U.S. DEPARTMENT OF ENERGY

ALLIANCE TO SAVE ENERGY

Compete. Council on Competitiveness

ACCELERATE ENERGY *Productivity* 2030

A Strategic Roadmap for American Energy Innovation, Economic Growth, and Competitiveness

Accelerate Energy Productivity 2030: A Strategic Roadmap for American Energy Innovation, Economic Growth, and Competitiveness was developed by the U.S. Department of Energy in partnership with the Council on Competitiveness and the Alliance to Save Energy.

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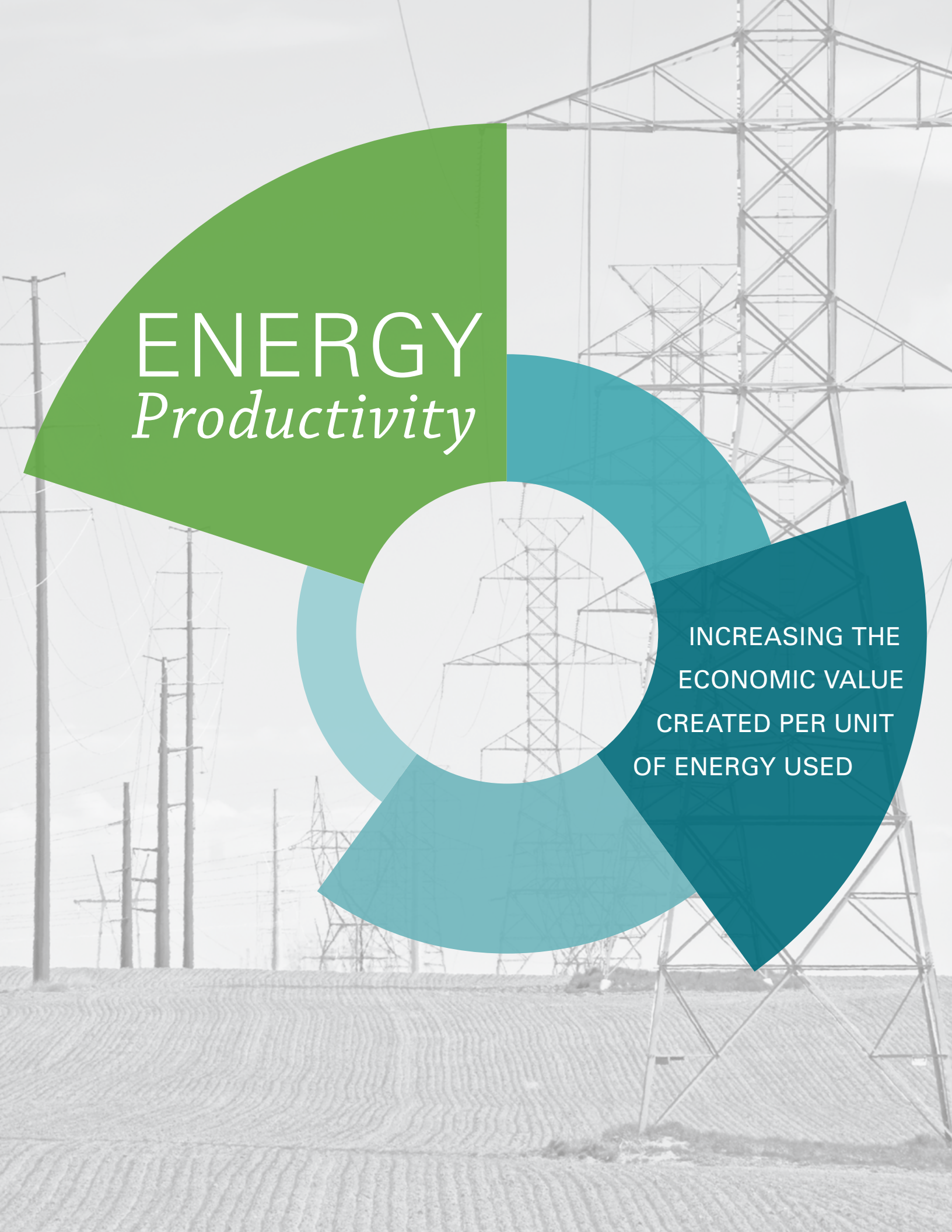
ENERGY
Productivity
INCREASING THE
ECONOMIC VALUE
CREATED PER UNIT
OF ENERGY USED

EXECUTIVE SUMMARY

In September 2014, responding to the presidential call to action to double energy productivity by 2030, U.S. Secretary of Energy Dr. Ernest Moniz announced the Accelerate Energy Productivity 2030 initiative. The U.S. Department of Energy (DOE) partnered with the Council on Competitiveness and the Alliance to Save Energy (collectively, the Partners) in a series of public dialogues and executive roundtables to raise awareness, galvanize support and develop the strategies necessary to double the United States' energy productivity, defined as the ratio of economic output (gross domestic product (GDP)) to primary energy use.

This publication—*Accelerate Energy Productivity 2030: A Strategic Roadmap for American Energy Innovation, Economic Growth, and Competitiveness* (*Roadmap*)—outlines a set of pathways to achieve this goal, and makes clear the direct, tangible, and long-lasting benefits in doing so: lower energy bills; job creation; economic growth; a more globally-competitive manufacturing and industrial base; and greater prosperity for Americans in the decades to come. This *Roadmap* identifies actions a broad range of stakeholders—including businesses; federal, state, and local governments; universities and community colleges; and individual consumers—can take to achieve the national goal of doubling energy productivity by 2030.

The *Roadmap* is organized around two main findings informed by the work of the Partners over the last 12 months:

1. **There are demonstrated, proven opportunities in every part of our economy to improve energy productivity.** The federal government can support increasing energy productivity in many ways, but cannot achieve the goal on its own. To be successful and achieve this national goal, we need decision-makers across the country also to take action. Attendees of Accelerate Energy Productivity 2030 events discussed a wide range of opportunities for diverse stakeholders to improve their energy productivity and contribute to meeting the national goal. The *Roadmap* highlights these success stories along with other effective approaches to driving increased productivity over the next 15 years.
2. **New analysis shows how energy productivity can contribute to economic growth.** Drawing on discussions from the regional roundtables and dialogues as well as existing studies, DOE analyzed illustrative scenarios under which the United States can meet the president's goal by investing in energy productivity improvements.

Underpinning the *Roadmap* is a newly developed modeling framework that uses historical data to project how changes in investment, energy use, and personal expenditures impact economic activity nationwide. The framework also provides insight into the macroeconomic effects of energy productivity. The model is built on established metrics for the economic and energy outcomes of six significant policy and investment strategies, each of which is based on broad areas of opportunity that stakeholders identified. The model then dynamically analyzes how changes in energy use from these strategies would impact GDP.

SUMMARY: HIGHLIGHTS OF STAKEHOLDER STRATEGIES

The Partners launched a series of dialogues with business, academic, and laboratory leaders; state and local government officials; and researchers to identify the most promising pathways to meet the national goal of doubling energy productivity by 2030. These three regional dialogues and roundtable discussions have informed the sample strategies explored in the *Roadmap*. Example strategies described in the *Roadmap* are presented by entity: federal, state, and local governments; commercial and industrial businesses; electric, gas, and water utilities; higher education institutions; and households. The strategies presented here are not meant to be comprehensive. Rather, the *Roadmap* focuses on scalable actions that have the potential to reduce energy consumption and support economic growth. These energy productivity strategies often involve multiple economic sectors and levels of government. To present a cohesive analysis of the potential impacts of the strategies, this analysis developed six productivity "wedges" as representations of aggregated individual strategies. These wedges are summarized in Section 3.

Taken together, these strategies offer a feasible path to the doubling of national energy productivity by 2030. The strategies also indicate that participating entities—including both individuals and organizations—can enjoy a potential share of the benefits of achieving this goal.

Government

- *Federal Government:* Invest in long-term energy productivity through research, development, and demonstration in transportation, buildings, and manufacturing technologies; secure energy productivity through setting and updating vehicle and product codes and standards, and providing energy performance information to consumers; support policy action by state and local governments and the private sector through the provision of tools and other resources to reap the benefits of energy efficiency; set the financial foundation for energy productivity through tax policies; help train a workforce geared for energy productivity; and lead by example in adopting new technologies and strategies in its own operations.
- *State Government:* Pursue policies to encourage greater energy efficiency; promote new and innovative financing for investments that support energy productivity; support and incentivize increased deployment of combined heat and power

(CHP); implement smart regional transportation solutions; and adopt and enforce increasingly efficient building codes.

- *State Regulators:* Adopt rates and implement related policies affecting utility sector efficiency programs that more effectively align efficiency efforts with utility business models; and support energy productivity investments in buildings and infrastructure.
- *Local Government:* Facilitate distributed generation; establish best practices regarding building energy information; support the development of advanced manufacturing ecosystems; and reduce personal vehicle miles traveled[1] through the built environment-transportation nexus.
- *National Laboratories:* Serve as incubators for new energy productivity technologies—and where appropriate, enable new energy-efficient technologies to move rapidly from the lab to the marketplace.

Businesses

- *Commercial Businesses:* Reduce energy consumption in their own buildings and facilities through energy efficiency; reinvest the resulting avoided energy costs into growing their businesses; adopt new financing models that promote energy productivity investments; encourage their suppliers and vendors to take measures to improve energy productivity; and assist in training a workforce geared for energy productivity.
- *Industrial Businesses:* In addition to taking similar steps to those taken by commercial entities, leverage public-private partnerships; adopt energy management systems; transition to advanced manufacturing technologies; and explore new, innovative products that enable energy productivity for customers and suppliers.

Utilities

- *Electric Utilities:* Modernize the grid infrastructure through smart grid investments and improving the efficiency and interoperability of generation, transmission, storage, and distribution; adopt new utility business models to empower the improvement of energy productivity; design rates and support related policies for utility energy efficiency programs that more effectively align energy efficiency with utility business models; and support energy productivity investments in buildings.
- *Water Utilities:* Adopt more energy-efficient and energy-extracting technologies at water and wastewater treatment facilities and more water-efficient technologies in distribution and end use water systems (e.g., wastewater treatment plants can implement more efficient pumps and deploy onsite waste to energy conversion, such as digesters and combined heat and power; end use hot water conservation measures also have a direct impact on energy consumption).

Higher Education Institutions, and Individuals and Households

- *Higher Education Institutions:* Create new curricula and expand workforce training opportunities across multiple disciplines (e.g., building trades, engineering, governmental policy, economics, and law) for careers in the clean

1 Vehicle miles traveled is a measure of distance traveled by vehicles over a given period, typically one year.

energy, energy efficiency, and advanced manufacturing fields; and act as demonstration and commercialization "accelerators," enabling new energy-productive technologies to move rapidly from the lab to the marketplace. In addition, higher education institutions can invest in making their facilities and fleets more efficient.

- *Individuals and Households:* Support the markets associated with energy-efficient products in the home and for transportation and use available resources to make informed choices.

MODELING ENERGY PRODUCTIVITY IMPROVEMENTS

To model the effect of the aforementioned strategies for energy productivity on the U.S. economy, the *Roadmap* describes six illustrative productivity "wedges" that collectively represent the strategies. Underlying each wedge are assumptions based on existing published studies of the effect of productivity investments on energy use in a particular sector of the economy. As a result, the wedges are representative of the types of first order effects one could anticipate from the strategies and actions identified in the *Roadmap*.

Using the wedges as a model input, the *Roadmap* employed a vector error correction model (VECM) to estimate the effect of the wedges on U.S. GDP. Although there are many different types of econometric models, VECMs have two advantages. First, they robustly capture interactions and feedback between sectors of the economy using historical relationships. And second, they dynamically estimate future effects of changes to the economy using those historical relationships. In other words, VECMs do not assume GDP remains fixed like many static models but allow, for example, changes in energy efficiency investment to produce GDP feedback effects through changes in energy prices and the amount of energy consumed, among other factors.

After running the model, the *Roadmap* is able to rank the six wedges according to their net effect on GDP. The wedges analyzed are not the only six options available for improving energy productivity, but are intended to be illustrative of the types of energy and economic changes that are expected from following *Roadmap* strategies and actions. The six wedges are presented in descending order of their estimated impact to U.S. energy productivity[2]:

- *Transportation:* Increasing the energy productivity of moving goods and people relies on developing and deploying new technologies that increase vehicle efficiency, create more options for mass transit, and better integrate transportation needs with the built environment to reduce the demand for motorized transport.
- *Technologies for Buildings Energy Productivity:* Improving the energy productivity of buildings requires both the widespread use of currently available energy-efficient technologies and practices, and the development of next generation technologies.
- *Smart Energy Systems:* Energy systems, particularly electricity generation systems and the electricity grid, are sources

2 Economic and energy effects are not estimated for wedge sub-elements. As a result, it is not possible to determine the relative impacts to energy productivity of wedge sub-elements.

and enablers of improvements to U.S. energy productivity. Broad and deep transformations are required to enable transitions to distributed energy resources, real-time energy pricing, smart appliances, and increased energy efficiency.

- *Financing for Buildings Energy Productivity:* Significant changes to financing mechanisms and market recognition of the value of energy productivity are required to ensure energy productivity-enabling technology is used by businesses and households. This includes addressing real or perceived risk to the use and deployment of these technologies, which can immediately and adversely impact the cost of financing.
- *Smart Manufacturing:* Sensors and other information and communications technology (ICT) will allow industries better control over their processes and will improve the energy management of their buildings.
- *Water Infrastructure:* Reducing energy consumption at water and waste water treatment plants and in water conveyance and distribution systems involves three actions: improving energy efficiency and demand response, implementing emerging technologies and processes, and deploying energy recovery and generation technologies.[3]

DOUBLING ENERGY PRODUCTIVITY BY 2030 IS ACHIEVABLE

The analysis demonstrates that through immediate and sustained actions, doubling energy productivity by 2030 is possible. The model estimates the energy productivity wedges increase energy productivity in 2030 to $287/million British thermal units (Btu) (MMBtu)— more than double the 2010 baseline of $134/MMBtu. The change in energy productivity is the result of increasing GDP ($2005) to $22.5 trillion and reducing primary energy use to 78 quadrillion (quads) Btu by 2030. In comparison, the Energy Information Administration's (EIA) *Annual Energy Outlook* (AEO) 2015 projections are $21.7 trillion and 103 quads Btu in 2030. Thus, in 2030, the *Roadmap* scenario achieves 3.6 percent higher GDP and 24 percent lower primary energy use than AEO 2015 projections. The model does account for energy used to produce the additional goods and services purchased by households. This results in aggregate energy savings values, including this additional energy from more goods and services, are approximately 14 percent smaller than the sum of each individual productivity wedge, as indicated by the dashed line in Figure 1.

3 Pabi, S., A. Amarnath, R. Goldstein, and L. Reekie, Electricity Use and Management in the Municipal Water Supply and Wastewater Utilities (Palo Alto, CA: Electric Power Research Institute, 2013), accessed July 2015, http://www.waterrf.org/PublicReportLibrary/4454.pdf.

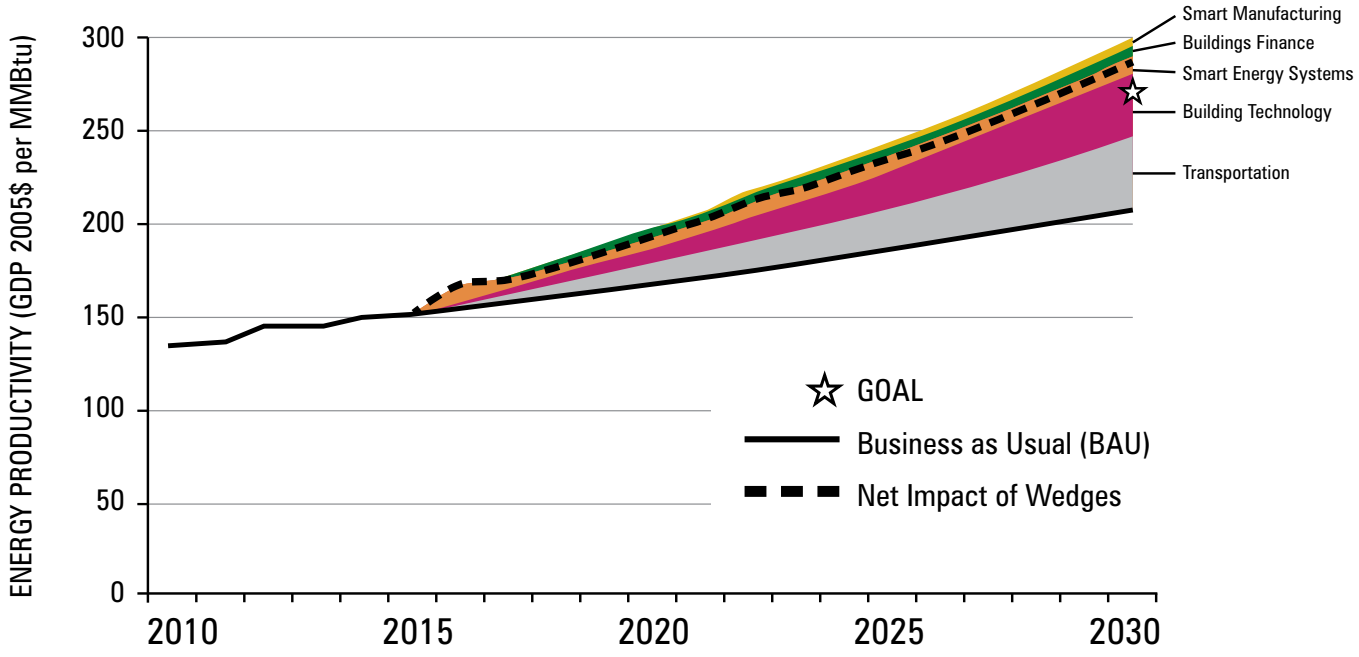

Figure 1. Estimated Energy Productivity Benefits to 2030

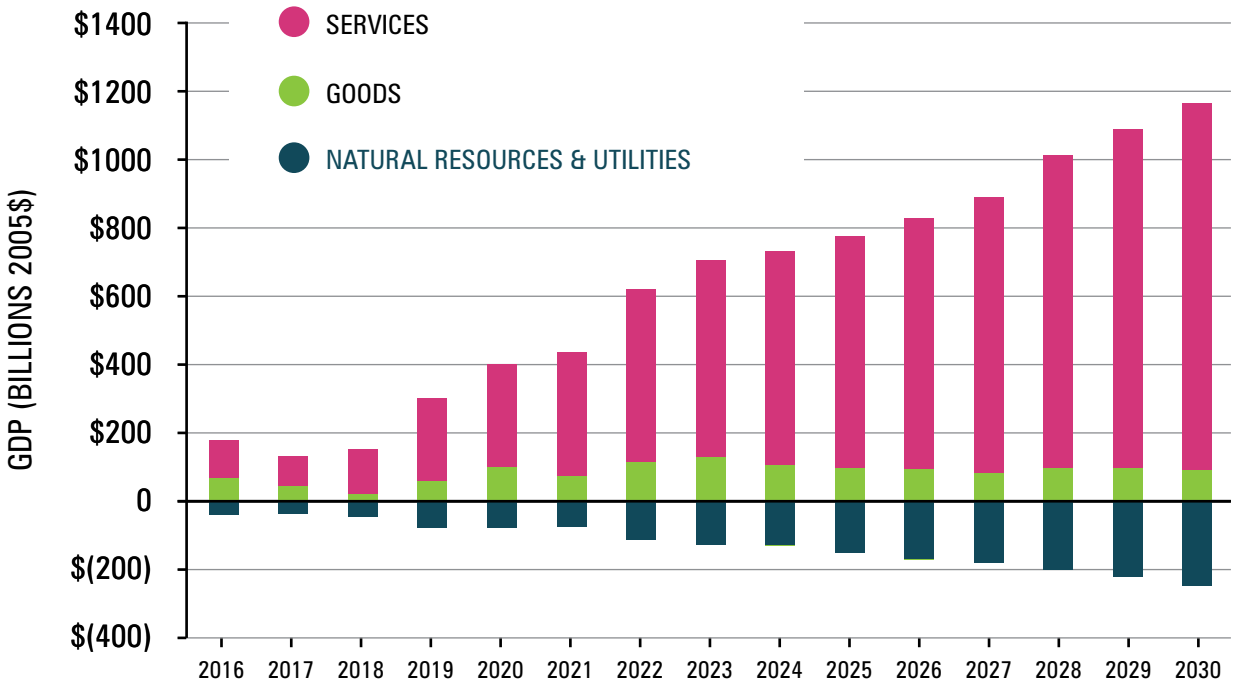

Figure 2. Estimated Changes to GDP by Sector

According to the model underpinning the *Roadmap*, the six energy productivity wedges will contribute in aggregate to a net increase of $922 billion in U.S. GDP by 2030. This is primarily supported by an increase of $753 billion in household expenditures and by a $169 billion increase in investment in products and services that increase energy efficiency. For households, there is a double benefit: they are able to increase their purchases of other goods and services in part by making energy efficiency investments that reduce their energy bills. Figure 2 shows the estimated changes to GDP by sector.

Producers of goods and services are also shown to benefit from increased economic activity spurred by energy productivity investments. The service industry shows the most significant growth, with a nearly $1.08 trillion increase over baseline economic activity by 2030. By 2030, goods-providing industries (e.g., manufacturing, agriculture, and construction) increase by approximately $51 billion over the model baseline. Declines in economic activity in the natural resources and utilities are due to decreases in energy expenditures and demand for production from utilities and their supply chain. No specific assumptions are made concerning export markets for natural resources.

CONCLUSION

As is clear from the Accelerate Energy Productivity 2030 regional roundtables and dialogues, as well as the modeling analyses, a wide range of available activities will yield significant productivity benefits. Implementing these activities will require changes in behavior, investment, and technology deployment in both the public and private sectors. Collectively, they can improve U.S. economic output, reduce U.S. energy consumption, and reduce the energy impact on the environment. Government and the private sector are already deploying many of these changes. While the task of doubling energy productivity is a significant challenge, the fact that many activities are already underway suggests that the nation can – and already is – beginning to meet this challenge. The *Roadmap* provides a foundation for scaling these efforts nationwide while allowing for flexible and tailored solutions.