RHODIUM GROUP

American Energy Productivity

The Economic, Environmental and Security Benefits of Unlocking Energy Efficiency

Prepared on behalf of the Alliance to Save Energy

February 2013

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ALLIANCE TO SAVE ENERGY

Using less. Doing more.

About Rhodium Group

Rhodium Group (RHG) combines policy experience, quantitative economic tools and on-the-ground research to analyze disruptive global trends. Our work supports the investment management, strategic planning and policy needs of firms in the financial, corporate and government sectors. RHG is based in New York City with associates in Washington, Berlin, Shanghai and New Delhi.

This project was led by RHG Partner Trevor Houser, who heads the firm's energy and natural resources work. Mr. Houser is also a visiting fellow at the Peterson Institute for International Economics in Washington, DC, where he writes on energy, commodity and environmental market and policy issues. He is an adjunct lecturer at the City College of New York, and a visiting fellow at the school's Colin Powell Center for Policy Studies. He is a member of the Council on Foreign Relations and the National Committee on US-China Relations and serves on the Advisory Boards of the Department of Energy-funded Energy Efficient Buildings Hub in Philadelphia and the Asia Society's Center on US-China Relations. He speaks regularly on international energy market and policy trends and has testified before the House Energy and Commerce Committee, the House Select Committee on Energy Independence and Global Warming, the US Helsinki Commission and the US-China Economic and Security Review Commissions.

Mr. Houser is the author most recently of *America's Energy Security Options* (2011), *A Role for the G20 in Addressing Climate Change?* (2010), *Assessing the American Power Act* (2010), *The Economics of Energy Efficiency in Buildings* (2009), *Leveling the Carbon Playing Field: International Competition and US Climate Policy Design* (2008), *The Roots of Chinese Oil Investment Abroad* (2008) and *China Energy: A Guide for the Perplexed* (2007).

Contents

Introduction

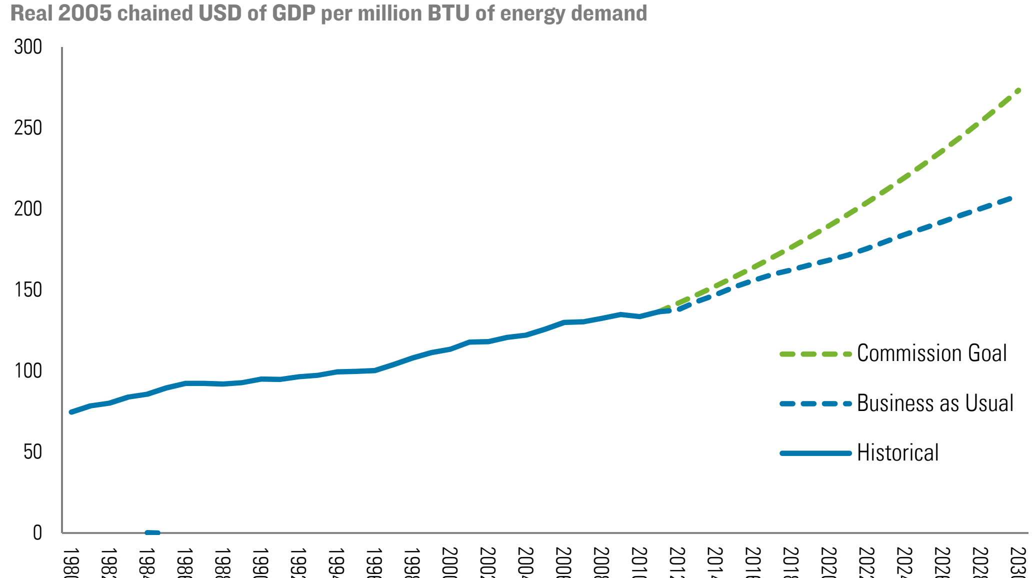
Energy is essential to American economic success. Like capital, labor and land, energy is an economic input, or "factor of production," that determines the speed and quality of economic growth. Countries grow either through more economic input or by using that input more efficiently. For example, when the size of a country's workforce grows, so does its economic potential. But it's not actually the number of workers that matter from an economic standpoint so much as the amount of work they are able to perform collectively. So improvements in education and technology that make workers more productive grow the economy even if the size of the labor force remains the same.

The same is true with energy. Whether heating homes, lighting office buildings, powering factories or moving goods and people, energy keeps a modern economy running. But it's the services energy provides (lighting, heating, transportation) that are valuable rather than the energy itself (coal, oil, natural gas and electricity). Expanding energy supply makes energy services more available and affordable. But so do improvements in the efficiency of buildings, factories, vehicles and transportation systems.

Recognizing the important role energy services play in the American economy, the Alliance Commission on National Energy Efficiency Policy ("the Commission") is recommending the US double energy productivity (the amount of economic output possible at a given level of energy supply) by 2030, and has outlined a set of policies that will help make that goal possible (Figure 1). The Commission's report is available online at http://www.energy2030.org.

Figure 1: Energy Productivity

Real 2005 chained USD of GDP per million BTU of energy demand



Source: EIA and Rhodium Group estimates

The Commission asked the Rhodium Group (RHG) to analyze the impacts of doubling energy productivity on US economic growth and job creation, as well as its implications for energy security and the environment. This report provides such an analysis, which was conducted independently of the Commission or the staff of the organizations contributing to the Commission's report.

Doubling energy productivity is an ambitious goal. It requires an annual improvement in energy productivity of 3.7% between now and 2030. America has achieved this rate of productivity improvement in the past, but never for such a sustained period of time. Therefore it's important to assess whether such gains are technically feasible, and at what cost. We have identified and analyzed a suite of productivity improvements across the buildings, industrial and transport sectors that are both technically feasible, economically attractive and consistent with the overall thrust the Commission's report.

It's important to note, however, that this is not an assessment of what the Commission's policy recommendations would actually deliver. Indeed those recommendations are intended to get the ball rolling, not necessarily finish the job. America's ability to achieve the Commission's goal, and capture the benefits outlined in this report, will depend on how, and at what pace, their recommendations are implemented, and what additional steps policymakers take in the years ahead.

Methodology

To assess the economic, environmental and security implications of the Commission's goal of doubling American energy productivity by 2030, RHG assessed both the costs of the efficiency improvements by sector, and their resulting energy savings. We relied on engineering studies of the technical efficiency potential in the buildings, industrial and transportation sectors, as well as the investment required to realize that potential. We selected efficiency improvements that are a) cost-effective, b) achievable with existing technology, and c) capable of achieving the Commission's energy productivity goal when combined. We then assessed the impact of this suite of policies on US economic growth, employment, industrial competitiveness, energy security and environmental quality using an integrated energy-economic model.

BUILDINGS

Our estimate of the costs and benefits of energy efficiency investments in residential and commercial buildings comes from a detailed model of the buildings sector developed by the World Business Council for Sustainable Development (WBCSD). In 2006 the WBCSD set out to assess potential energy savings in the global buildings sector and the economics of energy efficient building technology and design.[1] The project, the most comprehensive undertaking of its kind to-date, analyzed the economics of energy efficiency improvements in 19 million commercial and residential buildings around the world. The project culminated in a landmark report, published in 2009, on transforming the way buildings use energy.

Working with the model developers, we have updated the energy cost assumptions to reflect current projections and selected an efficiency pathway in residential and commercial buildings that's both economically attractive and consistent with the Commission's energy productivity goal. This pathway achieves a 30% reduction in energy consumption per square foot in 2030 relative to business-as-usual levels - on par with other estimates of achievable, cost-effective savings in the buildings sector (National Academy of Sciences 2010). Consistent with the Commission's report, our business-as-usual (BAU) scenario is the 2012 version of the Energy Information Administration's Annual Energy Outlook (EIA 2012a).

INDUSTRY

The most comprehensive assessment of industrial sector efficiency opportunities is a 2000 study titled "Scenarios for a Clean Energy Future" ("CEF study" for short). Conducted across five national laboratories at a cost of more than $1 million, the CEF study combines both detailed engineering estimates with economy-wide economic analysis (IWG 2000). The study estimates that a 22.4% reduction in energy consumption per unit of output is possible in the industrial sector through a

[1] See http://www.wbcsd.org for more information on the WBCSD's Energy Efficiency in Buildings project.

combination of efficiency improvements, including more efficient motors and greater use of combined heat and power (CHP).

More than a decade has passed since the CEF study was published and projections for industrial energy demand have since declined. This raises the possibility that some of the efficiency improvements identified in the CEF study are already included in our BAU scenario and thus the full cost-benefit estimates put forth in the CEF study no longer apply. A 2010 report by the National Academy of Sciences examined this question and expects this problem "to be negligible or nonexistent, because new energy efficiency opportunities arise each year as infrastructure and equipment age and as new and improved technologies are introduced into the marketplace" (2010). We have thus applied the CEF's industrial efficiency estimates and scaled both the investment costs and energy savings to the new baseline.

TRANSPORTATION

In keeping with the Commission's policy recommendations we analyzed two types of transportation interventions aimed at improving energy productivity in the sector: increased vehicle efficiency and reduced vehicle miles traveled. We modeled vehicle efficiency improvements through the application of Corporate Average Fuel Economy (CAFE) standards. CAFE standards establish a minimum efficiency level (measured in miles per gallon) for new cars and light trucks sold in the US. EIA's 2012 Annual Energy Outlook (the BAU scenario used in both this and the Commission's report) includes the Model Year (MY) 2012-2016 CAFE standards adopted in 2010.[2] In analyzing the Commission's goal we included the recently adopted MY 2017-2025 standards[3] and extended them to 2030 at a constant annual rate of growth. Estimates of the increase in vehicle costs required to meet these standards relative to the vehicle efficiency levels projected in the BAU scenario were taken from the EIA's National Energy Modeling System (discussed in more depth below).[4]

Vehicle miles traveled (VMT) can be reduced by expanding mass transit systems, improving urban and regional planning, or reducing highway congestion, among other strategies. We included in our analysis modeling conducted by Cambridge Systematics for the "Moving Cooler" report published in 2009 by the Urban Land Institute (Cambridge Systematics 2009). We selected the "Near-Term/Early Results" strategy bundle, which includes policies aimed at reducing congestion, improving traffic management, and expanding public transportation. In Cambridge Systematics' estimation, this bundle is capable of delivering a 12% reduction in VMT in 2030 relative to BAU.[5]

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[2] http://www.nhtsa.gov/PR/DOT-56-10

[3] http://www.nhtsa.gov/staticfiles/rulemaking/pdf/cafe/CAFE_2017-25_Fact_Sheet.pdf

[4] http://www.eia.gov/forecasts/aeo/assumptions/pdf/transportation.pdf

[5] The study expresses results in terms of greenhouse gas emission reductions. But as these reductions are almost entirely achieved through lower VMT, we assume a one-for-one ratio between greenhouse gas and VMT reductions.

PUTTING IT ALL TOGETHER

Most efficiency improvements require additional upfront investment (known as the "incremental first cost") that is recouped through subsequent energy savings. The incremental first cost of each of the interventions described above is taken from the underlying engineering study or model. We annualize the incremental costs using sector-specific interest rates and investment time-horizons to approximate the annual cost of the efficiency improvement if the investment was financed. We apply a 7% interest rate for buildings and vehicles and a 15% interest rate for industry, consistent with rates used in the 2010 National Academy of Sciences report. We apply a 10-year financing term for buildings and transportation systems. For industry and vehicles, the term is the life of the equipment.

We assess the energy cost savings produced by these investments using RHG-NEMS, a version of the EIA's National Energy Modeling System (NEMS) maintained by RHG. EIA uses NEMS to produce their Annual Energy Outlook (AEO), which projects the production, conversion, consumption, trade and price of energy in the US through 2040. NEMS is an energy-economic model that combines a detailed representation of the US energy sector with a macroeconomic model provided by IHS Global Insight. The version of RHG-NEMS used for this analysis is keyed to the 2012 version of the AEO to be consistent with the BAU scenario used in the Commission report.[6]

For buildings, we reduce delivered energy demand to both the residential and commercial sectors across energy type starting in 2013 and reaching 30% below BAU by 2030. This is a simplistic representation of the efficiency improvements derived from the WBCSD model as the economically optimal technology and design portfolio capable of delivering a 30% efficiency improvement may change the type, as well as quantity, of energy buildings consume. Yet comparing WBCSD output with RHG-NEMS model output, we believe this approach is sufficiently robust for our purposes. We take the same approach in the industrial sector, reducing delivered energy consumption by 22.4% in 2030 relative to BAU.

In the transportation sector, we model improved vehicle efficiency by increasing CAFE standards based on the recently adopted MY 2017-2025 rules, and extend those standards beyond 2025 at trend 2017-2025 rates. RHG-NEMS endogenously calculates the impact on energy consumption, as well as the increase in vehicle purchase costs. We model Cambridge Systematics' "Near-Term/Early Results" scenario by reducing VMT for passenger vehicles starting in 2013 and reaching 12% below BAU in 2030.[7]

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[6] Complete NEMS documentation is available on the EIA's web site – www.eia.gov. Documentation of the macroeconomic and energy sector assumptions used in the AEO 2012 version of NEMS is available at http://www.eia.gov/forecasts/archive/aeo12/index.cfm.

[7] We only capture the impact of VMT reductions on energy expenditures, not avoided vehicle purchases. Thus, our estimate of the net economic benefit of the VMT reduction strategy assessed is relatively conservative.

RHG-NEMS captures the impact of these efficiency improvements on energy prices, and of changes in energy prices on overall energy demand. Some have argued that energy efficiency improvements will make both energy and energy services cheaper and lead to greater consumption of energy, thus undermining any potential environmental or energy security benefits. In our modeling, this “rebound effect” is small – only 5-10% of the reduction in energy demand from the efficiency improvement is counteracted by increased demand thanks to lower energy costs. And as demonstrated later in this report, doubling energy productivity yields significant energy security and environmental benefits even after the rebound effect is taken into account. Moreover, the rebound effect is evidence of the economic benefit of energy efficiency. Cheaper energy services allows for greater production and consumption of goods and services – the very outcome the Commission is hoping to achieve.

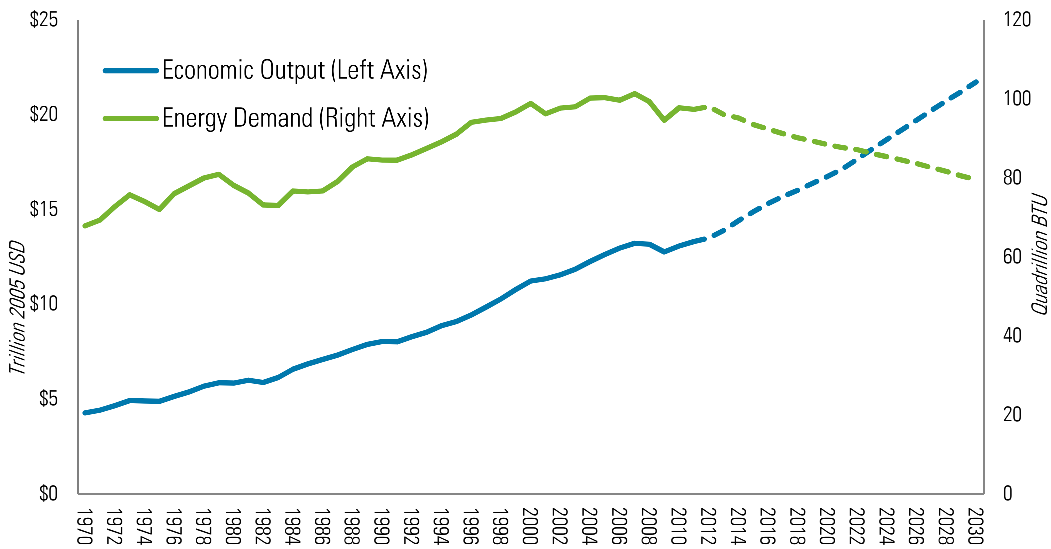
Once converged, the model reports energy consumption, production, trade, prices and expenditures both by fuel and sector, as well as annual levels of energy-related air pollution. We use this output to assess the economic, employment, environmental and security implications of the Commission’s goal. The combination of efficiency improvements modeled in this report come very close to doubling energy productivity by 2030. Doubling means a 100% improvement in energy productivity by 2030 relative to 2011 levels, defined as economic output (measured in 2005 dollars) divided by total primary energy consumption (measured in million BTU). Our analysis produces a 101.6% improvement in energy productivity over that time period. Thus, comparing our modeling results to the BAU scenario allows us to assess the economic, employment, environmental and security implications of the Commission’s goal relative to what is projected to occur under existing policy.

Economic and Employment Impacts

The Commission's goal is ambitious. Throughout America's history, energy demand has grown every year except during economic recessions and recoveries. Energy productivity improvements have slowed the rate of energy demand growth but not halted it completely. Doubling energy productivity by 2030 relative to 2011 levels would decouple energy demand and economic growth. Based on our review of the efficiency literature, and our analysis of its economic impact, we believe such a decoupling is both technically and economically possible. The efficiency improvements described above deliver an 18% reduction in overall US energy demand by 2030 relative to 2011 levels while sustaining (if not improving) trend economic growth (Figure 2).

Figure 2: Untying Economic Growth and Energy Demand

Economic output (left axis) and energy demand (right axis) under a doubling energy productivity scenario



To achieve the Commission's goal, an additional $166 billion in annual investment (in real 2010 USD) in building design and technology, energy efficient industrial equipment and vehicles, and energy saving transportation systems is required beyond what is projected to occur under business-as-usual (Table 1). In our suite of efficiency improvements, the transportation sector accounts for 48% of this investment, followed by residential and commercial buildings at 43%, with the remainder going to the industrial sector.

The reduction in energy consumption resulting from this investment would deliver $343 billion in annual energy cost savings in 2030 relative to BAU. Lower demand would lead to lower prices, which would cut energy bills by another $151 billion a year. Net of investment costs, Americans would save $327 billion a year. The biggest gains would be in the transportation sector at $139 billion a year, followed by buildings at $95 billion a year and industry at $94 billion a year. Table 2 allocates these sectoral gains to household, business and government consumers.

Table 1: Net Annual Savings by Sector in 2030

Billion 2010 USD

Sector	Energy Expenditures		Energy Savings			Investment Costs (c)	Net Savings (a-b+c)
	BAU (a)	Goal (b)	Improved Efficiency	Lower Prices	Total (a-b)		
Buildings	$493	$326	$140	$27	$167	$72	$95
Industry	$269	$161	$66	$43	$109	$15	$94
Transportation	$875	$657	$137	$81	$218	$79	$139
Total	$1,637	$1,144	$343	$151	$494	$166	$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.

Table 2: Net Annual Savings by Consumer Type in 2030

Billion 2010 USD

Sector	Energy Expenditures		Energy Savings			Investment Costs (c)	Net Savings (a-b+c)
	BAU (a)	Goal (b)	Improved Efficiency	Lower Prices	Total (a-b)		
Households	$718	$477	$177	$64	$241	$97	$145
Businesses	$856	$626	$149	$81	$230	$61	$169
Government	$62	$40	$16	$6	$22	$9	$13
Total	$1,637	$1,144	$343	$151	$494	$166	$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.

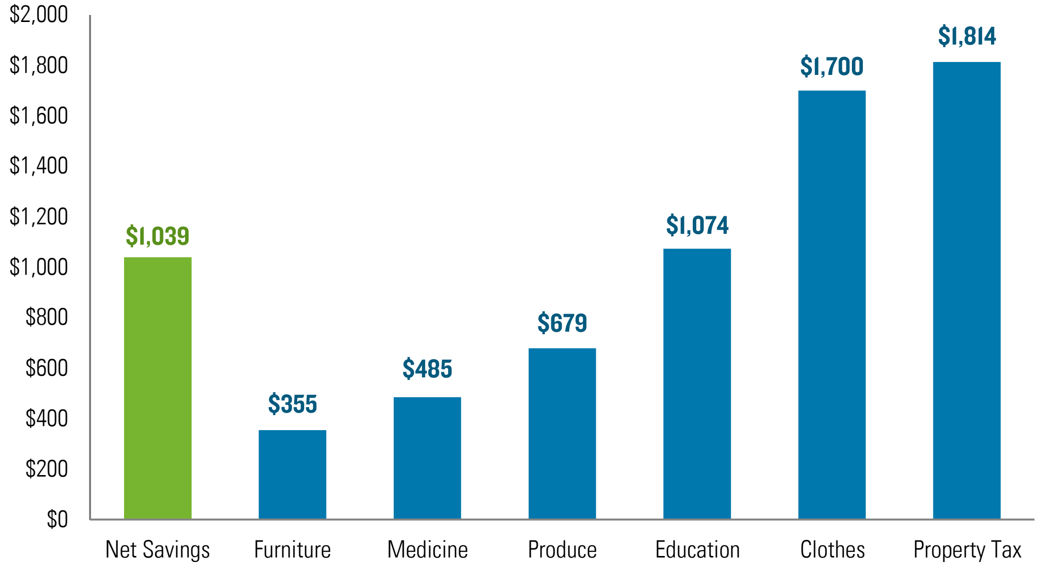
HOUSEHOLDS

To achieve the Commission's doubling target, we estimate that American households would need to invest a combined $97 billion a year in building and transportation efficiency. This investment would reduce annual energy expenditures by $241 billion for a net savings of $145 billion a year.[8] At currently projected levels of population growth, that's $1,039 per household a year, in real 2010 dollars. That's 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 (Figure 3). The impact on household budgets is comparable to the payroll tax cut that expired at the beginning of 2013. Over the life of the investment, net savings from a doubling of American energy productivity would allow American households to settle all outstanding credit card debt.

[8] May not sum to total due to rounding.

Figure 3: Net Household Savings vs. Household Spending

Real 2010 USD per household per year



Source: Census, Bureau of Labor Statistics and Rhodium Group estimates

BUSINESS

Doubling US energy productivity would require $61 billion in annual investment from American business, both in the commercial and industrial sectors. That investment would reduce business energy expenses by $230 billion a year, for an annual net savings of $169 billion. That's a significant reduction in production costs that can either be passed onto consumers or reinvested. For context, the US corporate sector paid $181 billion in income tax in 2011 (CBO 2012). Corporate profits are projected to grow as the economy recovers, but the net energy cost savings to American business from a doubling of energy productivity would still be equivalent in scale to a 35% reduction in the corporate income tax in the years ahead.[9]

Net energy savings to American business would be concentrated in, and particularly important for, energy-intensive manufacturing like chemicals, glass, paper, steel and aluminum. Energy costs play an important role in determining the international competitiveness of these industries. Lower energy prices combined with lower energy demand would reduce overall production costs for these industries by more than 10%, even after taking into account the cost of efficiency investments.

GOVERNMENT

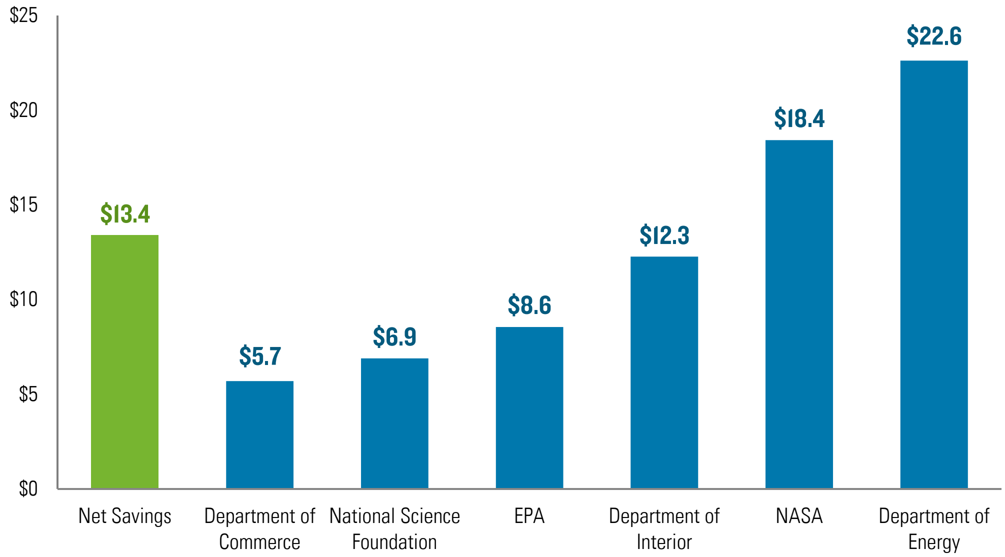
To do their part in achieving the Commission's goal, federal, state and local governments would need to invest $8.6 billion in building and vehicle efficiency improvements. These investments would lower government energy expenses by $22

[9] The CBO projects corporate income tax revenue of 2% of GDP in 2022 – the last year in their projection period. The net energy savings to businesses analyzed in this report equal 0.7% of GDP in 2030.

billion a year, yielding $13.4 billion in net annual savings. That's nearly as much as the annual budget of the Department of Commerce and EPA combined and nearly twice as much as the US spends on research through the National Science Foundation (Figure 4). Over a ten-year period, these savings would do more to improve the budget than taxing the unrepatriated foreign earnings of US corporations or raising the Medicare retirement age to 67.[10]

Figure 4: Net Government Savings vs. Federal Agency Budgets

Billion USD, agency budgets are FY 2011



Source: OMB, Rhodiium Group

ECONOMIC OUTPUT

Estimating the overall macroeconomic impact of doubling American energy productivity is challenging. Investment in energy efficient buildings, industries and transportation systems creates demand for a range goods and services (e.g. insulation, appliances, boilers and advanced vehicles). In normal economic conditions, efficiency would have to compete with other investment opportunities for labor and capital so an increase in demand created by greater efficiency investment might be offset by a decrease in demand from reduced investment elsewhere in the economy. When the economy is operating below full employment (as it is today), and there is capital and labor sitting idle on the sidelines waiting to be put to work, this is less of a concern. Indeed, efficiency investments can accelerate the pace of economic recovery by increasing overall investment and raising real household incomes by lowering energy costs.

Over the long-term, a reasonable upper-bound estimate of the economic benefits of doubling energy productivity is the $327 billion in net energy savings resulting from efficiency investments, which in nominal dollars amounts to 2% of GDP in 2030. Our

[10] See CBO Spending and Revenue Options: http://www.cbo.gov/publication/42307

analysis suggests that market failures are preventing households, businesses and federal, state and local governments from capturing those savings, even assuming efficiency investments are financed at competitive interest rates and payment terms. Put another way, the economy is operating up to $327 billion below its potential. [11] The policy and transaction costs required to achieve a doubling of energy productivity could erode some of the savings from efficiency gains, but the increase in overall economic output from achieving the Commission's goal would still be substantial.

EMPLOYMENT

Doubling energy productivity would add jobs in the construction, equipment and automobile industries thanks to additional efficiency investment. Lower energy demand means jobs lost in production, transformation and distribution of coal, oil, natural gas, nuclear and renewable energy. And when households and businesses spend money saved on energy on other goods and services, jobs will be created elsewhere in the economy. Finally, as mentioned above, over the long term some of the additional investment in efficiency will be offset by reduced investment elsewhere in the economy because of broader macroeconomic effects.

We combine the IMPLAN model of the US economy[12] and the IHS Global Insight Macroeconomic Model integrated in NEMS to assess the net impact of this mix of factors on overall US employment.[13] Investing $166 billion in energy efficient buildings, industrial equipment, vehicles and transportation systems produces 2.28 million jobs (Table 3). The construction and manufacturing sectors see significant gains, and when workers in those industries spend their paychecks the service, wholesale and retail trade sectors get a boost. As households and businesses spend the $372 billion in projected energy savings (net of investment costs), another 5.1 million jobs are created, primarily in the service, wholesale and retail trade sectors.

Offsetting these gains are employment declines resulting from a reduction in revenue to the energy industry. Mining employment (which includes coal, oil and natural gas) falls by 240,000 and wholesale and retail trade employment falls by 2.1 million, primarily due to less demand for labor at gasoline stations. Finally, using the IHS Global Insight model we estimate that broader macroeconomic effects would reduce the employment gains of efficiency investment and energy savings by an additional 991,000 jobs. That leaves a net increase in US employment in 2030 of 1.3 million as a result of doubling American energy productivity.

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[11] See the macroeconomic discussion paper prepared for the CEF report available at http://www.ornl.gov/sci/eere/cef/CEF-E4.pdf

[12] For more information see http://www.implan.com/

[13] This methodology was first employed in a 2010 study by RHG's Trevor Houser and Shashank Mohan for the Peterson Institute for International Economics available here: http://www.piie.com/publications/interstitial.cfm?ResearchID=1574

Table 3: Employment Impacts of Doubling Energy Productivity

Thousand jobs

	Efficiency Investment	Lost Energy Revenue	Redirected Energy Savings	Total
Agriculture	26	-47	111	89
Mining	12	-240	26	-203
Construction	346	-69	44	321
Manufacturing	457	-164	236	530
Transport, Information and Utilities	72	-482	160	-250
Wholesale and Retail Trade	296	-2,151	899	-955
Service	1,038	-1,904	3,534	2,668
Government	35	-44	69	60
Macroeconomic Effects				*-991*
Net Employment				1,268

Environmental and Security Implications

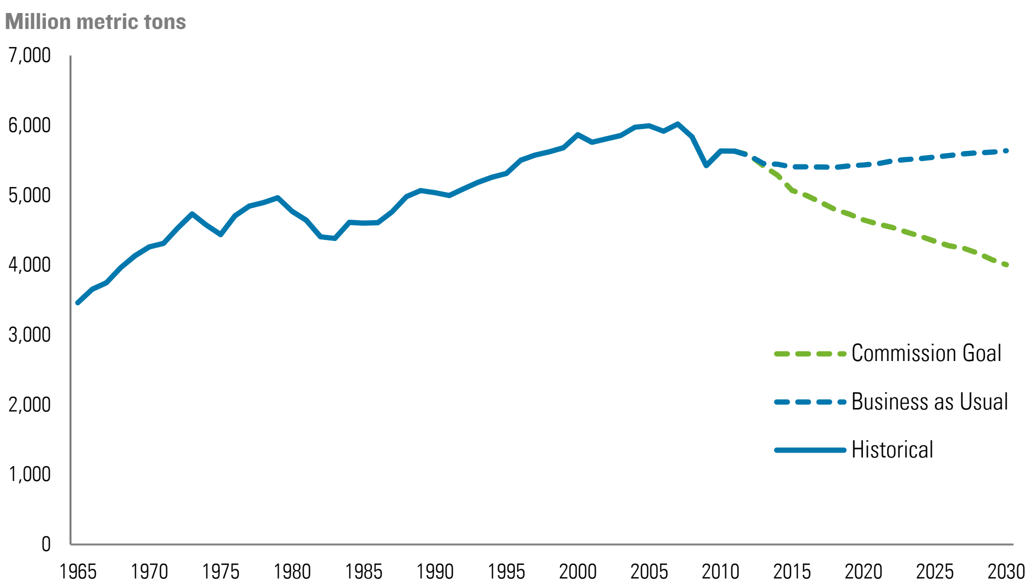
Beyond the economic and employment benefits discussed above, doubling American energy productivity would help the US achieve both environmental and energy security policy objectives.

ENVIRONMENT

Thanks to a combination of slow economic growth and a switch from coal to natural gas and renewables, US carbon dioxide (CO_2) emissions were 12.1% below 2005 levels during the first three quarters of 2012 (EIA 2012b). Yet the EIA projects US emissions will stabilize going forward as the economy recovers -- absent new policy from Washington or state and local governments (Figure 5). Doubling energy productivity would allow emissions to continue to decline while economic growth picks up and provides a cost-effective strategy for addressing climate change in the decades ahead.

At the Copenhagen climate change conference in 2009, the US committed to reduce greenhouse gas (GHG) emissions by 17% below 2005 levels by 2020. We estimate that if the Commission's goal is achieved, the US would meet that commitment, with CO_2 emissions falling 22% below 2005 levels by 2020 on the way to a 33% reduction by 2030. CO_2 accounts for more than 80% of total US GHG emissions and efficiency improvements would reduce other GHG emissions, such as methane released from natural gas production and delivery systems. CO_2 accounts for more than 80% of total US GHG emissions and efficiency improvements would reduce other emissions, such as methane released from natural gas production and delivery systems.

Figure 5: US CO2 Emissions



Source: EIA and Rhodium Group estimates

For regulatory purposes, the US government measures the cost of CO_2 emissions on the economy and society in the year 2030 at $34 dollar per ton (in real 2010 dollars).[14] In our analysis, annual US CO_2 emissions would be 786 million tons lower if the Commission's goal is achieved than under BAU. At $34 per ton, this reduction delivers an additional $27 billion in savings to the US.

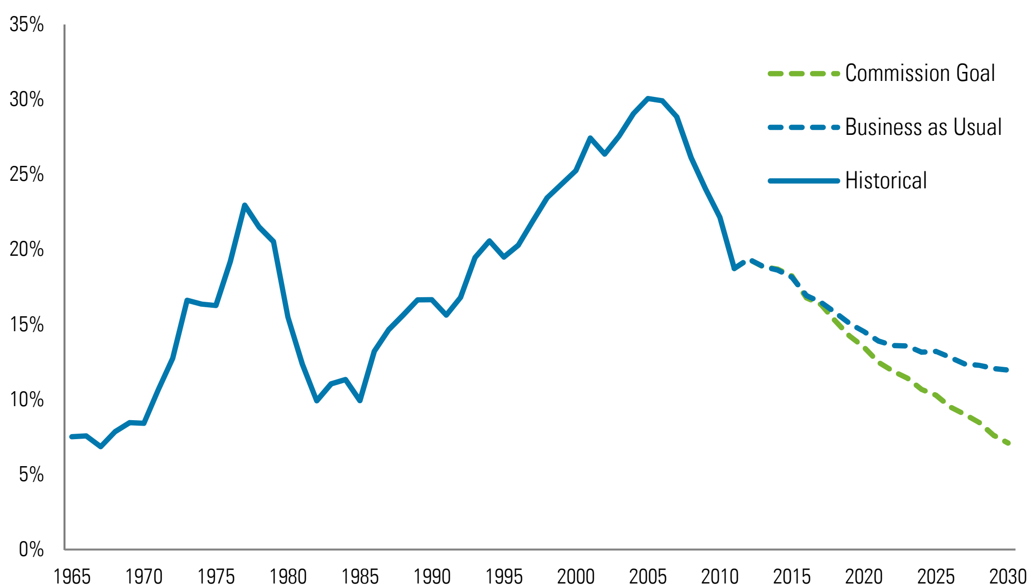
Doubling energy productivity will have other environmental benefits as well. We estimate that in 2030, sulfur dioxide (SO_2) emissions from the electric power sector would be 55% lower than under BAU (which includes existing environmental regulations) and nitrogen oxide (NO_x) emissions would be 45% lower. The National Research Council (NRC) estimates that each ton of SO_2 and NO_x emitted from a coal-fired power plant costs the US $5,800 and $1,600 in environmental and human health damages respectively (National Research Council 2009). Using these estimates, achieving the Commission's goal would yield an additional $6.6 billion in annual benefits through power sector air pollution reductions.

ENERGY SECURITY

Slower energy demand growth coupled with the recent boom in domestic oil and natural gas supply are reducing American dependence on imported energy (Figure 6). Net imports accounted for 19% of US energy consumption in 2011, down from 30% in 2006. The EIA projects this trend to continue, albeit at a more gradual pace. In their 2012 Annual Energy Outlook (our business-as-usual scenario) net energy imports fall to 12% of energy demand by 2030 (Table 4).

Figure 6: American Dependence on Imported Energy

Net imports as a share of total consumption



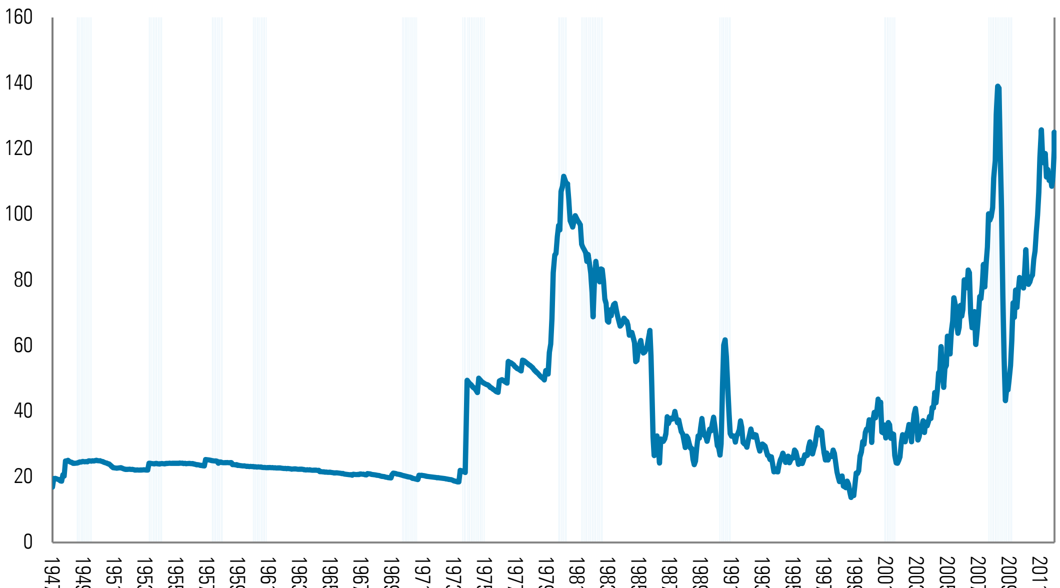
[14] Known as the "social cost of carbon". See http://www.epa.gov/otaq/climate/regulations/scc-tsd.pdf

Doubling energy productivity would accelerate this process. We estimate that achieving the Commission's goal would reduce net energy imports to 7% of US consumption by 2030. Net oil imports would fall from 8.6 million barrels per day (bbl/d) in 2011 to 4.5 million bbl/d in 2030, 2.4 million bbl/d lower than under BAU. Spending on imported energy would fall from $359 billion in 2011 (2.4% of GDP) to $244 billion in 2030 (1% of GDP), $106 billion lower than under BAU.

While this improvement in America's energy trade balance is significant, potentially more powerful is the impact of energy productivity improvements on the resilience of the US economy. Sudden increases in energy costs prompt economically painful changes in consumer behavior. Past oil price spikes have led to sudden shifts in vehicle preferences – forcing auto companies to make costly changes in investment and production plans (Hamilton 2009). Energy price spikes also lead to precautionary household savings which reduces consumption already strained by higher energy costs. It's no surprise then that energy price spikes have preceded 10 of the past 11 US economic recessions (Figure 7).[15]

Figure 7: Oil Prices and US Recessions

Real 2011 USD per barrel (line) and US economic recessions (vertical bars)



Source: NBER, BLS, EIA and Rhodium Group estimates

While the recent surge in US oil and natural gas supply is reducing the amount of energy Americans buy from abroad, the US will remain connected to the global energy market even if we become a net energy exporter in the years ahead. And that means energy prices within the US will still be impacted by events elsewhere in the

[15] There is considerable debate among economists regarding the degree to which rising energy prices have contributed to past recessions relative to other factors (Hamilton 2011; Kilian 2008), but there is broad consensus that large and sustained increases in energy costs are a significant macroeconomic risk.

world. Thus, increased energy productivity is an important compliment to increased energy supply as a strategy for making the US economy more secure. Achieving the Commission's goal would cut the share of economic output spent on energy in half relative to 2011 levels (Table 4). That would reduce the direct economic cost of future energy price spikes by up to 30% relative to BAU.

Table 4: Energy Implications of Commission Goal

	2011	2030		
		BAU*	Commission Goal	Difference
Energy Demand (qbtu)	**97.7**	**104.2**	**79.5**	**-24.7**
Coal (million short tons)	999.1	1,098.0	617.4	-480.6
Natural Gas (trillion cubic feet)	23.0	26.1	20.1	-6.0
Oil (million bbl/d)**	17.8	17.2	13.9	-3.2
Nuclear (billion kWh)	790.2	914.3	908.4	-5.9
Renewables (qbtu)	7.5	10.2	9.1	-1.1
Net Energy Imports (qbtu)	**18.3**	**12.6**	**5.7**	**-6.9**
Coal (million short tons)	-95.8	-81.2	-106.6	-25.4
Natural Gas (trillion cubic feet)	1.9	-0.9	-2.0	-1.1
Oil (million bbl/d)**	8.6	6.9	4.5	-2.4
Net Imports / Demand (%)	**18.7%**	**12.1%**	**7.1%**	**-5.0%**
Coal (million short tons)	-9.6%	-7.4%	-17.3%	-9.9%
Natural Gas (trillion cubic feet)	8.5%	-3.4%	-9.8%	-6.4%
Oil (million bbl/d)**	48.1%	40.0%	32.2%	-7.7%
Energy Price				
Coal (2010 USD per short ton)	40.3	47.7	48.5	0.8
Natural Gas (2010 USD per MMBTU)	3.9	6.3	3.6	-2.7
Crude Oil (2010 USD per barrel)***	108.9	126.6	117.7	-8.9
Gasoline (2010 USD per gallon)	3.4	4.1	3.6	-0.6
Electricity (2010 cents per kWh)	9.7	9.8	8.9	-0.9
Energy Expenditures (billion 2010 USD)	**1344.1**	**1637.1**	**1143.6**	**-493.5**
Net Imports (billion 2010 USD)	358.6	349.5	243.6	-105.9
Domestic Production (billion 2010 USD)	985.5	1287.6	900.0	-387.7
Total Energy Expenditures as a Share of GDP	9.1%	6.8%	4.7%	-2.0%
Net Energy Imports as a Share of GDP	2.4%	1.4%	1.0%	-0.4%

* BAU is the 2012 version of the Annual Energy Outlook. The EIA recently released an preliminary version of their 2013 Outlook which has different supply, demand and price forecasts. ** Oil refers to crude oil, NGLs and refined petroleum products. *** The average price of imported crude oil.

Conclusion

The Commission's goal of doubling energy productivity by 2030 is ambitious. It would, for the first time in US history, decouple economic growth from energy demand. But our analysis shows it is achievable through currently available energy efficiency solutions in the buildings, industrial and transportation sectors.

The cost of doubling energy productivity is substantial -- $166 billion a year in additional investment. But the economic, employment, environmental and security benefits are even greater. Doubling energy productivity would save the US economy $327 billion a year in energy expenses, net of investment costs, and create 1.3 million jobs. It would significantly reduce emissions of carbon dioxide, sulfur dioxide and nitrogen oxides, delivering an additional $34 billion in avoided costs and achieving a number of US environmental policy objectives. American dependence on imported energy would fall from 19% today to 7% by 2030 and the US economy would be much more resilient to future energy price shocks.

The policy recommendations outlined in the Commission's report are an excellent starting point for catalyzing improvements in American energy productivity. The country's ability to achieve the Commission's goal and capture the benefits outlined in this report will depend on the pace and manner in which those recommendations are adopted and what additional steps policymakers take in the years ahead.

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