Recycling as Economic Development:

Toward a Framework for Strategic Materials Planning

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by

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Chapter 1
Introduction

Americans generate 209 million tons of municipal solid waste annually, or 4.4 pounds per person per day.[1] The management of these wastes has become a major function of governments at the local and county levels, consuming a significant share of local tax dollars.

While the collection, treatment, and disposal of wastes had been a function of local governments at various places and times through history, more often these waste management functions had been a private responsibility. However, in the late 19th Century, amid growing concerns about urban public health conditions, localities across the U.S. began to take more active public roles. Over the past century, government's involvement in waste management has grown to embrace the establishment and coordination of services for waste collection, the regulation of when and how various materials may be discarded, and the siting and regulation of facilities for waste disposal.[2]

The modern practices of waste management and urban planning share a common heritage, emerging as part of the Progressive response to the extreme poverty, overcrowding, and unsanitary conditions in American cities of the late 19th Century. Perhaps because of this common heritage, waste management shares with other planning specializations rationalist approaches to the incorporation of knowledge into forward-looking policy development processes.[3] Despite this, waste management has never been considered a part of the planning profession, and has been relegated instead to the domain of public works agencies or solid waste management authorities.

Today, there may be reason to revisit this division. Due to environmental and economic pressures, waste management is undergoing a period of rapid evolution. No longer exclusively concerned with controlling the externalities associated with waste disposal, the objectives of waste management today are increasingly tied to those of local economic development. This paper will attempt to describe these emerging connections between waste management and strategic economic development planning, and explore how they might evolve into the future.

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[1] U.S. Environmental Protection Agency (1995), p. 2.

[2] For a brief description of waste management practices during 1890-1960, see Blumberg and Gottlieb (1989), pp. 5-10. For a more detailed account, see Melosi (1981).

[3] Blanco (1994), pp. 4-20.

1.1. The Rise of Recycling on the Public Agenda: Recycling As Waste Disposal[4]

The reuse or recycling of wastes has always been a part of human society in one form or another. Traditional human societies created useful products from waste materials left after animals were consumed for food. In the nineteenth century, paper was primarily a recycled product, made from old clothing and rags. During World War II, many Americans considered recycling a patriotic duty in support of the nation's war effort. With the rise of environmentalism in the early 1970s, recycling became linked in many people's minds with environmentally conscious behavior, but was not systematically linked with public policy until nearly two decades later.

Throughout this period, two cultural developments within American society were intensifying and heading toward a conflict. The consumer culture, flourishing since the 1950's, equated rising standards of living with increased consumption of material goods. At the same time, public apprehension about the state of the environment and its impact on human health had been growing since the late 1960's. These two trends collided visibly in the 1980's, when concern over the necessary but inherently polluting task of solid waste management met rising per-capita levels of waste generation.

In the late 1980's, a "garbage crisis" gripped many communities across the United States. The perception of a crisis by the public and the media began in 1987, as the infamous "Garbage Barge" *Mobro 4000* wandered the Atlantic coast for 164 days, looking for a place to unload.[5] The barge's long journey began after local officials on Long Island, NY were unable to make other arrangements after their local landfill had closed. *Mobro 4000*, whose contents were finally burned in a Brooklyn incinerator, became a symbol of the inadequacy of present ways of managing wastes, and brought waste management into the forefront of policy debates at the state and local levels.

In the ensuing wave of concern about solid waste issues, the foundations of modern "integrated waste management" policies were enacted by state legislatures across the nation. These policies required state and local officials to develop comprehensive plans for the disposal of municipal wastes. As these planning exercises proceeded, public awareness and concern over the environmental impacts of incinerators and landfills activities intensified. At the same time, the costs of building these facilities grew prohibitive, as new Federal regulations required costly new environmental controls that had the additional effect of making only extremely large facilities appear economically attractive.

While some areas did opt to invest in new incinerators or landfills, many others found this a political impossibility. Public officials turned to recycling as a politically acceptable alternative to new incineration and disposal facilities. Ordinances providing for the separate collection of recyclable materials were adopted across the country, and were embraced enthusiastically by the public. By

[4] For expanded accounts of the "garbage crisis" and the rise of modern recycling policy, see Blumberg and Gottleib (1989), Newsday, Inc. (1989), and Goldman (1991).

[5] Newsday, Inc. (1989), p. *x*.

1995, 46% of Americans had curbside recycling collection services.[6]

In many cases, state governments prompted local authorities to begin these recycling programs by handing down aggressive recycling or waste diversion targets. By 1995, forty-four states and the District of Columbia had established such mandates; the sixteen most ambitious had set targets at 50% or more.[7] Today, the recycling rate of the nation as a whole has reached 27% of all municipal solid waste generated.[8]

Until recently, recycling tended to be viewed as an alternative waste disposal option; state governments gave little thought to the demand side of the recycling equation. Policy was aimed at collecting recyclables and delivering them to the market, where it was assumed they would be absorbed. The result of these policies was to cause already-volatile scrap materials prices to plummet, as markets quickly saturated with supplies of recyclables. Since the early 1990's, secondary materials prices have continued to fluctuate sharply, due to imbalanced supply and demand, unstable market prices for counterpart raw materials, and other factors.

1.2. Recycling as an Economic Activity

State governments began to recognize the problems inherent in recycling policies that overemphasize materials supply, and to see the potential cost savings and other economic benefits that recycling offers. In the early 1990's, a wide range of "market development" policies were adopted by state governments trying to boost the demand for materials that they collected. The most common types of market development policies either sought to influence demand directly through government purchasing or requiring certain products to possess minimum recycled content, or sought to promote recycling via taxes, fees, and other pricing instruments.

If states are to achieve and maintain recycling rates of 50% or higher, then they will need to intensify these efforts and build domestic capacity to absorb secondary materials into their economies. This would imply a significant industrial shift from resource extraction to materials recycling, creating important economic opportunities for urban and rural regions alike. In order to realize these opportunities, new varieties of economic development planning will be required, focusing on analysis of the flows of materials through regional economies, and detection of economic opportunities for local re-utilization of these materials once they become wastes.

Meanwhile, environmental concerns have continued to grow. Today, environmental awareness reaches beyond localized concerns about public health to include larger-scale impacts of resource extraction and use upon natural ecosystems. Industrial society is grappling with the concept of

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[6] Steuteville (April 1996), p. 54.

[7] These states include West Virginia (50% by 2010); Michigan (50% by 2005); Nebraska (50% by 2002); South Dakota (50% by 2001); California, Colorado, Hawaii, Indiana, Iowa, New Mexico, New York, Oregon (50% by 2000); Maine (50% by 1998); Washington (50% by 1995); New Jersey (60% by 1995); Rhode Island (70%, no deadline). Steuteville (May 1996), p. 37.

[8] Steuteville (April 1996), p. 54.

"sustainable development," proclaiming its necessity but failing to develop a coherent vision of what it could mean in practice. Regardless of its specific definition, moving toward sustainable development would imply sharp reductions in the consumption of raw materials by human society, through some combination of a reduction in gross consumption and an increase in the rate of substitution of waste materials for raw materials.

While they remain popular, the recycling policies adopted to date have sought primarily to address a "garbage crisis" that has already receded from the public agenda.[9] In order to remain relevant to the broader environmental challenges facing society today, recycling or "materials" policies of the future must address the consumption and use of materials as well as their disposal, seeking to minimize environmental harm at each stage of a product's life cycle.

Traditional theories of environmental economics would suggest that the twin challenges described above—the integration of environmental and economic policies, and the reorientation of environmental policies to address root causes of environmental degradation—could be addressed through the appropriate use of economic instruments such as regulation, taxation or the distribution of property rights. For the time being, however, achieving the broad popular consensus needed to enact such sweeping revisions of economic and environmental policy remains infeasible.

Until it becomes possible to address the challenges of sustainable development in a comprehensive manner, progress might be achieved through incremental, innovative, and locally-oriented approaches. Starting from this perspective, this paper will explore some of the theoretical and policy challenges in linking recycling policy with local economic development.

1.3. The Meaning of "Recycling Policy"

The term "recycling policy" is used in this paper to represent a broad array of different policy instruments and objectives. This includes the full range of Federal, state, and local public policies that affect the degree to which waste materials re-enter the economy. The definition of "recycling" used here is intentionally imprecise, and encompasses many distinct types of materials and resource recovery, including primary or "closed-loop" recycling, secondary recycling or "cascading," and composting. Although this paper will not explore these in detail, it also addresses lessons that can be applied to some activities that are not recycling, such as materials re-use, and substitution of services for products. Incineration, which recovers energy from solid wastes, does not fall within the framework discussed here because it destroys more economic value that it creates.

Please see Appendix A for definitions of some key recycling concepts used in this paper.

[9] Tierney (1996).

Chapter 2
Three Perspectives on Recycling As Economic Development

"...In the highly developed economies of the future, it is probable that cities will become huge, rich, and diverse mines of raw materials. These mines will differ from any now to be found because they will become richer the more and the longer they are exploited.... Cities that take the lead in reclaiming their own wastes will have high rates of related development work...."
—Jane Jacobs[10]

Although much work attempting to link recycling policy with local economic development goals has been done at the grassroots level, academia has neither drawn theoretical connections between the two, nor examined existing linkages in any systematic way. This chapter will explore what three distinct theoretical realms might contribute to the development of such a theory. The following chapter will attempt to identify a region of overlap among these paradigms upon which a foundation for linking recycling and economic development policy may be built in the future.

2.1. Environmental economics: recycling in the marketplace

Historically, most environmental policies in the U.S. have been based upon ideas from environmental economics, a relative of neoclassical economic theory. Environmental economics generally adopts a neoclassical model of the economy's operation, but endorses certain government interventions in the marketplace to counter perceived externalities or market failures that lead to environmental harm. In theory, the most efficient of these interventions influence decisions in the private sector by means of price signals, using mechanisms which range from Pigovian taxes to tradable property rights.

In practice, many policies to promote recycling have sought to influence market behavior, directly or indirectly, using means other than price signals. While the wisdom or efficiency of these policy instruments may be debatable from the perspective of neoclassical economic theory, they generally fit within this framework because they are intended to compensate for perceived market failures or disadvantages faced by recycling in the marketplace.

2.1.1. Description of environmental economics paradigms

Michael Colby identifies five distinct paradigms of environmental policy:[11]

[10] Jacobs (1969), p. 111.

[11] Colby (1990).

"Frontier Economics" is a purist strain of neoclassical economics that believes that the market will automatically adjust to mitigate any undesirable outcomes of the economy, and that government intervention is therefore undesirable. The environment is seen as an inexhaustible source and sink for human needs. Furthermore, due to its infinite extent, the environment lies outside of the economist's realm of concern (since economics addresses the allocation of scarce resources).

"Environmental Protection" represents another neoclassical model in which government intervenes with regulations designed to allow the economy to operate as usual without generating unacceptable levels of externalities. Economic cost-benefit analysis is applied to determine "optimal" levels of pollution control, and end-of-pipe technologies are used to limit pollution to these levels.

"Resource Management" endorses an even greater degree of government intervention—in this case, the government directly utilizes price signals to ensure that they represent full social and environmental costs. The rights to deplete resources or to pollute thereby acquires prices that simulate scarcity (through tax or tradable permit schemes), based upon estimates of quantifiable externalities to human society.

"Eco-Development" is an emerging paradigm that would for the first time restrain economic growth to be compatible with the needs and capacities of natural systems. It departs from neoclassical economics in that it no longer regards the economic system as closed; rather, it sees the economy as embedded within the Earth's larger physical and ecological systems. Related fields include steady-state economics (Herman Daly *et al.*), ecological economics (Richard Norgaard *et al.*), and industrial ecology (John Ehrenfeld *et al.*).

Box 2.1: Paradigms of Environmental Economics

Environ./Econ. Paradigm	*Concept of Sustainability*	*Policy Strategy*	*Implications for Recycling*
Frontier Economics	Earth is limitless in terms of supporting human societies. Sustainability is not a concern; future is created through a price system based on free choice.	Governments act only as necessary to deal with unavoidable market failures. Technology can cure problems it creates.	Recycling will occur to the extent that the market demands it. Waste collection and disposal are best handled by regulated monopolies; gov't has a narrow role ensuring that this privilege is not abused.
Environmental Protection/ Externality Control	Earth is an open system. Waste and pollution are economic externalities; environmental problems are failures in the economic system. Future can be protected by interventions in the market.	Pollution reduction and control through laws and regulations. Technological optimism; risk manage-ment to handle uncertainty.	Gov't provides opportunities for recyclables to be handled apart from the rest of the waste stream. Environ. laws limit the attractiveness of resource extraction and waste disposal. In limited cases, gov't purchases or mandates the use of recycled goods.
Resource Management	Earth is a closed economic system. Resource mismanage-ment is an externality to be in-ternalized. Sustainability means maintaining the combined stocks of human and natural capital.	"Economize ecology" or "Get the price right." Technological optimism/ clean technology.	Taxes and other economic instruments aim to incorporate environmental costs into prices of raw materials and/or waste disposal options. Economic incentives directly encourage the use of recyclable commodities.

Adapted from Ehrenfeld (1994), p. 5.

"Deep Ecology" rejects the pursuit of economic development, advocating a return to less resource-intensive lifestyles and technologies, and a re-harmonization of human society with the natural systems that have historically nurtured it.

Among these five paradigms, the first three can be said to fall within the domain of neoclassical environmental economics, the theoretical basis for most environmental policies and laws in existence today. "Eco-development" has been the basis of few government actions,[12] but may yet become the basis for the environmental policies of the future. "Deep ecology" is inherently incompatible with the continued existence of a market economy.

Each of the three environmental economics paradigms has a unique lens through which public policy questions are viewed, and has thereby contributed in its own ways to the development of modern recycling policy. Some these implications of each are summarized in Box 2.1.

The environmental economics paradigms share a common belief that recycling policy should be coordinated from a high level of governance (state, regional, or national), and with minimal interference in the functioning of the broader economy. All three also view recyclable materials in the waste stream as commodities with the *potential* to enter into a global marketplace, but which may be utilized sub-optimally because of market failures.

Differing definitions of the "market" within which recycling must compete have caused different sources of market failure to become focal points for public policy. The earliest stages of recycling policy have tended to view recycling, landfilling, and incineration as "competing" waste disposal options, with local governments or waste management firms as the actors choosing among these options. Under this world view, low levels of recycling are thought to result from the failure of the prices of landfilling and incineration services to fully account for social and environmental externalities. Government should therefore mitigate this distortion by subsidizing the cost of recycling or increasing the price of other disposal options.

An alternative viewpoint is that recyclable (or secondary) materials are competing in the marketplace against virgin (or primary) materials. In this case, low levels of recycling are explained by the inadequate incorporation of externalities in the prices of the primary materials, or by other market barriers to the optimal utilization of recyclables. Appropriate policy actions in this case might include removal of subsidies for resource extraction, provision of subsidies for recycling, or artificial generation of demand for recyclables to establish a level playing field.

The remainder of this section will review briefly the general types of policies which have been implemented to correct for these market failures, and the implications of environmental economics for local recycling policy. An examination of whether or not the marketplace is recycling at "optimal" levels is beyond the scope of this paper (if such an optimum can even be said to exist).

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[12] The 1992 U.N. Framework Convention on Climate Change may be an early example of eco-development thinking. The Convention's objective (Article 2) seeks to steer a course for the global economy that would avert disruption to ecological and economic systems alike, but the policy instruments the treaty contains at present do not begin the task of realizing this objective.

Rather, the growing aggressiveness by governments in promoting recycling shall be taken as evidence of a political consensus that current recycling levels are indeed insufficient.

2.1.2. Policies associated with environmental economics

As discussed above, governments have enacted different types of recycling policies based upon different interpretations of the reasons why recycling is not occurring to the extent desirable. This section will explore this idea further.

Supply-side strategies

As noted in Chapter 1, the high hidden costs and decreasing political feasibility of landfilling and incineration led to the rise of a new wave of recycling policy at the state and local level in the U.S. over the past decade. The most common government interventions on behalf of recycling in this period have sought to address perceived disparities between the environmental and social costs of waste disposal and the prices found in the marketplace.

Assigning value through fees. A number of different fee schemes have been implemented to address this imbalance. Each tries to divert materials from the waste stream by assigning value to them at progressively earlier stages in the products' lifecycles. One of the most common approaches is to *increase the prices of incineration and landfilling* by raising tipping fees at landfills and incinerators, either directly (if they are owned or regulated by the government), or through taxation. To the extent that municipal waste collectors are unable to mitigate these costs by achieving higher recycling rates or exporting wastes to other jurisdictions, the costs are ultimately passed on to taxpayers.

Other fee schemes include *charging residences and businesses volume-based disposal fees* to encourage them to minimize and source-separate their wastes, and *implementing deposit-refund systems* for products or packaging. Deposits have a long track record in the U.S. and abroad, and have been very successful at achieving high recovery rates for specific, problematic categories of waste.

Assigning responsibility through mandates. Another prevalent class of recycling policies assigns responsibility for ensuring that recyclable materials in the waste stream are made available in the marketplace. *Providing special curbside collection services* is perhaps the most universal recycling policy in the U.S. Many state governments require localities to provide these services, and to achieve specified diversion rates by a target year. In the absence of such mandates, many localities provide collection services voluntarily, finding that they pay for themselves through decreased waste disposal costs and revenues from the sale of recovered materials.

Requiring waste generators to source-separate (prohibiting them from mixing recyclable materials with other wastes for disposal), often accompanies the provision of curbside collection services. Many governments have taken the extra step of requiring businesses and institutions to source-separate even in cases where no municipal collection services are being provided to these groups.

A final strategy in this category is *making manufacturers responsible for disposal costs* by requiring

them to "take back" products and packaging after their useful lifetimes are over. Germany's "Green Dot" program is the most broad-based and aggressive example of this type of policy, but smaller-scale efforts addressing narrower product categories exist elsewhere in Europe.

Underpinning all of these policies, particularly in the earliest years of their implementation in a particular place, has been a belief that once collected, these recyclable materials will easily be absorbed into the marketplace. According to this viewpoint, the government is effectively removing the high transaction costs associated with the need to purchase recyclables directly from individual households, and is thereby stabilizing the availability of these materials in the marketplace. Because of this assumption that inadequate or overly costly supply is the key factor limiting recycling rates, the strategies discussed above are often considered "supply-side" recycling policies.

Experience has shown that over-emphasis on supply-side strategies can be very problematic. In the late 1980's, as municipal recycling programs proliferated in the Northeast, recyclable materials flooded the market and prices collapsed.[13] For a time, as cities scrambled to find purchasers, the market price for old newspapers fell to a negative value. Large quantities of waste materials designated for recycling were instead incinerated or landfilled, or shipped overseas (where they disrupted foreign markets).[14] More recently, similar disruptions were created in Europe as Germany's Green Dot program was being phased in.[15]

Demand-side strategies

A more diverse, but less aggressively pursued policy arena addresses the demand for recyclable materials. Many different kinds of market failure limiting demand for these materials have been identified (the following list is by no means exhaustive).[16]

Under-pricing of virgin raw materials. Environmentalists have long contended that the environmental and social costs of natural resource extraction and primary materials production are inadequately reflected in the price of raw materials, because of unaddressed externalities or direct government subsidies. Since 1970, U.S. environmental policy has evolved to include numerous different economic and regulatory instruments aimed at limiting externalities from industrial activities and/or incorporating them into the prices of final products. Nonetheless, environmentalists argue, this work remains far from complete, particularly with regard to resource extraction industries such as mining and logging. In these sectors, both lax environmental laws and direct subsidies from Federal and state governments are believed to artificially reduce the price of virgin raw materials.

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[13] Magnuson (1990).

[14] The fraction of recovered waste paper exported abroad rose from 3% in 1970 to 18% by 1987 (Cairncross (1992), p. 239). Today, waste paper remains one of the country's leading exports by mass; in 1994, it was *the* leading export by mass from the Bay Area's ports.

[15] Reynolds (1994).

[16] Mount Auburn Associates & Northeast-Midwest Institute (1993), pp. 3-7; Hurst and Humphreys (1993).

A study by the California Integrated Waste Management Board (IWMB) investigated incentives provided by the State and Federal governments for resource production activities within California. The study found that the subsidies indeed exist, and are of significant magnitude: quantifiable incentives provided by the state government alone cost taxpayers $160 million annually (see Box 2.2).[17]

Box 2.2: Incentives for Timber Production in California

State:	Property Tax Shortfall in Timber Production Zones	$25.8 million	(1990-3 avg.)
	Fire Suppression Services	25.5 million	(1990-3 avg.)
	Forestry Research & Development	7.2 million	(FY 1990-1)
	Forest Practices Regulation	6.8 million	(1990-3 avg.)
	Forest Improvement Program	2.5 million	(FY 1991-2)
	Forest Pest Management	1.6 million	(FY 1991-2)
	Forest Products Utilization Program	0.4 million	(FY 1991-2)
	State Logging Roads	?.?	
Federal:	Tax Benefits (10.3%*$425 million)	$43.7 million*	(1987-9 avg.)
	Below-Cost Timber Sales (14.6%*$400 million)	58.3 million*	(1992 est.)

Source: California Integrated Waste Management Board (May 1993), pp. 16-48.
* Author's estimates based upon above source.

Imperfect availability and flow of information. The newness and decentralized nature of many segments of the recycling industry have posed significant barriers to the flow of information needed by potential consumers of recycled products. In the industrial and commercial sectors, purchasers may not be aware that they have the option to purchase recycled feedstocks or supplies; networks of buyers and sellers may not be fully developed; and there may be a lack of comparable information about availability and quality of products. These problems have grown less acute than they were a couple of years ago, as the institutional infrastructure of the recycling industry has matured. This process may have been helped along somewhat by government-sponsored waste exchanges, "buy recycled" campaigns, and other efforts to facilitate information flow.

Consumers, however, still face some of these problems when they attempt to purchase recycled products in the retail marketplace. The issue of recycled product labeling has been hotly debated in the courts, legislatures, and regulatory agencies for years. Different marketing strategies may lead some manufacturers to tout the "greenness" of their recycled products, while others omit any reference to their products' recycled content.

[17] California Integrated Waste Management Board (May 1993), p.1. The value cited in the report is actually $180 million/year, but this appears to be a typographical error because their numbers don't add up. "Incentives" include both direct government expenditures and tax breaks. It should be noted that the study concluded that the relationship between these subsidies and the competition between primary and secondary materials was not simple. For example, since very little California timber is used in domestic paper production, the state's timber production incentives cannot be said to be reducing the competitive position of recycled paper. This particular case of timber in California aside, however, the large magnitude of Federal subsidies for logging, mining, and energy production activities constitutes a significant market distortion.

Diseconomies of low levels of production. Beyond the information-related difficulties described above, recycling industries face a number of other market barriers due to their initial low levels of production. The supply/demand balance for certain recyclable materials has been extremely volatile, as recovery of the materials has ramped up rapidly, and capacity for absorbing these materials into the economy has come online in large, discrete blocks. Prices for recyclable commodities are also strongly influenced by the prices of their virgin counterparts, which may also be volatile. Paper prices and demand, for example, fluctuate with the business cycle on a magnified scale.[18] But whereas large-volume primary materials markets have the ability to compensate for these changing conditions by adjusting output, the much smaller secondary materials markets are far less able to compensate. Combined with uncertainties about the future directions of Federal and state policies toward recycling, leading-edge investments in new recycling capacity become risky propositions.

Based upon the assumption that the recycling industry will become stronger and more stable once it has grown significantly in scale, many policy interventions have sought directly to increase market demand for recyclables and to ensure that continuing demand for these materials will exist into the future.

The most direct way in which governments have attempted to increase demand for recyclables has been to use their own purchasing power. These procurement rules can be in the form of minimum content standards, price preferences, or set-asides favoring goods with recycled content. The most significant such procurement policy to date has been President Clinton's 1993 executive order requiring Federal agencies to purchase printing and writing paper with at least 20% postconsumer content by the end of 1994 and at least 30% postconsumer content by 1998.[19] A number of state and local governments have instituted similar requirements. California state agencies, for example, are required to dedicate certain minimum percentages of their procurements to high-grade papers, plastics products, tires, batteries, and paving materials with post-consumer content.[20]

A less-common approach is the adoption of mandatory content standards, requiring manufacturers to use minimum levels of postconsumer material in ***all*** products of a given type. Suffolk County, New York, the first local government to require newspaper publishers to use newsprint with a minimum recycled content, was provoked to do so by the crash of old newsprint prices in the late 1980's. Today, nine states have adopted similar requirements for newsprint (typically, 40-50% postconsumer waste by the end of the decade),[21] and several have also adopted mandatory content standards for other materials.[22]

Institutional or "non-market" barriers are said to exist on many different levels. Some are blatant, such as the discriminatory pricing policies of many railroads during the 1970's, under which

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[18] Paper Task Force (1995), pp.39-41.

[19] Executive Order 12873, October 20, 1993, §504.

[20] California Public Resources Code, §42200 ff.

[21] Totten and Settina (1993), Ch. III-4.

[22] California's mandatory content standards can be found in the Public Resources Code at the following locations: paving materials (§42700 ff.); newsprint (§42750 ff.); plastic trash bags (§42290 ff.); and fiberglass (§19500 ff.).

secondary materials were charged higher rates than their primary counterparts (this practice has since been eliminated). Another is the practice by some firms of over-specifying the quality of the products they need, e.g. prohibiting recycled paper purchases outright, or specifying brightness levels that preclude the use of most recycled paper products in the marketplace.

Another source of "non-market" barriers may be the vertical integration of certain economic sectors, which can stifle competition among suppliers of feedstocks. Mandatory recycled content regulations were instituted in part because several large newspaper publishers refused to use recycled newsprint because they owned their own forests and paper production operations.

Hybrid Strategies

Many of the most creative environmental policies being explored today are not as easily categorized, because they merge two or more of the above strategies, or they use other policy mechanisms entirely. California's Integrated Waste Management Board has produced a series of reports that look at innovative market-based approaches to integrated waste management, such as fee-based incentives and tradable-credit schemes.[23] Nearly all of these approaches are still based upon externality-minimizing or market-correcting principles similar to the simpler policies described above.

2.1.3. Implications for linking recycling and local economic development

As the preceding discussion should make clear, the arena of policy in which governments have sought to influence large-scale recycling markets is broad and deep. Many different types of approaches have been tried, and there has by now been significant real-world experience with many variations on each approach.

An understanding of large-scale market forces in the economy is of elemental importance to all aspects of public policy. It is of particular importance to recycling, since market realities fundamentally shape the willingness of businesses to participate in the secondary materials economy.

Significant market and nonmarket barriers to the broader use of secondary materials do indeed appear to exist. Even in the absence of government intervention to remove the remaining distortions, recycling rates are currently rising fast; with additional action, this trend can be expected to accelerate. Environmental economics suggests how to analyze and rectify these barriers and distortions. The development of more sophisticated recycling policies of the future can draw three important lessons from environmental economics:

Market failures and other barriers to increased utilization of secondary materials by industry are best addressed at the highest level of governance feasible (e.g. state, federal, or even international if possible). Attempts to compensate for market distortions in a geographically piecewise manner may only complicate the problem without achieving the intended results.

[23] Integrated Waste Management Board (July 1993 and July 1994).

Recycling policies should address directly a more fundamental array of economic and environmental objectives. Most policies that have been enacted to date have been largely successful at attaining their limited goals of minimizing the need to construct new incinerators and landfills. Government policies have not yet focused on the more ambitious objectives of substituting secondary materials for raw materials in industry, or of reducing the absolute magnitude of resource consumption in society. The policy instruments of environmental economics could bring far greater progress toward environmental objectives if the necessary political will existed to apply these instruments to more fundamental problems. In the absence of these incentives, there is no reason to expect that progress toward environmental objectives will be achieved.

Recycling policies would have greater impacts if they followed neoclassical principles more closely. Regulation has been the primary instrument through which gains in recycling have been achieved. In many cases, this has been appropriate (e.g. bans on ocean dumping of wastes, or strict regulation of the environmental impacts of landfills and incinerators). At other times, however, government policies have acted as impediments to the efficient operation of the marketplace. Recycling policies have paid very little attention to the stimulation of competition within the recycling industry. They have favored large, vertically-integrated firms over small- and medium-sized businesses (e.g. through the rewarding of exclusive, long-term contracts for the purchase of recyclables to the firm willing to purchase the greatest quantities for the longest period of time). Where they have sought to help small businesses (e.g. in California's program, explored in Chapter 4), they have done so based on criteria designed to achieve an arbitrary and narrow set of policy objectives. Many of today's recycling policies run counter to the logic of market-based competition. Closer attention to the neoclassical principles underlying environmental economics would suggest that policies should place greater emphasis on promoting competition as a means of achieving recycling objectives.

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Despite its breadth, the menu of approaches described in this chapter provides an unnecessarily narrow perspective on the nature of recycling. There are at least four key ways in which the neoclassical viewpoint is limiting: it precludes a proactive role for localities; it neglects linkages between recycling and economic development; it treats recyclables exclusively as commodities on the open market; and it equates higher levels of economic activity with higher levels of social benefit.

By ignoring spatial issues, the market-oriented approach precludes a proactive role for municipalities in the promotion of recycling. Under the market-oriented world view, there's not much that localities can (or should) do to affect the degree to which recycling occurs; they're at the mercy of the larger economic climate. With rare exceptions, cities and counties are assumed to be too small to influence macroeconomic patterns, since attempts to affect economic patterns at a point in space will lead to undesirable distortions. The appropriate role of cities, according to the environmental economics perspective, is to perform the functions assigned to them by higher levels of government: supply the market with recyclable materials, and perhaps help generate demand by enacting a progressive recycled-content procurement policy.

However, there is a great deal of evidence that local policy can indeed help increase the overall levels of recycling in the economy. They can work in a very hands-on way with potential recycling

entrepreneurs, the existing manufacturing base, local financial institutions, and economic development agencies to facilitate the formation of new enterprises to recycle materials that otherwise would not have re-entered the economy. One example of what can be done is California's Recycling Market Development Zone program, which is explored in Chapter 4.

Because of its treatment of demand for secondary materials as exogenous, this model views the local economic benefits of recycling as a zero-sum game. If they wish to reap economic development benefits from recycling, cities must successfully compete against other cities to attract capital investments in recycling into their areas. Given that the recycling industry is expanding rapidly, there may indeed be good reasons for cities to chase after transplants from the greater economy.

However, as asserted above, cities can develop new recycling-related economic activity. It is therefore possible that cities can generate net new jobs in the economy through these efforts, although this is less certain. The extent to which net new jobs are created in the processing and remanufacturing of secondary materials must be weighed against jobs that may be lost in primary materials industries due to consequent decreased demand for those materials. Although folk wisdom and anecdotal evidence hold that recycling industries are more labor-intensive than their virgin-material counterparts, this question has never been explored systematically.

The attraction of a major recycling facility to one's city may not be as desirable as it might seem. While it is generally true that on a mass-equivalent basis, reprocessing of recyclable materials produces significantly less pollution than the initial processing of raw materials, large recycling plants are far from clean. The relative importance of pollution emitted by an recycling plant is compounded by the far greater human exposures that could result if the plant is sited in an urban location.

Because of its treatment of secondary materials as commodities to be traded on the open market, this model ignores many local opportunities for recycling. If price and quantity become the only focal points for information about secondary materials, possibilities to add value locally can be overlooked.

Overemphasis on price: Selling a city's collected recyclables to the highest or longest-term bidder may be economically optimal in a theoretical sense, but it closes doors to local enterprises. In keeping with the treatment of recyclables as commodities is the assumption that the city, as seller of the material, reaps maximum benefit by selling to the highest bidder and/or seeking to stabilize demand. But once it contracts with such a purchaser, and the materials are exported, any opportunity for further local value-added through remanufacturing has been lost. It is possible that a city could get more revenue in the long run by settling for a lower price in order to give local enterprises the opportunity to purchase these resources.

Overemphasis on quantity: Many opportunities for recycling exist for materials that may not be exchanged on a national basis. There may be unique forms of scrap generated by a local manufacturing plant which may be perfect candidates for recycling even though no larger "market" for them exists. Avoidance of transportation costs can make recycling feasible on a local level where it might not make sense on a national level.

Neoclassical assumptions about the imperatives for economic growth may be detrimental in the long

run. Economists have long held that growth in the absolute scale of the economy (and therefore growth in levels of consumption) is necessary to advance human well-being. But this basic tenet of neoclassical economics has been questioned on both environmental and socio-political grounds.

The growth-oriented economy may fundamentally conflict with the long-term protection of Earth's resource base. If the economy is embedded within a finite resource base, as the Steady State and Ecological economists argue, there must be limits to its growth or eventually the marginal benefits of growth will disappear. According to this perspective, the goal of facilitating economic growth while controlling its externalities should be replaced with the goal of promoting economic development in a manner that protects the long-term survival of Earth's resources and ecosystems. Attempting to slow natural resource depletion through conventional forms of recycling policy fails to address the core issues of consumption, and is therefore doomed to have marginal environmental benefits.

It may not be desirable to see recycling transformed into a big business. The vast quantities of relatively pure materials sequestered in landfills or passing through the urban waste stream have inspired the idea that cities could reap huge economic windfalls by converting their waste streams into a profitable export base, and compete directly with rural supply regions in the world's commodity markets. But it is debatable whether this is desirable. High-throughput recycling plants are likely to look economically similar to their primary-material producing rivals: capital-intensive investments, facing cutthroat price-based competition and strong downward pressures on labor costs, with limited room for innovation (one of the main locational advantages a city can provide). Rural resource supply regions have rarely experienced sustained economic development from industries of this type, and it seems unlikely that the experiences of cities would be any different.

Allan Schnaiberg combines these two criticisms in his critique of the state of contemporary recycling.[24] He argues that the traditional primary materials industries have co-opted recycling, using it to further their interest in increased consumption while wrapping this consumption in an environmentally benign aura. Recycling, says Schnaiberg, cannot meet its environmental objectives if it serves only to further the "treadmill of production."

[24] Schnaiberg (1994).

2.2. Industrial Ecology

Industrial Ecology is an alternative conceptual framework that has the potential to supplement environmental economics where it is weak. This emerging field explores how environmental and economic improvements can be achieved in industry through simulation of resource utilization patterns found in nature, and through the management of the interface between industrial and natural systems (see Box 2.3). In particular, it advances a model of industrial systems that emphasizes closed resource cycles, in which waste products from industrial processes (including both materials and energy) are utilized as raw materials for other processes. IE aspires to develop a guiding vision and methodological tools to help facilitate the evolution of industry toward environmental sustainability.

2.2.1. Description of the industrial ecology paradigm

Industrial Ecology is a new synthesis of a cluster of ideas that have been around for decades. It has attracted a great deal of attention in both academic and corporate circles because of the power of its underlying metaphor. As a result, IE has grown quite broad as an increasing number of perspectives attempt to squeeze in under its tent; at present, no universally agreed-upon definition exists of the field's scope or purpose. Nonetheless, the underlying vision of IE is potentially of great importance, and the field may yet make significant contributions to the environmental policy arena.

Conceptual basis of IE

The simplest model that IE uses to visualize the differences between human and natural systems is shown in Box 2.4. A *Type I* system is one in which all inputs are imported and all wastes are exported; a *Type II* system recycles some of its wastes back into raw materials, attenuating its interactions with the outside universe; and an ideal *Type III* system achieves total recycling of its wastes, relying only on the external provision of energy for its existence.[25]

For the most part, today's natural ecosystems are close approximations to Type III (although for much of the early history of life on the planet, they were Type I). Our present industrial economy is

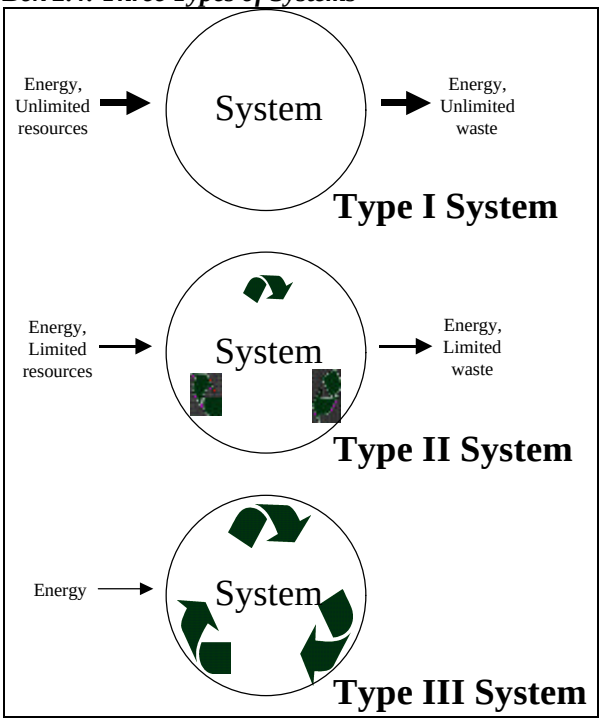
Box 2.3: Industrial Ecology as a paradigm for recycling policy

Concept of Sustainability	*Policy Strategy*	*Implications for Recycling*
Earth is a closed ecological system, in which human society and natural systems have co-evolved. Nature has intrinsic value, revealed through economic activity. Sustainability means independently maintaining stocks of human and natural capital.	"Ecologize economy" Economy based on functionality (services), not goods; on quality, not quantity. Technological realism; precautionary principle to handle uncertainty. Systems oriented lifecycle framework; product policies require new ways of planning, designing, and decision-making.	Not yet clear; depends on how IE evolves and enters the policy arena. Potentially, recycling becomes an end in itself, which may or may not be advisable. Tools for systematic analysis of the roles of materials in the economy could help inform policy.

Adapted from Ehrenfeld 1994, p. 5.

[25] A consequence of the Second Law of Thermodynamics is that even idealized systems need inputs of energy to compensate for the increased entropy that results from every process.

Box 2.4: Three Types of Systems



somewhere between Type I and Type II: vast quantities of materials make a single trip through the economy, but others (e.g. precious metals, and to a lesser extent, aluminum and steel) are recycled to a high degree. Appropriately-drawn boundaries around certain traditional human societies would reveal systems much closer to Type III. The challenge, according to industrial ecology, is to shift incrementally toward higher-order systems without decreasing human well-being.

Methodological and Institutional Basis of IE

The tangible contributions IE promises to make to the environmental policy arena relate more to methods of analysis than to new policy approaches. It offers a whole-systems approach embracing many different analytical methods. The major streams of work within industrial ecology include:[26]

Limiting dissipative uses of materials. Traditional forms of pollution control have been medium-specific, end-of-pipe technologies and regulations (e.g. catalytic converters on cars, scrubbers on smokestacks). Even more innovative approaches (e.g. tradable permits for SO_2 emissions) have focused on a limited range of pollution sources within a single medium. IE embraces pollution reduction strategies that are rooted early in the production cycle, and that emphasize that pollutants can become resources in different contexts.

Recently in vogue have been voluntary "pollution prevention" strategies, in which firms search for opportunities to reduce emissions at the source through process substitution, toxics use reduction, and other strategies. Tools used to accomplish this include total quality environmental management, life-cycle analysis, design for environment, and full-cost accounting.

At a larger scale of analysis, a key concept and tool is the "industrial metabolism" of a particular substance. Much as biologists may analyze the pathways by which nutrients are consumed, transformed, stored, and removed from living organisms, it is possible to develop similarly detailed analyses of how materials (e.g. toxic heavy metals) flow through the economy. In doing so, distinctions are drawn among material uses that are economically compatible with recycling; those for which recycling is technologically feasible, but not presently economically attractive; and inherently dissipative uses for which recycling is infeasible.[27] The result is a more detailed understanding of how certain pollutants enter the environment, and a framework for thinking about the types of comprehensive strategies that could be used to reduce these levels.

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[26] This framework is derived from the work of Hardin Tibbs and John Ehrenfeld. Tibbs (1991) focuses on the methodological aspects of these components, while Ehrenfeld (1994) examines their institutional implications.

[27] Robert Ayers, "Industrial Metabolism: Theory and Policy," p. 31, in Allenby & Richards (1994).

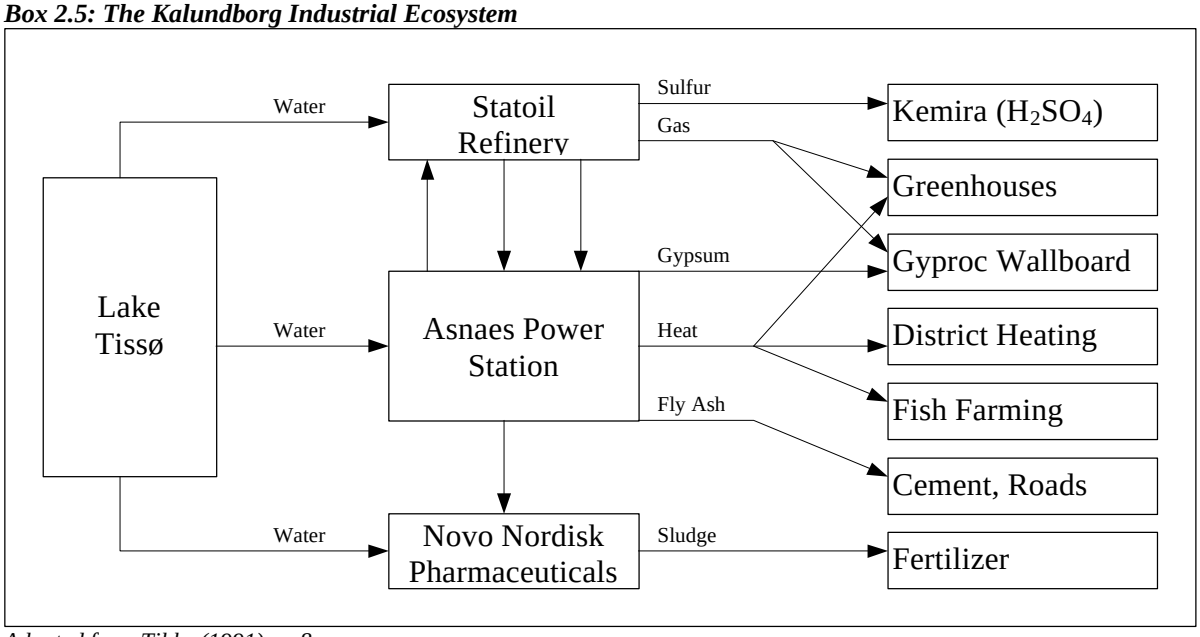
Closing material loops in industrial systems, by finding new uses for material that would otherwise enter the waste stream. This can be accomplished through product reuse, remanufacturing, repair; or the cascading or recycling of end-of-life products, packaging, and industrial by-products.

Kalundborg, Denmark has become the poster child of industrial ecology because of the unique interrelationships that have evolved within its economy (see Box 2.5). A number of businesses have sprouted up near the city's large refinery and power station, using the wastes from these facilities (including steam, waste water, waste heat, fly ash, sulfur, and gypsum). It has been studied closely as a possible model for how industrial ecology might be incorporated into future planning for industrial development. However, as will be discussed later, this system was much more the result of complex social and economic processes than any intentional attempt at environmental planning.

Dematerializing industrial output. This can be achieved by reducing the mass of materials used per product, prolonging the useful life of a product through more durable or modular design, or creating opportunities for remanufacturing and repair. In some cases, market forces are sufficient to carry this process along, particularly when the product is expensive or scarce (e.g. repair and reuse of auto parts); when technological change is rapid (e.g. modularity of computers); or when the cost of raw materials is high (e.g. thinning the walls of aluminum cans[28]).

More ambitious dematerialization strategies might include replacing the firm's emphasis from selling products to selling functionality or services. The theory here is that consumers really don't want many of the goods that they purchase (e.g. tools, appliances or even automobiles); they are seeking guarantees that they will have use of these goods when they need them. In some cases, consumers

Box 2.5: The Kalundborg Industrial Ecosystem



Adapted from Tibbs (1991), p. 8.

[28] Hosford and Duncan (1994).

may be willing to contract with companies for these services instead of purchasing the goods, as was commonplace a century ago. In some parts of the country, electric utilities have been forced by regulators to shift their focus from the selling of electricity to the selling of the services that electricity provides, as was done the earliest electric utilities a century ago.[29]

Improving efficiencies of energy use. IE has little new to add to this traditional goal of environmental policy, beyond analysis of energy flows in terms of the physical concepts of entropy, embedded energy, etc. Nonetheless, energy policy is necessarily a part of any comprehensive approach to environmental policy. Three important components of energy policy as viewed by an industrial ecologist might include:

- Reducing energy intensity, or the energy required per unit of economic output;
- Reducing carbon intensity, or the CO_2 released per unit of energy used; and
- Reducing energy waste, by reutilizing (cascading) waste heat to perform other tasks.

Balancing industrial input and output to natural ecosystem capacity. Methodologically, this is quite difficult. It requires a systematic research effort toward understanding ecosystems' abilities to accommodate different environmental stresses; the development of integrated approaches to determining where human activity is creating environmental impacts that exceed these limits; and the use of warning systems to indicate when thresholds of unacceptable impact have been reached.

The most ambitious effort of this type is the implementation of the U.N. Framework Convention on Climate Change, which has the formal objective of:

"...stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner."[30]

A massive research effort is underway to develop a scientific interpretation of this objective. Components of doing so include determining what this "level" and "time-frame" may be, as well as the economically- and scientifically-optimal timing and degree of emissions-curbing that will be needed to achieve it. Not surprisingly, this task is exceedingly difficult and fraught with controversy; nonetheless, it represents on a large scale how IE proposes smaller-scale environmental policies should be developed in the future, given the necessary political will.

Aligning policy to conform with long-term industrial system evolution. This is a necessary prerequisite to most of the above. Government policy must not only address the short-term ecological symptoms of the industrial economy. It must also provide vision and a flexible framework in which corporations are able and likely to evolve creatively in directions compatible with long-term ecosystem survival. As Ehrenfeld writes, "The invisible hand needs to be helped along the path to

[29] The first electric utilities were in the business of selling *light*, not electricity. See Roe (1984).

[30] INC/FCCC (1992), Article 2.

sustainability by the visible foot."[31]

This obviously would require a significantly broader constituency than the environmental community has historically been able to muster; entirely new approaches to policy-making may be necessary. Perhaps *because* of the difficulties the environmental movement has had in making progress in the past two decades, new forms of consensus-building have begun to appear, such as EPA's "negotiated rule-makings" and the Clinton Administration's collaborative environmental policy formulation experiments.

Policy should also seek to shift manufacturers' ideas about the nature of their relationships with products and customers. This might include shifts from sales of products to sales of equivalent services (as discussed above), or other forms of extended producer responsibility (such as the German "Green Dot" program).

2.2.2. Implications of IE for linking recycling and local economic development

Industrial Ecology remains a young field of study. Until the implementation of its vision has been more thoroughly thought out, it will remain unclear whether IE is genuinely a new policy paradigm or just a transient catch phrase. However, the program set out for IE by Ehrenfeld and others represents an ambitious attempt to visualize how industrialized societies can transform themselves incrementally to more sustainable economic patterns.

In its present form, Industrial Ecology is characterized by a systems-level analysis of the environmental implications of certain forms of consumption; and an emphasis on strategies which grow from scientific, engineering, and economic realities. At this early stage, the contributions IE might make to the improvement of recycling policies include:

Research methods and analysis tools. The techniques that are being developed within IE (Ayers' industrial metabolisms; Duchin's applications of input-output analysis; etc) have the potential to become useful analytical tools for understanding the flows of materials within a region's economy, and how economic policy might affect these flows.

A comprehensive perspective on materials flows. Although IE often fails to implement this in practice, its principle that complex environmental issues should be analyzed and addressed at a systems level is very important. A systems approach would suggest that recycling policy should be broadened in two major ways from its current narrow focus on municipal solid waste. First, it should address the full cycle of materials use, from natural resource extraction to disposal. Second, it should seek to promote materials efficiency and recycling across the entire waste stream (including resource extraction wastes, construction and demolition debris, industrial scrap, and agricultural wastes), not just the small fraction of wastes collected and disposed by municipalities.

A visionary paradigm for understanding how the economy and environment are linked. The basic but

[31] Ehrenfeld (1994), p. 28.

powerful concept behind IE, the modeling of economic systems after natural ones, can itself provide an important contribution to local economic development thought and practice. The broader field of Ecological Economics promises ultimately to develop an entirely new economics which explicitly addresses questions of limits and equity that have long been ignored within neoclassical economic thought.

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In its present form, Industrial Ecology suffers from a number of serious problems, which undermine its ability to contribute constructively to public policy. These include:

A big-business bias. Much of the impetus for IE has come from the business community. Some of IE's earliest advocates came from large firms (including General Motors and AT&T), as did the case studies they cite of successful IE practice (e.g. 3M). While this is of course not an inherent problem with IE, much of the existing IE literature and research agenda appears to have been directly or indirectly shaped by these private sector origins, leading to several of the problems listed below.

Improper selection of "system" boundaries. Although IE advocates a systems approach, most IE studies limit themselves to overly narrow system definitions. One manifestation of this problem is an over-emphasis on the firm, process or product as a level of analysis, leading to a disconnect between the broad transformative goals of IE and incremental process improvements have dominated its literature.[32] Investigations of alternatives to a product are often overlooked in favor of evaluating the most environmentally sound method of manufacturing the product. An example of this is the work by Frosch and Gallopolous on the industrial ecology of the automobile industry.[33] Their studies have focused on the recycling of auto parts, without exploring the possibility of reducing the environmental impacts of cars, or the feasibility of car makers becoming providers of mobility services to their customers. The result of an overemphasis on intra-firm analysis is that only opportunities that are economically advantageous to the firm are explored, ignoring the potential for public benefits or private benefits external to the firm.

A related problem is the application of IE principles to the movement of materials around the industrial economy, without addressing the broader issues that might motivate such an analysis. For example, "industrial metabolism" studies have done comprehensive analyses of materials flows, but have historically ignored the differential impacts that environmental discharges of these materials may have upon ecosystems or human health. For example, although metabolism studies have shown that lead bullets, fishing sinkers, and gasoline additives represent a small fraction of total lead emissions, they have not incorporated other evidence that these sources cause disproportionate damage to ecosystems and human health.[34]

Incomplete or improper application of the ecological paradigm. There are numerous ways in which

[32] O'Rourke, Connelly, and Koshland (1996).

[33] Frosch and Gallopolous (1989); Frosch (1995).

[34] Socolow and Thomas (forthcoming Spring 1997).

principles of ecology have been misapplied in IE:

The unit of analysis in ecology is the population, not the species. A population is a subcomponent of a species that lives within a region and interbreeds. IE adopts neoclassical economics' tendency to ignore space, looking at sectors on a national or international basis. It rarely examines communities of industries on a regional scale. While it is true that some forms of capital move globally, the forms of capital required by small enterprises is often far more geographically constrained.

In nature, the evolution of a species occurs on a time scale longer than the life spans of members of that species. In Darwinian evolution, birth and death of organisms are required for evolution to take place. In contrast, industrial ecology assumes that large firms can undergo evolution within their lifetimes. While it is clearly true that firms can and do evolve, it is far from clear whether economic evolution occurs faster in economies dominated by long- or short-lived firms. The implicit assumption of IE, that the transition to a sustainable economy is consistent with the continued existence and profitability of firms like GM and DuPont, is more Lamarckian than Darwinian. Furthermore, more recent theories of evolution have shown that it tends to be more discontinuous than incremental.

Imbalanced attention to all components of Ehrenfeld's framework. Despite their inclusion in Tibbs' and Ehrenfeld's framework for IE (described on the preceding pages), many important issues have not yet received much attention in the IE literature. Some of these include minimization of materials throughput (instead of just closing loops), reducing dissipative uses of materials, and the full gamut of social, institutional, political, and economic issues.[35]

Related to this is the failure of IE to make any original contributions to the policy arena. For the most part, IE advocates have simply echoed environmental economists by arguing that government's proper role is to provide information and eliminate market failures through pricing, in order to foster a climate in which firms can make decisions which are both profitable and pro-environment.[36] Also typical of IE's thinking about the role of government are arguments that excessive government regulation is the single greatest barrier to increased recycling of secondary materials, in that it inhibits inter-firm exchanges of hazardous materials.[37]

Also absent from the IE literature is the entire spectrum of related economic issues, including the basics of materials loop-closing; broader questions of industrial structure and organization; and implications of IE for regional economies. Rich literatures already exist for many of the issues not currently addressed by IE. The task ahead for IE is to create a coherent framework by building bridges to other fields of research.

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[35] O'Rourke, Connelly, and Koshland (1996).

[36] See, for example: Matthew Weinberg, Gregory Eyering, Joe Raguso, and David Jenson, "Industrial Ecology: The Role of Government," in Allenby and Richards (1994).

[37] See, for example: Frosch (1995).

2.3. Industrial Districts and Manufacturing Networks

Theories of "industrial districts" provide a second emerging model with important implications for recycling policy. Empirical observations of regional economies in Northern Italy and elsewhere have led to new understandings of how institutional structures and relationships among firms can help generate unusually strong capacities for economic and technological innovation.

Although industrial districts theory does not directly address recycling or the relationship between the economy and the environment, it describes how innovation and economic growth occur in industries which are similar to recycling in many ways. After the industrial districts model is described below, the following section will explore the applicability of the model to the issue of recycling.

2.3.1. Description of the industrial districts paradigm

Contemporary interest in industrial districts began in the mid-1970's, with the study of Northern Italy's industrial regions.[38] These regions gained attention for their ability to out-perform large firms in highly competitive economic sectors, while maintaining relatively high wages and achieving high levels of innovation. The economic benefits of this innovation have helped propel Italy's GNP ahead of that of the United Kingdom.[39]

Industrial districts are distinguished from other types of industrial clusters by the unique institutional structures they have formed. They tend to be dominated by small firms,[40] which have found novel ways to cooperate for mutual benefit in their highly competitive economic sectors. Through dense, decentralized networks of social and economic linkages, the enterprises that make up an industrial district operate collectively as the functional equivalent of a large firm, but with a degree of dynamism that is not ordinarily possible within a single organization. The key organizational

Box 2.6: Industrial Districts as a paradigm for recycling policy

Concept of Sustainability	*Policy Strategy*	*Implications for Recycling*
Sustainability is not addressed directly. However, this model does describe the characteristics that can help an economy adapt and thrive under conditions of rapid change: decentralization of decision-making, intensive inter-relationships among firms, etc.	Promote enterprise formation, strengthening of social and professional networks and civic organizations, cooperative arrangements among firms, public/private partnerships. Local government and institutions play central roles in promoting and shaping the development of the local economy, and can potentially integrate environmental objectives into development strategies.	The pressures faced by small recycling enterprises appear similar to those which caused other industries to adapt creatively and form the first industrial districts. Government can help promote innovation and investment in recycling by engaging the private sector in a proactive manner.

[38] See Piore and Sabel (1982).

[39] Werner Sengenberger and Frank Pyke, "Industrial districts and local economic regeneration: Research and policy issues," in Pyke and Sengenberger (1992), p.6.

[40] As will be discussed in further detail below, the frequent mention of "small firms" here is shorthand for the idea that decision-making in the economy is decentralized, rather than controlled by a few large firms.

characteristics of industrial districts include:[41]

External economies of scale. Cost efficiencies enjoyed by larger-sized operations, are realized externally to the firm. This is achieved through the collective purchasing and use of equipment that would exceed the needs or means of any single firm. Such "collective efficiencies" can also be gained through the provision of auxiliary services (advertising, finance, training, etc.) to groups of firms by a single agency.

Economies of scope, defined by Pyke as a greater degree "of ease and cost of responding to changing production and marketing requirements."[42] This is achieved through "flexible specialization," a mode of production that combines a highly flexible organizational structure, skill base, and capital investments. The high degree of division of labor found among firms in an industrial district allows the relationships among different sub-functions in the production process to adapt quickly as circumstances require. Ease of adaptivity is also facilitated through a skilled workforce and the use of multi-purpose equipment, such as computer-controlled machine tools.

Multiple channels of cooperation. The boundaries separating industrial district firms from one another and from other public and private institutions are blurred by several forms of collective effort, including:

- "Vertical Cooperation," close coordination between producers of intermediate goods or services and their customers, to tailor the products/services delivered by the first firm to meet the needs of the second firm.
- "Horizontal Cooperation" among firms otherwise engaged in direct competition is far less visible than vertical cooperation, but occurs nonetheless. In fact, strong horizontal competition helps drive vertical cooperation, as competitors seek to gain advantage by pushing their suppliers to innovate. But horizontal cooperation does still exist, in that firms may pool equipment or services as described above.
- "Diagonal Cooperation," specialists working for slightly different types of firms exchanging information or pooling research and development efforts.
- "Periodic Cooperation," firms temporarily joining forces to complete a project.
- Other important forms include cooperation between employers and labor unions, and between industry and government agencies.

Shared value systems and an atmosphere of trust are other important characteristics of cooperative industrial systems like industrial districts. The long-term success of an industrial district requires that firms agree on certain codes of behavior, and that they share a certain loyalty to their home region. However, recent research suggests that this mutual trust is not necessarily a precondition for such

[41] Pyke (1992), pp. 2-13.

[42] *ibid.*, p. 3.

cooperation; rather, it can develop over time as a result of cooperation.[43]

Strong collective institutions, including labor unions, employers' associations, regional governance bodies, and agencies for the centralized provision of services. In places where these are missing, such as Silicon Valley, informal social institutions or networks may play similar roles.

Mechanisms for the rapid dissemination of information, including professional and social networks, a labor force that is mobile among firms, etc. This is necessary for individual firms to maintain a high level of timely knowledge about markets, fashions, techniques, and competitors.

A climate of entrepreneurial dynamism. This is facilitated by the existence of a skilled workforce, and an environment in which workers can learn about running a business from their employers; cultural and economic acceptance of small-firm creation (including the availability of credit); protection from domination by large firms; and access the types of networks mentioned above.

A highly skilled labor force, capable of cooperating with management in the innovation process, and willing to adapt to constantly changing demands. Downward pressure on wages is avoided with a new, most trustful labor/management dynamic in which workers get training, advancement opportunities, and security (through social safety nets) in exchange for their skills and flexibility.

2.3.2. Industrial districts as an economic development model

The above organizational principles strike at the heart of a region's economy and culture. No short-term strategy can create these conditions for an industrial district where they do not already exist. However, instead of considering these characteristics as Boolean "conditions" for industrial district-like behavior, one can instead view them as qualities which a region may possess in varying degrees. By doing so, it is possible to envision an economic development path for a region, under which these characteristics are cultivated as a means of behaving increasingly like an industrial district over time.

The public policies that might move a regional economy in this direction largely involve the development of innovative institutions and cooperative relationships between government and the private sector. The various roles that these institutions can play include:

Providing businesses with "real services" not supplied by the private sector. These services might include the provision of technical information or expertise, specialized training or consulting, quality testing of manufacturers' feedstocks (particualrly important in a recycling economy), or translation services. If these services are not made available in a particular region by the private sector because of a lack of expertise or high start-up costs, their provision at cost (taking advantage of economies of scale at a regional level) can be justified as public goods.[44] Two types of information are needed: data on existing market conditions, including prospective partner firms (to reduce transaction costs);

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[43] Zeitlin, Jonathan, "Industrial Districts and Local Economic Regeneration: Overview and Comment," pp. 286-287, in Pyke and Sengenberger (1992).

[44] Brusco, Sebastiano, "Small firms and the provision of real services," in Pyke & Sengenberger (1992), pp. 186-188.

and projections of future market conditions (to improve investment decisions).[45] While some state governments are already engaged in providing this type of advice to recycling firms, their analyses at this stage are quite general and crude in nature. Methodologies for the sophisticated analysis of regional recycling economies do not yet exist.

Pooling the provision of other equipment and services available in the market but impossible to purchase in fractional quantities. This is the principle on which many small business incubators operate, allowing small start-ups to share telephone answering, accounting, and marketing services, as well as office equipment, meeting facilities, etc. Recycling companies may also want to share trucks, balers, cleansing machinery, and other expensive capital equipment.

Building cooperation and promoting regionalism, by helping groups of firms redefine their collective interest and common purpose through "studied trust." Sabel writes about one such effort in Pennsylvania: "By 'studying' their industries jointly, it was hoped, the parties would at best discover new sources of vitality which could serve as models for collective reorganization. At worst, it was further hoped, they would discover a reality different enough from the one they expected to force reconsideration of their traditional assumptions."[46] Similarly, a greater sense of regional identity and cooperation can be fostered through public-private partnerships and political consensus-building.[47]

Building regulatory consensus and flexibility. Efforts along these lines are growing increasingly common in environmental policy development. The Clinton Administration has convened collaborative processes on automobile fuel economy rules, logging in the Pacific Northwest, development along the central California coast, protection of the Everglades, and crafting a sustainable development vision for the nation. Environmental groups such as the Environmental Defense Fund are beginning to collaborate with industry to develop comprehensive strategies for improving the environmental performance of entire sectors. EDF's two major projects in this arena to date have focused on the printing industry and the pulp and paper industry.[48]

Facilitating enterprise development and access to credit, by backing loans by private banks, establishing new financial institutions with public funds, installing tax breaks or other assistance for new or expanding businesses, etc. The Materials for the Future Foundation has explored in detail the particular problems that small recycling firms face in gaining access to credit and capital. Their report contains twenty specific recommendations, including public/private cooperation to establish a voluntary financing network, development of vehicles for encouraging "economically-targeted

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[45] Julien, Pierre-André, "The role of local institutions in the development of industrial districts: The Canadian experience," in Pyke and Sengenberger (1992), pp. 201-202.

[46] Sabel, Charles F., "Studied trust: Building new forms of co-operation in a volatile economy," in Pyke and Sengenberger (1992), p. 238.

[47] Swanstrom (1995), pp. 27-29.

[48] The "Great Printers Project" included EDF, the Council of Great Lakes Governors, and the Printing Industries of America. The "Paper Task Force" included EDF, Duke University, Johnson & Johnson, McDonald's, NationsBank, The Prudential Insurance Company of America, and Time Inc.

investments" from pension funds, promotion of simplified public offerings, changing California's Industrial Development Bond program to reduce barriers to recycling firms, and clarification of Federal tax regulations that provide certain exemptions for facilities that utilize "valueless" solid waste.[49]

Reducing obstacles to inter-firm cooperation. At present, inter-firm cooperation on pollution prevention efforts may violate antitrust regulations.[50] In addition, governments' use of exclusive contracts for the purchase of recyclable materials collected from the municipal waste stream acts as a barrier to the use of these materials by local businesses.

2.3.3. Implications of industrial districts for linking recycling and economic development

The theory of industrial districts, as well as other models of economic development that focus on institutions, suggests a number of important lessons for future attempts to link recycling and economic development at the local level. However, serious consideration must first be given to the question of whether recycling industry genuinely resembles those found within industrial districts.

On one hand, it is unclear whether recycling represents an "industry" in the same sense as the sectoral clusters found in industrial districts. Recycling firms are spread across a wide range of economic sectors, and thus may not represent an "industry" at all. Furthermore, it is unlikely that recycling could ever become an economy driver or major export industry for an urban region. The relative prominence of recycling in a local economy will always remain lower than that of the industries found in conventional industrial districts (e.g. computers and software in Silicon Valley). On the other hand, the industrial districts literature does not appear to have found any limits to the types of industries which may comprise an industrial district; in fact, in some cases flexible specialization and manufacturing networks have observed operating without a specific industry focus.[51]

In some ways, however, the structure of the recycling industry at a local level resembles those of industrial districts' industries. The recycling industry's components are compatible with structural disintegration. The tasks that comprise the recycling of materials—collection, sorting/ baling, shredding/cleaning/processing, storing/marketing/brokering, and final use as a manufacturing feedstock—do not generally take place in the same facility, and are often separated into distinct enterprises. With the exception of the high-throughput materials (e.g. newsprint, glass, aluminum, steel), there does not seem to be a strong tendency toward vertical integration in the recycling industry. The fine division of labor found in industrial districts is already found in some parts of the recycling industry.

Due to a lack of usable economic statistics and a paucity of studies of the field, our understanding of

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[49] Wirka (1993).

[50] Frederick R. Anderson, "From Voluntary to Regulatory Pollution Prevention," p. 103 in Allenby and Richards (1994).

[51] See, for example, Robin Murray, "Flexible specialization in small island economies: The Case of Cyprus," in Pyke and Sengenberger (1992).

the recycling industry today is very weak. The coherence of the "recycling industry" is indeed debatable. However, even if a regional recycling industry cannot itself develop into an industrial district, several factors suggest that industrial districts may be an appropriate model for the future growth of the recycling industry.

At the regional level, the recycling industry's current needs and requirements for long-term success match well those of the industries that comprise successful industrial districts around the world. *First, the recycling industry needs the capacity for flexibility in the face of uncertainty.* The high volatility of secondary commodities markets, as well as the rapid evolution of technology and the policy environment, require that the recycling industry be flexible and possess the ability to innovate. To the extent feasible, it needs to maximize the flexibility of its capital investments and its organizational forms, so that enterprises can form and disband as market opportunities appear and disappear.

Second, the recycling industry relies heavily on information networks for the dissemination of innovations, news about market and political issues, availability of feedstocks and products, etc. These networks are already being built at the international, national, regional, state, and local levels, but they are generally limited to firms that think of themselves as "recyclers." Generally not included in the networks are recycling companies that don't identify themselves as such (because their main line of business is in a different sector), and potential recyclers not currently using secondary feedstocks. The industry would benefit from government or private sector assistance aimed at expanding these networks.

Third, new institutional structures are needed to foster the development of the recycling industry. Among the new institutions that could benefit the industry significantly are dedicated financing agencies, training and technical assistance agencies, collective marketing and outreach agencies, and cooperatives for equipment purchases and transport services. It could also benefit from a greater degree of awareness and cooperation among government agencies. The industry is currently hurt by arrangements in which governments cede ownership of their municipalities' recyclables as part of their contracts with large waste management firms: this structure can effectively keep recyclables out of reach of potential local purchasers.

Fourth, the recycling industry would benefit from a shift away from price-based competition. Institutional momentum and economies of scale in the production of virgin materials, suggest that it is unlikely that secondary materials will be able to out-compete virgin materials on the basis of price over the long run. A decentralized, innovative recycling industry would not need to: suppliers of secondary feedstocks could work closely with their clients to ensure the delivery of customized, quality feedstocks that closely match the purchaser's needs. These types of inter-firm relationships would enable the recycling to transcend commodity-oriented, price-based competition, and concentrate on the far more profitable opportunities in high value-added products.

The forms of government/private sector intervention that have worked on behalf of industrial districts translates well to the recycling context. Proactive policies by local governments—aimed at fostering inter-firm cooperation, a decentralized industrial structure, and a climate of entrepreneurship—would benefit both the recycling industry and the local economy as a whole.

Under the industrial districts-inspired economic development model, local governments and institutions have shed their irrelevance (from neoclassical economics) and now play leading roles in creating the conditions for growth.

Some of the policy approaches that could be used include fostering competition in contracting for municipal waste collection contracts; treating collected recyclables as means for generating local economic opportunity rather than commodities to be sold at maximum price; providing tax incentives for secondary materials use by local manufacturers; providing access to capital for new or expending recycling enterprises; assisting in the formation of new institutions (training/technical assistance/administrative/ purchasing/marketing cooperatives); and adopting supportive procurement policies.

Also particularly important is the creation of fora for the collaborative definition of recycling goals and policies, in order to build a common sense of purpose across the public and private sectors. This is particularly important for recycling, since the promotion of recycling by government is more normative in nature than the promotion of other industry-specific economic development strategies (since the latter is usually based on a desire to capture growth that is being driven by other factors).

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However, there are other ways in which the applicability of the industrial districts model to recycling is more questionable. As discussed above, it remains unclear whether recycling represents an "industry" in the same sense as the sectoral clusters found in industrial districts. Several additional problems include:

The industrial districts model provides an incomplete framework for a comprehensive economic policy for recycling. Broader market contexts play large roles in determining what types of economic decisions are likely to be made by the private sector, regardless of the how local economies are structured. Considered in isolation, the industrial districts model simply does not address important questions about the economic viability of recycling enterprises in general.

The theory gives limited guidance for how environmental policies can be integrated into a institutions-oriented economic development strategy. Beyond providing a model for how the public and private sectors should work collaboratively through regional institutions to address pressing public concerns, industrial districts theory has little to say about what form environmental policies should take.

It is unclear whether trade in waste products works the same way as trade in intentional (commercial) products. Because the generation of wastes is a consequence of the generation of intentional products, their supply may be somewhat less sensitive to market conditions than might be expected. On the other hand, strong demand for a particular secondary material could provide sufficient incentive for a firm to invest in the purification of its waste stream, thereby making it marketable as product. Systems of exchange among firms have been analyzed for both product and non-product outputs, but have not been systematically compared. Further research is necessary before strong conclusions regarding the applicability of the industrial districts model to the recycling

industry can be drawn.

Box 2.7: Lessons and problems for recycling policy from three conceptual frameworks

Lessons and Contributions

ENVIRONMENTAL ECONOMICS

Market barriers to increased recycling are best addressed at a high level of governance
Recycling policies should address relevant economic and environmental objectives more directly
Recycling policies would have greater impacts if they followed neoclassical principles more closely

INDUSTRIAL ECOLOGY

New research methods can improve our understanding of the role of materials in the economy
A systems perspective on materials flows can help improve the quality of environmental policy
IE provides a constructive vision for linking economic and environmental goals incrementally

INDUSTRIAL DISTRICTS

The structure of the recycling industry at a local level resembles those of industrial district industries
The recycling industry's needs match those of industries comprising successful industrial districts
Strategies that have successfully helped industrial districts translate well to the recycling context

Problematic or Unaddressed Issues

ENVIRONMENTAL ECONOMICS...

Precludes a proactive role for municipalities in the promotion of recycling
Views the local economic benefits of recycling as a zero-sum game
Ignores many local opportunities for recycling unusual commodities
Fails to question traditional concepts of economic growth and the inevitability of rising resource use

INDUSTRIAL ECOLOGY...

Exhibits a big-business bias.
Tends to select "system" boundaries improperly in its studies
Applies its own ecological paradigm incompletely or improperly
Focuses insufficiently on economic, institutional, and policy issues

INDUSTRIAL DISTRICTS

Provides an incomplete framework for a comprehensive economic policy for recycling
Gives limited guidance for how environmental and economic objectives are integrated
Doesn't clarify whether networks exchanging wastes resemble those exchanging traditional products

Chapter 3
Toward an Integrated Framework for Strategic Materials Stream Planning

"I think that we must learn to see the trash on our streets and roadsides, in our rivers, and in our woods and fields, not as the side-effects of 'more jobs' as its manufacturers invariably insist that it is, but as evidence of good work <u>not</u> done by people able to do it."
—Wendell Berry[52]

The preceding chapter examined three theoretical models, and considered what each might have to say about locally-based efforts to link recycling policy and economic development. Despite some points of conflict, these cannot be said to be competing models; they reside in entirely distinct fields of study. The connections between any pair of the trio have scarcely begun to be explored in academia.

The challenge that lies ahead is drawing lessons from each of these models that might be applied to the development of a new conceptual framework that explicitly links recycling with local economic development. Such a framework, when practically applied, will not resemble recycling policy as it has been implemented in the past. Rather, it will engage local governments in entrepreneurial partnerships with their region's private sector to enhance the utilization of secondary resources available within the local economy. Such an approach has been called "materials policy," or "strategic materials stream planning."

After briefly reviewing some key features of each of the three paradigms, this chapter will take a superfluous but entertaining detour exploring how they may be linked via concepts borrowed from ecology. It will then attempt to define an operational synthesis of the three models—i.e. their practical implications for policy development. Finally, the chapter will conclude with a brief description of some elements from these three models that can be seen operating together in real-world situations.

3.1. Advantages and failings of the above models

Each of the paradigms discussed in the preceding chapter has lessons to contribute to the development of the materials policies of the future. However, no single framework pursued exclusively can adequately address the full range of barriers to an intensive recycling economy, or provide the vision necessary to guide local policy-makers in the development of comprehensive policies linking environmental and economic objectives.

<u>*Environmental economics*</u> will continue to be the primary basis for developing national and state macro-level environmental policies long into the future. To the extent that today's public policies still fall short of ensuring that the full costs of natural resource extraction and waste disposal are

[52] Berry (1990), p. 128.

adequately represented in the economy's price signals, additional policies in the neoclassical mode are appropriate and necessary. One particularly important issue this policy domain can shed light upon in the future is whether price signals are being applied at the appropriate places: charging the full social and environmental costs of landfills to taxpayers instead of manufacturers or waste generators does little to address these externalities. Neo-classical theory can also suggest how government policies designed to promote recycling can be better designed to reduce monopoly and promote competition within the recycling industry.

However, as discussed earlier, there are at least four ways in which this model provides an incomplete framework for addressing the issue of recycling. First, by ignoring spatial issues, environmental economics ignores the possibility for municipalities playing a proactive role in promoting recycling. Second, because of its treatment of demand for secondary materials as exogenous, this model views the local economic benefits of recycling as a zero-sum game. Third, its treatment of secondary materials as commodities to be traded on the open market ignores many local opportunities for recycling that involve smaller scales and shorter transport distances. Finally, the neoclassical assumption that limits do not exist is unrealistic and unsustainable.

If grows to fulfil its promise, *industrial ecology* could bring new levels of sophistication to environmental policy. It would enable governments to understand the environmental impacts of industry at a systems level of analysis, and allow firms to integrate environmental considerations more fully into their strategic decision-making. These tools could potentially facilitate the crea-tion of cooperative frameworks through which meaningful environmental goals can be achieved in a flexible manner. Industrial ecology approaches can also be applied to improve our under-standing of the relationships within the recycling "industry," and its role in the greater economy.

But industrial ecology also represents an incomplete picture. One of its major current problems is a big-business bias, ignoring the roles played by small firms, and the potential need for structural changes in the economy. A second problem is its inadequate attention to institutional and policy issues. Finally, as discussed earlier, many industrial ecology studies have suffered from an improper selection of "system" boundaries.

Theories explaining *industrial districts* describe the types of institutional interactions found in certain vibrant and innovative regional economic sectors. They suggest the types of economic and organizational structures that may be desirable in an emerging industry. They also indicate ways that local or regional governments can promote cooperation among businesses, financial institutions, non-profit agencies, and the public sector to build the information networks and other conditions necessary to create a dynamic, locally-based recycling economy.

Institutions-oriented models of economic development, such as industrial districts theory, do not address themselves to solving environmental problems, or even applying normative value judge-ments to industrial patterns (such as secondary vs. virgin materials use). Several components need to be added to the model before they can be expanded into a blueprint for linking recycling and economic development. First, they need to include a description of macro-economic factors determining the playing field upon which businesses compete. Second, an explanation is needed of how to incorporate environmental objectives into an institutions-oriented economic development

strategy. Finally, there needs to be an understanding of whether recycling is indeed large or cohesive enough an industry for this strategy to be applied successfully.

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In many ways, these three approaches are complementary. A conceptual framework that integrates the three perspectives, creatively applying the lessons and tools of each, could provide a strong framework for future recycling policy, linking environmental objectives with local economic development.

Kalundborg, a central symbol of industrial ecology, in fact may represent an instance of the three models working in synch.[53] The prevailing economic climate and strong environmental policies created broad economic and regulatory conditions under which it became profitable to form the type of waste exchange seen at Kalundborg. Small-city social and professional networks and a climate of inter-firm cooperation opened the channels of communication and made inter-firm cooperation possible. Systems-level engineering analysis made the coordination of different firms' needs feasible. Thus, replicating Kalundborg does not require central planning of eco-industrial parks, as some industrial ecologists have suggested. Rather, it requires establishment of strong but flexible environmental policies, information sources and analytical tools for systems-level analysis of environmental/economic relationships, and networks and institutions through which this information can flow and potential new partnerships can be identified.

3.2. A conceptual synthesis based upon ecological principles

Expressing his disdain for sciences that attempt to explain and categorize diversity, Ernest Rutherford once wrote, "Science is divided into two categories, physics and stamp-collecting."[54] This statement exposes an important tension within modern thought, between the belief that the properties of nature (of the universe, the environment, etc.) can be explained by a finite set of fundamental laws, and the belief that nature's inherent complexity is best understood through analysis of its diversity. Both of these perspectives are represented with in all modern fields of study (including physics), but adherents to each tend to frown upon one another.

Neoclassical economics strives to be an axiomatic science, and has worked to claim the field of economics as its own. But many other streams of economic thought have existed through history. Whereas neoclassicists tend to distinguish only among land, labor and capital, early classical economists reserved a far more explicit role for energy and other natural resources as inputs to production.[55] Many of these theorists, most famously Thomas Malthus, saw the economy as an open-ended system interacting with the natural productive capacity of the earth.

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[53] *Technology and Policy* (1995).

[54] Bernal (1939).

[55] Christensen (1989).

Nature itself has provided a powerful model for thinking about human economic systems. From entropy to Darwinism, explicit and implicit metaphors from the natural world have been used by many economic and social thinkers over the past three decades.[56] The visionary social and economic ideals of Jane Jacobs, E.F. Schumacher, and Wendell Berry borrow eloquently (although not always explicitly) from models of how natural ecosystems function. Over the past decade, rising concerns over economic and environmental sustainability have led to a proliferation of new approaches to environmental/economic policy that incorporate ecological concepts, including Ecological Economics, Industrial Ecology, and numerous flavors of sustainable agriculture and sustainable development.

There are three primary ways in which natural ecosystems have served as a model or metaphor for human activities:

- ➢ Both natural systems and human systems exist in the same space, and impact one another significantly.

- ➢ Natural systems have prospered without eroding their resource base over time, or polluting themselves out of existence.

- ➢ Both are complex systems that, over long periods of time, have evolved structures for the allocation of scare resources through cooperation and competition among their constituent parts.

Both natural systems and human systems exist in the same space, and impact one another significantly. Under this perspective, the distinction between the two systems remains an artificial one, even after centuries of human efforts to decouple them. The long-term health of both will require significant changes in the ways that we manage the relationship between human activities and the greater whole.

This recognition that human systems must find ways to exist within natural limits is one of the core concepts of sustainable development. Although no universally-agreed definition of "sustainable development" exists, one principle that tends to underlie many recent definitions is a rejection of the notion that human and natural systems are distinct.[57]

The emerging field of Ecological Economics is beginning to explore this relationship formally. It rejects the neoclassical paradigm embraced by environmental economics and welfare economics, and instead seeks to build compatibility with environmental constraints and inter- and intra-generational equity directly into the very objectives of the economy.[58]

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[56] For a concise review of historical perspectives, see Daly (1968).

[57] The recent report of the President's Council on Sustainable Development, established by the Clinton Administration to develop a sustainable development agenda for the United States, provides a notable counter-example. They chose the concept of "stewardship" as a central building block of their vision of sustainability. While "stewardship" represents a long and rich philosophical tradition within environmentalism, it conceptualizes humans as outside of the natural world.

[58] See Krishnan, Harris, and Goodwin (1995).

Natural systems have prospered without eroding their resource bases over time, or polluting themselves out of existence. Ecosystems survive within their means; the materials and energy they need are generally assembled, stored, utilized and redispersed over finite areas, rather than borrowed from elsewhere.[59] Ecosystems are also energy efficient: they have compensated for the low availability of solar energy and a limited ability to capture this energy by developing very efficient systems for storing and sharing the energy that is captured. They accomplish these feats by:

- Minimizing their demand for energy and materials
- Decentralizing the task of gathering energy and materials into a useful form
- Repeatedly cascading the assembled energy and materials before releasing them to the environment
- Ultimately returning materials to the forms in which they were found
- Never gathering needed but potentially toxic materials in concentrations that could undermine the system.

The application of ecological principles to the management of resources and pollution is the primary domain of the emerging field of Industrial Ecology. More so than environmental economics, ecological economics, or other approaches, IE searches for ways to move resource use patterns to more closely resemble those found in nature.

As discussed in the preceding chapter, this represents an area in which industrialized human socio-economic systems are quite different from their natural counterparts. In today's industrial economy, most natural resources are used a single time before being returned to the environment in a form that makes them useless as future economic inputs. Only highly precious materials (e.g. gold) are recycled continuously through the economy; but even these continue to be extracted from the earth nearly as fast as technology will allow.

Another difference is that the smallest constituent unit of an ecosystem, the micro-organism, is ubiquitous, whereas humans and economic capital are not so to nearly the same degree. One explanation for the material inefficiency of industrial society may its failure to develop an equivalent to micro-organisms' vast, decentralized capacity to perform basic functions of assembly and disassembly of matter.

Both are complex systems that, over long periods of time, have evolved structures for the allocation of scare resources through cooperation and competition among their constituent parts. Human society has evolved a broad array of institutions that coordinate and facilitate cooperation toward common goals. In addition, capitalist societies emphasize competition among private institutions as the most efficient means of improving the public well-being. Both natural and (ideally) human systems:

- Are dynamic and evolutionary

[59]Materials that are relatively mobile (e.g. water, oxygen, nitrogen, and CO_2, to name a few) are transported by larger geochemical processes, not ecosystems themselves.

- Regulate their own behavior through signals (price, food availability, etc.)
- Gain their resiliency from diversity and redundancy
- Push toward the highest levels of activity that conditions allow
- Allocate scarce resources through cooperation and competition
- Make both entry (birth/enterprise formation) and exit (death/enterprise failure) from the system very easy

The theory of Industrial Districts has not generally made explicit use of ecological metaphors.[60] Nonetheless, it possesses strong parallels to ecological modes of thought:

Institutionalized arrangements for cooperation in the midst of competition exist in nature in numerous forms, including symbiotic relationships, etc. These are "institutionalized" through the co-evolution of physical characteristics, or through the intergenerational transmission of instinctive behavior. Within species, social forms of learning occur, as well as division of labor for child care, hunting, and defense responsibilities. Important services are decentralized (no animals generate their own oxygen; no plants decompose organic matter in the soil to generate nutrients for their use). An example of periodic cooperation might be occasions when small birds of various species band together to chase off an owl that poses a threat to their nests.

One difference between ecological and economic ideals of competition is particularly noteworthy: whereas neoclassical economic theory holds that market competition will yield an optimal outcome, evolutionary theory makes no such assumption. An ecosystem's balance is a temporary result of its having found a local region of temporary stability, not necessarily a global optimum. A species' success may be a result of its ability to compete and cooperate its way through some historical period of change, but is not necessarily an indication that it is optimally suited for the present. Institutional economists have argued that the same principles apply to competition in the economy.[61]

Diversity vs. Monoculture. Both natural systems and industrial districts gain their resiliency to shocks from diversity (many different types of actors) and redundancy (multiples of the same type of actor). Healthy ecosystems possess diversity in that they contain many species serving in unique ecological roles (niches), and that each species possesses genetic diversity. They gain redundancy from having many different organisms of each species, and multiple species sharing similar ecological niches. Ecosystems that lack this diversity are either deserts (with low overall activity levels) or monocultures (unhealthy and unstable systems that maximize one process at the expense of others).

Similarly, many different types of firms are present in industrial districts, yet each firm still faces competitors serving the same economic function. Industrial districts are said to achieve this diversity by finely dis-integrating labor among firms, and by keeping firm sizes small.

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[60] Parallels between structural and evolutionary patterns in nature and those in the human economy have been explored more explicitly elsewhere (even in contexts in which environmental protection has not been the focus). Examples include institutional economics (Söderbaum (1992)) and organizational theory (Boone and van Witteloostujin (1995)).

[61] Stark and Grabher (forthcoming 1997), p. 2.

David Birch's argument that small firms supply the economy's dynamism might be recast in an ecological light. It can be argued that economic evolution in a Darwinian mode would occur on time scales longer than that of a firm's lifetime; thus an economy dominated by large, long-lived businesses would be less able to adapt to sudden change, or would be slow to innovate to take advantage of new opportunities. If this is true, then the continued domination of the economy by large, long-lived firms might be seen as a hindrance to the evolution of the economy toward a more stable system. The assumption of many industrial ecologists that large firms could themselves be agents of the economy's evolution might be considered Lamarckian.

However, an economy of uniformly small businesses might be equally undesirable. Ecosystems existing only of small, short-lived organisms are generally found only where resources are unusually scarce, or conditions are unusually harsh; where they are found, the overall levels of biological "activity" are very low. By analogy, the existence of large businesses may be symptomatic of a healthy economic system, but their imbalanced domination of such a system would be detrimental. Besides, healthy ecosystems possess organisms that are "large" by several different measures—physical size (whales), life span (trees), or spheres of influence (eagles)—and any relationship among these definitions is tenuous at best.

Although the industrial districts of the Emilia-Romagna region are comprised nearly exclusively of small-to-medium-sized firms, this does not necessarily need to be the case for an industrial district to maintain its cooperative/competitive character. In fact, other regions have been identified which possess the characteristic inter-firm relationships of industrial districts, but which are comprised of a mix of small, medium, and large firms.[62]

The ecological model should be properly interpreted to suggest that diversity, redundancy, and decentralization helps keep a complex system dynamic yet stable (in the sense that catastrophes are rare).[63] The essential characteristic of industrial districts is that economic power is dispersed and balanced—not centralized into large, vertically integrated firms. This point is echoed by institutional economists, who have argued that "loss of institutional diversity will impede adaptability in the long run."[64]

Ease of Entry and Exit. Another way in which industrial districts parallel natural systems is the ease with which actors can enter and exit the system. In nature, organisms are born and die as a matter of course. Average life spans of organisms may vary by orders of magnitude, but the system is structured to ensure that both birth and death occur easily and frequently. The same cannot be said of the economic system. Enterprises can be extremely difficult to begin; many institutional factors (such as lack of credit availability or domination of a sector by large firms) work to limit the rates at which businesses can be started. Similarly, many national and local economic policies are designed to shield established firms from pressures that might drive them out of business.

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[62] Hubert Schmitz, "Industrial Districts: Model and reality in Baden-Württemberg, Germany" in Pyke and Sengenberger (1992).

[63] David Ehrenfeld, "The Management of Diversity: A Conservation Paradox" in Bormann and Kellert (1991).

[64] Stark and Grabher (forthcoming 1997), p. 1.

Industrial districts, however, *facilitate* enterprise formation by easing the availability of capital, disseminating the skills needed for entrepreneurship, and otherwise working to lower barriers to entry into the marketplace. Similarly, although it can be disruptive to many peoples' lives for a firm to go out of business, industrial districts generally do not appear to have established policies that hinder this from happening. This ease of entry and exit is a type of institutional flexibility that enable firms to form, disband, and re-form to best respond to changing economic conditions.

3.3. An operational synthesis

Environmental economics, industrial ecology, and industrial districts each provide lessons for how recycling policy might begin to move in the direction of strategic materials stream planning.

Setting appropriate policy and economic climates. Environmental economics suggests that higher (i.e. state and Federal) levels of government are the appropriate action points for setting the policy contexts necessary for recycling to succeed. Conventional economic and regulatory instruments inspired by evironmental economics represent the lion's share of recycling policies enacted to date, and deserve credit for bringing the nation's recycling rates as high as they have come so far. Future progress toward higher recycling rates will depend to a large degree on the continuance and extension of these efforts.

At the same time, the entire framework of solid waste management policy adopted since the landfill crises of the late 1980's should be reconsidered, in light of the policy priorities that are important today, and are expected to remain important into the future. Because their real aim was limiting the growth of landfills and incinerators, these policies had only marginal success in reducing natural resource degradation or creating remanufacturing jobs in urban regions. If these ecological and economic goals are expected to endure as societal objectives, then recycling policies should be reoriented toward achieving them.

Realistically, however, the prospects for federal or state policy changes of the magnitude necessary to impact virgin material prices significantly are slim in the present political climate. The ability of higher levels of government to act to reduce externalities or market distortions is complicated by the diverse constituencies represented in federal and state governments: resource supply regions often see a strong self-interest in preserving the *status quo*. Support for increased market interventions must come from local level, even though the policy levers available at this level tend to be relatively weak.

Promoting entrepreneurship and cooperation. The theories of industrial districts suggest that local and regional governments can facilitate economic development by fostering entrepreneurship. Many of the challenges facing the recycling industry (high levels of uncertainty, need for cooperation and innovation) parallel those facing the types of industries that have formed industrial districts in Europe and the United States. Particularly helpful for recycling firms would be cooperation between government and private banks on risk reduction for loans to recycling enterprises. Other strategies already familiar to many local economic development professionals are the establishment of small

business incubators, and the provision of tax breaks, low-interest loans, and other assistance for new or expanding enterprises.

Of equal importance is the cultivation of new institutional linkages and forms of cooperation among public agencies, private and non-profit companies, universities, and community organizations. Examples of such linkages might include adoption of government procurement policies targeted toward locally produced recycled products; establishment of regional councils on recycling market development; cooperation on the generation, analysis, and dissemination of data on region-specific recycling economics; and the sharing of equipment, services, and technologies among firms. Not only would the prospects for a strong local recycling industry be improved by increased partnership among existing businesses, but the nature of recycling itself—with the new producer-supplier relationships it requires—could feed back positively by providing an even greater degree of local cooperation.

Promoting diversity and decentralization. Another lesson from the industrial districts model is that a diversified, decentralized industrial structure can help increase rates of innovation. This suggests that many of today's recycling policies, which tend to maximize materials throughput via large-scale facilities, should instead be oriented toward establishing an innovative, self-sustaining recycling industry. In addition to remedying their neglect of small, innovative recycling firms, governments should also end such anticompetitive practices as monopolization of collection services for recyclables, and exclusive long-term contracts for the purchase of secondary materials. Government should also examine how antitrust regulations can be relaxed, so as not to prohibit companies from working together to share materials streams and reduce pollution. Finally, where possible, governments should move away from command-and-control environmental regulations and towards more market-oriented incentive systems for safeguarding human and ecological health.

Re-linking waste management with planning. Local economic and institutional climates play a role in determining whether secondary materials collected for recycling remain in the local economy or are exported elsewhere in the country or abroad. The levers which local officials can use to influence these outcomes are the techniques of local economic development planning.

A re-integration of strategic planning and waste management policy at the local level is therefore required. Such a merger would hearken back to the historic origins of both professions. Toward the end of the 19th Century, public concern over urban conditions gave rise to several different responses, including "scientific" reform (the Progressives), social reform (e.g. the settlement house movement), and aesthetic civic improvement (e.g. City Beautiful proponents).[65] Although these movements' prescriptions for the predicaments of their era were quite varied, each saw both the physical form of cities and the social practices conducted within them as key to affecting change. Over time, the new professions of public health and city planning began to emerge, both with strong planning traditions.

Certain disciplines within these new professions saw their emphases on reform-oriented planning

[65] Progressive reformers: see Melosi, pp. 51-104 and Hall, pp. 48-85; social reformers: Melosi, pp. 117-124 and Hall, pp. 40-44; aesthetic reformers: Melosi, pp. 105-113 and Hall, pp. 175-183.

diminish over time. The fields of transportation (in the city planning arena) and waste management (in the public health arena) evolved into engineering professions, in which the overriding objective became government provision of services and infrastructure sufficient to meet projected growth in demand. Today, waste management is largely a function of public health or public works departments at the municipal level, with virtually no institutional infrastructure for strategic planning. One of the first steps toward integrating recycling and economic development policy should be the development of this institutional capacity. Perhaps the best way to accomplish this would be the shifting of responsibility for recycling policy to economic development departments, where it properly belongs. Such a step would represent the re-integration of planning and waste management policy, a century after they diverged.

Development of new planning techniques. Analysis methods necessary for strategic economic development planning for the recycling industry simply have not yet been invented. These include the estimation of industrial waste generation rates and overall flows of materials through the urban economy, characterization of the present state of recycling within a regional economy, projections of potential job creation from value-added to the local waste stream, and identification of niche markets and new economic opportunities. Pioneering work along these lines has been done at the grassroots level, followed more recently by the efforts of a handful of consultants and state and Federal agencies. Cross-fertilization with emerging ideas and techniques from industrial ecology could help improve these potentially powerful analysis tools to the point that they can begin to contribute to strategic materials stream planning.

A more general lesson from industrial ecology is the need to consider problems from a systemic perspective. So far, recycling policies have had limited impacts because they have been driven by a relatively narrow problem: the growing economic, environmental, and political costs of disposing municipal solid waste in landfills and incinerators. Looking at materials use from a broader systems perspective would include questions concerning the environmental consequences of resource extraction and processing, urban economic vitality and rural economic sustainability, and the treatment of non-municipal waste streams.

3.4. Syntheses from the real world

Community-based organizations have been seeking to link recycling and economic development at the neighborhood level since at least the 1970's. Recently, however, awareness of these potential linkages has grown and entered the mainstream policy discourse.

The simplest synthesis recognizes that recycling is an industry like any other, and that attraction of recycling businesses brings jobs into a region. Recycling's inherent labor-intensity means that net jobs are created as waste management practices shift away from landfilling or incineration.

Perhaps because they are the most acutely aware of the costs of waste management, or because they are ever-vigilant for economic development opportunities, localities have been on the vanguard of linking recycling and economic development policy. One example is the city of Newark (NJ), which combined an aggressive recycling business incentive program with other assets (its role as a major

port and transportation hub, and its high municipal recycling rate), and attracted 80 recycling businesses to the city, employing over 1,000 people.[66]

Numerous state governments have acknowledged the link between recycling and economic development in recent years. New York became the first to do so in 1988, establishing a recycling market development division within its state economic development agency. California's program, initiated in the following year, is particularly noteworthy because it embraces a very wide range of approaches, and remains one of the few state-level policies that creates an explicit role for local governments in fostering the development of the recycling industry (this program will be explored in greater detail in the following chapter). By mid-1992, 24 states had established tax credits for businesses using recycled materials or purchasing recycling equipment.[67] More recently, as demand has risen sharply for recycled products, even less densely populated states like Georgia and Arizona have pursued aggressive business attraction strategies to gain a share of the expanding recycling industry.[68]

The planning profession is also beginning to take notice. In its recent plan for the New York metropolitan area, the Regional Plan Association estimated that the expansion of secondary materials manufacturing could provide $230 million in direct revenues from sales of recyclable commodities, and an additional $100 million in sales, taxes, and wages by 2015.[69] The RPA also embraced the imagery and logic of industrial ecology, calling the region's waste stream "'nutrients' for the next generation of production processes."[70]

A different (but not mutually-exclusive) perspective is that there is a local interest in encouraging the establishment of recycling enterprises as part of a broader waste management or economic development strategy. Berkeley (CA) has long been in the forefront of this approach in the United States. Since the 1970's, a diverse array of for- and non-profit enterprises has evolved through public/private partnerships to extract maximum value from the waste stream, locally whenever possible.[71] This system emerged initially due to local culture, politics, and enterprise, rather than any specific government policy guidance. Today, however, the further development of the local recycling industry is being encouraged by state and local economic incentives provided via the Oakland/Berkeley Recycling Market Development Zone (RMDZ), one of the most successful among the 40 such programs in California.

The provision of loans and grants to the private sector can take on a range of forms, scales, and purposes. At one extreme, it can serve to promote the construction of major new facilities that otherwise might not be built (particularly when these address "problem wastes" for which other

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[66] International Council for Local Environmental Initiatives (October, 1994).

[67] Slovin (1993), p.44.

[68] Mitchell (1994); Goldberg and McCarthy (1993).

[69] Yaro and Hiss (1996), p. 76.

[70] *ibid*., p. 74.

[71] Urban Ore and The Center for Neighborhood Technology (1994).

viable treatment options do not exist). For example, last year Michigan provided a $5 million grant to a firm for the construction of a tire recycling plant (out of a budget for such grants of $12.6 million).[72] At this end of the scale, loans and grants primarily assist existing businesses to expand their operations or open branch plants in a particular location. Emphasis is often put on maximizing "throughput," or the quantity of materials removed from the municipal waste stream due to the project.

At the other end of the scale of current practice are small loans or grants (in the $10k-$100k range) to new or existing enterprises emerging from within the local economy. For these loans, the tonnage of materials removed from the waste stream becomes less important than whether new jobs and a viable new enterprise are being created. Because of their reduced emphasis on throughput, these loans have a greater possibility of assisting businesses that address more eclectic fractions of the waste stream, such as industrial wastes that may not be generated in mass quantities. From an institutional perspective, these smaller-throughput firms can play important roles in the formation of manufacturing networks by forging new relationships with their local suppliers (who previously exported their wastes) and customers (who previously imported raw materials).

An extension of this approach would be to support recycling enterprises at the very smallest scale. Around many rapidly growing cities of the developing world, there has appeared an underclass of urban scavengers, making a living from recovering resources from landfills, and often living within them. Rather than punishing or otherwise discouraging these scavengers (as is very often done in other places), the city of Bandung, Indonesia decided to invest in them. By giving these impoverished entrepreneurs land and capital with which to establish cooperatives for the collection and processing of wastes for recycling, the city is reducing public health risks while simultaneously promoting economic development and reducing the costs of centralized waste management.[73] This approach has not yet been tried in the United States, although it might easily be applied to help urban scavengers of curbside recyclables establish more viable recycling enterprises.

Many municipalities have sought to achieve multiple social objectives simultaneously by relying on private non-profit organizations to provide local recycling services and manufacturing. Groups such as SunShares Recycling in Durham, North Carolina; Tri-City Economic Development Corporation in Union City, California; and Gulfcoast Recycling in Gulfport, Mississippi invest in the communities that they serve by hiring former welfare recipients, training them, and providing them with opportunities for advancement. Others show different forms of creativity—The Building Block salvages construction materials to help low-income residents with their home repair needs. Even non-profit recyclers can have economic ripple effects: both Berkeley's Ecology Center and Arcata's Community Recycling Center (both in California) have seen several small for-profit recycling enterprises cluster near their operations.[74]

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[72] Steuteville (May 1996), p. 36.

[73] International Council for Local Environmental Initiatives (1995). A similar approach has been used in La Paz, Bolivia; see International Council for Local Environment Initiatives (April, 1994). For a more in-depth study of relationships between the informal and formal recycling economies, see van Beukering (1994).

[74] Ruben (1994); Kirkpatrick (1993).

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The integration of recycling and local economic development policy represents more than an important opportunity to promote environmental quality and urban economic vitality: it also provides the rare possibility of linking environmental and economic objectives in an incremental, non-disruptive manner. Four key areas of understanding—the functioning of economic markets, the flows and transformations of natural resources in the economy, the conditions required for inter-firm cooperation and innovation, and real-world experience with building an intensive materials economy—can provide the guidance needed to build a sound policy foundation for the future.

Chapter 4
Case Study:
California's Recycling Market Development Zones

California's Recycling Market Development Zone (RMDZ) program is the centerpiece of one of the most diversified recycling efforts in the nation. With authorization of program's revolving loan fund due to sunset in 1997, now is an appropriate time to assess its performance. The chapter will review the origins of the RMDZ program, examine its impacts, and consider its relationship to the framework presented in the previous chapter.

4.1. Origins of the RMDZ program: Diversion from landfills

California's basic recycling law is the Integrated Waste Management Act of 1989.[75] Like recycling legislation enacted around that time in the Northeastern U.S., the impetus for California's law was the increasing environmental and economic costs associated with the disposal of municipal solid wastes. Among the Act's key findings were that:[76]

- California's 1988 per-capita waste generation rate was 1,500 pounds per year, highest in the nation;
- More than 90% of the state's solid wastes were sent to landfills;
- Most of the state's (then-designated) landfill space would be closed by the mid-1990's; and
- The state lacked a "coherent... policy to ensure that the state's solid waste is managed in an effective and environmentally sound manner."

The primary purpose of the Act was to establish such a coherent policy to reduce the amount of waste generated, and to reduce the state's dependence on landfills.

The central provisions of the law set forth requirements for cities and counties to develop detailed "integrated waste management plans," containing elements addressing waste characterization, source reduction, recycling, composing, special and hazardous wastes, and facility capacity and siting. Through implementation of these plans, cities and counties must "divert 25 percent of all solid waste from landfill or transformation [incineration] facilities by January 1, 1995, through source reduction, recycling, and composting facilities."[77] This diversion requirement increases to 50% in the year 2000.[78]

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[75] AB 939 (Sher), Stats. 1989, c. 1095.

[76] Public Resources Code, §40000.

[77] Public Resources Code, §41780.

[78] This target is similar to those in Massachusetts, New York, and New Jersey, which require recycling rates of 46%, 50% and 60%, respectively. However, California has a longer way to go to reach these levels: in January 1994, the three eastern states had recycling rates between 21% and 34%, while California's was only 11% (Hepler (July 1994), p.60).

In order to implement this mandate, counties and their constituent municipalities must meet the twin challenges of collecting at least half of the waste stream in a form in which it has the *potential* to be recycled, and identifying customers interested in purchasing the collected material. Although the collection of recyclables can be a logistically difficult and costly endeavor, the identification of stable markets for their recyclables poses the greater long-term obstacle to meeting the state's mandate.

Recognizing this problem comparatively early, in 1989 the Legislature also directed the Integra-ted Waste Management Board (IWMB) to develop a comprehensive plan to stimulate market demand for recyclables. The Legislature established a number of regulations and market incentives to promote the use of secondary materials, including preferential procurement policies, minimum content standards, and tax credits. In addition, the Legislature directed the IWMB to begin working with local governments to designate 40 Recycling Market Development Zones (RMDZs) around the state. The following year, the Legislature established a low-interest loan fund for recycling businesses located within RMDZs, funded at $5 million annually.

Thus, the Recycling Market Development Zone program and the state's broader market development strategy originated as supporting components of a broader effort to divert municipal solid waste away from landfills. Although it was recognized that full implementation of the 50% diversion goal could produce thousands of jobs in recycling-related industries, this seems to have been considered an incidental side-benefit of the strategy, not a motivating factor behind it.

The IWMB's market development efforts are built around four goals that focus more directly on market supply and demand of recycled materials than economic development relating to recycling enterprises (see Box 4.1). In its 1993 market development plan, the Board selected mixed paper, compost, and high density polyethylene (HDPE—milk bottle plastic) as "priority materials" for market development efforts. These materials were chosen because they had low diversion rates, made up significant shares of materials being disposed in landfills, and had high potential market demand.[79]

Box 4.1: California's Market Development Objectives

FROM CALIFORNIA PUBLIC RESOURCES CODE:

Article 30.3.1.2. Market Development Plan
(as added by AB 1909 (O'Connell), Stats. 1993, c. 733)

42005. (a) The board shall develop a comprehensive market development plan using existing resources that will stimulate market development in the state for post-consumer waste material and secondary waste material generated in the state.

(b) The board's market development plan shall include, but shall not be limited to, achieving all of the following goals:

(1) Increasing market demand for postconsumer waste materials and secondary waste materials available due to California's source reduction and recycling programs.

(2) Increasing demand for recycled content products, especially high quality, value-added products.

(3) Promoting efficient local waste diversion systems which yield high quality, industrially usable feedstocks.

(4) Promoting the competitive collection and use of secondary waste materials.

From the earliest days of the RMDZ program (and continuing today), the state government has used it as a tool to involve local governments in the effort to decrease the

[79] California Integrated Waste Management Board (March 1993) p. 7. The Board's exclusion of materials such as PET, office paper, and non-ferrous metals from its market development plan provides further evidence that the state's priority was waste diversion and not the development of recycling industries within the state. These materials were already being diverted to a significant degree, but were primarily exported for recycling elsewhere.

proportion of wastes destined for landfills and incinerators. However, as described below, the RMDZ program has acquired additional objectives over time, becoming as much about local economic development as about the extension of remaining landfill capacity.

4.2. Establishing the Zones

Between 1992 and 1995, the Integrated Waste Management Board worked with city and county officials around the state to establish forty Recycling Market Development Zones. The process of establishing the zones was a slow one, for several reasons:

Proposals for the designation of zones had to originate at the local level, and demonstrate the blessings of all relevant jurisdictions. Simply gaining consensus among several municipal and county governments on the boundaries for any type of zone—let alone the division of responsibilities for administering the zone—can itself be an arduous process. Compounded with the challenge of explaining to local authorities the (somewhat obscure) concept of the Recycling Market Development Zone, and how establishing one might be in their own self-interest, makes agreement even more difficult to obtain.

Not all institutional players shared the same objectives. The state's mandate to divert materials away from landfills notwithstanding, many agencies on the local level either hadn't established recycling as a priority, or didn't perceive recycling as relevant to their missions. For example, although a solid waste authority might employ a recycling coordinator and operate a collection program, it might still possess some institutional resistance to the large-scale diversion of wastes away from its landfill—especially if the agency's operating budget is funded from the landfill's revenues (as is often the case). An economic development agency, on the other hand, might never have considered recycling issues at all. In addition to these differences of mission, sharply contrasting institutional cultures between waste management and economic development agencies have tended to limit the lines of communication between these organizations.

The state wasn't necessarily in a rush. The Board saw an advantage in spreading out the designation of the zones over time, so that it could have different zones at different stages of development, and so it could learn from experience.

A great deal of the state government's effort during this time went into helping those interested in establishing an RMDZ gain the cooperation of other local agencies and navigate the application process. Very early on, it become clear that the RMDZ loan fund, and the potential economic development benefits it could provide, was the key reason why local governments might be interested in the program at all. In the early 1990s, municipalities across the state were struggling due to the recession, and they were eager for any type of business assistance they could get from the state. Thus, the Integrated Waste Management Board found itself "trying to appeal to economic development" to interest local governments even though the RMDZ program itself was primarily "not a program for economic development."[80]

[80] Telephone interview with Lisa Barry, Integrated Waste Management Board, 4/17/1996.

The zones that were finally established are diverse in many ways (see Box 4.2). They are located in both urban and rural areas, and in all parts of the state. They vary in size by several orders of magnitude. Together, they cover 39% of the state's land area.

The RMDZs consist of a wide array of different partnerships. The degree of pre-existing institutional cooperation varied widely from place to place. In some areas, the economic development and waste management agencies already had an ongoing dialogue and hit the ground running on the development of an RMDZ; in others, the lines of communication had to be opened first. As a result, the local impetus behind some zones is isolated within a single agency, while in others many different actors make a contribution. Several RMDZs overlap with other varieties of economic development zones, such as Enterprise Zones established by the California Department of Commerce, and Empowerment Zones/Enterprise Communities and Foreign Trade Zones established by the Federal government. Others are innovative public/private partnerships: the smallest zone in the program is an alliance between San Bernardino county and Kaiser Ventures to cluster related recycling enterprises in a two-square-mile area surrounding a major steel mill.

4.3. State Assistance for Recycling Businesses

Once established, the RMDZs provide a number of different benefits to businesses within their borders. The Board assists businesses in RMDZs through two programs:

- *The RMDZ Loan Program* offers low-interest loans to recycling businesses, non-profit organizations, and governments located within the zone. Businesses and non-profits can use funds for real property, equipment, working capital, refinancing of debt; governments may use funds for infrastructure and capital improvements which directly support recycling businesses within their zone.[81]

- *The California Recycling Business Awareness Team ("R-Team")* provides networking assistance and technical support to recycling businesses statewide. Services include provision of current data on market conditions; contacts at laboratories that conduct product quality testing; reports on recycling technologies; and access to a database of recycled content manufacturers; and permitting and siting assistance.[82]

[81] California Integrated Waste Management Board (January 1996), pp. C1-C3.

[82] *ibid*., pp. D1-D2.

Box 4.2: Key Features of California's Forty Recycling Market Development Zones

Recycling Market Development Zone	Area Desciption	Area (mi^2)	Zone Overlap			Other Incentives and Benefits:						
			Fed.	State	Local	CDBG	IDBs	Loan	Serv	Tax	Util	Other
Agua Mansa	Cities of Colton, Rialto, Riverside	16		✯		✯	✯			✯		
Anaheim	Anaheim Canyon Business Center	4			✯				✯		✯	Training
Central Coast	Monterey + 3 surrounding counties	8465						✯	✯	✯		
Chico	City of Chico + adjacent ind. property	130							✯	✯		
Chino Valley	Industrial land in Chino & Chino Hills				✯		✯	✯	✯	✯		
Contra Costa	Entire industrial shoreline of county	240		✯	✯							Procurement
Fresno County	Entire county	5966		✯				✯	✯			Procurement
Glenn County	Entire county	1317							✯			Training
Gtr. San Joaquin Val.	Six cities in Central Valley	68			✯					✯		Training
Humboldt	Entire county	3575		✯		✯		✯	✯	✯	✯	Infrastruct. Assist.
Kern County	Entire county	8162		✯		✯		✯				Infrastruct. Assist.
Long Beach	Industrial-zoned property in city	25		✯				✯		✯		
Los Angeles City	Enitre city	470	✯	✯	✯	✯	✯	✯	✯	✯	✯	
Los Angeles County	Compton, S. Gate, CIty Terrace, et al.	46			✯							
Madera County	Entire County	2140								✯		Infrastruct. Assist.
Merced/Atwater	Cities of Merced and Atwater	21							✯	✯		Infrastruct. Assist.
Mojave Desert Reg.	Five cities in SW San Bernadino Cnty.	200			✯							
Mother Lode	Counties of Calaveras and Tuolumne	3257				✯		✯	✯			
Napa/Solano	Napa county + Vallejo	785										Training, Infrastruct.
NE California	Counties of Modoc, Lassen, Plumas	11061							✯			Procurement
North San Diego	North-central part of county	1402					✯	✯	✯			Procurement
Oakland/Berkeley	All industrial land, plus Oakland CBD	40	✯	✯			✯	✯	✯	✯		
Oroville	Airport business park, indust. zones	11		✯		✯	✯	✯			✯	Infrastruct. Assist.
Placer County	Entire county	1405				✯		✯		✯		
Porterville	City and surrounding areas	45		✯		✯	✯			✯		
Riverside County	Eight cities throughout county	167			✯							
Sacramento	Southeastern indsutrial areas	7		✯			✯	✯	✯			Incubator; base conv.
San Bernadino/Kaiser	SW San Bernadino County	2							✯			Pub./Priv. Partnership
San Diego City	SE part of city along Mexico border		✯	✯					✯			
San Francisco	Entire city	47		✯				✯	✯			Procurmnt; base conv.
San Joaquin County	Entire county	1400		✯			✯	✯	✯			
San Jose	Entire city	172						✯	✯	✯	✯	
Santa Barbara Reg'l	Entire county	2406						✯	✯		✯	
Santa Clarita	Entire city	42				✯			✯		✯	Procurement; training
Shasta Metro	Three cities + county land	51		✯	✯		✯				✯	
Siskiyou County	Five cities along I-5	19		✯					✯			Incubator; training
Sonoma/Mendocino	Counties of Sonoma and Mendocino	5088				✯	✯	✯	✯			
S. Alameda County	Cities of Fremont and Union City	96								✯		Training
Stanislaus County	Entire county	1495							✯		✯	
Ventura County	Entire county	1847						✯	✯			Venture Capital Netwk.

Overlap with other economic zone programs:
- Fed — U.S. Enterprise Zone/Empowerment Community or Foreign Trade Zone
- State — California Enterprise Zones
- Local — Redevelopment Zone

Other incentives and benefits:
- CDBG — Community Development Block Grants
- IDBs — Industrial Development Bonds
- Loan — Locally-funded loan funds (incl. microenterprise)
- Serv — Business technical assistance and information services
- Tax — Tax benefits (other than those provided by local EZ or Redev. Zone)
- Util — Utility rate reductions

Sources: U.S. Bureau of the Census (1990), Integrated Waste Management Board (1996).

The above descriptions of local programs are based upon brief program descrptions provided by the IWMB. These descriptions are not necessarily complete.

Of these programs, the loan fund is the real core of the state's RMDZ effort. Under this program, businesses may borrow up to 50% of the cost of a project (up to a maximum of $1 million) for up to ten years, at an interest rate of 6% (recently lowered to 5.8%).[83] As of January, 1996, a total of 53 loan requests had been funded or were awaiting final approval (see Box 4.3, next page). In total, nearly $21 million in loans were provided to 51 companies, helping create an estimated 644 jobs and diverting over 1.5 million tons/year from the state's landfills.

The range of enterprises funded has been quite diverse. Those responsible for addressing the largest quantities of waste include recyclers of asphalt, concrete, and brick into new construction and paving materials; and remediators of contaminated soils. Others, such as Encore Ribbon (a remanufacturer of printer ribbons and cartridges) recycle extremely narrow fractions of the waste stream. Still others, including the Berkeley Ecology Center and the Arcata Community Recycling, are non-profit organizations primarily involved in collecting recyclable materials from the curbside and processing them for resale. Most of the loans were used for materials and equipment (79%) and working capital (60%). Relatively few projects used funds for land acquisition and site improvements (7.5%) or refinancing of debt (6%).[84]

The Board's criteria for approving the loans are less rigorous than those of commercial banks, but are still quite strict. Loan requests passed to the Board through the local recycling zones are first rated according to how well the materials they address fit with the priorities established in the Board's market development strategy (described in Box 4.1). After priority loans are identified, each undergoes a detailed credit review by a loan committee. This committee examines the cash flow, debt structure, and other aspects of the proposed project to assess the borrower's ability to repay the loan. In addition, the committee checks to ensure that prospective borrowers put up collateral equal to the full value of each loan. The value of this collateral is discounted to approximate its "quick sale value." As of May 1995, the average "liquidation collateral coverage ratio" for loans that had been approved was 1.66:1. Since the loan fund's inception, approximately 35% of the loan requests have been approved.[85]

The net effect of these loan criteria is to promote fewer, larger loans—nearly all for expansion of established businesses. Most start-up enterprises cannot meet the Board's cash flow or collateral requirements. Even if they can meet these standards, the cost of preparing a loan application and business plan (which can be $3,000-5,000) and the Board's application fee ($300 + 3%) make the cost of obtaining small loans prohibitive.[86] Some businesses have complained that the extra time and expense involved in obtaining these low-interest loans make them no more attractive that higher-interest loans from commercial banks.[87]

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[83] California Environmental Protection Agency (1996), p. 1.

[84] California Integrated Waste Management Board (January 1996), pp. 1-4.

[85] *ibid.*, p. B3.

[86] Interview with Lisa Barry, Integrated Waste Management Board, 4/17/96.

[87] Goldstein (1994), p. 46. However, please note that commercial banks often will not loan to recycling businesses, because of the perceived riskiness of the loans and the banks' lack of experience working with the recycling industry. As a result, the state loan fund is beneficial even if it is no more economically attractive.

Box 4.3: Loans Approved by California's Recycling Market Development Zone Loan Fund

Recycling Market Development Zone	Company Name	Loan Size ($1000)	1000 Tons Diverted	Jobs Created	Materials Used	Products
Chino Valley	Hi Life Products	1000.0	4.00	40	polyurethane	carpet cushions
Los Angeles City	California Fiberloft	1000.0	3.70	34	PET, paper, n.f. metal	non-woven textile prods., filters
Los Angeles City	Plastopan North America	1000.0	.72	30	HDPE	recycling and composting bins
Los Angeles City	Manfred Industries	1000.0	1.78	28	OCC, polyethylene	
Los Angeles City	Parco Recycling of Calif.	1000.0	15.00	25	tires	rubber for use in pavements
Los Angeles County	Los Angeles Fiber Co.	1000.0	37.50	25	textiles	recycled fiber
Los Angeles City	Acorn Paper Products Co.	1000.0	11.28	8	OCC	corrugated packaging & displays
San Jose	Markovits & Fox	1000.0	85.80	4	plast./rubber insul. wire	recovered plastics and metals
Long Beach	Talco Plastics	850.0	7.50	50	HDPE film	recycled plastic pellets
Long Beach	Eco Pave California	850.0	200.00	7	asphalt, concrete	asphalt, concrete
Oakland/Berkeley	Schnitzer Steel Industries	750.0	60.00	5	white goods	shredded steel
San Jose	Viking Container Co.	700.0	1.25	30	wood, OCC, plastics	corrugated packaging & displays
Long Beach	Talco Plastics	600.0	10.00	10	HDPE	recycled plastic pellets
Sonoma/Mendocino	Cold Creek Compost	565.0	16.50	2	organics	compost
San Diego City	Recycling Earth Products	500.0	65.00	40	drywall	recycled gypsum & paper
Los Angeles City	Ecoplast Corporation	500.0	n/a	22	plastics	recycled plastic pellets
Agua Mansa	Tigon Industries	500.0	17.10	18	tires and rubber	ground rubber for recycling
Los Angeles County	Apparel Mfg. Supply Co.	500.0	1.30	6	OCC, tissue paper	paper prods. for garment industry
Oakland/Berkeley	Ecology Center	480.0	19.00	5	multiple materials	collection & processing
Porterville	P'ville Sheltered Workshop	475.0	1.94	3	waxed OCC, sawdust	composite fuel logs
Contra Costa	REMCO	400.0	261.36	12	contaminated soil	remediated soil
Central Coast	Paul T. Beck Contractors	335.0	244.00	4	asphalt & concrete	construction materials
Long Beach	Jacobson Plastics	300.0	.98	15	plastics	injection-molded plastic products
San Jose	Golden Bear Packaging	300.0	1.00	10	OCC	corrugated packaging & displays
Los Angeles County	Aqua Terra Recycling	300.0	100.00	8	contaminated soil	remediated soil
Glenn County	North Valley Recon	300.0	25.00	3	asphalt & concrete	construction materials
Los Angeles County	Productivity California	266.0	5.80	5	HDPE, PP, PVC	plastic nursery containers
Riverside	LogWorld	250.0	18.00	20	organics, plastics, ONP	composite fuel logs
Southern Alameda	Commerical Filter Recycling	250.0	1.50	10	oil filters	recycled steel and paper
Oakland/Berkeley	American Soil Prods.	230.0	70.00	3	organics	soil products
Chino Valley	Exclusively Buff	225.0	.04	4	textiles	buffing and polishing wheels
Oakland/Berkeley	The Sutta Company	210.5	8.00	6	mixed paper	collection & processing
Ventura County	Marplast	200.0	.23	21	HDPE, PP	bottles and plastic packaging
Ventura County	Simi Valley Base	200.0	6.00	2	asphalt, concrete, brick	road base
San Diego City	Organic Recycling West	196.0	40.00	10	organics	compost and soil products
Long Beach	Ruiz Engineering Co.	175.0	120.00	3	asphalt, concrete	road base
Central Coast	Rossi Transport Service	162.0	1.45	1	organics	compost
Sacramento	Fiberwood Incorporated	150.0	20.00	21	mixed paper	cellulose insulation, mulch
Central Coast	Coast Recycling North	150.0	7.30	8	glass	recycled cullet for bottle mfgs
Oakland/Berkeley	The Sutta Company	150.0	.50	6	paper mill sludge	recovered pulp
Central Coast	Cranford	120.0	27.00	3	organics	compost
Oakland/Berkeley	Plastic Works	112.3	.12	7	PET, PP	point-of-purchase displays
Humboldt	Arcata Commun. Recycling	100.0	5.70	7	multiple materials	collection & processing
N. San Diego County	Oceanside Glasstile Co.	76.0	.35	11	glass	decorative tile
Central Coast	The Plactory	75.0	.10	13	HDPE & other plastics	recycled plastic products
Sonoma/Mendocino	Into the Woods	75.0	1.00	5	wood	paneling, wood flooring
San Jose	C&H Electronic Recovery	75.0	1.80	2	computers	computer parts for reuse
Oakland/Berkeley	McCoy Sanitary Supply Co.	60.0	.92	21	PP liners and bags	washed PP liners and bags
Los Angeles City	Plastic Form	60.0	.27	2	PS	PS packaging and displays
Sonoma/Mendocino	Encore Ribbon	50.0	.04	6	printer ribbons, carts.	remanufactured ribbons & carts.
Central Coast	California Grey Bears	48.0	.39	0	ONP	flower box insulators for nurseries
Sonoma/Mendocino	Recycled Lumberworks	40.0	.17	2	wood	wood products
Oakland/Berkeley	Badger Forest Products	29.6	1.20	2	mixed paper	paper rolls & sheets

In addition, enterprises targeting materials that would not otherwise end up in California landfills (because they are already being recycled inside or outside the state) are given low priority for receiving loans.

As a result of these effective barriers to small businesses and certain types of recyclers, relatively few RMDZs have been able to prepare applications of adequate quality and/or magnitude. Fifty-one percent of the loans approved to date have gone to just four zones: Los Angeles City (8), Oakland/Berkeley (8), Central Coast (6), and Long Beach (5). Twenty-one zones have not yet received a single loan. It is not clear why these zones have not succeeded in getting state loans: most of these zones (~81%) are located in primarily rural counties, but most (86%) are also relatively new, having been designated in the third or fourth years of the program. The Board is working with the under-funded zones to help them package better loan proposals, but it is not considering altering its lending criteria to better meet the needs of rural counties. It argues that these standards are necessary, in order to meet its obligation to state taxpayers to ensure that money is not lost, and to withstand the careful scrutiny it is getting in this time of shrinking public resources. In addition, it argues, the large loans "move the tonnage" necessary to meet the state's diversion goal.[88]

At present, the RMDZ loan fund is scheduled to sunset in mid-1997. In its report to the state Legislature on the loan fund, the Integrated Waste Management Board made the following recommendations:[89]

- ➢ Extending the existence of the fund and authorization to provide loans through 2006.
- ➢ Continuing the state's annual $5 million contribution through the year 2000.
- ➢ Establishing a $500K pilot program for recycling enterprises with the California Capital Access Program (CalCAP), an existing state program that encourages banks to loan to small businesses.

According to the Board's projections, implementation of these projections would enable to loan fund to issue a total of $214 million in loans and leverage $476 million in private investment from its total government contributions of $45 million. By 2006, the Board projects that nearly 8,000 jobs would be created and over 8.4 million tons per year diverted from the state's landfills.[90]

4.4. Local Approaches to RMDZs

Most RMDZs feature special services and/or incentives provided by one or more local agencies. As mentioned earlier, several RMDZs have been established within existing enterprise zones established by Federal, state, or local governments—thus encouraging recycling businesses to take advantage of the subsidized credit, tax breaks, and other benefits already in these areas. In addition, many RMDZs have added special services and incentives for recycling enterprises, including small business technical and information services (siting and environmental review assistance, market information,

[88] Interview with Lisa Barry, Integrated Waste Management Board, 4/17/96.

[89] IWMB (May 1995), p. 20.

[90] *ibid*., p. 19.

databases of recycling firms, assistance acquiring Small Business Administration loans, etc.); special utility rates; permitting assistance and fee reductions; tax breaks; local revolving loan funds; and many other benefits. A listing of the incentives offered by the RMDZs is provided in Box 4.2.[91]

In contrast to the state's primary objective of using the RMDZ program to divert waste from landfills, most local governments view their participation in the program as an extension of their existing economic development strategies. In most cases, the lead local agency responsible for administration of an RMDZ is an economic development agency, rather than a public works or recycling agency. As a result, RMDZs have tended to reflect the philosophies and/or approaches of local economic development efforts. Some examples include:

Business Attraction/Retention. Several zones, including the Agua Mansa, North San Diego County, and Kern County RMDZs, emphasize business attraction and retention as lead components of their market development strategies. Attraction efforts include attending trade shows, mass-mailing marketing materials to regional and national contacts, and early identification of recycling businesses elsewhere that may be looking to open new locations. Retention efforts include outreach to existing businesses to provide information on RMDZ benefits, and encouraging non-recycling businesses to convert to using recycled feedstocks, and mobilizing resources as necessary to help businesses stay or expand within the zone.[92]

Networking and rapid reaction are key to these strategies. To be successful, governments must attend carefully to the grapevines of the recycling industry and of their local economy, and be able to react quickly to mobilize the resources necessary to attract/retain a given business. This strategy also usually includes a strong focus on physical infrastructure, including the materials recovery facilities and transportation infrastructure needed to make the location attractive to recycling businesses.

In general, this strategy does not involve the establishment of special incentives for recycling businesses.[93] Similarly, it generally does not involve any hands-on or technical involvement with the local recycling industry on the part of governments. Rather, the strategy represents a targeting of traditional outreach efforts toward businesses in the recycling industry.

Entrepreneurship and small business development. Several rural, northern zones are focusing their efforts on endogenous, small-scale enterprises. Humboldt County cites its Overall Economic Development Plan, which prior to the establishment of the RMDZ already emphasized environmentally sound, high value-added, recycled feedstock manufacturers and "home-based and cottage industries." Humboldt argues that an emphasis on small-scale enterprises utilizing locally-

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[91] The reader should read Box 4.2 with caution because the information is not necessarily comparable across cities. To the extent feasible using very brief descriptions of each zone provided by the state, and other information made available by the individual zones, this table represents *additional* incentives available to recycling businesses (beyond other incentives that otherwise exist; exceptions include the CDBG, EZCA, and IDB columns). This was a somewhat subjective process; as far as the author can tell, no "quality controlled" list of these incentives exists.

[92] Dalton (1992), p. 118 ff.; Edelbrock (1993), Section IV; Kern County Resources Management Agency (1993).

[93] Within the North San Diego County zone is a targeted loan fund and several local recycled-content procurement policies, but these are not featured prominently in the zone's strategy.

available materials is necessary because a low overall level of waste generation, plus a remote location, make it difficult for the county to compete for purchasers in distant urban markets. Its strategy of providing needed credit to start-up enterprises (through four revolving loan funds) is aimed at diversifying and stabilizing local markets to avoid the need to compete in glutted, distant ones. The county's strategy also includes linkages to government procurement programs, and an effort to work with local paper mills to increase their use of wastepaper. The assertion that substituting secondary for virgin feedstocks "represents an important opportunity for the region" is quite a remarkable one for a timber region like Humboldt.[94]

The Mother Lode RMDZ in Calaveras and Tuolumne counties cites similar objectives: stimulating small-scale local demand in order to avoid competition in distant markets. Their plan argues that "the realities of economy-of-scale in manufacturing combined with the higher transportation costs to export products from a rural area dictate that... if you have a smaller quantity of recycled feedstock available, you need to produce higher value products."[95]

Not all zones pursuing this strategy are northern or rural. The City of Santa Clarita RMDZ (in northern Los Angeles County) believes that "small-scale locally-owned businesses, those that are relative in size and function to the amount of waste materials available in the region, would contribute the most to the successful development of the zone."[96] Santa Clarita, Ventura County, and other RMDZs have established business incubators to help nurture promising enterprises in their early states of existence.

While all of these zones also mention the importance of extra-zone marketing and infrastructure development, none makes these actions central elements of its strategy. Instead, the agencies involved take a much more details-oriented approach to understanding the nature of their local recycling industries.

Inter-firm linkages. Several zones emphasize the development of inter-firm relationships as an economic development strategy. All the of the zones described above as emphasizing small business development also cited the enhancement of inter-firm linkages as a key strategy. Each has conducted a detailed survey of existing businesses and inter-firm relationships in order to understand better the extent to which this is already happening and to what degree it might be expanded. In cooperation with the Community Environmental Council (and with the help of an EPA grant), the Ventura County RMDZ is conducting a detailed study of the obstacles to increased recycling in the county.

In addition, other zones not exclusively focusing on small businesses also use this strategy. The entire purpose of the tiny San Bernardino/Kaiser RMDZ is to attract businesses to a particular site to form relationships with an existing steel mill. Similarly, one of the goals of Ventura's RMDZ is to create a new business park for end-users of recycled materials surrounding a large materials recovery

[94] County of Humboldt (1992).

[95] Gainor & Associates (1994), p. 2-14.

[96] City of Santa Clarita (1995), p. 8.

facility in the county.[97]

As with the preceding strategy, this approach requires government agencies to work closely with local businesses in order to understand the technical issues they confront every day. In order to get businesses to link with each other, government must possess significant expertise, in order to provide new contacts and ideas that businesses would not have had otherwise.

Community economic development through non-profit enterprises have played important roles in several RMDZs. Some examples include:[98]

- The Tri-City Economic Development Corporation (Southern Alameda County RMDZ) hires non-mainstream workers (including senior citizens, the formerly homeless, unemployed immigrants, etc.) at a relatively high wage to collect and process recyclables. Tri-CED's profits, which totaled $100,000 over a recent five-year period, are distributed as grants to other community organizations in the area.

- The non-profit Arcata Community Recycling Center (Humboldt RMDZ) has had a "ripple effect" in the local economy, providing decent wages and benefits, and spurring the development of at least three new businesses, making handmade paper, wallboard, and decorative glass tiles.

- San Francisco has established a special loan fund for non-profit recycling enterprises.

Cross-border trade is a major focus of the San Diego City RMDZ. This zone is working with officials in Tijuana to establish a binational RMDZ, with help from the EPA and existing Foreign Trade Zone arrangements.[99]

Multiple Strategies. The Oakland/Berkeley RMDZ, one of the most active zones in the state, has been recognized with an Award for Excellence by the California Association for Local Economic Development. In its first three years of operations, it generated over $6 million in private investment, packaged over $2.6 million in loans and grants to businesses, and created an estimated 172 new jobs in businesses already employing 317 people.[100] It achieved these successes by pursuing a diverse strategy including promotion of business attraction and retention, small business formation, cooperation with non-profits, and other strategies. Key innovative elements include:

- *A conducive local policy environment*, including a special county-wide fund for loans (at 4.5% interest) and grants for recycling businesses, a generic revolving loan fund and small business incubator in Oakland, supportive procurement policies, and funding for a full-time zone coordinator. Also very important has been Berkeley's willingness to forego capital-intensive waste treatment facilities, instead addressing the waste stream in a "serial" manner, facilitating

[97] County of Ventura (1995).

[98] Ruben (1994).

[99] Dibble (1995), p. B1.

[100] Oakland/Berkeley RMDZ (1996), p. 1.

Box 4.4: Loans, Grants, and Other Assistance to Businesses in the Oakland/Berkeley RMDZ

Company Name	Date	Funding Agency	Funding Type	Amount ($1000)	10^3 Tons Diverted	Jobs Created	Materials Used	Products
Local Loans and Grants								
Pacific Paper Tube	Jan-93	ORLF	Loan	90.0		5	paper	paper tubes
Create-a-Saurus	Mar-94	ACRB	Grant	60.0	1.00	5	tires	playground equipment
The Garbage Collection	Mar-94	ACRB	Grant	44.2	.50	5	scrap fabric	clothing
Bay City Lumber	May-94	ACRB	Grant	37.0	1.10	3	old pallets	reconditioned pallets
Create-a-Saurus	Jan-95	ORLF	Loan	10.0			tires	playground equipment
C&K Salvage	Feb-95	OBDC	Loan	85.0		3	scrap wood	re-use
ABC Linen Company	Mar-95	ACRB	Grant	40.0	.16	2	(expansion of linen service)	
Create-a-Saurus	Mar-95	ACRB	Grant	85.0	5.00	10	tires	playground equipment
MBA Polymers	Mar-95	ACRB	Grant	75.0	1.59	5	(automated separation of plastic types)	
Used Rubber USA	Mar-95	ACRB	Grant	39.8	.01	3	tires	apparel & accessories
McCoy Sanitary Supply	May-95	OBDC	Loan	30.0	1.50	20	(polypropylene bag reconditioning)	
State Loans and Grants								
Ecology Center	Apr-93	IWMB	Loan	480.0	8.00	5	multiple materials	collection & processing
The Sutta Company	Apr-93	IWMB	Loan	210.5	8.00	6	mixed paper	collection & processing
Badger Forest Products	May-93	IWMB	Loan	29.6	5.00	2	mixed paper	paper rolls & sheets
McCoy Sanitary Supply	May-93	IWMB	Loan	60.0	.15	21	PP liners and bags	washed PP liners & bags
Schnitzer Steel Industries	May-93	IWMB	Loan	750.0	60.00	5	white goods	shredded steel
Plastic Works	Mar-94	IWMB	Loan	112.3	.03	6	PET, PP	sales displays
The Sutta Company	May-94	IWMB	Loan	150.0	.50	2	paper mill sludge	recovered pulp
American Soil Prods.	Nov-94	IWMB	Loan	230.0	20.00	3	organics	soil products
Create-a-Saurus	May-95	IWMB	Grant	61.6			tires	playground equipment
Other Local Assistance (permitting, siting, etc.)								
Environ. Filter Removal		RMDZ				6	(oil filter collection and processing)	
Appliance Recycling Co.		RMDZ				55	white goods	processed for recycling

Source: Oakland/Berkeley Recycling Market Development Zone, 1996, p.8.

participation by a wide range of recycling businesses.[101]

➢ *Initial emphasis on retaining and expanding local businesses, then moving toward attraction of complementary businesses from the outside*. One example: In 1993, the RMDZ helped Schnitzer Steel obtain a $750,000 loan from the state loan fund for an investment in equipment that would increase their capacity. The following year, the zone worked with PG&E—which was interested in promoting the replacement of old, inefficient refrigerators—to lure an expansion plant from the Minneapolis-based Appliance Recycling Corporation of America. ARCA hadn't been considering an expansion into California, but the linkages with Schnitzer and PG&E, along with the rapid permitting and siting assistance from the RMDZ, led it to open a plant in Oakland.[102]

➢ *Convergence with other economic development objectives and an existing economic base*. Another element in the RMDZ's success has been its overlap with Berkeley's existing economic development strategy: the expansion of its existing base of over 120 firms involved in recycling and other environmental technologies. This "Green Valley" strategy has received national attention, winning praise from the Clinton Administration.[103]

➢ *Cooperation with a local environmental organization*, the Materials for the Future Foundation,

[101] Urban Ore and the Center for Neighborhood Technology (1994).

[102] Riggle (1995), pp. 31-33.

[103] Wells (1994), p. A23.

has benefited the zone in several ways. In addition to providing grants and technical assistance to community-based recycling enterprises around the Bay Area, MFF has worked with other local organizations to produce two studies which are helping to shape recycling policy in the region: a "Materials Reprocessing Assessment for Local Economic Development" in the Bay Area, and a study on financing needs in the recycling industry.[104]

4.5. Evaluation of the RMDZ program

ANALYSIS OF REPORTS. In May 1995, the IWMB sent a report to the Legislature evaluating the RMDZ program. The major conclusions of this report (summarized in Box 4.5) are that the loan fund has contributed significantly to the achievement of the state's waste diversion goal; that they have leveraged new private investment in the state without exposing state taxpayers to unacceptable levels of risk; and that the program has stimulated job creation with less than half the government expenditure per job than is typical for Industrial Development Bonds.

Based on more recent data from the IWMB on loans through the end of January, 1996, this earlier analysis can be revised and expanded (see Box 4.6). Overall, the program helped generate employment at a rate of about $32,000 per job—higher than before, but still significantly lower than the $50,000 average for industrial development bonds. The program was also able to divert waste from landfills for under $14/ton in loans, much lower than the $40-50/ton it costs in California to dump the materials in a landfill.

Box 4.5: Key Conclusions of IWMB's Loan Program Evaluation

The Diversion Impacts of the Program are Significant
California's 50% waste diversion goal require an additional 11 million tons of material to be recycled or composted annually. On its own, the program has directly increased market demand 14% of the way to this goal.

The Loans Leverage Private Investment
Each $1 of public funds leveraged $1.22 of private investment. Sources of the private share included borrowers' equity (74%), private loans (15%), and other sources (11%).

The Loans Create/Sustain Jobs
The first 26 loans created or retained an estimated 369 jobs, at $21,987 per job. Industrial Development Bond programs typically create only one job per $50,000 of government investment.

Source: Analysis of the first 26 loans approved by the RMDZ loan program in IWMB (May 1995), pp. 4-7.

In its evaluation, the Board did not consider the effect of loan size on the efficiency with which the loans meet the program's objectives. Dividing the loans into three groups based upon the amount borrowed indicates that there has indeed been a relationship between size and effective-ness for the loans that have been made so far. Medium-sized loans ($150,001-499,999) have tended to meet the state's objective of diverting waste from landfills far more cost-effectively than loans of other sizes;

[104] Barakat & Chamberlin (1995); Wirka (1993).

whereas small-sized loans ($0-150,000) have tended to meet the local governments' objective of creating jobs far more cost-effectively than loans of other sizes.

Of course, this only indicates an anecdotal relationship between loan size and effectiveness based upon past experience. However, it does suggest that a closer exploration of the causes of this relationship are warranted. If systematic reasons can be found for why the largest of IWMB's loans do not deliver the employment or diversions benefits associated with small- or medium-sized loans, then the state should consider shifting its emphasis away from the large loans that it believes "move tonnage" most effectively.

It is perhaps notable that the observations made for the Integrated Waste Management Board's revolving loan fund are corroborated in part by a similar analysis of local public financing provided in the Oakland/Berkeley RMDZ. The mean size of the 11 loans and grants provided by the Alameda County Recycling Board, the Oakland Revolving Loan Fund, and the Oakland Business Development Center, was $54,000—making them smaller on average than the small loan category described above. Among these loans, the cost of diverting materials averaged $55/ton, while one job was generated for each $9,771 of public funds invested. Both of these findings continue the trend already seen between the medium- and small-sized loan categories in the above analysis.

ANALYSIS OF WRITTEN INTERVIEWS. Questionnaires were sent to the 44 local RMDZ administrators (in several zones, administration is carried out jointly by two agencies), soliciting their views on the strengths and weaknesses of the RMDZ program. Of these administrators, 39% are located in economic development or redevelopment agencies, 27% are in public works or solid waste management agencies, 7% are in city managers' offices, 7% are in private entities (consulting company, chamber of commerce, or large manufacturer in the zone), and 20% are in unidentified city or county offices. Unfortunately, the response rate to the questionnaire was low (30% of the zones

Box 4.6: Revised Indicators for Evaluating California's RMDZ Loan Fund

Loan Size	n	$1000 (total)	1000 tons	Jobs Created	$/ton	$/job	jobs /loan	$/loan
≥ $500,000	17	$14,315	538	384	$26.6	$37,300	22.6	$842,000
$150,001 - $499,999	19	$5,255	924	145	$5.7	$36,200	7.6	$276,600
≤ $150,000	16	$1,371	67	116	$20.5	$11,800	7.3	$85,700
All Loans	52	$20,940	1530	645	$13.7	$32,500	12.4	$402,700

Analysis based upon: Integrated Waste Management Board (1996), pp.1-4. One $500k loan, for which incomplete data is available, has been excluded.

responded, 23% completed questionnaires).[105] Therefore, the results should be interpreted with some caution.

[105] Three zone administrators wrote or called to say that they could not answer the questionnaire because their zones were so new; presumably, some of the others did not respond for the same reason.

The zone administrators indicated that their RMDZs are most closely connected with local economic development agencies. On a scale of 1 to 5, with higher values representing a higher degree of integration between the RMDZ and a given agencies policies and programs, local economic development agencies were given a rating of 4.8. Solid waste management authorities averaged 4.6; local enterprise/empowerment zones (where they exist) averaged 3.7; local job training agencies were given 3.0; and government procurement offices and private/quasi-private financial institutions were rated 2.2.

Administrators were also asked their perspectives on a variety of questions. Following is a summary of the questions and some typical responses:

What has been the primary impact of the RMDZ? Responses split approximately evenly among business formation, attraction, expansion, and switching of feedstocks. One interesting response was that the RMDZ had "helped the Waste Management Department develop a pro-business image."

What has been the primary constraint on the ability of your RMDZ to create jobs and/or increase demand for recyclables? The most common responses included inadequate staffing and administrative funds ("I have too many hats and can't devote as much time as needed"); inadequate local incentives; and the inability of small start-ups to borrow from state loan program. Others cited a low private sector interest, low virgin materials prices, difficulty in ensuring consistent feedstock supplies, and long lead times for projects to get off the ground.

Would increased cooperation from other local agencies enable your RMDZ to make a greater local impact? How? This question did not receive a strong response from the zone administrators; several seemed to feel that cooperation from other local agencies was not a limiting factor in their effectiveness. Those who did feel it could help called for a greater degree of permit streamlining, increased awareness and referrals from other agencies, and more funding for the RMDZ.

What changes would you propose in the State's RMDZ program and loan fund? The administrators called for more state incentives (such as tax relief in RMDZs), relaxing collateral requirements of the loan fund, speedier application processing, more aggressive national marketing, extension of the loan fund beyond 1997, "more hands-on help," and allowing "recyclers of all products to utilize grants, not just those who recycle materials that would otherwise go to a landfill."

What changes would you propose in the tools and mandate that your RMDZ has been given by local authorities? Respondents called for increased administrative resources, greater awareness among local agencies, and better permit streamlining capacity. None proposed substantive new tools that they might be given by local authorities. One suggested that no changes were needed, stating that the local governments "have made significant commitments to this program and continue to be supportive."

What strategies to link recycling with local economic development do you believe work and should be utilized more widely? Interestingly, half of the respondents came up with the same answer: locating the RMDZ effort within the local economic development agency. This is particularly interesting because it is an institutional issue, not a policy approach. Other responses included:

technical assistance to businesses, reviving the state's expired tax credit for purchases of recycling equipment, and "networking with community groups focusing on job creation."

What strategies have you found do not work? Only a few administrators answered this question. Responses included: newspaper and TV advertising to promote awareness of the zone, and large workshops for industry.

4.6. Comparison with lessons from theory

Section 3.3 concluded with an outline of suggested strategies for linking recycling and economic development, based upon key lessons from environmental economics, industrial districts, and industrial ecology. The present chapter has found that the California RMDZ program is not easily characterized because it is diverse, and hard information on the real-world implementation and results of the program are sparse. However, it appears that the major changes needed in the RMDZ program to make it more effective are broadly consistent with what would be suggested by conceptual framework presented earlier.

Setting appropriate policy and economic climates. The State of California has adopted a broad suite of policies designed to promote recycling, but these only partially offset the subsidies and tolerance of externalities enjoyed by the primary materials industries. Additional policies addressing the competitiveness of recycling in the marketplace will be necessary if a level playing field is to be achieved.

The Board should consider softening its "waste diversion" imperatives where these block loans that make environmental and economic sense. It is important to recognize the difference between projects that are environmentally desirable, and projects that are merely consistent with a state policy aimed at reducing landfill dependence. Projects such as bottle washing and reuse (which is environmentally superior to bottle recycling), or scrap metals recycling (which reduces the environmental costs of transporting scrap metals overseas and promotes the economic objective of enhancing the state's recycling infrastructure) do not currently meet the state's waste diversion criteria but should.

Another aspect of establishing an appropriate policy climate is ensuring that programs are not allowed to grow too diffuse. The RMDZ program is spread over 40 zones covering 39% of the state's land area. On one hand, the program has an interest in ensuring that resources are not squandered in ineffective zones; however, the program also has an important interest in maintaining a broad base of support for its continued existence. It is already clear that some RMDZs lack the necessary resources to make much progress toward that state's objectives; if this problem worsens over time, the IWMB should have a strategy for encouraging nearby zones to merge. For example, it may not make sense for rural counties like San Bernardino to have four zones, especially if it finds that each cannot muster the resources it needs for an activist administration. Currently, a number of factors, including the arbitrary requirement that zones must be contiguous, would prevent these zones from being merged.

Promoting entrepreneurship and cooperation. Many cities have already been on the entrepreneurship bandwagon for some time, establishing small business incubators, targeted tax breaks, low-interest loans, and other assistance for new or expanding businesses. While some individual RMDZs are emphasizing enterprise formation, the state government has provided only mixed support. Its revolving loan fund has been criticized for refusing help to start-ups, and for being so inefficient that even its subsidized rates are unattractive. If the Board wants local governments to prioritize the establishment of new recycling businesses in their economic development strategies, then it should provide leadership by educating local officials and assisting them to establish locally-administered revolving loan funds.

Emphasis should be placed on building cooperative institutions, both within the private sector, and between the public and private sectors. The Integrated Waste Management Board cited a range of institutional problems as hurdles that had to be overcome on the road to RMDZ designation, most notably the absence of channels between local economic development and solid waste management authorities. While the zone administrators interviewed indicated relatively good communications between their offices and economic development and waste management agencies, they suggested that their coordination with these two agencies remained weak. Channels between the zones and local procurement, job training, enterprise zone, and financial institutions were also poor.

This situation should be viewed as a positive challenge rather than an annoying obstacle. The establishment of a political and organizational culture in which local agencies cooperate to integrate into their operations the goal of fostering a local recycling industry is bound to be a difficult task. However, it represents one of the most important legacies the RMDZ program could leave behind. In cooperation with the state Department of Commerce, the Board should seek to assist zone administrators having difficulty winning the cooperation of local officials. Relatively small amounts of money aimed at training or other forms of capacity building could be particularly helpful in this regard.

The IWMB's proposed pilot project with CalCAP is worth exploring. Although CalCAP is described as a "small business" loan program, it is not clear whether it would actually stimulate microlending by private banks. The Board notes that CalCAP defines a small business as any employing fewer than 500 people (quite large compared with many of the recycling businesses seeking state loans).

Promoting diversity and decentralization. Only a few local governments have adopted the objective of building a decentralized, diversified recycling industry. Instead, many state and local policies have tended to be anti-competitive, favoring large transnational corporations over local or non-profit groups for provision of waste management services; granting exclusive, long-term contracts to purchasers of secondary materials; and favoring larger-sized loans over smaller ones. Where local governments have adopted the goal of decentralization, such as in Alameda and Humboldt counties, recycling and economic development have been connected more successfully.

Analysis of the loans approved by the Board to date indicates that very large loans have been efficient neither at diverting waste from landfills, nor at creating jobs. While medium-sized loans have been most efficient at waste diversion, the very smallest loans have had the best performance in

generating employment. Additionally, small loans best meet the needs of the state's rural regions.

These findings suggest that the state may be doing its taxpayers a disservice by insisting on collateral criteria so rigorous that they exclude small recycling start-ups. While it may not be wise or appropriate to run a centralized micro-loan program out of Sacramento, the state should search more actively for ways to decentralize the availability of capital and make a greater share available to smaller businesses. As mentioned earlier, one alternative would be for the state to provide matching funds to capitalize locally-based revolving loan funds. A greater degree of innovation would be assured if governments assisted small business formation while also promoting a competitive climate among these firms.

Re-linking waste management with planning. As noted earlier, the zones are employing a wide range of different approaches to building local recycling markets, and tend to reflect the economic development strategies already in place in their regions. However, this does not necessarily indicate that any strategic planning for the local materials stream is occurring. Most RMDZs act quite passively; they establish some incentives, mail out brochures, and wait for businesses to come to them. Others actively recruit recycling businesses as they would any potential new employer. Only a few of the more successful zones genuinely developed a strategic plan through analysis of their particular waste stream characteristics and economic conditions.

Several zone administrators expressed the view that RMDZs were better run from within economic development agencies, rather than waste management authorities. There are two explanations for this sentiment. First, economic development agencies are better equipped to think strategically about what businesses need. Second, in the interest of promoting an atmosphere of trust between government and the private sector, it is advisable not to put a regulatory agency in charge of working with data on the wastes that businesses generate.

Policy-makers should seek to cultivate a common sense of purpose and a shared set of objectives between the public and private sectors. The state may be doing itself a disservice by defining the objectives of the RMDZ program so narrowly that they are unlikely to be shared by local governments or the private sector. All of the zone administrators interviewed seemed to agree that economic development is the overarching goal for most local governments. Given that local government participation is a key ingredient of success for RMDZs, it is in the IWMB's interest to sharpen the program's ability to boost local economies. In order to build support and interest from local government and the private sector, economic development should be made an explicit objective of the program (alongside diversion of wastes from landfills); economic impacts should be considered as an additional (or alternative) criterion in the loan approval process.

Policy-makers should work with industry to create new channels for the generation and flow of technical information. Development of reliable and new types information will be essential for a strategic synthesis of recycling and local economic development planning. Today, the capacity to provide this information does not yet exist. The IWMB appears to recognize its importance, and is working to provide zone administrators with quarterly updates on market conditions, but greater sophistication is needed.

Creating channels for the flow of technical information is particularly tricky. Regional, statewide, and national networks of recyclers already exist; but the key challenge facing recyclers is not communication with one another, it is communication with the rest of the private sector. Local RMDZs can help this effort by getting recycling issues onto the agendas of local economic roundtables, and by reaching out to conventional industries to make them aware of potentially profitable opportunities for partnering with local recycling firms.

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California's Recycling Market Development Zone program is an early attempt to link environmental and economic objectives. As the State Legislature debates the continuation of the program and its revolving loan fund, it should look upon the program not as a single experiment, but as forty separate ones, since each RMDZ has adopted a unique approach. It should also listen carefully to the perspectives of those who have been implementing the program in the field, who have called for even stronger tools for linking recycling and economic development strategies together.

Chapter 5
Analysis for Strategic Materials Stream Planning

5.1. Introduction

If it is to help move the economy in the direction of sustainability, contemporary recycling policy has a long way to grow. The development of stronger and more aggressive public/private partnerships to boost the recycling economy will ultimately depend on the development of new analysis and planning tools. This will require a better understanding of the current and potential roles of recycling in the regional economy.

Although the potential local economic benefits of recycling have been recognized for many years, few systematic efforts to study it have been attempted. For the most part, these studies have attempted to quantify existing employment in a given region's recycling businesses, or to generalize about the job-creation potential of higher-intensity levels of recycling.

A number of important questions remain unaddressed. At the national level, the "recycling industry" remains poorly understood. No systematic analysis has been conducted of the emerging economic patterns associated with the growth of recycling, including numbers and types of jobs created and displaced by the rise of recycling; differential regional impacts; and implications for environmental quality and human health. The difficulty of conducting such a study is compounded by the lack of national economic statistics that explicitly address recycling-related activities.

At the local and regional levels, the development of more strategic approaches linking recycling and economic growth is hindered by a lack of tools and basic data for understanding the relationship between recycling and the local economy. Local and regional governments simply have no idea how wastes and raw materials are utilized within their economies, let alone the degree to which these materials are transported to and from their regions. In addition, economic implications of exporting materials abroad, rather than recycling them locally, remain unexamined.

After reviewing what has been attempted previously, this chapter will explore possible future research directions.

5.2. Data sources: Toward an epistemology of scrap

The development of any new analytical tools will depend on the types and quality of data that are available. This section will discuss the usefulness of various existing publicly-available data sources for determining "what is knowable" about a local scrap-based economy.

County Business Patterns (U.S. Dept. of Commerce) provides information on employment, payroll, and number of establishments in each industrial sector by 4-digit Standard Industrial Classification (SIC) Code. Data are released annually on the national, state, and county levels (they're a bit more difficult to find, but data also exist down to the zip code level). While this data source facilitates the examination of very localized geographic areas, it does not provide useful economic information such as value added, total value of sales, or quantity of goods produced. Its usefulness is further narrowed by the limitations of the SIC system, discussed below.

The *Census of Manufactures* (DOC) is published every five years, and includes data at the national, state, and metropolitan levels on employment, wages, value of shipments, value added, capital expenditures, materials costs, assets, and inventories in each 4-digit SIC code relating to manufacturing (7 digits for the national level). Also at the national level, the census provides detailed information on the value and quantity of feedstocks for each 4-digit industry.

To provide more continuous but less detailed data in non-census years, the DOC conducts an *Annual Survey of Manufacturers*. Much of the data provided by the Census and the Annual Survey are repackaged into a more useful form and resold by a variety of private firms. One example is *Manufacturing USA*, which covers nearly 500 industries.

Census of Transportation—Commodity Flow Survey (DOC/Bureau of Transportation Statistics) is based on a sample of 200,000 establishments, representing approximately 12 million shipments. Published data will eventually include ZIP code of origin and destination, 5-digit Standard Transportation Commodity Classification (STCC) code, weight, value, and modes of transport. The CFS was conducted from 1963 until 1977, and revived again in 1993 (the results of which have not yet been fully published).

Municipal Waste Stream Analyses are conducted by many state, county, and city governments. In addition to the standard information on the composition of municipal solid waste, some governments also gather limited data on the generation of auto and appliance scrap and construction and demolition debris. Less common are data on materials collected by private firms from commercial or industrial sources.

Curbside Recycling Program or *Materials Recovery Facility Records* maintained by some county or municipal governments, may contain useful data on the quantity and fate of materials actually diverted from the waste stream for recycling.

Import/Export Records from ports, international border crossings, and the U.S. Department of Commerce are broken down by detailed commodity, tonnage, and shipment value. The commodity definitions are specific enough that differences between primary and secondary materials can be distinguished.

Although excellent industry-wide data is available at a national level, information rapidly grows scarce as one focuses on narrower industries or geographic areas. No existing public data sources directly track materials flows or consumption at the state or regional levels.

It is likely that private sources of data may be of superior quality. Sectoral trade organizations, particularly for industries in which recycling has become an important public policy issue (e.g. the Society of the Plastics Industry or the American Paper Institute), are likely to have databases which track secondary materials and regional material flows among their members. Similarly, consultancies advising corporations on strategic business decisions are likely to have built computer models of their industries of specialty. Unfortunately, if they are not completely off-limits for public consumption, access to these information resources may be prohibitively expensive for public agencies.

5.3. Research on Local and Regional Recycling Economies

Three general approaches to examining the local economic implications of recycling have emerged: stepping down from federal economic data; stepping up from local case studies; and surveying recycling-related businesses.

5.3.1. Federal Economic Data

Federal economic data sources, including County Business Patterns and the pentennial economic census, provide a wealth of information on detailed economic sectors and geographic locations. Because of their routine use by local and regional governments for economic forecasting and impact analysis, they seem an obvious resource for analyzing the economics of recycling. However, the usefulness of these Federal data did not live up to its promise, and as a result, efforts to derive useful results from these data have not progressed very far.

5.3.1.1. County Business Patterns and the Economic Census

The Center for Neighborhood Technology, based in Chicago, made one of the first systematic attempts to quantify the secondary materials economy.[106] Their study used 1987 economic census data for Chicago's four-county metropolitan region to estimate scrap generation rates and the contribution of recycling to the region's economy.

The study's first step was to choose four materials for analysis (metals, tires, construction materials, and plastics) and to note how the use of these materials may be tracked in Federal economic data based on the Standard Industrial Classification (SIC) system. The study then attempted to estimate the scrap generated at each phase of a given material's use (see Box 5.1).

Unfortunately, CNT had to leave its analysis unfinished, as it discovered that the structure of the SIC system was not conducive to analysis of this kind. While certain characteristics of manufacturers in each SIC code were available at the county level (payroll, value added, etc.), other characteristics had to be based upon national averages (types of materials purchased per unit of output, etc.). Lower bounds on the amount of scrap generated within the region could be estimated from the Federal data, but no conclusions could be drawn about the actual utilization of scrap within the region.

[106] Sandlin (1993).

Box 5.1: Center for Neighborhood Technology's approach to scrap generation analysis for metals

	Primary Production	Fabrication of Products	Discard	Reuse
SIC Sectors	33 Primary Metals	34 Fabr. Metal Products 35 Machinery 37 Transport. Equipment	5093 Wholesale scrap trade 5015 Used auto parts	331 Steel mills, etc. 334 Secondary non-ferrous 336 Nonferrous foundries
Scrap	"Home scrap" not generally counted in recycling	"Trim scrap" = 5% * Cost of materials / Unit price of materials	"Post-use scrap" not calculated	Demand for scrap est. from cost of materials, unit prices, and nat'l scrap util. rates for each sector.

Source: Sandlin (1993), pp. 23, 27-29.

The CNT methodology on its own doesn't tell much beyond an estimate of scrap generation rates in a given region. However, it could be expanded into a more detailed and dynamic model, by including all 4-digit SIC industries (instead of just those easily identified as related to recycling), and by incorporating regional economic forecasts. Such a model could potentially tell policy makers how the types or quantities of wastes might change over time.

The primary problem with this approach, as CNT discovered, is the Standard Industrial Classification system itself. SIC is a 7-digit code used by many Federal economic data sources that categorizes business establishments by the types of activities in which they are engaged. For the vast majority of purposes, data are reported at the 1-digit (economic sector), 2-digit (major group) or 4-digit (industry group) level; only occasionally is information made available at the full 7-digit level.

Unfortunately, the SIC system was not designed with analysis of secondary materials industries in mind. In most cases, even at the 4-digit level, the SIC groupings lump together distinct types of industrial enterprises, preventing analysis of very specific economic niches. Only in a few cases do the codes distinguish between primary and secondary materials production (e.g ferrous or non-ferrous metals). Only in one case (tire retreading) does it distinguish manufacturers using secondary materials from those which rely on virgin resources.

Furthermore, the system classifies establishments and not the materials with which they work. This makes it virtually impossible to use SIC data to trace the use of a given material within a county's economy, or to look at the flows of products from one region to another.

Finally, and perhaps most frustrating to those analyzing these data, large portions of the data are suppressed when one attempts to examine detailed industries or geographic locations. To protect the confidentiality of individual companies, any data involving fewer than three firms is not revealed.

A number of other characteristics of the SIC system limits its usefulness for looking at the role of secondary materials industries in the economy. The current SIC system is outmoded in many ways, despite revision as recently as 1987. Some problems with the existing system that relate to recycling include:

- *Classifying establishments only according to their predominant activity*, disregarding information on secondary activities in which they may be involved. Since many manufacturers that use secondary feedstocks are not primarily in the recycling business, they are unlikely to be categorized as such.

- *Presuming fixed and stable locations* (storefronts, factories, etc.) in the definition of an "establishment." The changing nature of business and the availability of communications technologies have led to increasing number of enterprises not housed in a fixed facility. Also, since much of the pre-market collection and transport of recyclables occurs outside the bounds of formal establishments, these elements of the recycling economy are unlikely to be captured by economic statistics.

- *Dealing inadequately with auxiliary operations* to larger corporations (e.g. an establishment that transports or stores recyclables for a larger manufacturing enterprise)

- *Continuing ambiguities in the SIC's hierarchical structure.* For example, It is unclear whether recyclers are providing goods or services.

5.3.1.2. INPUT-OUTPUT ANALYSIS

In 1994, the U.S. Bureau of Mines and the Great Lakes Council of Governors initiated an ambitious attempt to study materials flows in the 8-state Great Lakes region using input-output analysis.[107] By closely examining the relationships among the region's industries, the investigators hoped to develop strategies for government procurement of recycled products that would maximize the economic benefit to the region.

In the first stage of this study, the authors began to use the economic input-output model IMPLAN, to investigate resource flows (raw materials, labor, energy, etc.) within 23 sub-sectors of the paper industry for the 8-state Great Lakes region. The authors also used geographic information system (GIS) software to study the spatial distribution of recycling-related infrastructure in the region.

Unfortunately, this analysis was never carried far enough to allow policy implications to be drawn. The U.S. Bureau of Mines was closed by Congress in 1995, and the principal investigators of this project were reassigned to other agencies. The Great Lakes Council of Governors is currently evaluating its own capacity to proceed with the project.

While the input-output methodology used by in the Bureau of Mines study is a snapshot fixed in time, its detail could potentially make it the basis of a more useful planning tool. In principle, the type and richness of data in a regional input-output table could provide exactly the type of information on industrial interrelationships needed to identify new opportunities for inter-firm recycling linkages.

[107] Rogich and Lemons (1994).

However, the use of the IMPLAN model may be a serious flaw in this approach. Despite its widespread use in economic development circles, the data used by IMPLAN should be considered highly suspect when dealing with specialized sectors or small economic regions. Some of the reasons for this are:

- IMPLAN's detailed input-output tables are generated from the same Federal economic census data which CNT found to contain such a high percentage of suppressed data at the county level. IMPLAN fills in the gaps by multiplying the number of establishments in a given sector by national averages for employment and output of those establishments. While this approximation is born of necessity, it is important to note that any and all information unique to a region's economy is lost.

- On top of this first approximation, algorithms based on national averages are used to estimate the degree to which firms interact locally, since no data is provided on this in the census. Thus, while IMPLAN's "local interactions table" may (e.g.) show that a county's publishers purchase paper from mills located in the same county, these data are not based on any actual evidence that this is true.

- Finally, the greatest flaw of IMPLAN is that both of the preceding sets of assumptions are essentially hidden from view. Unless the user is an expert, s/he never knows where assumptions were introduced, how they were made, or the degree of uncertainty introduced. Furthermore, opportunities to supplement the model with data from other sources are lost.

While the use of input/output models may be productive in principle, the use of "black box" modeling techniques is not. An alternative approach would be to build such a model from the bottom-up. A description of this approach appears later in this chapter.

5.3.2. Business Surveys

Numerous studies around the country have examined the connection between recycling and economic development via direct surveys of recycling businesses. The studies described below are representative of the different methodologies used.

5.3.2.1. EXTRAPOLATION FROM CASE STUDIES

The Institute for Local Self-Reliance (ILSR), based in Washington D.C., has tried several approaches to the estimation of the scale of a local recycling industry. Their first attempt was not a study of any particular region, but rather an exercise in estimating the *potential* job creation from recycling, based on real-world examples of "state of the art" enterprises.[108] The report uses EPA and other studies, plus estimates of the recoverable portion of the municipal waste stream, to estimate the secondary resources available from a hypothetical city of one million. The economic characteristics of several "state of the art" recyclers (scrap utilization, job creation, value added, etc.) are then used to

[108] Lewis (1994).

determine the job-creating potential from the hypothetical city's waste stream (which it determines to be 1,980 jobs). If we accept that we can apply this methodology to get a rough estimate of the job-creating potential from the waste stream in any city, then approximately 12,000 jobs could be created in the Bay Area (which has a population of roughly 6 million).

This approach clearly has several shortcomings. Among its questionable assumptions are that its model recycling ventures are replicable anywhere in the country, that markets have an insatiable appetite for the goods that the recyclers produce, and that industrial and post-consumer scrap are interchangeable. Nonetheless, this paper is still valuable in that it provides a vivid illustration that intensive recycling is not only feasible, but that it is already being implemented successfully by creative entrepreneurs around the country.

A recent study examining the San Francisco Bay Area is worth mentioning, because it used the same methodology, but far more conservative assumptions.[109] Like the ILSR analysis, this study also began by estimating the quantities of each type of waste produced. It then chose six recycling technologies for specific high-throughput commodities, and extrapolated from case studies to the entire Bay Area to estimate the job creation potential from local recycling of those commodities. Because of its selection of very narrow classes of materials and capital-intensive technologies, this survey predicts job benefits much lower than those predicted by the ILSR (355 vs. 12,000 workers), as was the waste diversion potential (216,000 vs. 3,828,000 tons). This translates into 608 tons/worker, versus 319 tons/worker for ILSR's smaller-scale enterprises.

Despite its narrow scope and methodological problems like those suffered by ILSR's similar study, the Bay Area study extends its analysis in several important directions. To begin with, it was produced as a cooperative effort among a consulting company, the University, the Association of Bay Area Governments, and the Materials for the Future Foundation—thereby partly embodying the goal of cooperation among diverse actors to define common interests and ideas. Secondly, the specific technologies investigated in the survey were chosen using a set of performance criteria that were specific to the San Francisco Bay Area (such as their land requirements and their impacts on water quality). Finally, the economic implications of the proposed plants were explored beyond a simple assessment of jobs created; also explored were electricity and energy requirements, potential for vertical integration with other industries, secondary economic effects, taxable profits, etc. As such, it represents an important early attempt to link materials flow analysis with the types of analysis required for strategic economic development planning.

The Northeast Recycling Council (NERC) took a different approach, focusing on value added from reprocessing and remanufacturing of secondary materials in 10 northeastern states.[110] To arrive at their estimates, they surveyed Massachusetts reprocessors and manufacturers about their inputs and production. Based on average results for tons/employee/year, and known employment at each of these companies (from state Department of Labor records, which are not a publicly available data source), the survey data was extrapolated to estimate total production. National or regional average

[109] Barakat & Chamberlin, Inc. (1995).

[110] Weston (1994).

commodity prices were then used to estimate the value added for each material. Key findings included 103,400 people employed in recycling-related businesses in the Northeast (25% in processing, 75% in manufacturing), and $7.2 billion value added by recycling in the region.

The approach used by NERC, measuring value added from changes in market prices, is sound in principle. However, their extrapolation of the results of a limited survey to the larger regional economy, and their reliance on data that is not publicly available, limit the usefulness of their methodology. This approach could be improved if more extensive and more accessible information sources could be identified.

5.3.2.2. COMPREHENSIVE SURVEYS

A second study by the Institute for Local Self-Reliance provides a detailed picture of existing practice and economic development potential from recycling activities in three cities in eastern Maryland and northeastern Virginia.[111] The current extent of recycling in the region was based on a comprehensive survey of known recyclers in the area. No extrapolations from this data appear to have been used. The surveys enabled ILSR to look at employment, recycling rates, use of materials originating locally, revenue per ton, and other data. These were compared with data from waste disposal industries. The study found that the region includes 5,100 jobs in recycling-related enterprises, vs. 1,100 jobs in waste disposal businesses (even though these industries "process" four times the material). ILSR also developed two scenarios of future employment, one recycling-intensive (based on case studies of successful local recycling programs), and one incineration-intensive (based on existing municipal plans to expand incineration capacity).

This second ILSR approach provides the most accurate and useful representation of a region's recycling economy. The drawback of this approach is that it is extremely difficult, both to identify all of the businesses that need to be surveyed, and to win their trust so that they will provide proprietary information about their activities. ILSR seems to have done a remarkable job in both respects; unfortunately, their report doesn't shed much light on how this was accomplished.

Another study employing a comprehensive survey approach was conducted in North Carolina.[112] Among their mail responses, telephone interviews, and data from the state's Employment Security Commission, the surveyors were able to assemble at least partial responses from 79% of the 474 recycling firms they targeted. The questions asked in the survey were quite detailed, covering company histories, sources of financing used, growth obstacles and opportunities, capital and labor intensity, and forms of technical and business assistance needed.

Based on the survey results, the study projected approximately 7,700 private sector recycling jobs in the state. Because the study focused more on the needs and characteristics of the recycling businesses in the state—rather than on the quantification of materials flows—it is more useful for developing general public policies toward recycling than for developing a detailed picture of the

[111] Platt, Jeanes, and Kaufmann (1995).

[112] Kirkpatrick (July 1995)

state's materials economy.

5.4. Future research directions

Given the limited quality of data that analysts have to work with, the pursuit of methodological tools for analyzing materials flows may seem a futile task. But this is not necessarily the case: a number of potential data sources remain untapped, and possibilities to combine the above technologies remain unexplored. This section will propose two promising directions for future research, using data for the San Francisco Bay Area for illustrative purposes.

5.4.1. An "Open Box" Manufacturing Input Analysis

In principle, the input/output methodology used in the Great Lakes region study could provide very useful information about existing relationships among firms in the local economy. However, its reliance on the "black box" of IMPLAN to fill in missing Federal data undermines its ability to produce locally meaningful results. A better method would be to use an open architecture model, in which all assumptions are explicit and can be changed as new data becomes available. Such a model could begin to be developed with Federal data sources, but could evolve over time based on results from periodic surveys of the region's businesses.

Appendix B contains the beginnings of such a model for two manufacturing sectors in the San Francisco Bay Area. The model estimates the local consumption of specific materials by the pulp/paper and publishing industries, using data from the 1992 U.S. Census of Manufactures. The model operates in seven stages, each of which is a distinct layer in a three-dimensional spreadsheet.

1. The first step is to compute some basic characteristics of the manufacturing sectors under consideration (see Table B1 in Appendix B). The Census of Manufacturers provides national data on number of establishments, number of employees, total payroll, value added, material cost, value of shipments, and capital expenditures for each industry (at the four-digit SIC level). So that we are able to fill in the gaps in the local data later on, we need to calculate the average firm size (in employees per establishment, and average per-employee payroll, value added, etc.

This use of national averages is problematic, as mentioned earlier, because it obscures any unique local characteristics of a given industry. Firm sizes vary sharply, so using aggregate data for this type of analysis is far from ideal, even if it is standard practice. Ideally, the smallest region for which complete data is available should be used here; it would have been better to use data for California instead of the whole U.S.

2. The next step is to input data on the local economy available from the Census of Manufactures. Data for the San Francisco Bay Area is broken into six primary metropolitan statistical areas (PMSAs), including Oakland, San Francisco, San Jose, Santa Cruz, Santa Rosa, and Vallejo. To simplify the analysis, we shall examine only the first three of these, which together comprise the economic core of the region. Table B2 displays the Census data grouped into 4-, 3-, and 2-digit SIC levels.

Because much of the data has been suppressed, either to protect the confidentiality of data from individual firms, or to save space (industries that employ fewer than 500 people are often skipped entirely), two "checksum" boxes have been created for accounting purposes. These boxes keep track of the differences between the values provided for an industry as a whole, and the sums of the values provided for the sub-industries within it. For example, at the three-digit SIC level, 700 jobs are listed in Oakland under "Books" (SIC 273). At the four-digit SIC level, 500 jobs are listed under the subindustry "book publishing" (SIC 2731), while none are listed elsewhere. The checksum box keeps track of these missing jobs (so that they can be allocated later) by putting the value 200 next to SIC 273.

3. Next, the first of two rounds of data adjustment is carried out: the "missing" jobs and economic activity for the three-digit industries is allocated among the unreported industries (see Table B3). Three rules are applied to accomplish this. First, where it is possible to deduce the number of unreported establishments in a given industry, these assigned. Second, unassigned employees are allocated on the basis of national averages of employees/establishment. Third, unassigned payroll, value added, material cost, etc. are allocated on the basis of national averages of $/employee (from Table B1). All of these allocations are subject to the constraint that the "budget" of unassigned data is not exceeded. When this is completed, new checksums are calculated for the two-digit industry groups.

4. The second of the two data adjustment rounds allocates the remaining unassigned data, using the same procedures (see Table B4). When this step is complete, all of the economic activity in these sectors known to be taking place in the region has been allocated among the industries in a manner that does not contradict the data provided (as it would if we had simply scaled everything up).

5. The next step (Table B5) is to add together the corrected data for the three PMSAs, and to calculate ratios like those calculated on Table B1.

6. Table B6 (two pages) summarizes the total materials consumed nationally by each industrial sector in 1992. These data are taken directly from the economic census. For some of these materials, consumption data is provided in both physical and economic units; for others it provides only dollar amounts. The materials codes are far more detailed than are the SIC codes used to classify the business types. As a result, we are given fairly good resolution on the inputs to manufacturing (e.g. seven categories of waste paper on Table B6), but rather poor resolution on the outputs from manufacturing.

7. Finally, in Table B7 (two pages), the materials consumed by local industry are calculated by multiplying together the materials consumed nationally by a sector and ratio of local to national expenditures on raw materials for that sector.

✧

Although this model can answer some basic questions about demand for raw materials within a region's economy, far more interesting questions can begin to be answered if the Census data is

supplemented with locally-specific survey data. Additional information that could be particularly useful may include the constraints surrounding companies' use of their raw materials (temporal distribution of need, quality requirements, etc.), the degree to which companies conform to "typical" behavior nationally, and the extent to which they currently exchange secondary or intermediate good with other local firms.

Ideally, of course, a model which encompasses the entire manufacturing sector of a region would be preferable to this sectoral approach. Such a model may become possible after the 1992 Census of Manufactures becomes fully available in electronic format. At the present time, however, much of the data needed is available only in print format.

5.4.2. Material Flux Analysis

Imports of basic materials and exports of recyclable commodities both represent lost economic opportunities for a metropolitan region. There are two ways in which these commodity flows can begin to be quantified directly.

One approach would be to characterize the flows of materials into and out from a region, based upon its trade patterns within the domestic economy. The Commodity Flow Survey, discussed above, will make possible this type of analysis. It should allow researchers to examine what types of materials are produced and consumed by a given region, from where in the country the region derives certain resources, and the comparative values of a region's imports and exports. Unfortunately, detailed origin-destination tables from this survey have not yet been made available.

A second approach would be to characterize the flows of materials that travel *through* a region without necessarily playing any specific role in its economy (besides the jobs created in transporting them). This would provide an indicator of the region's "materials flux," which can be conceptualized as an incidence of nutrients or energy potentially available for "capture" by small enterprises hungry for opportunities to add value. This type of analysis is only feasible for major ports or border regions, where rich Federal data exist on the quantities and values of imports and exports.

Appendix C illustrates how import/export data can be analyzed for the purposes of strategic materials stream planning, using pulp & paper, and nonferrous metals industries as examples.

Tables C1 through C4 summarize imports and exports of specific materials in 1994, for the entire United States, and for the Oakland-San Francisco Customs District[113] (which includes the Port of Oakland, the Port of San Francisco, and several smaller Bay Area terminals). Each of these tables is divided into three horizontal sections. The first of these rows represents primary goods, such as virgin wood pulps and metallic ores. The second rows represent secondary materials, including waste paper and metal scrap, which can substitute for the primary materials as inputs to production.

[113] It should be noted that these local data, which come from the Port of Oakland, do not appear to have been cleaned or otherwise quality-controlled. In cases where data were missing or clearly erroneous (e.g. unit prices an order of magnitude different from the U.S. average), they were imputed from other Port of Oakland data (if possible), or U.S. data as a last resort.

The third rows represent "processed" intermediate goods, which can then be used in the manufacture of final products. Vertical columns represent the weight and value of exports, the weight and value of imports, and the difference between the two.

Organization of data in this way can help identify economic opportunities for value added in a region. For example a net of 6.3 million metric tons (MMT) of newsprint was imported through the San Francisco Bay Area in 1994, representing a net expenditure of $2.9 billion. At the same time, a net of 0.13 MMT of mechanical pulp and 1.2 MMT of old newsprint were exported out through the region. This old newsprint was worth $142 million on export, but could be worth $142 x (0.47/0.12) = $556 million if it could be converted to new newsprint. The question for the investor is whether this can be achieved for less than the difference, or $414 million.

This is particularly easy to illustrate for newsprint and the nonferrous metals; other pulp and paper products are not as easily delineated.[114] Also, these results are not particularly helpful at the level of aggregation presented here, beyond providing an illustration of the magnitude of import-substitution opportunities that may exist in a region. The economics of large newsprint recycling mills are already well-known, and there is little more that can be learned from this type of import/export analysis.

The real reason why these data are useful is the degree of detail in which they are provided. Each of the rows in the charts on the following pages represents the sum of between one and two dozen distinct commodity types (e.g. "writing paper, uncoated, not over 10% mechanical fiber, <40 g/m^2, roll or sheet"). The challenge to the entrepreneur lies in identifying specific products in the waste stream currently being exported to which s/he can add value to make a profit. The small-scale entrepreneur is not necessarily interested in the magnitude of the exports, since his or her early operations will not nearly be able to absorb the capacity; rather, s/he is interested in identifying sources of raw materials that can be used as a local resource.

5.4.3. Working With What's at Hand

For the foreseeable future, until the Federal government makes a specific decision to track secondary materials in the economy, the data that strategic materials stream planners have to work with will necessarily be less than ideal. Nonetheless, analysis of trade, commodity transport, and economic census data can still provide a helpful picture of how materials flow through, and are used within, metropolitan regions.

Implementing these methodologies real-world contexts will be necessary to facilitate their future development. An enterprising regional governance organization might begin by building the necessary data sets from publicly available sources. As they can start sharing results with local businesses and industry groups, their data can begin to serve as the basis for a public/private dialogue on opportunities for adding value to the region's wastes locally. As the general level of trust begins to increase, businesses may then be more easily persuaded to participate actively be sharing data on

[114] For example, corrugated cardboard (in the 6416 category) is made from two layers of unbleached kraft paper (2514) and one layer of corrugation medium (2519).

the quantities and specifications of the materials they use and the wastes that they generate. From there, the models can begin to improve, and the range of uses to which they are applied can widen.

It is this spirit of entrepreneurship and cooperation at the local level that will ultimately be required if society is to succeed in making a transition to a more sustainable economy. By embracing this approach at an early stage, recycling policy can become an agent of this change.

Appendix A
Key terms and concepts used in this paper

A.1. Acronyms

ACRB	Alameda County Recycling Board
CAWF	Californians Against Waste Foundation (Sacramento, CA)
CDBG	Community Development Block Grants
CNT	Center for Neighborhood Technology (Chicago, IL)
DOC	U.S. Department of Commerce
EDF	Environmental Defense Fund (New York/Washington/Oakland)
EZCA	California Enterprise Zone
HDPE	High-Density Polyethylene (plastic used in milk containers)
IDB	Industrial Development Bond
ILSR	Institute for Local Self-Reliance (Washington, D.C.)
IWMB	California Integrated Waste Management Board
LDPE	Low-Density Polyethylene (plastic used in bags and some films)
MMT	Million Metric Tons
MSW	Municipal Solid Waste
NERC	Northeast Recycling Council
OBDC	Oakland Business Development Center
OCC	Old Corrugated Cardboard
ONP	Old Newsprint
ORLF	Oakland Revolving Loan Fund
PET	Polyethylene Terephthalate (plastic used in soda bottles)
PP	Polypropylene (plastic used in some butter tubs)
PS	Polystyrene (plastic used in Styrofoam and disposable eating utensils)
PVC	Polyvinyl Chloride (plastic used in some oil bottles and films)
RMDZ	Recycling Market Development Zone
SIC	Standard Industrial Classification code
STCC	Standard Transportation Commodity Code

A.2. Sources and Types of Wastes

The origin of waste materials generated by industrial processes can tell us a great deal about their spatial dispersion and their purity, two factors important in considering their potential future reuse. In general, wastes tend to be generated in four ways:[115]

[115] In the following discussion and throughout this paper, the term "waste" excludes wastewater, as well as low-mass non-product outputs (e.g. chemical pollutants).

Resource extraction wastes include wastes from mining, logging, and other resource extraction activities that generally remain at or near the point of extraction. The quantities of these wastes vary significantly by material type. Certain materials, such as salt or coal can be mined in a relatively pure form straight out of the ground. But materials which are less concentrated, such as gold, require much larger volumes of material to be taken out of the ground per unit of useful product. Similarly, there is wide variation among different forestry practices with regard to their relative generation of wood wastes. Resource extraction wastes generally would probably not tend to enter a metropolitan area's waste stream, and usually are not substances which industry is able to use.[116]

Resource refinement wastes include wastes from the manufacture of basic materials used by industry. These wastes vary in quality and usefulness. In the aluminum industry, where four tons of bauxite are needed to produce one ton of metal, these wastes would include 75% of the material entering the plant plus a certain amount of pure (but wasted) aluminum. The latter of these is most often fed directly back into a plant's input stream, and thus generally does not enter the economy as a waste product. It is alternatively called "home scrap" in the metals and plastics industries, "mill broke" in the paper industry, and "in-house cullet" in the glass industry. The spatial location of these resource refinement industries has been influenced by a range of factors, including the location of raw materials, water, and inexpensive energy and transportation. Today, we find some industries, such as paper and aluminum, along rivers in remote areas; while we find others, such as the steel industry, in more industrialized areas near the old coal fields of the East.

Fabrication wastes include those generated during the manufacture of end-use products, such as automobiles or clothing. It is alternatively called "industrial," "new," "prompt," "trim," or "pre-use" scrap. While not quite as pure or centrally located as the scrap from primary materials manufacture, these scrap materials nonetheless often possess enough of these qualities to make recycling economically feasible (and sometimes quite attractive). Because a great deal of product manufacturing takes place within metropolitan areas, these wastes will often be found within the urban economy. It should be noted, however, that they will not usually appear within the municipal waste stream, because manufacturers usually contract privately to have their wastes hauled away.

Post-use wastes are those generated when a product's useful life is over. There are numerous subcategories of these wastes, including construction and demolition debris, scrap automobiles, "white goods" (household appliances), and others. Certain types of these wastes still contain basic materials in relatively pure form, and come in large enough units that recycling is economically feasible. Other types, including many "post-consumer" wastes (those generated by commercial or residential end-users), are often highly dispersed or contaminated to a degree that can make recycling economically unattractive in the absence of policy interventions. Because cities are the centers of population and economic activity, they generate a great deal of post-use wastes; they may even generate a disproportionate share of these wastes, if it is true that waste generation grows faster than economic activity. Post-use wastes are often well-tracked by state and local governments, and are

[116] Wood wastes are an exception: they are an important part of the urban waste stream (but not due to resource extraction), and a range of options exist for beneficial reuse.

often the object of regional integrated waste planning efforts.

Municipal solid waste (MSW) is subcategory of post-use wastes that are generated by households, commercial enterprises, offices, and institutions. Even though they represent only about 5% of all solid wastes generated, they are particularly salient because governments absorb the costs of their collection and disposal. Because of this, MSW has become the primary focus of recycling policy. Agricultural, industrial, mining, and construction wastes have not received the same attention because their management costs are borne privately (or not at all).

A.3. A Note on Materials Reuse and Source Reduction

The term recycling technically implies that a discarded product is broken down into simple physical forms that resemble the basic raw materials from which it was initially made. This means returning waste paper back into pulp, and used glass or metal back into molten form. This decomposition and recomposition of matter are energy-intensive and pollution-generating processes. Although on balance recycling can reduce pollution substantially, it is far from environmentally benign.

Far more environmentally preferable is the *reuse* of products and materials, which does not involve returning them to their elementary forms. The prototypical "reuse enterprises" are companies that use refillable beverage containers.

Superior even to materials reuse is the direct reduction of materials consumption, made possible through the substitution of other forms of utility for the one-time use and disposal of physical goods. A "source reduction business" can include any type of service which acts as a substitute for the purchase of additional physical goods. These services can include product reconditioning or repair, short-term rental of tools or equipment, or direct provision of services in lieu of access to equipment.[117]

Throughout this paper, I have used the term "recycling" in an informal sense, in principle embracing both the concepts of recycling and reuse. I have done this mostly to avoid the need to belabor each point with a discussion of its relevance to recycling, reuse, and reduction. However, there is an important distinction to be made between recycling enterprises on one and, and reuse and source reduction enterprises on the other. While the line is no doubt fuzzy, most recycling activities relate more closely to manufacturing or goods production, whereas reuse and source reduction activities more closely resemble services. Thus, the question remains whether the discussion in this paper, which focuses on manufacturing and the production of goods, is relevant to the development of public policies to promote reuse and source reduction.

✧

A major success of today's recycling policies has been the sea change they have created in the economics of the recycling. No longer a marginal activity, recycling is now a strong, profitable, and

[117] Stahel and Jackson (1993).

diverse industry. In addition to a vast array of collectors, reprocessors, and recycled-content manufacturers operating on a local scale, recycling has seen substantial investment from the traditional primary commodities industries. Even strongly vertically integrated companies, such as those in the paper industry, have diversified their operations to include the manufacture of recycled products.

No comparable economic constituency has developed for source reduction or product reuse, because current production patterns are not structured to make source reduction an attractive investment. Although the economic and environmental benefits of a less materials-intensive economy may be substantial, they will also be diffuse. One of the most difficult challenges ahead for sustainable materials policy will be the creation of an economic and policy climate that can foster private investment in source reduction and materials reuse. This will require new ways of thinking about the roles and responsibilities of the firm in relation to the economy.

One policy approach through which governments can directly seek to promote source reduction and materials reuse is "extended producer responsibility," under which manufacturers retain certain obligations for a product's environmental performance beyond the time of sale. Some examples of the many forms this can take include *take back legislation*, which assigns manufacturers full-lifecycle responsibility for the packaging they create (e.g. Germany's Green Dot program); and *extended performance standards*, such as the requirement in the 1990 Clean Air Act Amendments that car makers provide ten-year warranties on new catalytic converters.

Firms can also voluntarily extend their responsibility for the environmental impacts of their products and services. This usually involves a creative redefinition of the firm's mission, from selling a physical product to providing customers with services equivalent to those the physical product would provide. Dairies and wineries that use refillable bottles have replaced sales of containers of liquid for sales of the liquid itself, while offering a return service for the customer. Photocopy machine rental companies provide offices with the ability to produce copies without actually selling them a machine. Such firms have a strong incentive to minimize waste by using durable, reliable products.

These "new" definitions of the role of the firm are actually a return to earlier patterns prevalent before World War II. Although numerous examples still exist in practice, their precipitous decline over the past several decades suggests the magnitude of the market forces they must confront.

Fostering a wider economic role for source reduction, reuse, and remanufacturing firms, will require similar policy approaches to those needed to promote recycling more generally. Firms substituting services for sales of product have similar needs to those of recycling firms in terms of developing networks within industry, and in gaining access to capital to get their operations started. Governments could help these firms in much the same way they have helped jump-start the recycling industry, by temporarily shielding these firms from market forces. For example, governments could:

- ➢ Establish tax or other incentives for firms to practice voluntary extended producer responsibility.

- ➢ Extend government procurement preferences to include not only recycled content products, but also services-in-lieu-of-products.

- ➢ Promote entrepreneurship by providing technical and permitting assistance, access to credit (including micro-loans), pooled facilities and services, and other benefits to new or expanding reuse or source reduction businesses. Currently, these businesses are excluded from the programs that already exist to assist recycling firms.

Future progress toward more sustainable patterns of resource use will require a more expansive framework than waste management policy has traditionally provided. Materials policies of the future will need to take a more comprehensive "systems" view of the flows of energy and materials through the economy. At the same time, they will need to broaden the constituency for such activist government by linking economic and environmental objectives in a proactive manner.

Appendix B: An "Open Box" Model for Industrial Input Analysis

Table B1:
United States Summary Table: Characteristics of Pulp, Paper & Publishing Industries

				(Millions of Dollars)										
SIC Code	Manufacturing Sector	Total Establishments	Total Employees	Total Payroll	Value Added	Material Cost	Value of Shipments	Capital Expend.	Employees per Establishment	Per-Employee Ratios ($1000/employee) Payroll	Value Added	Material Cost	Value of Shipments	Capital Expend.
2631	Paperboard Mills	204	51500	2136	8195	8013	16140	2041	252.5	41.5	159.1	155.6	313.4	39.6
2653	Corrugated & Solid Fiber Boxes	1646	111700	3264	6738	13079	19790	461	67.9	29.2	60.3	117.1	177.2	4.1
2657	Folding Paperboard Boxes	588	52700	1590	3565	4358	7933	296	89.6	30.2	67.6	82.7	150.5	5.6
2671	Paper, coated/laminated, packaging	204	17300	534	1427	2069	3508	129	84.8	30.9	82.5	119.6	202.8	7.5
2672	Paper, coated/laminated, n.e.c.	453	32400	1042	3551	4144	7688	270	71.5	32.1	109.6	127.9	237.3	8.3
2673	Bags: plastics, coated/laminated	521	38700	989	2854	2871	5708	186	74.3	25.5	73.7	74.2	147.5	4.8
2677	Envelopes	283	24900	672	1362	1488	2854	55	88.0	27.0	54.7	59.8	114.6	2.2
2711	Newspapers	8679	417000	10506	27247	6874	34124	1667	48.0	25.2	65.3	16.5	81.8	4.0
2721	Periodicals	4699	116200	4075	15833	6201	22034	234	24.7	35.1	136.3	53.4	189.6	2.0
2731	Book Publishing	2644	79600	2676	11494	5338	16731	327	30.1	33.6	144.4	67.1	210.2	4.1
2732	Book Printing	623	50900	1361	2834	1868	4688	198	81.7	26.7	55.7	36.7	92.1	3.9
2741	Miscellaneous Publishing	3390	65400	1733	8525	2477	10977	190	19.3	26.5	130.4	37.9	167.8	2.9
2752	Commerical Printing, lithographic	29344	439900	12048	24843	18723	43588	1629	15.0	27.4	56.5	42.6	99.1	3.7
2754	Commercial Printing, gravure	431	21500	726	1691	1861	3561	170	49.9	33.8	78.6	86.6	165.6	7.9
2759	Commercial Printing, n.e.c.	8690	107300	2597	5442	3791	9290	345	12.3	24.2	50.7	35.3	86.6	3.2
2782	Blankbooks & Looseleaf Folders	553	39100	932	2659	1124	3788	102	70.7	23.8	68.0	28.7	96.9	2.6
2789	Bookbinding	1098	27700	550	1017	309	1321	42	25.2	19.9	36.7	11.2	47.7	1.5
2791	Typesetting	2517	26100	688	1324	286	1612	61	10.4	26.3	50.7	11.0	61.8	2.3
2796	Platemaking Services	1673	38700	1445	2658	790	3452	166	23.1	37.3	68.7	20.4	89.2	4.3
		Source: 1992 Census of Manufactures, Industry Series, Table 1a												

Table B2:
Raw Data for Pulp, Paper & Publishing Industries in the S.F. Bay Area

SIC Code	Manufacturing Sector	Oakland PMSA							San Francisco PMSA							San Jose PMSA						
		Total Estab.	Total Employ.	Total Payroll	Value Added	Material Cost	Value of Shpmnts	Capital Expend.	Total Estab.	Total Employ.	Total Payroll	Value Added	Material Cost	Value of Shpmnts	Capital Expend.	Total Estab.	Total Employ.	Total Payroll	Value Added	Material Cost	Value of Shpmnts	Capital Expend.
2631	Paperboard Mills	3	E	?	?	?	?	2.4								2	E	?	?	?	?	?
2653	Corrugated & Solid Fiber Boxes	18	1200	41.5	63.2	147.9	210.7	4.9	4	E	?	?	?	?	?	9	900	32.2	59.8	141.4	199.8	?
2657	Folding Paperboard Boxes															4	E	?	?	?	?	?
2671	Paper, coated/laminated, packaging	4	E	?	?	?	?	2.3														
2672	Paper, coated/laminated, n.e.c.	7	600	11.7	33.1	19.9	52.8	2.1														
2673	Bags: plastics, coated/laminated	13	400	9.1	26.8	32.3	59.0	1.5														
2677	Envelopes								5	400	13.5	20.8	22.1	43	0.7							
2711	Newspapers	40	3100	71.2	174.2	46.4	220.9	3.3	70	4900	178.4	383.9	110.6	494.3	6.4	21	2400	93.8	251.4	49.9	301.3	6.1
2721	Periodicals	44	500	12.8	35.1	16.4	51.5	0.4	81	1400	47.4	248	95.8	344	3	35	600	17.5	66.3	27.7	93.9	0.7
2731	Book Publishing	48	500	18.7	84.8	27	107.5	1.9	72	1800	68.6	298.7	100.5	392.6	6.1	32	500	14.6	62.4	29.3	92.3	1.6
2732	Book Printing															11	400	10.5	19.9	11.9	31.6	1.6
2741	Miscellaneous Publishing								40	G	?	?	?	?	9.7	27	400	8.5	28.2	9.3	37.5	?
2752	Commerical Printing, lithographic	315	3000	87.4	220.6	207.5	436.8	9	376	4200	141.8	274.9	170.1	446.4	17.5	242	2400	67.5	135.2	83.1	217.8	5.4
2754	Commercial Printing, gravure															6	E	?	?	?	?	?
2759	Commercial Printing, n.e.c.	67	F	?	?	?	?	?	83	700	19.5	41.5	19.6	61.1	1.5	63	F	?	?	?	?	?
2782	Blankbooks & Looseleaf Folders	10	300	8.5	24.7	6.6	31.4	0.9								2	E	?	?	?	?	?
2789	Bookbinding								16	E	?	?	?	?	?							
2791	Typesetting	33	300	6.9	13.8	3.2	17	0.5	40	300	9.6	25.9	5.6	31.6	0.6							
2796	Platemaking Services								31	800	29.1	53.4	13	66.4	3.0	17	300	9.1	16.6	3.6	20.2	1.1
Three-Digital Totals:																						
263	Paperboard Mills	3	E	?	?	?	?	2.4								2	E	?	?	?	?	?
265	Paperboard Containers and Boxes	29	1600	51.6	86.2	170	255.8	7.1	7	E	?	?	?	?	1.0	14	G	?	?	?	?	2.2
267	Misc. Converted Paper Products	36	G	?	?	?	?	6.9	7	F	?	?	?	?	0.9							
271	Newspapers	40	3100	71.2	174.2	46.4	220.9	3.3	70	4900	178.4	383.9	110.6	494.3	6.4	21	2400	93.8	251.4	49.9	301.3	6.1
272	Periodicals	44	500	12.8	35.1	16.4	51.5	0.4	81	1400	47.4	248.0	95.8	344.0	3.0	35	600	17.5	66.3	27.7	93.9	0.7
273	Books	54	700	26.3	100.5	38.8	135.1	2.1	78	1900	71.8	305.8	103.4	402.1	6.6	43	900	25.1	82.3	41.2	123.9	3.2
274	Miscellaneous Printing								40	G	?	?	?	?	9.7	27	400	8.5	28.2	9.3	37.5	?
275	Commercial Printing	384	3900	114.1	272.4	236.7	516.6	11.5	462	4900	161.4	316.7	190.0	508.0	19.0	311	3500	102.9	67.2	245.2	127.0	371.5
278	Blankbooks and Bookbinding	18	400	10.4	27.9	7.3	35.3	1.1	18	E	?	?	?	?	1.5	10	400	10.5	30.8	6.4	37.2	?
279	Printing Trade Services	42	500	15.3	29.8	6.7	36.6	1.6	71	1100	38.6	79.3	18.5	98.0	3.6	44	E	?	?	?	?	1.2
Checksum:																						
263	Paperboard Mills	0	0	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	0.0	0.0	0.0
265	Paperboard Containers and Boxes	11	400	10.1	23.0	22.1	45.1	2.2	3	?	?	?	?	?	?	1	?	?	?	?	?	?
267	Misc. Converted Paper Products	12	?	?	?	?	?	1.0	2	?	?	?	?	?	0.2	0	0	0.0	0.0	0.0	0.0	0.0
271	Newspapers	0	0	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	0.0	0.0	0.0
272	Periodicals	0	0	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	0.0	0.0	0.0
273	Books	6	200	7.6	15.7	11.8	27.6	0.2	6	100	3.2	7.1	2.9	9.5	0.5	0	0	0.0	0.0	0.0	0.0	0.0
274	Miscellaneous Printing	0	0	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	0.0	0.0	0.0
275	Commercial Printing	2	900	26.7	51.8	29.2	79.8	2.5	3	0	0.1	0.3	0.3	0.5	0.0	0	0	0.0	0.0	0.0	0.0	0.0
278	Blankbooks and Bookbinding	8	100	1.9	3.2	0.7	3.9	0.2	2	?	?	?	?	?	?	8	400	10.5	30.8	6.4	37.2	?
279	Printing Trade Services	9	200	8.4	16.0	3.5	19.6	1.1	0	0	-0.1	0.0	-0.1	0.0	0.0	27	?	?	?	?	?	0.1
Two-Digit Totals:																						
26	Paper and Allied Products	68	3600	108.3	281.9	345.2	626.2	16.4	26	900	28.2	51.4	84.9	136.8	1.9	23	1500	56.4	141	240.7	377.8	2.5
27	Printing and Publishing	622	9500	260.5	669.2	373	1046	20.8	829	15900	560.5	2311.6	664.8	2946.1	50.0	493	8500	271.7	728.8	268.8	997	24.8
Checksum:																						
26	Paper and Allied Products	23	1400	46	158.8	145.1	303.7	3.2	17	500	14.7	30.6	62.8	93.8	1.2	8	600	24.2	81.2	99.3	178	2.5
27	Printing and Publishing	65	1800	55	116	65.9	180.9	4.8	20	1800	66.1	985.3	149.6	1109.7	2.2	37	1500	50.2	148.8	54	202.4	8.3

Source: 1992 Census of Manufactures, Geographic Area Series, Table 6.

Table B3:
Corrections, Round 1: Distribution of Unallocated Data from 3-Digit Industries

SIC	Manufacturing	Oakland PMSA							San Francisco PMSA							San Jose PMSA						
Code	Sector	Total Estab.	Total Employ	Total Payroll	Value Added	Material Cost	Value of Shpmnt	Capital Expend	Total Estab.	Total Employ	Total Payroll	Value Added	Material Cost	Value of Shpmnt	Capital Expend	Total Estab.	Total Employ	Total Payroll	Value Added	Material Cost	Value of Shpmnt	Capital Expend
2631	Paperboard Mills																					
2653	Corrugated & Solid Fiber Boxes																					
2657	Folding Paperboard Boxes	11	400	10.1	23	22.1	45.1	2.2	3							1						
2671	Paper, coated/laminated, packaging																					
2672	Paper, coated/laminated, n.e.c.																					
2673	Bags: plastics, coated/laminated																					
2677	Envelopes	12						1														
2711	Newspapers																					
2721	Periodicals																					
2731	Book Publishing																					
2732	Book Printing	6	200	7.6	15.7	11.8	27.6	0.2	6	100	3.2	7.1	2.9	9.5	0.5							
2741	Miscellaneous Publishing																					
2752	Commerical Printing, lithographic																					
2754	Commercial Printing, gravure	2	97	3.8	8.2	6.7	15.0	0.6	3	0	0.1	0.3	0.3	0.5	0							
2759	Commercial Printing, n.e.c.		803	22.9	43.6	22.5	64.8	1.9														
2782	Blankbooks & Looseleaf Folders								2								165	4.8	17.4	4.1	21.8	
2789	Bookbinding	8	100	1.9	3.2	0.7	3.9	0.2								8	235	5.7	13.4	2.3	15.4	
2791	Typesetting																					
2796	Platemaking Services	9	200	8.4	16	3.5	19.6	1.1														

Totals (Raw data plus first set of corrections)

SIC	Manufacturing	Oakland PMSA							San Francisco PMSA							San Jose PMSA						
Code	Sector	Total Estab.	Total Employ	Total Payroll	Value Added	Material Cost	Value of Shpmnt	Capital Expend	Total Estab.	Total Employ	Total Payroll	Value Added	Material Cost	Value of Shpmnt	Capital Expend	Total Estab.	Total Employ	Total Payroll	Value Added	Material Cost	Value of Shpmnt	Capital Expend
2631	Paperboard Mills	3						2.4								2						
2653	Corrugated & Solid Fiber Boxes	18	1200	41.5	63.2	147.9	210.7	4.9	4							9	900	32.2	59.8	141.4	199.8	
2657	Folding Paperboard Boxes	11	400	10.1	23	22.1	45.1	2.2	3							5						
2671	Paper, coated/laminated, packaging	4						2.3														
2672	Paper, coated/laminated, n.e.c.	7	600	11.7	33.1	19.9	52.8	2.1														
2673	Bags: plastics, coated/laminated	13	400	9.1	26.8	32.3	59.0	1.5														
2677	Envelopes	12						1	5	400	13.5	20.8	22.1	43	0.7							
2711	Newspapers	40	3100	71.2	174.2	46.4	220.9	3.3	70	4900	178.4	383.9	110.6	494.3	6.4	21	2400	93.8	251.4	49.9	301.3	6.1
2721	Periodicals	44	500	12.8	35.1	16.4	51.5	0.4	81	1400	47.4	248	95.8	344	3	35	600	17.5	66.3	27.7	93.9	0.7
2731	Book Publishing	48	500	18.7	84.8	27	107.5	1.9	72	1800	68.6	298.7	100.5	392.6	6.1	32	500	14.6	62.4	29.3	92.3	1.6
2732	Book Printing	6	200	7.6	15.7	11.8	27.6	0.2	6	100	3.2	7.1	2.9	9.5	0.5	11	400	10.5	19.9	11.9	31.6	1.6
2741	Miscellaneous Publishing								40						9.7	27	400	8.5	28.2	9.3	37.5	
2752	Commerical Printing, lithographic	315	3000	87.4	220.6	207.5	436.8	9	376	4200	141.8	274.9	170.1	446.4	17.5	242	2400	67.5	135.2	83.1	217.8	5.4
2754	Commercial Printing, gravure	2	97	3.8	8.2	6.7	15.0	0.6	3	0	0.1	0.3	0.3	0.5	0	6						
2759	Commercial Printing, n.e.c.	67	803	22.9	43.6	22.5	64.8	1.9	83	700	19.5	41.5	19.6	61.1	1.5	63						
2782	Blankbooks & Looseleaf Folders	10	300	8.5	24.7	6.6	31.4	0.9	2							2	165	4.8	17.4	4.1	21.8	0
2789	Bookbinding	8	100	1.9	3.2	0.7	3.9	0.2	16							8	235	5.7	13.4	2.3	15.4	0
2791	Typesetting	33	300	6.9	13.8	3.2	17	0.5	40	300	9.6	25.9	5.6	31.6	0.6							
2796	Platemaking Services	9	200	8.4	16	3.5	19.6	1.1	31	800	29.1	53.4	13	66.4	3.0	17	300	9.1	16.6	3.6	20.2	1.1
Two-Digit Totals:																						
26	Paper and Allied Products	68	3600	108.3	281.9	345.2	626.2	16.4	26	900	28.2	51.4	84.9	136.8	1.9	23	1500	56.4	141	240.7	377.8	2.5
27	Printing and Publishing	622	9500	260.5	669.2	373	1046	20.8	829	15900	560.5	2311.6	664.8	2946.1	50.0	493	8500	271.7	728.8	268.8	997	24.8
Checksum:																						
26	Paper and Allied Products	0	1000	35.9	135.8	123	258.6	######	14	500	14.7	30.6	62.8	93.8	1.2	7	600	24.2	81.2	99.3	178.0	2.5
27	Printing and Publishing	40	400	10.4	29.3	20.7	50.0	0.8	9	1700	62.8	977.9	146.4	1099.7	1.7	29	1100	39.7	118.0	47.6	165.2	8.3

Table B4:
Corrections, Round 2: Distribution of Unallocated Data from 2-Digit Industries

SIC	Manufacturing	Oakland PMSA							San Francisco PMSA							San Jose PMSA						
Code	Sector	Total Estab.	Total Employ	Total Payroll	Value Added	Material Cost	Value of Shpmnt	Capital Expend	Total Estab.	Total Employ	Total Payroll	Value Added	Material Cost	Value of Shpmnt	Capital Expend	Total Estab.	Total Employ	Total Payroll	Value Added	Material Cost	Value of Shpmnt	Capital Expend
2631	Paperboard Mills		352	16.0	79.4	65.4	143.7	0.0									200	10.0	42.3	46.4	87.5	2.0
2653	Corrugated & Solid Fiber Boxes									85	2.5	3.9	12.3	15.6	0.1							
2657	Folding Paperboard Boxes									85	2.6	4.4	8.6	13.1	0.2		178	6.5	16.0	21.9	37.3	0.2
2671	Paper, coated/laminated, packaging		158	5.3	18.4	22.5	41.6	0.0	2	65	2.0	4.1	9.5	13.5	0.2	2	63	2.3	6.9	11.2	17.7	0.1
2672	Paper, coated/laminated, n.e.c.								5	121	3.9	10.1	19.1	29.6	0.4	2	45	1.7	6.5	8.5	14.8	0.1
2673	Bags: plastics, coated/laminated								6	145	3.7	8.1	13.2	22.0	0.3	2	48	1.5	4.7	5.3	9.9	0.1
2677	Envelopes		491	14.5	38.0	35.0	73.3	0.0								2	67	2.2	4.9	6.0	10.8	0.0
2711	Newspapers																					
2721	Periodicals																					
2731	Book Publishing																					
2732	Book Printing																					
2741	Miscellaneous Publishing	40	400	10.4	29.3	20.7	50.0	0.8		996	40.3	786.7	113.2	876.7	1.2							
2752	Commerical Printing, lithographic																					
2754	Commercial Printing, gravure																239	10.9	35.5	21.8	60.4	3.5
2759	Commercial Printing, n.e.c.																621	20.3	59.5	23.1	82.1	3.7
2782	Blankbooks & Looseleaf Folders									183	6.7	75.2	15.7	92.7	0.2							
2789	Bookbinding									521	15.8	115.9	17.5	130.3	0.3							
2791	Typesetting															29	240	8.5	23.0	2.8	22.6	1.0
2796	Platemaking Services																					

Totals (Round 1 totals plus Round 2 corrections)

SIC	Manufacturing	Oakland PMSA							San Francisco PMSA							San Jose PMSA						
Code	Sector	Total Estab.	Total Employ	Total Payroll	Value Added	Material Cost	Value of Shpmnt	Capital Expend	Total Estab.	Total Employ	Total Payroll	Value Added	Material Cost	Value of Shpmnt	Capital Expend	Total Estab.	Total Employ	Total Payroll	Value Added	Material Cost	Value of Shpmnt	Capital Expend
2631	Paperboard Mills	3	352	16.0	79.4	65.4	143.7	2.4	0	0	0.0	0.0	0.0	0.0	0.0	2	200	10.0	42.3	46.4	87.5	2.0
2653	Corrugated & Solid Fiber Boxes	18	1200	41.5	63.2	147.9	210.7	4.9	4	85	2.5	3.9	12.3	15.6	0.1	9	900	32.2	59.8	141.4	199.8	0.0
2657	Folding Paperboard Boxes	11	400	10.1	23.0	22.1	45.1	2.2	3	85	2.6	4.4	8.6	13.1	0.2	5	178	6.5	16.0	21.9	37.3	0.2
2671	Paper, coated and laminated, packaging	4	158	5.3	18.4	22.5	41.6	2.3	2	65	2.0	4.1	9.5	13.5	0.2	2	63	2.3	6.9	11.2	17.7	0.1
2672	Paper, coated and laminated, n.e.c.	7	600	11.7	33.1	19.9	52.8	2.1	5	121	3.9	10.1	19.1	29.6	0.4	2	45	1.7	6.5	8.5	14.8	0.1
2673	Bags: plastics, laminated, and coated	13	400	9.1	26.8	32.3	59.0	1.5	6	145	3.7	8.1	13.2	22.0	0.3	2	48	1.5	4.7	5.3	9.9	0.1
2677	Envelopes	12	491	14.5	38.0	35.0	73.3	1.0	5	400	13.5	20.8	22.1	43.0	0.7	2	67	2.2	4.9	6.0	10.8	0.0
2711	Newspapers	40	3100	71.2	174.2	46.4	220.9	3.3	70	4900	178.4	383.9	110.6	494.3	6.4	21	2400	93.8	251.4	49.9	301.3	6.1
2721	Periodicals	44	500	12.8	35.1	16.4	51.5	0.4	81	1400	47.4	248.0	95.8	344.0	3.0	35	600	17.5	66.3	27.7	93.9	0.7
2731	Book Publishing	48	500	18.7	84.8	27.0	107.5	1.9	72	1800	68.6	298.7	100.5	392.6	6.1	32	500	14.6	62.4	29.3	92.3	1.6
2732	Book Printing	6	200	7.6	15.7	11.8	27.6	0.2	6	100	3.2	7.1	2.9	9.5	0.5	11	400	10.5	19.9	11.9	31.6	1.6
2741	Miscellaneous Publishing	40	400	10.4	29.3	20.7	50.0	0.8	40	996	40.3	786.7	113.2	876.7	10.9	27	400	8.5	28.2	9.3	37.5	0.0
2752	Commerical Printing, lithographic	315	3000	87.4	220.6	207.5	436.8	9.0	376	4200	141.8	274.9	170.1	446.4	17.5	242	2400	67.5	135.2	83.1	217.8	5.4
2754	Commercial Printing, gravure	2	97	3.8	8.2	6.7	15.0	0.6	3	0	0.1	0.3	0.3	0.5	0.0	6	239	10.9	35.5	21.8	60.4	3.5
2759	Commercial Printing, n.e.c.	67	803	22.9	43.6	22.5	64.8	1.9	83	700	19.5	41.5	19.6	61.1	1.5	63	621	20.3	59.5	23.1	82.1	3.7
2782	Blankbooks & Looseleaf Folders	10	300	8.5	24.7	6.6	31.4	0.9	2	183	6.7	75.2	15.7	92.7	0.2	2	165	4.8	17.4	4.1	21.8	0.0
2789	Bookbinding	8	100	1.9	3.2	0.7	3.9	0.2	16	521	15.8	115.9	17.5	130.3	0.3	8	235	5.7	13.4	2.3	15.4	0.0
2791	Typesetting	33	300	6.9	13.8	3.2	17.0	0.5	40	300	9.6	25.9	5.6	31.6	0.6	29	240	8.5	23.0	2.8	22.6	1.0
2796	Platemaking Services	9	200	8.4	16.0	3.5	19.6	1.1	31	800	29.1	53.4	13.0	66.4	3.0	17	300	9.1	16.6	3.6	20.2	1.1

Table B5:
San Francisco Bay Area Summary Table: Characteristics of Pulp, Paper & Publishing Industries

SIC Code	Manufacturing Sector	Total Establish.	Total Employees	*(Millions of Dollars)* Total Payroll	Value Added	Material Cost	Value of Shipments	Capital Expend.	Employees per Establish.	Per-Employee Ratios ($1000/employee) Payroll	Value Added	Material Cost	Value of Shipments	Capital Expend.
2631	Paperboard Mills	5	552	26	122	112	231	4	110.4	47.2	220.4	202.7	419.0	7.9
2653	Corrugated & Solid Fiber Boxes	31	2185	76	127	302	426	5	70.5	34.9	58.1	138.0	195.0	2.3
2657	Folding Paperboard Boxes	19	662	19	43	53	96	3	34.8	28.9	65.4	79.5	144.3	4.0
2671	Paper, coated/laminated, packaging	8	285	10	29	43	73	3	34.4	34.0	103.1	151.8	255.9	9.2
2672	Paper, coated/laminated, n.e.c.	14	766	17	50	47	97	3	54.9	22.6	64.9	62.0	126.9	3.4
2673	Bags: plastics, coated/laminated	21	593	14	40	51	91	2	28.5	24.1	66.9	85.8	153.4	3.1
2677	Envelopes	19	958	30	64	63	127	2	50.6	31.6	66.5	65.9	132.6	1.8
2711	Newspapers	131	10400	343	810	207	1017	16	79.4	33.0	77.8	19.9	97.7	1.5
2721	Periodicals	160	2500	78	349	140	489	4	15.6	31.1	139.8	56.0	195.8	1.6
2731	Book Publishing	152	2800	102	446	157	592	10	18.4	36.4	159.3	56.0	211.6	3.4
2732	Book Printing	23	700	21	43	27	69	2	30.4	30.4	61.0	38.0	98.1	3.3
2741	Miscellaneous Publishing	107	1796	59	844	143	964	12	16.8	33.0	470.0	79.7	536.7	6.5
2752	Commerical Printing, lithographic	933	9600	297	631	461	1101	32	10.3	30.9	65.7	48.0	114.7	3.3
2754	Commercial Printing, gravure	11	336	15	44	29	76	4	30.5	44.2	130.9	85.5	226.0	12.2
2759	Commercial Printing, n.e.c.	213	2124	63	145	65	208	7	10.0	29.5	68.1	30.7	98.0	3.4
2782	Blankbooks & Looseleaf Folders	14	647	20	117	26	146	1	46.2	30.8	181.2	40.9	225.5	1.7
2789	Bookbinding	32	856	23	133	20	150	1	26.8	27.3	154.8	23.9	174.7	0.6
2791	Typesetting	102	840	25	63	12	71	2	8.2	29.8	74.6	13.8	84.8	2.6
2796	Platemaking Services	57	1300	47	86	20	106	5	22.8	35.8	66.2	15.5	81.7	4.0

Table B6:
Material Inputs by Industry--Entire United States

	Material Code	190006		190007		190009		190010		190015		190072		190073		220011	229507	241101		241102	
	Material	Mixed Wastepaper		ONP		High-grade pulp substitutes		High-grade deinking		Other fibrous materials		Other waste mechanical pulp		OCC		Book cov. fabric	Coated Fabrics	Spruce etc.		Hemlock	
SIC Code	Manufacturing Sector	1000 sh tons	$	1000 sh tons	$	1000 sh tons	$	1000 sh tons	$	1000 sh tons	$	1000 sh tons	$	1000 sh tons	$	$	$	1000 cords	$	1000 cords	$
2631	Paperboard Mills	1215.2	44.4	1267.6	47.3	546.4	117.1	189.5	35.2	#N/A	#N/A	548.4	31.5	10020.5	599.3			480.6	39.6	#N/A	#N/A
2653	Corrugated & Solid Fiber Boxes																				
2657	Folding Paperboard Boxes																				
2671	Paper, coated/laminated, packaging																				
2672	Paper, coated/laminated, n.e.c.																				
2673	Bags: plastics, coated/laminated																				
2677	Envelopes																				
2711	Newspapers																				
2721	Periodicals																				
2731	Book Publishing																				
2732	Book Printing															56.1					
2741	Misc. Publishing																				
2752	Commerical Printing, lithographic															3					
2754	Commercial Printing, gravure																				
2759	Commercial Printing, n.e.c.															2.4					
2782	Blankbooks & Looseleaf Folders																13.7				
2789	Bookbinding																10.5				
2791	Typesetting																				
2796	Platemaking Services																				

	Material Code	241104		241108		241135		241137		242012		242013		260003		261102		261104		262100
	Material	Southern Pine		S. Mixed Hardwood		Other Softwoods		Other Hardwoods		Softwood chips, sawdust		Hardwood chips, sawdust		Paper & Paperboard		Woodpulp, same company		Purchased market pulp		Paper
SIC Code	Manufacturing Sector	1000 cords	$	1000 cords	$	1000 cords	$	1000 cords	$	1000 cords	$	1000 cords	$	1000 sh tons	$	1000 sh tons	$	1000 sh tons	$	$
2631	Paperboard Mills	15610.9	1138	3980.5	232.2	769.4	100.9	1214.1	84.2	10715.9	794.7	4158.2	266.2			#N/A	#N/A	86	37.2	
2653	Corrugated & Solid Fiber Boxes													27070.2	10014.5					
2657	Folding Paperboard Boxes													4712.2	2945.5					
2671	Paper, coated & laminated, packaging																			
2672	Paper, coated and laminated, n.e.c.																			
2673	Bags: plastic, laminated, and coated																			
2677	Envelopes																			
2711	Newspapers																			43.9
2721	Periodicals																			
2731	Book Publishing																			
2732	Book Printing																			
2741	Misc. Publishing																			
2752	Commerical Printing, lithographic																			
2754	Commercial Printing, gravure																			
2759	Commercial Printing, n.e.c.																			
2782	Blankbooks & Looseleaf Folders																			
2789	Bookbinding																			
2791	Typesetting																			18.4
2796	Platemaking Services																			22.2

Source: 1992 Census of Manufactures, Industry Series, Table 7.

Material Inputs by Industry--Entire United States (cont'd)

SIC Code	Manufacturing Sector	Material Code / Material	262108 Paper		262111 Newsprint	262112 Newsprint	262113 Newsprint, 30lb		262115 Newsprint, Other wt.		262121 Uncoated Paper, sheets	262122 Uncoated paper, rolls	262123 Coated Paper, Sheets	262124 Coated Paper, rolls	262131 Coated Paper	262140 Uncoated Paper	262188 Glassine Film	263105 Paperboard	265001 Paperboard & Corrug. Boxes	267231 Adhesive Paper
			1000 sh tons	$	$	$	1000 mt. ton	$	1000 mt. ton	$	$	$	$	$	$	$	$	$	$	$
2631	Paperboard Mills																		57.5	
2653	Corrugated & Solid Fiber Boxes																			
2657	Folding Paperboard Boxes																			
2671	Paper, coated/laminated, packaging		515.9	506															29.2	
2672	Paper, coated/laminated, n.e.c.		1421.9	1526															90.5	
2673	Bags: plastics, coated/laminated		116.542	107.8															182.6	
2677	Envelopes		1111.2	788.3													17.1		36.5	
2711	Newspapers						6914.4	3202.2	1384.9	629.5					37.9					
2721	Periodicals				66.3										986.1	185.2				
2731	Book Publishing				76.9										192.2	305.6				
2732	Book Printing					35.7					116.7	314.5	148.1	194.9					60.4	14.5
2741	Misc. Publishing				43.5										75.2	103.8				
2752	Commerical Printing, lithographic					931.8					1064.7	1611.6	1347.4	2016.4					126.6	110.4
2754	Commercial Printing, gravure					140					2.3	459.5	17.7	354.7					8.7	9
2759	Commercial Printing, n.e.c.					14.3					85.9	144.7	55.8	98.7					27.4	592.6
2782	Blankbooks & Looseleaf Folders														86.1	185.4		55.1	48.1	
2789	Bookbinding														21.2	17.6		13.9	11.8	
2791	Typesetting																			
2796	Platemaking Services																			

SIC Code	Manufacturing Sector	Material Code / Material	278200 Metal & Plastic Loosleaf Compon.	2796xx Printing Plates	282104 Plastic Resins	289101 Glues & Adhesives	289301 Printing Inks	291106 Petroleum Wax		308001 Plastic Film&Sheet	308003 Other Plastics	308007 Plastic Sheets, etc.	308011 Fab. Plastics Prods	308100 Plastic Film, Unsupport'd	330005 Steel	331022 Steel Sheet & Strip	331094 Steel Strip & Wire	335335 Aluminum Foil		3861xx Photosensi-tive Plates, Films, etc.
			$	$	$	$	$	million lbs	$	$	$	$	$	$	$	$	$	million lbs	$	$
2631	Paperboard Mills																			
2653	Corrugated & Solid Fiber Boxes					214.4	132.2	286.4	95				47.5			5.5				
2657	Folding Paperboard Boxes					29.6	219.3	17.184	5.7				30			26.7				
2671	Paper, coated & laminated, packaging				330.6	47.4	99.3					513						30.8	47.8	
2672	Paper, coated and laminated, n.e.c.				192.4	329	33.2					178.3						13.381	22.4	
2673	Bags: plastic, laminated, and coated				1200.6	39	69.8					325.3						10	20.5	
2677	Envelopes													34.6						
2711	Newspapers			51.8			172.9													126.7
2721	Periodicals						220.8													
2731	Book Publishing						45.9													
2732	Book Printing			33.9		29.3	64.7													53.3
2741	Misc. Publishing						4.3													
2752	Commerical Printing, lithographic			148.3		42.9	805.2													337.9
2754	Commercial Printing, gravure			14.3		9.1	458.5													4.7
2759	Commercial Printing, n.e.c.			27.8		28.7	103.5													22.4
2782	Blankbooks & Looseleaf Folders		119.1							104.3	14.2						16.6			
2789	Bookbinding		5.3							6.4	2.7						3.7			
2791	Typesetting																			34.7
2796	Platemaking Services														36.1					194.7

Source: 1992 Census of Manufactures, Industry Series, Table 7.

Table B7:
Material Inputs by Industry--San Francisco Bay Area

	Material Code	190006		190007		190009		190010		190015		190072		190073		220011	229507	241101		241102	
	Material	Mixed Wastepaper		ONP		High-grade pulp substitutes		High-grade deinking		Other fibrous materials		Other waste mechanical pulp		OCC		Book cov. fabric	Coated Fabrics	Spruce etc.		Hemlock	
SIC Code	Manufacturing Sector	1000 sh tons	$	1000 sh tons	$	1000 sh tons	$	1000 sh tons	$	1000 sh tons	$	1000 sh tons	$	1000 sh tons	$	$	$	1000 cords	$	1000 cords	$
2631	Paperboard Mills	16.96	0.62	17.69	0.66	7.63	1.63	2.65	0.49	#N/A	#N/A	7.65	0.44	139.87	8.37	0	0	6.71	0.55	#N/A	#N/A
2653	Corrugated & Solid Fiber Boxes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
2657	Folding Paperboard Boxes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
2671	Paper, coated/laminated, packaging	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
2672	Paper, coated/laminated, n.e.c.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
2673	Bags: plastics, coated/laminated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
2677	Envelopes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
2711	Newspapers	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
2721	Periodicals	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
2731	Book Publishing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
2732	Book Printing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.80	0	0	0	0	0.0
2741	Misc. Publishing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
2752	Commerical Printing, lithographic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.07	0	0	0	0	0.0
2754	Commercial Printing, gravure	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
2759	Commercial Printing, n.e.c.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.04	0	0	0	0	0.0
2782	Blankbooks & Looseleaf Folders	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.32	0	0	0	0.0
2789	Bookbinding	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.69	0	0	0	0.0
2791	Typesetting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
2796	Platemaking Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Total	16.96	0.62	17.69	0.66	7.63	1.63	2.65	0.49	#N/A	#N/A	7.65	0.44	139.87	8.37	0.91	1.02	6.71	0.55	#N/A	#N/A

	Material Code	241104		241108		241135		241137		242012		242013		260003		261102		261104		262100
	Material	Southern Pine		S. Mixed Hardwood		Other Softwoods		Other Hardwoods		Softwood chips, sawdust		Hardwood chips, sawdust		Paper & Paperboard		Woodpulp, same company		Purchased market pulp		Paper
SIC Code	Manufacturing Sector	1000 cords	$	1000 cords	$	1000 cords	$	1000 cords	$	1000 cords	$	1000 cords	$	1000 sh tons	$	1000 sh tons	$	1000 sh tons	$	$
2631	Paperboard Mills	217.90	15.88	55.56	3.24	10.74	1.41	16.95	1.18	149.58	11.09	58.04	3.72	0	0	#N/A	#N/A	1.20	0.52	0
2653	Corrugated & Solid Fiber Boxes	0	0	0	0	0	0	0	0	0	0	0	0	624.27	230.95	0	0	0	0	0
2657	Folding Paperboard Boxes	0	0	0	0	0	0	0	0	0	0	0	0	56.89	35.56	0	0	0	0	0
2671	Paper, coated & laminated, packaging	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2672	Paper, coated and laminated, n.e.c.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2673	Bags: plastic, laminated, and coated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2677	Envelopes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2711	Newspapers	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.32
2721	Periodicals	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2731	Book Publishing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2732	Book Printing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2741	Misc. Publishing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2752	Commerical Printing, lithographic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2754	Commercial Printing, gravure	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2759	Commercial Printing, n.e.c.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2782	Blankbooks & Looseleaf Folders	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2789	Bookbinding	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2791	Typesetting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.74
2796	Platemaking Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.57
	Total	217.90	15.88	55.56	3.24	10.74	1.41	16.95	1.18	149.58	11.09	58.04	3.72	681.17	266.51	#N/A	#N/A	1.20	0.52	2.63

Material Inputs by Industry--San Francisco Bay Area (cont'd)

SIC Code	Manufacturing Sector	Material Code	262108		262111	262112	262113		262115		262121	262122	262123	262124	262131	262140	262188	263105	265001	267231
		Material	Paper		Newsprint	Newsprint	Newsprint, 30lb		Newsprint, Other wt.		Uncoated Paper, sheets	Uncoated paper, rolls	Coated Paper, Sheets	Coated Paper, rolls	Coated Paper	Uncoated Paper	Glassine Film	Paperboard	Paperboard & Corrugated Boxes	Adhesive Paper
			1000 sh tons	$	$	$	1000 mt. ton	$	1000 mt. ton	$	$	$	$	$	$	$	$	$	$	$
2631	Paperboard Mills		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.80	0
2653	Corrugated & Solid Fiber Boxes		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2657	Folding Paperboard Boxes		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2671	Paper, coated/laminated, packaging		10.78	10.57	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.61	0
2672	Paper, coated/laminated, n.e.c.		16.29	17.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.04	0
2673	Bags: plastics, coated/laminated		2.06	1.91	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3.23	0
2677	Envelopes		47.15	33.45	0	0	0	0	0	0	0	0	0	0	0	0	0.73	0	1.55	0
2711	Newspapers		0	0	0	0	208.12	96.38	41.68	18.95	0	0	0	0	1.14	0	0	0	0	0
2721	Periodicals		0	0	1.50	0	0	0	0	0	0	0	0	0	22.25	4.18	0	0	0	0
2731	Book Publishing		0	0	2.26	0	0	0	0	0	0	0	0	0	5.65	8.98	0	0	0	0
2732	Book Printing		0	0	0	0.51	0	0	0	0	1.66	4.48	2.11	2.77	0	0	0	0	0.86	0.21
2741	Misc. Publishing		0	0	2.52	0	0	0	0	0	0	0	0	0	4.35	6.00	0	0	0	0
2752	Commerical Printing, lithographic		0	0	0	22.93	0	0	0	0	26.20	39.65	33.15	49.62	0	0	0	0	3.12	2.72
2754	Commercial Printing, gravure		0	0	0	2.16	0	0	0	0	0.04	7.09	0.27	5.47	0	0	0	0	0.13	0.14
2759	Commercial Printing, n.e.c.		0	0	0	0.25	0	0	0	0	1.48	2.49	0.96	1.70	0	0	0	0	0.47	10.19
2782	Blankbooks & Looseleaf Folders		0	0	0	0	0	0	0	0	0	0	0	0	2.03	4.37	0	1.30	1.13	0
2789	Bookbinding		0	0	0	0	0	0	0	0	0	0	0	0	1.40	1.16	0	0.92	0.78	0
2791	Typesetting		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2796	Platemaking Services		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total		76.28	63.41	6.27	25.84	208.12	96.38	41.68	18.95	29.37	53.71	36.50	59.56	36.81	24.69	0.73	2.22	13.72	13.26

SIC Code	Manufacturing Sector	Material Code	278200	2796xx	282104	289101	289301	291106		308001	308003	308007	308011	308100	330005	331022	331094	335335		3861xx
		Material	Metal & Plastic Loosleaf Compon.	Printing Plates	Plastic Resins	Glues & Adhesives	Printing Inks	Petroleum Wax		Plastic Film&Sheet	Other Plastics	Plastic Sheets, etc.	Fab. Plastics Prods	Plastic Film, Unsupport'd	Steel	Steel Sheet & Strip	Steel Strip & Wire	Aluminum Foil		Photosensi-tive Plates, Films, etc.
			$	$	$	$	$	million lbs	$	$	$	$	$	$	$	$	$	million lbs	$	$
2631	Paperboard Mills		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2653	Corrugated & Solid Fiber Boxes		0	0	0	4.94	3.05	6.60	2.19	0	0	0	1.10	0	0	0.13	0	0	0	0
2657	Folding Paperboard Boxes		0	0	0	0.36	2.65	0.21	0.07	0	0	0	0.36	0	0	0.32	0	0	0	0
2671	Paper, coated & laminated, packaging		0	0	6.91	0.99	2.07	0	0	0	0	10.72	0	0	0	0	0	0.64	1.00	0
2672	Paper, coated and laminated, n.e.c.		0	0	2.20	3.77	0.38	0	0	0	0	2.04	0	0	0	0	0	0.15	0.26	0
2673	Bags: plastic, laminated, and coated		0	0	21.26	0.69	1.24	0	0	0	0	5.76	0	0	0	0	0	0.18	0.36	0
2677	Envelopes		0	0	0	0	0	0	0	0	0	0	0	1.47	0	0	0	0	0	0
2711	Newspapers		0	1.56	0	0	5.20	0	0	0	0	0	0	0	0	0	0	0	0	3.81
2721	Periodicals		0	0	0	0	4.98	0	0	0	0	0	0	0	0	0	0	0	0	0
2731	Book Publishing		0	0	0	0	1.35	0	0	0	0	0	0	0	0	0	0	0	0	0
2732	Book Printing		0	0.48	0	0.42	0.92	0	0	0	0	0	0	0	0	0	0	0	0	0.76
2741	Misc. Publishing		0	0	0	0	0.25	0	0	0	0	0	0	0	0	0	0	0	0	0
2752	Commerical Printing, lithographic		0	3.65	0	1.06	19.81	0	0	0	0	0	0	0	0	0	0	0	0	8.31
2754	Commercial Printing, gravure		0	0.22	0	0.14	7.07	0	0	0	0	0	0	0	0	0	0	0	0	0.07
2759	Commercial Printing, n.e.c.		0	0.48	0	0.49	1.78	0	0	0	0	0	0	0	0	0	0	0	0	0.39
2782	Blankbooks & Looseleaf Folders		2.80	0	0	0	0	0	0	2.46	0.33	0	0	0	0	0	0.39	0	0	0
2789	Bookbinding		0.35	0	0	0	0	0	0	0.42	0.18	0	0	0	0	0	0.24	0	0	0
2791	Typesetting		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.40
2796	Platemaking Services		0	0	0	0	0	0	0	0	0	0	0	0	0.92	0	0	0	0	4.96
	Total		3.15	6.39	30.37	12.86	50.76	6.81	2.26	2.88	0.51	18.52	1.46	1.47	0.92	0.45	0.64	0.97	1.62	19.70

Appendix C: Illustration of commodity import/export analysis

Table C1:
United States Exports and Imports, 1994: Primary, Secondary, and Intermediate Pulp & Paper Products

Commodity Code	Commodity Type	Exports			Imports			Net Exports	
		10^3 kg	$1,000	$/kg	10^3 kg	$1,000	$/kg	10^3 kg	$1,000
2512x	Mechanical Pulp	67342	21036	0.31	199811	75997	0.38	-132469	-54961
2513x	Chemical Pulp, dissolving grades	621161	429206	0.69	69723	44791	0.64	551438	384415
2514x	Chemical Pulp, soda or sulfate, unbleached, non-dissolv.	151061	52779	0.35	157316	74240	0.47	-6255	-21461
2515x	Chemical Pulp, soda or sulfate, bleached, non-dissolving	4756021	2095338	0.44	4232911	1887656	0.45	523110	207682
2516x	Chemical Pulp, sulfite	478012	222674	0.47	238927	114560	0.48	239085	108114
2519x	Semi-Chemical Pulp (wood and non-wood)	121104	95074	0.79	241574	83478	0.35	-120470	11596
2511x	Waste Paper	7004377	877640	0.13	228932	34514	0.15	6775445	843126
25111	Waste Paper: unbleached kraft or paperboard or corrug.	3107700	349880	0.11	40952	7063	0.17	3066748	342817
25112	Waste Paper: bleached chemical pulp	1363345	214153	0.16	34569	6941	0.20	1328776	207212
25113	Waste Paper: mechanical pulp (newpapers, etc.)	1244166	144744	0.12	21562	2860	0.13	1222604	141884
25119	Waste Paper: other (unsorted scrap)	1289166	168863	0.13	131849	17650	0.13	1157317	151213
6411x	Newsprint	858709	479363	0.56	7151334	3333024	0.47	-6292625	-2853661
6412x	Paper & Paperboard: unbleached; writing, printing	639230	529433	0.83	2524322	1579230	0.63	-1885092	-1049797
6413x	Paper & Paperboard: coated or printed	1531071	1661076	1.08	1878167	1746324	0.93	-347096	-85248
6414x	Paper & Paperboard: kraft, uncoated	3493865	1385773	0.40	537244	320662	0.60	2956621	1065111
6415x	Paper & Paperboard: uncoated	225737	201567	0.89	314718	159889	0.51	-88981	41678
6416x	Paper & Paperboard: corrugated or perforated	634505	444236	0.70	421782	161506	0.38	212723	282730

Source: U.S. Exports and U. S. Imports History: Historical Summary 1991-1995, U.S. Bureau of the Census

Table C2:
Oakland-San Francisco Customs District Exports and Imports, 1994: Pulp & Paper Products

Commodity Code	Commodity Type	Exports						Imports						Total Net Exports	
		Liner Vessels		Tramp Vessels		Total		Liner Vessels		Tramp Vessels		Total			
		10^3 kg	$1,000	10^3 kg	$1,000	10^3 kg	$1,000	10^3 kg	$1,000	10^3 kg	$1,000	10^3 kg	$1,000	10^3 kg	$1,000
2512x	Mechanical Pulp	488	126	0	0	488	126	19	5	0	0	19	5	469	121
2513x	Chemical Pulp, dissolving grades	1398	1087	0	0	1398	1087	29	23	0	0	29	23	1369	1064
2514x	Chemical Pulp, soda or sulfate, unbleached, non-dissolv.	0	0	6516	3178	6516	3178	0	0	0	0	0	0	6516	3178
2515x	Chemical Pulp, soda or sulfate, bleached, non-dissolving	87464	44697	48534	27658	135998	72355	0	0	0	0	0	0	135998	72355
2516x	Chemical Pulp, sulfite	613	196	5552	2405	6165	2601	9	3	0	0	9	3	6156	2598
2519x	Semi-Chemical Pulp (wood and non-wood)	1724	929	378	268	2102	1197	922	104	0	0	922	104	1180	1093
2511x	Waste Paper	579066	65131	29342	3016	608408	68147	2	0	0	0	2	0	608406	68147
25111	Waste Paper: unbleached kraft or paperboard or corrug.	213794	22048	14280	1473	228074	23521	2	0	0	0	2	0	228072	23521
25112	Waste Paper: bleached chemical pulp	83315	11988	5452	784	88767	12772	0	0	0	0	0	0	88767	12772
25113	Waste Paper: mechanical pulp (newpapers, etc.)	202881	21620	5852	624	208733	22244	0	0	0	0	0	0	208733	22244
25119	Waste Paper: other (unsorted scrap)	79076	9488	3758	451	82834	9939	0	0	0	0	0	0	82834	9939
6411x	Newsprint	3119	1561	0	0	3119	1561	16258	30842	37454	14415	53712	45257	-50593	-43696
6412x	Paper & Paperboard: unbleached; writing, printing	4336	10180	106	48	4442	10228	12622	8898	1314	806	13936	9704	-9494	524
6413x	Paper & Paperboard: coated or printed	5730	2964	472	172	6202	3136	11457	10122	505	435	11962	10557	-5760	-7421
6414x	Paper & Paperboard: kraft, uncoated	13235	6144	805	303	14040	6447	281	9431	1	0	282	9431	13758	-2984
6415x	Paper & Paperboard: uncoated	1752	2494	17	37	1769	2531	2532	2663	20	21	2552	2684	-783	-153
6416x	Paper & Paperboard: corrugated or perforated	1943	1256	12999	594	14942	1850	96	378	0	0	96	378	14846	1472

Source: *Port of Oakland*

Note: Items that are underlined are imputed from the Port of Oakland data
Items that are double underlined are imputed from the Census Bureau data (above), subject to the constraints of the Port of Oakland data.

Table C3:
United States Exports and Imports, 1994: Primary, Secondary, and Intermediate Non-Ferrous Metals

Commodity Code	Commodity Type	Exports			Imports			Net Exports	
		10^3 kg	$1,000	$/kg	10^3 kg	$1,000	$/kg	10^3 kg	$1,000
283xx	Copper Ores	329536	393011	1.19	80955	126336	1.56	248581	266675
284xx	Nickel Ores	1746	4440	2.54	101	620	6.14	1645	3820
285xx	Aluminum Ores	129232	11569	0.09	11651705	289775	0.02	-11522473	-278206
2875x	Zinc Ores	412064	176147	0.43	27374	9638	0.35	384690	166509
2876x	Tin Ores	1012	3086	3.05	0	0	0.00	1012	3086
2882x	Nonferrous Waste & Scrap	696062	787863	1.13	616714	754454	1.22	79348	33409
28821	Copper Waste & Scrap	359804	431523	1.20	194413	308735	1.59	165391	122788
28822	Nickel Waste & Scrap	24223	43860	1.81	5752	21749	3.78	18471	22111
28823	Aluminum Waste & Scrap	263797	286447	1.09	362951	402755	1.11	-99154	-116308
28825	Zinc Waste & Scrap	39635	19598	0.49	51676	19809	0.38	-12041	-211
28826	Tin Waste & Scrap	8603	6435	0.75	1922	1406	0.73	6681	5029
6821x	Copper: Unrefined & Refined	186132	425600	2.29	563226	1238680	2.20	-377094	-813080
6823x	Copper: Bars, Rods, Profiles	47592	151904	3.19	85927	236342	2.75	-38335	-84438
6831x	Nickel: Unwrought	8209	32851	4.00	101850	591096	5.80	-93641	-558245
6832x	Nickel: Worked	3959	52135	13.17	9739	92713	9.52	-5780	-40578
6841x	Aluminum: Unwrought	392960	610922	1.55	2552911	3561469	1.40	-2159951	-2950547
6842x	Aluminum: Worked	48244	165335	3.43	54390	126331	2.32	-6146	39004
6861x	Zinc: Unwrought	14351	17767	1.24	793850	770336	0.97	-779499	-752569
6862x	Zinc: Worked	12498	19577	1.57	12387	19132	1.54	111	445
6871x	Tin: Unwrought	2558	13906	5.44	41155	214831	5.22	-38597	-200925
6872x	Tin: Worked	633	3116	4.92	388	2115	5.45	245	1001

Source: U.S. Exports and U. S. Imports History: Historical Summary 1991-1995, U.S. Bureau of the Census

Table C4:
Oakland-San Francisco Customs District Exports and Imports, 1994: Non-Ferrous Metals

Commodity Code	Commodity Type	Exports						Imports						Total Net Exports	
		Liner Vessels		Tramp Vessels		Total		Liner Vessels		Tramp Vessels		Total			
		10^3 kg	$1,000	10^3 kg	$1,000	10^3 kg	$1,000	10^3 kg	$1,000	10^3 kg	$1,000	10^3 kg	$1,000	10^3 kg	$1,000
283xx	Copper Ores	2	7	0	0	2	7	0	0	0	0	0	0	2	7
284xx	Nickel Ores	0	0	0	0	0	0	0	0	0	0	0	0	0	0
285xx	Aluminum Ores	603	1041	7	6	610	1047	2057	6580	70074	978	72131	7558	-71521	-6511
2875x	Zinc Ores	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2876x	Tin Ores	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2882x	Nonferrous Waste & Scrap	79793	77902	4171	5407	83964	83309	108	1168	6	10	114	1178	83850	82131
28821	Copper Waste & Scrap	25209		1453		26662	31017	0	0	6	10	6	10	26656	31008
28822	Nickel Waste & Scrap	507		20		527	926	108	1168	0	0	108	1168	419	-242
28823	Aluminum Waste & Scrap	39086		2418		41504	43716	0	0	0	0	0	0	41504	43716
28825	Zinc Waste & Scrap	11720		263		11983	5747	0	0	0	0	0	0	11983	5747
28826	Tin Waste & Scrap	2633		0		2633	1910	0	0	0	0	0	0	2633	1910
6821x	Copper: Unrefined & Refined	7013	17117	1	0	7014	17117	85	8328	269	592	354	8920	6660	8197
6823x	Copper: Bars, Rods, Profiles	181	5202	2	0	183	5202	1177	5745	0	36	1177	5781	-994	-579
6831x	Nickel: Unwrought	199	864	0	0	199	864	0	0	0	0	0	0	199	864
6832x	Nickel: Worked	209	2841	0	0	209	2841	24	290	0	0	24	290	185	2551
6841x	Aluminum: Unwrought	1487	2260	256	154	1743	2414	4695	4790	21	0	4716	4790	-2973	-2376
6842x	Aluminum: Worked	5394	20155	550	1066	5944	21221	6103	27028	336	1488	6439	28516	-495	-7295
6861x	Zinc: Unwrought	53	47	0	0	53	47	13477	41067	0	0	13477	41067	-13424	-41020
6862x	Zinc: Worked	210	480	0	0	210	480	0	1448	0	0	0	1448	210	-968
6871x	Tin: Unwrought	3	0	0	0	3	0	1264	13138	0	0	1264	13138	-1261	-13138
6872x	Tin: Worked	9259	3238	81	28	9340	3266	6	317	0	0	6	317	9334	2949

Source: *Port of Oakland*

Note: Items that are underlined are imputed from the Port of Oakland data
Items that are double underlined are imputed from the Census Bureau data (above), subject to the constraints of the Port of Oakland data.

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