



Connecting Industry to Mathematics Instruction

NSF ATE Award # 1954291

Sustainability

You are an environmental engineer for Grifols Therapeutics, a manufacturer of medicines made from human blood plasma. Environmental Engineers are responsible for managing the facility's impact on the surrounding environment.

You are gathering information to decide whether to continue with the current company that removes waste from the facility.

Grifols has earned a [Zero-Waste-to-Landfill](#) certification from Underwriters Laboratories for its environmental management, and maintains a goal of having Zero Waste enter the local landfill. This certification allows for up to 10% of total waste products to be removed using waste-to-energy incineration, with the remaining waste designated for recycled byproducts (such as plastic lumber).

Waste products from the plasma donation manufacturing process fall into one of three categories: medical waste-to-energy, where materials are transported off-site to be burned in an incinerator for generating power; medical waste that can be recycled; and shredded plastic bottles for recycling.

Explore

Grifols is currently working with ProSan Solutions for the proper disposal of these materials. ProSan Solutions charges \$0.75/pound to remove medical waste materials sent for waste-to-energy incineration; \$0.55/pound to remove medical waste materials to be treated and recycled, and \$0.04/pound to remove shredded plastic bottles (Grifols does its own shredding on-site).

If Grifols generated 625,000 pounds of waste-to-energy medical waste materials, 75,000 pounds of recyclable medical waste, and 1,500,000 pounds of shredded plastic bottles in 2021, calculate the total cost for the removal of these materials by ProSan Solutions.

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Product	Rate for disposal	Amount produced
Waste-to-Energy	\$0.75/pound	625,000 pounds
Medical recycling	\$0.55/pound	75,000 pounds
Shredded plastic	\$0.04/pound	1,500,000 pounds

MedCycle, a different plastics processor, is offering to pay Grifols \$0.22/pound for the shredded plastic bottles. How does this affect the overall financial situation of removing the waste materials from plasma donation if Grifols stays with ProSan for disposal of the other products?

Describe how this change will impact the overall cost of waste removal.

If Grifols sells the shredded plastic bottles to MedCycle, it is likely that ProSan Solutions will raise the cost to dispose of *all* Medical Waste products by \$0.20/pound.

How much will the plasma donation waste disposal cost if ProSan Solutions raises their prices, as anticipated?

Grifols has the option to leave ProSan Solutions to contract with Clayton Waste Transport, who will charge \$0.90/pound to dispose of Medical Waste, but has no capacity to treat and recycle the medical waste, meaning all waste except the plastic bottles would go to the incinerator. Plastic bottles would continue to be shredded by Grifols.

What is the total net expenditure for plasma donation waste disposal if Grifols accepts a contract with Clayton Waste Transport?

Which of the current scenarios is the most financially cost effective?

The value of recyclable plastic is volatile with the cost of crude oil. Which scenario is the most cost efficient if MedCycle reduces their offer to pay only \$0.05/pound for the shredded bottles? Support your claim with evidence.

Discuss

What happens as the value of recyclable plastic changes?

What are some other factors that could influence the cost of removing the waste products?

Explore

In order to meet the requirements of our Zero-Waste-to-Landfill Certification, the waste-to-energy materials can make up no more than 10% of the company's total waste production.

In 2021, the 625,000 pounds of Medical Waste sent for waste-to-energy incineration is 5% of Grifols total waste generated. Including other non-Medical waste-to-energy incineration streams, Grifols currently sends 8.5% of the total waste to waste-to-energy incineration.

Support each of your answers with evidence.

1. Using the information in the paragraph above, calculate the total waste production for Grifols in 2021.
2. Then calculate the amount of materials coming from the other waste-to-energy streams.
3. Grifols is concerned that switching to Clayton Waste Transport would lead to the waste-to-energy volume exceeding 10% of total waste, the standard for their Zero-Waste-to-Landfill Certification. If Grifols switches its disposal contract from SanPro Solutions to Clayton Waste Transport, what percentage of waste will be disposed of in this way?

Looking to the future:

Volume in pounds/year	Medical Waste (treatment + recycling)	Medical Waste (waste- to-energy)	Recyclable Plastic
2001	12,000	35,000	50,000
2007	20,000	120,000	210,000
2012	35,000	200,000	450,000
2015	44,000	315,000	675,000
2017	50,000	400,000	862,000
2019	63,000	507,000	1,108,000
2021	75,000	625,000	1,500,000
2023	92,000	750,000	1,800,000
2025	126,000	1,000,000	2,400,000
2030	178,000	1,500,000	3,600,000

Assume all other waste streams increase by 5% per year except for the streams shown in the chart provided above.

- What kind of regression model best fits the growth of Medical Waste (treatment+recycling)? Justify your answer.
- What kind of regression model best fits the growth of Medical Waste (waste-to-energy)? Justify your answer.
- What kind of regression model best fits the growth of Recyclable Plastic? Justify your answer.
- Use your regression models to project the total expected waste from plasma donation processing in the year 2050.
 - Medical Waste (treatment+recycling) _____ pounds
 - Medical Waste (waste-to-energy) _____ pounds
 - Recyclable Plastic _____ pounds

- e) Using the projected growth of 5% per year on all other waste production streams, what percentage of the total waste will be sent to waste-to-energy incineration in 2050?

Combine your regression models with the projection for all other waste streams to create a model predicting the total waste generated by the company.

- Will switching the disposal contract from SanPro Solutions to Clayton Waste Transport cause Grifols to exceed the 10% waste-to-energy criterion at some point in the future?
- Assuming the waste-to-energy stream exceeds the 10% criterion, in what year will the waste streams exceed the criterion currently set by the Zero-Waste-to-Landfill certification?

Based on **all** of the information you have collected about the plasma donation waste disposal, what would you recommend as the best course of action for the company?

Exit ticket: Grifols has recently switched to compostable utensils and plates in the company cafeteria. These items will degrade naturally, creating no new material for the local landfill. What other steps do you imagine could be taken to reduce the amount of waste generated by Grifols?