

Energy Efficiency Economics

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3/10/2016

Harvard Energy Journal Club

Energy Efficiency Economics Basics

Efficiency vs Efficacy

What's the difference?

Why does it matter?

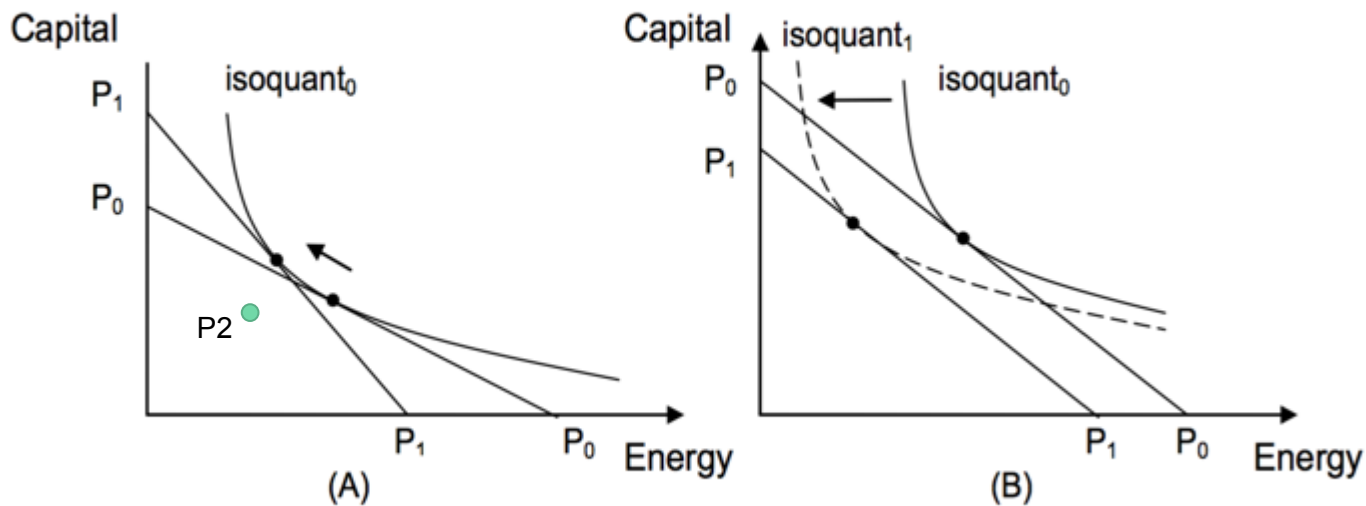
Efficiency vs Efficacy

Efficiency: both quantities in same unit; maximum possible efficiency 100%

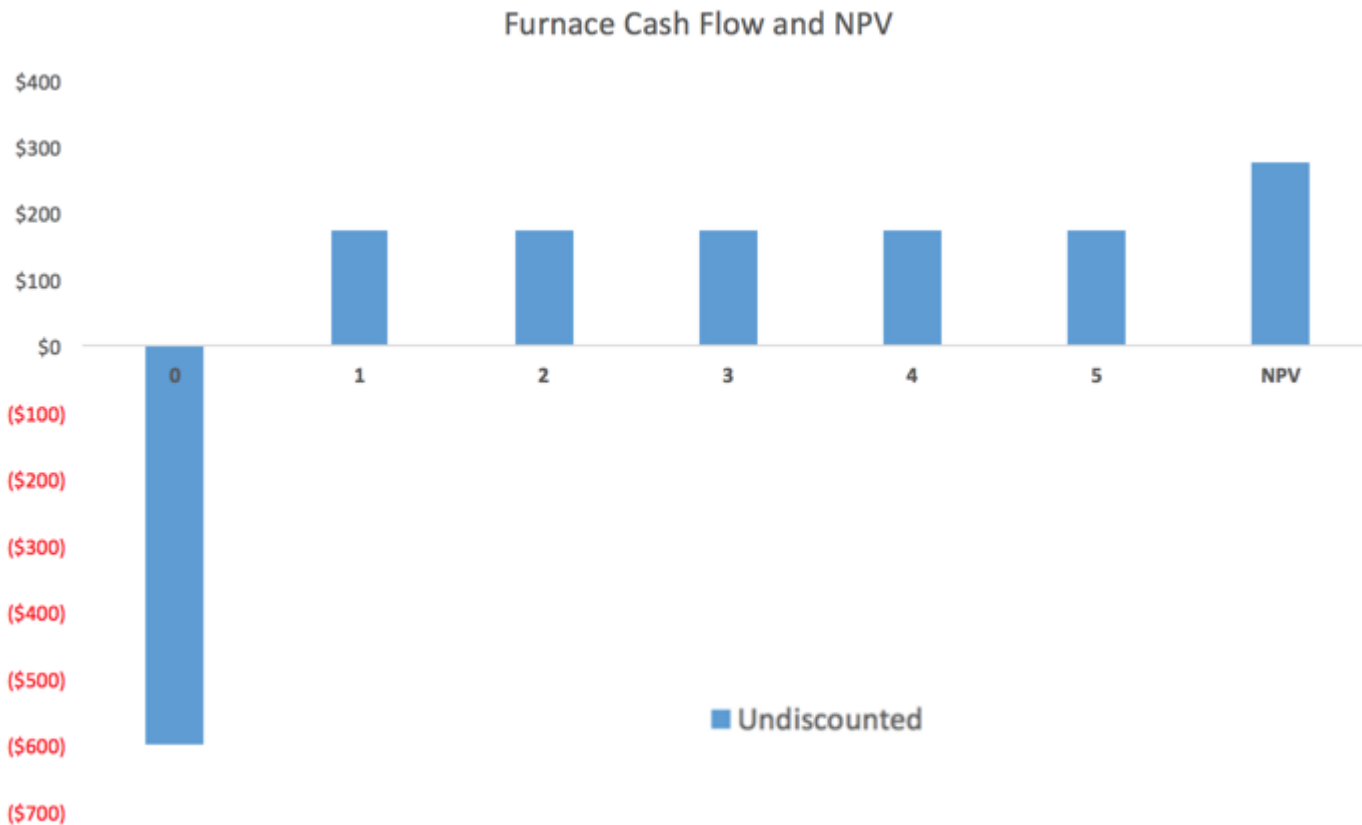
Efficacy: quantities not in same unit; maximum possible efficacy hard to define, entangled with other dimensions of the product

Substitutions vs technological change

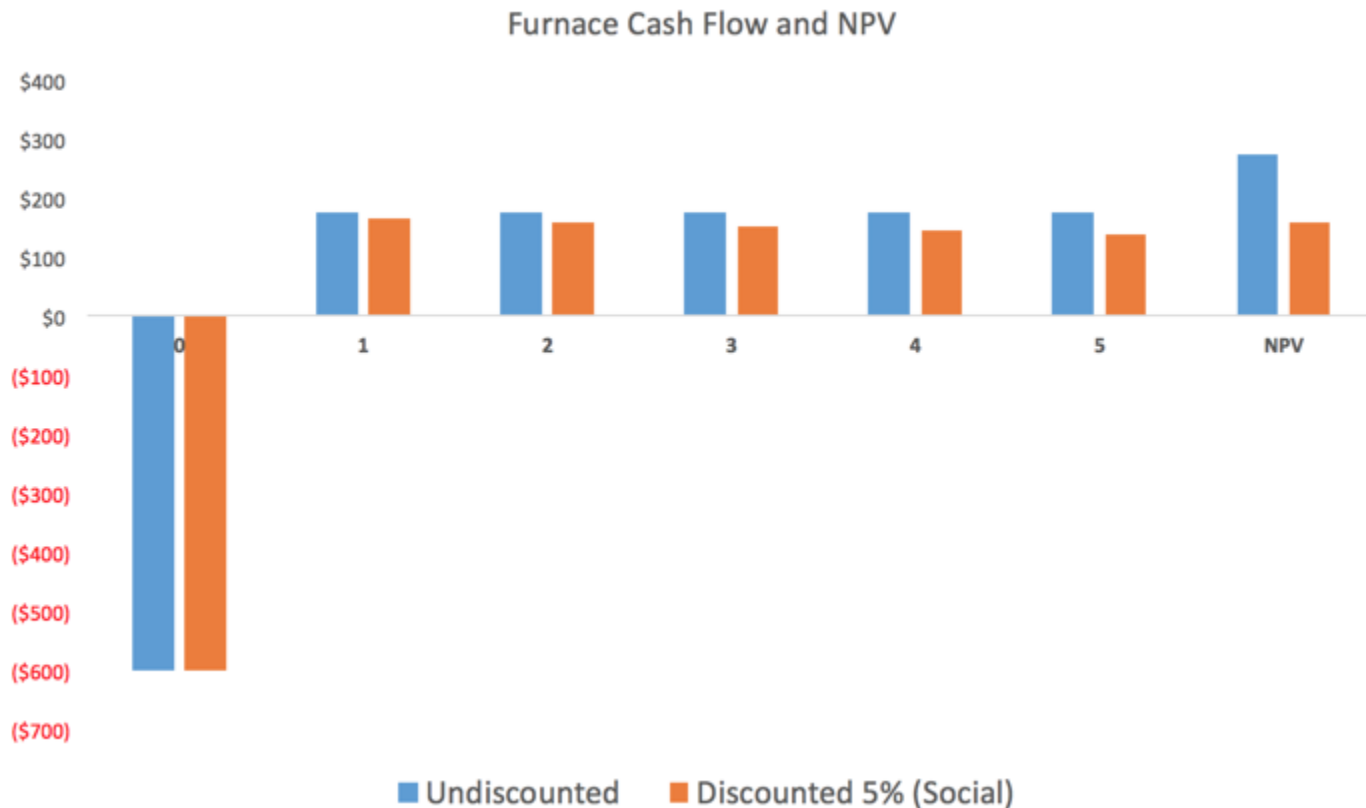
**Figure 1. (A) Energy Efficiency Improving Substitution versus
(B) Energy Saving Technological Change**



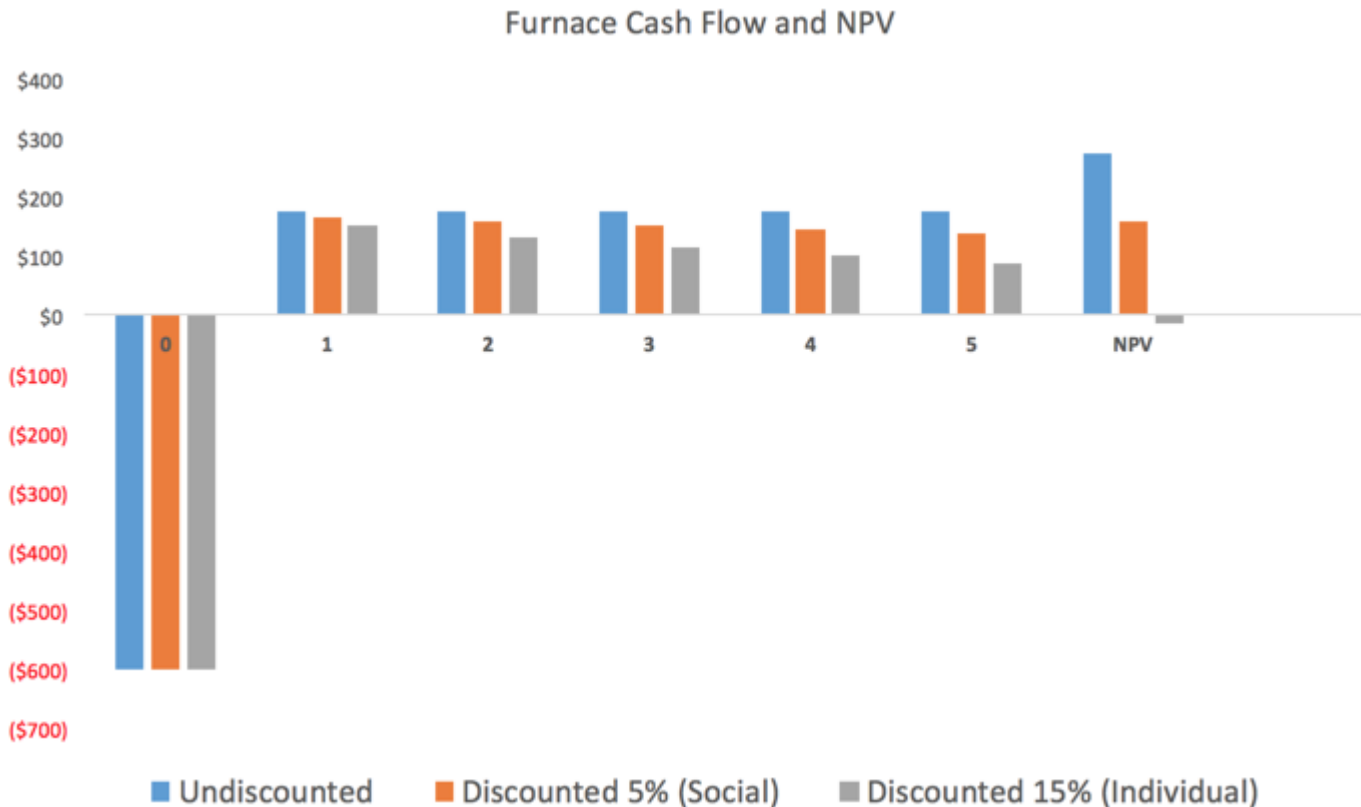
Discount Rates Can Have A Big Impact



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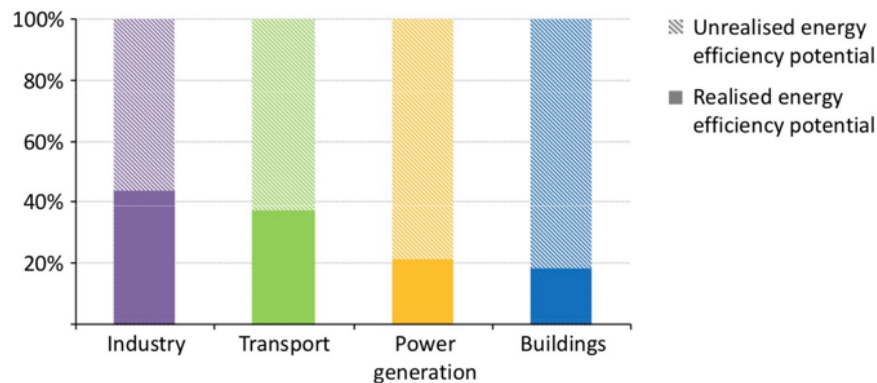


Energy Efficiency Gap



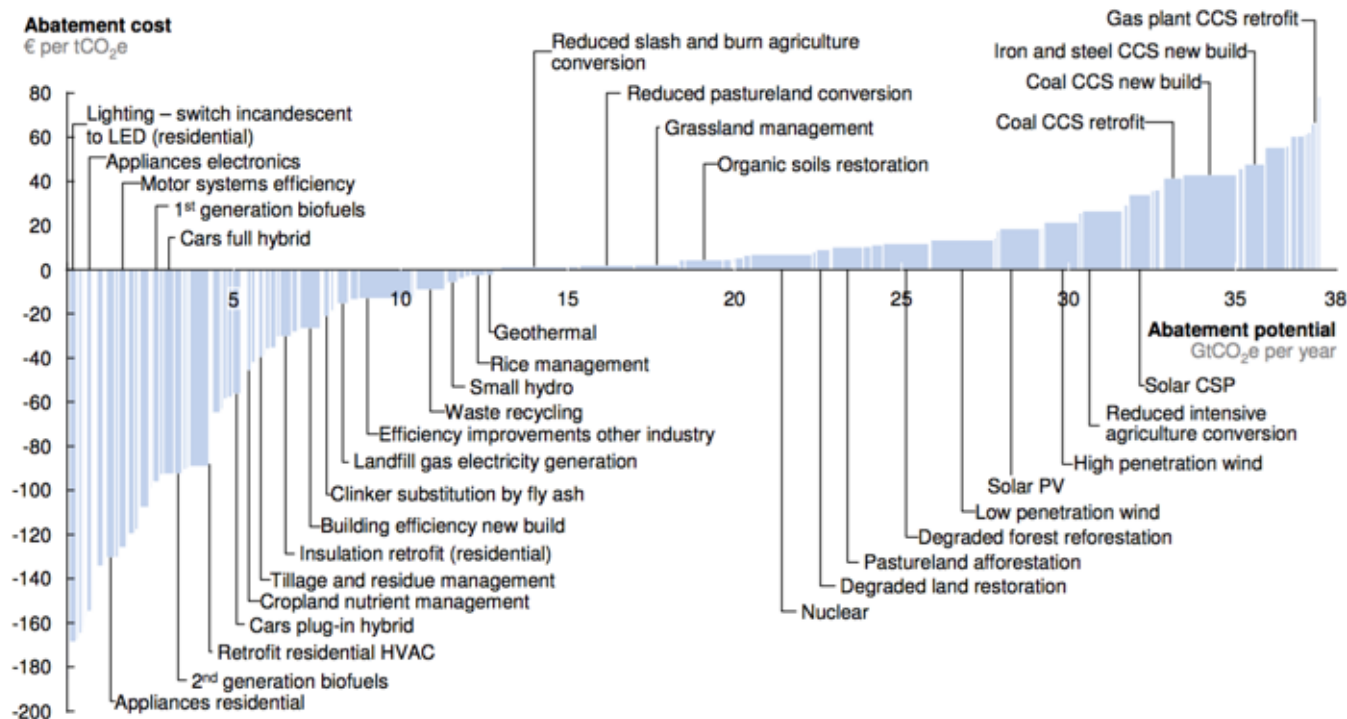
Energy efficiency: a huge opportunity going unrealised

Energy efficiency potential used by sector in the WEO 2012
New Policies Scenario



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

V2.1 Global GHG abatement cost curve beyond BAU – 2030



Note: The curve presents an estimate of the maximum potential of all technical GHG abatement measures below €80 per tCO₂e if each lever was pursued aggressively. It is not a forecast of what role different abatement measures and technologies will play.

Source: Global GHG Abatement Cost Curve v2.1

The Energy Efficiency Gap

What is it? What kind of consumers? Gap from whose perspective?

Innovation gap?

Is there an efficiency gap?

Are there good reasons for the apparent gap?

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Heterogeneous consumers (different levels of usage)

Costly information

Time investment

Discount rates and Social vs Private efficiency

Option Value

Energy price uncertainty

Is there an efficiency gap?

Are there bad reasons for the apparent gap?

Is there an efficiency gap?

Are there bad reasons for the apparent gap?

Incomplete information (about energy costs, efficiency of products...)

Non-optimizing consumers, behavioral failures

Prospect theory, loss aversion, heuristic decision making

Externalities

Average cost electricity pricing

Liquidity constraints

Principal-agent problems

Efficiency Policy

Mandatory efficiency standards

Energy labelings, informational campaigns

Financing

Time of Use pricing

Elasticities of Demand

How much does demand respond to price?

Suppose electricity prices go up 10%...

In the short run (days) how much do residential consumers reduce demand? How about industrial customers?

In the long run (years) how much do residential consumers reduce demand? How about industrial customers?

Elasticities of Demand

**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
<i>Residential</i>				
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)
<i>Commercial</i>				
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)
<i>Industrial</i>				
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				

Elasticities of Demand

In the short run energy demand inelastic; people don't turn off the furnace just because gas prices went up today. And expensive, long-lived capital (furnaces, power plants...) means people don't immediately buy more efficient devices.

But those elasticities aren't 0; typically in the range .15-.5

Rebound Effect

If demand goes down (slightly) when prices go up, then what happens when prices go down?

What happens to your marginal cost of lighting when you replace your incandescents with LED's?

Rebound Effect Overview

What were the main points of the conflicting readings?

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The Problem With Energy Efficiency

By MICHAEL SHELLINGER and TED NORDHAUS OCT. 8, 2014



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October 21st, 2014

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Spoiler alert: Yes.

By Inês Azevedo, Kenneth Gillingham, David Rapson, and Gernot Wagner

Rebound Effect Basics

5% increase in fuel economy but only 2% drop in fuel use -> 60% rebound

If over 100%, called “backfire”

Where do you think rebound likely to be highest? Where lowest? When could there be backfire?

Difference between costly and costless efficiency improvements matters

Ceteris paribus matters

Teasing apart terms

The true Jevon's paradox - energy efficiency and energy use increase together over time

Total rebound effect - all the ways an efficiency improvement *causes* more energy use

Direct rebound effect - buy more efficient car, drive more

Indirect rebound effect - buy more efficient car, spend saved gas \$ elsewhere

Economy-wide effects - increased economic growth due to increased energy productivity;
macroeconomic price effects

Wealth effects - even though efficiency increases demand does too due to exogenous wealth increases

Enabling new uses - e.g. LCD's reduced TV energy use relative to TV's but enabled

How to measure the direct rebound effect?

Via price elasticity?

Price elasticity by far the most common technique, done mostly in the developed world mostly on driving

Experiments: give people more efficient appliances and see what happens

Has been done a handful of times with huge range of resulting rebounds (.04 to -1.06); efficiency entangled with other attributes (refrigerator size, air conditioner loudness, etc)

How to measure the indirect rebound effect?

what else do people buy?

Could just use assume extra spending will have same energy intensity as economy as a whole;

or could use data on consumption patterns based on e.g. income brackets;

a few studies have done each

Experiments: give people more efficient appliances and see what happens

Has been done a handful of times with huge range of resulting rebounds (.04 to 1.06): efficiency entangled with other attributes (refrigerator size, air

How to measure the macroeconomic effects?

Don't bother

The Endless Rebound Debate

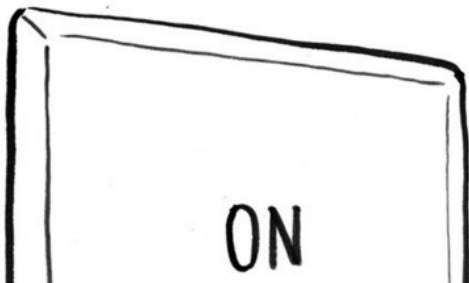
Revisiting the main points in the debate

Maybe take sides here and go back and forth?

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OAKLAND, Calif. — ON Tuesday, the Royal Swedish Academy of Sciences awarded the 2014 Nobel Prize in Physics to three researchers whose work contributed to the development of a radically more efficient form of lighting known as light-emitting diodes, or LEDs.

In announcing the award, the academy

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Lighting is critical to our livelihoods. Humans have used lighting technology since long before industrialization. For many centuries, this lighting was extremely inefficient, with over 95% of the energy

Reference

Gillingham et al (2009) “Energy Efficiency Economics and Policy” *Resources for the Future Discussion Paper*

<http://www.rff.org/files/sharepoint/WorkImages/Download/RFF-DP-09-13.pdf>