

ECONOMICS OF STATEWIDE RECYCLING: A CRITICAL REVIEW OF THE CALIFORNIA EXPERIENCE

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ABSTRACT

The state of California has developed an approach to recycling that attempts to overcome the limitations of traditional deposit programs. This approach, initiated by the *California Beverage Container Recycling and Litter Reduction Act of 1986* (commonly known as Assembly Bill 2020 or AB 2020), aims to achieve a recycling rate of 80 percent for all aluminum, glass, plastic, and steel beverage containers through the use of economic incentives. A critical component of the California program is the certified recycling centers created by AB 2020. Prior to the passage of AB 2020 in 1986, there were approximately 463 recycling centers operating in California. Enactment of AB 2020 produced a significant number of new recycling centers so that by the latter part of 1990, the total number of recycling facilities had risen to approximately 2,483. This article addresses the costs, inefficiencies, and problems associated with the certified recycling centers (CRCs). It compares the effectiveness of the older recycling centers, which existed prior to the enactment of AB 2020, with the effectiveness of the new certified recycling centers which have arisen as a result of AB 2020. Effectiveness is evaluated on the basis of volume of material recovered, recycling rates, operational costs, and eligibility for state subsidies. The article concludes that the current CRC system is seriously flawed and has the potential to seriously undermine the state's recycling efforts.

Recognizing the limitations of traditional beverage container deposit programs, the state of California has developed an approach to recycling that attempts to overcome some of the limitations of traditional deposit programs [1]. This approach, initiated by the *California Beverage Container Recycling and Litter Reduction Act of 1986* (commonly known as Assembly Bill 2020 or AB 2020), aims to achieve a recycling rate of 80 percent for all aluminum, glass, plastic, and steel beverage containers in California through the use of economic incentives to consumers [2]. The program's three primary objectives are:

- *Recyclability*: Ensure that each beverage container material (aluminum, glass, plastic, and steel) can be independently and economically recycled.
- *Convenience*: Make redemption and recycling of beverage containers convenient to customers.
- *Profitability*: Create and maintain a marketplace in which recycling centers and locations can provide consumers with recycling opportunities and do so profitably.

AB 2020 employs a unique system featuring four program elements, which are:

- Processing fees;
- Refund values;
- Redemption rates; and
- Convenience zones.

The processing fee is equal to the difference between the average scrap value of a beverage container and the average cost of recycling the container. It is intended to create incentives for beverage manufacturers (who pay the fee) to work with the state to enable the recycling industry to process reclaimed materials economically. The processing fee provides direct funding to recyclers and processors – based on the number of containers handled – to ensure that they can recycle beverage containers for a profit [3].

The refund value is the minimum value that a consumer or recycler receives when redeeming a container for cash. Regardless of whether the consumer returns the beverage container to a recycling center to receive the refund value, or to the processor (scrap dealer) to receive the refund value plus the scrap value, the refund value is intended to provide an economic incentive for consumer participation in the program. Only recycling centers that have been certified by the California Department of Conservation (DOC) can claim refund values, processing fees, or administrative fees from the Department [3].

The redemption rate is the proportion of empty containers returned to processors for recycling. The state aims to achieve redemption rates of 65 percent for aluminum, glass, plastic, and steel containers by June 30, 1992. AB 2020 enables the state to increase the refund values when redemption rates fail to reach the target [3].

A convenience zone is the area within a half-mile radius of any supermarket with \$2 million or more annual sales. AB 2020 requires at least one state-certified recycling center within every convenience zone in order to make redemption and recycling of beverage containers more convenient to consumers. Currently, there are more than 2,500 convenience zones in California, including five rural zones that have been designated by the state as being in areas that are not served by large supermarkets [3].

The California DOC makes Convenience Incentive Payments (CIPs) out of the California Beverage Container Recycling Fund for the establishment of recycling centers within the established convenience zones. Only recycling centers that have been certified by the California DOC are eligible to receive CIPs [3]. Thus, unless stated otherwise, all references to recycling centers in this article refer only to certified recycling centers.

Figure 1 presents an overview of the recycling program under AB 2020.¹ When the consumer returns empty redeemable beverage containers to a certified recycling center, the center pays the consumer the California refund value for the container. Depending on the type of center (staffed versus reverse vending machine), the consumer obtains the refund either: 1) directly from the center or 2) from the dealer (retailer-supermarket) when the consumer is issued a “receipt” from the center.

The center sells the empty redeemable containers to a certified processor, who pays the center:

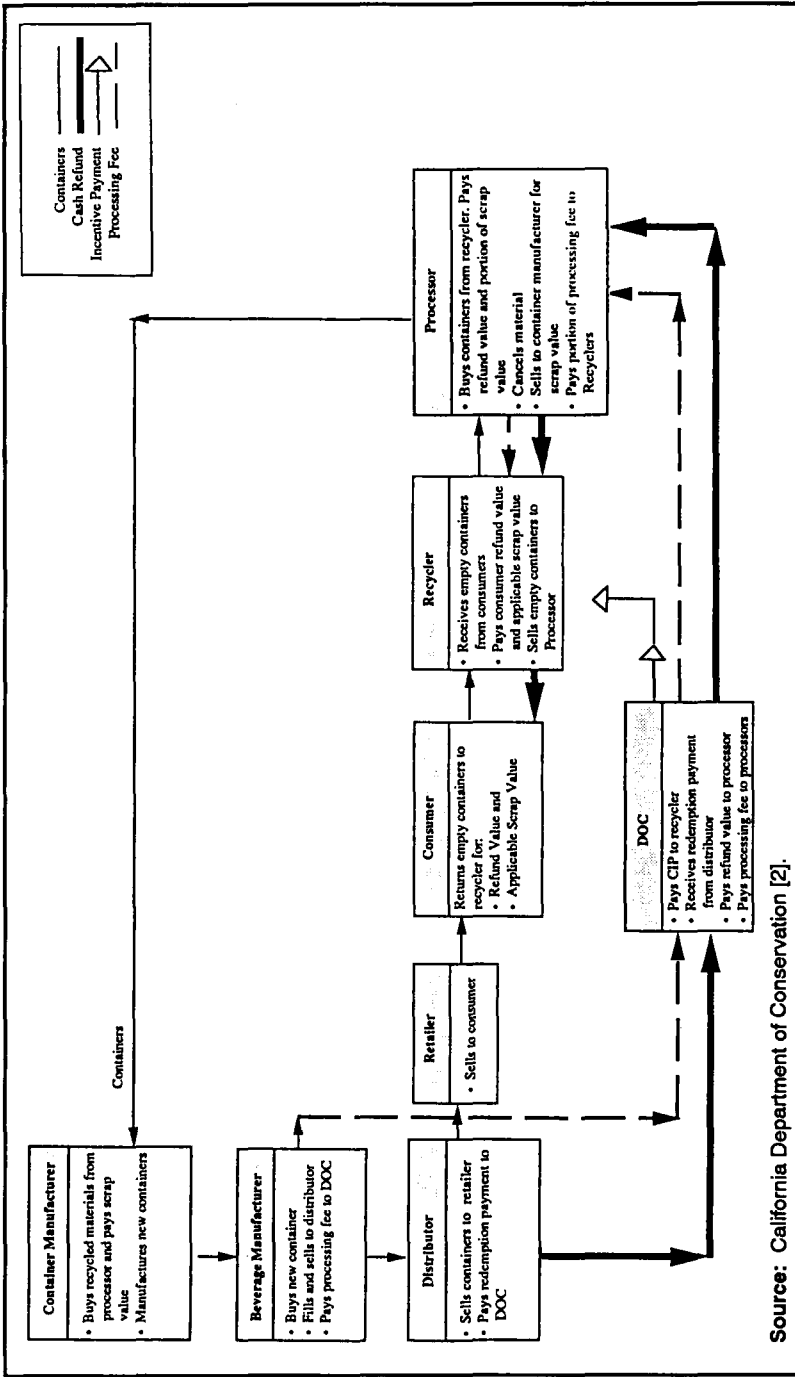
1. The refund value;
2. A portion of the scrap value;
3. A portion of any applicable processing fee; and
4. A portion of the administrative fee paid by the California DOC.

Certified recycling centers that are unprofitable may receive CIPs from the California DOC.

The processor “cancels” the material to remove it from the system, sells the recycled material to a container manufacturer (or other secondary material user) for scrap value, and invoices the California DOC for the refund value, administrative fee, and any applicable processing fee. For 1991, the redemption values, refund values, and processing fees were as follows:

- Redemption value: 2 cents for each container under 24 ounces;
4 cents for each container over 24 ounces.
- Refund value: 2.5 cents for each container under 24 ounces;
5 cents for each container over 24 ounces.

¹ The ensuing description of the California recycling program is extracted from Department of Conservation (Division of Recycling) documentation [4].



Source: California Department of Conservation [2].

Figure 1. Overview of California beverage container recycling program.

- Processing fee: 0.659 cent per glass container sold in California;
0.789 cent per plastic container sold in California;
3.789 cents per non-aluminum container sold in California;
0 cents per aluminum container sold in California.

This article addresses the costs, inefficiencies, and problems associated with the certified recycling centers. It compares the effectiveness of recycling centers existing prior to AB 2020 with that of centers established by the act. Effectiveness is evaluated in terms of recycling rates and volumes, operating costs, and extent of state subsidy.

CERTIFIED RECYCLING CENTERS (CRCs)

Prior to the passage of AB 2020 in 1986, there were approximately 463 recycling centers operating in the state of California. Enactment of AB 2020 produced many new recycling centers so that by the latter part of 1990 the total number of certified recycling centers had risen to approximately 2,484. Of this, 593 were reverse vending machines; the remainder were staffed buy-back centers [5].

Table 1 presents a breakdown of the various types of recycling centers. As depicted, the overwhelming majority of the recycling centers (65.5%) are located in supermarket parking lots. Of the post-AB 2020 (new) recycling facilities, some 78.2 percent are located in supermarket parking lots.

Table 2 depicts the net change in recycling rates over the period 1987 to 1990 for all recyclers and for pre-AB 2020 recyclers. Overall, recycling volume at pre-AB 2020 recyclers increased 14 percent, or 687 million additional containers, between 1987 and 1990. The increase was 28 percent before adjusting for increases in beverage container sales since 1987 [4]. The annual volume of aluminum containers recycled at pre-AB 2020 centers may not have changed since program inception after adjusting for increased beverage sales.

Table 1. Number and Location of Certified Recycling Centers (CRCs)

Location of Recycling Center	Number of Centers	
	Pre-AB 2020	Post-AB 2020
In Convenience Zone (CZ)		
• Not at supermarket	131	189
• At supermarket	48	1,580
Outside Convenience Zone (CZ)	284	252
Total	463	2,021

Source: California Department of Conservation [4].

Table 2. Net Change in Recycling Rates:
Pre- versus Post-AB 2020 Recycling Centers

Material	Annual Recycling Rates (Percentages)			
	All Recycling Centers		Pre-AB 2020 Centers	
	1987	1990	1987	1990
Aluminum	45	76	45	44
Glass	10	51	10	22
Plastic	0	31	0	11

Source: California Department of Conservation [4].

Table 3. 1990 Percentages of Returned Beverage Containers
by Facility and Beverage Container Type^a

Type of Recycling Center	Number of Centers	Types of Containers (Percentages)			
		All	Aluminum	Glass	Plastic
Curbside, drop off, and collection programs	205 ^b	11.3	7.9	28.1	4.5
Pre-AB 2020 centers					
• In CZs ^c	179	21.7	21.7	22.2	17.9
• Outside CZs	284	34.3	37.2	22.0	22.8
Post-AB 2020 (new centers)					
• In CZs	1,769	20.1	20.7	15.7	43.3
• Outside CZs	252	12.4	12.5	11.9	11.4
Total	2,689				

Source: California Department of Conservation [4].

^a First eight months of 1990.

^b Curbside facilities; other, unknown.

^c Convenience zones.

The proportions of beverage containers returned for recycling in 1990 (first eight months) at each type of recycling center are presented in Table 3 for each material type. Pre-AB 2020 recycling centers accounted for 56 percent of the beverage containers recycled in California in 1990. For the same period, post-AB 2020 recycling centers accounted for 32.5 percent of all beverage containers recycled in California. Pre-AB 2020 recycling facilities accounted for 58.9 percent of aluminum and 44.2 percent of the glass containers recycled, while post-AB 2020 facilities accounted for 33.2 percent and 27.6 percent respectively. Recycled plastic beverage containers at pre-AB 2020 facilities represented 40.7 percent of the 1990 total, compared to 54.7 percent for the newer centers.

Table 4. Increase in Recycling Level by Facility and Beverage Container Type: 1990 versus 1989

Facility Type	Percent Increase in Recycling Level ^a				Percent of Recycled Beverage Containers	
	All	Aluminum	Glass	Plastic	1990	1989
Curbside, drop-off, and collection programs	34.0	30.0	51.0	1.0	11.3	3.0
Pre-AB 2020 recycling centers	18.0	17.0	16.0	42.0	56.1	71.0
Post-AB 2020 recycling centers	48.0	53.0	33.0	57.0	32.6	26.0
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: California Department of Conservation [4].

^a 1.7 billion additional beverage containers were recycled: 1990 (first eight months) versus 1989 (first eight months).

Table 3 also illustrates the fact that although the pre-AB 2020 facilities are much fewer in number than the new recycling centers established via AB 2020, the pre-AB 2020 facilities outside of the convenience zones account for the largest proportion of recycled beverage containers – 34.3 percent of all beverage containers recycled, and 37.2 percent of the aluminum beverage containers recycled.

A comparison of the shares of beverage containers recycled in 1989 and 1990 for each type of recycling facility is depicted in Table 4. Pre-AB 2020 facilities showed a moderate decline in the proportion of beverage containers recycled – from 71 percent in 1989 to 56 percent in 1990. Post-AB 2020 facilities showed a slight increase – from 26 percent in 1989 to 32 percent in 1990.

Table 4 also demonstrates that pre-AB 2020 facilities represented 18 percent of the increase (1.7 billion additional beverage containers) in recycled beverage containers between 1989 and 1990. New facilities represented 48 percent of the increase; while curbside, drop-off, and collection programs represented 34 percent. Pre-AB 2020 facilities accounted for 42 percent of the increase in recycled plastic beverage containers. The 1989 and 1990 data demonstrate the continuing dominance of pre-AB 2020 recycling facilities, although the fastest rates of increase in overall beverage container recycling and aluminum and plastic beverage container recycling were experienced by the post-AB 2020 facilities. It is notable, however, that 69 percent of the post-AB 2020 recycling centers received CIPs in 1990, compared to only 1 percent of the pre-AB 2020 recycling centers [4]. This is discussed further in the following section.

CONVENIENCE INCENTIVE PAYMENTS (CIPs)

Convenience incentive payments (CIPs) are special payments made by the California DOC to certified recycling centers (CRCs) that serve as the sole redemption location in a convenience zone and that realize a net average monthly financial loss. CIPs are paid from the California Beverage Container Recycling Fund which is funded from proceeds from unredeemed containers. Originally envisioned as a mechanism to help ensure opportunities for beverage container recycling in rural or costly locations, CIPs have developed into a funding mechanism to keep the majority of new certified recycling centers in operation. Originally, AB 2020 provided that the CIP program cease on January 1, 1991. However, in 1988 this date was extended to January 1, 1993. The time extension was supported by both recyclers and retailers – recyclers requested a guaranteed income stream for five years in order to ensure financing for the establishment of convenience zone-based certified recycling centers; retailers supported this extension because they relied upon these centers to meet the AB 2020 convenience requirements [4].

Under AB 2020, CIPs are intended to be relatively short-term payments, to be used only to support certified recycling centers until such time that the centers' customer bases become sufficient to support the centers. Instead, the CIP has become more of a long-term support for a large number of unprofitable, inefficient certified recycling centers established pursuant to AB 2020. CIP expenditures of \$7 million in 1988 ballooned to \$13 million in 1991 [4].

A major goal of AB 2020 is that each container type mandated for redemption will, on its own and in sufficient volume, be able to be economically recycled. Under this scenario, CIPs would be needed only by those centers which were not receiving sufficient volume or mix of containers, mainly due to an inefficient recycling of glass and plastic [4]. Volumes of containers recycled and reliance on CIPs of each type of recycling facility are illustrated in Tables 5 and 6. In 1990, 1,408 of the 2,484 certified recycling centers operating in California received CIPs. This represents approximately 57 percent of the recycling centers operating in California. Further analysis indicates that 1,403 out of the 1,408 certified recycling centers receiving CIPs are post-AB 2020 (new) facilities. In essence, 69 percent (1,403 out of 2,021) of the new recycling centers received CIPs in 1990. This is in comparison with 1 percent of pre-AB 2020 recycling centers that received CIPs (5 out of 463 centers).

Moreover, as depicted in Table 5, the post-AB 2020 facilities receiving CIPs recycled a substantially smaller volume (average of 49,000 containers per month) in comparison to the pre-AB 2020 facilities that received CIPs (average of 395,000 per month). Overall, post-AB 2020 centers recycled an average of 164,000 containers per month, while the pre-AB 2020 centers recycled an average of 944,000 containers per month. Thus, the average monthly recycling volume for pre-AB 2020 facilities was six times greater than that for new facilities.

Table 5. 1990 Materials Mix, Volumes, and Reliance on CIPs:
Pre-AB 2020 versus Post-AB 2020 CRCs (January through August 1990)

Type of Recycling Center	Recycling Centers		Mix of Materials (Percentages)			Average Monthly Volume (000s)
	Number	Percent of Total	Aluminum	Glass	Plastic	
Pre-AB 2020 centers						
• In CZ ^a ; received CIP	5	<1	82	17	1	395
• In CZ; no CIP	174	7	81	18	1	986
• Outside CZ; no CIP	284	11.4	88	11	1	982
All pre-AB 2020 centers	463					977
Post-AB 2020 centers						
• In CZ; received CIP	1,403	56.6	76	18	6	49
• In CZ; no CIP	366	14.7	88	10	2	368
• Outside CZ; no CIP	252	10.2	82	17	1	505
All post-AB 2020 centers	2,201					164
Total	2,484	100.0	81	17	2	

Source: California Department of Conservation [4].

^a Convenience zone.

Table 5 also illustrates the mix of material recycled at the different types of recycling facilities. The new facilities receiving CIPs recycled a moderately lower proportion of aluminum containers (76 percent) in comparison to all other categories of recycling centers (81 to 88 percent). This reinforces the argument that CIPs may in essence be subsidizing glass and plastic recycling at these facilities – counter to the intent of the CIP program and the recyclability goal under AB 2020.

Table 6 relates the proportion of beverage containers recycled at the various types of recycling facilities to the CIPs received by these centers. The 1,403 new centers receiving CIPs accounted for only 8 percent of all beverage containers recycled by recycling centers during the first eight months of 1990. The pre-AB 2020 centers (only five of which received CIPs) accounted for about 68 percent.

The unprofitability and inefficiency of the new certified recycling centers created by AB 2020 is further depicted in Table 7, which demonstrates the degree to which post-AB 2020 recycling centers rely on CIPs to stay in operation. For two-thirds of the new certified recycling centers receiving CIPs in 1990 (939 of the 1,403 centers), the CIP payments represented over 50 percent of the centers' total revenues. For an additional 26 percent (368 of the 1,403 centers), CIP payments represented 26 to 50 percent of total revenues.

Table 6. 1990 CIPs and Beverage Containers Recycled:
Pre-AB 2020 versus Post-AB 2020 (January through August 1990)

Type of Recycling Center	Number of Centers	Percent of Total	Percent of Total CIPs Paid	Percent of Total Containers Recycled
Pre-AB 2020 centers				
• In CZ ^a ; received CIP	5	<1	<1	<1
• In CZ; no CIP	174	7	0	25
• Outside CZ; (no CIP)	284	11.4	0	42
Subtotal, pre-AB 2020 centers	463			68
Post-AB 2020 centers				
• In CZ; received CIP	1,403	56.6	100	8
• In CZ; no CIP	366	14.7	0	12
• Outside CZ; (no CIP)	252	10.2	0	12
Subtotal, post-AB 2020 centers	2,021			32

Source: California Department of Conservation [4].

^a Convenience zone.

Table 7. Reliance on CIPs for Revenues by Post-AB 2020 CRCs
(January through August 1990)

CIP as a Percent of Total CRC Revenues	CRCs Receiving CIPs	
	Number	Percent
0 - 25	101	7.2
26 - 50	368	26.1
51 - 75	678	48.2
76 - 100	261	18.5
Total	1,408 ^a	100.0

Source: California Department of Conservation [4].

^a Totals include five pre-AB 2020 recycling centers receiving CIPs.

Table 8 further breaks down the certified recycling centers receiving CIPs by facility type – staffed buy-back centers versus vending machines. As depicted, the reverse vending machines on average receive one-third the volume of containers and three times the CIP payment per container than do staffed buy-back centers. The reverse vending machine centers are extremely inefficient operations.

Table 8. Characteristics of Staffed Buy-Back Centers versus Reverse Vending Machine Buy-Back Centers

Type of Recycling Center	Number of Centers Receiving CIPs		Percent of Total Centers	Average Monthly Volume (Containers)	Average 1990 Monthly CIP (\$)
	1989	1990			
Reverse vending machines	425	556	93.8	24,500	862
Staffed buy-back centers	919	847	95.8	65,600	896
Total	1,344	1,403 ^a			

Source: California Department of Conservation [4].

^a All post-AB 2020 facilities.

In summary, CIPs are currently awarded only to certified recycling centers that demonstrate a financial need. Thus, in order to receive money, a recycling center must be unprofitable. Since the current \$18.5 million CIP allowance is sufficient to cover losses at most existing sites, operators have little incentive to reduce costs. Although under AB 2020 CIPs are intended to "establish" convenient recycling as opposed to maintain long-term recycling, most facilities receiving CIPs would not continue to operate if CIPs were discontinued. These centers have and will continue to rely upon these payments in order to remain in operation [4]. The deadline for ending the CIP program, now January 1, 1993 (as noted), is likely to be extended once again.

The California DOC reports that although the efficiency of recycling centers has improved as recycling volumes have increased (less CIP paid per container recycled, even as scrap values have declined), there is a fairly consistent reliance on CIPs of about \$1 million dollars per month statewide [4]. In addition, the priority for awarding CIPs encourages aluminum recycling and discourages recycling of glass and plastic. Centers that take in more glass or plastic containers typically have much higher operating costs while recovering much more weight in containers than centers that take in more aluminum. Yet these centers may be given lower priority because they may have lower container volume. In addition, the 5 cent per container cap favors aluminum over glass or plastic. Centers that recycle the more profitable aluminum containers are provided the same financial incentive as centers that recycle more of the less profitable glass or plastic. The per container cap, by not taking into account the type of material being recycled, ignores AB 2020 goals for each material [4].

Table 9. 1990 Average Monthly Profits and Losses:
Pre-AB 2020 versus Post-AB 2020 CRCs^a

Type of CRC	Number of CRCs	Average Monthly Profit (Loss) (\$)				Break-Even Point (Number of People)
		Aluminum	Glass	Plastic	Total	
Pre-AB 2020 Centers:						
• In CZ ^b ; received CIP	5	n/a ^c	n/a	n/a	n/a	n/a
• In CZ; no CIP	174	5,941	(2,310)	(547)	3,084	25,000
• Outside CZ; no CIP	284	7,398	(1,524)	(545)	5,329	15,000
Post-AB 2020 Centers						
• In CZ; received CIP	1,403	(177)	(636)	(556)	(1,369)	None ^d
• In CZ; no CIP	366	2,142	(1,358)	(312)	472	12,000
• Outside CZ; no CIP	252	3,486	(1,475)	(325)	1,686	13,000

Source: California Department of Conservation [4].

^a Estimates based on a representative sample of 100 CRCs and covers January through August 1990.

^b Convenience zone.

^c Data for the five pre-AB 2020 CRCs that received CIPs were not available

^d No break-even point.

ECONOMICS OF CERTIFIED RECYCLING CENTERS (CRCs)

The economic viability of a recycling center depends chiefly on five factors [4]:

1. Variable costs;
2. Fixed costs;
3. Scrap values;
4. Average monthly recycling level; and
5. Average materials mix.

This section evaluates the economic viability of pre-AB 2020 and post-AB 2020 recycling centers.²

Table 9 presents the average monthly profits and losses for 1990 in pre-AB 2020 versus post-AB 2020 recycling centers. Data for the five pre-AB 2020 centers that receive CIPs were not available. As depicted, pre-AB 2020 recycling centers were substantially more profitable than those established via AB 2020. On average, each of the 1,403 new recycling centers receiving CIPs lost \$1,369 per month; only 618 (30.6%) of the new recycling centers were profitable in their own right (operated without a CIP). Table 9 also illustrates that, on average, none of the certified recycling centers recycled glass or plastic profitably. As a

² The analyses discussed in this section are based on a sample of 100 recycling centers. The sampling and initial detailed analysis were conducted by the California Department of Conservation (assisted by Ernst & Young and R. W. Beck and Associates) and presented in [4].

Table 10. Pro Forma Economics of CRCs by Type, for Aluminum Recycling^a

	Pre-AB 2020 CRCs			Post-AB 2020 CRCs		
	In CZ ^b (CIP) (\$)	In CZ (No CIP) (\$)	Outside CZ (No CIP) (\$)	In CZ (CIP) (\$)	In CZ (No CIP) (\$)	Outside CZ (No CIP) (\$)
Scrap revenues	n/a ^c	13,213	14,243	601	5,320	6,864
Variable costs	n/a	4,497	5,013	701	2,325	2,184
Fixed cost	n/a	2,775	1,832	77	853	1,194
Profit (loss)	n/a	5,941	7,398	(177)	2,142	3,486
Number of people supporting center	n/a	38,000	41,000	2,000	16,000	20,000

Source: California Department of Conservation [4].

^a Based on a representative sample of 100 certified recycling centers.

^b Convenience zone.

^c Data for the five pre-AB 2020 centers that received CIPs were not available.

Table 11. Pro Forma Economics of CRCs by Type, for Glass Recycling^a

	Pre-AB 2020 CRCs			Post-AB 2020 CRCs		
	In CZ ^b (CIP) (\$)	In CZ (No CIP) (\$)	Outside CZ (No CIP) (\$)	In CZ (CIP) (\$)	In CZ (No CIP) (\$)	Outside CZ (No CIP) (\$)
Scrap revenues	n/a ^c	2,453	1,529	129	549	1,176
Variable costs	n/a	2,190	2,048	658	1,499	987
Fixed cost	n/a	2,573	1,005	107	408	1,664
Profit (loss)	n/a	(2,310)	(1,524)	(636)	(1,358)	(1,475)
Number of people supporting center	n/a	39,000	24,000	2,000	9,000	19,000

Source: California Department of Conservation [4].

^a Based on a representative sample of 100 certified recycling centers.

^b Convenience zone.

^c Data for the five pre-AB 2020 centers that received CIPs were not available.

result, the recyclability goal under AB 2020 is not being met because glass and plastic have not proved their own ability to be recycled. It is also notable that although the pre-AB 2020 facilities require the largest volume to break even, they are more profitable than the new facilities. No break-even volume exists for the new recycling facilities that receive CIPs (this is explained further in Tables 10 through 12).

Table 12. Pro Forma Economics of CRCs by Type, for Plastic Recycling^a

	Pre-AB 2020 CRCs			Post-AB 2020 CRCs		
	In CZ ^b (CIP) (\$)	In CZ (No CIP) (\$)	Outside CZ (No CIP) (\$)	In CZ (CIP) (\$)	In CZ (No CIP) (\$)	Outside CZ (No CIP) (\$)
Scrap revenues	n/a ^c	341	303	76	152	190
Variable costs	n/a	698	702	577	388	431
Fixed cost	n/a	190	146	55	76	84
Profit (loss)	n/a	(547)	(545)	(556)	(312)	(325)
Number of people supporting center	n/a	30,000	28,000	8,000	15,000	18,000

Source: California Department of Conservation [4].

^a Based on a representative sample of 100 certified recycling centers.

^b Convenience zone.

^c Data for the five pre-AB 2020 centers that received CIPs were not available.

Tables 10 through 12 present the relative economics of recycling in 1990 for each material impacted by AB 2020 and for each type of recycling facility. As depicted in Table 10, scrap revenues from aluminum exceed variable costs for all certified recycling centers except the new facilities receiving CIPs. For all but these facilities, further increases in the volume of aluminum beverage containers recycled will increase profits. For the 1,403 new facilities, the negative scale economies (variable cost per unit exceeding scrap value per unit) means that further increases in recycling volume will magnify losses – a break-even volume does not exist at current scrap prices and variable costs. Consequently, these facilities will require long-term maintenance through CIP subsidies.

Table 11 addresses the economics of the various types of recycling centers for glass. As depicted, the post-AB 2020 certified recycling centers in convenience zones (87.5% for all post-AB 2020 CRCs) have variable costs which exceed scrap revenues for glass. Increased recycling volume will only magnify losses. The same conclusion can be drawn for approximately 284 pre-AB 2020 facilities outside the convenience zones. In the case of plastic (Table 12), each type of recycling center demonstrates negative scale economies. On average, plastic fails to demonstrate its own recyclability for all types of recycling facilities.

Putting the cost data on a per unit basis also indicates that the pre-AB 2020 facilities have the lowest costs, rarely rely on CIPs, recycle the largest number of containers, and have a higher proportion of aluminum relative to glass and plastic [4]. This is true despite the fact that these facilities require the largest population base to break even. The pre-AB 2020 centers have well-established customer bases, handling procedures, marketing channels, production reporting, and equipment due to their years of recycling the three primary materials. Also, many pre-AB 2020 facilities are dual certified (i.e., certified as a recycler and a processor)

and share labor and economies between the two entities. The post-AB 2020 certified recycling centers typically rely on CIPs, have low recycling volumes, recycle a lower proportion of aluminum beverage containers, and demonstrate negative scale economies for all three materials [4]. Over the longer term, these facilities will not survive without CIP subsidies.

In summary, glass and plastic are currently (1990) not profitable for any of the five types of recycling facilities (Tables 11 and 12). Variable costs for plastic are higher than the scrap value of plastic for all five types of recycling centers. The more plastic a recycling center receives, the greater the loss on plastic. For glass, the evidence suggests the possible existence of slight scale economies, given the variability among the recycling centers. The key to profitability for a center appears to be high volume (absolute level and proportion) of aluminum beverage containers.

ADDITIONAL PROBLEMS WITH CRCs

Processing Fees and Recycled Materials Markets

Prior to enactment of AB 2020, recycling centers would most likely collect materials only if collection costs were less than the scrap values received. Thus, demand for materials on the free market drove recycling, and recycling centers operated where potential volume would be high, and usually collected only high-value materials like aluminum. Under AB 2020, which mandates the collection of unprofitable materials which previously had low recycling levels (such as glass, plastic, and non-aluminum metal beverage containers), recycling centers in California need to resort to either: a) subsidizing collection of low-value materials with collection of high-value materials, or b) increasing reliance on the CIP to cover losses. The California DOC reports that AB 2020 has had a significant effect on recycling and markets in California. The economic incentives to consumers, coupled with the mandates to collect aluminum, glass, and plastic beverage containers, have flooded the system with increased volumes of materials [4]. Since enactment of AB 2020, aluminum recycling increased 69 percent and glass 410 percent. Recycling of plastic beverage containers increased from zero containers prior to AB 2020 to 172 million in 1990 (31% of all plastic containers sold). Since demand for these materials has not increased at the same rate as the supply, particularly for glass and plastic, market values for these materials have fallen. Over the period January 1988 through June 1990, recycled aluminum prices declined by over 26 percent, recycled glass by over 20 percent, and recycled plastic by over 12 percent [4]. These decreases in scrap values have resulted in progressively smaller operating margins for recycling centers. The problem is especially acute for glass and plastic, which saw a dramatic increase in recycling volume and decrease in scrap value, so that the scrap value became insufficient to cover collection and processing costs.

In order to compensate recycling centers for losses due to the difference in scrap values and collection costs, AB 2020 implements a processing fee on glass and plastic. This fee is paid by beverage manufacturers (though a portion may be repaid by container manufacturers) into the California Beverage Container Recycling Fund administered by the state, which makes payments to processors.

Since the current fees have been in effect only from January 1, 1991, their effect on the system has not yet been estimated. The processing fee is based on the average recycling costs of larger-volume, lower-cost centers in California, which did not receive a CIP. Since the higher operational costs of centers which received CIPs are not included in the average, processing fees alone do not completely offset recycling costs for over half the centers in California; these centers rely on CIPs to stay in operation. Thus, due to the economic inefficiencies of the system, CIPs will remain an important source of funding for centers established pursuant to AB 2020 [4].

The future of the market for secondary materials in California is also likely to be affected by AB 939 which became effective in January 1990. Since AB 939 mandates reductions in solid waste of 25 percent by 1995, and 50 percent by 2000, local communities in California will have to adopt recycling programs, contributing significantly to the recycling of beverage containers as well as other secondary materials. The additional volume of materials collected as a result of these new programs will most likely impact markets for beverage containers.

Further, as other states strengthen their recycling programs, there could be an increase in the supply of recycled aluminum nationally. Although it is unlikely that the scrap value for aluminum would decline to the point where its collection is no longer economic, the national supply exceeding demand could result in regionalized market softening or, at the worst, softening of the market nationally [4].

The market for glass is also likely to be affected by AB 939. Under AB 939, recycling programs will collect not only California redemption value (CRV) glass, but also non-CRV glass containers. The California DOC states that according to waste generation studies, twice as much non-CRV glass is generated in California than CRV glass [4]. In addition, recycling of non-CRV glass is currently occurring at a low level. Thus, as local recycling programs proliferate, glass cullet could flood the market. Unless there is a strong increase in end-use markets for glass, the near-term future for glass appears bleak [4].

Disincentives to Retailers

AB 2020 provides little or no incentive to the dealer or retailer to encourage the redemption of containers. If containers are redeemed inside the store, the retailer is likely to lose money on the process. If they are redeemed outside, the process is paid primarily through CIPs, so that the retailer has no incentive to encourage cost-effective operations.

Supermarket chains contract with recycling center operators for redemption of empty beverage containers as required by AB 2020 but have little control over the centers. Since financial losses incurred by recycling centers are covered by the state up to the limit of the CIP, the only control the retailer has over the center is the option of cancelling the contract, which places both the recycler and the retailer at risk. Retailers also incur indirect costs associated with redemption of empty beverage containers. Often, retailer hosts for recycling centers redeem credit slips representing container redemptions. Also, when retailers use reverse vending machines, they are responsible for filling the machines with coins. In addition to these inconveniences and operating costs, retailers must wait for an extended period for reimbursement from recycling center operators.

The ability of retailer hosts to enforce quality standards on recycling centers is also limited. Since the center operators may owe the supermarkets thousands of dollars in credit slip reimbursements, supermarkets are reluctant to demand quality improvements in order not to jeopardize the reimbursement payments.

Impact of Curbside Programs

Curbside programs in California have proliferated with the advent of AB 2020. There currently are 171 city-wide or county-wide programs, thirty-four pilot programs, and approximately sixty-four planned programs [6]. AB 2020 has provided approximately 50 percent of the revenues for curbside programs; scrap values have provided the other half. Curbside programs accounted for one-third of the net increase in recycled containers in 1990 (first eight months) and almost one-third of all glass CRV containers recycled.

The primary concern over curbside programs is their potential impact on recycling centers. In the long term, when recycling rates are higher, it is likely that many beverage containers which might otherwise be brought to a recycling center will instead be placed at the curb for pickup if it is more convenient for the consumer to do so [4].

Adverse Differential between Redemption Value and Refund Value

AB 2020 relies on the unredeemed redemption payments for funding CIPs, refund values, administrative fees to recyclers and processors, and all other expenditures from the California Beverage Container Recycling Fund. In the fiscal year ending June 30, 1990, \$218 million was paid into the Fund in redemption payments, while \$130 million was paid out in refund values (non-recyclers pay effectively 20% of the refund value paid to recyclers). The remaining \$88 million represents essentially the costs to consumers who do not recycle [4].

According to the California DOC, the overall recycling rate for the period between July and December 1990 (the latest published data) is 67 percent [5]. Table 13 breaks down redemption and recycling rates for each of the materials.

Table 13. Redemption and Recycling Rates for Aluminum, Glass, Plastic, and Steel Beverage Containers: July 1 through December 31, 1990

Material	Redemption Rate (Percent)	Recycling Rate (Percent)
Aluminum	72	72
Glass	61	58
Plastic	40	40
Steel	4	4
Overall	67	67

Source: California Department of Conservation [4].

Under the present scenario, when the recycling rate reaches 80 percent, there will be no unredeemed redemption payments because the amount paid in to the California Beverage Container Recycling Fund by consumers will equal the amount paid out. When recycling rates exceed 80 percent, the program will have no net funds for paying refund values. In practicality, the Fund would actually deteriorate at recycling rates lower than 80 percent due to program costs other than refund values, i.e., CIPs, grants, and administrative costs [4].

Thus, as recycling rates increase, the solvency of the California Beverage Container Recycling Fund is weakened. Before program costs and refund values paid out exceed total redemption payments received into the Fund (which is likely to occur at a recycling rate of about 65 percent), the DOC is allowed to increase the redemption payment in order to increase revenues to the Fund. However, current statutes also endanger the solvency of the Fund because they provide for an automatic increase in the spread between redemption payments and refund values (from a 2 cent redemption payment and 2.5 cent refund value, to a 3 cent redemption payment and 5 cent refund value for any materials not reaching a 65 percent redemption rate), by June 30, 1992. The increase would become effective January 1993 [4].

CONCLUSIONS

AB 2020 seeks to achieve recycling rates of 80 percent for all aluminum, glass, plastic, and steel beverage containers in California. In order to reach these goals, it subsidizes the establishment of new recycling centers within established convenience zones through its CIP program. Prior to the enactment of AB 2020,

approximately 463 recycling centers were in operation in California. About 2,021 new centers were established as a result of AB 2020. Although these new centers have shown increases in recycling rates, most are economically inefficient, require CIPs to remain in operation, handle only a small proportion of the beverage containers recycled in California, and demonstrate negative scale economies for plastic, glass, and even aluminum.

Under AB 2020, CIPs were intended to be short-term subsidies to support recycling centers until they established adequate customer bases. These payments have now developed into a long-term support mechanism for a large number of unprofitable recycling centers established by AB 2020. In 1990, 69 percent of the post-AB 2020 centers received CIPs as compared to only 1 percent of the pre-AB 2020 centers. For almost two-thirds of post-AB 2020 facilities (939 of the 1,403 that receive CIPs), CIP payments represent over 50 percent of the centers' total revenues. For an additional 26 percent, CIP payments represent 26 to 50 percent of total revenues. On average, each of the new recycling centers receiving CIPs lost \$1,369 per month. Only about 30 percent of the new centers were profitable so that they did not require CIPs.

The new recycling centers demonstrate a higher increase in the overall recycling rate relative to the centers that were in operation prior to AB 2020 (48% versus 18%). However, the pre-AB 2020 facilities handle a volume of beverage containers which is six times greater than that of the new facilities (an average of 977,000 containers per month as compared to 164,000 container per month). In 1990, the older facilities accounted for 68 percent of the beverage containers recycled by recycling centers, while the new facilities accounted for 32 percent. Of the new facilities, those that received CIPs handled only 8 percent of the containers recycled in California. Although the new facilities demonstrate a higher rate of increase in the number of containers recycled, the older facilities continue to dominate recycling in California despite the fact that they require a larger population base to break even.

In terms of profitability for each of the three materials covered under AB 2020, scrap revenues from aluminum exceed variable costs for all types of recycling centers except the new certified facilities that receive CIPs. Thus, for the centers that show profits for aluminum, further increases in the volume of aluminum containers will increase profits; for the new centers that receive CIPs and show negative scale economies for aluminum, further increases in aluminum recycling volume will magnify losses. For glass and plastic containers, most recycling centers demonstrate negative scale economies, so that increased recycling volume of these materials will magnify losses and maintain the need for CIPs. Thus, aluminum recycling has been subsidizing glass and plastic in California.

The subsidized collection of unprofitable materials under AB 2020 has significantly impacted markets in California. Markets have been flooded with these materials, and since demand has not increased at the same rate as the supply, particularly for glass and plastic, scrap values for these materials have fallen.

Decreased scrap values have resulted in diminishing operating margins for recycling facilities, so that they resort to relying on CIPs in order to stay in operation.

Moreover, since the current \$18.5 million CIP allowance is sufficient to cover losses at most recycling centers, operators of recycling facilities have little incentive to reduce operational costs. Although CIPs were not intended to support long-term recycling under AB 2020, they have, again, become a funding mechanism to keep the majority of new recycling centers in operation. The original date for termination of the CIP program under AB 2020 (January 1, 1991) was extended to January 1, 1993. Due to their heavy reliance on CIPs, most of the new recycling centers would not continue to operate if these subsidies were discontinued.

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