Titles:

1. From GDP to Gross National Wealth: National accounting in the new age of scarcity (Preferred at this time)
2. Redefining GDP for the New Age of Scarcity
3. Expanding GDP for the New Age of Scarcity
4. Redefining The Wealth of Nations for the New Age of Scarcity (?)
   * CH: The Wealth of Nations is not grabbing enough
5. Expanding GDP to Gross National Wealth for the New Age of Scarcity (CH likes this although is a little wordy)
6. Expanding GDP to Gross National Wealth: (Analytical?) Tools for the New Age of Scarcity (BRH suggestion)
7. From GDP to Gross National Wealth: tools(?) for the New Age of Scarcity
8. From GDP to Gross National Wealth: Tooling up for the New Age of Scarcity

Objective:

The objective of this book is to develop a rigorous theoretical framework for economic analysis that fully accounts for the importance of capital in energy transitions, embraces the importance of non-market transactions, and leverages data from expanding systems of national accounts.

Motivation:

Impending material and energy supply constraints make it urgent that economies throughout the world adopt such a framework and expand their systems of national accounts.

Benefits of Implementing Our Framework:

1. Society will gain the capability to use existing I-O data to regularly (and correctly) assess energy (and material) intensity of economic output
2. Society will gain a deeper understanding of the real economy to inform planning for the energy transition
3. Society will gain the capability to assess new technologies and capital investments for future materials and energy requirements. (At present, new technologies and capital investments are assessed for industry & employment impacts only.)

HDH Detailed Outline:

Revised based on phone call with Charlie (18 July 2014)

# Introduction: The End of an Era

## Economic growth (growth rate of GDP) has stalled for mature (OECD, developed?) economies. Evidence:

### GDP for OECD vs. rest of world (graph)

### Flat growth of the U.S. middle-class salaries (Graph of middle-class salaries.)

### Unemployment

### High (and increasing) levels of government and private debt

### Inclusive wealth report: For some countries, GDP (flow) growth is coming at the expense of wealth (stock)

### Something here about stocks

### Introduce categories of stock vs. flow, wealth vs. income here

#### Wealth is a house, not a salary

#### Stocks can be natural (coal, oil) or human-made (machines, factories, airports, and roads)

## Stalling economic growth is a problem because:

### Society thinks that GDP growth raises living standards and well-being.

### Economic Policies are developed under the assumption that GDP will continue to grow.

### Economic expansion has been accompanied by tremendous improvement in living standards and various indices of well-being over recent centuries.

### Slowdown in economic expansion puts living standards and human well-being at risk.

### Economic growth is thought to be the answer for nearly every social problem [Daly]:

#### living standards,

#### inequity,

#### high levels of debt,

#### population:

##### high population growth (economic transition)

##### aging population (demographic transition, follows from economic transition)

#### unemployment

#### environmental impact (Kuznets curve)

## Why is economic stall happening? Economists think stalling occurs due to endogenous (by their definition) factors.

### slow-down in technological change and/or productivity

### lack of capital investment (secular stagnation theory)

### under-utilized labor and/or population growth slowing

### export of jobs overseas

### increasing (government and private) debt burden and/or debt to GDP ratio

### the end of the productivity bump from the entry of women into the workforce [Gordon 2012]

### declining quality of education [Gordon 2012]

### increasing inequality [Gordon 2012]

### increased factor price competition from globalization [Gordon 2012]

## Slowing growth may be due to exogenous factors also

### Examples of exogenous factors:

#### drawing down of natural capital (both sources and sinks)

#### increasing (material and energy) cost of obtaining resources

#### reduced quality and quantity of ecosystem services, e.g. flows that do not enter the economy and assimilative capacity of the biosphere

### Depletion of high-quality resource stocks (materials and energy)

### More evidence (graphs from Hollick and Hall, Tverberg, etc.)

## Slowing of today’s flows (including GDP) is connected to the status (remaining quantity and quality) of non-renewable resource stocks

### Generation of wealth seems to be correlated with the use of energy. Evidence: (Ecological footprint graph? from Hall and Klitgaard, p. 20, 19, p. 73)

### High-quality stocks (especially energy) have been depleted by previous flows! Evidence:

#### EROI decline

#### Decreasing ore grade for key minerals

#### Drawing down aquifers

### Quality of material and energy resources plays a key role in determining economic health. Evidence:

#### EROI decline and its effect on price [Heun, de Wit and King, Hall]

#### Supply constraints (relative to demand) in conventional/cheap oil leading to oil price increase and subsequent economic pain [Hamilton]

#### More energy required to mine lower grade ores

#### Drought and salination impacting agriculture

### Discuss Ricardian stuff here? (increasing "rent" on oil as evidence of declining stocks?)

### Can we make a transition?

#### Are renewable flow rates large enough to take the place of stock-based flows?

#### Can we increase rates of renewable flows quickly enough to make up for depleted natural capital stock flows?

#### E.g. solar to replace oil.

##### Need to electrify the vehicle fleet also.

##### Need grid storage.

## Tomorrow’s demand for energy and material flows from the biosphere is connected to today’s choices about investment in capital stock (machines, roads, etc. in the infrastructure of the economy, population)

### Today’s investments in society’s stocks of manufactured and natural capital establish tomorrow’s materials and energy requirements for both operation and maintenance of those stocks.

## Policy makers have tried to address the “problem” (slow-down in economic growth) by encouraging consumption thereby increasing rates of material and energy flow through the economy. The focus is solely on flows (e.g. GDP), not stocks.

### What has been done thus far?

#### Low interest rates & quantitative easing to motivate loans, business activity, consumption, and investment in productive capital and consumer durables (addresses 2.b.) without considering the (feedback) effects of these policies on current and future material and energy requirements. (Example ARRA.)

#### Increased incentives for R&D (addresses 2.a.) without considering the consequences of new technologies on material and energy needs of the economy.

#### In summary, economic decision-making focuses on consumption rather than well-being of population.

### Evidence that exogenous factors are left out of current economic policy/decision making:

#### Society and the economic establishment, especially in the US, do not include non-market transactions related to material/energy flows to/from the biosphere in economic decision-making at any level (national, sectoral, corporate, and personal). Note: the US does include non-market transactions in GDP for other categories; housing services provided by owner-occupants is imputed and accounts for almost 15% of GDP.

#### BEA:

##### Explicitly prevented (by congress) from collecting environmental accounts data

##### Erosion of data maintenance capacity.

###### [See Hall Gilford O’Connor Cleveland AND MURPHY ET AL on this, ALSO CLEVELAND. They used to have 30 people to update energy use of each major sector of the economy. Now they have 1 person doing the work of 30.]

#### We don’t place enough value on examining national wealth (a stock) compared to income and GDP (flows).

#### Discussions around energy intensity and EROI are not part of the common discourse.

#### Investments in R&D and technology are not evaluated for their impacts on future energy intensity and EROI.

#### There is a significant availability lag for input data to EI-O analyses. Therefore, estimates of energy intensity are, typically, 5-10 years behind.

##### [Lack of updating of 1970s Energy analyses - Energy Intensities DERIVED FROM I-O ANALYSIS. All we have is the Carnegie Mellon stuff. Environmental Input-Output Life Cycle.<http://eiolca.psc.edu/Models/index.html>]

## Consumption-driven economic growth cannot be sustained in the presence of exogenous factors. The economic analyses that support consumption-driven policies are incomplete, because biophysical limits that constrain the scale of the economy are not included in economic models. Three factors, in combination, are important:

### The rate at which materials and energy can be extracted from the biosphere is limited.

### Natural stocks of materials and fossil-fuel energy are finite.

### Today’s investments in society’s stocks of manufactured and natural capital establish tomorrow’s materials and energy requirements for both operation and maintenance of those stocks.

## As a consequence of the fact that we’re not including exogenous factors in economic decision-making we do not fully understand how the real economy operates:

### Society is ignorant of the role that capital (natural, manufactured [which presupposes human and social]) and its maintenance (current and future) plays in sustaining today’s economy and in constraining future economic prospects and choices.

### Economic policy encourages high flow-to-stock ratio rather than high stock-to-flow ratio [Boulding’s stock to consumption, Daly’s low throughput, Odum’s B/P]

### We don’t know where energy is embodied in our economy.

### Our knowledge of energy intensity does not account for capital stock accumulation and is therefore in error.

### Society is unable to properly frame and conceptualize the “problem” of “stalling” growth. Society is unable to adequately manage developing or mature economies; Society lacks the analytical tools and data to do so.

#### At present, there are few tools except for markets to help us understand these characteristics of the real economy.

#### Are markets adequate on the following important issues?

##### scale of the economy: no, scale is a non-market issue

##### distribution (who owns resources: private, public) - no, is a non-market issue

##### Allocation of resources (how are resources allocated to final demand) - yes, competitive markets are relatively good at this,

###### but “efficient” allocation is dependent on answers to 1 and 2 above.

##### In any case, if markets are to be helpful:

###### They require correct and complete information.

###### Values of non-market transactions must be available.

## As a consequence of not fully understanding how the real economy operates, our prescriptions for curing the “problem” of “stalling” economic growth may be worse than the disease.

### Stimulating the economy via consumption driven by investments in capital stock and R&D, without consideration of the material and energy consequences, increases economic throughput (GDP), but hastens the day when we reach the binding constraints.

### Doing so when you are already at a binding constraint will result in see-saw economic performance. (We may already be in the see-saw situation because we have hit a binding constraint for oil extraction rate.) Thus, attempts at maintaining growth in mature economies may produce more illth than wealth. The prescription may be worse than the disease.

## We are facing the end of the era wherein growth of living standards and well-being can be obtained from increased income. But, we’re blind to what should be done instead. This has to change!

# Chapter 2: Accounting for the Wealth of Nations

## Summary of Introduction.

### There are several big issues:

#### Slowing growth may be due to exogenous factors that are not included in economic theories and national accounting [Economic theory does not include exogenous factors which may be reducing economic growth.]

#### The economic establishment thinks that “stalling” of mature economies is, itself, a problem (i.e., a pathology of well-functioning economies). We think that stalling growth can cause problems, but is not pathological.

#### GDP (by itself) is an incomplete measure of economic (or human) well-being because (among other issues) it focuses on gross income (flows) and does not include the importance of wealth (stocks)

### Importantly, society faces two problems:

#### At present, we (as a society) and the economic establishment are ignorant of the role that non-market transactions (especially material/energy flows to/from environment) play in providing the raw materials that supply goods and services to meet society’s needs and wants.

#### At present, we (as a society) are ignorant of the role that capital (natural, manufactured [which presupposes human and social]) and its operation & maintenance (current and future) plays in sustaining present economic conditions and in constraining future economic prospects and choices.

## Society's ignorance of the role of capital and flows of materials, energy, and ecosystem services from biosphere in providing for the health of the economy is a manifestation of incomplete national accounting.

### Not fully accounting for non-market transactions (especially material/energy flows to/from environment) in national accounting

#### Need to account for flows of materials and energy to and from the biosphere

### Not fully accounting for and reporting capital stocks within the economy

#### BEA does track "value" of investment and depreciation

#### However, it needs to be accounted on a material basis

### Not fully accounting for natural resource stocks in the biosphere

## Why is society doing the accounting incorrectly? Because we do not have correct assumptions about the way the economy works. Why are our assumptions incorrect? Because we have the wrong metaphor for the economy? It is time to update the metaphor.

## The economy is society’s metabolism.

### The economy as society's metabolism has been introduced recently (Fischer-Kowalski; Gowdy; Heijman; Liu) to clearly identify economic activity as an interchange with the biosphere; energy and materials flow from the biosphere through society

### The metabolism metaphor has not been utilized to its full extent.

#### Anabolic process build up material stocks with the body (bones, muscle mass, tissues)

#### Catabolic processes break down molecules to release energy

#### Larger bodies (more stock) require large flow rates, even at rest

#### All metabolisms exist within the context of the encompassing biosphere

#### Size (scale) of the organism relative to the biosphere is an important limiting factor for expansion of species whose individual organisms are supported by similar metabolisms.

## What would change if we viewed the economy as society’s metabolism? Our understanding of the real economy would change significantly.

### Biosphere would be seen as sustaining the economic metabolism

#### Health of the economy would be seen as dependent on flows to/from the biosphere through the economy

#### direct analogy to economic ‘breathing’: oxygen from atmosphere is used to reduce carbon to CO2

#### materials are the ‘food’ that is stored within the economic ‘body’

### Society would understand that economic “stall” is not pathological, but natural and to be expected of mature economies that have encountered some type of limit.

#### There may be any number of limits (material/energy limits, population limits, ecosystem limits, complexity limits [Tainter] etc.)

#### It may be very difficult to discern which limit is being reached, due to feedback loops. Rather, need to look at/assess the entire system.

### Society would be less concerned about economic growth as measured by GDP (because we would understand that it can’t last forever) and more focused on human well-being.

### We would develop more indicators for economic health, not just pulse/temperature(?)

### We would view economic stocks as stores of useful materials and (embodied) energy to be utilized when broken down

## If society were to view the economy as a metabolism include important stocks and flows in economic models, society would develop broader criteria, indicators, and tools to characterize the health of the economy especially its ability to provide for the well-being of current and future generations, and its sustainability in relation to the biosphere.

### We would change our national accounting

#### We would keep very careful accounting of flows (good indicators of metabolic health)

##### between the biosphere and the economy

##### within the economy itself

###### throughput

###### into stocks

###### out of stocks

#### We would care more about stocks and include stocks on a material basis (not just a value basis) in national accounting

#### We would include the natural resource stocks upon which the economy depends in national accounting (physical basis)

### In what ways?

#### We would modify economic theory to include the fact that material and energy flows to and from the environment (non-market transactions) sustain the economy.

##### One of the most important features of the exchange of material and energy between the economy and the biosphere is the extraction of high quality materials and energy from the biosphere and emission of low quality materials and energy out of the economy (maintenance of entropic gradient).

#### We would expand the focus of our national accounting and economic theories beyond flows (GDP) to include stocks (of capital, especially), because stocks are vitally important to understanding the quantity and quality of future economic services. [Fishman 2014; Pauliuk 2014]

#### We would understand, plan, and act upon the knowledge that the sustaining environment (the biosphere) provides a constraint on the scale of the economy. We are approaching material and, especially, energy supply constraints.

##### Several nations have already begun to include non-market transactions related to the biosphere in economic decision-making at the national level (EW-MFA & SEEA). It needs to be done at the sectoral, firm, and household levels, too.

## This book outlines a rigorous theoretical framework that could be adopted in systems of national accounts (SNA) to properly account for capital stocks within the economy and important flows between the biosphere and the economy (2a and 2b). In so doing, we also make progress in accounting important stocks of natural resources (2c). The framework presented herein provides guidance for which data are to be collected, aggregated, and disseminated.

Outline of remaining chapters:

# Part I: Material and energy stocks and flows

# Chapter 3: Accounting material stocks and flows

# Chapter 4: Accounting direct energy stocks and flows

# Chapter 5: Accounting embodied energy stocks and flows

# Part II: Economic value and energy intensity

# Chapter 6: Accounting economic value stocks and flows

# Chapter 7: Estimating energy intensity

# Part III: Implications, Issues, and Summary

# Chapter 8: Implications

# Chapter 9: Questions to consider

# Chapter 10: Moving forward

# Chapter 11: Summary