NRC Says Existing Energy Efficiency Technologies Could Provide Major Savings

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Energy efficiency technologies that currently exist or that are likely to be developed in the near future could save considerable money as well as energy, according to a report from the National Research Council. Fully adopting these technologies could lower projected U.S. energy use 17–20% by 2020, and 25–31% by 2030.

Achieving full deployment of these efficiency technologies will depend in part on pressures driving adoption, such as high energy prices or public policies designed to increase energy efficiency. Nearly 70% of electricity consumption in the United States occurs in buildings. The energy savings from attaining full deployment of cost-effective, energy-efficient technologies in buildings alone could eliminate the need to add new electricity generation capacity through 2030, the report said. New power generation facilities would be needed only to address imbalances in regional energy supplies, replace obsolete facilities, or to introduce more environmentally friendly sources of electricity.

Many cost-effective efficiency investments in buildings are possible, the report said. For example, replacing appliances such as air conditioners, refrigerators, freezers, furnaces, and hot water heaters with more efficient models could reduce energy use by 30%. Opportunities for achieving substantial energy savings exist in the industrial and transportation sectors as well. For example, deployment of industrial energy efficiency technologies could reduce energy use in manufacturing 14–22% by 2020, relative to expected trends. Most of these savings would occur in the most energy-intensive industries, such as chemical manufacturing, petroleum refining, pulp and paper, iron and steel, and cement.

Although there is great potential, many barriers exist to widespread adoption of energy efficiency technologies, according to the report. The upfront costs can be high, which can deter investment despite the possibility of long-term cost savings. Volatile energy prices can cause buyers to delay purchasing more efficient technology due to a lack of confidence that they will see an adequate return on their investment. In addition, there is a shortage of readily available, trustworthy information for consumers hoping to learn about the relative performance and costs of energy-efficient technology alternatives. Investments in energy-efficient infrastructure are particularly important, as these can lock in patterns of energy use for decades. Therefore, taking advantage of windows of opportunity for infrastructure is crucial.

Overcoming these barriers will require significant public and private support, and sustained effort. Many energy efficiency initiatives have been successful, such as the U.S. Department of Energy and U.S. Environmental Protection Agency's Energy Star labeling program. Efforts undertaken by California and New York have yielded large energy savings for those states. These experiences provide valuable lessons for national, state, and local policymakers on enacting effective energy efficiency policies, according to the report.

This is the final report in a series from the National Academies' America's Energy Future project, which was undertaken to stimulate and inform a constructive national dialogue about the country's energy future. The committee was chaired by Lester B. Lave (Carnegie Mellon University); Maxine L. Savitz (Honeywell, Inc.) served as vice chair.

Copies of *Real Prospects for Energy Efficiency in the United States* are available from the National Academies Press (www.nap.edu), tel. 202-334-3313 or 1-800-624-6242.

Plug-In Hybrid Vehicle Costs Likely to Remain High, Benefits Modest for Decades

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Costs of plug-in hybrid electric cars are high—largely due to their lithium-ion batteries—and unlikely to drastically decrease in the near future, according to a report from the National Research Council. Costs to manufacture plug-in hybrid electric vehicles in 2010 are estimated to be as much as $18,000 more than for an equivalent conventional vehicle. Although a mile driven on electricity is cheaper than one driven on gasoline, it will likely take several decades before the upfront costs decline enough to be offset by lifetime fuel savings. Subsidies in the tens to hundreds of billions of dollars over that period will be needed if plug-in vehicles are to achieve rapid penetration of the U.S. automotive market. Even with these efforts, plug-in hybrid electric vehicles are not expected to significantly impact oil consumption or carbon emissions before 2030.

The report looks at plug-in hybrid electric vehicles that can operate on electricity for 10 or 40 miles. The PHEV-10 is similar to the Toyota Prius but with a larger battery. The PHEV-40 is similar to the Chevrolet Volt; it has a larger motor and a much larger battery than the PHEV-10. The lithium-ion battery technology used to run these vehicles is the key determinant of their cost and range on electric power. Battery technology has been developing rapidly, but steep declines in cost do not appear likely over the next couple of decades because lithium-ion batteries are already produced in large quantities for cell phones and laptop computers. In the first generation of production, the PHEV-10 battery pack is estimated to cost about $3,300, and the PHEV-40 battery pack about $14,000. While these costs will come down, a fundamental breakthrough in battery technology, unforeseen at present, would be needed to make plug-ins widely affordable in the near future.

According to the committee that wrote the report, the maximum number of plug-in electric vehicles that could be on the road by 2030 is 40 million, assuming rapid technological progress in the field, increased government support, and consumer acceptance of these vehicles. However, factors such as high cost, limited availability of places to plug in, and market competition suggest that 13 million is a more realistic number, the report said. Even this more modest estimate assumes that current levels of government support will continue for several decades.

Most of the electricity used to power these cars will be supplied from the country's power grid. If charged at night when the demand for electricity is lowest, the grid would be able to handle the additional demand for millions of plug-in hybrid electric vehicles, the report said. However, if drivers charge their vehicles at times of high demand, such as when they get home from work, the additional load could be difficult to meet unless new capacity is added. Smart meters, which bill customers based on time of use, may be necessary in order to encourage nighttime charging. In addition, some homes would require electrical system upgrades to charge their vehicle, which could cost more than $1,000.

Relative to hybrid vehicles, plug-in hybrid electric vehicles will have little impact on U.S. oil consumption before 2030, especially if fuel economy for conventional vehicles and hybrids continues to increase past 2020. PHEV-10s save only ~20% of the gasoline an equivalent hybrid vehicle would use, the report said. If 40 million PHEV-10s are operating in 2030, they would save about 0.2 million barrels of oil per day relative to less expensive hybrids, ~2% of current U.S. daily light-duty vehicle oil consumption. More substantial savings could be seen by 2050. PHEV-40s, which consume 55% less gasoline than hybrids, could have a greater impact on oil consumption.

Plug-in hybrid electric vehicles emit less carbon dioxide than equivalent conventional vehicles, but not less than hybrids

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after accounting for emissions at generating stations supplying their electrical power, the report said. Beyond 2030, assuming consumer acceptance, plug-in hybrid electric vehicles could account for significant reductions in U.S. carbon dioxide emissions, if electricity generation plants fired by fossil fuels were equipped with carbon capture and storage systems or replaced with renewable energy or nuclear-powered plants.

According to the report, a portfolio approach toward reducing U.S. dependence on oil is necessary for long-term success. This should include increasing the fuel efficiency of conventional vehicles and pursuing research, development, and demonstration into alternative strategies, including the use of biofuels, electric vehicles, and hydrogen fuel cell vehicles.

The committee was chaired by Michael P. Ramage, Executive Vice President of ExxonMobil Research and Engineering Co. (retired).

Copies of *Transitions to Alternative Transportation Technologies—Plug-In Hybrid Electric Vehicles* are available from the National Academies Press (www.nap.edu), tel. 202-334-3313 or 1-800-624-6242.

IEA Offers Blueprint to Deliver on Ambitious Climate Change Goals

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"While the details of a binding agreement may not be completely worked out in Copenhagen, it is more important than ever that participants send a strong, indicative and ambitious signal that can guide energy investment and policy decisions globally," said Nobuo Tanaka, the Executive Director of the International Energy Agency (IEA), in December 2009 at the United Nations Climate Change Conference (COP-15) in Copenhagen. "This conference is the most important climate meeting to date, as we urgently need a framework that goes beyond 2012, the end of the Kyoto Protocol first commitment period. The economic crisis, with the resulting fall in global energy-related CO_2 emissions of around 3% in 2009, gives us a unique window of opportunity to change our current, highly unsustainable energy path," said Tanaka. "Current pledges point in the right direction, but fall short of what is needed to keep the global temperature rise to around 2°C above pre-industrial levels. The IEA proposes an energy policy and technology blueprint that can deliver ambitious climate goals to be agreed in Copenhagen, with energy efficiency at the core of CO_2 reduction strategy in both the near and long term."

With energy accounting for 84% of global CO_2 emissions, the IEA has analyzed what needs to be done to limit the long-term concentration of greenhouse gases in the atmosphere to 450 parts per million (ppm) of CO_2 equivalent, in line with a 2°C increase in global temperature. On current trends, unless new measures are taken, global energy-related CO_2 emissions will reach 40 Gigatonnes (Gt) by 2030 (29 Gt in 2007) and continue rising thereafter, whereas climate stabilization requires emissions to peak around 2020 and then decline.

"The 450 Policy scenario of our flagship publication *World Energy Outlook 2009* is the right path to green growth but it is a radical departure from current trends," Tanaka said. For instance, the world would need to retire a significant portion of current coal-fired electricity plants before the end of their lifetime—by 2030, early closures around the world would amount to the equivalent of current total coal-based power generation in Japan, the European Union, and the United States. Around 60% of global electricity production in 2030 would need to come from a mix of renewables (37%), nuclear (18%), and plants fitted with carbon capture and storage (5%). Another illustration is the dramatic shift needed in car sales, with hybrids, plug-in hybrids and electric vehicles representing 60% of sales in 2030, from around 1% currently.

The bulk of the emissions reduction could be delivered by energy efficiency, accounting for over half of total abatement by 2030 in the IEA 450 Scenario. Energy efficiency is an absolute prerequisite for the deployment of the more expensive, low-carbon energy supply as it helps lowering demand first. IEA finds that the additional investment can be recouped by end-users through lower energy bills: in industry, buildings, and transport, the additional USD $8.3 trillion of required investment would lead to USD $8.6 trillion in savings between now and 2030.

"Sharing best policy practice in energy efficiency, and building capacity for implementation should be a priority area for any support from developed to developing countries coming out of Copenhagen," Tanaka said. "The social, economic, environmental, and energy security benefits of energy efficiency are too large to be missed, yet experience shows that proper policy frameworks are needed to reap these benefits. We are encouraged by the development of energy efficiency policies in countries like China, India, Brazil, or South Africa," Tanaka said.

To support a global transition to more efficient, low-carbon energy systems, the IEA estimates that USD $10.5 trillion (with USD $8.3 trillion in end-use) are needed by 2030. With such effort, global CO_2 emissions would decline after 2020, and be lower than the current level by 2030. "Countries' announcements in preparation for Copenhagen are encouraging. Although more is needed to be on track with our 450 scenario, with current pledges, if implemented, more in line with a 550 ppm scenario (leading to a [3°C] increase in global temperature). The results in the 2020–2030 decade will be crucial, as this is when most new technologies need to be deployed. The wave of investments that will come with the economic recovery must be climate friendly. A strong signal is needed now. Every year of delay adds USD $500 billion to the energy sector cost of reaching 450 ppm," Tanaka said.

The IEA has produced several roadmaps on key technologies to meet that challenge, and to guide environmental and energy decision makers on the path to needed innovations (e.g., on carbon capture and storage, wind, electric vehicle, and cement manufacturing). "A cost on CO_2 is also critical to guide investors toward low-carbon choices," Tanaka said. While the Clean Development Mechanism has achieved a lot in certain sectors, it has not curbed the growth in emissions in developing countries. Broader access to the carbon market ought to be a key element in a Copenhagen agreement, for example, through sector- or policy-based market mechanisms in developing countries. The IEA has shown how such mechanisms could reduce CO_2 emissions in key sectors like power generation, but these must be complemented by ambitious energy efficiency improvements on the end-use side.

"The energy path to stabilize climate is clear, but only vigorous action will put our economies on that path to green growth," Tanaka said. "A strong political signal is needed now in order to drive the necessary changes. The IEA will work with all countries to turn global climate goals into practical steps for the energy sector, including through the newly proposed international low-carbon energy technology platform," Tanaka said. The platform which was endorsed by the IEA Ministerial meeting in October 2009, will bring together policymakers, business representatives, and technology experts to discuss how best to encourage the spread of clean energy technologies, with a view to doubling investments in research, development, and demonstration by 2015.

"The IEA will be evaluating the energy implications of any emission goal coming out of Copenhagen, to set a clear pathway for the energy sector," Tanaka said. □

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