MAE321 Impact Essay
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The Case for Secondary Aluminum Smelting and Can Manufacturing in Trenton, New Jersey

Abstract

This paper aims to illustrate new opportunities for synergy between the aluminum and recycling industries and argues that an economically profitable, environmentally sustainable and socially equitable aluminum manufacturing enterprise is possible in Trenton, NJ. This paper provides a historical overview of aluminum can manufacturing and Alcoa company towns, followed by a discussion of the feasibility of using secondary aluminum as a source material.

The Aluminum Can

The easy-open aluminum beer can was first introduced in 1962 by the Pittsburgh Brewing Company in collaboration with the Aluminum Company of America (Alcoa) ("Alcoa Celebrates 125 Years"). Since then, containers and packaging have become one of the largest uses of aluminum globally, surpassed only recently by the automobile industry (Das, 24). Over 65 million tons of aluminum are produced annually and the global appetite for the metal continues to grow. Wong et al. estimate that an additional 25-30 million tons of aluminum will need to be produced annually by 2050 (Wong, 3332).

Most aluminum is produced using the Bayer and Hall-Héroult processes, both of which are incredibly energy intensive. A single kilogram of aluminum requires ~45 kWh of energy and ~12 kg of CO_2 to produce (Das, 24). The environmental impacts of this production cycle are immense. The aluminum industry alone accounts for 1% of greenhouse gas emissions (Neuman). However, the socioeconomic impacts of the aluminum industry – and in some cases its absence – are similarly immense and often overlooked.

Alcoa Company Towns

The socioeconomic impacts of the aluminum industry on the towns it occupies are multifaceted, making it difficult to delineate good from bad. Two illuminating case studies are the towns of Badin, South Carolina and Rockdale, Texas. Badin and Rockdale were so-called "company towns" – towns whose economies, governments and ways of life revolved around the aluminum manufacturing giant Alcoa. In Rockdale, Alcoa employed over 10% of residents and was responsible for 40% of the tax base; in Badin, the town charter – strongly influenced by Alcoa's presence – prohibited regulation of corporations (Sadasivam; Cataneo/Undark).

The legacy of Alcoa in these towns is complicated and fraught with contradiction. In Badin, for example, even as Alcoa offered a lucrative alternative to sharecropping for low-income African Americans, company policies were still characterized by Jim Crow era planning that led to de facto segregation for much of the twentieth century (Cataneo/Undark). Health conditions also reflected the dual nature of Alcoa's policies. Alcoa employees in Badin had greater longevity compared to the rest of the state population – a consequence of a stable

income from consistent employment – but a higher portion of deaths related to breathing diseases and cancer – likely due to contact with heavy metals and PCBs in coal ash, bauxite residue, spent pot lining and other industrial waste (Cataneo/Undark).

This legacy has grown even more complicated in recent years after Alcoa abandoned its smelteries in Badin and Rockdale, leaving behind coal ash, landfills and economic ruin. School enrollment in Rockdale has dropped 17% and commercial business dropped 50% since Alcoa withdrew in 2008 (Sadasivam). Now, many residents look back on the Alcoa years with nostalgia, longing for past prosperity. Others, however, blame Alcoa for leaving them with insufficiently remediated, unmarketable commercial properties that hinder the town's ability to revitalize and attract new businesses.

Debate over whether Alcoa was a philanthropic benefactor or callous exploiter of the working class lingers to this day. The reality is that Alcoa had the potential to be either – and for both better and worse – became both. Alcoa brought economic prosperity even as it perpetuated racial divides; it brought increased longevity even as it saddled employees with chronic health conditions; and it built prosperous communities even as it planned to eventually abandon them. But future ventures need not follow Alcoa's morally ambiguous example. It *is* possible to design an economically profitable, environmentally sustainable and socially equitable aluminum manufacturing enterprise. And such a forward-minded entrepreneurial venture has the opportunity to take root in Trenton, New Jersey.

Trenton, New Jersey

Trenton is similar to Badin and Rockdale in a number of respects. Trenton is a former twentieth century industrial hub that faced a severe economic downturn during the 1970s as many industries began to outsource manufacturing abroad (Mickle). Economic recovery programs such as the Urban Enterprise Zone and the relocation of the New Jersey state government have been used in an attempt to revitalize the city's economy with mixed results (Mickle). The construction of a major aluminum smelter and can manufacturer would be a significant step towards returning Trenton to its former status as an economic hub. However, care must be taken to ensure that such an enterprise is profitable, sustainable and equitable. The key to accomplishing this mission is secondary aluminum.

Secondary Aluminum

Secondary aluminum – recyclable aluminum acquired from waste products such as used cans and automobile parts – is an incredibly valuable resource. Recycling aluminum requires 90-95% less energy and generates 90-95% less CO_2 emissions compared to smelting primary aluminum from bauxite (Das, 24). This makes secondary aluminum more sustainable and more economical to manufacture. In fact, increasing the recycling rate of aluminum cans by just 1% yields savings of over $12 million USD for the aluminum industry; this has led the high concentration of aluminum scrap in cities to be dubbed an "urban mine" (Das, 24). Thus, while most primary aluminum smelting has been outsourced – mainly to the Middle East and Iceland –

in order to capitalize on cheap electricity, secondary aluminum manufacturing remains both feasible and competitive in the United States (Das, 24).

Most secondary aluminum comes from "new scrap", such as short-lived cans, rather than "old scrap", such as long-lived buildings (Rombach, 1015). Since the demand for aluminum products is still growing, and the lifetime of the aluminum products is lengthening (i.e. more aluminum is being used in building and aerospace applications), the recycled content of aluminum products as a whole is expected to remain low through mid-century (Rombach, 1019). Nevertheless, the total amount of aluminum waste available is expected to increase significantly in the near future (Rombach, 1018). The most effective way to salvage this aluminum would be to separate out the aluminum by alloy and recycle each alloy separately. This would allow specific alloys to be reused in their original context (Das, 26). However, advancements in collection and sorting technologies will need to be investigated to ensure feasibility. Until then, recycled aluminum is best used for non-critical applications such as aluminum cans.

Another major consideration is the extent of aluminum recycling. The recycling rate in the United States is variable and correlated with the price of aluminum. But even with price fluctuations, the maximum recycling rate is only 65% in the United States and is currently trending lower (~55%) (Chen, 934). Not all the aluminum that is unaccounted for goes directly to landfill however. A significant portion of the aluminum may be hibernating (i.e. not available for collection yet), or exported. Nonetheless, the fate of 20-25% of aluminum waste is unknown and likely lost to landfills (Chen, 936). Even though the collection rate of aluminum cans is remarkably high, "if aluminum is used in very thin layers as a barrier material in compound products, it often ends up either in waste incinerators or paper mills with low metal recovery efficiency or even in landfill" (Rombach, 1019). In other words, extracting aluminum from waste products can be challenging. Conveniently, Trenton is also home to TerraCycle, a major specialized recycling company. TerraCycle's mission is to make all waste recyclable and uses corporate partnerships to develop methods for recycling unconventional waste products ("Recycle the Unrecyclable"). For a vertically-integrated smelter/aluminum can manufacturer in Trenton, this partnership would offer a highly beneficial, unique aluminum supply chain.

Circular Economy

A unique supply chain is critical because of the many supply chain challenges impacting the global aluminum market today. In 2020, at the height of the Covid-19 pandemic, beverage makers were forced to phase out less popular drinks due to a surge in aluminum can demand (Bomey, 1). According to the Aluminum Association and the Can Manufacturers Institute, this unprecedented and unexpected demand was driven by restaurant closures and the collective shift from soda fountains to canned drinks (Sadeghi). Ultimately, this led Ball Corp., the leading can manufacturer in the United States, to open new manufacturing facilities in Nevada. But it remains clear that the industry was unprepared for rapid market demand when the crisis hit (Bomey, 1).

Aluminum supply troubles are likely to continue into the future as widespread energy curtailment in China leads to periodic closures of primary aluminum smelters and a drop in overall primary aluminum production (Ip and Su-Lin, 1). A unique supply chain supported by a partnership with TerraCycle would help insulate a Trenton-based manufacturer from these wider industry trends and provide economic opportunities when current can manufacturers cannot pivot to rapid production on demand.

In summary, using secondary aluminum to manufacture cans in Trenton is likely feasible and competitive; would circumvent the environmental and health-related issues associated with primary aluminum production; and ultimately serve to revitalize an economically-challenged city by providing stable employment and a reliable tax base. While the historical impact of the aluminum industry as a whole has been mixed, there is potential for the industry to reinvent itself and accomplish significant societal good by prioritizing sustainability, the health and safety of its workforce, and promoting American manufacturing by securing the supply chain through investment in a circular economy.

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