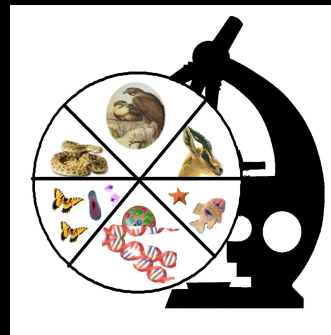
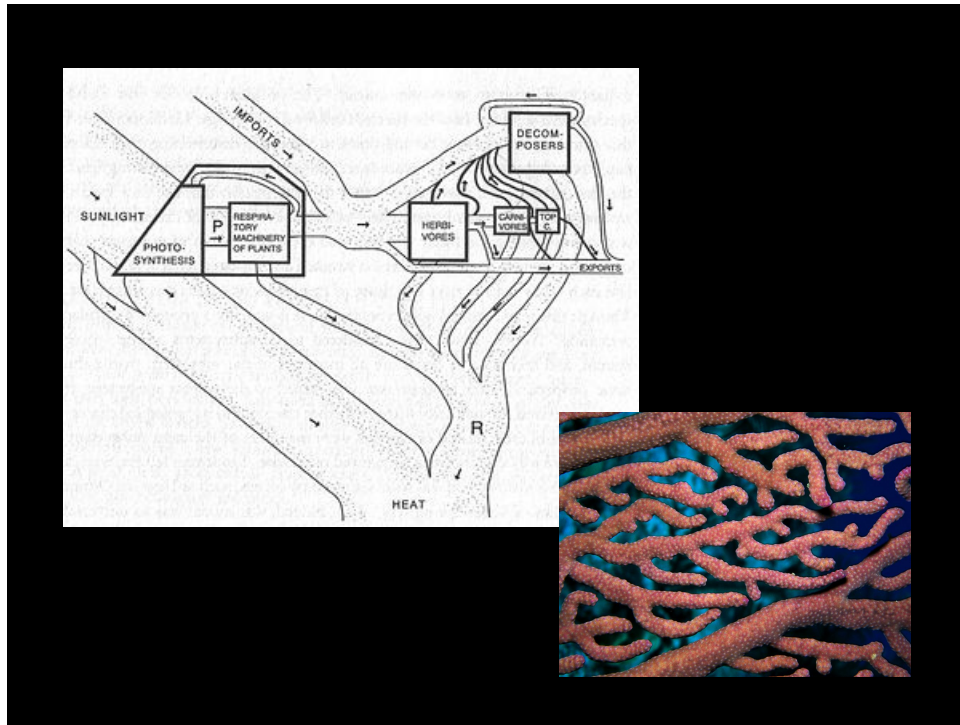


# Howard Thomas Odum (HT)

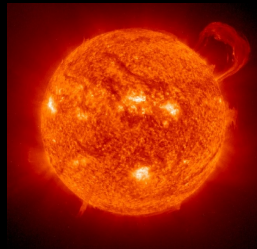


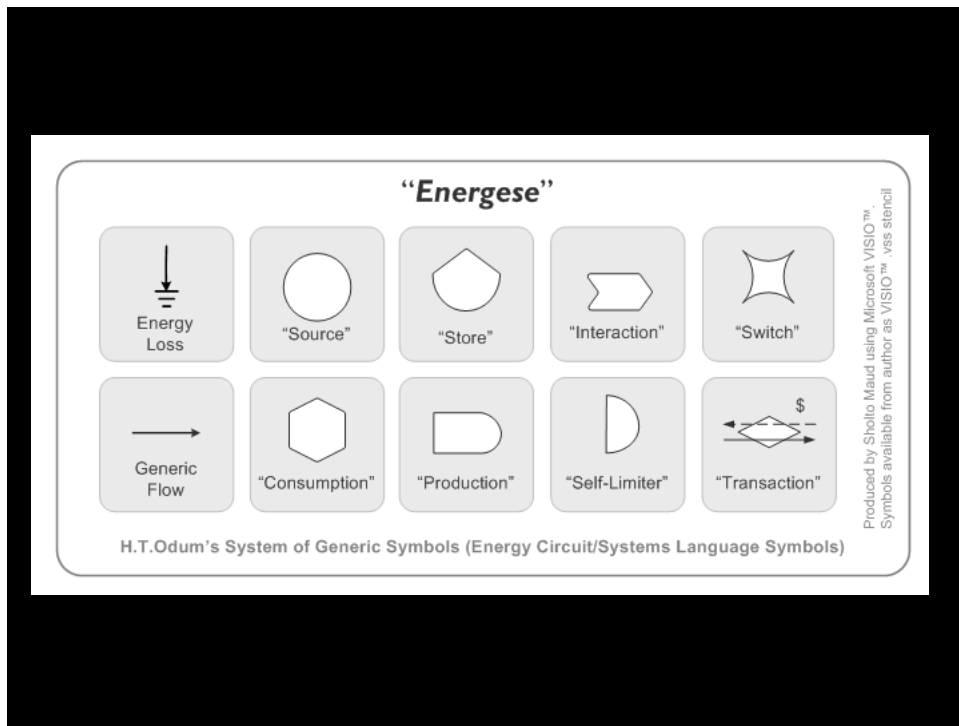
*American Ecologist*

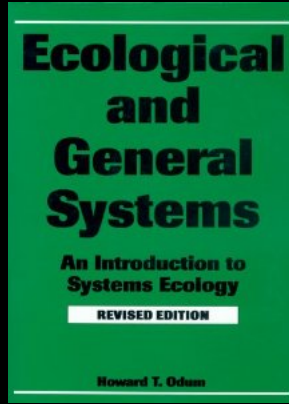




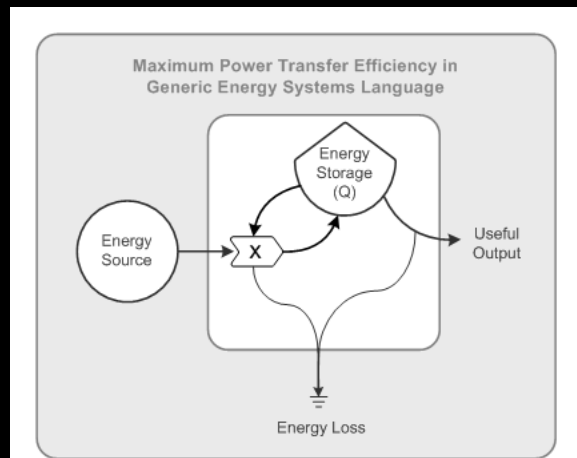
energy







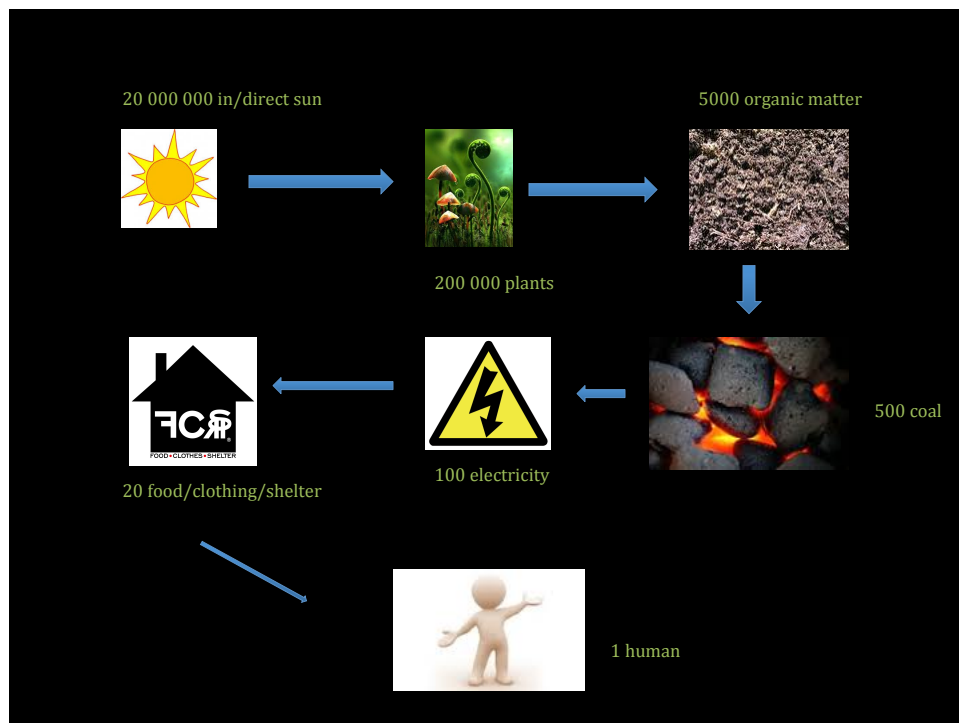
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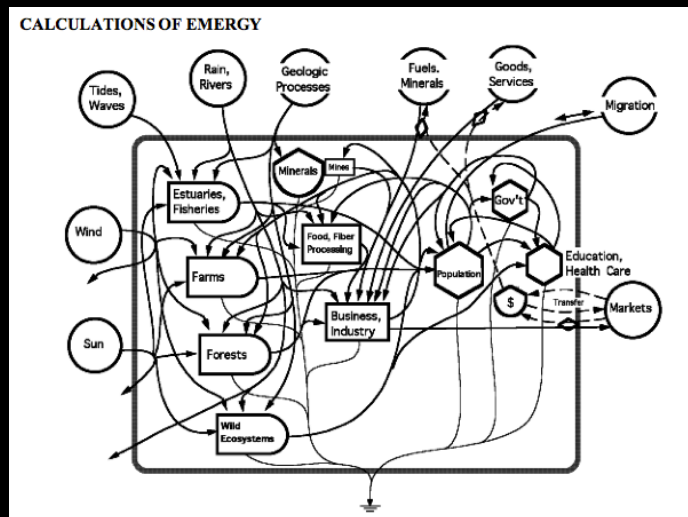
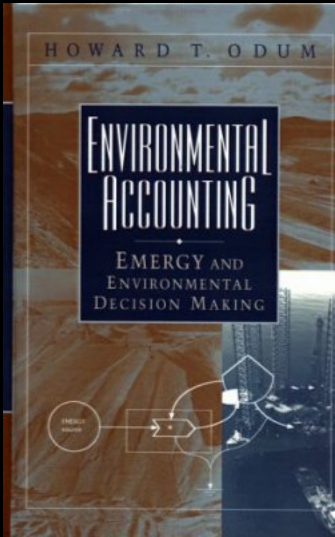


maximum power principle

# emergy

*"embodied energy"*  
*"energy memory"*  
*"past available energy use"*





*“Understanding the economy requires that both money circulation and the pathways of real wealth be represented together but separately. Money is only paid to people and never to the environment for its work... therefore, money and market values cannot be used to evaluate the real wealth from the environment. When the resources from the environment are abundant, little work is required from the economy”*  
HT, 1996

Energy economics: “the science of economics may profit by restating more of its theorems to include power principles. Studies of money alone are just as incomplete as studies of mineral cycles alone”  
HT, 1971

“When the resources are scarce, obtaining costs are higher... and the market puts a high value on the product. ... Market values are inverse to real wealth ... and cannot be used to evaluate environmental contributions or environmental impact”  
HT, 1996



“In the 1960s, I heard dinner table lectures regarding the energy and ecology problems we witness today. My father would be shocked that governments today trot out tar sands and shale gas as rescue strategies, a delusion he dismissed in the 1970s. Exploiting profit-positive but negative net-energy deposits, burns energy, destroys the boreal ecosystems, drains aquifers, and increases global heating. *My father never believed that we would be so stupid.*”  
- Mary Odum Logan

Reductionist?

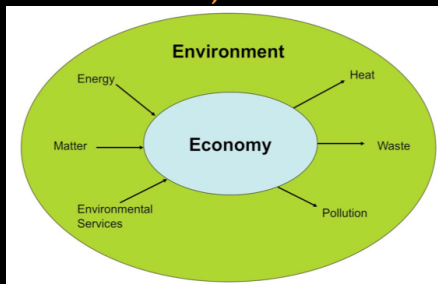
Incompatible comparisons?

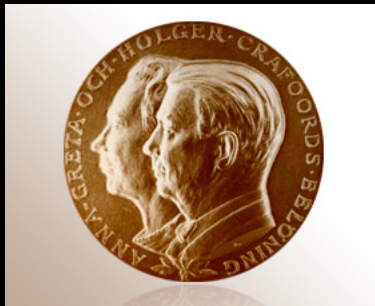
Technocratic optimist?



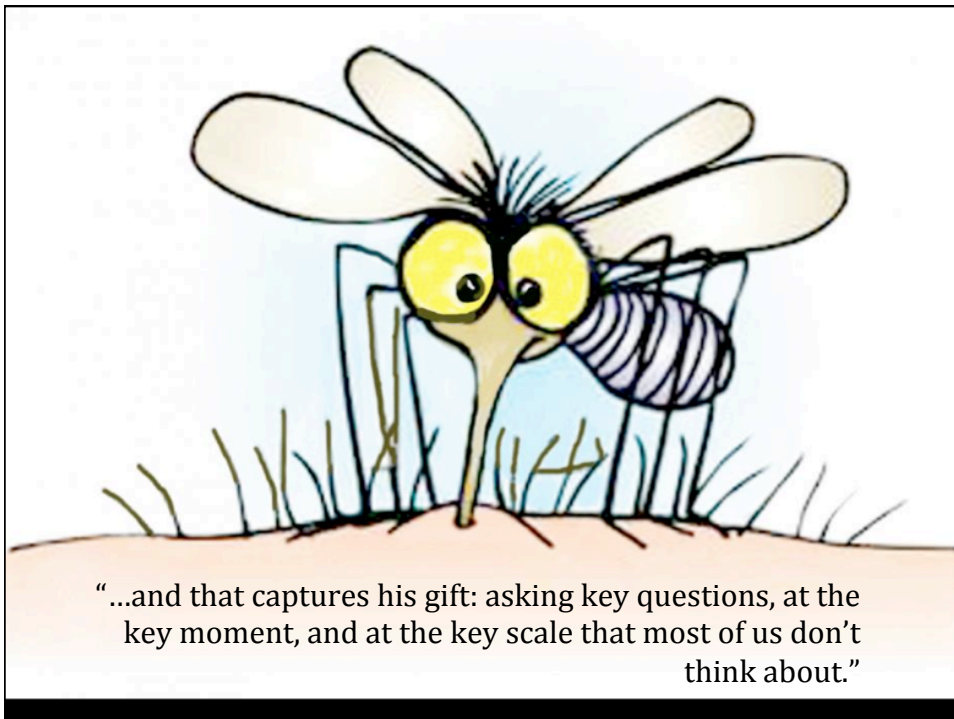


- Ecological modeling
- Ecological engineering
- Ecological economics
- Estuarine ecology
- Tropical ecosystems ecology
- General systems theory  
... radiation ecology, systems ecology, unified science, and the microcosm.





“They have systematized existing knowledge within the area and, through their own research, have opened up new fields, principally by viewing our surroundings as more or less firmly linked habitats, termed ecosystems. In this way they have laid a firm foundation for systems ecology, the study of how the different ecosystems are built up and how they function. The Odums have also done pioneering work as teachers, many of the world’s most eminent ecologists having been students of one brother or the other.”



“...and that captures his gift: asking key questions, at the key moment, and at the key scale that most of us don’t think about.”