Yes, but no

Adoption and Rejection of Energy Efficiency Measures

Mark Olsthoorn
Grenoble Ecole de Management

May 2, 2018

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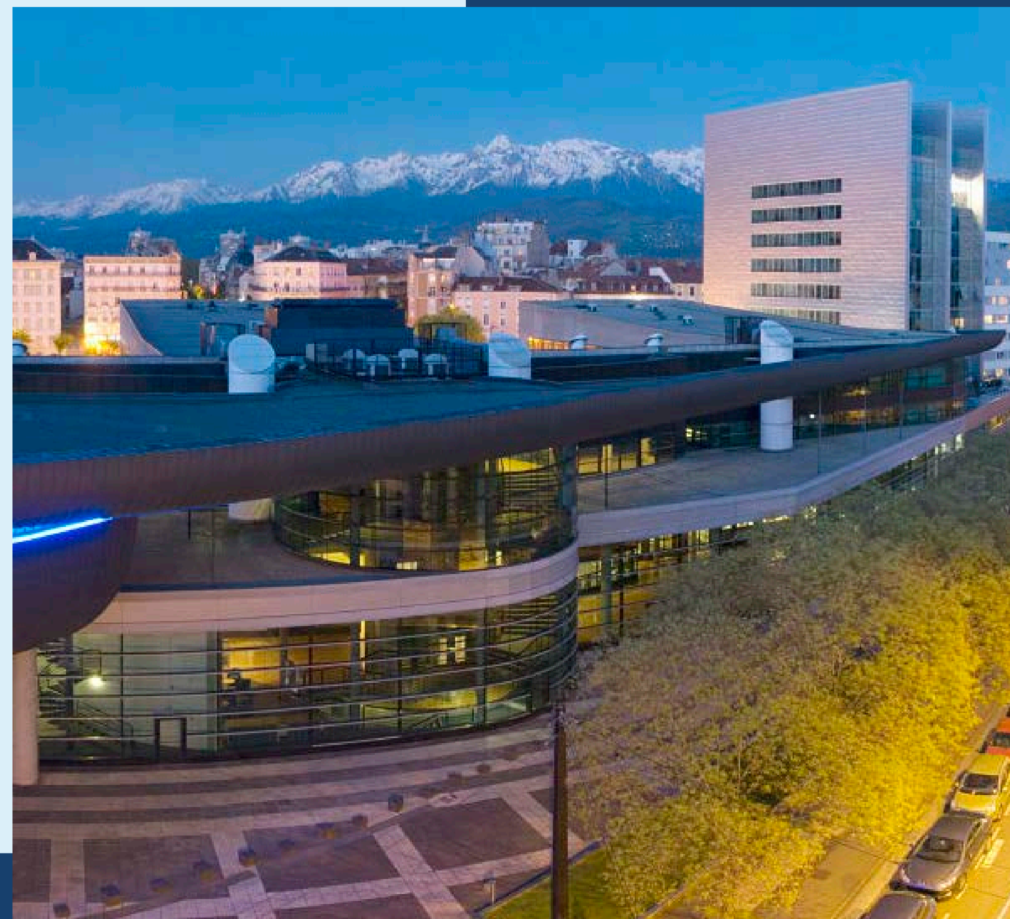

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12
chairs and institutes

approximately
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publications

38
reports

78
case studies
Over the last 5 years

170
PhD

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Acceptability, adoption
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Energy tracking (colouring)
Sharing economy

Renewable energy
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Prosumers
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Etc.

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MOOC New Energy Technologies

Energy Forum (5^{th} edition)

Yes, but no

Adoption and Rejection of Energy Efficiency Measures (EEMs)

Mark Olsthoorn

Clean Energy Solutions Center Webinars
May 2, 2018

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Outline

1 Introduction

Energy Efficiency Gap & Paradox

2 Empirical example 1

Explanations for (non-)adoption of energy efficiency measures

3 Empirical example 2

An instrument to promote adoption

4 Conclusion

Are we closing the gap?

Image: Washington State University

Energy efficiency: a win-win?

The US could "consume 30 to 40 percent less energy, and still enjoy the same or an even higher standard of living."

"Although some of the barriers are economic, they are in most cases institutional, political, and social."

- Daniel Yergin (1979)

Energy efficiency can save the US $1.2 trillion, with only $520 billion in upfront investments through 2020.

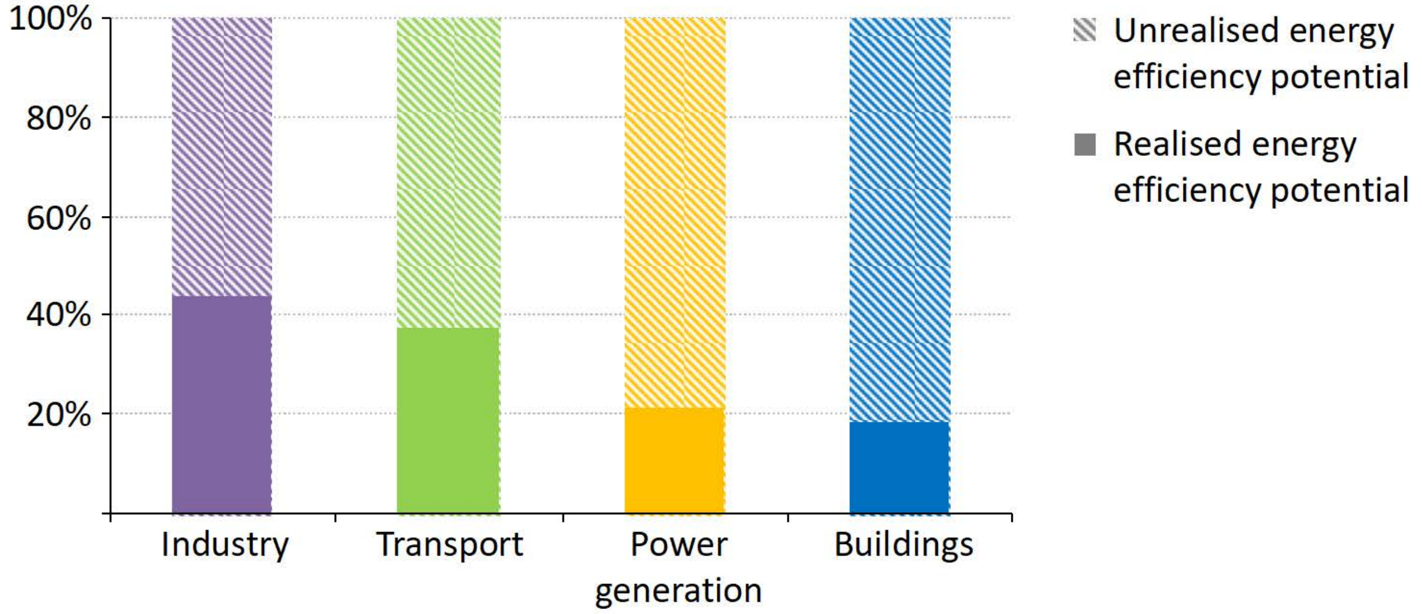
"Significant and <u>persistent</u> barriers will need to be addressed at multiple levels."

- McKinsey & Co. (2009)

Energy efficiency: a huge opportunity going unrealised

WORLD ENERGY OUTLOOK 2012

Energy efficiency potential used by sector in the New Policies Scenario



Two-thirds of the economic potential to improve energy efficiency remains untapped in the period to 2035

© OECD/IEA 2012

There is an apparent reality that some energy efficiency technologies that would be socially efficient are not adopted.

Energy efficiency gap

The apparent reality that some energy efficiency technologies that would pay off for adopters are nevertheless not adopted.

Energy efficiency paradox

Definitions by Gerarden et al. (2015)

Yes, but no

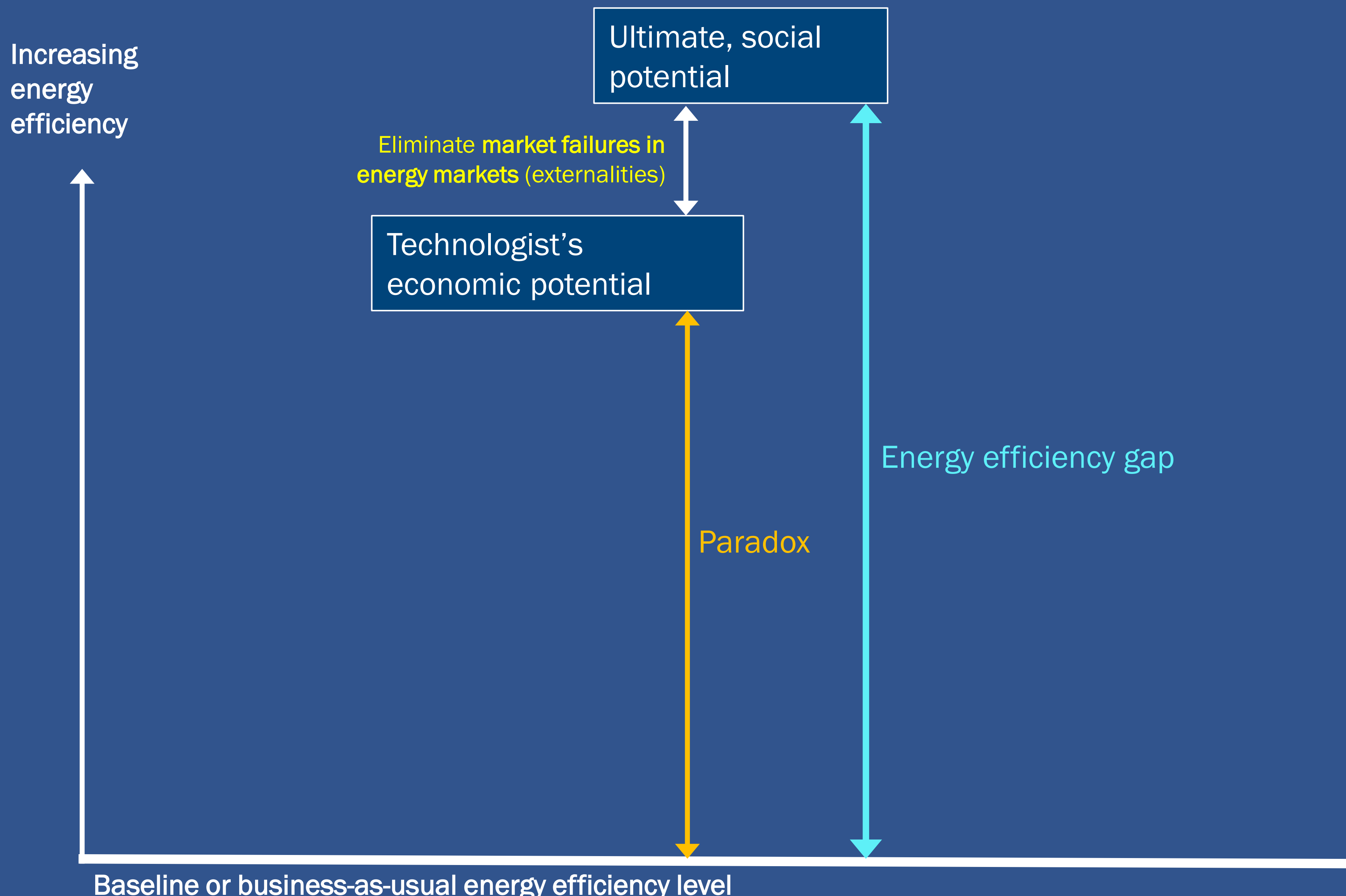
So why do we stand here confronted, as Pogo said, by insurmountable opportunities?

- Amory Lovins, 1976

If conservation actions are rational, then why shouldn’t governments simply wait for market forces to cause these actions?

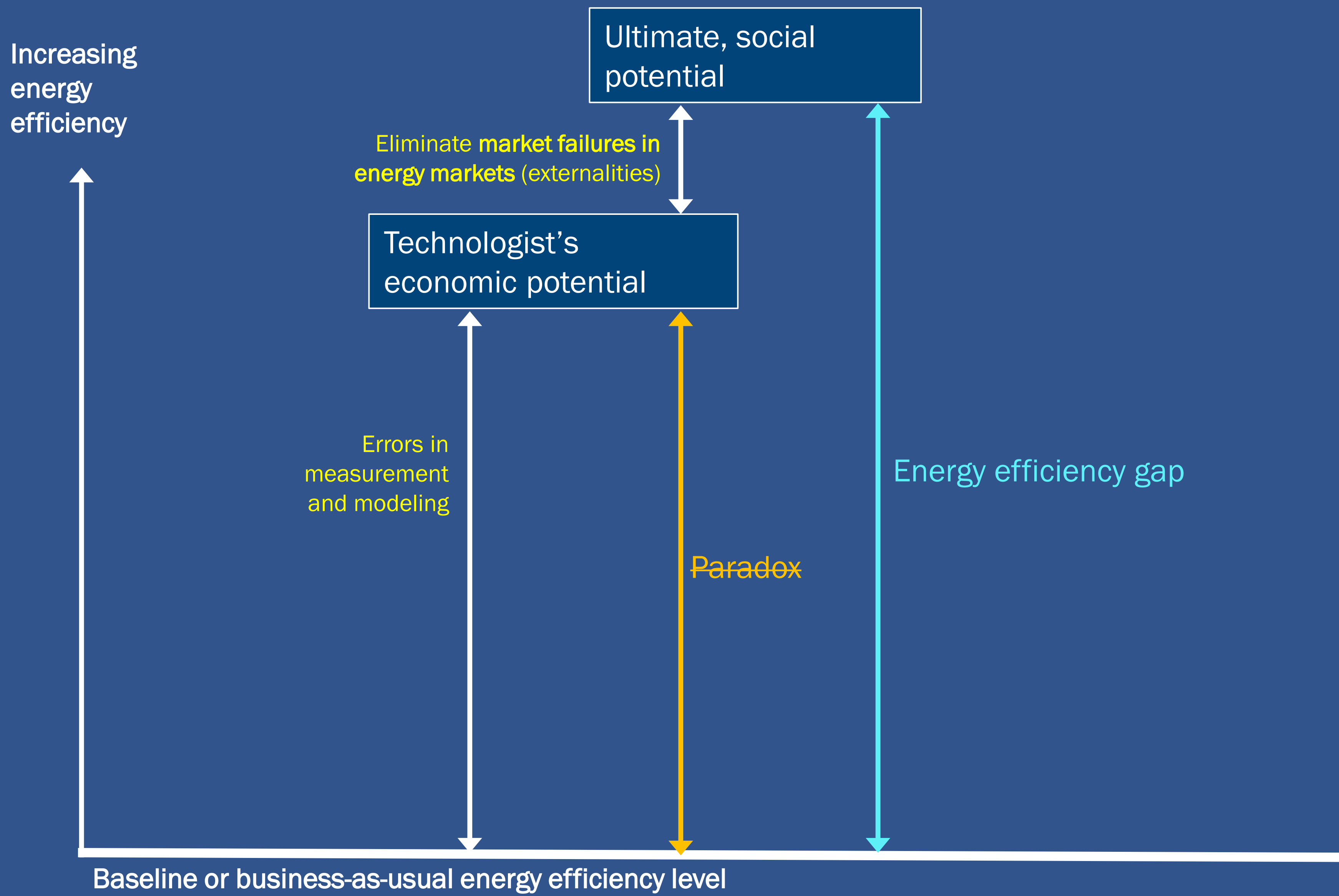
- Blumstein et al. 1980

Energy efficiency paradox & gap



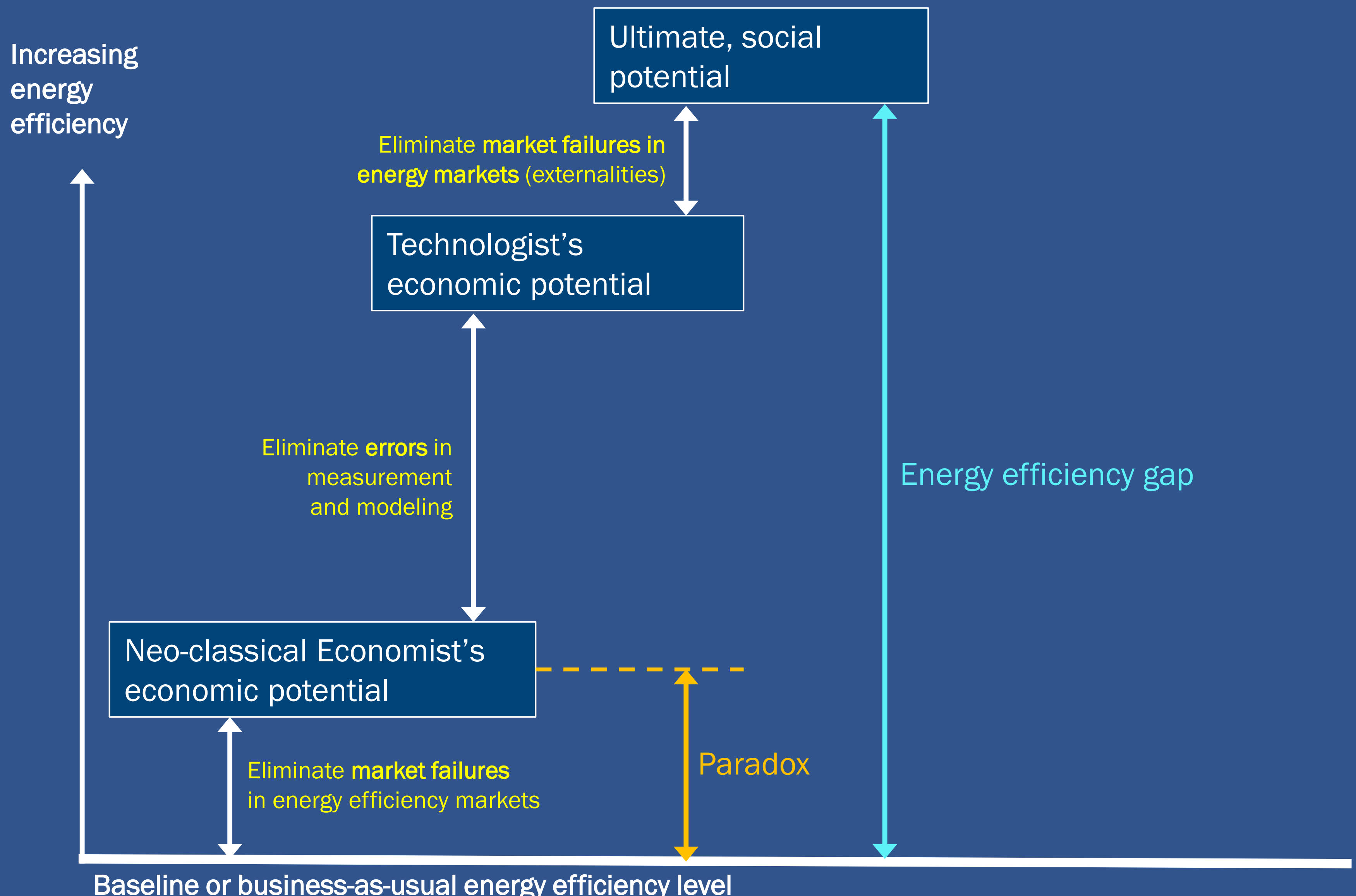
Adapted from: Jaffe & Stavins 1994

Navigating the energy efficiency paradox



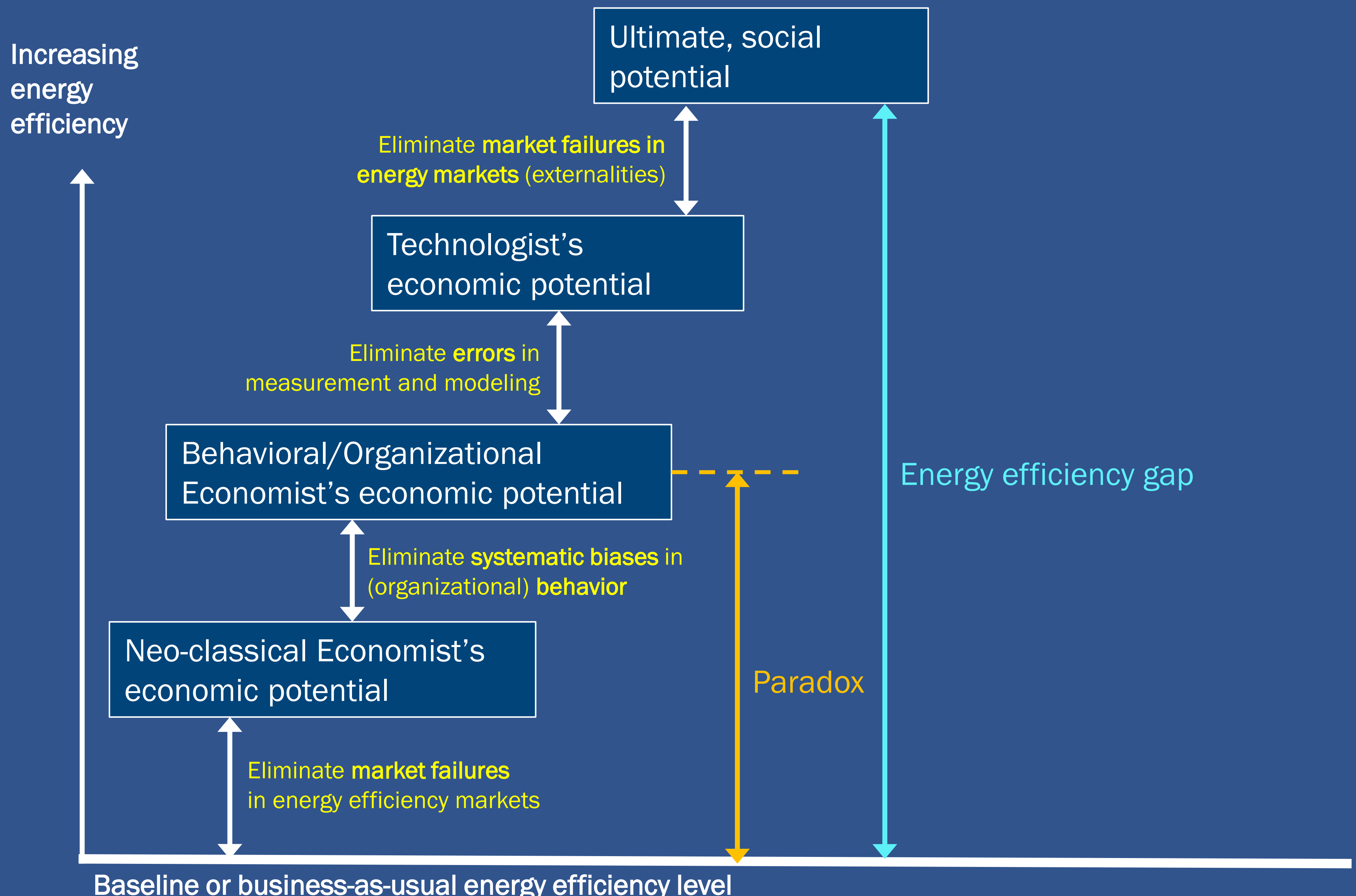
Adapted from: Jaffe & Stavins 1994

Navigating the energy efficiency paradox



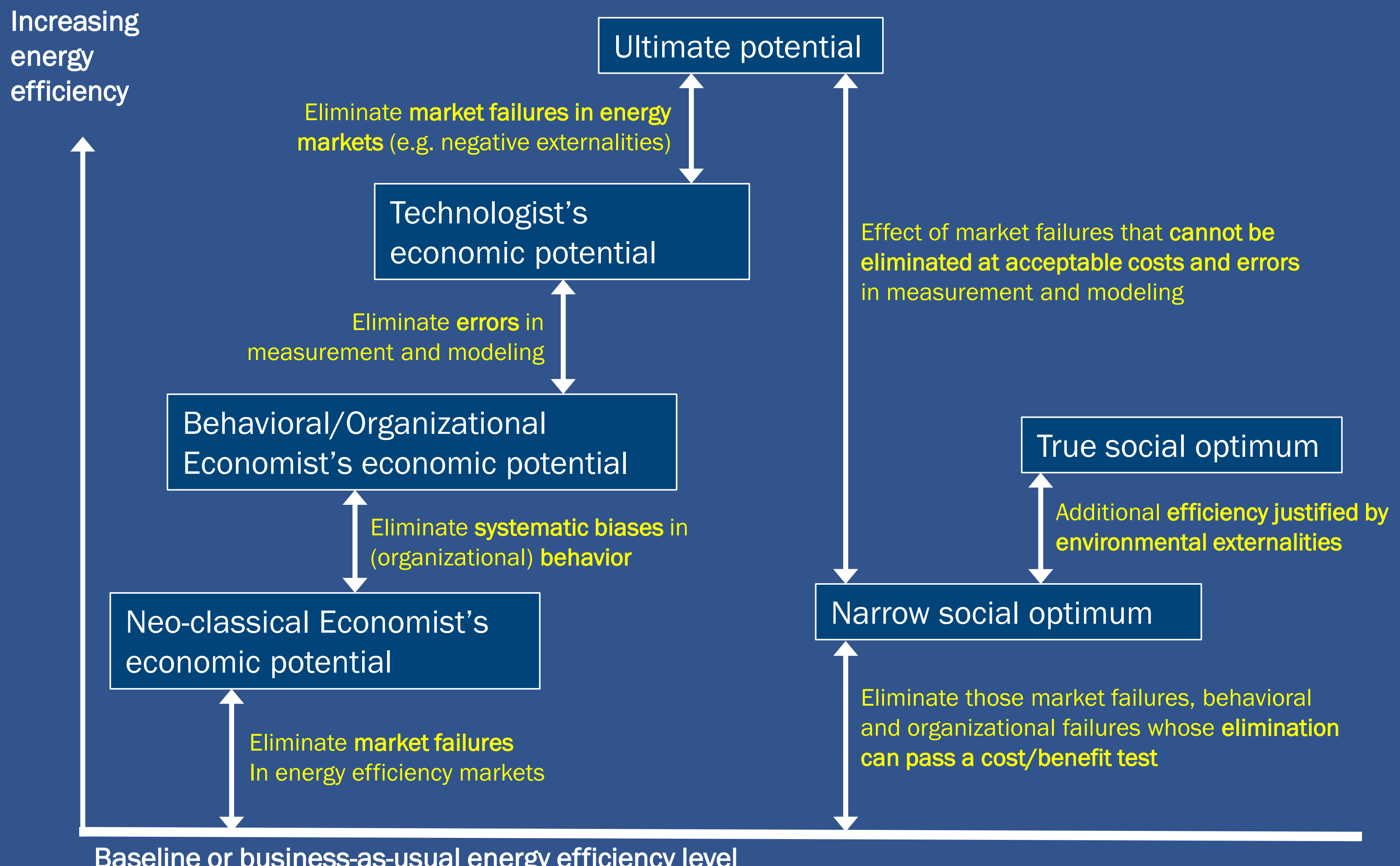
Adapted from: Jaffe & Stavins 1994

Navigating the energy efficiency paradox



Adapted from: Jaffe & Stavins 1994

Energy efficiency gap dissected



Adapted from: Jaffe & Stavins 1994

Explaining the gap

Question	Explanation category	Examples (*Barriers!*)
Why the gap may be small	Errors in measurement and modeling	Hidden costs Heterogeneity of users Risk and uncertainty Inferior non-energy performance Difficult access to capital
Explaining the paradox	Market failures in markets for energy efficiency products and services	Imperfect information Asymmetric information Learning-by-using Principal-agent relationships
	Systematic biases in (organizational) behavior	Loss and risk aversion Impatience (lack of self-control) Attention biases Bounded rationality
Explaining the gap	Market failures in energy markets	Negative externalities *Environmental pollution* *Energy security aspects*

1

Adoption of energy efficiency measures for non-residential buildings

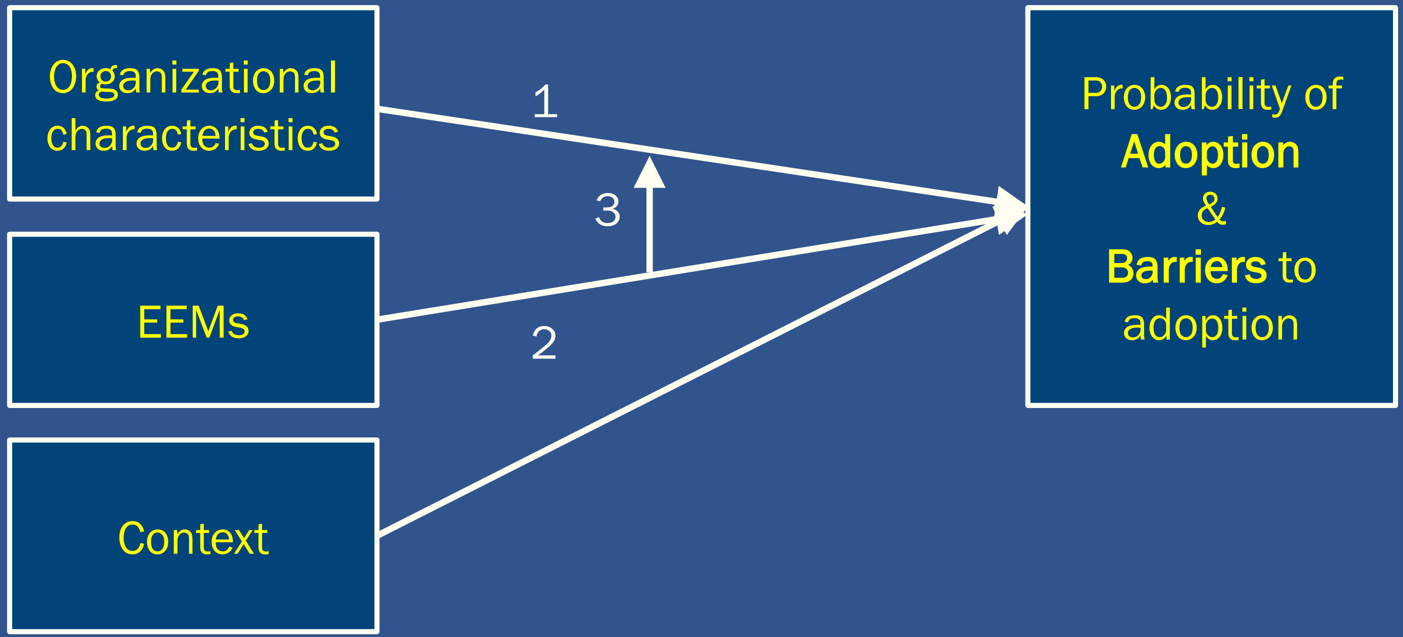
Technological and organizational heterogeneity in the commercial and services sector

Mark Olsthoorn, Joachim Schleich, Simon Hirzel

Ecological Economics 136 (2017) 240–254

Question

How are adoption and barriers to adoption of Energy Efficiency Measures (EEMs) related to characteristics of the company and of the technology?



Method

Representative,
large-sample survey

N = 2440

Germany:
Commercial & Services Sector

16% of energy end-use (AGEB 2015)

141 PJ efficiency gap in 2030 (IFEU et al. 2011)

Mostly in auxiliary, building-related measures (IFEU et al. 2011)*:*

- Lighting
- Insulation
- Heating systems

Method

4 Energy Eff. Measures (EEM)

- *Cross-cutting*
- *Ancillary functions*
- *Heterogeneous, yet not too specific*

Adoption and barriers questions structure

- *Did you adopt? ⟶ Full sample*
- *If no: did you consider? ⟶ reduce hypothetical bias*
- *If yes: which of 13 barriers relevant?*

Prime organizational attributes

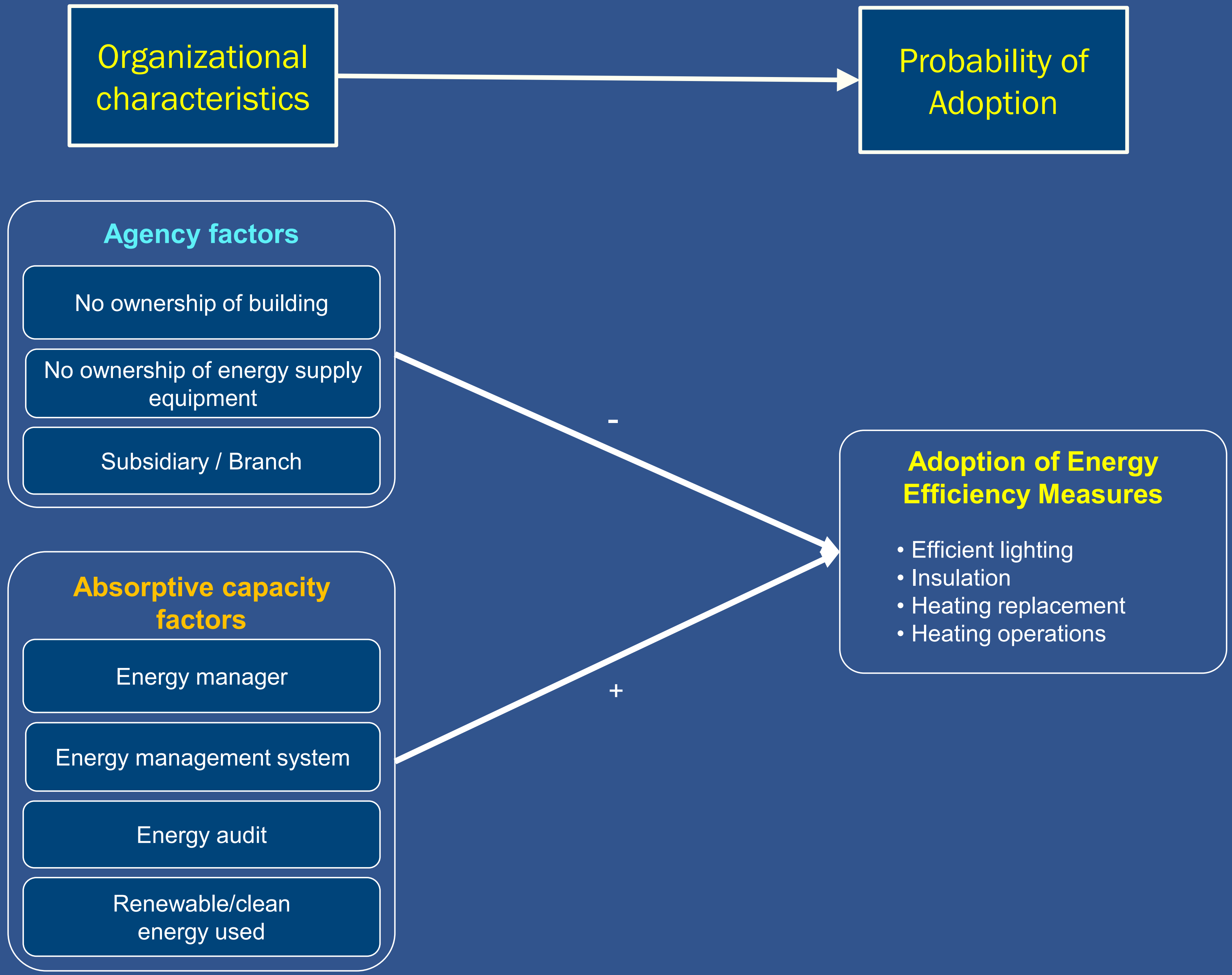
- *Agency factors*
- *Absorptive capacity factors (energy-specific)*

1. Efficient Lighting

2. Insulation

3. Heating System Repl.

4. Heating System Operations


Organizational characteristics
Probability of Adoption
Agency factors
No ownership of building
No ownership of energy supply equipment
Subsidiary / Branch
-
Absorptive capacity factors
Energy manager
Energy management system
Energy audit
Renewable/clean energy used
+
Adoption of Energy Efficiency Measures
• Efficient lighting
• Insulation
• Heating replacement
• Heating operations

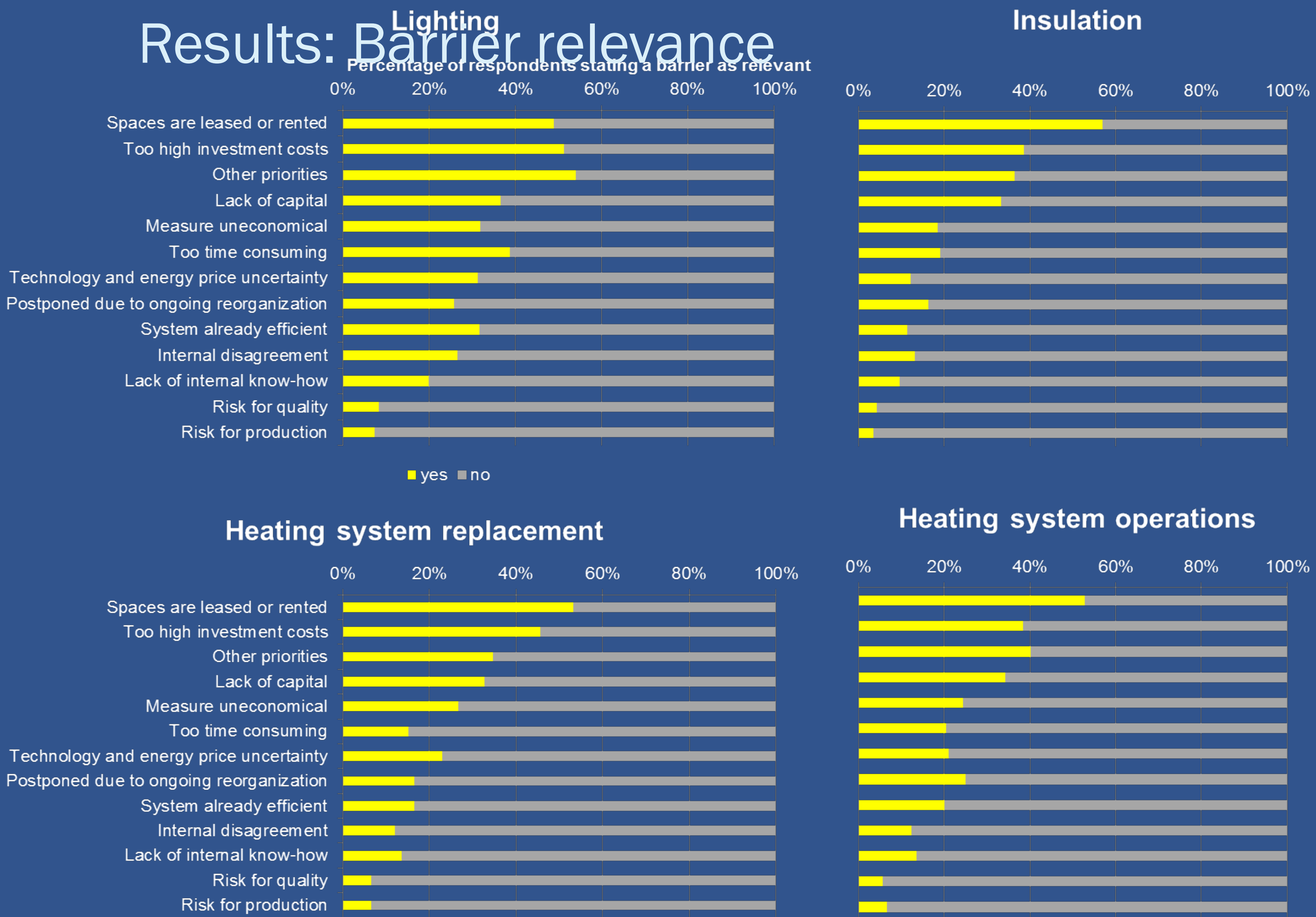
Results: Probability of Adoption (avg. marginal effects)

Variables	Any EEM	Lighting	Insulation	Heating replacement	Heating operations
Lighting	0.131***				
Insulation	-0.039***				
Heating replacement					
Heating operations	(base)				
Tenant	-0.026**				-0.056***
Heating system external	-0.049***			-0.106***	-0.076***
Subsidiary	-0.033**	-0.069*	-0.058 *		
Energy management system					
Environmental/energy manager	0.040**				0.056*
Energy audit	0.090***	0.170***	0.054 **	0.049**	0.100***
Renewable or clean energy used	0.054***	0.088*		0.073***	
Manufacturing sectors	-0.021*	-0.089***			
Elec. cost per employee (*1000 EUR)	0.009*	0.028**			
Ln(Employees)					0.021**
Electricity rate (EUR/kWh)	0.242***	0.536**			0.353**
Observations	4092	1083	1073	948	988

*** p<0.01, ** p<0.05, * p<0.1

Positive relationship   Negative relationship

Results: Barrier relevance



Results: Landlord-tenant barrier (avg. marginal effects)

Variables	Rented/leased space(s)
Lighting	-0.089**
Insulation	
Heating replacement	
Heating operations	(base)
Tenant	0.390***
Heating system external	0.072***
Subsidiary	
Energy management system	
Environmental/energy manager	
Energy audit	-0.156***
Renewable or clean energy used	
Control variables	Yes
Observations	486

*** p<0.01, ** p<0.05, * p<0.1

Conclusions

Organizational characteristics

Agency problems (external & internal) hinder adoption

Agency problems can be technology specific

Energy-knowledge resources associate with higher adoption

Barrier relevance vary little by type of technology

Most relevant:

- Owner-user dilemma
- Investment costs
- Other priorities

Least relevant:

- Technical risk

Potential implications for policy

Overcoming agency problems (split incentives): removing information asymmetries

- *Communication devices*
  - Energy audits
  - Energy-/eco-labeling
- *Bundling of risk and rewards in one entity (ESCO)*

Enhancing the ability to acquire, assimilate, and exploit energy-related knowledge (absorptive capacity)

- *Audits to enhance awareness (EU)*
- *Larger firms: promote energy management*
- *Small firms: ESCOs to provide scale*

2

Rebates for residential energy efficiency upgrades

The effect of Free Riding

Mark Olsthoorn, Joachim Schleich, Xavier Gassmann, Corinne Faure

Energy Economics 68 (2017) S33–S44

Energy efficiency subsidies and free riding

- Subsidy effectiveness overestimated due to rebound, moral hazard, free riding

- Free rider estimates in literature
  - *Large variation*
  - *Typically >50% !*

- **Can free riding be estimated *before* the subsidy policy?**

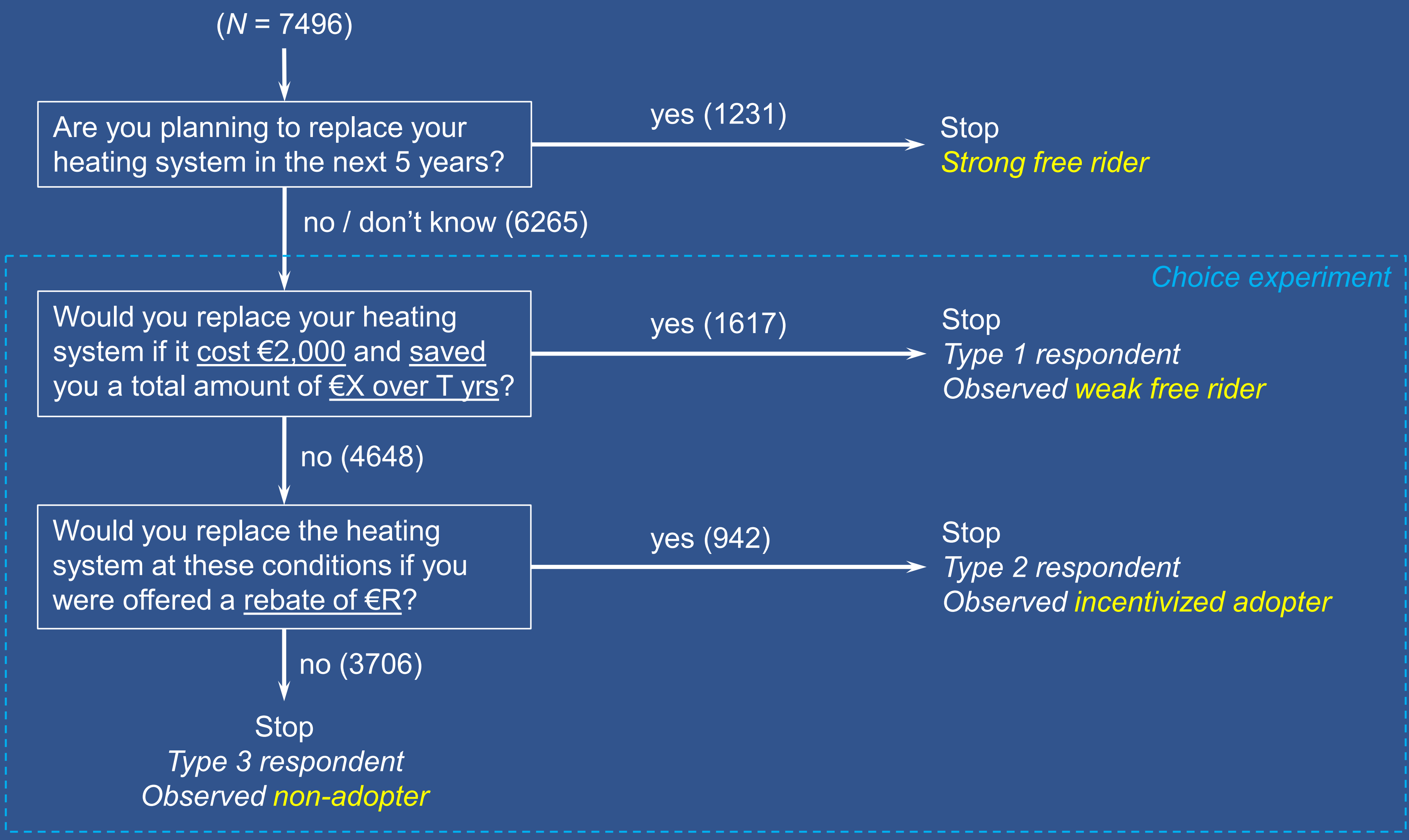
Household survey in 8 EU countries

(project page: http://www.briskee-cheetah.eu/briskee/)

Map source: http://philarcher.org/diary/2013/euromap/

- Households
- Representative
- Home owners
  - *N = 10 334*

A choice experiment to estimate households' threshold rebates



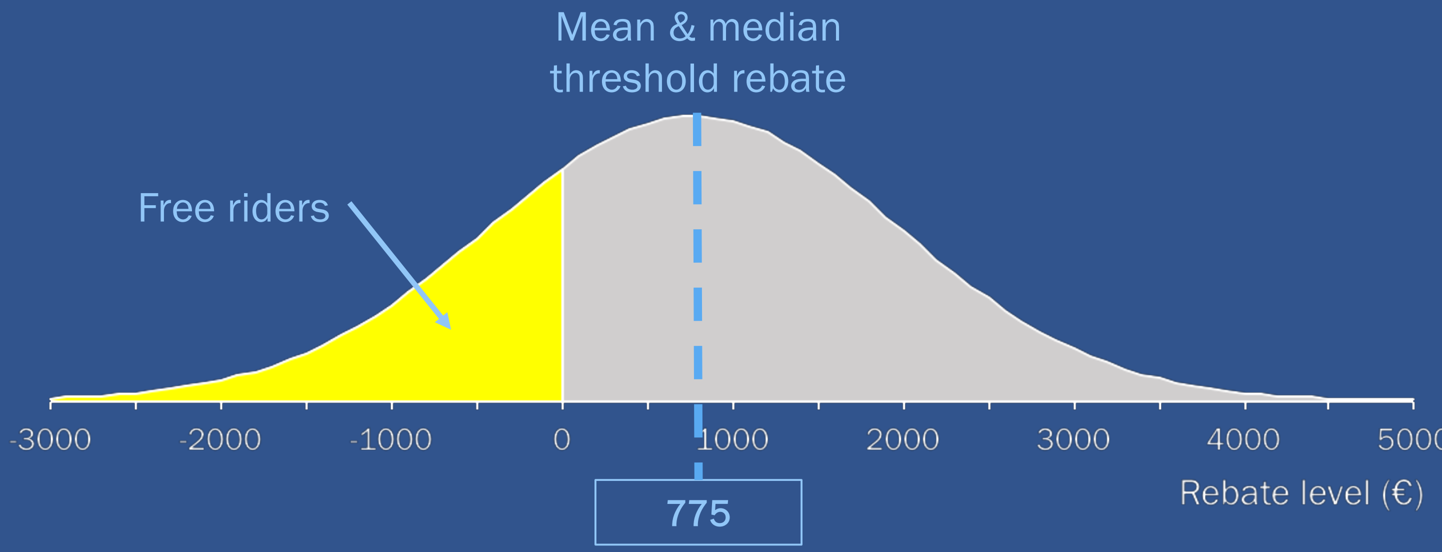
Estimates

Mean threshold rebates substantial

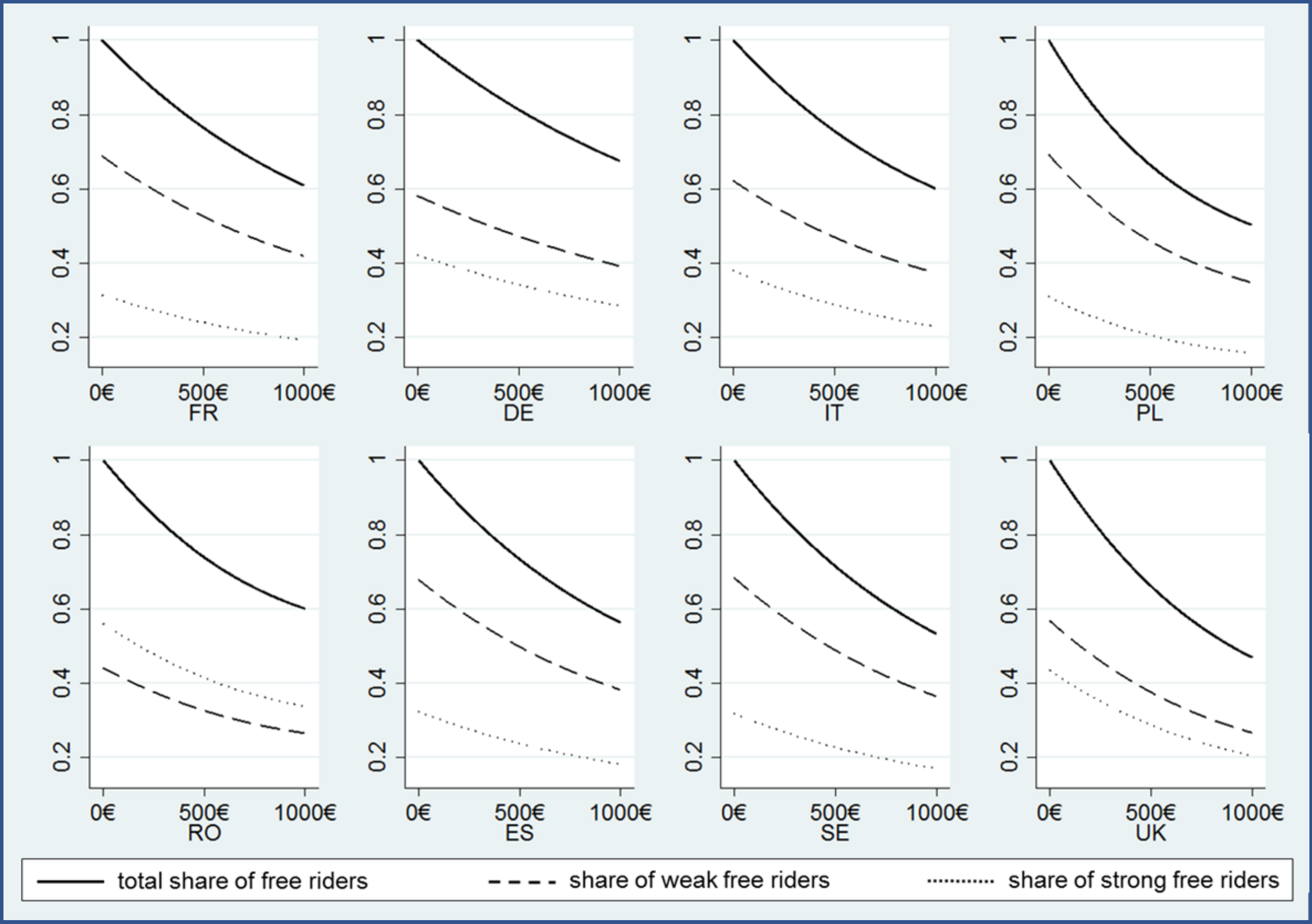
	All countries	FR	DE	IT	PL	RO	ES	SE	UK
Rebate	**775*****	889***	990***	665***	437***	354***	995***	1212***	876***
Sigma	**1205*****	1477***	1650***	1224***	861***	755***	1367***	1395***	972***
Observations	6265	801	508	894	1132	419	1155	541	815

p-values in parentheses

*** $p < 0.01$



Expected free-rider shares >50%



Conclusions

- With choice experiments, one can get at an estimate of free riding before implementing a subsidy policy.
- Free riders make up large share (majority) of expected beneficiaries of subsidies for heating system upgrades.

  >50% at rebate = €1000
- High rebate estimates -> premature replacement is associated with high opportunity costs.
- Subsidy may function as information devise

Implications

- Free riding makes subsidizing heating system upgrades to reach energy/emissions targets substantially more expensive.

- Country differences suggest that coordination can yield reductions in public subsidy expenditures.

- Subsidy expenditures would be much lower if low-cost (information) programs could turn weak free riders into (non-incentivized) adopters.

Conclusion

Are we closing the gap?

Old wine in new bottles?

- "Making our buildings more energy efficient, is one of the fastest, easiest, and cheapest ways to save money, combat pollution, and create jobs."

  – POTUS, 2011

- **EU: Energy Efficiency First**

  Ambitious energy efficiency targets for 2030 can reduce a Member State's dependence on energy imports, boost the local economy, increase its competitiveness and create additional green jobs.

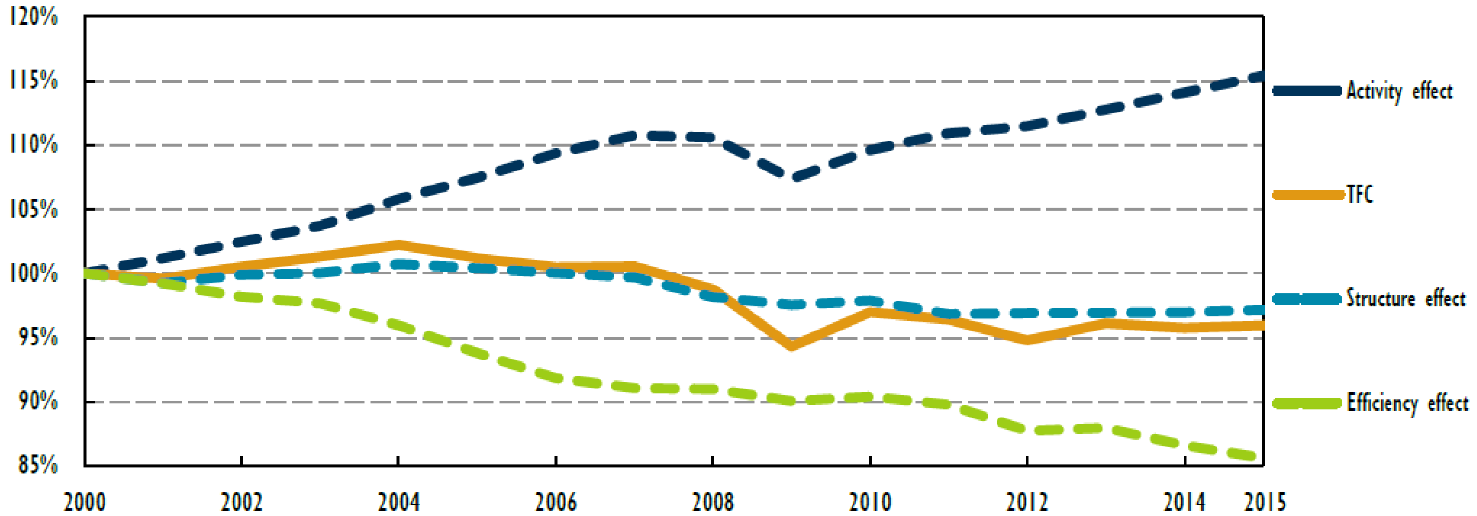
  – European Commission, 2016

Have we made no progress?

Total final consumption has declined over the last decade.

Energy efficiency is responsible for two-thirds of the downward pressure on demand.

Figure 1.10 Decomposition of total energy demand in IEA countries

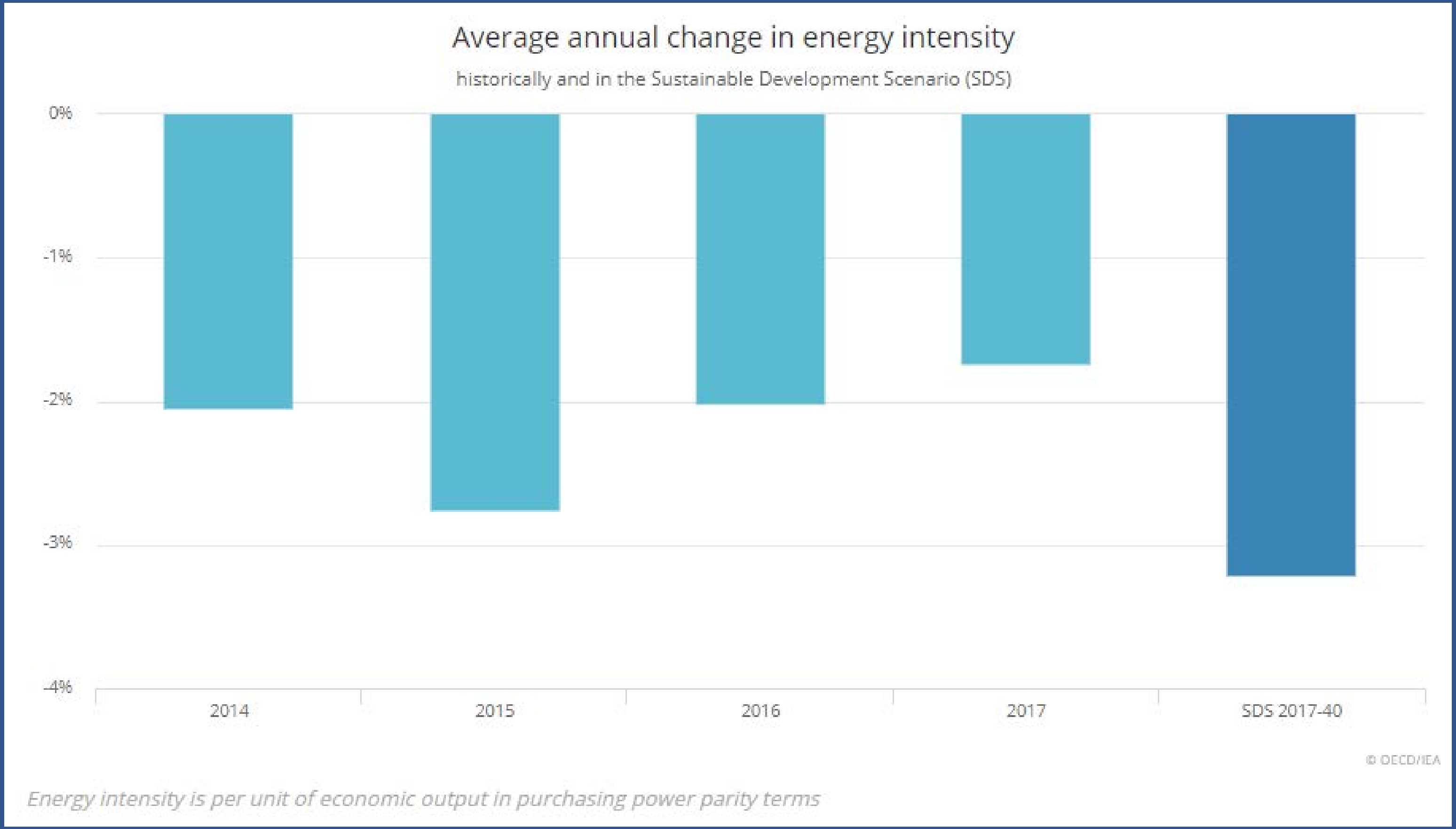


Note: Analysis based on the *IEA Energy Efficiency Indicators* database (2016 edition). TFC in this analysis covers the following sectors: residential, industry and services, passenger and freight transport. It does not include agriculture, non-energy, and energy supply sectors. The energy consumption decomposed in this analysis represents 90% of TFC in IEA countries in 2015.

Source: IEA 2016

Work is never over

"Improvements in global energy efficiency slowed down dramatically in 2017, because of a weakening of efficiency policy coverage and stringency as well as lower energy prices." *IEA, 2018*



Source: IEA 2018

Trends and future work

Emphasis on policy evaluations

- *Increasingly relevant and urgent*
- *Data availability growing*
- *Heterogeneity limits transferability*

Management in focus

- *Energy management is coming to the micro level*
- *Operational measures emphasize behavior and managerial aspects*

No, but yes

😉

Thank you

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Support for policies

Audits

- *Overcome landlord-tenant dilemma through mitigation of asymmetric information*

ESCOs

- *Merge split incentives*
- *Low-priority issue → core business*
- *Energy Performance Contracting (EPC)*

Find new *homogeneity* in expanded geographical scope

- *Central information repositories*

Estimates

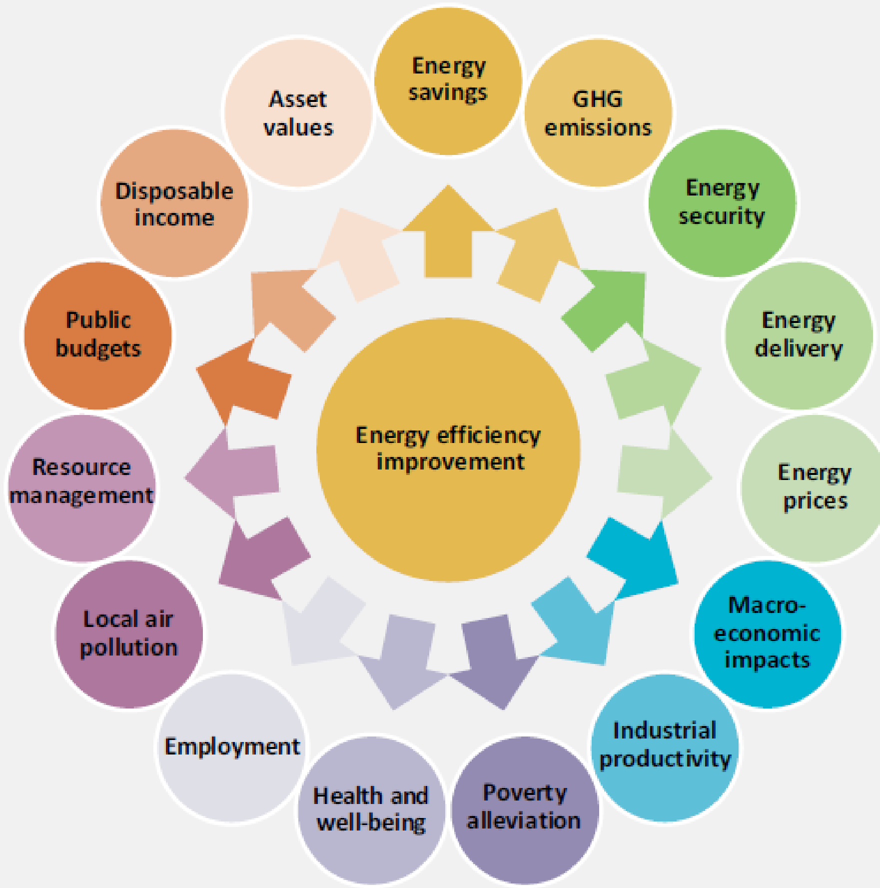
Effect of household characteristics

Correlations of the reservation rebate with socio-demographic and attitudinal variables.

Variable	Coefficient
Savings amount	-0.17 **
Savings duration	4.44
Gender	-10.45
Age	1.13
Education	-5.18
Income	2.60 **
Missing income	34.76
Household size	-60.78 ***
Environmental orientation	-98.49 ***
Cognitive Reflection Test	131.17 ***
Willingness to Wait	-91.23 ***
Willingness to Take Risks	-127.12 ***
Country dummies	Yes
Constant	751.91 ***
Sigma	1134.34 ***
Observations	6265
Log likelihood	-5554

*** $p < 0.01$, ** $p < 0.05$

Figure ES.2 The multiple benefits of energy efficiency improvements



Note: This list is not exhaustive, but represents some of the most prominent benefits of energy efficiency identified to date.
Source: Unless otherwise noted, all material in figures and tables in this chapter derives from IEA data and analysis.

Key point A multiple benefits approach to energy efficiency reveals a broad range of potential positive impacts.

Source: Capturing the multiple benefits of energy efficiency improvements, IEA 2014 (release: 09 September 2014)

Non-energy benefits from efficiency in industry

Table 1
Non-energy benefits from efficiency improvements

Waste	Emissions	Operation and maintenance
Use of waste fuels, heat, gas	Reduced dust emissions	Reduced need for engineering controls
Reduced product waste	Reduced CO, CO2, NOx, SOx emissions	Lowered cooling requirements
Reduced waste water		Increased facility reliability
Reduced hazardous waste		Reduced wear and tear on equipment/machinery
Materials reduction		Reductions in labor requirements
Production	**Working environment**	**Other**
Increased product output/yields	Reduced need for personal protective equipment	Decreased liability
Improved equipment performance	Improved lighting	Improved public image
Shorter process cycle times	Reduced noise levels	Delaying or Reducing capital expenditures
Improved product quality/purity	Improved temperature control	Additional space
Increased reliability in production	Improved air quality	Improved worker morale

For US iron and steel industry, "including productivity benefits explicitly in the modeling parameters would <u>double the cost-effective potential</u> for energy efficiency improvement"

Rebound effect: micro-economic mechanisms

Borenstein (2015), Sorrell (2009)

1. Direct savings effect
2. Direct rebound: income effect
3. Direct rebound: substitution effect
4. Indirect rebound: re-spending
5. Indirect: composition effect
6. Indirect: energy price effect