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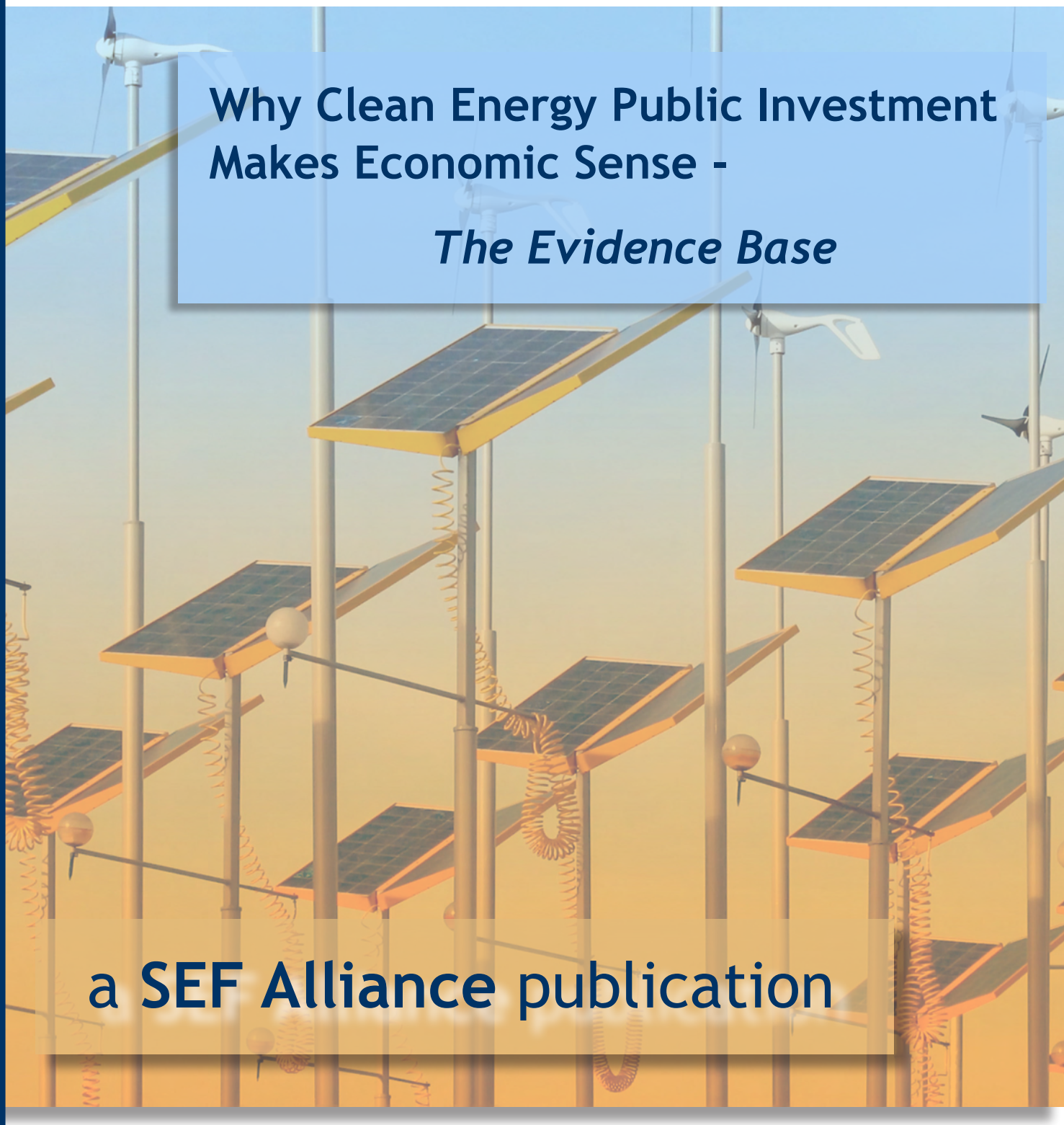
Why Clean Energy Public Investment Makes Economic Sense -

The Evidence Base



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prepared by
Management Information Services, Inc.

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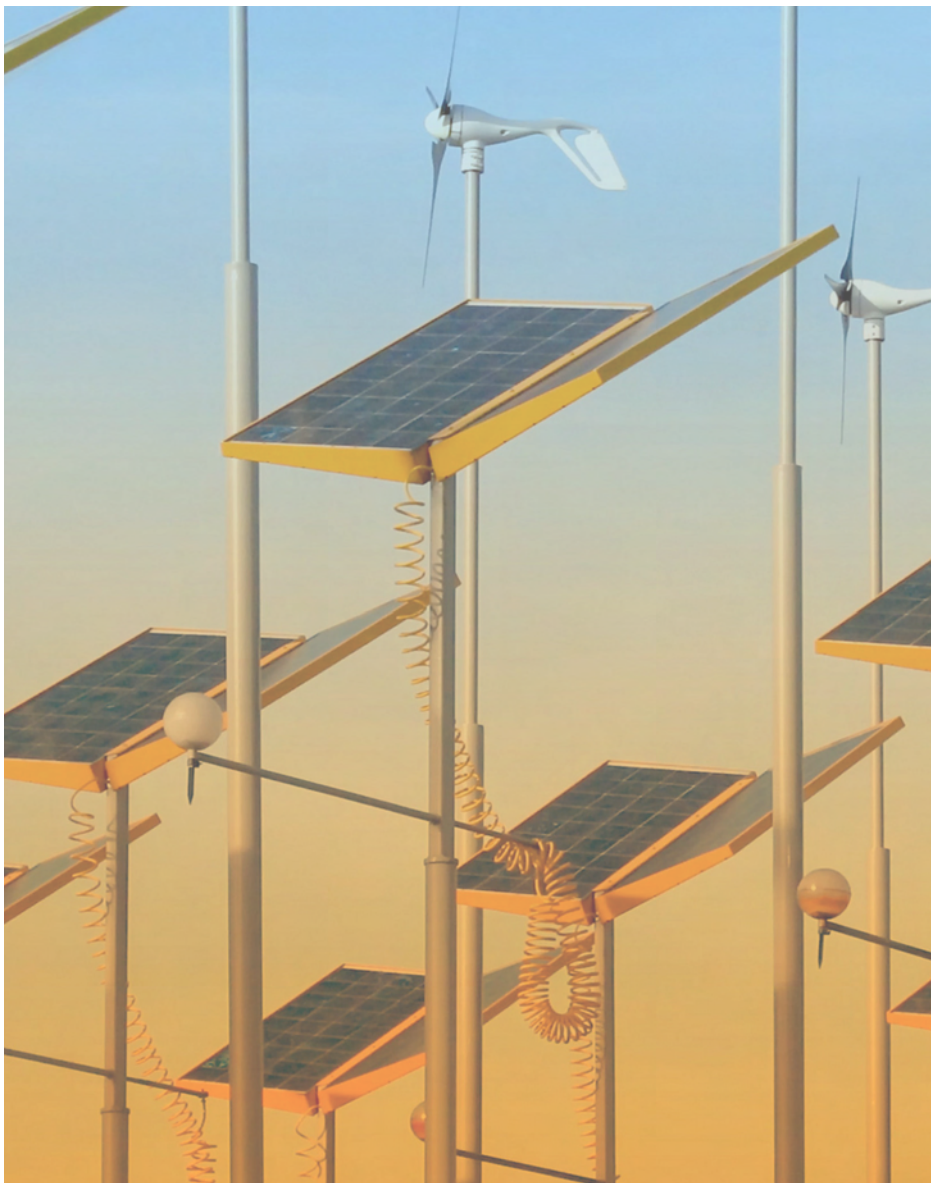
Why Clean Energy Public Investment Makes Economic Sense - The Evidence Base

An analysis of the connection between government clean energy spending and various measures of economic health



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ABOUT THIS REPORT

This is a publication of the UNEP SEF Alliance, an international coalition of public and publicly-backed clean energy funding organisations. The SEF Alliance began operating in January 2008 under the remit of the Sustainable Energy Finance Initiative (SEFI) of the United Nations Environment Programme (UNEP). In 2009, member organisations include the UK Carbon Trust, Sustainable Development Technology Canada (SDTC), Sitra, the Finnish Innovation Fund, and Sustainable Energy Ireland (SEI). The Alliance is governed directly by its members, and its activities are currently funded by the member organisations and by UNEP.

In response to the global economic downturn, SEF Alliance members identifed the economic impact of public clean energy investment as an area of high interest for specialised research. In particular, preliminary research indicated that countercyclical investment in sustainable energy could be a sound response to global economic recession. The SEF Alliance therefore commissioned this report from Management Information Services, Inc. (MISI), an internationally recognised economic research and management consulting firm, in order to assess the evidence base and provide a comprehensive analysis of why and how clean energy public investment makes economic sense.

ACKNOWLEDGEMENTS

MISI is grateful to members and staff of the UNEP SEF Alliance for assistance throughout the course of this project and for comments and suggestions on earlier drafts of the report. In particular, we appreciate the contributions of the following individuals: Matthew Kennedy with Sustainable Energy Ireland, David Harris Kolada with Sustainable Development Technology Canada, Sami Tuhkanen with Sitra, the Finnish Innovation Fund, David Vincent with the Carbon Trust, Eric Usher with the United Nations Environment Programme, Jamie Brown with the SEF Alliance Secretariat, Fatma Ben Fadhl with the United Nations Environment Programme, and Javier Garcia Monge with the Chilean Economic Development Agency (CORFO).

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Executive Summary

There is a growing interest in many nations in using "green" spending programs (renewable energy, energy efficiency, environmental initiatives, etc.) as economic stimulus and job creation programs. Nevertheless, there remains substantial controversy and uncertainty about the desirability and effectiveness of such initiatives, and the following questions must be addressed:

1. Do green programs facilitate economic growth and job creation?
2. Do green programs create more or fewer jobs than other types of economic stimulus programs, per dollar of spending?
3. How do the stimulus effects of green spending programs compare to those of tax cuts?
4. What barriers are inhibiting the rapid growth of green energy?
5. What are the most effective incentives for renewable energy and energy efficiency programs?
6. What information is required to inform policy-makers and elected officials as to the benefits of green stimulus programs?

We address these and related questions, and our major findings are summarized below.

Issue 1: Do Green Programs Facilitate Economic Growth and Job Creation?

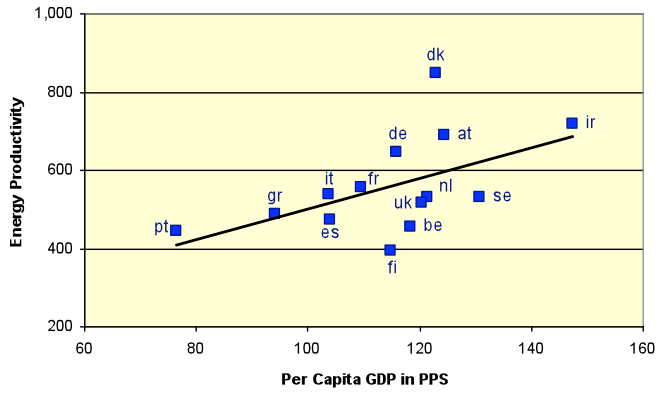
This is a timely and important issue:

- There has been substantial controversy over the years as to whether green programs act as a driver or a drag on nations' economies and job markets.
- The current severe worldwide economic recession makes it imperative to determine if such investments are fostering economic recovery and job growth.
- Many nations are rapidly increasing their investments in green stimulus programs and it is important to know whether these investments are compatible with economic growth and job creation.

The answer to this question is "Yes." We find that green programs facilitate economic growth and job creation. Government investments in these programs stimulate economic growth and job creation as well as providing various other economic and environmental benefits. We thus conclude that there is a strong positive relationship between clean energy/energy efficiency/environmental investments and economic prosperity and job growth. For example:

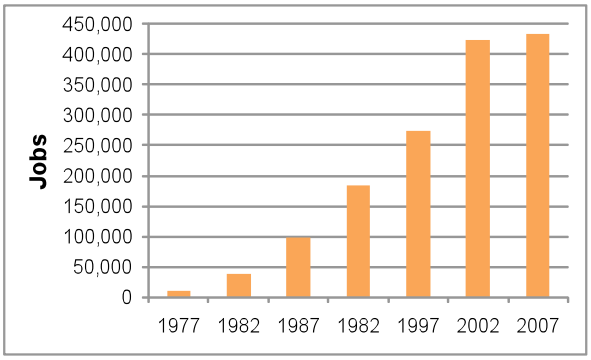
- Figure EX-1 shows that the relationship between energy efficiency and economic prosperity is positive; the more energy efficient the economy, the more prosperous it is.
- Figure EX-2 shows the net job creation in the USA state of California over the past three decades from investments in green energy programs – total job gains in excess of the jobs lost in the fossil fuel industries and the carbon fuel supply chain. By 2007, annual net job creation totalled nearly 450,000 in the state.

Figure EX-1:
Energy Efficiency and Economic Prosperity - 2006



Source: Eurostat and Management Information Services, Inc., 2009

Figure EX-2:
Net Job Growth in California Resulting From Green Program Investments



Source: University Of California and Management Information Services, Inc., 2009

GOVERNMENT INVESTMENTS IN GREEN PROGRAMS ARE GOOD FOR THE ECONOMY: THEY STIMULATE ECONOMIC GROWTH AND CREATE JOBS

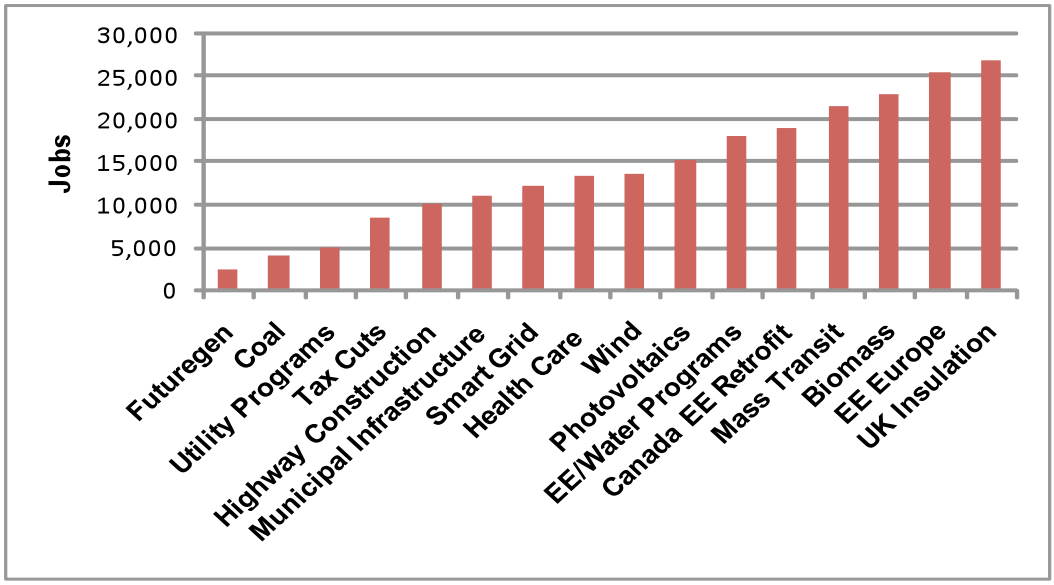
Thus, investments in clean energy and energy efficiency programs increase GDP, incomes, and jobs, reduce pollution and greenhouse gas (GHG) emissions, save energy, reduce energy costs, and reduce energy price fluctuations. Further, the relationship between i) clean energy, energy efficiency, and environmental programs and ii) economic growth and job creation is positive, not negative.

Issue 2: Do Green Programs Create More Jobs Than Other Types of Economic Stimulus Programs, Per Dollar of Spending?

The answer to this question is "Yes." We find that government spending on green stimulus programs is, dollar for dollar, more effective in creating jobs as is equivalent spending on more traditional alternatives, such as road construction or fossil fuel energy programs. These findings are summarized in Figure EX-3, which illustrates the relative job creation of different types of government spending programs. For example, it shows that per dollar of spending:

- Photovoltaics create more than 50 percent more jobs than highway construction.
- Biomass creates nearly twice as many jobs as does health care.
- Insulation programs create nearly three times as many jobs as municipal infrastructure.
- Mass transit creates more than four times as many jobs as utility programs.

Figure EX-3: Jobs Generated Per Billion Dollars of Expenditure on Selected Programs
(billion constant 2008 U.S. dollars)



Source: Management Information Services, Inc., 2009

More generally, this figure shows that:

- Investments in green stimulus and infrastructure programs usually generate, per dollar of expenditure, more jobs than most alternatives.
- Investments in energy efficiency programs are especially beneficial and cost effective, and often have negative net economic costs.
- Clean energy programs are powerful job creators, but the job creation effects depend importantly on the specific clean energy program and technology.

GREEN STIMULUS SPENDING CREATES MORE JOBS, PER DOLLAR, THAN MOST OTHER PROGRAMS

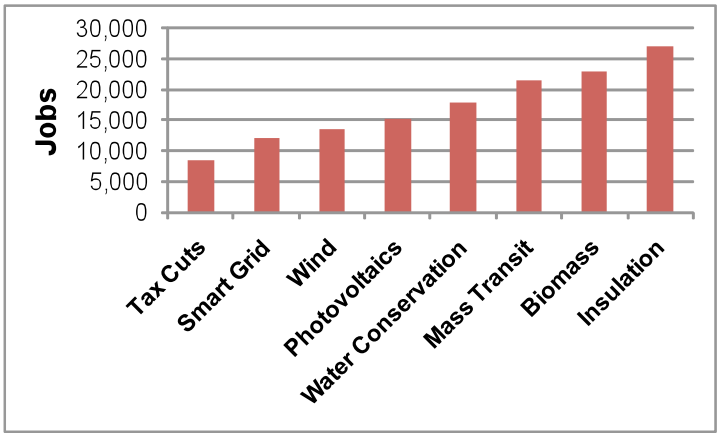
We thus conclude that green stimulus programs can act as expeditious and effective job creation mechanisms.

Issue 3. Do the Stimulus Effects of Green Spending Programs Have Greater Impacts Than Tax Cuts?

The answer to this question is "Yes." Green stimulus programs generate about three or four times as many jobs, per dollar, as do tax cuts. This is illustrated in Figure EX-3 and emphasized in Figure EX-4. Figure EX-4 shows that, per billion dollars:

- Smart grid investments create 50 percent more jobs than tax cuts.
- Wind programs create 60 percent more jobs than tax cuts.
- Photovoltaics creates nearly twice as many jobs as tax cuts.
- Water conservation programs create more than twice as many jobs as tax cuts.
- Mass transit creates nearly three times as many jobs as tax cuts.
- Biomass creates nearly three times as many jobs as tax cuts.
- Insulation programs create more than three times as many jobs as tax cuts.

Figure EX-4: Jobs Generated Per Billion Dollars of Expenditure on Tax Cuts and Selected Green Programs
(billion constant 2008 U.S. dollars)



Source: Management Information Services, Inc., 2009.

GREEN STIMULUS PROGRAMS GENERATE 3 TO 4 TIMES AS MANY JOBS, PER DOLLAR, AS DO TAX CUTS

Issue 4. What Barriers are Inhibiting Rapid Growth of Green Energy?

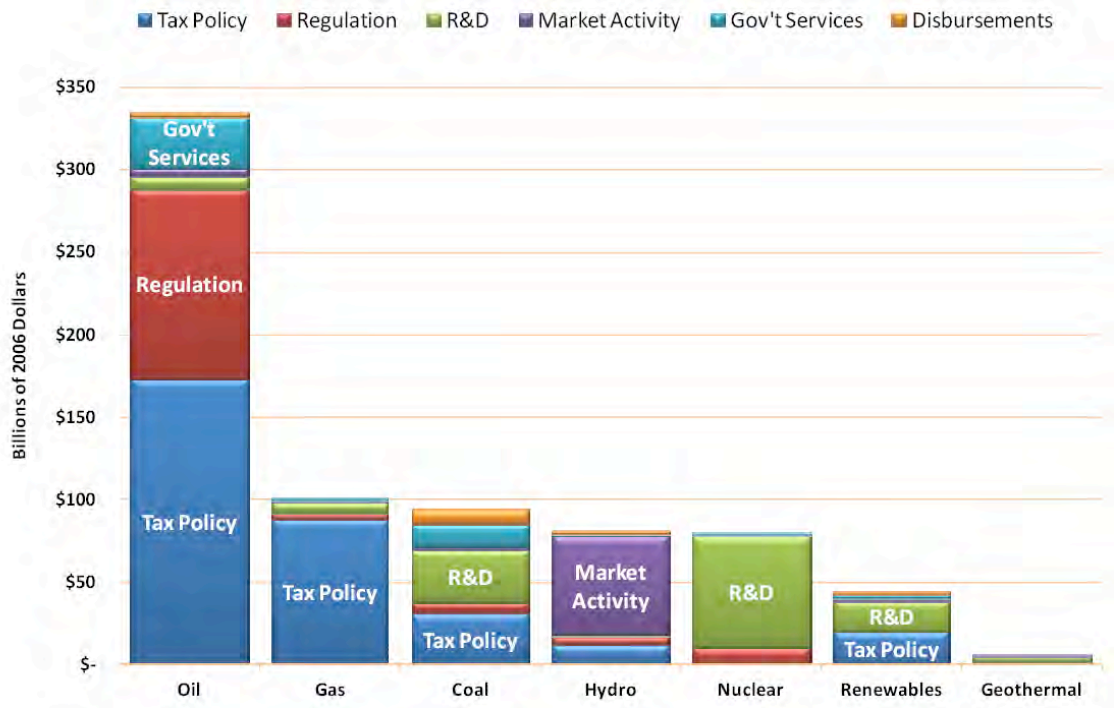
Subsidies, taxation, and other policies favouring conventional energy are a worldwide problem and allow fossil and nuclear energy to be sold at artificially low prices. This is the most serious barrier inhibiting the rapid growth of green energy.

A government's energy policies have a critical impact on clean energy development, and legacy energy policy, regulations, and subsidies are one of the key determinants of the success of clean energy initiatives and achievement of desired green energy goals. Due to legacy subsidies for conventional energy sources, large subsidies for clean energy may be required for many years to offset the embedded subsidies enjoyed by competing energy sources. Further, these clean energy subsidies may have to be larger and remain in place longer than most analysts and policy-makers realize.

CONVENTIONAL ENERGY SUBSIDIES ARE THE MOST SERIOUS BARRIER TO THE GROWTH OF GREEN ENERGY

For example, as summarized in Figure EX-5, in the USA the largest beneficiaries of federal government energy incentives have been oil, gas, coal, and nuclear energy, receiving nearly all incentives and subsidies provided. Of the $725 billion (2006 dollars) in government subsidies, renewables received only six percent ($44 billion). This situation is true in many other nations, and the historical legacy – and the pattern that continues – place clean energy at a serious economic disadvantage in the marketplace. Further, it will take decades of revised energy incentives policies to remedy these market distortions.

Figure 5: Comparison of USA Government Incentives for Energy Development, 1950-2006



Source: Management Information Services, Inc., 2009.

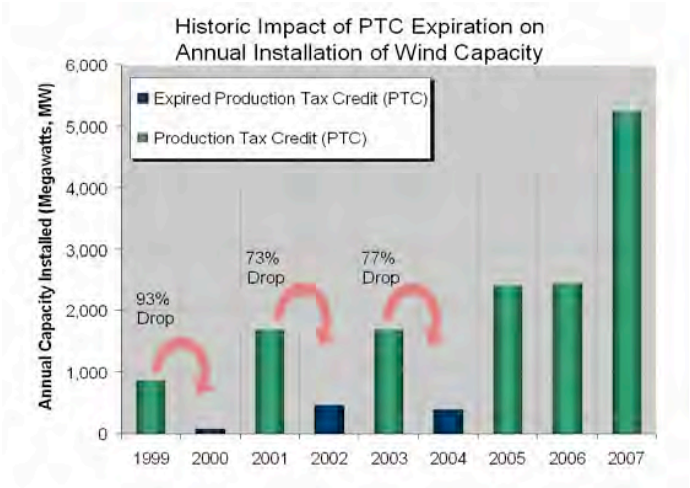
Issue 5: What are the Most Effective Incentives for Renewable Energy and Energy Efficiency Programs?

Clean energy incentives must be coordinated, complementary, and consistent, and it is the entire portfolio of incentives that is critical. Clean energy incentives must be complementary and reinforcing, and must be coordinated among federal, regional, and local governments, and even the largest financial incentives will not be effective unless appropriate, complementary regulatory and institutional incentives policies are also in place. Thus, to be effective, financial incentives for clean energy must be accompanied by complementary institutional and regulatory policies.

It is also important that clean energy incentives be consistent and predictable, and lack of these attributes will negate the incentives' effects. The importance of consistency is illustrated in Figure EX-6, which illustrates the inconsistent impact of the USA federal renewable energy production tax credit (REPTC) -- which provides a 2.1 ¢/kWh incentive (indexed to inflation) for the production of electricity from utility-scale wind turbines.[1] This figure shows that, not only has REPTC been critical in incentivizing the U.S. wind industry, but – even more important -- inconsistency and unpredictability in clean energy incentives

[1]Since the average U.S. electricity price is about 10.3 ¢/kWh (all sectors), REPTC represents an (indexed) electricity production subsidy of more than 20 percent. It is the most important U.S. federal renewable electricity incentive and has been critical in promoting wind generation in the U.S.

Figure EX-6:



Source: American Wind Energy Association, 2008.

policies can be devastating to the development of clean energy technologies. Thus, to be most effective, clean energy financial incentives must be consistent, predictable, and reliable.

Financial incentives must be carefully designed and implemented. The appropriate incentive size will depend on the context of the respective market, which will make it unique to each nation and jurisdiction, and well-designed fiscal incentives programs can play an important role in increasing market penetration of clean energy if implemented as part of an incentive portfolio. Historically, tax incentives have been awarded based on capacity; however, the literature suggests that they may be more effective if they are production-based, and clean energy financial incentives based on production are more effective than those based on capacity.

It is important to note that strong financial incentives policies and barrier reduction policies are both required, in tandem, to significantly increase clean energy development and, to be effective, financial incentives must be accompanied by barrier reduction policies. It is the portfolio of incentives that is critical and there is a quantifiable connection between the incentives portfolio and clean energy development, but optimizing the portfolio is essential. Further, successful combinations of financial and regulatory policies can be serendipitous as well as planned, and monitoring of incentive effects, interactions, and feedbacks is required.

THE PORTFOLIO OF CLEAN ENERGY INCENTIVES
MUST BE COORDINATED, COMPLEMENTARY, CONSISTENT, AND PREDICTABLE

Issue 6: What Information is Required to Inform Policy-Makers and Elected Officials as to the Benefits of Green Stimulus Programs?

We found that clean energy programs have many advantages in terms of economic stimulus and net job creation. This is an important finding, since:

- Many governments around the world have embarked on large green stimulus programs to stimulate economic recovery and job growth, and it is essential to assess the relative effectiveness of such programs.
- Resources are limited, and governments need to know the "bang for the buck" of various stimulus program alternatives.
- The issue of green stimulus spending and its net job impact have long been controversial.

POLICY-MAKERS MUST REALIZE THAT THE FUTURE IS NOW: BUSINESS AS USUAL IS NOT A VIABLE OPTION, AND TIME IS RUNNING OUT

The following questions thus arise:

- Given the economic and job advantages of green energy programs, why are not they being given more emphasis in the current economic stimulus programs in different nations?
- What information is required to inform policy-makers and elected officials as to the benefits of green stimulus programs?

Here we summarized the major benefits of green stimulus programs. However, **many decision-makers are unaware of these benefits**, and the following information needs to be communicated to policy-makers and legislators worldwide:

1. Green spending programs are generally more effective in creating jobs and facilitating economic growth than most other types of spending. Thus, clean energy programs provide more economic "bang for the buck" and represent ideal economic stimulus programs.
2. Clean energy programs are *net* job creators: Even recognizing the inevitable job losses in the fossil fuel and carbon-intensive sectors, the net job creation of clean energy programs is strongly positive.

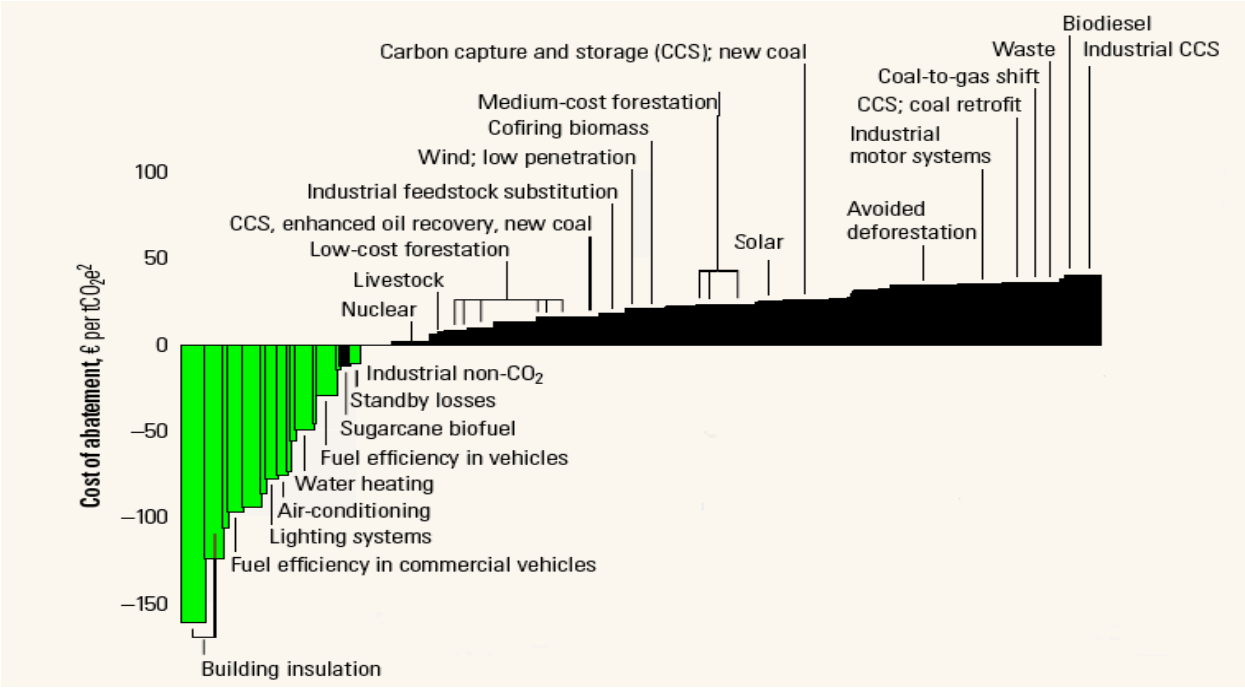
3. Tax cuts can be a useful and politically attractive policy instrument; however, green stimulus programs create three or four times as many jobs, per dollar, as do tax cuts. Thus, in the current depressed economic environment, green stimulus spending constitutes the preferred policy alternative.
4. Long term, holistic fiscal and institutional government policies are required to develop clean energy, and these incentives must be decades-long in scale due to imbedded subsidies for conventional energy.
5. The future is now: Business as usual is not a viable option. Even with large incentives and aggressive initiatives, it will take many years for clean energy to make significant inroads in the marketplace and to begin to displace conventional energy sources. Time is running out, and it is thus imperative that an accelerated policy shift to green energy be initiated immediately.

EVEN WITH LARGE INCENTIVES, IT WILL TAKE MANY YEARS FOR CLEAN ENERGY TO MAKE SIGNIFICANT INROADS, AND AN ACCELERATED POLICY SHIFT TO GREEN ENERGY MUST BE INITIATED IMMEDIATELY

Finally, decision-makers in all nations must recognize that green programs have complementary, mutually reinforcing effects on various policy objectives: They are cost effective, they increase energy efficiency and reduce fuel consumption, and they reduce environmental pollutants and GHG emissions. For example, Figure EX-7 illustrates that there are numerous inexpensive, reliable, and efficient green energy options, many of which are self-financing, and that clean energy contributes to the goal of sustainable development and also has significant economic benefits.

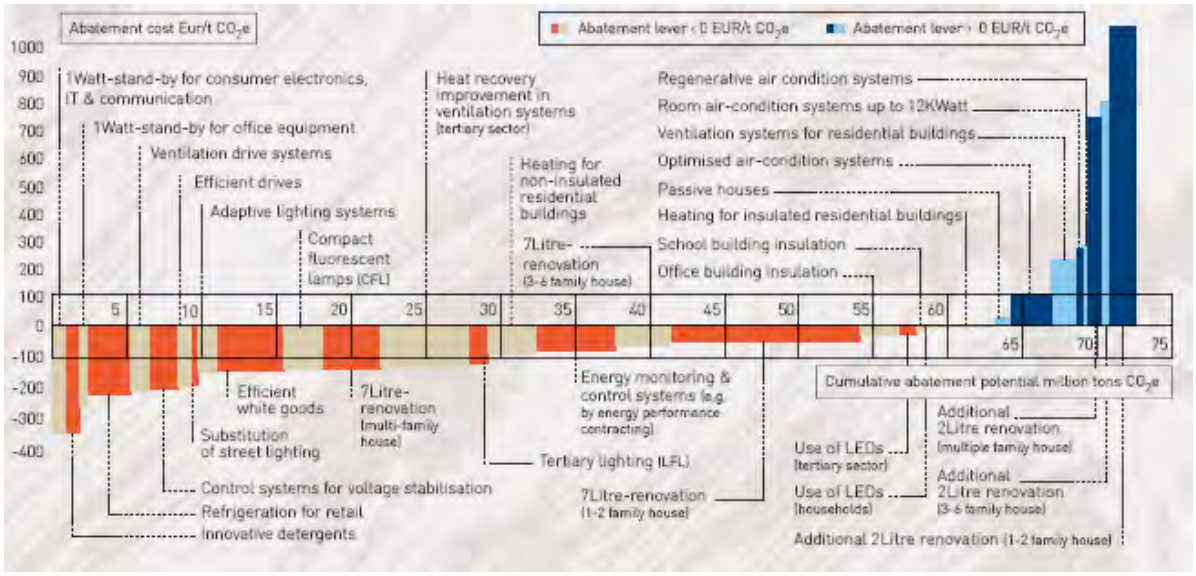
Green energy programs reduce GHG emissions and save costs, and of all possible measures to abate GHG emissions, those that use energy more efficiently have the lowest cost. For example, in the German economy, there is considerable untapped potential in cost-effective energy efficiency measures, especially for the residential sector -- almost 60 million tons of CO_2 by 2020. Figure EX-8 compares a number of CO_2 reduction measures for the residential sector in terms of cost and reduction potential -- the measures indicated in red are cost-effective.

Figure 7: Cost Effectiveness of Clean Energy Technologies



Source: Economic Commission for Europe

Figure 8: Abatement Costs and Potential for the German Residential Sector by 2020



Source: Business Europe, 2007

I. INTRODUCTION

This report analyzes the connection between government clean energy spending and various measures of economic health. Specifically, Management Information Services, Inc. (MISI):

- Assesses the relationship between (a) direct government financing of renewable energy and energy efficiency (RE&EE) and (b) economic health as measured by jobs, job quality, GDP growth, reduced pollution, energy and cost savings, reduced energy price fluctuations, and other appropriate metrics
- Compares and contrasts the economic and job impact of clean energy-related government stimulus programs with various government program and energy alternatives
- Discusses the implications of these findings for Canada, Ireland, Finland, the UK, and other nations

The report is organized as follows:

- Chapter II identifies the barriers to clean energy development, assesses government incentives designed to address these barriers, and assesses the relationship between clean energy development and various economic indicators.
- Chapter III compares the economic and job impacts of clean energy-related government stimulus programs with other government spending alternatives and estimates the relative job impacts of different types of government spending programs.
- Chapter IV discusses the implications of these findings for Canada, Ireland, Finland, the UK, and other nations.

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II. THE RELATIONSHIP BETWEEN GOVERNMENT CLEAN ENERGY PROGRAMS AND ECONOMIC INDICATORS

In this chapter we assess the relationship between government financing of renewable energy/energy efficiency and economic health as measured by jobs, job quality, GDP growth, reduced pollution, energy savings, energy cost savings, reduced energy price fluctuations, and other appropriate metrics.

II.A. Government Incentives for Clean Energy Programs

The direct government financing options MISI analyzes below include tax incentives, grants and rebates, technology assistance, loans and loan guarantees, finance assistance, renewable energy portfolios and feed-in-tariffs, business development services, clean energy certification programs, regulatory assistance, grid connection policies, and other financial and institutional incentive mechanisms. We then compare and analyze the relative economic merits and effectiveness of various public financial and institutional clean energy incentive mechanisms.

II.A.1. Barriers to Clean Energy Development

A government's energy policies can have a critical impact on clean energy development, and legacy energy policy, regulations, and subsidies are one of the key drivers in determining the success of clean energy initiatives and achievement of desired green energy goals. Below we first summarize potential barriers and then assess the remedies to these constraints on clean energy development.

Subsidies for conventional fuels. Subsidies and tax policies favoring nuclear and fossil fuel technologies are a worldwide problem and in many individual countries, and may allow fossil and nuclear energy to be sold at artificially low prices. The World Bank and IEA have estimated that global annual subsidies for fossil fuels are in the range of $100-200 billion. For example, in the USA, incentives for energy have included direct subsidies, tax concessions, market support, technology demonstrations, R&D, procurement mandates, information dissemination, technology transfer, directed purchases, government-funded regulation, and others. The U.S. federal government has provided an estimated $725 billion (2006$) for energy development since 1950, but renewables received less than seven percent of the total.[1]

Lax environmental regulation. Poor environmental standards and lax enforcement of existing standards are a problem – especially in many developing countries. For example, China and India both rely heavily coal, but in India, there are no current regulations on NOX or SO2 emissions from power plants. In China many coal power

[1] See the discussion in Section II.A.3.

plants are not within the jurisdiction of the central government and do not conform to strong environmental standards.

Fragmented industry and market. Markets for clean energy are new and relatively immature, and they often involve new technologies competing with mature conventional energy technologies.

Knowledge gaps. Consumers, lenders, developers, utility companies, and planners, both in developed and developing countries, often lack adequate information about clean energy.

Lack of technical skills. There may be a lack of technical skills to install, operate, and maintain clean energy technologies.

Lack of economies of scale. Production of clean energy technology components has not achieved economies of scale due to limited demand.

Higher clean energy costs. The costs of clean energy technologies are often higher than the market-based costs (which exclude externalities) of conventional technologies

Transaction costs. Transaction costs per kW of capacity (siting, permitting, planning, assembling financing, etc.) for clean energy technologies are often higher because of the smaller relative size of the projects, or because the technology requires additional research or time. For example, it costs more for financial institutions to evaluate the credit worthiness of multiple small projects than one large project.

Lack of access to finance. Clean energy projects often have difficulty accessing credit and often face higher interest rates than conventional energy projects; available loan terms may be too short relative to the equipment or investment lifetime; returns on investment for clean energy projects can be lower or can be subject to higher uncertainty than those for more conventional energy projects; and bank regulations and investment policies, often designed for larger conventional energy projects, can be inadequate or unsuitable for smaller, more numerous, distributed clean energy projects.

Legacy energy policies and regulations. Historical regulatory structures and policies in both developed and developing countries often favor fossil fuels and nuclear power.

State monopolies and power purchase agreements. In some nations, power utilities have a monopoly on electrical power production and distribution and the legal framework supports that monopoly. As a result, independent power producers may not be able to sell power to the utility or to third parties through power purchase agreements. Even if there has been deregulation, many former public utilities continue to control a large portion of generation, transmission, and distribution, allowing them to cross-subsidize these activities.

Discriminatory grid policies. Some utilities may engage in discriminatory grid policies that inhibit clean energy development; For example:

- Utilities may not allow adequate transmission access or may charge high prices for transmission access for clean energy.
- Remotely located facilities may have to pay high transmission charges based on distance or number of utility territories crossed.
- Intermittent generators may be charged a penalty if their energy delivery varies even by small amounts from scheduled amounts.
- Clean energy producers may not receive full credit for the power produced, due to discriminatory pricing.
- Utility interconnection requirements may be burdensome, inconsistent, and unclear.
- Liability insurance requirements may be excessive.

Administrative barriers. There may be restrictions on siting and construction for clean energy technologies such as wind turbines, solar, PV, and biomass facilities due to concerns relating to noise, unsightliness, and safety, particularly in urban areas.

II.A.2. Relative Merits of Potential Government Clean Energy Support Mechanisms

The design of individual incentives and the portfolio of incentives is critical for addressing the barriers discussed above and in determining the effectiveness of these policies in promoting clean energy development. A generic taxonomy of clean energy incentives is given in Table II-1, where the various incentives are indentified as addressing market preparation and technology accessibility. To maximize the effectiveness of financial incentives, the incentives should be designed to work with other policies to address different market barriers. Jurisdictions should design their financial incentives to complement other incentives and mandates at the regional and national levels.

Appropriately sized incentives are critical to encouraging growth of the clean energy market while balancing government fiscal resources and minimizing free-ridership. The optimal incentive size depends on the context of the respective market, which makes it unique to each government jurisdiction, resource, and technology. Financial incentives should be adequately capped to balance government fiscal restraints with the risk to consumers of not receiving the incentive if the demand is greater than expected. Further, financial incentive programs should be designed with a time horizon long enough to provide consistency to the market without creating a disincentive for price reductions. The appropriate incentive length depends largely on the market and technology status. There are three generic types of financial incentives: Tax incentives, grant and rebate programs, and loan guarantees.

Table II-1
Taxonomy of Clean Energy Incentives

Factors Affecting Market Preparation*	Factors Affecting Technology Accessibility*
Contractor Licensing	Corporate Tax Incentives
Equipment Certification	Grants
Generation Disclosure	Loans
Interconnection	Personal Tax Incentives
Land Access	Property Tax Incentives
Line Extension Analysis	Rebates
Net Metering	Renewable Energy Production Incentives
Public Benefit Fund	Sales Tax and VAT Incentives
Renewable Portfolio Standards	Renewable Obligation Certificates
Feed-in Tariff	

*The factors in each column are separate taxonomies.
Source: Management Information Services, Inc., 2009.

Tax Incentives

There are several types of tax incentives applicable to clean energy systems, and these include corporate, personal, property, and sales tax incentives. The income tax incentives are divided into two categories (personal and corporate) because the size of technology and incentive size depend on the end user. Property and sales tax incentives are included because they are fundamentally different mechanisms from income tax incentives:

- Corporate Tax Incentives. Corporate tax incentives provide tax incentives as either credits or deductions for the cost of equipment and/or installation of clean energy systems. The incentives usually range from 10 percent to 35 percent (or more) of the total cost, and there is rarely a cap set on the total incentive that an individual corporation can claim. However, some jurisdictions set a minimum on the investment that is needed to trigger a tax incentive.
- Personal Tax Incentives. Jurisdictions can provide personal tax credits or deductions of a set dollar amount, or up to a certain percentage of the total cost for the purchase and/or installation of clean energy equipment. Eligible technologies and the magnitude of tax incentives vary by jurisdiction.
- Property Tax Incentives. Because property taxes are collected locally, this incentive applies only if local authorities are given the opportunity to offer such an incentive. This incentive is generally offered as an exemption, exclusion, or a credit -- often based on the difference between the value of the clean energy system installed and the value of a similar conventional system.
- Sales Tax Incentives. A sales tax (or VAT) incentive allows purchases of clean energy equipment to be exempt from sales tax.

Jurisdictions can provide many types and levels of tax incentives, and the design of the individual incentives and the portfolio of incentives are critical in determining the effectiveness of these policies for promoting clean energy development. Tax incentives offer policy-makers flexibility in promoting clean energy development. They are rarely

the sole motive for consumers to invest and are usually insufficient if they are the only policy in place; however, tax incentives, if designed properly, can complement other policies. The design flexibility allows policy makers to direct financial support to a specific technology or sector that best fits the jurisdiction's goals and fiscal constraints. Due to the relatively high capital cost associated with many clean energy technologies, tax incentives are an effective means of reducing clean energy system capital costs. Tax incentives also are effective because they generally are easy for consumers to understand and use. These incentives, if designed properly and phased out at an appropriate rate, can aid in creating a sustainable market for clean energy. Nevertheless, to maximize effectiveness of tax incentives, it is important that the incentives be designed in coordination with other policies to address market barriers.[1]

The appropriate incentive size will depend on the context of the respective market, which will make it unique to each nation and jurisdiction. It is not sufficient to merely have a tax incentive; it must be large enough to increase investment without being so large as to strain a government's resources. In addition, the policy should be designed so that the incentives are not larger than the consumer's tax liability. Thus, tax incentives should:

- Be adequately capped -- the incentive needs to be adequately capped to reflect the fiscal realities in the jurisdiction and to reduce the risk to consumers of not receiving the incentive if the demand is greater than expected
- Have an appropriate time span -- tax incentives should be designed with a time horizon long enough to provide consistency to the market without becoming a crutch for the industry. Policies that are designed to last for too long are unlikely to provide the initial jump-start in investment that is often a desired goal of these types of programs. However, policies that offer incentives for too brief of a period, or have uncertainty surrounding short-term extensions, can be ineffective in providing the market stability that is desired.[2]
- Provide for proper evaluation to understand the impacts of incentive programs as well as providing guidance to policy-makers on programmatic changes necessary to optimize the incentive.

Well-designed tax incentives can play an important role in increasing market penetration of clean energy if implemented as part of an incentive portfolio. Historically, tax incentives have been awarded based on capacity; however, the literature suggests that they may be more effective if production-based provisions are included, especially for large systems.

[1]For example, a study of state clean energy policies in the USA found that states lacking interconnection policies faced difficulties in connecting clean energy to the grid, and this severely compromised the effectiveness of the clean energy financial incentives; see S. Gouchoe , V. Everette, and R. Haynes, "State Incentives for Renewable Energy: Case Studies of Program Effectiveness," North Carolina Solar Center, North Carolina State University, 2003.

[2]This scenario has been well-documented with the uncertainty of the extensions of the USA federal production tax credit and the resultant boom-bust cycle in wind development; see the discussion in Section II.A.3.

Loan Guarantees

These guarantees reduce the cost of capital and the cost to build a clean energy project, and this price reduction allows the project to be commercially viable at a point where it otherwise may not be. A guarantee is usually backed by the full faith and credit of a government jurisdiction and can encourage early commercialization of clean energy technologies. The guarantee can be for up to 100 percent of the cost of the loan and can be calibrated to guarantee a maximum percentage of the total cost of the clean energy project. The USA is aggressively utilizing this policy and is implementing a $150 billion loan guarantee program for new energy technologies that "avoid, reduce or sequester emissions of air pollutants and greenhouse gases."

Grants and Rebates

Grants are usually targeted to commercial, industrial, utility, education, and government sectors, and various grant programs are offered to encourage either clean energy R&D or to aid a project in achieving commercialization. Some grant programs are designated to support only a specific technology while others are available for a wide range of renewable resources. Rebate programs offer commercial and residential customers a rebate for installing certain clean energy equipment, and generally are directed toward solar thermal and photovoltaic systems. While most rebate programs are designed for residential and commercial consumers, a few programs are available for industry, institutions, and government agencies.

Grants and rebates can be important for increasing clean energy development (especially small, customer-sited projects), because they reduce the high capital costs often associated with clean energy installations. Unlike production incentives, grants and rebates do not require a long-term policy and financial commitment to a specific project, allowing for flexible support based on changes in the market.

Renewable Energy Production Incentives

Production incentives are financial incentives based on performance instead of capital investment and can be in the form of a tax credit or deduction or a direct cash payment. These incentives are based on the amount of electricity produced in terms of $/kWh generated or, for renewable fuels, in terms of $/gallon or liter produced. Production incentives promote clean energy because they encourage efficient, maximum generation from renewable energy facilities. Production incentives, in coordination with other policies, can provide funding stability sufficient to promote renewable energy development, and because the incentive is based on output, it encourages generators to develop efficient projects.

Public Benefit Fund

Also called a systems benefit charge (SBC), a public benefit fund (PBF) is a state- or utility-level program that sets a customer charge (typically in cents/kWh) for all electric utility customers. The funds are then directed to renewable energy and energy efficiency projects, including R&D and education programs. PBFs are an emerging policy

that provides consistent funding to renewable energy programs and reduces investment risk, and this policy has been very effective in the USA in encouraging energy efficiency programs.

Net Metering

This allows consumers who have on-site clean energy generating units to direct any excess electricity that they generate back into the grid. A bidirectional meter measures the electricity flowing to the consumer from the grid and from the consumer to the grid, and the consumer pays for the net electricity used from the grid. This results in the customer earning retail prices for the electricity delivered to the grid. Net metering can provide benefits to the customer and the utility, if there are enough systems to impact electricity supply.

Renewable Portfolio Standards

An RPS sets the minimum amount of electricity generated from renewable sources that electricity providers must meet by a certain date. Most RPS policies focus on the percentage of electricity generation, although some set the requirement based on total capacity. The definition of renewable sources that qualify to meet an RPS varies by jurisdiction, and RPS programs sometimes allow electricity providers to meet their requirements through the purchase of renewable energy credits. RPS provides policy-makers with the flexibility to design the policy to reflect jurisdictional goals, and this policy is widely considered to be one of the most important policies leading to increased renewable energy capacity.

Feed-in tariff

A feed-in tariff (also known as "EEG tariff" or "Advanced Clean Energy Tariff") is the payment per kWh for electricity produced by a clean energy source and requires regional or national electricity utilities to buy clean electricity at above-market rates set by the government. The higher price helps overcome the cost disadvantages of clean energy sources, and feed-in tariffs are widely used in European countries and are based on mandated prices of electricity sold into the electric grid from clean energy sources. The tariff can specify different prices for different clean energy sources and even different prices for specific types of clean energy – such as different wind regimes.

Renewable Obligation Certificates

ROCs (also known as Clean Obligation Certificates) require electricity suppliers to deliver a set proportion of power from clean energy sources. For example, in the UK generators receive one ROC for every 1,000 kWh of clean electricity generated, and can sell these to suppliers. A supplier unable to surrender ROCs equal to the set percentage must pay for each missing certificate into a buy-out fund which is then redistributed among the suppliers who surrendered ROCs. The market price of ROCs rises above the buy-out price if a shortfall is expected, for each ROC allows the holder not only to avoid paying the buy-out price, but also to share in the money paid in by those with a shortfall. The

design of the ROC effectively means that the total payment to clean generators, over and above the market price they receive for their power, is fixed.

Contractor Licensing

Licensing for contractors who want to install renewable energy systems guarantees that the contractors have the experience and knowledge necessary to ensure proper installation and maintenance.

Equipment Certification

This policy requires that clean energy equipment meets set standards, which ensures the quality of the equipment sold and reduces problems associated with inferior equipment. In USA markets for energy-efficient appliances, minimum standards have had significant effects on consumer energy use and market development.

Generation Disclosure

Disclosure policies require utilities to provide customers with information about their energy supply.

Interconnection Policy

Standards for connecting to the grid are necessary to maintain its safety and stability, and streamlined interconnection standards allow customers who want to connect a clean energy electric-generation system to the grid to do so through a transparent and equitable process.

Line-Extension Policy

For off-grid customers seeking access to electricity, the utility is required to provide a cost estimate for a line extension for grid power as well as information on the costs of alternative renewable energy options. Customers who want to be connected to the grid but are located in an area that is not serviced by the grid, are charged a service fee for connection based on the distance covered to extend power lines. Because it can be less expensive to build an on-site clean energy system, some jurisdictions require that utilities provide customers with information about renewable energy options when a line extension is requested.

Green Power Purchasing

Some jurisdictions require that a specific percentage of electricity used by government buildings and other facilities be generated from renewable energy sources. Voluntary green power programs may be mandated, but allow consumers to purchase green power through a utility program.

Renewable Energy Access Laws

Renewable energy access laws consist primarily of solar and wind easement policies to ensure that those with access to solar or wind resources are not obstructed as a result of new development. The easement is transferred with the property title if a sale occurs.

Table II-2 summarizes clean energy incentives in the UK; Table II-3 summarizes federal clean energy incentives in the USA.

Table II-2
Clean Energy Incentives in the UK

Scheme	Description	Cost	Paid by
Renewables Obligation	Electricity suppliers must buy a proportion of their sales from renewable generators, or pay a buy-out charge	£874 million in 2007/8	Electricity consumers
EU Emissions Trading Scheme	Renewable generators indirectly benefit from the increase in electricity prices as other companies pass the cost of emissions permits into the price of power	Perhaps £300 million in 2008, given current permit prices	Electricity Consumers
Carbon Emissions Reduction Target	Energy companies must install low-carbon items in homes, which could include microgeneration from 2008	Total cost will be £1.5 billion over 3 years -- most spent on energy efficiency	Gas and electricity consumers
Renewable Transport Fuel Obligation	Fuel suppliers must supply a proportion of biofuels or pay a buy-out charge	No more than £200 million in 2008/9	Consumers
Climate Change Levy	Electricity suppliers need not pay this tax (passed on to nondomestic consumers) on electricity from renewable generators	£68 million to UK generators; £30 million to generators abroad in 2007/8	Taxpayers, via reduced revenues
Lower fuel duty for Biofuels	The rate of fuel duty is 20 pence per liter below that for petrol and diesel	£100 million in 2007	Taxpayers, via reduced revenues
Environmental Transformation Fund	Grants for technology development and deployment, including subsidies for installing renewable generation, planting energy crops and developing biomass infrastructure.	£400 million over three years from 2008/9	Taxpayers
Research Councils	Grants for basic science research	£30 million in 2007/8	Taxpayers
Energy Technologies Institute	Grants to accelerate development (after the basic science is known) of renewables and other energy technologies	Allocation (and eventual size) of budget not yet announced.	Taxpayers And sponsoring companies

Source: The Economics of Renewable Energy, Volume I: Report, House of Lords, Select Committee on Economic Affairs, Nov. 2008.

Table II-3
Federal Clean Energy Incentives in the USA

Incentive	Description
Renewable Energy Production Tax Credit (REPTC)	The REPTC provides a 2.1 ¢/kWh incentive (indexed to inflation) for the production of electricity from utility-scale wind turbines. It is the most important federal RE electricity incentive and has been critical in promoting wind generation. Since the average U.S. electricity price is about 10.3 ¢/kWh (all sectors), REPTC represents an (indexed) electricity production subsidy of >20 percent.
Modified Accelerated Cost-Recovery System (MACRS)	The federal MACRS allows for recovery of cost invested in certain business property through accelerated depreciation. For wind, the current MACRS allows for cost recovery through depreciation over a period of five years.
Federal Business Energy Tax Credits	The following federal business energy tax credits are available: 1) fuel cells: The credit is equal to 30 percent of expenditures, with no maximum credit limit; 2) small wind turbines: The credit is equal to 30 percent of expenditures, with a maximum credit of $4,000; 3) geothermal systems: The credit is equal to 10 percent of expenditures, with no maximum credit limit; 4) microturbines: The credit is equal to 10 percent of expenditures, with no maximum credit limit; 5) combined heat and power: The credit is equal to 10 percent of expenditures, with no maximum limit.
Alternative Fuel Excise Tax Credit	A federal excise tax credit is available for alternative fuel that is sold for use or used as a fuel to operate a motor vehicle. The credit is $0.50 per gasoline gallon equivalent of compressed natural gas and $0.50 per liquid gallon of liquefied petroleum gas, LNG, and liquefied hydrogen.
Alternative Fuel Infrastructure Tax Credit	A federal tax credit is available for up to 30 percent of the cost of installing alternative fueling equipment, not to exceed $30,000. Qualifying alternative fuels are natural gas, liquefied petroleum gas, hydrogen, electricity, E85, or diesel fuel blends containing a minimum of 20 percent biodiesel. Fueling station owners who install qualified equipment at multiple sites are allowed to use the credit towards each location.
Biodiesel Mixture Excise Tax Credit	Biodiesel blenders are eligible for a federal volumetric excise tax credit in the amount of $1.00 per gallon of pure agri-biodiesel (e.g. biodiesel made from soybean oil) and pure biodiesel made from other sources (e.g. waste grease) blended with petroleum diesel.
Volumetric Ethanol Excise Tax Credit (VEETC)	Ethanol blenders are eligible for a federal excise tax credit of $0.51 per gallon of pure ethanol (minimum 190 proof) blended with gasoline.
Renewable Portfolio Standard (RPS)	An RPS is a regulatory policy that requires the increased production of RE sources such as wind, solar, biomass, and geothermal. The RPS mechanism generally places an obligation on electricity supply companies to produce a specified fraction of their electricity from RE sources. There is currently no federal RPS, although one may be soon created. However, 31 states have RPS in place, and these range from minimal and voluntary to mandatory and aggressive. As examples of the latter, California has an RPS of 20 percent by 2010, Texas has an RPS of 5,880 MW by 2015, Montana has an RPS of 15 percent by 2015, Connecticut has an RPS of 23 percent by 2020, and Illinois and Oregon have an RPS of 25 percent by 2025.

Source: Management Information Services, Inc., 2009.

II.A.3. Assessing the Effectiveness of Government Clean Energy Incentives

There are relatively few studies that rigorously assess the effectiveness and impact of clean energy incentives. Below we summarize the more relevant of these.

NREL Analysis of the Impact of U.S. Clean Energy Incentives

The U.S. National Renewable Energy Laboratory (NREL) analyzed the 50 US states according to their use of the most effective policies promoting clean energy electricity development and ranked the states on the basis of the most effective policies for clean energy.[1] The report identified those states that were leading the way with policy development to a clean energy economy and identified the incentives that had the highest impact on clean energy development. The research provided a quantitative understanding of the policy environment within the states, insight into the leading jurisdictions promoting clean energy, and a better understanding of how the policies impact clean energy development in the states.

In effect, the research treated the 50 U.S. states as jurisdictional laboratories to determine what incentives and combinations of incentives were most effective in promoting clean energy development. The report examined policy success stories for renewable energy development resulting from specific policies in various situations and connected those directly to renewable electricity development in a way that can inform effective policy design and implementation in other jurisdictions and other nations. This research presented important guidelines for answering such questions as:

- Which incentives work best in which jurisdictions?
- How does a policy-maker translate policy success in one jurisdiction to another?
- How can governments learn from each other and develop policies that have a high likelihood of success -- defined as increasing clean energy production?

The findings provided an understanding of where and when policies play a large role in clean energy development and which policies have the largest impacts.

The researchers used high-level correlation analysis and found significant connections between the existence of some state policies and in-state renewable energy-based electricity generation (or capacity, in the case of solar).[2] They found that:

- Existence of a renewable portfolio standard in a state is significantly correlated to higher wind-based electricity generation.
- Existence of an RPS is also significantly correlated to higher renewable percentages of overall electricity generation.

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[1] Elizabeth Brown and Sarah Busche, *State of the States 2008: Renewable Energy Development and the Role of Policy*, National Renewable Energy Laboratory, Technical Report NREL/TP-670-43021 October 2008.

[2] Statistically significant ($p<0.05$) correlations are used to understand basic connections between different datasets. In this case, correlations are used to establish a quantitative connection between policies and renewable energy capacity and generation at the state level. However, correlations do not necessarily imply causality and do not account for other contextual conditions.

- Line-extension analysis policies are correlated with higher wind capacity and generation.[1]
- Production incentives at the state level are significantly correlated with higher renewable electric capacity and generation, as well as all individual resource categories.
- Interconnection policies are correlated with increased renewable energy capacity and generation overall, as well as individually with higher biomass, hydroelectric, and PV capacity.
- States with barrier-reduction policies correlate with renewables development (as measured by generation, generation per capita, and generation per GSP).
- States with both strong financial incentives policies and barrier reduction policies experienced significant increases in clean energy development.
- There was not a strong correlation between incentives policies (without barrier reduction policies) and clean energy developments. This indicates that, to be effective, financial incentives must be accompanied by barrier reductions.

NREL concluded that there is a quantified connection between policy and clean energy development, and that understanding the details of the connection to better inform government policy development is critical. In addition to policy, there are many other contextual factors driving the development of renewable energy resources at the state level. Better understanding the role of each of these factors and their variation across states provides insight and understanding into the development of renewable energy resources, as well as the role of each in transformation of the clean energy market. The factors influencing renewable energy development and market transformation are similar across different jurisdictions. Finally, policy best practices are design based, not results based. Further investigation into policy outcomes and better understanding of policy design elements that are applicable across jurisdictions, government, and nations are critical to informing the development of policies that are effective in accelerating clean energy development.

Costs and Benefits of German Clean Energy Incentives

The German Federal Environmental Agency retained a team of experts to estimate the economic costs and benefits of Germany's energy and climate program.[2]
The incentives were analyzed on the basis of the key elements with regard to their program costs, investment costs, and energy costs saved. The study found that most of the incentives analyzed save costs and that, in total, by implementing these measures Germany can achieve gains of about 5 billion euro in 2020 -- Table II-4.[3] Further, the incentives would result in substantial reductions in GHG emissions.

[1]This result is interesting in that interviews with program administrators indicated that the policy was not intended to increase development of renewable resources, but to facilitate use of the most economic "last-mile" electricity solutions.
[2]Fraunhofer Institute for Systems and Innovation Research, *Economic Assessment of Measures in the Integrated Energy and Climate Programme*, Karlsruhe, 2007.
[3]Assumptions made regarding gas and oil prices were relatively moderate ($65 per barrel).

Table II-4
Costs and Benefits of German Clean Energy Incentives in 2020

Measure no.	Title of measure	Gross costs in billion euro	Annually saved (fossil) energy in billion euro	Reduction costs in euro/t CO_2
1	Combined heat and power	0.003	-0.3	12.9
2	Electricity from renewable energies	5.55	4.2	27
7	Energy management systems and support programmes energy/climate	2.30	3.2	-90
8	Energy-efficient products - households/industry	0.21	4.2	-266
10A	Energy Saving Ordinance	8.43	10.30	-47
10B	Replacement of night-storage heaters	1.05	0.90	23
12	Modernisation programme to reduce CO_2 emissions from buildings	2.43	3.20	-58
13	Energy-efficient modernisation of social infrastructure	0.49	0.26	163
14	Heat from renewable energies	4.42	3.5	77
15	Energy-efficient modernisation of federal buildings	0.06	0.080	-38
16	CO_2 strategy for passenger cars	6.44	8.7	-128
17	Biofuels	0.00	-1.0 to 2.0	84 to 168
	Total	**31**	**36.3**	**-26**

Source: Fraunhofer ISI (2007)

Specifically, the study found that:

- The annually apportioned investment costs amount to 31 billion euro in 2020.
- Energy savings would total more than 36 billion euro.
- The largest cost savings result from the energy saving ordinance, renewable electricity, energy efficient products, and heat from renewable energies.
- The most cost effective programs (in terms of CO2 reductions achieved per funds expended) are energy efficient products, CO2 strategy for passenger cars, and buildings modernization.

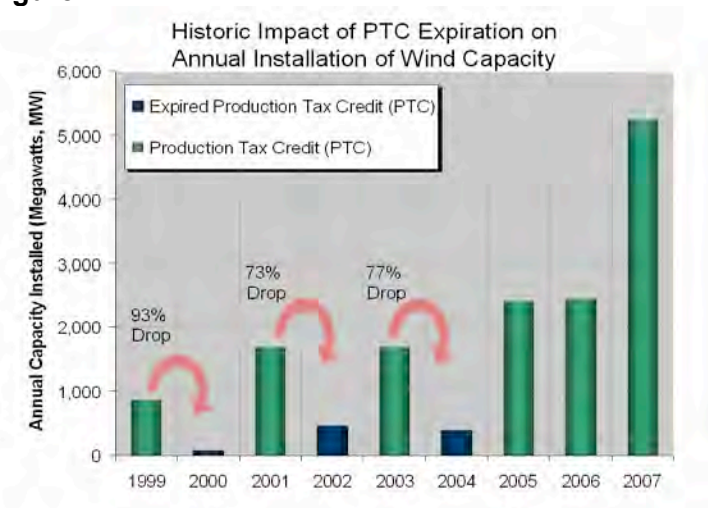
The study also provided examples of costs and benefits for individuals:

- Buildings. Insulating the ceiling of a cellar in a single family house costs around 2,000 euro, which saves about 150 euro in heating costs per year. The investment thus pays back in about 10 years – more rapidly in the case of rising oil and gas prices.
- Transport. Purchasing a small car with 20 percent greater efficiency costs an additional 100-200 euro and over six years saves about 700 euro -- more than five times the cost.
- Motors. An efficient 11 kW motor for industrial operation costs 100 euro more than a standard model, and this cost can be recouped in about one year.
- Products. A high-efficiency refrigerator (A++) costs around 50 euro more than a less efficient appliance, but saves 11 euro per year, and thus recoups its incremental cost in less than five years.

USA REPTC

The U.S. federal renewable energy production tax credit (REPTC) provides a 2.1 ¢/kWh incentive (indexed to inflation) for the production of electricity from utility-scale wind turbines. Since the average U.S. electricity price is about 10.3 ¢/kWh (all sectors), REPTC represents an (indexed) electricity production subsidy of more than 20 percent. It is the most important U.S. federal RE electricity incentive and has been critical in promoting wind generation in the U.S. – see Figure II-1.

Figure II-1



Source: American Wind Energy Association, 2008.

This figure shows that, not only has REPTC been critical in incentivizing the U.S. wind industry, but – perhaps even more important -- inconsistency and unpredictability in clean energy incentives policies can be devastating to the development of clean energy technologies.[1] For example, Figure II-1 shows that:

- When the REPTC expired on December 31, 1999, the U.S. wind industry virtually collapsed.
- When the REPTC was re-authorized at the end of 2000, the U.S. wind industry grew nearly 20-fold in 2001.
- When the REPTC expired on December 31, 2001, the U.S. wind industry declined by nearly three-quarters in 2002.
- When the REPTC was re-authorized at the end of 2002, the U.S. wind industry grew five-fold in 2003.
- When the REPTC expired on December 31, 2003, the U.S. wind industry declined by more than three-quarters in 2004.
- When the REPTC was re-authorized at the end of 2004, the U.S. wind industry grew nearly 20-fold by 2007.

Clean Energy Incentives Lessons From Europe

In Europe, there is a general consensus that incentives are needed for renewable energy systems, but there has been considerable debate over which incentive should be used: Renewable portfolio standards (RPS) or feed-in tariffs (FIT).[2] The debate has been especially intense between Germany and the UK, and has resulted in controversy within the European renewable energy community involving the German World Wind Energy Association and the UK Global Wind Energy Council. Nevertheless, a consensus in favor of FIT is emerging.

[1] See the discussion in Section II.B.2.

[2] J. F. Manwell, "Policy Options to Accelerate the Use of Renewable Energy: Lessons From Europe," Renewable Energy Research Laboratory, University of Massachusetts, October 2008.

An RPS involves a fixed quota for RE projects and an unspecified price for electricity sold – which is set by bidding. Feed-in tariffs involve a fixed price for electricity sold, but an unspecified quantity of RE capacity, and the deployment rate is a function of price.

RPS is in place in some USA states and some European countries, such as the UK. It is based on a quota, and retail suppliers are required to supply a certain fraction of electricity from clean energy sources. This requirement translates to a value for each kWh and an upper limit set by penalty for non-compliance. Typically, the renewable aspect of electricity is "unbundled" from the electrons and the renewable aspect is represented by renewable energy credits (REC's) – which can be bought and sold. The obligation is met by acquiring sufficient RECs, prices are set by bidding, and the value of REC's is difficult to quantify a priori. Values of REC's could change over time, and the supply/demand effect on REC's value creates difficulties when changing eligibility of clean energy sources.

The arguments in favor of an RPS include:

- Predictable market growth
- Minimization of costs to taxpayers and ratepayers through increased competition among developers
- No selection of technological winners
- Market based system of tradable credits
- Minimal costs

The disadvantages of an RPS include:

- Focus on lower price: May result in geographic concentration, risks NIMBY problems, and has high contract failure rates
- Targets near-market technologies
- Deployment rates are relatively slow
- A single price means a "windfall" for the best sites
- Favors large developers
- Less portfolio diversity
- Administratively cumbersome and costly

The feed-in tariff, which is also known as an "EEG tariff"[1] or an "Advanced Renewable Energy Tariff," is used in most European countries – see Table II-5. It is based on mandated prices of electricity sold into the electric grid from clean energy sources and can include different prices for different energy sources and different prices for different wind regimes. Table II-6 compares the Spanish, German, and Slovenian FIT Systems.

Denmark had a program similar to the feed-in tariff for wind in the 1980's, and Germany introduced FIT in 1991 – which has expanded and is regularly updated. Wind energy

[1]The abbreviation is from the German Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz, EEG); see *EEG – The Renewable Energy Sources Act*, Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Berlin, Germany, July 2007.

Table II-5
Feed-in Tariffs and RPS in Europe

Feed-in	RPS
Austria	Belgium
Denmark	Italy
France	Sweden
Germany	UK
Greece	Poland
Ireland	
Luxembourg	
Netherlands	
Portugal	
Spain	
Czech Republic	
Estonia	
Hungary	
Latvia	
Lithuania	
Slovak Republic	
Slovenia	

Source: J. F. Manwell, "Policy Options to Accelerate the Use of Renewable Energy: Lessons From Europe," Renewable Energy Research Laboratory, University of Massachusetts, October 2008.

increased rapidly in Germany and Spain after feed-in tariffs were implemented, and wind energy growth declined when renewable tariffs were repealed. Denmark switched to feed-in after a change of government, and opposition Conservatives in the UK are recommending feed-in tariffs.

An EEG is an obligation to purchase renewable energy. Under an EEG, a utility is obligated to connect clean energy sources to its grid at a connection point that is technically and economically suitable, suitability includes a reasonable upgrade if required, and the utility must purchase electricity at the fixed EEG rates. The costs to connect to the grid must be paid by the project operator, but costs to upgrade the grid are paid by the grid operator. The local utility pays the project operator for electricity at required rates and, in Germany, excess costs are distributed throughout the German electricity network. Under the German EEG, rates for wind depend on onshore or offshore, early years have higher rates, and the duration of high rates depends on site wind speed; rates for PV depend on the size and type of application.[1]

Germany has found the EEG to be simple, cheap, and effective. The FIT has significant advantages: It is highly efficient, allows price differentiation and reduces costs, possesses planning certainty, has low administrative expense, and has no effect on government budgets. However, it has the disadvantage of not being accepted by some sectors.[2]

The arguments in favor of a feed-in tariff include:

- Rapid deployment of resources
- Rapid development of local manufacturing
- Increases in local acceptance and participation
- Encouragement of geographic distribution
- Transparency and lower administrative cost
- More jobs, more investment, and more competition in manufacturing and equipment suppliers
- Minimal costs

[1] Ibid.

[2] Under the German Building Code, wind turbines in designated regions are permitted by right. Evidence has to be given as to why turbines should not be permitted -- rather than the other way around, and the code provides a streamlined planning and approval process. In addition, cities and communities are obliged to identify local wind resource areas.

Table II-6
Comparison of Spanish, German and Slovenian Feed-in Tariff Systems

Criterion	Spain	Germany	Slovenia
Guaranteed duration of tariff level	1 year [a]	Generally 20 years [b]	1 year
General duration of support	During the whole lifetime	Generally 20 years	10 years guaranteed
Are the tariffs stepped (regarding time, local conditions, etc)?	Yes	Yes	Yes
Degression of tariffs for new installations	Set in a flexible way	Predefined (2-6.5% p.a.)	No
Implementation of burden sharing	Through system operator OMEL – leads to equal distribution among all electricity consumers	Equal distribution among all electricity consumers with exceptions for energy intensive industries	Equal distribution among electricity consumers
Premium tariff possible?	Yes	No	Yes
Direct access to the spot market in combination with FIT possible	Yes	No	Yes
Supplemented by what kind of main additional support mechanisms	ICO-IDAE funding line, which provides with special conditions to investments in Renewable Energy (RE) and RUE investments. In general, investment incentives, soft loans and tax incentives	Soft loans and investment incentives by the market incentive programme for biomass combined heat and power (CHP), small hydro-power, photovoltaic (PV) in schools	Soft loans and investment incentives
Grid access	Guaranteed by law	Guaranteed by law	Guaranteed by law
Costs of balancing power	Not to be covered by Renewable Energy Sources (RES) generator	Not to be covered by RES generator	Not to be covered by RES generator
Demand orientation	Yes, for selected technologies under the fixed price option	No	Yes, for selected technologies
Forecast obligation	Yes	No	Yes
Specific tariffs for the following (sub)-technologies			
Biogas	Yes	Yes	Yes
Off-shore wind	Yes [c]	Yes	-
PV	Yes	Yes	Yes, Solar
Building integration of PV	No (only size dependent) [d]	Yes	No
Geothermal electricity	Yes	Yes	Yes
Solar-thermal electricity	Yes	No	Yes, Solar
Ocean technologies	Yes	No	No
Refurbishment large hydro	No	Yes	No
Biomass-CHP [e]	Yes	Yes	No
Renewable biomass resources	Yes	Yes	Yes
Innovative technology incl. fuel cells, micro turbines, etc	No	Yes	No

a) Annual changes can be very moderate; b) Except hydro power

Source: Anne Held, et. al., *Feed-In Systems in Germany, Spain and Slovenia: A Comparison*, Fraunhofer -- ISI and Energy Economics Groups, Karlsruhe, October 2007.

Feed-in tariffs are being implemented in North America. In Canada, they have been introduced in Ontario and Prince Edward Island, and in the USA they have been implemented in Washington state, Minnesota, Wisconsin (PV and biogas), New Mexico (PV only) and California (PV only).

The implications of the European experience include:

- There has been considerable emphasis on trading schemes, tax incentives, production tax credits, etc., with mixed results.
- FIT is generally preferred to RPS.
- Recent emphasis on deregulation and the primacy of the market may be ending.
- The German incentives model is effective.

The MISI Incentives Report

Over the past two decades, MISI has regularly published reports identifying, categorizing, and quantifying USA federal government incentives and subsidies for the energy industries. This research found that the federal government has historically employed a variety of incentives to support energy development and that the types, amounts, and targets of federal incentives have changed substantially over time. The findings provide a quantitative record of the incentives amounts expended, the types of incentives provided, and the energy sources targeted with each type of incentive. MISI's work has been critical for enabling policy-makers to follow where these expenditures have gone and determine what they have done for U.S. energy supply.

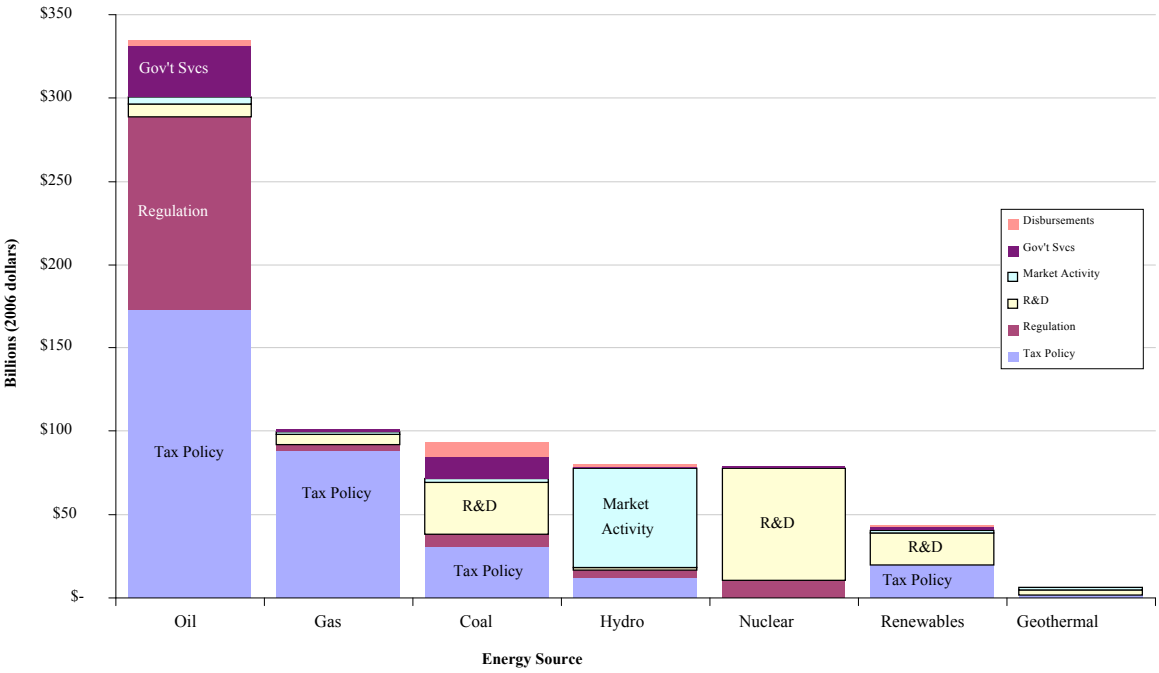
As summarized Figures II-2 and II-3, MISI's findings indicate that the largest beneficiaries of federal energy incentives have been oil, gas, coal, and nuclear energy, receiving nearly all incentives and subsidies provided.[1] Specifically, MISI found that:

- The U.S. federal government has provided an estimated $725 billion (2006 dollars) for energy development since 1950 -- including $81 billion for hydro power, $44 billion for renewables, and $6.5 billion for geothermal.
- Renewables, including geothermal but excluding large hydro, received less than seven percent of total -- $50 billion.
- By contrast, the oil, natural gas, coal, nuclear, and large hydro industries received $675 billion in Federal incentives.
- The largest type of incentive is tax concessions, amounting to about 45 percent of all incentives.
- Federally-funded regulation and R&D, at about 20 percent each, are the second and third largest incentives.

MISI concluded that the historical legacy of U.S. energy subsidies – and the pattern that continues – place clean energy at an economic disadvantage in the marketplace. Further, MISI estimated that it may take decades of revised energy incentives policies to remedy these market distortions.

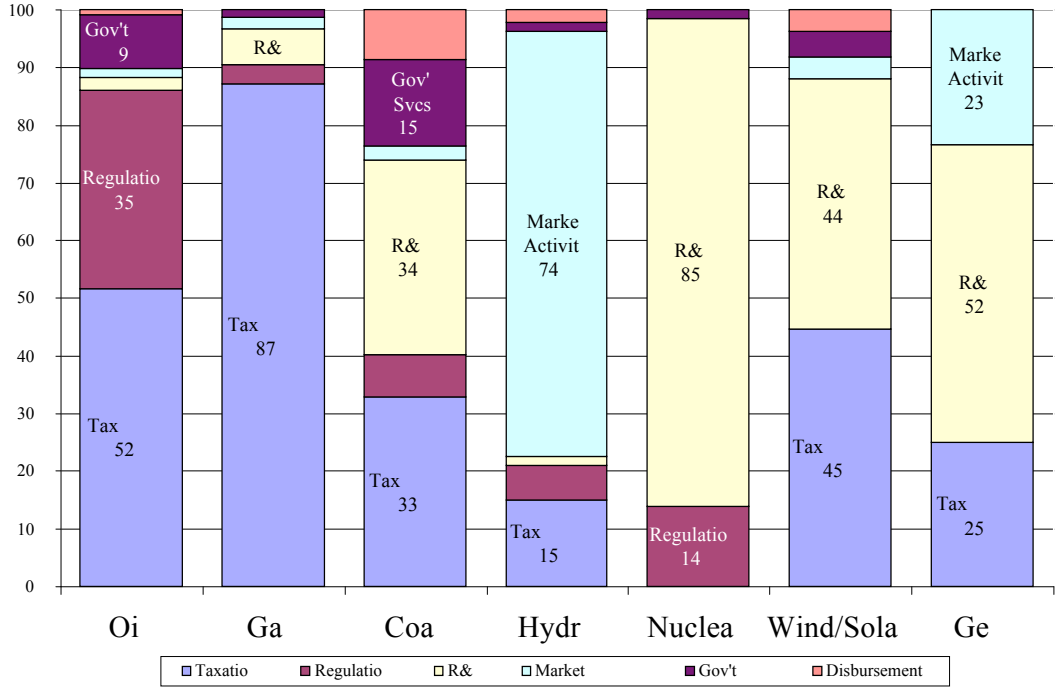
[1] Management Information Services, Inc., *Analysis of Federal Expenditures for Energy Development*, Washington, D.C., September 2008.

Figure II-2
Comparison of Federal Incentives for Energy Development 1950-2006



Source: Management Information Services, Inc., 2008

Figure II-3
Mix of Federal Incentives for Each Energy Source



Source: Management Information Services, Inc., 2008.

II.B. The Relationship Between Clean Energy Development and Economic Indicators

In this section we assess the relationship between clean energy development and economic indicators, such as jobs, incomes, GDP growth, reduced pollution, energy and cost savings, reduced energy price fluctuations, and other appropriate metrics. There are few reliable, rigorous analyses of these issues that have been conducted in any countries. We first summarize the results of several studies and then explore in depth the findings of several seminal studies.

II.B.1. Summary of Findings From Selected Studies

Economic Survey of Europe

An Economic Survey of Europe report found that In the developed market economies increased energy efficiency has been the result of structural change towards a service economy, of technological change towards less material- and energy-intensive production, and the adoption of new economic and environmental policies to internalize environmental externalities.[1] A further decoupling of growth and environment, and thus progress towards sustainable development, requires a number of policies, including:

- Adoption of an effective mix of economic instruments such as taxes, charges, and tradable permits to correct market and policy failures, internalized environmental and social costs, and induced changes in the composition of consumption and production
- Improvements in the efficiency of resource use and the "dematerialization" of the economy
- Changes in the content of economic growth
- Education to encourage industrial and collective responsibility and thereby induce behavioral changes that will support sustainable development

This study of the relationship between economic growth and environmental initiatives in Europe found that the experience holds valuable lessons, including:

- The transition from a trade-off to a complementary relationship between economic growth and environmental quality is both a long process and one that requires active policy interventions in terms of i) the integration of economic and environmental policies (e.g. the greening of fiscal policy), and ii) the phasing out of environmentally harmful subsidies and the introduction of policy instruments to internalize environmental costs.
- Industrial restructuring and market pricing do not guarantee the decoupling of economic growth from environmental pressures. In the presence of environmental externalities, pricing in sectors such as energy and transport (but also agriculture and industry) should reflect not only economic and international costs but also the social costs that have been traditionally ignored by markets and international trade.

[1] Theodore Panayotou, "Economic Growth and the Environment," *Economic Survey of Europe, 2003*, No. 2, Chapter 2, pp. 45-72.

- While command and control regulations have been effective in decoupling environment and growth and bringing about significant improvements in environmental quality in the developed market economies of the ECE region, this has been accomplished at an unnecessarily high cost. More recent experience of OECD countries demonstrates that combining command and control regulations with strong economic incentives is a more cost effective and flexible means of decoupling economic growth from environmental pressures and ensuring sustainable development.

Arizona Study

A study for the USA state of Arizona found that, overall, renewable energy is an excellent investment that provides strong returns for Arizona and that investments in renewable energy, dollar for dollar, produce a greater net benefit for Arizona's economy than conventional energy technologies.[1] Investing in a clean, renewable energy supply for Arizona would generate thousands of new high-paying jobs, benefit Arizona's economy, conserve scarce water supplies, and improve public health. Adopting a renewable energy standard to increase electricity generation from clean and renewable sources by at least one percent per year (reaching 10 percent of total electricity consumption by 2015 and 20 percent by 2020) would have a variety of benefits compared to business as usual. Between 2005 and 2020, investing in clean energy would:

- Create jobs, increasing net employment a total of 6,100 person-years by 2020
- Increase wages by a net annual average of $66 million, with a net present value of $570 million
- Increase the gross state product (GSP) by a net annual average of $200 million, with a net present value of $1.6 billion
- Assist rural areas, directly generating over $600 million in property taxes to fund education and other local government services
- Save water, conserving a total of 23 billion gallons, enough to supply the residential needs of Phoenix for three-quarters of a year
- Reduce emissions of nitrogen oxide, sulfur dioxide, and carbon dioxide

Colorado Study

A study for the USA state of Colorado found that developing Colorado's clean energy resources will yield better results than the alternatives.[2] It determined that, by investing in renewable energy to meet its electricity needs, the state will create jobs, stabilize energy prices, and reduce the long-term economic and environmental risk from global warming. Expanding Colorado's renewable energy standard will:

[1]Travis Madsen and Diane E. Brown, *Renewing Arizona's Economy: The Clean Energy Path to Jobs and Economic Growth*, Arizona PIRG Education Fund, April 2005.

[2]Travis Madsen, Timothy Telleen-Lawton, Will Coyne, and Matt Baker, *Energy for Colorado's Economy: Creating Jobs and Economic Growth with Renewable Energy*, Environment Colorado Research and Policy Center, Denver, Colorado, February 2007.

- Create a net increase of 4,100 person-years of employment through 2020
- Increase wages paid to workers in the state by a net cumulative total of $570 million
- Increase Colorado's share of U.S. GDP by a net of $1.9 billion through 2020
- Generate $400 million in property taxes (through 2020) to fund education and other local government services
- Reduce soot, smog, mercury, and GHG emissions from Colorado's electricity sector in 2020 by 11 percent
- Save a cumulative total of 18 billion gallons of water through 2020

Clean Energy, Economic Growth, and Jobs in the USA

A study of the relationship in the USA between investments in clean energy and environmental programs and economic and job growth found that the they are related and compatible.[1] For example, if found that:

- Contrary to conventional wisdom, environmental protection, economic growth, and jobs creation are complementary and compatible.
- Investments in clean energy and environmental programs create jobs and displace jobs, but the net effect on employment is positive.
- Clean energy and environment protection have grown rapidly to become a major sales-generating, job-creating industry with revenues of $300 billion and 5 million jobs in 2003.
- At the state level, the relationship between green policies and economic/job growth is positive, not negative -- states can have strong economies and simultaneously protect the environment.
- Clean energy and environmental jobs are concentrated in manufacturing and professional, information, scientific, and technical services, and are thus disproportionately the types of jobs all states seek to attract.

University of California Study

A report by the University of California of 13 independent studies analyzed the economic and employment impacts of the clean energy industry in the USA and Europe.[2] The studies employed different methods, were conducted by a variety of independent researchers in the USA and Europe, were conducted over different time periods, and analyzed different clean energy policies and technologies. Nevertheless, the report

[1]Roger Bezdek, Robert Wendling, and Paula DiPerna, "Environmental Protection, the Economy, and Jobs: National and Regional Analyses," *Journal of Environmental Management*, Vol. 86, No. 1 (January 2008), pp. 63-79, and Roger Bezdek and Robert Wendling, "Jobs Creation and Environmental Protection." *Nature*, Vol. 434, No. 7033 (March 31, 2005), p. 678.

[2]Daniel M. Kammen, Kamal Kapadia, and Matthias Fripp, *Putting Renewables to Work: How Many Jobs Can the Clean Energy Industry Generate?* RAEL Report, University of California, Berkeley, 2006.

found that expanding the use of clean energy is not only good for energy self-sufficiency and the environment, it also has a significant positive impact on employment.

The authors noted that, while it is often assumed that clean energy and environmental protection inevitably come at a financial cost, an increasing number of studies are finding precisely the opposite is true. Specifically, they found that greater use of renewable energy systems provides economic benefits through investments in innovation and through new job creation, while at the same time protecting the economy from political and economic risks associated with over-dependence on too limited a suite of energy technologies and fuels. While a shift from fossil fuels to renewables in the energy sector, at whatever scale, will create some economic and job losses, these losses can be adequately ameliorated through a number of policy actions. The report concluded that embedding support for renewables in a larger policy context of support for energy efficiency, green building standards, and sustainable transportation will have net positive impacts on the economy, employment, and the environment.

Economic Commission for Europe Study

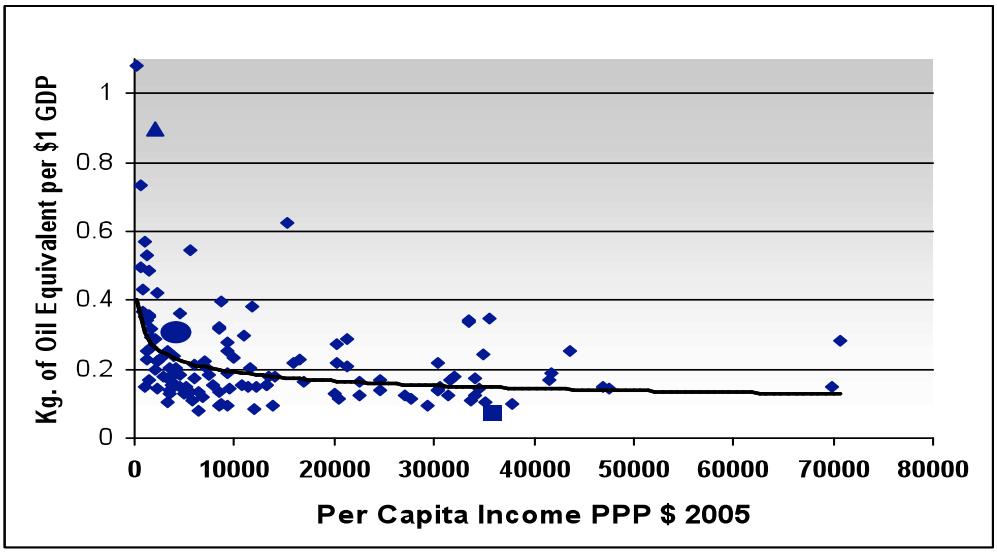
A study by the Economic Commission for Europe found that improved energy efficiency significantly reduces energy needs and CO_2 output and has significant economic benefits.[1] For example, it found that:

- Alternatives to fossil fuels, such as biofuels, waste products, wind, solar, and tidal are increasingly becoming cost effective.
- There are numerous inexpensive, reliable, easy, and efficient existing options, many of which are self-financing.
- Adaptation is more expensive than mitigation.
- Promoting energy efficiency will contribute to the goal of sustainable development and will also produce significant economic benefits.
- Switching to less CO_2 intensive fossil fuels and carbon capture and sequestration is imperative.

It found that that the cross-country variations in energy efficiency are quite large: The energy savings if all countries reach at least the average would total nearly 20 percent, and the energy savings if all countries reach the energy efficient frontier would total 42 percent – see Figure II-4.

[1]Marek Belka, "Energy Efficiency's Contribution to Reducing World Poverty: The Role of the Regional Commissions," Economic Commission for Europe, 2008.

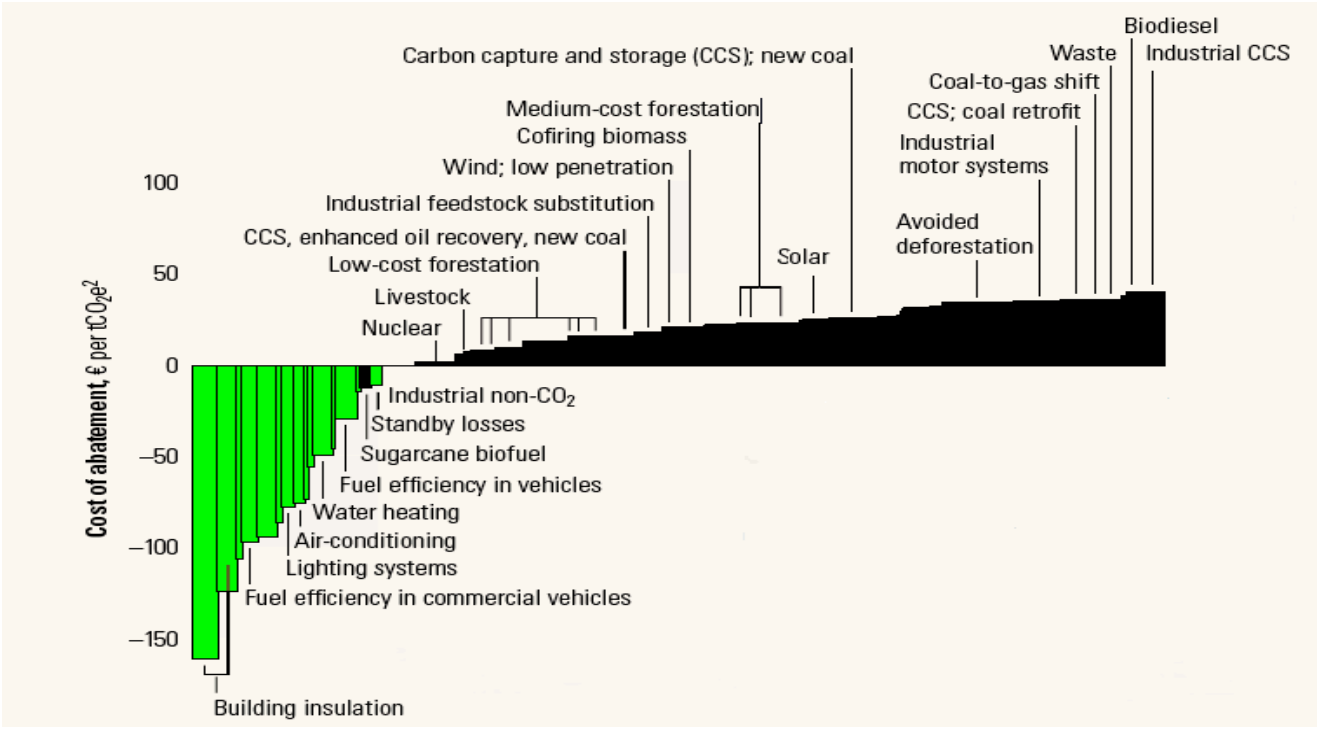
Figure II-4
Cross Country Variations in Energy Efficiency



Source: Economic Commission for Europe

The Commission also found that increasing energy efficiency is not only the least costly way to reduce CO_2, but in many technological applications actually has negative costs – Figure II-5.

Figure II-5
Cost Effectiveness of Clean Energy Technologies



Source: Economic Commission for Europe.

Vehicle Fuel Efficiency Standards in the USA

A study of the impact of vehicle fuel efficiency standards in the USA found that enhanced standards would have positive energy, environmental, economic, and job benefits.[1] The findings indicated that increased vehicle fuel efficiency standards will increase economic growth and create jobs. Specifically:

- Enhanced vehicle fuel efficiency standards would increase employment, although some industries and occupations will lose jobs. In total, 350,000 net new jobs would be created by 2020 through fuel efficient vehicle development, production, and sales.
- There are regional implications: Most states will gain substantial numbers of jobs; however, job increases and decreases will be spread unevenly among different sectors and industries within each state, and there will thus be job shifts within states as well as among states.
- Enhanced vehicle fuel efficiency standards would: (i) reduce U.S. annual oil consumption by as much as 60 billion gallons; (ii) save drivers $100 billion annually; and (iii) reduce annual US GHG emissions by 180 million tons.

European Commission Study

A European Commission study found that, just as development of the industrial society during the last century led to a massive increase in labor productivity, the key to Europe's future economic development now lies in increasing resource and energy productivity.[2] Specifically, this means developing and deploying innovative energy- and material-saving technologies, employing new environmentally-friendly technologies and products, optimizing work and production processes, and developing recycling potential. More efficient use of energy sources is vital to increasing resource productivity, and what is required are technologies that minimize not only energy conversion losses but also the emissions produced. The study concluded that:

- Strong action to fight climate change is compatible with continued economic growth and prosperity. It gives Europe a head start in the race to create a low-carbon global economy that will unleash a wave of innovation and create new jobs in clean technologies.
- In a time of growing oil prices and climate change concerns, renewable energy sources will help Europe reduce its CO_2 emissions, strengthen security of supply, and develop jobs and

[1]Roger Bezdek and Robert Wendling, "Fuel Efficiency and the Economy." *American Scientist*, Volume 93 (March-April 2005), pp. 132-139; Roger Bezdek and Robert Wendling, "Potential Long-term Impacts of Changes in U.S. Vehicle Fuel Efficiency Standards," *Energy Policy*, Vol. 33, No. 3 (February 2005), pp. 407-419.

[2]European Commission, *Boosting Growth and Jobs by Meeting Our Climate Change Commitments*, Brussels, January 2008.

growth in a high tech developing sector. Clean energy initiatives will enable Europe to be the leader in the race towards the low carbon economy.

- Development of clean energy is a win-win opportunity for the Member States to finance environmental projects and for economic growth in the EU.

Legally binding RE targets for Member States in 2020 are given in Table II-7.

Table II-7
Legally Binding Renewable Energy Targets for Member States in 2020

	Reduction target in sectors not covered by the EU ETS compared to 2005	Share Renewables in the final energy demand by 2020
AT	-16.0%	34%
BE	-15.0%	13%
BG	20.0%	16%
CY	-5.0%	13%
CZ	9.0%	13%
DK	-20.0%	30%
EE	11.0%	25%
FI	-16.0%	38%
FR	-14.0%	23%
DE	-14.0%	18%
EL	-4.0%	18%
HU	10.0%	13%
IE	-20.0%	16%
IT	-13.0%	17%
LV	17.0%	42%
LT	15.0%	23%
LU	-20.0%	11%
MT	5.0%	10%
NL	-16.0%	14%
PL	14.0%	15%
PT	1.0%	31%
RO	19.0%	24%
SK	13.0%	14%
SI	4.0%	25%
ES	-10.0%	20%
SE	-17.0%	49%
UK	-16.0%	15%

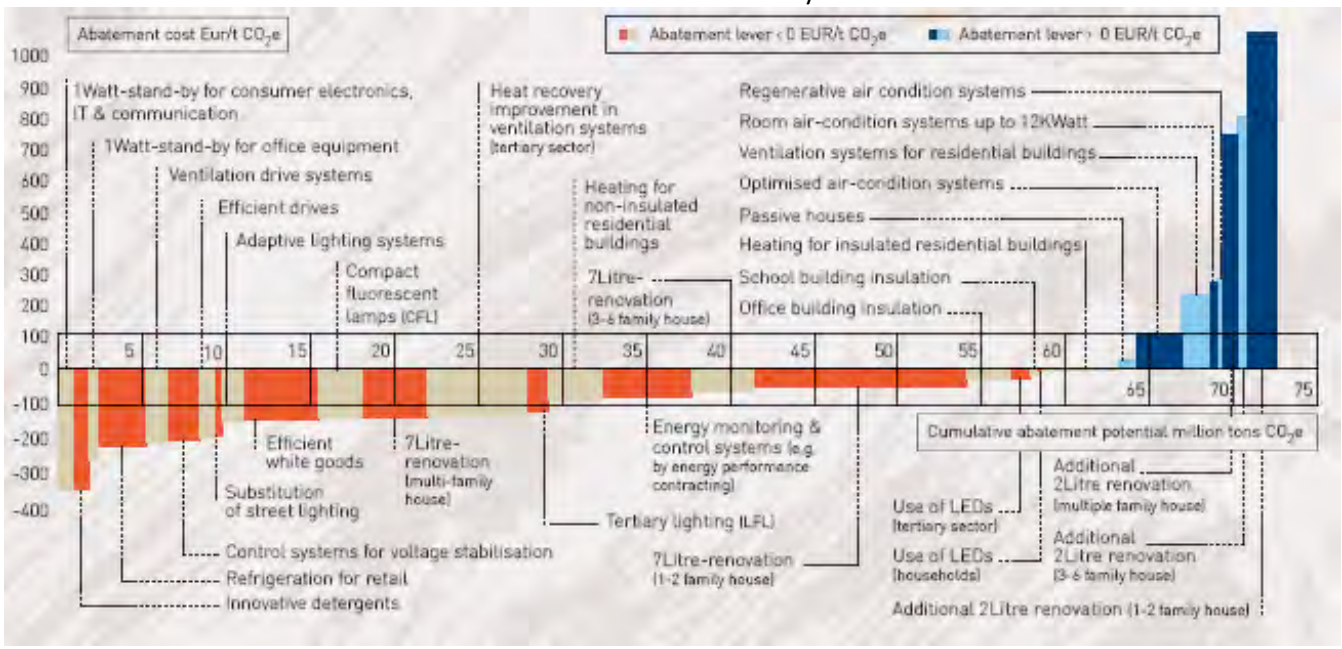
Source: European Commission, 2008

The Business Europe Study

A Business Europe study of the European experience found that energy efficiency reduces greenhouse gas emissions and saves costs, and that of all possible measures to abate GHG emissions, those that use energy more efficiently have the lowest cost.[1] It found, for example:

- In the EU 15, energy efficiency of energy end-users (industry, households, transport) improved by 11 percent between 1990 and 2004. However, improvements in several sectors have stagnated in recent years, which suggests that the "easy" measures have already been taken.
- For the German economy, there is considerable untapped potential in cost-effective energy efficiency measures, especially for the residential sector -- almost 60 million tons of CO_2 by 2020. Figure II-6 compares a number of CO_2 reduction measures for the residential sector in terms of cost and reduction potential – the measures indicated in red are cost-effective.
- Although much remains to be done in Europe, compared with other world regions it is very energy-efficient. If all countries in the world had Europe's energy productivity rate, then the world's energy consumption would be reduced by more than a quarter.
- Energy productivity in the industrial sector is several times higher in the EU than in the large emerging economies.

Figure II-6
Abatement Costs and Potential for the German Residential Sector by 2020



Source: Business Europe, 2007

[1]Business Europe, *Energy Efficiency: Reconciling Economic Growth and Climate Protection*, Brussels, December 2007.

II.B.2. In-depth Analyses

Several seminal studies have been conducted, and these are discussed at length here.

The MISI/ASES Report

Over the past several years, MISI and the American Solar Energy Association (ASES) conducted the first comprehensive analyses of the size and breadth of the clean energy industries in the USA and created the standard definition that provides comparability between data. The major contributions of this work include:

- Development of a rigorous definition of the RE and the EE industries
- Estimation of their current sizes and composition, including technology, sales, jobs, occupations, and skills
- Forecasting their growth to 2030 under three scenarios

Most recently, MISI found that in 2007 the U.S. clean energy industries generated $1,045 billion in sales and created over 9 million jobs.[1] The U.S. RE&EE revenues represent substantially more than the combined 2007 sales of the three largest U.S. corporations -- Wal-Mart, ExxonMobil, and GM ($905 billion). RE&EE are growing faster than the U.S. average and contain some of the most rapidly growing industries in the world, such as wind, photovoltaics, fuel cells, green buildings, recycling/ remanufacturing, and biofuels. With appropriate federal and state government policies, RE&EE could by 2030 generate over 37 million jobs per year in the U.S.[2]

Table II-8 shows the estimated 2007 size of the clean energy industries in the U.S. In the U.S. for RE:

- Gross revenues totaled nearly $43 billion and the number of jobs created by RE exceeded 500,000.
- Jobs created were disproportionately for scientific, technical, professional and skilled workers, and more than 95 percent of the jobs were in private industry.
- Over 70 percent of the jobs were in the biomass sector – primarily ethanol[3] and biomass power, and the second largest number of jobs was in the wind sector of the industry, followed by the geothermal and photovoltaics sectors.

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[1] Management Information Services, Inc., *Green Collar Jobs in the U.S. and Colorado: Economic Drivers for the 21st Century*, American Solar Energy Society, Boulder, Colorado, January 2009.

[2] These represent the total RE&EE generated jobs in that year, not new jobs or net jobs.

[3] Of the 540K total jobs created by renewable energy in the U.S. in 2007, 358K (71%) were in the biomass sector: 196K (39%) were in the ethanol sector, 7K (1.4%) were in the biofuels sector, and 155K (31%) were in the biomass power sector. Virtually all of the jobs in the ethanol sector are first-generation ethanol -- in the U.S. derived from corn due to government policies and incentives. Most future growth in U.S. ethanol is forecast to come from cellulosic ethanol.

In the U.S. for EE:

- Gross revenues totaled over $1 trillion and the number of jobs created by EE totaled nearly 8.6 million
- More than 98 percent of the jobs were in private industry
- Over 36 percent of the jobs were generated by the recycling, reuse, and remanufacturing sector, and the second largest number of jobs was generated by the nondurable manufacturing sector, followed by the miscellaneous durables manufacturing sector, and the computers, printers, copiers, etc. sector

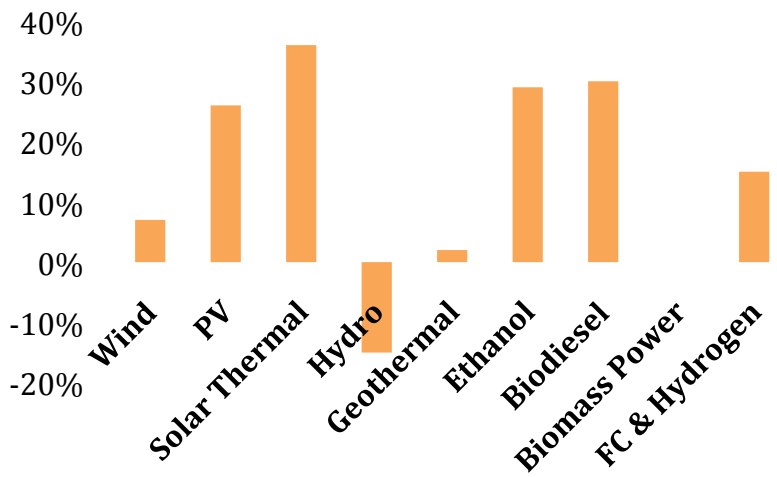
Table II-8
Summary of the U.S. Renewable Energy and Energy Efficiency Industries in 2007

Industry	**Revenues** (billions)	**Industry Jobs** (thousands)	**Total Jobs** (thousands)
Renewable Energy	$42.58	218	504
Energy Efficiency	1,002.92	3,745	8,586
TOTAL	$1,045.50	3,963	9,090

Source : Management Information Services, Inc. and American Solar Energy Society, 2008.

Total RE industry revenues increased 8.7 percent, from $39.2 billion in 2006 to $42.6 billion in 2007. Hydroelectric production decreased in 2007, and excluding the hydroelectric sector, RE industry revenues increased 11.1 percent, from $35.2 billion to $39.1 billion. Converting the 2006 RE data to constant 2007 dollars indicates that, in real terms, total RE revenues increased 5.5 percent, from $40.4 billion in 2006 to $42.6 billion in 2007. Excluding the hydroelectric sector, RE industry revenues increased 7.8 percent, from $36.3 billion to $39.1 billion – Figure II-7.

Figure II-7
Increase in Real RE Revenues, 2006 – 2007 (Constant 2007 dollars)



Source : Management Information Services, Inc. and American Solar Energy Society, 2008.

The real growth rate of U.S. GDP between 2006 and 2007 was 2.19 percent. Thus, including hydro, the RE industry grew more than twice as rapidly as the overall U.S. economy; excluding hydro, the RE industry grew more than three times as fast as the overall U.S. economy. Further, the biomass power sector is a significant part of the RE industry, but it grew little between 2006 and 2007. Excluding both hydro and biomass power, the U.S. RE industry grew 15.4 percent between 2006 and 2007 – more than seven times as fast as

the overall U.S. economy. Some sectors experienced very substantial growth: Solar thermal grew more than 35 percent, Biodiesel grew 30 percent, Ethanol grew nearly 30 percent, Photovoltaics grew more than 25 percent.[1]

Total EE industry revenues increased 7.5 percent, from $933 billion in 2006 to $1,003 billion in 2007. Converting the 2006 EE data to constant 2007 dollars indicates that, in real terms, total EE revenues increased 4.4 percent, from $961 billion in 2006 to $1,003 billion in 2007. The total number of jobs created by EE increased by more than 800,000. Thus, the U.S. EE industry between 2006 and 2007 grew about twice as rapidly as the overall U.S. economy.

In sum, this research found that:

- 2007 RE&EE sales represent substantially more than the combined 2006 sales of the three largest U.S. corporations (Wal-Mart, ExxonMobil, and General Motors -- $905 billion)
- RE&EE are growing more rapidly than U.S. average
- RE&EE contain some of the most rapidly growing industries in the world, such as wind, fuel cells, and biofuels

In 2007 these clean energy industries generated annually:

- More than a trillion dollars in industry sales
- More than 9 million jobs
- More than $100 billion in industry profits
- More than $150 billion in increased federal, state, and local government tax revenues
- Stimulus to U.S. manufacturing industry
- Displacement of imported oil
- Reduction in the U.S. trade deficit

California Study

A recent report analyzed the economic and job impact over the past two decades of California state policies, incentives, and mandates for clean energy and energy efficiency programs and found that California has grown more prosperous and added jobs even as it increased energy efficiency and clean energy and reduced per capita energy consumption and GHG emissions.[2] Major findings of the study include:

- From 2005 to 2007, jobs at clean energy companies grew by 10 percent, while the state economy's overall number of jobs grew one percent.

[1]While the percentage growth figures are important, it should be noted that some of the most rapidly growing RE sectors, such as PV, solar thermal, and biodiesel, are very small and even relatively modest growth in total revenues will thus produce large percentage increases.

[2]David Roland-Holst, *Energy Efficiency, Innovation, and Job Creation in California*, Center For Energy, Resources, and Economic Sustainability, University of California, Berkeley, October 2008.

- While Californians were reducing their individual energy use and GHG emissions, the state's economy grew, and state per capita GDP increased 28 percent from 1990 to 2006.
- Energy efficiency measures have enabled California households to redirect their expenditures toward other goods and services, creating about 1.5 million jobs with a total payroll of $45 billion, driven by household energy savings of $56 billion from 1972-2006.
- Job creation is in less energy intensive services and other categories, further compounding California's aggregate efficiency improvements and facilitating the economy's transition to a low carbon future.
- As a result of energy efficiency, California reduced its energy import dependence and directed a greater percentage of its consumption to instate, employment-intensive goods and services, whose supply chains also largely reside within the state, creating a multiplier effect of job generation.
- The same efficiency measures resulted in slower (but still positive) growth in energy supply chains, including oil, gas, and electric power. For every new job lost in these sectors, however, more than 50 new jobs have been created across the state's diverse economy.
- Clean energy and energy efficiency programs will continue the structural shift in California's economy from carbon intensive industries to more job intensive industries. While job growth continues to be positive in the carbon fuel supply chain, it is less than it would be without implementation of these policies.
- The economic benefits of energy efficiency innovation have a compounding effect. The first 1.4 percent of annual efficiency gain produced about 181,000 additional jobs, while an additional one percent yielded 222,000 more.
- California leads the USA in registering patents for green technologies and materials. The state also has the most venture capital for green startup companies, reaching a record $3.3 billion in 2008.
- California's economy uses energy more efficiently than the rest of the country, and the amount of GDP California generates for every unit of energy used is 68 percent higher than in the rest of the nation.

The report documented that, over the last generation, California has de-coupled from national trends of electricity demand, reducing its per capita electricity requirements to 40 percent below the national average. If this trend had not been established, the state would have had to build over 24 additional power plants and statewide emissions would have increased accordingly. However, this is only the direct effect of averted energy use and captures just a fraction of the economic impact of efficiency measures. Consumers were able to reduce energy spending and these savings were diverted to other demand. The stimulus thus provided by energy savings increased employment across a broad spectrum of consumer goods, services, and activities in all of their supply chains.

Using econometric analysis and detailed historical demand patterns for California and the USA, the report estimated the contribution to total state employment resulting from reducing household energy expenditure over the 35 year period 1972-2006. The results, in terms of net job creation, are presented in Table II-9. These estimates support the argument that energy efficiency stimulates net job creation and, although some energy sector industries may be adversely affected, energy efficiency saves households money.

The resulting expenditure shifts lead to demand driven job growth that far exceeds the losses to the carbon fuel supply chain, and 1,463,600 net new jobs were created over the period considered.[1] Further, sectoral examination of these results indicates that job creation is in less energy intensive services and other categories, further compounding California's aggregate efficiency improvements and facilitating the economy's transition to a low carbon future. More specifically, the results can be interpreted as estimates of the cumulative employment effects that have resulted because California households changed from national trends in electricity consumption.[2] In addition, the state reduced its energy import dependence, while directing a greater percent of its consumption to in-state economic activities.

Table II-10 translates efficiency-induced job growth into incomes and indicates that induced job growth has contributed approximately $45 billion to the California economy since 1972.

The report concluded that California's experience shows the potential of a green economy, and California's legacy of energy policies and resulting economic growth provides evidence that innovation and energy efficiency can make essential contributions to economic growth and stability. Had the state not embarked on its ambitious path to reduce emissions over three decades ago, the California economy would currently be in a significantly more vulnerable position. The results of this study indicate that, in addition to energy price vulnerability and climate damage, the risks of excessive energy dependence include lower long-term economic growth and that a lower carbon future for California is a more prosperous and sustainable future.

[1]Construction employment effects were omitted from the analysis because this is not classified as household (but investment) demand. However, independent evidence indicates that construction has benefited significantly from building standards and expenditure diversion to housing and real estate.

[2]These are calculated at each five-year milestone in the table, with the fairly conservative assumption that the attendant multiplier effects would take five years to run their course. In fact, the savings from additional efficiency are realized every year over the period considered, so the estimates may be significantly below the actual values.

Table II-9
Job Creation From Household Energy Efficiency

	1972	1977	1982	1987	1992	1997	2002	2007	Total
Agriculture	-	36	112	204	266	631	849	869	2,967
EnergyRes	-	(0)	(1)	(1)	(0)	(1)	(1)	(1)	(5)
ElectPwr	-	(266)	(1,140)	(2,236)	(3,405)	(4,720)	(5,809)	(5,944)	(23,520)
OthUtl	-	(12)	(78)	(2)	13	71	77	79	149
Construction	-	-	-	-	-	-	-	-	-
Light Industr	-	821	2,688	4,593	6,095	8,392	9,247	9,463	41,300
OilRef	-	(14)	(6)	(9)	(10)	(14)	(24)	(25)	(102)
Chemica	-	48	190	448	764	555	2,234	2,287	6,526
Cement	-	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Metals	-	2	1	4	(5)	(16)	(16)	(16)	(46)
Machinery	-	14	26	54	44	(38)	(51)	(52)	(2)
Semicon	-	0	0	3	8	176	318	325	830
Vehicles	-	20	38	133	133	240	427	437	1,428
OthInd	-	37	125	265	397	1,136	1,770	1,811	5,541
WhlRetTr	-	4,740	15,254	32,236	46,139	83,118	136,402	139,587	457,475
VehSales	-	-	-	-	-	215	0	0	215
Transport	-	9	31	(211)	76	202	305	312	724
FinInsREst	-	1,191	5,340	15,075	30,808	21,500	34,201	35,000	143,114
OthPrServ	-	3,063	11,456	25,848	45,596	64,397	96,352	98,602	345,313
PubServ	-	74	3,360	22,488	56,060	98,866	148,691	152,163	481,703
	-	9,763	37,396	98,892	182,977	274,710	424,974	434,898	1,463,611

Source: University Of California, October 2008

Table II-10
Employee Compensation Gains from Household Energy Efficiency
(millions of 2000 US dollars)

	1972	1977	1982	1987	1992	1997	2002	2007	Total
Agriculture	-	0	2	3	4	9	16	17	52
EnergyRes	-	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
ElectPwr	-	(10)	(50)	(111)	(190)	(303)	(441)	(546)	(1,652)
OthUtl	-	(1)	(4)	(0)	0	4	5	6	10
Construction	-	-	-	-	-	-	-	-	-
LightIndustr	-	20	70	117	162	214	284	323	1,190
OilRef	-	(1)	(0)	(0)	(1)	(1)	(2)	(3)	(8)
Chemica	-	2	7	16	27	23	87	97	258
Cement	-	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Metals	-	0	0	0	(0)	(1)	(1)	(1)	(2)
Machinery	-	0	1	2	2	(1)	(2)	(2)	(2)
Semicon	-	0	0	0	0	11	25	32	69
Vehicles	-	1	2	7	7	11	22	22	72
OthInd	-	1	3	7	12	36	67	82	208
WhlRetTr	-	105	336	707	1,026	1,859	3,530	3,647	11,211
VehSales	-	-	-	-	-	7	0	0	7
Transport	-	0	1	(8)	3	8	14	13	32
FinInsREst	-	31	158	512	1,207	971	2,036	2,415	7,329
OthPrServ	-	76	209	438	824	1,356	2,440	2,679	8,022
PubServ	-	2	107	730	1,866	3,160	5,526	6,422	17,814
	-	227	840	2,420	4,950	7,363	13,605	15,205	44,611

Source: University Of California, October 2008

Lisbon Council Study

A study by the Lisbon Council found that countries with innovative environmental and clean energy technologies register positive development in total factor productivity and thus experience dynamic economic growth.[1] In the future, interest will increase in integrated environmental protection, which starts at the production stage and proceeds through recycling and more efficient use of energy, water, and other raw materials. It is usually much more cost effective to avoid environmental pollution from the outset rather than having to remedy the consequences with end-of-pipe technologies in the final stages of the production process. In addition, companies often benefit directly from the cost-saving potential of production-integrated clean energy and environmental protection techniques, which can be considerable. Thus, production-integrated environmental protection will gain in importance worldwide.

The Lisbon Council conducted a study of how the EU's 14 largest economies[2] perform in reaching goals set out in the Lisbon Agenda. It ranked countries according to key criteria decisive for success in the 21st century: Economic growth, productivity growth, employment, human capital, future-oriented investment, and fiscal sustainability.[3]

The Lisbon Council report noted that building on the Lisbon Agenda's commitment to "sustainable economic growth," the European Commission proposed an integrated package of energy and climate-change proposals in January, 2007. Two months later, the proposal was approved by the European Council, and among the program's key commitments:

- A 20 percent increase in energy efficiency by 2020
- A 20 percent reduction in GHG emissions by 2020
- A 20 percent share of renewables in overall EU energy consumption
- A 10 percent biofuel component in vehicle fuel by 2020

Inventing and deploying clean energy and environmental technologies will be key to achieving the targets set out, and ambitious climate protection will require a massive refocus of the entire global economy. This refocus, in turn, can serve as an important driver of growth, bringing productivity increases in its wake and creating demand for better, cleaner technologies in new markets. New materials, better technologies, improved production processes, and intelligent products can help solve global environmental problems and keep the consequences of climate change in check. And, while success will come easiest to the countries that make the most efficient use of natural resources (raw materials, energy and water), the real winners will be the

[1] *European Growth and Jobs Monitor: Indicators for Success in the Knowledge Economy*, report prepared for the Lisbon Council by Allianz Dresdner Economic Research, 2008.

[2] Austria, Belgium, Denmark, Finland, France, Greece, Germany, Ireland, Italy, Netherlands, Poland, Spain, Sweden and the UK.

[3] It found that Finland tops the ranking and indicated that Finland will comfortably overshoot the Lisbon targets.

companies, countries, and regions that take the lead in developing and deploying the new technologies.

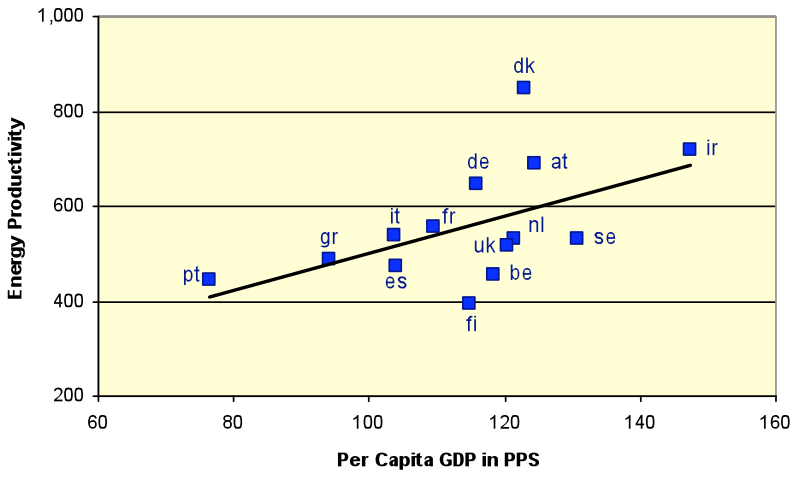
Permanently sustainable economic and environmental development requires substantial progress on resource productivity. Just as development of industrial society during the last century led to a massive increase in labor productivity, so the key to Europe's future economic development now lies in increased resource and energy productivity. Specifically, this means developing and deploying innovative clean energy and energy- and material-saving technologies, employing new environmentally-friendly technologies and products, optimizing work and production processes, and expanding recycling. More efficient use of energy is vital to increasing resource productivity, and technologies are required that minimize energy conversion losses and the emissions produced.

The development of new clean energy technologies not reliant on fossil fuels is a central plank of climate protection. Technologies using renewable energy sources – water, wind, solar, biomass, and geothermal power – to reduce demand for energy as a result of more efficient energy consumption offer particularly good prospects.

Under market conditions, technological progress generally focuses only on enhancing the productivity of resources or factors of production that generate costs for the private sector. Given that environmental pollutants are not priced by the market, emitters do not cost them out adequately. As a result, increased energy efficiency and resource productivity can only be achieved by internalizing the external costs of environmental pollution. Only if the tax and subsidy regime is redesigned and prices tell the "ecological truth" will companies and consumers be motivated to alter their production and consumption behavior. This means incentivizing desirable types of production and penalizing polluters.

The report addressed the central question: Can economic growth and prosperity be enhanced by clean energy and more efficient energy use, or does the reduced consumption of natural resources and energy automatically mean slower growth and less output? From a theoretical perspective, the answer depends on the type of environmental protection and energy policies put in place to achieve these objectives. The study conducted a cross-sectional analysis of economic performance in EU-15 countries for the year 2004 and found a positive correlation between energy efficiency and prosperity levels. MISI extended and updated this analysis, and the results are given in Figure II-8. This figure shows each country's energy

Figure II-8
Energy Efficiency and Prosperity – 2006



Source: Eurostat and Management Information Services, Inc., 2009.

productivity (the ratio of GDP to energy inputs) as a measure of energy efficiency relative to that country's overall prosperity (per capita GDP adjusted for purchasing power parity). The comparison shows that countries with high energy efficiency and energy productivity also exhibit high levels of prosperity.

The report also analyzed the five largest EU countries (Germany, UK, France, Italy, and Spain), to determine the impact of energy inputs on total factor productivity (TFP), and through TFP on economic growth. Specifically, it examined the contribution to economic growth measured by factors of production and by total factor productivity, computing the percentage change in the real input of capital, labor, and energy weighted with the respective income shares of value added for a specific period, and including energy inputs as an additional factor of production alongside capital and labor – the Solow growth decomposition.[1] The change in TFP was obtained by subtracting the contributions to growth by the factors of production from GDP growth.

The results of this analysis are summarized in Table II-11, which used the Solow growth decomposition model to disaggregate and chart factors of production and total factor productivity for five-year periods from 1980 to 2004 at the industry level in the EU's five largest economies.[2] The findings indicated a positive correlation between energy productivity, economic growth, and overall prosperity. In other words, viewed from the medium to long term, investing in more productive and thus more efficient use of energy is not only good for the environment, it also promotes economic growth and prosperity. The results of this growth decomposition showed that total factor productivity generally delivered a notable contribution to economic growth, particularly in the case of Germany, where half the value added in the years from 1985 to 1994 was accounted for by an increase in total factor productivity.[3]

The report also analyzed the correlation between energy productivity and total factor productivity. Following the logic of the Solow decomposition model, the deployment of more clean energy and energy-efficient technologies could increase the efficiency of production with given capital and labor inputs. In that case, total factor productivity would increase. However, it is also conceivable that energy efficiency increases as a result of the use of certain types of energy, possibly because their use has been administratively decreed, so that output on given capital and labor inputs – and with it total factor productivity – declines.

[1]This is a technique for measuring factor inputs developed by U.S. economist and Nobel Laureate Dr. Robert Solow.

[2]The calculations were based on the EU KLEMS database. The income weighting is between 50 percent and 66 percent for labor, between 20 percent and 35 percent for capital, and between five percent and 20 percent for energy.

[3]One exception is Spain, where total factor productivity shrank between 1995 and 2004, even though real economic growth over the same period averaged more than three percent per year. This is partly a reflection of strong economic growth in Spain in areas of low productivity, such as housing construction and the services sector.

Table II-11
Energy Productivity and Prosperity

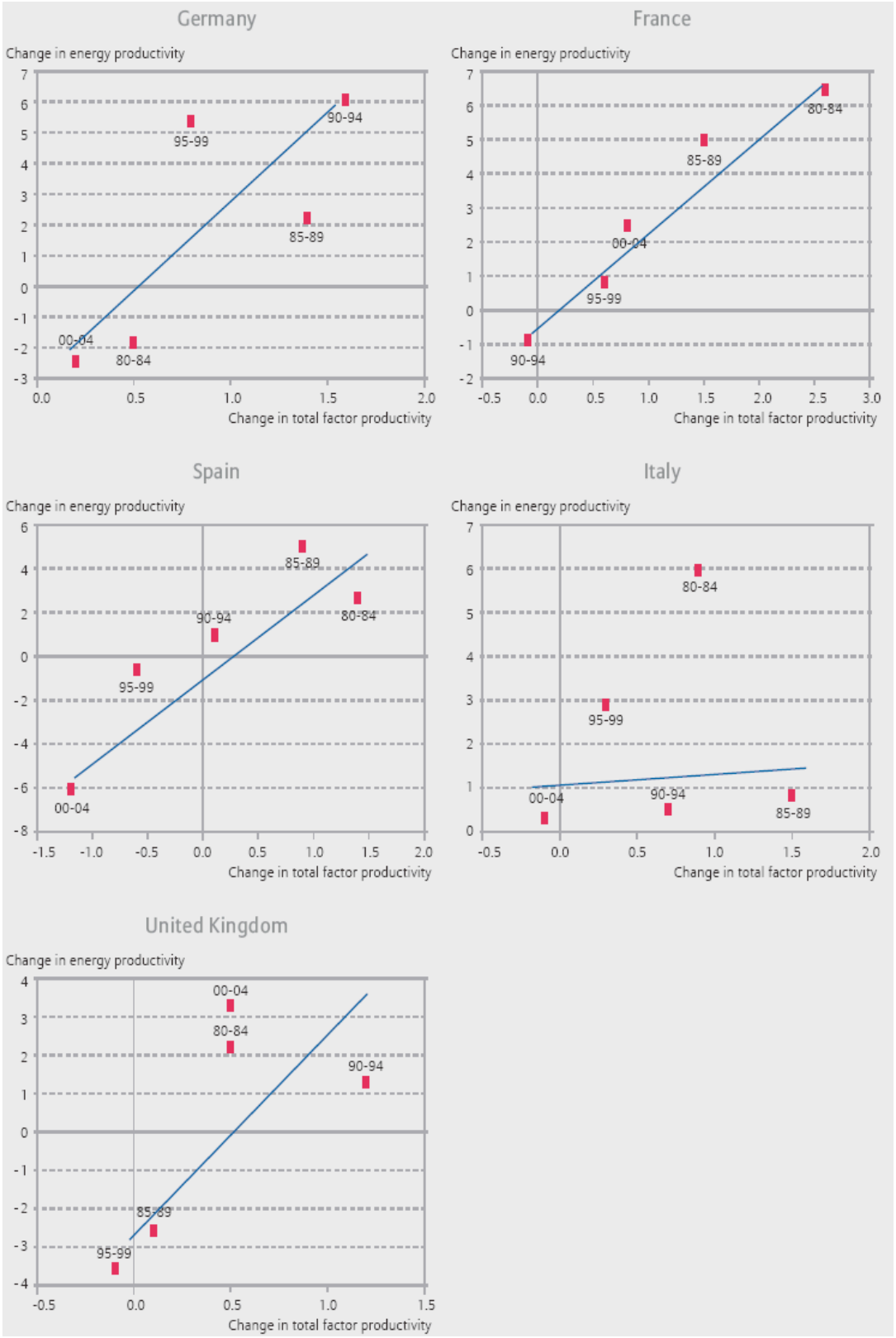
	GDP	Energy	Labour	Capital	TFP
Germany					
80-84	1.1	0.3	-0.3	0.6	0.5
85-89	2.7	0.0	0.5	0.8	1.4
90-94	2.7	-0.2	0.0	1.2	1.6
95-99	1.7	-0.2	-0.2	1.3	0.8
00-04	1.2	0.3	-0.1	0.8	0.2
France					
80-84	2.0	-0.7	-0.6	0.7	2.6
85-89	2.8	-0.2	0.5	1.0	1.5
90-94	1.2	0.1	0.3	0.8	-0.1
95-99	2.3	0.1	0.8	0.8	0.6
00-04	1.9	0.0	0.3	0.9	0.8
Italy					
80-84	1.8	-0.6	0.6	1.0	0.9
85-89	3.2	0.2	0.6	0.9	1.5
90-94	1.1	0.0	-0.3	0.7	0.7
95-99	1.6	-0.1	0.5	0.9	0.3
00-04	1.4	0.1	0.5	0.9	-0.1
Spain					
80-84	1.1	-0.3	-0.9	0.9	1.4
85-89	4.1	-0.2	1.7	1.6	0.9
90-94	2.1	0.1	0.6	1.3	0.1
95-99	3.4	0.3	2.2	1.6	-0.6
00-04	3.3	0.8	2.0	1.7	-1.2
United Kingdom					
80-84	0.4	-0.2	-1.0	1.1	0.5
85-89	3.5	0.8	1.2	1.4	0.1
90-94	1.5	0.0	-0.6	0.9	1.2
95-99	3.1	0.5	1.1	1.6	-0.1
00-04	2.6	-0.1	1.0	1.2	0.5

The results were positive, indicating that countries which adopt clean energy and environmental technologies quickly do reap benefit in overall productivity performance. Figure II-9 shows the change in total factor productivity for the individual countries and the five periods in comparison to the change in energy productivity. The trend lines all show a positive correlation between energy productivity and total factor productivity in each of the countries surveyed.

The report found that that the more efficient use a country makes of energy as a production input, the greater the increase will tend to be in total factor productivity and thus in economic growth and prosperity. In four of the five countries surveyed, the analysis also showed a positive connection between changes in energy productivity and labor productivity. Only in Italy, where the correlation between energy productivity and total factor productivity is the least pronounced of the countries analyzed, can no clear reciprocal relationship be identified.[1]

[1]This finding of a positive correlation between energy productivity and labor productivity/total factor productivity corresponds with the findings of several other studies, which also conclude that, as a rule, high rates of increase in labor productivity are accompanied by similarly strong increases in total factor productivity. See, for example, Nicholas Crafts, "What Creates Multi-Factor Productivity?" Paper prepared

Figure II-9
The Relationship Between Energy Productivity and
Total Factor Productivity in Germany, France, Spain, Italy, and the UK



Source: The Lisbon Council, 2008

for the joint ECB, Bank de France and The Conference Board conference "The Creation of Economic and Corporate Wealth in a Dynamic Economy", Frankfurt 2008.

The report thus concluded that – far from harming Europe's long-term competitiveness – clean energy and energy efficiency will be a driver of future growth. The EU can benefit from "first-mover advantage" with regards to energy efficiency and application of new clean energy technologies. The contribution that Europe can make towards solving the world climate problem lies in creating a functioning market for emission rights and initiating a competitive European market for renewable energies. Both will ultimately lead to the development of energy efficient technologies that will reduce CO_2 emissions. In creating these markets, Europe will prove that clean energy, energy efficiency, economic growth, and carbon control are not only compatible, but are ultimately mutually self re-enforcing.

Solar Energy Research and Education Foundation Study

A study prepared for the Solar Energy Research and Education Foundation (SEREF) analyzed the economic impact on the U.S. economy of extending federal tax credits for solar technologies – photovoltaics (PV), solar water heating, and concentrating solar power (CSP).[1] The SEREF study analyzed an 8-year extension of the current federal Investment Tax Credit (ITC) for solar technologies,[2] and estimated the impact of a full 8-year extension, as opposed to several 1-year or 2-year extensions.[3] Short term extensions do not provide stable support for long term capital investments to increase manufacturing or complete utility-scale solar power plants, and typically lead to "boom-bust" cycles of annual installations, as seen in the U.S. wind industry (see the discussion in Section II.3.A of the problems of the temporary extensions of the USA REPTC).

The study:

- Projected market size with current and reduced federal tax credits
- Estimated direct employment and investment impacts using internal databases, industry interviews, and publicly available models
- Projected indirect and induced impacts using publicly available studies and models

As shown in Figure II-10, the study found that the federal solar ITC is critical for development of clean energy technologies. For example:

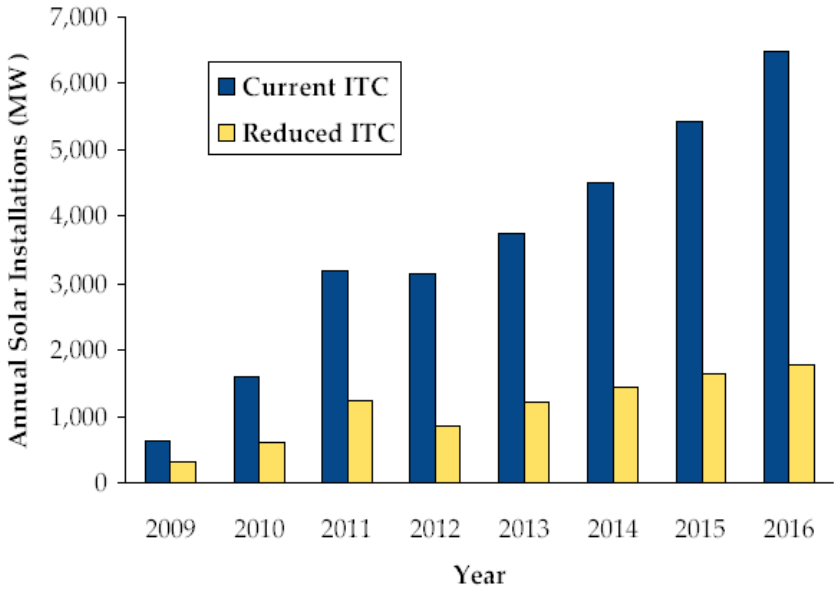
[1] *Economic Impacts of Extending Federal Solar Tax Credits*, report prepared for the Solar Energy Research and Education Foundation by Navigant Consulting, September 2008.

[2] The Current ITC provides a 30 percent tax credit for residential systems (capped at $2,000 for qualified solar properties) and a 30 percent tax credit for commercial properties.

[3] The Energy Tax Act of 1978 established a 15 percent tax credit for solar energy. This credit continued uninterrupted for 8 years until the Tax Reform Act of 1986 provided for a phased reduction. On January 1, 1987 the credit fell to 12 percent. On January 1, 1988 the credit further reduced to 10 percent. The credit remained at this level until 2005. The Energy Policy Act of 2005 created a new commercial and residential ITC for fuel cells and solar energy systems that applied from January 1, 2006 through December 31, 2007. This legislation was the first creation of a residential solar investment tax credit. The credit was extended for one additional year in December 2007 by the Tax Relief and Health Care Act of 2007. The solar ITC was set to expire on December 31, 2008, but was renewed shortly prior to that date.

- Solar project economics are highly dependent on the ITC, and an extended ITC results in market sizes two to three times larger than with reduced tax credits.
- Increased project returns also result in more available capital for solar projects, further driving growth.

Figure II-10
Impact of the ITC on USA Solar Installations, 2009 – 2016



Source: Solar Energy Research and Education Foundation, 2008

The study found, as shown in Figure II-11, that:

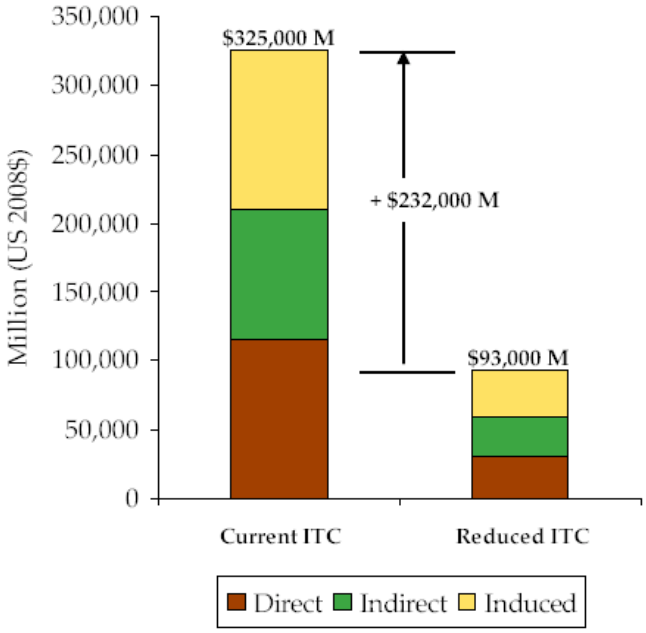
- Extending the ITC would result in increased investment of $232 billion between 2009 and 2016.
- $232 billion equates to a 250 percent increase in U.S. investment between 2009 and 2016.
- Most of the direct impact will be on U.S. manufacturing and construction industries.

The study also found that, as shown in Figure II-12, that:

- Extending the current ITC could create an additional 276,000 jobs and 1,200,000 job-years of employment between 2009 and 2016.
- Extending the ITC could result in increase of over 276,000 jobs in 2016.
- The potential increase in U.S. solar supported employment in 2016 is 276,000 Jobs
- 276,000 jobs is equivalent to a 168 percent increase in employment supported by the U.S. solar industry.

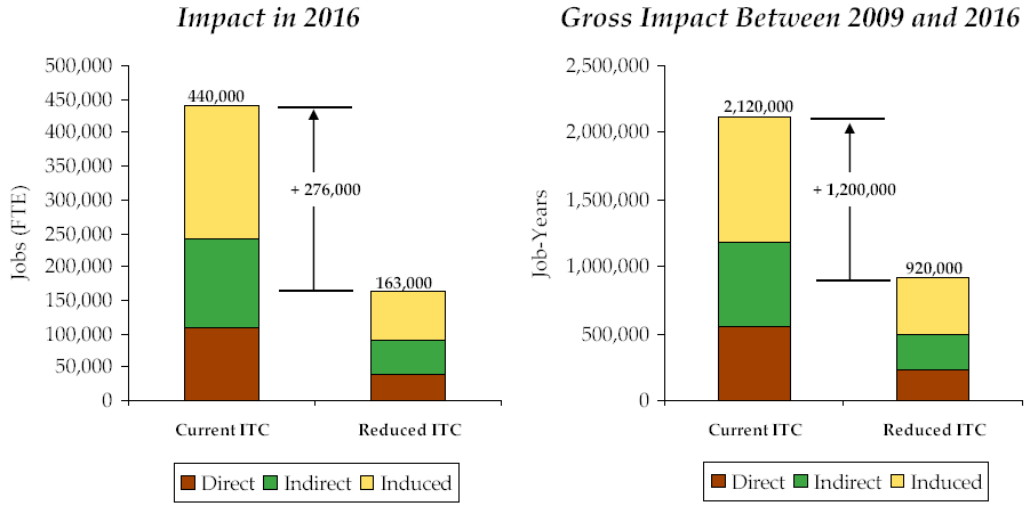
- Most of the direct impact will be felt by U.S. manufacturing and construction industries.
- By extending the ITC, the U.S. solar industry could create (directly and indirectly) an additional 440,000 jobs in 2016 -- of these 440,000 jobs, 110,000 jobs are directly in the solar industry and the remaining jobs are in industries supporting the solar industry or are a result of economic activity stimulated by the U.S. solar industry.

Figure II-11
Total USA Solar-Related Investments, 2009-2016



Source: Solar Energy Research and Education Foundation, 2008

Figure II-12
Increases in USA Clean Energy Employment



Source: Solar Energy Research and Education Foundation, 2008

The Canadian Photovoltaics Experience

Canadian federal government funding levels supporting renewable energy programs in Canada declined in the late 1980's and throughout most of the 1990's. However, since 2000 this trend has been reversed and there has been an increasing level of interest in the clean energy industry and in support from the government. As with individual states in the USA, a number of the provinces are aggressively supporting RE&EE programs and federal government incentive programs are being matched by a number of provincial programs.

For example, in 2009 the Ontario government introduced its Green Energy Act (GEA) designed to increase investment in clean energy and energy efficiency projects with the intent of becoming a leader of green economies by increasing conservation, creating new jobs, and increasing economic growth in Ontario. The GEA is expected to:

- Expedite growth of sustainable energy resources such as wind, solar, hydro, biomass, and biogas
- Generate 50,000 lasting, well-paying new jobs
- Improve management of household energy costs
- Increase quality of life for all Ontario's citizens

The following mechanisms would be employed to facilitate transition to a green economy. The government of Ontario would:

- Create a feed-in tariff
- Establish the right to connect to the electricity grid for appropriate renewable energy projects
- Establish approval processes that guarantee service for renewable energy projects that meet necessary regulatory requirements

To date Ontario has purchased about 1,000 megawatts of new renewable energy and investments in RE, in place or under construction, total about $4 billion.

With respect to federal government clean energy programs, Table II-12 shows that, at least for PV, government financing has had an impact on industrial financial factors -- in particular in such areas as job growth and revenues.

Table II-12
Trends in the Growth of the Photovoltaic Industry In Canada
(Prices in Canadian dollars)

	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Public budget (thousands)	$890	$1,500	$1,950	$5,955	$8,540	$9,800	$7,700	$8,150
Percent change	--	68	30	205	43	15	-21	6
Cumulative installed PV (kW)	5,826	7,154	8,836	9,997	11,830	13,884	16,746	20,484
Percent change	30	23	24	13	18	17	21	22
Modular price (CAD/W)	$11.1	$10.7	$9.4	$7.1	$6.2	$5.5	$4.3	$5.4
Percent change	--	3.5	12	24	13	10	22	-24
Jobs in PV	250	260	275	535	615	765	975	1,018
Percent change	14	4	6*	94	15	24	27	11
PV revenues (millions)	$40	$42	$45	$95	$100	$125	$150	$201
Percent change	5	5	7	111	5	25	20	34

Source: *National Report of PV Power Applications in Canada, 2006*,
and Management Information Services, Inc., 2009

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III. COMPARISON OF THE ECONOMIC AND JOB IMPACTS OF CLEAN ENERGY-RELATED GOVERNMENT STIMULUS PROGRAMS WITH OTHER GOVERNMENT SPENDING ALTERNATIVES

In this section, we examine the hypothesis that government spending on green stimulus programs, such as clean energy, energy efficiency building retrofits, mass transit, etc., are as effective in creating jobs as is equivalent spending on more traditional alternatives, such as road construction.

III.A. Europe's Clean Energy and Green Jobs Strategy

Europe's policy for support of clean energy and jobs dates to at least 1997, when the European Commission presented the White Paper for a Community Strategy and Action Plan entitled "Energy for the Future: Renewable Sources of Energy."[1] The EU set a goal to transform its pattern of energy utilization to reach the then-stated goal of reducing GHG emissions by 2010 to 15 percent below 1990 levels.

The White Paper noted that renewable energy sources "are currently unevenly and insufficiently exploited in the European Union," and, at the time, renewable energy comprised less than six percent of EU energy consumption. The White Paper established an ambitious goal of energy utilization through policy and incentives such that by 2010 the EU would have doubled the contribution of renewables to achieve nearly 12 percent of its energy consumption. The ambitious nature of this goal is clear, since in 1997 EU energy production already included large hydroelectric producers, and hydro energy has little room to grow.

The White Paper developed the rationale for support of renewable energy:

> "Development of renewable energy sources can actively contribute to job creation, predominantly among the small and medium sized enterprises which are so central to the Community economic fabric, and themselves form the majority in the various renewable energy sectors. Deployment of renewables can be a key feature in regional development with the aim of achieving greater social and economic cohesion within the Community."[2]

Thus, as early as 1997 the creation of clean energy jobs and jobs in green industries was stated as a major goal. The White Paper estimated that between 500,000 and 900,000 new jobs would be created and that "while it is not possible to reach any hard conclusions as is the likely cumulative level of job creation which would derive from

[1] http://ec.europa.eu/energy/library/599fi_en.pdf. See the discussion in Gabriel Calzada Álvarez, Raquel Merino Jara, Juan Ramón Rallo Julián, and José Ignacio García Bielsa, *Study of the Effects on Employment of Public Aid to Renewable Energy Sources*, Univisidad de Juan Carlos, March 2009.
[2] http://ec.europa.eu/energy/library/599fi_en.pdf.

investments in the various forms of renewable energy sources, it is quite clear that a pro-active move towards such energy sources will lead to significant new employment opportunities."

In 2001, following the recommendation of the White Paper, the EU approved Directive 2001/77/CE of the European Parliament and of the Council on the promotion of electricity produced from renewable energy sources in the internal electricity market. The EU initiated development of renewable energy by aiming for "the global indicative target of 12 percent of gross domestic energy consumption by 2010" through the use of renewable sources of energy, as part of which an objective for the electricity sector was added later that year, a "22.1 percent indicative share of electricity produced from renewable energy sources." Thus, for at least the past decade, job development has been a major goal of the EU's green energy initiatives.

Also in 2001, the Monitoring and Modeling Initiative on Targets for Renewable Energy (MITRE) project was established by the European Commission "to confirm the view that the EU renewable energy targets are achievable, and to inform key policy and decision makers of the economic and employment benefits of a proactive renewable strategy in order to meet the targets."[1] The project lasted two years and its main conclusion was a projected net employment growth in the EU of 950,000 jobs under current policies, and up to 1,660,000 under the Advanced Renewable Strategy of meeting a 22.1 percent share of electricity produced from RE sources by 2010. The study concluded that "a more proactive encouragement of renewable gives rise to significant employment gains."

In 2007, the EC adopted an ambitious energy and climate policy package that would "set the pace for a new global industrial revolution." At the European summit in March 2007, an agreement was adopted mandating specific EU-wide binding targets to achieve 20 percent of total energy consumption in the EU 2020. In November 2007, the Commission released its Strategic Energy Technology Plan and in January of 2008 proposed a directive that included objectives for each country, so that the common goal of the plan could be reached. During the March 2008 EU summit, an agreement was reached to adopt an energy and climate measure package by the end 2008 which would replace the measures from the 2001 directive.

The package passed the Industry Committee of the European Parliament with nearly unanimous support, and in December 2008 this directive was approved, substituting for the measures and objectives from the 2001 directive. According to the new directive, each member state must implement its own share of renewable energy so that the EU can achieve, by 2020, the goal of going from a total of 8.5 percent (in 2005) RE to 20 percent. Each EU country promised to increase its share of renewable energy production by at least 5.5 percent from 2005 levels, and creation of green jobs was the proposal's major rationale.

The different policy initiatives and responses to climate change currently being implemented at all levels of government will each have employment consequences, and

[1] *Meeting the Targets and Putting Renewables to Work,* EU Commission on Monitoring and Modeling Initiative on Targets for Renewable Energy (MITRE), http://mitre.energyprojects.net/.

the pace of green job creation is expected to accelerate in the future. The UNEP contends that a global transition to a low-carbon and sustainable economy will create large numbers of green jobs across many sectors of the economy and can become an engine of sustainable development.

The UNEP defines Green Jobs as positions in agriculture, manufacturing, R&D, administrative, and service activities aimed at alleviating environmental threats. This definition includes jobs that help to protect and restore ecosystems and biodiversity, reduce energy consumption, de-carbonize the economy, and minimize or avoid the generation of waste and pollution. A successful strategy to green the economy involves environmental and social full-cost pricing of energy and materials inputs, in order to discourage unsustainable patterns of production and consumption. A green economy is an economy that values both nature and people and creates decent and adequately paid jobs.

Greater efficiency in the use of energy, water, and materials is a core objective, but the critical question is where to draw the line between efficient and inefficient practices. A low threshold will define a greater number of jobs as green, but may yield an illusion of progress. Given technological progress and the urgent need for improvement, the dividing line between efficient and inefficient must rise over time. Therefore, "green jobs" is a relative and highly dynamic concept -- in other words there will be "shades of green" in employment.

III.B. The Issue of Clean Energy and Green Jobs

III.B.1. How Many Green Jobs are There?

The UNEP green jobs report estimated that, globally, around 300,000 workers are employed in wind power and more than 100,000 in solar photovoltaics.[1] In China, the USA. and Europe more than 600,000 are employed in solar thermal -- by far most of them in China. Almost 1.2 million workers are estimated to be employed in biomass in just four leading countries: Brazil, the USA, Germany, and China. Overall, in countries where data are available, the number of people employed in renewables is presently around 2.3 million -- Table III-1. The UNEP concluded that, "Given the present gaps in employment information, this is no doubt a very conservative figure." MISI estimates of green jobs indicate that this is, indeed, a conservative estimate.

The issue of clean energy jobs or green collar jobs is currently of intense and growing interest worldwide. MISI determined that such jobs include those in the following three categories:

- Jobs relating to environmental protection
- Jobs relating to clean/renewable energy
- Jobs relating to energy efficiency and cleantech

[1] United Nations Environment Programme, *Background Paper on Green Jobs*, Nairobi, Kenya, 2008.

Table III-1
Employment Estimates in the Renewable Energy Sector,
Global and Selected Countries, 2006

Renewable Energy Source	World / Selected Countries[1]	Employment
Wind	World	300,000
Solar PV	World	115,000
Solar Thermal	China, Europe, USA	624,000 +
Biomass/Biofuels	Brazil, USA, China, Germany	1,174,000
Hydropower	Europe, USA	39,000
Geothermal	USA, Germany	25,000
Renewables, Combined		**2,277,000**

Source: United Nations Environment Programme

There is considerable overlap between these categories. For example, most jobs related to renewable energy and energy efficiency/clean tech could be considered environmental jobs. On the other hand, many types of environmental jobs, such as those related to air, water, and solid waste remediation may not qualify as renewable energy or energy efficiency jobs. Nevertheless, taken together, these three categories should encompass a universal definition of green or green collar jobs.

Tables III-2. III-3, and III-4 present MISI estimates of U.S. green jobs:

- Table III-2 shows that there are about 6.1 million environmental protection jobs generated (directly and indirectly) in the U.S.
- Table III-3 shows that there are about 0.5 million renewable energy (RE) jobs generated (directly and indirectly) in the U.S.
- Table III-4 shows that there are about 8.6 million energy efficiency (EE) jobs generated (directly and indirectly) in the U.S.

Given the overlapping definitions, these jobs estimates are not additive. Nevertheless, MISI estimates that there are probably, at present, about 12-14 million green jobs generated (directly and indirectly) in the U.S.[1]

[1]This is the estimate of the total jobs generated, developed using input-output models; see the discussion in Roger Bezdek, Robert Wendling and Paula DiPerna, "Environmental Protection, the Economy, and Jobs: National and Regional Analyses," *Journal of Environmental Management*, Vol. 86, No. 1 (January 2008), pp. 63-79; and Management Information Services, Inc. "Green Job Issues, Definitions, and Estimates," prepared for the Minnesota Pollution Control Agency, July 2008.

Table III-2
Environmental Protection Expenditures and Jobs
In the U.S. Economy, 1970 - 2020

	Expenditures (billions of 2004 dollars**)**	**Jobs** (thousands)
1970	$40	704
1975	79	1,352
1980	125	2,117
1985	163	2,838
1990	210	3,517
1995	235	4,255
2004	320	5,104
2007	422	6,069
2010	397	5,861
2015	439	6,207
2020	$486	6,913

Source: Management Information Services, Inc., 2009.

Table III-3
The Renewable Energy Industry in the U.S., 2007

Industry Segment	**Revenues/ Budgets** (billions)	**Industry Jobs**	**Total Jobs Created**
Wind	$3.3	17,300	39,600
Photovoltaics	1.3	8,700	19,800
Solar Thermal	0.14	1,300	3,100
Hydroelectric Power	3.5	7,500	18,000
Geothermal	2.1	10,100	23,200
Biomass			
Ethanol	8.4	83,800	195,700
Biodiesel	0.4	3,200	7,300
Biomass Power	17.4	67,100	154,500
Fuel Cells	1.1	5,600	12,800
Hydrogen	0.81	4,100	9,400
Total, Private Industry	38.45	208,700	483,400
Federal Government	0.65	900*	2,100
DOE Laboratories	1.9	3,800**	8,700
State and Local Government	0.95	2,600	5,800
Total Government	3.5	7,300	16,600
Trade and Professional Associations and NGOs	0.63	1,600	3,500
TOTAL, ALL SECTORS	$42.58	217,600	503,500

*Includes Federal employees and direct support contractors.
**Includes Federal employees, laboratory employees, and direct support contractors.
Source : Management Information Services, Inc. and American Solar Energy Society, 2008.

Table III-4
The Energy Efficiency Industry in the U.S., 2007

Industry Segment	**Revenues /Budgets** (billions 2007 dollars)	**Industry Jobs** (thousands)	**Total Jobs Created** (thousands)
ESCO	3.8	23	53
Recycling, reuse, & remanufacturing	290	1,372	3,154
Vehicle manufacturing	86	193	443
Household appliances and lighting	35	134	308
Windows and doors	13	54	123
Computers, printers, copiers, etc.	105	360	828
TV, video, and audio equipment	48	193	447
HVAC systems	13	47	108
Industrial and related machinery	21	82	187
Miscellaneous durable manufacturing	110	397	901
Nondurable manufacturing	218	518	1,183
Utilities	2.2	14	32
Construction	48	288	660
Total, Private Industry	993	3,675	8,427
Federal government EE spending	3.8	16	37
State government EE spending	3.2	29	65
Local government EE spending	2.4	22	50
Total Government	9.4	67	152
EE Trade and Professional Associations and NGOs	0.52	3	7
TOTAL, ALL SECTORS	$1,002.92	3,745	8,586

Source : Management Information Services, Inc. and American Solar Energy Society, 2008

III.B.2. Definitions and Concepts

As noted, environmental protection, RE, and EE currently create 12-14 million jobs in the U.S., and these are distributed widely throughout all states and regions. But how many of these are "environmental jobs" or "green jobs?" More specifically, what constitutes a "green job?" While a definitive analysis of this important topic remains to be undertaken, MISI analysis indicates that there is no rigorous, well-accepted definition of a green job. Rather, the definitions used are often loose and contradictory.

Even restricting the discussion to a portion of the green jobs industry – such as RE and EE – involves difficult conceptual and definitional issues. For example:

- Windows and doors, gas and oil furnaces, home appliances, motors, etc. are offered at wide ranges of energy efficiencies. How do we evaluate and allocate these? What constitutes an "energy efficient" product? More "energy efficient" than what? Ones that

are more energy efficient than similar products currently being offered? Or only ones that meet a current or future energy standard?

- There are fine gradations of the energy efficiencies of many products: Where is the dividing line between a product that is "energy efficient" and one that is not?
- The new generation of many products is more energy efficient than the previous generation. Where is the cutoff?
- Energy efficiency is currently a very powerful PR and marketing strategy. Many things are advertised as being "energy efficient," and no one advertises their product as being "energy inefficient." Care will have to be taken to sort through these claims.[1]
- Many electric and gas utilities offer renewable and energy efficiency products and services. Should these be identified, quantified, and included as part of the industry? If so, it may be difficult to accurately segregate some of these.
- Low-flow faucets, showerheads, and toilets conserve significant amounts of water. In doing so, they indirectly reduce energy requirements by reducing the amount of energy required to heat, pump, transport, and process water. Should water conservation products be thus included in the definition of the RE and EE industry? Some portion thereof?
- Hybrid vehicles are a part of the RE and EE industry, but how are these to be disaggregated from the total operations of the automobile manufacturers? What about the parts suppliers? What about all of the automobile dealerships -- do we allocate a portion of their sales to the RE and EE industry based on the portion of "fuel efficient" vehicles they sell? Similar questions pertain to vehicle repair and body shops.
- What about flex-fuel vehicles?
- Should we include vehicles at or above certain fuel efficiency levels as part of the RE and EE industry? If so, where is the cutoff?
- Wood burning stoves have increased rapidly in popularity and are obviously a biomass heating option. However, outlets that sell wood stoves also sell a wide variety of other products, such as gas stoves, gas logs, decorative fireplace accessories, etc. that cannot be classified as RE & EE.
- Many products can serve energy efficiency purposes, but can also serve a variety of other purposes, and it is not always clear at the point of sale what the intended purpose is.[2]
- It is relatively straightforward if the EE product exists as a distinct, specified entity being solely produced at a specific plant, rather

[1]For example, several years ago MISI conducted an audit of the mandated RE&EE programs in New Jersey for the New Jersey Board of Public Utilities. We found that some utilities in the state were classifying natural gas fuel cells as "renewable." As another example, the USA state of Colorado classifies Rentech as an RE firm even though Rentech's business is coal-to-liquids technology.

[2]For example, caulking products can be used for weather stripping, sealing windows and doors, plugging air leaks, and other energy efficiency purposes. However, they can also be used for a variety of other purposes. Similar comments apply to various filters, valves, and many other products.

than as one product out of many being produced at a plant.[1] However, what about a large facility that produces, among other things, energy efficient light bulbs?

- Are all recycling activities part of the RE and EE industry?

Indirect Job Creation

There is also the issue of how to take account of indirect job creation and how broadly or narrowly to define an indirect green job. For example, what of ancillary jobs created across the street from a factory producing solar collectors shortly after it opens, such as a doughnut shop, fast food restaurant, dry cleaner, etc. whose customers are primarily the workers at the renewable energy factory. Are these latter jobs also considered to be "indirect" green jobs? MISI includes such indirect jobs in the definition of green jobs, although we also conclude they are not "as green" as the direct jobs created.

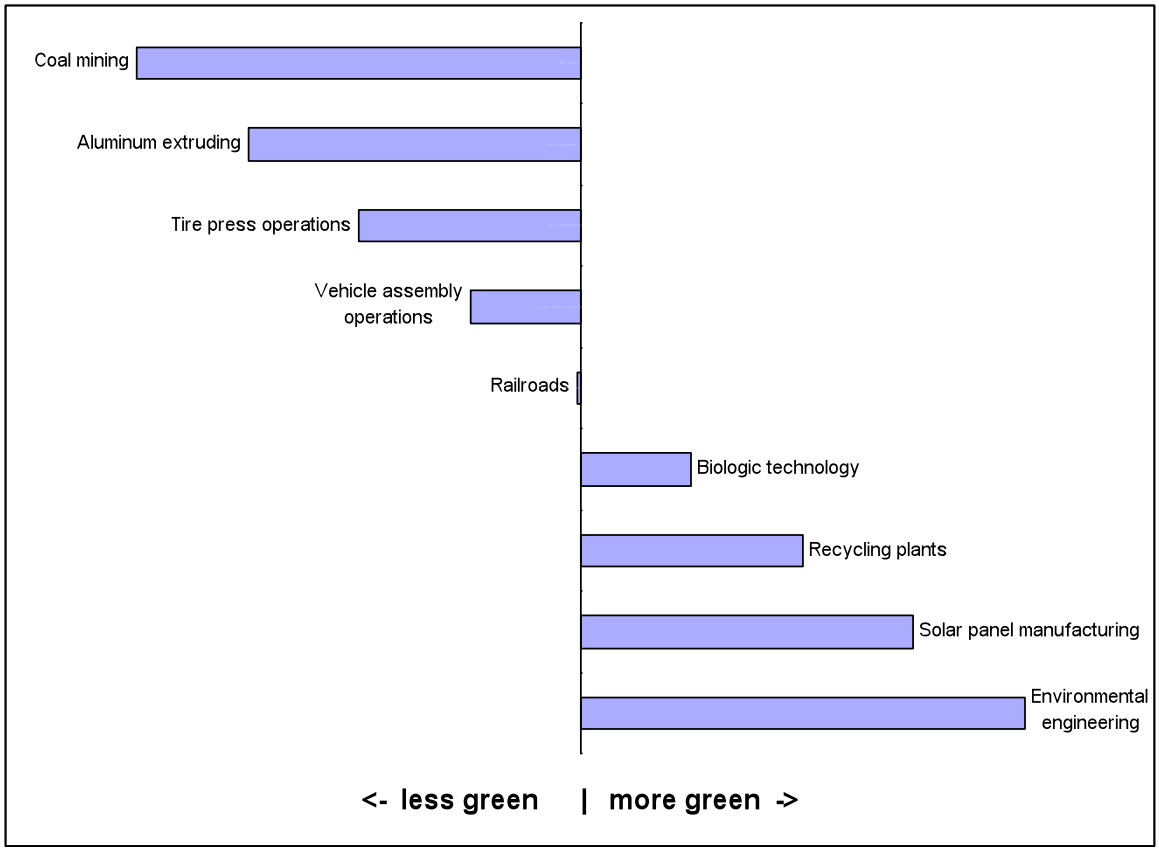
More generally, jobs can be considered to be "green" relative to the way the job was performed previously, i.e., in a production process, a change in technology that reduces waste emissions or energy consumption makes the jobs in that process "greener" than before. Still, can these jobs continue to be counted as green jobs when newer technology makes available ways of furthering green production, e.g., further reducing energy consumption?

Two approaches can be used to address the relativity cited. The first approach targets green jobs, which could be new jobs or the greening of existing jobs, and defines a green job as one that emphasizes activities that contribute to environmentally sustainable development. A second approach focuses on the economy as a whole, defining a green economy as an economy that is environmentally sustainable, and green jobs as those jobs required to make an economy environmentally sustainable. Similarly, the term "green sector" can be used to collectively describe companies involved in businesses designed to limit negative environmental impacts. However, this definition of green jobs as employment opportunities arising from expenditures on activities that support environmentally sustainable development, or which reduce negative impacts on the environment, also presents ambiguities.

Therefore, based on extensive research and literature review, MISI considers that green jobs are perhaps best understood when viewed in a continuum across a spectrum, with jobs that generate obvious environmental resource degradation or extraction at one end; a range of greener jobs involving clean production measures and technologies to reduce environmental impacts in the center, and the other end of the spectrum where jobs have a positive environmental impact (Figure III-1).

[1] For example, Venture Lighting, International is located in the USA state of Ohio and specializes in energy efficient metal halide lighting systems. Thus, all of Venture Lighting's products can legitimately be classified within the RE&EE industry.

Figure III-1
The Green Job Spectrum



Source: Management Information Services, Inc.

Using the spectrum concept, MISI defines clean energy industries and green jobs as those which, as a result of environmental pressures and concerns, have produced the development of numerous products, processes, and services which specifically target the reduction of environmental impact. Green jobs include those created both directly and indirectly by green industry expenditures.

III.B.3. Types of Green Jobs Created

There exists little rigorous and comprehensive research addressing the practical relationship between green industry and technology and existing jobs or future green job creation. Even some research in this area sponsored by environmental organizations is off the mark, in that it has tended to emphasize jobs creation in classically green activities, such as ecologists, environmental lawyers, or workers in recycling plants. However, while these jobs certainly count as green jobs, MISI's data suggest that the classic green job constitutes only a small portion of the total number of green jobs in the economy. The vast majority of green jobs are standard jobs for accountants, engineers, computer analysts, clerks, factory workers, truck drivers, mechanics, etc. In fact, most of the persons employed in these jobs may not even realize that they owe their livelihood to the green economy.

Thus, for example, the vast majority of the jobs created by RE are standard jobs for accountants, engineers, computer analysts, clerks, factory workers, truck drivers, mechanics, etc. This is illustrated in Table III-5, which lists the jobs created by renewable energy in the USA in 2007 within selected occupations. This table shows that in 2007 RE generated in the U.S.:

- More jobs for shipping and receiving clerks (2210) than for biochemists and biophysicists (1,580)
- More jobs for carpenters (780) than for environmental engineers (630)
- More jobs for truck drivers (9,500) than for forest and conservation workers (1,440)
- More jobs for janitors (3,610) than for environmental science technicians (1,690)
- More jobs for bookkeeping clerks (8,228) than for civil engineers (3,080)
- More jobs for plumbers (4,670) than for mechanical engineers (1,950)
- More jobs for electricians (6,330) than for computer software engineers (3,260)
- More jobs for inspectors, testers, and sorters (2,400) than for HVAC mechanics and installers (2,130)
- More jobs for security guards (1,310) than for surveyors (690)

Thus, many U.S workers are dependent on renewable energy for their employment, although they often would have no way of recognizing that connection unless it is brought to their attention. This is likely true in many other nations as well.

Table III-5
Renewable Energy Jobs Generated in the U.S. in 2007

Occupation	Jobs
Truck Drivers	9,500
Bookkeeping and Accounting Clerks	8,228
Electricians	6,330
Plumbers, Pipefitters, and Steamfitters	4,670
Agricultural Equipment Operators	4,260
Sales Representatives	4,140
Janitors and Cleaners	3,610
Business Operations Specialists	3,390
Computer Software Engineers	3,260
Civil Engineers	3,080
Computer Programmers	2,660
Inspectors, Testers, and Sorters	2,400
Shipping and Receiving Clerks	2,210
HVAC Mechanics and Installers	2,130
Mechanical Engineers	1,950
Chemical Technicians	1,880
Machinists	1,820
Environmental Science Technicians	1,690
Sheet Metal Workers	1,600
Biochemists and Biophysicists	1,580
Forest and Conservation Workers	1,440
Engineering Managers	1,350
Industrial Engineers	1,340
Security Guards	1,310
Purchasing Agents	1,280
Computer and IT Managers	1,210
Payroll and Timekeeping Clerks	1,160
Electrical and Electronic Equipment Assemblers	840
Carpenters	780
Industrial Production Managers	760
Surveyors	690
Training and Development Specialists	650
Environmental Engineers	630
Tool and Die Makers	620
Employment, Recruitment, and Placement Specialists	600
Tax Preparers	580
Database Administrators	560

Source: Management Information Services, Inc. and American Solar Energy Society, Green Collar Jobs in the U.S. and Colorado: Economic Drivers for the 21st Century, Boulder, Colorado, January 2009.

III.B.4. The Jobs Distribution in Typical Green Companies

There are thousands of green and clean energy companies located throughout the USA and they generate jobs for 12-14 million workers in virtually every community. Given the wide diversity in the size, function, and technologies of green companies, it is impossible to estimate the job profile of the "average" green firm. However, it is possible to identify the jobs and earnings profiles of typical types of firms involved in clean energy and green areas of work. Tables III-6, III-7, and III-8 illustrate this:

- Table III-6 shows the occupational job distribution and employee earnings of a typical environmental remediation services company.
- Table III-7 shows the occupational job distribution and employee earnings of a typical wind turbine manufacturing company.
- Table III-8 shows the wages, educational requirements, and growth forecasts for selected green occupations

These tables illustrate the points made above. First, firms working in green and clean energy industries employ a wide range of workers at all educational and skills levels and at widely differing earnings levels.

Second, in green and clean energy companies, many of the employees are not classified as being in "green" specialties. For example, even in the environmental remediation services firm profiled in Table III-6, most of the workers are in occupations such as laborers, clerks, bookkeepers, accountants, maintenance workers, cost estimators, etc. All of these employees owe their jobs and livelihoods to environmental protection, but, in general, they perform the same types of activities at work as employees in firms that have little or nothing to do with the environment.

This is illustrated even more forcefully in Table III-7. The occupational job distribution of a typical wind turbine manufacturing company differs relatively little from that of a company that manufactures other products. Thus, the production of wind turbines and wind turbine components requires large numbers of engine assemblers, machinists, machine tool operators, mechanical and industrial engineers, welders, tool and die makers, mechanics, managers, purchasing agents, etc. These are "green" workers only because the company they work for is manufacturing a renewable energy product. Importantly, with the current angst concerning the erosion of the manufacturing sector in Europe and North America and the loss of manufacturing jobs, it is relevant to note that many environmental and clean energy technologies are growing rapidly.[1] These types of firms can help revitalize the manufacturing sector and provide the types of diversified, high-wage jobs that all nations seek to encourage.

As shown in Table III-8, wages and salaries in many sectors of the green industries in the USA are higher than U.S. average wages. Although many cleantech industries require highly educated workers with masters or doctoral degrees, as noted, the green industries employ a wide variety of occupations. Nevertheless, many occupations in the green industries include jobs which require associate's degrees, long-term on-the-job training, or trade certifications, including engineers, chemists, electrical grid repairers, power

[1]For example, wind power is the most rapidly growing source of electrical power in the world.

plant operators and power dispatchers, chemical technicians, mechanical engineering technicians, and RE&EE technicians, all of which pay higher than U.S. average wages.

Table III-6

Typical Employee Profile of a 100-person USA, Environmental Remediation Services Co., 2004

Occupation	Employees	Earnings per Employee
Hazardous Materials Removal Workers	22	$39,800
Septic Tank Servicers and Sewer Pipe Cleaners	8	33,400
Construction Laborers	7	35,600
First-Line Supervisors/Managers of Construction/Extraction	5	55,700
Truck Drivers, Heavy and Tractor-Trailer	5	36,500
General and Operations Managers	3	94,900
Laborers and Freight, Stock, and Material Movers	2	23,800
Truck Drivers, Light Or Delivery Services	2	30,200
Office Clerks	2	25,700
Refuse and Recyclable Material Collectors	2	29,500
Insulation Workers	2	35,500
Secretaries (except Legal, Medical, and Executive)	2	28,600
Bookkeeping, Accounting, and Auditing Clerks	2	34,400
Plumbers, Pipefitters, and Steamfitters	1	45,300
Executive Secretaries and Administrative Assistants	1	40,400
Maintenance and Repair Workers	1	33,900
Environmental Engineering Technicians	1	40,600
Operating Engineers and Other Const. Equip. Operators	1	44,600
First-Line Supervisors/Managers of Office/Administrative	1	52,300
Chief Executives	1	128,100
Construction Managers	1	81,400
Cleaners of Vehicles and Equipment	1	23,900
Cost Estimators	1	62,400
Janitors and Cleaners	1	28,300
Environmental Engineers	1	76,900
Industrial Truck and Tractor Operators	1	30,500
Carpenters	1	42,400
Construction and Maintenance Painters	1	36,600
Accountants and Auditors	1	59,200
Dispatchers (except Police, Fire, and Ambulance)	1	32,500
Water and Liquid Waste Treatment Plant and System Operators	1	34,500
First-Line Supervisors/Managers of Transportation Operators	1	51600
Sales Representatives, Wholesale and Manufacturing	1	46,900
Customer Service Representatives	1	33,400
First-Line Supervisors/Managers of Mechanics and Repairers	1	53,900
Environmental Scientists and Specialists	1	68,200
Receptionists and Information Clerks	1	25,100
Environmental Science and Protection Technicians	1	49,300
Other employees	12	52,100
Employee Total	*100*	*$43,600*

Source: Source: Management Information Services, Inc. and American Solar Energy Society, Green Collar Jobs in the U.S. and Colorado: Economic Drivers for the 21st Century, Boulder, Colorado, January 2009

Table III-7
Typical Employee Profile of a 250-person USA Wind Turbine Manufacturing Company, 2007
(Selected Occupations)

Occupation	Employees	Earnings per Employee
Engine and Other Machine Assemblers	31	$36,900
Machinists	27	41,300
Team Assemblers	16	30,700
Computer-Controlled Machine Tool Operators	12	41,500
Mechanical Engineers	10	73,300
First-Line Supervisors/Managers of Production/Operating	10	60,800
Inspectors, Testers, Sorters, Samplers, and Weighers	8	41,100
Lathe and Turning Machine Tool Setters/Operators/Tenders	6	40,800
Drilling and Boring Machine Tool Setters/Operators/Tenders	4	40,500
Welders, Cutters, Solderers, and Brazers	4	40,600
Laborers and Freight, Stock, and Material Movers	4	30,300
Maintenance and Repair Workers	4	44,900
Tool and Die Makers	4	44,800
Grinding/Lapping/Polishing/Buffing Machine Tool Operators	4	35,500
Multiple Machine Tool Setters/Operators/Tenders	4	41,400
Industrial Engineers	3	71,900
Industrial Machinery Mechanics	3	46,900
Engineering Managers	3	110,600
Shipping, Receiving, and Traffic Clerks	3	32,700
General and Operations Managers	3	123,600
Industrial Production Managers	3	95,000
Industrial Truck and Tractor Operators	3	34,900
Purchasing Agents	3	57,100
Cutting/Punching/Press Machine Setters/Operators/Tenders	3	32,000
Production, Planning, and Expediting Clerks	3	46,100
Milling and Planing Machine Setters/Operators/Tenders	3	41,200
Mechanical Drafters	2	40,600
Customer Service Representatives	2	39,700
Bookkeeping, Accounting, and Auditing Clerks	2	36,300
Office Clerks, General	2	29,800
Sales Representatives, Wholesale and Manufacturing	2	56,300
Janitors and Cleaners	2	30,200
Sales Engineers	2	73,900
Accountants and Auditors	2	61,000
Tool Grinders, Filers, and Sharpeners	2	44,800
Executive Secretaries and Administrative Assistants	2	44,000
Mechanical Engineering Technicians	2	51,900
Electricians	2	50,700
Other employees	48	50,600
Employee Total (126 occupations in the industry)	*250*	*$47,300*

Source: Source: Management Information Services, Inc. and American Solar Energy Society, Green Collar Jobs in the U.S. and Colorado: Economic Drivers for the 21st Century, Boulder, Colorado, January 2009

Table III-8
Clean Energy, Energy Efficiency, and Related Occupations:
Wages, Educational Requirements, and Growth Forecasts
(Selected Occupations)

Occupation	10-year % Growth Forecast	Median Salary	% With Bachelor's Degree	Education
Materials Scientists	8	$75,800	94	Bachelor's
Physicists	7	93,300	92	Doctoral
Microbiologists	17	64,600	96	Doctoral
Biological Technicians	17	37,200	60	Associate
Conservation Scientists	6	54,800	88	Bachelor's
Chemists	7	64,800	94	Bachelor's
Chemical Technicians	4	40,900	27	Associate
Geoscientists	6	74,700	94	Doctoral
Natural Science Managers	14	101,000	90	Bachelor's
Environmental Eng. Technicians	24	42,800	18	Associate
Soil and Plant Scientists	20	59,100	64	Bachelor's
Mechanical Eng. Technicians	12	47,400	18	Associate
Environmental Sci. Technicians	16	39,100	47	Associate
Biomedical Engineers	31	76,900	60	Bachelor's
Chemical Engineers	11	80,800	92	Bachelor's
Mechanical Engineers	10	78,600	88	Bachelor's
Electrical Engineers	12	77,700	83	Bachelor's
Environmental Engineers	14	76,000	82	Bachelor's
Computer Scientists	26	95,900	67	Doctoral
Life & Physical Sci. Technicians	20	46,100	50	Associate
Utility Plant Operatives	4	54,100	10	OJT
HVAC Technicians	12	38,300	14	OJT
Energy Audit Specialists	18	40,300	18	OJT
Forest & Conservation Workers	6	27,500	8	OJT
Refuse & Recycling Workers	5	26,400	2	OJT
Insulation Workers	6	$30,800	2	OJT

Source: Source: Management Information Services, Inc. and American Solar Energy Society, Green Collar Jobs in the U.S. and Colorado: Economic Drivers for the 21st Century, Boulder, Colorado, January 2009

III.C. Relative Job Creation by Different Types of Government Spending Programs – Findings of Selected Studies

MISI reviewed over 100 studies conducted worldwide of the economic and jobs impacts of "green stimulus" (i.e. relating to clean energy and energy efficiency) and related sustainable programs and investments compared to more traditional infrastructure and energy programs. Here we summarize several of these studies, and we then normalize the results based on the empirical data available.

Australian Power Plant Jobs Study

This report assessed the impact of the Coolimba Power Station, a $1 billion investment based on a 400 - 450 MW coal fired power station, located in the Mid West region of Western Australia, 270 km north of Perth.[1] Aviva and AES will jointly develop the Coolimba Power project and the Central West Coal mine. The power station will provide up to eight percent of the power for the SWIS network and is designed for future adoption of carbon capture and storage (CCS).

This study found that, as well as reliable and low cost power, the Coolimba Power Station will facilitate economic development in the region, and the report estimated that Coolimba will:

- Contribute at least 600 jobs during construction
- In the long term, host 100 permanent jobs for locally housed employees when commercial operation commences in 2013
- Be a reliable, secure, and competitive power supply for the Mid West and the SWIS
- Inject $1 billion in the region, with indirect and flow-on benefits from the project creating as many as three times more jobs within the local communities in the longer term
- Encourage the expansion of local commerce for retail, services, and light industrial activities, all of which will provide multiple benefits to the local community
- Lead the way in technological innovation and a clean energy future

Alberta, Canada Green Jobs Study

This study by Greenpeace, the Sierra Club, and the Alberta Federation of Labor found that Alberta's economy is rapidly shedding jobs and that it is necessary to reduce the Province's environmental footprint, reorient the Alberta economy, and place it on a more sustainable track.[2] The study found that there are three main sectors where Alberta can create tens of thousands of green jobs:

[1] *Commercializing Carbon Capture and Storage,* Coolimba Power, 2008.
[2] Greenpeace, the Sierra Club, and the Alberta Federation of Labor, *Green Jobs: It's Time to Build Alberta's Future*, 2008.

- Energy efficiency. Energy efficiency is one of the most attractive green jobs sectors because the money saved on reducing energy consumption often covers the full cost of the investments, and then some – it is a strategy that pays for itself. By retrofitting every home that needs it – insulating, weather-stripping, and installing high efficiency windows and furnaces – jobs for 6,500 to 14,000 Albertans will be created over the next two years, while reducing energy consumption, emissions, and homeowner costs. This program would cost less than $2 billion and would provide high payback to homeowners indefinitely.
- Transit and high-speed rail. Establishing good transit systems can provide automobile drivers alternatives and help reduce urban sprawl. Alberta can reduce its automobile dependency by rehabilitating buses and light rail transit (LRT) rolling stock, building rapid-bus systems, expanding LRT systems, and creating a new high-speed rail system. Doing so would employ 19,000 to 28,000 Albertans over the next seven years, and the investment required would total about $10 billion.
- Renewable energy. Alberta can accelerate development of its clean energy sector by establishing RE tariffs that encourage new clean energy development. Mandatory RE targets for utilities and bans on new carbon emitting energy projects would also help to increase the proportion of renewable energy on the grid, and a new provincial crown corporation – the Alberta Renewable Energy Corporation – could make the early investments needed to rapidly build the sector, as occurred with fossil fuels decades ago. An RE sector created by these policies would employ thousands of Albertans and reduce emissions and fossil fuel dependence.

The report also recommended that other green jobs should be created in providing water treatment for First Nations communities, improving wastewater treatment systems, reforestation, and cleaning up contaminated sites. These opportunities can create many more green jobs in rural and urban areas.

These changes would help to diversify Alberta's economy by ensuring that industries can compete on a level playing field, and they would also develop a local and more sustainable economy. These changes would create a demand for workers and new skills, and the report recommended that Alberta create an overall green jobs strategy that combines policy shifts to create green jobs and green workforce development programs.

Canadian Efficient Water Infrastructure Study

This study from the Forum for Leadership on Water, the Canadian Water and Wastewater Association, and the Alliance for Water Efficiency noted that many experts and organizations are calling for infrastructure investments to stimulate the Canadian

economy, including specific attention to water and wastewater infrastructure.[1] While the authors agree with the need to invest in water and wastewater infrastructure, they feel that there is a risk that resources will simply be expended on the creation of traditional, expensive, and energy-intensive pipelines, pumps, and plants. The report proposed an alternative approach that can be deployed quickly and broadly, creating jobs and stimulating the economy much faster than traditional water infrastructure projects. This approach includes repairing and upgrading existing infrastructure, restoring green infrastructure, and facilitating new technology and innovation in water efficiency. This approach will create jobs, save energy and money, and protect and enhance public health and the environment.

This sustainable, energy efficient water infrastructure program would:

- Reduce the water infrastructure deficit
- Create jobs
  -- $1 billion invested in addressing the water infrastructure deficit would create between 11,500 and 47,000 jobs.
  -- Investments in water efficiency can be quickly deployed to yield 15,000 to 22,000 new jobs for each $1.2 billion spent with broad-based economic benefits.
- Save money: Investments in green infrastructure and water efficiency would save millions of dollars in forestalling future large capital expenditures in infrastructure.
- Conserve water and energy

German BMU Clean Energy Study

This study by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) finds that one of the pivotal challenges of the 21st century will be to change the energy supply structure to protect the environment and climate, reduce German dependence on energy imports, and stabilize energy prices.[2] The major tasks are to reduce energy consumption, increase energy efficiency, and use more renewable energy. Clear goals have already been set: For example, in 2020 at least 10 percent of the total energy demand in Germany and at least 20 percent of the nation's electricity should be generated from renewable resources. The long-term goal set by the German Federal Government in its sustainability strategy is to supply half of Germany's total energy demand using renewable energy sources by the middle of this century.

In this context, the economic significance of renewable energy has increased over the last few years: In 2005 this sector already earned more than 16 billion Euros from the construction and operation of systems and created about 170,000 jobs. Nevertheless,

[1]Forum for Leadership on Water, the Canadian Water and Wastewater Association, and the Alliance for Water Efficiency, *Clean Water, Green Jobs: A Stimulus Package for Sustainable Water*, December 19, 2008.
[2]Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, *Impact of the Expansion of Renewable Energy on the German Labour Market with Special Consideration of Foreign Trade*, Berlin, Germany, 2006.

the report noted that despite this success, the long-term impact of the expansion of renewable energy on growth and employment is still being disputed.

The study examined this issue in detail based on an extensive questionnaire involving more than 1,000 companies and extensive theoretical models. It found that the increased use of renewable energy and job creation can permanently go hand in hand. Accordingly, employment in the renewable energy field could double by 2020 even when applying rather conservative assumptions. Further, the net impact – after subtracting all possible negative employment effects – is also a clear and sustainable positive employment stimulus.

UK Local Government Association Green Jobs Study

This study by the UK Local Government Association (LGA) found that a structural transformation of the UK economy is necessary and that this transformation has the potential to assist the high growth environmental industries that will generate green jobs.[1] It recommends a Green New Deal that involves targeted area based initiatives, like the Community Energy Saving Program (announced by the government in September 2008) to promote a green pathway out of recession.

The study estimated that to meet the government's renewable energy targets, jobs in this industry will need to increase from 16,000 to 133,000, and that the potential for new jobs in home energy efficiency totals 20,000. There will also be new jobs in managing the risks associated with climate change, and the research showed that the job opportunities will differ from area to area. The variation is the result of the way industrial sectors cluster, the different opportunities for energy generation (for example, in wind speed and biomass stock), the penetration of home energy efficiency measures, the nature of the building stock and proposed development, and the variation in the risk areas face from climate change.

In its plan for jobs in the low-carbon economy the LGA recommended that central government:

- Provide access to up-front capital to enable householders to invest in solid wall insulation (where they own an older home) and microgeneration through a national energy loans fund
- Reform the Carbon Emission Reduction Target to facilitate a council-led area based national insulation program to provide basic insulation to the ten million homes that require it
- Provide support to community groups and councils to help them realize the benefit from renewable development in their areas, enabling some local areas to voluntarily identify themselves as growth points for renewable energy

[1]Local Government Association, *Putting People First: Creating Green Jobs, Developing Local Low-Carbon Economies*, London, January 2009.

- Devolve employment and skills budgets to give local partners the flexibility to undertake courses that meet the skills needs of the low carbon economy
- Devolve the decisions and funding for investment in the green economy from Regional Development Agencies to sub-regional partnerships
- Re-localize business rates, which would allow councils to reduce business rates for local businesses that meet agreed low-carbon standards

LGA estimated that, collectively, these measures will help create 150,000 new jobs in the low-carbon economy -- jobs that help save carbon, reduce fuel poverty, increase UK energy security, and build resilience in those areas at greatest risk from climate change.

EU Energy Efficiency Jobs Study

This study by Association for the Conservation of Energy estimated the employment impacts of 44 energy efficiency investment programs that are ongoing, or were recently implemented in nine EU countries.[1] A case study approach was complemented by two modeling exercises. First, an enhanced form of input-output (I-O) modeling was applied to case studies in the residential sector. Second, a general equilibrium modeling (GEM) approach was applied, considering the macro-economic impacts of the portfolio of energy efficiency programs represented in the case studies. All three approaches found that, in the majority of cases, energy efficiency investment programs increased employment.

The major findings are summarized in Table III-9, and include:

- Of the 44 cases studied, 38 were found to have generated additional employment.[2]
- Both modeling exercises confirmed that programs of investment in energy efficiency increase employment.
- Per million Euros of total expenditure, energy efficiency programs typically resulted in 8 to 14 additional person-years of employment.
- The employment effect of energy efficiency programs is almost always positive, and the jobs are often in sectors, locations, and skill groups that are prioritized in employment policies.
- Nevertheless, while job creation will be a desirable side effect of the programs, it should not be the primary objective.

[1]Joanne Wade, Victoria Wiltshire, and Ivan Scrase, *National and Local Employment Impacts of Energy Efficiency Investment Programmes*, Association for the Conservation of Energy, London, April 2000.
[2]In two cases investments in energy efficiency created employment, but it was considered that in the absence of the program the investments would have occurred anyway, and there were insufficient data for analysis in four cases.

- In the residential sector, employment gains were typically higher than in other sectors; however, the investments tended to be less cost-effective in terms of energy savings than in other sectors.
- In the commercial/public sector, employment gains were typically lower than in the residential sector, but investments were more cost effective.
- In industry, investments were very cost effective and led to a mid-range quantity of employment. These performed better, in terms of cost effectiveness and employment, than the fiscal policies in the industrial sector studied, two of which were found to have merely accelerated investments that would have occurred anyway.
- Demand side management initiatives tended to generate relatively little employment, but were successful in identifying cost-effective investments.
- Institutional and regional programs tended to generate fairly high levels of employment and cost-effective investments.
- Fiscal policies created large amounts of employment in the residential sector in relation to total expenditure.
- Many of the programs identified a creation of new employment in manual occupations, especially residential programs.
- In the industrial sector, some programs created employment principally for engineers, consultants, and technicians.
- Some case studies identified job creation in small local firms. For example, energy efficiency measures generate investments that are geographically dispersed, and re-spending of money saved on energy bills will largely be within the local economy.

Table III-9

Median Figures For Key Data on Expenditure and Employment For the Case Studies
Data in undiscounted 1995 ECUs (Euros)

TYPE OF INITIATIVE *Sector* (number of case studies)	Total expenditure (MEuro)	Duration studied (years)	Expenditure per year (MEuro)	Government expenditure (% of total)	Simple payback period (years)	Person-years identified per MEuro	Person-years identified/MEuro government spending
FISCAL							
Residential (11)	8.2	2.0	8.0	77.0	18.0	13.5	22.5
Commercial/public (4)	14.6	6.0	6.7	13.0	12.3	9.0	49.8
Industry (5)	18.5	2.0	9.3	14.0	6.6	3.8	21.1
REGULATORY							
Residential (4)	2030	18.5	119	0.5	24.5	11.3	2260
INFO./EDUCATION							
Residential (5)	4.8	3.0	1.6	8.0	39.0	14.0	940
Commercial/public (3)	9.8	5.0	5.5	10.0	2.6	8.6	86
Industry (4)	5.3	3.0	1.4	12.0	2.6	11.8	100
OTHER							
Utility DSM (7)	7.8	4.0	6.0	8.0	5.6	8.8	120
Institutional programmes (5)	6.6	4.0	1.7	15.0	5.5	13.0	86.7

Source: Association for the Conservation of Energy, 2000

University of Massachusetts Infrastructure Jobs Study

This University of Massachusetts study analyzed the employment impacts of an expanded USA infrastructure investment program and what it would take to create millions of jobs.[1] It developed specific policy scenarios based on an assessment of the USA's infrastructure needs in four core areas -- transportation, energy, water systems, and public school buildings -- and estimated the employment that would be created if the policies were implemented. It also examined what the long-run impacts of such a program would be in terms of productivity and overall economic growth.

It found that all forms of spending will produce jobs, but that infrastructure investment is a highly effective engine of job creation. It estimated that infrastructure investment spending will create about 18,000 total jobs for every $1 billion in new investment spending, including direct, indirect, and induced jobs.[2] By contrast, a tax cut will create, at most, about 14,000 total jobs per $1 billion in spending, 22 percent less than infrastructure investments. The study results are summarized in Table III-10.

Table III-10
Estimated Employment Effects of Increased USA Infrastructure Spending

category of infrastructure	jobs per $1 billion infrastructure investment	
	direct/indirect	with induced
energy	11,705	16,763
gas	15,976	21,888
electricity generation, transmission, distribution	9,819	14,515
solar	10,951	15,767
wind	10,076	14,880
transportation	13,829	18,930
average roads and bridges	13,714	18,894
roads and bridges: new	12,638	17,472
roads and bridges: repair	14,790	20,317
rail	9,932	14,747
mass transit	17,784	22,849
aviation	14,002	19,266
inland waterways/levees	17,416	23,784
school buildings	14,029	19,262
new institutional construction	14,291	19,637
repair of non-residential buildings	13,768	18,886
water	14,342	19,769
dams	17,416	23,784
drinking water	12,805	17,761
waste water	12,805	17,761

Source: University of Massachusetts, 2009.

[1]Political Economy Research Institute, *How Infrastructure Investments Support the U.S. Economy: Employment, Productivity and Growth*, University of Massachusetts, Amherst, Massachusetts, January 2009.

[2]Induced effects refer to the additional employment, output, and value-added that is produced when the additional employment income generated by an initial demand stimulus -- as captured by the direct and indirect effects -- is spent. The magnitude of the induced effects depends on how the additional employment income translates into household expenditures and the size of the multiplier effects associated with the increase in household spending. See the discussion in Ibid.

Center for American Progress Green Jobs Study

The Center for American Progress report advocated a "green economic recovery program to strengthen the U.S. economy over the next two years and leave it in a better position for sustainable prosperity."[1] This initiative was designed to expand job opportunities, stimulate economic growth, stabilize the price of oil, fight global warming, and build a green, low-carbon economy.

The report's recommended green economic recovery program would spend $100 billion dollars over two years in six green infrastructure investment areas, and would be paid for with proceeds from auctions of carbon permits under a GHG cap-and-trade program. The authors estimated that the program would create 2 million jobs by investing in six energy efficiency and renewable energy strategies:

- Retrofitting buildings to improve energy efficiency
- Expanding mass transit and freight rail
- Constructing "smart" electrical grid transmission systems
- Wind power
- Solar power
- Next-generation biofuels

Most of the federal spending would be in the form of public infrastructure investments in public building retrofits, public transportation, building smart grid systems, and through federal fund transfers to state and local governments. Investments in RE&EE are also central to this proposal, and would be funded through a combination of public funds, tax credits, and loan guarantees. The authors recommended that this $100 billion green energy stimulus package be spent in the six technology areas listed above. The program would allocate the funding through:

- Tax credits ($50 billion)
- Direct government spending ($46 billion)
- Federal Loan guarantees ($4 billion)

The authors contend that this would result in:

- Widespread employment gains
- Lower unemployment
- Renewed construction and manufacturing work
- More stable oil prices
- Self-financing energy efficiency

[1] Center for American Progress, *Green Recovery: A Program to Create Good Jobs and Start Building a Low-Carbon Economy*, Washington, D.C., September 2008.

FutureGen Impact Study

This study estimated that the economic impact of locating a "GHG emissions free" coal gasification and carbon sequestration project in the USA state of Illinois would result in significant positive economic activity for the state and the local economy.[1] Impact results were estimated for two models: A state level model and a two county model.

The report concluded that FutureGen would have a much larger impact than the 1,300 construction jobs and 150 permanent jobs that would be created. The study showed that during the four-year construction period, there would be more than $1 billion in economic impact statewide and 1,225 indirect and induced spin-off jobs created as a result of the economic ripple effect generated by FutureGen. Once the facility is operational, the study estimated that it would generate $135 million annually in total statewide economic output, with an $85 million annual increase in the local area alone.

Report highlights included the following impacts from the operation of the clean coal facility:

- $135 million increase in statewide economic output from facility operation
- $34 million increase in statewide labor income from facility operation
- $91 million increase in statewide value added from facility operation
- $11 million increase in tax revenues from facility operation
- An increase of 510 jobs in Illinois from facility operation
- $258 million increase in statewide economic output from construction
- $116 million increase in statewide labor income from construction
- An increase of 2,525 jobs in Illinois from construction
- $85 million increase in local economic output
- $20 million increase in income for local labor
- $59 million increase in local value added
- An increase of 360 new jobs in the local area

Power Generation Plant Economic Impact Study

This report estimated the likely economic impact of the construction and operation of the Taylorville Energy Center (TEC), a 630 MW IGCC clean coal power generation facility proposed to be built by Christian County Generation, LLC.[2] TEC would be the first clean-coal power plant built in Illinois, would be among the most environmentally-friendly,

[1]Ira Altman, *FutureGen: The Economic Impacts of Clean Coal for Illinois*, report prepared by Department of Agribusiness Economics, College of Agricultural Sciences, Southern Illinois University-Carbondale, June 2007.

[2]John Lewis and Lisa Bergeron, *The Economic Impacts of an Electric Power Generation Facility in Illinois*, report prepared by Regional Development Institute, Northern Illinois University, May 2007.

commercially-sized coal plants in the world, and would make high-sulfur Illinois coal an environmentally viable fuel source.

The report estimated that TEC would generate the following economic impacts. In terms of construction, it would:

- Create 1,500 full-time and part-time jobs, with 793 additional jobs created in industries like manufacturing, healthcare, retail, and professional services
- Generate $1.1 billion in direct and indirect economic activity
- Provide total employee compensation of $334 million
- Generate $9.9 million in total state and local tax revenues

In terms of ongoing operations, it would:

- Create 663 direct and indirect jobs in Christian County
- Generate $355.9 million in annual economic activity
- Provide average annual gross savings to Illinois customers of $190 million during the first eight full years of operation
- Provide total annual employee compensation of $24.3 million, with average power generation facility employee compensation of $57,059 plus benefits -- more than twice the county average of $26,415
- Generate $4.47 million in annual state and local tax revenues

In terms of coal mining, it would:

- Create 416 direct and indirect jobs
- Generate $78.5 million in annual economic activity
- Provide total annual employee compensation of $20.1 million, with average mining industry employee compensation of $67,650 including benefits -- more than two and a half times the county average of $26,415
- Require more than 1.5 million tons of Illinois coal annually
- Generate $9.2 million in annual state and local tax revenues

The report concluded that TEC would be an economic boon to the region, would help revitalize the Illinois coal industry, and would provide thousands of jobs and hundreds of millions of dollars in investment for central Illinois. It also found that central Illinois would benefit from a regional ripple effect that will create hundreds of new positions in industries such as retail, hospitality, and healthcare. Further, the addition of 630 MW of baseload power would also help stabilize electric rates and provide significant benefit for consumers.

III.D. Estimating the Relative Job Creation of Different Types of Government Spending Programs

III.D.1 Estimating Jobs Created Per Dollar of Expenditures

MISI conducted the most comprehensive review to date of studies of the economic and jobs impacts of "green stimulus" (i.e. relating to clean energy and energy efficiency) and related sustainable programs and investments compared to more traditional infrastructure and energy programs. This analysis reviewed:

- Over 100 independent studies that
- Analyzed 85 programs and technologies
- Conducted over the past decade
- In five nations and Europe
- That estimated the jobs created per billion dollars of expenditures

To ensure comparability of the findings, expenditures were normalized to constant 2008 U.S. dollars.[1] The conversion factors used were:

- 1 Euro equals $1.32 U.S.
- 1 Canadian Dollar equals $0.83 U.S.
- 1 British Pound equals $1.47 U.S.
- 1 Australian Dollar equals $0.72 U.S.

The green stimulus programs assessed included:

- Solar
- Wind
- Photovoltaics
- Geothermal
- Biofuels
- Biomass power
- Biomass co-firing
- Smart Grid
- Energy efficiency building retrofits
- Weatherization programs

[1] Purchasing power parities (PPPs) are the rates of currency conversion that eliminate the differences in price levels between countries. Per capita volume indices based on PPP converted data reflect only differences in the volume of goods and services produced. Comparative price levels are defined as the ratios of PPPs to exchange rates and provide measures of the differences in price levels between countries. The PPPs can be expressed are in national currency units per US dollar.

Per capita volume indices should not be used to rank countries, since PPPs are statistical constructs rather than precise measures. Further, minor differences between countries should be interpreted with caution. The PPP adjustments between U.S. dollars and Australian, British, and Canadian currencies are relatively small, respectively, 1.15, 1.07, and 1.02.

Source: Organization for Economic Cooperation and Development, "Purchasing Power Parities – Comparative Price Levels," Main Economic Indicators, July 2009 - ISSN 0474-5523, pp 191-192.

- Water/energy efficiency programs
- Water efficiency retrofits
- Insulation programs
- Energy service companies
- Recycling and reuse
- Utility energy efficiency programs
- Green construction
- Environmental remediation programs
- Mass transit
- Highway environmental enhancements

The traditional and alternative energy, stimulus, infrastructure, and related programs analyzed included:

- Coal power plants
- Underground coal gasification
- Oil and gas programs
- Higher education infrastructure
- Tax cuts
- Local government infrastructure
- State and provincial government infrastructure
- Utility programs
- Health care programs
- Single family housing
- Multi-family housing
- Clean coal with CCS
- Highway construction
- Highway repair and refurbishing
- Bridge construction
- Rail construction
- Coal-to-liquids
- Oil shale
- Enhanced oil recovery
- Futuregen

The results of this analysis are summarized in Table III-11 and Figure III-2 which summarize the results of 44 of the studies reviewed.

Table III-11
Jobs Per Dollar of Spending on Alternative Energy,
Stimulus, Infrastructure, and Related Programs

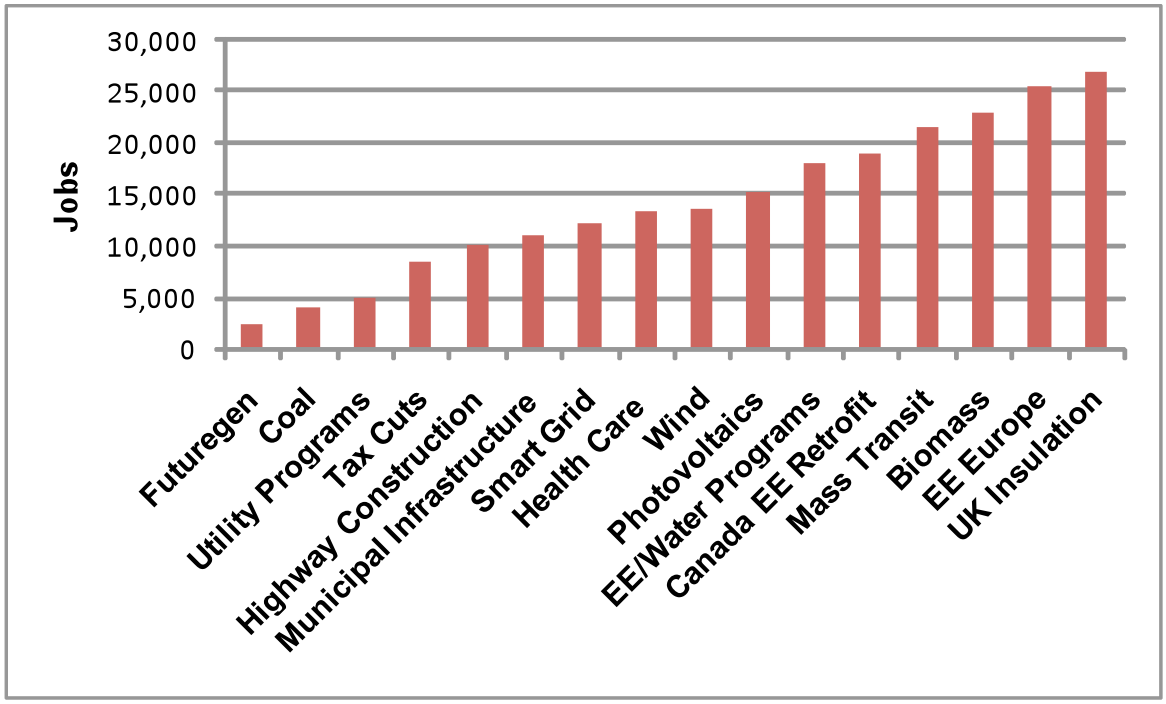
Country	**Project**	**Total Jobs Per $1 Billion U.S.** (2008$)	**Source**	**Year of Estimate**
Australia	Coolimba Power Station	3,000	Coolimba Power	2008
Australia	Underground coal gasification	3,200	PricewaterhouseCoopers	2008
Canada	Public health infrastructure Tax cuts	21,600 6,700	Ontario Public Service Employees Union	2009
Canada	Local government infrastructure	9,600	Canada West Foundation	2009
Canada	University infrastructure	9,900	Association of Universities and Colleges of Canada	2009
Canada	Provincial infrastructure	10,600	British Columbia Liberal party	2009
Canada	Infrastructure	12,100	Canadian Centre for Policy Alternatives	2009
Canada (Alberta)	Oil & gas extraction Mass transit Housing EE retrofit	3,000 20,800 11,100 – 23,600	Greenpeace, Sierra Club, Alberta Federation of Labor	2009
Canada	Municipal infrastructure	9,300	Infrastructure Canada	2008
Canada	Water efficiency retrofit	17,500	Forum for Leadership on Water	2008
Canada	EE building retrofit	19,000	Federation of Canadian Municipalities	2005
Europe	Energy efficiency programs	26,800	Ecofys	2005
Europe	Energy efficiency programs	24,000	Association for the Conservation of Energy	2000
Germany	EE apartment retrofit	17,000	German Alliance for Work and the Environment	2006
Germany	Renewable energy programs	9,800	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety	2006
UK	Higher education infrastructure	13,800	University estimate	2009
UK	Home insulation retrofit	27,000	Local Government Association	2009
UK	Residential EE	10,500	UK government.	2000
USA	Utility programs Mass transit Environmental remediation Health care Tax cuts	5,000 22,000 10,000 14,000 10,400	MISI	2009
USA	Smart Grid	10,000	General Electric and Cisco	2009
USA	Single family housing Multi-family housing	11,100 18,000	Greater Minnesota Housing Fund	2009
USA	Building EE retrofit Highway construction Highway repair	18,000 9,300 10,400	Apollo Alliance	2009
USA	Broadband, health IT, and smart grid	31,600*	IBM	2009

Country	Project	Total Jobs Per $1 Billion U.S. (2008$)	Source	Year of Estimate
USA	Natural gas Electricity GT&D Solar Wind Rail Mass Transit School buildings Waste water treatment	21,900 14,500 15,800 14,900 14,700 22,850 19,300 17,800	Political Economy Research Institute	2009
USA	Clean Coal with CCS	17,500	BBC Research and Consulting	2009
USA	Highway stimulus program	4,500	White House	2009
USA	Wind PV Solar thermal Hydro Geothermal Biofuels Biomass power	12,000 15,300 22,100 5,100 11,100 23,000 8,900	MISI	2008
USA	Insulation programs ESCO Recycling & reuse Utility EE programs Green construction	12,000 14,600 10,900 16,000 14,500	MISI	2008
USA	Water/energy efficiency infrastructure	18,500	Alliance for Water Efficiency	2008
USA	EE&RE policies	33,000	Obama energy and economic policy document	2008
USA	EE&RE policies	20,000	Center for American Progress	2008
USA (Colorado)	RE EE O&G drilling O&G extraction	9,300 8,900 16,000 2,200	MISI/ASES	2008
USA	Environmental programs	14,900	MISI	2008
USA	Health care Education Mass transit Building weatherization Tax cuts	12,900 17,700 19,800 12,800 10,100	University of Massachusetts	2007
USA	Taylorville Energy Center	4,500	Northern Illinois University	2007
USA	Futuregen	2,600	Southern Illinois University	2007
USA	Energy infrastructure	8,000	Southern States Energy Board	2006
USA	CTL OS EOR	9,800 8,000 7,700	MISI/SAIC	2006
USA	Highway construction	14,900	U.S. Department of Transportation	2006
USA	Mesaba energy project	5,000	Excelsior Energy, Inc.	2005
USA	EE, RE, smart grid, and infrastructure	11,000	Apollo Alliance	2004
USA	Renewable energy	10,500	Apollo Alliance	2004

Country	Project	Total Jobs Per $1 Billion U.S. (2008$)	Source	Year of Estimate
USA	Highway construction Highway restoration Bridge construction Highway environmental enhancements Highway widening	15,700 15,200 17,000 21,600 13,300	Good Jobs First	2003
USA	Coal Wind PV	3,900 5,700 5,650	Renewable Energy Policy Project	2001

*Job estimate not comparable.
Source: Management Information Services, Inc., 2009

Figure III-2
Jobs Generated Per Billion Dollars of Expenditure on Selected Programs
(billion constant U.S. 2008 dollars)



Source: Management Information Services, Inc., 2009

Even with the spending and jobs estimates normalized on the basis of constant U.S. dollar expenditures (per one billion 2008 dollars), the estimates vary considerably. Nevertheless, some significant findings emerge.

First, spending for traditional energy, power, and utility programs generate relatively few jobs per dollar of expenditure compared to most alternative investments. For example:

- A conventional coal-fired power plant generates between about 3,000 and 5,000 jobs per billion dollars of spending
- Underground coal gasification creates about 3,200 jobs per billion dollars of spending

- Traditional utility programs generate about 5,000 jobs per billion dollars of spending
- Oil and gas programs can generate as many as 22,000 or as few as 2,200 jobs per billion dollars of spending
- Coal-to liquids, oil shale, and enhanced oil recovery generate between about 7,700 and 9,800 jobs per billion dollars of spending

In contrast, energy efficiency programs usually generate the most jobs per dollar expenditures compared to most alternative investments. For example:

- European energy efficiency programs generate between about 24,000 and 27,000 jobs per billion dollars of spending
- In Germany, energy efficiency apartment retrofit programs generate 17,000 jobs per billion dollars of spending
- In Canada, energy efficiency building retrofit programs create 19,000 jobs per billion dollars of spending and mass transit programs create 21,000 jobs per billion dollars of spending
- In the UK, home insulation retrofit programs create 27,000 jobs per billion dollars of spending
- In the USA, energy efficiency building retrofit programs create between 12,000 and 18,000 jobs per billion dollars of spending
- In the USA, green construction creates 14,500 jobs per billion dollars of spending
- In the USA, utility energy efficiency programs create 16,000 jobs per billion dollars of spending and energy service company programs create 14,600 jobs per billion dollars of spending

Table III-11 also illustrates that combined water/energy efficiency programs can have an especially large job creation potential. For example:

- In Canada, water efficiency retrofit programs create 17,500 jobs per billion dollars of spending
- In the USA, water and energy efficiency program create 18,500 jobs per billion dollars of spending
- In the USA, investments in waste water treatment create 17,800 jobs per billion dollars of spending

This table illustrates that an alternative often advocated instead of green stimulus programs – or any kind of infrastructure program, tax cuts or tax rebates, has a relatively small job creation potential per dollar expended. For example,

- In Canada, tax cuts generate 6,700 jobs per billion dollars
- In the USA, tax cuts create about 10,000 jobs per billion dollars

Transportation infrastructure investments have a potentially wide range of job creation impacts. For example, in the USA:

- Highway construction programs create between about 5,000 and 15,000 jobs per billion dollars of spending
- Highway restoration, repair, and enhancement programs create between about 13,000 and 15,000 jobs per billion dollars of spending
- Bridge construction creates 17,000 jobs per billion dollars of spending
- Highway environmental enhancements create 21,600 jobs per billion dollars of spending
- Mass transit programs create between about 20,000 and 23,000 jobs per billion dollars of spending (21,000 jobs in Canada)
- Rail infrastructure programs create 14,700 jobs per billion dollars of spending

The job impacts of other types of infrastructure programs vary widely. For example:

- In Canada, university infrastructure programs create about 10,000 jobs per billion dollars of spending
- In Canada, provincial and municipal infrastructure programs create between about 10,000 and 12,000 jobs per billion dollars of spending
- In the UK, higher education infrastructure programs create 13,800 jobs per billion dollars of spending
- In the USA, housing programs create between about 11,000 and 18,000 jobs per billion dollars of spending
- In the USA, education and school construction create between about 18,000 and 19,000 jobs per billion dollars of spending
- In the USA, health care creates between about 13,000 and 14,000 jobs per billion dollars of spending
- In the USA, environmental remediation programs create between about 10,000 and 15,000 jobs per billion dollars of spending
- In the USA, Smart Grid infrastructure programs create between about 10,000 and 14,500 jobs per billion dollars of spending

The job creation potential of specific renewable energy programs differs significantly, depending on the program. For example:

- In Germany, it is estimated that RE programs generate about 10,000 jobs per billion dollars of spending
- In the USA it is estimated that RE programs generate between about 10,000 and 33,000 jobs per billion dollars of spending
- In the USA:
- Solar energy programs generate between about 16,000 and 22,000 jobs per billion dollars of spending
- Wind programs generate between about 12,000 and 15,000 jobs per billion dollars of spending
- PV programs generate 15,300 jobs per billion dollars of spending
- Biofuels generate 23,000 jobs per billion dollars of spending

- Geothermal programs generate 11,100 jobs per billion dollars of spending
- Biomass power programs generate 8,900 jobs per billion dollars of spending
- Hydro programs generate 5,100 jobs per billion dollars of spending

A number of potentially significant findings emerge from these data.

First, while precise comparison across studies is difficult for the reasons discussed, it is clear that investments in green stimulus and infrastructure programs, in general, generate, per dollar of expenditures, as many and usually more jobs than most alternatives. Specifically, energy efficiency retrofit programs usually generate more jobs per dollar of expenditure than any other program. These programs can generate as many as 27,000 jobs per billion dollars of expenditure, whereas most other programs generate between 5,000 and 15,000 jobs per billion dollars of expenditure. Further, water/energy efficiency programs are also powerful job creators, and can create between 18,000 and 19,000 jobs per billion dollars of expenditure

Second, investments in fossil-fuel programs generate relatively few jobs per dollar of expenditure. Conventional power plants and utility programs generate between 3,000 and 5,000 jobs per billion dollars of expenditure.

Third, tax cuts are often proposed as an alternative to green stimulus programs. However, tax cuts generate about 6,000 to 10,000 jobs per billion dollars of expenditure. This job generation is only about one-third to one-fourth that of some green stimulus programs.

Fourth, transportation infrastructure programs differ markedly in their job generation effects, but "green" transportation initiatives tend to generate significantly more jobs per dollar than does highway construction. Highway construction creates between about 5,000 and 15,000 jobs per billion dollars of spending, highway repair creates about 14,000 jobs per billion dollars of spending, and bridge construction creates 17,000 jobs per billion dollars of spending. However, mass transit programs create between about 20,000 and 23,000 jobs per billion dollars of spending, and highway environmental enhancements create nearly 22,000 jobs per billion dollars of spending. Thus, mass transit programs create nearly twice as many jobs per dollar expended as does highway construction, and highway environmental enhancements generate nearly 50 percent more jobs per dollar expended that does highway repair or bridge construction.

Fifth, the job impacts of investments in other types of infrastructure vary considerably; for example:

- University infrastructure programs create between about 10,000 and 14,000 jobs per billion dollars of spending
- State, provincial, and local government infrastructure programs create between about 10,000 and 19,000 jobs per billion dollars of spending

- Housing programs create between about 11,000 and 18,000 jobs per billion dollars of spending
- Health care creates between about 13,000 and 14,000 jobs per billion dollars of spending
- Environmental remediation programs create between about 10,000 and 15,000 jobs per billion dollars of spending
- Smart Grid infrastructure programs create between about 10,000 and 15,000 jobs per billion dollars of spending.

These job creation effects are, per dollar, higher than conventional fossil fuel power plant investments and are higher than the job creation effects of tax cuts, are equal to or higher than the impacts of highway construction programs, but are considerably below the job creation of mass transit and highway environmental restoration programs.

Finally, clean and renewable energy programs can be powerful job creators, but the job creation effects can depend importantly on the RE program and technology. While, in general, RE programs generate between about 16,000 and 22,000 jobs per billion dollars of spending, the job creation differs among clean energy technologies; for example:

- Biofuels generate 23,000 jobs per billion dollars of spending
- PV programs generate 15,300 jobs per billion dollars of spending
- Wind programs generate between about 12,000 and 15,000 jobs per billion dollars of spending
- Geothermal programs generate 11,100 jobs per billion dollars of spending
- Biomass power programs generate 8,900 jobs per billion dollars of spending
- Hydro programs generate 5,100 jobs per billion dollars of spending

Thus, a major finding that emerges here is that the jobs creation effects of spending on clean and renewable energy programs can differ by a factor of more than four, depending on the specific program or technology.

Accordingly, one must be cautious when estimating the jobs impacts of "green stimulus" programs – both in an absolute sense and compared to other alternatives. We can say with a high level of confidence that investments in energy efficiency retrofit programs, water/energy efficiency programs, biomass, solar thermal, and mass transit programs will likely generate, per dollar, more jobs than most other alternatives. We can also say with a high level of confidence that green stimulus programs, energy efficiency programs, and renewable energy programs will generate, per dollar, an order of magnitude more jobs than will expenditures for fossil fuel plants or tax cuts. We can thus accept, with a high degree of confidence, the hypothesis that "green stimulus" (i.e. relating to clean energy and energy efficiency) can provide equal or greater economic benefits than most traditional programs while also providing environmental benefits.

Nevertheless, this is not universally true with respect to all types of green programs compared to all other types of programs. Thus, for example:

- Bridge construction creates 17,000 jobs per billion dollars of spending, whereas PV creates about 15,000 jobs per billion dollars of spending
- Health care creates between about 13,000 and 14,000 jobs per billion dollars of spending, whereas geothermal programs generate about 11,000 jobs per billion dollars of spending
- State, provincial, and local government infrastructure programs create between about 10,000 and 19,000 jobs per billion dollars of spending – somewhat more than environmental remediation programs, which create between about 10,000 and 15,000 jobs per billion dollars of spending
- Highway repair creates about 14,000 jobs per billion dollars of spending – about the same as Smart Grid infrastructure programs, which create between about 10,000 and 14,500 jobs per billion dollars of spending
- Many infrastructure programs generate more jobs per dollar than RE programs such as biomass power (8,900 jobs per billion dollars of spending) and hydro (5,100 jobs per billion dollars of spending).

III.D.2 Estimating Jobs Created Per MW of Capacity Created

Another way to measure the relative job creation potential of green stimulus programs is by the jobs created per MW, and some studies contend that clean energy programs create, per MW, more jobs than conventional alternatives. For example, a widely quoted study conducted at the University of California, Berkeley, reported that, across a broad range of scenarios, the renewable energy sector generates more jobs than the fossil fuel-based energy sector per unit of energy delivered (i.e., per average megawatt).[1] Specifically, it concluded that:

- The renewable energy sector generates more jobs per megawatt of power installed, per unit of energy produced, and per dollar of investment, than the fossil fuel-based energy sector.
- While a shift from fossil fuels to renewables in the energy sector will create some job losses, these losses can be adequately mitigated through a number of policy actions.
- Embedding support for renewables in a larger policy context of support for energy efficiency, green building standards, and sustainable transportation will greatly enhance net positive impacts on the economy and employment.

[1] Daniel M. Kammen, Kamal Kapadia, and Matthias Fripp, *Putting Renewables to Work: How Many Jobs Can the Clean Energy Industry Generate?* RAEL Report, University of California, Berkeley, 2006.

We examined the hypothesis that clean energy programs, per MW, generate more jobs than conventional alternatives by reviewing the empirical evidence. Our analysis reviewed:

- Over 50 independent studies that
- Analyzed 30 programs and technologies
- Conducted over the past decade
- In two nations and for Europe and the world

The results of 23 of these studies are summarized in Table III-12.

This table illustrates that the estimates of jobs/MW from the different studies vary too widely to permit derivation of any definitive conclusions. For example:

- The estimates of jobs generated by wind differ by a factor of 24, from as few as 0.7/MW to as many as 16.7/MW
- The estimates of jobs generated by PV differ by a factor of 8, from as few as 7.4/MW to as many as 51/MW
- The estimates of jobs generated by natural gas differ by a factor of 10, from as few as 1.0/MW to as many as 10.4/MW
- The estimates of jobs generated by coal differ by a factor of 18, from as few as 1.0/MW to as many as 18.2/MW
- The estimates of jobs generated by biomass differ by a factor of four, from as few as 0.8/MW to as many as 2.8/MW

We thus conclude that the hypothesis that clean energy programs, per MW, generate more jobs than conventional alternatives can be neither conclusively accepted nor rejected.

Table III-12
Jobs Created Per Megawatt by Different Energy Technologies

Country	Project	Total Jobs Per MW	Source	Year of Estimate
EU	Wind	15.4	European Wind Energy Association	2000
Spain	Biomass	4.0	Moreno and López	2006
Spain	PV	34.6	Moreno and López	2006
USA	Clean coal with CCS	2.5	BBC Research and consulting	2009
USA	Wind	3.6	National Renewable Energy Laboratory	2009
USA	Nuclear Coal Gas Wind	5.0 2.2 0.6 0.9	Ventyx	2009
USA	Wind	5.1	Northern Arizona University	2008
USA	Grid connected solar electricity	6.5	Solar Initiative of New York	2007
USA	Coal Gas Wind	18.2 10.4 16.7	NREL	2006
USA	wind	6.6	NREL -- rural areas	2006
USA	Gas	1.0	Renewable and Appropriate Energy Laboratory	2006
USA	Coal Gas Oil Nuclear Wind PV Solar thermal Hydro	6 3.5 4 14 4 45 40 3	MISI	2006
USA	Solar RPS	1.1	UCS	2005
USA	PV	7.4	Renewable Energy Policy Project	2001
USA	Wind	0.7	REPP	2001
USA	Biomass – high estimate	2.8	REPP	2001
USA	Biomass – low estimate	0.8	REPP	2001
USA	Coal	1.0	REPP	2001
USA	Solar Wind Coal Biomass co-firing	35.5 4.8 6.0 8.8	REPP	2001
USA	Utility O&M	0.4	EIA	1999
World	PV	51	EPIA and Greenpeace	2007
World	Wind	2.8	EWEA and Greenpeace	2003
World	PV	10.6	Greenpeace	2001

Source: Management Information Services, Inc., 2009

III.E. Do Clean Energy Programs Destroy Jobs?

In recent months, a number of studies have appeared that question the job impacts of green stimulus and RE&EE programs and initiatives. For example:

- The Spanish Univisidad de Juan Carlos published a study contending that, in Spain, every renewable energy job created "destroys" at least 2.2 jobs -- on average, about nine jobs lost for every four created.[1] The study contended that these results can be generalized for other countries and for RE programs in general.
- The USA Institute for Energy Research (IER) examined four recently published clean energy and green jobs studies and concluded that a government campaign to stimulate green jobs would have no net economic benefits and would likely have negative economic consequences by forcing higher-cost alternative energy sources on the economy and would result in net job losses.[2]
- Researchers at the USA University of Illinois reviewed the green job literature and found that there is no standard definition of a "green job," that creating green jobs will not increase productive employment, and that green jobs programs do not promote employment growth.[3]
- The USA Congress of Racial Equality (CORE) – a pioneering civil rights organization -- has criticized green jobs initiatives as being elitist, failing to create jobs for those who need them the most, and for diverting funds from other more important social welfare, jobs, and anti-poverty programs.[4]
- Good Jobs First – a U.S. pro-labor organization – criticized green job creation as being characterized by low pay and below-average wages, poor benefits, subject to off-shoring, having insecure tenure, and being largely non-unionized.[5]

A comprehensive critique of each of these studies is outside the scope of the current project. However, such criticisms of clean energy and green jobs programs cannot be dismissed out of hand.

First, in recent years the hyperbole concerning clean energy and green jobs has sometimes reached unrealistic levels, and various advocates throughout the world have advanced green jobs creation as a cure for most economic and social problems. Such advocacy is not only unrealistic, it risks destroying the credibility of viable, necessary

[1]Gabriel Calzada Álvarez, Raquel Merino Jara, Juan Ramón Rallo Julián, and José Ignacio García Bielsa, *Study of the Effects on Employment of Public Aid to Renewable Energy Sources*, Univisidad de Juan Carlos, March 2009.

[2]Robert Michaels and Robert P. Murphy, *Green Jobs: Fact or Fiction?* Institute for Energy Research, January 2009.

[3]Andrew P. Morriss, William T. Bogart, Andrew Dorchak, and Roger E. Meiners, *Green Jobs Myths*, University of Illinois Law and Economics Research Paper Series No. Le09-001, 2009.

[4]Paul Driessen, "Green-Collar Jobs – or Con Jobs?" Congress of Racial Equality, 2009.

[5]Philip Mattera, "High Road Or Low Road? Job Quality in the New Green Economy," a report by Good Jobs First, Washington, D.C. , February 2009.

green jobs initiatives. Over-promising results and impacts is a guaranteed way to discredit the entire concept.

Second, and closely related, it is important to be aware of the limitations and constraints of clean energy and green jobs stimulus programs – especially in the short run. While, as demonstrated here, clean energy has enormous potential for job creation, green stimulus programs on their own will not quickly get the world out of the economic and financial recession it is currently in. For example, in a recent analysis for the U.S. Department of Energy, MISI noted that:[1]

- Between 2006 and 2007 growth in the clean energy industries in the USA created about 590,000 new jobs, and this is significant and noteworthy
- However, in a single month, January 2009, U.S. economy lost 600,000 jobs, and this rate of job loss has increased since January.
- Thus, the U.S. economy was losing more jobs every month than clean energy created in an entire year.
- The clean energy portion of the U.S. stimulus will create about 230,000 jobs per year over the period 2009 – 2011, which is about 20 percent of the 3.5 million jobs President Obama predicts the entire stimulus plan will generate
- However, during the current recession, by May 2009, the U.S. economy had already lost more than five million jobs, and the high rate of job loss was continuing.

Thus, while helpful and necessary, green stimulus and green jobs programs by themselves are not likely to be sufficient to remedy current world economic problems.

Finally, not all clean energy and green stimulus jobs programs and initiatives are created equal, and some are likely inefficient and are not cost effective. Recognizing this fact and dealing with it does not negate the overall potential of sustainable energy development programs and their employment generation potential.

On the other hand, even cursory examination of the studies mentioned above indicates some of their weakness. For example, the Univisidad de Juan Carlos study:

- Does not actually identify the jobs allegedly destroyed by clean energy programs, but simply notes what the Spanish government is spending on various programs.
- Fails to establish cause and effect. Thus, while green jobs have been created and other jobs lost, the study does not establish a causal relationship between the two; e.g. jobs may have been lost no matter what the Spanish government did. Further, it could be argued that creation of the clean energy jobs, given the worldwide economic recession, prevented a bad situation from getting worse.

[1]Roger H. Bezdek, "Green Collar Jobs: Economic Drivers For The 21st Century," presented at the U.S. Department of Energy, Washington, D.C., February 19, 2009.

- Suggests that clean energy is subject to boom and bust. However, the problems with Spain's boom and bust cycles have nothing to do with clean energy, but with the boom and bust experiences of the past two decades.
- Fails to note that Spain's support for clean energy came out of existing tax revenues and that the Spanish government has reduced corporate income-tax rates.

The IER study is not persuasive. It is a very short treatment of an important subject, often reads more like a polemic than a rigorous analysis, and does not evidence a thorough understanding of the clean energy jobs studies it is criticizing.

The CORE and Good Jobs First studies raise some legitimate concerns about green job creation: Whether green jobs are appropriate for disadvantaged socioeconomic groups and whether they are subject to low pay and poor working conditions. These are serious issues, but they have been dealt with extensively in the green jobs literature. Further, it is important to recognize – as emphasized in the current project – that there is nothing inherently "good" about clean energy jobs: They can be subject to the same problems and concerns as any other types of jobs, and clean energy stimulus programs thus require careful design and monitoring.

More generally, it is necessary to consider the alternatives advanced by the critics of clean energy and green stimulus jobs programs. The authors of the Univisidad de Juan Carlos, IER, and University of Illinois studies are conservatives who are critical of virtually any type of government energy or jobs programs. This may be a philosophically defensible position. However, the alternatives proposed are "market based" solutions that involve deregulation, minimal government programs or intervention, and letting the unfettered private sector solve the problem. However, it can be argued that these are the very policies that have led the world to the current economic and financial quagmire – the most serious since the Great Depression of the 1930s.

Finally, the problem with the entire line of reasoning here is that these critics seem to be engaged in short-term thinking as opposed to long-term assessment. In the short term, fossil fuel programs may be cheaper – especially if all environmental costs are not internalized. However, in the long term, given concerns over global warming and fossil fuel resource depletion, it is imperative that the world energy mix shift in favor of a less carbon intensive economy and clean energy jobs. The concerns of organizations such as CORE and Good Jobs First can be addressed with antipoverty programs, worker training, jobs standards and protections, etc.

IV. IMPLICATIONS OF FINDINGS FOR CANADA, FINLAND, IRELAND, THE UK, AND OTHER NATIONS

IV.A. The Significance of Government Incentives Policies

Our research has derived some important findings, implications, and lessons for Canada, Finland, Ireland, the UK and other nations with respect to clean energy policy, and these are summarized below.

Legacy Policies and Incentives Matter

A government's energy policies can have a critical impact on clean energy development, and legacy energy policy, regulations, and subsidies are one of the key determinants of the success of clean energy initiatives and achievement of desired green energy goals. Subsidies and taxation favoring nuclear and fossil fuel technologies are a worldwide problem and in many individual countries, and may allow fossil and nuclear energy to be sold at artificially low prices.

For example, the USA federal government has provided $725 billion (2006 dollars) for energy development since 1950, but renewables received less than seven percent of the total. MISI thus concluded that the historical legacy of U.S. energy subsidies places clean energy at a serious economic disadvantage in the marketplace. Further, MISI estimates that it would take decades of revised energy incentives policies to remedy these market distortions – especially since large subsidies to conventional fuels continue.

> **Finding Number 1. Due to legacy subsidies to conventional energy sources, large subsidies for clean energy may be required for many years to offset the embedded subsidies enjoyed by competing energy sources. Further, these clean energy subsidies may have to be larger and remain in place longer than most analysts and policy-makers realize.**

Clean Energy Incentives Programs are Necessary

Appropriately sized incentives are critical to encouraging growth of the clean energy market while balancing government fiscal resources and minimizing free-ridership. The appropriate incentive size will depend on the context of the respective market, which will make it unique to each government jurisdiction, resource, and technology.

Coordinated and Complementary Clean Energy Incentives Policies are Critical

Clean energy incentives must be complementary and reinforcing, and must be coordinated among federal, regional, and local governments. Experience has shown that even the largest financial incentives will not be effective unless appropriate, complementary regulatory and institutional incentives policies are also in place, and this is a policy error that is frequently made.

> **Finding Number 2. To be effective, financial incentives for clean energy must be accompanied by complementary institutional and regulatory policies.**

Financial Incentives Must be Carefully Designed and Implemented

The appropriate incentive size will depend on the context of the respective market, which will make it unique to each nation and jurisdiction. It is not sufficient to merely have a tax incentive; it must be large enough to increase investment without being so large as to deplete a government's resources. In addition, the policy should be designed so that tax incentives are not larger than the a consumer's tax liability, since the consumer would unable to take full advantage of the incentive.

Well-designed tax incentives can play an important role in increasing market penetration of clean energy if implemented as part of an incentive portfolio. Historically, tax incentives have been awarded based on capacity; however, the literature suggests that they may be more effective if production-based provisions are included, especially for large systems.

> **Finding Number 3. Clean energy financial incentives based on production are more effective than those based on capacity.**

The Impact of Clean Energy Incentives

There are relatively few studies that rigorously assess the effectiveness and impact of clean energy incentives. However, NREL analyzed the 50 U.S. states according to their use of the most effective policies promoting clean energy electricity and treated the 50 states as jurisdictional laboratories to determine what incentives and combinations of incentives were most effective. Key findings include:

- A renewable portfolio standard increases wind-based electricity generation.
- An RPS results in a higher percentage of clean energy in overall electricity generation.
- Line-extension analysis policies facilitate higher wind capacity and generation.
- Production incentives increase renewable electric capacity and generation overall, as well as individual resource categories.

- Interconnection policies are required to increase renewable energy capacity and generation overall, as well as individually for higher biomass, hydroelectric, and PV capacity.
- Barrier-reduction policies are required to facilitate clean energy development.
- Strong financial incentives policies and barrier reduction policies are both required, in tandem, to significantly increase clean energy development and, to be effective, financial incentives must be accompanied by barrier reductions.

Finding Number 4. It is the portfolio of incentives that is critical and there is a quantifiable connection between the incentives portfolio and clean energy development, but optimizing the portfolio is essential.

Finding Number 5. Successful combinations of financial and regulatory policies can be serendipitous as well as planned, and monitoring of incentive effects, interactions, and feedbacks is required.

Consistency of Incentives

It is important that clean energy incentives be consistent and predictable, and a lack of these attributes will negate the incentives' effects. In Canada and the USA, and in many other nations, clean energy incentives increased in the late 1970s and early 1980s, declined from the mid-1980s through the late 1990s, and then increased over the past decade. This rollercoaster policy had devastating effects on clean energy development. Further, over the past decade in the USA the renewable energy production tax credit has been periodically renewed and terminated, and this seriously hampered wind energy development.

Finding Number 6. To be effective, clean energy financial incentives must be consistent, predictable, and reliable.

RPS v. FIT

In Europe, there has been considerable debate over whether renewable portfolio standards (RPS) or feed-in tariffs (FIT) are preferable. Most European nations are now using the FIT, and this policy is being increasingly used in North America. The advantages of FIT include rapid deployment of technologies and of local manufacturing, encouragement of geographic distribution, transparency, low administrative cost, investment and job creation, and enhanced competition in manufacturing and equipment suppliers.

Finding Number 7. A feed-in-tariff is a more effective incentive policy than a renewable portfolio standard.

IV.B. Clean Energy Development and Economic Indicators

There is substantial anecdotal and empirical evidence of a positive relationship between clean energy development and various socioeconomic indicators, such as jobs, incomes, GDP growth, reduced pollution, energy savings, energy cost savings, reduced exposure to energy price fluctuations, and other metrics. For example:

- A study for the USA state of Arizona found that clean energy is a good investment that provides strong returns; that, per dollar, clean energy investments produce greater economic benefits than traditional technologies; and that investing in clean energy generates thousands of new jobs, stimulates Arizona's economy, conserves water, and improves public health.
- A study for the USA state of Colorado found that developing clean energy yields better economic results than the alternatives and that by investing in renewable energy the state will create jobs, stabilize energy prices, and reduce the long-term economic and environmental risk from global warming.
- A study in the USA found that clean energy, economic growth, and jobs creation are complementary and compatible; that the net effect of clean energy deployment on employment is positive; that clean energy and environment protection have grown rapidly to become a major sales-generating, job-creating industry; and that at the state level, the relationship between clean energy policies and economic/job growth is positive -- states can have strong economies and clean energy.
- A review by the University of California of studies that analyzed the economic and employment impacts of the clean energy industry in the USA and Europe found that clean energy development is not only good for energy self-sufficiency and the environment, it also has a significant positive impact on employment.
- A study by the Economic Commission for Europe found that improved energy efficiency significantly reduces energy needs and CO_2 output; that there are numerous inexpensive, reliable, and efficient existing options, many of which are self-financing; and that increasing energy efficiency is the least costly way to reduce CO_2 and often has negative costs.
- A study in the USA found that enhanced vehicle fuel efficiency standards have positive energy, environmental, economic, and job benefits and increase economic growth, create jobs, reduce energy consumption and prices, increase GDP, and substantially reduce annual U.S. GHG emissions.
- A European Commission study found that the key to Europe's future economic development lies in increasing resource and energy productivity, that strong action to fight climate change is compatible with continued economic growth and prosperity, and that development of clean energy is a win-win opportunity for the

Member States to finance environmental projects and for economic growth in the EU.

- A Business Europe study of the European experience found that energy efficiency reduces GHG emissions and saves costs, and that of all possible measures to abate GHG emissions, those that use energy more efficiently have the lowest cost.
- A MISI study found that in 2007 the USA clean energy industries generated $1,045 billion in sales and created over 9 million jobs; that they are growing faster than the U.S. average and contain some of the most rapidly growing industries in the world; and that the U.S. RE industry grew more than seven times as fast as the overall U.S. economy.
- A study of California found that the state has grown more prosperous and added jobs over the past three decades even as it increased energy efficiency and clean energy and reduced per capita energy consumption and GHG emissions: From 2005 to 2007, clean energy jobs increased by 10 percent, while the state economy's job growth was one percent; while Californians were reducing energy use and GHG emissions, the state's economy grew and state per capita GDP increased 28 percent from 1990 to 2006; and energy efficiency measures have created about 1.5 million FTE jobs and produced net household energy savings of $56 billion from 1972-2006.
- A study by the Lisbon Council found that nations with innovative environmental technologies have higher growth in total factor productivity and thus dynamic economic growth; that economic growth and productivity are enhanced by more efficient energy use; investing in more productive and economical use of energy is not only good for the environment, it also promotes economic growth and prosperity; that there is a positive correlation between energy productivity, economic growth, and overall prosperity; and that countries that adopt clean energy and environmental technologies quickly increase their overall productivity.
- A study of the impact on the U.S. economy of federal tax credits for solar technologies found that extending the ITC would result in increased investment of $232 billion and create 440,000 jobs

Finding Number 8. Investments in clean energy and energy efficiency programs increase GDP, incomes, and jobs, reduce pollution and GHG emissions, save energy, reduce energy costs, and reduce exposure to energy price fluctuations.

Finding Number 9. The relationship between i) clean energy, energy efficiency, and environmental programs and ii) economic growth and job creation is positive, not negative.

Finding Number 10. Investments in energy efficiency programs are especially beneficial and cost effective, and often have negative net economic costs.

Finding Number 11. Clean energy programs increase productivity and economic prosperity.

IV.C. The Economic and Job Impacts of Clean Energy-Related Government Stimulus Programs Compared to Other Government Spending Alternatives

Jobs Per Dollar

MISI conducted the most comprehensive review to date of studies of the economic and jobs impacts of "green stimulus" (i.e. relating to clean energy and energy efficiency) and related sustainable programs and investments compared to more traditional infrastructure and energy programs. The analysis reviewed over 100 independent studies that analyzed 85 programs and technologies conducted over the past decade in five nations and Europe that estimated the jobs created per dollar of expenditures. Our major findings include:

- Spending for traditional energy, power, and utility programs generate relatively few jobs per dollar compared to most alternative investments.
- Energy efficiency programs usually generate the most jobs per dollar compared to alternative investments.
- Combined water/energy efficiency programs have an especially large job creation potential.
- An alternative often advocated instead of green stimulus programs, tax cuts, has a relatively small job creation potential per dollar expended.
- Transportation infrastructure investments have a potentially wide range of job creation impacts.
- The job impacts of other types of infrastructure programs vary widely.
- The job creation potential of specific clean energy programs differs significantly, depending on the program.

Accordingly, one must be cautious when estimating the jobs impacts of green stimulus programs – both in an absolute sense and compared to other alternatives. Nevertheless, we found that investments in energy efficiency retrofit programs, water/energy efficiency programs, biomass, solar thermal, and mass transit programs will likely generate, per dollar, more jobs than most other alternatives. We also found that green stimulus programs, energy efficiency programs, and renewable energy programs will generate, per dollar, an order of magnitude more jobs than will expenditures for fossil fuel plants or tax cuts. We can thus accept, with a high degree of confidence, the hypothesis that "green stimulus" (i.e. relating to clean energy and energy efficiency) can

provide equal or greater economic and job benefits than most traditional programs while also providing environmental and other benefits.

Finding Number 12. Investments in green stimulus and infrastructure programs, in general, usually generate, per dollar expenditure, more jobs than most alternatives.

Finding Number 13. Investments in fossil-fuel programs generate relatively few jobs per dollar of expenditure.

Finding Number 14. Green stimulus programs generate about three or four times as many jobs, per dollar, as do tax cuts.

Finding Number 15. Transportation infrastructure programs differ markedly in their job generation effects, but "green" initiatives tend to generate significantly more jobs per dollar than does highway construction, and mass transit programs create nearly twice as many jobs per dollar expended as does highway construction.

Finding Number 16. Clean energy programs are powerful job creators, but the job creation effects depend importantly on the specific clean energy program and technology.

Jobs Per Megawatt

Another way to measure the relative job creating potential of green stimulus programs is by the jobs created per MW, and some studies contend that clean energy programs create, per MW, more jobs than conventional alternatives. We examined this hypothesis by reviewing the empirical evidence. We reviewed over 50 independent studies that analyzed 30 programs and technologies conducted over the past decade in two nations and for Europe and the world.

We found that the estimates of jobs/MW from the different studies vary too widely to permit derivation of any definitive conclusions. We thus concluded that the hypothesis that clean energy programs, per MW, generate more jobs than conventional alternatives can be neither conclusively accepted nor rejected.

Finding Number 17. There is no conclusive empirical evidence that clean energy programs generate more jobs (or fewer jobs), per MW, than do conventional alternatives.

IV.D. Clean Energy Programs and Job Destruction

In recent months, a number of studies have appeared that contend that clean energy programs actually destroy jobs, not create them. A critique of these studies indicates that, while such criticisms of clean energy and green jobs programs cannot be dismissed out of hand, the studies are far from persuasive. More important, there exists substantial research showing that the net economic and job creation effects of clean energy programs are strongly positive.

> **Finding Number 18. Studies contending that clean energy programs actually destroy jobs are not persuasive, and there is substantial evidence indicating that the net economic and job creation effects of clean energy programs are strongly positive.**

About the SEF Alliance

The UNEP SEFI Public Finance Alliance, or "SEF Alliance", is an international coalition of public and publicly-backed sustainable energy financing organisations. Its aim is to improve the effectiveness of member organisations to finance and transform clean energy markets within their own countries, and to assist other governments in establishing similar programmes.

The 2009 member funds are the U.K. Carbon Trust, Sustainable Development Technology Canada, SITRA, the Finnish Innovation Fund, and Sustainable Energy Ireland. Each member finances the development of sustainable energy markets in its respective region, and find managers use this platform to exchange best practices, pool resources, and launch joint projects. The SEF Alliance is under the remit of the Sustainable Energy Finance Initiative (SEFI) of the United Nations Environment Programme (UNEP) but is governed directly by its members. For more information, see www.sefalliance.org.

About MISI

Management Information Services, Inc. (MISI) is an economic research firm with expertise on a wide range of complex issues, including renewable energy, energy efficiency, the environment, labour markets, and education and training requirements. The MISI staff offers expertise in economics, information technology, engineering, and finance, and includes former senior officials from private industry, federal and state government, and academia. Over the past three decades MISI has conducted extensive proprietary research, and since 1985 has assisted hundreds of clients, including Fortune 500 companies, nonprofit organisations and foundations, trade associations, academic and research institutions, and state and federal government agencies including the White House, the National Academies of Science, the U.S. Department of Energy, the U.S. Environmental Protection Agency, the Department of Defense, NASA, the U.S. General Services Administration, the U.S. Energy Information Administration, the American Solar Energy Society, the Energy Foundation, the Rockefeller Foundation, the John Merck Foundation, the Joyce Foundation, and the Office of Al Gore.

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