**Climate impacts of sustainable growth strategies**

The various sustainable growth strategies considered have a wide range of climate impact per job added. At the low end, the business services strategy has a low impact of roughly 1 ton of CO2 per job per year, mostly from the energy use in office buildings. Cleantech jobs that center on software development will have a similar profile. Advanced manufacturing businesses that focus on producing fabricated or electronic components or products produce roughly 5-10 tons of CO2 per job per year. These higher emissions are due primarily to the electric power needed for equipment. Cleantech jobs such as solar panel assembly, battery assembly or power electronics manufacturing will have emissions in this range. Strategies such as Clean Supply Chains and some forms of Advanced Manufacturing have emissions in the 20-40 tons/job/year range. In both cases, these emissions are largely driven by fuel use - by transportation vehicles in the case of Clean Supply Chains, and by high temperature processes in the case of manufacturing plastics and rubber components, food and beverage products, and foundries.

Manufacturing of primary materials, such as iron or steel, cement, aluminum, and chemicals is associated with much higher emissions, 200 or more tons/job/year, in some cases much more. These emissions come from a combination of high fuel use required for very high temperature processes and emissions that are inherent to the material itself.

All growth strategies considered have pathways to reduce the emissions per job and eventually reach zero emissions in the future, but those pathways depend on the current source of emissions. Office-based jobs and manufacturing jobs that use electricity for power will decline in carbon intensity as renewable energy supplies a greater percentage of the electrical grid. Industries that use fuel for transportation or process heat will have to shift to electric heat sources and transportation, both of which are in early stages of expansion. Clean Supply Chains businesses have the potential to offset some emissions by using their large roof area to host solar generation resources as well. Finally, high emissions materials industries will require new technologies for decarbonization, such as hydrogen-based iron and steel production, carbon capture and sequestration, or other new approaches. In many cases, early examples of these technologies exist, but may currently be only at the pilot plant or demonstration level.

**Other environmental risks of sustainable growth strategies**

Advanced manufacturing, Clean Supply Chains and Cleantech businesses can pose additional risks of environmental harm, however these industries include a wide range of very different activities. As a group, they all have risks of air, water and solid waste pollution, but individual businesses may be safe in one or more of these areas due to good pollution prevention practices, the nature of their business or both.

In general, businesses have a variety of strategies available to reduce their environmental impact. The air pollution risks differ depending on the manufacturing type, but mitigation strategies broadly include identifying alternate materials, changing processes to capture and recycle pollutants instead of releasing them, and treating plant exhaust to burn or neutralize pollutants. Water pollution is similarly managed through a combination of material selection, process modification and onsite water treatment. Solid waste pollutants are managed through recycling where possible, as well as incineration for energy recovery.

Businesses within a manufacturing category have widely varying pollution profiles depending on their specific processes, mitigation strategies and level of corporate responsibility. Maintaining a low pollution risk for the community requires identifying good operators, mandating good practices and monitoring behavior. State and federal regulatory frameworks already support these efforts.

**Assessing Environmental Impacts of Development Strategies in Comparison to Existing Impacts**

Comparing the environmental impacts of the target development strategies to the existing environmental risk landscape in the region can be considered two ways. First, we examined the list of contaminated locations in the region to identify if these business types have a legacy of pollution in this area. Of the [114 superfund sites identified in the region](https://cumulis.epa.gov/supercpad/Cursites/srchsites.cfm), 33 are from spills resulting from one-time events, improperly stored materials or drug labs. A further analysis shows that illegal dumps or landfills that did not properly segregate and manage hazardous waste account for 17 sites. These are the two largest categories of contaminated sites. Additionally, chemical, ordnance, or pyrotechnic businesses have contaminated 15 locations. Another nine locations are classified as plating or coating businesses (which could potentially be considered “advanced manufacturing”), and two sites are metal manufacturing facilities. Development projects that include businesses of this type will need to ensure that current waste reduction, storage and disposal regulations are followed to reduce risks from this type of manufacturing activity. Of the remaining contaminated sites that can be classified, the military (7 sites) and mining and smelting (7 sites) are the two largest categories. Overall, these results suggest that manufacturing as a whole is not primarily responsible for legacy environmental issues in the region, however specific categories of manufacturing, particularly plating and coating, chemical manufacture and processing, and pyrotechnics manufacturing warrant particular attention to ensure compliance with environmental regulations. In addition, the prevalence of illegal dump sites indicates the need for enforcement of waste disposal regulations more broadly.

The second approach to contextualizing the environmental risks of these growth strategies is examining the [recent record of toxic material releases in the region](https://www.epa.gov/toxics-release-inventory-tri-program/tri-basic-data-files-calendar-years-1987-present). In 2022, of the top 20 emitters in the region, half could fall in the category of advanced manufacturing, in particular, they are manufacturers of plastic or rubber products, fabricated metals, or transportation equipment. However, looking at the 87 companies in those categories that reported toxic emissions, there is a broad range of performance within each category, with some facilities recycling a large fraction of their waste or treating it onsite rather than releasing toxic materials. Across those three categories, 63% of companies reduced their emissions by 95% or more through treatment and recycling, and 10% reported having no emissions at all. These data suggest that supporting sustainable growth in the region through the advanced manufacturing strategy need not result in environmental harm, provided that companies follow good practices - as required by existing federal and state regulations - to reduce and manage waste safely. (Investing in inspection and enforcement resources as well as support and guidance to help companies upgrade their practices may be helpful for minimizing the environmental impacts of growth.)