ACEEE 30th Anniversary Policy Conference

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Real Prospects for Energy Efficiency in the United States (National Academy Press, 2010)

Table S.1: Panel Estimate of Potential for Cost-Effective Annual U.S. Energy Savings in Quads, Achievable with Energy Efficiency Technologies

	Conservative Estimate	
	2020	2030
Buildings - primary (source) electricity	9.4	14.4
- natural gas	2.4 (63%)	3.0
Transportation, light duty vehicles	2.0 (11%)	8.2
Industry, manufacturing	4.9 (26%)	4.9
Total	18.6	30.5

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Buildings as Energy Consumers

Buildings 40%

Transportation
28%

Industry
32%

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US Carbon Dioxide Emissions (EIA BAU)
Millions of tonnes - Carbon

	RESIDENTIAL+ COMMERCIAL		INDUSTRIAL		TRANSPORTATION		TOTAL	
	2005	**2025**	**2005**	**2025**	**2005**	**2025**	**2005**	**2025**
Petroleum	43	48	119	142	526	743	688	933
Natural Gas	120	149	122	150	10	14	252	313
Coal	3	3	55	47	0	0	58	49
Electricity	458	675	182	223	4	6	644	904
TOTAL	624	875	478	562	541	763	1643	2199
		1.7%/yr		0.8%/yr		1.7%/yr		1.5%/yr

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Energy Research at DOE – Was it Worth IT?
Energy Efficiency and Fossil Energy Research 1978 to 2000 (National Academy Press 2001)

- Examined 17 efficiency and 22 fossil energy research programs
- $13B investment yielded estimated $40B economic return
- Three energy efficiency programs, costing approximately $11M, produced nearly ¾ of the benefit!
  - Compressors for refrigerators and freezers
  - Electronic ballasts for fluorescent lighting
  - Low-emission window glass

  - Supplemented by standards and regulations

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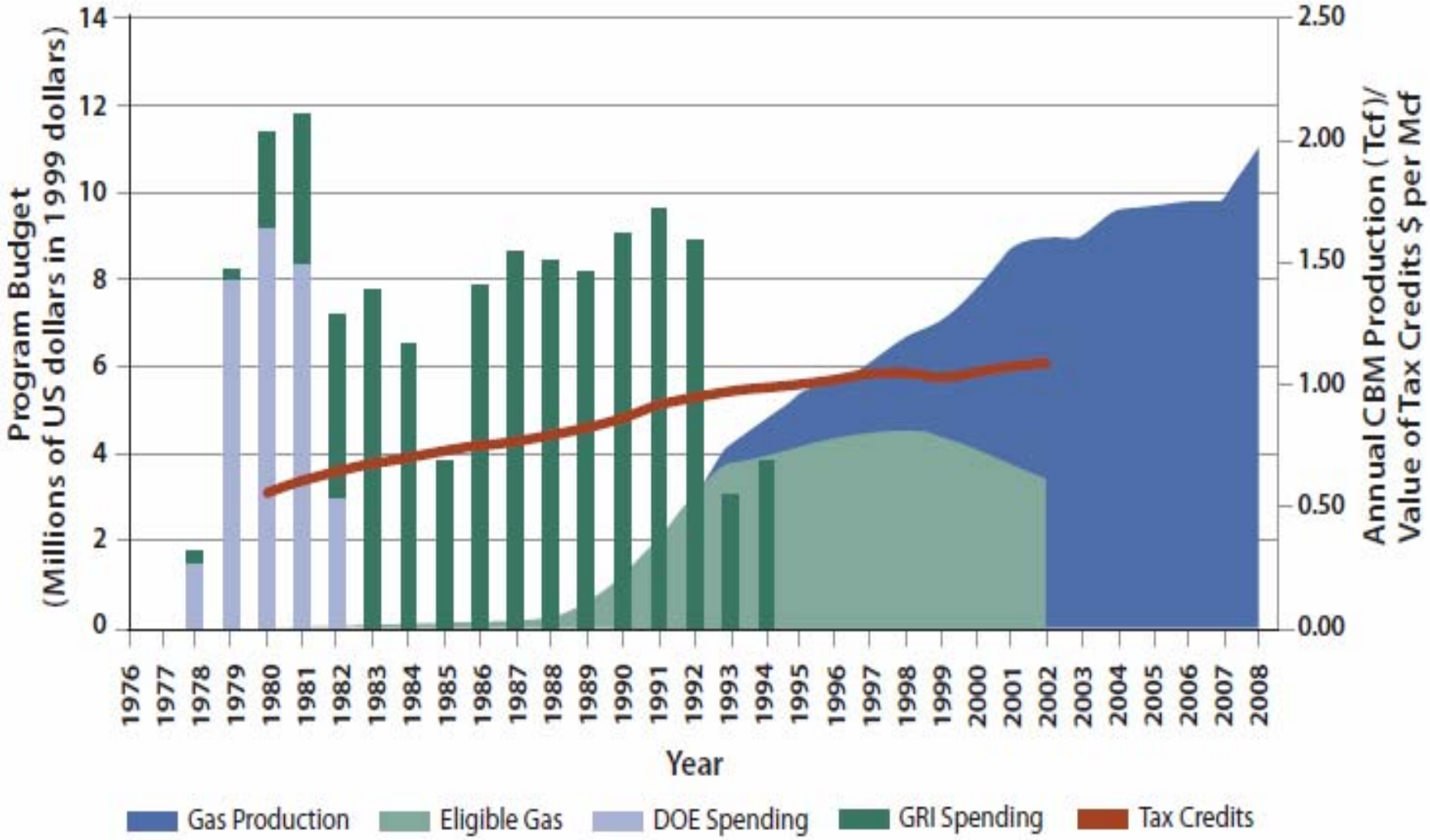
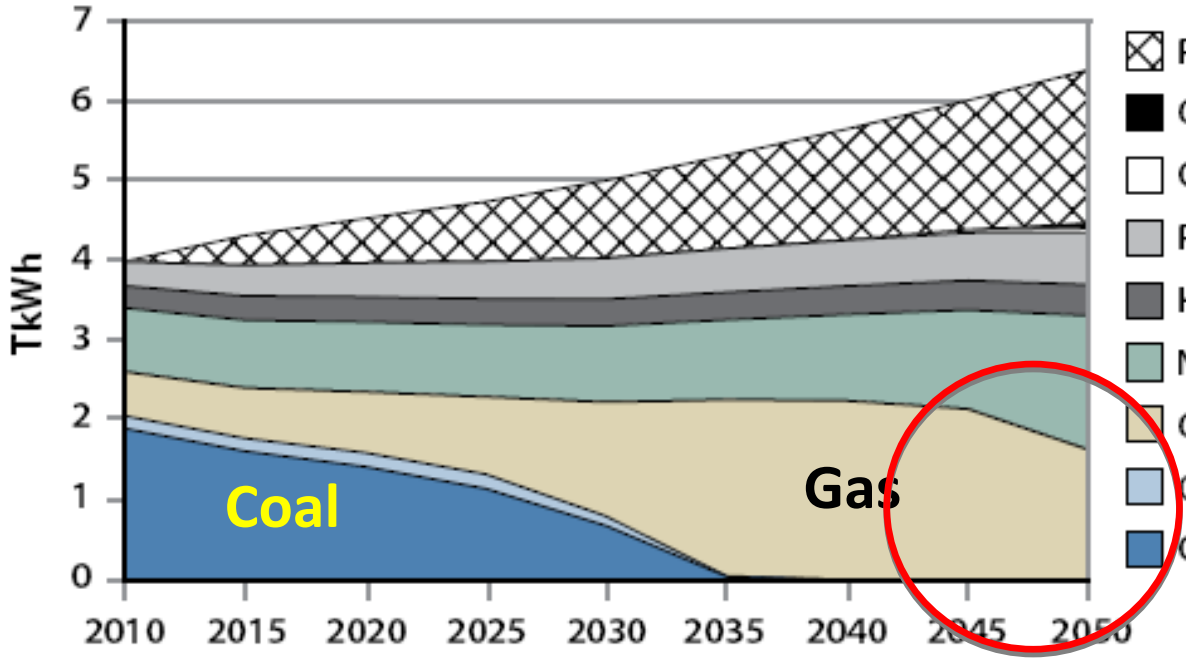
Off-budget R&D Spending and Coalbed Methane



MIT Future of Natural Gas Study

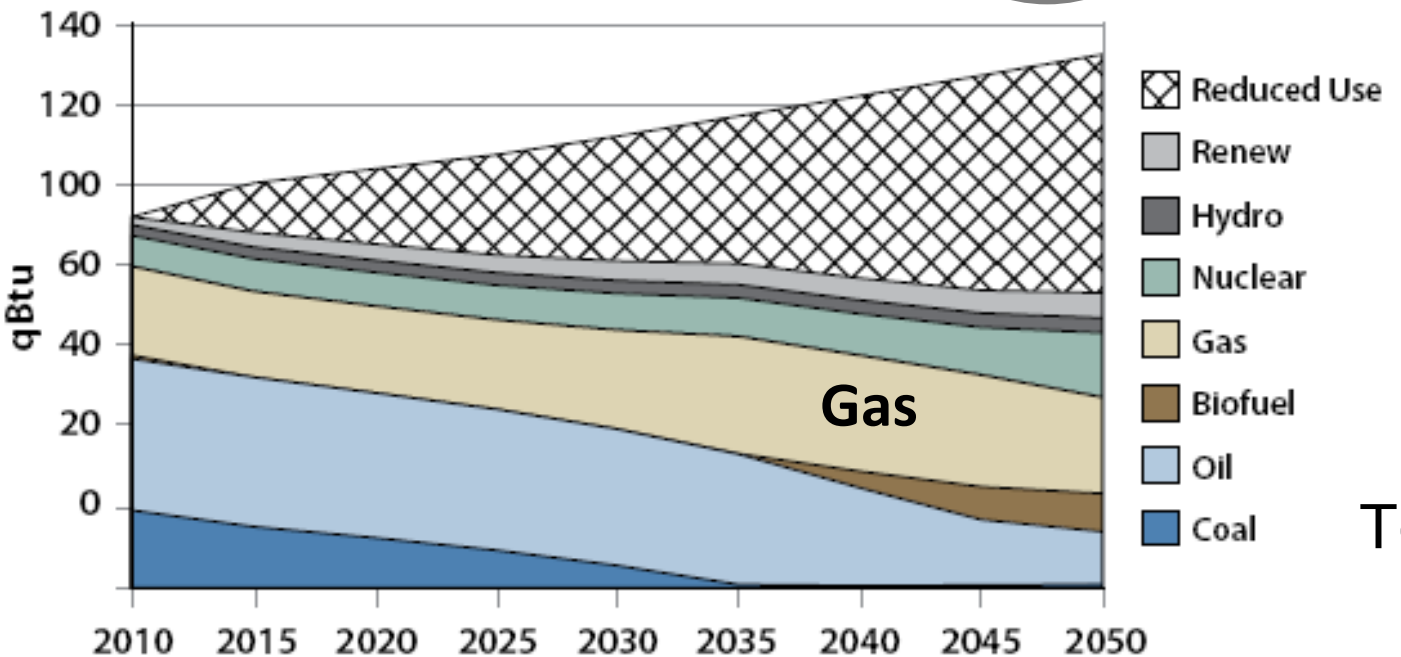


Price-based mitigation

50% by 2050

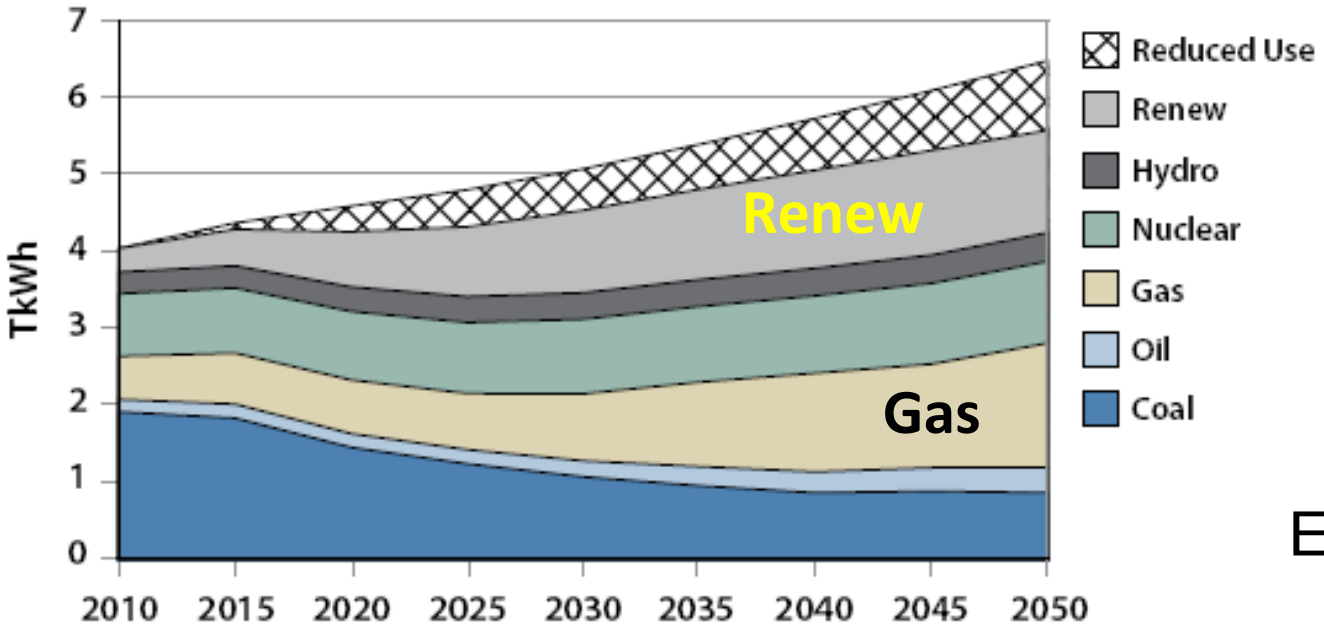
No offsets

Electric sector



Total energy

MIT Future of Natural Gas Study

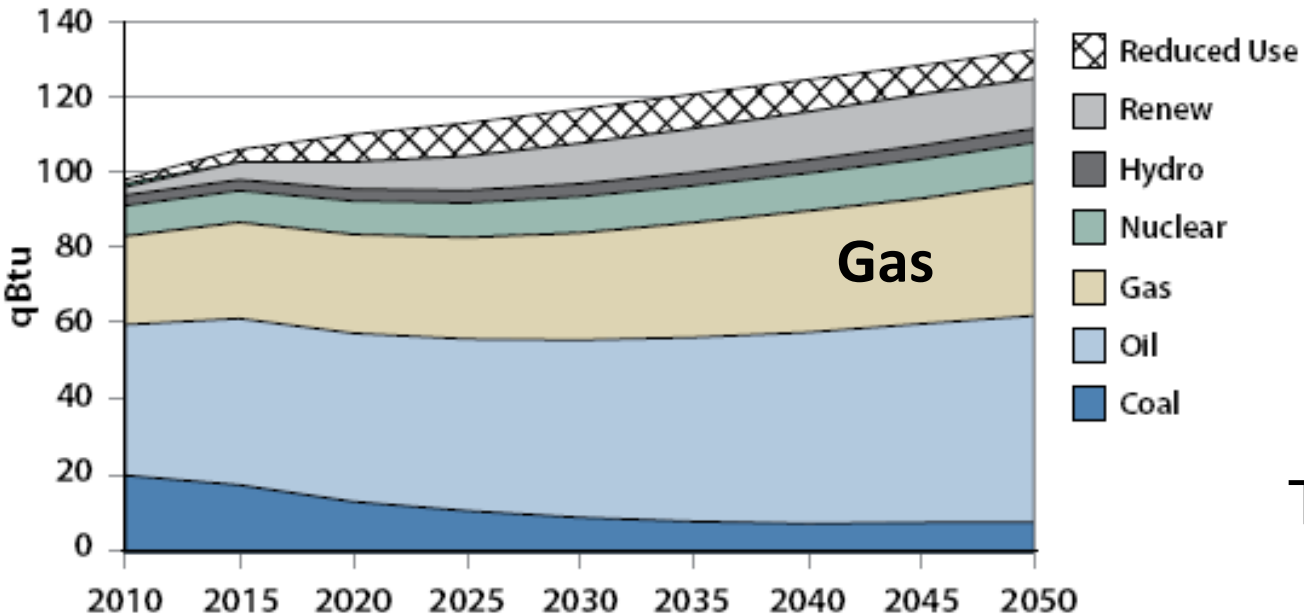


Regulatory mitigation

25% RES 2030

55% coal retire

Electric sector



Total energy

Priority actions for this decade

- Major push on energy efficiency (freedom of action at Federal executive level? DOE Hubs and Hub-lets? address opportunities and barriers in context of integrated energy policy)

- Substitution of NG(CC) for old inefficient coal (CAA rule making/EPA? reality of old coal plants and marginal cost)

- Accelerated RDD&D/Innovation for transformation (where's the $10B? PCAST recommendations for scale and new revenue streams; need business and consumer support)

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Examples of efficiency policies and barriers

- Barriers
  - Up front capital costs
  - Greater returns on alternate investments
  - Energy price volatility and uncertain payback
  - Long lived assets locking-in technologies
  - Lack of clear information for consumers
- Policies
  - Efficiency standards (vehicles, appliances,…)
  - Energy Star
  - Building codes
  - CHP incentives
  - Utility and state end-use efficiency programs
  - RD&D

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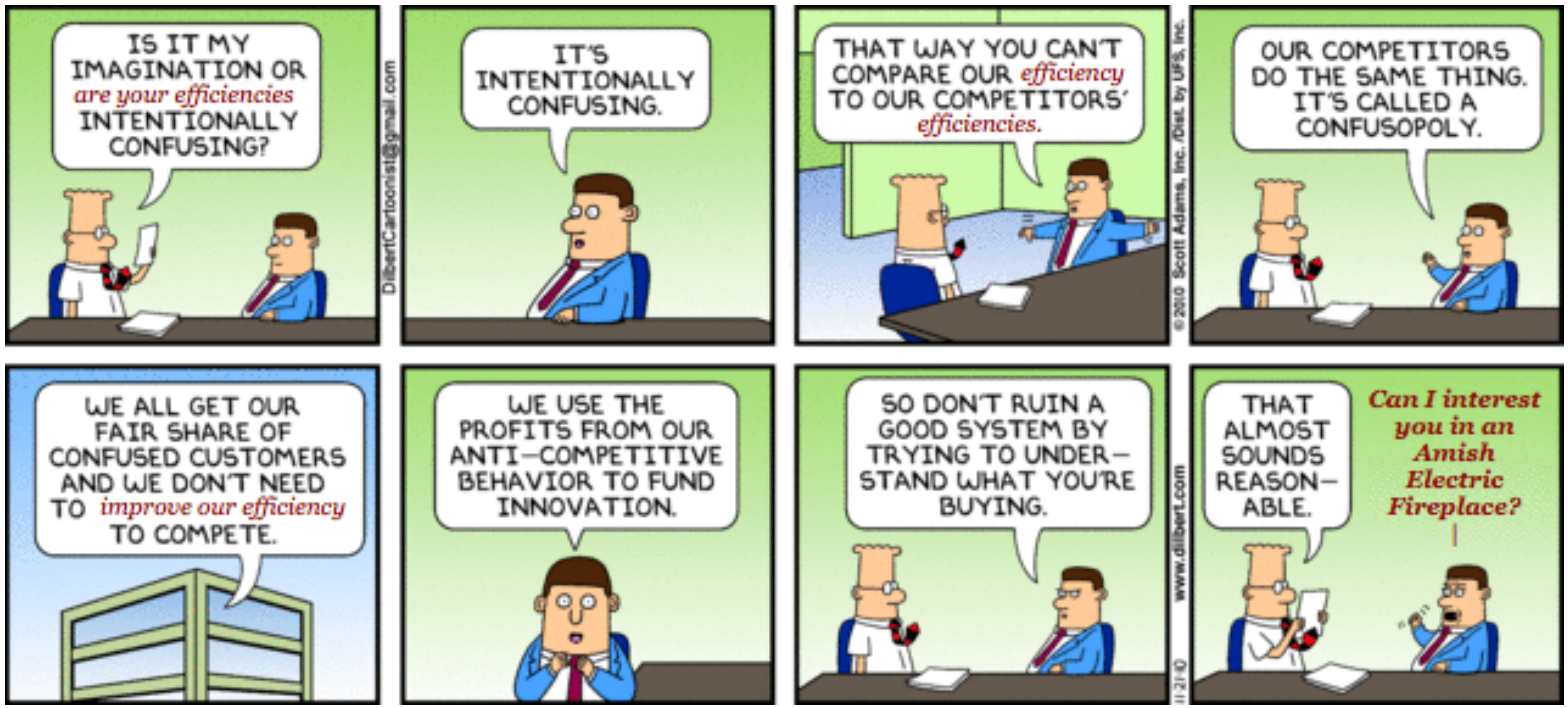
Doctored Dilbert (Steve Connors)



Report to the President on Accelerating the Pace of Change in Energy Technologies through an Integrated Federal Energy Policy

President's Council of Advisors on Science and Technology

November 29, 2010

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- Federal role in end-to-end innovation extends well beyond R&D and must be placed within a comprehensive energy policy.

- “Energy policy” is an amalgam, and often a derivative product, of a wide range of policies and draws upon diverse policy instruments.
  - Environment, economic competitiveness, national security, taxes, land use,…
  - R&D, demonstrations, subsidies, incentives, standards, regulations, purchasing power,…
  - Multiple agencies

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Recommendation: The President should establish a Quadrennial Energy Review (QER).

* Short and long term objectives in context of economic, environmental, and security priorities;
* Outlines legislative proposals and resource requirements (RD&D, incentives,…) and anticipated Executive actions (programmatic, regulatory,…) across multiple agencies;
* Provides strong analytical base.

QER led in the EOP, but with the Department of Energy providing the Executive Secretariat.

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Recommendation: The DOE component of the interagency QER should be prepared promptly.

* Target DOE-QER for June 2011, focusing on DOE objectives, priorities and resource requirements and providing basis for coordination with other agencies;

* Build process and components of interagency QER over four years, targeting January 2015, then settling into quadrennial schedule.

PCAST encourages Congress to use the QER as a basis for a 4-year authorization process, guiding annual appropriations.

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PCAST recommends that the President support annual energy RDD&D expenditures of about $16B – an increase of about $10B.

- PCAST concludes, along with many others, that we are substantially underinvesting relative to leapfrog opportunities;
- Scale appropriate to role of energy in GDP and commensurate with investments of leaders;
- Actual funding will be bottom-up, incorporating results of QER, but it is important to set a scale for R&D portfolio construction;
- Experience with the initial solicitations in the new competitive peer-reviewed energy technology innovation programs suggests that there is ample research capacity to utilize such a funding increase effectively;
- Additional DOE R&D funding should emphasize these competitive programs driving energy technology innovation.

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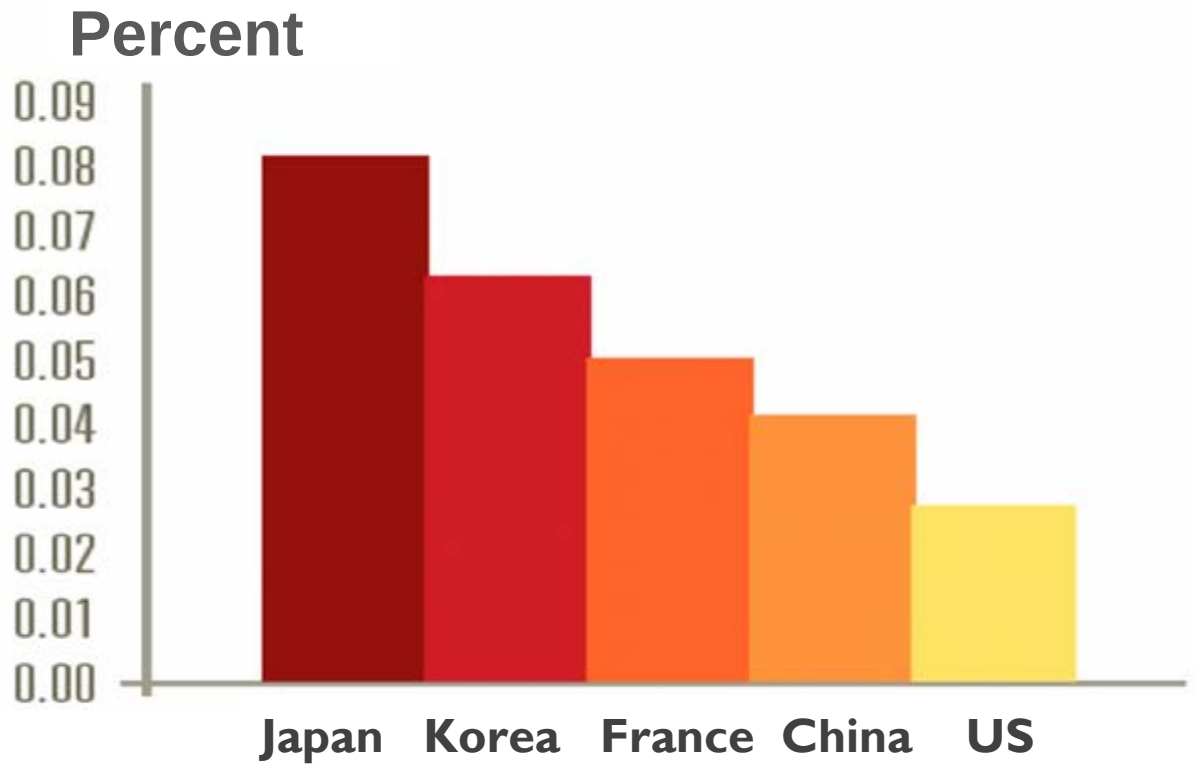
Public Energy RD&D Spending as a Share of GDP, 2007



Source: American Energy Innovation Council (2010). *A Business Plan for America's Energy Future.*

PCAST recommends that the President engage the private sector and Congress to generate the additional funding through “new” revenue streams. This can be accomplished through legislation or through regulatory mechanisms put in place with the collaboration of industry and consumers.

- Where can we find $10B/year? Neither annual appropriations nor a CO2 emissions charge look promising for the near term.
- E.g., 1mill/kWh and 2 cents/gal would yield about $8B/year.
- Prospect is for innovation that lowers consumer costs, protects the environment, and enhances security.
- Precedent exists.

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Recommendation: The Secretary of Energy should implement full range of authorities to streamline and enhance focus on energy objectives.

- Extend processes and procedures used successfully in ARPA-E;
- Manage demonstrations guided by private sector practice;
- With OMB, streamline loan guarantees;
- Review national laboratory capabilities for 21st century energy innovation;
- Form a dedicated Office of Energy Policy, headed by a Director and with a substantial expansion of professional policy staff, and an Office of International Affairs that would continue to be led by an Assistant Secretary;

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Recommendation continued

- Evaluate other potential organizational changes against the criteria of increased focus on QER objectives and alignment with emerging energy technologies and markets; e.g.,
  - Undersecretaries for Energy and Science and for Operations (including EM);
  - separate offices for Energy Efficiency and for Renewable Energy, each headed by an Assistant Secretary;
  - organization of the applied energy offices around end uses rather than “fuels”.

- The newly reconstituted SEAB could helpfully be engaged in these organizational and process evaluations.

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Additional recommendations:

- Inventory existing legislative energy subsidies and incentives and propose reallocation aligned with evolving QER priorities.
- Enhance the Federal Government's opportunity to advance energy technology innovation through its purchasing power (e.g., length of contracts, ESPCs for leased space, budget scoring, incorporate life cycle and social costs,…).
- Leverage international collaboration through a reestablished CISET, operating at the Undersecretary level and developing resourced projects.

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Additional recommendations cont'd:

- DOE should establish a mission-based competitively-awarded traineeship program to address critical energy workforce needs.
  - Integrated programs: PhD and Masters graduate student training, curriculum development, postdocs, undergraduate research,…
- DOE, along with NSF, should initiate a multidisciplinary social science research program, integrated into the energy research and applied programs.

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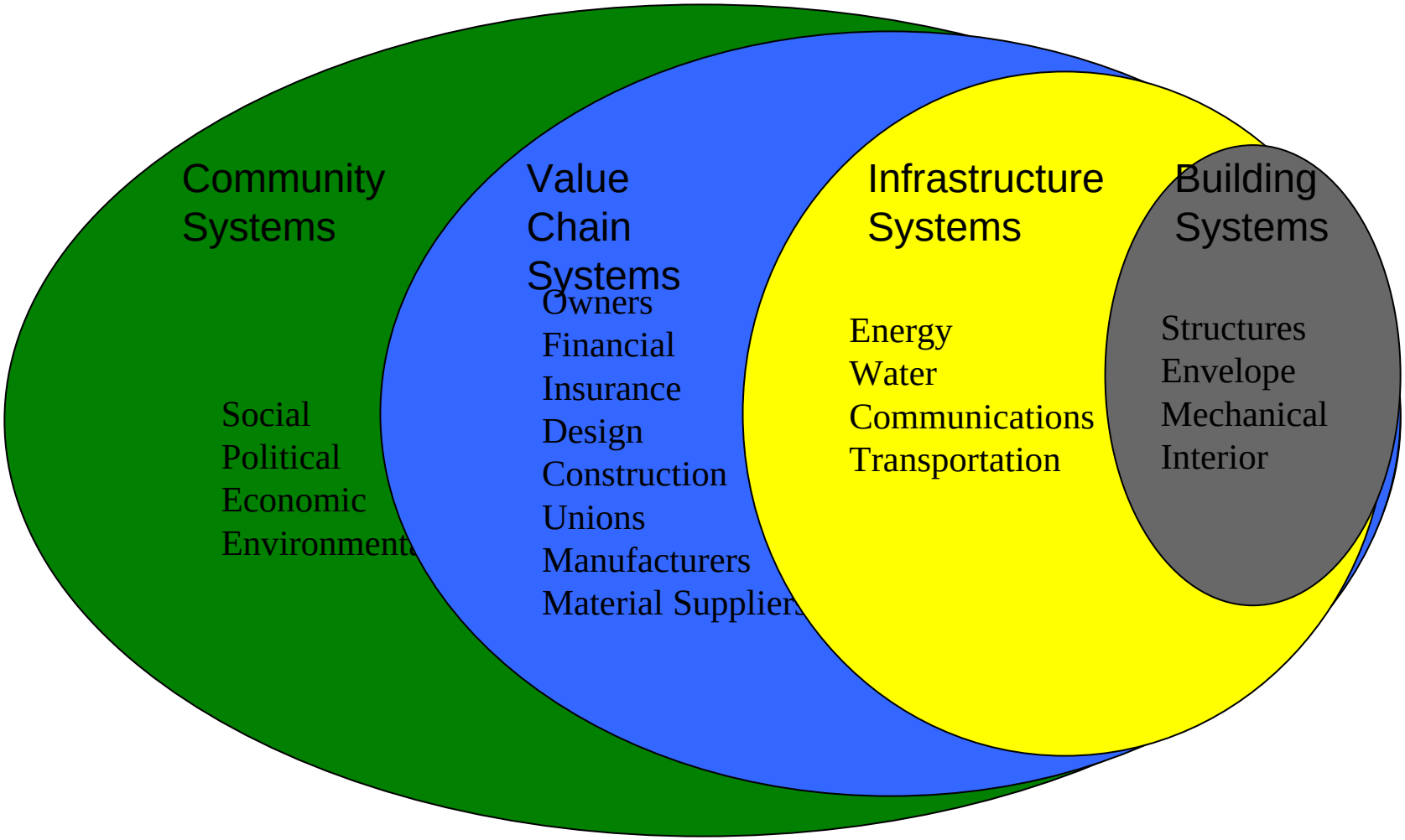
Systems Approach



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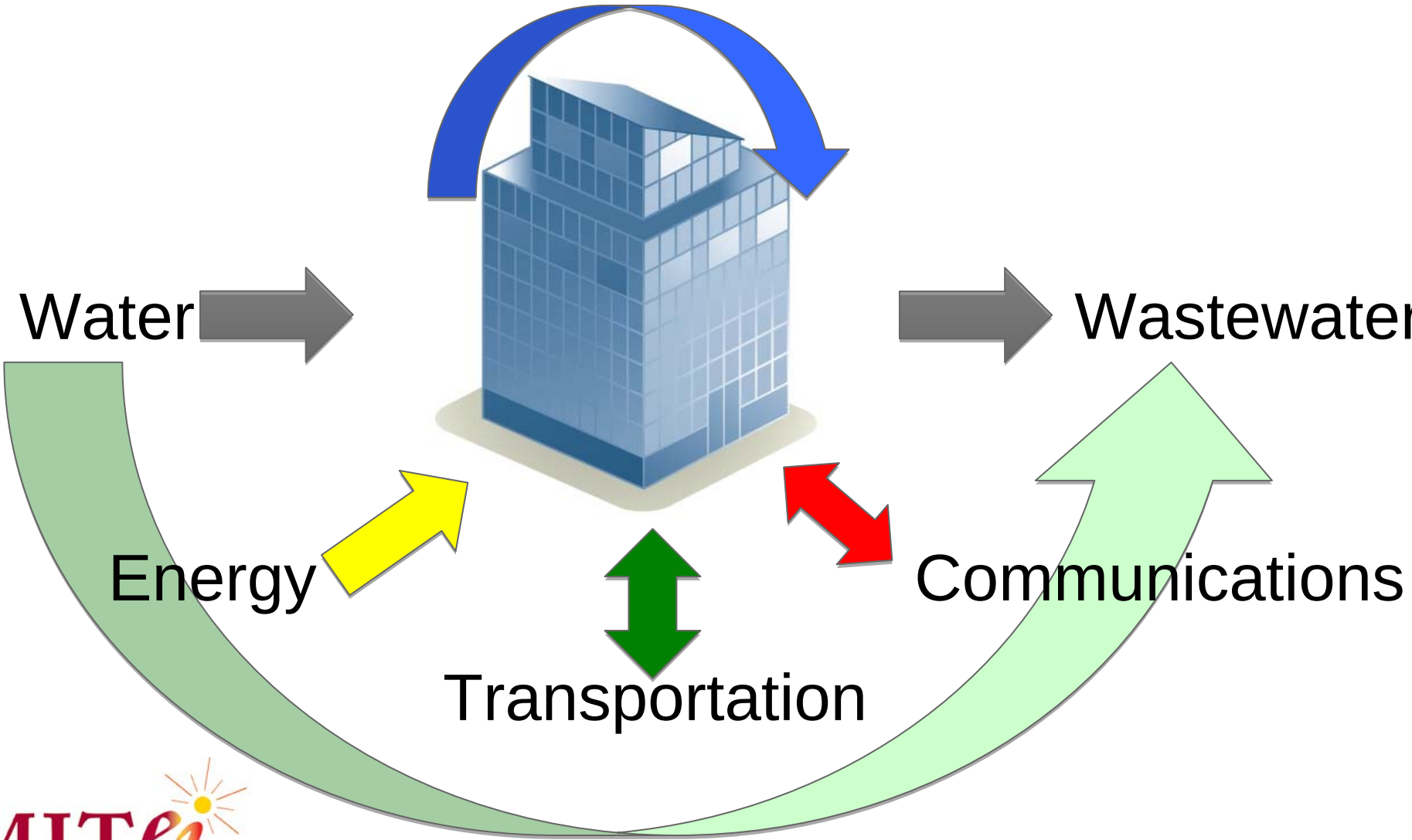
Sarah Slaughter, MIT

System Interdependencies



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RDD&D Partnerships

Research Community

Value Chain Partners

Diffusion Partners

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Integrated Research Groups

- ***Advanced Components and Materials (ACM)*** *– focuses on improving components and materials for building and infrastructure systems, and the systems that connect between or through these domains;*
- ***Information and Controls (I&C)*** *– focuses on sensing, monitoring, feedback, regulation, and control systems for built facilities (buildings and infrastructure);*
- ***Building and Infrastructure Systems Integration (BISI)*** *– focuses on the characterization, modeling, and empirical verification of the interaction among components, equipment, and systems that influence the creation, operation, and upgrades of built facilities;*
- ***Community-Scale Systems (CSS)*** *– focuses on the network of organizations and systems for and across communities and the value chain needed to identify existing solutions and to develop and translate new technical ideas into demonstrable and significant improvements in performance and resiliency.*

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Selected Example Projects

- ACM
  - Nano-engineered surfaces for hydrophilic/phobic surfaces
  - Insulating wallpaper
  - Organic LED
  - Tuned Multi-Functional Envelopes
  - Sustainable Nano-engineered Structural Materials

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Selected Example Projects

- I&C
  - Nonintrusive Utility Monitoring
  - Continuous Commissioning and Diagnostics
  - Behavior-Based Energy and water Efficiency
- BISI
  - Design Diagnostics – Machine Learning for analysis and Models
  - Modeling Net Zero Installations
  - Data Visualization of Large Data Sets

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Selected Example Projects

- CSS
  - System Architecture Design for Interconnected and Integrated Smart Grids and Buildings
  - Emerging Occupations for Upgrading Building and Infrastructure Systems

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