

**Counterfactual Analysis of  
Energy Efficiency Policies in the U.S.  
Across Three Decades:  
A Time Series Cross Section Approach**

**Presented at:  
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## The fuels that generate the U.S. supply of electricity

Generation	2003		2004		2005	
	GWh	Percent	GWh	Percent	GWh	Percent
Coal	1,973,737	50.8%	1,978,620	49.8%	2,013,179	49.6%
Nuclear	763,733	19.7%	788,528	19.8%	781,986	19.3%
Natural Gas	649,908	16.7%	708,979	17.8%	757,974	18.7%
<b>ENERGY EFFICIENCY PROGRAM COMMITMENT 2006:</b>						<b>6.8%</b>
Hydro	275,806	7.1%	268,417	6.8%	269,587	6.6%
Petroleum	119,406	3.1%	120,646	3.0%	122,522	3.0%
Other	87,410	2.2%	90,408	2.3%	94,932	2.3%
Other Gases	15,600	0.4%	16,766	0.4%	16,317	0.4%
Other	6,121	0.2%	6,679	0.2%	4,749	0.1%
<b>Total</b>	<b>3,891,721</b>	<b>100%</b>	<b>3,979,043</b>	<b>100%</b>	<b>4,061,246</b>	<b>100%</b>

**If you only look at energy use, it appears that there are no energy savings. I call it “The Curse of Invisibility”**

## Study Design

- Commitment Quartiles (4) -- Based on an signs of program activity in 48 states where “program” is inclusive of all governmental initiatives
  - 12 Strong States (*S*)
  - 24 Moderate States (*M*)
  - 12 Weak States (*W*)
- Study Periods (2) -- Based on historical events, data availability
  - Base Period 1977 to 1991 (15 yrs.) or 1970 to 1979 (10 yrs.)
  - Treatment Period 1992 to 2003 (12 yrs.)
- Economic Sectors (3) – Together in 2006 they used ~99% of U.S. electricity
  - Commercial (~36 %)
  - Industrial (~27%)
  - Residential (~37%)

**Suppose we have 3 neighborhoods with noticeably different commitments to energy efficiency programs**

**Strong**



**Moderate**



**Weak**



## Imagine that we have two periods:

- (1) Ancien Regime (no energy efficiency policies up to 1991)
- (2) Nouveau Regime (1992 to the present)

tres Ancien



tres Nouveau



**How would the energy use of the 36 *SM* states have changed if they behaved like the 12 *W* states in the base and treatment periods?**

$$EI^W = \beta_0^W + \sum_{j=1}^n \beta_j^W X_j^W + u^W$$

Each sector's model is estimated twice:

The 1<sup>st</sup> equation describes how *W* states behaved  
in the Base Period

The 2<sup>nd</sup> equation describes how *W* states behaved  
in the Treatment Period

The *characteristics* (or  **$X$ 's**) of the  **$SM$**  states are placed into the  **$W$ 's behavioral equations** (consisting of the  **$B$ 's**)

$$EI_{Counterfactual}^{SM} = \beta_0^W + \sum_{j=1}^n \beta_j^W X_j^{SM}$$

Since the  **$W$**  states had weak commitment to energy efficiency, the counterfactual change in  $EI$  from the base to the treatment period removes the program commitment effect

A final calculation subtracts the factual from the counterfactual – this is called a ***difference-in-differences (DID)*** estimator

***DID:***

**By subtracting the**

*factual  $\Delta EI$*

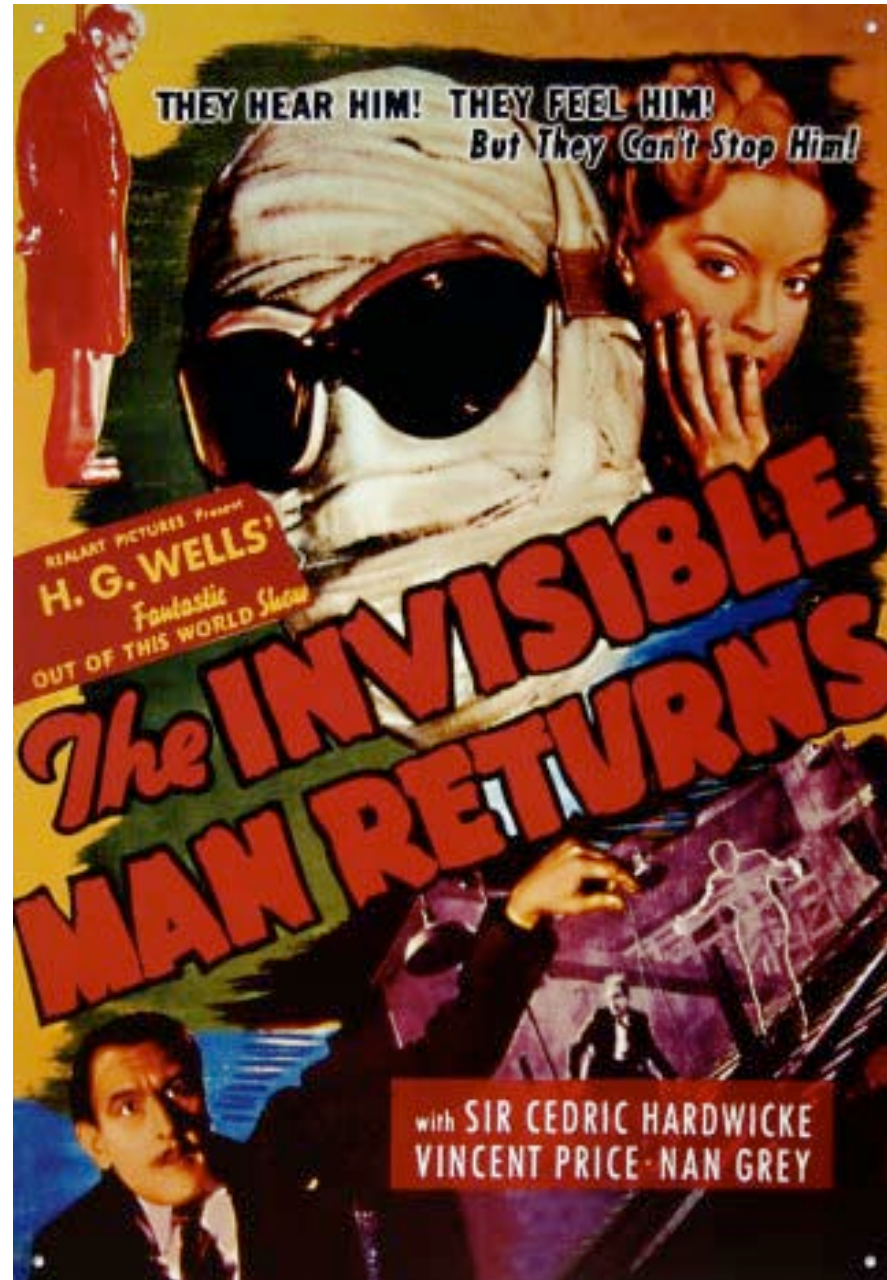
**from the**

*counterfactual  $\Delta EI$*

**the**

**INVISIBLE  
ENERGY SAVINGS**

**is made visible**



**Sector-level electricity savings**  
**from the average values of the Base Period**  
**to the average values of the Treatment Period**

SM States (n=36)	Level of Electricity (GWh) Use			Electricity Intensity		
	Base	Treatment	% Change	Base	Treatment	% Change
	<b>Residential</b>					
Factual	670,272	949,968	41.7%	12.1	14.5	19.3%
Counterfactual	693,203	919,711	32.7%	11.8	13.9	17.7%
95% C.L. (+/-)	15.1%	8.2%		6.1%	3.1%	
Net Impact			9.1%			1.6%
	<b>Commerical</b>					
Factual	558,303	865,047	54.9%	627.4	578.7	-7.8%
Counterfactual	664,761	1,111,229	67.2%	689.6	692.2	0.4%
95% C.L. (+/-)	22.4%	34.5%		3.4%	5.2%	
Net Impact			-12.2%			-8.1%
	<b>Industrial</b>					
Factual	675,353	793,024	17.4%	2,928	2,898	-1.0%
Counterfactual	925,015	1,175,135	27.0%	2,787	3,088	10.8%
95% C.L. (+/-)	21.9%	31.0%		2.9%	4.1%	
Net Impact			-9.6%			-11.8%

**Sector-weighted aggregate U.S. electricity savings in 2006  
(due to energy efficiency policies since 1992)<sup>1</sup>**

<b>Sector</b>	<b>Industrial</b>	<b>Commerical</b>	<b>Residential</b>
Impact on 2006 MWh	-27.2%	-9.5%	11.1%
% Weighted 2006 Savings (n=48)	-6.9%	-2.9%	3.0%
<b>2006 Net Impact of Energy Efficiency Program Commitment (3 Sectors, 48 States):</b>			
<b>-6.8%</b>			

<sup>1</sup> calculated based on Horowitz, Marvin J. (2007). "Changes in Electricity Demand in the United States from the 1970s to 2003," *The Energy Journal*, 28(3):87 – 113.

## Energy efficiency savings compared to electricity generation fuels

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