The Economics of Energy Efficiency: Barriers to Profitable Investments

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Renaissance of Energy Efficiency

- Cost savings for companies and households in light of high energy prices
- Environmental benefits (global warming, local pollutants)
- Improved security of energy supply
- Other co-benefits (employment, exports, productivity)

Key question: How large are profitable savings potentials from improved energy efficiency?

Motivating Example 1: Action Plan for Energy Efficiency

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)

Motivating Example 2: Climate Policy

a) EU Climate Policy, Impact Assessment

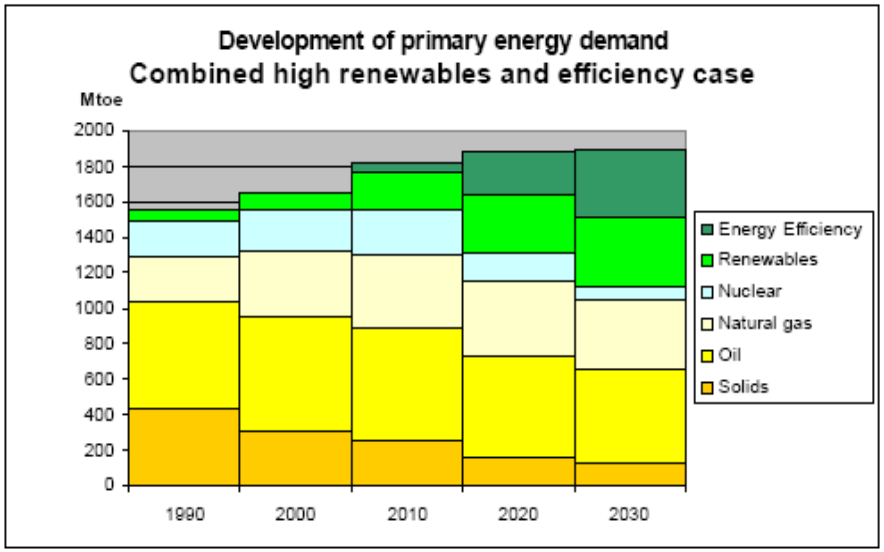

Figure 9: Impact of the strong renewable energy and energy efficiency penetration on the EU's primary energy demand (PRIMES modelling results)

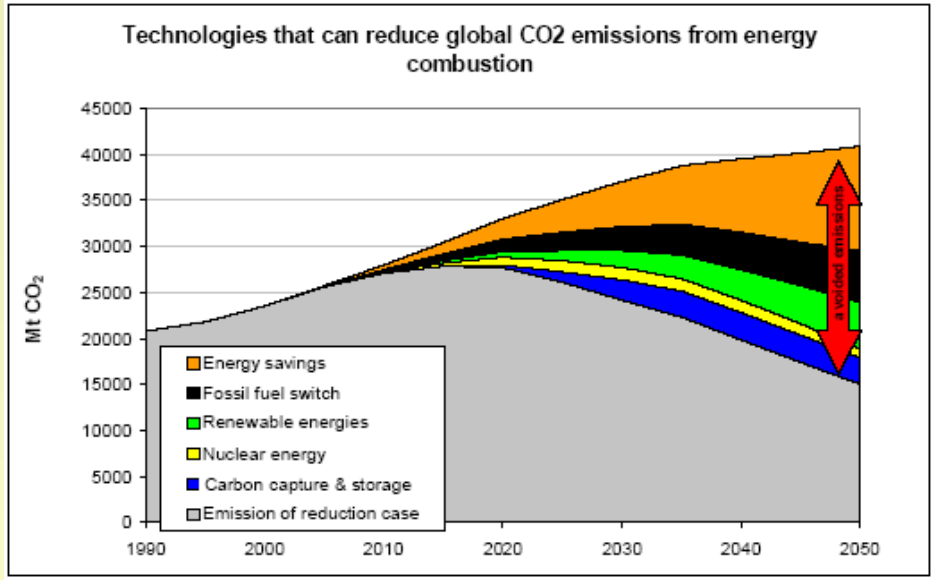

Figure 17: Decomposition of global CO_2 reductions technologies for fossil fuel combustion (JRC-IPTS, POLES model)

Source: Commission Staff Working Dokument accompanying document to the Communicatin from the Commission to the Council, the European Parliament, the European Economic and Social committee and the Committee of the Regions Limiting Global Climate Change to 2 degrees Celsius The way ahead for 2020 and beyond, Impact Assessment, 10 January 2007.

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

Questions Emerging from Technology-Based Modeling

- 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?

Taxanomy of Barriers

Based on neo-classical, transaction costs and behavioural economics theory

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.

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

Case Study: Barriers to Energy Efficiency in the German Higher Education Sector

General information on German HES	
Institutions (mostly public) Universities	370 86
Students (in Mio.) Universities (in Mio.)	1.8 1.2
Employees (in Mio.)	0.48
Scientific staff	45 %
Funding Investment budget	federal/state
Operative budget	state
Total expenditure (in Mio. €)	26,000

Ongoing challenges for German HES
Tight federal and state budgets
Major reforms increasing autonomy of individual institution
Transition to business accounting
Global budgeting
Increasing competition from other public and private institutions
New programme designs (BA. Master)
Tuition

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

Energy Consumption Patterns in German HES

Energy consumption and energy cost data (estimates)		
Total energy consumption	TWh	11
Share of electricity consumption	%	40
Ventilation/AC	%	30-50
Lighting	%	20-40
Office equipment	%	20-30
Share of thermal energy consumption	%	60
Space (and process) heating	%	> 90
Hot water	%	< 10
Total energy costs	Mio. €	500
Share of electricity costs	%	60
Share of energy costs on total budget	%	2

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

Selected measures for the rational use of energy
Space heating
Thermostatic radiator valves
Programming heating and ventilation controls to match occupancy patterns and/or temperature Use of building energy management system (BEMS)
Lighting
Replacement of 38mm fluorescents with 26mm Use of high frequency electronic ballasts Use of compact fluorescents Use of photocell, acoustic or movement sensors
Plant room Insulation of pipes, valves and flanges Use of boiler sequencing controls Replacement of oversized boiler plant Installation of condensing boilers Installation of CHP
Building fabric Draught proofing of windows and doors Retrofitting insulation to walls and roofs Use of secondary or double glazing on refurbishment
Electrical equipment Specification of high efficiency office equipment Specification of high efficiency motors Use of variable speed drives in pumps, fans and other applications Automatic switch off of fans & pumps

Relevant Barriers and Policies in German HES

General category	Specific instance	Policies
Split incentives	Departments not accountable for energy costs	Devolved budgeting.
	Limited transferability of funds	Global budgeting (degree of implementation varies by Federal State).
	State construction agency responsible for the planning of new buildings and refurbishment	Increase universities' planning and financial authority; put operating/facility/space management company in charge; privatisation of all facility/space, building codes.
	Contractors etc. for buildings not accountable for operating costs	Targets for energy performance and operating costs to be included in tender; integrated design processes, building codes.
Access to capital	Availability of capital to school	Energy service contracting.
	Allocation of capital within university	Conduct profitability analyses; life-cycle costing; make university funding a function of energy performance or energy audits; environmental/energy management schemes; subsidies for energy audits; raise awareness at top administration level via voluntary agreements etc.
Hidden costs	Lack of time, management costs	Energy service contracting; full-time energy manager; targeted information programmes; co-operative procurement; subsidies for energy audits.
	Complex and time-consuming decision-making process	Change responsibilities and shorten processes through laws; devolve financial and decision-making responsibility to individual institutions; involve ESCOs.
Imperfect information	Information on energy use and needs	Invest in information systems and BEMS; energy manager to improve co-ordination of energy management; improved communication with top management; energy committee; best practice programs.

Conclusions

- Results from case study: barriers exist and lead to inefficient outcomes
- Profitable potential identified in technology-based bottom up models likely to be overstated because of barriers
- German HES as a showcase for existence of multiple types of barriers (split incentives!)
- Difficult to assess relative importance of barriers
- Case-by-case rather than general approach appropriate for barriers analysis
- Need a portfolio of (reinforcing) policies at organizational, sectoral and national/international level to address various types of barriers
- BUT: Would need cost-benefit analyses to justify policy intervention
- Required: methodologically sound ex-post energy efficiency programme evaluations