Contribution to Plenary on

“DO INNOVATIONS AND TECHNICAL EFFICIENCY IMPROVEMENTS DRIVE ENERGY CONSUMPTION UP OR DOWN?”

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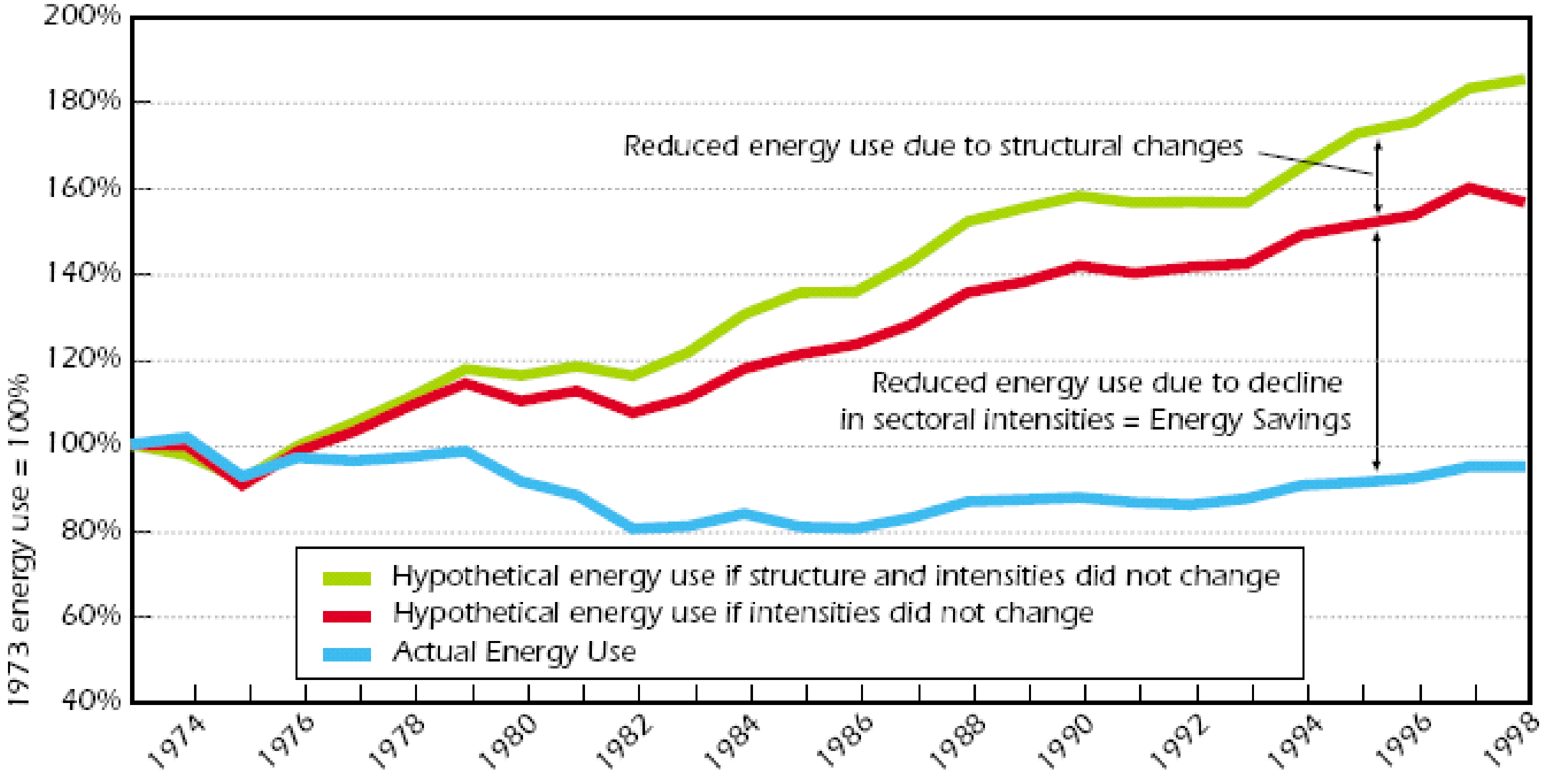
Overview

Short answer: Improved energy efficiency will drive down energy use

More difficult question: By how much?

The Past: Historical Energy Use in Industry in 11 OECD Countries – Decomposition Analysis

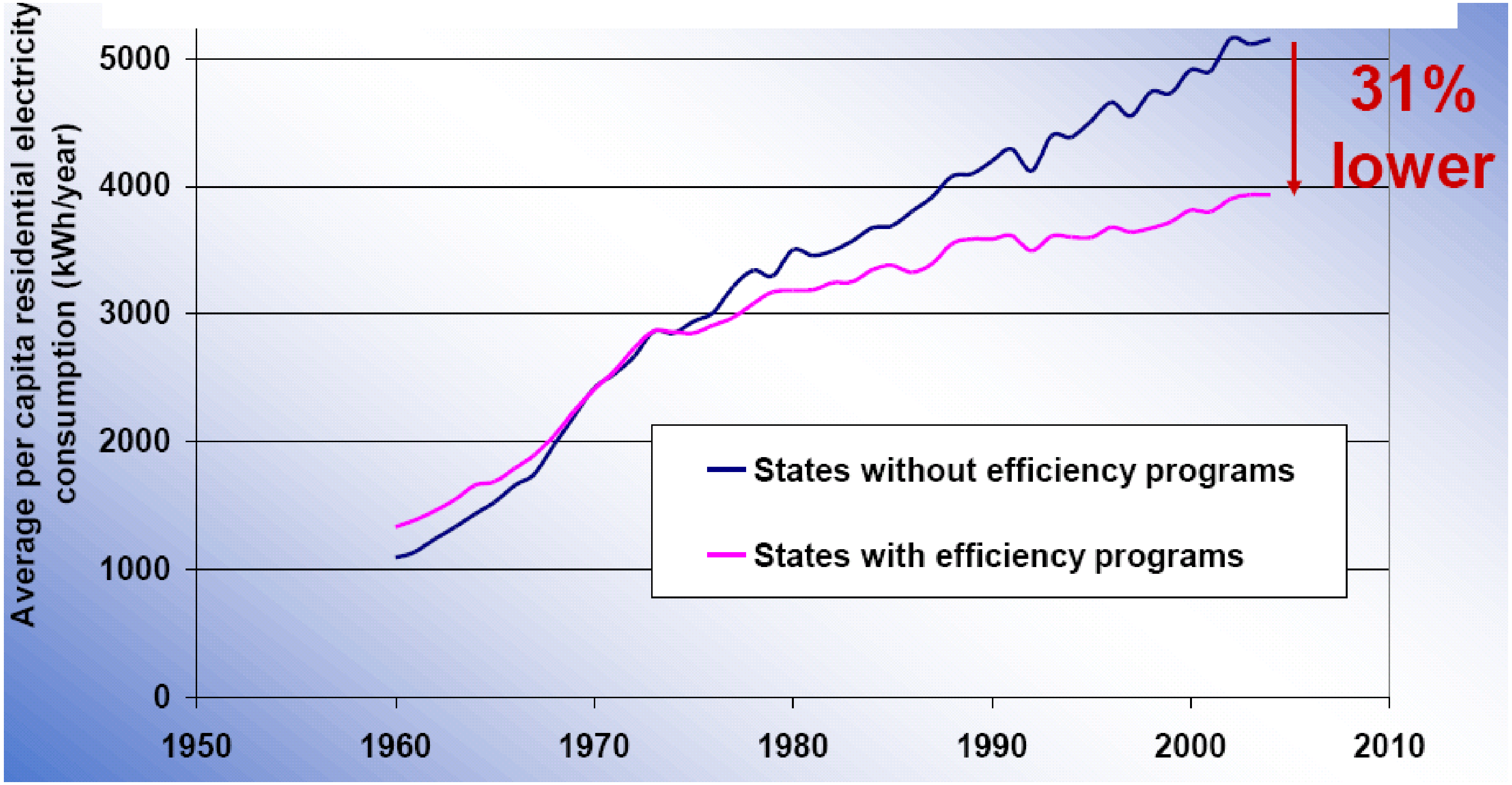
Specific Energy Use in Industry (1973=100%)



Quelle: IEA (2004) 30 years of energy use

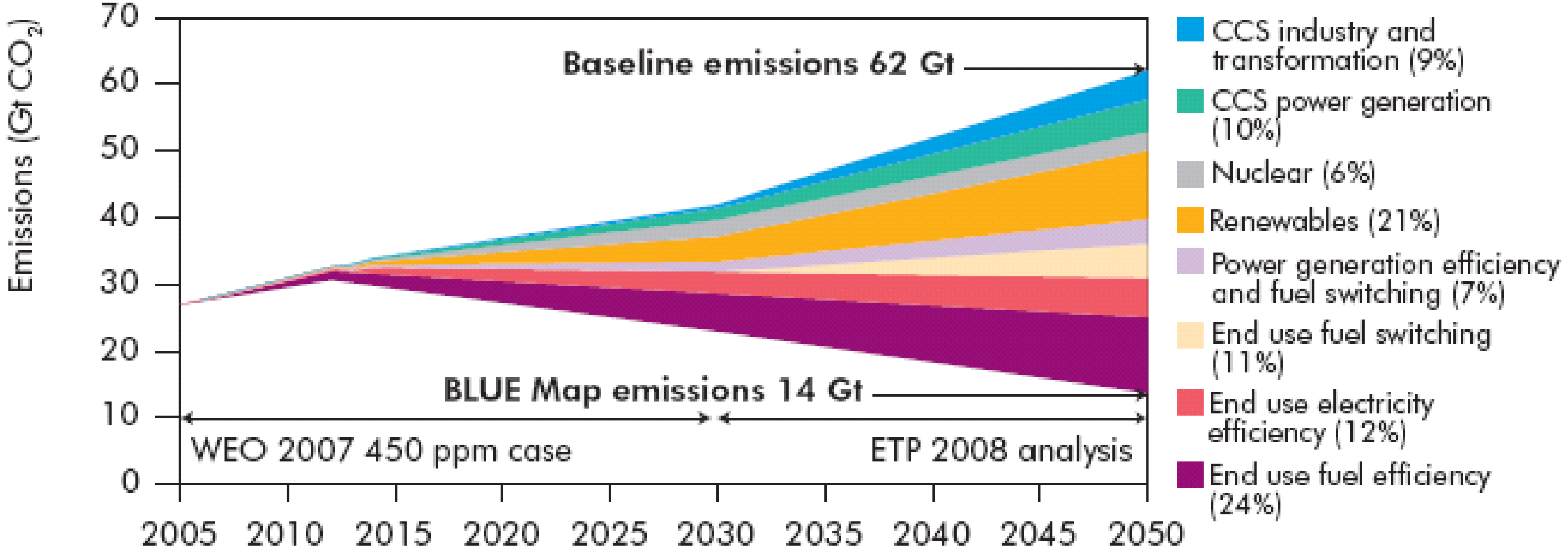
Is Energy Efficiency Policy effective? - Some Evidence from the US

US per capita residential electricity in States with and without efficiency programs (simple differences approach)



Quelle: IEA, 2008

The Future: Global GHG Projections, BAU vs 450 ppm (IEA, 2008)



„ …energy efficiency improvements in buildings, appliances, transport, industry and power generation represent the largest and least costly [CO_2] savings" (IEA, Energy Technology Perspectives 2008)

The Future: EU Impact Assessment (2007)

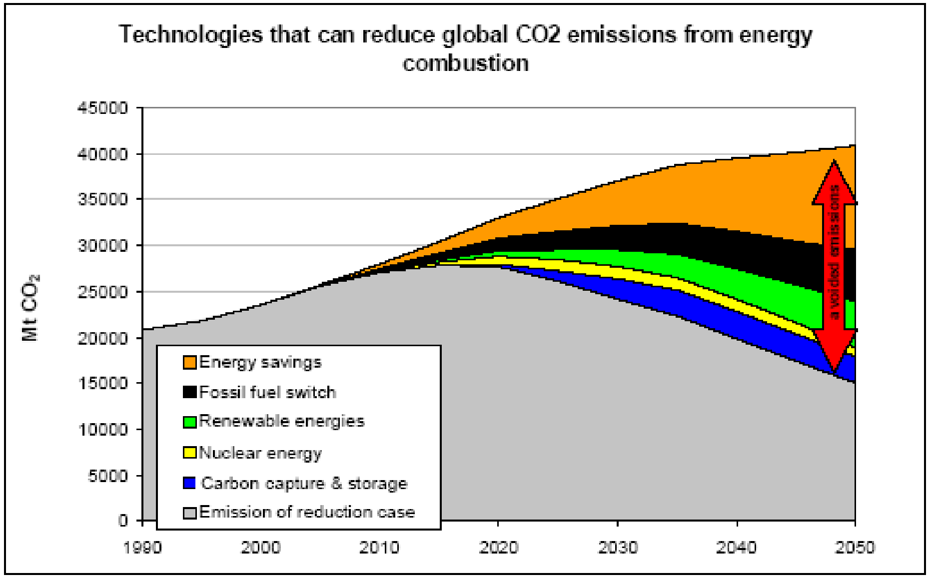
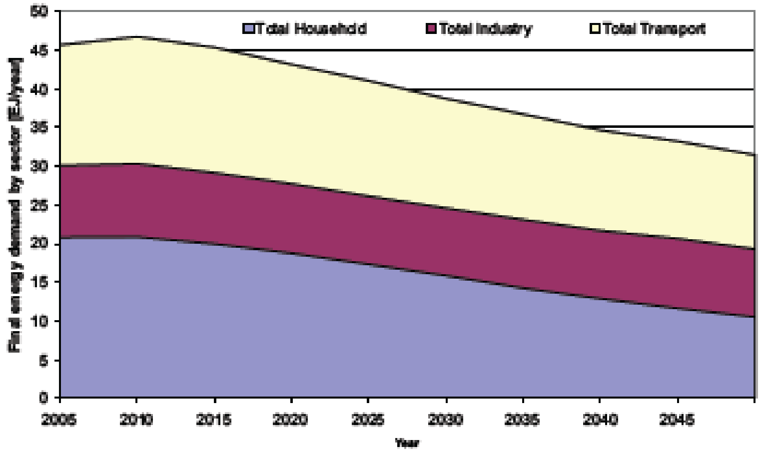


Figure 17: Decomposition of global CO_2 reductions technologies for fossil fuel combustion (JRC-IPTS, POLES model)

Results of technology-based studies typically suggest that energy efficiency will contribute to 30-50% of required CO_2-emission reductions until 2050.

The Future: EU ADAM (Project 2009)



Improved energy efficiency enables a reduction in final energy demand of 50% in households, 5% in industry and 20 in transport for the period 2005 to 2050 (Hulme et al. 2009).

Figure 4.1: European energy demand (left) and greenhouse gas emissions by sector (right) to achieve a 450 ppm CO_2-equivalent scenario.

Energy efficiency and other options (CCS, REN) are rather substitutes for less ambitious emission targets, but complements for more ambitious targets.

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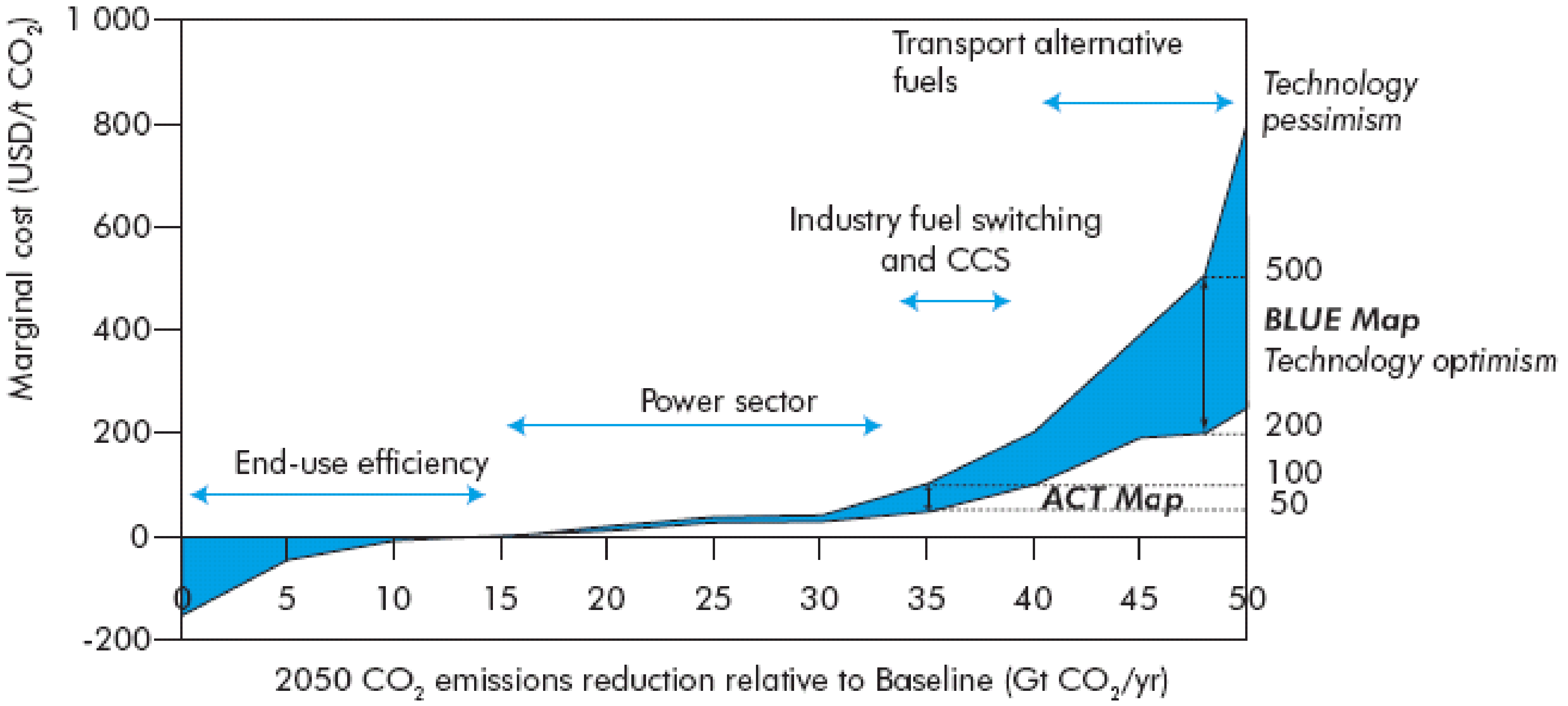
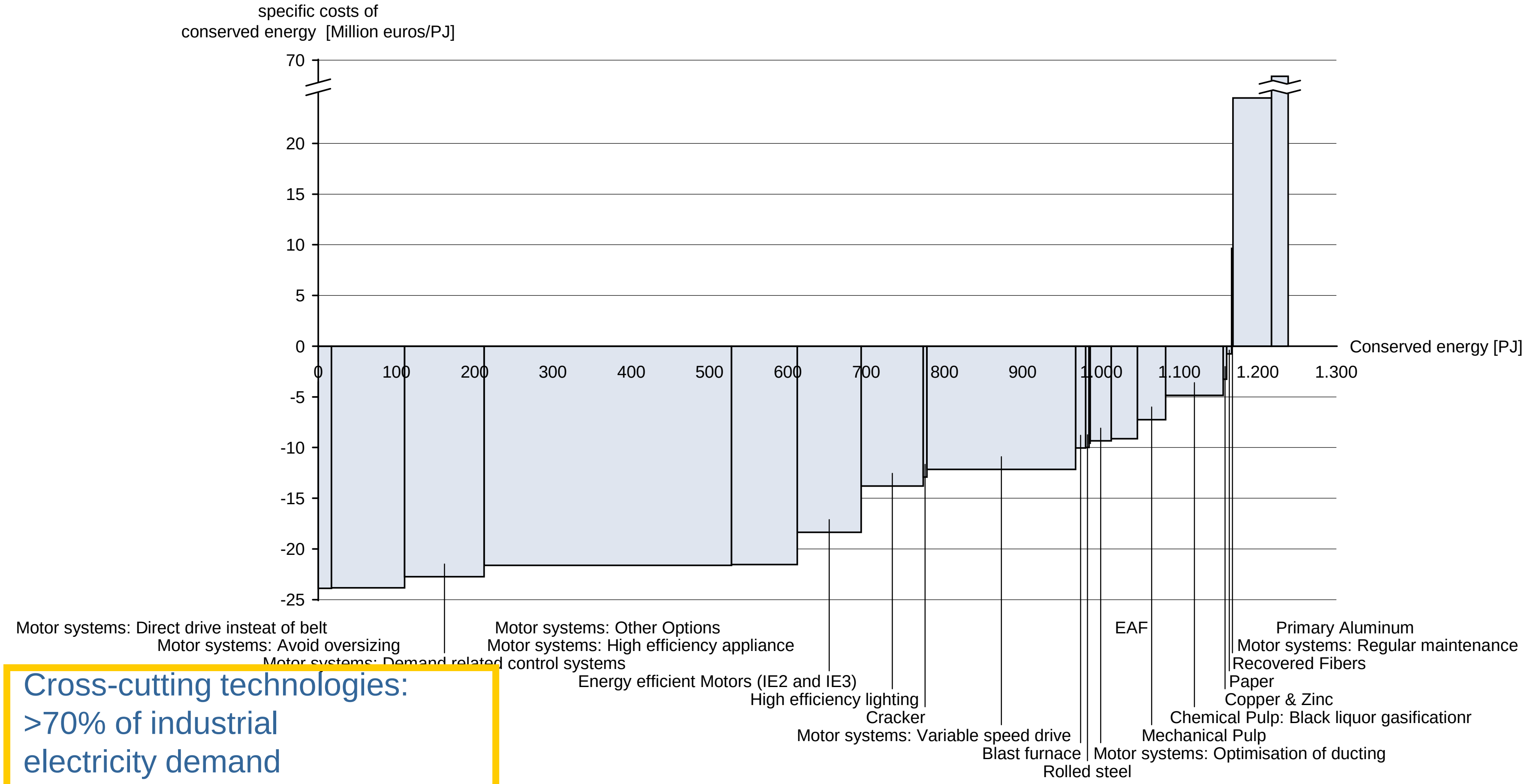
GHG Emissions: Marginal Abatement Costs 2050, global (IEA 2008)



Source: IEA (2008) Energy Technology Perspectives 2050

CO_2-Abatement cost curves in industry for EU in 2030 (electricity)



Cross-cutting technologies: >70% of industrial electricity demand

(electric motor systems account for about 65%)

Source: Fraunhofer ISI, ISI-Industry

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EU Action Plan for Energy Efficiency (2006)

Indicative Target: Improvement in Energy Efficiency of 20 % by 2020

End use sector	**Energy Consumption (Mtoe) 2005**	**Energy Consumption (Mtoe) 2020 (BAU)**	**Energy Saving Potential 2020 (Mtoe)**	**Full Energy Saving Potential**	**Main measures**
Residential	280	338	91	27%	wall insulation, glazing, appliances
Commercial buildings (Tertiary)	157	211	63	30%	energy management systems
Manufacturing industry	297	382	95	25%	motors, fans, pumps, lighting
Transport	332	405	105	26%	modal switch

Source: European Commission, Action Plan for Energy Efficiency: Realising the Potential, COM(2006)545 final, 19 October 2006.

"Additional investment expenditure in more efficient and innovative technologies will be more than compensated by the more than € 100 billions annual fuel savings." (EC, Action Plan for Energy Efficiency, p. 3)

Latest McKinsey study for US (August 2009)

……the U.S. economy has the potential to reduce annual non-transportation energy consumption by roughly 23 % by 2020, eliminating more than $1.2 trillion in waste – well beyond the $520 billion upfront investment (not including program costs) that would be required. The reduction in energy use would also result in the abatement of 1.1 gigatons of greenhouse gas emissions annually – the equivalent of taking the entire U.S. fleet of passenger vehicles and light trucks off the roads.

Various „barriers“ prevent potentials to be realized

(neoclassical, transaction costs & behavioural economics)

Barrier	Claim
Risk	Short paybacks required for energy efficiency investments may reflect a rational response to higher technical or financial risk, business or market uncertainty.
Imperfect information	Lack of information on energy use, energy efficiency opportunities or performance of energy efficient technologies may lead to cost effective opportunities being missed.
Hidden costs	Hidden costs (to observer!) include overhead costs for management, disruptions to production, staff replacement and training, and the costs associated with gathering, analysing and applying information. Likewise, engineering-economic analyses may fail to account for either the reduction in utility associated with energy efficient technologies, or the additional costs associated with them. As a consequence, these analyses may overestimate energy efficiency potential.
Access to capital	If organisation cannot raise sufficient external funds, energy efficient investments may be prevented from going ahead. Investment could also be inhibited by internal capital budgeting procedures, investment appraisal rules and the short-term incentives of energy management staff.
Split incentives	Energy efficiency opportunities are likely to be foregone if actors cannot appropriate the benefits of the investment. For example, if individual departments within an organisation are not accountable for their energy use they will have no incentive to improve energy efficiency. Landlord-tenant problem is similar.
Bounded rationality	Because of constraints on time, attention, and the ability to process information, individuals do not make decisions in the manner assumed in classical economic models. As a consequence, they may neglect energy efficiency opportunities, even when given good information and appropriate incentives.

Source: based on Sorrell, O'Malley, Schleich and Scott: *The Economics of Energy Efficiency*, 2004.

Information matters: Design of Labelling scheme
(Heinzle & Wüstenhagen, 2009)

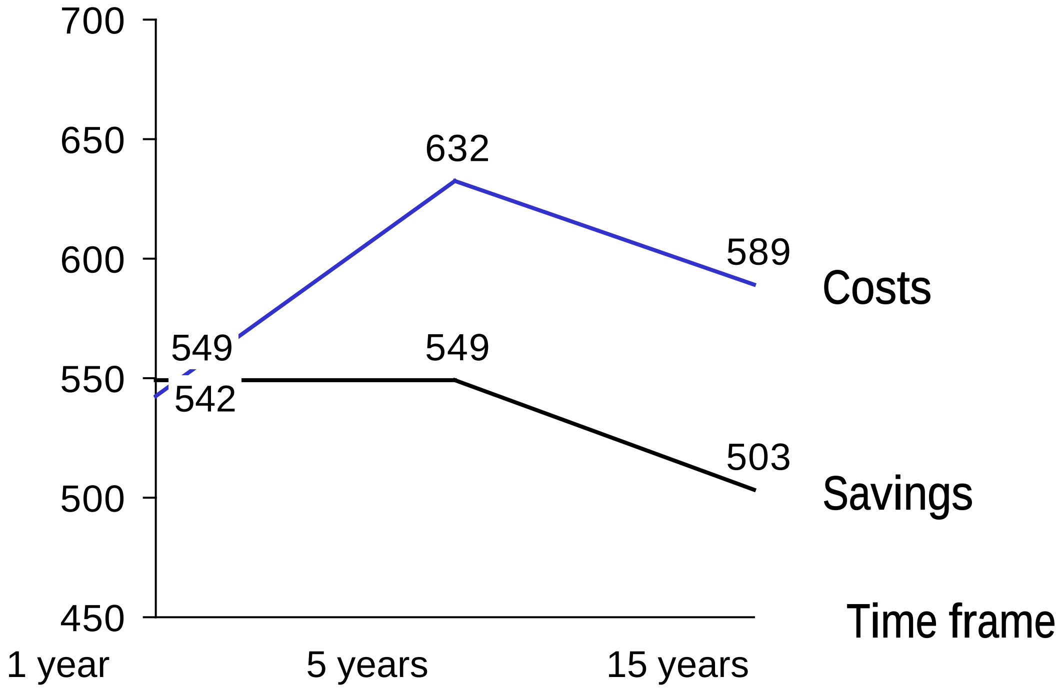
The willingness to pay for energy-efficient TVs with the existing A-G scale is about four times higher than with the new categories. While with the old label format, switching from a B-labelled to an A-labelled TV increased consumers' stated willingness-to-pay by 133 € (a price premium of 18 % compared to the average product in the sample), the parallel change from A to A-20 % in the new format caused a willingness-to-pay of only 28 € (4 % premium).

(seco@home, study funded under BMBF socio ecological research program)

Presentation of information matters: Framing effects and information on energy label (Faure 2009)

Mean Willingness-to-Pay (WTP)
for efficient fridge
(in Euros)

People react more strongly when confronted with losses (costs) than with profits (savings) (Kahneman & Tversky)



Insights from behaviour economics, psychology and social psychology

- Neoclassical assumption of perfect rational behaviour not always justified
- Deviation from rational behaviour may lead to systematic under (and over) investment in energy efficiency (possibly justifying policy interventions)
- Personal and social norms,, values, believes, lifestyle, embeddedness in social environment matter (Lit: Wilson & Dowlatabadi, 2007)

Implications of behavioural, psychological and sociological effects for direct “Rebound”

- Behavioural routines tend to weaken rebound
- Change in personal norms or self deception may positively interact with reduced costs of energy service (e.g. High rebound in transport – Frondel et al. 2008)

Conclusions

- Historically, innovations and technical efficiency improvements have significantly driven down energy use
- Large untapped potential for energy efficiency improvements still exists, in particular in building sector
- Diverse set of barriers impedes realization of technological potential
- Behavioural, psychological and sociological factors are relevant (in particular in household sector) and also may generally weaken or strengthen „pure economic“ rebound effects – but so far limited empirical work
- Policy intervention would have to be justified on case by case basis

Thank you!

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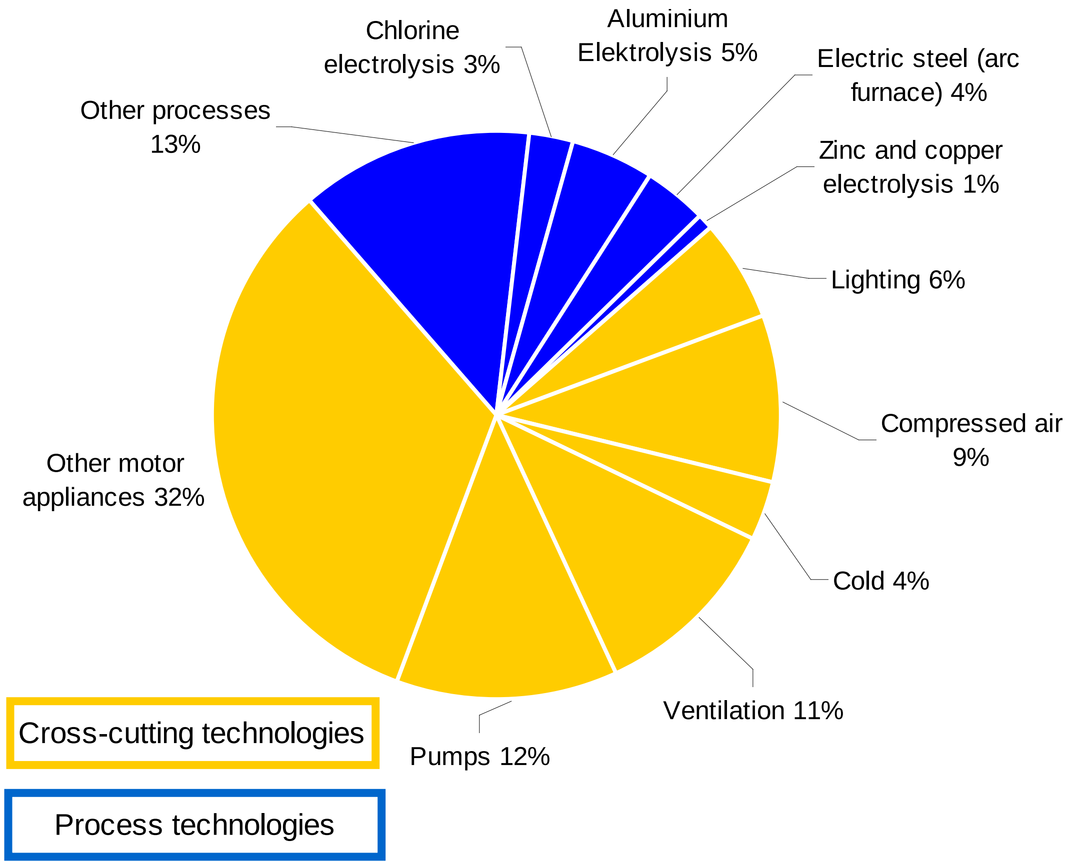
High potential of cross-cutting technologies

Shares of industrial electricity demand by appliances (EU27, 2004)



Cross-cutting technologies: >70% of industrial electricity demand

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Backup: key questions on barriers, economic efficiency and rational for energy policy

- Do individuals and organisations really 'leave money on the floor' by neglecting cost-effective measures to improve energy efficiency?
- What is the nature of the 'barriers' which lead to "*efficiency gap*", i.e. prevent individuals and organisations from investing in technologies which are profitable under existing (and expected) economic conditions?
- Do these barriers hinder an efficient resource allocation?
- Can these barriers be overcome by policy intervention?
- Should these barriers be overcome by policy intervention?

Backup: ICT and electricity use

- *Informations- und Kommunikationstechnologien (IKT) verbrauchen bereits jetzt zehn Prozent des Gesamtstrombedarfs – und dieser Wert wird bis 2020 um mehr als 20 Prozent steigen. Das haben das Berliner Fraunhofer-Institut für Zuverlässigkeit und Mikrointegration IZM und das Karlsruher Fraunhofer-Institut für System- und Innovationsforschung ISI in einer gemeinsamen Studie herausgefunden. In der im Auftrag des Bundesministeriums für Wirtschaft und Technologie (BMWi) erstellten "Abschätzung des Energiebedarfs der weiteren Entwicklung der Informationsgesellschaft" geben die beiden Institute zudem Handlungsempfehlungen, um den wichtigsten Trends zu begegnen.*

Phasing out inefficient light bulbs…..

- Recent study by GFK (August 2009) finds that sales of light bulbs in first two quarters in 2009 increased in Germany by about 1/3, while decreasing in other EU countries. For example, in the NL sales decreased by 35%, in the UK by 23% and in France by 9%
- Is this a sign of irrational behaviour by Germans or for costs associated with policy intervention?

Backup: Barriers and Economic Efficiency

	Explain efficiency gap	Do not explain efficiency gap
Barriers that may impede efficient economic outcome	*Examples:* • Asymmetric information and split incentives • Public good attributes of information • Positive externalities of technology adoption	*Examples:* • Distortions in energy pricing (e.g. departures from marginal cost pricing, subsidies, etc.) • Environmental externalities (e.g. climate change)
Barriers that do not impede efficient economic outcome	*Examples:* • Hidden costs (e.g. disruptions to production) • Reduced product performance lower reliability, quality)	-

Source: Based on Jaffe and Stavins (1994) and Sorrell et al. (2004)

Not all barriers result in inefficient outcome -

not every economic inefficiency constitutes a barrier

Backup: Estimates for energy price elasticities

Table 1. Ranges of Estimates of Energy Own-Price Elasticities (absolute values shown; all values are negative)

	Short-run		Long-run	
	Range	Sources	Range	Sources
Residential				
Electricity	0.14–0.44	Dahl (1993)	0.32–1.89	Bernstein & Griffin (2005), Hsing (1994)
Natural gas	0.03–0.76	Bohi & Zimmerman (1984), Dahl (1993)	0.26–1.47[a]	Bohi & Zimmerman (1984), Dahl(1993)
Fuel oil	0.15–0.34	Wade (2003)	0.53–0.75	Dahl (1993), Wade (2003)
Commercial				
Electricity	0–0.46	Dahl (1993)	0.24–1.36	Wade (2003), Dahl (1993)
Natural gas	0.14–0.29	Dahl (1993), Wade (2003)	0.40–1.38	Wade (2003), Bohi & Zimmerman (1984)
Fuel oil	0.13–0.49	Dahl (1993), Wade (2003)	0.39–3.5	Wade (2003), Newell & Pizer (2008)
Industrial				
Electricity	0.11–0.28	Bohi & Zimmerman (1984), Dahl (1993)	0.22–3.26	Bohi & Zimmerman (1984), Dahl (1993)
Natural gas[a]	0.51–0.62	Bohi & Zimmerman (1984)	0.89–2.92	Dahl (1993), Bohi & Zimmerman (1984)
Fuel oil	0.11	Dahl (1993)	0.5–1.57[b]	Bohi & Zimmerman (1984)

[a] Estimates drawn largely from regional studies.
[b] Estimates for 19 states

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