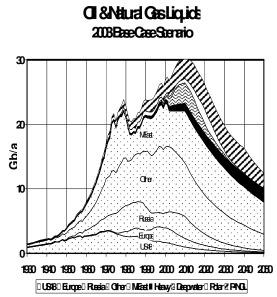

Solar Power Agriculture, a new Paradigm for Energy Production

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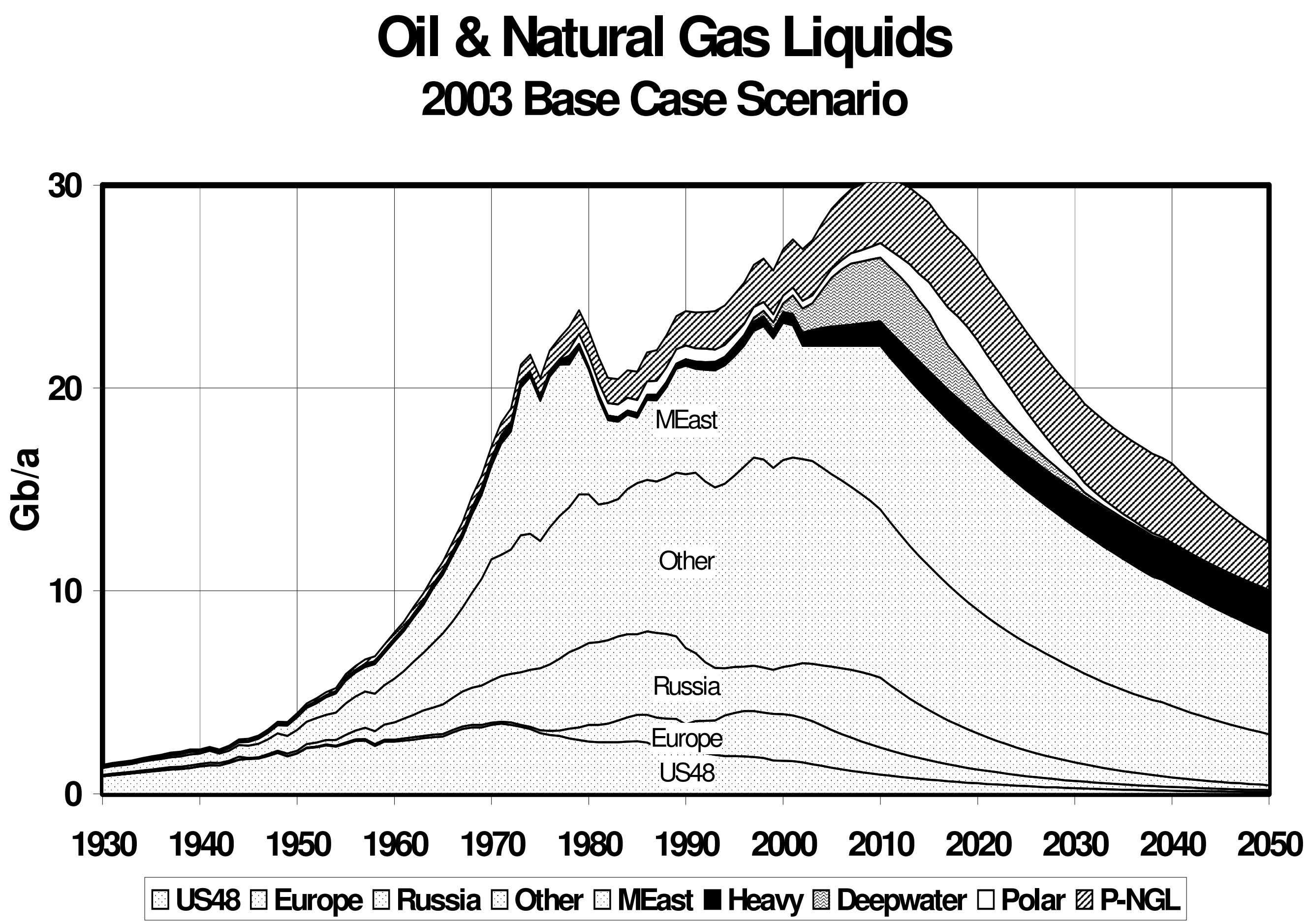
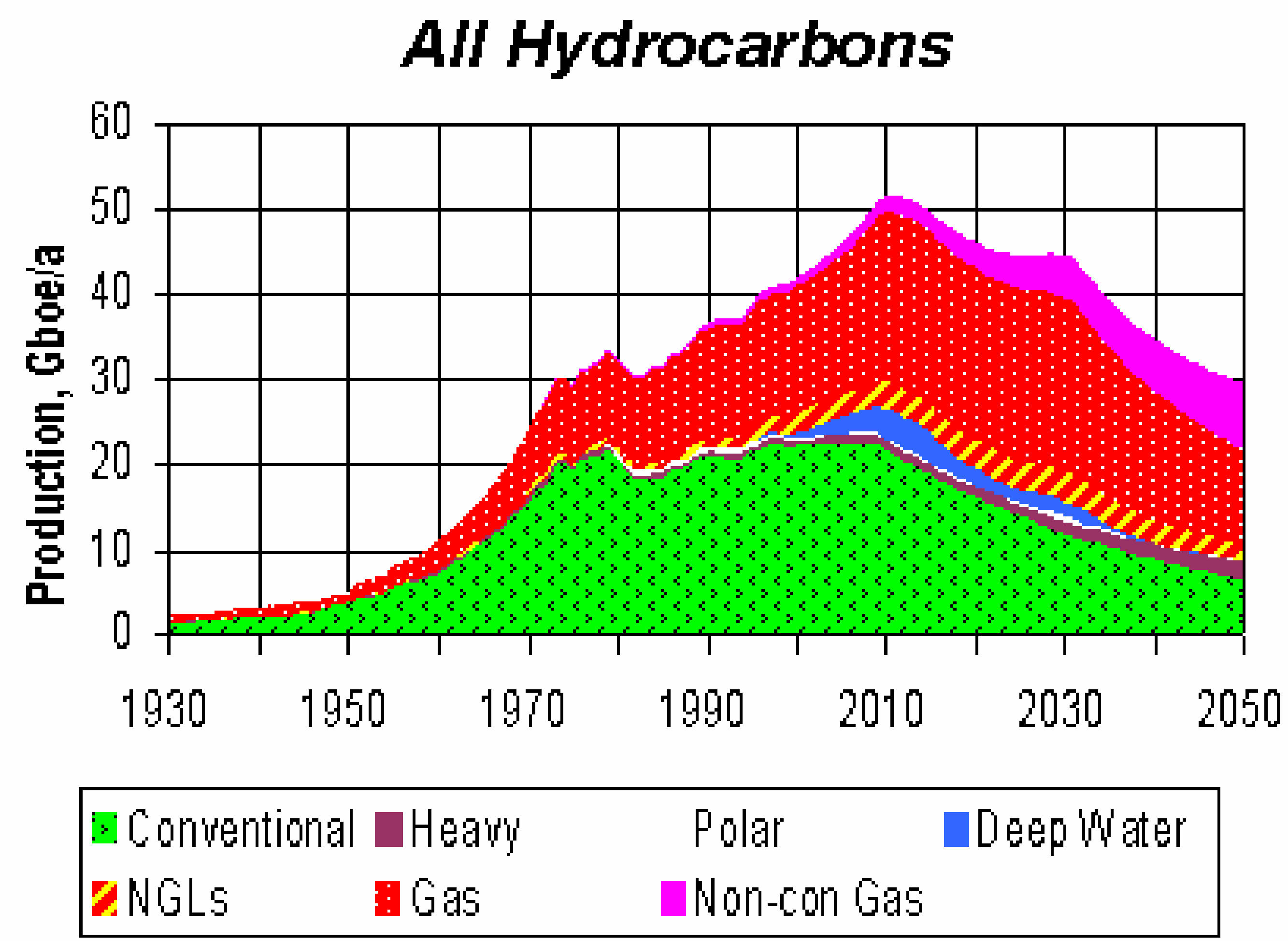
The typical production curve of the “Mineral Economy is “bell shaped”. The curve shown here for crude oil is one example of several studies which all give similar results. Crude oil remains to this date the main fossil resource in the global economy



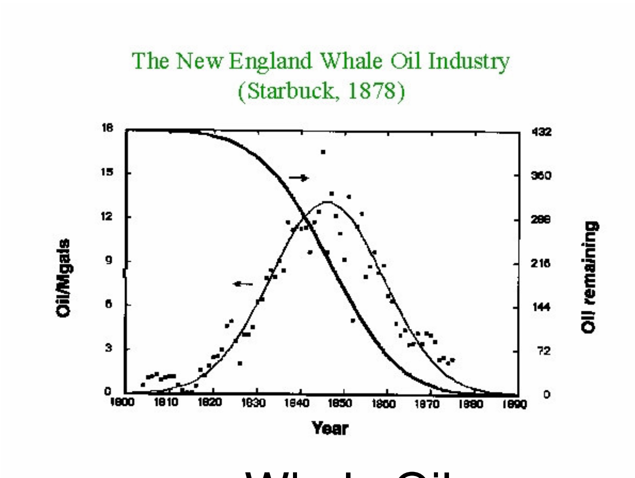
ASPO model of crude oil Production (Campbell 2004, www.peakoil.net)

More mineral resources can be added to the amount which is defined as "recoverable". However, the general shape of the curve changes little. In this case, the addition is for "all hydrocarbons".

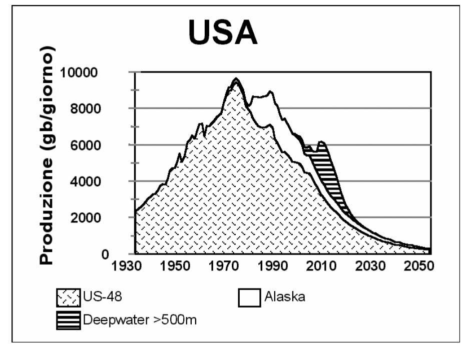


ASPO models of hydrocarbon production (Campbell 2004, www.peakoil.net)

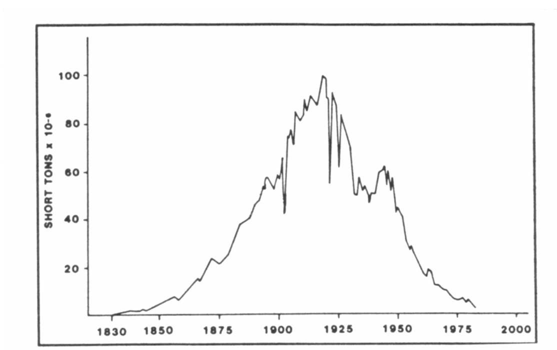
There are many known, historical cases of bell Shaped Curves for “mineral” production (“mineral” is intended as anything that is produced (or “extracted”) faster than it can be replaced.Hence also whaling produced the same kind of curve



Whale Oil

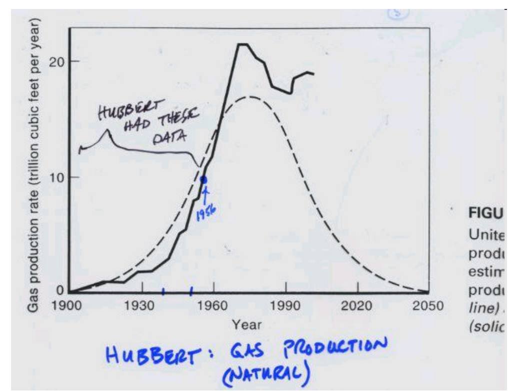


US 48 Oil



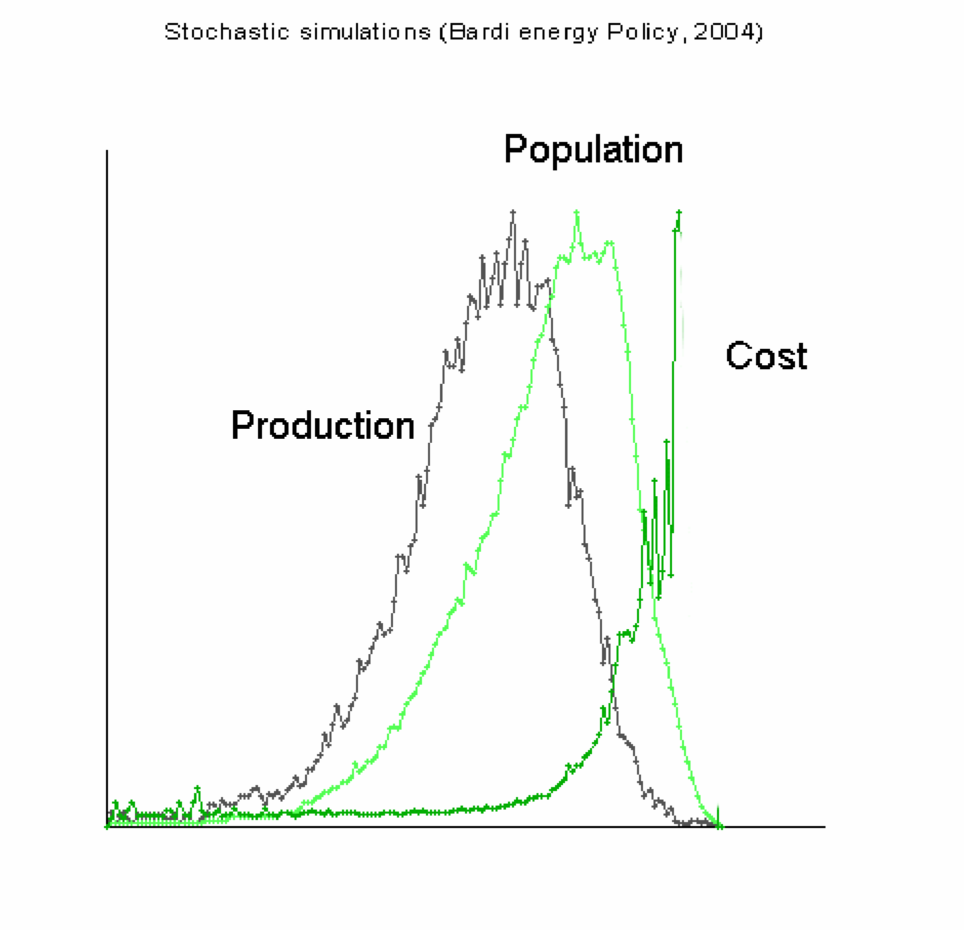
The annual production of anthracite coal from Pennsylvania displays a bell-shaped curve. Major deviations from the curve are a dip during the Great Depression (1929–38) and a peak during World War II.

Pennsyvania coal

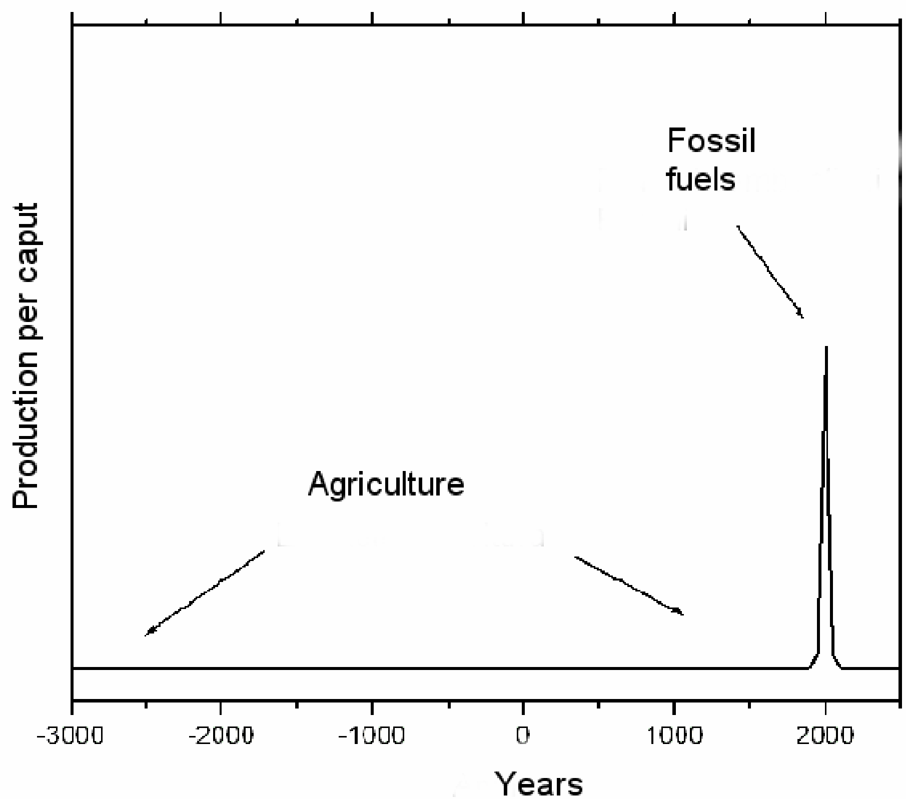


USA Natural gas

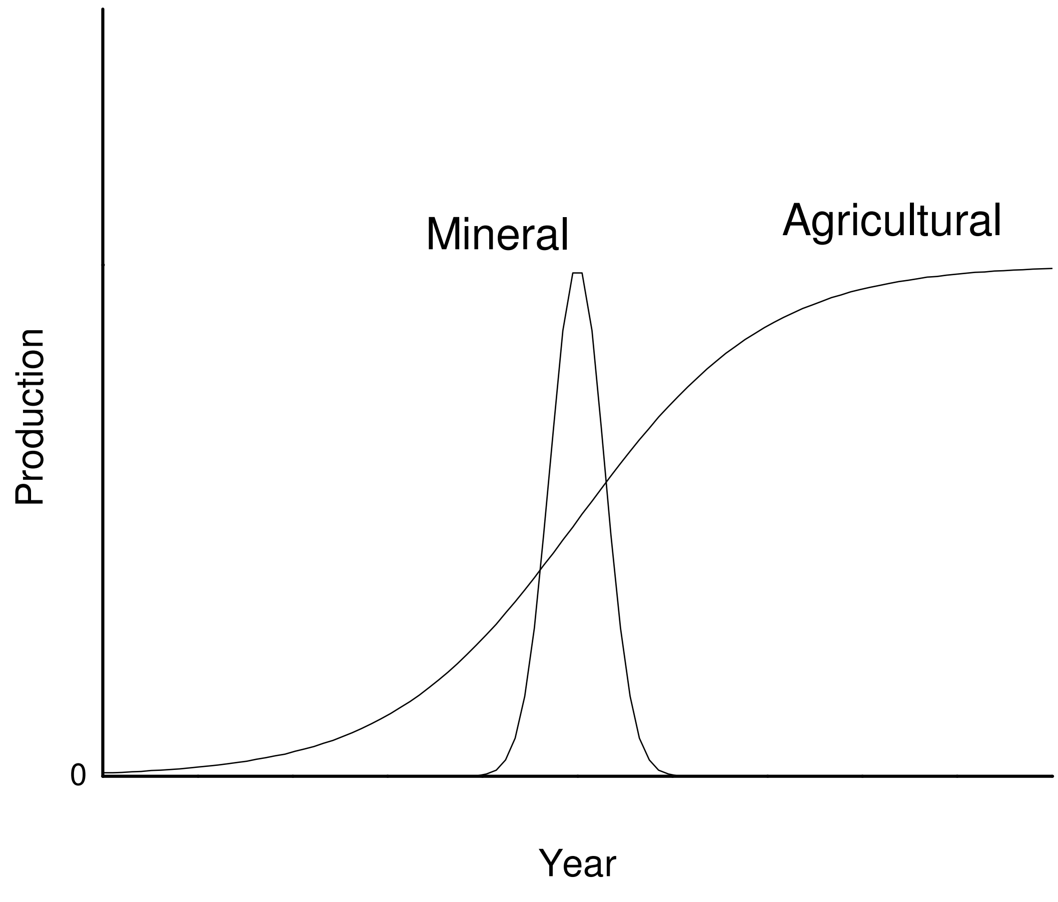
The fact that the production curve is “bell shaped” has consequences on population. In this stochastic simulation (bardi energy policy, in press 2004) we see that in the hypothesis that the economy depends completely on fossil resources (not far from reality) population follows production with a delay of some years.



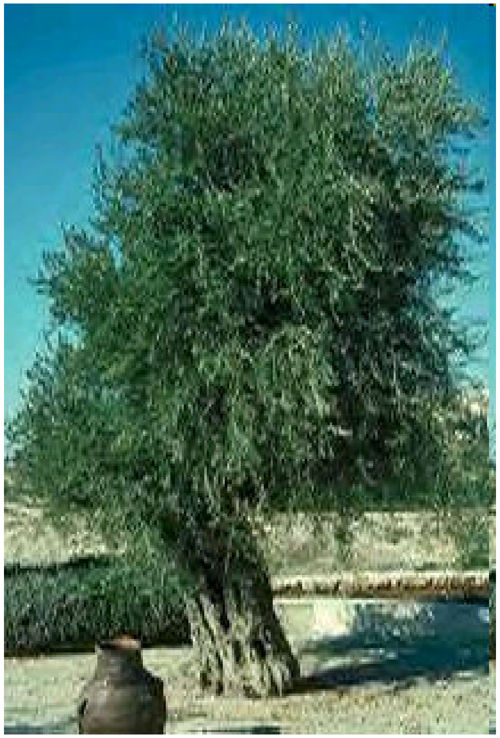
Most of the debate on the subject of resources depletion, so far, has been on whether we are close to the peak or not, with the disagreement being quantifiable on the range of decades at most. However, if we plot the fossil fuel production curve on its “natural” scale, that within the timespan of human civilization, we see that one or a few decades more or less makes no difference. The age conventional hydrocarbons will last about two hundred years. Coal or “unconventional” resources might somewhat lengthen it, but the overall picture doesn’t change.



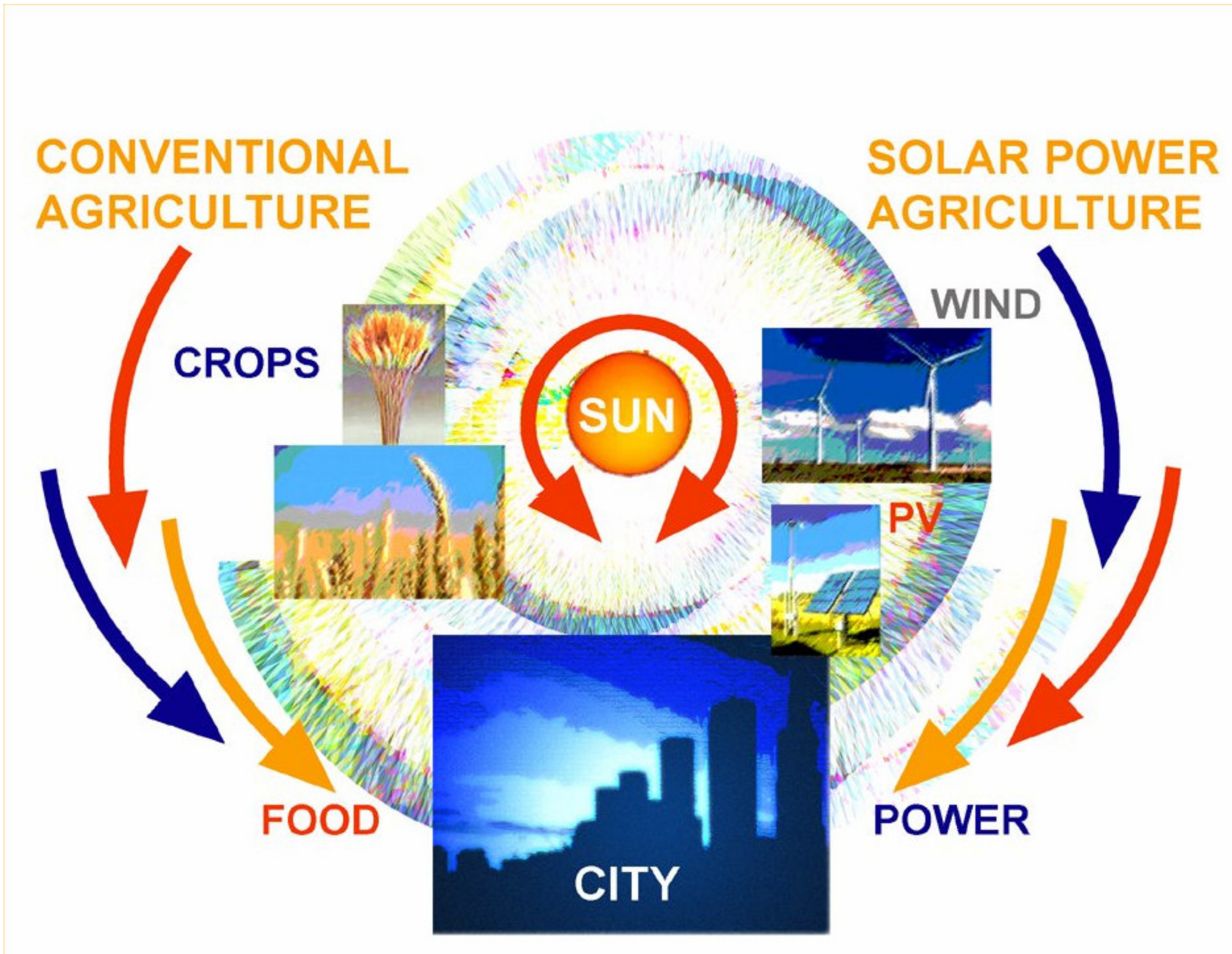
The production curve of agriculture is completely different from that of mineral resources. Agriculture is, at least in principle, sustainable and its curve tends to an asymptotic plateau when the Land resources are saturated.



The approaching depletion of fossil fuels has led some environmentalists to theorize the return to agriculture; with all the appropriate paraphernalia: spades, rakes, etc.This return would not be possible without a substantial reduction in population and great suffering. However, we do not need to go back to oil lamps and peasants dressed in rags. From an ECONOMICAL viewpont, renewable energy is the same as agriculture as it follows the same “S-shaped” production curve. From this point of view, wind turbines (or any other kind of renewable method) are another fom of agriculture, just they produce electric power rather than food or biomass.



Once we set in this frame of mind, we can conceive a production model where different forms of agriculture are all producing goods that are sold to cities. This model of production, "Solar power agriculture", is definitely not the same as some modern approaches to "energy independence for agriculture e.g. FAO-SREN. It is, rather, an extension of a successful economic model which has been in use for the past 6 thousand years at least.



The question regarding “Solar Power Agriculture” is obviously whether it is possible to “embed” solar plants within existing agriculture and produce sufficient power for human needs. This, very obviously, depend on what we mean for “human needs”. In any case, a calculation based on present day technologies and present day needs, shows that the amount of agricultural land available is largely sufficient and that won’t compete with food production for land.

	Millions square km
Land “potentially suitable for agriculture”	**130**
Land used for food production	**50**
Arable land (crops production)	**1.5**

Table 3

Method	Approx. efficiency of light conversion (ratio of incident solar energy to electric power delivered to users)	Order of magnitude deliverable power per area occupied (footprint) for an irradiation of 1200 $kWh/m^2/year$. ($kWh/m^2/year$)
Organic biomass	**~ 0.1%**	**~1**
Solar direct (PV or solar thermoelectric)	**5%-10%**	**~ 100**
Solar indirect (wind)	**n.a.**	**~ 10000 (on suitable sites only)**

	Land area needed as percentage of land used for food production ($50x10^6$ Km^2)	
Technology	**Percent area for Target 1** Energy equivalent to present value of world electricity generation ($1x10^7$ GWh/year)	**Percent Area for Target 2** Energy equivalent to present value of world TFC ($8x10^7$ GWh/year)
BIOMASS conversion to electric power	**21%**	**>100%**
SOLAR DIRECT conversion (PV or solar concentration)	**0.2%**	**1.5%**
SOLAR INDIRECT conversion (wind)	**0.003%**	**0.03%**

Worldwide Land Use and Compatibility

One of the advantages of the concept of “solar power agriculture” is the improvement in public perception. The public is familiar with the concept that most of the non-protected land of the planet is farmed and is radically modified in comparison with its “natural” state. New concepts, such as wind turbines, are often rejected as unfamilar and suspicious. However, once the idea of power production by renewables is framed with a well known and accepted context, agriculture, the public acceptance improves radically.

The concept of “solar power agriculture” is still unfamilar to planners. However, if it were possible to frame the idea as a concrete means to support agriculture, considerable financial resources could be bnlocked with the double advantage of supporting the rural world and advancing towards a renewables based economy

15 EU States

Subsidy to renewables: 5.9 billion Euros/Year

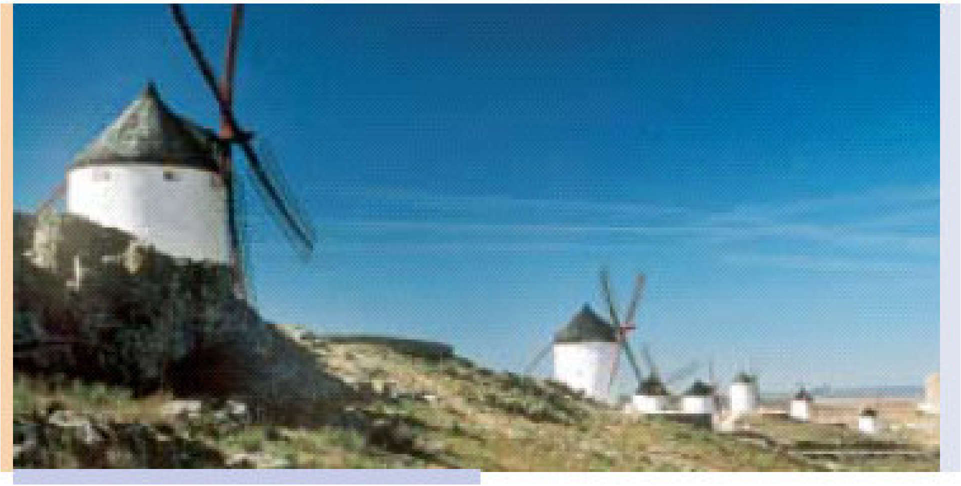
Subsidy to fossil fuels: 21.7 billion Euros/year

Source: EEA

Table 2: EAGGF Guarantee and Guidance planned expenditure by main measures 2000–2006 (EU-15)[5]

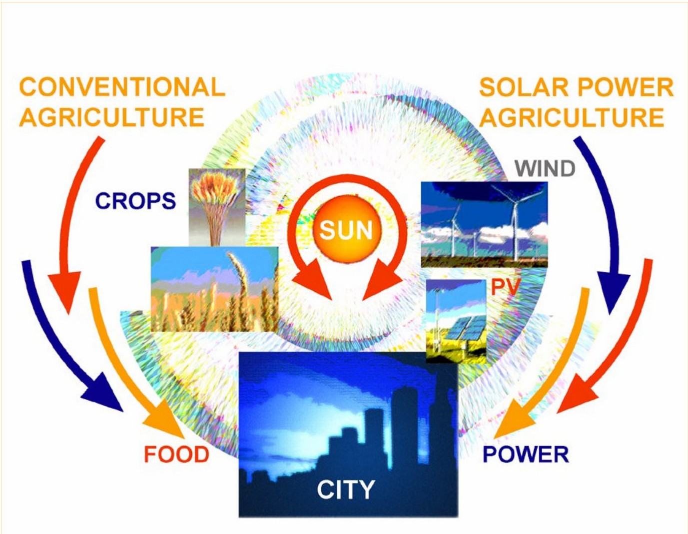
Rural development measures	million EUR	share
Investments in farms	4 682.0	9.5 %
Young farmers	1 824.0	3.7 %
Vocational training	344.0	0.7 %
Early retirement	1 423.0	2.9 %
Less favoured areas and areas with environmental restrictions	6 128.0	12.5 %
	13 480.0	27.5 %
Agri-environment	3 760.0	7.7 %
Investments in processing/marketing	4 807.0	9.8 %
Afforestation of agricultural land, other forestry	12 649.0	25.8 %
Adaptation and development of rural areas		
Total rural development measures*	49 097.0	100.0 %

*Not all programmed expenditure is included, for example evaluation, technical assistance (in the case of Guidance) and certain commitments relating to the previous programming period.



http://europa.eu.int/comm/agriculture/rur/publi/index_en.htm

SOLAR POWER AGRICULTURE



More data about the concept of "Solar Power agriculture can be found at:
www.aspoitalia.net/aspoenglish/documents/bardi/solarpoweragriculture_bardi_2004.pdf

The site of the ASPO association is at www.peakoil.net

The home page of the author (Ugo Bardi) is at:
www.unifi.it/unifi/surfchem/solid/bardi

Comments and suggestions are welcome at bardi@unifi.it