

EMergy and environmental accounting: A method for evaluation of sustainability



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What is Emergy analysis?



- Methodology for environmental accounting developed by professor **H.T. Odum**, from University of Florida during the last three decades.



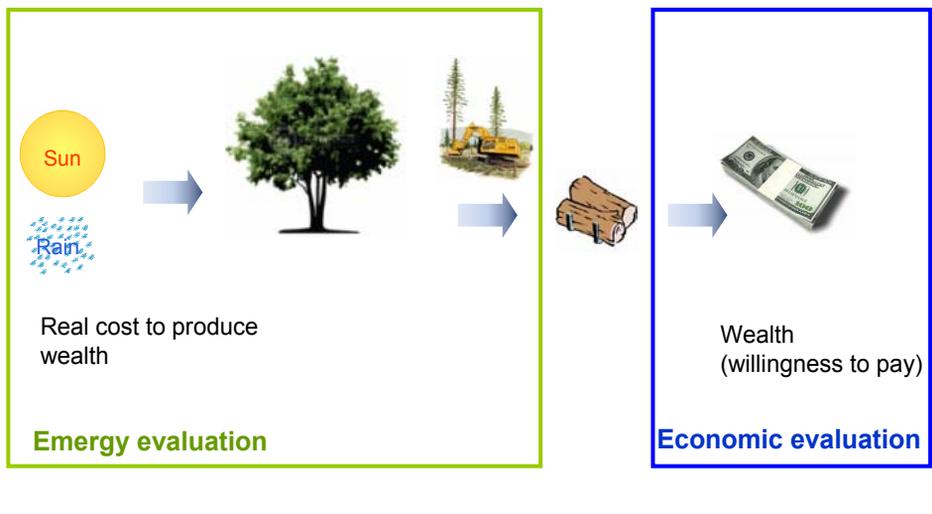
H.T. Odum (1924-2002)

How does emergy analysis work?



- Odum identified the work of biosphere, driven by solar energy, as the **source of resources** and **environmental services**, and provided a common measure for them (solar emergy).
- Odum suggested emergy to be the basis for value and sustainability assessments.

Environmental cost



What is energy analysis for?



1 - Assessment of environmental sustainability and carrying capacity.

- It measures how much of goods and services the planet can supply in a renewable way



Fossil fuels



Natural capital and
Ecosystem services

2 - Environmental decision making:

- It helps to plan how to use the available resources

The solar energy embodied

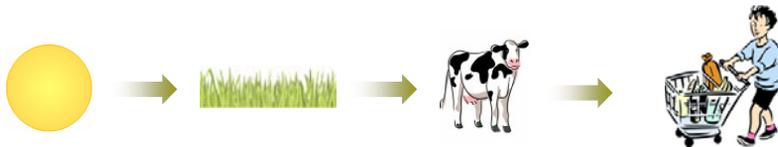


- **Sunlight** is the most abundant source of energy on earth.
- Many **solar joules** are required to make other kinds of more concentrated energy or matter.
- It is convenient to express **all other kinds of resources** in terms of the **sunlight equivalents required** directly and indirectly (**emergy**).

Energy quality



- Energy transformations generate **hierarchies** over production chains similar to the well-known food chain in ecosystems:



- Energy analysis is able to recognize the **energy quality** of the flows of biosphere.
 - One Joule of pasture is not equal to one Joule of meat

Renewable resources



- Energy analysis is able to account for the **renewable resources** on the same basis.



Sun



Tides



Deep heat



Rain



- It evaluates the environmental support provided by renewables, most often disregarded in economic analyses.
- It helps to plan how to properly use these resources.

Nonrenewable resources from nature



- Energy analysis is able to account for the **non renewable resources from nature** on the same basis.



Topsoil loss from erosion



Fossil fuels



Biodiversity

...

Human labor



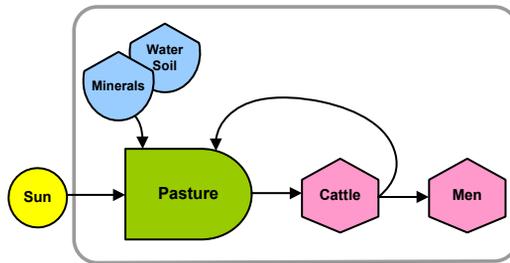
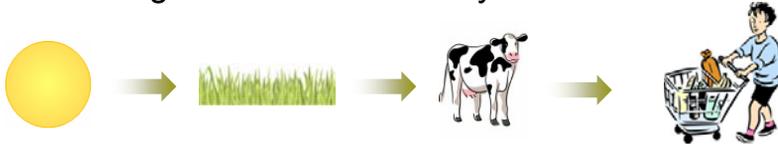
- Energy analysis is able to account for the **human labor** on the same basis.
- It quantifies the energy required to support the human labor (measure of standard of living):
 - Less industrialised people use less energy than people in industrialised countries



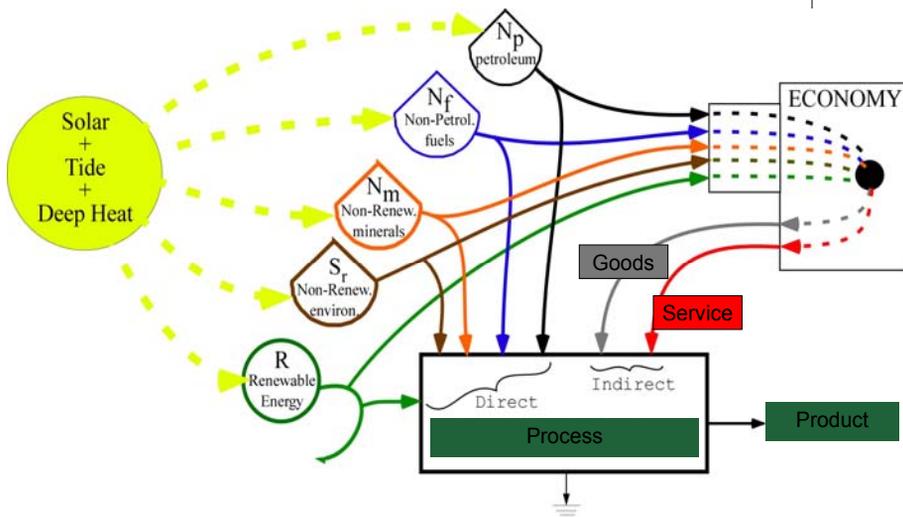
Energy system language



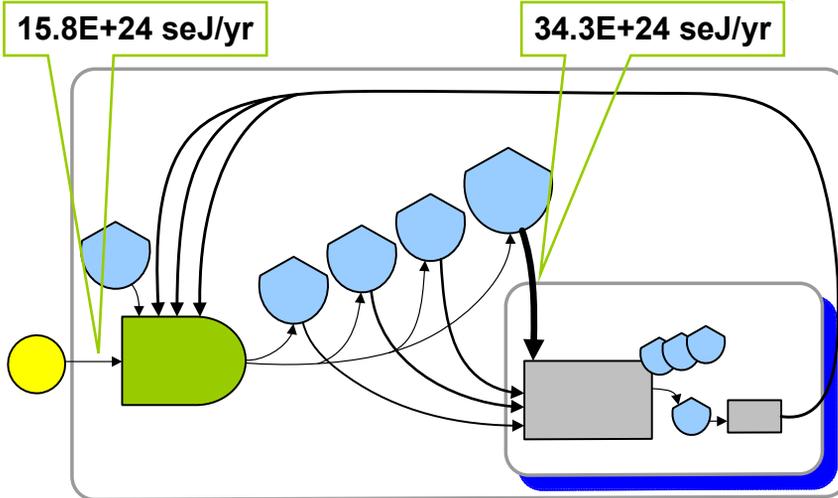
- It is a concise way of visualizing systems and describing them mathematically.



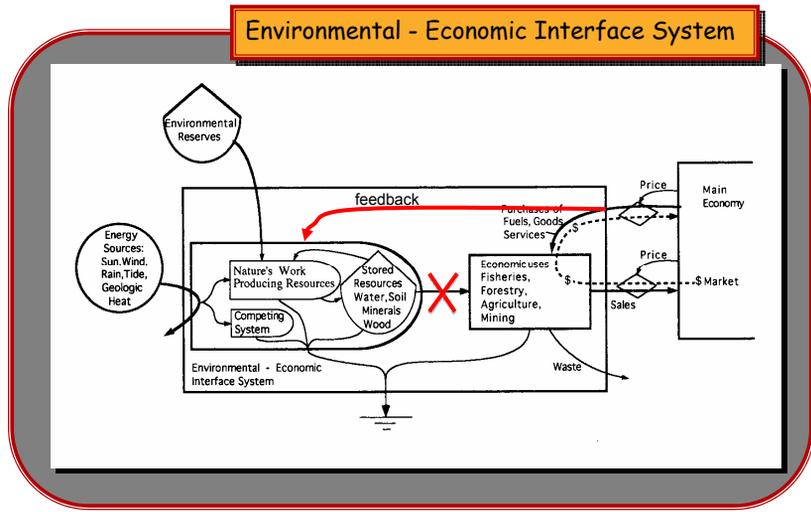
Various Paths for Solar Energy



System diagram - Biosphere vision

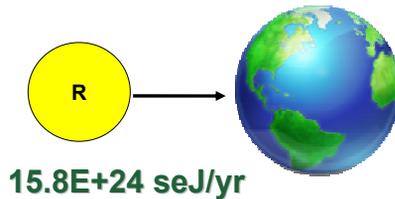


Prosperity comes from resources, not from money



Biomass
Water
Soil

Carrying capacity



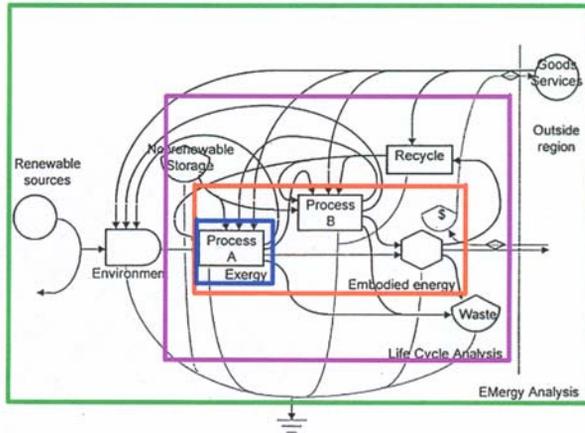
- The energy standard of living is $2.4E+16$ seJ/per/yr (average global per capita energy use):
- The carrying capacity of the earth's biosphere is about 670 million people at the present average standard of living.

Multimethod evaluation

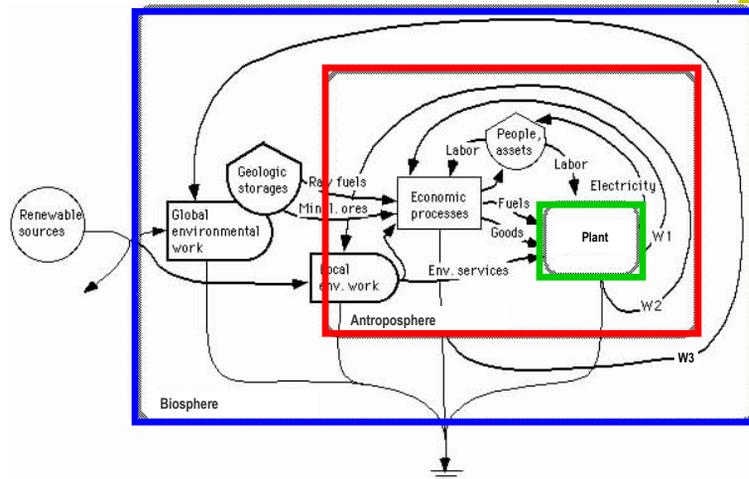


- Energy analysis is likely to be used in parallel with other methods:
 - LCA;
 - Energy analysis;
 - Economic evaluations;
 - Ecological footprint;
- Energy is a donor side evaluation:
 - It evaluates the appropriate use of resources;
 - LCA focuses on the impact of emissions;

Scales of interest



Environmental work supporting a power plant





- Connect now to national energy analysis tables at: <http://sahel.ees.ufl.edu/>
- Then, show ppt about the energy baseline of the biosphere