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Advancing Opportunity, Prosperity, and Growth

POLICY BRIEF 2017-16

Promoting Energy Innovation with Lessons from Drug Development

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We believe that today's increasingly competitive global economy demands public policy ideas commensurate with the challenges of the 21st Century. The Project's economic strategy reflects a judgment that long-term prosperity is best achieved by fostering economic growth and broad participation in that growth, by enhancing individual economic security, and by embracing a role for effective government in making needed public investments.

Our strategy calls for combining public investment, a secure social safety net, and fiscal discipline. In that framework, the Project puts forward innovative proposals from leading economic thinkers — based on credible evidence and experience, not ideology or doctrine — to introduce new and effective policy options into the national debate.

The Project is named after Alexander Hamilton, the nation's first Treasury Secretary, who laid the foundation for the modern American economy. Hamilton stood for sound fiscal policy, believed that broad-based opportunity for advancement would drive American economic growth, and recognized that "prudent aids and encouragements on the part of government" are necessary to enhance and guide market forces. The guiding principles of the Project remain consistent with these views.

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Promoting Energy Innovation with Lessons from Drug Development

Introduction

Although there has been a shift in recent years toward cleaner energy sources, current policies appear insufficient to provide the emissions reductions necessary to avoid catastrophic climate change while sustaining economic growth. Despite its importance to both the climate and the economy, investment in energy innovation remains particularly low, as shown in figure 1. For example, R&D intensity for fuel suppliers and utilities is negligible relative to other industries, especially relative to the high R&D intensity in the pharmaceuticals sector.

A new Hamilton Project policy proposal by Anna Goldstein, Pierre Azoulay, Joshua Graff Zivin, and Vladimir Bulović translates some of the most useful features of the pharmaceuticals innovation pipeline into proposed reforms for energy R&D. The authors discuss ways in which drug discovery and development have been successful in bringing new and improved products to market. Where differences exist in how R&D is supported between the two sectors, the authors consider how features of the pharmaceutical sector might be usefully applied to energy innovation.

Three specific proposals for the energy innovation system emerge from this analysis: establishment of (1) a robust system of contract research, (2) uniform technical standards for communicating reliability, and (3) better regulatory incentives for electric utilities.

The Challenge

Goldstein, Azoulay, Graff Zivin, and Bulović begin by discussing the similarities in energy and pharmaceutical innovation as well as the unique challenges of energy research and development. An understanding of both the similarities and differences is important for drawing the appropriate lessons from innovation in the pharmaceutical sector.

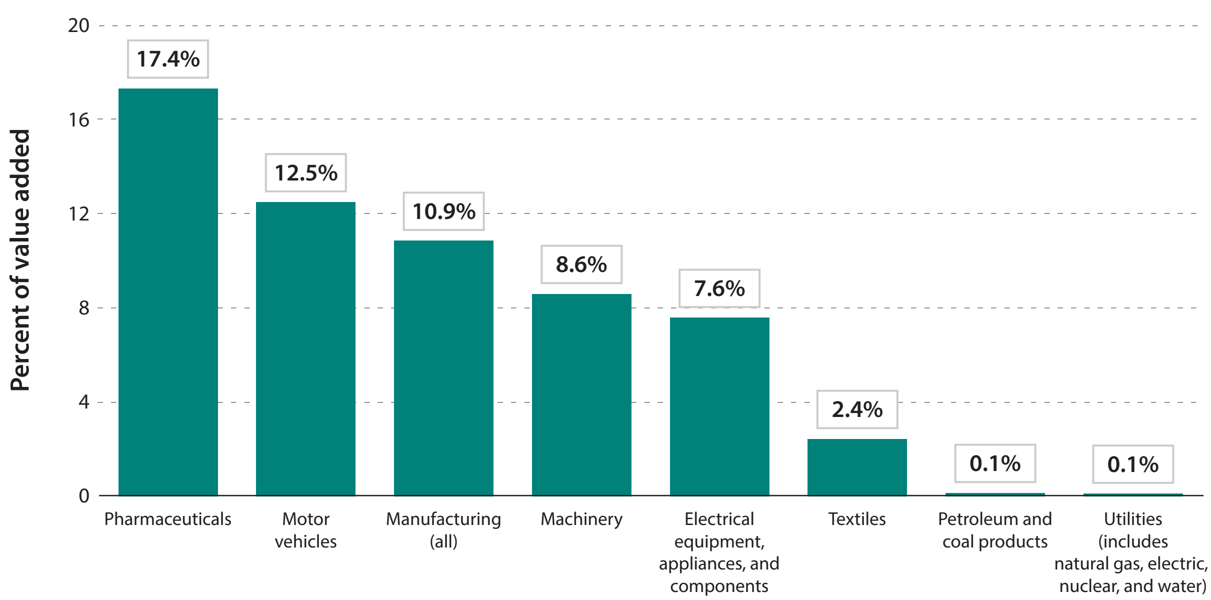
Similarities in the Challenges of Energy and Pharmaceutical Innovation

Spillovers from R&D

Both energy and pharmaceuticals R&D produce important spillover benefits for society. Because the benefits of R&D cannot be exclusively captured by any one firm, their incentive to undertake costly investments is limited. Consequently, economic theory and evidence suggest that private investment in research tends to be insufficient. The authors argue that these spillovers imply an important role for government- and university-sponsored research in creating knowledge that can

FIGURE 1.

Domestic R&D Intensity, by Industry



Source: Bureau of Economic Analysis 2013; National Science Foundation 2013; authors' calculations.

Note: calculations are for 2013. R&D intensity is defined as domestic R&D expenditures divided by value added.

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supply industries like energy and pharmaceuticals with new technologies. Figure 2, though, shows that although the fraction of GDP allocated to R&D has remained roughly constant since the early 1960s, federal spending on R&D has declined.

Extended Development Timelines

Starting with the initial scientific research and ending with final manufacturing and delivery, both energy and pharmaceutical innovation pathways are very costly and prolonged. For energy innovation, the lag between public research funding and the issue of a resulting patent can be 20 years or more, according to the authors. For pharmaceuticals, after a research investment has led to the creation of a valuable new molecular entity, 8 to 16 years are typically required until a product is released to the market.

Consequently, the returns to investment generally appear only after many years have passed. Both energy and pharmaceutical technologies must be tested and retested for optimum safety and performance, which involves expensive demonstrations. These undertakings, with uncertain payoffs, require large investments from those who wish to ultimately commercialize the innovations.

Differences in the Challenges of Energy and Pharmaceutical Innovation

Lack of Market Incentives

One crucial difference between innovation in energy and in pharmaceuticals is that energy-related emissions generate environmental costs that affect society at large, costs that are not borne by energy producers. As long as there is no penalty for generating carbon emissions, there will not be a level playing field for clean fuels, which must compete directly on price with polluting energy sources. As a result, the authors maintain that there is no market incentive to innovate for the sake of reducing emissions.

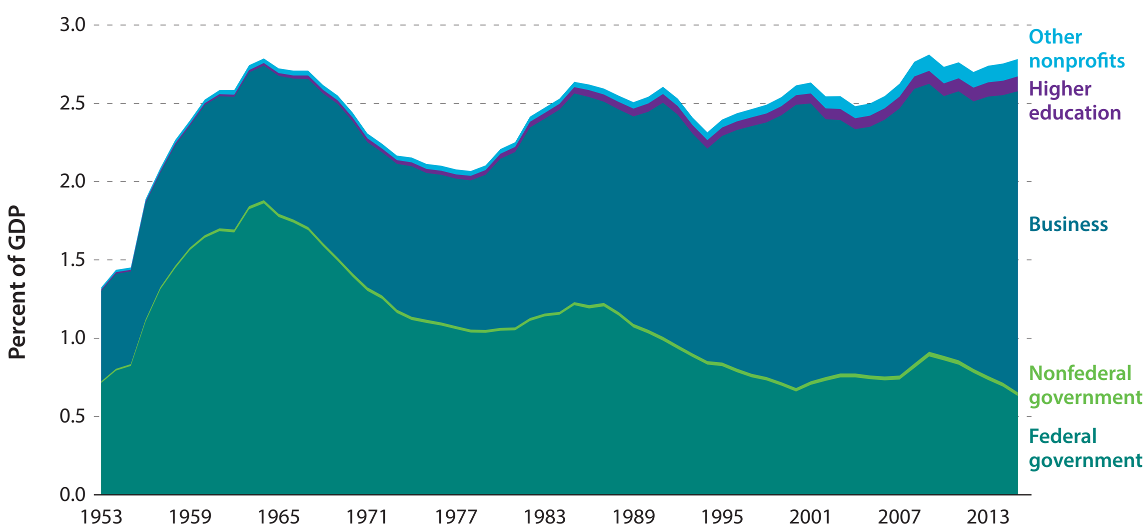
Furthermore, for power generation in particular, the incentive to innovate even for the sake of more-efficient energy usage is often weak. In most states a utility company's spending is regulated by a public utility commission. The utility earns a regulated rate of return on its capital assets, with reimbursement for operating costs. A utility that invests in a more efficient use of fuel would therefore be penalized by a reduced operating cost reimbursement.

Complex Regulatory Landscape

The authors point to another important difference between energy and pharmaceuticals innovation: the scope of activities that fall within each category. Pharmaceuticals are relatively well-defined, in that they are chemical or biological products with patients as their end users, and are delivered either via a pharmacy or a hospital. Energy, on the other hand, includes more than a dozen subsectors and can refer to the many technologies involved in energy supply or energy consumption, from oil drilling equipment and solar photovoltaics, to automobiles and home appliances.

FIGURE 2.

U.S. Spending on R&D, 1953–2015, by Source



Source: National Science Foundation, 1953–2015.

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The diversity of technologies in energy markets leads to a complex regulatory landscape, including both federal- and state-level oversight. In the energy sector, the range of technologies and types of regulatory scrutiny increases uncertainty and costs. By contrast, the U.S. Food and Drug Administration (FDA) is responsible for regulating the safety and efficacy of all drugs marketed in the United States. This centralization is possible in part because the effectiveness of a drug can be measured according to one primary criterion: How likely is it to have the intended effect on human patients?

A New Approach

Given these challenges, the authors examine practices and institutions that successfully support pharmaceutical innovation. They then propose ways to implement these features in the energy industry.

A Robust System of Contract Research

The early stages of the innovation system entail proving that a new idea has promise, which allows an entrepreneur to attract initial investment and to develop the idea. The authors observe that this phase of technology R&D is typically expensive and time-consuming. A new design for an energy storage device could require the creation of a working device prototype, followed by many rounds of testing and improvement. In the case of drug development, companies might need to optimize the synthesis of a new molecule, perform quality assurance, and conduct animal research before they receive approval to conduct human clinical trials.

In the pharmaceuticals sector, contract research organizations (CROs) are a critical institution for helping firms cope with these costs. The authors explain that CROs facilitate the development process by providing a standard set of services with a standard array of lab equipment and supplies. In addition to outsourcing their preclinical research, companies frequently hire CROs to conduct clinical trials.

There are some firms that offer R&D contract services to companies developing energy technology, but the diversity of technological paradigms in energy research means that each company's needs are much more specialized. Overall, the availability of contract research in the energy sector is limited.

The authors argue that energy innovation could be enhanced with better implementation of this valuable practice from the pharmaceutical industry. They propose that regional actors—government, universities, U.S. National Laboratories (National Labs), and companies—work to foster the creation of a robust set of research service providers to supplement existing user facilities. These services would be matched to regional strengths, taking into consideration the local business environment and the local scientific expertise, and would make important use of the National Labs infrastructure.

Roadmap

- The Department of Energy will increase the availability of contract research through the U.S. National Laboratories, encouraging more engagement with entrepreneurs through modified resource allocation and researcher performance evaluation.
- Federal and state policy makers will convene and financially support the establishment of standards bodies by energy industry stakeholders.
- States will encourage innovation in electricity generation by reimbursing utilities for testing and deploying new technologies, either through guaranteed cost recovery for innovative projects or through a competitive project selection process.

Uniform Technical Standards for Communicating Reliability

As a new technology progresses toward the creation of a marketable product, companies must prove that the technology can be made profitable. In order to appeal to investors, firms must also demonstrate that the product will meet the performance targets required by the market. For drugs, clinical research is needed to demonstrate the safety and efficacy of the product, and investors can use the three stages of FDA-approved clinical trials as a benchmark for progress toward marketability.

The authors point out that energy products have no such benchmarking system to provide investors with the same level of confidence. Nonetheless, establishing clear technical standards is particularly important given the significant risks associated with energy R&D. Some technologies—for example, cars, batteries, building insulation, and nuclear reactors—entail safety concerns that require testing and quality control before release. In other cases, the reliability of a product's performance is the primary risk, as with the lifetime of a solar panel or the longevity of a battery.

The authors argue that policy makers and energy industry professionals within each subsector should work to create an environment where uncertainty is minimized through certification by trusted standards bodies. As much as possible, standards should be uniform, rather than segmented and overlapping, to minimize costs for compliance. In addition, standards should be regularly evaluated to ensure that

Learn More about This Proposal

This policy brief is based on The Hamilton Project policy paper, "Promoting Energy Innovation with Lessons from Drug Development," which was authored by

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they do not discourage adoption of significant technology improvements. Even when standards are led by industry associations, they should receive public support and funding, especially in their infancy.

Better Regulatory Incentives for Electric Utilities

Although many pharmaceutical products can be made profitable if they are proven safe and effective, this is not universally true. Historically, drugs designed to treat rare diseases were generally not profitable. One response to this problem was the Orphan Drug Act, which grants tax credits and a seven-year period of exclusive marketing to qualifying drugs, along with sizable direct government investments in R&D through the National Institutes of Health. The authors note that, although additional exclusivity rights and associated monopoly power might not be the right incentives to provide in the energy sector, the experience of the Orphan Drug Act illustrates the importance of providing public support and powerful incentives to encourage innovation.

Goldstein and colleagues argue that improved incentives to innovate are especially needed for electricity generation. Some technologies—such as distributed energy resources and digital home sensing—are available to improve energy efficiency but are not being fully implemented. To accelerate the evolution of the electric grid, utilities need direct incentives to participate in the innovation process.

The authors therefore propose that states create mechanisms to reimburse utilities for testing and deploying new technologies. States should also provide a clear path for these technologies to become part of the utility's standard assets once their effectiveness has been proven. Programs should be tailored to the needs of each state; options include guaranteed cost recovery for innovative projects or a competitive project selection process. If done correctly, any costs that are shared with electricity consumers will be repaid in the long run by lower operating costs after new technologies have been successfully deployed.

Benefits and Costs

The authors' proposals would make the energy innovation system more effective, and would allow for the development of additional new technologies. A large body of evidence establishes the value of R&D and the substantial positive spillovers to society, but research also suggests important differences in the effectiveness of innovation pipelines across various industries.

Because the authors intend to build on existing R&D infrastructure, their proposals are more feasible than would otherwise be the case. Increased collaboration with the National Labs would allow start-ups to focus on their comparative advantages. Similarly, establishment of uniform technical standards within energy subsectors would occur in partnership with industry stakeholders who would provide necessary expertise.

Given the challenges outlined by the authors, their proposals can make important contributions to the goal of adequately funding and supporting energy R&D. By improving the availability of reliable, inexpensive energy services, two goals would be achieved. First, economic growth would be enhanced through reductions in energy costs. Second, the damaging impact of climate change would be mitigated to the extent that carbon emissions are reduced.

Conclusion

Informed by the experience of pharmaceutical innovation, Goldstein, Azoulay, Graff Zivin, and Bulović propose reforms to the practices and institutions that support energy innovation. A robust system of contract research, uniform technical standards for communicating reliability, and better regulatory incentives for electric utilities would accelerate the creation and deployment of improved energy technologies. Importantly, improved incentives and supports for technology deployment are complementary to investments in research and development. These approaches would enhance the expected profitability of energy innovation and facilitate the transition to a clean energy system.

Questions and Concerns

1. Given the importance of technical standards, why hasn't third-party certification emerged already? What is the best candidate for an institution that would provide third-party certification?

The lack of uniformity among different energy technologies makes it difficult for disparate industry groups to coordinate on performance standards. This problem is particularly acute for nascent technologies that might not be developed enough to have an industry association to facilitate the process. The authors recognize that state and federal policy makers could be instrumental in establishing and legitimizing standards bodies for developing technologies.

The optimal third-party certification institution would depend on the subsector. Member organizations or industry associations are promising actors that can help to draft standards and establish certification practices. For technologies that relate to electricity generation, transmission, or distribution, public utility commissions and electric utility companies could support and enforce these standards by incorporating them as requirements for connecting to the electrical grid.

2. If collaboration between National Labs researchers and entrepreneurs were enhanced, would National Labs resources be strained, impeding progress in existing projects?

The incentives for National Labs researchers to participate in entrepreneurial projects would be designed such that they do not crowd out the most valuable existing projects. Additional National Labs funding might be necessary, however, to accommodate the increase in entrepreneurial collaboration. With fees set appropriately, an influx of energy innovation partners would help the National Labs to expand their impact.

3. Not all previous efforts to promote innovation in the energy sector have been successful. How would this policy proposal maximize the effectiveness of federal investments?

It is impossible to precisely predict which technological approaches will bear fruit; some efforts will naturally turn out to be more successful than others. Federal innovation policy should establish the conditions and incentives that are most likely to facilitate the development of successful technologies. The authors' policy proposal would address some shortcomings in energy R&D policy, and would help entrepreneurs get the support they need during the most challenging phases of technology development.

Highlights

The innovation system that develops and deploys new pharmaceuticals holds important lessons for energy R&D. Anna Goldstein, Pierre Azoulay, Joshua Graff Zivin, and Vladimir Bulović consider three aspects of the pharmaceutical innovation system that might be instructive for policy makers who want to advance energy innovation: (1) the availability of contract research organizations to perform specialized research, (2) a centralized regulatory framework for staged trials, and (3) public funding for research when costs are greater than potential private payoffs.

The Proposal

Establish a robust system of contract research. The authors propose that regional actors collaborate to establish contract research services well-suited to each region's local strengths. As part of this strategy, they propose working within the infrastructure of the US National Laboratories.

Implement uniform technical standards. The authors propose that policy makers and energy industry professionals within each subsector work to establish trusted standards bodies that would use certification to minimize investor uncertainty. These standards bodies would receive public support and funding.

Create better regulatory incentives for electric utilities. The authors propose that states create mechanisms to reimburse utilities for testing new technologies. States should also provide a clear path for these technologies to become part of the utility's standard assets once effectiveness has been proven.

Benefits

Accelerating energy innovation is both a necessary part of climate change mitigation and a spur to economic growth. The authors' proposed policies would enhance the expected profitability of energy innovation and encourage investment in the transition to a clean energy system. Improving the availability of reliable, inexpensive energy services can have wide-ranging benefits for society, including both businesses and consumers.

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