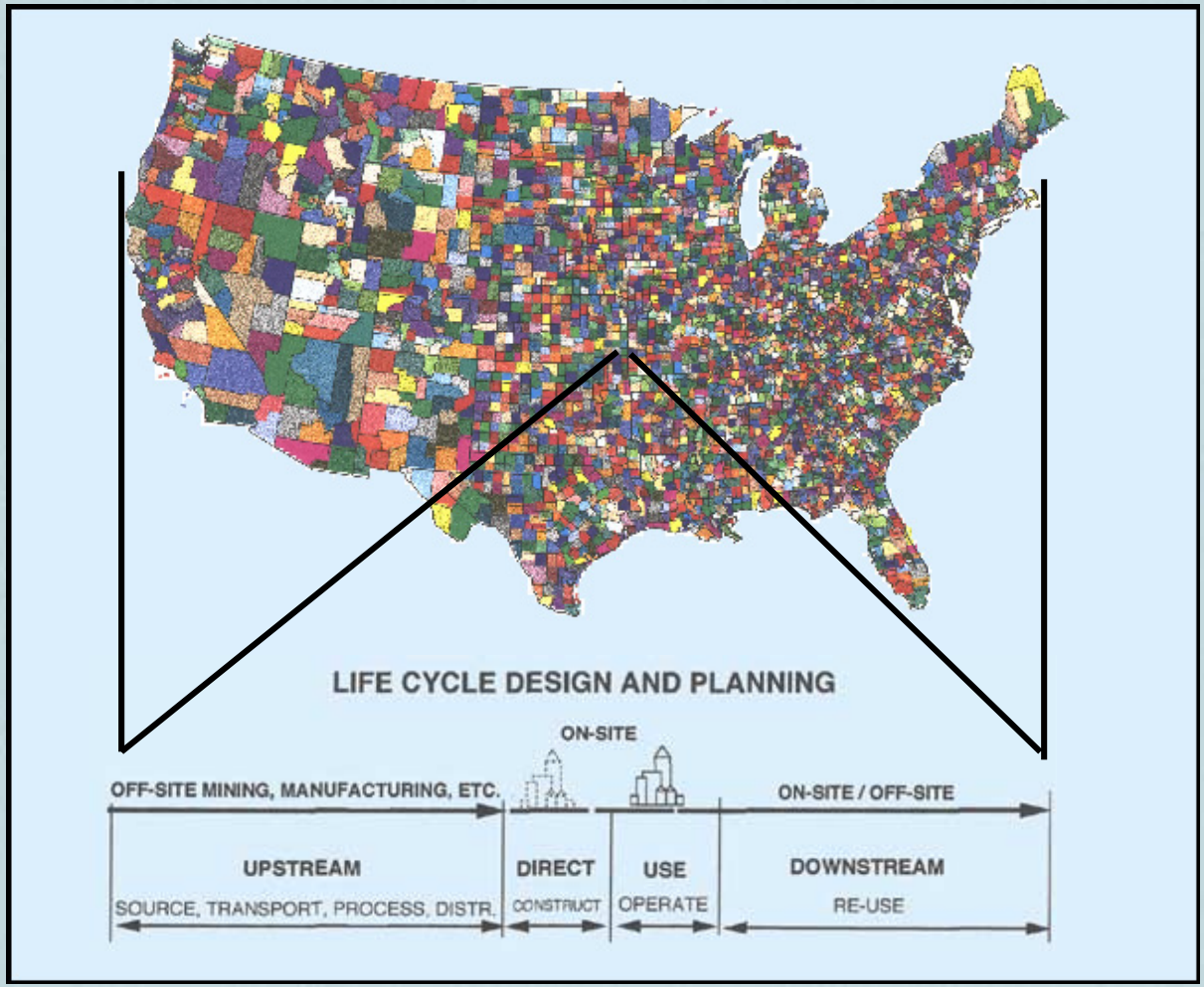
**$CO_2$ EMISSIONS LIFE CYCLE BALANCING**

$CO_2$ emissions occur at every stage of a building's life cycle.
$CO_2$ balancing may be attained by using long-lasting CO2 sink materials and products.




**AS AN INPUT / OUTPUT MODELING TOOL BASELINE GREEN CAN OPERATE AT SEVERAL SCALES OF IMPACT FROM THE COUNTRY TO THE COUNTY AND EVEN ZIP CODE**

**A Base Line Green™ has been created to better design and engineer environmentally and economically sophisticated buildings, towns and city regions using national data for the continental U.S.**

**This data represent over 12 million U.S. businesses in a manner that not only shows their economic impact but their greenhouse gases, criteria air pollutants and toxic release.**

**Building accounts for roughly 40 percent of the materials flow in the global economy each year.**

**In the U.S., one-sixth to two-thirds of the environmental impact nationwide is due to wood and mineral extraction, water and energy, and the processing and manufacturing phases of the life cycle within the construction industry.**

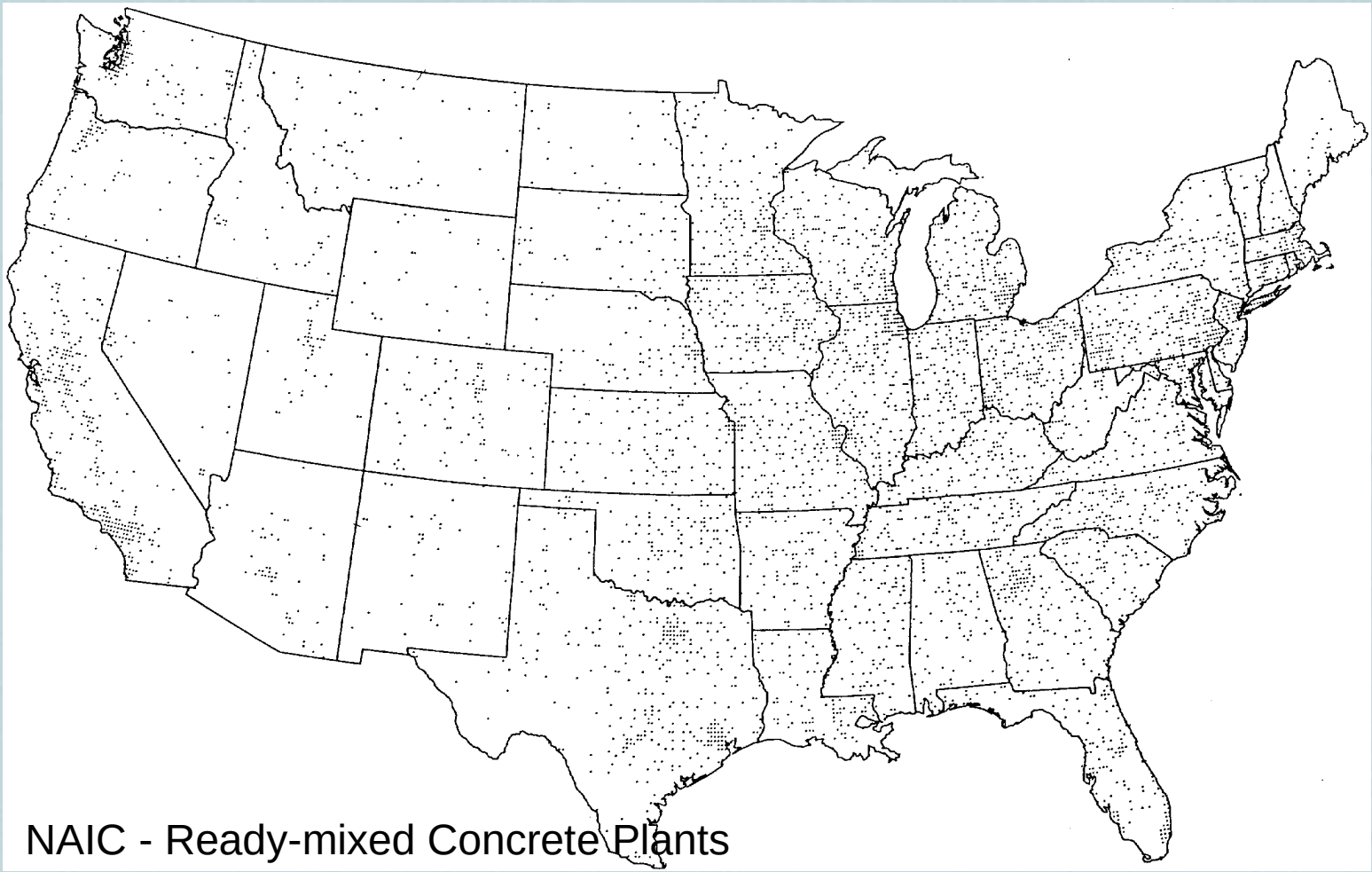
**This impact is associated directly to how all facets of the built environment are constructed, how they operate, and the manner in which maintenance occurs.**

1. Base lines the entire life cycle of 489 industrial categories within the U.S. economy and represents their environmental and economic impacts according to regions (includes 39 building construction sectors)

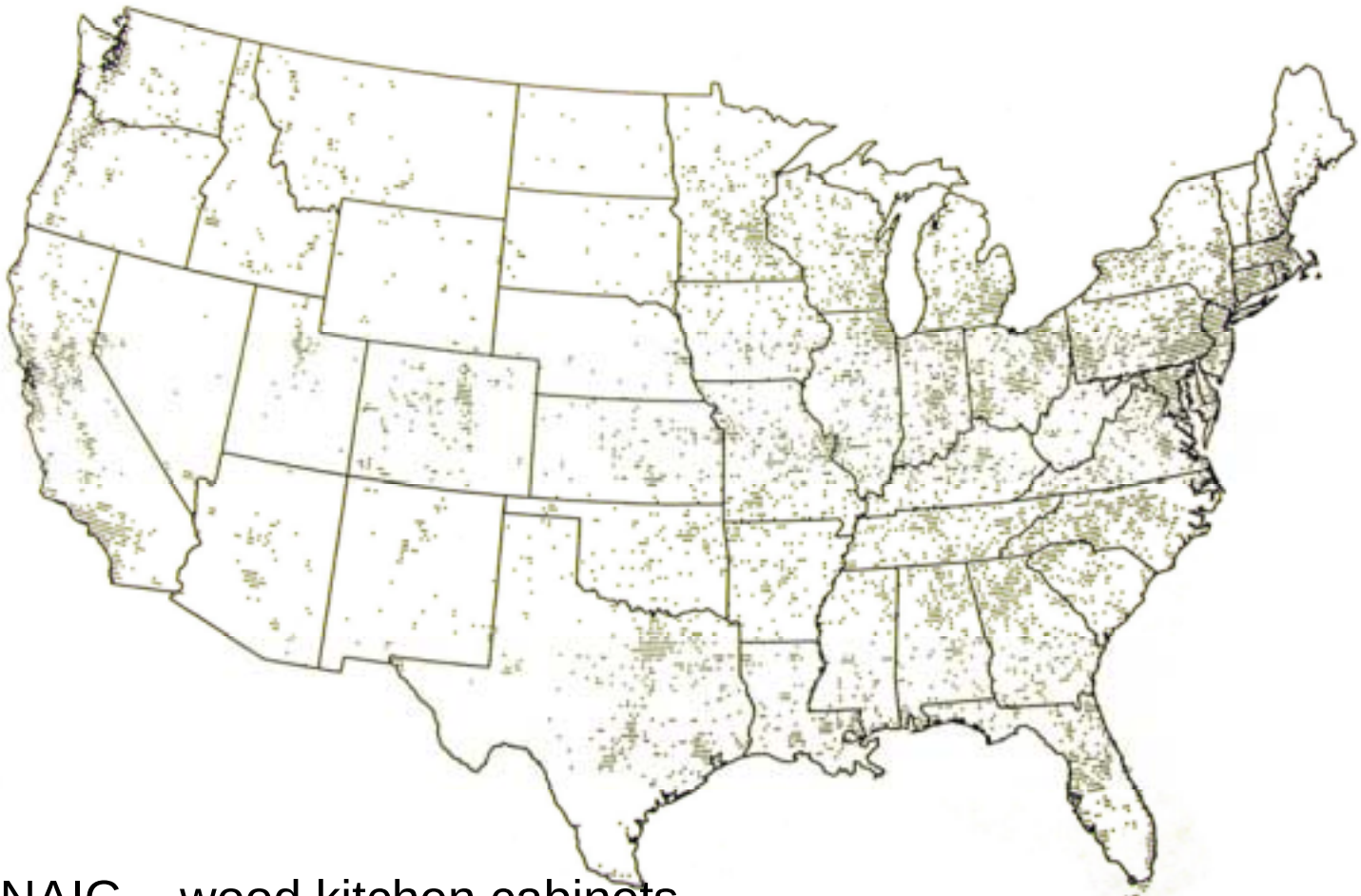
2. Correlates Standard Industrial Code (SIC) and its related Bureau of Economic Analysis code (BEA) to Construction Specifications Institute (CSI) and ASTM (Uniformat) categorization systems

3. Depicts impacts hierarchically and graphically for all major facets of buildings and utilities

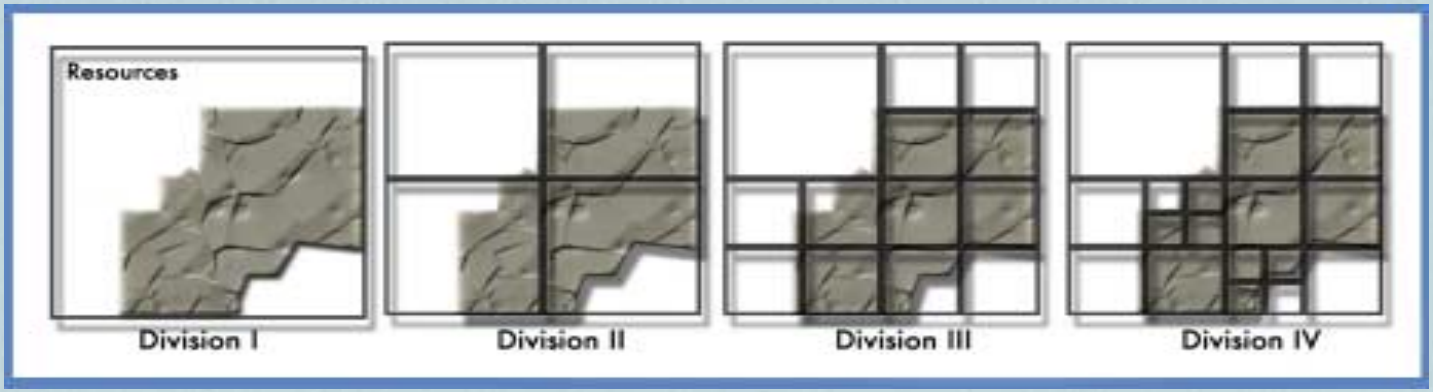
4. Shows in GIS format where the generic condition effects environment and/or economies.



NAIC - Ready-mixed Concrete Plants

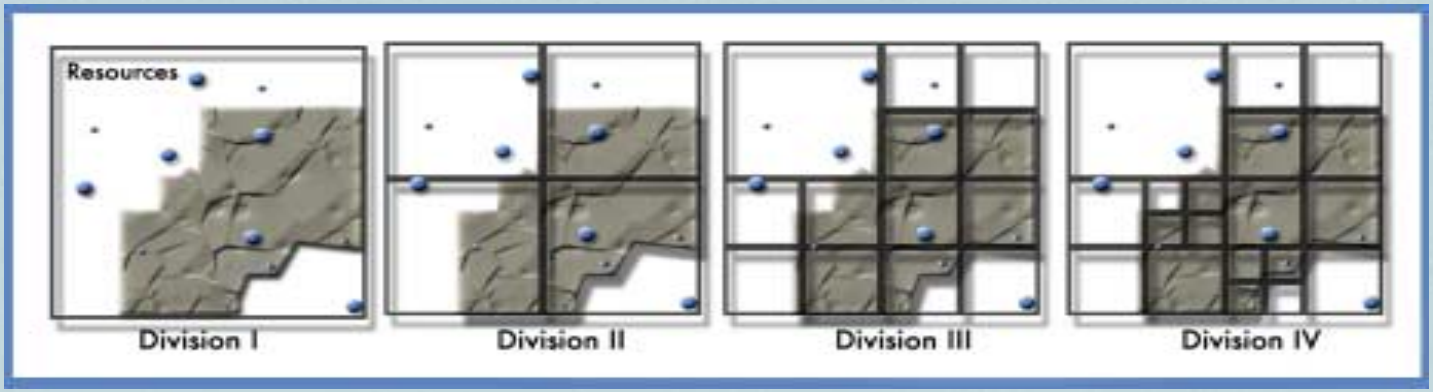


NAIC - wood kitchen cabinets



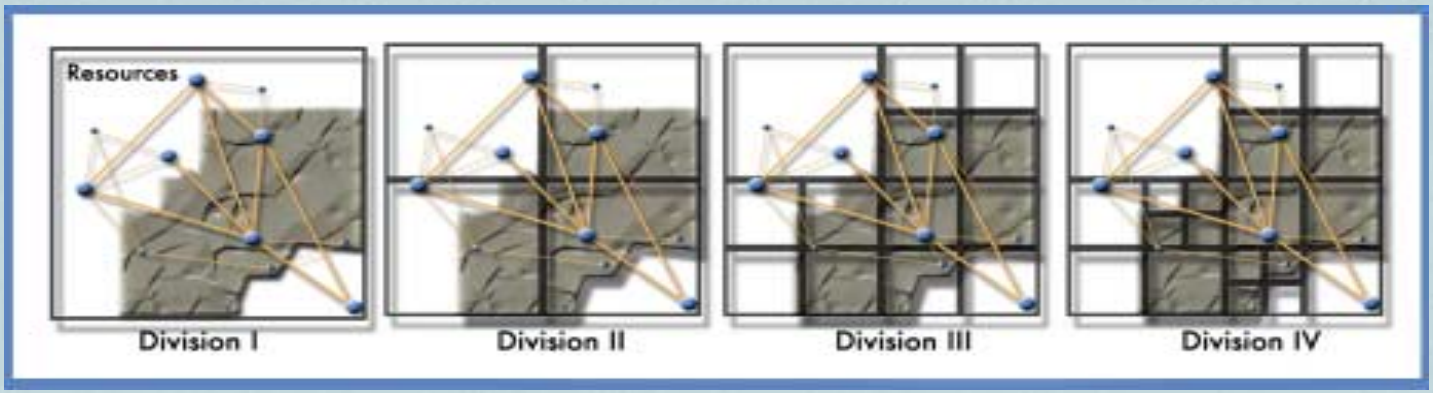

## Area sources + re-sources

Are subjected to suitability Analysis incorporating Ecological land planning methods.




## Point resources

Are subjected to Regional input / output with embedded data sets + location Analysis according to SIC and GIS protocols.

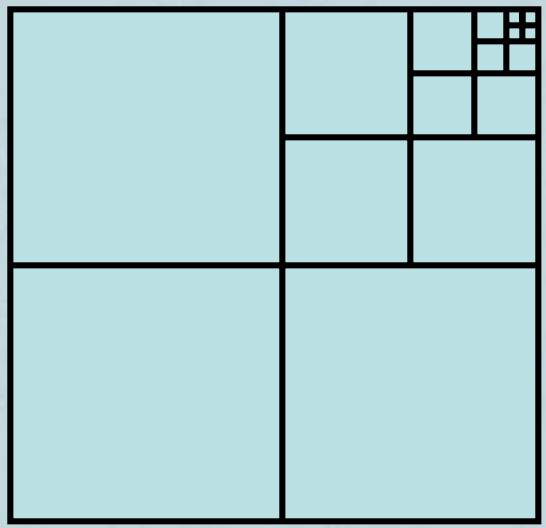


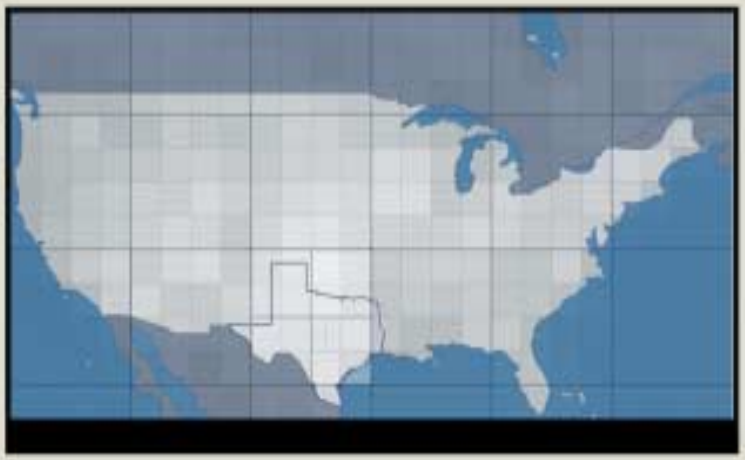

## Network resources

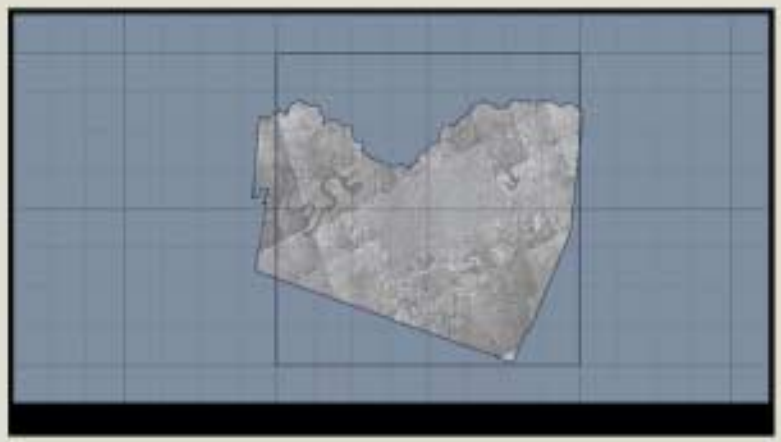
Are subjected to life cycle partitioning according to activity + probability network analysis for life cycle Clustering.

# EQUAL AREA PROJECTION AREAS

| LEVEL | LONG DISTANCE (METRIC) | LAT DISTANCE (METRIC) | LONG DISTANCE (ENGLISH) | LAT DISTANCE (ENGLISH) | NORTH AMERICAN GRIDS |
|---|---|---|---|---|---|
| I | 720 KM | 720 KM | 450 MILES | 450 MILES | 2 X 2 |
| II | 80KM | 80KM | 50 MILES | 50 MILES | 10 X 10 |
| III | 16 KM | 16 KM | 10 MILES | 10 MILES | 50 X 50 |
| IV | 3.75 km | 3.75 km | 2.4 miles | 2.4 miles | 400 x 400 |
| V | 439 meters | 439 meters | 669 feet | 669 feet | 3,600 x 3,600 |
| VI | 83 meters | 83 meters | 126 feet | 126 feet | 18,000 x 18,000 |
| VII | 17 meters | 17 meters | 53 feet | 53 feet | 90,000 x 90,000 |

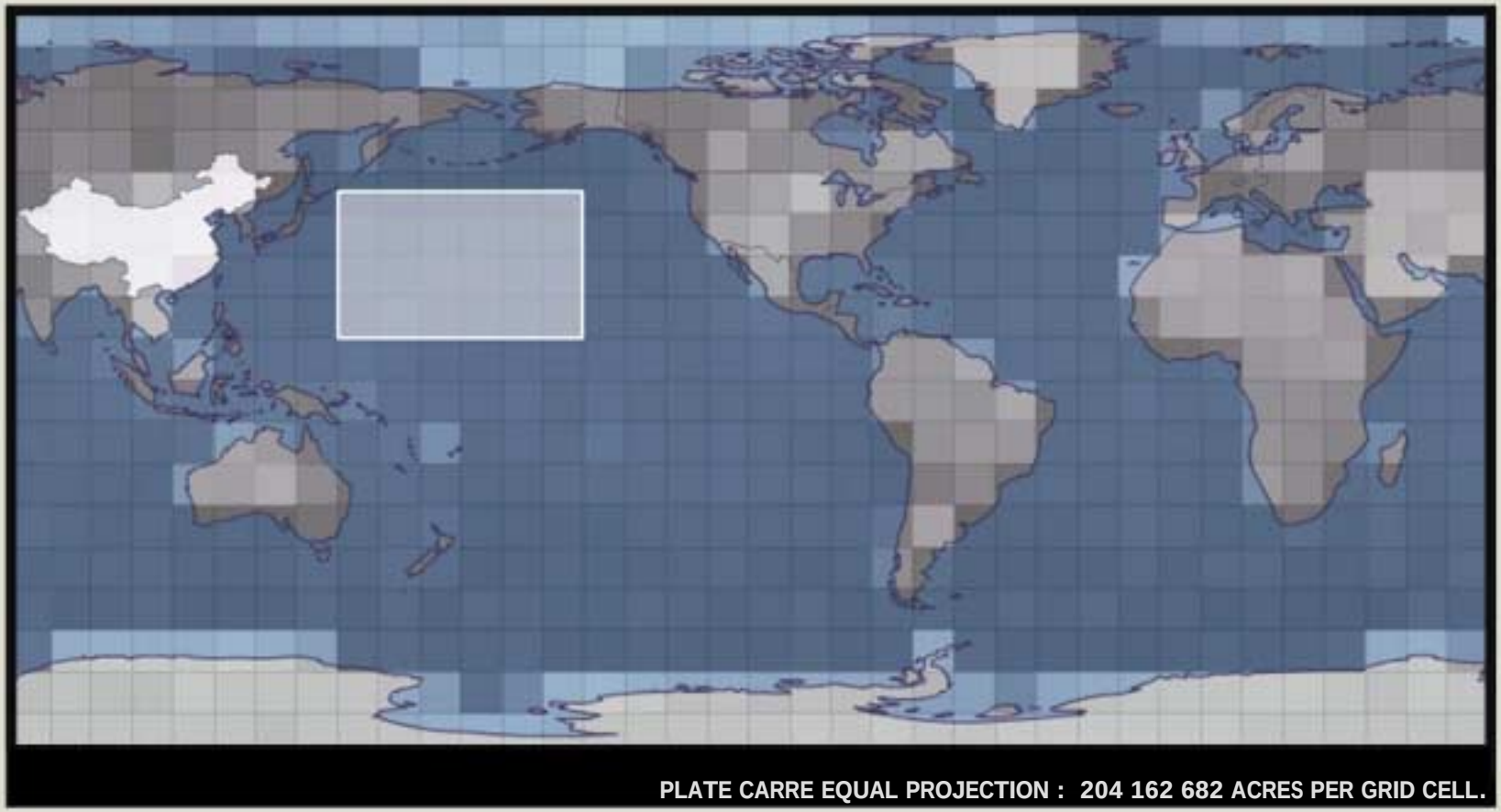






# EXAMPLE OF INFINITE GRID SCALES - WORLD TO COUNTY

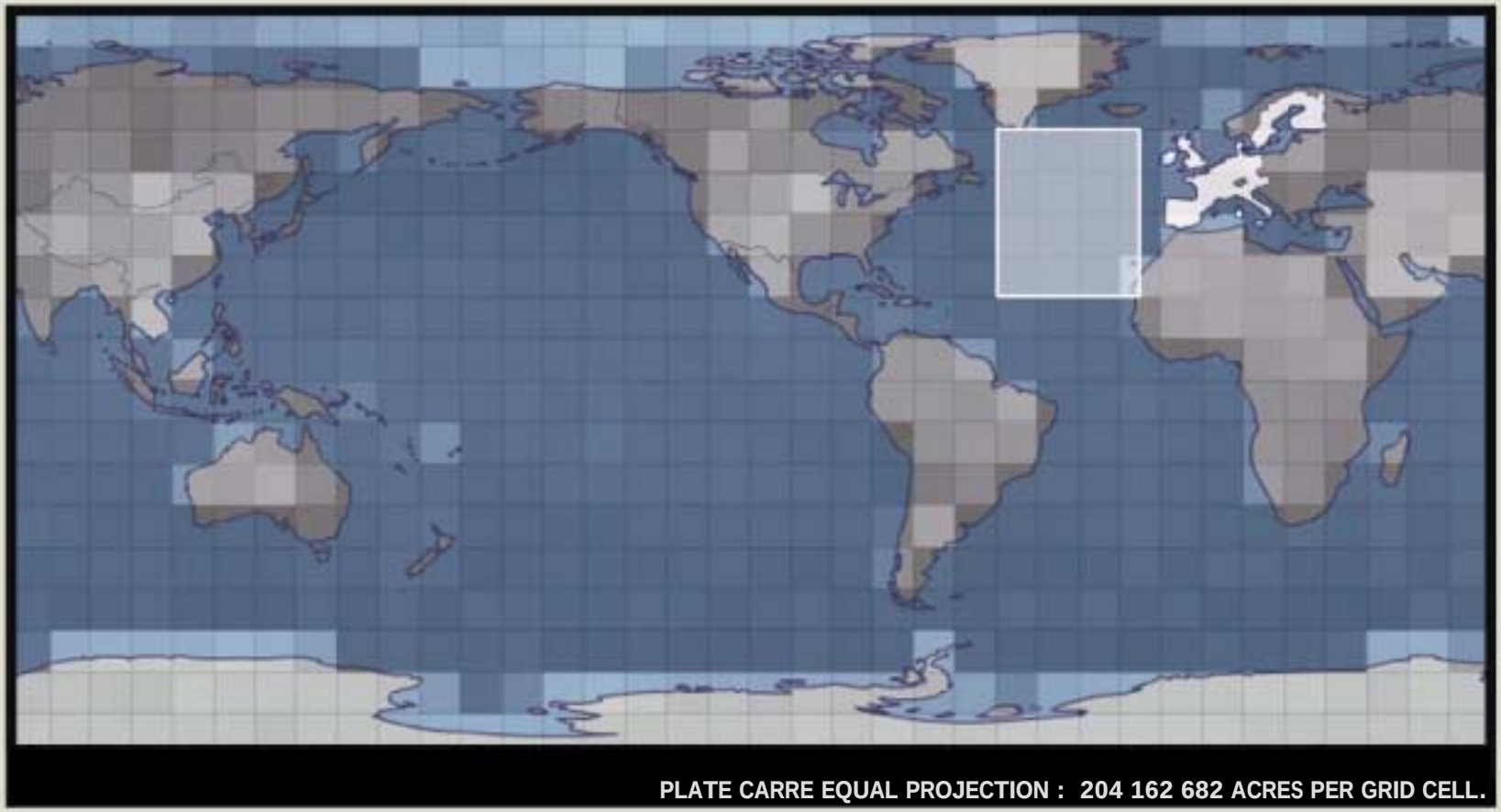
# LifeCycleSpace™
# &
# LifeCycleRatio™




# CHINA'S FOOTPRINT NEEDS

| | |
|---|---|
| INTERNAL CAPACITY | 8.9 cells |
| DEFICIT | 12 cells |

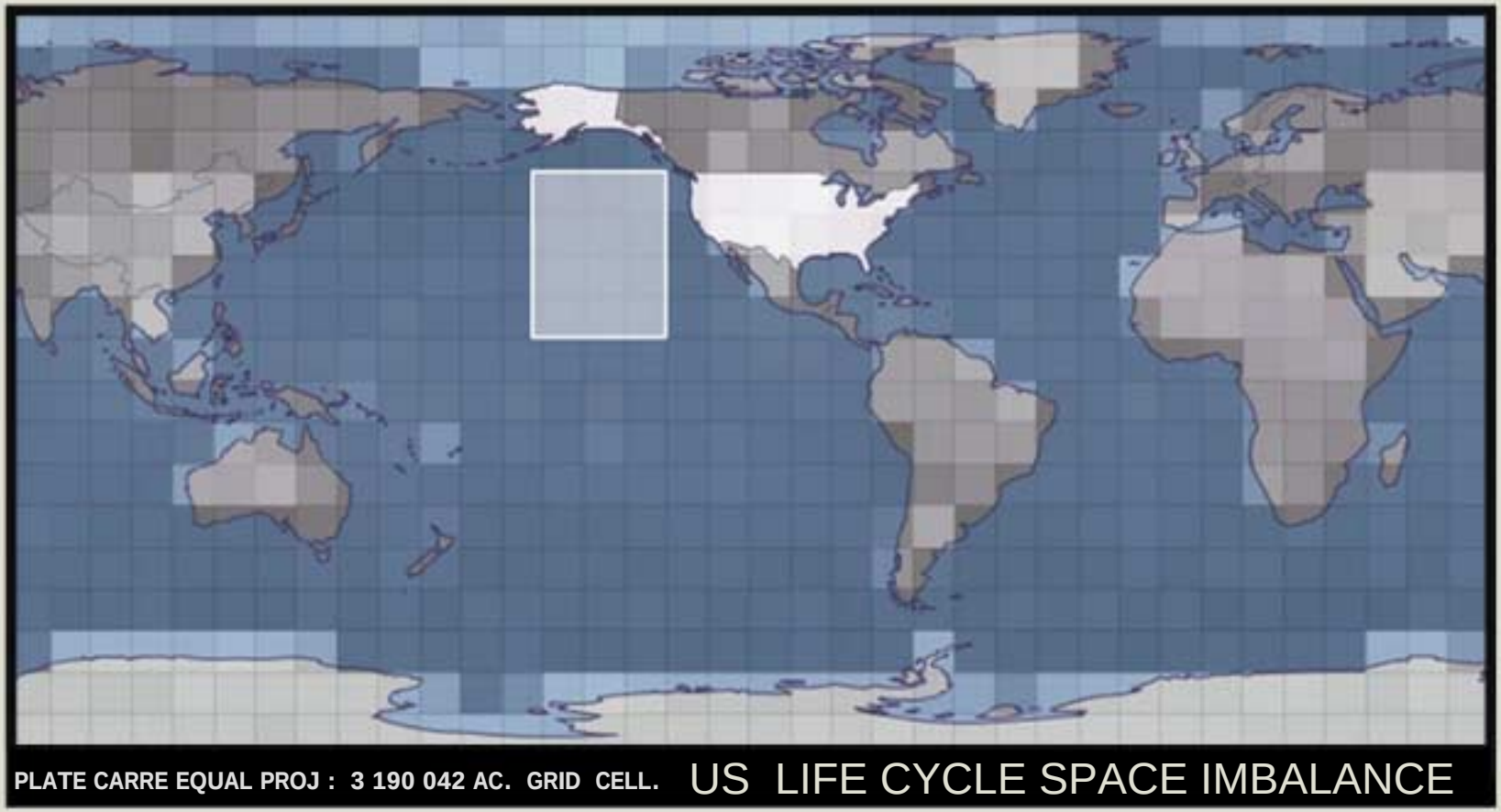
SOURCE: LIVING PLANET REPORT




# EUROPE'S FOOTPRINT NEEDS

| | |
|---|---|
| INTERNAL CAPACITY | 10.5 cells |
| DEFICIT | 10.5 cells |

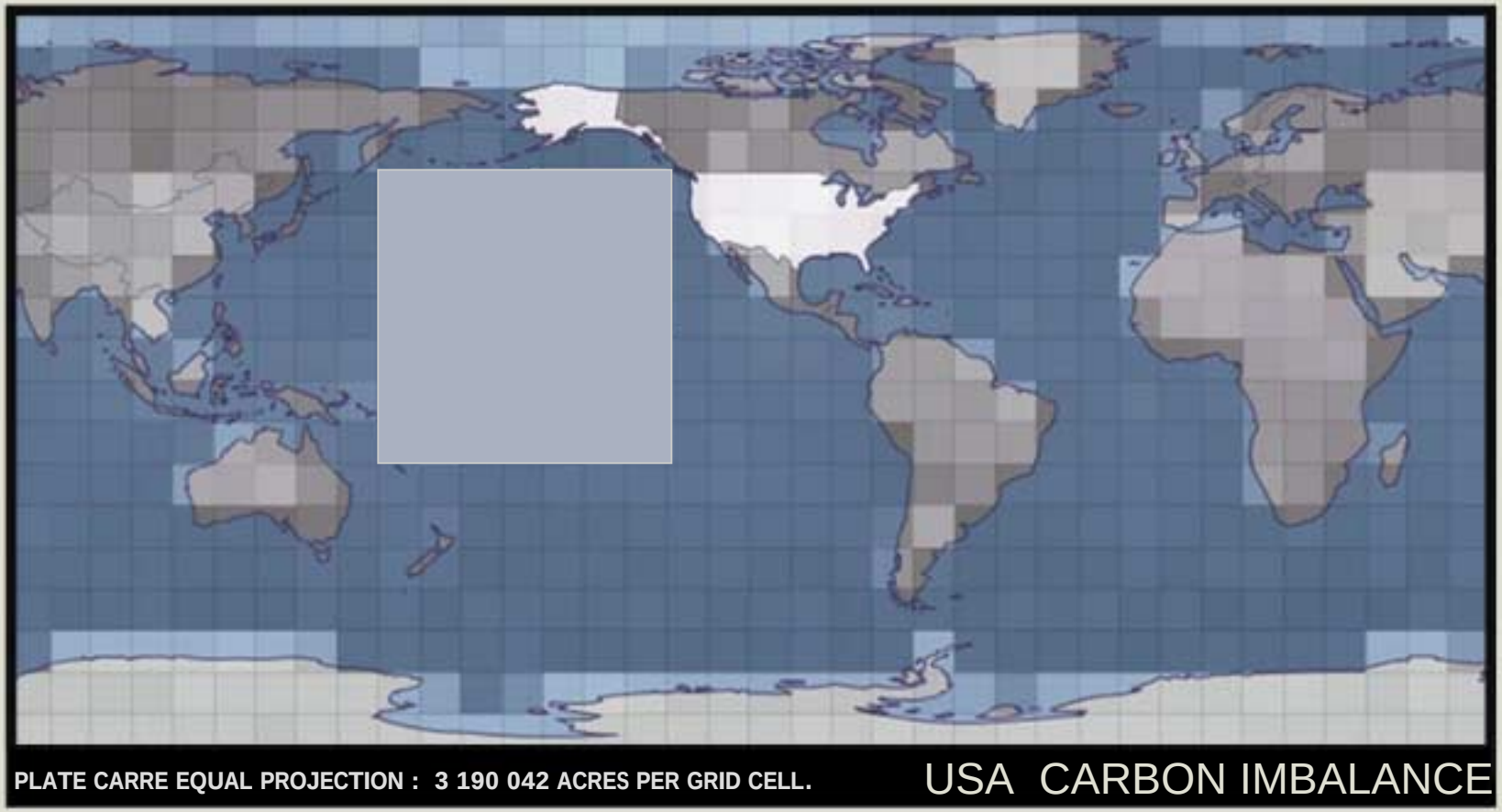
SOURCE: LIVING PLANET REPORT




# U.S. FOOTPRINT NEEDS

| | |
|---|---|
| INTERNAL CAPACITY | 17.8 cells |
| DEFICIT | 13.1 cells |

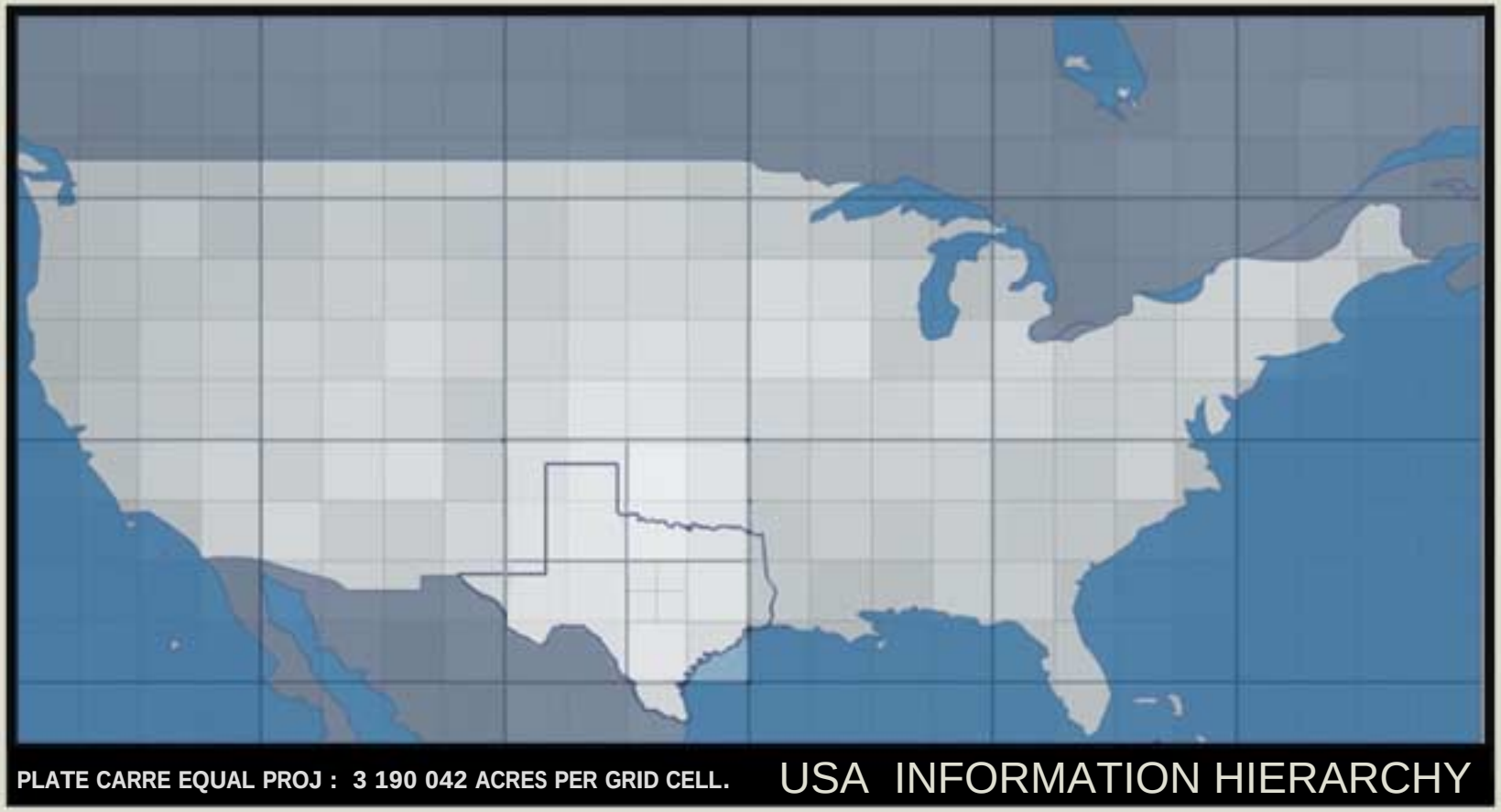
SOURCE: LIVING PLANET REPORT




# U.S. FOOTPRINT NEEDS

| | |
|---|---|
| INTERNAL CAPACITY | 17.8 cells |
| DEFICIT | 48 cells |

SOURCE: LIVING PLANET REPORT




**AIR ($CO^2$)** -imbalanced ( 2.7 times area of U.S. s. WWF, CENSUS, USDA)

**WATER** - Ground recharge, 0.17
- Surface, 0.18
(588% over balanced)

**ENERGY** -Non- renewable makes up 95% of the total energy supply

**MATERIALS** -Recycled materials only make up 6% of total

**Spatial** **Numeric**

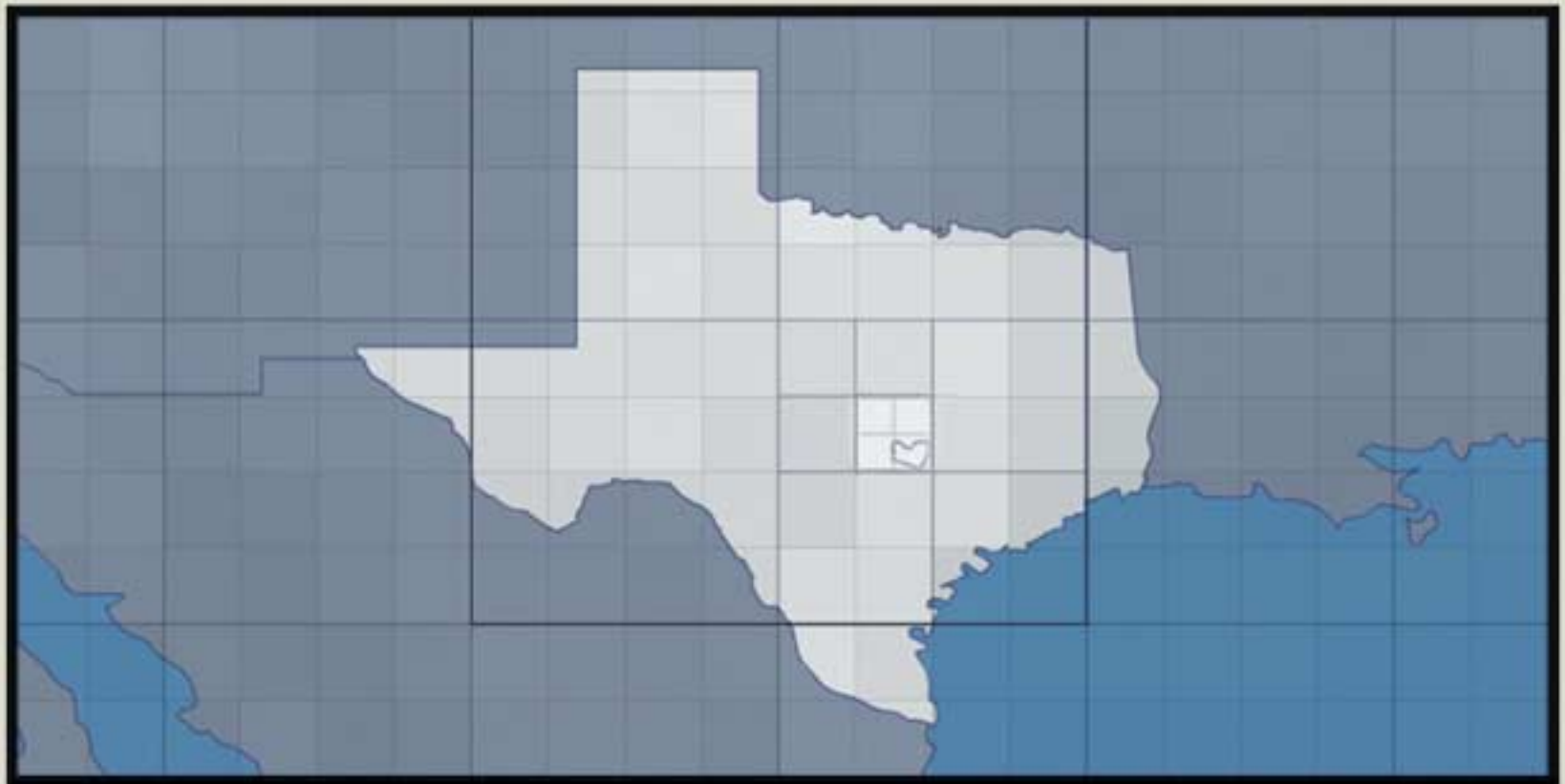


PLATE CARRE EQUAL PROJ : 3 190 042 ACRES PER GRID CELL.

# TEXAS INFORMATION HIERARCHY

**AIR ($CO^2$)** - 8.8 times area of Texas needed

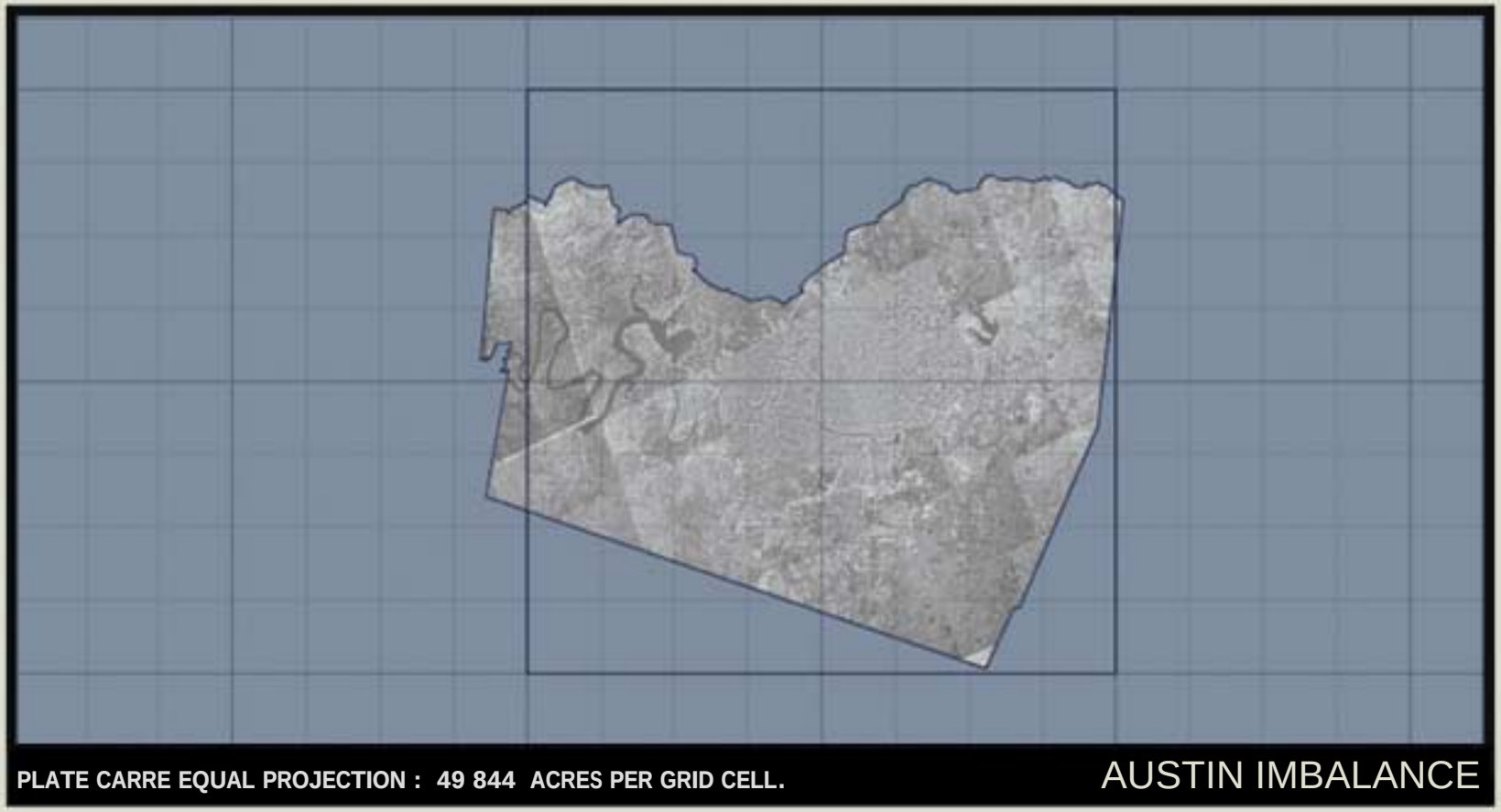
**WATER**
- Ground recharge, 1.67
- Surface, 0.62

(160% imbalanced)

**ENERGY** -only .7% renewable (potential within state according to governors energy office could supply 25 times the present population of Texas

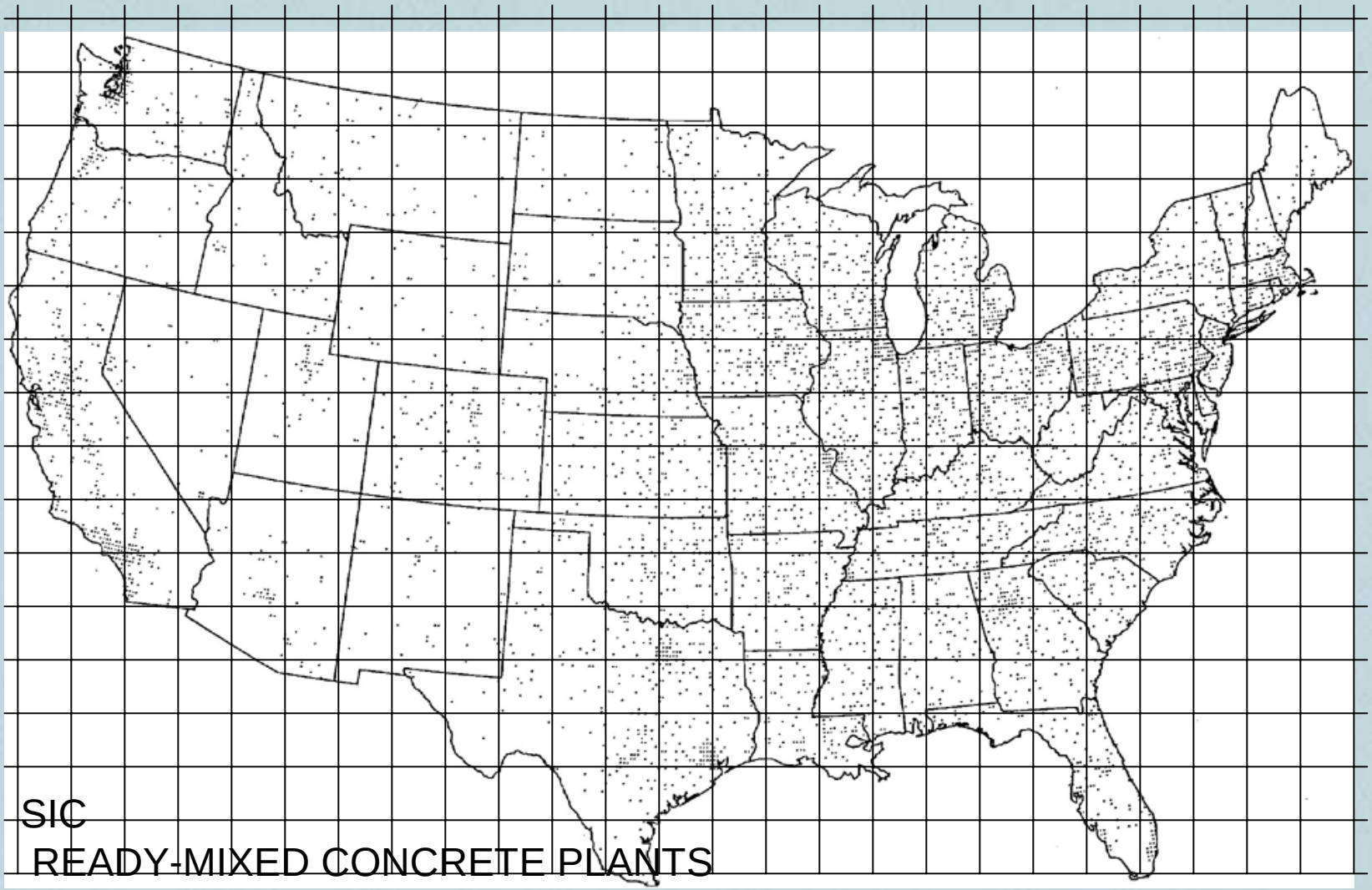
**MATERIALS** - N/A

**Spatial** **Numeric**




| | |
|---|---|
| AIR ($CO^2$) | - 62% tree cover loss* |
| WATER | - 56% worse in water use |
| FOOD | - 57% of local farming reduced* |
| ENERGY | - Renewable 4% of total |
| MATERIALS | - Solid waste recycled, 14% reduction* |

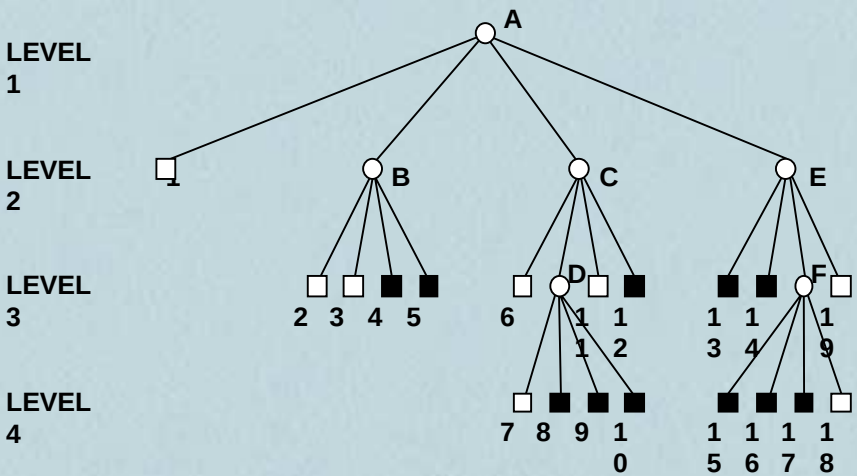
**All Numeric** * **All over over ten years**


SIC
READY-MIXED CONCRETE PLANTS

# QUAD TREE G.I.S NETWORK LIFE CYCLE. (UPSTREAM ANALYSIS)

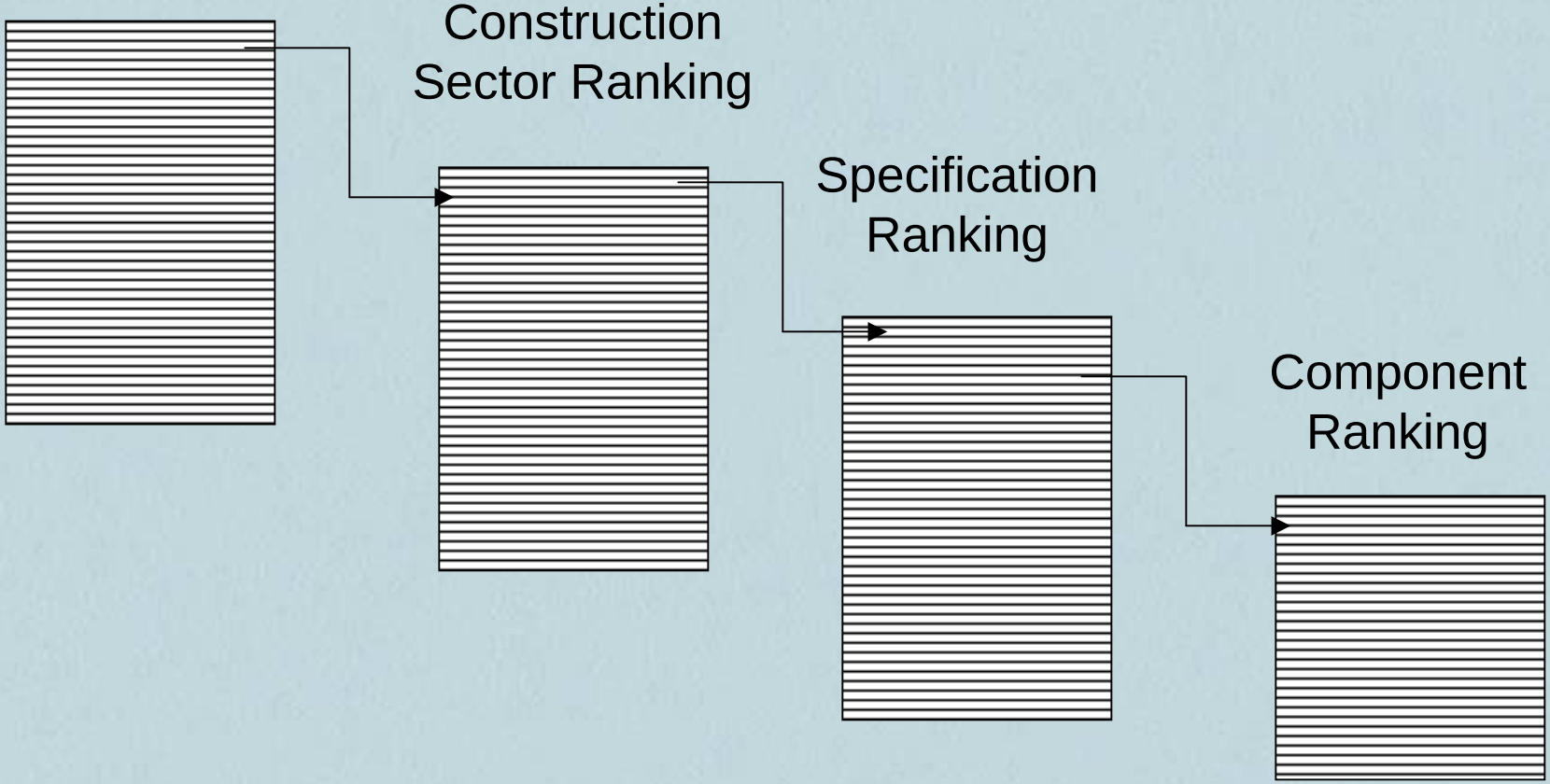
-

## EXAMPLES CAN DEMONSTRATE LEVELS OF AREA RESOURCE OR POINT RESOURCE DEPENDENCY



# Life Cycle Space Infinite Information Hierarchy

National upstream Environmental Impact
Per $M of Construction Activity
G.H.G Admissions



## National Ranking

| Industry Name |
|---|
| **1.** New bldgs & M and R |
| **2.** Retail trade, except eating & drinking |
| **3.** Petroleum refining |
| **4.** Wholesale trade |
| **5.** Eating and drinking places |
| **6.** Motor vehicles & passenger car bodies |
| **7.** Industrial inorganic & organic chemicals |
| **8.** Gas production and distribution (utilities) |
| **9.** Blast furnaces and steel mills |
| **10.** Miscellaneous plasics products |

## Construction Sector Ranking

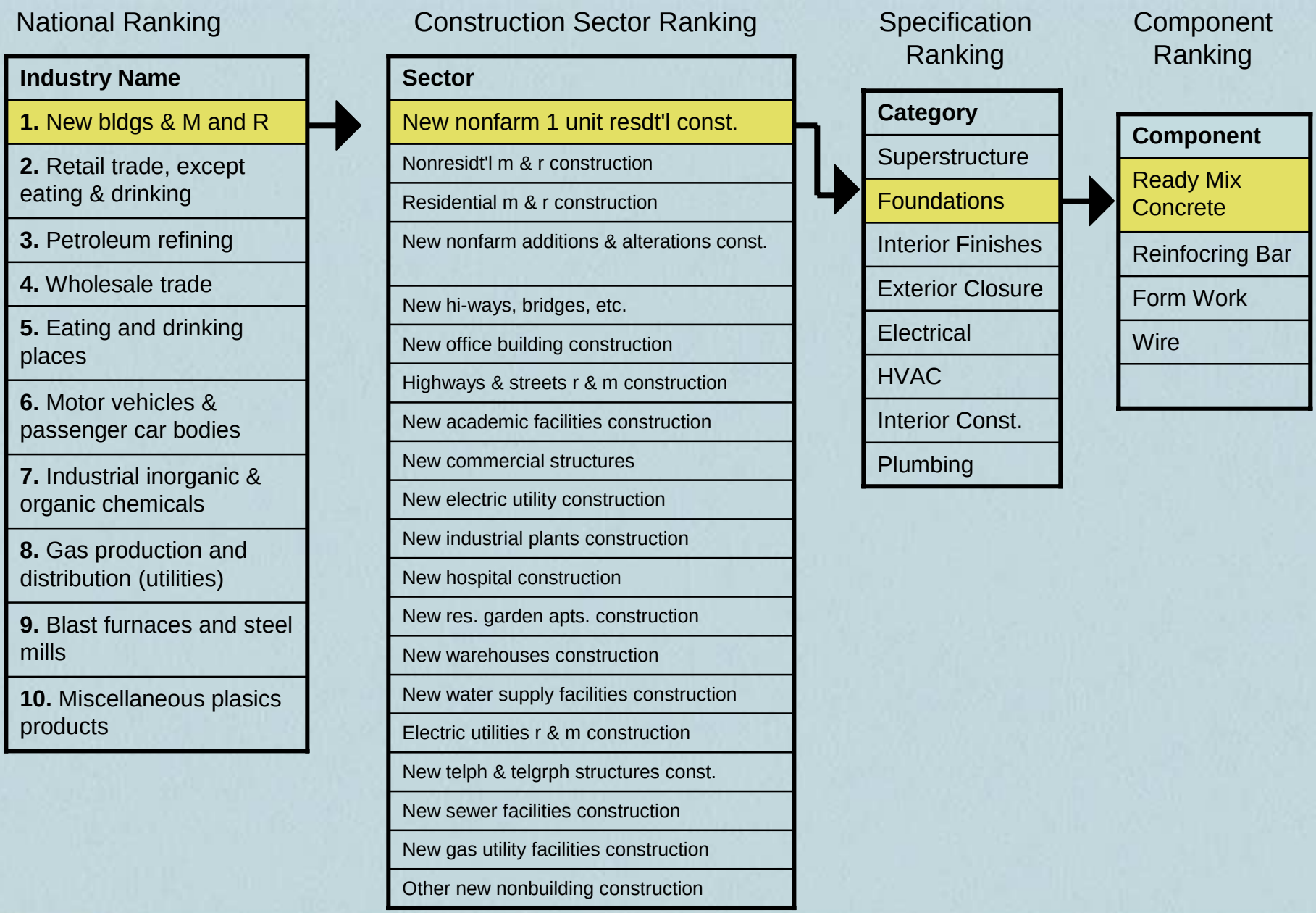
| Sector |
|---|
| New nonfarm 1 unit resdt'l const. |
| Nonresidt'l m & r construction |
| Residential m & r construction |
| New nonfarm additions & alterations const. |
| New hi-ways, bridges, etc. (xy-axis const.) |
| New office building construction |
| Highways & streets r & m construction |
| New academic facilities construction |
| New commercial structures |
| New electric utility construction |

## Specification Ranking

| Category |
|---|
| Superstructure |
| Interior Finishes |
| Foundations |
| Exterior Closure |
| Electrical |
| HVAC |
| Interior Const. |
| Plumbing |

## Component Ranking

| Component |
|---|
| Ready Mix Concrete |
| Hydrolic Cement |
| Reinfocring Bar |
| Form Work |
| Wire |




# Life Cycle Space Infinite Information Hierarchy

**National upstream Environmental Impact**

**Per $M of Construction Activity- G.H.G Admissions**

**BASELINE GREEN™**

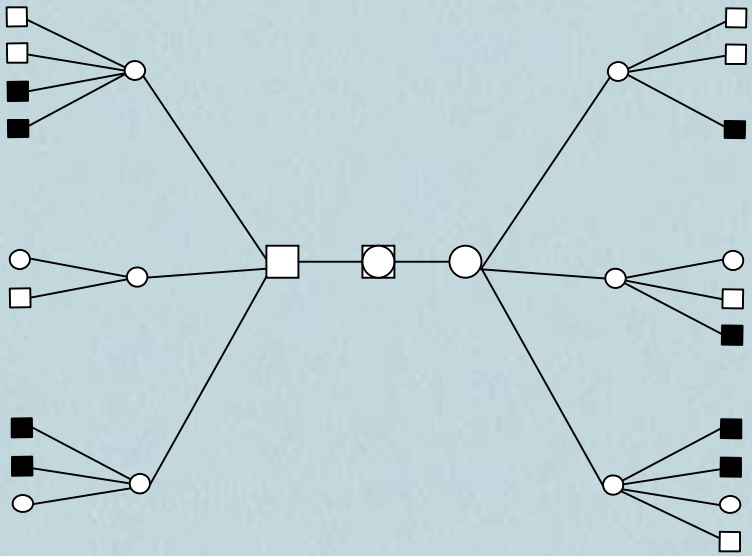
www.cmpbs.org

# LifeCycleBalance™

# QUAD TREE NETWORK LIFE CYCLE BALANCING™
# AREA OR POINT

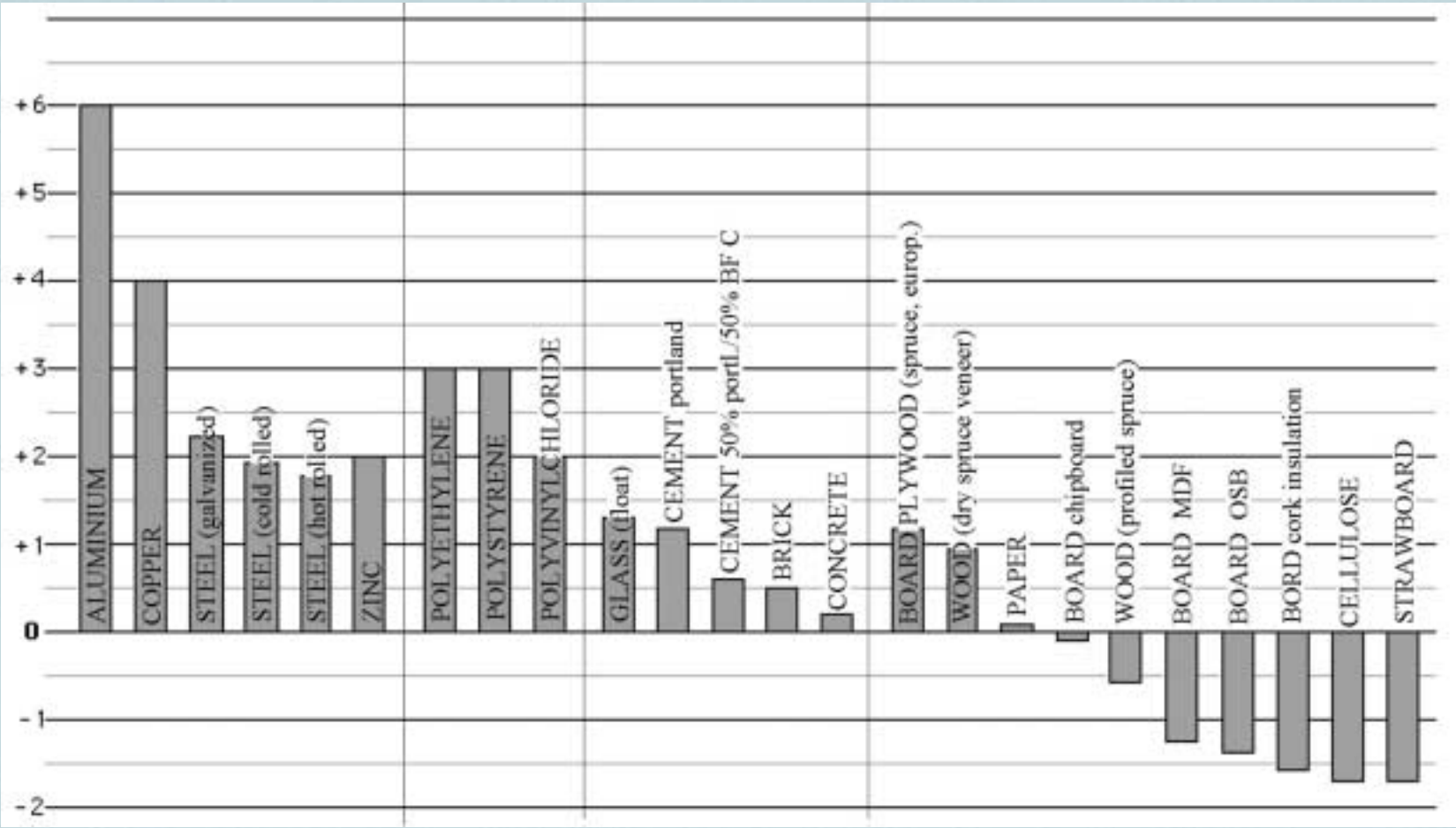
UPSTREAM

DOWN STREAM



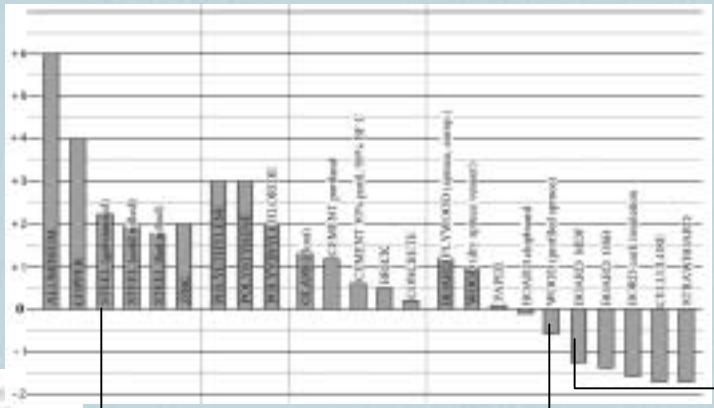
SOURCE

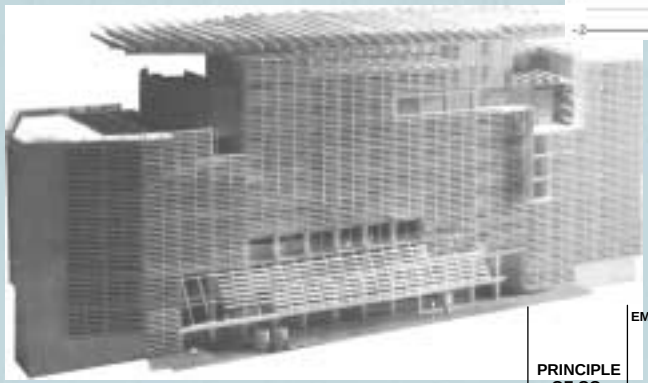
RE-SOURCE

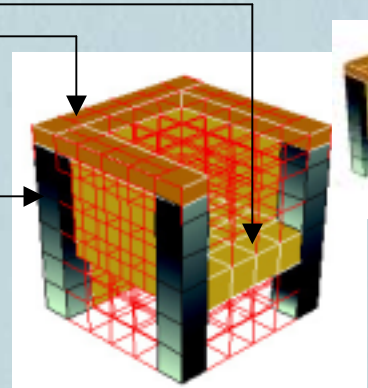


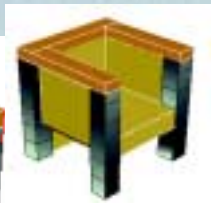

**CDIR = ($CO_{2e}$ - $CO_{2s}$) / weight of material**

Where CO2e = weight of upstream CO2 emissions
and CO2s = equivalent weight of CO2 stored as carbon in the material
Positive ratios indicate net carbon dioxide sources; negative ratios indicate net carbon dioxide sinks.







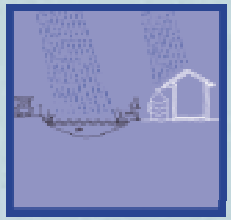


| 1 unit = | 64 | SQ.INCHES | (1/27th sq ft) |
|---|---|---|---|
| | 512 | C.INCHES | |

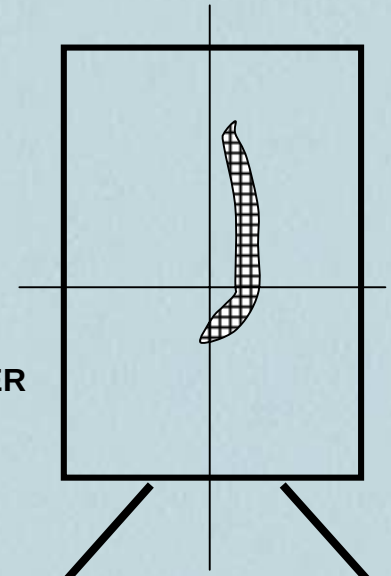
| PRINCIPLE OF $CO_2$ BALANCING | EMISSION $+\sum$ | SINK $-\sum$ | SINK $-\sum$ | BALANCING $\leq 0$ |
|---|---|---|---|---|
| volume | 28 units (+ SCREWS) | 70 units (2.6 s.f.) | 5 units (0.19 s.f.) | |
| density | 500.00 | 40.00 | 50.00 | |
| weight | 26.90 | 104.00 | 9.50 | |
| $CO_2$ factor | 1.95 | - 0.54 | - 0.54 | |
| net $CO_2$ | + 52.50 | - 56.20 | - 5.10 | Total $CO_2$ Balancing = - 8.8 Lbs |

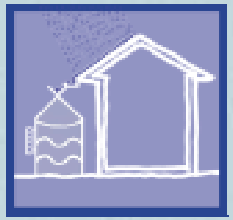
Life cycle $CO_2$ balance may be easier to attain at smaller scales.
The carbon sink capacity of the biomass materials negates the upstream CO2 emissions impact of all the materials used in the furnishing example illustrated above. A 50-100 year product lifetime is assumed.

# LifeCycleSpace™
# &
# LifeCycleBalance™

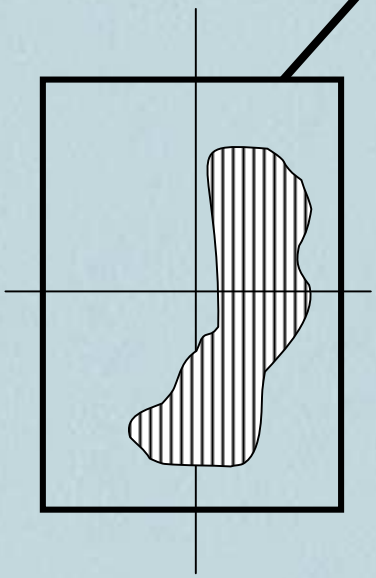


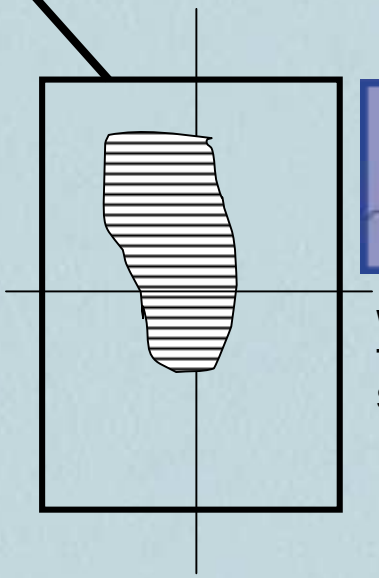
WATER
HARVESTING
WITH WASTEWATER
SUITABILITY

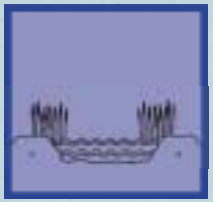




WATER
HARVESTING
SUITABILITY







WASTE WATER
TREATMENT
SUITABLITY

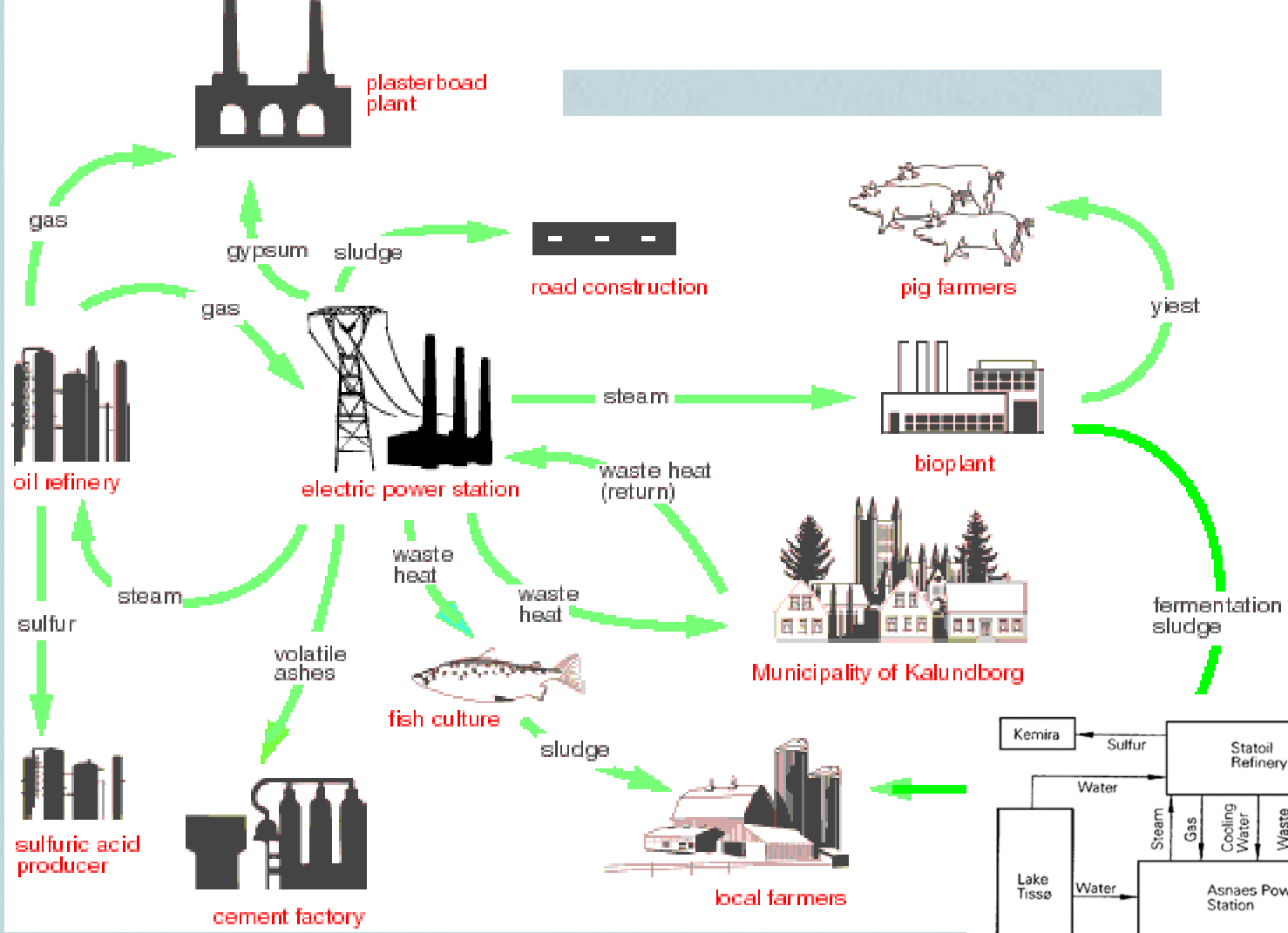
# AREA SOURCE AND RESOURCE BALANCING SUITABILITY MAPPING

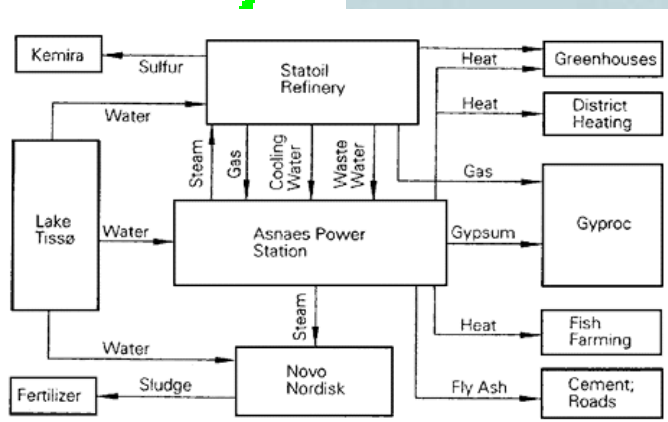
QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.

# AREA SOURCE AND RESOURCE BALANCING SUITABILITY MAPPING

www.cmpbs.org

GREENBALANCE™

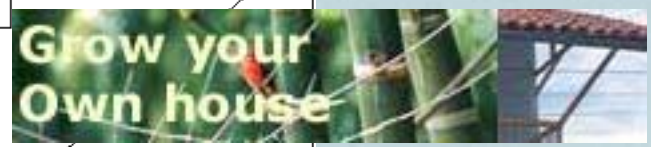


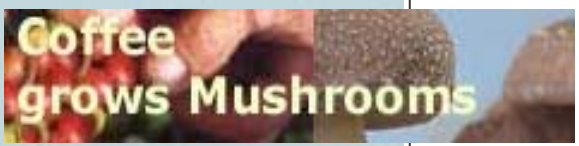




# Industrial Ecosystem at Kalundborg, Denmark

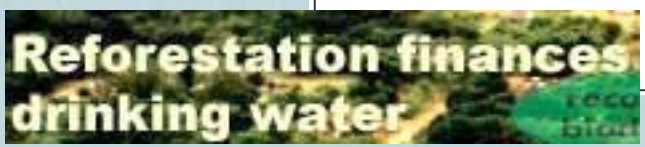

Beer Bakes Bread


Cement Goes Organic

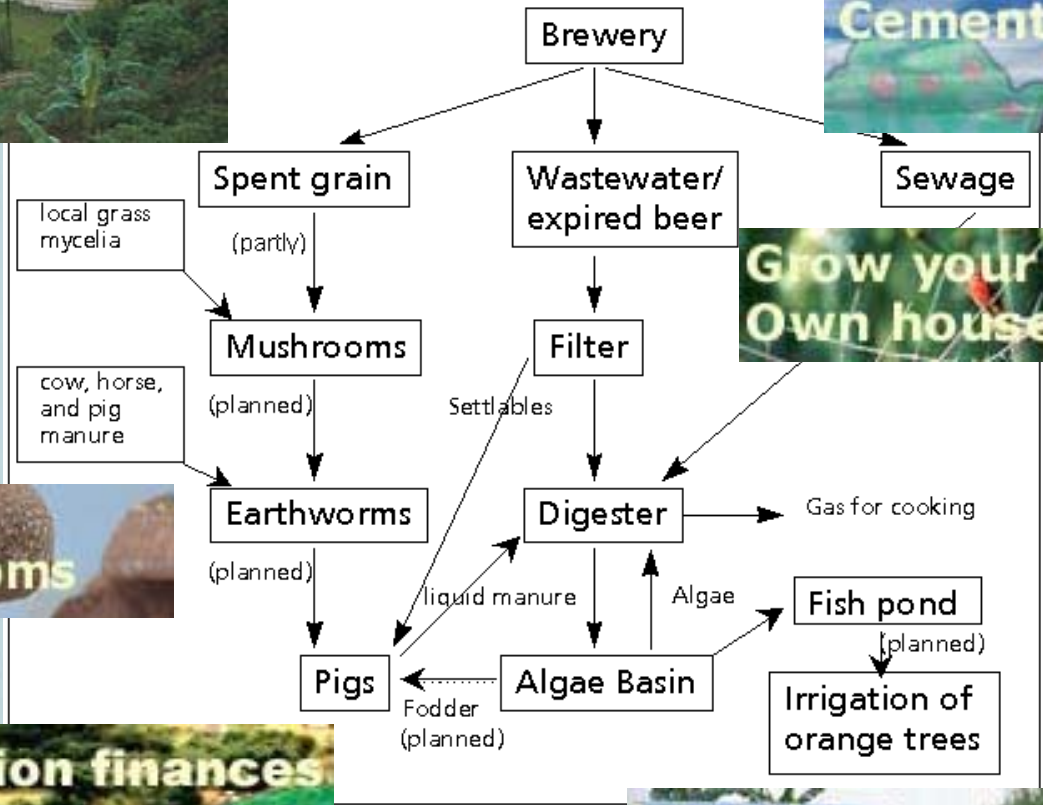

Grow your
Own house


Coffee
grows Mushrooms


Water Hyacinth
fights AIDS

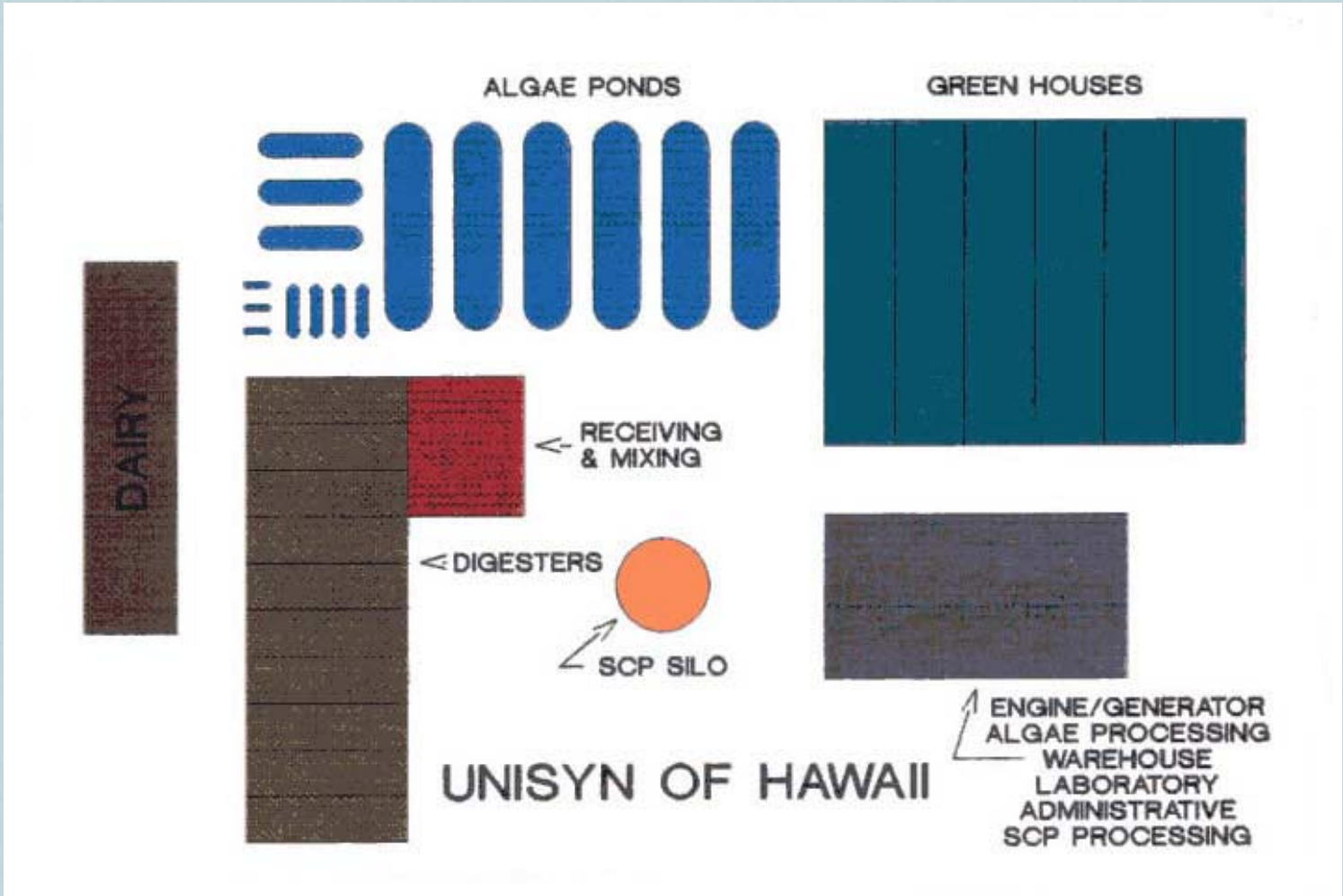

Reforestation finances
drinking water


Learning
to live in Systems


Brewery
Spent grain
Wastewater/
expired beer
Sewage
local grass
mycelia
(partly)
Mushrooms
Filter
cow, horse,
and pig
manure
(planned)
Settlables
Earthworms
Digester
Gas for cooking
(planned)
liquid manure
Algae
Fish pond
(planned)
Pigs
Algae Basin
Irrigation of
orange trees
Fodder
(planned)

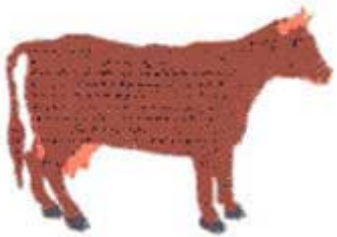


# UNISYN HAWAII - WASTE, FOOD, ENERGY, VITAMINS


ALGAE PONDS
GREEN HOUSES
DAIRY
RECEIVING
& MIXING
DIGESTERS
SCP SILO
ENGINE/GENERATOR
ALGAE PROCESSING
WAREHOUSE
LABORATORY
ADMINISTRATIVE
SCP PROCESSING
UNISYN OF HAWAII

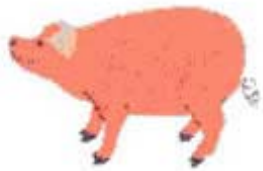
# INPUT

(COMPARATIVE TOTAL - 185 WET TONS / DAY)



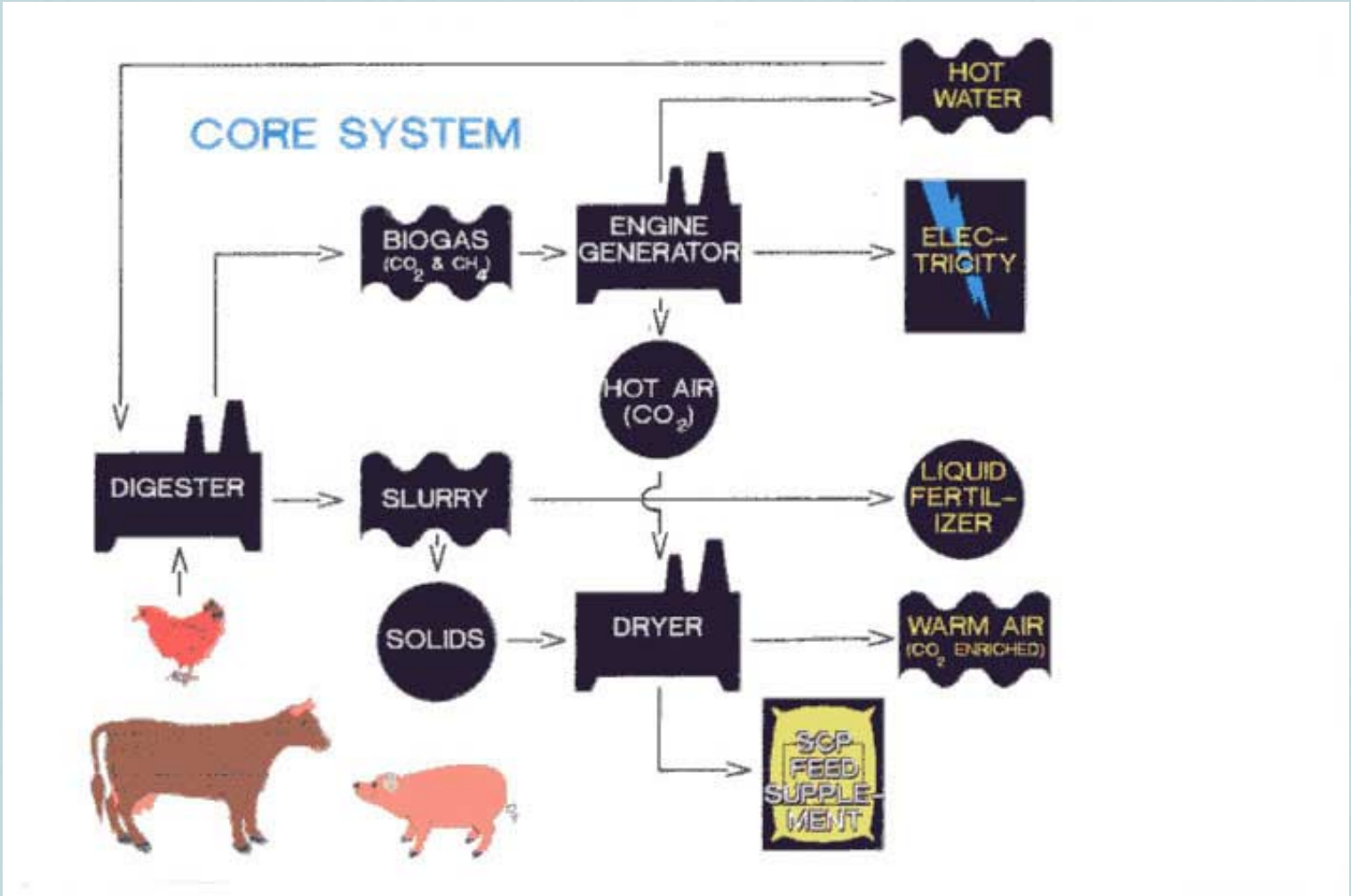
6,250

1,350,000



41,625

10,375


CORE SYSTEM
HOT WATER
BIOGAS ($CO_2$ & $CH_4$)
ENGINE GENERATOR
ELEC-TRICITY
HOT AIR ($CO_2$)
DIGESTER
SLURRY
LIQUID FERTIL-IZER
SOLIDS
DRYER
WARM AIR ($CO_2$ ENRICHED)
SCP FEED SUPPLE-MENT

# OUTPUT

(PER DAY)





15,360 KWH

10 TONS

3,666 LBS TOMATOES

1,833 LBS BASIL

375 LBS

# OUTPUT

The annual revenue value for products from UNISYN's Hawaii facility:

| PRODUCT | PRICE | ANNUAL REVENUE VALUE |
|---|---|---|
| Electricity | $.06/KW | $33,776 |
| SCP | $300/Ton | $1,080,000 |
| Basil | $1.85/Pound | $555,000 |
| Algae | $25.00/Kilo | $1,534,090 |
| | TOTAL: | $3,500,866 |

* 78% of the electricity is used to operate the plant.