

Fins a on es pot mantenir el  
creixement?

Ferran Puig Vilar – 09/02/2015

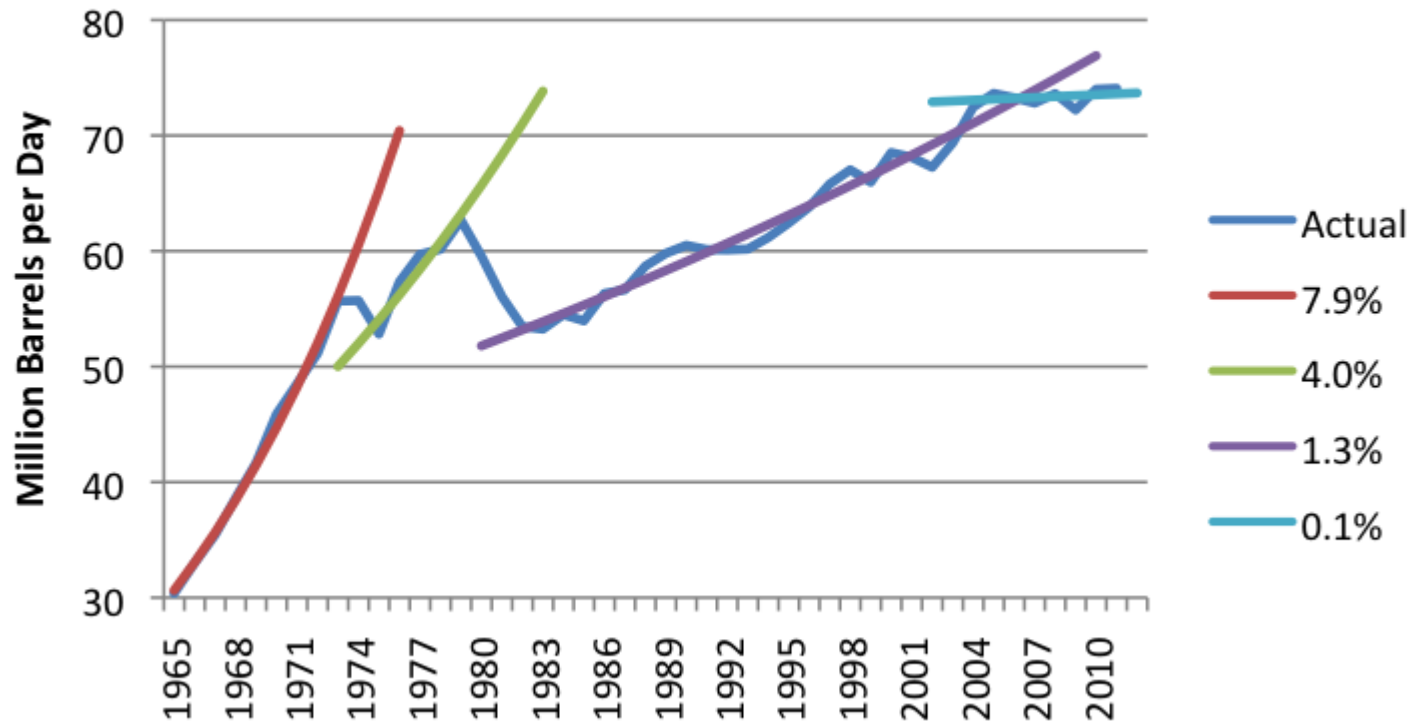
# Conceptes previs

---

- ▶ **Energia**
  - ▶ Zenit de producció d'un recurs mineral
  - ▶ Taxa de retorn energètica TRE / EROEI (!) d'una font d'energia primària
  - ▶ Combustibles fòssils no convencionals
  - ▶ Limitacions energies alternatives
  - ▶ La paradoxa de Jevons
- ▶ **Dinàmica de sistemes**
  - ▶ Realimentació i interacció
  - ▶ Modelització top-down
  - ▶ Contorn d'un sistema
  - ▶ Cicle de vida
- ▶ **Economia**
  - ▶ Rendiments decreixents
  - ▶ Funció de producció de Solow
  - ▶ Relació economia–energia → esclaus; MM

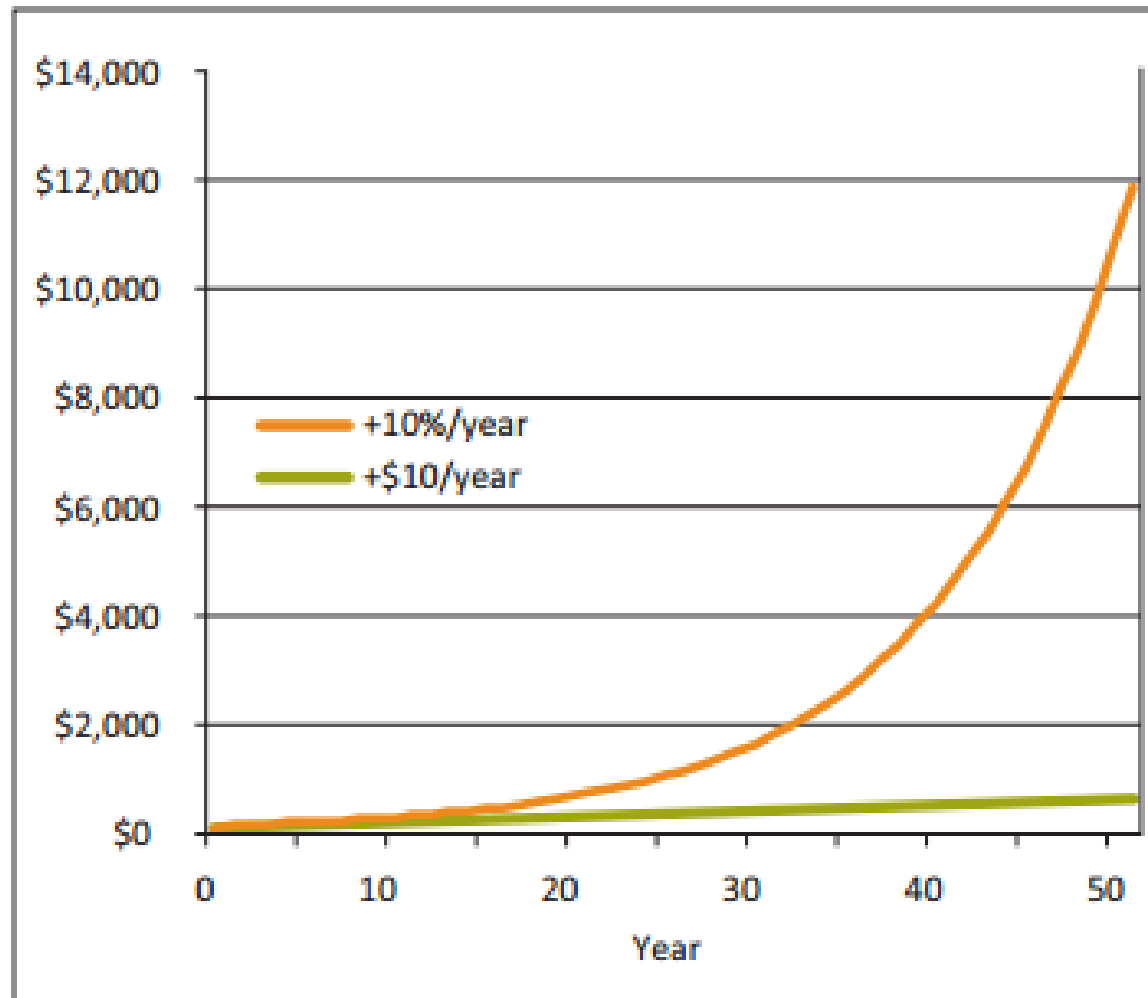


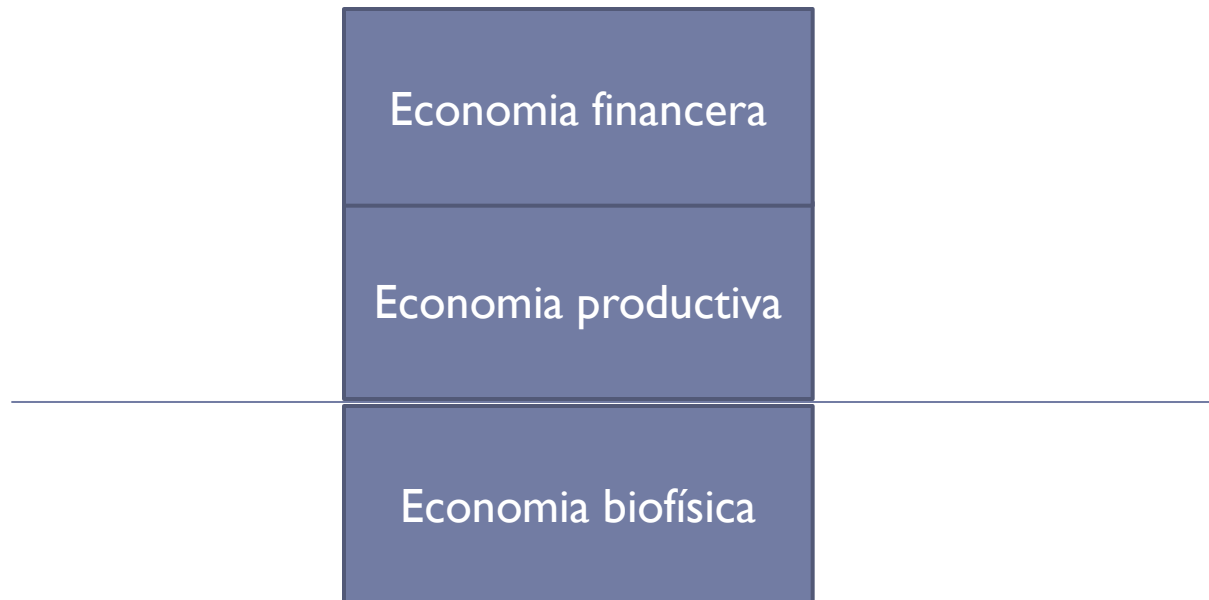
## World Crude Oil Production & Fitted Growth %





## Exponential Growth Versus Arithmetic Growth

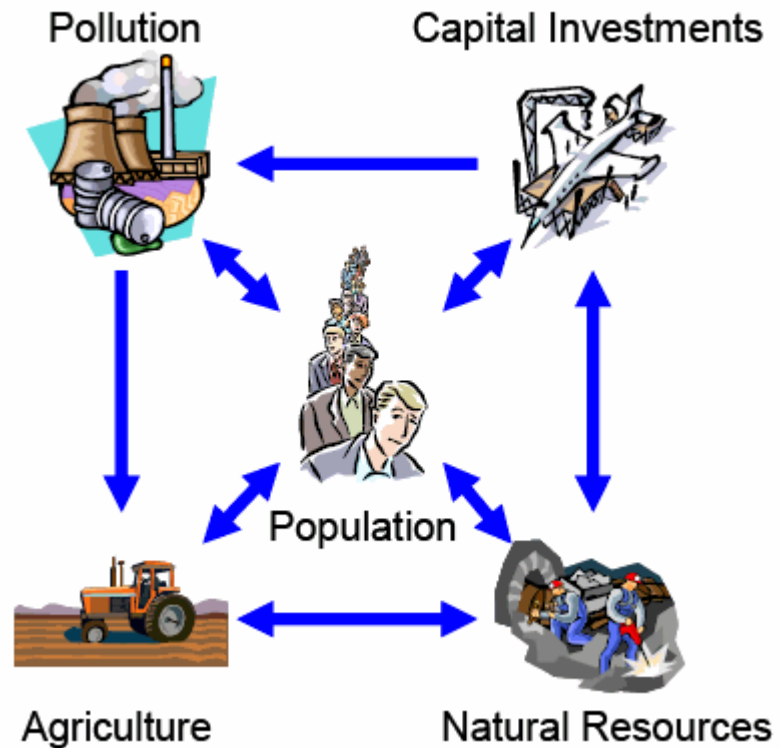




Joan Martínez-Alier (2010) - Hacia una economía sostenible: dilemas del ecologismo actual - Club de Roma Barcelona - 14/12/2010 - Departament d'Economia i d'Història Econòmica, Universitat Autònoma de Barcelona: "La economía tiene tres pisos: arriba está el ático y sobre-ático, una lujosa penthouse bien amueblada y con abrigadas alfombras, con salones de ruleta y bacará, donde se anotan y negocian las deudas que durante un tiempo pueden crecer exponencialmente; en medio, está un piso muy atareado con mucha gente y mucho ruido, que parece ser el principal ya que contiene la economía productiva donde se producen y consumen bienes y servicios, una mezcla de fábrica de automóviles y grandes almacenes en época de rebajas; y por abajo está el sótano con la sala de máquinas, el depósito del carbón y la sucia habitación de las basuras, que proporciona energía a todo el edificio y también sirve de sumidero."

# Informe: Els límits del creixement

---



# Original i revisions pròpies

---

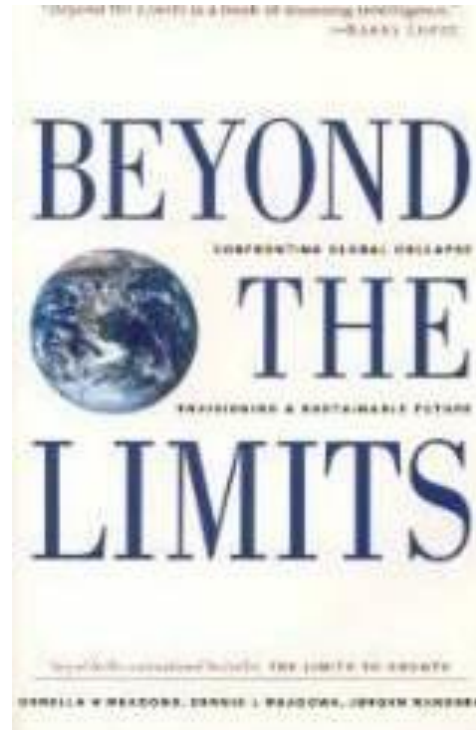
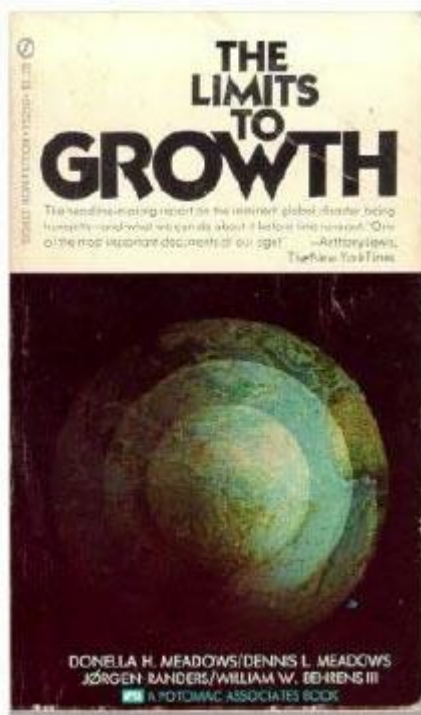
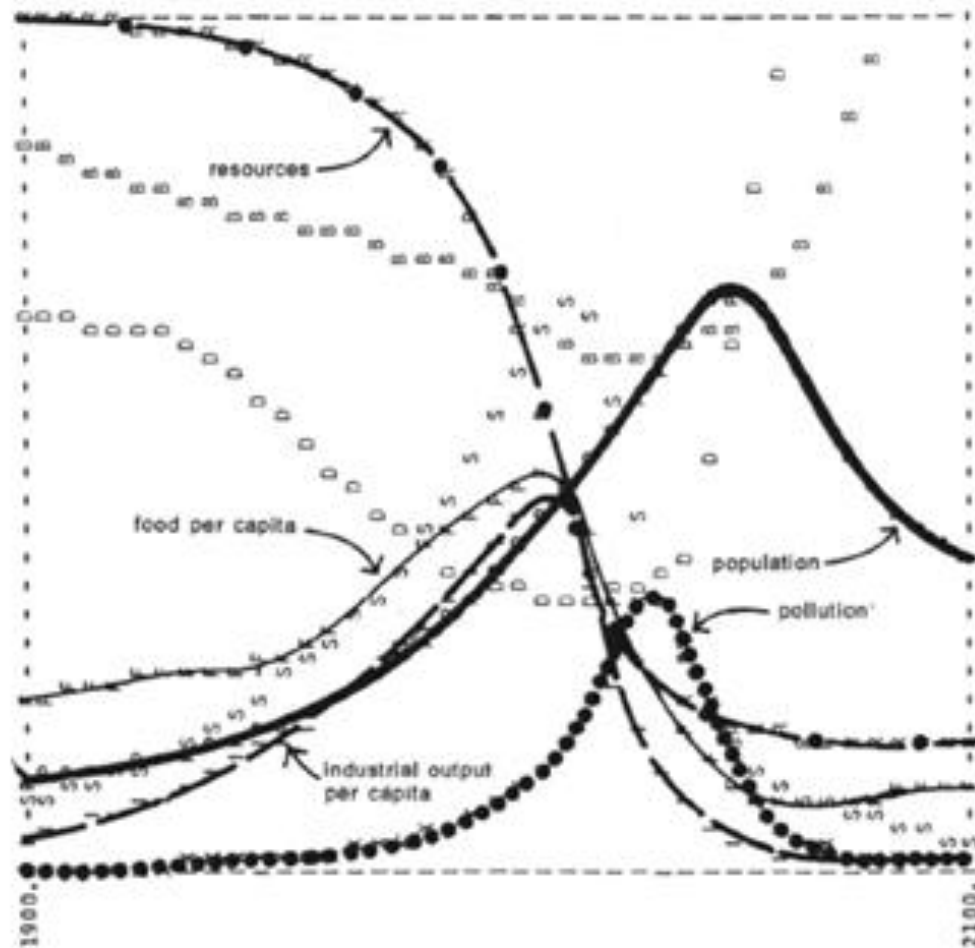
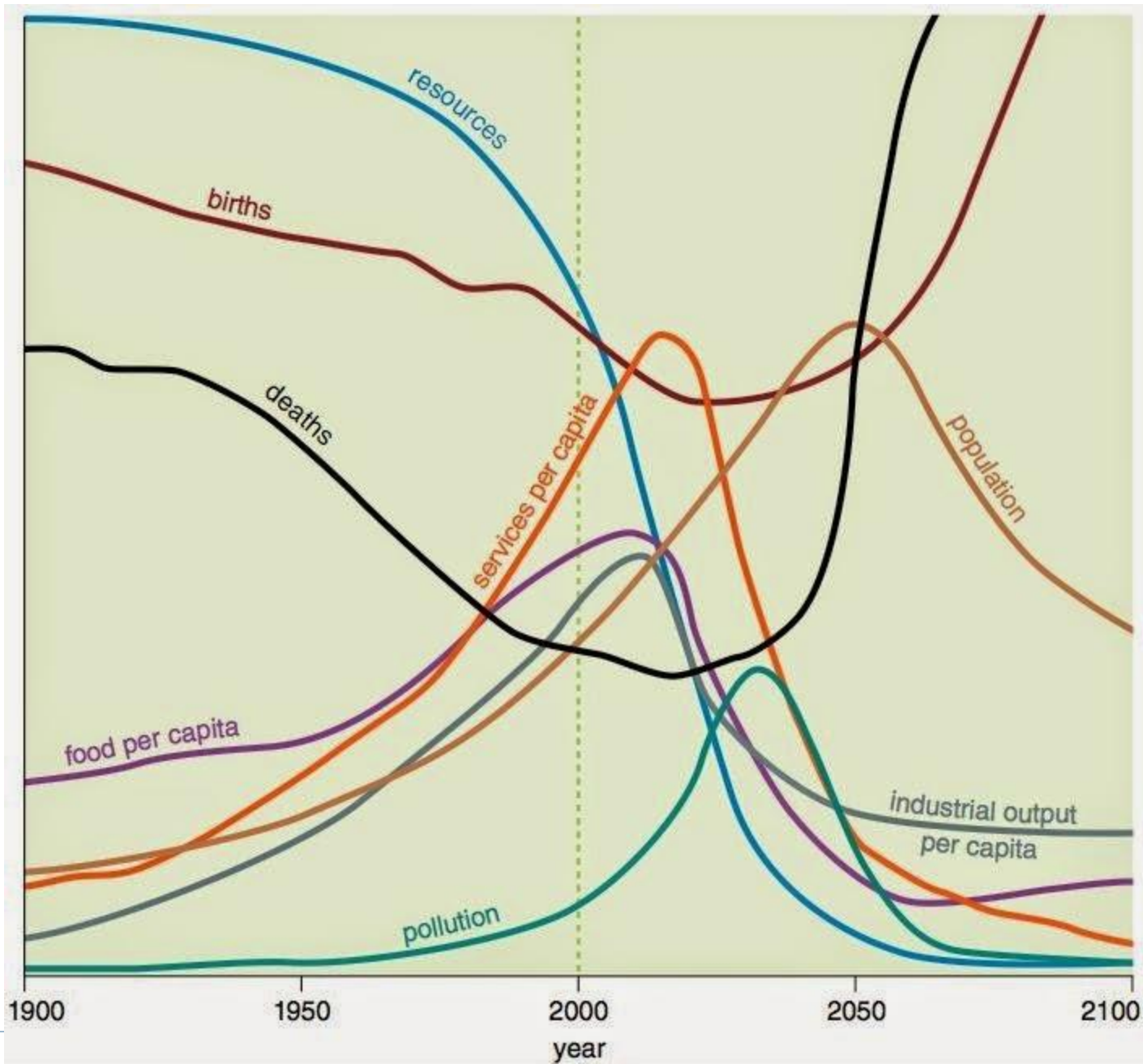




Figure 35 WORLD MODEL STANDARD RUN





UGO BARDI

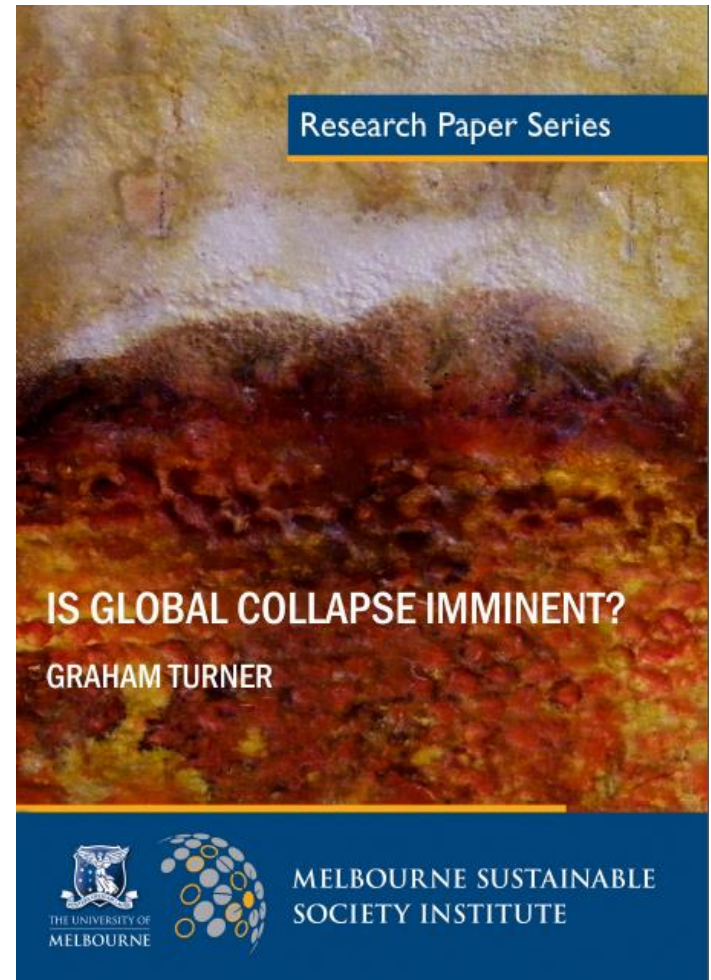
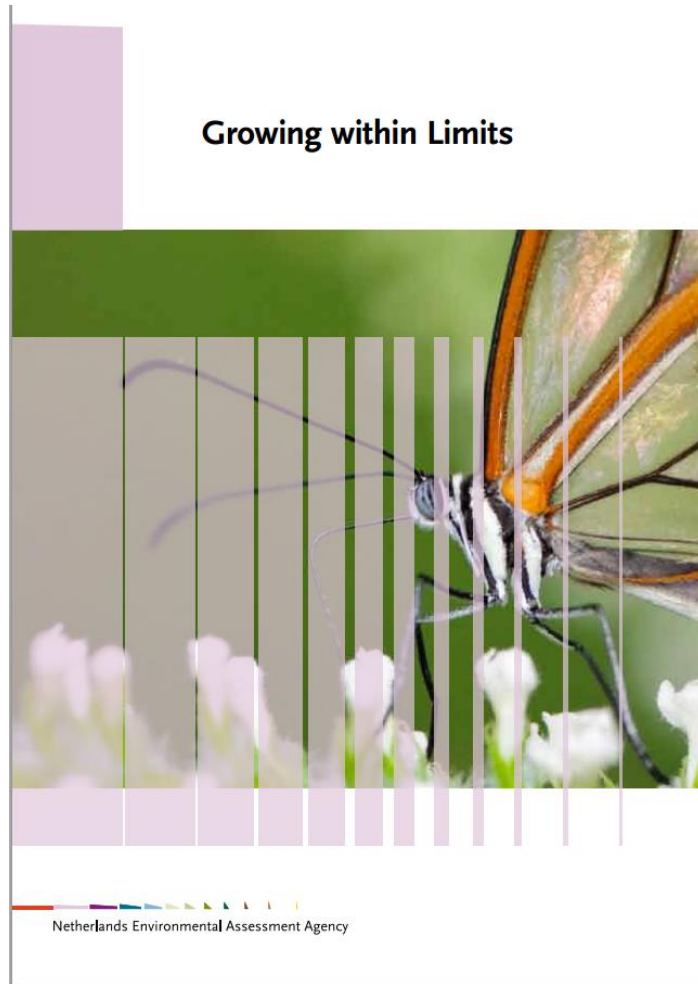
# LOS LÍMITES DEL CRECIMIENTO RETOMADOS

PRÓLOGO DE FEDERICO MAYOR ZARAGOZA  
Y EPÍLOGO DE JORGE RIECHMANN

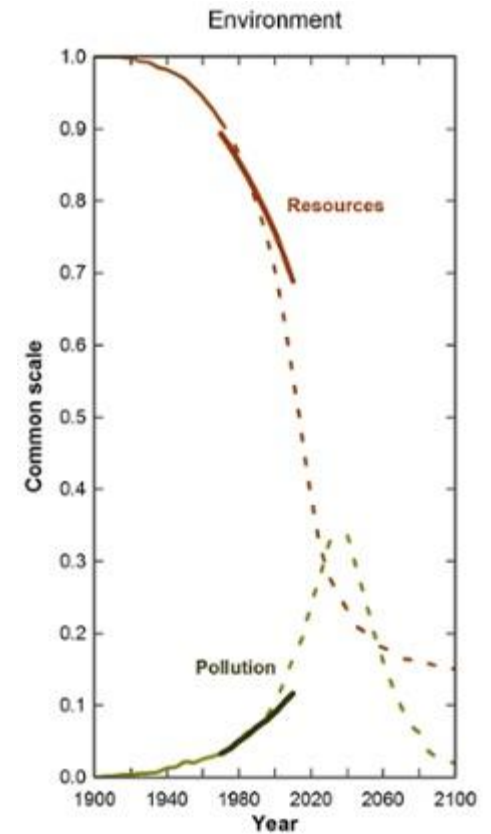
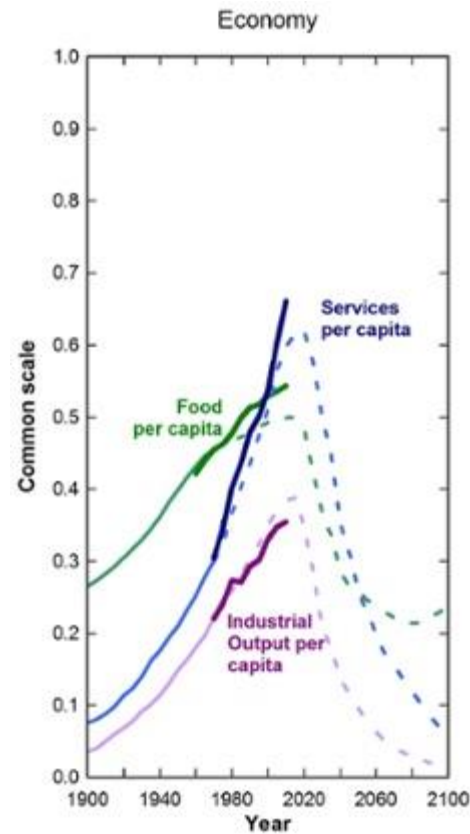
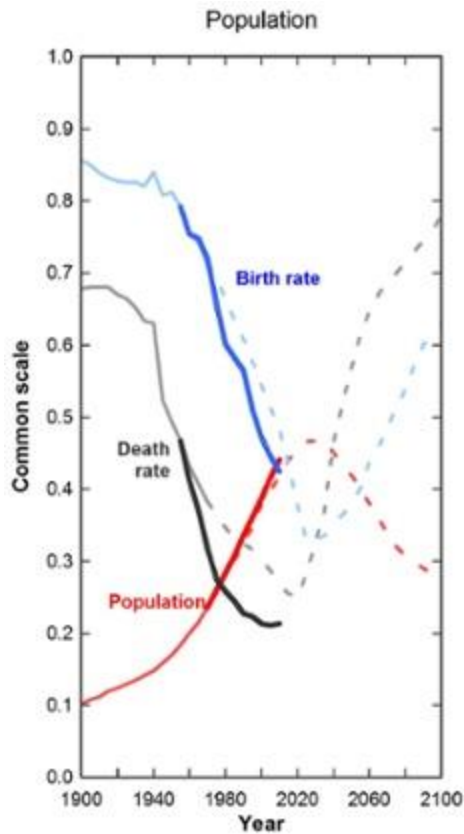


# Revisions externes

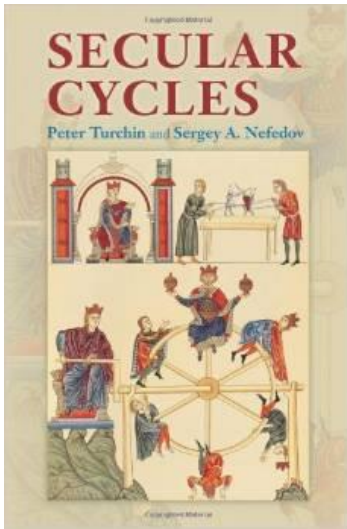
---



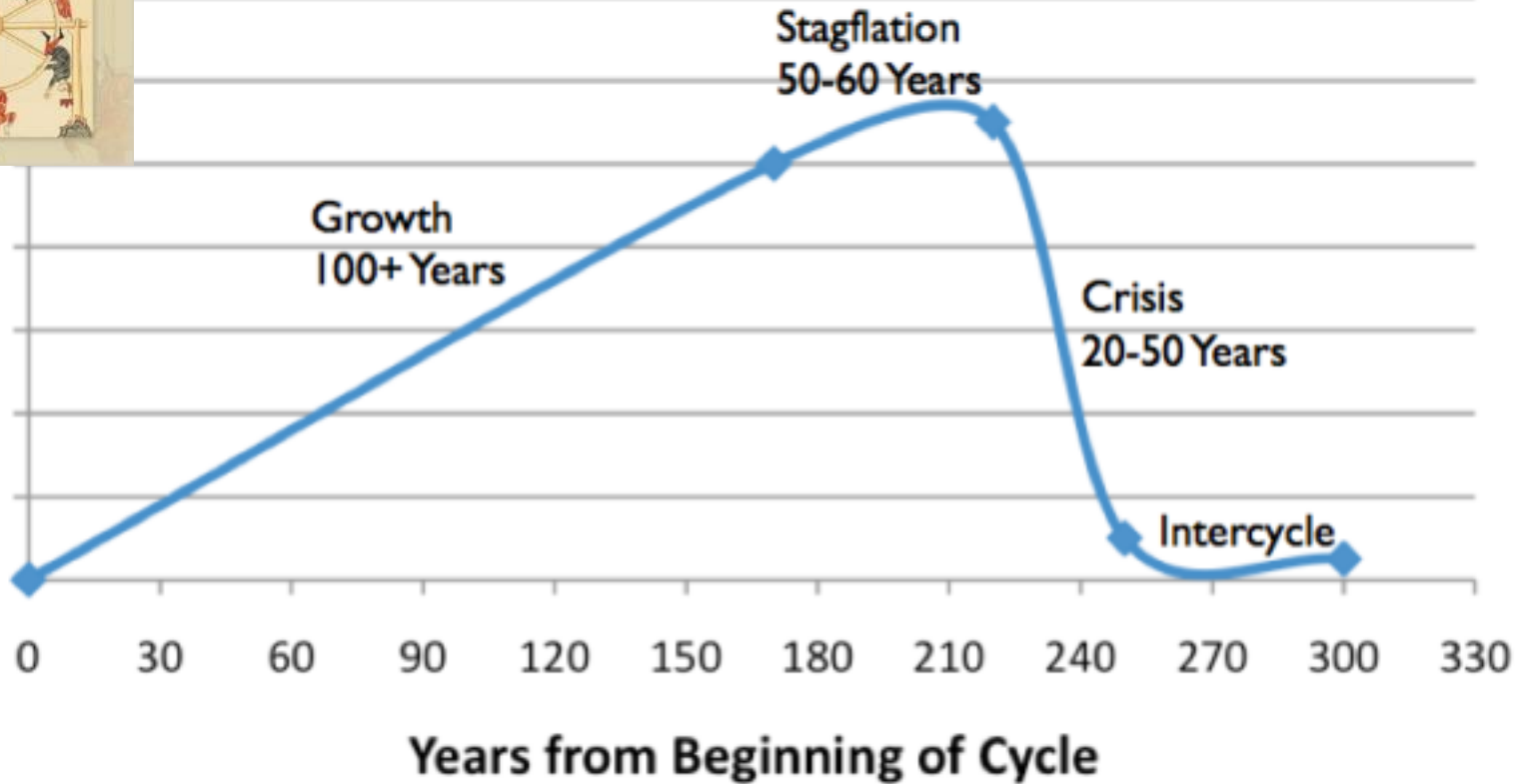
# Què diu la darrera revisió (agost 2014)



▶ Graham Turner and Cathy Alexander - Limits to Growth was right. New research shows we're nearing collapse - The Guardian, 02/09/2014 - <http://www.theguardian.com/commentisfree/2014/sep/02/limits-to-growth-was-right-new-research-shows-were-nearing-collapse>



## Shape of Typical "Secular Cycle"





Contents lists available at ScienceDirect

Energy

journal homepage: [www.elsevier.com/locate/energy](http://www.elsevier.com/locate/energy)

## Fossil fuel depletion and socio-economic scenarios: An integrated approach

Iñigo Capellán-Pérez <sup>a,\*</sup>, Margarita Mediavilla <sup>b</sup>, Carlos de Castro <sup>c</sup>, Óscar Carpintero <sup>d</sup>,  
Luis Javier Miguel <sup>b</sup>

<sup>a</sup> *Low Carbon Programme, Instituto de Economía Pública, University of Basque Country, Avd. Lehendakari Aguirre, 48015 Bilbao, Spain*

<sup>b</sup> *Systems Engineering and Automatic Control, Escuela de Ingenierías Industriales, Paseo del Cauce s/n, University of Valladolid, 47011 Valladolid, Spain*

<sup>c</sup> *Applied Physics Department, Escuela de Arquitectura, Av Salamanca, 18, University of Valladolid, 47014 Valladolid, Spain*

<sup>d</sup> *Applied Economics Department, Facultad de Ciencias Económicas, Paseo del Cauce, s/n, University of Valladolid, 47011 Valladolid, Spain*

### ARTICLE INFO

#### Article history:

Received 14 January 2014

Received in revised form

12 September 2014

Accepted 14 September 2014

Available online xxx

#### Keywords:

Renewable limits

Fossil fuel depletion

Global warming

System dynamics

Peak oil

Global Environmental Assessment

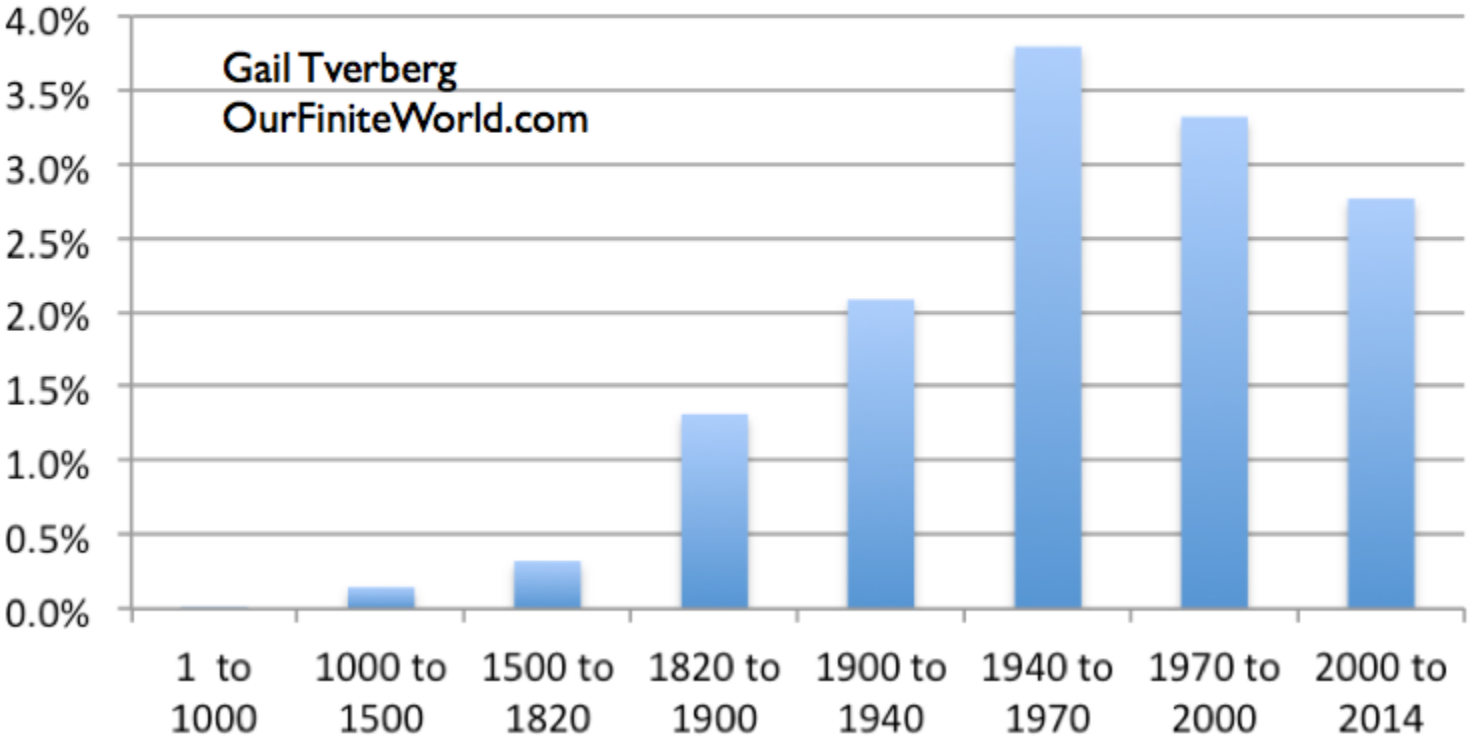
### ABSTRACT

The progressive reduction of high-quality-easy-to-extract energy is a widely recognized and already ongoing process. Although depletion studies for individual fuels are relatively abundant, few of them offer a global perspective of all energy sources and their potential future developments, and even fewer include the demand of the socio-economic system.

This paper presents an Economy-Energy-Environment model based on System Dynamics which integrates all those aspects: the physical restrictions (with peak estimations for oil, gas, coal and uranium), the techno-sustainable potential of renewable energy estimated by a novel top-down methodology, the socio-economic energy demands, the development of alternative technologies and the net CO<sub>2</sub> emissions.

We confront our model with the basic assumptions of previous Global Environmental Assessment (GEA) studies. The results show that demand-driven evolution, as performed in the past, might be unfeasible: strong energy-supply scarcity is found in the next two decades, especially in the transportation sector before 2020. Electricity generation is unable to fulfill its demand in 2025–2040, and a large

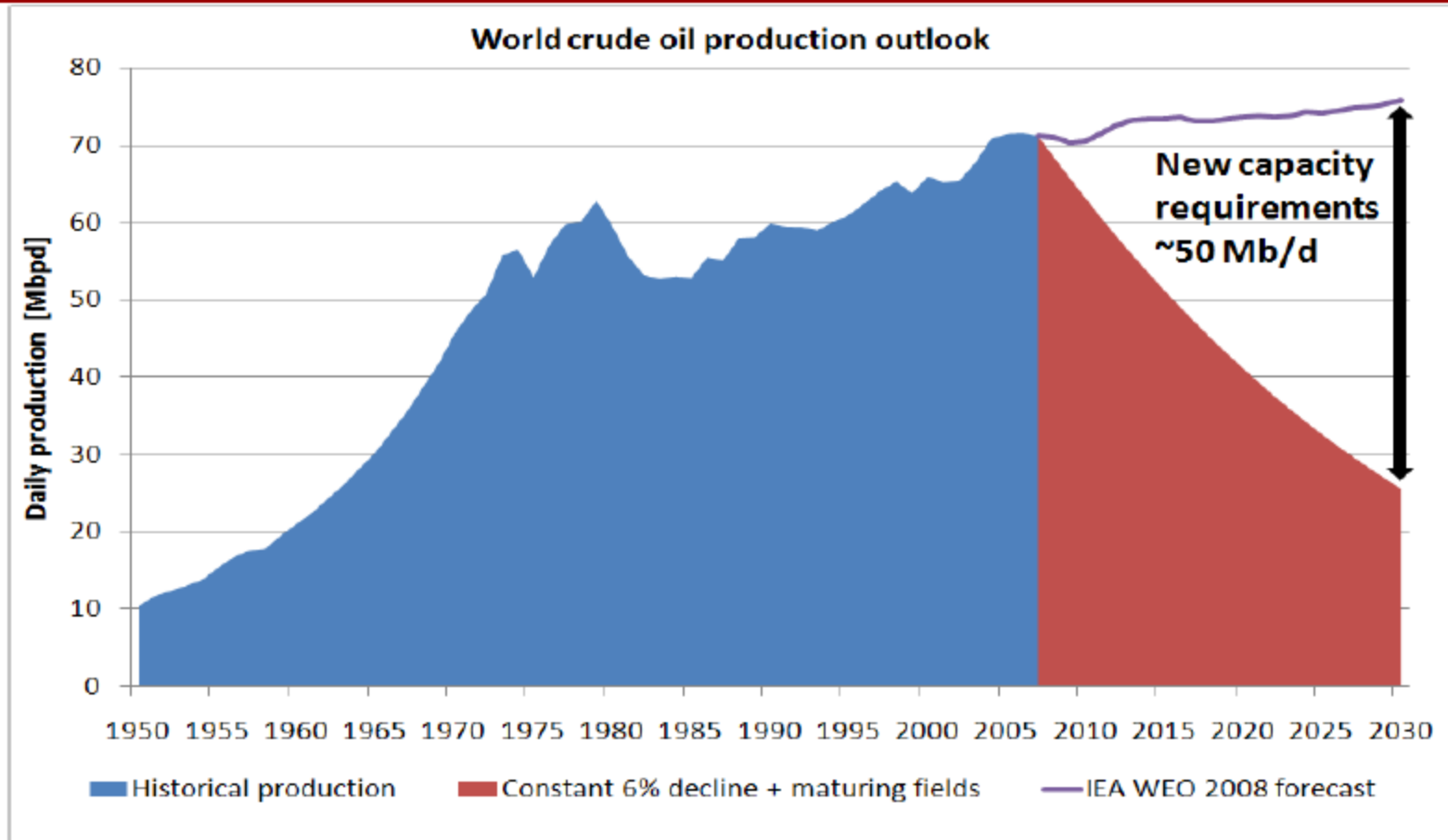
# Average Annual % Growth in GDP





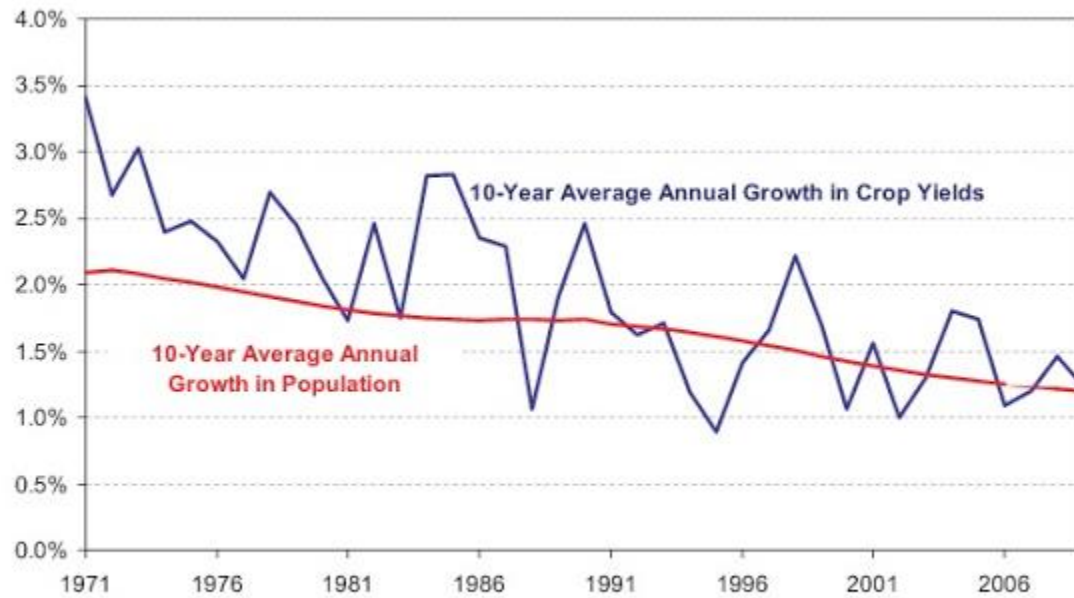


# Future production needs?



Source: Höök, Hirsch & Aleklett (2009) Giant oil field decline rates and their influence on world oil production, *Energy Policy*, Volume 37, Issue 6, Pages 2262-2272

### 10-Year Average Annual Growth in Crop Yields

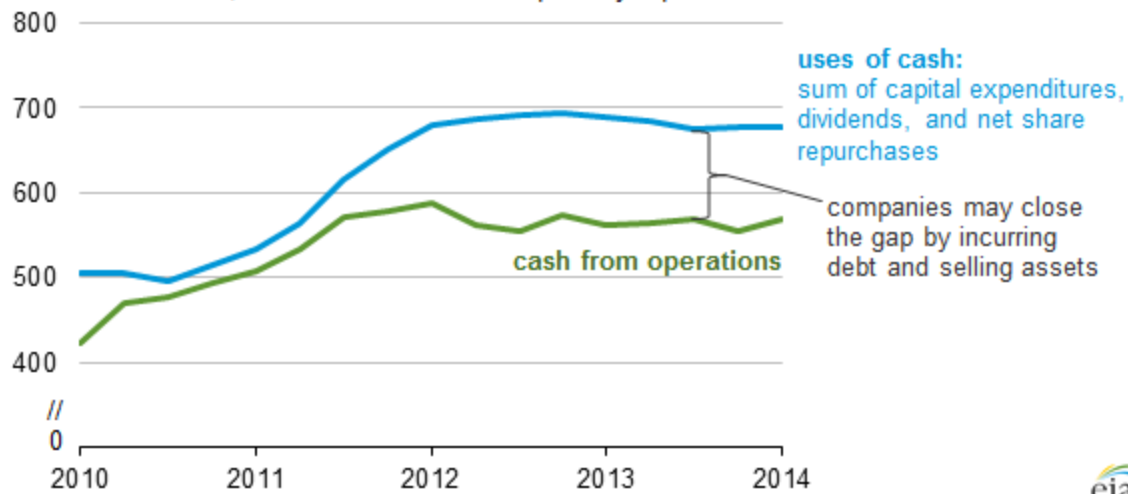


Source: Food and Agriculture Organization of the United Nations As of 12/31/09



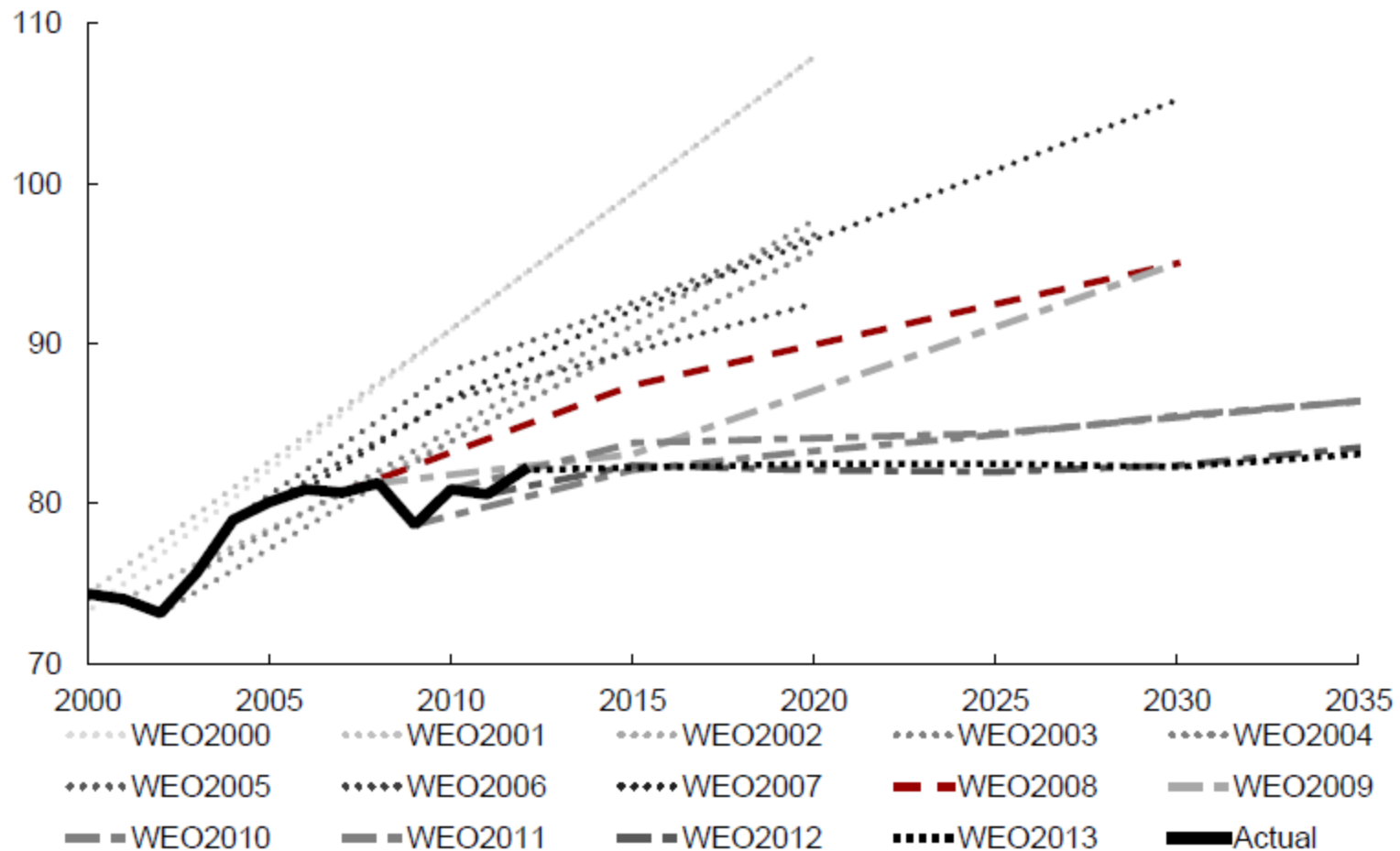
### Major energy companies' cash from operations and uses of cash

billion 2014 dollars, annualized values from quarterly reports





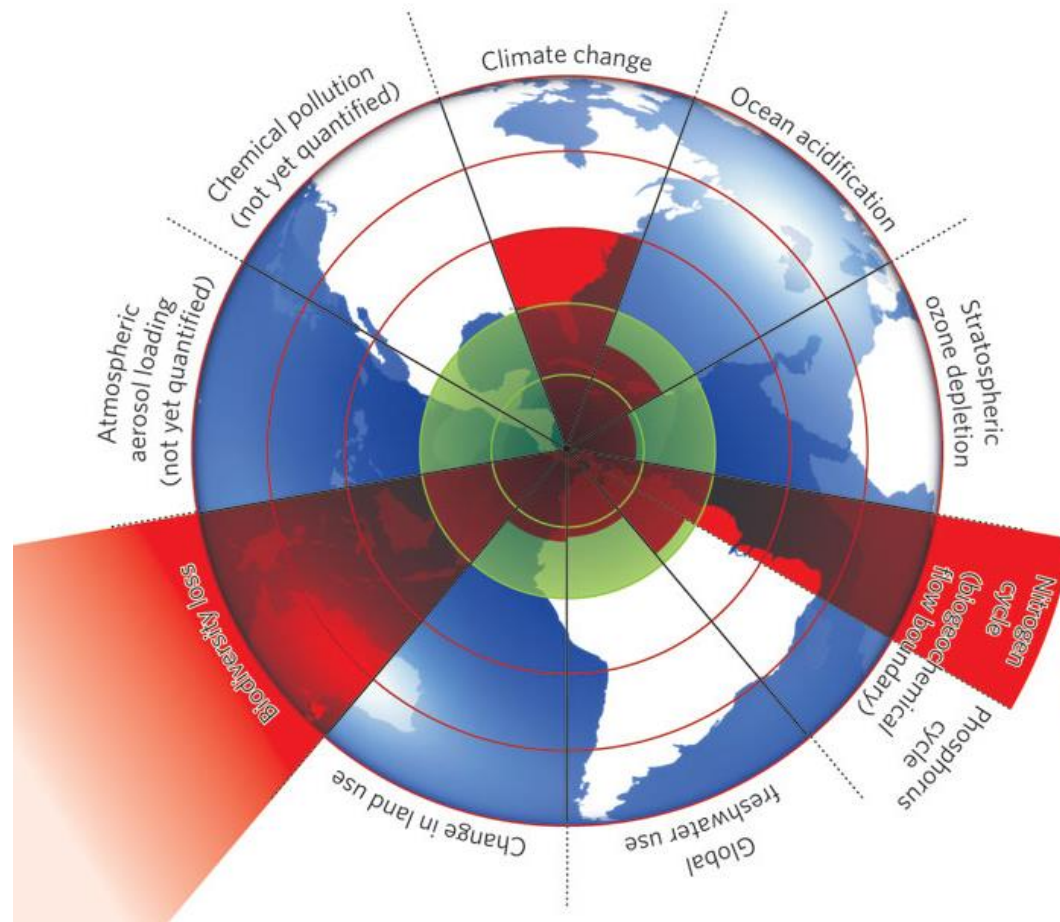
# Conventional outlook



Sources: IEA World Energy Outlook 2000-2013



# A safe operating space for humanity



Johan Rockström et al (2009) - A safe operating space for humanity -  
Nature 461:472-475 doi:10.1038/461472a - 29 autores

A Global Forecast  
for the Next Forty Years



Jorgen Randers

A REPORT TO THE CLUB OF ROME  
COMMEMORATING THE 40TH ANNIVERSARY OF  
*The Limits to Growth*



# Informes oficiales

---







---

# Gràcies

<http://ustednoselocree.com>

