Commercialization and Deployment

Topic Issue Paper

Overview:

Commercializing and deploying cleaner and more advanced energy technologies into the marketplace at a significant rate and scale can help address our Nation's most pressing energy and economic challenges.

Our energy demand is projected to rise by more than fifty percent by 2050. Climate Change, Energy Security, and escalating commodity prices have demanded our national attention for domestic reasons, as well as calling for America to lead by example internationally. R&D on advanced energy technologies is a critical piece of the solution and should continue to increase. The problem is not solved, however, until those advanced energy technologies are ubiquitously deployed into the marketplace, changing the way we harness and consume energy.

The Department of Energy is uniquely positioned to address many such challenges and the following are just a few of the identified opportunities:

Ongoing Commercialization Initiatives: Numerous current government initiatives provide the framework for short-term, large impact changes and are scalable. Examples include:

- National lab originated technology commercialization by co-funding efforts with corporate partners;
- Government prizes or competitions (e.g. X-Prize, California Cleantech Open, MIT Clean Energy Entrepreneurship Prize, etc.) for breakthrough technical accomplishments in energy technologies.

Innovative Management Practices:

- Extend funding along the entire technology development pipeline, including prototypes and demonstrations;
- Continued streamlining of new technology transfer tools throughout the national laboratories (e.g. Pre-approved, standardized model User Agreements for proprietary and non-proprietary research);
- Development and implementation of commercialization and deployment metrics across the Department to evaluate DOE's innovation activities in order to better understand what is working and what needs improvement

Legislative *Policy Proposals:*

- Extend federal power purchase agreement contract authority from 10 to 30 years, to enable the federal government to make large-scale purchases of longer-lived energy technologies key to meeting the EISA 2007 goal of zero energy federal buildings;
- Fund and innovatively implement the Advanced Research Projects Agency for Energy (ARPA-E), authorized in the America Competes Act of 2007 so as to provide flexibility and accelerated funding for advanced energy projects.
- Create a quasi-governmental entity – similar to EX-IM Bank – to manage and support the financial scale-up risk of commercial scale advanced energy projects.

Background:

The national laboratory infrastructure that emerged from World War II played a key role in winning the Cold War and enabling the United States to be the first Nation to place a man on the moon. When an energy crisis arose in 1973, it may have seemed logical for the Government to focus this scientific resource on developing alternative energy technologies that could enable the United States to become "energy independent." Putting a man on the moon, however, is a much different task than putting a photovoltaic panel on the roof of house. For one, the government bought the technology in the former case, but not in the latter.

After decades of experience, policymakers now understand that advanced energy technology research is not enough to solve our nation's energy problems-- the technologies also need to be moved into the market. Since the 1970's, the policy makers have sought to improve its methods for transferring technology from publicly-funded laboratories to the marketplace and various laws have been enacted to this end.[1] Provisions of these laws explicitly encourage commercial deployment of DOE's technologies, and establish technology transfer as a mission of DOE's National Laboratories[2]. For the most part, technology transfer is not a separately funded program but an activity transacted by the National Labs as appropriate. The Labs conduct technology transfer activities to ensure the fullest use of the results of the nation's Federal investment in research and development. The major methods of transferring IP are licensing; cooperative research and development agreements, user agreements, and "work for others".

Additionally, EPAct 2005 required the appointment of a Technology Transfer Coordinator "… *to be the principal advisor to the Secretary on all matters relating to technology transfer and commercialization*." The Undersecretary for the Office of Science was appointed by the Secretary for this role. Responsibilities include overseeing the activities of the Technology Transfer Working Group; the expenditure of funds allocated for technology transfer within the Department; the activities of each technology partnership ombudsman[3], and efforts to engage private sector entities, including venture capital companies. To assist this Coordinator develop policy recommendations and monitor the overall technology transfer activities across the DOE, a Technology Transfer Policy Board was established. The Board is populated with career DOE employees to ensure continuity and because extensive knowledge of technology transfer activities within the DOE is critical to the Board's effectiveness.

While legislation and Technology Transfer organizations are sending clear signals to the national laboratories about technology transfer, Congressional funding levels and earmarks and Administrative officials have at times sent mixed signals that compromise the efficient and effective technology transfer. For example, in the 1990s some Congressmen began using the term "corporate welfare" to describe technology transfer activities and by the mid-1990s many of these programs were cut back dramatically and are only being implemented in a piece-meal fashion today.

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[1] Stevenson-Wydler Technology Innovation Act, 1980; Bayh-Dole Act, 1980; the National Competitiveness Technology Transfer Act of 1989, Executive Order 12591 of 1987; Technology Transfer Commercialization Act of 2000; Section 1001 of the Energy Policy Act of 2005; the Secretarial Policy Statement on Technology Transfer at DOE Facilities (January 31, 2008).

[2] Technology transfer is defined as a process by which knowledge, intellectual property (IP) or capabilities developed at the Department of Energy's National Laboratories are transferred to another entity.

3 As appointed under section 11 of the Technology Transfer Commercialization Act of 2000 (42 U.S.C. 7261c)

Even with Technology Transfer laws and the Lab Tech Transfer Offices and the Technology Transfer Working Group, the mixed signals, but more importantly, the current energy challenges call for additional efforts to increase the pace and scale of commercialization.

Recent Commercialization and Deployment Initiatives:

Technology innovation is a process filled with uncertainty and risk, involving a multitude of public and private sector entities with differing interests and resources. In the United States, the breadth and depth of the Federal Government's role in the innovation process puts it in a unique position to increase the stability and direction of what is typically a risky and uncertain process and send clearer signals to the market place about the energy technologies it plans to research, develop, demonstrate, and deploy to advance the Nation's energy security, environmental, and economic goals. Technology innovation progress through several stages and the Governments role and opportunity to influence - increase stability, reduce risk, drive pace - varies with each stage.

These stages include research in basic science, applied science to develop and demonstrate the technology, preparing for a transfer to the private sector technology investors, scaling up the technology and developing infrastructure, and the technology finally reaching the market[4]. Technologies must be discovered, researched, developed and deployed to realize value for the American taxpayer. Without commercialization and deployment, intellectual property has no value. The illustration below is a simplified but useful way understanding the major components in the innovation pipeline.

The Innovation Pipeline

The transfer of technology over the gap between applied science and technology investors has been referred to as the "commercialization valley of death" due to the high risk of moving from government to private funding and a technology still unproven at commercial scale. Programs designed to bridge this gap should aim to attract – not displace – private sector investment as private capital markets are the most efficient means of scaling and deploying advanced energy technologies. Such programs should be designed to correct market imperfections and remove the non-market forces restricting the deployment of advanced energy technologies.

Several leverage points were identified where the commercialization efforts could best assist in correcting market imperfections and removing barriers. These include: efforts to increase the volume and speed of technologies moving out of the lab (throughput), scaling up technologies, creating early markets in which to

[4] This simple linear model, while useful in understanding the innovation pipeline is not meant to imply that the actual innovation process is simple or linear – instead the real process is non-linear and iterative.

deploy technologies, convening bodies to develop standards, addressing infrastructure and the supply chain, and helping pull technologies into the market.

Following are just a few examples of the types of efforts that DOE has been undertaking over the past few years to help increase the pace and scale of commercialization and deployment. This is a small sample of a very wide range of commercialization levers that are available to the government (e.g. mandates, procurement, risk mitigation, incentives). Academic review indicates best results come from using a mixture of commercialization and deployment options along the range. *(A full listing of options and examples of how these options are in use in DOE Offices is included in Appendix A and more detailed information on these and others can be provided upon request)*

- *Combined construction and operating license for GenIII+ nuclear power plants* – Understanding that Federal rules and regulations can sometimes act as barriers to the deployment of new energy technologies, DOE's Office of Nuclear Energy has been working closely with the Nuclear Regulatory Commission (NRC) in the implementation of a one-step Construction and Operating licensing (COL) process, which minimizes regulatory uncertainty so that billions of dollars will not get spent constructing new nuclear power plants that then cannot receive a license to operate. In 2005, DOE negotiated 50-50 cost-shared contracts with two industry consortia (NuStart Energy Development and Dominion Nuclear North Anna) to demonstrate the COL process, complete design certification for two Gen III+ LWR technologies), and complete the first-of-a-kind engineering needed for the plant final designs.

- *Consortia for Grid Applications* – Electricity Delivery and Energy Reliability has created a consortium to support grid modernization in partnership with utilities. The Advanced Grid Applications Consortium (GridApp) provides informational briefings and technology showcases to promote the use of emerging grid technologies by all member utilities and "fast tracks" the engineering development, demonstration, verification, and validation of high-impact technologies and practices, thereby enabling the beta-testing to be completed in less than 12 months.

- *Creation of the Commercialization Program in EERE* – EERE recruited externally and hired entrepreneurs, industry executives and banking experts to form a career Commercialization Team to provide deep experience and relevant capabilities in the team to drive effective commercialization initiatives. This strong commercial competence has aided the newly inserted cross-cutting team in gaining credibility and building good working relationships with the numerous technology programs and national labs the team interfaces with on a day to day basis.

- *Entrepreneurs in Residence (EIR) Program at DOE National Laboratories* – Recognizing the different experience and skill sets involved in developing new technologies compared to creating new businesses, DOE's Office of Energy Efficiency and Renewable Energy established an EIR program at three National Laboratories (NREL, ORNL, SNL) that places entrepreneurs from leading venture capital firms in the laboratory for one year to work with research scientists to identify promising technologies with the ultimate goal to start up a new business that contributes to DOE's mission. The EIR program fundamentally changes the way DOE conducts business with minimal cost to the government. After the original pilot program, the EIR Program was expanded to an additional five labs (PNNL, LBNL, LLNL, ANL, and BNL).

- *Investment Protection for Advanced Energy Technologies* – In addition to working to improve the nuclear licensing process, the Energy Policy Act of 2005 is helping reduce the financial investment risks of new nuclear plants by providing protection against delays in the commencement of full operation due to litigation or NRC approval. In case of delays beyond the private sector's control, the Federal Government will cover the full cost of the delays for the first two reactors, up to $500 million each, and 50 percent of the cost of delays beyond 180 days for the next four reactors, up to $250 million each. Covered costs of delay include principal and interest and the incremental cost of purchased power to replace contracted power from the nuclear facility.

- *Low Interest Loan Programs* – Congress recently added loan guarantees to the menu of financial options available for deploying advanced energy technologies and authorized $38.5 billion in loan guarantee authority for projects that employ advanced technologies that avoid, reduce or sequester emissions of air pollutants and greenhouse gases. The Loan Guarantee Program, managed by DOE, is designed to accelerate the commercialization of innovative, environmentally-friendly technologies. In October, 2008 DOE received 19 Part I applications from 17 electric power companies for federal loan guarantees to support the construction of 14 single- and dual-unit nuclear power projects, 21 new reactors in all, in response to its June 30, 2008 solicitation. Also authorized recently was $25 billion in low interest loans for manufacturing advanced technology vehicles, those vehicles which meet 125% of CAFE standards.

- *Technology Commercialization Fund for national lab technology commercialization* – DOE National Laboratory innovations struggle to find post-research and pre-venture capital funding once the idea is no longer a research project, yet also not sufficiently prototyped to attract private investment. For the Technology Commercialization Fund the National Laboratories, in conjunction with industry, identify promising technologies facing the "commercialization valley of death." The lab then makes matching funds available to any private sector partner that wishes to pursue deployment of the technology. The Fund was $7.2 million in FY07 and $7 million in FY08 and has yielded significant original interest from the private sector to commercialize National Laboratory intellectual property. While success is hard to measure at this early stage in the program, the very fact that industry partners are involved in each project bodes well for success. Further, because the funding is parceled out depending on reaching specific milestones, taxpayers are ensured a better ROI than if the projects were funding all at once.

- *Technology Showcases and Forums for Investors* – Visibility is a prerequisite for commercializing innovation. If an entrepreneur never learns of a technology's promise, that technology will stay at the lab indefinitely. Recognizing this market dynamic Energy Efficiency and Renewable Energy created a forum called the DOE Venture Capital Technology Showcase. Programs identified their most promising national lab technologies awaiting a commercialization partner and these technologies were presented to a group of leading cleantech venture capitalists actively seeking investment opportunities – 30 investment firms attended in 2007 and about 60 firms attended in 2008. While costing only time to organize and print materials, the event served an indispensible role in promoting program technologies.

- *Regional Carbon Sequestration Partnerships* – To enable the network nature of innovation and the need to transfer ideas, objects, and people between an array of organizations for technologies to succeed commercially, the Office of Fossil Energy is supporting the Regional Carbon Sequestration Partnerships which include more than 350 state agencies, universities, and private companies, spanning 40 states, three Indian nations, and four Canadian provinces. The objectives are to determine the most suitable technologies, regulations, and infrastructure needs for carbon capture and sequestration in different regions of the U.S. and Canada.

Options for Building Up Existing DOE Initiatives: These ongoing initiatives have a scalable nature and as such provide flexibility and opportunities for short term changes as they can relatively easily be scaled up (*more detailed information with examples can be provided upon request*):

- *Increase national lab technology commercialization funding requiring a corporate matching partner* – Technology "maturation" funding of this type has proven to be a good return on investment when it has been utilized in the past. Increasing the amount of funding, increasing the number of labs receiving funding, ensuring a long-term commitment to such funding, and targeting the funds at specific technology barriers (i.e. transmission, integration, storage), could have a significant positive impact.

- *Increase government prizes or competitions* (e.g. EcoCar: The NeXt Challenge, California Cleantech Open, MIT Clean Energy Entrepreneurship Prize, etc.) – Prizes are a proven tool to leverage U.S. tax dollars for best harnessing the creativity of the private sector. DOE could play a major collaborator leadership role by convening and supporting the best of the best advanced energy prizes.

- *EIR Program* – Following the successful evaluation of its pilot phase in 2008, the EIR program was expanded from three to eight national laboratories. More labs could be added quickly and the program could be tailored to address specific commercialization barriers.

Management Best Practices:

- *Extend funding along the entire technology development pipeline* (including protyping and demonstrations) – Funding for technology innovation often times stops short of commercialization in the national labs by one - two years. This was one of the things learned from the EIR program via the venture capital backed entrepreneurs. Ensuring funding through to commercialization, ensuring that a commercialization pathway is mapped and measured, and adding commercial input, would help prevent having valuable intellectual property (IP) sitting on the lab shelves because it is judged by the investment community as still needing further development.

- *Ensure consistent utilization of technology transfer tools throughout the national laboratories* – Many tools are available to help Labs facilitate technology transfer (e.g. entrepreneurial leave, Entrepreneur in Residence, bonuses, technology transfer objectives in annual performance objectives, royalty sharing, streamlined licensing contracts, etc.). However, not all these tools are fully or consistently utilized. The Technology Transfer Policy Board continues to review such practices, contracts, and cross-lab collaborations and knowledge sharing. The work of this Board to ensure consistent policies across the labs could cut down the time and risk involved for companies and investors to work with the national labs.

- *Develop and implement commercialization and deployment metrics to evaluate Government's innovation activities in order to better understand what is working and what needs improvement* – Studies on overall DOE effectiveness[5] have included recommendations to place greater emphasis on outcomes in the measurement of technology transfer performance and also found that current metrics based on inputs rather than outputs had obvious limitations[6]. Since these reports in the mid-1990s, DOE labored to better evaluate the impacts of its commercialization and deployment programs, yet Department-wide evaluation metrics have not been adopted. If this is to change, several difficult issues must be addressed to fairly appraise public investment technology commercialization, including: (1) the need to track the progress of program participants for extended periods; (2) complexities associated with accounting for spin-off technologies; (3) determining the external and internal validity of program evaluations; and (4) dealing with performance data that are dominated by a small number of highly successful technologies.[7]

Policy Proposals:

- *Modify federal procurement laws to enable agencies to make large-scale purchases of advanced energy technologies – creating an early market for a new technology* to enable the world's largest energy user (the federal government) to make large-scale purchases of advanced energy technologies – "*Walking the Talk".* The U.S. Federal Government is the world's largest volume-buyer of energy-related products and the Nation's largest consumer of energy, with an annual energy bill of $10 billion. The Federal Government can play an important role in creating early markets for advanced energy technologies and various laws, Presidential Executive Orders, and procurement regulations now require Federal agencies to purchase advanced energy technologies, which is accelerating the commercialization and increasing the deployment of many of these products and services. However, government procurement generally requires that equipment be "on the list" before it can be purchased. New equipment has a hard time getting on the list, because it has not been used in a government installation before. In addition, cost and performance issues often discourage Federal agencies from accepting the "risks" associated with new technologies, thereby resulting in the purchase of conventional energy technologies in most instances.
- *Fund the Advanced Research Projects Agency for Energy (ARPA-E)* – Authorized in the America Competes Act of 2007, ARPA-E was designed to provide flexible and accelerated funding for advanced energy research. ARPA-E was authorized but never funded by Congress. (see Appendix B)
- *Create an "EXIM-type Bank for Domestic Clean Energy"* – This would effectively and expediently manage the financial scale-up risk of commercial scale advanced energy projects. (see Appendix B)
- *Tying financial incentives to technology costs or market penetration targets* – Incentives are needed until an advanced energy technology reaches cost and market share targets which enable it to continue to penetrate the market without further Federal tax subsidies. However, most financial incentives are instead tied to an authorization ceiling (e.g., not to exceed $25 million) or period of time (e.g., expires

[5] Galvin Report was asked to propose alternate futures for DOE laboratories; Yergin Study assessed the rationale for Federal Government support of energy R&D, reviewed the priorities and management of the overall program, and recommended how to more efficiently and effectively deliver more value to American taxpayers.
[6] Galvin Report concluded "one of the most common metrics used by DOE and others to assess the technology transfer performance of the laboratories is the rate at which new CRADAs are being signed."
[7] Marilyn A. Brown. "Performance Metrics for a Technology Commercialization Program" in the *International Journal of Technology Management.* 1997, Vol. 13, Number 3, pp. 229-244.

December 31, 2008). For example, the Renewable Energy Production Tax Credit (PTC) has been in place for 16 years, and has been one of the major drivers of the current surge in construction and planning of wind farms. However, it has never been authorized for more than five years at a time, and some renewals have been for as little as one year at a time. The lack of a long-term, stable Federal policy has caused counter-productive effects - boom and bust cycles, leading to equipment supply shortages and higher equipment and construction prices. In addition, the practice of tying financial incentives to authorization ceilings and periods of time in fact has very little linkage to the rationale for these incentives, which is to foster the market penetration of the targeted technologies by "artificially" reducing their cost in the early period of deployment. As the technology moves up a market share "S-curve" and penetrates more of its target market, the logic is that "economies of scale" and "learning by doing" will bring the costs down and enable the technology to continue to grow without additional incentives. Given this rationale for financial incentives, a more effective commercialization and deployment approach may be to tie the financial incentives to technology costs or market penetration targets rather than an authorization ceilings or time periods. This would foster market stability and enable companies to better plan their future in this market.

Summary and Next Steps

The energy challenges facing the Nation have increased significantly due to growing concerns about climate change and our Nation's dependence upon foreign oil supplies. In the years ahead, it will be critical for the United States commercialize and deploy cleaner and more advanced energy technologies into the marketplace at a rate and scale that can serve to address our Nation's most pressing energy and economic challenges. In this context, the Federal Government should consider increasing funding for activities currently underway that have proven record of positively impacting the commercialization and deployment of advanced energy technologies, as well evaluate new options that could improve the management practices of the Federal Government's science and technology enterprise and new Congressional policies that will help pull advanced energy technologies into the marketplace.

Appendix A:

Government Levers Available to Accelerate Technology Commercialization & Deployment

A wide range of government non-R&D options or "levers" exist to accelerate the commercial deployment of advanced energy technologies.[8] The levers available to government range from regulatory mandates that push a technology into the market to financial incentives that encourage consumers to pull a technology into the market. Between these two end-points are a variety of levers that can be used by government to increase the speed and scale of a technology's commercial deployment, such as taxes that raise the cost of competing technologies or government procurements that create an early market for a new technology.

There is no "silver bullet" to commercialize technology and the "best lever" is dependent upon a variety of factors, such as the market-readiness of the technology, its target market, competing technologies and policies, the nation's political institutions and economy, and the technology's strategic value to the Nation. Studies of the role of government in technology innovation have found that multiple levers, working together in a synergistic package, were the key to successful technological innovation and particularly to the success of radical technological transformations in power sector technologies, computers/electronics, and agricultural biotechnology.[9]

This "multiple levers approach" is at work today as the Federal Government implements numerous policies to support commercialization and deployment to increase our energy options and reduce the Nation's dependence on oil. The range of these non-R&D levers with examples of activities in the DOE Offices, as well as some activities which have not been enacted, is listed below.

<u>Legal and Regulatory</u>

- Codes and Standards
  - Renewable Fuel Standard
  - Building Codes (EE)
  - State energy codes (EE)
  - Renewable Portfolio Standard (not in effect at Federal level)
  - Grid Interconnection Codes (not in effect at Federal level)
- Cap and Trade
  - Sulfur Emissions (FE)
  - Carbon Emissions (not in effect at Federal level)
- Other Mandates
  - Net Metering(not in effect at Federal level)
  - Time-of-Use Electricity Pricing (not in effect at Federal level)
  - Appliance Standby Power Settings (not in effect at Federal level)

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[8] Sources: Vicki Norberg-Bohm et al. *The Role of Government in Energy Technology Innovation: Insights for Government Policy in the Energy Sector.* Kennedy School of Government, Harvard University. October 2002; Roy Rothwell and Walter Zegveld. *An Assessment of Government Innovation Policies* in Government Innovation Policy edited by J. David Roessner, St. Martin's Press, 1981; and John Mock et al. *Moving R&D to the Marketplace.* May 1993.

[9] Vicki Norberg-Bohm et al. *The Role of Government in Energy Technology Innovation: Insights for Government Policy in the Energy Sector.* Kennedy School of Government, Harvard University. October 2002.

Taxes

- Production
  - Carbon
  - Fossil-Generated Electricity
- Consumption
  - Gasoline
  - BTU
- Purchase
  - "Gas Guzzler"
  - "High Carbon Commodities"

Information and Outreach

- Education
  - Ratatouille Energy Saving Campaign (EE)
  - Hydrogen Road Tour (EE)
  - LNG Public Education Forums (FE)
  - What is the Smart Grid? – An E-Forum (OE)
  - Nuclear Energy Fellowship and Scholarship Program (NE)
  - Plasma Science and Fusion Center's Educational Outreach Programs at MIT (SC)
- Information Sources
  - Alternative Fueling Station Locator Website (EE)
  - Database of State Incentives for Renewables and Efficiency (EE)
  - Energy Assurance Daily (OE)
  - Nuclear Power Deployment Scorecard (FE)
  - Fossil Energy NEWSALERT (FE)
- Labeling
  - Energy Star (EE)
  - Carbon Content (not in effect at Federal level)
- Training
  - Emergency Preparedness Training (OE)
  - Industrial Best Practices (EE)
  - Nuclear Worker Training Program (NE) (*proposed program*)
- Competitions
  - Solar Decathlon (EE)
  - EcoCAR Competition (EE)
  - 30th Annual University Coal Research Competition (FE)
  - National Science Bowl® for High School Students (SC)
- Fellowships/Scholarships/Residences
  - Methane Hydrate Research Fellowship (FE)
  - AAAS Congressional Science and Engineering Fellowship (SC)
  - Advanced Fuel Cycle Master's Degree Fellowships (NE)
- Network Building
  - Grid Applications consortium (OE)
  - Technology Commercialization Showcase (EE)

        - National Lab Entrepreneur in Residence Program (EE)
    - Conferences/Workshops
        - 2008 DOE Nuclear Suppliers Outreach Conference (NE)
        - Solar America Initiative – Market Transformation Technical Exchange Meeting (EE)
        - National Renewable Energy Marketing Conference (RE)
        - Clean Coal and Power Conference (FE)
        - Smart-Grid Conference (OE)
    - Energy Audits/Assessments
        - National Energy Audit Tool (EE)
        - Industrial Assessment Centers (EE)

Partnerships

- Product Development
    - Carbon Sequestration Regional Partnerships (FE)
    - Solar America Cities Partnership (EE)
    - Global Nuclear Energy Partnership (NE)
    - Advanced Nuclear Power Plant Design Criteria (NE)
    - Superconductivity Partnership Initiative (OE)
- Product Demonstrations
    - Southwest Regional Partnership Carbon Storage Demonstration Project (FE)
    - Field Demonstration of a 24-kV Warm Dielectric HTS Cable (OE)
- License Agreements
    - High-temp superconducting wire manufacture licensed lab buffer tech (OE)
    - REScheck license agreement (EE)
    - Clean Fractionation (to separate complex biomass raw materials into individual process streams that can feed both the sugar and thermochemical platforms of the integrated biorefinery (EE)
- Public Enterprise
    - Power Marketing Administration (DOE)

Procurement

- Services
    - Green Power
    - Advanced Metering at Federal Buildings
- Equipment
    - Energy Star Computers
    - Alternative Fuel Vehicles

Risk Mitigation

- Financial Liability Ceilings
    - Price Andersen Act
- Loan Guarantees
    - Clean Energy Loan Guarantee program
    - Section 136 Auto Loans (EE)

- Risk Insurance

Financial Incentives

- Tax Incentives
  - Renewable Energy Production Incentive
  - Alternative Fuel Excise Tax Credit
- Grants
  - Low Income Housing Weatherization (EE)
  - Tribal Energy Program Grant (EE)
- Loans
  - Energy Efficient Mortgages
  - Clean Renewable Energy Bonds
- Rebates
  - Renewable Energy Rebate Program
  - Advanced Transmission and Distribution Technologies

Appendix B

Financing America's Clean Energy Needs

An estimated $1.4 Trillion of capital is needed by 2030 to reach stated national energy goals (e.g. 20 in 10; reaching 20% of the nation's electricity from renewable sources; and 20% from nuclear energy by 2030). This amounts to $50-100 billion dollars and is far in excess of 2007's recorded $12 billion of investments. Additionally, a relatively small amount of public-private "seed funding" is needed at the very early stage of innovation commercialization, for the purposes of translating and accelerating scientific discoveries and cutting-edge inventions into marketplace applications.

Administering complex financial transactions requires management stability, flexibility, agility and experience not found in traditional federal agencies. In turn, quasi-governmental agencies have been established and specifically granted the necessary flexibility to effectively administer complex financial transactions.

Proposal: Establish an independent, non-partisan quasi-governmental agency focused on domestic clean energy investment to achieve our national energy goals in a consequential time frame.

This entity would focus on early-stage commercialization (as envisioned in the Advanced Research Projects Agency for Energy, or ARPA-E, which Congress authorized in 2007) and later-stage technology scaling (as Congress authorized with the DOE Loan Guarantee Program). Possible products and services could include: loan guarantees, direct loans, equity investment, risk management, debt instruments, standardization (e.g. renewable energy credits) and mortgage securitization.

Background: Large-Scale Clean Energy Development faces a number of challenges.

First Mover Disadvantage

To date, few commercial-scale clean energy production facilities have been built and operated. Building Plant #1 presents a significant financing challenge due to the combined dynamics of capital intensity and direct relationship between risk aversion and cost of capital. Before progressing down the engineering learning curve gained through construction experience, Plant #1 will likely require a 100% contingency premium over the expected cost of Plant #n. Also, without an operations track record for the design, risk adverse debt investors will not provide financing, so equity must fund the entire project which severely depresses the Return on Equity (ROE).

Illustrative 500 million gallon biorefinery at $5 per gallon of annual capacity
Plant #1: 100% contingency, no debt = 3% ROE
Plant #n: No contingency, 80% debt, 7% cost of debt = 15% ROE

Hidden Fundamental Economic Advantage

Free fuel gives clean energy production – especially wind, solar and geothermal – a fundamental economic advantage over incumbent fossil fuels. This advantage, however, can only be realized through intelligent financial engineering as the up-front capital cost of clean energy typically exceeds that of fossil fuels. Lower cost of capital increases the relative competitiveness of clean energy by increasing the value of clean energy larger future cash flows.