

# Why focus on Energy Demand?

Systems Energy Assessment gives the total Economic Energy Demand of Businesses<sup>1</sup>

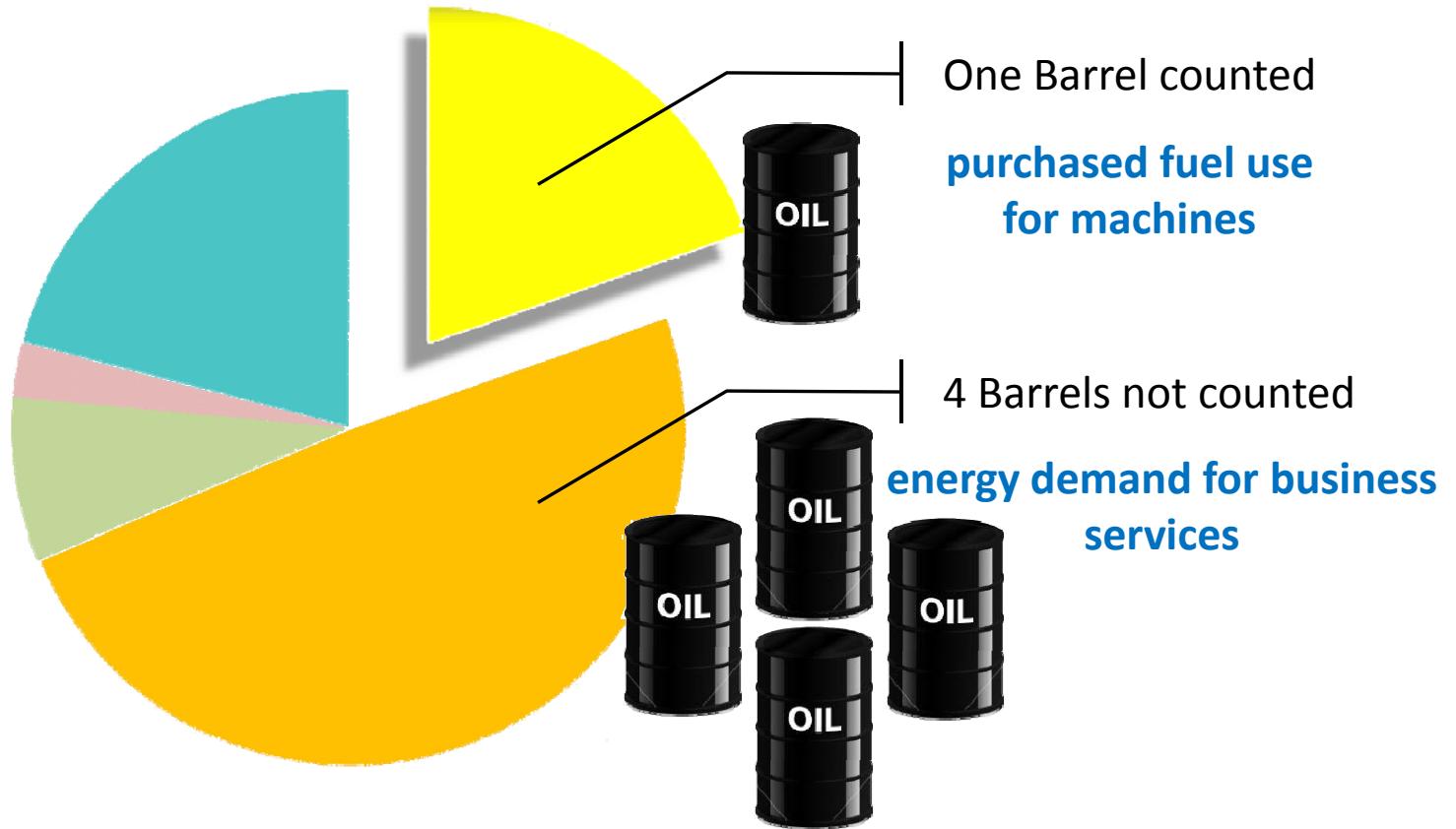
- Energy use is visible. Energy demand is larger, has the same effects, and is mostly invisible
- Impacts increase with constant dollar GDP, which measures units of constant product
- GDP increases faster with improving energy efficiency & uses of energy have bigger effects
- The harm of impacts increases as the environment suffers more impacts

Spending money requests economic services from around the world, all using energy



# Part of the Total Demand Wasn't Counted<sup>2</sup>

Counting only business fuel use, misses the energy demand of business services

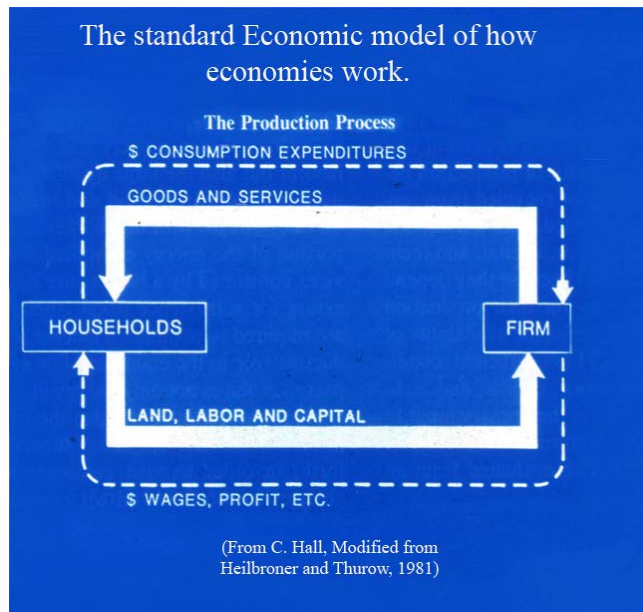


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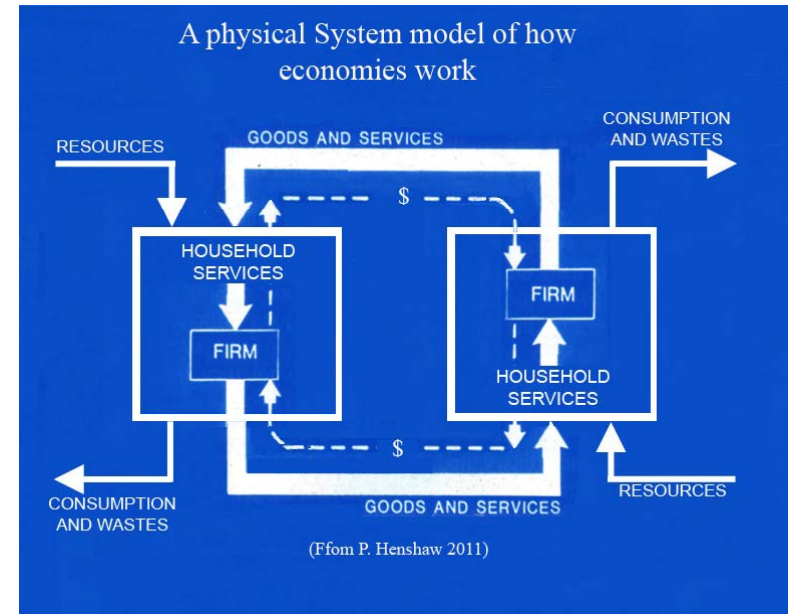


# Why wasn't 80% of the energy counted??<sup>3</sup>

The traditional economic accounting ignores that households run businesses



The Economic System Model treats businesses and households as separate accounting categories, working independent of each other, one producing and the other consuming products.



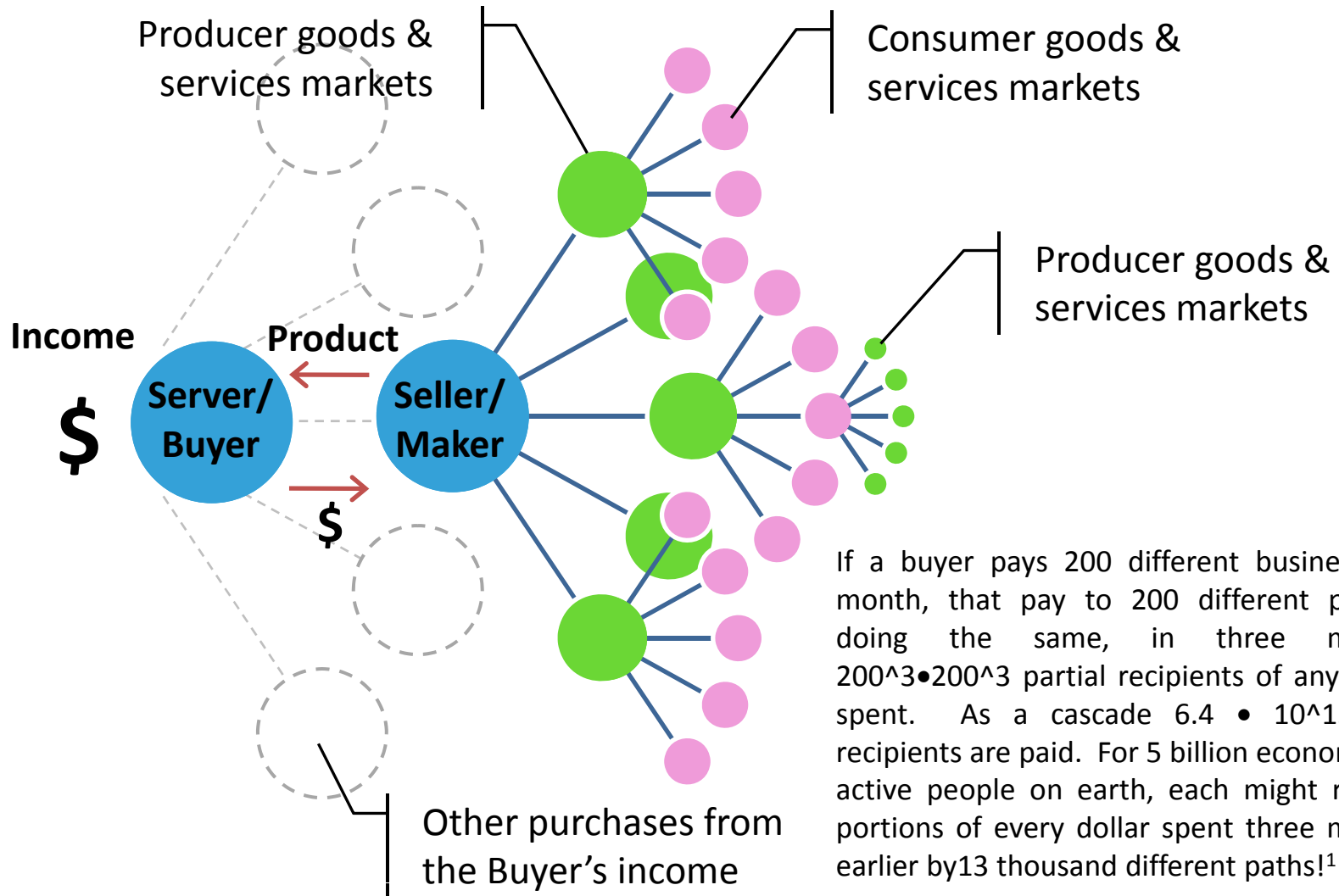
A Physical System Model treats businesses as a working network of households that supply, run and provide services to operate them, treating all payments as for material services for operating the business.

“A Firm” is physically a cultural network of households that may employ technology too



# How Wide Spread is Energy Demand?

Server/Buyer -- Seller/Maker -- Server/Buyer 2 -- Seller/Maker 2



## Money demands exceedingly diverse energy use



# How Big is Energy Demand?

- Hidden energy demand from business services is  $\sim 4$  times the energy uses recorded<sup>1</sup>
- All money ends as pay for people operating the businesses that pay them.
- Energy/\$ for consumption is “about average” 8000btu/\$ and .47kgCO<sub>2</sub>/\$<sup>1</sup>
- So money measures hidden energy demand
- US municipal solid waste - 4.5 lb/person.dy<sup>2</sup>
- US energy demand CO<sub>2</sub> – 110 lb/person.dy<sup>3</sup>

Total energy demand often 5 times the visible



# A business unit, at the point of sale

## Parts that need to work together



### Materials

- Natural Resources
- Purchased Products

### Tools

- Technology
- Structures

### Workplace

- Development
- Real Estate
- Organization

### Workers

- Operators
- Operation services
- Managers

### Environment

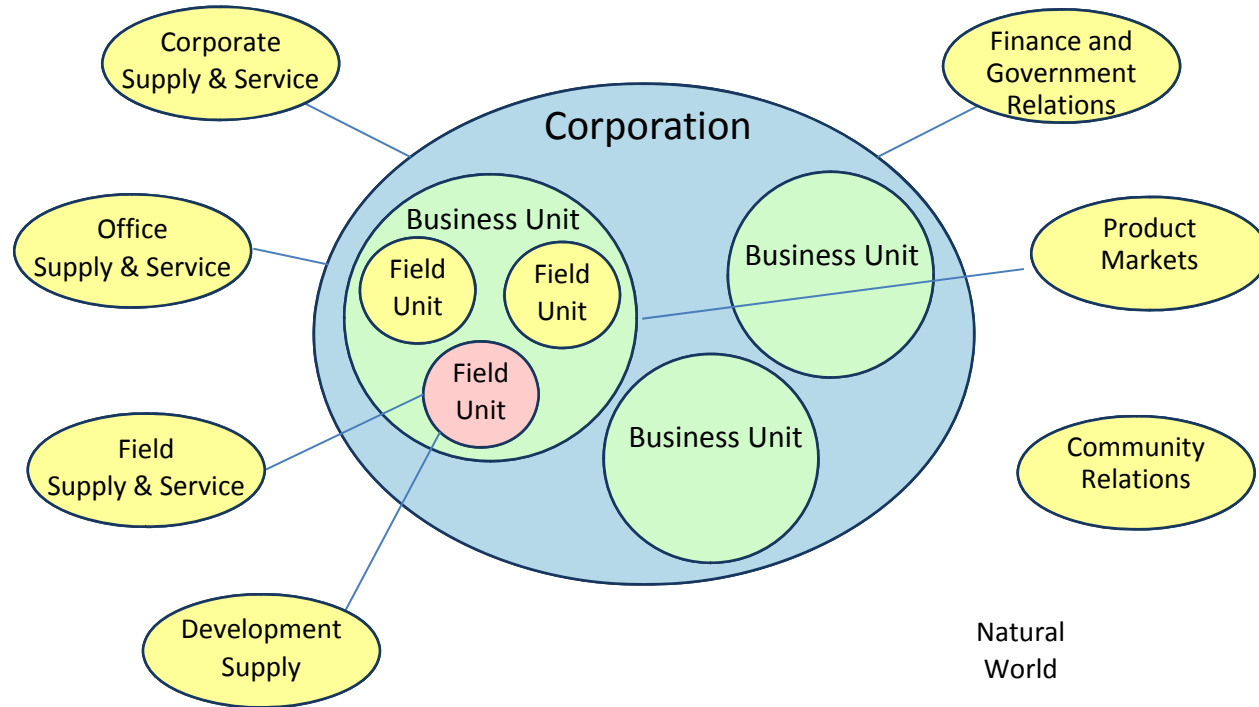
- Government
- Finance
- Society



# Coordinated parts that all take energy to deliver



# Businesses as environmental systems



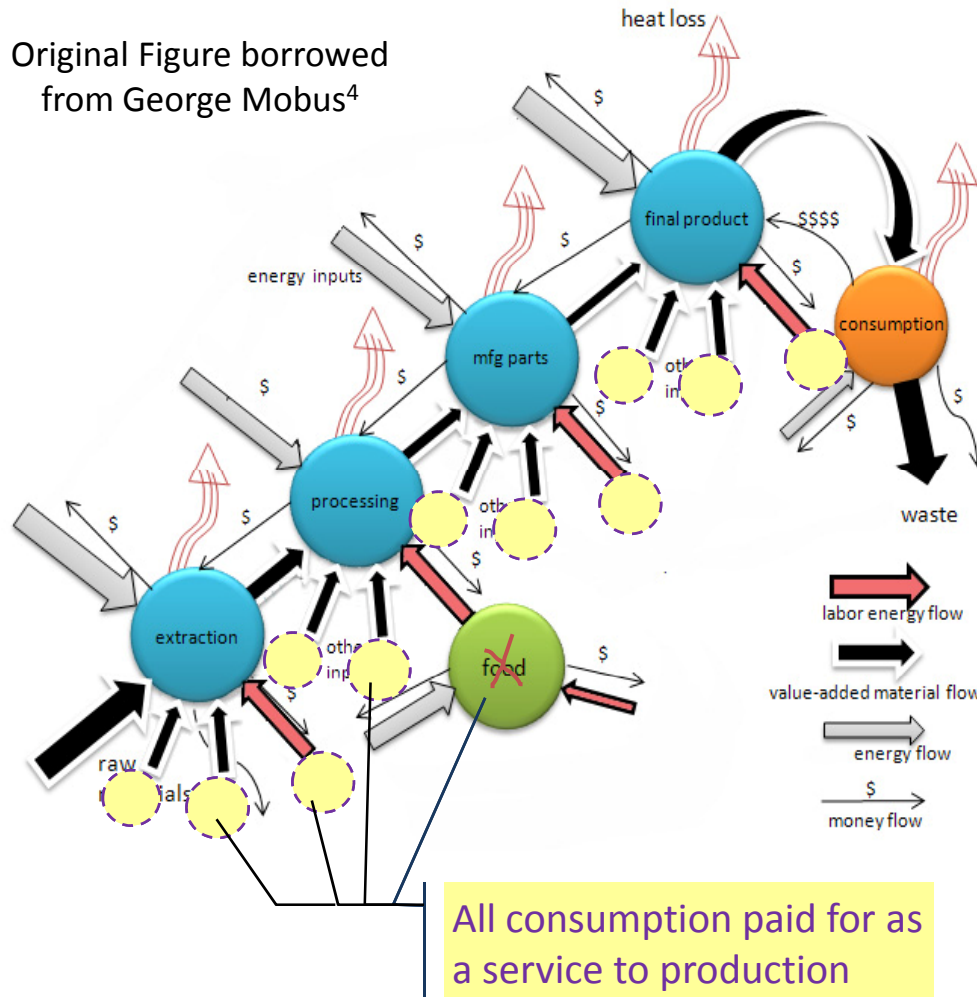
- Systems are environments for their parts
- Matched active and passive parts work as Organized Units
- Cells, Organisms, Businesses, Cities, Cultures, Economies
- Growth starts with local resources and a seed of design
- Growing control of their environment ends in a stable relationship with it, or runs out.

**Systems are market places with all your stuff**



# Adjusting the way of counting energy use 8

Original Figure borrowed  
from George Mobus<sup>4</sup>



Counting material energy + demand

- Energy uses are now traced from resource extraction to product use.
- Energy need of material processes counted, but not needs for services.
- Food as material input to labor, and material energy inputs to food, may be counted.
- Energy demand created by paying labor and other services for running the business is not counted.
- Energy demand from services is ~80% of total business energy need

Original Figure was simplified for reduction here, adding yellow circles and note to represent the addition the energy demand of business services. The model of counting only the material energy uses of the material chain of production is typical of H.T. Odum and others, such as the LCA world standard for business energy accounting

## Counting observed energy use, not energy demand





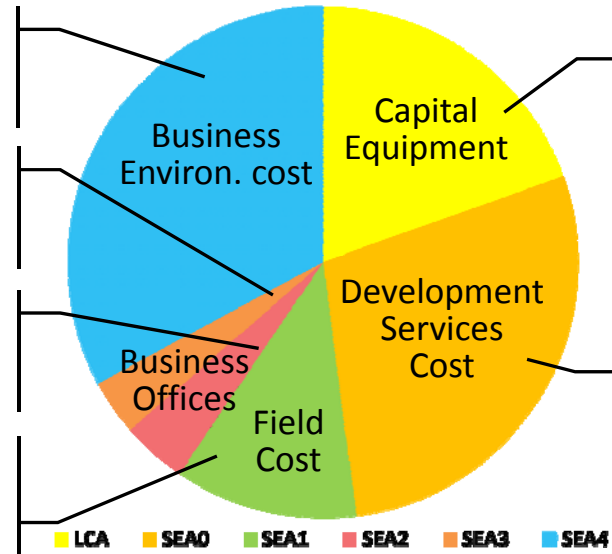
# Life Cycle Energy For a Model Wind Farm <sup>9</sup>

32% dSEA4 – Services of government and finance

4% dSEA3 – Service of corporate management

4% dSEA2 – Service of business management

13% dSEA1 – Service of field operations



19% – Material costs of wind farm technology, **1/5 of the total**

28% dSEA0 – Service cost of wind farm technology



Adding up the total for each scale of system organization, working as a unit

[Systems Energy Assessment \(SEA\)](#)

Money paid to people creates ~4 times the energy use as material costs of machines



# Adding up Total Energy Demand

Combining Purchased Fuel use and Economic Energy Demand	\$ Cost	Fuel Factor	Fuel use TE	Demand Factor Eii	Energy Demand EE	Total kWh
Equipment Investment	\$71.63		0.00	1.5	64.35	64.35
Physical Plant Development	\$24.15		0.00	1.5	67.66	67.66
Field Operation technology	\$18.12	0.51	17.20	1.5	24.98	42.18
Field Operation fuels	\$0.27	12.17	6.15	1.0	0.51	6.65
Field Business Services	\$0.20	-		0.9	0.34	0.34
Field employees	\$2.75	-		0.9	4.62	4.62
Business Office technology	\$0.25	0.51	0.24	1.5	0.34	0.58
Biz Office Fuels	\$0.54	12.17	12.29	1.0	1.01	13.30
Business Office services	\$1.50	-		0.9	2.52	2.52
Business Office salaries	\$1.54	-		0.9	2.59	2.59
Corporate technology	\$0.10	0.51	0.09	1.5	0.14	0.23
Corporate Fuels	\$0.05	12.17	1.14	1.0	0.09	1.23
Corporate operations & services	\$0.50	-		0.9	0.84	0.84
Invest Land & Local Taxes	\$3.00			0.9	5.04	5.04
Invest Fees & Insur	\$5.34			0.9	8.97	8.97
Finance cost estimate	\$69.92	4 to 8		1.0	130.60	130.60
Cost of Government estimate	\$13.25			0.9	22.28	22.28
<b>Total</b>	<b>\$213.12</b>					<b>464.87</b>

- Each business expense is assessed for fuel use and economic demand
- Energy intensity adjustment, Tii and Eii, times average intensity  $E_E$  cost = energy use and demand
- The world average energy intensity,  $EiW = 1.883 \text{ kWh}/\$,$
- There is the simple quick way and the long complicated way
- The total cost times  $EiW$  is quick,  $\$ * EiW = 401 \text{ kWh}, 86\%$  of 465 kWh
- The old way, counting only material energy uses is off by 500%

Money is a far more accurate measure of energy use than energy uses



1. *Symbols:  $T_{ii}$  = tech fuel use rate factor;  $E_{ii}$  = econ demand rate factor;  $T_{ii}$  and  $E_{ii}$  adjust the world average economic intensity  $E_{iW}$  to give the total energy demand per dollar of cost.*
2. *Symbols:  $TE$  = tech fuel use total,  $EE$  = econ fuel use total;  $\$T$  = economic value added for  $TE$  using  $1/E_{iW}$ ;  $\$E$  is either the actual cost or = the economic value added for  $EE$  using  $1/E_{iW}$*
3. World Average GDP energy intensity,  $E_{iW}$  from EIA = 1.883kWh/\$, declining at  $\sim 1.24\%/yr$ .
4. Tax rate on net revenue is 36%, approximating the ratio of US combined local, state and federal government costs to GDP, from [http://www.usgovernmentrevenue.com/yearrev2008\\_0.html](http://www.usgovernmentrevenue.com/yearrev2008_0.html)
5. New Discussion, links and updates might be found at the Systems Energy Assessment web page, [www.synapse9.com/pub/SEA](http://www.synapse9.com/pub/SEA)

## References

1. P.F. Henshaw (2011) [System Energy Assessment \(SEA\):](#) Defining EROI for Energy Businesses as Whole Systems, for [Sustainability MDPI](#) and in Cornell physics archive [arXiv:1104.3570v1](http://arxiv.org/abs/1104.3570v1)
2. US EPA (2008) Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2008  
<http://www.epa.gov/osw/nonhaz/municipal/pubs/msw2008rpt.pdf>
3. based on \$40,584/yr US per capita income, times .47kg/\$, the world average production of CO<sub>2</sub>/\$ of GDP
4. George Mobus Feb 6, 2011 blog post "[Yet another look at cost inflation](#)"  
[http://questioneverything.typepad.com/question\\_everything/2011/02/yet-another-look-at-cost-inflation.html](http://questioneverything.typepad.com/question_everything/2011/02/yet-another-look-at-cost-inflation.html)

