Doubling U.S. Energy Productivity by 2030

ALLIANCE TO SAVE ENERGY

Using less. Doing more.

Alliance Commission on National Energy Efficiency Policy

FEBRUARY 7, 2013

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FOREWORD

As co-chairs of the Alliance Commission on National Energy Efficiency Policy, we are pleased to present this comprehensive report that can set our nation on a path to double our energy productivity and make our economy more competitive. Over the past year we have worked with our commission members and the Alliance staff to produce a bipartisan plan that has the support of all the major groups in energy efficiency.

This comprehensive report reflects the thoughtful, in-depth efforts of the Commission. We considered a wide range of policies and technologies that have the potential to increase our energy productivity and allow us to get more return from our nation's energy dollar, and we selected those that have the best chance to help us achieve that goal. The Commission itself is a diverse group of national leaders that generously donated their time and expertise to this bipartisan effort, and we want to thank them for their selfless efforts.

The nation – both the public and private sector – finds itself at the heart of one of the greatest challenges facing our society; to create new sustainable energy solutions for the future and develop an energy system that can supercharge our economic prosperity for the 21st century. The Alliance Commission on National Energy Efficiency Policy has helped chart this course towards that future.

The report's stated goal of doubling energy productivity by 2030 is an aggressive, yet achievable goal. Increased energy productivity is a worthy pursuit, with multiple benefits related to growing and strengthening our economy, as well as supporting strong environmental stewardship. This blueprint provides a path for federal, state and local officials to make policy decisions that will unleash investment in energy productivity and allow us to bolster our energy security.

We look forward to helping advance a diversity of energy efficiency policy solutions, especially those developed and championed through the critical public-private partnerships emphasized in the Commission's report.

Mark R. Warner
United States Senator
Commonwealth of Virginia

Thomas B. King
President
National Grid US

INTRODUCTION

I am pleased and excited to present the recommendations and final report of the Alliance Commission on National Energy Efficiency Policy. This ambitious endeavor – dubbed ***Energy 2030*** – is the culmination of a year's worth of research, collaboration and hard work by those involved.

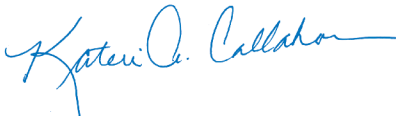
Created and led by Senator Mark Warner (D-Va.) and National Grid US President Tom King, the Alliance's Commission includes energy thought leaders from business, academia, government, and the non-profit sector. In collaboration with technical and international advisory councils, the Commissioners shaped their policy prescriptions to address some of the most pressing matters of our time: improving economic performance and global competitiveness; enhancing the quality of life for all Americans; driving technological innovation; and increasing the reliability, resiliency and security of our energy infrastructure – all while ensuring a healthy and clean environment.

For decades energy efficiency has been America's most abundant, affordable and accessible energy resource, and the policies and strategies that support it, many crafted by the Alliance, have benefited our nation's people, economy and environment. In keeping with this Alliance history and recognizing the urgent need to drive our economy forward, ***the Commission established an ambitious goal of doubling U.S. energy productivity (getting twice as much from each national energy "dollar") by 2030***.

The Commission has concluded that this aggressive goal can be realized through greater investment, modernization and education. ***Energy 2030*** is carefully crafted to appeal broadly to lawmakers of both parties and the general public, and to ensure that we maximize energy productivity in every aspect of our economy – from family homes to the shop floor to the ways we move people and goods.

On behalf of the Board of Directors, Associates and staff of the Alliance, as well as energy efficiency advocates worldwide, my sincerest thanks and appreciation go to all of those involved in creating ***Energy 2030*** – a clarion, national goal and a plan for how to act quickly to achieve it. The Alliance will work to make certain that the goal of doubling U.S. energy productivity is embraced widely and fully, and that the Commissioners' tireless work ultimately translates into actionable policy offerings and best practices for businesses and consumers.

If you are not yet part of ***Energy 2030***, please join us. By working together, we can make today's challenge of achieving greater energy productivity tomorrow's reality.



Kateri Callahan
President of the Alliance to Save Energy

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SUMMARY COMMISSION RECOMMENDATIONS

The United States can double its energy productivity[1] by 2030 using cost-effective technologies and practices. Benefits to the nation from achieving this goal would be monumental. According to the economic impact modeling described later in this report, the net benefits could be over $1,000 a year in average household savings in utility and transportation costs, over a million added jobs, a one-third reduction in carbon dioxide emissions, and a similar reduction in oil imports. The Alliance Commission on National Energy Efficiency Policy urges policy makers and the private sector to take immediate and concerted action—based on the recommendations below—to grow our economy and create jobs while using less energy and reducing associated costs, environmental harm and security impacts.

We recommend three overarching strategies to meet this energy productivity goal:

- **UNLEASH INVESTMENT** in energy productivity throughout the economy,
- **MODERNIZE REGULATIONS** and Infrastructure to improve energy productivity, and
- **EDUCATE AND ENGAGE** consumers, workers, business executives, and government leaders on ways to drive energy productivity gains.

Because energy productivity gains are cost-effective, we believe these strategies can be implemented without burdensome mandates or massive government spending. However, to achieve this goal and its benefits, some public-private partnerships, and targeted government investments will be needed, and some rules will need to be reformed and strengthened. Thus we make the following policy recommendations for federal, state, and local governments, as well as the private sector (more details on each recommendation appear later in this report).

UNLEASH INVESTMENT IN ENERGY PRODUCTIVITY

Well over a trillion dollars in cost-effective energy savings opportunities are available in the United States, but achieving the savings will require the investment of hundreds of billions of dollars. Currently, a broad energy efficiency finance sector does not exist. Action is needed to provide capital for investments to increase energy productivity.

RECOMMENDATIONS

- **Make financing more easily available for energy efficiency projects:**
  - Make more capital available by enabling institutional investors to buy energy efficiency financial obligations on a large scale using securities based on uniform contract structures and better performance data.
  - Establish state and local programs for financing of efficiency measures, which may use repayment on utility bills or on property tax bills (the capital could be provided by institutional investors).
  - Consider household energy and transportation costs when underwriting mortgages to allow for larger or more attractive loans for homes with lower monthly costs.
- **Advance energy productivity through federal tax reform:**
  - Reform federal energy efficiency tax incentives so that they focus on high efficiency technologies and measures and on promoting innovation and market transformation.
  - Adjust commercial and industrial depreciation schedules to encourage investments that can boost energy productivity.
- **Support energy productivity innovation and market adoption:**
  - Increase federal investment in basic and applied research, development, demonstration, deployment, and technical assistance.
- **Governments lead by example:**
  - Apply innovative best practices to government buildings and vehicle fleets.
  - Make all cost-effective efficiency improvements to federal buildings using private financing and public funds

[1] *Energy productivity is the level of economic activity achieved using a given amount of energy, or dollars of Gross Domestic Product divided by the total energy used in the country.*

MODERNIZE REGULATIONS AND INFRASTRUCTURE

Governments, businesses, and individuals will be spending trillions of dollars to modernize our nation's infrastructure (such as smart energy grids, and multi-model transportation networks) and other capital (such as green building, advanced air conditioners, and hybrid vehicles). As all of these systems use energy, these investments will provide a tremendous opportunity to improve energy productivity. Action to reduce energy waste will also help achieve the goals of modernization, which include economic growth, reliability, clean air and water, and consumer cost savings.

RECOMMENDATIONS

» **Create a national "Race to the Top" style energy productivity competition targeted at states and communities:**

- Incentivize innovation and adoption of best practices by state and local governments based on energy productivity improvements, investments, and regulatory reform. States would receive technical assistance and funding based upon policy and regulatory reforms like those recommended in this report on building energy codes and disclosure, efficiency programs and financing, utility reform, and transportation planning and investments.

» **Use energy productivity to achieve regulatory and planning goals:**

- Adopt utility policies that make full use of all cost-effective demand-side management (end-use energy efficiency and demand response) as a resource. Such state-level policies may include broad and targeted savings goals, financial incentives for utilities, time-variant customer rates, fair treatment of combined heat and power and other distributed resources, and harmonized program evaluation.
- Advance regional and local transportation and land use plans that promote energy productivity by improving access to work, services, school, and play, and by increasing transportation options including safe walking, biking and public transportation. Provide funding and technical assistance to enable efficient development patterns and transportation infrastructure that is consistent with the regional and local plans.
- Use energy efficiency as an emissions reduction strategy in environmental regulations.
- Ensure major government and regulated infrastructure spending on energy grids, transportation infrastructure, and water and waste systems increases energy productivity.

» **Strengthen building, equipment, and vehicle efficiency standards:**

- Steadily and aggressively increase the stringency of building energy codes, with quick adoption and effective compliance measures.
- End current delays and update federal appliance and equipment, vehicle, and manufactured housing efficiency standards to maximum technologically feasible and economically justified levels.

EDUCATE AND ENGAGE STAKEHOLDERS

Successful adoption and implementation of policies that will enable a doubling of U.S. energy productivity requires the engagement and leadership of stakeholders across the economy. The current deficit information, coupled with our human tendency to revert to the inefficient status quo or norm, are major barriers to greater energy productivity. Action is needed to provide easy access to reliable, useful information and to encourage consumers, workers, business executives, and government leaders to engage in reducing energy waste.

RECOMMENDATIONS

» **Provide information on building energy efficiency and energy use:**

- Develop effective building energy ratings, benchmarks, and disclosure methods for commercial and residential buildings; require periodic disclosure in commercial buildings and disclosure at time of sale or rental in residential buildings; and incorporate the information in building appraisals and real estate listings.
- Enable customers and third parties authorized by the customers to access their energy usage data, while ensuring customer privacy.
- Develop harmonized energy use labels with discrete ratings for appliances and vehicles that are coordinated with building energy labels.

» **Improve corporate energy management and transparency:**

- Effectively manage corporate energy use and report on energy productivity as part of corporate sustainability reporting.

» **Develop educated consumers and trained technicians:**

- Develop school and university curricula on energy use and productivity, conduct consumer campaigns, develop technical certifications, and provide related workforce training and continuing education.

WHY DOUBLE U.S. ENERGY PRODUCTIVITY?

The Alliance Commission on National Energy Efficiency Policy (the Commission) adopted the goal of doubling U.S. energy productivity by 2030 relative to 2011 levels. Energy productivity means the level of economic output divided by the total energy used to achieve it, and can be expressed as dollars of Gross Domestic Product (GDP) per unit of energy consumed (in British thermal units—Btu). Meeting that target can deliver multiple large benefits to the United States, including enhanced economic competitiveness, technological innovation, greater energy reliability and security, and strengthened stewardship of our environment and natural resources.

The Commission's energy productivity target is aggressive but achievable. Figure 1 shows how the Commission's goal compares with the reference (or business-as-usual) case projection of the U.S. Energy Information Administration (EIA) 2012 Annual Energy Outlook.

Over the last 40 years, the United States has made significant gains in energy productivity. In 1970, about $63 billion of GDP in year 2005 dollars were produced per quadrillion Btu (quad) of energy used in the United States.[2] In 2011, the figure was about $135 billion per quad.[3] The Commission's goal is for the U.S. economy to achieve $270 billion (in 2005 dollars) of GDP for each quadrillion Btu consumed in 2030.

If not for U.S. energy productivity gains since the early 1970s, the United States would need to consume about 50% more energy—with concomitant impacts on energy bills, oil imports, energy reliability and security, and environmental quality—to deliver today's GDP. Another way to think of this is that energy efficiency is our "first fuel," contributing more to the national economy than any individual fuel or source of energy supply. Figure 2 graphically illustrates the point.

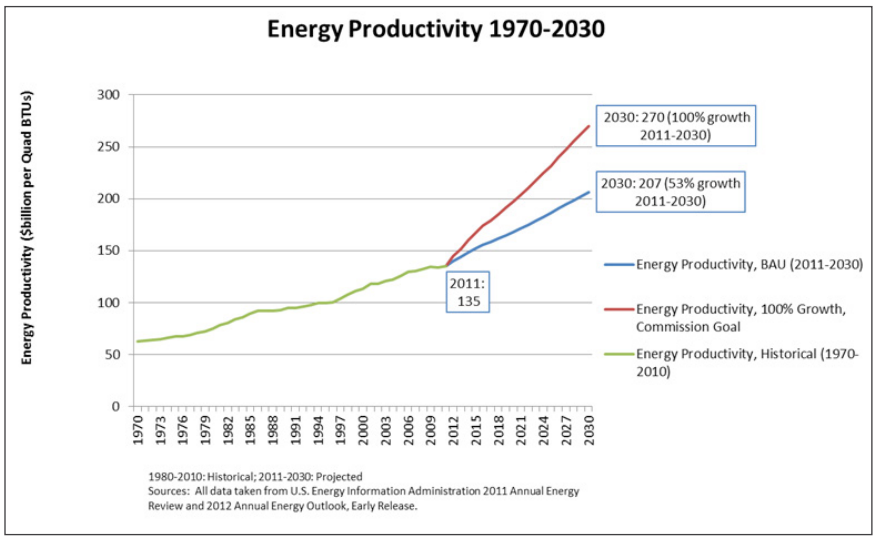

Figure 1. Historic and Projected U.S. Energy Productivity as Compared to the Commission Goal (billion 2005 dollars of GDP per quadrillion Btu)

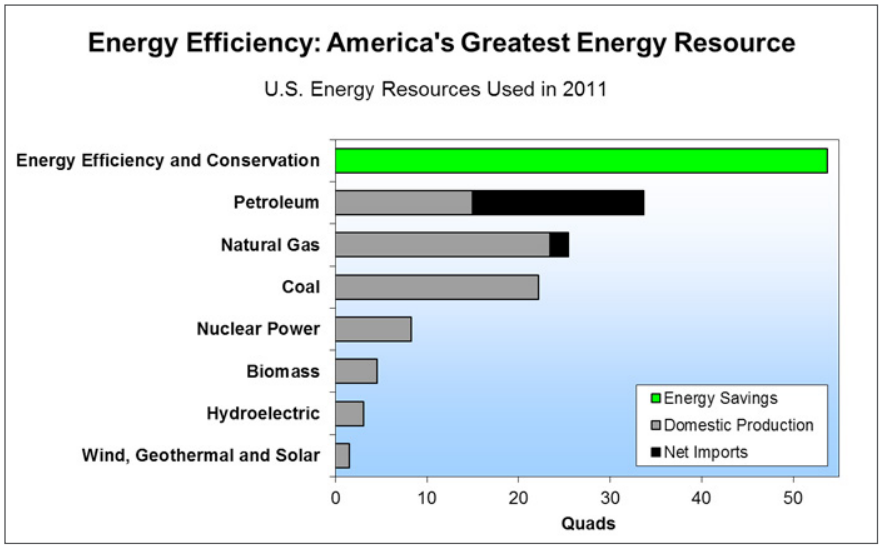

Figure 2. Energy Efficiency: America's Greatest Energy Resource
Note: Energy savings are based on energy efficiency improvements since 1973.
Source: Alliance to Save Energy 2013

2 *Energy consumption data from U.S. Energy Information Administration, "Table 1.1 Primary Energy Overview, Selected Years, 1949-2011." ; GDP data from U.S. Department of Commerce, "Current-Dollar and 'Real' Gross Domestic Product" spreadsheet.*

3 *U.S. Energy Information Administration, "Annual Energy Outlook 2012 early release." The Commission agreed to use the reference case of this AEO release as a baseline.*

Our enhanced energy productivity came from a combination of factors, including policies and changes in technology, economic structure, and demographics. Improvements in material and water productivity, from reduced waste and increased recycling, also contributed to national energy productivity because significant amounts of energy are required to process and distribute materials and water in the economy.

The Commission found large energy productivity gain potential across all economic sectors and fuels (although its national economic productivity goal does not suggest a goal of doubling energy productivity in each individual sector). Each major sector is itself a large consumer of energy as shown in Figure 3, which provides a snapshot of current and projected energy use in the United States.

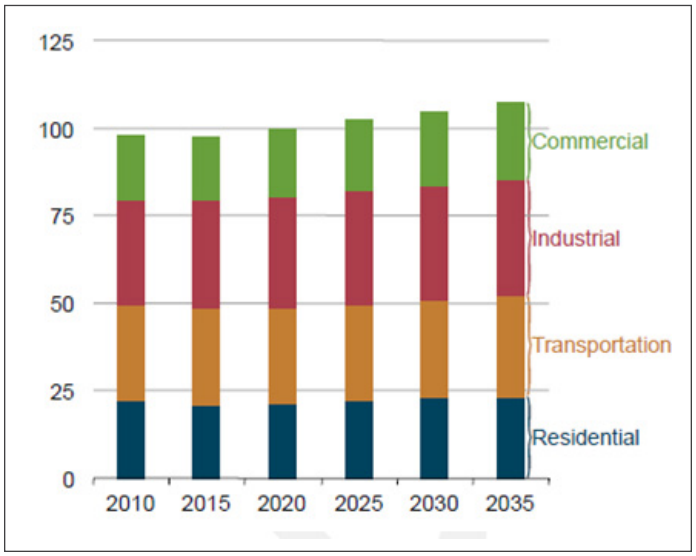

Figure 3. Primary U.S. energy use by end-use sector, 2010-2035 (quadrillion Btu

While the United States has made significant energy productivity progress over the last several decades, the nation cannot afford to rest on its laurels. Indeed, heightened international economic competition; stresses on American energy, transportation, and other physical infrastructure; continued economic and geopolitical vulnerabilities to energy price shocks (despite increased North American oil and natural gas production); and multiple environmental challenges associated with energy all indicate a need to strengthen U.S. efforts to enhance energy productivity.

Productivity of energy use, like productivity of capital, labor, and material inputs, is integral to economic competitiveness. Companies that make the most efficient and effective use of inputs to production—more bang for the buck and, in the case of energy, more bang for the Btu—tend to be more profitable and competitive than less productive firms in their industries. Regionally and nationally, higher energy productivity of companies and public sector institutions can lead toward enhanced prosperity and quality of life not only because of the greater productivity and competitiveness of businesses but also from greater efficiency in public services and infrastructure, more reliable and secure energy services, and reduced public health and environmental effects of energy-related pollution and degradation.

Although energy productivity is just one factor that contributes to economic well-being, it is noteworthy that a number of industrial countries exhibit higher levels of energy productivity than the United States does, and that major emerging economies are experiencing energy productivity growth. Figure 4 illustrates energy productivity trends for selected countries, though the graph should be used with caution since differing national industrial structures, climate, size, and other factors affect energy productivity.

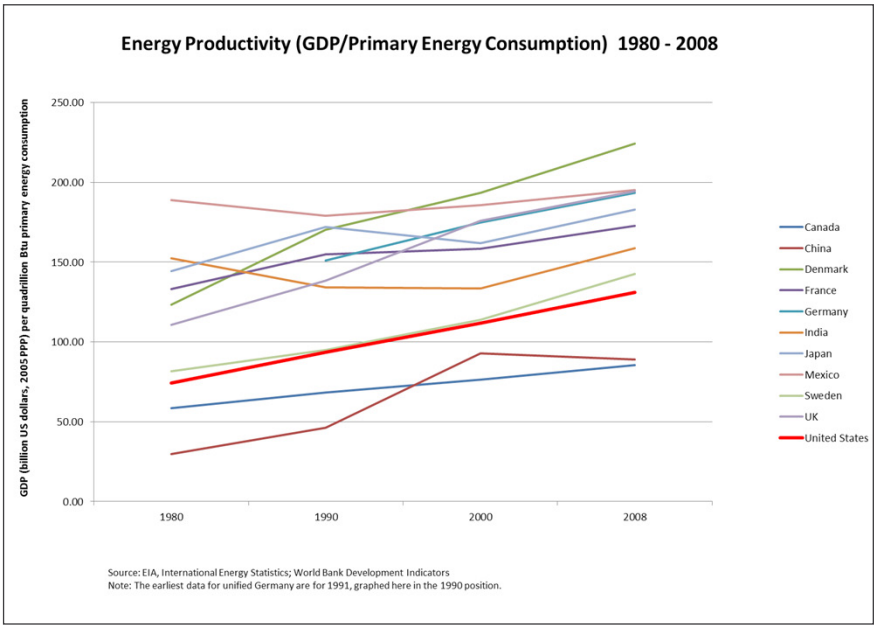

Figure 4. Energy Productivity Comparisons of Selected Countries

At the Commission's request, the Rhodium Group modeled potential impacts of doubling U.S. energy productivity between now and 2030. The Rhodium Group used engineering studies to identify cost-effective investment opportunities in the building, industrial, and transportation sectors. The integrated energy-economic model suggests that $166 billion (year 2010 dollars) in energy productivity investments each year could yield a net annual savings of over $327 billion nationwide in 2030 and yield a net employment increase of almost 1.3 million jobs in that year. Per household savings are estimated at about $1,000 per year and national industrial output could increase by $100 billion in 2030 due to reduced energy costs. The Rhodium Group's analysis also points to significant reductions in carbon dioxide emissions (down to 4 billion tons or 33% below 2005 levels) as well as sulfur dioxide and nitrogen oxides emissions. Further, lower oil imports and higher energy productivity would decrease American vulnerability to oil price spikes, reducing direct costs of spikes by up to 30% relative to business-as-usual. The model projects that in 2030, the United States would import 7% of its energy demand rather than 12% in the business-as-usual case.[4]

The next section of this report describes principal findings of the Commission and briefly summarizes some significant points from the supporting research reports.

COMMISSION FINDINGS

The Commission relied on a series of research reports and a systems integration report (described in the "Background Research for Policy Development" section) to establish the current status and potential for energy productivity in various economic sectors. This section first summarizes top level cross-cutting findings from the report. This is followed by a discussion of barriers and opportunities to energy productivity improvement and an examination of cross-cutting themes of investment, technology, human behavior, and government and governance.

TOP LEVEL FINDINGS:

There is potential to greatly improve American energy productivity across all sectors of the economy using existing technologies and practices and by developing new technologies and approaches.

Energy productivity improvements offer multiple benefits to individual firms and consumers as well as to the nation and society as a whole. Among these benefits are greater economic productivity and competitiveness; technological innovation; consumer and business cost savings and reduced vulnerability to energy price volatility; more reliable and secure energy systems; and reduced adverse environmental impacts.

Energy productivity gains come from energy-specific investments and also are co-benefits of investments undertaken primarily for other reasons. New capital stock tends to be more energy efficient than older stock. So industrial plants refurbished or expanded to improve production rates or product quality can also deliver greater energy (and material and labor) productivity. Likewise, building renovation and upgrades, old vehicle replacement, and infrastructure enhancements offer energy productivity improvements.

Numerous hurdles impede implementation of currently cost-effective energy productivity investments and hinder the development of new technologies and practices. These include split incentives between those who make energy decisions and those who pay energy bills, information barriers and uncertainties, first cost and financial return criteria, and some regulatory disincentives, among others. (See also Table 1.)

Public policies can provide tools for overcoming these impediments. These are discussed further in the Commission's recommendations section.

Private sector policies and governance are vital for achieving energy productivity gains since the private sector dominates economic decision making. Some companies have organized themselves to better recognize and implement energy productivity opportunities, through corporate goals, employee incentives and accountability, and use of formal Energy Management Systems, for example. Sometimes working with government agencies, the private sector develops and adopts technical standards, workforce training criteria, and professional norms pertinent to energy management. They can also advance energy productivity among their peers and through their supply chains.

4 *Rhodium Group, "American Energy Productivity: The Economic, Environmental and Security Benefits of Unlocking Energy Efficiency."*

OPPORTUNITIES AND BARRIERS

Table 1 encapsulates selected opportunities and barriers identified in the Commission research reports.

Table 1. Energy Productivity Improvement Opportunities and Barriers

OPPORTUNITIES	BARRIERS
EFFICIENCY POTENTIAL: » Large potential to expand use of currently available best practices and technologies » Large potential for new, more efficient technologies and processes » Advances in information technologies and smart and intelligent systems » Energy efficiency is often the lowest cost energy resource (i.e., often cheaper to save than to buy energy) **INFORMATION, INVESTMENT, AND MANAGEMENT:** » Capital modernization and investments made for other purposes often increase energy productivity as a co-benefit » Energy management systems integrate energy in corporate decision making, motivate employees and stakeholders to pursue efficiency, and inculcate continual improvement ethos » Education and training of workers, managers, policy makers, the public » Improved data and information can: • Empower consumers/users to better manage energy • Control risks and uncertainties to unleash greater investment • Spur adoption of energy efficient technologies and practices » Government leadership by example as test bed and early market for energy efficient products, technologies, and services **REGULATIONS, PLANNING, AND INCENTIVES**: » Utilities, grid operators, and regulators increasingly value and plan for demand-side resources (energy efficiency, demand response, and CHP); well-crafted rate structures, incentives, and rules can promote utility-customer partnerships » Increasing recognition of energy efficiency as a means to improve environmental quality, including in air quality planning and regulation, and as further highlighted in the impact modeling section of this report » Codes and standards can set floor that protects consumers and shifts market » Tax policies can encourage energy productivity » Land use and infrastructure planning and approval processes can enhance energy productivity of communities and infrastructure systems	**FINANCIAL BARRIERS:** » High investment hurdle rates (i.e., require high ROI rates and short payback periods) » High first cost of various efficiency measures » Cost reducing, including energy savings, investments can be undervalued relative to other investment opportunities » Macroeconomic uncertainties and weak economy **MARKET STRUCTURE BARRIERS:** » Split incentives (e.g., landlord-tenant relationship) inhibit optimal investment » Fragmented industries and spillover effects lead to modest levels of R&D » Diverse utility rate structures, incentives, and regulations have varied, inconsistent impacts on energy efficiency across the states **INFORMATION BARRIERS:** » Insufficient data and information on performance of energy productivity measures » Energy is a small portion of production costs for many businesses so may not garner strong management attention » Shortage of skilled, qualified energy managers and analysts » Manufacturing extension and technical services are modestly supported and limited in scope » Low public awareness of energy efficiency options and benefits **PRICING AND REGULATORY BARRIERS:** » Tax and depreciation rules that discourage capital investment » Environmental impacts may not be fully reflected in cost structures » Moderate natural gas prices in the U.S., while a boon to consumers, may reduce attention to energy savings opportunities

INVESTMENT

In each sector examined—manufacturing, buildings, transportation, and electric and natural gas systems—the opportunities for cost-effective benefits are vast compared to those of the resources made available. For example, McKinsey & Company estimated that $354 billion in building energy efficiency investments during 2009-2020 could yield $685 billion in savings.[5] But in 2010 about $18-20 billion was invested in the sector by a combination of utility energy efficiency programs, Energy Savings Performance Contracts (mainly for public sector buildings), and one-time federal stimulus (American Recovery and Reinvestment Act) spending. There is a great opportunity for additional investment vehicles to profitably finance energy efficiency improvements.

For manufacturing, the National Research Council cited estimated potential savings of 14 to 22% of total industrial sector energy use (4.9-7.7 quads) in 2020 as compared to projected energy use in the reference case. The savings were based on cost-effective technologies that yield at least a 10% internal rate of return or a return greater than the company's cost of capital plus a risk premium.[6]

Uncertainties and risks, capital constraints, corporate strategy, and public policy affect decisions to invest in energy productivity as significantly as they do other investment decisions. Businesses and households can be dissuaded from making energy or other upgrades by high first-costs. Both often demand very rapid payback on investments. Table 2 illustrates typical ranges of returns demanded by different investor categories. Companies often prefer growth investments that expand production and product offerings over cost savings investments (such as for saving energy) even when the cost savings investments offer greater immediate returns. Consumers, businesses, and investors are also affected by uncertainty and perceived risks—will upgrading lighting, replacing an industrial furnace, buying hybrid trucks, or putting money in an energy efficiency investment fund, for example, deliver the desired performance?

Energy productivity investments may be undertaken primarily to achieve energy benefits, but often energy productivity gains are a co-benefit of investments made for other purposes. A broader modernization of manufacturing, renovation of building stock, replacement of vehicles, and upgrade of infrastructure can yield energy productivity gains while simultaneously improving economic productivity and business competitiveness, quality of products and services, and energy and environmental performance. For example, in manufacturing, the growth of scrap-using electric arc furnace mini-mills in the U.S. iron and steel industry has occurred mainly for economic competitiveness reasons but it has also raised energy productivity. Promising opportunities for such investments exist across all sectors of the economy.

Table 2. Illustrative Investment Requirements by Sector

SECTOR	SIMPLE PAY-BACK (YEARS)	RETURN-ON-INVESTMENT (ANNUAL %)
Government	7-30	3-10
Investors	3-7	10-25
Industry	1-3	25-100

Source: Citigroup, Inc. 2012.

These investment issues interact with the particular structures of the different economic sectors. Transportation and mobility related investments can be especially complex because of multiple planes of investment (vehicle purchase, transportation infrastructure, and land use decisions that affect transportation) that involve multiple private and public sector decision makers. Infrastructure and building investments can lock in land use patterns and associated transportation needs. On the other hand, information and communication technology (ICT) investments are providing new opportunities for transportation, such as intelligent transportation systems, logistics and fleet management software, and telework.

For the electric and natural gas infrastructure sectors, changing demand, aging infrastructure, growing interaction of electricity and natural gas systems, integration of variable energy resources such as wind and solar, and potential impacts of electric vehicles add to the challenges and opportunities. A 2011 American Society of Civil Engineers report estimated a need for electricity system cumulative investments of $107 billion by 2020 and nearly $732 billion by 2040 to keep up with projected demand.[7] The sector can benefit from advanced meters, smart grid technology, and smarter end-use technologies that allow for improved system energy productivity while also enhancing safety and security as well as the cost-effectiveness of delivering energy services to customers.

5 *Granade, et al., "Unlocking Energy Efficiency in the U.S. Economy," 29, 55.*

6 *National Research Council, America's Energy Future: Technology and Transformation, Table 4.10.*

7 *American Society of Civil Engineers, "Failure to Act: The Economic Impact of Current Investment Trends in Electricity Infrastructure."*

Further, electric and natural gas ratepayer-funded end-use energy efficiency and load management programs could help meet the demand at a lower cost. Electricity ratepayer programs saved an estimated 112 billion kWh of electricity in 2010, enough to power nearly 10 million homes or nearly 3% of U.S. electricity consumption in 2010.[8] Natural gas ratepayer programs saved U.S. customers 81 trillion Btu in 2010, or about 0.33% of U.S. natural gas consumption.[9] In 2011 electric and natural gas efficiency programs invested $8 billion in energy efficiency and load management programs.[10]

This investment discussion has focused on physical capital. However, other forms of investment are also important. Investments in R&D are critical to developing new technologies. Related investment in technology demonstration and validation as well as in technical assistance can facilitate the deployment of energy productivity enhancing technologies and practices. Further, investment in human capital, for the workforce that operates and maintains machines, buildings, facilities, vehicles, and infrastructure is also critical to operational and behavioral efficiency.

TECHNOLOGY

Energy productivity technological improvements stem from plant level innovations and from formal R&D. Both new technology and the spread of existing best practices offer a large scope for enhancing energy productivity. Opportunities exist for widely applicable technologies (such as heating and cooling systems, motors, and automated controls), as well as for processes that are specific to individual industries or types of facilities (such as specialized manufacturing operations). Material efficiency and recycling are important to energy productivity since large amounts of energy are used to produce, process, and distribute materials and water; wasted and discarded materials are wasted and discarded energy.

Buildings, industrial systems, infrastructure, and transportation systems are all complex with numerous interacting parts that should be viewed holistically in order to maximize energy productivity. For instance, astute building designers can find using integrated design that high performance windows may allow a smaller, less expensive heating and cooling system to service the building. A lighter, stronger material may take more energy to produce than a conventional material but could yield much greater fuel savings when incorporated into an airplane or car.

Information and communication technologies (ICT) notably promise efficiency benefits across all economic sectors. Real-time building monitoring and control technologies can yield large operational savings. Improved electronic controls in individual vehicles, vehicle telematics and fleet management, intelligent transportation systems, and next generation air traffic control all increase transportation energy productivity. Also, ICT facilitates telework and the substitution of communication for travel. And a smart electric grid can both reduce grid losses and help boost end-use efficiency.

For buildings, available but poorly diffused technologies for lighting, windows, roofing, furnaces, and boilers, as well as building controls, can reduce energy consumption by 30% to 50% compared to the typical building.[11] Emerging technologies in heating and cooling, appliances, lighting, windows, and electronics offer even more. Building energy productivity also requires effective operations and maintenance (O&M), combining training and motivation of building operators with the growing capabilities of building monitoring and control technologies.

For vehicles, there are many technological avenues for fuel economy improvement in addition to ICT areas mentioned above—lightweight materials, engines, transmissions, aerodynamics, tires, and other components. Hybrid drive systems provide further efficiency benefits while developments in plug-in electric and hydrogen fuel-cell systems have the potential to offer greater gains. And many opportunities pertain to rail, marine, and aviation modes as well.

Smart energy grid technologies will also be important for addressing challenges of better integrating electric and natural gas systems, accommodating variable resources such as wind and solar, and handling the potential growth of electric vehicles, which can be either strains or assets to grid reliability and efficiency.

8 *Wallace and Foster, "State of the Efficiency Program Industry," Fig. 23.*

9 *Ibid., Fig. 24.*

10 *Ibid., Fig. 2.*

11 *ASHRAE, "Advanced Energy Design Guides."*

HUMAN BEHAVIOR

All energy productivity activities and decisions are functions of human behavior. Thus, behavior is the ultimate "cross-cutting" theme. People:

- Develop new goods, services, and technologies;
- Buy or adopt energy using products and practices;
- Operate energy using products and practices;
- Can respond to feedback on energy use, price signals, and operational performance to improve decision making; and
- Adopt and implement policies and programs intended to influence others' energy use.

In order to act to improve energy productivity, a person or company must first pay attention to the issue and the potential benefits, then be convinced that one or more measures are a good idea and make a decision to act, and finally have the knowledge and skills to implement the measures. All these actions are influenced by information and uncertainties over performance, costs, benefits, and risks of products, technologies, and practices and by ways people make or avoid decisions given the uncertainties.

For organizations, corporate structures and cultures are key to establishing effective patterns of behavior. Corporate commitments, lines of responsibility and accountability, employee recognition and incentives, and formal energy management systems (such as those conforming to the ISO 50001 standard) can encourage energy productivity gains just as companies previously organized to advance quality and environmental management (including through ISO 9000 and ISO 14001 standards for quality and environmental management systems). Table 3 lists the "Seven Habits of Efficient Companies" identified by William Prindle as key elements in organizing companies to achieve energy efficiency gains.[12] The Dow Chemical Company is just one example of a company that motivates employee innovation, helping the company to reduce energy consumption per pound of product by 40% since 1990, saving a cumulative $24 billion and 5.2 quads (roughly 5% of a single year's total U.S. energy consumption).[13]

Improving energy productivity also requires a robust, skilled workforce. Well-trained operators and maintenance staff are needed to optimize energy management in industrial operations, buildings, transportation systems, and physical infrastructure. Recognized technical credentials can help companies better identify qualified employees and contractors while helping advance career opportunities for workers with pertinent training.

Table 3. The Seven Habits of Highly Efficient Companies

1. Efficiency as a core strategy.
2. Leadership and organizational support is real and sustained.
3. The company has smart efficiency goals.
4. The strategy relies on a robust tracking and measurement system.
5. The organization puts substantial efforts into efficiency.
6. The energy efficiency strategy shows demonstrated results.
7. The company effectively communicates efficiency results.

Derived from Prindle, "From Shop Floor to Top Floor," table ES-1, p. vii

In buildings, owners and builders decide on building components that affect energy use; building operators affect energy use through operations and maintenance (O&M); and occupants exert control over many types of energy-using equipment. Energy management can be affected by building energy use feedback and benchmarking systems, building staff training and occupant education, social norms and marketing, and financial incentives. Behavior based energy efficiency approaches, such as energy feedback systems, can empower building operators and individual households to better manage their energy use and costs. An Environmental Defense Fund study estimated a $3 billion potential annual savings if simple monthly comparative energy-use reports were sent to residential customers nationally.[14]

Within the transportation sector, significant energy productivity opportunities lie in providing greater transportation choice and to consumers and motivating different behavior. This includes more efficient vehicle choices and more efficient driving as well as alternatives to personal automotive travel, including public transit, bicycling, telecommuting, the development of more walkable communities. Energy productivity benefits of mobility choice can also include energy cost savings, reduced traffic congestion, improved community quality of life, and an improved environment.

12 *Prindle, "From Shop Floor to Top Floor," 84.*

13 *Dow Chemical Co. Responsible Care Awards Program submission for "Dow Ringwood Site Cuts Energy Consumption by 56,000 MM BTU/yr."*

14 *Davis, "Behavior and Energy Savings: Evidence from a Series of Experimental Interventions," 2.*

GOVERNMENT AND GOVERNANCE

Federal, state, and local governments can influence energy productivity, directly and indirectly, in many ways. The list of pertinent government policy topics is long—R&D, technology demonstration and validation, technical assistance, education and training, voluntary programs, tax provisions, utility ratemaking and regulation, financial regulation, information and disclosure, efficiency standards, land use and facility siting, transportation and water infrastructure, environmental regulations, public procurement, intellectual property, antitrust, and others. This subsection focuses on some (but not all) areas germane to energy productivity, with additional discussion accompanying the Commission's policy recommendations.

The broader term, governance, includes public and private sector policies, management systems, industry standards, and professional norms, all of which can play significant roles in advancing or impeding energy productivity improvements depending on how they are designed and implemented. Private sector governance is critical to advancing energy productivity since it is the private sector that is the primary performer of economic activities. As discussed previously, corporate and organizational governance can create, or thwart, motivations for managers, employees, and other stakeholders to identify and undertake energy productivity improvements.

R&D and deployment activities can be directly supported by government or encouraged through R&D, demonstration, public-private consortia, tax, technical assistance, intellectual property, and other policies. Federal support of R&D at national laboratories, universities, and companies has been critical to innovation in energy efficiency. Both broad technical assistance programs such as Manufacturing Extension Partnership and targeted efficiency deployment programs help bring the innovations into use and improve American manufacturing competitiveness.

Tax and depreciation *rules* can have significant direct and indirect energy impacts. Tax policies can offer favorable tax treatment for energy-efficient products and activities or they can provide broader incentives (for example, through accelerated depreciation schedules) for capital investment, which can indirectly favor energy productivity growth. Tax policies can also encourage R&D, training, and other pertinent activities. Some tax policies, such as depreciation provisions, can have reduced or, perhaps, favorable fiscal impacts on the Treasury compared to other measures.

Utility regulation and ratemaking processes have been, and will remain, critical to energy productivity advancements. Electric and natural gas utilities are highly regulated. Their motivation and ability to support energy efficiency is highly dependent on the legal and regulatory framework in which they operate, including how utility commissions determine rates, criteria for allowable investments, and incentives or mandates to pursue energy efficiency. As noted previously, utility ratepayer programs fund billions of dollars of energy efficiency projects annually, delivering significant electricity and natural gas savings. Also, there is interest in "on-bill" finance or "on-bill" repayment, in which energy utility bills are used as the vehicle for repayment of loans or other financial obligations.

Financial regulations can improve or hinder opportunities for profitable energy productivity investment. Federal statutes govern allowable corporate structures, such as master limited partnerships and real estate investment trusts, for certain investment activities. These laws can affect the ability of business to favorably package energy efficiency investments to investors. There may be opportunities for the federal government to facilitate securitized secondary markets for energy efficiency and productivity investments. Further, where there is a nexus of mortgages to the federal government and its related government-sponsored entities (GSEs), rules could support consideration of energy costs in mortgage underwriting. Also, rules could remove impediments to property assessed clean energy (PACE) financing mechanisms, which allow homeowners to repay energy upgrade financing via their property tax or other local charges.

Information, data, and energy disclosure policies are important to overcome the information barrier—the energy efficiency of a building, appliance, or vehicle is not readily apparent. Product energy labeling (such as those for automobiles and some appliances) and building energy use disclosures (starting to be required in several U.S. and foreign jurisdictions) give consumers useful information to make purchasing and leasing decisions. Voluntary programs, such as Energy Star, can identify higher efficiency products and buildings. Utility regulations and voluntary programs such as Green Button can provide consumers their own energy usage information in order to better manage home and business utility energy use. The federal government also could facilitate the collection and analysis of energy efficiency measure performance data that would be useful for stimulating development of privately capitalized investment funds and, potentially, securitized secondary markets for energy efficiency.

Voluntary programs, both publicly and privately administered, can play important roles in promoting energy productivity products and practices. For instance, the Energy Star label—supported by EPA and DOE—is widely recognized by consumers as signifying energy-efficient products. Some manufacturers and builders have significantly increased the energy efficiency of their products in order to earn the label and appeal to consumers. The U.S. Green Building Council Leadership in Energy and Environmental Design (LEED) building program has become a valuable certification in portions of the commercial real estate market. The DOE established a Superior Energy Performance program to encourage and recognize industrial and commercial companies that implement energy management systems that conform to the ISO 50001 standard. Voluntary labels, designations, and certifications can help transform markets, pushing energy productivity levels upward.

Codes and standards for buildings, vehicles, appliances, and other equipment have delivered remarkable gains in energy productivity and savings for consumers, and promise to deliver still more in the future. The codes and standards have been so successful that non-regulated equipment is a fast growing portion of total energy use, raising the issue of covering more categories (including electronics) and larger systems. Compliance, especially with building energy codes, also is an issue. Although codes and standards generally apply to new equipment and construction, a few localities have begun to impose requirements on building operational performance or retrofits, such as a retro-commissioning (building system tune-up) provision in New York City that will apply to large commercial buildings.[15]

Land use and infrastructure planning and approval processes are usually implemented primarily by state and local governments. State and local authorities have a major responsibility for not only building and maintaining surface transportation infrastructure, but also often operating public transit systems. They also provide multi-modal transportation accommodations such as sidewalks, pedestrian signals, bicycle lanes, electric vehicle charging stations and other features. Land use and transportation infrastructure decisions have long term, deep impacts on energy consumption patterns. Improvements in regional and local planning have shown large benefits for energy productivity. The federal government also has a large role in funding surface transportation and can provide guidance, incentives, and performance criteria. Also the federal government, often in partnership with state and local authorities, has strong inference on aviation, rail, and maritime transport systems.

Environmental regulations and policies can better recognize energy efficiency as a means to improve environmental quality, including in air quality planning and regulation. Environmental regulations can be made more innovation friendly and conducive to energy efficiency as an environmental compliance strategy if they are well designed.

Leadership by example is a role that all levels of government can play. As the federal government is the nation's largest energy user, its purchasing power can propel markets for energy efficient products and services, whether for equipment, buildings, or transportation, while saving taxpayers money through reduced energy expenses. State and local governments are collectively even larger energy buyers and markets for energy services and high efficiency facilities and products. And government, particularly federal agencies, can serve as a test bed for emerging technologies and practices that meet government mission needs but which can also have spin-off applications in the broader civilian economy.[16]

15 *Sobin and Steele, "NYC, DC, SanFran & Austin: Cities Use Local Policies to Make Buildings More Efficient."*

16 *The Department of Defense, Environmental Security Technology Certification Program, operates an installation energy test bed to demonstrate and validate technologies for meeting defense installation mission needs (Marqusee, "Military Installations and Energy Technology Innovation.") while the General Services Administration has an analogous test bed program.*

COMMISSION RECOMMENDATIONS

Based on the findings from the research reports, the Alliance Commission on National Energy Efficiency Policy developed this set of unanimous recommendations for federal, state, and local governments as well as the private sector, with the intention of doubling energy productivity by 2030. While we believe that doubling energy productivity will be cost-effective and bring benefits to consumers, businesses, and the nation, a large number of barriers will prevent success without concerted government and private sector action.

The recommendations were selected based on an assessment of their potential impact, their political viability, and their implementability. Because energy productivity decisions are made by everyone, most of the recommendations cut across economic sectors. As many of the recommendations seek national harmonization and state or local implementation, the federal, state, and local recommendations often are intertwined.

The recommendations are organized under three overarching strategies:

- **UNLEASH INVESTMENT** in energy productivity throughout the economy—well over a trillion dollars in cost-effective energy savings opportunities are available in the United States, but achieving the savings will require investment of hundreds of billions of dollars;
- **MODERNIZE REGULATIONS** and Infrastructure to improve energy productivity—investments by governments, businesses, and individuals to modernize our nation's infrastructure and other capital (buildings, equipment, vehicles) provide tremendous opportunity to improve energy productivity; and
- **EDUCATE AND ENGAGE** consumers, workers, business executives, and government leaders on ways to drive energy productivity gains—to succeed we need to develop human capital throughout the economy.

UNLEASH INVESTMENT

MAKE FINANCING MORE EASILY AVAILABLE FOR ENERGY EFFICIENCY PROJECTS

Convenient and affordable financing is vital in order to provide the hundreds of billion dollars in investment needed to double energy productivity and to overcome the barrier posed by the high initial cost of many measures. But there currently is little financing specifically for energy efficiency investments other than the Energy Savings Performance Contracts and Utility Energy Service Contracts, which are used mostly for government buildings (discussed later in this section). In particular there is a need for a "secondary market" for energy efficiency loans and other financial obligations, essentially selling the obligations wholesale to investors to free up capital for more projects. There is an additional need for better valuation of the cost savings from energy efficiency that enable borrowers to pay back loans.

Make more capital available by enabling institutional investors to buy energy efficiency financial obligations on a large scale using securities based on uniform contract structures and better performance data:

- The Alliance to Save Energy should convene a consortium of financial institutions, rating agencies, energy efficiency program evaluators, and others in the private sector, to work with the federal agencies to foster a secondary market for energy efficiency financial obligations. The consortium should draft uniform contract language, underwriting guidelines, and energy data requirements (for obligations that depend on energy performance) to allow for sufficient scale of consistent financial obligations to interest investors. The consortium should also gather reliable data on energy efficiency and loan performance of projects in order to better quantify the risks.
- State and local governments should work to aggregate and resell loans in secondary capital markets, such as in the Warehouse for Energy Efficiency Loans (WHEEL) program.

Establish state and local programs for financing of efficiency measures, which may use repayment on utility bills or on property tax bills (the capital could be provided by institutional investors):

» States and local governments should work with utilities, the private sector, and the federal government to establish effective energy efficiency financing mechanisms for residential and commercial buildings (including loans, leases, energy services agreements, power purchase agreements). Repayment on utility bills or property tax bills can reduce risk by encouraging timely payment and by allowing an obligation to stay with the building when it is sold. (Of course administrative costs and any impacts on payment of the bills would need to be addressed.) Such financing mechanisms may include:

- On-bill repayment (OBR) programs administered by utilities but with capital provided by third parties, including banks and other investors;
- On-bill finance programs with capital provided by utilities from ratepayer or shareholder funds; and
- Property assessed clean energy (PACE) financing with repayment on property tax bills. The capital is usually obtained by local or state governments issuing bonds for residential buildings and by third parties working directly with the building owner for commercial buildings.

» Congress should direct the Federal Housing Finance Agency, working with the Department of Energy (DOE), to establish guidelines and rules for residential PACE financing that are compatible with mortgage lending practices in order to allow a senior lien like that of property taxes for cost-effective projects.

Consider household energy and transportation costs when underwriting mortgages to allow for larger or more attractive loans for homes with lower monthly costs:

» The Department of Housing and Urban Development (HUD) should improve the accuracy of mortgage underwriting by ensuring that reductions in energy and transportation costs are considered in the underwriting process of loans backed by federal mortgage agencies. Larger loans (or more attractive loans with strict income or assessment requirements) should be permitted for energy-efficient homes and for homes in locations that allow transportation options other than driving because the homes are more valuable and because owners with lower energy and transportation bills are able to make higher mortgage payments.

ADVANCE ENERGY PRODUCTIVITY THROUGH FEDERAL TAX REFORM

Federal tax incentives have played a key role in encouraging market adoption of energy-efficient new homes, home improvements and appliances, new commercial buildings and upgrades, hybrid cars and heavy duty vehicles, and public transportation. But the incentives are not always carefully targeted or kept up-to-date. At the same time the tax code has discouraged business investments with unrealistically slow depreciation—in some cases equipment that typically lasts fifteen years can only be depreciated over 39 years (and the energy costs that would be saved can be expensed in one year). Federal tax reform offers the opportunity to create a more efficient incentive structure.

Reform federal energy efficiency tax incentives so that they focus on high efficiency technologies and measures and on promoting innovation and market transformation:

» Congress should reform and extend federal tax incentives that promote energy efficiency. The incentives should be reformed by strengthening their qualifying criteria, amounts, and durations to ensure that they focus on high efficiency technologies and measures and on promoting innovation and market transformation. One approach would be to direct DOE or EPA to set the specific criteria, preferably based on designations used in market transformation programs, which would allow for more timely and expert response to market changes.

Adjust commercial and industrial depreciation schedules to encourage investments that can boost energy productivity:

» Congress should adjust commercial and industrial depreciation schedules to reflect more accurately the average lifetimes of equipment and measures. Congress should also consider accelerated or bonus depreciation to encourage modernizing capital stock. New equipment, buildings, and vehicles tend to be more energy efficient than old stock. Since depreciation adjustment changes the timing but not the total amount of tax paid to the Treasury, fiscal impacts can be relatively modest (and the increased economic activity may be fiscally beneficial).

SUPPORT ENERGY PRODUCTIVITY INNOVATION AND MARKET ADOPTION

Private R&D budgets are small in many sectors related to energy productivity in part due to the fragmented markets and industry structures and to the spillover of knowledge. Market barriers also prevent adoption and commercialization of new innovations. Thus government support both for R&D and for a wide range of deployment programs has been critical to advances in energy productivity. Often these programs have been most effective in concert: R&D support helps develop technologies, technical assistance and incentives assist early market introduction, information programs spur broad commercialization, and standards ensure that all consumers benefit and push markets forward toward further innovation.

Increase federal investment in basic and applied research, development, demonstration, deployment, and technical assistance:

- Congress should increase support for DOE and other energy efficiency R&D for all economic sectors. The federal government should also encourage private R&D through other policy approaches such as public-private consortia, the R&D tax credit, and supporting challenges or contests.
- Congress should increase support for energy efficiency demonstration, deployment, and technical assistance at DOE, EPA, and other agencies (from Building America to Industrial Assessment Centers to Energy Star to weatherization of low-income homes). DOE should maintain a balanced portfolio of research and deployment programs.
- Federal, state, utility, and other technical assistance providers should coordinate activities to offer companies a unified array of services across energy and non-energy areas. Congress and the states should include energy productivity in manufacturing and agricultural extension services and other technical assistance.
- Federal, state, and local governments should coordinate their efforts to offer, and encourage the private sector to offer, the use of buildings and other facilities as test beds to demonstrate and validate emerging energy productivity technologies and practices, and as early markets for the innovations.

GOVERNMENTS LEAD BY EXAMPLE

The federal government is the largest single energy user, responsible for just over 1% of energy use, in the United States. State and local governments combined own one fifth of commercial building space, with much larger energy use. [17] But beyond their own energy use, governments can serve as highly visible test beds and early adopters of innovative technologies and practices. They also can influence their large base of contractors and suppliers to increase their energy productivity.

Apply innovative best practices to government buildings and vehicle fleets:

- Federal, state, and local agencies should apply innovative best practices to government buildings and vehicle fleets, including (several of these already are required for federal buildings):
  - Setting targets for efficiency improvement;
  - Implementing energy management systems, including under the ISO 50001 standard;
  - Benchmarking, rating, and disclosing of building energy use and efficiency (see below);
  - Conducting ongoing or periodic recommissioning to ensure buildings are performing as they were designed;
  - Considering location efficiency when siting facilities;
  - Procuring innovative high-efficiency equipment and vehicles; and
  - Encouraging energy management in supply chains.

Make all cost-effective efficiency improvements to federal buildings, using private financing and public funds:

- Federal agencies should make all cost-effective efficiency improvements in their buildings with annual targets for savings and/or funding. Agencies can use private financing (energy savings performance contracts and utility energy service contracts, under which private contractors and financial institutions are paid from energy savings over time) as well as public funds, especially since appropriations are very tight.

17 *USEIA, Annual Energy Review 2011, Tables 1.3 and 1.12; D&R International, Buildings Energy Data Book, Table 3.2.3.*

MODERNIZE REGULATIONS AND INFRASTRUCTURE

CREATE A "RACE-TO-THE-TOP" STYLE ENERGY PRODUCTIVITY COMPETITION TARGETED AT STATES AND COMMUNITIES

State policies including building energy codes, regulation of utility demand-side management, and transportation and land use planning are key drivers of energy productivity. More recently cities have taken the lead on building energy disclosure, community-based building energy upgrade programs, and other areas. But the best practices need wider dissemination. The education "Race to the Top" initiative has spawned significant education reforms and has received broad, bi-partisan support. An energy productivity competition that similarly provides federal resources and rewards states for progress toward becoming more energy productive could spur significant advances in efficiency throughout the nation.

Incentivize innovation and adoption of best practices by state and local governments based on energy productivity improvements, investments, and regulatory reform. States would receive technical assistance and funding based upon policy and regulatory reforms like those recommended in this report on building energy codes and disclosure, efficiency programs and financing, utility reform, and transportation planning and investments.

- The federal government should develop an energy productivity "Race to the Top" to spur state and local energy policy reform as the education initiative spurred education reform, with the goal of doubling U.S. energy productivity by 2030.
- DOE should help states and local governments implement innovative policies and programs, and should develop scoring criteria on energy productivity improvements in the jurisdiction, increased effectiveness of efficiency codes and programs, transportation infrastructure investments, and regulatory reform (because of wide differences between the states, they should be graded on improvements, not on an absolute scale).
- The Office of Management and Budget should work with federal agencies to use these criteria in setting a variety of related federal funding to states and local governments, including as scoring factors in competitive grants.
- The assistance and scoring should focus on policies like those recommended to states and local governments throughout this report.

USE ENERGY PRODUCTIVITY TO ACHIEVE REGULATORY AND PLANNING GOALS

A wide range of regulations and government investments affect energy use in every economic sector. Increasing energy productivity can be an important way to meet the goals of those regulations and investments if they are designed well. Thus electric and natural gas state and utility programs funded by ratepayers are the primary delivery vehicle for energy efficiency in our nation, with budgets over $8 billion in 2011 (more than double those of three years before). [18] The programs avoid much larger investments in power plants, transmission lines, and gas pipelines. Transportation and land-use planning can help reduce the need to drive by creating walkable communities and transportation alternatives. Industrial efficiency measures such as combined heat and power can reduce air pollution while lowering costs. And investments in water and wastewater systems can reduce water losses, thus reducing the power needed to pump and treat the water.

18 *Wallace and Forster, State of the Efficiency Program Industry, 15.*

Adopt utility policies that make full use of all cost-effective demand-side management (end-use energy efficiency and demand response) as a resource. Such state-level policies may include broad and targeted savings goals, financial incentives for utilities, time-variant customer rates, fair treatment of combined heat and power and other distributed resources, and harmonized program evaluation:

- State public utility commissions (PUCs) and municipal and cooperative utilities should adopt policies that make full use of all cost-effective end-use energy efficiency and demand-response resources. Recognizing differences between states, such policies may include:
- Set energy savings and demand reduction goals based on the available cost-effective potential, measure progress toward the goals, and provide incentives to achieve them;
  - Set goals, metrics, and incentives to achieve the enhanced benefits of demand-side resources enabled by smart grid technologies;
  - Use time-variant rates where appropriate to create actionable price signals to customers based on the real-time cost of energy, accompanied by effective customer education to help them make use of the savings opportunities;
  - Adopt utility rate structures that remove financial disincentives to use end-use energy efficiency and demand response resources that benefit customers and create earnings opportunities;
  - Ensure that demand-side management programs are available to all customers, including low-income customers; and
  - Encourage combined heat and power and other distributed resources where they enhance energy productivity and reliability, are cost-effective, and meet efficiency criteria. Adopt interconnection rules and rates and fees for combined heat and power and other distributed resources that are fair and reasonable (including utility recovery of associated costs and avoidance of cost shifting) and ensure reliability and safety.
- DOE should strengthen its State and Local Energy Efficiency Action Network work to convene states, utilities, evaluation professionals, industry, consumer and environmental organizations, and other stakeholders to develop nationally harmonized evaluation, measurement, and verification (EM&V) approaches and protocols that are credible, transparent, reasonable in cost, and adaptable to regional and state jurisdictional contexts. DOE should also provide technical assistance to states to facilitate adoption of these approaches and protocols.

Advance regional and local transportation and land use plans that promote energy productivity by improving access to work, services, school, and play, and by increasing transportation options including safe walking, biking and public transportation. Provide funding and technical assistance to enable efficient development patterns and transportation infrastructure that is consistent with the regional and local plans:

- Congress should direct the Department of Transportation and the Environmental Protection Agency (EPA) to establish performance standards for long-range regional transportation plans, which are developed by Metropolitan Planning Organizations, to achieve increases in energy productivity for the transportation sector and related environmental goals while improving mobility and connectivity for all transportation modes.
- Metropolitan Planning Organizations and other regional planning agencies should establish or update regional transportation plans and land use plans that meet the standards, and local governments should establish or update local transportation and land-use plans, codes, and zoning that are consistent with the regional plans (both with federal, state, and private sector assistance). This planning should seek to achieve energy-efficient mobility, connectivity, and accessibility.
- Congress (together with and as a catalyst to state governments, local/regional governments, and the private sector) should provide resources and enable directed funding and incentives to promote efficient development patterns and transportation infrastructure that are consistent with the regional and local plans.

Use energy efficiency as an emissions reduction strategy in environmental regulations:

- EPA, state, and local air regulators should, to the extent possible, encourage energy efficiency as an emissions reduction strategy and, as appropriate, allow and credit efficiency measures as compliance options in their regulations and procedures.
- EPA, DOE, and other relevant agencies should collaborate with state and local authorities to facilitate recognition and crediting of energy efficiency in state and regional air quality plans, and should provide guidance and technical assistance to encourage regulated entities to implement energy efficiency as compliance and productivity strategies.

Ensure major government and regulated infrastructure spending on energy grids, transportation infrastructure, and water and waste systems increases energy productivity.

- Utilities and state PUCs should use smart grid capabilities to increase energy productivity, including by targeting demand-side management, providing consumers with detailed use information, and improving system efficiency through better voltage control.
- Congress, the Department of Transportation, and state transportation agencies should direct transportation funding to increase viable transportation options other than driving.
- Congress, EPA, and state and local governments should ensure new water and wastewater infrastructure achieves both water efficiency and energy efficiency, including water use savings, leak reductions and efficient equipment. They also should increase recycling and more efficient collection of municipal solid waste.

STRENGTHEN BUILDING, EQUIPMENT, AND VEHICLE EFFICIENCY STANDARDS

Standards and codes have been among the most effective energy efficiency policies, setting a performance floor for equipment, buildings, and vehicles. They protect consumers (especially some renters and buyers who pay the energy bills but cannot choose the products), lower prices, and spur innovation. They also have enormous potential: New appliance standards could save an estimated 3% of all energy use by 2035 and save consumers a net $170 billion.[19] Potential savings from building codes are similar if they were to be adopted and enforced nationwide. And new vehicle standards are projected to save another 3% of energy use by 2030.

Steadily and aggressively increase the stringency of building energy codes, with quick adoption and effective compliance measures:

- The International Code Council and American Society of Heating, Refrigerating, and Air-Conditioning Engineers, with DOE support, should build on recent 30% energy savings and steadily increase the energy efficiency of their model building energy codes and standards. The updates should continue to be cost-effective, stakeholder-driven, and fuel and technology neutral.
- State and local governments should quickly adopt these updates or more stringent "stretch" codes, and should deploy the resources needed (including resources from building permit fees) to achieve full compliance with the codes.
- HUD should quickly update efficiency requirements for new homes with federally subsidized loans and for public housing, and DOE should quickly update the requirements for federal buildings, based on the most recent model codes.

End current delays and update federal appliance and equipment, vehicle, and manufactured housing efficiency standards to maximum technologically feasible and economically justified levels:

- DOE and the Office of Management and Budget (OMB) should end current delays in setting appliance efficiency standards and make timely updates at the "maximum level that is technologically feasible and economically justified," as required by law.
- DOE and OMB should end current delays and quickly set efficiency standards for manufactured housing based on the most recent model codes.
- Both the federal government and states should set new standards for electronics, industrial equipment, and other products when justified by the energy savings.
- The Department of Transportation and EPA should strengthen the new heavy duty vehicle standards as they extend them.

19 *Lowenberger et al., The Efficiency Boom, 3, 5.*

EDUCATE AND ENGAGE

PROVIDE INFORMATION ON BUILDING ENERGY EFFICIENCY AND ENERGY USE

Car drivers see fuel economy information in every advertisement and receive frequent feedback when they look at the dashboard (especially those with fuel economy gauges). But homeowners and commercial building managers often have no idea about the efficiency of a building. Major appliances are labeled in stores, but even whole tenant spaces in commercial buildings often are not submetered in operation. Better energy information may transform how buildings are designed and operated if it is made available at the right times and in useful ways. New smart technologies provide much more detailed information, while new policies are making the information more available to consumers.

Develop effective building energy ratings, benchmarks, and disclosure methods for commercial and residential buildings; require periodic disclosure in commercial buildings and disclosure at time of sale or rental in residential buildings; and incorporate the information in building appraisals and real estate listings:

- DOE and EPA should engage a stakeholder coalition to develop model building energy ratings, benchmarks, and disclosure methods for commercial buildings and for residential buildings that are based on the best existing systems and practices, user friendly, adjusted to climate regions, and universally available. The coalition should consider inclusion of location efficiency information. DOE should ratify the ratings/benchmarks/disclosure developed by the stakeholders as the national models, and ensure needed comparative data are available and up-to-date.
- The federal government should adopt the national models for use in all federal buildings and, where practical, federally subsidized buildings and buildings with loans from federal mortgage agencies. HUD and DOE should encourage appraisers, lenders, and the real estate industry to incorporate the information into valuation of buildings and real estate listings.
- State and local governments should require disclosure of energy information using the national models in commercial buildings and at time of sale or rental in residential buildings.

Enable customers and third parties authorized by the customers to access their energy usage data, while ensuring customer privacy:

- PUCs should develop rules and procedures that enable customers to access their energy usage data and to authorize third parties to access their data. The data should be accessible in a national standard data format such as Green Button. The rules and procedures should ensure effective privacy protections and address legacy data systems.

Develop harmonized energy use labels with discrete ratings for appliances and vehicles that are coordinated with building energy labels.

- DOE, EPA, and the Federal Trade Commission should develop harmonized energy use labels for appliances and vehicles, coordinated with building labels above, and harmonized product certifications. The labels should show discrete ("categorical") energy efficiency ratings, which have been shown to be more effective with consumers and are used in most other countries. DOE also should study ratings and test methods for building energy subsystems.

IMPROVE CORPORATE ENERGY MANAGEMENT AND TRANSPARENCY

Private sector energy management is critical for achieving energy productivity gains since the private sector dominates economic activity. While specific best practices and standards are important, increasing corporate energy productivity must start with good management and reporting. Corporate goals and commitments, employee incentives and accountability, use of formal Energy Management Systems, and transparent reporting of energy use can encourage energy productivity gains. Companies also can influence the energy productivity of their peers, supply chains, and others.

Effectively manage corporate energy use and report on energy productivity as part of corporate sustainability reporting.

- Companies should effectively manage their energy use, including by implementing the new ISO 50001 standard for energy management systems with certification through DOE's Superior Energy Performance.
- Companies should report on their energy use, energy productivity, and energy efficiency investments as part of corporate sustainability reporting, providing accountability to investors and the public (as comparisons between companies often will be difficult, may need common benchmarks or to compare companies only against their own historical performance).
- Companies should work to encourage improved energy management among their suppliers, customers, and peers in order to make supply chains more cost-effective.

DEVELOP EDUCATED CONSUMERS AND TRAINED TECHNICIANS

In order to succeed, all of these recommendations need people with the skills to implement them. We need government leaders and business executives who understand the importance of energy productivity to our economy, environment, and security. We need construction workers, building and plant managers, city planners, and many other kinds of workers skilled at implementing efficiency measures (and with credentials that prove it). We need consumers who understand what steps they can take to lower energy bills. In other words, we need to invest in human capital as well as physical capital.

Develop school and university curricula on energy use and productivity, conduct consumer campaigns, develop technical certifications, and provide related workforce training and continuing education:

- Companies, professional associations, labor organizations, secondary and higher educational institutions, government, and other stakeholders should collaborate to promote, improve, and, as warranted, develop technical training curricula and credentials to include energy efficiency technologies and practices. These could include training and credentials for energy management (such as energy auditing and building commissioning) as well as incorporating energy content into related technical and continuing education curricula (such as for building trades, vehicle repair, and equipment operation).
- Energy management and productivity should be incorporated in secondary and higher education curricula and continuing education programs, including vocational-technical, architecture, engineering, and business management programs.
- Governments, companies, non-governmental organizations, media, and, as appropriate, educational institutions should collaborate to heighten consumer awareness, understanding, and motivation regarding actions to improve energy efficiency and productivity, using behavioral research to increase the effectiveness of the education.

ECONOMIC IMPACT MODELING

The Commission asked the Rhodium Group (RHG) to analyze the economic, employment, environmental, and security implications of doubling American energy productivity by 2030. RHG conducted the analysis independently of the Commission or participating organizations. Its findings are summarized below. Details on the methodology used for the analysis, as well as detailed results, are available at energy2030.org.

ECONOMIC IMPACTS

The United States can achieve the Commission's goal of doubling energy productivity by 2030 with currently available technology and design practices. To do so, households, businesses, and federal, state, and local governments will need to invest an additional $166 billion a year (in real 2010 U.S. dollars) in building improvements, energy efficient vehicles and industrial equipment, and energy saving transportation systems (Table 4). This investment would both reduce the amount of energy needed to run the American economy and the price of energy for U.S. consumers, lowering overall energy costs by $494 billion a year. Net of investment costs, annual savings to American households, businesses, and government agencies would total $327 billion, and economic growth and energy demand would be decoupled for the first time in recent history (Figure 5).

By 2030 the average household would save $1,039 per year in energy costs, net of the investment required to deliver those energy savings. That is roughly the same as what the average American household spends on education and nearly as much as average household spending on medicine and produce combined. American business would save $169 billion a year, almost as much as the corporate sector paid in federal income tax in 2011. Efficiency improvements combined with lower energy prices would also make energy-intensive industries like chemicals, glass, steel, and cement more competitive internationally. And efficiency improvements in government buildings and vehicles would save taxpayers $13 billion a year, nearly as much as the annual budgets of the Department of Commerce and Environmental Protection Agency combined.

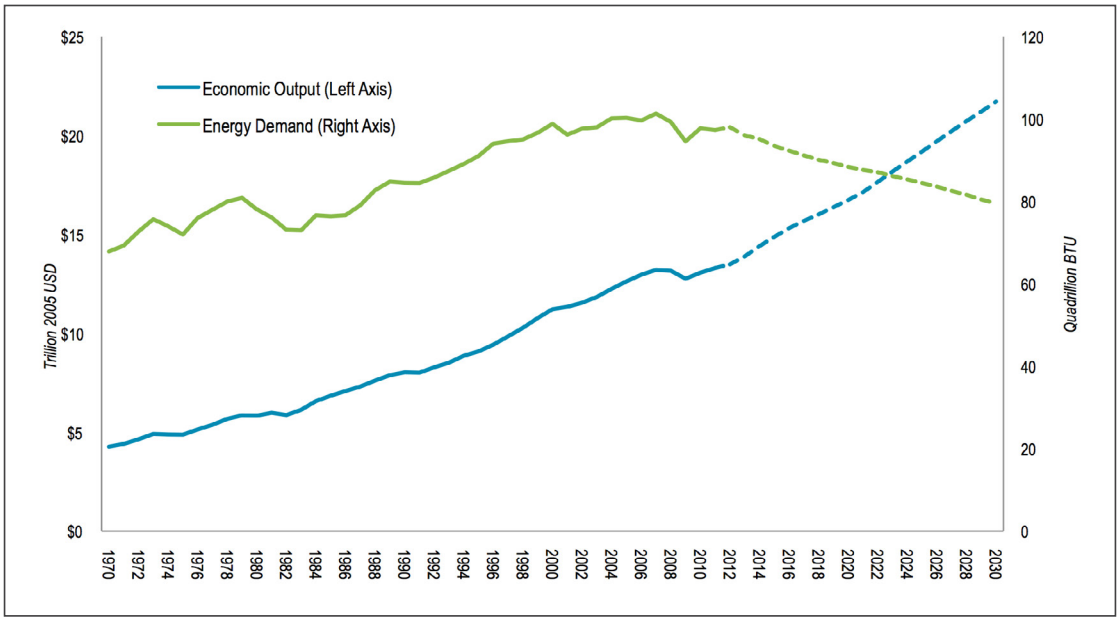

Figure 5: Untying Economic Growth and Energy Demand
Economic output (left axis) and energy demand (right axis) under a doubling energy productivity scenario
Source: BEA, EIA and Rhodium Group estimates

Table 4: Annual Costs and Benefits of Doubling US Energy Productivity

Billion 2010 USD

BY SECTOR			
SECTOR	INVESTMENT COSTS	ENERGY SAVINGS	NET SAVINGS
Buildings	$72	$167	$95
Industry	$15	$109	$94
Transportation	$79	$218	$139
Total	**$166**	**$494**	**$327**

BY CONSUMER			
CONSUMER	INVESTMENT COSTS	ENERGY SAVINGS	NET SAVINGS
Households	$97	$241	$145
Businesses	$61	$230	$169
Government	$9	$22	$13
Total	**$166**	**$494**	**$327**

Notes: Investment costs are annualized using sector-specific interest rates and financing terms. Energy expenditures and savings are in the year 2030 once a doubling is achieved. May not sum to totals due to rounding.

Capturing the benefits of profitable efficiency investments in buildings, industry, and transportation could increase U.S. economic output by as much as 2% in 2030. Doubling American energy productivity would also change the composition of the U.S. economy, redirecting revenue from energy supply to more labor-intensive manufacturing and service sector activities. RHG estimates that successfully achieving the Commission's goal could increase overall U.S. employment by 1.3 million jobs.

ENVIRONMENTAL BENEFITS

Doubling energy productivity would deliver substantial reductions in carbon dioxide (CO2) emissions, providing a cost-effective strategy for addressing climate change. RHG estimates that if the Commission's goal is achieved, U.S. CO2 emissions will decline to 4.65 billion tons by 2020, 22% below 2005 levels. That surpasses America's 17% emission reduction commitment made at the Copenhagen climate change conference in 2009. By 2030, the Commission's goal would reduce U.S. CO2 emissions to 4 billion tons, or 33% below 2005 levels.

Doubling energy productivity will have other environmental benefits as well. RHG estimates that in 2030, sulfur dioxide (SO2) and nitrogen oxides (NOx) emissions would be, respectively, 55% and 45% lower than business-as-usual, yielding important public health benefits.

SECURITY IMPLICATIONS

The recent boom in domestic oil and natural gas supply is reducing American dependence on imported energy. Doubling energy productivity would accelerate this process. RGH estimate that achieving the Commission's goal would reduce net energy imports to 7% of U.S. energy consumption by 2030, down from 19% today. More importantly, it would make the U.S. economy more resilient to future energy price spikes. Even if net U.S. energy imports decline to zero, America will remain part of the global energy market and thus vulnerable to supply disruptions elsewhere in the world. But by doubling energy productivity, the direct economic cost of a global price spike would be reduced by up to 30%.

BACKGROUND RESEARCH FOR POLICY DEVELOPMENT

In addition to the Commission's policy recommendations discussed earlier in this report, the Alliance to Save Energy worked with Commission members, designated representatives, technical advisers, an international advisory council, and other partners to complete seven research reports. The reports address the following areas: the history of energy efficiency; residential and commercial buildings; transportation, land use, and accessibility; manufacturing; smart grid and power generation; and natural gas infrastructure, plus a systems integration report that identifies commonalities and connections among the sector reports. In addition, we contracted for economic impact modeling to project the energy, economic, and environmental implications of national energy productivity doubling (described in another section).

These research reports provide an organized review of existing literature on energy efficiency, assess the current state of efficiency within the economy, and include a collection of best-practice case studies. Each report discusses the cross-cutting issues of investment, technology, human behavior, and government as they relate to opportunities and challenges of increasing energy productivity in the United States. These reports were used to provide the technical basis and support for the Commission's development of recommendations for doubling the nation's energy productivity by 2030.

This section provides a brief overview of each of the research reports. A full version of the reports can be accessed on the Alliance website.

HISTORY OF ENERGY EFFICIENCY

Over the past 40 years, the United States made large gains in energy productivity. Since 1970, the nation expanded its economic output more than three times while the demand for energy grew by only 50%. According to the American Council for an Energy-Efficient Economy (ACEEE), energy efficiency "fueled" about three-quarters of the new demand for energy services since 1970 while conventional energy resources met only a quarter of that demand.[20]

The history of energy efficiency in the United States provides a useful reference and guide to any future national energy efficiency strategy. The energy challenges faced in the 1970s, 1980s, and 1990s offer experiences and lessons likely to apply in coming decades. While the salience of energy and energy efficiency in national policy has waxed and waned over time, a strong architecture of policy tools has developed at federal, state, and local levels. Therefore, this paper aims to outline the history of energy efficiency policies and programs in the United States to better understand how energy productivity increased over the last decades.

RESIDENTIAL & COMMERCIAL BUILDINGS

Buildings account for approximately 40% of all U.S. energy use. Building efficiency in the United States represents an investment opportunity in the hundreds of billions of dollars, with potential savings estimated as high as $1 trillion over the next 10 years – 30% of what we now spend annually on electricity.[21] New and existing building stock can become more efficient and productive through adoption and enforcement of codes and standards, investment in efficiency retrofits, improving technologies, and educating users, among other means.

This report assesses the state of building energy efficiency in order to inform the Commission in its development of policy recommendations for expanding energy productivity in residential and commercial buildings. It examines the unique financing challenges in the buildings sector, an array of available energy productivity technologies, new developments in providing building efficiency information, and recent policy innovations.

TRANSPORTATION, LAND USE & ACCESSIBILITY

Accounting for 28% of U.S. energy use and 71% of its oil consumption, the transportation sector has large effects on national energy productivity, environmental protection, and energy security.[22] Land use planning and development patterns have large effects on how Americans access jobs, services, recreation, friends, and family and on the energy required to do so. Thus, land use and transportation planning are vital to energy productivity advance. However, improving energy productivity also requires more efficient cars, trucks, trains, buses, and planes, as well as some potentially "game-changing" infrastructure improvements for electric-drive vehicles that use batteries or fuel cells. Also, advances in information and communication technologies offer much energy productivity promise, from controls in individual vehicles to intelligent transportation systems to further substitution of communication for transport and travel.

20 *Laitner et al., "Long-Term Energy Efficiency Potential," 4.*

21 *Rockefeller Foundation and DB Climate Change Advisors, Building Energy Efficiency Retrofits, 7.*

22 *Davis, Diegel and Boundy, Transportation, 2-3; 1-23.*

Well-designed policies and strategies coupled with collaboration among federal, state, and local governments offer a large potential to improve the energy productivity of our transportation, land use, and accessibility systems. Furthermore, they support robust economic development and business and employment opportunity, enhanced mobility choice and quality of life, and strengthened environmental protection and energy security. This research report summarizes these opportunities and their potential as well as some of the barriers to achieving that potential.

MANUFACTURING

Manufacturing is vital to American economic well-being, accounting for over 11% of GDP and 60% of exports, and directly employing nearly 12 million workers with above average wages and benefits.[23] The sector consumes 26 quadrillion Btu or about 27% of national energy use.[24] New technologies, improved products and processes, energy management systems, and recovery of otherwise wasted heat and materials all offer opportunities to enhance U.S. manufacturing energy productivity, as well as help strengthen overall U.S. economic productivity. Energy productivity advances can come from energy-focused investments or as a co-benefit of investment undertaken primarily for other competitive reasons. Various barriers impede the adoption of cost-effective energy efficiency measures as well as the development of new efficient technologies and practices. Both corporate management approaches and public policies can help overcome these impediments.

This research report describes industrial energy productivity trends, projections, opportunities, and barriers. It discusses investment, technological, human behavior, and government and governance contexts in the manufacturing sector to help the Commission explore energy productivity policy options.

POWER GENERATION AND SMART GRID

Smart grid technologies offer great potential to increase the efficiency of U.S. power generation, transmission, and distribution while creating a more versatile and reliable electric power grid.

The purpose of this report is to focus on energy productivity, emphasizing power generation as it relates to Smart Grid and Smart Grid implementation as drivers for an improved energy economy that uses cleaner resources and to encourage continued investment in Smart Grid technologies with respect to reliability, security, efficiency and renewable integration, and affordability through this discussion.

NATURAL GAS INFRASTRUCTURE

The outlook for natural gas features a rapidly changing resources base, impacts on different value-chains for the direct-use of natural gas, and increasing coordination of the electric and gas grids. These features provide near term and longer term opportunities to increase energy productivity in the United States

This report focuses on the potential for the U.S. natural gas distribution infrastructure to support the Commission's goal of substantially increased energy productivity.

SYSTEMS INTEGRATION

The Commission recognized at its first meeting that any structure used to describe the energy system in the United States, such as by the sectors addressed in the research reports, would fail to convey fully the interconnectedness of the energy system.

This report identifies major commonalities and interdependencies across the sector-based reports to allow for a systems-thinking approach to policy recommendations.

23 U.S. Department of Commerce, "The Competitiveness and Innovative Capacity of the United States", 6-1.

24 Ibid., 9.

CONCLUSION

The goal of doubling American energy productivity by 2030 is aggressive but achievable. The potential for improvement in all sectors of the economy is huge. Advancing U.S. energy productivity will not only save money but will also raise overall economic productivity, offering corresponding benefits to business competitiveness, household income, and employment. Energy productivity improvements can also deliver greater energy reliability and security, technological innovation, less vulnerability to energy price shocks, and reduced adverse environmental impacts.

Energy productivity gains can come from energy-focused investments as well as from investments undertaken primarily for other purposes, such as increasing plant production, improving building amenities and performance, modernizing vehicle fleets, and upgrading infrastructure. Energy productivity also increases when materials and water are used efficiently and waste is reduced.

New technologies and techniques are needed--whether plant-floor innovations or products of formal R&D—but enormous gains are also available from accelerating the spread of existing technologies and practices.

Although energy efficiency is often cost-effective and the lowest cost energy resource, numerous barriers impede energy productivity advances. As recounted in this report, there are multiple investment hurdles ranging from a common split between who makes energy decisions and who pays the energy bill, to lack of information on energy efficiency and how to improve it, to management structures and cultures. Upfront costs of efficiency measures, lack of dedicated financing, modest financial resources and trained human resources, poorly designed regulations, and other policies also can impede energy productivity.

The hurdles, however, can be overcome by effective public and private sector policies. Reaping the full economic, jobs, security and environmental improvements that accrue from doubling our energy productivity will require active participation of policy makers at all levels of government, businesses across the economic spectrum and consumers.

- The Commission has assembled a package of recommendations for all of the stakeholders who must be involved if we are to unleash the full potential of energy efficiency. The recommendations are organized around the themes of:
- **UNLEASH INVESTMENT** in Energy Productivity, including innovative financial mechanisms, tax provisions, and support for R&D and deployment activities;
- **MODERNIZE REGULATIONS** and Infrastructure, including a “Race to the Top” style competition to spur action by states and local governments, well-designed regulations and standards, and utility policies and incentives; and
- **EDUCATE AND ENGAGE** Stakeholders, including improved data and information and corporate energy management.

These recommendations are intended to appeal to policy makers regardless of party and are offered not only to the Congress and federal agencies, but also to the broader community of public and private sector policy and decision makers. They are offered with the conviction that energy productivity is critical to securing America’s prosperity, strength, and well-being in the years to come.

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ALLIANCE TO SAVE ENERGY

Using less. Doing more.

The Alliance to Save Energy promotes energy efficiency worldwide to achieve a healthier economy, a cleaner environment, and greater energy security. Founded in 1977, the Alliance to Save Energy is a non-profit coalition of business, government, environmental, and consumer leaders.

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