BRIEFING BY JESSE JENKINS

HOSTED BY THE CENTER FOR CLIMATE AND ENERGY DECISION MAKING

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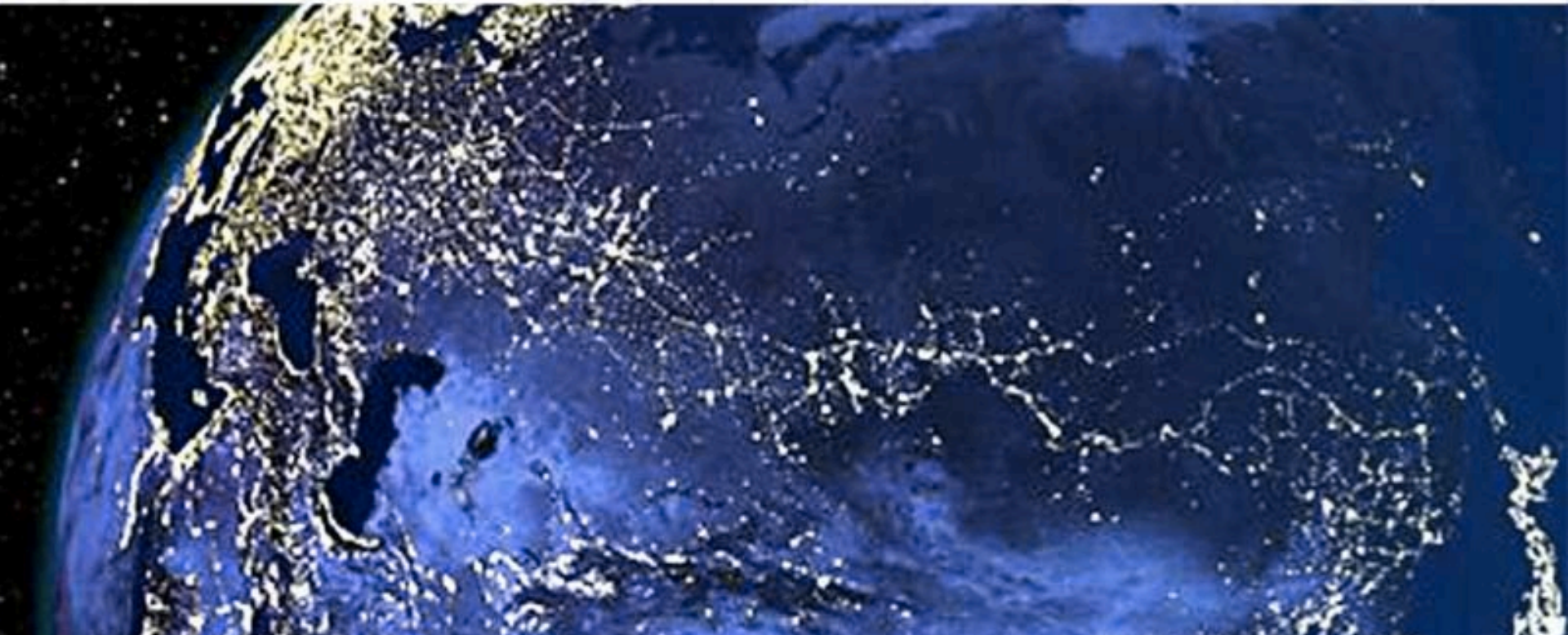
BREAKTHROUGH INSTITUTE

ENERGY EFFICIENCY AND THE REBOUND EFFECT

A SUMMARY OF RESEARCH



A REVIEW OF THE LITERATURE

BY JESSE JENKINS
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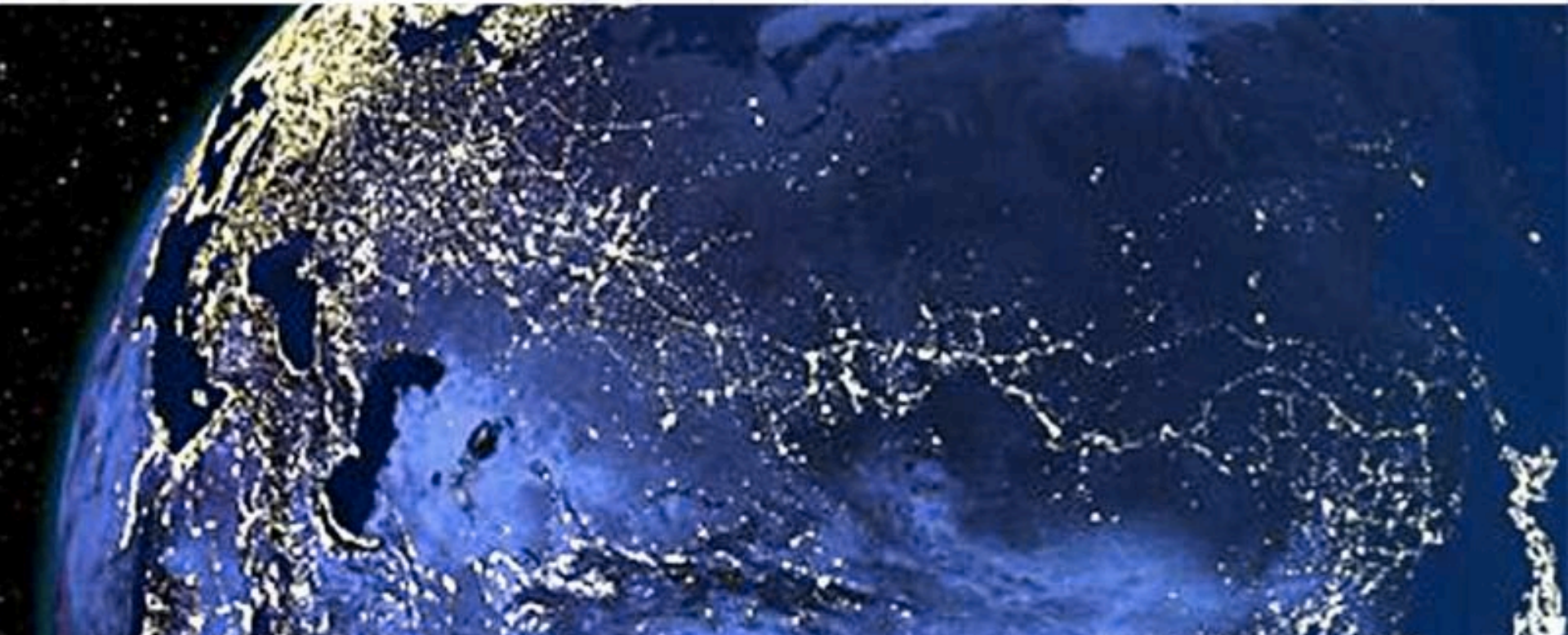
MICHAEL SHELLENBERGER

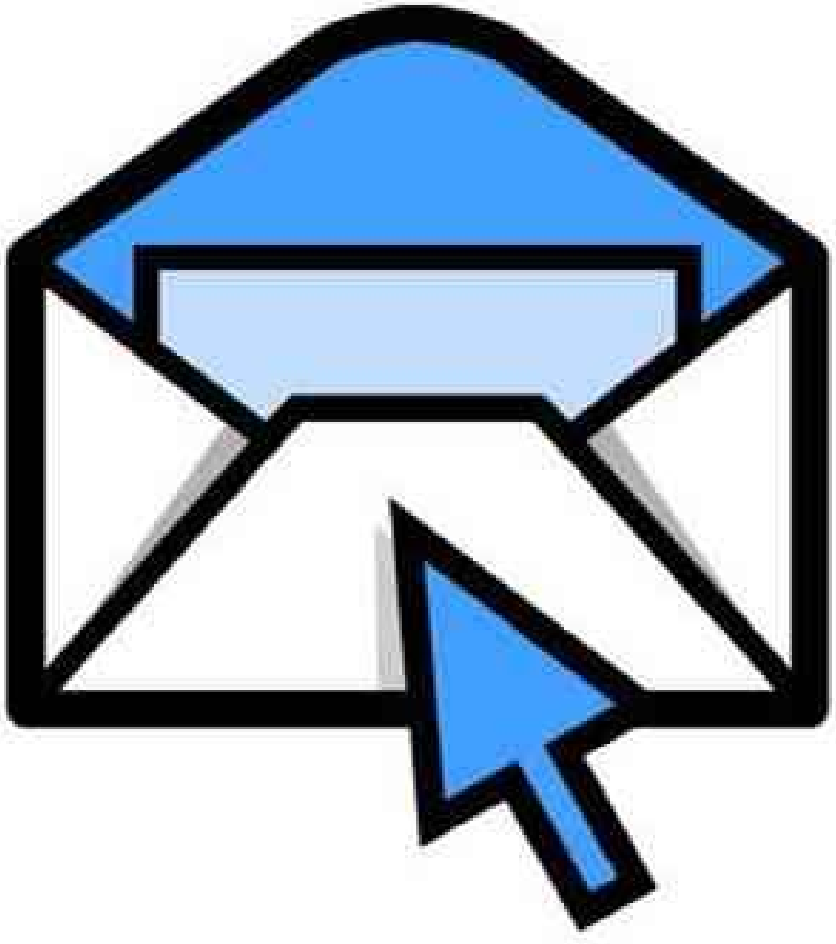
BREAKTHROUGH INSTITUTE

ENERGY EMERGENCE

REBOUND & BACKFIRE AS EMERGENT PHENOMENA



EMAIL DIALOGUE



Jesse Jenkins

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Jonathan Koomey

Danny Collenward

Skip Laitner

Amory Lovins

…

1. REVIEW OF LITERATURE: CONCLUSION

"Rebound effects are real and significant, and combine to drive a total, economy-wide rebound in energy demand with the potential to erode much (and in some cases all) of the reductions in energy consumption expected to arise from below-cost efficiency improvements."

(p 4)

2. REBOUND LEAST WHERE MOST STUDIED

DIRECT REBOUND FOR CONSUMERS IN RICH NATIONS = ROUGHLY 10-30%

TABLE 2.1:
Scale of Direct Rebound for Consumer Energy Services in Developed Nations – Summary

Energy Service	Range of Estimates	Best Guess	Degree of Confidence (Notes)
Automotive transport	5-87%	10-30%	HIGH (*Unmeasured in these studies are changes in automotive attributes, particularly heavier vehicles and more powerful engines.*)
Space heating	1.4-60%	10-30%	MEDIUM (*Unmeasured in these studies are increases in the space heated and an increase in thermal comfort.*)
Space cooling	0-50%	1-26%	LOW (*Unmeasured in these studies are increases in the space cooled and an increase in thermal comfort.*)
Water heating	<10-40%	??	VERY LOW (*Unmeasured in these studies are reports of increased shower length or purchase of larger water heating unit.*)
Other consumer energy services	0-49%	<20%	LOW

3. REBOUND GREATEST WHERE LEAST STUDIED

REBOUND MUCH LARGER IN DEVELOPING NATIONS

?? 30-80+% ??



3. REBOUND GREATEST WHERE LEAST STUDIED

TYPICAL DIRECT REBOUND VALUES FOR INDUSTRY MAY BE 20-70%



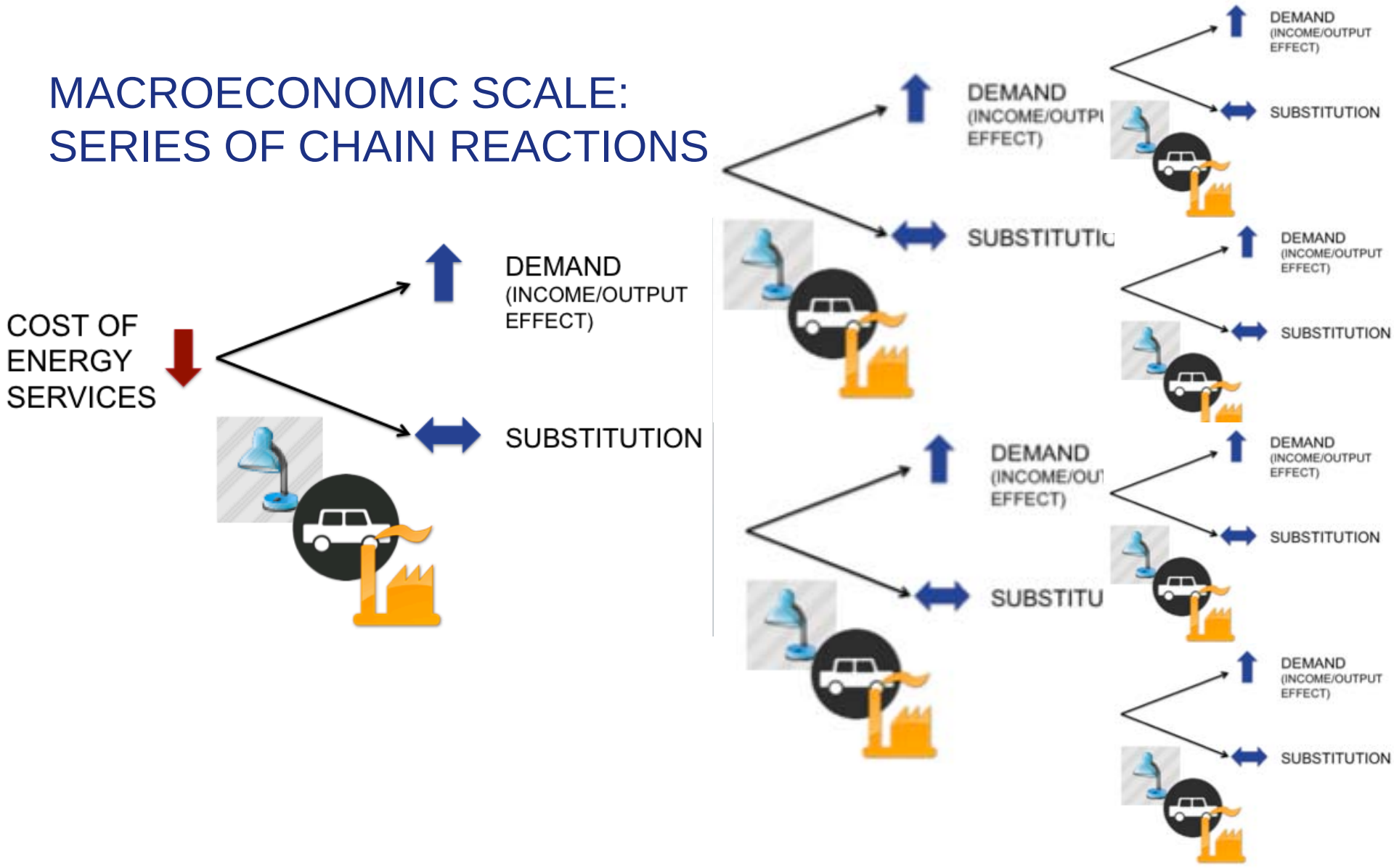
3. REBOUND GREATEST WHERE LEAST STUDIED

TABLE 2.2: Scale of Direct Rebound for Producing Sectors

Sector	Long-term rebound	Share of rebound due to substitution	Share of rebound due to output	Long-term rebound from substitution	Long-term rebound from output
Electric utilities	120%	75%	25%	90%	30%
Transportation	59%	57%	43%	34%	25%
Services	25%	90%	10%	23%	3%
Chemicals	53%	38%	62%	20%	33%
Construction	58%	94%	6%	55%	3%
Primary Metals	66%	84%	16%	55%	11%
Agriculture	39%	47%	53%	18%	21%
Financial Industries	61%	95%	5%	58%	3%
Government Enterprises	40%	87%	13%	35%	5%
Food & Kindred Products	40%	98%	2%	39%	1%
Paper & Allied Products	44%	80%	20%	35%	9%

4. MACRO-REBOUNDS ARE EMERGENT

MACROECONOMIC SCALE: SERIES OF CHAIN REACTIONS



4. MACRO-REBOUNDS ARE EMERGENT

ECONOMIC GROWTH

ENERGY PRODUCT-IVITY

ENERGY USE

SCALE OF TOTAL, ECONOMY-WIDE REBOUND?

TABLE 3.1: Survey of CGE Simulations of Economy-wide Rebound Effect

Study	Country/ Region	Projected Economy-wide Rebound
Semboja (1994)	Kenya	170-350%
Dufournaud et al. (1994)	Sudan	47-77%
Van Es et al. (1998)	Holland	15%
Vikstrom (2004)	Sweden	50-60%
Washida (2004)	Japan	35-70% (53% in central scenario)
Grepperud and Rasmussen (2004)	Norway	Small for oil use but >100% for electricity
Glomsrod and Wei (2005)	China	>100%
Hanley et al. (2005)	Scotland	120%

MORE ON P. 34 OF REPORT

SCALE OF TOTAL, ECONOMY-WIDE REBOUND?

"At the global scope most relevant to climate change and energy resource depletion concerns … perhaps the most robust picture of global economy-wide rebound to date … projects that global efforts to capture 'no-regrets,' below-cost energy savings opportunities will trigger **rebound effects that collectively erode more than half (52%) of projected energy savings potential**….

(p. 50).

SCALE OF TOTAL, ECONOMY-WIDE REBOUND?

- COMPLICATING FACTORS INCREASE BACKFIRE RISK
  - BACKFIRE = REBOUND > 100%
  - BACKFIRE MEANS EFFICIENCY *INCREASES* NET ENERGY USE, NOT DECREASES.

1. BACKFIRE RISK: MULTI-FACTOR PRODUCTIVITY GAINS

"**Improved energy efficiency, especially end-use efficiency, often delivers better services.** Efficient houses are more comfortable; efficient lighting systems can look better and help you see better; efficiency motors can be more quiet, reliable, and controllable; efficient refrigerators can keep food fresher for longer; efficient cleanrooms can improve the yield, flexibility, throughput, and setup time of microchip fabrication plants; ... retail sales pressure can rise 40% in well-daylit stores ... **Such side- benefits can be one or even two orders of magnitude more valuable than the energy directly saved.** ...**[I]n efficient buildings,** ... labor productivity typically rises by about 6-16%. Since office workers in industrialized countries cost ~100x more than office energy, a 1% increase in labor productivity has the same bottom-line effect as eliminating the energy bill – and **the actual gain in labor productivity is ~6-16x bigger than that**."

(Amory Lovins, 2005)

2. BACKFIRE RISK: FRONTIER EFFECTS



WHERE DOES THIS LEAVE US?

- REBOUND EFFECTS ARE REAL, SIGNIFICANT, AND CAN NO LONGER BE IGNORED.
- COMBINE TO ERODE MUCH – AND IN SOME CASES ALL – OF PROJECTED ENERGY SAVINGS FROM BELOW-COST EFFICIENCY MEASURES.

WHERE DOES THIS LEAVE US?

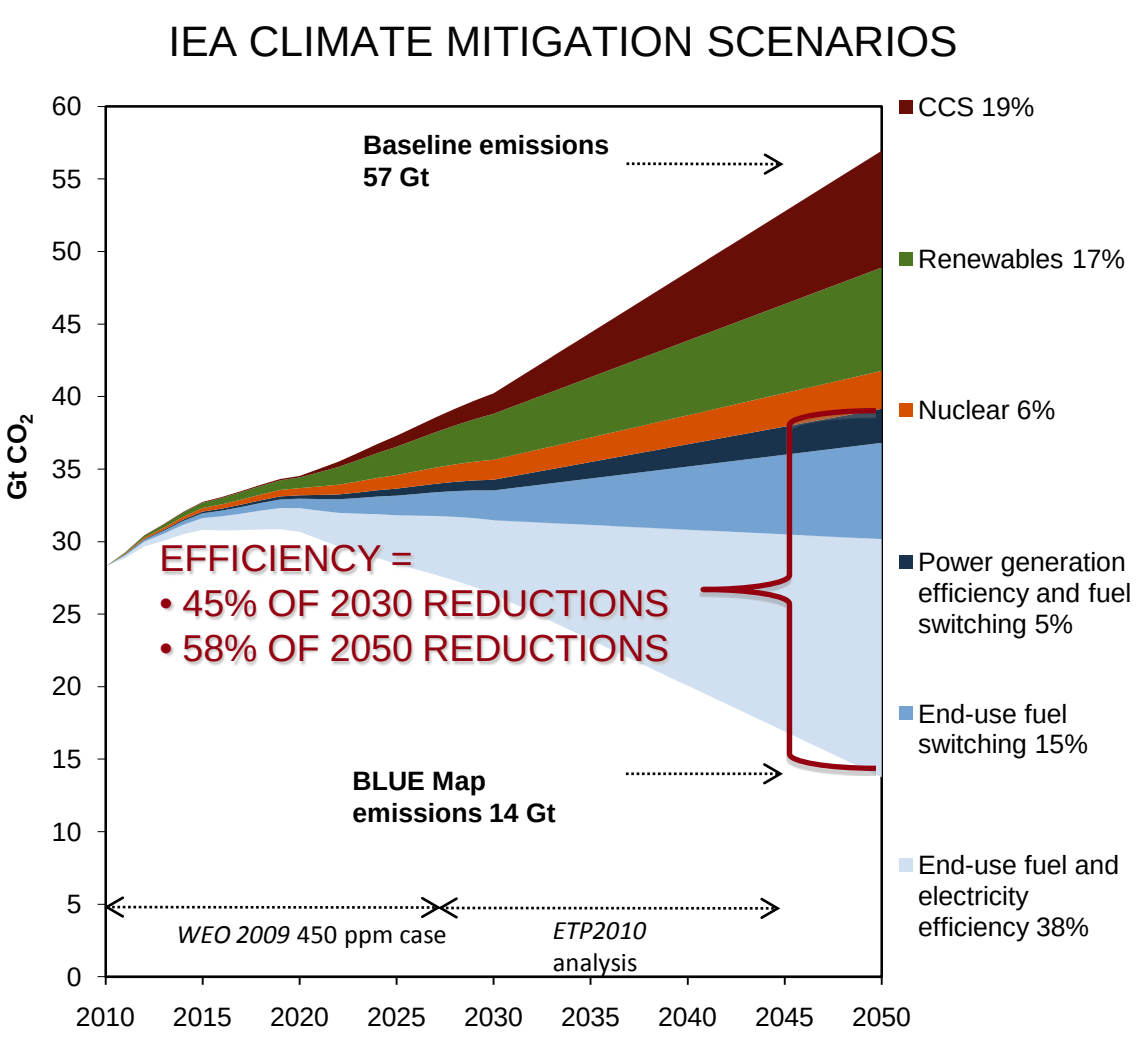
- FURTHER RESEARCH
  1. Saturation effects for end-use energy services (diminishing rebounds over time?)
     - Differences by income distribution?
  2. Rebounds in developing/emerging economics
     - >90% of energy demand growth
     - “The shadow of Jevons lurks” here (Schipper & Grubb, 2000)
  3. Rebounds in productive sectors (particularly substitution & capital turnover dynamics)
     - ~2/3rds of global energy use
  4. Multi-factor productivity gains & implications for rebound, backfire, and economic growth
     - Relates to debate of role of energy productivity in economic growth (neoclassical vs. ecological economists)
  5. Frontier effects (how do we predict/forecast?)

WHERE DOES THIS LEAVE US?

- EFFICIENCY IS STILL GOOD ECONOMIC POLICY, AND PLENTY OF REASONS TO CONTINUE TO PURSUE TRULY COSY-EFFECTIVE EFFICIENCY

- **BUT** CONVENTIONAL CLIMATE MITIGATION STRATEGIES (WHICH TYPICALLY IGNORE REBOUND) ARE **DANGEROUSLY OVERRELIANT ON EFFICIENCY**

ENERGY EFFICIENCY



SOURCE: Thomas Kerr, IEA. Based on World Energy Outlook 2009 and Energy Technologies Perspectives 2010 reports.

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