Subsidies to Energy Industries

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Glossary

consumer-subsidy equivalent Integrated metric of aggregate support provided to consumers by varied government policies; policies that act as taxes are incorporated by using the opposite sign.

cross-subsidies Policies that reduce costs to particular types of customers, products, or regions by increasing charges to other groups.

intermediation value Difference between the break-even cost of debt, insurance, or other programs to large governments and what these same services would cost if a smaller, higher risk private firm or individual had to buy them directly.

producer-subsidy equivalent Integrated metric of aggregate support provided to producers by varied government policies; policies that act as taxes are incorporated by using the opposite sign.

renewable portfolio standards Requirements mandating purchase of preset percentages of renewable electricity in particular service regions; the standards normally compete eligible supply sources against each other to minimize the per-unit subsidy.

subsidies Government-provided goods or services that would otherwise have to be purchased in the market or special exemptions from standard required payments or regulations; subsidies may be in cash but often involve shifting risks from private parties to taxpayers or the public.

Whether by intent or by accident, government interventions affect the relative prices of various energy technologies and with them the pattern of energy use and investment. Depending on their structure, interventions can act as either taxes or subsidies to particular technologies, producers, or consumers. The lines can blur; some "taxes" may be insufficient even to cover the cost of beneficial government services, leaving a residual subsidy to the "taxed" parties.

1. INTRODUCTION

Energy resources vary widely in terms of their capital intensity, reliance on centralized networks, environmental impacts, and energy security profiles. Although the policies of greatest import to a particular energy option may differ, their aggregate impact may be significant. Subsidies to conventional fuels can slow research into emerging technologies, thereby delaying their commercialization. Subsidies and exemptions to polluting fuels reduce the incentive to develop and deploy cleaner alternatives. Inadequate tracking and recovery of costs associated with protecting energy security reduces the drive toward diversification.

Justifications for energy subsidies include social welfare, protection and promotion of jobs or industries, rural development, and energy security. Existing policies often fail to achieve these aims in practice. Because subsidies can be worth millions of dollars and often require sophistication or connections to obtain, policies implemented to help poorer segments of society may end up enhancing the wealth of more powerful groups instead. Often, the objectives of subsidy programs can be achieved in a manner that is more narrowly targeted and efficient than the subsidy policies now in place. For example, decoupling subsidy payments from resource-depleting activities can greatly reduce the environmental damages associated with the transfers.

This article examines the general issue of subsidy definition and measurement and then presents central issues associated with subsidization at each stage of a generic fuel cycle. Aggregate patterns of subsidization and the challenges of subsidy reform are addressed in the subsequent two sections.

2. SUBSIDY DEFINITION AND MEASUREMENT

Government interventions encompass a wide range of regulatory, fiscal, tax, indemnification, and legal actions. By modifying the rights and responsibilities of various parties involved with the energy sector, these actions decrease (subsidize) or increase (tax) either energy prices or production costs. As discussed in what follows, differing approaches to subsidy definition and measurement have historically led to disparate subsidy analyses that are difficult to compare or compile.

2.1 Common Disagreements in Subsidy Definition

Disagreements over the proper definition of subsidy are common. Conflicts often arise over the form and timing of the transfer, the definition of the "non-subsidized" baseline, and the boundaries of analysis.

2.1.1 Form and Timing of Transfer

Energy subsidies are often viewed primarily as cash payments from a government agency to private businesses or individuals. Payments to low-income households to enable them to purchase heating oil and grants to businesses to help them develop particular energy technologies are examples. In reality, subsidies can take many different forms, and a more accurate definition must include government-provided goods or services, including risk bearing, that would otherwise have to be purchased in the market. Much market activity involves controlling and sharing the risks and rewards of economic activities, and risk-oriented subsidies are quite important. Subsidies can also be in the form of special exemptions from standard required payments such as tax breaks. Although cash payments are easily measured within a single year, more complex subsidies such as loan guarantees are best evaluated over multiple years so that patterns in losses or investment distortion can be seen more clearly.

2.1.2 Defining the Baseline

Subsidies must often be measured against a baseline. What would taxes owed have been in the absence of this special tax break? How much would industry have had to pay in interest to build that new facility if the government had not guaranteed the loan? Many disagreements over subsidy definition originate in differing views on the appropriate baseline:

2.1.2.1 Indirect Versus Direct Transfers Some argue that interventions "count" as energy subsidies only if they directly target the energy sector. For example, the U.S. Energy Information Administration did not count subsidies to energy facilities provided by tax-exempt general-purpose municipal bonds in its tallies, arguing that the bonds did not constitute an energy subsidy if hospital and road construction could also use them. Similarly, fees to use the U.S. inland waterway system have historically been insufficient to reimburse system construction and maintenance costs. Although oil and coal industries are among the largest users of the system, the fee subsidies (which allow oil and coal a lower delivery cost than would otherwise be possible) are often discounted on the grounds that many commodities use the system. Because many subsidies tilt the energy-playing field toward a particular fuel even if there are also nonenergy beneficiaries, such policies should not be ignored. Rather, any policy that has the effect of subsidizing prices or production costs should be assessed. This may include policies targeted at single sectors, multiple sectors, specific geographic areas, or specific factors of production.

2.1.2.2 Externalities Although the levels vary by fuel, most energy production and consumption generate wide-ranging externalities such as pollution. Exemptions from appropriate environmental controls (e.g., less stringent air pollution control requirements for certain old power plants in the United States) penalize cleaner energy types and are properly viewed as subsidies. However, externalities do create an analytic challenge because they are difficult to monetize. Koplow and Dernbach documented that decisions about which externalities to include and how to value them can generate very large variation in subsidy estimates, on the order of hundreds of billions of dollars per year. Segregating externality-related subsidies from fiscal subsidies can help to improve data comparability and transparency.

2.1.2.3 Intermediation Value Subsidy recipients often incorrectly claim that risk-based subsidies such as loan guarantees have no value unless there are defaults. In addition to the direct cost of the government, all of these policies have an intermediation value as well given that the government's cost of debt or indemnification is lower than what could be attained by the recipient on its own. For particularly high-risk endeavors, such as sales of large energy assets to politically unstable countries, the intermediation value can be very large. Because some energy resources have much greater access to these government programs than do others, distortions in relative energy prices can result. For example, transactional data on subsidized international lending assembled for the World Commission on Dams show that lending has heavily favored fossil fuels over renewables.

2.1.3 Boundaries of Analysis

Energy is a primary material, an input to refined energy products (e.g., gasoline, electricity), and an input to nonenergy materials (e.g., metals, consumer goods). To provide an accurate picture of energy subsidies, analytic boundaries with respect to three areas must be addressed: calculation of net values, level of government, and subsidies to complements.

2.1.3.1 Calculation of Net Values Because interventions can act as taxes or subsidies, interventions should be treated holistically so that end values represent net, rather than gross, subsidies to energy. Policies that affect multiple sectors need to be prorated so that only the portion applicable to energy is counted. Although proration is not always possible to do precisely (some policies have joint effects), reasonable allocations based on intensity of use, share of production, or similar metrics often provide reasonable proxies. Similarly, taxes or fees levied on fuels should be counted against the gross subsidy to generate the value net of offsets.

2.1.3.2 Level of Government Interventions occur at multiple levels of government, and all levels can affect energy costs to some degree. Analysis of these policies should be internally consistent; if tax offsets at the state level are deducted from energy subsidy values, state-level subsidies should be included as well.

2.1.3.3 Subsidies to Complements Energy subsidies have many second-order effects as they flow through other activities in the economy. Although detailed assessment is beyond the scope of this article, these policies can influence basic aspects of economic structure such as materials production, recycling, and energy demand. Subsidized electricity to primary aluminum is endemic and inhibits adoption of less energy-intensive materials. Similarly, subsidies for converting wastepaper, animal waste, and landfill gas into energy reduce the viability of recycling and composting alternatives. Widespread subsidies to driving spur increased road use and demand for gasoline.

2.2 Methods of Transferring Value

Table I provides an overview of intervention types. Depending on the policy specifics, many interventions generate either a net subsidy or a net tax. Cash transfers from government to private industry may originate from a handful of the intervention types, including direct spending, government ownership, and research and development (R&D) support. However, subsidies resulting from avoided expenditures by private firms are more common. These include government provision of market-related information; access to below-market credit, insurance, or government-provided goods and services; tax breaks; and exemptions from prudent regulation on health-, environment-, or safety-related aspects of an enterprise.

Market controls, including general regulations, provisions governing access to resources, restrictions on energy-related imports or exports, and purchase requirements can act as either a tax or a subsidy depending on one's market position. For example, past restrictions on oil exports from Alaska acted as a *de facto* tax on Alaskan producers because they could not sell output to the highest bidder. However, the very same policy provided oil subsidies to consumers on the West Coast of the United States. Although driven by government policy and having important effects on energy market structure, these policies often involve transfers between various producers and consumers rather than transfers from taxpayers. Cross-subsidies follow a similar pattern, with some users paying less than they should and others paying more than they should. They commonly occur when rate structures must be approved by governments or in markets protected from competition.

Special energy taxes, as their name suggests, tend to act as taxes rather than as subsidies. However, a tax should be classified as "special" only if it is above and beyond appropriate baseline recovery of revenue. The baseline taxation of energy should (1) compensate public sector owners for the sale of valuable energy resources, (2) recover public sector costs associated with the public provision of energy-related services, (3) equal the baseline tax on

TABLE I

Common Forms of Government Interventions in Energy Markets

Intervention type	Description
Access[a]	Policies governing the terms of access to domestic onshore and offshore resources (e.g., leasing)
Cross-subsidy[a,b]	Policies that reduce costs to particular types of customers or regions by increasing charges to other customers or regions
Direct spending[b]	Direct budgetary outlays for an energy-related purpose
Government ownership[b]	Government ownership of all or a significant part of an energy enterprise or a supporting service organization
Import/Export restriction[a]	Restrictions on the free market flow of energy products and services between countries
Information[b]	Provision of market-related information that would otherwise have to be purchased by private market participants
Lending[b]	Below-market provision of loans or loan guarantees for energy-related activities
Price controls[a]	Direct regulation of wholesale or retail energy prices
Purchase requirements[a]	Required purchase of particular energy commodities, such as domestic coal, regardless of whether other choices are more economically attractive
Research and development[b]	Partial or full government funding for energy-related research and development
Regulation[a]	Government regulatory efforts that substantially alter the rights and resposibilities of various parties in energy markets or that exempt certain parties from those changes
Risk[b]	Government-provided insurance or indemnification at below-market prices
Tax[a,b]	Special tax levies or exemptions for energy-related activities

Source: Koplow, D. (1998). "Quantifying Impediments to Fossil Fuel Trade: An Overview of Major Producing and Consuming Nations." Paper prepared for the OECD Trade Directorate.

[a] Can act either as a subsidy or a tax depending on program specifics and one's position in the marketplace.

[b] Interventions included within the realm of fiscal subsidies.

other commodities, and (4) charge an appropriate levy for negative externalities associated with production and use of the resource. Many assessments of energy taxation fail to incorporate appropriate measures for baseline levels, improperly classifying as an "energy tax" or an "environmental tax" policies that in fact recover only a portion of public costs and leave residual subsidies.

Government ownership of energy-related enterprises, including power generation and transmission, oil production and refining, coal mines, and road and pipeline networks, is common around the world. Many of these activities generate large subsidies to consumers as well as depleting fiscal resources. Subsidies are multilayered. The enterprise is often fairly high risk, attains access to low-cost tax-exempt government debt, pays no taxes on net income, and is not expected to earn a return on capital. Operating losses may ensue above and beyond these cost structure subsidies due to poor controls or politicization of the rate structure. These enterprises can be complex and difficult to analyze but often contribute to significant energy market distortions.

2.3 Methods of Measuring Subsidy Magnitude

Efforts to assess subsidy magnitude have generally focused either on measuring the value transferred to market participants from particular programs (program-specific approach) or on measuring the variance between the observed and the "free market" price for an energy commodity (price gap approach). One set of methods that captures both pricing distortions (net market transfers) and transfers that do not affect end market prices (net budgetary transfers) is the producer subsidy equivalent (PSE) and consumer subsidy equivalent (CSE) metrics commonly employed in the agricultural sector. Use of these in the energy sector has so far been limited to annual assessments of PSEs for coal in a handful of countries.

These approaches differ in the amount of data required to calculate them and in the degree to which they successfully measure budget transfers plus market transfers. Program-specific transfer assessments capture the value of government programs benefiting (or taxing) a particular sector, whether these benefits end up with consumers (as lower

TABLE II

Overview of Subsidy Measurement Approaches

Approach/description	Strengths	Limitations
Program specific: Quantities value of specific government programs to particular industries: aggregates programs into overall level of support	Captures transfers whether or not they affect end market prices	Does not address questions of ultimate incidence or pricing distortions
	Can capture intermediation value (which is higher than the direct cost of government lending and insurance	Sensitive to decisions on what programs to include
		Requires program-level data
Price gap: Evaluates positive or negative "gaps" between the domestic price of energy and the delivered price of comparable products from abroad	Can be estimated with relatively little data; very useful for multicountry studies	Sensitive to assumptions regarding "free market" and transport prices
	Good indicator of pricing and trade distortions	Understates full value of supports because ignores transfers that do not affect end market prices
PSE/CSE: Systematic method to aggregate transfers plus market supports to particular industries	Integrates transfers with market supports into holistic measurement of support	Data intensive
	Separates effects on producer and consumer markets	Little empirical PSE/CSE data for fossil fuel markets

Source: Koplow, D., and Dernbach, J. (2001). Federal fossil fuel subsidies and greenhouse gas emissions: A case study of increasing transparency for fiscal policy, *Annu. Rev. Energy Environ.* **26**, 361–389.

prices), producers (through higher revenues), or resource owners (through higher rents). Unless integrated into a macroeconomic model, this information tells little about the ultimate incidence of the subsidy programs and their effect on market prices. By definition, the price gap metric highlights observed price distortions, although it misses the often substantial fiscal supports that do not affect consumer energy prices but do affect the structure of supply. The combination of PSE and CSE data provides insights into both. Table II briefly summarizes the main approaches that have been used in both domestic and international subsidy assessments as well as their respective strengths and limitations.

3. SUBSIDIES THROUGH THE FUEL CYCLE

Because no two fuel cycles are exactly the same, examining subsidies through the context of a generic fuel cycle is instructive in providing an overall framework from which to understand how common subsidization policies work. Subsidies are grouped into preproduction (e.g., R&D, resource location), production (e.g., extraction, conversion/generation, distribution, accident risks), consumption, postproduction (e.g., decommissioning, reclamation), and externalities (e.g., energy security, environmental, health and safety).

3.1 Preproduction

Preproduction activities include research into new technologies, improving existing technologies, and market assessments to identify the location and quality of energy resources.

3.1.1 Research and Development

R&D subsidies to energy are common worldwide, generally through government-funded research or tax breaks. Proponents of R&D subsidies argue that because a portion of the financial returns from successful innovations cannot be captured by the innovator, the private sector will spend less than is appropriate given the aggregate returns to society. Empirical data assembled by Margolis and Kammen supported this claim, suggesting average social returns on R&D of 50% versus private returns of only 20 to 30%.

However, the general concept masks several potential concerns regarding energy R&D. First, ideas near commercialization have much lower spillover than does basic research, making subsidies harder to justify. Second, politics is often an important factor in R&D choices, especially regarding how the research plans are structured and the support for follow-on funding for existing projects.

Allocation bias is also a concern. Historical data on energy R&D (Table III) demonstrate that R&D spending has heavily favored nuclear and fossil energy across many countries. Although efficiency,

TABLE III

Federal Research and Development Support by Energy Type

Region	Nuclear fission	Fossil fusion	Fossil energy	Renewables, efficiency, conservation	Other[a]
United States (percentages)					
1950–1993[b]	49.2	13.1	21.5	16.2	0
1998–2003[c]	17.7	16.2	32.6	30.2	3.4
IEA members[d](percentages)					
1974–1993	49.7	10.8	14.1	14.0	11.4
1994–1998	39.3	11.0	10.6	20.8	18.4
Total spending (billions of 2001 dollars)					
1974–1998	117.3	26.5	33.0	36.8	30.6
			Coal: 23.5	Renewables: 19.8	
			Oil and gas: 9.5	Conservation: 17.0	

[a] Includes electrical conversion and distribution, energy storage, and unclassified spending.
[b] Koplow, D. (1993). "Federal Energy Subsidies: Energy, Environmental, and Fiscal Impacts: Technical Appendix." Alliance to Save Energy, Washington, DC.
[c] U.S. Department of Energy. (2003). "Budget Authority History Table by Appropriations."
[d] International Energy Agency. (2003). *Research and Development Database*.

renewables, and conservation have captured a higher share of public funds during recent years, the overall support remains skewed to a degree that may well have influenced the relative competitiveness of energy technologies. Extensive public support for energy R&D may also reduce the incentive for firms to invest themselves. U.S. company spending on R&D for the petroleum refining and extraction sector was roughly one-third the multi-industry average during the 1956–1998 period based on survey data from the U.S. National Science Foundation. For the electric, gas, and sanitary services sector, the value was one-twentieth, albeit during the more limited 1995–1998 period.

3.1.2 Resource Location

Governments frequently conduct surveys to identify the location and composition of energy resources. Although these have addressed wind or geothermal resources on occasion, they most often involve oil and gas. Plant siting is another area where public funds are used, primarily to assess risks from natural disasters such as earthquakes for large hydroelectric or nuclear installations. Survey information can be important to evaluate energy security risks and to support mineral leasing auctions, especially when bidders do not operate competitively. However, costs should be offset from lease sale revenues when evaluating the public return on these sales. Similarly, the costs of siting studies should be recovered from the beneficiary industries.

3.2 Production

Energy production includes all stages from the point of resource location through distribution to the final consumers. Specific items examined here include resource extraction, resource conversion (including electricity), the various distribution links to bring the energy resource to the point of final use, and accident risks.

3.2.1 Extraction of Energy Resources

General procedures for leasing access to energy minerals on public lands and more general subsidies for promoting energy extraction both are important areas to evaluate. Extraction-related subsidies are most common for oil and gas production, although they also support nuclear fission (due to uranium mining), geothermal, and coal.

3.2.1.1 Accessing Publicly Owned Energy Resources Terms of access for energy minerals on public lands can be a source of enormous subsidies. In countries where leases or concessions are granted through graft rather than competitive bidding, wealth transfers worth billions of dollars can occur. Although there are not good statistics on the losses, the problem appears to be large. Oxfam America finds that states most dependent on oil tend to have very low Human Development Index (HDI) rankings. The HDI, developed by the UN Development Program, ranks states according to a combined measure of income, health, and education. Transparency International finds strong linkages between large mining and petroleum sectors as well as elevated levels of bribery and corruption. Low-cost access to energy minerals also tends to remove the incentive for careful management because profits can be had even with inefficient operation. Lease operation can also generate subsidies such as when self-reported royalties are calculated improperly. The Project on Government Oversight has documented state and federal court awards in excess of $10 billion in response to litigation in the United States over oil and gas royalty underpayments.

3.2.1.2 Promoting Extraction Activities Policies to reduce the cost of extraction are widespread and often take the form of tax or loan subsidies or royalty concessions. They are found at both the national and state levels. Particular market niches may be targeted, from geographical (e.g., deep sea recovery of oil, timbering in a particular forest), to technological (e.g., tax breaks for more advanced oil drilling or coal gasification), to life cycle related (e.g., lower royalties on idle wells that are restarted). In some cases, baseline tax policy may be applied by firms in creative ways to generate large subsidies. U.S.-based multinationals receive a tax credit for foreign taxes paid to avoid double taxation of foreign income. Yet in many oil-producing regions with low or no corporate income taxes, foreign governments have reclassified royalty payments into corporate taxes, generating a tax write-off estimated by Koplow and Martin at between $0.5 billion and $1.1 billion annually.

However, many subsidies to extraction are not restricted to particular market niches. Percentage depletion allowances in the United States allow most firms mining oil, gas, uranium, or coal to deduct more costs from their taxable income than they have actually incurred. Accelerated write-offs of extraction-related investments are also common. For example, many multiyear costs in the U.S. oil and gas industry may be deducted immediately (expensed) rather than over the useful lives of the investments. All of these special provisions tend to reduce the effective tax rate on benefiting energy industries. Data collected by the Energy Information Administration (EIA) suggest that the major U.S. energy firms paid federal taxes that were one-quarter to one-half the prevailing nominal rates between 1977 and 1995.

3.2.2 Conversion

Raw energy materials normally go through some conversion prior to consumption. Crude oil is refined into a wide range of specialized products such as gasoline and heating oil. Coal may be pulverized or cleaned prior to use. A combination of heat and machinery converts raw fuels (including wind and solar) into electricity. Common government supports to the conversion stage include capital subsidies, production tax credits or purchase requirements, and exemptions from appropriate protections for environmental quality, worker health, and accident risks. Because this third category affects multiple phases of the fuel cycle, it is addressed in a separate section.

3.2.2.1 Capital Subsidies Subsidies to capital formation, usually through accelerated depreciation or investment tax credits, are common. Although applicable to multiple economic sectors, they are often of great benefit to energy producers. This is due both to their relative capital intensity and to provisions in the tax code that grant special accelerated depreciation schedules for energy-related assets. For example, in the United States, three sectors of relevance to energy—electric light and power, gas facilities, and mining, shafts, and wells—have allowable depreciation schedules that are 28, 45, and 44% faster, respectively, than the actual economic depreciation of their assets according to data compiled by the U.S. Treasury. Capital subsidies are of greatest benefit to large-scale generation assets with long construction times (nuclear, hydro, and coal) and are of greatest detriment to energy resources that conserve capital (most prominently energy conservation).

3.2.2.2 Tax Credits/Purchase Mandates A second class of subsidies to the conversion stage are tax credits or purchase mandates for certain types of energy. These subsidies occur at both the federal and the state/provincial levels and most often support emerging power sources such as solar, wind, and biomass-based electricity. Whereas many of the subsidies to conventional power sources are expensive regardless of whether the energy investments ultimately succeed, the tax credits and purchase mandates tend to be more efficient. For example, federal tax credits for wind energy in the United States cost taxpayers nothing unless a private investor is successful in getting a wind plant operating. If the plant goes offline, so too do the credits. Renewable portfolio standards (RPSs), a common form of purchase mandates adopted by many U.S. states, are even more efficient. In addition to providing no subsidy unless the power is delivered, RPSs often compete eligible power sources against each other, driving down the unit subsidy as technologies improve.

Despite their benefits, these approaches have run into some political problems. Specifically, as the subsidies have grown, so too has lobbying pressure to expand the range of eligible sources. Federal tax credits now include poultry waste, a great benefit to the handful of very large chicken processors. At the state level, unsustainable biomass sources are sometimes included, as are waste-to-energy and landfill gas systems. Thus, although energy diversification goals are still being met, the supply is not necessarily renewable or particularly clean.

3.2.3 Transportation and Distribution

Fuel cycles may involve multiple transportation steps, including movement of raw fuels to point of refining, refined fuels to the point of consumption, and movement of wastes to disposal sites. Relevant modes of transport include road, rail, water, pipelines, and transmission lines.

Although specific energy resources vary widely in their transport intensity and in the modes of transportation and distribution on which they rely (Table IV), there are some common themes. Government construction, maintenance, and operation of transportation infrastructure frequently give rise to subsidies when user fees do not cover costs. These subsidies are often understated because municipalities might not properly cost the resources being

TABLE IV

Impact of Transport Subsidies on the Energy Sector

Transport mode	Issues	Energy sector impacts
Water: Inland	Waterway maintenance often provided by governments; user fees may not recover costs	Reduces delivered price of bulk oil and coal
Water: Coastal and international	Coastal ports, harbors, and shipping oversight subsidized by federal and other government entities; user fees might not recover costs	Reduces delivered price of bulk oil and coal
	Fuel consumed during shipment in international waters generally tax free	
Road	Most roadways are municipally owned and operated; user fees (primarily from fuel taxes) often insufficient to cover costs	Primarily benefits refined petroleum products
	Large trucks often pay proportionately less in taxes than the damage they cause roadways	Waste products from coal combustion or waste-to-energy plants may sometimes move by truck as well
Rail	Many rail lines do not recover their full costs	Largest beneficiary is coal, with some benefits to oil
Pipeline	Rights of way, safety and security, and environmental cleanup contribute to reduced costs of pipeline ownership and operation	Primarily benefits oil and natural gas
	Depending on circumstances, government ownership may generate large subsidies to users and use government monopoly to levy high taxes on users	
Electrical Transmission Grid	Rights of way, tax breaks for municipal ownership or capital investment, and government research and development can generate subsidies to eletrical distribution	Benefits all sources of centralized electricity in proportion to their share as a prime mover in generating stations; coal, nuclear, natural gas, hydroelectricity, and oil are the main beneficiaries
	Inaccurate pricing of distance can generate cross-subsidies to rural users	

Source: Earth Track Inc., Cambridge, MA.

consumed. For example, tax exemptions on transportation bonds used to finance roads are routinely ignored, as are the free grants of rights-of-ways for rail, road, pipeline, and transmission links. So too is the opportunity cost of land covered by roadways and parking facilities. Although this space occupies 1.7, 2.1, and 3.5% of the total land area in the United States, Germany, and Japan, respectively, Todd Litman of the Victoria Transport Policy Institute noted that no property tax is paid on the vast majority of this space. This understates the direct costs of the infrastructure and the rights to use it.

Cross-subsidies between user groups may further distort relative prices. Large trucks pay less in highway fees than the damage they cause, generating an incremental subsidy to deliveries of refined fuels such as gasoline. Deep-berth ships such as large oil tankers may be the primary drivers of channel- or port-deepening projects, yet they often contribute to costs based only on volume of shipments. In the electricity sector, transmission tariffs may represent broad averages of the cost of service rather than rising as the distance traveled and density of users decline. By delivering subsidized electricity to remote users, transmission cross-subsidies mask the cost of line maintenance and new construction. This can destroy niche markets in which off-grid technologies (often renewable) would otherwise have been able to compete. Cross-subsidies between peak pricing and low demand periods are also common in electricity markets because real-time metering is not widely used at the retail level. This can dampen retail investments in demand-side management.

Power sources such as wind and solar require no shipment of input fuels or waste. Improved energy efficiency and some off-grid technologies require no transmission grid either. As a result, subsidies to energy transport can increase the barriers to renewable energy and efficiency. A major U.S. study conducted by Cone and colleagues in 1978 found that an estimated $15.2 billion in federal money subsidized transport of U.S. oil stocks between 1950 and 1977. The policies generating these subsidies have continued during the ensuing quarter-century or so.

3.2.4 Accident Risks

A handful of energy activities have the potential to cause catastrophic harm, including large oil spills, dam failures, and nuclear accidents. Many governments cap, shift, or ignore the potential liabilities from these activities. Functioning insurance markets and litigation would normally help to drive up prices for the more dangerous energy sources or particularly negligent operators. Government policies that mask these signals impede substitution to safer alternatives.

3.2.4.1 Large Oil Spills Within the United States, the Oil Pollution Act of 1990 stipulates use of commercial insurance for a first tier of insurance. A public trust fund financed by levies on oil sales provides supplemental coverage, although payments out of the fund are capped at $1 billion per incident. Based on empirical assessments of spill cleanup costs by Anderson and Talley, at least five spills over the past three decades or so would have exceeded the $1 billion cap, although most spills will be adequately covered. Internationally, the 1992 Civil Liability Convention governs liability for oil spills, also using a two-tier system. Insurance held by the vessel owner provides the first tier. Levies on cargo owners feeds the second tier, with receipts held in the International Oil Pollution Compensation Fund. The maximum compensation available from both tiers is roughly $174 million, a level shown to be insufficient by spills occurring in both 1997 and 1999. Although the caps are likely to be raised by 50%, Alfred Popp, chairman of the group working on the latest rounds of reforms, noted that concerns about liability shortfalls persist. The subsidy value of these caps is not known.

3.2.4.2 Dam Failures Many activities that would pose a very large potential risk if accident scenarios materialized rely on a system of strict liability. Strict liability focuses only on magnitude of the potential damages rather than on the intent, negligence, or degree of care of the operator. Although the failure of a large dam near a populated area can cause catastrophic loss of life, assurance for such potential liabilities is poorly characterized. Although loss of life from a dam failure will likely trigger widespread litigation, the rules of that litigation are predominantly set at the state level. Analysis by Denis Binder for the Association of State Dam Safety Officials indicates that a slight majority of states reject strict liability in dam failures. Furthermore, the piecemeal approach to coverage within the United States makes it difficult to evaluate whether existing coverages are adequate. Poor characterization of the risks extends to the international arena as well. To the extent that liability insurance is not in place or is too low, subsidies to hydroelectricity would result.

3.2.4.3 Nuclear Accidents Nuclear accidents can expose large populations to dangerous levels of radioactivity, triggering enormous liabilities for the firm responsible. Caps on nuclear liability are common throughout the world. The United States, under the Price–Anderson Act, has a two-tier system of indemnification: a first tier of commercial insurance ($300 million per reactor) plus a second pooled tier (maximum of $83.9 million per reactor) funded by retroactive assessments on all reactors in case any reactor has an accident. Japanese nuclear operators must provide financial security of $520 million; damages above that amount will be paid by the government. In China, the limit is roughly $36 million. In Ukraine, it is roughly $70 million.

International efforts to standardize liability under the Convention on Supplementary Compensation for Nuclear Damage would establish minimum liability coverage worldwide, although for many countries this would also constitute the maximum. Under the convention, operators would directly face a first tier of liability. A country fund would provide secondary coverage. Because country payments rely on a sovereign guaranty rather than a prefunded instrument such as a trust fund, they may be at some risk.

Aggregate coverage under the U.S. system is estimated at roughly $9.2 billion per accident, although most of this is paid out over nearly 9 years by utilities, so the present value of the coverage is substantially lower. Liability levels established under the convention would provide less than $900 million per accident. Loss statistics from the Insurance Services Office and from the Disaster Insurance Information Office provide some context. Since 1950, there have been approximately 20 hurricanes with adjusted damages in excess of the convention cap, and both Hurricane Andrew and the Northridge earthquake had damages that exceeded the Price–Anderson cap even before adjusting retroactive premiums to present values.

Subsidies arise when government caps fall below expected damages from an incident and caps under both Price–Anderson and the convention are likely to do so. Damages above that level are, in effect, shifted to the state or to the affected population. Heyes estimated that the subsidy to reactors under Price–Anderson ranges between 2 and 3 cents per kilowatt-hour, a value that would roughly double the operating costs of nuclear plants. In addition, there are incremental subsidies associated with indemnification for nuclear contractors and government-owned facilities. Because other countries have lower liability caps and weaker inspection regimes, they likely have higher liability subsidies as well.

3.3. CONSUMPTION

Government support for energy consumption falls into three main categories: poverty alleviation, economy-wide below-market pricing, and targeted subsidies for certain classes of consumers.

3.3.1 Poverty Alleviation

Subsidies to heat and power for poorer citizens are common, frequently in the form of a lump-sum grant or reduced cost access to municipal resources. Often consumption oriented, these subsidies may miss opportunities to implement conservation measures among the target populations. Targeting can be a problem as well, with funds not reaching the groups most in need. According to the International Energy Agency (IEA), the poorest citizens often rely on noncommercial fuels such as dung (biomass comprises as much as 80% of the energy market in rural countries with a high reliance on subsistence agriculture) or live outside the reach of the subsidized electrical grid.

3.3.2 General Subsidies

Nations with large domestic energy industries sometimes institute policies that keep local prices well below world levels. These subsidies may protect antiquated energy-consuming industries that otherwise would be unable to compete, or they may serve as "rewards" to the electorate for supporting a particular official. For example, price gap data for Venezuela and Iran compiled by the Organization for Economic Cooperation and Development (OECD) and IEA show that these large oil producers heavily subsidize both industrial and residential use of petroleum. Subsidies are also common in many service areas close to large municipal hydroelectric generating stations. For example, rates to customers of the Power Marketing Administration dams in the United States were long heavily subsidized. Although the quantities of power or oil flowing through these regions make these subsidies seem costless, they are not. Domestic sales at subsidized rates forgo energy export revenues, increase local pollution, and contribute to a production base that is increasingly noncompetitive with that deployed elsewhere in the world.

3.3.3 Targeted Exemptions

Most OECD countries exempt coal and heavy fuel oils used in industry, as well as aviation fuels used on international flights, from the baseline levies on energy. Excise tax rates on coal used in the industrial or power sector are often lower than those on much cleaner natural gas. The OECD noted that these exemptions "effectively mean that a large proportion of total carbon emissions in OECD countries is untaxed," generating weaker incentives to adopt even low-cost abatement options.

3.4 Postproduction Activities

Energy production and conversion require large facilities, often located in remote or pristine environments. Postoperational cleanup can be complex. Decommissioning addresses removal of physical infrastructure, whereas remediation and reclamation address problems with land and water. For markets to make accurate decisions about the relative cost of energy resources, the cost of these postproduction activities must be included in energy prices during the operating life of the facility in much the same way that the cost of an employee pension would be. Indeed, failure to accrue funds for postclosure costs during operations would make public subsidy likely given that revenues often drop to zero on plant closure.

3.4.1 Decommissioning

Decommissioning subsidies arise when infrastructure removal costs are ignored or underestimated or when accrued funds are mismanaged. Costs can be significant at large-scale energy installations such as hydroelectric dams and oil refineries. Where installations are remote (e.g., offshore oil rigs), radioactive (e.g., nuclear plants), or widely dispersed (e.g., gathering pipelines), costs per unit of capacity can be particularly high. Requirements for long-term environmental or safety monitoring (e.g., nuclear plants and some mines) can drive costs up further.

Pipelines and hydroelectric dams provide examples of costs being ignored entirely. Koplow and Martin made inquiries to many U.S. officials regarding pipeline closure. They found that although there are regulations governing proper abandonment, advance funding of closures was not required. The risks of insolvency appeared to be fairly high, especially for the smaller companies that often own older gathering pipelines. Regarding dams, the U.S. Federal Energy Regulatory Commission indicated in a 1994 policy statement that it will "not generically impose decommissioning funding requirements on licensees" but rather will stipulate them on a case-by-case basis at the time of relicensing. According to Andrew Fahlund of American Rivers, this policy has been implemented such that if a "dam owner is too poor, it is too burdensome to require them to maintain a fund, and if they are rich, they will have plenty of money available for such an eventuality."

Underestimating decommissioning requirements is of great concern with nuclear plants. IEA data indicate that the anticipated cost per unit of power capacity can vary by a factor of 10 across plants. IEA multicountry data suggest median decommissioning values of between 21 and 37% of the overnight capital cost (i.e., before financing) to build the plant. If funds are not properly accumulated during the plant's operating life, taxpayer burdens will be large. Inadequate provision for closure is also apparent in the oil and gas sector. Koplow and Martin found shortfalls in funding to plug and abandon oil wells in the United States approaching $600 million per year, of which approximately 75% represented insufficient bonding at wells still in operation.

Public bailouts can also be required if accrued funds for postclosure activities are lost through negligence, bankruptcy, or theft. If funds are retained within the firm, bankruptcy is a significant risk, especially given the 40- to 60-year time frame between fund collection and use. Increased segregation of each energy asset into its own company (now becoming the norm in the U.S. nuclear industry) greatly increases this risk. Loss through negligence is less likely where regulations preclude speculative investing. Nuclear decommissioning trusts within the United States are held outside the firm and are subject to conservative investment requirements to reduce the likelihood of loss.

3.4.2 Reclamation and Remediation

Small subsidies to site reclamation and remediation may arise through government-sponsored research into remediation technologies or through regulatory oversight of extraction activities that are not recovered via user fees. Much larger subsidies are associated with remediation of government-owned energy-related installations or where reclamation bonding has been insufficient to pay for the damage caused by private operators. James Boyd at Resources for the Future pointed to widespread inadequacy of reclamation bonding levels. For example, in the U.S. states of Indiana, Kentucky, and Tennessee, reclamation of coal mine sites is below 20%. Reclamation bond levels have generally been inadequate. Estimated liability for high priority (public health and safety concerns) coal mine remediation in the United States is $6.6 billion, according to the U.S. Office of Surface Mining Reclamation and Enforcement. Many mining regions around the world have unreliable, incomplete, or nonexistent data on abandoned mines and their associated costs. These shortfalls may be made up by general tax revenues. However, more often, resource damage is not mitigated and continuing environmental releases are not controlled. Spending to address environmental concerns at nuclear energy-related infrastructure owned by the U.S. government has run approximately $500 million per year, much of which is paid by general taxpayers.

3.5 Energy Externalities

External costs of energy production and consumption can include pollution, land degradation, health impairments, congestion, and energy security. This article differentiates between two types of subsidies. The first involves existing government spending to address recognized problems associated with particular energy resources. Included here would be public funding to protect energy supplies and assets; public absorption of energy worker health care costs; and/or public subsidies to pollution control or abatement. Because this spending involves actual outlays, it is counted as a fiscal subsidy. A second class of policies involves loopholes in regulatory controls that allow additional damages to human health or the environment to continue without compensation. This second group is often difficult to quantify and is segregated as an externality.

3.5.1 Energy Security

Energy plays a central role in industrialized economies, and supply disruptions can trigger widespread economic dislocations. Geopolitical problems, accidents, and terrorism all are potential triggers. Lovins and Lovins identified a handful of factors that drive security concerns. These include long distribution channels, geographically concentrated delivery or production systems, interconnected systems that can spread failures, specialized labor and control systems to operate capital-intensive facilities that are very difficult to replace, and dangerous materials that can elevate the severity of any breach.

Energy security strategies include protection of energy-related assets and supply routes, stockpiling of vulnerable resources, and supply diversification. Where costs of these responses are borne by the general public rather than by the appropriate energy producers and/or consumers, the market incentive to build a more resilient, decentralized, and diversified supply system is reduced. Security subsidies tend to benefit oil the most, with particularly high transfers to imported oil from unstable regions such as the Persian Gulf. Additional beneficiaries are centralized electricity and natural gas. Off-grid power and conservation are the sources most disadvantaged. Subsidies to protecting energy installations and stockpiling are explored in detail in the following subsections.

3.5.1.1 Protection of Assets and Supply Links The larger the energy installation, the greater the target and the bigger the dislocation that an attack or accident would cause.

Defending energy-related assets is an increasing concern of governments around the world. Pipeline defense is listed as its own objective within Georgia's defense and security strategy. The United States has become involved with training the Colombian military to defend oil pipelines in that country, pushing for funding of $98 million to support the effort. Within the United States, core assets include the Trans-Alaska Pipeline System (TAPS), through which nearly 25% of total U.S. crude production flows, and nuclear plants. In response to inquiries from Koplow and Martin, Alaskan and federal officials said that no public funds were spent ensuring TAPS security. Nonetheless, the military has historically conducted training and planning exercises around the pipeline. In the nuclear sector, increased public subsidies have come through rising deployment of state-level security or National Guard troops around plants during periods of high terrorist alerts. However, surveys of nuclear plant workers by the Project on Government Oversight reveal employee concerns that training and spending levels are still insufficient. Although these anecdotes indicate that public expenditures in the area of protecting energy-related assets are likely large, data to quantify the subsidies are generally unavailable.

The costs of defending oil shipments through the Persian Gulf is an exception. As one of three central missions for the U.S. military in the region, there have been multiple efforts to value the subsidy to oil. Koplow and Martin reviewed eight historical studies of these costs and found general agreement that this presence is of great benefit to oil supply security. Disagreements centered on cost attribution. Some assessments attributed an extremely small portion of the military cost to oil, arguing that the same basic force structure would be needed for the other missions. Koplow and Martin pointed out that equivalent arguments could be made for each mission area given that the common costs of the vessels and personnel are what are most expensive.

They argued instead for treating the military presence through the lens of joint costs and allocating a reasonable portion (in this case, one-third) to the oil sector. This approach yields a subsidy to the oil sector in the range of $11.1 billion to $27.4 billion per year (roughly $1.65–$3.65/barrel originating from the region), depending on which of the detailed costing studies are used. Although funded by U.S. taxpayers, the benefits accrue to oil consumers in Europe and Japan as well. Recovering this cost via an excise fee on shipments would help to encourage increased supply diversification.

3.5.1.2 Stockpiling Petroleum has been the main focus of stockpiling efforts given its importance to world transport and military readiness. Under the terms of the IEA, oil-importing member states are required to hold stocks equal to 90 days of the previous year's net oil imports as a buffer against short-term supply disruptions. Subsidies arise if the costs of stockpiling are borne by taxpayers rather than by oil consumers. Relevant expenses include constructing and operating the stockpiles, interest costs on oil inventories and infrastructure, and any payments to third parties for nongovernmental stockpiling (two-thirds of IEA-mandated stocks are held commercially).

Buffer stocks for oil within the United States are held within the publicly owned Strategic Petroleum Reserve (SPR). The SPR has incomplete cost accounting, most prominently ignoring the interest costs associated with more than $16 billion it has spent to purchase its oil inventory since the reserve's inception. Private firms must finance all working capital, including inventory, in their operations, and cost savings from reducing inventory levels can be large. Public oil stockpiles are no different; capital tied up in the enterprise much be borrowed, at interest, through Treasury bond markets. Analysis by Koplow and Martin for 1995 estimated annual subsidies to the SPR at between $1.7 billion and $6.1 billion, depending on whether unpaid interest on oil inventories is compounded. Because carrying costs are sensitive to the cost of capital, declining interest rates during recent years mean that current SPR subsidies will be lower than they were during the mid-1990s. Although the details of stockpile financing in other countries are not easy to discern (the IEA collects data only on physical flows, not on financial flows), some countries do recover at least a portion of their stockpiling costs from consumers. These include Japan, France, Germany, Korea, and Taiwan.

Subsidies to stockpiles slow transition to less vulnerable, more diversified supplies. Formal tracking of stockpile finance by the IEA, as well as the formalization of accounting rules for calculating costs, would leverage market forces for improved supply security.

3.5.2 Environmental, Health, and Safety Externalities

Externalities involve damages associated with energy production or use that are imposed on surrounding populations or ecosystems without compensation. These may include environmental damage, materials damage, human health effects, and nuisance factors such as bad smells and loud noises. Worker health is sometimes not counted as an externality under the argument that workers are compensated for the added risks of their jobs through higher wages. Such a conclusion requires that workers have some degree of choice in whether or not to accept jobs and that employers can be taken to task retroactively for gross negligence. This is not the case in many countries around the world. As a result, it is reasonable to consider as subsidies high levels of occupational illness, especially when the costs of maintaining those workers falls on the general taxpayers.

Governments are routinely involved with efforts to make certain energy-related activities safer for workers. This is most prominent regarding coal and nuclear fuel cycles, where dedicated government agencies exist to inspect and educate mines and production sites. If these costs are not paid entirely by the producers or consumers of the affected energy type, subsidies ensue. Public responsibility for workers' health care and/or pension costs also constitute subsidies. This has been quite common in the area of coal. For example, government payments to U.S. coal miners afflicted with black lung have exceeded $30 billion. Black lung levels are now rising (or are being better documented) in other countries such as Russia, Ukraine, and China. Coal mine fatalities continue at extremely high levels in many of these countries as well.

Although difficult to quantify and normalize, external costs arise in many different ways through the fuel cycle. Table V provides an overview of these costs, in large part relying on data developed by ExternE. A project of the European Commission, ExternE has more than 50 research teams trying to quantify the externalities for key fuel cycles.

External costs are highest for coal and oil, although newer conversion technologies can reduce the toll per unit of power significantly. The environmental costs of nuclear power also appear low, even

TABLE V

Overview of Externalities by Energy Resource

Fuel	Years of life lost/TWh[a]	Environmental damage costs (Euro-cents/kWh)[a]	Quantifiable external costs (Euro-cents/kWh)[b]
Coal, 1995	1065	13	2.6
Coal, >2000	113	4	3.4 (lignite)
Oil, 1995	830	10	
Oil, >2000	139	2.6	
Gas, 1995	161	2.4	1.1
Gas, >2000	29	1.7	
Nuclear<100years	1	0	0.2
Nuclear>100years	8	0.2	
Biomass, range	20–100	0–0.8	
Photovoltaic, range	4–11	0.1–0.3	0.8
Wind	4–9	0	0.09
Hydro			0.07

[a] Rabl, A., and Spadaro, J. (2001). The ExternE project: Methodology, objectives, and limitations. *In* "Externalities and Energy Policy: The Life Cycle Approach", Nuclear Energy Agency, workshop proceedings. Organization for Economic Cooperation and Development, Paris.

[b] Includes available estimates for health effects crop losses, material damage, noise, acidification/eutrophication, and global warming. Viridis, M. (2001). Energy policy and externalities: The life Cycle approach. Organization for Economic Cooperation and Development, Paris. *In* "Externalities and Energy Policy: The Life Approach". Nuclear Energy Agency workshop proceedings.

though they are quite sensitive to assumptions regarding accidents at plants. The data also indicate that renewable energy sources would become far more competitive if the market were forced to account for external costs.

4. PATTERNS OF SUBSIDIZATION

Developing an aggregate picture of energy subsidization is extremely difficult due to the scope of policies affecting the sector and to tremendous fragmentation of the data across thousands of government ministries worldwide. There has been no global multifuel estimate of energy subsidy magnitude, although two efforts come close. Myers and Kent developed a global estimate for fossil ($119 billion/year) and nuclear energy ($12 billion/year), with an additional $200 billion per year in externalities. Van Beers and de Moor estimated global subsidies to all fuels ($250 billion/year, with more than 60% supporting fossil) but did not include externalities. Both estimates were built by aggregating data from preexisting smaller assessments rather than from a comprehensive policy survey. Different definitional and valuation approaches, as well as gaps in regions covered, make aggregation difficult. Although the resultant values indicate that energy subsidies are quite large, they are unlikely to provide much precision as to the true subsidy magnitude.

Common themes are nonetheless visible across many of the smaller studies. For example, Koplow and Dernbach found that the fossil share of total subsidies exceeded 55% in four of six major U.S. multifuel energy subsidy studies conducted since 1978. In the remaining two, methodological inconsistencies largely explain the deviation. Within the fossil category, coal and/or oil normally received a larger share than did cleaner natural gas. Estimates for nuclear varied more widely. Where liability caps for accidents and capital subsidies were included, nuclear subsidies comprised 25% or more of the totals. Where they were incorrectly excluded, reported nuclear subsidies were much lower. Renewables and efficiency garnered 5% or less in most of the studies. Only when many large subsidies to other fuels were excluded did the aggregate subsidy estimates fall low enough to bring the renewables/efficiency share above 15%.

This pattern across fuels is broadly consistent with trends discussed earlier in this article. Historical spending on R&D has heavily favored fossil fuel and nuclear power, as has the use of export credit agencies. Subsidies to capital formation have supported primarily these same fuels, whereas those to energy security have favored oil and nuclear energy.

Failure to internalize pollution or health externalities generates subsidies primarily to coal and oil. Yet for many large industrial consumers, these fuels are exempt from taxation throughout the OECD. Government support for renewables, efficiency, and conservation is extremely modest. There have been recent gains in the share of public R&D supporting these areas, and some newer energy resources are eligible for tax credits or are included within purchase mandates. However, the overall pattern is one in which established energy types, often with poor environmental profiles, continue to receive most of the public support provided to the energy sector.

5. SUBSIDY REFORM

Modeling efforts, summarized by Koplow and Dernbach, suggest that subsidy reform is likely to generate environmental gains. Within the United States, modeling suggests that reforms could achieve a substantial (18% of the nonsequestration reductions) portion of the Kyoto 2010 carbon reduction targets. Modeling of international reforms projects some global reductions in greenhouse gas emissions by 2010 (0.2–8.0%), although results are sensitive to assumptions regarding subsidy values and fuel substitution options. Given the hundreds of billions of dollars involved with current subsidies, reforms also seem likely to reduce fiscal expenditures in many countries throughout the world.

Energy subsidies and subsidy reform have attracted the attention of many international governmental and nongovernmental organizations, as well as country-level ministries, over the past 15 years or so. Despite this attention, successful reforms have been few. This outcome reflects the role of political economy in subsidy creation, continuation, and reform. Who gets public resources is often an intensely political decision. Powerful groups in society are best positioned to institute policies that generate transfers to themselves. Furthermore, the theory of rent seeking indicates that groups that have received subsidies in the past will invest at least a portion of those gains to ensure that the subsidies keep coming.

Fossil, nuclear, and hydro energy sources all have been around for a long time, involve large companies and/or large government ministries, and have sufficient scale to dedicate staff to political lobbying. In addition, because the cost of many subsidies rises as the installed base eligible for them grows, the large installed base of fossil, nuclear, and hydro also contributes to these resources capturing the lion's share of subsidies.

Given the strong political opposition to subsidy reform, a transitional process to precede policy change with much increased transparency makes sense. Initial steps to qualitatively identify and describe subsidies seems simple but can greatly change the political dynamics of subsidization by making recipients more visible to their competitors and the taxpayers. Quantifying the value of these transfers is the next step and helps policymakers to prioritize which subsidies are most important to address first. Consistent approaches should be used so that estimates done for different countries, or those done by different researchers, can be compared more easily. Separating externalities from fiscal subsidies is one element of standardization, as is applying consistent rules on offsets.

Modeling the impacts of these transfers on human, environmental, and fiscal health should come next, followed by modeling the effects of potential subsidy reforms. Summarizing a series of global workshops on energy subsidies, the UN Environment Program suggested that reforms should be implemented gradually and with strong transitional policies. A gradual approach might not make sense in all cases given that political forces may be able to stop some reforms entirely. However, transitional approaches that decouple payments from practices that harm human health or the environment should be pursued. Eligibility for existing subsidies can also be made contingent on acceptable environmental practices. Finally, new or replacement subsidies should be structured to leverage competitive markets (as do the RPSs) rather than providing support whether or not there is a successful outcome.

6. CONCLUSION

Subsidies remain a large presence in energy markets throughout the world. The scope, complexity, and politics of these policies help to explain why there is no global subsidy data set. However, all indications are that these subsidies cost hundreds of billions of dollars per year, impede market penetration of cleaner and more efficient methods of providing energy services, and increase damages to human health and the environment. Efforts to overcome the inherent political resistance to subsidy reform are needed, if only to greatly improve the ability to identify, describe, and quantify subsidies to particular fuels throughout the world.

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