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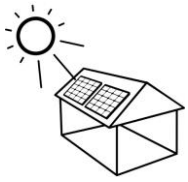

SUBSIDIES TO SOLAR AND WIND ENERGY IN CANADA – AN INVENTORY

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SUBSIDIES TO SOLAR AND WIND ENERGY IN CANADA – AN INVENTORY

By Robert Lyman

Robert Lyman is an Ottawa energy policy consultant and former public servant of 27 years; prior to that he was a diplomat for 10 years.

Introduction

An active public debate rages in Canada and other countries about the "subsidies" that allegedly are paid to the oil and natural gas industry. Far less attention is paid to the subsidies paid to the renewable energy industries, including solar and wind energy, for electricity generation. The purpose of this paper is to "shine some light" on the latter subject, by identifying the different sources of incentive funding now provided by governments in Canada, and to some extent other countries, to solar and wind energy sources and uses.

What are "Subsidies"?

This subject is made far more complex than it should be by the different meanings that have been given to the term "subsidy" and by the different methodologies that have been used to estimate the value of a subsidy. According to Wikipedia, a subsidy is "*a form of financial aid or support extended to an economic sector (or institution, business, or individual) generally with the aim of promoting economic and social policy. Although commonly extended from government, the term subsidy can relate to any type of support – for example from NGOs or as implicit subsidies. Subsidies come in various forms including: direct (cash grants, interest-free loans) and indirect (tax breaks, insurance, low-interest loans, accelerated depreciation, rent rebates)*."

Subsidies are usually paid by governments to certain individuals or groups and therefore represent a transfer of funds from one group of citizens (i.e. taxpayers) to others. When the subsidy goes to a commercial enterprise operating in a market environment, it gives that enterprise an advantage over other firms. These facts have tended to give a pejorative connotation to the term, although it has not discouraged governments from giving hundreds of billions of dollars in direct and indirect subsidies every year. In simple terms, government subsidies distort the competitive marketplace. Whether they are good or bad may well depend on whether the benefit of government involvement outweighs the costs of the distortion.

In the case of solar and wind energy projects, the subsidies, or market advantages, provided by governments in Canada and elsewhere fall into several different categories:

- Funding of research and development, conducted either in government research facilities or in private research laboratories
- Funding for technology demonstration projects
- Grants, contributions and low-interest loans made either to suppliers or purchasers
- Preferential procurement practices
- Tax incentives such as credits, deductions, and exemptions that are not provided to other firms and allowing firms to pass these benefits on to outside investors in the form of flow-through shares
- Preferences granted through regulation
- Preferential, above-market utility rates, as used in "feed-in-tariffs" regimes, often guaranteed at fixed rates for the life of the contract
- Restrictions on local government ability to impose property and other taxes on solar and wind project sites

These and other incentives may be applied at federal and provincial government levels, creating multiple, and often-duplicative subsidy possibilities.

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A Brief Look at the U.S. Situation

There does not yet exist a comprehensive list of the subsidies and other market advantages provided to solar and wind energy projects in Canada, so no one can know with certainty either the cost or benefits of these measures. In the United

States, the situation is slightly better, in that the Energy Information Administration published a report in March 2015 (*Analysis and Projections: Direct Federal Financial Interventions and Subsidies in Fiscal Year 2013)* in response to a request by the U.S. Congress. As indicated in the title, the report addresses only the incentives provided by the U.S. federal government. The following table indicates the expenditures:

Table 1

Renewable Energy Subsidies and Support by Type, 2013
($million)

Beneficiary	Direct Expenditure	Tax Expenditure	R&D	Total
Solar	2,969	2,076	284	5,328
Wind	4,274	1,614	49	5,936
Totals	7,243	3,690	333	11, 264

Subsidies for all renewable energy sources plus "conservation" in 2013 totaled $17 billion, or 58% of all U.S. federal spending on energy sources.

Solar and Wind Subsidies in Canada

Research, Development and Demonstration

Only a limited amount of information is available on federal government funding of R, D&D and almost none on any funding done by provincial governments. In a sense, Canada would be well-placed to be a "free rider" in this area as hundreds of millions of dollars are being spent each year in other countries, all trying to achieve scientific and technological breakthroughs in renewable energy, and these efforts have been generously funded by governments for over 30 years.

The Government of Canada announced the Clean Energy Fund (CEF) in January 2009. Initially announced as a $1 billion expenditure, that was reduced to $800 million in Budget 2010. $26.4 million over two years was allocated for "clean energy" R&D conducted by federal departments and agencies in a range of activities from basic research to pre-demonstration pilot projects. About $146 million was provided for smaller scale demonstration projects in renewable and clean energy systems. About 26% of the R&D was in renewables in the "built environment", including solar and wind.

Budget 2017 included additional measures to promote "clean energy innovation", including:

- $400 million over five years, starting in 2017, to recapitalize Sustainable Development Technology Canada's SD Tech Fund to support projects to develop and demonstrate new clean technologies, including those that address environmental issues such as climate change, air quality, clean water and clean soil.
- $200 million over four years, starting in 2017-18, to support clean technology research, development and demonstration and the adoption of clean technology in Canada's resource sectors.
- Up to $950 million over five years, starting in 2017-18, focused on "supporting highly innovative sectors such as clean technology and natural resources, including a small number of business-led innovation super-clusters"
- $229 million over four years, starting in 2018-19, to continue research and development activities in clean energy and transportation innovation.

The federal government has not indicated what portion of these funds will go to solar and wind.

Grants, Contributions and Low-Interest Loans

Grants and contributions are direct program expenditures by governments usually made either to the producer or the purchaser of a good. The main difference between grants and contributions is that grants are usually made without conditions. Low-interest loans confer a financial benefit on the recipient because the financing cost of the loan is lower than the recipient would have to pay when borrowing at commercial rates.

The federal government is the main source of grants, contributions and low-interest loans for solar and wind energy in Canada.

Before 2017, the largest source of federal government funding of renewable power sources was the ecoEnergy for Renewable Power program. This was launched in April 2007 to subsidize the generation of electricity from wind, photovoltaic, biomass, low-impact hydro and geothermal energy. It will spend about $1.4 billion and to increase generation capacity by 4500 megawatts (generation of 14 terawatt hours) by offering a refund of one cent per kilowatt-hour to providers of energy. No contribution agreement was signed after March 31, 2011, but the program itself will end on March 31, 2021.

Budget 2017 included several new measures:

- Nearly $1.4 billion in new financing, starting in 2017, through the Business Development Bank of Canada and the Export Development Bank, including $389 million in equity financing and $570 million in working capital to support "clean technology firms", plus about $450 million in additional project financing for capital-intensive "clean technology firms".
- $100 million as part of the Strategic Innovation Fund to "attract and support new high-quality business investments" in clean technology.
- $100 million to support next-generation smart grid, storage and clean electricity technology demonstration projects
- $200 million to support deployment of emerging renewable energy technologies nearing commercialization
- $220 million to subsidize the replacement of diesel fuel-generators in rural remote communities south of the 60th parallel by "renewable power solutions"
- $$182 million to develop and implement new building codes to retrofit existing buildings and build net-zero energy consumption buildings across Canada
- $14.5 million over four years, starting in 2017, to federal departments to develop a "clean technology data strategy"

In short, the federal government will spend over $2.4 billion over the next four years to promote the production and use of "clean energy", a major part of which will be solar and wind companies.

The grants and contributions extend to municipalities. In 2000, the Government of Canada endowed the Federation of Canadian Municipalities (FCM) with $550 million to establish the Green Municipal Fund. An additional $125 million top-up to this endowment was also announced in Budget 2016 and will be added to the Fund in 2017–18. The Fund supports partnerships and leveraging of both public and private sector funding to reach higher standards of air, water and soil quality, and climate protection. The fund is used by FCM to sponsor and support a wide range of initiatives by municipal governments, many of which are capital projects.

The Green Municipal Fund Annual Report for 2016-2017 included a table on the capital projects that the fund has approved since its inception, broken down by province and territory and by type of financing, but not by energy source. There have been 199 capital projects, involving $88.6 million in grants and $671 million in loans.

The provincial and territorial governments have implemented a wide range of programs to assist and subsidize solar, wind, other alternative energy and energy efficiency purchases. Natural Resources Canada has on its website a list and short description of 272 different programs. It can be seen here:

http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/policy_e/results.cfm?searchType=default&sectoranditems=all%7C0&max=10&categoryID=all&regionalDeliveryId=all&programTypes=4&keywords=&pageId=1

There are no publicly available estimates of the costs of these programs or of the distribution of the funding among energy sources. One can only wonder how many of these hundreds of funding programs were subject to cost-benefit analysis before they were introduced or have had assessments of program effectiveness since.

Two examples of the programs that the provinces have implemented are Quebec's refundable tax credit and Alberta's residential and commercial solar program. The temporary "Renovert Tax Credit" is intended to encourage individuals to invest in "eco-friendly" (the euphemisms never cease) home renovation work that has a positive environmental impact. The amount of a tax credit that a home owner could claim corresponds to 20% of the eligible expenses paid after March 17, 2016 and before October 1, 2017 that exceeds $2,500, up to a maximum tax credit of $10,000. The solar and wind industries are probably lobbying Quebec for the extension of this program, and would like to see a similar tax credit established at the national level. Alberta's Residential and Commercial Solar Program aims to have new solar panels on 10,000 rooftops in the province by 2020. The incentive is in the form of a rebate of 75 cents per watt, capped at $10,000 for residential systems with interconnection approval from the Wire Service Provider (WSP) signed on or after April 15, 2017.

Preferential Procurement Practices

In April 2006, the federal government introduced its Policy on Green Procurement. It directs federal departments and agencies to incorporate environmental considerations into the procurement decision-making processes for all goods and services purchased. This is an extraordinary commitment, as the federal government is one of the largest buyers of goods and services in the country. Departments are responsible for setting green procurement targets and including environmental criteria and specifications. The government does not publish any information concerning the additional costs of using "green" goods and services.

The Trudeau Government has committed that the federal government will use 100% "clean electricity" by 2025. The anticipated cost of this commitment was not announced. One cannot help but wonder whether every Canadian military base will have to operate on wind and solar energy.

Tax Instruments

There are several ways in which the tax systems of the federal and provincial governments can provide benefits to an individual business firm. These include deductions, credits, exemptions and various other allowances that affect the

amounts of tax payable. The allowances usually concern corporate income taxes, personal income taxes, excise taxes and sales taxes.

Every year, Finance Canada publishes a report on federal government "tax expenditures". The concept of tax expenditures is based on the idea that whenever the government, to achieve a public policy objective, applies preferential tax rates, exemptions, deductions, deferrals and tax credits, these measures deviate from the core function of the tax system, which is to raise revenues to fund government expenditures. The money a taxpayer does not pay in tax is considered by Finance and treasury departments as revenue lost to the government, and therefore, in theory, an "expenditure". In other terms, the government could have achieved the same objectives by spending, but it chose to lower taxes instead.

Calculating the value of the tax expenditure can be complicated, because the financial benefit conferred is the difference between what a taxpayer actually pays and what he or she would have paid under a "benchmark" tax system using a general tax rate applied to a broadly defined tax base. In the case of the two measures that affect the renewable energy industries, the Accelerated Capital Cost Allowance and the accelerated deductibility of Canadian Renewable and Conservation Expenses, the rate at which certain capital costs can be deducted for tax purposes is more rapid than what would be permitted under the usual benchmark (the usual benchmark varies for different kinds of capital assets, at rates corresponding to the usual economic life of the assets). When the rate at which the capital assets can be deducted for tax purposes exceeds that which would be permitted under the benchmark, this increases tax deductions (i.e. lowers taxes) in the early years of the asset's life and increases them in the later years. Arguably, this represents a deferral, rather than a reduction, of taxes. However, given the time value of money, this can offer very large financial benefits to the firm.

Oil sands producers used to qualify for accelerated capital cost allowances, but criticism from environmental groups that this represented an unfair taxpayer subsidy led the federal government to withdraw this benefit in 2010. It then demonstrated that it had no objection to the principle of accelerated capital cost allowances by extending the same benefit to "green" energy investments.

The Accelerated Capital Cost Allowance for clean energy generation equipment means that certain energy generation equipment, including wind and solar, can be depreciated on a declining-balance basis at the accelerated rate of 30% (Class 43.1), and other equipment (acquired after February 22 2005 and before 2020) can be depreciated on a declining balance basis at the accelerated rate of 50% (Class 43.2).

Canadian Renewable and Conservation Expenses (CRCE) can be deducted in full (100% deductibility) in the year in which they are incurred. These expenses cover start-up costs, including engineering and feasibility studies. This deduction, furthermore, can be carried forward indefinitely (i.e. used in future taxation years) or transferred to flow-through share investors. By selling flow-through shares, the

investor can recoup today in cash the present value of the future tax savings. The combination of 100% write off in the year incurred plus flow through shares marks an extremely generous treatment.

Prior to 2012, Finance Canada published its estimates of the present value of the tax expenditures related to accelerated capital cost allowances. These reports provided lots of ammunition for critics of the petroleum industry. Since 2012, the department has declined to publish the estimates of the tax expenditures for renewable energy firms on the grounds that this poses insurmountable methodological problems.

Preferences Granted Through Regulation

Economic regulation is pervasive in the electrical energy industry in Canada. In most provinces, governments own the companies that generate, transmit, and distribute electrical energy. Government regulatory bodies determine a utility's revenue requirements and establish prices or rates for each class of customers. Governments may require utilities to develop integrated resource planning, or a long-term plan to guide future energy efficiency, generation, transmission, and distribution investments, and in some cases direct what must be included in the plan. Regulatory bodies consider and approve, or reject, proposed power plants. As will be discussed in the next section, some governments (such as Ontario) legislate the purchasing and rate practices of utilities in order to provide higher rates to certain preferred energy sources. Others seek to achieve the same objective by imposing renewable energy portfolio standards, which require utilities to meet a certain percentage of their sales with designated resource types.

Each province has adopted a different approach, but none has gone further than Ontario to insert environmental policy considerations into electrical utility decisions formerly guided mainly by economic and engineering factors. As part of an electricity policy established in 2003 and implemented in legislation through the Green Energy and Green Economy Act (GEGEA) of 2009, Ontario has implemented a strategy that explicitly favours renewable energy over other generation sources, and seeks to raise consumer rates as a means to reduce electricity consumption. Among other things, this strategy seeks to stimulate investment in renewable energy projects (such as wind, solar, hydro, biomass and biogas) and to increase energy conservation.

One of the more important effects of the GEGEA has been on the authority of local governments and communities to decide about energy projects located within their jurisdictions. Before 2009, Ontario municipalities were considered the key review and approval bodies for the construction of a renewable energy generation project. Under the *Planning Act*, municipalities have the power to enact official plans and zoning by-laws to determine local planning policy and to restrict the use of land respectively. Renewable energy projects frequently required approval from a municipality to amend either or both the official plan and zoning by-laws. Under the GEGEA, approvals for renewable energy projects are "streamlined" by:

- exempting them from environmental assessment requirements under the *Environmental Assessment Act*;
- consolidating approvals under the *Environmental Protection Act* into a single "Renewable Energy Approval"; and
- curtailing municipal powers under the *Planning Act* to create a number of exemptions for renewable energy generation facilities.

Most significantly for municipalities, the GEGEA exempts renewable energy generation projects from the sections of the *Planning Act* dealing with official plans, zoning by-laws, demolition control areas, and development permit systems. These exemptions mean that municipalities lost all power to block, alter, or control renewable energy projects. The public lost both a powerful forum in which to express concern and to influence development and its third party right of appeal against a planning approval for a renewable energy project to the Ontario Municipal Board.

The GEGEA was fashioned with the advice of environmentalist advocacy groups. The act also stripped the Ontario Energy Board of its ability to regulate the electricity sector in a balanced way, taking the interests of consumers into account, and gave the Minister of Energy the power to issue simple "directives" to the Ontario Power Authority. (The Ontario Power Authority was merged with the Independent Electricity System Operator effective January 1, 2015.) The Minister has issued dozens of directives since that time.

A subsequent Ontario Minister of Finance, Dwight Duncan, decreed that a cap should be placed on the property taxes industrial wind turbines must pay. He decided that these facilities must be assessed by the Municipal Property Assessment Corporation (MPAC) at a maximum of $40,000 per megawatt (MW). According to research by Parker Gallant, a prominent commentator on Ontario electricity issues, the estimated capital cost of the 4,800 MW of the industrial wind turbines now operating in Ontario is $1 million to $1.5 million per MW, so the total capital costs of the ones operating is $4.8 billion to $7.2 billion. At the $40,000 per MW MPAC assessment decreed by Duncan, the total assessment is $192 million.

For energy sources that allegedly protect the natural environment, it is ironic (and sad) that the Ontario Ministry of Natural Resources often fails to enforce regulations concerning the effect of industrial wind turbines on local noise levels, the killing of birds and bats, and harm caused to endangered species. The Ministry acknowledges that there are high levels of bat mortality at some Ontario wind turbine projects, but claims that the totals are only 19 bats per turbine per year. It claims that turbines kill only 5 birds per turbine per year. There are regulations in place that govern the environmental effects of turbines, but the problem is one of enforcement. According to a 2016 report by Bird Studies Canada, bats are being killed at the rate of 18.5 per turbine, resulting in an estimated 46,656 bat deaths between May 1 and October 1,

2015. While birds are less affected, the report indicated that there were 14,606 birds killed by turbines in the same period. Failing to shut down wind turbines for not complying with species-at-risk regulations is yet another form of favourable regulatory treatment.

The special privileges and advantages given to solar, wind and other renewable energy developers under the GEGEA translate into significant savings and reduced risks for them. Again, however, there is no way to quantify the value of the implicit subsidy conferred.

Preferential Above-Market Rates for Solar and Wind Generation

Multiple strategies have been used to increase the revenues of renewables projects or to provide revenue certainty for these projects across Canada. These strategies were well summarized in an Energy Market Analysis published by the National Energy Board in October 2016.

It can be read here:

https://www.neb-one.gc.ca/nrg/sttstc/lctrct/rprt/2016cndrnwblpwr/2016cndrnwblpwr-eng.pdf

"*Contracts can be awarded through different mechanisms which may vary in terms of objectives, level of support and overall design:*

- *Requests for proposals (RFPs) specifically for renewables power projects, solicit competitive proposals, typically up to specified capacity targets. RFPs often favour mature projects and experienced developers, which can meet stringent targets.*
- *Feed-in Tariffs usually offer standardized long-term contracts and administratively set payments, often specific to a particular technology. Standard terms make it easier for small projects and new entrants to qualify.*
- *Standing Offer Programs (SOPs) for renewable projects allow entrants to apply at any time the program is in effect and provide guaranteed payments that, in contrast to FITs, are typically the same for all renewable energy technologies.*
- *Contracts for differences are types of contracts in which the sellers and buyers agree to a fixed price, but the producer sells electricity in an open market and receives whatever price the market is offering. Subsequently, payment is made by either party to the contract to compensate for differences between the fixed price and the market price."*

Ontario has by far the most solar and wind generation facilities of any province. Currently, Ontario has 4200 MW of grid-connected (Tx) wind generating capacity and 600 MW distributor (Dx) connected wind capacity. For solar, there is 2100 MW of Dx connected capacity and 300 MW of Tx connected capacity, according to IESO.

Much more is published about the pricing of renewables generation in Ontario than in other provinces. One of the key provisions of the GEGEA was its authorization of the government, through its publicly owned electrical utilities, to provide above market prices and preferential access to transmission for renewable energy generation sources. The Act also allowed the government to require Hydro One, the province-wide transmission company, to build new transmission lines to connect new renewable energy generation to the provincial grid. Renewable sources were given "first-to-the-grid" rights, meaning that, when power is available from them, it must be purchased first in preference to lower-cost sources of generation. When solar and wind generation surge, increasing total generation above provincial demand, this often causes the "steam off" of nuclear power plants and hydro spilling, as well as curtailment of other sources of generation, all of which Ontario ratepayers pay for.

Wind and solar energy are not competitive with electrical energy produced from existing generation sources like coal, oil, natural gas, hydro or nuclear. The government of Ontario made the situation worse by departing from a system in which renewable energy sources had to go through a competitive bidding process to one in which all new sources were eligible to receive a feed-in-tariff (FIT) that the trading company, the Independent Electricity System Operator (IESO), must pay. Suppliers were given 20-year contracts in which the rates were guaranteed for the life of the contracts. The initial FIT rates for on-shore wind projects were 13.5 cents per kilowatt hour (kWh), four times the rates at that time for conventional energy. The rate set for rooftop solar energy was 80.1 cents per kWh, 30 times the cost of conventional energy.

Over time, the FIT rates have been adjusted downwards somewhat, but they remain high. Under the 2017 IESO price schedule, solar PV (rooftop) FIT rates range from 31.1 cents per kWh for projects less than 6 kW in size to 20.7 cents per kW for projects between 100 kW and 500 kW in size. The 2017 FIT rate for onshore wind projects is 12.5 cents per kWh.

The actual cost of renewable energy generation in Ontario is far higher than is implied by the FIT rates. Solar and wind energy are intermittent generation sources that produce electricity only when the sun shines or the wind blows respectively. Production from these sources can be interrupted suddenly, whereas generation must be continuously available to meet modern needs. Electricity demand also varies by time of day and season, but in ways that do not correspond to the times when wind and solar generation are available. Electricity cannot be stored, except at very high cost. All of these factors mean that utilities must bear extra system-wide costs to use solar and wind, and these system-wide costs increase as the proportion of intermittent generation increases.

To make matters worse, the Ontario government has persisted in contracting for more and more solar and wind energy generation, even though the current

generation capacity in the province exceeds demand. The consequence of this determination to favour renewable energy producers has been that the province frequently must curtail generation from other producers (i.e. pay them not to produce). When even this is not sufficient, the province has dumped surplus electricity on export markets at a loss.

There are different ways of calculating the costs of the Ontario policies. In her December 2015 report, the Ontario Auditor General found that, from the beginning of the FIT program to the end of 2015, ratepayers had paid over $9.2 billion more for renewable energy generation than if the government had continued with its previous competitive procurement policy. She also found that, from 2009 to 2014, ratepayers paid generators $339 million to shut down their operations at times of electricity surplus in the province. During that same period, Ontario's electricity exports to neighbouring jurisdictions cost ratepayers $3.1 billion, as power was worth less than paid under the generous FIT contracts.

Scott Luft, a noted expert in utility economics and close follower of Ontario electricity trends, often reports on his blog "Cold Air" on the data publicly available and those he is able to obtain through Access to Information requests. In a July 23, 2017 article, he analyzed the growing subsidy of solar and wind energy in Ontario. He quantified the subsidy as the cost paid above the cost paid for other supply. Calculating the average cost of electricity is complex, so those interested in his methodology should read his analysis here.

http://coldair.luftonline.net/2016/07/the-growing-subsidy-of-wind-and-solar.html

He concludes that the average cost paid to all generators other than wind and solar generators in 2015 was $71 per MW. Using data on the grid-connected generation capacity, generation capacity "embedded" in distribution systems (mainly solar), the supply cost and the amount paid by ratepayers, he calculated that since 2006, Ontario has spent over $10 billion on solar and wind output. Calculating as a subsidy the amount paid to solar and wind generators due to contracting their generation above the average cost of all other generators, the total subsidy is $6.4 billion. Annual subsidies to solar generators exceeded $1.2 billion in 2015 alone, while those to industrial wind generators were about $600 million. In 2015, solar and wind represented more than 20% of Ontario's electricity supply costs, while providing 8.3% of actual generation.

Germany is much farther down the track that Ontario is on, and its experience should be heeded. In July 2014, Finadvice, a German M&A consulting company in the utility sector, published a report entitled, *Development and Integration of Renewable Energy: Lessons from Germany*. It described the financial impacts of Germany's feed-in-tariff program:

"Germany's FIT program has cost more than $412 billion to date (including granted and guaranteed, but not yet paid, FIT)). Former German Minister of the Environment

Peter Altmaier recently estimated that the program costs could reach $884 billion (680 billion euros) by 2022. He added that this figure could increase further if the market price of electricity falls, or if the rules and subsidy levels are changed. It is estimated that Germany will pay $31.1 billion in subsidies in 2014 alone."

Conclusion

Because of gaps in the data and the sheer number of policies and programs that provide advantages to solar and wind generation in Canada, there is no way to accurately assess the magnitude of the subsidies now being provided to the solar and wind industries in Canada. The assistance through support for technology development and application, program spending, preferential procurement, favourable regulatory treatment, and above-market utility rates indicates that governments are embarked on a concerted effort to promote certain energy technologies over others, regardless of the objective costs and benefits.

In effect, the rationale for major subsidization of solar and wind energy sources usually rests on two central arguments. The first starts with the premise that humans are causing catastrophic global warming, the effects of which a century from now indicate that there is a present day "social benefit" of emissions reduction so great that it more than offsets the economic costs of subsidies.

A recent report from the National Research Council pointed out that any assessment of the social benefit of emissions reduction (or its twin, the social cost of carbon) will suffer from uncertainty, speculation, and lack of information about (1) future emissions of greenhouse gases, (2) the effects of past and future emissions on the climate system, (3) the impact of changes in climate on the physical and biological environment, and (4) the translation of these environmental impacts into economic damages. As a result, any effort to quantify and monetize the harms associated with climate change will raise serious questions of science, economics, and ethics and should be viewed as provisional.

One can debate this subject at length, but the reality is that few studies of the social benefit of emissions reduction indicate a value above U.S. $25 per tonne of carbon dioxide equivalent today, and that would not justify the current large subsidies to renewables. Indeed, none of the countries that have made extremely large investments in solar and wind energy (e.g. Germany, Spain and the United Kingdom) have justified this on the basis of any consistently applied cost-benefit analysis entailing use of a social benefit of carbon dioxide emission avoidance.

The second rationale often used is that solar and wind are "infant industries", as defined in economic theory. These are supposed to be nascent industries that do not yet have the economies of scale of their older competitors, and thus need to be protected through tariffs and other trade barriers until they can attain similar economies of scale. The concept has been broadened to justify large and long-lasting subsidies to favoured "green" industries. Mark Mills, in his 1999 essay, "*Getting It*

Wrong: Energy Forecasts and the End-of-Technology Mindset" provided an eloquent comment on this thesis:

"Windmills, solar power, indeed the entire panoply of favoured alternatives, are not new or revolutionary inventions. They do not arise from newly discovered principles of science; neither are they based on, nor do they epitomize, fundamental changes in engineering capabilities. Indeed, most alternative energy technologies are more stone-age in character than high-tech: burning wood and trash, tapping hot springs, capturing running water and the wind. The most exotic of the alternatives, solar photovoltaics, is based on the scientific phenomenon whose discovery yielded Einstein a Nobel Prize, and led to the first solar-electric cell being demonstrated in 1925. We have had more than ample time—75 years—for this technology to follow long-standing commercialization trajectories were it going to do so."

Electricity generation from wind was first invented by Sir James Blyth in 1887. That makes the technology 130 years old. These infant industries take a long time to grow up!

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Cover Image solar house:
https://www.freepik.es/iconos-gratis/casa-con-panel-solar-instalado_733520.htm

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About

Friends of Science Society is an independent group of earth, atmospheric and solar scientists, engineers, and citizens, celebrating its 15th year of offering climate science insights. After a thorough review of a broad spectrum of literature on climate change, Friends of Science Society has concluded that the sun is the main driver of climate change, not carbon dioxide (CO2).

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