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McMaster University
Inspiring Innovation and Discovery

Conservation & Demand Management
in a Sustainable Energy Future
Conference and Exhibit

Sustainable Energy – Sustainable Business

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THE BOSTON CONSULTING GROUP

Sustainability megatrends are drivers of large opportunities

The world is facing increasing scarcities and externalities ...

1. Climate change
2. **Energy scarcity and energy price volatility**
3. Water scarcity
4. Scarcity of and limited access to raw materials
5. Food security challenge
6. Waste and waste management

... creating opportunities within different areas

Reduce usage
Reduction of energy-consuming products or services

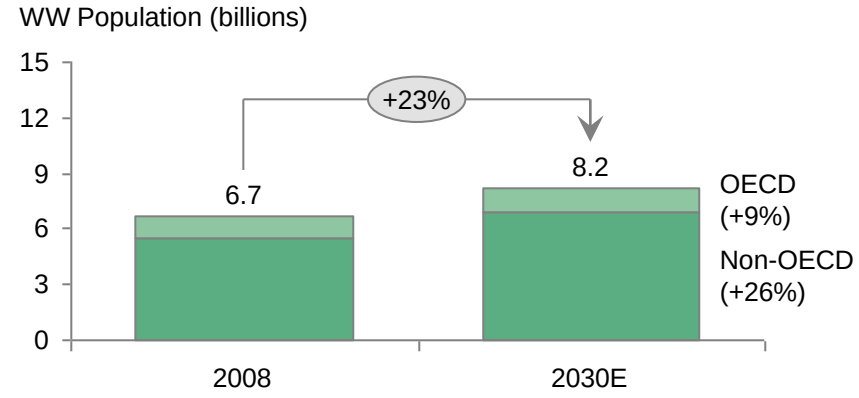
Increase efficiency
Increased productivity of energy usage

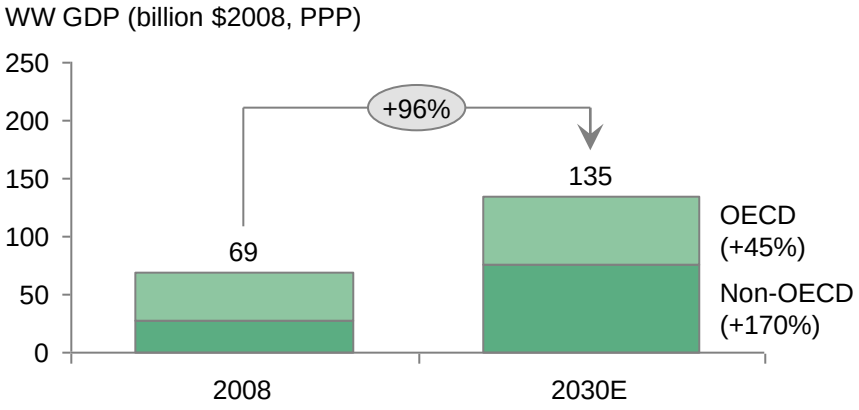
Replace with alternative energy
Switching from conventional resources to renewables like solar or wind

But which opportunities are the ones to focus on? A closer look into the megatrend "Energy scarcity and energy price volatility" is needed

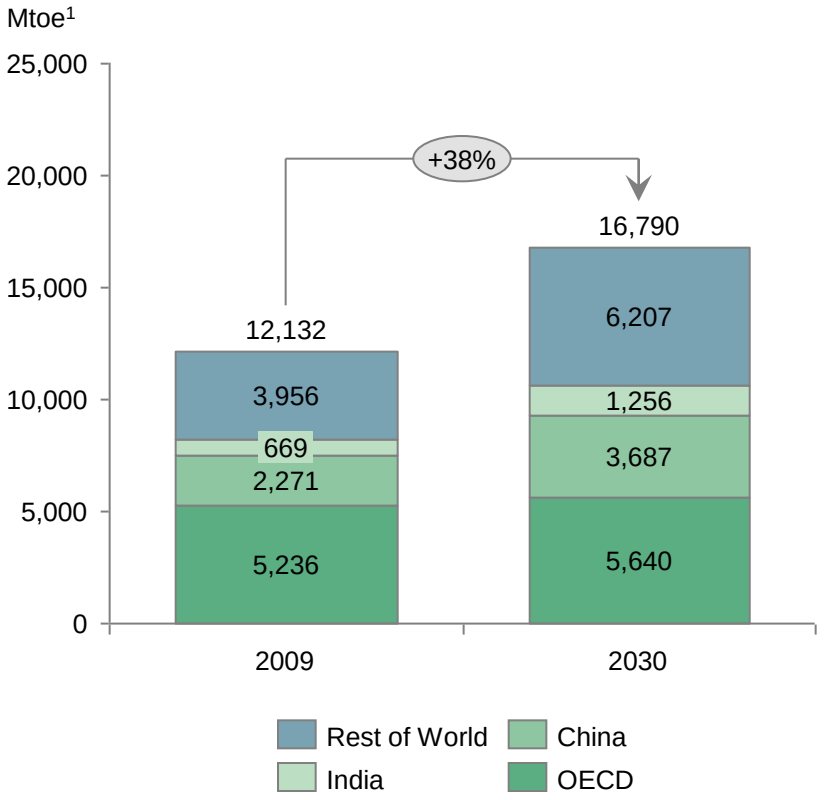
Driven by population growth and rising living standards in RDEs, global energy demand will rise by ~40% until 2030 ...

Population and GDP growth (2008-2030E)





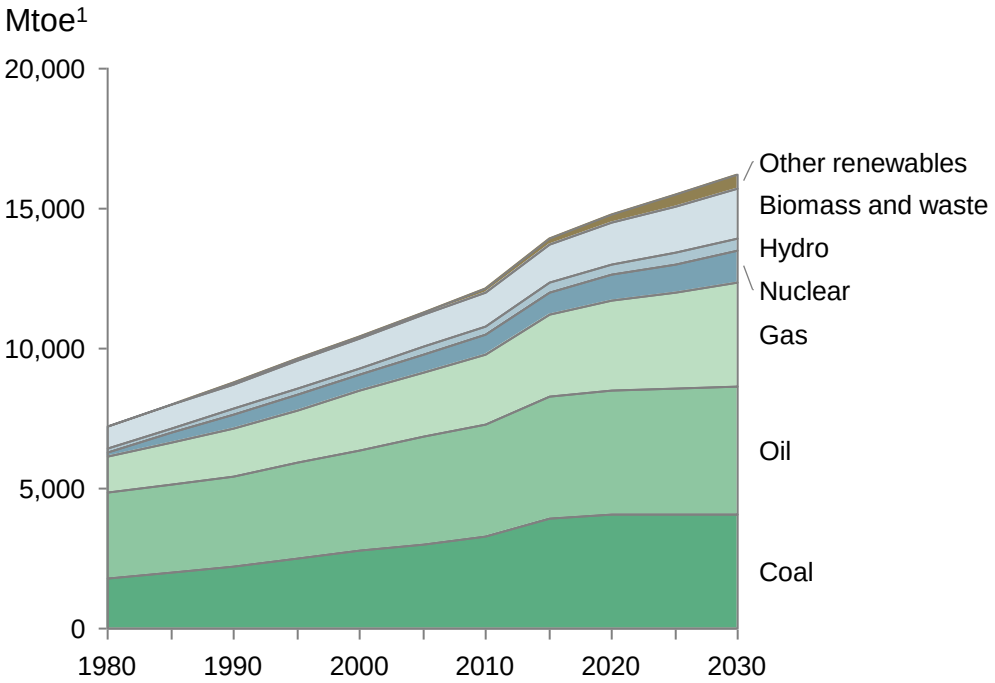
Increase of ~40% in energy demand until 2030



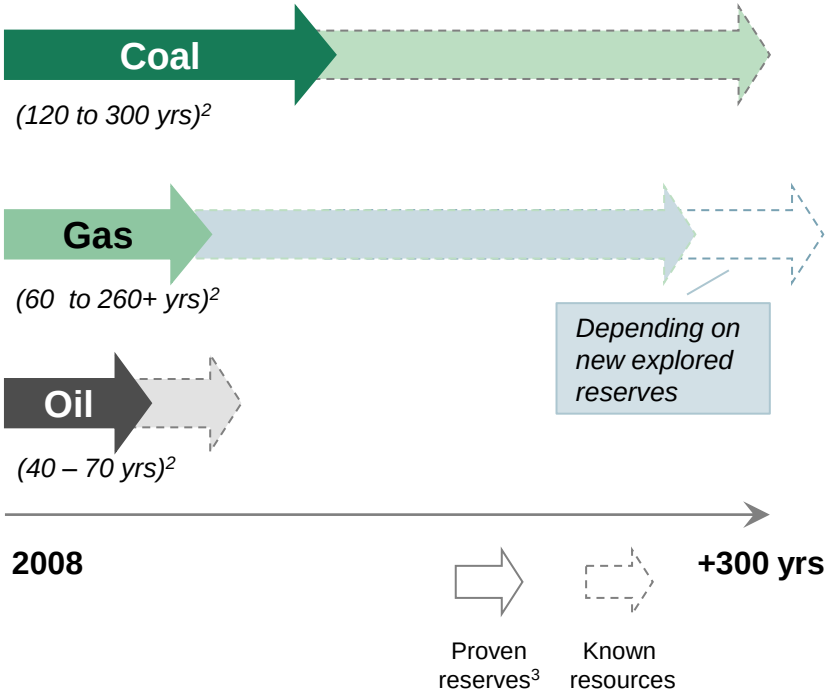
1. Million tonnes of oil equivalent
Source: IEA World Energy Outlook 2011

... but current resources are finite and will only be able to meet the demand for energy for a limited time

The demand for energy is expected to accelerate in the coming years ...

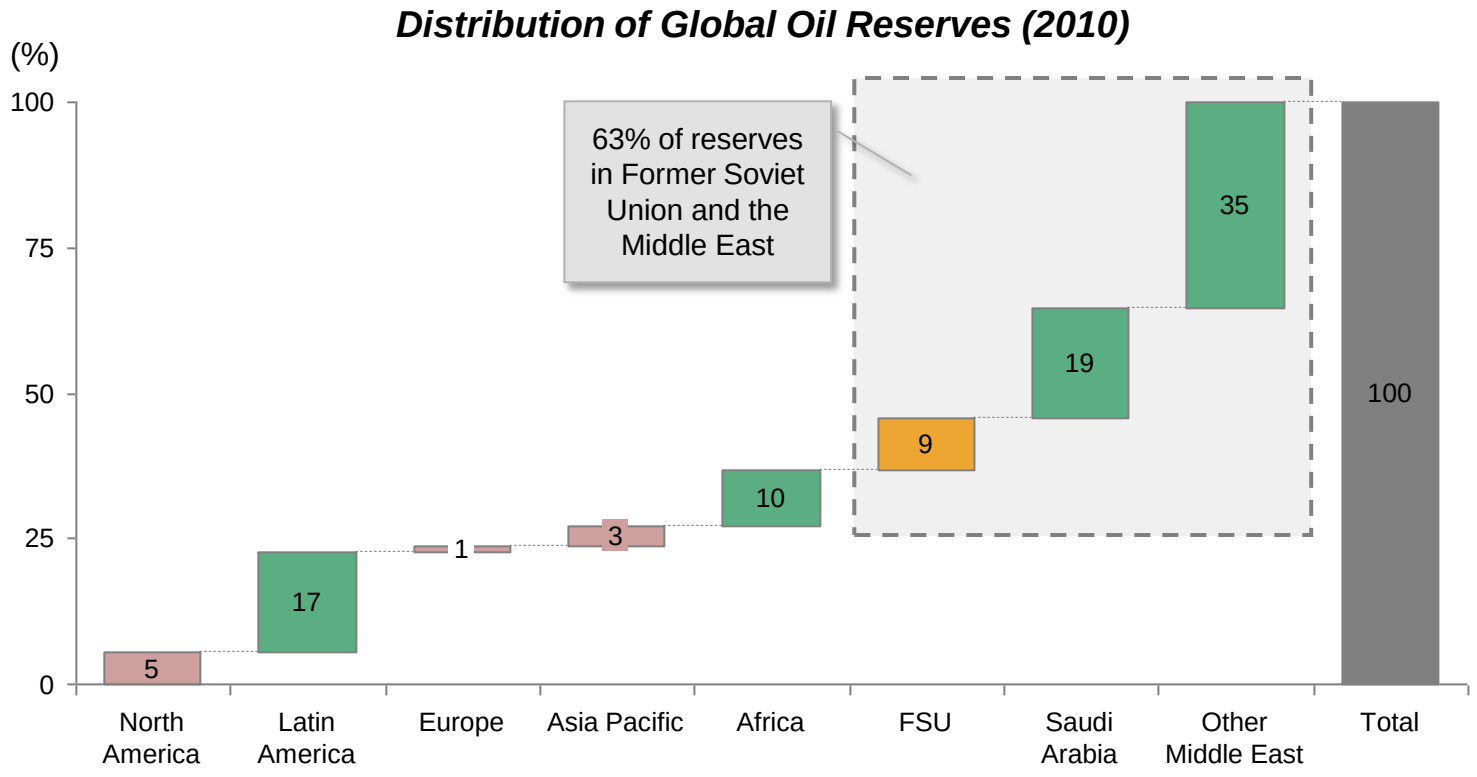


... leading to depletion of resources in the future



1. Million tonnes of oil equivalent 2. Depletion of resources at 2008 consumption rates 3. Those quantities that geological and engineering information indicates with reasonable certainty can be recovered in the future from known reservoirs under existing economic and operating conditions
Source: EA World Energy Outlook 2011, USGS, OPEC; World Nuclear Association, BCG Analysis

Growing imbalance of energy demand and production/supply establishes a new global power balance

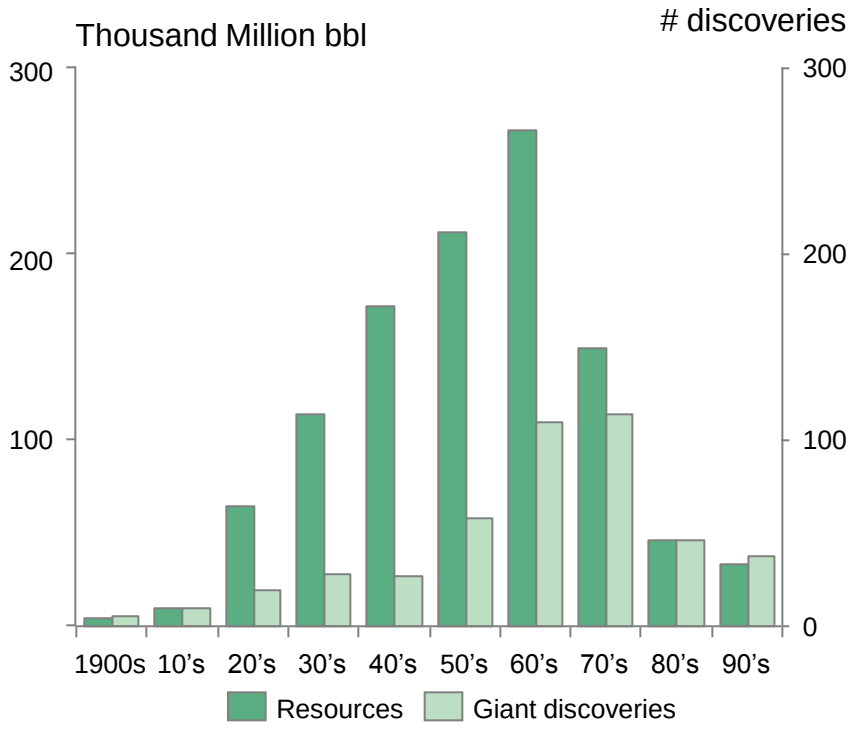


Similar patterns apply for gas reserves

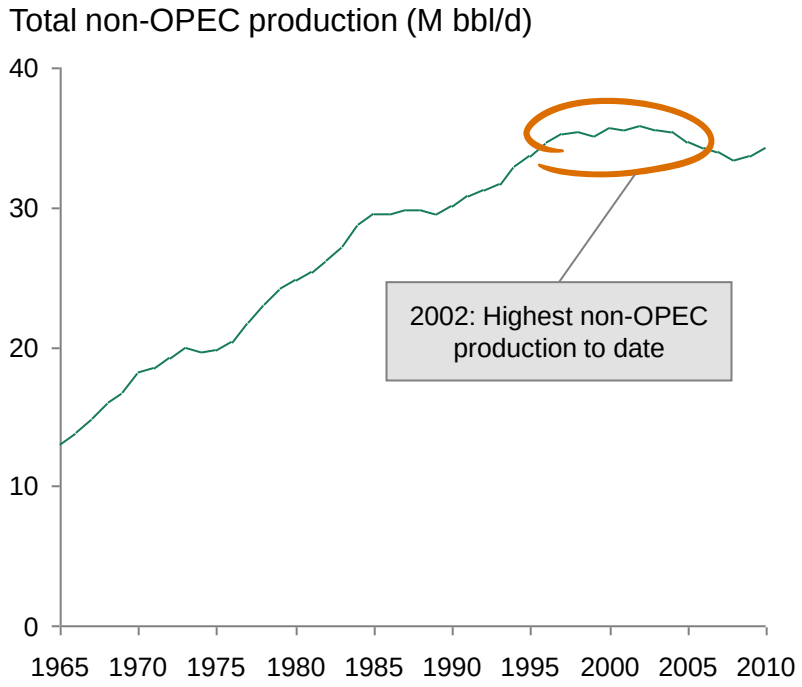
Source: BP Statistical Review 2011; 2010 figures

As energy resources are harder to get ...

Average size of discoveries has declined[1]



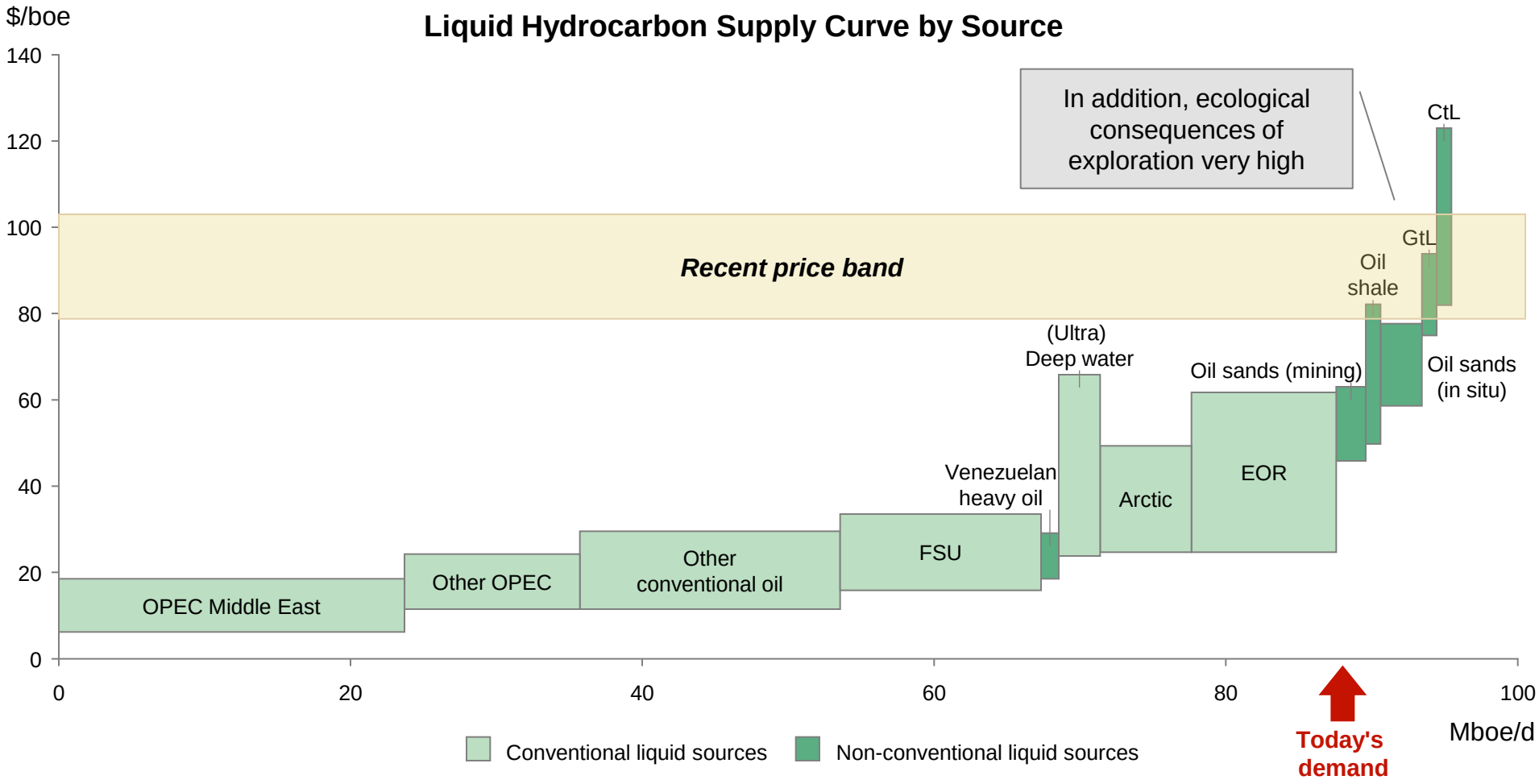
Growth in non-OPEC oil production difficult to achieve



Growing share of production from oil and gas areas which are harder to access: Offshore, Unconventional and Deepwater

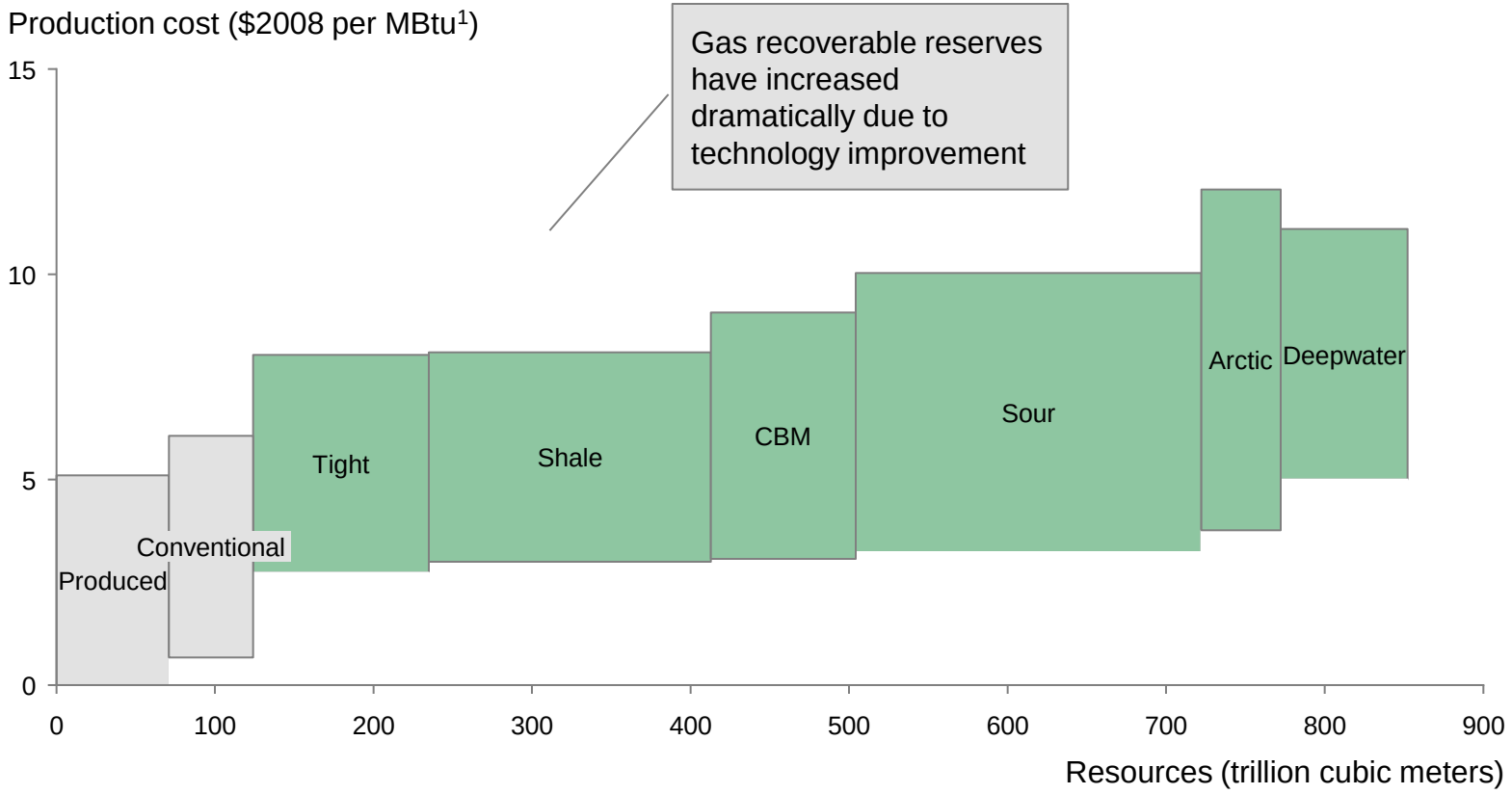
1. Giant oilfields: oilfields with recoverable reserves above 500 Gb
Source: AAPG; UHDSG; IHS; WMK; BP Statistical Review of World Energy June 2011

... energy supply will have a growing cost



Note: Assumed average vs. marginal costs; 10% return for conventional and 13% return for unconventional technologies; no subsides for biofuels; no carbon offset costs; after severance and production taxes
Source: ConocoPhillips Strategic Decisions 2008, BP Statistical review 2008

Large resources of unconventional gas exist, but uncertain if accessibility is as large as needed to cover energy demand



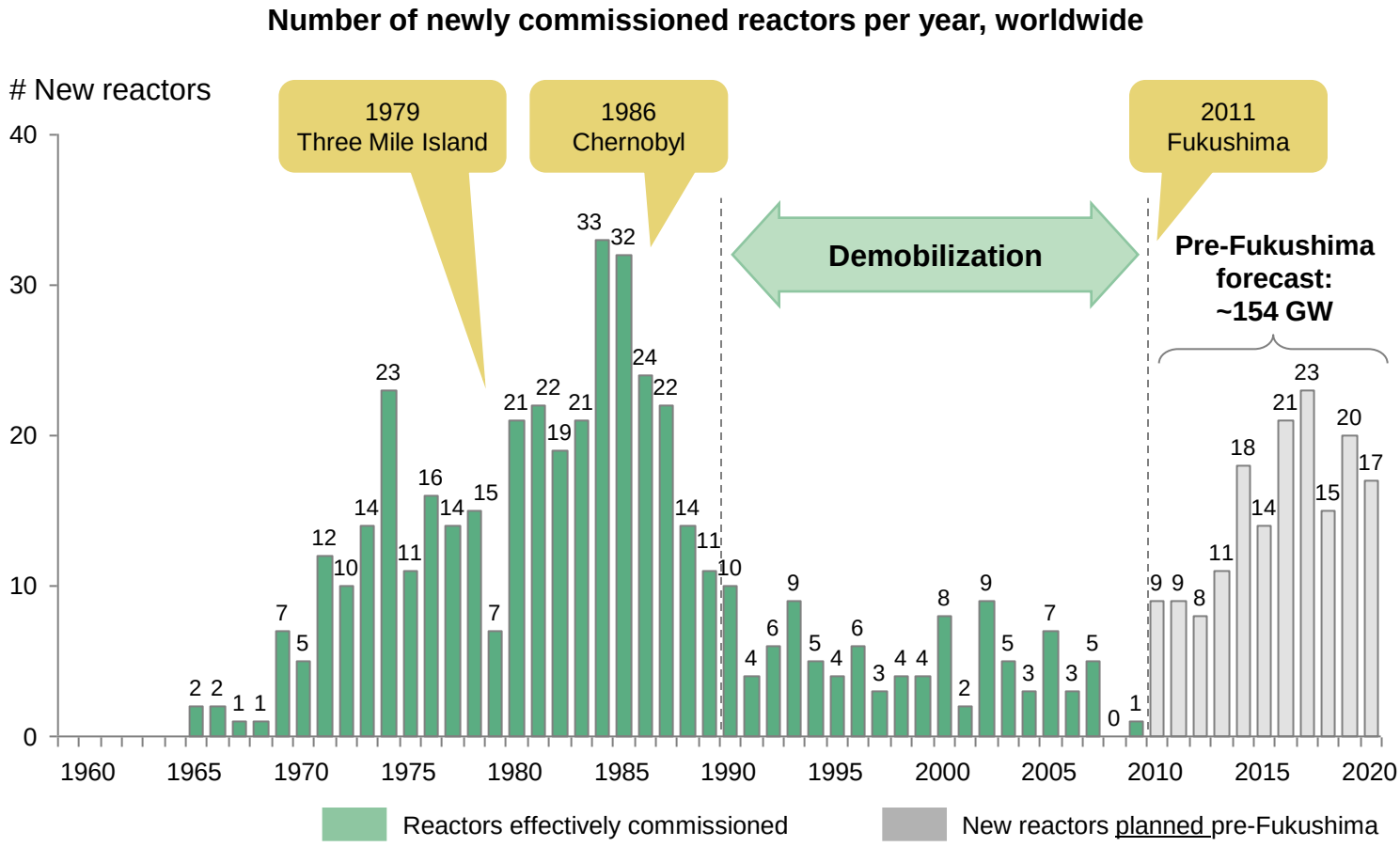
Cost of extraction and environmental issues might limit unconventional gas to be a sufficient solution

1. Million British thermal units

Note: Areas indicate availability of gas resources as a function of estimated costs of production in 2008. Only sources with significant potential production before 2030 are included. These costs are based on the economics of gas production only, not taking into account the value or cost of any liquids production. However, some costs for associated gas production are shared with liquids production costs, thereby generally lowering overall costs for associated gas. Transportation costs are additional.

Source: IEA World Energy Outlook 2009

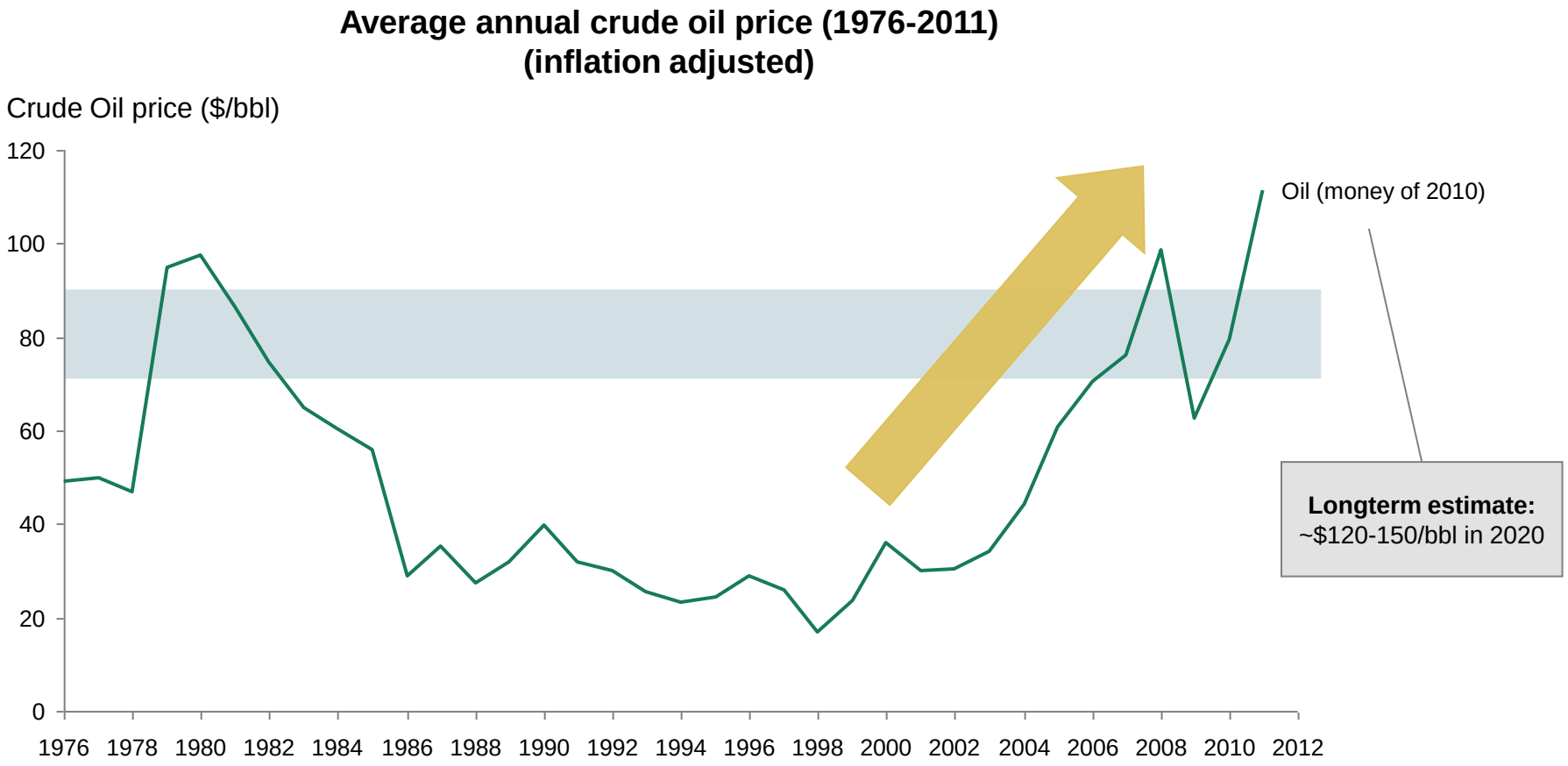
After Fukushima, nuclear is unlikely to ease the scarcity significantly



Downturn similar to post-Chernobyl period much more likely

Source: IAEA, WNA, BCG analysis

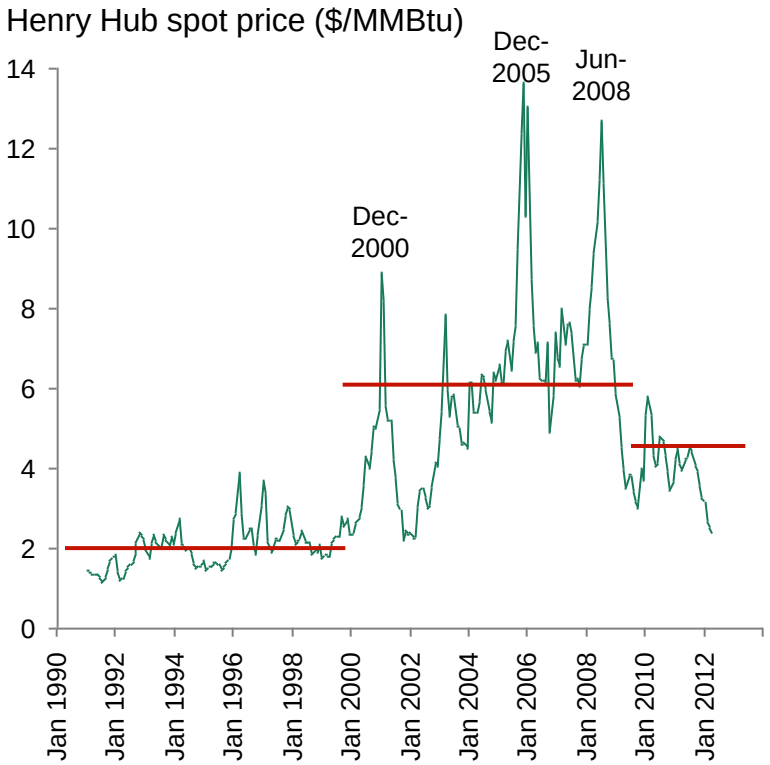
As a consequence of scarce resources, oil prices have been increasing in most years for over a decade ...



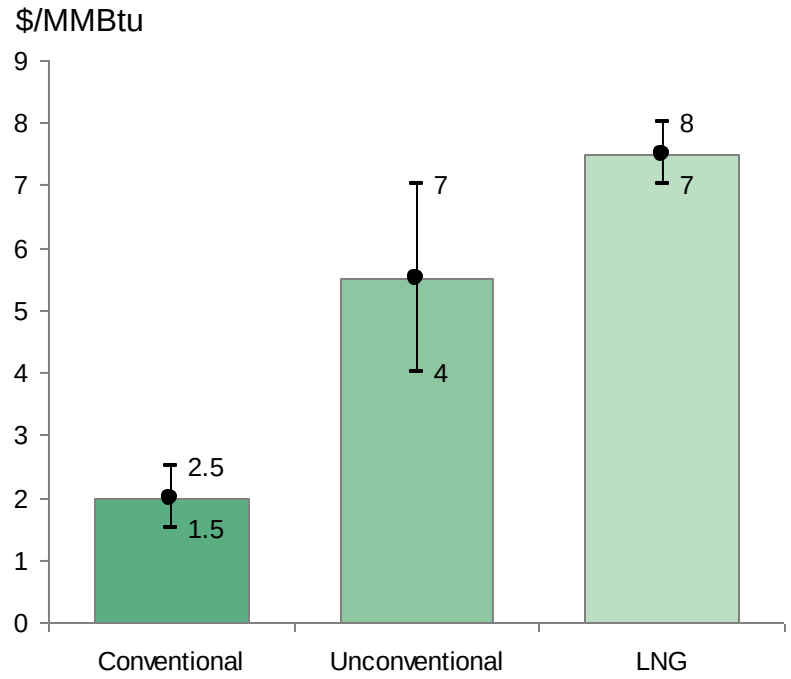
Source: BP Statistical Review of World Energy June 2011 (Europe Brent); IEA World Energy Outlook 2011

... and gas prices are significantly higher than in the nineties with a high level of volatility

Gas prices before 2000 ∅ 2 $/MMBtu



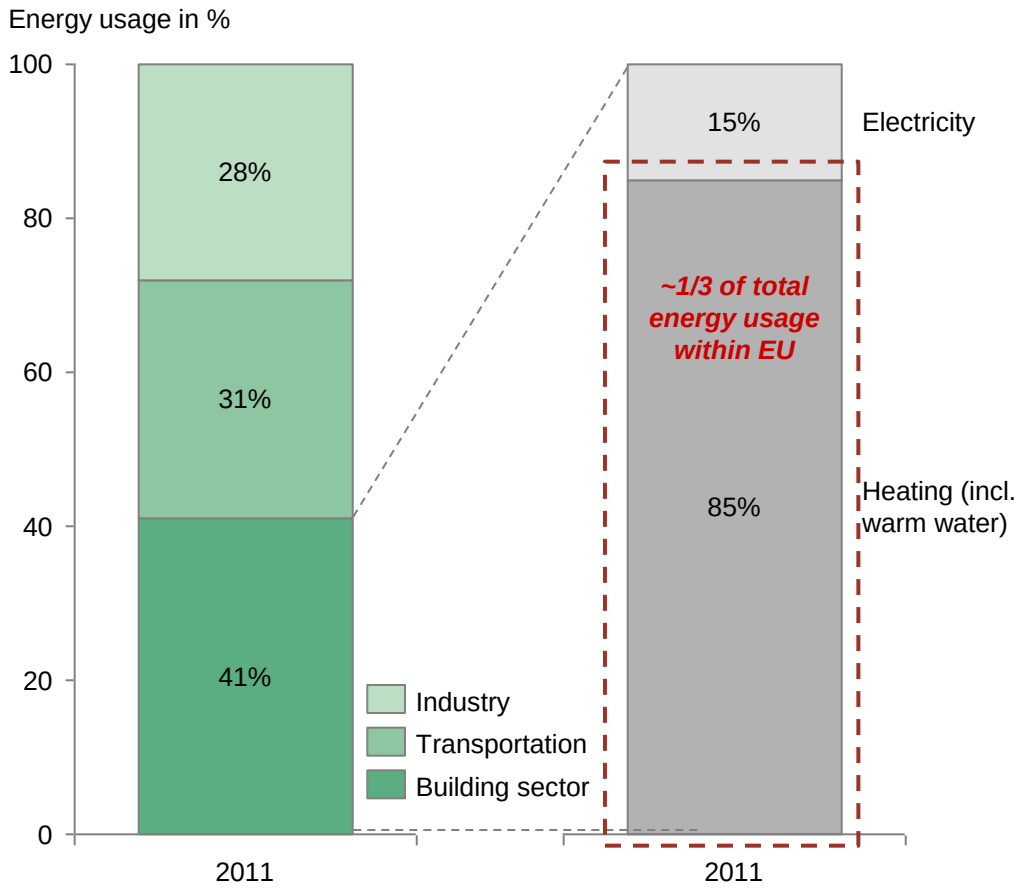
Major new sources of supply will require significantly higher prices



Source: Bloomberg NGUSHHUB Index

Price volatility is especially key within energy consumption, that can be split into buildings, industry and transportation

End usage of energy by sectors within the EU



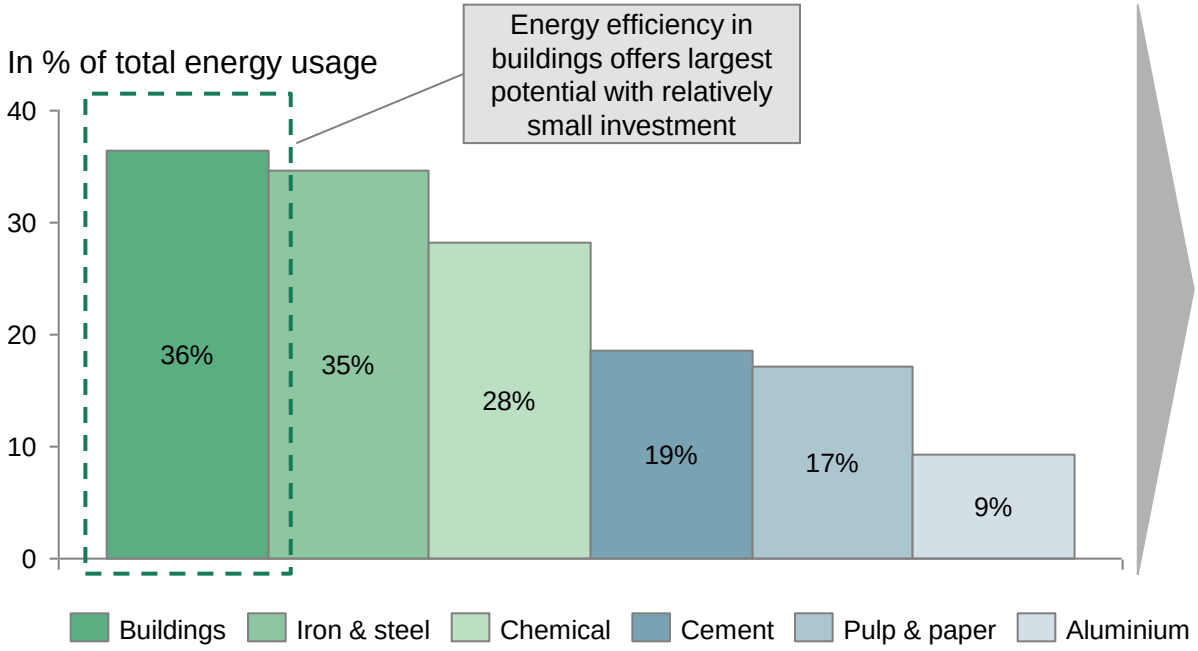
Source: BDH – Brochure "Energetische Modernisierung von Ein- und Mehrfamilienhäusern"

Heating as key area for efficiency improvements

- CO2 emission as main initiator of greenhouse effect
- According to the EU these emissions will need to be reduced by 30% until 2020
- As industry and transportation are already more efficient than housing, focus for efficiency improvements can be laid on heating incl. water warming within housings which accounts for one third of the total energy usage in Europe (average age of heating systems ~18 years)

Many industry segments offer large improvement potential by using energy more efficiently

Relative savings potential as % of total energy use in industry



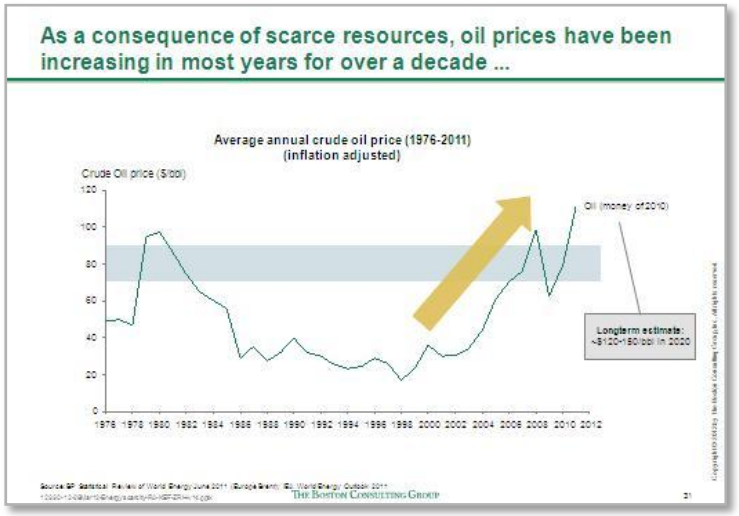
Energy efficiency in buildings as one of the key topics

- Due to attractive ratio between required investments and impact of efficiency improvements, large opportunities within buildings expected
- Nevertheless, all types of users plus producers need to be assessed to get a complete picture of business opportunities

1: Based on current market prices; adjusted to exclude taxes and subsidies on energy and to include carbon price of $30 per metric ton
Source: IEA Energy Technologies Perspectives 2010. BCG analysis

To respond to volatile prices, improvement measures need to be identified, resulting in opportunities

To reduce the issue of price volatility...



... several options have large potential

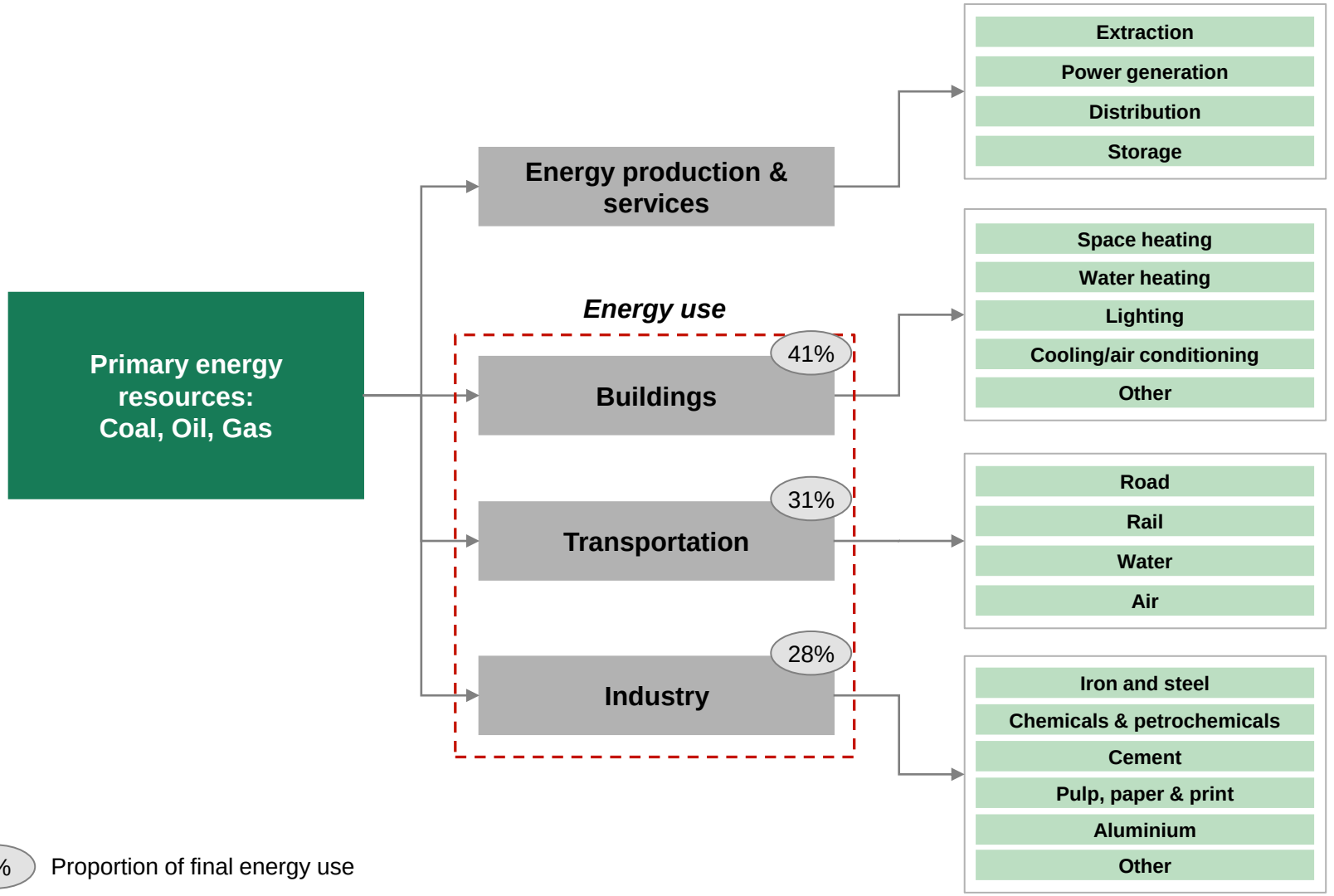
A Reduce usage of existing energy resources

B More efficient use of existing energy resources

C Replace with alternative/renewable energy sources

Energy scarcity and volatile energy prices can be a risk, but if appropriately approached, it offers tremendous opportunities for growth

Growth opportunities can be found in many different areas of energy usage



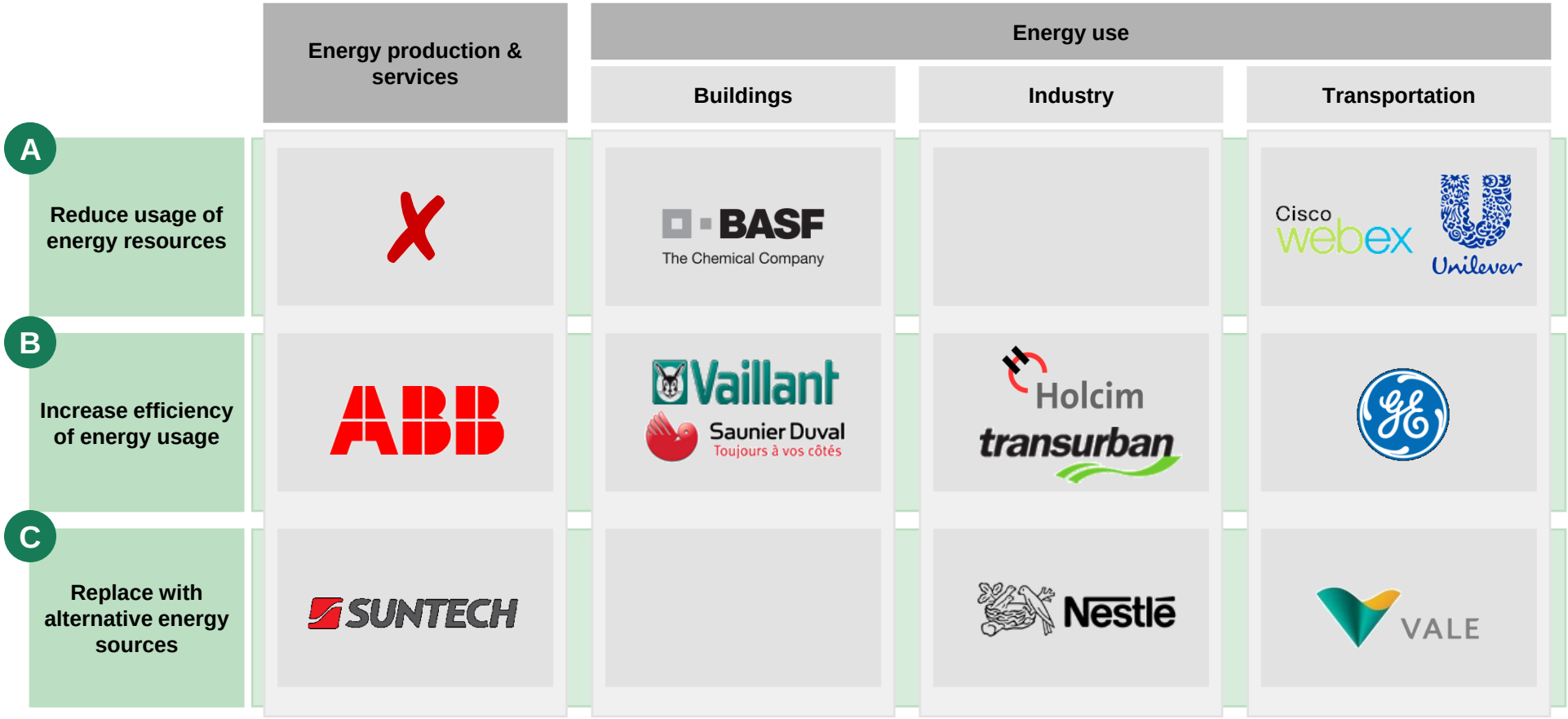
In all areas of energy production & services and use large opportunities exist to save costs and grow the business

	Energy production & services	Energy use		
		Buildings	Industry	Transportation
A **Reduce usage of energy resources**	✗	• Building materials • Insulation • Design of building	• Waste reduction/lean production	• Public transport • Car sharing • Telecommunication
B **Increase efficiency of energy usage**	• Power plant efficiency • Transmission efficiency • Smart grids	• Smart homes • HVAC • Lighting • Electrical appliances	• Machinery efficiency • Energy-efficient materials • Better packaging • Smart technologies	• Fuel efficiency • Light materials • Logistics • Hybrid systems
C **Replace with alternative energy sources**	• Wind • Solar • Hydro • Biomass • Biofuels	• Geothermal energy • Solar • Combined heat and power systems	• Wind • Biomass • Biofuels • Waste to energy • Solar • Hydro • Use of waste heat	• Electric vehicles • Fuel cells • Batteries

All companies should reflect how these opportunities can be applied to their business

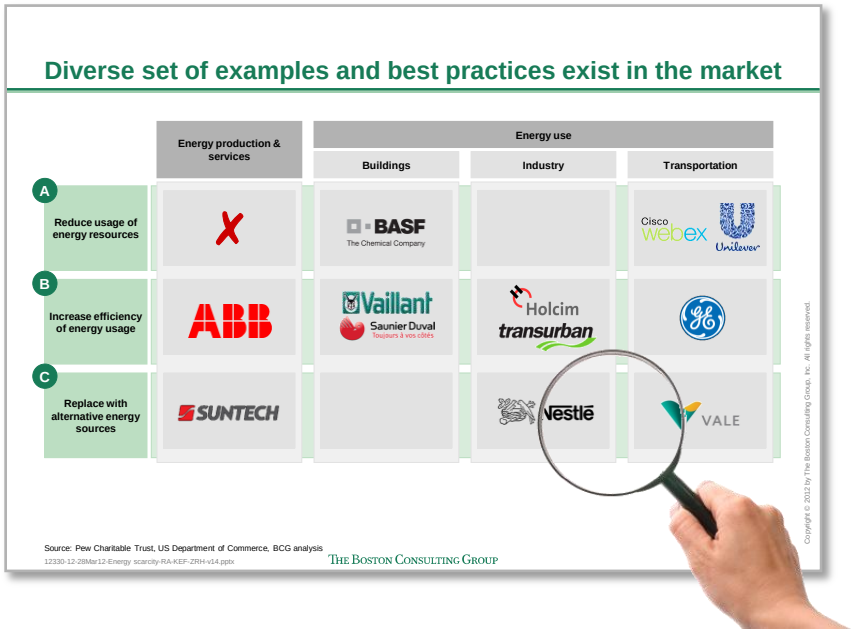
Source: Pew Charitable Trust, US Department of Commerce, BCG analysis

Diverse set of examples and best practices exist in the market



Source: Pew Charitable Trust, US Department of Commerce, BCG analysis

Companies can optimize their operations and redefine their business models – furthermore, new businesses emerge



I **Incremental efficiencies** — *"Do things better"*

II **Change in the operating model** — *"Do things differently"*

III **Change in the value proposition** — *"Do different things"*