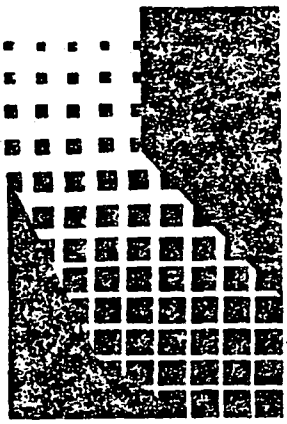

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# CALIFORNIA'S INCENTIVES FOR PRODUCTION OF VIRGIN AND SECONDARY MATERIALS

MAY 1993

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# Disclaimer

The statements and conclusions of this report are those of the Contractor and not necessarily those of the California Integrated Waste Management Board, its employees, or the State of California. The State makes no warranty, express or implied, and assumes no liability for the information contained in the succeeding text.

# Acknowledgments

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|---|---|
| **Committee Members** | Paul Relis, Chairman<br>Wesley Chesbro<br>Jesse Huff |
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| **Prime Contractor** | Tellus Institute |
| **Contract Number** | IWM-C-1082 |

The research presented in this study represents an intensive joint effort by people from several organizations. At Tellus Institute, Frank Ackerman directed the study, and Irene Peters played a major role in all stages of research; other Tellus staff who participated include Roger Geller, Betsy Gynn, Rebecca Little, Gretchen McClain, Karen Shapiro, and Dorota Szlenk. Four subcontractors provided essential contributions to the data collection and analysis: Rod Miller of Greener Futures, Lenny Goldberg of Lenny Goldberg & Associates, Tedd Ward of Gainer & Associates, and Eugene Tseng, Shelly Higgins, Paul Waters, and Yu-Yue Widrig of Eugene Tseng & Associates. Printing was done by SDV Print, of San Jose, California.

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# Preface

This report is only a limited look at the role of subsidies as they may impact markets for secondary materials. For years the idea has circulated that the sizable historical subsidies provided to virgin materials industries have inhibited the development of secondary materials markets. According to this reasoning, the marketability of secondary materials would be improved by ending or reducing virgin materials subsidies.

The report only deals with the question of price competition between virgin and secondary materials, and it only examines in detail incentives provide by the State of California to virgin materials industries. Furthermore, it is confined to the *current* financial benefit from State materials incentives.

For California, at least, the report suggests that current subsidies for virgin materials do not benefit those materials at the expense of secondary materials. However, this does not imply that the subsidies have not benefitted virgin materials industries themselves, nor does it address what direct actions are needed to stimulate secondary materials industries. A full determination of this issue -- a study well beyond the scope of this one -- would address at least the following areas of research:

1. What was the historic cumulative effect of past Federal and State government subsidies (which were larger than current ones) on virgin materials infrastructure? For example, are virgin materials attractively priced because of economies of scale made possible by the long history of subsidies to virgin material production? Factors examined would include the effect of subsidies on capital formation, infrastructure development, security and profitability of investment and price.

2. What would happen if we provided the equivalent incentives to secondary materials industries as we historically provided to develop our forests, mines, and oil and gas wells?

The California Integrated Waste Management Board currently has no plans to continue research along these lines. It is, however, working on practical issues such as increasing public and private sector procurement of recycled-content products, pursuing new avenues of increasing the financing available to manufacturers of recycled products, and analyzing a variety of minimum utilization/content options.

Asking questions about subsidies does not imply a Board endorsement of subsidies of any kind. Providing government incentives may or may not be effective or wise. However, since subsidies are a market development option, it behooves decision-makers to become more knowledgeable about what incentives have done and can do.

A final word of caution in reading this report: The methodology for the report required that an extreme case be made for direct incentives provided to virgin materials. Otherwise, critics would easily fault the report's conclusion if it failed to consider the effect of incentives held by some researchers in the field to be important. That means that the report includes as "subsidies" provisions of law, programs, and policies that others feel are not subsidies. Thus, no decisions regarding changes to the "subsidies" should be made without a more thorough analysis than was possible for this report.

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# Executive Summary

This is a study of two basic questions:

1. Does California provide substantial incentives for production of virgin materials?

2. Do State virgin material incentives put secondary materials at a competitive disadvantage in the marketplace?

The project began with a request from the California Integrated Waste Management Board (CIWMB) for "a study of State incentives to virgin and secondary materials and a determination of the effect, if any, of these incentives on the demand for secondary materials." The goal was to assist CIWMB in formulating policies "to improve the competitive advantage of secondary material relative to virgin materials." A research team of five organizations, led by Tellus Institute, performed the study in late 1992. The other team members were Gainer & Associates, Lenny Goldberg & Associates, Greener Futures, and Eugene Tseng & Associates.

In order to guide the reader through our detailed findings, we begin with the conclusions and policy implications, then describe our methodology and present a chapter-by-chapter summary of our report.

## Conclusions

The answers to the two basic questions are:

1. YES. California provides a number of virgin material incentives, through preferential tax treatment, regulations, and government spending. Quantifiable incentives cost the State at least $180 million annually[1] (see Chapter 1). California is not alone in this regard; similar federal incentives are worth billions of dollars (Chapter 2). In contrast, secondary material incentives created by State spending and tax reductions are much smaller (Chapter 3).

2. NO. There are two parts to the answer. First (Chapter 4), California's virgin and secondary materials largely do not compete with each other. The leading materials, oil, gas, and timber, account for more than two-thirds of the value of virgin material production and receive virtually all of the quantifiable State incentives. Most oil and

[1] The estimate doubles to $360 million annually if California's lack of an oil severance tax is counted as an oil production incentive. See Chapter 1.

gas production is used for fuel, and most California timber is used for construction lumber; thus they face little or no competition from secondary materials. Recycled paper, which accounts for over half the State's secondary materials tonnage, competes with virgin production from other states and Canadian provinces -- but there is almost no virgin paper production in California.

Second (Chapter 5), even in the few cases of direct competition between in-state virgin and secondary materials, such as asphalt, plastic containers, and glass, there is little evidence that virgin incentives have a noticeable effect on the competitive position of secondary materials.

The answer to the second question may come as a surprise. Yet there is a "mismatch" between most of California's virgin and secondary materials, i.e., a lack of head-to-head competition within the state. Direct competition between in-state sources of virgin and recycled materials could occur only in a few scattered cases. In the cases of direct competition, state virgin material subsidies are too small to have a major impact on secondary materials markets. But most of California's material production, and material incentives, cannot be understood within a framework of in-state virgin vs. secondary competition.

## The Importance of Incentives

The California Integrated Waste Management Board contracted for this study because of the widespread belief that reducing or eliminating virgin materials incentives would help secondary materials find markets. Given the mismatch between California virgin and secondary materials and the limited impact in cases of direct competition, this belief appears to have little foundation as far as California incentives are concerned. Whether or not virgin material incentives put secondary materials at a competitive disadvantage, it may be desirable to provide State secondary material incentives to reduce landfill capacity requirements.

There are two other distinct reasons why policymakers might be interested in modifying existing virgin materials incentives. The validity of these reasons and the wisdom of making changes based on these reasons, however, are beyond the scope of this study. In brief, the two reasons are:

A. **If virgin material incentives cause a net reduction in State revenues.**

B. **If incentives induce virgin material production with undesirable environmental impacts,** such as air pollution and oil spills from oil production, or loss of natural habitats and recreational benefits from timber production.

There remains a broader historical issue beyond the extent to which current virgin material incentives affect the current producers of secondary materials. That is, given the history of inequality, how much investment would be needed for secondary and virgin materials to

compete on an even footing? In the past, federal government policy granted incentives to virgin materials industries in order to stimulate their growth. Over time, the cumulative value of those incentives is likely to have been enormous. One result is that virgin materials industries throughout the United States have developed infrastructures that allow the economies of scale and other benefits not generally enjoyed by producers of secondary materials. The appropriate strategy to overcome this historical handicap on secondary materials producers is an important topic that is beyond the scope of this study.

From the standpoint of economic theory, incentives for either virgin or secondary materials should be based on an evaluation of their respective *full* costs, that is, the cost accruing to individual producers and consumers as well as the cost accruing to society at large. In most cases, secondary materials use has overall societal benefits (such as saving landfill space, and the environmental cost of landfills) which call for incentives on their recovery and use. In contrast, the use of virgin materials is often associated with societal costs (such as environmental damage through mining and harvesting), that would call not only for a removal of incentives, but a creation of disincentives.

## Policy Implications

Several distinct levels of government play a role in adopting and implementing materials policy. The initial objective of this report was the development of policy recommendations for CIWMB, based on issues of management of solid waste and secondary materials markets. But there are much broader policy implications of the analysis presented here. In fact, there are three levels of policy considerations that emerge from this report: first, some proposals require action by the federal government; second, others involve State policy, but extend beyond the mandate of CIWMB; and finally, still others are clearly the responsibility of CIWMB. We discuss each of the three categories in turn. Some issues, such as timber incentives and paper recycling, may intersect with all three levels of policymaking.

### *National/International*

First, some issues of material incentives are **inherently national or international in scope.** These involve questions of subsidies, taxes and environmental impacts that are difficult for a single state government to address.

Recycling paper does save trees, though almost entirely outside California. An analysis on a national or even North American scale would show the benefits of California's paper recycling program in replacing virgin production in the U.S. Northwest, British Columbia, and other papermaking areas. If federal incentives, or state/provincial incentives within the papermaking areas, are as large as California timber incentives, then they might constitute obstacles to recycling. Removal of virgin incentives, and/or creation of greater paper recycling incentives, might help conserve forests in papermaking areas.

Oil is marketed and traded internationally, so State production incentives have almost no impact on price, and therefore on level of use. However, energy is also the area of most substantial federal virgin material subsidies. Through taxes, import policies, and other measures, the federal government can have a major impact on oil use, price, and availability. If clean air and development of alternative-fuel vehicles are public policy goals, should federal energy subsidies be removed? Should higher gasoline taxes be established? Clean air goals are currently being addressed through severe local restrictions on future fuel use in affected areas, such as southern California. Elimination of federal oil subsidies, and increase of federal oil taxes, might make it easier to reduce gasoline use via market mechanisms.

*State*

Second, other aspects of incentives are **State issues involving multiple environmental and economic goals.** While it is appropriate for the State government to address these issues, CIWMB is not likely to be the lead agency in proposing policy changes.

California's timber subsidy, as explained in Chapter 1, includes State funding of fire suppression and other services that benefit the timber industry, and the tax break provided by the current low level of the timber yield tax. Elimination of this subsidy would discourage timber production, and would encourage source reduction and/or substitution of other materials in construction. The benefits of such a change would be a boost to the State treasury and the reduction of environmental damage from timber harvesting, including a decrease in the rate of habitat loss and protection of recreational and aesthetic values. Costs of eliminating timber subsidies might include job losses, depending on the balance of jobs created by logging vs. conservation and recreation industries.

California's incentives for oil production consist of tax breaks that benefit in-state producers. Elimination of the incentive might discourage production from some economically marginal oil wells, but would have little effect on consumption levels. The benefits of such a change would include increased tax revenues on wells that continue producing, and reduction in the environmental impacts of oil drilling and production. Costs would include potential tax losses and other economic losses if oil production is reduced, and potentially increased risks of oil spills in transporting out-of-state oil.

*CIWMB*

The final category are **incentives for secondary material production.** Here it makes sense for CIWMB to initiate policy, based on waste management requirements rather than on competition with virgin materials. California waste management policy, particularly as embodied in AB 939, places a high priority on reduction in landfilling. Therefore it is reasonable to provide incentives for secondary materials use in manufacturing.

Looking more broadly at secondary materials and landfill impacts, the largest components of the waste stream arriving at landfills are paper products, yard waste, and construction and demolition debris. The most common toxic substances in landfills are the items classified as household hazardous waste. Thus incentives for secondary material industries, designed to minimize landfill capacity or environmental impacts, should be focused on these materials. Through its Action Plans for these and other materials, CIWMB is developing strategies for reduction and recycling of major waste stream components. This, in the end, is an appropriate goal for State secondary material incentives.

## Methodology: What Counts as an Incentive?

Our study is not the first one to face the problem of defining government subsidies and incentives. In a recent analysis of federal energy subsidies, the Energy Information Administration (a division of the U.S. Department of Energy) states that

> There is no universally accepted definition of what constitutes a subsidy. A typical textbook definition of a subsidy is a transfer of economic resources by the Government to the buyer or seller of a good or service that has the effect of reducing the price paid, increasing the price received, or reducing the cost of production of the good or service.[1]

The Energy Information Administration (EIA) report includes both "direct subsidies," meaning federal budget outlays and tax expenditures, and "indirect subsidies," such as "provision of energy or energy services at below-market prices; loans or loan guarantees; insurance services; research and development; and the unreimbursed provision by the Government of environmental, safety, or regulatory services."[2] Regarding the problem of measuring tax expenditures -- subsidies provided via reductions in tax revenue rather than through budget outlays -- the EIA report observes

> Tax expenditures exist when actual tax treatment for particular kinds of taxpayers deviates from standard tax treatment. There is disagreement as to what constitutes standard treatment, both in principle and in practice. As a result, lists of tax expenditure items ... can and do differ.[3]

Our approach is similar to the EIA methodology.[4] We have examined California state budgets, tax expenditures, and agency activity in an attempt to identify government transfers of resources to raw material producers. Major quantifiable incentives we have identified include unreimbursed provision of fire protection to timberland owners; State tax expenditures paralleling federal ones described by EIA and others; and unique tax provisions for the State's virgin material industries.

Some analysts might quarrel with our identification of incentives, and argue for exclusion of some tax expenditures or program costs included in this report. In one case, we present

subsidy estimates with and without a controversial aspect of the State tax laws. But bear in mind the quantitative conclusions reached in Chapter 5: even when there is direct competition between virgin and recycled products, California virgin material incentives do not noticeably affect the competitive position of secondary materials. In fact, virgin material incentives do not have significant impacts on prices paid by consumers, with the possible exception of lumber and wood products. These conclusions are only made stronger by including a longer list of incentives in the analysis. If this conclusion holds for our relatively inclusive list of incentives, it is all the more true under a more exclusive definition of State incentives.

## Chapter Summaries

The remainder of this summary presents the principal findings of the study, chapter by chapter. The report contains five chapters:

Chapter 1: California Virgin Material Incentives
Chapter 2: Federal Virgin Material Incentives
Chapter 3: California Secondary Material Incentives
Chapter 4: Impacts of Major Virgin Material Incentives -- Timber and Oil
Chapter 5: Impacts on Virgin-Secondary Material Competition -- Asphalt, Plastics, Glass

### *Chapter 1: California Virgin Material Incentives*

California's mines, wells, and forests produced $9.1 billion of raw materials in 1990. More than half of this amount, $5.5 billion, was oil and gas, while $0.9 billion was timber. Other materials worth more than $0.1 billion were sand and gravel, Portland cement, boron minerals, gold, and crushed stone.

The most important State incentives for virgin material production are tax expenditures and subsidies benefitting the timber and oil and gas industries. The quantifiable incentives for nonfuel mining are quite small by comparison.

#### Timber Incentives

State programs and tax provisions that benefit the timber industry have a total annual value of $70 million, or 8% of the value of the timber harvest. The first two of the eight items account for three-quarters of the total benefit.

The **Timber Yield Tax** is appropriately designed to tax harvests rather than standing timber. (In contrast, a property tax on uncut timber would create a continual incentive for overcutting.) However, the *level* of the timber yield tax is very low, only 2.9% of the value of harvested timber. As a result, the yield tax per dollar of timber property is much less than the property tax per dollar of nontimber property. To achieve equity in tax burdens on timber and

nontimber property, the yield tax should be raised to at least 6.8% of the value of harvested timber, generating an additional $25.8 million in annual tax revenue.

**Fire suppression** for the more than 30 million acres of State Responsibility Areas costs the State government an annual average of $8.60 per acre. The State Responsibility Areas include 4.9 million acres of private timberlands; fire suppression on these private lands, at $8.60 per acre, costs the State $42.5 million. Other western states recover 32% to 60% of fire suppression costs from property owners. Using the other states' recovery rates as a standard, as much as 60% of the $42.5 million, or $25.5 million, might be counted as a subsidy.

**Smaller State programs** benefitting timber owners include: State university spending on forestry research and extension services; State regulation and inspection of timber harvest practices; forest improvement grants to small landholders; forest pest management; and the forest products utilization program. As detailed in Chapter 1, these programs amount to a $18.5 million annual subsidy to the timber industry.

### Oil and Gas Incentives

We have identified two important features of the California tax code that are widely interpreted as State subsidies to the oil and gas industry, and a third which is a subject of controversy. The two widely accepted subsidies in the tax code are **percentage depletion**, worth $45 million annually, and **expensing of intangible drilling costs**, worth $30 million annually.[5] The controversial tax provision, viewed as a subsidy by some but not by others, is the absence of a State oil severance tax. Proponents of such a tax suggest that it might raise $180 million annually, while others argue that it is not appropriate or desirable to impose any oil severance tax. The total annual State tax subsidy to the oil and gas industry is thus $75 million (1.4% of sales) without the severance tax calculation, or $255 million (4.6% of sales) with it.

### Nonfuel Mining Incentives

California's nonfuel mining industry receives two small State tax breaks, parallel to the provisions benefitting the oil industry. Percentage depletion is worth $5 million in tax reduction for mining, and expensing of exploration and development costs is worth $10 million. The combined $15 million annual benefit amounts to only 0.6% of the value of the materials produced by the State's mines.

Two other regulatory issues may provide implicit subsidies to mining enterprises, but the dollar value of such subsidies is unknown. First, State law sets standards for mine reclamation, but enforcement practices have allowed many mines to avoid paying the required reclamation costs. Second, there are reports of illegal sand and gravel mining on State lands, particularly in rural areas of some northern counties. Such mining receives an unintended subsidy equal to the fair market value of legitimate leases on the State lands.

*Chapter 2: Federal Virgin Material Incentives*

Federal incentives for forest products, petroleum production, and mining, principally in the form of tax advantages, have existed for decades. Although the Tax Reform Act of 1986 reduced many of these tax expenditures, significant federal incentives are still on the books.

**Forestry incentives**

The logging and forest products industries receive federal tax advantages and benefits from below-cost timber sales on federal lands. Tax provisions favoring the industry include expensing of multi-period timber growing costs, a $222 million annual federal tax expenditure in the late 1980's, and investment credits and amortization options for reforestation costs, a $203 million annual tax expenditure.

Many analysts have concluded that the U.S. Forest Service sells timber below cost. Published estimates of the annual cost to taxpayers range from $200 million to $800 million; both a Wilderness Society study and a draft EPA study calculated annual losses of around $400 million in the 1980's. Claims that federal timber sales enhance the regional economy by creating jobs are controversial, with some finding them substantial, and others finding them outweighed by employment in non-timber activities such as commercial fishing and tourism.

**Energy incentives**

A wide range of federal tax expenditures, regulations, and programs benefit the oil and gas industry. Federal agencies, such as the Office of Technology Assessment (OTA) and the General Accounting Office (GAO), have identified many tax expenditures that provide preferential treatment for oil companies. For example, OTA estimates that percentage depletion for oil and gas producers amounts to a $797 federal tax expenditure, while GAO concludes that some petroleum investments "are actually more profitable after taxes than before taxes because they help reduce taxes on other income."

A 1992 study by the Energy Information Administration (EIA) identifies $8 billion in federal energy subsidies in fiscal 1982, partially offset by $3 billion in energy excise taxes for general revenue purposes. The subsidies include energy-related programs, tax expenditures, and research and development funding. Among the most important subsidies in the EIA analysis are low-income heating assistance; expenditures on hydropower development and electric power sales; percentage depletion for energy producers; tax breaks for alcohol fuels; and research on nuclear power and coal technology. Many federal energy-related activities are not included in the EIA subsidy calculation, such as the costs of the Strategic Petroleum Reserve, federal uranium enrichment, and highway construction and other transportation programs.

**Nonfuel mining incentives**

The same tax advantages for nonfuel mining found in California law are available on a larger scale from the Internal Revenue Service. Depletion allowances were worth $340 million of tax expenditure annually in the late 1980's. Expensing of exploration and development costs averaged $35 million of tax expenditure.

Hardrock mining on federal lands is also subsidized by the General Mining Act of 1872. Private interests that discover valuable minerals on federal lands can stake a claim to mine there for only $100 a year; there are currently 150,000 active claims. Moreover, anyone who establishes a hardrock mining claim can buy the land on which it is located for $29 or less per acre; often the price is under $5 per acre. In some reported cases, claimants have received land with a market value of roughly one thousand times the price they paid to the government.

Environmental protection standards which could be more stringent are seen by some as another boon to primary resource extraction. There has been little overall federal regulation of mining waste disposal, in contrast to the treatment of other industries. Mines account for 50 actual and hundreds of potential Superfund sites, with cleanup costs in the billions of dollars.

**Water rates**

The federal government has provided subsidized water in arid western states. One study estimates that over the history of federal water sales, only 37% of the costs of water supply have been recovered from the users of the water. A draft EPA study estimates a subsidy of $5 billion per year; it is unclear how much of this subsidy benefits virgin materials industries.

**Impacts of federal subsidies**

Studies done in the 1970's concluded that federal subsidies do not significantly discourage or reduce the use of secondary materials. The subsidies were estimated to affect the price of virgin paper by 1%, copper by 5%, and steel by 2%. A more recent EPA study of the impact of federal subsidies has not yet been released. According to a brief press report on the draft study, its conclusion is the same as in the earlier studies. The EPA draft found energy policies to be the most important federal barrier to recycling, because virgin material industries use more energy than their secondary counterparts. In the extreme, the federal energy subsidy is worth 17% of the value of virgin aluminum; yet despite this subsidy, aluminum recycling is quite profitable. In the paper industry, federal virgin material subsidies were worth an estimated $500 - $700 million in 1988, reducing the cost of virgin materials used in the paper industry by less than 3%. This does not appear to be a major obstacle to paper recycling.

Despite the limited current significance, it is still possible that the history of virgin material incentives played a major role in establishing resource-intensive patterns of industrial growth. In an earlier era, resource abundance was taken for granted, and development of a sparsely populated wilderness was seen as a priority. The federal government vigorously and

successfully promoted resource use -- and the consequences of that success still shape American industry today.

*Chapter 3: California Secondary Material Incentives*

The secondary materials supply created by the State's recycling and composting programs amounted to more than 5 million tons of materials in 1990, or more than 20 million cubic yards of avoided landfill disposal. The diversion of these materials leads to avoided cost savings in collection and disposal, totalling an estimated $494 million for 1990, an average of $96 per ton of diverted material.

State incentives for secondary materials use include: a few small State-funded tax credits, grants and loan programs; direct legislative incentives for waste diversion; and indirect legislative incentives, such as minimum content and targeted procurement preferences. In contrast to the virgin material incentives described in Chapter 1, the State spends very little on promotion of secondary materials use.

Several small State programs provide direct support to industries using secondary materials. Used Oil Grants, funded by deposits paid when lubricating oil is sold, offer incentives of four cents per quart for oil recyclers. Market Development Grants are paid to manufacturers who use postconsumer and secondary materials as feedstocks. Tire Recycling Grants pay for small-scale research and business development plans using recycled tires. Recycling Manufacturing Equipment Tax Credits, in effect between 1989 and 1993, are available for business investment in equipment used to make products from secondary materials. The Recycling Market Development Zone Revolving Loan Fund provides low interest loans for publicly owned infrastructure and other capital improvements in designated Recycling Market Development Zones.

Direct legislative incentives for waste diversion include the State's mandates for local waste diversion planning and implementation, and the laws creating the beverage container recycling program, first enacted as AB 2020 in 1986. Container recycling includes consumer deposits, refunded when the containers are returned, and several other payments to support the necessary recycling infrastructure. It also includes processing fees, paid by container manufacturers and refunded to recyclers and processors; the processing fees raise the value of beverage container scrap materials high enough to cover the cost of recycling and processing.

Indirect legislative incentives for diversion include numerous laws requiring minimum recycled content, or targeting recycled content products for preference in State procurement. Minimum content legislation requires that selected products embody a specific percentage of secondary or Recycled content standards have been set for fiberglass insulation, glass containers, newsprint, rigid plastic containers, and trash bags; a standard may also be set for telephone directories. More detailed regulations apply to State government procurement preferences: there is a price preference for vendors of recycled paper and products made from recycled tires,

a recycled content standard for automobile batteries, a requirement to maximize use of compost on State projects, a preference for oil purchases with maximum recycled content, recycled paper purchasing requirements, and requirements to use recycled paving materials where possible.

*Chapter 4: Impacts of Virgin Material Incentives -- Timber and Oil*

Almost all of the quantifiable California incentives for virgin material production, as seen in Chapter 1, benefit two leading industries: timber and oil. The impacts of State incentives on these industries are important in a number of ways, but have very little effect on the competitive position of secondary materials.

**Timber incentives**

State incentives are worth 8% of the market value of California timber. If passed along to the end users of timber-based products, these incentives might have a noticeable effect on prices (although less than a 8% effect, since final product prices also include value added and any nontimber material costs).

More than nine-tenths of California's timber harvest is made into lumber, most of which is used in construction. Most of the remainder is made into veneer and plywood. The State's comparatively small paper industry relies heavily on sawmill residues, and uses almost no virgin timber. Therefore, timber production incentives may affect the construction industry, but have virtually no impact on virgin or recycled paper markets.

Reduction or elimination of timber incentives might increase the price of construction. Such an increase might discourage housing construction, encourage a shift from single-family to multi-family housing, and/or induce a reduction in the amount of timber per housing unit. There are many opportunities for housing redesign for lumber conservation. Switching to 24-inch spacing of studs, using metal brackets at corner wallboard junctions, and eliminating unnecessary lumber in floor framing can save hundreds of board feet of lumber per house. Both concrete and steel can substitute for lumber in many construction applications. However, concrete is comparatively expensive, and steel lacks some of the desirable properties of would.

A small recycling industry for construction lumber does exist; its main problem is a lack of sufficient supply of waste wood. One recycler reports that demolition contractors do not believe it is profitable to dismantle old buildings carefully and sell the wood waste, rather than grinding and burning it. Demolition activity fluctuates widely from year to year, due to such factors as changing economic conditions, urban renewal plans, and earthquakes and other disasters; thus the supply of recycled lumber inevitably fluctuates as well.

In the Los Angeles area, a small recycled lumber industry is well established, primarily processing lumber from television and motion picture sets. However, this industry is unique

in having a predictable supply of relatively clean used lumber. Overall, recycled lumber has less than a 2% market share, with most of it going for remodelling rather than new construction.

**Oil incentives**

Most California oil production is heavy oil, which must undergo special treatment before it can be processed further. As a result, it commands a lower price than light oil. Prices for heavy and light oil tend to move in parallel, with the cost difference reflecting the additional refining cost for heavy oil.

State incentives for the oil and gas industry are worth 1.4% of the value of production if the severance tax is not included, or 4.6% if it is. However, elimination of these incentives would not be likely to affect final product prices or consumption. California is integrated into the national and world oil markets, and the State's output is far too small a fraction of the world total to have a noticeable effect on prices. More than half of the crude oil received by California refineries comes from outside the state, mainly from Alaska and to a lesser extent from Indonesia. Under federal law, Alaskan oil cannot be exported, so it must be shipped to West Coast or Gulf Coast states.

Elimination of incentives might reduce the State's production, although a 1980 study concluded that this effect would be very small. An tax increase on oil production (which would result from the elimination of State incentives) would make marginal oil wells unprofitable. Since an oil well reaches its maximum output early in life and produces at a declining rate thereafter, a tax increase would hasten the arrival of the time when the well is no longer profitable. Very little oil, though, is produced by wells near the end of their lifetime. "Stripper wells," those yielding less than 10 barrels a day, currently account for only 8% of California's production, compared to 13% in 1980. A tax that led to shutting in these wells earlier would have only modest effects on total output. Local and regional environmental regulation is likely to have a greater impact on production decisions.

If a tax increase did lead to reduced oil production in the State, it might have environmental benefits as well as economic costs. Heavy oil extraction often involves steam injection, with steam created by burning oil on site. California oil has high sulfur and nitrogen content, so oil burning for steam injection is a significant contributor to air pollution in oil-producing areas, such as Kern County. However, reduced in-state production would likely mean increased oil shipping into California ports, with the attendant risks of oil spills.

*Chapter 5: Competition Between Virgin and Secondary Materials – Asphalt, Plastics and Glass*

There are exceptions to the "mismatch" between California's virgin and secondary materials. In a few cases, the State does produce both virgin and secondary forms of the same material. Chapter 5 examines three such cases, asphalt, plastics, and glass.

The first two products are made in part from oil. Would a 5% subsidy to oil production (roughly the amount of our higher estimate, including the severance tax), if passed on to final product consumers, affect the competitive position of virgin vs. recycled asphalt or plastics? The answer is no in both cases. Asphalt recycling is prospering, while plastics recycling is in its infancy; but neither would be noticeably helped or harmed by a 5% change in the price of crude oil.

In the case of glass, on the other hand, quantifiable State incentives for virgin production are insignificant. State programs, such as AB 2020, play a substantial role in promotion of recycling and marketing of secondary beverage container glass.

**Asphalt**

Asphalt-concrete, widely used for paving roads, is a mixture of 95% rock and sand aggregate, and 5% asphalt-cement, or bitumen. The latter is a heavy petroleum product, and accounts for 2.4% of the State's petroleum use. In 1991, virgin asphalt-concrete sold for roughly $23 per ton, excluding transportation; the cost of petroleum accounted for about 16% of the final product price, while the cost of aggregate was 41%. Thus the incentives identified in Chapter 1, worth almost 5% of the value of petroleum (using the higher estimate) and 0.6% of the value of nonfuel mining, amount to about 1% of the price of virgin asphalt-concrete -- excluding transportation. If such incentives were removed, and the full amount were passed on to asphalt customers, the price of asphalt-concrete would increase by roughly $0.25/ton. Use of the lower oil incentive estimate might cut even this modest increase in half.

The dominant influences on asphalt recycling are transportation and disposal costs. When virgin materials must be trucked from far away, and discarded asphalt must be hauled to remote landfills, the cost of transportation can easily outweigh the production cost. A rough estimate of transportation cost is $3.25 per ton per hour of travel; at this rate, the virgin material incentives (higher estimate) are equal to the value of about 5 minutes of additional trucking. Landfill costs in some urban areas also approach or equal the $23 per ton price of virgin asphalt. Over time, landfill tipping fees are likely to increase, making this factor even more significant.

Driven by transportation and disposal costs, asphalt recycling is a big and growing business in California. Several techniques exist for producing asphalt-concrete with 15% to 100% recycled content, either through in-place recycling or in central facilities. Los Angeles is the world leader in asphalt recycling, and other California cities are also active in this field.

Asphalt recycling can be expected to increase in areas remote from sources of virgin rock and sand aggregate, and in areas where landfill tipping fees are high and rising. However, it may never be cost-effective in rural areas with abundant sources of aggregate and low-cost landfills.

**Plastics**

Plastics, made from oil and gas feedstocks, involve several complex steps of refining and processing. In the process, value is added to the raw material, so that wellhead oil and gas costs are only a fraction of the final cost of plastics. If one ton of plastic were produced directly from one ton of light crude oil (an obvious oversimplification of the intricacies of the plastics industry), then the cost of the oil would account for only 9% - 18% of the cost of several widely used plastic resins. Based on these figures, incentives of 5% of the value of oil production would be translate to 0.45% - 0.90% of the value of plastic resins. Even if such an incentive were fully passed on to plastics producers, it does not appear to constitute a significant cost advantage for virgin production. The lower incentive estimate, of course, would have even smaller effects.

Plastics recycling is a new and still experimental endeavor. High-grade recycled plastics cannot yet be mass-produced in a cost-effective manner, though interesting research and development in plastics recycling is proceeding in many places. Rough cost estimates supplied by one manufacturer suggest that for soda bottle production, virgin plastic costs about 50 cents per pound, while recycled plastic costs about 70 cents per pound. In other words, the cost differential between the two production processes is many times larger than the value of virgin material incentives. In the case of plastics the immaturity of the technology, and to a lesser extent the uncertainty of the quantity and quality of recycled supply, are the factors limiting secondary production.

**Glass**

Glass production is a well-established industry, and one in which virgin and secondary materials can be used in the same processes with relative ease. Almost any proportion of secondary content can be used in glassmaking, although frequent changes in secondary content can damage a furnace or lead to production of defective glass. Higher secondary content leads to lower melting temperatures and allows slightly lower energy use; but since total energy use is only about 10% of the cost of glass container manufacturing, the energy savings from use of secondary content are not a major competitive factor.

Virgin material incentives for the materials used in glassmaking are insignificant. Secondary incentives, on the other hand, are substantial, as identified in Chapter 3. At present, glass containers made in the State include an average of 10% cullet from in-house production waste, 30% post-consumer cullet, and 60% virgin materials. In the absence of State secondary incentives, probably little if any of the post-consumer cullet would be used. Thus the incentives, designed to reduce littering and landfill requirements, have succeeded in stimulating the widespread use of secondary materials in manufacturing.

# Executive Summary - Endnotes

1. Energy Information Administration, *Federal Energy Subsidies: Direct and Indirect Interventions in Energy Markets*, November 1992, p.1.

2. Ibid., p.2.

3. Ibid., p.21.

4. Our data for quantifiable incentives reflects the revenue cost to California, comparable to the "Federal revenue foregone" figures in the EIA report. Conversion to the "outlay equivalent basis," which EIA favors for reporting purposes, would increase the value of California tax expenditures described in Chapter 1.

5. The Franchise Tax Board has stated that these estimates were correct at the time they were developed, in 1992, but notes that revised federal tax projections in early 1993 led to somewhat lower figures for future years, $34 million for percentage depletion and $20 million for intangible drilling expenses. Personal communication from Tam Margetich, Franchise Tax Board, February 9, 1993.

# Chapter 1: State Virgin Materials Incentives

## I. California's Virgin Raw Materials

### *Production Value*

California produces more than $9 billion of virgin raw materials annually, as shown in Table 1.1 and Figure 1.1 on the following pages. Oil and gas account for more than half of this total, or $5.5 billion. Timber is next in importance, with annual production worth $0.9 billion. The remaining materials are the products of nonfuel mining. These consist primarily of construction materials such as sand and gravel, portland cement, and crushed stone. Other mining products include boron materials, gold, and a wide range of industrial materials produced in smaller quantities.

### *Incentives*

Our review of State laws, regulations, and policies identified many incentives to virgin materials production, of widely varying size and importance to producing industries. By far the most complex and most valuable (as a percent of sales) were the incentives to timber production; these total $70 million, about 8% of total timber sales or 11% of private timber sales. Section II of this chapter, *Timber Incentives*, details these incentives. The most important are State funding of fire suppression, and the tax advantage obtained from payment of the timber yield tax in lieu of property taxes. However, several smaller State programs also contribute to timber incentives.

Tax provisions favoring the oil and gas industry, described in Section III, *Oil and Gas Incentives*, of this chapter, provide an effective subsidy to that industry. Analysis of some of these tax provisions, and hence the value of the subsidy, is a topic of controversy, as discussed in Section III. Two approaches to the analysis yield subsidies of $75 million (1.4% of oil and gas sales), or $255 million (4.6% of sales).

Finally, for nonfuel mining, we found two small tax breaks, worth 0.6% of sales, and two potentially important, nonquantifiable regulatory provisions favoring virgin mining. These are described in Section IV, *Nonfuel Mining Incentives*, of this chapter.

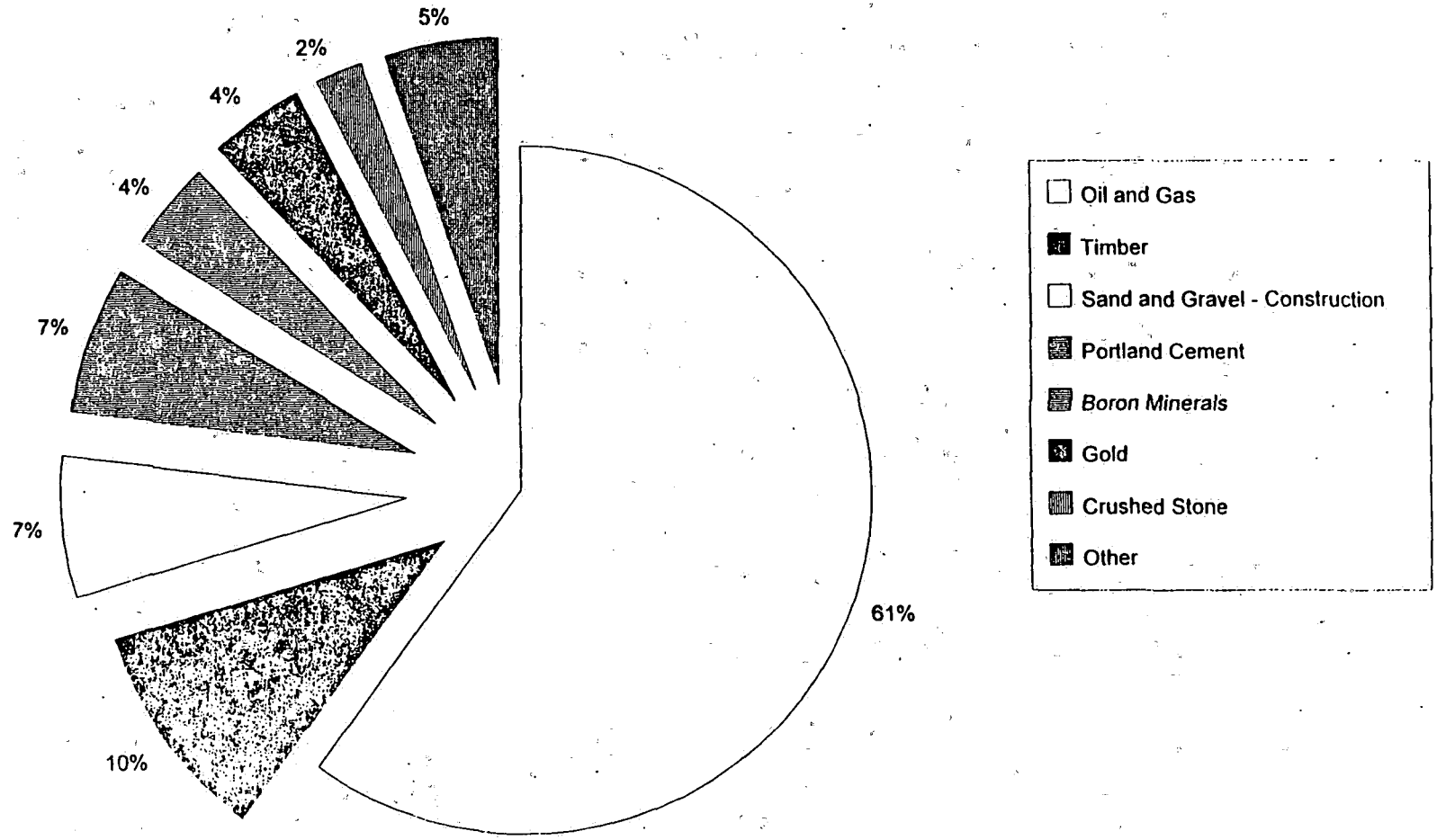
**Table 1.1**
**Value of California Virgin Raw Materials (1990)**

| | Value ($ million) | Including Oil and Gas % of Value in State | Excluding Oil and Gas % of Value in State |
|---|---|---|---|
| Oil | 4,812 | 53% | --- |
| Gas | 721 | 8% | --- |
| Timber | 890* | 10% | 25% |
| Sand and Gravel - Construction | 623 | 7% | 17% |
| Portland Cement | 620 | 7% | 17% |
| Boron Minerals | 404 | 4% | 11% |
| Gold | 391 | 4% | 11% |
| Crushed Stone | 201 | 2% | 6% |
| Sand and Gravel - Industrial | 46 | 0% | 1% |
| Clays | 41 | 0% | 1% |
| Lime | 23 | 0% | 1% |
| Gypsum | 14 | 0% | 0% |
| All Other (including Dimension Stone, Silver Gemstones, Pumice, and Masonry Cement) | 360 | 4% | 10% |
| **Total Value (without Oil and Gas)** | **$3,612** | **39%** | **100%** |
| **Total Value (with Oil and Gas)** | **$9,145** | **100%** | **---** |

* This is the value of the harvest subject to the Timber Yield Tax (see Chapter 2 for a description of this tax). The harvest area includes some federal and some Timber Production Zone land and accounts for 97% of the total timber harvest in the state.

Source: California Board of Equalization.

## Figure 1.1
## Value of California Raw Material Output (1990)




Source: California Board of Equalization.

## II. Timber Incentives

California has 18.6 million acres of commercial forest lands. Nearly two thirds of these lands are public holdings, mostly owned by the federal government. Of the 7.2 million acres of private commercial timberlands, approximately half are held by forest industry corporations, and half by individual owners.[1] In 1990, the total timber harvest in California was 4.251 billion board feet, of which 63% came from private lands, 36% from National Forest Service land, and 1% from State lands and from two federal agencies: the Bureau of Indian Affairs and the Bureau of Land Management.[2]

Most of California's commercial timberlands are designated as "Timber Production Zones" or TPZs. Industry primarily pays a Timber Yield Tax on these lands, which taxes the gross value of timber as it is harvested as opposed to a property tax which would impose a yearly tax on the amount of uncut timber on the land. (The Timber Yield Tax is described in detail later in this section.) In addition, there is a residual property tax on TPZs, based on the residual land value separate from the timber value. TPZ lands — only 2% of which are public — are protected from encroachment (land uses that might be incompatible with timber operations).[3]

The Timber Yield Tax is primarily directed at harvests from TPZs. However, this tax is also paid on some harvests from outside the TPZs. In 1990, the total harvest subject to the Timber Yield Tax was 3.998 billion board feet, or 97% of the total timber harvest in the State. The value of this harvest was $890.5 million. Of this value, 71.8% (or $639 million) were private and 28.2% were public timber sales.[4]

### *Forest Industry Subsidies*

There are a number of public services and programs that provide direct support to the timber industry. There is also one major provision in the tax law that can be interpreted as a subsidy to the industry. We estimate that the value of these programs and tax provisions amounted to roughly $70 million in 1990, which is 7.8% of the value of the harvest subject to Timber Yield Tax, or 10.9% of the value of private harvest subject to the tax. The items making up the subsidy are as follows:[5]

| | |
|---|---|
| Property Tax Shortfall in Timber Production Zones | $ 25.8 million |
| Fire Suppression Services | $ 25.5 million |
| Forestry Research & Development | $ 7.2 million |
| Forest Practices Regulation | $ 6.8 million |
| Forest Improvement Program | $ 2.5 million |
| Forest Pest Management | $ 1.6 million |
| Forest Products Utilization Program | $ 0.4 million |
| **Total** | **$ 69.8 million** |

The following text sections describe these programs, while Table 1.2 provides detail on recent annual costs of many of the programs. (In several cases, projected fiscal year 1992-93 spending is included along with actual spending for earlier years.)

## 1. Timber Production Zones and the Timber Yield Tax

Timberland owners can request that local governments designate their land as a "Timber Production Zone" (TPZ - pursuant to Section 51110 *et seq.* of the Government Code). Nearly 5.5 million acres of the State's 7.2 million acres of private forests are designated TPZs. Similar to protection provided to agricultural lands by the Williamson Act, the designation as Timber Production Zones protects forest lands from encroachment by land uses that are incompatible with timber operations.[6] The main feature of this arrangement, however, is that these areas are not subject to the traditional property tax, but instead pay a "Timber Yield Tax."

The yield tax was designed to generate the same amount of tax revenue that would have been paid as property tax on the standing timber, but paid *at the time of cut.* The intent of this tax design is to avoid creating tax incentives for overcutting. A traditional property tax would impose a yearly tax burden on the amount of *uncut* timber on the land, forcing excessive cuts for at least two reasons: first, the property tax would decline after the timber is cut, and second, the tax burden might be so high that additional cutting would be encouraged for the purpose of paying the taxes. There might even be an incentive to sell or convert timberland to development purposes to pay the property taxes.

The timber yield tax, in contrast, taxes only that proportion of timber which is being cut, thus creating no new incentives to cut timber. Specifically, it imposes a tax rate on the gross value of timber as it is harvested.

The yield tax was designed to generate a tax revenue equivalent to a property tax on the timberlands. Originally, the rate was set at 6.0% of the value of the timber harvest. In 1978, this rate generated approximately $41 million.[7] The revenue from the yield tax has diminished considerably since then. After Proposition 13 broadly cut property taxes, the timber yield tax rate was first reduced to half of the prior rate, or 3%, and then lowered to 2.9%, to reflect the more than 50% cut in property taxes which occurred for all property owners under Proposition 13. This rate of 2.9% has not been changed since, although it is likely that considerable changes in property values have occurred in recent years.

On $890.5 million worth of timber harvest subject to the yield tax, the 2.9% rate generated $24,937,000 in yield taxes in 1990 (compared to $41,342,000 in 1978 on a lower 1978 yield). The proportion of tax revenue collected from private lands is 71.8%.[8] Thus, $17,904,000 in yield taxes came from private lands in timber production zones. In addition, property taxes are paid on the residual value of the unimproved land itself, as it would be assessed without the timber. The value of the 5.5 million private acres in the TPZ was assessed at $426 million,

according to the Board of Equalization, or less than $100 per acre, and tax of $4.26 million was collected.[9] Thus the total tax bill under yield tax and property tax law came to $22,160,000.

This amount appears to be significantly less than the property tax equivalent would be. However, in the absence of property valuations, the correct property tax value cannot be determined directly. Therefore we will estimate the true value of private timberland in the State, and the property tax that would be assessed on property of that value. Conceptually, to be consistent with Proposition 13, the fair market value of the timber property should be assessed and then discounted for approximate assessment ratios based on the change in ownership method of reassessment.

We suggest the following ways to estimate the fair market value of timber property:

- **Changes in ownership.** Between 1977 and 1986, 2.4 million acres were sold for $3 billion, which implies an average sales price of $1250 per acre. At 5.5 million acres of TPZ land, the value of timberland in TPZ's would be about $6.9 billion. Sale prices presumably include the residual non-timber value of the land, so it is *not* appropriate to add the $426 million residual value to this figure.[10]

- **Board foot value.** The market value of standing timber is estimated to be, on average, $100 per 1000 board feet, or 10 cents per board foot. There are 84 billion board feet of standing timber on private lands, giving timber values of $8.4 billion. In addition, the residual non-timber value of $426 million should be added, giving a total value of $8.8 billion.[11]

Estimates of sales price per acre which we obtained in discussions with experts in the field appear consistent with these numbers. We thus assume a range of property values between $6.9 and $8.8 billion.

At the going rate of 1% in tax, without discounting for the Proposition 13 assessment system, the amount of property tax revenue generated ranges from $69 million to $88 million, or from three to four times the amount that is currently paid. The more accurate Proposition 13 equivalent value would be to discount the $6.9 to $8.8 billion in TPZ land value by the average overall assessment ratios. The Board of Equalization has been using a 0.7 average assessment ratio (i.e., the 1% tax rate applies to an assessed value averaging 70% of current market value). At $6.9 billion, the total assessed value would be $4.8 billion, which would generate a tax payment of $48 million.

An alternative approach generates a very similar estimate. In reality, property values used for assessment under Proposition 13 are not always updated to the market value of the property unless a change in ownership occurs. Actual data on change in ownership of timberlands are available between 1977 and 1986. In that period, 2.4 million acres were sold for $3 billion.

The remaining 3.1 million acres, assuming they have not been sold since 1986 (a rather conservative assumption), might be valued at 1978 or 1975 values, with a annual increase of 2%. A very conservative estimate for these acres would add at least $2 billion in 1992 values, bringing total assessed value on a "real" Proposition 13 basis to about $5 billion. That would generate $50 million in property tax.

We will use the smaller of these two figures, $48 million, as the property tax equivalent for private TPZ timberlands, recalling that it was based on our lower estimate of property values. The effective subsidy due to the differential tax treatment of timberlands is then $48 million minus the tax currently paid:

$48.0 million - $22.2 million = **$25.8 million**

Note that $4.3 million of the $48.0 million comes from the property tax on the residual value of the land. To raise the remainder, $43.7 million in timber yield tax collected from private lands would require a tax rate of about 6.8% on the timber harvest.

## 2. Fire Suppression

California's arid climate places timberlands at risk to forest fires. Early in this century, the California Department of Forestry and Fire Protection (CDF) began to assume responsibility for fire fighting in certain areas. Today, State law (PRC Section 4100) requires the CDF to establish areas of responsibility for fire prevention and suppression, or State Responsibility Areas (SRAs). The State has direct responsibility for fire suppression for 30.475 million acres. Of this amount, 4.939 million acres are private timberlands within the SRAs, amounting to 16.2% of the total area protected by the State.[12]

Fire suppression services are also provided by the federal government. The State government does not solely protect State lands, nor does the U.S. Government protect only federal land; rather, they share the responsibility in order to make efficient use of their fire fighting resources. Where federal land is adjacent to State lands, the State protects federal lands, and vice versa. The State also provides fire fighting services on some 6 million acres in local responsibility areas. Lacking detailed information on the federal/state swap of services, we will assume that the fire fighting efforts which each level of government provides for the other are equivalent, in terms of cost and area of lands protected.

Fire prevention and suppression costs vary from year to year. In the last three fiscal years (actual 1990-91 and 1991-92, and budgeted 1992-93) CDF spent an annual average of $262 million on fire prevention and suppression (see Table 1.2 for annual amounts).[13] This average divided by the number of acres under CDF protection yields a cost of protection per acre:

$262 million / 30.475 million acres = $8.60/acre

We then estimate the value of fire suppression on private timberlands as this cost per acre applied to the private timberlands in the State Responsibility Areas:

4.939 million acres x $8.60/acre = $42,475,000

For comparison, the area which the federal government protects is 47.590 million acres, of which 4.8%, or 2.261 million acres are private land. We do not have a number for federal fire suppression expenditures, but assuming that the federal government spends as much per acre as the State does, the analogous federal amount would be:

2.261 million acres x $8.60/acre = $19,445,000.

Fire suppression protects the environment, a public good, as well as the value of timber and non-timber businesses, a private good. There are residential buildings and non-timber businesses on or close to timberlands that are also protected by CDF fire-fighting activities. We have no information on the value of non-timber activities on timberlands protected by the public sector. However, as of ten years ago, other western states were recovering 32% to 60% of fire suppression costs from property owners benefiting from fire suppression activity.[14] Using the other states' recovery rates as a standard, the worst-case estimate is that 60% of State fire suppression spending could be counted as a timber industry subsidy. Thus we estimate 60% of $42.5 million, or **$25.5 million**, is the State fire suppression subsidy.[15]

### 3. University Research and Development Expenditures

Several programs, sponsored in part with State funds, develop and disseminate research information on forestry practices and management. Although research projects are spread among many individual faculty members of the University of California and California State University systems, the primary state forest research organization is the University of California Agricultural Experiment Station. Research information and technical assistance is disseminated to private entities through the U.C. Cooperative Extension, which is paid for by a combination of federal, State, and county funds.[16]

Based on information provided by the University of California for fiscal year 1990-91, we estimate that forestry-related research and administrative expenditures (State funds) of the U.C. Agricultural Experiment Station and the U.C. Cooperative Extension totaled around **$7.2 million.**[17] Examples of research projects that the Experiment Station is pursuing include: Detection and Evaluation of Early Stages of Wood Decay, Optimizing the Drying Process For Commercial Western Softwoods and Hardwoods, Process Monitoring and Nondestructive Evaluation of Wood and Wood-based Composites, Fracture Criteria For Wood, and Long-term Recovery of Streams Disturbed By Timber Harvest and Related Activities.

### 4. Forest Practices Regulation

CDF regulates timberland management and harvest through Timber Harvest Plans. These documents describe the scope of harvest and replanting operations and specify measures to protect bodies of water and wildlife from the effects of logging. It is CDF's responsibility to review and approve these plans and to inspect timberlands to ensure proper compliance.

Timber Harvest Plans are intended as functional equivalents to Environmental Impact Reports; thus timber harvesters are not required to produce Environmental Impact Reports. The plans also substitute for permits that are otherwise granted through the Water Resources Control Board.

The Legislative Analyst has recommended that cost of timber industry regulation be borne by fees on the land that is subject to Timber Harvest Plans. The Legislative Analyst states that such fees would "be consistent with the legislature's actions in requiring that the cost of similar regulatory programs administered by other state agencies, such as the Department of Food and Agriculture and water quality control boards, be fully or partially reimbursed through industry fees and assessments."[18]

To date, the State legislature has attempted to fund environmental protection activities through fees wherever possible. A large number of fees bear witness to this effort: hazardous waste fees, landfill fees, and air and water permit fees. A comparable fee on land subject to Timber Harvest Plans was indeed adopted by the legislature through the Budget Act in 1981, but it was never implemented. In the Attorney General's opinion (Ops. Cal. Atty. Gen. 864 (1981)), the Budget Act did not provide sufficient authority for CDF to assess the fees. The fees have since been introduced in the legislature but have failed to pass.

Timber harvest regulation is funded through General Fund and similar fund monies. The annual average of amounts spent or budgeted for timber harvest regulation is $6.79 million for fiscal years 1990-91 through 1992-93.[19]

### 5. CDF Forest Improvement Element

CDF manages a "Resources Protection and Improvement" element which is composed of various programs designed to enhance forestry in California (pursuant to the authority of numerous Public Resources Code sections and specific authority of the Forest Improvement Program, PRC Section 4790 *et seq.*). The Forest Improvement Program provides grants to small nonindustrial landholders for projects such as the clearing of competitive undergrowth, tree planting, erosion control activities, tree thinning, and preparation of timber management plans. Program staff states that most of the program's resources are directed towards forest improvement. A small percentage of the activities have wildlife habitat benefits.[20]

The Forest Improvement Program is funded primarily through the sale of timber from State owned timberlands (paid into the General Fund). For fiscal year 1991-92, General Fund expenditures on forest improvement amounted to **$2.554 million**. The budget for the next fiscal year has been increased to $3.355 million (see Table 1.2).

### 6. Forest Pest Management

CDF, in coordination with the U.S. Forest Service, engages in pest control activities. A substantial portion of this activity occurs outside of private timberlands. However, private timberlands benefit from the management of pests and the reduction of pest damage.

According to CDF, pests destroy over 10 times more volume of timber than are lost to forest fires and "in 1989, some six billion board feet of timber was killed by insects and diseases...."[21] Since the timber industry is the primary beneficiary of the program, we allocate the full cost of the program to subsidies to the industry.

In FY 1991-92 general fund and related expenditures for pest management activities totaled **$1.626 million** (see Table 1.2).

### 7. Forest Products Utilization Program

This program provides technical assistance to industry by promoting harvesting and sawmilling techniques which increase efficiency. The program also assists in the development of "new forest product markets." This program might very well lead to timber conservation, by encouraging greater harvesting and milling efficiency. On the other hand, the market development activities might lead to greater demand for timber and offset the conservation effects. We therefore allocate the full cost of this program to subsidies to the timber industry.

Expenditures on the Forest Utilization Program were **$0.41 million** in the fiscal year 1991-92 (see Table 1.2).

### 8. Road Building

We have considered the question of whether public funds, collected from sources other than the timber industry, are used for road building activities which serve, in essence, as an infrastructure benefit for the timber industry. If roads are constructed, maintained, or reconstructed to standards that support the weight of log bearing vehicles (and log bearing vehicles are the heaviest vehicles using the roads), then some portion of construction costs are, in effect, an industry subsidy. The federal government does pay for road building on National Forest Service lands, and a substantial percentage of that money comes from the sale of federal timber.

We have not been able to identify the portion, if any, of road building expenditures that might be counted as timber industry subsidies, as road building activities are funded through a wide variety of revenue sources (special or improvement district assessments, federal highway funds, State tax funds generated by the gas tax), and local taxation methods. Therefore, the value of this subsidy, if any, is not included in the total estimate of incentives to virgin timber production.

## Table 1.2
## Annual Timber Statistics

### Fire Suppression Cost ($ millions)

| | FY 90-91 (actual) | FY 91-92 (actual) | FY 92-93 (budget) |
|---|---|---|---|
| General Fund | 281.098 | 227.999 | 211.897 |
| Capital Outlay | 8.044 | 10.421 | 1.187 |
| Administration | ------ | 22.630 | 22.816 |
| **Total State Expenditures** | **$289.142** | **$261.050** | **$235.900** |
| **3 Year Average** | **$262.030** | | |

### Forest Practice Regulation ($ millions)

| | FY 90-91 (actual) | FY 91-92 (actual) | FY 92-93 (budget) |
|---|---|---|---|
| General Fund | 4.760[22] | 4.466 | 4.617 |
| Proposition 99 | 1.887 | 2.573 | 0.520 |
| Administration | --- | 0.747 | 0.800 |
| **Total** | **$6.647** | **$7.786** | **$5.937** |

### Forest Improvement Program ($ thousands)

| | FY 91-92 (actual) | FY 92-93 (budget) |
|---|---|---|
| General Fund | 2,404 | 3,205 |
| Administration | 150 | 150 |
| **Total** | **$2,554** | **$3,355** |

(continued)

Table 1.2 (continued)

**Pest Management ($ thousands)**

| | FY 91-92 (actual) | FY 92-93 (budget) |
|---|---|---|
| Off Shore Oil | 483 | 722 |
| General Fund | 829 | 578 |
| Proposition 99 | 125 | 125 |
| Administration | 260 | 340 |
| Reimbursements | (71) | (65) |
| **Total** | **$1,626** | **$1,765** |

**Forest Utilization ($ thousands)**

| | FY 91-92 (actual) | FY 92-93 (budget) |
|---|---|---|
| General Fund | 362 | 336 |
| Administration | 50 | 50 |
| **Total** | **$412** | **$386** |

Source: Office of the Governor, Governor's 1992-1993 Budget Plan.[23]

## III. Oil and Gas Incentives

California oil production in 1990 exceeded 320 million barrels from 49,706 wells. The value of this production was $4.8 billion. Natural gas production was greater than 320 billion cubic feet in 1990, at a value of $721 million. Thus the total value of oil and gas production was $5.5 billion. (These numbers do not include oil and gas produced from federal Outer Continental Shelf waters.)[24]

We have identified two important features of the California tax code that are widely interpreted as State subsidies to the oil and gas industry, and a third which is a subject of controversy. The two widely accepted subsidies in the tax code are percentage depletion, worth $45 million annually, and intangible drilling expenses, worth $30 million annually.[25] The controversial tax provision, viewed as a subsidy by some but not by others, is the absence of a State oil severance tax. Proponents of such a tax suggest that it might raise $180 million annually, while others argue that it is not appropriate or desirable to impose any oil severance tax. The total annual State tax subsidy to the oil and gas industry is thus $75 million (1.4% of sales) without the severance tax calculation, or $255 million (4.6% of sales) with it.

### *Percentage Depletion*

Oil companies are permitted "percentage depletion" deductions beyond the rate of normal "cost depletion" to account for depletion of their natural resource base and the inherently risky process of investment in oil. This has been identified as a tax expenditure because percentage depletion is at a higher rate than normal cost depletion would allow. The difference between percentage depletion and cost depletion for all natural resources is $50 million, of which approximately 90%, or **$45 million** is received by the oil and gas industry.[26]

### *Intangible Drilling Expenses*

For tax purposes, most business investments cannot be immediately deducted from taxable income. Rather, investments must normally be amortized over a lifetime of several years. The alternative, "expensing" of investments, allows immediate deduction of the full amount of the investment in the year in which it is incurred. Expensing serves to speed up tax deductions, thus providing a benefit to business by delaying tax obligations.

Oil companies are allowed to "expense" their intangible drilling expenses, i.e., the overhead costs (intangible costs) of sinking new wells. Their calculation for California is not necessarily related to their production in California but rather to the extent to which oil companies' income is apportioned to California for purposes of taxation.

According to the Franchise Tax Board, the difference between expensing and 10-year amortization of intangible drilling expense is a **$30 million** tax expenditure.[27]

*Oil Severance Tax*

Opinions differ sharply on the question of a State oil severance tax, or royalty, on California oil production. Without attempting to judge the merits of the two positions, we simply present the two sides of the debate, and point out their differing implications for the calculation of virgin material subsidies.

Proponents of a State severance tax observe that in the wake of the 1970's oil crises, almost all oil-producing states and countries imposed oil severance taxes or royalties on production occurring within their borders. Internationally, OPEC nations have demanded and won significant payments from the oil companies. Within the United States, 13 of the top 14 oil producing states have adopted severance taxes. Alaska charges a severance tax of 15% of the value of production. In Louisiana the severance tax is 12.5%; in Oklahoma it is 7.0%; in Texas, it is 4.6%. California, alone among major oil producing states, does not collect any revenue (beyond a regulatory fee) from the State's producers.[28] Therefore, an oil company comparing the benefits of producing in California versus other oil-producing regions would effectively experience a subsidy, due to the State's lack of a severance tax.

Opponents of a State severance tax respond that it is inappropriate and misleading to classify the lack of one single tax as a subsidy. Interstate tax equity, the principle on which the pro-severance position rests, should be judged on the basis of the total tax burden on oil companies, not on narrow comparisons of one specific aspect of state tax codes. California imposes other taxes on corporations, including oil companies, that are not matched by some major oil-producing states. So on a total tax burden basis, the interstate comparison would be more complex.

Still more complexity is added by the differential quality of crude oil. Most California oil is low-value heavy crude (see Chapter 4), while other states produce higher-value light crude. Thus California oil production costs and revenues may not be comparable to other states.

How much is at stake in this debate? At present, California oil interests pay a 1% property tax to their county of origin, based on the value of oil as it is produced at the wellhead. In other states, oil producers face an average State and local tax burden of at least 6%. Thus severance proponents estimate the effective subsidy due to the absence of a State severance tax as at least 5% of the wellhead value of California oil. Assuming 300 million barrels of oil at $12 per barrel (which is slightly lower in both price and quantity than the actual 1990 data), a 5% subsidy would amount to **$180 million**. Severance tax opponents, of course, estimate an effective subsidy of **$0**.

## IV. Nonfuel Mining Incentives

California has a rich history of mining activity. Today the State produces well over 210 million short tons of nonfuel minerals worth more than $2.7 billion annually.[29] As shown in Table 1.1, more than half of this amount (by value) consists of construction materials — sand and gravel, portland cement, and crushed stone. The State's major non-construction minerals are boron and gold; many other minerals are produced in smaller quantities.

We have identified two small tax breaks that benefit nonfuel mining, parallel to two of the tax provisions favoring the oil and gas industry. We have also identified two regulatory issues that may provide implicit subsidies to mining enterprises: inconsistent enforcement of mine reclamation standards, and mining on State lands by operators without leases (who do not pay State royalties).

### *Mining Tax Benefits*

Mineral and ore mining benefits from two of the same tax provisions that subsidize the oil and gas industry: percentage depletion at a rate above normal cost depletion and expensing of natural resource exploration and development costs instead of amortization of these costs. As explained in the discussion of oil and gas, above, percentage depletion permits a larger write-off than normally would be taken if only the value of the depleted mineral were subtracted from taxable income. Expensing means that costs can be written off more rapidly than would be the case if, as is normal, those costs were written off over the lifetime of the investment.

The Franchise Tax Board (FTB) estimates that $5 million of the benefit from percentage depletion allowances (the excess over cost depletion) accrues to minerals other than oil.[30] In addition, FTB estimates that non-oil expensing of exploration and development costs for mining industries amount to a $10 million tax break in 1992.[31]

The value of these two tax provisions, $15 million, amounts to roughly 0.6% of the value of shipments of California's nonfuel mining industry.

### *Regulation of Mine Reclamation*

Regulatory standards for mining activities are primarily set by the State and enforced by local governments. In particular, the State Department of Conservation (DOC) and the Mining and Geology Board establish the standards for compliance with the principal act requiring mine reclamation, the Surface Mining and Reclamation Act (SMARA, PRC Section 2710 *et seq.*, enacted in 1976). It is the responsibility of local governments to issue permits for surface mining activities and to review and approve required reclamation plans and financial assurances.

SMARA reclamation standards are designed to enable mined land to serve some beneficial use after mining activities have stopped. Reclamation activities can include structural filling, slope preparation, and revegetation. In light of substantial noncompliance, SMARA was strengthened in 1990. However, DOC has noted substantial problems with local governments' implementation of the Act even after the 1990 amendments.[32]

First, local governments, in a large number of cases, have not yet required mine operators to submit reclamation plans. By June 1992, 26% of the known operating mines still had not submitted plans.[33]

Second, local governments have approved plans which, according to DOC, "are so vague they are unenforceable." DOC states that few of the approved plans meet SMARA standards. This is important because reclamation plans are the key to the enforcement of SMARA regulations. Plans identify the actions that will be taken to mitigate environmental and public safety hazards existing at the end of mining operations.

Third, financial assurances are required, accompanying the reclamation plans, to guarantee that future reclamation activities can be funded. Only 25% of the required financial assurances have been submitted.[34]

In all, DOC reports that only 5% of local agencies are fully complying with the requirements of SMARA, e.g., approving plans in compliance with State standards, requiring financial assurances and performing inspections. Four local agencies were cited as engaging in illegal mining activities themselves.

The lack of compliance with SMARA allows the mining industry to avoid costs of reclamation and environmental damage mitigation that are required by public edict. Environmental problems which result from inadequate reclamation include loss of aesthetic value, siltation problems, water drainage problems and accident hazards.

Other industries whose facilities disturb surface areas are required to properly close and eliminate environmental hazards associated with their exhausted operations. For example, landfills are subject to extensive (and expensive) closure and postclosure requirements. Hence, it is reasonable to view substandard enforcement of reclamation requirements as providing an implicit subsidy for the mining industry. No estimates are available of the dollar value of this subsidy.

The reclamation costs under discussion here are the eventual costs of reclamation of currently operating mines, which will be incurred in the future when the mines close. Prudent accounting practices would require that these costs be collected during the mines' operating years, in order to have funds available at the time of closure. Such costs should not be confused with the cost of reclamation of California's thousands of abandoned mines, many of which were abandoned long before the 1976 enactment of SMARA (indeed, many were abandoned in the nineteenth century).

*Sand and Gravel Mining On State Lands*

Some sand and gravel mining operations occur on State lands administered by the State Lands Commission (SLC). These lands may be subject to State sovereign ownership interests, consisting of fee and/or public trust easement. The State acquired such sovereign ownership of the beds of its tidal and navigable waterways upon its admission to the United States in 1850. The SLC requires leases for mining operations on State-owned fee lands and reviews projects on easement lands to assure consistency with public trust needs of the area. When State-owned fee lands are leased, the SLC collects a royalty on sand, gravel, and other minerals extracted from the State's lands.

In certain cases, the SLC has been unable to secure leasing and royalty agreements from the entities that are extracting sand and gravel from State lands. These cases of "trespass" mining allow producers to obtain free use of the State's resources without compensating the State.

For example, Sidnie Olson, Senior Planner for Humboldt County, indicates that permits have been issued for 700,000 to 800,000 cubic yards of sand and gravel mining in that county,[35] and estimates that 75% of this mining will occur on land administered by the State Lands Commission. Humboldt County itself does 10% of the sand and gravel mining in the county. The SLC has obtained some royalties for mining operations in Humboldt County, but many permit holders have not paid royalties.

Operators and adjoining land owners frequently dispute the State's ownership of areas to be mined. They attribute trespass mining to a lack of clearly drawn and understood boundaries around State lands. Resolution of these disputes is costly and time consuming, and can result in delays in bringing mining operations under lease. SLC staff is actively pursuing several mining operators who staff believes are extracting resources from the State's lands without authorization.

Clearly, trespass mining receives a subsidy equal to the fair market value of the State lands and resources being used. It is difficult to quantify the scope of trespass mining, as there is no data available as to its extent nor on the value of the land it uses.

# Chapter 1 - Endnotes

1. California Department of Forestry and Fire Protection. *California's Forest and Rangelands: Growing Conflict Over Changing Uses.* July 1988, p. 110.

2. U.S.D.A. Forest Service. *Production, Prices, Employment, and Trade in Northwest Forest Industries, First Quarter 1992,* p.20, table 19. By Debra D. Warren, Pacific Northwest Research Station.

3. California Department of Forestry and Fire Protection. *California's Forests and Rangelands: Growing Conflict Over Changing Uses.* July 1988, p.156.

4. Personal Communication of Lenny Goldberg with Jeff Reynolds, Statistics Division, State Board of Equalization, November 1992.

5. The dollar figures here are taken from Table 1.2 in this chapter. Some amounts have been averaged over a two or three year period (as shown in the table); other amounts pertain to a fiscal year. The summary does however represent a valid comparative picture of state programs and tax provisions that comprise subsidies to the timber industry.

6. California Department Forestry and Fire Protection. *California's Forests and Rangelands: Growing Conflict Over Changing Uses,* July 1988, p. 156.

7. California Board of Equalization. *Annual Report,* 1991.

8. Ibid.

9. Personal Communication of Lenny Goldberg with Jeff Reynolds, Statistics Division, California Board of Equalization.

10. California Department of Forestry and Fire Protection. *"California's Forests and Rangelands: Growing Conflict Over Changing Uses.* July 1988, p. 35.

11. Personal Communication of Lenny Goldberg with Jeff Reynolds, Statistics Division, State Board of Equalization, November 1992.

12. Personal Communication of Rod Miller with Andrew Richardson, Research Analyst II, CDF, October 15, 1992.

13. Office of the Governor. *Governor's 1992-1993 Budget Plan.* Also Personal Communications with Ed Lee, CDF Budget Department, Staff Services Manager, October-November, 1992.

The expenditure numbers include General Fund and General Fund-like expenditures. General Fund-like expenditures are those from funds other than the General Fund that are supported by varied revenue sources, e.g., from oil leases on State Lands Commission lands and from Federal Outer Continental Shelf leases. This money, like General Fund money, could be spent for any governmental purpose.

To calculate the three year average, we used actual expenditures for fiscal year 1990-91 and 1991-92, and budgeted expenditures for FY 1992-93. We included the current budget year of 1992-93 because it reflects current policy and recent budget cuts.

14. Legislative Analyst. *Analysis of the Budget Bill FY 1982-1983.*

15. The California Legislative Analyst and CDF have recommended that a portion of the costs of fire suppression be assessed on some of the property owners receiving the benefits of State fire protection. Proposals introduced in the legislature on behalf of CDF have attempted to recover around 5% of budgeted fire suppression costs from property owners. However, these proposals have failed. See Legislative Analyst, *Analysis of the 1992-93 Budget Bill*, January 1992.

16. California Department Forestry and Fire Protection. *California's Forests and Rangelands: Growing Conflict Over Changing Uses.* July 1988, pp. 158-160.

17. Glass, Richard, University of California, Office of the President, Oakland, CA. Personal Communication, October 8, 1992. We calculated the $7.2 million estimate from three types of data provided by the university: 1) forestry-related program costs of the Agricultural Experiment Station, 2) forestry-related program costs of the Cooperative Extension Service, and 3) an estimate of administrative costs for the forestry programs of the Agricultural Experiment Station. The third item was developed by taking total the administrative budget of the Agricultural Experiment Station and multiplying by the percentage of forestry programs for the Experiment Station.

18. Legislative Analyst. *Analysis of the 1991-92 Budget Bill.* January 1991.

19. Office of the Governor. *Governor's 1992-1993 Budget Plan.* Also Personal Communications with Ed Lee, California Department of Forestry and Fire Protection, Budget Department, October-November 1992.

20. Personal Communication of Rod Miller with Ken Pimlott, California Department of Forestry and Fire Protection, Forestry Technician, October-November 1992.

21. Department of Forestry and Fire Protection. *Resource Management: Program Objectives and Description* January, 1990.

22. The figure includes administrative costs.

23. Office of the Governor. *Governor's 1992-1993 Budget Plan.* Also Personal Communication with Ed Lee, CDF Budget Department, Staff Services Manager, October-November, 1992. (See explanatory text from Endnote 7.)

24. California Department of Finance. *California Statistical Abstract.* 1991.

25. The Franchise Tax Board has stated that these estimates were correct at the time they were developed, in 1992, but notes that revised federal tax projections in early 1993 led to somewhat lower figures for future years: $34 million for percentage depletion and $20 million for intangible drilling expenses. Personal communication from Tam Margetich, Franchise Tax Board, February 9, 1993.

26. Spilberg, Phil. Research Director, Division of Statistics, California Franchise Tax Board. Letter to Lenny Goldberg, October 2, 1992.

27. Ibid.

28. California State Senate Revenue and Taxation Committee, August 1992.

29. California Department of Finance. *California Statistical Abstract.* 1991.

30. Personal Communication of Lenny Goldberg with Phil Spilberg, Research Director, Division of Statistics, California Franchise Tax Board. September 1992. (This is rough estimate only.)

31. Spilberg, Phil. Research Director, Division of Statistics, California Franchise Tax Board. Letter to Lenny Goldberg, October 2, 1992.

32. Department of Conservation. *SMARA Briefing.* June 1992.

33. Ibid.

34. Ibid.

35. Personal Communication of Rod Miller with Sidnie Olson, Senior Planner, County of Humboldt, November 1992. (These are capacity figures. The actual amount removed is likely to be smaller.)

# Chapter 2: Federal Virgin Materials Incentives

In the first chapter we investigated California tax and regulatory incentives for virgin material production. In this second chapter we review the available literature on analogous federal incentives, estimating the value of incentives where possible, and speculating briefly about the likely effect of the incentives.

Our review covers timber incentives in Section I below; energy incentives in Section II; nonfuel mining in Section III; water rates in Section IV; and a summary assessment of the impact of federal incentives in Section V.

Federal incentives for mining, petroleum production, and timber production, often in the form of tax advantages, have existed for decades. In the words of a report by the federal Office of Technology Assessment (OTA), incentive programs "have become embedded in the economic system and are now an integral part of the industrial infrastructure and economics of natural resource development and production."[1] The federal government's efforts to stimulate economic activity through natural resource extraction dates back to the end of the last century when "the development of natural resources was encouraged to fuel economic growth."[2]

Although governmental incentives for primary resource industries still exist, the Tax Reform Act of 1986 substantially reduced the scope of federal tax incentives. However, the history of generous incentives has had an impact; one observer asserts that it is common for budding industries to request the federal government to compensate for historical benefits to well-established players and thereby enhance competition.[3] This concept of rectifying past inequities between established and infant industries could be relevant to the comparison of virgin and secondary materials.

One of the most recent and thorough studies of federal tax and programmatic subsidies for virgin materials was performed for the U.S. Environmental Protection Agency (EPA) in 1991; however, the study has yet to be released. *Resource Recycling* published a brief summary of an early draft of the EPA study in June 1992; at present that is the only published form in which the study results have appeared. We discuss the results of the draft EPA study in Section VI below, along with results of earlier studies, and a general perspective on the historical importance of federal subsidies.

## I. Timber

The principal federal subsidies to virgin timber harvesting come from tax benefits, below-cost federal timber sales, and National Forest Service assistance to timber harvesting. Two

major tax benefits are worth $425 million annually, while estimates of federal losses on timber sales are around $400 million.

The nation's timberlands include 70 million private industrial acres held by large land owners, 85 million acres of National Forest Service lands, and 276 million acres held by small land owners and farmers. In 1990, the timber harvest from federal lands in the U.S. totalled 10.5 billion board feet worth $1.19 billion.[4]

### *Tax Benefits*

Tax laws have long favored timber producers. Prior to the Tax Reform Act of 1986, they received substantial benefits from capital gains treatment of timber income. Under the post-1986 tax code, two other provisions are significant. First, expensing of multi-period timber growing costs allows immediate recovery of tax deductions that might otherwise be spread over the lifetime of the timber operation. It averaged $222 million annually in federal tax costs in fiscal years 1987-1989.[5]

Second, federal tax law includes investment credits and seven-year amortization for reforestation expenditures. Seven-year amortization of commercial reforestation costs is an alternative to requiring capitalization during the year when the timber is cut; thus, like expensing, it speeds up the tax deductions available to the industry. Reforestation costs are also eligible for a 10% investment credit if the timber is not depreciable. For fiscal years 1987-1989 the annual tax cost of these provisions averaged $203 million.[6] Since this program provides an incentive to reforest private lands, it encourages long-term forest management and reduces economic pressure for incompatible development.

### *Below-Cost Timber Sales*

A number of studies find that timber from federal lands is sold at prices below the actual cost of harvesting.[7] This conclusion is generally based on a comparison of U.S. Forest Service (USFS) program costs with receipts from timber sales from USFS lands. The USFS assists the harvesting of timber from its lands in several ways, including road building, forest improvement and management, fire suppression, technical assistance, and reforestation.

However, when logging companies bid for the purchase of federal timber, the companies' costs of building logging roads are deducted from the purchase price.[8] The industry suggests that this deduction is justified since the roads can be used by the public and are therefore not solely related to timber production.[9]

Studies vary in their estimates of the difference between USFS timber management costs and timber sales revenue. Some of the variation may be due to inconsistencies in the type

of program costs looked at, such as administrative costs and payments to states. Barry Flamm of the Wilderness Society provided detailed information to the U.S. Congress from the USFS. These data show that the annual losses from fiscal years 1982-1987 averaged about $200 million, not counting payments to counties within the states.[10]

Payments to states are an important part of the cost of USFS forest management. States with federal timber lands receive payments for timber sales from within their borders. The majority of this money is returned to the host counties for schools and roads. The federal payments are meant to offset the lack of property tax revenues resulting from the presence of federal land in a county.

When payments to states are included, Flamm reports average annual losses from federal timber sales for fiscal years 1982-1987 of $401 million. Figures for state payments include "value of roads built by purchaser credit."[11] The EPA draft study, as summarized in *Resource Recycling*, reports that below-cost timber sales cost taxpayers around $400 million per year;[12] a 1992 article in *The Public Interest* uses a figure of $800 million per year.[13]

One possible explanation of timber sales below market value is that they may be linked to other government objectives. Logging provides economic support for many rural areas. The USFS asserts that 1990 timber sales sustained 106,000 jobs and generated $500 million in federal taxes.[14] However, such employment and income benefits are uncertain and variable. For example, when the Alaskan National Lands Act was passed, Congress guaranteed around $40 million a year of forest-related expenditures in the Tongass National Forest regardless of timber demand, in an attempt to support the fragile economy of the area. But in recent years, demand for Tongass timber has declined and so have local forest product jobs. Commercial fishing and tourism now provide more jobs in the area than logging. Flamm asserts that in the Tongass National Forest the government is recovering as little as one penny for every taxpayer dollar spent.[15] Ralph Nader places the Tongass returns at $10 for every $100 spent by the government.[16]

## II. Energy Incentives

There are two categories of federal energy incentives to consider: taxes and programs that benefit the producers of fuels (oil, gas, and coal), and those that benefit electric utilities. The former category is most directly comparable to the California oil and gas incentives identified in Chapter 1. However, both categories are significant in the broader analysis of virgin materials incentives, since energy is an important input into virgin materials extraction and processing. For almost every material, virgin production is more energy-intensive than secondary production[17]. Any subsidy to energy industries, therefore, can result in an indirect subsidy to virgin materials industries throughout the economy.

A number of federal tax provisions benefit the oil, gas, and coal industries. The OTA, for instance, has estimated that the excess of percentage depletion over cost depletion (a tax provision discussed in Chapter 1) for the oil and gas industry amounts to an annual tax expenditure of $797 million.[18]

In 1990, the General Accounting Office (GAO) analyzed proposed tax incentives for oil producers designed to stimulate domestic production. Their analysis focused on the "marginal effective" tax rate; i.e., the tax rate that the oil companies actually paid on their last dollar of income, after accounting for all deductions, exemptions, and special provisions. GAO noted "that the marginal effective federal corporation tax rates, that is the tax rates on genuinely incremental investments for domestic petroleum production, are already among the lowest for a major industry, due to the effects of existing tax incentives." GAO further estimated "marginal effective rates on petroleum production investments to be about half of the statutory rate of 34% for integrated producers (i.e., producers with significant refining activity or retail activity). Marginal effective rates can be near zero for independent (i.e., non-integrated) producers eligible for percentage depletion, a favorable tax treatment for depletable costs."[19]

GAO attributes the low marginal effective rates on petroleum investments to the immediate deductibility of intangible drilling costs rather than their being depreciated over time like normal business investments. GAO suggests that petroleum investments in some cases "are actually more profitable after taxes than before taxes because they help reduce taxes on other income."[20]

*Federal Energy Subsidies in 1992*

A study by the Energy Information Administration (a branch of the U.S. Department of Energy) evaluates federal energy subsidies in fiscal year 1992.[21] It reviews a wide range of energy-related federal programs, tax provisions, and regulations, and discusses alternative methods of valuing the resulting energy subsidies. On an "outlay equivalent basis," the subsidies are worth at least $8 billion.[22] The Energy Information Administration (EIA) reduces this total by $3 billion, the amount of gasoline excise tax that is not earmarked for specific transportation purposes; the net result is a $5 billion annual subsidy, or roughly 1% of total revenues of the energy industry.

The EIA study notes that the amount of subsidy declined sharply during the 1980's. Federal tax expenditures, in particular, were much higher at the beginning of the decade than at the end. It also notes that changes in the definition of subsidies could double the estimated $5 billion net subsidy.

Table 2.1 summarizes the major energy subsidies identified by EIA. The largest items were low-income heating assistance; federal agency spending on electric power supply; percentage depletion for oil, gas and coal companies; research on nuclear power and coal

technology; the alternative fuel production credit; and the excise tax exemption for alcohol fuels. Perhaps the least-publicized of these measures was the alternative fuel production credit, available for production through the year 2002 from wells or facilities placed into service between 1980 and 1992. According to EIA, "This tax credit provision has a substantial impact on only one of the alternative fuels: gas produced from coal seams..."[23]

Many energy-related expenditures are not included in the EIA subsidy calculation: the costs of the Strategic Petroleum Reserve, federal uranium enrichment activity, benefits of tax exemption for publicly owned electric utilities, costs of highway construction, gasoline taxes earmarked for highway construction and other transportation purposes, and research on fusion power and on basic nuclear science. Inclusion of some of these expenditures could easily double the estimated $5 billion net subsidy.

In addition, EIA cites a $3 billion estimate for the value of the Price-Anderson Act to nuclear plant operators; that act limits industry liability for nuclear accidents, thus reducing industry insurance premiums. However, EIA apparently misclassified this subsidy, including it in a survey of the costs to industry of regulatory compliance.[24]

## Table 2.1
## Federal Energy Subsidies, Fiscal Year 1992

| **Program outlays:** | **Million dollars** |
|---|---|
| Department of Health and Human Services, Low-Income Home Energy Assistance Program | 1,143 |
| Tennessee Valley Authority, Bonneville Power Administration, and other power marketing administrations, outlays minus receipts | 803 |
| Corps of Engineers and Bureau of Reclamation, hydroelectric power projects | 562 |
| Department of Energy conservation and technical assistance grants | 262 |
| Other programs | 639 |
| **Subtotal, program outlays** | **3,409** |
| **Tax expenditures:** | |
| Excess of percentage over cost depletion for oil, gas, and coal | 1,025 |
| Alternative fuel production credit (mainly for coalbed methane) | 670 |
| Excise tax exemption for alcohol fuels | 460 |
| Other tax provisions | 405 |
| **Subtotal, tax expenditures** | **2,560** |
| **Research and development:** | |
| Nuclear power (excludes fusion and basic science research) | 890 |
| Coal (clean coal technology, advanced combustion techniques, etc.) | 551 |
| Conservation | 258 |
| Renewables | 244 |
| Other research | 101 |
| **Subtotal, research and development** | **2,043** |
| **Energy (mainly gasoline) excise tax for general revenue** | **-3,132** |
| NET SUBSIDY | $4,880 |

Source: Energy Information Administration, *Federal Energy Subsidies: Direct and Indirect Interventions in Energy Markets*, November 1992, Tables 1, 2, and 6. Tax expenditures are valued on the "outlay equivalent" basis; see note 24.

## III. Nonfuel Mining

Although still large in absolute terms, domestic mining plays a smaller part today in meeting America's metal and mineral needs than it did in the past. Both imports and recycling have become increasingly important. Currently lead has a recycling rate of 73%. Copper is being recycled at a 60% rate, iron and steel at 56%, aluminum 45%, and tin 38%.[25] All of the virgin bauxite-alumina, three-fourths or more of the nickel, chromium, and tin, and about a third of the zinc required for U.S. industry are now imported. In addition, the use of new materials, such as plastics and ceramics, has further reduced dependence on domestic virgin minerals.

However, in spite of this transition, the American mineral resource industry is still federally subsidized. Through depletion allowances, expensing of exploration and development costs, bargain-priced private use and purchase of public lands, and limited overall federal regulation of mining waste, the federal government continues to foster primary materials extraction.

### *Tax Benefits: Depletion Allowances*

One such incentive is depletion allowances. Under this tax provision, mineral producers may deduct between 5% and 22% of the value of production when computing taxable income, subject to a limit of 50% of taxable income. The theory is that this encourages the mining industry to take increasing risks to locate and develop mineral resources. Depletion allowances were originally enacted to stimulate metal mining during the difficult economic times of World War I and the Great Depression. During World War II, depletion allowances were applied to nonmetallic minerals as well.

According to the U.S. Office of Technology Assessment (OTA), "the significance of percentage depletion allowance is that the deduction is based on production, not on the amount of capital invested in developing the property."[26] John Young of Worldwatch puts it more ironically: "depletion allowances make perfect sense as long as a nation wants to promote mining, discourage recycling and divert investment into mining from other possibly more productive sectors of the economy."[27]

The OTA reports that for the three years following the tax law changes of 1986, mining depletion allowance tax revenue losses averaged $340 million annually for nonfuel minerals.[28] *Resource Recycling's* summary of the draft EPA study states that depletion allowances for mineral, ore and gas producers amount to approximately $1 billion annually.[29] Young points to $5 billion in lost taxes over the last ten years, and the President's 1992 budget projects a tax expenditure of $560 million.[30]

*Tax Benefits: Expensing of Exploration and Development Costs*

OTA identified an average $35 million in federal tax expenditures due to the expensing of exploration and development costs. Expensing provisions allow mining interests to accelerate the write-off of investment costs rather than amortizing the costs over a period of time, as is required for similar investments in other industries.

*Mining On Public Lands and Former Public Lands*

Private interests profit from hardrock mining on federal lands because of two provisions of the General Mining Act of 1872. First, upon discovery of valuable minerals on federal lands, private mining interests can stake a claim to extract the mineral without paying fees or royalties to the federal government. The claim-holder, although required to perform a minimum of $100 of "assessment work" annually per claim,[31] might actually pay no out-of-pocket expenses if he performs this work himself.

It is difficult to calculate the amount of compensation that should be paid to the federal government for the private use of public resources. However, charging market prices or royalties on transferred land would raise a substantial sum of money. In 1988, $4 billion worth of hardrock mining took place on former federal lands.[32]

The Congressional Budget Office (CBO) calculates that just raising the annual fee to $1000, roughly the equivalent at today's prices of $100 in 1872, would raise $75 million from 150,000 active claims. The estimate includes the assumption that half of the active claims would become inactive because of the increased fee. CBO suggests that rents or royalties are an alternative to the fees, but administration would be expensive.[33] In contrast to the nominal-fee arrangement for hardrock mining, royalties must be paid for oil and gas extraction from federal lands.

The second provision of the General Mining Act of 1872 that benefits mining interests is the transfer of ownership provision. Any interest that establishes a hardrock mining claim can buy the land on which the claim is located for $29 or less per acre; CBO lists the typical price as between $2.50 and $5 per acre.[34] Although these prices do not include the owner's costs to prove validity of the claim and to develop the mine, they are still low enough to provide an important subsidy to mine owners.

The General Accounting Office (GAO) reviewed 20 mining claims or patents that were transferred to private ownership for a total of $14,500. GAO found the actual market value of the mines to be $14 to $48 million. In another example of below market transaction, one purchaser obtained 17,000 acres of oil shale lands from the Bureau of Land Management for $42,000 and sold the land within a month to Shell Oil for $37 million.[35]

*Environmental Protection Standards*

Environmental protection standards, which could be more stringent, are another boon to primary resource extraction. The waste disposal problems created by extractive industries are potentially immense: the nation's mines, for example, produced 3.4 billion tons of waste in 1989. Yet unlike other industries, there has been little overall federal regulation of mining waste disposal. Mining is exempt from hazardous waste regulation under the Resource Conservation and Recovery Act (RCRA). Mines currently account for 50 Superfund sites; 800-1500 additional mining sites need to be assessed for possible Superfund listing.[36] The cost of cleaning up the 50 sites currently on the Superfund list is estimated at between $7.5 and $50 billion.[37]

Environmental protection regulations are obviously much more than an economic question; mining activity can have a lasting, disruptive impact on the environment. It is estimated that each year "one-half million acres are directly disturbed by nonfuel mining."[38] In one example, smelting activity at Copper Hill in Tennessee left a "dead zone" of 17,000 acres where vegetation does not grow.[39]

It is difficult to calculate the total financial advantages afforded the mining industry by environmental protection regulations which are more lax than those governing other large industries. However, one measure might be cleanup costs. If the industry were assessed for cleanup costs, the result might be an internalization of some environmental costs, perhaps affecting the price of virgin materials.

No figures on annual cleanup costs are available; the accumulated costs imposed by past and present mining activity clearly stretch into the billions of dollars. For example, cleanup of the Clark Fork River basin in Montana is estimated at $1 billion.[40] John Young at Worldwatch characterizes a section of the Clark Fork River as a "140 mile ribbon of contamination."[41] The river was the site of more than a century of mining and smelting, including what was once the world's largest open pit mine, the Berkeley Pit copper mine. Today the Clark Fork basin includes 200 million cubic meters of tailing ponds covering almost 9,000 acres, containing 200 tons of cadmium, 9,000 tons of arsenic, 20,000 tons of lead, 90,000 tons of copper, and 50,000 tons of zinc.[42]

## IV. Water Rates

Many other government policies affect the costs of raw materials. Water rates, in particular, are often mentioned in connection with subsidies to virgin materials.

Federal water policy was initially designed to propel settlement in the West, which in many places is dependent upon public investment in water resources. The massive Central Valley Project in California, for example, is operated by the federal Bureau of Reclamation.

One of the most thorough discussions of federal water subsidies has been done by Richard Wahl of Resources for the Future. He focuses on the repayment system or pricing that has benefitted water users. Over the history of federal water sales, according to Wahl, only 37% of all costs have been recovered from all users of federal water.[43]

The EPA draft study summarized in *Resource Recycling* places the cost of water subsidies identified at $5 billion per year. It is difficult to determine how much of this subsidy goes to materials industries. The EPA study allocates $6 million worth of water subsidies to the virgin paper industry based on the assumption that 85% of the industry's water is "self-supplied," that is, water to which manufacturers have their own water rights.[44]

CBO suggests that prices charged for federal water supplied for western water projects by the Bureau of Reclamation "are generally substantially lower than the economic value of the water; for agricultural users, they rarely cover the federal costs associated with the water project."[45]

## V. Impacts of Federal Subsidies

Several studies of federal subsidies for virgin materials have drawn conclusions about the effects of the subsidies on the use of secondary materials. All such studies were done more than a decade ago, with the exception of the (unreleased) 1991 EPA study. Much has changed in that decade. Tax code changes, particularly the 1986 revision, have affected resource extraction industries; recycling has become a much larger, long term part of solid waste management strategy. The OTA calls the 1970s studies dated and notes that they did not look at glass and plastics.[46]

The 1970s studies conclude that there are subsidies generated at the federal level for virgin materials. However, the subsidies do not significantly discourage or reduce the use of secondary materials. OTA summarizes the 1970s studies by saying "under the most likely scenario subsidies were estimated to affect the price of virgin paper by 1%, copper by 5%, and steel by 2%."[47] Nonetheless, the 1970s studies project an increase in the use of secondary materials if the subsidies are eliminated, ranging from 0.5% for paper to 1% for aluminum. But OTA points out that, "in recent years, in fact, the real increase in recycling has been significantly higher than these estimated increases, independent of the tax differences."[48]

With one major exception, the draft results of the recent EPA study suggest that federal subsidies of virgin materials do not give them a price advantage over recovered materials. The important exception is that of energy subsidies. According to the *Resource Recycling* summary, energy policies are the "one broad area of federal policy [that] can be considered a substantial economic barrier to recycling."[49] This is because extraction and purification of most virgin materials requires significantly more energy than the corresponding recycling processes[50].

For mining, the draft EPA study, according to *Resource Recycling*, concludes that while the dollar value of depletion allowances is large, "the impact of these benefits on recycling appears to be small... given the low fraction of domestically produced resources used in the production of some primary materials, the small share of total production costs attributable to these benefits and the existence of an alternative minimum tax."[51] The EPA study further concludes that subsidies due to low mining charges for use of resources on federal lands and lack of mining reclamation "do not appear to be major issues of concern to recycling."[52]

Likewise, the EPA study concludes that subsidies of below cost water "do not appear to play a significant role in discouraging recycling."[53]

The EPA study reportedly estimates the total subsidy available to the virgin paper industry through reductions in the cost of their materials. The subsidies that benefit papermakers included tax benefits, below cost timber sales, energy, and water, totaling $488 million to $709 million in 1988 dollars. These subsidies are estimated to reduce the cost of virgin materials to the paper industry by between 1.89% and 2.75% -- amounts that are not likely to constitute a major barrier to recycling.[54]

### *The Historical Role of Virgin Material Incentives*

Having reviewed the available literature, we end this chapter with a speculation about the possible historical significance of federal incentives. It is an important topic, but one that cannot be given more than suggestive, speculative discussion within the context of this study.

Currently, federal incentives for virgin material production do not appear large enough to have much effect on the competitive position of secondary materials. But the historical role of federal incentives was much greater. Until the 1986 tax reform, timber, oil, and mining interests benefitted from much larger federal tax breaks than they enjoy today. The generous provisions of the General Mining Act of 1872 have of course been in effect for more than a century. Massive federal support for an oil-based transportation system stretches back at least to the beginnings of the interstate highway system in the 1950s. Government support for nuclear power, in the unsuccessful pursuit of "electricity too cheap to meter," dates to the same period. In earlier times, programs such as federal land grants encouraged extensive exploitation of the nation's natural resources.

Many of these virgin materials incentives were created many decades ago, at a time when the economic development of the nation's vast wilderness areas was on the agenda. Natural resources were in plentiful supply, and environmental quality was an unknown concept (although even then specific areas may have suffered from severely degraded environmental quality).

It seems reasonable to suspect that the history of government subsidies has helped to create entrenched patterns of resource-intensive industrial development. Decades of incentives for use of virgin materials would naturally influence corporate purchasing practices, managerial attitudes, design of equipment and technologies, engineering training and labor force skills. Once the industrial culture of virgin resource use is established, the mere removal of most federal incentives may not be enough to allow meaningful competition between virgin and secondary materials.

# Chapter 2 - Endnotes


1. U.S. Congress, Office of Technology Assessment (OTA). *Facing America's Trash: What's Next for Municipal Solid Waste,* OTA-O-424, Washington, D.C.: U.S. Government Printing Office, October 1989, p. 197.

2. Ibid., p. 197.

3. Fields, H. *Leveling the Playing Fields for Virgin and Recycled Subsidies.* Recycling Today, Volume 1, number 8, October 1990, pp. 99-101.

4. U.S. Department of Agriculture. *Agricultural Statistics 1991.* Washington, D.C.: U.S. Government Printing Office, 1991, pp. 462-463.

5. U.S. OTA, op. cit., p. 199.

6. Ibid. pp. 198-199.

7. Ibid., p. 200.

8. Kalmanofsky, J. *Subsidized Timber Sales Raise Public Benefit Issue. Christian Science Monitor.* June 20, 1991, p. 10.

9. U.S. OTA, op.cit., p. 200.

10. Flamm, B.R.. Statement of Barry R. Flamm, Wilderness Society, on the Fiscal Year 1989 Budget Request For the Forest Service, USDA, before the Interior Subcommittee of the Appropriations Committee, United States House of Representatives, February 25, 1988, pp. 540-560.

11. Ibid.

12. Powell, J. *Federal Disincentives to Recycling.* Resource Recycling. June 1992, pp. 44-45.

13. Moore, S. *So Much For 'Scarce Resources.' The Public Interest.* Winter 1992, p. 97.

14. Kalmanofsky, op.cit., p. 10.

15. Flamm, op.cit.

16. Nader, R. *Rip-off, Inc.: How to Stop Corporations From Making Off With Everything We Taxpayers Own.* Mother Jones. May-June 1991, p. 16.


17. Some virgin paper mills obtain a significant amount of their process energy from burning wood waste. In these cases, their total energy requirements may still be greater than for recycled paper production, but their purchased energy requirements may be lower.


18. U.S. OTA, *Facing America's Trash,* op.cit., p. 198.

19. U.S. General Accounting Office. *Additional Petroleum Production Tax Incentives Are of Questionable Merit.* Washington, D.C.: U.S. Government Printing Office, GAO/GGD-90-75, July 1990.

20. Ibid.

21. Energy Information Administration (EIA). *Federal Energy Subsidies: Direct and Indirect Interventions in Energy Markets.* November 1992.

22. This means that tax expenditures are valued at the amount of budget outlay that would be required to create the same dollar benefit to industry. EIA calculates that $1.5 billion of federal income tax expenditure (reduction in tax revenue to the government) has a budget outlay equivalent of $2.1 billion (the government would have to give the industry that much to create the same after-tax benefits). The $2.1 billion estimate is used in the summary tables and in the results cited here. Ibid., p.6.

23. Ibid., p.29.

24. Ibid., Table 22 and pp.77-78. The Price-Anderson Act is the only item in Table 22 that benefits the energy industry, but it is added to the other regulatory compliance costs as if it were a cost increase.

25. Young, J.E.. *Mining the Earth*: WorldWatch Paper 109. Worldwatch Institute: Washington, D.C., pp.11-13.

26. U.S. OTA. *Facing America's Trash*, op. cit., p. 199.

27. Young, J.E. *Free-loading Off Uncle Sam.* Worldwatch, January-February 1992, pp. 34-35.

28. U.S. OTA. *Facing America's Trash*, op. cit., p. 198.

29. Based on the findings of the other studies on depletion allowances it is likely that the *Resource Recycling* summary should read "oil" instead of "ore" when it states "mineral, ore, and gas producers." Depletion allowances appear to be worth around $500 million annually for mining operators and oil and gas depletion allowances are worth somewhere between $390 million and $797 million annually, according to Powell, op.cit.

30. Young, J.E.. *Mining the Earth*: Worldwatch Paper 109. Worldwatch Institute: Washington, D.C., p.29.

31. U.S. Congressional Budget Office. *Reducing The Deficit: Spending and Revenue Options*. Washington, D.C.: U.S. Government Printing Office), March 1988, pp. 196-201.

32. Young, J.E., *Mining the Earth*: Worldwatch Paper 109. Worldwatch Institute: Washington, D.C., p. 29.

33. U.S. Congressional Budget Office. *Reducing The Deficit: Spending and Revenue Options*. Washington, D.C.: U.S. Government Printing Office), March 1988, pp. 196-201.

34. Young, J.E.. *Mining the Earth*: Worldwatch Paper 109. Worldwatch Institute: Washington, D.C., p. 29.

35. *A Pick Axe Too Far.* The Economist, April 25, 1992, p. 27.

36. Young, J.E.. *Mining the Earth*, op.cit., pp.36-38.

37. *A Pick Axe Too Far.* Op.cit., p. 27.

38. Young. *Mining the Earth*, op.cit., p. 24.

39. Ibid. 21.

40. *A Pick Axe Too Far.* Op.cit., p. 17-18.

41. Young, J.E. *Free-loading Off Uncle Sam.* Worldwatch. January-February 1992, pp.34-35.

42. Young, J.E. *Mining the Earth*: Worldwatch Paper 109. Worldwatch Institute: Washington, D.C., p. 36.

43. Wahl, R. *Markets for Federal Water: Subsidies, Property Rights and The Bureau of Reclamation.* Resources For the Future, Washington, D.C., 1989.

44. Ibid.

45. U.S. Congressional Budget Office. *Reducing The Deficit: Spending and Revenue Options*. Washington, D.C.: U.S. Government Printing Office), March 1988, pp. 196-201.

46. U.S. OTA, op. cit., p. 200-201.

47. Ibid.

48. Ibid.

49. Powell, J.. *Federal Disincentives to Recycling.* Resource Recycling. June 1992, pp. 44-45.

50. See note 19 for discussion of exceptions.

51. Ibid.

52. Ibid.

53. Ibid.

54. Ibid.

# Chapter 3: State Incentives for Secondary Materials

In Chapter 1, we investigated California State tax and regulatory incentives for virgin material production. Chapter 2 reviewed the literature on federal incentives for virgin materials. This chapter deals with California incentives for secondary materials.

Secondary materials supply is discussed in Section I of this chapter. A few, very small tax reduction, loan and grant programs for industries using secondary materials are described in Section II. Much more important than these programs, however, are the major State legislative and regulatory initiatives that promote the use of secondary materials: AB 2020, and secondary content legislation, discussed in Section III. Finally, Section IV summarizes the wide range of secondary content requirements for different materials and products.

Since the most important secondary material incentives are provided by regulations rather than by State spending or tax reductions, it is difficult to place a dollar value on California's subsidy in this area. If measured by the direct cost to the State government, secondary material incentives appear small. Yet it is clear that State policy has influenced the use of certain secondary materials.

## I. California's Secondary Materials Supply

California produces massive quantities of secondary materials each year. Unlike virgin materials, there are no Census Bureau or other government data on the value of secondary materials. The California Integrated Waste Management Board (CIWMB) collects systematic data on the material diverted from the waste stream; since these data were developed for waste management rather than for market analysis, they track the quantity, but not the value, of the State's secondary materials.

According to the CIWMB figures, reuse, recycling and composting efforts accounted for diversion (i.e., avoidance of landfilling or incineration) of 5.2 million tons of California's solid waste in 1990, a volume of roughly 20.7 million cubic yards.[1] This created substantial supplies of many secondary materials, as shown in Table 3.1. The immense volume of diverted material may be difficult to visualize: it is enough to cover a two-lane highway from Los Angeles to San Francisco, 11 feet deep[2] -- just from one year's waste diversion.

Table 3.1
Weight and Volume of California's Secondary Materials Supply (1990)

| Material | Weight Diverted thousand tons | % | Density lb/cu yd | Volume Diverted thousand cu yds | % |
|---|---|---|---|---|---|
| Paper | | | | | |
| Cardboard and bags | 1,190 | 23% | 360 | 6,611 | 32% |
| Newspaper | 823 | 16% | 552 | 2,982 | 14% |
| Office (ledger) paper | 237 | 5% | 582 | 814 | 4% |
| Mixed and other paper | 387 | 7% | 613 | 1,263 | 6% |
| Plastics | 75 | 1% | 191 | 785 | 4% |
| Glass | 537 | 10% | 1,258 | 854 | 4% |
| Metals | | | | | |
| Aluminum cans | 145 | 3% | 366 | 792 | 4% |
| All other | 18 | 0% | 501 | 72 | 0% |
| Yard waste | 566 | 11% | 584 | 1,938 | 9% |
| Other organics | | | | | |
| Food waste | 243 | 5% | 1,216 | 400 | 2% |
| Wood waste | 480 | 9% | 333 | 2,883 | 14% |
| Textiles, tires, diapers, etc. | 246 | 5% | 500 | 984 | 5% |
| Other waste | 102 | 2% | 1,500 | 136 | 1% |
| Special wastes (ash, sludge, etc.) | 117 | 2% | 1,500 | 156 | 1% |
| **TOTAL** | **5,166** | **100%** | | **20,670** | **100%** |

Source: For Column 1, see endnote 1; for Column 3, see endnote 2.

*Avoided Collection and Disposal Cost*

Diversion of material from the waste stream through source reduction, reuse, recycling, or composting reduces solid waste collection and disposal costs. An earlier Tellus Institute study performed for CIWMB (the 1991 *Disposal Cost Fee Study*) estimated collection and disposal costs by material. The results, based on actual California collection costs for 1990 and on an average $13 per ton landfill tipping fee, are shown in the first column of Table 3.2.[3] These costs, multiplied by the quantities of waste diverted (first column of Table 3.1), yield the avoided waste management cost due to diversion in 1990 (second column of Table 3.2). The total is $494 million, an average of $96 per ton of diverted material.

The avoided costs shown in Table 3.2 are **not** measures of the value of the secondary materials. Rather, they are waste management cost savings potentially created by diversion of the materials. These savings could benefit the households, businesses and municipalities who would have ultimately paid for the additional garbage collection and disposal if diversion had not occurred. Thus taxpayers would not lose money if they offered subsidies to diversion up to the amounts of the avoided costs. For example, Table 3.2 shows costs of $70 per ton for collection and disposal of newspapers. So a newspaper recycling program, if it has net costs to the taxpayers of under $70 per ton, will result in an overall savings.

Landfilling has environmental as well as monetary costs. Therefore, the benefits of reducing landfill requirements are greater than the monetary savings; in effect, waste diversion has environmental as well as monetary "avoided cost" savings. The same study that performed the avoided cost calculations also estimated the environmental impacts of landfill gas and leachate emissions, and tried to trace them back to individual waste stream components.[4] Although there is considerable scientific uncertainty about the processes giving rise to landfill gas and leachate, it seems likely that hazardous emissions are largely due to the presence of household hazardous waste (HHW). This small category, roughly 1% of the waste stream, includes batteries, oil-based paints, many household solvents, pesticides, and other hazardous substances. Most of the toxic chemicals found in landfill gas and leachate can also be found in HHW.

Table 3.2
California Waste Collection and Disposal Costs (1990)

| Material | Collection and disposal cost ($/ton) | Avoided cost due to diversion (million $) |
|---|---|---|
| Paper | | |
| Cardboard and bags | $116 | 138 |
| Newspaper | 70 | 58 |
| Office (ledger) paper | 94 | 22 |
| Mixed and other paper | 102 | 39 |
| Plastics | 223 | 17 |
| Glass | 27 | 14 |
| Metals | | |
| Aluminum cans | 294 | 43 |
| All other | 117 | 2 |
| Yard waste | 81 | 46 |
| Other organics | | |
| Food waste | 81 | 20 |
| Wood waste | 89 | 43 |
| Textiles, tires, diapers, etc. | 149 | 37 |
| Other waste | 65 | 7 |
| Special wastes (ash, sludge, etc.) | 65 | 8 |
| TOTAL | 96 | 494 |

Source: For Column 1, see endnote 4. Column 2 is calculated from Column 1 and from Table 3.1.

Based on this analysis, subsidies for recycling, composting, and processing of secondary materials might be set to equal avoided costs, with an extra subsidy for diversion of HHW or other environmentally damaging waste components. In fact, such calculations have not generally entered into determination of State subsidies and incentives.

## II. Grants, Tax Credits, and Low-interest Loans

We have identified several State programs that provide direct support to industries using secondary materials. These secondary materials incentives are still in their infancy; and most have not yet been fully implemented. In contrast to virgin material incentives, most of the programs described here are notable for their small size.

### *Used Oil Grant*

Under the *Used Oil Collection Demonstration Grant Program Act* (PRC sections 3475 et seq.), beginning October 1, 1002, oil manufacturers must pay CIWMB $0.04 per quart of lubricating oil sold, transferred, or imported into the State. Then, beginning April 1, 1993, the Board may pay a recycling incentive fee of $0.04 per quart of lubricating oil recycled to certified used oil collection centers, industrial generators, and curbside collection programs. In addition, funds will be available to electric utilities for used lubricating oil generated and used for electrical generation, subject to compliance with health codes.

Agency: CIWMB
Size of program: Total funds available are slated for $10 million annually
Funds disbursed: None yet. Program being developed as of early 1993.

### *Grants for Market Development*

Grants (PRC section 14581(c)) are paid to nonprofit and governmental agencies to promote the use of postconsumer and secondary materials as feedstocks in manufacturing. The 1992 program will pay up to 50% of the total project cost of a market development program. This program also helps with locating federal and foundation grant funds and assists in the grant application process.

Agency: Department of Conservation
Size of program: $ 1.5 million.
Funds disbursed: $ 1.5 million in grants were approved in October, 1992.

### *Tire Recycling Grant Program*

The *California Tire Recycling Act* authorizes a Tire Recycling Program and the California Tire Recycling Management Fund. The purpose of the program is to promote innovative research and business development that will use or consume waste tires in California. The first funds were spent on Caltrans research into rubberized modified asphaltic concrete using scrap tires. In the first two full years of the program, over $1 million has been allocated for this purpose. Beginning in 1993, funding up to $50,000 will be available for individual tire-related business

development projects to cover the costs of research, technical validation, market and business plans, and economic analysis. Grants up to $100,000 will be available for individual innovative research projects.

Agency: CIWMB, Research and Technology Development Division
Size of program: $1 million available in fiscal year 1992-93
Funds disbursed: No grant awarded yet (as of early 1993). Tentative application approval date is April, 1993.

***Recycling Manufacturing Equipment Tax Credit***

This provision (Revenue and Tax Code, Sections 17052.14 and 23612.5) allows a tax credit against a business' state income tax liability of up to 40% of the investment on qualified recycling equipment, not to exceed $ 250,000. Qualified equipment must be purchased between January 1, 1989, and December 31, 1993, must be used to produce finished products with no less than 50% secondary material and 10% post-consumer material, or component parts from 100% recycled and 80% post-consumer waste. CIWMB reviews and certifies equipment applications, and notifies the Franchise Tax Board of the certifications. The exact value of the credit is determined by the Franchise Tax Board.

Agency: CIWMB and Franchise Tax Board
Size of program: CIWMB estimates the value of the tax credits that have been certified at $3.85 million, or 40% of the total qualified private investment of $9.63 million.

***Recycling Market Development Zone Revolving Loan Fund***

This Loan Fund (PRC section 42145, authorized by Senate Bill 2310) provides direct loans to recycling businesses and local governments located in designated Recycling Market Development Zones. There are 12 such zones (designated in July 1992), with another 8 to be designated in 1993. Each eligible business or local governmental agency may borrow up to 50% of the cost of a capital improvement or infrastructure project, to a maximum of $1 million. Interest rates will be set annually by the CIWMB, based on the State Pooled Money Investment Account Rate.

Agency: CIWMB
Size of program: Up to $5 million annually in low-interest loans. Additionally, the CIWMB made a $1 million allocation from the California Tire Recycling Management Fund to the RMDZ Loan Fund for fiscal year 1992-93, for tire-related projects within the zones.
Funds disbursed: No loans awarded yet (as of late 1992). First loans are likely to be disbursed in April 1993.

## III. Direct Incentives to Stimulate Collection of Secondary Materials

California law provides both regulatory and monetary incentives to encourage recovery of secondary materials from the waste stream. There have been State laws requiring recovery of resources from the waste stream since the passage of the Nejedly-Z'berg-Dills Solid Waste Management and Resource Recovery Act of 1972. As a result of both regulatory and monetary incentives, as well as voluntary participation, Californians were diverting 5.2 million tons annually from disposal as of 1990 (see Table 3.1). Regulatory incentives were more important than monetary incentives in achieving waste diversion.

### Diversion Planning and Implementation

Prior to the passage of the Integrated Waste Management Act of 1989 (PRC sections 40000 *et seq.*), the law required counties to plan for diversion of at least 20 percent of their waste from disposal, or more if feasible. There was no deadline for achievement of the goal. Nonetheless, the 5.2 million ton annual diversion in 1990 was 11.5% of the total waste generated.

The Integrated Waste Management Act of 1989 (the IWM Act) increased the regulatory responsibility for resource recovery considerably. First, the new law made cities, as well as counties, responsible. Both had to assure waste generated within their jurisdictions was diverted from disposal through source reduction (waste prevention) and recycling and composting. The law set penalties of up to $10,000 per day for failure by cities and counties to prepare adequate diversion plans.

The IWM Act's second regulatory change was to set higher diversion goals and deadlines for their achievement. Under the law, cities and counties are expected to divert 25% from disposal by 1995 and 50% by 2000. The penalty for failure to implement plans for this diversion is also set at $10,000 per day. (There is no penalty, however, for failure to achieve the goals.)

### Beverage Container Recycling

The California Beverage Container Recycling and Litter Reduction Act has stimulated secondary materials supply by compensating collection. This act was first passed in 1986 (AB 2020) and has been amended every year since. The law creates an infrastructure for beverage container recycling and, through deposit refunds and price supports to scrap value, compensates for collection of used beverage containers. These AB 2020 payments do not constitute a State subsidy; rather, they are state-mandated transfer payments between firms and consumers.

Because of AB 2020, it is easy and convenient for most Californians to recycle their used soda and beer containers. The Department of Conservation (DOC), Division of Recycling enforces provisions of the law which require every supermarket with annual sales of $2 million or more to have a redemption center within a half-mile radius or be in a community served by a residential curbside recycling program. Redemption centers, certified by DOC, refund

container deposits. This, along with the convenience, rewards the collection of used beverage containers. As of 1990, 59% of used beverage containers, by weight, were being returned for recycling.

Operation of beverage container redemption centers and recycling programs would be a money-loser if it were not for other incentives of the AB 2020 program. These are market development payments, grants to certified community conservation corps, convenience incentives payments, administrative fees, and processing fees.

The AB 2020 fees that provide direct support to secondary materials recycling in fiscal year 1991/92 were:

| | |
|---|---|
| Administration Fees | $5.1 million |
| Convenience Incentive Payments (paid to recyclers) | $17.3 million |
| Processing Fees (paid to recyclers and processors) | $13.8 million |
| Grants to Certified Community Conservation Corps | $6.0 million |
| Market Development Payments | 9.2 million |

These payments total $51.4 million, a substantial-sounding sum of money. However, the total must be interpreted with caution; the recipients of the payments are widely varied. There is no single activity, agency, or industry that received a subsidy of $51.4 million.

**The Administration Fee** (PRC sections 14573 and 14573.5) is given to recyclers and processors to cover their cost of administering container refunds. In 1991, recyclers received 0.5% and processors 1.75% of the refund value.

**Convenience Incentive Payments** (CIP) are provided to recyclers which the DOC determines could not otherwise operate profitably within their "convenience zones." In 1991, the total value of CIP's paid to recyclers was $17.3 million; of that total, $13.0 million was for aluminum containers, $3.8 million for glass, and $0.5 million for plastic.

**The Processing Fee** (AB 2020, PRC section 14575) provides a price support for the scrap value of those materials whose scrap value is insufficient to cover container recycling costs. In practice, aluminum has always been exempt due to its high scrap value, and plastic containers have become exempt due to the plastic industry's effort to boost their scrap value (see Chapter 5). The processing fee is paid by bottlers (i.e., beverage manufacturers) to the DOC, who then disburses it to recyclers and processors on the basis of tons of material recovered. Through the processing fee system, container manufacturers bear the net cost of container recycling (the cost of recycling net of the scrap value of the secondary materials).

The DOC sets the processing fee to reflect the difference between the scrap value of a material and the cost of recycling and processing it (including a reasonable financial return). The fee is assessed anew each year to reflect changes in recycling costs and scrap values. In 1991, $13.8 million was paid out in processing fees. Substantial amendments passed in the 1992

legislative session, together with the plastic industry's initiative to raise scrap values, make it likely that processing fee payments will not remain at the same level in the future.

**Grants to Certified Community Conservation Corps** (PRC section 14581(a)) are made annually for performance of litter abatement, recycling, and related activities. In 1991 these payments amounted to $6.0 million.

**Market Development Payments** (PRC section 14581.5(b)) are made to encourage glass recycling. The DOC makes these payments to glass container manufacturers who use cullet as feedstock. In 1991, these payments amounted to $9.2 million.

## IV. Indirect Incentives -- Recycled Content Legislation

Two other types of legislation, minimum content laws and targeted procurement laws, indirectly increase the demand for secondary materials, and thus create incentives for secondary material supply. Minimum content legislation requires that products embody a specific percentage of secondary or post-consumer material. Even if some secondary materials were more expensive than their virgin equivalents, minimum content legislation should ensure their use — if it can be verified and enforced. Above and beyond minimum content requirements, the State can and does target recycled content products for preferential government procurement.

Targeted government procurement serves a dual purpose:

a) the State government is a major consumer, and procurement favoring products with secondary materials content creates a demand for these materials in and of itself

b) more importantly, this guaranteed market allows businesses that use secondary materials to develop technologies and processes and to establish themselves, even though initially they may not be able to compete with businesses that use virgin materials.

For these reasons, State law sometimes sets standards for preferential government procurement that are more aggressive than those in minimum content legislation for the State as a whole.[5] Furthermore, State procurement guidelines or regulations sometimes contain provisions that price preferences are to be given to products from recycled materials.
The incentives listed here vary widely in importance, as do the materials covered. Incentives for paper, the material that accounts for the largest tonnage of recycling, may be of great importance to the future of California recycling programs and secondary materials markets. Other standards address more specialized economic niches.

## A. Glass

In 1990, glass represented 10% by weight (4% by volume) of the material diverted from disposal, as shown in Table 3.1. The two laws listed here took effect in 1992, too recently to have had a measurable impact on diversion.

### Fiberglass

PRC section 19500 *et seq.*

Beginning in 1992, fiberglass building insulation made or sold in California must be produced using not less than 10% glass cullet. The percentage increases to 20% in 1994, and to 30% by 1995. Plate glass cullet may be more suitable in fiberglass production than container glass cullet.

### Glass Containers

PRC sections 14513 and 14552

Beginning in 1992, all glass containers made or sold in California have to be produced with a cullet content of no less than 15%. The percentage increases to 25% in 1993, and then by 10% every 3 years, reaching 65% in 2005.

## B. Paper

In 1990, paper represented 51% by weight (56% by volume) of the material diverted from disposal. Thus far, the only minimum content law aimed at providing a market for this material is one which requires a minimum recycled content for newsprint used in California. CIWMB is also studying the feasibility of requiring a minimum recycled content for paper used in telephone directories.

### Newsprint

PRC sections 42750 - 42791

Beginning in 1991, 25% of all newsprint used by commercial printers and publishers in California has to be "recycled content newsprint." (This is defined as containing no less than 40% post-consumer waste paper.) The required percentage of using recycled content newsprint increases to 30% in 1994 and then by 5% every two years, reaching 50% by the year 2000.

The paper industry ascribes some of the interest in building new recycled newsprint capacity to this law and similar laws passed in other states.

**Telephone Directories**

PRC sections 42550 - 42556

By July 1, 1994, CIWMB is to complete a study on the feasibility of using recycled materials in the manufacture of telephone directories, without significantly increasing production costs or decreasing durability. The goal of this law is that at least 30% of telephone directories distributed in California contain recycled materials in 1994, 40% by 1996, and 50% by the year 2000. If the report finds the use of recycled paper is feasible for telephone directories, the minimum content goals will take effect January 1, 1995.

## C. Plastics

Plastics of all types constitute only a small percentage of the material diverted from disposal: 1% by weight (4% by volume) in 1990, as shown in Table 3.1. The one law requiring minimum recycled content for plastic containers will first take effect in 1995. Another minimum content law does not specify what material must be recycled into new products. This is a law which requires a minimum recycled content for trash bags. Because the law only became effective in 1993, there has not yet been a measurable impact on secondary materials markets.

**Plastic Packaging Containers**

PRC sections 42300 - 42340

By 1995, all rigid plastic containers (with special exceptions) sold in California must meet one of four criteria: 1) be made from at least 25% post consumer material, 2) have a recycling rate of at least 25% (55% for PET), 3) be reusable or refillable, or 4) be a "source reduced container". The definition of "source reduced container" is one with a ratio of package volume or weight per unit of product, or per use of product, reduced by 10% as compared to a base year 5 years prior, without material substitution.

## D. Other Recycled Content Products

There is one recycled content law in effect in California, relating to trash bags, which does not specify what material is to be recycled.

### Trash Bags

PRC section 41970

Beginning in 1993, every seller of trash bags of 1.0 millimeter thickness or more will have to ensure that they contain at least 10% post-consumer material. Beginning 1995, trash bags over 0.75 millimeter thickness have to contain at least 30% post-consumer waste.

### *Targeted State Procurement*

### General: Purchase Preferences and Goals

PCC section 12162(b) and PRC section 42210(a); PRC section 42891(a)
PRC sections 12200 - 12226

At present, a price preference of 5% is given to vendors of recycled paper and products made from recycled tires.

Also, State and local public agencies shall give preference to products from recycled materials over products from virgin materials, if fitness, quality and price are equal. The State has set a goal of 10% of all State purchases being of recycled products by 1991, 20% by 1993, and 40% by 1995.

### Batteries for Automobiles and Light Trucks

PRC sections 42440-42443

Beginning June 1992, all lead acid batteries purchased for automobiles and light trucks by State agencies need to have a minimum of 75% post-consumer lead.

### Compost and Co-compost Products

PRC sections 42240-42247
PCC sections 12180-12185

State agencies are required to maximize the use of compost. In practice, compost is used more often as a mulch for water conservation and weed control than for fertilizer.

Several California Departments (General Services, Transportation, Forestry and Fire Protection, Parks and Recreation), in collaboration with the Waste Management Board, are exploring the potential to use compost, co-compost, and chemically fixed sewage sludge in a number of applications. These include public land restoration projects, State landscaping projects, and park and recreational area maintenance programs. The agencies are required to reach agreements on the amount of compost and co-compost products that are to be used in these applications. The law does not mandate specific amounts.

## Oil

PCC sections 10405-10409

Every State procuring agency shall purchase lubricating and industrial oil from the seller whose product contains the greatest percentage of recycled oil, provided that the product meets the performance standard of the agency and is not more expensive than the virgin oil product. As of September 1992, no oil refined from recycled base stock had been purchased by the State, due to difficulties with certification in compliance with engine warranties. State purchase of recycled oil is expected to begin in 1993.

## Paper

PRC sections 42200-42215
PCC sections 12160-12169
PCC sections 10855-10860

Since January 1991, 25% of all reams of high-grade bleached writing paper purchased by the State Department of General Services have been reams of recycled paper. (Recycled paper is defined as containing no less than 50% secondary paper, and no less than 10% post-consumer waste.) Beginning 1994, at least 30% of the high-grade reams purchased by the State has to be recycled paper. The required percentage increases to 35% by 1997 and to 40% by the year 2000.

The department gives a price preference of up to 5% of the lowest bid price for recycled paper products over virgin paper products, but the total preference must not exceed $ 100,000 per bid. To encourage the use of post-consumer waste, the department's specifications include a requirement that recycled paper contracts be awarded to the bidder with the greatest post-consumer content. Beginning in 1992, the Department and the University of California are both required to devote 35% of their total budget for paper products to recycled paper, increasing to 40% by 1994, and 50% by 1996.

## Paving Materials

PRC section 42700

The Director of Transportation is to review and modify bid specifications to require the use of recycled asphalt, crushed concrete subbase, foundry slag, and paving materials containing the waste materials crumb rubber, ash, glass, and glassy aggregates. Contracts for these items will be made available if their price is competitive for the purpose intended.

## Tires, Retreaded

PRC sections 42400-42416

Retreaded tires are currently widely used for State freight vehicles. The Department of General Services has developed specifications for the purchase of retreaded tires designed to maximize the use of retreads without jeopardizing safety or the intended use of the tire. A study of tread-wear on retreaded tires will be completed through the Department of General Services by 1993.

## Tire Recycling

PGC section 667999.151(c)
PRC sections 42890-42895

The Department of General Services gives a 5% price preference for the purchase of products made from used tires including rubber, oil, natural gas, carbon black, asphalt rubber, floor tiles, carpet underlays, mats, drainage pipes, garbage cans, retreaded tires, and water hoses. The combined amount of preference granted is not to exceed $ 100,000 per year.

# Chapter 3 - Endnotes

1. Weight is based on the CIWMB Interim Database, 25 November 1992 revision, the source for most of the following discussion. The figures apparently exclude asphalt recycling, since it occurs either in place, or at specialized recycling facilities that are classified as disposal sites under state regulations. Volume is estimated by using the densities reported in *Conversion Factor Study*, a 1992 report to CIWMB by Cal Recovery and Tellus Institute. Densities for the last three items in Table 3.1 are estimated based on reported densities for similar materials.

2. Based on 400 miles of highway, 24 feet wide.

3. Tellus Institute. *Disposal Cost Fee Study*. Table 6.25, pp. 6-54.

The costs used here are the "Existing landfill - conventional costs" from Table 6.25, based on an average tipping fee of $13 per ton. No environmental costs are included. Higher tipping fees, or inclusion of environmental costs, would lead to higher cost estimates.

The waste categories used in this report are slightly different from those in the *Disposal Cost Fee Study*. The categories "mixed and other paper", "plastics", and "textiles, tires, diapers, etc." in this report are aggregations of 2-4 categories in the earlier study. In these cases, weighted averages were formed of the relevant waste management costs, weighted by the quantities landfilled as shown in *ibid.*, Table 3-8, page 3-28, column 1. The categories "yard waste", "food waste", and "special wastes" were not used in the earlier study; of these, the first two were assigned the cost for "miscellaneous organics", while the third was assigned the cost for "other waste."

4. Tellus Institute. *Disposal Cost Fee Study*. pp. 5-1 to 5-6.

5. Minimum *utilization* requirements, a broader category that includes minimum content, have not yet been enacted but are being analyzed by a variety of State and national organizations.

# Chapter 4: The Impacts of Major Incentives

In this chapter, we investigate the general impact of incentives on California's major raw materials. There are two major sections in which we discuss the impact of incentives on timber use and on the oil industry.

For the most part, we find that California does not produce directly competing virgin and secondary materials. State timber is used almost entirely for lumber, not paper, production. California's substantial supply of recycled paper therefore competes primarily against virgin supplies from other states and Canada. And although the State's oil and gas production is of great economic and environmental importance, it is used primarily for fuel, not for virgin materials competing with secondary supply.

**Timber incentives**, worth 8% of the value of production, likely reduce the price and stimulate the use of the State's timber. Almost all California timber is turned into lumber, the bulk of it for use in construction. Higher prices due to the reduction or elimination of incentives would discourage lumber use. There are a number of opportunities for redesign of housing construction to reduce timber use; price increases would accelerate these redesign efforts. Other materials such as concrete or steel might also increase their market share in construction.

There is also a very small lumber recycling industry in the State, with apparent potential for growth. Higher virgin timber prices might boost the fortunes of this infant industry. Possible obstacles to lumber recycling include its labor-intensive, small-scale technology, large and unpredictable fluctuations in the supply of scrap lumber from demolition, and traditional reluctance to rely on secondary materials in an area such as new housing construction. The prospects for lumber recycling is an important topic for further investigation.

**Oil incentives**, worth either 1.4% or 4.6% of the value of production (see Chapter 1 for explanation of the two estimates), are too small, on either estimate, to affect the level of oil prices or consumption in the State. The market for oil is nationally and internationally integrated, and California production is an insignificant fraction of world supply. Much of the State's oil use is already supplied by Alaskan and foreign producers, while the State's heavy oil requires additional processing and is of relatively low value.

Removal of incentives might reduce in-state production, although a 1980 study estimated that there would be little effect. If a new tax, or elimination of tax expenditure, did reduce production, it would have environmental benefits for the State (due to reduction of drilling and pumping of oil), as well as potential environmental risks from shipping of increased oil imports. The economic gains from additional State tax revenue would have to be balanced against the losses from reduced oil industry activity.

# I. Timber

### *Consumption in California*

We found in Chapter 1 that the timber industry received the largest State virgin material incentives as a percentage of sales. While some incentives were difficult to quantify and to allocate to the industry, there is no doubt that the State's incentives to timber production are substantial.

California has an important timber industry, but also appears to import a much greater quantity of timber-based products than it exports. With 12% of the nation's population and 13% of its gross domestic product (as of 1989),[1] California accounts for only 5.5% of U.S. timber production and 5.8% of U.S. paper output. Moreover, paper production relies much more heavily on waste paper in California than in the rest of the nation. In 1987, California paper mills used twice as much waste paper as wood pulp; nationally, waste paper usage was just over one-fourth of wood pulp usage. California paper production used just 1.2% of the nationwide wood pulp consumption in 1987.[2] Even that small amount of wood pulp came in large part from sawmill residue, rather than from virgin timber.

More than nine tenths of California's timber harvest (by volume) is made into lumber, most of which is used in construction. Although there is already a modest level of lumber recycling activity, both existing and potential uses of secondary lumber are limited. Incentives for timber production, if passed on to consumers, tend to make timber products cheaper, and stimulate sales of timber. Removal of State timber incentives, if passed on to consumers (causing a price increase), would likely discourage the consumption of timber. To a lesser extent, price increases for timber might also encourage timber recycling. Therefore, in this section we explore the uses of timber and possibilities for source reduction.

### *The Uses of Timber*

Timber is made into lumber, structural and nonstructural panels, and pulp for paper and paperboard. Timber also serves as the base for some chemical materials, such as rosin, turpentine, and lignin derivatives which are used in a variety of applications (adhesives, thinners, etc.). Finally, timber is also used as a fuel.

By far the greatest share of timber is processed into lumber, in California even more so than nationwide. Much of California's timber comes from old growth forests, yielding logs of substantial size; therefore, much of it can be manufactured into high grade lumber. The production of lumber generates enough residue to provide the paper industry with its limited requirements for wood pulp, so that there is hardly any paper manufacture from virgin timber in the State.

Lumber production residue also accounts for some of the large volume of wood waste reported in the State's waste stream, a portion of which is composted to yield soil amendments or burned as fuel (see Table 3.1 in Chapter 3).

**Table 4.1**
**Products from the California Timber Harvest, 1985[3]**
**(in percent of volume)**

| | |
|---|---|
| Lumber (volume of logs destined for sawmills) | 91.7 % |
| Veneer and plywood | 5.1 % |
| Log exports | 1.9 % |
| Pulp and board | 0.8 % |
| Post, pole and piling | 0.4 % |
| Shake and shingle | 0.1 % |

Source: USDA Forest Service

Structural panels are another significant product made from timber. Structural panels (mostly plywood) and non-structural panels (particle board) are made from wood flakes and glue, and are mainly used in construction and furniture production. The difference between structural and nonstructural panels is that the former are used in more demanding applications; they hold together walls of buildings and therefore need to be strong and waterproof. The flakes that go into their production have to meet specific geometric requirements; therefore, they are made from logs which are cut with the specific purpose of producing these kinds of flakes. Nonstructural panels are mostly made from sawmill residue.[4]

*The Uses of Lumber*

California sawmills produced $ 1.6 billion worth of lumber in 1991. Two thirds of this output was sold within the State; some 3% was exported abroad; the remainder was sold to other states, primarily in the western U.S.[5]

In the absence of California-specific data on the use of lumber, we will first present national data and then speculate how California might differ from the national average.

The biggest market for lumber is construction. In 1986, 60% of the nation's lumber (in volume) was used in construction - just over half in new residential construction. Another 12% of lumber was used for shipping (skids, boxes, crates, pallets and use in transportation,

handling, and storage), and 8% in manufacturing (mostly furniture). The remaining 20% went to other uses, including upkeep and improvement of nonresidential structures, roof support and other applications in mines, household purchases for do-it-yourself consumption, and made-on-the-job products such as advertising and display structures. (However, this final 20 % is the residual category and thus is likely to include any statistical discrepancies in the other categories).[6]

It seems reasonable to assume that a greater share of total lumber consumption is used in construction in California than in the U.S. as a whole.[7] The suburbanization of the State, the population growth of recent years, and the standard of living make it likely that the predominant use of lumber is residential construction, predominantly single-family houses. In the following, we therefore concentrate on construction as the main user of timber products.

***Determinants of the Use of Timber Products in Construction***

The timber products used in construction are lumber, structural panels, and non-structural panels. Lumber is mainly used for framing, panels for walling and siding. New housing has long been the largest single U.S. market for timber products. In 1986, more than a third of the lumber and structural panel products and over a fourth of the nonstructural panel products were used for the construction of new housing units.

The volume of timber consumed in new residential construction depends on the number and type of units built and the amount of wood products used in each type of unit. As to the latter, single-family houses use more timber per square foot of living space than do multi-family houses; and detached houses use more than attached houses. Larger buildings use more of other materials, mainly concrete. Trends that increase the use of timber per house include the increasing presence of garages and wooden decks. Also, there has been a trend toward using wood as the principal exterior siding material in new single-family house construction.

The removal of subsidies to the timber industry would be likely to cause an increase in the price of timber and of timber products. There are many potential effects of such a change: higher timber prices could reduce timber consumption by

- discouraging the construction of new housing,
- inducing a shift from single-family to multi-family house construction, or
- inducing a reduction of the use of timber per unit constructed, either through reducing the amount of timber per house, or through a shift to other materials used for housing construction.

While the first two possibilities are very important, a discussion on the demand for housing is beyond the scope of this project. We focus here on the last possible effect of reducing timber consumption: redesign and source reduction in construction, a shift to other materials, and where possible, increased lumber recycling.

Even without a change in subsidies, timber prices have risen recently and are likely to do so even more as ongoing logging reduces supply. A study by the Forest Products Research Lab estimates that the use of softwood lumber per square foot of floor area in residential construction will decline by 24 % between 1986 and 2040 (an annual decline of 0.5%).[8] Reduction or removal of timber subsidies would likely lead to an even faster decline in lumber use per unit.

### *Redesign for Lumber Conservation*

Timber can be saved in construction by eliminating over-design and by using engineered structural wood members. Most wooden structures are built stronger than necessary, due to practices left over from times when stronger structures were necessary. Newer technologies allow for much lighter structures, but old habits die hard. For example, in 1988, nine tenths of exterior wall framing was still spaced at 16 inch intervals, although 24 inch intervals would suffice; similar proportions apply to wall and roof framing. This dates back to a time when walls were plastered over a wooden lath; the plasterboard used today can easily span wider spaces. Approximately 400 board feet of lumber could be saved in walls and partitions of a typical single-family home by converting to 24 inch spacing.[9]

There are other instances where timber can be saved in building a house. For example, a metal bracket supporting the wallboard junction in corners can replace three studs of lumber; in a typical home, this substitution could save 100 board feet. In floor framing, about 700 board feet per house could be saved by using shorter lumber stock and by eliminating unnecessary bridging between joists (this opportunity only applies to about half of the new housing stock, because the other half is built on a concrete slab floor). Researchers at the Forest Products Laboratory in Madison, Wisconsin, estimate that about 10 % to 15 % of dimension lumber could be saved in new residential construction by changing building practices.

More timber could be saved by using more sophisticated parts, often prefabricated. One example is the wood I-joist, whose design recognizes that the most critical part of a member are the top and bottom edges; hence, it saves material in the middle part. Another example is laminated veneer lumber. A modern problem affecting wood use is that better insulation has led to higher rates of wood decay, because of increasing condensation. This can be reversed by vapor retarding techniques such as the airtight drywall approach.

An increase in timber prices, due to reduction or removal of subsidies, would likely lead to an acceleration of these trends toward redesign for lumber conservation.

### *Substitution of Other Materials for Wood*

The materials that could substitute for lumber in construction are concrete and steel. Concrete is a material much superior to wood, as far as strength, durability, sound transmission, and fire

resistance are concerned. However, it is also much more expensive. Thus, at present it only "pays" to use concrete in large structures where its properties are really needed. There is generally no prospect for its use in light frame construction, except in basement walls and footings where its resistance to decay is important. Steel is strong, and can cost less than wood, but it has a far higher heat conduction rate and also transmits sound more easily than wood. At present prices, savings from using steel would be eliminated by correcting for these qualities. Nevertheless, steel construction is likely to play a role in the future, particularly in larger structures, both residential and commercial.[10]

An increase in the price of lumber might, at the margin, make concrete or steel attractive in selected additional uses. No plausible price increase will lead to all-concrete housing development, but a gradual shift away from wood is to be expected if its price rises faster than the price of competing materials.

### *Use of Waste Wood in Construction*

A recycling industry for construction lumber does exist, but its current market share is very small. However, opportunities for expansion seem promising. So far, wood salvaging businesses seem to have no problem marketing their products; the main operational obstacle is the lack of sufficient waste wood supply. The owner of a remilling business recently deplored the fact that demolition contractors simply did not believe that it would be profitable to dismantle old buildings carefully and to sell the woodwaste, although he was willing to pay as much for waste wood as the average price at which green timber sells.[11] Instead, demolition contractors frequently grind and burn waste wood from old buildings.

In addition to contractors' reluctance, wood recyclers face difficulties imposed by the fluctuating level of supply. The level of demolition activity varies widely from year to year, and does not always follow the business cycle or other obvious economic indicators. The expected variation will be even greater in the limited geographical area serving any single recycling facility.

Resawing waste wood into lumber is more expensive than cutting green logs, because it is more labor intensive. Old lumber may contain nails and other metal parts which can ruin the expensive sawblades used in large scale milling operations. Metal parts have to be removed from old wood pieces, and smaller blades (band saw mills) are used to cut the wood. The businessman quoted above sells his product for the same or a slightly higher price than virgin timber mills.[12] However, as the price of virgin timber rises, the more expensive recycling process could become more competitive.

A small recycled lumber industry has been thriving in the Los Angeles area for years, gleaning most of its feedstock from the area's television and motion picture industry. The entertainment industry uses lumber in the construction of sets that are quite often dismantled within days or weeks of their fabrication. This studio lumber, along with lumber from additional sources

including demolition activities, discarded pallets and others, sustains a number of processing yards.

Contractors may be reluctant to use secondary wood on a larger scale for new construction. In general, resistance of replacing virgin materials with secondary ones is all too common. Although lumber made from waste wood is perfectly adequate for many of the structural applications using virgin timber, resistance in this case may be more persistent as individual building inspectors fear they might incur some liability if structure failure occurs.

Recyclers estimate that the total amount of virgin wood market share replaced by recycled lumber is less than 2%, with most of it going into remodelling rather than new construction.[13] The market potential, the cost structure, and the implications of the obstacles to recycling identified here are topics deserving further study.

## II. Oil

### *Effects of Production Incentives*

In Chapter 1 we found that California oil production received incentives via several provisions of the State tax code. What effect do these incentives have on the State's management of its oil resources? Two questions are of interest here: First, do they lower prices of oil-derived products, and hence increase consumption? Second, do they increase production in the State?

The first question can be answered with more certainty than the second. Prices of oil-derived products are very unlikely to be affected by oil production incentives in the State since California is well integrated into the national and world market. The State produces such a small share of total oil supplies that its taxes and incentives can have little effect on national or world prices.

As to the second question, we do not know how much production is affected by State policy. A RAND Corporation study in 1980 came to the conclusion that production would be affected only to a very small degree by imposition of a severance tax of 6%.[14] Many of the factors examined in that report are still applicable, although the world oil price is now lower than in 1980. Whatever the effect a tax increase may have on production, consumption of oil products would not likely decrease because imports would make up any decrease in production.

### *Oil Production*

California's oil industry is different from that of other states because of the predominance of heavy oil. Heavy oil (defined by the American Petroleum Institute as having a degree of gravity of 20 or less), constitutes half to two thirds of the State's reserves; some four fifth of U.S. heavy oil resources lie in California. In production, the share of heavy oil reached 64%

in 1980, rising steadily during the preceding years.[15] At present, the share of heavy oil in the State's production is similar, or perhaps a little lower.[16]

Heavy oil is less valuable to industry because it needs to undergo special treatment before it can be processed further. Coking or hydrotreating are required to make it a substitute for light oil. Only a few low-value products can be directly derived from heavy oil; they are mainly residual fuel oils, such as bunker oil used to power ships.

As a consequence, heavy oil is cheaper than light oil. Oil prices vary with the degree of gravity; oil companies usually post a price for a base grade and a rate by which the price changes according to the change in gravity. Thus the heavy oil price tends to move in parallel with the price of light oil, the difference reflecting the additional cost of refining it into a light crude equivalent.

California does not export much crude oil, but imports a lot. Less than half of the crude oil received by the State's refineries comes from in-state wells; in 1990, 46% came from Alaska, and almost 6% from abroad, mostly Indonesia.[17] (Both Alaskan and Indonesian oil are relatively light.) In the past, California also imported oil from Persian Gulf nations; however, these declined as imports of Alaskan oil increased. Federal legislation, which was enacted as part of the deal that established the TransAlaskan Pipeline bars exports of Alaskan oil; thus Alaskan oil must be shipped to other states of the U.S., predominantly California, Texas, and Louisiana.

### *Effects on the Price of Oil and Oil-derived Products*

The oil market, especially that for light oil, is a world market, and the oil price is a world price. Transportation costs account for regional variation; however, the share of transportation cost is small, given the high value of the resource. What is important is that the regional prices closely follow the world market price. California's share in world production is not big enough to influence the world price in any noticeable way. Thus, one would expect the prices for light crude and California heavy crude to move in parallel fashion, with the light crude price being dictated by the world markets and the heavy crude price following the light crude price.

Some circumstances could perturb this relationship. First, there might not be enough capacity to refine heavy crude into light crude equivalent. This seems to have been the case in the early 1980s, probably because refiners failed to anticipate oil price developments in the crises of the 1970s.[18] If the supply of heavy crude exceeds the refining capacity, its price would drop, irrespective of the world price for light crude. Second, if refiners are vertically integrated, that is, if they are involved in both production and refining, and if their refineries use heavy crude both from their own wells and from small independent producers, it could be beneficial for the integrated producers to make the price of heavy crude drop. They would not be hurt by lower wellhead prices since they are purchasing from themselves, and would benefit to the extent that

they purchase heavy crude from independent producers. However, it is arguable whether this strategy - if indeed it could be pursued - would be profitable.[19]

But whatever happens to the wellhead price of heavy crude oil, it is unlikely to affect the price, and hence the consumption, of oil-derived products such as gasoline or plastics. The more value is added to the raw material oil, the less transportation cost will matter to price. The markets for high value oil-derived products are truly national, if not world, markets. Thus, the price for oil-derived products is independent of production levels for California.

*Effects on the Production of Oil*

The extent to which production would be affected by a reduction in incentives depends on the profitability of the State's oil wells. How many wells are marginal, i.e., operate with a profit margin that would be wiped out by a modest increase in effective tax rates?

Oil well profitability depends on the well-head price received by the producer. Tax incentives worth even 4.6% of the price, let alone 1.4% (the two levels estimated in Chapter 1) are only a small part of this price; expected world oil prices are likely to matter more, given the wide range over which they fluctuate. Nonetheless, a tax increase on oil production could affect production decisions in two ways, through its effect on the profitability of existing wells, and through its effect on the expected return on the construction of new wells. We will discuss each in turn.

Oil wells differ greatly in their production cost profile, but one important feature is common to all wells: the timepath of production. An oil well does not produce a constant flow of oil (barrels per day) over its lifetime; rather, it reaches maximum output early in its life and produces at a declining rate thereafter. That is, early in its life it is very profitable; it becomes less so with age. When the revenue from operating the well falls to the level of operating cost, the well will be shut in.

A higher tax burden would reduce the revenue obtained from the well at each point of its lifetime and would hasten the arrival of the time when the well is no longer profitable. Hence, a lower after-tax well-head price for oil (the result of a tax increase) would affect the oldest wells first. Wells that produce less than 10 barrels a day are called "stripper wells." At present, around 8% of California's oil production comes from these wells.[20] The share of stripper wells was a little higher in 1980 — some 13% of all wells. Based on this number and on historical information on well shut-ins, the 1980 RAND study concluded that a 6% tax increase would have minimal impact on production.

Investment in new wells depends on the expected return. A tax on oil decreases this return for those potential new wells that were already marginal. The effect of a tax on investment and production from new wells would be very slight in the beginning and have a cumulative effect

as time goes on. It seems likely that over a long time horizon, fluctuations in oil prices (both actual and expected) would overwhelm the effect of a modest tax increase.

### *Environmental Impacts of Oil Production*

The production and refining of oil has significant environmental impacts; this is especially true for the extraction of heavy oil. Since heavy oil does not flow easily, it is usually extracted by injecting steam in the oil reservoir. The steam is generated by burning the oil produced on site. California's heavy oil tends to be dirty, with a relatively high sulfur and nitrogen content.[21] The emissions from extraction contribute significantly to air pollution in the locality where the oil is produced. California air quality regulations have in the past been a constraint on production in Kern County, the State's major oil producing area.

Incentives for oil production, to the extent that they encourage in-state production, have a damaging effect on the environment in California. Of course, since a decrease in local production would be replaced by imports, one could argue that the environmental effects in California simply are traded for environmental effects elsewhere. A decline in California oil production might be made up by increased imports of Alaskan oil, for example. The environmental improvement in California's oil-producing regions would then be "traded" for the environmental impacts of increased Alaskan oil production and shipping from Alaska to California. How should a reduction of air pollution in Kern County be weighed against the increased risk of spills from increased oil shipping? The question is of course beyond the scope of this study.

# Chapter 4 - Endnotes

1. Data sources are:
   Population: *California Statistical Abstract,* 1992, p. 10.
   Gross state product: *California Statistical Abstract,* 1992, p. 47.
   State and U.S. timber production: U.S. Forest Service, *An Analysis of the Timber Situation in the United States,* 1989-2040. December 1990. Various tables of production by ownership and woodtype, chapters 6 and 7.
   U.S. Gross Domestic Product: *Economic Report of the President,* February 1991, p. 296.

2. Data sources are:
   For U.S. and CA paper production: *Statistical Abstract of the United States,* 1990, table 691, p.426, and *California Statistical Abstract,* 1992, p.47.
   For composition of California's paper pulp: U.S. Dept. of Commerce, *Current Industrial Reports.* 1988.

3. Howard, James O., and F.A. Ward. *California's Forest Products Industry 1985.* U.S.D.A. Forest Service, Pacific Northwest Research Station, Portland, OR. Research Bulletin PNW-RB-150. 1988.

4. Personal Communication of Irene Peters with Henry Spelter, Forest Products Laboratory, Madison, Wisconsin, November 1992.

5. Western Wood Products Association. *1991 Statistical Yearbook of the Western Lumber Industry.* August 1992, p. 2.

6. U.S.D.A. Forest Service. *An Analysis of the Timber Situation in the United States: 1989-2040.* General Technical Report RM-199, December 1990, p. 23, table 17.

7. We assume that California's share of the nation's housing construction is greater than its share of the nation's furniture manufacturing, shipping, and miscellaneous lumber-using activities.

8. U.S.D.A. Forest Service. *Analysis of the Timber Situation in the United States: 1989-2040.* A Technical Document Supporting the 1989 USDA Forest Service RPA Assessment. General Technical Report RM-199, p. 224.

9. Ibid., p.222

10. Ibid., p. 224

11. Logsdon, Gene. *New Profits in Old Woods.* In Business, July/August 1992, p. 46-49.

12. In Business, July/August 1992, p. 46-49.

13. Personal Communication of Paul Waters with Tim Dillon, Master Recycling, El Monte, California, November 1992.

14. RAND Corporation. *The Effect of a Severance Tax on California's Oil Production.* 1980.

15. Ibid., p. 16

16. Personal Communication of Irene Peters with Rob Hauser, Department of Conservation, Division of Oil and Gas, November 1992.

17. California Energy Commission. *Quarterly Oil Report.* June 1992, p.6, table A-1.

18. RAND Corporation, op. cit., p.87.

19. The RAND study argues that this is unlikely (p. 88).

20. Conservation Committee of California Oil and Gas Producers. *Annual Review of California Oil and Gas Production*, 1992, p. B-24.

21. The share of high-sulfur residual fuel oils produced by Californian refineries is more than ten times the share of low sulfur residual fuel oils. Cf. California Energy Commission, *Quarterly Oil Report,* June 1992, table 1-A, p.6.

# Chapter 5:
# Competition Between Virgin and Secondary Materials

What are the relative costs of making the same products with virgin versus secondary materials? How do the State incentives identified in Chapters 1 and 3 affect the competitive position of virgin versus secondary producers?

In this chapter we address such questions through case studies of three products that can be made with either virgin or secondary materials: asphalt-concrete, plastics, and glass containers. These products incorporate only a small fraction of California's raw materials. As explained earlier, most of the State's virgin materials do not compete with secondary materials, while major secondary materials such as recycled paper compete with out-of-state virgin supply. However, in the cases of asphalt, plastics, and glass, there are opportunities for head-to-head competition between in-state virgin and secondary materials.

In each of the three cases we find that virgin material incentives have minimal impact on the competitive position of secondary producers. In one case, namely glass, the secondary material incentives created by AB 2020 and other State policies provide an important boost to the use of recycled content.

## I. Asphalt-Concrete Production

Asphalt-concrete, or asphalt pavement, is the mixture of asphaltic bitumen (an oil-derived product) and "aggregate" (rock and sand) used to cover a sub-base and base layer of aggregate material in road pavements. Approximately 95% of asphalt-concrete is light-colored pieces of rock and sand. Only 5.2% of the concrete mixture is asphaltic bitumen (also called bitumen, or asphalt cement), the heavy petroleum product that gives asphalt pavement its name. Asphaltic bitumen is a black, sticky substance that has been refined to provide specifically engineered characteristics when mixed with aggregate. Asphaltic bitumen is used as a protective film, adhesive and binder because of its waterproof and weather resistant properties. It coats and holds together the rock as the concrete mix is shaped into a smooth surface.

In order to form asphalt-concrete, the mixture of asphaltic bitumen and rock aggregate must be heated to approximately 300°F to flow properly during application and to achieve the appropriate shape and density during compaction. As it cools, it hardens to maintain strength and stability when subjected to local use and weather conditions.[1] One mile of asphalt highway (24 feet wide, four inches thick) contains an average 3,060 tons of asphalt-concrete -- about 2,900 tons of aggregate and 160 tons of liquid asphaltic bitumen -- and occupies nearly 43,000 cubic feet of space.[2]

*The Role of Oil in Asphalt Production*

Asphaltic bitumen is derived from crude oil. Oil is a mixture of hydrocarbons. Refining, the first step in processing crude oil, breaks down this mixture into components of different density. Asphalt is a very heavy component of crude oil that is left when the lighter components are distilled off. In 1988, it accounted for 2.4% of the State's petroleum use, by volume.[3] Of the State's asphalt production, 38% is a byproduct of refining by three large oil refineries, Chevron, Shell and Conoco, which primarily produce gasoline and other higher-value products. The remaining 62% comes from smaller independent refineries focusing on asphalt production. These smaller refineries tend to purchase heavy crude (see Chapter 4) produced in southern or central California.[4]

In the independent asphalt refineries, crude oil is refined via atmospheric and vacuum tower distillation: first naphtha is removed, then kerosene and gas oil are distilled off, leaving asphalt. When heavy California crude is used, between 30% and 60% of the crude oil is extracted as asphalt (by weight).

*The Price of Oil and the Cost of Asphalt-Concrete*

In 1991, the average price of virgin asphalt-concrete to California users was $23 per ton, excluding transportation.[5] In order to determine the impact of virgin material incentives on asphalt markets, it is first necessary to estimate the "cost shares" of raw materials -- the percentage of the $23 per ton that is attributable to the costs of crude oil and aggregate.

The simplest approach, which we adopt here, is to base costs shares directly on the weight of raw materials. Since asphalt-concrete is 5.2% oil-based bitumen, we assume that each ton of virgin asphalt-concrete contains 5.2% of a ton of oil. In 1991, the price of California heavy crude was $12.96 per barrel, or $72.56 per ton.[6] The cost of 5.2% of a ton of oil was therefore (5.2% * $72.56), or $3.77. The cost of oil thus comprised ($3.77/$23.00), or 16.4% of the price of virgin asphalt-concrete.

Similarly, asphalt-concrete is 94.8% aggregate, and the average cost of virgin aggregate was $10/ton.[7] Therefore each ton of asphalt-concrete contains 94.8% of a ton of aggregate, worth $9.48, and the resulting cost share of aggregate in virgin asphalt-concrete is ($9.48/$23.00), or 41.2%.

This procedure yields only a rough estimate. It relies on the major simplification that the many products which are made from crude oil have the same value. Bitumen tends to be a cheap by-product of oil refining and is less valuable than other, lighter oil products.[8] Consequently, it should bear less than a proportionate share of the cost of crude oil. This implies that the share of the price of asphalt attributable to crude oil should be even less than the simple estimate of 16.4%. However, more rigorous development of cost shares would be a major undertaking, and is beyond the scope of this project.

Using our cost share estimates, we can calculate the impact of virgin material incentives. In a word, they turn out to be minimal, even if the higher oil incentive estimate is used. Use of the lower oil incentive estimate, of course, reduces the minimal impacts still further.

A ton of asphalt, worth $23.00 in 1991, contained an estimated $3.77 worth of oil and $9.48 of aggregate. The quantifiable State incentives identified in Chapter 1 amounted to (using the higher oil incentive estimate) almost 5% of the value of oil and gas production, and 0.6% of the value of nonfuel mining output. If these incentives were fully passed on to asphalt producers, the cost of a ton of asphalt would be reduced by (5% * $3.77), or $0.19, for oil incentives, and (0.6% * $9.48), or $0.06, for mining incentives. The total is $0.25 per ton, or 1% of the price of asphalt-concrete. Using the lower oil incentive estimate, we would obtain an even smaller impact. In either case it is too small to have a significant effect on the market for asphalt.

*Recycling Asphalt-Concrete*

As asphalt-concrete ages, oxidation and other factors cause the pavement to harden. The loss of flexibility leads to cracks in the concrete. Temperature changes, ultraviolet radiation and heavy use contribute to cracking. Spot patching of weakened areas seldom imparts the same durability as the original coating. The rock aggregate however retains its desired quality, namely hardness.

A road can be patched and repaved with either new asphalt-concrete or recycled asphalt-concrete. While virgin asphalt-concrete covers over the original asphalt surface with more material, recycling removes and reuses the old concrete. Asphaltic bitumen can be rejuvenated with light petroleum additive.[9] Some recycling processes use up to 100% recycled content, although most use only 15%. Also, old asphalt-concrete is often stripped from the road, crushed and used as base or sub-base aggregate, rather than being recycled into new asphalt-concrete.

Asphalt pavement is used for paving new roads or repairing and repaving existing ones. Both applications allow for the use of recycled asphalt-concrete. On-site recycling is used for patching and repaving existing roads; in-plant recycling produces a secondary asphalt paving product that can be used in the construction of new roads. The advantages of recycling asphalt pavement include avoiding disposal costs and saving landfill space. In addition, on-site recycling has the advantage of saving transportation costs, which are a significant share of such a low-value product. A number of different methods have been developed for reclaiming and recycling asphalt-concrete, including the following three techniques:[10]

**Cold In-place Recycling**: Characterized as a train approach, this process employs milling machines (typically cold planers) with crushers attached to pulverize the asphalt pavement while cutting the roadway to a desired depth. A mixing unit then adds agents that rejuvenate

asphaltic bitumen and deposits the blended material in a windrow for laying and compaction by conventional equipment.

**Hot In-place Recycling**: High intensity heaters raise pavement temperatures to 250°F while a hoe loosens and mixes the softened asphalt-concrete. An oscillating or vibratory device then levels and redistributes the heated material, followed by a roller that immediately compacts it. After applying a petroleum-based agent to restore the adhesive qualities of asphaltic bitumen, this recycled surface can be overlayed with fresh hot-mix asphalt-concrete or sealed with a heavier petroleum product.

**Hot-mix (in-plant) Recycling**: Existing pavement is removed either by milling or by a ripping/crushing technique, and sent to existing batch-plant or drum mix virgin asphalt producers. Batch-plant recycling can blend 20 to 40% reclaimed asphalt pavement with virgin materials by adding the reclaimed material to already "super-heated" fresh aggregate. Heat conduction softens the reclaimed asphalt pavement as virgin asphaltic bitumen is added to the hybrid mixture. Drum-mix techniques allow as much as a 50:50 mix by blending recycled asphalt-concrete downstream from the heat source. A third method for in-plant recycling is microwave asphalt recycling. This method produces hot-mix from 100% recycled asphalt pavement: first the recycled asphalt paving is air-dried, then microwave energy is used to heat the material to the desired temperature.[11]

### *Savings from Recycling Asphalt-Concrete*

Two sources provide some documentation of the savings from recycling asphalt-concrete. First, the city of Los Angeles, the world's largest asphalt recycler, reports that a mixture of 15% reclaimed asphalt pavement and 85% virgin materials is $2 per ton cheaper than 100% virgin asphalt-concrete.[12] The second source, the Department of Transportation (Caltrans), finds even greater savings from either of two recycled options.

Caltrans reports paving an average of $35.00 per ton for 100% virgin dense graded asphalt-concrete, transportation included. In contrast, hot central plant recycled asphalt-concrete, containing 50% reclaimed pavement, costs $29.30, a 16% savings. Cold in-place recycled asphalt-concrete, which is 100% reclaimed pavement, is even cheaper, only $14.50 per ton. However, Caltrans requires a conventional asphalt-concrete overlay over all cold in-place recycled pavements. This is required because cold recycled mixes do not perform well as a wearing surface under heavy truck traffic. Using equal quantities of virgin and cold recycled pavement, the average cost is thus $24.75 per ton (the average of $35.00 and $14.50), a 29% savings compared to the all-virgin price.[13]

The savings from recycling of $2 per ton in Los Angeles, or roughly $6 to $10 per ton for Caltrans, dwarf the estimated virgin material incentives of $0.25 or less. Recycled pavement is cost-effective in these situations, with or without the comparatively tiny incentive for virgin materials.

Transportation is an important factor in the cost of asphalt-concrete. The costs of using virgin materials includes the cost of transportation of aggregate from quarries and bitumen from refineries. Reclaiming old pavement avoids the cost of transporting it to a landfill, as well as the disposal fee at the landfill. As travel times become greater, the cost quickly becomes significant: assuming a fee of $65 per hour of travel of a 20 ton truck, the transportation costs are $3.25 per ton per hour.

Thus if asphalt recycling avoids 2-3 hours of transportation, it will produce savings of $6.50 - $9.75 per ton, comparable to those reported by Caltrans. The virgin material incentives of 25 cents per ton (on the higher estimate) would be outweighed by no more than 5 minutes of trucking; that is, if the virgin material incentives were fully passed on to asphalt buyers, it would be cost-effective to buy virgin materials from 5 minutes farther away.

Avoided disposal costs contribute significantly to the savings associated with the reuse and recycling of asphalt pavement; the Asphalt Recycling and Reclaiming Association reported a savings of $40/ton for avoided landfill costs in asphalt recycling, which included tipping fees, transport and labor. In a survey of three landfills in Los Angeles and Orange County, the tipping fee for clean asphalt averaged $9.58 (and ranged from free to $22.75). In Los Angeles, disposal cost savings appear to be greater than the raw materials savings from asphalt recycling.[14]

Asphalt is a unique waste material in that the agency that generates asphalt pavement waste (typically a local government) has to pay for its disposal. Avoided disposal costs are therefore a major market incentive for asphalt pavement recycling. In contrast, the generators of post-consumer waste typically do not directly bear the disposal cost, so the avoided disposal cost does not provide an incentive to use post-consumer secondary materials.

## II. Plastics Production

Plastics consist of long chains of hydrocarbon molecules. They are formed by linking together individual molecules in a process called polymerization. The single molecules used in this process are called monomers; the chains they form are called polymers. Before, during, and after polymerization, additives are mixed into the plastic to impart specific qualities to the final product such as color, durability and flexibility.

For this analysis, we focus on three of the leading plastic resins, or polymer types: high-density polyethylene (HDPE), low density polyethylene (LDPE), and polyethylene terephthalate (PET). These resins are used in many applications; among other things, they are used widely in product packaging (although they are by no means the only resins used in packaging). PET is the main material from which soda bottles are made (they also contain an HDPE base); HDPE is used in milk bottles, and in yogurt and other food containers; and both HDPE and LDPE are used for plastic film and many other packaging applications.

*The Role of Oil in Plastics Production*

The two major raw materials used in plastics production are natural gas and crude oil, both of which are complex mixes of hydrocarbons. The first step in the processing of oil and natural gas is refining, which breaks down these mixtures into their constituent components. The principal natural gas constituents utilized in plastics production are ethane and propane. The principal products from crude oil refining used in plastics are liquified petroleum gas (LPG, a mixture of propane and butane), naphtha, and gas oil.

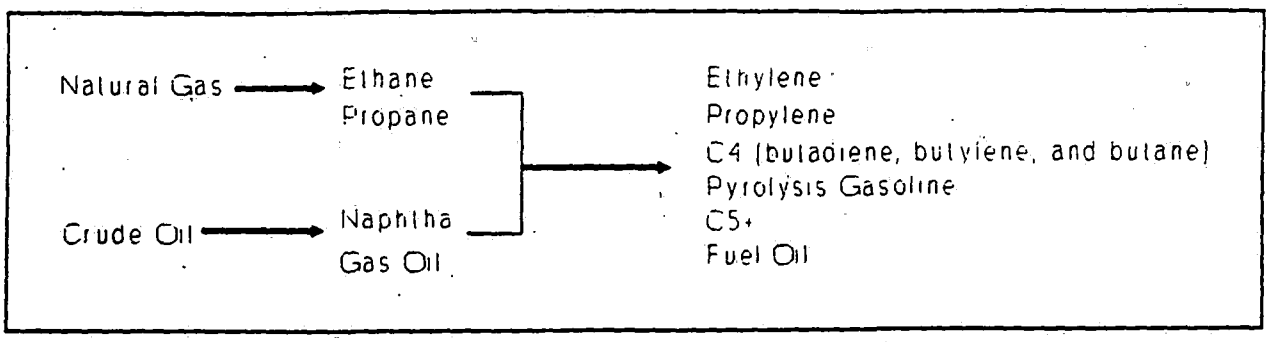
Once ethane, propane, LPG, naphtha, and gas oil are isolated from natural gas and crude oil, they can be processed into organic chemicals that are used as feedstocks for plastics production: ethylene, propylene, benzene, and paraxylene. Some plastics, such as HDPE and LDPE, are produced directly from plastic feedstocks. Others, such as PET, require further processing of the feedstocks into intermediate chemicals which are then used in the manufacture of plastic materials.

HDPE, LDPE and PET resins all require ethylene as a feedstock. Ethylene is manufactured in a "cracking" process that breaks apart the hydrocarbon compounds. The input to the cracking process is a mix of hydrocarbons found in oil and gas, specifically ethane, propane, naphtha, and heavy gas oil. The output resulting from the cracking process is a mix of products including ethylene, propylene, pyrolysis gasoline and fuel oil, and other hydrocarbons. The amount of each product produced depends on the mix of inputs used in the cracking process. The light hydrocarbons such as ethane and propane are the easiest to crack and yield the fewest byproducts, whereas the cracking of heavier materials results in more byproducts, and less ethylene production.

The following is reported to be a typical mix of inputs, by weight, for ethylene production by a U.S. producer: 33.6% ethane, 13.1% propane, 26.9% naphtha, and 26.4% gas oil.[15] Ethylene comprises only 43.5% (by weight) of the total products produced from this mix of feedstocks. Over 15% of the product is propylene, a monomer used in the production of polypropylene plastic. The flow of materials in ethylene production is illustrated in Figure 5.1. HDPE and LDPE are both produced by the polymerization of ethylene into polyethylene, using slightly different polymerization processes. Both processes require just over one ton of ethylene to produce one ton of plastic resin.

PET production is more complicated than the manufacture of HDPE or LDPE. PET is manufactured by a condensation polymerization reaction of two feedstock derivatives, ethylene glycol and either dimethyl terephthalate (DMT) or terephthalic acid (PTA). These are two alternative production processes for PET which are apparently used in similar proportions. Lacking information on production with PTA, we only consider the production process utilizing DMT. The first feedstock, ethylene glycol, is formed from the oxidation of ethylene. The second feedstock, DMT, is produced in two steps: first, naphtha (a crude oil derivative) is

**Figure 5.1** Ethylene Production Materials Flow




transformed into paraxylene; then paraxylene is combined with methanol to produce DMT.

Production of one ton of PET requires over four tons of oil (see first column of Table 5.1). Note however, that not all this crude oil is eventually transformed into PET. Instead, 4.11 tons is the quantity of crude oil that must be distilled to produce enough naphtha and gas oil to produce the necessary amounts of DMT and ethylene for the manufacture of one ton of PET. Similarly, approximately 3.5 tons of crude oil are needed to manufacture one ton of HDPE or LDPE resin, but not all the constituents of that 3.5 tons of crude oil end up in the resin product.

### *The Price of Oil and the Cost of Plastics Production*

Because of the nature of petrochemical production processes, calculating a cost share for oil in resin production is not a straightforward procedure. As mentioned in the discussion of asphalt, the different outputs of the refining process have different values, and the mix of outputs can change, across refineries as well as within a single plant. How much of each output is produced depends on the mix of the inputs; market prices for outputs will play a role, as well. Thus, calculation of the oil cost share requires a number of simplifying assumptions.

We make the following simplifying assumptions: First, there are no losses in the production processes, and production of one ton of plastic requires exactly one ton of oil. Second, the joint products resulting from the refining steps all have the same value. As in the case of asphalt, a more rigorous calculation that avoids these unrealistic assumptions would be a major undertaking, far beyond the scope of this study.

With these simplifying assumptions, we arrive at the following cost shares of oil in plastic resins: PET 9.15%, HDPE 15.66%, LDPE 18.02% (see Table 5.1). These numbers were developed using the average 1991 price for Saudi light benchmark crude, $17 per barrel, or 5.68 cents per pound.[16] The true cost shares of oil would be even higher if the feedstocks for plastic production are of higher value than other outputs of the refining process, as seems to be the case.[17]

Using the cost shares of crude oil for plastic resin production, it is easy to estimate the maximum potential impact of California oil incentives on plastics markets. As with asphalt, the result is that the impact is minimal, even if the higher estimate of oil incentives is used. The higher estimate of oil incentives identified in Chapter 1 amounted to roughly 5% of the value of production. If this amount were fully passed on to plastics producers, it would be worth (5% * 9.15%), or 0.46% of the price of PET, (5% * 15.66%), or 0.78% of the price of HDPE, and (5% * 18.02%), or 0.90% of the price of LDPE. Use of the lower estimate of incentives, of course, would produce even more minute impacts on the prices of plastic resins.

**Table 5.1**
**1991 Oil Cost Shares for PET, HDPE and LDPE**

| | Tons Oil/ Ton Resin | Avg Price Crude Oil $/ton | Avg Market Price/ton Resin $/ton | Oil Cost Share |
|---|---|---|---|---|
| **PET** | 4.11 | 113.5 | 1240 | 9.15% |
| **HDPE** | 3.49 | 113.5 | 725 | 15.66% |
| **LDPE** | 3.60 | 113.5 | 630 | 18.02% |

NOTE:
1. Cost data from "Barometer: Quarterly Update," Modern Plastics, October 1992.
2. Oil Costs represent the average price for Saudi light benchmark crude, assuming 300 pounds per barrel.

### *Plastics Recycling*

Plastics recycling, while still in its infancy, is making rapid progress. Early practice usually implied simply regrinding the waste resins which turned out a plastic material that was inferior to the virgin version. "Closed-loop recycling" (manufacturing the material into the same product) was not possible, so the "recycled" plastic would find its way into ill-famed products such as plastic park benches and flower pots - often, no better than an outlet for plastic waste.

Simply regrinding plastic waste is referred to as "primary" recycling. Far more sophisticated processes exist today. "Secondary" recycling implies the physical or thermal reprocessing of waste resin material, and "tertiary" recycling involves breaking down the material into its chemical constituents: polymers, monomers, fuels, or other chemicals.[18]

The ease with which plastic resins can be recycled depends on their chemical make-up. There are two basic types of plastic resins: thermoplastic resins and thermosetting resins. Thermoplastics consist of simple hydrocarbon chains; thermosets of cross-linked chains. The

latter are stronger and are used in many special applications. They are also called "engineered plastics". Thermoset resins include polyurethane, phenolic, urea and melamine, unsaturated polyester, epoxy and alkyd. On the other hand, the major packaging plastics are all in the thermoplastics category.[19] However, thermosets increasingly are used in packaging applications (such as microwaveable trays). In 1991, thermoplastics accounted for 84.9% of U.S. plastics sales by weight.[20]

Thermoplastics can, in principle, be recycled by remelting and reforming (secondary recycling). An issue of critical importance to secondary recycling is the purity of waste feedstock material. Trace amounts of foreign resins can ruin a whole batch of recycled resins. This problem will become more acute with growth in the supply of waste plastics from curbside collection, since these plastics are typically mixed. PET and PVC bottles look very much alike; one PVC bottle can render a truckload of PET bottles worthless. Therefore, great effort is being invested in researching processes that sort resins. One potential automated process involves the use of X-ray fluorescence to detect the chlorine atoms in PVC.[21]

There are still regulatory barriers to closed-loop secondary recycling in food container manufacture. Plastic recyclers find it difficult to demonstrate to the Food and Drug Administration that the recycled resin suffices the agency's stringent hygienic safety standards. Tertiary recycling has the great advantage that it yields a plastic resin which is a perfect substitute for the virgin resin and which can be used in food contact applications.[22] Producers of both Coca-Cola and Pepsi bottles already use some recycled post-consumer PET bottles.[23]

Tertiary recycling (also called "chemical reclamation")[24] completely depolymerizes the waste resins. The monomer feedstock can be purified to be identical to its virgin cousin, and is a true alternative to feedstock derived from virgin crude oil. The most advanced tertiary recycling processes can accept mixed waste polymer as feedstock. However, it is common for chemical recyclers to process relatively pure waste resins.

Eastman Chemicals (a division of Eastman Kodak) is one of three companies in the U.S. that are currently recycling polyester resin (the other two are Freeman Chemical Corporation, and the Polyester Division of Goodyear Tire and Rubber Co.). Eastman Chemicals use the methanolysis process to recycle clean PET waste. Methanol and a catalyst are added to the waste resin, which breaks down into the components DMT and ethylene glycol. These substances are then used as the raw feedstock for new PET production, using the same polymerization process used to manufacture virgin PET.[25]

### *The Cost of Plastics Recycling*

Obtaining cost information (and for that matter, production information) about plastics recycling is difficult because the processes are often proprietary to individual companies. We received the following summary cost data from Eastman Chemicals:[26]

It costs approximately $0.50 per pound to manufacture PET monomers from virgin materials. In contrast, the cost of the methanolysis process is only $0.25 per pound. However, the waste resin has to be prepared before it can be subjected to this process. Eastman reports that when the cost of collection, sorting, baling and flaking or pelletizing are included, the total cost of remanufacturing PET resin ranges between $0.60 and $0.70 per pound -- $0.10 to $0.20 above the price of virgin production.[27]

Our higher estimate of California oil incentives translates to 0.46% of the price of virgin PET, or only $.0023, roughly a quarter of a cent, per pound. Eastman Chemicals' figures imply that the difference between virgin and recycled processing costs is 40 to 80 times as great as the value of State incentives. Using the lower oil incentive estimates, the processing cost difference would be well over 100 times the value of State incentives. The market advantage of virgin materials reflects production cost differences, perhaps due to the immaturity of plastics recycling technology.

Many of the steps to prepare PET containers for chemical reclamation are also common to secondary recycling of PET and HDPE. After the initial collection, sorting and baling of recyclable plastic bottles, the basic reclamation process for recycling PET and HDPE bottles involves the following operations: debaling; granulation into flakes; air classification of the granulate to take out light particles and fines; washing granulate to remove labels, glue, and dirt; separation of contaminants, HDPE and PET; rinsing and dewatering; centrifugal drying of the particles; hot air drying; extrusion and pelletizing. Recycled plastic that has been repelletized in this manner can be fabricated into products with the same technology used for virgin production. The use of these flakes and pellets is, however, limited to non-food contact applications.

A recent study for the State of Wisconsin provided the following cost breakdown of activities associated with these recycling steps for PET and HDPE:[28]

| | Cost in cents/lb | |
|---|---|---|
| Process Step | PET | HDPE |
| Collect | 2-4 | 2-4 |
| Sort | 3 | 3 |
| Bale | 2-5 | 2-5 |
| Ship bales to reclaimer | 2-3 | 2-3 |
| Granulate | 5-8 | 4-8 |
| Wash and Dry | 6-10 | 10-15 |
| Extrude and pelletize | 7 | 5 |
| Ship to end user | 2 | 2 |
| TOTAL | 28-42 | 29-43 |

There is yet another cost to recycling plastics, a high rate for workers compensation, which may put it at a competitive disadvantage compared to virgin resin production. Workers compensation is a premium levied on the payroll for insuring the workforce against accidents. While all manufacturers are required to buy this insurance, they are assigned different premiums -- presumably, based on the differing probabilities of work-related accidents, reflecting the nature of the individual production processes.

Due to the novelty of plastics recycling and the variety of resin recycling and remanufacturing processes, there is a great deal of uncertainty about what rate to assign to this type of business.[29] At present, most resin recycling facilities are placed into the same category as injection molding, with rates of 13% or more of payroll outlays; virgin resin producers who qualify for the chemical manufacturing rate pay only 5.9% of payroll.[30] If resin recycling (done by processors other than virgin resin producers) does not give rise to more or worse accidents than virgin resin production, this constitutes an unfair practice and disadvantages the former.

***The Role of Incentives***

California's beverage container legislation provides incentives for PET recycling. The Processing Fee system, designed to create an infrastructure for the recycling of beverage containers, establishes a price which supports the collection of PET soda bottles. While a price support system worked well for glass (which is the subject of the following section), the system broke down for PET bottles. We briefly speculate about why this happened.

The Department of Conservation set the Processing Fee at a very high rate for PET, reflecting the high cost of recycling. The Processing Fee is ultimately paid by the container manufacturer, who has to credit bottlers for the Processing Fee they pay on each container. In the case of glass, container manufacturers are the ones who utilize secondary material. In plastic container production, that is generally not the case. This is due to the nature of the production process. Two very different major production stages are required in the production of plastic containers, a petrochemical production stage and mechanical container formation stage. These are not usually carried out by the same enterprise. (In glass container manufacture, there is one single comparable production step which happens within a single plant.) The resin producers do not make containers. However, they are equipped to recycle plastics, in sophisticated chemical processes that yield a product which can compete for the same uses as the virgin product.

Why then should resin producers worry about the Processing Fee? Because it hurts an important market for plastics resins. Packaging absorbed 25% of U.S. resin sales in 1991.[31] In that light, it is not surprising that the virgin resin producers took steps to circumvent the Processing Fee system and pursue plastics recycling under their own regime. Incentives for the use of secondary materials must be targeted at those who can utilize them in production. As of today, that is not the case in plastic beverage container production.

Bottlers paid the Processing Fee on PET containers in only one year, 1991. In 1992, virgin resin producers formed the Plastics Recycling Corporation of California (PRCC) which buys back plastic containers at the estimated recycling cost for PET as determined by the Department of Conservation (in 1993, $ 807 per ton of PET). This practice exempts the bottlers from paying the Processing Fee on PET containers, since the fee is levied only if the scrap value is less than the cost of recycling the material. The Plastics Recycling Corporation now has the responsibility to handle the post-consumer PET waste. Some of it is exported to Pacific Rim countries, some is baled and stored, and some is recycled in the State, either by independent processors or by virgin resin producers -- several of whom are engaged in or experimenting with chemical resin recycling.[32]

## III. Production of Virgin and Secondary Glass Containers

Three main types of glass are found in the municipal solid waste stream:

- container glass;
- flat glass; and
- pressed or blown glass.

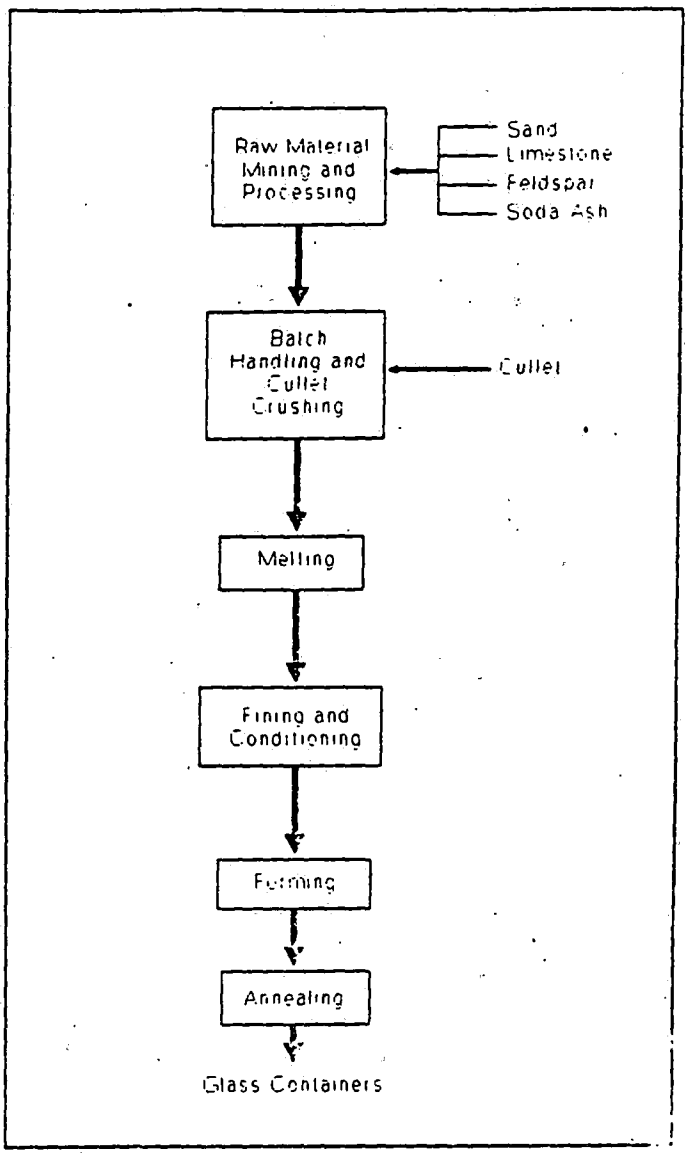
Container glass is used for food and beverage containers; flat glass includes sheet or window glass and plate glass. Pressed or blown glass is used in the production of stemware, tableware, cookware such as Pyrex, lighting and electronic glassware, and glass fiber.

All three types of glass can be found in municipal solid waste. Container glass, which is readily recycled into new containers, comprises the great majority of glass waste. Flat glass and pressed or blown glass, a small portion of the glass waste stream, cannot be recycled for containers because of their differing composition and physical properties including melting point.

### *Production of Virgin Glass*

The manufacturing of container glass (also known as soda-lime glass) requires the production steps shown in Figure 5.2. The major raw materials for virgin container glass production include silica sand, limestone, soda ash, and feldspar. Minor constituents are added to produce flint, green, and amber glass. These raw material are delivered to the glass plant and stored in silos until they are proportioned into batches prior to use. Some cullet, that is, scrap glass, is added to the batch which is then melted in a furnace at 2800°F. As cullet facilitates the melting process and reduces the temperature required to melt the raw materials, even "virgin" glass contains some cullet, typically around 10%, provided from in-house scrap.

Figure 5.2 Glass Container Production




Once the batch is fully melted, the temperature of the glass is gradually lowered and any gas bubbles are eliminated, a process known as fining. The temperature of the glass is further reduced to a working temperature (approximately 2000° F) before the molten glass is formed into a container. During the forming process, the glass cools unevenly, causing internal stresses which must be relieved. The containers are therefore transferred into an oven and reheated until the inside and outside temperatures equalize, a process called annealing.

### *Glass Recycling*

Virgin materials are not necessary to glass making. Glass is one of the few materials which can be recycled indefinitely and is technically 100% recyclable. The processes required for producing recycled glass are the same as outlined in Figure 5.2 for virgin glass.

Only the recipe for producing the glass will change - the more cullet that is used, the less sand, limestone, feldspar, and soda ash required. As cullet melts at lower temperatures than the raw materials in the batch, increasing the amount of cullet in the furnace decreases the amount of energy required to produce molten glass. The energy required for the remaining production stages is unaffected by cullet use. Thus, the use of cullet in glass production is desirable; the only limiting factor is the availability of high quality cullet.

While glass manufacturers can use different levels of cullet, frequent changes in the ratio of recycled to virgin material will cause fluctuations in furnace temperature which can shorten the furnace service life or result in defective containers. Thus manufacturers require long-term, reliable supplies of cullet. Inconsistency of cullet quality as well as quantity may limit the level of cullet use. Glass containers produced in California contain an average of 30% post-consumer material; the actual post-consumer content used in the State's production facilities varies from 15% to 50%[33] Thus, to produce one ton of glass containers, an average of 600 pounds of postconsumer cullet and 200 pounds of pre-consumer cullet is utilized.

Table 5.2 shows the energy savings attributable to varying amounts of cullet use. Ten percent cullet is equivalent to "virgin" glass, using only in-house scrap; 40% cullet content includes the 10% in-house and 30% post-consumer cullet used on average and 60% cullet content is comprised of 10% in-house and 50% post-consumer cullet. Each 10% increase in cullet use reduces the furnace energy requirement by 0.125 MMBtu per ton of glass containers produced. Thus, increasing cullet use from 10% to 40% provides a 0.375 MMBtu energy savings for glass melting. Glass furnaces use natural gas to provide this energy. Based upon a natural gas cost of $2.29 per MMBtu,[34] this energy savings provides a $0.86 savings per ton of glass produced using 40% cullet content. Corresponding data are also provided in Table 5.2 for glass containers containing 60% cullet.

**Table 5.2**
**Energy and Cost Savings[35]**

| Percent Cullet | Energy Requirements (MMBtu/ton) | Energy Savings (MMBtu/ton) | Percent Savings | Cost Savings (1) (per ton) |
|---|---|---|---|---|
| 10% | 4.750 | --- | --- | --- |
| 40% | 4.375 | 0.375 | 7.9% | $0.86 |
| 60% | 4.125 | 0.625 | 13.2% | $1.43 |

(1) Based upon natural gas cost of $2.29/MMBtu.

To put the energy cost savings in perspective, the following are the major components of the cost of glass container manufacturing:[36]

| | |
|---|---|
| Labor | 35% - 40% |
| Raw materials | 18% - 22% |
| Other materials (agents, maintenance) | 4% - 7% |
| Utility costs | 8% - 12% |
| Other (admin/marketing) | 25% - 30% |

Glass recycling saves energy and hence reduces utility costs, albeit by a very small amount. Note that the utility cost includes the energy requirements for melting and for the subsequent stages of production. The energy requirement for the melting stage is about half of the requirements for all production stages together.

The use of cullet may also save some raw material costs to the glass container manufacturer. However, there is a trade-off between the savings that can be realized through the use of cullet and the uncertainty of its supply.

*The Role of Incentives*

The production incentives which the State provides to the virgin raw materials used in glass making are very small, if counted as a percentage of the value of output. They are not likely to influence the extent of virgin vs. secondary materials use in glass manufacture. Rather, the extent of recycling is affected by the steadiness of supply of secondary feedstock. In the past, this factor has favored the use of virgin materials.

California's beverage container legislation, discussed in Chapter 3, ensures a steady stream of secondary glass through its deposit/refund system. It offers a regulatory incentive, but it is not a State subsidy, since all the funds involved are collected from beverage users and container manufacturers. The infrastructure necessary to recycle cullet is funded through the Processing Fee system, which requires container manufacturers to credit bottlers for the Processing Fee they pay on each container. The main beneficiaries of this system are recyclers, whose activities are supported with the Processing Fee funds. The dominant cost component in recycling glass is indeed the cost of recovering the material from the waste stream. Processors used to receive a small share of the Processing Fee, but this provision is being abandoned as of 1993.

The use of cullet has been further encouraged by Market Development Payments (funded out of Processing Fee receipts). Most Market Development Payments have been paid to manufacturers who use colored cullet, which is not as easy to recycle as clear glass. However, Market Development Payments are unlikely to continue under the 1992 legislative changes.

In sum, the incentives benefitting secondary glass amounted to $ 20.55 million in 1991, with the following shares attributable to individual programs:

| | |
|---|---|
| Processing Fee Payments | $ 11.35 million |
| Market Development Payments | $ 9.20 million |

In that year, some 578,000 tons of glass were recycled;[37] thus the incentive was $ 35.60 per ton of secondary material. In comparison, the scrap value of glass averaged $ 71.60 in 1990.[38] The incentive appears to be substantial. It is likely that without it, much less secondary glass would have been used by the California glass industry.

# Chapter 5 - Endnotes

1. Asphalt Recycling and Reclaiming Association. *Asphalt Pavement: A National Resource.* Press Release of April 5, 1991, p.1.

2. Ibid, p.2.

3. Derived from statistics on California oil refineries output, in: California Energy Commission. *Quarterly Oil Report. First Quarter 1989.* June 1989, p.16.

4. Personal Communication of Eugene Tseng with Huntway Refining, November 1992.

5. Personal Communication by Eugene Tseng with various California pavers. Prices paid by pavers contacted ranged from $21 to $25 per ton; $23 per ton is used in calculations.

6. Personal Communication of Rebecca Little with the California Energy Commission, Fuels Office, December 1992.

7. Asphalt Recycling and Reclaiming Association.

8. As stated previously, a large share of Californian asphalt production comes from dedicated refineries. It is not clear what implication this has for the price of asphalt.

9. Asphalt Recycling and Reclaiming Association. *Asphalt Pavement: A National Resource.* Press Release, April 5, 1991, p 2.

10. Asphalt Recycling and Reclamation Association. *Technical Disciplines.* (Recycling processes are described in this document.)

11. CIWMB, *Market Status Report: Pavement* (Draft), August 1992. (Hot-mix microwave process from Lin Lindert, CIWMB)

12. Personal Communication of Eugene Tseng with The City of Los Angeles, Street Maintenance Department December 1993.

13. Memorandum from John West, Chief of the Division of New Technology, Materials, and Research, California Department of Transportation, February 9, 1993.

14. Personal Communication of Eugene Tseng with The City of Los Angeles, Street Maintenance Department December 1992. The Department reports saving a total of $1.5 million annually on raw materials and disposal costs, of which approximately $400,000 comes from using recycled pavement in the hot mix asphalt process.

15. Ulrich, Henri. *Raw Materials for Industrial Polymers.* Oxford University Press: New York, NY, 1988, p.5.

16. *Barometer: Quarterly Update.* Modern Plastics. October 1992. (Market prices of resin and the crude oil are based on average of quarterly data).

The *domestic* first purchase price (averaged through October 1991) was 5.54 cents/pound (*Monthly Energy Review*, DOE/EIA, January 1992). The average 1991 (through October) *domestic* refiner acquisition cost was 6.48

cents/pound. (The imported refiner acquisition cost for the same period is 6.20 cents/pound). Using this lower domestic price changes the oil cost shares only slightly.

17. Historically, the market price of ethylene is higher than that of propylene and butadiene; in 1991 ethylene cost $432.50/ton while propylene sold for $362.50/ton and butadiene for $335/ton. (See *Barometer: Quarterly Update.* Modern Plastics. October 1992.)

18. Nir, M.M., J. Miltz, and A.Ram. *Update on Plastics and the Environment: Progress and Trends.* Technion, Israel Institute of Technology, Haifa, Israel. p.28

19. CIWMB. *Plastics: Waste Management Alternatives. Use, Recyclability, and Disposal.* May 1992. Publication No. 401-92-2200. p. 7 ff.

20. *Modern Plastics,* January 1992. Referenced in CIWMB, op. cit., p.9

21. Developed by ASOMA Instruments Inc. (Austin, Texas), National Recovery Technologies (Nashville, Tennessee). See CIWMB, op.cit., p. 34.

22. Nir et al., op. cit., p.28

23. CIWMB. *Plastics: Waste Management Alternatives. Use, Recyclability, and Disposal.* May 1992. Publication No. 401-92-2200. p. 40

24. CIWMB, op. cit., p. 40

25. CIWMB, op.cit., p.40

26. Personal communication of Eugene Tseng with Eastman Chemical, November 1992.

27. The following Eastman data were used: $0.10 for collection; $0.05 to sort and bale; $0.20 for bale breaking, grinding, cleaning and flaking, and an additional $0.10 to pelletize.

28. *Plastics Collection News.* Resource Recycling's Plastics Recycling Update, October 1992.

29. Personal communication of Rod Miller with Randy Hogan, Workers Compensation Insurance Rating Bureau, January 1993.

30. Personal communication of Rod Miller with Michael Kopulsky, Envirothane, January 1993.

31. *Modern Plastics,* January 1992. Quoted in CIWMB, op. cit., p.10

32. CIWMB. *Plastics: Waste Management Alternatives. Use, Recyclability, and Disposal.* May 1992. Publication No. 401-92-2200.

33. Personal Communication of Karen Shapiro with Kier Furey, Department of Conservation, Division of Recycling and Kirsten Ritchie, Western States Glass Recycling Program, October 1992.

34. Energy Information Administration. *Short-Term Energy Outlook - Quarterly Projections.* November 1992.

35. State of California, Solid Waste Management Board. *Energy Analysis of Secondary Material Used in Product Manufacture.* Sacramento, CA 1979.

36. Personal Communication of Eugene Tseng with Kirsten Ritchie, November 1992.

37. Personal Communication of Eugene Tseng with Keir Furey, Department of Conservation, Division of Recycling, November 1992.

38. Department of Conservation. *Notification of Processing Fees.* November 30, 1990 (Memo by Ralph Chandler, Director).