



SEVERE WEATHER AND MANUFACTURING IN AMERICA

COMPARING THE COST OF DROUGHTS, STORMS,
AND EXTREME TEMPERATURES
WITH THE COST OF NEW EPA STANDARDS

2015 Update

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PREFACE

In June 2014, we issued our first report on climate change’s impact on American manufacturing. That report compared the costs associated with climate change to the potential costs of new Environmental Protection Agency (EPA) standards designed to gradually limit the amount of carbon American power plants emit. At the time, the EPA projected its draft standards could increase utility rates by 6.2 percent in 2020. In August 2015, the EPA issued final standards, which are projected to increase rates by about half as much (3.2 percent). This update of our June 2014 report reflects these new, lower EPA cost estimates.

INTRODUCTION

On August 3, 2015, the Environmental Protection Agency (EPA) published final greenhouse gas standards for existing U.S. power plants. States may choose from a variety of options to meet the standards, including energy efficiency investments and relying more on natural gas or renewable energy.

The EPA estimates that utilities will increase their rates by 3.2 percent (in 2020)¹ to pay for the investments these new standards require. The standards' true impact on rates will vary from state to state. Moreover, rates will be determined by much larger forces, including the strength of our economy, which drives demand for energy.

Critics of the EPA standards argue that increasing manufacturers' electricity costs will encourage them to move production overseas. The merits of this argument depend largely on two simple questions: **(1) How much of a manufacturer's costs does electricity represent, and (2) how will a 3.2 percent increase affect its global competitiveness?**

Proponents of the EPA standards argue that they are a necessary response to the immediate and long-term costs of severe weather caused by climate change. This argument raises a third question: **How much does severe weather affect manufacturers' costs?**

To answer these questions, we compare: (1) the cost of reforms intended to address severe weather with (2) the costs manufacturers face from severe weather itself.

EXECUTIVE SUMMARY

Manufacturers have built massive supply chains that are highly specialized, fast moving, and global. But these advancements also make supply chains highly interdependent, which makes them vulnerable to climate change.

MANUFACTURERS AND SUPPLY CHAIN RISK

American manufacturers rely on massive, highly specialized, global supply chains, which represent about 60 percent of the average manufacturer's costs.ⁱⁱ For advanced manufacturers, these supply chains operate on a just-in-time basis that requires factories to operate with as little as two to four hours of parts inventory on site. Just-in-time delivery saves manufacturers money on overhead, but it also makes supply chains more vulnerable to disruptions, like severe weather. Because supply chains are global, disruptions on the other side of the planet can slow down or shut down an American factory.

SEVERE WEATHER'S IMPACT ON MANUFACTURERS

Historically, U.S. factories have incurred four unexpected disruptions each year, causing 20 hours of factory downtime, on average.ⁱⁱⁱ Causes include mechanical failure, power outages, and supply disruptions. But large weather disasters are becoming more frequent. Over the past four years, American factories have been disrupted by typhoons in Thailand, hurricanes in the Gulf of Mexico, droughts in Texas, tornadoes in Kentucky, erratic water levels across the Great Lakes, and flooding in the Northeast. The total impact per facility, per year, is far greater than the 20 hours of unexpected downtime a plant has historically experienced.

TRENDS AGGRAVATING SUPPLY CHAIN RISK

First, as supply chains grow (and become more global), they become less transparent. Second, small

businesses, which dominate the lower levels of supply chains, are less likely to survive catastrophic events. Third, America's infrastructure is aging, while congestion is growing. Fourth, disruptions cost plants operating at full capacity more.

IMPACT OF EPA STANDARDS ON MANUFACTURERS' COSTS

While manufacturers use a great deal of electricity, the cost of that electricity is a comparatively small portion of their total costs. The average for manufacturers is 0.9 percent.^{iv} Therefore, if the proposed standards were to increase electricity rates by 3.2 percent in 2020, the average industry's total costs would rise 0.029 percent. In other words, if it costs a company \$100 to make one of its products, that cost would increase less than three cents.

**SEVERE WEATHER COSTS
A MANUFACTURING PLANT
MORE**

IN ONE HOUR

**THAN EPA STANDARDS WILL
COST IT OVER AN ENTIRE
YEAR.**

SCALE AND INTERDEPENDENCE OF 21ST CENTURY SUPPLY CHAINS

Specialization is meant to maximize efficiency. Sourcing globally is meant to cut costs. Just-in-time inventory is meant to reduce overhead. But each of these characteristics also makes the manufacturing supply chain vulnerable to climate-related disruptions.

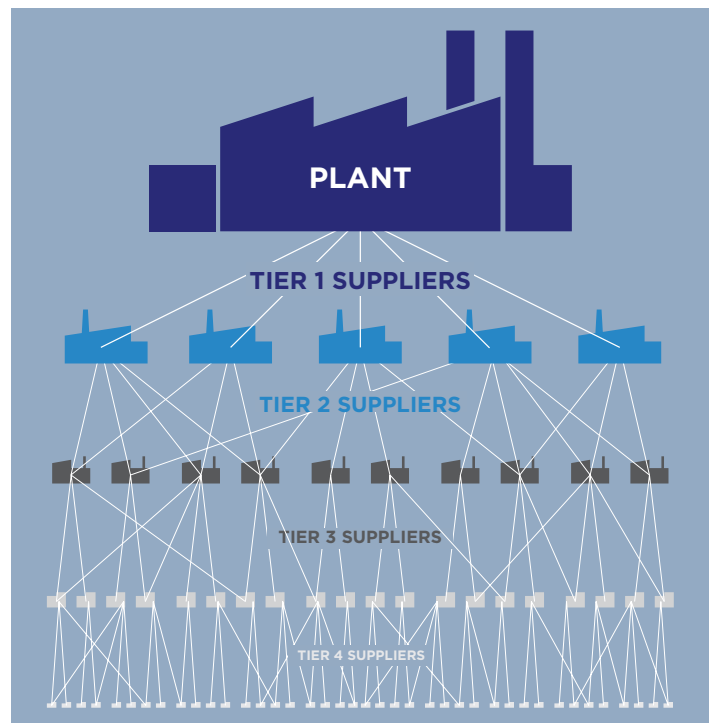
Scale. American manufacturers rely on massive, highly specialized, global supply chains, which represent about 60 percent of the average manufacturer's costs.^v

Complexity. Most supply chains are highly specialized and vertically integrated. Tier 4 suppliers produce basic materials, which Tier 3 suppliers use to produce basic parts. Tier 2 suppliers assemble these basic parts into subcomponents and complex parts, which Tier 1 suppliers use to produce finished components. Those components are assembled into finished goods by manufacturers. Because each supplier serves more than one factory, and because components can move back and forth from factory to factory as they are produced, these tiers of suppliers operate less as a chain and more as a network. For example, an automaker with plants in Michigan and Ontario, Canada, estimates that some of its parts will cross the U.S.-Canada border seven times before they are installed in a finished car or truck.^{vi}

Speed. These supply chains operate on a just-in-time basis that requires factories to operate with as little as two to four hours of parts inventory on site. Just-in-time delivery saves manufacturers money on overhead, but it also makes supply chains more vulnerable to disruptions, like severe weather. A factory with only two hours of parts on site shuts down if a shipment is delayed more than two hours.

Global. Because supply chains are global, disruptions on the other side of the planet can slow down or shut down an American factory. American manufacturers rely increasingly on suppliers operating in regions or countries that are highly vulnerable to rising sea levels, severe storms, and extreme temperatures. In a May 2014 report, S&P ranked nations according to their vulnerability to climate change.

The bulk of nations scoring worst were deemed vulnerable because their populations, cities, and factories are concentrated at low elevations, close to shore. Of 116 nations measured, critical parts and materials supplying countries scored in the bottom quartile, including Thailand, Malaysia, Philippines, Vietnam, and Bangladesh. China, one of America's biggest parts suppliers, ranked 82nd out of 116 in terms of climate change resilience.^{vii}



COSTS OF SEVERE WEATHER

Historically, U.S. factories incur four unexpected disruptions each year, causing 20 hours of factory downtime, on average.^{viii} Causes include mechanical failure, labor shortages, power outages, and supply disruptions.

Temperatures from 2001 to 2014 were warmer than any previous decade in every region of the United States. For the contiguous 48 states, 13 of the 15 warmest years on record have occurred in the past 15 years.^{ix} As a result, large weather disasters, or weather events causing more than \$1 billion in damages, are becoming more frequent. The U.S. experienced 20 weather disasters in the 1980s, 47 in the 1990s, and 48 in the 2000s; but in just the past five years, 49 weather disasters have occurred, more than double the pace of the previous two decades.^x

Over the past four years, American factories have been disrupted by hurricanes in the Gulf of Mexico, droughts in Texas, tornadoes in Kentucky, erratic water levels across the Great Lakes, and flooding in the Northeast. The result? Cargo ships have carried less cargo to avoid running aground. Ports are preparing for more hurricanes (and rising sea levels). Highways, bridges, and rail lines are subject to more frequent delays.

Because manufacturers' supply chains are global, severe weather in foreign markets affects U.S. factories, as well. When storms in Asia flooded more than 1,000 factories across Thailand, parts shipments from that country temporarily ceased.^{xi} These factories produced 25 percent of the world's supply of hard disk drives. Production by consumer electronics manufacturers in the U.S. dropped by nearly one-third for the following two quarters, while hard disk drive component costs increased by 10 percent.

EXAMPLES OF SUPPLY CHAIN DISRUPTION

Coastal Operations. In August 2012, oil producers in the Gulf Coast prepared for Hurricane Isaac by evacuating 60 percent of their rigs and reducing produc-

tion by more than 90 percent. The affected rigs and plants produce about 20 percent of the domestic oil American companies use to manufacture a variety of products using petrochemicals, from fertilizers to detergents to plastics.^{xiii}

Shipping. American manufacturers rely on shipments of materials and parts shipped on the Missouri and Mississippi Rivers and across the Great Lakes. While snow-melt and recent rainfall have raised levels substantially, droughts in 2012 and 2013 caused those lakes and rivers to fall to near record lows. In recent years, shippers compensated for these low water levels by reducing the amount of cargo they carried (allowing their ships to float higher in the water, which reduced their draft). To gain a single inch of waterline, a large cargo ship must dump 270 tons of cargo. In 2013, Lakes Huron and Michigan were 23 inches below their normal levels. Ships crossing those lakes carried 6,000 fewer tons per trip than they carried in 1997 (from 71,000 tons to 65,000 tons). One ship, for example, left 18 percent of its iron ore cargo on the dock.^{xiv} Erratic water levels add uncertainty to freight shipping schedules and have economic repercussions across the region.

Highways and bridges. The bulk of parts produced in the U.S. are shipped by truck. Imported parts, which arrive by ship and typically move by train, are shipped by truck from rail line to the factory.

Because of the volume of parts and materials manufacturers ship, the costs of severe weather disruptions can be enormous. When a winter storm in 2010 closed Highway 402 near Port Huron, Michigan, officials diverted traffic south to the Ambassador Bridge, causing day-long delays for shippers. Factories in both Michigan and Ontario experienced parts shortages and shut down production lines.^{xv}

Severe storms during the winter of 2014 slowed or stopped production at factories across the country.

Ports. Manufacturers rely heavily on parts and materials imported through ports in Norfolk, Virginia;



To gain one inch of draft, large cargo ships have to leave 270 tons of cargo on the dock. That's the equivalent of 90 mid-size sedans.

Mobile, Alabama; and Los Angeles, California. By design, ports operate at sea level. In many cases, the roads, structures, and power stations that serve them are at or near sea level, as well. For this reason, the Mobile and Norfolk ports, which are critical to manufacturers nationwide, have been considered to be two of the country's most vulnerable to hurricanes and other severe weather. The Port of Los Angeles, which handles 31 percent of U.S. port container movements, and the Ports of South Louisiana, Galveston, and Houston, which handle 25 percent of the tonnage handled by U.S. ports, have also been identified as at risk.

In late October 2012, Superstorm Sandy generated a significant storm surge in New York City, flooding the Port of New York-New Jersey and the roads and rail lines that serve it. During the week the port was closed, shippers were forced to divert 25,000 shipping containers to other ports, causing week-long disruptions in American manufacturing supply chains. These shipments included parts and goods used by a wide range of industries, including aerospace, auto, food, and medical machinery manufacturers.^{xvi}

Rail. Severe heat and drought have compromised railroad lines across Texas, slowing the passage of parts and materials through the region. Rail shipments have also been disrupted by recent storms. After the storms of winter 2014, manufacturers reported several month-long shipment delays.^{xvii}

Droughts and Manufacturing. Historic droughts in California have hurt the state's semiconductor manufacturing industry. Large volumes of highly-purified water are needed to polish the silicon blanks used to make chips for computers, cell phones, and cars. Without enough water, the fabrication plants cannot operate at capacity, threatening manufacturers' ability to remain in the state.

BUSINESS TRENDS INCREASING SEVERE WEATHER RISKS

Four industry trends threaten to increase supply chain risk substantially

As supply chains grow and become global, they become less transparent. A manufacturer or supplier may not know where all of its parts are sourced. For example, in a study of the industrial impact of the 2010 Thailand floods and 2011 Japan tsunami, nearly half of the production disruptions affecting manufacturers were caused by lower-tier suppliers that the manufacturers did not know.^{xviii}

Small businesses, which dominate the lower levels of manufacturing supply chains, are less likely to survive catastrophic events. Tiers 2 and 3 of manufacturing supply chains are comprised largely of small businesses (typically, fewer than 250 employees per location).^{xix} Disasters have a disproportionate impact on small and medium-sized enterprises. According to the U.S. Department of Homeland Security, one-quarter of small and medium-sized enterprises do not re-open after a catastrophic event. Because they have smaller cash reserves, tend to operate out of a single location, and are less likely to have backup systems, they have a harder time relocating.

America's infrastructure is aging, while congestion is growing. A study by the Texas Transportation Institute found that peak traffic periods (rush hours) have expanded to six hours per day, while off-peak hours have grown more congested. Across America's 498 urban areas, only one in nine trips were disrupted by traffic congestion in 1982. By 2011, one in four trips were disrupted. During this same period, the number of delays for commuters more than doubled.

Disruptions cost more at plants operating near full capacity. Manufacturing is a highly capital-intensive business, so profits depend largely on how well a company manages the number of factories it builds and uses. If building a new plant costs \$1 billion, having that plant offline or underutilized can cost hundreds of millions of dollars each year. While a factory operating at 50 percent capacity can make up for a lost shift over time, a plant operating at full capacity loses that production entirely.

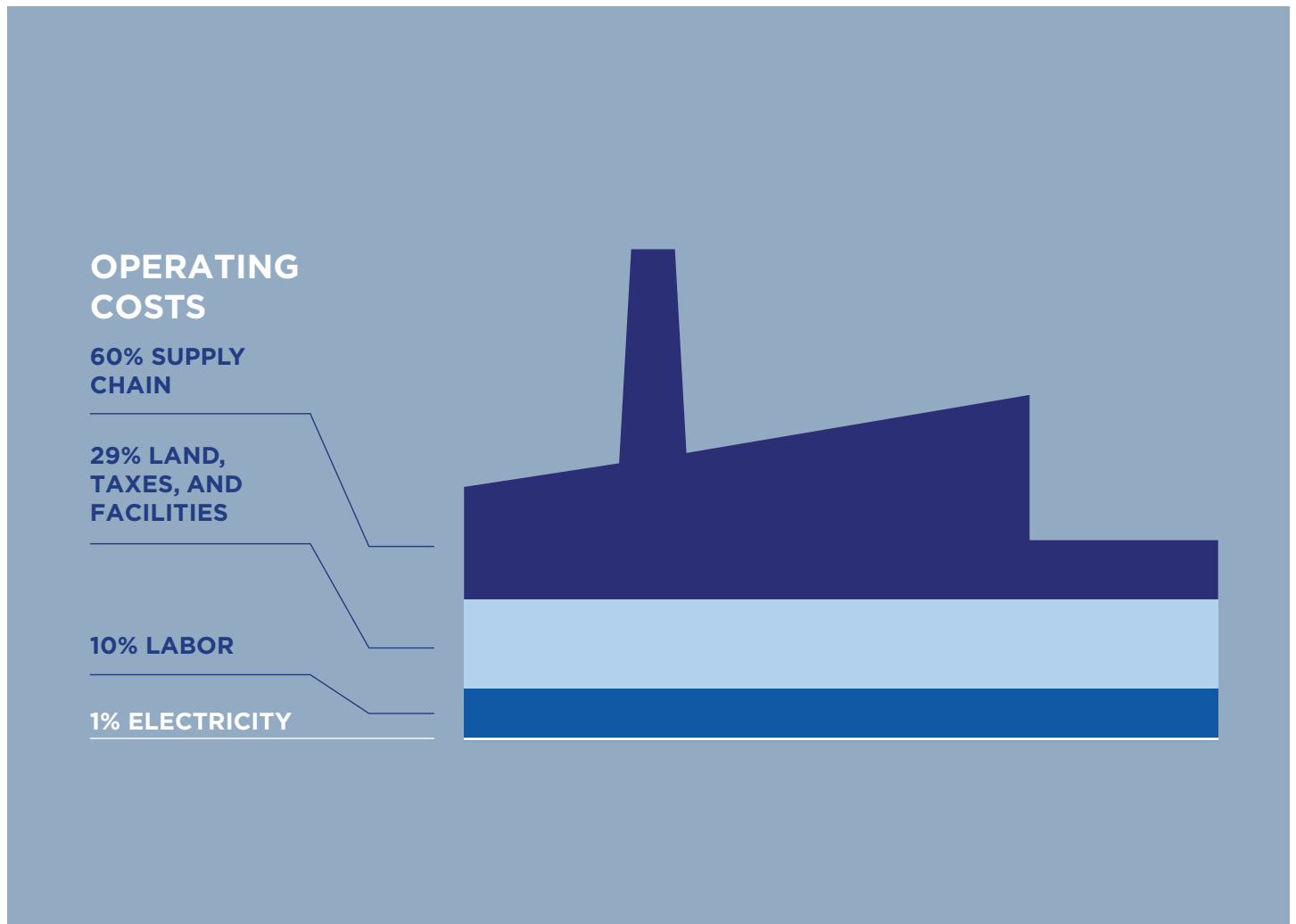
ELECTRICITY COSTS FOR MANUFACTURERS

ELECTRICITY USAGE, POTENTIAL IMPACT OF EPA STANDARDS

While manufacturers use a great deal of electricity, the cost of that electricity is a comparatively small portion of their total costs. For 60 percent of America's largest manufacturing sectors, electricity costs represent 1 percent or less of their total expenses. The average across all industries is 0.9 percent. Only

paper, non-metallic materials, and primary metals have electricity costs of 2 percent or more.

Therefore, if the proposed standards were to increase electricity rates by 3.2 percent in 2020, the average industry's total costs would rise 0.029 percent. In other words, if it costs a company \$100 to make one of its products, that cost would increase less than three cents.



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