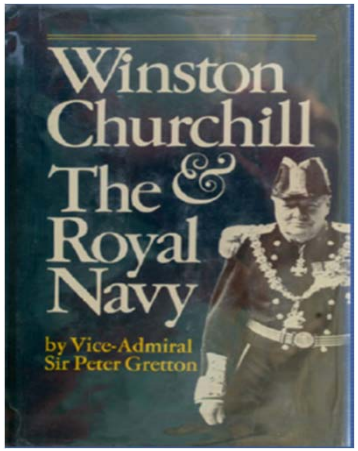
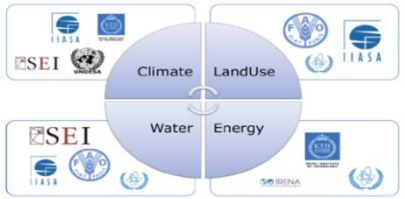
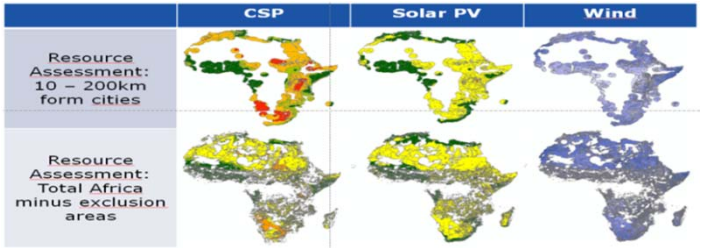
Future Energy Insights and Nuclear Power

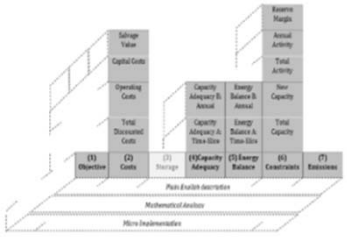
Mark Howells,
Professor and head of the division of Energy Systems Analysis (KTH-dESA)
Royal Institute of Technology, SWEDEN

division of Energy Systems Analysis
Royal Institute of Technology, Sweden









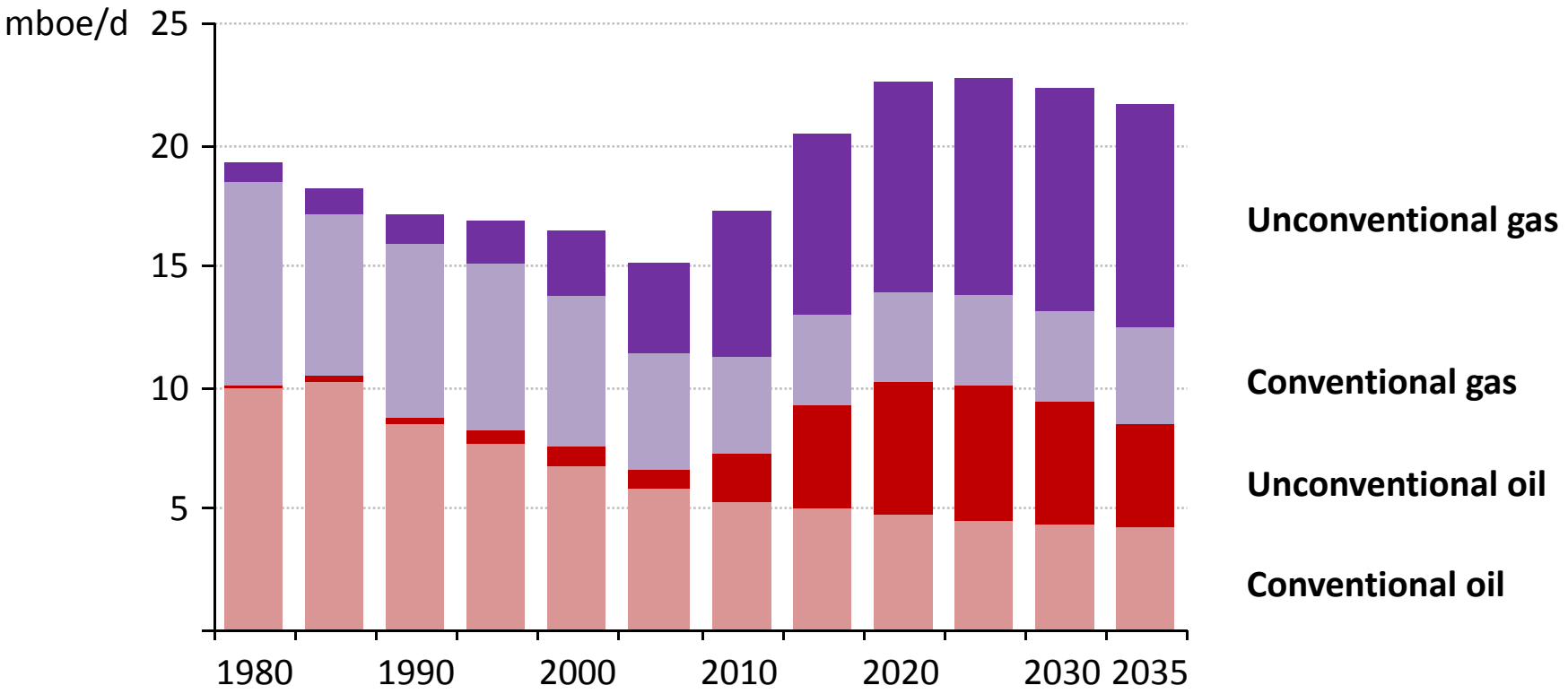
Contents

- Foundations of global energy system shifting
  - *Resurgence in oil & gas production in some countries*
  - *Retreat from nuclear in some others growth in others*
  - *Changing global energy map likely to have significant implications for competiveness & geopolitics*
- In a resource constrained world, nuclear has a key role to play

A United States oil & gas transformation

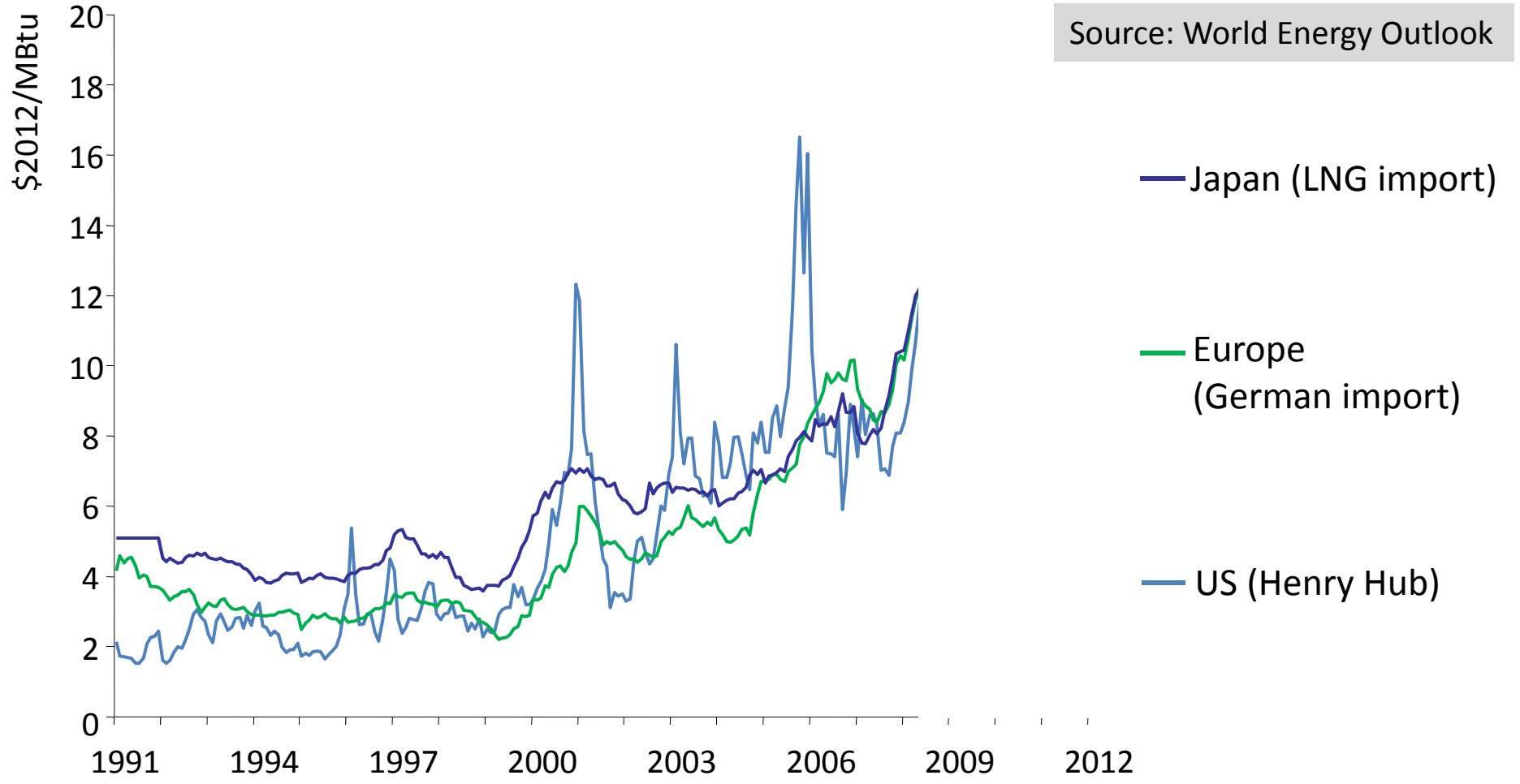
US oil & gas production

Source: World Energy Outlook



The surge in unconventional oil & gas production has implications well beyond the United States

De-coupling of regional gas prices

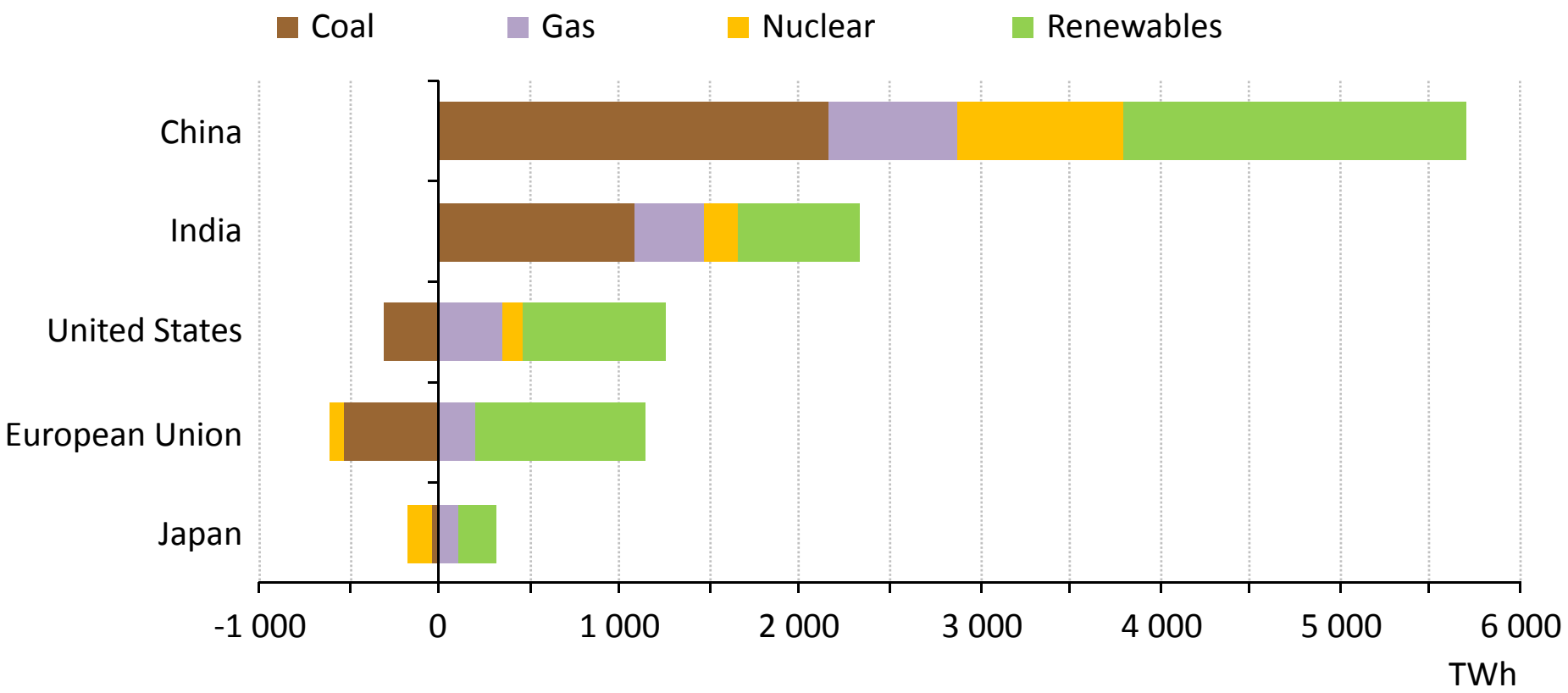


At its lowest level in 2012, natural gas in the United States traded at around one-fifth of import prices in Europe & one-eighth of those in Japan

A power shift to emerging economies

Change in power generation, 2010-2035

Source: World Energy Outlook

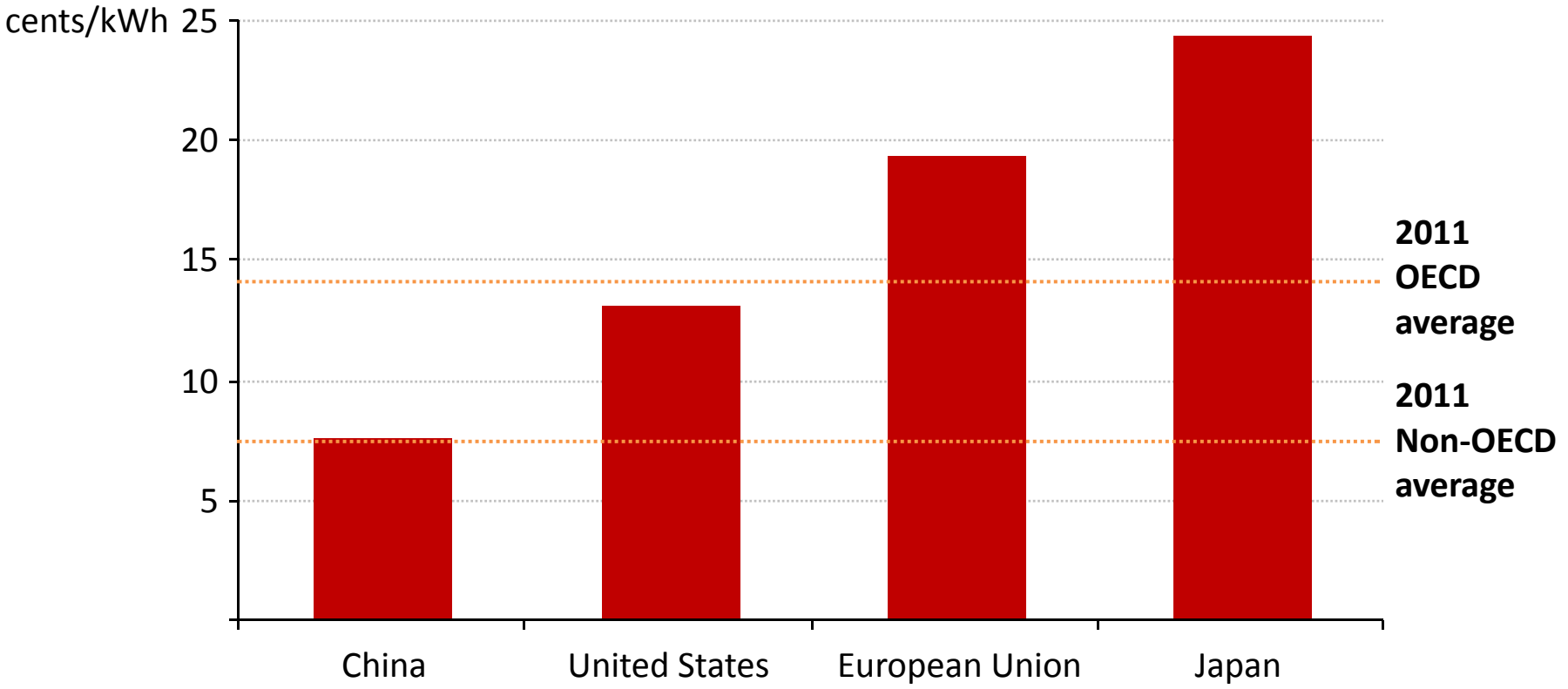


Need for electricity in emerging economies drives a 70% increase in global demand, with renewables accounting for half of new global capacity

Wide variations in the price of power

Average household electricity prices, 2035

Source: World Energy Outlook



Electricity prices are set to increase with the highest prices persisting in the European Union & Japan, well above those in China & the United States

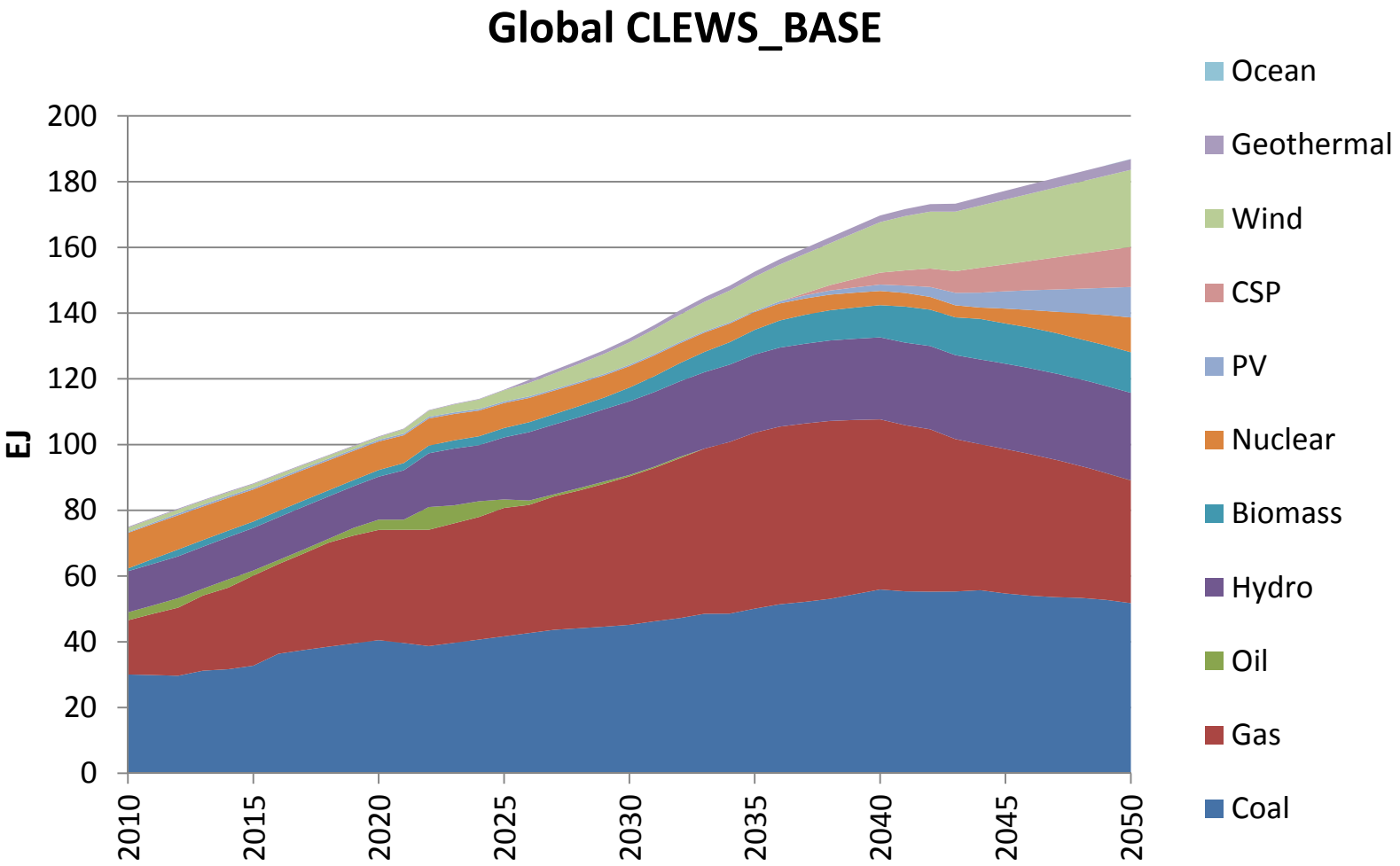
Insights from an Integrated Global CLEWS** Model

Aim: A flexible model with large solution space based on realistic projections.

- Demand projections for heat and electricity based on IEA ETP 6^{o}C scenario – assumes no new policy action and continuance of current code of practice.
- Renewable energy technologies allowed (not forced) to come in at a rate corresponding to IEA ETP 2^{o}C scenario – non-hydro or biomass RE increase 25fold by 2050, compared to 2009.
- CO_2 limit based on IEA ETP 6^{o}C scenario – did not want to limit the system.
- Yield improvement of land and food production based on FAO projections – food demand connected with population projections

**CLEWs – Climate Land Energy Water strategies model
Developed by UNDESA and KTH-dESA

Total Power Generation

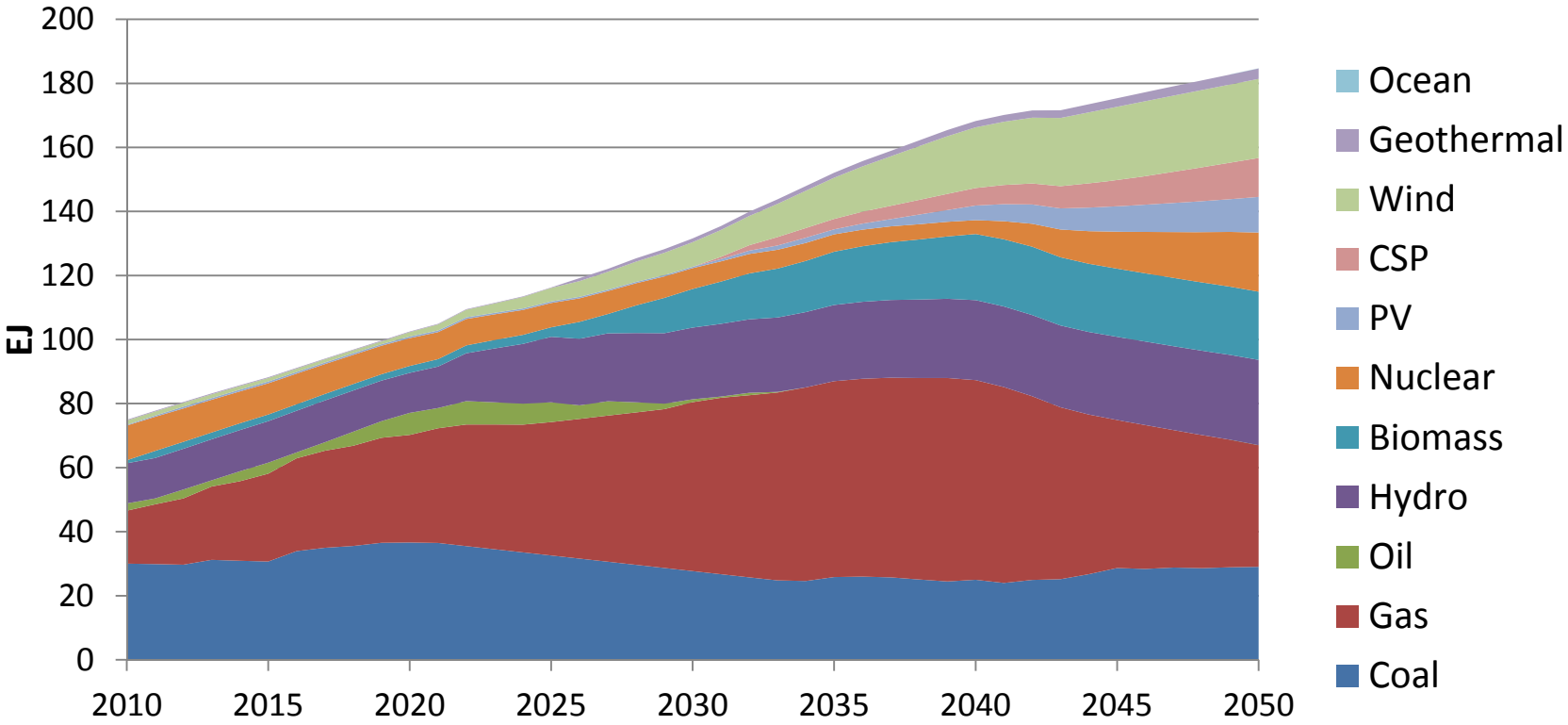


Global CLEWs model

CO_2 Tax Scenario

- Additional tax on emissions (GHG as CO_2-equivalent) of:
  - Linear increase from 1 to 15 $/t$CO_{2EQ}$ in years 2016-2030
  - Linear increase from 15 to 25 $/t$CO_{2EQ}$ in years 2031-2050
- Land use emissions were approximated with a capital cost per land area

Power with CO_2 tax



Main effects

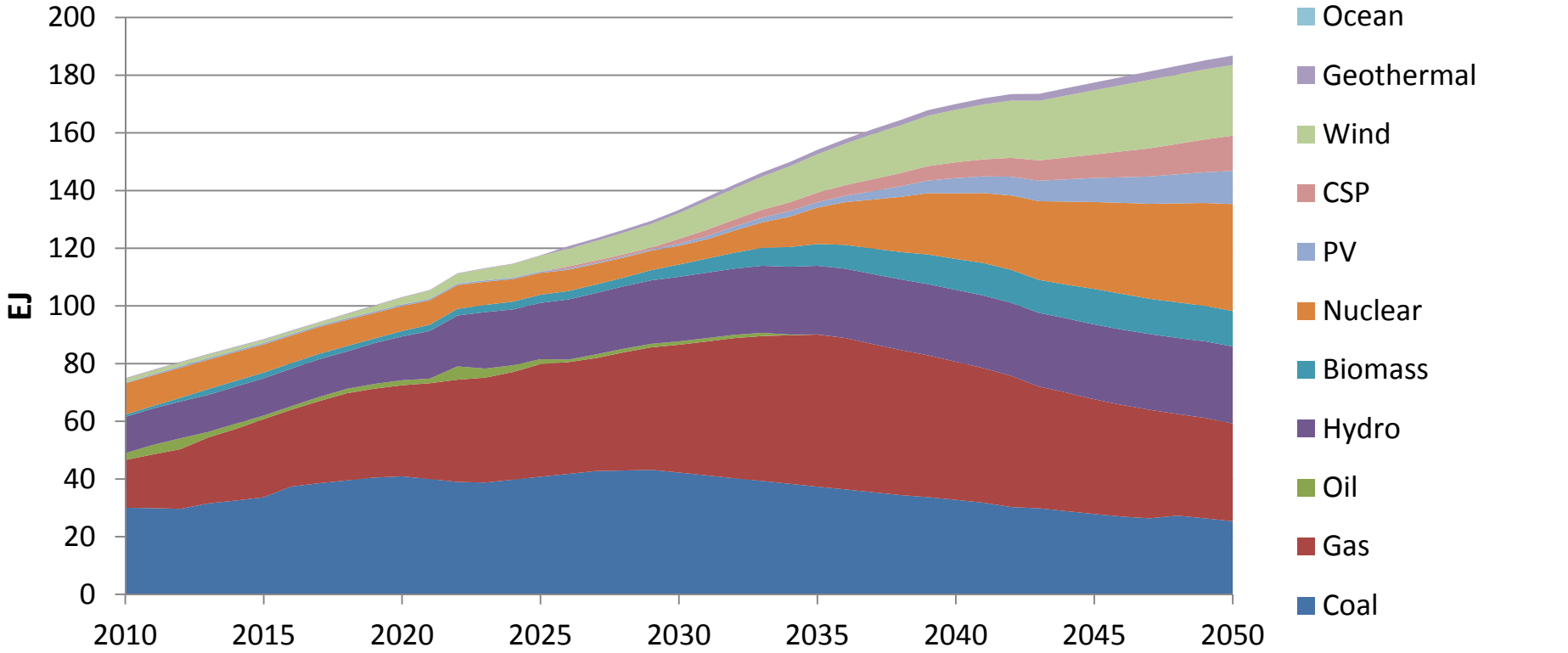
- Less coal
- More biomass, gas and nuclear power
- Renewables already at maximum market penetration

Land Limitation Scenario

- Land use change is responsible for over 30% of global CO_2 emissions and it affects biodiversity, ecosystem services etc.
- Total land capacity was restricted to current area (no area exchange between climate zones possible)
- This meant a necessary intensification of agricultural production (more fertiliser and irrigation)

FAO. (2011). *LOOKING AHEAD IN WORLD FOOD AND AGRICULTURE: Perspectives to 2050*. (P. Conforti, Ed.). Rome: Food and Agriculture Organization of the United Nations.

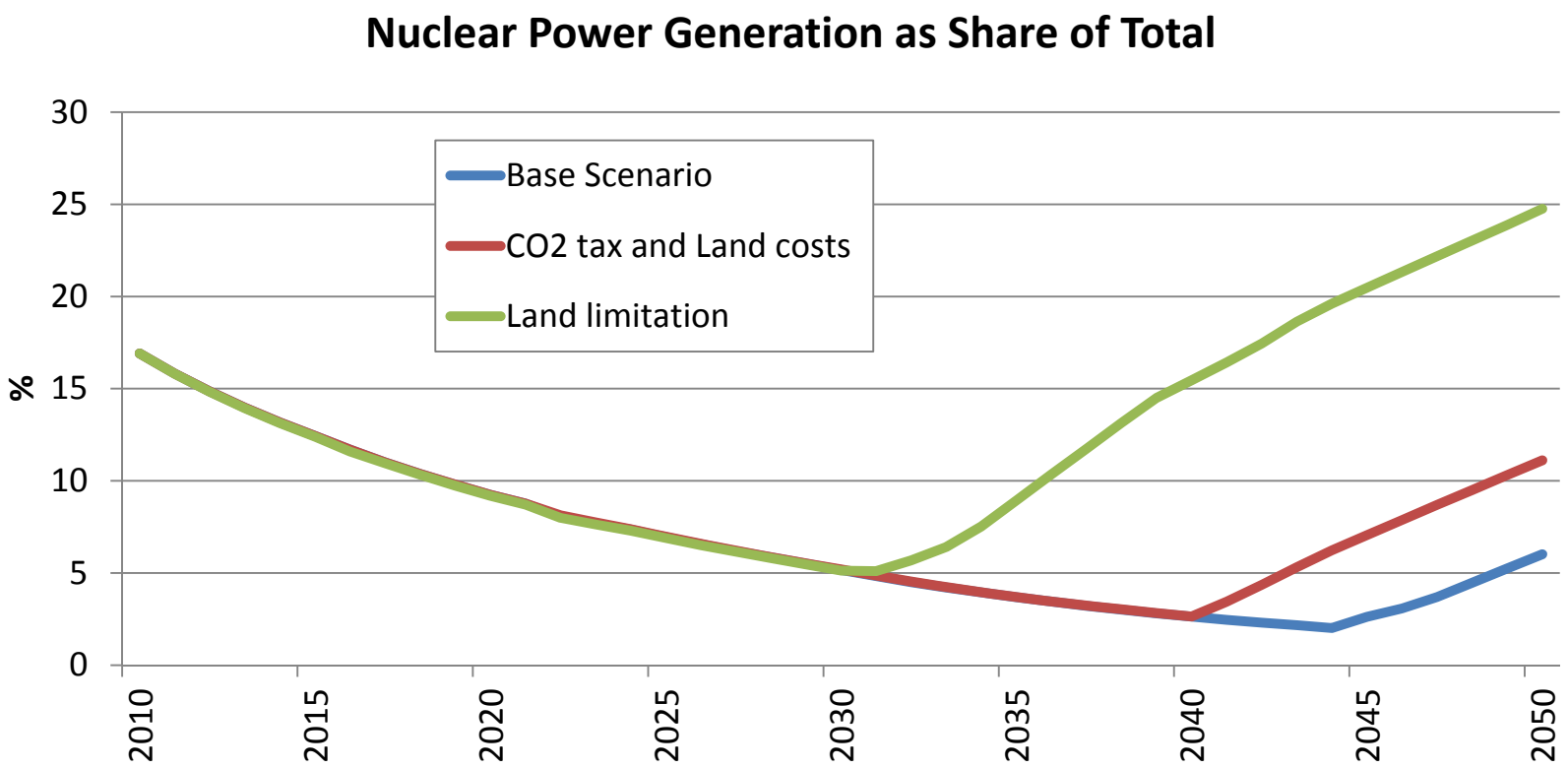
Power with Land Limitation and CO_2 tax



Main effects

- Biomass is more expensive or not available
- Nuclear is only remaining low-emission power technology
- Penetration rates for new technologies would need to be adapted
- Other factors (like biomass from waste) are not considered

Nuclear Share Comparison



Global CLEWs model

Conclusions

- Policy makers face critical choices in reconciling energy, environmental & economic objectives
- Changing outlook for energy production & use may redefine energy pricing, economic competiveness & geopolitical balances
- Shifting away from or towards nuclear can have significant implications for a country's energy security, electricity prices & climate change objectives
- In a resource constrained world, nuclear can be an attractive option

Acknowledgements

IEA, WORLD ENERGY OUTLOOK
UNDESA, GSDR