Assessing the Potential for Supply Chain Environmental Impact Reductions

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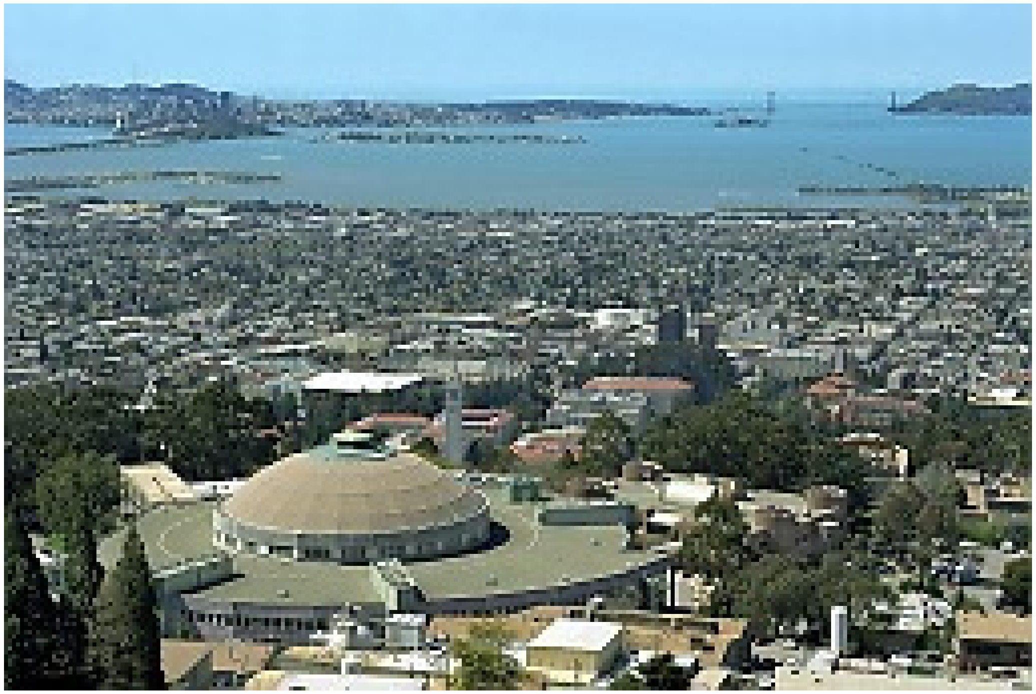
Eric Masanet, Ph.D.
Energy Analysis Department
Environmental Energy Technologies Division

Ernest Orlando Lawrence Berkeley National Laboratory

Lawrence Berkeley National Laboratory (LBNL)

- U.S. Department of Energy research laboratory
- Managed by the University of California
- 4000 employees
  - — 200 UC faculty
  - — 600 graduate students
  - — 90 post doc fellows
  - — many visiting foreign researchers
- 10 Nobel Laureates

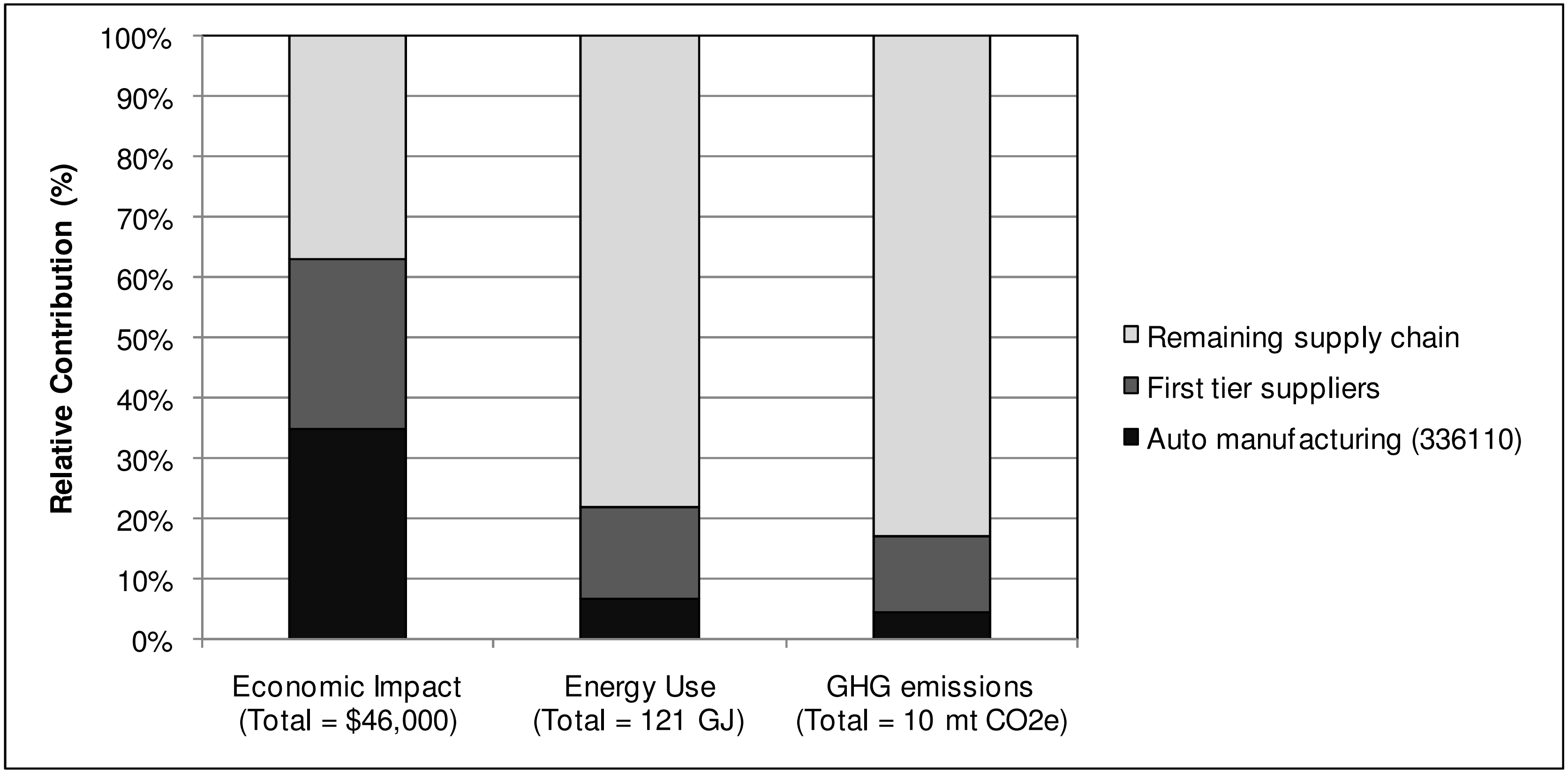


Overview

- So we've established a supply chain "footprint." Now what?
- Supply chain "potential" assessment refers to the modeling of discrete technological and operational options for reducing environmental impacts along the entire supply chain
  - Adoption of best practice technologies and management practices
  - Emerging technologies
  - Consideration of cost implications and other barriers to adoption
- Traditional LCA software tools do not typically provide the rich "bottom up" modeling details necessary to facilitate such analyses
- Objective: couple LCA (process and IO models) with detailed models (energy, emissions, cost, etc.) of discrete technologies and non-technological measures for different economic sub-sectors to assess improvement potentials (process, firm, supply chain)
- Target audience: policy makers and OEMs with complex supply chains

Example of OEM leverage (i)

Economic Impact, Energy Use, and GHG Emissions Associated with the Manufacture of a Midsize U.S. Passenger Car



Sources: Derived from (1) Hendrickson, C.T., Lave, L.B., and H.S. Matthews(2006). Environmental Life Cycle Assessment of Goods and Services. Resources for the Future Press, Washington, DC. and (2) Carnegie Mellon University Green Design Institute (2008) Economic Input-Output Life Cycle Assessment (EIO-LCA), US 1997 Industry Benchmark model [Internet], Available from:<http://www.eiolca.net>

Example of OEM leverage (ii)

Electricity Use and Motor System Electricity Savings Potentials of Selected Sectors in the Manufacture of a Midsize U.S. Passenger Car

IO Sector	Description	Total Electricity Use (kWh)	Motor System Electricity Use (kWh)	Motor System Efficiency Potential	Potential Electricity Savings (kWh)
336110	Automobile and light truck manufacturing	727	313	15%	47
			Auto manufacturer total		***47***
Selected major suppliers (direct and indirect)					
336300	Motor vehicle parts manufacturing	1283	552	15%	83
331111	Iron and steel mills	681	341	12%	41
331312	Primary aluminum production	574	80	12%	10
331510	Ferrous metal foundries	215	71	12%	9
325180	Other basic inorganic chemical manufacturing	130	74	16%	12
32721A	Glass and glass products, except containers	102	33	15%	5
325211	Plastics material and resin manufacturing	89	51	16%	8
334413	Semiconductors and related device manufacturing	86	28	23%	6
325190	Other basic organic chemical manufacturing	85	48	16%	8
326210	Tire manufacturing	65	34	15%	5
			Total for selected suppliers		***186***

Source: Sathaye, J.A., Lecocq, F., Masanet, E., Najam, A., Schaeffer, R., Swart, R., and H. Winkler (2008). "Opportunities to change development pathways towards lower greenhouse gas emissions through energy efficiency." Journal of Energy Efficiency. Forthcoming.

Process/technology rich LCA models

Infrastructure:

- Transportation (freight and passenger)
- Buildings
- Pavements
- Electricity generation: wind, hydro, solar, coal, natural gas
- Water treatment
- Used oil
- Automotive and plastics shredder residue
- Smart Lighting
- Pesticide Protection
- Sustainable IT
- Sustainable Communities

Services:

- Telework/telecommuting
- News delivery using wireless and wired telecommunications
- Teleconferencing versus business travel

Electronics industry:

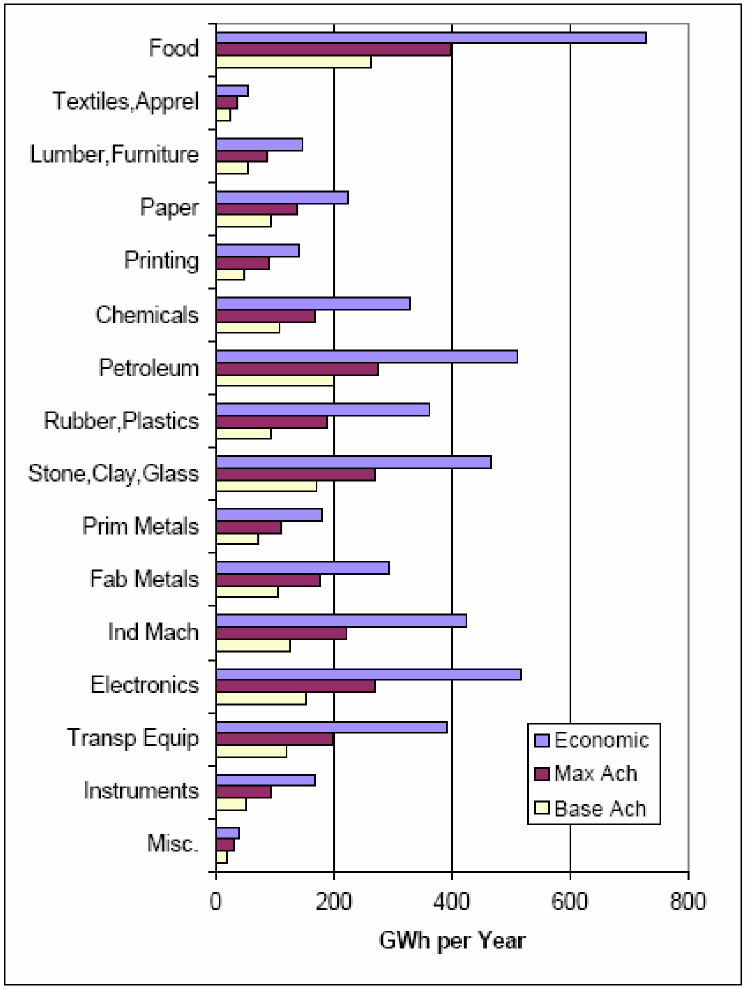
- E-waste recycling systems
- Life-cycle optimization of personal computers
- Semiconductor manufacturing

Consortium on Green Design and Manufacturing

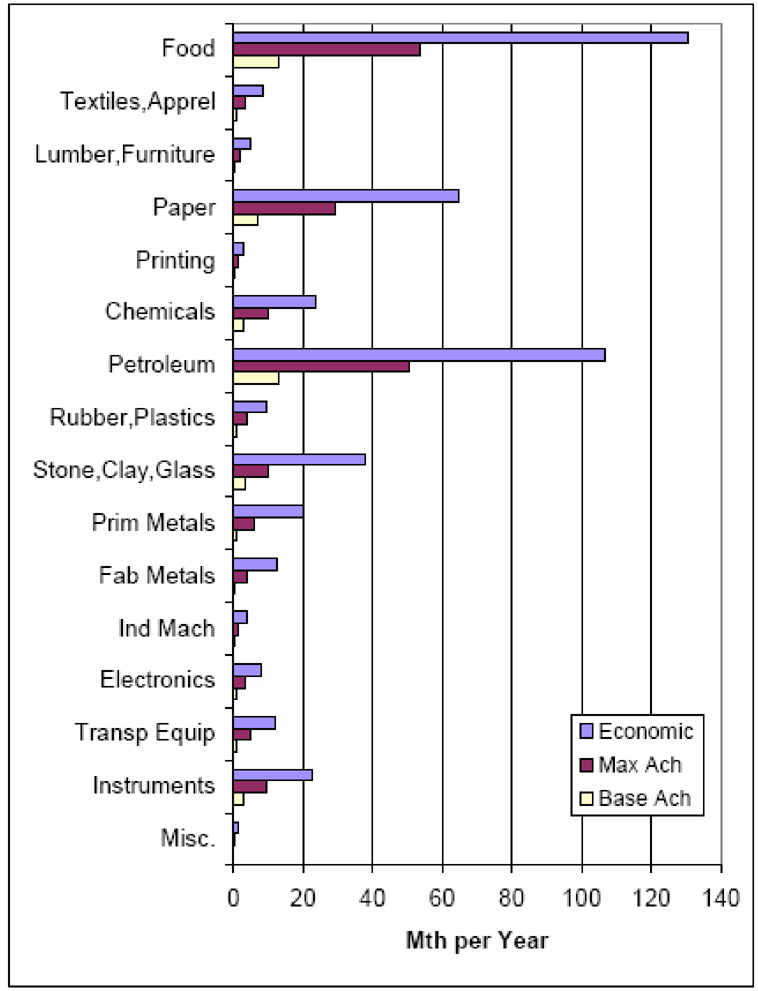
A Multi-Disciplinary Research and Educational Partnership Between Industry, Government, and Academia.

Modeling of improvement potentials (i)

Potential California Energy Savings by Industry Group – Cumulative through 2016



Electricity

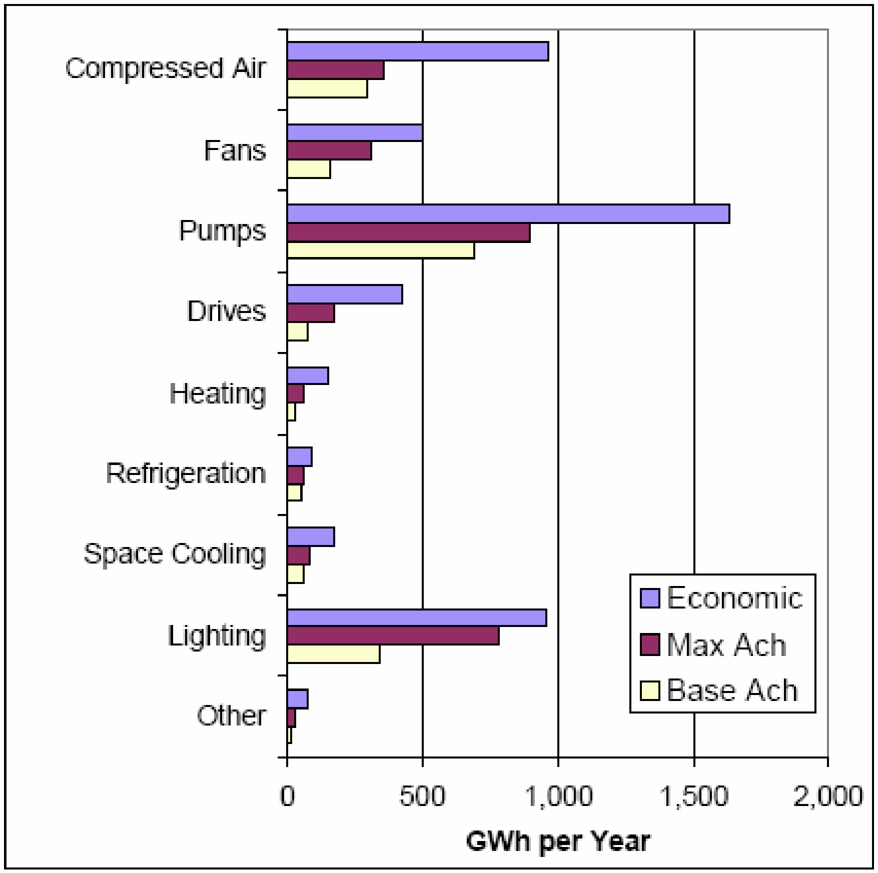


Natural Gas

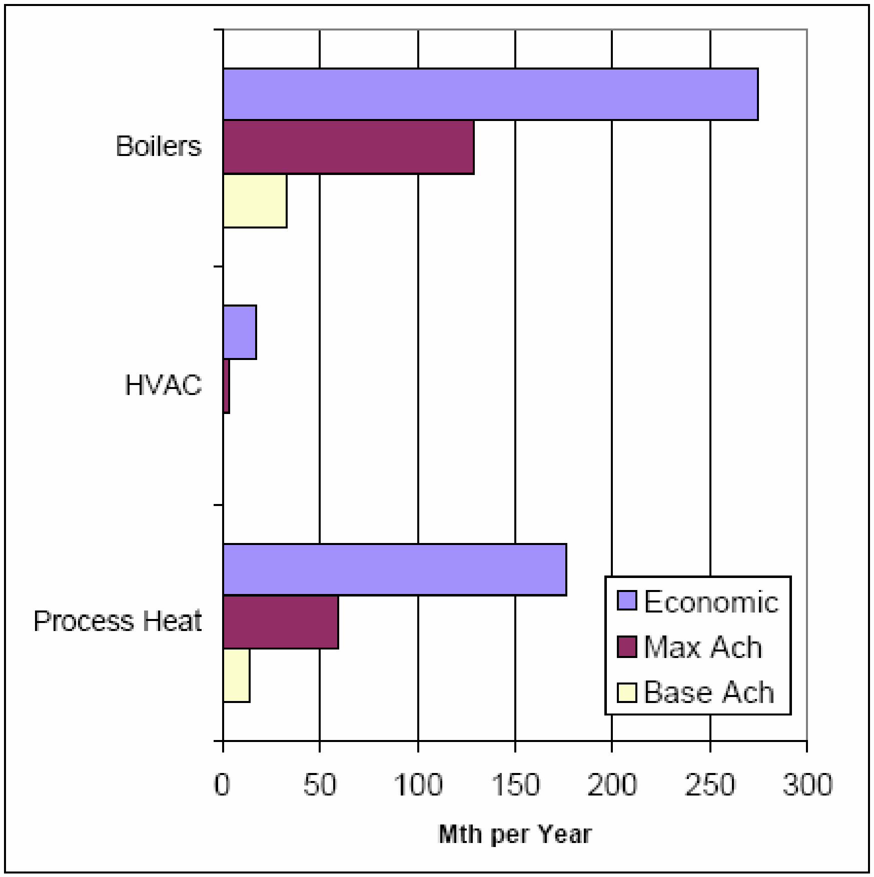
Friedmann, R., F. Coito, E. Worrell, L. Price, E. Masanet, and M. Rufo (2005). "California Industrial Energy Efficiency Potential." Proceedings of the 2005 ACEEE Summer Study on Energy Efficiency in Industry, West Point, New York, ACEEE.

Modeling of improvement potentials (ii)

Potential California Energy Savings by End Use – Cumulative through 2016



Electricity



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Technology characterization

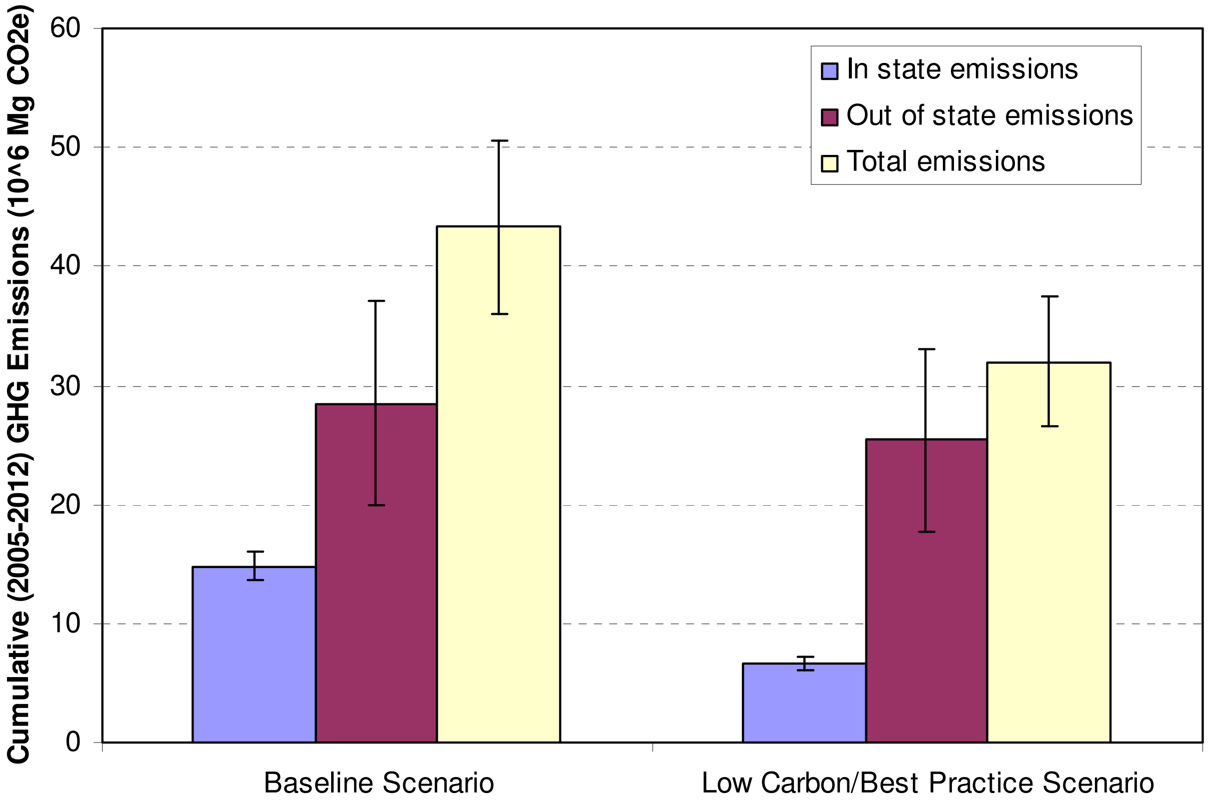
Example: Liquid Membrane Technologies – Chemicals Manufacturing

Reference technology				
Description	Distill the isopropyl/water mixture to its azeotropic point, then do a liquid/liquid extraction			
Throughput or annual operating hours	tons	1.0		
Electricity use	kWh	120.90		11% electricity EIA 1997
Fuel use	MBtu	8.36		89% fuel EIA 1997
Primary Energy use	MBtu	9.39		25% of energy (4693 btu/lb) is for separation. DeBeer 1994
New Measure Information:				
Description	Distill the mixture to its azeotropic point, separate with liquid membrane			
Electricity use	kWh	120.90		
Fuel use	MBtu	3.34		Technology saves 60% of separation fuel input
Primary Energy use	MBtu	4.38		
Current status		Commercialized		
Date of commercialization		2000		
Estimated average measure lifetime	Years	10		
Savings Information:				
Electricity savings	kWh/%	0.00	0%	
Fuel savings	MBtu/%	5.016	60%	
Primary energy savings	MBtu/%	5.016	53%	
Penetration rate		Medium		
Feasible applications	%	20%		
Other key assumptions for savings				
Electricity savings potential in 2015	GWh	0.0		
Fuel savings potential in 2015	Tbtu	0.81		
Primary energy savings potential in 2015	Tbtu	0.81		
Cost Effectiveness				
Investment cost	$	-7		$62.6/ton for full installation of membrane separator DeBeer 1994
Type of cost		Incremental		
Change in annual costs (O&M/other benefits)	$	17		Operating costs are lower, but membrane must be replaced frequently
Cost of conserved energy (electricity)	$/kWh	-		
Cost of conserved energy (fuel)	$/Mbtu	3.11		
Cost of conserved energy (primary energy)	$/Mbtu	3.11		
Simple payback period	Years	11.2		Fuel mix in US from EIA 1997
Internal rate of return	%	6%		
Key non energy factors				
Productivity benefits		None		
Product quality benefits		None		
Environmental benefits		Significant		Decreases CO2 emissions
Other benefits		Significant		Investment 10% less than conventional installation
Current promotional activity	H,M,L	High		Dow Chemical promoting

Source: N. Martin, E. Worrell, M. Ruth, L. Price, R.N. Elliott, A.M. Shipley, J. Thorne (2000). Emerging Energy-Efficient Technologies. Lawrence Berkeley National Laboratory, Berkeley, California. LBNL-46990.

Applications to policy analysis

Life-Cycle Optimization of Personal Computers in California: Projected Cumulative Life-Cycle GHG Emissions (2005-2012)



Preliminary technical potential for GHG emissions reductions:

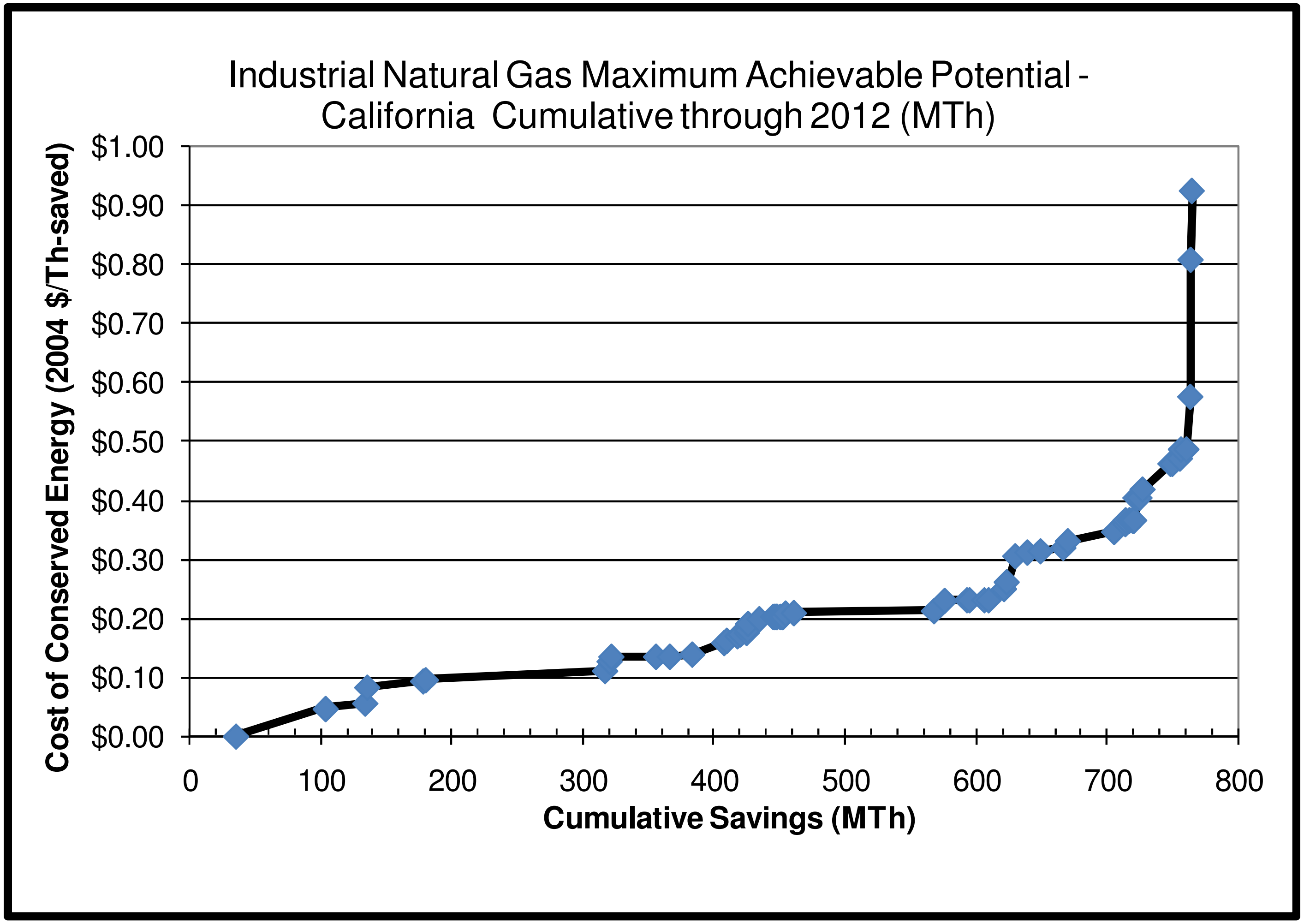
- **Total = 11.3 10^6 Mg CO_2e**
- **In state = 8.2 10^6 Mg CO_2e**
- **Out of state = 3.1 10^6 Mg CO_2e**

2004 CA net emissions = 471 **Mg CO_2e**

Source: Masanet, E., and A. Horvath (2006). "An Analysis of Measures for Reducing the Life-Cycle Energy Use and Greenhouse Gas Emissions of California's Personal Computers." University of California Energy Institute Technical Report, Berkeley, California.

What will it cost?

Example supply curve for industrial natural gas efficiency measures



Some synergistic projects

- **Modeling of long-term (2050) energy efficiency potentials for the California industrial, commercial, and residential sectors** [*California Energy Commission*]

- **Assessment of emerging industrial energy-efficient technologies (joint with ACEEE)** [*CEC, NYSERDA, Focus on Energy*]

- **Life-Cycle Assessment for Mitigating the Greenhouse Gas Emissions of Retail Products (UC Berkeley, LBNL, Carnegie Mellon)** [*California Air Resources Board*]

- **ENERGY STAR for Industry** [*U.S. Environmental Protection Agency*]

Contact information

Eric Masanet
International Energy Studies Group
Energy Analysis Department
Environmental Energy Technologies Division
Lawrence Berkeley National Laboratory
1 Cyclotron Road, Berkeley, CA 94720
(510)486-6794
ermasanet@lbl.gov

Arpad Horvath
Associate Professor
Department of Civil and Environmental Engineering
University of California, Berkeley
215B McLaughlin Hall
Berkeley, CA 94720-1712
(510)642-7300
horvath@ce.berkeley.edu