

5th

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ADVANCES IN CLEANER PRODUCTION

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Growth, De-growth and Circular Economy. A Resource-based Perspective on Sustainability

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False Messages: Failure Stories & Lost Opportunities

At societal level: More of the same...

- More parking lots help solve the traffic problem
- GMOs help solve the worldwide nutrition problem
- Antibiotics cure all infection diseases
- Monetary liquidity facilitates growth
- High Speed Trains help trade and mobility

Within the energy field:

- The end of fossil fuels age is beyond the corner
- Fossil fuels prices keep increasing
- Renewable energies can fully replace fossil energies
- Efficiency decreases energy and material consumption
- Biomass fuels are renewable and will replace fossil energy

"More parking lots help solve the traffic problem"

The expectation to be able to find a park for their car makes commuters more available to drive to their work place.

This **increases**:

- Road traffic
- Demand for new and better roads
- Fuel consumption
- Airborne emissions

Decreases the economic profitability of mass transport, that becomes "optimized" only over the most profitable lines and times



And ultimately **translates** into a higher demand for new parking lots to host more cars coming.

"GMOs help solve the worldwide nutrition problem"



Ecological Indicators

Volume 57, October 2015, Pages 48–60



Environmental assessment of maize production alternatives: Traditional, intensive and GMO-based cropping patterns

G.C. Rótolo^a,   , C. Francis^{b, c}, R.M. Craviotto^a, S. Ulgiati^d

According to our results, GMOs do not provide higher yields compared to conventional intensive agriculture, do not decrease resource investment, do not increase pest resistance, do not provide higher income to farmers, do not decrease land cropped, do increase business of biotech seed companies and international trade corporations.

"Antibiotics cure all infection diseases"

The Epidemic of Antibiotic-Resistant Infections: A Call to Action for the Medical Community from the Infectious Diseases Society of America

Brad Spellberg,^{1,2} Robert Guidos,⁵ David Gilbert,⁷ John Bradley,^{3,4} Helen W. Boucher,⁸ W. Michael Scheld,⁶
John G. Bartlett,⁹ and John Edwards, Jr.,^{1,2} for the Infectious Diseases Society of America

¹Division of Infectious Diseases, Harbor–University of California–Los Angeles (UCLA) Medical Center, Torrance, ²Geffen School of Medicine, UCLA, Los Angeles, and ³Children's Hospital San Diego and ⁴University of California at San Diego, California; ⁵Infectious Diseases Society of America, Alexandria, and ⁶Division of Infectious Diseases, University of Virginia Health System, Charlottesville, Virginia; ⁷Division of Infectious Diseases, Providence Portland Medical Center and Oregon Health Sciences University, Portland, Oregon; ⁸Tufts–New England Medical Center, Boston, Massachusetts; and ⁹Department of Medicine, Johns Hopkins University School of Medicine, Baltimore, Maryland

The ongoing explosion of antibiotic-resistant infections continues to plague global and US health care. Meanwhile, an equally alarming decline has occurred in the research and development of new antibiotics to deal with the threat. In response to this microbial "perfect storm," in 2001, the federal Interagency Task Force on Antimicrobial Resistance released the "Action Plan to Combat Antimicrobial Resistance; Part 1: Domestic" to strengthen the response in the United States. The Infectious Diseases Society of America (IDSA) followed in 2004 with its own report, "Bad Bugs, No Drugs: As Antibiotic Discovery Stagnates, A Public Health Crisis Brews," which proposed incentives to reinvigorate pharmaceutical investment in antibiotic research and development. The IDSA's subsequent lobbying efforts led to the introduction of promising legislation in the 109th US Congress (January 2005–December 2006). Unfortunately, the legislation was not enacted. During the 110th Congress, the IDSA has continued to work with congressional leaders on promising legislation to address antibiotic-resistant infection. Nevertheless, despite intensive public relations and lobbying efforts, it remains unclear whether sufficiently robust legislation will be enacted. In the meantime, microbes continue to become more resistant, the antibiotic pipeline continues to diminish, and the majority of the public remains unaware of this critical situation. The result of insufficient federal funding; insufficient surveillance, prevention, and control; insufficient research and development activities; misguided regulation of antibiotics in agriculture and, in particular, for food animals; and insufficient overall coordination of US (and international) efforts could mean a literal return to the preantibiotic era for many types of infections. If we are to address the antimicrobial resistance crisis, a concerted, grassroots effort led by the medical community will be required.

A recent UK-Downing Street report warns about the emergence of antibiotic-resistant Infections (*Escherichia coli*, *Klebsiella pneumoniae*, *Staphylococcus aureus*). Premier Cameron warns of medical 'dark ages and calls for more research on new antibiotics. (July 2014, <http://www.bbc.com/news/health-28098838>)

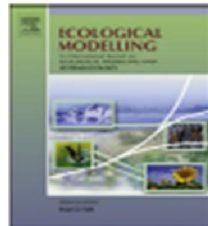
"Monetary liquidity facilitates growth"

Ecological Modelling 223 (2011) 4–13

Contents lists available at ScienceDirect

Ecological Modelling

journal homepage: www.elsevier.com/locate/ecolmodel

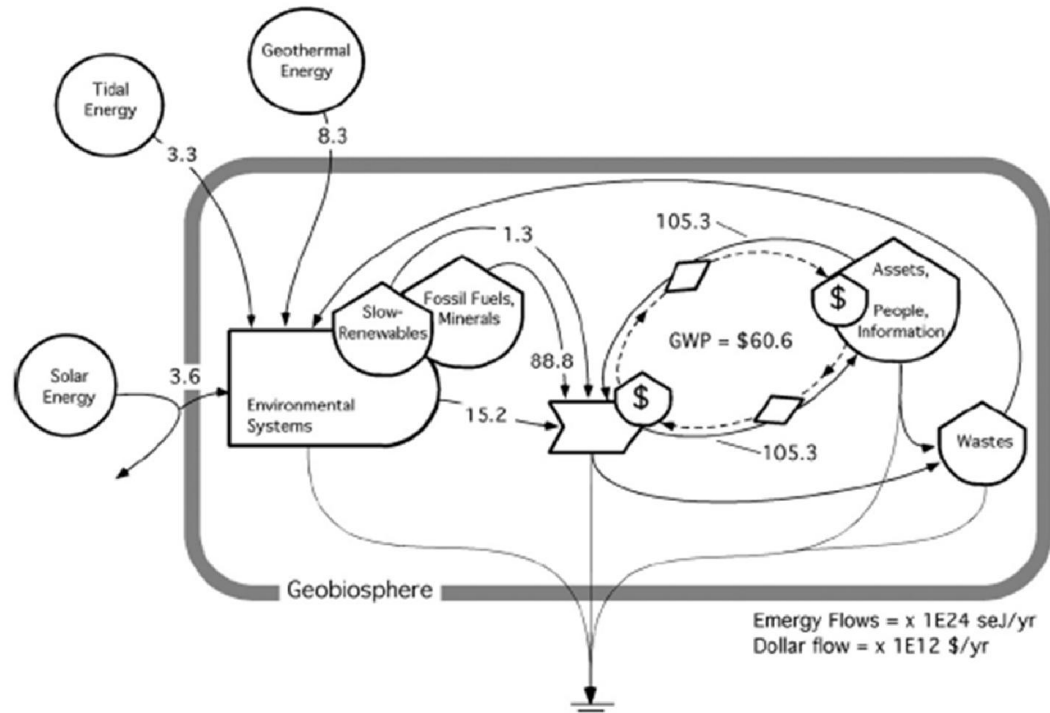
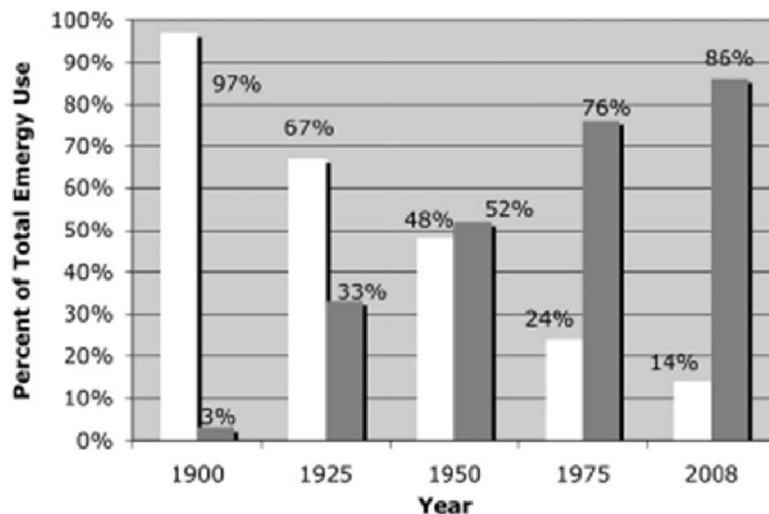


Understanding the global economic crisis: A biophysical perspective

Mark T. Brown^{a,*}, Sergio Ulgiati^b

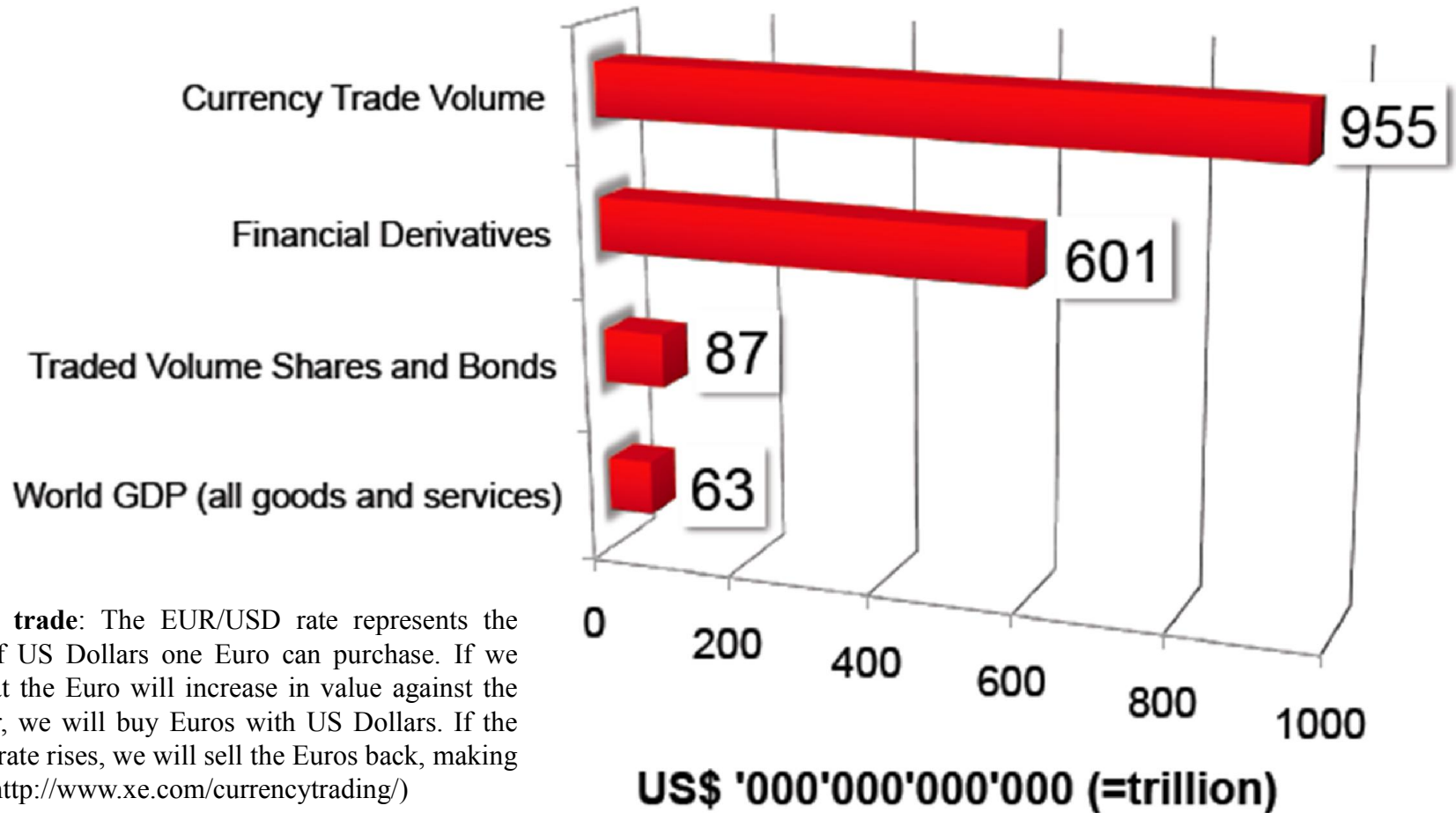
^a University of Florida, USA

^b Parthenope University of Naples, Italy



"What" is actually growing ?

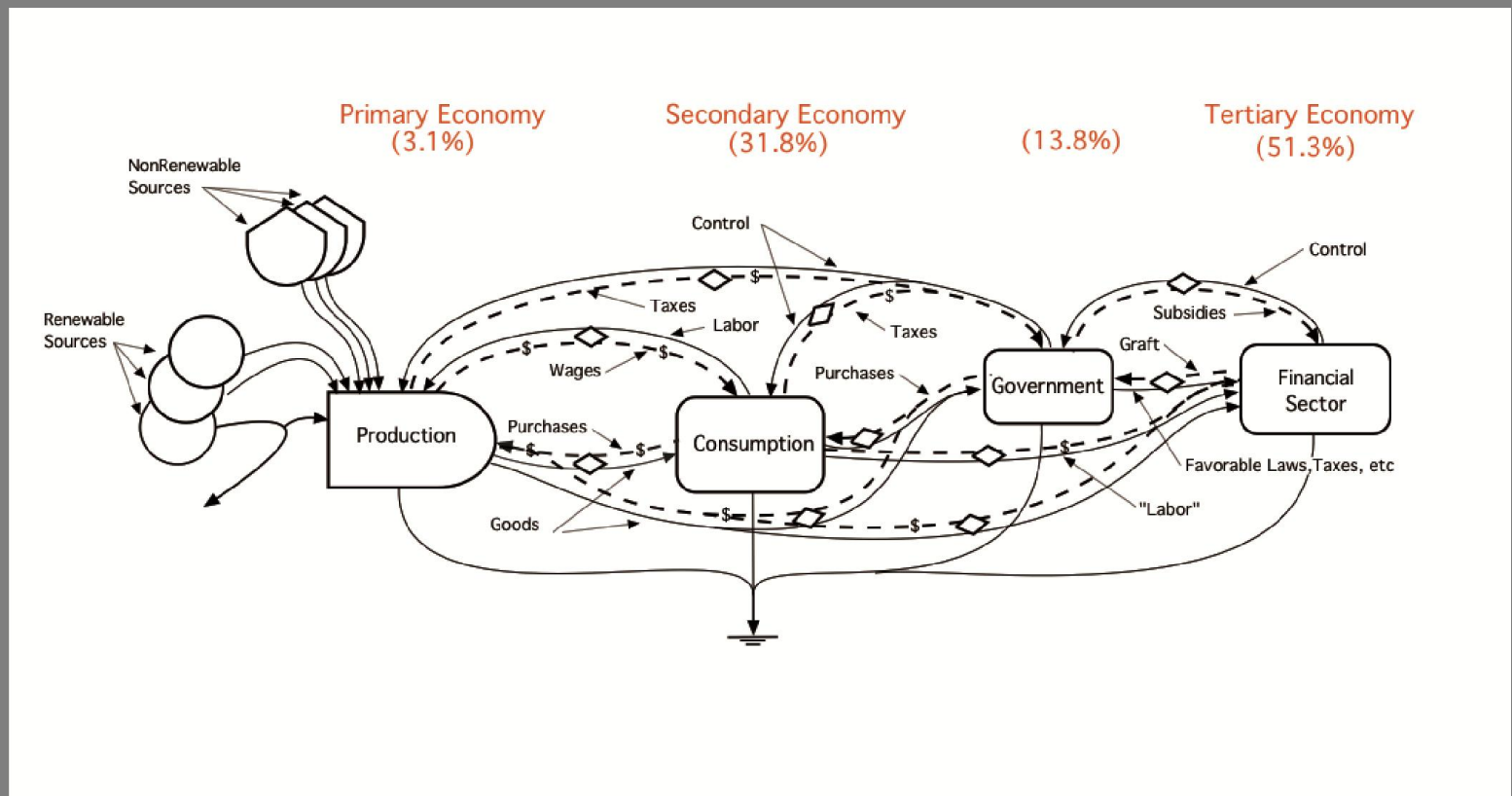
› Some facts among a lot of fiction (for 2010):



Currency trade: The EUR/USD rate represents the number of US Dollars one Euro can purchase. If we expect that the Euro will increase in value against the US Dollar, we will buy Euros with US Dollars. If the exchange rate rises, we will sell the Euros back, making a profit. (<http://www.xe.com/currencytrading/>)

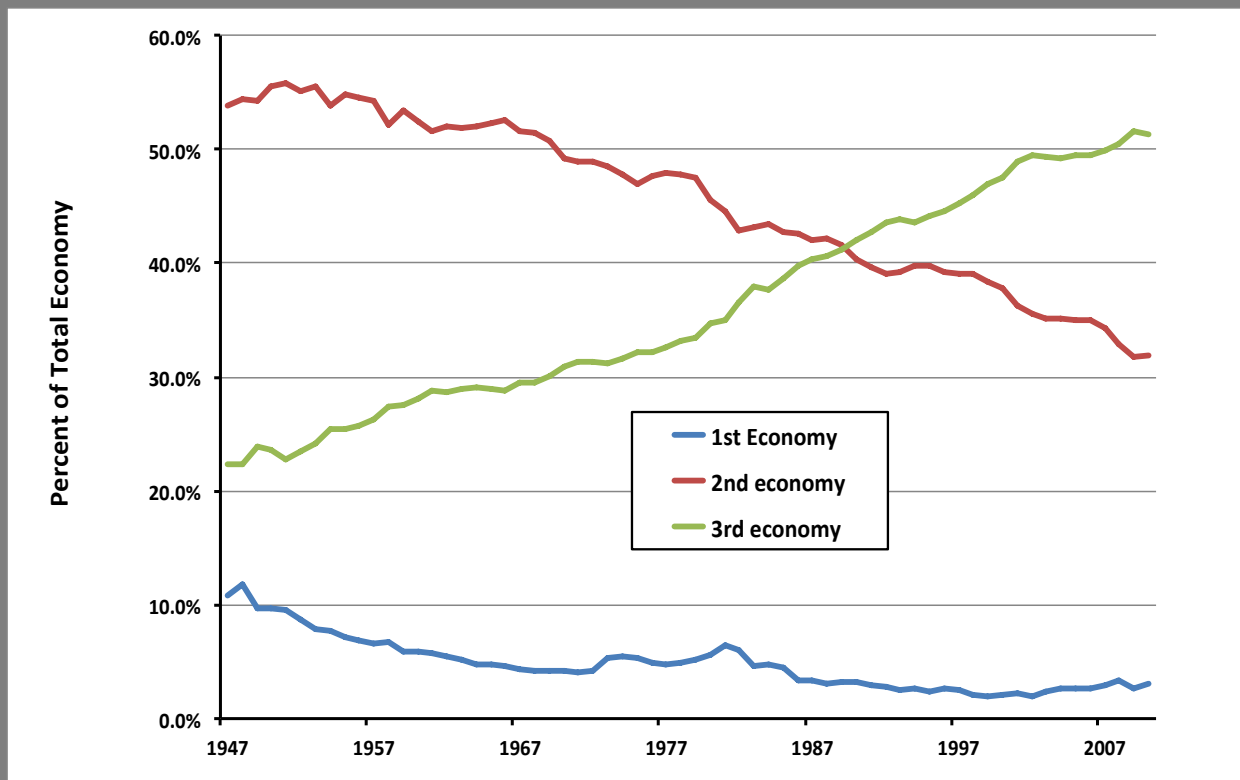
(Thomas Maschmeyer, 2011)

The XXI century economy is dominated by the financial sector, which makes GDP grow and decline and provides constraints to Governments.



Brown and Ulgiati, 2012, **The Tertiary Economy: A threat to the global economy**. The 8th International Workshop "Advances in Energy Studies" – Mumbai, India, 25-27 October 2012.

The case of USA



Brown and Ulgiati, 2012, **The Tertiary Economy: A threat to the global economy**. The 8th International Workshop “Advances in Energy Studies” – Mumbai, India, 25-27 October 2012.

"High Speed Trains help trade and mobility"

The
Economist

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Infrastructure projects

The great train robbery

High-speed rail lines rarely pay their way. Britain's government should ditch its plan to build one

Sep 3rd 2011 | from the print edition

AT THE launch of the Liverpool-Manchester railway in 1830, a statesman was killed when he failed to spot an approaching train. That was not the last time a new train line has had unintended consequences. Victorian railways ushered in a golden age of prosperity; these days politicians across the developed world hope new rapid trains, which barrel along at over 250mph (400kph), can do the same. But high-speed rail rarely

delivers the widespread economic benefits its boosters predict. The British government—the latest to be beguiled by this vision of modernity—should think again (see article (<http://www.economist.com/node/21528294>)).



"The end of fossil fuels age is beyond the corner. Fossil fuels prices keep increasing"

The so called "end of cheap oil" and the "peak oil" seem to have been postponed by:

- Economic crisis
- Political strategies
- Increased offer (e.g.: fracking, no matter the environmental consequences)



Efficiency decreases energy and material consumption (Jevon's paradox and rebound effect)

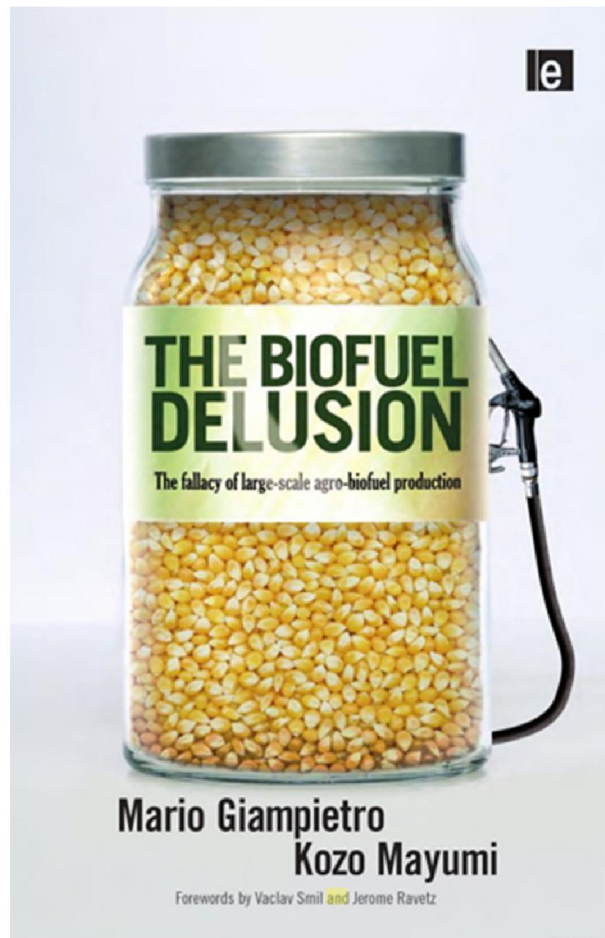
Jevons paradox: as technology progresses, the increase in efficiency with which a resource is used tends to increase (rather than decrease) the rate of consumption of that resource.

In 1865, the English economist William Stanley Jevons observed that technological improvements that increased the efficiency of coal-use led to the increased consumption of coal in a wide range of industries.

The issue has been re-examined by modern economists: In addition to reducing the amount needed for a given use, improved efficiency lowers the relative cost of using a resource, which tends to increase the quantity of the resource demanded, potentially counteracting any savings from increased efficiency. Additionally, increased efficiency accelerates economic growth, further increasing the demand for resources.

The rebound effect is the reduction in gains expected from new technologies that increase the efficiency of resource use, because of behavioral or other systemic responses.

Nevertheless, increased efficiency can improve material living standards.



"Biomass fuels are renewable and will replace fossil energy"

Critical Reviews in Plant Sciences, 20(1):71–106 (2001)

A Comprehensive Energy and Economic Assessment of Biofuels: When “Green” Is Not Enough

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Land constraints with biodiesel: the case of Italy

Sunflower: max 2.5 ton seeds/ha; average Italy 1.6 ton seeds/ha

Oil content (40-50%): 0.8-1.3 ton fuel/ha

Net biodiesel production: 0.5-0.9 t fuel /ha

Average individual consumption:
 $10000 \text{ km/yr} / 15 \text{ km/kg} = 666 \text{ kg fuel/yr} \Rightarrow 1 \text{ ha}$

Circulating cars: 25 million \Rightarrow
Oil seeds needed: 50 million ton seeds
Land needed: 25 million ha

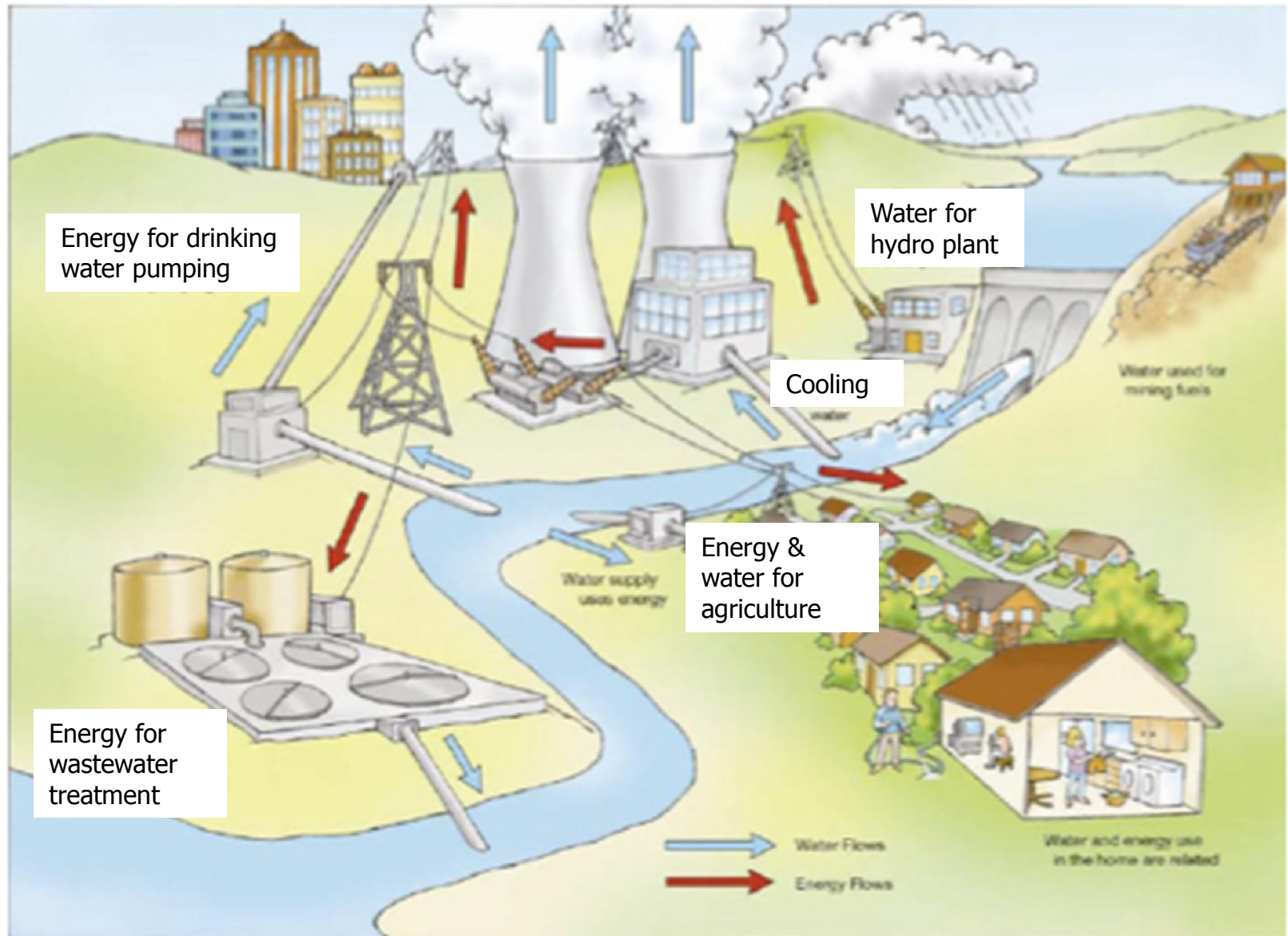
Land constraints with cellulosics: the case of Sweden

(A) Total energy used in the transport sector: 358.6×10^9 MJ

(B) Energy per hectare from switchgrass: 9×10^4 MJ/ha (best value published, Pimentel and Patzek, 2006)

Total land needed = $A/B = 35,900 \text{ km}^2 = 16.6 \%$ of available forest land,
i.e. an ecological nonsense

The Water-Energy Nexus

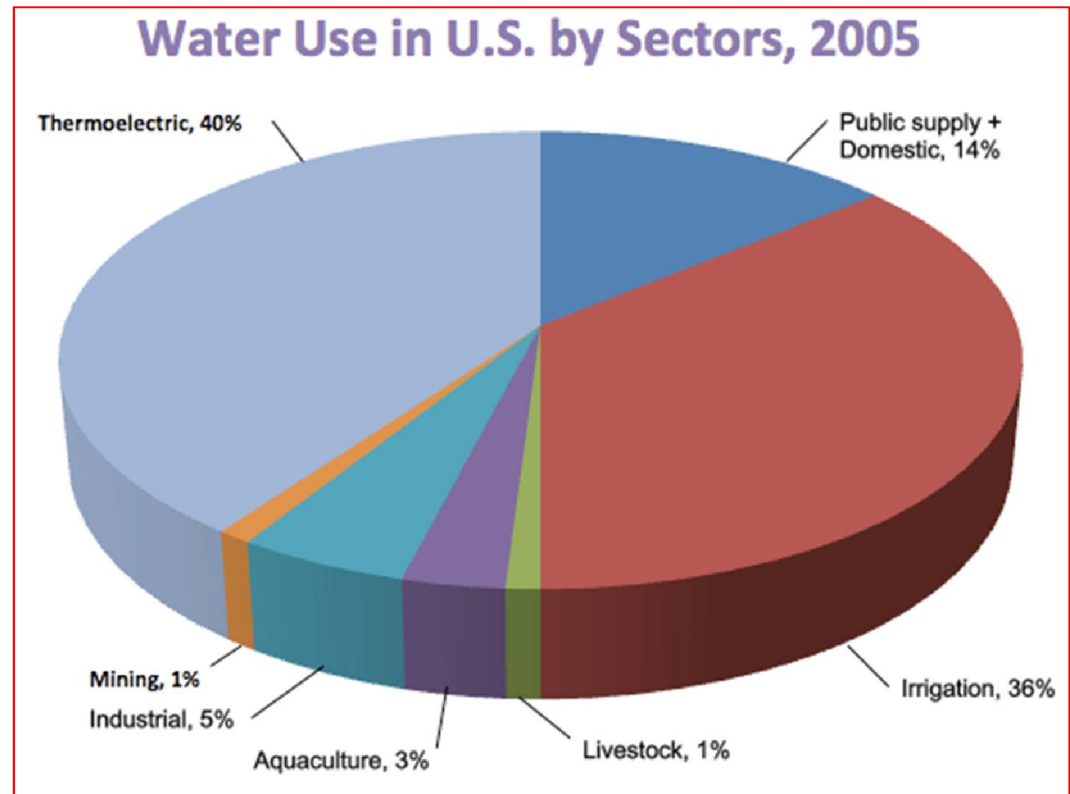


It takes water “to make” energy

One kWh requires 60 liters of water (average).

The global water withdrawal worldwide in the year 2000 has been 4000 km³, about 30% of total world availability of fresh water.

In the year 2025 this fraction is expected to grow up to 70% and to be returned to the environment with diverse forms of alteration and contamination.



It takes energy “to make” water

In the year 2005 the commercial energy invested for water withdrawal and delivering has been about 655 MTOE, i.e. 7% of total world energy consumption, and about 3.5 times the Italian energy use. For the sake of clarity:

1. Pumping 1 m³ of water from a 30 m depth at a 50% pump efficiency requires 0.16 kWh. Same to lift water up to 30 m above ground level, for distribution.
3. Potabilization: filtering, disinfecting, imply an energy demand of 0.5 kWh/m³.
3. Desalination: some foresee that large amounts of water will be extracted by the sea in the near future. At present, 15% of USA water comes from such source. Energy costs are:
 - Reverse osmosis: 5 kWh/m³.
 - Multi-stage flash distillation: 25 kWh/m³.

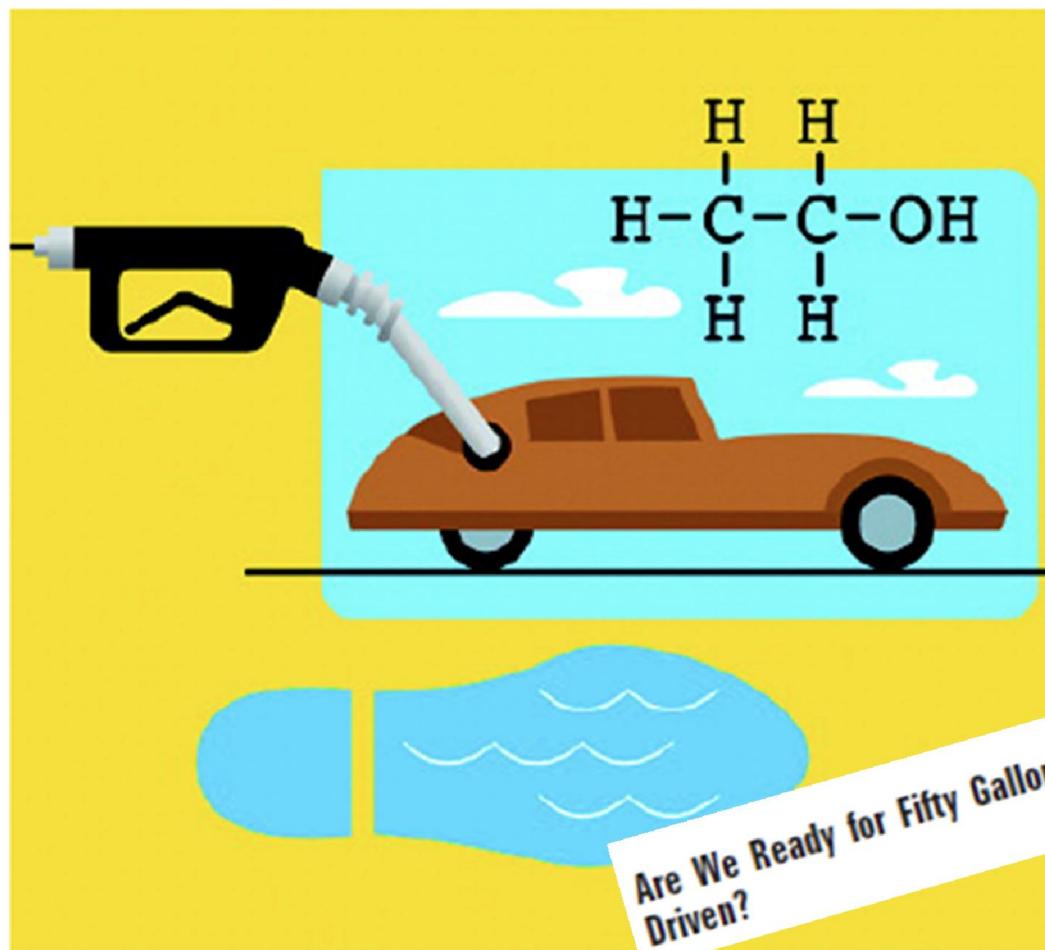
SIDE PROBLEM: One m³ of water contains about 35 kg of salts (NaCl and others). The present worldwide desalination capacity of 40 million m³ water/yr translates into 1.4 million ton mixed salts/yr, unsuitable for food and hard to dispose of.

The Water Footprint of Biofuels: A Drink or Drive Issue?

R. Dominguez-Faus, Susan E. Powers, Joel G. Burken, and Pedro J. Alvarez

Environ. Sci. Technol., 2009, 43 (9), 3005-3010 • DOI: 10.1021/es802162x • Publication Date (Web): 01 May 2009

Downloaded from <http://pubs.acs.org> on May 12, 2009





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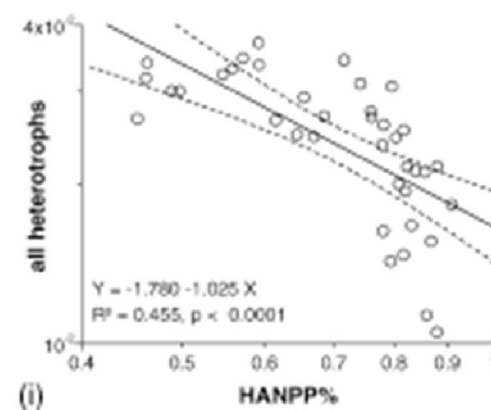
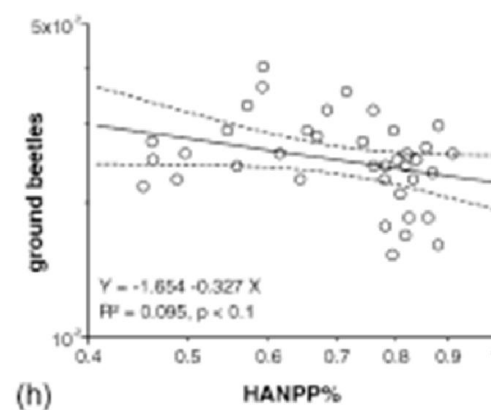
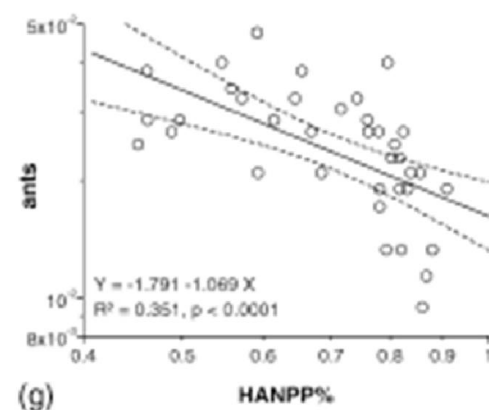
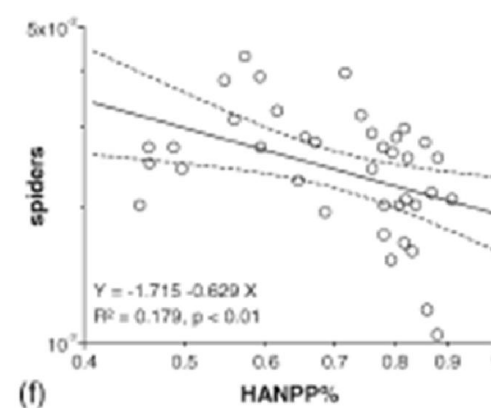
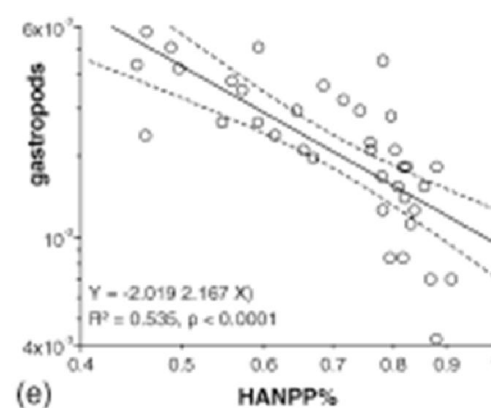
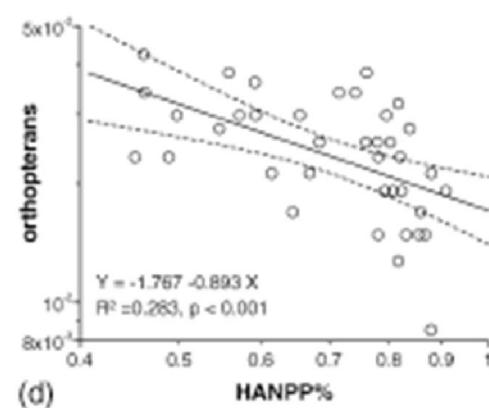
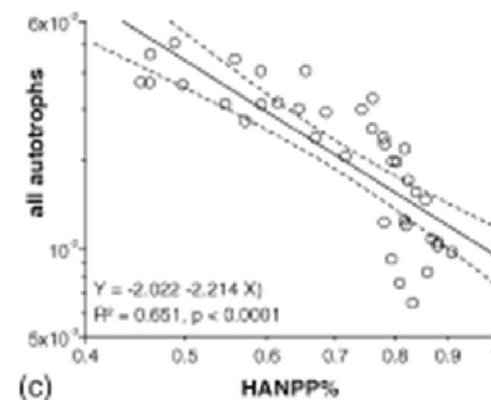
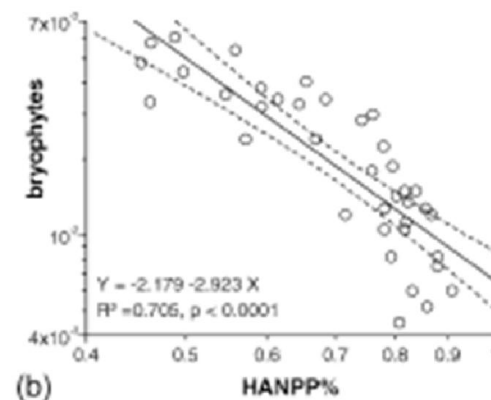
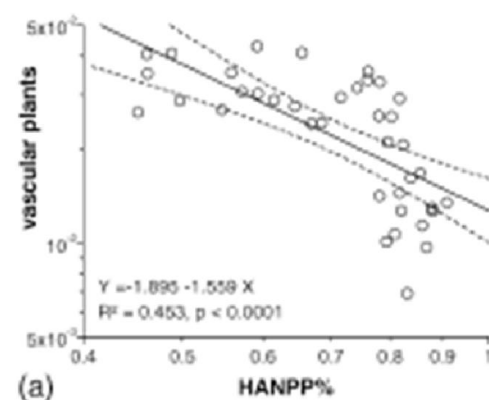
Agriculture, Ecosystems and Environment 102 (2004) 213–218

**Agriculture
Ecosystems &
Environment**

www.elsevier.com/locate/agee

Human appropriation of net primary production and species diversity in agricultural landscapes

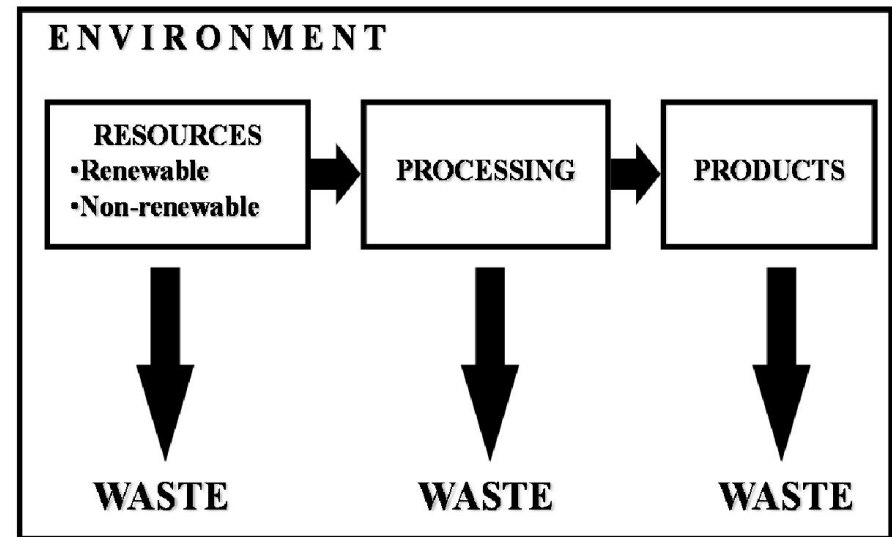
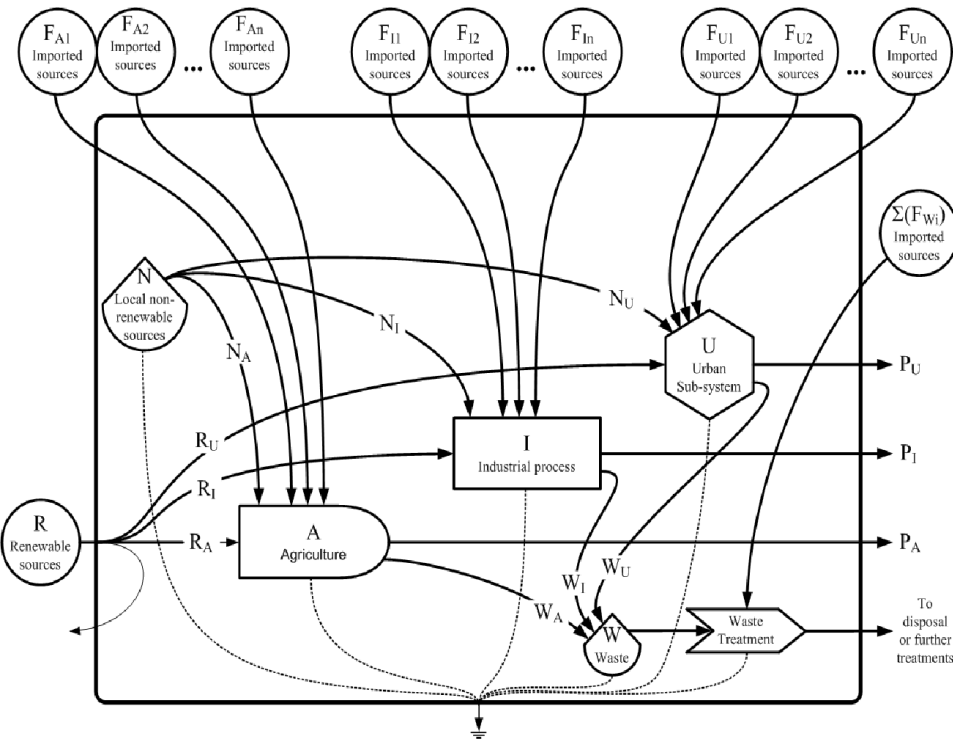
Helmut Haberl^{a,*}, Niels B. Schulz^a, Christoph Plutzer^b, Karl Heinz Erb^a,
Fridolin Krausmann^a, Wolfgang Loibl^c, Dietmar Moser^b, Norbert Sauberer^b,
Helga Weisz^a, Harald G. Zechmeister^b, Peter Zulka^d



The need
for a
vision



Linear models have dominated human economies until recently



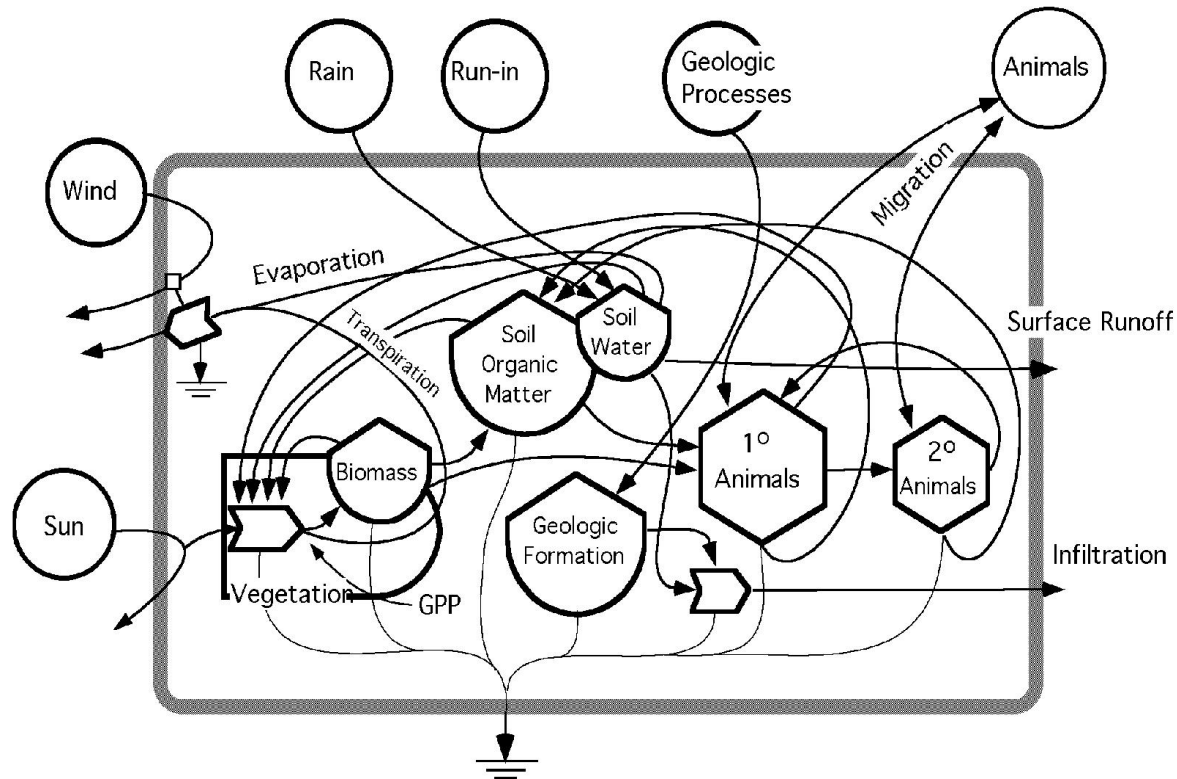
Key resources for economics: land, labor and capital

Natural Systems are different...but aren't we nature too ?

Ecosystems recycle every kind of waste. The concept itself of “waste” is not appropriate for ecosystems.

The products from one component are always a useful resource for another component.

Ecosystems display circular, zero-waste patterns.

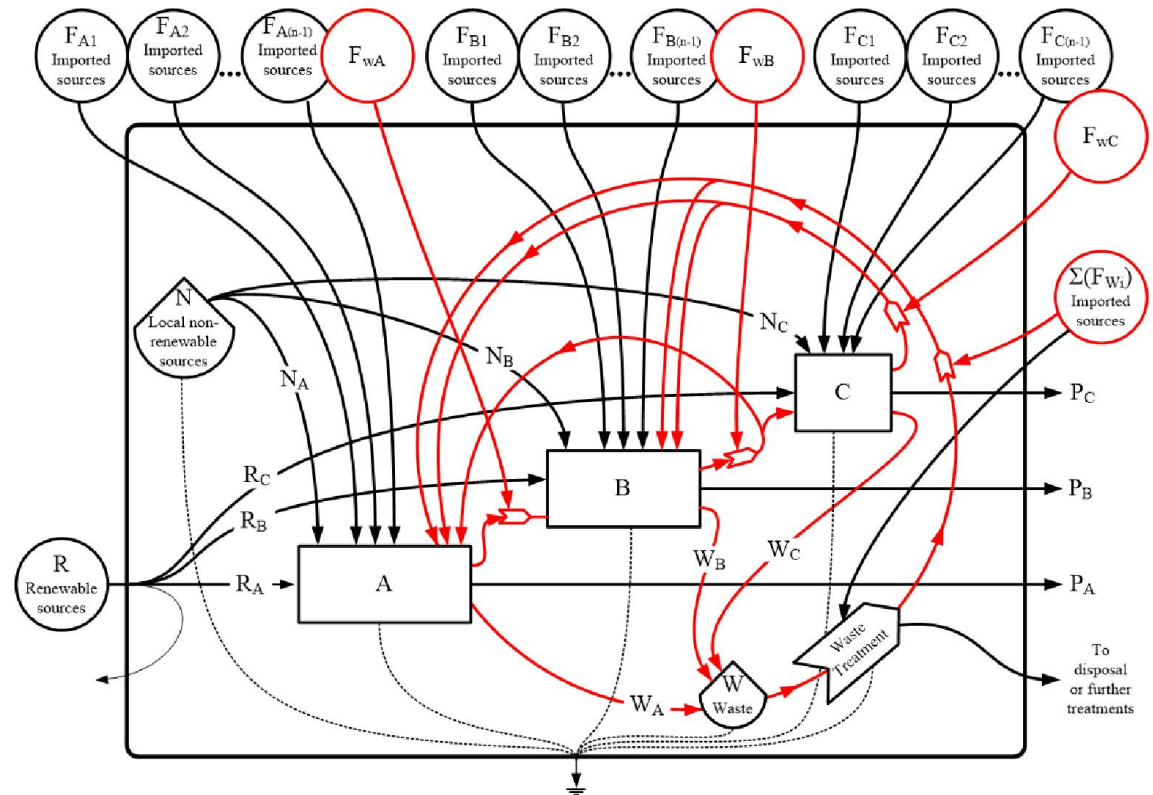


Natural Systems

Green model design: the Circular Economy

Pillars:

1. Minimising the consumption of non-renewable natural resources and energy;
2. Changing production and consumption patterns;
3. Moving towards zero waste production and waste prevention



Circular Economy: An expected transition to a balanced interplay of environmental and economic systems

- We live in a closed system – Resources are limited
- Mining resources affects the environment
- Increasing population affects resource consumption
- Competition for resources – Need to reduce resource consumption
- Waste generation is overwhelming
- Waste is resources not converted into useful products
- A large fraction of resources can be reused, recycled, recovered
- Governments and business are increasingly aware of the need for careful resource management (especially in Europe, China, USA).



Monitoring successes, not only failures.

A circular case study.

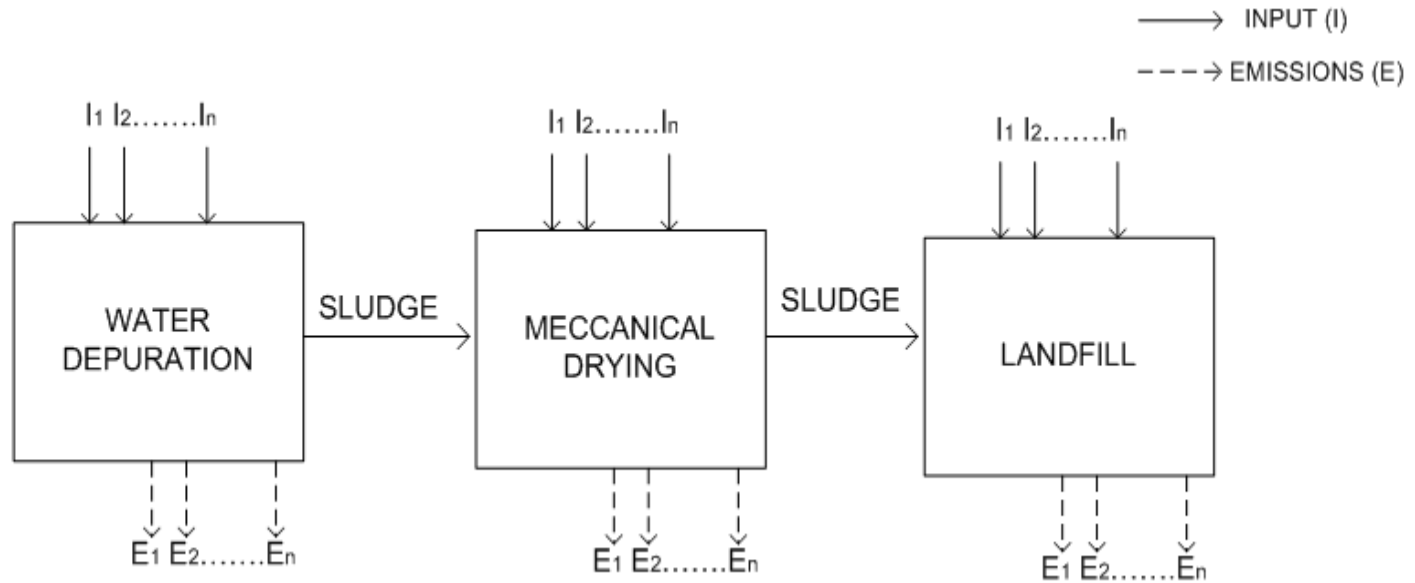
The case of Waste Water Treatment



Waste water treatment plant located in Campania Region, Nocera Inferiore, serving 300,000 inhabitants.

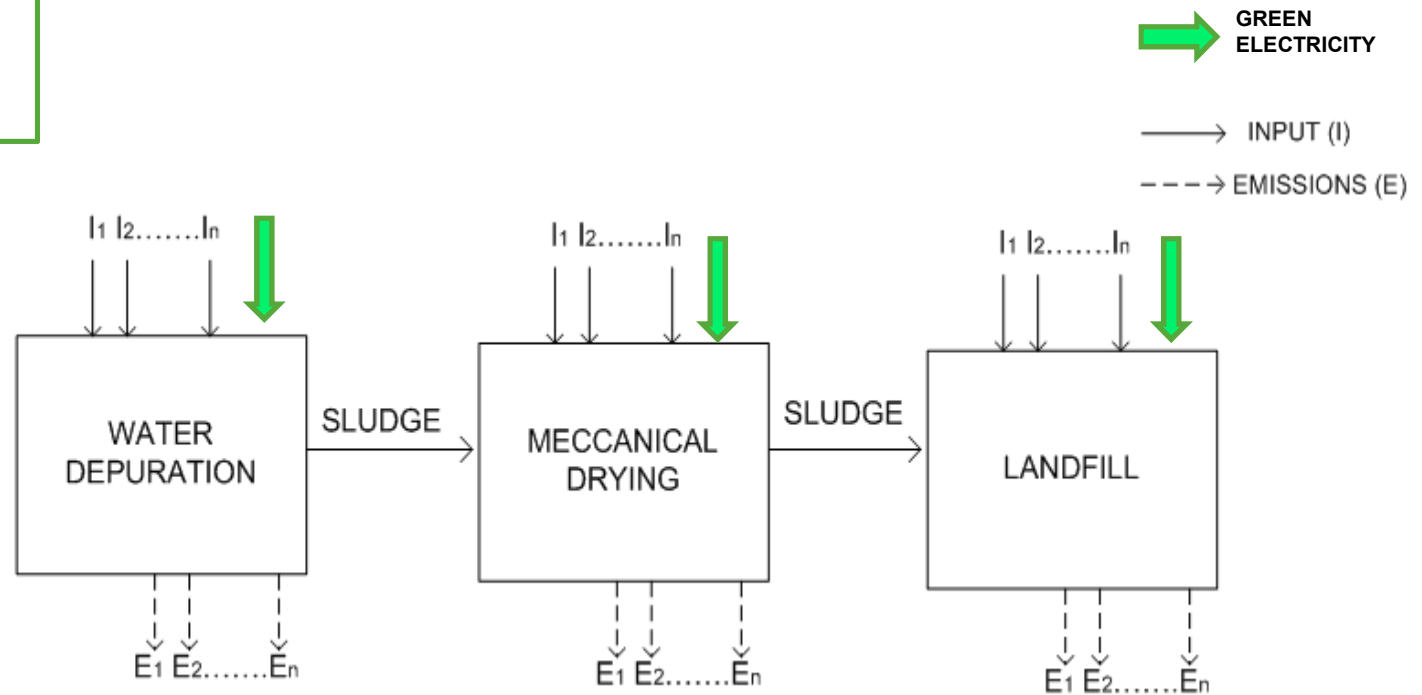
Goal: to compare the environmental performance of five scenarios for wastewater and sludge management in a WWT plant and understand the potential advantage of circular technology.

Scenario A: Present linear management performed within the plant.



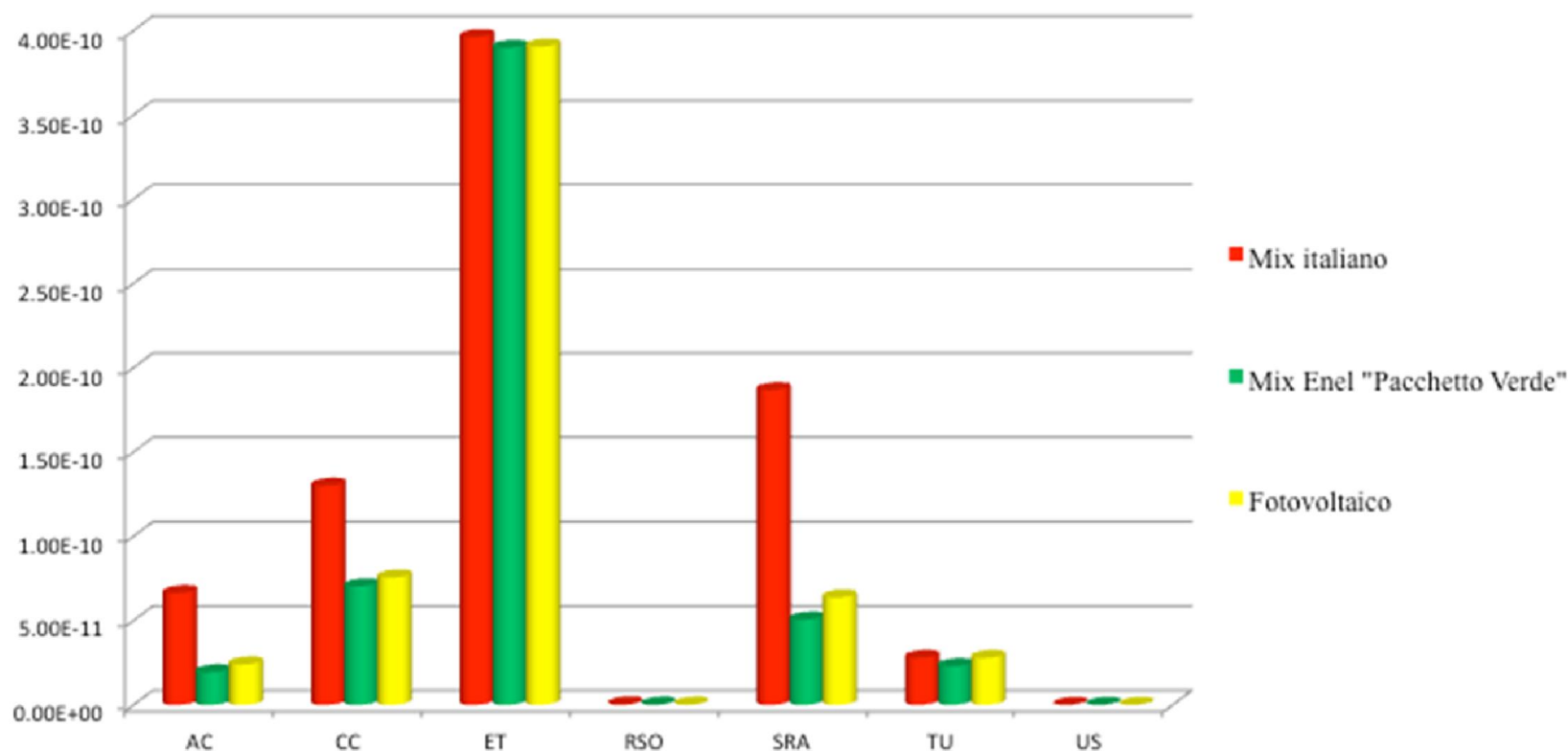
Scenario B: using green power from grid

ENEL Green Power mix:
57.3% wind,
29.2% hydro,
9.0% geothermal,
3.4% solar,
1.1% biomass.



Conventional wastewater treatment with sludge landfilling and improvement scenarios

ENEL «PACCHETTO VERDE» E IL FOTOVOLTAICO



LEGENDA

AC = Acidificazione

CC = Cambiamenti Climatici

ET = Eutrofizzazione

RSO = Riduzione dello Strato di Ozono

SRA = Sfruttamento delle Risorse Abiotiche

TU = Tossicità Umana

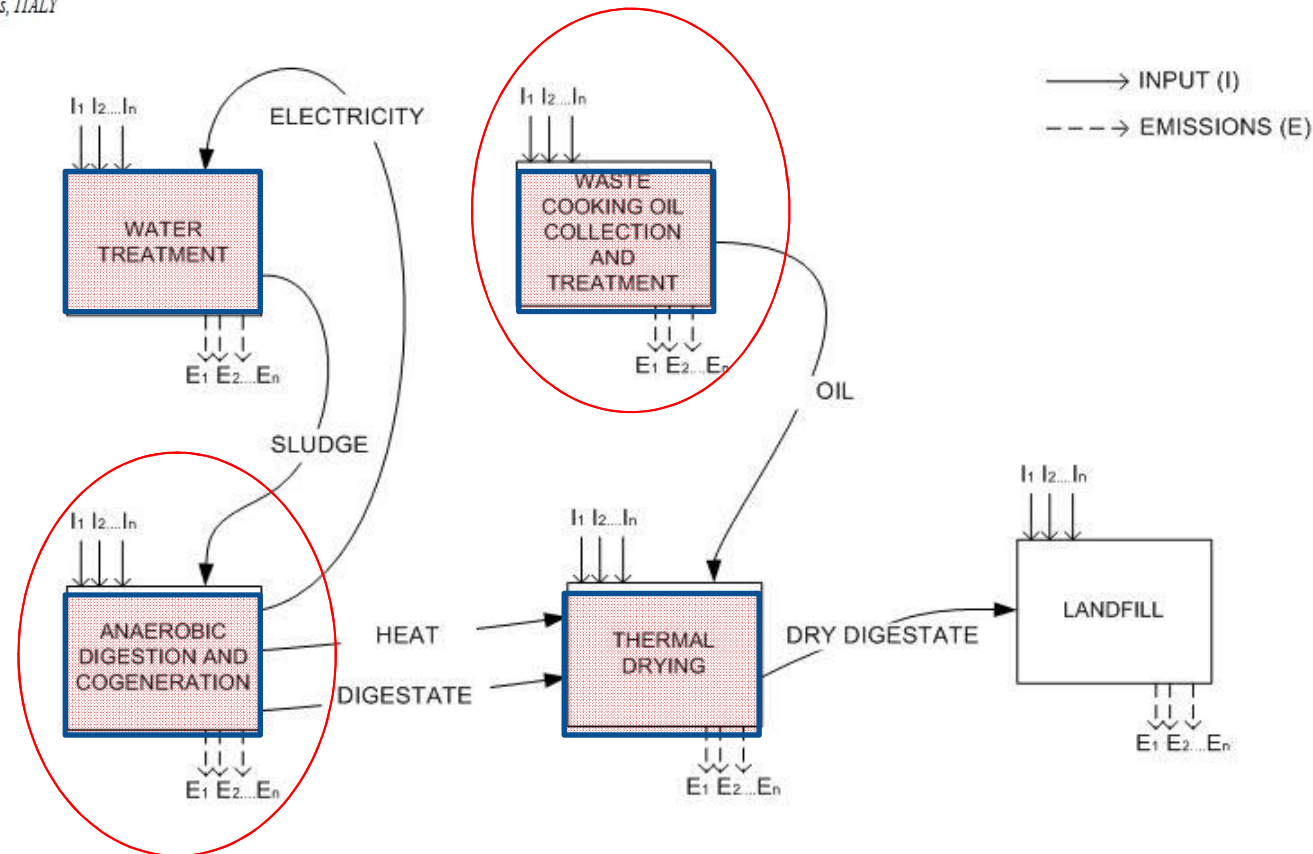
US = Uso del Suolo

Scenario C: Recycling biogas and cooking oil

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Recycling Waste Cooking Oil into Biodiesel: A Life Cycle Assessment

M. RIPA*, C. BUONAURO, S. MELLINO, G. FIORENTINO, S. ULGIATI
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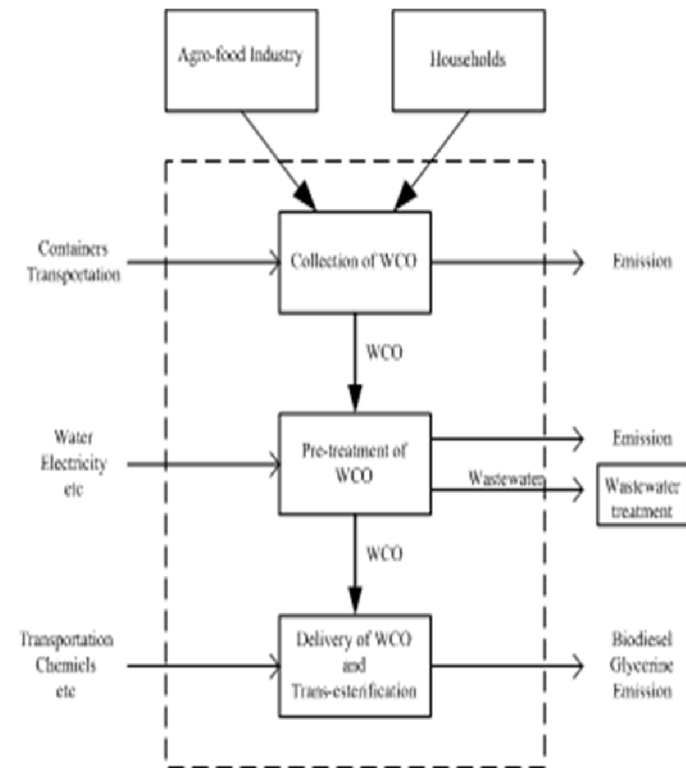


Recycling Waste Cooking Oil into Biodiesel: A Life Cycle Assessment

Problem Statement

WCO causes hard negative environmental impacts caused by the uncontrolled disposal of such products. Diverting WCO from improper disposal extends the product life cycle and prevents the contamination of groundwater supplies with this harmful liquid waste

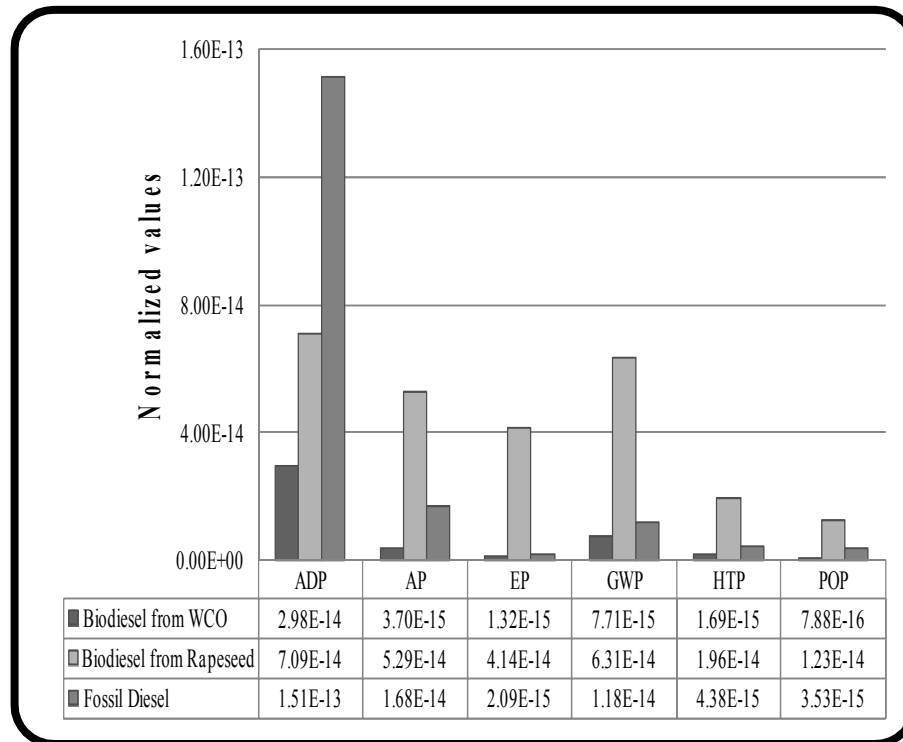
Alternative Solution



Schematic flowchart of the WCO system

Recycling Waste Cooking Oil into Biodiesel: A Life Cycle Assessment

A comparison with biodiesel from rapeseed and fossil diesel



CML 2001 normalized impacts calculated for the comparison among biodiesel from WCO, rapeseed and fossil diesel.

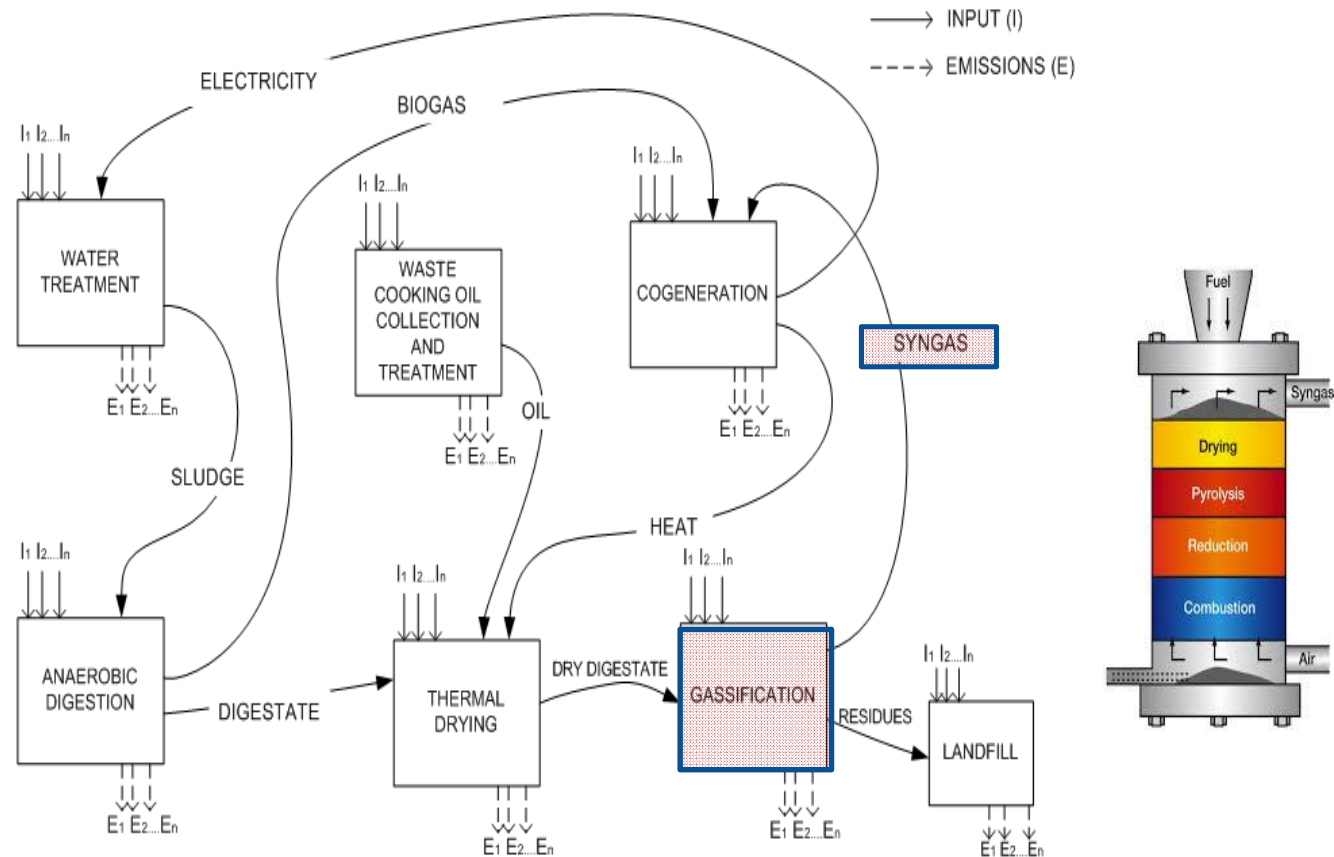
CED impacts calculated for the comparison among biodiesel from WCO, rapeseed and fossil diesel

Impact Category	Unit	Biodiesel from WCO	Biodiesel from rapeseed	Fossil diesel
Non-renewable, fossil	MJ	9.59	22.5	53.4
Non-renewable, nuclear	MJ	0.56	2.78	0.60
Non-renewable, biomass	MJ	1.44E-04	1.23E-03	6.33E-05
Renewable, biomass	MJ	2.32E-02	47.6	2.21E-02
Renewable, wind, solar, geothermal	MJ	7.80E-03	3.26E-02	1.13E-02
Renewable, hydro	MJ	0.12	0.47	7.07E-02

Scenario D – Syngas from digestate



Submitted EU
proposal **INES** –
INnovative **E**fficient
systems for sewage
Sludge management



Scenario E – Fertirrigation of non-food crops



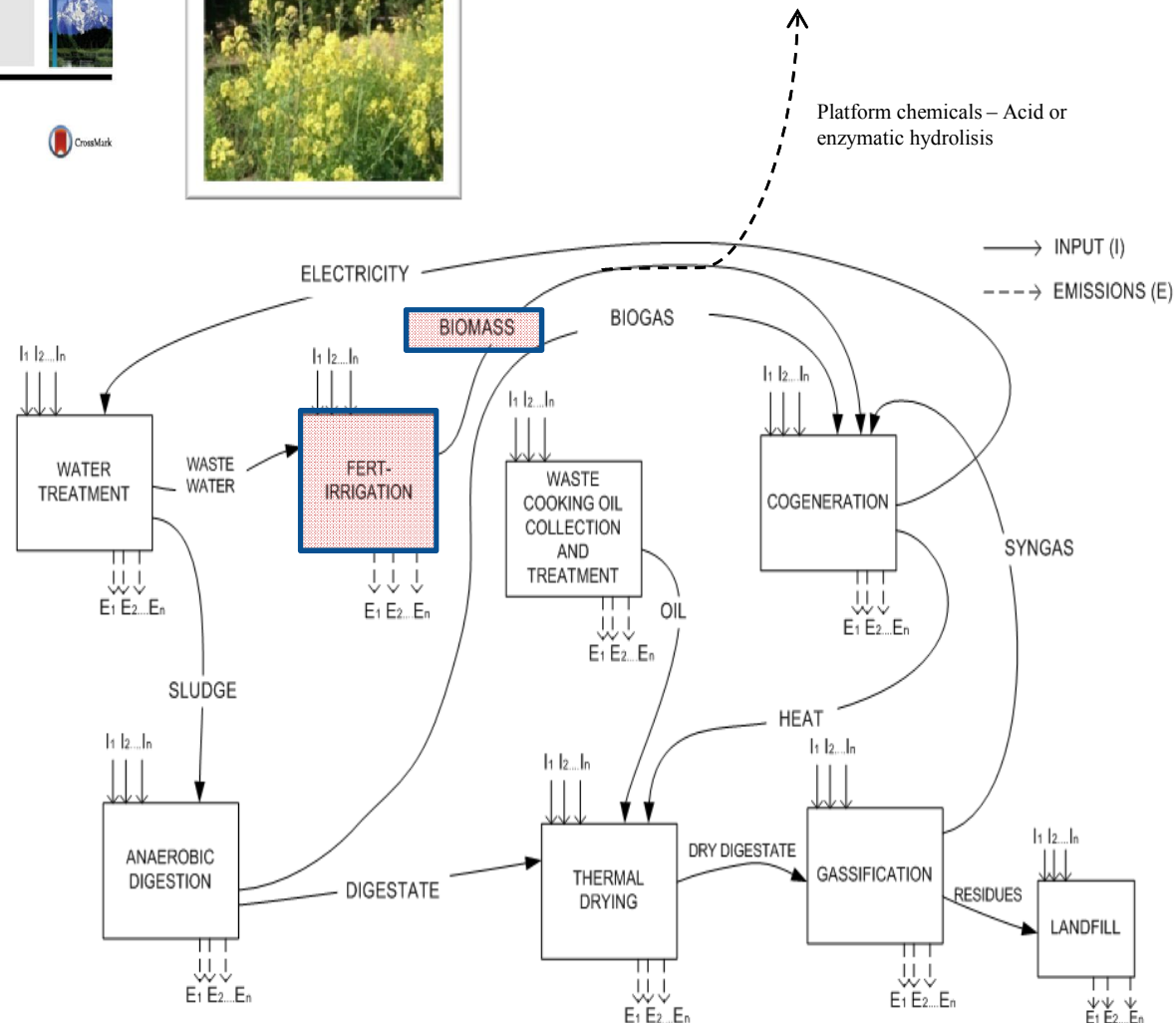
Life cycle assessment of *Brassica carinata* biomass conversion to bioenergy and platform chemicals

G. Fiorentino ^{a,*}, M. Ripa ^a, S. Mellino ^a, S. Fahd ^b, S. Ulgiati ^a



Assessing the environmental performance and sustainability of bioenergy production in Sweden: A life cycle assessment perspective

Elvira Buonocore^a, Pier Paolo Franzese, Sergio Ulgiati



Results - 1

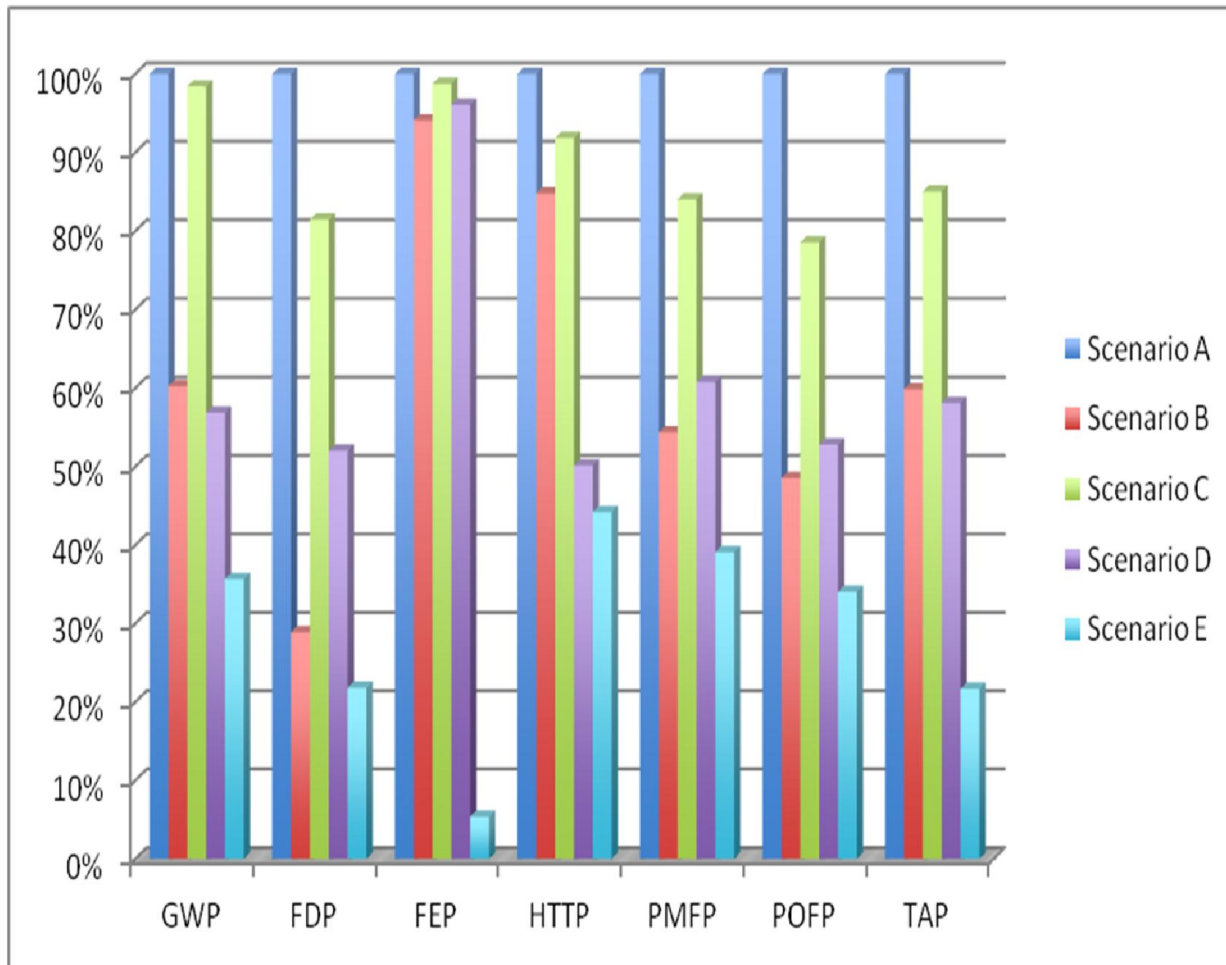
LCA (ReCiPe Midpoint H)

Impact category	Scenario BAU	Scenario Green Power	Scenario "recycle"	Scenario "syngas"	Scenario "fertirrigation"
Climate change-GWP (kg CO ₂ -Eq)	657.05	395.98	646.69	373.79	234.47
Fossil depletion-FDP (kg oil-Eq)	129.01	37.29	105.09	67.14	28.14
Freshwater eutrophication-FEP (kg P-Eq)	0.83	0.78	0.82	0.80	0.04
Human toxicity-HTTP (kg 1,4-DCB-Eq)	184.29	156.25	169.28	92.45	81.49
Particulate matter formation-PMFP (kg PM10-Eq)	0.59	0.32	0.49	0.36	0.23
Photochemical oxidant formation-POFP (kg NMVOC)	1.40	0.68	1.10	0.74	0.48
Terrestrial acidification-TAP (kg SO ₂ -Eq)	1.65	0.99	1.41	0.96	0.36

Total contribution of the five scenarios to impact categories (absolute values).
Values are referred to 1000 m3 of waste water treated (functional unit)

Results - 2

LCA (ReCiPe Midpoint H) - characterized impacts



The best performance in all the impact categories is achieved in Scenario E .



The growth ethics

Growth, growth, growth...

The G-20 Toronto Summit for International Economic Cooperation, June 2010, resulted in 48 resolutions on international economic cooperation. The second resolution was as follows:

*2. Building on our achievements in addressing the global economic crisis, we have agreed on the next steps we should take to ensure **a full return to growth** with quality jobs, to reform and strengthen financial systems, and to create strong, **sustainable and balanced global growth**. (our emphasis added)*

In the 27 pages of resolutions and annexes in support of those resolutions, the term “growth” was used 67 times and the terms “sustain”, “sustainable”, “sustainability” most often coupled to “growth” were used 43 times. Even more telling, the terms “resource(s)” while used 17 times never once mentioned “natural resources” (only referring to “financial resources”), and **the term “energy” was never mentioned at all.**

(Brown and Ulgiati, 2011. **Understanding the Global Economic Crisis: A Biophysical Perspective. Ecological Modelling, 223: 4-13**)

Need for a paradigm shift...Now, not tomorrow

As long as the dominant economic paradigm is neoclassical economics, then the only course for human civilization is to grow its economy, to grow its population, to grow its consumption, as **growth is the first, second, and third commandments of the current economic paradigm that insists that human well being and happiness are linked to increasing income.**

No amount of tinkering with neoclassical economics can change it into a paradigm that can do without growth.

We need an economic paradigm shift, a new paradigm that can accept as a major tenant that **continued growth is undesirable and untenable.**

When some economies grow, others are impoverished

In a world where economic growth is becoming more and more difficult to achieve,...**when some economies grow, others are impoverished.**

The growth of population, GDP, number of cars and roads, built environment, food production, number of cell phones, etc., worldwide **involves increased extraction and burning of fossil fuels, increased mining, increased soil erosion, increased movement of sediments from land to oceans, increased deforestation, fishing, air and water pollution, decreased biodiversity,...., increased number of environmental refugees,** increased political instability worldwide, and finally decreased democracy and respect of human rights in those countries where resources are extracted for export to wealthy countries.

How long can this last?

Not all wants are needs

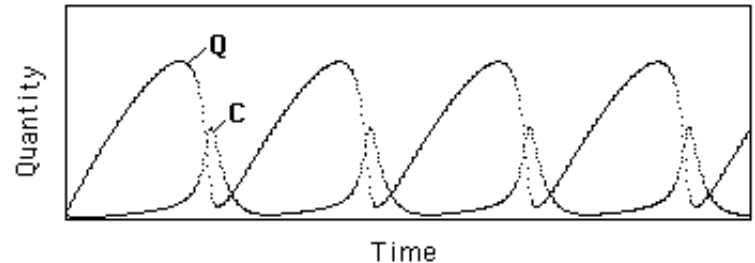
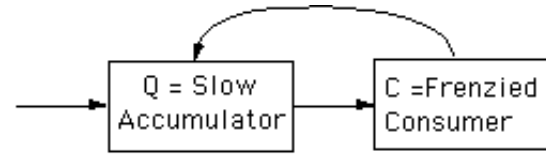
- Having been taught that “**more is beautiful**” and “**quantitative growth is good**”, we are hardly able to conceive other values (**community values, clean and healthy environment, democracy, shared goods, community care of the young and the elderly, satisfactory relations, and tasty food**).
- The future can still be about growth, but according to other parameters and different measures of wealth. Such changes must be accompanied by **appropriate policies** that recognize new values as the basis for qualitative, not quantitative growth.
- We cannot achieve sustainability without redefining and redirecting human wants in **ways that are less consuming of natural resources**.
- Since not all wants are needs, it may even happen that in the transition some wants are not fulfilled.



The pulsing paradigm

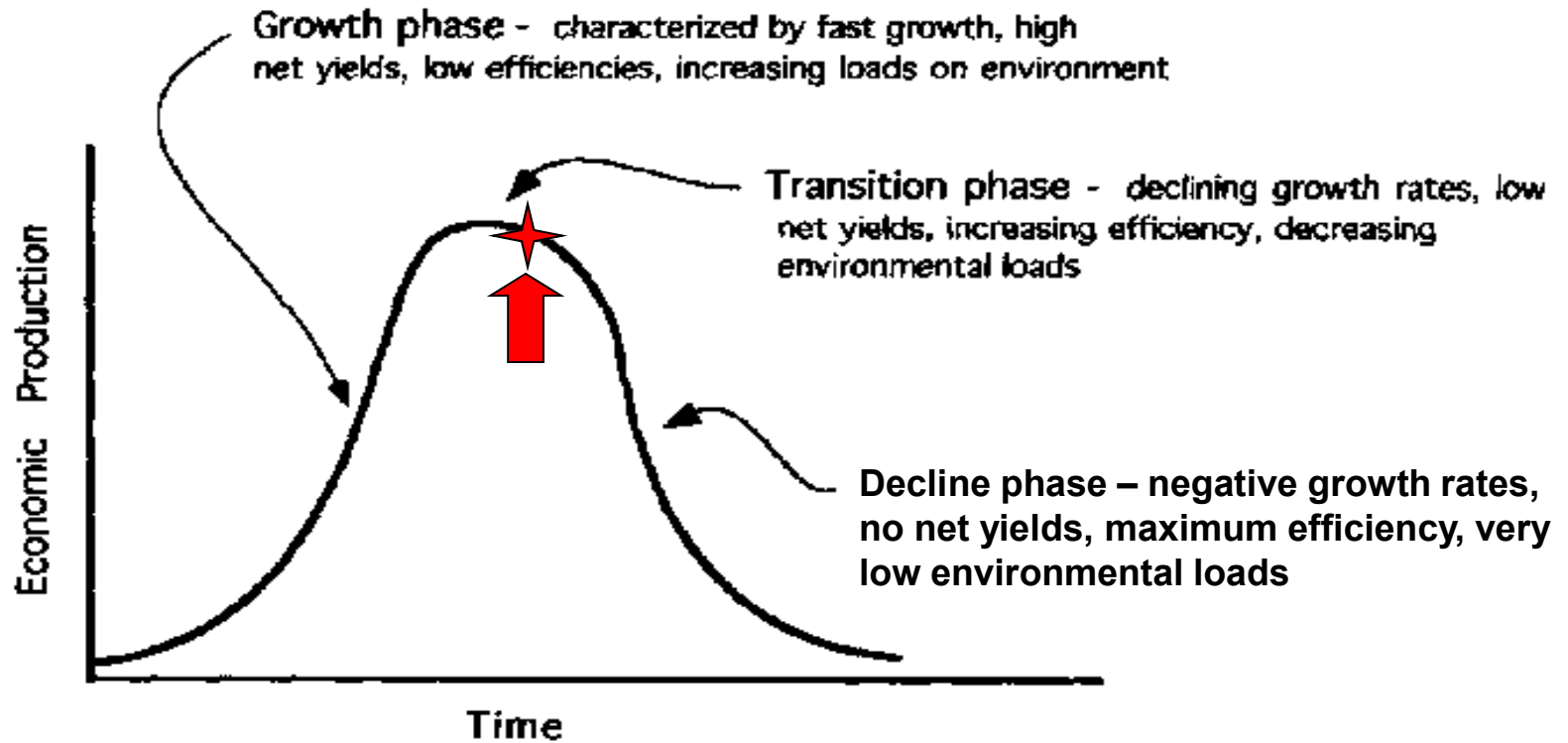
Sustainability is not achieved once for ever

Systems follow oscillating patterns and adopt different sustainability strategies
(Odum & Odum, 2001)



- (1) **growth on abundant available resources:** increase of population, structure, and assets, low-efficiency, high-competition;
- (2) **climax and transition:** the system reaches the maximum size allowed by available resources, increases efficiency, develops collaborative patterns, and prepares for descent by storing information;
- (3) **descent:** less resources available, decrease of population and assets, increased recycling, transmission of information in a way that minimizes losses;
- (4) **low-energy restoration:** no-growth, consumption smaller than accumulation, storage of resources for a new cycle ahead.

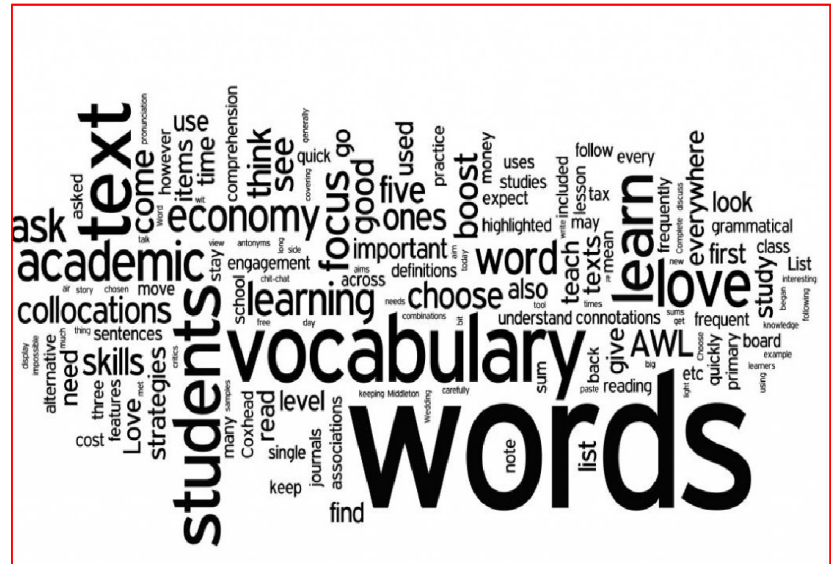
Cycles of growth and descent



A sustainability discourse is needed

As surprising as it may be, **we do not have a word to specifically refer to qualitative growth**. As a consequence, the previously proposed terms always bear some “negative” meaning as *de-growth* or *way-down* or *down-sizing*.

We also need a semantic revolution to become aware that words are not neutral and have a built-in judgment of value according to the dominating paradigm.



An effort is needed to find **not only a new thermodynamics and a new economics of sustainability, but also a sustainability discourse**, i.e., a new mode of organizing knowledge, ideas, experience and language around shared values based on qualitative growth.

Thanks for your attention!