Energy from biomass: the size of the global resource

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Biomass Power Generation 2012

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Imperial College London

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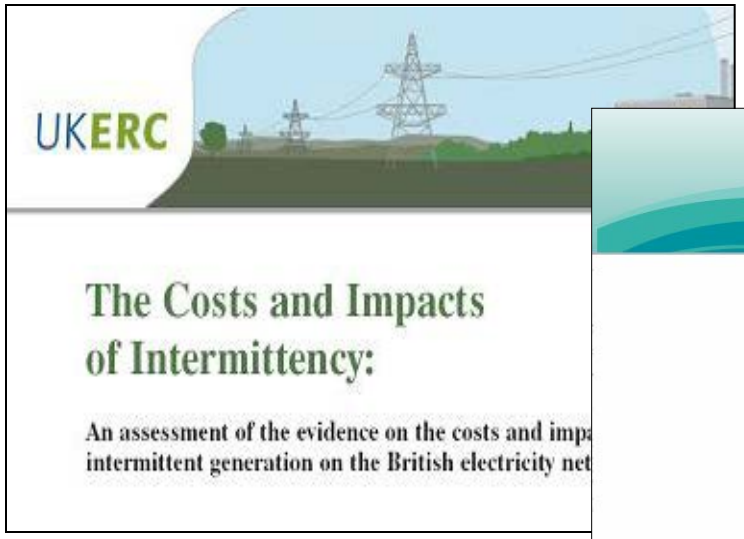
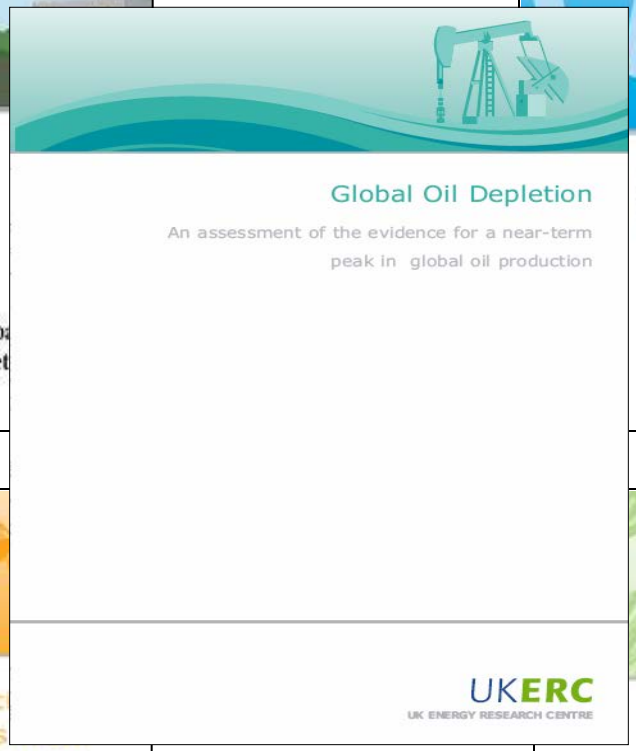
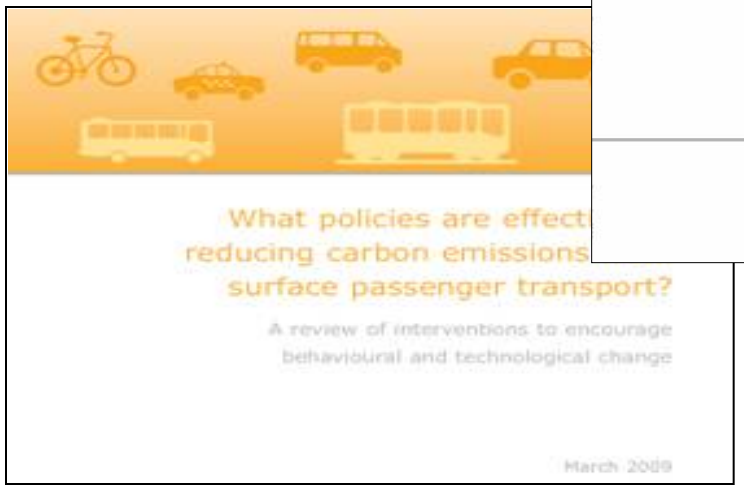
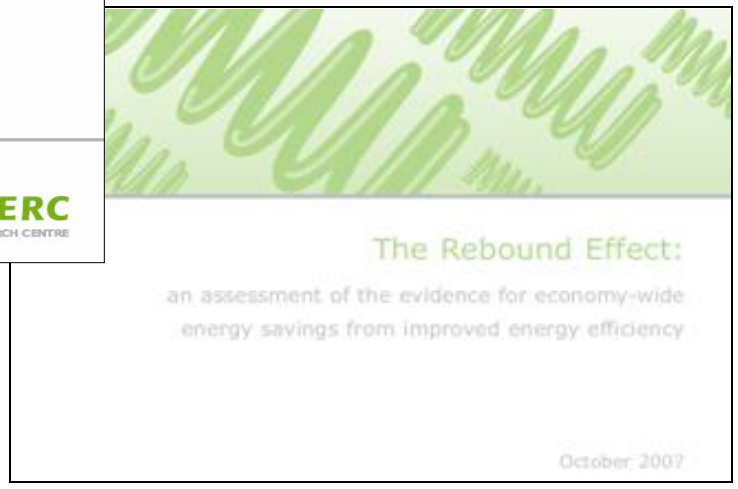
Imperial College Technology & Policy Assessment reports: topical, authoritative and accessible









Existing biomass resource assessments have failed to convince the sceptics...

"Estimates are wildly over optimistic..."

"It'll never happen... "

Vs.

"Oh, no, not again...we've done this already"

"Done to death..."

... plenty of fertile ground for disagreement

Political ambitions:

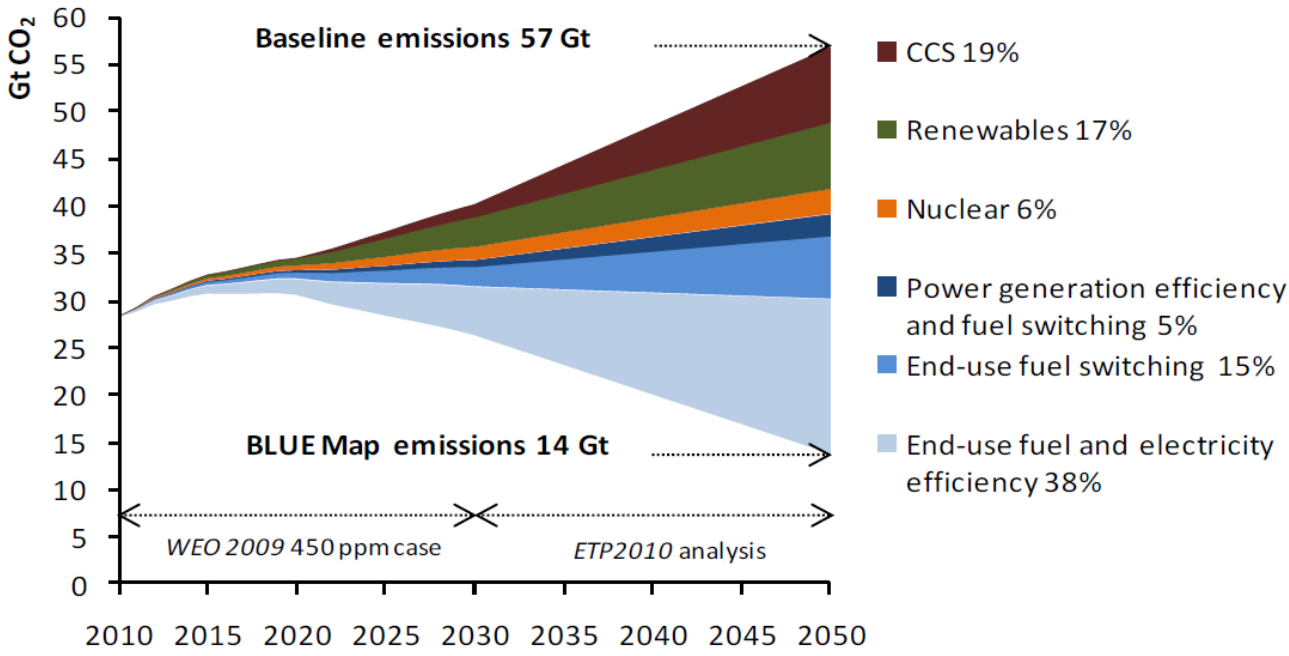
energy security, climate change, rural development

Contentious interactions:

food supply & price spikes, water use, biodiversity, land use

A major role in energy scenarios:

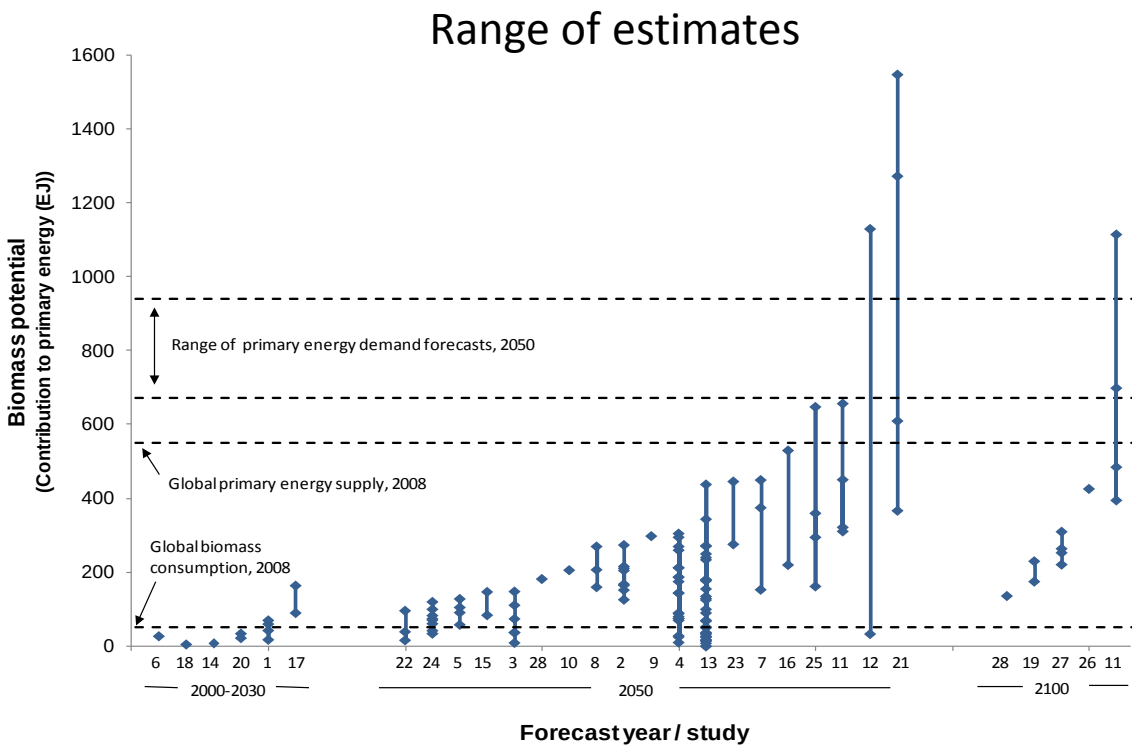
e.g. IEA Blue Map
EU RED



Understanding sources of contention

What did IMPERIAL do?

- Found out why the range of estimates is so large
- Disaggregated key assumptions – and explored how reasonable they are
- Identified key uncertainties affecting biomass *and* food estimates

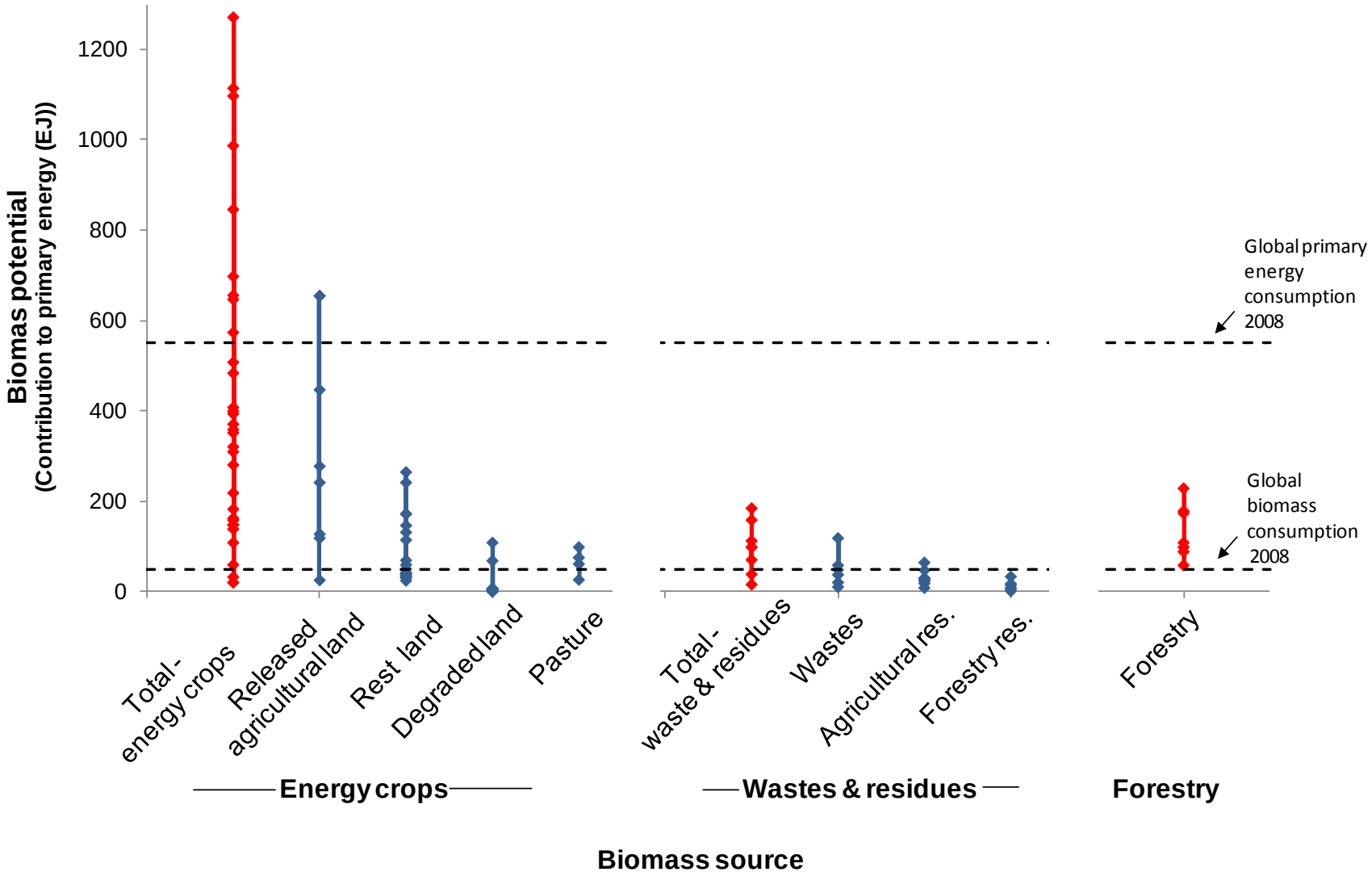


Systematic review:

>90 biomass potential studies published over the last 20 yrs

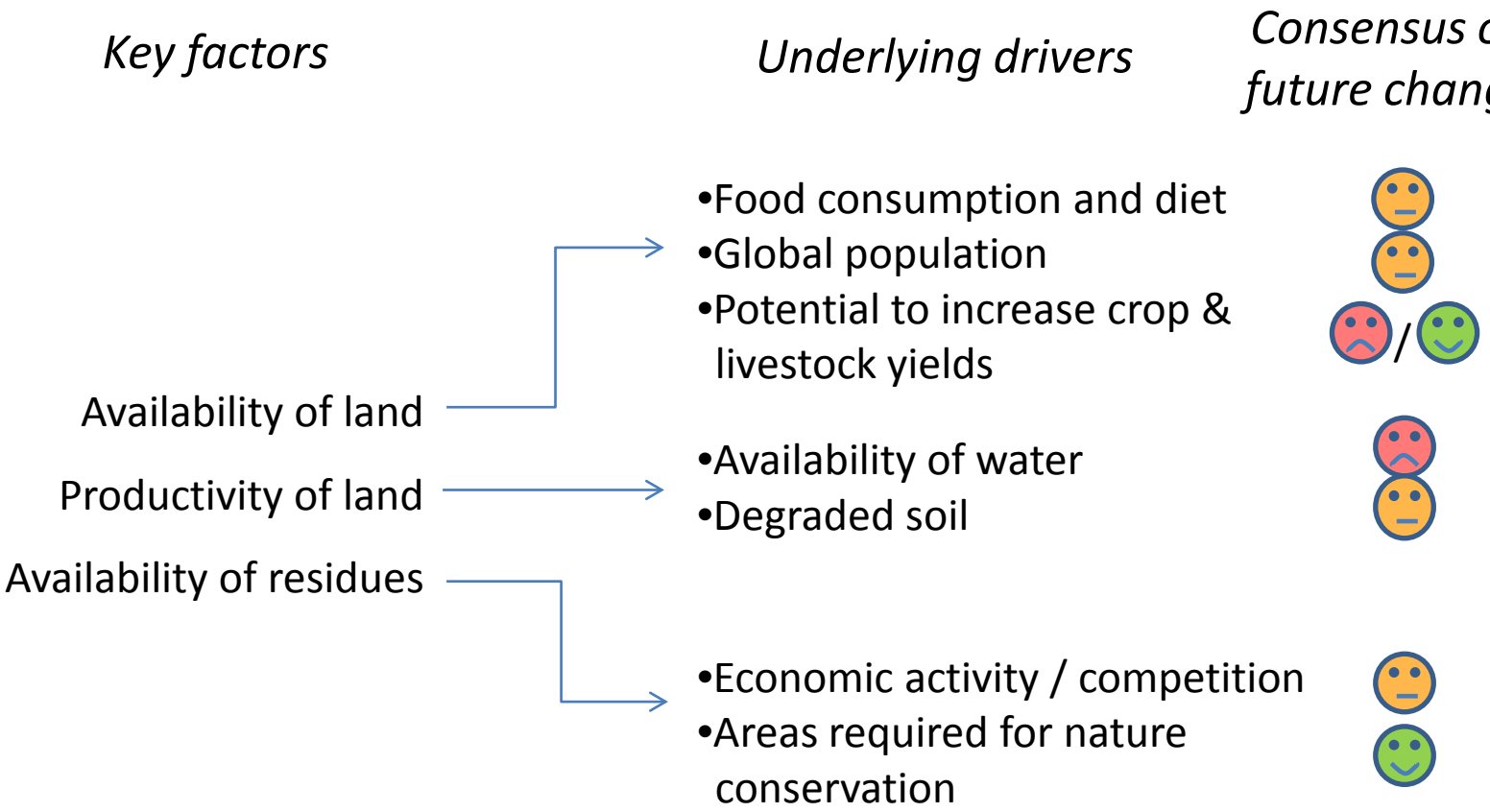
- Direct input from experts and industry
- Contrasted biomass potential estimates with expectations for conventional agriculture and food production

Future sources of biomass: energy crops dominate, but residues and forestry have a role



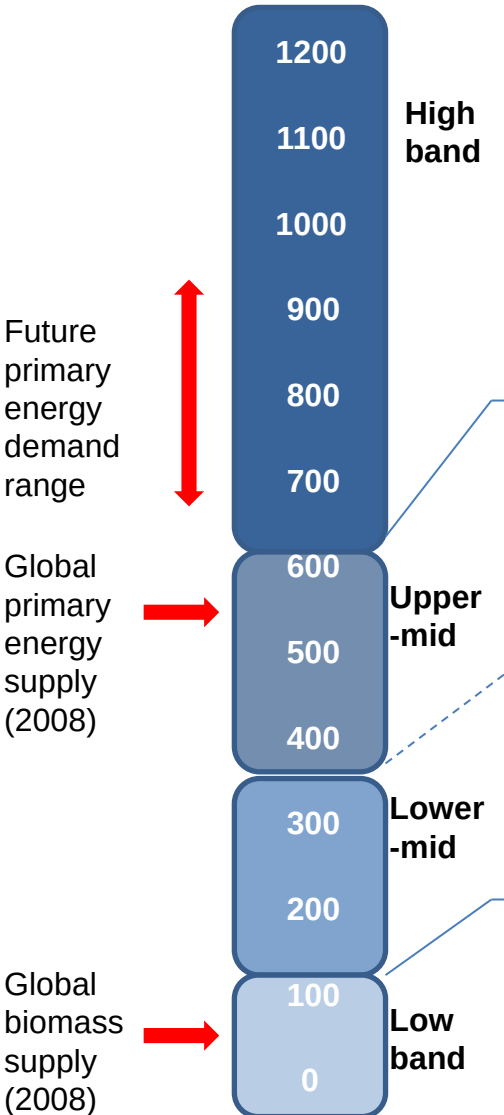
(NB: Categories are not completely mutually exclusive , estimates include unconstrained values)

Methodological niggles, but good agreement on key drivers



... But, future trends are very uncertain

The result you get depends on the assumptions you are prepared to accept



Essential pre-conditions

High band

- Crop yields outpace demand: >2,500Mha land for energy crops (includes >1,300Mha good agricultural land)
- High or very high input farming, limited, and landless, animal production with dung recovery
- Low population (<9bn)
- Vegetarian diet OR extensive deforestation / conversion to managed forestry
- All residues [a] (<100EJ constrained use, not included in all studies)

Upper -mid

- Crop yields outpace demand: >1,500Mha land for energy crops (includes >1000Mha good agricultural land)
- Low population OR vegetarian diet OR extensive deforestation / conversion to managed forestry
- All residues [a] (<100EJ constrained use, not included in all studies)

Lower -mid

- Crop yields keep pace with demand: < 500Mha land for energy crops (mostly non-agricultural)
- Low population OR vegetarian diet OR limited deforestation.
- All residues [a] (<100EJ, constrained use, included in most studies)

Low band

- Little or no land for energy crops (<400Mha max)
- High meat diet OR low input agriculture
- Limited expansion of cropland area AND high level of environmental protection
- Agricultural residues (<30EJ, not included in all studies)

[a] Agricultural residues, forestry residues, wastes (dung, MSW, industrial)

Many uncertainties remain

- Can crop yields keep pace with demand?
  - Grounds for optimism but not complacency
  - Intensification not a *silver bullet*
  - Scope for improved collaboration
- What about water?
  - Scarcity a major issue for food and energy crops
  - Many management options, but increasing crop drought tolerance could reduce yields
- Environmental impacts of energy crops?
  - May be positive or negative – examples from agriculture show us what we need to avoid

Aral Sea: a victim of irrigation

Oklahoma dust storms 1935

Can conflicting viewpoints be reconciled?

"Estimates are wildly over optimistic..."

"It'll never happen... "

Vs.

"Oh, no, not again...we've done this already"

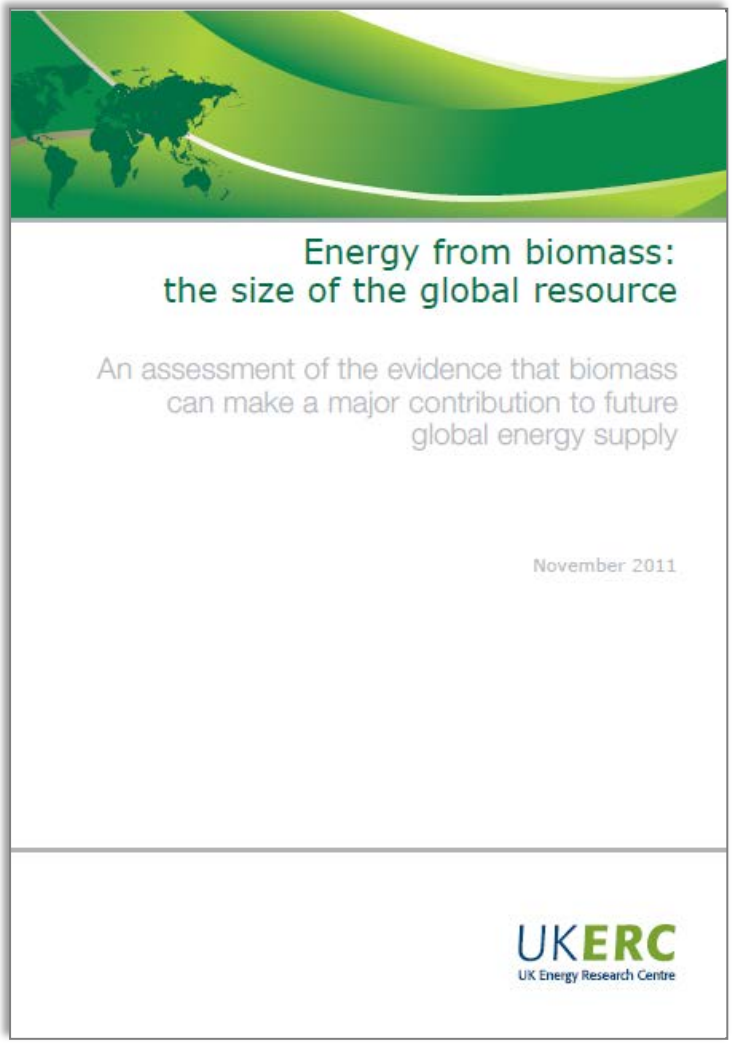
"Done to death..."

- Food potentials are *extrapolations* – Biomass potentials are *what if* scenarios.
- Reasonable concerns about sustainability of food production – not adequately reflected in biomass estimates
- Energy trends poorly reflected in food forecasts

- Studies make the best of limited data
- Good agreement on major drivers
- No consensus on vocabulary – names or meanings
- Need for empirical evidence, demonstration and experience

Insights for policy and future research

- ~20% of global primary energy (*100EJ - technical potential*) is possible with stretching but plausible assumptions
- There is a choice between sustainable and unsustainable biomass
  - Sustainable biomass requires investment, infrastructure and effective regulation
- Policy should focus on practical opportunities
  - Biomass potentials are uncertain because future food yields are uncertain, and will remain so
  - No strong basis to dismiss co-production of food and energy out of hand
  - Increasing food yields is a win-win option provided soil and water resources are conserved
- Bioenergy is not an all or nothing option – we need to learn what works
  - Where will the first few exajoules come from? How much will it cost? will sustainability governance schemes work?



Thank you for your attention

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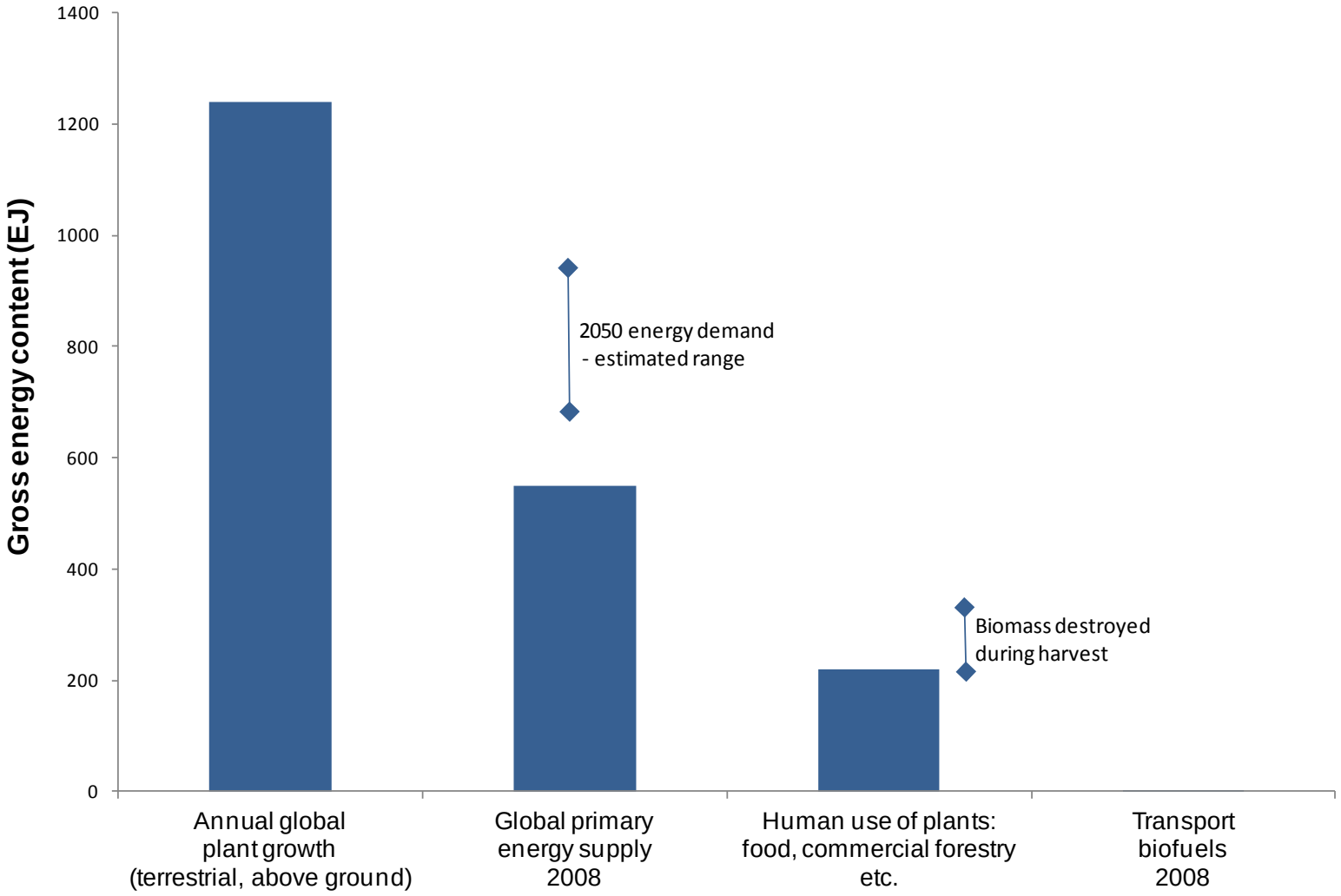
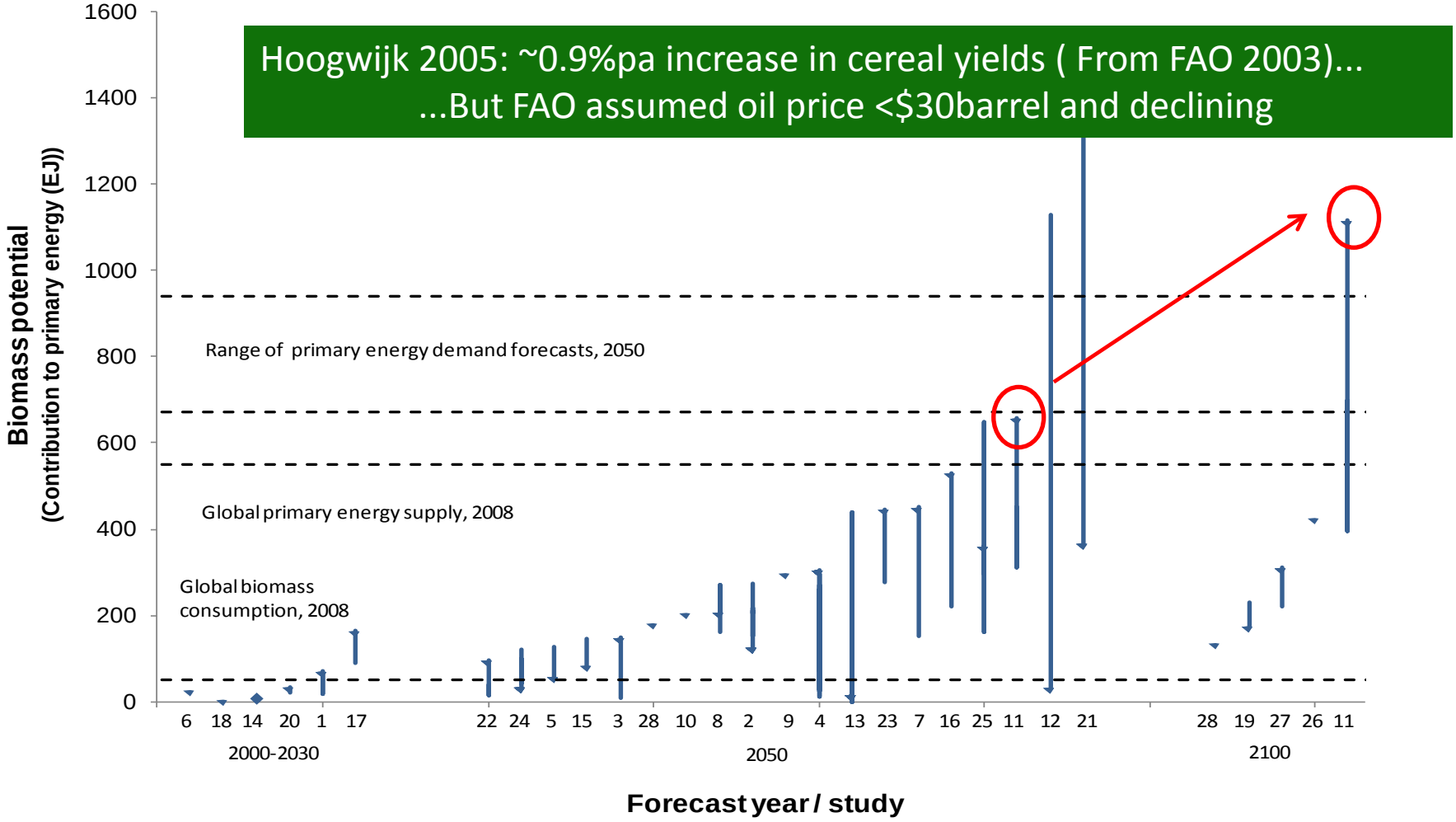
A reality check:

Replacing all fossil fuels with biomass is not an option, but a major contribution to energy supply is a possibility



(Source: data from Haberl et al. 2007, BP 2010, IPCC 2011)

Technological advances will be critical
Extrapolating yield trends may be over simplistic



Energy crop yield estimates