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Raices de la insostenibilidad socio-economica

EL FUTURO DE LA TECNOLOGÍA DESPUÉS DEL AGOTAMIENTO DEL PETRÓLEO

23 Septiembre 2015 - Universidad de Valladolid

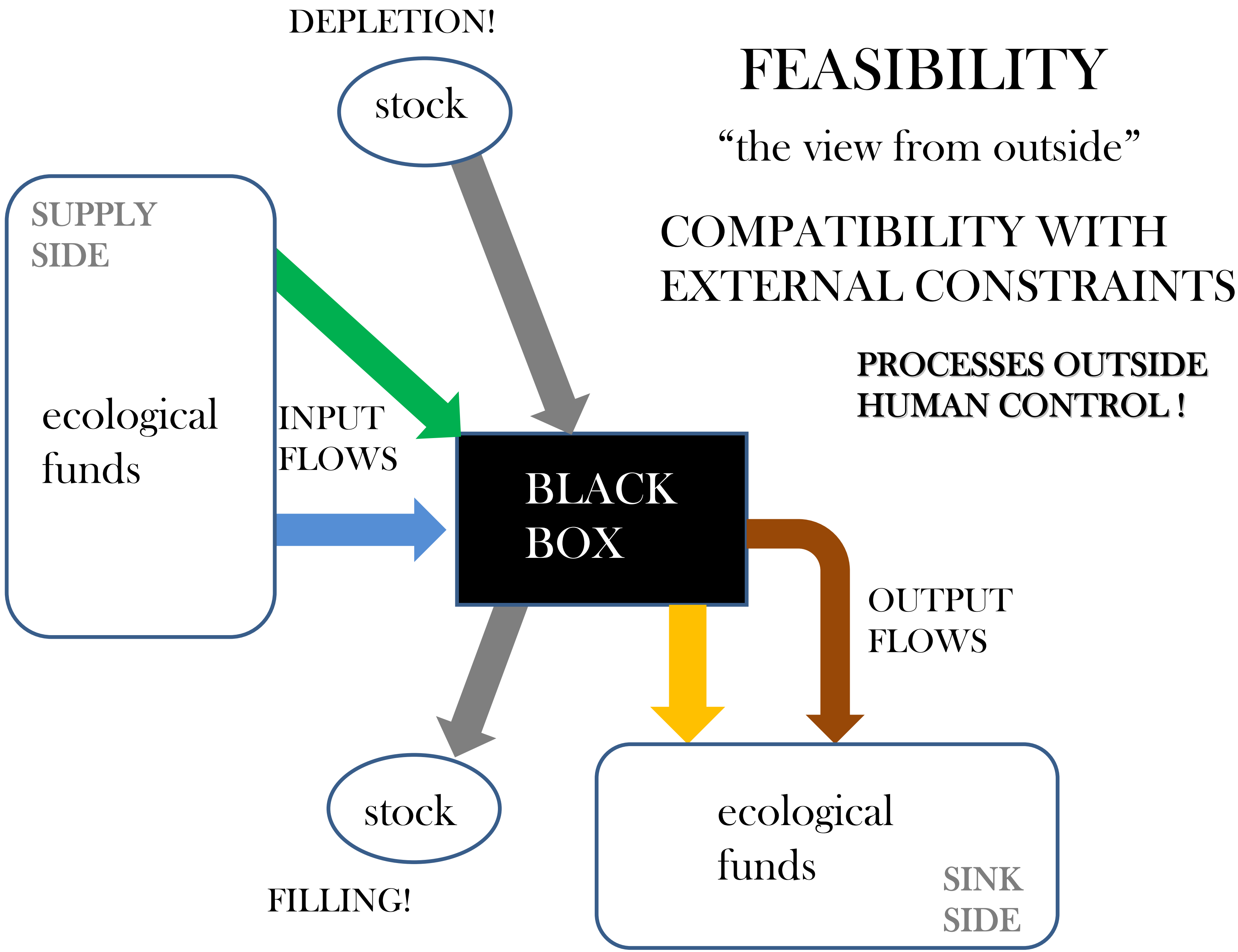
Centro Buendía UVa

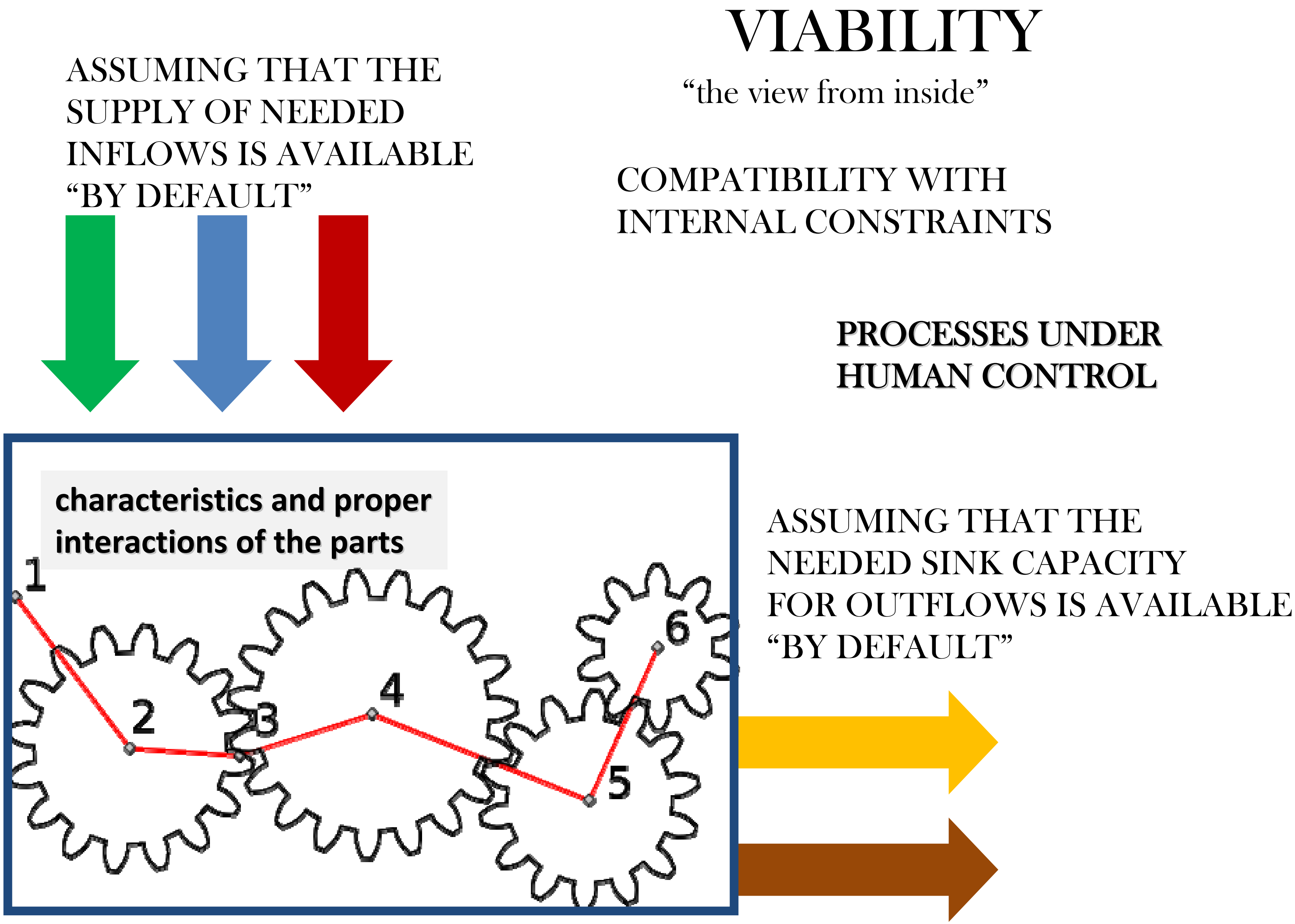

1. Feasibility, Viability and Desirability: a critical appraisal of the concept of EROI (Energy Return On the Investment)
2. The dynamic energy budget of society and the SUDOKU effect
3. Using the flow-fund model of Georgescu-Roegen to implement the DPSIR framework (Driver, Pressure, State, Impact and Response)
4. Cómo los economistas perdieron contacto con la realidad biofísica: MONEY is no longer good for MONITORING

1. Feasibility, Viability and Desirability: a critical appraisal of the concept of EROI (Energy Return On the Investment)

If we want to understand the quality of energy sources we must specify how much energy carriers we must invest in order to produce energy carriers and what is the speed of the rotation of investment in society . . .

WHY ENGINEERS ARE NOT GOOD AT ENERGETICS


FEASIBILITY
"the view from outside"
COMPATIBILITY WITH EXTERNAL CONSTRAINTS
PROCESSES OUTSIDE HUMAN CONTROL !
DEPLETION!
stock
SUPPLY SIDE
ecological funds
INPUT FLOWS
BLACK BOX
OUTPUT FLOWS
stock
FILLING!
ecological funds
SINK SIDE


VIABILITY
“the view from inside”
ASSUMING THAT THE SUPPLY OF NEEDED INFLOWS IS AVAILABLE “BY DEFAULT”
COMPATIBILITY WITH INTERNAL CONSTRAINTS
PROCESSES UNDER HUMAN CONTROL
characteristics and proper interactions of the parts
1
2
3
4
5
6
ASSUMING THAT THE NEEDED SINK CAPACITY FOR OUTFLOWS IS AVAILABLE “BY DEFAULT”

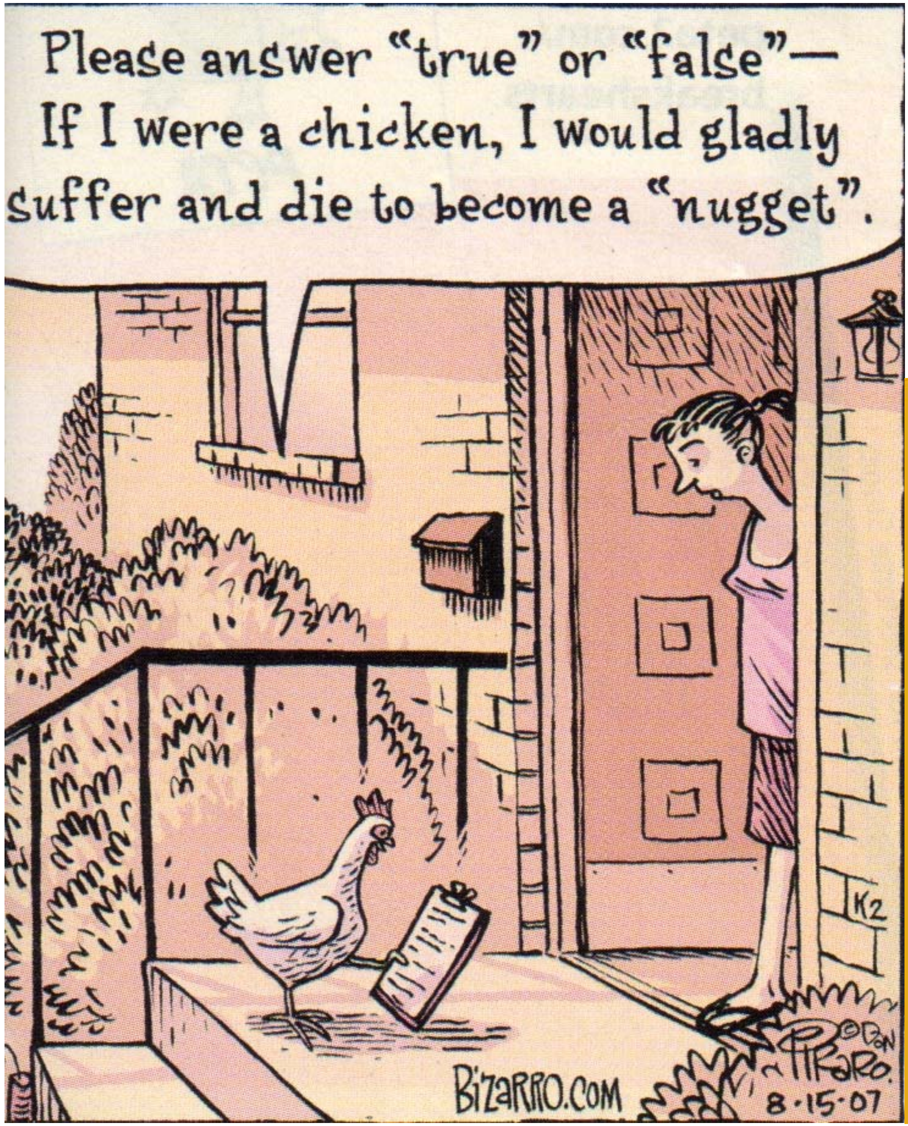
Values, Taboos, Cultural Identity
Path Dependence (history matters . . .)

DESIRABILITY

"whose view counts?"

COMPATIBILITY WITH NORMATIVE VALUES & SOCIAL INSTITUTIONS

PROCESSES UNDER HUMAN CONTROL



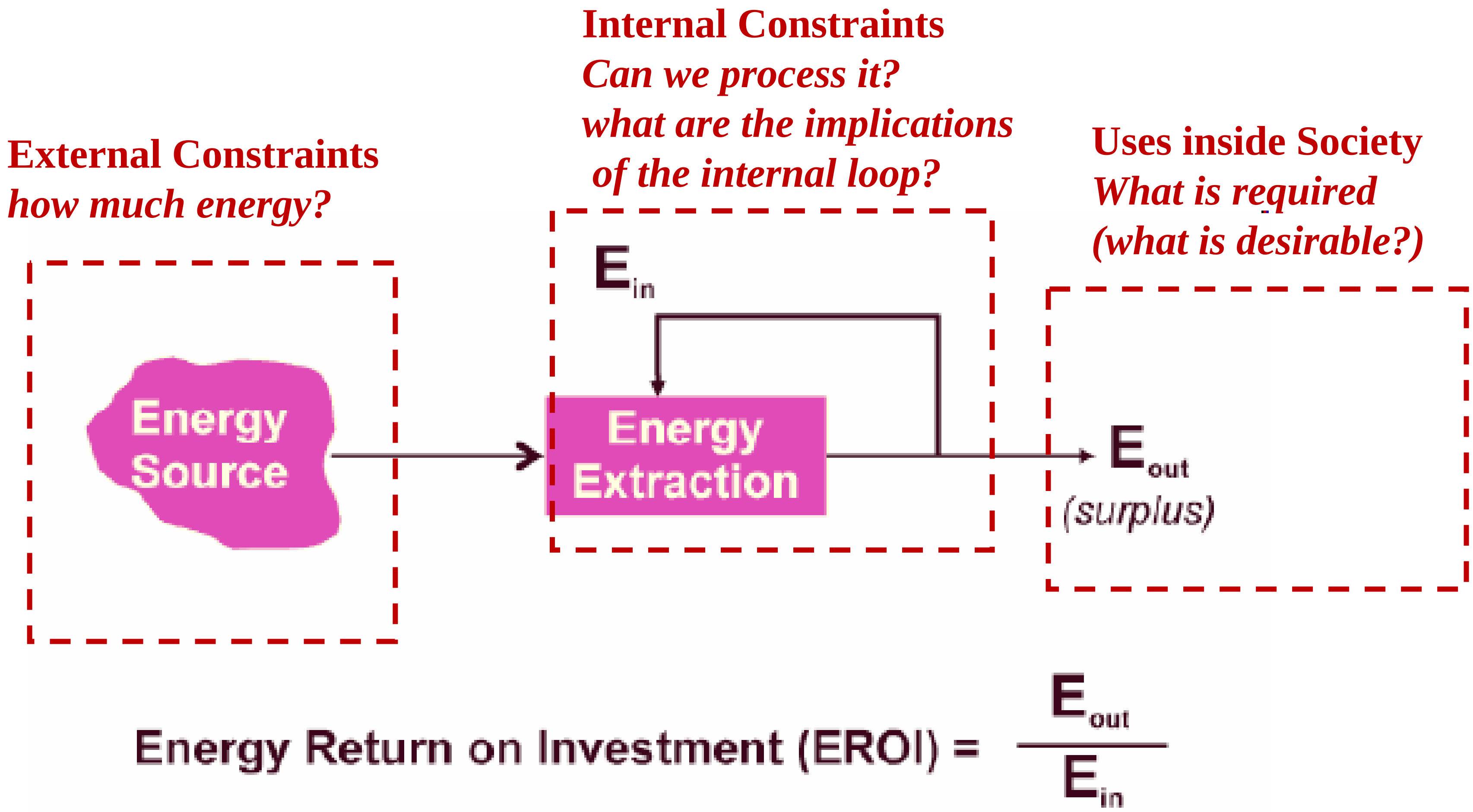
Analyzing Net Energy Analysis using the concepts of FEASIBILITY, VIABILITY and DESIRABILITY

According to a recent study in UK there is an average 2€ in loose change down the back of home sofa

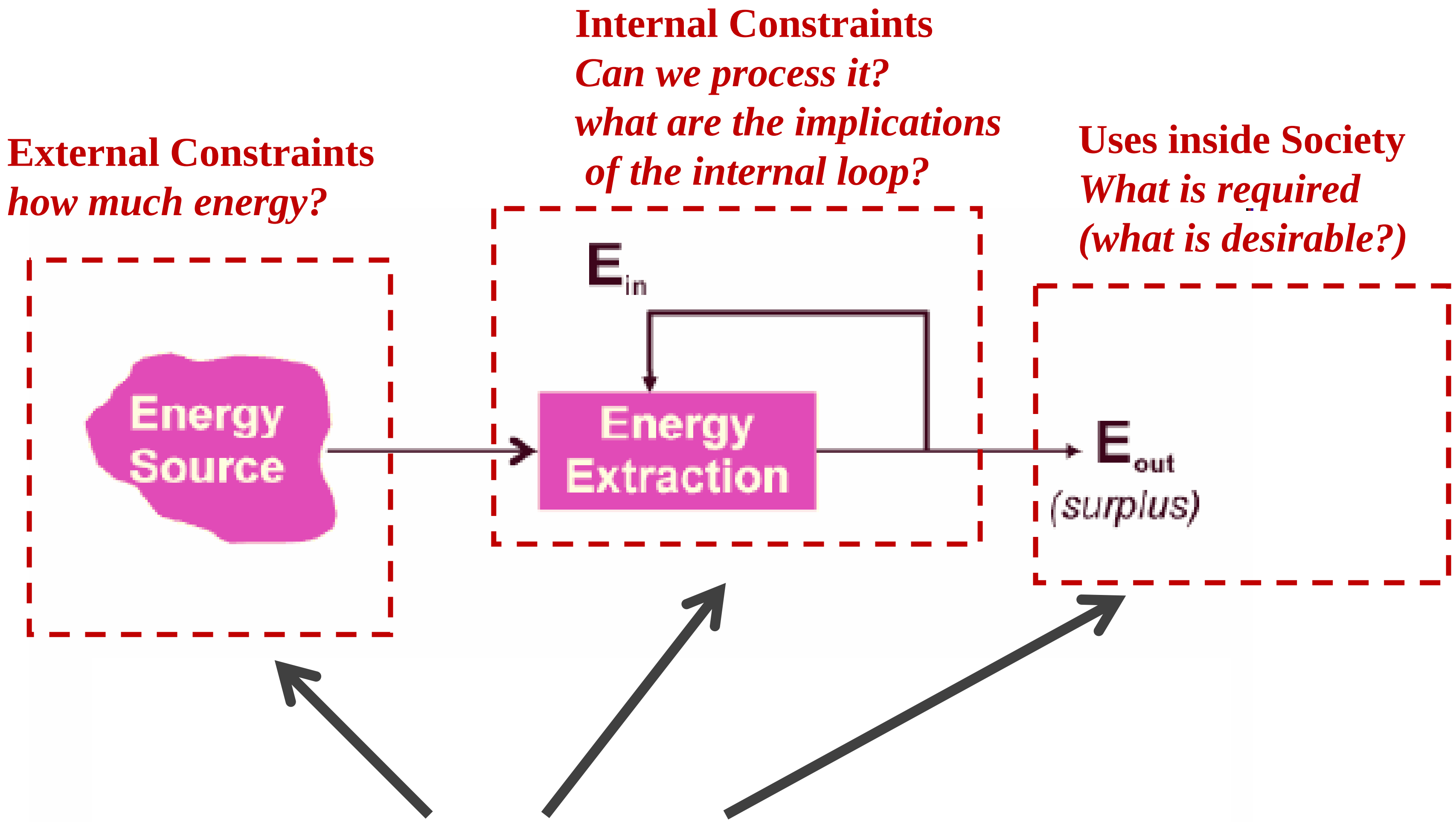
1 million € spread in 500,000 sofas

A bird in the hand is worth two in the bush!

1 million € concentrated in a pack of 100 € bills

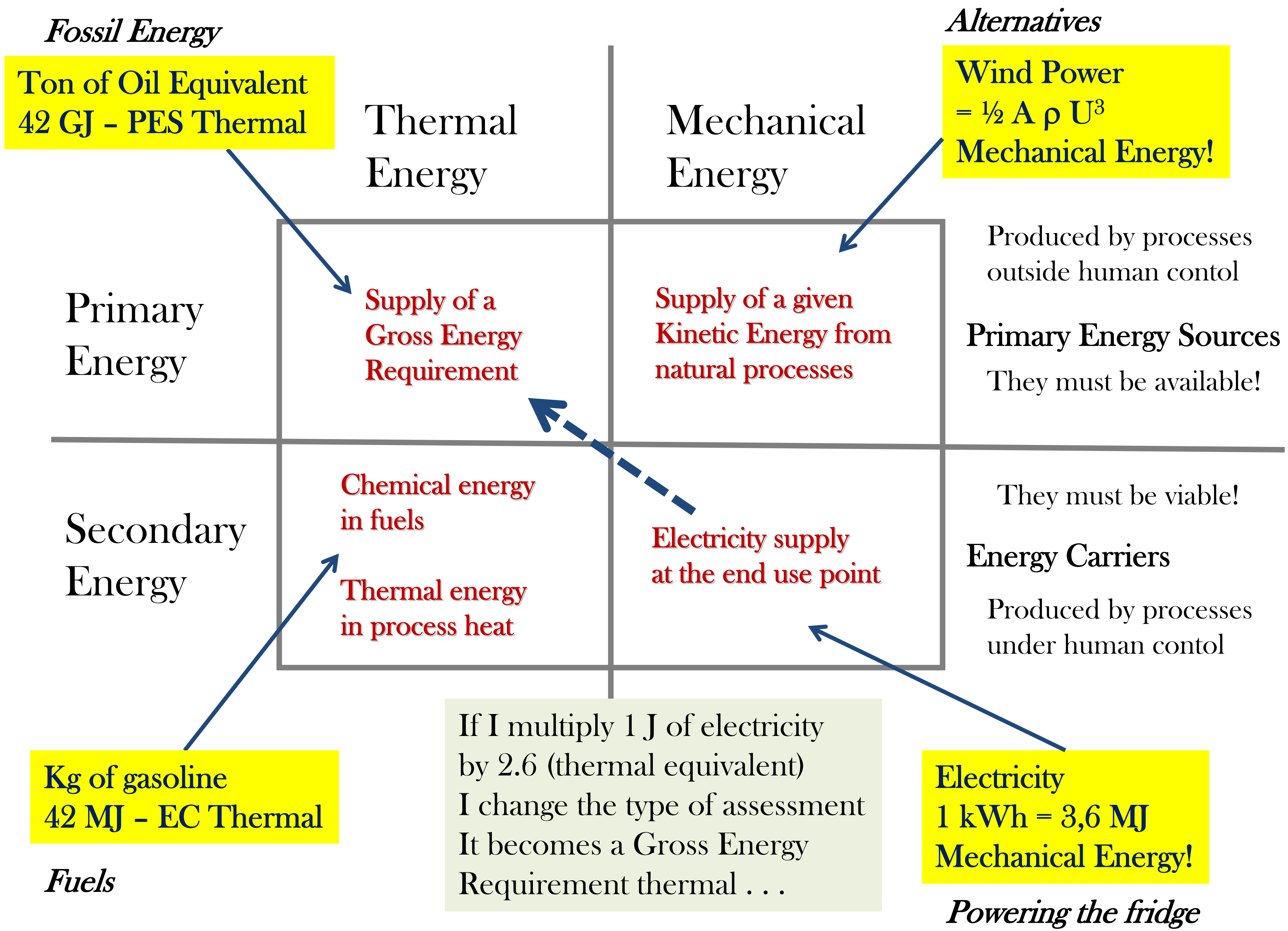


The basic idea of EROI

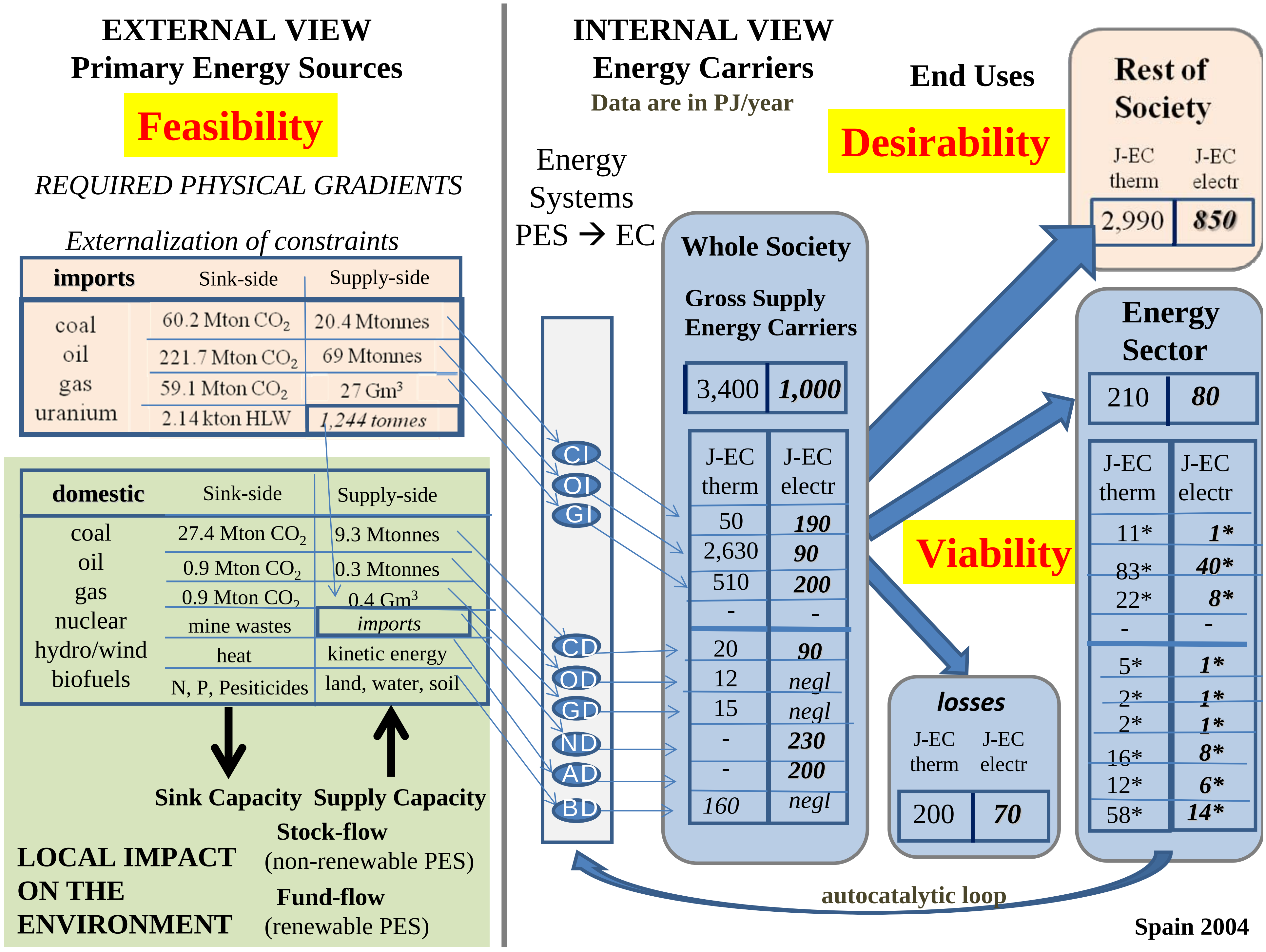


Peak-oil has to do with the relation between:

- Technical viability – capability of producing the required supply in EM;
- Socio-economic viability – expected net supply;

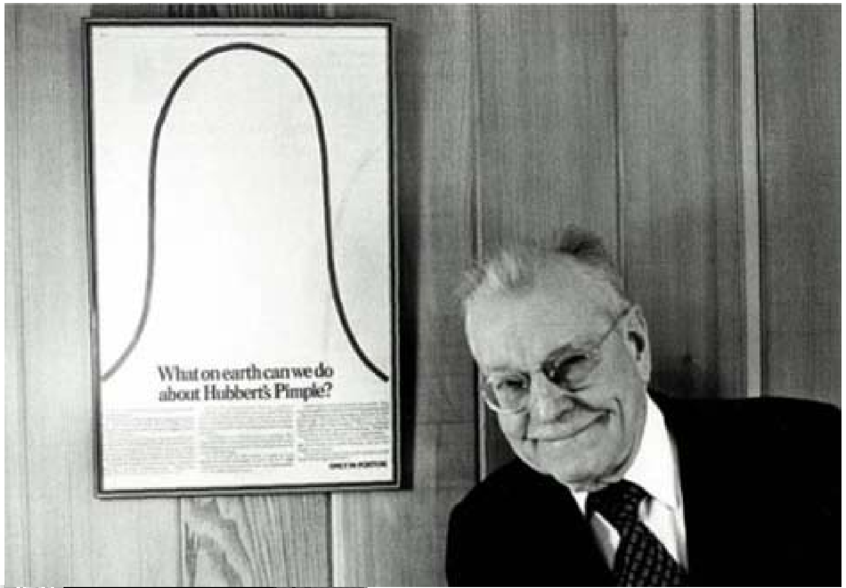


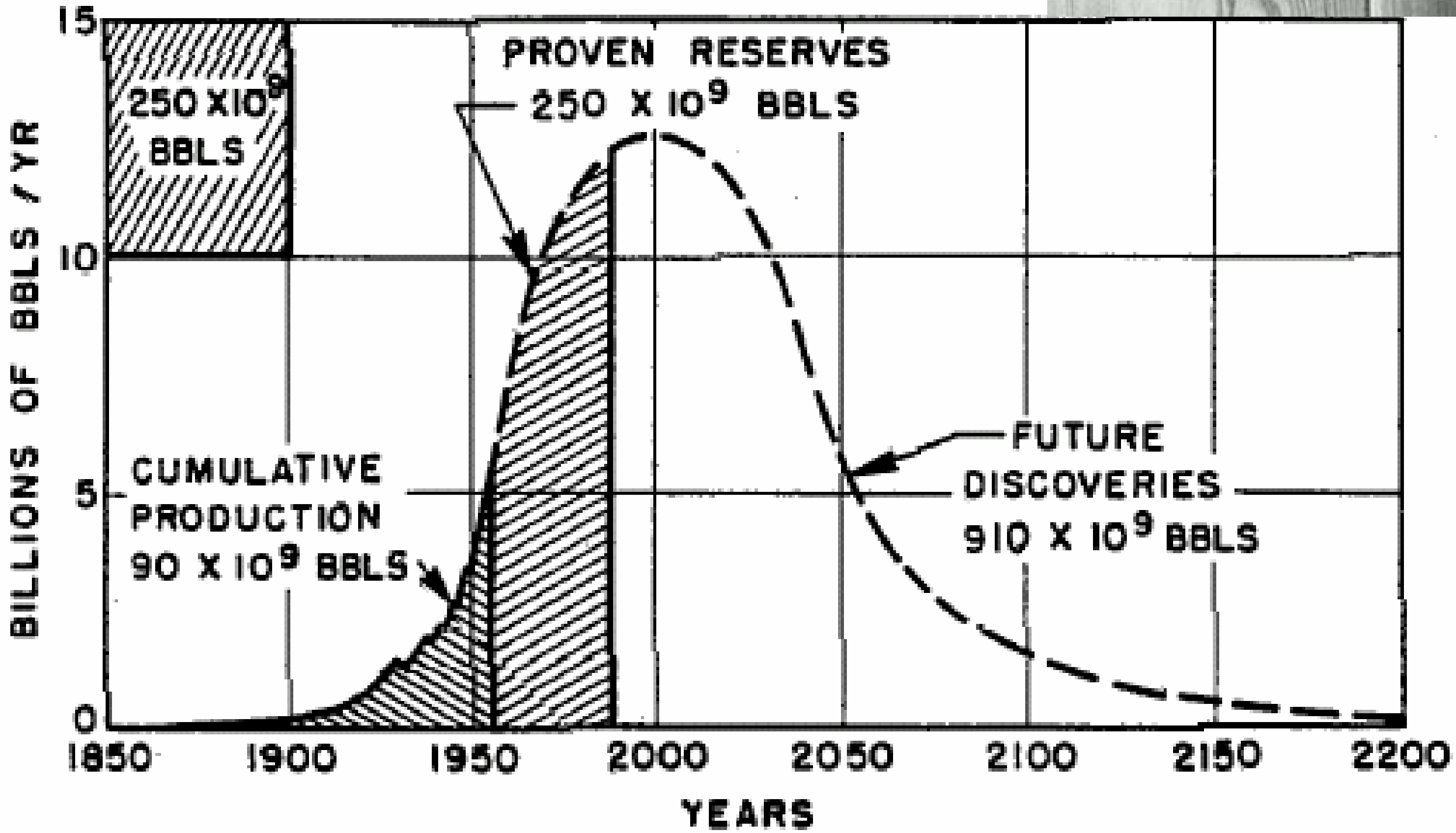
Fossil Energy
Ton of Oil Equivalent
42 GJ – PES Thermal
Thermal Energy
Mechanical Energy
Alternatives
Wind Power
= ½ A ρ U³
Mechanical Energy!
Primary Energy
Supply of a Gross Energy Requirement
Supply of a given Kinetic Energy from natural processes
Produced by processes outside human contol
Primary Energy Sources
They must be available!
Secondary Energy
Chemical energy in fuels
Thermal energy in process heat
Electricity supply at the end use point
They must be viable!
Energy Carriers
Produced by processes under human contol
Kg of gasoline
42 MJ – EC Thermal
Fuels
If I multiply 1 J of electricity
by 2.6 (thermal equivalent)
I change the type of assessment
It becomes a Gross Energy
Requirement thermal . . .
Electricity
1 kWh = 3,6 MJ
Mechanical Energy!
Powering the fridge


EXTERNAL VIEW
Primary Energy Sources
Feasibility
REQUIRED PHYSICAL GRADIENTS
Externalization of constraints
imports
Sink-side
Supply-side
coal
oil
gas
uranium
60.2 Mton CO2
221.7 Mton CO2
59.1 Mton CO2
2.14 kton HLW
20.4 Mtonnes
69 Mtonnes
27 Gm3
1,244 tonnes
domestic
Sink-side
Supply-side
coal
oil
gas
nuclear
hydro/wind
biofuels
27.4 Mton CO2
0.9 Mton CO2
0.9 Mton CO2
mine wastes
heat
N, P, Pesiticides
9.3 Mtonnes
0.3 Mtonnes
0.4 Gm3
imports
kinetic energy
land, water, soil
Sink Capacity
Supply Capacity
Stock-flow
(non-renewable PES)
Fund-flow
(renewable PES)
LOCAL IMPACT ON THE ENVIRONMENT
INTERNAL VIEW
Energy Carriers
Data are in PJ/year
Energy Systems
PES → EC
CI
OI
GI
CD
OD
GD
ND
AD
BD
Whole Society
Gross Supply Energy Carriers
3,400
1,000
J-EC therm
J-EC electr
50
190
2,630
90
510
200
-
-
20
90
12
negl
15
negl
-
230
-
200
160
negl
End Uses
Desirability
Rest of Society
J-EC therm
J-EC electr
2,990
850
Energy Sector
210
80
J-EC therm
J-EC electr
11*
1*
83*
40*
22*
8*
-
-
5*
1*
2*
1*
2*
1*
16*
8*
12*
6*
58*
14*
Viability
losses
J-EC therm
J-EC electr
200
70
autocatalytic loop
Spain 2004

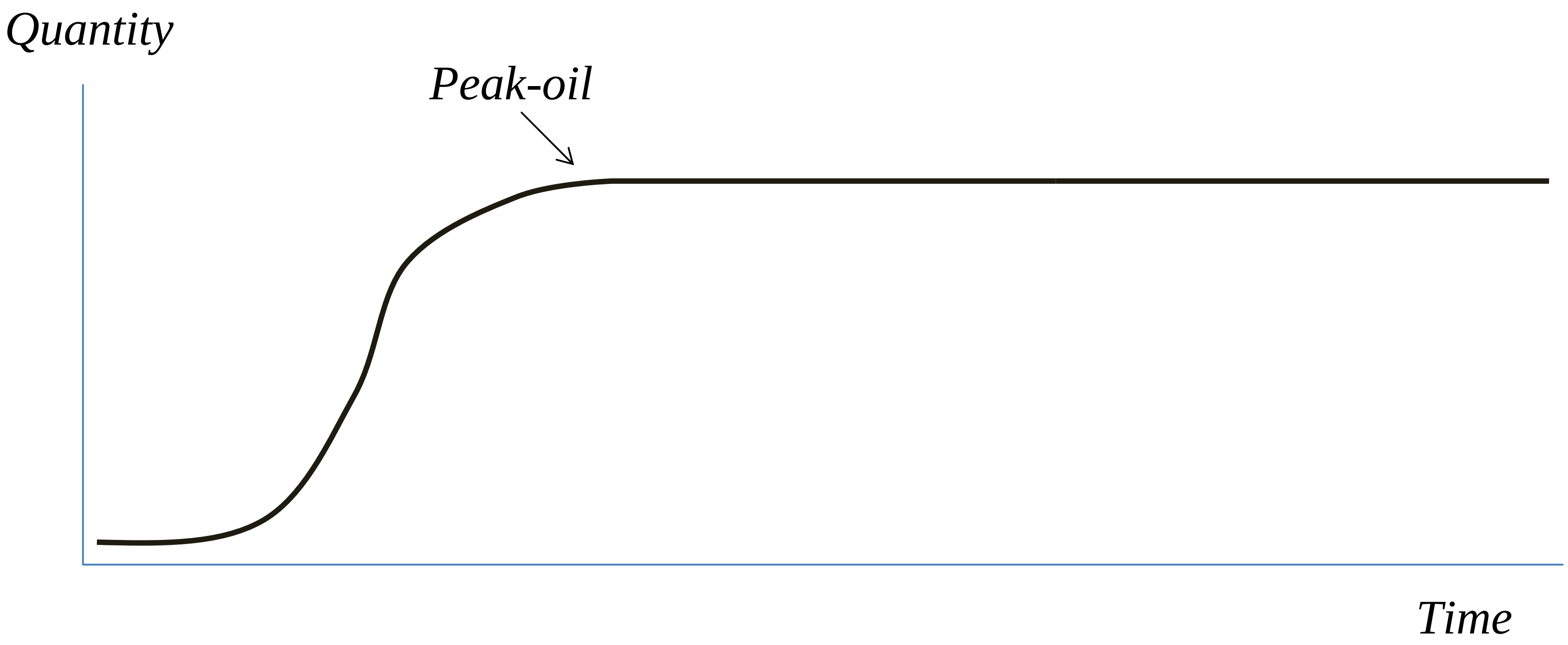
Hubbert's Peak

In 1956 M. K. Hubbert delivered his famous speech at Shell



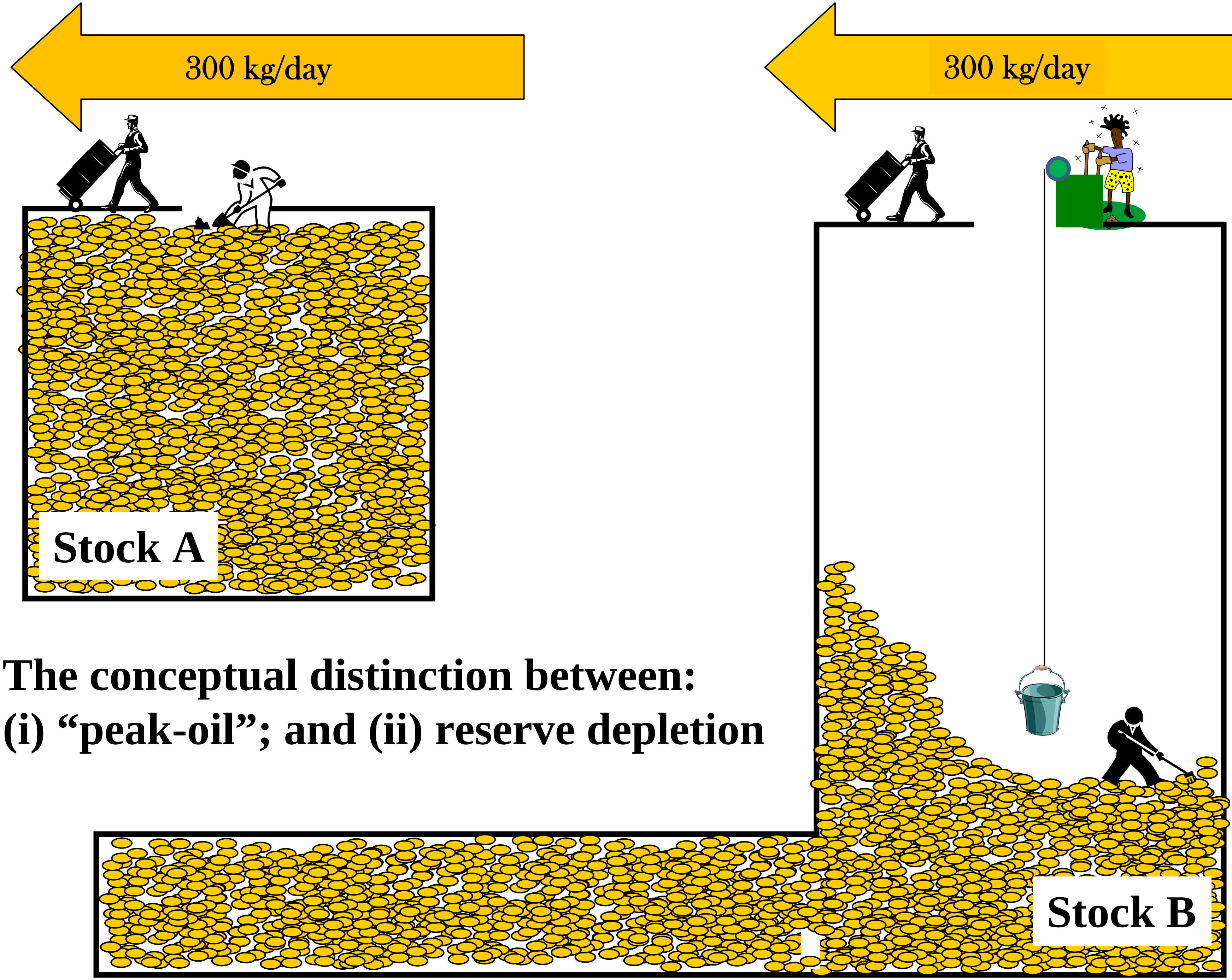


Peak-oil **is not only about** “the end of the supply of fossil energy”

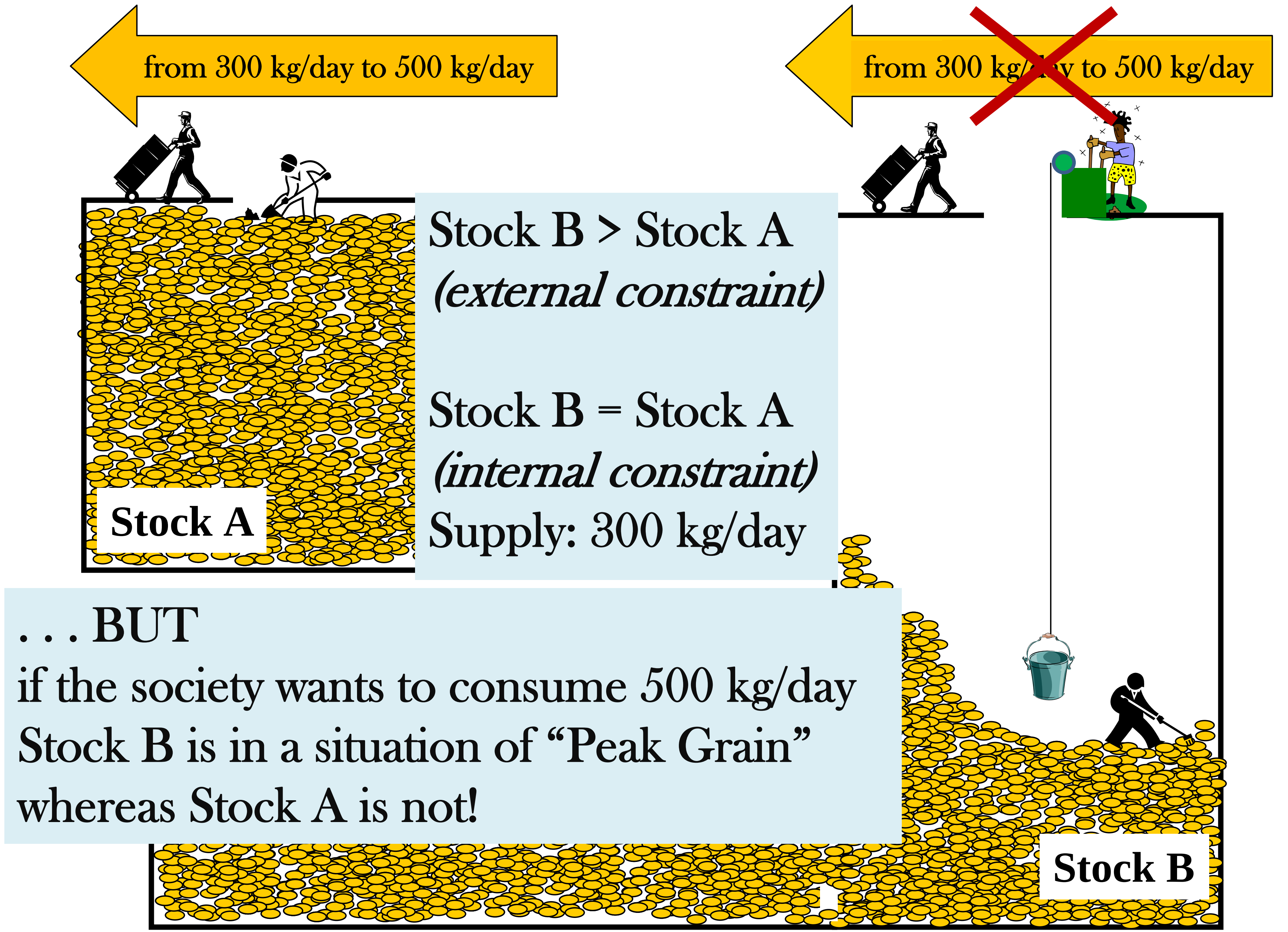


According to Hubbert **Peak oil** is the point in time when the maximum rate of extraction of petroleum is reached . . .

Peak-oil **is about** “the end of conventional economic growth”



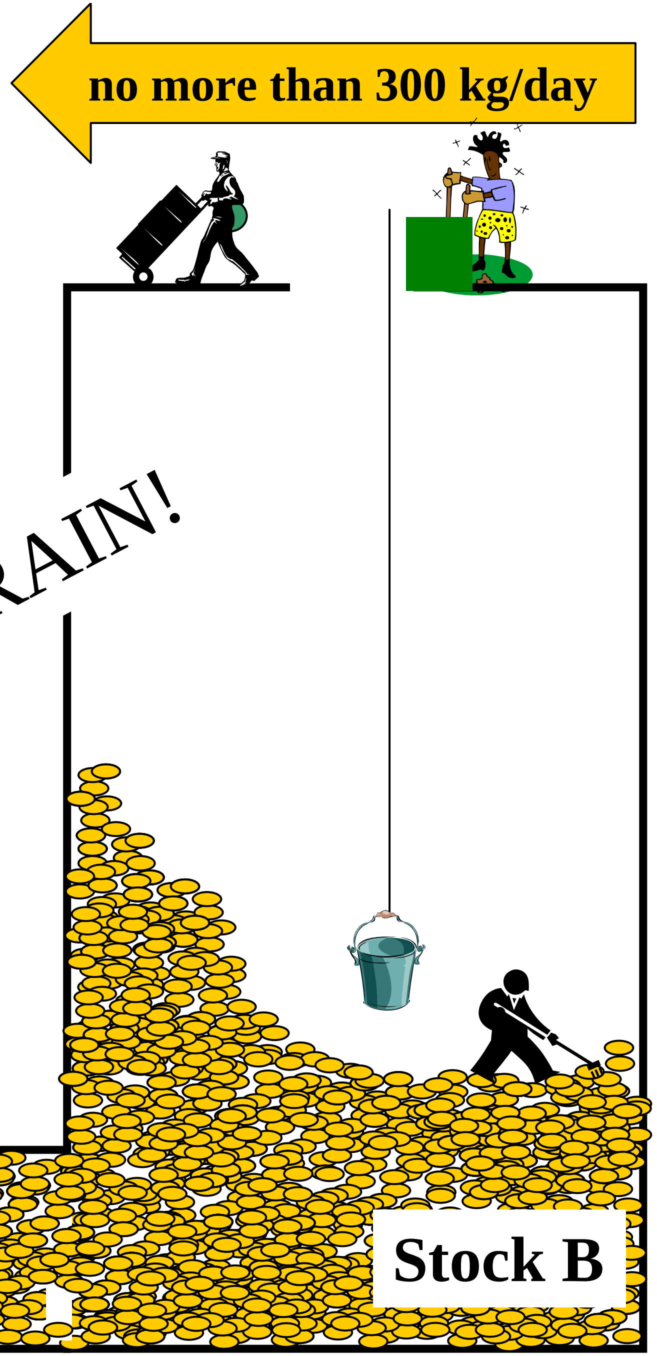
The conceptual distinction between:
(i) "peak-oil"; and (ii) reserve depletion

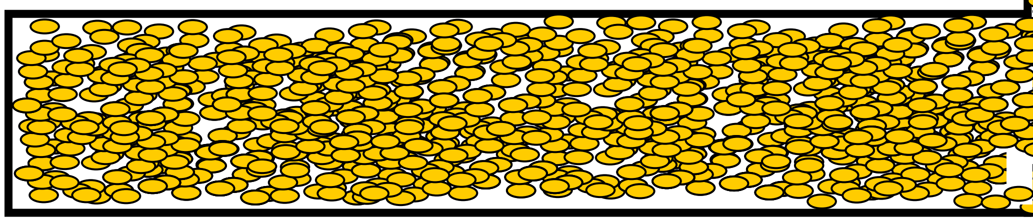

from 300 kg/day to 500 kg/day
from 300 kg/day to 500 kg/day
Stock B > Stock A
(external constraint)
Stock B = Stock A
(internal constraint)
Supply: 300 kg/day
Stock A
. . . BUT
if the society wants to consume 500 kg/day
Stock B is in a situation of "Peak Grain"
whereas Stock A is not!
Stock B

Feeding a growing village made up of this type of households

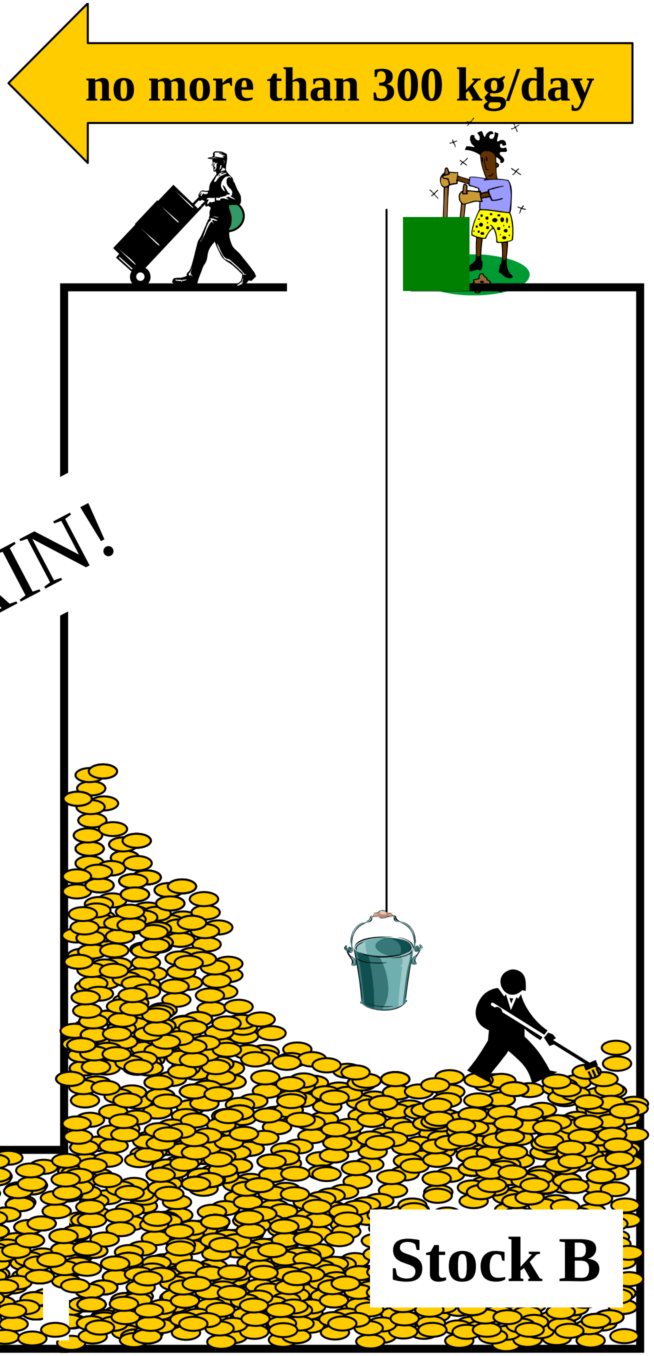
NO PEAK-GRAIN!

The systemic ambiguity about the definition of "peak-oil" . . .





Feeding a growing village made up of this type of households



The systemic ambiguity about the definition of "peak-oil" . . .

Illustrating the systemic problems faced when studying the Net Energy Analysis as a simple output/input ratio

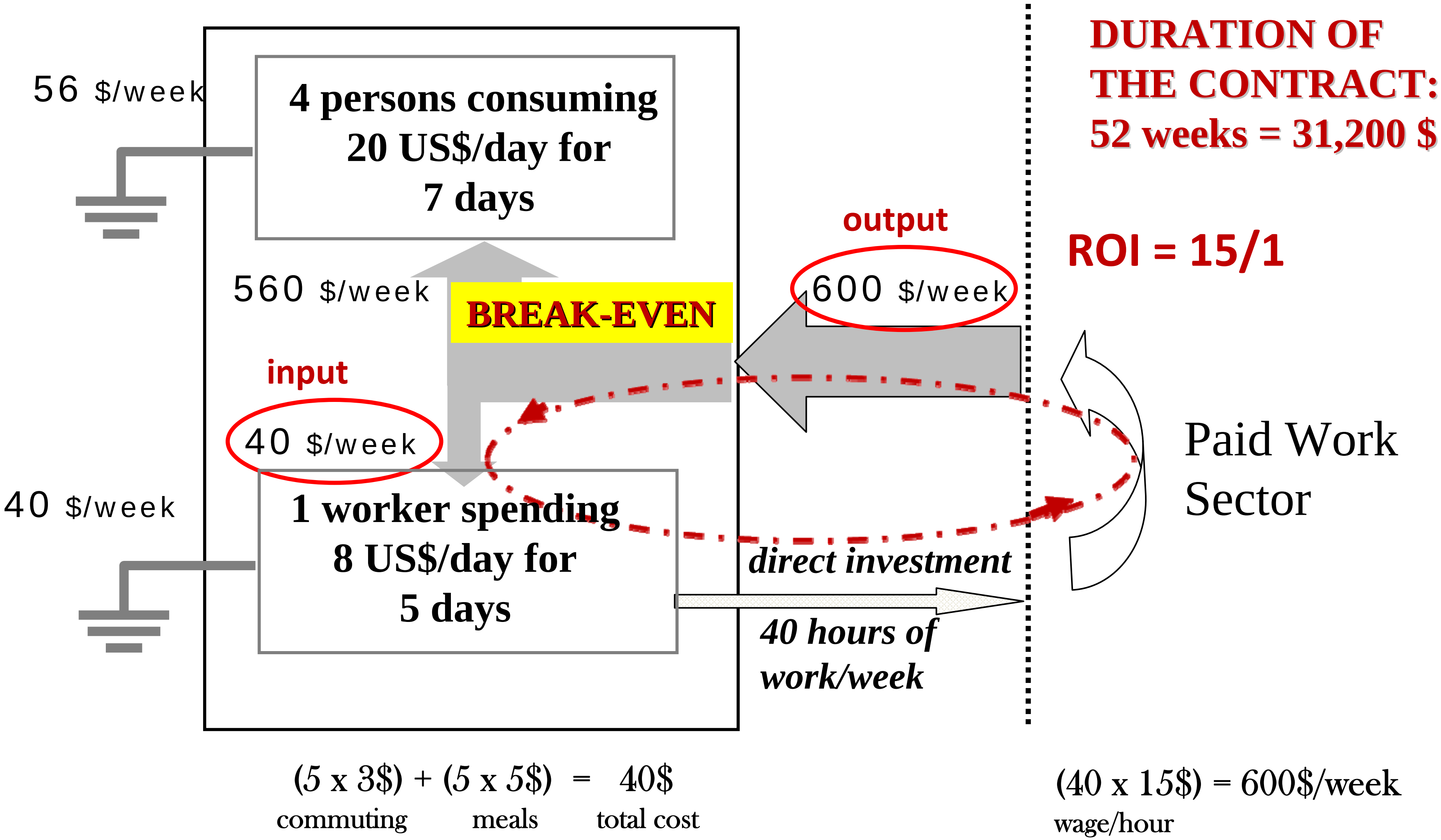
Using the analogy with the Economic Return On Investment we can look at the dynamic budget of money of a household:

In the analogy:

* JOB = a source of income for the family;
* Investment = the money spent to work
* Return on the investment = the salary

The question: is the EROI useful to assess the quality of a Job as source of income?

The dynamic economic budget of a household of *n* people:
1 housekeeper + *x* children + 1 breadwinner (JOB → paid work)



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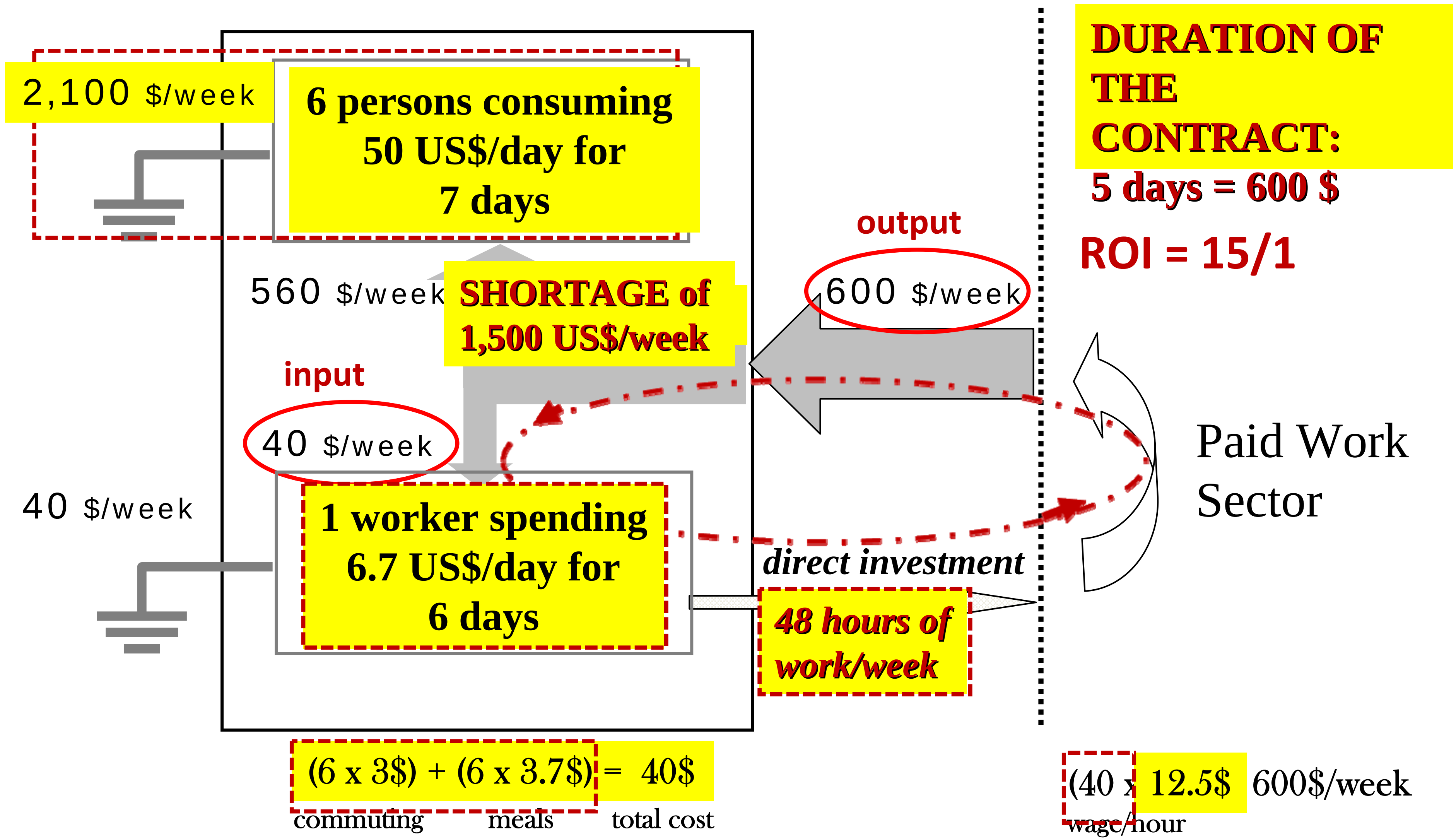
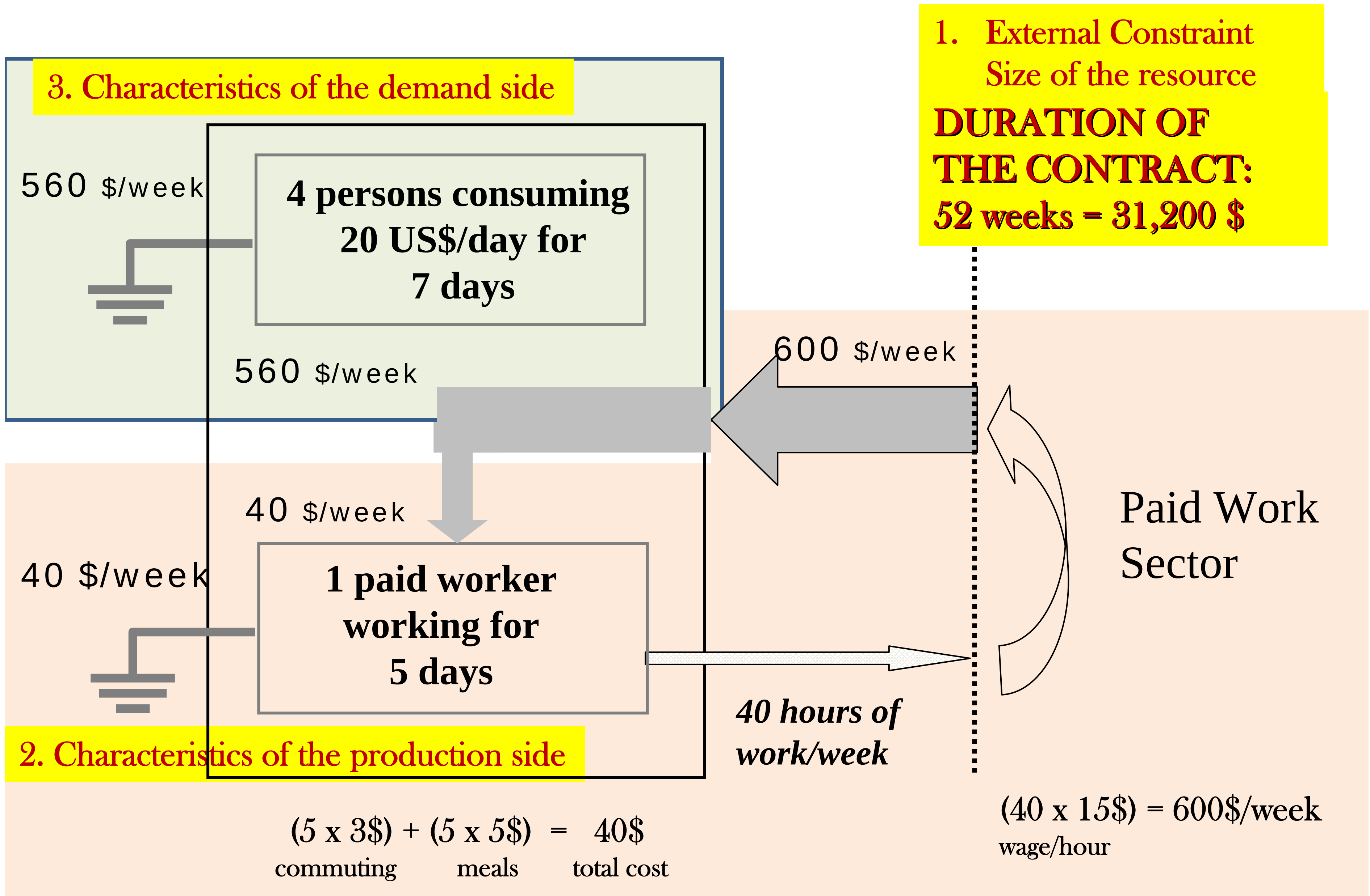
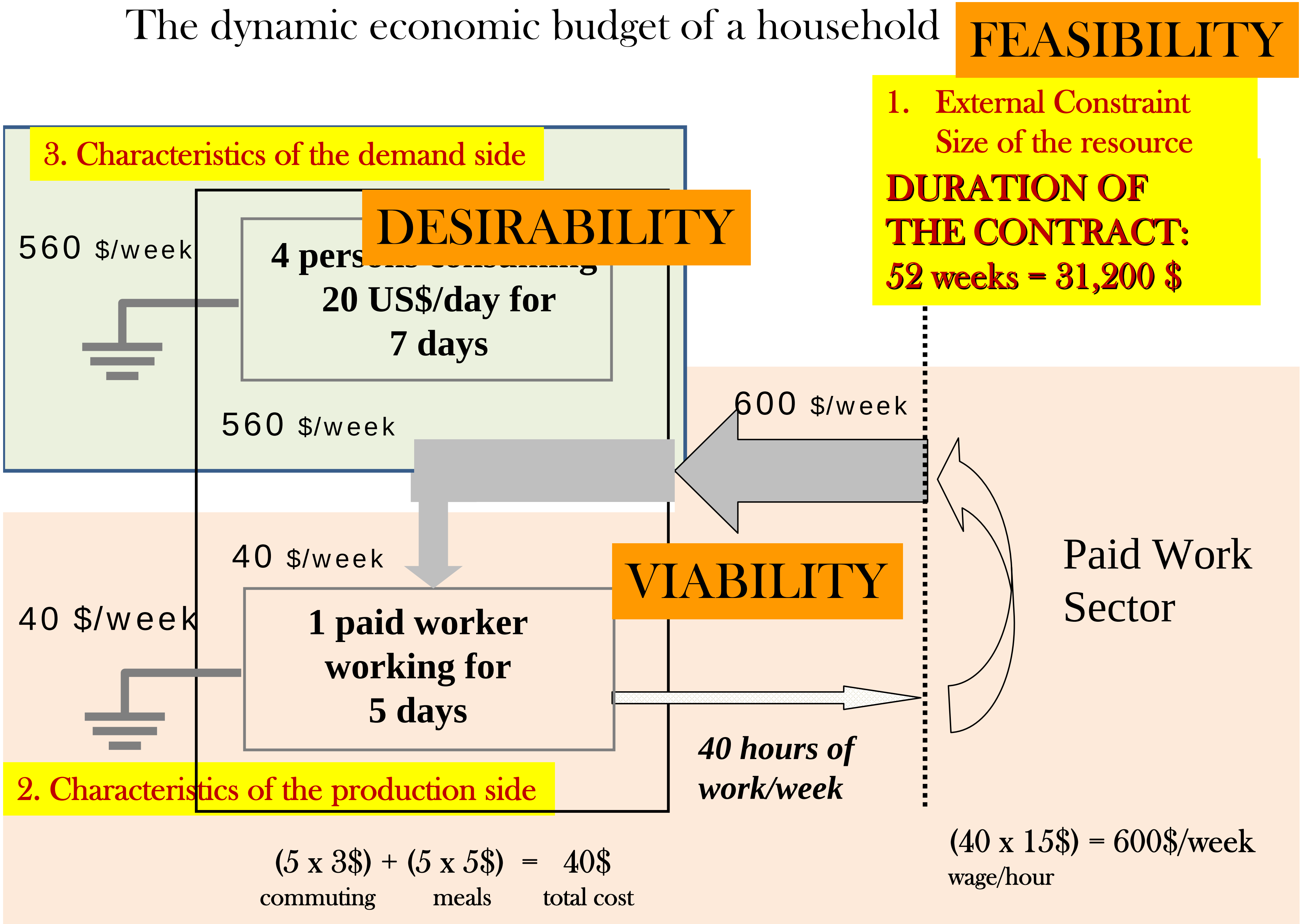


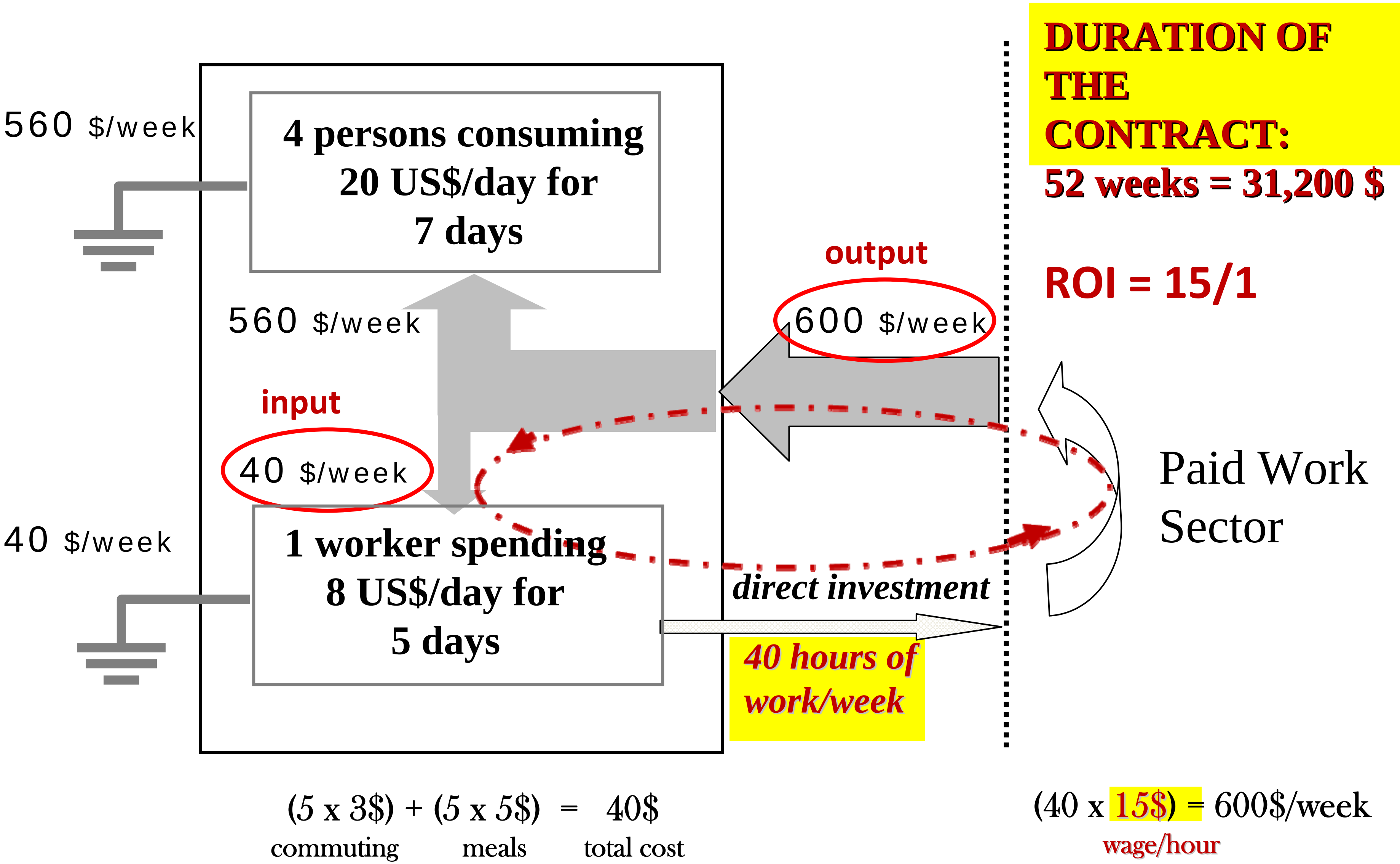
The dynamic economic budget of a household

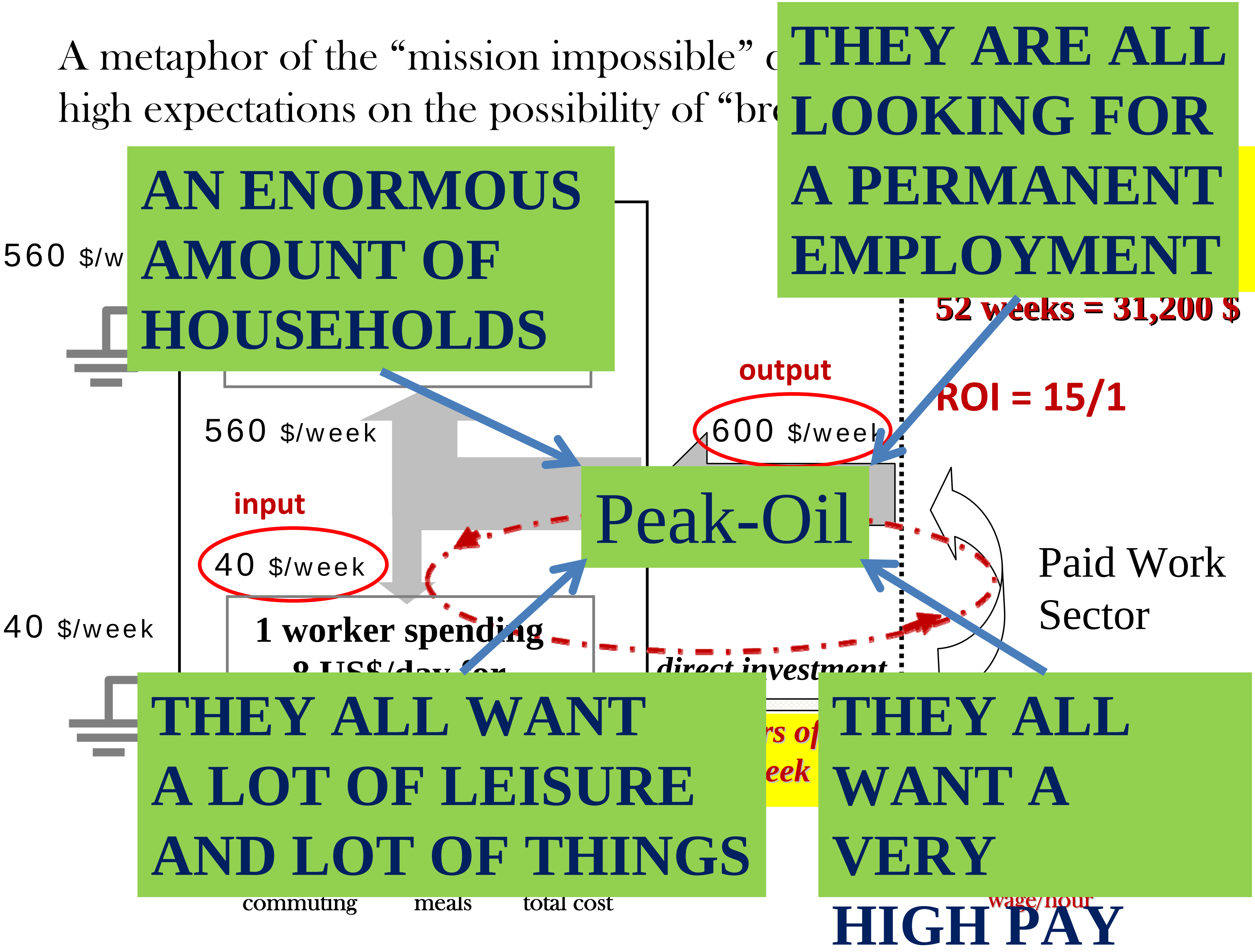


The dynamic economic budget of a household



A metaphor of the "mission impossible" determined by high expectations on the possibility of "breaking even"




A metaphor of the "mission impossible" c
high expectations on the possibility of "bre
THEY ARE ALL LOOKING FOR A PERMANENT EMPLOYMENT
AN ENORMOUS AMOUNT OF HOUSEHOLDS
560 $/w
52 weeks = 31,200 $
output
ROI = 15/1
560 $/week
600 $/week
input
40 $/week
Peak-Oil
Paid Work Sector
40 $/week
1 worker spending
direct investment
THEY ALL WANT A LOT OF LEISURE AND LOT OF THINGS
THEY ALL WANT A VERY HIGH PAY
commuting
meals
total cost

PROBLEMS IF WE LOOK ONLY AT THE "EROI"

Conceptual problem #1

It misses the characteristics of the production side (pattern of production) on the internal view VIABILITY

The same EROI (e.g.15/1) can be good or bad depending on the productivity of production factors:
(1) what is the wage;
(2) how much labor is required to obtain the income;
(3) the productivity and maintenance of the worker

PROBLEMS IF WE LOOK ONLY AT THE “EROI”
Conceptual problem #2

It misses the implications of external constraints
FEASIBILITY

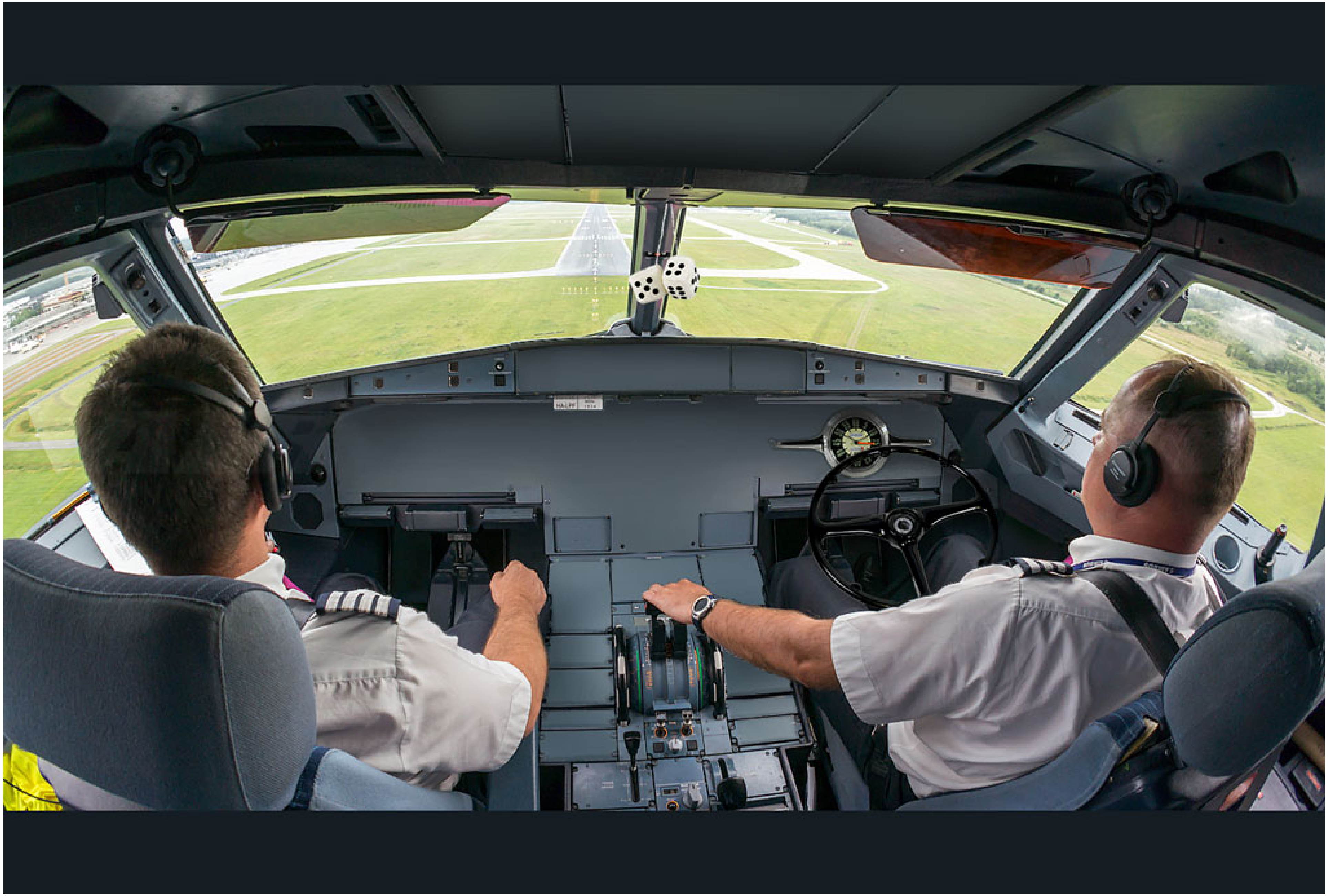
The same EROI (e.g.15/1) can be referring to resources to be exploited of different size:
(1)The job you are considering is for 1 week
(2)The job you are considering is for 1 year

PROBLEMS IF WE LOOK ONLY AT THE “EROI”
Conceptual problem #3

It misses the characteristics of the demand side (pattern of consumption) on the internal view DESIRABILITY

The same EROI (e.g.15/1) can be good or bad depending on the type of metabolic pattern
The dynamic budget production ←→ consumption can be in good shape or in bad shape:
(1)a family of 4 people;
(2)a single
(3)a family of 6 people

The amount of controls and commands needed by a pilot



Would you fly on this airplane?

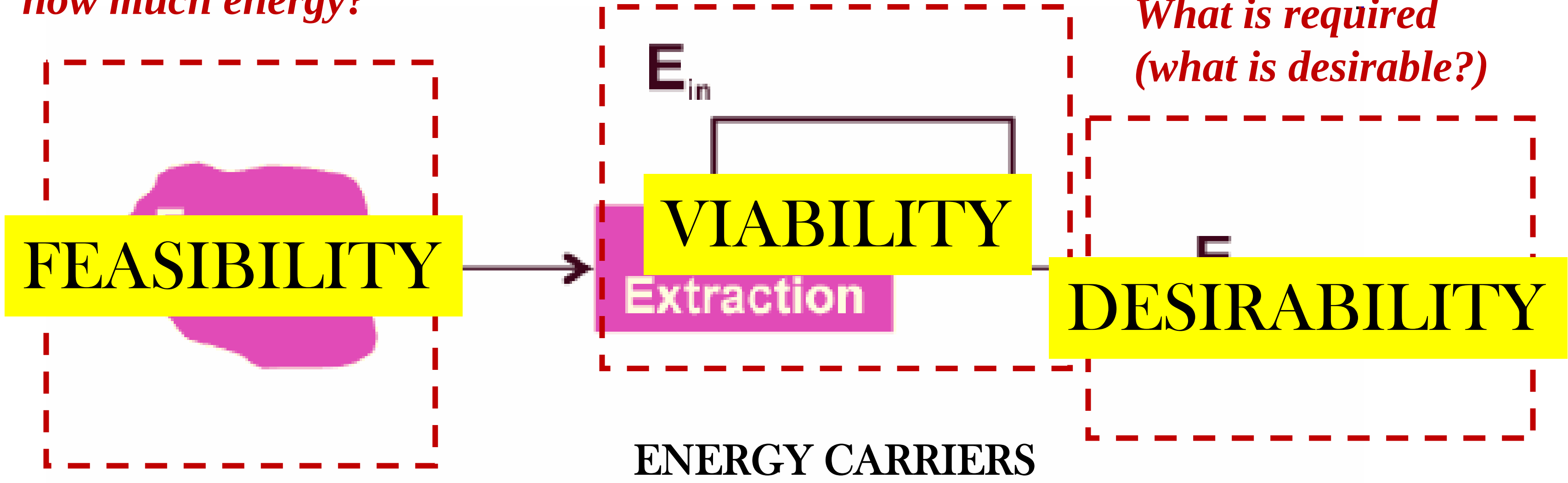
2. The dynamic energy budget of society and the SUDOKU effect

Doing the same type of analysis
of the economic dynamic budget of a
household to a biophysical analysis of
the metabolic pattern of energy
of a socio-economic system

External Constraints
how much energy?

Internal Constraints
what are the implications of the internal loop?

Uses inside Society
What is required (what is desirable?)



PRIMARY ENERGY SOURCES

- Coal
- Oil
- Uranium
- Wind
- Hydropower
- etc.

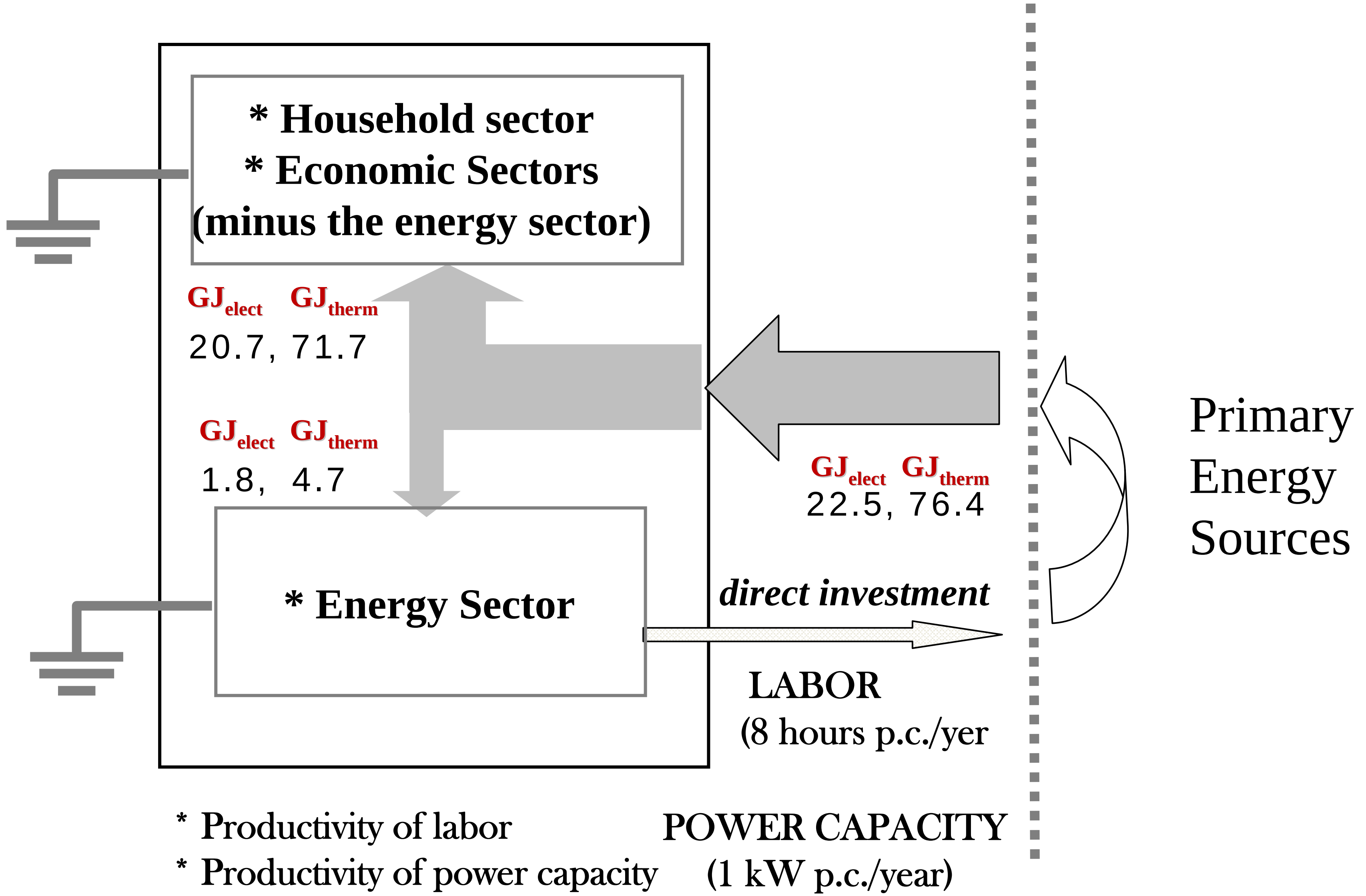
ENERGY CARRIERS

- Electricity
- Fuels
- Process heat

END USES

- energy services expressing required functions

Exosomatic dynamic budget of SPAIN – values p.c. per year:
FUNDS [HA: 8,760 hours; PC: 38 kW] – FLOWS [22.5 GJ_{elect}; 76.4 GJ_{therm}]



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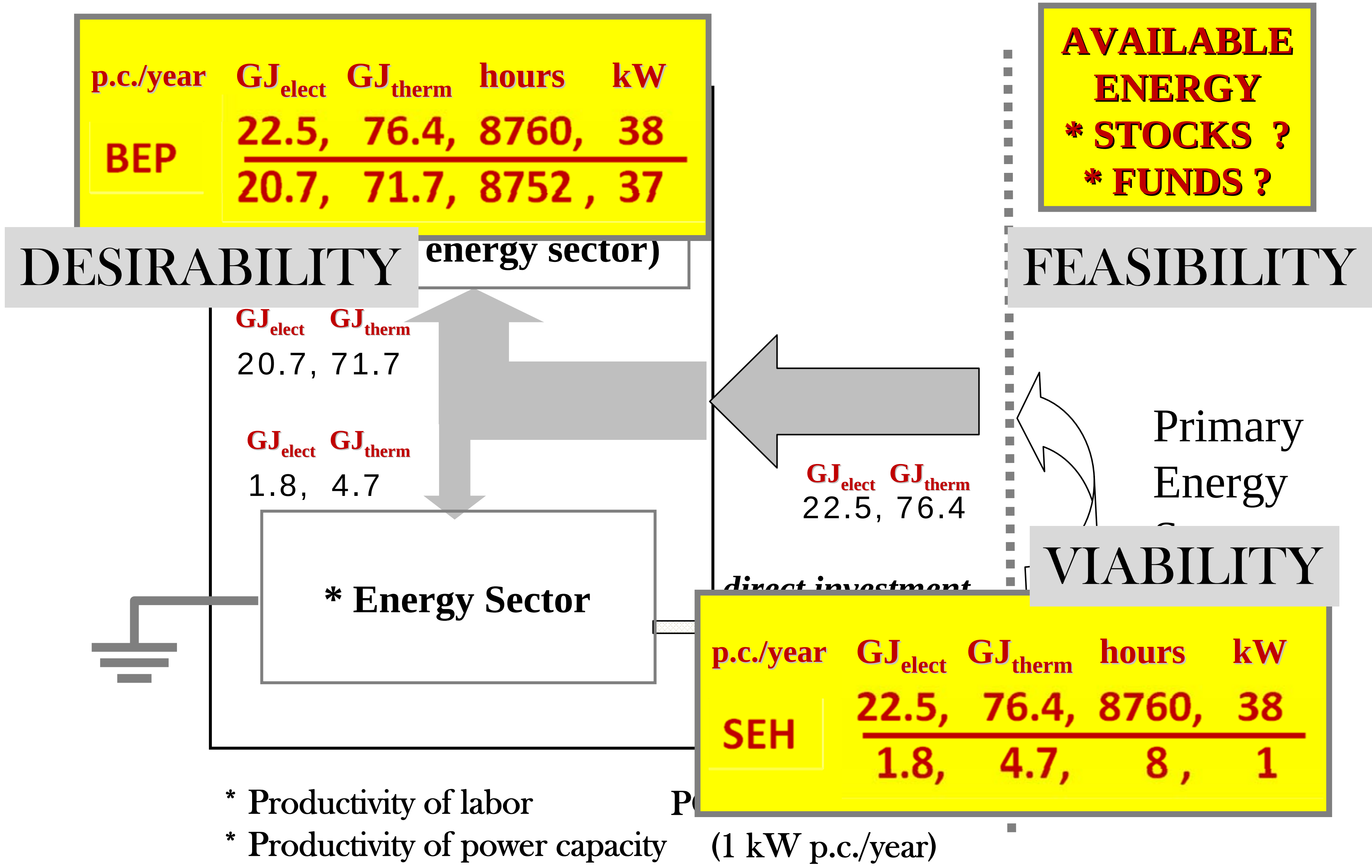
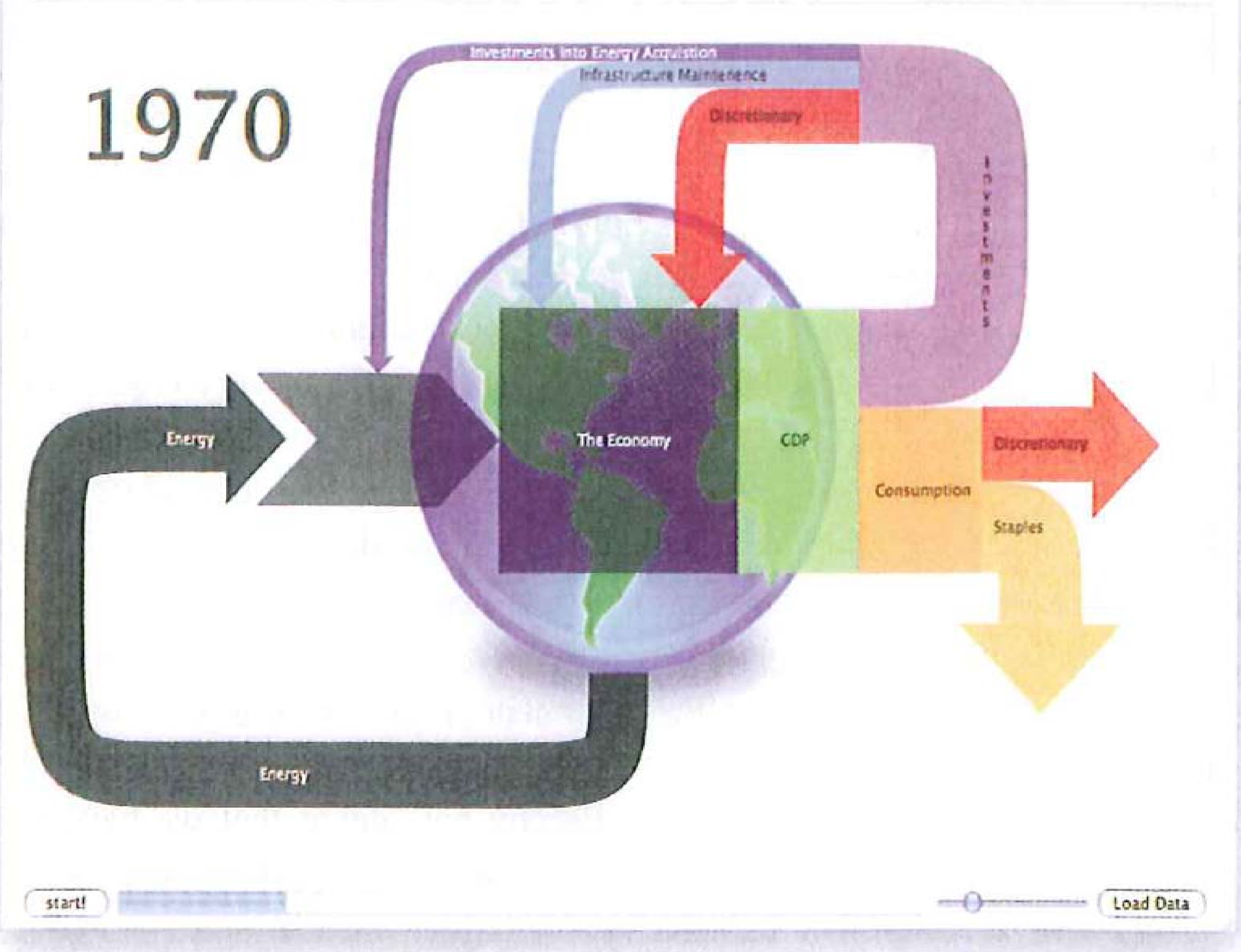


The cheese-slicer – the narrative proposed by Charlie Hall



Hall C.A.S. and Klitgaard K.A. 2011 Energy and the Wealth of Nations: Understanding the Biophysical Economy

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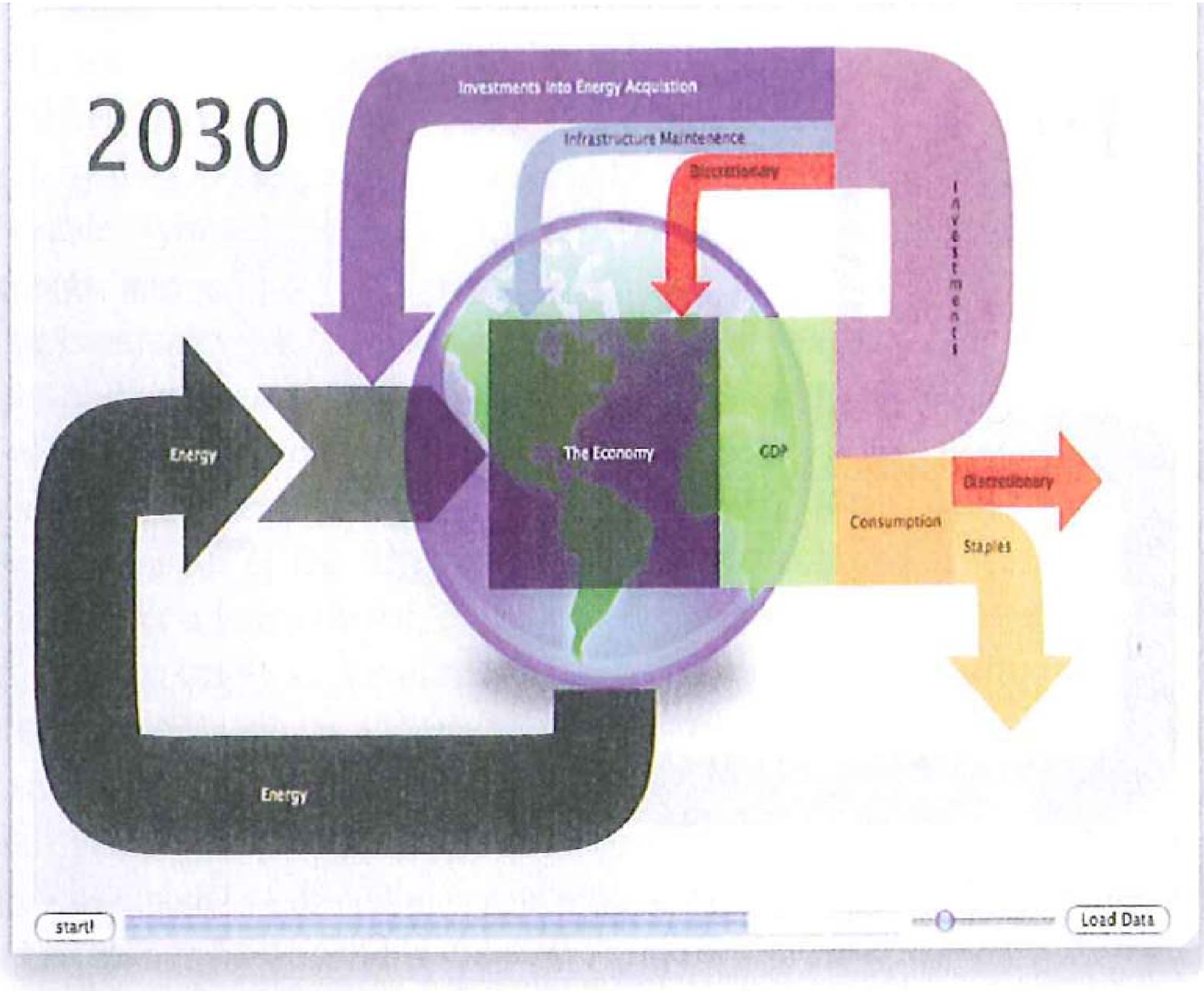

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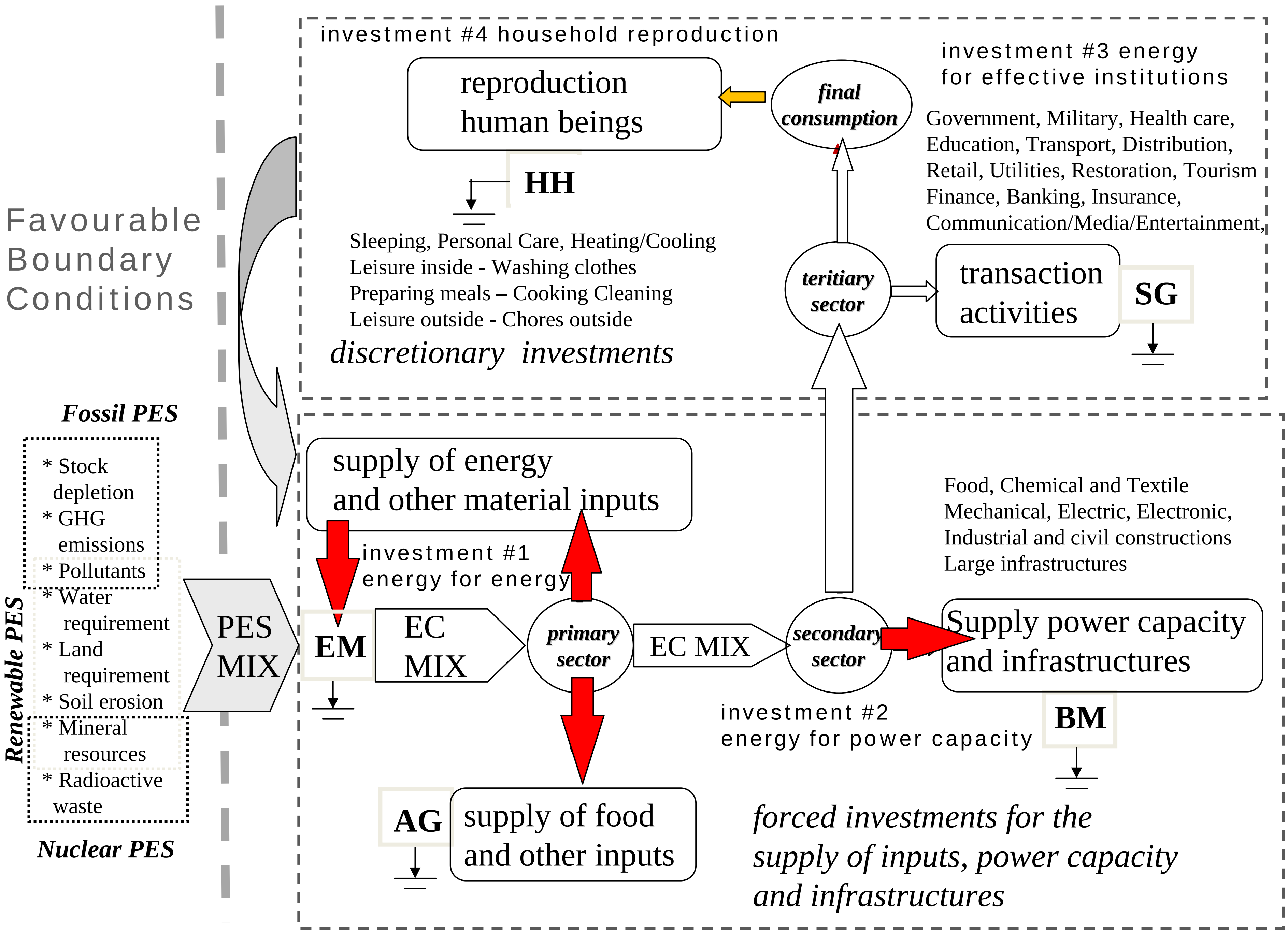
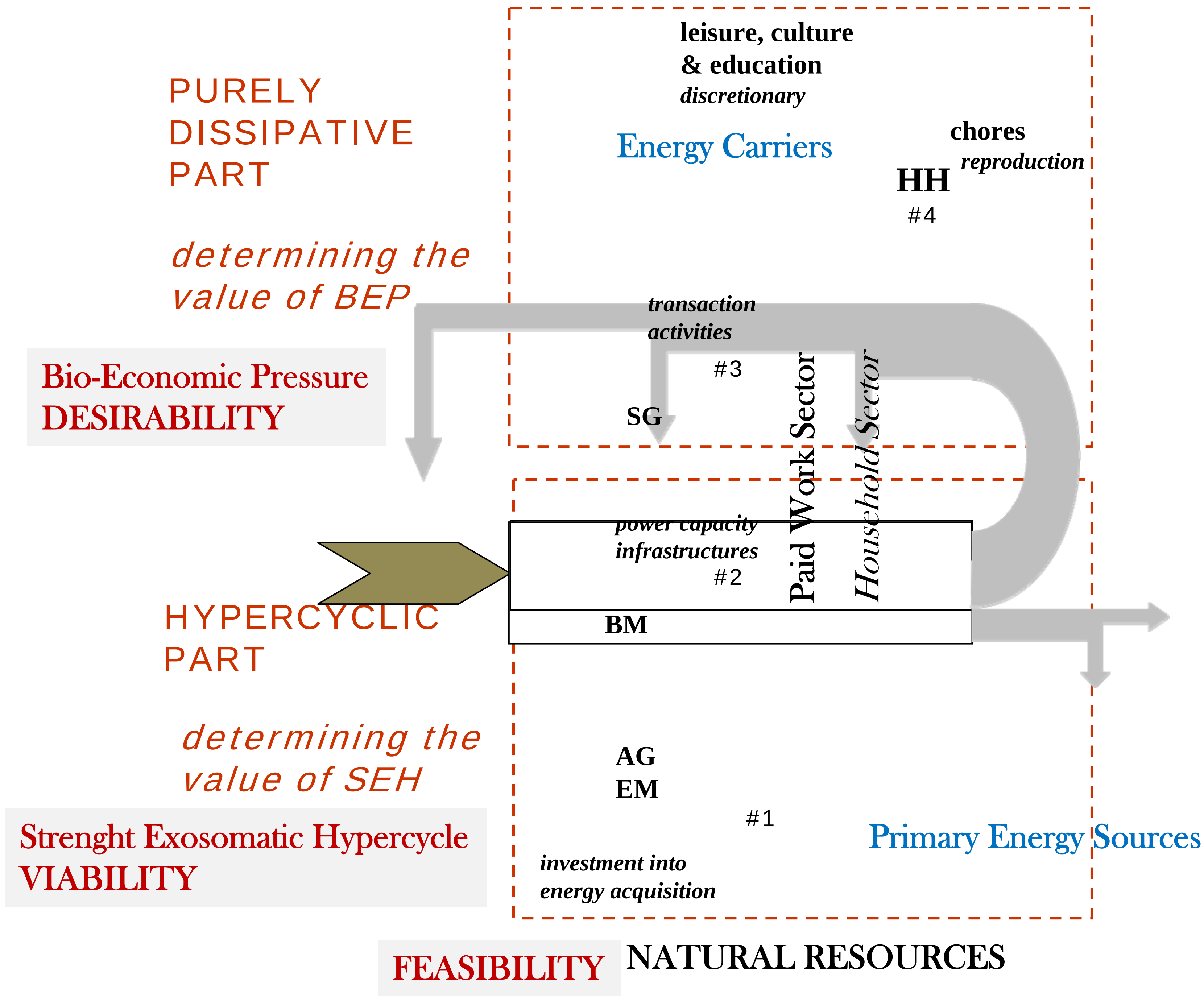
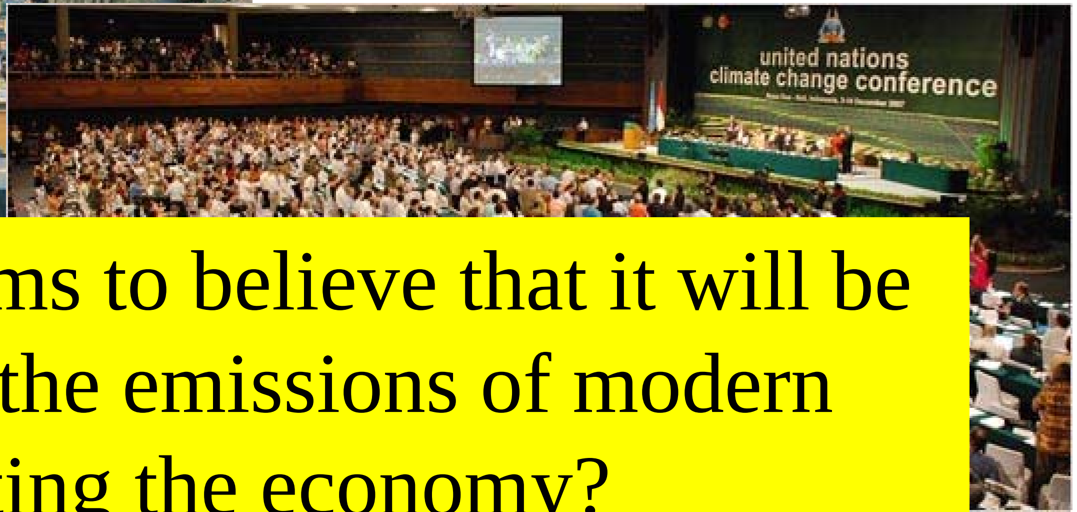

investment #4 household reproduction
reproduction human beings
final consumption
investment #3 energy for effective institutions
Government, Military, Health care, Education, Transport, Distribution, Retail, Utilities, Restoration, Tourism Finance, Banking, Insurance, Communication/Media/Entertainment,
HH
Favourable Boundary Conditions
Sleeping, Personal Care, Heating/Cooling
Leisure inside - Washing clothes
Preparing meals – Cooking Cleaning
Leisure outside - Chores outside
discretionary investments
teritiary sector
transaction activities
SG
Fossil PES
supply of energy and other material inputs
Food, Chemical and Textile
Mechanical, Electric, Electronic,
Industrial and civil constructions
Large infrastructures
* Stock depletion
* GHG emissions
* Pollutants
* Water requirement
* Land requirement
* Soil erosion
* Mineral resources
* Radioactive waste
investment #1 energy for energy
Renewable PES
PES MIX
EM
EC MIX
primary sector
EC MIX
secondary sector
Supply power capacity and infrastructures
investment #2 energy for power capacity
BM
AG
supply of food and other inputs
forced investments for the supply of inputs, power capacity and infrastructures
Nuclear PES


PURELY DISSIPATIVE PART
determining the value of BEP
Bio-Economic Pressure
DESIRABILITY
leisure, culture & education
discretionary
Energy Carriers
chores
reproduction
HH
#4
transaction activities
#3
SG
Paid Work Sector
Household Sector
power capacity infrastructures
#2
BM
HYPERCYCLIC PART
determining the value of SEH
Strenght Exosomatic Hypercycle
VIABILITY
AG
EM
#1
investment into energy acquisition
Primary Energy Sources
FEASIBILITY
NATURAL RESOURCES

Would you believe someone telling you that Messi next year will eat ¼ of what he eats now while playing the same quality of football?



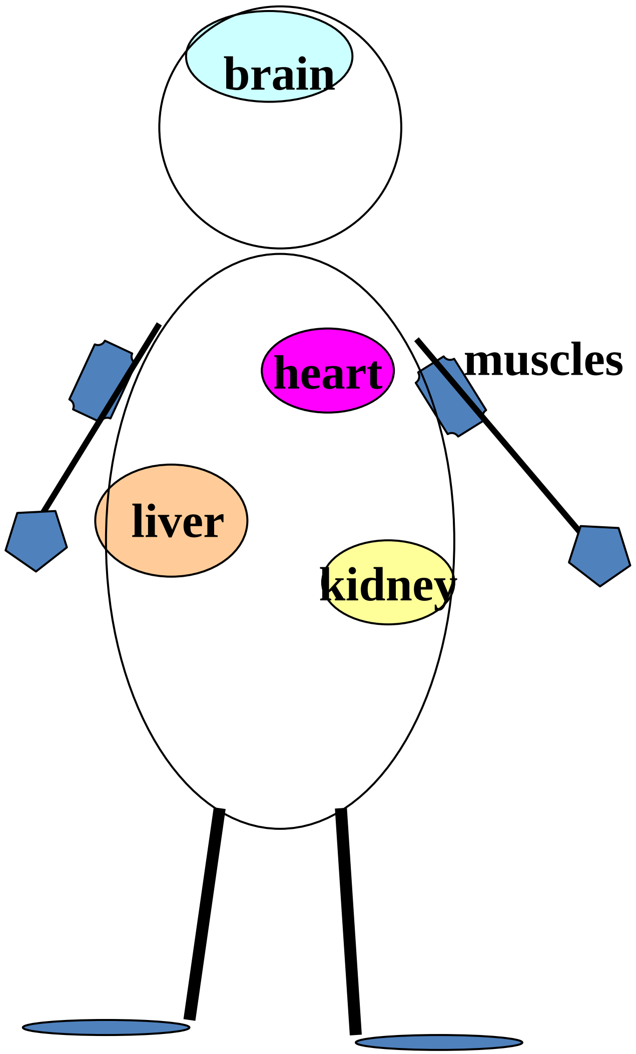
So why everybody seems to believe that it will be possible to cut 75% of the emissions of modern societies without affecting the economy?

COP15
COPENHAGEN
UN CLIMATE CHANGE CONFERENCE 2009

Since nobody seems to object to the claim
that it would be possible to cut the emission
of developed countries of 75% in two decades

humankind seems to believe that it is easier to
re-adjust the metabolic rate of a complex
socio-economic system than the metabolic rate
of a human organism (Lionel Messi)!

We don’t believe we can cut food to Messi, because we have a multi-level knowledge of human metabolism!



WHOLE MESSI level *n*

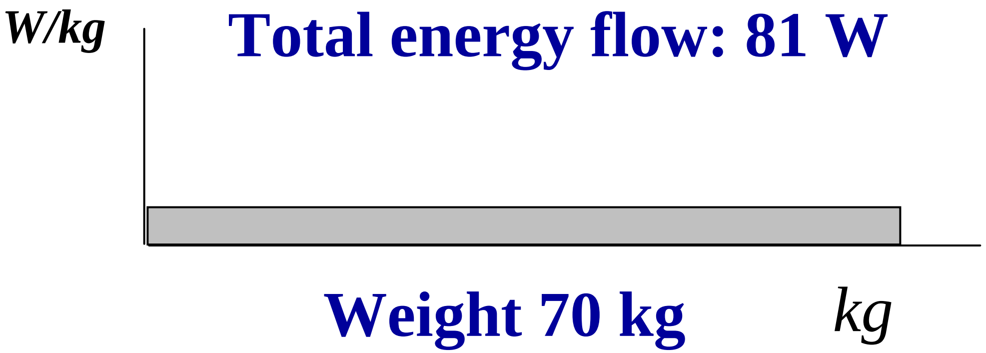
Total mass = 70 kg

Metabolic Rate = 1.16 W/kg

Endosomatic Flow = 81 W

PARTS OF MESSI level *n-1*

	kg	*W/kg*	*W*
Liver	1.8	9.7	17.4
Brain	1.4	11.6	16.2
Heart	0.3	21.3	6.4
Kidneys	0.3	21.3	6.4
Muscles	28.0	0.6	16.8
Fat	15.0	0.2	3.0
Others	23.2	0.6	14.0

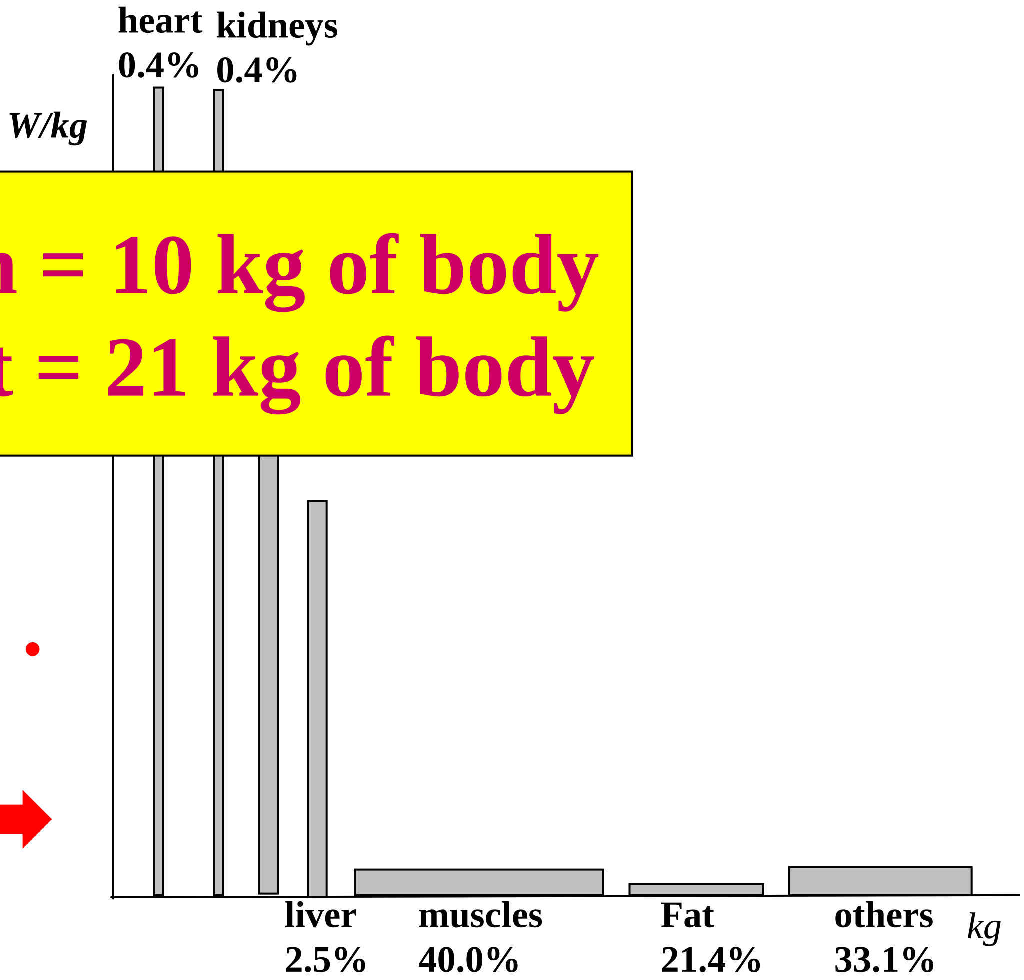


When looking at the whole

Metabolic rate: 1.2 W/kg

1 kg of brain = 10 kg of body
1 kg of heart = 21 kg of body

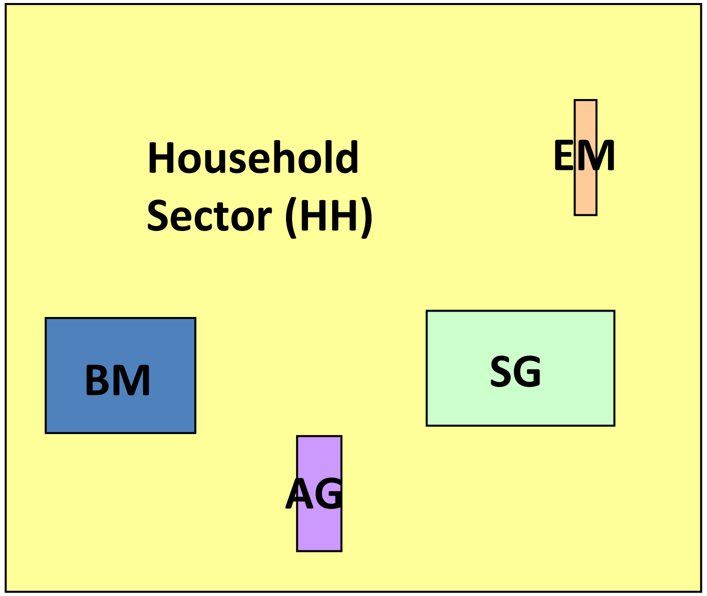
but when
inside the
not all the kg of
“body” are the same . . .



Total Human Activity 60.8 Gh (year)

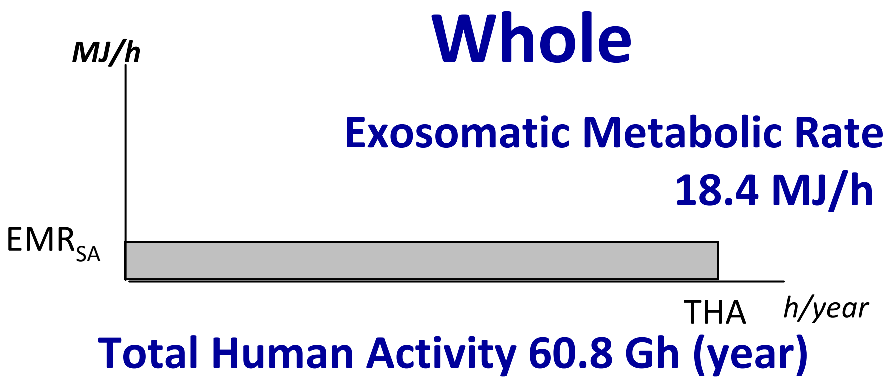
Total Energy Throughput 1,120 PJ (year)

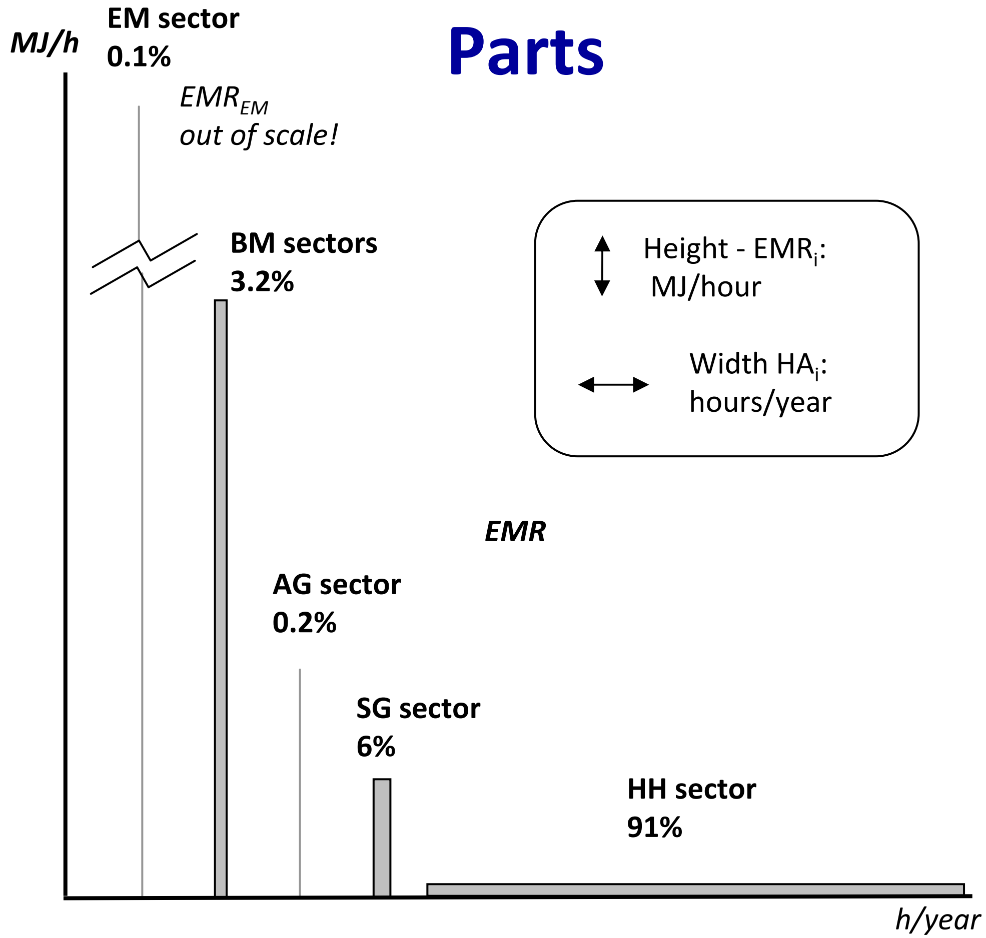
Exosomatic Metabolic Rate 18.4 MJ/h



Relative size of the compartments expressed in hours/year

CATALONIA 2005





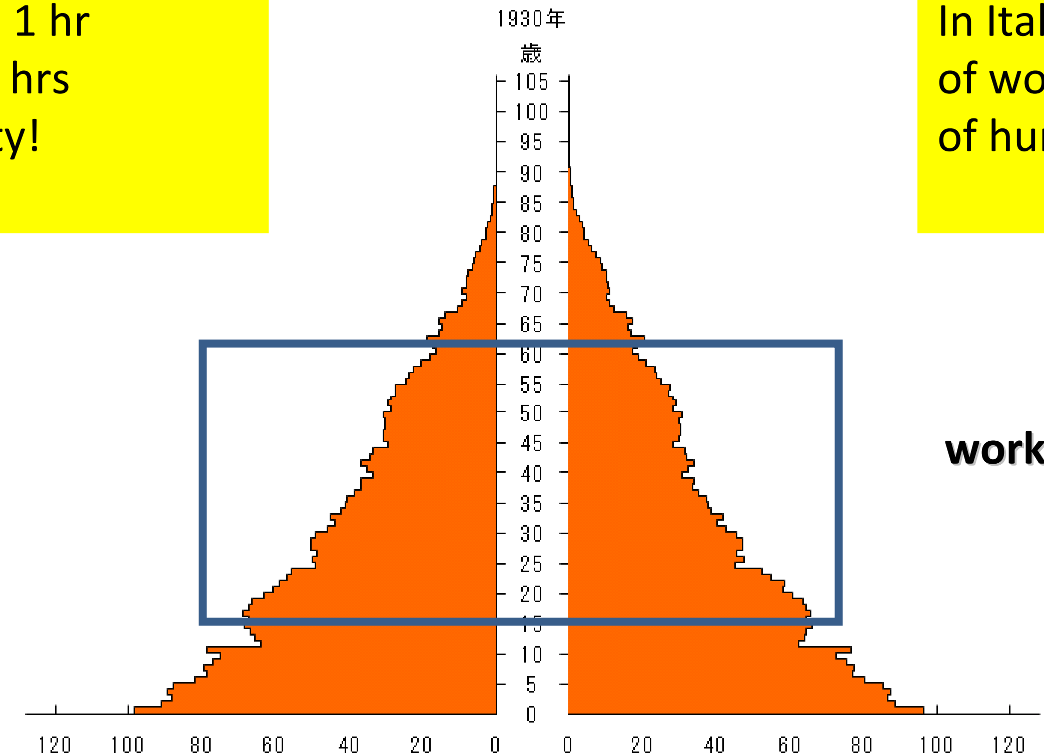
SPAIN 2007

	Product.-Consum. Factors *(Flow and Fund elements)*			Metabolic Characteristics *(Flow/Fund ratios)*		
	Energy *(GJ p.c./y)*	**Human Activity** *(hrs p.c./y)*	**Power Capactity** *(kW p.c./y)*	**Exosomatic Metabolic Rate** *(MJ/hour*	**Intensity Power Capactity** *(MJ/kW)*	
whole society	159.0	8,760	38.0	18	4.2	Level n
Household sector	44.5	7,825	27.0	6	1.6	Level n-1
Service & Government	56.5	598	7.0	94	8.1	Level n-2
Building & Manufacturing	41.0	280	1.5	146	27.3	Level n-3
Energy & Mining	13.0	8	1.0	1611	13.1	Level n-3
Agriculture	4.5	48	1.5	92	3.0	Level n-3

		Human Activity (hrs p.c./y)				
Whole society	159.0	8,760	38.0	18	4.2	**Level n**
Household sector	44.5	7,825	27.0	6	1.6	**Level n-1**

In China there is 1 hr of work out of 5 hrs of human activity!

In Italy there is 1 hr of work out of 13 hrs of human activity!

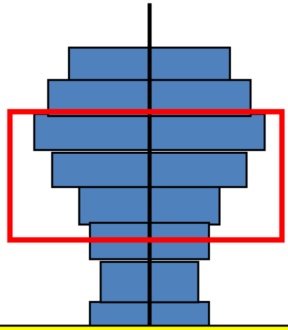


work force

Population structure of Japan

The work supply to the economy in hours per capita . . .

ITALY

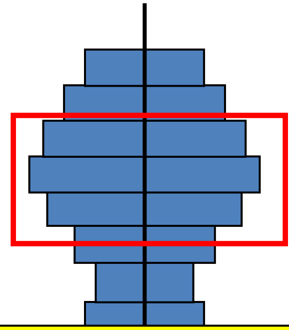


p

13 hours consuming
1 hour producing

680 hours of work
per capita per year

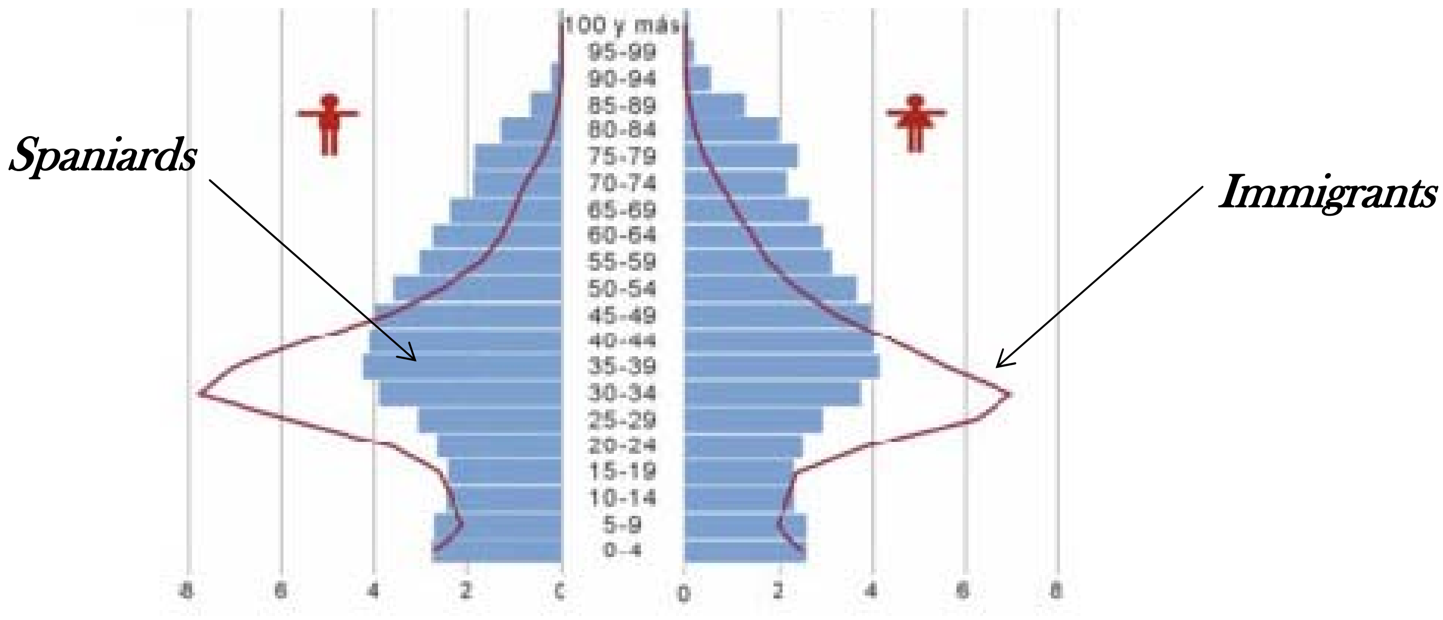
CHINA



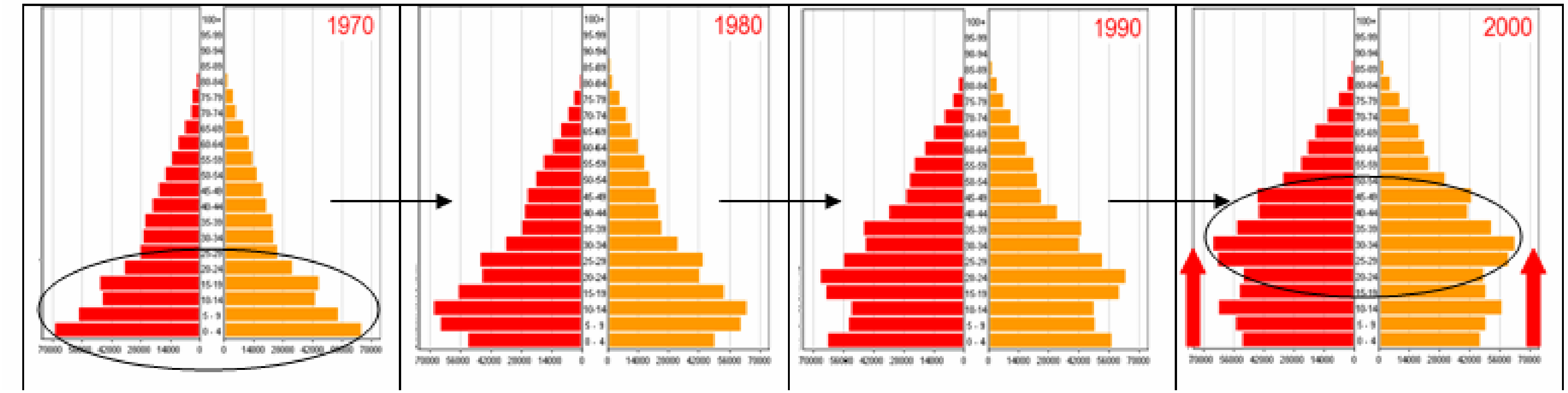
5 hours consuming
1 hour producing

1,650 hours of work
per capita per year

Population pyramid: Spaniards versus Immigrants

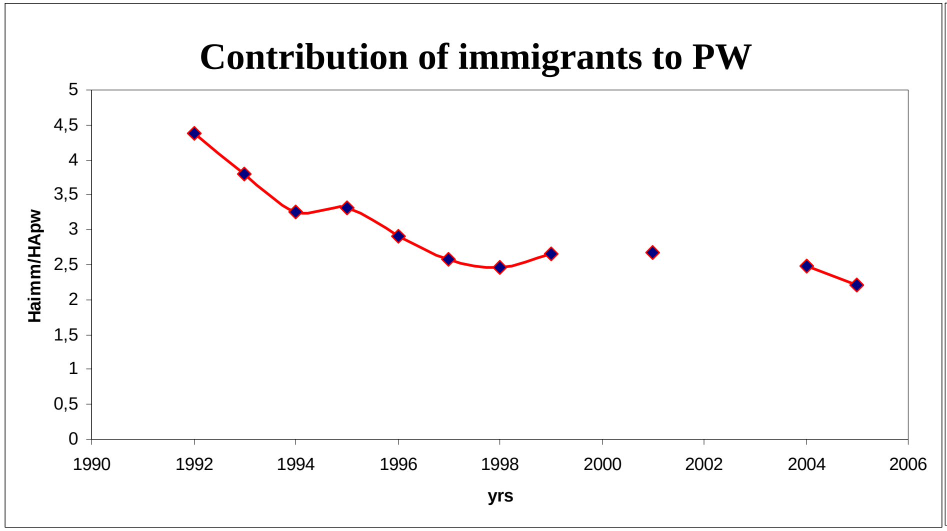


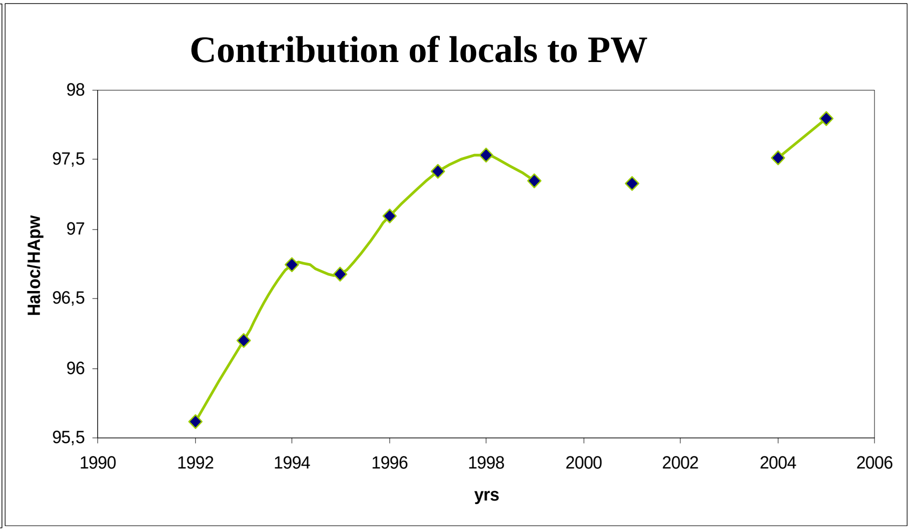
Source: Censo de Población y Viviendas 2011



Lag-times and waves . . . changes in demographic structure of China 1970-2000

The change in time of the net supply of hours of working time
of Turkish immigrants in the PW sector of German economy

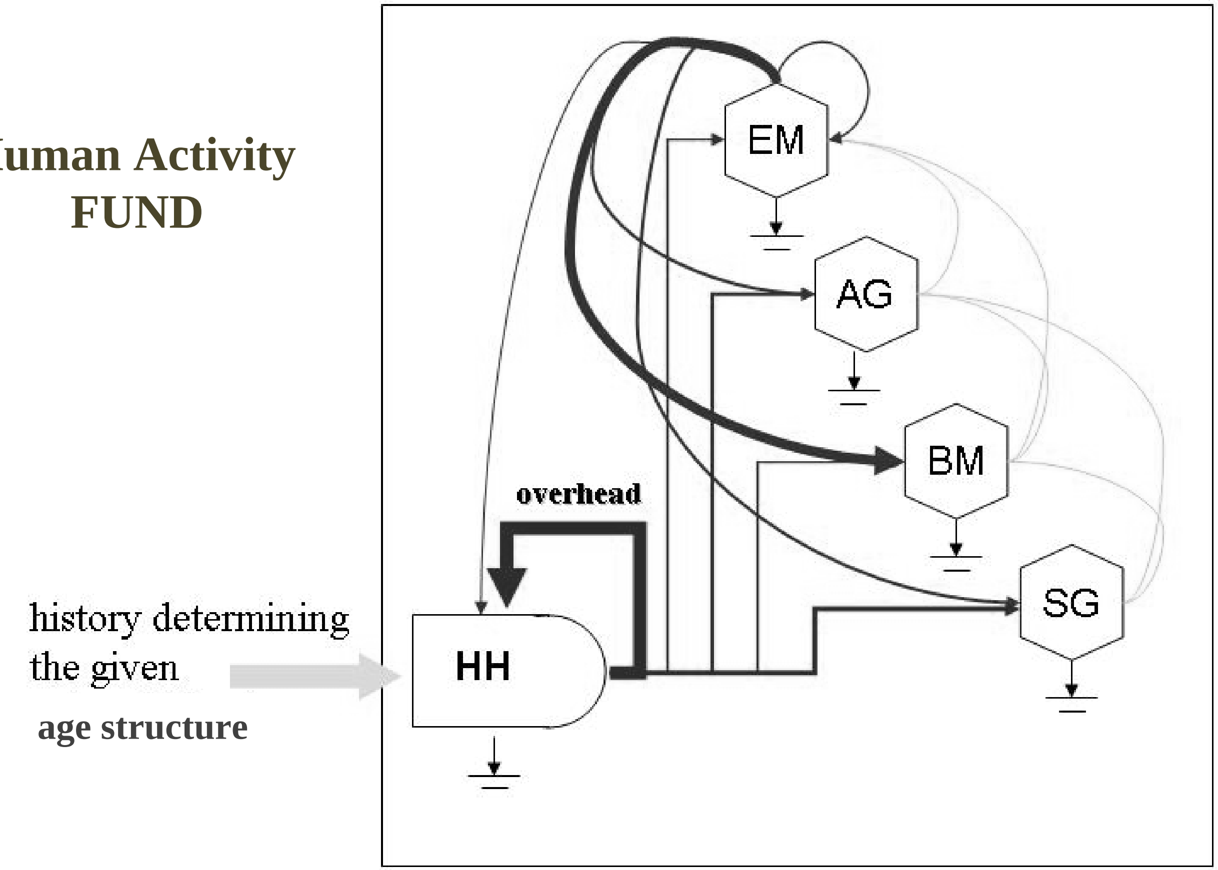


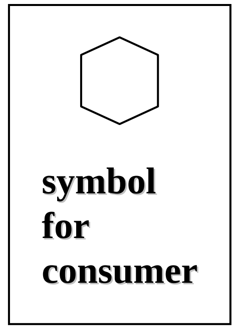


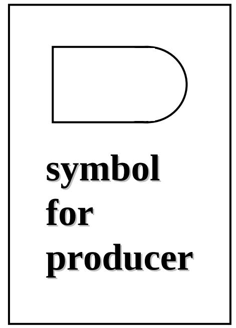
Checking the congruence between demand and supply of human activity

Human Activity FUND

Socio-economic metabolic pattern







A large fraction of the total of Human Activity is required to reproduce Human Activity: ***dependent population***, ***physiological overhead***, ***leisure***

	Product.-Consum. Factors *(Flow and Fund elements)*			Metabolic Characteristics *(Flow/Fund ratios)*		
	Energy *(GJ p.c./y)*	Human Activity *(hrs p.c./y)*	Power Capactity *(kW p.c./y)*	Exosomatic Metabolic Rate *(MJ/hour*	Intensity Power Capactity *(MJ/kW)*	
Household sector	44.5	7,825	27.0	6	1.6	Level n-1

from 6 hrs/week
to 2 hrs/week

from 6 hrs/day
to 40 minutes!

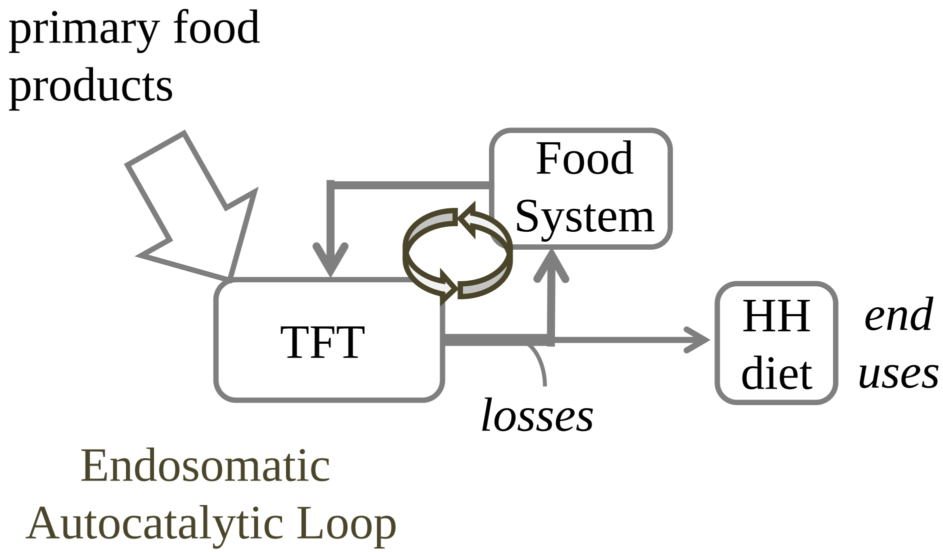
commuting
shopping
leisure

Labor time in the Household

SPAIN 2007

	Product.-Consum. Factors *(Flow and Fund elements)*			Metabolic Characteristics *(Flow/Fund ratios)*		
	Energy *(GJ p.c./y)*	Human Activity *(hrs p.c./y)*	Power Capactity *(kW p.c./y)*	Exosomatic Metabolic Rate *(MJ/hour*	Intensity Power Capactity *(MJ/kW)*	
whole society	159.0	8,760	38.0	18	4.2	Level n
Household sector	44.5	7,825	27.0	6	1.6	Level n-1
Service & Government	56.5	598	7.0	94	8.1	Level n-2
Building & Manufacturing	41.0	280	1.5	146	27.3	Level n-3
Energy & Mining	13.0	8	1.0	1611	13.1	Level n-3
Agriculture	4.5	48	1.5	92	3.0	Level n-3

Endosomatic Energy FLOW



A fraction of the total of flow of Food Products is required to produce Food Products: ***seeds***, ***eggs***, ***feed***

In addition the stabilization of the food supply requires also:
**** FUNDS: labor, land and capital*** and ***FLOWS: energy carriers, water use***
*** Natural Processes outside human control** (solar radiation, soil, rain, pollination, biodiversity, etc.)

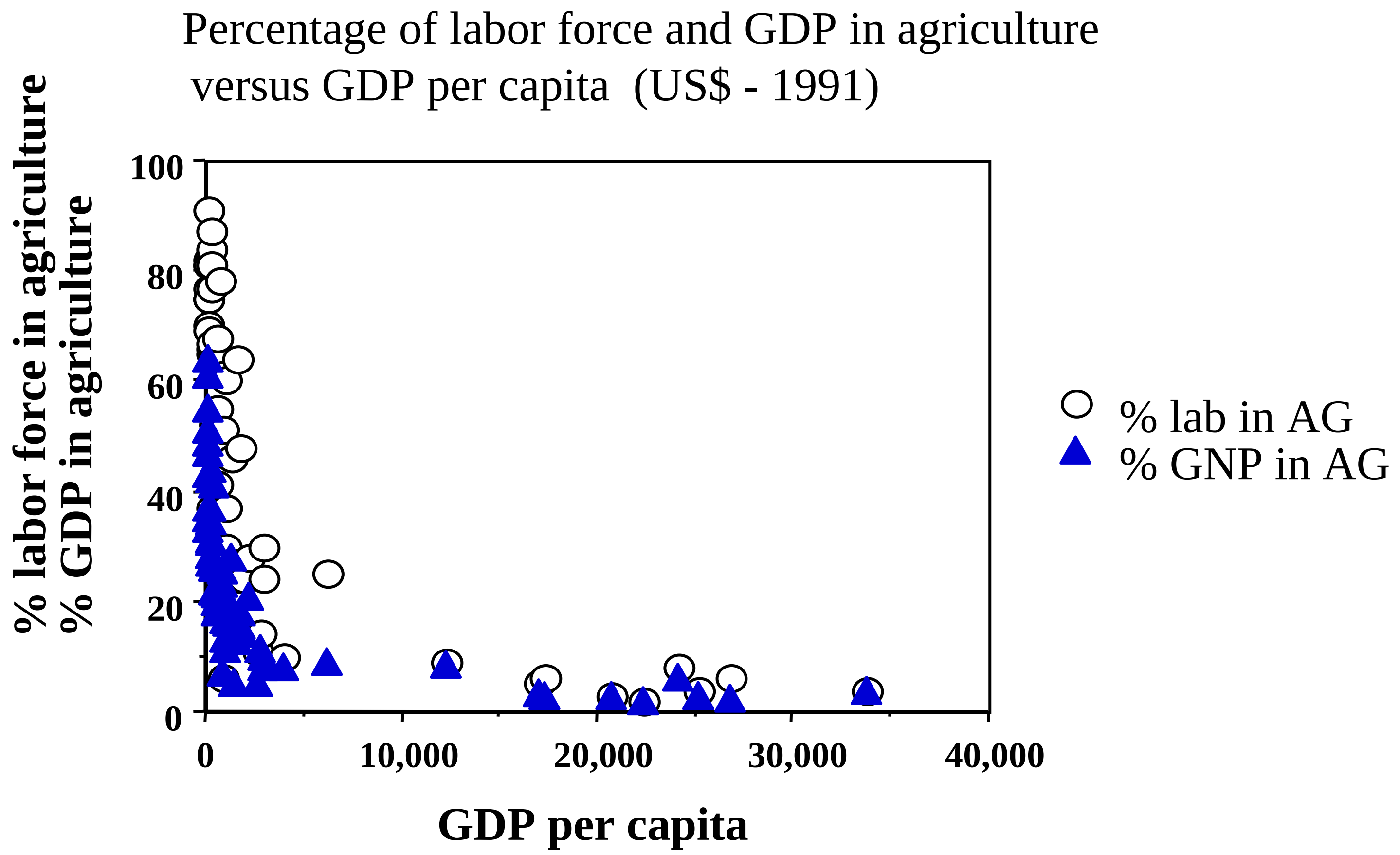
Agriculture	4.5	48	1.5	92	3.0	Level n-3

Labor time in Agriculture

Productivity of labor:
700 kg of grain per hour

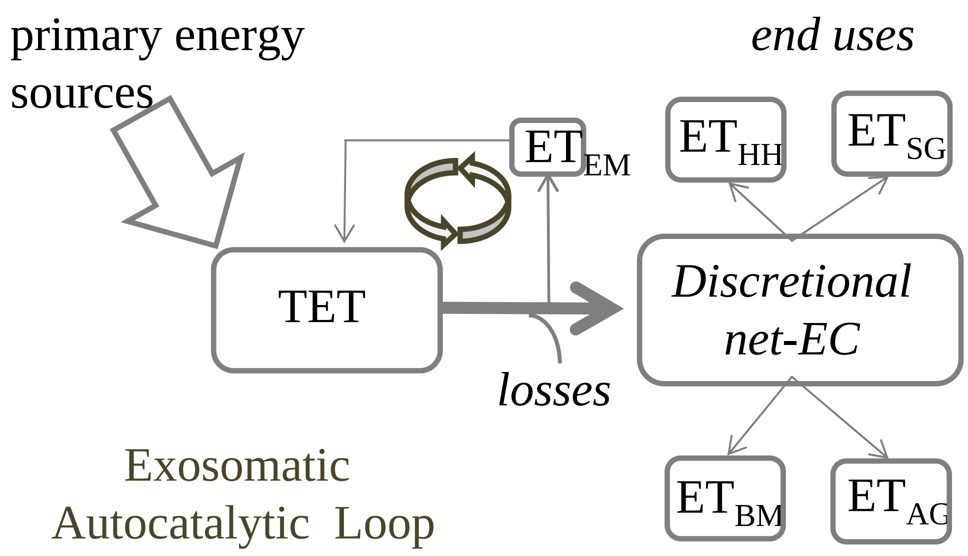
Productivity of labor:
1 kg of grain per hour

If the *work force* of a society is just producing its own food that society will never become rich . . .



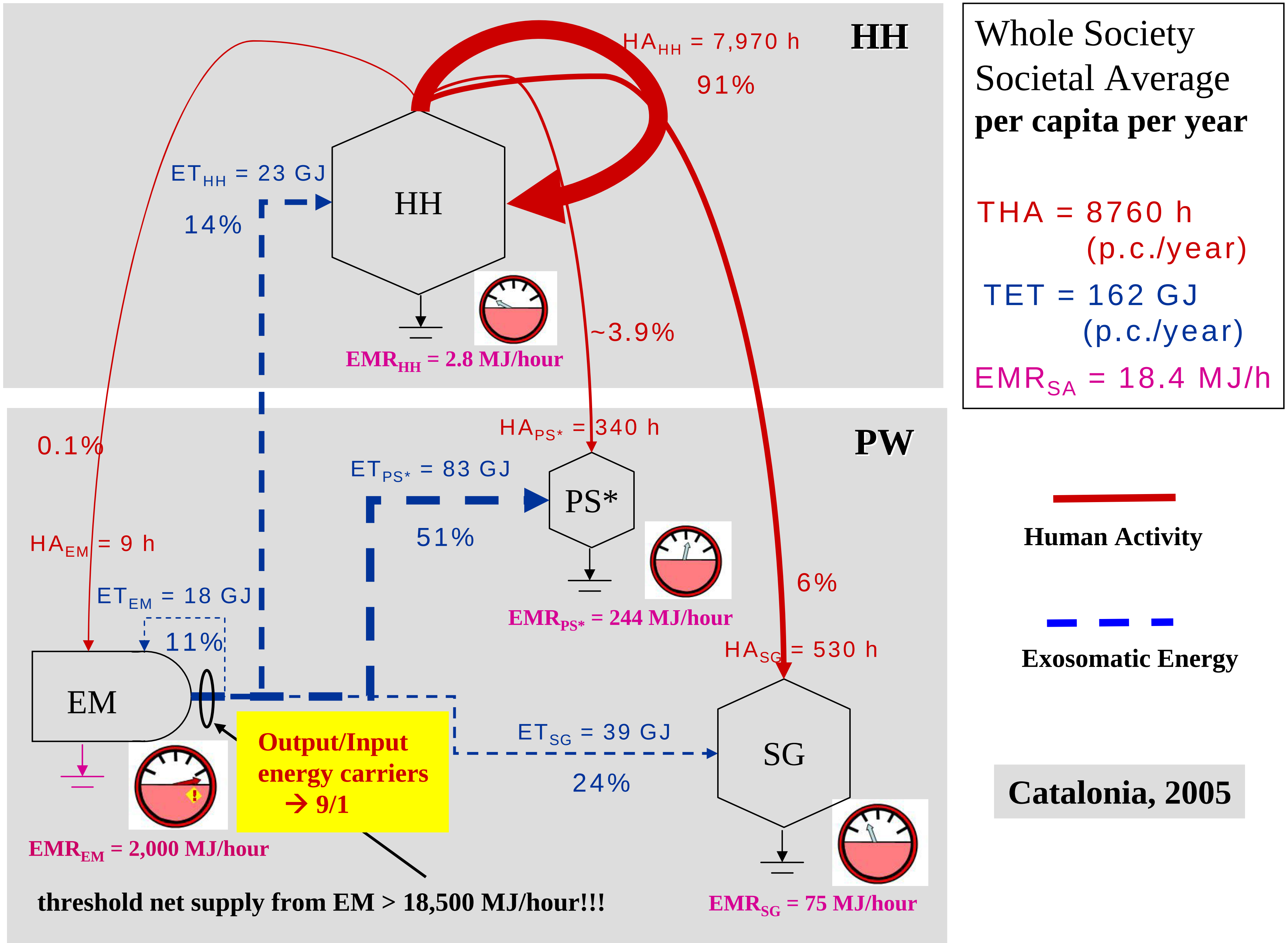
All developed countries have less than 5% of their work force in agriculture

Exosomatic Energy FLOW



A fraction of the total of flow of Energy Carriers is required to produce Energy Carriers: ***fuels***, ***process heat***, ***electricity***

In addition the stabilization of the energy carriers supply requires also:
* ***FUNDS: labor, land and capital*** and ***FLOWS: energy carriers, water uses;***
* **Natural Processes outside human control** (solar radiation, waterfalls, wind, past fixation of solar energy into stocks of fossil energy)


HH
HA$_{HH}$ = 7,970 h
91%
ET$_{HH}$ = 23 GJ
14%
HH
~3.9%
EMR$_{HH}$ = 2.8 MJ/hour
PW
0.1%
HA$_{PS*}$ = 340 h
ET$_{PS*}$ = 83 GJ
PS*
51%
HA$_{EM}$ = 9 h
ET$_{EM}$ = 18 GJ
6%
EMR$_{PS*}$ = 244 MJ/hour
11%
HA$_{SG}$ = 530 h
EM
Output/Input energy carriers → 9/1
ET$_{SG}$ = 39 GJ
SG
24%
EMR$_{EM}$ = 2,000 MJ/hour
threshold net supply from EM > 18,500 MJ/hour!!!
EMR$_{SG}$ = 75 MJ/hour
Whole Society
Societal Average
per capita per year
THA = 8760 h (p.c./year)
TET = 162 GJ (p.c./year)
EMR$_{SA}$ = 18.4 MJ/h
Human Activity
Exosomatic Energy
Catalonia, 2005

SPAIN 2007

	Product.-Consum. Factors *(Flow and Fund elements)*			Metabolic Characteristics *(Flow/Fund ratios)*		
	Energy *(GJ p.c./y)*	Human Activity *(hrs p.c./y)*	Power Capactity *(kW p.c./y)*	Exosomatic Metabolic Rate *(MJ/hour*	Intensity Power Capactity *(MJ/kW)*	
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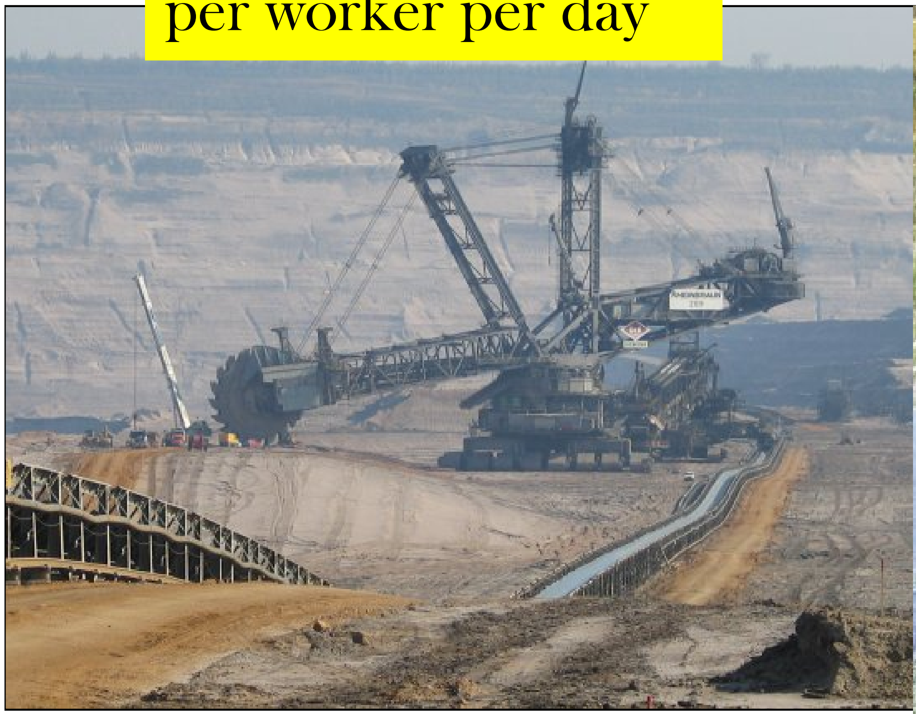
Energy & Mining	13.0	8	1.0	1611	13.1	Level n-3
Agriculture	4.5	48	1.5	92	3.0	Level n-3

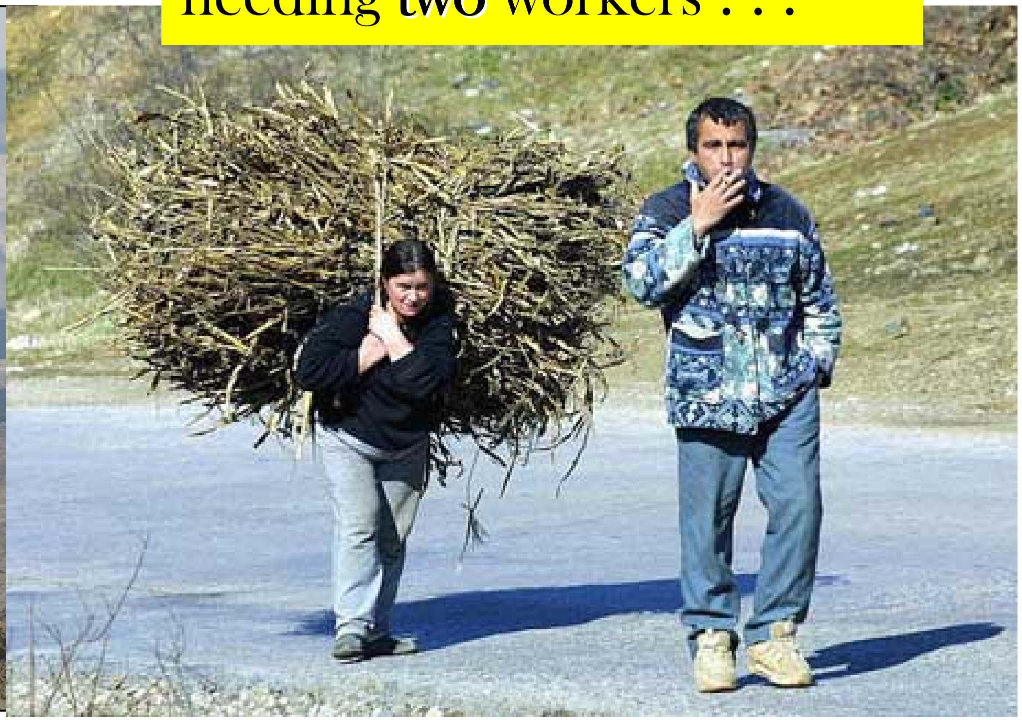
Energy & Mining | 13.0 | 8 | 1.0 | 1611 | 13.1 | Level n-3

Labor time in Energy and Mining

Productivity of labor:
1,400 trucks of coal
per worker per day



Productivity of labor:
0.01 truck of coal-equivalent
needing two workers . . .



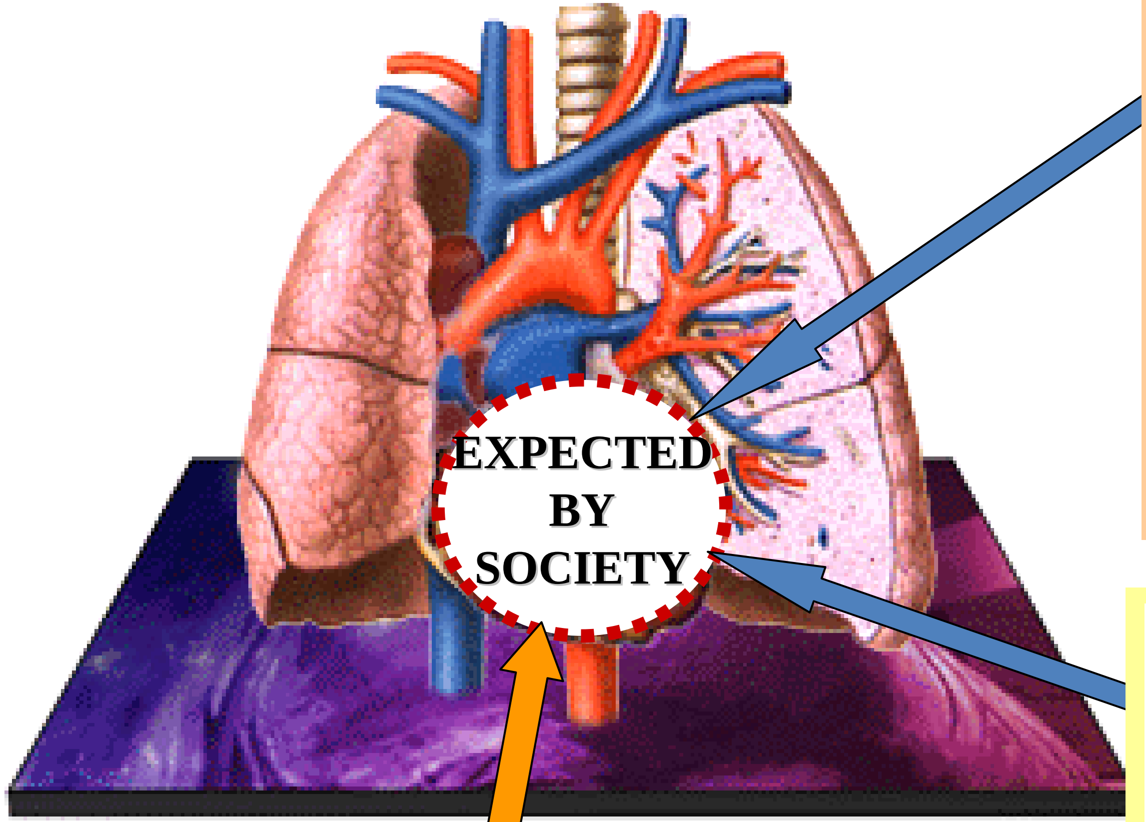
The crucial difference between fossil fuels and biofuels

Fossil energy has a tremendous advantage over all alternative energy sources. When assessing the biophysical cost of production of energy carriers, oil has not to be produced, it is already there!

Fossil fuels are energy carriers with a very low biophysical cost of production *(e.g. extraction → oil → gasoline)*

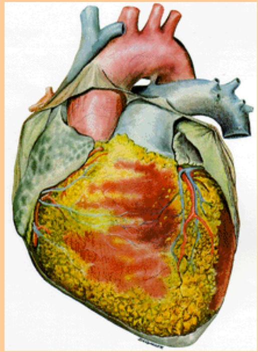
Biofuels are energy carriers with a very high biophysical cost of production *(e.g. soil + sun → biomass → beer → ethanol)*

The heart metaphor



given the characteristics of its metabolism a society can only invest in its energy sector a limited amount of:

*** hours of work**
*** hectares of colonized land**



Energy Sector powered by fossil fuels

- Technical Coefficients
- Biophysical Constraints

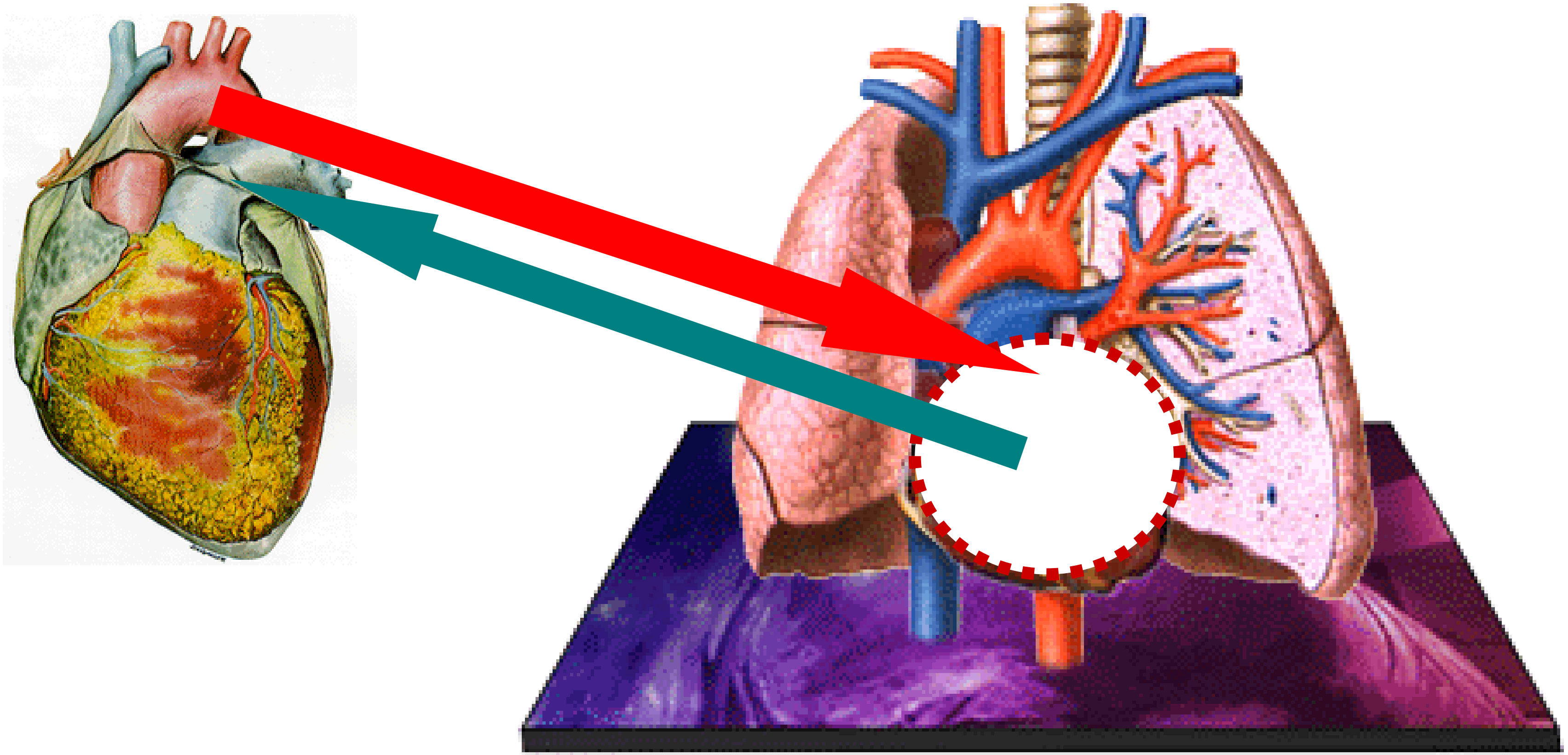
Energy Sector powered by biofuels

- Technical Coefficients
- Biophysical Constraints

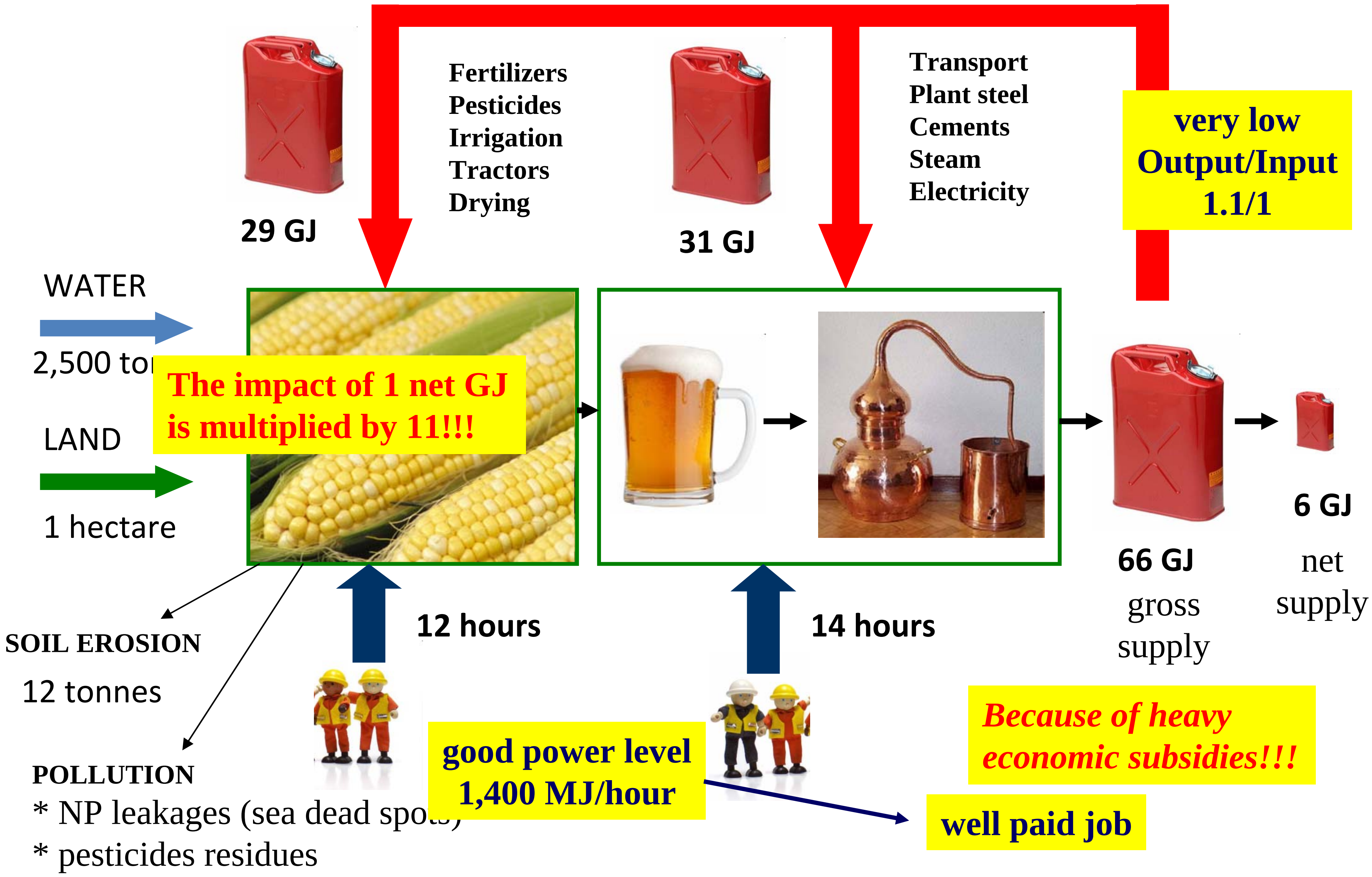
(i) Requirement of working hours
(ii) Availability of working hours

CHECKING INTERNAL CONSTRAINTS . . .

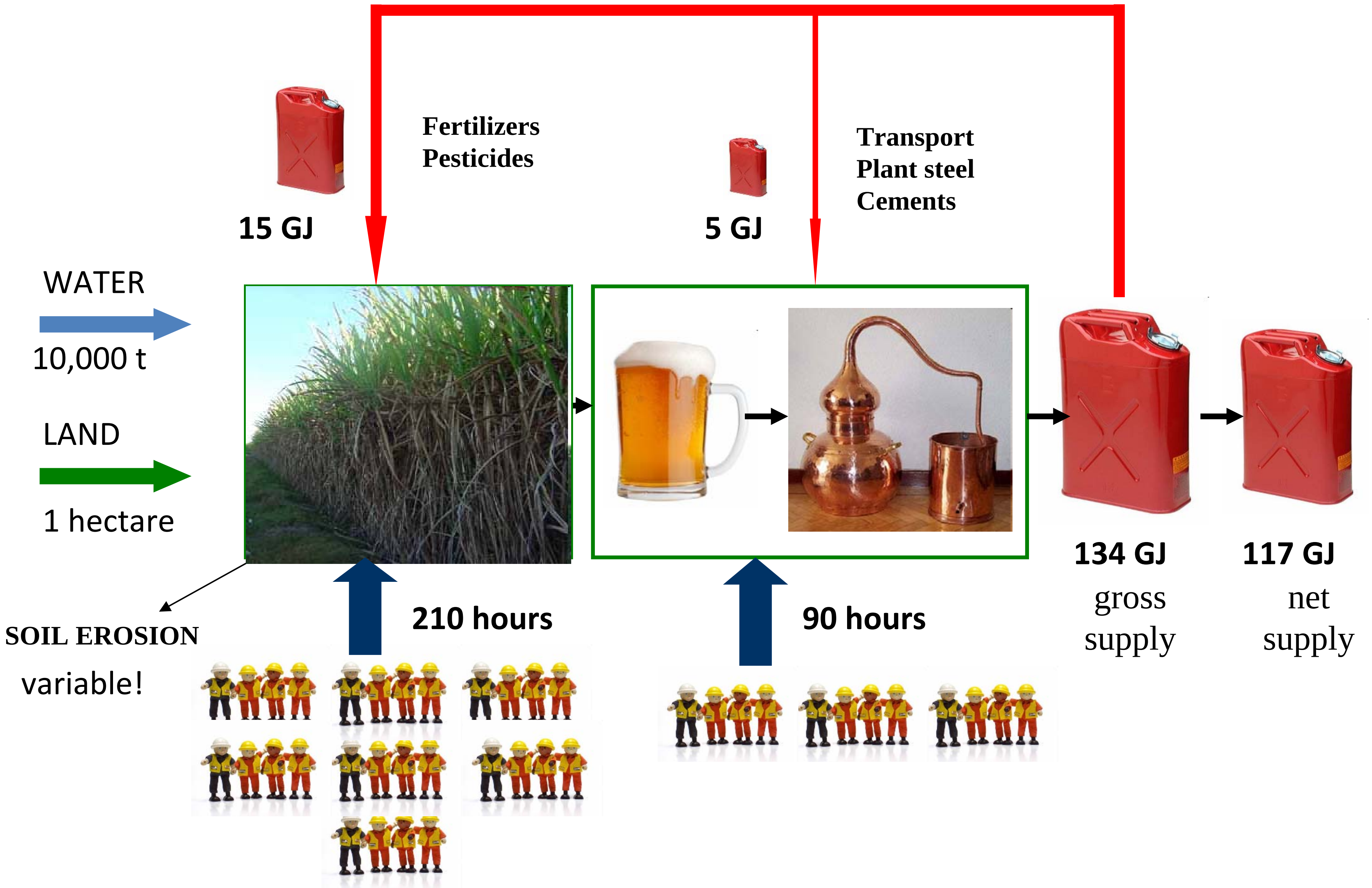
Productivity of work → are they "good jobs"?



Ethanol Production from Corn (USA) - **1 hectare**



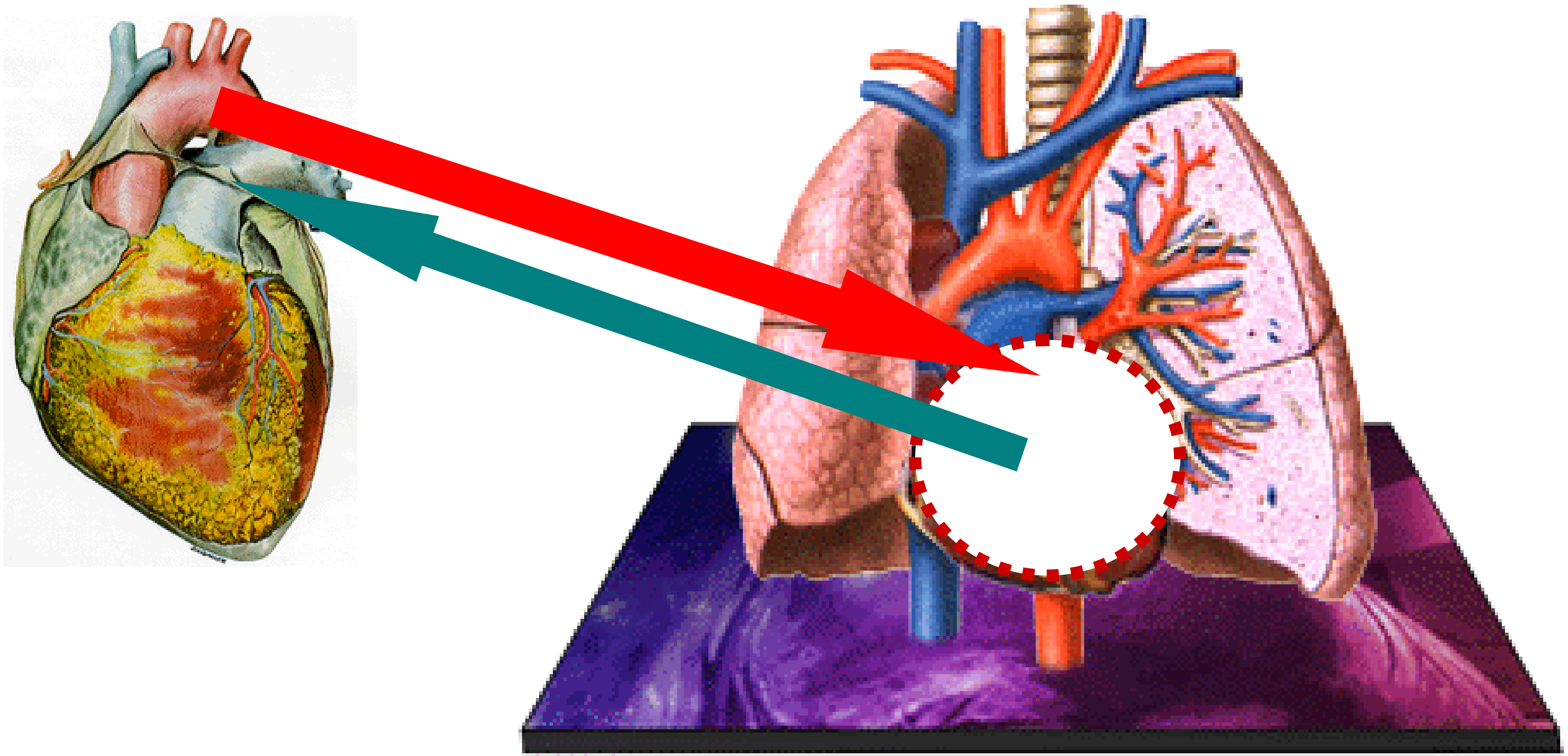
Ethanol Production from Sugarcane (Brazil) - **1 hectare**

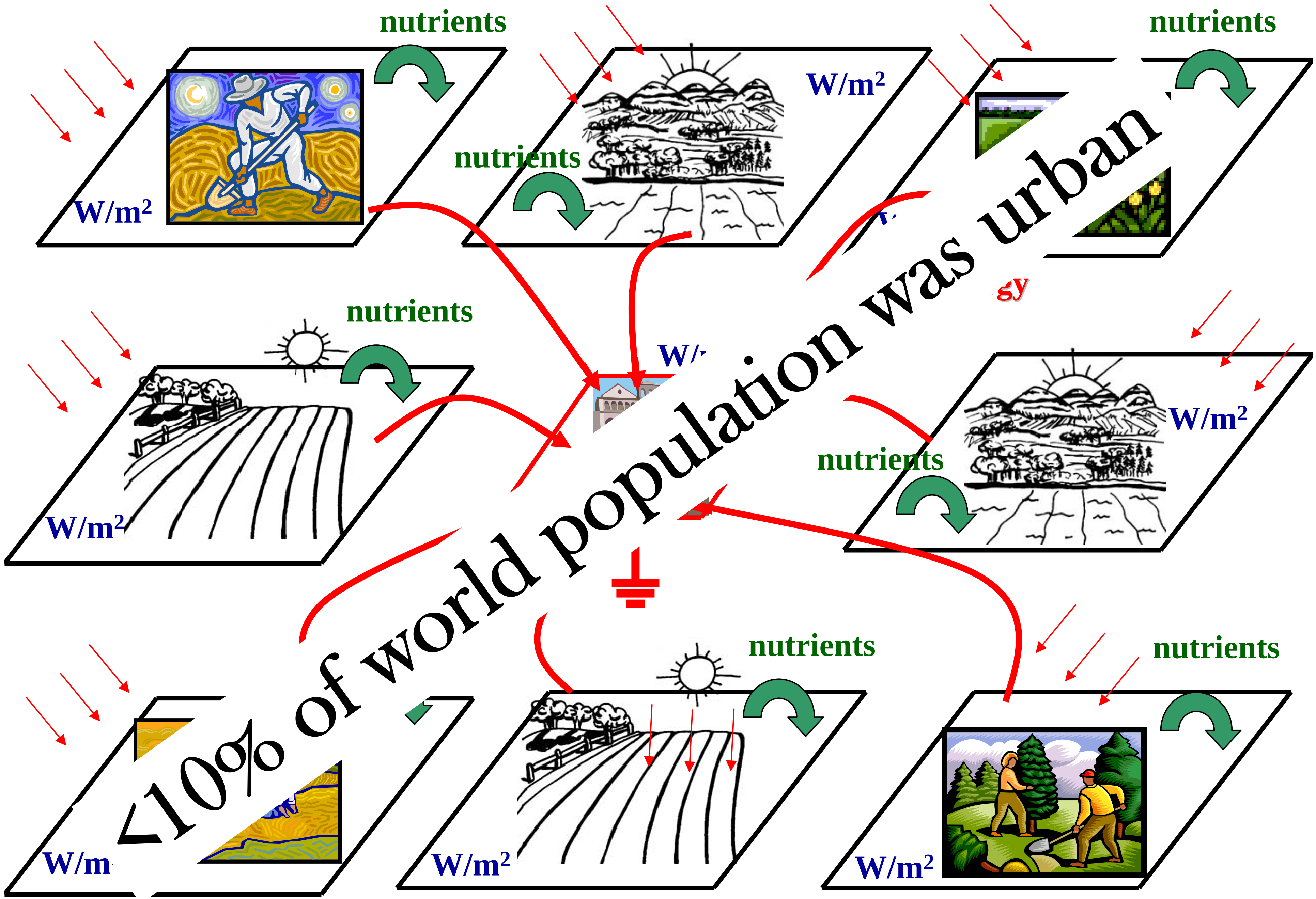


(i) Requirement of cropland
(ii) Availability of cropland

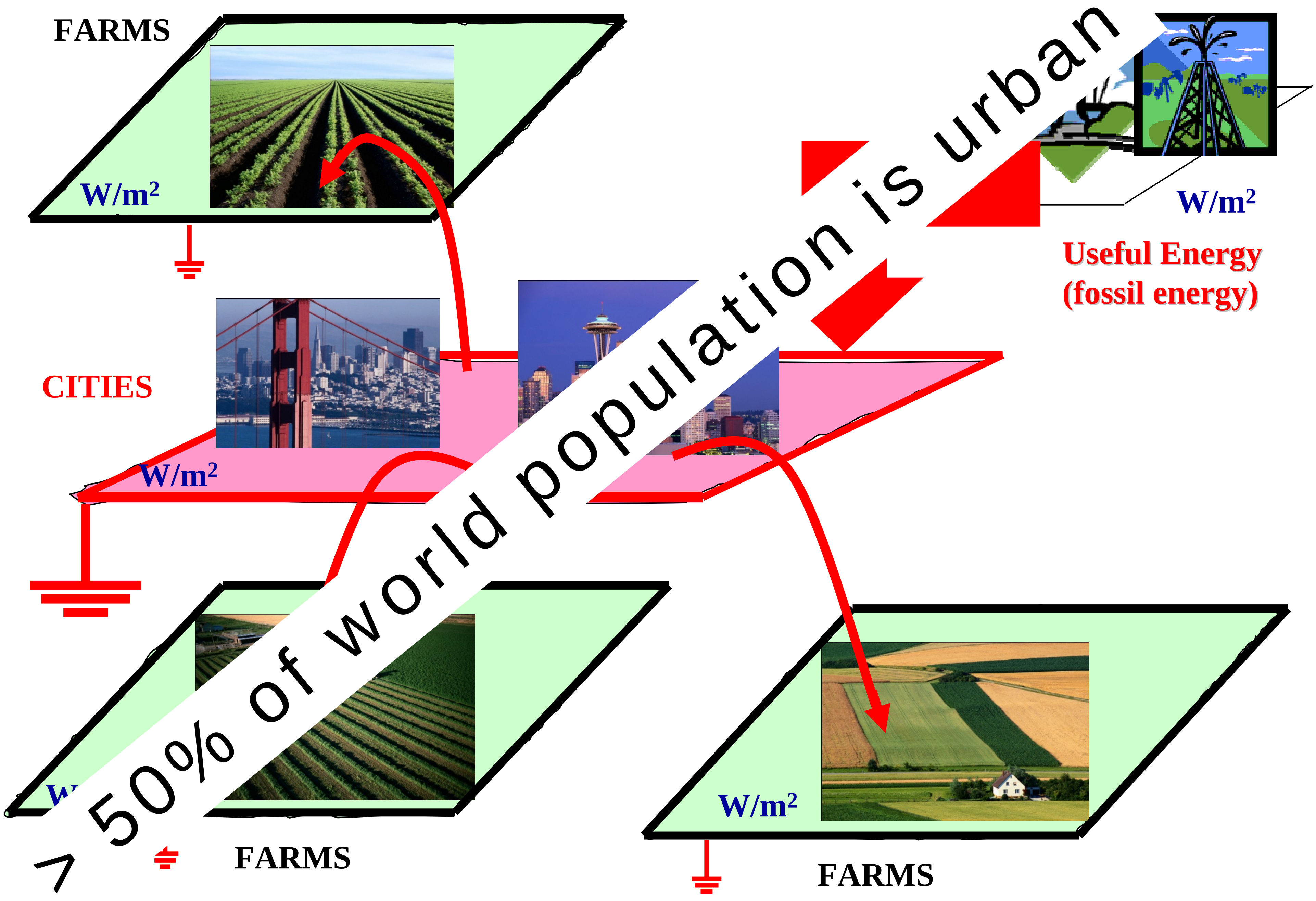
CHECKING EXTERNAL CONSTRAINTS . . .

Productivity of land → are they "concentrated flows"?

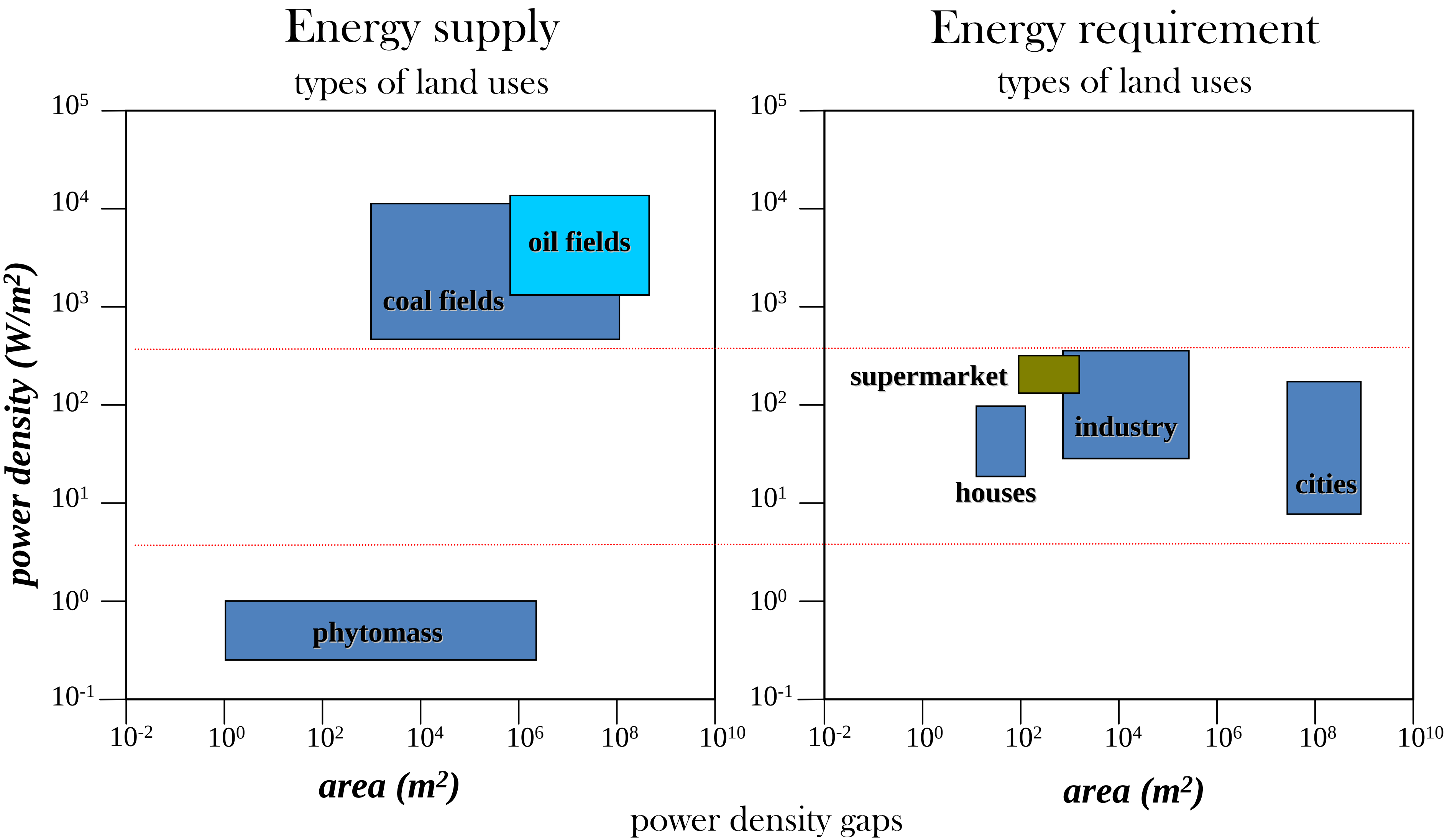




<10% of world population was urban
nutrients
W/m²



FARMS
W/m^2
Useful Energy
(fossil energy)
W/m^2
CITIES
W/m^2
> 50% of world population is urban
W/m^2
FARMS
FARMS



after Vaclav Smil 2003 Energy at the Crossroads, The MIT press
(Fig. 5.2 and Fig. 5.3)

PRE-INDUSTRIAL TIMES

Rural areas supply energy inputs (food and fuels) to the cities

Density of Energy Flows

REQUIREMENT

Modern cities **10 – 100** W/m^2

SUPPLY

Pythomass **0.1 – 1** W/m^2

from Smil, 2003

Density of Energy Flows

SUPPLY

Oil fields & Coal mines **400 – 10,000** W/m^2

REQUIREMENT

Modern cities **10 – 100** W/m^2

from Smil, 2003

POST-INDUSTRIAL TIMES

Urban areas supply energy inputs (for producing food and fuels) to the countryside

Desirability

BIO-ECONOMICS WORKS!

SPAIN 2007

	Product.-Consum. Factors *(Flow and Fund elements)*			Metabolic Characteristics *(Flow/Fund ratios)*	Bio-Economic Pressure	
	Energy *(GJ p.c./y)*	Human Activity *(hrs p.c./y)*	Power Capactity *(kW p.c./y)*	Exosomatic Metabolic Rate *(MJ/hour*	Intensity Power Capactity *(MJ/kW)*	
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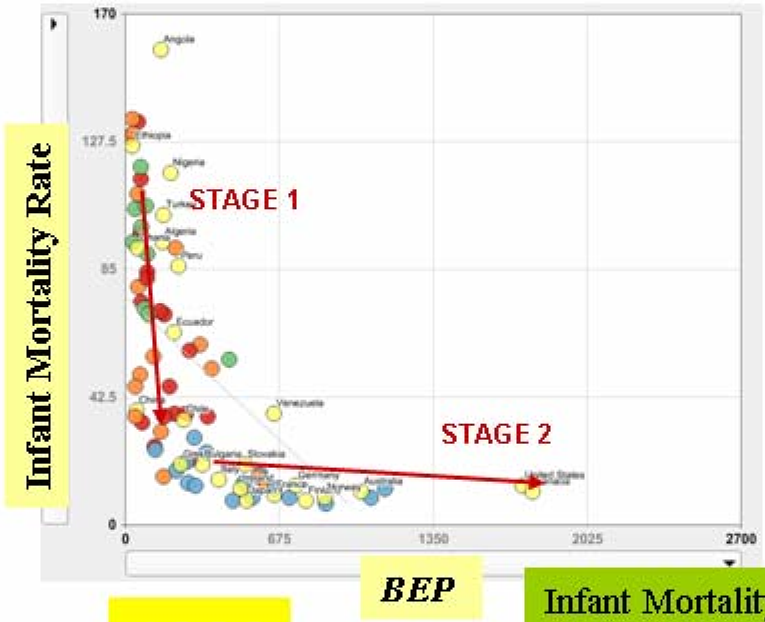
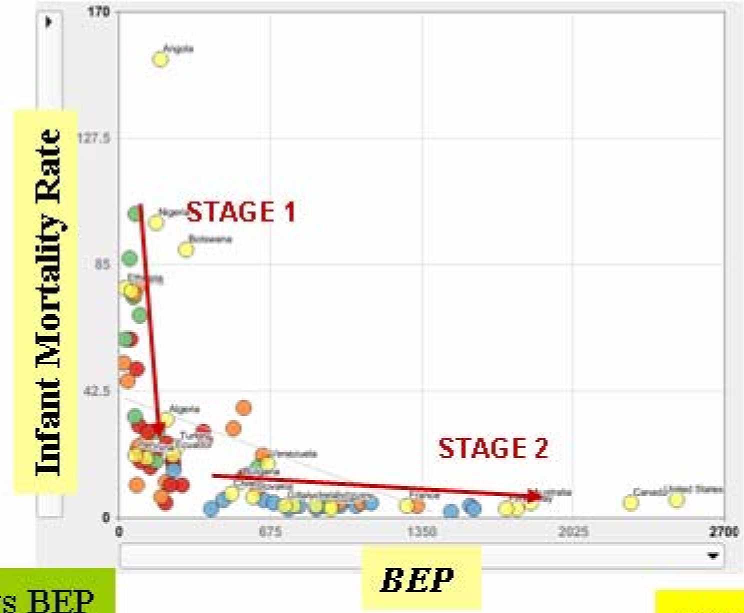
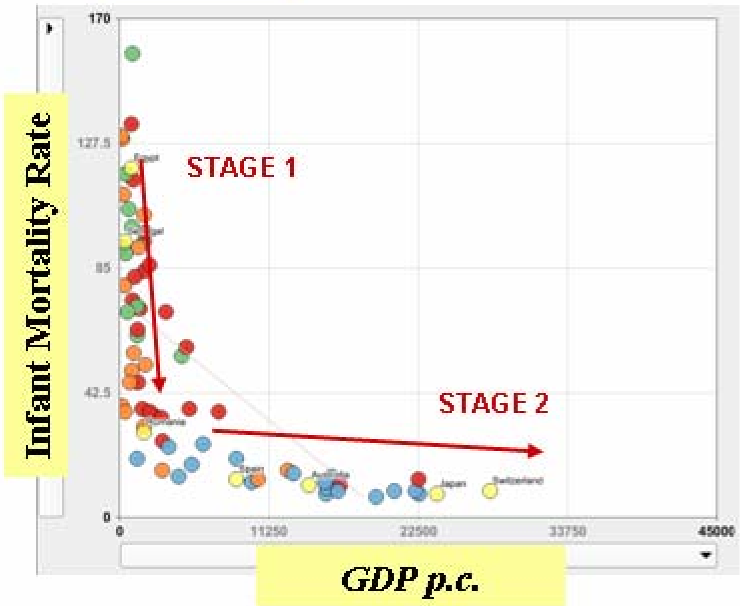


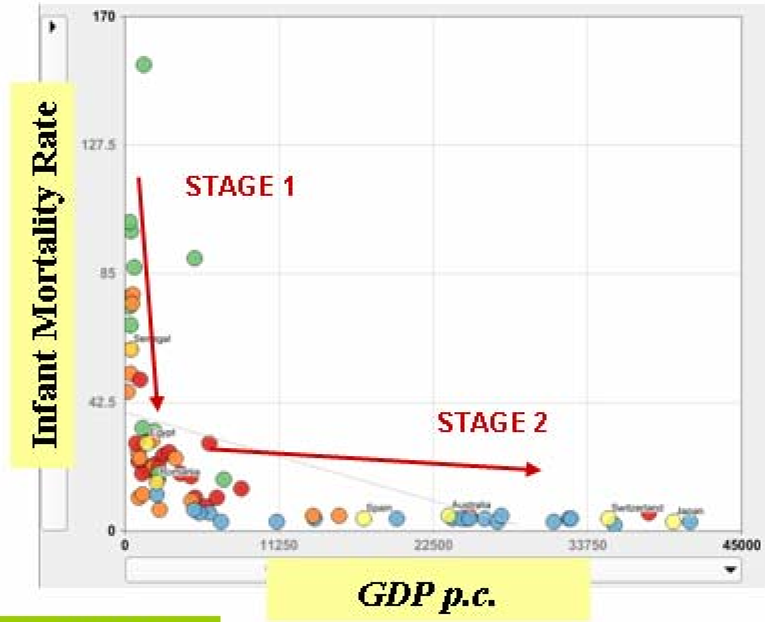


Infant Mortality Rate vs BEP

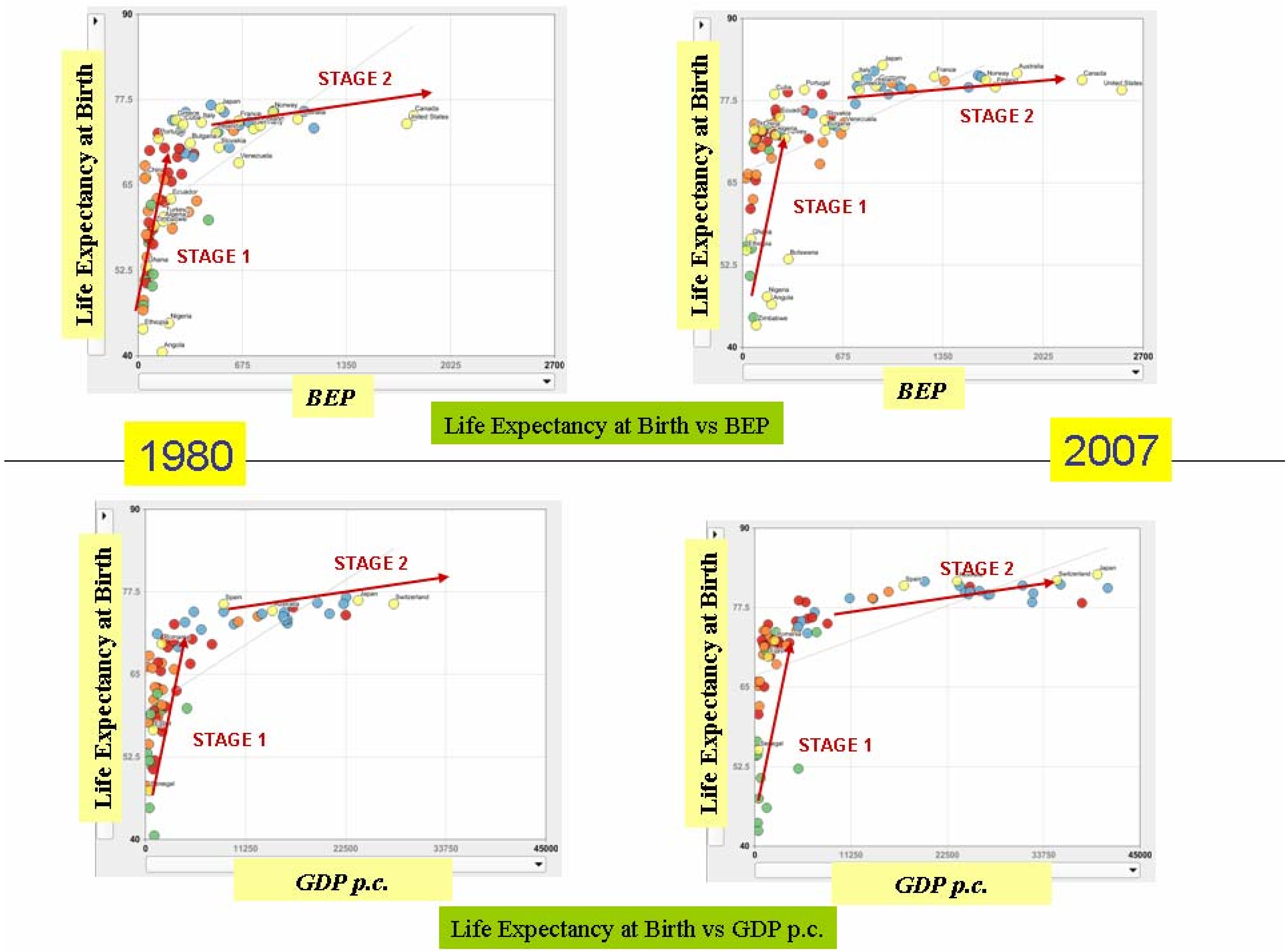
1980

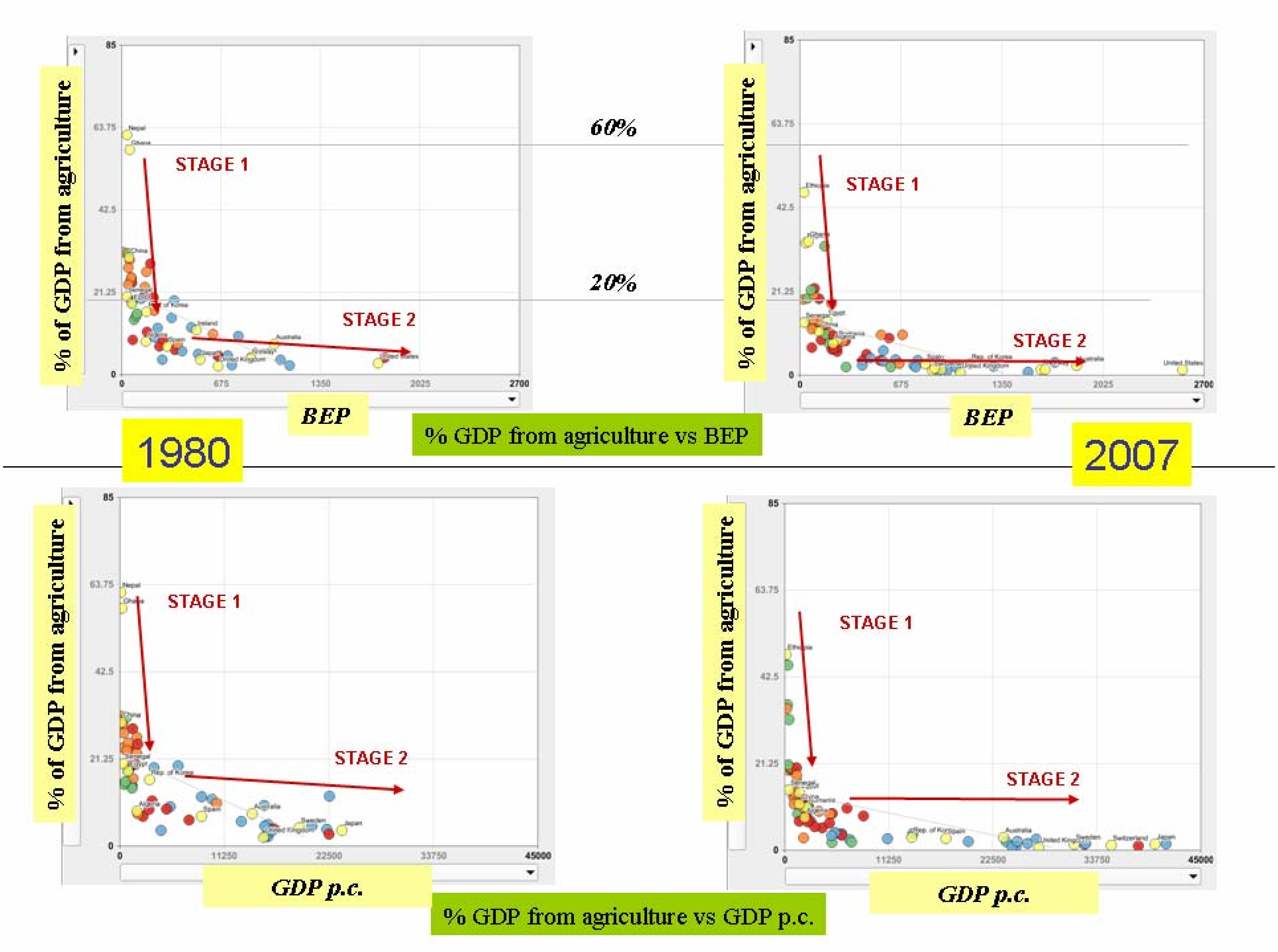
2007





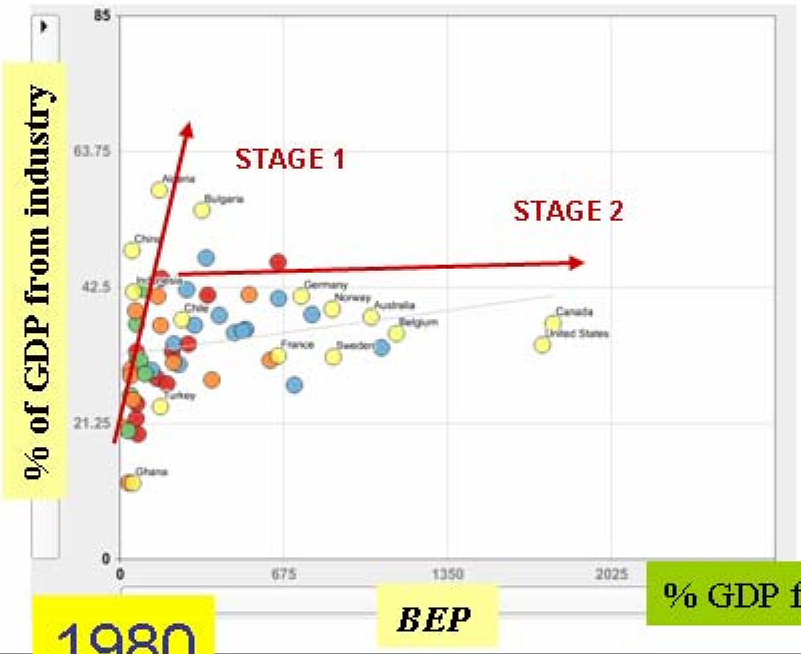
Infant Mortality Rate vs GDP p.c.

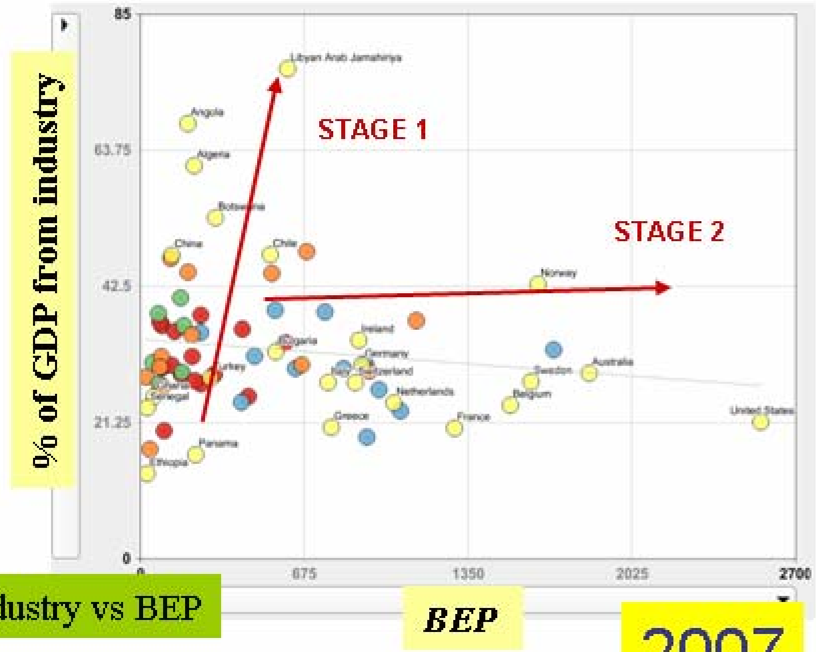

Life Expectancy at Birth
90
77.5
65
52.5
40
0
675
1350
2025
2700
STAGE 1
STAGE 2
BEP
Life Expectancy at Birth
STAGE 1
STAGE 2
BEP
Life Expectancy at Birth vs BEP
1980
2007
Life Expectancy at Birth
STAGE 1
STAGE 2
0
11250
22500
33750
45000
GDP p.c.
Life Expectancy at Birth
STAGE 1
STAGE 2
GDP p.c.
Life Expectancy at Birth vs GDP p.c.


% of GDP from agriculture
STAGE 1
STAGE 2
60%
20%
BEP
1980
% GDP from agriculture vs BEP
2007
GDP p.c.
% GDP from agriculture vs GDP p.c.
85
63.75
42.5
21.25
0
675
1350
2025
2700
11250
22500
33750
45000

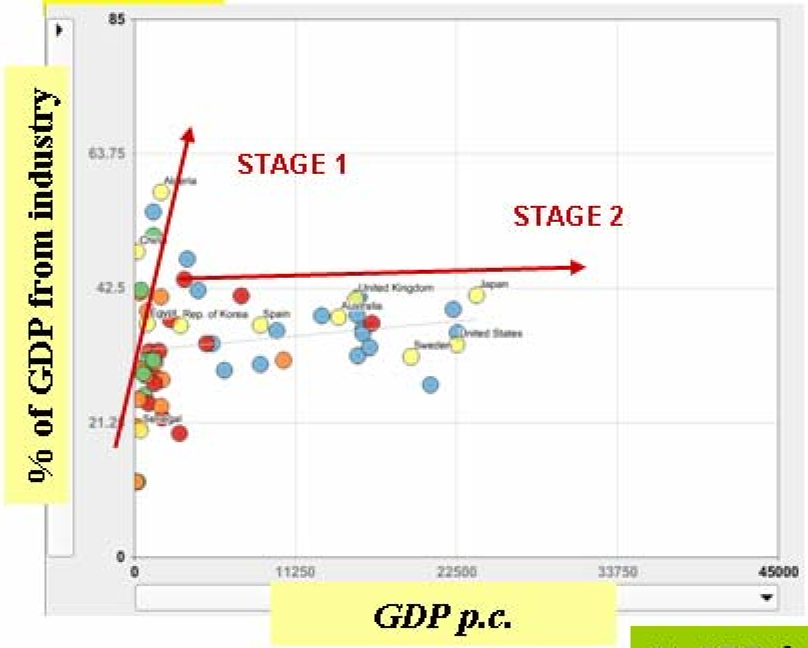
1980

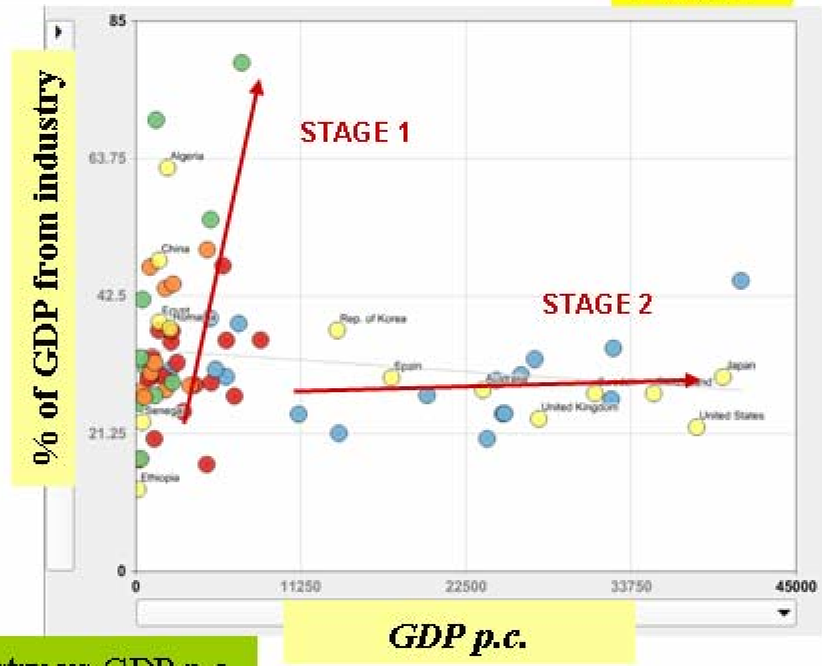
2007



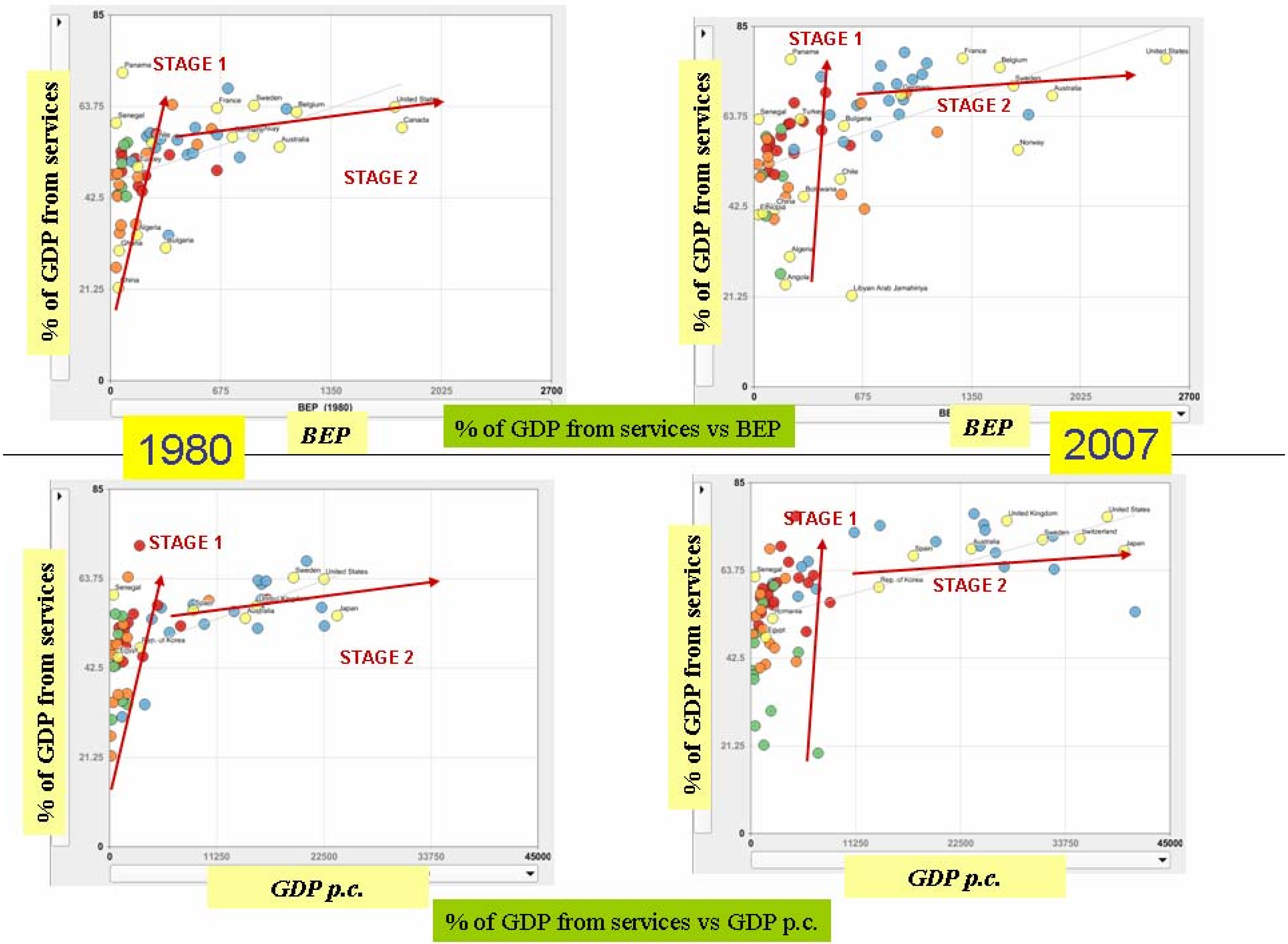


% GDP from industry vs BEP

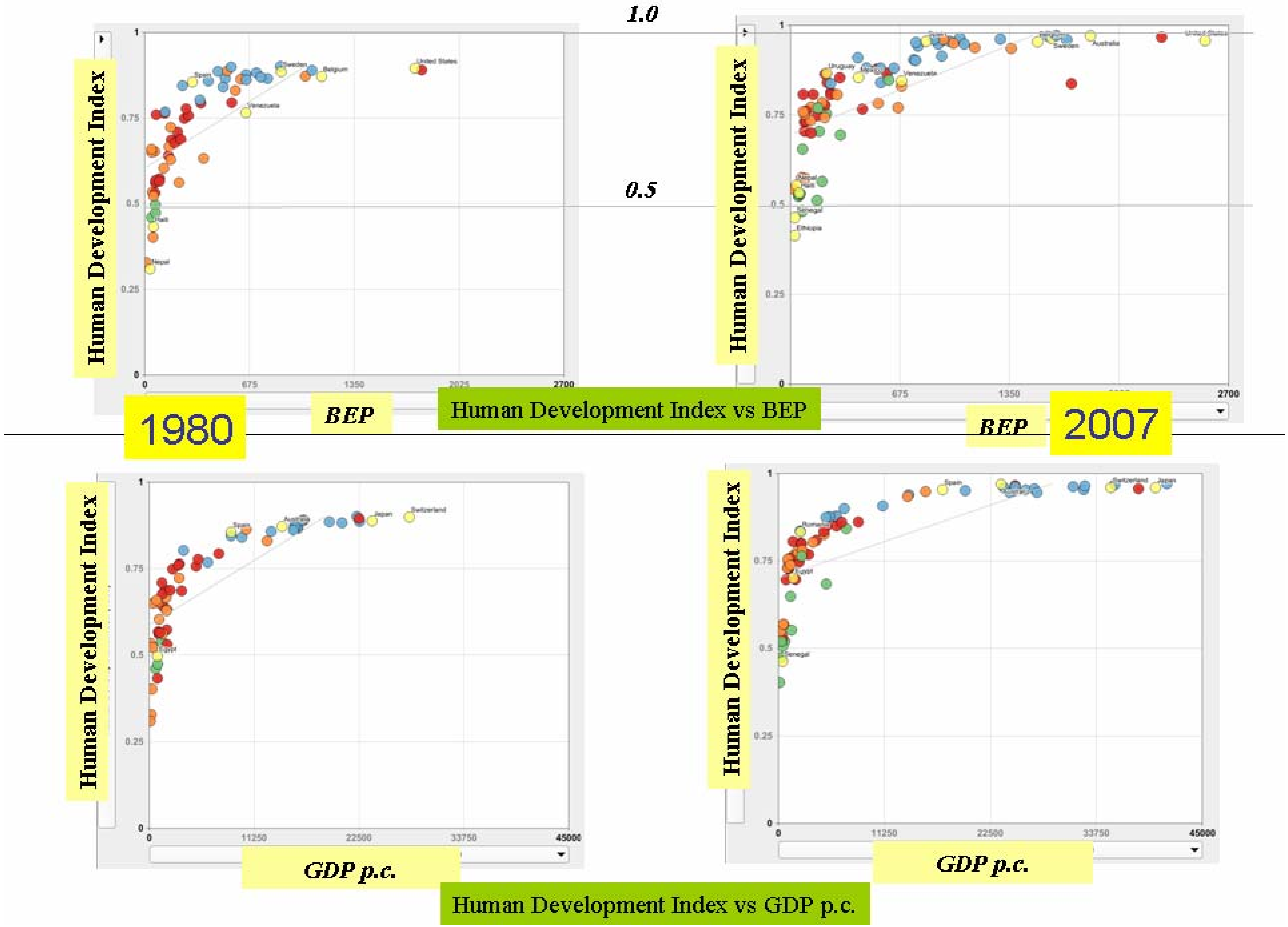


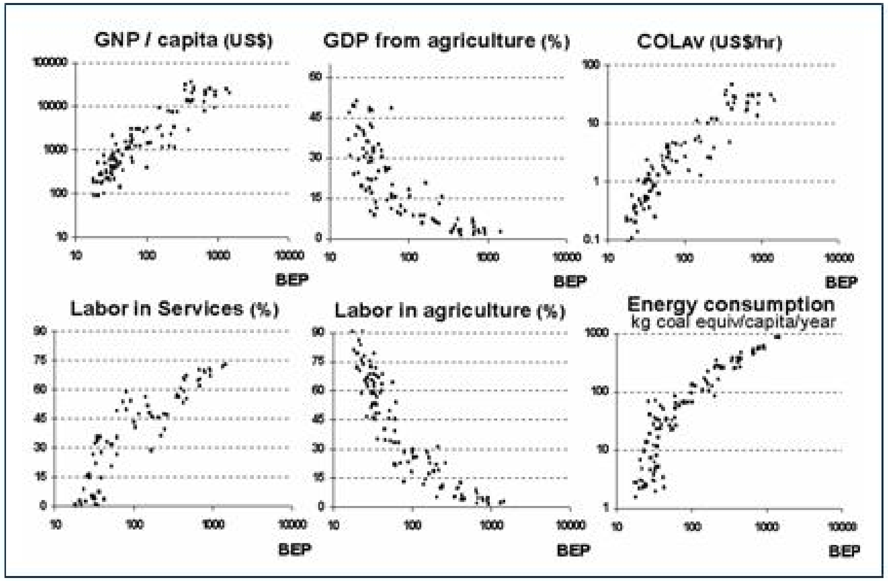


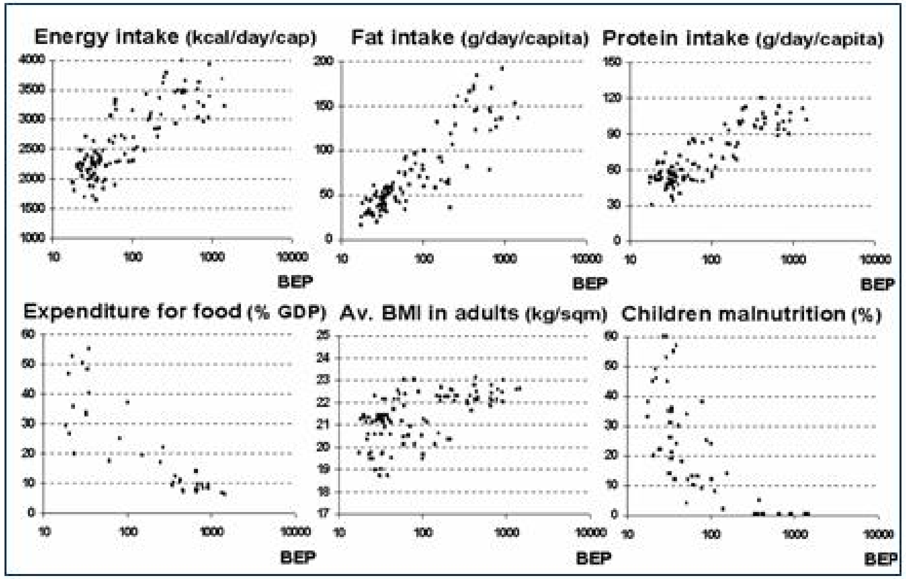
% GDP from industry vs GDP p.c.

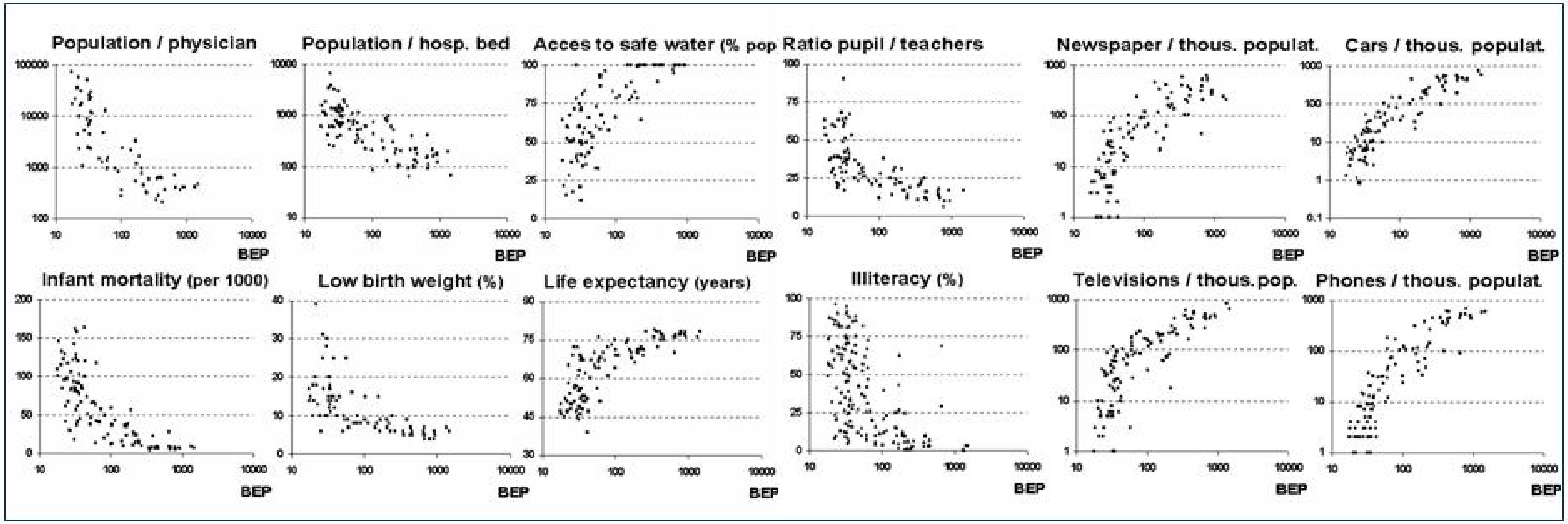


% of GDP from services vs BEP
1980
2007
STAGE 1
STAGE 2
% of GDP from services
BEP
BEP (1980)
% of GDP from services vs GDP p.c.
GDP p.c.
85
63.75
42.5
21.25
0
675
1350
2025
2700
11250
22500
33750
45000


1.0
0.5
Human Development Index
1980
BEP
Human Development Index vs BEP
2007
GDP p.c.
Human Development Index vs GDP p.c.
Spain
Sweden
Belgium
United States
Venezuela
Haiti
Nepal
Uruguay
Senegal
Ethiopia
Australia
Switzerland
Japan
Egypt
Romania
0
0.25
0.5
0.75
1
675
1350
2025
2700
11250
22500
33750
45000


GNP / capita (US$)
GDP from agriculture (%)
COLAV (US$/hr)
Labor in Services (%)
Labor in agriculture (%)
Energy consumption
kg coal equiv/capita/year
BEP


Energy intake (kcal/day/cap)
Fat intake (g/day/capita)
Protein intake (g/day/capita)
Expenditure for food (% GDP)
Av. BMI in adults (kg/sqm)
Children malnutrition (%)
BEP

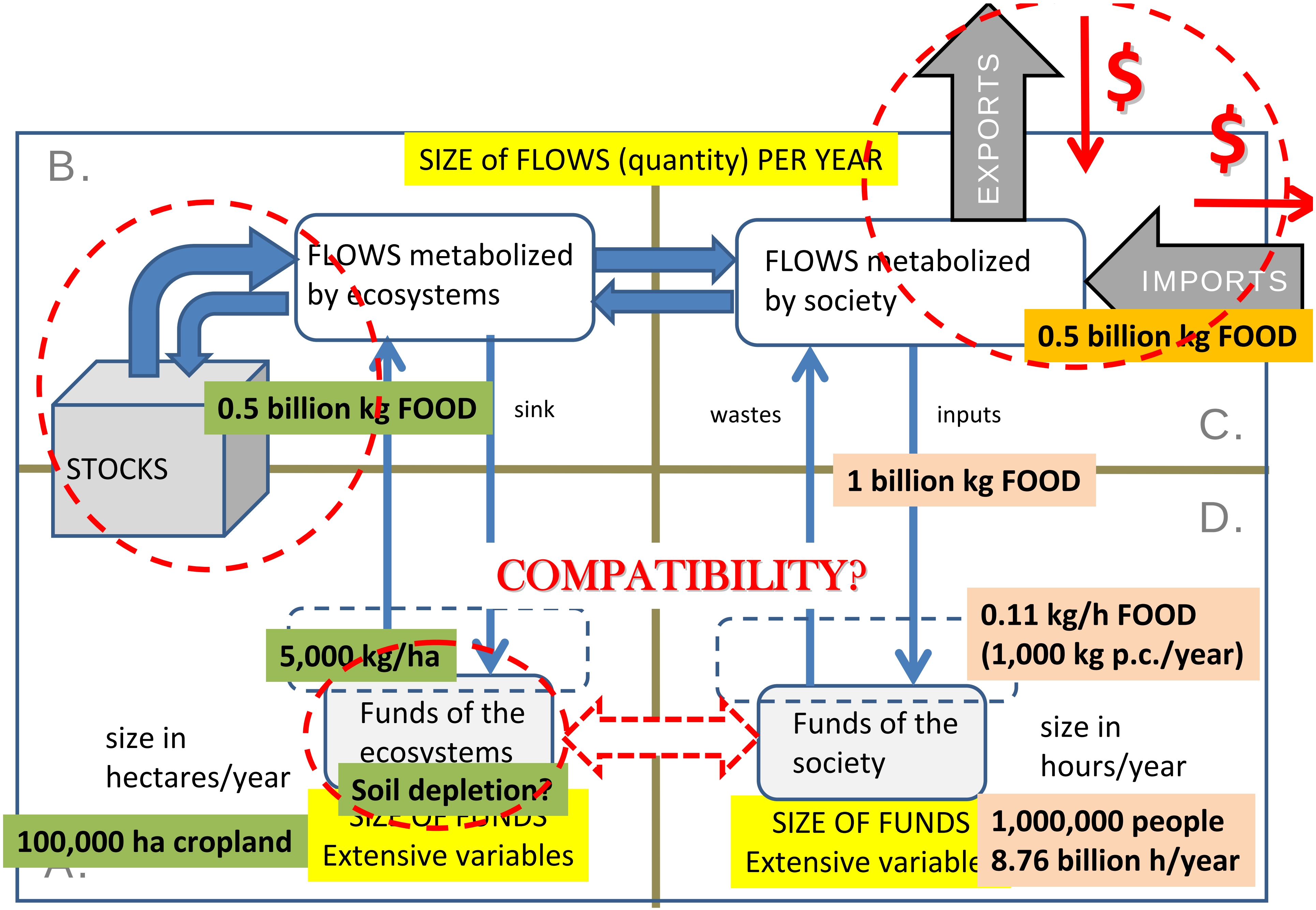

Population / physician
Population / hosp. bed
Acces to safe water (% pop
Ratio pupil / teachers
Newspaper / thous. populat.
Cars / thous. populat.
Infant mortality (per 1000)
Low birth weight (%)
Life expectancy (years)
Illiteracy (%)
Televisions / thous. pop.
Phones / thous. populat.
BEP

3. Using the flow-fund model of Georgescu-Roegen to implement the DPSIR framework (Driver, Pressure, State, Impact and Response)

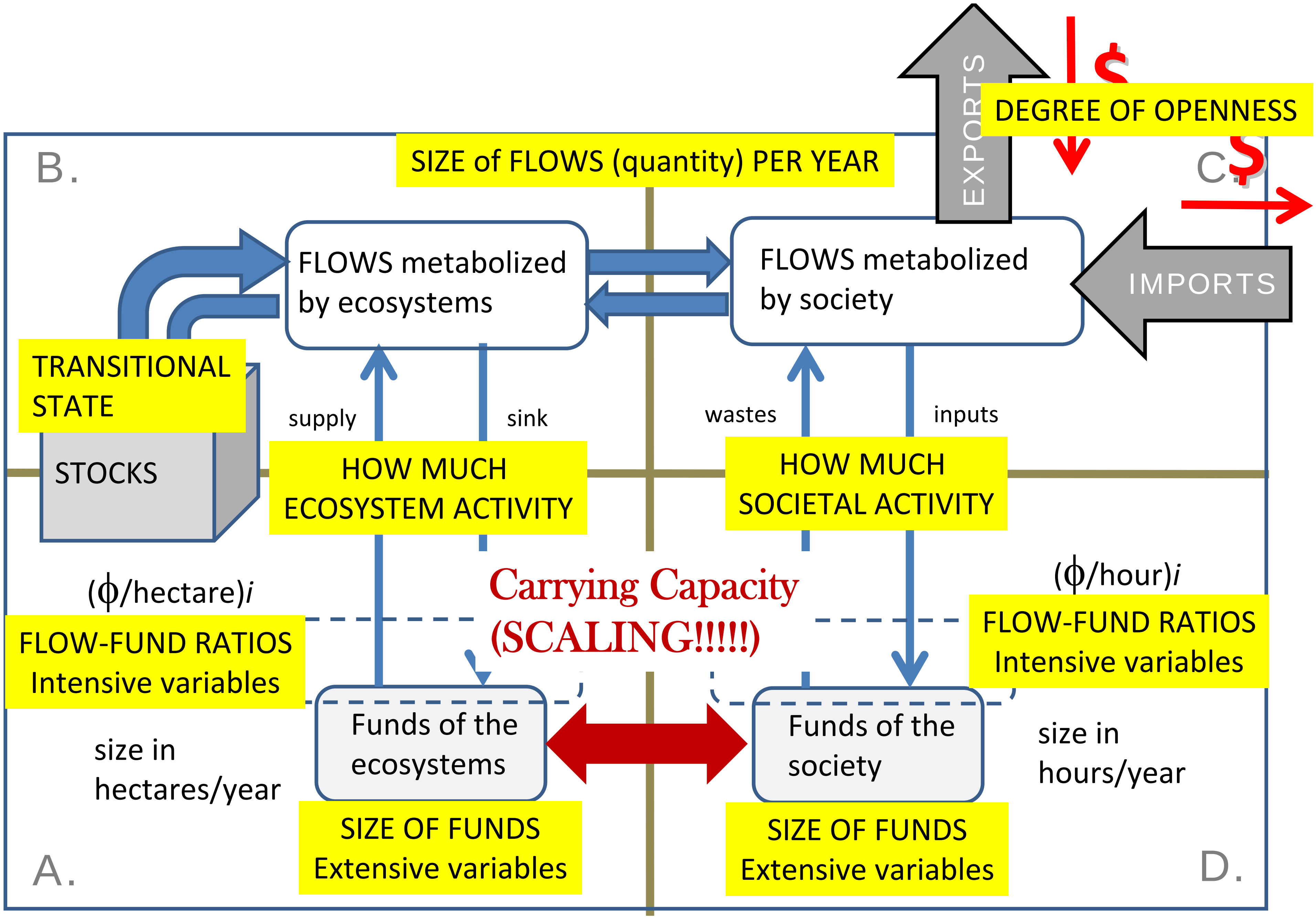
It is required to assign meaning to numbers referring to different scales and dimensions – it provides the semantic framework neede to assess the factors determining the sustainability of Socio-Ecological Systems

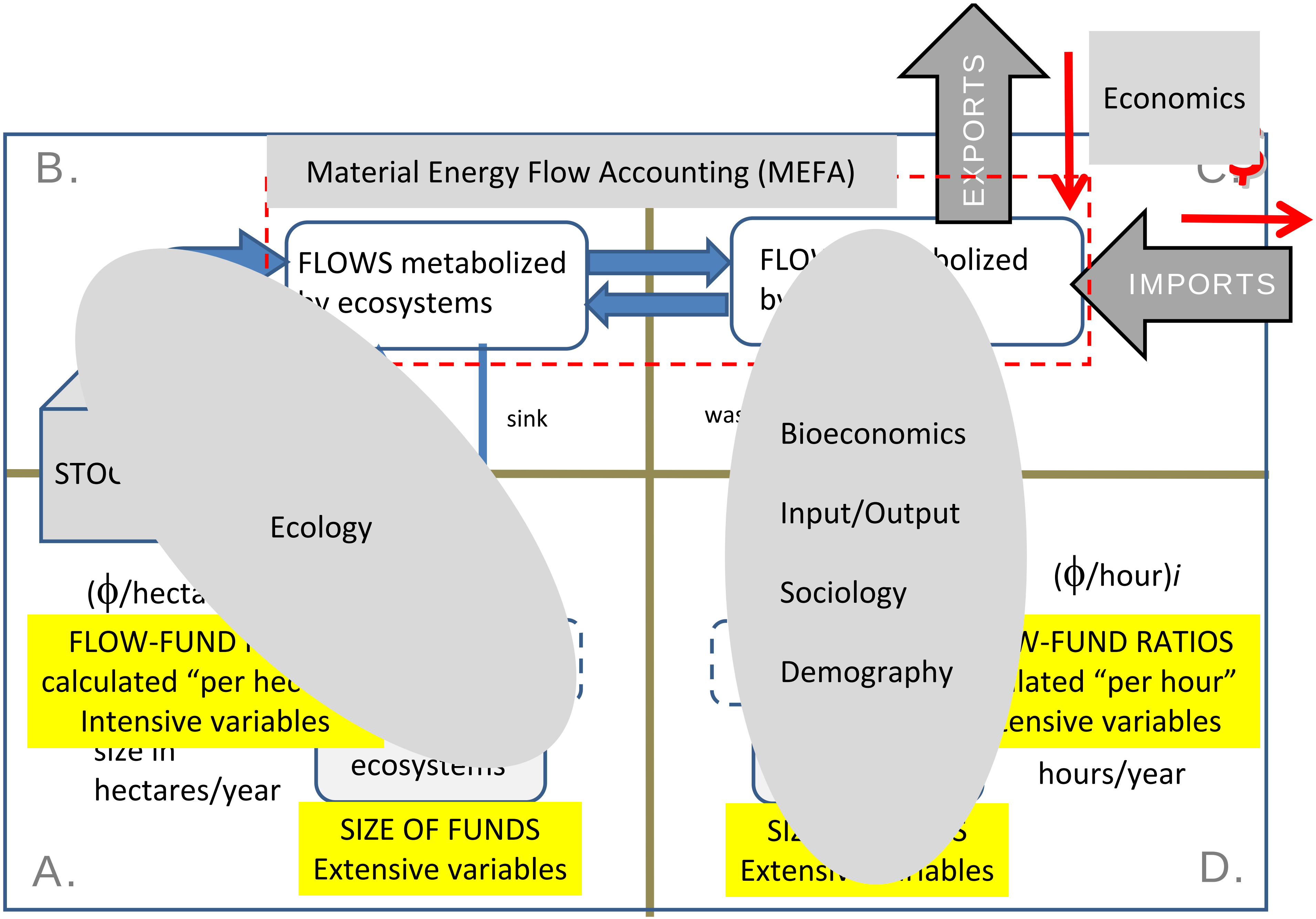
DRIVERS	**what is causing changes** * Large scale natural trends affecting ecosystems * What type of societal activities (per unit of size) * How much societal activity (size of the types)	OUTSIDE HUMAN CONTROL UNDER HUMAN CONTROL
PRESSURE	**what society does to ecosystems, natural resources and Gaia (bio-geochemical cycles)** * Types of flows ***from*** and ***to*** the environment (non-renewable and renewable) * How much flow of each type (size) on the SUPPLY side and on the SINK side	
STATE	**the situation with ecosystems and socio-economic systems**	* What type of societal activities (per unit of size) * How much of societal activities of each type (size) * What type of ecosystems (per unit of size) * How much ecosystem of each type (size)
IMPACT	**the damage to ecosystems and natural resource**	*= depletion of stocks and damage to funds* * Which stocks and how much depletion * Which funds in which ecosystems – levels of stress
RESPONSE	**what has been done (changing activities under human control) to improve the situation**	

		USEFULNESS
DRIVERS	**what is causing changes** * Predictions (??!!!?) of changes in processes outside human control *Trend analysis on demographic and socio-economic variables * Scenarios of technological changes	
PRESSURE	**what society does to ecosystems, natural resources and Gaia (bio-geochemical cycles)** Assessing the flows (food, energy, water, material, wastes) metabolized by human societies altering natural metabolic patterns of ecosystems (fund and stocks)	
STATE	**the situation with ecosystems and the situation with societies** * Characterizing the metabolic pattern of ecosystems * Characterizing the metabolic pattern of societies	
IMPACT	**the damage to ecosystems and depletion of natural resource** Assessing the stress referring to different types of funds (soil, terrestrial and aquatic ecosystems, human health, bio-geochemical cycles) THIS TASK REQUIRES ADDRESSING THE ISSUE OF MULTIPLE SCALES	
RESPONSE	**achievements in relation to targets** (but they must be contextualized!)	

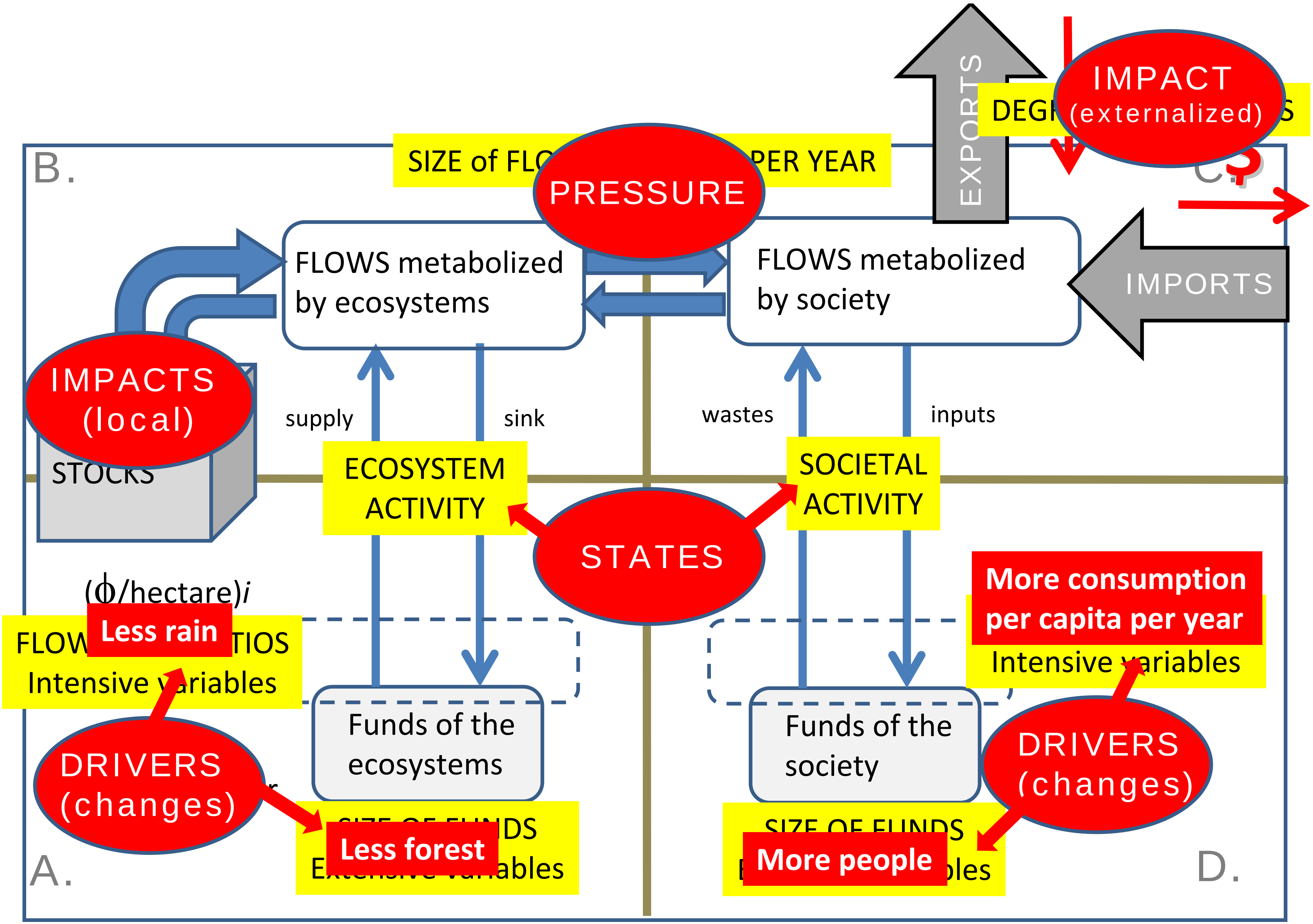


B.
SIZE of FLOWS (quantity) PER YEAR
EXPORTS
$
$
FLOWS metabolized by ecosystems
FLOWS metabolized by society
IMPORTS
0.5 billion kg FOOD
STOCKS
0.5 billion kg FOOD
sink
wastes
inputs
C.
1 billion kg FOOD
D.
COMPATIBILITY?
0.11 kg/h FOOD
(1,000 kg p.c./year)
5,000 kg/ha
Funds of the ecosystems
Funds of the society
size in hectares/year
size in hours/year
Soil depletion?
SIZE OF FUNDS
Extensive variables
SIZE OF FUNDS
Extensive variable
100,000 ha cropland
1,000,000 people
8.76 billion h/year
A.


EXPORTS
$
DEGREE OF OPENNESS
B.
SIZE of FLOWS (quantity) PER YEAR
C.
$
FLOWS metabolized by ecosystems
FLOWS metabolized by society
IMPORTS
TRANSITIONAL STATE
STOCKS
supply
sink
wastes
inputs
HOW MUCH ECOSYSTEM ACTIVITY
HOW MUCH SOCIETAL ACTIVITY
(ϕ/hectare)i
Carrying Capacity (SCALING!!!!!)
(ϕ/hour)i
FLOW-FUND RATIOS Intensive variables
FLOW-FUND RATIOS Intensive variables
size in hectares/year
Funds of the ecosystems
Funds of the society
size in hours/year
SIZE OF FUNDS Extensive variables
SIZE OF FUNDS Extensive variables
A.
D.



EXPORTS
Economics
B.
Material Energy Flow Accounting (MEFA)
FLOWS metabolized
by ecosystems
FLO
bolized
by
IMPORTS
sink
was
STO
Ecology
Bioeconomics
Input/Output
Sociology
Demography
(ϕ/hour)i
(ϕ/hecta
FLOW-FUND
calculated "per hec
Intensive variables
W-FUND RATIOS
lated "per hour"
ensive variables
size in
hectares/year
ecosystems
hours/year
SIZE OF FUNDS
Extensive variables
SI
S
Extensi
iables
A.
D.

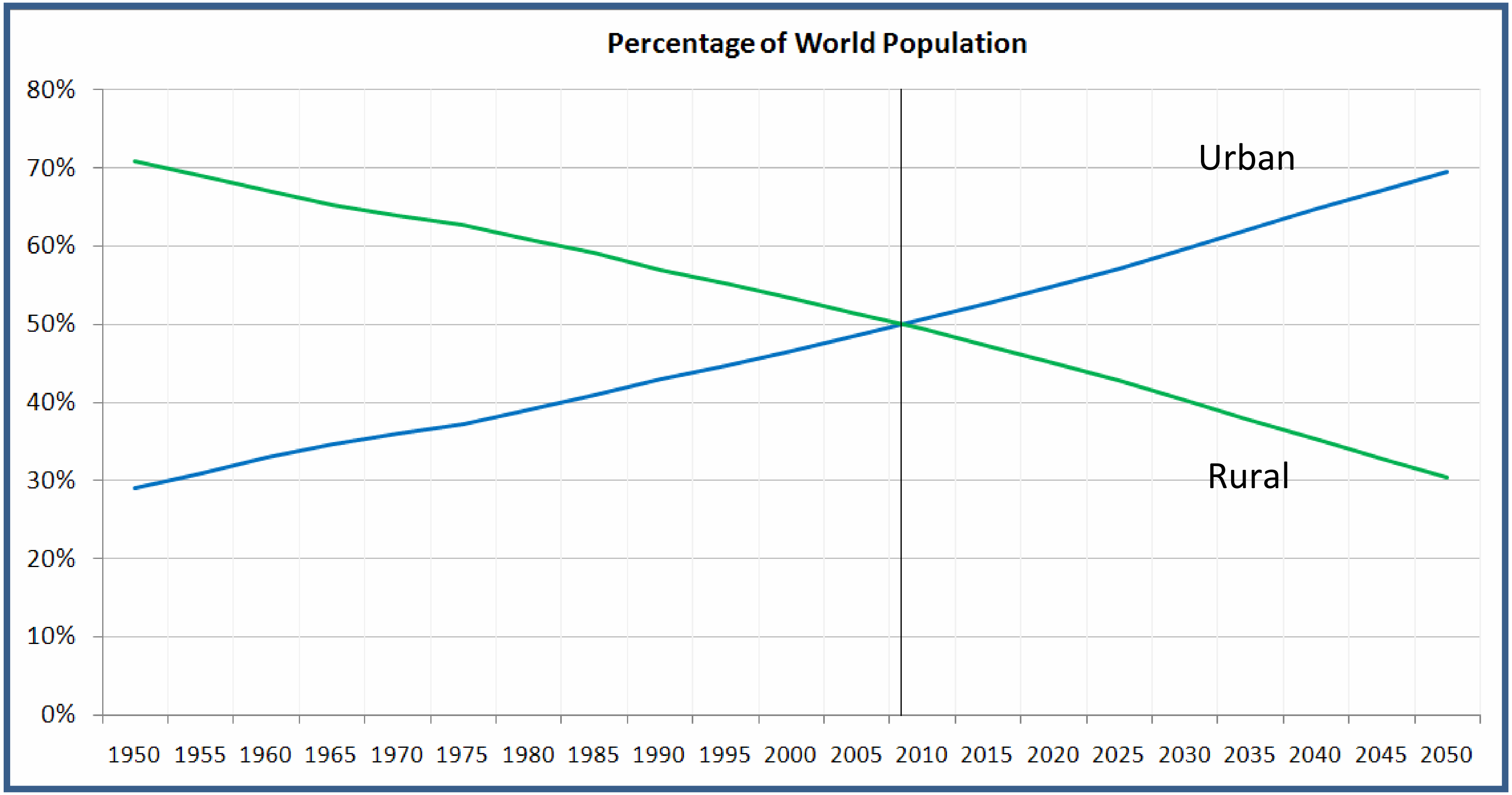


B.
SIZE of FLO
PRESSURE
PER YEAR
EXPORTS
DEGI
IMPACT
(externalized)
S
C.
FLOWS metabolized by ecosystems
FLOWS metabolized by society
IMPORTS
IMPACTS
(local)
STOCKS
supply
sink
wastes
inputs
ECOSYSTEM ACTIVITY
SOCIETAL ACTIVITY
STATES
(ϕ/hectare)i
FLOW
Less rain
TIOS
Intensive variables
More consumption per capita per year
Intensive variables
Funds of the ecosystems
Funds of the society
DRIVERS
(changes)
DRIVERS
(changes)
DS
Less forest
ables
SIZE OF FUNDS
More people
ples
A.
D.

4. Cómo los economistas perdieron contacto con la realidad biofísica: MONEY is no longer good for MONITORING

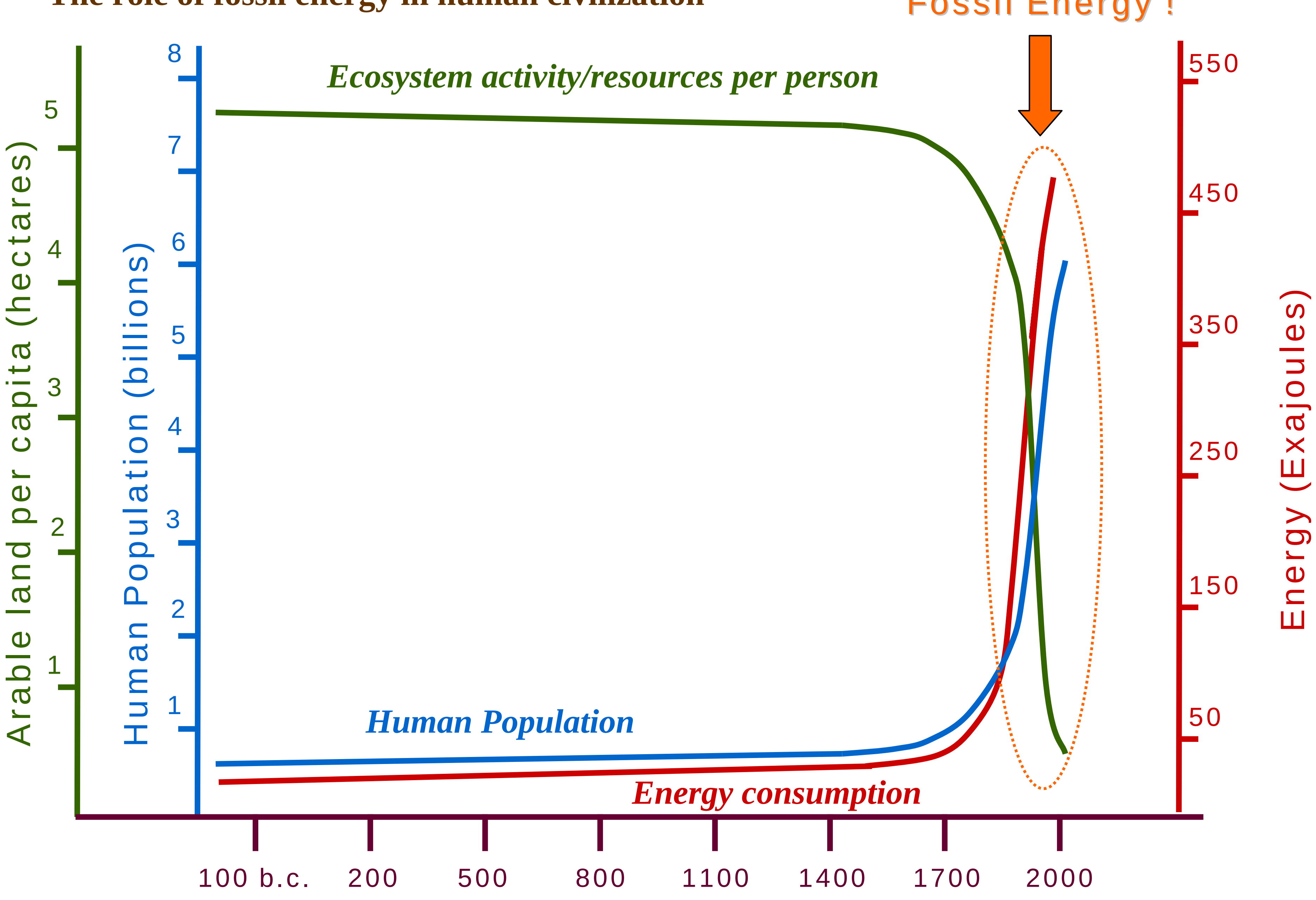
The delirium of urban elites . . .

Urban settlements are taking over the planet and replacing the rural world!



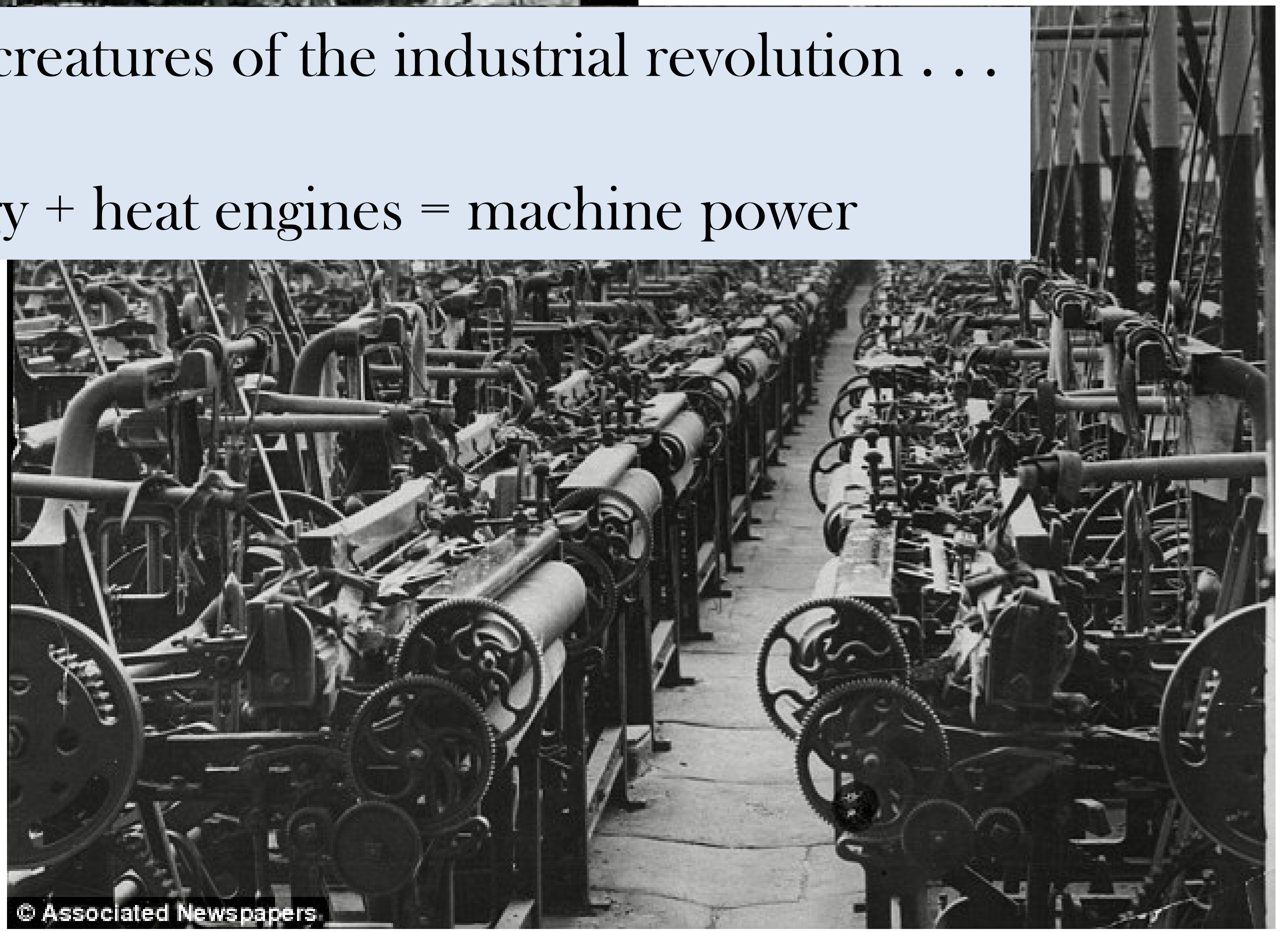
http://esa.un.org/unup/p2k0data.asp

The role of fossil energy in human civilization



Cities are creatures of the industrial revolution . . .

fossil energy + heat engines = machine power



The inhabitants of the cities of the east coast of the USA (e.g. Boston, New York, Baltimore) heated their homes with coal from England, brought from a distance of over a thousand leagues, rather than with the wood of their forests located ten leagues away. Transporting the goods ten leagues overland was mor ... agues

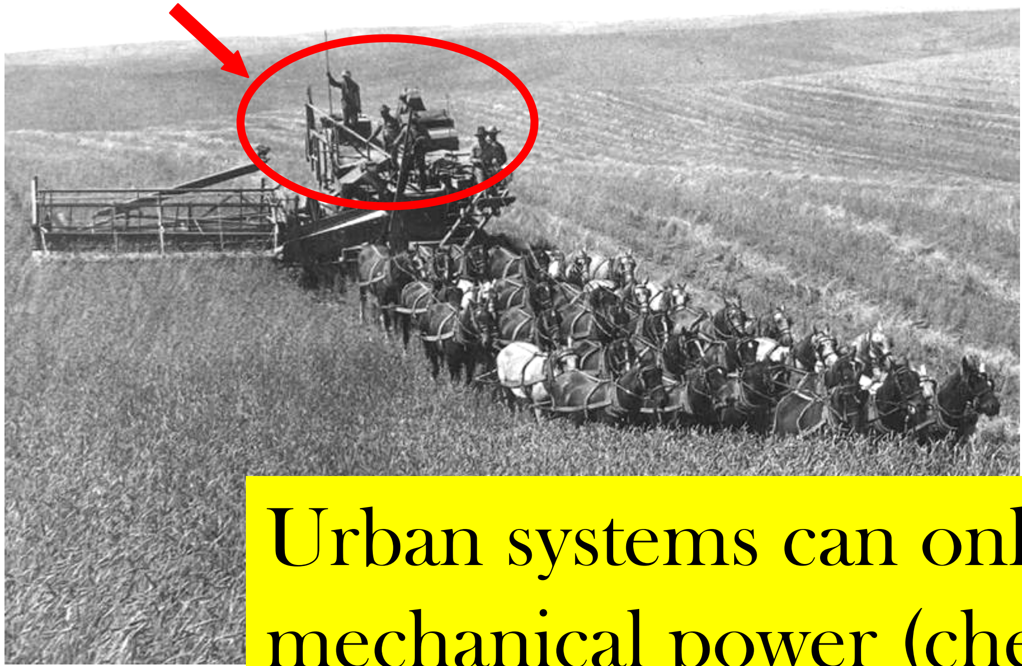
overseas

Cities needs cheap transportation because they live on inputs coming from distant places . . .

Jean Baptiste Say

Lecture to the Collège de France

1828



33 HP animal power (controlled by 5 workers)

* land for feed
* work for caring them
* smell

Urban systems can only work using mechanical power (cheap power). . .

200 HP mechanical power (controlled by 1 worker)

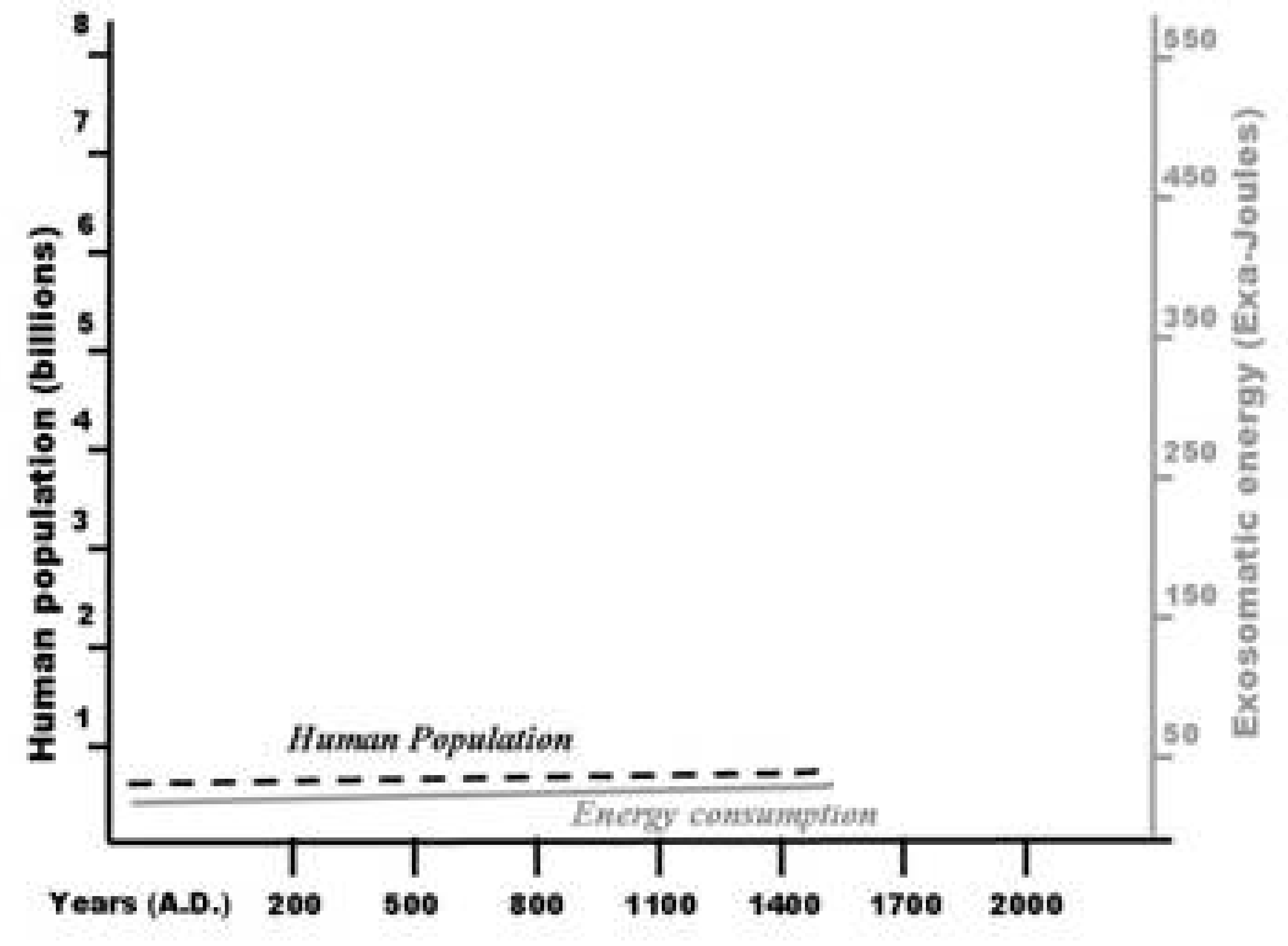
* fuel
* maintenance and spare parts
* CO_2 emission
* iron and other materials
* construction of the machine

Horse Manure in the streets of New York City (1983)

Transport before fossil energy was problematic for the cities . . .

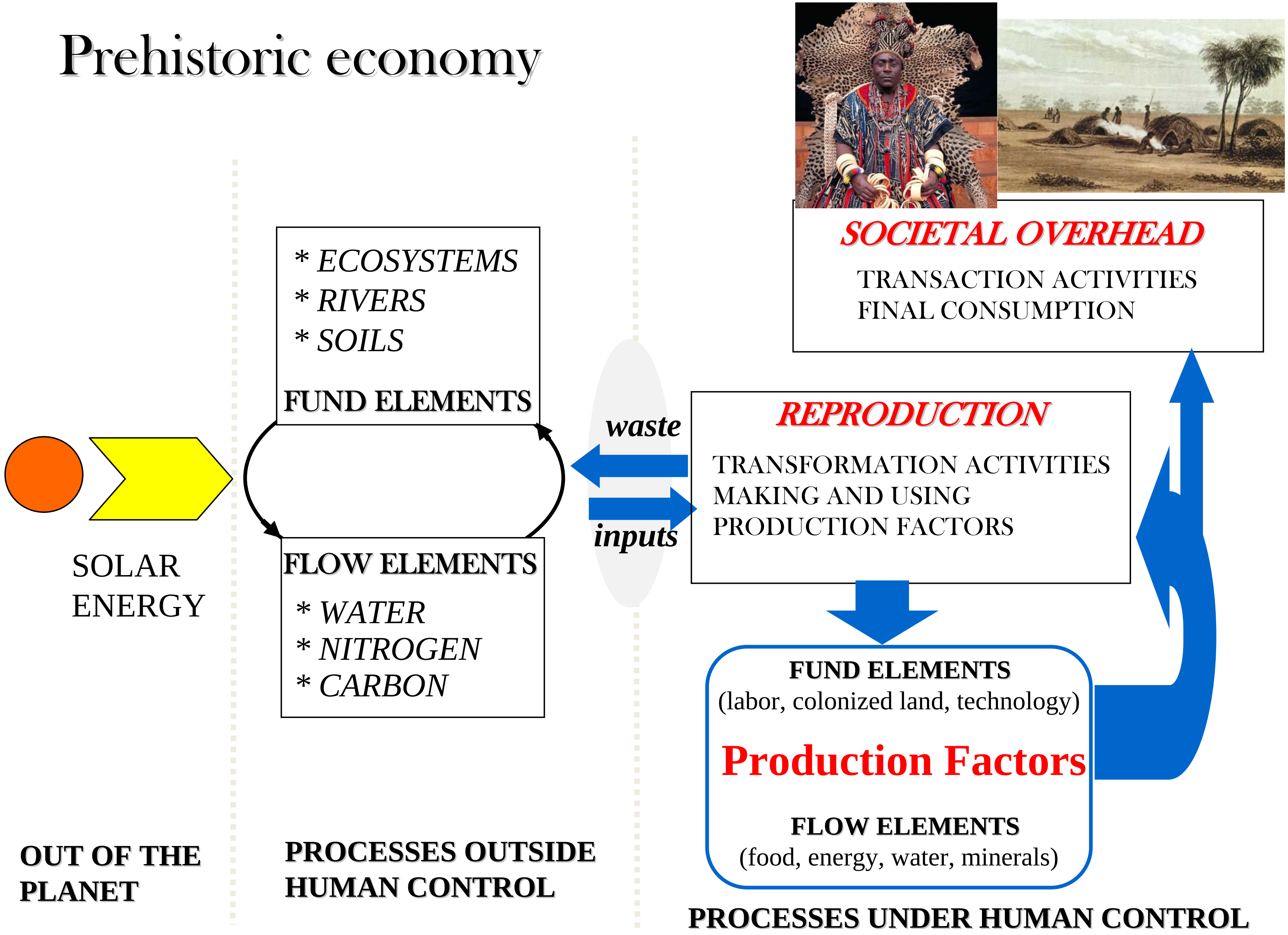
Cities are *entirely open systems* depending totally from inputs coming from the outside that are concentrated, processed and consumed in a small fraction of the total area.

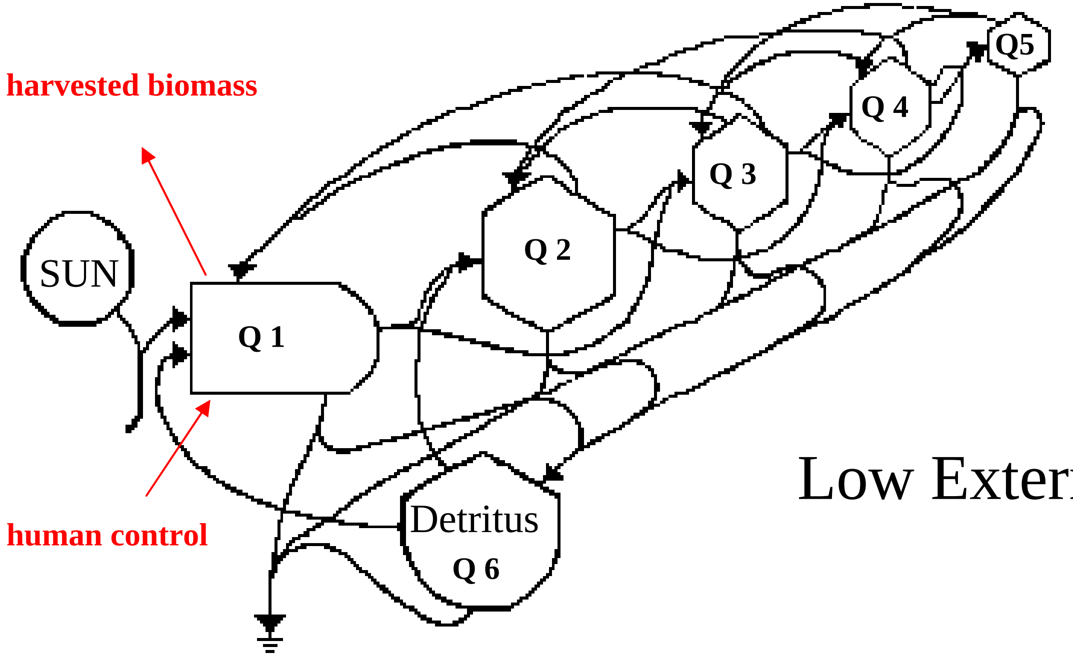
The supply of these inputs depends on:
(i) availability of cheap fossil energy;
(ii) technology (mechanical power);
(iii) resources produced by rural communities
(iv) ecological services



The situation in the past

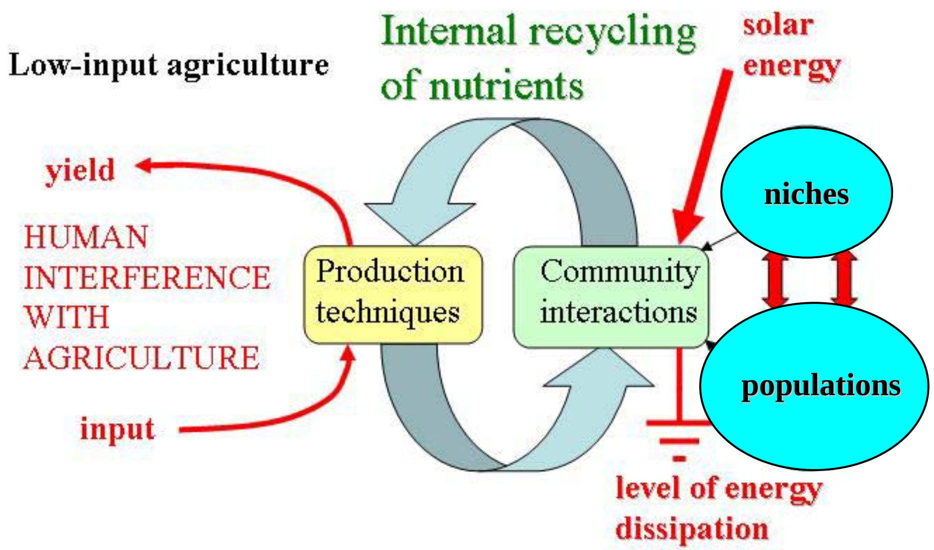
Prehistoric economy



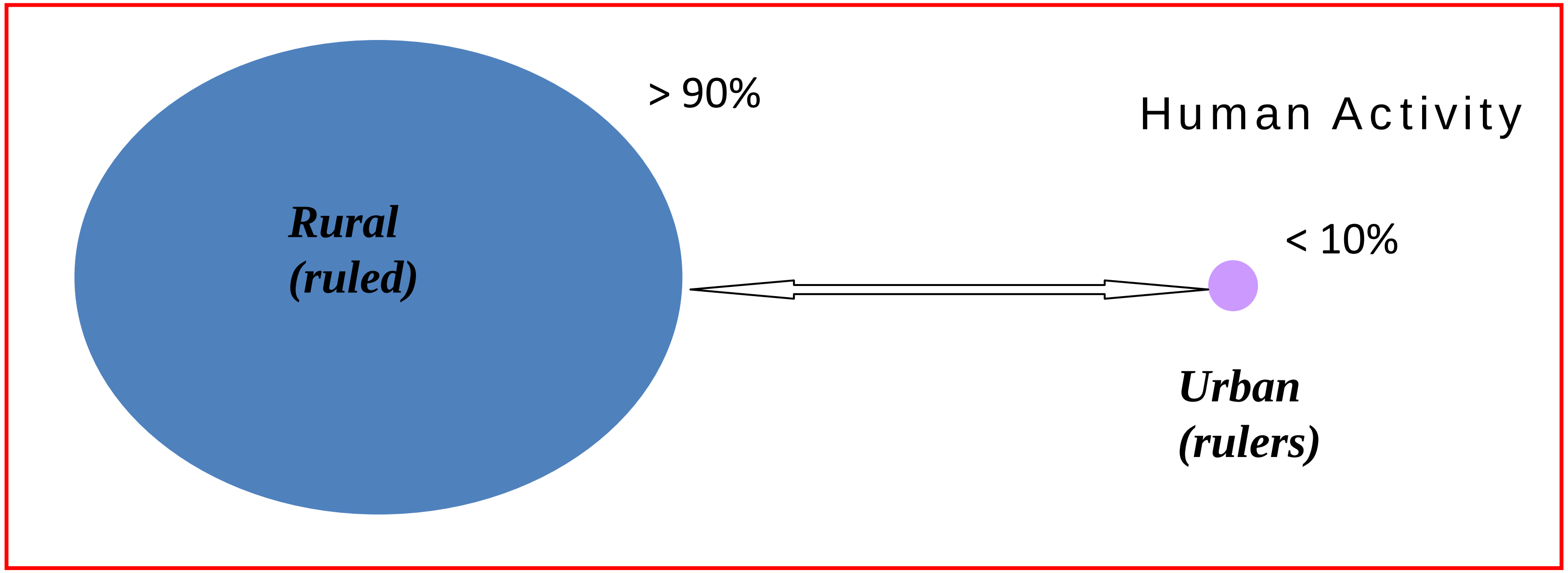


GOOD for the environment
* LOW density of population
* POOR rural communities

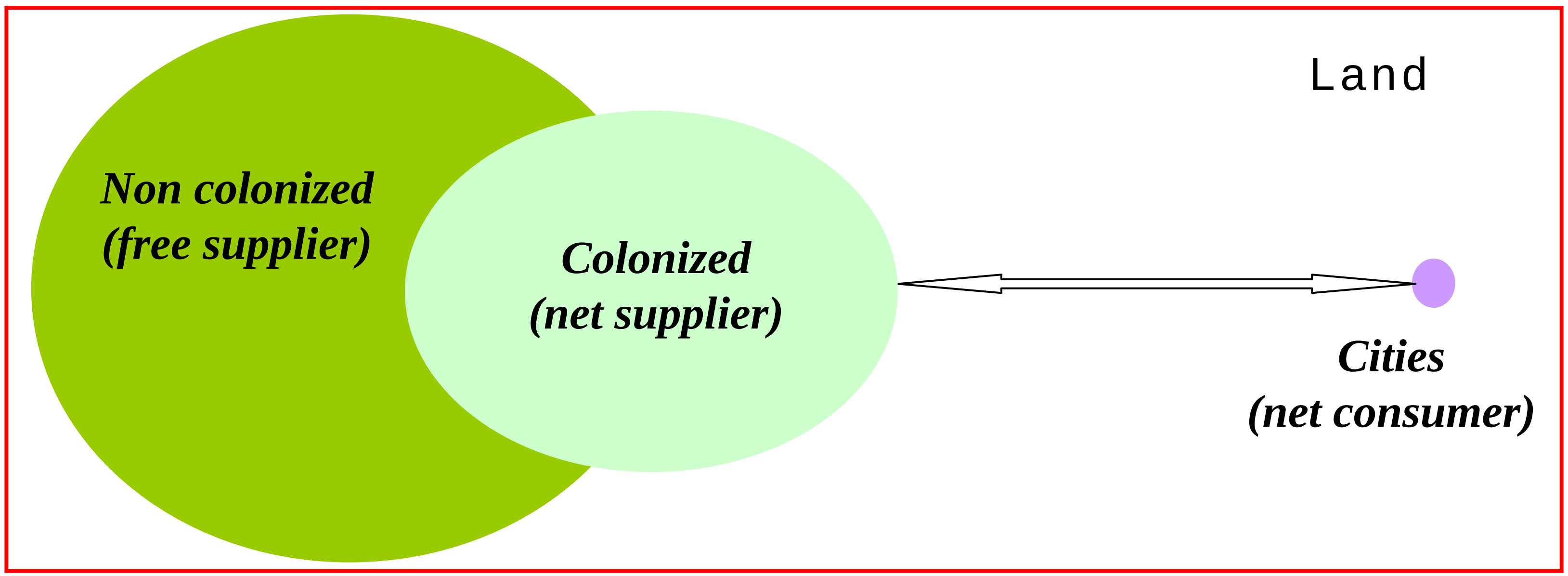
Low External Input Agriculture



You produce:
1 ton of grain/ha
1 kg of grain per hour of labor

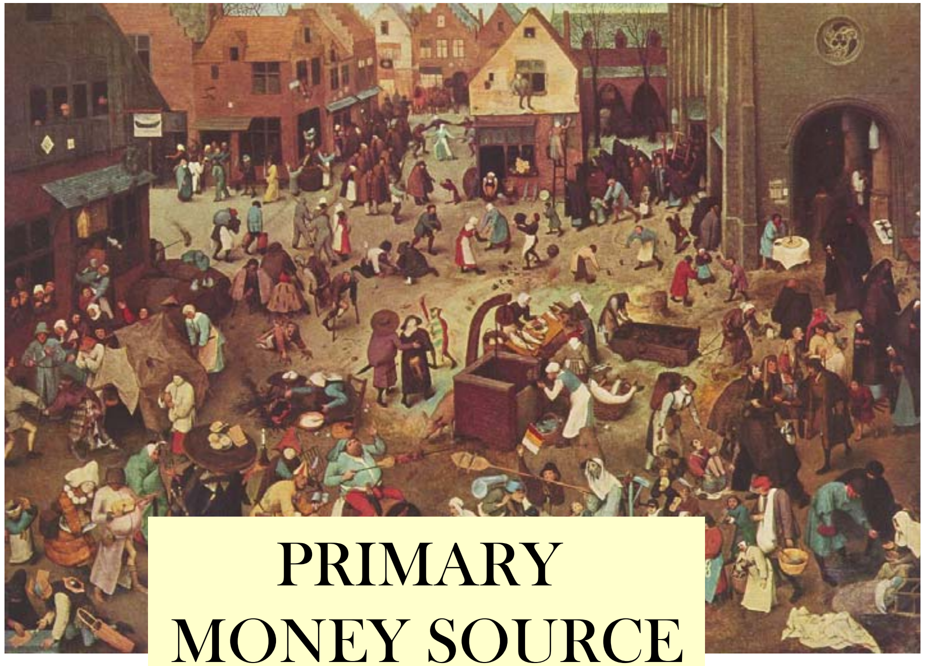


Pre-industrial Societies: Hierarchical Relations



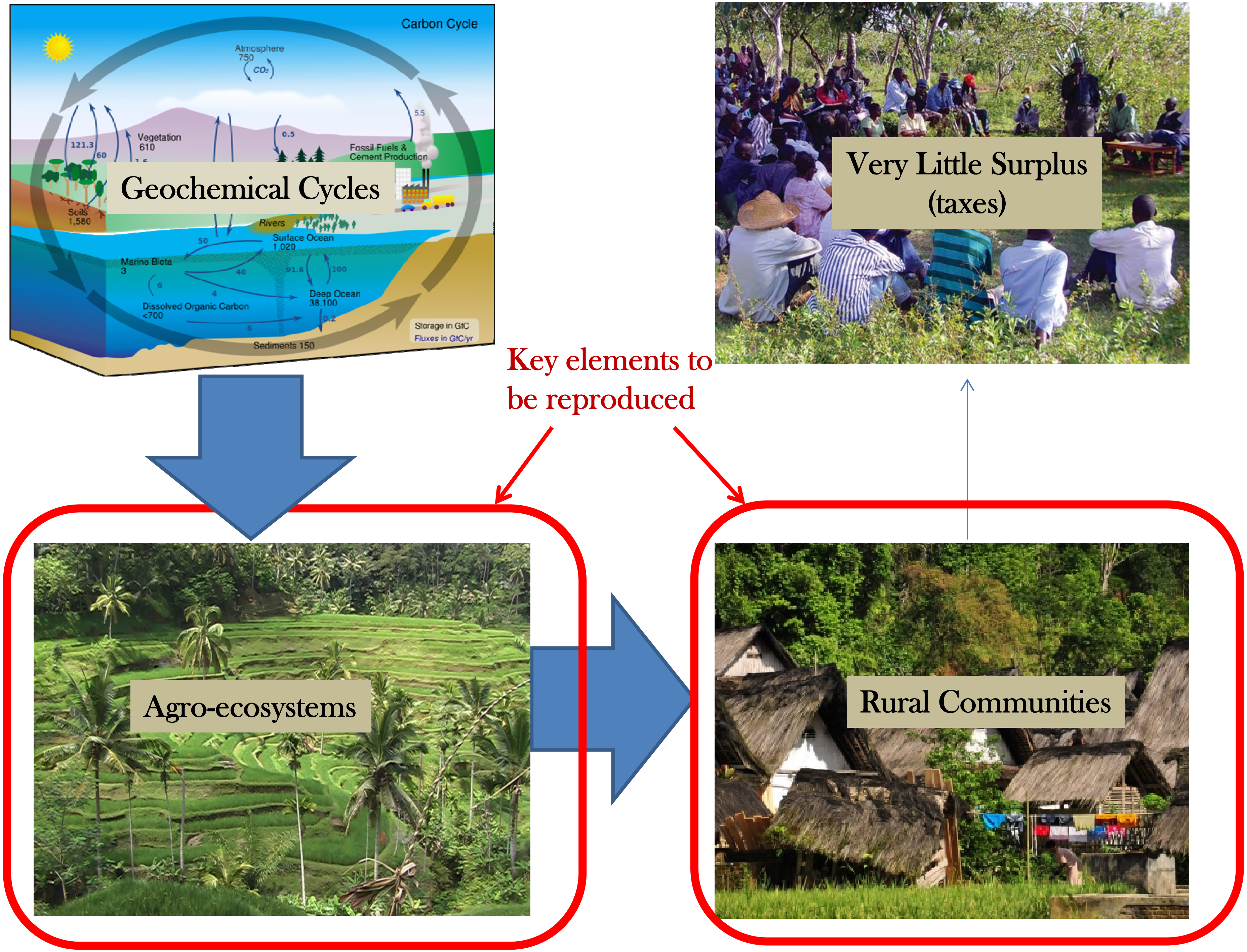
The social perception of primary sources of relevant flows **before the industrial revolution**

PRIMARY FOOD SOURCE

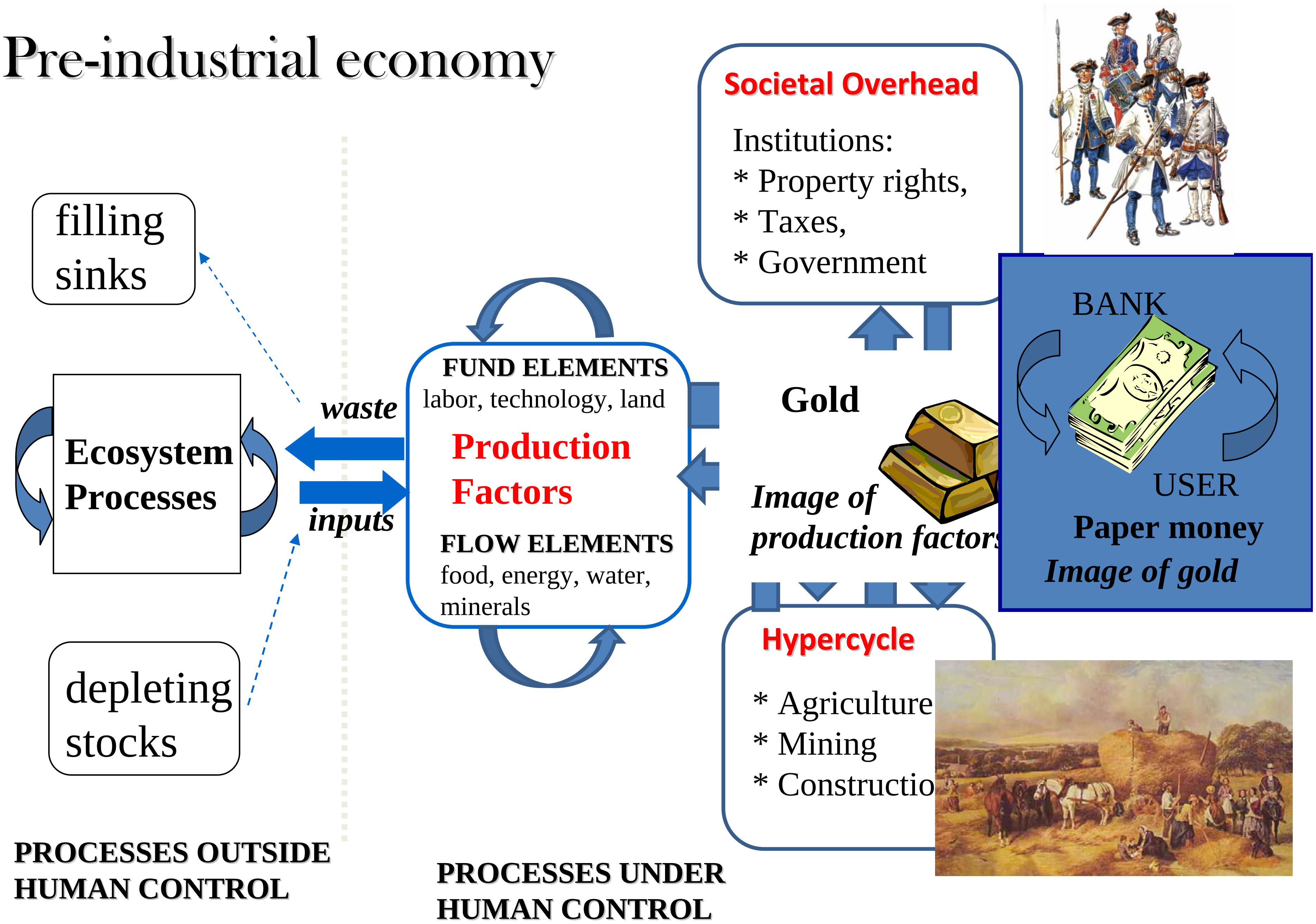


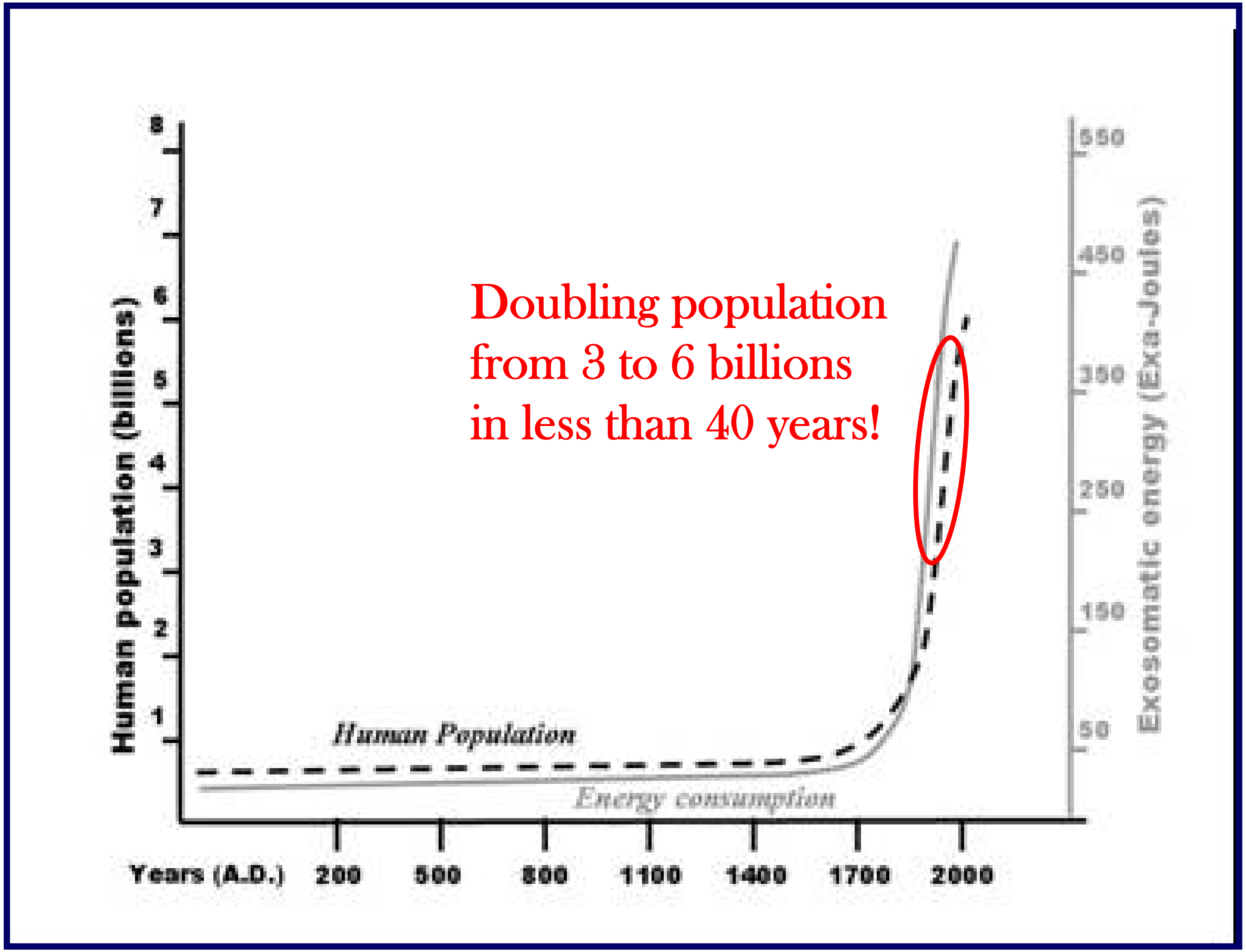
PRIMARY MONEY SOURCE

PRIMARY ENERGY SOURCE

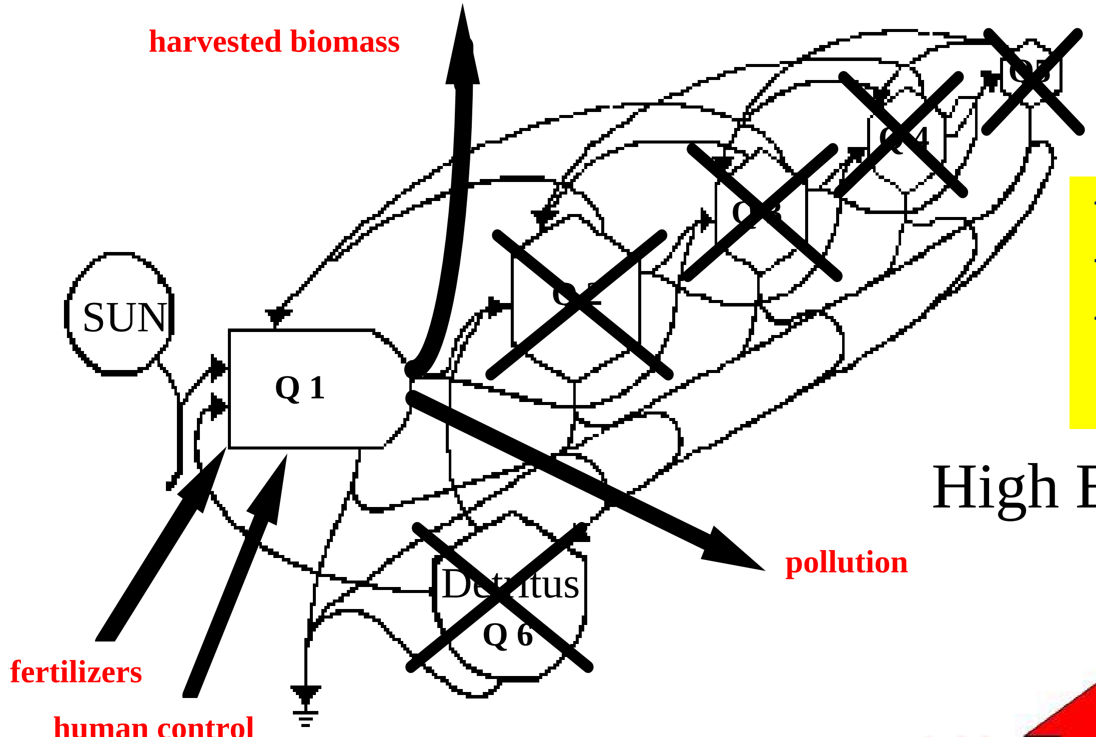

Carbon Cycle
Atmosphere
750
Vegetation
610
Fossil Fuels &
Cement Production
Soils
1,580
Rivers
Surface Ocean
1,020
Marine Biota
3
Deep Ocean
38,100
Dissolved Organic Carbon
<700
Sediments 150
Storage in GtC
Fluxes in GtC/yr
Geochemical Cycles
Very Little Surplus
(taxes)
Key elements to
be reproduced
Agro-ecosystems
Rural Communities

Pre-industrial economy



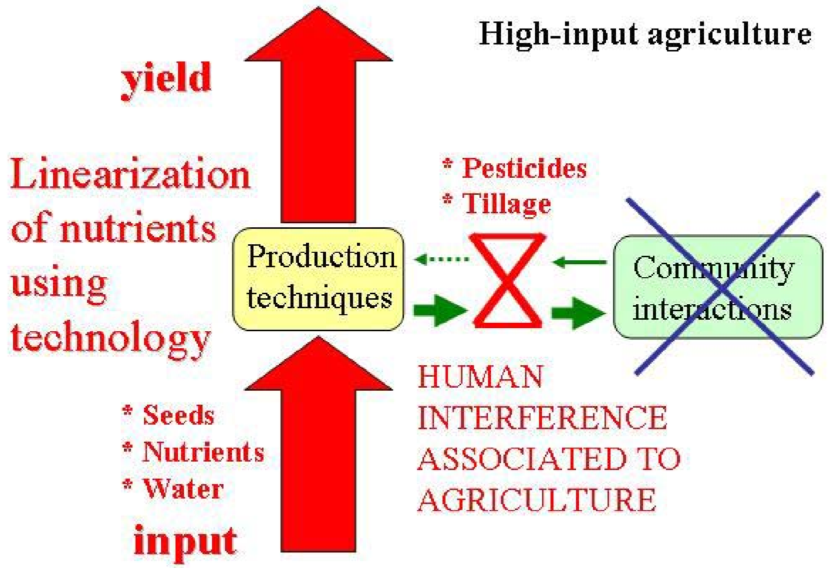


The situation after the industrial revolution

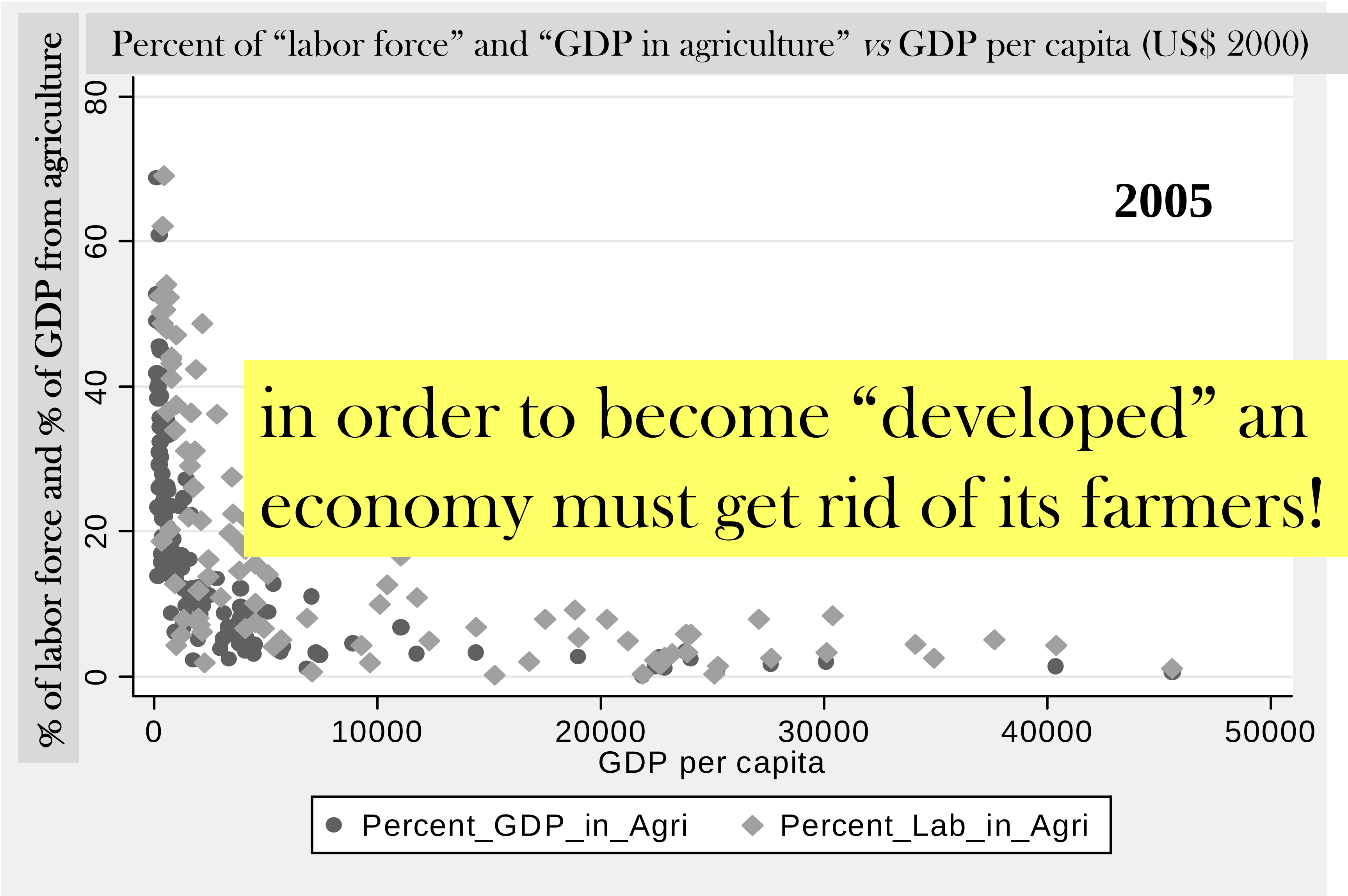


* BAD for the environment
* HIGH density of population
* rural communities DEPEND ON SUBSIDIES

High External Input Agriculture

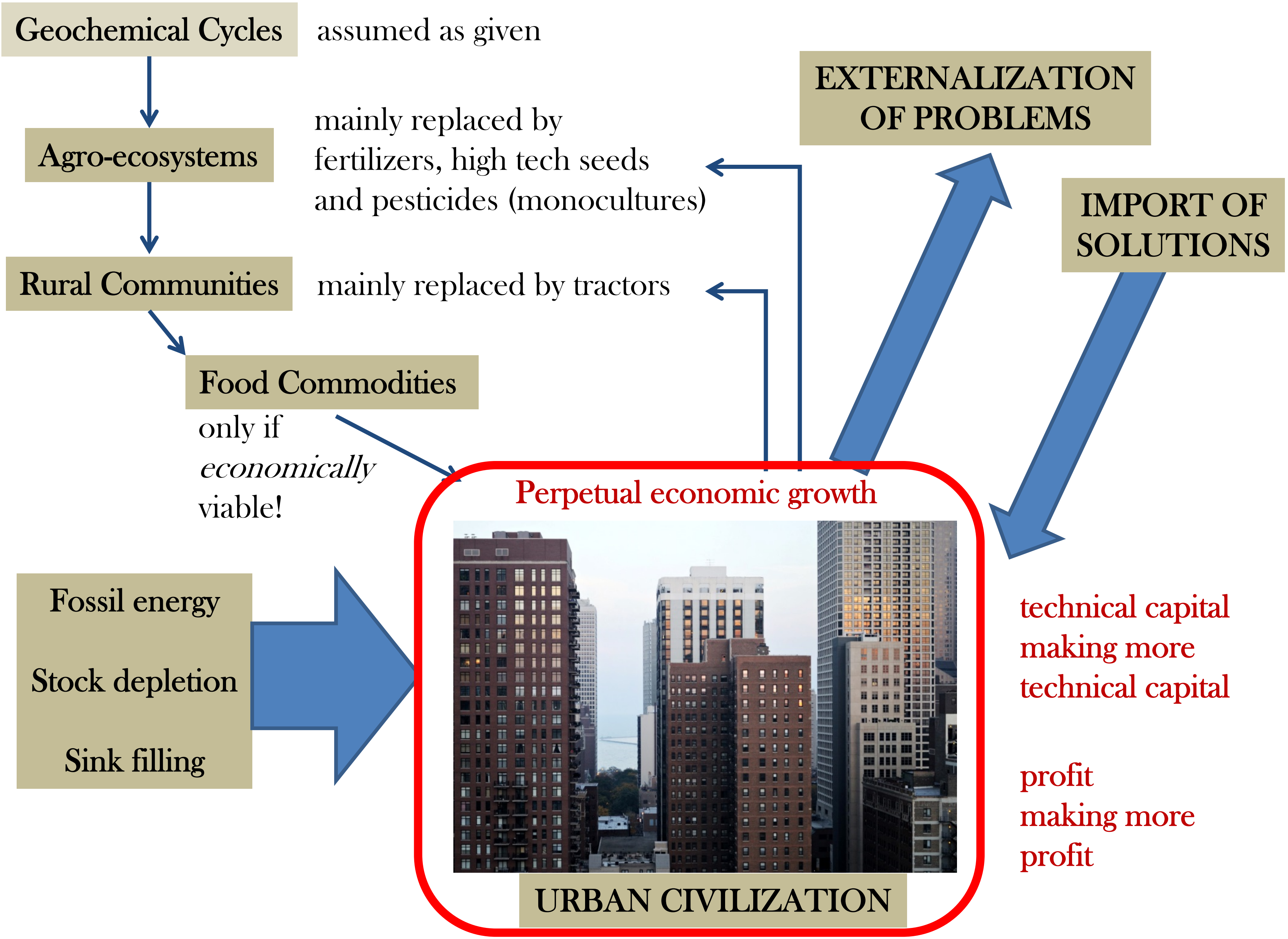


You produce:
8 tonnes of grain/ha
800 kg of grain per hour of labor



Source: WDI (2005).

The social perception of primary sources of relevant flows **after the industrial revolution**


Geochemical Cycles
assumed as given
Agro-ecosystems
mainly replaced by fertilizers, high tech seeds and pesticides (monocultures)
Rural Communities
mainly replaced by tractors
Food Commodities
only if *economically* viable!
EXTERNALIZATION OF PROBLEMS
IMPORT OF SOLUTIONS
Fossil energy
Stock depletion
Sink filling
Perpetual economic growth
URBAN CIVILIZATION
technical capital making more technical capital
profit making more profit

Geochemical Cycles — assumed as given

Agro-ecosystems — mainly replaced by fertilizers, high tech seeds and pesticides (monocultures)

Rural Communities — mainly replaced by tractors

Food Com...

EXTERNALIZATION OF PROBLEMS

...ORT OF ...TIONS

Fossil e...

Stock dep...

Sink filling

This hypercycle is breaking the national level of governance

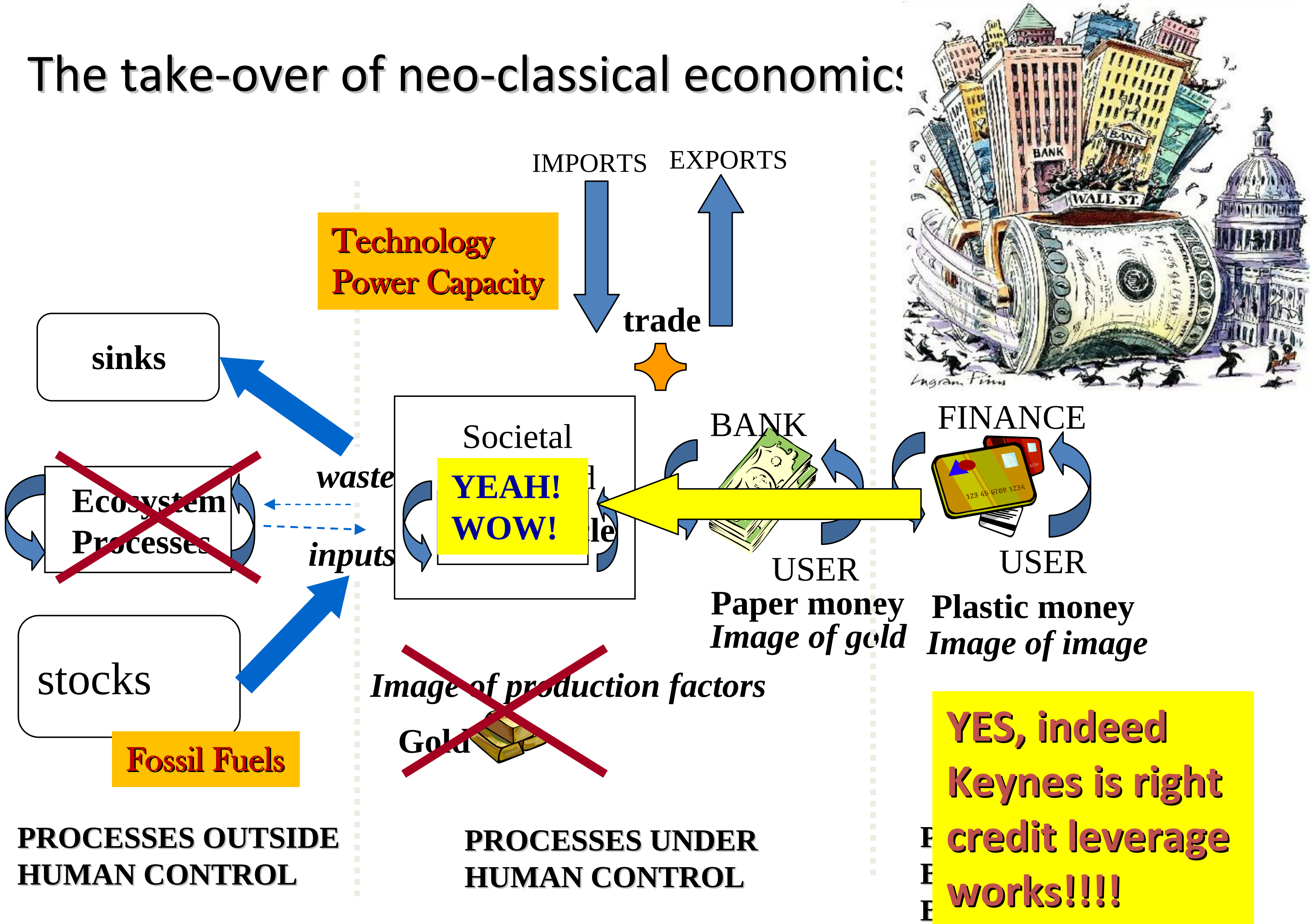
GLOBALIZATION means that national urban systems are more and more taken over by international financial elites living "delocalized" in MEGACITIES . . .

URBAN CIVILIZATION

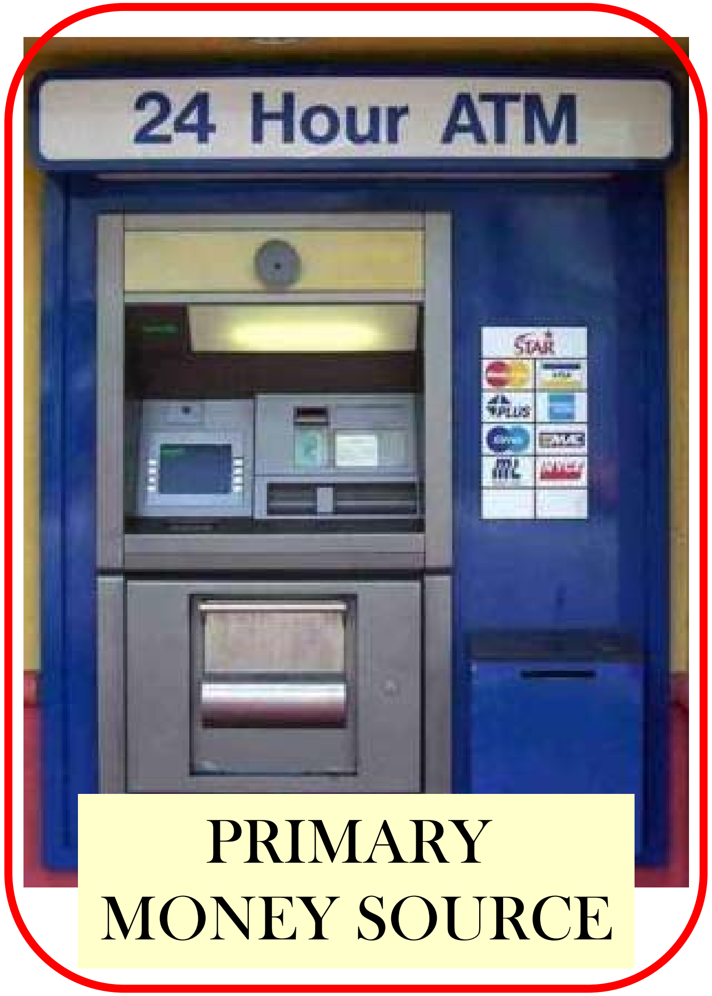
technical capital making more technical capital

profit making more profit

The take-over of neo-classical economics

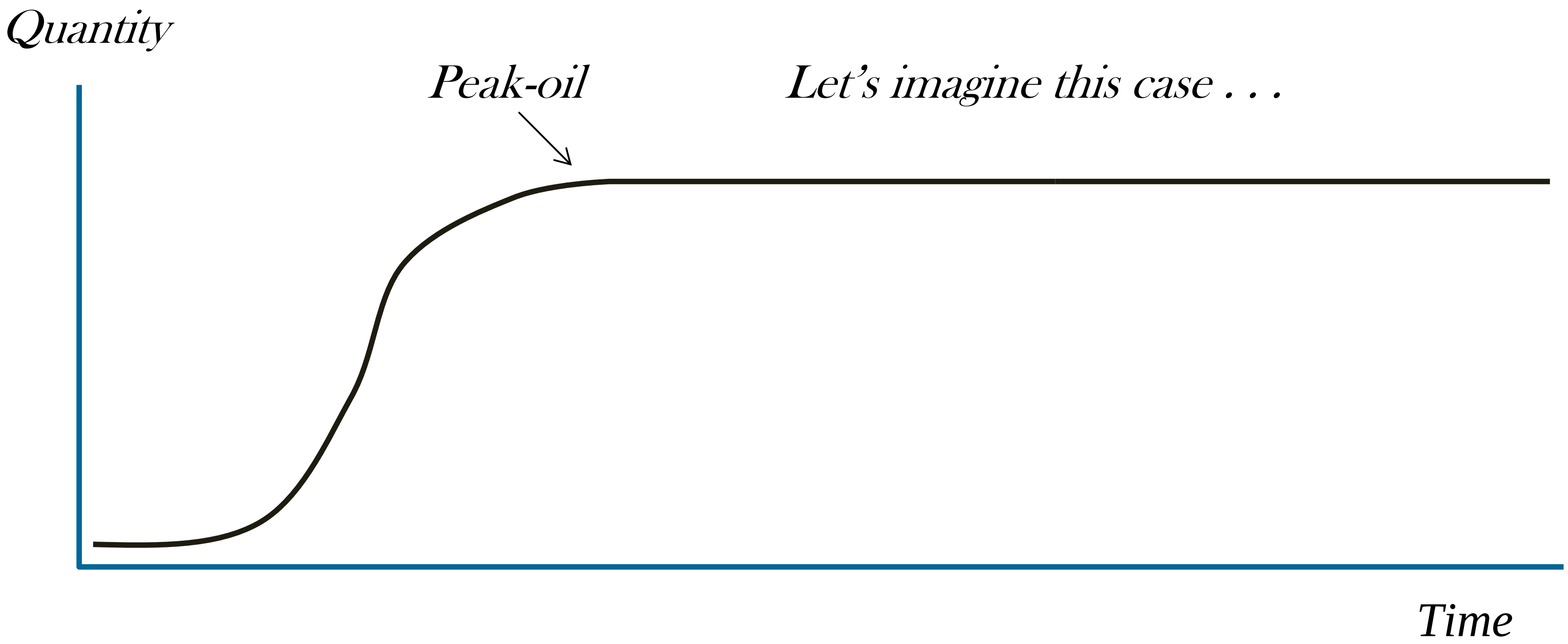


The social perception
of primary sources
of relevant flows **among
urban elites** . . .



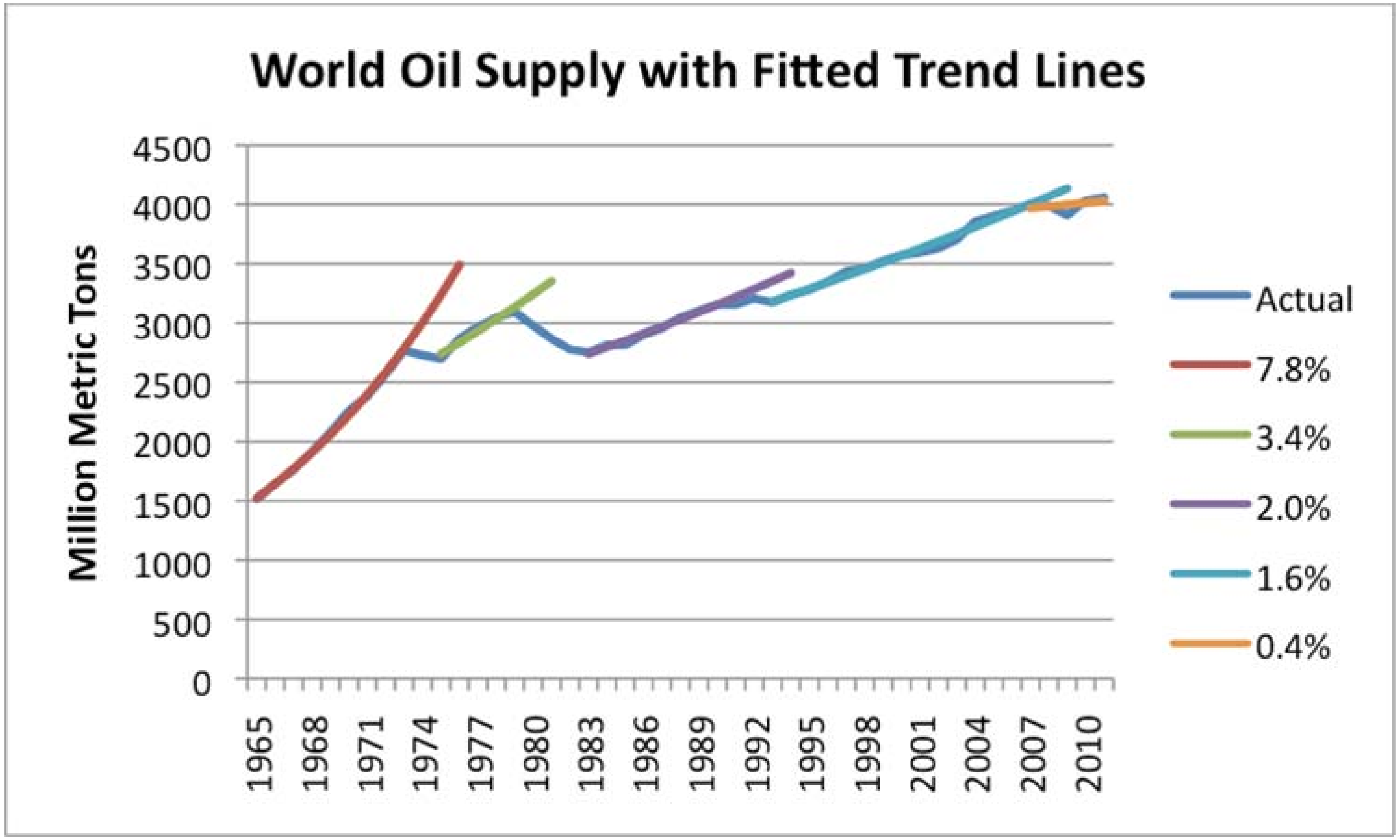
!

A different take on **Peak oil . . .**
"the point in time when the maximum rate of extraction of petroleum (and other limiting resources!) is reached . . ."



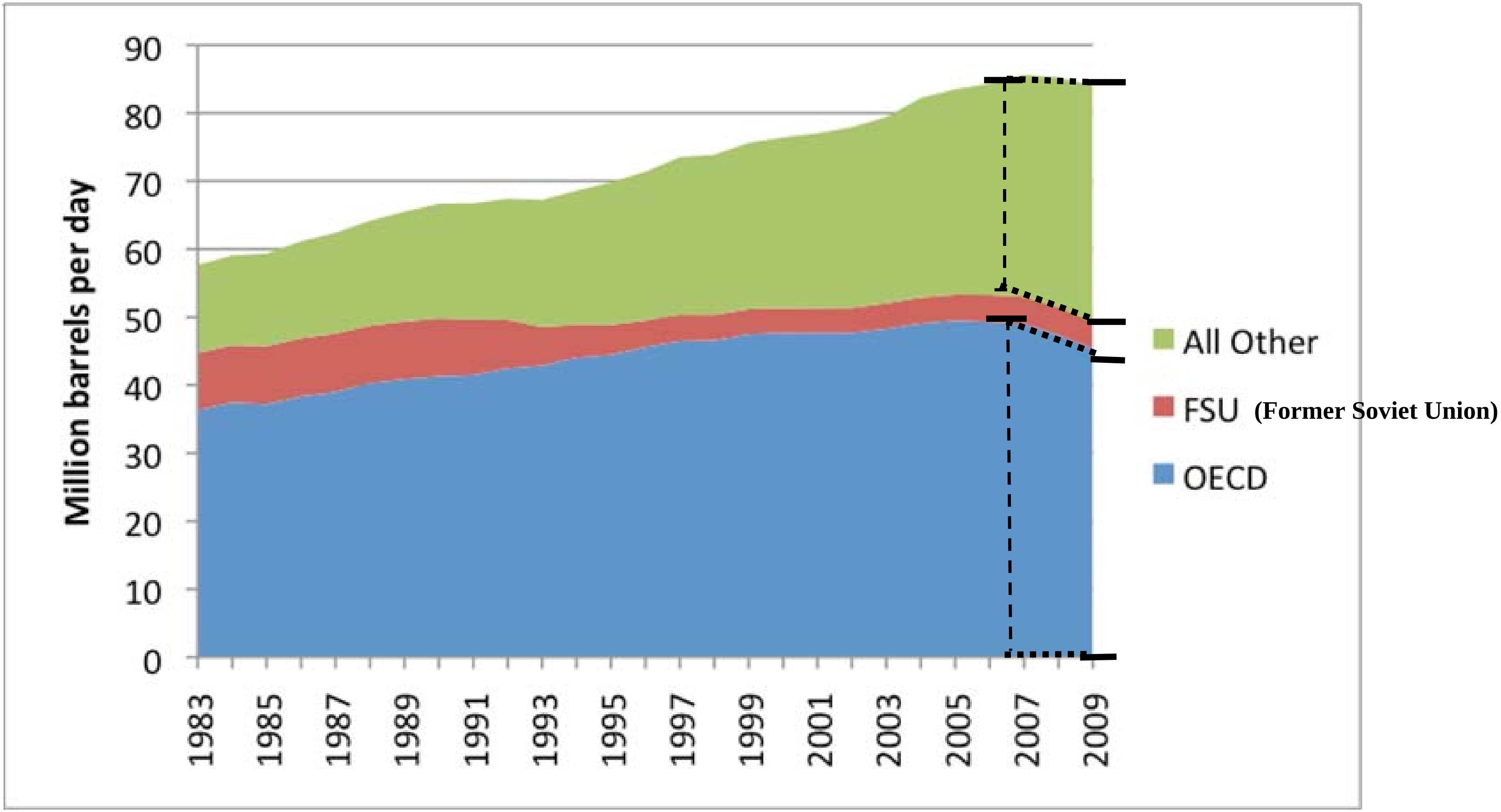
Then **the relevance of peak-oil is not about** "the end of the supply of fossil energy", rather it is about the end of conventional economic growth based on credit leverage . . .

The end of the growth in oil supply



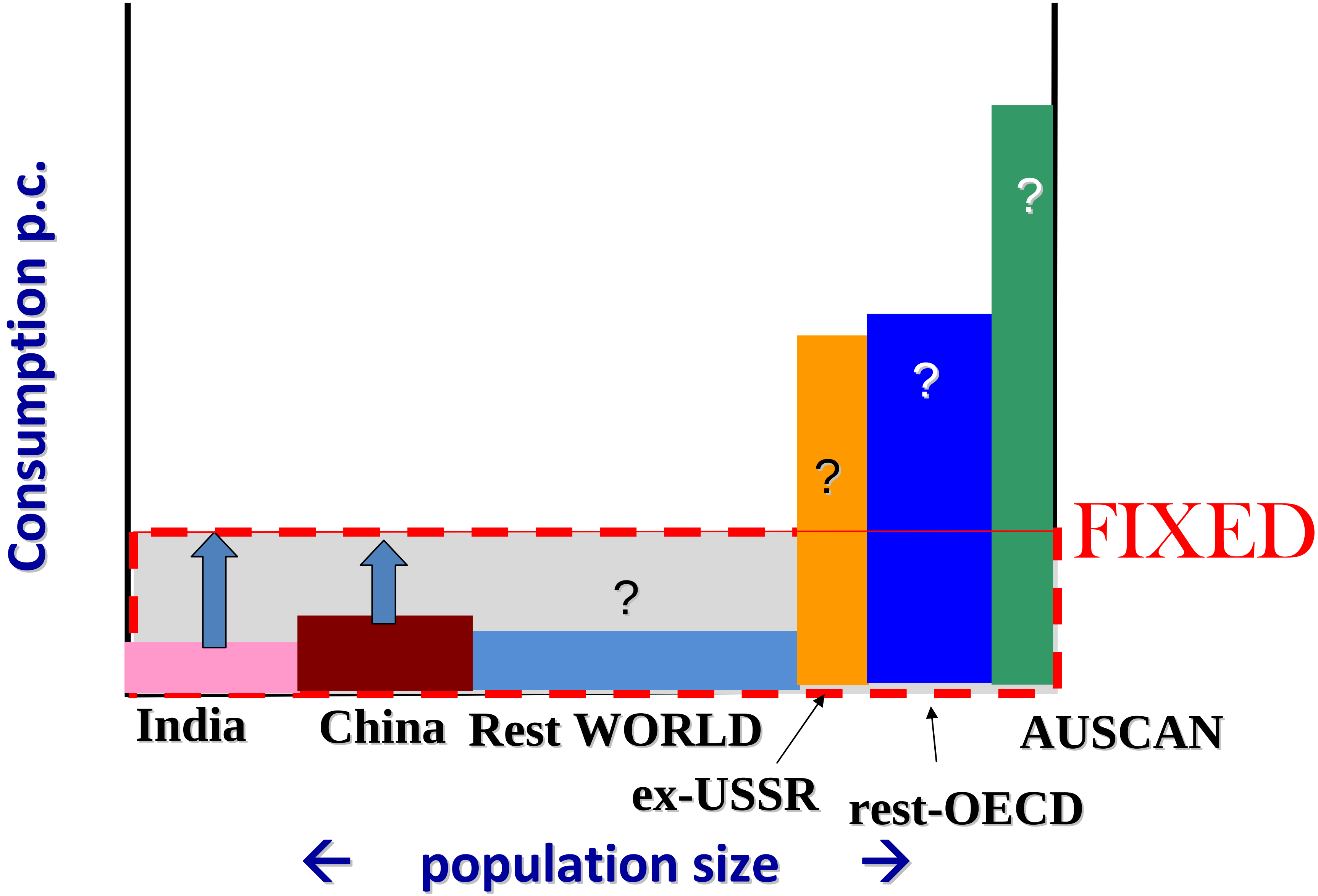
Based on BP's 2012 Statistical Review of World Energy data

Trends in oil consumption



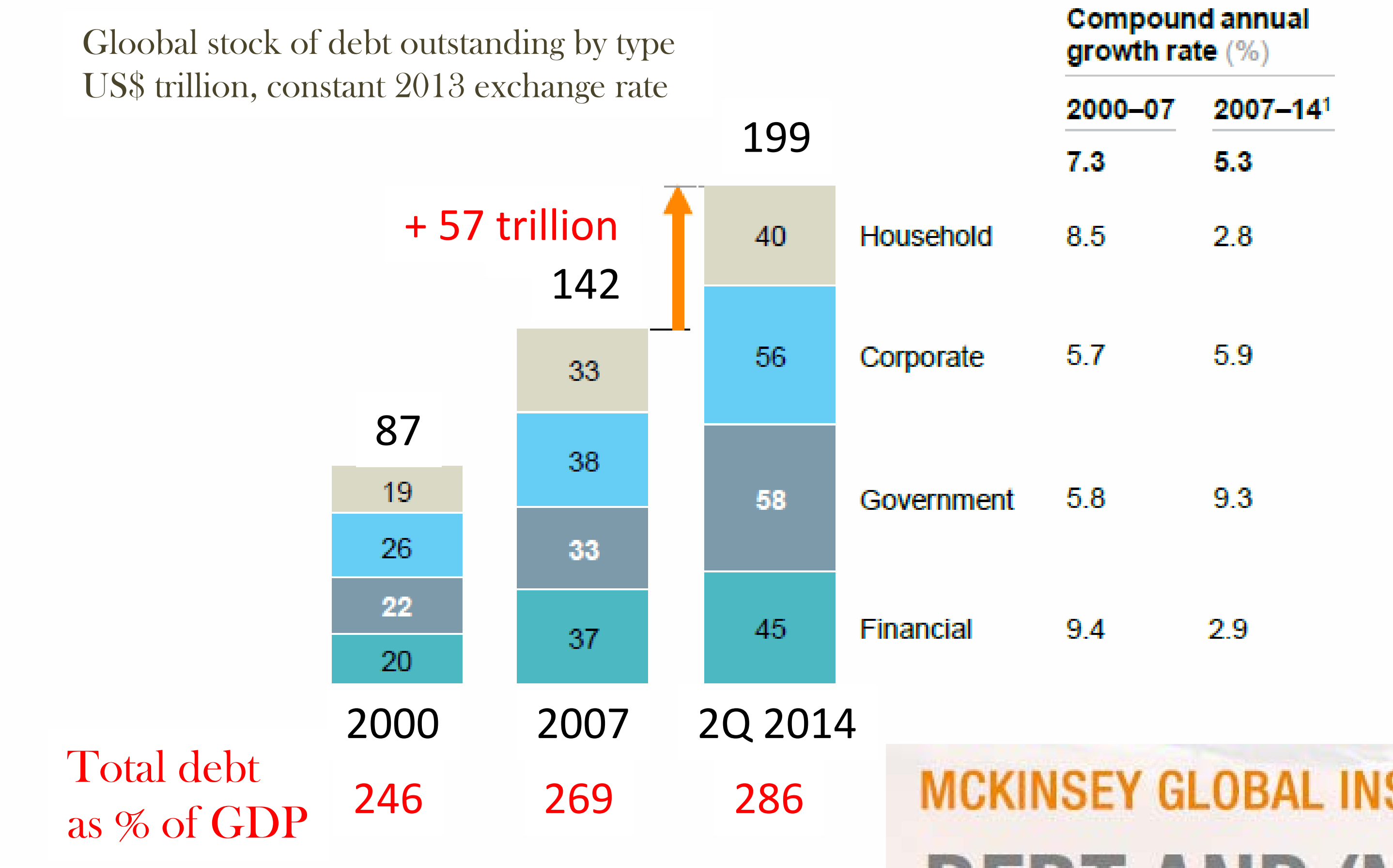
Source: BP Statistical Review of World Energy 2010

Change in the consumption of fossil energy



Welcome to the era of
“Ponzi Scheme Economics”!

Global debt has increased by $57 trillion since 2007, outpacing world GDP growth



World GDP 2007
40 Trillions

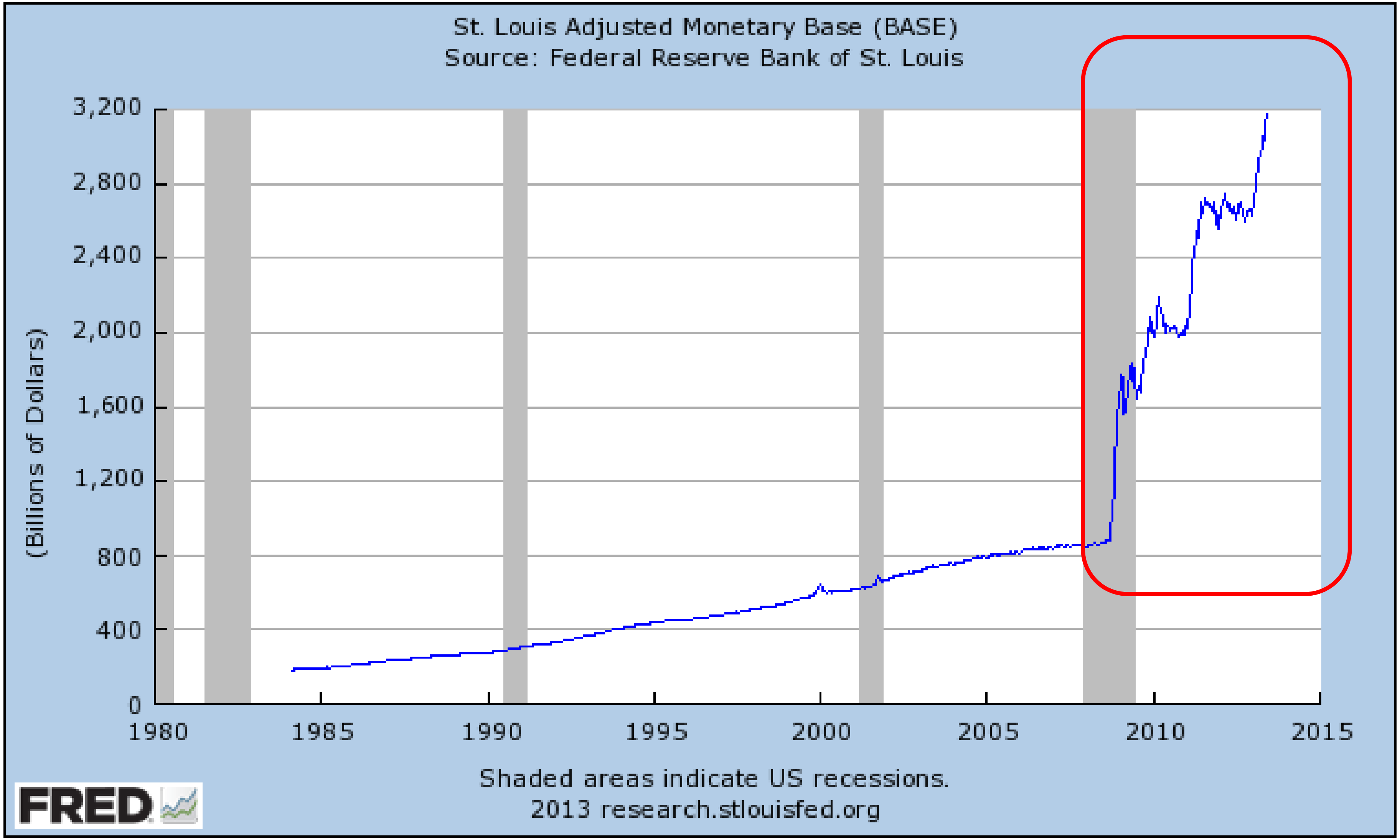
World GDP 2014
78 Trillions

MCKINSEY GLOBAL INSTITUTE

DEBT AND (NOT MUCH) DELEVERAGING

February 2015

http://www.mckinsey.com/insights/economic_studies/debt_and_not_much_deleveraging



Printing money now is called "*quantitative easing*" . . .

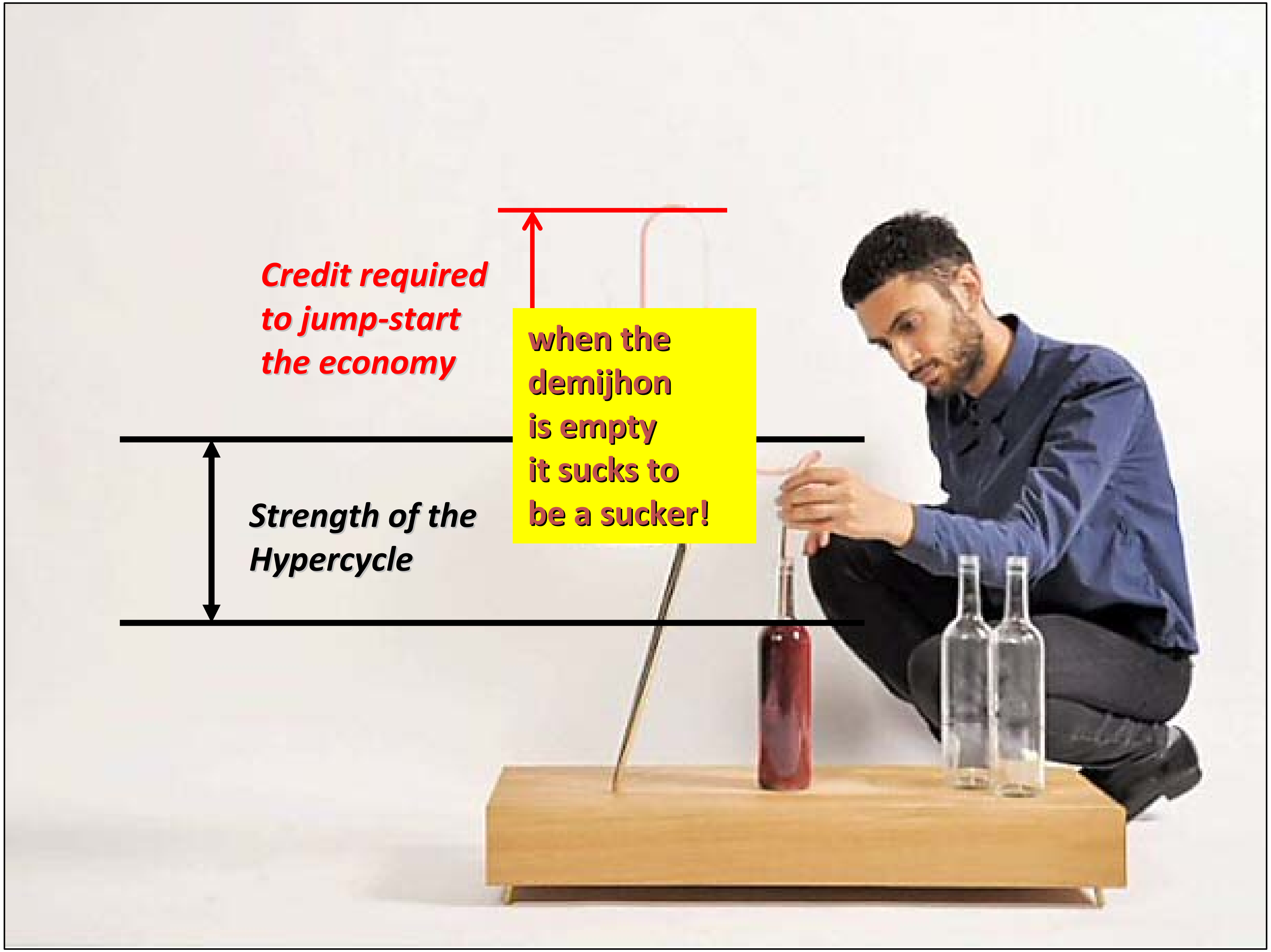
The Elephant In The Room: Deutsche Bank's $75 Trillion In Derivatives Is 20 Times Greater Than German GDP

Submitted by Tyler Durden on 04/28/2014 14:56 -0400

It is perhaps supremely ironic that the last time we did an in depth analysis of Deutsche Bank's financial situation was precisely a year ago, when the largest bank in Europe (and according to some, the world), stunned its investors with a 10% equity dilution. Why the capital raise if everything was as peachy as the ECB promised it had been? It turned out, ***nothing*** was peachy, and in fact DB would proceed to undergo a massive balance sheet deleveraging campaign over the next year, in which it would quietly dispose of all the ugly stuff on its balance sheet during the relentless Fed and BOJ-inspired "dash for trash" rally in a way not to spook investors about everything else that may be beneath the Deutsche covers.

5 U.S. Banks Each Have More Than 40 Trillion Dollars In Exposure To Derivatives

When is the U.S. banking system going to crash? I can sum it up in three words. Watch the derivatives. It used to be only four, but now there are five "too big to fail" banks in the United States that each have more than 40 **trillion** dollars in exposure to derivatives. Today, the U.S. national debt is sitting at a grand total of about 17.7



Rethinking Keynesian policies . . .

https://www.bis.org/publ/work490.pdf

BIS Working Papers
No 490

Why does financial sector growth crowd out real economic growth?

by Stephen G Cecchetti and Enisse Kharroubi

Monetary and Economic Department

February 2015

5. Conclusion

In this paper, we study the real effects of financial sector growth and come to two important conclusions. First, the growth of a country's financial system is a drag on productivity growth. That is, higher growth in the financial sector reduces real growth. In other words, financial booms are not, in general, growth-enhancing, likely because the financial sector competes with the rest of the economy for resources. Second, using sectoral data, we examine the distributional nature of this effect and find that credit booms harm what we normally think of as the engines for growth – those that are more R&D-intensive. This evidence, together with recent experience during the financial crisis, leads us to conclude that there is a pressing need to reassess the relationship of finance and real growth in modern economic systems.

Financial Economy

- Virtual fund elements
  = virtual assets believed

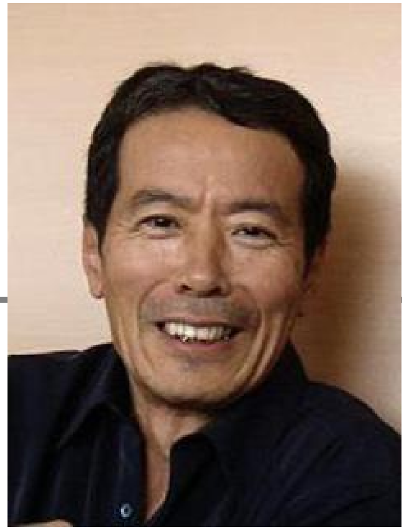
Big advantage!
No issues of scale

- They do not have any biophysical basis = they exist only in human perceptions (and on hard disks)

Big advantage!
You can do it as long as people want to believe

- An… natically in … intensive ch…

Big advantage!
quicker than light in adjusting



Kozo Mayumi

Biophysical Economy

- Physical fund elements

Big problem!
The size matters and exponential growth can only be temporary

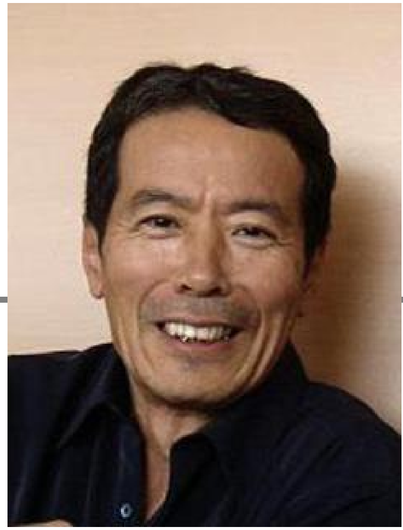
to energy and matter flows

Big problem!
Biophysical processes do imply "reality checks"

- Strong … hole
  = seve… es
  (years …

Big problem!
slow to adjust

Financial Economy


Kozo Mayumi

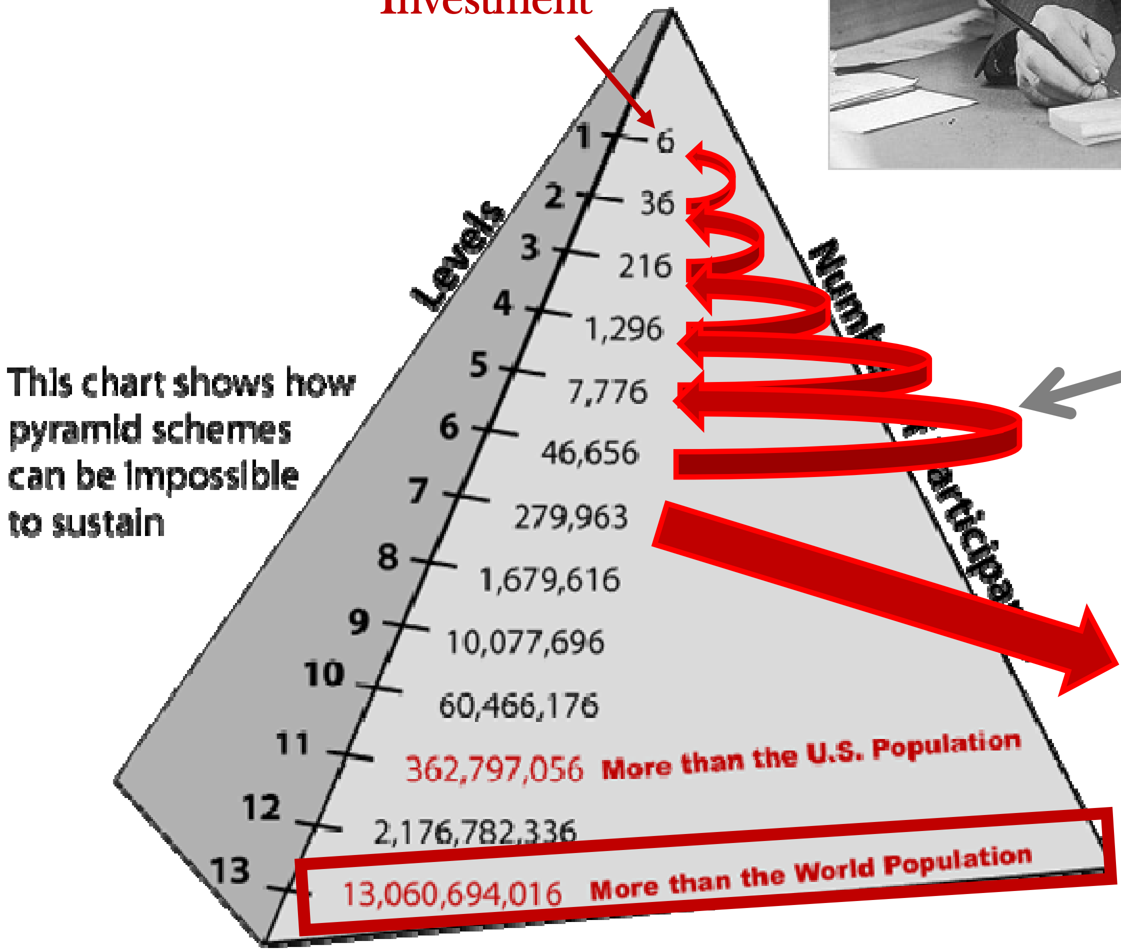
Biophysical Economy

Money investments are controlled by decision makers not worried about the future of their families, cities, countries

Money investments are controlled by individuals concerned with the future of their families, cities and countries

Why is oil below 60 US$/barrel?

Starting
Investment



When the scheme is operating at this point, it is the best of the possible investments!!!!!

TAKE THE MONEY
AND RUN!

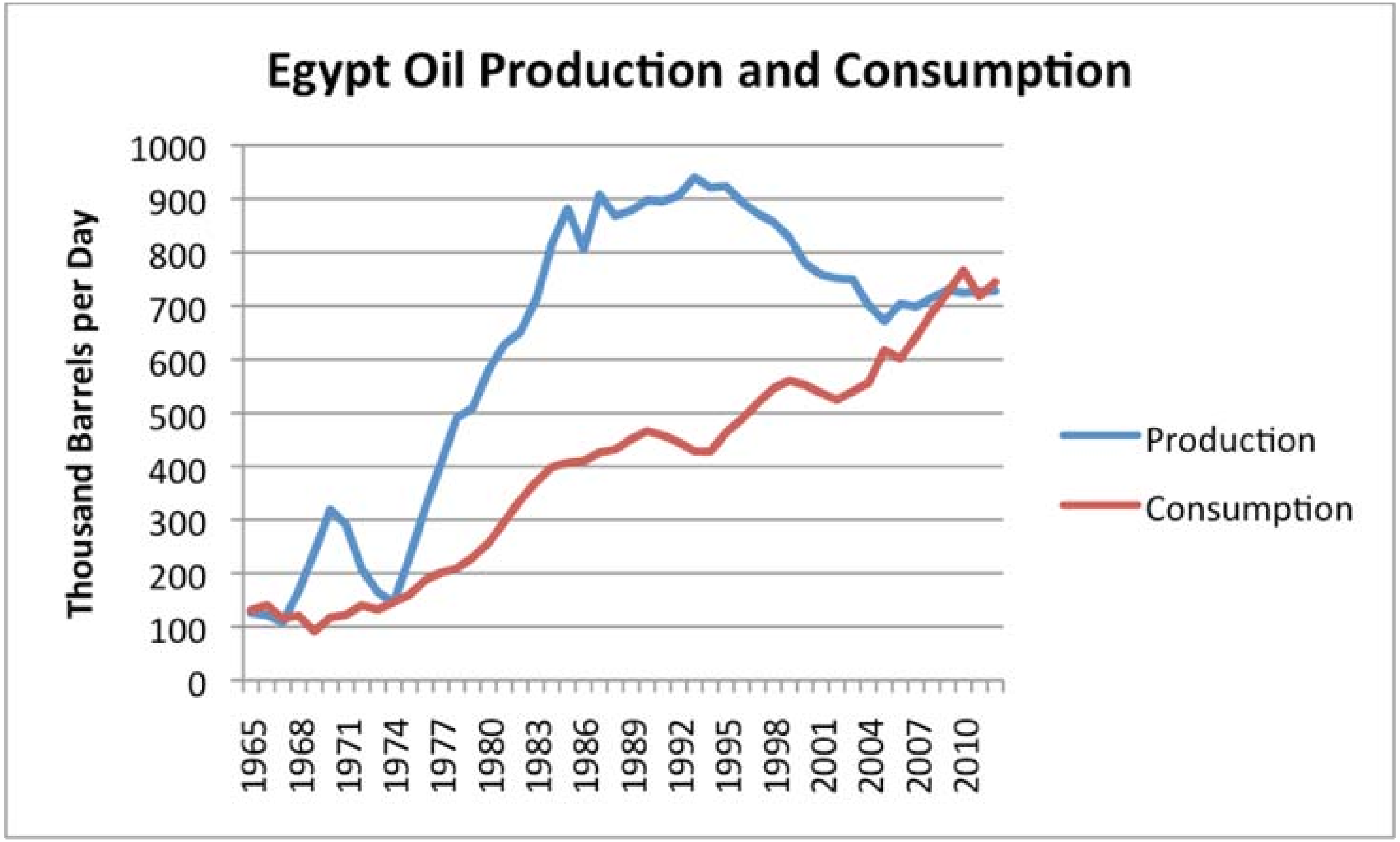
NO PLACE WHERE TO RUN!

Th


MIT Technology Review
VOL. 115 NO. 6 | $5.99 US
HAS QUANTUM COMPUTING FINALLY ARRIVED?
Upfront p24
HOW TOMORROW'S STARTUPS WILL BE FUNDED
Business Report p75
TECH TRANSFORMS MUSIC, ART, AND PROSE
Reviews p87
Buzz Aldrin, Apollo 11 moonwalker, would like a word with you.
You Promised Me Mars Colonies. Instead, I Got Facebook.
We've stopped solving big problems. Meet the technologists who refuse to give up. p26

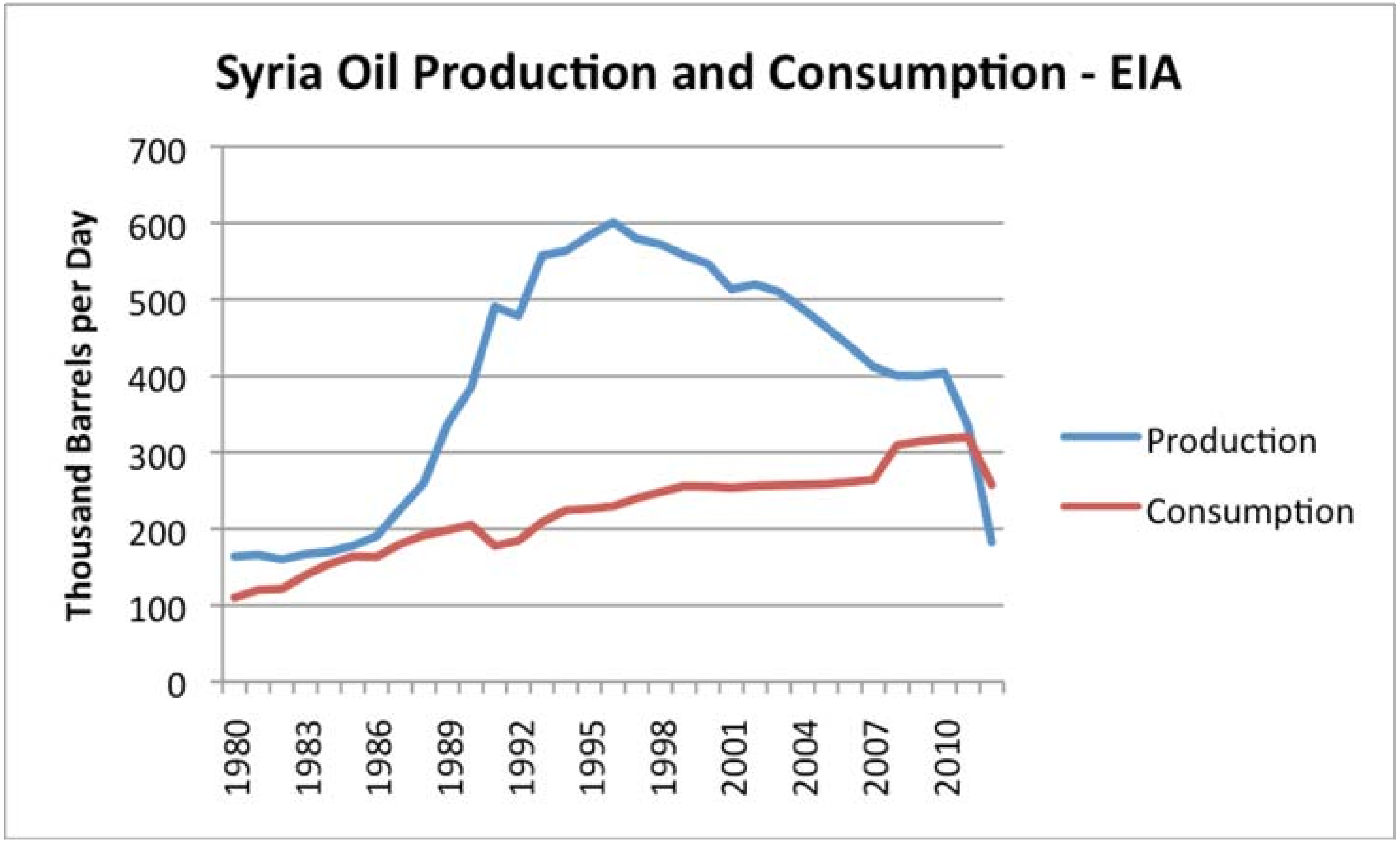
ALL DERIVATIVES INCLUDING: FUTURES, SWAPS, COLLATERALIZED DEBT OBLIGATIONS, OPTIONS, MORTGAGE BACKED SECURITIES, FORWARD CONTRACTS, CREDIT DEFAULT SWAPS

CONCLUSION



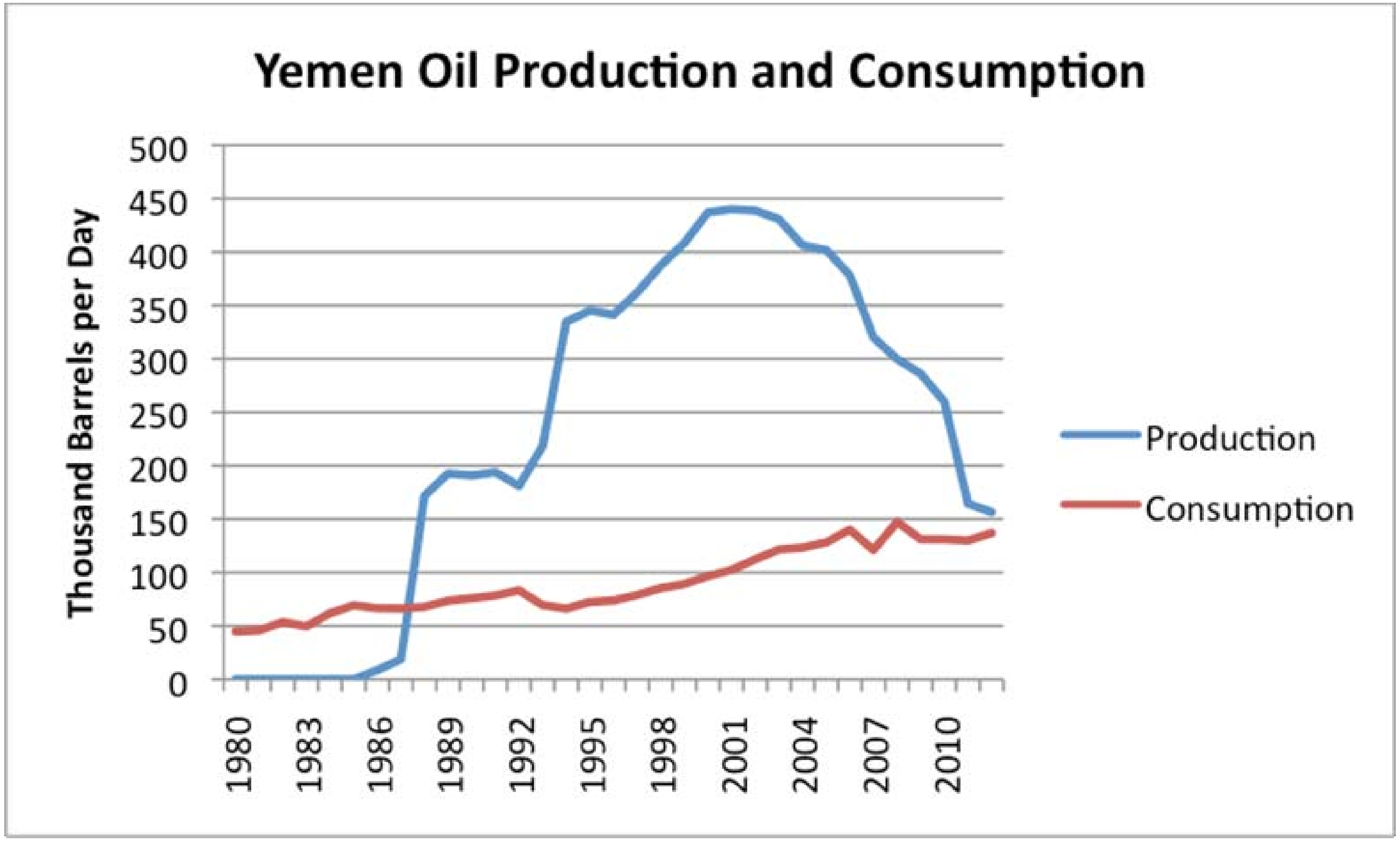
A different look at Arab spring . . .

http://gailtheactuary.files.wordpress.com/2013/09/syria-oil-production-and-consumption-eia.png



A different look at Arab spring . . .

http://gailtheactuary.files.wordpress.com/2013/09/syria-oil-production-and-consumption-eia.png



Next in line for an Arab spring?

http://gailtheactuary.files.wordpress.com/2013/09/syria-oil-production-and-consumption-eia.png

Implosion at the level of the household: the guards stopping to act as guards . . .

si usted lee esta diapositiva significa
que lo conseguiste . . .

muchas gracias por su heroica atención

BOOKS ABOUT MuSIASEM