

**Imperial College
London**

100 years of living science

100

**Transportation in a Sustainable
Society: Technology**
Prof Roderick A Smith

**10th EU Hitachi Science and Technology
Forum Paris 11-13 May 2007**

Global warming.... A far greater threat to the world than
international terrorism

UK Government Chief Scientist, Prof Sir David King

....alarming and simply unsustainable

UK Prime Minister, Tony Blair

Our house is burning down and we are blind to it

French President Jacques Chirac

I stand before you as a representative of an endangered people..
As a result of global warming and sea level rise, my country may
disappear from the face of the Earth.

President of the Republic of the Maldives.

The real basis of the world economy:

- Capture of resources
- Processing into “useful” products using energy
- Distribution and use
- Disposal
- It is governed by physical laws of thermodynamics and continuity

The desire for growth:

- Exponential growth of modest rate leads to doubling in short times
- eg. 3%, 23 years, 10% 7 years
- But the killer is that:
Each successive doubling period uses the total resource of all previous doubling periods combined

Key questions:

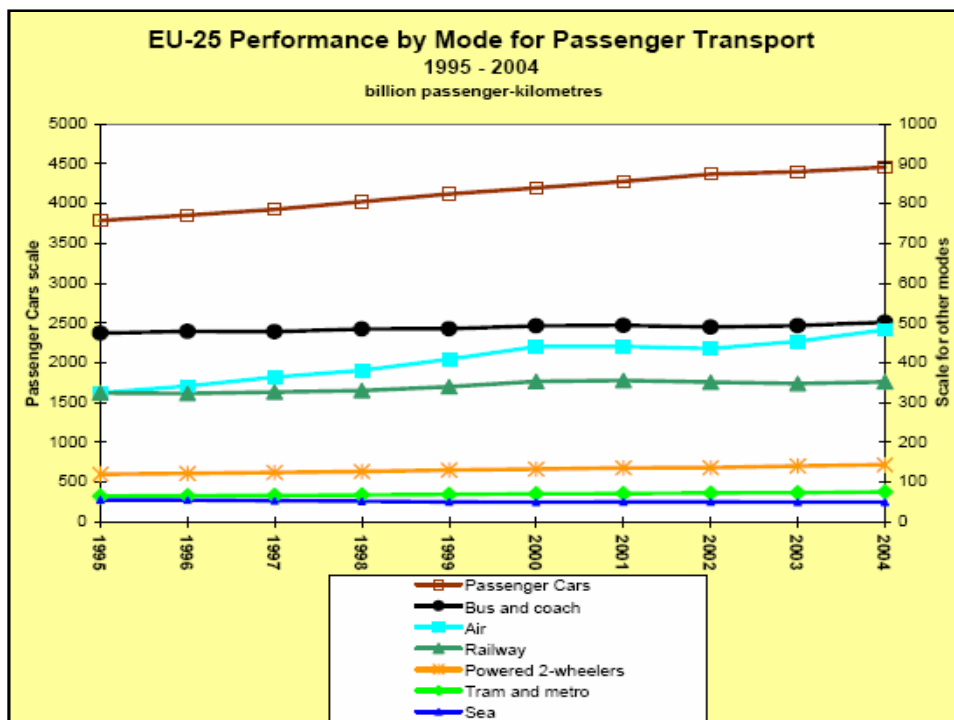
- How to get people to understand the logarithmic, rather than linear, nature of our dilemma?
- How many planets do we need to sustain our present lifestyle and expectations?



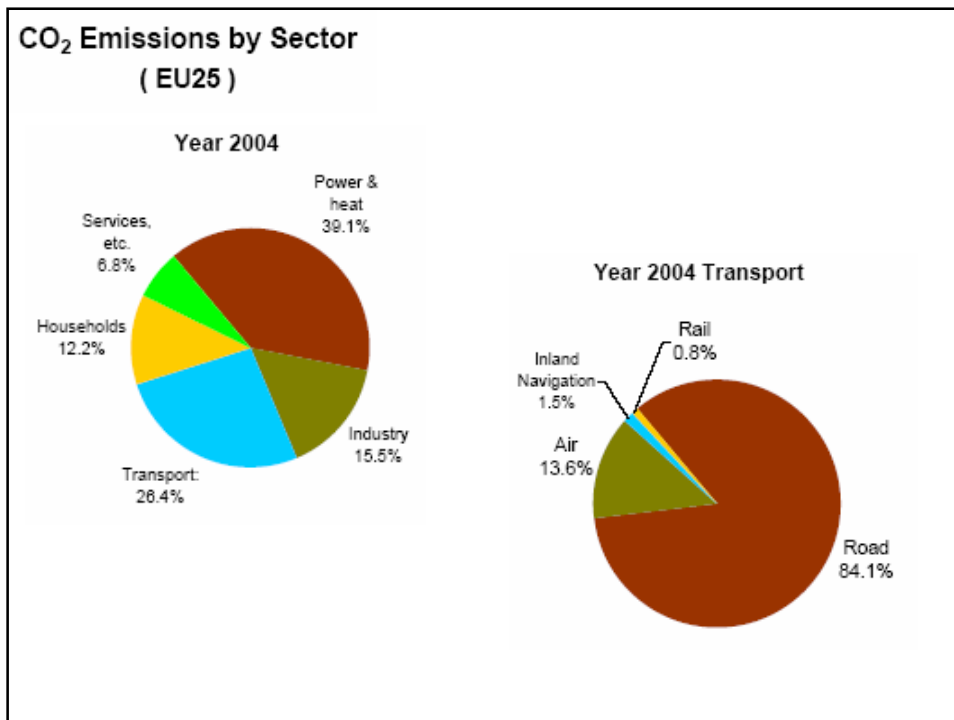
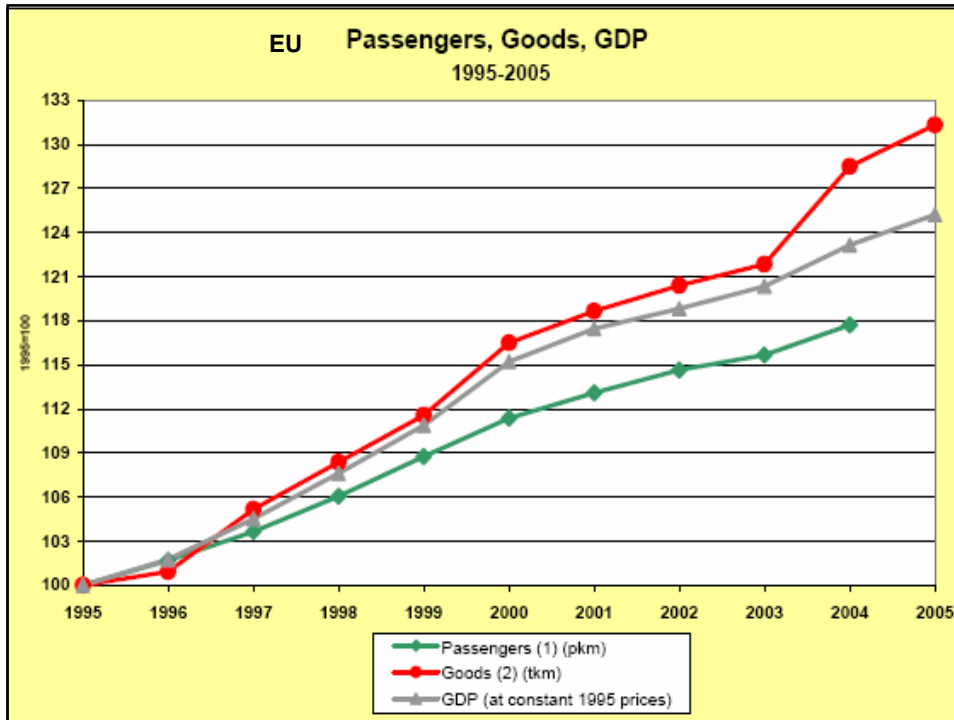
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Climate change:

- The scientific consensus on measurements of the past is now very strong; eg. IPCC 2007 report
- The science behind the greenhouse effect is well understood: established many years ago
- The effects of global warming in the future are predictable, but with variations in time scale and magnitude
- But these variations in predictions are narrowing as climate science matures
- **And transport presents a huge problem for climate change**



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La Migraine:

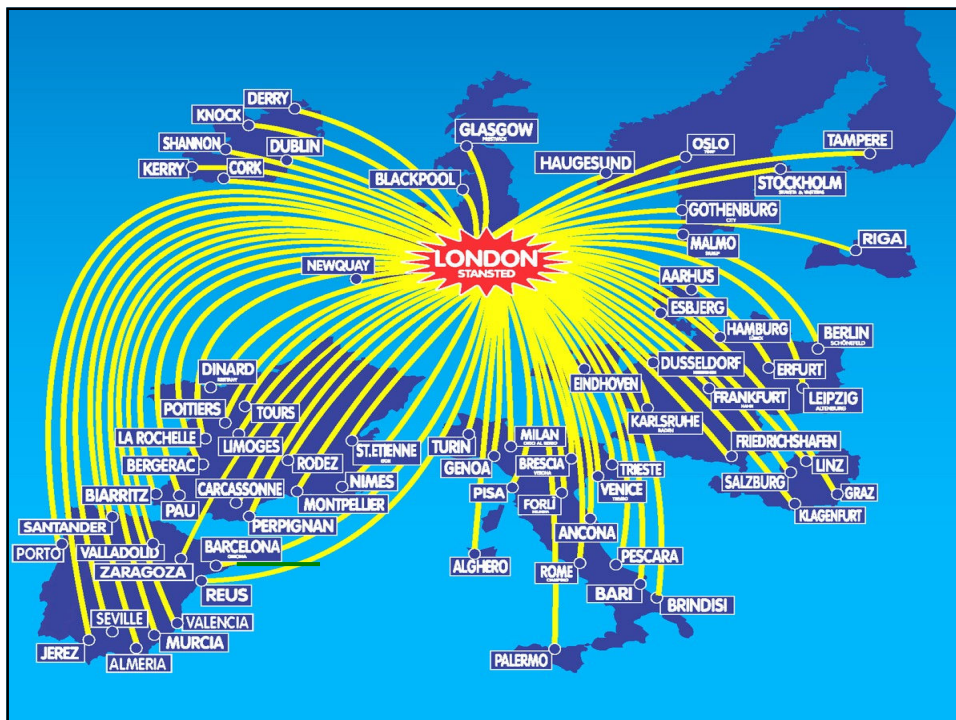
Inflammmation périphérique

~~ou~~ dysfonction centrale?

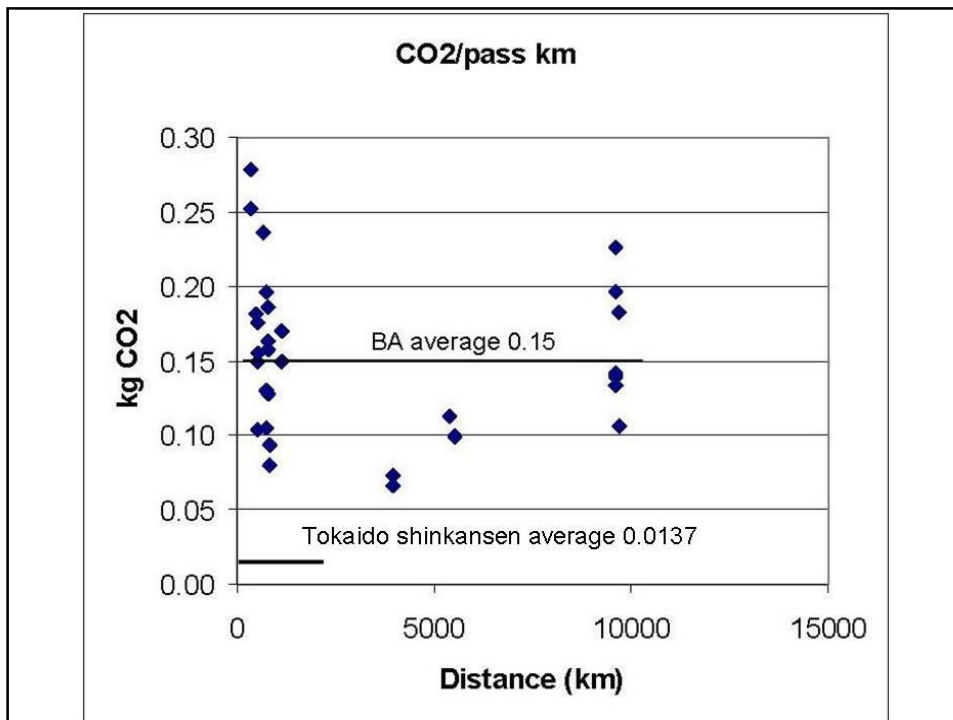
et



Salon Jacob



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Possible measures:

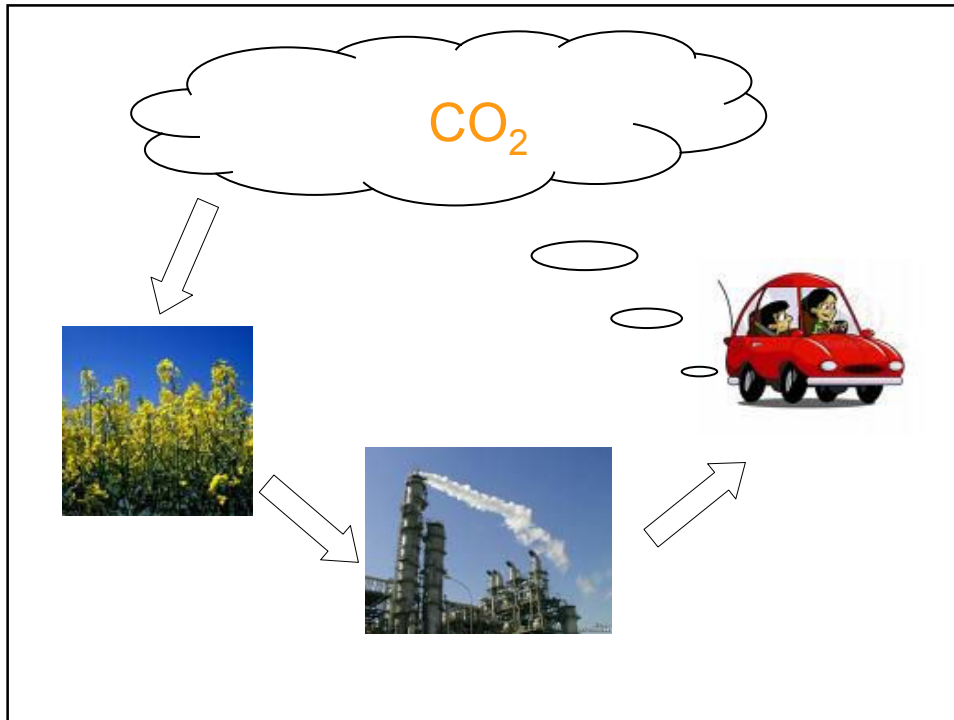
- Improving vehicle and systems energy efficiency
- Increasing the use of renewable and other low carbon energy sources and expanding world access to cleaner and more efficient transport technologies, coupled with a more rapid development and deployment of advanced technologies
- Developing politically acceptable, but aggressive, policies to shift the direction of transport to a more sustainable path

Alternative fuels:

- Most in practice offer only small CO₂ reductions on a life-cycle or well to wheel basis. Four options provide a > 50% reduction in CO₂
 - Alcohol derived from cellulose biomass, using biomass as the process fuel
 - Bio-diesel from oil crops
 - Hydrogen produced from a low greenhouse gas (GHG) source (eg. renewable electricity), used to power fuel cell vehicles
 - Low GHG electricity itself when used with electric cars

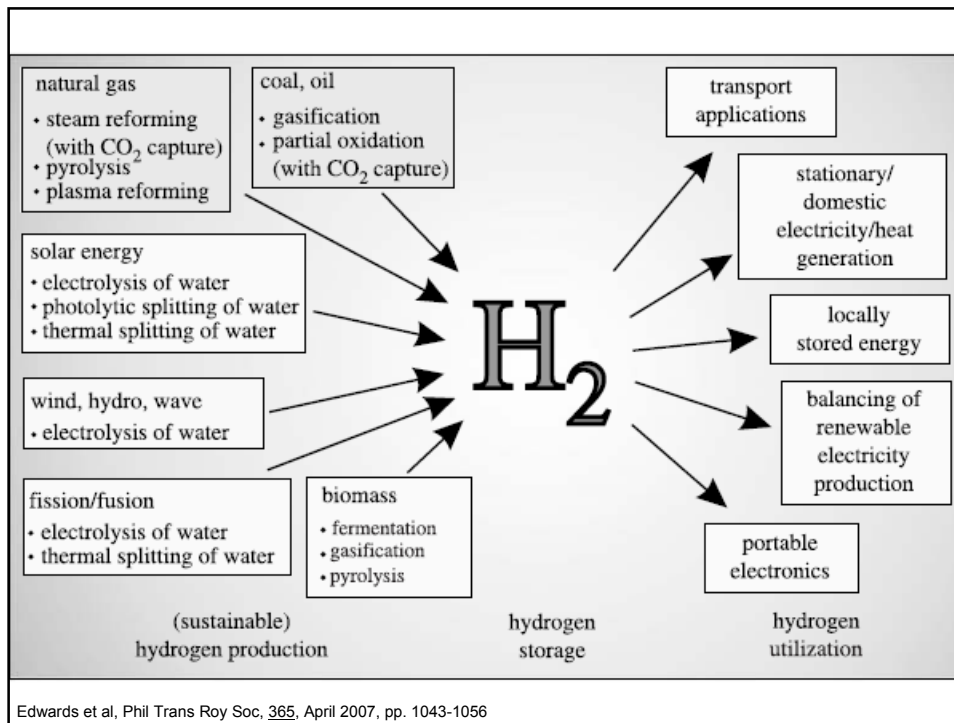
What is Biofuel?

- Fuel derived from Biomass
- Biomass = recently living organisms or their metabolic by-products
- Renewable Energy Source – *as long as the biomass is replenished*



Fundamental Economics

- UK arable land area: 64,000 km²
- Rapeseed yield: 1000 kg oil/ha
- => **6.4 Mtonne pa of rapeseed oil**
- Oil to biodiesel yield: 97% by mass
- => **6.2 Mtonne pa of biodiesel**
- 2006 UK transport petroleum consumption: 54 Mtonne
- All UK arable rape seed => 12% transport

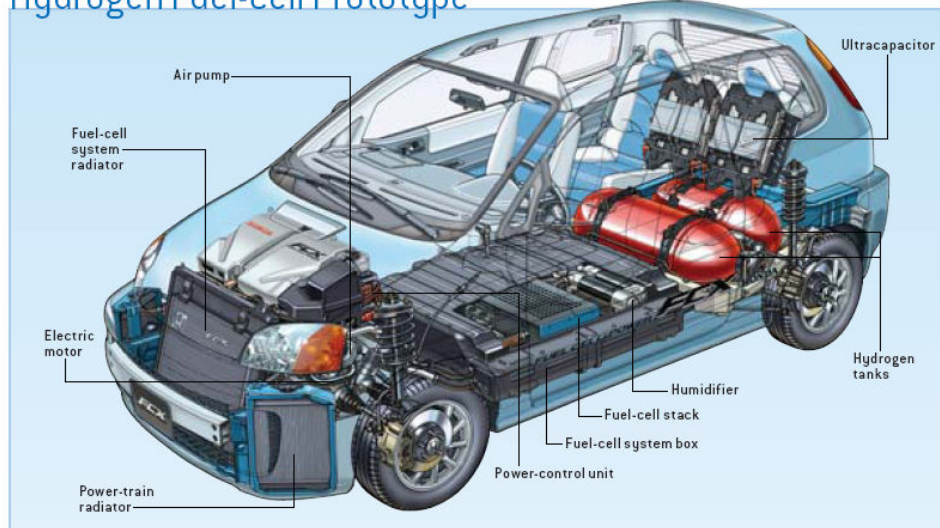


Needed for realisation of hydrogen fuel cell cars:

- Boost onboard hydrogen storage capacity substantially
 - Must operate at practical temperatures,
 - Be refilled in a few minutes,
 - Be economically competitive
- Cut the price tags of fuel-cell drive trains to 1/100 of current costs
- Increase the power plants' operating lifetimes x 5
- Enhance their energy output for larger vehicles
- Create a hydrogen fuelling infrastructure

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Hydrogen Fuel-Cell Prototype



Ashley, Scientific American, March2005, 292, 3, pp62-70

(a)



MgH_2
52.6 kg

Mg_2NiH_4
111.3 kg

H_2 (liquid)
4 kg

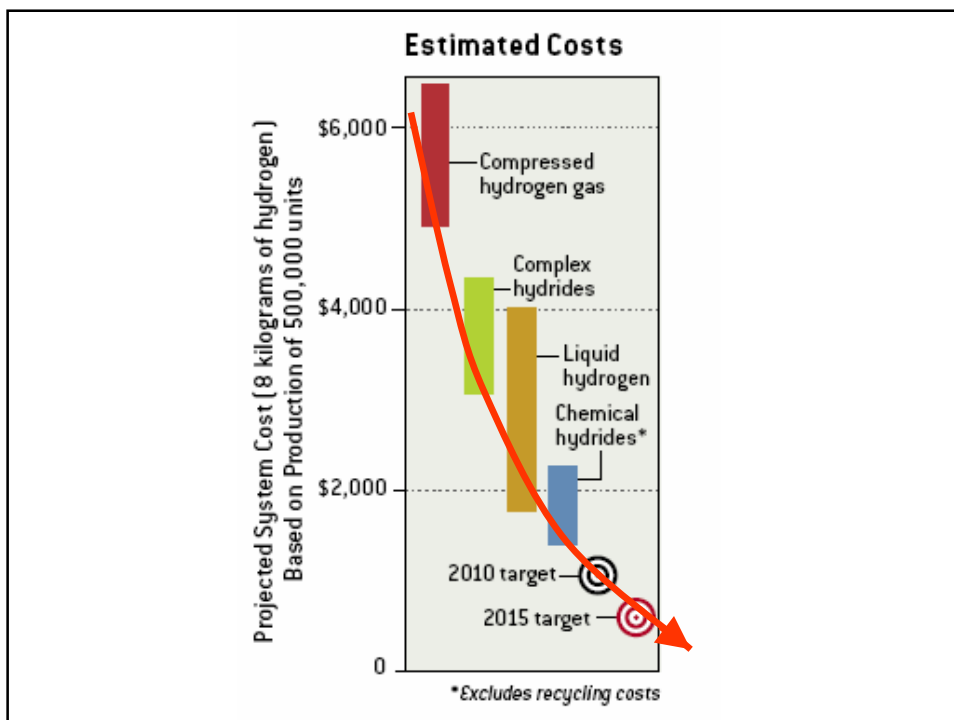
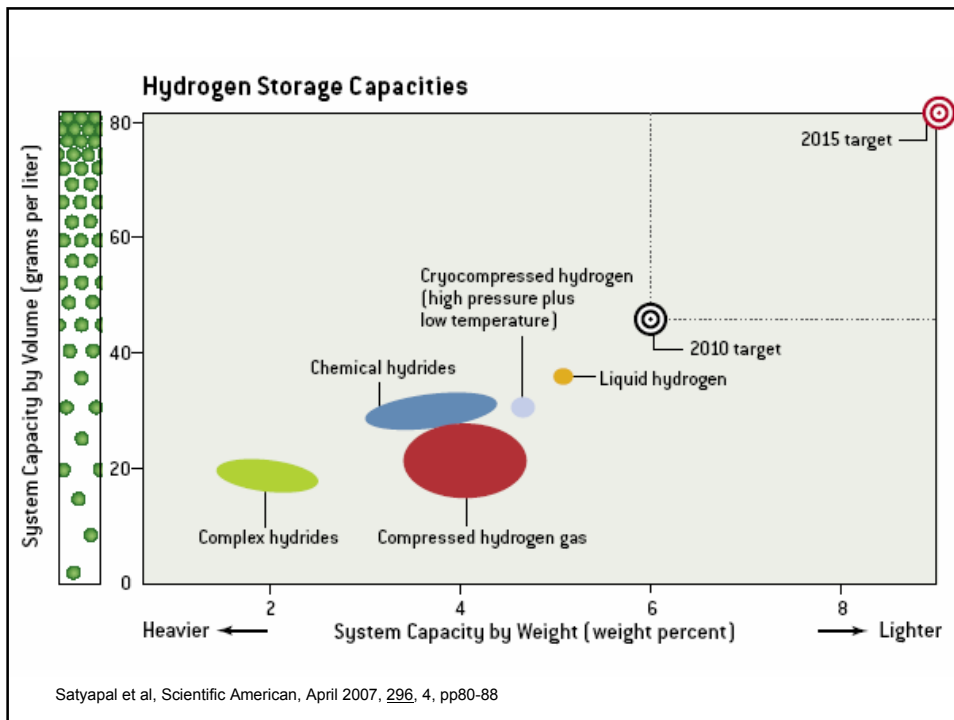
H_2 (200 bar)
4 kg

(b)



Edwards et al, Phil Trans Roy Soc, 365, April 2007, pp. 1043-1056

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Transport demand management:

- Information technology??
- Technology to implement policy eg:
 - Speed limits
 - Congestion charging
 - Road pricing
- The question remains: how to grow GDP without an increase in transport?
- Freight?

50 year horizon:

- Transport has developed incrementally in the last 50 years
- There are no significant **radical** prospects to tantalise us
- The hydrogen economy?
- Cars to become electronic “trains”?
- What we do locally is likely to be swamped globally.

Can technology meet the severe challenges raised by transport energy use and the associated emissions?

We are danger of the term “sustainable transport” becoming an oxymoron.

Thank you!