STRATEGIES TO FINANCE LARGE-SCALE DEPLOYMENT OF RENEWABLE ENERGY PROJECTS:

AN ECONOMIC DEVELOPMENT AND INFRASTRUCTURE APPROACH

Clean Energy Group

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Notes

This report uses the term “clean energy” to include the primary commercially available renewable energy sources such as solar energy, onshore and offshore wind energy, geothermal energy, wave and tidal power, and hydro-electricity as well as associated ancillary technologies such as energy storage, smart grid application for transmission, and other future renewable energy enabling technologies.

About IEA-RETD

The IEA-RETD is comprised of nine countries: Canada, Denmark, France, Germany, Ireland, Japan, the Netherlands, Norway, and the United Kingdom. Hans Jørgen Koch, Deputy State Secretary, Ministry of Climate and Energy, Danish Energy Agency, serves as Chair of the IEA-RETD.

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About Clean Energy Group

Clean Energy Group (CEG), a national U.S. nonprofit organization, promotes effective clean energy policies, develops low-carbon technology innovation strategies and works on new financial tools to stabilize greenhouse gas emissions. CEG concentrates on climate and clean energy issues at the state, national and international levels, as it works with diverse stakeholders from governments as well as the private and nonprofit sectors.

CEG assists states to create and implement innovative practices and public funding programs to advance clean energy markets and project deployment; creates networks of U.S. and international policy makers to address climate stabilization; advances effective, 21st century, distributed innovation theories for climate technology; develops new finance and commercialization tools; and works to attract new investors to move clean energy technologies to the market more quickly. CEG's work is designed to greatly accelerate the commercialization of breakthrough low-carbon technologies and to massively scale up existing clean energy technologies as rapidly as possible to strengthen the economy and stabilize climate change emissions. CEG is supported by major foundations, state governments, and federal agencies.

Founded in 1998, CEG is headquartered in Montpelier, Vermont, with staff also based in Washington, D.C. In 2002, CEG created and now manages a separate, national, nonprofit alliance of 20 state-based, U.S. public clean energy funds and programs— the Clean Energy States Alliance or CESA.

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How to Use this Document

This document provides the context and describes some of the challenges that currently face the financing of large-scale renewable energy deployments. While many of the solutions are interwoven within the broad context of this report, for ease of reading and understanding, they are presented in the following order within the four main recommendations described in the Clean Energy Solutions section of this report: 1) clean energy as a new economic development system, 2) finance, 3) innovation, and 4) public policy.

Within each section, the main points are introduced in the form of summary boxes placed on the left-hand side of page. Relevant suggested recommendations are highlighted in a separate box off-set to the right or at the end of a sub-section. It is intended that this format will provide readers with a method to rapidly locate sections within the content that are of particular interest and an effective way to extract and highlight the most compelling points.

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Executive Summary

There appears to be universal global consensus among many policymakers that trillions of dollars of new investment must be raised to finance the massive deployment of clean energy technologies to address climate change risks. While undoubtedly some results can be gained from energy conservation and efficiency, there remains an unavoidable need for new energy generation. The absolute amounts of funding for financing large-scale deployments of renewable energy projects remain significantly larger than the levels invested to date.

Despite the dire need for high levels of finance for future large-scale deployments of renewable energy, neither the funds nor any convincing mechanisms to produce them in these needed amounts have been forthcoming from the public- or the private-sector. Such massive financial commitments have been made all the more difficult in the current financial crisis, with historic budget deficits in OECD countries.

The fact of the matter is that the level of capital is available if new conventional, investors are brought into the clean energy space on terms that are within their investment parameters. But new approaches are required in order to access, attract, and direct those funds for the benefit of building a clean energy infrastructure.

Over the past two decades, governments have learned a lot about effective clean energy finance mechanisms, which has helped achieve the current levels of renewable energy deployments. There is no need to abandon these proven mechanisms. However, to date, existing mechanisms have failed to sufficiently reduce the risk-to-reward ratio enough to give private-sector investors sufficient profit levels and confidence in clean energy opportunities for the game-changing investment levels needed for the future.

Therefore, new approaches to scale up financing for the acceleration of clean energy investment are needed—approaches that answer the following questions:

- What's holding back both public and private investors?
- What actions could policymakers and the private sector take to spur higher levels of investments into the clean energy sector?
- What fundamental change—such as national clean energy economic development plans—will appeal to all political persuasions to gain rapid consensus for new and effective policies?
- Is it possible to develop cheaper, innovative technologies that can achieve a scale-up of clean energy with much lower incremental costs?

The world is faced with the challenge to secure sufficient investment to achieve the scale of deployments that will drive down costs and, in turn, attract increased investment levels. The solution is unlikely to be action to simply to scale up more of the same public subsidies— an unviable option with many countries facing unprecedented national deficits.

Rather, a possible alternative path forward could come from combining existing support mechanisms with new public finance measures that are now used to finance infrastructure like roads, bridges and other public projects. These new measures could require new policies and establishment of new funding institutions like public national clean energy investment banks.

To be successful, new financial mechanisms must be structured to reduce the burden on highly leveraged public-sector budgets while providing sufficient returns to conventional private-sector investors. The plan to achieve this over the next few years must be an integrated one. It must bring together economic development, finance, innovation and energy policies.

To develop such an approach, it is important to understand the larger technology and finance context. The financing challenge is only one part of a massive technological transition needed to shift the global economy away from its dependence on high-carbon energy. The necessary transformation is on the scale of the information technology (IT) revolution of the past three decades, but it will be even more complex. This is because, unlike IT, energy technologies are embedded within a capital-intensive, highly networked infrastructure system with powerful incumbent interests. From an investor's perspective in this environment, financing clean energy technology means more risk, higher capital costs, longer timeframes, and uncertain rewards.

These factors -- and the lack of allocated capital to finance the development of new technology with new risks from proof of concept to commercial deployment, known as the "valley of death"-- are only a few of the technological and competitive problems making scale-up difficult.

In addition, there are some well known market failures that further complicate this financing problem: carbon and other emissions are mostly un-priced making renewable technology currently more costly as compared to incumbent generating technologies that free ride on externalized pollution and health impacts; innovation is hindered through "spillover effects"; infrastructure is a public good with reduced incentives for private investment; and intermittent renewable energy requires complementary investments in energy storage and related technologies to make deployment of renewable power economical at-scale.

In this context, a fundamental task for public finance and policy is to improve the clean energy investment risk-to-reward ratio needed to entice private investors.[1] The risk-to-reward ratio is a comparison of how much money an investment could lose compared to its profit potential. To encourage private investors to direct capital into clean energy technologies, governments have an important role to reduce the risks associated with clean energy technologies (technical, institutional, policy) and, at the same time, increase the profit potential of these investments.

Governments have a critical role to play in reducing clean energy technology risks while simultaneously making the returns sufficiently attractive for private investors.

Investors have different comfort levels that match the wide range of risks and rewards. Venture capitalists take on high risk for the expectation of high returns. On the other hand, institutional investors, such as pension funds, look for lower-risk investments with reliable lower returns—for example, infrastructure bonds.

In order to better align these conventional investor needs with the funds that are required for financing large-scale deployment of renewable energy projects, other questions arise:

- Which policies can influence clean energy infrastructure investments to perform like (or better than) traditional infrastructure, industrial, and municipal bonds?
- What kinds of policies will reduce risk and generate competitive returns for clean energy?
- Are existing investment institutions sufficient or should new institutions help restore investor confidence where it has been eroded by a history of changing or short-term policies?

Framed in this way, in order to solve the finance problem, policymakers must consider taking a host of non-finance as well as finance-based actions as a package of integrated solutions.

Clean energy is no longer simply an environmental strategy but is part of an economic development strategy.

It is important to understand the non-financial circumstances that will help mobilize the capital markets. Clean energy is no longer simply an environmental strategy. It is now an economic development strategy gaining interest across the globe, one that could help lift the world out of the economic downturn or, in the case of countries unaffected by it, provide a new market strategy for growth and poverty alleviation.

The public sector has begun to do its share. Today, the accumulated public finance investments in the clean energy sector demonstrate that governments have an increasing stake in commercial success of the renewable energy market. Global clean energy investment reached a level of USD 243 billion (Euro 174 billion) in 2009. However, much of that was from China and other countries offering a massive, one-time stimulus package to spark the industry.[2]

Consider viewing the clean energy challenge as a 50-plus year infra-structure–building exercise.

But public funding is not enough. The major task for governments and the private sector is to conceive of the clean energy challenge as an infrastructure-building exercise for the next thirty to fifty years. This challenge will require a set of many tools that were employed by industrial economies over the last century to build out the existing transportation, telecommunication, and energy infrastructure systems that dominate today. Of course, many of these systems have produced other environmental and social problems, but it is unquestionable that these systems achieved the kind of scale that is desired for the renewable energy sector.

The four strategies (economic development, financial innovation and mechanisms, technology innovation support mechanisms, and public policies) require new institutional structures.

These infrastructure systems relied on at least four kinds of targeted public and private approaches to achieve their unprecedented dominance. They include:

- *Economic development policies* to address and link the many actors throughout the economic system, using: "innovation economics" to create incentives, overcome institutional barriers and build the case for a large scale technological transition. Our current forms of embedded infrastructure (rail, road, water, gas and electricity) have been spurred by economic development and competitiveness as drivers for their investments.

- *Financial innovation and mechanisms* that made it possible for a diverse range of private investors to obtain safe and predictable returns because of public interventions that reduced investor risk and created stable investment environments, and thereby made trillions of dollars in capital available for major infrastructure investments.
- *Technology innovation strategies* that drove cost reductions and performance improvements in new technologies and crucial enabling technologies that created and supported the integration of new infrastructures into mainstream society.
- *Enabling energy policies* that mandated investments in infrastructure created a stable investment demand that gave investors confidence to invest based on a predictable, long-term returns horizon.

In short, an economic and infrastructure systems-approach made it possible for societies to scale up major technological transitions throughout history. It is the way built infrastructure becomes culturally dominant.

It is also the way that clean energy must evolve for it to achieve scale and technological dominance.

Then, this proposed new vision builds on established successes from which new are developed and incorporated. This is usually how progress is made—a combination of emerging disruptive approaches blended with those that are proven.

In line with historical successes in these other areas, it would put economic development at the forefront for developing national clean energy infrastructure approaches. This contrasts with many current strategies that see economic development merely as a secondary benefit from deployment of clean renewable energy projects. Seen in this different way, a national clean energy, economic development initiative will require the integration of finance, innovation, and policy**.**

Framed in this way, certain strategies should be considered:

- Recast public support around a national, economic-development initiative, whereby investment in a new energy infrastructure could produce both short term returns in the form of jobs and wealth creation, as well as the longer-term advantage of putting clean energy at the forefront of economic competitiveness.

- Design policies to improve the risk-to-reward ratio, which would decrease risk and increasing profit potential for private investors, thus providing sufficient and reliable long-term returns.

- Make investment in new energy infrastructure as attractive as investments in non-energy infrastructure such as broadband, airports, and municipalities, and provide an array of new investment opportunities for conventional investors that control the bulk of private capital in most countries.

The body of this report highlights the menu of options for each of the core strategies, which will have to match to the unique circumstances of each nation. The infrastructure building challenge is not limited to a single country. The challenge is universal, and nations are likely to consider technologies that match their natural resources.

Each section of the report provides specific, relevant recommendations, which are proposed based on proven practices and emerging ideas from the OECD and non-OECD countries. While there is urgency to make an immediate impact of enormous scale for the benefit of the planet's environment and to meet national as well as regionally agreed goals, some of the recommended solutions are complex and will take time to build.

However, we should not despair at the size or scale of the task as societies have performed similar undertakings in the past. Perhaps in some ways, we are better equipped than earlier generations to make this transition as we have the benefit of history, combined with newly available technology. This should enable us well to plan and take incremental steps that will create long-term success to transition to a new, sustainable energy infrastructure.

The recommendations of this report are intended for the immediate short-term period (present-2015) and are given so that national governments can adopt them quickly as initial steps in attaining the solutions proposed in this report. This could be seen as the "stand up" period when new economic development strategies, finance, technology innovation, and policies are put in place in an integrated manner to support the build-out of the new, renewable energy infrastructure.

A summary of the recommendations for each solution set is detailed below:

Economic Development

Policies should support clear national economic development strategies that can attract step-change levels of capital to invest in a new clean energy economy. Infrastructure investment offers the economic development potential for nations to grow their economies. These policies could include:

- Fill identified gaps in various technology industry value chains such as manufacturing support, workforce development, and supply chain mapping.
- Create high-tech, clean energy clusters that optimize productivity by co-locating different links of the supply chain and factors of production (supply of different components and a skilled work force). Regional governments could administer the clusters and provide appropriate financial support mechanisms such as grants, tax breaks, and discounted land to attract industry.
- Build local markets for a country's clean energy products.
- Bolster business enterprises specializing in overseas resources development that seek cooperative green-growth endeavors abroad.

Finance

A country could look to build a robust clean energy infrastructure that highly leverages public funds to achieve national goals by attracting high amounts of private capital investment. These policies and practices should include:

- Institutionalize (possibly under a new structure such as an investment bank) the functions to promote, integrate, coordinate, or manage the economic development, finance mechanisms, and technology innovation required for massive clean energy technology deployment.
- Create investment incentives with reassurances that will attract funds from new and wider range of well-resourced investment pools—including profitable corporations (using appropriately designed tax incentives).
- Explore the creation of "green bonds" to provide long-term, widespread capital for renewable infrastructure projects.
- Align investment reduced risk-to-reward ratio clean energy opportunities and appropriate returns.

Innovation

Countries might adopt and support technology innovation programs to:

- Increase private and public research and development in renewable energy technologies.
- Use "systems innovation" to increase innovation all along the technology development value chain—from lab to product development, to business and finance models.
- Use "open and distribution" innovation to tap the dispersed, global talent and collaborate across institutions because of the evolution of Internet tools and "open innovation" companies that link seekers and solvers on particular product development challenges to supplement in-house research and accelerate the technology development cycle.
- Look to "reverse innovation" strategies and partnerships—designing, creating, and manufacturing climate technology products in partnership with developing countries to make them less expensive and then later adapt and export them to OECD countries.

Enabling Energy Policies and Mandates

Countries could consider a host of technology push and pull demand strategies and policies to support the scale-up of existing technologies and increase support for emerging technologies. These policies could:

- Adopt a combination of either or both national or sub-national feed-in tariffs (FITs) or national tax credit schemes, combined with mandatory renewable procurement for utilities, to achieve much greater penetration of renewable power into the existing generation mixes of those countries.
- Mandate more public procurement of renewable power from national governmental agencies such as defense which are often the largest consumers of energy with enormous procurement power.
- Implement mandatory use of renewable technologies in new buildings to reduce demand on already stressed national grids.
- Encourage more technology turn-over and avoid technology lock-in. Using a leasing-type model where a developer does not sell the technology but retains ownership of the project and leases the technology for a long term contract rate that is comparable to the regular price of electricity.
- Address "Valley of Death" commercialization gaps by putting in place an "emerging technology renewable auction mechanism" (ET-RAM) that would require locally regulated utilities to procure clean energy project outputs from specific technology classes up to a predetermined cost limit, at guaranteed prices competitively bid by the winning developers; such a mechanism would be designed to overcome the concerns about available demand and price levels that typically face efforts to finance emerging technologies.

Of course, this is not the end of the story and more work will follow. A second phase (2016-2020) would incorporate and advance the demonstrated positive results from the earlier deployments of large-scale renewable energy projects. Initial investment returns would then be reinvested for subsequent deployments, with the results designed to gain the attention and confidence of more cautious investors. With each recycling of capital, the levels of funding will increase. In other words, the results from the efforts in the first phase would become apparent, which in turn could increase investment in the next.

The next generation of policies and programs would be devised to build on the first-generation, integrated strategies so that a fully formed "infrastructure investment" portfolio would drive new clean energy investment for the next half century (2020-2050).

This report intends to provide recommended steps to countries that have started and can advance along this new clean energy economy path. It is a promising direction for the 21st century infrastructure creation that could produce jobs, wealth, and environmental benefits through proven public and private investment structures and strategies.

Framing the Clean Energy Challenge

This section examines the scale of clean energy investment needed; the barriers to investment flow; identifies untapped sources of finance; and how to create conditions for unlocking those investments.

SCALE OF INVESTMENT NEEDED

There appears to be global consensus among many policy makers that, to address climate mitigation and adaptation, trillions of dollars worth of new investment must be raised to finance massive deployment of clean energy technologies. These funds will be needed, for both OECD and non-OECD countries.[3] The capital required for the clean energy technology turnover is on the scale of changing the entire highway and air transport systems with radically new forms of technologies.

We need new approaches to address the challenges of scaling up finance for large-scale deployments of clean energy.

The IPCC SRREN estimates global cumulative renewable energy investments needed to be USD 1,360 to 5,100 billion for the decade 2011 to 2020, and from USD 1,490 to 7,180 billion for the decade 2021 to 2030 (USD 2005). The lower values refer to the IEA World Energy Outlook 2009 Reference Scenario and the higher ones to a scenario that seeks to stabilize atmospheric CO_2 (only) concentration at 450 ppm.[4] While these totals are large, they amount to less than 1 percent of the world's GDP.[5]

But, given the current financial crisis where OECD governments face historic budget deficits, achieving such massive monetary commitments from public coffers has been made all the more difficult. It is fair to deduce that, if the current financial system continues to struggle against unprecedented stressors, large public investments—on the order of magnitude needed to finance the shift to new energy technologies—may not materialize.

Therefore, new approaches to the problem of scaling up clean energy deployment finance are needed- approaches that rely primarily on private investment. Even though public investment will remain critical, most of the new sources of finance must come from the private sector and from existing financial markets.

The good news is that this investment level is not insurmountable when compared with the health of corporate balance sheets. The investment money is in the system. For example, foreign investment in Brazil alone has risen very tangibly, reaching USD 500 billion in Q1 2011.[6] Also, many reports indicate that major corporations, even in these hard times, are siting with cash rich balance sheets rather than investing. For example, in the first quarter of 2010, US corporations had accumulated over USD 1.8 trillion in cash on their balance sheets.[7]

However, while the private sector (banks, investors, pension funds) has deployed significantly more capital into this space recently, it has not met the levels needed. The stark fact appears to be that the current financial system does not have the existing tools to produce the required investment from either the public or the private sector.

The key questions remain whether public investments will continue in these tough times, and whether private investment will flow to less risky markets instead of clean energy. To bring greater investment to clean energy at greater scale, driving down costs, lowering investment risks, creating more stable policy environments and increasing the risk to reward ratios are all critical to ensure that renewable energy is a mainstream element of private investment portfolios.

OBSTACLES TO CLEAN ENERGY INVESTMENT

The fundamental obstacle to large-scale investment in clean energy technologies is that the perceived risk to reward ratio is unattractive to most investors. Risk profiles of renewable energy projects remain high, with rewards too low unless offset with particularly favorable project-specific circumstances and public finance support.

For today's investors, financing clean energy projects implies "greater uncertainty" and it is easier to invest elsewhere.

Most of the clean energy technologies are relatively new, meaning that investors face a host of new risks that they never have addressed before in financial deals. This equates to higher transaction costs to cover learning. The many different investors needed for large-scale projects compounds the problem.

While this situation is changing in many sectors such as onshore wind and solar, from many investors' perspective, clean energy technologies still are often perceived to have higher risks, greater capital costs, longer timeframes than other infrastructure sub-sectors and uncertain rewards. It is important to change these perspectives across the renewable energy landscape.

Deep pocket investors are in "wait-and-see" mode, which potentially "locks-out" clean energy.

In general, many of the larger investors have adopted a "wait-and-see" approach for the deployment of renewable energy projects. Newer and risky—particularly capital intensive—is always a tougher investment bet than old and reliable. This "wait-and-see" approach is based on several prominent factors that significantly hamper the scale of their deployments.

Technology Risks

Clean energy technologies are new. As noted, most clean energy technologies are new as compared to conventional energy investments—such coals plants and natural gas turbines. New and untested technologies raise the costs of due diligence, on top of the fact that these projects may start out small in nature but many in number, further raising the transaction costs of projects, sometimes turning a profitable project into an unprofitable one. In addition, many new technologies originate from technology companies that are start-ups and have not had time to build up healthy balance sheets, which in turn discourages project finance investors. Technology performance risk is not well covered under current insurance mechanisms.

The present day high-risk nature of clean energy investments means that only a narrow set of investors with a high-risk appetite are willing to invest, limiting the possibility of scaling up deployments.

New, capital intensive technologies face the 'Valley of Death' before commercialization. Companies seeking to move their technology from the laboratory to the marketplace must bridge the notorious funding gap known as the "Valley of Death" before commercialization—the point when the lab work and proof-of-concept have been completed, and it is time to build the first full-scale projects or manufacturing plants. Energy technologies appear to suffer particularly high attrition at this point in the development cycle. The fundamental problem is the dearth of capital that does not align the correct risk/reward profile with appropriate or adequate capital resources. Venture capitalists will gladly take on significant risk but have limited capital. Banks have adequate capital but lack the appetite for risk.[8]

Most current renewable energy technologies cost more than competing fossil fuel technologies, under current accounting systems that do internalize location or timing of available resource, energy security, or pollution. In particular, clean energy technologies often have higher upfront capital costs- and low to zero fuel costs- but financing schemes and discounting are such that the upfront costs discourage the return scenarios for investors. While the prices of clean energy technologies are coming down, and some financial engineering of projects through leasing models gives customers project prices comparable to commodity electricity, this overall competitive disadvantage is a reality that must be addressed. The unsubsidized cost of generating a watt hour of clean power for the most part remains uncompetitive with the same watt from coal or natural gas. While some of cost difference is attributable to the current ultra-low price for natural gas—against which green technologies primarily compete—clearly there is a need to accelerate technology innovation; achieve greater experience to expose cost benefits; develop new business models to reduce end user costs; and quickly advance scale-up—as all are needed before price parity can be reached.[9] Arguments for fossil fuel technologies should include all externalities in the pricing would help, meanwhile, these arguments alone do not change the cost profile of renewable technologies.

Potential projects burdened with complementary infrastructure costs. Investments in specific projects are often burdened with additional costs associated with transmission, interconnection, and construction facilities (such as installation vessels for offshore wind deployments). For example, current-generation wind farms tend to be located close to existing transmission. But as investments are planned for scaling up that technology on land or offshore, they may require significantly new investments in more transmission, meaning massive upgrades to that grid infrastructure.[10] Typically the costs fall on the project developers to help secure and make the necessary large investments and often require extended investment timeframes. In addition, the build-out of new clean energy technologies such as offshore wind will require a massive complementary infrastructure build-out of goods and services to support the industry such as marine ports, maintenance and supply vessels—and there is no readily available capital to invest in that complementary infrastructure.

Many technologies are not ready for large-scale deployment.

Scale up of renewable energy generation will require expensive enabling technologies because wind and solar technologies are intermittent resources. Scale-up of wind or solar deployments will require the creation of an entirely new support infrastructure of energy storage and distribution technologies. This is not unfeasible but is frequently underestimated as an impediment to massive deployment of renewable technologies. Many of these technologies are simply not technologically ready for large-scale deployment without these enabling technology investments. Any renewable deployment scheme must include a complementary, significant investment in enabling storage technologies.[11]

Competitive Risks

The global finance crisis and associated tight bank regulations restrict lending in new areas. Large clean energy investments on the scale required can exhaust even utility or corporate balance sheets. And due to the financial crisis, tighter bank regulations may further restrict lending in new areas. This would require the expansion of the investor pool beyond these traditional investors.

The recent recession has spurred governments around the globe to step up short-term financial support for renewables. However, the downturn has also resulted in dramatically deeper fiscal deficits and enormous national debts. Spain, Greece, and UK have all been forced to cut government spending significantly and substantial cuts are on the way in the US. Most recently, Greece, Ireland, and Portugal have required a major bailout from the International Monetary Fund and the EU.[12] Debt crises, reduced public expenditures and high unemployment rivaling the Great Depression do not create favorable political environments for public investments in any new technologies.

Today's global financial problems affect clean energy investments.

Historic, embedded, institutional relationships among the stakeholders support incumbent fossil fuel technologies. These relationships are not often conducive to accepting new renewable technologies. The unfamiliar elements of clean energy technologies require questions to be answered and do not harmoniously fit into the existing relationships, which can cause long bureaucratic delays; all of which work against attracting investment. The problems become more complex when new technologies traverse multiple administrative levels, each with a different regard for how the new technology should "fit" into the existing infrastructure regime. Spain, for example, has been faulted for overlapping procedures and competencies between the national and the regional governments. Proceedings involving multiple applications that must be conducted contemporaneously are often interlocking at specific stages and deter investors. In contrast, other European Members states such as Germany have established uniform administrative procedures and one single permit is issued.[13]

The incumbent fossil fuel infrastructure's relation-ships hinder and act to "lock-out" clean energy.

The familiarity and the established relationships of the "locked-in" fossil fuel system can in itself act to "lock-out" deployments of large-scale renewable energy projects (See Case Study 1: The Germany's Nuclear Phase Out). New low-carbon technologies face the challenge of transforming a nation's economy in a manner that is initially dependent on the old carbon-based infrastructure—e.g., transmission, base-load, and reliable fossil generation. Yet eventually, this tie will have to be broken with the infrastructure's "entrenchment of high-carbon assets which would later have to be scrapped."[14]

Case Study: Germany's Nuclear Phase Out and its potential to lock-out renewable energy with short falls coming from new gas or coal plants.

Germany's announcement on 30 May 2011 that it will shut down all of its nuclear power stations by 2022 leaves the country looking for ways to substitute the electricity generation while simultaneously meeting targets to cut carbon emissions. In the short term, Germany has ramped up spare capacity at existing coal-fired plants, and has also started importing electricity from France and central Europe. In the longer term, the government wants to raise Germany's use of renewable sources from the current 17 percent of electricity generation to 35 percent by 2020.

The country already has enough gas and coal plants under construction to provide 10 gigawatts for 2015, but this is merely to replace old plants. If Germany doesn't import electricity, even with a doubling of power from renewable sources combined with a 10 percent cut in demand this doesn't quite replace the low-carbon nuclear power that will be lost. This means that Germany may need to import electricity and build more gas or coal plants thereby 'locking out' the full renewable energy deployment potential.

Richard Van Noorden, "The Knock-on Effects of Germany's Nuclear Phase Out," *Nature*, June 3, 2011.

Increasing pressure from the natural gas industry as a competitive threat to greater renewable development. Many investors think shale gas development could have a negative effect on renewable energy prospects.[15] However, recent investigative reports by *The New York Times* suggest that the economics of shale gas may be vastly overstated, and the prospective reserves to be tapped may be wildly exaggerated by industry to produce short-term investor interest; a "shale gas bubble" like the excesses of Enron has been suggested by industry insiders.[16] The true costs and benefits of shale gas, and its competitive position versus renewable technologies, are still to be determined.

Political Risks

Clean energy technologies also face significant political risks. The first is regulatory risk**.** Because they tap energy from natural resources, clean energy technologies often face significant regulatory risks for siting and environmental permitting- particularly when projects are sited in public environments like ocean energy technologies. The second is uncertainty over long-term policies. The clean energy industry is driven by policy that can be uncertain over the long term, thus adding in another layer of investor risk to project finance.

Market Failures

Compounding these technological, competitive and political risks are some well known market failures that further complicate the problem of financing new clean energy projects. A recent study by the UK government set out these problems in smart detail. They include:

- The carbon effects of emissions; their externalities remain largely un-priced—and will remain so—in most programs for investors around the world.

- The so-called “spillover effects” of technology cannot be fully captured by innovators in the private sector, meaning that more public investment is required to induce sufficient technology innovation in clean energy.
- Infrastructure investment remains a public good, but requires an effective private business model to induce investment.
- Energy largely remains a monopoly with a regulated structure, where it can be difficult for new, disruptive technologies to obtain competitive private returns.[17]

Fundamentally, the present day high-risk nature of clean energy investments means that only a narrow set of investors with a high-risk appetite are willing to invest, limiting the possibility of scaling up deployments.

UNTAPPED INVESTMENT SOURCES

As nations seek a step-change in investment levels for financing large-scale deployment of clean energy projects, the amount of capital needed extends beyond any of the levels attained to date. Because of the structure of clean energy investments and the barriers described above, most clean energy capital has come from high-risk investors- venture funds, angle investors and project equity investors. However, these sources are limited and there are much greater pools of private capital that could be tapped if the risk/reward ratio were improved.

Potential sources of new private investments include pensions, sovereign funds, insurance funds, and private corporations. The key for government policies will be to influence or engineer investment instruments such that they match the risk vs. reward needs of these alternative sources of funding.

Pension Funds

Pension funds have been identified as a potential significant contributor to financing the large-scale deployment of renewable energy projects. In particular, the "P8 Group," consisting of 12 of the world's largest public pension funds with a combined USD 3.5 trillion in assets,[18] is a key target.

Pension funds are likely candidates for significant investments in the future financing of large-scale deployments of clean energy.

Historically, pension funds have not made infrastructure-based investments. However, they are now searching beyond the traditional asset classes of equities, bonds, cash, and real estate.[19] As infrastructure class assets have been made available for investment by pension funds, it has opened enormous opportunities for investments of size.

According to a 2007 survey, conducted by Richard Davies Investor Relations for *Financial News*, return expectations for the asset class infrastructure over 10 years were an annualized 9.5 percent, putting it in second place behind private equity (11.3 percent). In comparison, stocks were expected to return 9.0 percent and bonds 5.1 percent.[20] This should suggest that pension funds, when provided with the correctly structured asset class, could well align their investment needs with infrastructure and be attracted to finance large-scale renewable energy projects.

However, the performance of stocks involved in infrastructure historically have out-shone the private equity or direct infrastructure investment.[21] This underscores the historic trend of pension investments mainly in well-established funds and the reluctance of wealthy pension funds to take on project-specific risks. To date, this funding source has been reluctant to fully embrace the clean energy sector as an investment opportunity. In some countries, there may be legal restrictions that limit pension investments to stocks and bonds rather direct project investment.

There are some signs of increased interest, however, such as PGGM of the Netherlands and the Korean Teachers' Credit Union; and other institutional investors have committed USD 479 million to a China-focused infrastructure fund managed by the Macquarie Group and China Everbright. Macquarie is also raising USD 500 million for a North American renewable energy fund. A little more than a year ago, it also launched the USD 408 million Macquarie Mexican Infrastructure Fund, which has invested in two of the country's largest wind farms.[22] Australian Macquarie Group is by far the biggest manager, managing assets of over USD 20 billion for pension funds, with a market share of 44 percent, with equity invested in more than 100 assets across 25 countries.[23]

Pension funds are likely candidates to play an important role in financing future renewable energy projects. It seems that some may have appetites for strong growth and have the potential for investment in primary markets during project construction phase, but others that require longer-term steady returns could align with secondary markets and invest in the operation and maintenance of the renewable energy projects.

Sovereign Funds

The world's top ten sovereign funds total approximately USD 3.8 trillion and are another source of funds with resources suitable to invest in the clean energy infrastructure. The largest sovereign-wealth fund belongs to the United Arab Emirates, whose Abu Dhabi Investment Authority manages assets worth USD 627 billion. China has multiple sovereign funds, the largest is the SAFE Investment Company, which has holdings worth USD 347 billion, but the country's total sovereign funds' worth is estimated to be USD 831 billion, more than any other country's holdings. In designing policies to encourage investments by sovereign funds, policy makers should remain mindful that many of the biggest sovereign funds belong to oil exporters and are part of the incumbent infrastructure. There are, however, some sovereign wealth funds found in China, Singapore, Hong Kong, and Australia that are not oil exporters[24] and may be easier to draw initially into financing the new clean energy infrastructure.

Insurance Funds

Insurance Funds may also have the potential to be harnessed in a similar way to pension and sovereign wealth funds. For example, in the United States, California insurance companies have been offered incentives to invest in "green" technology, including clean energy projects, when former Governor Arnold Schwarzenegger signed a bill making insurers eligible for a 20 percent tax credit for qualified investments in low- and moderate-income urban and rural communities. California's AB 1011 legislation added environmentally friendly investments to a list of allowed projects under the California Organized Investment Network (COIN) program, collaboration between insurance regulators, the insurance industry, community affordable housing and economic development organizations. COIN was established in 1996 as an industry-preferred voluntary alternative to legislation that would have made it mandatory for insurers to invest in under-served communities.[25] This would suggest that given the correct financial or tax incentives, insurance companies could well be another new source of capital.

Profitable Corporations
An interesting new source of funding is emerging from private companies that are non-energy related. Some have started to take an interest in the direct investment opportunities within the clean energy sector. Google, as an example, is leading this emerging trend of private companies seeking to pioneer their presence and become a major force in renewable energy.

Case Study: Google

Google has invested more than USD 400 million in renewable energy projects from 2010-2011. It has invested in six projects, either as conventional or tax and lease equity. These include USD 55 million in lease equity for Terra-Gen Power's Alta wind energy centre phase IV; USD 168 million in equity in BrightSource Energy's 392MW Ivanpah solar concentrating plant in California; USD 100 million in tax equity for Caithness Energy's 845MW Shepherds Flat wind plant in Oregon; USD38.8 million for a tax equity stake in NextEra Energy's 169.5MW Peace Garden wind portfolio in North Dakota; a 37.5% stake in the development of the Atlantic Wind Connection submarine transmission line off the US Atlantic coast; and €3.5 million (USD 5 million) in the Solarpark Brandenburg solar photovoltaic generating plant in Germany. The company's equity in the renewable energy generating plants allows it to sell power from these plants to the local merchant markets as an "offset" for the power its data centers consume in the same regions.

The Google example demonstrates the proactive ways progressive companies can act and lead by example on clean energy investment. There must be other private companies that are progressive global corporate citizens and could use financial incentives to take similar actions, thereby using their profits to invest in the clean energy infrastructure. So far, Google is one of the first US non-financial services companies to make use of the tax equity incentives. It has not invested with debt, but there is speculation that a recent announcement to issue bonds could see a change in the company's investment strategy.[26] Profitable private corporations can use national tax incentives to contribute to the transformation of the new clean energy infrastructure.

AN ECONOMY-WIDE INFRASTRUCTURE CHALLENGE

The range of risks and market failures in renewable energy suggests that there is no single bullet solution to scaling up clean energy investments. The barriers run across the entire economy—they are political, historical, and technological. To mobilize untapped potential investors, comprehensive national, regional, and state strategies are needed that build public support and overcome these multiple obstacles.

Considerations beyond finance are needed to ensure institutional, policy, and economic factors are correctly aligned to match new investments.

It is also important to put this problem in a larger context. One can only hope to solve the finance problem by finding solutions that go far beyond finance. The ability to raise capital and finance projects for clean energy depends on a host of other institutional, policy, and economic factors. It is not possible to select "finance" as a singular problem that can be resolved out of this context. If those other institutional elements are not properly aligned to provide the right incentives to induce investors to finance projects, the money will not flow.

The financing challenge is only one part of a massive technological transition needed to shift the global economy away from its dependence on high carbon energy. The necessary transformation is on the scale of the information technology (IT) revolution of the past three decades.

Clean energy scale up will require a process of radical infrastructure "transition management." Transition management focuses on how to encourage regime changes—fundamental changes in sectors or entire economies—"involving wholly new technical functions, new knowledge bases, and new organizational forms."[27] The transition to a clean energy economy requires just such a new regime—with accompanying new knowledge bases and new institutions. It is about converting a fossil fuel infrastructure into a clean energy infrastructure—and in the process, creating a new clean energy economy with jobs and economic benefits derived from a whole new set of investments in emerging technologies.

Countries facing economic crisis have a strong need to show governments are adopt-ing policies for job creation and economic growth.

In this time of economic crises, particularly in OECD countries, there is a strong need to demonstrate that any government policy promotes jobs and economic growth. While this financial situation might be temporary, the pressure to show economic benefits from government programs is likely to be a long-term policy driver. Robust national clean energy economies might be one of our best hopes to create wealth, jobs and economic competitiveness. Many progressive policymakers are beginning to see that the building of a new clean energy infrastructure could put many of its citizens back to work.

In the past, Infrastructure spending has been the key to long-term economic growth and prosperity. This was the case for building bridges, highways, educational systems, and communications networks. Strong infrastructure has always been seen as precondition to a modern, developed economy. Clean energy is the "new infrastructure" that, as yet, has not developed all of the industry elements—economic, legal, regulatory and institutional—at the scale and scope that are needed.

Because building a new energy infrastructure is such a complex challenge and one of the transformational technological transitions in global history, successfully managing the transition will require a system or economy wide approach—principally through smart economic development strategies that are geared to leveraging private capital. There are many gaps in the clean energy value chain that must be filled before we will begin to see large-scale deployments.

Countries must look to and support that entire value chain of players in the clean energy space—to strengthen the roles of universities, manufacturers, supply chains, financing entities, developers, installers, local governments, and customers in clean energy market development.

In summary, nations that embark on an integrated strategy leading to a new infrastructure system will need to have demonstrated government commitment that goes beyond creating market signals and setting national goals. Building infrastructure and engaging the level of finance needed to do so will require a new set of tools, which are proposed in following section of this report.

How to Scale Up Renewables: A Solution Found in a Set of Strategies

This section recommends four interrelated strategies to address the clean energy challenge from an economy-wide, infrastructure approach. In combination, these are designed to induce a new set of large institutional investors to invest into the clean energy space to achieve the necessary scale of investment for a clean energy infrastructure transition.

The four interrelated strategies needed to create the conditions to get this finance flowing are:

- **Economic development policies** that link and coordinate the many stakeholders throughout the clean energy development chain and that help to incentivize and build the case for the clean energy technology transition.
- **Financial mechanisms** that make it possible for a diverse range of private investors to get involved in clean energy investments, mainly through public interventions that reduce risks and new institutions and mechanisms that pair public and private investments.
- **Innovation strategies** that drive cost reductions and performance improvements in new technologies and crucial enabling technologies.
- **Enabling Energy policies** that support favorable environments to make it possible for investors to rely on stable, long-term policy signals and that mandate clean energy investments in infrastructure and new technologies.

Each strategy is complementary to the other. Each standing alone is insufficient. Each depends on a new way of framing the clean energy challenge as an economic and infrastructure transition challenge.

Over the past few decades, governments have developed a number of successful support mechanisms and finance instruments to stimulate markets and reduce the risks of investment in existing clean energy technologies. Countries will need to rely on a combination of continuing support for and scaling existing mechanisms, and new approaches in clean energy. Each section provides an overview of the different mechanisms that have been used so far with traditional sources of public and private investment- as well as new programs that should be enacted.

ECONOMIC DEVELOPMENT

The good news is that some countries have already made clean energy an element of national economic competitiveness. With the economic rise of the Asian economies, there is an increasing emphasis on clean energy support as a new form of “national industrial policy.” China and Korea’s recent massive investments in technologies like wind, solar, fuel cells and in related enterprises are only the latest examples of what governments can do along every segment of the technology value chain—from research to technology innovation, to manufacturing, to deployment and export markets. Similarly, in the United Kingdom, Ireland, Norway and Portugal

Governments that do not consider economic development and clean energy as an integrated strategy, but view economic development simply as a consequential benefit, may fall behind other nations.

programs have been underway to grow the offshore wind and marine industries, with a concentrated focus on industry support.

Some of these governments are already strategically aligning their resources with a possible intention of taking a global leadership role in clean energy economic development. Such approaches are an extension of the national interests. But also, when combined with finance for export assistance, their national efforts could directly drive down the cost of technologies, not only for their home markets, but they could reduce the price of technologies for global markets. This is a good thing for the global commons, which depend on bringing down the price of clean energy so that it is competitive with fossil fuel technologies. The use of economic development strategies, then, is another way to achieve this important goal.

Of course, there are cautions that are raised with this approach. Trade rules, state support restrictions and related state aid rules must be respected in this effort. The challenge is to create smart and durable economic development strategies that do not run afoul of existing limitations. But simply not to adopt such efforts due to the difficulty of satisfying these rules might consign many countries to a loser's position in the race to benefit from clean energy economic benefits in the future.

Positioning clean energy under a national economic development umbrella could have positive implications for how clean energy is financed and how public policy is shaped.

At present, countries are adding clean energy to the "must do" infrastructure portfolio. That is an historic shift in the way we have seen clean energy, which in the past arguably has largely been relegated to a secondary environmental strategy focusing only on ways to finance individual projects.

All national programs will not be identical, but will be tailored to the specific circumstances and renewable energy resources of each country. But, in the end, if countries do not look at clean energy as a form of industrial policy or an economic competitiveness strategy, they might well fall short of reaching the potential to scale up technologies to achieve economic benefit from them, while collectively failing to reduce emissions of greenhouse gases as well.

As indicated, many countries have various support mechanisms to finance individual projects. But they realize that this is not enough to build a clean energy economy, grow jobs and expand markets for these technologies.

So to build upon their investments in financing these individual projects, many governments are putting in place broader economic development policies for clean energy. These policies include:

- Identifying supply chains for renewable energy technologies.
- Making equity investments in solar and wind companies.
- Developing industry clusters in areas such as modern energy storage companies.
- Supporting business incubators in many towns and cities.
- Funding emerging technology innovation efforts.
- Providing working capital for expanding growth companies.

- Developing workforce training programs.
- Promoting trade and export programs.[28]

The understanding of the term "Economic Development" is starting to change from the traditional definition involving a zero sum game of attracting and retaining business to one of an integrated approach that grows the clean energy pie.

In summary, these governments have continued to build upon their traditional model of individual project financing. But they now have a new model that incorporates a broader economic development and community development focus on innovation, industry development, finance, workforce training, and exports, relying in part on regional clusters of mutually supportive businesses and research institutions. These are the new bottom-up strategies to build regional clean energy economies that many governments are now pursuing.

National Examples of Clean Energy Economic Development Strategies

There are many economic development strategies in clean energy employed by national governments. They offer important lessons for what countries could to do expand their clean energy policies into a more directed, "industry creation" exercise.

China

According to most accounts, China's economic development strategy to capture the benefits of clean energy is truly "breathtaking."[29] They have pursued a broad-based economic strategy with many integrated elements. However, much of this strategy is targeted not to domestic demand, but to export of products, a key distinction in their economic development plan.[30] And much of what they are doing is controversial among OECD countries. Their programs include:

- **Market creation.** "Stable, long-term policies for promoting clean energy demand are key to spurring investment in technology innovation, manufacturing, and deployment activities in China. … Local officials are also increasingly being held accountable by basing their promotion prospects at least partially on the fulfillment of these targets."[31]
- **Infrastructure building.** "China's infrastructure investments are impressive, tangible, and breathtaking, and they're driven by rapid economic growth and urbanization. Large-scale deployment of intercity high-speed passenger rail, intra-city subway systems, and high-voltage grid transmission wires" are key investments. …China has national high-tech development zones[54] (technology innovation and manufacturing clusters), many of which focus on energy technologies, on top of dozens of provincial- and university-level clusters. These high-tech clusters create an industrial ecology that optimizes productivity by co-locating different links of the supply chain (including R&D) and factors of production (supply of different components and a skilled work force). Regional governments administer the clusters and provide generous financial incentives such as grants, tax breaks, and discounted land to attract industry."[32]

Some countries provide specific examples that could be considered for replication.

- **Building Human Capital**. "The government…supports these incumbent worker training programs, and it sometimes provides up to a year of public financial support for businesses to send workers as far away as Germany and the United States to acquire technical skills in the wind and solar industries."

- **Joint Research and Development**. "High-profile multinational companies including Applied Materials (capital equipment for solar manufacturing), Novazymes (biofuels), and IBM (high-speed rail software control systems) are already opening major R&D centers in China... (they have)… proximity to a stable market and customers (Chinese solar manufacturers), and the availability of skilled human capital were key factors in their decisions to locate R&D activities in China." It has also recently created 16 research centers into various clean energy areas.[33]
- **Developing a National Plan**. According to reports, as early as the 1980s, China identified clean energy technologies as part of its long-term "State High Tech Development Plan" (known as the "863 Program") that was intended to encourage indigenous capacity and investment for new technology innovations. To date, China has led the world in total investments in renewable and energy efficiency for a total of about USD 34.6 billion, with much going to asset finance. It does plan to spend anywhere from USD 400 to USD 600 billion in the power sector in the next ten years.[34] In addition to finance, China has policies for required procurement by government entities of these projects. It also allows research and development expenses to be deducted from taxable income; has state owned banks provide discounted interest rate loans; supports companies that buy indigenous products; and matches venture capital investment with public funds.

Recommendation: China's economic development programs could be replicated in other countries but care should be taken to execute in ways that do not run afoul of international trade practices.

- **Increasing Manufacturing Efficiencies**. Much of China's approach to create exports has been based on licensing foreign technologies, and then creating more efficient manufacturing processes to produce those technologies more cheaply for export abroad. Much of public investment goes to support more modern manufacturing facilities.[35]
- **Trade Barriers**. Of course, the downside of China's approach is that it is liberally based on the imposition of trade barriers to international trade and investment in low-carbon technology, along with extracting concessions from foreign companies and creating national standards that favor local products.[36]

South Korea

On August 15, 2008, the 60th anniversary of the founding of the Republic of Korea, President Lee Myung-bak announced a new national policy vision of "Low Carbon, Green Growth." This "Green New Deal" was designed to redirect about 2 percent of the country's GDP toward low-carbon initiatives. Most of the investment focus will be on infrastructure projects.[37]

South Korea recently announced it will invest USD 46 billion over "five years in clean technology sectors"—over one percent of the nation's gross domestic product (GDP)—with the explicit goal of increasing Korea share of the global clean tech export market by eight percentage points. This "Green New Deal" investment program will focus in particular on solar, LED lighting, nuclear, and hybrid car technologies.[38]

The key economic development elements of the program include the following:

- The plan encourages business enterprises specializing in overseas resources development to explore cooperative green-growth endeavors abroad.
- South Korea's major strategic industries such as automotive, chemicals, semiconductors and steel, will be encouraged to increase green-tech R&D and capital investment with the objective of raising green goods export by such industries from 10 percent in 2009 to 15 percent by 2013 and 22 percent in 2020.
- Recently, the government announced steps to convert existing industries into low-carbon industries, aimed at turning key industries, including automobiles, iron and steel, and semiconductors, into low-carbon-oriented champions. On Dec. 2, 2010, the Ministry of Knowledge Economy disclosed these "industrial development strategies for green growth" to achieve the national vision of low carbon and green growth.[39] The strategies consist of three parts: "green innovation," "green restructuring," and "green value chain." See Annex III, but in essence South Korea views emissions mitigation as a business model that would require the country to re-think fundamental economic structures such as taxation, transportation, and energy infrastructure in order to capture the economic growth opportunity presented by renewable energy technology development.[40]

Korea is also building local markets for its clean energy products. Sixty percent of individually-owned houses will have solar panels by 2012, according to the ministry.[41] This translates to a total of 100,000 houses to be powered by solar energy by next year, which is a significant increase from the 14,500 houses with panels in 2007, according to the Ministry of Knowledge Economy. Also, all government-planned housing facilities will be equipped with solar power panels.

Both China and Korea's Green Growth Strategies were cited by the OECD in its own Green Growth reports as desirable models to follow.[42]

Denmark

In the 1970s, Denmark had coal-fired electrical power plants and relatively high carbon dioxide emissions per capita. Following the energy crisis, Denmark sought renewable clean energy as a way of decreasing both its dependence on other countries for energy and its global warming pollution. Further, two years after the Chernobyl disaster, Denmark passed a law forbidding the construction of nuclear power plants and the national planning of wind power was deliberately streamlined by authorities in order to minimize hurdles. The Danish system was successfully developed incorporating public fund support of 30 percent towards the initial capital cost in the early years, which was gradually reduced to zero. This coincided with a feed-in tariff which remains in place today. The result of this initiative, beyond the high percentage of wind-generated electricity used by the Danes, is that the country produces almost half of the wind turbines used around the world by Danish manufacturers such as Vestas and Siemens Wind Power along, with many associated component suppliers.

Recommendation: Consider strategically and deliberate use of existing local markets to stimulate and accelerate growth for a country's clean energy products.

United States

For the last decade, clean energy projects like wind, solar, and biomass have proliferated across the United States. While the federal government tax and incentive policies have played a key role, a little known but critical reason for the growth of the clean energy industry has been state clean energy funds. These clean energy funds, which have dedicated state funding now in over twenty states, are strategic public investors in thousands of these projects.

State (sub-national) public clean energy funds are in the perfect position to institute a new set of economic development strategies to create a clean energy economy.

In the early years and still in many states today, clean energy funds have been focused primarily on individual project financing and deployment. But public state fund roles are changing with the growth of the clean energy industry. Beyond investing in projects, some of these state funds are also taking on economic development activities within their states.[43]

Along with project investment activity, some state funds now are focusing efforts on economic development activities to grow the industries that those renewable energy projects have spawned. These state-level activities include identifying supply chains renewable energy technologies and applications such as offshore wind, making equity investments in solar and wind companies, and developing industry clusters in areas such as modern energy storage companies. A few state funds also have been active in business incubation—providing working capital for expanding growth companies, public venture capital, and workforce training.

The US state governments have been the leading public investors in clean energy projects on the ground in the U.S. And as highlighted earlier, some states such as California with its AB 1011 have started integrating ways to leverage public funding from other sources.

Recommendation: Create sub-national, special-purpose funds to support renew-able energy and energy efficiency investments; these funds could be financed through a modest surcharge on utility bills, although they may have a more specific source of funding (for example, a negotiated settlement with a utility).

FINANCE

How can governments engineer finance investment instruments to attract the funding levels needed for a clean energy infrastructure?

Treating clean energy as infrastructure investment is relatively new and untested. But it seems to be a very promising way to create the necessary institutions, reduce investor risk, and raise sufficient capital so that clean energy can someday be treated as a safe, reliable investment at large scale.

To date, the trend has been for investors to assess the opportunity to invest in individual renewable energy projects of different technologies, often with unique circumstances, yet supported by either broad national or regional government incentives. The financing of these early renewable energy projects has often involved complex project finance arrangements to dilute the multiple risks with large-deal structural and transaction costs, which take time to arrange. This has resulted in an incremental approach to investment, based on opportunity, knowledge (or lack of), and investor assessment of risk for the different deployments. The magnitude of the funds required to build the new clean energy economy requires a step-change in investment level. New and innovative mechanisms must be found to reduce the risk concerns of the investor community while simultaneously paving the way to attract new sources of finance.

Financing Mechanisms

There are many mechanisms to attract private capital for financing large scale deployments of clean energy, including the following:

Bonds

Bonds are a mechanism to borrow against future economic benefits. This is particularly relevant for the clean energy deployments in which the assets have high upfront costs. Bonds are a way to create the investment needed now to deliver the benefits over the long-term in the future. Green bonds or climate bonds are tied to specific climate change mitigation or adaptation investments and allow governments to raise capital, or support the private sector in raising capital to:

- Build renewable energy generation and its enabling infrastructure, and
- Support clean energy economic development opportunities

However, as Green and Climate Bonds are relatively novel and are aimed to finance an emerging energy sector and its associated infrastructure, "government contingency guarantees, or political risk insurance will be essential."[44]

Issuance of Green Bonds is not completely new; it originated from the municipalities that wanted to raise funds through fixed interest bonds to convert Brownfield sites for use with energy efficient buildings.

Recommendation: Explore the creation of new financing solutions such as "green bonds" to provide long-term, widespread capital for green infrastructure projects.

More ambitious levels of funds have been raised through issuance of Green Bonds by institutions such as the World Bank, which in 2008 launched its "Strategic Framework for Development and Climate Change" to help stimulate and coordinate public and private sector activity in this area. The World Bank Green Bond is an example of the kind of finance innovation the World Bank is trying to encourage within this framework. The World Bank Green Bond raises funds from fixed income investors to support World Bank lending for eligible projects that seek to mitigate climate change or help affected people adapt to it. The product was designed in partnership with Skandinaviska Enskilda Banken (SEB) to respond to specific investor demand for a triple-A rated fixed income product that supports projects that address the climate challenge. Since 2008, the World Bank has issued over USD 2 billion in Green Bonds.[45]

In the U.S. tax credit bonds have been used to finance many public goods. Most recently clean energy projects. New Clean Renewable Energy Bonds (New CREBS) are a modification of an original Federal allocation. The American Recovery and Reinvestment Tax Act of 2009 increased this allocation to a total of USD 2.4 billion, which helped raise significant capital for renewable energy projects.

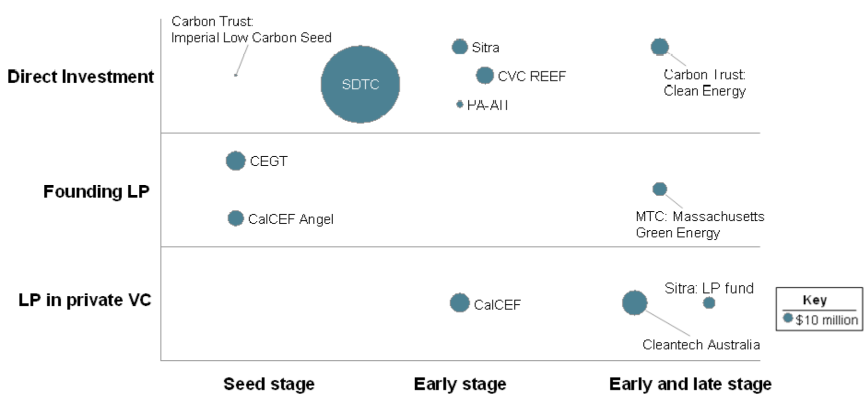
Early Stage Equity Support and Venture Capital
Given that business "start-ups" and new technologies are important components in any nation's economic development strategy, it is important to consider the factors for financing this important sector of the clean energy continuum.

Venture capital has been the source of financing for most important new technology firms and industries over the past few decades, particularly in the U.S. So many national and state governments have been expecting venture capitalists to play a similar role in the clean energy sector. Unfortunately, as a number of experts have recently warned, the characteristics of the clean energy industry may not be well suited to private venture capital. Venture capitalist investments tend to be smaller-scale, in non-capital intensive industries that have the promise of big wins, in short timeframes. Because these characteristics do not match the clean energy sectors, a recent paper from the University of California Berkeley concludes that, "Venture capital model for funding clean technology innovation is unlikely to be successful and the imposition of venture capital goals on clean technology firms may even be harmful to their survival."[46]

Recommendation: Governments seeking expansion of new clean energy technologies are most likely needed to provide financial support to fill the Venture Capital void for the seed, early and late stages of new venture investment.

A study of the venture capital investments in clean technologies reveals a trend from the first funds focused on early and late stages of venture capital to more recent funds focused on seed and early stage of venture capital. This is summarized in the diagram below: [47]

FIGURE 1
MAP OF PUBLIC CLEAN ENERGY VENTURE CAPITAL FUNDS BY TARGET INVESTMENT STAGE 2000-2008



Source: UNEP SEF Alliance Public Venture Capital Study (New Energy Finance) 2008

Governments remain essential to provide some matching support to fill gaps for the support in the seed, early and late stages of investments.

Case Study: European High Growth and Innovative SME Facility

The European High Growth and Innovative SME Facility (GIF)- part of the European Investment Fund (EIF)- on behalf of the European Commission, invests in venture capital funds which focus on small high-growth firms. A condition for an investment is that all investment decisions are made on the basis of commercial market principles. The EIF stake in such funds enables them to invest more in early-stage SMEs and to attract additional investors more easily. Funds which specialize in eco-innovation will have the possibility of proportionately higher EU participation.

The GIF builds on the achievements of previous EU schemes, through which some € 309 million were invested in 39 funds in the last decade, leading to investments in a total of 357 small firms. The catalytic effect of these schemes is substantial, as the EU investment amounted to just 17 percent of their combined total capital.[1]

The High Growth and Innovative SME Facility covers both "seed and early-stage" (GIF1) and "expansion stage" (GIF2) financing. Overall, it covers much of the life cycle of small, dynamic firms, and is also able to work with business angels, supporting their investments.

Loan Guarantees

A number of countries are engaged in offering loan guarantees targeted at a number of areas along the clean energy development chain from manufacturing plants to growth stage businesses.

Loan guarantees (i.e., agreeing to repay the borrower's debt obligation in the event of a default) remain an important finance tool.

The Asian Development Bank (ADB) is set to offer up to USD 150 million as a loan guarantee program for solar installations in India. The guarantees will be available to local and foreign commercial banks that finance private sector solar power plants in the country and will cover 50% of the payment default risk on bank loans made to project developers. The guarantees will help mobilize long-term funding for solar energy development and support the Government of India's push to diversify its energy mix away from a heavy reliance on fossil fuels to lower-carbon, renewable sources.[48]

Another example loan guarantees is the Financial Institution Partnership Program (FIPP), which is a robust, risk-sharing partnership between the US Department of Energy (DOE) and qualified finance organizations such as banks for loan guarantees for certain renewable energy generation projects. The open solicitation is designed to expedite the loan guarantee process and expand senior credit capacity for renewable energy generation projects that use commercial technologies.

Loan guarantees have been one of the dominant support mechanisms in the US to facilitate the private sector investment in the larger scale deployments. To date, the agency has guaranteed over $30 billion in loans, claiming that these loans have saved or created over 61,000 jobs.[49]

Export Credit Assistance

Export Credit Assistance provides financial assistance through export credit assistance by providing differential financial support (low-interest loans or ‘export assistance’) to locally-owned manufacturers can support the expansion of domestic renewable energy industries to operate in overseas markets.

Export credit assistance has been used by many countries, but most extensively by Germany, which encourages the dissemination of German technology, particularly in the developing world.

Investment Banks

Many of the finance mechanisms described above are managed by existing energy or finance institutions. There is some evidence to show that existing institutions, such as ministries of energy are not equipped to make the most effective investment decisions in the clean energy space. They often lack the financial expertise and experience necessary to navigate these complicated deals and mechanisms. For these reasons, governments are creating new institutions to manage investments in renewable and other clean energy technologies.

The proposed UK Green Investment Bank, which will leverage public funds, offer technical expertise, and run on a private-sector basis, offers promising solutions.

The Proposed UK Green Investment Bank

The UK Government appears to have a promising solution with its proposed Green Investment Bank (GIB).

The GIB is expected to be the first national Green Infrastructure Bank. The GIB is an example where the UK government has elected to create a new entity and to charge it with the responsibility of delivering outcomes that enable the nation to meet its national renewable energy target to derive 15 percent of all energy from renewable sources by 2020. The organization will have a focus on specific ”financial solutions” that are directly targeted at the existing financing risks that now impede large scale deployment of renewable energy as a way of making it happen.

The GIB is expected to launch in the form of an “incubator” to start investments as soon as 2012. This will show a demonstrated commitment with early action, while it waits to receive European Commission approval to raise wholesale or retail debt funding.

An early launch of GIB as an “incubator” will add investor confidence.

The UK's government is planning to fund the GIB with approximately £3 billion (USD 4.87 billion) in capital, which is a substantial increase from earlier indications of initial funding of £1 billion. The plan is for the GIB to quickly grow into an independent investing and borrowing institution. The GIB’s borrowing is likely to extend beyond Treasury into the capital markets. The UK government has suggested that the increased capital, much of which would be in the form of guarantees rather than subscribed equity and built up over a period of time, should enable the GIB to then raise debt capital through issuing green bonds, which might allow the GIB to attract and leverage another £15 billion in private sector funding.

The GIB intends to target its investments to different risk profiles associated with different risk categories for renewable energy projects. The investment categories include both the:

- Construction phase, which involves the following risk types: location, development contracts, start-up delay, permitting and compliance, power off-taker contracts, and environ-mental liabilities, and
- Operational phases with the following different risk types: technology performance, machinery breakdown, business interruption, and project inspection.

The GIB expects to directly address ”risk mitigation,” in both the construction phase and the operational phase, by taking a first-loss debt position, or via guarantees or insurance-like products. The risk mitigation will be enhanced when combined with an innovative financial tool in the form of an "upfront refinancing commitment," which guarantees an exit for long-term bank finance.[50] In particular, a suite of financial solutions under consideration by GIB could well be a toolkit that any national government could employ to reduce investor risk and raise additional private capital for clean energy:

GIB is expected to take a "first loss" position as a practical step in addressing risk mitigation.

- It is considering how to institutionalize a finance buffer in the form of a "capital provision" of equity and senior debt thus making a type of ”top-up” instrument to ensure finance packages are competed. This will limit any stalling through temporary lack of finance.
- It might use the capital provision to help stabilize funding fluctuations, if technology allows for trajectory advancement causing demand to out-pace capital supply.
- In addition to acting as a 'buffer' when equity investment is in short supply, the GIB is proposing a proactive approach of co-investment on a "pari passu" basis. The resulting effect will assist larger-scale projects, with either increased assets and associated reduced costs from gained economies of scale, or multiple projects beyond the limitations of the sponsoring investor. This "pari passu" basis for equity investment directly contributes to the acceleration and scale-up of the deployments.
- The co-investment mechanism has additional power when it is combined with the GIB's planned "pre-agreed" secondary market, which allows equity investors a clear exit path from the construction phase. Completed projects financed either on balance sheet or by co-investment have the potential to receive investment funds for additional future deployments. This proposed built-in exit to senior debt investments will reduce effective maturity of loans and allow more investment flows onto new renewable energy assets.

The GIB could provide model solutions for other nations to emulate.

- The subordinated debts for the operational phase of project deployments have different risks than for the construction phase. The operational phase subordinated debt is more likely to align with institutional investors which might attract the emerging clean energy investments of the pensions.

While the GIB remains a concept at this time, it could bring many of needed answers for financing the scale up of renewable energy deployments and provide model solutions for other countries to emulate.

Interestingly, one of the proposed mechanisms to attract early private finance to leverage the GIB's initial public debt investment is for the GIB to raise funds through green bonds.

Some of the proposed principles to be used by the GIB are to some degree already in existence in other investment banks.

European Investment Bank
The European Investment Bank (EIB), with its commitment that 20 percent of its financing portfolio is dedicated to renewable energy projects, with financing up to 50 percent of investment costs, provides significant risk mitigation in a manner similar to that proposed by GIB. The EIB has played an important role in financing European renewable energy deployments to date. In 2009, EIB's loans to the renewable energy sector reached in excess of USD 5.6 billion (€ 4 billon), which, by 2011, increased beyond USD 9.4 billion (€ 6 billion). So why can't the EIB simply scale up its risk-mitigation role? For the EIB to do so, there is an argument for it to increase the 20 percent rate and to apply the funds solely for large-scale renewable deployments. This may result in an increase of larger-scale deployments in the short term, but it will most likely become rapidly exhausted, signaling a stalled, or at a minimum, a constrained market.

German KfW
The German KfW, is another example of a leading institution that offers long-term credit lines to partner lending institutions, at market conditions, to finance investments in energy efficiency and renewable energy. KfW acts on behalf of the German Government and the European Commission, in drawing on public funds and raising funds on the capital market. The technical assistance provided by KfW in some ways mirrors an internal expertise that GIB is planning to emulate. However, unlike the planned GIB, KfW responds to individual investment requests that are made in conjunction with a partner lending institution, the latter taking ultimate full responsibility and credit risk.

United States
Already, even before its formal launch, the UK Green Investment Bank concept is starting to be replicated. In May of this year, the US State of Connecticut launched its Clean Energy Finance and Investment Authority (CEFIA), which will be the USA's first full-scale Green Bank at the sub-national level. The Department of Environmental Protection (DEP) and the Department of Public Utility Control (DPUC) will be merged into the newly created Department of Energy and Environmental Protection (DEEP).

The Connecticut Clean Energy Fund is supported by a USD 0.1 cent per kilowatt-hour charge on electric bills. The bill allows CEFIA to: (1) finance energy efficiency projects; (2) support projects that seek to use electric,

Recommendation: Institutionalize (possibly under a new structure such as an investment bank) the functions to promote, integrate, coordinate, or manage the economic development, finance mechanisms, and technology innovation required for massive clean energy technology deployment.

hybrid, or alternative fuel vehicles, associated infrastructure and related storage; and (3) provide low-cost financing for clean energy technologies. CEFIA may finance up to 80 percent of the cost of clean energy projects and 100 percent of the cost of energy-efficiency projects.[51]

INNOVATION

Along with economic development policy and financial support interventions, innovations in technology cost and performance will be crucial for achieving large scale deployment of clean energy.

Case Study: Views on Climate and Clean Energy technology innovation

Professor Scott Barrett of Columbia University described the need for breakthroughs in climate technology this way:

> Emissions of CO_2 and other greenhouse gases can be reduced significantly using existing technologies, but stabilizing concentrations will require a technological revolution – a "revolution" because it will require fundamental change, achieved within a relatively short period of time. (Barrett, S. "The Coming Global Climate-Technology Revolution." *Journal of Economic Perspectives 23* (2009): 53-75.)

U.S. Secretary of Energy, Steven Chu countered a common myth that all we need to do is scale up existing technologies:

> Another myth is [that] we have all the technologies we need to solve the energy challenge. It's only a matter of political will.... I think political will is absolutely necessary...but we need new technologies to transform the energy landscape.
>
> (Chu, S. "Panel 4: The Visible Hand: Government's Role in the Clean Energy Transformation; Opportunities to Accelerate Deployment of Energy." *National Clean Energy Summit*. August 18, 2009. Web. 3 Dec. 2009. www.cleanenergysummit.org/video/video.html.)

While many technically feasible clean energy technologies are available, most are not commercially competitive without government subsidies. Breakthroughs in the cost, performance, and scalability of clean energy technologies are necessary. The reason is simple—existing technologies at current costs and performance cannot meet the demand for carbon-neutral energy.

The only way to address this part of the challenge is with effective, new innovation policies. Innovation doesn't usually happen by itself—or through pricing alone- despite what neoclassical economists might like to believe.[52] The empirical evidence on technology innovation in many different sectors, from jet engines, to the internet, to semi-conductors, show time and again that direct government innovation policy is crucial to achieving real technological breakthroughs.[53]

There are many ways theories and strategies governments and companies can use to craft policies and programs to accelerate clean energy innovation on a national and international level.

Recommendation: Governments and private companies should use "open and distributed" innovation to tap the dispersed, global talent, and collaborate across institutions because of the evolution of Internet tools and "open innovation" companies that link seekers and solvers on particular product development challenges to supplement in-house research and accelerate the technology development cycle.

Systems Innovation

Innovation does not refer to just early-stage technological breakthroughs in a laboratory. Indeed business theory shows that innovation can encompass the re-packaging or combining of existing technologies, the development of new uses or business models for products, processes or services.

Technology innovation in this context means creating commercial products that can compete in the marketplace. According to a leading innovation expert, "an innovation in the economic sense is accomplished only with the first commercial transaction."[54]

A key way to rapidly bring down the costs and scale up clean energy technologies will be to increase innovation all along the technology development value chain—from lab to product development, and to business and finance models. Innovation is needed at all of these stages to increase performance and decrease costs of technologies.

Recommendation: Use "systems innovation" to increase innovation all along the technology development value chain: from lab to product development, to business and finance models. Innovation is needed at all of these stages to increase performance and decrease costs of technologies.

What this means for governments and private companies is that they must look for more linkages, coordination and collaboration with the many players from scientists and engineers to utilities and regulators.

Open and distributed Innovation

To accelerate commercialization of their products and increase return on their research investments, forward thinking companies today look outside their walls to capture expertise in other companies, institutions, sectors and countries. They recognize Bill Joy's (founder of Sun Microsystems) Law that "the smartest people work for someone else."[55] Companies are able to tap this dispersed, global talent and collaborate across institutions because of the evolution of Internet tools and "open innovation" companies that link seekers and solvers on particular product development challenges—to supplement in-house research and accelerate the technology development cycle.

Increased innovation is needed from the lab to product development as well as in business and finance models.

Corporate examples of open innovation are now widespread and proven. Companies as diverse as IBM, Proctor and Gamble, Boeing, and Eli Lilly, have placed open innovation at the center of their innovation strategies.

The business literature has defined open and distributed innovation as the leading corporate trend in the last twenty years. [56]

Disruptive Innovation and Niche Markets[57]

The theory of "disruptive innovation" was popularized by Harvard Business School Professor Clayton Christensen in his book "*The Innovator's Dilemma*" in the mid-1990s. Under his theory, innovative technologies rarely find success by entering directly into mainstream markets or by competing on price or performance. Early success usually occurs in niche markets where the fundamental characteristics of the application are "suited to the merits" of the technology. At some point, the products move up the value chain adding more performance and other characteristics through scale and learning and often reducing cost. Niche does not mean small, but refers to suitable. Technologies then often develop from the fringes to overtake the conventional technology.[58] The theory is used to explain the evolution of technologies as diverse as transistor radios, motor scooters, disk drives and steel manufacturing.

Recommendation: Use "disruptive innovation" mechanisms to ensure that innovative technologies find success in early "niche markets," where the fundamental characteristics of the application are "suited to the merits" of the technology; focus on "non-consumers" who are looking for attributes that the current power system does not provide (such as high reliability or power quality).

In a recent paper, Christensen and co-authors apply the theory of disruptive innovation to clean energy. They argue that the first major customers for this form of new energy will be "*nonconsumers*"—customers in the developing world not now served by the grid. Christensen writes:

> *In these countries, there is so much non-consumption that green technologies need only be better than the alternative: nothing. Just as Sony's transistor radio gained acceptance among non-consumers, green technologies such as solar lighting will find enthusiastic receptions in the unconnected villages of the developing world.*[59]

Technologies with niche applications can become mainstream.

Christensen and co-authors reach this conclusion after noting that new energy technologies will have a difficult time competing against commodity (fossil fuel) grid power for several reasons: technical intractability; system complexity; and difficult head to head competition, i.e., the incumbent infrastructure.

Reverse innovation

One of the most compelling and surprising new innovation trends is called "reverse innovation"—designing, creating, and manufacturing a product in a developing country that is later adapted and exported to developed countries. Jeffrey Immelt, the CEO of General Electric, and his co-authors coined the term "reverse innovation" in an article that describes two new GE medical devices—a USD 1,000 handheld electrocardiogram device and a USD 15,000 portable ultrasound machine—that were originally developed for markets in rural India and China. These

Recommendation: Look to "reverse innovation" strategies and partnerships—designing, creating, and manufacturing clean energy products in developing countries to make them less expensive and then later adapt and export them to OECD countries.

radically cheap devices are now being sold in the US and Europe.

The Economist highlighted this reverse innovation trend—sometimes called "frugal innovation"—

> *The emerging world will undoubtedly make a growing contribution to breakthrough technology innovations... People who used to think of the emerging world as a source of cheap labor must now recognize that it can be a source of disruptive innovation as well.* [60]

The innovation trends for the future suggest developing countries are becoming hotbeds of business innovation in much the same way as Japan did from the 1950s onwards. They are coming up with new products and services that are dramatically cheaper than their Western equivalents: USD 3,000 cars, USD 300 computers and USD 30 mobile phones that provide nationwide service for just 2 cents a minute. They are reinventing systems of production and distribution, and they are experimenting with entirely new business models. All the elements of modern business, from supply-chain management to recruitment and retention, are being re-jigged or reinvented in one emerging market or another.

Reverse innovation with low cost clean energy technologies are likely to find markets where political will seeks to overcome powerful incumbent infrastructure.

It seems inevitable that reverse innovation will be applied to low cost clean energy technologies. The emergence of China as a preeminent manufacturer and exporter of low carbon technologies seems just the beginning of this emerging reverse innovation trend throughout the developing world.[61] This could be good news for the OECD countries, which need access to cheap clean energy technologies to meet ambitious political goals. Also, OECD countries can still reap significant economic benefits in the integration, sale and installation of these technologies in their home markets.

New technologies in the OECD are up against powerful incumbent industries, and economic pressures are limiting the political will to pay for more expensive clean technologies. Many developing countries don't have this industrial/infrastructure legacy. Thus in meeting the needs of the two billion energy poor, non-consumers in the developing world, technology and business model innovations may well also address the clean energy challenges of the OECD.

Open Innovation Tools and Distributed Networks

Open and distributed innovation approaches and tools can be used by both governments and energy companies, with the resulting benefits used to reduce the costs of clean energy technology development and accelerate product development.[62]

Prizes may help foster innovation.

Distributed innovation networks could be established by governments in partnership with industry that would link players all along the development chain to accelerate lab to market development of new technologies. This would mean linking researchers and engineers to utilities and regulators early in the technology development process. These networks should have concrete market goals and milestones for particular energy product development—not just open-ended knowledge sharing. Incentive structures for participation and intellectual property management need to be clearly defined. These networks could use open innovation tools such as prize competitions.

Other Innovation Opportunities
Other innovation initiatives that governments and companies should pursue include:

- Specialized niche markets that can be used to pilot and begin to develop and commercialize new technologies. For example in backup power, fuel cells can provide distributed generation electricity source and emergency backup power. The technology is cost effective when the system's heat is used for cooling and grid interruption risk is included in calculations—in supermarkets and data centers, for example, which have high cooling loads and need to operate 24/7.

- Other opportunities exist in partnering with and supporting energy innovation in developing countries where technologies have less competition and may be able to come down the learning and cost curve before competing in OECD markets.[63]

Examples of Innovation Policies to Spur Large-Scale Clean Energy Finance

There are many concrete policies and programs that governments and companies can undertake based on the lessons from these successful innovation trends. However, many governments are beginning to experiment with promising new policies—some examples include the following:

Public sector co-funding with private industry is a way of leveraging the capital needed to make clean energy project financing available during this era of economic austerity.

Public-Private Partnerships for Research and Development
Funding clean energy research and development to achieve cost reductions is expensive and many OECD governments are struggling with competing budgetary needs and large deficits. In many cases they are unable politically to provide the scale of funding needed for real commercialization breakthroughs. One opportunity is to work in partnership with private industry to co-fund research that promotes the entire industry.

Europe
The Marie Curie EU FP7 is available to support collaborative research projects carried out by consortia with participants from different countries, aiming at developing new knowledge, new technology, products, demonstration activities or common resources for research. It also provides financial assistance for networks of excellence where a joint program of activities implemented by a number of research organizations that integrate their activities, carried out by research teams in the framework of longer term cooperation. Support for coordinating activities aimed at shared research activities and policies such as networking, exchanges, trans-national access to research infrastructures, studies, conferences.

There is also support available for multi-financed large-scale initiatives that involve national or joint technology initiatives requiring a combination of funding of different kinds and from different sources: private and public, European and national.[64]

UK Carbon Trust Wind Accelerator

The U.K. Carbon Trust has developed a consortium to support smaller scale, for offshore wind research and development—the Offshore Wind Accelerator (OWA). The goal of the program is to reduce the cost of offshore wind energy by 10 percent by 2020. The Accelerator hopes to achieve this goal by targeting four key areas that are most promising and critical for achieving cost reductions: turbine foundations and installation techniques, access to and maintenance of distant turbines, optimal wind farm array layouts, and reduction in electricity transmission losses and costs.

The research is jointly funded by £25 million in public funds and £25 million in private funding from eight industrial partners, each provided £3.125 million.[65] The incentive for these companies to participate and fund the initiative is that they are the end users of wind energy technologies, the final project developers who are looking for cost reductions and improvements in access and maintenance, foundations, and transmission. As part of the funding consortium, the companies also have the added benefit of a right of first refusal on the sale of any IP resulting from the funded projects. Despite these benefits to industry, establishing the partnership took considerable effort on the part of Carbon Trust to convince the private companies of the benefits to the private partners in comparison to the costs.

The UK Carbon Trust has a public/private co-funded OWA program with shared benefits.

Two solicitations have been released to date for foundations and access-related projects. Researchers or companies who win the competitive bid receive funding of up to £100,000 per concept and potentially several million pounds of funding to take the concepts to full-scale demonstration as well as the opportunity to work with eight leading offshore wind developers with licenses to construct 30GW of offshore wind in UK waters (60 percent of the UK's licensed capacity).

The "Accelerator" model works well when the co-funders seek "industry solutions" rather than to capture intellectual property.

This public-private model works well in the offshore wind sector because the core industrial partners are not interesting in owning new technologies; instead they are the end users who want to see problems solved. Technology innovators are keen to come forward and engage since they know that their intellectual property is not exposed, and that the chances of getting to market are greatly improved by partnering with large project developers.

Governments can continue to support industry collaboration approaches and develop incentives modeled after these examples for particular clean energy products.

United States

One extremely successful example of this model is the U.S. Department of Defense initiated Semiconductor Manufacturing Alliance (SEMATECH). SEMATECH is a unique global collaboration of semiconductor manufacturers who work together in what is termed the "pre-competitive" research and development space, to overcome common manufacturing challenges and reduce costs. It is one of the most unique and successful examples of industry and government collaboration.

This industry consortium, a not-for-profit membership organization, was started initially to strengthen the US semiconductor industry in the mid-1980s, when the US perceived competitive threats from Japan. At that time, the US government engaged fourteen manufacturers to come together to solve common manufacturing problems and to collectively share risks associated with new industry processes. Funding for the research was shared by the private sector and the federal government. U.S. Department of Defense and industry each put in USD 100 million a year for over a decade.[66]

Recommendation: Develop more private and public research and development consortia such as the Carbon Trust's Offshore Wind Accelerator Program and the US SEMATECH to reduce the cost burden of energy R&D on governments and accelerate market applications.

While the industry was initially reluctant to work with their competitors, after 10 years they found that the model was so successful that they continued to fund the collaborative research even after public funding ceased. SEMATECH officials say the model "has stood up against soaring R&D costs, rampant consolidations and severe downturns to deliver to its member companies 540 percent annual return on investment, and USD 2 billion in value in the past five years alone." "The model really does apply very broadly," they have written. "The key is to identify the line between what is collaborative, and what has to remain competitive."[67]

Such a model could be used in the clean energy space among clean energy project developers or particular technology sectors.

ENABLING ENERGY POLICIES AND MANDATES

To reach climate recovery levels with deep penetration of clean energy by the year 2050, we will need both massive scale-up of existing technologies and major new technology breakthroughs.[68] The policies in the sections above in economic development, finance and innovation address the different gaps along the technology development chain. However, in addition to those areas described above, supporting energy policies and mandates will be necessary to create market demand for clean energy technologies and accelerate the siting and construction of new projects.

Policies to Scale Up Existing Technologies

For more than twenty years governments have experimented with various support mechanisms for clean energy. Many of these have been incredibly successful at creating early markets and achieving the levels of penetration we see today, particularly for terrestrial wind or silicon based solar panels. In most cases, these policies are designed to create long- term market demand to provide a secure environment for investors.

Policy makers should maintain and extend successful existing policies.

Some of the most successful national policies that have brought many existing technologies to their current level of deployment involve reducing initial higher costs using dependable and consistent price-based instruments (or tax incentives) paired with quantity-based instruments that mandate procurement. This combination of financial subsidy, such as Feed-in Tariffs, and mandatory procurement, such as renewable portfolio standards, has been the most powerful driver of renewable success in the last decade. These are likely to continue to be the most important drivers of scaling up existing technologies. If more countries continue using either or both of these policy regimes—either FITs or national tax credit schemes combined with a mandatory renewable energy procurement for utilities—the world would see much greater penetration of renewable power into the existing generation mixes of those countries.

Financial subsidies combined with mandatory procurement have been powerful drivers.

Feed-in Tariffs

The most common price-based instrument is the well-tested "feed-in tariff" (FIT) and the more recent "feed-in premium" (FIP). FITs are payments per kilowatt-hour for electricity generated by a renewable resource. The FIT price is based on the cost of the electricity produced, plus a reasonable profit for the producer. They are generally set for a long time period, for example in Germany for a twenty-year term, which in turn supports a long-term contract for a developer to install that technology. They are most commonly used in Europe where they are set at higher than fossil fuel prices in tranches by technology type. FIPs are subsidies paid to renewable energy produces on top of the market rate of electricity. They can be perceived as more risky because of market fluctuations. The advantages of FITs and FIPs are that they are simple to understand and have greater predictability than other mechanisms such as market-based renewable energy certificates.

More than forty-five countries have adopted FITs as their subsidy regime, making it the most popular renewable energy incentive program in the world.[69] The new government in the UK is adopting FITs, even under the Conservative Party, based on the inadequacies of the past RFP-type programs.[70] The Government of Ireland recently announced a FIT for Anaerobic Digestion CHP, biomass CHP, biomass co-firing and energy crop co-firing. This is added to the suite of FIT that already exist in Ireland including, onshore wind, offshore wind, ocean technology and landfill gas.

Fixed FITs provide certainty for investors. However, care must be taken to not erode investor confidence through too frequent FIT review and downward adjustments.

Many proponents claim FITs should be the preferred subsidy for any national government promoting clean energy.[71] German officials have confirmed that due to their FIT program, in 2007, the country had over 14 percent of its entire power mix generated by renewable power.[72]

Nevertheless, European governments that implement FITs, including Spain, Germany and Italy, are quite aggressively reducing the levels of support in the next few years. Still, many argue that FITs are the most effective instrument to bring greater levels of renewable energy on line quickly, with reduced risk of contract failure, which plagues many requests for proposal (RFP) schemes.[73]

Tender schemes

Another way for governments to encourage large-scale development of existing renewable energy is to run competitive auctions for projects of different technologies or resource tenders for prime sites (e.g., wind), accompanied by benefits such as long-term power purchase agreements. Tender schemes usually lead to cost-efficient support for renewable energy deployments as investors have to compete for support, but they run risk of having imperfect market knowledge.

Government tendering programs of this type have historically not provided long-term market stability or profitability. The UK's Non-Fossil Fuel Obligation, which provided periodic tenders for renewable energy generation during the 1990s, is the most commonly cited example of government-run bidding processes. Ultimately, policymakers found that these tenders were not sufficiently certain and the contracts not sufficiently profitable to draw much manufacturing interest to the country. Government-run competitive bidding for wind projects has been or is being used in Canada, India, Japan, some US states, and China. The programs in Canada and China have resulted in significant new wind capacity under contract. Brazil has embarked on the same approach (See box). Whether these countries experience similar problems to those experienced in the UK remains to be seen.[74]

Case Study: The Brazil Renewable Tender

The Brazil renewable tender scheme has recently received much attention. The country produces most of its 112 GW electricity from 83 GW of hydroelectric power. The current national energy development plan foresees a 13% average annual increase of new renewable energy projects by 2019. However, significant projects have been planned for other renewable energy technology types, especially wind and biomass.

The Brazilian government combined two different types of tender: one that counts towards the nation's energy matrix and the other, a "reserve" tender. In the first type of tender (A-3), the buyers are distributors. They are committed to developing the winning projects and completing their connection to the grid within three years. Meanwhile, "reserve" tenders are part of a plan launched in 2008 and managed by the Electric Energy Commercialisation Agency (CCEE), aiming at increasing the country's energy security with additional "reserve" energy added to the national interconnection system. The reserve was effectively a way to "carve out" the large hydroelectric facilities. Winning tenders will sign a 20-year purchase and sale of energy agreement valid from 2012.

The A-3 tender was originally for wind, biomass, and small hydro, but some early confusion arose as these technologies suddenly had to compete with allowed natural gas projects. The starting price in each category has been planned to be made public a few days before the auction. The auction is structured as price-descending, which means that any firm offering the lowest price per megawatt-hour will receive the concession for that project.

In May 31, 2011 Brazil's Empresa de Pesquisa Energética (EPE), the technical bureau related to Brazil's Ministry of Mines and Energy (MME), confirmed that a total of 582 projects were registered for participation at both the Renewable and the A-3 energy auctions. This tendering mechanism demonstrates the effectiveness of the Brazilian Government to encourage significant participation in the renewable energy market with private sector finance. However, the long term success of this tendering process will become apparent in a few years as there is risk, similar to that experienced by the UK with its offshore wind farm tender, in that not all winners develop their awarded projects.

Source: *Eco Periodicals*, July 2010

Renewable Portfolio Standards (RPS)

Twenty-nine states in the US (as well as the District of Columbia and Puerto Rico) have passed RPS laws that require their utilities to purchase certain percentages of their electricity from renewable sources each year. States vary as to the percentages and times for compliance, which range upwards of 30 percent compliance by 2020. The laws differ in terms of which technology resources are permitted, but they generally cover all conventional renewable technologies such as wind, solar and biomass, with some states including fuel cells, whether powered by renewable or a natural gas fuel source.[75] About fifty percent of nationwide retail electricity sales are covered by mandatory state RPS policies. There is little likelihood that an RPS would be enacted at the national level.

Assuming that full compliance is achieved, current mandatory state RPS policies in the US will require the addition of roughly 60 gigawatts (GW) of new renewables capacity by 2025, equivalent to 4.7 percent of projected 2025 electricity generation in the U.S., and 15 percent of projected electricity demand growth.[76]

For the most part, these laws operate so that the lowest cost resource is generally selected as the preferred option to comply with the law. As a result, lowest-cost, large-scale wind projects have been the principal winners under state RPS policies. To expand the portfolio of options, many state RPS laws have been amended to create "carve outs" for specific technologies like solar or energy efficiency or combined heat and power that otherwise would not have competed economically with wind.[77]

Many RPS laws include sub-categories as "carve outs" to enable different technologies to compete with wind.

Many US state governments use Renewable Energy Certificates (REC) to track compliance with Renewable Portfolio Standards (RPS). They provide organizations and individuals with a mechanism to keep the legal title to the environmental benefits of renewable energy distinct from the flow of electrons. This allows individuals, utilities, load serving entities, businesses, government agencies, and non-profits to claim the value and benefits of the renewable energy associated with RECs as their own. Purchasers of RECs provide renewable energy project owners with a revenue stream that supplements the revenue they secure from the sale of the project's electricity. These additional revenues improve renewable energy project economics, increasing their competitiveness with fossil fuels.

RPS laws have helped drive the creation of markets for renewable energy technologies but in many cases the relative percentages remain small. It is too early to see if the laws are sufficiently robust to achieve the higher percentages and the associated investment expected in the coming decade.

Cap and Trade

Europe's greenhouse gas trading system emerged as a driver for climate change rather than financing clean energy but remains the most advanced and comprehensive scheme for pricing carbon and trading credits, based on allocation programs to reduce emissions and generate revenues for other cleaner energy technologies. There seems to be continuing, strong support for the system throughout Europe.[78] However, there are doubts whether such a scheme would be used through a global mechanism. Further, with the recent developments in the United States, it is extremely unlikely that cap and trade will become a policy instrument or funding source for US-based greenhouse gas emissions strategies, although there are sub-national trading efforts underway in some parts of the country.

Nevertheless, the mechanism remains a way to raise private capital through carbon finance mechanisms. There is so much literature on this field that is otherwise so well known that an in-depth review here would be superfluous.

Tax Measures

The Tax Credits remain important.

In addition to the price based instruments and quantity based instruments, it is not uncommon to combine these support mechanisms with complementary tax measures. However, tax measures can have big impacts on government budgets.

Production Tax Credit (PTC) and Investment Tax Credits

At the national level in the United States, the key fiscal instruments for promoting renewable energy are the federal (national) production tax credit (PTC) and the investment tax credit (ITC). Similar tax credits have been adopted at the local level.[79] For the investment tax credit, businesses and individuals who buy clean energy systems are able to receive a tax credit of 30 percent of the capital cost. For the PTC, businesses receive a pre-determined tax credit per kilowatt-hour of power produced differentiated by technology.[80] These credits can be sold to companies with large tax liabilities. During the recent economic downturn the number of entities (mostly large banks) that had tax liabilities fell dramatically limiting the pool of potential investors that could make use of the investment tax credit. As a result, a grant in lieu of tax credit was introduced to support clean energy projects.

The limited duration of PTC policies and the dependency on legislative short-term extensions limits their effectiveness.

One problem with the PTC and ITC is that it is usually extended for one to two year periods, for example the PTC for wind expires in 2012. The uncertain nature of legislative extensions has been a major problem for renewable energy project developers in the United States.

The combination of these tax credits for a typical wind project can be quite favorable for investors. It is reported that investors are able to obtain a complete return of their investment in about five years, and that investors in projects are able to achieve double digit returns.[81]

The combination of different tax credits is working to attract investments in US onshore wind projects.

The economic value of the combined tax benefits is considerable—close to 50% of a solar photovoltaic system's installed cost can be recovered through the ITC and accelerated depreciation.[82] For a wind project using the PTC, the present value of the combined tax benefits sometimes can exceed the system's cash revenues from the sale of electricity and renewable energy certificates.[83]

These tax credits are generally good policy tools if there are a large number of companies with profits and taxes they want to avoid through investing in these tax credits from renewable projects.

Accelerated Capital Cost Allowance

Ireland's Accelerated Capital Cost Allowance (ACA) is a tax incentive for companies paying corporate tax and aims to encourage investment in energy efficient equipment. The ACA offers an attractive incentive whereby it allows companies to write off 100% of the purchase value of qualifying energy efficient equipment (49 approved technologies) against their profit in the year of purchase.[84]

In 2007, the Canadian government introduced an accelerated capital cost allowance (ACCA) in the form of a two-year straight line depreciation rate for business investments in manufacturing and processing machinery and equipment. This allows businesses to write off these investments against taxable income more rapidly than the 30 percent declining balance method of depreciation previously applied to manufacturing and processing assets. The two-year write-off generates important cash flow for companies investing in new production technologies—and cash flow is critical for companies that are investing to grow their business as they emerge from recession. Under the traditional model of depreciation (30 per cent declining balance), it takes 14 years to depreciate 99 per cent of capital expenditures.

By contrast, the ACCA allows businesses to depreciate their investments completely over a three-year period, allowing them to deduct almost USD 42 cents more per dollar invested. This provides an additional return on capital of approximately 12-15 percent. The recent extension to the ACCA will grant Canadian manufacturers more than USD 600 million in 2012-13, and an estimated USD 2.5 billion over the next five years. In contrast, within the US the new tax plan enables American manufacturers to write-off one-hundred per cent of their expenditures on machinery and equipment in the year those investments are made. An example of Accelerated Capital Cost Allowance for a solar panel purchase in Canada can be found in Annex II.

Recommendation: It is clear that the combination of financial incentives with complementary tax measures has contributed to attracting initial investments to launch the clean energy sector and to form the foundation of a clean energy economy. It will be essential that this combination remains intact and strong—and not cut back as part of government short-term cost saving exercises—if investor confidence is to be strengthened, allowing nations to finance large-scale deployment of renewable energy projects.

IMPROVING AND ADDING TO EXISTING POLICIES

In general, many of the above mechanisms have worked with relative success. There is not a consensus of one set of mechanisms being optimal over another. But an important factor to consider is the robustness of the mechanisms to withstand both political and financial 'shocks' as governments and policy makers seek to balance national budgets.

The questions now are:

- What policies are most appropriate to take current single or double digit market penetration and scale those technologies to be the dominant power source in the next fifty years?
- How do we avoid lock-in of these technologies so that they can innovate and allow for turnover to more efficient capital stock?
- Which policies will bring these technologies to a point that they will not rely on significant subsidy support to compete with fossil fuel technologies?

There is a strong set of arguments not to disband any of the existing support mechanisms as this in itself indicates policy inconsistency leading to greater investment vulnerability. Instead, they can be changed incrementally and some new policies added. Policies can be set to facilitate the creation or expansion of a domestic market sometimes pegged to a specific sub-sector of energy users. Other policies can focus on reducing barriers —such as siting or establishing a market with early public sector customers—to encourage investment in clean energy projects. Still other innovations are in the finance sector to reduce the end user cost of technologies.

Here are some other promising strategies that have evolved to complement these existing policies:

- **Leasing to avoid lock-in**. Any system of support through long term contracts inevitably "locks in" the technology current at the time into place for the life time of the project. Whatever technology is new at the outset of the project will be outdated by the expiration of the project. There could well be more efficient, lower cost and more reliable replacements that appear during the lifetime of the project. The key to this problem, as least for distributed systems, is where the customer is the owner of the project, and there is no further incentive for the developer to replace the installed technology with any new technology. This dynamic could be changed through a leasing model. Under this framework, a developer does not sell the technology (usually distributed technologies such as solar and fuel cells) to the customer; instead, the developer retains ownership of the project and leases the technology for a long-term contract rate that is comparable to the regular price of electricity.[85] If this arrangement becomes the norm, it could create the right incentives for the developer, the owner of the technology, to install new technologies before contract expiration if the costs are cheaper and the technology more reliable.

- **Mandatory Uses for Specific Renewable Technologies.** Many countries have implemented various forms of mandatory use of renewable technologies in new buildings. For example, Bangladesh is considering a new bill with mandatory provisions for the installation of solar panels that could generate at least 2 per cent of the total power demand of residential buildings and 5 per cent of the demand of commercial buildings.[86] Japan similarly has plans to

> **Recommendation:** Implement mandatory use of renewable technologies in new buildings, such as solar electric or solar water heating or other renewable technologies; this can be accomplished by amendments to building codes.

make solar power mandatory in all new buildings in the wake of the Fukushima nuclear disaster.[87] Puerto Rico's building code makes solar water heating mandatory for one and two dwelling units.[88] In the United States, the State of New Jersey is considering making solar mandatory on all new schools.[89] This effort has included utilities in India that refuse to make power connections unless solar water heating systems are installed.[90]

- **Accelerating Demand for Clean Energy with Public Sector Procurement.** There is an argument that some governments can contribute to building the clean energy market through taking a 'first to use' position as an early customer. This provides potential advantages with immediate economies of scale and reinforces the signal of commitment by the governments and their respective agencies.

  In the United States, the Defense Department is the largest consumer of electricity in the country, with enormous procurement power (See Annex IV). Recently, it has decided to make commitments to purchase renewable power at many of its hundreds of bases across the country, providing a long term procurement market demand for new projects.

  Recommendation: Mandate more public procurement of renewable power from national agencies such as defense agencies, which are often the large consumers of energy with enormous procurement power.

- **Adaptive management and streamlining the regulatory process.** The siting and environmental permitting of renewable energy projects is often a challenge under current regulatory frameworks at national and sub-national levels in many countries. Current regulatory permitting processes are particularly difficult for the newest technologies that tend to have the least capital to navigate the expensive regulatory review process and for which there is less information available regarding potential environmental impacts that regulators require for making permitting decisions. Governments must look to create more favorable regulatory environments if they are to facilitate promising renewable energy technology deployment, commercialization and finance. There are several strategies and mechanisms that can be used to address the major regulatory hurdles facing renewable technologies.

  Recommendation: Establish policies that encourage more turn-over of technologies and avoid technology lock-in. Instead of selling technologies to customers, adopt or require use of a leasing model where a developer remains engaged through ownership with the business model base on long term contract rate that is comparable to the regular price of electricity and margin found in the advance of incorporated technologies.

The regulatory process will always be a balance between different interests. Risk assessment and prioritization should be used in making regulatory decisions for renewable energy technologies. However, these risks should be placed within a proper context. Because renewable energy generation is not subject to the catastrophic risks associated with many fossil fuel and nuclear energy supply technologies, governments should apply a reasonable level of regulatory flexibility to support this new industry. Use of an ***integrated risk framework*** for renewable energy projects can provide decision makers and stakeholders with a common ground for analyzing and managing risk and designing more effective siting strategies. Governments must ensure that agency staff and decision-makers have adequate experience and knowledge of the renewable energy technologies that they are regulating, including their characteristics, benefits, and risks.

Because renewable energy projects are subject to multiple regulatory authorities and governing laws, coordination between relevant agencies is critical to facilitating a reasonable regulatory framework. Creation of a ***one-stop-permitting shop*** would allow developers to reduce time spent with multiple agency reviews.

A smart regulatory program strategy will need to integrate monitoring with ***adaptive management approaches***. Adaptive management is a strategic approach that entails learning through the experience of early projects and using flexibility in implementing a regulatory program to easily accommodate and integrate new information and improved risk knowledge from early projects to revise regulatory requirements as appropriate.

Policies to Scale Up Emerging Technologies

One of the biggest impediments to further progress in clean energy is a persistent dearth of capital for potentially lower-cost breakthrough technologies that have advanced out of the laboratory but still require expensive field testing and trial installations before being deployed at scale. Financing exists for early stage, potentially high-risk/high-return technologies in the form of venture capital. It is available for late-stage, potentially low-risk/low-return technologies in the form of project financing. But what about those technologies that fall somewhere in between?

Support is needed to advance low–carbon technologies through the costly pre-commercial testing phase.

The problems posed by this funding "Valley of Death" represent fundamental, structural market shortcomings that most experts believe cannot be resolved by the private sector acting on its own. Even in good times, when lending standards are most flexible, banks and other financial institutions are simply not structurally positioned to back large scale projects deploying new technologies.[91]

Technologies that fall into this category could include next generation solar technologies that do not use silicon, or wind storage systems that use compressed gas to minimize intermittency, or in the non-renewable area, technologies to capture carbon from industrial or electric generation plants. All of these technologies are still technologically risky and require special incentives to move from early demonstration to later stage commercial application.

Policies are required to direct public funding support for technologies to transverse the "valley of death."

There are two policy suggestions that should be considered for these new technology breakthroughs.

- **Utility Procurement and Reverse Auction.** Under such a program, a public sector body like a utility regulator would mandate that utilities would encourage developers of projects that employ novel technologies, which are deemed to hold special promise, to "bid in" alongside others in a competitive process to win a fixed-price contract under a pre-established utility-level program cap. Those offering to sell their electricity at lowest cost within a targeted technology grouping would be awarded publicly-supported power purchase agreements, potentially at above-market rates. Such a plan takes its inspiration from European feed-in-tariffs (FITs) that offer developers fixed-price contracts and cash flow certainty. But unlike FITs, this scheme would see market participants, not policy makers, take the lead in setting prices.

Such an "emerging technology renewable auction mechanism" (ET-RAM) would require locally regulated utilities to procure clean energy project outputs from specific technology classes up to a predetermined cost limit, at guaranteed prices competitively bid by the winning developers. Such a mechanism would be designed to overcome the concerns about available demand and price levels that typically face efforts to finance emerging technologies. It would provide new technologies with guaranteed demand at a fixed energy price, supported by the purchasing power of financially robust regulated utilities. Where there is a desire to explore this ET-RAM structure, interested power system regulators would establish a reverse (or "Dutch") auction program incorporating incentives for emerging technologies that are viewed to have special promise in their region.

Importantly, the initial selection of the targeted technologies would require a careful, system–wide assessment of supply/demand balance issues, an analysis of the relevant technology value chains, and the gaps required to be filled by this form of financial intervention. Prices (perhaps set under market target caps designed to avoid exorbitant bidders claiming an unduly high price in a extremely thin auction) would be bid by developers to utilities through a confidential reverse auction process, with interested developers bidding in specific power types (i.e., "baseload," "peaking–as available," "non-peaking–as available," etc.) and proposed power volumes up to a target cost level mandated by the regulator. If individual support price caps (above the referent prices) were to be used for selected emerging technologies, they could be set after careful consultation, and would be intended to allow support levels adequate to trigger new investment in the selected emerging technology, but not so high as to produce undue market price distortions. Such price caps could also incorporate staged development, with higher levels set for smaller initial deployments and lower ones used for later stage, more mature (though still not fully commercialized), larger-scale installations.[92]

- **Efficacy Insurance and (National) Reinsurance Pool.** New technologies by definition present new risks that are challenging, if not nearly impossible to quantify. It is this fear of the unknown and the inability to calculate chance of loss that tends to keep conventional project lenders on the sidelines when presented with opportunities to back power- or fuel-generating plants that deploy cutting-edge equipment. But what if a third player were to step in to provide an insurance product that mitigated either risks involved with construction of a project or its performance over a lifetime?

Efficacy insurance provides protection against a technology that does not perform as its developer had projected.

Such an insurance provider could be a private-sector player with unique capabilities to assess and quantify risk, or a government agency with an exceptionally large balance sheet and uniquely positioned to shoulder risk.

One potential structure for a clean energy technology insurance package involves investors pooling capital to underwrite such policies. Project owners or developers would pay a premium and transfer the performance risk of the specific novel technology elements to the new insurance pool.

Recommendation: Address "Valley of Death" financing gaps by putting in place an "emerging technology renewable auction mechanism" (ET-RAM) that would require locally regulated utilities to procure clean energy project outputs from specific technology classes up to a predetermined cost limit, at guaranteed prices competitively bid by the winning developers.

Recommendation: Along with the ET-RAM, either mandate or encourage insurance companies to provide "efficacy insurance" that would provide protection against a technology that does not perform as its developer had projected. Its coverage pays out at a rate that supports bringing an underperforming piece of equipment up its original specification, or allows it to be upgraded or replaced. It can also provide liquidated damages up to the value covered by the policy. Some form of backstop "reinsurance pool," perhaps guaranteed by the national or sub-national governments, would complement that insurance product.

Conclusion

Starting the clean energy economy has required considerable public effort, private risk taking, and creative finance. While in some ways it feels as if we have only just begun and there is so much more to achieve, we have learned a great deal from the technological, financial, and policy perspectives of the last two decades. However, now is the time to apply this critical knowledge in a manner that results in accelerated large-scale deployment of renewable energy projects through an integrated, economic-development approach to clean energy infrastructure and market expansion.

This clean energy infrastructure building exercise will require a step-change in levels of finance. It will require greater public and private sector participation than in the past, especially in this era when governments are facing unprecedented debt. This is the time for governmental officials to act as leaders to create new finance strategies and structures to strengthen national workforces and put citizens to work in stainable long-term jobs that will help build nations with robust clean energy economies.

Historically, governments have funded clean energy projects primarily to bring climate and environmental improvements, with economic development viewed as a secondary benefit. This report has outlined a path forward based on a new vision—one that puts economic development at the forefront of creating a clean energy infrastructure for the 21st century. The vision will require significantly higher funding levels that can be induced if policy makers create policies and institutions to attract and unleash targeted pools of private funds in sufficient quantities and with typical infrastructure-type returns. This vision also requires a commitment to foster innovation to reduce technology costs and to improve the long-term investment climate for large-scale clean energy projects.

There is no prescriptive single set of steps that is universally suitable to solve all challenges. Every country has its unique resources and circumstances in which to build an appropriate clean energy infrastructure.

However, for the nations that are getting started, they might consider the broad recommendations to introduce economic development policies that favor support for clean energy industries. These would also involve the creation or growth of a clean energy domestic market.

For the nations that have an abundant renewable energy resource and strength in technology and manufacturing, they might consider aligning policies with finance to support exports of specific technology components that can drive down costs for the benefit of their own domestic markets and citizens.

All countries might consider the most effective finance mechanisms and appropriate institutions to raise the necessary private finance needed over the long haul for the growth and development of their clean energy economies.

In the end, the most important point is this: Investors have many choices to place their funds. Over several decades, through a combination of public investment and policy support, countries have created reliable investment opportunities in conventional infrastructure improvements such as roads, ports and airports. We take these investment opportunities for granted, but they have come about through creative, dedicated, and persistent public policy initiatives throughout the twentieth century.

The same scale and scope of policy development is now needed to create national clean energy infrastructure investment opportunities for a broad class of potential private investors. If these opportunities are present, private capital will flow to support a scale up in renewable energy infrastructure. If they are not, capital will go to other investments. It is really that simple.

These investment opportunities and the potential for scale up also should even hold in times of financial crises. For the ultimate scale up of these new technologies is in itself a source of new wealth creation on the order of transitions of the past such as the energy, transportation and Internet industries. For the 21st century, a modern infrastructure-creation exercise in clean energy could produce significant jobs, wealth, and environmental benefits through proven public and private investment structures and strategies.

ENDNOTES

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[91] This section borrows heavily and paraphrases parts of our report that Clean Energy Group and Bloomberg New Energy Finance prepared on this topic. See "Crossing the Valley of Death" http://www.cleanegroup.org/assets/Uploads/CEGBNEF-2010-06-21valleyofdeath.pdf (June 2010).
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