The transition towards renewable energies: physical limits and temporal conditions

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LOW CARBON PROGRAMME
EUSKAMPUS JRP ON ENERGY AND ENVIRONMENT

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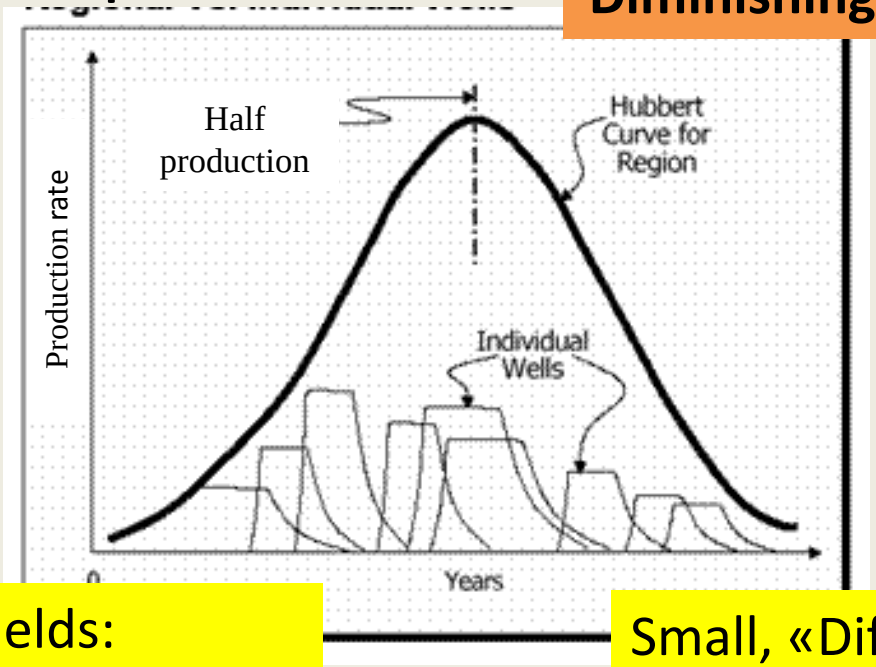
Universidad del País Vasco
Euskal Herriko Unibertsitatea

Motivation (I)

- Fossil fuels: around 85% of:
  - total primary energy
  - anthropogenic CO_2 emissions
- Subject to depletion:

Diminishing returns



Large, «Easy» fields:
- High (E & €) profitability
- Cheap energy

Small, «Difficult» fields:
- Low (E & €) profitability
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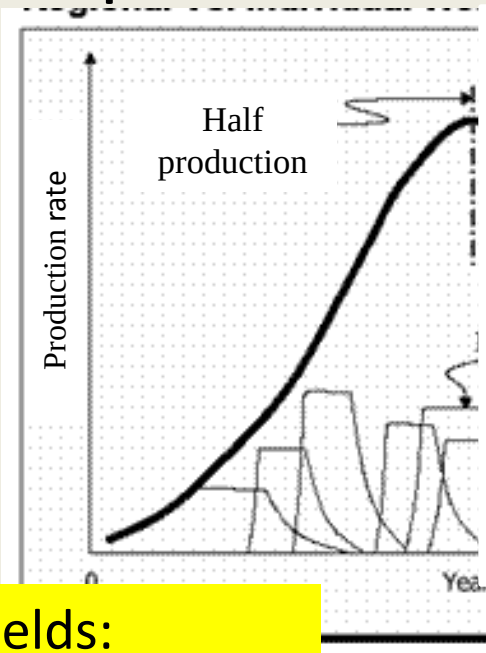

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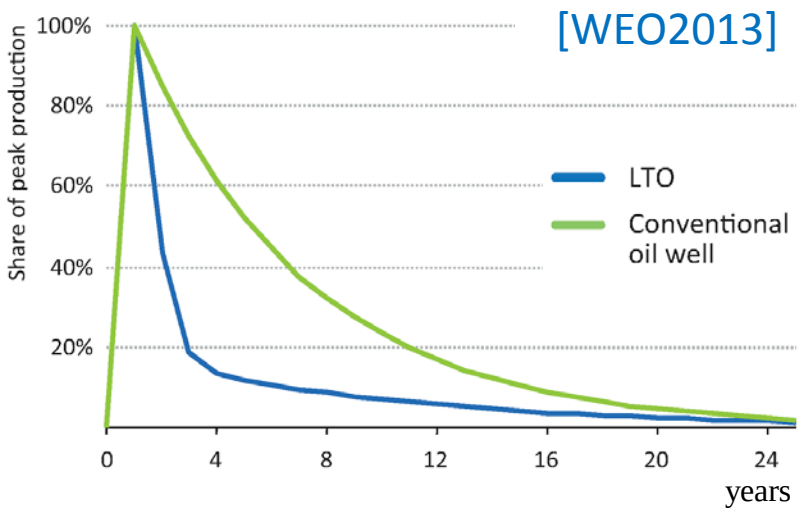

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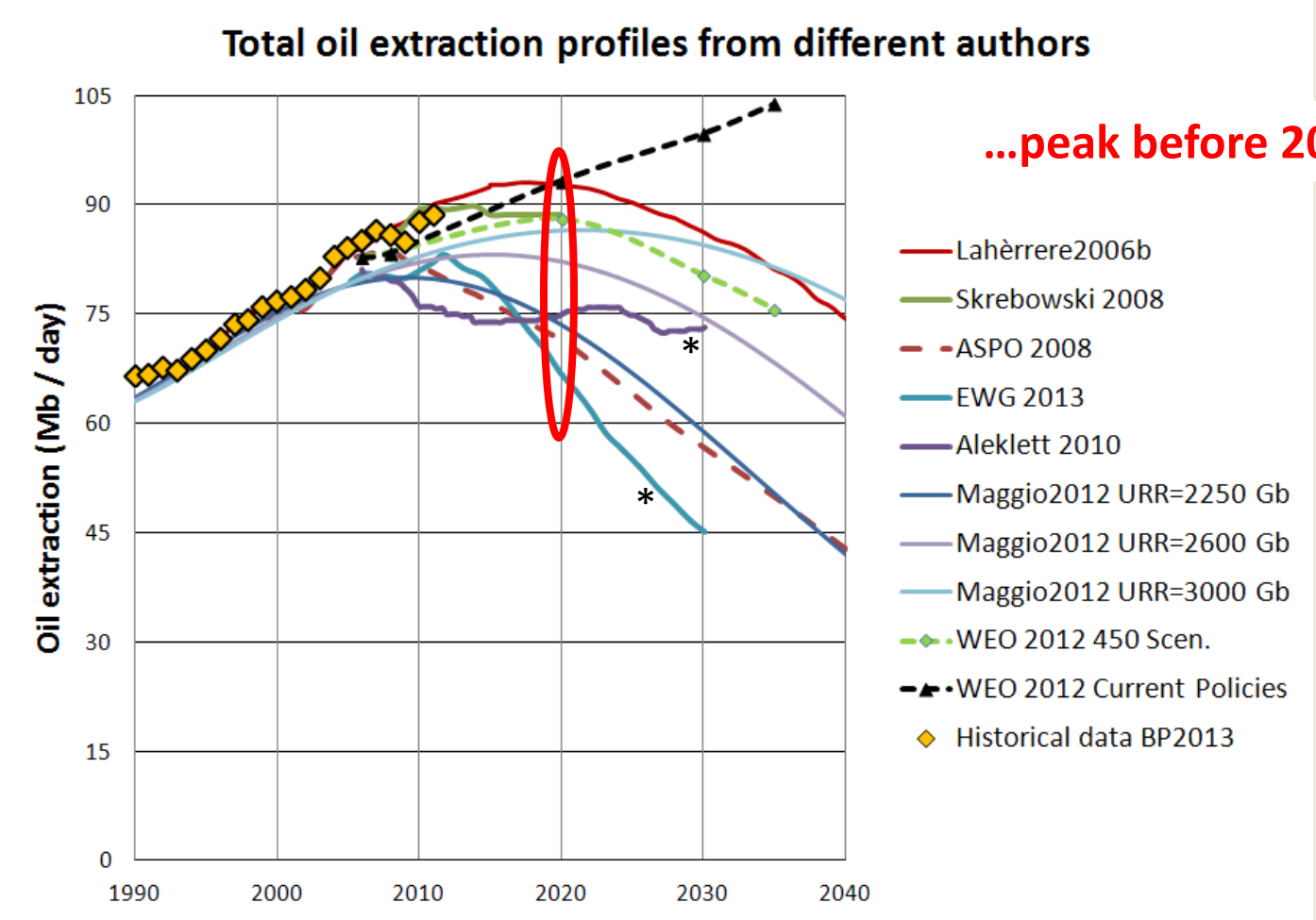

…peak before 2020…

Updated from [Mediavilla2013]

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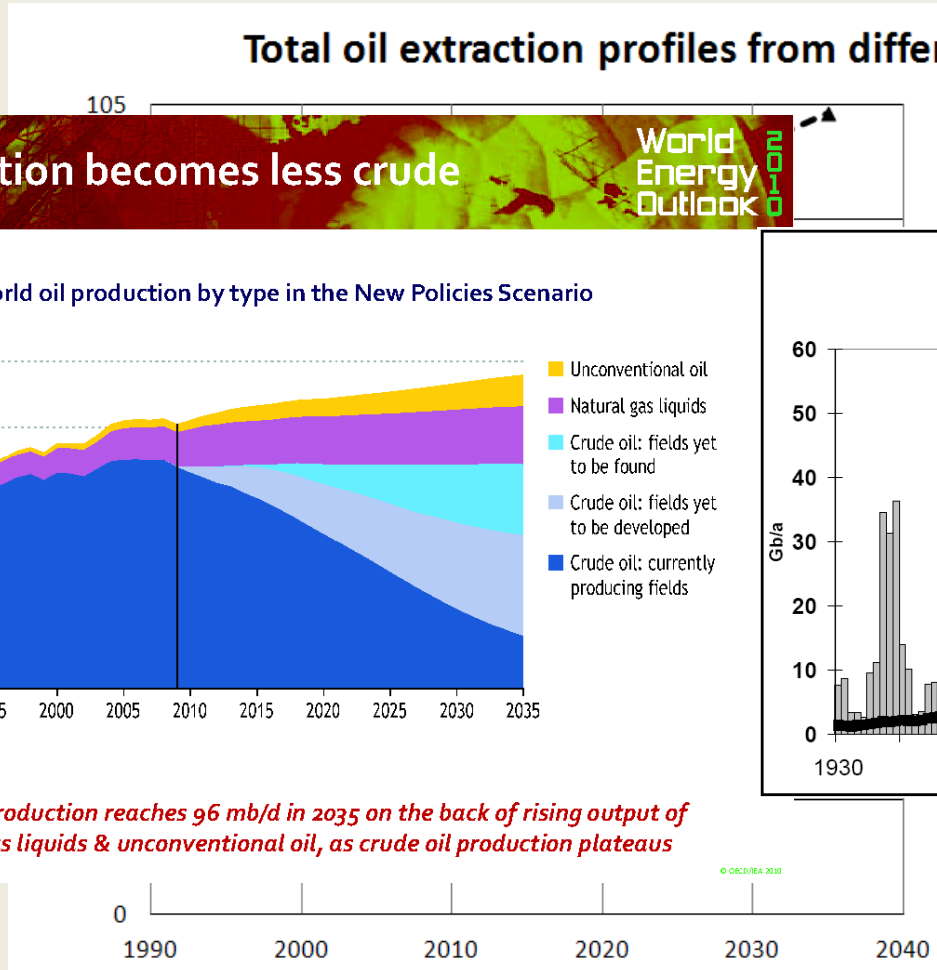

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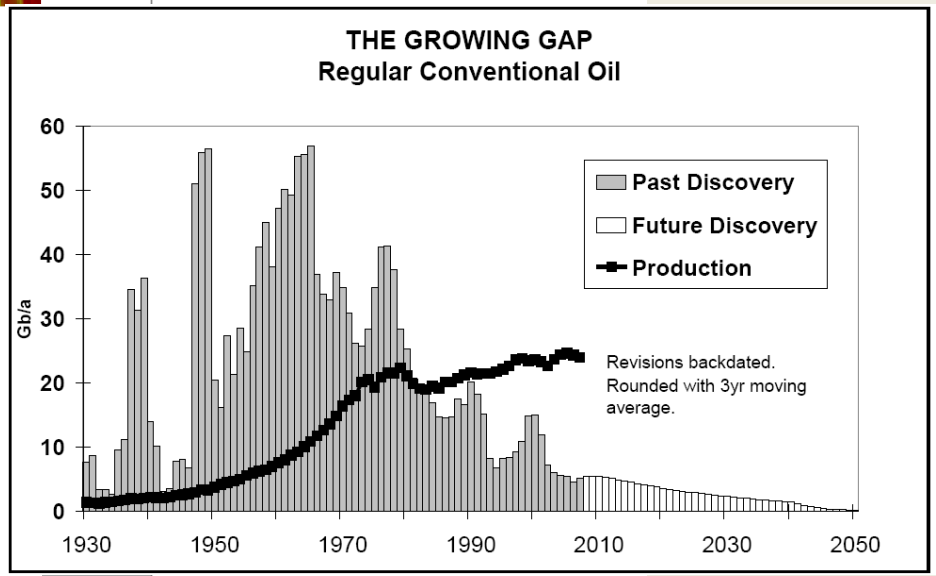
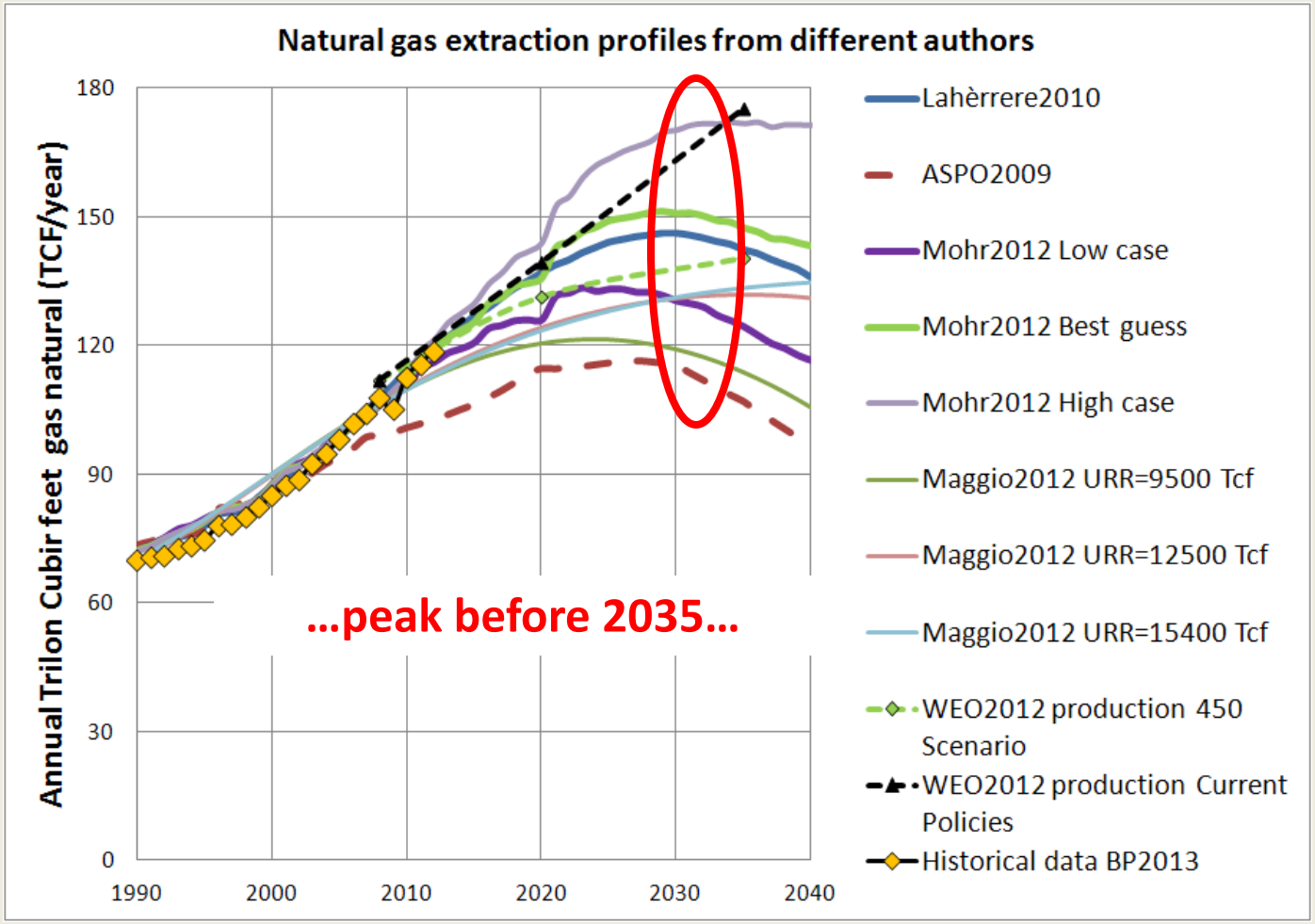


[ASPO 2009]

Updated from [Mediavilla2013]

Motivation (II)

- Fossil fuels: gas



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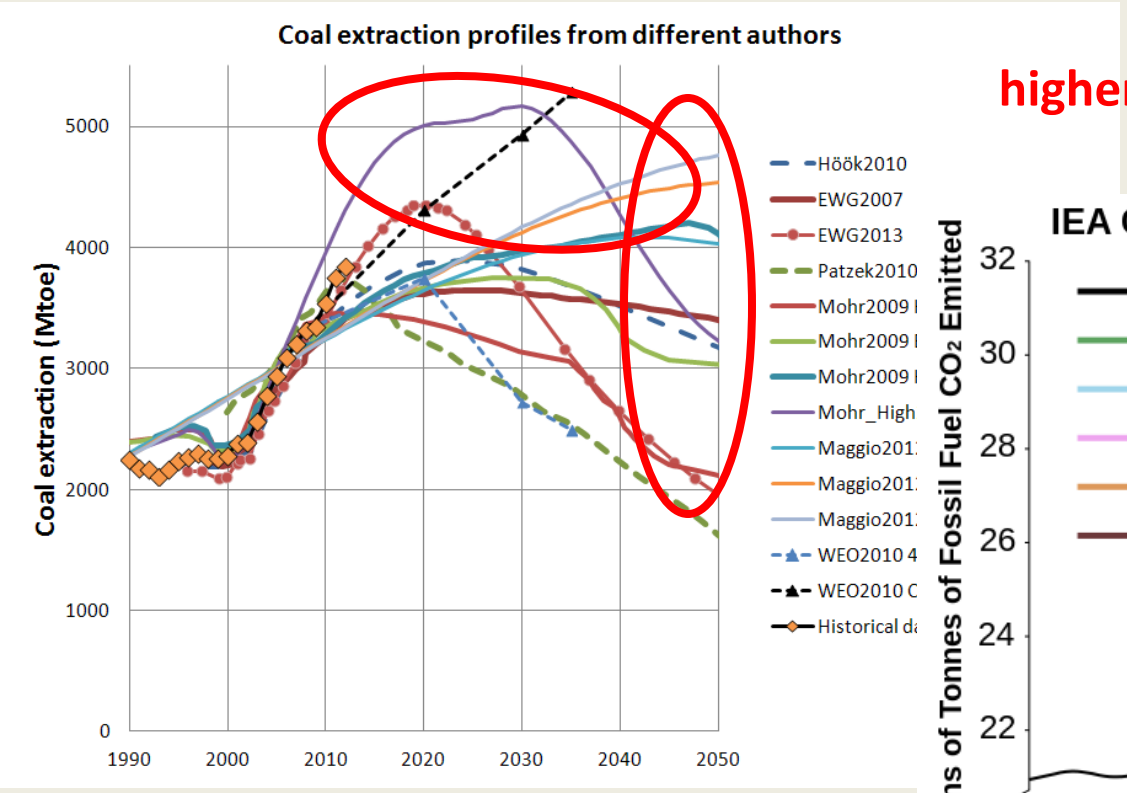
Motivation (II)

- Fossil fuels: coal



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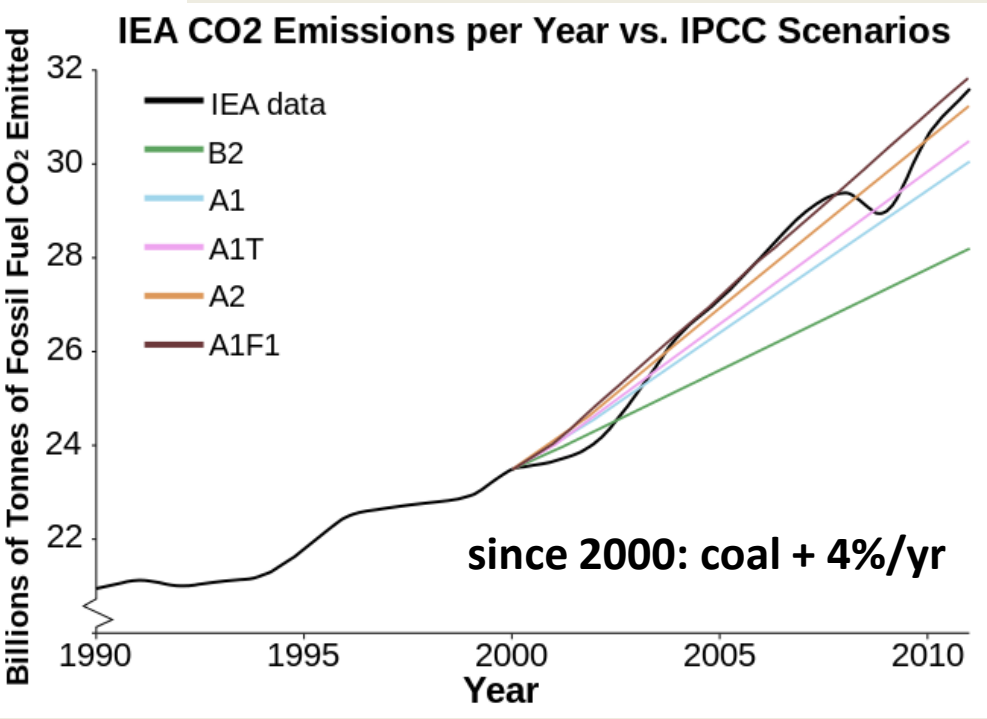
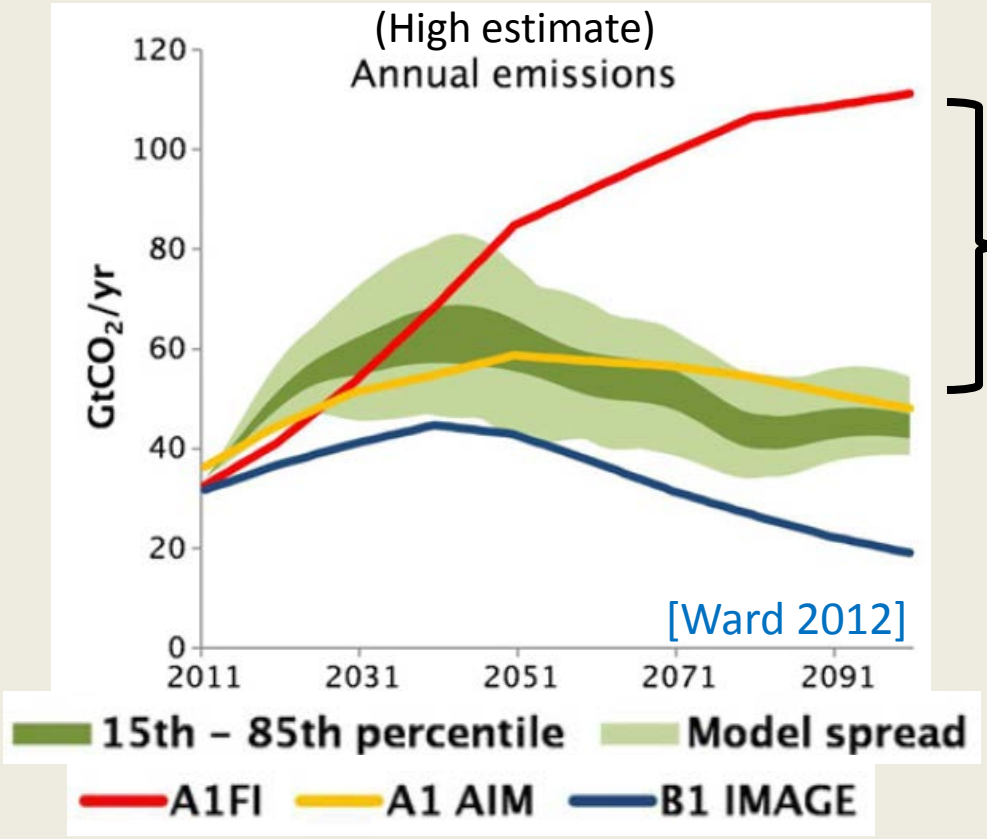
higher uncertainties; BUT….



Opportunities (I)

- Energy transition to avoid dangerous climate change:



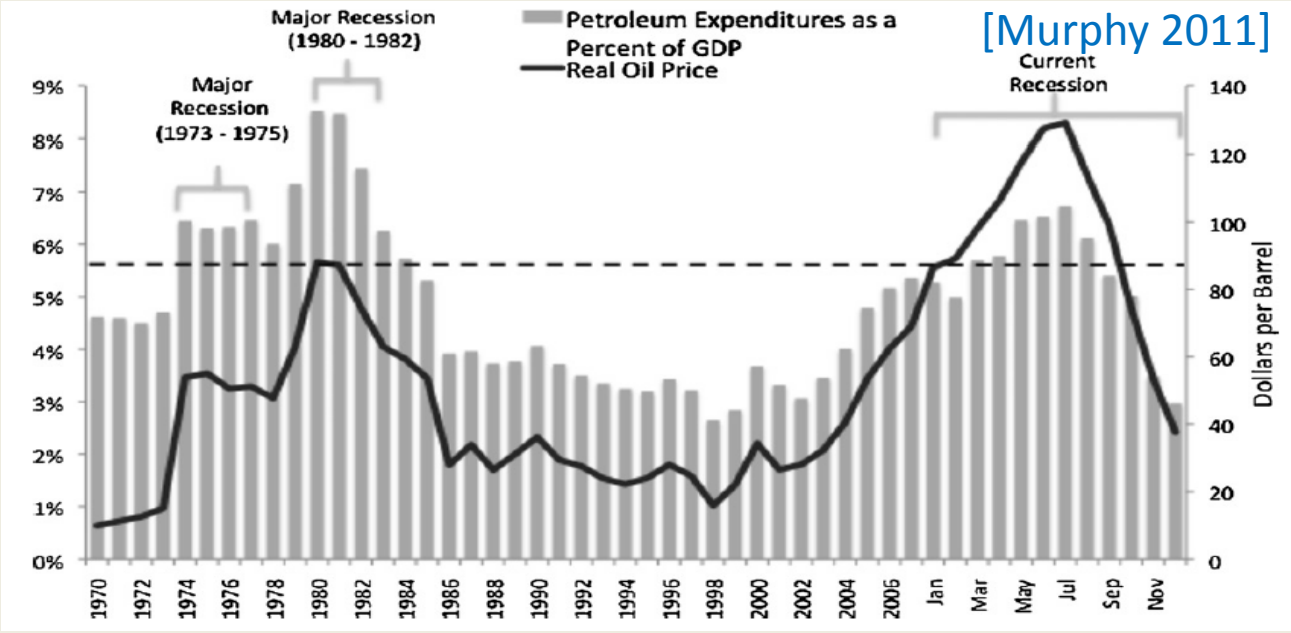
The consideration of geological restrictions invalidates high IPPC SRES scenarios.

HOWEVER, From SRES 2000, the impacts have been revised upwards (e.g. [IPCC2014], [Smith 2009])

Opportunities (II)

- Energy transition to overcome the fossil-based model: reduction of the economic vulnerability:
  - to price shocks,
  - external dependency.

(e.g. [Hamilton 2011]: 10/11 US recessions associated with oil price spikes)



Challenges & barriers (I)

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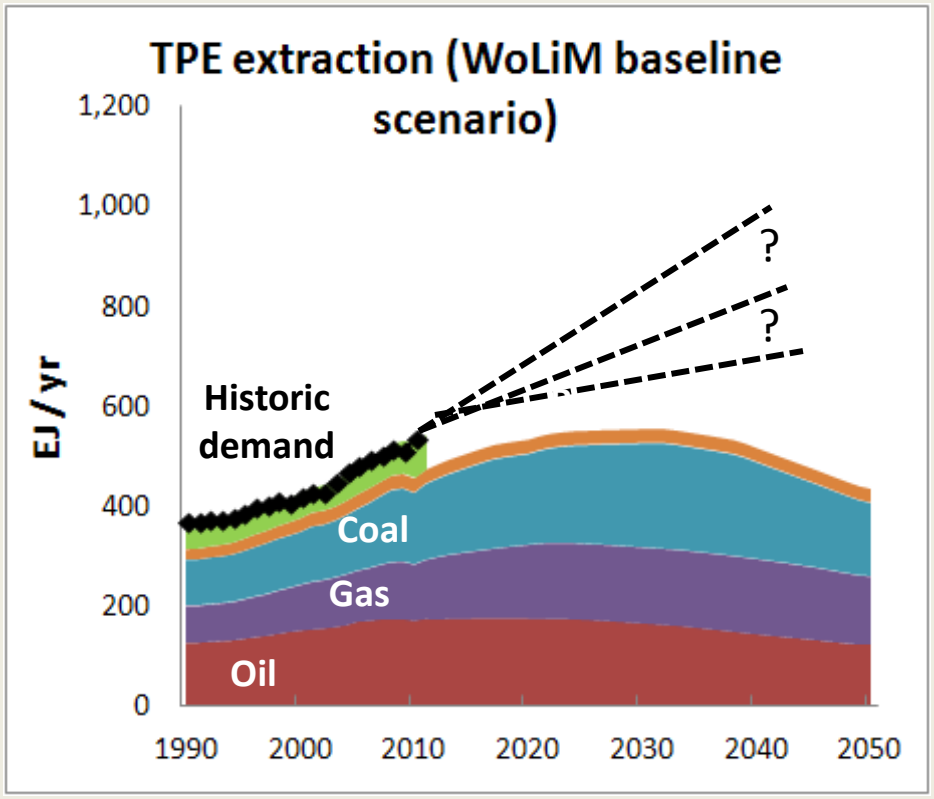

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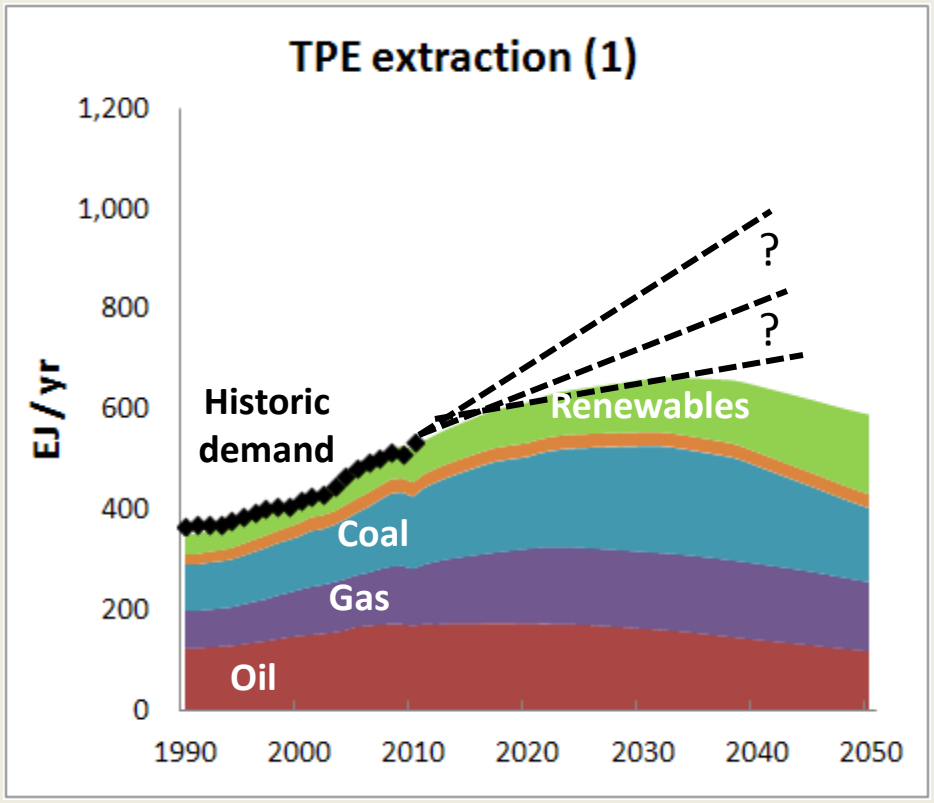

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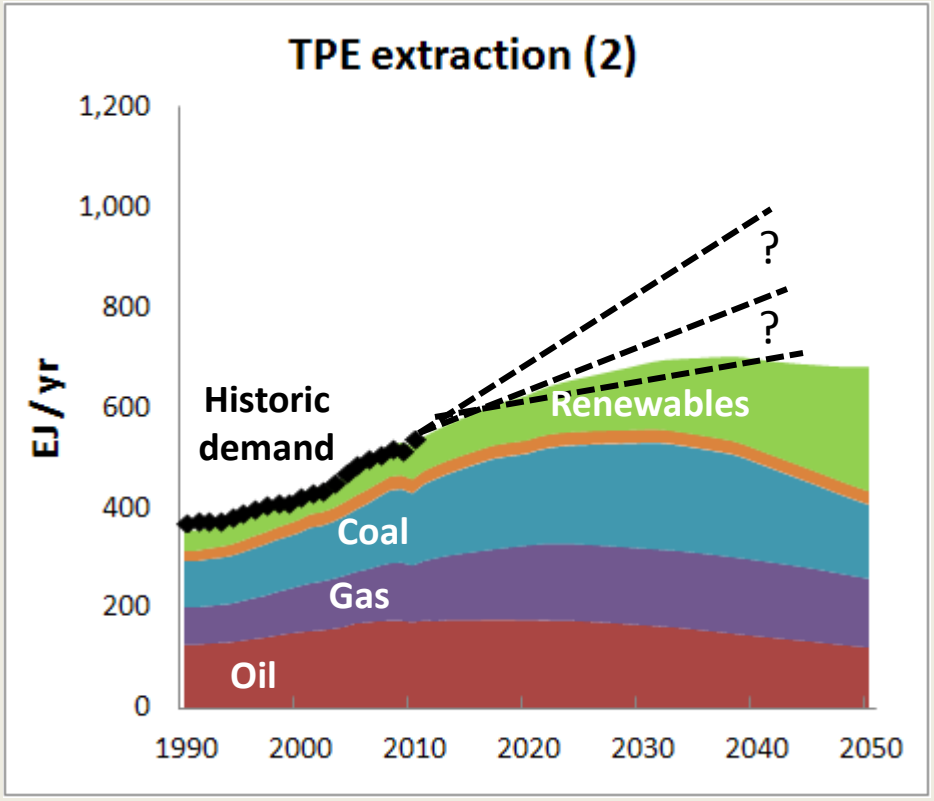

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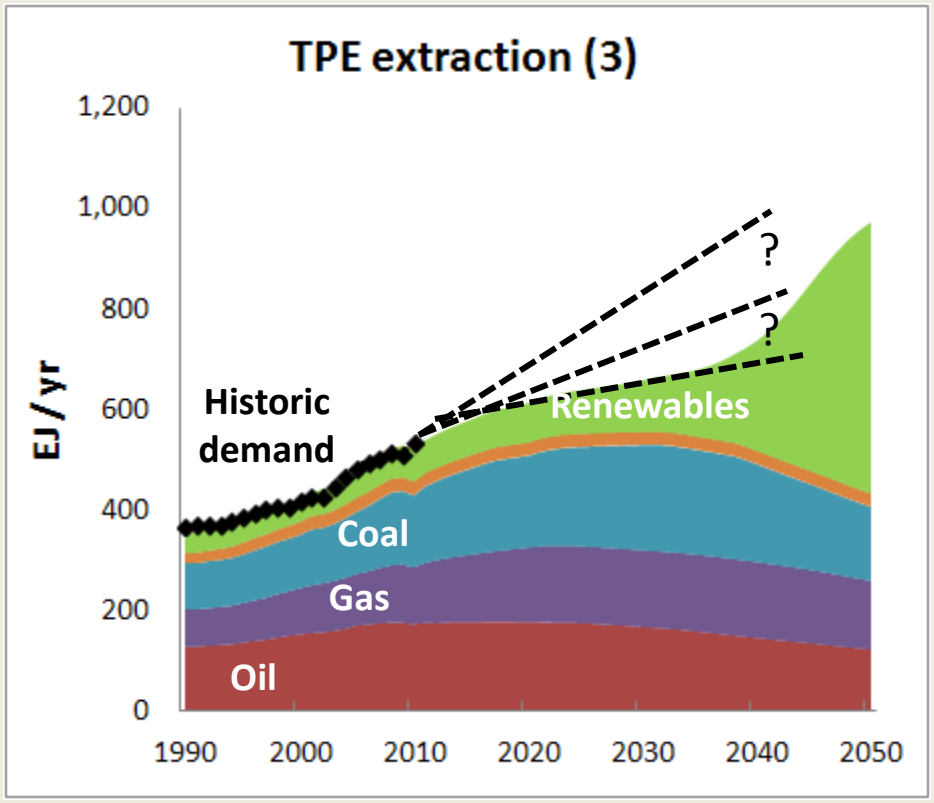

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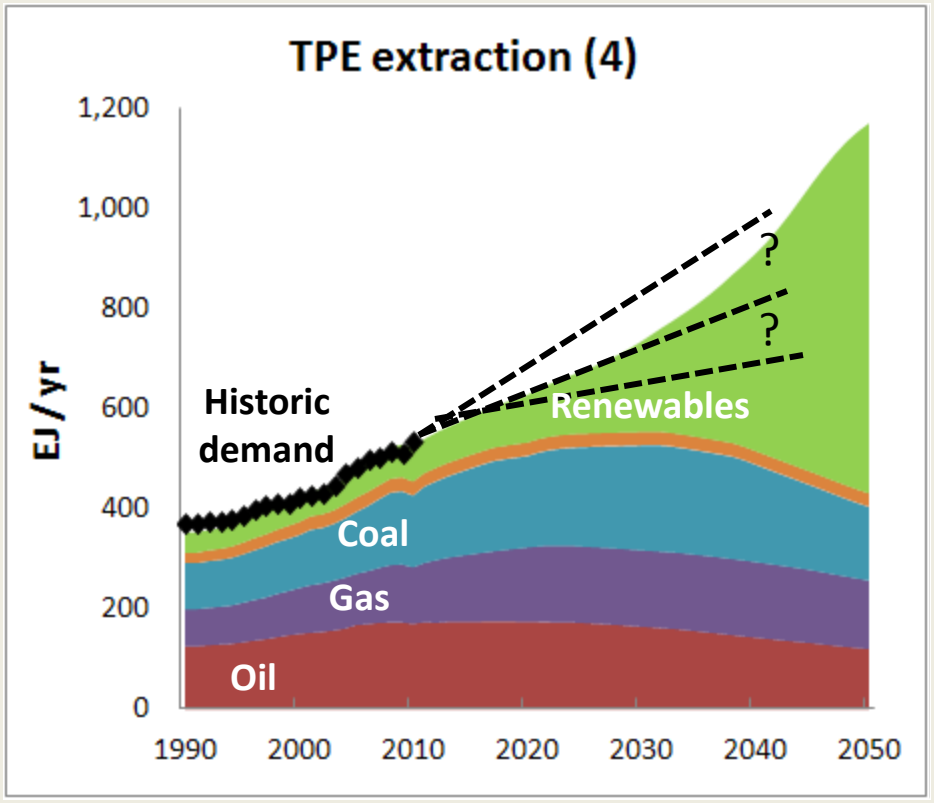
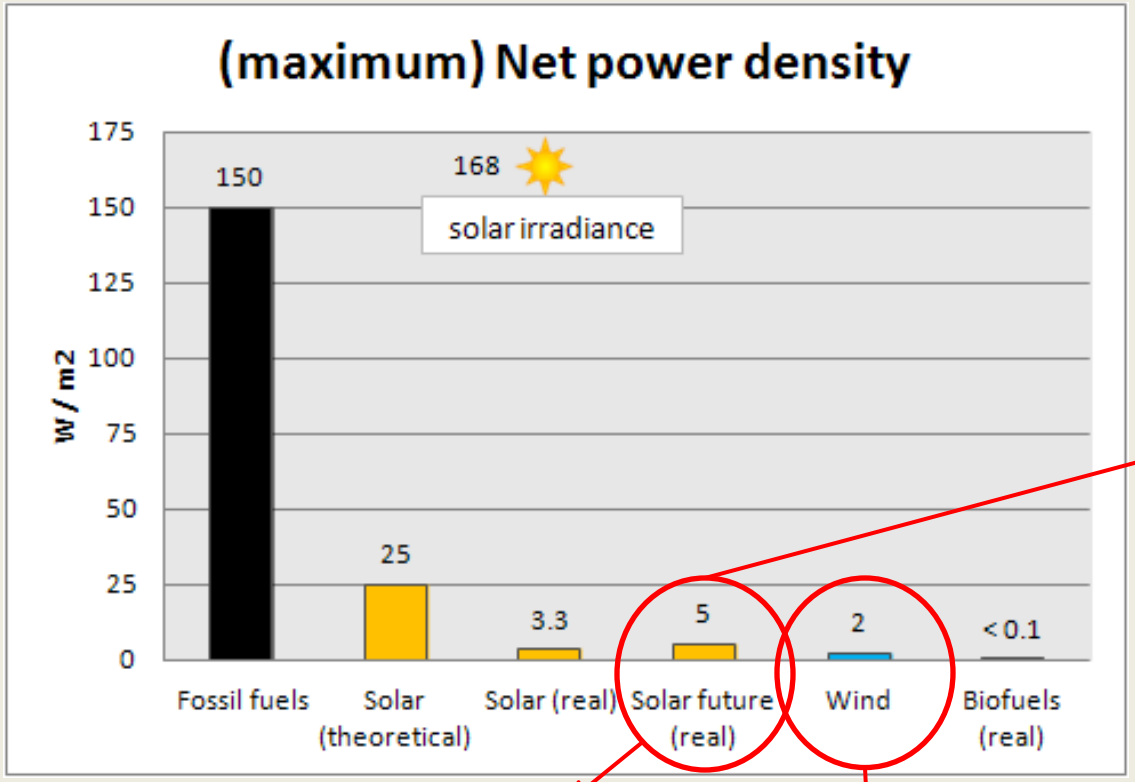


Paths: dependent on demand, technology, policies, potential, etc.

Challenges & barriers (II)

2. Renewable ("low") densities & potentials:



$$Net\ power = Gross\ power \cdot (1 - \frac{1}{EROI})$$

e.g. 100 Mha ≈ 130 EJ/yr.

WIND. Application of 1st law of conservation of energy ≈ < 35 EJ/yr.

[de Castro 2011, 2013a, 2013b]

Challenges & barriers (I)

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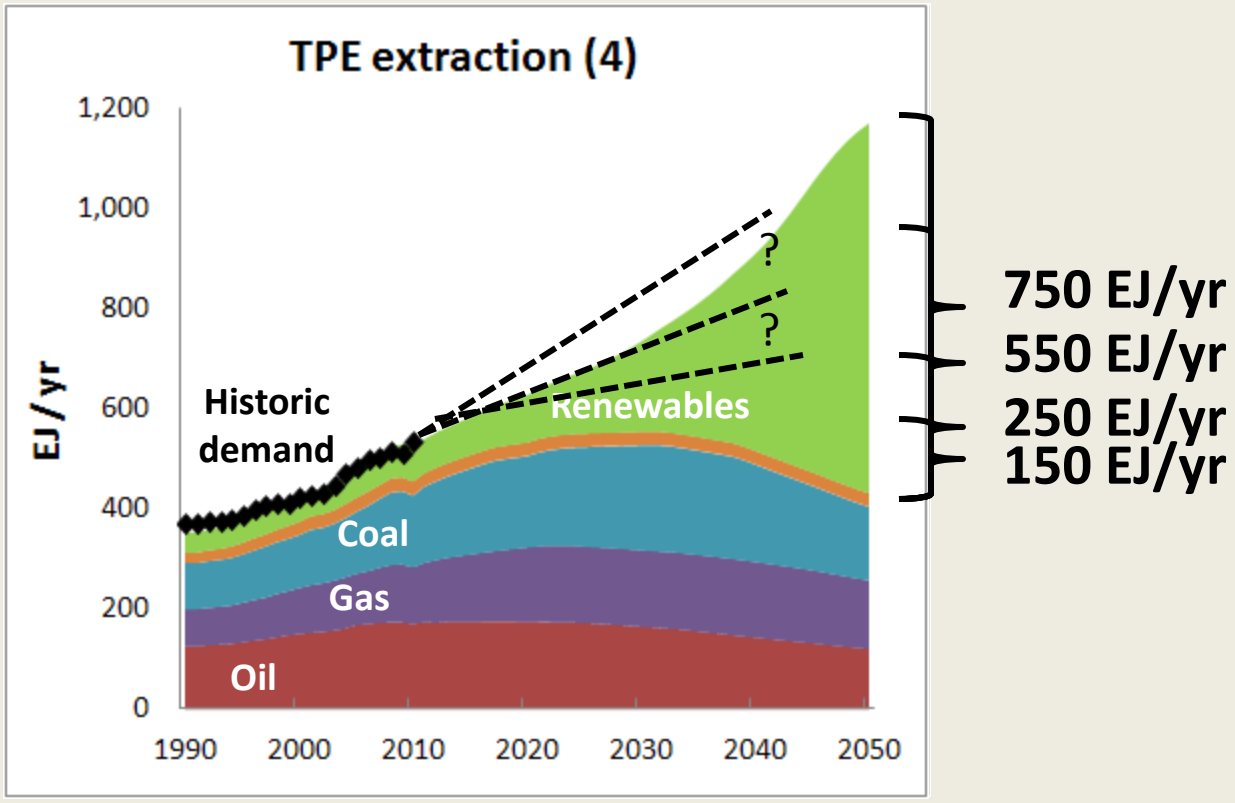
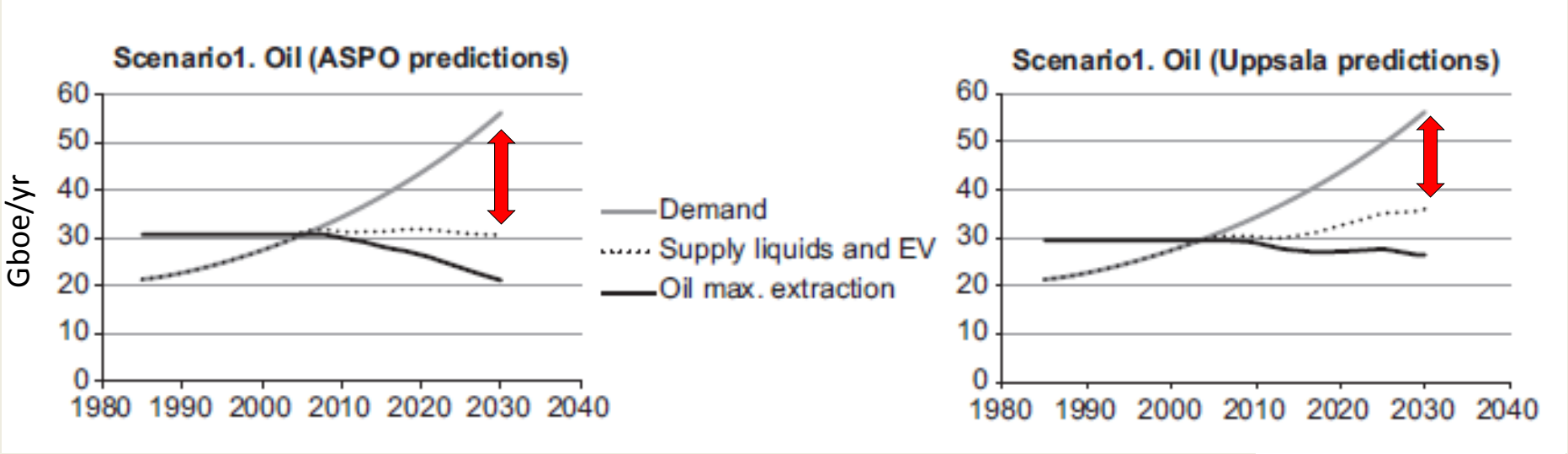


Challenges & barriers (III)

3. Most critical sector: Transport (95% oil)



[Mediavilla2013]

Oil substitution policies: biofuels, Electric&Hybrid car, efficiency improvement, CTL, GTL,

(only) technological change might not be enough

Proposals

- **Urgent action**:
  - Peakoil & CO2 exponential trends,
  - Transport: critical sector,
    - Oil substitution rate < oil decline rate,
  - (only) technological solutions might not be enough.
- Climate change mitigation & fossil fuels depletion **anticipation synergies**:
  - "Effective" (high+sustained) carbon prices,
  - Renewables development (**!** potentials),
  - Energy demand reduction <-> challenged by GDP-Energy coupling.

Thank you very much

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