

Section A: Introduction

The German government is considering legislation intended to reduce the amount of waste from scrapped automotive vehicles by requiring each auto maker to be responsible for the final disposal of its cars. This legislation is in response to the increasing amount of non-recyclable components, primarily polymers, in vehicles that remain after shredding. This automotive shredder residue (ASR) threatens the existence of the low-margin private network of vehicle recycling, dismantling and shredding companies because it has no economic value and must be discarded. BMW is interested in developing a recycling program that will both satisfy and influence the draft legislation in a way that is cost-effective and consistent with its environmental ethics and reputation for social responsibility.

The first choice that BMW must make is whether to create an independent national take-back infrastructure or to modify the existing national take-back infrastructure. This question is answered through a cost-effectiveness framework and is discussed in section B. The second choice that BMW must make is how to structure the recycling program to either reuse or dispose of all components of their automobiles. This question is best answered through evaluation of the equity, efficiency, administrative simplicity, transparency, and goal attainment of each option and is discussed in Section C.

Section B: Decision for Take-Back Infrastructure

Of the two take-back options, developing a primarily independent take-back infrastructure is the most cost-effective to reduce the ASR of BMW vehicles. It supports profitable remanufactured parts, higher-value residuals, and reductions in materials procurement and disposal costs. The other option, modifying the existing take-back structure, is unmanageable, exploitable, environmentally substandard, and may not attainment the goal due to BMW's small level of influence relative to other manufacturers. Consequently, BMW should deploy its own take-back and dismantling network and partner with the existing shredding companies to manage ASR.

B.1. Independent Take-Back Infrastructure

BMW should develop a network of company managed dismantlers that handle only BMW vehicles. These dismantlers would buy vehicles from the final owners at fair prices, after accounting for costs of operations and disposal. It is expected that because of the cost savings to

BMW, this price will be above that of non-BMW dismantlers, assuming all dismantlers are required to meet the same stringent environmental regulations. Because of the low capital costs, these private dismantlers could be established relatively quickly. And because of the small portion of the overall domestic vehicle market, there would only need to be a small number of geographically dispersed processing centers.

BMW would not try to establish its own shredding operations. This capital-intensive industry is already well established in Germany. BMW would instead partner with these existing shredders and provide them a stream of high-quality, low ASR vehicles for which BMW will receive a premium over the prices paid to other dismantlers.

- **Profitable Remanufacturing**

An independent take-back infrastructure will provide BMW with a guaranteed and large supply of parts for remanufacturing. BMW's existing remanufacturing is profitable, but depends on a flow of parts from dismantlers. There is a substantial waiting list for these parts because they sell at 50-80% of new parts yet are backed by similar warranties. By controlling the source of these parts, BMW can ensure a steady supply and profit from the demand.

- **Higher-Value Residuals**

BMW should use the existing network of approximately 44 shredders. These companies tend to be fewer and stable because of the large capital investment in equipment. It would be possible to form partnerships with these companies who would welcome a source of very low ASR vehicles. The cost savings from lower disposal costs would be shared by the shredder with BMW and provide funds to support the dismantling operation.

- **Reductions in Materials Procurement and Disposal Costs**

BMW has already produced cost savings in its current recycling program. The current program sorts and reuses many of the company's production wastes and therefore uses less landfill disposal and requires fewer new materials. The independent take-back structure for vehicle recycling would be a larger scale operation of the same economic nature and would continue to enjoy the same cost savings.

B.2. Existing Take-Back Infrastructure

Modifying the existing national take-back infrastructure has many disadvantages including high training expenses, remediation costs, opportunities for exploitation, and limited BMW influence.

- **Unmanaged and Untrained**

If BMW designed its vehicles with easier dismantling and labeling of components, it would have to train employees at dismantling companies. Such a solution faces several problems. The dismantling industry employs unskilled labor to strip vehicles. The costs of training would be high and the results questionable due to frequent churn in an unskilled labor pool. Dismantlers tend to be small and under managed and—because of the small initial capital expense—transient. This suggests that even if BMW were to develop training, it would be difficult to establish partnerships with the dismantlers to ensure ongoing training programs. Furthermore, to be effective, all dismantlers would need to be trained in the BMW-specific techniques. Such a program would be administratively complex and expensive. A more effective strategy is to have BMW managed dismantlers with more skilled employees specifically trained in handling BMW vehicles. This would be much more efficient and achieve the goal in a less costly way.

- **Exploitable**

The existing infrastructure has the potential for exploitation by non-cooperative manufacturers. For the shared infrastructure to be effective, all companies should participate to reduce the total ASR. The costs borne by the shredders for disposal of ASR are not traceable back through national dismantlers to the manufacturer of the vehicles, so there is an incentive to cheat. This creates a traditional multiplayer prisoner's dilemma. A manufacturer who can slip a higher ASR content vehicle into the dismantler mix would benefit from lower overall costs (this is the payoff for defection), while manufacturers that cooperate by reducing the content of their vehicles through DFE methods will have higher costs (the sucker's payoff). The incentive is even greater when one considers the latency between payoff and detection: the defection payoff is immediate while the defection detection is quite some time in the future. The dilemma results when all manufacturers cheat and the overall decrease in vehicle recyclability leads to extreme costs to the manufacturers (including the likelihood of punitive damages). Universal cheating will also exacerbate the waste problem because shredders may refuse to accept vehicles if they cannot cost-effectively dispose of the non-recyclable waste.

In such situations it is necessary to increase the costs of defection and decrease the latency of detection. This can be done by modifying the existing infrastructure to include random sampling of vehicles from different manufacturers and imposing stiff fines on vehicles that fail to meet dismantling and recyclability limits. To decrease the latency, the government can also require that manufacturers provide one vehicle each year (to be randomly selected from among production models) to be disassembled and analyzed for ease of separation and materials use.

Such an approach would increase administrative complexity, and costs to the government and manufacturers. It might also lead to evasive tactics on the part of manufacturers who produce vehicles for multiple markets so that vehicles sold in Germany satisfy the requirements while those sold in other countries do not. (Even BMW sells twice as many vehicles in the European market as it does in the German market.) Problems arise because many of these vehicles may end their life in Germany due to the borderless nature of the European Union. Therefore this approach might not even be effective.

- **Uncertifiable**

The existing infrastructure does not meet current environmental standards (only 10% meet certification requirements). Almost all dismantlers lack leachate systems and other processes for dealing with hazardous waste. The use of the existing dismantling infrastructure would incur huge capital expenses to bring these systems into compliance with environmental requirements. These costs are prohibitive in the low-margin dismantling industry. The government would therefore likely bear the bulk of the costs of remediation or site cleanup. Left in private hands, there would have to be on-going inspections and fines to ensure dismantlers remain in compliance. This would increase governmental administrative complexity.

- **Small Influence**

If BMW were to seek modifications to the existing take-back infrastructure, it would find that its influence would be quite small. It represents only 10% of the domestic market. It would be forced to adopt methods employed by the market leaders even though they may not be the most cost-effective for BMW or the most appropriate for BMW vehicles. This would stifle BMW's goal attainment because they are attempting to comply with the environmental legislation in the manner which achieves their own goals—not the market's goals—with least cost.

Section C: Recycling and Reuse Issues

After deciding to create an independent take-back structure, BMW must then choose from five recycling and reuse options within that structure. The options are as follow:

1. Take-back processed vehicles and landfill ASR,
2. Take-back processed vehicles and incinerate ASR,
3. Recycle plastics for use in other industries,
4. Use recycled polymers in BMW vehicles, and
5. Incorporate design for environment methods.

Given that BMW would chose to develop their own take-back network of dismantlers, each option has issues concerning equity, efficiency, administrative simplicity, transparency, and goal attainment. Below, each is discussed according to those factors.

1. Take-back processed vehicles and landfill ASR

Under the chosen system, BMW will be taking back all of its vehicles, dismantling the usable parts, and sending the unusable parts to national shredders. If it is responsible for its own portion of the ASR from these dismantling plants, BMW has the option of sending the ASR to a landfill and using all virgin plastic parts in new cars. Currently, Germany is running out of landfill space and is not allowed to export any of its waste. Thus, not only is landfill disposal costly, but it will only get costlier as landfills become fewer, more filled, and more high-tech. This option has problems with efficiency. BMW's goal is to comply with new regulations in the least costly manner. Landfills will not only become more expensive in the future but also—unlike the next option, incineration—have no beneficial returns for BMW. Therefore it accomplishes the goal in the most obvious yet least beneficial manner.

2. Take-back processed vehicles and incinerate ASR

BMW also has the option of incinerating its portion of the ASR created by the shredding companies. This option is more efficient than the previous landfill option. Incineration creates energy by burning the unwanted ASR. If BMW could harness this energy and either use it or sell it as electricity, it could potentially profit. However, incineration brings about issues of environmental friendliness because it releases myriad pollutants into the air. This is a problem with goal attainment because although BMW would be disposing of its waste as per the new regulation, it would most likely be subject other environmental restrictions and would create external costs in other environmental legislative arenas.

Also, if BMW is to use the energy created by incineration to create benefits, this option could be much more administratively complex than landfill disposal. Rather than simply paying someone to take away the waste to a landfill, BMW would have to build its own facilities for incineration and electricity generation or partner with someone with such facilities.

3. Recycle plastics for use in other industries

BMW has the option of creating a market for its used plastic parts by making them feedstock for other plastic industries. The market for its plastics is an economic incentive for dismantlers, be they company-owned or national. Recycling the plastics for other industries would lower disposal costs for shredding companies because there would be less ASR. This option is equitable for everyone in the market since it creates new business and lifts burdens from the shredding companies. It also achieves the goal of regulation compliance without the immediate environmental impacts of landfill disposal and incineration. However, this option requires a market to develop for recycled plastics. This can be spurred through the implementation of the next option, use of recycled polymers in BMW vehicles.

4. Use recycled polymers in BMW vehicles

In addition to selling old plastic parts, BMW also has the option of using recycled plastics in the fabrication of their new parts. Currently, there are no proven differences between recycled and virgin polymers so the use of these recycled plastics would not compromise goal attainment. Also, the only reason recycled plastics are not used more in the automobile industry is because of their lack of supply. A lack of supply threatens efficiency and goal attainment since BMW most likely would not be able to use 100% recycled plastics. However, if BMW could use mixed recycled/virgin plastics, or if the supply of recycled plastics increased, this option would not only be efficient but also equitable. Like the previous option of selling old plastics, this option would create a market that would benefit “producers” of recycled plastics and all car companies that wanted to utilize them.

This option would create environmental benefits for Germany as a whole by reducing discarded plastics but would not necessarily address the problem of ASR disposal unless reclaimed plastics from dismantled vehicles were a competitive source of recycled plastics. If they were not, then companies such as BMW may be forced to pay a premium over market prices to obtain plastics from dismantlers to attain the goal of reducing ASR.

5. Incorporate design for environment methods

To meet legislation, BMW could also alter their designs and processes to reduce, reuse, and recycle. Measures such as labeling plastic parts, making cars easier to disassemble, and standardizing on fewer polymers would increase the vehicle's recyclability and reduce the ASR component from BMW cars. This option will help increase the supply and decrease the cost of plastics reclaimed by dismantlers. It therefore supports options 3 and 4 above which both depend on inexpensive widely available polymer supplies. This approach is not administratively simple, but it is transparent to entire auto industry and achieves BMW's goal at a cost that should be competitive with the other options, although most of those costs would be borne at the beginning of a product's life rather than the end.

Section D: Conclusion

BMW is faced with the decision of altering the design of its recycling strategy to incorporate new government environmental legislation. The legislation requires that each manufacturer must become fully responsible for the ultimate disposal of its cars. Under a cost-effectiveness framework, BMW should create its own independent take-back network for collection and dismantling of its cars. Once the cars have been collected, BMW then has options for disposal of the remaining unusable plastics. Landfill disposal and incineration do not solve the problem of the existence of these wastes, but simply pass the pollution into the air and soil. Changes should be made in the use of the plastics long before a car is scrapped for parts. Although it might become the most costly solution, incorporating design for environmental (DFE) methodology is the only option that addresses the entire problem. It deals with the problem of these unrecyclable plastics during the design and production phases rather than just saving them until the scrapping phase. BMW's goal is to comply with the new regulation not only in the most cost-effective manner, but also in a way that concurs with their company environmental ethics. BMW has always been a leader in its recycling program and DFE is the most progressive environmentally responsible solution to the current problem.