

*Energy and Money

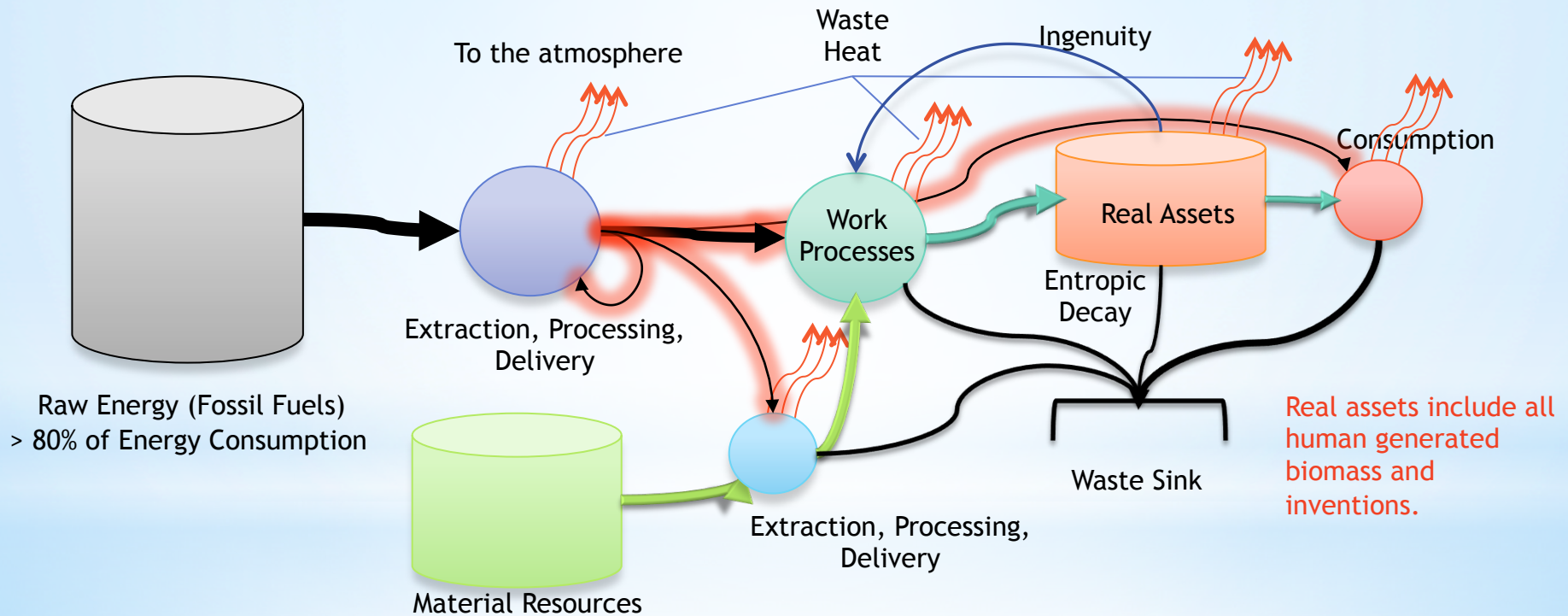
George Mobus,

*Institute of Technology, University of
Washington Tacoma*

Fourth Annual Biophysical
Economics Meeting

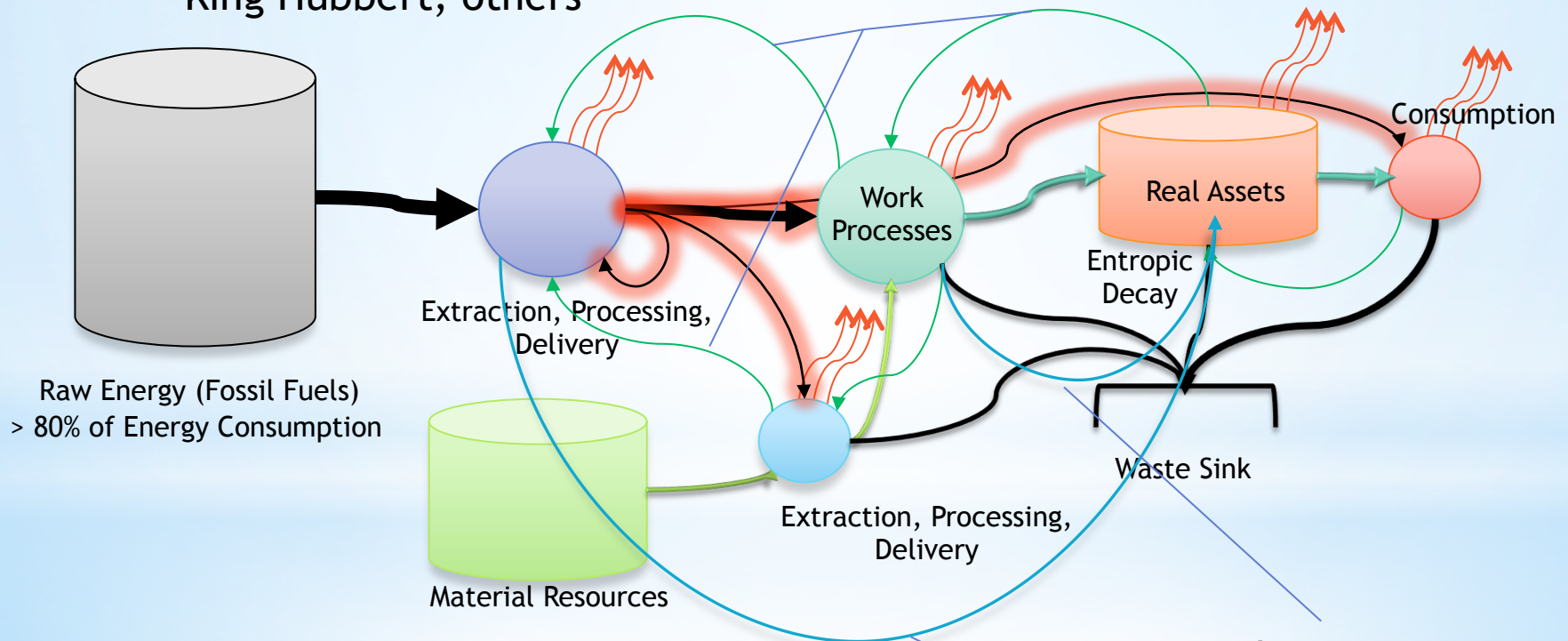
*Energy, Work, & Wealth

Its all just biophysical process. Energy flow through the system drives the transformation of high entropy material to low entropy assets. Energy is continually dissipated.



*Controlling Energy and Material Flows

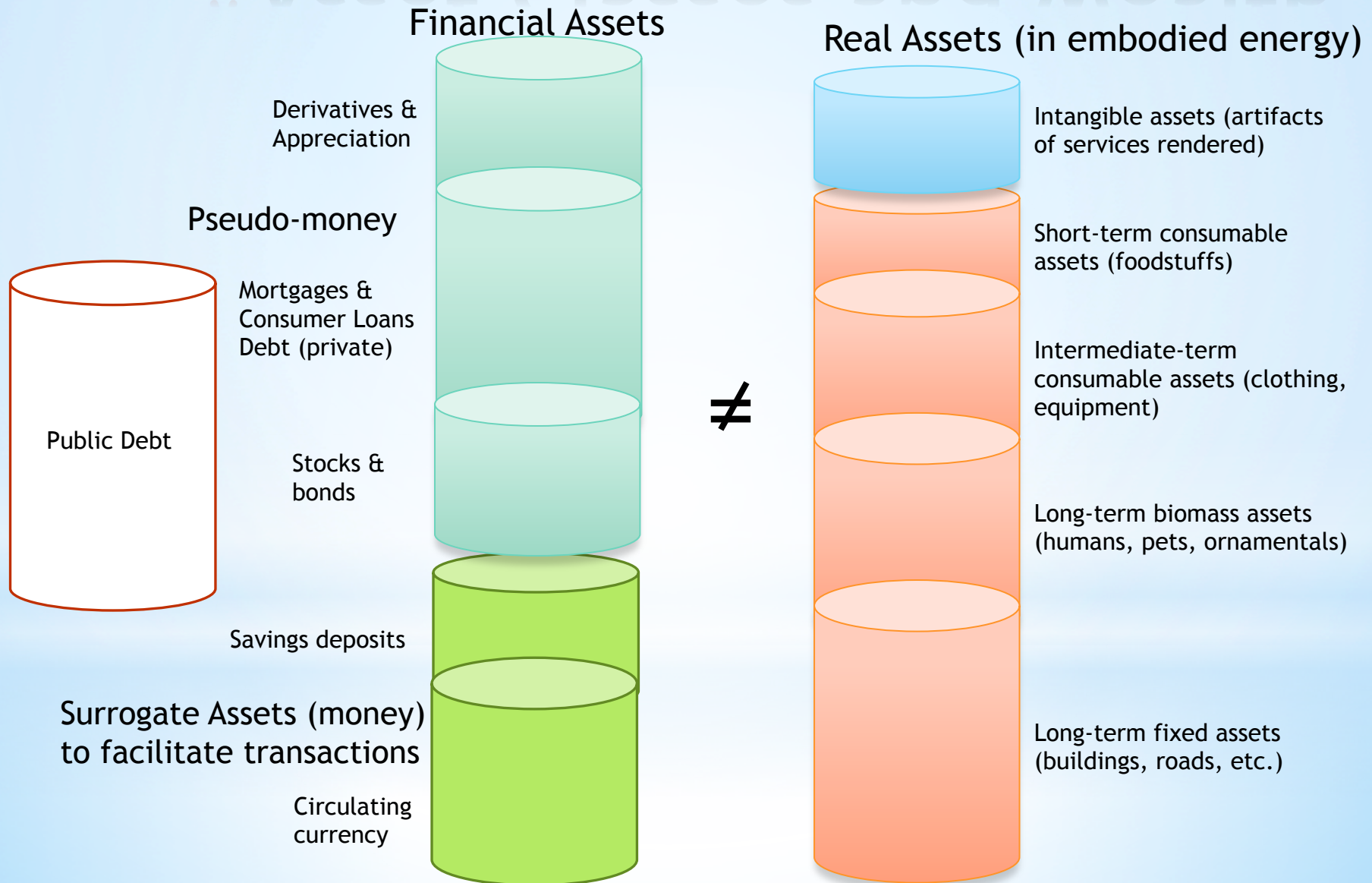
Currency (money) as flow *regulation messages* - Howard Odum, M. King Hubbert, others



We pay others for work to be done on stuff/
services we want. We are paid to do work on stuff/
services that others want.

Money recycles as wages to
regulate human work.

* Asset Classes and Wealth



* Money

- * Token used to denote *value* of goods and services (G&S) - **Real Assets**
- * Origins and history of development - cuneiform in clay to physical tokens to coinage with intrinsic value
- * Layers of abstraction to another kind of commodity
- * Components of valuation calculus in the physical world
 - * energy required to produce - a biophysical baseline
 - * utility value (strictly)
 - * hedonic value
 - * less opportunity costs
 - * less sunk costs
- * In the modern world no one has any idea how to calculate most of these - we estimate based on presumed values of other G&Ls - let the markets decide!
- * Financial *pseudo-assets* have become so abstracted from *real assets* that modern money is useless as a measure of wealth

*Exergy == Work

*Useful (economic) work

- * extracting materials and energy (incl. food)
- * refining
- * shaping and forming
- * manufacturing, construction, transportation, etc.
- * services

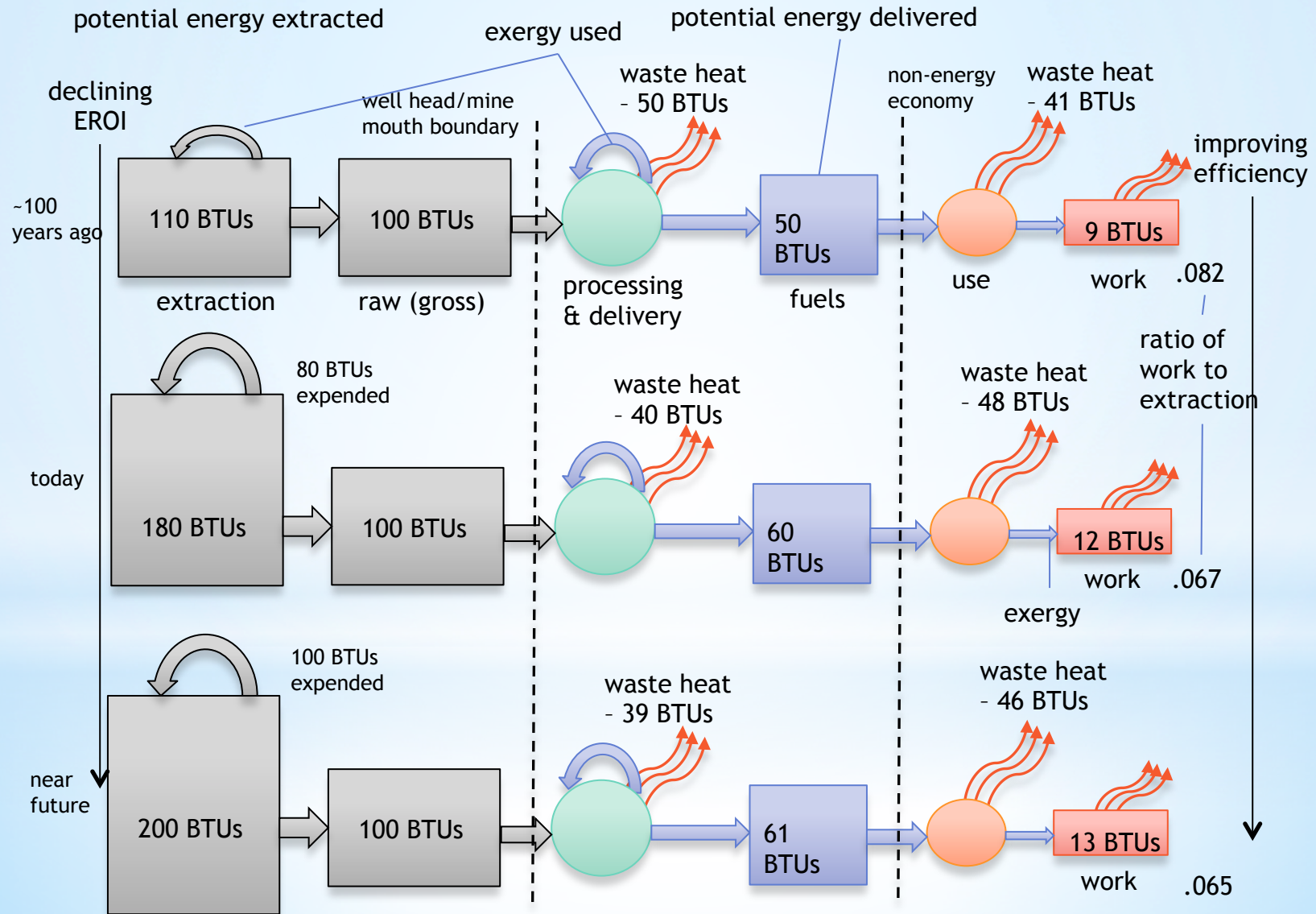
*Value of a product

- * embedded work
- * utility of the product, e.g. increasing the efficiency of useful work or increasing flow of energy (tools)

* Exergy is that portion of total energy required to obtain *useful work* (it depends on the nature of the work process as much as on the energy content of fuel)

* Exergy Return on Energy Extracted

Declining EROI as Compared with Increasing Work Efficiency



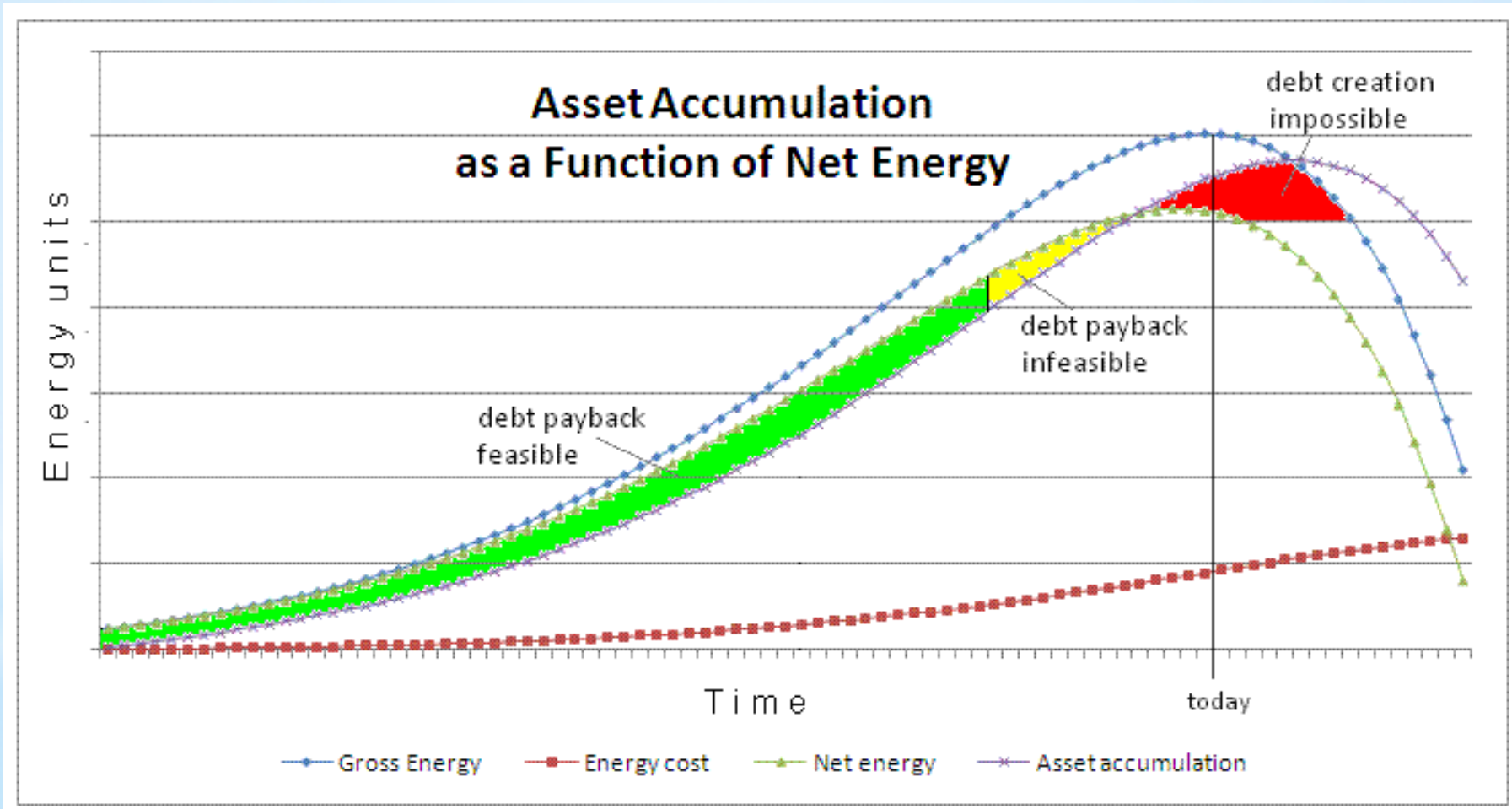
*Four Factors Collide

- * Depletion and geophysical limits - e.g., Peak Oil
 - * Limiting supply driving up prices
- * Declining EROI (mine mouth/well head)
 - * Increasing costs of extraction (e.g., non-conventional methods)
- * Decreasing rate of efficiency improvements (e.g. Carnot's limit)
- * Increasing population (with increasing expectations)
 - * Decreasing net energy available per capita
- * Lead to:
 - * Diminishing total work to produce real assets
 - * Less wealth per capita over time
 - * Increasing disparity between wealthy and poor?

*Exergy Basis for Currency

- * Similar to a “gold” standard in stabilizing value without the silliness of gold fever
- * Exergy resource - based on actual amount of work that can be done in the near future
- * Exergy embodied - based on actual amount of work already done
- * Value of assets can be computed from work done in past
- * Total circulating currency + savings determined by excess net energy available
- * Borrowing from savings to invest in future returns
- * When net energy peaks asset production peak will follow - there will be no savings!

*Relation: Energy-Work-Assets



Based on two of the factors - Depletion and Declining EROI

*Future work

- * Investigate the dynamics of all four factors operating in the system
- * Incorporate stocks and flows of money as a regulation system - maybe a hybrid with agent-based modeling
- * Continue to watch the evolution of our global system

*Questions