



# “The best way to use energy is not to use it” \*

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\* Jeroen van der Veer, quoted in Rob Routs, *New Powertrain Technologies* (Shell, 2007):  
“Our chief executive, Jeroen van der Veer, often says that the best way to use energy is not to use it. The best way to mitigate CO<sub>2</sub> emissions is not to emit them.”



# Energy, Efficiency & Economic Growth

- Energy Consumption (direct and indirect) is prime indicator of economic activity
- Energy Efficiency is a driver for economic growth

Jevons paradox (1862)

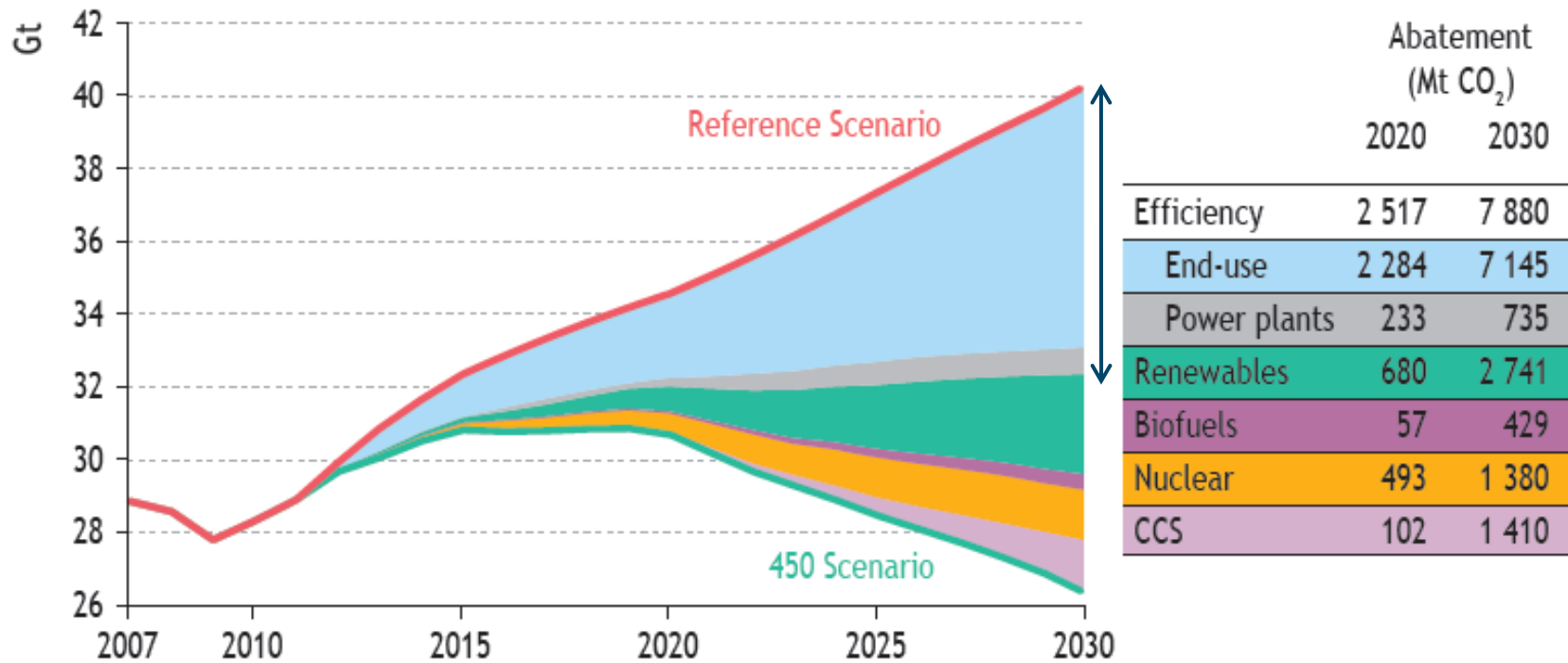
*Technological progress that increases the efficiency with which a resource is used, tends to increase (rather than decrease) the rate of consumption of that resource.*

Khazzoom-Brookes postulate (1980s):

*Improvements in energy efficiency work to increase, rather than decrease, energy consumption*

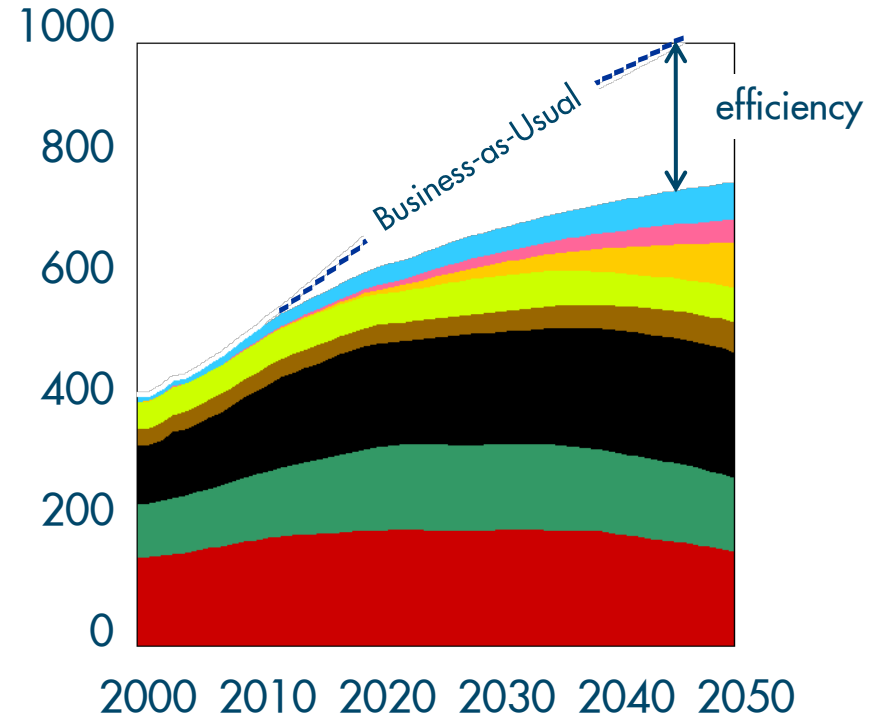
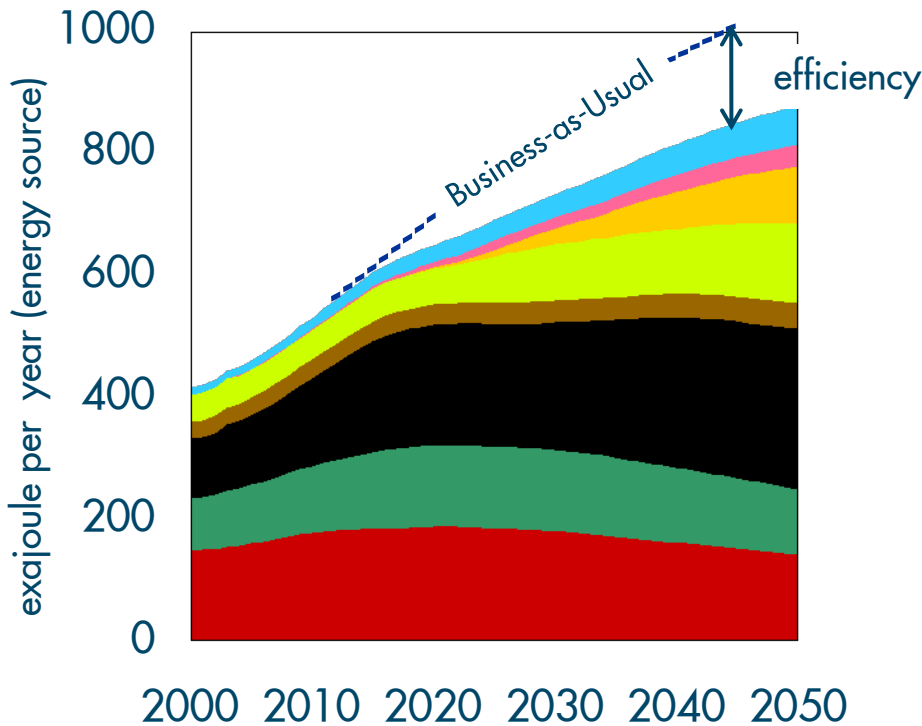
# Energy Efficiency in Energy Scenarios (1)

**Figure 5.8** • World energy-related CO<sub>2</sub> emission savings by policy measure in the 450 Scenario



Source: IEA World Energy Outlook (2009)

# Energy Efficiency in Energy Scenarios (2)



■ Oil 
 ■ Gas 
 ■ Coal 
 ■ Nuclear 
 ■ Biomass 
 ■ Solar 
 ■ Wind 
 ■ Other Renewables

# Three hard truths will shape the future of the energy system

- Surge in energy demand
- Supply will struggle to keep pace
- Environmental stresses are increasing



# The Jevons Paradox on a Finite Planet

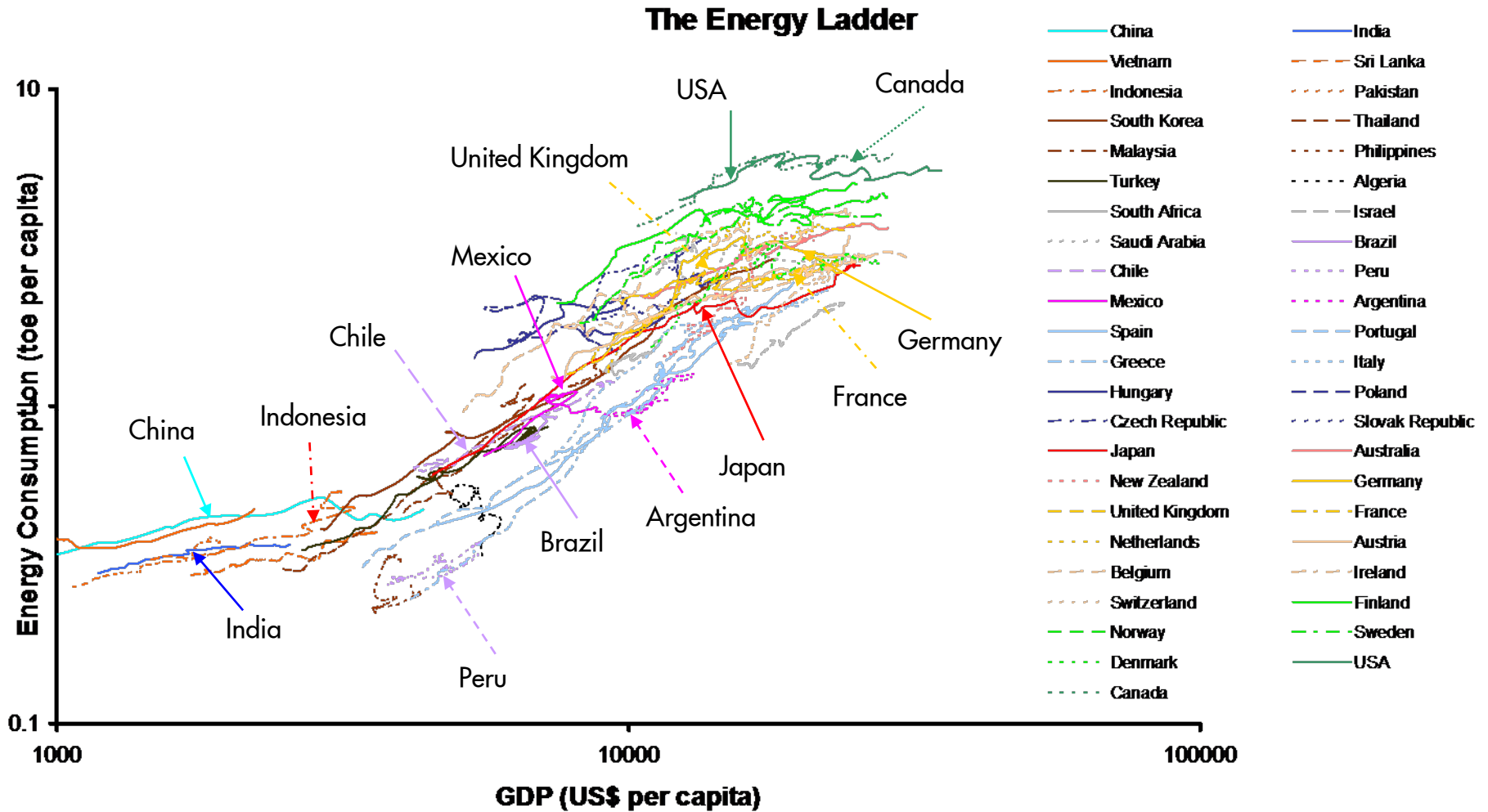
Jevons paradox (1862)

*Technological progress that increases the efficiency with which a resource is used, tends to increase (rather than decrease) the rate of consumption of that resource.*

1. Surge in energy demand
  - The Jevons paradox is still valid
2. Supply will struggle to keep pace
  - Oil & Gas, Coal (Jevons!) are finite
  - But renewables are limited in important ways as well
3. Environmental stresses are increasing
  - Not only are the (fossil) inputs finite, but the CO<sub>2</sub> output is (or must be) limited also

# Surge in Energy Demand

## Energy ladder – the S curve

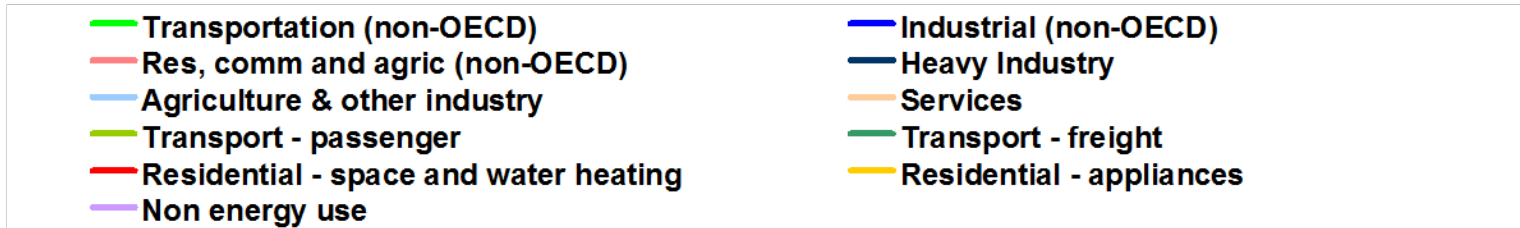
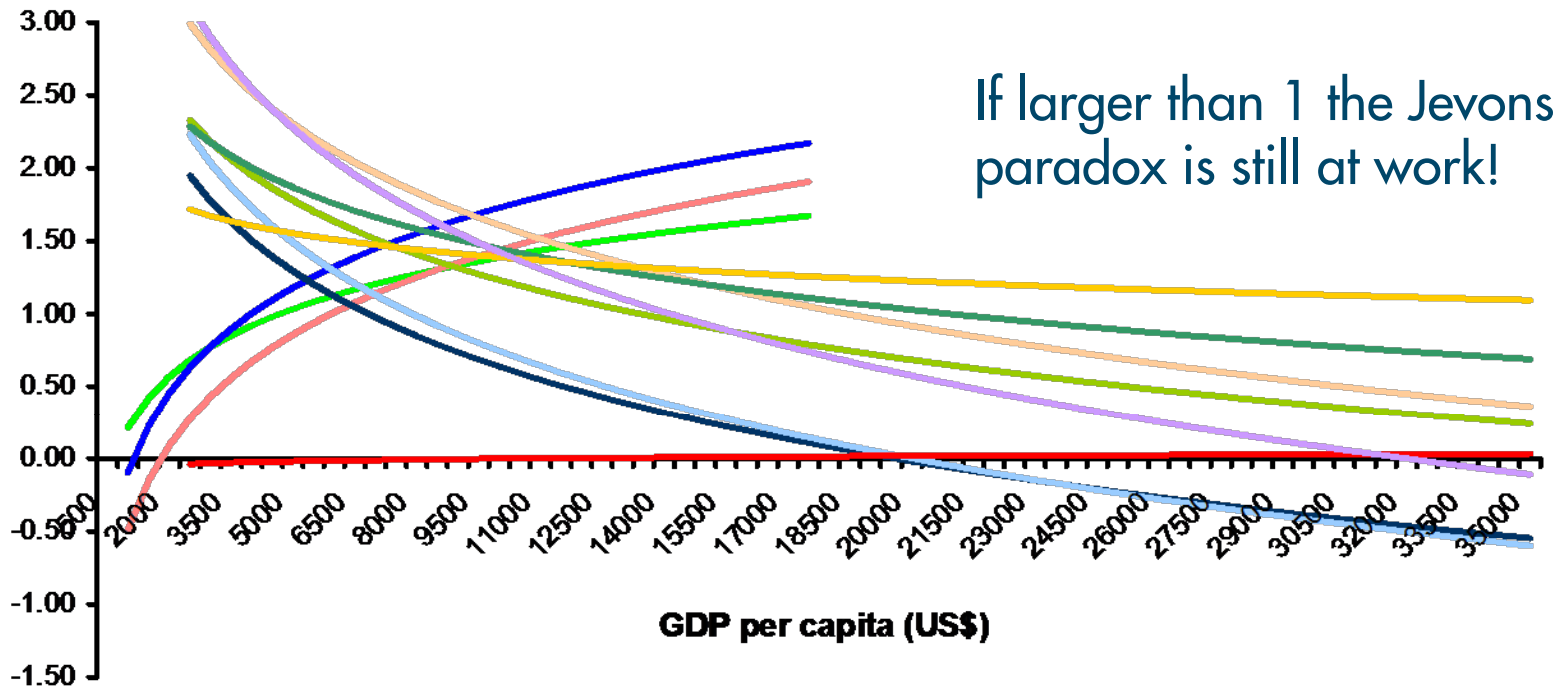


Source: Mattia Romani and Arthur van Benthem for Shell

# Surge in Energy Demand

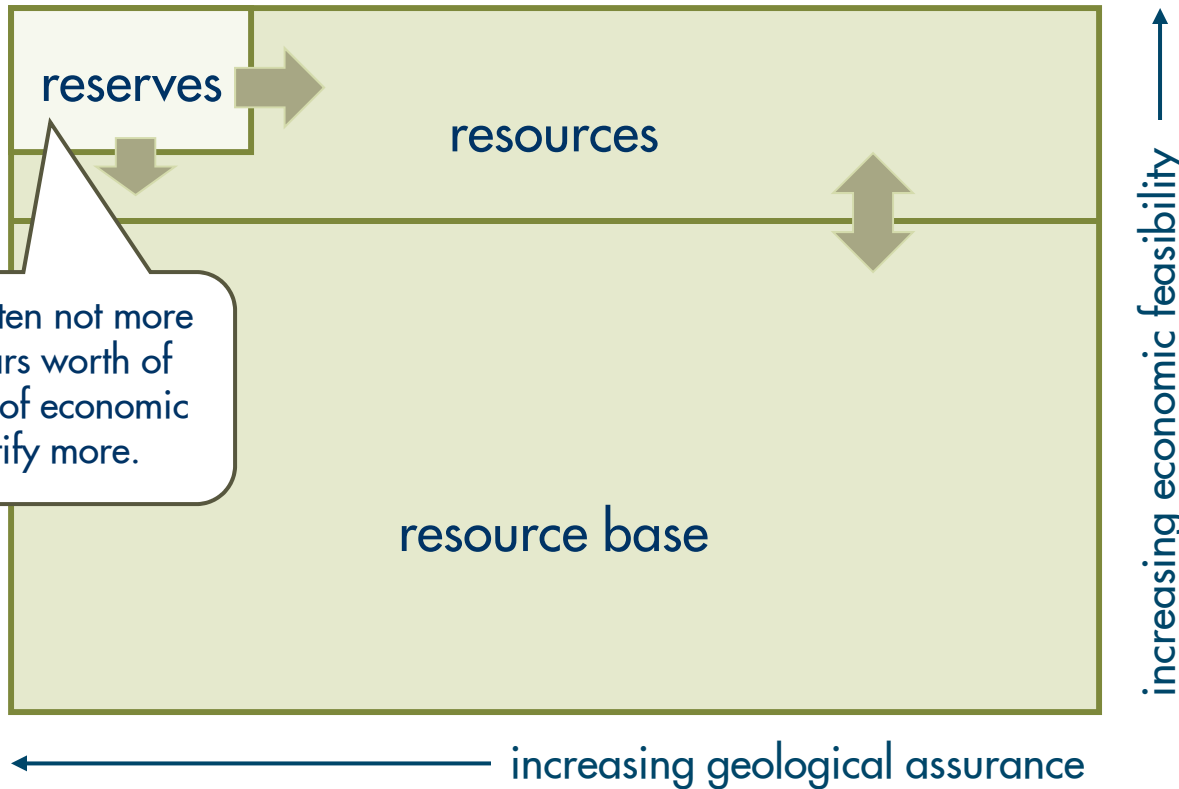
## Long-run income elasticity – sectors

**Income Elasticity per Sector**



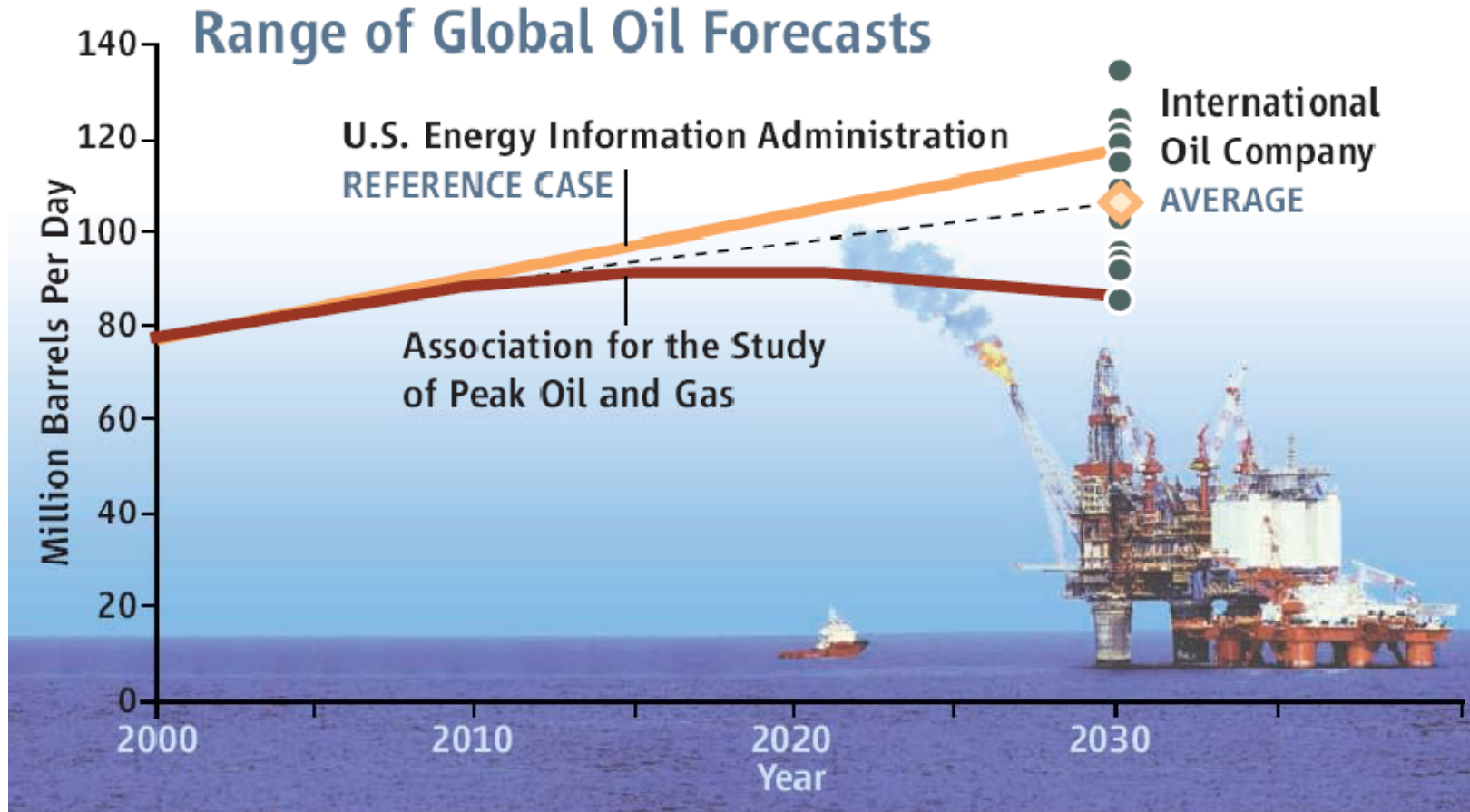
# Supply will struggle to keep pace

Oil, Gas & Coal - reserves, resources and the resource base



# The Oil Outlook of Today

Oil supply “will struggle to meet growing demand”

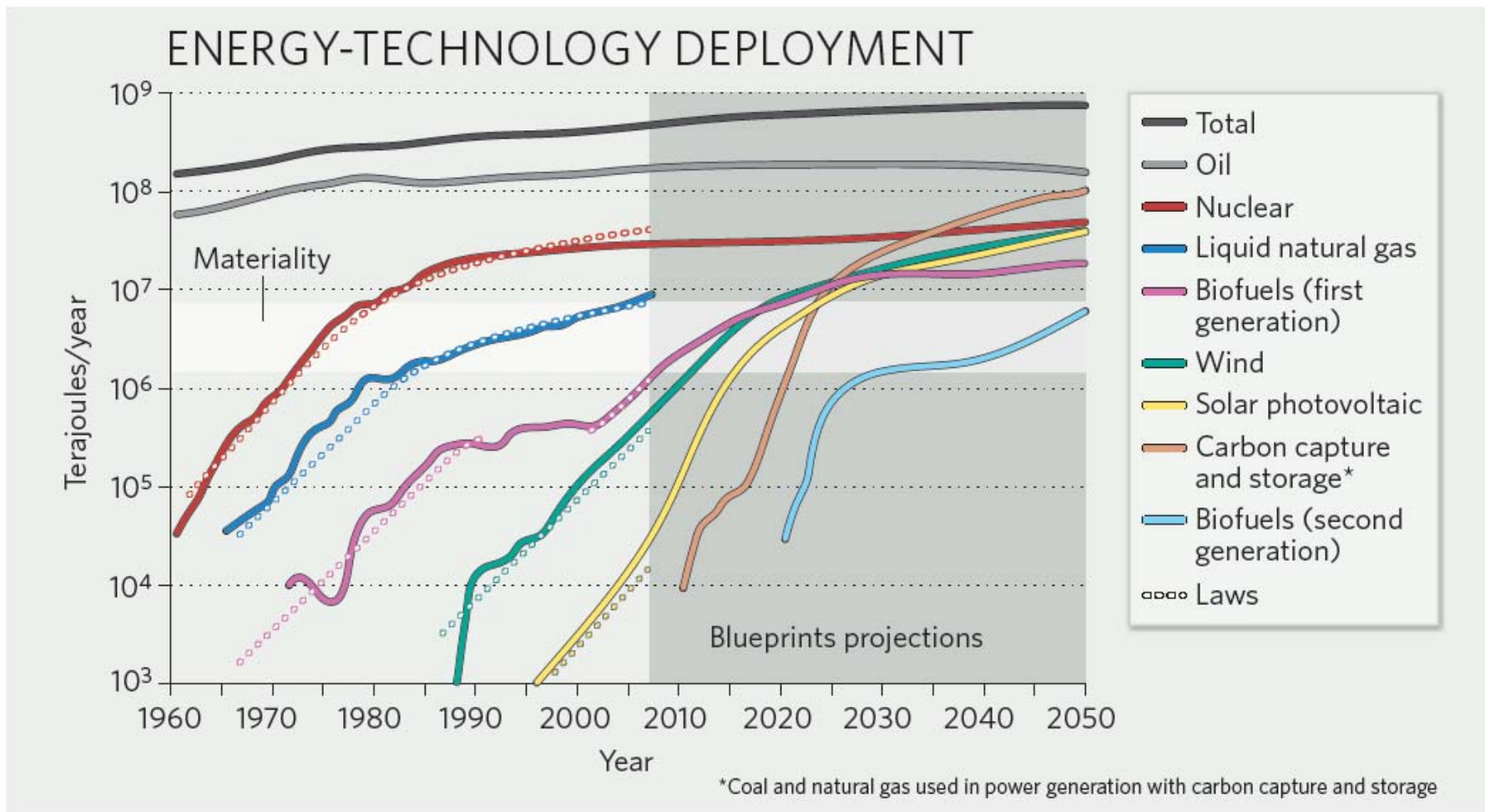


Source: NPC report, discussed in: Science, 317, 437 (21 July 2007)

# Supply will struggle to keep pace

## Renewables grow fast, but from a small base

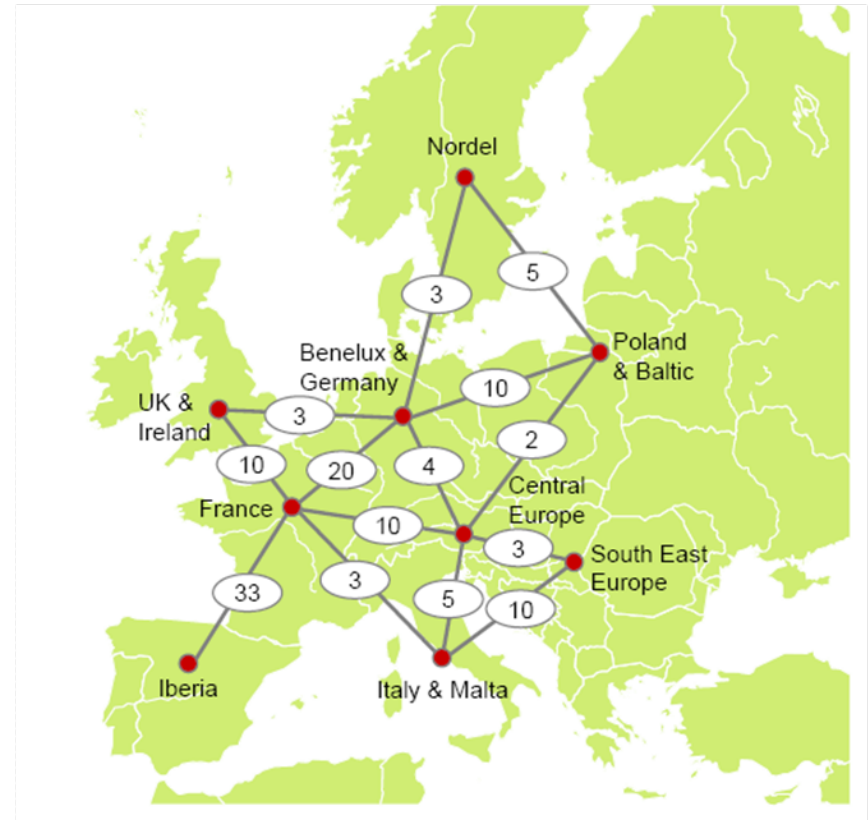
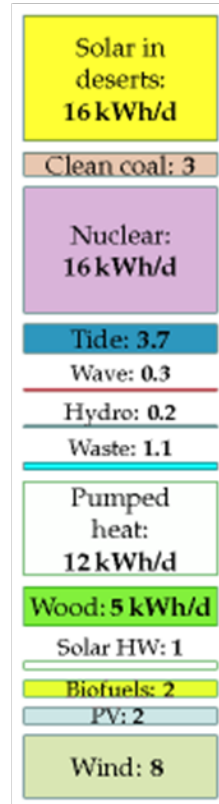
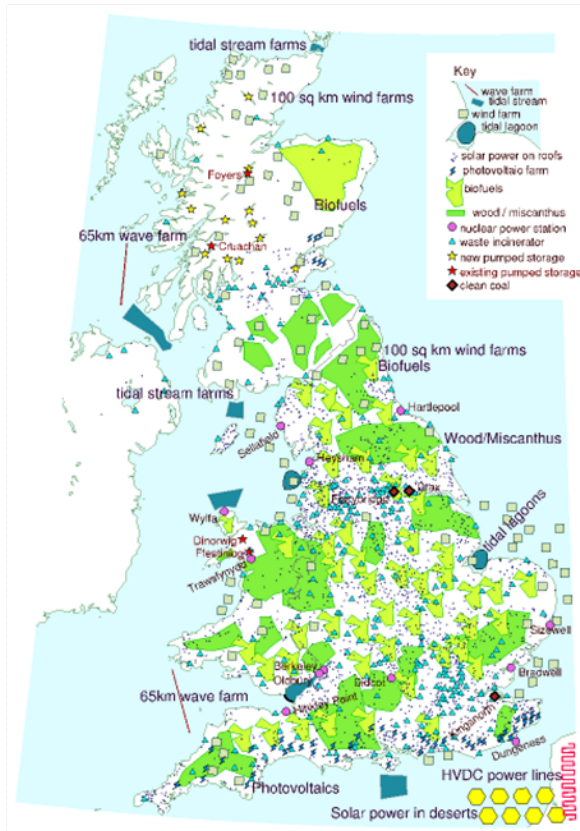
HISTORIC DATA: OECD/IEA/PREDICTIONS: SHELL INTERNATIONAL



Source: Gert Jan Kramer and Martin Haigh, *Nature*, **462**, 568 (2009)

# Supply will struggle to keep pace

Once material, spatial & infrastructure planning will be the main bottle neck

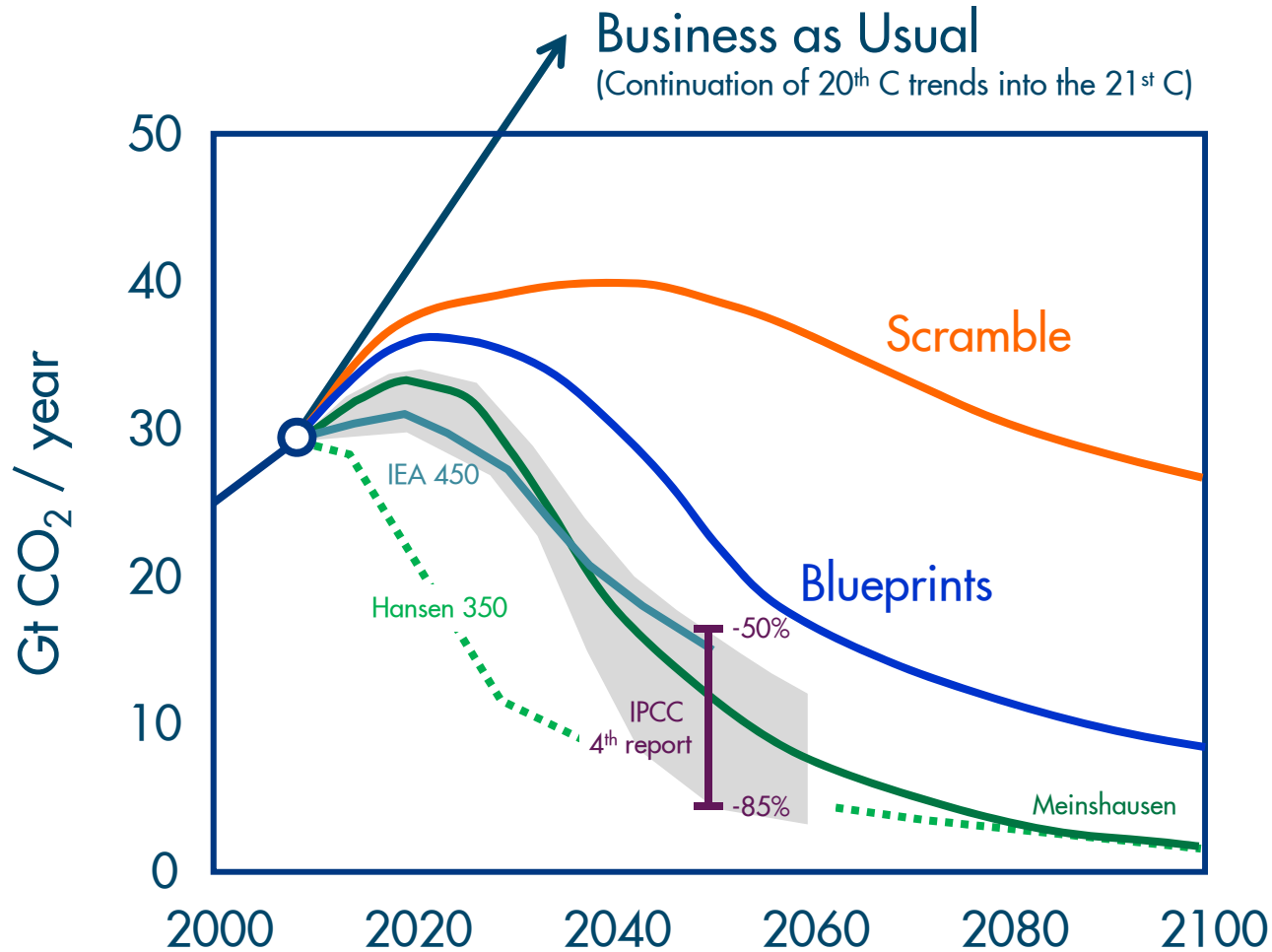


“Industrialization of the country side”

Massive grid expansion to allow 60% RES

# Environmental stresses are increasing

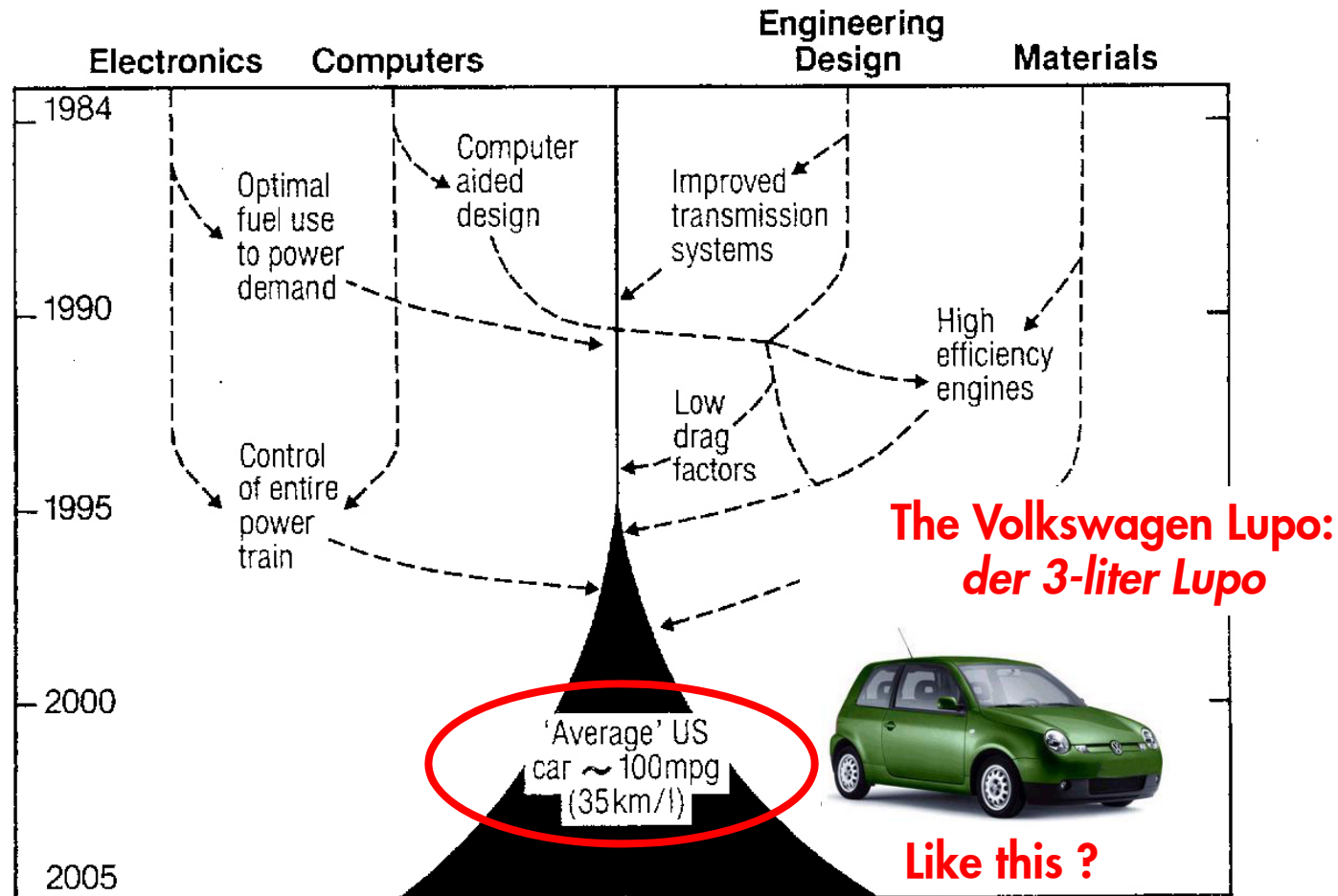
## Climate change and CO<sub>2</sub> emissions loom large



Sources: Shell International BV; IPCC 4<sup>th</sup> Assessment Report (2007); IEA WEO 2009; Meinshausen et al., *Nature* **458**, 1158–1162 (2009); Hansen et al., *The Open Atmospheric Science Journal*, **2**, 217-231 (2008)

# Return to Efficiency (1)

Efficient cars – we have them, but we don't buy them

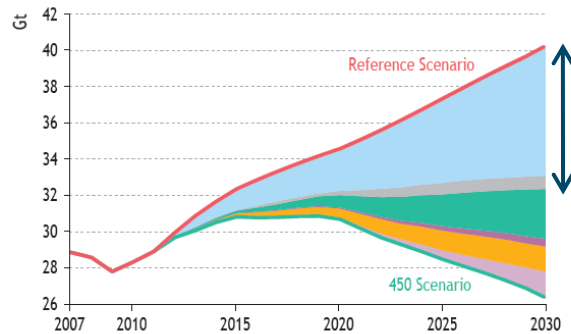


Source: Ford Motor Co; Science, (1984), 225, 587

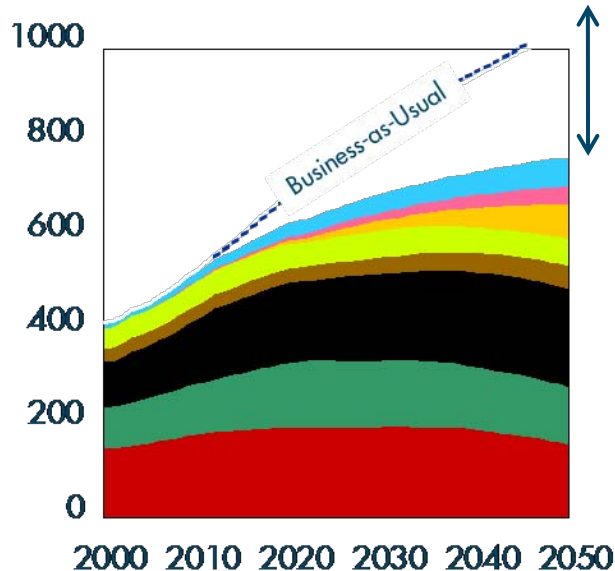
Source: Shell Scenarios 1980s (adapted from a Ford paper)

# Return to Efficiency

iea 450 scenario



Blueprints



- The demand side will grow strongly
- The supply side is constrained
- The pressure to reduce enormous
- Everyone looks at efficiency to “close the gap”
- The track record of efficiency in delivering reduction in energy consumption is rather poor
- We need a clearer distinction between energy efficiency and energy conservation



Acknowledgement: Martin Haigh

More information: [www.shell.com/scenarios](http://www.shell.com/scenarios)