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# Federal Disincentives: A Study Of Federal Tax Subsidies And Other Programs Affecting Virgin Industries And Recycling

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United States Environmental Protection Agency

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## FOREWORD

This report was initially drafted by Temple, Barker & Sloane, Inc. (TBS) for EPA's Office of Policy Analysis. EPA circulated the report for comment within the Agency and to several outside reviewers. Subsequently, EPA integrated these comments into this final report.

EPA would like to acknowledge the contributions of several individuals to the research and writing in the report. The initial draft was prepared by Douglas Koplow and Kevin Dietly of TBS with assistance from Dr. Terry Dinan of the Office of Policy Analysis. They were substantially assisted in their research by generous contributions of time and data from H. Richard Heede of Rocky Mountain Institute in Boulder, Colorado. His pioneering work measuring federal energy subsidies filled an important gap in the background data. Seymour Fiekowsky of the U.S. Department of the Treasury also provided important information on the federal tax code.

EPA also acknowledges the contributions of the reviewers of the draft report. Thomas Gillis of the Waste Policy Branch of the Office of Policy Analysis (OPA) managed the development of the final report, providing comments and coordinating the work of the reviewers, and drafting the final report. Adam R. Saslow, also of OPA's Waste Policy Branch, reviewed and edited the material and coordinated the publication of the report.

## EXECUTIVE SUMMARY

In February 1989, EPA's Municipal Solid Waste Task Force recommended a national strategy for addressing the emerging issues in solid waste management. As part of *The Solid Waste Dilemma: An Agenda for Action*, the task force called for a study of existing disincentives to recycling. This report responds to that recommendation.

Disincentives to recycling are the product of numerous factors -- governmental policies at all levels, market forces, and structural conditions within a particular industry. This particular report focuses on identifying federal government policies that may hinder recycling activity and assessing their impact. We expressly *do not* consider many other important factors that may also affect recyclables such as state and local taxes, investment, and recycling policies; private or municipal underpricing of existing landfill capacity; U.S. foreign policy and issues of industrial structure. Our focus, rather, is on federal tax subsidies and other programs for extractive industries that affect the competing secondary industries. Of the various recycling markets existing (paper, aluminum, plastic, and glass), the pulp and paper market is highlighted as a case study of the impacts of disincentives because of paper's dominance in the municipal waste stream.

This general discussion of disincentives is divided into three sections: those based on the federal tax code, all other federal programs, and the case study of the paper industry. Much of the federal tax code and natural resource development policies were found to have historical antecedents dating back to the early 20th century or other periods of economic hardship during which the Congress sought to encourage development of natural resources and extractive industries. For example, Congress authorized the first depletion deductions for minerals in 1913. Timber sales from the federal government date to 1891. And below-cost mining leases have their antecedent in the Mining Law of 1872.

In many cases, the original intent of the tax provisions or programs have become antiquated. Nevertheless, industry lobbying has been effective and the programs have remained, resulting in continued preferential treatment for primary extractive industries vis-à-vis secondary markets. The Tax Reform Act of 1986 eliminated some energy subsidies, the 10% investment tax credit, the energy tax credit, and the capital gains allowances which had separated long-term capital gains from ordinary income for tax purposes (See Appendix A) since 1922. This report, for the most part, deals with the post-1986 world.

For several reasons, we have been unable to ascertain the precise magnitude of the impacts of the federal tax and program subsidies on secondary materials markets ("cross-elasticity" effects). First, the pricing mechanism is the primary vehicle by which tax and other subsidies in primary industries can have an effect on recycled markets. Theoretically, subsidies should lower the price of the subsidized good, rendering a comparative advantage not available to secondary competitors. The supply curve for the subsidized good "artificially" shifts to the right, lowering its price vis-à-vis the secondary material. However, if a market is monopolized, domestic subsidies to the industry are not likely to have a material impact on the market price of the good. This may also be the case if the subsidized industry is producing an output priced on the international market rather than on the basis of domestic supply and demand.

For the markets we examined, this cross-elasticity effect that domestic subsidies could yield was substantially weakened because prices were set on the international market. Despite this dampening effect, some cross-elasticity measures are used to estimate the effects of federal subsidies for primary

production of paper, steel, copper, aluminum, and lead on their recycled competitors (waste paper, scrap steel, scrap copper, scrap aluminum, and scrap lead, respectively). The cross-elasticity estimates, however, date back to 1977 and 1978. A fruitful areas for further research might be the development of newer cross-elasticity estimates. Calculation of these new estimates was beyond the recommendations of the *Agenda for Action* and, thus, beyond the scope of this report. Nevertheless, more current estimates might be needed to replace older estimates to give us a better idea of the magnitude of the cross-over effects.

Although we could not determine *significant* impacts of subsidies on recycling through the price mechanism, subsidies to virgin industries (which undoubtedly raise their profit margins) render these industries more attractive to new entrants over the long run. Entry into the virgin industries becomes more likely and exit less likely in comparison to the unsubsidized world -- with the total effect being an "over-production" of the virgin material compared to quantities that would result from an undistorted market. Although we have strong reason to believe that depletion allowances, tax policies and other subsidies bolster virgin materials production through their long-run impact on entry into the industry, we did not consider the entry and exit issue in this report.

Other findings that can be drawn from the report include the following:

Depletion allowances provided approximately $1.06 billion in benefits to independent oil and gas producers and to all mining industries in FY 1988. The impact of these benefits on the glass, aluminum, and oil and gas markets appeared to be small, however, given the small fraction of domestically produced natural resources used in the production of some primary materials, the small share of total production costs attributable to these benefits, and the existence of the alternative minimum tax.

The majority of federal subsidies to primary production are indirect in the form of support to energy production. The total value of federal energy subsidies in 1988 was $26.7 billion. Since recycling tends to be far less energy-intensive than primary production, energy subsidies passed on to energy consumers in the form of lower prices could vastly favor virgin production over recyclable. For example, primary aluminum uses an average of 95% more energy than secondary material, and recycled paper requires 43% less energy that virgin pulp. Although we have reason to believe that energy subsidies are not heavily reflected in domestic prices, a conservative scenario that assumes the full subsidy is passed on to energy consumers (such as aluminum producers) would result in the energy-intensive primary aluminum industry receiving a total of $331 million in subsidies in 1989, or 23% of the delivered price of aluminum.

The timber industry received specific benefits from the tax code, which amounted to $459 million in FY 1988, also comprising a rather small fraction of the total timber market.

Special tax provisions and direct program outlays cost the individual U.S. taxpayer close to $30 billion in 1988, with the significant portion of the total going for energy subsidies. While the downstream effects to primary producers of paper, aluminum, glass, and other materials were difficult to quantify for reasons cited above, we can be quite confident in concluding that the overwhelming bias of federal tax policies and program outlays favors extractive industries and their beneficiaries over recycled markets.

# I. INTRODUCTION

In many communities, tightening landfill capacity, rising disposal costs, and increasing concern about the environmental effects of landfilling and incineration, are posing very complex problems for waste managers. Although EPA views solid waste management as a state and local responsibility, it believes that the federal government can provide its expertise to identify and analyze key problems. Toward this end, in February 1988 EPA created a task force, which published its findings a year later in *The Solid Waste Dilemma: An Agenda for Action.* The *Agenda* identifies next steps for EPA in a number of areas, such as source reduction, recycling, and reducing the risks associated with incineration and landfilling. This report responds to a recommendation in the initial plan for EPA to complete a study of existing disincentives to recycling.

A number of disincentives to recycling have been frequently mentioned, especially in analyses sponsored by EPA in the late 1970's. The most commonly cited examples include the tax code, federal subsidies for natural resource development, trade policies and discriminatory freight rates. In addition to federally controlled disincentives, governmental policies at all levels, market forces, and structural conditions within a particular industry (e.g., vertical integration, which inhibits shifts away from virgin inputs) may be working against efforts to incite the development of markets for recycled goods.

Development of an effective strategy to encourage recycling requires an understanding of all forces affecting different aspects of the recycling market. This particular report identifies the federal government policies that may pose the greatest hindrance to recycling activity and attempts to assess their impacts. Time and resource constraints prohibit us from considering many other important factors that may also affect recyclables. With the exception of one report,[1] neither the public nor the private sector has analyzed these topics in recent years. As a result, EPA initiated this project with several objectives in mind:

- Identify current disincentives resulting from federal regulations and federally subsidized programs.

- Quantify the magnitude of federal subsidies wherever possible.

- Complete a detailed examination of disincentives to paper recycling. The objectives of the case study were to quantify, to the extent possible:

  - the dollar value of federal subsidies provided, either directly or indirectly, to producers of virgin pulp; and,

  - the potential impact of subsidies on production decisions (i.e., the choice between primary and secondary inputs to production).

At a later time, EPA may analyze other federal programs and different industries. In the meantime, it is hoped that this information will contribute to federal policy development designed to promote environmentally sound recycling, conservation, and energy efficiency in the most cost-effective manner possible.

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1 Franklin Associates, Ltd., and the Center for Economic Policy Analysis. Economic Incentives and Disincentives for Recycling of Municipal Solid Waste. DRAFT. December 1988. Prepared for the Office of Technology Assessment.

## II. POTENTIAL DISINCENTIVES TO RECYCLING: FEDERAL TAX CODE

### Introduction

For the purposes of this report, a potential federal disincentive to recycling is defined to exist where federal tax or expenditure policy increases the cost of using recycled materials relative to the cost of virgin materials, where the recycled material is a substitute for the virgin material. A disincentive can be created by increasing the relative price of recycled goods, either by increasing the production cost of the recycled material or by decreasing the production cost of the virgin material. As a result of this disincentive, fewer feedstocks for recycling may be consumed in the marketplace than would otherwise be the case.

This report does not consider the long-run incentive effects of tax or expenditure policies; instead, it considers only short-run impacts on costs and prices. For example, federal tax policy might decrease a commodity's production cost, but have no impact on its product price (i.e., the subsidy is not "passed through" to consumers in the form of a price decrease). In the long run, the profit to be earned producing such goods might attract additional firms or other additional investment, eventually lowering product prices (because of increased supply). This report considers only direct effects on product prices, rather than the indirect effects caused by entry into or exit from the industry. The latter issue would be a suitable topic for future research.

In this chapter, we explore the potential disincentives created by the current federal tax code, as amended in 1986. More recent changes to the tax code continue to make this area rich for further analysis. There is a long history of structuring federal, state, and local tax codes to provide incentives that will spur industrial or natural resource development, some of which may be deterrents to recycling. The potential tax disincentives we examined in this effort fall into one of five categories:

- *percentage depletion allowances*, which are available solely to primary minerals and some oil/gas extraction companies;
- *tax provisions for the timber industry*, which include special treatment of expenses associated with timber production;
- *tax provisions for development of energy*, which include expending of exploration and development costs, tax-exempt bonds, and percentage depletion allowances;
- *financing provisions*, which may either subsidize or hinder virgin material production; and,
- *other tax considerations*, which is a catchall for other general tax deductions--not directed solely at the virgin materials producers--that could influence the costs of primary and secondary materials, depending on the characteristics of the production process and the firm (e.g., accelerated pollution control expenditure amortization).

This chapter describes the main disincentives in each of these categories. In particular, the chapter presents the origin of the disincentive, how the disincentive operates, the main industries affected, and the extent to which the disincentive could adversely affect recycling--using either qualitative or quantitative measures. Additional information about the history of the disincentive and its operation may be found in Appendix A of this report.

## Percentage Depletion Allowances

Purpose of These Allowances

Percentage depletion allowances are tax deductions that are available to mineral producers (including oil and gas) which are intended to promote resource exploration and development.

Depletion allowances were initially enacted to encourage development of natural resources -- specifically minerals and oil and gas -- during times of economic hardship (e.g., the World Wars). While Congress intended to rescind these tax benefits once economic activity increased, lobbying efforts by the primary industries resulted in their retention. Appendix A contains a brief summary of the major events leading up to the tax code provisions for existing percentage depletion allowances.

How Percentage Depletion Allowances Work

Producers are permitted to deduct a portion of the depletable resource's value each year. Theoretically, this provides them with seed money to initiate activities to replace the lost resource. Depletion allowances vary by industry and by the location of the resource (i.e., domestic or foreign).[2] There are also limitations in the tax code regarding the extent to which percentage depletion allowances can be used.

There are two methods for calculating depletion deductions from taxable income for non-timber natural resources:[3]

1. *Cost depletion allowances* permit industry to gradually recover *capital outlays*. The rate of recovery depends on the ratio between the current unit sales of a mineral and the total anticipated unit sales from the property. Cost depletion, like depreciation for capital equipment, is a standard accounting method used to recover investment costs, and has existed since the origin of the tax code in 1913. Cost depletion is calculated as:

$$(X + Y - Z) * P$$

where: X = The acquisition cost of the mine.
Y = Certain costs incurred to convert the raw deposit into a producing deposit.
Z = Previous depletion deductions already claimed.
P = The percent of the total mineral deposit sold during the fiscal year.

2. *Percentage depletion allowances* provide for a tax deduction against the *gross income* generated by the property.[4] Percentage depletion allowances enable the taxpayer a chance to recover more than the

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[2] A related federal program, foreign tax credits, may indirectly subsidize the production of virgin materials abroad. This report does not address the foreign tax credit program.

[3] Robert Tannenwald, Analysis and Evaluation of Arguments for and Against Percentage Depletion, Congressional Research Service, March 22, 1978.

[4] Charles W. Russell and Robert W. Bowhay, Income Taxation of Natural Resources, 1989, Paramus, N.J.: Prentice Hall, In., 1989), p. 805.

initial investment in the property. Percentage depletion is a straight percentage of gross income from the mine property, regardless of mine value or actual investment expenditures:

$$I * D$$

where: I = Gross income from the property.
D = Allowable percentage depletion (this varies by industry -- see Table II-2).

Companies must compute depletion deductions using both approaches and then claim the larger of the two amounts (i.e., the one that results in the lower net income and, therefore, the lower tax obligation). If cost depletion results in the higher value, the company uses cost depletion until its investment has been fully recovered. After this point, the company may deduct the value of the percentage depletion. Thus, the true value of the subsidy to primary minerals industries is the value of tax deductions that occur after investment costs have been recovered.

Percentage depletion deductions may not exceed 50% of taxable income (calculated before deductions) in a given tax year.[5] A company may use depletion allowances regardless of whether or not it sells the mineral or fuel in question on the open market or uses it directly (as in a captive or vertically integrated firm). Depletion allowances for internal use are calculated on the basis of an imputed market value of the materials.[6]

Percentage depletion allowances provided a gross tax benefit of greater than $1 billion in FY 1988 according to federal government budget estimates.[7] Table II-1 summarizes the special tax treatment for producers of virgin materials; $743 million (70 percent) of the depletion allowance benefit in 1988 accrued to energy producers, with the remaining $318 million claimed by non-fuel mineral producers. The table shows the effect of the 1986 Tax Reform Act. For example, during 1987 there was a decline in the cost of this special tax treatment, although in some cases such as timber (discussed later), the tax benefits may have simply shifted to different, previously unused categories.

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5 Tannenwald, pp. 3, 5.

6 Russell and Bowhay, p. 803. This is an important point because many mineral processing industries are vertically integrated.

7 Franklin Associates, Ltd., and the Center for Economic Policy Analysis, Economic Incentives and Disincentives for Recycling of Municipal Solid Waste, Draft, December 1988. Prepared for the Office of Technology Assessment.

## Table II-1
## ESTIMATED COSTS FOR SPECIAL TAX TREATMENT FOR VIRGIN MATERIALS PRODUCTION, FISCAL YEARS 1980 TO 1989
### (in millions of 1987 dollars)[a]

| | FY 80 | FY 81 | FY 82 | FY 83 | FY 84 | FY 85 | FY 86 | FY 87 | FY 88 | FY 89 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Minerals:** | | | | | | | | | | |
| Expensing of exploration and development costs, non-fuel minerals | 27 | 31 | 30 | 62 | 65 | 85 | 88 | 35 | 34 | 37 |
| Excess of percentage over cost depletion, non-fuel mineral | 493 | 506 | 466 | 531 | 589 | 493 | 500 | 410 | 318 | 293 |
| Capital gains treatment of iron ore | 27 | 25 | 24 | 45 | 44 | 32 | 31 | 10 | - | - |
| *Subtotal - Minerals* | 548 | 563 | 519 | 638 | 698 | 610 | 618 | 455 | 352 | 330 |
| **Timber:** | | | | | | | | | | |
| Capital gains treatment of certain timber income | 740 | 756 | 808 | 831 | 997 | 610 | 690 | 290 | 10 | - |
| Expensing of multi-period timber growing costs | - | - | - | - | - | - | - | 130 | 256 | 279 |
| Investment credit and seven-year amortization for reforestation expenditures | - | - | 12 | 34 | 49 | 53 | 57 | 210 | 203 | 195 |
| *Subtotal - Timber* | 740 | 756 | 820 | 864 | 1,046 | 663 | 747 | 630 | 468 | 474 |
| **Total - Mineral and Timber** | 1,288 | 1,319 | 1,339 | 1,503 | 1,744 | 1,272 | 1,365 | 1,085 | 820 | 804 |
| **Energy:** | | | | | | | | | | |
| Expensing of exploration and development cost for oil and gas[b] | 2,980 | 3,419 | 3,428 | 2,639 | 1,978 | 519 | 639 | (675) | (400) | (172) |
| Excess of percentage over cost depletion for oil and gas | 2,041 | 2,656 | 2,667 | 1,944 | 1,771 | 1,659 | 1,936 | 1,030 | 743 | 618 |
| **Total - Energy** | 5,021 | 6,075 | 6,095 | 4,582 | 3,750 | 2,178 | 2,575 | 355 | 343 | 446 |
| **Total - Mineral, Timber & Energy** | 6,309 | 7,394 | 7,434 | 6,085 | 5,494 | 3,450 | 3,940 | 1,440 | 1,163 | 1,250 |

Note: The corporate and individual categories have been combined for all years to give a total. In the energy category, the individual benefits dominate substantially; in Fiscal Year 1985, 1986, 1987, 1988, and 1989 the corporate benefit is negative for expensing of exploration and development costs.

[a] Franklin Associates, Ltd., "Economic Incentives and Disincentives for Recycling of Municipal Solid Waste Draft," for the Office of Technology Assessment, December 1988. Based on Franklin analysis of the "Budget of the United States for Fiscal Year 1982, 1983, 1984, 1985, 1986, 1987, 1988, 1989."

[b] Some of these values are negative, meaning that the Treasury actually received revenues for these years. Since current repayment of previously deferred taxes under the exploration expensing provisions exceeds the new deferred taxes due to reductions in the expensing provisions in the Tax Reform Act, these values will stay negative until earlier deferrals are paid over time, and these figures will again be positive (Seymour Fiekowsky, U.S. Department of Treasury, personal communication, June 28, 1989).

## Table II-2
## APPLICABLE PERCENTAGE DEPLETION ALLOWANCES[1]

| Rate | Eligible Materials |
|---|---|
| **22%** | - Regulated natural gas, fixed contract natural gas, and geothermal production (subject to certain conditions).<br>- Sulfur, Uranium.<br>- If from deposits in the United States: anorthosite, clay, laterite, and nephelite syenite (to the extent that alumina and aluminum compounds are extracted therefrom), asbestos, bauxite, celestite, chromite, corundum, fluorspar, graphite, ilmenite, kyanite, mica, olivine, quarts crystals (radio grade), rutile, block steatite talc, zircon.<br>- If from deposits in the United States, ores of the following metals: antimony, beryllium, bismuth, cadmium, cobalt, columbium, lead, lithium, manganese, mercury, molybdenum, nickel, platinum and platinum group metals, tantalum, thorium, tin, titanium, tungsten, vanadium, and zinc. |
| **15%** | - Oil and gas wells, subject to certain conditions; domestic gold, silver, copper, iron ore; oil shale (not subject to 7½% depletion). |
| **14%** | - Metal mines other than those listed at 22% or 15%, rock asphalt, vermiculite.<br>- Ball clay, bentonite, china clay, sagger clay, and clay used or sold for use for purposes dependent on its refractory purposes, so long as the material is not specifically listed at 22% above, or 7½% or 5% below.<br>- All other minerals not listed here, including, but not limited to, aplite, barite, borax, calcium carbonates, diatomaceous earth, CB feldspar, fullers earth, garnet, gilsonite, granite, limestone, leonardite, magnetite, magnesium carbonates, marble, mollusk shells (including clam shells and oyster shells), phosphate rock, potash, quartzite slate, soapstone, stone (used or sold for use by the mine owner or operator as dimension stone or ornamental stone), thenardite, tripoli, trona, and (if not applicable under 22%) bauxite, flake graphite, fluorspar, lepidolite, mica, spodumene, and talc (including prophyllite) unless material is used for rip rap, ballast road material, rubble concrete aggregates or similar purposes, in which case the allowable depletion is 5%.<br>- "All other materials" does <u>not</u> include soil, sod, dirt, turf, water, or mosses, minerals from sea water, the air, or similar inexhaustible resources; oil or gas wells |
| **10%** | - Asbestos from foreign sources.<br>- Brucite, coal, lignite, perlite, sodium chloride, and wollastronite.<br>- Natural gas produced from geopressured brine subject to certain conditions |
| **7½%** | - Clay and shale used or sold for use in the manufacture of sewer pipe or brick, and clay, shale and slate used or sold for use as sintered or burned lightweight aggregates |
| **5%** | - Gravel, peat, pumice, sand, scoria, shale (except when listed as eligible for 15% or 7½% depletions), stone (except as eligible for 14% depletion). |

Beneficiaries of these Allowances

The primary beneficiaries of percentage depletion allowances are all mining industries (including clay, gravel, and hardrock minerals, such as copper) and independent oil and gas extraction companies. Table II-2 summarizes the depletion allowances under the current tax code, which range from 5 to 22 percent of gross annual income. Depletion allowances could be subsidizing primary production in the following areas that compete with recycling:

- *Aluminum*: From domestic sources: nephelite syenite--when alumina and aluminum compounds are extracted (22 percent) and bauxite (22 percent). From U.S.-owned foreign deposits: bauxite (14 percent).

- *Other metals*: From domestic sources: cadmium, chromite, lead, mercury, nickel, platinum, tin, zinc (22 percent); copper, iron ore (15 percent). From U.S.-owned foreign deposits, 14 percent.

- *Plastics, used oil recycling*: Oil and gas extraction (10 to 22 percent), generally available only to independent producers.

- *Glass*: Sand (5 percent), clay for refractory properties (15 percent).

- *Concrete and road materials*: Any minerals that may receive a 14 percent depletion allowance when used directly, or a 5 percent depletion allowance when used in concrete or as ballast road material.[8]

Also, depletion allowances subsidize energy (e.g., oil and gas extraction (10 - 22 percent), oil shale (15 percent), uranium (22 percent)), which may also be beneficial to primary industries, especially energy-intensive ones like aluminum production.

How These Allowances Affect Recycling

The magnitude of the impact on recycling of any given subsidy, if one exists, will vary by the size of the depletion allowance, the virgin material mined, the structure of the industry using the material, and the availability of substitutes for both product feedstocks and for the final product. For many of the inputs listed in Table II-2, prices are set on the international market. As a result, these rather significant domestic subsidies do not significantly affect market price. In the long run, depletion allowances and other subsidies "distort" the market by making the production of virgin materials more attractive than it otherwise would be. Profits -- artificially raised by favorable tax policies -- attract greater entry into the virgin materials market than otherwise would be the case. It was beyond the scope of this project to gather detailed data on each recycling market or to determine whether depletion allowances stimulate exploration for new minerals and thereby subsidize their use.[9] Instead, we used readily available information to explore whether depletion allowances posed a significant disincentive to recycling. First, we relied on findings from a December 1988 report by Franklin Associates, Ltd. (FAL), et al., which reviewed key studies from the late 1970's to quantify the impact of various disincentives to recycling. Second, for a few industries (including oil and gas,

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[8] Recycled materials can be used in road construction. For example, cullet is turned into glasphalt, and shredded used tires can be made into rubberized asphalt. Also, there is reuse of asphalt (through remelting) and concrete aggregate.

[9] For a complete discussion of these arguments, see Tannenwald.

aluminum, and glass) we performed a screening analysis using currently available information. We then assessed the fraction of the total primary product price that might be attributable to depletion allowances.

The studies in this review generally indicated that subsidies to virgin material production do not discourage the use of recyclable feedstocks. For example, as shown in Table II-3, an Environmental Law Institute (ELI) report using econometric modeling[10] predicted that eliminating tax subsidies to virgin materials would change their prices, in the most likely situation, from between 1 and 5 percent. The most common consumer recyclables (e.g., paper, steel, and aluminum) had price change impacts that were predicted to be 2.2 percent or less. Taking this one step further, Table II-3a shows that the ELI report and a 1978 JACA Corporation analysis each predicted modest increases (generally less than 1%) in the quantity of secondary materials supplied once the virgin materials prices increased. To the extent that the 1986 tax amendments may restrict some companies from taking advantage of these tax deductions, the estimated impacts on the supply of recyclables are further diluted (see Appendix A for a discussion of changes to the tax code).

**Table II-3**

**IMPACTS OF TAX SUBSIDIES ON VIRGIN MATERIAL SUPPLY CURVES**

| Industry | Predicted Cost Impacts (percent change) Maximum Possible | Most Likely |
|---|---|---|
| Paper | +4.2 | +1.0 |
| Steel | +3.0 | +2.0 |
| Copper | +6.0 | +5.0 |
| Aluminum | - | +2.2 |
| Lead | | +3.0 |

Source: Franklin Associates, Ltd., December 1988, p.13, based on an evaluation of a 19?6 Environmental Law Institute study for EPA

**Table II-3a**

**EXPECTED INCREASE IN RECYCLING OF SECONDARY MATERIALS WITH SUBSIDY ELIMINATION**

| Material | Quantity Increase (percent) |
|---|---|
| Waste paper | 0.04 - 0.63 |
| Scrap steel | 0.42 - 2.00 |
| Scrap copper | 0.35 |
| Scrap aluminum | 1.00 |
| Scrap lead | 0.75 |

Source: Franklin Associates, Ltd., December 1988, pg. 13, based on an evaluation of a 19?8 Environmental Law Institute report for EPA and a 19?? report by JACA Corporation for the U.S. Bureau of Mines

*Industry Examples*

We performed an initial screening analysis of the aluminum, glass, and the oil and gas industries to provide perspective on the fraction of primary product costs that could be attributed to tax subsidies.

*Aluminum*

Outside of energy, bauxite is a key input to aluminum production. However, only about 6.4 percent of all bauxite used in the U.S. aluminum industry today originates from domestic bauxite

[10] The models applied in these studies were developed nearly 20 years ago and, thus, do not take into account changes in the recycling environment (i.e., technology, environmental consciousness, etc...). Updating these models would be a suitable topic for future research.

sources.[11] No U.S. facilities are currently producing metallurgical-grade aluminum.[12] Thus, percentage depletion allowances on domestic bauxite are not a factor. However, since U.S.-owned foreign deposits are also eligible for percentage depletion allowances (although at 14 percent rather than 22 percent), there could be some impacts on the domestic aluminum market from this tax benefit.

The U.S. Bureau of Mines estimates that the bauxite mining and drying process constitutes less than 2 percent of the market price of finished aluminum.[13] Therefore, even if all imported aluminum came from wholly U.S.-owned foreign deposits, advantages accruing to the primary industry due to percentage depletion allowances would be less than 0.25 percent of the market price for aluminum.[14] As a result, there is likely to be a negligible impact on primary aluminum production prices and, thus, on recycling.

*Glass*

Using information obtained from the 1982 Census of Manufactures on glass products, it appears that the cost of sand, clay for refractors, and other minerals (all supported by depletion allowances) account for roughly 4 percent of the total delivered cost for glass containers. These figures are not dramatically different for other glass products, such as flat, pressed, blown, and industry glass. Thus, it is doubtful that depletion allowances (of either 5 or 14 percent) for inputs to virgin glass manufacturing have any significant impact on glass recycling. The maximum estimated impact is 0.6 percent of the final delivered cost.

*Oil and Gas*

Currently, depletion allowances are available only to independent oil and gas producers. In the lower 48 states (there are few independent producers in Alaska), independent producers account for approximately 30 percent of the total oil and gas consumed nationwide.[15] However, a smaller fraction will qualify for depletion allowances under the current tax code. It is currently estimated that between 25 and 40 percent of all independent producers (accounting for 8 to 12 percent of the domestically consumed oil and gas) pay the standard tax, rather than the alternative minimum tax and would be eligible to claim depletion allowances. An even smaller percentage may use the depletion allowances because of additional criteria that must be met

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[11] U.S. Department of the Interior, Bureau of Mines, Minerals Yearbook: Volume I, Metals and Minerals, 1986 (Washington, D.C.: U.S. Government Printing Office, 1988), p. 145.

[12] David Wilburn, U.S. Bureau of Mines, personal communication, October 3, 1989. Non-metallurgical uses for aluminum include aluminum-oxide abrasives.

[13] David Wilburn, U.S. Bureau of Mines, personal communication, October 3, 1989. This assumes a 15 percent return on investment.

[14] This estimate was derived as follows: (14% depletion on non-domestic bauxite) x (100% of imported bauxite from U.S.-owned foreign deposits) x (2% bauxite cost as a fraction of aluminum cost). The actual impact would be even lower, since only the portion of percentage depletion that is in excess of cost depletion is a subsidy, and since some portion of the savings would most likely be passed through to the bauxite user.

[15] U.S. Environmental Protection Agency, Office of Solid Waste, The Solid Waste Dilemma: An Agenda for Action, Background Document, Washington, D.C. (September 1988), p. 3.F-4.

under the tax code.[16] Also, it should be noted that benefits may not be transferred with a property sale.[17] Thus, it appears that a very small fraction of the oil and gas produced domestically is actually subsidized by depletion allowances. Where production is subsidized it should have no effect on the market price for oil and gas. Thus, the oil and gas depletion allowance subsidy should have no impact on recycling.

Caveats

In general, the findings from this examination of depletion allowances suggest that these subsidies to virgin material production are costing taxpayers well over $1 billion per year (see Table II-1). However, we cannot reach strong conclusions regarding the relationship between these depletion subsidies and recycling markets because: (1) empirical models were developed in the late 1970's (key assumptions may no longer be applicable; and, (2) rough calculations for a few industries show that only a small fraction of the primary product cost is attributable to minerals subsidized by depletion allowances. However, depletion allowances are not the bulk of federal disincentives to recycling -- as will be shown in this chapter and elsewhere. In addition, our analysis did not capture the long-run effects of enhanced profitability among subsidized industries, which undoubtedly encourages more entry into the industry than would result from an unsubsidized world.

## Tax Code Provisions For The Timber Industry

Historically, there have been two general types of tax code provisions for the timber industry: (1) capital gains allowances for timber and (2) the expensing of some timber management expenditures in the year in which they were incurred, rather than waiting until the timber was harvested. Under the current tax code, as amended in 1986, only the latter category of deductions remains available to the timber industry. In this section, we describe the tax policies affecting the timber industry: timber management policy and reforestation expenses. Appendix A presents information on capital gains taxes, since the tax code may address them in the future.

In general, expenditures to enhance the value of an investment (e.g., development of a new product) may be either "capitalized" or "expensed" for tax purposes, depending upon the type of investment project. Capitalization is required when expenditures are made to enhance the value of an investment and the revenues or the increase in value associated with that investment will not be realized for two years or more. In this scenario, the costs incurred in a given year may not be used to offset current taxable income until the investment begins to yield a saleable product or service (e.g., a road to be used, mature timber to be sold). At the point of recovery, the initial investment plus interest may be "amortized" (recovered) throughout the useful life of the investment.

Expenditures for current operating expenses or on investments with a producing life of less than two years may be "expensed." In other words, they may be deducted from income in the year in which they are incurred, rather than being deducted at some date in the future. This allows firms to reduce their taxes now,

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[16] These include a cap at 50% of taxable income from the property for the year, and 65% of the taxpayer's income from all oil properties, limited to the first 1,000 barrels per day.

[17] Environment and Energy Study Institute, Weekly Bulletin, April 10, 1989.

rather than when the investment produces income. The result is, in effect, a zero-interest loan equal to the amount of tax paid on the expenditure for the amount of time the tax payment is deferred.

Following these general principles, the timber industry should be capitalizing all of its expenditures associated with timber production. However, there are special tax provisions that allow the timber industry to expense some interim management costs against current income rather than capitalizing the expenses until the timber is harvested (typically 20 or 30 years hence). The rationale for this exception is that the time from initial investment until harvest is so long that there is a great deal of uncertainty associated with the value of the final harvest. The discussion that follows provides more detail on which costs are capitalized and expensed in the timber industry. Figure II-1 summarizes schematically the expenditure flows in the timber industry.

**Figure II-1**

**TIMBER PRODUCTION COSTS**

| Initial investment | | Profit Realization (20-30 yrs) | |
|---|---|---|---|
| Planting Costs[a] | Interim Management Expenses | Cutting | Closure |
| Land Acquisition | Thinning | Spur Roads (harvest season only) | Reforestation[b] |
| Seedings | Herbicide/Pesticide Application | | |
| Access Roads | Brush Removal | | |
| Labor & Equipment | Labor & Equipment | | |
| | Taxes | | |
| | Interest on Loans | | |

Notes: The costs of shaded activities can be expensed in the fiscal year in which they are incurred. The costs of the unshaded activities cannot be recovered until timber cutting starts (generally 20-30 years).

[a] If existing land is reforested (during closure), planting costs are not incurred in the next cycle.
[b] Reforestation may be only partially expensed

Many expenses associated with timber production must be capitalized in the same manner as in any other industry. These expenses include initial product, labor, and equipment expenses for planting the timber stands, preparing preparation, and buying and planting the seedlings. The construction of timber roads must also be capitalized, although not necessarily over the same period as the timber stand. Tax treatment of the costs associated with roads will vary depending upon the type of road (primary, secondary, or spur). The costs are amortized using cost depletion allowances for each category of expenditures--non-road expenses and road expenses--once the timber harvest begins. While cost depletion is a common tax policy in many industries, some people have argued that timber stands should not benefit from cost depletion allowances when other agricultural crops do not. Timber producers have countered that the 20-30 year time frame of

timber investments makes timber harvesting more like plant construction than like farming. In any case, unlike mineral and energy extraction, timber producers may recover only their initial investments.

Expensing of Timber Management and Reforestation Costs

All costs of managing the forest stands may be deducted in the year in which they are incurred, although technically they should be included in forest capitalization expenditures. Provisions allowing the expensing of these costs were retained in the Tax Reform Act of 1986 because industry asserted that capitalization requirements would impose a significant incremental bookkeeping burden on individual landowners.[18] Allowable deductions for management and reforestation activities include all material and labor costs associated with annual brush removal, taxes on the timber stand, interest on loans, and thinning, pest and/or weed control.[19] While this policy has existed for many years, tax expenditures were almost zero until 1987 (when the capital gains treatment for the industry began to be phased out, see Appendix A and Table II-1). Expenditures for interim management costs jumped from nearly zero in FY 1986 to $130 million in FY 1987. These expenditures reached $279 million in FY 1989.[20]

Two special tax provisions to encourage reforestation of timbered land also provide the industry with tax reductions. First, individual or corporate taxpayers are eligible for a 10% annual tax credit (up to a total of $1,000) on the first $10,000 in qualifying reforestation expenses. Second, the amortization of the $10,000 in eligible reforestation expenses may be accelerated (7 years versus 20 to 30 years). That is, the entire $10,000 is amortized sooner, so that the forester recovers the investment faster and receives a $1,000 tax credit. Qualifying expenses for this benefit include only those costs that must normally be capitalized and include direct costs to plant or seed for forestation and reforestation purposes (e.g., site preparation, seed or seedling costs, labor, and tool costs).[21]

As with the deductions for interim management costs, deductions for the reforestation benefits have increased markedly since tax reform in 1986 (Table II-1), primarily because the base for estimating the amount of the deduction has been changed. Claimed deductions for the investment tax credit and the rapid amortization of the first $10,000 in reforestation expenditures jumped from $57 million in FY 1986 to $210 million in FY 1987, although these claims decreased slightly (to $195 million) in FY 1989.[22]

The impact of timber subsidies on the paper recycling industry is the focus of the case study summarized in Chapter IV. As shown by the 1976-77 data presented in Table II-3, eliminating tax subsidies to the paper industry would likely increase costs by as much as 1%.

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18 Ross W. Gorte and Jack H. Taylor, Timber Industry: Possible Effects of Various Tax Reform Proposals, Congressional Research Service, updated 12 1 86, p. 7.

19 Russell and Bowhay, pp. 2220-21; Gorte and Taylor, p. 1.

20 Franklin and Associates, December 1988, p. 3.

21 Russell and Bowhay, pp. 2220-23.

22 Franklin Associates, December 1988, p. 3.

**Tax Provisions For Development Of Energy**

Energy is currently subsidized through several major tax policies: allowable expensing of some exploration and development costs (which would normally be capitalized), tax-exempt bonds, and percentage depletion allowances.[23]

The oil and gas industry may expense exploration and development costs, as well as the intangible costs associated with locating and drilling a well (other than purchases of equipment). For example, expenditures to survey potential sites and prepare a well for drilling may be expensed as intangible drilling costs.[24] For hard rock minerals,[25] firms may also expense exploration costs to locate a body of ore or to determine its extent or quality. Additionally, firms may expense developmental costs until the mine becomes productive.[26] While these deferred taxes must eventually be paid, the expensing provisions provide industry with interest-free loans (in the form of deferred taxes) for a portion of the enterprise's development costs.

Tax-exempt bonds, such as tax-exempt pollution control bonds and tax-exempt bonds for publicly owned utilities, also provide subsidies to capital-intensive utilities. For example, the nuclear industry, as the most capital-intensive of the energy industries, receives a significant percentage of the federal subsidies provided by tax-exempt bonds.

Benefits to Primary versus Secondary Industries

The importance of these subsidies for our study of recycled markets lies in the comparison of energy requirements for primary versus secondary industries. Materials reclamation can save large amounts of energy, particularly in the energy-intensive primary industries (Table II-4 summarizes various estimates of energy savings from recycling). Energy savings arise from a number of differences between primary and secondary production:[27]

- The energy required to extract and transport raw materials is usually greater than the energy required to transport secondary materials.
- In many cases, the energy required to manufacture products from primary materials is greater than that required for secondary production..
- The energy required for transporting primary products to markets is usually higher than that for transporting secondary products since primary production sites are generally further from markets than recycling operations. The relationship can, however, be reversed where the recycled goods need to be transported to distant primary production facilities.

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23 Other tax provisions include accelerated depreciation and the "investment tax credit" (now eliminated).

24 Russell and Bowhay, p. 113; Congressional Budget Office, Reducing the Deficit: Spending and Revenue Options, February 1989, p. 357.

25 Hard rock minerals are found in deposits mixed with rock (e.g., gold, copper, lead, and iron).

26 Russell and Bowhay, pp. 120-23.

27 Robert Forsell Stauffer, "Energy Savings From Recycling," Resource Recycling, January February 1989, p. 24.

If we define "energy intensive" by a firm's energy costs relative to their total production costs, analysis suggests the following: an energy intensive primary industry (using large quantities of subsidized energy) will accrue greater benefits from energy's special tax treatment than a less energy intensive secondary industry. While both primary and secondary industries benefit from the subsidies, the net subsidy to primary producers is greater because energy costs are a larger component of aggregate production costs. Thus, the impact of subsidized energy on secondary industries could be significant, albeit indirectly, as raw materials extraction and processing firms are some of the largest industrial users of electricity in the United States.[28] In general, however, federal energy subsidies have little effect on actual energy prices because energy prices are determined in the world energy market. Nonetheless, there may be circumstances where energy subsidies have substantial effects (for example, a regional power authority can subsidize electricity prices, attracting primary producers) on production costs.

**Table II-4**
**ENERGY SAVINGS FROM RECYCLING**

| | 100% Virgin MBtu/ton | 100% Recycled MBtu/ton | % Savings |
|---|---|---|---|
| Aluminum[a] | 250.7 | 11.8 | 95% |
| Paper[b] | 46.6 | 22.3 | 43% |
| Glass[c] | | | 8% |
| Plastics (PET)[d] | 98.0 | 12.0 | 88% |
| Steel[e] | | | 61% |
| Rubber[f] | | | 44% |

Note: These point estimates are averages of figures reported in several published studies. E.P.A. cannot comment on the validity or comprehensiveness of the estimates. To the best of our knowledge, the estimates represent comparative energy use during the production process using primary or secondary feedstocks. For a complete presentation of identified studies, see Table B-1 in Appendix B.

Sources

[a] Richard Porter and Tim Roberts, eds., Energy Savings by Wastes Recycling (New York: Elsevier Applied Science Publishers, 1985), p. 60. High and low estimates. Robert Barnes, "The Energy Involved in Producing Engineering Materials," Proc. Instn. Mechanical Engineers, Vol. 190, 29/76, in Porter and Roberts, p. 60. Energy Savings for Aluminum Ingot Production, P. Pautz and H. J. Pietrozenuik, "Abfall and Energie," Umweltbudesamt, June 1983, Berlin, in Porter and Roberts, p. 63.

[b] "Secondary v. Virgin Fiber Newsprint," Pulp and Paper, V. 50, #5, May 1976, in Porter and Roberts, p. 66. L. Hanserud and O. Olsson, "Skall vi Branna upp eller Atervinna Returpapperet," Teknisk Tidskrift, 2, pp. 18-19, in Porter and Roberts, p. 67. Environment Canada, Net Energy Savings from Solid Waste Management Options, Ottawa, 1976, in Porter and Roberts, p. 68. "Economics of Recycled Fiber Usage for Linerboard," Pulp and Paper, V. 50, #4, April 1976, in Porter and Roberts, p. 66.

[c] Robert Cowles Letcher and Mary Sheil, "Source Separation and Citizen Recycling," in William D. Robinson, ed., The Solid Waste Handbook (New York: John Wiley & Sons, 1986), in Cynthia Pollack, Mining Urban Wastes: The Potential for Recycling (Washington, DC: The Worldwatch Institute, April 1987), p. 22.

[d] Roberta Forsell Stauffer, "Energy Savings From Recycling," Resource Recycling, January/February 1989, p. 59

[e] Porter and Roberts, p. 13

[28] John Ruston. "Developing Markets for Recycled Materials." in Proceedings of the 1988 Conference on Solid Waste Management and Materials Policy. New York: New York Legislative Commission on Solid Waste Management, 1988), p. H-100.

Potential Impacts of Energy Tax Subsidies on Aluminum Production Costs: A Case Study

In this section, we report the preliminary findings of a simple analysis we performed using readily available information. In this analysis we assessed the potential impacts of tax-based energy subsidies on the production of aluminum. Energy subsidies extending beyond tax subsidies are described fully in Chapter III.

To assess the importance of energy tax subsidies on the cost of energy-intensive primary production, we examined aluminum production. We view aluminum as a good indicator of the potential importance of energy tax subsidies on recycling because (1) recycling aluminum saves proportionally more energy (an average of 95 percent) than any other material, and (2) energy accounts for a significant share of total aluminum production costs.

Producing virgin aluminum from bauxite requires an average of 250.7 million Btu/ton, while deriving aluminum from recycled feedstock requires only an average of 11.8 million Btu/ton.[29] Thus, secondary feedstocks yield an energy savings of approximately 95 percent.[30] To determine the net value of the subsidy to primary aluminum, we first identified industry's energy use patterns from a report on industry generated by the U.S. Department of Energy, Energy Information Survey (EIA).[31] The EIA survey characterized consumption for all of the fuel sources for every category except electricity. However, since electricity constitutes the majority of the aluminum industry's energy usage, and since the magnitudes of the subsidy vary widely by the type of electricity generation (see Table III-4), we estimated the source of electricity (fossil fuel, hydroelectric, or nuclear) for the industry. To do this, we matched state-by-state primary aluminum production capacity in 1986[32] and electricity sources.[33] Actual data are presented in Table B-2, in Appendix B. The energy mix and estimated tax subsidies to primary aluminum are presented in Table II-5.

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29 See chart in Appendix B for range and sources of estimates.

30 Robert Letcher and Mary Sheil, "Source Separation and Citizen Recycling," in William D. Robinson, ed., The Solid Waste Handbook (New York: John Wiley & Sons, 1986), cited in Stauffer, p. 59.

31 U.S. Department of Energy, Energy Information Administration, Manufacturing Energy Consumption Survey: Consumption of Energy, 1985, Washington, D.C., 1988), p. 20, November 1988.

32 U.S. Department of the Interior, Bureau of Mines, Minerals Yearbook: Volume I, Metals and Mineral, 1986, (Washington, D.C.: U.S. Government Printing Office, 1988), p. 97.

33 Operating generating capacity is current as of December 31, 1988, and is from "1989 Annual Statistical Report," Electrical World, April 1989, p. 63.

## Table II-5

## ESTIMATED ENERGY CONSUMPTION IN, AND TAX SUBSIDIES TO, THE PRIMARY ALUMINUM INDUSTRY (TAX-BASED SUBSIDIES ONLY)[34]

| Fuel Type | Estimated Consumption[a] (MBtu) | Tax Subsidy[b] (1988$/MBtu) | Total Estimated[c] Tax Subsidy |
|---|---|---|---|
| Source Fuel for Elec.:[d] | | | |
| Hydroelectric | 34.10% | $0.56 | |
| Fossil Fuel | 56.03% | $0.31 | |
| Nuclear | 9.81% | $2.08 | |
| Other | 0.06% | $0.04 | |
| | **100.00%** | | |
| Purchased Electric[e] | 210.000.000 | $0.57 | $119.432.250 |
| Residual Fuel Oil | 2.650.000 | $0.08 | $212.000 |
| Distillate Fuel Oil | 300.000 | $0.08 | $24.000 |
| Natural Gas | 23.000.000 | $0.08 | $1.840.000 |
| LPG | 1.000.000 | $0.08 | $80.000 |
| Coal | 418.000 | $0.03 | $12.540 |
| Coke and Breeze | 2.650.000 | $0.03 | $79.500 |
| Other | 10.700.000 | $0.04 | $428.000 |
| **Total** | **250,718,000** | **$0.49** | **$122,851,820** |

**Sources and Notes**

[a] Energy consumption data for the primary aluminum industry are from the U.S. Energy Information Administration, Manufacturing Energy Consumption Survey: Consumption of Energy, 1985, pp. 17, 20. Consumption figures for residual fuel oil and coke and breeze were withheld by EIA to protect proprietary data. However, the sum of the two categories, derived by subtracting all released categories from the industry total, was 5.3 trillion Btu. This figure was divided equally into the residual oil and coke and breeze categories above.

[b] Estimates were derived using the value of tax expenditures divided by the total power supplied in 1984, both from Table III-4. The derivations are shown in Appendix B, Table B-2.

[c] Estimates were derived by multiplying energy consumption by the estimated subsidy (column 2 x column 3).

[d] The fuel mix used to generate electricity used by the primary aluminum producers is based upon data on aluminum production provided in the Bureau of Mines, Minerals Yearbook, 1986, and data on state electrical generating capacity, provided in "1989 Annual Statistical Report," Electrical World, April 1989, p. 63. Plant capacity figures for fossil fuels include geothermal plants. Estimates assume that aluminum plants use the same electricity mix as the state as a whole. Derivation of electricity shares is presented in more detail in Table B-3, in Appendix B.

[e] The overall subsidy for purchased electric power by primary aluminum producers is a consumption-weighted average based on the shares of types of electricity generation shown in column two.

As shown in Table II-5, the average tax subsidy to the primary aluminum industry is $0.49 per MBtu. This value is a consumption-weighted average of all of the fuel types (and their associated tax subsidy values) used by the industry. Using this average subsidy value and the above estimates of required energy for virgin and secondary production, we derive the following estimate of the net energy tax subsidy to virgin aluminum

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[34] Table II-5 addresses only tax-based subsidies. Table III-5 is more comprehensive and includes a variety of other energy subsidies.

production. Note that this subsidy estimate assumes that secondary aluminum production uses the same energy mix as primary aluminum (and therefore has the same average subsidy).

**Tax-based energy subsidy per ton for virgin aluminum:**

Average energy use per ton virgin aluminum = 250.7 million Btu/ton
Average energy subsidy = $0.49/million Btu
Energy subsidy per ton virgin aluminum = ($0.49)(250.7) = $123/ton

**Tax-based energy subsidy per ton for recycled aluminum:**

Average energy use per ton recycled aluminum = 11.8 million Btu/ton
Average energy subsidy = $0.49/million Btu
Energy subsidy per ton recycled aluminum = ($0.49)(11.8) = $6/ton

**Net tax-based energy subsidy for virgin aluminum production:**

$123 virgin subsidy/ton - $6 recycled subsidy/ton = $117 net subsidy/ton

*Conclusion*

The average market price for aluminum for the five-year period 1984-88 was .704/lb., or $1,410/ton, delivered.[35] Therefore, the net tax-based energy subsidy for virgin aluminum production of $117/ton equals 8.3 percent of the delivered price.

*Caveats*

This estimate is subject to several caveats. First, the magnitude of the subsidy may be understated, since the delivered price for aluminum includes transport costs and producer markup. Also, this subsidy represents only energy subsidies from tax provisions. Other subsidies described in Chapter III account for a much larger share of total energy subsidies, especially for electricity production. Furthermore, it's important to underscore the key assumption of this analysis: that the full magnitude of energy subsidies from tax provisions is passed on to energy consumers (aluminum producers). Known as the "cost pass through" issue, this analysis has assumed that all cost savings are passed on to the consumer. We did this to yield a "worst case" scenario -- i.e., a maximum subsidy to the aluminum industry. However, as stated in our discussion of depletion allowances, the predominance of the international market in setting price mitigates the domestic subsidy "pass through" to energy consumers in the form of a lower price. Thus, our aluminum analysis should be viewed as a maximum scenario for the full impact of special tax provisions for the energy industry. In addition, as indicated in the following section, many tax-based financing subsidies were eliminated in 1986, thus significantly reducing the overall magnitude of federal subsidies.

**Financing Provisions**

The Tax Reform Act (TRA) of 1986 rescinded many of the incentives that were aimed at capital investment (e.g., the investment tax credit, accelerated depreciation and preferential treatment of capital gains

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[35] Prices from American Metal Market, Metal Statistics 1987 and Metal Statistics 1989, (New York: Fairchild Publications, 1987, 1989).

(see Appendix A)). The TRA also capped the amount of tax-exempt municipal bonds[36] available for supporting privately-owned and operated projects considered beneficial to the public. These policy changes removed tax subsidies that had benefitted large, highly capital-intensive endeavors.

It is unclear what impact these changes have had on recycling capacity and specifically the expansion of existing capacity or the construction of new facilities which utilize secondary materials. In some instances, the elimination of the aforementioned financing incentives may harm recycling, but not as much as it will affect other waste management options. For example, materials recovery facilities (MRFs)--which are owned and operated by both municipalities and private companies--do not require as large a capital investment as do waste-to-energy plants. In the area of integrated waste management, private activity bonds (PAB's) were used primarily to support capital-intensive projects, such as the building of a waste-to-energy facility. In this instance, removal of the financing incentives may actually have helped recycling, which competes for capital against waste-to-energy facilities.

The Tax Reform Act of 1986 restricted the use of PAB's, but it did not eliminate them. Some types of facilities are still eligible for PAB's, including all new waste processing or treatment plants handling solid waste, wastewater, sludges, or hazardous materials. This includes recycling and composting facilities, as long as the feedstock to the plant has a negative market value (i.e., the facility is paid to take the material).

Processing plants may be benefitting from lower-cost loans. However, a minimum of $1 million in plant costs would be necessary to justify the transaction costs associated with PAB's, eliminating the benefit for smaller-scale projects.[37] In addition, since there is no maximum bond issue size, large capital projects still stand to gain the most from the PAB's that remain. Finally, since scrap dealers usually pay some small amount for their inputs, they are not eligible for tax-free loans.

### Other Tax Considerations

Other federally-derived[38] tax advantages exist that, although not directed at primary producers, could benefit them more than secondary producers. An example of such a tax policy is the allowable amortization of pollution control equipment. Pollution control expenditures can be deducted from taxes and are subsidized in the tax code through shorter depreciation schedules (5 versus 7 years for most capital investments). While this subsidy may well reflect public welfare considerations, it still provides tax benefits for "dirtier" industries.

Primary producers are subject to various (primarily state) taxes. Typically, these vary substantially by state and commodity. The three main types of state taxes are:[39]

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[36] Now known as "private-activity bonds" or PAB's, these instruments were formerly known as "industrial development bonds," or IDB's.

[37] John C. MacLean "Tax Exempt Debt Financing for Privately Owned Facilities," BioCycle, August 1988, p. 62.

[38] Consideration of state-level incentives and disincentives was outside the scope of this project.

[39] Booz-Allen and Hamilton, Inc., An Evaluation of the Impact of Discriminatory Taxation on the Use of Primary and Secondary Raw Materials, pp. 17-17b. Prepared for the US EPA, 1975. NTIS # PB-240 988.

- Severance Tax: A flat-rate tax per unit mined or cut.
- Production Tax: A percentage or flat rate tax levied on the produced good, rather than on the unit removed.
- Yield Tax Laws: Function in a similar manner to a severance tax. Relieves timber owners from annual property taxes, and imposes a tax on the land at the time of timber harvest.

**Conclusions**

More current cross-elasticity estimates are needed to better gauge the impacts of virgin materials prices on recycling market quantities. However, based on available data, we can conclude the following:

- The impact of tax benefits provided by percentage depletion allowances and special expensing provisions is affected by:

  -- the predominance of the international market in setting prices for most virgin materials, including energy, and
  -- the restriction of oil and gas depletion allowances to the smaller, independent producers.

- In our simplified analysis, we found that the net tax-based energy subsidy for primary aluminum production was approximately 8.3 percent of the delivered price. Because primary processors typically consume more energy than secondary processors, this subsidy does favor the former.

- The impact of reduced financing provisions after 1986 on recycling is unclear and warrants further investigation. However, it does seem clear that reductions in the amount of municipal financing have had a negative impact on waste-to-energy units, which compete with recycling.

## III. POTENTIAL DISINCENTIVES TO RECYCLING: FEDERAL PROGRAMS

In addition to policies discussed to this point. Congress has legislated policies which in many ways support the development of virgin resources (vis-á-vis recycled substitutes) and their transport. Federal policies which support the development of virgin resources are directed toward:

- *Timber production*. in the form of below-cost timber sales;
- *Mining subsidies*, by lowering the cost and requirements for mining leases and land reclamation, respectively;
- *Energy subsidies*, through various federal programs subsidizing the construction and operation of utilities as well as provisions supporting waste-to-energy facilities under the Public Utilities Regulatory Policies Act of 1978 (PURPA);
- *Water subsidies*, as part of federal water projects and water sales; and,
- *Transportation subsidies*. through various federal programs related to the maintenance of the transportation infrastructure.

Each are discussed in more detail in the sections that follow.

### Timber Production

The federal government is directly involved in promoting and subsidizing timber production via two means. First. as the owner or manager of over 100 million acres of timberland. the federal government owns over 20 percent of all commercial timber acres in the United States.[40] Thus. below-cost timber subsidies could have an important impact on virgin material prices. The impact of timber subsidies is discussed generally below and as part of a specific "case study" (on virgin paper and paperboard production) in Chapter IV. Second. the government provides technical support in the form of land management "consulting" to the many private timber owners. We were unable to quantify the impact of this technical support.

*Below-Cost Timber Sales*

The first federal forest reserves were set aside in 1891.[41] The federal government initially supported the production of timber from federal lands to encourage the settlement and development of the West. The government's timber policy was expected to attract new settlers. provide jobs. increase industrial activity. and

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[40] U.S. Department of Commerce. "Forest Land - total and Timberland Acres." Statistical Abstract of the United States. 1989. Table 1144. The U.S. Forest Service. within the U.S. Department of Agriculture oversees the vast majority of federal forest land (88.7 million acres). the Bureau of Land Management within the Department of the Interior manages a much smaller amount of land (6 million acres all in the western U.S.).

[41] From John H. Beuter. Federal Timber Sales. Congressional Research Service. February 9. 1985. Report 85-96-ENR.

provide the impetus for the development of transportation systems. The government has continued to use timber policy as a means to a similar end with regard to economic development in southeast Alaska.[42]

Timber sales involve the transfer of ownership of timber on federal government land to private enterprise. Federal timber sales were first authorized in 1897 and the first sales were made in 1899. Below-cost timber sales subsidize the wood products industries including the operation of pulp, paper, lumber, and forest products companies. Although not all timber sales are below-cost, even those sales that do generate positive cash flow do not necessarily yield a profit to the federal land manager, an important criterion for most private market transactions.

The accounting of timber sales is fairly complex, making the calculation of gain or loss difficult. The subsidies provided by the government are found in several aspects of the transaction, including treatment of road costs, pricing timber tracts, cross-subsidization between less and more desirable timber species, allocation of administrative expenses, and export restrictions on logs. Each is discussed below.

**Treatment of Road Costs**. In many cases, the largest concentration of mature, marketable timber on federal lands is in remote, inaccessible areas that are often steep and rocky. Frequently, there is a need to build roads to reach these locations. Before 1964, the construction of roads and other means of access to these timberlands was considered part of the government's cost of making a timber sale. The National Forest Roads and Trails Act of 1964, however, provided the first legislative recognition of purchaser-built roads (i.e., roads built by the timber company rather than the government) as part of a timber sale contract. Thus, the government may pay for roads directly (by constructing or maintaining them) or benefit indirectly (by receiving roads built by the timber purchaser as partial compensation for timber). The inexact calculations of cost or benefit (related to the development of roads) ultimately yield imprecise assessments of profit or loss. Losses from timber sales may, thus, be understated.

Roads built or maintained directly by the government are financed via Congressional appropriations. They are financed much like large-scale private projects with lump-sum amounts dedicated as Congressional budget line-items. However, the Forest Service allocates only a very small portion of the total project cost in a given year's budget. For example, the Forest Service often amortizes the costs of road building over the turnover period of the stand (i.e., the time between one harvest and the next harvest of the same stand). Thus, road costs for Tongass National Forest in Alaska are amortized over 129 years, rather than the useful life of the road or the length of time during which the road will be used to harvest the current stand (as would be the normal accounting practice). The government's amortization practice allows the Forest Service to minimize the impact of road building costs on any particular year's budget.[43]

Another area in which road building costs might subsidize timber sales relates to the treatment of purchaser-built roads. There has been some disagreement about how to treat purchaser-built roads in Forest Service accounting procedures.[44] Sometimes these costs are actually treated as receipts, with the argument that since timber value is created by the road and there is a net inflow of money to the Treasury, the roads do not decrease value, but rather create it. On the other hand, many argue that road building should be treated as

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42 More detail on the history of federal timber sales in Alaska can be found in Appendix A.

43 Richard Rice, Economist, Resource Planning and Economics, the Wilderness Society, "Below-Cost Timber Sales and 'Cross Subsidies' on the Tongass National Forest." Internal memorandum to Philip Shabecoff, May 18, 1989.

44 Beuter, p. 48.

a cost, since the portion of the timber value that has been traded for the roads (bid prices are lower for no-road areas) represents foregone receipts to the Treasury. When the cost of road credits are treated as receipts, the road costs are lost to the government twice: once with a lower sale price for the timber sale, and again when the Forest Service reports the expenditure as a net receipt.[45]

**Timber Appraisal Value**. Sales of federal timber under the 1976 National Forest Management Act, and the preceding 1897 Organic Administration Act, are authorized only at or above the appraised value of the stand. Ostensibly, the purpose of these provisions is to prevent the "giving away" of a natural resource. However, neither law provides guidelines on how to calculate the appraised value. The final appraised value is the advertised rate used for setting minimum bids for the timber tracts.

The process of timber appraisal has remained virtually unchanged over the past 90 years and contains a number of components which provide industry with subsidies:

- Residual value calculation of timber value. In order to determine a reasonable asking price for a product, most industries assess the fixed and variable costs of producing a product as well as the price of competing products. The Forest Service reverses this process by starting with the market price of timber and the salable product in the stand. They then deduct the estimated costs associated with the purchaser's access, harvest, and process time. The Forest Service accounts for a reasonable rate of profit.[46] The residual of this calculation is the estimated value of the actual timber in the stand based on current market prices. As evidenced by the calculation, the advertised rate does not consider the costs incurred by the Forest Service in making a sale.

- Calculation of the base rate. Each species has a minimum sell value per thousand board feet, set by the Forest Service. The total value for a timber tract may be derived by estimating the volume of each species on a tract and multiplying it by the respective base rates. Originally, the estimate for the base rate included the Forest Service's transaction costs. However, these rates have not been adjusted upward over time to reflect the rising costs of making a sale. Today, while the base rate still forms the minimum value accepted in bids from timber purchases, it is unrelated to the market value of the timber to the Forest Service's sales-related costs. The base rate is the minimum price at which a timber tract will be sold, even if the advertised rate is lower.

- Advertised rates versus timber's worth. Advertised rates (based on the residual value calculations) and bids do not necessarily reflect what will be paid for the timber or what the federal government will earn on the sale. Advertised rates are still subject to discounts and stumpage rate adjustments for less desirable species (see cross-subsidization, below). In addition, bids do not determine revenues, since

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[45] The Forest Service has argued that 100 percent of the road building costs should not be allocated to timber sales, since the roads often have other benefits. For example, roads may reduce forest management and protection costs for future timber sales to some degree, by improving access for the thinning and caring of stands. Roads may also facilitate access to the timberlands for many other land users, which may have positive recreational benefit. However, roads may bring unexpected costs. For example, they may create -- and often in perpetuity -- costs for road maintenance and environmental protection by exacerbating problems with erosion and non-point source run-off. Furthermore, increased recreational use may exacerbate environmental problems. Finally, the presence of roads usually preempts Wilderness designation (Beuter, p. 44).

[46] Sources have noted that special federal tax provisions for virgin industries may be offset, in part, by special state or local taxes for resource extraction (e.g., royalty or yield tax, see Chapter II). For timber, federal sales include the cost of local yield taxes when calculating the advertised rates for their sales. (See Beuter, p. 56.)

the government is paid as wood is removed from the forest, and wood may be removed behind schedule or not at all.

Non-competitive bidding. On tracts such as the Tongass where there are multi-year contracts, there is no competition for cutting rights. Thus, there is no competitive bidding process, and cutting rights are priced at the minimum value. For other tracts, the winning bidder may pay the advertised rate set by the Forest Service, but will usually pay more.

**Cross-Subsidization Between Desirable and Undesirable Species.** Timber is priced not by estimated market value, but by what the Forest Service feels the average purchaser can afford to pay and still make a profit. Some species are expected to cost more to harvest than they are worth and, therefore, have a "negative appraised value." Because the timber is believed to be "worthless," the Forest Service encourages industry to harvest this timber by combining tracts containing "worthless" species with tracts of high-value timber. This combining of tracts, referred to as cross-subsidization, results in a reduction in the price charged for the high-value timber because it is offset by the negative appraisal value of the low-value stock.

By law, the Forest Service must charge at least a nominal amount, or "base rate," for harvesting each species. To meet the requirements of this law, the Forest Service sells the lower-value species at the base rate, and then reduces the sale price of the high-value species to compensate for "overcharging" on the low-value species.[47] In essence, the Forest Service is paying a lumber company to harvest the logs.

**No Allocation of General and Administrative Costs.** The operation of timber sales by the Forest Service requires efforts in both the national and regional Forest Service offices. The Service is charged with managing sustainable cuttings on federal lands to ensure healthy timber stands in perpetuity. Therefore, it must develop a harvest schedule that considers:

* The age and mix of species in a given stand;
* The value of the timber;
* The need for access to the stand;
* Concerns for community stability;
* Environmental concerns associated with the cutting of timber; and
* The salvage of damaged timber (e.g., due to insects, fires, volcanoes).[48]

General administration and overhead costs (like those associated with developing a harvest schedule) are not reflected in the price of the timber, although they can be substantial. For example, general and administrative costs for the Forest Service Region 10 offices in 1988 were $6.1 million.[49] An estimate of the planning costs associated with the management of sustainable cutting (including all Forest Service's national and regional efforts) was $144 million in 1983.[50] Depending on the species mix of a tract and the value of a particular sale, these unrecovered planning costs may exceed the tract's advertised rate and approach 5

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[47] Rice, "Timber Revenues and Expenditures on the Tongass National Forest, 1988," p. 3.

[48] Beuter, p. viii.

[49] Rice, "Timber Revenues and Expenditures on the Tongass National Forest, 1988," Memorandum, May 18, 1989. Region 10 for the U.S. Forest Service includes Alaska, Hawaii, Puerto Rico, and the U.S. Virgin Islands.

[50] Beuter, p. viii.

percent of the market value of stand.[51] A simple way to allocate these general costs would be on the basis of total volumes of timber sold in a given sale as a percentage of total regional and national sales. Private industry must include general and administrative costs in its pricing and decision-making criteria. Not including such costs for government sales reduces the acceptable selling price for the timber.

*Export Restrictions on Logs*

In 1968, U.S. Department of the Interior and the U.S. Department of Agriculture jointly issued limitations on the export of logs from federal lands in western Oregon and western Washington (Forest Service Region 6). Later that year, the Foreign Assistance Act of 1968 extended this ban to all federal land west of the 100th median (which bisects Texas and the Dakotas). Under the ban, only those species declared (by the Secretary of Agriculture and the Secretary of the Interior) to be surplus to domestic needs were available for export. This ban has been continually renewed and expanded to a virtually complete ban on the export of logs from federal timberlands.[52] In rare circumstances, the federal government has allowed exceptions to the ban for species for which there is no domestic demand and/or no domestic processing facilities.[53] To the extent that the ban limits markets for some domestic timber, it may act to artificially lower the price relative to that obtained in a free and open market. We could not quantify the impact on recycling, however.

*Technical Support from the Department of Agriculture*

The Forest Service provides various programs to help improve timber management, including fire protection, insect and disease control, and forest utilization/management. These programs seem to be used primarily by small- to medium-sized land owners.[54] Unfortunately, we could not locate more detailed information on their impact.

*Potential Impact on Recycling*

The annual cost of timber subsidies to the Treasury was estimated at between $126 million and $382 million. In terms of the U.S. paper industry, this number represents only about 4% of the value of total paper production. The effect on the paper market of these below-cost sales is further diluted by the small fraction (one-third) of the total below-cost timber that goes to paper production. Applying this number to the total, the effect of below-cost timber sales on recycling is estimated to be between $42 million and $126 million.

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51 Ibid., p. 56.

52 Ibid., p 19. Ron Lewis, USDA Forest Service, Timber Management Division, personal communication, July 21, 1989.

53 In the Tongass National Forest, for example, the Alaska Pulp Corporation, a Japanese-owned corporation, is allowed to export Alaska yellow cedar because there is little or no domestic demand for the wood, no processing facilities exist in the U.S. and it represents only 1 to 2 percent of the total harvest from the forest (Miller Ross, USDA Forest Service, Tongass National Forest, personal communication, November 6, 1990).

54 Franklin Associates, Ltd., Economic Incentives and Disincentives for Recycling of Municipal Solid Waste, Draft, (Washington, D.C.: Office of Technology Assessment, December 1988), pp. 10-11.

## Mining Subsidies

The federal government has established specific requirements for reclaiming mining lands. However, active mines developed before 1974 -- and even before 1981, in some instances -- are exempt from these costly post-closure actions.

*Below-cost Mining Leases*

While timber sales and coal, oil and gas leases may subsidize the extraction of resources, the land still belongs to the government following these actions. In contrast, the extraction of hardrock minerals is governed by the Mining Law of 1872. Provisions of this law allow a potential miner to stake a claim on federal land where valuable minerals may exist. Once a claim has been staked, the miner need only spend $100 a year on mineral exploration or development work to retain the claim forever, along with all revenues from any hardrock minerals extracted from the claim. Unlike the case with all other minerals, the claimant is not required to pay the federal government a royalty on the minerals extracted. In addition, the Mining Law's patent provision allows the claim holder to transfer property rights, both surface and sub-surface rights, to private ownership for between $2.50 and $5.00 per acre.[55] This provision has yielded the sales of 3.2 million acres of public land (an area approximately the size of Connecticut) over the last 117 years.[56]

Since the 1920's, the scope of this law has been significantly narrowed. Legislation has removed "fuel" minerals (e.g., oil, gas, and coal) and "common variety" minerals (e.g., sand, gravel, stone, and cinders) from the law's authority. Legislative action has also withdrawn more than 135 million acres (of a total 727 million acres of federal lands) from mining for use as wilderness areas and national parks. However, efforts to change the law's hardrock minerals patent and annual work provisions have not been successful.[57] These loopholes have resulted in an enormous number of claims. As of 1985, the Bureau of Land Management had recorded two million claims.[58] However, as the development of rural areas for recreational uses (e.g., skiing) has expanded, the driving force behind the "mining" acquisitions today is usually the land value for non-mining uses, such as development, rather than for mining purposes.[59]

*Absence of Land Reclamation Requirements Before 1974*

Closing a mine and reclaiming the land through re-vegetation can be very expensive and does not result in any tangible benefits to the mining company. To the extent that mining operations can avoid these

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55 Alice Rivlin, (former) Chair of the Governing Council of the Wilderness Society and Senior Fellow in the Brookings Institute's Economic Studies Program, Statement before the Senate Budget Committee, March 15, 1989, p. 9.

56 "Bumpers Moves Mining Law Reform," Weekly Bulletin, June 5, 1989, p. B4.

57 U.S. General Accounting Office, The Mining Law of 1872 Needs Revision (March 1989), p. 3. Legislation introduced by Sen. Dale Bumpers (D-Ark) would eliminate the transfer of land ownership, impose an 8 percent federal royalty on all minerals extracted in commercial quantities, and would greatly increase the annual requirements to prove that a claim is productive (Weekly Bulletin, June 5, 1989).

58 Ibid., Interior Should Recover the Costs of Recording Mining Claims, September 1986, GAO/ECED-86-217.

59 GAO reviewed 20 patents issued since 1970, for which the government received less than $4,500. The market value today was between $13.8 million and $47.9 million. Many of the lands are located near ski resorts. U.S. General Accounting Office, March 1989, pp. 3, 4.

reclamation costs, their product costs are reduced. The Forest Service has regulated post-mining land reclamation only since August 1974. Before then, mining carried out under the authority of the Mining Law of 1872 had no provisions to ensure land reclamation. Mining on lands owned by the Bureau of Land Management (BLM) have been regulated in this manner only since 1981.[60]

The U.S. General Accounting Office (GAO) estimates that, as of 1988, 424,049 acres of federal land disturbed by hardrock mining operations remains unreclaimed. Of this, 281,581 acres are situated on abandoned, suspended, or unauthorized mining operations. The estimated cost of reclaiming this land is $284 million.[61] Most of this land was mined before federal requirements for financial guarantees were initiated in 1974 (Forest Service) and 1981 (BLM). These guarantees seem to be working, with most new mines with financial guarantees being adequately reclaimed, reducing the current importance of this subsidy.[62] Even today, however, the BLM land protection requirements are much less demanding than those of the Forest Service. BLM mine sites that are less than 5 acres are not required to post financial guarantees, and even larger sites rarely have financial guarantee requirements enforced. For example, in 1986, only one of 566 BLM hardrock mining sites had posted a reclamation bond. As a result, more than one-third of the sites were left unreclaimed.[63]

## Energy Subsidies[64]

The production of saleable energy requires three main steps: extraction of fuel minerals, processing of fuel minerals, and delivery of processed fuels to point of use (e.g., a gas station or an electrical outlet in a factory). The conversion of raw materials into energy varies enormously by energy type. Therefore government subsidies may differ in applicability and magnitude by energy type, and different energy types may receive a disproportionate amount of federal support. For example, electricity, the most capital-intensive form of energy, delivered 13 percent of U.S. energy in 1984, but received 65 percent of federal subsidies (about $33 billion), reducing the average price of electricity by about 20 percent.[65]

Energy subsidies lower the cost of energy to both primary and secondary producers, but to the extent that primary production is more energy intensive (see Table II-4, for example), primary producers receive a greater subsidy for their costs of production. Energy subsidies are pervasive. In 1984, they included: 33

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60 U.S. General Accounting Office, An Assessment of Hardrock Mining Damage (April 1988), GAO/RCED-88-123BR, pp. 9, 17.

61 Ibid., General Accounting Office estimates are based on random samples from mine operations in the 11 Western states (AZ, CA, CO, ID, MT, NV, NM, OR, UT, WA, WY) where most hard rock mining takes place.

62 U.S. General Accounting Office, Financial Guarantees Encourage Reclamation of National Forest System Lands (August 1987), GAO/RCED-87-157.

63 Ibid., statement of James Duffus III, Director of Natural Resources Management Issues - Resources, Community, and Economic Development Division, before the House of Representative Subcommittee on National Parks and Public Lands, April 11, 1989.

64 All dollar figures in this section have been scaled to constant 1988 dollars using GNP implicit price deflators found in the Department of Commerce, Survey of Current Business.

65 Amory Lovins and Richard Heede, "Hiding the True Costs of Energy Sources," The Wall Street Journal, September 17, 1985, p. 28.

categories of tax expenditures, program outlays for energy development in 57 agencies, and direct loans and loan guarantees from federal agencies.[66] As Table III-1 shows, these subsidies affect all stages of energy extraction, processing, sale, and use. Subsidies that were eliminated in the Tax Reform Act of 1986 are not included in this table.

**Table III-1**

**MAJOR FEDERAL SUBSIDIES FOR THE PRODUCTION, PROCESSING, AND SALE OF ENERGY**

Fuel extraction, processing, and delivery

Extraction:
- Percentage depletion allowances*
- Expensing of drilling and exploration costs*
- Deduction for tertiary injectants for crude oil*
- Expensing of R & D expenditures*
- Credit for increasing R & D expenditures*
- Below-cost mining leases and timber sales
- Deduction for future reclamation; rapid amortization for reforestation expenditures*
- Bevill amendment exclusion of extraction waste from mining operations

Processing:
- Bevill amendment exclusion of mining wastes
- Expensing of R & D expenditures*
- Credit for increasing R & D expenditures*
- Subsidies for enriched uranium

Delivery:
- Deferral of tax on shipping companies*
- Interest exclusion for private activity bonds (PAB's) for docks and airports*
- Subsidized maintenance and development of truck, barge, and ship transport infrastructure
- Federal subsidized loans or loan guarantees on transportation projects

Utility subsidies

Plant construction:
- Tax-exempt bonding of publicly owned utilities*
- Exclusion of interest on energy PAB's*
- Exclusion of interest on state and local PAB's*
- Direct federal loans, loan guarantees, or bonding for utility construction projects
- Tax deductions for cancelled projects*

Plant operating costs:
- Price-Anderson cap on utility liability for nuclear accidents
- Incomplete accounting for nuclear plant decommissioning cost
- Federally subsidized or paid-for storage of radioactive waste
- Nuclear waste disposal R & D

Energy sales:
- Gasohol exemption from gasoline excise tax*
- Below-market sales of energy from federal projects (Tennessee Valley Authority, Bonneville Power Administration)
- Required purchase of power at above-market rates through states-level requirements allowed under PURPA

* Denotes tax-based policies, some of which are addressed in Chapter II.

Sources: Richard Heede, Rocky Mountain Institute, "Table C: 1984 Federal Energy Subsidies: Tax Expenditures - Low Estimate," 1984 data updated April 1989; "1984 Federal Energy Subsidies: Program Obligations," 1984 data updated April 1989; A Preliminary Assessment of Federal Energy Subsidies in FY 1984, testimony before the House Subcommittee on Energy and Commerce, June 20, 1985; Center for Renewable Resources, The Hidden Costs of Energy, (October 1985); "Utilities Move Closer to Nuclear Decommissioning External Trust Compliance," Public Utilities Fortnightly, March 2, 1989; Franklin Associates, Ltd., and the Center for Economic Policy Analysis, Economic Incentives and Disincentives for Recycling Municipal Solid Waste, Draft, December 1988, prepared for the Office of Technology Assessment; Cynthia Pollack, Mining Urban Wastes: The Potential for Recycling (Worldwatch Institute, April 1987).

[66] H. Richard Heede, Rocky Mountain Institute, testimony before the Subcommittee on Energy Conversation and Power of the House of Representatives Committee on Energy and Commerce, "A Preliminary Assessment of Federal Energy Subsidies in FY 1984," June 20, 1985, p. 7; Ibid., Rocky Mountain Institute, "Table C: 1984 Federal Energy Subsidies: Tax Expenditures - Low Estimate," 1984 data updated April 1989; "1984 Federal Subsidies: Program Obligations," 1984 data updated April 1989.

Because of the breadth of energy subsidies, data on the level and effect of the subsidies are difficult to find. One comprehensive assessment was performed in 1985 by the Rocky Mountain Institute, a pro-conservation research group. We have used their estimates of energy subsidies in 1984 as a starting point. Because the 1986 Tax Reform Act removed some tax subsidies to energy, we reduced the figures presented by Rocky Mountain Institute to reflect these changes. We assumed that once a tax provision was eliminated, funds would be reallocated into other, previously unused tax benefits. We then added several subsidies relating to nuclear power that were not included in the Rocky Mountain Institute study and scaled the final estimates to 1988 dollars. As shown in Table III-2, we estimated that the total annual value of federal energy subsidies in 1988 dollars is $26.7 billion.

In the next sections we describe key components of the $26.7 billion subsidy. The total subsidy estimates by energy sources are then summarized in Table III-4.

**Table III-2**

**EXAMPLES OF PROGRAM OUTLAYS SUBSIDIZING ENERGY IN FY 1984**
**(In 1988 $millions)**

| Agency | Subsidy | Major Purpose |
|---|---|---|
| Department of Energy | $3.500 | $1.74 billion spent on R&D for civilian fission; $606 million spent on R&D for civilian fusion; uses for the remainder are unknown |
| Department of Labor<br>Department of Health and Human Services | $1.600 | Black Lung Program |
| Army Corps of Engineers | $1.200 | Work allocated to the waterborne transport of oil, gas, and coal; construction, rehabilitation, operation, and maintenance of hydroelectric dams |
| Nuclear Regulatory Commission | $515 | Energy-related activities |
| Environmental Protection Agency | $233 | Estimate of work related to the environmental impact of energy |

Source: Richard Heede, A Preliminary Assessment of Federal Energy Subsidies in 1984, Rocky Mountain Institute, June 20, 1985; ibid., "1984 Federal Energy Subsidies Program obligations," 1984 data updated in April 1989

*Direct Program Outlays*

The federal government devotes significant resources each year to improve energy security and increase the state of knowledge regarding a particular energy source. While many of these expenditures may seem valuable for the nation, they are not spread evenly across all available options. This may skew private-sector research and investment patterns away from the most cost- and time-efficient options. Table III-2 presents some of the largest FY 1984 program outlays to illustrate the magnitude of Federal Loans, Loan Guarantees, and Bonding to Energy-Related Enterprises. The Federal Financing Bank offers favorable interest rates to many energy development projects through various agencies. The major costs associated with these loans are interest-rate subsidies and occasional defaults on principal repayments. These costs are off-budget and therefore are not easily identified. Table III-3 presents a summary of the estimated costs of FY 1984 loans and guarantees to energy in 1988 dollars.

**Table III-3**

**COST OF LOANS AND GUARANTEES TO ENERGY, FY 1984**
(in 1988 $millions)

| Agency | Subsidy |
|---|---|
| Tennessee Valley Authority | $880 |
| Bonneville Power Administration | $294 |
| Other Power Marketing Adminstrations | $176 |
| Rural Electrification Adminstration | $4,482 |
| Maritime Adminstration | N/A |
| Synthetic Fuels Corporation | $113 |
| Department of Energy | N/A |
| Export-Import Bank | $311 |
| **Total** | **$6,256** |

Source: Heede, June 20, 1985, p. 24.

*Other Subsidies*

We supplemented the Heede estimates of the total federal subsidy to nuclear power to include subsidies provided by the Price-Anderson Act, and subsidies related to decommissioning costs. In addition, we considered the $1.2 billion per year in federal support for uranium enrichment,[67] but assumed the subsidy to be zero, since the proportion that goes to commercial reactors rather than military use could not be determined.

The Price-Anderson Act, which limits the liability of a nuclear plant for an accident, has been estimated to reduce costs to facility operators by $11.3-$22.6 million ($1988) per reactor year.[68] With approximately 84 active nuclear reactors in the country in 1984,[69] this subsidy totals between $949 million and $1,898 million, or an average of $1,424 million annually.

The costs to decommission a spent nuclear reactor are extremely high, and only recently have they been forced into the utility rate structure. In 1984, 80 percent of reactors had an internal trust put aside to provide

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67 Weekly Bulletin, June 5, 1989, p. B13.

68 Herbert Dennenberg, Pennsylvania Insurance Commissioner, cited in the Center for Renewable Resources, The Hidden Costs of Energy (October 1985), p. 7.

69 World Nuclear Industry Handbook 1990, Nuclear Engineering International, p. 36.

for the cost of decommissioning.[70] Because the federal government may be responsible for the decommissioning of the remaining 20 percent of the reactors, this is, in effect, a subsidy.

To calculate the annual value of this subsidy, we reviewed several estimates of plant decommissioning costs. These cost estimates ranged between $50 million and $3 billion.[71] Based on our review, we selected an average cost per reactor of $1.5 billion. At $1.5 billion per reactor, the cost of decommissioning 16.8 reactors (20 percent of the 84 reactors in operation in 1984) would be $25.2 billion. In order to calculate the annual obligation needed to accumulate this $25.2 billion, we assumed the following:

Money would be set aside annually;
The lifespan of a reactor was equal to the length of its Nuclear Regulatory Commission license, or 40 years; and
An annual real interest rate of 3 percent.

Applying these assumptions, it would be necessary to dedicate $334 million each year. At the end of 40 years, the fund would total $25.2 billion.

*Other Policies that Affect the Competitiveness of Recyclables*

The Public Utilities Regulatory Policy Act of 1978 (PURPA) established one other subsidy to some waste-to-energy plants. PURPA required major utilities to purchase electricity from other generators at a price that reflects the utilities' avoided costs of expanding capacity, provided that these generators produced power through some combination of cogeneration, biomass, waste-to-energy, or other renewable source. The Act also allowed states to require that this power be purchased at an even higher rate, and a number of states do so. This increment subsidizes alternative energy sources, thereby making waste-to-energy plants (which compete against recycling) more competitive than would otherwise be the case.[72] We could not quantify this subsidy for this analysis.

*Summary*

Table III-4 presents our best-guess estimate of energy subsidies by energy type, including all sources of federal support (i.e., not just non-tax subsidies). Since tax subsidies comprised about 70 percent of total energy subsidies in 1984, the loss of subsidies, such as accelerated cost recovery, investment tax credits, expensing of construction-period interest, and capital gains treatment of coal royalties, reduced the original Rocky Mountain Institute estimates substantially.[73] However, the remaining total value of federal energy subsidies of $26.7 billion in 1988 considerably dwarfs all other subsidies discussed in this report. A better understanding of how these subsidies differentially affect primary versus secondary production would greatly

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[70] "Utilities Move Closer to Nuclear Decommissioning External Trust Compliance." Public Utilities Fortnightly, March 2, 1989, p. 21.

[71] Cynthia Pollack, Decommissioning: Nuclear Power's Missing Link (Washington, D.C.: The Worldwatch Institute, April 1986).

[72] Franklin Associates, Ltd., p. 83

[73] Eliminated statutes from Seymour Fiekowsky, Office of Tax Analysis, Department of the Treasury, personal communication, July 7, 1989.

enhance our understanding of the bulk of federal disincentives to recycling. However, conclusions in this regard are subject to the same difficulty stated in Chapter II and elsewhere -- namely, the pricing issue. Undoubtedly, recycled materials consume less energy and would benefit far less than primary producers from reduced energy costs. However, it's not clear that domestic energy subsidies are significantly translated through the price mechanism.

## Table III-4

## FEDERAL SUBSIDIZATION OF ENERGY (Millions of 1988$)

**(Using Estimates of Tax Provisions Eliminated in the 1986 Tax Reform Act)**

| | Crude Oil & NGL | Natural Gas | Coal | Synthetic Fuel | Fossil Electric | Nuclear Electric | Fusion | Hydro-Electric | Non-Hydro Renewables | End-Use Efficiency | Total (1988$) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Tax Expenditures**[a] | 1,728 | 1,388 | 542 | 32 | 1,879 | 2,305 | 0 | 610 | 484 | 131 | 9,098 |
| **Program Obligations**[b] | 2,339 | 487 | 2,222 | 226 | 405 | 2,338 | 688 | 148 | 449 | 312 | 9,613 |
| **Loans and Loan Guarantees**[c] | ? | ? | 14 | 113 | 1,816 | 4,230 | ? | ? | ? | 84 | 6,256 |
| **Other Subsidies** | | | | | | | | | | | |
| **Nuclear Decommissioning**[d] | | | | | | 334 | | | | | 334 |
| **Price-Anderson Act**[e] | | | | | | 1,424 | | | | | 1,424 |
| **Totals, in million 1988$** | 4,067 | 1,875 | 2,777 | 371 | 4,100 | 10,630 | 688 | 758 | 933 | 526 | 26,724 |
| **Power Supplied in 1984**[f] **(quadrillion Btu)** | 20.957 | 17.750 | 19.696 | 0 | 6.002 | 1.110 | 0 | 1.096 | 2.929 | 11.260 | 81 |
| **Subsidy/MBtu ($/MBtu)** | 0.19 | 0.11 | 0.14 | 0 | 0.68 | 9.58 | 0 | 0.69 | 0.32 | 0.05 | 0.33 |

* All estimates are 1984 subsidy amounts scaled to constant 1988 dollars using GNP implicit price deflators found in the Department of Commerce, Survey of Current Business. Subsidies do not include $1.2 billion per year in federal uranium enrichment expenditures, since the proportion that goes to commercial reactors rather than military use could not be determined (Weekly Bulletin, June 5, 1989, p. B13).

Sources and Notes:

[a]Richard Heede, Rocky Mountain Institute, "Table C: 1984 Federal Subsidies: Tax Expenditures - Low Estimate," 1984 data updated April 1989. Tax subsidies were updated to reflect existing tax laws using the following sources: Seymour Fiekowsky, U.S. Department of Treasury, personal communication, June 28, 1988; Jeff Jacobsen, Internal Revenue Service, Personal communication, September 25, 1989, Tax Management, Inc. The Tax Reform Act of 1986: Volume II, Detailed Analysis, 1987; Department of the Treasury, Internal Service, Internal Revenue Cumulative Bulletin 1986-3: Volume 4, Conference Report 99-841; John MacLean, "Tax Exempt Debt Financing for Privately Owned Facilities," BioCycle, August 1988; Mark Battersby, "Financing Under the Tax Reform Act of 1986," Resource Recycling, January/February 1987; Jerry Powell, "Tax Reform: What's the Effect on Recycling," Resource Recycling, November/December 1986.

[b]Richard Heede, "1984 Federal Energy Subsidies: Program Obligations," 1984 updated April 1989.

[c]Loan and loan guarantee subsidies are government costs for subsidized interest rates, defaults on principal payments, and overhead for operating the loan program. Data are from Richard Heede, A Preliminary Assessment of Federal Energy Subsidies in FY 1984, testimony before the House Subcommittee on Energy Conservation and Power of the Committee on Energy and Commerce, June 20, 1985, p. 24.

[d]Nuclear decommissioning cost subsidy estimates are based on per reactor cost estimates from "Utilities Move Closer to Nuclear Decommissioning External Trust Compliance," Public Utilities Fortnightly, March 2, 1989, p. 21. Estimates represent the 20 percent of the industry that has not yet established any form of decommissioning trusts (utilities with internal trusts rather than the external trusts required by the NRC were not included), and were scaled to 1988 dollars.

[e]Price-Anderson Act subsidy estimates are from Herbert Dennenberg, Pennsylvania Insurance Commissioner, cited in the Center for Renewable Resources, The Hidden Costs of Energy, October 1985, p. 7. Dennenberg estimates $10 - $20 million per reactor in 1984 dollars (or $11.3 - $22.6 million year in 1988 dollars). For 84 reactors, the subsidy ranges from $949 - $1,989 million, or an average of $1,424 million per year.

If we examine Table III-4, it is apparent that tax subsidies alone account for only a portion of total federal energy subsidies. We repeated the analysis of energy subsidies in the aluminum industry, but this time included all energy subsidies. Table III-5 reports energy consumption and subsidies to the aluminum industry. It includes the same data as Table II-5, but the subsidies are higher to reflect not only tax-based subsidies but many of the subsidies discussed earlier in this chapter as well.

**Table III-5**

**ESTIMATED ENERGY CONSUMPTION IN, AND SUBSIDIES TO, THE PRIMARY ALUMINUM INDUSTRY (ALL SUBSIDIES)**

| Fuel Type | Estimated Consumption[a] (MBtu) | Estimated Subsidy[b] (1988$/MBtu) | Total Estimated[c] Subsidy |
|---|---|---|---|
| Source Fuel for Elec.:[d] | | | |
| Hydroelectric | 34.10% | $0.69 | |
| Fossil Fuel | 56.03% | $0.68 | |
| Nuclear | 9.81% | $9.58 | |
| Other | 0.06% | $0.10 | |
| | **100.00%** | | |
| Purchased Electric[e] | 210,000,000 | $1.56 | $326,791,920 |
| Residual Fuel Oil | 2,650,000 | $0.19 | $503,500 |
| Distillate Fuel Oil | 300,000 | $0.19 | $57,000 |
| Natural Gas | 23,000,000 | $0.11 | $2,530,000 |
| LPG | 1,000,000 | $0.19 | $190,000 |
| Coal | 418,000 | $0.14 | $58,520 |
| Coke and Breeze | 2,650,000 | $0.14 | $371,000 |
| Other | 10,700,000 | $0.10 | $1,070,000 |
| Total | 250,728,000 | $1.34 | $335,975,520 |

Sources and Notes

[a] Energy consumption data for the primary aluminum industry are from the U.S. Energy Information Administration, Manufacturing Energy Consumption Survey: Consumption of Energy, 1985, pp. 17, 20. Consumption figures for residual fuel oil and coke and breeze were withheld by EIA to protect proprietary data. However, the sum of the two categories, derived by subtracting all released categories from the industry total, was 5.3 trillion Btu. This figure was divided equally into the residual oil and coke and breeze categories above.

[b] Initial estimates were provided by Richard Heede, Rocky Mountain Institute, to reflect 1984 data which he revised in 1989. These, in turn were updated by Temple, Barker & Sloane, to reflect changes brought about by the Tax Reform Act of 1986. Estimates were scaled to constant 1988 dollars using implicit price deflators for the Gross National Product, found in the Department of Commerce, Survey of Current Business.

[c] Derived by multiplying energy consumption by the estimated subsidy (column 2 x column 3).

[d] The fuel mix used to generate electricity used by the primary aluminum producers is based upon data on aluminum production provided in the Bureau of Mines, Minerals Yearbook, 1986, and data on state electrical generating capacity, provided in "1989 Annual Statistical Report," Electrical World, April 1989, p. 63. Plant capacity figures for fossil fuels include geothermal plants. Estimates assume that aluminum plants use the same electricity mix as the state as a whole. Derivation of electricity shares is presented in more detail in Table B-3, in Appendix B.

[e] The overall subsidy for purchased electric power by primary aluminum producers is a consumption-weighted average based on the shares of types of electricity generation shown in the second column.

Including tax and non-tax benefits, the average subsidy to the primary aluminum is $1.34 per MBtu.[74] This value is a consumption-weighted average of the tax subsidies associated with each of the energy types used by the industry. Using this average subsidy value, and the estimates presented in Chapter II of required energy for virgin and secondary production, we derived a net subsidy estimate for the primary aluminum industry.

**Energy subsidy per ton for virgin aluminum**:

Average energy use per ton - virgin aluminum = 250.7 million Btu/ton
Average energy subsidy = $1.34/million Btu
Energy subsidy per ton = ($1.34) (250.7) = $336/ton

**Energy subsidy per ton for recycled aluminum**:

Average energy use per ton - recycled aluminum = 11.8 million Btu/ton
Average energy subsidy = $1.34/million Btu
Energy subsidy per ton = ($1.34) (11.8) = $16/ton

**Net energy subsidy for virgin aluminum production**:

$336 virgin subsidy/ton - $16 recycled subsidy/ton = $320 net subsidy/ton

As reported in Chapter II, the current market price for aluminum is $1,410/ton, delivered. Therefore, the net energy subsidy for virgin aluminum production equals 22.7 percent of the delivered price.

*Caveats*

As with the estimate in Chapter II, this estimate is subject to a number of caveats. First, the magnitude of the subsidy may be understated, since the delivered price for aluminum includes transport costs and producer markup. Second, as explained in Chapter II, the magnitude of the subsidy is overstated due to the "cost pass-through" issue. Cost savings resulting from energy program subsidies may not be reflected in prices due to the dominance of the international market in setting price. Consequently, subsidies to production are usually income transfers more than reduced prices to final consumers. It is this caveat that makes our results overstate the amount of total subsidies actually accruing to the energy consumer, as opposed to being retained by the utility.

## Federal Subsidies for Water

As was the case with early timber subsidies, water projects were initiated in large part to speed the development of the western and southwestern parts of the country where arid climates served as the major limiting factor to these areas supporting significant human populations. Although federal water sales are initiated mainly by the Bureau of Land Management within the Department of the Interior, 18 federal agencies currently exercise some responsibility for water programs and projects. There are at least 25

[74] In contrast, the average subsidy arising from taxes only amounted to $0.49 per million Btu.

separate water programs with 70 separate Congressional appropriations accounts. These programs are governed by over 200 federal rules, regulations, and laws.[75]

In order to achieve its development goals for may parts of the nation, the federal government has historically subsidized water deliver and consumption via three means. First, the federal government has paid for many water control and delivery systems through direct disbursements and through highly subsidized loans with lenient payback schedules. Special provisions for federally sponsored water projects include no charge for interest, repayment periods of up to 60 years, and the use of an "ability to pay" criterion (as opposed to a consumption-based approach[76]) in determining the share of costs that beneficiaries would bear. Second, long-term contracts for water sales on water delivered from these projects (which may span forty years) are generally written for prices below the government's delivery costs. Finally, water pricing by water utilities is targeted at recovering fixed plus variable expenses plus a profit. Pricing policies do not have any incentive mechanism which might force the consumer to pay a greater price for greater consumption. Such a pricing mechanism would relate consumption to the utility's future efforts to replace the used water. Currently, because of low-cost delivery and sale, water consumption may remain high (even in areas where non-replaceable water reserves are being depleted), and relatively inexpensive technologies to improve water efficiencies may not be adopted. The total current federal expenditures on water-related programs and projects exceeds $5 billion annually.[77]

*Impacts of Water Subsidization on Industry*

Federal water subsidies may have significant adverse impacts on recycling industries. Like energy, recycling generally requires less water than does virgin production. The four largest industrial users of water are the steel manufacturing, chemical and allied products, paper and allied products, and petroleum refining industries.[78] These industries compete with entities which recycle scrap metal, plastics, paper and used oil, respectively. These recycling activities can yield water savings (vis-a-vis the virgin analogues) that can reach as high as 58 percent.[79] Moreover, primary petroleum refineries, utilities and mining operations are able to reduce energy costs and capitalize on what may be an indirect federal subsidy by consuming large volumes of water. This substitution of less costly water for more costly energy could further hinder the competitiveness of recyclables.

The impact of direct water subsidies on recyclables is affected by a number of factors. Primarily, the largest water subsidies are found in areas where very little of the water is used for industrial production. Water is most heavily subsidized in the western and southwestern United States where nearly 91 percent of

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75 Charles H. W. Foster and Peter P. Rogers, "Federal Water Policy: Toward an Agenda for Action," discussion paper E-88-05 of the Energy and Environmental Policy Center, Kennedy School of Government, August 1988, p. 9.

76 Sandra Postel, Conserving Water: The Untapped Alternative (Washington, D.C.: The Worldwatch Institute, September 1985), p. 47.

77 Foster and Rogers, p. 9.

78 Wayne Solley, Charles Merk, and Robert Pierce, Estimated Use of Water in the United States in 1985, U.S. Geological Survey Circular 1004, 1988, p. 30.

79 Estimated water savings from recycling are 40% for steel, 50% for glass, and 58% for paper. See Robert Cowles Letcher and Mary Sheil, "Source Separation and Citizen Recycling," in William D. Robinson, ed., The Solid Waste Handbook (New York: John Wiley & Sons, 1986).

the subsidized water is used for irrigation. California and Idaho alone account for 37 percent of all water used for irrigation, nationally.[80] While many of the water subsidies are intended to support agriculture, even if they were available for all uses, their impact on recycling would most likely be limited. In the nine western water regions,[81] 79.4 percent of all fresh water consumed is used for irrigation. This figure increases to 81 percent if livestock watering is included. Industrial use in these regions comprises just 2.0 percent of all fresh water used.[82]

Use of water for thermoelectric cooling represents the single largest withdrawal use nationwide. Virtually all of the water used for cooling (99 percent) comes from surface water sources, and an even larger percentage is self-supplied by the utilities. Generally, utilities must have a permit to access this water, as well as a discharge permit to control any potential pollutant problem (e.g., thermal, radioactivity, corrosion inhibitors). However, utilities usually do not pay directly for the use of water, although regulations vary by state.[83] While 97 percent of the water is returned to the original surface waterbody after use,[84] the cost free use of water may be viewed as a subsidy to energy production, although we have not quantified it's impact.

Use of subsidized water for mining operations could also adversely impact recycling industries. However, "except for some washing and milling, water used at mining sites tends to be an impediment to, or a byproduct of, the extraction process."[85] All water used in mining is self-supplied, and regulated at the point of discharge rather than the point of withdrawal. To the extent that free use of self-supplied water is viewed as a subsidy, prices of the resulting energy or minerals may be subsidized.

Even if water usage was subsidized or free, pollution control requirements dramatically increase the costs of consumption. Restrictions on allowable discharges seem to be the force that is currently driving industrial water usage rates. More stringent restrictions have led to continued increases in water recycling rates since the 1950's. As shown in Table III-6, despite whatever subsidies may exist for water use, water recycling rates for all manufacturing sectors have risen from 1.82 in 1954 to 8.63 in 1985. Pollution control regulations may have played an important role in encouraging this conservation.

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80 Solley et al., p. 23.

81 Missouri Basin, Arkansas-White-Red, Texas-Gulf, Rio Grande, Upper Colorado, Lower Colorado, Great Basin, Pacific Northwest, and California.

82 Percentages are derived from data in Solley et al., passim.

83 Wayne Solley, personal communication, July 6, 1989.

84 Solley et al., p. 38.

85 Figures represent the number of times each unit of water is used within the manufacturing process before being discharged.

**Table III-6**

**WATER RE-USE RATES IN U.S. MANUFACTURING INDUSTRIES, 1954-78 (with projections for 1985 and 2000)**

| Year | Paper and Allied Products | Chemical and Allied Products | Petroleum And Coal Products | Primary Metal Industries | All Manufacturing |
|---|---|---|---|---|---|
| 1954 | 2.38 | 1.60 | 3.33 | 1.29 | 1.82 |
| 1959 | 3.12 | 1.61 | 4.38 | 1.53 | 2.16 |
| 1964 | 2.66 | 1.98 | 4.41 | 1.46 | 2.13 |
| 1968 | 2.90 | 2.10 | 5.08 | 1.55 | 2.31 |
| 1973 | 3.37 | 2.66 | 6.36 | 1.79 | 2.89 |
| 1978 | 5.30 | 2.89 | 6.98 | 1.91 | 3.42 |
| 1985 | 6.64 | 13.19 | 18.33 | 5.99 | 8.63 |
| 2000 | 11.84 | 28.03 | 32.73 | 12.31 | 17.08 |

NOTE: The figures above represent the number of times, on average, each unit of water is used within the manufacturing process before being discharged.

Sources: U.S. Department of Commerce, Bureau of the Census, Water Use in Manufacturing, 1981. Projections for 1985 and 2000 from Culp et al., Water Reuse Recycling, Evaluation of Needs and Potential, Volume 1, Department of the Interior. Statistics cited in Sandra Postel, Conserving Water: The Untapped Alternative, The Worldwatch Institute, September 1985.

*Potential Impact on Recycling*

Federal water subsidies do not seem to be a significant factor in inhibiting recyclables in the marketplace. The highest subsidies support uses that do not compete with recyclable products (e.g., agriculture). In addition, the largest industrial users of water tend to be located along water sources to facilitate inexpensive use of self-supplied water for processing. This use is not affected by federal subsidies, although the fact that users usually do not pay the municipality for water rights may subsidize the resulting product price. The practice by utilities of pricing water below replacement cost may slightly reduce the cost of virgin production, although the magnitude is not known.

## Transportation Subsidies

Transportation is an integral part of any manufacturing or re-manufacturing process. Raw materials -- either virgin or secondary -- need to be transported from the point of supply to the point of their use. This can be a significant component of production costs. Subsidies to different transportation sectors may alter the shipping decisions that are made by factories, shipping goods or materials using a method that is more expensive or less efficient than the method that would be chosen with no subsidies. Because virgin industries are generally located in closer proximity to the natural resource feedstock than to their markets, it is possible that they receive some marginal benefit from these subsidies relative to their recycling counterparts.

*Subsidies to Rail Transport*

Historically, there has been concern that recyclers shipping by rail were subject to discriminatory freight rates against recyclables relative to virgin feedstocks and products, and that such discriminatory pricing put them at a competitive disadvantage. Our general findings do not indicate that this concern is valid with respect to federal regulation.

Railroad rates for both inter- and intra-state transport are governed by the Interstate Commerce Commission (ICC).[86] In the 1970's, there was much debate regarding discriminatory pricing for transport of secondary materials, and in 1977, Congress ordered the ICC to conduct a study on this topic. The initial results, made available in February 1977, indicated that there was discriminatory pricing against reclaimed rubber, copper matter, zinc dross, aluminum residues, cullet (glass scrap), and miscellaneous non-ferrous residues.[87]

In 1978, the National Association of Recycling Industries and the Institute of Scrap Iron and Steel challenged the results of this study in court, resulting in a new study that was completed in April 1979. The results of this analysis showed that discriminatory pricing was found in parts of the country against ferrous metals, aluminum scrap, and wastepaper.[88] While the courts ordered that such discriminatory pricing cease within 90 days, action was so slow that the affected industries sought legislative changes.

The Staggers Rail Act of 1980, Section 10731, ordered the ICC to determine a revenue-to-variable cost ratio for all non-ferrous recyclable or recycled materials that was less than or equal to the average revenue-to-variable cost ratio necessary to "provide a sound transportation system in the United States." The ICC determined that a revenue-to-variable cost ratio of 146 percent was a reasonable cap for recyclable materials.

The ferrous industry was excluded from Section 10731 because it opted not to be included in this provision. At the time of the Staggers Act, and even today, rail freight rates for ferrous materials were low, and a cap may have actually increased rates.[89] Based on a recent conversation with the Institute for Scrap Recycling Industries, discriminatory rates in transportation are not a major concern of members today.

*Other Subsidies to Transportation*

If virgin materials production relies more heavily on transportation than secondary materials, additional federal policies may subsidize primary production. For example:

Highway construction costs are paid primarily by highway users. The Federal Highway Trust Fund was created by Congress to facilitate the necessary financial support. This Trust Fund is financed in large part, through a portion of fuel taxes. However, a sizable portion of highway construction is paid

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[86] History information is from Senator Joseph L. Bruno, Legislative Commission on Solid Waste Management, Incentives for Recycling, January 1988, pp. 10-13.

[87] Interstate Commerce Commission, Investigations of Freight Rates for the Transportation of Recyclables or Recycled Commodities, Ex Parte 319, Washington, DC, 1977.

[88] Interstate Commerce Commission, Ex Parte 319, Sub-No. 1, Washington, DC, April 16, 1979.

[89] Personal communication with Deb Levin, Institute for Scrap Recycling Industries, June 1, 1989.

via direct state and federal funding. Between 1991 and 1995, taxes from highway users are estimated to provide $71.5 billion to the highway account of the Highway Trust Fund. Over the same period, $81.5 billion is projected to be spent on current highway programs,[90] representing a net shortfall of $10 billion. The general taxpayer will pay the difference and not the highway user. Thus, this method of financing acts as a subsidy to the major users of the road system.

- Inland water transportation, mainly by barge, is used extensively to move bulk items (such as oil) within certain parts of the United States. Operating, maintaining, and developing the inland waterway system in this country was estimated to cost $700 million in 1990. Operation and maintenance costs (such as for locks, dams, and maintenance dredging) accounted for approximately $300 million, and new construction costs were expected to account for the remaining $400 million. These costs are not typically borne by the users, thus the $700 million acts as a federal subsidy to barge transport.[91]

- Ports must be maintained so that the channel depths are sufficient to support the desired type of shipping. United States ports are maintained by the Army Corps of Engineers, which provide this service for 180 ports at the cost of nearly $500 million per year. Only about 30 percent of this cost is recovered through a tax on the value of commercial cargo loaded or unloaded at ports that are not part of the Inland Waterway System.[92] The remaining 70 percent of the costs, or $350 million per year is a subsidy to the users of these ports.

- The Coast Guard provides numerous services for civilian navigation, including aids to navigation (e.g., buoys and channel markings, search and rescue services, and marine safety programs). These services account for nearly half the Coast Guard's operating budget, or about $910 million in 1989. An additional $80 million annually is appropriated for related capital expenditures on marine safety and navigation program,[93] for a total of $990 million. Almost all these costs are borne by the general taxpayer, and thus represent a subsidy to civilian navigation and to the commercial shipping industry in particular.[94]

*Impacts on Recycling*

The total subsidy to transportation provided within these four categories is slightly over $4 billion annually. Their impact on recycling depends upon the relative use of transportation modes by virgin versus secondary industries. Because virgin industries are generally located close to the natural resources, and therefore farther away from their markets, it is likely that they receive some marginal benefit over recycling industries from transportation subsidies. Secondary materials, at the same time, require additional transportation for collection and processing. The relative advantages will vary by plant and possibly by commodity as well. A number of federal policies affecting road, rail, inland waterway, and ocean shipping

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90 Congressional Budget Office, Reducing the Deficit: Spending and Revenue Options (February 1990), p. 277.

91 Ibid., p. 272; T. Allan Comp, ed., Blueprint for the Environment, 1989, pp. 332-33.

92 Congressional Budget Office, p. 244.

93 Ibid., CBO; p. 275.

94 Ibid., CBO, p. 275.

have been identified. While we did locate some estimates of the overall magnitude of transportation subsidies, we were not able to estimate the net impact on recycling.

## Conclusions

*Timber subsidies*

In comparison to the size of the U.S. paper market, below-cost timber sales comprise approximately 4% of total production in the United States. Thus, timber subsidies should not have a significant impact on timber prices.

*Mining Subsidies*

Below-cost mining leases are the major non-tax subsidy currently available for minerals development. Based on available information, it appears that most of these leases are used today because of speculation on the value of the land, and not the minerals. Thus, at present, below-cost mining leases appear to have only a minimal impact on the reclamation of minerals.

*Energy Subsidies*

There are numerous federal policies which act as subsidies and encourage development of energy resources. These programs totalled a staggering $26.7 billion in 1988. Inasmuch as primary production is far more energy intensive than secondary production, these subsidies almost certainly provide a disincentive to recycling. However stating the precise magnitude of this disadvantage is difficult, due to the international derivation of energy prices.

*Water Subsidies*

Water is subsidized primarily for agricultural uses in areas of the country with low industrial development. Thus, we would not expect that water subsidies would have any significant impact on recycling for the commodities of concern. The most significant impact could result from some water utilities using pricing schemes that do not include replacement costs.

*Transportation Subsidies*

Rail transportation rates, since the Staggers Rail Act of 1980, do not seem to discriminate against secondary industries. Other modes of transportation receive subsidies for maintenance and construction. While in each case some of the money to support the transportation network is paid by the industry, some subsidies come from general revenues. The impact of these subsidies on recycling is unclear because we do not know if primary producers, on balance, rely more heavily on transportation than do secondary producers.

## IV. THE MAGNITUDE OF FEDERAL SUBSIDIES: CASE STUDY OF THE PAPER INDUSTRY

### Industry Overview

In 1986, the United States consumed 78.8 million tons of paper and paperboard. Of this, about 22.3 million tons, or approximately 28 percent of total use (including converting scrap),[95] were recovered for recycling, with much of the remainder sent to landfills for disposal.[96] Paper and paperboard discards in 1986 constituted 35.6 percent (by weight) of the municipal waste stream, the largest category of discards.[97]

The paper and paperboard industry in the U.S. includes about 600 paper and paperboard mills, of which about 200 mills use feedstocks comprised of only reclaimed paper.[98] Another 300 mills use at least some wastepaper in their manufacture of paper and paperboard.[99] Overall rates of the domestic industry's use of wastepaper have been edging slowly upwards over time. For example, the proportion of recyclable paper consumed to total paper and paper board production rose from 22.8 percent in 1970 to 25.0 percent in 1987, an increase of only 2.2 percentage points (or 9.6%) in 18 years. Including exported wastepaper, this figure increases to 28.5 percent in 1987.[100] However, both of these use rates include converting wastes (i.e., wastes created during paper processing at the mills).

In 1986, post-consumer paper recovery as a percent of gross discards stood at 22.6 percent. Table IV-I presents the recovery rates for various types of paper. The post-consumer recovery rates are highest for corrugated paper and newsprint. Printing and writing papers, which account for the highest consumption, have a below-average recycling rate of 21.9 percent.

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95 Converting scrap refers to production wastes that are recycled before ever reaching a consumer, as compared to post-consumer paper products that are recycled after they have been used by the consumer.

96 See Table IV-1. See also "The Federal Paper Guideline," Waste Age, October 1988, p. 158. More recent data indicate that in 1988 recovery was over 30 percent at 26.2 million tons (Franklin Associates, Ltd., Paper Recycling: The View to 1995 Summary Report, prepared for the American Paper Institute, February 1990, Table 1-2).

97 U.S. EPA, The Solid Waste Dilemma: An Agenda for Action, p. A.A-2, from U.S. E.P.A., Characterization of Municipal Solid Waste in the United States, 1960 to 2000 (Update 1988), March 20, 1988. Note that this percentage increased to 37.5 % in 1990 (U.S. E.P.A., Characterization of Municipal Solid Waste in the United States: Update 1992, July, 1992.)

98 Cynthia Pollack, Mining Urban Wastes: The Potential for Recycling (Washington, D.C.: The Worldwatch Institute, April 1987), p. 22. According to the American Forest and Paper Association (AFPA) the number of mills has decreased to 547. The number of mills that use solely reclaimed paper as a feedstock remains at about 200. Recent estimates indicate that more than 425 mills use at least some wastepaper in their manufacturing processes. Personal conversation with AFPA, June 1, 1994.

99 American Paper Institute, "Facts About Waste Paper Recycling/(pamphlet)", 1988.

100 American Paper Institute (henceforth cited as API), "Recyclable Paper Utilization and Recovery," 1988 Statistics of Paper, Paperboard, & Wood Pulp New York, 1988), p. 50.

## Table IV-1

## SUMMARY OF CONSUMPTION, DIVERSIONS AND RECOVERY, AND NET WASTE DISCARDED FOR PAPER AND PAPER AND PAPER PRODUCTS, 1986

**(In thousand short tons and percent)**

| Paper Category | Consumption | Converting Scrap | Diversion | Gross Waste Discarded | Total Recqvery | Post-Consumer Waste Recovery | Net Waste Discarded | Total Recovery (as a % of consumption) | Post-Consumer Recovery (as a % of gross discards) |
|---|---|---|---|---|---|---|---|---|---|
| Paper | | | | | | | | | |
| Newsprint | 12,994 | 325 | 63 | 12,606 | 4,125 | 3,800 | 8,806 | 31.7% | 30.1% |
| Printing-Writing Papers | 21,989 | 2,618 | 1,347 | 18,024 | 4,806 | 2,188 | 15,836 | 21.9% | 21.1% |
| Paper Packaging and Industrial Converting | 5,076 | 254 | 289 | 4,533 | 514 | 260 | 4,273 | 10.1% | 5.7% |
| Tissues | 5,144 | 257 | 1,906 | 2,981 | 257 | 0 | 2,981 | 5.0% | 0.0% |
| Total Paper | 45,203 | 3,454 | 3,605 | 38,144 | 9,702 | 6,248 | 31,896 | 21.5% | 16.4% |
| Paperboard | | | | | | | | | |
| Containerboard (corrugated) | 21,604 | 2,160 | 0 | 19,444 | 10,160 | 8,000 | 11,444 | 47.3% | 41.1% |
| Boxboard and Other Paperboard | 10,963 | 1,864 | 2,002 | 7,097 | 2,264 | 400 | 6,697 | 20.6% | 5.6% |
| Total Paperboard | 32,567 | 4,024 | 2,002 | 26,541 | 12,424 | 8,400 | 18,141 | 39.0% | 31.6% |
| Construction Paper | 2,046 | 143 | 1,903 | 0 | 143 | 0 | 0 | 7.0% | 0.0% |
| TOTAL | 78,816 | 7,621 | 7,510 | 64,685 | 22,269 | 14,648 | 50,037 | 27.0% | 22.6% |
| Percent of Total Consumption | 100% | 9.5% | 9.4% | 81.0% | 27.9% | - | 62.7% | - | - |

* Includes converting scrap.

Sources: American Paper Institute (consumption); Franklin Associates, Ltd., Characterization of Municipal Solid Waste in the United States, 1960 to 2000, Working Papers, Part E. From U.S. EPA, "Appendix A: Paper," The Solid Waste Dilemma: An Agenda for Action.

The rate of growth in wastepaper use is slight when compared to the rapid growth in wastepaper exports, which increased more than tenfold over the same 1970-87 period.[101] Additionally, wastepaper use rates in Japan and most of Western Europe are substantially higher than those in the United States.[102]

The slow growth in domestic consumption of wastepaper is difficult to understand, since a number of production factors favor recycled production relative to virgin production. Paper production from recycled pulp can save both energy and water. In addition, large population centers provide both major sources of wastepaper and major markets for recycled products. This should reduce transportation costs relative to virgin production. Finally, recycling mills tend to be smaller-scale operations than virgin mills, and are therefore less expensive to build.

A number of factors have been suggested as causes for the slow growth in the utilization of post-consumer wastepaper. These include:

- A volatile and irregular supply of wastepaper;
- Federal subsidies for virgin production;
- Low pulp costs in the United States compared to more expensive pulp in the countries to which we export wastepaper; and,
- Product specifications that make the use of recycled wastepaper difficult or impossible.

To some degree, all of the above factors probably play a role in the use rate of recycled paper. However, this chapter examines only the impact of federal subsidies on the costs of producing virgin paper, and the resulting effect on paper recycling. Specifically, we focus on six federal programs identified in Chapters II and III that apply to virgin pulp production: *federal tax policies*, *below cost timber sales*, *energy subsidies*, *water subsidies*, *federal pollution control requirements*, and *export restrictions*.

## Method

To measure the impact of the federal subsidies, we computed the size of each subsidy and then compared the level of subsidization with a measure of production costs in the paper and paperboard industry. This approach relies on two simplifying assumptions.

First, we assumed that federal subsidies that reduce the cost of factors of production (e.g., percentage depletion allowances for independent oil and gas producers) are passed through as lower energy prices, not retained as increased profits by the primary beneficiary. In other words, if an energy subsidy amounting to 19

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[101] API, "Recyclable Paper Utilization and Recovery," p. 50.

[102] Pollack, p. 26.

cents per million Btu were implemented, the price of energy would fall by 19 cents per million Btu.[103] Conversely, if the subsidy were removed, the price of energy would rise by the same amount.

The second assumption was that decreases in virgin material production costs (brought about by subsidies) adversely affect the share of recycled versus virgin inputs, and that the removal of the subsidies would increase the price of virgin paper and paperboard products, compared to those made from recycled fiber.

One additional comment on method relates to the measurement of impacts; we compare the subsidies to the cost of materials for those portions of the paper and paperboard industry (Standard Industrial Classification, or SIC 26) that produce or use pulp as a raw material. We included SICs 261 (pulp mills), 262 (paper mills except building paper), 263 (paperboard mills), and 266 (building paper and board mills). We excluded SICs 264 (miscellaneous converted paper products) and 265 (paperboard containers and boxes) because they purchase paper or paperboard for fabrication or conversion. Because their cost of materials included purchases of finished products from these other sectors, it would be inappropriate to incorporate that cost.

The industries analyzed expended $25.8 billion for materials in 1988.[104] We used total cost of materials as the basis for our impact analysis because it provided an aggregate estimate of expenditures on the industry inputs that receive federal subsidies. Once paper mills are constructed, it is relatively expensive to switch from trees (virgin pulp) to wastepaper (recycled pulp) as a feedstock, because of different equipment requirements and because plant locations are chosen so as to minimize the costs of obtaining the raw materials for which the plant was initially built. The substantial capital investments required for a mill are presumably based on the likely production costs of using either recycled or virgin raw materials and the demand for the final products. Because one of the main factors influencing capital decisions is the cost of inputs, it is appropriate to examine the impact of the subsidies on the total cost of production.

### Federal Tax Policies

Federal tax policies favoring virgin timber production fall into two main categories: tax benefits for timber production and harvesting, and tax benefits for plant construction, in the form of private activity bonds (PAB's). These categories will be addressed separately.

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[103] For some factors, subsidies may only result in increased profits because prices are set on a broader market (e.g., a world price for oil). In these cases, our approach will overstate the impact that a subsidy has on prices and, therefore, on the choice of inputs to production.

[104] U.S. Department of Commerce, Bureau of the Census, 1987 Census of Manufactures, Preliminary Report, Industry Series: Pulp, Paper, and Board Mills, August 1989. 1987 data were scaled to 1988 using the producer price index for pulp, paper, and allied products (SIC 26), found in U.S. Department of Commerce, Survey of Current Business, August 1989. SIC 266 (building paper and board mills) was not included as a category in the 1987 Census, and therefore was only partially included in our cost of materials figure. We do not believe that this introduces any serious errors for two reasons. First, SIC 266 in the 1986 Annual Survey of Manufactures represented only 2.2 percent of the cost of materials for SICs 261, 262, 263, and 266. In addition, all construction papers have been reclassified into SIC 2621, and are therefore included in our estimate. Only insulating papers, reclassified under SIC 2493 (reconstituted wood products) are not included. However, the Bureau of the Census at this time had no more specific information regarding what proportion of SIC 2493 was previously classified as SIC 266. (Al Forman, Bureau of the Census, personal communication, October 11, 1989).

Tax Benefits for Timber Production and Harvesting

Current tax policies subsidizing the production and harvest of timber include three major provisions: expensing of multi-period growing costs, reforestation investment tax credits, and 7-year amortization of reforestation expenses.[105] The benefit to the timber industry from expensing of multi-period timber growing costs was $256 million in FY 1988; reforestation investment tax credits and rapid amortization that year provided the industry with an additional $203 million subsidy.[106] Total tax subsidies for timber production and harvesting in FY 1988, therefore, were $459 million.

Only a portion of these subsidies is available to the paper and paperboard industry, however. The most recent data we collected indicates that 33.1 percent of total timber harvests is converted into pulp products.[107] We therefore assumed that an equal share of the tax subsidies could be attributed to timber harvests for pulping purposes. Thus, 33.1 percent of the $459 million subsidy, or $152 million in tax benefits, goes to virgin paper and paperboard production. Assuming conservatively that this entire savings is passed on to the paper manufacturer, rather than retained by the timber producer, savings from these tax policies amount to 0.59 percent of the cost of materials in 1988. These policies alone seem unlikely to significantly affect paper recycling efforts.

Tax Benefits for Plant Construction

Prior to the 1986 Tax Reform Act, a host of tax benefits subsidized borrowing and investment for capital projects. To the extent that virgin mills are typically larger than recycled fiber mills and are integrated into timber and pulp processing, virgin mills require more capital, and these incentives could have promoted the use of virgin fiber. However, the Tax Reform Act eliminated all federal subsidies that we could identify as subsidizing large, wholly private, capital investment projects,[108] and we do not believe capital subsidies are an issue affecting paper mills today.

**Below-Cost Timber Sales**

The federal government sells a great deal of timber from federally owned timberland. Many of these sales fail to earn enough revenue to meet the government's costs of developing and managing the timber stands. Some sales do not even earn enough revenue to cover the government's costs of planning the sales. These "below-cost timber sales" subsidize timber buyers because the price that is charged for the cutting

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105 Capital gains benefits were eliminated in the Tax Reform Act of 1986 and are discussed in Appendix A.

106 See Table II-1 for more detailed information.

107 We assume that the fraction of timber sales going to pulp and paper end uses in 1988 is the same as it was in 1986. Timber sales data from the United States Department of Commerce, "Timber Products - Production, Foreign Trade, and Consumption, by Type of Product: 1960 to 1986," Statistical Abstract of the United States, 1989, Table 1146.

108 The Tax Reform Act reduced the subsidy to borrowing in a number of ways. Among the changes affecting the construction costs of a virgin paper mill: an increase in the depreciation periods for most capital equipment from five to seven years; the repeal of the 10 percent investment tax credit; the elimination of tax-exempt bond status for many uses that had received such status as industrial development bonds (the predecessor to private activity bonds); a lower annual capital cap on private activity bonds; and, the elimination of provisions which allowed the expensing of plant construction costs.

rights is below what would be required to induce similar sales if the sales were managed by private enterprises.

The magnitude of the subsidy associated with below-cost timber sales may be approximated by the Forest Service's total losses on the sales. Realistically, a private timber owner would not sell timber cutting rights just to cover the costs of the sale; the firm would also seek a profit. Since we had no way to estimate a reasonable profit from Forest Service's sales, we used its losses alone as our lower-bound estimate for the industry subsidy. This probably underestimates the true subsidy to some degree, since adding an expected profit component to timber sales would increase the losses. Therefore, as an upper bound, we assumed that if it were a private owner, the Forest Service would seek a 4.6 percent profit on sales.[109]

U.S. Forest Service timber sales accounted for, on average, $874 million annually in gross receipts between 1982 and 1988.[110] During the same time period, the Forest Service spent $1.2 billion annually on road construction, sales administration, reforestation, and other timber program costs. Thus, the Forest Service realized an average annual loss of $326 million.[111] We used this as a lower bound estimate of the timber subsidy. If the Forest Service were operating as a private owner, it would seek to price its product such that sales exceeded expenditures by 4.6 percent, or $1.255 billion. As actual receipts totaled only $874 million, the Forest Service lost $381 million in potential revenue annually. We used this figure as our upper bound estimate of the timber subsidy.

The impact of this subsidy on the pulp and paper industry is diluted by a number of factors, including:

- The percent of total commercial timberland owned by the federal government;
- The fraction of federal sales that go into pulp instead of timber;
- The total pulpwood and pulp from federal lands as a percent of total demand by the paper industry; and,
- Pulp costs as a fraction of total materials costs to paper mills.

Timberland Ownership

Of the total amount of commercial timber harvested in the United States in fiscal 1988, 25 to 35 percent, or approximately 4 percent of production, was sold at below-cost prices.[112] Thus, the impact on

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109 This figure represents the average return on sales ratio for the logging industry in 1988; Industry Norms and Key Business Ratios, 1987-88, Dun & Bradstreet Credit Services.

110 The Wilderness Society, testimony before the Interior Subcommittee of the House Appropriations Committee, February 1, 1989.

111 Alice Rivlin, Chair of the Governing Council of The Wilderness Society and Senior Fellow in the Economic Studies Program of the Brookings Institute, Statement before the Senate Budget Committee, March 15, 1989, p. 5.

112 Data in this paragraph from: Forest Statistics of the United States, 1987, USDA Forest Service, Pacific Northwest Division, Resource Bulletin #PNW-RB-168, September 1989; Fighting Forest Fire and Forest Fire Protection Expenditures, 1978-88, unpublished data on file, USDA Forest Service, Office of Fire and Aviation Management; 1988 Forest Help Through Silviculture and Integrated Pest Management, Supporting Appendices, Government Printing Office, Washington, D.C.

timber prices of below-cost sales is almost negligible. Since the federal government controls only a small fraction of all domestic commercial timber sales, its ability to influence paper prices is limited. This influence is further reduced when we look at the fraction of federal timber going into pulp, as opposed to other timber uses.

Fraction of Federal Sales Going into Pulp

In fiscal year 1988, total federal government timber sales were 12,588 million board feet,[113] with a small fraction going primarily into pulp. Table IV-2 presents data on the FY 1988 federal timber harvests.

Timber going primarily into pulp is classified under the category of roundwood sales.[114] However, using sales of roundwood as a proxy for federal timber going into pulp is likely to underestimate the true volume used for pulp; lumber mills that purchase saw timber generate wastes that are a supplemental source of pulp for integrated timber/paper mills. In addition, the Forest Service's Timber Sale Program Information Reporting System (TSPIRS), from which we gathered these harvest figures, is currently in a trial phase. Thus, there may be some errors in the classification of sales going into saw timber versus roundwood.

**Table IV-2**

**TIMBER HARVESTS FROM FEDERAL LANDS, FY 1988**
**(Millions of Board Feet)**

| End Use | Volume Harvested | Percent of Harvest |
|---|---|---|
| Sawtimber | 10,163 | 81% |
| Roundwood Sales | 1,667 | 13% |
| Other | 758 | 6% |
| Total Harvest | 12,588 | 100% |

Source: United States Department of Agriculture, Forest Service, Timber Sale Program Annual Report, Fiscal Year 1988 Test, National Summary. "Other" refers to post and pole use, and other miscellaneous uses.

While our estimates indicate that 13 percent of timber from federal lands is slated for pulp use, 33.1 percent of all timber produced domestically in 1986 ended up in paper (see footnote 101). Because total roundwood sales are likely to underestimate federal timber sales for the reasons stated above, we used the federal harvest data and the overall domestic production data to develop low- and high-end estimates of the impacts of timber subsidies. The low-end estimate accounts for the share of total federal harvests going to paper (13%), and assumes no return on sales. The high-end estimate represents the national average of pulp going to paper (33.1%), with a 4.6 percent return on sales.

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113 United States Department of Agriculture, Forest Service, Timber Sale Annual Report, Fiscal Year 1988 Test, National Summary, p. 8.

114 Bill LeVere, United States Department of Agriculture, Forest Service, personal communication, June 16, 1989. According to Mr. LeVere, the roundwood classification is as good a proxy for timber going into pulp as is available, although it is not equally good in all Forest Service regions. Other timber uses, such as utility poles, are counted as "Other."

We estimate that the timber subsidy ranges from 0.16 to 0.49 percent of the cost of materials for pulp and paper mills (see Table IV-3). This figure also assumes that the entire subsidy will be passed through to the timber mills, which is an unlikely prospect. Therefore, it does not seem as though below-cost timber sales are a significant barrier to recycling. Because federal timberland and pulp demand patterns vary regionally, below-cost timber sales may play a more significant role within certain industrial sub-sectors, although which sub-sectors is unclear.

**Table IV-3**

**BELOW-COST TIMBER SALES**
**AVERAGE ANNUAL SUBSIDY FOR FY 82-88**
($ millions)

| | Lower Bound | Upper Bound |
|---|---|---|
| Forest Service Losses/Subsidy to Timber Industry | $326 | $381 |
| Share Credited to Paper and Paperboard | 13.0% | 33.1% |
| Subsidy to Paper and Paperboard | $42 | $126 |
| Cost of Materials to SICs 261, 262, 263, 266 | $25,808 | $25,808 |
| Subsidy as Percent of Cost of Materials | 0.16% | 0.49% |

In developing these estimates, we assume that the federal share of total commercial timberland in 1987 and the fractions of total timber consumed for pulp products in 1986 are valid proxies for these variables in 1988.

## Energy Subsidies

Paper and paperboard manufacturing uses an enormous amount of energy, ranking fourth in industrial energy use behind steel, oil refining, and chemicals. In fact, energy use by paper and allied products industries (SIC 26) in 1985 amounted to 12.6 percent of all industrial energy use.[115] Recycling paper may save between 22 and 64 percent of the energy necessary to manufacture paper from virgin feedstocks (see Table B-1 in Appendix B), depending upon the type of paper being recycled.

Using data from the American Paper Institute (energy consumption by energy type in the Paper and Allied Products sector) and the information developed in Chapter III (subsidies per million Btu ), we derived an estimate of the energy subsidy going to the industry as a whole. This derivation is presented in Table IV-4. Note that the subsidy scenario presented is a best estimate. As mentioned in Chapter III, our subsidy estimate assumes a complete loss of tax provisions eliminated in the Tax Reform Act of 1986, rather than a substitution of underused tax benefits, and a retention of some portion of the revenues. To the extent that such substitution exists, our estimates of tax subsidies to energy, and therefore to energy used by the paper industry, will be understated.

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[115] U.S. Department of Energy, Energy Information Administration, Manufacturing Energy Consumption Survey: Consumption of Energy, 1985, November 1988, p. 17.

Table IV-4 shows energy consumption in the first column. The industry relies on self-generated energy for about 57 percent of its needs in these sectors. The subsidy estimates for different types of purchased energy are taken from Chapter III and multiplied by energy consumption to arrive at total subsidies. Overall energy subsidies to the paper industry are estimated to be $486 million in 1988. Also in 1988, the American Paper Institute estimated a recyclable paper use rate of 24.4 percent.[116] Since energy subsidies are available to both virgin and recycling industries, only the net value of the subsidy is important. This net value is calculated by subtracting the percent of total estimated energy use for paper made using recycled fiber from the percent of total energy use attributable to virgin production. The net subsidy also depends on the level of energy savings from recycling, as discussed below.

To compute the share of the energy subsidy received by virgin producers, we used the recycled paper use rate of 24.4 percent and a range of energy savings from recycled fiber (from 22 to 64 percent). This range defines the continuum of subsidies: the more energy saved by use of recycled fiber, the higher the subsidy to virgin producers. Table IV-5 shows the steps in the calculation of the net subsidy. Based on these figures, we computed that the net subsidy to virgin producers of paper and paperboard is between 60 and 79 percent of the total energy subsidy.[117]

Of the initial $486 million in energy subsidies to paper production, between $291 and $385 million may be classified as net subsidies to virgin production. If the full impact of energy subsidies were reflected in prices to the consumer, the subsidy would account for 1.1 - 1.5% of the industry's total material cost of $25.8 billion in 1988. However, the "cost pass through" issue again haunts our conclusions. Given the international derivation of most energy prices, it is not clear how much of the subsidy is reflected in price and is thus passed through to virgin paper producers.

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[116] The recyclable paper utilization rate equals the ratio of recyclable paper consumption to total production of paper and board. American Paper Institute, Economics Department. "The Paper & Allied Products Industry in the United States," March 3, 1989.

[117] Derivation of net shares is shown in Appendix B, pages B-4 and B-5.

## Table IV-4

## ENERGY USE IN THE PAPER INDUSTRY, 1988
## (1988 Dollars)

| FUEL TYPE | Est. 1988 Energy Consumption (Mil. Btu)[1] | Subsidy Per Million Btu[2] | Total Subsidy[3] ($Millions) |
|---|---|---|---|
| PURCHASED ENERGY | | | |
| Electricity[4] | | | |
| Fossil fuel-derived | 113,368,954 | $0.68 | $77.1 |
| Nuclear-derived | 28,772,065 | $9.58 | $275.6 |
| Hydroelectric-derived | 17,596,574 | $0.69 | $12.1 |
| Other renewables-derived | 1,426,907 | $0.10 | $0.1 |
| Electricity Totals | 161,164,500 | $2.26 | $365.0 |
| Steam[5] | 21,388,200 | $0.00 | $0.0 |
| Coal | 338,192,300 | $0.14 | $47.3 |
| Residual Fuel Oil | 178,507,100 | $0.19 | $33.9 |
| Distillate Fuel Oil | 10,496,200 | $0.19 | $2.0 |
| Liquid Propane Gas[6] | 2,707,600 | $0.19 | $0.5 |
| Natural Gas | 339,429,300 | $0.11 | $37.3 |
| Other Purchased Energy | 2,270,100 | $0.10 | $0.2 |
| Energy Sold[7] | (39,868,700) | | $0 |
| **Total Purchased Energy** | **1,014,286,600** | **$0.48** | **$486.3** |
| SELF-GENERATED ENERGY[8] | | | |
| Hogged Fuel (50% Moisture Content) | 267,585,100 | $0 | $0 |
| Bark (50% Moisture Content) | 123,915,200 | $0 | $0 |
| Spent Liquid (Solids) | 935,121,900 | $0 | $0 |
| Self-Gen. Hydro-electric | 11,558,300 | $0 | $0 |
| Other Self-Generated | 11,965,500 | $0 | $0 |
| **Total Self-Generated** | **1,350,146,000** | **$0** | **$0** |
| TOTAL ENERGY CONSUMED | 2,364,432,600 | $0.21 | $486.3 |

**NOTES:**

[1]Energy consumption data are from American Paper Institute, "Pulp, Paper Paperboard Industry, Estimated Fuel and Energy Use," in 1989 Statistics of Paper Paperboard & Wood Pulp, New York, NY, 1989, p. 51. Data refer to paper fabricators only (SICs 261, 262, 263, 266). (Andy Echel, API, personal communication, September 15, 1989).

[2]Subsidies per million Btu were developed in Chapter III.

[3]Total subsidy equals (subsidy/MBtu) x (MBtu consumed).

[4]Total electricity consumed is from API. Relative contributions to electric energy are based on consumption rates by electric utilities in 1988. Information is from the Department of Energy, U.S. Energy Information Administration, Monthly Energy Review, February 1988.

[5]Subsidies for steam power may exist through co-generation clauses under PURPA, by which states can require utilities to buy such power at above-market rates. Whereas these subsidies, if they were to exist, would be state, not federal, and since we had no way to estimate their magnitude, we assumed that most of the benefits for purchased steam were retained by the seller, and set the subsidy at zero.

[6]Liquid Propane Gas (LPG) is a petroleum product, and was thus attributed the subsidy rate of crude oil and natural gas liquids (NGL).

[7]We assumed that subsidies to energy sold by the paper mills were capture through the subsidies on the initial fuels, and that the benefits from these subsidies were retained by the mills, rather than passes on to the energy consumer. This conservative assumption is reflected in that the subsidy on marketed power is zero, rather than negative (i.e., the paper mill loses some subsidies).

[8]Self-generated power was treated as unsubsidized. Most subsidies on wood used as fuel (hogged fuel, bark spent liquors) have already been counted through timber subsidies and tax benefits.

**Table IV-5**

**DERIVATION OF THE SHARE OF TOTAL ENERGY SUBSIDIES THAT ACCRUE TO PRODUCERS USING VIRGIN FIBER**

| Savings from Use of Recycled Fiber | Low | High |
|---|---|---|
| Energy Savings from Recycling (1) | 22% | 64% |
| Paper Produced (million tons) (2) | 88.8 | 88.8 |
| From Virgin Fiber | 67.1 | 67.1 |
| From Recycled Fiber | 21.7 | 21.7 |
| Energy Consumed (trillion Btu) (3) | 2.364 | 2.364 |
| For virgin production | 1.888 | 2.118 |
| For recycled production | 476 | 246 |
| Net Subsidy (in % of energy used) (4) | 59.8% | 79.2% |

NOTES:

(1) The high-end subsidy estimate assumes that recycling saves 64% of the energy required for virgin paper production, and corresponds to the estimated energy savings from recycling tissue and sanitary paper. The low-end estimate assumes savings of only 22%, and corresponds to the average energy savings from recycling newsprint. These figures are the high and low points on the estimated range of energy savings presented in Table B-1.

(2) Total production for 1988 represents total production of paper, paperboard, and pulp, and is from American Paper Institute, 1989 Statistics of Paper, Paperboard, & Wood Pulp, p. 51. Production is allocated among virgin and recycled sectors based upon a 24.4 percent recyclable paper utilization rate for 1988, as described in the text above.

(3) Total energy use by SICs 261, 262, 263, and 266 for 1988 are from API, 1989 Statistics of Paper, Paperboard, & Wood Pulp, p. 51. Total energy use was divided into virgin and recycled shares based upon the tonnage production of each, and the energy savings from recycling. More detailed information on the derivation of the relative shares of energy to each sector may be found in Appendix B.

(4) Net energy subsidy to virgin production is derived by subtracting the percent of total energy use by recycled production from the percent of total energy use by virgin production.

## Water Subsidies

Recycling operations use 42% less water than facilities that rely on virgin feedstocks. As a whole, water use (i.e., withdrawals) by the paper industry in 1982 ranked third among all industries after primary metals and chemicals. The paper and allied products sector accounted for 18.9 percent of all water used for industrial manufacturing uses (including processing, cooling, and other uses; thermoelectric cooling is a different category) and 37.3 percent of all water used for industrial processing. This made the industry the largest water consumer for processing purposes in 1982.[118] Of the total amount withdrawn by the paper industry, only 15 percent was supplied from public water systems; 64 percent was self-supplied surface water, 18 percent self-supplied ground water, and 3 percent self-supplied tidewater. Overall, 85 percent of the industry's water demand was met by self-supplied sources not usually subject to federal pricing subsidies.[119]

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[118] U.S. Department of Commerce, Bureau of the Census, Water Use in Manufacturing, 1982 Census of Manufactures, March 1986.

[119] Ibid., Table 3a.

We could not identify more recent industry-specific water-use data, and because of the increasing water reuse rate in the industry (see Table III-6), we did not feel it appropriate to estimate 1988 water usage using industrial activity indicia. Therefore, we combined 1988 water subsidies with 1982 use rates. These results, therefore, should be viewed as a worst-case scenario of the subsidies' effects. Since the worst-case subsidy as a percent of the industry's cost of materials is so small, we do not believe that the errors introduced by this assumption affect the final results of our analysis.

While the paper industry is a large industrial water consumer, compared to other uses such as thermoelectric cooling and agriculture, the paper industry accounts for a much smaller share of total water consumption (only 1.2 percent in 1982). Table IV-6 presents the relative use of water among different sectors of the economy.

We do not believe that water subsidies are an important factor affecting the paper industry for four reasons. First, water subsidies are generally targeted at agricultural uses (see discussion in Chapter III). Second, even if the subsidies were evenly distributed among all sectors, the paper industry uses a small fraction of all water withdrawals. Third, 85 percent of all the water the paper industry does use is self-supplied and, therefore, not generally subject to federal subsidies. Finally, since use of most of the water is self-supplied, water pollution control expenditures[120] and related pollution liability exposure seem to be more important factors driving industry water use. These other concerns probably explain, at least in part, the increase in water recycling for paper and allied products from 2.38 uses in 1954 to 6.64 uses in 1985.[121]

If we assume that all users of federally supplied water receive subsidies in proportion to their use of that water, the entire paper and paperboard industry receives a relatively small benefit. Since the entire paper manufacturing sector (SICs 261, 262, 263, 266) accounts for 1.2 percent of withdrawals and 15 percent of those withdrawals are water for which federal subsidies exist, the industry would receive 0.18 percent of the total federal water subsidy, or about $9 million per year in 1988. However, since the water subsidies benefit both primary and secondary producers, the net subsidy to virgin production would be even lower. Assuming that recycling operations use 42 percent of the water use that primary operations use,[122] and using the 1988 recycled paper use rate of 24.4 percent with 1982 water use rates, a net subsidy of 76% accrues to virgin production.[123] Hence, of the estimated $9 million in water subsidies, virgin production receives a net subsidy of $7 million, or 0.03 percent of the 1988 cost of materials.

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120 Water pollution control expenditures totaled $3.23 billion between 1966 and 1986, according to the American Paper Institute (API, p. 59).

121 See Table III-6.

122 Robert Cowles Letcher and Mary Sheil, "Source Separation and Citizen Recycling," as cited in Worldwatch Paper #76, Mining Urban Wastes: The Potential for Recycling, Cynthia Pollock, April 1987.

123 Derivation of net shares is shown in Appendix B, page B-6.

**Table IV-6**

**WATER WITHDRAWALS, BY SECTOR**
**(Billions of Gallons per Day)**

| | 1982 | Percent of Total Withdrawals |
|---|---|---|
| Public Supply | 35 | 8.3% |
| Irrigation and Livestock | 150 | 35.4% |
| Industrial Use | | |
| · Thermoelectric | 200 | 47.1% |
| · Other Industrial Users Except SICs 261,262,263,266 | 34 | 8.0% |
| · Paper (SICs 261,262,263,266) | 5 | 1.2% |
| Total Withdrawals | 424 | 100.0% |

SOURCE: Wayne Solley et al. Estimated Use of Water in the United States in 1985. United States Geological Survey (USGS) Circular 1004, 1988, p. 69. Water use in the paper industry from Department of Commerce. Estimated Use of Water in Manufacturing. 1982 data were interpolated from 1980 and 1985 data. Estimates were scaled to match USGS total withdrawals to reduce rounding errors.

## Pollution Control Requirements

There have been concerns that federal pollution control requirements may be less stringent for primary producers, thereby acting as a disincentive to recycling. We did not find any evidence that this is the case in the paper and paperboard industry. In cases where emissions of a pollutant are higher from a recycled paper mill, the controls should be more stringent, and we found no arguments that control requirements incorporated any bias against recycled paper mills. Plant size is one factor that may discriminate against recycled mills because virgin mills are typically much larger. This may allow for greater economies of scale in control expenditures, but it does not reflect a systematic bias against recycled fiber as an input. Additional discussion of pollution control requirements for the paper and paperboard industry may be found in Appendix A.

## Export Restrictions

Export restrictions on logs from federal lands have been in effect since 1968. Provisions prohibit the export of all logs from federal land west of the 100th meridian (which bisects Texas and the Dakotas) except for species declared by the Secretary of Agriculture and the Secretary of Interior to be surplus to domestic needs.[124] Initially enacted in 1968, the export ban was set to expire at the end of 1971, but has been renewed on an annual rider to the Interior and Related Agencies Appropriation Acts every year since then. In addition, legislation has been introduced to make this ban law so that it needn't be renewed each year.[125]

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[124] Between 1960 and 1968, log exports from Oregon and Washington increased twenty-fold, from 100 million board feet to more than 2 billion board feet. The export restrictions were initiated under pressure from the domestic wood products manufacturers, who were being forced to compete with the export market for timber. (John H. Beuter. Federal Timber Sales, Congressional Research Service, February 9, 1985, p. 19).

[125] One bill sponsored by Sen. Packwood (OR) seeks to convert the rider into a permanent federal law. The other, sponsored by Rep. Williams (MT), seeks to provide states with the authority to restrict timber exports from state lands. Information from Ron Lewis, USDA Forest Service, Timber Management Division, personal communication, July 21, 1989.

Restricting log exports reduces aggregate demand for timber, thereby depressing the price of that timber in the remaining domestic markets. Should the export ban depress prices significantly, timber resources would be underpriced on the marketplace, reducing the incentives to use pulp substitutes such as wastepaper. While we do not have the necessary data to quantify the impacts of the export restrictions on paper recycling, we would expect their impacts to be small for most of the same reasons that below-cost timber sales were of limited impact:

- the United States is a net importer of logs, even with prices that are, perhaps, reduced by export restrictions,[126] and
- the federal share of timber used in pulp and paper ranges from 13 percent (low-end estimate) to 33.1 percent (high-end estimate).

**Federal Subsidies Of Virgin Paper In Perspective**

We estimate total subsidies to virgin paper and paperboard in SICs 261, 262, 263, and 266 of between $491 million and $669 million in 1988 (see Table IV-7), although the relative shares of the subsidy will vary by end-product and production process. While large in dollar terms, even using worst-case assumptions (i.e., the full magnitude of the subsidy is reflected in prices), this subsidy represents only 2.6 percent of the cost of materials for these industry sectors. Furthermore, subsidies for virgin paper are offset at least in part by existing subsidies for recycled paper, such as procurement policies and state or local taxes levied on timber cutting. While federal subsidies of virgin paper production undoubtedly cost the taxpayer hundreds of millions of dollars and may reduce the incentives slightly to switch from virgin to recycled paper production, their overall impact on paper recycling seems minimal.[127]

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126 U.S. Department of Commerce, Bureau of the Census. "Timber Products- Production, Foreign Trade, and Consumption, by Type of Product: 1960 to 1986," Statistical Abstract of the United States 1989, Table 1146.

127 There has been some speculation that inexpensive imported pulp might be hindering the use of recycled fiber. However, in 1986, net pulp imports represented only 14.8 percent of total U.S. pulp consumption (Bureau of Census, "Timber Products - Production, Foreign Trade, and Consumption, by Type of Product).

**Table IV-7**

**SUMMARY OF SUBSIDIES FOR VIRGIN PAPER PRODUCTION**

| | LOW-END ESTIMATE | | HIGH-END ESTIMATE | |
|---|---|---|---|---|
| Subsidy Type | $Millions | % of Industry Cost of Materials | $Millions | % of Industry Cost of Materials |
| Tax Benefits | $152 | 0.59% | $152 | 0.59% |
| Below-Cost Timber Sales | $42 | 0.16% | $126 | 0.49% |
| Energy | $291 | 1.13% | $385 | 1.49% |
| Water | $6 | 0.02% | $6 | 0.02% |
| **TOTAL** | **$491** | **1.90%** | **$669** | **2.59%** |

As a final point, some federal subsidies that hinder recycling may also confer public welfare benefits. For example, reforestation tax credits, with their ceilings of $10,000 of expenditures per year and a $1,000 tax credit, are aimed primarily at smaller landholders. While these subsidies reduce the cost of timber production slightly, they also reduce the pollutant impacts on surrounding waterways (such as from silvicultural runoff) and reduce government and private expenditures in other areas (e.g., by retaining topsoil). The elimination of some special policies may reduce the value of standing timber and with it the value of holding the land for timber production. Landowners may find an increased incentive to use the land for other, more profitable purposes. Perhaps, in part as a response to losses of tax benefits in the Tax Reform Act of 1986, there have been a number of large timber sales in the past few years aimed at developing the land, rather than using it for sustainable timber production. Since timber companies may own large amounts of land within a state,[128] changes in landholding decisions can have rapid and severe impacts on a state or region. We have not conducted a benefit-cost analysis of these subsidies, which would indicate whether they provide net benefits to society; we have only computed the cost side of the equation for an aggregated group of related firms in the paper industry.

No federal policies seem individually to subsidize virgin production enough to significantly affect paper recycling. Even when combined, their impacts do not appear to be the major factor limiting the demand for recycled fiber in the marketplace. Because a steady supply of post-consumer paper as well as an increased demand for paper with recycled content are both recent occurrences, the markets will most likely need a number of years to properly adjust to these changes.

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128 For example, nine companies owned 9,435,000 acres of Maine timberland in 1986, representing 53 percent of total forest land in the state, and 47.6 percent of total land area (Phyllis Austin, "Are Paper Companies Destroying the Maine Woods," Business and Society Review, Fall 1986, #59, p. 23).

## REFERENCES


American Paper Institute, "Facts About Waste Paper Recycling" (pamphlet), 1988.

_____, Economics Department. "The Paper & Allied Products Industry in the United States," March 3, 1989.

_____, Materials Recycling: The Virtue of Necessity (Washington, D.C.: The Worldwatch Institute, October 1983).

_____, 1988 Statistics of Paper, Paperboard, & Wood Pulp (New York, 1988).

_____, 1989 Statistics of Paper, Paperboard, & Wood Pulp (New York, 1989), p. 51.

American Pulpwood Association, Pulpwood Statistics, June 1986.

Anderson, Robert C., and Richard D. Spiegelman. Impact of the Federal Tax Code on Resource Recovery. (Washington, D.C.: U.S. Environmental Protection Agency, December 1976), NTIS #PB-264-886.

"1989 Annual Statistical Report," Electrical World. April 1989, p. 63.

Austin, Phyllis, "Are Paper Companies Destroying the Maine Woods?" Business and Society Review, Fall 1986, #59, pp. 20-24.

Beuter, John H, Federal Timber Sales. (Washington D.C.: Congressional Research Service, February 9, 1985), CRS 85-96-ENR.

Booz-Allen and Hamilton, Inc., An Evaluation of the Impact of Discriminatory Taxation on the Use of Primary and Secondary Raw Materials, Washington D.C.: U.S. Environmental Protection Agency, 1975, NTIS #PB-264-886.

Booz-Allen and Hamilton, Inc., An Evaluation of the Impact of Discriminatory Taxation on the Use of Primary and Secondary Raw Materials (Washington, D.C.: U.S. Environmental Protection Agency, Prepared for the US EPA, 1975), NTIS # PB-240 988.

Case, Clifford P., "Designing Effective Procurement Policies." BioCycle, May 1989, p. 62.

Center for Renewable Resources, The Hidden Costs of Energy (Washington, D.C.: 1985).

Chandler, William U., Energy Productivity: Key to Environmental Protection and Economic Progress (Washington, D.C.: The Worldwatch Institute, January 1985).

Comp, T. Allan, ed., Blueprint for the Environment (Salt Lake City, UT: Howe Brothers, 1989).

Congressional Budget Office, Reducing the Deficit: Spending and Revenue Options (Washington, D.C., February 1989).

Edinger, Jim. OAQPS, personal communication June 6, 1989.

David Wilburn, U.S. Bureau of Mines, personal communication, October 3, 1989.

Duffus, James III, Director of Natural Resources Management Issues - Resources, Community, and Economic Development Division, U.S. General Accounting Office. Statement Before the House of Representatives Subcommittee on National Parks and Public Lands, April 11, 1990.

Environment and Energy Study Institute, Weekly Bulletin, April 10, 1989.

Environmental Defense Fund, To Burn or Not to Burn, August 1985.

"EPA Notice of Proposed Rule-Making for Bevill Exclusion of Mining Waste under Resource Conservation and Recovery Act," 53 Federal Register 15316, April 17, 1985).

Espe, Carl, "Capital Spending Survey: 1988-1990," Pulp & Paper, January 1989, p. 108.

"The Federal Paper Guideline," Waste Age, October 1988, p. 158.

Fiekowsky, Seymour, U.S. Department of Treasury, personal communications, June 28, 1989, and July 7, 1989.

Fiekowsky, Seymour, Office of Tax Analysis, Department of the Treasury, personal communications, June 28, 1989 and July 7, 1989.

Flavin, Christopher, Nuclear Power: The Market Test, Washington, D.C.: The Worldwatch Institute, December 1983).

Forman, Al, Bureau of the Census, personal communication, October 11, 1989.

Foster, Charles, and Peter P. Roger, Federal Water Policy: Toward an Agenda for Action, Discussion paper E-88-05 of the Energy and Environmental Policy Center, Kennedy School of Government, August 1988.

Franklin Associates, Ltd., and the Center for Economic Policy Analysis, Economic Incentives and Disincentives for Recycling of Municipal Solid Waste, Washington, D.C.: (Office of Technology Assessment December 1988), draft.

Franklin Associates, Ltd., and International Research and Technology Corporation, Solid Waste Management and the Paper Industry, (New York: Solid Waste Council of the Paper Industry, American Paper (Institute, February 1979).

Gorte, Ross W., and Jack H. Taylor, Timber Industry: Possible Effects of Various Tax Reform Proposals (Washington, D.C.: Congressional Research Service, updated 12/1/86.

Harvey, Ben, "Access to Export Markets Essential for Paper Recycling," Recycling Times, May 23, 1989, p. 6.

_____, "1984 Federal Energy Subsidies: Program Obligations," Preliminary and Unreleased updates of 1984 data Snownmann, CO: Rocky Mountain Institute, July 1989).

_____, A Preliminary Assessment of Federal Energy Subsidies in FY 1984, testimony before the House Subcommittee on Energy Conservation and Power, Committee on Energy and Commerce, U.S. House of Representatives, June 20, 1985.

Heede, H. Richard, Revised estimates of energy subsidies in FY 1984, updated in 1989.

Heede, H. Richard, "Table C: Final Estimates of Federal Energy Subsidies in FY 1984: Tax Expenditures - Low Estimate," Preliminary and unreleased updates of 1984 data, (Snownmass, CO: Rocky Mountain Institute, July 1989).

Interstate Commerce Commission, Ex Parte 319, Sub-No.1 (Washington, D.C.: April 16, 1979).

Interstate Commerce Commission, Investigations of Freight Rates for the Transportation of Recyclables or Recycled Commodities, Ex Parte 319 (Washington, D.C., 1977).

Jacobsen, Jeff, Internal Revenue Service, personal communication, September 25, 1989.

Levin, Deb, Institute for Scrap Recycling Industries, personal communication, June 1, 1989.

LeVere, Bill, United States Department of Agriculture, Forest Service, personal communication, June 16, 1989.
Lewis, Ron, United States Department of Agriculture Forest Service, Timber Management Division, personal communication, July 21, 1989.

Lovins, Amory, and Richard Heede, "Hiding the True Costs of Energy Sources," The Wall Street Journal, September 17, 1985, p. 28.

MacLean, John C, "Tax Exempt Debt Financing for Privately Owned Facilities," BioCycle, August 1988, p. 62.

"Market Update," Resource Recycling, March/April 1989, p. 18.

Pollack, Cynthia, Mining Urban Wastes: The Potential for Recycling (Washington, D.C.: The Worldwatch Institute, April 1987.

Mohin, Tim, OAQPS, personal communication, June 6, 1989.

Porter, Richard, and Tim Roberts eds., Energy Savings by Wastes Recycling (New York: Elsevier Applied Science Publishers, 1985).

Powell, Jerry, "Tax Reform: What's the Effect on Recycling," Resource Recycling, (November/December 1986).

Postel, Sandra. Conserving Water: The Untapped Alternative. (Washington, D.C.: The Worldwatch Institute, September 1985).

_____, "Timber Revenues and Expenditures on the Tongass National Forest, 1988." Memorandum. May 18, 1989.

Rivlin, Alice. Statement before the Senate Budget Committee. March 15, 1989.

Rivlin, Alice, "Statement Before the Senate Budget Committee," March 15, 1989.

Russell, Charles W., and Robert W. Bowhay. Income Taxation of Natural Resources 1989. (Paramus, N.J. Prentice Hall, Inc., 1989).

Ruston, John, "Developing Markets for Recycled Materials," in Proceedings of the 1988 Conference on Solid Waste Management and Materials Policy, New York: New York Legislative Commission on Solid Waste Management, 1988). p. H-100.

Solid Waste Report, September 18, 1989. p. 290.

Solley, Wayne, United States Geological Survey, personal communication. July 1989.

Solley, Wayne, et al. Estimated Use of Water in the United States in 1985. United States Geological Survey Circular 1004, 1988.

"State Workers Experiment with Recycled Paper." Waste Age, May 1988, p. 20.

Stauffer, Roberta Forsell, "Energy Savings from Recycling," Resource Recycling, January/February 1989.

Tannenwald, Robert. Analysis and Evaluation of Arguments for and Against Percentage Depletion. Washington, D.C.: Congressional Research Service, March 22, 1978).

Tax Management, Inc., The Tax Reform Act of 1986: Volume II, Detailed Analysis, 1987.

United States Accounting Office. An Assessment of Hardrock Mining Damage (April 1988), GAO/RCED-88-123BR.

_____, Financial Guarantees Encourage Reclamation of National Forest System Lands (August 1987). GAO/RCED-87-157.

_____, Interior Should Recover the Costs of Recording Mining Claims (September 1986), GAP/RCED-86-217.

_____, The Mining Law of 1872 Needs Revision (March 1989). GAO/RCED-89-72.

United States Department of Agriculture, Forest Service. Timber Sale Program Annual Report, Fiscal Year 1988 Test, National Summary, (Washington, D.C.: Government Printing Office).

United States Department of Commerce. "Forest Land - Total and Timberland Area," Statistical Abstract of the United States 1989, Table 1144.

United States Department of Commerce, Bureau of Economic Analysis Business Statistics, 1984 (Washington, D.C.: September 1985).

United States Department of Commerce, Bureau of the Census, 1987 Census of Manufactures, Preliminary Report, Industry Series: Pulp, Paper, and Board Mills (Washington, D.C.: August 1989).

United States Department of Commerce, Survey of Current Business, various issues.

_____. Economic Impact Analysis of Effluent Guidelines and Standards for the Pulp, Paper, and Paperboard Industry (October 1982), EPA 440/2-82-015.

United States Department of Energy, Energy Information Administration. Manufacturing Energy Consumption Survey: Consumption of Energy, 1985 (Washington, D.C.: November 1988) p. 20.

United States Department of the Interior, Bureau of Mines, Minerals Yearbook: Volume I, Metals and Mineral, 1986 (Washington, D.C.: U.S. Government Printing Office, 1988).

United States Department of the Treasury. Internal Revenue Service. Internal Revenue Cumulative Bulletin, Public Law 99-514, Tax Reform Act of 1986, Volume 1, Text of the Law.

_____, The Solid Waste Dilemma: An Agenda for Action," Background Document (December 1988).

_____, Survey of Current Business (Washington, D.C.: June 1987, March 1988, April 1989, August 1989).

_____, Statistical Abstract of the United States, 1989 (Washington, D.C., 1989).

_____, "Timber Products - Production, Foreign Trade, and Consumption, by Type of Product: 1960 to 1986," Statistical Abstract of the United States, 1989, Table 1146.

_____, Water Use in Manufacturing, 1982 Census of Manufactures (Washington, D.C.: March 1986).

U.S. Environmental Protection Agency, Development Document for Effluent Limitations Guidelines, New Source Performance Standards, and Pretreatment Standards for the Pulp, Paper, and Paperboard and the Builders' Paper and Board Mills Point Source Categories (October 1982). NTIS No. PB83-163949.

United States Environmental Protection Agency, Office of Solid Waste. The Solid Waste Dilemma: An Agenda for Action, Background Document (September 1988).

United States Environmental Protection Agency. "Appendix A: Paper," The Solid Waste Dilemma: An Agenda for Action, February 1989.

United States General Accounting Office, An Assessment of Hardrock Mining Damage, (April 1988), GAO/RCED-88-157.

Weekly Bulletin, September 11, 1989.

The Wilderness Society, America's Vanishing Rain Forest: A Report on Federal Timber Management in Southeast Alaska (1986).

## APPENDIX A: HISTORY OF FEDERAL POLICIES AND SUMMARIES OF POLICIES NOT COVERED IN THE MAIN REPORT

### Federal Tax Policies

History of Percentage Depletion Allowances[129]

Congress first authorized depreciation deductions for minerals in the Internal Revenue Act of 1913 (the term "depletion" was first coined in a subsequent 1916 revenue act). The cost of depletions were based on the acquisition costs of the mines, including funds needed to develop the property. This was the counterpart to depreciation schedules for capital equipment, and it still remains in the current tax code. For mines discovered before 1913, an attempt was made to value the asset. For mines discovered after 1913, investment costs were used in the cost depletion calculations.

Problems soon arose because, in many situations, especially in oil and gas, the 1913 calculated asset values were significantly higher than the investment costs for new developments after 1913. Thus, tax benefits resulting from cost depletions were much higher for existing properties than for new, which was argued by industry to discourage new development. In response, Congress introduced the concept of cost depletion based on "discovery values" for the oil and gas industry in the Revenue Act of 1918. This modification allowed depletion deductions to be based on the fair market value of newly discovered wells, assessed within 30 days of acquisition.

Discovery depletion presented two major problems that caused numerous administrative burdens for both the taxpayer and the federal government: (1) how to assess fair market value, and (2) how to limit the tax benefits when prices fell. The difficulties encountered in assessing a fair market value of a new project stemmed from data gaps, the absence of guidelines, and frequent litigation over the Department of Treasury's appraisals. The impact of price changes was first evidenced in 1921 when prices dropped. There was a general concern that well owners would minimize, or possibly avoid, tax payments using the depletion deductions that were still based on pre-1921 assessed discovery values. In response to the latter, Congress limited the maximum deductions to the net taxable income derived from the well. (This limit was further reduced to 50 percent of the net taxable income, which still applies.) Congress also authorized the use of percentage depletion on gross income for the oil and gas industry in the Internal Revenue Act of 1926.

In 1932, the percentage depletion allowances were extended to all primary metal industries, coal, and sulphur extraction industries to aid in their post-Depression recovery. Other nonmetallic commodities began receiving percentage depletion benefits during World War II. By 1954, all minerals (except those derived from the air) were given some form of percentage depletion allowance, with the actual allowable percentage varying by mineral and mineral location.[130] In the Tax Reform Act of 1969 (section 501), the allowable percentage deductions were reduced in a number of cases and increased in a few (the maximum percentage

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[129] Primary source for history information: Anderson, Robert C. and Richard D. Spiegelman, Impact of the Federal Tax Code on Resource Recovery, prepared by the Environmental Law Institute for EPA, December 1976, pp. 9-15, and personal communication with Seymour Fiekowsky, Office of Tax Analysis, Department of the Treasury, June 28, 1989.

[130] Franklin Associates, Ltd. and the Center for Economic Policy Analysis, Economic Incentives and Disincentives for Recycling of Municipal Solid Waste DRAFT, December 1988, p. 5. Prepared for the Office of Technology Assessment.

depletion allowable was set at 22 percent). In 1975, the percentage depletion allowances were eliminated for large oil and gas operators.

The only major change brought about by the Tax Reform Act of 1986 involved whether a firm could qualify for depletion allowances under the newly-created alternative minimum tax payment schedule. To determine the amount of taxes that a company must pay, the firm must calculate a standard tax figure, factoring in various deductions (e.g., depletion allowances) and an alternative minimum tax. The firm must pay whichever tax estimate is higher.[131] In some industries, such as oil and gas, this change in the tax calculation method could reduce the usage of depletion allowances. Estimates from the Department of Treasury show substantial drops in the costs to the federal government associated with depletion allowances for minerals and oil and gas after 1987 (Table II-1).

Capital Gains Allowances

*Description*

Capital gains are revenues generated from the sale of personal and business assets, such as real estate and factories. The rationale was that taxing such gains as ordinary income discouraged individuals from selling their capital assets (farms, mineral properties, etc.). The lower tax rate on gains from the sale of fixed assets would, in theory, help to facilitate property transfers of capital goods from less productive to more productive ownership, as well as to encourage investments into new capital stock.

*History*

Long-term capital gains were separated from ordinary income for tax purposes in the Revenue Act of 1922. In 1944, the timber industry successfully petitioned Congress to enact a special tax ruling that treated the income from timber sales as capital gains income, rather than as normal income derived from the sale of a product.[132] These provisions are discussed in Section 117(k) of the Internal Revenue Code (now Section 631).[133] These benefits were available even if the timber was being used in the owner's business.

Opponents to the capital gains allowance for timber revenue believed that it should be treated as normal income because it is essentially the same as revenue from the sale of agricultural commodities (which did not get capital gains exclusions) except for timber's longer growing period. Proponents argued that the longer growing period creates large uncertainties and risks and, therefore, differentiates timber production from agriculture.[134]

Prior to 1986, capital gains were taxed at a rate of 28 percent, versus the maximum 46 percent tax rate for ordinary corporate income. In the Tax Reform Act of 1986, these capital gains benefits were eliminated.

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131 U.S. EPA, The Solid Waste Dilemma: An Agenda for Action," Background Document, p. 3.F-4.

132 Ross Gorte and Jack Taylor, Timber Industry: Possible Effects of Various Tax Reform Proposals, Congressional Research Service, Updated 12/1/86, p. 1.

133 Anderson and Spiegelman, pp. 20-25.

134 Franklin Associates, et al., December 1988, p. 7.

*How the Capital Gains Allowances Worked*

Revenues earned from the sale of timber were treated separately from normal income. Rather than offsetting these earnings with day-to-day business expenses, capital gains were off-set with capital losses for a given year. The net capital gains were then taxed at a maximum rate of 28 percent, regardless of total corporate or individual earnings. Normal income was taxed at a higher maximum rate of 46 percent.

Since 1986, capital gains have been treated in the same manner as normal income. However, some benefits may still be obtained by differentiating capital gains from normal income. For example, a maximum of $3,000 per year of capital losses may be offset against normal income for a firm that does not differentiate between capital gains income and income from product sales. However, a firm with large capital losses is allowed to deduct unlimited losses against corporate capital gains, as long as the capital gains income is differentiated from product-derived income.[135]

While capital gains allowances were eliminated by the Tax Reform Act of 1986, there has been talk about reinstating this tax benefit for a few years. Should such benefits be reinstated, they would benefit all industries with fixed assets to some degree. However, mature industries, likely to have more fixed assets in the form of plants and land would be more likely to have capital gains than would a new industry, such as a recycling facility. In addition, the timber industry, which since 1944 has been eligible for capital gains deductions, would also benefit substantially.

Foreign Tax Credit

Any U.S. corporation doing business internationally is eligible for a foreign tax credit which reduces U.S. taxes by the amount of taxes already paid to a foreign government.[136] The purpose of this provision is to avoid double taxation of income earned in foreign operations. A taxpayer has the option of treating foreign income taxes either as a credit or as a deduction from domestic taxes, although all foreign taxes must be treated in the same manner. Foreign taxes taken as credits may generally be subtracted directly from U.S. tax liabilities, while taxes taken as deductions simply reduce domestic taxable income.

While income tax payments can be credited, other operating expenses (including natural resource extraction) are subject only to deductions as operating expenses. Hence, a multi-national may have an interest in minimizing domestic tax burdens by substituting foreign income taxes for other foreign payments, such as mineral extraction royalties, which may only be deducted from taxable income. Firms in the extractive industries often pay royalties to the owner of the land where the resource lies. If the owner of the land is a foreign government and if the government chooses to label the royalty as a tax payment, then what would have been a conventional cost of doing business (deductible at the prevailing tax rate) becomes a full tax credit.

Because secondary producers do not generally receive their inputs from foreign operations (e.g., we do not import raw or processed wastes from other nations), they are not as likely as primary producers to receive

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135 Franklin Associates, et al., December 1988, p. 8.

136 Charles W. Russell and Robert W. Bowhay, Income Taxation of Natural Resources 1989, Paramus, NJ: Prentice Hall, Inc., 1989 pp. 2905-2908; Booz-Allen and Hamilton, Inc. An Evaluation of the Impact of Discriminatory Taxation on the Use of Primary and Secondary Raw Materials, Prepared for the U.S. EPA, 1975, NTIS #PB-264-886, pp. 11-15.

benefits resulting from foreign tax credits. This may indirectly act to place secondary producers at a relative disadvantage.

Major Subsidies to Natural Resource Extraction and Energy Eliminated in the Tax Reform Act of 1986

Prior to the Tax Reform Act of 1986, energy was more heavily subsidized than is now the case.[137] The tax amendments eliminated a number of investment incentives, including the 10% investment tax credit and the energy tax credit. The Act also lengthened capital depreciation schedules from 5 to 7 years and reduced the availability of tax-exempt industrial development bonds (or IDB's, now called private activity bonds, or PAB's).[138] Other important changes included the elimination of accelerated cost recovery, expensing of construction-period interest, and the institution of the alternative minimum tax.[139] The loss of these provisions, in some instances, may have helped recycling by reducing the attractiveness of waste-to-energy plants, as well as by reducing subsidies to energy, of which primary industry consumes in much large quantities.

In addition to being a potential competitor with recycling for the solid waste stream, waste-to-energy plants are long-term, capital-intensive construction projects. As a result, they benefitted substantially under federal subsidized borrowing schemes eliminated in the Tax Reform Act of 1986. The elimination of these subsidies has been estimated to increase the costs of incinerator disposal by 50 to 65 percent.[140] Therefore, a subsidy of such magnitude may have led to the development of incineration capacity in some areas of the country that will compete with recyclables for many years to come.

**Federal Timber Sales - History**

The U.S. government has sold timber from federal lands for more than 90 years. The first federal forest reserves were set aside in 1891. Timber sales from these lands were authorized in 1897, and the first sale was made in 1899. Two federal agencies are responsible for managing federal timber sales. The Forest Service, Department of Agriculture, oversees the vast majority of federal forest land (88.7 million acres). The Bureau of Land Management, Department of the Interior, manages a much smaller amount of land (6 million acres) in the western United States. The federal government initially supported the production of timber from federal lands to encourage the settlement and development of the West. The government envisioned many benefits ensuing from its timber policies including: attracting new settlers, providing jobs, increasing industrial activity, and developing transportation systems. The most significant attempt to use timber as the means to spur economic development occurred in southeast Alaska.

As early as 1914, the Forest Service began to assess the prospects of selling timber to induce the construction of a pulp mill in Alaska. The goal was to establish "working circles" throughout Southeast Alaska, with a pulp mill at the center point of each circle providing employment for surrounding residents and

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137 Congressional action may ultimately restore or increase these subsidies. This could have some impact on recycling.

138 Franklin Associates, Ltd., et al., p. 80.

139 The alternative minimum tax establishes a minimum tax payment required by firms, irrelative of eligible deductions, to ensure that all profitable firms pay at least some taxes.

140 Smith-Barney, The President's Tax Proposals: An Analysis of the Effect on Resource Recovery Financing, June 3, 1985, cited in the Environmental Defense Fund, To Burn or Not to Burn, August 1985.

settlers.[141] The federal government targeted the Tongass National Forest as the site for this development. The first timber sale in this region was the Juneau Unit Sale in 1927 for 5 billion board feet of timber, although timbering never took place. Other timber sales completed in 1921, 1922, and 1927 were also unsuccessful and thus cancelled for economic reasons.[142]

Until the 1940s, timbering remained a local activity to meet local uses. World War II then created new impetus for expanded timbering. During this decade, the two mainstays of the Alaskan economy collapsed. Over-fishing led to the collapse of the salmon industry between 1941 and 1950, and the gold mining industry was closed down as a "non-essential" activity by the War Production Board in the early 1940s, with the last mine closing in 1944. Finally, military bases in the area were of strategic importance, increasing the federal desire to settle the area.[143]

All of these forces greatly increased pressures to employ and anchor residents with a new industry, and timber was seen as the most promising opportunity. The Tongass Timber Act, passed in 1947, authorized timber sales in Tongass despite Native Eskimo claims to land rights. In 1951, the Ketchikan unit sale was signed for 8.25 billion board feet of timber over a 50-year contract length. In 1954 and 1955, two additional long-term sales for 10.5 billion board feet were approved,[144] and in 1955, the Juneau unit sale, made originally in 1927, was re-offered, although it again was unsuccessful.[145]

The 50-year contract lengths were unprecedented in Forest Service history, although the companies that received them said that they were necessary in order to compensate them for the risks associated with putting a pulp mill in a sparsely populated region with a harsh climate. For a total investment of $50 million for the Ketchikan and Sitka pulp mills, industry received 50 years of guaranteed timber sales at low stumpage fees.[146]

From the period after 1914 through the 1930s, the federal government succeeded in spurring development in various sections of the West. However, after this period the initial goals to be achieved with below cost wood sales began changing. By about 1940, in all areas except Southeast Alaska, the timber sales were viewed as a way to stabilize and anchor the rural communities that had grown dependent on federal timber for their livelihoods. In 1969, with the passage of the National Environmental Policy Act, environmental protection finally became a factor in Forest Service decision making. In 1976, with the passage of the National Forest Management Act, timber sale economics also became a stated criteria of timber sales (i.e., The Forest Service was forced to consider the costs associated with sale decisions (e.g. where, and for how much, to sell timber).

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141 The Wilderness Society, America's Vanishing Rain Forest: A Report on Federal Timber Management in Southeast Alaska, 1986, p. 28.

142 The Wilderness Society, p. 28.

143 The Wilderness Society, p. 28.

144 The Wilderness Society, p. 34.

145 The Juneau sale was bought and defaulted on twice between 1955 and 1975, and in 1976 was finally cancelled when a third bidder withdrew because of environmental litigation. (John H. Beuter, Federal Timber Sales. Congressional Research Service, February 9, 1985, CRS 85-96-ENR, p. 32).

146 The Wilderness Society, p. 34.

Today, most timberland is roaded, and the necessary market, infrastructure, and services are in place to adequately harvest and process timber. Occasionally, the federal government will sponsor timber sales that are aimed primarily at community development. However, most federal timber sales are made to support existing mills and the stability of timber-dependent communities and regions. In many situations, these sales are non-economic, resulting in revenue losses to the government. Such sales have resulted in clashes between the Forest Service and environmentalists.

## APPENDIX B: DERIVATION OF VALUES USED IN THE BODY OF THE REPORT

**Table B-1**

**ENERGY SAVINGS FROM RECYCLING, BY MATERIAL [1]**

| Material | 100% Virgin GJ/tonne | 100% Virgin GJ/ton | 100% Virgin MBtu/ton | 100% Recycled GJ/tonne | 100% Recycled GJ/ton | 100% Recycled MBtu/ton | % Savings | Source |
|---|---|---|---|---|---|---|---|---|
| **Aluminum** | 219.0 | 241.3 | 229.0 | 9.0 | 9.9 | 9.4 | 96% | (2) |
| | 251.0 | 276.6 | 262.5 | 17.0 | 18.7 | 17.8 | 93% | (2) |
| | 250.6 | 276.2 | 262.1 | 7.2 | 7.9 | 7.5 | 97% | (3) |
| | 238.3 | 262.6 | 249.2 | 12.1 | 13.3 | 12.7 | 95% | (4) |
| Average | 239.7 | 264.2 | 250.7 | 11.3 | 12.5 | 11.8 | 95% | |
| **Paper** | | | | | | | | |
| Newsprint | | 21.0 | 19.9 | | 14.5 | 13.8 | 31% | (5) |
| | 20.2 | 22.3 | 21.1 | 16.7 | 18.4 | 17.5 | 17% | (6) |
| | 32.5 | 35.8 | 34.0 | 27.0 | 29.8 | 28.2 | 17% | (7) |
| Average - newsprint | | | 25.0 | | | 19.8 | 22% | |
| Linerboard | | 28.4 | 27.0 | | 21.4 | 20.3 | 25% | (8) |
| Corrugated | 35.2 | 38.8 | 36.8 | 21.3 | 23.5 | 22.3 | 39% | (7) |
| Tissues and Sanitary | 65.2 | 71.9 | 68.2 | 23.7 | 26.1 | 24.8 | 64% | (7) |
| **Cullet** | | | 15.6 | | | 14.8 | 5% | (9) |
| | 23.0 | 25.3 | 24.1 | 17.0 | 18.7 | 17.8 | 26% | (10) |
| | | | | | | | 4-32% | (11) |
| White | 20% cullet to 100% cullet | | | | | | 26% | (12) |
| Green | 30% cullet to 100% cullet | | | | | | 6-12% | (13) |
| **Plastics** | | | | | | | | |
| PET | | | 98.0 | | | 12.0 | 88% | (14) |
| HDPE | 52.7 | 58.1 | 55.1 | | | | | (15) |
| LDPE | 49.6 | 54.7 | 51.9 | | | | | (15) |
| PVC | 28.5 | 31.4 | 29.8 | | | | | (15) |
| Polystyrene | 65.5 | 72.2 | 68.5 | | | | | (15) |
| **Steel** - high estimate | | | | | | | 47% | (11) |
| - low estimate | | | | | | | 74% | (11) |
| Average | | | | | | | 61% | |
| **Rubber** | 99.0 | 109.1 | 103.5 | 55.0 | 60.6 | 57.5 | 44% | (16) |
| Retreads - Cars | | | | | | | 63% | (17) |
| Retreads - Commercial. | | | | | | | 30% | (17) |

Sources and Notes to Table B-1:
Conversion Factors: 1 tonne = 1.102 tons; 1 MBtu = .949 Gigajoules (GJ)

(1) These numbers should be viewed as indicators of the relative differences in energy consumption between primary and secondary production rather than as precise appraisals of the energy required in each process.

(2) Richard Porter and Tim Roberts, eds., Energy Savings by Wastes Recycling, (NY: Elsevier Applied Science Publishers, 1985), p. 64. High and low estimates.

(3) Robert Barnes. "The Energy Involved in Producing Engineering Materials." Proc. Instn. Mechanical. Engineers, Vol. 190, 29/76, in Porter and Roberts, p. 60. Energy savings for aluminum ingot production.

(4) P. Pautz and H. J. Pietrozeniuk, "Abfall and Energie." Umweltbudesamt, June 1983, Berlin, in Porter and Roberts, p. 63.

(5) "Secondary versus Virgin Fiber Newsprint." Pulp and Paper, V. 50, #5, May 1976, in Porter and Roberts, p. 66.

(6) L. Hanserud and O. Olsson, "Skall vi Branna upp eller Atervinna Returpapperet," Teknisk Tidskrift, 2, pp. 18-19, in Porter and Roberts, p. 67.

(7) Environment Canada, Net Energy Savings from Solid Waste Management Options, Ottawa, 1976, in Porter and Roberts, p. 68.

(8) "Economics of Recycled Fiber Usage for Linerboard." Pulp and Paper, V. 50, #4, April 1976, in Porter and Roberts, p. 66.

(9) A. Purcell, The Waste Watchers, 1980, in Roberta Forsell Stauffer, "Energy Savings From Recycling," Resource Recycling, January/February 1989, p. 59.

(10) Porter and Roberts, p. 13. Savings represent an increase from 20% to 100% cullet.

(11) Robert Cowles Letcher and Mary Sheil, "Source Separation and Citizen Recycling," in William D. Robinson, ed., The Solid Waste Handbook, (New York: John Wiley & Sons, 1986), in Cynthia Pollack, Mining Urban Wastes: The Potential for Recycling, (Washington, DC: The Worldwatch Institute, April 1987), p. 22.

(12) I. Bousted and G. F. Hancock, "Energy Savings Through Glass Recycling," for the Glass Manufacturers Association, 1982, in Porter and Roberts, p. 71.

(13) Assovetro (Italian Glass Manufacturers Association) and CNR (Italian National Research Center), 1981, in Porter and Roberts, p. 73.

(14) Stauffer, p. 59. Assumes plastics fabrication energy of 49,000 Btu/lb.

(15) Plastics feedstock energy content from Porter and Roberts, p. 89. These were converted into primary fabrication energy requirements using energy use ratios for feedstock content versus fabrication, developed by J. Milgrom, SRI International, "An Overview to Plastics Recycling," in Porter and Roberts, p. 88.

(16) Porter and Roberts, p. 13.

(17) Porter and Roberts, p. 79.

## Derivation of Estimated Tax Subsidies to the Primary Aluminum Industry

To derive estimated tax subsidies to the aluminum industry, we used data on 1984 tax subsidies provided by Richard Heede of the Rocky Mountain Institute. We updated these estimates to reflect changes brought about by the Tax Reform Act of 1988 and scaled the resulting values to constant 1988 dollars using implicit price deflators for the Gross National Product from the Department of Commerce, Survey of Current Business. We then divided the total dollar value of tax expenditures for each form of energy by the total amount of each energy type used by the aluminum industry. This derivation is shown below in Table B-2.

**TABLE B-2**

| | Hydro-electric | Fossil Fuel | Nuclear | Hydro Renewable and End-Use Efficiency | Residential Fuel Oil | Distillate Fuel Oil | Natural Gas | LPG | Coal | Coke and Breeze |
|---|---|---|---|---|---|---|---|---|---|---|
| Tax Expenditure (millions $) | $610 | $1,879 | $2,305 | $615 | $1,728 | $1,728 | $1,388 | $1,728 | $542 | $542 |
| Power Supplied in 1984 (quadrillion Btu) | 1.096 | 6.002 | 1.110 | 14.189 | 20.957 | 20.957 | 17.75 | 20.957 | 19.696 | 14.189 |
| Subsidy/MBtu | $0.56 | $0.31 | $2.08 | $0.04 | $0.06 | $0.06 | $0.06 | $0.06 | $0.03 | $0.04 |

## Table B-3
## ESTIMATED FUEL INPUTS TO ELECTRICITY USED FOR PRIMARY ALUMINUM PRODUCTION

| State | Primary Alum. Prod. Capacity, 1986 | | Existing Electricity Capacity | | | | Existing Shares of State Capacity | | | Percent of Tot. U.S. Primary Production Supplied by State Capacity Fueled By: | | | State |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Metric Tons (1000's) | % of US Prod. | Hydro-electric | Nuclear | Fossil | Total | % Hydro | % Nuclear | % Fossil | Hydro-Electric | Nuclear | Fossil | |
| AL | 105 | 2.6% | 2857 | 5233 | 11900 | 19989 | 14.3% | 26.18% | 59.53% | 0.37% | 0.68% | 1.55% | AL |
| IN | 270 | 6.7% | 94 | 0 | 21435 | 21528 | 0.4% | 0.00% | 99.57% | 0.03% | 0.00% | 6.66% | IN |
| KY | 335 | 8.3% | 746 | 0 | 15860 | 16608 | 4.5% | 0.00% | 95.50% | 0.37% | 0.00% | 7.92% | KY |
| LA | 105 | 2.6% | 0 | 2236 | 15967 | 18204 | 0.0% | 12.28% | 87.71% | 0.00% | 0.32% | 2.28% | LA |
| MD | 160 | 4.0% | 531 | 1829 | 8097 | 10457 | 5.1% | 17.49% | 77.43% | 0.20% | 0.69% | 3.07% | MD |
| MO | 204 | 5.1% | 1064 | 1236 | 14353 | 16653 | 6.4% | 7.42% | 86.19% | 0.32% | 0.37% | 4.35% | MO |
| MT | 163 | 4.0% | 2207 | 0 | 2595 | 4866 | 45.4% | 0.00% | 53.33% | 1.83% | 0.00% | 2.15% | MT |
| NC | 115 | 2.8% | 1949 | 5125 | 13815 | 20889 | 9.3% | 24.53% | 66.14% | 0.27% | 0.70% | 1.88% | NC |
| NY | 241 | 6.0% | 5037 | 5234 | 22904 | 33174 | 15.2% | 15.78% | 69.04% | 0.91% | 0.94% | 4.12% | NY |
| OH | 245 | 6.1% | 119 | 2215 | 25279 | 27613 | 0.4% | 8.02% | 91.55% | 0.03% | 0.49% | 5.55% | OH |
| OR | 200 | 5.0% | 7873 | 1216 | 1277 | 10366 | 76.0% | 11.73% | 12.32% | 3.76% | 0.58% | 0.61% | OR |
| SC | 181 | 4.5% | 2348 | 6799 | 7179 | 16326 | 14.4% | 41.65% | 43.97% | 0.64% | 1.87% | 1.97% | SC |
| TN | 160 | 4.0% | 3714 | 2441 | 12124 | 18279 | 20.3% | 13.35% | 66.33% | 0.81% | 0.53% | 2.63% | TN |
| TX | 205 | 5.1% | 600 | 1250 | 60623 | 62473 | 1.0% | 2.00% | 97.04% | 0.05% | 0.10% | 4.93% | TX |
| WA | 1201 | 29.7% | 19859 | 2060 | 2217 | 24136 | 82.3% | 8.53% | 9.19% | 24.47% | 2.54% | 2.73% | WA |
| WV | 148 | 3.7% | 174 | 0 | 14988 | 15163 | 1.1% | 0.00% | 98.85% | 0.04% | 0.00% | 3.62% | WV |
| **Total** | **4038** | **100.0%** | | | | | | | | **34.10%** | **9.81%** | **56.0%** | |

**Sources and Notes:**

(1) Primary aluminum production capacity is for 1986, and is from the Bureau of Mines, Minerals Yearbook, Volume I: Metals and Minerals, 1986, Washington, D.C.: U.S. Government Printing Office, 1988, p.97.

(2) State electrical generating capacity is from "1988 Annual Statistical Report," Electrical World, April 1989, p. 63. Estimates assume that all plants operate at 100 capacity. Plant capacity figures for fossil fuels include geothermal plants, as well as Electrical World categories for fossil stream, combustion turbine, and internal combustion plants.

(3) National shares of sources of electricity consumed by the primary aluminum sector are production weighted averages.

(4) The national mix for all users is included for comparison, and is from the Department of Energy, U.S. Energy Information Administration, Monthly Energy Review, February, 1988.

**Derivation of Net Energy Subsidy to Virgin Paper Production**

A) Knowns:

- Total production in 1988: 88.8 million tons
- Recycled paper utilization rate in 1988: 24.4 percent
- Total energy consumed in paper production in 1988: 2,364 trillion Btu

B) $Tons_{recycled}$ = (24.4% recycled fiber content in new production)(88.8 million tons total production) = 21.7 million tons recycled

$Tons_{virgin}$ = (75.6% virgin fiber content in new production)(88.8 million tons total production) = 67.1 million tons virgin

**Low-end energy subsidy estimate for paper:**

1) Paper recycling saves 22 percent of the energy required to make virgin paper.

2) $Energy_{total} = (Energy_{per\ ton\text{-}recycled})(Tons_{recycled}) + (Energy_{per\ ton\text{-}virgin})(Tons_{virgin})$

3) $Energy_{recycled} = (.78)(Energy_{virgin})$

$a = Energy_{per\ ton\text{-}recycled}$
$b = Energy_{per\ ton\text{-}virgin}$

$a = .78b$

2,364 trillion Btu = (a)(21.7 mil. tons recycled) + (b)(67.1 mil tons virgin)

= (.78b)(21.7) + (b)(67.1)
= 84.03b
b = 28.13 trillion Btu = $Energy_{per\ million\ tons\text{-}virgin}$
a = (.78)(28.13) = 21.94 TBtu = $Energy_{per\ million\ tons\text{-}recycled}$

4) Total energy use by recycled sector = $(Energy_{per\ ton\text{-}recycled})(Tons_{recycled})$ = (21.94 TBtu/million tons)(21.7 million tons) = 476 trillion Btu = 20.1 percent of total energy use

Total energy use by virgin sector = $(Energy_{per\ ton\text{-}virgin})(Tons_{virgin})$ = (28.13 TBtu/million tons)(67.1 million tons) = 1,888 trillion Btu = 79.9 percent of total energy use

5) Net subsidy to the virgin sector = $(Percent\ of\ Total\ Energy)_{virgin\ sector}$ - $(Percent\ of\ Total\ Energy)_{recycled\ sector}$ =

79.9% - 20.1% = 59.8%

(.598)($486 million) = $291 million

**High-end energy subsidy estimate for paper:**

1) Paper recycling saves 64 percent of the energy required to make virgin paper.

2) $Energy_{total} = (Energy_{per\ ton\text{-}recycled})(Tons_{recycled}) + (Energy_{per\ ton\text{-}virgin})(Tons_{virgin})$

3) $Energy_{recycled} = (.36)(Energy_{virgin})$

$a = Energy_{per\ ton\text{-}recycled}$
$b = Energy_{per\ ton\text{-}virgin}$

$a = .36b$

2,364 trillion Btu = (a)(21.7 mil. tons recycled) + (b)(67.1 mil. tons virgin)

= (.36b)(21.7) + (b)(67.1)
= 74.91b
b = 31.56 trillion Btu = $Energy_{per\ million\ tons\text{-}virgin}$
a = (.36)(31.56) = 11.36 TBtu = $Energy_{per\ million\ tons\text{-}recycled}$

4) Total energy use by recycled sector = $(Energy_{per\ ton\text{-}recycled})(Tons_{recycled})$ =
(11.36 TBtu/million tons)(21.7 million tons) = 246 trillion Btu =
10.4 percent of total energy use

Total energy use by virgin sector = $(Energy_{per\ ton\text{-}virgin})(Tons_{virgin})$ =
(31.56 TBtu/million tons)(67.1 million tons) = 2,118 trillion Btu =
89.6 percent of total energy use

5) Net subsidy to the virgin sector =

$(Percent\ of\ Total\ Energy)_{virgin\ sector} - (Percent\ of\ Total\ Energy)_{recycled\ sector}$ =

89.6% - 10.4% = 79.2%
(.792)($486 million) = $385 million

**Derivation of net Water Subsidy to Virgin Production**

A) Knowns:

- Total production in 1988: 88.8 million tons
- Recycled paper utilization rate in 1988: 24.4 percent
- Total water consumed in paper production in 1982: 5.03 billion gallons/day

B) $Tons_{recycled}$ = (24.4% recycled fiber content in new production)(88.8 million tons total production) = 21.7 million tons recycled

$Tons_{virgin}$ = (75.6% virgin fiber content in new production)(88.8 million tons total production) = 67.1 million tons virgin

**Estimated net water subsidy to virgin paper producers:**

1) Paper recycling uses 42 percent of the amount of water required to make virgin paper.

2) $Water_{total} = (Water_{per\ ton\text{-}recycled})(Tons_{recycled}) + (Water_{per\ ton\text{-}virgin})(Tons_{virgin})$

3) $Water_{recycled} = (.42)(Water_{virgin})$

$a = Water_{per\ ton\text{-}recycled}$
$b = Water_{per\ ton\text{-}virgin}$

$a = .42b$

5,030 million gallons/day = (a)(21.7 mil. tons recycled) + (b)(67.1 mil. tons virgin)

$= (.42b)(21.7) + (b)(67.1)$
$= 76.21b$
$b = 66.00$ Mgal/Mtons-day = $Water_{per\ million\ tons\text{-}virgin}$
$a = (.42)(66.00) = 27.72$ Mgal/Mtons-day = $Water_{per\ million\ tons\text{-}recycled}$

4) Total water use by recycled sector = $(Water_{ton\text{-}recycled})(Tons_{recycled})$ = (27.72 Mgal/Mtons-day)(21.7 million tons) = 602 Mgal/day = 12.0 percent of total water use

Total water use by virgin sector = $(Water_{ton\text{-}virgin})(Tons_{virgin})$ = (66.0 Mgal-Mtons/day)(67.1 million tons) = 4,429 Mgal/day = 88.0 percent of total water use

5) Net subsidy to the virgin sector =

$(\text{Percent of Total Water})_{virgin\ sector}$ - $(\text{Percent of Total Water})_{recycled\ sector}$ =

88.0% - 12.0% = 76.0%
(.76)($9 million) = $7 million

1. **Source:** Charles W. Russell and Robert W. Bowhay. Income Taxation of Natural Resources. 1989. Paramus. NJ: Prentice Hall, Inc., 1989, pp. 806-07.