Let's Talk Trash

Do we live more by waste than ingenuity? Americans generate a minimum of 280 pounds per person per day. Most of that is out of sight, out of mind. So solutions come hard, but they begin by recognizing the necessity

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As Americans we generate a lot of refuse, rubbish, runoff, garbage, trash, sewage, and effluvia of all kinds. For the most part, however, waste is a hidden problem. But hardly without impact. From a more critical perspective, waste creates an array of social, economic, and environmental consequences that will be harder and harder to avoid — unless we take preemptive actions to set targets or legislate goals that encourage a much greater scale of resource productivity, which is the root issue.

We can start to explore the many dimensions of a very big problem as we begin with perhaps the familiar metric of 4.4 pounds of municipal solid waste created each day for every inhabitant in the United States. That refers to the daily waste that is dumped into the local landfills. In 2014 that added up to just over 258 million tons. The bad news? That is only the tip of a vast waste iceberg.

In addition to the solid landfill wastes, what if we add in the dumping of energy-related greenhouse gas emissions, plus all of the hazardous and criteria air pollutants? What if we also add to the totals all the fecal matter not only from humans, but also from animals we eat? And finally, what if we include losses from soil erosion from cropland and rangeland? In that case, the total levels of waste would jump to about 280 pounds per person per day. Across the entire U.S. population, that adds up to a combined 16.6 billion tons of aggregate wastes in that year, the last one for which we have complete data.

Assessing the aggregate magnitude of waste is just one way to look at the problem. We can also explore the many unexpected ways that waste is produced every single day; and in turn, we can examine the various environmental burdens. We can then determine the lost economic opportunity arising from that waste. But a bigger question will arise when studying this issue in its full dimensions: Are we living more by waste than ingenuity?

But let's back up a bit. . .

Unfortunately, we don't have the time or resources to create a full accounting of what we might call *the invisible burden of waste*. Yet, we can still explore the likely magnitude of total wastes, and the full array of environmental and economic problems that result. And we can do this using a *Fermi estimate* for the year 2014. Enrico Fermi was both a theoretical and experimental physicist known for his ability to make good approximate calculations with little or no actual data.

The good news? There are reasonably suitable data from various government reports and research studies that we can tap into. At the same time, they are data that have not been previously totaled up in an aggregate way to reflect the scale of waste within the United States. So with the hope that this different perspective might lead to a more productive result, as did Fermi we are looking more for insight than precision.

With a preliminary accounting of waste in hand, we provide a "first look" investigation into the vari-

ous impacts and costs of those wastes. We next generate a thought experiment of how those costs might impact or hamstring the U.S. economy. Finally, we draw some conclusions about what might be done to turn around the costs so that we might encourage a more robust and more sustainable economy in the years ahead.

For ease of convenience, tapping into a variety of available databases from the Environmental Protection Agency and the Energy Information Administration, we can start the tabulation with greenhouse gases and the criteria and hazardous air pollutants. The greenhouse gases, which contribute to the serious problem of global climate change, include energy-related carbon dioxide emissions from the combustion of fossil fuels. The six criteria pollutants regulated by the Clean Air Act include carbon monoxide, lead, ground-level ozone, particulate matter, nitrogen dioxide, and sulfur dioxide. Among the 187 hazardous air pollutants, also known as air toxics, are benzene (found in gasoline) and methylene chloride (used as a solvent and paint stripper by some industries). In the aggregate, these various air emissions sum up to about 6 billion tons per year.

Fecal matter from humans, cows, and pigs adds about 1.3 billion tons. That may seem more than we might otherwise imagine, but there are about 88 million cows generating perhaps 65 pounds of manure each day apiece, and about 68 million pigs producing about 13 pounds per day per animal. And there is the U.S. population of about 319 million inhabitants (in 2014) also producing about 1 pound per person per day. The math suggests, from a fecal material standpoint, we may have a population equivalent to 7 billion people. And that does not include any of the waste matter from dogs, cats, goats, sheep, poultry, and other domestic critters.

Losses from the erosion of our soils? That is also much bigger than we might imagine. According to the National Science and Technology Council, citing the latest data, for 2012, there are an estimated 1.9 billion acres of cultivated and uncultivated land in the United States. While management practices have improved erosion, we are still losing about 4.6 tons of soil per acre every year. That adds up to a total of 8.9 billion tons annually. And this accounting does not incorporate the loss of soil quality from our current pavement, landscaping, and agricultural practices.

Adding up these amounts altogether — the relatively small 258 million tons of municipal wastes, concurrently with the 6.1 billion tons of various air pollutants and emissions, the 1.3 billion tons of fecal matter, and the 8.9 billion tons of soil losses? It turns out we are now producing a minimum of 16.6 billion tons of various wastes per year. If we look at it another way, that is about 2.4 pounds of wasted matter for each dollar of personal income that we earn in the United States.

More interesting, the total of 16.6 billion tons does not include water or water losses, mining tailings, the degradation of soil quality, and the many other forms of waste at play in our economy. Indeed, those 16.6 billion tons are significantly bigger than the material footprint for the United States that researchers published in 2013. They estimate that the average American buys 50,000 pounds of raw materials annually for all the stuff we buy or use in any given year. Using the criteria for what researchers call the material footprint, clearly we are living more by waste than ingenuity.

It is not simply the huge quantities of materials that we consume, it is also the consequences that follow from the many forms of waste.

Let us first consider all the livestock manure that is dumped every single day on the many agricultural lands in the Midwest, along or near the Mississippi River. Gathering in what are euphemistically called large Concentrated Animal Feeding Operations, the wastes build up. In October 2017, there was a poisoning caused by dairy runoff in Dyersville, Iowa, in which an estimated 60,000 fish were killed along nearly seven miles of stream. Then in various ways, the feces, urine, and bacteria continue to wash away down The Big Muddy. As more and more of those wastes accumulate, they become a form of nutrient pollution, and are dumped at the mouth of the Mississippi and into the Gulf of Mexico. There they contribute to the Dead Zone, more properly the hypoxia zone, which occupies an area the size of New Jersey.

The Dead Zone is an area of low-to-no oxygen that can kill fish and other marine life. The agricultural nutrients, including manure, that flow downstream and into surface waters stimulate harmful algae. As one research study notes, although "farmers often claim a deep-seated knowledge of their land because they work it, the degree to which some farmers choose to not make the connection between how they farm and its impact on water quality is dispiriting." But that might be said of all of us within the United States.

Even with the information technology revolution, paper is still very much a part of our everyday life. Every year, one estimate suggests, Americans use about 90 million tons of paper and paperboard. That includes more than 2 billion books, 350 million magazines, and 24 billion newspapers that are published on an annual basis.

Currently, about 64 percent of all paper products are recycled. This is the highest rate of recycling of any product. Even with this very high rate, however, paper and paperboard still make up 16 percent of all landfill space in the United States. What might not be known is that the paper and pulp industry is also the fourth highest contributor of greenhouse gases globally. It contributes to methane gas emissions from landfills all over the world. One kilogram of methane has the same heat trapping ability of 25 kilograms of carbon dioxide over a 100-year period.

Even with paper leading the way in recycling rates, the use of paper products still produces a high level of waste. Junk mail is a good example. With credit card offers, advertising specials, and other clutter, one in every five pieces of mail is considered instant trash by recipients. Over 90 percent of people say they do not even look at their junk mail before discarding.

Today, 100 million pieces of junk mail are sent out to homes each year and 44 percent of this mail will end up directly in landfills, making up 6.5 million tons of waste products entering our landfills each year. This means that junk mail alone contributes 16 percent of CO_2 emissions from the paper and pulp industry every year.

As we discuss below, water is already wasted in huge amounts, and the paper industry is another example of this. It takes between 4,000 to 12,000 gallons of water to produce one ton of paper pulp. Moreover, the paper industry ranks fourth in hazardous chemical releases and ranks third in the releases of chemicals to surface water. So not only does it take a great deal of water to produce paper, the industry is also a leader in polluting the nation's water resources.

Though they do their best to hide it from public view, American food retailers typically experience in-store losses of 43 billion pounds of food a year. Store managers routinely over order, for fear of running out of a particular product. Entire shelves of perfectly edible shell peas are transferred into dumpsters to make room for incoming peas; pallets of zucchini are rejected because they curve too much. If the affected wholesaler can't quickly find another market nearby (a discount chain that tolerates curvy vegetables, for example, or a food bank with refrigerated space), the load will be dumped.

And there is more. The inefficient use of food is putting immense pressure on Earth's resources. Just how much pressure? That is not well understood. When we begin thinking about it, however, we might immediately think of the food that is thrown away in our homes, or the food left behind on a large bowl or plate in a restaurant. But this, again, is just the tip of the iceberg lettuce.

Today, as much as 40 percent of all food produced in the United States goes uneaten. Indeed, one estimate suggests that, each year, 165 million tons of food is lost or wasted before it even reaches the household. Almost all food waste in the United States ends up in landfills, where it accounts for almost 25 percent of all U.S. methane emissions.

Most will quickly understand that wasting hefty amounts of food can have enormous detrimental effects, especially as the United Nations classifies two-thirds of the world's population as "food insecure." But the damage is not finished when food is thrown away. What is not seen are the resources wasted in the production process. An enormous amount of land, energy, water, and capital needs to be considered when calculating the full impact of wasted food. Consider some quick facts to put food wastage into perspective: four percent of all U.S. oil consumption and 25 percent of all fresh water used to grow food is for food that will go uneaten.

By one estimate, food-related packaging creates 580 pounds of CO_2 emissions per person each year. If 40 percent of the food goes uneaten, then that percentage of the packaging that holds food is needlessly used. Adding up the U.S. population of 319 million people in 2014, we might attribute 37 million tons of CO_2 emissions to packaging for food that is never eaten.

In addition, the food must travel. Red meat, for example, is transported as far as 13,500 miles before it reaches the consumer. That, in turn, requires fossil fuels that generate additional CO_2 emissions. If Americans throw out a good portion of the meat that is purchased, then all those traveled miles are wholly wasted, even as they continue to generate additional carbon dioxide emissions.

As we already noted, water is another key resource that is unfortunately wasted at nearly every point in the food chain. By one estimate U.S. annual consumption of water is about 418,000 gallons per capita, or about 8 billion tons in the aggregate within the United States. About 70 percent of freshwater withdrawals goes to agricultural consumption and agricultural drainage. Another 24 percent goes to industrial and municipal wastewater use. With these

percentages in mind, here we focus on agricultural uses to better understand water use efficiency.

The production of food or clothes takes an enormous amount of water. By one set of estimates, for example, it takes an average of 660 gallons of water to produce a single tee-shirt, and 2,000 gallons to make a single pair of jeans. However, these totals look incredibly small compared to the amount of water used to produce food.

It takes 33 gallons to produce a single apple, 42 gallons for a banana, and a whopping 634 gallons to produce a hamburger. It takes 441 gallons of water to raise, water, feed and process one pound of boneless beef and a shocking 198 gallons to produce one single ounce of chocolate. Again, thinking about that 40 percent of food produced in the United States is never eaten, we can begin to get a picture of how much water is wasted in the production and consumption of food.

Less thoroughly examined is the energy to produce all the food, paper, clothing, shelter and the many other necessities of life. If we add up all the coal, oil, natural gas, and other energy resources used within our economy, and compare them based on their corresponding heat values, it turns out that the U.S. consumes about 4.9 billion tons of coal equivalent to power our entire economy each year. But there is also a huge waste associated with the consumption of that energy.

Building on the work of Robert Ayres, Benjamin Warr, Reiner Kümmel, and others, we estimate that the U.S. economy is only about 16 percent energy-efficient. In other words, the United States has a corresponding energy waste of about 4.1 billion tons of coal. Much of that waste is found in the release of air pollutants and greenhouse gas emissions already referenced.

Other aspects of waste include fly ash from the coal burned in power plants or the waste heat from driving our cars or firing up our many industrial processes. At the same time, we can use energy — and especially what we can call energy productivity — as a basis to highlight how reducing waste might strengthen the economy.

In 1950, the U.S. economy generated about $1,200 of economic activity for every ton of coal equivalent consumed in the United States (based on constant 2009 dollars). By 2014 that grew to $3,200 per ton. That's an annual improvement of about 1.5 percent. The question here is how much more social and economic well-being might have emerged had we been able otherwise to reduce the level of waste.

Last year a United Nations International Resource Panel suggested that reducing material consumption by 30 percent from current levels of use might increase global GDP by $2 trillion by 2050. If the United States follows that same trajectory, domestic annual GDP might increase by $750 billion above current projections. In effect, energy productivity would double to about 3 percent annually — reaching an output of nearly $10,000 per ton of coal equivalent in 2009 dollars.

While a 3 percent annual rate of improvement seems like a large jump, it is a rate that we exceeded 13 times since 1970. The key is to promote the right set of policies that set targets for waste reduction and greater levels of energy productivity. Solutions come hard, but they begin by recognizing the problem before us. Whether through incentives, performance standards, or waste targets, there are any number of studies which suggest it can be done. The outcome is a stronger, more robust economy, as well as a healthier environment.

And how might we begin to elevate the performance of our economy? Three things come immediately to mind.

First, we badly need dialogue. ELI could convene a national discussion about the scale of waste that burdens both the environment and the economy. Whether food, water, materials, or energy, the inefficient use of resources weakens and makes less-resilient our social and economic well-being.

Second, the dialogue would benefit from a thoughtful review of key legislation. Yes, we have the Solid Waste Disposal Act, the Soil Conservation and Domestic Allotment Act, and the Clean Air Act and Clean Water Act, among other national legislation. But they focus more on pollution control rather than greater resource productivity and waste reduction, constraining the larger opportunity. And how can they meaningfully integrate a common national purpose like resource productivity with other legislation like the Corporate Average Fuel Economy standards and the National Appliance Energy Conservation Act?

Finally, we need to develop new business models. Today's economy and business revenues are primarily anchored to the sale of commodities such as tons of coal, steel, and paper. How can we move into new market and institutional arrangements that pull more revenues from value-added services that promote resource productivity rather than the sale of things like gasoline or electricity? And how can new technologies, including distributed electronic ledgers like blockchain, or digital enterprises like cloud computing, positively shape those business models? The opportunities are clearly there. The question is whether we will take advantage of them. **TEF**